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Aircraft Particle Emissions eXperiment (APEX)

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Preface

The work reported herein was sponsored by National Aeronautics and Space Administration, (NASA), the Environmental Protection Agency (EPA), and the Department of Defense (DOD). Managed by Chowen Chou Wey, Army Research laboratory at NASA Glenn Research Center, the Aircraft Particle Emissions eXperiment (APEX) was conducted at NASA's Dryden Flight Research Center April 2004 to afford the scientific community an opportunity to systematically investigate the emissions of a commercial-class aircraft, NASA's DC-8, during ground-based operation. APEX included participants from more than ten institutions, each providing unique measurement capabilities for trace gas and/or particle species.

The primary objectives of the experiment were to: examine the impact of fuel sulfur and aromatic content on soot and secondary particle formation; follow the evolution of particle characteristics and chemical composition within the engine exhaust plume as it cooled and mixed with background air; evaluate new aircraft engine emission measurement and sampling techniques; and provide a data set for use in studies to model the impact of aircraft emissions on local air quality.

To achieve these objectives, extensive particle and trace-gas species measurements were performed on samples drawn from the exhaust of NASA's DC-8 aircraft, which is equipped with four General Electric CFM56-2-C1 engines, as the engines were operated at 11 different engine power settings, ranging from idle to maximum thrust, and burned three different fuels (base JP8 fuel, high sulfur fuel and high aromatic fuel). Including initial "shake-down" operations, data were collected over a total of 38 hrs of engine run time. To examine the evolution of particle concentrations and microphysical properties, samples were drawn from inlet probes positioned 1, 10, and 30 m downstream of the right inboard engine exhaust plane. At the 1 m sampling locations, multiple probe tips were used to exam the spatial variations of emissions properties across the exhaust plume. This test matrix provided engine gas and particle emission information for more than 400 testing conditions.

This project and its report are accumulations of excellent contributions from the individuals acknowledged below and other persons too numerous to list. Although participants worked as a team with contributions beyond individual responsibilities, primary functions associated with each were:

Project Management	Chowen Chou Wey	ARL at NASA GRC
Project Scientist	Chowen Chou Wey	ARL at NASA GRC
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	Denise Bryant	ATA/AEDC
ARI Particle composition and HC Team	Richard Miake-Lye	ARI
	Scott Herndon	ARI
	Paul Yelvington	ARI
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NASA Gas and Particle Team	Bruce Anderson	NASA LaRC
	Changlie Wey	QSS/NASA GRC
	Xu Li-Jones	UT/NASA GRC
	Edward Winstead	GATS/NASA LaRC
	Lee Thornhill	SAIC/NASA LaRC
	Charles Hudgins	NASA LaRC
NASA Test Facility Team	David Lux	NASA DFRC
	Bill Condzella	NASA DFRC
	Thomas Grindle	NASA DFRC
PM Particle Mass	Donald Holve	PM LLC
SWRI Fuel Analysis	Cliff Moses	SWRI

UCR Particle Composition Team	Wayne Miller	UCR
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UMR Particle Team	Philip Whitefield	UMR
	Donald Hagen	UMR
	Prem Lobo	UMR
WPAFB Particle Mass Team	Edwin Corporan	AFRL WPAFB
	Matthew J. DeWitt	UDRI
	Orvin Monroig	AFRL WPAFB

AEDC:	Arnold Engineering Development Center
AFRL:	Air Force Research Laboratory
ARI:	Aerodyne Research Inc.
ARL:	Army Research Laboratory
ATA:	Aerospace Testing Alliance (ATA)/AEDC
DFRC:	Dryden Flight Research Center
GEAE:	General Electric Aircraft Engine
GRC:	John H. Glenn Research Center at Lewis Field
LaRC:	Langley Research Center
MSU:	Montana State University
NASA:	National Aeronautics and Apace Administration
SAIC:	Science Applications International Corp.
UCR:	University of California, Riverside
UDRI:	University of Dayton Research Institute
UMR:	University of Missouri, Rolla
WPAFB:	Wright Patterson Air Force Base

Executive Summary

APEX was the first ground-based experiment to simultaneously examine the gas-phase and particle emissions from a modern commercial-class aircraft over the complete power range of its engines. As such, a great deal of new information was obtained. In terms of **non-volatile particles (NVP; presumably black carbon) emissions**, we found that:

- NVP exhibited a single mode, basically log-normal size distribution, with individual particles ranging from a few nm to ~ 300 nm in diameter
- Both the geometric mean diameter (GMD) and standard deviation of the NVP size distribution increased with power, ranging ~15 nm and ~1.5 at idle to ~40 nm and ~1.8, respectively, at maximum power condition
- For the three fuels tested, NVP size as well as number and mass emission indices (EIn, EIm) did not depend on fuel properties or downstream sampling distance (plume age)
- EIn*NVP* varied from ~0.16 to 3×10^{15} kg^{-1}, and were highest for minimum and high power conditions and a minimum at power levels corresponding to approach
- For low power settings, EIn*NVP* decreased over time, potentially as a function of engine operating temperature and/or increasing local ambient air temperature
- EIm*NVP* was nonlinearly dependent on engine power and was typically < 20 mg kg^{-1} over the 4 to 70 percent power range and >200 mg kg^{-1} at 85 to 100 percent thrust levels.

Samples collected further downstream of the engine exhaust plane often contained large numbers of particles that evaporated at temperatures below 300 °C. For these **volatile particle (VP) emissions,** we found that:

- Although readily apparent at the 30 m sampling location, VP were not observed at 1 m and were barely detectable in the 10 m samples
- VP containing samples typically exhibited a nucleation mode that peaked in the 3 to 10 nm size range
- At 30 m sampling location, EIn*VP* was highly dependent upon fuel sulfur content (FSC) and was substantially enhanced in the case where the engine burned sulfur-doped fuel
- In addition to sulfur, hydrocarbon (HC) species accounted for a significant fraction of VP mass at 30 m sampling location
- At the 30 m sampling location, EIn*VP* was typically much higher than EIn*NVP*, but depended on, in addition to fuel composition, engine power, sample age and dilution history, and ambient temperature
- In aged plumes, along with forming new particles, low volatility HC's and sulfur condensed onto the surface of NVP, increasing their diameter and, potentially, their water solubility
- In aged plumes and at low engine powers, EIm*VP* was roughly equivalent to EIm*NVP*
- EIn*VP* decreased with power, which may reflect a lower production of aerosol precursors at higher engine power settings or simply a shift in the equilibrium between.new particle formation and condensation onto existing particle surface.

For **total particle (TP) emissions**, we noted that:

- At high engine powers, particle mass emissions were dominated by black carbon at all sampling locations
- At lower engine powers, EIn*TP* was substantially greater at 30 m than at 1 m, indicating that significant gas to particle conversion occurred as the plume cooled and aged

- Average TP size monotonically increased with engine power
- At 30 m and for all fuel types, under low ambient temperature conditions, a nucleation mode was observed with a mean diameter at or below 10 nm
- At 30 m, EIn*NVP* increased while EIn*VP* decreased with engine power; the sum of these trends produced an overall decrease in EIn*TP* with increasing engine power
- At the 1 m sampling location and for any given power setting, EIn*TP* values were substantially different in samples drawn through standard gas inlet probes/heated lines than in samples provided by particle probes which provided 4 to 10-fold concentric dilution near the inlet tip.

From the extensive **gas phase species measurements performed during APEX**, we note that:

- EINO_X, EI*CO*, and EI*HC* agreed with the manufacturer's model predictions as well as with values archived in the ICAO data base
- The NO_2 fraction of NO_X varied from ~0.7 at idle to ~0.09 at maximum power
- Although substantial at idle, EI*HC* decreased by factors of 100+ and were almost negligible above 15 percent power
- EI*HC* depended strongly on engine combustion conditions, e.g., ambient temperature affects combustor inlet temperature and hence HC emissions
- When plotted as a function of fuel flow rate, the emissions indices for higher molecular weight hydrocarbons correlated with those of HCHO
- Slight differences in EI*HCHO* were observed between the various fuel types
- HC emissions from the engine were much higher after cold-starts and power transients

Contents

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1. Introduction

Over the past decade, the National Aeronautics and Space Administration (NASA) has sponsored a variety of studies to assess the environmental impact of aviation and to gather detailed aircraft emission data for use in guiding development of more efficient and less polluting turbine engine technology. An important recent such study was the Aircraft Particle Emissions Experiment (APEX) conducted at NASA Dryden Flight Research Center (DFRC), Edwards Air Force Base, California in April 2004. Particle and gas emissions from one of the NASA DC-8 aircraft's CFM-56-2C1 engines were measured as functions of engine power, fuel composition, plume age, and local ambient conditions. The specific objectives were: to examine the impact of fuel sulfur and aromatic content on soot and secondary particle formation; to follow the evolution of particle characteristics and chemical composition within the engine exhaust plume as it cooled and mixed with background air; to examine the spatial variation of particle properties across the exhaust plume; to evaluate new measurement and sampling techniques for characterizing aircraft particle and gas-phase emissions; and to provide a data set for use in studies to model the impact of aircraft emissions on local air quality.

APEX is a collaborative research effort, sponsored by NASA, the Environmental Protection Agency (EPA) and the Department of Defense (DOD). It brought together a diverse group of scientists (see table 1) to address its objectives, including researchers from three NASA centers, the USEPA, the Army, the Air Force, three universities, engine and airframe manufacturers, and two private research corporations.

TABLE 1.—RESEARCH TEAMS THAT PROVIDED EXPERTISE TO APEX

Organization	Principal Investigator (PI)	Measurements
AEDC	Robert Howard Robert.Howard@arnold.af.mil	NO_X, CO, CO_2, THC, speciated hydrocarbons and Smoke Number
ARI	Richard Miake-Lye rick@aerodyne.com	Reactive Nitrogen Species, Hydrocarbons, Volatile Particle Composition, Black Carbon
EPA	John Kinsey kinsey.john@epamail.epa.gov	Air Toxics, Particle Physical Properties and Composition
GE	Willard Dodds Willard.Dodds@ae.ge.com	Engine Parameters
MSU	Berk Knighton bknighton@montana.edu	Volatile Organic Compounds
NASA GRC	Changlie Wey changlie.wey@grc.nasa.gov	NO_X, NO, NO_2, N_2O, SO_2, O_2, CO, CO_2, HC, speciated hydrocarbons
NASA GRC	Chowen Wey chowen.c.wey@grc.nasa.gov	Project manager and scientist
NASA LaRC	Bruce Anderson bruce.e.anderson@nasa.gov	Particle Physical Properties, Black Carbon
Process Metrix	Don Holve dholve@processmetrix.com	Particle Mass
UCR	Wayne Miller wayne@mail.cert.ucr.edu	Particle Composition
UMR	Donald Hagen hagen@umr.edu	Particle Physical Properties
UMR	Philip Whitefield pwhite@umr.edu	Particle Physical Properties
WPAFB	Edwin Corporan edwin.coporan@wpafb.af.mil	Particle Mass

During APEX, the DC-8 particle and gas emissions were measured at 11 engine power settings for each of the three different fuels (base, high sulfur, and high aromatic fuels; app. B) in samples drawn from probes located 1, 10 and 30 m downstream from the engine exhaust plane. At the 1 m and 10 m sampling locations, multiple probe tips were used to examine the spatial variations of emissions properties across the exhaust plume. This testing matrix provided engine gas and particle emission information for more than 400 test conditions. Ambient conditions as well as engine temperatures, fuel flow rates, fan speeds, etc., were carefully documented for each of the test points examined during the experiment. APEX results represent the first and most extensive set of gas and particle emissions data from an in-service engine wherein multiple instruments were used to quantify important species of interest.

Data summarized in this report were recorded and archived by investigators from NASA, the University of Missouri-Rolla (UMR), Aerodyne Research Inc. (ARI), Arnold Engineering Development Center (AEDC), Montana State University (MSU), and Wright Patterson Air Force Base (WPAFB). Important parameters include particle size distributions, particle number and mass emission indices (EIn and EIm), volatile and non-volatile particle fractions, black carbon mass emission indices, emission indices for major combustion gases [carbon dioxide (CO_2), carbon monoxide (CO), nitrogen oxides (NOx), total hydrocarbons (THC)] and emission indices for trace combustion gases, including sulfur dioxide (SO_2), nitrous oxide (N_2O), nitrous acid (HONO), and a number of light hydrocarbons. Emission data collected during engine power transients are not included in the data base.

Results from measurements made by EPA will be published separately at a later date. The University of California, Riverside (UCR) and Process Metrix participated in APEX to evaluate new instruments and sampling techniques. Data collected by UCR have not been provided to the APEX team and will not be discussed. Findings by Process Metrix are included in appendix J, but are not discussed further in this report.

Data collected during this experiment are research oriented. Great caution is advised when applying the data to different engine and ambient conditions. At times, ambient conditions significantly affected measured emission quantities. As an example, crosswinds sometimes caused the plume to largely miss the 30 m probe. Thus when CO_2 was only marginally above the ambient level (e.g., data point 308 shown in the app. A, among others), the exhaust plume was very dilute, resulting in large uncertainties in calculated emission indices.

2. Test Description

2.1 Aircraft DC-8 and CFM-56 Engines

The NASA DC-8 (fig. 1) tested during APEX has a wing span of 43.4 m, is 45.9 m long, and is equipped with four in-service commercial General Electric CFM-56-2C1 engines. Manufactured by McDonnell Douglas, the aircraft is normally used as a NASA flying science laboratory.

The CFM56-2 is a high bypass turbine engine (fig. 2) certified at 98 KN (22,000 lb) thrust with dual rotor front-fan configuration, bypass ratio of 6.0, and engine pressure ratio of 23.5. It has a single stage fan with a pressure ratio at altitude climb of 1.61, three stages of low-pressure compression with a pressure ratio of 2.84 (including fan) and a 9 stage axial flow high pressure configuration with a pressure ratio of 11.43. The high-pressure turbine has a single axial air-cooled stage. The fan turbine drives both the fan and low-pressure compressor and has four axial-flow, uncooled stages. Table 2 lists the defined values of engine fan speed at each power levels.

Figure 1.—A McDonnell Douglas DC-8 aircraft powered with four CFM-56-2C1 engines.

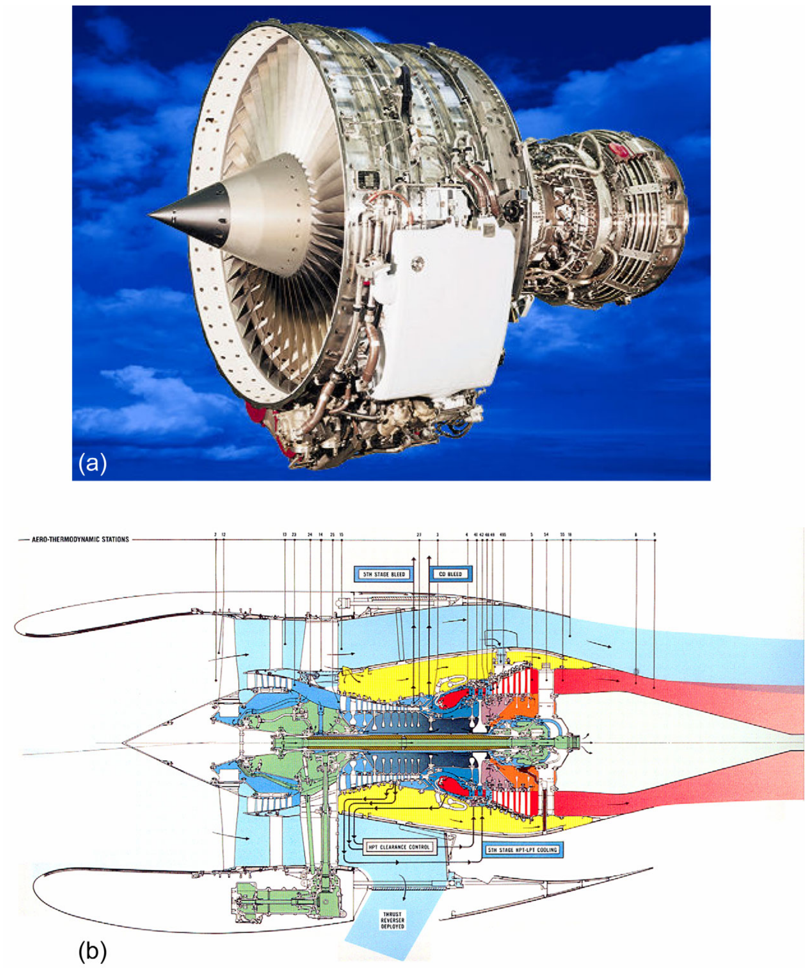

Figure 2.—CFM56 engine. (a) Photo. (b) Cross sectional diagram.

TABLE 2.—NOMINAL CFM-56-2-C1 ENGINE OPERATIONAL PARAMETERS

CFM56-2C1 Turbofan Engine	
Rated Thrust	97.86 kN
Bypass Ratio	6.0
Engine Pressure Ratio	23.5
Set Points	
% Thrust	**Fan Speed, N1**
Ground Idle	20.0
7	25.0
30	52.5
45	63.2
65	74.1
85	82.7
100	88.5

Besides the DC-8 commercial aircraft, the CFM-56-2 also powers a variety of military aircraft, including the KC-135R, C-135FR, E-3, KE-3 and E-6 tactical and strategic aircraft. F108 is the engine's US military designation.

2.2 Ambient Conditions and Engine Test Matrix

APEX was conducted at the NASA DFRC between April 20 and 29, 2004. The prevailing wind was from the southwest, but varied from all directions during the experiment period. Wind speeds ranged from 0.4 to 14.3 m/s. The ambient temperature and dew point ranged from 16 to 36 °C and from –10 to –2 °C, respectively during the whole experiment. The wide ranges of the ambient conditions impacted the engine operation and therefore the emissions data, hence caution is advised in interpreting variations in the measured data. The ambient submicron particle concentrations measured at the testing site were typically $< 5\ \mu g/m^3$.

Two different engine testing matrices were used for each fuel used. The "NASA" test matrix was designed to investigate the effects of engine operating parameters on particle emissions. It included 11 power settings: 4, 5.5, 7, 15, 30, 40, 60, 65, 70, 85, and 100% (restricted to about 93%, henceforth, 100%). Except for the 100% thrust level where run-time was limited to 1.5 min, approximately 10 min were spent at each power setting to allow adequate time for analyzing samples from each of the 3 downstream probes. The "EPA" test matrix followed the International Civil Aviation Organization (ICAO)-defined LTO (Landing-Take Off) cycle to simulate aircraft emissions at the airport, and consisted of approximately 4 repetitions of 26 min at idle (7%), 0.7 min at takeoff (100%), 2.2 min at climb (85%), and 4 min at approach (30%) power settings.

A portable weather station was erected a short distance from the test site and used to continuously monitor and record ambient wind, temperature, and pressure throughout the engine runs. The engine operating parameters including fan speed, core speed, exhaust temperature (near the end of nozzle), and fuel flow rate were read from the airplane cockpit panel and recorded manually. Engine parameter and ambient condition data for all test points are provided in appendix A, table A-1.

Ambient pressure was relatively constant at ~930 millibar (mb) during the test period and had a negligible effect on engine operation. However, ambient temperature fluctuations clearly affected emission levels. Several different fuel flow rates were observed at the same engine fan speed (fig. 3a), or at the same engine core speed (fig. 3b), or at the same exhaust temperature (fig. 3c) reflecting the fact that, as ambient conditions change, different fuel flow rates are required to achieve the same level of engine power. The effect of ambient temperature variations on engine operation can be incorporated into the engine operating parameters with a parameter, θ, defined as $\theta = T_{ambient,R}/518.67$. Figure 4 shows that each corrected engine operating parameter corresponds to a unique fuel flow rate. Variation of fuel flow rate at each given power setting is shown in figure 5. All measured gas emissions were hence plotted as functions of engine fuel flow rate, instead of percent engine power, to avoid the potentially misleading perspective that large fluctuations in gas emissions occur at the same engine power setting.

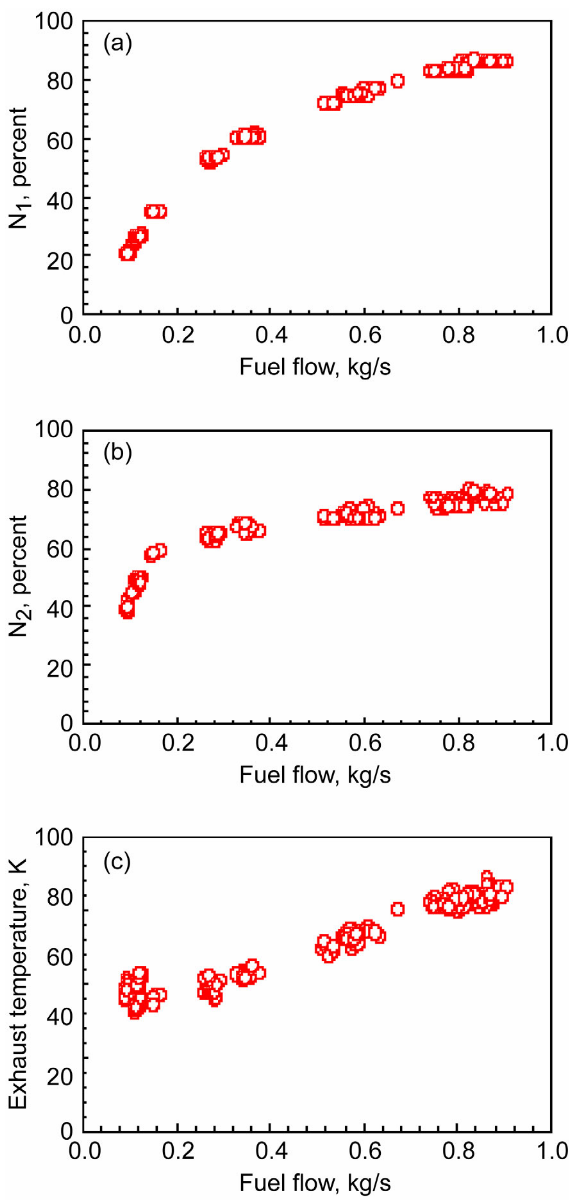

Figure 3.—Engine operating conditions. (a) Engine fan speed. (b) Engine core speed. (c) Engine exhaust temperature.

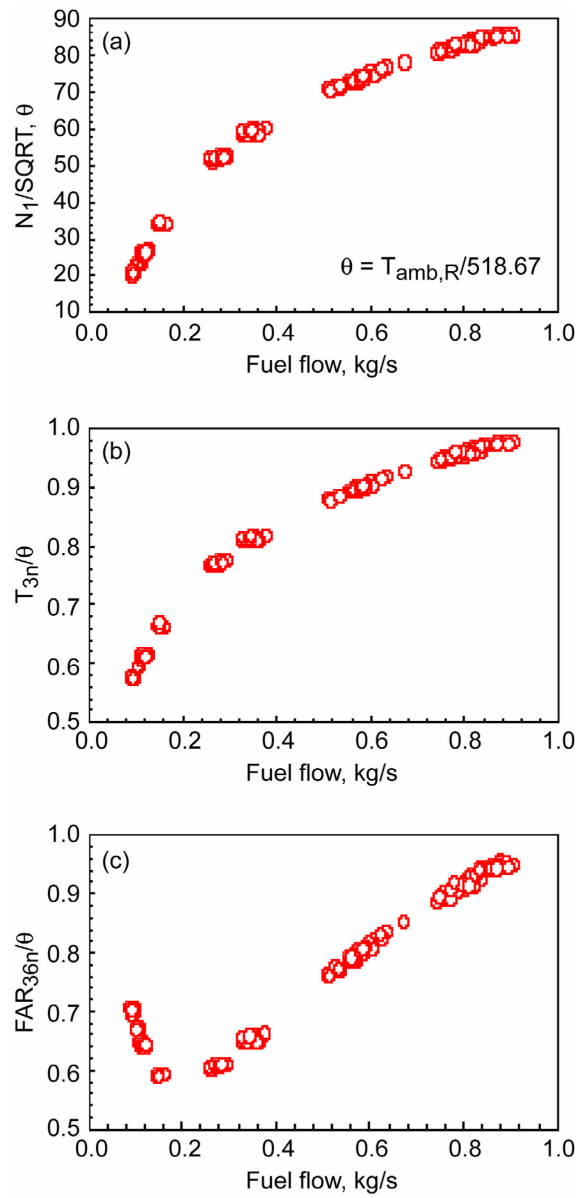

Figure 4.—Corrected engine operating parameters as a function of fuel flow rate. (a) Fan speed. (b) Normalized combustor inlet temperature. (c) Normalized fuel air ratio.

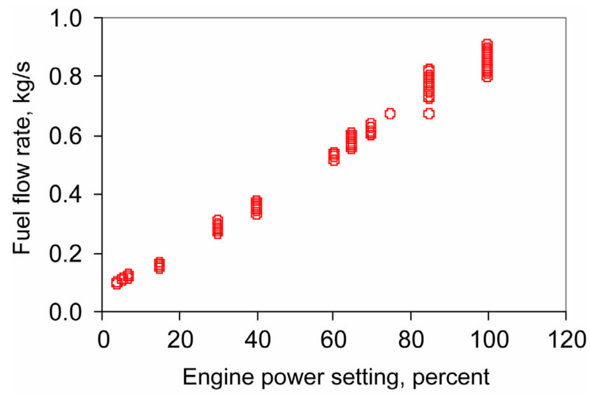

Figure 5.—Engine fuel flow rate at different engine power setting

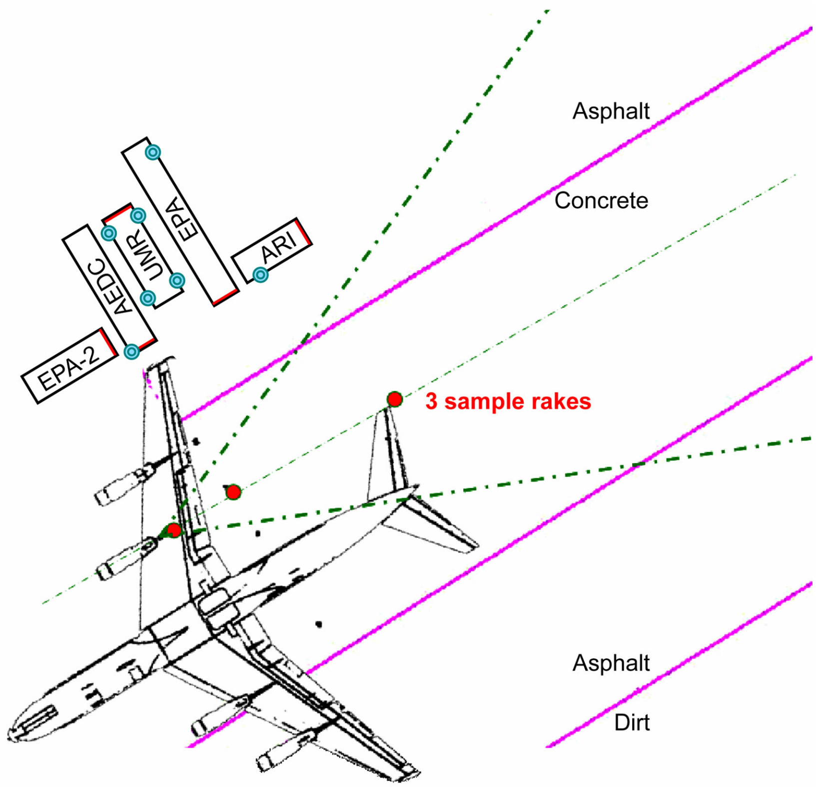

Figure 6.—Test field layout showing the positions of the aircraft, instrument trailers and sampling probes (red dots). The NASA particle measurement system and the central sample distribution manifold are located in the EPA trailer. NASA gas measurement systems are located in the AEDC trailer.

2.3 Measurement Setup

2.3.1 Experimental Layout

The source aircraft, a four-engine, McDonnell Douglas DC-8 was chocked on a concrete testing pad on the ground at NASA DFRC. Figure 6 is a sketch diagram of the experimental layout. Gas and particle sampling probes were set at 1, 10, and 30 m downstream from the exhaust plane of the aircraft’s right, inboard engine. Instrument trailers were parked on the right wing side of the aircraft at about 25 m away from the test engine.

2.3.2 Sampling Probes

Multi-port particle and gas sample rakes were designed, built, and successfully deployed to map the spatial variations of emissions properties across the exhaust plume at the 1 and 10 m probe locations. As shown in figure 7 (a) and (b), these rakes held six traditional gas inlet ("G") probes and six particle inlet ("P") probes which allowed introduction of dilution air just downstream of the probe tip (fig. 8). To provide adequate flow for filter and whole-air samplers, six additional, large-diameter gas inlet ("GG") probes were attached to either side of the 1 m rake, aligned horizontally with the six, centerline-mounted gas probes. The particle and gas probes were mounted in an alternating pattern at 32 millimeter (mm) spacings and numbered from the top to bottom in the rake. The 1-m sample rake was minimally cooled with low pressure water. At the 30 m location, there was a single probe (fig. 9), which sampled the mixed exhaust plume without further dilution.

The center of the 1 m rake was aligned approximately 77 mm to the side of the engine vent tube. Temperature probes (type-K thermocouples) and total and static pressure probes mounted on the rake were used to map the core-flow position.

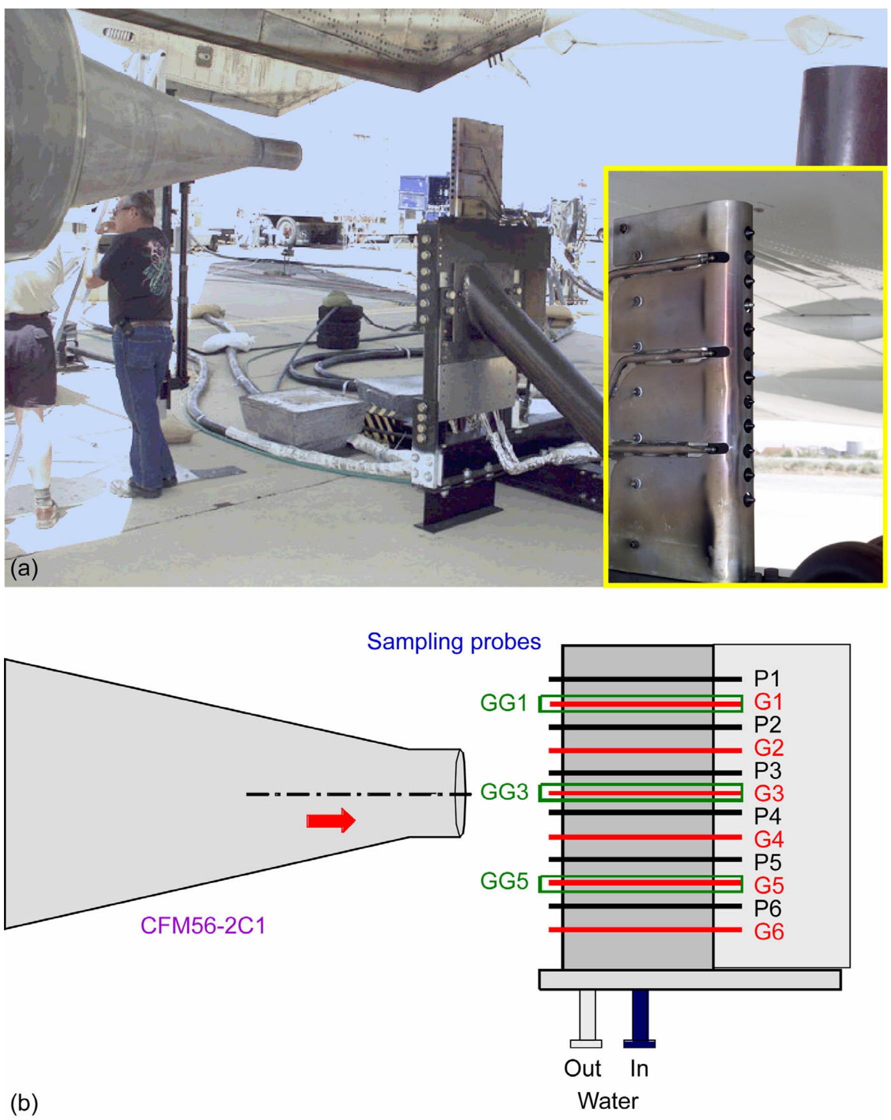

Figure 7.—1m sample rake with 6 gas (G1 – G6), 6 particle (P1 – P6), and 6 external (GG1 – GG6) sample probes. (a) Photos. (b) Schematic.

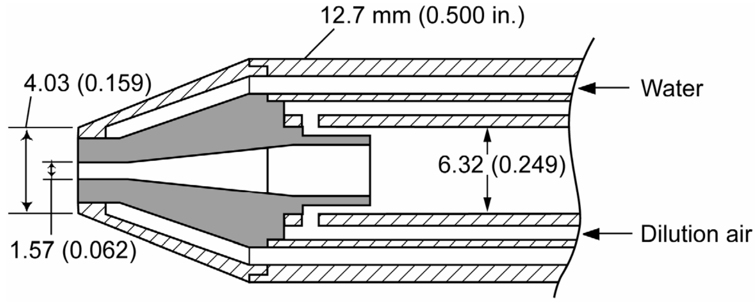

Figure 8.—Particle probe tip cross section, with dilution gas introduced on the probe tip.

Figure 9.—Single sampling probe mounted on a tripod stand at 30 m.

2.3.3 Sample transfer and particle sample dilution

Figure 10 shows a diagram of the particle sampling system and provides information on the transport tubing used to connect the rakes/probes with the NASA central sample distribution manifold that was located in the rear of the EPA trailer. The six particle sampling tips on the 1 and 10 m rakes were connected to six-port valve boxes which, in turn, were controlled remotely by a computer. The operating software allowed the operator to open and close any combination of valves simultaneously (fig. 11). Flow from the individual valves were merged using six-port converging manifolds that had very shallow input angles to prevent particle loss due to inertial impaction.

Sample air was transported from the 1 and 10 m converging manifolds via 12.7 mm internal-diameter (i.d.), thick-walled unheated stainless steel tubing (24 and 21 m, respectively) to ball valves plumbed to the input side of the central particle sample distribution manifold (henceforth, sample distribution manifold). The sample distribution manifold was constructed from a 50 mm i.d. thick-walled aluminum cylinder into which holes were bored on either end to allow insertion of sample flow and extraction tubes (fig. 12). The cylinder had a 16 mm i.d. and plates with underlying gaskets covering each end. Four 12.7 mm i.d. stainless tubes were inserted at shallow angles into the input side of the sample distribution manifold whereas five 9.5 mm i.d. tubes emanated from the downstream side. The tubes were held in place with set-screws and sealed with epoxy glue. Conductive tubing was used to connect the sample selection valves to the manifold. Ball valves, 9.5 mm i.d., were attached to the extraction tubes and used to cut off flow to the various participating groups when they were not actively drawing sample air. From there, sample air was distributed through 7.4 mm i.d. stainless tubing to instruments suites located within the EPA, Aerodyne, and UMR trailers.

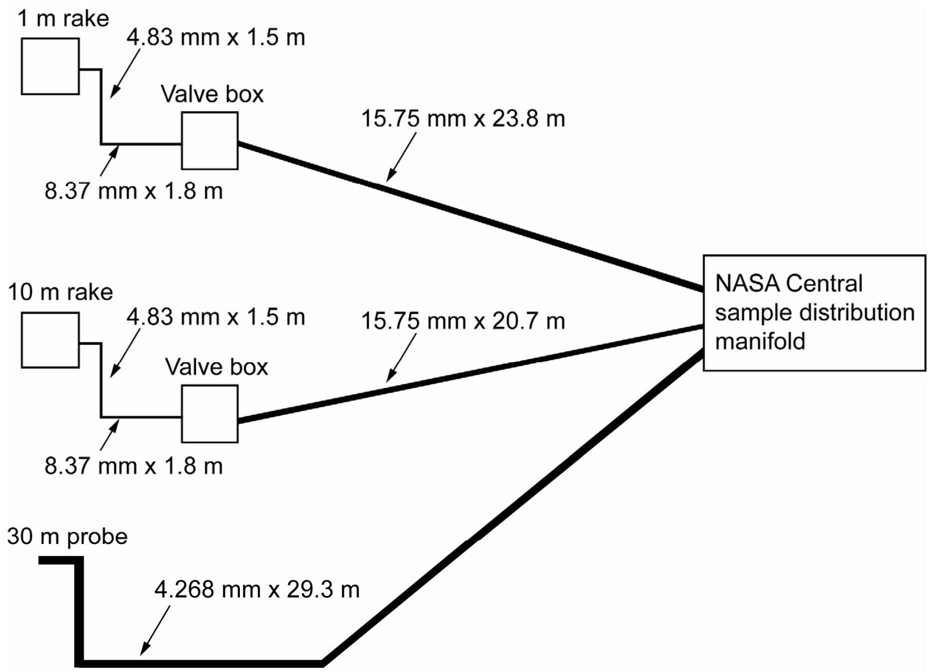

Figure 10.—Single sampling probe mounted on a tripod stand at 30 m.

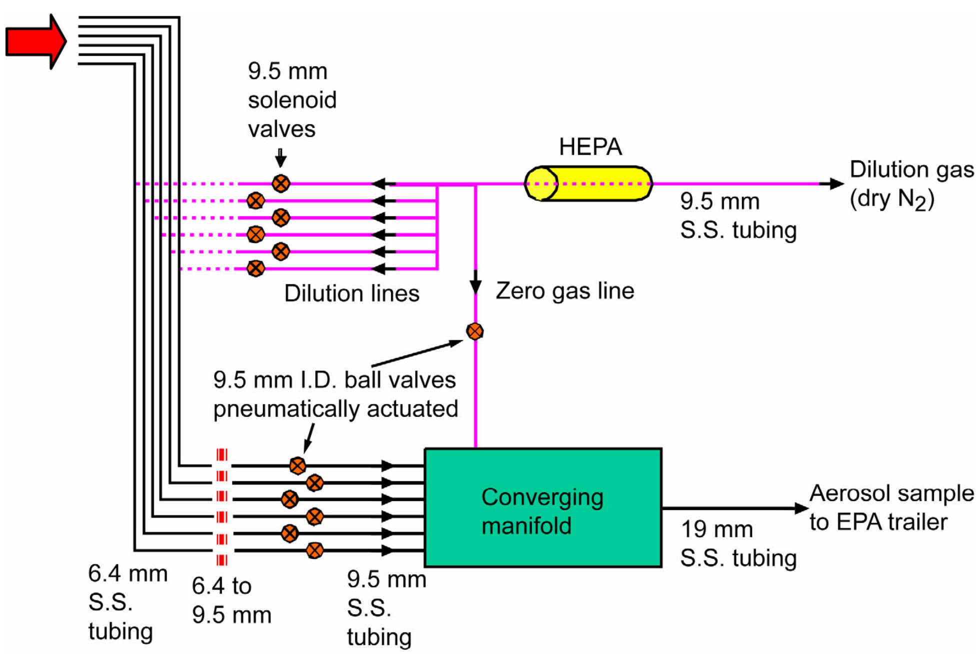

Figure 11.—Diagram of the 1 m and 10 m particle sample probe systems. The remotely controlled valves were mounted within enclosures placed at the bases of the sampling rakes and connected to the particle probes with 6.4 mm I.D. (dilution lines) and 9.5 mm I.D. (sample lines) stainless steel tubing. The converging manifold was connected to the downstream sides

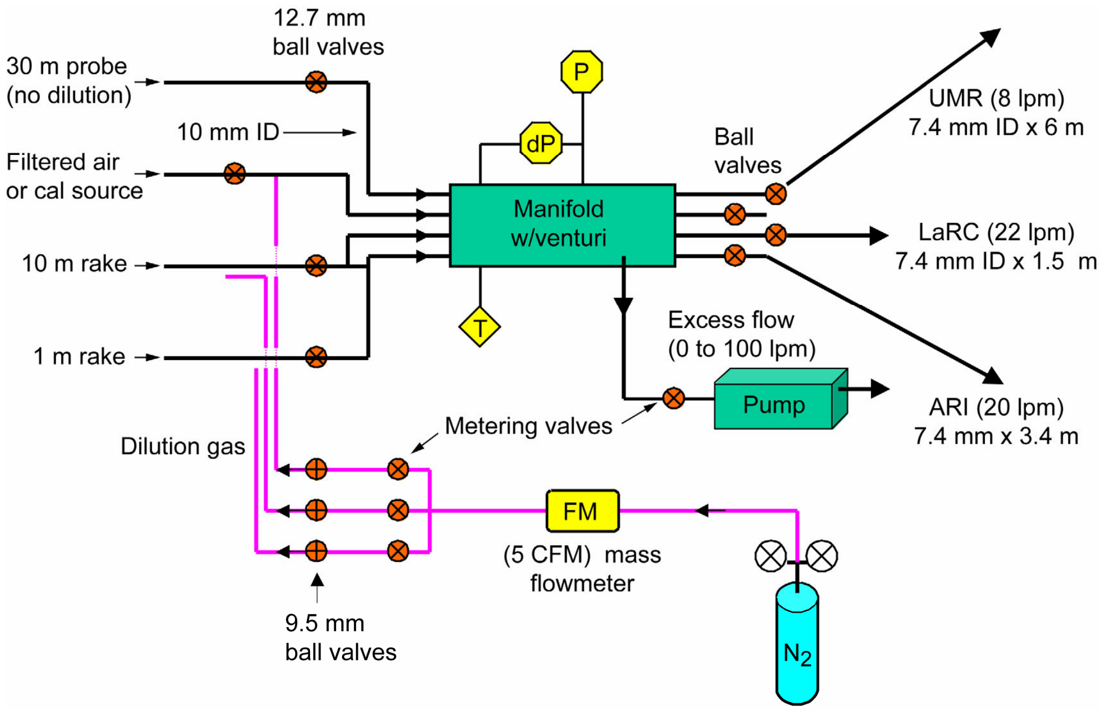

Figure 12.—Diagram of the sample selection and distribution system that was located in the EPA trailer.

For the 30 m location, the sample transport line was a 29 m length of polished stainless-steel sanitary tube (48 mm i.d.). Air was continuously drawn though the probe using a blower mounted within the EPA trailer. A cyclone was plumbed into the line to remove particles larger than 2.5 μm in diameter from the sample flow. Particle samples were extracted from the center of the 48 mm tube through a 7.4 mm i.d. stainless tube that was bent 90° to face into the incoming flow. From there, sample air was transported through ~3 m of 7.4 mm i.d. tubing to a ball valve on the input side of the sample distribution manifold. Sample residence time within the particle sampling system was < 6 s. Table 3 provides flow parameters and residences times for each of the sample rakes/probes.

TABLE 3.—SAMPLE RESIDENCE TIME WITHIN THE PARTICLE SAMPLING SYSTEM

Sampling System Element	Flow Parameters			1m Probe	10 m Probe	30 m Probe
	vol rate (lpm)	velocity (m/s)	Reynolds Number	res time (s)	res time (s)	res time (s)
0.25" tube	50	42	35,000	0.04	0.04	
0.375" tube	50	19	24,000	0.09	0.09	0.16
0.5" tube	50	9.8	17,000	0.22	0.22	0.05
0.75" tube	50	4.1	11,000	5.80	5.05	
1.8" tube	1152	11.7	34,000			2.50
	Totals residence time ->			6.2	5.4	2.7

At the 1 m location, particle samples were diluted at each particle probe tip with a concentric flow of dry nitrogen (N_2) to obtain dilution-ratios ranging from 3 to 180, but mostly values between 8 and 13. Dilution gas flow rate was controlled using manual metering valves and typically adjusted to achieve predetermined dilution ratios. Flow rates were monitored and recorded using analog-output, mass flow meters. The relative humidity of the diluted samples was less than 10% in most cases. The dilution at the probe tip served to: (1) lower the relative humidity of the exhaust sample to avoid water condensation in the transfer line; (2) reduce particle precursor concentrations to prevent formation of new particles and deposition of volatile species onto the surface of soot particles; (3) lower the particle concentrations to reduce coagulation and diffusion losses to the wall of the transfer line; and (4) lower the particle concentrations to levels compatible with the measurement instrumentation.

Particle samples collected at 10 m used the same type of probes and sample transport tubing, but after initial measurements early in the APEX mission, samples were typically not diluted. The 30 m location probe was a single probe with a 35.1 mm probe tip smoothly expanded to 51 mm i.d. tube that sampled the exhaust plume gases without introducing any dilution because exhaust plume were already diluted significantly with ambient air. Samples to all particle instruments were distributed through the sample distribution manifold, except for the tapered element oscillating microbalances (TEOM) that received sample from a dedicated gas sampling line with no dilution. Particle data presented in this report have been corrected for dilution by dry N_2.

Gas samples (undiluted) were transferred through about 30 m of heated (177 °C) sampling line (12.7 mm i.d.) to individual instruments (fig. 13). Residence time within the gas sampling systems was less than 10 s, which is within the SAE Aerospace Recommended Practice (ARP 1256B) limits.

Except for the maximum power condition, gas samples were taken by rotating through all gas probes at the 1m and 10 m locations. Particle samples were taken from different dilution probe tips on the 1m and 10 m rakes during the initial testing to determine the positions that were most deeply embedded in the core exhaust flow. Based on these tests, samples were drawn from a single position on the 1m rake (typically P3) and from ganging all six probe tips at 10m during most succeeding tests.

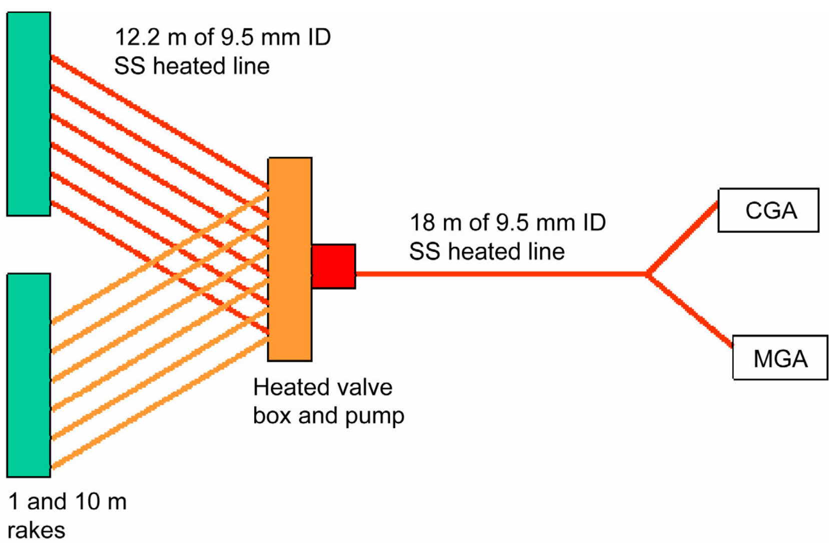

Figure 13.—Schematic of gas sample system.

2.3.4 Particle Line Loss Correction

As described in the section above, samples were drawn through fairly long lengths of transport tubing before being introduced into the analytical instruments. Because flow through these lines was turbulent and sample residence times were 3 s or more (table 3), substantial transport losses of nucleation and accumulation mode exhaust particles due to diffusion and inertial impaction were anticipated. In post-test experiments performed by UMR to establish line-loss correction factors (see app. I), the transmission efficiency of the 1 and 10 m sampling lines were evaluated with NaCl particles and freshly generated diesel soot particles. The penetration of particles through the common particle sampling line (CPSL) from the probes to the sample distribution manifold ranged from about 20% for 10 nm particles to about 70% for particles larger than 30 nm (fig. 14). The penetration of particles from the probes to the UMR particle instruments was about 30% lower than that for the CPSL for 10 nm particles, but at similar level for larger particles.

Except where indicated, the data presented in appendix A are corrected by a common line loss factor for the section from the probe to the sample distribution manifold using the fitted particle penetration function shown in figure 15. The UMR and NASA data were also corrected for the line loss from the sample distribution manifold to their particle instrument. The line loss from the sample distribution manifold to the ARI instruments was determined to be fairly low for small particle sizes. The ARI data were not corrected for the line loss between the sample distribution manifold to the particle instruments. Data acquired with instruments that provided scalar measurements of total mass, absorption coefficient, etc., were corrected for line losses using the power-specific correction ratios shown in figure 16. These values represent the ratio of the corrected to uncorrected, integrated volume size distributions. Similar ratios were derived for total number densities (corrected/uncorrected, integrated number distributions) and surface areas (corrected/uncorrected, integrated surface area distributions).

TEOM measurements were made on undiluted samples drawn from a dedicated 1 m gas sampling line/probe. The resulting data have not been corrected for line-loss effects; the likely impact of this sampling strategy upon measured particle properties are discussed in section 4.5.

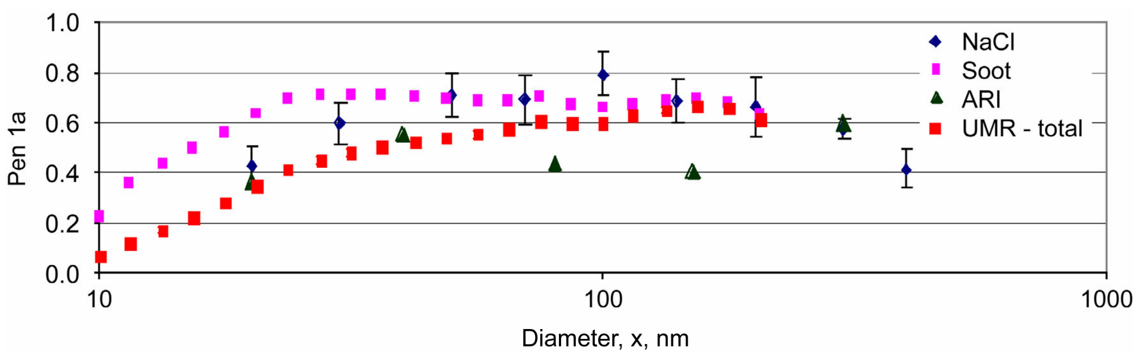

Figure 14.—Particle penetration through the 1 m particle sampling system: blue diamonds for NaCl calibrations (probe tip to the sample distribution manifold), pink squares for diesel calibrations (probe tip to the sample distribution manifold), red squares for diesel calibration (probe tip to UMR DMS), and green triangles for NaCl Calibrations (probe tip to ARI).

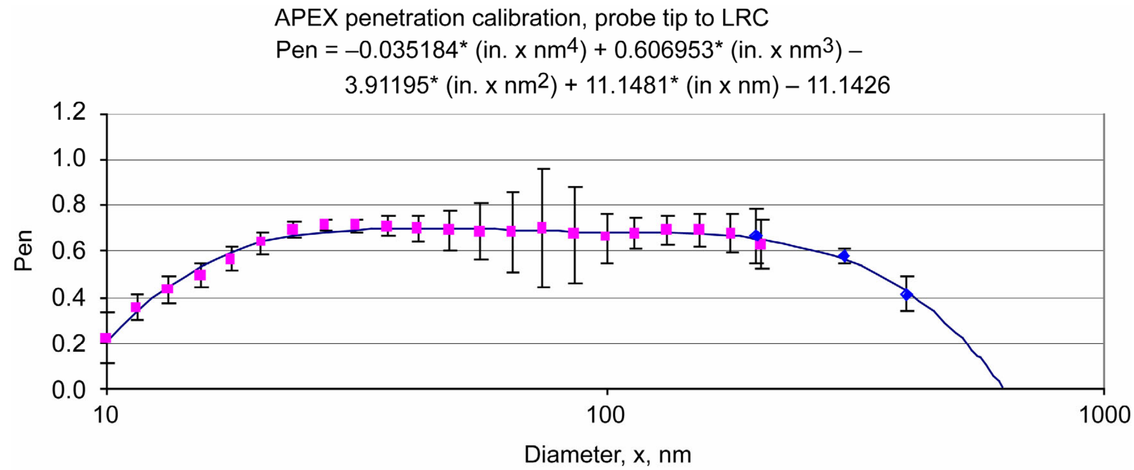

Figure 15.—Fitted particle penetration curve as a function of particle size.

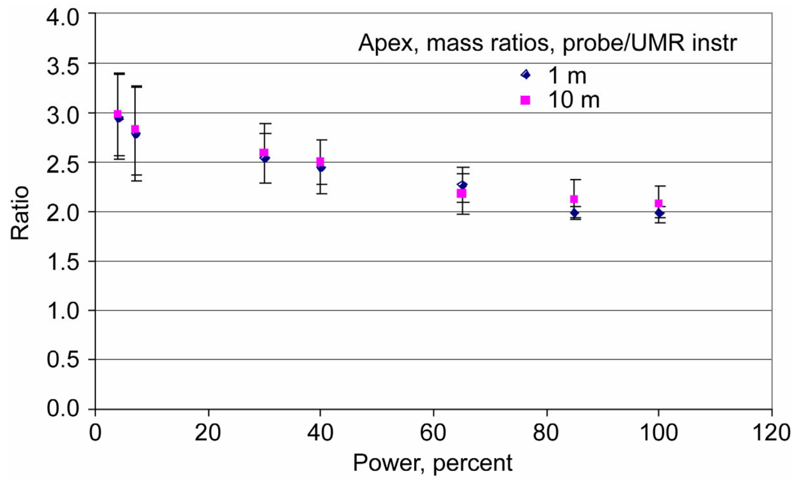

Figure 16.—Ratio of particle mass at the probe tip at 1 m and 10 m.

2.3.5 Instruments

A large array of state-of-the-art instruments was deployed to characterize gas and particle emissions from the CFM56-2C1 engine. Table 1 lists the individual groups that contributed measurement expertise; detailed descriptions of their instrument suites and sampling approaches are included within the attached appendices. The paragraphs below briefly describe key instruments deployed by each of the 10 participating experiment groups.

AEDC with assistance of Advanced Fuel Research used three MKS Model 2030, Fourier-transform infrared spectrometer-type, multi-gas analyzers (MGA) to measure a variety of species including CO_2, CO, water vapor (H_2O), nitrogen monoxide (NO), nitrogen dioxide (NO_2), SO_2, and the lighter hydrocarbons (app. D). This group also provided a standard Smoke Meter and followed Society of Automotive Engineers (SAE) Aerospace Recommended Practices (ARP) 1179 as closely as possible to determine smoke number (SN) values (app. D). In addition, AEDC also used APEX as an opportunity to test a newly-developed, open-path laser-induced incandescence (LII) particle analyzer; a verbal evaluation of this instrument's performance and utility is available from the AEDC PI, Robert Howard (table 1).

ARI in conjunction with MSU, deployed several, fundamentally different instruments to characterize trace gas and aerosol species within the diluted "aerosol" samples. Tunable infrared diode-laser absorption spectrometers (TILDAS) were used to record ethylene (C_2H_4), NO_2, nitrous acid (HONO), and formaldehyde (CH_2O) concentrations at 1 Hz frequency (app. E; app. F). The MSU Protron Transfer-Reaction Mass Spectrometer (PTR-MS) was integrated into the ARI sampling system to measure a variety of volatile organic species including methanol (CH_3OH), acetaldehyde (CH_3CHO), acetic acid (CH_3OH), benzene (C_6H_6), toluene (C_7H_8), phenol (C_6H_5OH) and naphthalene (C_{10} H_8) (app. G). An Aerosol Mass Spectrometer (AMS; app. J) was used to determine aerosol non-refractory chemical compositions and chemically-speciated size distributions. This instrument is sensitive to particles in the 0.03 to 1 μm size range and provides quantitative assays of sulfate, nitrate, ammonium, and organic aerosol fractions. A Multi-Angle Aerosol Photometer (MAAP) was used to measure aerosol absorption coefficients, which were subsequently converted to particle mass using empirical correction factors (app. J). Total particle concentrations were determined with an extended-range condensation particle counter (CPC).

The EPA brought their mobile, on-road diesel test laboratory, which housed duplicate instrument benches to monitor both background and plume concentrations/characteristics of air toxics and particles. The primary instrument suites included ultrafine CPCs for total particle concentrations; scanning particle mobility spectrometers (SMPS) for determining particle size in the 0.003 to 0.5 μm diameter range; a tapered element oscillating microbalance (TEOM) for total mass; an aethelometer for wavelength-dependent particle absorption coefficients; and an electrical low-pressure impactor (ELPI) for particle number densities and inertial mass. This group also collected filter, sorbent, and canister samples for off-line analysis by various techniques for total aerosol mass, elemental and organic carbon aerosol mass, soluble ion mass, elemental composition, air toxic concentrations, and volatile organic compound concentrations. The EPA focused their efforts upon characterizing samples collected from the 30 m probe and a 1 m gas-type probe/dilution stack sampler. In order to collect sufficient sample for subsequent gravimetric and wet-chemical analyses, they typically integrated their filter and canister samples over the entire engine run, from start-up to power-down.

NASA was responsible for measuring “certification” gas concentrations, so they provided a standard package of conventional gas analyzers (CGA) to determine CO_2, CO, Total Hydrocarbons (THC), and NOx (app. C). Standard procedures defined by SAE ARP 1256B were followed as closely as possible for these measurements to facilitate comparisons with data residing in the ICAO archive and to the engine manufacturer model predictions that were based on local ambient conditions. An MGA similar to those used by AEDC was also deployed to record speciated hydrocarbons, NO, NO_2, N_2O and SO_2. NASA gas emissions measurement systems were housed in the AEDC trailer.

The NASA particle emissions measurement system was housed in the EPA trailer and focused on establishing particle microphysical properties and examining the evolution of these properties with plume age. Described in appendix H, their instrument suite included CPCs with heated and unheated inlets to determine nonvolatile and total particle concentrations; SMPS instruments with heated and unheated inlets to measure nonvolatile and total aerosol size distributions in the 7 to 300 nanometer (nm) size range; an optical particle counter to determine particle size and concentration in the 0.1 to 3 μm size range; and a particle-soot absorption photometer (PSAP) or aethelometer to record aerosol absorption coefficients.

As described in appendix K, Process Metrix brought an experimental multi-angle optical scattering instrument to APEX to determine particle mass. Housed in the AEDC trailer, this instrument was primarily deployed for test and evaluation purposes. Thus, its data are not included within the appendix A listings or within the subsequent discussions of this report.

UCR was also a “piggyback” participant, and used APEX as an opportunity to test and evaluate various methods of collecting aerosol filter samples for off-line analysis for soluble ion and elemental species, low volatility air toxics, and total elemental/organic carbon. Filter samples were successfully collected over the course of several engine runs. Limited results were presented at the APEX data workshop in Cleveland Ohio (November, 2004). However, because of their experimental nature, these data are not provided to be included within appendix A or the discussions within this report. Further details of the UCR experiment can be obtained from the UCR PI, Wayne Miller (table 1).

As described in appendix I, the UMR group focused on determining the physical and hydration properties of the engine's particle emissions. Their instrument suite included a new Cambustion Differential Mobility Spectrometer (DMS-500) which measures complete particle size distributions over the 0.01 to 1 μm size range at 0.1 Hz frequency; a standard SMPS that also records aerosol size spectra, but at a much lower frequency; a CPC to measure total particle concentrations; and a deliquescence instrument to determine soluble aerosol mass fraction. This group also deployed a portable weather station to continuously record ambient P, T, RH and winds.

WPAFB used APEX as an opportunity to test the efficacy of their TEOM in recording the aerosol mass emissions from an in-use commercial aircraft engine. Sampling from an undiluted gas-sample inlet, the instrument's precision proved to be highly susceptible to changes in sample pressure and concentration. Selected data are included within appendix A.

2.3.6 Test Point Number Designation

The test point number is a combination of the last digit in the date between April 20 and 29 and a sequence number of the test point for that day. For example, the test point number 305 represents the fifth test point recorded on April 23. Under each engine condition, multiple gas and particle measurements were performed. Please note that the test point number defines the sequential engine condition. Gas measurements were not assigned additional point numbers for each data point at the same engine condition while particle measurements were assigned sequential numbers as the different probes were selected at a given engine conditions.

2.4 Fuel Analysis

Three different fuels were employed during APEX to examine the impact of fuel sulfur and aromatic content upon primary and secondary particle emissions: "Base" which was standard JP-8 supplied by the Edwards AFB fuel dump; "High Sulfur" which was produced by mixing a large aliquot of tertiary butyl disulfide into a tanker truck containing base fuel; and "high aromatic" which was obtained from a nearby California-based refinery. Multiple samples of these fuels were collected from the aircraft fuel pumps and subsequently analyzed by SWRI for such properties as density, viscosity, smoke point, aromatic and sulfur content, naphthalenes, hydrogen content, etc. Results of these analyses along with an informative discussion of fuel properties and specifications are presented in appendix B. Briefly, the tests revealed that the base fuel contained 383 parts-per-million by mass (ppmm) sulfur and 17.6% (by volume) aromatic compounds, the high aromatic fuel contained 530 ppmm sulfur along with 21.6% aromatic species and high sulfur contained 1595 ppmmS and 17.6% aromatics (see table 4). Other fuel properties can influence engine emissions, however, with the possible exception of naphthalene content, the base and high aromatic fuels were virtually identical in all other tested parameters.

TABLE 4.—FUEL PROPERTIES FOR THE THREE TYPES OF FUEL USED

Specification tests	Unit	ASTM method	Limit	Base fuel	High-S fuel	High-A fuel
Density @ 15 °C	kg/m^3	D4502	775 to 840	819.9	819.4	811.4
Viscosity @ –20 °C	m^2/s	D445	8.0 max	4.86×10^{-6}	4.86×10^{-6}	4.88×10^{-6}
Smoke point	mm	D1322	18 max	19.9	19.5	20
Heat of combustion	MJ/kg	D4809	42.8 min	43.22	43.33	43.27
Sulfur, wt	ppm	D5453	3000 max	383	1595	530
Aromatics, vol	%	D1840	25 max	17.6	17.3	21.8
Naphthalenes, vol	%	D1319	3.0 max	0.93	1.31	1.34
Non-specification tests						
Hydrogen content, wt	%	D3701	–	13.69	13.67	13.7
Surface tension @ 10 °C	N/m	D1331	–	0.02766	0.02766	0.02772
@ 40 °C	N/m			0.02538	0.02538	0.02542

3. Gas Emissions Results

3.1 Fuel to Air Ratio

The fuel flow rate required to achieve a specific percentage of maximum engine thrust is highly dependent upon ambient conditions. For example, the 22 °C variation in ambient temperature observed during APEX produced significant changes in N1, the engine fan speed (fig. 17) which, in turn, led to highly variable Fuel-to-Air Ratios (FAR) for any given level of thrust (fig. 18). The changes in fuel flow and FAR at low power settings significantly affected both particle and gas-phase emissions. To reduce the apparent variability in the data, we have chosen to plot emission parameters as functions of fuel flow rate rather than percentage of maximum thrust. Based on engine cycle calculations, measured sample fuel-air-ratios at each point was within 10% of the expected core flow value throughout the experiment (fig. 18).

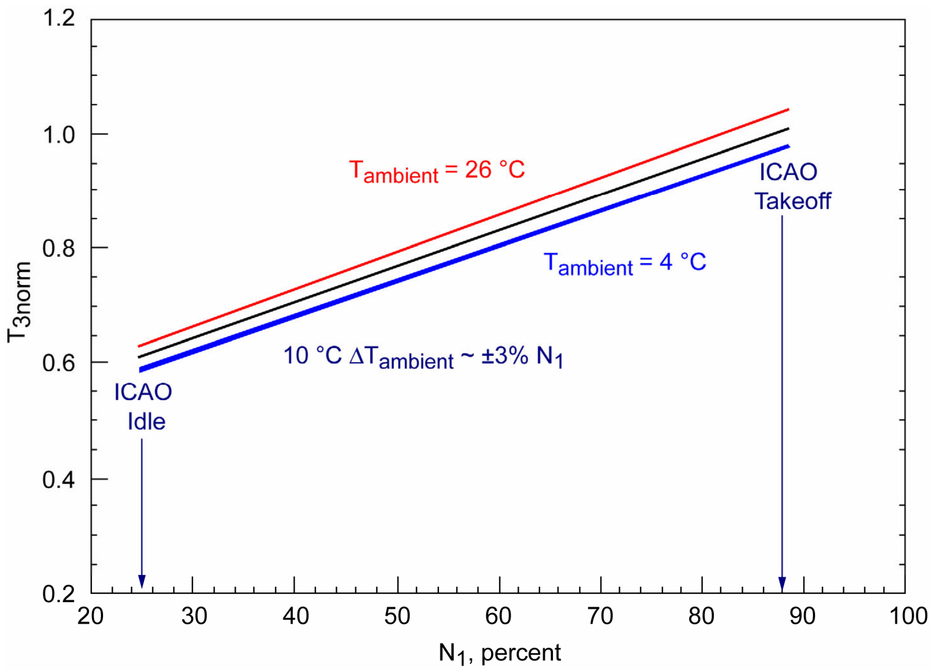

Figure 17.—Effect of ambient temperature on combustor inlet temperature and engine fan speed (Dodds, 2004). Ambient temperature varied up to 20 °C through the whole test period, leading to significant variation of engine operating parameters.

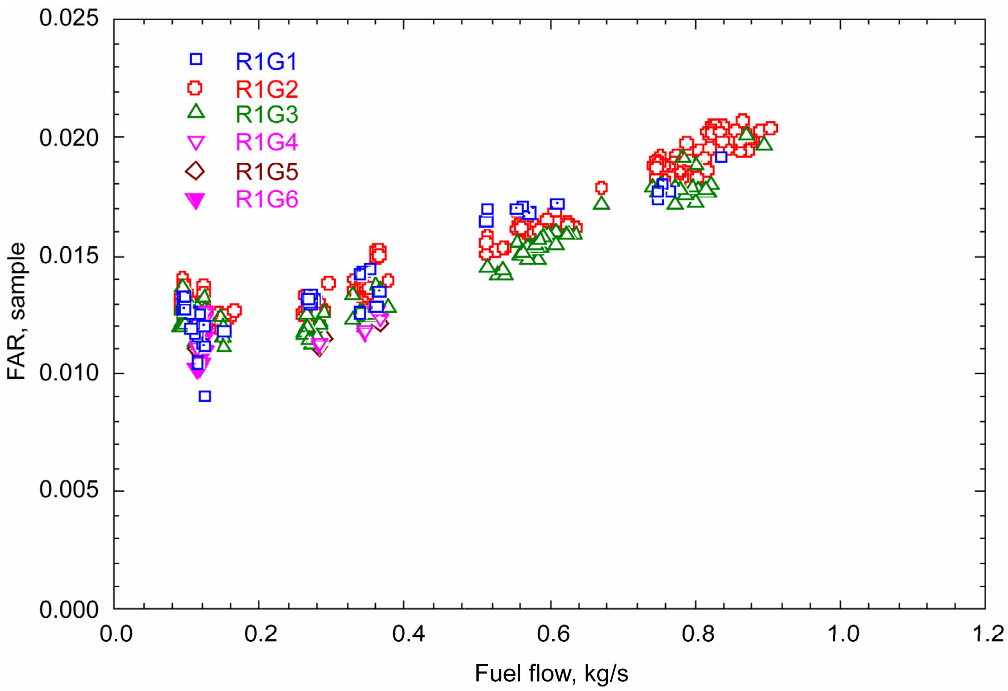

Figure 18.—Fuel-air ratio versus engine flow rate. Sample fuel/air ratio calculated from measured data is within 10% of the expected core flow value through the whole test.

3.2 Gas Emissions Measured by the CGA and the MGA

Measurement results indicate that EINO_X gradually increased with power, from about 2.5 g/kg-fuel at ground idle, 4% of maximum rated thrust, to about 17 g/kg-fuel at maximum power, 93% of maximum rated thrust. NO_X emissions measured from the 1 m rake were in good agreement with the ICAO certification data and the predictions from cycle calculation performed by GEAE. NO_X data are corrected for humidity to the standard atmospheric condition. (fig. 19)

EI*CO* decreased sharply in the low power setting range, from up to 90 g/kg-fuel at ground idle to about 4 g/kg-fuel at 30%, to less than 1 g/kg-fuel above 60% of maximum rated thrust. (fig. 20). Variations in fuel sulfur or aromatic content had no apparent effect on CO and NO_X emissions. EISO_2 were fairly constant with power and varied in direct proportion to the fuel sulfur content.

EI*HC* varied considerably at low power settings, largely as a result of engine cold starts and of changes in combustor inlet temperatures caused by diurnal variations in ambient temperature. (fig. 21) The EI*HC* ranged from ~1g/kg-fuel to 15 g/kg-fuel at idle, but were typically ~1 g/kg-fuel at power settings >30%. Individual hydrocarbon species exhibited similar engine power dependencies.

Both CH_4 and N_2O have global warming potentials that are greater than that of CO_2. Measured CH_4 concentration was less than the ambient background level at all power conditions except at ground idle and idle. Measured N_2O concentrations were almost constant at 0.7 to 0.8 ppm, whereas the background concentration was about 0.3 ppm.

Detailed analyses of the CGA and MGA data are provided in appendix C. All CGA and MGA data measured are available in appendix A tables A-2 and A-3, respectively.

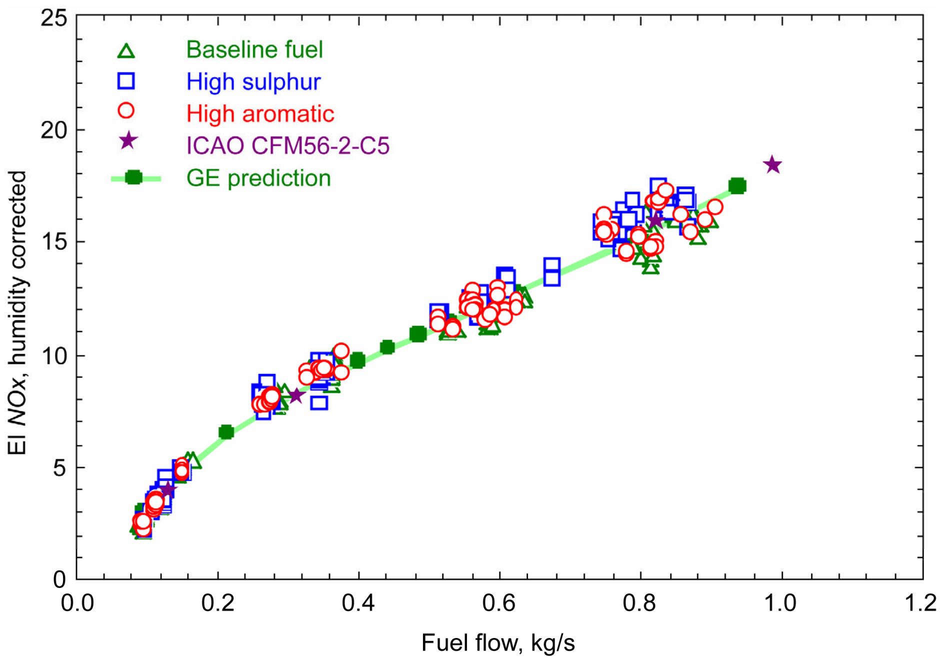

Figure 19.—EI *NOx* versus engine flow rate. Measured data are in good agreement with the ICAO certification data and GEAE predictions.

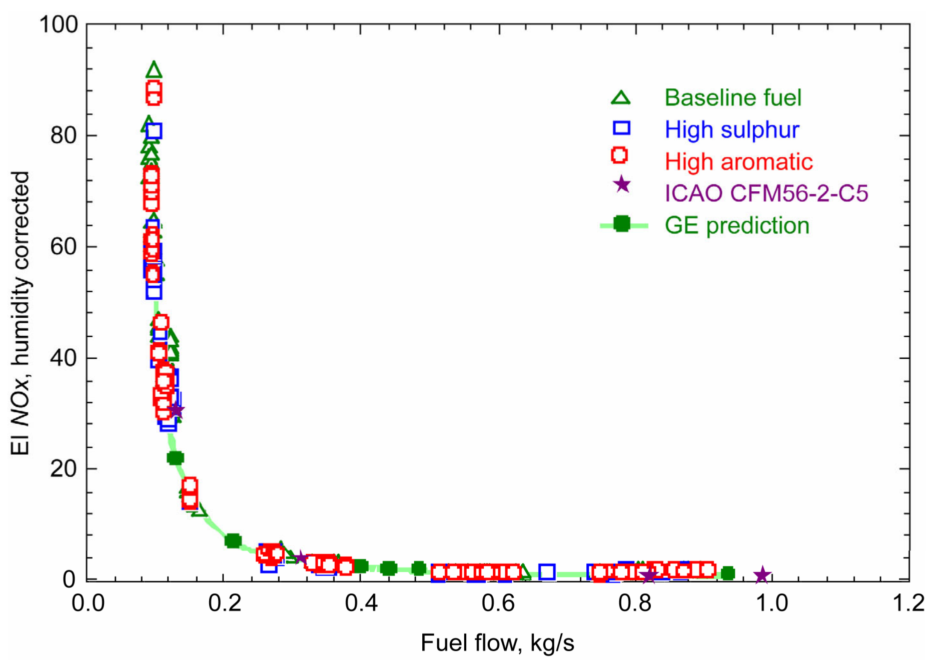

Figure 20.—EI *CO* as a function of engine fuel flow rate. Measured data are in excellent agreement with ICAO data and GEAE predicted values.

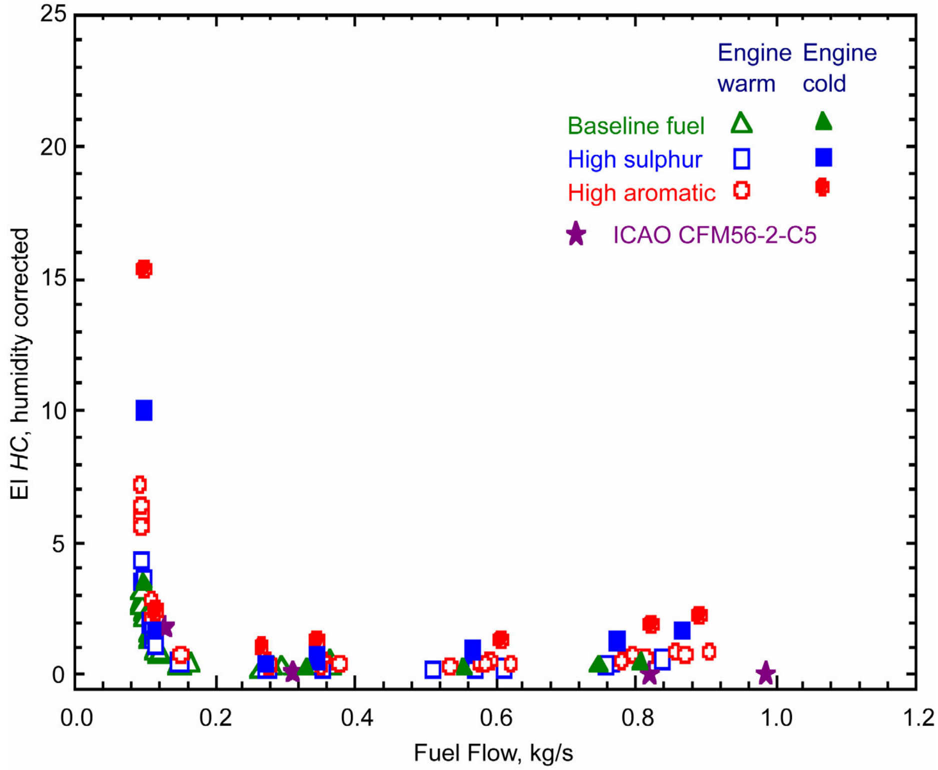

Figure 21.—Effect of engine temperature on EI *HC* (data from probe R1G2). EI *HC* is higher with colder engine.

3.3 Emission Indices of Gas Species Measured by the TILDAS and the PTR-MS

Average CH_2O, C_2H_4, NO_2 and HONO EIs derived from ARI TILDAS measurements are plotted as functions of fuel flow rate in figure 22. Values from the 1 m, 10 and 30 m sampling probes and from the gas and particle probes on the 1 m rake are represented. EICH_2O decreased sharply from about 2 g/kg-fuel at 4% power to <0.1 g/kg-fuel at 15% and higher power settings and exhibited no clear plume aging or sampling probe dependency. EIC_2H_4 were also highly variable at lower power settings, correlated in part with variations in ambient conditions. Values ranged from less than 0.1 to 3 g/kg-fuel and showed no particular trends with plume age or sampling location. At high power settings, EI values decreased to < 0.2 g/kg-fuel. EINO_2 gradually decreased from about 3.5 g/kg-fuel at idle to about 1 g/kg-fuel at high power settings. HONO emissions were modest compared to NOx, and EI values increased slightly with power setting, but showed no trends with plume age or probe selection. A thorough analysis of the nitrogen oxides (NO/NO_2/HONO) emissions can be found in appendix E; the TILDAS data analysis is presented in appendix F.

In figure 23, all gas species measured with the PTR-MS are plotted as functions of fuel flow rate, showing the overall range for each species under each power setting during the whole experiment. The emission characteristics for these components is similar to that observed for other hydrocarbon measurements shown in figures 21 and 22: 1) the EI values are highest at the lowest engine power setting and decrease exponentially with increasing engine power; and 2) measured EI values are highly variable under low power conditions.

The interrelationship of the hydrocarbon emissions measured using the PTR-MS and TILDAS techniques has aided in the interpretation of the sources of variability in the hydrocarbon emission indices presented in this report. Correlation plots constructed by plotting the EI data in figure 23 relative to the EI measurements of CH_2O in figure 22a reveal strong linear relationships between all of the different hydrocarbons. This suggests that the observed variability in the different hydrocarbon measurements is real and that the hydrocarbon emissions scale together and infers that hydrocarbon speciation is independent of power setting and fuel composition. This result is discussed in more detail in appendix F. Interpretation and validation of the components quantified using the PTR-MS technique is provided in appendix G.

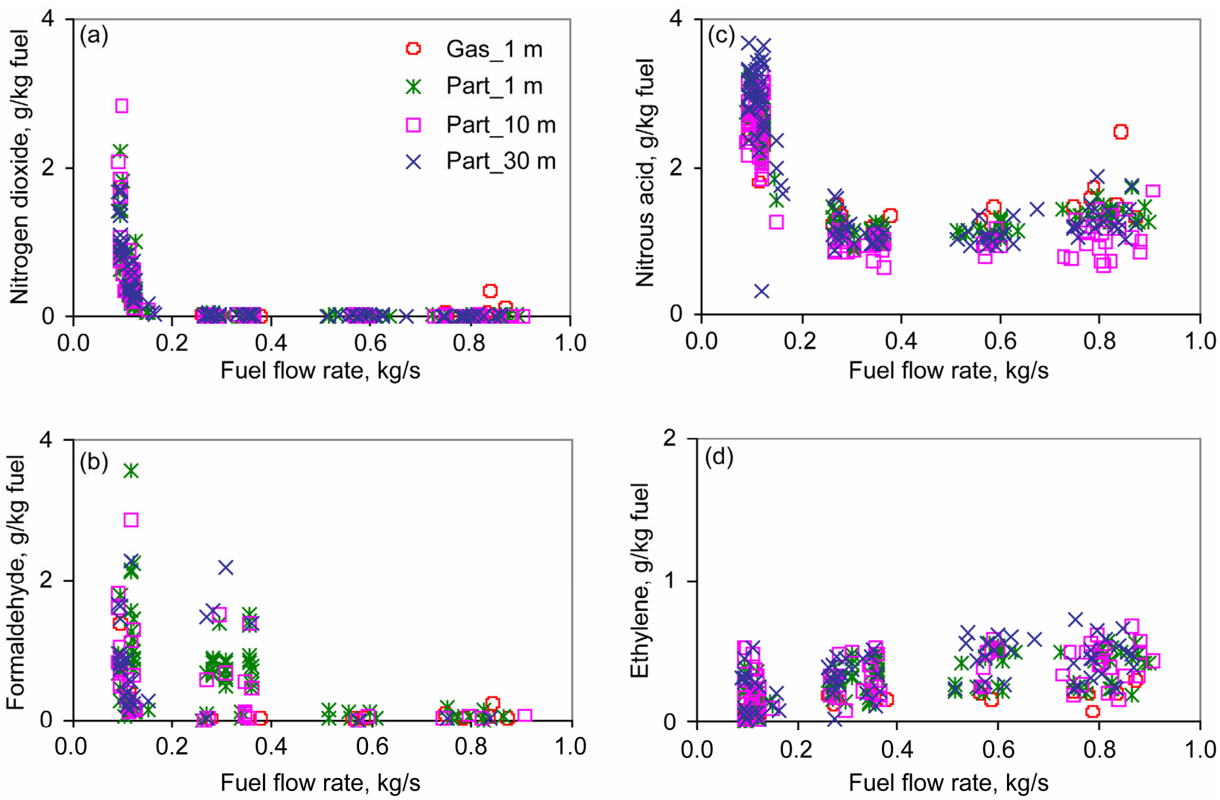

Figure 22.—Emission indices measured by TILDAS from both gas and particle probes at 1 m, 10 m, and 30 m. (a) Formaldehyde. (b) Ethylene. (c) Nitrogen dioxide. (d) Nitrous acid.

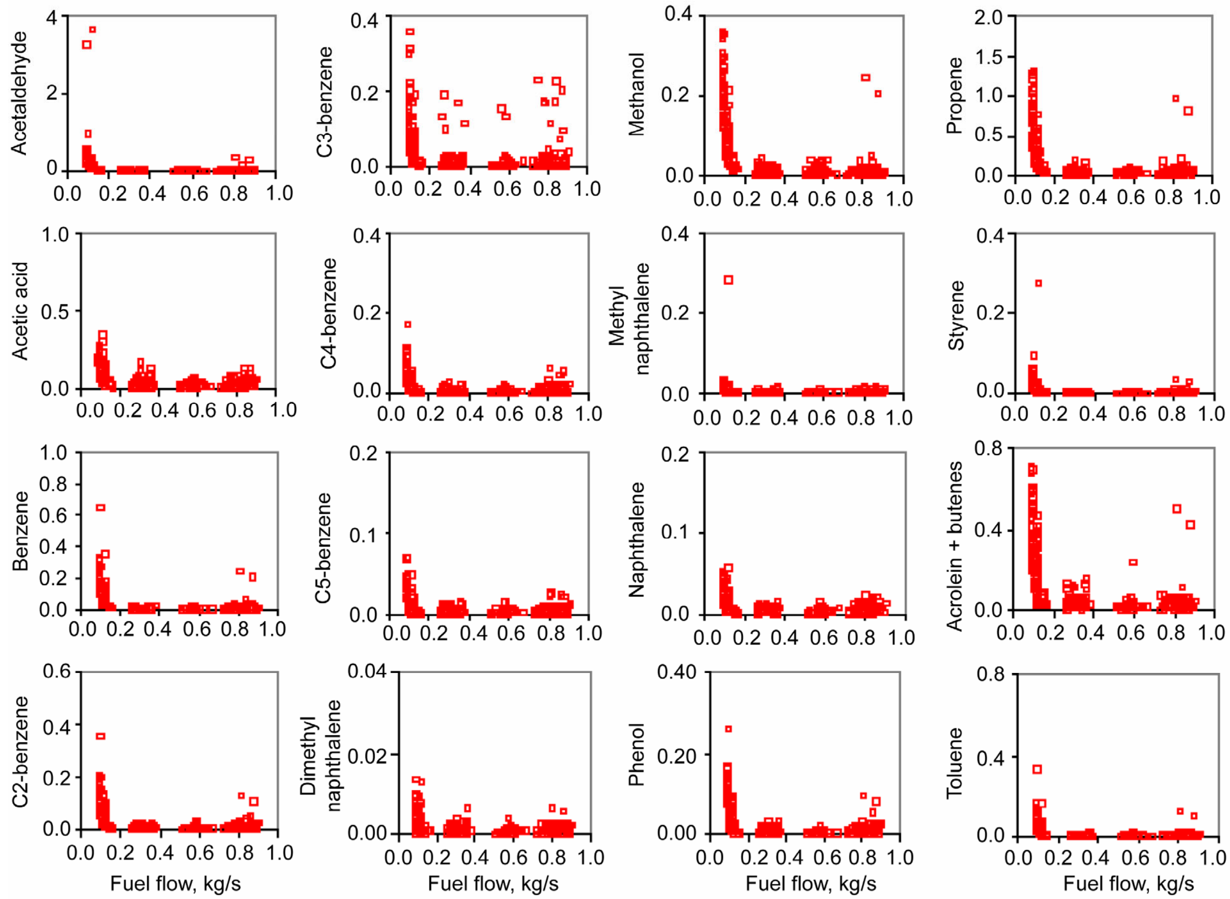

Figure 23.—Emissions indices measured by the PTR_MS.

4. Particle Emissions Results

4.1 Total particle characteristic

NASA (app. H), UMR (app. I), ARI (app. J) and WPAFB provided the measurements of particle concentrations and physical characteristics that are included within the tables of appendix A. Data compiled by the groups (figs. 23 to 25) indicate that at 1 m, emitted particles were log-normally distributed within a single mode and ranged from a few nm to over 300 nm in diameter. The particles are primarily black carbon, although both volatility and AMS measurements indicate that a small fraction was internally and externally mixed non-refractory aerosols (possibly organics) that presumably formed within the sample transport system. Dynamic shape factors derived by comparing aerodynamic and mobility diameters suggest that the soot particles are likely compact conglomerates composed of a few fairly large primary nodes and are not significantly different in morphology from soot generated by premixed flames and diesel engines (app. J). Number-based mean diameters (GMD) increased approximately linearly with thrust from about 15 nm at idle (with a geometric standard deviation of about 1.5) to ~40 nm (with a geometric standard deviation of about 1.8) at maximum power. Corresponding volume-weighted mean diameters (VMD) increased from ~40 to 75 nm over the same power range. Number-based emission indices, EIn, were highly variable, but exhibited maxima at low and high power settings and a minimum at medium thrust. Although values from individual runs varied from 0.1 to 5×10^{15} kg^{-1}, grand averaged line-loss corrected EIn ranged from $\sim0.7\times10^{15}$ kg^{-1} at 30% to $\sim1.1\times10^{15}$ kg^{-1} at 4 and 100% power. Line-loss corrected mass-based emission indices, EIm, derived from SMPS-type measurements were typically 10 to 30 mg kg^{-1} in the lower power ranges (<65%) and >200 mg kg^{-1} at climb and takeoff thrust.

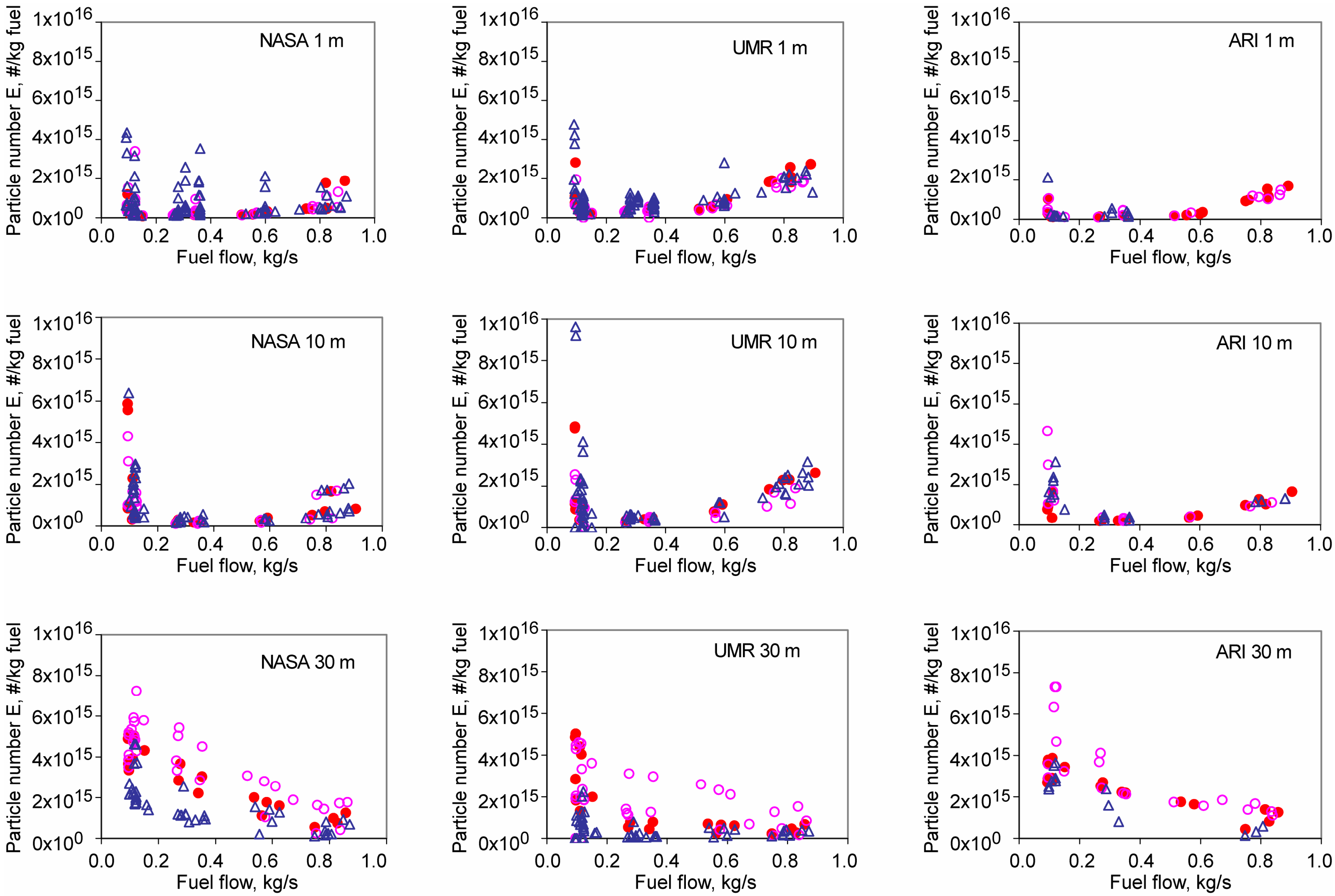

Figure 24.—EIn measured by the NASA CPC (left column), UMR DMS500 (middle column) and the ARI CPC (right column) as functions of fuel flow rate at 1 m, 10 m and 30 m sampling locations using three types of fuel.

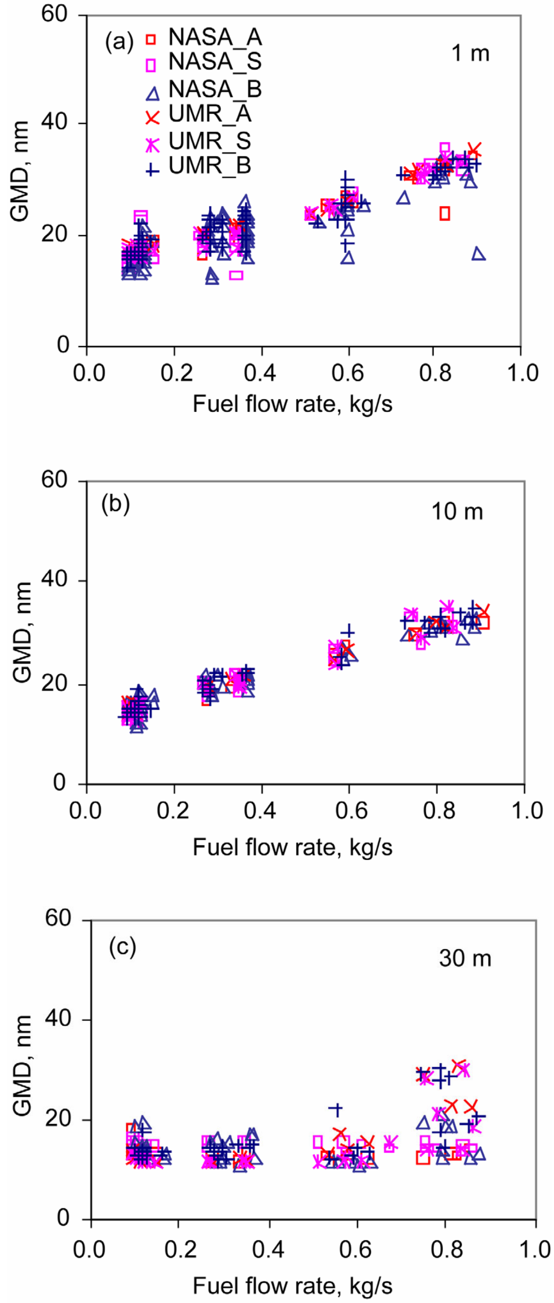

Figure 25.—Particle geometric mean diameters (GMD) measured by the NASA SMPS and the UMR DMS500 as functions of fuel flow rate at 1 m, 10 m, and 30 m using three types of fuel.

Similar trends in particle size, concentration, and mass loading were observed in samples collected from the 10 m inlet probes (figs. 23 to 25). ARI and NASA note that the black carbon and nonvolatile particle EIs were unaffected by the plume dilution and aging that took place between the 1 and 10 m sampling locations. However, many of the 10-m size distributions exhibited increased number densities in the 10 to 20 nm range indicating that secondary particles were forming within the plume and/or sample transport system as the exhaust underwent natural dilution and aging. At low engine powers, average EIn were at least a factor of two greater than those at 1 m, but EIm were essentially the same suggesting that the freshly nucleated particles accounted for a negligible fraction of the total aerosol mass loading. Contributions from the nucleation mode caused the apparent GMD to decrease slightly (a few nanometers) at the low power settings, but had no effect on calculated VMD values.

At both the 1 and 10 sampling locations, changes in the fuel matrix did not appreciably affect the composition, concentration or physical characteristics of the engine's particle emissions. However, results from the "mapping" tests indicated that samples collected from inlet tips located near the edge of the core flow exhibited slightly higher EIn and EIm values than seen near the plume center (app. I). Also, samples drawn from near the center-line mounted vent tube contained higher levels of condensed organic aerosols bearing engine oil mass-spectral signatures (app. J). Exhaust gas flow through these regions compose a miniscule fraction of the overall mass ejected from the engine, so we anticipate these non-uniformities will have a negligible impact on average engine particle emissions.

Changes in ambient temperature introduced significant variability in the engine's primary particle emissions. For example, EIn at ground idle decreased by a factor of two over the course of an engine run as local air temperature increased ~10 °C due to solar heating (app. H). Plotting the EIn as a function of fuel flow rate instead of engine power (which varies with inlet temperature) explains some, but not all, of this variability. Previous tests have shown that soot emissions are highly dependent on fuel droplet size and FAR on a micro-scale within the combustor, and it is possible that both these parameters depend in a nonlinear way upon fuel flow rates and inlet temperatures. ARI found that plotting hydrocarbon EIs as functions of the load parameter, θ, collapsed much of the variability (app. F). θ depends on combustor inlet temperature (T_3) and pressure (P_3), the mass flow rate through the combustor, and a combustor geometry factor. A similar analysis of the particle emissions may help explain its residual variability.

Nucleation-mode particles had a dominant effect on intensive parameters measured in the 30 m probe samples. At this location, aerosol distributions typically exhibited two distinct modes, one corresponding to nonvolatile particles and peaking at roughly the same diameters observed in the 1 m samples, and the other occupied by freshly nucleated sulfur and organic aerosols and typically peaking at < 12 nm. It is not clear whether these new particles formed within the expanding plume or during the ~ 6 s samples spent within transport tubing before being analyzed—or possibly some combination of the two. Combined, the two separate particle modes caused apparent GMD values calculated over 9 to 245 nm range to remain at <15 nm for all power settings. VMD were also reduced substantially across the power spectrum, which indicates that the secondary aerosols comprised a significant fraction of the overall mass loading.

As a result of secondary aerosol formation, EIn values at 30 m were typically 5 to 20 times greater than in comparable samples drawn from the 1 m probe. These values also decreased with increasing engine power, a result that may reflect the action of several factors including: less mixing and aging in the high-velocity, high engine-power cases; a shift in equilibrium between new particle formation and condensation of material onto existing particles as more surface area becomes available at high engine powers; and an overall reduction in condensable material as engine power is increased. It is hard to find evidence to support mixing/dilution argument because the idle plumes were at most 50% more dilute than the takeoff plumes, and the overall sample ages, which were dominated by the time spent within sampling lines, were essentially the same. As for the second assertion, ARI reports finding increased levels of organic aerosol deposited on the surface of soot particles at high engine powers (app. J); their AMS is not sensitive to the nucleation mode particles, so a shift in equilibrium from nucleation to condensation would be seen as an increase in non-refractory emissions with power. This observation would also counter the argument that less material is available for condensation at high engine powers, as does the measurements by NASA which indicate that significant amounts of volatile aerosols are present at all power settings.

For the low power settings, the total mass of material condensed in the plume at 30 m (plus the long length of sampling line) was substantially higher than seen in the 1 m samples. Although black carbon values were relatively unchanged, line-loss corrected EIm values at ground idle increased from ~15 mg kg^{-1} at 1 m to over 150 mg kg^{-1} at 30 m. These EIm differences decreased with power and essentially vanished at thrust levels ≥65% (fig. 26).

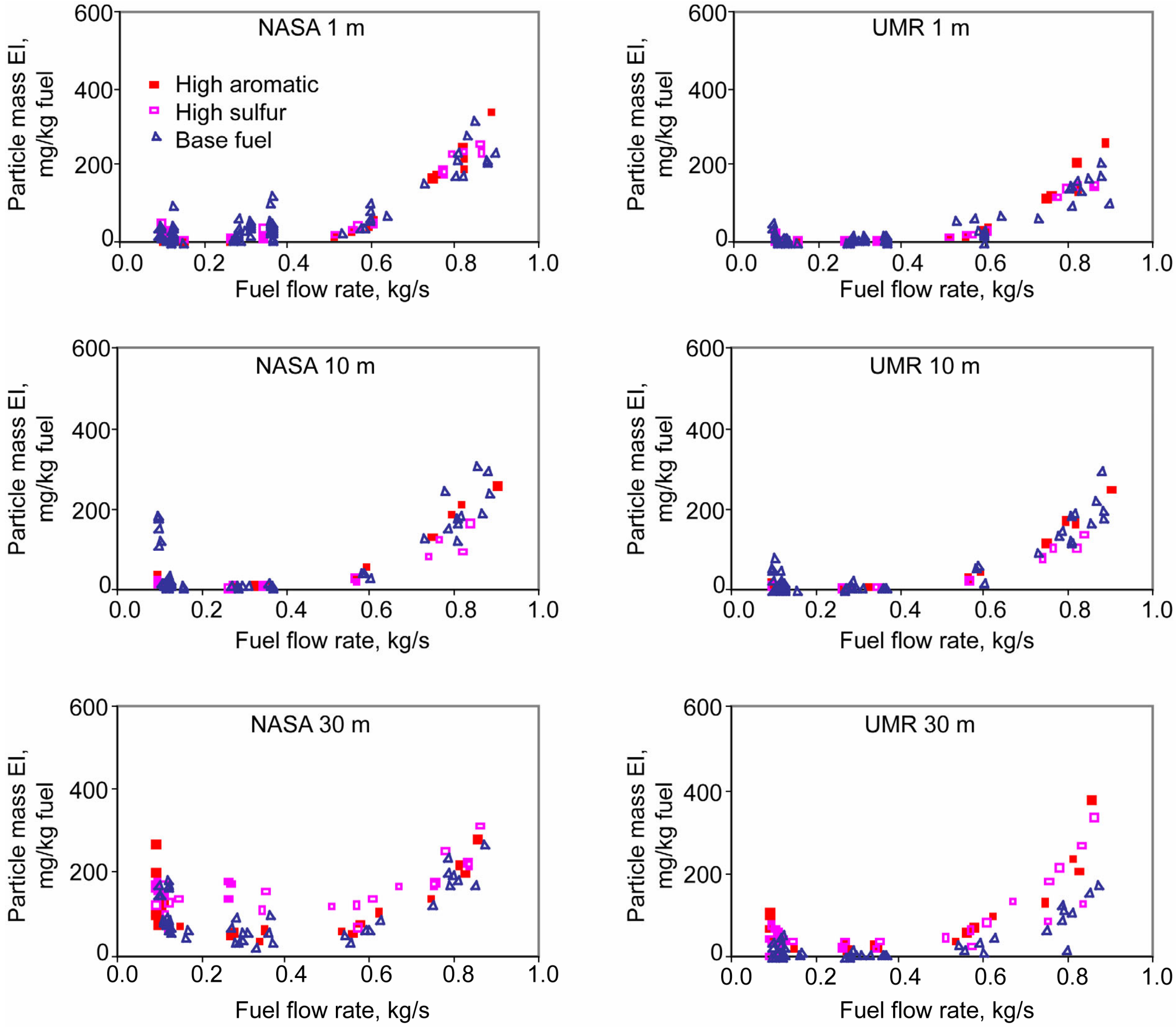

Figure 26.—EI*m* measured with the NASA SMPS (left column) and the UMR DMS500 (right column) as a function of fuel flow rate at 1 m, 10 m, and 30 m using three different fuels. Values are calculated with density of 1 g/cm^3.

Fuel sulfur concentration had a substantial impact on both the number and mass of particles present in samples drawn from the 30 m probe. EIn values varied in rough proportion to fuel sulfur content, with values at any given power setting following the trend that high sulfur fuel (HS) > high aromatic fuel (HA) > base JP8 fuel (BASE). The extra ~1200 ppmS in the HS fuel led to EIn values that were a minimum of twice those seen in comparable BASE fuel cases and to enhancements in EIm that were consistent with ~1% of the fuel sulfur being converted into S(IV) species within the combustor or near-field exhaust plume (app. H).

4.2 Volatile particle characteristics

Duplicate SMPS and CPC instruments with thermal-denuder inlets were deployed by NASA to discriminate the engine's refractory particle emissions from secondary aerosols that form downstream of the combustor (app. H). In addition, ARI operated their AMS system throughout the tests to provide direct measurements of nonrefractory aerosol aerodynamic size and concentration over the 30 to 1000 nm diameter range (app. J).

Results show that at the 1 m sampling location, EIn and EIm values measured with the "hot" instruments were somewhat less than those derived from the "cold" instrument suite, clearly indicating the presence of volatile aerosols. Similarly, the AMS measured small concentrations of condensed organics in the 1 m samples at high engine powers. It is improbable that these aerosols formed within the exhaust as the temperature at the inlet tip was well in excess of those required for condensation of low volatility organics. It is more likely that, even though samples were typically diluted by a factor of 10 with dry N_2, the material condensed during transport through the long sampling lines. Indeed, previous tests have shown that the condensation of volatile species within sample lines is highly dependent on sample dilution (Anderson et al., 2005). A limited dilution ratio study conducted during APEX tended to show that relatively invariant EIm and EIn values were obtained at dilution ratios > 6, but apparently higher dilutions were required to suppress condensation in cases where large quantities of low volatility material was present.

Increased amounts of condensed, volatile material were present in samples drawn from the 10 m probe. At this position, the plume was typically diluted by a factor of 10 or more with background air. At low power settings, 40 to 60% of particles > 10 nm in diameter evaporated when samples were heated to 300 °C. The new particles were typically < 20 nm in diameter and only accounted for a few percent of the total particle mass, but contributed to EIn values that were often a factor of two higher than seen in comparable 1 m samples. The fraction of externally mixed volatile particles decreased to ~10% at high engine powers, but AMS results show that significant amounts of nonrefractory material was still present on the surface of the soot particles even at 100% thrust.

At 30 m, volatile aerosols completely dominated number-based size distributions and accounted for an appreciable fraction of the overall mass loading. The fraction of particles that completely evaporated below 300 °C varied from about 70 to 95%, depending on ambient conditions and engine thrust level. As noted above, total EIn were typically 5 to 20 times greater than in the 1 m samples and tended to decrease with increasing engine thrust. Figure 27 shows examples of heated and unheated particle size distributions measured at 4, 30, 85, and 100% engine power that illustrate the phenomenon behind these changes. A volatile nucleation mode peaking at ~20 nm is clearly evident in low engine power cases, which accounts for the greatly enhanced EIn. At climb and takeoff thrust levels, it appears that a large portion of the condensed material is present as coatings on the more prominent soot mode rather than in the less dominant nucleation mode, which results in an overall decrease in EIn. Similarly, AMS measurements indicate that amount of material deposited upon soot surface increases with engine power.

The amplitude of the nucleation mode (and EIn) seen in the 30 m size distributions was clearly regulated by fuel sulfur concentration. The NASA observations suggest that, excluding the highly variable data recorded at 4% power, EIm and EIn averaged ~52 mg kg^{-1} and 3×10^{16} kg^{-1}, respectively, higher for the HS fuel than for the BASE fuel. Based on a number of conservative assumptions, this enhancement corresponds to a fuel S conversion factor, ε, of 0.8 to 1.0% (app. H). AMS observations suggest that organic aerosol mass emission indices are roughly equivalent to those of sulfate in the HS fuel case. Please note, however, that the AMS is relatively insensitive to nucleation mode aerosols, which appears to be the size range where a majority of the sulfate aerosol mass is sequestered.

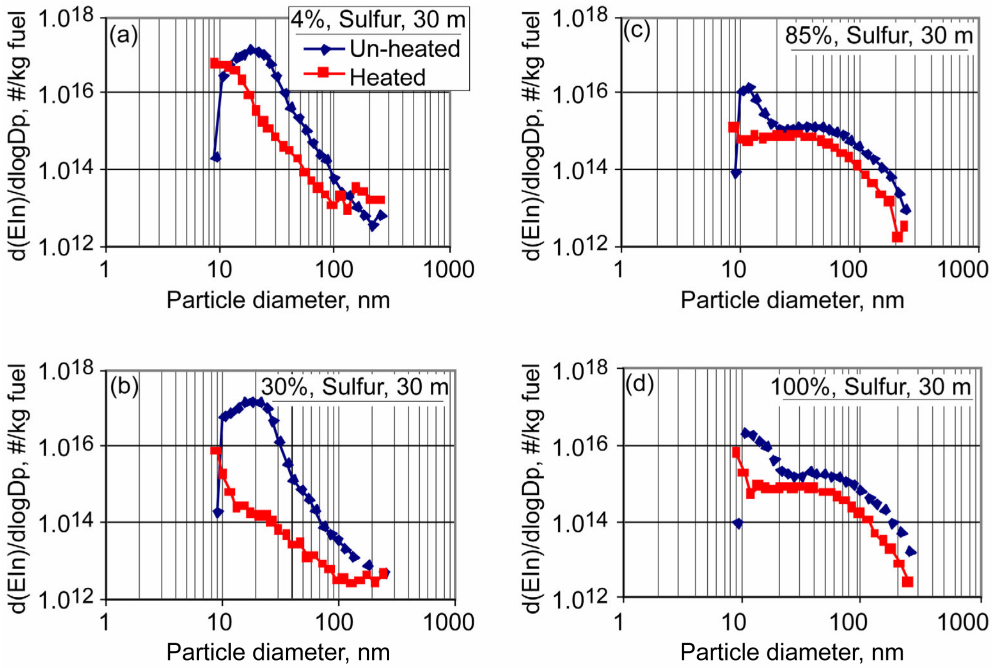

Figure 27.—Particle size distribution measured on April 27 with the NASA SMPS from heated (300 ºC) (red) and unheated (blue) samples from 30 m probe at engine power levels of 4%, 30%, 85%, and 100% thrust with high sulfur fuel.

4.3 Particle composition

Particle chemical composition was measured with the ARI AMS, which identified significant sulfate and organic components from the 30 m probe samples for particles greater than 30 nm in vacuum aerodynamic diameter (dva). The AMS measured the non-refractory, or volatile, composition of particles ranging from 30 nm to 1 µm dva using mass spectrometry (app. J). The AMS was complemented by the MAAP instrument measurements of the (refractory) black carbon mass. These measurements can be compared and contrasted with the particle size distributions measured with the SMPS and DMS500 instruments. Especially useful are the direct comparisons with the derived volatile contributions from the heated and unheated particle distribution measurements. However, in doing such comparisons, it is essential to account for the differences in the type and range of particle sizes quantified by each technique (e.g., SMPS: 9 nm to 245 nm mobility diameter vs AMS: 30 nm to 1 µm dva). In fact, several different modes of the total particle size distributions have been identified and each of them is affected by condensable species to differing degrees and different ways.

At higher power settings, black carbon is the dominant chemical component at all sampling locations. For samples from the 30 m probe at lower power settings, the black carbon mass emission index decreases as the engine power is decreased and both the sulfate and organic contributions become a more significant fraction of the total particle mass. The condensed sulfate EI varies only a modest amount within experimental uncertainty as power was varied, while the condensed organic EI increases significantly at powers close to idle, when unburned hydrocarbons and CO EIs are also increasing. Assuming that in burning the two fuels the engine produces similar level of soot emissions, differences in EIm values between the base and high sulfur fuels suggest that about 1% of the fuel sulfur contaminants are converted into S(VI) species within the combustor or near-field engine exhaust plume (app. H).

4.4 Comparison of Gas and Particle Probes in Particle Measurement

To assess probe and sample dilution effects on measured particle characteristics, on three occasions during the “EPA” test sequences we alternately sampled flow at 1 m from a standard aerosol dilution probe and from a gas probe/heated sample line to which dilution air was introduced about 15 m downstream of the inlet tip. Example size distributions recorded downstream of the two probe systems are shown in figure 28. At low engine powers, a nucleation/growth mode peaking at 30 to 40 nm is evident in the gas-probe samples and small diameter particles are notably missing. This mode is probably produced by a combination of condensation of low-volatility organics and sulfate species and rapid coagulation of small particles in the in the section of transport tube where samples are undiluted. Particle number densities approach 10^8 cm^{-3} in the undiluted exhaust and the e-folding time for coagulation at such concentrations is ~1 s. In addition, assuming an ε of 1%, sulfuric acid concentrations were on the order of 10^{11} cm^{-3} within the exhaust plume. The saturation vapor pressure for H_2SO_4 is ~10^7 cm^{-3} at ambient temperatures, which suggests that condensation of this species may have occurred, even though the transport tube was heated to about 180 °C. In addition to coagulation, the absence of small particles may also be due to enhanced turbulent diffusive losses within the narrow diameter, soot-coated gas sampling line. Evidence for this effect is more clearly seen in the spectra collected at high engine powers. Here, possibly due to a lack of easily condensable species, the nucleation/growth mode is absent in the gas-probe distributions and the size distributions appear similar to those recorded downstream of the aerosol probes, only with “low-pass” filters applied.

The enhanced nucleation, coagulation, and overall transport losses that occurred within the gas-probe system caused its EIn and EIm values to vary quite widely from those measured using the aerosol inlet system. At low engine powers and due to nucleation, gas probe EIn and EIm values were typically higher than particle probe values. The reverse was true at high engine powers. The relatively smooth, log-normally shaped size distributions measured downstream of the particle probe, when contrasted with the rather messy spectra seen when using the gas probe, seem to justify the added expense and complexity of deploying the specially designed particle probes (fig. 29).

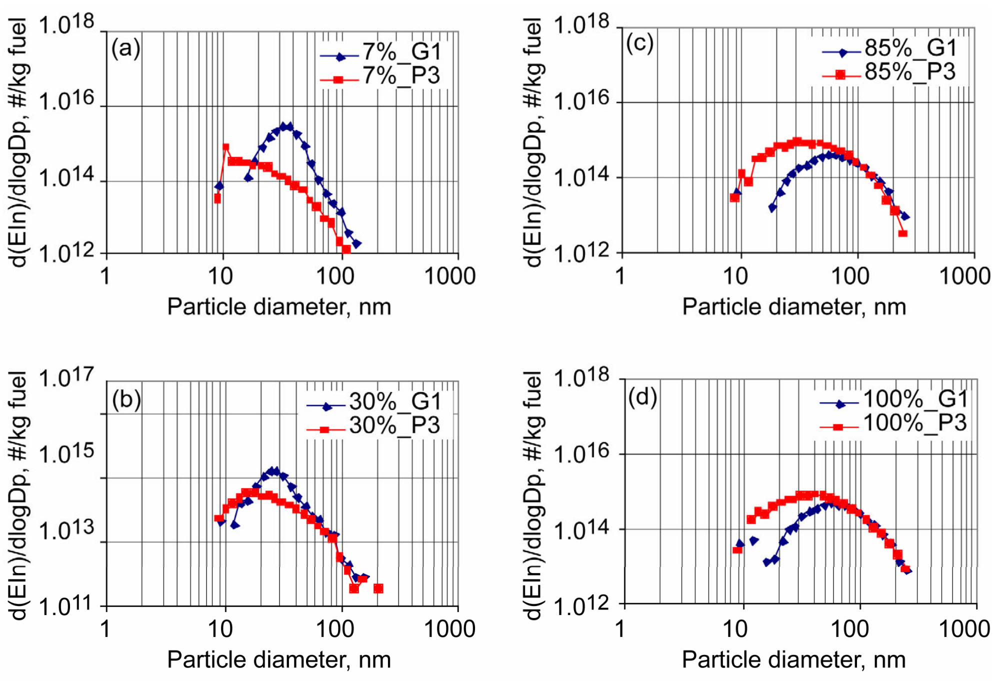

Figure 28.—Particle size distributions measured by NASA from gas probes (G1) and particle probe (P3) at 1 m on April 29 with high sulfur fuel. (a) 7%. (b) 30%. (c) 85%. (d) 100%.

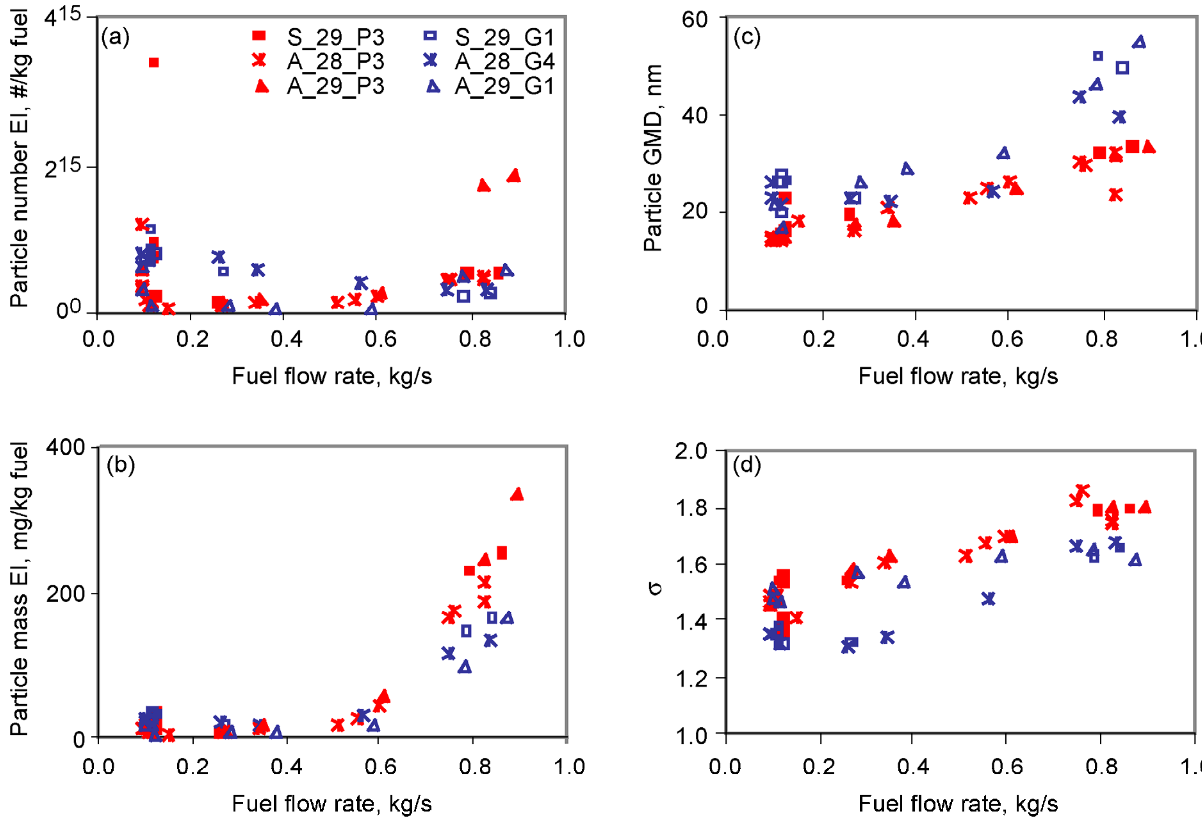

Figure 29.—Particle properties measured by NASA from gas probes (G1 and G4) and particle probe (P3) at 1 m on April 28 and 29 with high aromatic fuel (A) and high sulfur fuel (S). When sampled from gas probes, exhaust sample dilutions were added at the sample distribution manifold. (a) EIn. (b) EIm. (c) GMD. (d) Sigma.

4.5 Possible Dilution Effects in Measured Particle Properties

Aircraft exhaust plumes contain high concentrations of aerosol precursors as well as condensable water vapor and measured particle emissions indices are known to be highly sensitive to the details of sample collection and dilution (i.e., Anderson, 2006). Our exploration of probe effects is described in section 4.4. To establish the acceptable range of sample dilutions, repeated particle characterization measurements were made on samples drawn from the 1 m probe as dry N_2/sample-air ratios were varied from 6 to 93. Results of the study indicate that EIn values are relatively constant at dilutions >10, but somewhat suppressed at lower values (fig. 30). This is likely caused by enhanced particle coagulation in the less dilute case. EIm exhibited the opposite trend, reaching a maximum at low dilutions. Although it appeared that dilution ratios of 20 to 30 would have produced the most repeatable measurements of particle intensive parameters, for practical reasons such as instrument pressure and sensitivity limitations, dilution ratios were maintained in the 8 to 13 range for most of the experiment. Appendices H and J address the impact of the less than optimum 1 m probe dilution ratios on volatile aerosol concentrations.

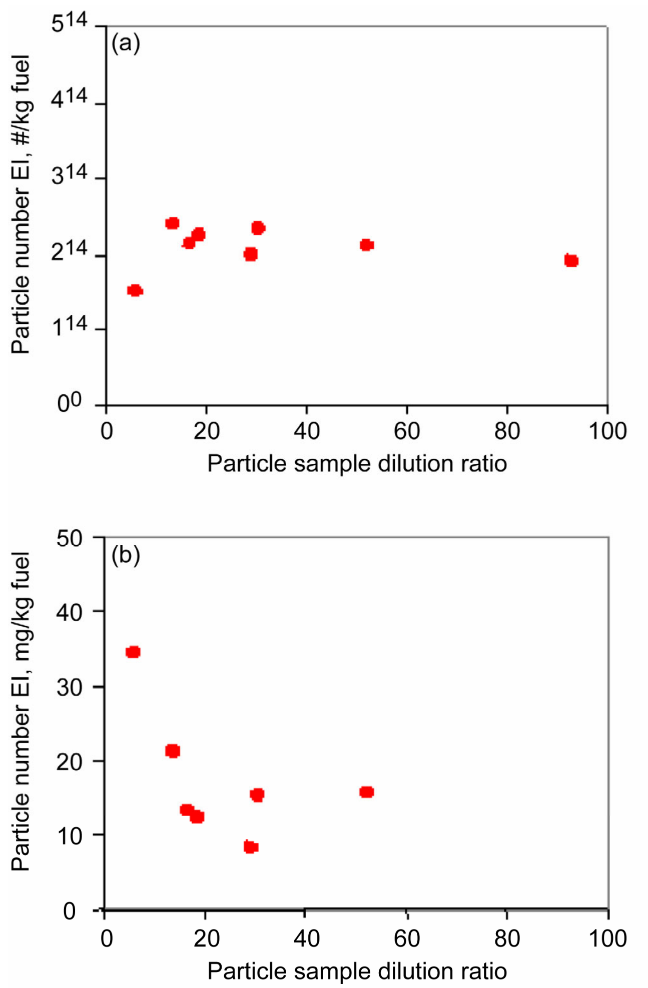

Figure 30.—Particle properties vs. particle sample dilution ratio measured by NASA at 1 m using probe P3 at 7% engine power with base fuel. (a) EIn. (b) EIm.

4.6 Data Differences Among Particle Measurement Groups

You will note that duplicate values for many aerosol parameters appear in appendix A, either in data sets provided by a single investigator or between those archived by two or more groups (table 5). Ideally, for any given engine run these values would be in close agreement, and in many cases they are, at least to within the limits of precision of the instruments. However, because of differences in instrument sensitivity, data processing and calibration procedures, start and stop times for the sampling intervals, and sampling system/background corrections, the duplicate values sometimes vary relative to each other by factors of two or more.

TABLE 5.—PARAMETERS FOR WHICH DUPLICATE VALUES ARE PRESENTED IN APPENDIX A.

Parameters	Measurement Technique	Group
EIn	TSI-3022 CPC	ARI
	TSI-3760 CPC	NASA
	TSI-3022 CPC	NASA
EIm	SMPS size analyzer	NASA
	DMS-500 size analyzer	UMR
	TEOM	WPAFB
GMD, VMD, SIG	SMPS size analyzer	NASA
	DMS-500 size analyzer	UMR
BC	MAAP	ARI
	PSAP	NASA

In addition, because of the research-oriented nature of APEX, many of the instruments deployed to the experiment were relatively new and somewhat unproven. For example, UMR's Cambustion DMS-500 was developed for use in on-road diesel engine emission studies and APEX marked its first use in characterizing gas-turbine engine particle emissions. To evaluate its efficacy for this application, UMR investigators made comparisons between DMS-500 derived extensive and intensive aerosol parameters and those determined with more conventional (i.e., CPCs and SMPS) instruments. As described within appendix I, they found relatively good agreement between DMS-500 and SMPS GMD and SIG measurements, but some small, systematic differences in higher moment shape parameters and EIn.

Figures 31 to 34 provide a closer look at the level of agreement between the various measurement approaches. For EIn, we see that the values derived from the CPC instruments are highly correlated and typically in agreement to within ±20% (fig. 31). However, the differences are systematic rather than random and are rather easily explained. The lower size sensitivities (50% cut point) of the TSI-3022 and –3760 CPCs are 7 and 11 nm, respectively. Since the particle size distributions were typically skewed to small diameters, NASA's TSI-3022 simply counted more particles than their –3760. ARI deployed a TSI-3022 exactly like the NASA unit, but they did not apply a particle loss correction for the length of line between the sampling manifold and their instrument rack, whereas NASA did. Hence, the ARI data are typically 30% lower, which is approximately the magnitude of the line-loss correction factor that was applied to the NASA data.

EIn values derived from DMS-500 measurements exhibit a fair amount of scatter and slight nonlinearity when compared to the CPC results. Reviewing figure 31, note that the DMS500 EIn are higher at low concentrations, but lower at higher particle concentrations. There are several possible explanations for these discrepancies. The CPCs provide a scalar measurement of the number of particles over an ill-defined size range, whereas the DMS-500 outputs 32 channels of size-resolved number densities which must be integrated across the size range of interest to yield total number density. To facilitate comparisons with the SMPS results, the DMS-500 spectra were integrated over the 9 to 245 nm size range while the TSI-3760 CPC typically counts all particles within the ~11 to 1000 nm size range. In addition, the CPC data were corrected for line loss using the scalar, power dependent multipliers shown in figure 17, whereas the DMS-500 spectra were corrected for sample line transmission efficiency using the penetration vector shown in figure 16. Finally, unlike the NASA and ARI CPC data, the DMS-500 spectra were corrected for the presence of background aerosols using measurements that were recorded before and after the individual engine runs (app. I). These differences in data correction and processing procedures, while having minimal effects on first-order size distribution shape parameters such as GMD, likely explain most of the variance between the archived SMSP and DMS500 EIm data (fig. 32).

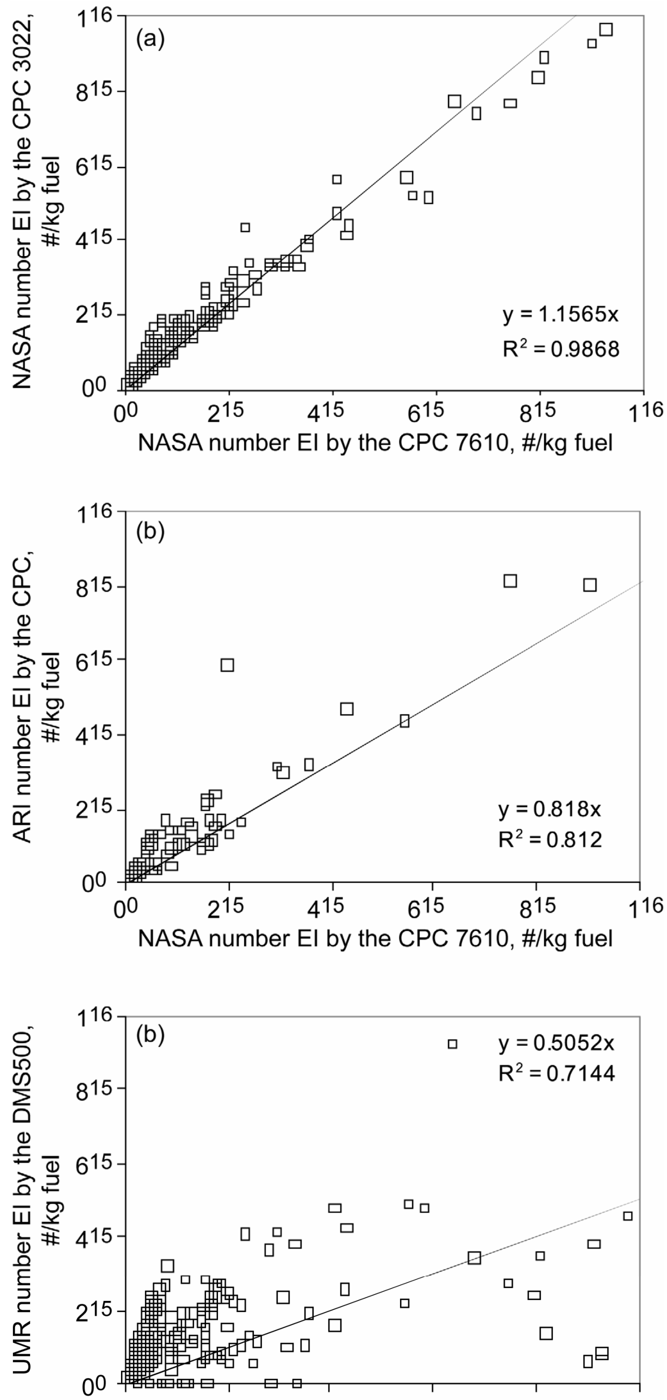

Figure 31.—Comparison of EIn derived from three CPCs and the DMS500.

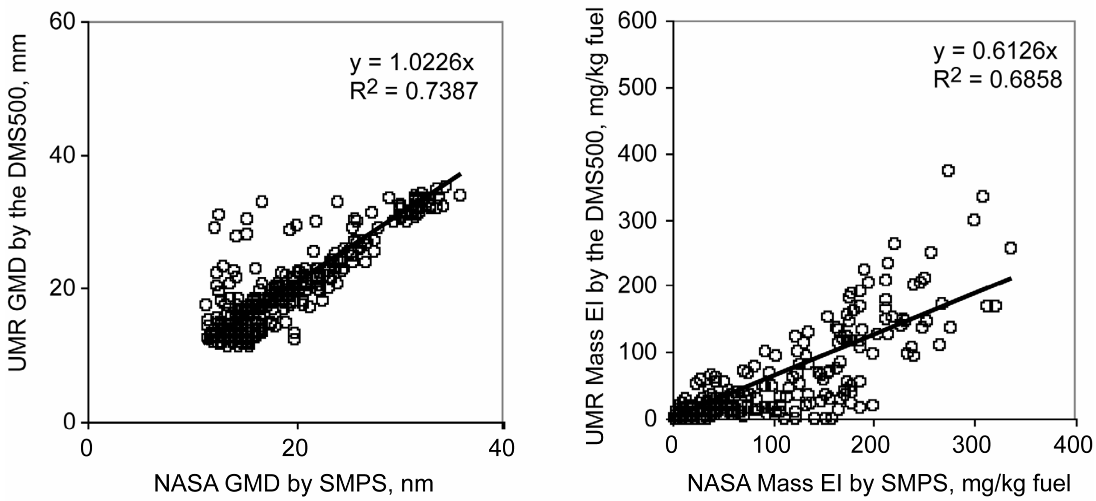

Figure 32.—Comparison of particle geometric mean diameter and mass emission indices derived from the DMS500 and SMPS.

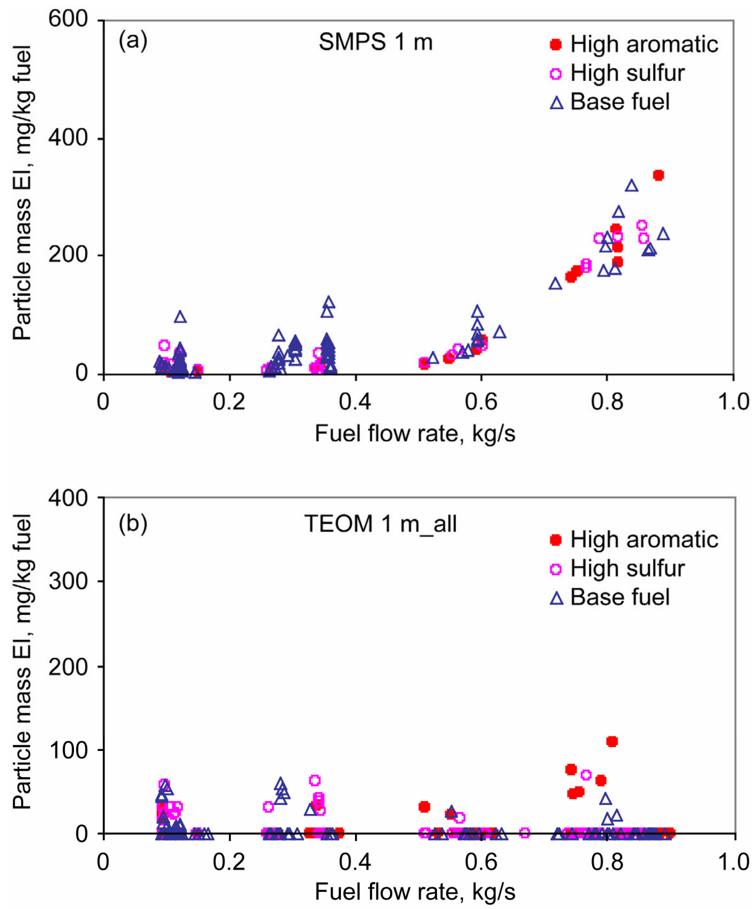

Figure 33.—Particle mass emission indices determined with the SMPS and TEOM.

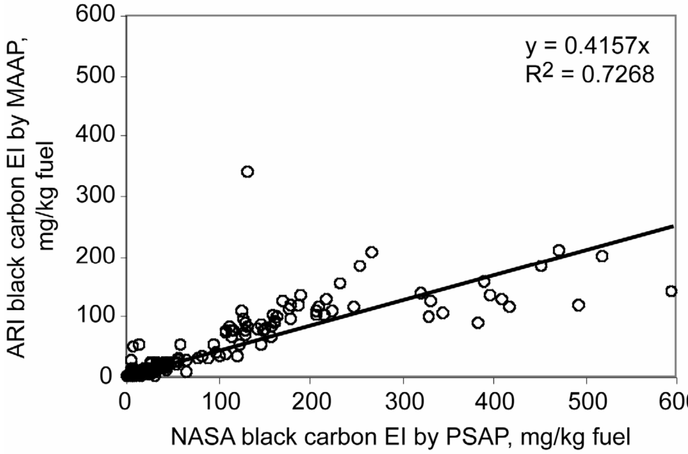

Figure 34.—Comparison of black carbon emission indices by derived from MAAP and the PSAP measurements

The differences in EIm between the DMS500 and SMPS are inconsequential when compared to those between the TEOM and SMPS (fig. 33). Although, because the TEOM drew sample from a gas probe, sampling line losses and dilution effects might have produced some differences, there was essentially no correlation between the two data sets. Mass concentrations at 1 m were typically >1 mg m^{-3} at power settings >70%, which is well above the TEOM detection limit (0.2 mg/m3). Pressure and flow fluctuations related to changes in engine power coupled with the high levels of acoustic noise may have interfered with the oscillation frequency of the sensitive detection unit of the TEOM and rendered much of its data unreliable. The reader may contact the TEOM PI (table 1) for other possible explanations and information on more recent applications of this measurement technique.

In addition to the multiple approaches used to establish particle number/mass concentrations and microphysical properties, two different instruments were used to measure aerosol absorption coefficients: a MAAP and a PSAP. As shown in figure 34, EIs derived from these data were well correlated, but the PSAP values were typically a factor of two to three higher in magnitude. Along with possible differences in line-loss correction factors and the start and end times of sampling intervals, there are two likely explanations for these differences. First, the MAAP data are corrected for scattering from the filter media, whereas the PSAP data are not, and secondly, the mass absorption coefficients used to convert the aerosol absorption coefficients into mass may not be entirely appropriate for gas turbine engine particle emissions. The first effect causes the PSAP absorption coefficients to be slightly higher than those measured by the MAAP and is particularly important for downstream measurements where larger background aerosols were mixed into the exhaust plume. In these cases, the PSAP black carbon EIs may be overestimated by a factor of two. An empirical correction algorithm has been developed for the PSAP, but it requires independent measurements of aerosol scattering, which were not performed during APEX. As for mass absorption coefficients, a value of 6.6 m^2 g^{-1} was applied to both the PSAP and MAAP data. However, the PSAP uses a 535 nm light source whereas the MAAP uses a 880 nm light. Petzold et al., (MAAP paper) tested this value on MAAP data recorded behind diesel vehicles and the resulting EIs agreed well with values determined with independent EC/OC measurement approaches. A much higher coefficient should probably be used for conversion of the PSAP data; indeed, a value of 15 m^2 g^{-1} produces EIs that are much good agreement with the MAAP values as well as nonvolatile EIm derived from the "heated" SMPS size distribution measurements.

5. Summary

Measurements from all probes at the 1 m rake were within the core engine exhaust, although samples drawn from the top gas probe (G1) were sometimes mixed with 5 to 10% fan air. Similar variations at upper probes (G1 – G3) were observed from the 10 m rake, but higher proportions of fan air were sometimes mixed in the samples because of the strong ambient wind. Gas emissions measured from the 10 m rake carried the same trend as those from the 1 m rake with a dilution factor of approximately 10. Higher uncertainty should be considered when using 10 m data.

NO_X emissions measured from the 1 m rake were in good agreement with ICAO certification data and predictions from cycle calculations performed by GEAE. CO emissions also agreed well with ICAO data and GEAE predicted values. EI*CO* increased when $EINO_X$ decreased as expected. HC emissions had the same trend as CO. HC levels were much higher when the engine is cold and this effect was observed throughout the field project. Similar effects were noted in GEAE's early emissions variability testing of CF6-50 engines. SO_2 and some lighter hydrocarbons were measured by MGA. However, much higher uncertainties should be applied when using these data. SO_2 concentrations varied directly according to fuel sulfur content. More than 90% of fuel sulfur content was converted to SO_2 with high uncertainty level.

Particle EIn ranged from $>1\times10^{15}$ particles/kg-fuel at 1 m to 6×10^{16} particles/kg-fuel at 30 m. At the 1 and 10 m locations, EIn reached a minimum at medium power levels. At the 30 m location, EIn values were greatest at idle, then monotonically decreased with increasing thrust. EIn values were typically a factor of 10 greater at the 30 m sampling location than at 1 m indicating that large numbers of new particles formed within the exhaust plume as it cooled. Particle mass and black carbon emission indices (EIm and $EIm_{BC,}$ respectively) were a minimum at low powers and increased with power, reaching values >0.3 g/kg-fuel at thrust levels >85%.

For the close sampling locations, the particle size distribution typically exhibited a single mode, log-normal size distribution, with individual particles ranging from a few nm to about 300 nm in diameter. The GMD of the nonvolatile particles increased roughly linearly with engine power setting, ranging from about 15 nm at idle to 40 nm at the maximum power. At 30 m, size distributions often exhibited a prominent nucleation mode, particularly in medium to low engine power cases. This dominance of small particles resulted in GMD values of smaller than 15 nm for all power settings, although the distribution is distinctly bimodal, especially at the highest powers.

At high engine powers, black carbon dominated total particle mass emissions at all sampling locations. At low power settings, the sulfate component was negligible at 1 m, but accounted for 20% or more of the total mass at 30 m, depending on the sulfur content of the fuel being burned. Organic particles also contributed a significant mass fraction to samples collected at 30 m. As the exhaust plume aged between 1 m and 30 m, more sulfate particles were formed comparing to organic particles. The volatile particle fraction clearly increased with plume age, accounting for 50% to greater than 90% of total number and 40 to 75% of total mass at 30 m, depending on engine power settings and fuel composition.

Results show that within the tested concentration ranges, fuel sulfur and aromatic content did not affect particle emission properties observed at 1 and 10 m. However, significant increases in nucleation mode number densities and mass were observed at the 30 m sampling location when using high sulfur fuel. On both a mass and number basis, the highest concentrations of volatile particles were seen when the engine burned high sulfur fuel. No fuel effect was observed on black carbon emissions for the fuel parameters varied in this study.

Significant variations were found in particle emission indices measured across the diameter of the engine exhaust at the 1 m location. At a given power setting, particle EIn measured within samples from the plume edge can be ten times higher than those from the center of the exhaust plume. This suggests that substantial particle nucleation occurred within samples pulled from the exhaust plume edge where the temperature was colder and exhaust was more diluted by ambient air.

6. Conclusion

With the extensive data acquired and detail analysis performed, our understanding of trace gas species and particle emissions was greatly advanced. As our knowledge deepens, a great number of scientific questions and engineering challenges arise. Areas where critical research efforts are required to: (not in any specific order):

- Develop optimal particle sampling approaches, including low-loss probes and transmission lines
- Obtain detailed knowledge (validated model calculation) of particle evolution within sampling systems under typical operating conditions of temperature, pressure, and velocity
- Observe particle formation/evolution within exhaust plumes, as the plumes age and mix with background air; data over a broad range of ambient conditions and fuel sulfur concentrations is particularly needed to validate existing microphysical models
- Characterize the microphysical properties aircraft-emitted soot, including its morphology, mass density as a function of size, and solubility as a function of fuel sulfur
- Develop an aerodynamic-quench sample probe for accurate measurements of surface-active HC species and CO
- Acquire a more thorough knowledge of the links between fuel composition and soot/secondary particle formation and characteristics
- Determine the links between combustor/engine design and operation and particle emissions

Appendix A
Aircraft CFM56-2-C1 Engine Gas and Particle Emission Data Collected by NASA, UMR, ARI, WPAFB During APEX*

*Contact: Chowen Wey, phone: 216-433-8357, email: Chowen.C.Wey@grc.nasa.gov

TABLE A-1.—AIRCRAFT CFM56-2-C1 ENGINE OPERATIONAL PARAMETERS AND AMBIENT PARAMETERS MEASURED DURING THE AIRCRAFT PARTICLE EMISSIONS EXPERIMENT (APEX).

Test Point No.[1]	Test Date	Fuel Type[2]	Engine Operational Parameters					Ambient Parameters		
			Power	Fan Speed	Core Speed	Exhaust Temp	Fuel Flow Rate	Temp.	Pressure	Dew Point
			%	%	%	K	kg/s	K	Pa	K
301	4/23/2004	base	7	26.4	68.0	753.4	0.122	294	93795	265
302	4/23/2004	base	30	53.9	83.2	789.4	0.307	294	93803	265
303	4/23/2004	base	40	57.9	87.0	810.2	0.357	295	93790	265
304	4/23/2004	base	30	53.8	83.0	780.8	0.295	295	93785	265
305	4/23/2004	base	7	26.8	70.0	743.3	0.118	295	93787	265
306	4/23/2004	base	7	26.1	67.0	769.2	0.123	298	93524	265
307	4/23/2004	base	30	52.6	85.0	781.6	0.281	298	93490	265
308	4/23/2004	base	40	60.2	87.0	825.7	0.361	298	93460	265
308b	4/23/2004	base	40	64.3	87.0	841.0	0.361	299	93458	265
308c	4/23/2004	base	40	60.8	87.0	824.5	0.361	299	93448	265
309	4/23/2004	base	30	52.3	84.0	770.9	0.268	300	93436	265
310	4/23/2004	base	7	26.0	67.0	756.2	0.118	300	93424	265
501	4/25/2004	base	4	21.0	55.0	794.0	NA	301	93876	268
502	4/25/2004	base	65	74.5	90.0	930.6	0.598	301	93856	268
503	4/25/2004	base	70	77.0	93.0	944.0	NA	301	93830	268
504	4/25/2004	base	65	74.5	91.0	916.0	0.598	301	93848	268
505	4/25/2004	base	60	72.0	90.0	898.0	NA	301	93848	268
506	4/25/2004	base	85	83.2	95.0	994.0	0.724	301	93815	268
507	4/25/2004	base	100	86.0	99.0	1020.0	0.806	301	93831	268
508	4/25/2004	base	7	26.5	68.0	757.0	0.118	302	93812	268
509	4/25/2004	base	100	86.0	98.0	1040.0	0.806	303	93845	268
510	4/25/2004	base	85	83.0	96.0	1006.0	0.728	303	93769	268
511	4/25/2004	base	85	83.0	99.0	1041.0	0.800	304	93689	264
512	4/25/2004	base	30	52.5	85.0	792.0	0.281	304	93710	264
513	4/25/2004	base	7	26.5	69.0	779.0	0.121	305	93698	264
514	4/25/2004	base	100	86.0	97.0	1039.0	0.796	306	93660	264
515	4/25/2004	base	30	52.0	70.0	804.0	0.278	306	93700	264
516	4/25/2004	base	7	27.0	70.0	793.0	0.123	306	93729	264
517	4/25/2004	base	85	83.5	98.0	1013.0	0.785	304	93674	264
518	4/25/2004	base	7	26.5	70.0	835.0	0.123	305	93680	264
519	4/25/2004	base	100	86.0	97.0	1042.0	0.844	303	93652	264
520	4/25/2004	base	85	83.0	78.0	1050.0	0.825	305	93652	264
521	4/25/2004	base	30	52.5	75.0	789.0	0.275	305	93654	264
522	4/25/2004	base	7	26.5	70.0	790.0	0.120	305	93626	264
523	4/25/2004	base	100	86.0	96.0	1060.0	0.850	305	93587	264
524	4/25/2004	base	85	83.0	74.0	1040.0	0.773	306	93560	264
525	4/25/2004	base	30	52.5	75.0	795.0	0.267	306	93571	264
526	4/25/2004	base	7	26.5	68.0	796.0	0.122	306	93589	264
601	4/26/2004	base	7	26.4	67.0	745.3	0.121	291	94049	268
602	4/26/2004	base	100	86.0	97.0	1032.0	0.883	291	94073	268
603	4/26/2004	base	85	83.0	95.0	999.0	0.804	291	94060	268
604	4/26/2004	base	30	53.0	73.0	755.0	0.282	291	94058	268
605	4/26/2004	base	7	26.4	68.0	724.5	0.113	291	94057	268
606	4/26/2004	base	100	86.0	95.0	1031.0	0.882	291	94074	268
607	4/26/2004	base	85	83.0	95.0	1001.0	0.784	291	94078	268
608	4/26/2004	base	30	53.0	82.0	764.0	0.283	292	94064	268

TABLE A-1.—(Continued).

Test Point No.[1]	Test Date	Fuel Type[2]	Engine Operational Parameters Power %	Fan Speed %	Core Speed %	Exhaust Temp K	Fuel Flow Rate kg/s	Ambient Parameters Temp. K	Pressure Pa	Dew Point K
609	4/26/2004	base	7	26.4	70.0	728.0	0.116	293	94067	268
610	4/26/2004	base	100	86.0	95.0	1037.0	0.896	295	94064	268
611	4/26/2004	base	85	83.0	97.0	1017.0	0.803	295	94108	268
612	4/26/2004	base	30	53.0	84.0	772.0	0.282	296	94077	268
613	4/26/2004	base	7	26.4	70.0	737.0	0.115	296	94085	268
614	4/26/2004	base	100	86.0	98.0	1044.0	0.871	297	94067	268
615	4/26/2004	base	85	83.0	97.0	1024.0	0.784	297	94028	268
616	4/26/2004	base	30	53.0	85.0	792.0	0.288	297	94059	268
617	4/26/2004	base	7	26.4	70.0	766.5	0.125	298	94068	268
618	4/26/2004	base	4	21.5	60.0	798.0	0.098	305	94016	268
619	4/26/2004	base	100	86.0	97.0	1038.0	0.806	306	94036	268
620	4/26/2004	base	85	83.0	90.0	1008.0	0.707	306	94025	268
621	4/26/2004	base	65	75.0	92.0	932.0	0.554	306	94010	268
622	4/26/2004	base	40	60.0	88.0	821.0	0.329	306	94009	268
623	4/26/2004	base	4	21.0	60.0	788.0	0.094	307	93985	268
624	4/26/2004	base	40	60.0	87.0	813.0	0.362	306	93982	268
625	4/26/2004	base	30	53.0	83.0	785.0	0.265	306	93953	268
626	4/26/2004	base	15	35.0	77.0	756.0	0.146	306	93946	268
627	4/26/2004	base	7	26.4	70.0	761.0	0.118	306	93942	268
628	4/26/2004	base	5.5	24.0	65.0	779.0	0.105	306	93966	268
629	4/26/2004	base	4	21.0	60.0	794.0	0.098	306	93917	268
630	4/26/2004	base	5.5	24.0	65.0	785.0	0.108	307	93928	268
631	4/26/2004	base	7	26.7	70.0	778.0	0.121	307	93926	268
632	4/26/2004	base	15	35.0	78.0	766.0	0.159	307	93938	268
633	4/26/2004	base	30	54.0	85.0	805.0	0.296	307	93922	268
634	4/26/2004	base	4	21.0	60.0	805.0	0.096	306	93916	266
635	4/26/2004	base	40	61.0	87.0	841.7	0.365	308	93914	265
636	4/26/2004	base	30	53.0	85.0	792.0	0.282	307	93916	265
637	4/26/2004	base	15	35.0	78.0	759.0	0.151	308	93883	264
638	4/26/2004	base	7	26.4	68.0	771.7	0.113	308	93886	264
639	4/26/2004	base	5.5	24.0	65.0	778.0	0.105	309	93886	264
640	4/26/2004	base	4	21.0	60.0	797.0	0.100	308	93906	264
641	4/26/2004	base	5.5	24.0	65.0	791.0	0.111	307	93870	264
642	4/26/2004	base	7	26.4	70.0	777.0	0.121	307	93863	264
643	4/26/2004	base	15	35.0	79.0	769.0	0.165	307	93865	264
701	4/27/2004	base	4	21.0	58.0	752.0	0.097	289	93876	269
702	4/27/2004	base	100	86.0	95.0	1037.0	0.879	290	93864	269
703	4/27/2004	base	85	83.0	94.0	1013.0	0.813	290	93897	269
704	4/27/2004	base	65	74.5	90.0	906.0	0.585	290	93896	269
705	4/27/2004	base	4	20.5	59.0	767.0	0.091	290	93916	270
706	4/27/2004	base	100	86.0	97.0	1014.0	0.876	292	93925	270
707	4/27/2004	base	85	83.0	95.0	998.0	0.800	292	93920	270
708	4/27/2004	base	70	77.0	91.0	930.0	0.635	292	93907	270
709	4/27/2004	base	65	74.5	90.0	896.0	0.575	292	93914	270
710	4/27/2004	base	60	72.0	90.0	876.0	0.528	292	93906	270

TABLE A-1.—(Continued).

Test Point No.[1]	Test Date	Fuel Type[2]	Engine Operational Parameters					Ambient Parameters		
			Power	Fan Speed	Core Speed	Exhaust Temp	Fuel Flow Rate	Temp.	Pressure	Dew Point
			%	%	%	K	kg/s	K	Pa	K
711	4/27/2004	base	4	21.0	59.0	755.0	0.093	292	93913	271
712	4/27/2004	base	100	86.0	97.0	1018.0	0.873	293	93929	271
713	4/27/2004	base	85	83.0	96.0	1010.0	0.818	293	93922	271
714	4/27/2004	base	65	74.5	90.0	910.0	0.583	293	93931	271
715	4/27/2004	base	4	20.5	59.0	771.0	0.0932	294	93931	271
716	4/27/2004	base	100	86.0	97.0	1009.0	0.863	294	93908	271
717	4/27/2004	base	85	83.2	95.0	1008.0	0.804	295	93897	271
718	4/27/2004	base	65	74.5	91.0	912.0	0.580	295	93907	271
719	4/27/2004	base	4	20.5	59.0	768.7	0.093	295	93896	272
720	4/27/2004	base	100	86.0	97.0	1011.0	0.848	296	93908	272
721	4/27/2004	base	85	83.0	96.0	1000.0	0.787	296	93904	272
722	4/27/2004	base	70	76.7	92.0	933.0	0.625	296	93894	272
723	4/27/2004	base	65	74.5	91.0	912.0	0.589	297	93901	272
724	4/27/2004	base	60	72.0	90.0	892.0	0.539	297	93898	272
725	4/27/2004	base	4	20.5	59.0	779.0	0.092	297	93886	272
726	4/27/2004	sulfur	4	21.0	60.0	813.0	0.096	306	93079	265
727	4/27/2004	sulfur	100	86.0	97.0	1050.0	0.838	307	93079	265
728	4/27/2004	sulfur	85	83.0	95.0	1036.0	0.753	305	93079	265
729	4/27/2004	sulfur	65	74.5	92.0	948.0	0.575	305	93079	265
730	4/27/2004	sulfur	40	61.0	85.0	829.0	0.346	307	93079	265
731	4/27/2004	sulfur	30	52.5	85.0	784.0	0.264	306	93079	265
732	4/27/2004	sulfur	7	26.5	69.0	767.0	0.112	307	93243	265
733	4/27/2004	sulfur	4	21.5	62.0	797.7	0.097	306	93395	265
734	4/27/2004	sulfur	100	86.0	99.0	1035.0	0.822	306	93377	265
735	4/27/2004	sulfur	85	83.0	97.0	1023.0	0.743	306	93363	265
736	4/27/2004	sulfur	65	74.5	93.0	950.0	0.570	306	93365	265
737	4/27/2004	sulfur	40	60.0	88.0	834.0	0.343	306	93352	265
738	4/27/2004	sulfur	30	52.5	85.0	782.0	0.265	306	97106	265
739	4/27/2004	sulfur	7	26.3	70.0	764.0	0.115	306	93321	265
740	4/27/2004	sulfur	4	21.0	60.0	782.0	0.095	305	93321	265
741	4/27/2004	sulfur	100	86.0	99.0	1046.0	0.824	305	93321	265
742	4/27/2004	sulfur	85	83.5	95.0	1027.0	0.775	307	93321	265
743	4/27/2004	sulfur	70	76.8	94.0	957.0	0.608	306	93308	265
744	4/27/2004	sulfur	65	74.5	92.0	937.0	0.559	305	93306	265
745	4/27/2004	sulfur	60	72.0	91.0	918.0	0.515	305	93314	265
746	4/27/2004	sulfur	40	60.0	88.0	825.0	0.340	305	93314	265
747	4/27/2004	sulfur	30	53.0	85.0	784.0	0.267	305	93314	265
748	4/27/2004	sulfur	15	34.9	78.0	758.0	0.151	305	93314	265
749	4/27/2004	sulfur	7	26.5	70.0	766.0	0.118	305	93314	265
750	4/27/2004	sulfur	5.5	24.0	65.0	777.0	0.106	305	93314	265
751	4/27/2004	sulfur	4	21.3	61.0	796.0	0.098	305	93314	265
801	4/28/2004	sulfur	4	21.0	60.0	786.0	0.098	294	92945	266
802	4/28/2004	sulfur	100	86.0	97.0	1040.0	0.866	294	92934	266
803	4/28/2004	sulfur	85	82.8	93.0	1017.0	0.773	294	92922	265
804	4/28/2004	sulfur	65	74.5	90.0	929.0	0.569	295	92918	266
805	4/28/2004	sulfur	40	60.0	85.7	812.5	0.344	295	92903	266

TABLE A-1.—(Continued).

Test Point No.[1]	Test Date	Fuel Type[2]	Engine Operational Parameters: Power	Fan Speed	Core Speed	Exhaust Temp	Fuel Flow Rate	Ambient Parameters: Temp.	Pressure	Dew Point
			%	%	%	K	kg/s	K	Pa	K
806	4/28/2004	sulfur	30	52.9	82.0	774.0	0.271	296	92895	265
807	4/28/2004	sulfur	7	26.4	69.0	747.0	0.112	296	92901	265
808	4/28/2004	sulfur	4	21.5	60.0	766.0	0.095	296	92896	265
809	4/28/2004	sulfur	100	86.0	98.0	1021.0	0.839	296	92889	265
810	4/28/2004	sulfur	85	83.0	95.0	1013.0	0.767	297	92891	265
811	4/28/2004	sulfur	65	74.5	91.0	926.0	0.568	297	92885	265
812	4/28/2004	sulfur	40	60.7	88.0	816.0	0.347	297	92886	264
813	4/28/2004	sulfur	30	52.9	84.0	777.0	0.277	298	92888	265
814	4/28/2004	sulfur	7	26.4	69.0	754.0	0.112	297	92882	265
815	4/28/2004	sulfur	4	21.5	60.0	779.0	0.097	298	92877	265
816	4/28/2004	sulfur	100	86.0	98.0	1022.0	0.835	298	92877	265
817	4/28/2004	sulfur	85	83.0	93.0	1010.0	0.757	298	92877	265
818	4/28/2004	sulfur	70	76.8	92.0	944.0	0.610	299	92863	266
819	4/28/2004	sulfur	65	74.5	91.0	927.0	0.572	299	92866	266
820	4/28/2004	sulfur	60	71.9	90.0	896.0	0.512	299	92858	266
821	4/28/2004	sulfur	40	60.5	88.0	818.0	0.354	299	92871	266
822	4/28/2004	sulfur	30	52.8	84.0	774.0	0.273	299	92861	266
823	4/28/2004	sulfur	15	34.8	78.0	749.0	0.149	299	92841	266
824	4/28/2004	sulfur	7	26.4	69.0	757.0	0.114	299	92827	266
825	4/28/2004	sulfur	5.5	23.9	65.0	767.0	0.106	300	92829	266
826	4/28/2004	sulfur	4	21.5	60.0	782.0	0.097	299	92818	266
827	4/28/2004	aromatic	4	20.5	58.0	808.0	0.095	302	92597	269
828	4/28/2004	aromatic	100	86.0	98.0	1049.0	0.828	302	92607	269
829	4/28/2004	aromatic	85	83.0	95.0	1020.0	0.748	301	92587	269
830	4/28/2004	aromatic	65	74.6	92.0	936.0	0.563	302	92591	269
831	4/28/2004	aromatic	40	60.4	88.0	825.0	0.340	301	92594	269
832	4/28/2004	aromatic	30	53.5	85.0	780.0	0.271	303	92593	269
833	4/28/2004	aromatic	7	26.1	69.0	754.0	0.110	301	92578	269
834	4/28/2004	aromatic	4	21.5	61.0	781.0	0.096	302	92572	270
835	4/28/2004	aromatic	100	86.0	98.0	1030.0	0.818	302	92566	272
836	4/28/2004	aromatic	85	83.0	95.0	1020.0	0.751	301	92573	271
837	4/28/2004	aromatic	65	74.5	91.0	935.0	0.564	301	92561	271
838	4/28/2004	aromatic	40	60.0	87.0	825.0	0.329	293	92567	271
839	4/28/2004	aromatic	30	52.8	85.0	776.0	0.267	301	92567	271
840	4/28/2004	aromatic	7	26.0	69.0	756.0	0.110	302	92577	270
841	4/28/2004	aromatic	4	21.0	60.0	773.0	0.094	302	92588	271
842	4/28/2004	aromatic	100	86.0	99.0	1030.0	0.825	302	92555	270
843	4/28/2004	aromatic	85	83.0	97.0	1024.0	0.760	302	92561	269
844	4/28/2004	aromatic	100	86.0	100.0	1033.0	0.825	302	92532	272
845	4/28/2004	aromatic	85	83.0	97.0	1011.0	0.750	302	92540	271
846	4/28/2004	aromatic	70	77.0	93.0	945.0	0.598	302	92556	271
847	4/28/2004	aromatic	65	74.5	92.0	924.0	0.554	301	92533	272
848	4/28/2004	aromatic	60	72.0	90.0	906.0	0.513	302	92515	271
849	4/28/2004	aromatic	40	60.4	88.0	820.0	0.340	301	92525	269
850	4/28/2004	aromatic	30	52.9	85.0	775.0	0.267	301	92525	268
851	4/28/2004	aromatic	15	35.0	78.0	747.0	0.151	301	92514	270

TABLE A-1.—(Continued).

Test Point No.[1]	Test Date	Fuel Type[2]	Engine Operational Parameters					Ambient Parameters		
			Power	Fan Speed	Core Speed	Exhaust Temp	Fuel Flow Rate	Temp.	Pressure	Dew Point
			%	%	%	K	kg/s	K	Pa	K
852	4/28/2004	aromatic	7	26.4	69.0	763.0	0.112	302	92500	269
853	4/28/2004	aromatic	5.5	24.0	65.0	766.0	0.106	302	92498	270
854	4/28/2004	aromatic	4	21.0	60.0	781.0	0.096	302	92487	272
855	4/28/2004	aromatic	100	86.5	99.0	1043.0	0.835	302	92513	272
856	4/28/2004	aromatic	85	83.0	96.0	1013.0	0.748	302	92452	271
857	4/28/2004	aromatic	65	74.5	92.0	923.0	0.563	301	92466	272
858	4/28/2004	aromatic	40	60.5	88.0	822.0	0.345	301	92463	270
859	4/28/2004	aromatic	30	52.5	85.0	775.0	0.261	302	92465	263
860	4/28/2004	aromatic	7	26.5	70.0	758.0	0.113	302	92467	261
861	4/28/2004	aromatic	4	21.5	60.0	781.0	0.096	301	92419	272
901	4/29/2004	aromatic	4	20.5	59.0	796.0	0.098	291	93063	268
902	4/29/2004	aromatic	100	86.0	97.0	1061.0	0.891	292	93063	268
903	4/29/2004	aromatic	85	83.0	94.0	1045.0	0.822	292	93066	268
904	4/29/2004	aromatic	65	74.5	90.0	941.0	0.608	292	93080	268
905	4/29/2004	aromatic	40	60.0	86.0	823.0	0.348	292	93071	268
906	4/29/2004	aromatic	30	52.0	82.0	778.0	0.267	292	93069	268
907	4/29/2004	aromatic	7	26.5	70.0	742.0	0.115	293	93069	268
908	4/29/2004	aromatic	4	20.5	60.0	776.0	0.094	293	93054	268
909	4/29/2004	aromatic	100	86.0	98.0	1063.0	0.906	293	93078	268
910	4/29/2004	aromatic	85	83.5	94.0	1029.0	0.796	293	93079	268
911	4/29/2004	aromatic	65	75.0	90.0	938.0	0.592	293	93070	268
912	4/29/2004	aromatic	40	60.4	87.0	817.0	0.355	293	93065	268
913	4/29/2004	aromatic	30	52.0	82.0	774.0	0.275	294	93059	268
914	4/29/2004	aromatic	7	26.5	69.0	741.0	0.112	294	93075	268
915	4/29/2004	aromatic	4	21.5	60.0	765.0	0.094	295	93092	268
916	4/29/2004	aromatic	100	86.0	95.0	1024.0	0.857	295	93097	268
917	4/29/2004	aromatic	85	83.5	94.0	1033.0	0.814	295	93067	268
918	4/29/2004	aromatic	70	76.9	90.0	939.0	0.624	294	93083	268
919	4/29/2004	aromatic	65	74.5	90.0	922.0	0.580	295	93081	268
920	4/29/2004	aromatic	60	72.0	90.0	899.0	0.535	295	93067	268
921	4/29/2004	aromatic	40	60.0	85.0	815.0	0.353	295	93090	268
922	4/29/2004	aromatic	30	53.0	83.0	776.0	0.277	294	93070	268
923	4/29/2004	aromatic	15	35.0	78.0	739.0	0.151	293	93091	268
924	4/29/2004	aromatic	7	26.5	68.0	744.0	0.115	293	93101	268
925	4/29/2004	aromatic	5.5	24.0	65.0	752.0	0.110	292	93101	268
926	4/29/2004	aromatic	4	21.0	60.0	781.0	0.096	292	93151	268
927	4/29/2004	aromatic	100	86.0	98.0	1029.0	0.872	293	93142	268
928	4/29/2004	aromatic	85	83.5	94.0	1009.0	0.781	292	93132	268
929	4/29/2004	aromatic	65	74.8	90.0	936.0	0.586	293	93121	268
930	4/29/2004	aromatic	40	60.5	86.0	826.0	0.378	292	93127	268
931	4/29/2004	aromatic	30	53.0	85.0	800.0	0.278	293	93135	268
932	4/29/2004	aromatic	7	26.5	68.0	769.0	0.113	293	93128	268
933	4/29/2004	aromatic	4	20.8	60.0	783.0	0.096	293	93107	268
934	4/29/2004	sulfur	7	26.5	68.4	827.1	0.123	296	92954	268
935	4/29/2004	sulfur	100	86.0	98.0	1078.0	0.868	296	92929	268
936	4/29/2004	sulfur	85	83.0	95.0	1058.0	0.790	296	92923	268

TABLE A-1.—(Concluded).

Test Point No.[1]	Test Date	Fuel Type[2]	Engine Operational Parameters					Ambient Parameters		
			Power	Fan Speed	Core Speed	Exhaust Temp	Fuel Flow Rate	Temp.	Pressure	Dew Point
			%	%	%	K	kg/s	K	Pa	K
937	4/29/2004	sulfur	75	79.0	93.0	1001.0	0.673	297	92930	268
938	4/29/2004	sulfur	30	52.0	85.0	807.0	0.266	297	92931	268
939	4/29/2004	sulfur	7	26.5	69.7	792.7	0.116	297	92917	268
940	4/29/2004	sulfur	100	85.2	98.0	1069.0	0.843	297	NA	NA
941	4/29/2004	sulfur	85	83.5	97.0	1058.0	0.787	297	92895	268
942	4/29/2004	sulfur	30	52.9	60.0	810.0	0.272	297	92878	268
943	4/29/2004	sulfur	7	27.3	70.0	821.5	0.126	298	92882	268
944	4/29/2004	sulfur	100	86.0	99.0	1087.0	0.863	298	92881	268
945	4/29/2004	sulfur	85	83.5	97.0	1058.0	0.794	298	92867	268
946	4/29/2004	sulfur	30	52.5	85.0	813.0	0.262	297	92879	268
947	4/29/2004	sulfur	7	26.5	70.0	817.0	0.123	297	92870	268
948	4/29/2004	sulfur	100	86.0	98.0	1072.0	0.863	297	92883	268
949	4/29/2004	sulfur	85	83.5	96.0	1051.0	0.781	297	92881	268
950	4/29/2004	sulfur	30	53.0	83.0	819.0	0.270	297	92879	268
951	4/29/2004	sulfur	7	26.5	70.0	798.0	0.118	296	92891	268

Note:
1. The test point No. defines the sequential engine testing conditions.
2. Three types of fuel were used: base for base JP-8 fuel, aromatic for high aromatic fuel, and sulfur for base fuel with sulfur additive.

TABLE A-2.—AIRCRAFT CFM56-2-C1 ENGINE GAS EMISSION DATA MEASURED WITH NASA CONVENTIONAL GAS ANALYZER (CGA) DURING APEX.

Test Point No.[1]	Power	Probe ID[2]	CGA Time		Measured gaseous concentration							Gaseous emission index				Combustion Efficiency	Molar Humidity	Fuel/Air, in sample	Theta[4]	P3norm[4]	T3norm[4]	FAR36norm[4]
	%		Start	End	CO_2 (dry) ppm	CO (dry) ppm	O_2 (dry) %	NOx (wet) ppm	NO(wet) ppm	NO_2 (wet) ppm	HC (wet) ppm	EI[3]CO g/kg fuel	EIHC g/kg fuel	EINOx g/kg fuel	EINO g/kg fuel	%						
301	7	R1G2	9:25:47	9:26:07	25307	461.40	17.32	24.57	12.54	11.99	41.84	36.37	1.94	3.27	1.67	98.952	0.0035	0.0121	1.02	0.150	0.625	0.653
	7	R1G3	9:27:06	9:27:26	25567	468.08	17.26	24.71	12.55	12.12	36.61	36.52	1.68	3.26	1.65	98.974	0.0035	0.0122				
	7	R1G4	9:28:29	9:28:49	23966	454.19	17.47	24.09	11.79	12.20	34.70	37.81	1.70	3.38	1.66	98.942	0.0035	0.0115				
	7	R1G5	9:30:12	9:30:32	22948	436.36	17.62	23.31	11.39	11.90	32.87	37.96	1.68	3.41	1.67	98.940	0.0035	0.0110				
	7	R1G6	9:31:55	9:32:15	21722	422.30	17.79	21.19	10.75	10.39	33.54	38.82	1.81	3.28	1.66	98.907	0.0035	0.0104				
	7	R1G1	9:33:43	9:34:03	20550	384.09	17.97	19.98	10.25	9.72	31.37	37.38	1.79	3.27	1.68	98.943	0.0035	0.0098				
	7	R2G2	9:35:45	9:36:05	1402	23.24	20.51	1.09	0.76	0.33	12.22	41.77	12.64	3.25	2.24	97.755	0.0035	0.0005				
	7	R2G4	9:37:03	9:37:23	1259	21.30	20.56	1.18	0.93	0.23	5.92	44.30	7.08	4.04	3.18	98.251	0.0035	0.0005				
	7	R2G6	9:38:49	9:39:09	1287	21.61	20.56	1.21	1.01	0.20	7.71	43.59	8.95	4.02	3.35	98.082	0.0035	0.0005				
	7	R2G1	9:40:45	9:41:05	1257	20.40	20.56	1.23	1.10	0.14	8.48	42.43	10.14	4.21	3.77	97.989	0.0035	0.0005				
	7	R2G3	9:42:09	9:42:29	1241	20.04	20.55	1.06	0.92	0.19	8.43	42.42	10.26	3.70	3.20	97.977	0.0035	0.0005				
	7	R2G5	9:44:16	9:44:36	1383	22.77	20.54	1.28	1.11	0.17	8.13	41.83	8.59	3.87	3.38	98.158	0.0035	0.0005				
302	30	R1G2	9:48:06	9:48:26	30460	58.35	16.64	69.18	60.61	8.58	7.58	3.88	0.30	7.80	6.84	99.879	0.0035	0.0143	1.02	0.373	0.789	0.621
	30	R1G3	9:49:17	9:49:37	26866	56.51	17.11	60.94	53.32	7.64	7.14	4.27	0.32	7.78	6.80	99.868	0.0035	0.0126				
	30	R1G4	9:51:12	9:51:32	24447	54.11	17.43	56.63	48.70	7.95	6.67	4.50	0.33	7.93	6.82	99.862	0.0035	0.0115				
	30	R1G2	10:05:08	10:05:28	30420	56.20	16.60	69.54	61.47	8.08	17.35	3.74	0.68	7.85	6.94	99.844	0.0035	0.0143				
	30	R1G3	10:06:33	10:06:53	26865	54.31	17.08	61.99	54.30	7.68	14.84	4.10	0.66	7.91	6.93	99.838	0.0035	0.0126				
	30	R1G4	10:07:59	10:08:19	24486	53.53	17.40	55.18	47.96	7.23	13.54	4.44	0.66	7.72	6.71	99.830	0.0035	0.0115				
	30	R1G5	10:09:33	10:09:53	23833	51.43	17.48	53.81	46.88	6.90	12.12	4.38	0.61	7.73	6.73	99.836	0.0035	0.0112				
	30	R1G6	10:11:04	10:11:24	24240	54.08	17.43	58.95	51.21	7.76	11.29	4.53	0.56	8.33	7.23	99.838	0.0035	0.0114				
	30	R1G1	10:12:49	10:13:09	27584	52.53	16.98	63.42	56.50	6.90	9.93	3.86	0.43	7.89	7.03	99.866	0.0035	0.0130				
	30	R2G2	10:14:00	10:14:20	2127	4.62	20.36	4.27	3.87	0.38	10.22	5.10	6.49	7.77	7.05	99.232	0.0035	0.0009				
	30	R2G3	10:15:39	10:15:59	2208	4.62	20.37	4.69	4.33	0.35	8.92	4.88	5.42	8.18	7.56	99.343	0.0035	0.0009				
	30	R2G4	10:17:00	10:17:20	2374	5.72	20.36	4.90	4.66	0.21	4.59	5.57	2.57	7.87	7.50	99.612	0.0035	0.0010				
	30	R2G5	10:18:38	10:18:58	2493	5.77	20.35	5.19	4.95	0.22	4.86	5.31	2.58	7.89	7.53	99.617	0.0035	0.0010				
	30	R2G6	10:20:11	10:20:31	2507	5.68	20.37	5.32	5.07	0.23	5.97	5.19	3.14	8.03	7.65	99.564	0.0035	0.0011				
	30	R2G1	10:21:56	10:22:16	1824	4.27	20.45	3.74	3.55	0.16	6.54	5.67	4.99	8.18	7.78	99.368	0.0035	0.0007				
	30	R2G2	10:23:39	10:23:59	29277	55.48	16.78	68.52	61.00	7.51	8.56	3.84	0.35	8.04	7.15	99.875	0.0035	0.0138				
303	40	R1G2	10:42:56	10:43:16	31892	46.65	16.25	79.52	70.44	9.06	15.51	2.96	0.58	8.58	7.60	99.872	0.0035	0.0150	1.02	0.449	0.832	0.670
	40	R1G3	10:44:19	10:44:39	28088	43.43	16.79	70.85	63.10	7.75	13.89	3.14	0.59	8.66	7.71	99.867	0.0035	0.0132				
	40	R1G4	10:45:42	10:46:02	25382	42.97	17.17	62.88	54.53	8.33	12.77	3.44	0.60	8.49	7.36	99.859	0.0035	0.0119				
	40	R1G5	10:46:55	10:47:15	25168	41.38	17.29	61.37	53.28	8.11	11.93	3.34	0.57	8.36	7.25	99.865	0.0035	0.0118				
	40	R1G6	10:48:40	10:49:00	24996	41.90	17.26	64.03	56.50	7.52	11.00	3.40	0.53	8.78	7.74	99.867	0.0035	0.0118				
	40	R1G1	10:50:43	10:51:03	28105	42.94	16.85	69.78	61.97	7.81	9.58	3.10	0.41	8.52	7.57	99.886	0.0035	0.0132				
	40	R2G3	10:52:09	10:52:29	2242	4.12	20.26	5.63	5.01	0.59	10.04	4.28	6.00	9.65	8.58	99.300	0.0035	0.0009				
	40	R2G3	10:53:13	10:53:33	2169	4.20	20.31	5.11	4.85	0.23	9.62	4.53	5.98	9.10	8.64	99.296	0.0035	0.0009				
	40	R2G4	10:55:02	10:55:22	2364	4.68	20.31	5.66	5.36	0.26	6.70	4.58	3.77	9.13	8.66	99.515	0.0035	0.0010				
	40	R2G5	10:56:38	10:56:58	2417	4.64	20.32	5.87	5.60	0.24	4.30	4.43	2.36	9.26	8.83	99.660	0.0035	0.0010				
	40	R2G6	10:57:57	10:58:17	2768	4.66	20.28	6.57	6.40	0.18	5.51	3.81	2.60	8.87	8.65	99.651	0.0035	0.0012				
	40	R2G1	10:59:41	11:00:01	1954	3.60	20.38	4.57	4.40	0.15	6.61	4.40	4.65	9.21	8.87	99.432	0.0035	0.0008				
	40	R2G2	11:01:14	11:01:34	2072	4.16	20.37	4.97	4.73	0.22	6.96	4.74	4.56	9.35	8.89	99.432	0.0035	0.0008				

TABLE A-2.—(Continued).

Test Point No.[1]	Power	Probe ID[2]	CGA Time		Measured gaseous concentration							Gaseous emission index				Combustion Efficiency	Molar Humidity	Fuel/Air, in sample	Theta[4]	P3norm[4]	T3norm[4]	FAR36norm[4]
	%		Start	End	CO_2 (dry) ppm	CO (dry) ppm	O_2 (dry) %	NOx (wet) ppm	NO(wet) ppm	NO_2 (wet) ppm	HC (wet) ppm	EI^3CO g/kg fuel	EIHC g/kg fuel	EINOx g/kg fuel	EINO g/kg fuel	%						
304	30	R1G2	11:04:50	11:05:10	28753	57.44	16.80	67.99	59.77	8.20	7.38	4.05	0.31	8.12	7.13	99.874	0.0035	0.0135	1.02	0.377	0.794	0.625
	30	R1G3	11:06:17	11:06:37	25797	55.39	17.18	59.90	52.17	7.73	7.09	4.36	0.33	7.96	6.93	99.865	0.0035	0.0121				
	30	R1G4	11:07:54	11:08:14	23994	51.14	17.42	55.39	47.56	7.81	7.09	4.33	0.35	7.90	6.79	99.863	0.0035	0.0113				
	30	R1G5	11:09:15	11:09:35	23552	50.02	17.47	54.14	46.27	7.87	7.11	4.32	0.36	7.87	6.73	99.863	0.0035	0.0111				
	30	R1G6	11:11:03	11:11:23	23666	50.76	17.45	55.25	47.69	7.54	7.04	4.36	0.35	7.99	6.90	99.862	0.0035	0.0111				
	30	R1G1	11:12:13	11:12:33	26902	52.22	17.01	61.97	53.94	8.05	6.39	3.94	0.28	7.90	6.88	99.879	0.0035	0.0127				
305	7	R1G2	11:15:09	11:15:29	24746	396.08	17.27	26.20	13.04	13.13	23.83	32.03	1.13	3.57	1.78	99.134	0.0035	0.0118	1.02	0.154	0.630	0.651
	7	R1G3	11:16:13	11:16:33	24501	411.01	17.28	24.95	11.95	12.95	24.39	33.55	1.17	3.44	1.64	99.095	0.0035	0.0117				
	7	R1G4	11:18:15	11:18:35	23107	391.92	17.48	23.55	11.00	12.48	23.88	33.94	1.21	3.44	1.60	99.081	0.0035	0.0110				
	7	R1G5	11:19:46	11:20:06	22268	379.43	17.60	22.84	10.62	12.19	23.77	34.11	1.25	3.46	1.61	99.073	0.0035	0.0106				
	7	R1G6	11:21:12	11:21:32	21204	373.62	17.73	21.83	10.41	11.39	25.49	35.27	1.41	3.47	1.65	99.030	0.0035	0.0101				
	7	R1G1	11:22:36	11:22:56	21194	351.24	17.74	24.04	11.91	12.07	26.78	33.21	1.48	3.82	1.89	99.071	0.0035	0.0101				
	7	R2G3	11:25:27	11:25:47	1755	28.43	20.35	1.57	1.04	0.49	6.20	38.87	4.88	3.54	2.34	98.599	0.0035	0.0007				
	7	R2G4	11:26:57	11:27:17	1870	29.83	20.33	1.60	1.08	0.54	7.52	37.75	5.48	3.34	2.25	98.565	0.0035	0.0008				
	7	R2G5	11:28:41	11:29:01	1507	24.72	20.40	1.35	1.01	0.38	7.69	40.74	7.29	3.68	2.74	98.314	0.0035	0.0006				
	7	R2G6	11:30:07	11:30:27	1919	31.65	20.35	1.77	1.31	0.47	8.03	38.79	5.66	3.58	2.65	98.522	0.0035	0.0008				
	7	R2G1	11:31:30	11:31:50	1514	24.29	20.40	1.39	1.10	0.28	7.47	39.83	7.05	3.77	2.99	98.360	0.0035	0.0006				
	7	R1G2	11:37:37	11:37:57	24790	383.83	17.25	25.80	13.21	12.57	23.19	31.00	1.10	3.52	1.80	99.162	0.0035	0.0118				
306	7	R1G2	14:52:39	14:52:59	25045	458.31	17.91	24.45	11.00	13.39	33.61	36.52	1.58	3.29	1.48	98.985	0.0035	0.0120	1.03	0.150	0.633	0.663
	7	R1G3	14:53:59	14:54:19	25213	461.13	17.89	24.45	11.03	13.37	29.90	36.50	1.39	3.27	1.47	99.003	0.0035	0.0121				
	7	R1G4	14:55:07	14:55:27	24069	455.64	18.06	23.15	10.28	12.81	28.36	37.78	1.38	3.24	1.44	98.974	0.0035	0.0115				
	7	R1G5	14:56:58	14:57:18	23273	441.91	18.16	22.56	9.75	12.78	27.53	37.91	1.39	3.26	1.41	98.971	0.0035	0.0112				
	7	R1G6	14:58:30	14:58:50	21948	424.55	18.35	21.56	9.44	12.09	29.73	38.63	1.59	3.30	1.45	98.934	0.0035	0.0105				
	7	R1G1	15:00:04	15:00:24	21002	385.91	18.49	22.00	9.63	12.32	30.23	36.75	1.69	3.52	1.54	98.968	0.0035	0.0101				
307	30	R1G2	15:05:19	15:05:39	28454	64.03	17.50	61.29	53.36	7.94	8.46	4.56	0.36	7.39	6.43	99.857	0.0035	0.0134	1.03	0.374	0.800	0.630
	30	R1G3	15:06:34	15:06:54	26112	60.92	17.82	59.15	50.89	8.27	7.26	4.73	0.33	7.76	6.68	99.856	0.0035	0.0123				
	30	R1G4	15:08:06	15:08:26	24175	58.23	18.09	53.94	45.92	7.96	6.38	4.89	0.32	7.64	6.50	99.854	0.0035	0.0114				
	30	R1G5	15:09:44	15:10:04	23481	56.70	18.19	52.24	43.91	8.30	5.83	4.91	0.30	7.61	6.40	99.855	0.0035	0.0111				
	30	R1G6	15:11:08	15:11:28	22867	55.60	18.28	51.15	43.45	7.66	5.98	4.94	0.31	7.65	6.50	99.853	0.0035	0.0108				
	30	R1G1	15:12:46	15:13:06	23995	52.95	18.11	53.11	46.48	6.61	5.12	4.48	0.25	7.58	6.63	99.869	0.0035	0.0113				
	30	R2G2	15:14:08	15:14:28	1837	3.28	21.19	4.37	3.96	0.39	2.85	4.33	2.17	9.52	8.62	99.682	0.0035	0.0007				
	30	R2G3	15:15:37	15:15:57	1986	3.25	21.20	4.63	4.27	0.35	4.50	3.90	3.11	9.18	8.45	99.597	0.0035	0.0008				
	30	R2G4	15:17:06	15:17:26	2067	4.05	21.18	4.70	4.29	0.39	4.71	4.64	3.10	8.88	8.10	99.581	0.0035	0.0008				
	30	R2G5	15:18:45	15:19:05	2204	4.16	21.18	4.90	4.62	0.28	4.58	4.42	2.80	8.60	8.10	99.616	0.0035	0.0009				
	30	R2G6	15:20:17	15:20:37	2321	4.63	21.17	5.30	4.86	0.42	4.42	4.63	2.54	8.74	8.02	99.637	0.0035	0.0010				
	30	R2G1	15:21:46	15:22:06	1702	3.11	21.24	3.92	3.72	0.20	4.35	4.49	3.62	9.37	8.88	99.532	0.0035	0.0007				
	30	R2G1	15:21:46	15:22:06	1702	3.11	21.24	3.92	3.72	0.20	4.35	4.49	3.62	9.37	8.88	99.532	0.0035	0.0007				
	30	R1G2	15:23:32	15:23:52	27384	65.09	17.67	60.93	53.07	7.89	5.45	4.82	0.24	7.63	6.65	99.863	0.0035	0.0129				
	30	R1G4	15:24:46	15:25:06	23698	61.14	18.16	51.99	44.16	7.83	4.70	5.24	0.24	7.51	6.38	99.853	0.0035	0.0112				
308	40	R1G2	15:27:22	15:27:42	31165	40.56	17.11	80.65	71.24	9.39	4.31	2.64	0.17	8.90	7.86	99.921	0.0035	0.0147	1.03	0.450	0.842	0.678
	40	R1G3	15:29:04	15:29:24	28550	39.07	17.47	75.81	66.31	9.48	4.21	2.78	0.18	9.12	7.98	99.917	0.0035	0.0134				
	40	R1G4	15:30:33	15:30:53	26031	34.00	17.81	70.67	61.59	9.09	3.78	2.65	0.17	9.31	8.12	99.920	0.0035	0.0122				

TABLE A-2.—(Continued).

Test Point No.[1]	Power	Probe ID[2]	CGA Time		Measured gaseous concentration							Gaseous emission index				Combustion Efficiency	Molar Humidity	Fuel/Air, in sample	Theta[4]	P3norm[4]	T3norm[4]	FAR36norm[4]
			Start	End	CO_2 (dry)	CO (dry)	O_2 (dry)	NOx (wet)	NO(wet)	NO_2 (wet)	HC (wet)	EI[3]CO	EIHC	EINOx	EINO							
	%				ppm	ppm	%	ppm	ppm	ppm	ppm	g/kg fuel				%						
308b	40	R1G5	15:32:01	15:32:21	25515	30.35	17.89	72.19	62.79	9.39	3.61	2.42	0.17	9.70	8.44	99.926	0.0035	0.0120	1.04	0.491	0.865	0.710
	40	R1G6	15:33:36	15:33:56	25514	28.35	17.89	73.04	64.33	8.73	3.68	2.26	0.17	9.82	8.65	99.930	0.0035	0.0120				
	40	R1G1	15:35:09	15:35:29	25417	25.22	17.89	70.89	62.96	7.92	3.18	2.02	0.15	9.57	8.50	99.938	0.0035	0.0119				
	40	R2G2	15:36:41	15:37:01	2205	1.01	21.12	6.58	6.01	0.58	1.69	1.08	1.04	11.57	10.56	99.871	0.0035	0.0009				
	40	R2G3	15:38:02	15:38:22	2414	1.04	21.10	6.77	6.40	0.34	2.73	1.00	1.51	10.71	10.12	99.826	0.0035	0.0010				
	40	R2G4	15:39:37	15:39:57	2293	1.57	21.13	6.22	5.90	0.31	3.28	1.59	1.92	10.43	9.91	99.771	0.0035	0.0010				
308c	40	R2G5	15:41:01	15:41:21	2525	2.03	21.12	6.91	6.33	0.56	3.30	1.85	1.73	10.38	9.50	99.784	0.0035	0.0011	1.04	0.449	0.844	0.680
	40	R2G6	15:42:31	15:42:51	2746	2.46	21.09	7.47	6.86	0.61	3.29	2.03	1.57	10.20	9.36	99.796	0.0035	0.0012				
	40	R2G1	15:44:07	15:44:27	1952	0.99	21.18	5.35	4.99	0.33	3.16	1.22	2.24	10.85	10.11	99.748	0.0035	0.0008				
	40	R1G2	15:45:42	15:46:02	30966	38.49	17.16	83.11	73.27	9.84	4.25	2.52	0.16	9.23	8.14	99.924	0.0035	0.0146				
309	30	R1G2	15:49:14	15:49:34	27161	61.90	17.66	62.81	53.88	8.98	3.61	4.62	0.16	7.93	6.80	99.876	0.0035	0.0128	1.04	0.372	0.805	0.633
	30	R1G3	15:51:00	15:51:20	25319	60.90	17.91	57.98	49.23	8.79	3.28	4.88	0.15	7.84	6.66	99.870	0.0035	0.0119				
	30	R1G4	15:52:22	15:52:42	23698	58.33	18.13	53.61	45.05	8.52	3.24	5.00	0.16	7.74	6.51	99.866	0.0035	0.0112				
	30	R1G5	15:53:38	15:53:58	23116	59.03	18.22	51.67	42.70	8.93	3.32	5.19	0.17	7.65	6.32	99.861	0.0035	0.0109				
	30	R1G6	15:55:29	15:55:49	22447	56.68	18.31	50.17	42.55	7.61	3.52	5.13	0.19	7.65	6.49	99.861	0.0035	0.0106				
	30	R1G1	15:56:59	15:57:19	24136	52.98	18.07	54.54	46.92	7.59	3.04	4.46	0.15	7.74	6.66	99.880	0.0035	0.0114				
	30	R2G2	15:58:42	15:59:02	1746	2.67	21.17	3.90	3.49	0.37	2.02	3.74	1.64	9.04	8.10	99.748	0.0035	0.0007				
	30	R2G4	16:00:03	16:00:23	2047	3.66	21.15	4.71	4.25	0.47	2.90	4.24	1.94	9.01	8.14	99.707	0.0035	0.0008				
310	7	R1G2	16:02:53	16:03:13	24529	435.06	18.00	25.19	11.52	13.63	23.02	35.44	1.10	3.46	1.58	99.057	0.0035	0.0117	1.04	0.146	0.633	0.673
	7	R1G4	16:04:29	16:04:49	23439	432.63	18.13	23.39	9.80	13.54	21.57	36.87	1.08	3.36	1.41	99.026	0.0035	0.0112				
	7	R1G6	16:05:59	16:06:19	21358	402.56	18.42	21.68	9.23	12.41	22.32	37.69	1.23	3.41	1.45	98.992	0.0035	0.0102				
	7	R2G2	16:07:32	16:07:52	1465	26.59	21.21	1.65	0.86	0.77	5.45	45.40	5.35	4.65	2.43	98.399	0.0035	0.0006				
	7	R2G4	16:09:25	16:09:45	1692	32.14	21.20	3.63	2.16	1.46	7.51	45.73	6.15	8.51	5.08	98.311	0.0035	0.0007				
501	4	R1G2	11:20:45	11:21:05	27440	1125.12	17.21	19.82	10.75	9.04	12.85	80.00	0.54	2.39	1.29	98.067	0.0043	0.0134	1.04	0.111	0.599	0.733
	4																					
502	65	R1G2	11:24:13	11:24:33	36172	21.99	16.15	129.04	120.08	8.76	12.47	1.23	0.42	12.33	11.47	99.930	0.0043	0.0170	1.04	0.634	0.933	0.826
	65	R1G4	11:25:19	11:25:39	33809	26.07	16.47	117.46	107.57	9.44	13.38	1.56	0.48	11.98	10.97	99.916	0.0043	0.0159				
	65	R1G5	11:26:56	11:27:16	30781	23.46	16.90	103.98	94.12	9.57	13.55	1.55	0.53	11.63	10.53	99.911	0.0043	0.0145				
	65	R1G6	11:28:36	11:28:56	30991	22.51	16.93	110.12	100.15	9.65	13.67	1.47	0.53	12.23	11.13	99.912	0.0043	0.0146				
	65	R1G1	11:30:05	11:30:25	28404	15.96	17.28	100.73	92.93	7.76	11.15	1.14	0.47	12.20	11.25	99.926	0.0043	0.0134				
	65	R1G3	11:31:29	11:31:49	34257	20.95	16.49	115.02	107.60	7.27	10.49	1.24	0.37	11.59	10.84	99.934	0.0043	0.0161				
	65	R2G2	11:32:24	11:32:44	3015	1.03	20.74	9.63	8.58	1.01	4.27	0.76	1.83	11.85	10.56	99.799	0.0043	0.0013				
	65	R2G2	11:32:56	11:33:16	2964	0.98	20.79	10.17	9.03	1.11	4.06	0.74	1.77	12.76	11.33	99.805	0.0043	0.0013				
	65	R2G3	11:34:40	11:35:00	3254	1.68	20.77	11.22	10.51	0.66	4.51	1.15	1.78	12.69	11.88	99.795	0.0043	0.0014				
	65	R2G4	11:36:02	11:36:22	3397	0.47	20.76	10.84	10.52	0.32	3.64	0.31	1.37	11.70	11.36	99.856	0.0043	0.0015				
	65	R2G6	11:39:06	11:39:26	3917	1.14	20.71	13.11	12.94	0.16	0.96	0.64	0.31	12.11	11.96	99.954	0.0043	0.0017				
	65	R2G1	11:40:30	11:40:50	2664	0.48	20.88	8.87	8.68	0.19	1.49	0.41	0.74	12.55	12.29	99.917	0.0043	0.0011				
	65	R1G2	11:42:43	11:43:03	35737	19.10	16.32	134.66	124.50	10.12	14.28	1.08	0.48	13.02	12.03	99.926	0.0043	0.0168				
503	70	R1G2	11:44:56	11:45:16	34832	18.79	16.43	133.11	121.98	10.97	15.41	1.09	0.53	13.19	12.09	99.921	0.0043	0.0164	1.04	0.672	0.949	0.857
	70	R1G4	11:46:33	11:46:53	36574	17.57	16.18	144.90	132.50	12.17	17.00	0.97	0.56	13.69	12.52	99.921	0.0043	0.0172				
504	65	R1G2	11:48:39	11:48:59	35790	20.12	16.29	131.73	119.82	11.83	16.55	1.14	0.56	12.71	11.56	99.918	0.0043	0.0168	1.04	0.634	0.933	0.826
	65	R1G3	11:49:57	11:50:17	33907	19.87	16.55	126.64	114.14	12.13	16.95	1.19	0.60	12.88	11.61	99.912	0.0043	0.0159				

TABLE A-2.—(Continued).

Test Point	Power	Probe ID[2]	CGA Time		Measured gaseous concentration							Gaseous emission index				Combustion Efficiency	Molar Humidity	Fuel/Air, in sample	Theta[4]	P3norm[4]	T3norm[4]	FAR36norm[4]
					CO_2 (dry)	CO (dry)	O_2 (dry)	NOx (wet)	NO(wet)	NO_2 (wet)	HC (wet)	EI[3]CO	EIHC	EINOx	EINO							
No.[1]	%		Start	End	ppm	ppm	%	ppm	ppm	ppm	ppm	g/kg fuel				%						
505	60	R1G3	11:51:53	11:52:13	31602	21.15	16.85	107.58	97.09	10.08	14.23	1.36	0.54	11.73	10.58	99.914	0.0043	0.0149	1.04	0.597	0.918	0.797
	60	R1G2	11:53:00	11:53:20	34591	21.70	16.44	119.04	107.69	10.72	15.09	1.27	0.52	11.88	10.74	99.918	0.0043	0.0162				
506	85	R1G2	11:55:06	11:55:26	37889	16.20	15.99	176.27	161.28	14.75	20.43	0.87	0.65	16.09	14.72	99.915	0.0043	0.0178	1.04	0.777	0.990	0.938
	85	R1G3	11:56:41	11:57:01	36645	18.97	16.16	163.19	148.71	14.32	19.87	1.05	0.65	15.39	14.02	99.910	0.0043	0.0172				
507	100	R1G2	11:58:37	11:58:47	39016	17.59	15.85	204.46	187.54	16.74	23.08	0.91	0.71	18.14	16.64	99.907	0.0043	0.0183	1.04	0.828	1.009	0.976
508	7	R1G2	12:06:12	12:06:32	25094	388.82	17.71	28.38	15.37	12.95	18.04	31.03	0.85	3.83	2.07	99.186	0.0043	0.0120	1.05	0.149	0.640	0.673
	7	R1G3	12:08:05	12:08:25	26195	405.49	17.56	28.51	15.29	13.18	19.20	30.98	0.86	3.68	1.98	99.186	0.0043	0.0125				
	7	R1G4	12:09:11	12:09:31	24918	395.99	17.74	26.95	13.89	12.99	18.10	31.81	0.86	3.66	1.88	99.167	0.0043	0.0119				
	7	R1G5	12:10:33	12:10:53	24203	379.98	17.85	26.39	13.78	12.60	17.58	31.44	0.86	3.69	1.93	99.176	0.0043	0.0116				
	7	R1G6	12:11:30	12:11:50	22955	358.37	18.03	25.49	13.86	11.57	16.21	31.29	0.83	3.75	2.04	99.182	0.0043	0.0110				
	7	R1G1	12:13:10	12:13:30	22048	333.34	18.17	26.37	14.67	11.65	16.32	30.34	0.87	4.04	2.25	99.200	0.0043	0.0105				
	7	R2G2	12:14:26	12:14:46	1879	25.97	20.95	3.11	1.39	1.67	6.70	32.78	4.87	6.49	2.89	98.742	0.0043	0.0008				
	7	R2G3	12:15:34	12:15:54	2051	28.25	20.93	2.04	1.51	0.51	5.77	32.16	3.79	3.83	2.85	98.866	0.0043	0.0008				
	7	R2G4	12:16:37	12:16:57	2124	29.61	20.93	2.07	1.59	0.48	5.55	32.35	3.49	3.75	2.87	98.891	0.0043	0.0009				
	7	R2G6	12:18:07	12:18:27	2265	32.83	20.93	2.23	1.76	0.44	5.19	33.26	3.03	3.73	2.94	98.916	0.0043	0.0010				
	7	R2G1	12:19:25	12:19:45	1745	23.97	21.00	1.73	1.51	0.20	4.86	33.14	3.87	3.94	3.46	98.834	0.0043	0.0007				
	7	R1G2	12:20:14	12:20:34	26025	371.14	17.68	28.85	17.52	11.30	15.86	28.58	0.72	3.76	2.28	99.257	0.0043	0.0124				
509	100	R1G2	12:24:25	12:24:35	41129	25.84	15.55	203.70	186.22	17.31	23.84	1.27	0.70	17.17	15.69	99.900	0.0043	0.0193	1.05	0.823	1.014	0.978
510	85	R1G2	12:25:42	12:26:02	38624	19.82	15.89	178.26	162.51	15.40	21.30	1.04	0.67	15.97	14.56	99.909	0.0043	0.0181	1.05	0.768	0.994	0.937
511	85	R1G2	13:23:58	13:24:18	40457	27.19	15.73	200.25	184.23	15.98	22.08	1.36	0.66	17.13	15.76	99.902	0.0030	0.0190	1.06	0.765	0.996	0.939
512	30	R1G2	13:26:15	13:26:35	28141	60.35	17.45	69.05	60.86	8.20	11.74	4.35	0.50	8.41	7.41	99.848	0.0030	0.0132	1.06	0.359	0.807	0.634
	30	R1G4	13:28:02	13:28:22	24565	57.73	17.96	60.70	52.42	8.27	11.83	4.77	0.57	8.45	7.30	99.830	0.0030	0.0116				
513	7	R1G2	13:31:03	13:31:23	26775	440.72	17.74	29.02	14.86	14.12	19.60	32.90	0.86	3.66	1.87	99.141	0.0030	0.0128	1.06	0.148	0.645	0.681
	7	R1G3	13:33:05	13:33:25	26579	464.11	17.65	28.00	13.70	14.27	19.80	34.87	0.88	3.55	1.74	99.093	0.0030	0.0127				
	7	R1G4	13:34:45	13:35:05	25143	449.14	17.85	26.54	12.14	14.36	19.92	35.68	0.93	3.56	1.63	99.069	0.0030	0.0120				
	7	R1G5	13:35:44	13:36:04	24505	431.95	17.92	25.58	12.06	13.47	18.74	35.23	0.90	3.52	1.66	99.083	0.0030	0.0117				
	7	R1G6	13:37:28	13:37:48	22958	409.67	18.14	24.48	11.88	12.58	17.55	35.69	0.90	3.59	1.74	99.072	0.0030	0.0110				
	7	R1G1	13:38:25	13:38:45	22705	392.26	18.17	25.90	13.09	12.80	17.84	34.57	0.92	3.84	1.94	99.095	0.0030	0.0109				
	7	R2G2	13:40:45	13:41:05	1727	31.52	21.16	1.97	1.30	0.67	4.01	43.91	3.22	4.53	2.98	98.647	0.0030	0.0007				
	7	R2G3	13:41:50	13:42:10	1806	33.74	21.17	1.89	1.30	0.60	5.62	44.43	4.26	4.11	2.81	98.530	0.0030	0.0007				
	7	R2G4	13:43:42	13:44:02	1848	33.70	21.17	1.98	1.28	0.68	6.41	43.18	4.72	4.19	2.71	98.513	0.0030	0.0008				
	7	R2G6	13:45:25	13:45:45	2076	39.59	21.14	2.26	1.56	0.67	6.48	44.13	4.16	4.15	2.88	98.547	0.0030	0.0009				
	7	R2G1	13:46:21	13:46:41	1638	30.71	21.17	1.75	1.44	0.31	5.93	45.57	5.06	4.27	3.51	98.423	0.0030	0.0007				
	7	R1G2	13:48:38	13:48:58	26054	440.23	17.74	28.31	14.31	13.96	19.39	33.77	0.88	3.67	1.85	99.119	0.0030	0.0125				
514	100	R1G2	14:01:44	14:01:54	40830	25.87	15.74	195.14	178.64	16.49	22.75	1.28	0.67	16.54	15.14	99.903	0.0030	0.0192	1.06	0.814	1.021	0.982
515	30	R1G2	14:04:12	14:04:32	28911	61.64	17.36	71.08	61.73	9.35	13.25	4.32	0.55	8.43	7.32	99.844	0.0030	0.0136	1.06	0.352	0.809	0.635
	30	R1G4	14:05:50	14:06:10	25092	57.24	17.87	60.24	50.97	9.26	13.14	4.63	0.63	8.22	6.95	99.829	0.0030	0.0118				
	30	R1G2	14:06:45	14:07:05	28701	62.55	17.39	69.14	59.54	9.58	13.57	4.42	0.57	8.26	7.11	99.840	0.0030	0.0135				
516	7	R1G2	14:09:02	14:09:22	27369	412.65	17.52	30.40	16.19	14.15	19.64	30.17	0.85	3.76	2.00	99.207	0.0030	0.0131	1.06	0.151	0.651	0.679
517	85	R1G2	14:12:13	14:12:33	40626	25.08	15.75	192.02	173.37	18.40	25.29	1.25	0.75	16.36	14.77	99.896	0.0030	0.0191	1.06	0.774	0.999	0.945

TABLE A-2.—(Continued).

Test Point No.[1]	Power	Probe ID[2]	CGA Time		Measured gaseous concentration							Gaseous emission index				Combustion Efficiency	Molar Humidity	Fuel/Air, in sample	Theta[4]	P3norm[4]	T3norm[4]	FAR36norm[4]
	%		Start	End	CO_2 (dry) ppm	CO (dry) ppm	O_2 (dry) %	NOx (wet) ppm	NO(wet) ppm	NO_2 (wet) ppm	HC (wet) ppm	EI^3CO g/kg fuel	EIHC g/kg fuel	EINOx g/kg fuel	EINO g/kg fuel	%						
518	7	R1G2	14:14:25	14:14:45	27990	414.36	17.44	29.86	15.57	14.01	19.45	29.62	0.82	3.61	1.88	99.222	0.0030	0.0133	1.06	0.148	0.645	0.681
	7	R1G3	14:15:34	14:15:54	28442	443.18	17.37	29.40	14.87	14.37	19.93	31.15	0.83	3.50	1.77	99.186	0.0030	0.0136				
	7	R1G3	14:15:58	14:16:18	28421	440.83	17.37	29.86	14.85	14.89	20.62	31.01	0.86	3.55	1.77	99.186	0.0030	0.0136				
	7	R1G4	14:17:24	14:17:44	26672	420.68	17.62	29.21	14.11	15.06	20.85	31.55	0.92	3.70	1.79	99.167	0.0030	0.0127				
	7	R1G5	14:19:16	14:19:36	26530	414.51	17.64	28.69	14.61	14.03	19.48	31.26	0.87	3.66	1.86	99.179	0.0030	0.0127				
	7	R1G6	14:20:37	14:20:57	24960	379.45	17.86	27.65	14.58	13.04	18.16	30.45	0.86	3.74	1.97	99.199	0.0030	0.0119				
	7	R1G1	14:22:24	14:22:44	24967	396.45	17.84	28.32	15.91	12.36	17.26	31.79	0.81	3.83	2.15	99.172	0.0030	0.0119				
	7	R2G2	14:23:51	14:24:11	1821	29.60	21.04	2.05	1.38	0.64	1.52	38.81	1.15	4.43	2.99	98.974	0.0030	0.0007				
	7	R2G3	14:25:13	14:25:33	1777	29.49	21.07	1.96	1.32	0.62	2.87	39.77	2.22	4.37	2.93	98.843	0.0030	0.0007				
	7	R2G4	14:26:55	14:27:15	1882	31.48	21.05	2.03	1.39	0.62	3.72	39.61	2.70	4.22	2.89	98.800	0.0030	0.0008				
	7	R2G6	14:28:29	14:28:49	2042	34.97	21.05	2.17	1.50	0.68	3.67	39.90	2.41	4.09	2.82	98.821	0.0030	0.0008				
	7	R2G1	14:29:06	14:29:26	1663	28.49	21.09	1.72	1.47	0.30	3.37	41.63	2.83	4.15	3.53	98.739	0.0030	0.0007				
519	100	R1G2	14:31:16	14:31:26	43156	31.42	15.47	220.99	201.56	19.03	26.13	1.47	0.73	17.75	16.19	99.892	0.0030	0.0202	1.05	0.822	1.014	0.978
520	85	R1G2	14:32:39	14:32:59	40417	24.64	15.78	194.58	176.46	17.97	24.72	1.23	0.74	16.66	15.11	99.897	0.0030	0.0190	1.06	0.762	0.998	0.940
	85	R1G3	14:35:00	14:35:20	41252	29.27	15.65	201.26	182.12	19.01	26.10	1.43	0.76	16.89	15.28	99.890	0.0030	0.0193				
521	30	R1G3	14:36:38	14:36:58	26370	59.85	17.68	64.92	55.55	9.39	13.31	4.60	0.60	8.43	7.21	99.832	0.0030	0.0124	1.06	0.358	0.810	0.636
	30	R1G5	14:38:02	14:38:22	24117	56.24	17.98	58.90	49.63	9.22	13.09	4.73	0.65	8.36	7.04	99.824	0.0030	0.0114				
	30	R1G2	14:39:39	14:39:59	28308	61.44	17.41	69.68	59.88	9.81	13.87	4.40	0.59	8.44	7.25	99.838	0.0030	0.0133				
	30	R2G2	14:43:00	14:43:20	1971	4.34	20.99	5.02	4.48	0.53	0.02	5.27	0.01	10.06	8.97	99.875	0.0030	0.0008				
522	7	R1G2	14:53:12	14:53:32	28279	433.69	17.36	31.17	15.87	15.25	21.10	30.67	0.88	3.73	1.90	99.191	0.0030	0.0135	1.06	0.148	0.645	0.681
	7	R1G3	14:55:00	14:55:20	28066	441.93	17.38	29.90	15.08	14.79	20.49	31.48	0.86	3.60	1.82	99.174	0.0030	0.0134				
	7	R1G4	14:56:19	14:56:39	26489	427.28	17.60	28.31	14.12	14.17	19.66	32.26	0.87	3.61	1.80	99.155	0.0030	0.0127				
	7	R1G5	14:57:18	14:57:38	25918	418.70	17.70	28.04	13.54	14.47	20.07	32.31	0.91	3.65	1.76	99.150	0.0030	0.0124				
	7	R1G6	14:59:02	14:59:22	24468	397.58	17.89	26.58	13.34	13.20	18.38	32.52	0.88	3.67	1.84	99.148	0.0030	0.0117				
	7	R1G1	15:00:40	15:01:00	25368	417.34	17.76	28.33	14.11	14.16	19.66	32.90	0.91	3.77	1.88	99.136	0.0030	0.0121				
	7	R2G2	15:02:22	15:02:42	1709	29.66	21.00	1.98	1.28	0.69	1.81	41.95	1.47	4.62	2.99	98.868	0.0030	0.0007				
	7	R2G3	15:03:49	15:04:09	1836	32.08	21.00	2.06	1.45	0.60	2.93	41.56	2.18	4.39	3.09	98.806	0.0030	0.0007				
	7	R2G4	15:05:59	15:06:19	1814	32.54	21.02	1.95	1.26	0.68	3.09	42.75	2.33	4.23	2.73	98.762	0.0030	0.0007				
	7	R2G6	15:07:01	15:07:21	2170	38.51	20.98	2.34	1.52	0.80	3.05	40.91	1.87	4.10	2.66	98.852	0.0030	0.0009				
	7	R2G1	15:08:45	15:09:05	1613	29.30	21.04	1.89	1.55	0.34	2.66	44.43	2.32	4.73	3.88	98.724	0.0030	0.0006				
	7	R1G2	15:30:43	15:31:03	28035	438.09	17.33	31.01	16.75	14.22	19.73	31.24	0.83	3.74	2.02	99.183	0.0030	0.0134				
523	100	R1G2	15:52:49	15:52:59	42863	31.53	15.41	221.72	201.53	19.90	27.28	1.49	0.77	17.93	16.30	99.888	0.0030	0.0201	1.06	0.816	1.019	0.981
524	85	R1G2	15:53:48	15:54:08	40989	28.74	15.63	192.83	174.62	18.03	24.80	1.42	0.73	16.28	14.75	99.894	0.0030	0.0192	1.06	0.759	1.001	0.941
	85	R1G2	15:54:03	15:54:23	40743	27.51	15.67	191.03	172.83	17.84	24.54	1.37	0.73	16.23	14.68	99.895	0.0030	0.0191				
	85	R1G2	15:54:28	15:54:48	40280	25.76	15.72	186.43	168.37	17.64	24.27	1.29	0.73	16.01	14.46	99.897	0.0030	0.0189				
	85	R1G2	15:54:40	15:55:00	40054	25.59	15.77	188.84	169.77	18.26	25.11	1.29	0.76	16.31	14.66	99.894	0.0030	0.0188				
	85	R1G2	15:55:08	15:55:28	40412	25.65	15.71	192.63	174.24	17.81	24.51	1.28	0.73	16.49	14.92	99.897	0.0030	0.0190				
525	30	R1G2	15:56:29	15:56:49	27719	65.21	17.42	66.76	56.97	9.81	13.87	4.77	0.60	8.25	7.04	99.828	0.0030	0.0131	1.06	0.357	0.812	0.638
	30	R1G4	15:58:18	15:58:38	24196	62.22	17.90	56.82	48.04	8.74	12.45	5.22	0.61	8.03	6.79	99.816	0.0030	0.0114				
	30	R1G4	15:58:50	15:59:10	24125	62.99	17.90	57.42	48.96	8.42	12.02	5.30	0.59	8.14	6.94	99.816	0.0030	0.0114				

TABLE A-2.—(Continued).

Test Point No.[1]	Power	Probe ID[2]	CGA Time		Measured gaseous concentration							Gaseous emission index				Combustion Efficiency	Molar Humidity	Fuel/Air, in sample	Theta[4]	P3norm[4]	T3norm[4]	FAR36norm[4]
					CO_2 (dry)	CO (dry)	O_2 (dry)	NOx (wet)	NO(wet)	NO_2 (wet)	HC (wet)	EI[3]CO	EIHC	EINOx	EINO							
	%		Start	End	ppm	ppm	%	ppm	ppm	ppm	ppm	g/kg fuel				%						
526	7	R1G2	16:01:23	16:01:43	28609	412.76	17.27	31.58	17.25	14.28	19.81	28.87	0.82	3.74	2.04	99.240	0.0030	0.0136	1.06	0.147	0.647	0.684
	7	R1G3	16:02:31	16:02:51	28522	425.76	17.27	31.34	16.61	14.67	20.34	29.86	0.84	3.72	1.97	99.214	0.0030	0.0136				
	7	R1G4	16:03:38	16:03:58	26660	404.18	17.53	28.90	14.81	14.04	19.50	30.34	0.86	3.67	1.88	99.201	0.0030	0.0127				
	7	R1G5	16:05:14	16:05:34	25675	412.92	17.68	27.44	13.13	14.30	19.84	32.17	0.91	3.61	1.73	99.153	0.0030	0.0123				
	7	R1G6	16:06:15	16:06:35	24244	409.37	17.87	25.79	12.55	13.20	18.38	33.78	0.89	3.59	1.75	99.117	0.0030	0.0116				
	7	R1G1	16:07:41	16:08:01	24706	404.30	17.80	27.56	13.48	14.06	19.52	32.74	0.93	3.76	1.84	99.138	0.0030	0.0118				
	7	R1G2	16:10:40	16:11:00	27997	456.03	17.34	29.78	14.71	15.04	20.82	32.54	0.88	3.60	1.78	99.148	0.0030	0.0134				
601	7	R1G2	8:11:18	8:11:38	25347	559.26	17.79	24.40	10.30	14.02	64.80	43.80	2.99	3.23	1.36	98.672	0.0043	0.0122	1.01	0.151	0.619	0.645
	7	R1G3	8:12:44	8:13:04	25125	521.14	17.84	24.43	10.67	13.72	50.29	41.26	2.35	3.27	1.43	98.796	0.0043	0.0121				
	7	R1G4	8:13:48	8:14:08	23727	498.35	18.04	23.02	9.55	13.41	46.06	41.80	2.27	3.26	1.35	98.791	0.0043	0.0114				
	7	R1G5	8:15:06	8:15:26	23242	477.98	18.12	22.66	9.30	13.30	42.16	40.97	2.13	3.27	1.34	98.825	0.0043	0.0112				
	7	R1G6	8:15:59	8:16:19	21813	472.14	18.33	21.44	8.58	12.81	44.95	43.10	2.41	3.30	1.32	98.747	0.0043	0.0105				
	7	R1G1	8:17:38	8:17:58	23496	476.93	18.10	24.27	9.87	14.32	43.97	40.44	2.19	3.47	1.41	98.831	0.0043	0.0113				
	7	R2G2	8:18:53	8:19:13	1650	32.40	21.09	2.01	1.12	0.89	15.46	47.27	12.99	4.84	2.71	97.591	0.0043	0.0007				
	7	R2G3	8:20:07	8:20:27	1692	33.20	21.12	1.77	1.18	0.59	10.19	47.12	8.33	4.16	2.76	98.060	0.0043	0.0007				
	7	R2G4	8:22:28	8:22:48	1988	38.67	21.12	1.87	1.27	0.61	12.92	45.18	8.70	3.62	2.45	98.069	0.0043	0.0008				
	7	R2G6	8:22:45	8:23:05	1981	38.93	21.13	1.90	1.27	0.62	12.94	45.66	8.74	3.69	2.47	98.053	0.0043	0.0008				
	7	R2G1	8:23:50	8:24:10	1494	28.58	21.17	1.54	1.17	0.36	12.31	47.27	11.72	4.22	3.21	97.717	0.0043	0.0006				
	7	R1G2	8:25:34	8:25:54	24523	464.72	18.02	25.36	11.18	14.11	38.39	37.79	1.84	3.48	1.54	98.928	0.0043	0.0118				
602	100	R1G2	8:28:42	8:28:52	42421	27.84	15.57	197.19	179.04	17.79	12.00	1.33	0.34	16.13	14.65	99.935	0.0043	0.0199	1.01	0.859	0.986	0.963
603	85	R1G2	8:30:25	8:30:45	38965	20.62	16.01	167.80	152.78	14.91	9.94	1.07	0.31	14.91	13.58	99.944	0.0043	0.0183	1.01	0.801	0.965	0.922
604	30	R1G2	8:33:35	8:33:55	27606	68.76	17.58	63.05	54.03	9.04	8.94	5.05	0.39	7.84	6.72	99.843	0.0043	0.0130	1.01	0.376	0.782	0.616
	30	R1G4	8:35:16	8:35:36	23776	61.99	18.09	53.86	45.33	8.51	9.02	5.29	0.45	7.76	6.53	99.830	0.0043	0.0112				
605	7	R1G2	8:38:15	8:38:35	24450	482.01	17.97	25.09	10.29	14.73	37.39	39.29	1.79	3.45	1.42	98.898	0.0043	0.0117	1.01	0.151	0.619	0.645
	7	R1G3	8:39:40	8:40:00	24513	488.67	17.97	24.57	9.62	14.90	34.76	39.72	1.66	3.37	1.32	98.900	0.0043	0.0118				
	7	R1G4	8:41:30	8:41:50	23195	468.98	18.20	23.03	7.90	15.08	33.75	40.31	1.71	3.34	1.14	98.883	0.0043	0.0111				
	7	R1G5	8:42:00	8:42:20	22972	419.81	18.23	24.99	11.89	13.05	31.24	36.51	1.60	3.66	1.74	98.983	0.0043	0.0110				
	7	R1G6	8:44:30	8:44:50	21230	435.11	18.46	21.32	7.72	13.58	34.90	40.89	1.93	3.37	1.22	98.847	0.0043	0.0102				
	7	R2G1	8:58:05	8:58:25	1516	28.27	21.04	0.88	0.25	1.03	8.83	46.07	8.28	2.38	0.66	98.089	0.0043	0.0006				
606	100	R1G2	9:05:08	9:05:18	42494	27.22	15.47	197.32	180.77	16.25	8.83	1.30	0.25	16.12	14.77	99.944	0.0043	0.0199	1.01	0.859	0.986	0.963
607	85	R1G2	9:06:16	9:06:36	38987	20.61	15.94	176.16	159.57	16.31	7.63	1.07	0.24	15.65	14.17	99.951	0.0043	0.0183	1.01	0.801	0.965	0.922
608	30	R1G2	9:09:16	9:09:36	27702	67.15	17.49	62.65	53.28	9.19	6.91	4.91	0.30	7.76	6.60	99.855	0.0043	0.0130	1.01	0.375	0.785	0.617
	30	R1G4	9:11:06	9:11:26	23907	61.02	18.00	54.17	45.49	8.65	7.18	5.18	0.36	7.76	6.52	99.842	0.0043	0.0113				
609	7	R1G2	9:13:59	9:14:19	24006	444.46	17.96	25.25	11.01	14.20	32.11	36.96	1.57	3.54	1.54	98.975	0.0043	0.0115	1.02	0.151	0.623	0.651
	7	R1G3	9:16:08	9:16:28	24566	448.92	17.87	25.32	11.05	14.19	28.67	36.48	1.37	3.47	1.52	99.006	0.0043	0.0118				
	7	R1G4	9:17:06	9:17:26	23247	435.74	18.05	23.90	9.34	14.52	28.19	37.43	1.42	3.46	1.35	98.978	0.0043	0.0111				
	7	R1G5	9:18:55	9:19:15	22821	420.18	18.12	23.68	9.68	13.93	27.18	36.79	1.40	3.49	1.43	98.996	0.0043	0.0109				
	7	R1G6	9:20:37	9:20:57	21343	402.48	18.34	22.13	9.08	13.05	28.74	37.69	1.58	3.49	1.43	98.957	0.0043	0.0102				
	7	R1G1	9:21:47	9:22:07	21864	407.14	18.24	24.08	10.24	13.79	33.40	37.21	1.79	3.71	1.58	98.947	0.0043	0.0105				
	7	R2G2	9:23:18	9:23:38	1621	28.74	21.01	1.93	1.18	0.77	11.92	43.03	10.28	4.76	2.91	97.961	0.0043	0.0006				
	7	R2G3	9:23:51	9:24:11	1565	27.83	21.03	1.78	1.11	0.62	10.84	43.56	9.77	4.59	2.86	97.999	0.0043	0.0006				
	7	R2G4	9:26:50	9:27:10	1746	31.76	21.04	1.71	1.15	0.54	9.22	43.50	7.27	3.86	2.59	98.251	0.0043	0.0007				
	7	R2G6	9:28:21	9:28:41	1959	35.02	21.02	1.96	1.22	0.71	5.69	41.90	3.92	3.87	2.41	98.623	0.0043	0.0008				
	7	R2G1	9:29:45	9:30:05	1461	25.63	21.06	1.49	1.11	0.36	6.01	43.91	5.93	4.20	3.14	98.376	0.0043	0.0006				

TABLE A-2.—(Continued).

Test Point No.[1]	Power	Probe ID[2]	CGA Time		Measured gaseous concentration							Gaseous emission index				Combustion Efficiency	Molar Humidity	Fuel/Air, in sample	Theta[4]	P3norm[4]	T3norm[4]	FAR36norm[4]
			Start	End	CO_2 (dry)	CO (dry)	O_2 (dry)	NOx (wet)	NO(wet)	NO_2 (wet)	HC (wet)	EI[3]CO	EIHC	EINOx	EINO							
	%				ppm	ppm	%	ppm	ppm	ppm	ppm	g/kg fuel				%						
526	7	R1G2	16:01:23	16:01:43	28609	412.76	17.27	31.58	17.25	14.28	19.81	28.87	0.82	3.74	2.04	99.240	0.0030	0.0136	1.06	0.147	0.647	0.684
610	100	R1G3	9:40:12	9:40:22	41999	28.53	15.47	198.09	179.19	18.39	7.74	1.37	0.22	16.37	14.80	99.945	0.0043	0.0197	1.02	0.847	0.995	0.968
611	85	R1G3	9:41:44	9:42:04	40287	24.05	15.70	181.61	162.98	18.19	6.37	1.21	0.19	15.62	14.02	99.953	0.0043	0.0189	1.02	0.791	0.975	0.927
612	30	R1G3	9:44:44	9:45:04	25970	59.36	17.67	60.71	51.28	9.43	6.07	4.64	0.28	8.02	6.77	99.863	0.0043	0.0122	1.03	0.372	0.793	0.624
	30	R1G5	9:46:10	9:46:30	23593	56.17	17.99	54.05	45.42	8.61	6.41	4.84	0.32	7.85	6.59	99.854	0.0043	0.0111				
	30	R1G2	9:47:32	9:47:52	26078	58.92	17.65	60.28	50.97	9.31	6.73	4.58	0.31	7.93	6.70	99.861	0.0043	0.0123				
613	7	R1G2	9:49:45	9:50:05	26394	455.68	17.56	27.82	12.87	14.93	24.60	34.48	1.10	3.56	1.65	99.080	0.0043	0.0126	1.03	0.150	0.628	0.659
	7	R1G3	9:51:11	9:51:31	26852	473.68	17.49	27.47	12.13	15.34	22.18	35.21	0.97	3.46	1.53	99.075	0.0043	0.0128				
	7	R1G4	9:53:10	9:53:30	25364	456.24	17.69	26.08	10.93	15.11	21.87	35.92	1.01	3.47	1.45	99.055	0.0043	0.0121				
	7	R1G5	9:54:15	9:54:35	24802	440.22	17.78	25.57	11.00	14.52	21.31	35.46	1.01	3.48	1.50	99.066	0.0043	0.0119				
	7	R1G6	9:56:07	9:56:27	23251	417.67	18.00	24.04	10.28	13.70	22.53	35.91	1.14	3.48	1.49	99.043	0.0043	0.0111				
	7	R1G1	9:57:04	9:57:24	24280	438.84	17.84	26.32	11.73	14.55	26.79	36.10	1.30	3.65	1.63	99.022	0.0043	0.0116				
	7	R2G2	9:59:10	9:59:30	1723	29.41	20.92	1.88	1.15	0.73	9.12	41.01	7.33	4.33	2.65	98.304	0.0043	0.0007				
	7	R2G3	10:00:42	10:01:02	1759	30.49	20.92	1.80	1.15	0.63	5.18	41.55	4.07	4.05	2.58	98.617	0.0043	0.0007				
	7	R2G4	10:01:53	10:02:13	1850	31.90	20.90	1.87	1.14	0.72	4.88	40.92	3.61	3.97	2.41	98.678	0.0043	0.0008				
	7	R2G6	10:03:36	10:03:56	2069	36.22	20.89	2.07	1.28	0.74	6.86	40.61	4.43	3.83	2.37	98.603	0.0043	0.0009				
	7	R2G1	10:05:02	10:05:22	1587	28.25	20.93	1.68	1.20	0.48	7.12	43.60	6.33	4.28	3.05	98.343	0.0043	0.0006				
614	100	R1G3	10:15:57	10:16:07	42838	33.61	15.29	210.00	189.76	19.98	6.64	1.59	0.19	17.02	15.38	99.944	0.0043	0.0201	1.03	0.841	1.000	0.971
615	85	R1G3	10:17:27	10:17:47	40776	27.24	15.56	186.44	167.80	18.16	5.66	1.35	0.17	15.85	14.27	99.951	0.0043	0.0191	1.03	0.785	0.979	0.930
616	30	R1G3	10:20:30	10:20:50	26684	59.83	17.49	62.90	52.81	10.10	5.36	4.55	0.24	8.09	6.79	99.869	0.0043	0.0126	1.03	0.371	0.795	0.626
	30	R1G5	10:22:01	10:22:21	24416	56.25	17.81	57.09	47.30	9.77	5.54	4.68	0.27	8.01	6.64	99.863	0.0043	0.0115				
	30	R1G2	10:22:44	10:23:04	26852	60.05	17.48	63.04	53.65	9.39	5.16	4.54	0.23	8.06	6.85	99.870	0.0043	0.0126				
617	7	R1G2	10:26:00	10:26:20	26623	390.35	17.47	29.70	15.94	13.73	17.11	29.36	0.76	3.78	2.03	99.234	0.0043	0.0127	1.03	0.149	0.632	0.664
	7	R1G3	10:27:20	10:27:40	26327	399.74	17.51	29.09	15.06	13.98	16.55	30.40	0.74	3.74	1.94	99.212	0.0043	0.0126				
	7	R1G4	10:28:41	10:29:01	25054	386.18	17.69	27.44	13.39	14.00	16.24	30.87	0.76	3.71	1.81	99.198	0.0043	0.0120				
	7	R1G5	10:30:00	10:30:20	24504	374.29	17.77	26.85	13.46	13.36	15.91	30.60	0.77	3.71	1.86	99.205	0.0043	0.0117				
	7	R1G6	10:31:08	10:31:28	23033	353.50	17.97	25.43	13.00	12.38	16.88	30.77	0.86	3.73	1.91	99.191	0.0043	0.0110				
	7	R1G1	10:32:21	10:32:41	23409	341.84	17.91	27.03	14.65	12.36	17.51	29.29	0.88	3.91	2.12	99.224	0.0043	0.0112				
	7	R2G2	10:33:44	10:34:04	1642	24.44	20.87	1.90	1.22	0.66	7.54	36.27	6.44	4.65	2.99	98.504	0.0043	0.0007				
	7	R2G3	10:34:45	10:35:05	1788	26.21	20.86	1.99	1.37	0.60	7.01	35.09	5.41	4.41	3.02	98.635	0.0043	0.0007				
	7	R2G4	10:36:18	10:36:38	1866	27.82	20.87	1.98	1.30	0.68	4.56	35.41	3.34	4.17	2.73	98.834	0.0043	0.0008				
	7	R2G6	10:37:12	10:37:32	2018	29.86	20.86	2.13	1.43	0.70	3.56	34.65	2.38	4.09	2.74	98.948	0.0043	0.0008				
618	4	R1G2	11:56:28	11:56:48	27631	908.15	17.04	22.56	7.00	15.50	81.78	64.47	3.43	2.71	0.84	98.143	0.0043	0.0134	1.06	0.114	0.609	0.738
619	100	R1G2	12:01:18	12:01:28	41463	29.72	15.28	200.52	183.42	16.67	13.35	1.45	0.39	16.77	15.34	99.927	0.0043	0.0194	1.06	0.817	1.021	0.982
620	85	R1G2	12:02:23	12:02:43	38858	23.57	15.64	177.24	161.81	15.23	10.37	1.23	0.32	15.79	14.42	99.939	0.0043	0.0182	1.06	0.763	1.001	0.941
	85	R1G3	12:04:27	12:04:47	38217	24.48	15.74	179.19	162.36	16.35	8.37	1.30	0.26	16.23	14.70	99.943	0.0043	0.0179				
621	65	R1G3	12:06:36	12:06:56	33203	21.95	16.42	119.62	106.97	12.42	7.18	1.34	0.26	12.43	11.11	99.943	0.0043	0.0156	1.06	0.633	0.948	0.838
	65	R1G2	12:07:52	12:08:12	35849	24.14	16.08	129.34	115.60	13.28	6.46	1.36	0.22	12.46	11.14	99.946	0.0043	0.0168				
622	40	R1G2	12:10:29	12:10:49	29751	43.47	16.89	83.26	72.52	10.72	5.85	2.96	0.24	9.62	8.38	99.907	0.0043	0.0140	1.06	0.437	0.856	0.686
	40	R1G3	12:12:11	12:12:31	28258	41.78	17.21	77.36	67.15	10.22	5.80	3.00	0.25	9.41	8.17	99.905	0.0043	0.0133				
623	4	R1G3	12:14:54	12:15:14	28198	887.64	17.13	22.61	6.29	16.28	60.80	61.87	2.50	2.67	0.74	98.296	0.0043	0.0137	1.07	0.110	0.609	0.750
	4	R1G2	12:17:29	12:17:49	28864	880.83	17.03	22.47	5.84	16.34	67.34	60.00	2.71	2.60	0.67	98.319	0.0043	0.0140				
	4																					

TABLE A-2.—(Continued).

Test Point No.[1]	Power	Probe ID[2]	CGA Time		Measured gaseous concentration							Gaseous emission index				Combustion Efficiency	Molar Humidity	Fuel/Air, in sample	Theta[4]	P3norm[4]	T3norm[4]	FAR36norm[4]
					CO_2 (dry)	CO (dry)	O_2 (dry)	NOx (wet)	NO(wet)	NO_2 (wet)	HC (wet)	EI^3CO	EIHC	EINOx	EINO							
	%		Start	End	ppm	ppm	%	ppm	ppm	ppm	ppm	g/kg fuel				%						
624	40	R1G2	12:21:15	12:21:35	32347	41.92	16.66	86.06	75.60	10.46	10.67	2.63	0.40	9.16	8.05	99.899	0.0043	0.0152	1.06	0.437	0.856	0.686
	40	R1G3	12:22:20	12:22:40	29292	39.83	17.04	80.42	70.21	10.21	9.29	2.76	0.38	9.44	8.24	99.897	0.0043	0.0138				
	40	R1G4	12:23:42	12:24:02	26926	40.27	17.36	71.18	60.72	10.45	8.64	3.04	0.38	9.08	7.74	99.890	0.0043	0.0127				
	40	R1G5	12:24:36	12:24:56	26667	38.37	17.41	72.46	61.93	10.54	8.10	2.92	0.36	9.33	7.97	99.895	0.0043	0.0125				
	40	R1G6	12:25:42	12:26:02	26863	38.04	17.39	73.89	64.35	9.54	8.06	2.87	0.36	9.44	8.23	99.897	0.0043	0.0126				
	40	R1G1	12:26:58	12:27:18	27304	39.24	17.32	69.98	61.12	8.85	6.73	2.92	0.30	8.80	7.69	99.902	0.0043	0.0128				
	40	R2G2	12:29:02	12:29:22	2705	3.51	20.54	5.86	5.13	1.02	2.38	2.95	1.15	8.14	7.12	99.815	0.0043	0.0011				
	40	R1G2	12:31:00	12:31:20	31694	42.46	16.75	85.03	74.24	10.69	5.42	2.71	0.21	9.24	8.07	99.916	0.0043	0.0149				
	40	R2G3	12:32:25	12:32:45	2884	3.82	20.51	5.84	5.05	1.08	2.31	2.99	1.04	7.55	6.53	99.826	0.0043	0.0012				
	40	R2G4	12:33:45	12:34:05	2871	4.16	20.52	7.21	6.50	0.69	3.63	3.27	1.64	9.36	8.44	99.759	0.0043	0.0012				
	40	R2G6	12:35:20	12:35:40	3408	5.27	20.46	8.13	7.43	0.66	4.67	3.42	1.75	8.72	7.97	99.745	0.0043	0.0015				
	40	R2G1	12:36:34	12:36:54	2544	3.77	20.57	6.09	5.75	0.32	4.87	3.39	2.53	9.06	8.55	99.668	0.0043	0.0011				
	40	R1G2	12:38:08	12:38:28	31732	42.11	16.76	87.51	76.42	11.09	6.27	2.69	0.24	9.50	8.29	99.913	0.0043	0.0149				
625	30	R1G2	12:43:47	12:44:07	28295	61.24	17.19	67.69	57.37	10.35	4.12	4.39	0.17	8.22	6.96	99.879	0.0043	0.0133	1.06	0.362	0.815	0.640
	30	R1G3	12:45:19	12:45:39	26636	60.94	17.40	62.57	52.93	9.65	3.58	4.64	0.16	8.06	6.82	99.875	0.0043	0.0125				
626	15	R1G3	12:47:54	12:48:14	26145	213.43	17.44	36.02	25.08	10.91	6.73	16.46	0.31	4.70	3.27	99.583	0.0043	0.0124	1.06	0.208	0.704	0.626
	15	R1G2	12:49:16	12:49:36	26441	206.29	17.41	37.66	26.94	10.68	6.72	15.74	0.30	4.86	3.48	99.600	0.0043	0.0125				
627	7	R1G2	12:51:51	12:52:11	25152	366.61	17.68	29.21	15.97	13.20	15.03	29.21	0.71	3.93	2.15	99.243	0.0043	0.0120	1.06	0.147	0.646	0.685
	7	R1G3	12:53:09	12:53:29	25346	382.62	17.60	28.23	14.75	13.43	14.42	30.24	0.67	3.77	1.97	99.222	0.0043	0.0121				
628	5.5	R1G3	12:56:06	12:56:26	26774	630.89	17.38	24.95	7.66	17.22	30.58	46.75	1.34	3.13	0.96	98.768	0.0043	0.0129	1.06	0.130	0.629	0.710
	5.5	R1G2	12:57:37	12:57:57	26373	607.09	17.45	25.11	8.82	16.23	33.35	45.70	1.48	3.20	1.12	98.778	0.0043	0.0127				
629	4	R1G2	13:00:47	13:01:07	28499	834.94	17.13	23.82	6.58	17.18	56.42	57.71	2.31	2.79	0.77	98.414	0.0043	0.0138	1.06	0.110	0.608	0.747
	4	R2G6	13:02:50	13:03:10	1872	64.50	20.83	1.78	0.69	1.06	10.29	79.66	7.32	3.63	1.41	97.396	0.0043	0.0008				
	4	R1G2	13:10:02	13:10:22	28404	858.72	17.14	23.82	6.87	16.87	61.27	59.48	2.51	2.80	0.81	98.352	0.0043	0.0138				
630	5.5	R1G2	13:12:43	13:13:03	26807	572.64	17.38	26.36	10.46	15.83	33.76	42.47	1.48	3.31	1.31	98.855	0.0043	0.0129	1.07	0.130	0.631	0.713
	5.5	R2G6	13:14:17	13:14:37	1818	43.79	20.80	1.95	0.89	1.06	7.95	56.78	5.94	4.17	1.90	98.072	0.0043	0.0007				
631	7	R1G2	13:16:36	13:16:56	26800	391.63	17.41	29.93	16.83	13.04	19.49	29.26	0.86	3.78	2.13	99.227	0.0043	0.0128	1.07	0.148	0.650	0.685
	7	R2G6	13:18:14	13:18:34	1732	27.88	20.82	2.22	1.36	0.85	6.77	38.73	5.42	5.10	3.12	98.548	0.0043	0.0007				
632	15	R1G2	13:20:22	13:20:42	26012	168.89	17.54	41.43	31.68	9.70	8.85	13.12	0.41	5.44	4.16	99.651	0.0043	0.0123	1.07	0.208	0.706	0.629
	15	R2G6	13:22:08	13:22:28	1835	13.43	20.81	3.21	2.51	0.68	4.84	17.59	3.65	6.95	5.44	99.221	0.0043	0.0007				
633	30	R1G2	13:24:16	13:24:36	29354	54.38	17.11	72.97	62.83	10.14	6.63	3.76	0.27	8.54	7.36	99.885	0.0043	0.0138	1.07	0.371	0.823	0.647
	30	R2G6	13:25:52	13:26:12	2446	3.63	20.72	6.99	6.25	0.72	3.21	3.42	1.74	10.88	9.74	99.745	0.0043	0.0010				
634	4	R1G2	13:27:55	13:28:15	27866	889.94	17.24	23.35	6.43	16.88	61.71	62.74	2.57	2.79	0.77	98.269	0.0043	0.0135	1.06	0.110	0.608	0.747
	4	R2G6	13:31:10	13:31:30	1923	71.95	20.79	1.71	0.60	1.11	12.32	85.68	8.45	3.37	1.19	97.142	0.0035	0.0008				
	4	R1G2	13:33:55	13:34:15	28294	928.53	17.14	23.01	6.38	16.56	75.64	64.38	3.10	2.70	0.75	98.178	0.0035	0.0138				

TABLE A-2.—(Continued).

Test Point No.[1]	Power	Probe ID[2]	CGA Time		Measured gaseous concentration							Gaseous emission index				Combustion Efficiency	Molar Humidity	Fuel/Air, in sample	Theta[4]	P3norm[4]	T3norm[4]	FAR36norm[4]
					CO_2 (dry)	CO (dry)	O_2 (dry)	NOx (wet)	NO(wet)	NO_2 (wet)	HC (wet)	EI^3CO	EIHC	EINOx	EINO							
	%		Start	End	ppm	ppm	%	ppm	ppm	ppm	ppm	g/kg fuel				%						
635	40	R1G2	13:39:56	13:40:16	32472	36.04	16.65	93.58	81.87	11.72	11.14	2.25	0.41	9.92	8.68	99.906	0.0035	0.0153	1.07	0.439	0.863	0.692
	40	R1G3	13:41:32	13:41:52	28885	33.79	17.12	86.30	75.21	11.07	9.00	2.37	0.37	10.26	8.94	99.907	0.0035	0.0136				
	40	R1G2	13:42:50	13:43:10	31932	34.60	16.72	94.55	82.39	12.15	7.72	2.20	0.29	10.19	8.88	99.919	0.0035	0.0150				
	40	R1G3	13:43:58	13:44:18	28687	32.48	17.15	86.09	75.31	10.79	7.46	2.30	0.31	10.31	9.02	99.915	0.0035	0.0135				
	40	R1G4	13:45:43	13:46:03	26254	31.45	17.47	78.62	67.31	11.29	6.24	2.43	0.28	10.27	8.80	99.914	0.0035	0.0123				
	40	R1G5	13:46:58	13:47:18	25796	34.56	17.53	75.14	63.94	11.22	5.76	2.72	0.27	9.99	8.50	99.909	0.0035	0.0121				
	40	R1G6	13:47:55	13:48:15	26575	35.50	17.44	77.46	66.94	10.52	6.48	2.71	0.29	10.00	8.64	99.907	0.0035	0.0125				
	40	R1G1	13:49:30	13:49:50	28717	32.91	17.15	84.71	73.87	10.83	5.62	2.33	0.23	10.13	8.84	99.922	0.0035	0.0135				
	40	R2G2	13:50:44	13:51:04	2052	1.62	20.70	6.87	6.18	0.66	2.22	1.88	1.48	13.13	11.81	99.808	0.0035	0.0008				
	40	R2G3	13:52:00	13:52:20	2181	2.06	20.71	7.22	6.47	0.74	3.86	2.22	2.39	12.82	11.50	99.709	0.0035	0.0009				
	40	R2G4	13:53:30	13:53:50	2246	2.55	20.71	7.26	6.58	0.67	4.97	2.65	2.97	12.45	11.28	99.641	0.0035	0.0009				
	40	R2G6	13:55:00	13:55:20	2543	2.82	20.69	8.30	7.50	0.78	4.96	2.54	2.58	12.34	11.15	99.683	0.0035	0.0011				
	40	R2G1	13:55:54	13:56:14	1747	2.05	20.78	5.71	5.33	0.37	4.84	2.87	3.90	13.21	12.33	99.543	0.0035	0.0007				
636	30	R1G2	14:00:03	14:00:23	27699	55.02	17.28	71.29	60.55	10.76	4.60	4.03	0.20	8.83	7.50	99.885	0.0035	0.0130	1.07	0.361	0.817	0.642
	30	R1G3	14:01:21	14:01:41	25618	56.78	17.55	63.02	53.53	9.50	4.26	4.50	0.20	8.43	7.16	99.874	0.0032	0.0121				
637	15	R1G2	14:04:23	14:04:43	26278	193.84	17.45	40.47	29.23	11.22	6.28	14.89	0.28	5.25	3.79	99.622	0.0032	0.0124	1.07	0.207	0.708	0.631
	15	R1G3	14:05:29	14:05:49	25209	193.38	17.58	37.61	27.28	10.26	6.46	15.49	0.30	5.08	3.69	99.606	0.0032	0.0119				
	15	R1G2	14:06:33	14:06:53	25499	186.99	17.55	38.54	27.95	10.55	8.61	14.81	0.40	5.15	3.73	99.612	0.0032	0.0121				
638	7	R1G2	14:08:00	14:08:20	26773	461.07	17.35	28.73	13.41	15.29	18.63	34.40	0.82	3.62	1.69	99.110	0.0032	0.0128	1.07	0.146	0.650	0.690
	7	R1G3	14:09:40	14:10:00	25711	462.00	17.48	26.94	12.00	14.92	18.57	35.88	0.85	3.53	1.57	99.072	0.0032	0.0123				
	7	R1G2	14:10:56	14:11:16	26516	455.71	17.38	28.13	13.20	14.89	19.64	34.33	0.87	3.58	1.68	99.106	0.0032	0.0127				
639	5.5	R1G2	14:12:45	14:13:05	27228	600.41	17.27	26.08	9.47	16.59	29.87	43.81	1.28	3.22	1.17	98.842	0.0032	0.0131	1.07	0.130	0.635	0.718
	5.5	R1G3	14:14:30	14:14:50	26418	598.77	17.36	25.25	8.62	16.56	28.57	45.02	1.27	3.21	1.10	98.816	0.0032	0.0127				
640	4	R1G2	14:18:31	14:18:51	27736	772.94	17.19	24.35	7.22	17.07	49.61	54.99	2.08	2.93	0.87	98.500	0.0032	0.0134	1.07	0.110	0.611	0.753
	4	R1G3	14:20:00	14:20:20	26916	783.98	17.29	23.21	5.96	17.20	48.03	57.43	2.07	2.87	0.74	98.443	0.0032	0.0130				
641	5.5	R1G2	14:26:59	14:27:19	26563	530.27	17.37	26.65	11.10	15.49	28.15	39.75	1.24	3.38	1.41	98.942	0.0032	0.0127	1.07	0.130	0.631	0.713
	5.5	R2G6	14:28:03	14:28:23	1745	41.35	20.75	2.10	0.89	1.23	7.11	56.37	5.58	4.72	1.99	98.118	0.0032	0.0007				
642	7	R1G2	14:31:10	14:31:30	26295	395.73	17.44	29.53	15.92	13.57	17.55	30.13	0.79	3.80	2.05	99.213	0.0032	0.0125	1.07	0.146	0.648	0.688
	7	R2G6	14:32:58	14:33:18	1780	31.92	20.77	2.28	1.22	1.04	6.11	42.82	4.72	5.04	2.71	98.522	0.0032	0.0007				
643	15	R1G2	14:35:04	14:35:24	26733	162.57	17.40	42.59	32.81	9.74	7.68	12.29	0.34	5.44	4.19	99.677	0.0032	0.0126	1.07	0.208	0.706	0.629
701	4	R1G2	8:05:38	8:05:58	26660	1269.72	17.84	17.50	4.37	13.07	219.06	91.65	9.34	2.14	0.53	96.913	0.0045	0.0132	1.00	0.114	0.578	0.698
702	100	R1G2	8:10:18	8:10:28	42444	34.55	15.78	190.08	172.95	16.63	23.40	1.65	0.67	15.54	14.14	99.895	0.0046	0.0199	1.01	0.860	0.983	0.962
703	85	R1G2	8:11:18	8:11:38	40623	28.75	16.03	170.45	154.39	15.64	19.07	1.43	0.57	14.55	13.17	99.910	0.0047	0.0191	1.01	0.802	0.963	0.921
	85	R1G3	8:12:47	8:13:07	37730	25.07	16.43	154.68	139.43	14.91	16.83	1.35	0.54	14.18	12.79	99.915	0.0047	0.0177				
704	65	R1G3	8:15:12	8:15:32	31598	18.86	17.30	104.74	93.49	11.28	14.18	1.21	0.54	11.42	10.20	99.918	0.0047	0.0148	1.01	0.656	0.908	0.812
	65	R1G2	8:16:36	8:16:56	33387	18.80	17.06	112.61	101.21	11.06	12.78	1.14	0.46	11.64	10.46	99.927	0.0047	0.0157				
705	4	R1G2	8:19:20	8:19:40	25822	1033.63	18.01	19.38	5.16	14.18	115.73	77.92	5.15	2.47	0.66	97.655	0.0047	0.0127	1.01	0.111	0.576	0.707
	4	R1G3	8:20:54	8:21:14	24296	1024.29	18.24	17.70	3.61	14.04	128.93	81.89	6.07	2.39	0.49	97.469	0.0049	0.0120				
	4	R1G2	8:25:49	8:26:09	26239	1022.67	17.99	19.25	4.43	14.79	132.00	75.88	5.78	2.42	0.56	97.639	0.0049	0.0129				
706	100	R1G2	8:28:59	8:29:09	41476	25.63	15.95	191.30	173.51	17.40	23.19	1.25	0.68	16.01	14.52	99.903	0.0052	0.0194	1.01	0.854	0.988	0.964
707	85	R1G2	8:30:31	8:30:51	40139	22.39	16.13	177.64	160.02	17.38	17.31	1.13	0.52	15.34	13.82	99.921	0.0049	0.0188	1.01	0.797	0.968	0.924
	85	R1G3	8:32:04	8:32:24	36745	21.46	16.61	155.03	138.50	16.15	15.56	1.18	0.51	14.59	13.04	99.921	0.0049	0.0172				
708	70	R1G3	8:34:02	8:34:22	33863	18.86	17.02	123.52	109.56	13.63	13.86	1.13	0.49	12.59	11.17	99.924	0.0049	0.0159	1.01	0.692	0.928	0.846
	70	R1G2	8:35:23	8:35:43	34480	17.25	16.94	128.16	114.25	13.48	12.61	1.01	0.44	12.84	11.44	99.932	0.0049	0.0162				

TABLE A-2.—(Continued).

Test Point No.[1]	Power	Probe ID[2]	CGA Time		Measured gaseous concentration							Gaseous emission index				Combustion Efficiency	Molar Humidity	Fuel/Air, in sample	Theta[4]	P3norm[4]	T3norm[4]	FAR36norm[4]
					CO_2 (dry)	CO (dry)	O_2 (dry)	NOx (wet)	NO(wet)	NO_2 (wet)	HC (wet)	EI[3]CO	EIHC	EINOx	EINO							
	%		Start	End	ppm	ppm	%	ppm	ppm	ppm	ppm	g/kg fuel				%						
709	65	R1G2	8:38:03	8:38:23	33506	17.63	17.06	118.92	105.60	12.83	11.22	1.07	0.40	12.25	10.88	99.935	0.0049	0.0157	1.01	0.652	0.912	0.815
	65	R1G3	8:40:26	8:40:46	31623	18.23	17.29	108.45	95.77	12.25	10.60	1.17	0.40	11.82	10.44	99.932	0.0049	0.0149				
710	60	R1G3	8:42:29	8:42:49	30244	19.94	17.52	98.85	86.76	12.04	10.04	1.34	0.40	11.26	9.88	99.929	0.0049	0.0142	1.01	0.613	0.897	0.785
	60	R1G2	8:44:50	8:45:10	32295	21.19	17.22	104.34	92.35	11.77	9.06	1.33	0.34	11.14	9.86	99.935	0.0052	0.0152				
711	4	R1G2	8:46:58	8:47:18	25973	974.08	18.00	20.15	4.63	15.48	105.60	73.20	4.68	2.56	0.59	97.812	0.0052	0.0127	1.01	0.114	0.583	0.707
	4	R1G3	8:48:21	8:48:41	24347	956.79	18.24	17.96	2.84	15.09	110.17	76.60	5.20	2.43	0.38	97.681	0.0052	0.0119				
	4	R1G2	8:50:38	8:50:58	26078	990.78	18.00	19.66	4.30	15.28	116.60	74.09	5.15	2.49	0.54	97.745	0.0054	0.0128				
712	100	R1G2	8:58:12	8:58:22	42592	27.70	15.78	200.65	181.80	18.28	22.62	1.32	0.64	16.37	14.83	99.905	0.0056	0.0200	1.02	0.851	0.991	0.966
713	85	R1G2	8:59:57	9:00:17	39611	20.66	16.22	178.55	160.06	18.01	17.39	1.06	0.53	15.63	14.01	99.922	0.0056	0.0186	1.02	0.794	0.970	0.925
	85	R1G3	9:01:13	9:01:33	37570	21.45	16.46	157.54	140.95	16.27	16.30	1.16	0.52	14.52	12.99	99.920	0.0056	0.0176				
714	65	R1G3	9:04:17	9:04:37	31490	17.76	17.29	102.67	90.44	12.13	14.15	1.14	0.54	11.25	9.91	99.919	0.0056	0.0148	1.02	0.650	0.915	0.816
	65	R1G2	9:06:09	9:06:29	33598	17.72	17.03	116.84	103.84	12.34	12.73	1.07	0.46	12.01	10.67	99.929	0.0056	0.0158				
715	4	R1G2	9:08:20	9:08:40	26051	983.03	17.99	19.57	4.84	14.69	107.40	73.63	4.75	2.48	0.61	97.795	0.0056	0.0128	1.02	0.110	0.583	0.719
	4	R1G3	9:10:03	9:10:23	24698	1012.00	18.17	18.11	2.86	15.23	117.21	79.71	5.45	2.41	0.38	97.583	0.0056	0.0121				
	4	R1G2	9:11:32	9:11:52	26177	1007.21	17.98	19.45	4.27	15.13	121.41	74.98	5.34	2.45	0.54	97.705	0.0056	0.0128				
716	100	R1G2	9:17:31	9:17:41	42057	24.74	15.85	197.54	178.05	18.91	22.89	1.19	0.66	16.31	14.70	99.906	0.0056	0.0197	1.02	0.848	0.993	0.967
717	85	R1G2	9:19:00	9:19:20	40577	21.77	16.05	185.59	166.34	18.68	18.48	1.09	0.55	15.87	14.23	99.919	0.0056	0.0190	1.02	0.793	0.976	0.930
	85	R1G3	9:20:11	9:20:31	37914	22.50	16.42	167.33	150.60	16.50	17.40	1.20	0.55	15.29	13.76	99.916	0.0056	0.0178				
718	65	R1G3	9:22:46	9:23:06	32457	18.71	17.20	115.27	102.22	12.61	14.95	1.17	0.55	12.26	10.87	99.917	0.0056	0.0152	1.02	0.646	0.919	0.819
	65	R1G2	9:24:10	9:24:30	33705	18.81	17.02	118.46	105.04	13.17	13.78	1.13	0.49	12.14	10.76	99.924	0.0056	0.0158				
719	4	R1G2	9:26:15	9:26:35	26051	983.03	17.99	19.57	4.84	14.69	107.40	73.63	4.75	2.48	0.61	97.795	0.0057	0.0128	1.02	0.109	0.585	0.722
	4	R1G3	9:28:15	9:28:35	24627	1006.96	18.18	17.36	3.44	13.89	115.87	79.55	5.40	2.32	0.46	97.591	0.0057	0.0121				
	4	R1G2	9:32:30	9:32:50	26571	965.94	17.94	18.78	3.80	14.96	120.50	70.99	5.23	2.34	0.47	97.809	0.0058	0.0130				
720	100	R1G2	9:34:29	9:34:39	41549	23.05	15.91	192.81	174.31	18.26	22.68	1.12	0.66	16.11	14.57	99.908	0.0057	0.0195	1.03	0.843	0.998	0.969
721	85	R1G2	9:36:04	9:36:24	39957	19.20	16.13	174.29	156.75	17.39	18.12	0.97	0.55	15.13	13.61	99.922	0.0057	0.0187	1.03	0.787	0.977	0.929
	85	R1G3	9:37:29	9:37:49	37340	19.85	16.49	160.83	144.25	16.21	17.21	1.08	0.56	14.91	13.38	99.919	0.0057	0.0175				
722	70	R1G3	9:39:35	9:39:55	33842	17.20	16.99	122.13	108.22	13.33	15.31	1.03	0.54	12.47	11.05	99.921	0.0057	0.0159	1.03	0.678	0.936	0.847
	70	R1G2	9:40:50	9:41:10	34944	16.70	16.84	127.95	112.90	14.64	14.10	0.97	0.49	12.66	11.17	99.929	0.0058	0.0164				
723	65	R1G2	9:43:05	9:43:25	34361	18.27	16.91	116.89	103.35	13.22	12.91	1.08	0.45	11.76	10.40	99.929	0.0057	0.0161	1.03	0.642	0.924	0.821
	65	R1G3	9:44:59	9:45:19	32650	18.22	17.14	107.75	95.04	12.46	12.62	1.13	0.47	11.39	10.05	99.927	0.0057	0.0153				
724	60	R1G3	9:47:22	9:47:42	30282	18.71	17.47	98.32	86.49	11.44	11.95	1.25	0.47	11.19	9.85	99.923	0.0057	0.0142	1.03	0.604	0.908	0.792
	60	R1G2	9:48:42	9:49:02	32614	19.43	17.15	105.41	92.68	12.55	11.18	1.21	0.41	11.16	9.81	99.930	0.0058	0.0153				
725	4	R1G2	9:52:10	9:52:30	26921	995.30	17.86	18.93	3.76	14.83	107.80	72.18	4.62	2.33	0.46	97.842	0.0058	0.0132	1.03	0.109	0.588	0.728
726	4	R1G2	15:06:36	15:06:56	28201	917.21	17.02	21.83	3.88	17.93	135.14	63.69	5.54	2.57	0.46	97.950	0.0035	0.0137				
727	100	R1G2	15:12:20	15:12:30	43762	33.69	15.08	219.00	201.00	18.00	46.51	1.56	1.29	17.36	15.93	99.835	0.0035	0.0205	1.07	0.807	1.024	0.983
728	85	R1G2	15:14:10	15:14:30	40890	27.00	15.42	195.00	177.00	18.00	39.48	1.33	1.17	16.51	14.98	99.852	0.0035	0.0192	1.06	0.758	0.998	0.940
	85	R1G3	15:15:55	15:16:15	37778	26.28	15.84	171.16	155.02	16.31	35.94	1.41	1.15	15.65	14.17	99.852	0.0035	0.0177				
729	65	R1G3	15:17:30	15:17:50	32594	20.68	16.54	121.54	108.28	12.92	35.83	1.29	1.32	12.83	11.43	99.838	0.0035	0.0153	1.06	0.622	0.943	0.831
	65	R1G2	15:19:21	15:19:41	34847	20.48	15.74	128.76	114.27	14.11	31.53	1.19	1.09	12.74	11.30	99.863	0.0035	0.0164				
730	40	R1G2	15:22:40	15:23:00	29071	39.18	17.03	83.62	72.50	10.89	28.21	2.73	1.16	9.87	8.56	99.820	0.0035	0.0137	1.07	0.444	0.865	0.695
	40	R1G3	15:24:30	15:24:50	26508	36.83	17.36	74.97	64.84	9.90	27.61	2.82	1.24	9.69	8.38	99.809	0.0035	0.0125				
731	30	R1G3	15:26:54	15:27:14	24918	54.63	17.59	59.94	50.73	8.93	26.00	4.45	1.25	8.23	6.97	99.771	0.0035	0.0117	1.06	0.356	0.812	0.638
	30	R1G2	15:29:18	15:29:38	26914	55.16	17.32	67.52	57.58	9.54	23.74	4.16	1.05	8.60	7.33	99.797	0.0035	0.0127				

TABLE A-2.—(Continued).

Test Point No.[1]	Power	Probe ID[2]	CGA Time		Measured gaseous concentration							Gaseous emission index				Combustion Efficiency	Molar Humidity	Fuel/Air, in sample	Theta[4]	P3norm[4]	T3norm[4]	FAR36norm[4]
			Start	End	CO_2 (dry)	CO (dry)	O_2 (dry)	NOx (wet)	NO(wet)	NO_2 (wet)	HC (wet)	EI^3CO	EIHC	EINOx	EINO							
	%				ppm	ppm	%	ppm	ppm	ppm	ppm	g/kg fuel				%						
732	7	R1G2	15:31:40	15:32:00	26358	422.50	17.37	26.91	12.84	13.90	39.50	32.03	1.76	3.45	1.65	99.071	0.0035	0.0126	1.07	0.147	0.649	0.687
	7	R1G3	15:33:20	15:33:40	24902	395.99	17.56	25.21	11.21	13.91	38.15	31.80	1.80	3.42	1.52	99.073	0.0035	0.0119				
733	4	R1G3	15:35:32	15:35:52	25803	716.16	17.42	20.79	3.87	16.93	72.01	54.77	3.24	2.69	0.50	98.389	0.0035	0.0125	1.06	0.114	0.611	0.741
	4	R1G2	15:37:02	15:37:22	28062	744.85	17.11	23.37	5.85	17.41	72.73	52.40	3.02	2.78	0.70	98.467	0.0035	0.0136				
	4	R1G2	15:38:18	15:38:38	28190	739.90	17.09	23.81	5.84	17.63	71.58	51.83	2.96	2.82	0.69	98.486	0.0035	0.0136				
734	100	R1G2	15:44:43	15:44:53	42780	29.97	15.19	208.96	189.79	19.05	23.15	1.42	0.65	16.94	15.38	99.901	0.0035	0.0201	1.06	0.812	1.021	0.982
735	85	R1G2	15:46:20	15:46:40	40074	25.29	15.53	185.55	167.06	18.41	20.16	1.28	0.61	16.03	14.43	99.909	0.0035	0.0188	1.06	0.758	1.001	0.941
	85	R1G3	15:47:37	15:47:57	38204	26.73	15.79	182.83	164.67	17.99	20.80	1.42	0.66	16.54	14.90	99.901	0.0035	0.0179				
736	65	R1G3	15:49:24	15:49:44	32595	21.24	16.54	123.52	109.15	13.86	20.02	1.32	0.74	13.05	11.53	99.895	0.0035	0.0153	1.06	0.622	0.945	0.832
	65	R1G2	15:51:24	15:51:44	35291	21.19	16.18	135.00	120.69	14.10	17.04	1.22	0.58	13.20	11.80	99.913	0.0035	0.0166				
737	40	R1G2	15:53:53	15:54:13	29247	37.23	16.99	85.86	74.73	11.10	16.13	2.58	0.66	10.08	8.78	99.873	0.0035	0.0138	1.06	0.435	0.856	0.686
	40	R1G3	15:55:22	15:55:42	26783	35.89	17.32	76.96	66.57	10.39	16.71	2.72	0.75	9.84	8.52	99.862	0.0025	0.0126				
738	30	R1G3	15:57:57	15:58:17	25131	30.98	17.54	61.18	51.32	9.87	16.20	2.50	0.77	8.34	7.00	99.864	0.0035	0.0118	1.06	0.356	0.812	0.638
	30	R1G2	15:59:49	16:00:09	26979	57.14	17.30	66.30	56.35	9.96	14.84	4.30	0.66	8.42	7.16	99.833	0.0032	0.0127				
739	7	R1G2	16:03:12	16:03:32	26317	386.78	17.35	28.83	15.01	13.76	28.99	29.42	1.30	3.71	1.93	99.179	0.0035	0.0126	1.06	0.146	0.646	0.686
	7	R1G3	16:05:10	16:05:30	25334	377.82	17.48	27.10	13.41	13.63	28.16	29.86	1.31	3.62	1.79	99.167	0.0035	0.0121				
740	4	R1G3	16:07:10	16:07:30	26607	768.34	17.28	21.90	4.57	17.27	70.29	56.91	3.07	2.74	0.57	98.356	0.0035	0.0129	1.06	0.110	0.606	0.744
	4	R1G2	16:09:10	16:09:30	28162	795.97	17.07	23.54	6.01	17.49	75.22	55.70	3.11	2.79	0.71	98.381	0.0035	0.0136				
741	100	R1G2	16:15:51	16:16:01	43806	35.13	15.01	229.11	211.80	17.31	17.23	1.62	0.48	18.15	16.78	99.914	0.0035	0.0205	1.06	0.814	1.019	0.981
742	85	R1G2	16:17:22	16:17:42	41077	27.87	15.38	200.02	180.34	18.96	14.33	1.37	0.42	16.87	15.21	99.926	0.0035	0.0193	1.07	0.764	1.006	0.949
	85	R1G3	16:18:43	16:19:03	38220	27.91	15.76	189.08	170.73	18.34	15.32	1.48	0.48	17.10	15.44	99.917	0.0035	0.0179				
743	70	R1G3	16:21:21	16:21:41	34106	21.03	16.30	135.85	120.04	15.58	14.14	1.25	0.50	13.73	12.13	99.921	0.0035	0.0160	1.06	0.656	0.960	0.860
	70	R1G2	16:23:07	16:23:27	35749	19.73	16.09	144.91	129.32	15.66	11.96	1.12	0.40	13.99	12.49	99.933	0.0035	0.0168				
744	65	R1G2	16:25:40	16:26:00	34623	20.50	16.25	131.01	116.46	14.24	10.63	1.20	0.37	13.05	11.60	99.935	0.0035	0.0163	1.06	0.623	0.943	0.831
	65	R1G3	16:27:22	16:27:42	31988	20.49	16.58	120.49	106.51	13.66	11.96	1.30	0.45	12.97	11.46	99.925	0.0035	0.0150				
745	60	R1G3	16:29:26	16:29:46	30800	21.66	16.75	110.26	96.51	13.54	11.82	1.43	0.46	12.32	10.78	99.920	0.0035	0.0145	1.06	0.587	0.927	0.802
	60	R1G2	16:31:18	16:31:38	33633	22.12	16.38	116.42	103.17	13.06	9.81	1.33	0.35	11.93	10.57	99.934	0.0035	0.0158				
746	40	R1G2	16:33:36	16:33:56	28772	38.39	17.03	80.02	69.20	10.80	9.45	2.71	0.39	9.55	8.26	99.897	0.0035	0.0135	1.06	0.436	0.854	0.684
	40	R1G3	16:35:11	16:35:31	26717	36.30	17.31	73.90	62.68	11.18	10.11	2.76	0.45	9.49	8.05	99.890	0.0035	0.0126				
747	30	R1G3	16:37:10	16:37:30	25156	54.97	17.52	59.35	48.97	10.35	9.84	4.44	0.47	8.08	6.67	99.849	0.0035	0.0118	1.06	0.362	0.813	0.639
	30	R1G2	16:39:10	16:39:30	26833	56.00	17.31	64.44	54.54	9.92	8.92	4.23	0.40	8.23	6.97	99.861	0.0035	0.0126				
748	15	R1G2	16:41:17	16:41:37	25767	177.56	17.43	37.78	27.39	10.33	11.63	13.92	0.54	5.00	3.62	99.619	0.0035	0.0122	1.06	0.207	0.701	0.625
	15	R1G3	16:42:55	16:43:15	24446	176.63	17.61	35.49	24.76	10.70	12.09	14.60	0.59	4.95	3.45	99.598	0.0035	0.0116				
749	7	R1G3	16:44:52	16:45:12	25128	365.95	17.49	26.44	12.70	13.72	24.03	29.18	1.13	3.56	1.71	99.202	0.0035	0.0120	1.06	0.148	0.645	0.681
	7	R1G2	16:46:40	16:47:00	25901	362.24	17.39	28.14	14.84	13.26	22.21	28.03	1.01	3.68	1.94	99.240	0.0035	0.0123				
750	5.5	R1G2	16:48:38	16:48:58	27148	540.28	17.21	25.57	9.36	16.18	35.16	39.61	1.52	3.17	1.16	98.917	0.0035	0.0130	1.06	0.131	0.628	0.707
	5.5	R1G3	16:51:10	16:51:30	26214	538.34	17.33	24.38	7.55	16.78	37.18	40.86	1.66	3.13	0.97	98.874	0.0035	0.0126				
751	4	R1G3	16:53:06	16:53:26	27146	769.66	17.18	22.39	4.54	17.82	67.22	55.90	2.88	2.75	0.56	98.399	0.0035	0.0131	1.06	0.112	0.608	0.740
	4	R1G2	16:55:30	16:55:50	27852	791.69	17.08	22.48	5.34	17.10	77.70	56.00	3.24	2.69	0.64	98.360	0.0035	0.0135				
801	4	R1G2	8:04:30	8:04:50	27389	1146.82	17.56	19.35	4.46	14.86	240.28	80.95	10.01	2.31	0.53	97.097	0.0037	0.0135	1.02	0.113	0.587	0.712
802	100	R1G2	8:07:41	8:07:51	42265	30.58	15.65	197.77	181.80	15.77	60.17	1.46	1.72	16.21	14.90	99.794	0.0038	0.0198	1.02	0.840	0.993	0.967
803	85	R1G2	8:09:38	8:09:58	40338	23.51	15.93	177.12	162.17	14.47	43.11	1.18	1.29	15.19	13.91	99.843	0.0035	0.0189	1.02	0.781	0.971	0.923
	85	R1G3	8:11:13	8:11:33	36479	21.01	16.48	160.45	145.14	15.11	37.29	1.17	1.23	15.18	13.73	99.850	0.0036	0.0171				

TABLE A-2.—(Continued).

Test Point No.[1]	Power	Probe ID[2]	CGA Time		Measured gaseous concentration							Gaseous emission index				Combustion Efficiency	Molar Humidity	Fuel/Air, in sample	Theta[4]	P3norm[4]	T3norm[4]	FAR36norm[4]
					CO_2 (dry)	CO (dry)	O_2 (dry)	NOx (wet)	NO(wet)	NO_2 (wet)	HC (wet)	EI^3CO	EIHC	EINOx	EINO							
	%		Start	End	ppm	ppm	%	ppm	ppm	ppm	ppm	g/kg fuel				%						
804	65	R1G3	8:13:24	8:13:44	31622	16.83	17.17	110.58	98.90	11.13	30.52	1.08	1.16	12.03	10.76	99.859	0.0036	0.0149	1.02	0.640	0.919	0.819
	65	R1G2	8:14:47	8:15:07	33930	17.35	16.86	119.52	108.49	10.70	26.78	1.04	0.95	12.14	11.02	99.881	0.0036	0.0159				
805	40	R1G2	8:17:44	8:18:04	27934	36.27	17.70	76.39	66.73	9.64	22.05	2.63	0.94	9.38	8.20	99.844	0.0036	0.0131	1.02	0.446	0.832	0.670
	40	R1G3	8:19:30	8:19:50	25530	34.69	18.04	69.27	59.09	10.13	20.43	2.76	0.96	9.30	7.93	99.840	0.0036	0.0120				
	40	R1G2	8:22:04	8:22:24	28162	36.47	17.68	75.02	65.39	9.62	17.72	2.63	0.75	9.14	7.97	99.863	0.0036	0.0133				
	40	R1G3	8:23:05	8:23:25	25711	33.73	18.01	69.63	59.30	10.30	17.02	2.66	0.79	9.29	7.91	99.858	0.0037	0.0121				
	40	R1G4	8:24:24	8:24:44	24954	33.40	18.11	67.60	56.69	10.92	17.73	2.72	0.85	9.28	7.79	99.851	0.0037	0.0117				
	40	R1G5	8:25:41	8:26:01	25956	33.40	17.98	70.35	59.68	10.64	17.00	2.61	0.78	9.29	7.88	99.860	0.0035	0.0122				
	40	R1G6	8:26:44	8:27:04	25671	35.21	18.03	71.26	60.45	10.79	16.77	2.78	0.78	9.51	8.07	99.856	0.0035	0.0121				
	40	R1G1	8:28:03	8:28:23	30449	38.43	17.36	80.72	69.28	11.44	14.25	2.56	0.56	9.11	7.82	99.884	0.0034	0.0143				
	40	R2G6	8:29:36	8:29:56	2948	0.56	21.10	9.07	7.89	1.17	13.30	0.43	5.83	11.40	9.91	99.407	0.0034	0.0013				
	40	R2G1	8:31:01	8:31:21	2612	0.52	21.16	8.18	7.17	1.01	12.37	0.45	6.21	11.78	10.32	99.368	0.0034	0.0011				
	40	R1G2	8:32:31	8:32:51	28287	36.33	17.69	77.70	67.32	10.38	11.66	2.61	0.49	9.43	8.17	99.889	0.0034	0.0133				
	40	R1G1	8:35:43	8:36:03	30461	39.30	17.35	81.25	69.58	11.64	9.79	2.62	0.39	9.17	7.85	99.900	0.0035	0.0143				
806	30	R1G1	8:37:52	8:38:12	27641	59.94	17.74	64.51	54.12	10.37	9.18	4.40	0.40	8.00	6.72	99.857	0.0035	0.0130	1.03	0.368	0.793	0.623
	30	R1G2	8:39:33	8:39:53	25589	59.78	18.02	59.78	49.92	9.83	9.29	4.74	0.43	8.00	6.68	99.845	0.0035	0.0120				
807	7	R1G2	8:42:37	8:42:57	24980	443.37	18.06	25.87	11.20	14.64	35.78	35.43	1.68	3.49	1.51	98.999	0.0033	0.0120	1.03	0.149	0.628	0.659
	7	R1G1	8:45:06	8:45:26	24732	419.21	18.10	26.62	11.32	15.26	38.96	33.87	1.85	3.63	1.54	99.019	0.0033	0.0118				
808	4	R1G1	8:47:05	8:47:25	26295	794.44	17.84	22.13	4.93	17.14	108.63	59.38	4.78	2.79	0.62	98.127	0.0033	0.0128	1.03	0.116	0.594	0.712
	4	R1G2	8:48:35	8:48:55	26527	816.18	17.81	21.74	4.88	16.81	99.80	60.46	4.36	2.72	0.61	98.144	0.0034	0.0129				
809	100	R1G2	8:55:14	8:55:24	42318	26.84	15.69	206.76	188.95	17.41	19.84	1.28	0.57	16.94	15.48	99.913	0.0034	0.0198	1.03	0.834	0.998	0.969
810	85	R1G2	8:57:00	8:57:20	39940	20.95	16.01	184.65	167.74	16.27	13.59	1.06	0.41	16.00	14.54	99.934	0.0034	0.0187	1.03	0.776	0.979	0.930
	85	R1G1	8:58:27	8:58:47	37797	13.70	16.31	181.81	165.31	16.14	11.37	0.73	0.36	16.63	15.12	99.947	0.0034	0.0177				
811	65	R1G1	9:00:44	9:01:04	35887	16.28	16.57	135.59	121.59	13.69	9.21	0.92	0.31	13.04	11.70	99.948	0.0034	0.0168	1.03	0.636	0.924	0.821
	65	R1G2	9:02:13	9:02:33	33892	16.85	16.86	123.42	110.76	12.05	8.58	1.01	0.30	12.55	11.27	99.946	0.0034	0.0159				
812	40	R1G2	9:04:09	9:04:29	28286	34.20	17.63	80.48	70.92	9.53	8.20	2.45	0.35	9.77	8.61	99.908	0.0032	0.0133	1.03	0.449	0.839	0.677
	40	R1G3	9:05:59	9:06:19	25780	32.50	17.98	72.34	62.90	9.44	9.79	2.56	0.45	9.62	8.36	99.894	0.0032	0.0121				
	40	R1G4	9:07:23	9:07:43	25067	31.80	18.07	70.40	58.88	11.49	9.93	2.58	0.47	9.62	8.05	99.892	0.0032	0.0118				
	40	R1G5	9:08:57	9:09:17	26061	31.55	17.94	73.19	62.11	11.08	9.43	2.46	0.43	9.63	8.17	99.899	0.0032	0.0123				
	40	R1G6	9:10:29	9:10:49	26122	32.56	17.92	73.53	62.54	10.97	9.36	2.53	0.43	9.65	8.21	99.898	0.0032	0.0123				
	40	R1G1	9:12:08	9:12:28	30552	35.80	17.31	82.91	70.91	11.98	7.39	2.38	0.29	9.33	7.98	99.915	0.0032	0.0144				
	40	R2G6	9:14:00	9:14:20	3168	0.54	21.05	10.05	8.86	1.17	7.36	0.38	2.98	11.68	10.30	99.693	0.0033	0.0014				
	40	R2G4	9:15:10	9:15:30	2722	0.64	21.11	8.66	7.57	1.07	7.05	0.53	3.38	11.92	10.42	99.649	0.0033	0.0012				
	40	R1G2	9:17:05	9:17:25	28651	33.58	17.61	80.92	70.04	10.87	6.65	2.38	0.28	9.70	8.40	99.916	0.0033	0.0135				
813	30	R1G2	9:25:00	9:25:20	26024	53.94	17.94	62.51	52.49	10.01	6.01	4.21	0.28	8.23	6.91	99.874	0.0034	0.0122	1.03	0.366	0.797	0.627
	30	R1G1	9:26:36	9:26:56	28065	55.24	17.65	67.64	56.89	10.76	5.22	3.99	0.22	8.27	6.95	99.884	0.0034	0.0132				
814	7	R1G1	9:29:15	9:29:35	24877	420.88	18.04	26.41	11.40	14.97	32.47	33.81	1.53	3.58	1.54	99.052	0.0034	0.0119	1.03	0.149	0.630	0.661
	7	R1G2	9:31:05	9:31:25	25487	434.25	17.96	26.29	12.01	14.25	28.99	34.04	1.34	3.48	1.59	99.067	0.0034	0.0122				
815	4	R1G2	9:33:29	9:33:49	26928	809.46	17.72	22.36	5.50	16.82	81.38	59.14	3.51	2.76	0.68	98.260	0.0034	0.0131	1.03	0.115	0.597	0.718
	4	R1G1	9:35:01	9:35:21	26736	791.16	17.73	22.44	5.18	17.22	98.86	58.21	4.29	2.79	0.64	98.204	0.0035	0.0130				
816	100	R1G1	9:41:46	9:41:56	40880	23.33	15.74	203.12	185.30	17.61	17.49	1.15	0.52	17.21	15.70	99.921	0.0035	0.0192	1.03	0.828	1.002	0.972
817	85	R1G2	9:43:22	9:43:42	40023	21.88	15.91	184.45	167.56	16.72	12.07	1.11	0.36	15.96	14.50	99.938	0.0035	0.0188	1.03	0.774	0.982	0.931
	85	R1G1	9:45:08	9:45:28	38356	14.83	16.15	181.63	164.26	17.10	9.39	0.78	0.30	16.38	14.81	99.952	0.0035	0.0180				

TABLE A-2.—(Continued).

Test Point No.[1]	Power	Probe ID[2]	CGA Time		Measured gaseous concentration							Gaseous emission index				Combustion Efficiency	Molar Humidity	Fuel/Air, in sample	Theta[4]	P3norm[4]	T3norm[4]	FAR36norm[4]
			Start	End	CO_2 (dry)	CO (dry)	O_2 (dry)	NOx (wet)	NO(wet)	NO_2 (wet)	HC (wet)	EI^3CO	EIHC	EINOx	EINO							
	%				ppm	ppm	%	ppm	ppm	ppm	ppm	g/kg fuel				%						
818	70	R1G1	9:47:22	9:47:42	36676	13.74	16.39	147.67	133.48	13.99	7.56	0.76	0.25	13.91	12.57	99.957	0.0035	0.0172	1.04	0.668	0.943	0.852
	70	R1G2	9:48:57	9:49:17	34971	15.23	16.64	135.15	122.43	12.30	6.90	0.88	0.24	13.34	12.08	99.956	0.0036	0.0164				
819	65	R1G2	9:51:06	9:51:26	33975	16.34	16.78	125.12	111.56	13.03	6.20	0.97	0.22	12.70	11.32	99.955	0.0036	0.0160	1.04	0.632	0.929	0.824
	65	R1G1	9:52:36	9:52:56	35819	15.22	16.52	137.06	122.80	13.80	5.65	0.86	0.19	13.21	11.84	99.961	0.0036	0.0168				
820	60	R1G1	9:54:45	9:55:05	34963	18.43	16.64	124.90	111.02	13.30	5.14	1.07	0.18	12.33	10.96	99.957	0.0036	0.0164	1.04	0.594	0.912	0.793
	60	R1G2	9:56:05	9:56:25	32032	17.33	17.07	111.00	98.99	11.64	5.04	1.10	0.19	11.94	10.64	99.955	0.0037	0.0150				
821	40	R1G2	9:58:37	9:58:57	28477	32.58	17.55	83.21	72.71	10.12	5.34	2.32	0.22	10.04	8.77	99.923	0.0037	0.0134	1.04	0.447	0.844	0.680
	40	R1G1	10:00:26	10:00:46	30649	35.60	17.24	84.05	72.39	11.63	4.51	2.36	0.18	9.43	8.12	99.927	0.0037	0.0144				
822	30	R1G1	10:02:39	10:02:59	27840	54.41	17.63	67.47	56.70	10.78	4.38	3.96	0.19	8.32	6.99	99.888	0.0037	0.0131	1.04	0.364	0.799	0.628
	30	R1G2	10:04:09	10:04:29	25993	53.19	17.89	62.70	53.17	9.51	4.88	4.15	0.22	8.27	7.01	99.880	0.0037	0.0122				
823	15	R1G2	10:06:20	10:06:40	25012	194.56	18.01	36.21	25.35	10.82	9.83	15.70	0.47	4.93	3.45	99.584	0.0038	0.0118	1.04	0.209	0.689	0.611
	15	R1G1	10:08:29	10:08:49	24977	182.29	18.02	37.78	26.77	10.97	9.17	14.74	0.44	5.16	3.65	99.610	0.0038	0.0118				
824	7	R1G1	10:10:09	10:10:29	25248	409.20	17.97	27.05	12.26	14.75	27.68	32.41	1.29	3.62	1.64	99.109	0.0038	0.0121	1.04	0.149	0.634	0.666
	7	R1G2	10:11:44	10:12:04	25671	426.75	17.91	26.80	12.49	14.30	25.99	33.23	1.19	3.52	1.64	99.100	0.0038	0.0123				
825	5.5	R1G2	10:14:05	10:14:25	26347	592.07	17.80	24.30	7.97	16.29	43.91	44.62	1.95	3.10	1.02	98.757	0.0038	0.0127	1.04	0.131	0.618	0.695
	5.5	R1G1	10:16:01	10:16:21	26183	564.83	17.81	24.68	7.91	16.70	48.22	42.86	2.16	3.17	1.01	98.777	0.0038	0.0126				
826	4	R1G1	10:18:08	10:18:28	26647	794.24	17.73	22.38	5.28	17.04	98.89	58.62	4.30	2.79	0.66	98.192	0.0038	0.0129	1.04	0.115	0.599	0.720
	4	R1G2	10:19:45	10:20:05	27124	813.42	17.66	22.43	5.67	16.73	84.26	58.99	3.61	2.75	0.70	98.254	0.0038	0.0132				
827	4	RIG2	12:51:35	12:51:55	28861	1006.81	17.32	21.46	4.20	17.24	136.79	68.14	5.48	2.46	0.48	97.852	0.0048	0.0141	1.05	0.114	0.604	0.729
	4	RIG1	12:52:49	12:53:09	27078	995.61	17.58	20.31	3.85	16.45	174.27	71.61	7.40	2.47	0.47	97.577	0.0049	0.0133				
828	100	RIG2	12:55:22	12:55:32	43727	35.55	15.39	216.66	199.33	16.94	29.16	1.64	0.81	17.21	15.83	99.881	0.0048	0.0205	1.05	0.816	1.012	0.977
829	85	RIG2	12:57:03	12:57:23	40633	26.50	15.80	184.48	168.06	16.07	20.86	1.32	0.62	15.74	14.34	99.907	0.0048	0.0191	1.04	0.764	0.989	0.935
	85	RIG1	12:58:18	12:58:38	37033	17.33	16.31	176.58	160.68	15.58	17.81	0.95	0.58	16.49	15.01	99.920	0.0049	0.0174				
830	65	RIG1	13:00:15	13:00:35	36421	19.62	16.40	137.59	123.53	14.04	14.31	1.09	0.47	13.06	11.73	99.927	0.0049	0.0171	1.05	0.627	0.936	0.829
	65	RIG2	13:01:39	13:01:59	34857	20.45	16.62	126.94	114.15	12.36	12.73	1.19	0.44	12.58	11.31	99.928	0.0048	0.0164				
831	40	RIG2	13:04:15	13:04:35	29236	37.40	17.41	81.32	70.47	10.82	10.90	2.59	0.45	9.57	8.29	99.894	0.0048	0.0138	1.04	0.443	0.848	0.682
	40	RIG1	13:05:46	13:06:06	30152	38.53	17.28	81.50	70.16	11.33	9.64	2.59	0.38	9.30	8.01	99.901	0.0049	0.0142				
832	30	RIG1	13:07:54	13:08:14	28375	54.38	17.51	67.71	56.67	11.05	8.43	3.89	0.36	8.20	6.86	99.873	0.0045	0.0134	1.05	0.367	0.811	0.638
	30	RIG2	13:09:50	13:10:10	27151	53.25	17.69	64.97	55.28	9.69	8.06	3.98	0.36	8.22	6.99	99.871	0.0049	0.0128				
833	7	RIG2	13:12:01	13:12:21	26310	432.84	17.77	26.63	12.46	14.13	27.53	32.88	1.23	3.42	1.60	99.104	0.0049	0.0126	1.04	0.146	0.635	0.675
	7	RIG1	13:13:32	13:13:52	24499	396.67	18.02	25.77	11.41	14.30	31.27	32.39	1.50	3.55	1.57	99.089	0.0049	0.0117				
834	4	RIG1	13:16:25	13:16:45	26297	739.12	17.73	21.54	4.93	16.58	86.72	55.40	3.84	2.73	0.62	98.315	0.0049	0.0127	1.05	0.114	0.604	0.729
	4	RIG2	13:17:47	13:18:07	27645	766.98	17.55	22.29	5.86	16.41	74.42	54.71	3.14	2.70	0.71	98.401	0.0054	0.0134				
835	100	RIG2	13:26:24	13:26:34	43145	32.16	15.48	209.13	190.30	18.50	13.03	1.51	0.37	16.86	15.34	99.928	0.0059	0.0202	1.05	0.815	1.012	0.977
836	85	RIG2	13:27:51	13:28:11	40337	25.19	15.86	181.16	162.79	17.83	9.68	1.26	0.29	15.59	14.01	99.941	0.0059	0.0189	1.04	0.764	0.989	0.935
	85	RIG3	13:29:26	13:29:46	38376	25.77	16.15	171.07	154.55	16.56	9.79	1.36	0.31	15.44	13.95	99.937	0.0053	0.0180				
837	65	RIG3	13:31:10	13:31:30	32315	19.43	16.98	112.98	100.67	11.96	9.23	1.22	0.34	12.06	10.75	99.937	0.0053	0.0152	1.04	0.627	0.933	0.826
	65	RIG2	13:32:58	13:33:18	34675	20.15	16.66	124.02	110.98	12.57	7.01	1.18	0.24	12.36	11.06	99.948	0.0054	0.0163				
838	40	RIG2	13:35:05	13:35:25	28704	39.87	17.48	77.54	67.59	9.98	6.47	2.82	0.27	9.30	8.11	99.907	0.0059	0.0135	1.02	0.447	0.828	0.667
	40	RIG3	13:36:34	13:36:54	26197	38.64	17.81	69.13	59.80	9.30	7.14	3.00	0.33	9.07	7.84	99.897	0.0054	0.0123				
839	30	RIG3	13:40:06	13:40:26	24930	53.68	18.02	57.39	48.01	9.36	6.53	4.37	0.31	7.90	6.61	99.866	0.0053	0.0117	1.04	0.362	0.803	0.631
	30	RIG2	13:41:09	13:41:29	26899	54.77	17.76	63.74	53.49	10.23	5.71	4.13	0.25	8.14	6.83	99.878	0.0054	0.0127				

TABLE A-2.—(Continued).

Test Point No.[1]	Power	Probe ID[2]	CGA Time		Measured gaseous concentration							Gaseous emission index				Combustion Efficiency	Molar Humidity	Fuel/Air, in sample	Theta[4]	P3norm[4]	T3norm[4]	FAR36norm[4]
			Start	End	CO_2 (dry)	CO (dry)	O_2 (dry)	NOx (wet)	NO(wet)	NO_2 (wet)	HC (wet)	EI[3]CO	EIHC	EINOx	EINO							
	%				ppm	ppm	%	ppm	ppm	ppm	ppm	g/kg fuel				%						
840	7	RIG2	13:43:39	13:43:59	25697	425.16	17.87	26.07	11.91	14.12	25.20	33.08	1.16	3.43	1.57	99.107	0.0054	0.0123	1.05	0.145	0.636	0.678
	7	RIG3	13:45:08	13:45:28	25132	422.88	17.94	24.28	10.26	13.96	25.87	33.64	1.21	3.26	1.38	99.089	0.0050	0.0120				
841	4	RIG3	13:47:55	13:48:15	26082	811.22	17.77	20.15	3.59	16.48	78.70	61.15	3.50	2.57	0.46	98.213	0.0054	0.0127	1.05	0.111	0.601	0.736
	4	RIG2	13:49:27	13:49:47	27881	833.74	17.53	21.74	5.09	16.58	84.59	58.82	3.53	2.60	0.61	98.265	0.0054	0.0135				
842	100	RIG2	13:56:30	13:56:40	43329	32.05	15.45	211.88	192.63	19.13	13.21	1.50	0.37	16.99	15.45	99.928	0.0049	0.0203	1.05	0.815	1.012	0.977
843	85	RIG2	13:58:02	13:58:22	38708	27.83	16.07	176.40	158.93	17.13	10.05	1.46	0.31	15.78	14.22	99.934	0.0049	0.0182	1.05	0.762	0.991	0.936
844	100	RIG2	14:11:33	14:11:43	43056	30.98	15.40	210.14	191.47	18.45	13.83	1.46	0.39	16.97	15.46	99.927	0.0058	0.0202	1.05	0.815	1.012	0.977
845	85	RIG2	14:12:52	14:13:12	40239	24.69	15.81	184.47	167.30	16.74	10.02	1.24	0.30	15.90	14.42	99.941	0.0053	0.0189	1.05	0.761	0.991	0.936
	85	RIG3	14:14:25	14:14:45	37749	24.76	16.17	168.81	151.73	16.64	9.43	1.33	0.30	15.49	13.92	99.939	0.0058	0.0177				
846	70	RIG3	14:17:22	14:17:42	33733	18.91	16.75	123.75	110.22	13.31	8.10	1.14	0.29	12.68	11.29	99.944	0.0062	0.0158	1.05	0.663	0.952	0.858
	70	RIG2	14:19:16	14:19:36	35140	17.91	16.56	134.41	120.93	13.19	6.14	1.03	0.21	13.22	11.89	99.955	0.0049	0.0165				
847	65	RIG2	14:21:27	14:21:47	34262	20.05	16.71	121.18	108.08	12.63	5.34	1.19	0.19	12.22	10.90	99.953	0.0053	0.0161	1.04	0.627	0.933	0.826
	65	RIG1	14:22:47	14:23:07	36168	19.62	16.45	129.94	116.64	13.11	5.24	1.10	0.17	12.44	11.17	99.957	0.0062	0.0170				
848	60	RIG1	14:24:55	14:25:15	36117	22.21	16.44	122.14	108.35	13.54	4.36	1.25	0.15	11.70	10.38	99.956	0.0058	0.0170	1.05	0.588	0.920	0.798
	60	RIG2	14:26:30	14:26:50	33089	22.10	16.86	109.90	97.46	12.02	4.10	1.35	0.15	11.47	10.17	99.953	0.0053	0.0155				
849	40	RIG2	14:29:41	14:30:01	28924	36.88	17.45	80.57	70.14	10.12	4.22	2.59	0.18	9.58	8.34	99.922	0.0049	0.0136	1.04	0.443	0.848	0.682
	40	RIG1	14:31:30	14:31:50	26770	34.64	17.75	74.19	64.06	9.95	5.05	2.63	0.23	9.52	8.22	99.916	0.0049	0.0126				
850	30	RIG1	14:33:46	14:34:06	27962	56.97	17.59	67.37	56.97	10.33	3.74	4.13	0.16	8.27	7.00	99.887	0.0044	0.0132	1.04	0.363	0.803	0.632
	30	RIG2	14:35:06	14:35:26	26706	54.74	17.76	63.89	53.70	10.19	3.98	4.16	0.18	8.21	6.90	99.884	0.0044	0.0126				
851	15	RIG2	14:37:27	14:37:47	25430	183.65	17.93	36.34	25.90	10.39	7.83	14.58	0.37	4.88	3.47	99.621	0.0044	0.0120	1.04	0.210	0.694	0.615
	15	RIG1	14:39:14	14:39:34	24971	174.08	18.00	37.39	26.66	10.68	7.87	14.09	0.38	5.11	3.65	99.632	0.0054	0.0118				
852	7	RIG1	14:41:27	14:41:47	25285	409.34	17.94	25.74	11.20	14.49	26.13	32.38	1.22	3.44	1.50	99.117	0.0049	0.0121	1.05	0.148	0.639	0.674
	7	RIG2	14:42:52	14:43:12	26261	433.18	17.80	25.61	11.31	14.26	24.34	32.97	1.09	3.30	1.46	99.116	0.0048	0.0126				
853	5.5	RIG2	14:44:51	14:45:11	26967	552.28	17.68	24.59	8.39	16.12	34.02	40.74	1.48	3.07	1.05	98.895	0.0049	0.0129	1.05	0.131	0.622	0.699
	5.5	RIG1	14:46:10	14:46:30	24852	518.10	17.91	23.03	7.19	15.79	40.92	41.49	1.93	3.12	0.97	98.832	0.0053	0.0119				
854	4	RIG1	14:48:12	14:48:32	27260	822.18	17.63	21.49	4.38	17.08	97.46	59.29	4.16	2.63	0.54	98.192	0.0058	0.0132	1.05	0.111	0.601	0.736
	4	RIG2	14:50:18	14:50:38	28347	860.22	17.45	21.70	4.70	16.91	87.40	59.65	3.59	2.55	0.55	98.240	0.0058	0.0138				
855	100	RIG2	14:58:13	14:58:23	43173	33.41	15.49	214.12	194.83	18.70	15.02	1.56	0.42	17.25	15.70	99.921	0.0062	0.0202	1.05	0.824	1.015	0.984
856	85	RIG1	14:59:40	15:00:00	37719	18.72	16.24	169.44	152.95	15.98	10.19	1.00	0.33	15.56	14.05	99.944	0.0057	0.0177	1.05	0.761	0.991	0.936
	85	RIG2	15:00:59	15:01:19	39909	23.88	15.94	180.02	162.27	17.46	8.23	1.21	0.25	15.65	14.11	99.947	0.0057	0.0187				
857	65	RIG2	15:03:15	15:03:35	34427	19.47	16.70	120.62	107.22	13.04	6.52	1.15	0.23	12.11	10.77	99.950	0.0061	0.0162	1.04	0.626	0.933	0.826
	65	RIG3	15:05:03	15:05:23	32127	19.57	17.02	112.15	99.17	12.33	7.27	1.24	0.27	12.05	10.65	99.944	0.0056	0.0151				
858	40	RIG3	15:06:58	15:07:18	26410	34.39	17.80	72.80	63.14	9.57	7.30	2.64	0.33	9.47	8.22	99.905	0.0052	0.0124	1.04	0.443	0.848	0.683
	40	RIG2	15:08:26	15:08:46	29019	36.62	17.45	80.33	69.68	10.15	5.77	2.56	0.24	9.53	8.26	99.916	0.0052	0.0136				
859	30	RIG2	15:11:25	15:11:45	26616	57.42	17.79	62.36	52.30	10.03	5.01	4.38	0.22	8.03	6.73	99.875	0.0030	0.0125	1.05	0.358	0.803	0.631
	30	RIG3	15:12:48	15:13:08	24930	55.49	18.03	59.35	49.24	10.08	5.51	4.52	0.26	8.15	6.76	99.867	0.0026	0.0117				
860	7	RIG3	15:15:01	15:15:21	24491	387.27	18.07	25.97	12.05	13.89	22.73	31.65	1.09	3.58	1.66	99.147	0.0022	0.0117	1.05	0.148	0.640	0.673
	7	RIG2	15:17:03	15:17:23	26042	392.72	17.85	27.51	13.72	13.72	21.69	30.19	0.98	3.57	1.78	99.193	0.0027	0.0124				
861	4	RIG2	15:20:37	15:20:57	25259	797.74	17.91	19.19	3.28	15.86	84.11	62.07	3.86	2.53	0.43	98.156	0.0059	0.0123	1.04	0.115	0.603	0.726
	4	RIG3	15:21:09	15:21:29	26043	811.06	17.82	20.34	3.52	16.78	84.15	61.22	3.75	2.60	0.45	98.187	0.0058	0.0127				
901	4	R1G2	8:52:21	8:52:41	26313	1214.60	17.80	18.49	4.82	13.61	356.14	88.50	15.31	2.28	0.59	96.390	0.0042	0.0131	1.01	0.110	0.578	0.710
	4	R1G3	8:53:11	8:53:31	26500	1194.58	17.78	18.95	4.71	14.20	339.40	86.57	14.51	2.32	0.58	96.515	0.0042	0.0132				
902	100	R1G2	8:59:28	8:59:38	43174	38.52	15.56	204.69	189.43	15.18	80.67	1.80	2.26	16.43	15.20	99.732	0.0042	0.0203	1.01	0.847	0.988	0.964

TABLE A-2.—(Continued).

Test Point No.[1]	Power	Probe ID[2]	CGA Time		Measured gaseous concentration							Gaseous emission index				Combustion Efficiency	Molar Humidity	Fuel/Air, in sample	Theta[4]	P3norm[4]	T3norm[4]	FAR36norm[4]
			Start	End	CO_2 (dry)	CO (dry)	O_2 (dry)	NOx (wet)	NO(wet)	NO_2 (wet)	HC (wet)	EI^3CO	EIHC	EINOx	EINO							
	%				ppm	ppm	%	ppm	ppm	ppm	ppm	g/kg fuel				%						
903	85	R1G2	9:00:46	9:01:06	41638	29.54	15.77	186.00	170.63	15.19	63.88	1.43	1.85	15.47	14.19	99.781	0.0042	0.0195	1.01	0.790	0.968	0.924
	85	R1G3	9:02:30	9:02:50	38261	25.45	16.25	168.41	153.80	14.21	52.47	1.35	1.65	15.21	13.89	99.803	0.0042	0.0180				
904	65	R1G3	9:04:42	9:05:02	32947	18.79	17.00	114.32	103.05	10.92	41.89	1.16	1.53	11.95	10.77	99.820	0.0042	0.0155	1.01	0.647	0.912	0.815
	65	R1G2	9:06:21	9:06:41	33839	18.02	16.90	121.36	110.65	10.26	35.97	1.08	1.28	12.36	11.27	99.847	0.0042	0.0159				
905	40	R1G2	9:08:33	9:08:53	28820	41.86	17.60	79.47	70.02	9.44	29.97	2.94	1.25	9.47	8.34	99.806	0.0042	0.0136	1.01	0.450	0.825	0.666
	40	R1G3	9:10:01	9:10:21	26339	38.30	17.93	73.34	64.33	9.00	27.30	2.95	1.24	9.55	8.38	99.807	0.0042	0.0124				
906	30	R1G3	9:12:24	9:12:44	24348	63.71	18.21	56.82	48.25	8.52	25.35	5.31	1.24	7.99	6.78	99.751	0.0042	0.0115	1.01	0.363	0.779	0.612
	30	R1G2	9:13:47	9:14:07	26372	66.08	17.94	62.78	54.25	8.52	22.57	5.08	1.02	8.16	7.05	99.778	0.0042	0.0124				
907	7	R1G2	9:17:10	9:17:30	24221	415.64	18.20	27.00	11.97	14.98	49.49	34.27	2.40	3.76	1.67	98.955	0.0042	0.0116	1.02	0.151	0.623	0.650
	7	R1G3	9:18:26	9:18:46	23818	415.16	18.25	26.04	10.77	15.22	46.92	34.81	2.31	3.68	1.52	98.951	0.0042	0.0114				
908	4	R1G3	9:20:50	9:21:10	24646	894.57	18.08	20.23	3.09	17.11	148.17	70.84	6.91	2.71	0.41	97.645	0.0042	0.0121	1.02	0.110	0.581	0.716
	4	R1G2	9:21:52	9:22:12	25887	912.65	17.91	21.26	4.44	16.79	136.00	68.89	6.05	2.71	0.57	97.776	0.0042	0.0127				
909	100	R1G2	9:30:06	9:30:16	43470	35.17	15.52	212.10	193.82	18.22	31.76	1.64	0.88	16.93	15.48	99.873	0.0042	0.0204	1.02	0.844	0.991	0.966
910	85	R1G2	9:31:34	9:31:54	40598	23.69	15.94	184.36	167.36	16.57	23.68	1.18	0.70	15.73	14.28	99.902	0.0042	0.0190	1.02	0.797	0.973	0.932
	85	R1G3	9:32:51	9:33:11	38076	24.18	16.31	172.32	157.32	14.83	21.21	1.28	0.67	15.65	14.29	99.903	0.0042	0.0179				
911	65	R1G3	9:34:50	9:35:10	33620	19.45	16.94	119.68	108.48	10.82	18.28	1.17	0.65	12.27	11.13	99.907	0.0042	0.0158	1.02	0.653	0.918	0.822
	65	R1G2	9:36:35	9:36:55	34172	18.15	16.87	121.90	110.10	11.51	15.70	1.08	0.55	12.31	11.12	99.919	0.0042	0.0160				
912	40	R1G2	9:39:11	9:39:31	28884	40.80	17.60	80.19	70.75	9.38	13.43	2.86	0.56	9.54	8.42	99.877	0.0042	0.0136	1.02	0.454	0.830	0.670
	40	R1G3	9:40:33	9:40:53	26296	37.57	17.95	73.53	64.65	8.86	13.19	2.90	0.60	9.60	8.44	99.872	0.0042	0.0124				
913	30	R1G3	9:44:26	9:44:46	24336	60.00	18.24	57.46	48.74	8.68	12.35	5.01	0.61	8.09	6.86	99.822	0.0042	0.0115	1.02	0.361	0.783	0.615
	30	R1G2	9:45:53	9:46:13	26425	62.98	17.94	63.75	54.16	9.59	11.51	4.83	0.52	8.27	7.03	99.834	0.0042	0.0124				
914	7	R1G2	9:49:12	9:49:32	24624	448.05	18.13	26.20	10.88	15.29	44.96	36.30	2.14	3.58	1.49	98.933	0.0042	0.0118	1.02	0.151	0.625	0.652
	7	R1G3	9:50:59	9:51:19	23647	447.03	18.27	24.75	8.83	15.86	44.88	37.71	2.23	3.52	1.26	98.891	0.0042	0.0113				
915	4	R1G3	9:53:20	9:53:40	24629	927.49	18.08	19.92	2.84	17.04	149.90	73.40	6.99	2.66	0.38	97.577	0.0042	0.0121	1.02	0.116	0.592	0.709
	4	R1G2	9:55:09	9:55:29	26521	958.47	17.80	21.39	4.32	17.03	166.21	70.46	7.21	2.66	0.54	97.624	0.0042	0.0130				
916	100	R1G2	10:02:44	10:02:54	43173	34.55	15.55	206.88	188.14	18.49	29.89	1.62	0.84	16.63	15.12	99.878	0.0042	0.0202	1.02	0.839	0.995	0.968
917	85	R1G2	10:04:17	10:04:37	40731	24.57	15.89	177.40	160.98	16.22	21.22	1.22	0.63	15.09	13.70	99.908	0.0042	0.0191	1.02	0.792	0.978	0.934
	85	R1G3	10:05:31	10:05:51	37876	23.51	16.30	166.05	150.34	15.45	19.02	1.26	0.61	15.16	13.73	99.910	0.0042	0.0178				
918	70	R1G3	10:08:50	10:09:10	33868	18.91	16.88	122.14	108.99	12.82	14.78	1.13	0.53	12.44	11.10	99.921	0.0042	0.0159	1.02	0.681	0.932	0.847
	70	R1G2	10:10:40	10:11:00	34616	17.36	16.78	128.32	115.02	13.06	12.48	1.02	0.43	12.79	11.47	99.933	0.0042	0.0163				
919	65	R1G2	10:12:46	10:13:06	33995	18.46	16.86	117.81	105.07	12.34	10.85	1.10	0.38	11.96	10.66	99.936	0.0042	0.0160	1.02	0.641	0.919	0.819
	65	R1G3	10:14:21	10:14:41	32804	18.97	17.02	112.91	100.24	12.32	10.60	1.17	0.39	11.87	10.53	99.934	0.0042	0.0154				
920	60	R1G3	10:16:39	10:16:59	30732	18.46	17.31	101.58	90.63	10.89	10.10	1.22	0.39	11.38	10.15	99.932	0.0042	0.0144	1.02	0.603	0.904	0.789
	60	R1G2	10:18:59	10:19:19	32576	19.85	17.06	108.55	96.24	11.76	8.47	1.24	0.31	11.49	10.18	99.940	0.0042	0.0153				
921	40	R1G2	10:21:39	10:21:59	28973	39.45	17.56	81.84	70.99	10.82	7.47	2.76	0.31	9.71	8.42	99.904	0.0042	0.0136	1.02	0.447	0.832	0.670
	40	R1G3	10:23:26	10:23:46	26549	35.55	17.88	74.76	65.07	9.68	7.78	2.72	0.35	9.67	8.41	99.901	0.0042	0.0125				
922	30	R1G3	10:25:52	10:26:12	24622	57.98	18.14	58.76	49.49	9.25	7.83	4.78	0.38	8.18	6.89	99.850	0.0042	0.0116	1.02	0.371	0.789	0.621
	30	R1G2	10:27:45	10:28:05	26784	61.00	17.84	64.56	54.52	10.02	6.94	4.62	0.31	8.27	6.98	99.860	0.0042	0.0126				
923	15	R1G2	10:30:02	10:30:22	24312	201.92	18.16	35.87	24.88	10.94	14.34	16.76	0.70	5.02	3.49	99.536	0.0042	0.0115	1.02	0.213	0.679	0.597
	15	R1G3	10:31:31	10:31:51	23529	199.24	18.26	34.09	23.10	10.94	14.29	17.09	0.72	4.93	3.34	99.526	0.0042	0.0111				
924	7	R1G3	10:34:10	10:34:30	23771	448.70	18.21	24.48	8.71	15.73	37.38	37.66	1.85	3.47	1.23	98.931	0.0042	0.0114	1.02	0.151	0.623	0.650
	7	R1G2	10:35:58	10:36:18	25181	456.81	18.01	26.27	10.64	15.62	39.06	36.20	1.82	3.52	1.42	98.967	0.0042	0.0121				
925	5.5	R1G2	10:38:25	10:38:45	25749	600.98	17.92	24.31	6.88	17.38	61.02	46.28	2.77	3.16	0.90	98.636	0.0042	0.0124	1.01	0.134	0.604	0.672

TABLE A-2.—(Continued).

Test Point No.[1]	Power %	Probe ID[2]	CGA Time Start	CGA Time End	Measured gaseous concentration: CO_2 (dry) ppm	CO (dry) ppm	O_2 (dry) %	NOx (wet) ppm	NO(wet) ppm	NO_2 (wet) ppm	HC (wet) ppm	Gaseous emission index: EI[3]CO g/kg fuel	EIHC g/kg fuel	EINOx g/kg fuel	EINO g/kg fuel	Combustion Efficiency %	Molar Humidity	Fuel/Air, in sample	Theta[4]	P3norm[4]	T3norm[4]	FAR36norm[4]
926	4	R1G2	10:52:22	10:52:42	26800	926.04	17.73	21.89	4.73	17.14	148.02	67.52	6.37	2.70	0.58	97.777	0.0042	0.0131	1.01	0.113	0.583	0.707
927	100	R1G2	10:54:41	10:54:51	43049	32.12	15.54	196.46	178.30	17.89	26.30	1.51	0.74	15.84	14.37	99.891	0.0042	0.0202	1.02	0.845	0.991	0.966
928	85	R1G2	10:56:20	10:56:40	39431	22.41	16.07	169.46	152.67	16.69	17.36	1.15	0.53	14.88	13.41	99.920	0.0042	0.0185	1.01	0.800	0.971	0.930
	85	R1G3	10:57:50	10:58:10	37952	25.32	16.26	163.90	148.26	15.32	15.30	1.35	0.49	14.94	13.51	99.920	0.0042	0.0178				
929	65	R1G3	10:59:47	11:00:07	33285	19.53	16.93	116.60	104.41	11.97	12.81	1.19	0.46	12.08	10.82	99.926	0.0042	0.0156	1.02	0.650	0.917	0.820
	65	R1G2	11:01:56	11:02:16	34242	18.99	16.80	120.39	107.48	12.40	10.31	1.12	0.36	12.13	10.83	99.937	0.0042	0.0161				
930	40	R1G2	11:04:31	11:04:51	29545	34.66	17.45	81.24	71.09	10.06	8.77	2.38	0.36	9.46	8.27	99.909	0.0042	0.0139	1.01	0.456	0.828	0.670
	40	R1G3	11:06:01	11:06:21	27270	30.24	17.76	82.78	72.58	10.17	9.18	2.25	0.40	10.43	9.14	99.907	0.0042	0.0128				
931	30	R1G3	11:08:21	11:08:41	24537	57.84	18.14	59.63	50.13	9.48	8.77	4.79	0.43	8.33	7.00	99.845	0.0042	0.0116	1.02	0.372	0.787	0.619
	30	R1G2	11:10:00	11:10:20	26668	60.03	17.84	65.60	55.74	9.85	7.67	4.57	0.34	8.44	7.17	99.858	0.0042	0.0126				
932	7	R1G2	11:12:21	11:12:41	24760	445.54	18.06	26.64	11.17	15.43	35.81	35.92	1.70	3.63	1.52	98.986	0.0042	0.0119	1.02	0.151	0.623	0.650
	7	R1G3	11:13:50	11:14:10	24275	434.24	18.12	25.56	9.95	15.59	35.03	35.72	1.70	3.55	1.38	98.991	0.0042	0.0116				
933	4	R1G3	11:16:42	11:17:02	24706	921.95	18.04	20.01	2.89	17.09	122.87	72.83	5.72	2.67	0.39	97.717	0.0042	0.0121	1.02	0.112	0.584	0.712
	4	R1G2	11:18:08	11:18:28	26140	933.47	17.82	21.14	4.31	16.82	126.00	69.77	5.55	2.67	0.54	97.806	0.0042	0.0128				
934	7	R1G2	13:50:04	13:50:24	28550	529.58	17.59	29.54	12.66	16.83	53.76	36.93	2.22	3.49	1.50	98.911	0.0042	0.0137	1.03	0.150	0.629	0.658
	7	R1G4	13:53:04	13:53:24	26504	485.43	17.93	28.34	11.80	16.50	41.04	36.51	1.82	3.60	1.50	98.960	0.0042	0.0127				
	7	R1G5	13:54:30	13:54:50	26271	477.36	17.96	28.18	12.28	15.86	39.91	36.24	1.79	3.62	1.58	98.970	0.0042	0.0126				
	7	R1G6	13:55:53	13:56:13	25822	467.00	18.04	28.06	12.09	15.91	39.97	36.08	1.82	3.66	1.58	98.971	0.0042	0.0124				
	7	R2G6	13:59:01	13:59:21	2051	34.31	21.37	2.15	1.09	1.07	18.28	38.65	11.86	4.00	2.03	97.906	0.0042	0.0009				
	7	R2G4	14:00:27	14:00:47	1526	24.17	21.47	1.56	0.89	0.68	16.14	38.98	14.99	4.15	2.37	97.585	0.0042	0.0006				
	7	R1G1	14:03:40	14:04:00	25148	447.58	18.27	28.31	12.67	15.61	29.80	35.54	1.39	3.80	1.70	99.026	0.0042	0.0120				
	7	R1G2	14:04:50	14:05:10	27964	480.16	17.83	30.44	14.42	15.97	29.70	34.27	1.25	3.68	1.74	99.070	0.0042	0.0134				
935	100	R1G2	14:06:52	14:07:02	44122	38.67	15.62	218.45	200.37	17.80	12.48	1.77	0.34	17.20	15.78	99.924	0.0042	0.0207	1.03	0.834	0.998	0.969
936	85	R1G2	14:08:43	14:09:03	42142	33.04	15.87	198.53	181.67	16.29	10.42	1.59	0.30	16.34	14.96	99.933	0.0042	0.0198	1.03	0.779	0.977	0.929
937	75	R1G2	14:11:06	14:11:26	38029	24.47	16.46	157.15	142.21	14.65	9.23	1.30	0.29	14.30	12.94	99.940	0.0042	0.0178	1.03	0.708	0.953	0.877
	75	R1G3	14:12:47	14:13:07	36443	26.53	16.67	145.16	130.30	14.51	9.46	1.47	0.31	13.76	12.35	99.934	0.0042	0.0171				
938	30	R1G3	14:15:50	14:16:10	25445	63.76	18.22	57.08	48.43	8.58	9.50	5.08	0.45	7.69	6.52	99.836	0.0042	0.0120	1.03	0.358	0.790	0.620
	30	R1G2	14:17:37	14:17:57	27091	65.91	18.00	62.25	53.15	8.81	8.63	4.93	0.38	7.88	6.73	99.846	0.0042	0.0128				
939	7	R1G2	14:20:36	14:20:56	26208	425.97	18.11	29.74	15.08	14.62	26.57	32.49	1.19	3.84	1.94	99.117	0.0042	0.0125	1.03	0.150	0.631	0.660
	7	R1G3	14:21:40	14:22:00	25997	436.25	18.13	28.91	13.30	15.57	27.31	33.53	1.24	3.76	1.73	99.089	0.0042	0.0124				
	7	R1G5	14:24:29	14:24:49	25049	437.84	18.26	27.75	12.07	15.65	30.42	34.91	1.43	3.74	1.63	99.037	0.0042	0.0120				
	7	R1G6	14:26:22	14:26:42	23975	422.91	18.42	26.50	11.05	15.42	35.34	35.24	1.73	3.73	1.55	98.999	0.0042	0.0115				
	7	R2G2	14:29:21	14:29:41	1292	16.83	21.55	1.18	0.53	0.62	10.44	33.84	12.08	3.92	1.75	97.997	0.0042	0.0005				
	7	R2G3	14:31:10	14:31:30	1914	27.51	21.52	1.90	0.91	0.97	9.42	33.88	6.69	3.86	1.85	98.535	0.0042	0.0008				
	7	R2G4	14:32:40	14:33:00	1611	22.95	21.58	1.61	0.89	0.70	8.64	34.86	7.55	4.04	2.23	98.426	0.0042	0.0006				
	7	R2G6	14:34:13	14:34:33	2003	28.23	21.53	1.79	0.99	0.80	8.31	33.00	5.59	3.46	1.90	98.666	0.0042	0.0008				
	7	R2G1	14:35:29	14:35:49	2111	30.51	21.52	1.21	0.99	0.23	8.82	33.49	5.58	2.19	1.79	98.655	0.0042	0.0009				
940	100	R1G2	-	-	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
941	85	R1G2	14:48:22	14:48:42	40044	33.04	15.39	200.26	181.74	18.10	5.85	1.67	0.18	17.32	15.72	99.943	0.0042	0.0188	1.03	0.785	0.983	0.937
942	30	R1G2	14:50:48	14:51:08	25453	64.34	17.50	63.93	54.41	9.09	5.75	5.13	0.27	8.61	7.33	99.853	0.0042	0.0120	1.03	0.367	0.795	0.625
	30	R1G3	14:52:02	14:52:22	23936	62.66	17.72	62.88	53.42	9.45	5.93	5.32	0.30	9.00	7.64	99.846	0.0042	0.0113				

TABLE A-2.—(Concluded).

Test Point No.[1]	Power	Probe ID[2]	CGA Time		Measured gaseous concentration							Gaseous emission index				Combustion Efficiency	Molar Humidity	Fuel/Air, in sample	Theta[4]	P3norm[4]	T3norm[4]	FAR36norm[4]
					CO_2 (dry)	CO (dry)	O_2 (dry)	NOx (wet)	NO(wet)	NO_2 (wet)	HC (wet)	EI^3CO	EIHC	EINOx	EINO							
	%		Start	End	ppm	ppm	%	ppm	ppm	ppm	ppm	g/kg fuel				%						
943	7	R1G2	14:54:40	14:55:00	26319	408.48	17.40	32.76	17.70	15.00	15.56	31.06	0.70	4.21	2.28	99.201	0.0042	0.0126	1.03	0.153	0.636	0.658
	7	R1G4	14:55:58	14:56:18	25940	413.18	17.46	31.85	16.39	15.42	15.66	31.87	0.71	4.15	2.14	99.180	0.0042	0.0124				
	7	R1G3	14:56:28	14:56:48	25915	411.03	17.47	32.12	16.45	15.64	15.75	31.74	0.72	4.19	2.15	99.183	0.0042	0.0124				
	7	R1G5	14:59:12	14:59:32	25299	409.28	17.56	31.11	15.56	15.49	17.77	32.37	0.83	4.16	2.08	99.157	0.0042	0.0121				
	7	R1G6	15:00:53	15:01:13	24500	393.10	17.69	31.01	15.49	15.49	20.04	32.12	0.96	4.28	2.14	99.149	0.0042	0.0117				
	7	R1G1	15:02:00	15:02:20	18911	296.16	18.15	26.05	14.34	11.66	14.63	31.48	0.91	4.65	2.56	99.169	0.0042	0.0090				
944	100	R1G2	15:21:05	15:21:15	42437	34.97	15.59	214.91	199.89	14.96	6.38	1.67	0.18	17.57	16.35	99.943	0.0042	0.0199	1.03	0.829	1.002	0.972
945	85	R1G2	15:22:52	15:23:12	40603	30.74	15.85	194.58	175.95	18.20	5.21	1.53	0.16	16.61	15.02	99.949	0.0042	0.0190	1.03	0.782	0.985	0.938
946	30	R1G2	15:25:23	15:25:43	26309	65.78	17.83	65.48	56.32	9.17	5.57	5.07	0.25	8.53	7.34	99.856	0.0042	0.0124	1.03	0.363	0.792	0.623
	30	R1G3	15:26:56	15:27:16	24703	63.01	18.07	60.82	51.76	9.06	5.82	5.18	0.28	8.44	7.18	99.850	0.0042	0.0116				
947	7	R1G2	15:29:40	15:30:00	26670	431.40	17.75	30.68	15.35	15.29	23.75	32.34	1.05	3.89	1.95	99.135	0.0042	0.0127	1.03	0.150	0.631	0.660
	7	R1G3	15:31:10	15:31:30	26661	443.54	17.78	30.11	13.85	16.22	24.54	33.24	1.08	3.82	1.76	99.111	0.0042	0.0127				
	7	R1G4	15:32:32	15:32:52	26372	442.20	17.83	30.16	13.47	16.63	25.34	33.50	1.13	3.86	1.73	99.100	0.0042	0.0126				
	7	R1G5	15:34:04	15:34:24	26198	441.96	17.85	29.96	13.27	16.67	28.19	33.70	1.27	3.86	1.71	99.082	0.0042	0.0125				
	7	R1G6	15:35:29	15:35:49	25427	419.85	17.97	29.52	13.46	16.05	30.81	33.01	1.43	3.92	1.79	99.082	0.0042	0.0122				
	7	R1G1	15:37:18	15:37:38	18465	331.18	18.84	22.73	10.77	11.92	22.49	35.97	1.43	4.14	1.96	99.012	0.0042	0.0088				
948	100	R1G2	15:55:46	15:55:56	41323	32.97	15.73	205.89	187.16	18.16	6.32	1.61	0.18	17.28	15.70	99.944	0.0042	0.0194	1.03	0.831	1.000	0.971
949	85	R1G2	15:57:56	15:58:16	39521	28.03	15.99	187.85	170.51	17.06	5.47	1.44	0.17	16.46	14.94	99.950	0.0042	0.0185	1.03	0.785	0.983	0.937
950	30	R1G2	15:59:50	16:00:10	25495	62.58	17.94	64.01	54.45	9.60	6.11	4.98	0.29	8.61	7.32	99.854	0.0042	0.0120	1.03	0.368	0.795	0.626
	30	R1G3	16:01:02	16:01:22	24209	60.07	18.12	59.97	50.92	9.05	6.68	5.04	0.33	8.49	7.21	99.849	0.0042	0.0114				
951	7	R1G2	16:03:58	16:04:18	25840	430.47	17.85	29.51	14.41	15.08	29.85	33.29	1.36	3.86	1.88	99.082	0.0042	0.0124	1.03	0.150	0.629	0.658
	7	R1G3	16:05:34	16:05:54	25654	430.79	17.88	29.48	13.67	15.76	29.95	33.55	1.37	3.88	1.80	99.074	0.0042	0.0123				
	7	R1G4	16:06:52	16:07:12	25159	423.66	17.95	28.91	12.87	15.99	29.58	33.66	1.38	3.88	1.73	99.071	0.0042	0.0120				
	7	R1G5	16:08:37	16:08:57	24991	437.10	17.97	28.52	11.92	16.57	36.84	34.93	1.73	3.85	1.61	99.006	0.0042	0.0120				
	7	R1G6	16:09:59	16:10:19	24122	414.75	18.09	27.77	11.75	15.99	42.01	34.35	2.05	3.88	1.64	98.988	0.0042	0.0115				
	7	R1G1	16:11:32	16:11:52	26292	433.76	17.79	30.59	14.87	15.66	31.82	32.96	1.43	3.93	1.91	99.083	0.0042	0.0126				

Note:

1. The test point No. defines the sequential engine testing conditions. It is a combination of the last digit in the date between April 20 and 29 and a sequence number of test point for that day. If the test point number is 305, the test point was for the 5th test point on April 23.
2. In probe ID, "R1" and "R2" stand for sampling rake at 1 m and 10 m sampling locations, respectively. G1 to 6 stands for gas sampling probe tip # 1 to 6.
3. "EI" stands for emission index. The CGA data are analyzed based on SAE ARP 1533 and ICAO Annex 16 method.
4. P3norm, T3norm and FAR36norm are the pressure, temperature and fuel to air ratio at engine station 3 and 3 to 6, normalized to the corresponding values at 100% thrust on a standard day at Dryden (Press.=13.53 psia, Temp.=518.67 R); Theta is the ratio of ambient temperature to standard temperature, Theta = (F + 459.67)/518.67.

TABLE A-3.—AIRCRAFT CFM56-2-C1 ENGINE GAS EMISSION DATA MEASURED WITH THE NASA MULTI-GAS ANALYZER (MGA) DURING APEX. PART A

Test Point No.[1]	Power	Probe ID[2]	MGA Time		Measured gaseous concentration						Gaseous emission index				H_2O	Fuel/Air Ratio	Combustion Efficiency
					CO_2	CO	NOx	NO	NO_2	THC from CGA	EI^3CO	EIHC from CGA	EINOx	EINO			
	%		Start	End	%	ppm	ppm	ppm	ppm	ppm	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	%		%
301	7	R1G2	9:25:47	9:26:06	24980	434.92	30.62	14.36	16.25	41.84	34.75	1.91	4.02	1.88	2.91	0.0123	98.99
	7	R1G3	9:27:09	9:27:29	25410	445.07	30.93	14.34	16.59	36.61	34.96	1.65	3.99	1.85	3.32	0.0125	99.01
	7	R1G4	9:28:32	9:28:51	23880	428.98	28.75	12.93	15.82	34.70	35.87	1.66	3.95	1.77	2.94	0.0118	98.99
	7	R1G5	9:30:13	9:30:33	22960	412.06	28.69	13.06	15.63	32.87	35.85	1.64	4.10	1.87	2.72	0.0113	98.99
	7	R1G6	9:31:55	9:32:15	21630	396.21	25.50	12.13	13.38	33.54	36.61	1.77	3.87	1.84	2.82	0.0106	98.96
	7	R1G1	9:33:51	9:34:11	19580	354.43	24.62	11.87	12.75	31.37	36.24	1.84	4.13	1.99	2.45	0.0096	98.97
	7	R2G2	9:35:48	9:36:07	1360	23.22	1.37	0.99	0.39	12.22	43.30	13.05	4.21	3.02	0.54	0.0005	97.68
	7	R2G4	9:37:05	9:37:25	1250	22.54	1.71	1.24	0.47	5.92	47.17	7.09	5.88	4.26	0.54	0.0005	98.18
	7	R2G6	9:39:02	9:39:21	1370	23.90	1.47	1.14	0.33	7.71	44.31	8.19	4.48	3.47	0.54	0.0005	98.14
	7	R2G1	9:40:48	9:41:08	1290	20.89	1.60	1.24	0.36	8.48	41.91	9.75	5.26	4.08	0.53	0.0005	98.04
	7	R2G3	9:42:11	9:42:30	1260	21.13	1.57	1.18	0.39	8.43	43.70	9.99	5.33	4.00	0.52	0.0005	97.97
	7	R2G5	9:44:17	9:44:36	1460	24.08	1.82	1.30	0.52	8.13	41.20	7.97	5.11	3.64	0.55	0.0006	98.24
302	30	R1G2	9:48:10	9:48:29	29660	60.72	82.30	73.63	8.67	7.58	4.15	0.30	9.23	8.26	3.32	0.0144	99.87
	30	R1G3	9:49:18	9:49:37	26630	59.31	74.53	66.13	8.40	7.14	4.52	0.31	9.32	8.27	3.62	0.0129	99.86
	30	R1G4	9:51:14	9:51:34	24170	56.10	68.41	59.82	8.59	6.67	4.71	0.32	9.44	8.25	2.80	0.0117	99.86
	30	R1G2	10:05:13	10:05:33	29640	58.88	83.20	74.50	8.70	17.35	4.02	0.68	9.34	8.36	3.35	0.0144	99.84
	30	R1G3	10:06:36	10:06:55	26430	56.61	75.03	66.60	8.43	14.84	4.34	0.65	9.45	8.39	3.02	0.0128	99.83
	30	R1G4	10:07:58	10:08:18	24630	55.93	67.51	59.15	8.37	13.54	4.61	0.64	9.14	8.00	2.85	0.0119	99.83
	30	R1G5	10:09:35	10:09:55	23630	54.32	65.47	57.02	8.45	12.12	4.67	0.60	9.24	8.05	2.76	0.0114	99.83
	30	R1G6	10:11:07	10:11:27	23960	56.69	69.55	60.94	8.61	11.29	4.80	0.55	9.68	8.48	2.98	0.0116	99.83
	30	R1G1	10:12:49	10:13:09	27020	54.90	76.12	68.35	7.77	9.93	4.12	0.43	9.38	8.42	3.08	0.0131	99.86
	30	R2G2	10:14:02	10:14:21	2410	4.54	6.33	5.79	0.54	10.22	4.33	5.58	9.92	9.07	0.64	0.0010	99.34
	30	R2G3	10:15:39	10:15:58	2180	4.14	6.24	5.71	0.53	8.92	4.43	5.47	10.98	10.06	0.60	0.0009	99.35
	30	R2G4	10:17:01	10:17:21	2330	4.51	6.47	5.96	0.51	4.59	4.48	2.61	10.56	9.74	0.63	0.0010	99.63
	30	R2G5	10:18:38	10:18:58	2470	4.93	6.91	6.29	0.62	4.86	4.58	2.59	10.54	9.60	0.65	0.0011	99.63
	30	R2G6	10:20:10	10:20:30	2560	5.02	7.06	6.50	0.57	5.97	4.48	3.05	10.35	9.52	0.65	0.0011	99.59
	30	R2G1	10:21:57	10:22:16	1850	3.51	4.83	4.45	0.39	6.54	4.57	4.88	10.34	9.51	0.58	0.0008	99.40
	30	R2G2	10:23:39	10:23:58	28660	58.06	83.02	74.25	8.77	8.56	4.11	0.35	9.64	8.62	3.25	0.0139	99.87

TABLE A-3.—PART A (Continued)

Test Point	Power	Probe	MGA Time		Measured gaseous concentration						Gaseous emission index				H_2O	Fuel/Air	Combustion Efficiency
					CO_2	CO	NOx	NO	NO_2	THC from CGA	EI^3CO	EIHC from CGA	EINOx	EINO			
No.[1]	%	ID[2]	Start	End	%	ppm	ppm	ppm	ppm	ppm	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	%	Ratio	%
303	40	R1G2	10:43:03	10:43:22	30160	49.75	92.21	83.63	8.59	15.51	3.34	0.60	10.17	9.23	3.40	0.0147	99.86
	40	R1G3	10:44:21	10:44:40	27820	45.62	86.05	77.32	8.73	13.89	3.32	0.58	10.30	9.26	3.18	0.0135	99.86
	40	R1G4	10:45:43	10:46:03	25160	44.86	75.52	66.69	8.83	12.77	3.62	0.59	10.01	8.84	2.90	0.0122	99.86
	40	R1G5	10:46:56	10:47:15	24730	43.78	73.93	65.16	8.78	11.93	3.59	0.56	9.97	8.79	2.86	0.0120	99.86
	40	R1G6	10:48:43	10:49:02	24770	44.15	76.61	68.33	8.29	11.00	3.62	0.52	10.31	9.20	3.03	0.0120	99.86
	40	R1G1	10:50:44	10:51:03	27440	44.88	83.66	75.15	8.52	9.58	3.32	0.41	10.16	9.12	3.18	0.0133	99.88
	40	R2G3	10:52:11	10:52:31	2390	3.45	7.53	6.84	0.69	10.04	3.32	5.54	11.92	10.83	0.63	0.0010	99.37
	40	R2G3	10:53:24	10:53:43	2100	3.19	6.51	5.93	0.58	9.62	3.57	6.17	11.97	10.90	0.61	0.0009	99.30
	40	R2G4	10:55:06	10:55:25	2370	3.49	7.48	6.89	0.59	6.70	3.40	3.74	11.96	11.02	0.62	0.0010	99.55
	40	R2G5	10:56:38	10:56:57	2490	3.89	7.45	6.80	0.65	4.30	3.58	2.27	11.28	10.29	0.64	0.0011	99.69
	40	R2G6	10:58:01	10:58:20	2880	4.24	8.60	7.98	0.61	5.51	3.31	2.47	11.03	10.24	0.65	0.0013	99.68
	40	R2G1	10:59:42	11:00:02	1970	2.88	5.91	5.50	0.41	6.61	3.48	4.58	11.74	10.93	0.58	0.0008	99.46
	40	R2G2	11:02:18	11:02:37	29570	50.85	89.45	80.29	9.15	6.96	3.49	0.27	10.07	9.04	3.61	0.0144	99.89
304	30	R1G2	11:04:53	11:05:12	28310	59.55	81.90	72.28	9.62	7.38	4.26	0.30	9.63	8.50	3.19	0.0138	99.87
	30	R1G3	11:06:20	11:06:40	25620	57.94	72.58	63.62	8.95	7.09	4.59	0.32	9.44	8.27	2.96	0.0124	99.86
	30	R1G4	11:07:57	11:08:17	23810	54.32	67.40	58.39	9.00	7.09	4.63	0.35	9.44	8.18	2.79	0.0115	99.86
	30	R1G5	11:09:20	11:09:39	23370	53.48	65.80	56.99	8.81	7.11	4.65	0.35	9.39	8.14	2.71	0.0113	99.86
	30	R1G6	11:11:07	11:11:26	23550	53.38	67.17	59.09	8.08	7.04	4.60	0.35	9.51	8.37	2.88	0.0114	99.86
	30	R1G1	11:12:10	11:12:29	26640	54.51	75.15	66.52	8.63	6.39	4.15	0.28	9.40	8.32	3.03	0.0129	99.87
305	7	R1G2	11:15:09	11:15:29	24550	370.64	31.23	15.12	16.11	23.83	30.23	1.11	4.18	2.03	2.86	0.0121	99.18
	7	R1G3	11:16:27	11:16:47	24540	392.17	30.29	14.10	16.19	24.39	31.97	1.14	4.06	1.89	2.87	0.0121	99.14
	7	R1G4	11:18:19	11:18:38	22880	366.55	28.58	12.93	15.65	23.88	32.08	1.20	4.11	1.86	2.70	0.0112	99.13
	7	R1G5	11:19:51	11:20:10	22150	360.13	27.55	12.13	15.41	23.77	32.56	1.23	4.09	1.80	2.68	0.0109	99.11
	7	R1G6	11:21:14	11:21:33	21200	353.25	26.55	11.80	14.75	25.49	33.37	1.38	4.12	1.83	2.67	0.0104	99.08
	7	R1G1	11:22:41	11:23:00	21260	333.35	28.60	13.56	15.04	26.78	31.43	1.45	4.43	2.10	2.59	0.0104	99.12
	7	R2G3	11:25:36	11:25:55	1710	27.59	2.23	1.32	0.90	6.20	38.89	5.00	5.15	3.06	0.55	0.0007	98.59
	7	R2G4	11:27:13	11:27:32	1720	29.21	2.32	1.44	0.88	7.52	40.79	6.01	5.32	3.29	0.56	0.0007	98.44
	7	R2G5	11:28:45	11:29:04	1500	25.80	2.09	1.31	0.78	7.69	42.65	7.28	5.68	3.56	0.54	0.0006	98.27
	7	R2G6	11:30:08	11:30:27	1850	32.50	2.83	1.87	0.97	8.03	41.53	5.88	5.95	3.92	0.57	0.0008	98.44
	7	R2G1	11:31:30	11:31:49	1470	25.06	2.16	1.46	0.70	7.47	42.50	7.26	6.01	4.06	0.55	0.0006	98.28
	7	R1G2	11:37:39	11:37:58	24400	359.68	31.78	15.59	16.20	23.19	29.53	1.09	4.29	2.10	2.84	0.0120	99.20

TABLE A-3.—PART A (Continued)

306	7	R1G2	14:52:39	14:52:58	25290	427.80	30.81	12.47	18.34	33.61	33.79	1.52	4.00	1.62	2.87	0.0125	99.05
	7	R1G3	14:54:01	14:54:21	25510	430.25	30.58	12.76	17.82	29.90	33.69	1.34	3.93	1.64	2.88	0.0126	99.07
	7	R1G4	14:55:09	14:55:29	24240	422.14	28.96	11.75	17.21	28.36	34.79	1.34	3.92	1.59	2.77	0.0119	99.05
	7	R1G5	14:57:01	14:57:21	23400	414.25	28.21	11.07	17.14	27.53	35.37	1.35	3.96	1.55	2.70	0.0115	99.03
	7	R1G6	14:58:39	14:58:58	22130	398.19	26.75	10.70	16.05	29.73	35.96	1.54	3.97	1.59	2.81	0.0109	99.00
	7	R1G1	15:00:06	15:00:26	21300	369.00	27.35	11.13	16.22	30.23	34.67	1.63	4.22	1.72	2.56	0.0105	99.02
307	30	R1G2	15:05:22	15:05:42	28350	68.19	75.28	65.80	9.48	8.46	4.87	0.35	8.84	7.72	3.13	0.0138	99.85
	30	R1G3	15:06:35	15:06:55	26150	65.92	71.44	62.16	9.29	7.26	5.11	0.32	9.10	7.92	2.91	0.0127	99.85
	30	R1G4	15:08:08	15:08:27	24130	63.26	65.55	56.24	9.31	6.38	5.32	0.31	9.06	7.77	2.74	0.0117	99.84
	30	R1G5	15:09:45	15:10:04	23590	61.93	64.23	54.70	9.52	5.83	5.33	0.29	9.08	7.73	2.71	0.0114	99.85
	30	R1G6	15:11:13	15:11:32	22870	60.24	62.24	53.67	8.58	5.98	5.35	0.30	9.08	7.83	2.81	0.0111	99.84
	30	R1G1	15:12:50	15:13:09	24060	57.41	65.19	57.14	8.05	5.12	4.84	0.25	9.03	7.92	2.73	0.0117	99.86
	30	R2G2	15:14:13	15:14:32	2140	5.31	6.07	5.28	0.79	2.85	5.82	1.79	10.94	9.51	0.55	0.0009	99.68
	30	R2G3	15:15:35	15:15:55	2140	5.34	5.93	5.16	0.77	4.50	5.86	2.83	10.68	9.30	0.56	0.0009	99.58
	30	R2G4	15:17:12	15:17:32	2140	5.53	6.70	5.97	0.73	4.71	6.06	2.96	12.06	10.75	0.55	0.0009	99.56
	30	R2G5	15:18:45	15:19:04	2370	6.00	6.88	6.08	0.80	4.58	5.85	2.56	11.00	9.72	0.55	0.0010	99.61
	30	R2G6	15:20:17	15:20:37	2510	6.41	7.12	6.27	0.85	4.42	5.85	2.31	10.67	9.40	0.57	0.0011	99.63
	30	R2G1	15:21:50	15:22:09	1790	4.63	5.55	4.98	0.58	4.35	6.28	3.38	12.37	11.09	0.52	0.0007	99.51
	30	R2G1	15:21:50	15:22:09	1790	4.63	5.55	4.98	0.58	4.35	6.28	3.38	12.37	11.09	0.52	0.0007	99.51
	30	R1G2	15:23:37	15:23:56	27220	68.08	74.39	65.04	9.35	5.45	5.07	0.23	9.10	7.95	3.01	0.0132	99.86
	30	R1G4	15:24:50	15:25:09	23720	64.72	64.22	54.78	9.43	4.70	5.54	0.23	9.03	7.70	2.69	0.0115	99.85
308	40	R1G2	15:27:25	15:27:45	30960	45.44	97.55	87.29	10.26	4.31	2.97	0.16	10.49	9.38	3.39	0.0151	99.91
	40	R1G3	15:29:03	15:29:22	28540	44.05	92.06	81.83	10.23	4.21	3.13	0.17	10.74	9.55	3.17	0.0139	99.91
	40	R1G4	15:30:35	15:30:55	25920	39.55	85.49	75.35	10.14	3.78	3.10	0.17	11.00	9.69	2.92	0.0126	99.91
308b	40	R1G5	15:32:03	15:32:22	25380	34.55	87.00	76.88	10.12	3.61	2.77	0.17	11.44	10.11	2.85	0.0123	99.92
	40	R1G6	15:33:40	15:33:59	25570	33.11	88.30	79.13	9.17	3.68	2.63	0.17	11.52	10.32	2.93	0.0124	99.92
	40	R1G1	15:35:12	15:35:32	25300	29.74	86.54	78.04	8.50	3.18	2.39	0.15	11.41	10.29	2.83	0.0123	99.93
	40	R2G2	15:36:40	15:36:59	2380	2.75	8.65	7.77	0.88	1.69	2.68	0.94	13.81	12.40	0.57	0.0010	99.84
	40	R2G3	15:38:22	15:38:17	2510	2.92	9.50	8.62	0.88	2.73	2.67	1.43	14.26	12.94	0.57	0.0011	99.79
	40	R2G4	15:39:40	15:39:59	2460	3.21	8.50	7.65	0.84	3.28	3.00	1.76	13.05	11.75	0.56	0.0010	99.75
308c	40	R2G5	15:41:07	15:41:27	2620	3.59	9.54	8.66	0.88	3.30	3.13	1.64	13.64	12.37	0.56	0.0011	99.76
	40	R2G6	15:42:35	15:42:54	2880	3.86	10.09	9.13	0.96	3.29	3.02	1.47	12.95	11.72	0.58	0.0012	99.78
	40	R2G1	15:44:07	15:44:27	2120	2.75	7.40	6.66	0.75	3.16	3.06	2.01	13.51	12.15	0.53	0.0009	99.73
	40	R1G2	15:45:54	15:46:14	30780	41.78	101.45	90.94	10.50	4.25	2.75	0.16	10.97	9.83	3.34	0.0150	99.92

TABLE A-3.—PART A (Continued)

Test Point No.[1]	Power	Probe ID[2]	MGA Time		Measured gaseous concentration						Gaseous emission index				H_2O	Fuel/Air Ratio	Combustion Efficiency
					CO_2	CO	NOx	NO	NO_2	THC from CGA	EI^3CO	EIHC from CGA	EINOx	EINO			
	%		Start	End	%	ppm	ppm	ppm	ppm	ppm	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	%		%
309	30	R1G2	15:49:14	15:49:33	26980	65.61	76.63	66.34	10.29	3.61	4.93	0.16	9.46	8.19	2.97	0.0131	99.87
	30	R1G3	15:51:01	15:51:20	25210	64.53	70.83	61.04	9.79	3.28	5.19	0.15	9.36	8.07	2.82	0.0122	99.86
	30	R1G4	15:52:23	15:52:43	23710	62.74	65.61	55.81	9.79	3.24	5.37	0.16	9.23	7.85	2.68	0.0115	99.86
	30	R1G5	15:53:46	15:54:05	23220	63.15	63.26	53.45	9.81	3.32	5.52	0.17	9.09	7.68	2.67	0.0112	99.85
	30	R1G6	15:55:28	15:55:48	22500	60.60	61.56	52.68	8.88	3.52	5.47	0.18	9.13	7.81	2.67	0.0109	99.85
	30	R1G1	15:57:01	15:57:20	24120	57.91	66.91	58.08	8.83	3.04	4.87	0.15	9.25	8.03	2.72	0.0117	99.87
	30	R2G2	15:58:43	15:59:02	1950	4.81	5.55	4.73	0.82	2.02	5.89	1.42	11.17	9.52	0.52	0.0008	99.72
	30	R2G4	16:00:05	16:00:25	2210	5.19	6.50	5.70	0.80	2.90	5.49	1.76	11.29	9.90	0.55	0.0009	99.70
310	7	R1G2	16:03:00	16:03:20	24920	409.92	31.23	13.44	17.79	23.02	32.89	1.06	4.12	1.77	2.83	0.0123	99.12
	7	R1G4	16:04:33	16:04:52	23760	406.21	28.91	11.49	17.42	21.57	34.18	1.04	4.00	1.59	2.71	0.0117	99.09
	7	R1G6	16:06:05	16:06:25	21660	378.44	26.62	10.66	15.96	22.32	34.96	1.18	4.04	1.62	2.60	0.0106	99.06
	7	R2G2	16:07:38	16:07:57	1750	31.41	1.88	0.54	1.34	5.45	42.96	4.27	4.22	1.21	0.50	0.0007	98.56
	7	R2G4	16:09:20	16:09:39	1790	34.70	2.61	1.24	1.37	7.51	46.04	5.71	5.69	2.70	0.49	0.0007	98.35
501	4	R1G2	11:20:51	11:21:10	27373	1122.92	21.67	4.37	17.30	12.85	80.01	0.52	2.54	0.51	3.30	0.0138	98.07
502	65	R1G2	11:24:15	11:24:34	35304	27.26	137.82	126.32	11.50	12.47	1.56	0.41	12.98	11.90	4.03	0.0172	99.92
	65	R1G4	11:25:23	11:25:42	33428	31.89	123.63	111.94	11.70	13.38	1.93	0.46	12.30	11.14	3.82	0.0163	99.91
	65	R1G5	11:27:00	11:27:19	30270	28.99	111.47	100.14	11.33	13.55	1.94	0.52	12.26	11.01	3.52	0.0147	99.90
	65	R1G6	11:28:36	11:28:56	30781	28.48	115.50	104.63	10.87	13.67	1.88	0.52	12.49	11.32	4.15	0.0150	99.90
	65	R1G1	11:30:13	11:30:33	28154	20.58	110.95	101.47	9.48	11.15	1.48	0.46	13.14	12.01	3.26	0.0137	99.92
	65	R1G3	11:31:31	11:31:50	31890	26.26	121.36	111.22	10.14	10.49	1.67	0.38	12.67	11.61	3.69	0.0155	99.92
	65	R2G2	11:32:29	11:32:48	3085	2.44	11.96	10.73	1.23	4.27	1.76	1.77	14.22	12.76	0.78	0.0013	99.78
	65	R2G2	11:32:58	11:33:18	2939	2.21	11.43	10.24	1.19	4.06	1.69	1.78	14.35	12.86	0.75	0.0013	99.78
	65	R2G3	11:34:45	11:35:04	3182	3.60	12.58	11.68	0.90	4.51	2.52	1.81	14.45	13.42	0.76	0.0014	99.76
	65	R2G4	11:36:02	11:36:22	3337	2.49	12.94	12.04	0.89	3.64	1.66	1.38	14.11	13.14	0.79	0.0015	99.82
	65	R2G6	11:39:07	11:39:26	3805	2.89	15.20	14.20	1.00	0.96	1.66	0.32	14.37	13.42	0.84	0.0017	99.93
	65	R2G1	11:40:34	11:40:53	2584	2.02	10.51	10.05	0.47	1.49	1.79	0.76	15.29	14.61	0.71	0.0011	99.88
	65	R1G2	11:42:50	11:43:09	34965	24.53	144.47	132.20	12.27	14.28	1.42	0.47	13.74	12.57	3.91	0.0171	99.92
503	70	R1G2	11:45:05	11:45:25	34381	24.31	142.18	129.33	12.85	15.41	1.43	0.52	13.75	12.51	3.86	0.0168	99.91
	70	R1G4	11:46:42	11:47:02	35817	23.37	156.50	142.64	13.86	17.00	1.32	0.55	14.53	13.24	4.04	0.0175	99.91
504	65	R1G2	11:48:39	11:48:58	34896	25.21	142.31	129.17	13.14	16.55	1.46	0.55	13.56	12.31	3.90	0.0170	99.91
	65	R1G3	11:50:06	11:50:25	33654	25.36	134.16	121.16	13.00	16.95	1.53	0.58	13.26	11.98	3.86	0.0164	99.91
505	60	R1G3	11:51:52	11:52:12	31142	26.74	116.86	105.24	11.62	14.23	1.74	0.53	12.49	11.25	3.56	0.0152	99.91
	60	R1G2	11:53:00	11:53:20	34018	27.78	129.07	116.47	12.60	15.09	1.65	0.51	12.62	11.39	3.85	0.0166	99.91

TABLE A-3.—PART A (Continued)

Test Point No.[1]	Power %	Probe ID[2]	MGA Time Start	MGA Time End	Measured gaseous concentration: CO_2 %	CO ppm	NOx ppm	NO ppm	NO_2 ppm	THC from CGA ppm	Gaseous emission index: EI^3CO g/kg fuel	EIHC from CGA g/kg fuel	EINOx g/kg fuel	EINO g/kg fuel	H_2O %	Fuel/Air Ratio	Combustion Efficiency %
506	85	R1G2	11:55:06	11:55:26	36897	21.28	189.62	173.25	16.37	20.43	1.17	0.64	17.08	15.61	4.11	0.0180	99.91
	85	R1G3	11:56:43	11:57:03	35923	24.73	177.07	161.07	16.00	19.87	1.39	0.64	16.39	14.91	4.06	0.0176	99.90
507	100	R1G2	11:58:30	11:58:49	38143	23.32	215.21	197.12	18.09	23.08	1.24	0.70	18.75	17.17	4.28	0.0187	99.90
508	7	R1G2	12:06:15	12:06:35	25139	397.42	31.80	15.46	16.33	18.04	31.63	0.82	4.16	2.02	2.99	0.0124	99.17
	7	R1G3	12:08:12	12:08:31	26431	392.46	36.00	20.48	15.53	19.20	29.72	0.83	4.48	2.55	3.13	0.0130	99.22
	7	R1G4	12:09:10	12:09:29	24977	401.57	30.84	14.73	16.11	18.10	32.16	0.83	4.06	1.94	3.10	0.0123	99.16
	7	R1G5	12:10:27	12:10:47	24339	388.00	29.48	14.11	15.37	17.58	31.91	0.83	3.98	1.91	2.96	0.0120	99.17
	7	R1G6	12:11:35	12:11:54	22875	363.23	28.66	14.71	13.95	16.21	31.81	0.81	4.12	2.12	3.50	0.0112	99.17
	7	R1G1	12:13:02	12:13:22	22295	346.87	28.80	14.40	14.40	16.32	31.19	0.84	4.25	2.13	2.72	0.0109	99.18
	7	R2G2	12:14:30	12:14:49	2132	32.69	2.78	1.74	1.04	6.70	35.44	4.16	4.95	3.10	0.63	0.0009	98.75
	7	R2G3	12:15:37	12:15:57	2103	31.97	2.49	1.61	0.88	5.77	35.24	3.64	4.51	2.92	0.61	0.0009	98.81
	7	R2G4	12:16:36	12:16:55	2141	33.26	2.56	1.61	0.95	5.55	35.89	3.43	4.53	2.86	0.63	0.0009	98.81
	7	R2G6	12:18:13	12:18:32	2296	36.53	2.61	1.59	1.02	5.19	36.33	2.96	4.27	2.60	0.63	0.0010	98.85
	7	R2G1	12:19:30	12:19:49	1785	28.14	1.95	1.39	0.56	4.86	37.69	3.73	4.30	3.07	0.58	0.0007	98.74
	7	R1G2	12:20:19	12:20:38	22178	324.75	27.85	15.51	12.34	15.86	29.38	0.82	4.14	2.30	2.67	0.0109	99.23
509	100	R1G2	12:24:11	12:24:31	39906	32.52	212.80	194.68	18.13	23.84	1.65	0.69	17.71	16.20	4.37	0.0196	99.89
510	85	R1G2	12:25:48	12:26:08	37451	25.56	189.71	172.68	17.03	21.30	1.38	0.66	16.83	15.32	4.12	0.0183	99.90
511	85	R1G2	13:24:03	13:24:23	39759	32.73	209.78	192.62	17.16	22.08	1.66	0.64	17.52	16.09	4.33	0.0195	99.90
512	30	R1G2	13:26:19	13:26:38	28147	67.34	75.03	64.91	10.12	11.74	4.85	0.48	8.87	7.67	3.19	0.0137	99.84
	30	R1G4	13:28:06	13:28:25	24637	64.94	64.40	54.90	9.50	11.83	5.35	0.56	8.71	7.42	2.90	0.0119	99.82
513	7	R1G2	13:31:11	13:31:30	26766	438.03	32.50	14.95	17.55	19.60	32.70	0.84	3.98	1.83	3.07	0.0132	99.15
	7	R1G3	13:33:07	13:33:27	26775	461.30	31.83	14.11	17.72	19.80	34.40	0.85	3.90	1.73	3.09	0.0132	99.11
	7	R1G4	13:34:44	13:35:04	25279	446.39	29.85	12.08	17.77	19.92	35.26	0.90	3.87	1.57	2.94	0.0125	99.08
	7	R1G5	13:35:43	13:36:02	24839	428.83	29.08	12.05	17.03	18.74	34.50	0.86	3.84	1.59	2.86	0.0122	99.10
	7	R1G6	13:37:29	13:37:49	23289	411.50	27.41	11.85	15.56	17.55	35.32	0.86	3.86	1.67	3.31	0.0115	99.08
	7	R1G1	13:38:28	13:38:47	23106	396.63	28.31	12.88	15.43	17.84	34.34	0.88	4.02	1.83	2.80	0.0114	99.10
	7	R2G2	13:40:44	13:41:03	2795	51.02	3.53	1.99	1.54	4.01	40.48	1.82	4.60	2.59	0.64	0.0012	98.87
	7	R2G3	13:41:52	13:42:11	2119	37.79	2.60	1.70	0.90	5.62	41.17	3.51	4.65	3.03	0.56	0.0009	98.68
	7	R2G4	13:43:48	13:44:08	2117	37.83	2.69	1.68	1.01	6.41	41.23	4.00	4.82	3.01	0.59	0.0009	98.63
	7	R2G6	13:45:26	13:45:45	2253	41.70	2.59	1.32	1.27	6.48	42.24	3.76	4.32	2.20	0.60	0.0010	98.63
	7	R2G1	13:46:24	13:46:43	1839	33.99	2.52	1.91	0.61	5.93	43.75	4.37	5.33	4.03	0.56	0.0008	98.53
	7	R1G2	13:48:40	13:48:59	25941	431.20	31.10	14.29	16.81	19.39	33.22	0.86	3.94	1.81	2.97	0.0128	99.13
514	100	R1G2	14:01:28	14:01:47	38729	34.86	203.06	185.15	17.90	22.75	1.82	0.68	17.41	15.88	4.18	0.0190	99.89

TABLE A-3.—PART A (Continued)

Test Point No.[1]	Power %	Probe ID[2]	MGA Time Start	MGA Time End	Measured gaseous concentration: CO_2 %	CO ppm	NOx ppm	NO ppm	NO_2 ppm	THC from CGA ppm	Gaseous emission index: EI^3CO g/kg fuel	EIHC from CGA g/kg fuel	EINOx g/kg fuel	EINO g/kg fuel	H_2O %	Fuel/Air Ratio	Combustion Efficiency %
515	30	R1G2	14:04:13	14:04:32	28503	68.88	77.66	66.74	10.92	13.25	4.89	0.54	9.06	7.79	3.18	0.0139	99.83
	30	R1G4	14:05:50	14:06:10	24872	65.59	65.31	55.50	9.81	13.14	5.35	0.61	8.75	7.43	2.85	0.0121	99.81
	30	R1G2	14:06:49	14:07:08	27927	68.79	74.64	64.11	10.52	13.57	4.99	0.56	8.89	7.64	3.12	0.0136	99.83
516	7	R1G2	14:09:05	14:09:24	27477	419.52	34.57	16.96	17.61	19.64	30.53	0.82	4.13	2.03	3.11	0.0135	99.20
517	85	R1G2	14:12:19	14:12:39	38805	30.20	209.16	190.08	19.07	25.29	1.57	0.75	17.90	16.27	4.22	0.0190	99.89
518	7	R1G2	14:14:26	14:14:45	27631	418.54	35.23	17.55	17.68	19.45	30.30	0.81	4.19	2.09	3.12	0.0136	99.21
	7	R1G3	14:15:34	14:15:53	27903	430.09	35.89	18.27	17.61	19.93	30.82	0.82	4.22	2.15	3.27	0.0138	99.19
	7	R1G3	14:16:03	14:16:22	28218	441.08	35.01	16.94	18.08	20.62	31.24	0.84	4.07	1.97	3.25	0.0139	99.18
	7	R1G4	14:17:30	14:17:50	26698	428.95	32.73	14.87	17.86	20.85	32.11	0.89	4.02	1.83	3.05	0.0132	99.16
	7	R1G5	14:19:17	14:19:37	26131	416.04	31.99	15.15	16.84	19.48	31.84	0.85	4.02	1.90	3.00	0.0129	99.17
	7	R1G6	14:20:45	14:21:04	24476	379.14	30.37	15.32	15.04	18.16	31.01	0.85	4.08	2.06	3.40	0.0120	99.19
	7	R1G1	14:22:22	14:22:41	24571	390.35	31.07	15.31	15.76	17.26	31.80	0.81	4.16	2.05	2.83	0.0121	99.17
	7	R2G2	14:23:59	14:24:19	2036	33.89	2.81	1.70	1.11	1.52	38.84	1.00	5.29	3.20	0.55	0.0009	98.99
	7	R2G3	14:25:17	14:25:36	1958	32.56	2.35	1.40	0.95	2.87	39.05	1.97	4.63	2.76	0.56	0.0008	98.89
	7	R2G4	14:26:54	14:27:14	1960	34.16	2.80	1.62	1.18	3.72	40.86	2.55	5.51	3.19	0.55	0.0008	98.79
	7	R2G6	14:28:31	14:28:51	2229	38.11	2.84	1.64	1.20	3.67	39.21	2.16	4.80	2.77	0.57	0.0010	98.86
	7	R2G1	14:29:10	14:29:30	1909	31.87	2.33	1.65	0.68	3.37	39.38	2.38	4.73	3.34	0.55	0.0008	98.84
519	100	R1G2	14:30:57	14:31:17	41545	38.84	242.30	221.89	20.40	26.13	1.89	0.73	19.36	17.73	4.47	0.0204	99.88
520	85	R1G2	14:32:44	14:33:04	38646	28.77	206.56	187.77	18.79	24.72	1.51	0.74	17.76	16.14	4.17	0.0189	99.89
	85	R1G3	14:35:00	14:35:20	39821	35.19	217.36	197.66	19.70	26.10	1.79	0.76	18.13	16.48	4.35	0.0195	99.88
521	30	R1G3	14:36:38	14:36:57	25840	65.50	72.05	61.50	10.55	13.31	5.14	0.60	9.29	7.93	2.94	0.0125	99.82
	30	R1G5	14:38:05	14:38:25	24199	70.74	63.98	54.46	9.52	13.09	5.93	0.63	8.81	7.50	2.84	0.0117	99.80
	30	R1G2	14:39:42	14:40:02	27722	68.60	75.75	64.81	10.94	13.87	5.01	0.58	9.09	7.78	3.09	0.0135	99.82
	30	R2G2	14:43:07	14:43:26	2082	5.11	6.17	5.44	0.73	0.02	5.80	0.01	11.51	10.15	0.55	0.0009	99.86
522	7	R1G2	14:53:19	14:53:39	27815	430.82	34.68	16.96	17.73	21.10	30.96	0.87	4.09	2.00	3.15	0.0137	99.19
	7	R1G3	14:55:06	14:55:26	27591	437.48	34.00	16.16	17.84	20.49	31.69	0.85	4.04	1.92	3.13	0.0136	99.17
	7	R1G4	14:56:24	14:56:44	26277	429.92	31.69	14.61	17.08	19.66	32.70	0.86	3.96	1.82	3.03	0.0129	99.15
	7	R1G5	14:57:22	14:57:42	25783	418.88	31.26	14.19	17.07	20.07	32.48	0.89	3.98	1.81	2.96	0.0127	99.15
	7	R1G6	14:59:09	14:59:29	24142	396.16	29.84	14.11	15.74	18.38	32.83	0.87	4.06	1.92	3.17	0.0119	99.14
	7	R1G1	15:00:37	15:00:56	24919	422.41	30.91	14.62	16.28	19.66	33.88	0.90	4.07	1.93	2.91	0.0123	99.11
	7	R2G2	15:02:24	15:02:43	3193	55.96	4.10	2.45	1.65	1.81	38.34	0.71	4.62	2.75	0.69	0.0014	99.03
	7	R2G3	15:03:51	15:04:11	1987	35.34	2.67	1.77	0.91	2.93	41.58	1.97	5.17	3.41	0.56	0.0008	98.83
	7	R2G4	15:05:58	15:06:17	1901	34.05	2.65	1.49	1.17	3.09	42.22	2.19	5.40	3.03	0.57	0.0008	98.79
	7	R2G6	15:07:06	15:07:25	2353	40.35	3.01	1.64	1.37	3.05	39.00	1.69	4.78	2.61	0.59	0.0010	98.91
	7	R2G1	15:08:43	15:09:03	1869	31.31	2.35	1.66	0.70	2.66	39.69	1.93	4.90	3.45	0.54	0.0008	98.87
	7	R1G2	15:30:46	15:31:06	27555	433.83	34.33	17.68	16.64	19.73	31.47	0.82	4.09	2.11	3.12	0.0136	99.18

TABLE A-3.—PART A (Continued)

Test Point No.[1]	Power %	Probe ID[2]	MGA Time Start	MGA Time End	Measured gaseous concentration CO_2 %	CO ppm	NOx ppm	NO ppm	NO_2 ppm	THC from CGA ppm	Gaseous emission index EI^3CO g/kg fuel	EIHC from CGA g/kg fuel	EINOx g/kg fuel	EINO g/kg fuel	H_2O %	Fuel/Air Ratio	Combustion Efficiency %
523	100	R1G2	15:52:40	15:52:59	41400	38.79	229.41	208.73	20.67	27.28	1.89	0.76	18.39	16.74	4.44	0.0203	99.88
524	85	R1G2	15:53:48	15:54:07	39264	33.85	208.00	188.34	19.67	24.80	1.74	0.73	17.59	15.93	4.22	0.0192	99.89
	85	R1G2	15:54:56	15:55:15	38373	30.45	203.51	184.24	19.27	25.11	1.60	0.76	17.62	15.95	4.12	0.0188	99.89
525	30	R1G2	15:56:33	15:56:53	27329	72.03	74.93	63.45	11.48	13.87	5.34	0.59	9.12	7.72	3.06	0.0133	99.82
	30	R1G4	15:58:20	15:58:40	23948	70.01	61.81	51.63	10.17	12.45	5.93	0.60	8.60	7.18	2.75	0.0116	99.80
	30	R1G4	15:58:49	15:59:09	24231	70.16	62.36	52.36	10.00	12.02	5.87	0.58	8.57	7.20	2.75	0.0118	99.80
526	7	R1G2	16:01:25	16:01:45	28230	415.95	36.28	18.29	17.99	19.81	29.47	0.80	4.22	2.13	3.17	0.0139	99.23
	7	R1G3	16:02:33	16:02:53	28243	425.92	35.49	17.64	17.85	20.34	30.16	0.82	4.13	2.05	3.16	0.0139	99.21
	7	R1G4	16:03:41	16:04:01	26556	404.10	33.32	16.01	17.32	19.50	30.45	0.84	4.12	1.98	3.01	0.0131	99.20
	7	R1G5	16:05:19	16:05:38	25824	415.46	31.82	15.07	16.75	19.84	32.17	0.88	4.05	1.92	2.96	0.0127	99.16
	7	R1G6	16:06:17	16:06:37	24393	414.22	29.30	13.23	16.07	18.38	33.95	0.86	3.94	1.78	3.02	0.0120	99.12
	7	R1G1	16:07:45	16:08:04	24520	404.88	30.94	13.58	17.36	19.52	33.02	0.91	4.15	1.82	2.81	0.0121	99.13
	7	R1G2	16:10:40	16:10:59	27753	452.34	34.00	15.35	18.65	20.82	32.56	0.86	4.02	1.81	3.10	0.0137	99.15
601	7	R1G2	8:11:29	8:11:48	25185	540.53	26.41	7.51	18.90	64.80	42.62	2.93	3.42	0.97	2.70	0.0125	98.71
	7	R1G3	8:13:06	8:13:25	23831	483.87	26.75	10.11	16.64	50.29	40.42	2.41	3.67	1.39	2.55	0.0118	98.81
	7	R1G4	8:14:04	8:14:23	23627	485.49	25.74	8.10	17.64	46.06	40.91	2.22	3.56	1.12	2.62	0.0117	98.82
	7	R1G5	8:15:21	8:15:40	23177	468.85	25.03	8.15	16.88	42.16	40.30	2.08	3.53	1.15	2.68	0.0114	98.85
	7	R1G6	8:16:09	8:16:29	21850	464.39	23.76	7.25	16.51	44.95	42.32	2.35	3.56	1.09	2.65	0.0108	98.77
	7	R1G1	8:17:56	8:18:15	21962	437.38	25.14	8.81	16.33	43.97	39.71	2.29	3.75	1.31	2.62	0.0108	98.84
	7	R2G2	8:19:04	8:19:23	2333	46.65	2.91	1.41	1.50	15.46	45.13	8.57	4.62	2.24	0.62	0.0010	98.08
	7	R2G3	8:20:21	8:20:40	1838	38.53	2.34	1.25	1.09	10.19	49.35	7.47	4.92	2.63	0.56	0.0008	98.09
	7	R2G6	8:22:56	8:23:15	2181	44.23	2.47	1.07	1.40	12.94	46.29	7.76	4.25	1.84	0.60	0.0009	98.14
	7	R2G1	8:24:04	8:24:23	1758	33.47	2.24	1.33	0.91	12.31	45.26	9.53	4.98	2.95	0.56	0.0007	97.98
	7	R1G2	8:25:50	8:26:10	24047	447.61	27.24	10.36	16.88	38.39	37.13	1.82	3.71	1.41	2.83	0.0119	98.95
602	100	R1G2	8:28:45	8:29:04	40665	34.08	203.97	188.04	15.93	12.00	1.70	0.34	16.66	15.36	4.20	0.0199	99.93
603	85	R1G2	8:30:41	8:31:00	37067	24.38	177.64	163.69	13.95	9.94	1.33	0.31	15.93	14.68	4.78	0.0181	99.94
604	30	R1G2	8:33:45	8:34:04	27179	73.88	67.92	58.19	9.73	8.94	5.51	0.38	8.32	7.13	3.26	0.0132	99.83
	30	R1G4	8:35:51	8:36:10	24690	69.53	61.32	51.90	9.42	9.02	5.71	0.42	8.27	7.00	2.94	0.0120	99.82
605	7	R1G2	8:38:26	8:38:45	24145	466.46	27.49	9.34	18.15	37.39	38.51	1.77	3.73	1.27	2.93	0.0119	98.92
	7	R1G3	8:39:53	8:40:12	24105	473.81	27.00	9.59	17.41	34.76	39.17	1.65	3.67	1.30	3.36	0.0119	98.92
	7	R2G1	8:58:17	8:58:36	1551	31.18	2.21	1.27	0.94	8.83	49.21	7.98	5.73	3.29	0.62	0.0006	98.05
606	100	R1G2	9:05:14	9:05:33	39585	31.14	200.28	182.80	17.48	8.83	1.59	0.26	16.81	15.34	4.35	0.0194	99.94

TABLE A-3.—PART A (Continued)

Test Point	Power	Probe	MGA Time		Measured gaseous concentration						Gaseous emission index				H_2O	Fuel/Air	Combustion Efficiency
					CO_2	CO	NOx	NO	NO_2	THC from CGA	EI^3CO	EIHC from CGA	EINOx	EINO			
No.[1]	%	ID[2]	Start	End	%	ppm	ppm	ppm	ppm	ppm	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	%	Ratio	%
607	85	R1G2	9:06:31	9:06:50	37339	24.58	181.93	165.18	16.75	7.63	1.33	0.24	16.20	14.71	4.21	0.0183	99.95
608	30	R1G2	9:09:35	9:09:54	27213	71.72	69.59	58.67	10.92	6.91	5.34	0.29	8.51	7.18	3.19	0.0132	99.85
	30	R1G4	9:11:22	9:11:41	23555	66.18	58.91	49.20	9.71	7.18	5.70	0.35	8.34	6.96	2.84	0.0114	99.83
609	7	R1G2	9:14:16	9:14:35	23745	431.94	28.65	11.07	17.58	32.11	36.32	1.55	3.96	1.53	2.87	0.0117	98.99
	7	R1G3	9:16:22	9:16:41	24205	421.31	29.88	13.08	16.80	28.67	34.77	1.36	4.05	1.77	3.07	0.0119	99.05
	7	R1G4	9:17:20	9:17:39	23296	424.14	26.94	9.36	17.58	28.19	36.36	1.38	3.79	1.32	2.82	0.0115	99.01
	7	R1G5	9:19:07	9:19:26	22644	409.87	26.34	9.27	17.07	27.18	36.17	1.37	3.82	1.34	2.77	0.0111	99.01
	7	R1G6	9:20:53	9:21:12	20911	390.05	24.41	9.31	15.10	28.74	37.29	1.57	3.83	1.46	2.99	0.0103	98.97
	7	R1G1	9:22:01	9:22:20	21536	400.00	26.48	9.57	16.91	33.40	37.11	1.77	4.04	1.46	3.13	0.0106	98.95
	7	R2G2	9:23:28	9:23:47	2235	40.91	2.93	1.55	1.38	11.92	41.73	6.96	4.91	2.60	0.70	0.0010	98.32
	7	R2G3	9:24:07	9:24:26	1836	33.15	2.39	1.27	1.12	10.84	42.65	7.99	5.05	2.68	0.66	0.0008	98.20
	7	R2G4	9:27:01	9:27:20	1896	34.81	2.47	1.15	1.32	9.22	43.12	6.54	5.03	2.34	0.65	0.0008	98.33
	7	R2G6	9:28:38	9:28:57	2099	39.17	2.77	1.46	1.31	5.69	43.10	3.59	5.01	2.64	0.67	0.0009	98.63
	7	R2G1	9:29:55	9:30:15	1621	28.98	2.24	1.35	0.89	6.01	43.51	5.17	5.52	3.33	0.63	0.0007	98.46
610	100	R1G3	9:40:16	9:40:35	39573	35.44	201.95	184.35	17.60	7.74	1.81	0.23	16.95	15.48	4.35	0.0194	99.93
611	85	R1G3	9:42:03	9:42:22	38668	29.55	191.57	174.37	17.20	6.37	1.55	0.19	16.46	14.99	4.34	0.0189	99.94
612	30	R1G3	9:44:57	9:45:17	25535	65.84	67.30	56.81	10.49	6.07	5.23	0.28	8.78	7.41	2.97	0.0124	99.85
	30	R1G5	9:46:25	9:46:44	23167	62.54	59.74	50.04	9.70	6.41	5.48	0.32	8.60	7.20	2.76	0.0112	99.84
	30	R1G2	9:47:42	9:48:02	24564	89.01	63.16	52.48	10.68	6.73	7.35	0.32	8.56	7.11	2.90	0.0119	99.80
613	7	R1G2	9:49:58	9:50:18	25945	442.18	31.40	13.26	18.14	24.60	34.04	1.08	3.97	1.68	3.04	0.0128	99.09
	7	R1G3	9:51:26	9:51:45	26356	454.82	30.99	12.35	18.64	22.18	34.46	0.96	3.86	1.54	3.06	0.0130	99.09
	7	R1G4	9:53:22	9:53:42	24889	426.27	30.74	13.14	17.60	21.87	34.22	1.01	4.05	1.73	2.92	0.0123	99.10
	7	R1G5	9:54:30	9:54:49	24386	425.60	28.87	11.35	17.52	21.31	34.87	1.00	3.89	1.53	2.87	0.0120	99.08
	7	R1G6	9:56:17	9:56:36	22866	407.84	26.92	10.67	16.25	22.53	35.65	1.13	3.87	1.53	3.12	0.0112	99.05
	7	R1G1	9:57:15	9:57:34	24001	429.04	29.22	11.71	17.51	26.79	35.70	1.28	3.99	1.60	2.88	0.0118	99.03
	7	R2G2	9:59:21	9:59:41	1929	35.50	2.56	1.34	1.22	9.12	43.07	6.34	5.10	2.67	0.62	0.0008	98.35
	7	R2G3	10:00:58	10:01:18	1932	35.02	2.62	1.28	1.34	5.18	42.54	3.60	5.23	2.55	0.62	0.0008	98.64
	7	R2G4	10:02:06	10:02:26	1927	36.28	2.85	1.47	1.38	4.88	44.16	3.40	5.70	2.94	0.62	0.0008	98.62
	7	R2G6	10:03:53	10:04:12	2169	39.65	2.88	1.38	1.50	6.86	41.99	4.16	5.01	2.40	0.64	0.0009	98.60
614	100	R1G3	10:16:00	10:16:20	40933	42.39	214.38	195.07	19.31	6.64	2.09	0.19	17.39	15.83	4.55	0.0201	99.93
615	85	R1G3	10:17:37	10:17:57	39198	31.58	195.96	177.41	18.55	5.66	1.63	0.17	16.61	15.04	4.32	0.0192	99.94

TABLE A-3.—PART A (Continued)

Test Point No.[1]	Power %	Probe ID[2]	MGA Time Start	MGA Time End	Measured gaseous concentration: CO_2 %	CO ppm	NOx ppm	NO ppm	NO_2 ppm	THC from CGA ppm	Gaseous emission index: EI^3CO g/kg fuel	EIHC from CGA g/kg fuel	EINOx g/kg fuel	EINO g/kg fuel	H_2O %	Fuel/Air Ratio	Combustion Efficiency %
616	30	R1G3	10:20:42	10:21:01	26084	66.30	70.12	59.29	10.83	5.36	5.15	0.24	8.95	7.57	3.04	0.0127	99.86
	30	R1G5	10:22:18	10:22:38	24300	62.53	63.18	53.14	10.04	5.54	5.22	0.27	8.67	7.29	2.88	0.0118	99.85
	30	R1G2	10:22:57	10:23:17	26139	64.90	69.77	59.38	10.39	5.16	5.04	0.23	8.89	7.57	3.05	0.0127	99.86
617	7	R1G2	10:26:11	10:26:31	25877	381.69	33.79	17.11	16.68	17.11	29.54	0.76	4.29	2.17	3.05	0.0127	99.23
	7	R1G3	10:27:38	10:27:58	25872	375.25	34.24	18.18	16.06	16.55	29.05	0.73	4.35	2.31	3.04	0.0127	99.24
	7	R1G4	10:28:56	10:29:15	24637	360.20	32.74	16.88	15.86	16.24	29.30	0.76	4.37	2.26	2.93	0.0121	99.24
	7	R1G5	10:30:14	10:30:33	24079	370.07	30.17	15.16	15.01	15.91	30.79	0.76	4.12	2.07	2.91	0.0118	99.20
	7	R1G6	10:31:21	10:31:41	22635	348.93	28.68	14.21	14.47	16.88	30.90	0.86	4.17	2.07	3.15	0.0111	99.19
	7	R1G1	10:32:39	10:32:58	22374	327.86	29.65	15.27	14.38	17.51	29.40	0.90	4.37	2.25	2.74	0.0110	99.22
	7	R2G2	10:34:35	10:34:55	2073	30.78	2.75	1.87	0.88	7.54	34.48	4.84	5.06	3.44	0.64	0.0009	98.71
	7	R2G3	10:34:55	10:35:14	1988	29.42	2.81	1.75	1.06	7.01	34.64	4.73	5.43	3.38	0.62	0.0008	98.71
	7	R2G4	10:36:32	10:36:51	2066	31.92	3.01	1.67	1.34	4.56	35.93	2.94	5.57	3.09	0.62	0.0009	98.86
	7	R2G6	10:37:30	10:37:49	2151	37.35	2.84	1.51	1.33	3.56	40.04	2.19	5.00	2.66	0.62	0.0009	98.84
618	4	R1G2	11:56:45	11:57:04	27553	877.09	25.60	3.83	21.77	81.78	62.49	3.34	3.00	0.45	3.22	0.0138	98.20
619	100	R1G2	12:01:27	12:01:46	39970	35.08	210.66	192.91	17.75	13.35	1.77	0.39	17.51	16.03	4.36	0.0196	99.92
620	85	R1G2	12:02:35	12:02:54	37630	27.64	188.11	171.64	16.47	10.37	1.49	0.32	16.62	15.16	4.08	0.0184	99.93
	85	R1G3	12:04:41	12:05:01	37163	28.60	187.30	170.98	16.32	8.37	1.56	0.26	16.75	15.29	4.06	0.0182	99.94
621	65	R1G3	12:06:48	12:07:07	32273	25.85	130.79	117.39	13.40	7.18	1.62	0.26	13.49	12.11	3.61	0.0157	99.94
	65	R1G2	12:08:05	12:08:25	34932	27.96	141.57	126.41	15.16	6.46	1.62	0.21	13.48	12.04	3.84	0.0171	99.94
622	40	R1G2	12:10:41	12:11:00	29254	49.00	92.43	80.50	11.93	5.85	3.40	0.23	10.52	9.16	3.27	0.0142	99.90
	40	R1G3	12:12:28	12:12:47	27352	47.02	85.24	74.06	11.18	5.80	3.49	0.25	10.38	9.02	3.09	0.0133	99.89
623	4	R1G3	12:15:13	12:15:33	27105	867.76	25.90	4.97	20.93	60.80	62.89	2.52	3.08	0.59	3.12	0.0136	98.27
	4	R1G2	12:17:39	12:17:58	27908	884.17	26.44	5.58	20.86	67.34	62.23	2.71	3.06	0.65	3.25	0.0140	98.27
624	40	R1G2	12:21:32	12:21:52	30333	83.14	89.90	78.58	11.32	10.67	5.55	0.41	9.85	8.61	3.41	0.0148	99.83
	40	R1G3	12:22:31	12:22:50	28112	51.86	88.11	77.61	10.50	9.29	3.74	0.38	10.44	9.19	3.16	0.0137	99.87
	40	R1G4	12:23:58	12:24:18	25903	68.61	76.31	66.27	10.04	8.64	5.37	0.39	9.81	8.52	3.02	0.0126	99.84
	40	R1G5	12:24:47	12:25:06	25517	45.92	77.50	67.23	10.27	8.10	3.65	0.37	10.12	8.78	2.95	0.0124	99.88
	40	R1G6	12:25:55	12:26:14	25661	50.78	78.72	69.60	9.12	8.06	4.02	0.37	10.22	9.04	3.15	0.0124	99.87
	40	R1G1	12:27:13	12:27:32	26021	44.75	76.13	66.90	9.23	6.73	3.49	0.30	9.75	8.57	2.98	0.0126	99.89
	40	R1G2	12:31:16	12:31:35	27841	44.76	87.02	76.15	10.87	5.42	3.26	0.23	10.41	9.11	3.16	0.0135	99.90
	40	R2G3	12:32:43	12:33:03	2637	4.90	8.01	7.01	1.00	2.31	4.23	1.14	11.36	9.94	0.61	0.0011	99.79
	40	R2G4	12:34:01	12:34:20	2832	6.16	8.40	7.35	1.05	3.63	4.90	1.66	10.98	9.61	0.63	0.0012	99.72
	40	R2G6	12:35:38	12:35:58	2711	4.24	8.32	7.49	0.83	4.67	3.55	2.24	11.43	10.29	0.62	0.0012	99.69
	40	R2G1	12:36:46	12:37:06	2375	3.41	6.83	6.03	0.80	4.87	3.32	2.71	10.91	9.63	0.60	0.0010	99.65
	40	R1G2	12:38:23	12:38:43	30556	47.19	96.20	84.32	11.88	6.27	3.13	0.24	10.48	9.18	3.41	0.0149	99.90

TABLE A-3.—PART A (Continued)

Test Point No.[1]	Power	Probe ID[2]	MGA Time		Measured gaseous concentration						Gaseous emission index				H_2O	Fuel/Air Ratio	Combustion Efficiency
					CO_2	CO	NOx	NO	NO_2	THC from CGA	EI^3CO	EIHC from CGA	EINOx	EINO			
	%		Start	End	%	ppm	ppm	ppm	ppm	ppm	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	%		%
625	30	R1G2	12:44:04	12:44:23	27119	66.41	75.98	64.71	11.27	4.12	4.96	0.18	9.33	7.94	3.04	0.0132	99.87
	30	R1G3	12:45:31	12:45:51	25503	65.49	68.67	58.18	10.49	3.58	5.21	0.16	8.97	7.60	2.90	0.0124	99.86
626	15	R1G3	12:48:07	12:48:26	25327	215.81	40.68	27.87	12.81	6.73	17.18	0.31	5.32	3.64	2.91	0.0124	99.57
	15	R1G2	12:49:25	12:49:44	25702	209.44	42.64	30.00	12.64	6.72	16.43	0.30	5.50	3.87	2.93	0.0125	99.58
627	7	R1G2	12:52:10	12:52:29	25405	364.58	33.42	17.21	16.21	15.03	28.76	0.68	4.33	2.23	2.93	0.0125	99.26
	7	R1G3	12:53:28	12:53:47	25266	372.34	32.35	15.65	16.70	14.42	29.52	0.65	4.21	2.04	2.91	0.0124	99.24
628	5.5	R1G3	12:56:23	12:56:42	26785	618.08	28.62	7.21	21.41	30.58	45.79	1.30	3.48	0.88	3.08	0.0133	98.79
	5.5	R1G2	12:57:50	12:58:10	26705	603.08	28.79	8.44	20.35	33.35	44.83	1.42	3.51	1.03	3.06	0.0133	98.80
629	4	R1G2	13:01:05	13:01:24	27845	782.98	28.72	8.02	20.70	56.42	55.44	2.29	3.34	0.93	3.19	0.0139	98.47
	4	R2G6	13:03:02	13:03:21	2470	72.04	2.57	0.73	1.84	10.29	64.78	5.30	3.80	1.08	0.62	0.0011	97.95
	4	R1G2	13:10:19	13:10:39	28210	840.67	27.31	6.22	21.09	61.27	58.65	2.45	3.13	0.71	3.19	0.0141	98.38
630	5.5	R1G2	13:12:55	13:13:14	27204	565.50	30.20	10.44	19.76	33.76	41.33	1.41	3.63	1.25	3.08	0.0135	98.89
	5.5	R2G6	13:14:32	13:14:52	2430	51.94	2.70	0.90	1.80	7.95	48.04	4.21	4.10	1.37	0.58	0.0011	98.45
631	7	R1G2	13:16:48	13:17:08	26387	386.46	33.75	17.77	15.98	19.49	29.32	0.85	4.21	2.21	2.99	0.0130	99.23
632	15	R1G2	13:20:32	13:20:52	25944	173.89	46.86	35.15	11.71	8.85	13.53	0.39	5.99	4.49	2.94	0.0126	99.64
	15	R2G6	13:22:19	13:22:39	2375	17.12	4.33	3.21	1.12	4.84	16.54	2.68	6.87	5.09	0.58	0.0010	99.34
633	30	R1G2	13:24:26	13:24:45	29314	61.97	81.77	70.31	11.46	6.63	4.28	0.26	9.28	7.98	3.25	0.0143	99.87
	30	R2G6	13:26:03	13:26:23	3062	6.05	8.83	7.59	1.24	3.21	4.41	1.34	10.58	9.10	0.62	0.0013	99.76
634	4	R1G2	13:28:10	13:28:29	27744	861.21	26.63	6.03	20.60	61.71	61.02	2.50	3.10	0.70	3.13	0.0139	98.32
	4	R1G2	13:34:10	13:34:29	28388	920.50	26.66	5.83	20.83	75.64	63.61	2.99	3.03	0.66	3.24	0.0143	98.21
635	40	R1G2	13:40:10	13:40:29	31737	44.72	101.63	89.45	12.18	11.14	2.85	0.41	10.65	9.38	3.49	0.0155	99.89
	40	R1G3	13:41:47	13:42:07	28615	40.45	94.20	83.12	11.08	9.00	2.87	0.37	10.96	9.67	3.16	0.0139	99.90
	40	R1G2	13:43:05	13:43:24	31269	42.38	104.26	91.76	12.50	7.72	2.75	0.29	11.10	9.77	3.45	0.0152	99.91
	40	R1G3	13:44:13	13:44:33	28749	39.92	96.15	84.95	11.20	7.46	2.82	0.30	11.14	9.84	3.16	0.0140	99.90
	40	R1G4	13:46:00	13:46:20	26302	41.66	84.91	73.85	11.06	6.24	3.21	0.28	10.76	9.36	2.90	0.0128	99.90
	40	R1G5	13:47:08	13:47:28	26004	42.10	82.29	71.63	10.66	5.76	3.29	0.26	10.55	9.18	2.90	0.0126	99.90
	40	R1G6	13:48:07	13:48:26	26710	57.27	83.79	74.18	9.61	6.48	4.35	0.28	10.45	9.25	3.10	0.0130	99.87
	40	R1G1	13:49:44	13:50:03	28437	38.89	91.49	81.03	10.46	5.62	2.77	0.23	10.72	9.49	3.15	0.0138	99.91
	40	R2G2	13:51:02	13:51:21	3251	4.68	10.31	9.23	1.08	2.22	3.20	0.87	11.57	10.36	0.64	0.0014	99.84
	40	R2G3	13:52:10	13:52:29	2774	4.37	8.63	7.78	0.85	3.86	3.56	1.80	11.55	10.42	0.58	0.0012	99.74
	40	R2G4	13:53:47	13:54:07	2871	5.68	8.89	7.89	1.00	4.97	4.45	2.23	11.44	10.16	0.60	0.0012	99.67
	40	R2G6	13:55:15	13:55:34	2968	4.51	9.42	8.40	1.02	4.96	3.41	2.15	11.69	10.42	0.61	0.0013	99.71
	40	R2G1	13:56:13	13:56:33	2371	3.29	6.98	6.31	0.67	4.84	3.21	2.70	11.18	10.10	0.55	0.0010	99.65

TABLE A-3.—PART A (Continued)

Test Point	Power	Probe	MGA Time		Measured gaseous concentration						Gaseous emission index				H_2O	Fuel/Air	Combustion Efficiency
					CO_2	CO	NOx	NO	NO_2	THC from CGA	EI^3CO	EIHC from CGA	EINOx	EINO			
No.[1]	%	ID[2]	Start	End	%	ppm	ppm	ppm	ppm	ppm	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	%	Ratio	%
636	30	R1G2	14:00:17	14:00:36	27657	61.96	79.45	68.20	11.25	4.60	4.54	0.19	9.56	8.21	3.06	0.0134	99.87
	30	R1G3	14:01:34	14:01:54	25726	63.38	70.38	59.94	10.44	4.26	5.00	0.19	9.11	7.76	2.89	0.0125	99.86
637	15	R1G2	14:04:39	14:04:59	26347	198.11	45.51	32.88	12.63	6.28	15.17	0.28	5.72	4.14	2.97	0.0129	99.62
	15	R1G3	14:05:47	14:06:07	25354	197.51	42.69	30.50	12.19	6.46	15.72	0.29	5.58	3.99	2.83	0.0124	99.60
	15	R1G2	14:06:46	14:07:05	25177	237.80	41.77	28.87	12.90	8.61	19.03	0.39	5.49	3.79	2.82	0.0123	99.51
638	7	R1G2	14:08:13	14:08:33	26786	447.82	32.83	14.78	18.05	18.63	33.40	0.80	4.02	1.81	2.98	0.0132	99.14
	7	R1G3	14:09:58	14:10:17	26044	450.34	30.86	12.72	18.14	18.57	34.53	0.82	3.89	1.60	2.89	0.0128	99.11
	7	R1G2	14:11:06	14:11:26	26456	445.39	32.23	14.13	18.10	19.64	33.63	0.85	4.00	1.75	2.96	0.0130	99.13
639	5.5	R1G2	14:12:53	14:13:13	27365	581.50	30.14	9.83	20.31	29.87	42.23	1.24	3.60	1.17	3.05	0.0136	98.88
	5.5	R1G3	14:14:40	14:15:00	26575	587.65	28.85	8.38	20.47	28.57	43.93	1.22	3.54	1.03	2.99	0.0132	98.85
640	4	R1G2	14:18:44	14:19:03	27759	752.01	27.84	6.69	21.15	49.61	53.49	2.02	3.25	0.78	3.10	0.0139	98.54
	4	R1G3	14:20:11	14:20:31	26878	772.50	26.86	5.29	21.57	48.03	56.67	2.02	3.24	0.64	3.06	0.0134	98.47
641	5.5	R1G2	14:27:10	14:27:29	25917	510.93	29.87	11.75	18.12	28.15	39.26	1.24	3.77	1.48	2.93	0.0128	98.95
	5.5	R2G6	14:28:18	14:28:37	2755	56.44	3.34	1.27	2.07	7.11	45.35	3.27	4.41	1.68	0.57	0.0012	98.61
642	7	R1G2	14:31:23	14:31:42	26197	389.13	34.15	17.55	16.60	17.55	29.74	0.77	4.29	2.20	2.95	0.0129	99.22
	7	R2G6	14:33:10	14:33:29	2350	38.93	3.24	1.59	1.65	6.11	37.66	3.39	5.15	2.53	0.54	0.0010	98.78
643	15	R1G2	14:35:16	14:35:36	26500	169.69	48.43	36.73	11.70	7.68	12.93	0.34	6.06	4.60	2.95	0.0129	99.66
726	4	R1GG3	15:03:10	15:10:58	26457	867.86	25.03	14.87	10.16	73.52	64.37	3.12	3.05	1.81	2.99	0.0133	98.18
727	100	R1GG3	15:11:57	15:12:55	39287	40.49	222.52	206.94	15.58	13.97	2.08	0.41	18.81	17.50	4.17	0.0192	99.91
728	85	R1GG3	15:14:13	15:16:20	37530	32.76	201.65	184.71	16.94	13.93	1.77	0.43	17.86	16.36	4.00	0.0184	99.92
729	65	R1GG3	15:16:59	15:20:43	32478	26.32	139.99	126.78	13.21	11.30	1.64	0.40	14.34	12.99	3.53	0.0158	99.92
730	40	R1GG3	15:21:51	15:25:26	27394	44.41	91.69	82.12	9.57	15.03	3.29	0.64	11.15	9.98	3.00	0.0133	99.86
731	30	R1GG3	15:26:15	15:30:09	25363	61.93	73.19	64.32	8.87	15.66	4.95	0.72	9.61	8.45	2.78	0.0123	99.81
732	7	R1GG3	15:31:27	15:33:24	24426	400.15	31.17	18.86	12.31	26.80	32.76	1.26	4.19	2.54	2.75	0.0120	99.10
733	4	R1GG3	15:35:30	15:43:18	25731	705.35	26.20	13.30	12.90	50.66	54.14	2.23	3.30	1.68	2.89	0.0128	98.51
734	100	R1GG3	15:44:07	15:45:15	38816	35.37	219.01	199.11	19.90	12.16	1.84	0.36	18.75	17.04	4.11	0.0190	99.92
735	85	R1GG3	15:46:24	15:48:11	37524	32.10	207.31	187.83	19.48	12.92	1.73	0.40	18.36	16.64	3.98	0.0184	99.92
736	65	R1GG3	15:49:00	15:52:44	32548	25.85	144.32	129.46	14.86	10.84	1.61	0.39	14.76	13.24	3.49	0.0159	99.92
737	40	R1GG3	15:53:42	15:57:27	27101	42.65	93.11	82.52	10.59	15.98	3.19	0.68	11.44	10.14	2.95	0.0132	99.86
738	30	R1GG3	15:58:45	16:01:50	25441	63.10	74.19	64.44	9.75	15.50	5.03	0.71	9.71	8.44	2.80	0.0123	99.81
739	7	R1GG3	16:03:08	16:06:13	25134	378.85	32.94	20.35	12.59	25.42	30.17	1.16	4.31	2.66	2.77	0.0124	99.18
740	4	R1GG3	16:07:21	16:14:01	26390	770.63	26.55	13.36	13.19	55.69	57.55	2.38	3.26	1.64	2.92	0.0132	98.41

TABLE A-3.—PART A (Continued)

Test Point	Power	Probe	MGA Time		Measured gaseous concentration						Gaseous emission index				H_2O	Fuel/Air	Combustion Efficiency
					CO_2	CO	NOx	NO	NO_2	THC from CGA	EI^3CO	EIHC from CGA	EINOx	EINO			
No.[1]	%	ID[2]	Start	End	%	ppm	ppm	ppm	ppm	ppm	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	%	Ratio	%
741	100	R1GG3	16:15:09	16:16:18	39533	38.64	233.17	211.90	21.27	12.90	1.98	0.38	19.59	17.80	4.15	0.0194	99.92
742	85	R1GG3	16:16:47	16:20:31	37651	32.69	209.86	189.89	19.97	13.27	1.76	0.41	18.52	16.76	3.96	0.0184	99.92
743	70	R1GG3	16:21:01	16:24:35	33652	25.32	158.41	142.19	16.22	11.38	1.52	0.39	15.66	14.06	3.59	0.0164	99.92
744	65	R1GG3	16:25:53	16:28:19	32202	25.13	142.82	127.96	14.86	12.77	1.58	0.46	14.76	13.22	3.45	0.0157	99.92
745	60	R1GG3	16:28:49	16:32:13	31174	26.13	128.84	115.08	13.76	13.67	1.70	0.51	13.76	12.29	3.39	0.0152	99.91
746	40	R1GG3	16:33:22	16:36:17	27024	43.43	89.45	78.73	10.72	15.73	3.26	0.68	11.03	9.70	3.16	0.0131	99.86
747	30	R1GG3	16:37:16	16:40:01	25402	61.90	71.81	62.08	9.73	16.12	4.94	0.74	9.42	8.14	2.99	0.0123	99.81
748	15	R1GG3	16:41:00	16:43:46	24478	183.60	43.51	33.08	10.43	17.53	15.14	0.83	5.89	4.48	2.93	0.0119	99.56
749	7	R1GG3	16:44:25	16:47:49	25101	365.38	33.11	20.70	12.41	25.47	29.16	1.16	4.34	2.71	3.00	0.0123	99.20
750	5.5	R1GG3	16:49:17	16:51:43	25927	525.22	29.56	16.17	13.39	34.90	40.31	1.53	3.73	2.04	3.09	0.0128	98.90
751	4	R1GG3	16:53:40	16:56:16	26535	770.26	26.75	16.14	10.61	59.27	57.21	2.52	3.26	1.97	3.16	0.0133	98.40
801	4	R1GG3	8:01:22	8:06:13	25292	1087.72	20.14	7.56	12.58	142.60	83.38	6.26	2.54	0.95	3.07	0.0129	97.42
802	100	R1GG3	8:07:12	8:08:20	38916	40.82	202.12	186.01	16.11	14.28	2.12	0.43	17.25	15.88	3.86	0.0191	99.91
803	85	R1GG3	8:08:58	8:11:53	36771	31.38	180.01	163.01	17.00	13.06	1.73	0.41	16.27	14.73	3.95	0.0180	99.92
804	65	R1GG3	8:12:42	8:16:25	32013	25.76	126.94	113.47	13.47	12.30	1.63	0.45	13.20	11.80	3.87	0.0156	99.92
805	40	R1GG3	8:17:33	8:36:58	26803	45.74	83.71	73.47	10.24	15.87	3.46	0.69	10.40	9.13	3.05	0.0130	99.85
806	30	R1GG3	8:37:47	8:41:10	24712	68.50	65.68	56.02	9.66	16.68	5.62	0.78	8.85	7.55	2.83	0.0120	99.79
807	7	R1GG3	8:41:59	8:45:32	23779	431.49	28.84	15.85	12.99	33.96	36.23	1.63	3.98	2.19	2.78	0.0117	98.99
808	4	R1GG3	8:46:21	8:53:57	24801	782.71	23.98	13.24	10.74	71.24	62.05	3.23	3.12	1.72	2.89	0.0124	98.22
809	100	R1GG3	8:54:55	8:56:03	38659	34.70	205.73	186.44	19.29	12.84	1.82	0.38	17.68	16.02	4.20	0.0189	99.92
810	85	R1GG3	8:56:22	8:59:17	37041	30.07	188.52	169.72	18.80	13.63	1.64	0.43	16.92	15.23	4.02	0.0181	99.92
811	65	R1GG3	8:59:46	9:03:00	32214	25.47	132.22	117.64	14.58	11.54	1.60	0.42	13.66	12.15	3.59	0.0157	99.92
812	40	R1GG3	9:03:39	9:23:33	27226	43.43	87.72	76.99	10.74	15.92	3.24	0.68	10.73	9.42	3.07	0.0132	99.86
813	30	R1GG3	9:24:21	9:28:05	25015	63.94	68.90	58.95	9.96	15.16	5.18	0.70	9.17	7.85	2.89	0.0121	99.81
814	7	R1GG3	9:28:53	9:32:17	24036	418.43	29.39	16.12	13.27	32.15	34.78	1.53	4.01	2.20	2.80	0.0118	99.03
815	4	R1GG3	9:33:35	9:40:23	25228	775.01	24.59	13.09	11.50	65.19	60.46	2.91	3.15	1.68	2.97	0.0126	98.29
816	100	R1GG3	9:41:12	9:42:10	38372	34.69	207.36	187.65	19.71	13.54	1.83	0.41	17.95	16.25	4.16	0.0188	99.92
817	85	R1GG3	9:42:39	9:46:03	37083	30.76	189.91	170.66	19.25	13.51	1.68	0.42	17.02	15.30	4.05	0.0181	99.92
818	70	R1GG3	9:46:42	9:49:46	33310	25.07	145.31	129.48	15.84	11.85	1.52	0.41	14.52	12.93	3.69	0.0162	99.92
819	65	R1GG3	9:50:25	9:53:20	32272	25.20	133.74	118.93	14.82	12.88	1.58	0.46	13.79	12.26	3.61	0.0157	99.92
820	60	R1GG3	9:53:49	9:57:03	30296	25.50	120.70	107.35	13.35	11.87	1.71	0.46	13.27	11.80	3.42	0.0147	99.91
821	40	R1GG3	9:57:52	10:01:16	27308	42.41	89.10	78.14	10.96	15.98	3.15	0.68	10.87	9.53	3.10	0.0133	99.86
822	30	R1GG3	10:01:54	10:05:18	25265	63.54	69.82	59.83	9.99	16.13	5.10	0.74	9.20	7.89	2.92	0.0123	99.81
823	15	R1GG3	10:06:16	10:08:52	23968	197.80	40.75	29.89	10.86	19.62	16.65	0.95	5.63	4.13	2.81	0.0117	99.51

TABLE A-3.—PART A (Continued)

Test Point	Power	Probe	MGA Time		Measured gaseous concentration						Gaseous emission index				H_2O	Fuel/Air	Combustion Efficiency
					CO_2	CO	NOx	NO	NO_2	THC from CGA	EI^3CO	EIHC from CGA	EINOx	EINO			
No.[1]	%	ID[2]	Start	End	%	ppm	ppm	ppm	ppm	ppm	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	%	Ratio	%
824	7	R1GG3	10:10:09	10:12:45	24396	412.53	29.95	16.38	13.57	31.18	33.79	1.46	4.03	2.20	2.86	0.0120	99.06
825	5.5	R1GG3	10:13:53	10:16:38	25086	567.98	27.30	13.19	14.10	42.89	44.96	1.94	3.55	1.71	2.94	0.0124	98.75
826	4	R1GG3	10:17:55	10:21:44	25390	781.42	24.56	12.94	11.62	65.45	60.56	2.90	3.13	1.65	2.99	0.0127	98.29
827	4	R1GG3	12:50:02	12:53:56	26068	937.44	23.65	12.25	11.41	90.25	70.32	3.88	2.91	1.51	3.21	0.0131	97.96
828	100	R1GG3	12:54:54	12:55:53	39228	37.68	215.41	195.51	19.89	13.86	1.94	0.41	18.24	16.56	4.44	0.0192	99.91
829	85	R1GG3	12:56:32	12:58:58	37848	32.99	193.42	173.84	19.58	13.17	1.76	0.40	16.98	15.26	4.30	0.0185	99.92
830	65	R1GG3	12:59:47	13:02:52	32713	25.39	134.28	119.37	14.91	9.88	1.57	0.35	13.66	12.14	3.79	0.0159	99.93
831	40	R1GG3	13:03:41	13:06:46	27336	42.98	88.95	78.09	10.86	15.25	3.19	0.65	10.84	9.51	3.23	0.0133	99.86
832	30	R1GG3	13:07:15	13:10:30	25431	60.10	71.86	62.02	9.85	14.90	4.79	0.68	9.41	8.12	3.08	0.0123	99.82
833	7	R1GG3	13:11:38	13:15:02	24365	413.11	29.70	17.09	12.61	29.36	33.89	1.38	4.00	2.30	3.05	0.0120	99.07
834	4	R1GG3	13:16:20	13:24:57	25429	728.78	25.10	13.60	11.50	58.26	56.53	2.59	3.20	1.73	3.18	0.0127	98.41
835	100	R1GG3	13:25:45	13:26:34	38872	34.96	211.39	190.80	20.58	12.51	1.82	0.37	18.07	16.31	4.49	0.0190	99.92
836	85	R1GG3	13:27:34	13:30:08	37798	31.85	194.12	173.95	20.17	13.81	1.70	0.42	17.07	15.29	4.42	0.0185	99.92
837	65	R1GG3	13:30:47	13:34:02	32458	24.89	132.90	117.74	15.16	9.81	1.55	0.35	13.63	12.07	3.84	0.0158	99.93
838	40	R1GG3	13:35:10	13:38:44	26926	45.64	83.87	72.95	10.92	14.57	3.44	0.63	10.38	9.02	3.31	0.0131	99.86
839	30	R1GG3	13:39:23	13:42:28	25277	61.15	70.16	60.04	10.12	15.20	4.91	0.70	9.25	7.91	3.11	0.0123	99.81
840	7	R1GG3	13:43:37	13:46:51	25222	424.14	30.45	16.51	13.94	29.59	33.60	1.34	3.96	2.15	3.13	0.0124	99.08
841	4	R1GG3	13:48:09	13:55:08	25938	808.92	24.82	13.33	11.49	67.43	61.32	2.93	3.09	1.66	3.27	0.0130	98.27
842	100	R1GG3	13:55:57	13:57:05	39319	35.99	216.12	194.97	21.15	12.13	1.85	0.36	18.26	16.47	4.54	0.0193	99.92
843	85	R1GG3	13:58:13	14:00:29	37719	31.48	198.27	177.88	20.39	11.83	1.69	0.36	17.47	15.67	4.32	0.0185	99.92
844	100	R1GG3	14:10:42	14:11:51	38902	33.74	215.72	194.71	21.01	12.28	1.75	0.37	18.42	16.63	4.55	0.0190	99.92
845	85	R1GG3	14:12:30	14:16:04	37306	30.30	193.85	173.75	20.10	11.24	1.64	0.35	17.27	15.48	4.30	0.0182	99.93
846	70	R1GG3	14:17:02	14:20:17	33327	23.98	145.23	128.84	16.39	10.11	1.46	0.35	14.50	12.86	3.89	0.0163	99.93
847	65	R1GG3	14:20:46	14:23:51	31972	24.49	130.46	115.35	15.10	10.86	1.55	0.39	13.58	12.01	3.83	0.0156	99.92
848	60	R1GG3	14:24:20	14:27:45	30958	25.85	120.24	106.10	14.14	10.56	1.69	0.40	12.93	11.41	3.71	0.0151	99.92
849	40	R1GG3	14:28:43	14:32:07	27582	42.78	89.88	78.41	11.47	14.64	3.15	0.62	10.85	9.47	3.29	0.0134	99.86
850	30	R1GG3	14:32:46	14:36:11	25249	61.53	71.10	60.65	10.45	13.76	4.94	0.63	9.38	8.00	3.06	0.0123	99.82
851	15	R1GG3	14:37:09	14:40:04	24147	185.85	42.09	31.09	11.00	16.94	15.53	0.81	5.78	4.27	2.96	0.0118	99.55
852	7	R1GG3	14:41:32	14:43:48	24916	425.40	30.05	15.81	14.24	29.04	34.11	1.33	3.96	2.08	3.10	0.0123	99.07
853	5.5	R1GG3	14:44:37	14:47:22	25250	522.87	28.21	13.31	14.90	36.95	41.20	1.67	3.65	1.72	3.11	0.0125	98.87
854	4	R1GG3	14:48:21	14:55:58	25727	808.60	24.46	13.20	11.25	68.10	61.79	2.98	3.07	1.66	3.26	0.0129	98.25
855	100	R1GG3	14:57:26	14:58:43	39075	36.83	216.56	195.43	21.13	11.11	1.91	0.33	18.41	16.61	4.45	0.0191	99.92
856	85	R1GG3	14:59:52	15:02:08	37208	31.02	189.06	169.07	19.99	13.67	1.69	0.43	16.89	15.10	4.35	0.0182	99.92
857	65	R1GG3	15:02:57	15:05:42	32369	24.80	131.36	116.06	15.30	10.02	1.55	0.36	13.51	11.93	3.84	0.0158	99.93

TABLE A-3.—PART A (Continued)

Test Point	Power	Probe	MGA Time		Measured gaseous concentration						Gaseous emission index				H_2O	Fuel/Air	Combustion Efficiency
					CO_2	CO	NOx	NO	NO_2	THC from CGA	EI^3CO	EIHC from CGA	EINOx	EINO			
No.[1]	%	ID[2]	Start	End	%	ppm	ppm	ppm	ppm	ppm	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	%	Ratio	%
858	40	R1GG3	15:06:31	15:09:45	27214	41.88	88.36	76.98	11.38	14.01	3.12	0.60	10.82	9.42	3.30	0.0132	99.87
859	30	R1GG3	15:10:44	15:13:29	25272	63.53	70.51	59.97	10.54	15.28	5.10	0.70	9.29	7.90	2.99	0.0123	99.81
860	7	R1GG3	15:14:28	15:18:02	24827	384.92	32.37	18.51	13.86	26.65	31.03	1.23	4.29	2.45	2.83	0.0122	99.15
861	4	R1GG3	15:20:08	15:22:34	26055	807.06	24.67	12.44	12.23	68.22	60.92	2.95	3.06	1.54	3.31	0.0131	98.27
901	4	R1P2	8:52:25	8:57:45	25763	1149.60	20.04	2.69	17.34	178.04	86.25	7.65	2.47	0.33	2.88	0.0131	97.21
902	100	R1P2	8:58:54	8:59:52	40391	44.88	213.15	197.32	15.82	22.76	2.25	0.65	17.52	16.22	4.33	0.0198	99.88
903	85	R1P2	9:01:19	9:03:16	38990	30.71	199.40	184.86	14.55	13.38	1.59	0.40	16.99	15.75	4.05	0.0191	99.92
904	65	R1P2	9:04:14	9:07:19	33701	24.26	138.77	128.39	10.38	13.56	1.46	0.47	13.70	12.67	3.80	0.0164	99.92
905	40	R1P2	9:08:46	9:11:12	29403	52.54	87.43	78.24	9.20	14.71	3.62	0.58	9.89	8.85	3.38	0.0143	99.86
906	30	R1P2	9:12:11	9:15:25	26974	75.44	70.00	60.19	9.81	17.21	5.66	0.74	8.63	7.42	3.24	0.0131	99.79
907	7	R1P2	9:17:02	9:19:28	23552	404.89	29.62	12.50	17.13	38.56	34.35	1.87	4.13	1.74	2.92	0.0116	99.01
908	4	R1P2	9:21:05	9:24:19	25338	909.80	22.79	3.68	19.11	110.85	70.18	4.90	2.89	0.47	2.96	0.0128	97.86
909	100	R1P2	9:29:39	9:30:18	41150	39.05	225.54	207.77	17.77	15.90	1.92	0.45	18.20	16.76	4.28	0.0202	99.91
910	85	R1P2	9:31:36	9:33:52	38047	26.97	197.42	181.07	16.35	14.36	1.43	0.44	17.24	15.82	4.01	0.0186	99.92
911	65	R1P2	9:34:50	9:37:54	33938	23.49	142.88	129.74	13.14	13.65	1.40	0.47	14.01	12.72	3.82	0.0166	99.92
912	40	R1P2	9:39:02	9:43:15	29494	50.37	88.96	77.71	11.25	12.85	3.46	0.51	10.04	8.77	3.40	0.0144	99.87
913	30	R1P2	9:44:22	9:47:46	27230	72.29	71.98	60.71	11.28	17.13	5.38	0.73	8.80	7.42	3.16	0.0132	99.80
914	7	R1P2	9:48:54	9:52:28	24234	434.15	29.33	12.23	17.11	41.21	35.75	1.94	3.97	1.65	2.82	0.0119	98.97
915	4	R1P2	9:53:55	10:00:24	26159	932.33	23.23	3.91	19.32	111.58	69.66	4.77	2.85	0.48	2.96	0.0132	97.89
916	100	R1P2	10:02:21	10:03:19	40766	38.67	218.31	200.43	17.88	13.59	1.92	0.39	17.78	16.33	4.14	0.0200	99.92
917	85	R1P2	10:04:08	10:07:32	37826	26.60	195.80	178.46	17.34	13.98	1.42	0.43	17.20	15.68	4.09	0.0185	99.92
918	70	R1P2	10:08:01	10:11:35	34364	22.56	150.03	135.20	14.83	13.04	1.33	0.44	14.52	13.09	3.82	0.0168	99.92
919	65	R1P2	10:13:12	10:15:48	33930	23.98	140.45	125.71	14.74	12.55	1.43	0.43	13.77	12.33	3.81	0.0166	99.92
920	60	R1P2	10:16:17	10:20:39	32790	26.92	128.59	114.55	14.04	13.53	1.66	0.48	13.05	11.62	3.76	0.0160	99.91
921	40	R1P2	10:21:28	10:24:52	29642	49.42	90.14	77.93	12.21	13.35	3.38	0.52	10.12	8.75	3.46	0.0144	99.87
922	30	R1P2	10:25:30	10:28:55	27384	70.30	72.74	61.15	11.59	16.52	5.20	0.70	8.84	7.43	3.18	0.0133	99.81
923	15	R1P2	10:29:43	10:33:07	23900	204.80	41.86	29.31	12.55	22.21	17.28	1.07	5.80	4.06	2.78	0.0117	99.49
924	7	R1P2	10:33:46	10:37:10	24510	431.96	29.95	12.40	17.56	40.05	35.18	1.87	4.01	1.66	2.81	0.0121	98.99
925	5.5	R1P2	10:37:59	10:41:23	25226	570.39	27.30	7.13	20.17	54.54	44.87	2.46	3.53	0.92	2.92	0.0125	98.70
926	4	R1P2	10:42:31	10:53:22	26237	906.90	23.90	4.15	19.76	106.71	67.64	4.56	2.93	0.51	3.02	0.0132	97.96
927	100	R1P2	10:54:30	10:55:09	40705	38.45	214.11	196.54	17.56	14.35	1.91	0.41	17.47	16.03	4.16	0.0200	99.91
928	85	R1P2	10:56:27	10:58:43	37470	26.24	190.91	173.68	17.24	13.98	1.42	0.43	16.94	15.41	4.08	0.0183	99.92
929	65	R1P2	10:59:22	11:03:24	33919	24.15	141.40	126.91	14.49	13.53	1.44	0.46	13.87	12.45	3.88	0.0165	99.92
930	40	R1P2	11:04:13	11:07:17	30636	44.02	96.88	84.40	12.49	12.46	2.91	0.47	10.52	9.17	3.55	0.0149	99.88

TABLE A-3.—PART A (Concluded)

Test Point	Power	Probe	MGA Time		Measured gaseous concentration						Gaseous emission index				H_2O	Fuel/Air	Combustion Efficiency
					CO_2	CO	NOx	NO	NO_2	THC from CGA	EI[3]CO	EIHC from CGA	EINOx	EINO			
No.[1]	%	ID[2]	Start	End	%	ppm	ppm	ppm	ppm	ppm	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	%	Ratio	%
931	30	R1P2	11:07:56	11:11:10	27407	69.28	74.01	62.32	11.69	16.22	5.12	0.69	8.99	7.57	3.13	0.0133	99.81
932	7	R1P2	11:12:09	11:15:52	24242	424.38	30.02	13.28	16.74	39.66	34.95	1.87	4.06	1.80	2.80	0.0119	98.99
933	4	R1P2	11:17:19	11:20:04	25115	928.76	22.98	4.55	18.42	111.79	72.21	4.98	2.93	0.58	2.98	0.0127	97.81
934	7	R1P2	13:51:55	14:06:07	26646	464.63	31.63	13.40	18.24	31.47	34.79	1.35	3.89	1.65	2.93	0.0132	99.05
935	100	R1P2	14:07:05	14:07:44	42527	46.15	232.81	214.19	18.61	15.71	2.19	0.43	18.17	16.72	4.58	0.0209	99.91
936	85	R1P2	14:08:04	14:10:00	40785	37.90	213.94	196.31	17.64	14.74	1.88	0.42	17.42	15.98	4.30	0.0200	99.91
937	75	R1P2	14:10:39	14:14:31	36571	27.27	170.67	155.63	15.04	13.29	1.51	0.42	15.51	14.15	3.84	0.0179	99.92
938	30	R1P2	14:15:29	14:19:02	27588	74.18	74.68	63.66	11.02	17.69	5.45	0.74	9.00	7.68	2.98	0.0134	99.80
939	7	R1P2	14:30:01	14:45:30	25665	416.95	32.35	15.70	16.66	29.94	32.47	1.34	4.14	2.01	2.76	0.0126	99.10
940	100	R1P2	14:46:38	14:46:57	42198	45.41	232.25	212.42	19.84	15.76	2.17	0.43	18.27	16.71	4.42	0.0207	99.91
941	85	R1P2	14:48:44	14:49:03	42225	45.91	236.27	215.91	20.36	15.51	2.20	0.43	18.57	16.97	4.42	0.0207	99.91
942	30	R1P2	14:50:21	14:53:44	27394	72.02	75.62	64.25	11.37	17.61	5.33	0.75	9.18	7.80	2.84	0.0133	99.80
943	7	R1P2	14:55:11	15:20:12	26223	378.64	33.92	18.14	15.79	24.38	28.91	1.07	4.25	2.27	2.80	0.0129	99.21
944	100	R1P2	15:21:11	15:21:19	42219	45.46	237.71	217.23	20.48	15.91	2.18	0.44	18.69	17.08	4.41	0.0207	99.91
945	85	R1P2	15:21:58	15:24:04	40190	37.19	211.43	191.90	19.53	15.24	1.87	0.44	17.47	15.86	4.17	0.0197	99.91
946	30	R1P2	15:25:12	15:28:25	27150	73.91	74.03	62.59	11.44	17.04	5.51	0.73	9.07	7.67	2.83	0.0132	99.80
947	7	R1P2	15:29:43	15:54:54	25427	414.05	31.71	15.29	16.43	27.03	32.55	1.22	4.10	1.97	2.76	0.0125	99.11
948	100	R1P2	15:55:52	15:56:12	41305	44.46	225.77	206.23	19.54	16.62	2.18	0.47	18.15	16.57	4.40	0.0203	99.90
949	85	R1P2	15:57:00	15:58:37	39588	35.98	207.27	188.17	19.10	14.76	1.84	0.43	17.39	15.79	4.12	0.0194	99.91
950	30	R1P2	16:00:05	16:02:59	26318	71.20	72.21	61.11	11.11	18.00	5.48	0.79	9.13	7.73	2.81	0.0128	99.79
951	7	R1P2	16:03:57	16:12:41	25820	417.85	32.47	16.63	15.84	29.08	32.35	1.29	4.13	2.11	2.82	0.0127	99.11

Note:

1. The test point No. defines the sequential engine testing conditions. It is a combination of the last digit in the date between April 20 and 29 and a sequence number of test point for that day. If the test point number is 305, the test point was for the 5th test point on April 23.
2. In probe ID, "R1" and "R2" stand for sampling rake at 1 m and 10 m sampling locations, respectively. G1 to 6 stands for gas sampling probe tip # 1 to 6.
3. "EI" stands for emission index.

TABLE A-3.—AIRCRAFT CFM56-2-C1 ENGINE GAS EMISSION DATA MEASURED WITH THE NASA MULTI-GAS ANALYZER (MGA) DURING APEX PART B

Test Point No.[1]	Power	Probe	MGA Time		Measured gaseous concentration							Gaseous emission index					
					Acetylene (C_2H_2)	Ethylene (C_2H_4)	Formaldehyde (HCHO)	Formic Acid (HCOOH)	Jet Fuel A	Methanol (CH_3OH)	Propylene (C_3H_6)	EIC_2H_2	EIC_2H_4	EIHCHO	EIHCOOH	$EICH_3OH$	EIC_3H_6
	%	ID[2]	Start	End	ppm							g/kg fuel					
301	7	R1G2	9:25:47	9:26:06	2.16	4.72	6.46	0.28	1.46	0.87	1.37	0.16	0.38	0.55	0.04	0.08	0.16
	7	R1G3	9:27:09	9:27:29	1.96	4.13	5.77	0.36	1.13	0.84	0.95	0.14	0.32	0.48	0.05	0.08	0.11
	7	R1G4	9:28:32	9:28:51	1.74	3.96	5.05	0.12	0.99	0.79	1.01	0.13	0.33	0.45	0.02	0.07	0.13
	7	R1G5	9:30:13	9:30:33	1.68	3.86	5.07	0.06	0.92	0.69	1.03	0.14	0.33	0.47	0.01	0.07	0.13
	7	R1G6	9:31:55	9:32:15	1.71	4.09	4.68	0.16	17.06	0.57	1.35	0.15	0.38	0.46	0.02	0.06	0.19
	7	R1G1	9:33:51	9:34:11	1.64	3.90	4.61	0.90	1.04	0.61	1.17	0.15	0.40	0.50	0.15	0.07	0.18
	7	R2G2	9:35:48	9:36:07	0.09	0.35	0.72	0.38	0.31	0.13	0.18	0.16	0.64	1.44	1.15	0.28	0.51
	7	R2G4	9:37:05	9:37:25	0.09	0.42	0.61	0.18	0.28	0.19	0.20	0.17	0.88	1.35	0.61	0.45	0.61
	7	R2G6	9:39:02	9:39:21	0.10	0.37	0.64	0.03	0.06	0.12	0.17	0.17	0.68	1.27	0.10	0.25	0.46
	7	R2G1	9:40:48	9:41:08	0.09	0.35	0.76	0.02	0.08	0.17	0.32	0.17	0.70	1.63	0.08	0.38	0.96
	7	R2G3	9:42:11	9:42:30	0.08	0.37	0.68	0.02	0.23	0.17	0.17	0.15	0.76	1.50	0.05	0.39	0.51
	7	R2G5	9:44:17	9:44:36	0.09	0.37	0.67	0.03	0.14	0.21	0.04	0.15	0.63	1.21	0.09	0.41	0.09
302	30	R1G2	9:48:10	9:48:29	0.30	0.12	0.19	2.89	0.61	0.06	0.56	0.02	0.01	0.01	0.32	0.00	0.06
	30	R1G3	9:49:18	9:49:37	0.39	0.13	0.71	1.71	0.49	0.14	0.42	0.03	0.01	0.06	0.21	0.01	0.05
	30	R1G4	9:51:14	9:51:34	0.14	0.11	0.23	1.03	0.36	0.03	0.48	0.01	0.01	0.02	0.14	0.00	0.06
	30	R1G2	10:05:13	10:05:33	0.33	0.06	0.11	2.06	0.73	0.15	0.50	0.02	0.00	0.01	0.23	0.01	0.05
	30	R1G3	10:06:36	10:06:55	0.31	0.09	0.38	0.84	0.39	0.04	0.15	0.02	0.01	0.03	0.11	0.00	0.02
	30	R1G4	10:07:58	10:08:18	0.28	0.17	0.59	1.10	0.38	0.17	0.40	0.02	0.01	0.05	0.15	0.02	0.05
	30	R1G5	10:09:35	10:09:55	0.14	0.16	0.50	0.52	0.43	0.11	0.41	0.01	0.01	0.05	0.07	0.01	0.05
	30	R1G6	10:11:07	10:11:27	0.14	0.14	0.28	0.28	8.33	0.13	0.25	0.01	0.01	0.03	0.04	0.01	0.03
	30	R1G1	10:12:49	10:13:09	0.29	0.12	0.34	1.64	0.45	0.03	0.43	0.02	0.01	0.03	0.20	0.00	0.05
	30	R2G2	10:14:02	10:14:21	0.00	0.11	0.50	0.58	0.19	0.10	0.18	0.00	0.10	0.50	0.90	0.11	0.25
	30	R2G3	10:15:39	10:15:58	0.01	0.13	0.46	0.24	0.17	0.13	0.10	0.01	0.14	0.52	0.42	0.16	0.16
	30	R2G4	10:17:01	10:17:21	0.00	0.12	0.37	0.17	0.15	0.16	0.14	0.00	0.11	0.40	0.27	0.18	0.20
	30	R2G5	10:18:38	10:18:58	0.00	0.12	0.40	0.10	0.24	0.18	0.00	0.00	0.11	0.40	0.15	0.19	0.00
	30	R2G6	10:20:10	10:20:30	0.00	0.13	0.45	0.07	0.18	0.18	0.10	0.00	0.12	0.43	0.10	0.18	0.13
	30	R2G1	10:21:57	10:22:16	0.01	0.13	0.40	0.09	0.30	0.28	0.15	0.01	0.17	0.56	0.19	0.42	0.29
	30	R2G2	10:23:39	10:23:58	0.33	0.12	0.27	0.91	0.41	0.03	0.35	0.02	0.01	0.02	0.10	0.00	0.04

TABLE A-3.—PART B (Continued)

Test Point No.[1]	Power	Probe ID[2]	MGA Time		Measured gaseous concentration							Gaseous emission index					
					Acetylene (C_2H_2)	Ethylene (C_2H_4)	Formaldehyde (HCHO)	Formic Acid (HCOOH)	Jet Fuel A	Methanol (CH_3OH)	Propylene (C_3H_6)	EIC_2H_2	EIC_2H_4	EIHCHO	EIHCOOH	$EICH_3OH$	EIC_3H_6
	%		Start	End	ppm							g/kg fuel					
303	40	R1G2	10:43:03	10:43:22	0.32	0.18	0.29	0.72	0.54	0.20	0.52	0.02	0.01	0.02	0.08	0.02	0.05
	40	R1G3	10:44:21	10:44:40	0.31	0.12	0.37	0.54	0.41	0.22	0.39	0.02	0.01	0.03	0.06	0.02	0.04
	40	R1G4	10:45:43	10:46:03	0.30	0.14	0.54	0.45	0.35	0.23	0.49	0.02	0.01	0.05	0.06	0.02	0.06
	40	R1G5	10:46:56	10:47:15	0.31	0.20	0.74	0.32	0.33	0.20	0.34	0.02	0.02	0.06	0.04	0.02	0.04
	40	R1G6	10:48:43	10:49:02	0.32	0.14	0.43	0.28	6.68	0.15	0.27	0.02	0.01	0.04	0.04	0.01	0.03
	40	R1G1	10:50:44	10:51:03	0.32	0.15	0.31	0.61	0.46	0.23	0.42	0.02	0.01	0.02	0.07	0.02	0.05
	40	R2G3	10:52:11	10:52:31	0.00	0.15	0.40	0.10	0.21	0.15	0.17	0.00	0.15	0.41	0.15	0.17	0.25
	40	R2G3	10:53:24	10:53:43	0.00	0.17	0.46	0.16	0.26	0.27	0.00	0.00	0.18	0.55	0.30	0.35	0.00
	40	R2G4	10:55:06	10:55:25	0.00	0.12	0.41	0.03	0.15	0.16	0.00	0.00	0.11	0.42	0.04	0.17	0.00
	40	R2G5	10:56:38	10:56:57	0.01	0.13	0.39	0.09	0.23	0.25	0.01	0.00	0.12	0.39	0.13	0.26	0.01
	40	R2G6	10:58:01	10:58:20	0.00	0.11	0.36	0.02	0.07	0.15	0.18	0.00	0.08	0.30	0.03	0.14	0.21
	40	R2G1	10:59:42	11:00:02	0.00	0.11	0.37	0.06	0.14	0.08	0.18	0.00	0.14	0.48	0.12	0.11	0.32
	40	R2G2	11:02:18	11:02:37	0.35	0.13	0.26	0.24	0.44	0.23	0.34	0.02	0.01	0.02	0.03	0.02	0.03
304	30	R1G2	11:04:53	11:05:12	0.31	0.12	0.29	0.25	0.34	0.21	0.51	0.02	0.01	0.02	0.03	0.02	0.05
	30	R1G3	11:06:20	11:06:40	0.33	0.17	0.37	0.22	0.38	0.25	0.28	0.02	0.01	0.03	0.03	0.02	0.03
	30	R1G4	11:07:57	11:08:17	0.11	0.19	0.66	0.23	0.45	0.23	0.09	0.01	0.02	0.06	0.03	0.02	0.01
	30	R1G5	11:09:20	11:09:39	0.16	0.13	0.59	0.13	0.30	0.02	0.36	0.01	0.01	0.05	0.02	0.00	0.05
	30	R1G6	11:11:07	11:11:26	0.16	0.13	0.47	0.39	3.68	0.04	0.42	0.01	0.01	0.04	0.06	0.00	0.05
	30	R1G1	11:12:10	11:12:29	0.29	0.11	0.40	0.19	0.38	0.30	0.44	0.02	0.01	0.03	0.02	0.03	0.05
305	7	R1G2	11:15:09	11:15:29	1.65	3.34	4.38	0.65	0.59	0.65	1.21	0.12	0.27	0.38	0.09	0.06	0.15
	7	R1G3	11:16:27	11:16:47	1.55	3.31	4.68	0.82	0.59	0.60	0.97	0.12	0.27	0.41	0.11	0.06	0.12
	7	R1G4	11:18:19	11:18:38	1.39	3.12	4.46	0.82	0.55	0.52	0.87	0.11	0.27	0.42	0.12	0.05	0.11
	7	R1G5	11:19:51	11:20:10	1.34	3.11	4.51	0.78	0.57	0.65	0.61	0.11	0.28	0.43	0.11	0.07	0.08
	7	R1G6	11:21:14	11:21:33	1.49	3.38	4.78	0.87	6.64	0.33	0.87	0.13	0.32	0.48	0.13	0.03	0.12
	7	R1G1	11:22:41	11:23:00	1.58	3.64	4.95	0.86	0.65	0.67	1.11	0.14	0.34	0.50	0.13	0.07	0.16
	7	R2G3	11:25:36	11:25:55	0.10	0.39	0.60	0.12	0.10	0.24	0.15	0.13	0.55	0.90	0.28	0.38	0.32
	7	R2G4	11:27:13	11:27:32	0.10	0.38	0.70	0.14	0.19	0.16	0.32	0.13	0.53	1.04	0.32	0.26	0.66
	7	R2G5	11:28:45	11:29:04	0.08	0.41	0.63	0.08	0.22	0.19	0.23	0.12	0.68	1.12	0.20	0.35	0.56
	7	R2G6	11:30:08	11:30:27	0.13	0.49	0.73	0.15	0.34	0.28	0.32	0.15	0.62	1.00	0.31	0.40	0.61
	7	R2G1	11:31:30	11:31:49	0.09	0.41	0.70	0.09	0.36	0.30	0.06	0.15	0.69	1.26	0.26	0.58	0.14
	7	R1G2	11:37:39	11:37:58	1.47	2.99	4.01	0.82	0.49	0.68	0.99	0.11	0.24	0.35	0.11	0.06	0.12

TABLE A-3.—PART B (Continued)

Test Point No.[1]	Power	Probe ID[2]	MGA Time		Measured gaseous concentration							Gaseous emission index					
					Acetylene (C_2H_2)	Ethylene (C_2H_4)	Formaldehyde (HCHO)	Formic Acid (HCOOH)	Jet Fuel A	Methanol (CH_3OH)	Propylene (C_3H_6)	EIC_2H_2	EIC_2H_4	EIHCHO	EIHCOOH	$EICH_3OH$	EIC_3H_6
	%		Start	End	ppm							g/kg fuel					
306	7	R1G2	14:52:39	14:52:58	1.88	3.97	5.21	1.20	0.72	0.65	0.92	0.14	0.31	0.44	0.16	0.06	0.11
	7	R1G3	14:54:01	14:54:21	1.74	3.61	4.74	1.11	0.59	0.72	0.79	0.13	0.28	0.40	0.14	0.06	0.09
	7	R1G4	14:55:09	14:55:29	1.44	3.46	4.62	0.85	0.61	0.74	1.04	0.11	0.28	0.41	0.11	0.07	0.13
	7	R1G5	14:57:01	14:57:21	1.47	3.45	4.66	0.98	0.60	0.61	0.76	0.12	0.29	0.42	0.14	0.06	0.10
	7	R1G6	14:58:39	14:58:58	1.55	3.78	5.11	0.82	6.42	0.49	1.09	0.13	0.34	0.49	0.12	0.05	0.15
	7	R1G1	15:00:06	15:00:26	1.68	4.05	5.32	1.09	0.93	0.77	0.92	0.15	0.38	0.53	0.17	0.08	0.13
307	30	R1G2	15:05:22	15:05:42	0.35	0.15	0.11	0.28	0.43	0.15	0.16	0.02	0.01	0.01	0.03	0.01	0.02
	30	R1G3	15:06:35	15:06:55	0.32	0.18	0.30	0.42	0.38	0.28	0.36	0.02	0.01	0.02	0.05	0.02	0.04
	30	R1G4	15:08:08	15:08:27	0.13	0.19	0.43	0.46	0.34	0.27	0.36	0.01	0.02	0.04	0.06	0.03	0.05
	30	R1G5	15:09:45	15:10:04	0.15	0.21	0.56	0.35	0.44	0.25	0.02	0.01	0.02	0.05	0.05	0.02	0.00
	30	R1G6	15:11:13	15:11:32	0.19	0.15	0.43	0.42	4.87	0.02	0.20	0.02	0.01	0.04	0.06	0.00	0.03
	30	R1G1	15:12:50	15:13:09	0.11	0.13	0.18	0.36	0.45	0.22	0.53	0.01	0.01	0.02	0.05	0.02	0.07
	30	R2G2	15:14:13	15:14:32	0.00	0.18	0.24	0.03	0.09	0.21	0.05	0.00	0.20	0.28	0.05	0.27	0.09
	30	R2G3	15:15:35	15:15:55	0.00	0.23	0.28	0.03	0.17	0.23	0.00	0.00	0.25	0.33	0.05	0.29	0.00
	30	R2G4	15:17:12	15:17:32	0.02	0.17	0.31	0.14	0.34	0.18	0.10	0.02	0.19	0.36	0.25	0.22	0.16
	30	R2G5	15:18:45	15:19:04	0.00	0.19	0.22	0.02	0.05	0.20	0.05	0.00	0.19	0.23	0.04	0.22	0.07
	30	R2G6	15:20:17	15:20:37	0.00	0.18	0.15	0.00	0.09	0.23	0.10	0.00	0.17	0.15	0.00	0.24	0.13
	30	R2G1	15:21:50	15:22:09	0.01	0.16	0.18	0.00	0.17	0.07	0.16	0.01	0.22	0.26	0.00	0.11	0.31
	30	R2G1	15:21:50	15:22:09	0.01	0.16	0.18	0.00	0.17	0.07	0.16	0.01	0.22	0.26	0.00	0.11	0.31
	30	R1G2	15:23:37	15:23:56	0.30	0.16	0.20	0.42	0.30	0.16	0.34	0.02	0.01	0.02	0.05	0.01	0.04
	30	R1G4	15:24:50	15:25:09	0.14	0.17	0.50	0.27	0.39	0.17	0.23	0.01	0.01	0.05	0.04	0.02	0.03
308	40	R1G2	15:27:25	15:27:45	0.35	0.13	0.20	0.09	0.43	0.30	0.33	0.02	0.01	0.01	0.01	0.02	0.03
	40	R1G3	15:29:03	15:29:22	0.32	0.09	0.20	0.13	0.44	0.22	0.23	0.02	0.01	0.01	0.01	0.02	0.02
	40	R1G4	15:30:35	15:30:55	0.31	0.19	0.41	0.08	0.39	0.24	0.27	0.02	0.01	0.03	0.01	0.02	0.03
308b	40	R1G5	15:32:03	15:32:22	0.31	0.16	0.49	0.11	0.32	0.13	0.46	0.02	0.01	0.04	0.01	0.01	0.06
	40	R1G6	15:33:40	15:33:59	0.30	0.15	0.35	0.25	2.82	0.04	0.31	0.02	0.01	0.03	0.03	0.00	0.04
	40	R1G1	15:35:12	15:35:32	0.31	0.12	0.13	0.11	0.34	0.13	0.25	0.02	0.01	0.01	0.01	0.01	0.03
	40	R2G2	15:36:40	15:36:59	0.00	0.17	0.27	0.05	0.17	0.22	0.02	0.00	0.17	0.28	0.08	0.24	0.02
	40	R2G3	15:38:22	15:38:17	0.00	0.16	0.36	0.09	0.25	0.25	0.08	0.00	0.15	0.35	0.14	0.26	0.11
	40	R2G4	15:39:40	15:39:59	0.00	0.18	0.15	0.01	0.09	0.18	0.01	0.00	0.17	0.15	0.02	0.20	0.01

TABLE A-3.—PART B (Continued)

Test Point No.[1]	Power	Probe	MGA Time		Measured gaseous concentration							Gaseous emission index					
					Acetylene (C_2H_2)	Ethylene (C_2H_4)	Formaldehyde (HCHO)	Formic Acid (HCOOH)	Jet Fuel A	Methanol (CH_3OH)	Propylene (C_3H_6)	EIC_2H_2	EIC_2H_4	EIHCHO	EIHCOOH	$EICH_3OH$	EIC_3H_6
	%	ID[2]	Start	End	ppm							g/kg fuel					
308c	40	R2G5	15:41:07	15:41:27	0.00	0.20	0.24	0.10	0.17	0.23	0.20	0.00	0.17	0.22	0.15	0.23	0.25
	40	R2G6	15:42:35	15:42:54	0.02	0.14	0.43	0.01	0.00	0.14	0.10	0.02	0.11	0.36	0.01	0.12	0.11
	40	R2G1	15:44:07	15:44:27	0.01	0.19	0.27	0.01	0.23	0.25	0.00	0.01	0.21	0.32	0.02	0.31	0.00
	40	R1G2	15:45:54	15:46:14	0.30	0.15	0.02	0.20	0.51	0.31	0.47	0.02	0.01	0.00	0.02	0.02	0.05
309	30	R1G2	15:49:14	15:49:33	0.32	0.17	0.21	0.10	0.31	0.25	0.37	0.02	0.01	0.02	0.01	0.02	0.04
	30	R1G3	15:51:01	15:51:20	0.34	0.19	0.28	0.17	0.32	0.11	0.36	0.02	0.02	0.02	0.02	0.01	0.04
	30	R1G4	15:52:23	15:52:43	0.16	0.17	0.40	0.10	0.38	0.12	0.15	0.01	0.01	0.04	0.01	0.01	0.02
	30	R1G5	15:53:46	15:54:05	0.15	0.16	0.57	0.12	0.36	0.24	0.56	0.01	0.01	0.05	0.02	0.02	0.07
	30	R1G6	15:55:28	15:55:48	0.16	0.15	0.40	0.09	2.10	0.06	0.20	0.01	0.01	0.04	0.01	0.01	0.03
	30	R1G1	15:57:01	15:57:20	0.16	0.18	0.24	0.15	0.46	0.25	0.05	0.01	0.02	0.02	0.02	0.02	0.01
	30	R2G2	15:58:43	15:59:02	0.00	0.18	0.27	0.00	0.10	0.18	0.00	0.00	0.22	0.35	0.00	0.25	0.00
	30	R2G4	16:00:05	16:00:25	0.01	0.15	0.21	0.00	0.08	0.13	0.00	0.01	0.16	0.23	0.00	0.15	0.00
310	7	R1G2	16:03:00	16:03:20	1.76	3.72	4.59	0.68	0.61	0.61	0.86	0.13	0.30	0.39	0.09	0.06	0.10
	7	R1G4	16:04:33	16:04:52	1.48	3.34	4.58	0.66	0.52	0.56	0.76	0.11	0.28	0.41	0.09	0.05	0.10
	7	R1G6	16:06:05	16:06:25	1.41	3.40	4.71	0.56	3.97	0.50	1.03	0.12	0.31	0.46	0.08	0.05	0.14
	7	R2G2	16:07:38	16:07:57	0.09	0.45	0.61	0.08	0.18	0.25	0.00	0.11	0.62	0.88	0.18	0.39	0.00
	7	R2G4	16:09:20	16:09:39	0.10	0.52	0.51	0.04	0.23	0.20	0.22	0.13	0.69	0.73	0.09	0.31	0.44
501	4	R1G2	11:20:51	11:21:10	9.683	24.261	25.534	3.347	11.194	3.015	8.012	0.637	1.719	1.938	0.390	0.244	0.851
502	65	R1G2	11:24:15	11:24:34	0.340	0.050	0.400	0.547	0.499	0.185	0.551	0.018	0.003	0.025	0.051	0.012	0.047
	65	R1G4	11:25:23	11:25:42	0.386	0.070	0.699	0.691	0.693	0.193	0.760	0.022	0.004	0.045	0.068	0.013	0.069
	65	R1G5	11:27:00	11:27:19	0.393	0.075	0.672	0.638	0.734	0.065	0.689	0.024	0.005	0.048	0.070	0.005	0.069
	65	R1G6	11:28:36	11:28:56	0.459	0.088	0.676	0.579	4.289	0.000	0.576	0.028	0.006	0.047	0.062	0.000	0.057
	65	R1G1	11:30:13	11:30:33	0.344	0.104	0.662	0.418	0.462	0.286	0.588	0.023	0.008	0.051	0.049	0.023	0.063
	65	R1G3	11:31:31	11:31:50	0.361	0.081	0.491	0.361	0.615	0.224	0.686	0.021	0.005	0.033	0.038	0.016	0.065
	65	R2G2	11:32:29	11:32:48	0.000	0.036	0.642	0.179	0.263	0.226	0.348	0.000	0.026	0.495	0.212	0.186	0.376
	65	R2G2	11:32:58	11:33:18	0.024	0.044	0.543	0.140	0.134	0.245	0.405	0.017	0.034	0.443	0.175	0.213	0.463
	65	R2G3	11:34:45	11:35:04	0.024	0.066	0.851	0.097	0.217	0.295	0.360	0.016	0.046	0.634	0.111	0.235	0.376
	65	R2G4	11:36:02	11:36:22	0.023	0.045	0.651	0.081	0.234	0.275	0.350	0.014	0.030	0.461	0.088	0.207	0.347
	65	R2G6	11:39:07	11:39:26	0.019	0.019	0.574	0.131	0.288	0.203	0.390	0.010	0.011	0.352	0.123	0.133	0.335
	65	R2G1	11:40:34	11:40:53	0.016	0.112	0.717	0.194	0.356	0.278	0.333	0.013	0.099	0.676	0.281	0.279	0.440
	65	R1G2	11:42:50	11:43:09	0.379	0.039	0.263	0.211	0.412	0.214	0.693	0.020	0.002	0.016	0.020	0.014	0.060

TABLE A-3.—PART B (Continued)

Test Point No.[1]	Power	Probe ID[2]	MGA Time		Measured gaseous concentration							Gaseous emission index					
					Acetylene (C_2H_2)	Ethylene (C_2H_4)	Formaldehyde (HCHO)	Formic Acid (HCOOH)	Jet Fuel A	Methanol (CH_3OH)	Propylene (C_3H_6)	EIC_2H_2	EIC_2H_4	EIHCHO	EIHCOOH	$EICH_3OH$	EIC_3H_6
	%		Start	End	ppm							g/kg fuel					
503	70	R1G2	11:45:05	11:45:25	0.360	0.053	0.305	0.222	0.552	0.358	0.798	0.020	0.003	0.019	0.021	0.024	0.070
	70	R1G4	11:46:42	11:47:02	0.373	0.043	0.268	0.293	0.437	0.238	0.427	0.020	0.002	0.016	0.027	0.015	0.036
504	65	R1G2	11:48:39	11:48:58	0.357	0.023	0.222	0.193	0.466	0.340	0.815	0.019	0.001	0.014	0.018	0.022	0.071
	65	R1G3	11:50:06	11:50:25	0.394	0.050	0.258	0.263	0.447	0.207	0.616	0.022	0.003	0.017	0.026	0.014	0.055
505	60	R1G3	11:51:52	11:52:12	0.383	0.084	0.241	0.102	0.413	0.230	0.666	0.023	0.005	0.017	0.011	0.017	0.065
	60	R1G2	11:53:00	11:53:20	0.367	0.057	0.237	0.193	0.419	0.236	0.556	0.020	0.003	0.015	0.019	0.016	0.049
506	85	R1G2	11:55:06	11:55:26	0.655	0.072	0.128	0.133	0.396	0.269	0.718	0.033	0.004	0.008	0.012	0.017	0.059
	85	R1G3	11:56:43	11:57:03	0.393	0.057	0.306	0.214	0.390	0.190	0.676	0.021	0.003	0.018	0.020	0.012	0.057
507	100	R1G2	11:58:30	11:58:49	0.627	0.015	0.265	0.205	0.548	0.344	0.726	0.031	0.001	0.015	0.018	0.021	0.057
508	7	R1G2	12:06:15	12:06:35	1.656	3.153	4.393	1.075	0.450	0.509	1.229	0.122	0.250	0.373	0.140	0.046	0.146
	7	R1G3	12:08:12	12:08:31	1.389	2.542	4.084	0.921	0.435	0.484	0.984	0.097	0.192	0.330	0.114	0.042	0.111
	7	R1G4	12:09:10	12:09:29	1.368	2.509	4.102	0.848	0.528	0.430	0.812	0.101	0.200	0.350	0.111	0.039	0.097
	7	R1G5	12:10:27	12:10:47	1.090	2.364	3.950	0.930	0.524	0.553	0.959	0.083	0.193	0.346	0.125	0.052	0.118
	7	R1G6	12:11:35	12:11:54	1.125	2.268	3.752	0.840	2.834	0.176	0.810	0.091	0.198	0.350	0.120	0.018	0.106
	7	R1G1	12:13:02	12:13:22	1.239	2.641	3.894	0.923	0.591	0.532	0.882	0.103	0.236	0.373	0.136	0.054	0.118
	7	R2G2	12:14:30	12:14:49	0.097	0.280	0.944	0.175	0.202	0.313	0.300	0.098	0.302	1.091	0.309	0.386	0.486
	7	R2G3	12:15:37	12:15:57	0.108	0.243	1.002	0.111	0.016	0.226	0.339	0.110	0.266	1.176	0.201	0.283	0.558
	7	R2G4	12:16:36	12:16:55	0.080	0.265	0.844	0.181	0.237	0.274	0.301	0.080	0.285	0.971	0.319	0.336	0.484
	7	R2G6	12:18:13	12:18:32	0.074	0.300	0.943	0.150	0.258	0.290	0.275	0.068	0.297	0.999	0.244	0.328	0.408
	7	R2G1	12:19:30	12:19:49	0.091	0.257	0.836	0.137	0.315	0.359	0.246	0.112	0.342	1.194	0.299	0.546	0.491
	7	R1G2	12:20:19	12:20:38	0.973	1.987	2.968	0.580	0.376	0.448	0.727	0.081	0.179	0.286	0.086	0.046	0.098
509	100	R1G2	12:24:11	12:24:31	0.631	0.030	0.141	0.301	0.438	0.235	0.916	0.030	0.002	0.008	0.025	0.014	0.069
510	85	R1G2	12:25:48	12:26:08	0.667	0.065	0.000	0.131	0.368	0.200	0.693	0.033	0.004	0.000	0.012	0.012	0.056
511	85	R1G2	13:24:03	13:24:23	0.615	0.024	0.291	0.386	0.601	0.404	0.691	0.029	0.001	0.016	0.032	0.023	0.053
512	30	R1G2	13:26:19	13:26:38	0.345	0.057	0.512	0.251	0.349	0.255	0.435	0.023	0.004	0.039	0.030	0.021	0.047
	30	R1G4	13:28:06	13:28:25	0.361	0.108	1.018	0.301	0.453	0.191	0.376	0.028	0.009	0.089	0.041	0.018	0.046

TABLE A-3.—PART B (Continued)

Test Point No.[1]	Power	Probe ID[2]	MGA Time		Measured gaseous concentration							Gaseous emission index					
					Acetylene (C_2H_2)	Ethylene (C_2H_4)	Formaldehyde (HCHO)	Formic Acid (HCOOH)	Jet Fuel A	Methanol (CH_3OH)	Propylene (C_3H_6)	EIC_2H_2	EIC_2H_4	EIHCHO	EIHCOOH	$EICH_3OH$	EIC_3H_6
	%		Start	End	ppm							g/kg fuel					
513	7	R1G2	13:31:11	13:31:30	1.464	2.845	3.679	0.720	0.525	0.491	0.719	0.101	0.211	0.293	0.088	0.042	0.080
	7	R1G3	13:33:07	13:33:27	1.457	2.811	3.819	0.770	0.549	0.457	0.792	0.100	0.208	0.303	0.094	0.039	0.088
	7	R1G4	13:34:44	13:35:04	1.398	2.774	3.972	0.816	0.555	0.586	0.607	0.102	0.218	0.334	0.105	0.053	0.072
	7	R1G5	13:35:43	13:36:02	1.334	2.570	3.871	0.805	0.452	0.445	0.966	0.099	0.206	0.332	0.106	0.041	0.116
	7	R1G6	13:37:29	13:37:49	1.213	2.722	4.205	0.835	2.205	0.420	0.834	0.096	0.232	0.385	0.117	0.041	0.107
	7	R1G1	13:38:28	13:38:47	1.361	3.099	4.412	0.949	0.780	0.548	0.764	0.109	0.267	0.407	0.134	0.054	0.099
	7	R2G2	13:40:44	13:41:03	0.132	0.426	1.008	0.210	0.284	0.273	0.319	0.097	0.336	0.852	0.272	0.246	0.378
	7	R2G3	13:41:52	13:42:11	0.106	0.314	0.885	0.138	0.174	0.249	0.255	0.107	0.340	1.027	0.246	0.309	0.415
	7	R2G4	13:43:48	13:44:08	0.108	0.347	0.938	0.241	0.430	0.290	0.283	0.108	0.376	1.089	0.429	0.359	0.460
	7	R2G6	13:45:26	13:45:45	0.109	0.345	0.703	0.137	0.232	0.271	0.064	0.102	0.348	0.759	0.227	0.312	0.097
	7	R2G1	13:46:24	13:46:43	0.099	0.323	0.825	0.216	0.446	0.293	0.348	0.118	0.413	1.131	0.455	0.428	0.668
	7	R1G2	13:48:40	13:48:59	1.442	2.903	3.835	0.788	0.428	0.522	0.973	0.103	0.222	0.315	0.099	0.046	0.112
514	100	R1G2	14:01:28	14:01:47	0.658	0.080	0.126	0.398	0.394	0.156	0.525	0.032	0.004	0.007	0.034	0.009	0.041
515	30	R1G2	14:04:13	14:04:32	0.348	0.089	0.400	0.219	0.409	0.199	0.382	0.023	0.006	0.030	0.025	0.016	0.041
	30	R1G4	14:05:50	14:06:10	0.350	0.122	0.764	0.252	0.461	0.239	0.381	0.026	0.010	0.066	0.034	0.022	0.046
	30	R1G2	14:06:49	14:07:08	0.329	0.097	0.487	0.206	0.324	0.209	0.430	0.022	0.007	0.038	0.024	0.017	0.047
516	7	R1G2	14:09:05	14:09:24	1.260	2.329	3.024	0.662	0.261	0.538	0.721	0.085	0.169	0.235	0.079	0.045	0.078
517	85	R1G2	14:12:19	14:12:39	0.602	0.027	0.155	0.264	0.556	0.259	0.558	0.029	0.001	0.009	0.023	0.015	0.043
518	7	R1G2	14:14:26	14:14:45	1.208	2.327	2.907	0.658	0.363	0.609	0.865	0.081	0.168	0.224	0.078	0.050	0.093
	7	R1G3	14:15:34	14:15:53	1.183	2.076	2.796	0.647	0.451	0.566	0.624	0.078	0.148	0.213	0.076	0.046	0.067
	7	R1G3	14:16:03	14:16:22	1.182	2.066	2.873	0.608	0.386	0.504	0.513	0.077	0.146	0.217	0.070	0.041	0.054
	7	R1G4	14:17:30	14:17:50	1.090	1.935	2.986	0.616	0.439	0.442	0.405	0.075	0.144	0.238	0.075	0.038	0.045
	7	R1G5	14:19:17	14:19:37	1.056	1.912	2.954	0.615	0.468	0.360	0.612	0.075	0.146	0.241	0.077	0.031	0.070
	7	R1G6	14:20:45	14:21:04	0.876	1.767	3.040	0.640	1.875	0.292	0.658	0.066	0.144	0.265	0.086	0.027	0.080
	7	R1G1	14:22:22	14:22:41	1.003	2.146	2.865	0.686	0.468	0.447	0.647	0.075	0.174	0.249	0.091	0.041	0.079
	7	R2G2	14:23:59	14:24:19	0.074	0.266	0.765	0.133	0.379	0.219	0.111	0.079	0.303	0.935	0.249	0.285	0.190
	7	R2G3	14:25:17	14:25:36	0.049	0.231	0.805	0.079	0.295	0.319	0.003	0.055	0.275	1.029	0.154	0.435	0.006
	7	R2G4	14:26:54	14:27:14	0.088	0.284	0.714	0.095	0.406	0.290	0.180	0.097	0.338	0.909	0.186	0.394	0.322
	7	R2G6	14:28:31	14:28:51	0.082	0.270	0.757	0.120	0.197	0.308	0.183	0.078	0.276	0.830	0.202	0.360	0.281
	7	R2G1	14:29:10	14:29:30	0.085	0.254	0.810	0.101	0.093	0.170	0.000	0.097	0.313	1.066	0.205	0.239	0.000
519	100	R1G2	14:30:57	14:31:17	0.644	0.000	0.071	0.245	0.539	0.234	0.733	0.029	0.000	0.004	0.020	0.013	0.053

TABLE A-3.—PART B (Continued)

Test Point No.[1]	Power	Probe	MGA Time		Measured gaseous concentration							Gaseous emission index					
					Acetylene (C_2H_2)	Ethylene (C_2H_4)	Formaldehyde (HCHO)	Formic Acid (HCOOH)	Jet Fuel A	Methanol (CH_3OH)	Propylene (C_3H_6)	EIC_2H_2	EIC_2H_4	EIHCHO	EIHCOOH	$EICH_3OH$	EIC_3H_6
	%	ID[2]	Start	End	ppm							g/kg fuel					
520	85	R1G2	14:32:44	14:33:04	0.629	0.076	0.116	0.176	0.469	0.290	0.616	0.030	0.004	0.007	0.015	0.017	0.048
	85	R1G3	14:35:00	14:35:20	0.589	0.015	0.269	0.238	0.658	0.306	0.530	0.028	0.001	0.015	0.020	0.018	0.040
521	30	R1G3	14:36:38	14:36:57	0.345	0.140	0.667	0.191	0.447	0.243	0.081	0.025	0.011	0.056	0.025	0.022	0.010
	30	R1G5	14:38:05	14:38:25	0.156	0.159	1.108	0.323	0.409	0.252	0.420	0.012	0.013	0.099	0.044	0.024	0.053
	30	R1G2	14:39:42	14:40:02	0.347	0.089	0.480	0.079	0.319	0.146	0.358	0.023	0.007	0.037	0.009	0.012	0.039
	30	R2G2	14:43:07	14:43:26	0.025	0.139	0.512	0.064	0.340	0.267	0.056	0.026	0.157	0.620	0.120	0.344	0.096
522	7	R1G2	14:53:19	14:53:39	1.192	2.282	2.957	0.717	0.430	0.415	0.740	0.079	0.163	0.227	0.084	0.034	0.079
	7	R1G3	14:55:06	14:55:26	1.070	1.980	2.674	0.675	0.390	0.322	0.725	0.072	0.143	0.206	0.080	0.027	0.078
	7	R1G4	14:56:24	14:56:44	1.090	1.972	2.863	0.742	0.396	0.455	0.552	0.077	0.149	0.232	0.092	0.039	0.063
	7	R1G5	14:57:22	14:57:42	1.076	1.975	3.039	0.649	0.428	0.308	0.716	0.077	0.152	0.251	0.082	0.027	0.083
	7	R1G6	14:59:09	14:59:29	0.953	2.109	3.234	0.712	1.259	0.141	0.731	0.073	0.174	0.286	0.096	0.013	0.090
	7	R1G1	15:00:37	15:00:56	1.202	2.356	3.228	0.786	0.575	0.589	0.782	0.089	0.188	0.276	0.103	0.054	0.094
	7	R2G2	15:02:24	15:02:43	0.121	0.398	0.908	0.217	0.237	0.283	0.284	0.077	0.271	0.663	0.243	0.220	0.290
	7	R2G3	15:03:51	15:04:11	0.086	0.320	0.772	0.054	0.386	0.242	0.225	0.093	0.374	0.968	0.104	0.324	0.394
	7	R2G4	15:05:58	15:06:17	0.090	0.288	0.758	0.136	0.368	0.306	0.284	0.103	0.355	1.002	0.276	0.432	0.526
	7	R2G6	15:07:06	15:07:25	0.087	0.288	0.768	0.096	0.271	0.236	0.184	0.077	0.277	0.791	0.151	0.260	0.266
	7	R2G1	15:08:43	15:09:03	0.080	0.197	0.863	0.000	0.000	0.189	0.259	0.093	0.248	1.166	0.000	0.273	0.490
	7	R1G2	15:30:46	15:31:06	1.162	2.196	2.871	0.707	0.334	0.500	0.943	0.078	0.158	0.222	0.084	0.041	0.102
523	100	R1G2	15:52:40	15:52:59	0.597	0.048	0.218	0.307	0.591	0.357	0.623	0.027	0.002	0.011	0.025	0.020	0.045
524	85	R1G2	15:53:48	15:54:07	0.647	0.077	0.040	0.163	0.380	0.123	0.455	0.031	0.004	0.002	0.014	0.007	0.035
	85	R1G2	15:54:56	15:55:15	0.592	0.045	0.139	0.164	0.498	0.360	0.480	0.029	0.002	0.008	0.014	0.022	0.038
525	30	R1G2	15:56:33	15:56:53	0.362	0.094	0.268	0.103	0.381	0.203	0.199	0.025	0.007	0.021	0.012	0.017	0.022
	30	R1G4	15:58:20	15:58:40	0.169	0.155	0.835	0.302	0.519	0.204	0.163	0.013	0.013	0.075	0.042	0.020	0.021
	30	R1G4	15:58:49	15:59:09	0.232	0.146	0.836	0.243	0.498	0.269	0.301	0.018	0.012	0.075	0.033	0.026	0.038
526	7	R1G2	16:01:25	16:01:45	1.127	1.972	2.533	0.568	0.391	0.405	0.478	0.074	0.139	0.191	0.066	0.033	0.051
	7	R1G3	16:02:33	16:02:53	1.022	1.705	2.372	0.530	0.469	0.559	0.591	0.067	0.120	0.179	0.061	0.045	0.063
	7	R1G4	16:03:41	16:04:01	0.934	1.669	2.633	0.587	0.372	0.508	0.741	0.065	0.125	0.211	0.072	0.044	0.083
	7	R1G5	16:05:19	16:05:38	1.081	1.989	3.243	0.590	0.406	0.466	0.701	0.077	0.153	0.268	0.075	0.041	0.081
	7	R1G6	16:06:17	16:06:37	0.990	2.361	3.607	0.680	1.031	0.373	0.862	0.075	0.192	0.315	0.091	0.035	0.105
	7	R1G1	16:07:45	16:08:04	1.353	3.054	4.023	0.804	0.433	0.509	0.855	0.102	0.248	0.350	0.107	0.047	0.104
	7	R1G2	16:10:40	16:10:59	1.276	2.578	3.361	0.755	0.412	0.618	0.825	0.085	0.185	0.258	0.089	0.051	0.089

TABLE A-3.—PART B (Continued)

Test Point No.[1]	Power	Probe	MGA Time		Measured gaseous concentration							Gaseous emission index					
					Acetylene (C_2H_2)	Ethylene (C_2H_4)	Formaldehyde (HCHO)	Formic Acid (HCOOH)	Jet Fuel A	Methanol (CH_3OH)	Propylene (C_3H_6)	EIC_2H_2	EIC_2H_4	EIHCHO	EIHCOOH	$EICH_3OH$	EIC_3H_6
	%	ID[2]	Start	End	ppm							g/kg fuel					
601	7	R1G2	8:11:29	8:11:48	3.244	7.102	12.484	3.182	3.449	0.931	2.165	0.236	0.557	1.049	0.410	0.083	0.255
	7	R1G3	8:13:06	8:13:25	2.280	5.222	10.190	1.883	2.957	0.811	1.554	0.176	0.434	0.907	0.257	0.077	0.194
	7	R1G4	8:14:04	8:14:23	2.247	5.197	6.762	0.877	1.545	0.880	1.388	0.175	0.436	0.607	0.121	0.084	0.174
	7	R1G5	8:15:21	8:15:40	2.120	4.885	6.847	0.851	1.275	0.908	1.299	0.168	0.418	0.627	0.119	0.089	0.167
	7	R1G6	8:16:09	8:16:29	2.311	5.474	7.371	0.511	2.060	0.812	1.559	0.194	0.496	0.716	0.076	0.084	0.212
	7	R1G1	8:17:56	8:18:15	2.245	5.185	7.811	1.256	1.302	0.813	1.482	0.188	0.468	0.756	0.186	0.084	0.201
	7	R2G2	8:19:04	8:19:23	0.202	0.665	1.213	0.307	0.314	0.267	0.436	0.180	0.637	1.245	0.483	0.292	0.627
	7	R2G3	8:20:21	8:20:40	0.180	0.572	1.081	0.129	0.335	0.262	0.375	0.213	0.728	1.474	0.270	0.381	0.716
	7	R2G6	8:22:56	8:23:15	0.193	0.654	1.153	0.101	0.305	0.240	0.029	0.186	0.680	1.285	0.173	0.285	0.045
	7	R2G1	8:24:04	8:24:23	0.154	0.515	1.062	0.167	0.302	0.236	0.311	0.192	0.692	1.529	0.369	0.362	0.627
	7	R1G2	8:25:50	8:26:10	2.093	4.770	8.943	1.875	1.320	0.719	1.481	0.160	0.393	0.790	0.254	0.068	0.183
602	100	R1G2	8:28:45	8:29:04	0.661	0.112	6.723	1.702	0.567	0.176	0.727	0.030	0.006	0.356	0.138	0.010	0.054
603	85	R1G2	8:30:41	8:31:00	0.668	0.041	1.303	1.491	0.411	0.101	0.549	0.034	0.002	0.076	0.133	0.006	0.045
604	30	R1G2	8:33:45	8:34:04	0.386	0.147	0.627	0.346	0.170	0.297	0.535	0.027	0.011	0.050	0.042	0.025	0.060
	30	R1G4	8:35:51	8:36:10	0.329	0.186	0.763	0.549	0.187	0.152	0.538	0.025	0.015	0.067	0.074	0.014	0.066
605	7	R1G2	8:38:26	8:38:45	2.303	5.277	7.198	1.190	0.988	0.821	1.592	0.176	0.433	0.633	0.161	0.077	0.196
	7	R1G3	8:39:53	8:40:12	2.173	4.722	6.707	1.415	0.847	0.728	1.384	0.166	0.388	0.591	0.191	0.068	0.171
	7	R2G1	8:58:17	8:58:36	0.142	0.427	0.955	0.167	0.288	0.258	0.307	0.205	0.666	1.596	0.428	0.460	0.718
606	100	R1G2	9:05:14	9:05:33	0.618	0.073	0.164	0.355	0.360	0.207	0.692	0.029	0.004	0.009	0.030	0.012	0.053
607	85	R1G2	9:06:31	9:06:50	0.654	0.127	0.007	0.218	0.251	0.102	0.424	0.033	0.007	0.000	0.019	0.006	0.034
608	30	R1G2	9:09:35	9:09:54	0.336	0.157	0.383	0.165	0.131	0.245	0.451	0.023	0.012	0.030	0.020	0.021	0.050
	30	R1G4	9:11:22	9:11:41	0.206	0.126	0.658	0.389	0.176	0.156	0.442	0.016	0.011	0.060	0.055	0.015	0.057
609	7	R1G2	9:14:16	9:14:35	2.118	4.748	6.467	1.020	0.730	0.639	1.430	0.164	0.397	0.579	0.140	0.061	0.179
	7	R1G3	9:16:22	9:16:41	1.725	3.760	5.343	1.138	0.533	0.527	1.160	0.131	0.309	0.470	0.153	0.049	0.143
	7	R1G4	9:17:20	9:17:39	1.794	3.930	5.684	1.006	0.482	0.616	0.993	0.142	0.335	0.519	0.141	0.060	0.127
	7	R1G5	9:19:07	9:19:26	1.679	3.688	5.351	0.984	0.591	0.472	1.088	0.137	0.324	0.503	0.142	0.047	0.143
	7	R1G6	9:20:53	9:21:12	1.743	3.889	6.748	1.321	1.010	0.487	1.241	0.154	0.370	0.688	0.206	0.053	0.177
	7	R1G1	9:22:01	9:22:20	2.078	4.675	9.509	1.834	0.549	0.767	1.351	0.178	0.431	0.940	0.278	0.081	0.187
	7	R2G2	9:23:28	9:23:47	0.171	0.510	1.004	0.289	0.069	0.180	0.321	0.162	0.519	1.096	0.484	0.210	0.490
	7	R2G3	9:24:07	9:24:26	0.137	0.436	0.969	0.185	0.188	0.237	0.210	0.162	0.555	1.322	0.387	0.345	0.401
	7	R2G4	9:27:01	9:27:20	0.144	0.416	0.822	0.079	0.000	0.161	0.252	0.164	0.509	1.079	0.159	0.225	0.463
	7	R2G6	9:28:38	9:28:57	0.163	0.502	0.882	0.144	0.076	0.246	0.378	0.166	0.552	1.039	0.260	0.309	0.623
	7	R2G1	9:29:55	9:30:15	0.122	0.439	0.890	0.140	0.250	0.266	0.300	0.169	0.653	1.419	0.342	0.452	0.670

TABLE A-3.—PART B (Continued)

Test Point No.[1]	Power	Probe ID[2]	MGA Time		Measured gaseous concentration							Gaseous emission index					
					Acetylene (C_2H_2)	Ethylene (C_2H_4)	Formaldehyde (HCHO)	Formic Acid (HCOOH)	Jet Fuel A	Methanol (CH_3OH)	Propylene (C_3H_6)	EIC_2H_2	EIC_2H_4	EIHCHO	EIHCOOH	$EICH_3OH$	EIC_3H_6
	%		Start	End	ppm							g/kg fuel					
610	100	R1G3	9:40:16	9:40:35	0.618	0.015	0.180	0.350	0.366	0.132	0.584	0.029	0.001	0.010	0.029	0.008	0.045
611	85	R1G3	9:42:03	9:42:22	0.598	0.045	0.179	0.255	0.331	0.251	0.792	0.029	0.002	0.010	0.022	0.015	0.062
612	30	R1G3	9:44:57	9:45:17	0.353	0.140	0.567	0.103	0.170	0.235	0.440	0.026	0.011	0.048	0.013	0.021	0.052
	30	R1G5	9:46:25	9:46:44	0.176	0.114	0.684	0.276	0.277	0.178	0.594	0.014	0.010	0.064	0.040	0.018	0.078
	30	R1G2	9:47:42	9:48:02	0.545	0.863	1.264	0.145	0.399	0.163	0.545	0.042	0.071	0.111	0.020	0.015	0.067
613	7	R1G2	9:49:58	9:50:18	1.729	3.481	4.606	0.956	0.381	0.709	1.209	0.123	0.266	0.378	0.120	0.062	0.139
	7	R1G3	9:51:26	9:51:45	1.556	3.005	4.101	0.900	0.360	0.520	1.097	0.109	0.226	0.331	0.111	0.045	0.124
	7	R1G4	9:53:22	9:53:42	1.483	2.797	4.030	0.930	0.323	0.471	0.854	0.110	0.223	0.345	0.122	0.043	0.102
	7	R1G5	9:54:30	9:54:49	1.239	2.786	4.147	0.953	0.287	0.476	0.962	0.094	0.227	0.362	0.128	0.044	0.118
	7	R1G6	9:56:17	9:56:36	1.335	2.940	4.585	0.971	0.736	0.480	0.977	0.108	0.256	0.427	0.139	0.048	0.127
	7	R1G1	9:57:15	9:57:34	1.598	3.721	5.121	1.024	0.529	0.683	1.162	0.123	0.308	0.454	0.139	0.065	0.144
	7	R2G2	9:59:21	9:59:41	0.106	0.384	0.814	0.131	0.148	0.222	0.323	0.119	0.464	1.055	0.260	0.307	0.586
	7	R2G3	10:00:58	10:01:18	0.114	0.390	0.834	0.113	0.194	0.228	0.236	0.128	0.472	1.081	0.225	0.315	0.428
	7	R2G4	10:02:06	10:02:26	0.103	0.373	0.710	0.128	0.254	0.248	0.356	0.115	0.451	0.920	0.254	0.343	0.646
	7	R2G6	10:03:53	10:04:12	0.130	0.362	0.862	0.063	0.000	0.103	0.264	0.127	0.381	0.971	0.109	0.124	0.416
614	100	R1G3	10:16:00	10:16:20	0.611	0.061	0.287	0.344	0.459	0.169	0.595	0.028	0.003	0.015	0.028	0.009	0.044
615	85	R1G3	10:17:37	10:17:57	0.604	0.010	0.218	0.165	0.441	0.283	0.624	0.029	0.001	0.012	0.014	0.017	0.048
616	30	R1G3	10:20:42	10:21:01	0.346	0.153	0.442	0.064	0.206	0.156	0.305	0.025	0.012	0.037	0.008	0.014	0.035
	30	R1G5	10:22:18	10:22:38	0.236	0.116	0.696	0.201	0.253	0.155	0.393	0.018	0.010	0.062	0.027	0.015	0.049
	30	R1G2	10:22:57	10:23:17	0.349	0.155	0.567	0.183	0.250	0.179	0.391	0.025	0.012	0.047	0.023	0.016	0.045
617	7	R1G2	10:26:11	10:26:31	1.372	2.495	3.401	0.692	0.225	0.448	0.722	0.098	0.192	0.280	0.087	0.039	0.083
	7	R1G3	10:27:38	10:27:58	1.206	2.125	3.042	0.656	0.232	0.429	0.756	0.086	0.164	0.251	0.083	0.038	0.087
	7	R1G4	10:28:56	10:29:15	1.079	2.043	3.067	0.731	0.261	0.332	0.722	0.081	0.165	0.266	0.097	0.031	0.088
	7	R1G5	10:30:14	10:30:33	1.014	2.142	3.388	0.765	0.267	0.347	0.616	0.078	0.177	0.300	0.104	0.033	0.076
	7	R1G6	10:31:21	10:31:41	1.066	2.202	3.570	0.810	0.617	0.267	0.668	0.087	0.194	0.337	0.117	0.027	0.088
	7	R1G1	10:32:39	10:32:58	1.110	2.297	3.160	0.653	0.309	0.436	0.764	0.092	0.205	0.302	0.096	0.044	0.102
	7	R2G2	10:34:35	10:34:55	0.082	0.278	0.615	0.068	0.029	0.231	0.290	0.084	0.309	0.733	0.124	0.294	0.484
	7	R2G3	10:34:55	10:35:14	0.077	0.293	0.726	0.085	0.013	0.112	0.139	0.083	0.342	0.907	0.163	0.149	0.243
	7	R2G4	10:36:32	10:36:51	0.082	0.291	0.602	0.057	0.036	0.223	0.287	0.085	0.327	0.726	0.105	0.287	0.484
	7	R2G6	10:37:30	10:37:49	0.127	0.416	0.788	0.036	0.144	0.209	0.295	0.125	0.442	0.898	0.063	0.254	0.471

TABLE A-3.—PART B (Continued)

Test Point No.[1]	Power	Probe ID[2]	MGA Time		Measured gaseous concentration							Gaseous emission index					
					Acetylene (C_2H_2)	Ethylene (C_2H_4)	Formaldehyde (HCHO)	Formic Acid (HCOOH)	Jet Fuel A	Methanol (CH_3OH)	Propylene (C_3H_6)	EIC_2H_2	EIC_2H_4	EIHCHO	EIHCOOH	$EICH_3OH$	EIC_3H_6
	%		Start	End	ppm							g/kg fuel					
618	4	R1G2	11:56:45	11:57:04	4.695	12.527	14.199	2.871	3.075	1.642	3.988	0.309	0.888	1.078	0.334	0.133	0.424
619	100	R1G2	12:01:27	12:01:46	0.582	0.175	0.155	0.512	0.497	0.300	0.774	0.027	0.009	0.008	0.042	0.017	0.058
620	85	R1G2	12:02:35	12:02:54	0.652	0.178	0.137	0.358	0.478	0.281	0.742	0.032	0.010	0.008	0.031	0.017	0.060
	85	R1G3	12:04:41	12:05:01	0.604	0.184	0.226	0.327	0.494	0.298	0.774	0.030	0.010	0.013	0.029	0.018	0.063
621	65	R1G3	12:06:48	12:07:07	0.346	0.227	0.065	0.195	0.334	0.126	0.404	0.020	0.014	0.004	0.020	0.009	0.038
	65	R1G2	12:08:05	12:08:25	0.358	0.157	0.054	0.270	0.290	0.110	0.432	0.019	0.009	0.003	0.026	0.007	0.037
622	40	R1G2	12:10:41	12:11:00	0.295	0.182	0.204	0.214	0.198	0.178	0.388	0.019	0.013	0.015	0.024	0.014	0.040
	40	R1G3	12:12:28	12:12:47	0.295	0.190	0.482	0.148	0.255	0.245	0.425	0.020	0.014	0.038	0.018	0.021	0.047
623	4	R1G3	12:15:13	12:15:33	3.784	9.575	11.097	1.810	1.468	1.407	2.924	0.253	0.690	0.857	0.214	0.116	0.316
	4	R1G2	12:17:39	12:17:58	4.275	10.792	12.322	2.031	1.999	1.491	2.903	0.278	0.755	0.924	0.233	0.119	0.305
624	40	R1G2	12:21:32	12:21:52	0.376	0.255	0.331	0.403	0.358	0.161	0.441	0.023	0.017	0.024	0.044	0.012	0.044
	40	R1G3	12:22:31	12:22:50	0.356	0.318	0.581	0.298	0.271	0.089	0.654	0.024	0.023	0.045	0.035	0.007	0.070
	40	R1G4	12:23:58	12:24:18	0.393	0.385	1.356	0.398	0.407	0.117	0.430	0.028	0.030	0.113	0.051	0.010	0.050
	40	R1G5	12:24:47	12:25:06	0.334	0.214	0.777	0.314	0.399	0.064	0.440	0.025	0.017	0.066	0.041	0.006	0.052
	40	R1G6	12:25:55	12:26:14	0.402	0.301	1.003	0.499	0.504	0.024	0.529	0.029	0.024	0.085	0.064	0.002	0.062
	40	R1G1	12:27:13	12:27:32	0.353	0.212	0.304	0.193	0.291	0.112	0.421	0.025	0.016	0.025	0.025	0.010	0.049
	40	R1G2	12:31:16	12:31:35	0.276	0.184	0.193	0.157	0.263	0.151	0.357	0.019	0.013	0.015	0.019	0.013	0.039
	40	R2G3	12:32:43	12:33:03	0.014	0.197	0.383	0.070	0.085	0.172	0.217	0.011	0.169	0.351	0.098	0.168	0.279
	40	R2G4	12:34:01	12:34:20	0.018	0.163	0.431	0.040	0.000	0.069	0.287	0.013	0.129	0.366	0.052	0.063	0.342
	40	R2G6	12:35:38	12:35:58	0.017	0.172	0.312	0.099	0.180	0.179	0.254	0.013	0.144	0.279	0.136	0.171	0.318
	40	R2G1	12:36:46	12:37:06	0.001	0.161	0.315	0.087	0.080	0.200	0.007	0.000	0.156	0.327	0.138	0.221	0.010
	40	R1G2	12:38:23	12:38:43	0.322	0.182	0.132	0.114	0.316	0.199	0.344	0.020	0.012	0.009	0.012	0.015	0.034
625	30	R1G2	12:44:04	12:44:23	0.352	0.218	0.274	0.140	0.233	0.092	0.341	0.024	0.016	0.022	0.017	0.008	0.038
	30	R1G3	12:45:31	12:45:51	0.330	0.231	0.390	0.132	0.239	0.086	0.390	0.024	0.018	0.033	0.017	0.008	0.046
626	15	R1G3	12:48:07	12:48:26	0.671	0.918	1.328	0.326	0.234	0.283	0.479	0.049	0.073	0.113	0.042	0.026	0.057
	15	R1G2	12:49:25	12:49:44	0.653	0.925	1.183	0.303	0.174	0.262	0.494	0.047	0.072	0.099	0.039	0.023	0.058
627	7	R1G2	12:52:10	12:52:29	1.242	2.321	2.983	0.690	0.273	0.385	0.836	0.090	0.182	0.251	0.089	0.035	0.098
	7	R1G3	12:53:28	12:53:47	1.182	2.233	2.833	0.708	0.266	0.296	0.769	0.087	0.176	0.239	0.092	0.027	0.091
628	5.5	R1G3	12:56:23	12:56:42	2.200	5.000	6.172	1.331	0.613	0.827	1.014	0.150	0.368	0.487	0.161	0.070	0.112
	5.5	R1G2	12:57:50	12:58:10	2.277	5.419	6.636	1.290	0.594	0.814	1.439	0.156	0.401	0.526	0.157	0.069	0.160

TABLE A-3.—PART B (Continued)

Test Point No.[1]	Power	Probe ID[2]	MGA Time		Measured gaseous concentration							Gaseous emission index					
					Acetylene (C_2H_2)	Ethylene (C_2H_4)	Formaldehyde (HCHO)	Formic Acid (HCOOH)	Jet Fuel A	Methanol (CH_3OH)	Propylene (C_3H_6)	EIC_2H_2	EIC_2H_4	EIHCHO	EIHCOOH	$EICH_3OH$	EIC_3H_6
	%		Start	End	ppm							g/kg fuel					
629	4	R1G2	13:01:05	13:01:24	3.324	8.620	10.140	1.739	1.373	1.258	2.534	0.217	0.607	0.765	0.201	0.101	0.268
	4	R2G6	13:03:02	13:03:21	0.306	0.999	1.348	0.212	0.259	0.247	0.395	0.255	0.895	1.294	0.312	0.253	0.531
	4	R1G2	13:10:19	13:10:39	3.703	9.511	10.935	1.793	1.502	1.264	2.736	0.239	0.660	0.813	0.204	0.100	0.285
630	5.5	R1G2	13:12:55	13:13:14	2.081	4.781	5.954	1.278	0.605	0.794	1.240	0.140	0.347	0.464	0.153	0.066	0.135
	5.5	R2G6	13:14:32	13:14:52	0.176	0.604	0.877	0.165	0.103	0.134	0.267	0.151	0.557	0.866	0.250	0.141	0.369
631	7	R1G2	13:16:48	13:17:08	1.224	2.348	3.008	0.716	0.264	0.410	0.707	0.086	0.177	0.243	0.089	0.035	0.080
632	15	R1G2	13:20:32	13:20:52	0.520	0.533	0.577	0.303	0.172	0.078	0.437	0.037	0.041	0.048	0.039	0.007	0.051
	15	R2G6	13:22:19	13:22:39	0.037	0.226	0.425	0.104	0.069	0.198	0.296	0.033	0.217	0.436	0.164	0.217	0.425
633	30	R1G2	13:24:26	13:24:45	0.324	0.213	0.281	0.174	0.208	0.150	0.415	0.021	0.015	0.021	0.020	0.012	0.043
	30	R2G6	13:26:03	13:26:23	0.020	0.242	0.366	0.119	0.082	0.098	0.412	0.014	0.176	0.285	0.142	0.082	0.450
634	4	R1G2	13:28:10	13:28:29	3.679	9.748	11.173	1.649	1.559	1.463	2.921	0.241	0.687	0.844	0.191	0.118	0.309
	4	R1G2	13:34:10	13:34:29	4.331	11.508	13.273	1.961	2.264	1.682	3.505	0.276	0.791	0.977	0.221	0.132	0.361
635	40	R1G2	13:40:10	13:40:29	0.324	0.124	0.166	0.250	0.477	0.297	0.485	0.019	0.008	0.011	0.026	0.022	0.046
	40	R1G3	13:41:47	13:42:07	0.341	0.189	0.507	0.257	0.325	0.087	0.304	0.022	0.013	0.038	0.030	0.007	0.032
	40	R1G2	13:43:05	13:43:24	0.314	0.156	0.058	0.234	0.358	0.196	0.168	0.019	0.010	0.004	0.025	0.014	0.016
	40	R1G3	13:44:13	13:44:33	0.324	0.184	0.482	0.190	0.263	0.034	0.266	0.021	0.013	0.036	0.022	0.003	0.028
	40	R1G4	13:46:00	13:46:20	0.325	0.264	0.794	0.263	0.207	0.199	0.497	0.023	0.020	0.065	0.033	0.017	0.057
	40	R1G5	13:47:08	13:47:28	0.349	0.214	0.712	0.287	0.499	0.133	0.326	0.025	0.017	0.059	0.037	0.012	0.038
	40	R1G6	13:48:07	13:48:26	0.444	0.417	1.092	0.360	0.468	0.088	0.515	0.031	0.031	0.088	0.045	0.008	0.058
	40	R1G1	13:49:44	13:50:03	0.336	0.182	0.241	0.156	0.192	0.005	0.332	0.022	0.013	0.018	0.018	0.000	0.035
	40	R2G2	13:51:02	13:51:21	0.013	0.180	0.294	0.075	0.065	0.144	0.245	0.008	0.123	0.215	0.084	0.112	0.251
	40	R2G3	13:52:10	13:52:29	0.028	0.163	0.398	0.074	0.019	0.159	0.251	0.022	0.133	0.347	0.099	0.148	0.306
	40	R2G4	13:53:47	13:54:07	0.017	0.193	0.305	0.079	0.082	0.112	0.229	0.012	0.151	0.255	0.101	0.100	0.268
	40	R2G6	13:55:15	13:55:34	0.024	0.178	0.343	0.107	0.100	0.151	0.265	0.017	0.134	0.276	0.132	0.129	0.298
	40	R2G1	13:56:13	13:56:33	0.016	0.178	0.254	0.042	0.000	0.078	0.330	0.014	0.172	0.263	0.067	0.086	0.479
636	30	R1G2	14:00:17	14:00:36	0.330	0.244	0.415	0.089	0.227	0.240	0.405	0.022	0.018	0.032	0.011	0.020	0.044
	30	R1G3	14:01:34	14:01:54	0.343	0.242	0.578	0.173	0.265	0.146	0.287	0.025	0.019	0.049	0.022	0.013	0.034
637	15	R1G2	14:04:39	14:04:59	0.611	0.715	0.911	0.317	0.207	0.170	0.317	0.043	0.054	0.074	0.040	0.015	0.036
	15	R1G3	14:05:47	14:06:07	0.553	0.724	1.044	0.321	0.238	0.272	0.567	0.041	0.057	0.089	0.042	0.025	0.067
	15	R1G2	14:06:46	14:07:05	0.919	1.713	2.121	0.343	0.559	0.381	0.675	0.068	0.136	0.181	0.045	0.035	0.081

TABLE A-3.—PART B (Continued)

Test Point No.[1]	Power	Probe ID[2]	MGA Time		Measured gaseous concentration							Gaseous emission index					
					Acetylene (C_2H_2)	Ethylene (C_2H_4)	Formaldehyde (HCHO)	Formic Acid (HCOOH)	Jet Fuel A	Methanol (CH_3OH)	Propylene (C_3H_6)	EIC_2H_2	EIC_2H_4	EIHCHO	EIHCOOH	$EICH_3OH$	EIC_3H_6
	%		Start	End	ppm							g/kg fuel					
638	7	R1G2	14:08:13	14:08:33	1.449	2.903	3.432	0.749	0.310	0.408	0.757	0.100	0.215	0.273	0.091	0.035	0.084
	7	R1G3	14:09:58	14:10:17	1.473	2.966	3.867	0.791	0.373	0.546	0.824	0.104	0.226	0.316	0.099	0.048	0.094
	7	R1G2	14:11:06	14:11:26	1.486	2.994	3.662	0.799	0.392	0.367	0.703	0.104	0.225	0.295	0.099	0.031	0.079
639	5.5	R1G2	14:12:53	14:13:13	2.073	4.831	5.876	1.172	0.539	0.856	1.502	0.139	0.349	0.455	0.139	0.071	0.163
	5.5	R1G3	14:14:40	14:15:00	1.998	4.529	5.713	1.234	0.519	0.724	1.173	0.138	0.337	0.455	0.151	0.061	0.131
640	4	R1G2	14:18:44	14:19:03	3.063	8.045	9.513	1.604	1.187	1.330	2.478	0.201	0.569	0.721	0.186	0.107	0.263
	4	R1G3	14:20:11	14:20:31	3.050	7.523	9.029	1.744	1.049	1.200	1.788	0.207	0.549	0.706	0.209	0.100	0.196
641	5.5	R1G2	14:27:10	14:27:29	1.714	4.031	5.090	1.058	0.444	0.649	1.022	0.122	0.308	0.417	0.133	0.057	0.117
	5.5	R2G6	14:28:18	14:28:37	0.173	0.612	0.907	0.216	0.066	0.170	0.156	0.128	0.490	0.777	0.284	0.155	0.187
642	7	R1G2	14:31:23	14:31:42	1.199	2.255	2.726	0.739	0.247	0.425	0.535	0.085	0.171	0.222	0.092	0.037	0.061
	7	R2G6	14:33:10	14:33:29	0.114	0.422	0.633	0.118	0.146	0.122	0.227	0.102	0.404	0.650	0.186	0.134	0.326
643	15	R1G2	14:35:16	14:35:36	0.490	0.453	0.622	0.335	0.218	0.174	0.201	0.034	0.034	0.051	0.042	0.015	0.023
726	4	R1GG3	15:03:10	15:10:58	4.330	11.010	13.320	1.940	1.960	1.780	3.470	0.297	0.812	1.053	0.235	0.150	0.384
727	100	R1GG3	15:11:57	15:12:55	0.800	0.210	0.330	0.410	0.420	0.240	0.650	0.038	0.011	0.018	0.035	0.014	0.050
728	85	R1GG3	15:14:13	15:16:20	0.810	0.200	0.270	0.300	0.360	0.250	0.550	0.040	0.011	0.016	0.026	0.015	0.044
729	65	R1GG3	15:16:59	15:20:43	0.530	0.160	0.350	0.300	0.400	0.250	0.380	0.031	0.010	0.023	0.031	0.018	0.035
730	40	R1GG3	15:21:51	15:25:26	0.530	0.210	0.720	0.210	0.340	0.280	0.390	0.036	0.016	0.057	0.025	0.024	0.043
731	30	R1GG3	15:26:15	15:30:09	0.560	0.220	0.910	0.160	0.320	0.260	0.340	0.041	0.018	0.078	0.021	0.024	0.041
732	7	R1GG3	15:31:27	15:33:24	1.340	2.630	3.720	0.680	0.350	0.550	0.710	0.101	0.214	0.325	0.091	0.051	0.087
733	4	R1GG3	15:35:30	15:43:18	3.010	7.040	8.990	1.280	0.820	1.220	2.070	0.213	0.537	0.735	0.161	0.106	0.237
734	100	R1GG3	15:44:07	15:45:15	0.780	0.210	0.360	0.270	0.580	0.410	0.700	0.038	0.011	0.020	0.023	0.024	0.054
735	85	R1GG3	15:46:24	15:48:11	0.800	0.210	0.140	0.180	0.330	0.180	0.430	0.040	0.011	0.008	0.016	0.011	0.035
736	65	R1GG3	15:49:00	15:52:44	0.530	0.180	0.320	0.150	0.410	0.260	0.460	0.031	0.011	0.021	0.015	0.018	0.043
737	40	R1GG3	15:53:42	15:57:27	0.500	0.160	0.680	0.150	0.330	0.220	0.510	0.035	0.012	0.054	0.018	0.019	0.057
738	30	R1GG3	15:58:45	16:01:50	0.540	0.220	0.650	0.100	0.400	0.180	0.280	0.040	0.017	0.055	0.013	0.016	0.033
739	7	R1GG3	16:03:08	16:06:13	1.350	2.340	3.340	0.600	0.340	0.560	0.830	0.099	0.185	0.284	0.078	0.051	0.099
740	4	R1GG3	16:07:21	16:14:01	3.300	7.920	9.890	1.340	0.990	1.320	2.270	0.228	0.588	0.787	0.164	0.112	0.253
741	100	R1GG3	16:15:09	16:16:18	0.820	0.260	0.510	0.240	0.450	0.250	0.590	0.039	0.013	0.028	0.020	0.015	0.045
742	85	R1GG3	16:16:47	16:20:31	0.770	0.220	0.210	0.200	0.360	0.240	0.620	0.038	0.012	0.012	0.018	0.015	0.050
743	70	R1GG3	16:21:01	16:24:35	0.520	0.170	0.160	0.130	0.420	0.230	0.500	0.029	0.010	0.010	0.013	0.016	0.045
744	65	R1GG3	16:25:53	16:28:19	0.530	0.190	0.220	0.140	0.340	0.210	0.370	0.031	0.012	0.015	0.014	0.015	0.035
745	60	R1GG3	16:28:49	16:32:13	0.510	0.180	0.340	0.130	0.310	0.290	0.480	0.031	0.012	0.024	0.014	0.021	0.047

TABLE A-3.—PART B (Continued)

Test Point No.[1]	Power	Probe ID[2]	MGA Time		Measured gaseous concentration: Acetylene (C_2H_2)	Ethylene (C_2H_4)	Formaldehyde (HCHO)	Formic Acid (HCOOH)	Jet Fuel A	Methanol (CH_3OH)	Propylene (C_3H_6)	Gaseous emission index: EIC_2H_2	EIC_2H_4	EIHCHO	EIHCOOH	$EICH_3OH$	EIC_3H_6
	%		Start	End	ppm							g/kg fuel					
746	40	R1GG3	16:33:22	16:36:17	0.540	0.190	0.630	0.120	0.380	0.250	0.290	0.037	0.014	0.050	0.015	0.021	0.033
747	30	R1GG3	16:37:16	16:40:01	0.580	0.250	0.830	0.100	0.330	0.210	0.300	0.043	0.020	0.071	0.013	0.019	0.036
748	15	R1GG3	16:41:00	16:43:46	0.640	0.750	1.360	0.320	0.350	0.290	0.300	0.049	0.062	0.120	0.043	0.027	0.037
749	7	R1GG3	16:44:25	16:47:49	1.400	2.280	3.060	0.550	0.460	0.500	0.690	0.103	0.181	0.260	0.072	0.045	0.082
750	5.5	R1GG3	16:49:17	16:51:43	2.040	4.130	5.330	0.910	0.410	0.750	1.130	0.145	0.315	0.436	0.114	0.065	0.129
751	4	R1GG3	16:53:40	16:56:16	3.460	8.490	10.420	1.370	1.190	1.320	2.390	0.237	0.627	0.825	0.166	0.111	0.265
801	4	R1GG3	8:01:22	8:06:13	8.616	22.159	24.880	3.000	9.604	3.019	6.970	0.610	1.689	2.032	0.376	0.263	0.797
802	100	R1GG3	8:07:12	8:08:20	0.593	0.150	0.320	0.281	1.286	0.219	0.651	0.029	0.008	0.018	0.024	0.013	0.051
803	85	R1GG3	8:08:58	8:11:53	0.579	0.137	0.246	0.241	0.802	0.319	0.777	0.029	0.008	0.014	0.022	0.020	0.064
804	65	R1GG3	8:12:42	8:16:25	0.365	0.111	0.253	0.207	0.525	0.241	0.523	0.021	0.007	0.017	0.021	0.017	0.049
805	40	R1GG3	8:17:33	8:36:58	0.315	0.154	0.656	0.141	0.427	0.247	0.397	0.022	0.012	0.053	0.017	0.021	0.045
806	30	R1GG3	8:37:47	8:41:10	0.146	0.140	0.741	0.133	0.359	0.124	0.516	0.011	0.011	0.065	0.018	0.012	0.063
807	7	R1GG3	8:41:59	8:45:32	1.592	3.704	5.384	0.846	0.596	0.745	0.956	0.123	0.309	0.482	0.116	0.071	0.120
808	4	R1GG3	8:46:21	8:53:57	4.083	10.186	13.015	1.609	2.124	1.654	3.126	0.299	0.803	1.099	0.208	0.149	0.370
809	100	R1GG3	8:54:55	8:56:03	0.601	0.197	0.521	0.233	0.695	0.394	0.790	0.029	0.010	0.029	0.020	0.023	0.062
810	85	R1GG3	8:56:22	8:59:17	0.604	0.144	0.251	0.196	0.502	0.232	0.747	0.031	0.008	0.015	0.018	0.014	0.061
811	65	R1GG3	8:59:46	9:03:00	0.326	0.111	0.296	0.222	0.437	0.168	0.430	0.019	0.007	0.020	0.023	0.012	0.040
812	40	R1GG3	9:03:39	9:23:33	0.326	0.132	0.688	0.128	0.437	0.228	0.449	0.022	0.010	0.055	0.016	0.019	0.050
813	30	R1GG3	9:24:21	9:28:05	0.337	0.184	0.799	0.165	0.455	0.265	0.323	0.025	0.015	0.069	0.022	0.024	0.039
814	7	R1GG3	9:28:53	9:32:17	1.436	3.352	4.834	0.789	0.501	0.610	1.151	0.110	0.277	0.428	0.107	0.058	0.143
815	4	R1GG3	9:33:35	9:40:23	3.807	9.318	11.844	1.588	1.668	1.498	2.615	0.274	0.723	0.984	0.202	0.133	0.304
816	100	R1GG3	9:41:12	9:42:10	0.591	0.175	0.410	0.225	0.582	0.242	0.666	0.029	0.009	0.023	0.019	0.015	0.052
817	85	R1GG3	9:42:39	9:46:03	0.610	0.163	0.208	0.206	0.421	0.209	0.626	0.031	0.009	0.012	0.018	0.013	0.051
818	70	R1GG3	9:46:42	9:49:46	0.344	0.099	0.143	0.105	0.433	0.203	0.578	0.019	0.006	0.009	0.010	0.014	0.053
819	65	R1GG3	9:50:25	9:53:20	0.351	0.127	0.237	0.147	0.423	0.223	0.442	0.020	0.008	0.016	0.015	0.016	0.041
820	60	R1GG3	9:53:49	9:57:03	0.330	0.130	0.260	0.152	0.358	0.227	0.414	0.020	0.009	0.019	0.017	0.017	0.041
821	40	R1GG3	9:57:52	10:01:16	0.331	0.151	0.747	0.114	0.349	0.224	0.463	0.023	0.011	0.059	0.014	0.019	0.051
822	30	R1GG3	10:01:54	10:05:18	0.342	0.190	0.841	0.126	0.372	0.220	0.398	0.025	0.015	0.072	0.017	0.020	0.048
823	15	R1GG3	10:06:16	10:08:52	0.526	0.914	1.740	0.337	0.392	0.321	0.468	0.041	0.077	0.156	0.046	0.031	0.059
824	7	R1GG3	10:10:09	10:12:45	1.334	3.065	4.398	0.757	0.379	0.503	1.153	0.101	0.250	0.384	0.101	0.047	0.141
825	5.5	R1GG3	10:13:53	10:16:38	2.313	5.294	7.130	1.076	0.691	0.914	1.646	0.169	0.417	0.601	0.139	0.082	0.194
826	4	R1GG3	10:17:55	10:21:44	3.755	9.236	11.712	1.539	1.581	1.527	2.784	0.269	0.712	0.967	0.195	0.135	0.322

TABLE A-3.—PART B (Continued)

Test Point No.[1]	Power	Probe ID[2]	MGA Time		Measured gaseous concentration							Gaseous emission index					
					Acetylene (C_2H_2)	Ethylene (C_2H_4)	Formaldehyde (HCHO)	Formic Acid (HCOOH)	Jet Fuel A	Methanol (CH_3OH)	Propylene (C_3H_6)	EIC_2H_2	EIC_2H_4	EIHCHO	EIHCOOH	$EICH_3OH$	EIC_3H_6
	%		Start	End	ppm							g/kg fuel					
827	4	R1GG3	12:50:02	12:53:56	5.169	14.794	15.799	1.978	3.208	2.035	4.348	0.358	1.103	1.263	0.242	0.174	0.486
828	100	R1GG3	12:54:54	12:55:53	0.612	0.129	0.398	0.232	0.661	0.305	0.611	0.029	0.007	0.022	0.020	0.018	0.047
829	85	R1GG3	12:56:32	12:58:58	0.620	0.123	0.271	0.196	0.486	0.246	0.560	0.031	0.007	0.015	0.017	0.015	0.045
830	65	R1GG3	12:59:47	13:02:52	0.366	0.095	0.300	0.105	0.458	0.292	0.509	0.021	0.006	0.020	0.011	0.021	0.047
831	40	R1GG3	13:03:41	13:06:46	0.329	0.102	0.662	0.160	0.325	0.222	0.508	0.023	0.008	0.052	0.019	0.019	0.056
832	30	R1GG3	13:07:15	13:10:30	0.360	0.139	0.749	0.132	0.353	0.180	0.377	0.027	0.011	0.064	0.017	0.016	0.045
833	7	R1GG3	13:11:38	13:15:02	1.353	3.281	4.570	0.766	0.424	0.629	0.918	0.103	0.268	0.399	0.103	0.059	0.112
834	4	R1GG3	13:16:20	13:24:57	3.287	8.910	10.611	1.434	1.267	1.351	2.509	0.235	0.687	0.877	0.182	0.119	0.290
835	100	R1GG3	13:25:45	13:26:34	0.609	0.127	0.470	0.227	0.487	0.376	0.867	0.029	0.007	0.026	0.019	0.022	0.067
836	85	R1GG3	13:27:34	13:30:08	0.627	0.094	0.297	0.172	0.503	0.274	0.557	0.031	0.005	0.017	0.015	0.017	0.045
837	65	R1GG3	13:30:47	13:34:02	0.370	0.100	0.277	0.149	0.315	0.194	0.426	0.021	0.006	0.018	0.015	0.014	0.040
838	40	R1GG3	13:35:10	13:38:44	0.329	0.103	0.753	0.137	0.257	0.309	0.510	0.023	0.008	0.061	0.017	0.027	0.057
839	30	R1GG3	13:39:23	13:42:28	0.343	0.130	0.838	0.167	0.307	0.256	0.492	0.025	0.010	0.072	0.022	0.023	0.059
840	7	R1GG3	13:43:37	13:46:51	1.479	3.334	4.460	0.691	0.350	0.664	1.023	0.108	0.263	0.377	0.089	0.060	0.121
841	4	R1GG3	13:48:09	13:55:08	3.904	10.664	12.205	1.531	1.670	1.586	3.027	0.273	0.804	0.986	0.190	0.137	0.342
842	100	R1GG3	13:55:57	13:57:05	0.624	0.131	0.465	0.191	0.595	0.327	0.732	0.030	0.007	0.026	0.016	0.019	0.056
843	85	R1GG3	13:58:13	14:00:29	0.594	0.100	0.329	0.182	0.439	0.366	0.754	0.029	0.005	0.019	0.016	0.022	0.060
844	100	R1GG3	14:10:42	14:11:51	0.624	0.127	0.450	0.227	0.564	0.319	0.672	0.030	0.007	0.025	0.019	0.019	0.052
845	85	R1GG3	14:12:30	14:16:04	0.612	0.144	0.354	0.177	0.450	0.320	0.657	0.031	0.008	0.021	0.016	0.020	0.053
846	70	R1GG3	14:17:02	14:20:17	0.362	0.101	0.272	0.126	0.390	0.283	0.500	0.020	0.006	0.018	0.013	0.020	0.045
847	65	R1GG3	14:20:46	14:23:51	0.359	0.118	0.326	0.165	0.332	0.205	0.407	0.021	0.007	0.022	0.017	0.015	0.039
848	60	R1GG3	14:24:20	14:27:45	0.364	0.122	0.354	0.096	0.363	0.238	0.525	0.022	0.008	0.025	0.010	0.018	0.051
849	40	R1GG3	14:28:43	14:32:07	0.338	0.139	0.766	0.102	0.282	0.232	0.412	0.023	0.010	0.060	0.012	0.019	0.045
850	30	R1GG3	14:32:46	14:36:11	0.342	0.168	0.881	0.169	0.383	0.278	0.307	0.025	0.013	0.075	0.022	0.025	0.037
851	15	R1GG3	14:37:09	14:40:04	0.459	0.822	1.679	0.323	0.302	0.323	0.448	0.035	0.068	0.150	0.044	0.031	0.056
852	7	R1GG3	14:41:32	14:43:48	1.386	3.267	4.513	0.727	0.361	0.629	0.905	0.103	0.261	0.386	0.095	0.057	0.108
853	5.5	R1GG3	14:44:37	14:47:22	1.931	4.816	6.063	0.961	0.451	0.876	1.458	0.141	0.377	0.509	0.124	0.079	0.171
854	4	R1GG3	14:48:21	14:55:58	3.880	10.695	12.321	1.546	1.725	1.598	3.076	0.274	0.813	1.003	0.193	0.139	0.351
855	100	R1GG3	14:57:26	14:58:43	0.605	0.133	0.540	0.235	0.605	0.397	0.779	0.029	0.007	0.030	0.020	0.023	0.060
856	85	R1GG3	14:59:52	15:02:08	0.630	0.123	0.316	0.151	0.442	0.192	0.521	0.032	0.007	0.018	0.013	0.012	0.042
857	65	R1GG3	15:02:57	15:05:42	0.378	0.116	0.369	0.116	0.322	0.235	0.466	0.022	0.007	0.025	0.012	0.017	0.044
858	40	R1GG3	15:06:31	15:09:45	0.329	0.091	0.755	0.129	0.257	0.274	0.575	0.023	0.007	0.060	0.016	0.023	0.064
859	30	R1GG3	15:10:44	15:13:29	0.339	0.131	0.830	0.144	0.279	0.196	0.590	0.025	0.011	0.071	0.019	0.018	0.071

TABLE A-3.—PART B (Continued)

Test Point No.[1]	Power	Probe ID[2]	MGA Time		Measured gaseous concentration							Gaseous emission index					
					Acetylene (C_2H_2)	Ethylene (C_2H_4)	Formaldehyde (HCHO)	Formic Acid (HCOOH)	Jet Fuel A	Methanol (CH_3OH)	Propylene (C_3H_6)	EIC_2H_2	EIC_2H_4	EIHCHO	EIHCOOH	$EICH_3OH$	EIC_3H_6
	%		Start	End	ppm							g/kg fuel					
860	7	R1GG3	15:14:28	15:18:02	1.154	2.759	3.821	0.664	0.336	0.490	1.024	0.086	0.221	0.328	0.088	0.045	0.123
861	4	R1GG3	15:20:08	15:22:34	3.948	10.742	12.252	1.499	1.635	1.600	3.132	0.275	0.806	0.985	0.185	0.137	0.353
901	4	R1P2	8:52:25	8:57:45	10.713	29.842	25.900	4.423	17.238	3.377	9.400	0.742	2.226	2.070	0.542	0.288	1.052
902	100	R1P2	8:58:54	8:59:52	0.643	0.075	7.910	3.508	5.436	0.270	0.641	0.030	0.004	0.422	0.287	0.015	0.048
903	85	R1P2	9:01:19	9:03:16	0.601	0.113	1.012	0.994	2.830	0.256	0.718	0.029	0.006	0.056	0.084	0.015	0.056
904	65	R1P2	9:04:14	9:07:19	0.345	0.084	0.636	0.585	1.459	0.207	0.573	0.019	0.005	0.041	0.058	0.014	0.051
905	40	R1P2	9:08:46	9:11:12	0.354	0.112	0.496	0.382	0.803	0.165	0.357	0.023	0.008	0.036	0.043	0.013	0.037
906	30	R1P2	9:12:11	9:15:25	0.375	0.180	0.648	0.302	0.546	0.139	0.348	0.026	0.013	0.052	0.037	0.012	0.039
907	7	R1P2	9:17:02	9:19:28	1.807	4.541	5.197	0.815	0.833	0.722	1.216	0.142	0.383	0.470	0.113	0.070	0.154
908	4	R1P2	9:21:05	9:24:19	6.361	17.736	16.772	1.844	5.686	2.268	5.375	0.453	1.360	1.378	0.232	0.199	0.618
909	100	R1P2	9:29:39	9:30:18	0.608	0.154	2.448	0.950	1.711	0.260	0.627	0.028	0.008	0.128	0.076	0.015	0.046
910	85	R1P2	9:31:36	9:33:52	0.605	0.123	0.643	0.459	0.739	0.155	0.630	0.030	0.007	0.036	0.040	0.009	0.050
911	65	R1P2	9:34:50	9:37:54	0.349	0.104	0.435	0.243	0.515	0.144	0.570	0.019	0.006	0.028	0.024	0.010	0.051
912	40	R1P2	9:39:02	9:43:15	0.341	0.119	0.484	0.178	0.440	0.147	0.461	0.022	0.008	0.035	0.020	0.012	0.047
913	30	R1P2	9:44:22	9:47:46	0.344	0.155	0.596	0.160	0.234	0.212	0.564	0.024	0.012	0.047	0.020	0.018	0.063
914	7	R1P2	9:48:54	9:52:28	1.940	5.040	6.224	0.884	0.757	0.790	1.544	0.148	0.413	0.546	0.119	0.074	0.190
915	4	R1P2	9:53:55	10:00:24	6.382	17.829	17.351	1.954	5.412	2.295	5.459	0.440	1.325	1.381	0.239	0.195	0.608
916	100	R1P2	10:02:21	10:03:19	0.608	0.116	1.835	0.843	1.517	0.303	0.785	0.028	0.006	0.097	0.068	0.017	0.058
917	85	R1P2	10:04:08	10:07:32	0.610	0.101	0.483	0.368	0.662	0.174	0.658	0.030	0.005	0.028	0.032	0.011	0.053
918	70	R1P2	10:08:01	10:11:35	0.348	0.098	0.310	0.209	0.429	0.124	0.480	0.019	0.006	0.020	0.020	0.008	0.042
919	65	R1P2	10:13:12	10:15:48	0.330	0.091	0.249	0.173	0.452	0.254	0.567	0.018	0.005	0.016	0.017	0.017	0.051
920	60	R1P2	10:16:17	10:20:39	0.366	0.108	0.208	0.101	0.268	0.081	0.362	0.021	0.007	0.014	0.010	0.006	0.033
921	40	R1P2	10:21:28	10:24:52	0.350	0.110	0.265	0.134	0.261	0.143	0.391	0.022	0.008	0.019	0.015	0.011	0.040
922	30	R1P2	10:25:30	10:28:55	0.363	0.159	0.492	0.110	0.202	0.207	0.422	0.025	0.012	0.039	0.013	0.017	0.047
923	15	R1P2	10:29:43	10:33:07	0.730	1.460	2.014	0.419	0.214	0.264	0.454	0.057	0.123	0.181	0.058	0.025	0.057
924	7	R1P2	10:33:46	10:37:10	1.832	4.738	5.788	0.918	0.601	0.695	1.399	0.138	0.384	0.502	0.122	0.064	0.170
925	5.5	R1P2	10:37:59	10:41:23	2.888	7.409	8.777	1.272	1.154	0.970	2.078	0.210	0.580	0.736	0.164	0.087	0.244
926	4	R1P2	10:42:31	10:53:22	5.861	16.806	17.269	2.082	4.962	2.183	5.291	0.404	1.246	1.372	0.254	0.185	0.589
927	100	R1P2	10:54:30	10:55:09	0.613	0.148	1.392	0.774	1.450	0.170	0.592	0.028	0.007	0.074	0.063	0.010	0.044
928	85	R1P2	10:56:27	10:58:43	0.603	0.119	0.395	0.391	0.691	0.152	0.558	0.030	0.006	0.023	0.035	0.009	0.045
929	65	R1P2	10:59:22	11:03:24	0.356	0.096	0.268	0.240	0.443	0.159	0.479	0.020	0.006	0.017	0.023	0.011	0.043
930	40	R1P2	11:04:13	11:07:17	0.347	0.119	0.314	0.161	0.325	0.167	0.370	0.021	0.008	0.022	0.017	0.013	0.037
931	30	R1P2	11:07:56	11:11:10	0.345	0.178	0.475	0.151	0.160	0.221	0.429	0.024	0.013	0.037	0.018	0.019	0.047

TABLE A-3.—PART B (Concluded)

Test Point No.[1]	Power	Probe ID[2]	MGA Time		Measured gaseous concentration							Gaseous emission index					
					Acetylene (C_2H_2)	Ethylene (C_2H_4)	Formaldehyde (HCHO)	Formic Acid (HCOOH)	Jet Fuel A	Methanol (CH_3OH)	Propylene (C_3H_6)	EIC_2H_2	EIC_2H_4	EIHCHO	EIHCOOH	$EICH_3OH$	EIC_3H_6
	%		Start	End	ppm							g/kg fuel					
932	7	R1P2	11:12:09	11:15:52	1.809	4.651	5.877	0.957	0.549	0.715	1.388	0.138	0.381	0.516	0.129	0.067	0.171
933	4	R1P2	11:17:19	11:20:04	6.176	17.716	18.529	2.204	5.365	2.317	5.448	0.443	1.370	1.535	0.280	0.205	0.632
934	7	R1P2	13:51:55	14:06:07	1.403	3.056	4.110	0.998	0.571	0.577	1.066	0.097	0.228	0.328	0.122	0.049	0.119
935	100	R1P2	14:07:05	14:07:44	0.652	0.049	0.405	0.462	0.569	0.167	0.703	0.029	0.002	0.021	0.036	0.009	0.050
936	85	R1P2	14:08:04	14:10:00	0.610	0.071	0.338	0.379	0.554	0.270	0.816	0.028	0.004	0.018	0.031	0.015	0.060
937	75	R1P2	14:10:39	14:14:31	0.510	0.098	0.318	0.298	0.496	0.235	0.648	0.026	0.005	0.019	0.027	0.015	0.054
938	30	R1P2	14:15:29	14:19:02	0.376	0.155	0.564	0.179	0.317	0.162	0.471	0.026	0.011	0.044	0.022	0.014	0.052
939	7	R1P2	14:30:01	14:45:30	1.319	2.660	3.699	0.776	0.240	0.514	1.024	0.095	0.206	0.307	0.099	0.046	0.119
940	100	R1P2	14:46:38	14:46:57	0.643	0.101	0.291	0.373	0.429	0.197	0.752	0.028	0.005	0.015	0.029	0.011	0.054
941	85	R1P2	14:48:44	14:49:03	0.647	0.084	0.309	0.339	0.363	0.164	0.812	0.029	0.004	0.016	0.027	0.009	0.058
942	30	R1P2	14:50:21	14:53:44	0.349	0.163	0.621	0.201	0.240	0.128	0.520	0.024	0.012	0.049	0.024	0.011	0.057
943	7	R1P2	14:55:11	15:20:12	0.916	1.685	2.329	0.589	0.173	0.432	0.773	0.065	0.128	0.190	0.074	0.038	0.088
944	100	R1P2	15:21:11	15:21:19	0.642	0.127	0.337	0.348	0.372	0.236	0.777	0.028	0.006	0.017	0.027	0.013	0.056
945	85	R1P2	15:21:58	15:24:04	0.653	0.126	0.230	0.260	0.295	0.103	0.601	0.030	0.006	0.012	0.021	0.006	0.045
946	30	R1P2	15:25:12	15:28:25	0.358	0.163	0.590	0.192	0.216	0.149	0.573	0.025	0.012	0.047	0.023	0.013	0.064
947	7	R1P2	15:29:43	15:54:54	1.074	2.189	2.971	0.681	0.194	0.498	0.886	0.078	0.171	0.249	0.088	0.045	0.104
948	100	R1P2	15:55:52	15:56:12	0.640	0.091	0.473	0.425	0.460	0.225	0.589	0.029	0.004	0.025	0.034	0.013	0.043
949	85	R1P2	15:57:00	15:58:37	0.649	0.116	0.275	0.258	0.336	0.157	0.659	0.031	0.006	0.015	0.022	0.009	0.050
950	30	R1P2	16:00:05	16:02:59	0.371	0.158	0.594	0.183	0.228	0.103	0.637	0.026	0.012	0.049	0.023	0.009	0.073
951	7	R1P2	16:03:57	16:12:41	1.293	2.572	3.513	0.747	0.209	0.501	0.960	0.092	0.198	0.290	0.095	0.044	0.111

Note:

1. The test point No. defines the sequential engine testing conditions. It is a combination of the last digit in the date between April 20 and 29 and a sequence number of test point for that day. If the test point number is 305, the test point was for the 5th test point on April 23.
2. In probe ID, "R1" and "R2" stand for sampling rake at 1 m and 10 m sampling locations, respectively. G1 to 6 stands for gas sampling probe tip # 1 to 6.
3. "EI" stands for emission index.

TABLE A-3. AIRCRAFT CFM56-2-C1 ENGINE GAS EMISSION DATA MEASURED WITH THE NASA MULTI-GAS ANALYZER (MGA) DURING APEX PART C

Test Point No.[1]	Power	Probe ID[2]	MGA Time		Measured gaseous concentration							Gaseous emission index						
					SO_2	N_2O	Methane (CH_4)	1,3-Butadiene (C_4H_6)	Acetone (C_3H_6O)	Ethane (C_2H_6)	Propane (C_3H_8)	$EISO_2$	EIN_2O	$EICH_4$	EIC_4H_6	EIC_3H_6O	EIC_2H_6	EIC_3H_8
	%		Start	End	ppm							g/kg fuel						
301	7	R1G2	9:25:47	9:26:06	n/a	0.743	2.00	0.23	n/a	n/a	n/a	n/a	0.09	0.09	0.04	n/a	n/a	n/a
	7	R1G3	9:27:09	9:27:29	n/a	0.753	1.89	0.33	n/a	n/a	n/a	n/a	0.09	0.08	0.05	n/a	n/a	n/a
	7	R1G4	9:28:32	9:28:51	n/a	0.715	1.98	0.29	n/a	n/a	n/a	n/a	0.09	0.09	0.05	n/a	n/a	n/a
	7	R1G5	9:30:13	9:30:33	n/a	0.713	1.97	0.27	n/a	n/a	n/a	n/a	0.10	0.10	0.04	n/a	n/a	n/a
	7	R1G6	9:31:55	9:32:15	n/a	0.669	2.18	0.25	n/a	n/a	n/a	n/a	0.10	0.11	0.04	n/a	n/a	n/a
	7	R1G1	9:33:51	9:34:11	n/a	0.663	2.06	0.27	n/a	n/a	n/a	n/a	0.11	0.12	0.05	n/a	n/a	n/a
	7	R2G2	9:35:48	9:36:07	n/a	0.349	1.99	0.24	n/a	n/a	n/a	n/a	1.02	2.11	0.87	n/a	n/a	n/a
	7	R2G4	9:37:05	9:37:25	n/a	0.306	1.99	0.20	n/a	n/a	n/a	n/a	1.00	2.37	0.81	n/a	n/a	n/a
	7	R2G6	9:39:02	9:39:21	n/a	0.317	2.02	0.24	n/a	n/a	n/a	n/a	0.92	2.12	0.86	n/a	n/a	n/a
	7	R2G1	9:40:48	9:41:08	n/a	0.326	1.99	0.18	n/a	n/a	n/a	n/a	1.02	2.27	0.69	n/a	n/a	n/a
	7	R2G3	9:42:11	9:42:30	n/a	0.321	1.95	0.29	n/a	n/a	n/a	n/a	1.04	2.30	1.17	n/a	n/a	n/a
	7	R2G5	9:44:17	9:44:36	n/a	0.333	1.99	0.22	n/a	n/a	n/a	n/a	0.89	1.93	0.71	n/a	n/a	n/a
302	30	R1G2	9:48:10	9:48:29	n/a	0.802	0.58	0.05	n/a	n/a	n/a	n/a	0.09	0.02	0.01	n/a	n/a	n/a
	30	R1G3	9:49:18	9:49:37	n/a	0.771	0.66	0.13	n/a	n/a	n/a	n/a	0.09	0.03	0.02	n/a	n/a	n/a
	30	R1G4	9:51:14	9:51:34	n/a	0.743	0.81	0.12	n/a	n/a	n/a	n/a	0.10	0.04	0.02	n/a	n/a	n/a
	30	R1G2	10:05:13	10:05:33	n/a	0.802	0.55	0.01	n/a	n/a	n/a	n/a	0.09	0.02	0.00	n/a	n/a	n/a
	30	R1G3	10:06:36	10:06:55	n/a	0.800	0.70	0.11	n/a	n/a	n/a	n/a	0.10	0.03	0.02	n/a	n/a	n/a
	30	R1G4	10:07:58	10:08:18	n/a	0.735	0.78	0.06	n/a	n/a	n/a	n/a	0.09	0.04	0.01	n/a	n/a	n/a
	30	R1G5	10:09:35	10:09:55	n/a	0.725	0.80	0.12	n/a	n/a	n/a	n/a	0.10	0.04	0.02	n/a	n/a	n/a
	30	R1G6	10:11:07	10:11:27	n/a	0.811	0.87	0.15	n/a	n/a	n/a	n/a	0.11	0.04	0.02	n/a	n/a	n/a
	30	R1G1	10:12:49	10:13:09	n/a	0.786	0.71	0.04	n/a	n/a	n/a	n/a	0.09	0.03	0.01	n/a	n/a	n/a
	30	R2G2	10:14:02	10:14:21	n/a	0.340	1.89	0.17	n/a	n/a	n/a	n/a	0.51	1.02	0.30	n/a	n/a	n/a
	30	R2G3	10:15:39	10:15:58	n/a	0.366	1.90	0.19	n/a	n/a	n/a	n/a	0.61	1.15	0.40	n/a	n/a	n/a
	30	R2G4	10:17:01	10:17:21	n/a	0.385	1.86	0.21	n/a	n/a	n/a	n/a	0.60	1.05	0.40	n/a	n/a	n/a
	30	R2G5	10:18:38	10:18:58	n/a	0.394	1.86	0.18	n/a	n/a	n/a	n/a	0.57	0.98	0.32	n/a	n/a	n/a
	30	R2G6	10:20:10	10:20:30	n/a	0.353	1.85	0.18	n/a	n/a	n/a	n/a	0.49	0.94	0.31	n/a	n/a	n/a
	30	R2G1	10:21:57	10:22:16	n/a	0.413	1.87	0.21	n/a	n/a	n/a	n/a	0.84	1.39	0.51	n/a	n/a	n/a
	30	R2G2	10:23:39	10:23:58	n/a	0.810	0.55	0.01	n/a	n/a	n/a	n/a	0.09	0.02	0.00	n/a	n/a	n/a

TABLE A-3.—PART C (Continued)

Test Point No.[1]	Power	Probe ID[2]	MGA Time		Measured gaseous concentration							Gaseous emission index						
					SO_2	N_2O	Methane (CH_4)	1,3-Butadiene (C_4H_6)	Acetone (C_3H_6O)	Ethane (C_2H_6)	Propane (C_3H_8)	$EISO_2$	EIN_2O	$EICH_4$	EIC_4H_6	EIC_3H_6O	EIC_2H_6	EIC_3H_8
	%		Start	End	ppm							g/kg fuel						
303	40	R1G2	10:43:03	10:43:22	n/a	0.764	0.52	0.05	n/a	n/a	n/a	n/a	0.08	0.02	0.01	n/a	n/a	n/a
	40	R1G3	10:44:21	10:44:40	n/a	0.757	0.58	0.14	n/a	n/a	n/a	n/a	0.09	0.02	0.02	n/a	n/a	n/a
	40	R1G4	10:45:43	10:46:03	n/a	0.738	0.81	0.03	n/a	n/a	n/a	n/a	0.09	0.04	0.01	n/a	n/a	n/a
	40	R1G5	10:46:56	10:47:15	n/a	0.741	0.71	0.09	n/a	n/a	n/a	n/a	0.10	0.03	0.01	n/a	n/a	n/a
	40	R1G6	10:48:43	10:49:02	n/a	0.786	0.85	0.13	n/a	n/a	n/a	n/a	0.10	0.04	0.02	n/a	n/a	n/a
	40	R1G1	10:50:44	10:51:03	n/a	0.780	0.59	0.09	n/a	n/a	n/a	n/a	0.09	0.03	0.01	n/a	n/a	n/a
	40	R2G3	10:52:11	10:52:31	n/a	0.343	1.90	0.20	n/a	n/a	n/a	n/a	0.52	1.04	0.37	n/a	n/a	n/a
	40	R2G3	10:53:24	10:53:43	n/a	0.364	1.84	0.15	n/a	n/a	n/a	n/a	0.64	1.17	0.31	n/a	n/a	n/a
	40	R2G4	10:55:06	10:55:25	n/a	0.336	1.88	0.19	n/a	n/a	n/a	n/a	0.51	1.04	0.35	n/a	n/a	n/a
	40	R2G5	10:56:38	10:56:57	n/a	0.391	1.84	0.18	n/a	n/a	n/a	n/a	0.56	0.96	0.31	n/a	n/a	n/a
	40	R2G6	10:58:01	10:58:20	n/a	0.353	1.80	0.15	n/a	n/a	n/a	n/a	0.43	0.80	0.23	n/a	n/a	n/a
	40	R2G1	10:59:42	11:00:02	n/a	0.340	1.87	0.20	n/a	n/a	n/a	n/a	0.64	1.28	0.46	n/a	n/a	n/a
	40	R2G2	11:02:18	11:02:37	n/a	0.761	0.52	0.06	n/a	n/a	n/a	n/a	0.08	0.02	0.01	n/a	n/a	n/a
304	30	R1G2	11:04:53	11:05:12	n/a	0.779	0.60	0.06	n/a	n/a	n/a	n/a	0.09	0.02	0.01	n/a	n/a	n/a
	30	R1G3	11:06:20	11:06:40	n/a	0.766	0.71	0.13	n/a	n/a	n/a	n/a	0.09	0.03	0.02	n/a	n/a	n/a
	30	R1G4	11:07:57	11:08:17	n/a	0.755	0.83	0.15	n/a	n/a	n/a	n/a	0.10	0.04	0.03	n/a	n/a	n/a
	30	R1G5	11:09:20	11:09:39	n/a	0.703	0.78	0.12	n/a	n/a	n/a	n/a	0.10	0.04	0.02	n/a	n/a	n/a
	30	R1G6	11:11:07	11:11:26	n/a	0.741	0.84	0.10	n/a	n/a	n/a	n/a	0.10	0.04	0.02	n/a	n/a	n/a
	30	R1G1	11:12:10	11:12:29	n/a	0.752	0.58	0.06	n/a	n/a	n/a	n/a	0.09	0.03	0.01	n/a	n/a	n/a
305	7	R1G2	11:15:09	11:15:29	n/a	0.729	1.74	0.23	n/a	n/a	n/a	n/a	0.09	0.08	0.04	n/a	n/a	n/a
	7	R1G3	11:16:27	11:16:47	n/a	0.714	1.79	0.26	n/a	n/a	n/a	n/a	0.09	0.08	0.04	n/a	n/a	n/a
	7	R1G4	11:18:19	11:18:38	n/a	0.730	1.80	0.26	n/a	n/a	n/a	n/a	0.10	0.09	0.04	n/a	n/a	n/a
	7	R1G5	11:19:51	11:20:10	n/a	0.736	1.76	0.28	n/a	n/a	n/a	n/a	0.10	0.09	0.05	n/a	n/a	n/a
	7	R1G6	11:21:14	11:21:33	n/a	0.670	1.93	0.33	n/a	n/a	n/a	n/a	0.10	0.10	0.06	n/a	n/a	n/a
	7	R1G1	11:22:41	11:23:00	n/a	0.674	1.90	0.21	n/a	n/a	n/a	n/a	0.10	0.10	0.04	n/a	n/a	n/a
	7	R2G3	11:25:36	11:25:55	n/a	0.332	1.93	0.14	n/a	n/a	n/a	n/a	0.73	1.54	0.38	n/a	n/a	n/a
	7	R2G4	11:27:13	11:27:32	n/a	0.341	1.94	0.19	n/a	n/a	n/a	n/a	0.74	1.54	0.50	n/a	n/a	n/a
	7	R2G5	11:28:45	11:29:04	n/a	0.381	2.07	0.19	n/a	n/a	n/a	n/a	0.98	1.94	0.61	n/a	n/a	n/a
	7	R2G6	11:30:08	11:30:27	n/a	0.391	2.02	0.22	n/a	n/a	n/a	n/a	0.78	1.46	0.54	n/a	n/a	n/a
	7	R2G1	11:31:30	11:31:49	n/a	0.405	2.00	0.23	n/a	n/a	n/a	n/a	1.07	1.93	0.76	n/a	n/a	n/a
	7	R1G2	11:37:39	11:37:58	n/a	0.731	1.66	0.25	n/a	n/a	n/a	n/a	0.09	0.08	0.04	n/a	n/a	n/a

TABLE A-3.—PART C (Continued)

Test Point No.[1]	Power	Probe ID[2]	MGA Time		Measured gaseous concentration							Gaseous emission index						
					SO_2	N_2O	Methane (CH_4)	1,3-Butadiene (C_4H_6)	Acetone (C_3H_6O)	Ethane (C_2H_6)	Propane (C_3H_8)	$EISO_2$	EIN_2O	$EICH_4$	EIC_4H_6	EIC_3H_6O	EIC_2H_6	EIC_3H_8
	%		Start	End	ppm							g/kg fuel						
306	7	R1G2	14:52:39	14:52:58	n/a	0.738	1.75	0.34	n/a	n/a	n/a	n/a	0.09	0.08	0.05	n/a	n/a	n/a
	7	R1G3	14:54:01	14:54:21	n/a	0.724	1.73	0.31	n/a	n/a	n/a	n/a	0.09	0.08	0.05	n/a	n/a	n/a
	7	R1G4	14:55:09	14:55:29	n/a	0.727	1.74	0.22	n/a	n/a	n/a	n/a	0.09	0.08	0.04	n/a	n/a	n/a
	7	R1G5	14:57:01	14:57:21	n/a	0.707	1.77	0.31	n/a	n/a	n/a	n/a	0.09	0.09	0.05	n/a	n/a	n/a
	7	R1G6	14:58:39	14:58:58	n/a	0.695	1.97	0.27	n/a	n/a	n/a	n/a	0.10	0.10	0.05	n/a	n/a	n/a
	7	R1G1	15:00:06	15:00:26	n/a	0.694	1.94	0.38	n/a	n/a	n/a	n/a	0.10	0.10	0.07	n/a	n/a	n/a
307	30	R1G2	15:05:22	15:05:42	n/a	0.824	0.56	0.16	n/a	n/a	n/a	n/a	0.09	0.02	0.02	n/a	n/a	n/a
	30	R1G3	15:06:35	15:06:55	n/a	0.776	0.73	0.09	n/a	n/a	n/a	n/a	0.09	0.03	0.01	n/a	n/a	n/a
	30	R1G4	15:08:08	15:08:27	n/a	0.773	0.82	0.16	n/a	n/a	n/a	n/a	0.10	0.04	0.03	n/a	n/a	n/a
	30	R1G5	15:09:45	15:10:04	n/a	0.726	0.74	0.23	n/a	n/a	n/a	n/a	0.10	0.04	0.04	n/a	n/a	n/a
	30	R1G6	15:11:13	15:11:32	n/a	0.735	0.86	0.14	n/a	n/a	n/a	n/a	0.10	0.04	0.02	n/a	n/a	n/a
	30	R1G1	15:12:50	15:13:09	n/a	0.754	0.80	0.14	n/a	n/a	n/a	n/a	0.10	0.04	0.02	n/a	n/a	n/a
	30	R2G2	15:14:13	15:14:32	n/a	0.336	1.88	0.24	n/a	n/a	n/a	n/a	0.58	1.17	0.50	n/a	n/a	n/a
	30	R2G3	15:15:35	15:15:55	n/a	0.383	1.91	0.21	n/a	n/a	n/a	n/a	0.66	1.19	0.44	n/a	n/a	n/a
	30	R2G4	15:17:12	15:17:32	n/a	0.390	1.92	0.27	n/a	n/a	n/a	n/a	0.67	1.20	0.57	n/a	n/a	n/a
	30	R2G5	15:18:45	15:19:04	n/a	0.360	1.92	0.24	n/a	n/a	n/a	n/a	0.55	1.06	0.45	n/a	n/a	n/a
	30	R2G6	15:20:17	15:20:37	n/a	0.354	1.82	0.19	n/a	n/a	n/a	n/a	0.50	0.94	0.34	n/a	n/a	n/a
	30	R2G1	15:21:50	15:22:09	n/a	0.340	1.96	0.27	n/a	n/a	n/a	n/a	0.72	1.51	0.70	n/a	n/a	n/a
	30	R2G1	15:21:50	15:22:09	n/a	0.340	1.96	0.27	n/a	n/a	n/a	n/a	0.72	1.51	0.70	n/a	n/a	n/a
	30	R1G2	15:23:37	15:23:56	n/a	0.747	0.67	0.11	n/a	n/a	n/a	n/a	0.09	0.03	0.02	n/a	n/a	n/a
	30	R1G4	15:24:50	15:25:09	n/a	0.753	0.85	0.14	n/a	n/a	n/a	n/a	0.10	0.04	0.02	n/a	n/a	n/a
308	40	R1G2	15:27:25	15:27:45	n/a	0.788	0.51	0.10	n/a	n/a	n/a	n/a	0.08	0.02	0.01	n/a	n/a	n/a
	40	R1G3	15:29:03	15:29:22	n/a	0.774	0.55	0.18	n/a	n/a	n/a	n/a	0.09	0.02	0.02	n/a	n/a	n/a
	40	R1G4	15:30:35	15:30:55	n/a	0.760	0.72	0.15	n/a	n/a	n/a	n/a	0.09	0.03	0.02	n/a	n/a	n/a
308b	40	R1G5	15:32:03	15:32:22	n/a	0.774	0.70	0.10	n/a	n/a	n/a	n/a	0.10	0.03	0.02	n/a	n/a	n/a
	40	R1G6	15:33:40	15:33:59	n/a	0.726	0.73	0.11	n/a	n/a	n/a	n/a	0.09	0.03	0.02	n/a	n/a	n/a
	40	R1G1	15:35:12	15:35:32	n/a	0.742	0.77	0.10	n/a	n/a	n/a	n/a	0.09	0.03	0.02	n/a	n/a	n/a
	40	R2G2	15:36:40	15:36:59	n/a	0.368	1.87	0.22	n/a	n/a	n/a	n/a	0.56	1.03	0.41	n/a	n/a	n/a
	40	R2G3	15:38:22	15:38:17	n/a	0.390	1.92	0.29	n/a	n/a	n/a	n/a	0.56	1.00	0.51	n/a	n/a	n/a
	40	R2G4	15:39:40	15:39:59	n/a	0.367	1.86	0.20	n/a	n/a	n/a	n/a	0.54	0.99	0.36	n/a	n/a	n/a
308c	40	R2G5	15:41:07	15:41:27	n/a	0.409	1.90	0.32	n/a	n/a	n/a	n/a	0.56	0.94	0.54	n/a	n/a	n/a
	40	R2G6	15:42:35	15:42:54	n/a	0.362	1.83	0.30	n/a	n/a	n/a	n/a	0.44	0.81	0.44	n/a	n/a	n/a
	40	R2G1	15:44:07	15:44:27	n/a	0.368	1.91	0.25	n/a	n/a	n/a	n/a	0.64	1.21	0.53	n/a	n/a	n/a
	40	R1G2	15:45:54	15:46:14	n/a	0.775	0.56	0.10	n/a	n/a	n/a	n/a	0.08	0.02	0.01	n/a	n/a	n/a

TABLE A-3.—PART C (Continued)

Test Point No.[1]	Power	Probe	MGA Time		Measured gaseous concentration							Gaseous emission index						
					SO_2	N_2O	Methane (CH_4)	1,3-Butadiene (C_4H_6)	Acetone (C_3H_6O)	Ethane (C_2H_6)	Propane (C_3H_8)	$EISO_2$	EIN_2O	$EICH_4$	EIC_4H_6	EIC_3H_6O	EIC_2H_6	EIC_3H_8
	%	ID[2]	Start	End	ppm							g/kg fuel						
309	30	R1G2	15:49:14	15:49:33	n/a	0.789	0.66	0.15	n/a	n/a	n/a	n/a	0.09	0.03	0.02	n/a	n/a	n/a
	30	R1G3	15:51:01	15:51:20	n/a	0.772	0.71	0.13	n/a	n/a	n/a	n/a	0.10	0.03	0.02	n/a	n/a	n/a
	30	R1G4	15:52:23	15:52:43	n/a	0.747	0.81	0.16	n/a	n/a	n/a	n/a	0.10	0.04	0.03	n/a	n/a	n/a
	30	R1G5	15:53:46	15:54:05	n/a	0.751	0.77	0.13	n/a	n/a	n/a	n/a	0.10	0.04	0.02	n/a	n/a	n/a
	30	R1G6	15:55:28	15:55:48	n/a	0.722	0.86	0.17	n/a	n/a	n/a	n/a	0.10	0.04	0.03	n/a	n/a	n/a
	30	R1G1	15:57:01	15:57:20	n/a	0.754	0.77	0.23	n/a	n/a	n/a	n/a	0.10	0.04	0.04	n/a	n/a	n/a
	30	R2G2	15:58:43	15:59:02	n/a	0.359	1.93	0.21	n/a	n/a	n/a	n/a	0.69	1.34	0.50	n/a	n/a	n/a
	30	R2G4	16:00:05	16:00:25	n/a	0.343	1.92	0.22	n/a	n/a	n/a	n/a	0.57	1.15	0.45	n/a	n/a	n/a
310	7	R1G2	16:03:00	16:03:20	n/a	0.718	1.78	0.30	n/a	n/a	n/a	n/a	0.09	0.08	0.05	n/a	n/a	n/a
	7	R1G4	16:04:33	16:04:52	n/a	0.747	1.76	0.34	n/a	n/a	n/a	n/a	0.10	0.08	0.05	n/a	n/a	n/a
	7	R1G6	16:06:05	16:06:25	n/a	0.690	1.89	0.31	n/a	n/a	n/a	n/a	0.10	0.10	0.05	n/a	n/a	n/a
	7	R2G2	16:07:38	16:07:57	n/a	0.387	2.07	0.28	n/a	n/a	n/a	n/a	0.83	1.61	0.73	n/a	n/a	n/a
	7	R2G4	16:09:20	16:09:39	n/a	0.355	2.07	0.31	n/a	n/a	n/a	n/a	0.74	1.56	0.78	n/a	n/a	n/a
501	4	R1G2	11:20:51	11:21:10	6.213	0.73	7.876	1.449	0.779	0.798	3.448	1.006	0.081	0.319	0.198	0.114	0.061	0.384
502	65	R1G2	11:24:15	11:24:34	4.950	0.75	0.536	0.215	0.546	0.206	0.459	0.646	0.068	0.018	0.024	0.065	0.013	0.041
	65	R1G4	11:25:23	11:25:42	3.670	0.72	0.614	0.058	0.153	0.217	0.716	0.506	0.069	0.021	0.007	0.019	0.014	0.068
	65	R1G5	11:27:00	11:27:19	3.591	0.69	0.782	0.050	0.963	0.247	0.354	0.547	0.072	0.030	0.006	0.133	0.018	0.037
	65	R1G6	11:28:36	11:28:56	3.742	0.72	0.647	0.141	0.415	0.230	0.788	0.560	0.074	0.024	0.018	0.056	0.016	0.081
	65	R1G1	11:30:13	11:30:33	3.960	0.67	0.866	0.126	0.369	0.331	2.084	0.649	0.076	0.036	0.017	0.055	0.025	0.235
	65	R1G3	11:31:31	11:31:50	4.135	0.74	0.674	0.100	0.463	0.275	0.366	0.597	0.074	0.024	0.012	0.061	0.019	0.036
	65	R2G2	11:32:29	11:32:48	0.513	0.43	2.075	0.288	0.721	0.140	1.216	0.844	0.487	0.854	0.400	1.077	0.108	1.377
	65	R2G2	11:32:58	11:33:18	0.461	0.35	2.070	0.270	0.615	0.116	1.218	0.801	0.413	0.900	0.397	0.969	0.095	1.455
	65	R2G3	11:34:45	11:35:04	0.655	0.38	2.057	0.328	0.411	0.187	0.688	1.041	0.418	0.818	0.440	0.592	0.139	0.752
	65	R2G4	11:36:02	11:36:22	0.840	0.38	2.088	0.285	0.306	0.156	1.099	1.268	0.398	0.788	0.363	0.418	0.110	1.140
	65	R2G6	11:39:07	11:39:26	0.969	0.41	2.079	0.277	0.676	0.152	0.884	1.268	0.372	0.680	0.306	0.802	0.093	0.795
	65	R2G1	11:40:34	11:40:53	0.715	0.40	2.079	0.303	0.605	0.144	0.767	1.438	0.550	1.046	0.515	1.103	0.136	1.061
	65	R1G2	11:42:50	11:43:09	5.059	0.78	0.613	0.119	1.120	0.326	0.292	0.666	0.070	0.020	0.013	0.134	0.020	0.026
503	70	R1G2	11:45:05	11:45:25	4.537	0.71	0.572	0.034	0.442	0.371	0.029	0.608	0.065	0.019	0.004	0.054	0.023	0.003
	70	R1G4	11:46:42	11:47:02	5.188	0.74	0.523	0.203	0.833	0.138	0.376	0.667	0.066	0.017	0.022	0.097	0.008	0.033
504	65	R1G2	11:48:39	11:48:58	5.158	0.76	0.600	0.101	1.041	0.346	0.000	0.681	0.069	0.020	0.011	0.124	0.021	0.000
	65	R1G3	11:50:06	11:50:25	4.658	0.74	0.574	0.146	0.714	0.101	0.554	0.637	0.070	0.020	0.017	0.089	0.007	0.052
505	60	R1G3	11:51:52	11:52:12	4.558	0.73	0.664	0.163	0.845	0.245	0.144	0.675	0.074	0.025	0.020	0.113	0.017	0.015
	60	R1G2	11:53:00	11:53:20	5.031	0.75	0.532	0.180	0.570	0.206	0.585	0.681	0.069	0.018	0.021	0.070	0.013	0.054

TABLE A-3.—PART C (Continued)

Test Point No.[1]	Power	Probe ID[2]	MGA Time		Measured gaseous concentration							Gaseous emission index						
					SO_2	N_2O	Methane (CH_4)	1,3-Butadiene (C_4H_6)	Acetone (C_3H_6O)	Ethane (C_2H_6)	Propane (C_3H_8)	$EISO_2$	EIN_2O	$EICH_4$	EIC_4H_6	EIC_3H_6O	EIC_2H_6	EIC_3H_8
	%		Start	End	ppm							g/kg fuel						
506	85	R1G2	11:55:06	11:55:26	5.517	0.70	0.518	0.115	1.094	0.277	0.371	0.688	0.060	0.016	0.012	0.124	0.016	0.032
	85	R1G3	11:56:43	11:57:03	5.085	0.73	0.502	0.106	0.466	0.216	0.553	0.652	0.064	0.016	0.012	0.054	0.013	0.049
507	100	R1G2	11:58:30	11:58:49	5.065	0.72	0.419	0.117	0.576	0.194	1.090	0.611	0.059	0.013	0.012	0.063	0.011	0.090
508	7	R1G2	12:06:15	12:06:35	4.893	0.77	1.800	0.356	1.100	0.233	1.370	0.885	0.096	0.081	0.054	0.180	0.020	0.171
	7	R1G3	12:08:12	12:08:31	4.656	0.77	1.663	0.321	0.841	0.228	1.610	0.802	0.091	0.072	0.047	0.131	0.018	0.191
	7	R1G4	12:09:10	12:09:29	4.520	0.77	1.696	0.358	0.689	0.105	1.530	0.823	0.096	0.077	0.055	0.114	0.009	0.192
	7	R1G5	12:10:27	12:10:47	4.242	0.76	1.697	0.268	0.672	0.309	1.621	0.793	0.098	0.079	0.042	0.114	0.027	0.208
	7	R1G6	12:11:35	12:11:54	4.051	0.72	1.662	0.334	1.268	0.166	0.942	0.806	0.099	0.083	0.056	0.229	0.016	0.129
	7	R1G1	12:13:02	12:13:22	4.107	0.73	1.783	0.372	0.726	0.150	1.602	0.839	0.103	0.091	0.064	0.134	0.014	0.225
	7	R2G2	12:14:30	12:14:49	0.514	0.38	2.166	0.293	0.723	0.162	1.058	1.266	0.644	1.335	0.609	1.616	0.188	1.792
	7	R2G3	12:15:37	12:15:57	0.618	0.36	2.173	0.300	0.412	0.125	0.935	1.549	0.612	1.362	0.634	0.937	0.147	1.610
	7	R2G4	12:16:36	12:16:55	0.636	0.40	2.173	0.326	1.267	0.101	1.750	1.560	0.678	1.333	0.674	2.817	0.117	2.952
	7	R2G6	12:18:13	12:18:32	0.580	0.41	2.113	0.234	0.650	0.128	1.233	1.312	0.634	1.194	0.446	1.331	0.136	1.917
	7	R2G1	12:19:30	12:19:49	0.517	0.41	2.118	0.335	0.807	0.038	1.066	1.574	0.852	1.612	0.860	2.227	0.055	2.233
	7	R1G2	12:20:19	12:20:38	4.010	0.69	1.645	0.292	0.894	0.164	1.548	0.825	0.098	0.085	0.051	0.167	0.016	0.219
509	100	R1G2	12:24:11	12:24:31	5.250	0.74	0.466	0.028	1.059	0.245	0.895	0.605	0.059	0.013	0.003	0.111	0.013	0.071
510	85	R1G2	12:25:48	12:26:08	5.594	0.69	0.533	0.175	1.261	0.257	0.479	0.687	0.058	0.016	0.018	0.140	0.015	0.041
511	85	R1G2	13:24:03	13:24:23	4.592	0.75	0.456	0.000	0.000	0.166	1.001	0.531	0.060	0.013	0.000	0.000	0.009	0.080
512	30	R1G2	13:26:19	13:26:38	4.519	0.86	0.799	0.202	0.630	0.309	1.861	0.740	0.096	0.033	0.028	0.094	0.024	0.209
	30	R1G4	13:28:06	13:28:25	3.589	0.79	0.996	0.229	0.408	0.092	1.867	0.672	0.102	0.047	0.036	0.069	0.008	0.240
513	7	R1G2	13:31:11	13:31:30	4.979	0.77	1.643	0.323	0.766	0.136	1.333	0.845	0.090	0.070	0.046	0.118	0.011	0.156
	7	R1G3	13:33:07	13:33:27	4.996	0.77	1.743	0.331	0.757	0.120	1.501	0.847	0.089	0.074	0.047	0.116	0.010	0.175
	7	R1G4	13:34:44	13:35:04	4.562	0.76	1.782	0.332	0.589	0.055	1.428	0.819	0.094	0.080	0.050	0.096	0.005	0.176
	7	R1G5	13:35:43	13:36:02	4.432	0.74	1.792	0.291	0.878	0.291	1.491	0.811	0.094	0.082	0.045	0.146	0.025	0.187
	7	R1G6	13:37:29	13:37:49	4.228	0.70	1.843	0.338	0.849	0.269	1.177	0.825	0.094	0.090	0.056	0.150	0.025	0.158
	7	R1G1	13:38:28	13:38:47	4.204	0.74	1.842	0.364	0.639	0.122	1.641	0.827	0.100	0.091	0.060	0.114	0.011	0.222
	7	R2G2	13:40:44	13:41:03	0.569	0.38	2.137	0.300	0.473	0.077	0.852	1.026	0.471	0.964	0.457	0.774	0.065	1.057
	7	R2G3	13:41:52	13:42:11	0.562	0.37	2.176	0.284	0.803	0.058	0.649	1.392	0.622	1.347	0.594	1.802	0.068	1.105
	7	R2G4	13:43:48	13:44:08	0.473	0.39	2.180	0.347	0.839	0.073	0.648	1.173	0.665	1.351	0.725	1.884	0.084	1.104
	7	R2G6	13:45:26	13:45:45	0.627	0.36	2.148	0.278	0.498	0.050	0.971	1.443	0.565	1.237	0.541	1.039	0.054	1.537
	7	R2G1	13:46:24	13:46:43	0.519	0.38	2.256	0.318	0.405	0.146	0.309	1.519	0.763	1.651	0.785	1.073	0.200	0.622
	7	R1G2	13:48:40	13:48:59	4.718	0.73	1.701	0.306	0.767	0.186	1.246	0.826	0.088	0.075	0.045	0.122	0.015	0.150

TABLE A-3.—PART C (Continued)

Test Point No.[1]	Power	Probe ID[2]	MGA Time		Measured gaseous concentration							Gaseous emission index						
					SO_2	N_2O	Methane (CH_4)	1,3-Butadiene (C_4H_6)	Acetone (C_3H_6O)	Ethane (C_2H_6)	Propane (C_3H_8)	$EISO_2$	EIN_2O	$EICH_4$	EIC_4H_6	EIC_3H_6O	EIC_2H_6	EIC_3H_8
	%		Start	End	ppm							g/kg fuel						
514	100	R1G2	14:01:28	14:01:47	5.811	0.75	0.500	0.181	0.947	0.209	0.316	0.690	0.061	0.015	0.018	0.102	0.012	0.026
515	30	R1G2	14:04:13	14:04:32	4.689	0.84	0.783	0.263	0.888	0.173	1.817	0.758	0.093	0.032	0.036	0.130	0.013	0.202
	30	R1G4	14:05:50	14:06:10	3.603	0.78	1.050	0.230	0.512	0.137	1.905	0.668	0.099	0.049	0.036	0.086	0.012	0.243
	30	R1G2	14:06:49	14:07:08	4.476	0.83	0.797	0.214	0.685	0.289	1.813	0.738	0.095	0.033	0.030	0.102	0.022	0.206
516	7	R1G2	14:09:05	14:09:24	5.040	0.80	1.544	0.300	0.812	0.174	1.778	0.834	0.091	0.064	0.042	0.122	0.014	0.202
517	85	R1G2	14:12:19	14:12:39	5.552	0.78	0.520	0.167	0.852	0.166	0.817	0.658	0.063	0.015	0.017	0.092	0.009	0.067
518	7	R1G2	14:14:26	14:14:45	5.116	0.79	1.550	0.290	0.888	0.302	1.097	0.842	0.089	0.064	0.040	0.132	0.023	0.124
	7	R1G3	14:15:34	14:15:53	5.072	0.80	1.460	0.248	0.651	0.241	1.425	0.826	0.090	0.059	0.034	0.096	0.018	0.160
	7	R1G3	14:16:03	14:16:22	5.134	0.79	1.389	0.322	0.751	0.159	1.715	0.827	0.087	0.056	0.044	0.110	0.012	0.190
	7	R1G4	14:17:30	14:17:50	4.747	0.80	1.498	0.350	0.797	0.076	1.753	0.808	0.094	0.064	0.050	0.123	0.006	0.205
	7	R1G5	14:19:17	14:19:37	4.743	0.77	1.453	0.268	0.843	0.111	1.689	0.825	0.092	0.063	0.039	0.133	0.009	0.202
	7	R1G6	14:20:45	14:21:04	4.353	0.75	1.568	0.323	1.318	0.157	0.242	0.810	0.096	0.073	0.051	0.222	0.014	0.031
	7	R1G1	14:22:22	14:22:41	4.461	0.79	1.543	0.328	0.544	0.130	1.576	0.826	0.100	0.071	0.051	0.091	0.011	0.201
	7	R2G2	14:23:59	14:24:19	0.373	0.37	2.198	0.347	0.425	0.200	0.792	0.971	0.656	1.431	0.763	1.004	0.244	1.418
	7	R2G3	14:25:17	14:25:36	0.357	0.41	2.187	0.324	0.610	0.108	1.196	0.973	0.770	1.491	0.746	1.506	0.138	2.241
	7	R2G4	14:26:54	14:27:14	0.543	0.37	2.227	0.335	0.177	0.222	0.498	1.476	0.700	1.514	0.770	0.437	0.283	0.931
	7	R2G6	14:28:31	14:28:51	0.585	0.38	2.169	0.340	0.598	0.121	0.625	1.367	0.611	1.268	0.671	1.268	0.133	1.005
	7	R2G1	14:29:10	14:29:30	0.412	0.36	2.191	0.296	0.376	0.068	1.004	1.158	0.700	1.539	0.701	0.957	0.090	1.938
519	100	R1G2	14:30:57	14:31:17	5.666	0.80	0.451	0.095	1.122	0.240	0.552	0.627	0.061	0.013	0.009	0.113	0.012	0.042
520	85	R1G2	14:32:44	14:33:04	5.848	0.71	0.494	0.127	0.926	0.194	0.657	0.696	0.058	0.015	0.013	0.100	0.011	0.054
	85	R1G3	14:35:00	14:35:20	5.414	0.79	0.508	0.145	0.936	0.114	1.425	0.625	0.063	0.015	0.014	0.098	0.006	0.113
521	30	R1G3	14:36:38	14:36:57	4.355	0.82	0.934	0.281	0.588	0.149	1.688	0.777	0.101	0.042	0.042	0.095	0.013	0.207
	30	R1G5	14:38:05	14:38:25	3.682	0.77	0.991	0.198	0.315	0.278	2.089	0.702	0.100	0.047	0.032	0.054	0.025	0.274
	30	R1G2	14:39:42	14:40:02	4.695	0.83	0.855	0.198	0.696	0.232	1.854	0.780	0.095	0.036	0.028	0.105	0.018	0.212
	30	R2G2	14:43:07	14:43:26	0.424	0.35	2.179	0.323	0.165	0.248	0.523	1.095	0.624	1.407	0.703	0.386	0.300	0.929

TABLE A-3.—PART C (Continued)

Test Point No.[1]	Power	Probe ID[2]	MGA Time		Measured gaseous concentration							Gaseous emission index						
					SO_2	N_2O	Methane (CH_4)	1,3-Butadiene (C_4H_6)	Acetone (C_3H_6O)	Ethane (C_2H_6)	Propane (C_3H_8)	$EISO_2$	EIN_2O	$EICH_4$	EIC_4H_6	EIC_3H_6O	EIC_2H_6	EIC_3H_8
	%		Start	End	ppm							g/kg fuel						
522	7	R1G2	14:53:19	14:53:39	5.274	0.80	1.456	0.343	0.927	0.187	1.222	0.862	0.089	0.060	0.047	0.137	0.014	0.137
	7	R1G3	14:55:06	14:55:26	5.226	0.77	1.436	0.368	1.005	0.170	1.588	0.861	0.087	0.059	0.051	0.150	0.013	0.180
	7	R1G4	14:56:24	14:56:44	4.701	0.77	1.475	0.286	0.501	0.000	1.641	0.813	0.092	0.064	0.042	0.079	0.000	0.195
	7	R1G5	14:57:22	14:57:42	4.823	0.77	1.566	0.330	0.998	0.149	1.464	0.850	0.093	0.069	0.049	0.160	0.012	0.177
	7	R1G6	14:59:09	14:59:29	4.567	0.75	1.595	0.373	0.957	0.241	1.637	0.860	0.098	0.075	0.059	0.163	0.021	0.212
	7	R1G1	15:00:37	15:00:56	4.587	0.75	1.674	0.265	0.840	0.206	1.295	0.836	0.094	0.076	0.041	0.139	0.018	0.162
	7	R2G2	15:02:24	15:02:43	0.747	0.41	2.181	0.340	0.518	0.096	0.728	1.163	0.442	0.849	0.447	0.731	0.070	0.779
	7	R2G3	15:03:51	15:04:11	0.574	0.37	2.236	0.325	0.296	0.215	0.562	1.535	0.674	1.496	0.734	0.718	0.270	1.034
	7	R2G4	15:05:58	15:06:17	0.480	0.38	2.253	0.333	0.390	0.194	0.797	1.353	0.741	1.588	0.792	0.998	0.256	1.544
	7	R2G6	15:07:06	15:07:25	0.755	0.36	2.202	0.219	0.596	0.027	1.031	1.660	0.551	1.210	0.406	1.186	0.027	1.557
	7	R2G1	15:08:43	15:09:03	0.480	0.35	2.207	0.293	0.237	0.063	1.151	1.383	0.689	1.590	0.712	0.618	0.085	2.280
	7	R1G2	15:30:46	15:31:06	5.178	0.80	1.513	0.301	1.067	0.213	1.501	0.854	0.091	0.062	0.042	0.160	0.016	0.170
523	100	R1G2	15:52:40	15:52:59	5.864	0.81	0.460	0.071	0.733	0.208	0.841	0.651	0.062	0.013	0.007	0.074	0.011	0.064
524	85	R1G2	15:53:48	15:54:07	6.310	0.75	0.573	0.165	1.502	0.168	0.690	0.739	0.060	0.017	0.016	0.159	0.009	0.056
	85	R1G2	15:54:56	15:55:15	6.013	0.73	0.561	0.118	1.249	0.227	0.309	0.721	0.060	0.017	0.012	0.136	0.013	0.026
525	30	R1G2	15:56:33	15:56:53	4.746	0.81	0.807	0.239	0.916	0.011	1.813	0.800	0.094	0.034	0.034	0.140	0.001	0.210
	30	R1G4	15:58:20	15:58:40	3.327	0.79	1.032	0.196	0.572	0.052	2.264	0.641	0.104	0.050	0.032	0.100	0.005	0.300
	30	R1G4	15:58:49	15:59:09	3.455	0.80	1.017	0.235	0.413	0.048	1.887	0.658	0.105	0.048	0.038	0.071	0.004	0.247
526	7	R1G2	16:01:25	16:01:45	5.321	0.80	1.326	0.348	1.101	0.062	1.589	0.857	0.088	0.053	0.047	0.161	0.005	0.176
	7	R1G3	16:02:33	16:02:53	5.167	0.78	1.404	0.240	0.820	0.202	1.606	0.832	0.087	0.057	0.033	0.120	0.015	0.178
	7	R1G4	16:03:41	16:04:01	4.694	0.80	1.441	0.248	0.815	0.233	1.538	0.804	0.094	0.062	0.036	0.127	0.019	0.181
	7	R1G5	16:05:19	16:05:38	4.573	0.78	1.533	0.339	0.729	0.124	1.904	0.805	0.094	0.068	0.050	0.116	0.010	0.230
	7	R1G6	16:06:17	16:06:37	4.426	0.74	1.724	0.327	0.635	0.206	1.860	0.825	0.095	0.080	0.052	0.107	0.018	0.238
	7	R1G1	16:07:45	16:08:04	4.576	0.75	1.795	0.311	0.867	0.088	1.443	0.848	0.096	0.083	0.049	0.146	0.008	0.184
	7	R1G2	16:10:40	16:10:59	5.216	0.77	1.604	0.318	0.639	0.202	1.239	0.853	0.086	0.066	0.044	0.095	0.016	0.139

TABLE A-3.—PART C (Continued)

Test Point No.[1]	Power	Probe ID[2]	MGA Time		Measured gaseous concentration							Gaseous emission index						
	%		Start	End	SO_2	N_2O	Methane (CH_4)	1,3-Butadiene (C_4H_6)	Acetone (C_3H_6O)	Ethane (C_2H_6)	Propane (C_3H_8)	$EISO_2$	EIN_2O	$EICH_4$	EIC_4H_6	EIC_3H_6O	EIC_2H_6	EIC_3H_8
					ppm							g/kg fuel						
601	7	R1G2	8:11:29	8:11:48	4.230	0.73	2.820	0.488	0.424	0.387	2.476	0.758	0.090	0.126	0.074	0.069	0.033	0.305
	7	R1G3	8:13:06	8:13:25	3.320	0.78	2.370	0.473	0.061	0.337	2.808	0.630	0.102	0.113	0.076	0.011	0.030	0.367
	7	R1G4	8:14:04	8:14:23	3.250	0.77	2.450	0.450	0.237	0.250	2.374	0.622	0.101	0.117	0.073	0.041	0.022	0.313
	7	R1G5	8:15:21	8:15:40	3.180	0.77	2.330	0.481	0.299	0.253	2.483	0.621	0.103	0.114	0.079	0.053	0.023	0.333
	7	R1G6	8:16:09	8:16:29	2.090	0.73	2.560	0.491	0.187	0.238	2.947	0.433	0.104	0.133	0.086	0.035	0.023	0.420
	7	R1G1	8:17:56	8:18:15	3.570	0.69	2.400	0.479	0.449	0.296	2.089	0.737	0.098	0.124	0.083	0.084	0.029	0.296
	7	R2G2	8:19:04	8:19:23	0.670	0.35	2.130	0.393	0.401	0.215	1.102	1.474	0.529	1.166	0.726	0.796	0.221	1.659
	7	R2G3	8:20:21	8:20:40	0.670	0.36	2.090	0.347	0.411	0.250	0.689	1.951	0.721	1.520	0.852	1.084	0.341	1.378
	7	R2G6	8:22:56	8:23:15	0.840	0.38	2.120	0.343	0.460	0.102	1.865	1.999	0.622	1.260	0.688	0.991	0.114	3.049
	7	R2G1	8:24:04	8:24:23	0.600	0.37	2.090	0.378	0.330	0.122	0.957	1.845	0.782	1.605	0.980	0.918	0.176	2.021
	7	R1G2	8:25:50	8:26:10	4.630	0.69	2.230	0.427	0.402	0.320	2.341	0.873	0.089	0.105	0.068	0.069	0.028	0.303
602	100	R1G2	8:28:45	8:29:04	6.030	0.75	0.310	0.146	0.489	0.215	0.603	0.682	0.058	0.009	0.014	0.050	0.011	0.047
603	85	R1G2	8:30:41	8:31:00	5.270	0.76	0.370	0.153	0.698	0.214	1.087	0.654	0.065	0.011	0.016	0.079	0.012	0.093
604	30	R1G2	8:33:45	8:34:04	4.900	0.79	0.690	0.206	0.289	0.394	2.005	0.831	0.092	0.029	0.029	0.044	0.031	0.234
	30	R1G4	8:35:51	8:36:10	4.360	0.74	0.920	0.272	0.260	0.219	2.276	0.814	0.095	0.043	0.043	0.044	0.019	0.292
605	7	R1G2	8:38:26	8:38:45	5.210	0.72	2.510	0.455	0.709	0.331	1.903	0.978	0.093	0.118	0.072	0.121	0.029	0.246
	7	R1G3	8:39:53	8:40:12	4.810	0.69	2.400	0.451	0.956	0.313	0.022	0.904	0.089	0.113	0.071	0.163	0.028	0.003
	7	R2G1	8:58:17	8:58:36	0.780	0.38	2.220	0.390	0.499	0.133	0.904	2.799	0.937	1.979	1.173	1.613	0.222	2.216
606	100	R1G2	9:05:14	9:05:33	6.040	0.75	0.430	0.170	0.927	0.287	0.776	0.702	0.060	0.012	0.017	0.098	0.016	0.062
607	85	R1G2	9:06:31	9:06:50	6.440	0.70	0.460	0.205	1.022	0.113	0.916	0.794	0.059	0.014	0.021	0.114	0.007	0.078
608	30	R1G2	9:09:35	9:09:54	5.110	0.77	0.770	0.283	0.542	0.409	1.835	0.865	0.090	0.033	0.040	0.083	0.032	0.214
	30	R1G4	9:11:22	9:11:41	4.070	0.73	0.980	0.221	0.457	0.340	1.941	0.797	0.098	0.048	0.037	0.081	0.031	0.261
609	7	R1G2	9:14:16	9:14:35	5.140	0.69	2.380	0.458	0.513	0.221	1.778	0.982	0.091	0.114	0.074	0.089	0.020	0.234
	7	R1G3	9:16:22	9:16:41	5.210	0.75	2.090	0.439	0.639	0.285	1.695	0.978	0.097	0.098	0.069	0.109	0.025	0.219
	7	R1G4	9:17:20	9:17:39	4.540	0.70	2.200	0.449	0.462	0.275	2.240	0.885	0.094	0.107	0.074	0.082	0.025	0.300
	7	R1G5	9:19:07	9:19:26	4.760	0.68	2.140	0.437	0.515	0.227	1.910	0.955	0.094	0.107	0.074	0.094	0.021	0.263
	7	R1G6	9:20:53	9:21:12	4.280	0.68	2.290	0.438	0.454	0.190	1.757	0.930	0.102	0.124	0.080	0.089	0.019	0.263
	7	R1G1	9:22:01	9:22:20	4.330	0.68	2.390	0.414	0.301	0.237	1.510	0.913	0.099	0.126	0.074	0.058	0.023	0.219
	7	R2G2	9:23:28	9:23:47	0.880	0.35	2.290	0.379	0.141	0.118	1.069	2.041	0.558	1.333	0.744	0.297	0.129	1.711
	7	R2G3	9:24:07	9:24:26	0.800	0.35	2.240	0.394	0.476	0.111	1.138	2.340	0.704	1.629	0.967	1.255	0.151	2.276
	7	R2G4	9:27:01	9:27:20	0.930	0.35	2.300	0.371	0.290	0.147	1.316	2.619	0.678	1.610	0.876	0.736	0.193	2.533
	7	R2G6	9:28:38	9:28:57	0.900	0.37	2.370	0.375	0.450	0.210	0.747	2.252	0.636	1.489	0.795	1.025	0.247	1.291
	7	R2G1	9:29:55	9:30:15	0.780	0.38	2.280	0.389	0.333	0.187	0.821	2.662	0.892	1.939	1.116	1.027	0.298	1.920

TABLE A-3.—PART C (Continued)

Test Point No.[1]	Power	Probe ID[2]	MGA Time		Measured gaseous concentration							Gaseous emission index						
					SO_2	N_2O	Methane (CH_4)	1,3-Butadiene (C_4H_6)	Acetone (C_3H_6O)	Ethane (C_2H_6)	Propane (C_3H_8)	$EISO_2$	EIN_2O	$EICH_4$	EIC_4H_6	EIC_3H_6O	EIC_2H_6	EIC_3H_8
	%		Start	End	ppm							g/kg fuel						
610	100	R1G3	9:40:16	9:40:35	5.520	0.74	0.360	0.116	0.345	0.203	1.095	0.642	0.059	0.010	0.011	0.036	0.011	0.087
611	85	R1G3	9:42:03	9:42:22	5.380	0.74	0.400	0.105	0.499	0.231	0.925	0.640	0.061	0.012	0.011	0.054	0.013	0.076
612	30	R1G3	9:44:57	9:45:17	4.430	0.75	0.840	0.250	0.090	0.299	2.159	0.800	0.093	0.038	0.038	0.015	0.025	0.268
	30	R1G5	9:46:25	9:46:44	3.960	0.71	0.990	0.273	0.074	0.205	1.958	0.789	0.097	0.049	0.046	0.013	0.019	0.268
	30	R1G2	9:47:42	9:48:02	4.520	0.74	1.050	0.330	0.265	0.224	2.086	0.848	0.095	0.049	0.052	0.045	0.020	0.269
613	7	R1G2	9:49:58	9:50:18	5.390	0.70	1.870	0.431	0.557	0.311	1.618	0.943	0.084	0.082	0.064	0.088	0.026	0.195
	7	R1G3	9:51:26	9:51:45	5.370	0.74	1.760	0.390	0.809	0.253	1.636	0.925	0.088	0.076	0.057	0.126	0.020	0.194
	7	R1G4	9:53:22	9:53:42	4.970	0.72	1.770	0.405	0.646	0.085	1.819	0.907	0.090	0.081	0.062	0.107	0.007	0.228
	7	R1G5	9:54:30	9:54:49	4.840	0.71	1.820	0.398	0.520	0.181	1.649	0.902	0.091	0.085	0.063	0.088	0.016	0.211
	7	R1G6	9:56:17	9:56:36	4.620	0.67	1.860	0.416	0.445	0.172	1.945	0.918	0.092	0.092	0.070	0.080	0.016	0.266
	7	R1G1	9:57:15	9:57:34	4.810	0.68	2.010	0.421	0.342	0.264	1.449	0.910	0.088	0.095	0.067	0.059	0.023	0.188
	7	R2G2	9:59:21	9:59:41	0.720	0.35	2.110	0.416	0.360	0.122	0.848	1.986	0.664	1.458	0.970	0.902	0.158	1.612
	7	R2G3	10:00:58	10:01:18	0.730	0.36	2.150	0.390	0.674	0.005	1.190	2.016	0.684	1.486	0.910	1.688	0.006	2.262
	7	R2G4	10:02:06	10:02:26	0.790	0.34	2.150	0.405	0.249	0.215	0.703	2.186	0.647	1.486	0.945	0.624	0.279	1.336
	7	R2G6	10:03:53	10:04:12	0.970	0.35	2.120	0.379	0.286	0.135	0.885	2.335	0.579	1.274	0.769	0.623	0.152	1.463
614	100	R1G3	10:16:00	10:16:20	5.900	0.75	0.380	0.192	0.202	0.084	1.728	0.663	0.058	0.011	0.018	0.021	0.004	0.133
615	85	R1G3	10:17:37	10:17:57	5.830	0.72	0.410	0.146	0.530	0.202	0.943	0.684	0.058	0.012	0.014	0.056	0.011	0.076
616	30	R1G3	10:20:42	10:21:01	4.970	0.79	0.820	0.316	0.606	0.173	1.945	0.879	0.096	0.036	0.047	0.097	0.014	0.236
	30	R1G5	10:22:18	10:22:38	4.240	0.73	0.950	0.271	0.163	0.164	2.168	0.805	0.095	0.045	0.043	0.028	0.015	0.283
	30	R1G2	10:22:57	10:23:17	4.830	0.76	0.850	0.370	0.567	0.132	2.063	0.852	0.092	0.038	0.055	0.091	0.011	0.250
617	7	R1G2	10:26:11	10:26:31	5.430	0.71	1.590	0.400	0.757	0.080	1.625	0.955	0.086	0.070	0.059	0.121	0.007	0.197
	7	R1G3	10:27:38	10:27:58	5.290	0.76	1.570	0.402	0.522	0.152	1.668	0.931	0.092	0.069	0.060	0.083	0.013	0.202
	7	R1G4	10:28:56	10:29:15	4.900	0.77	1.510	0.385	0.636	0.181	1.922	0.906	0.098	0.070	0.060	0.107	0.016	0.244
	7	R1G5	10:30:14	10:30:33	4.810	0.71	1.610	0.389	0.688	0.198	1.610	0.910	0.092	0.076	0.062	0.118	0.018	0.209
	7	R1G6	10:31:21	10:31:41	4.700	0.74	1.710	0.420	0.300	0.110	1.913	0.946	0.102	0.086	0.071	0.055	0.010	0.265
	7	R1G1	10:32:39	10:32:58	4.600	0.70	1.730	0.426	0.639	0.040	1.885	0.938	0.098	0.088	0.073	0.118	0.004	0.264
	7	R2G2	10:34:35	10:34:55	0.870	0.33	2.150	0.354	0.396	0.060	1.171	2.215	0.578	1.366	0.759	0.912	0.071	2.046
	7	R2G3	10:34:55	10:35:14	0.930	0.37	2.080	0.388	0.399	0.085	0.876	2.490	0.681	1.386	0.872	0.963	0.106	1.605
	7	R2G4	10:36:32	10:36:51	0.830	0.38	2.120	0.364	0.495	0.101	0.878	2.124	0.669	1.363	0.790	1.154	0.122	1.552
	7	R2G6	10:37:30	10:37:49	0.920	0.35	2.160	0.349	0.334	0.089	1.209	2.242	0.586	1.312	0.716	0.736	0.101	2.020
618	4	R1G2	11:56:45	11:57:04	6.090	0.72	4.000	0.791	1.205	0.605	2.612	0.986	0.080	0.162	0.108	0.177	0.046	0.291
619	100	R1G2	12:01:27	12:01:46	5.490	0.78	0.200	0.007	0.400	0.344	1.266	0.632	0.062	0.006	0.001	0.042	0.019	0.100

TABLE A-3.—PART C (Continued)

Test Point No.[1]	Power	Probe ID[2]	MGA Time		Measured gaseous concentration							Gaseous emission index						
					SO_2	N_2O	Methane (CH_4)	1,3-Butadiene (C_4H_6)	Acetone (C_3H_6O)	Ethane (C_2H_6)	Propane (C_3H_8)	$EISO_2$	EIN_2O	$EICH_4$	EIC_4H_6	EIC_3H_6O	EIC_2H_6	EIC_3H_8
	%		Start	End	ppm							g/kg fuel						
620	85	R1G2	12:02:35	12:02:54	5.790	0.73	0.310	0.064	0.837	0.309	0.732	0.708	0.061	0.009	0.007	0.093	0.018	0.062
	85	R1G3	12:04:41	12:05:01	5.520	0.71	0.280	0.058	0.626	0.362	0.653	0.684	0.060	0.009	0.006	0.070	0.021	0.056
621	65	R1G3	12:06:48	12:07:07	5.200	0.76	0.540	0.255	0.961	0.235	0.765	0.742	0.075	0.019	0.031	0.124	0.016	0.075
	65	R1G2	12:08:05	12:08:25	6.000	0.77	0.380	0.287	1.226	0.204	1.074	0.791	0.070	0.013	0.032	0.146	0.013	0.097
622	40	R1G2	12:10:41	12:11:00	5.520	0.83	0.540	0.200	1.135	0.310	2.037	0.870	0.090	0.021	0.027	0.162	0.023	0.221
	40	R1G3	12:12:28	12:12:47	4.750	0.76	0.640	0.173	0.637	0.448	2.106	0.801	0.088	0.027	0.025	0.097	0.035	0.244
623	4	R1G3	12:15:13	12:15:33	6.060	0.69	3.430	0.593	1.021	0.605	1.875	0.998	0.078	0.141	0.082	0.152	0.047	0.212
	4	R1G2	12:17:39	12:17:58	6.390	0.70	3.600	0.733	1.160	0.372	2.203	1.022	0.077	0.144	0.099	0.168	0.028	0.242
624	40	R1G2	12:21:32	12:21:52	5.160	0.83	0.580	0.174	1.096	0.326	0.768	0.783	0.087	0.022	0.022	0.151	0.023	0.080
	40	R1G3	12:22:31	12:22:50	4.830	0.78	0.650	0.186	1.074	0.412	2.105	0.792	0.088	0.027	0.026	0.160	0.032	0.237
	40	R1G4	12:23:58	12:24:18	4.120	0.83	0.760	0.158	0.382	0.288	2.346	0.733	0.102	0.034	0.024	0.062	0.024	0.287
	40	R1G5	12:24:47	12:25:06	4.090	0.76	0.780	0.104	0.823	0.347	2.195	0.740	0.095	0.035	0.016	0.135	0.029	0.273
	40	R1G6	12:25:55	12:26:14	4.330	0.76	0.690	0.145	1.045	0.382	1.827	0.779	0.094	0.031	0.022	0.170	0.032	0.226
	40	R1G1	12:27:13	12:27:32	4.470	0.76	0.630	0.184	0.922	0.285	2.090	0.793	0.093	0.028	0.028	0.148	0.024	0.255
	40	R1G2	12:31:16	12:31:35	4.860	0.78	0.660	0.237	1.262	0.200	1.394	0.805	0.089	0.027	0.033	0.189	0.016	0.159
	40	R2G3	12:32:43	12:33:03	0.900	0.37	1.890	0.342	0.694	0.265	0.650	1.767	0.499	0.925	0.565	1.231	0.243	0.875
	40	R2G4	12:34:01	12:34:20	0.930	0.37	1.860	0.317	0.627	0.277	1.085	1.683	0.460	0.843	0.485	1.030	0.235	1.353
	40	R2G6	12:35:38	12:35:58	0.900	0.36	1.870	0.299	0.823	0.232	0.789	1.711	0.471	0.892	0.481	1.422	0.207	1.034
	40	R2G1	12:36:46	12:37:06	0.760	0.37	1.930	0.272	0.660	0.124	1.535	1.680	0.562	1.067	0.508	1.323	0.129	2.334
	40	R1G2	12:38:23	12:38:43	5.020	0.80	0.530	0.223	0.686	0.304	0.598	0.757	0.083	0.020	0.028	0.094	0.021	0.062
625	30	R1G2	12:44:04	12:44:23	5.010	0.81	0.580	0.242	1.040	0.349	2.097	0.852	0.095	0.025	0.035	0.160	0.028	0.245
	30	R1G3	12:45:31	12:45:51	4.490	0.80	0.740	0.186	0.668	0.239	1.798	0.812	0.099	0.033	0.028	0.109	0.020	0.224
626	15	R1G3	12:48:07	12:48:26	4.800	0.82	0.990	0.260	0.861	0.202	2.270	0.869	0.102	0.045	0.040	0.141	0.017	0.282
	15	R1G2	12:49:25	12:49:44	4.930	0.82	0.940	0.262	0.462	0.256	2.097	0.879	0.101	0.042	0.039	0.075	0.021	0.257
627	7	R1G2	12:52:10	12:52:29	5.250	0.78	1.390	0.312	1.178	0.292	1.703	0.941	0.096	0.062	0.047	0.191	0.025	0.210
	7	R1G3	12:53:28	12:53:47	5.250	0.79	1.350	0.319	1.398	0.286	1.954	0.946	0.098	0.061	0.049	0.228	0.024	0.242
628	5.5	R1G3	12:56:23	12:56:42	5.590	0.74	2.160	0.403	0.959	0.239	1.862	0.941	0.086	0.091	0.057	0.146	0.019	0.216
	5.5	R1G2	12:57:50	12:58:10	5.560	0.71	2.100	0.482	0.818	0.272	1.976	0.939	0.082	0.089	0.069	0.125	0.022	0.230
629	4	R1G2	13:01:05	13:01:24	6.090	0.69	2.990	0.609	0.729	0.430	1.906	0.980	0.076	0.120	0.083	0.106	0.032	0.211
	4	R2G6	13:03:02	13:03:21	0.960	0.35	2.140	0.330	0.521	0.161	1.352	1.962	0.492	1.096	0.570	0.967	0.155	1.904
	4	R1G2	13:10:19	13:10:39	6.310	0.73	3.220	0.668	0.907	0.369	1.894	1.000	0.080	0.128	0.089	0.130	0.027	0.207

TABLE A-3.—PART C (Continued)

Test Point No.[1]	Power	Probe ID[2]	MGA Time		Measured gaseous concentration							Gaseous emission index						
					SO_2	N_2O	Methane (CH_4)	1,3-Butadiene (C_4H_6)	Acetone (C_3H_6O)	Ethane (C_2H_6)	Propane (C_3H_8)	$EISO_2$	EIN_2O	$EICH_4$	EIC_4H_6	EIC_3H_6O	EIC_2H_6	EIC_3H_8
	%		Start	End	ppm							g/kg fuel						
630	5.5	R1G2	13:12:55	13:13:14	5.560	0.74	1.980	0.404	0.682	0.300	1.665	0.924	0.085	0.082	0.057	0.103	0.023	0.190
	5.5	R2G6	13:14:32	13:14:52	1.020	0.37	2.040	0.331	0.501	0.212	0.612	2.145	0.535	1.074	0.588	0.956	0.209	0.886
631	7	R1G2	13:16:48	13:17:08	5.260	0.80	1.380	0.302	0.998	0.249	1.747	0.907	0.095	0.059	0.044	0.156	0.020	0.207
632	15	R1G2	13:20:32	13:20:52	5.160	0.80	0.780	0.284	1.198	0.247	2.042	0.913	0.097	0.035	0.042	0.192	0.020	0.249
	15	R2G6	13:22:19	13:22:39	0.870	0.40	1.910	0.340	0.646	0.308	0.775	1.911	0.604	1.046	0.628	1.282	0.316	1.167
633	30	R1G2	13:24:26	13:24:45	5.180	0.85	0.560	0.293	0.519	0.166	2.439	0.814	0.092	0.022	0.039	0.074	0.012	0.264
	30	R2G6	13:26:03	13:26:23	0.880	0.38	1.860	0.305	0.765	0.299	0.727	1.460	0.433	0.774	0.428	1.153	0.233	0.831
634	4	R1G2	13:28:10	13:28:29	6.100	0.69	3.350	0.629	0.803	0.414	2.049	0.982	0.076	0.135	0.085	0.117	0.031	0.227
	4	R1G2	13:34:10	13:34:29	6.380	0.71	3.750	0.778	0.733	0.488	2.445	1.002	0.077	0.147	0.103	0.104	0.036	0.264
635	40	R1G2	13:40:10	13:40:29	5.410	0.81	0.530	0.149	0.948	0.307	0.622	0.785	0.081	0.019	0.018	0.125	0.021	0.062
	40	R1G3	13:41:47	13:42:07	5.020	0.83	0.610	0.202	0.621	0.277	2.080	0.809	0.092	0.025	0.027	0.091	0.021	0.230
	40	R1G2	13:43:05	13:43:24	5.350	0.87	0.560	0.281	1.273	0.148	0.701	0.788	0.088	0.021	0.035	0.170	0.010	0.071
	40	R1G3	13:44:13	13:44:33	5.100	0.81	0.590	0.208	1.005	0.320	2.219	0.818	0.089	0.024	0.028	0.146	0.024	0.245
	40	R1G4	13:46:00	13:46:20	3.980	0.79	0.790	0.111	0.051	0.406	2.218	0.698	0.095	0.035	0.016	0.008	0.033	0.268
	40	R1G5	13:47:08	13:47:28	3.950	0.77	0.700	0.174	0.272	0.252	2.305	0.701	0.094	0.031	0.026	0.044	0.021	0.281
	40	R1G6	13:48:07	13:48:26	4.110	0.76	0.720	0.140	0.008	0.315	2.538	0.710	0.090	0.031	0.020	0.001	0.025	0.301
	40	R1G1	13:49:44	13:50:03	4.720	0.82	0.600	0.144	0.653	0.309	2.181	0.765	0.091	0.024	0.020	0.096	0.023	0.243
	40	R2G2	13:51:02	13:51:21	0.900	0.39	1.870	0.325	0.617	0.188	0.985	1.398	0.417	0.729	0.427	0.871	0.137	1.055
	40	R2G3	13:52:10	13:52:29	0.880	0.36	1.860	0.268	0.678	0.193	0.964	1.631	0.459	0.864	0.420	1.142	0.168	1.232
	40	R2G4	13:53:47	13:54:07	0.890	0.36	1.890	0.255	0.673	0.192	1.049	1.586	0.441	0.843	0.384	1.088	0.161	1.287
	40	R2G6	13:55:15	13:55:34	0.890	0.38	1.940	0.340	0.438	0.218	0.997	1.529	0.449	0.832	0.492	0.681	0.175	1.176
	40	R2G1	13:56:13	13:56:33	0.800	0.36	1.910	0.279	0.537	0.044	1.314	1.773	0.549	1.056	0.521	1.076	0.046	1.998
636	30	R1G2	14:00:17	14:00:36	4.930	0.78	0.610	0.192	0.639	0.429	2.393	0.822	0.089	0.025	0.027	0.096	0.034	0.274
	30	R1G3	14:01:34	14:01:54	4.460	0.80	0.690	0.179	0.672	0.229	2.336	0.800	0.099	0.031	0.027	0.109	0.019	0.288
637	15	R1G2	14:04:39	14:04:59	5.180	0.82	0.820	0.305	1.189	0.097	2.233	0.902	0.098	0.036	0.045	0.188	0.008	0.267
	15	R1G3	14:05:47	14:06:07	4.850	0.82	0.940	0.242	0.892	0.291	2.036	0.878	0.102	0.043	0.037	0.146	0.025	0.253
	15	R1G2	14:06:46	14:07:05	4.920	0.82	1.180	0.297	0.718	0.240	2.218	0.895	0.103	0.054	0.046	0.118	0.020	0.277
638	7	R1G2	14:08:13	14:08:33	5.530	0.76	1.530	0.349	1.094	0.231	1.752	0.938	0.089	0.065	0.050	0.168	0.018	0.204
	7	R1G3	14:09:58	14:10:17	5.230	0.75	1.580	0.309	0.671	0.311	2.025	0.912	0.090	0.069	0.045	0.106	0.025	0.243
	7	R1G2	14:11:06	14:11:26	5.490	0.76	1.590	0.338	1.152	0.179	1.784	0.942	0.090	0.068	0.049	0.179	0.014	0.211

TABLE A-3.—PART C (Continued)

Test Point No.[1]	Power	Probe ID[2]	MGA Time		Measured gaseous concentration							Gaseous emission index						
			Start	End	SO_2	N_2O	Methane (CH_4)	1,3-Butadiene (C_4H_6)	Acetone (C_3H_6O)	Ethane (C_2H_6)	Propane (C_3H_8)	$EISO_2$	EIN_2O	$EICH_4$	EIC_4H_6	EIC_3H_6O	EIC_2H_6	EIC_3H_8
	%				ppm							g/kg fuel						
639	5.5	R1G2	14:12:53	14:13:13	5.700	0.74	2.070	0.369	0.874	0.416	1.295	0.941	0.084	0.085	0.051	0.131	0.032	0.147
	5.5	R1G3	14:14:40	14:15:00	5.460	0.72	2.000	0.458	0.882	0.250	1.910	0.928	0.084	0.085	0.066	0.136	0.020	0.223
640	4	R1G2	14:18:44	14:19:03	6.040	0.72	2.760	0.535	0.813	0.441	1.616	0.976	0.080	0.112	0.073	0.119	0.033	0.180
	4	R1G3	14:20:11	14:20:31	5.840	0.68	2.770	0.576	0.658	0.257	1.799	0.974	0.078	0.115	0.081	0.099	0.020	0.206
641	5.5	R1G2	14:27:10	14:27:29	5.180	0.72	1.830	0.394	0.711	0.205	1.826	0.905	0.086	0.080	0.058	0.113	0.017	0.219
	5.5	R2G6	14:28:18	14:28:37	0.910	0.35	1.970	0.304	0.625	0.173	1.146	1.662	0.440	0.900	0.469	1.036	0.148	1.441
642	7	R1G2	14:31:23	14:31:42	5.350	0.77	1.380	0.304	1.024	0.122	1.933	0.929	0.092	0.060	0.045	0.161	0.010	0.231
	7	R2G6	14:33:10	14:33:29	0.770	0.37	2.070	0.311	0.437	0.257	0.538	1.693	0.559	1.133	0.575	0.867	0.264	0.810
643	15	R1G2	14:35:16	14:35:36	5.100	0.82	0.770	0.292	1.060	0.155	2.328	0.884	0.098	0.033	0.043	0.166	0.013	0.277
726	4	R1GG3	15:03:10	15:10:58	18.470	0.69	3.690	0.640	0.710	0.670	1.890	3.114	0.080	0.156	0.091	0.109	0.053	0.219
727	100	R1GG3	15:11:57	15:12:55	27.230	0.74	0.270	0.180	1.830	0.430	0.560	3.187	0.060	0.008	0.018	0.194	0.024	0.045
728	85	R1GG3	15:14:13	15:16:20	25.600	0.73	0.340	0.170	1.570	0.400	0.970	3.138	0.062	0.010	0.018	0.174	0.023	0.082
729	65	R1GG3	15:16:59	15:20:43	22.380	0.72	0.480	0.190	1.290	0.380	0.670	3.175	0.070	0.017	0.023	0.166	0.025	0.065
730	40	R1GG3	15:21:51	15:25:26	18.880	0.79	0.560	0.170	0.560	0.450	2.450	3.178	0.091	0.024	0.024	0.085	0.036	0.284
731	30	R1GG3	15:26:15	15:30:09	17.520	0.77	0.670	0.160	0.650	0.480	2.510	3.185	0.096	0.031	0.025	0.107	0.041	0.314
732	7	R1GG3	15:31:27	15:33:24	17.660	0.77	1.510	0.260	0.770	0.340	2.080	3.287	0.099	0.070	0.041	0.130	0.030	0.266
733	4	R1GG3	15:35:30	15:43:18	19.040	0.69	2.680	0.380	0.770	0.550	1.750	3.322	0.083	0.117	0.056	0.122	0.045	0.210
734	100	R1GG3	15:44:07	15:45:15	26.410	0.72	0.310	0.120	1.340	0.530	0.390	3.129	0.059	0.009	0.012	0.144	0.029	0.032
735	85	R1GG3	15:46:24	15:48:11	25.750	0.72	0.370	0.160	1.460	0.360	1.000	3.157	0.061	0.011	0.017	0.162	0.021	0.084
736	65	R1GG3	15:49:00	15:52:44	22.370	0.70	0.480	0.140	1.120	0.420	0.690	3.167	0.068	0.017	0.017	0.144	0.028	0.067
737	40	R1GG3	15:53:42	15:57:27	18.960	0.78	0.640	0.130	1.070	0.570	2.190	3.226	0.091	0.027	0.019	0.165	0.046	0.256
738	30	R1GG3	15:58:45	16:01:50	17.950	0.78	0.700	0.160	0.970	0.350	2.420	3.253	0.097	0.032	0.025	0.159	0.030	0.302
739	7	R1GG3	16:03:08	16:06:13	17.950	0.76	1.410	0.170	0.770	0.490	1.890	3.250	0.095	0.064	0.026	0.126	0.042	0.235
740	4	R1GG3	16:07:21	16:14:01	19.670	0.69	2.870	0.480	0.760	0.470	1.960	3.339	0.081	0.122	0.069	0.117	0.037	0.229
741	100	R1GG3	16:15:09	16:16:18	26.940	0.74	0.250	0.180	1.060	0.380	1.020	3.134	0.059	0.007	0.018	0.112	0.021	0.082
742	85	R1GG3	16:16:47	16:20:31	25.830	0.73	0.340	0.150	1.670	0.440	0.650	3.156	0.061	0.010	0.016	0.185	0.025	0.055
743	70	R1GG3	16:21:01	16:24:35	23.410	0.71	0.490	0.140	1.530	0.450	0.480	3.204	0.067	0.017	0.016	0.190	0.029	0.045
744	65	R1GG3	16:25:53	16:28:19	22.360	0.73	0.530	0.190	1.440	0.310	1.140	3.199	0.072	0.019	0.023	0.187	0.021	0.112
745	60	R1GG3	16:28:49	16:32:13	21.720	0.72	0.540	0.140	1.000	0.430	1.710	3.211	0.073	0.020	0.018	0.134	0.030	0.174
746	40	R1GG3	16:33:22	16:36:17	18.940	0.77	0.640	0.200	1.080	0.350	2.340	3.232	0.090	0.027	0.029	0.167	0.028	0.275
747	30	R1GG3	16:37:16	16:40:01	17.680	0.77	0.670	0.170	0.780	0.450	2.610	3.209	0.096	0.030	0.026	0.128	0.038	0.326
748	15	R1GG3	16:41:00	16:43:46	17.420	0.82	0.940	0.250	0.840	0.350	2.240	3.266	0.106	0.044	0.040	0.143	0.031	0.289
749	7	R1GG3	16:44:25	16:47:49	18.210	0.76	1.380	0.250	0.890	0.290	2.100	3.303	0.095	0.063	0.038	0.146	0.025	0.262
750	5.5	R1GG3	16:49:17	16:51:43	19.070	0.73	1.840	0.330	0.870	0.400	1.870	3.327	0.088	0.080	0.049	0.138	0.033	0.224

TABLE A-3.—PART C (Continued)

Test Point No.[1]	Power	Probe ID[2]	MGA Time		Measured gaseous concentration							Gaseous emission index						
			Start	End	SO_2	N_2O	Methane (CH_4)	1,3-Butadiene (C_4H_6)	Acetone (C_3H_6O)	Ethane (C_2H_6)	Propane (C_3H_8)	$EISO_2$	EIN_2O	$EICH_4$	EIC_4H_6	EIC_3H_6O	EIC_2H_6	EIC_3H_8
	%				ppm							g/kg fuel						
751	4	R1GG3	16:53:40	16:56:16	20.160	0.69	3.010	0.540	0.950	0.520	2.010	3.403	0.080	0.127	0.077	0.145	0.041	0.233
801	4	R1GG3	8:01:22	8:06:13	20.753	0.69	7.299	1.169	0.506	0.852	4.682	3.615	0.082	0.318	0.172	0.080	0.070	0.561
802	100	R1GG3	8:07:12	8:08:20	29.095	0.74	0.349	0.118	1.725	0.393	1.081	3.438	0.060	0.010	0.012	0.185	0.022	0.088
803	85	R1GG3	8:08:58	8:11:53	27.308	0.71	0.419	0.080	1.659	0.442	0.631	3.417	0.061	0.013	0.008	0.188	0.026	0.054
804	65	R1GG3	8:12:42	8:16:25	23.812	0.70	0.543	0.106	1.642	0.332	0.841	3.427	0.070	0.020	0.013	0.214	0.022	0.083
805	40	R1GG3	8:17:33	8:36:58	19.993	0.80	0.699	0.177	1.111	0.283	2.464	3.440	0.094	0.030	0.026	0.173	0.023	0.291
806	30	R1GG3	8:37:47	8:41:10	18.603	0.79	0.836	0.127	1.238	0.298	2.636	3.471	0.101	0.039	0.020	0.209	0.026	0.338
807	7	R1GG3	8:41:59	8:45:32	18.451	0.72	1.960	0.260	1.120	0.146	2.291	3.521	0.095	0.094	0.042	0.194	0.013	0.301
808	4	R1GG3	8:46:21	8:53:57	20.061	0.68	3.847	0.508	0.895	0.558	2.454	3.615	0.084	0.173	0.077	0.146	0.047	0.304
809	100	R1GG3	8:54:55	8:56:03	28.918	0.70	0.336	0.100	1.305	0.335	0.802	3.441	0.058	0.010	0.010	0.141	0.019	0.066
810	85	R1GG3	8:56:22	8:59:17	28.006	0.72	0.448	0.118	1.745	0.285	0.831	3.479	0.062	0.014	0.012	0.197	0.017	0.071
811	65	R1GG3	8:59:46	9:03:00	24.152	0.73	0.547	0.184	1.535	0.151	0.832	3.454	0.071	0.020	0.022	0.199	0.010	0.082
812	40	R1GG3	9:03:39	9:23:33	20.389	0.78	0.698	0.171	1.076	0.236	2.510	3.453	0.091	0.030	0.024	0.165	0.019	0.292
813	30	R1GG3	9:24:21	9:28:05	18.823	0.80	0.816	0.184	0.999	0.179	2.339	3.470	0.101	0.038	0.029	0.167	0.016	0.296
814	7	R1GG3	9:28:53	9:32:17	18.732	0.74	1.884	0.228	1.098	0.266	2.088	3.539	0.096	0.089	0.036	0.188	0.024	0.271
815	4	R1GG3	9:33:35	9:40:23	20.452	0.67	3.501	0.518	0.941	0.360	2.349	3.626	0.082	0.155	0.078	0.151	0.030	0.286
816	100	R1GG3	9:41:12	9:42:10	29.177	0.74	0.439	0.130	1.906	0.295	0.621	3.498	0.061	0.013	0.013	0.207	0.017	0.051
817	85	R1GG3	9:42:39	9:46:03	28.037	0.71	0.441	0.157	1.781	0.241	0.857	3.479	0.061	0.014	0.016	0.200	0.014	0.073
818	70	R1GG3	9:46:42	9:49:46	25.135	0.71	0.580	0.125	1.821	0.303	0.542	3.476	0.068	0.020	0.015	0.228	0.020	0.052
819	65	R1GG3	9:50:25	9:53:20	24.105	0.73	0.626	0.199	1.596	0.118	1.182	3.441	0.071	0.022	0.024	0.207	0.008	0.116
820	60	R1GG3	9:53:49	9:57:03	22.721	0.73	0.679	0.175	1.550	0.189	0.888	3.457	0.076	0.026	0.023	0.214	0.014	0.093
821	40	R1GG3	9:57:52	10:01:16	20.315	0.78	0.704	0.130	0.928	0.268	2.666	3.430	0.091	0.030	0.019	0.142	0.021	0.310
822	30	R1GG3	10:01:54	10:05:18	18.791	0.78	0.795	0.151	0.876	0.244	2.722	3.429	0.097	0.036	0.023	0.145	0.021	0.342
823	15	R1GG3	10:06:16	10:08:52	18.354	0.82	1.181	0.192	1.138	0.176	2.406	3.512	0.108	0.057	0.031	0.197	0.016	0.317
824	7	R1GG3	10:10:09	10:12:45	19.100	0.75	1.812	0.212	1.361	0.257	2.003	3.557	0.096	0.084	0.033	0.230	0.022	0.256
825	5.5	R1GG3	10:13:53	10:16:38	19.823	0.71	2.384	0.266	1.166	0.263	2.048	3.567	0.088	0.107	0.040	0.190	0.022	0.253
826	4	R1GG3	10:17:55	10:21:44	20.437	0.68	3.513	0.499	0.976	0.359	2.393	3.600	0.082	0.155	0.074	0.156	0.030	0.290
827	4	R1GG3	12:50:02	12:53:56	9.265	0.66	4.486	0.857	0.623	0.741	2.069	1.580	0.077	0.191	0.123	0.096	0.059	0.243
828	100	R1GG3	12:54:54	12:55:53	11.204	0.74	0.261	0.119	1.442	0.348	1.283	1.313	0.060	0.008	0.012	0.153	0.019	0.103
829	85	R1GG3	12:56:32	12:58:58	10.715	0.70	0.325	0.196	1.280	0.257	1.276	1.302	0.058	0.010	0.020	0.141	0.015	0.107
830	65	R1GG3	12:59:47	13:02:52	9.287	0.68	0.516	0.138	1.072	0.296	0.618	1.308	0.066	0.018	0.016	0.137	0.020	0.060
831	40	R1GG3	13:03:41	13:06:46	8.087	0.76	0.654	0.162	1.242	0.432	1.976	1.364	0.088	0.028	0.023	0.190	0.034	0.229
832	30	R1GG3	13:07:15	13:10:30	7.592	0.75	0.767	0.170	1.022	0.325	2.181	1.377	0.093	0.035	0.026	0.168	0.028	0.272

TABLE A-3.—PART C (Continued)

Test Point No.[1]	Power	Probe ID[2]	MGA Time		Measured gaseous concentration							Gaseous emission index						
					SO_2	N_2O	Methane (CH_4)	1,3-Butadiene (C_4H_6)	Acetone (C_3H_6O)	Ethane (C_2H_6)	Propane (C_3H_8)	$EISO_2$	EIN_2O	$EICH_4$	EIC_4H_6	EIC_3H_6O	EIC_2H_6	EIC_3H_8
	%		Start	End	ppm							g/kg fuel						
833	7	R1GG3	13:11:38	13:15:02	7.484	0.70	1.654	0.284	0.790	0.249	1.905	1.396	0.090	0.077	0.045	0.134	0.022	0.244
834	4	R1GG3	13:16:20	13:24:57	8.240	0.66	3.085	0.523	0.657	0.473	1.617	1.453	0.080	0.136	0.078	0.105	0.039	0.196
835	100	R1GG3	13:25:45	13:26:34	10.334	0.73	0.328	0.105	1.220	0.461	0.679	1.223	0.059	0.010	0.011	0.131	0.026	0.055
836	85	R1GG3	13:27:34	13:30:08	9.902	0.71	0.329	0.157	1.149	0.213	1.707	1.205	0.060	0.010	0.016	0.127	0.012	0.143
837	65	R1GG3	13:30:47	13:34:02	9.101	0.68	0.458	0.169	1.003	0.297	0.744	1.292	0.066	0.016	0.020	0.129	0.020	0.073
838	40	R1GG3	13:35:10	13:38:44	7.608	0.74	0.700	0.145	0.814	0.445	2.120	1.303	0.087	0.030	0.021	0.126	0.036	0.250
839	30	R1GG3	13:39:23	13:42:28	7.289	0.75	0.804	0.148	0.930	0.353	2.208	1.330	0.094	0.037	0.023	0.154	0.030	0.277
840	7	R1GG3	13:43:37	13:46:51	7.373	0.72	1.654	0.261	0.563	0.314	2.023	1.328	0.089	0.075	0.040	0.092	0.027	0.251
841	4	R1GG3	13:48:09	13:55:08	8.240	0.65	3.542	0.609	0.653	0.511	1.643	1.420	0.077	0.153	0.089	0.102	0.041	0.195
842	100	R1GG3	13:55:57	13:57:05	9.931	0.74	0.313	0.115	0.770	0.266	1.274	1.162	0.060	0.009	0.011	0.082	0.015	0.102
843	85	R1GG3	13:58:13	14:00:29	9.749	0.70	0.364	0.091	1.114	0.359	0.839	1.189	0.059	0.011	0.009	0.123	0.021	0.070
844	100	R1GG3	14:10:42	14:11:51	9.692	0.71	0.303	0.135	0.793	0.300	1.313	1.146	0.058	0.009	0.014	0.085	0.017	0.107
845	85	R1GG3	14:12:30	14:16:04	9.949	0.68	0.357	0.133	1.160	0.327	0.628	1.227	0.058	0.011	0.014	0.130	0.019	0.053
846	70	R1GG3	14:17:02	14:20:17	9.063	0.67	0.520	0.142	1.202	0.270	0.591	1.253	0.063	0.018	0.017	0.151	0.018	0.056
847	65	R1GG3	14:20:46	14:23:51	8.792	0.70	0.591	0.243	1.402	0.226	0.589	1.267	0.070	0.021	0.030	0.183	0.015	0.058
848	60	R1GG3	14:24:20	14:27:45	8.485	0.70	0.611	0.177	1.186	0.277	0.632	1.263	0.071	0.023	0.022	0.160	0.019	0.065
849	40	R1GG3	14:28:43	14:32:07	7.642	0.77	0.607	0.210	0.661	0.262	2.466	1.278	0.088	0.025	0.030	0.100	0.021	0.283
850	30	R1GG3	14:32:46	14:36:11	7.129	0.78	0.814	0.254	0.670	0.179	2.099	1.302	0.097	0.037	0.039	0.111	0.015	0.264
851	15	R1GG3	14:37:09	14:40:04	6.985	0.80	1.082	0.240	0.693	0.321	1.981	1.327	0.105	0.051	0.039	0.119	0.029	0.259
852	7	R1GG3	14:41:32	14:43:48	7.322	0.70	1.665	0.315	0.577	0.219	2.019	1.335	0.088	0.076	0.048	0.095	0.019	0.253
853	5.5	R1GG3	14:44:37	14:47:22	7.487	0.70	2.058	0.326	0.776	0.355	1.594	1.341	0.086	0.092	0.049	0.126	0.030	0.196
854	4	R1GG3	14:48:21	14:55:58	8.110	0.65	3.521	0.634	0.632	0.501	1.766	1.409	0.077	0.153	0.093	0.100	0.041	0.211
855	100	R1GG3	14:57:26	14:58:43	9.746	0.71	0.316	0.061	0.851	0.397	0.738	1.147	0.057	0.009	0.006	0.091	0.022	0.060
856	85	R1GG3	14:59:52	15:02:08	9.641	0.70	0.380	0.110	1.299	0.285	1.552	1.192	0.060	0.012	0.012	0.146	0.017	0.132
857	65	R1GG3	15:02:57	15:05:42	8.810	0.68	0.505	0.160	1.002	0.256	0.750	1.254	0.067	0.018	0.019	0.129	0.017	0.073
858	40	R1GG3	15:06:31	15:09:45	7.645	0.76	0.738	0.149	0.926	0.403	1.791	1.296	0.089	0.031	0.021	0.142	0.032	0.209
859	30	R1GG3	15:10:44	15:13:29	7.263	0.76	0.796	0.161	0.927	0.343	2.165	1.325	0.096	0.036	0.025	0.153	0.029	0.272
860	7	R1GG3	15:14:28	15:18:02	7.339	0.75	1.568	0.245	0.861	0.280	1.696	1.345	0.095	0.072	0.038	0.143	0.024	0.214
861	4	R1GG3	15:20:08	15:22:34	8.112	0.65	3.515	0.614	0.545	0.465	1.852	1.392	0.076	0.151	0.089	0.085	0.037	0.218
901	4	R1P2	8:52:25	8:57:45	6.660	0.71	8.611	1.708	0.651	1.787	4.686	1.136	0.084	0.367	0.246	0.101	0.143	0.549
902	100	R1P2	8:58:54	8:59:52	9.168	0.81	0.162	0.096	1.053	0.523	0.986	1.043	0.064	0.005	0.009	0.109	0.028	0.077
903	85	R1P2	9:01:19	9:03:16	9.289	0.79	0.241	0.135	1.154	0.546	0.733	1.096	0.064	0.007	0.013	0.123	0.030	0.060
904	65	R1P2	9:04:14	9:07:19	8.328	0.77	0.421	0.165	1.461	0.555	0.994	1.138	0.072	0.014	0.019	0.181	0.036	0.093

TABLE A-3.—PART C (Continued)

Test Point No.[1]	Power	Probe ID[2]	MGA Time		Measured gaseous concentration							Gaseous emission index						
					SO_2	N_2O	Methane (CH_4)	1,3-Butadiene (C_4H_6)	Acetone (C_3H_6O)	Ethane (C_2H_6)	Propane (C_3H_8)	$EISO_2$	EIN_2O	$EICH_4$	EIC_4H_6	EIC_3H_6O	EIC_2H_6	EIC_3H_8
	%		Start	End	ppm							g/kg fuel						
905	40	R1P2	9:08:46	9:11:12	7.436	0.85	0.588	0.246	1.517	0.326	1.631	1.165	0.091	0.023	0.033	0.215	0.024	0.176
906	30	R1P2	9:12:11	9:15:25	7.020	0.82	0.620	0.254	1.297	0.413	2.537	1.199	0.096	0.027	0.037	0.201	0.033	0.298
907	7	R1P2	9:17:02	9:19:28	6.536	0.74	2.022	0.365	1.135	0.397	2.599	1.261	0.099	0.098	0.059	0.198	0.036	0.345
908	4	R1P2	9:21:05	9:24:19	8.084	0.70	5.246	1.003	1.065	0.879	3.811	1.417	0.084	0.230	0.148	0.169	0.072	0.459
909	100	R1P2	9:29:39	9:30:18	10.040	0.81	0.231	0.157	1.194	0.377	1.214	1.122	0.062	0.007	0.015	0.121	0.020	0.093
910	85	R1P2	9:31:36	9:33:52	9.582	0.76	0.335	0.172	1.663	0.430	0.960	1.159	0.063	0.010	0.018	0.182	0.024	0.080
911	65	R1P2	9:34:50	9:37:54	8.762	0.77	0.469	0.183	1.723	0.429	0.994	1.189	0.072	0.016	0.021	0.212	0.027	0.093
912	40	R1P2	9:39:02	9:43:15	7.523	0.82	0.587	0.189	1.475	0.454	1.020	1.175	0.088	0.023	0.025	0.209	0.033	0.110
913	30	R1P2	9:44:22	9:47:46	7.044	0.82	0.677	0.186	1.256	0.521	2.414	1.192	0.095	0.029	0.027	0.193	0.041	0.281
914	7	R1P2	9:48:54	9:52:28	6.735	0.75	2.145	0.337	1.046	0.529	2.345	1.261	0.096	0.100	0.053	0.178	0.046	0.302
915	4	R1P2	9:53:55	10:00:24	8.265	0.70	5.268	1.017	0.948	0.936	3.710	1.403	0.081	0.224	0.146	0.146	0.075	0.433
916	100	R1P2	10:02:21	10:03:19	10.030	0.80	0.259	0.093	1.294	0.453	0.461	1.131	0.062	0.007	0.009	0.132	0.024	0.036
917	85	R1P2	10:04:08	10:07:32	9.626	0.74	0.337	0.173	1.738	0.468	0.794	1.171	0.062	0.010	0.018	0.192	0.027	0.066
918	70	R1P2	10:08:01	10:11:35	8.855	0.74	0.430	0.206	1.778	0.392	0.897	1.187	0.069	0.014	0.023	0.216	0.025	0.083
919	65	R1P2	10:13:12	10:15:48	8.640	0.77	0.455	0.168	1.558	0.397	0.913	1.173	0.072	0.015	0.019	0.192	0.025	0.085
920	60	R1P2	10:16:17	10:20:39	8.493	0.80	0.515	0.193	1.829	0.321	1.229	1.193	0.078	0.018	0.023	0.233	0.021	0.119
921	40	R1P2	10:21:28	10:24:52	7.592	0.84	0.590	0.234	1.615	0.259	1.274	1.180	0.090	0.023	0.031	0.228	0.019	0.136
922	30	R1P2	10:25:30	10:28:55	7.091	0.82	0.653	0.205	1.140	0.361	2.595	1.193	0.095	0.028	0.029	0.174	0.029	0.300
923	15	R1P2	10:29:43	10:33:07	6.509	0.81	1.223	0.285	1.202	0.227	2.449	1.249	0.107	0.059	0.046	0.209	0.020	0.323
924	7	R1P2	10:33:46	10:37:10	6.866	0.77	2.069	0.375	1.223	0.438	2.400	1.271	0.098	0.096	0.059	0.205	0.038	0.306
925	5.5	R1P2	10:37:59	10:41:23	7.298	0.74	2.687	0.441	1.170	0.502	2.577	1.305	0.091	0.120	0.067	0.190	0.042	0.317
926	4	R1P2	10:42:31	10:53:22	8.310	0.71	4.938	0.930	1.071	0.967	3.388	1.409	0.083	0.209	0.133	0.165	0.077	0.395
927	100	R1P2	10:54:30	10:55:09	10.234	0.79	0.283	0.231	1.270	0.280	1.047	1.156	0.061	0.008	0.022	0.130	0.015	0.081
928	85	R1P2	10:56:27	10:58:43	9.570	0.75	0.377	0.212	1.619	0.338	1.054	1.175	0.063	0.012	0.022	0.180	0.020	0.089
929	65	R1P2	10:59:22	11:03:24	8.783	0.77	0.467	0.195	1.788	0.360	1.065	1.193	0.072	0.016	0.022	0.220	0.023	0.099
930	40	R1P2	11:04:13	11:07:17	7.779	0.83	0.552	0.215	1.419	0.278	1.183	1.170	0.086	0.021	0.027	0.193	0.020	0.122
931	30	R1P2	11:07:56	11:11:10	7.140	0.83	0.678	0.202	1.097	0.325	2.539	1.200	0.096	0.029	0.029	0.167	0.026	0.293
932	7	R1P2	11:12:09	11:15:52	6.909	0.75	2.092	0.336	1.174	0.426	2.404	1.294	0.096	0.098	0.053	0.199	0.037	0.310
933	4	R1P2	11:17:19	11:20:04	8.386	0.68	5.301	1.020	0.947	0.853	3.560	1.482	0.082	0.234	0.152	0.152	0.071	0.432
934	7	R1P2	13:51:55	14:06:07	18.794	0.80	1.590	0.250	1.259	0.300	2.234	3.199	0.094	0.068	0.036	0.194	0.024	0.261
935	100	R1P2	14:07:05	14:07:44	29.381	0.85	0.272	0.097	1.654	0.239	1.688	3.175	0.063	0.007	0.009	0.162	0.012	0.125
936	85	R1P2	14:08:04	14:10:00	28.519	0.81	0.336	0.130	1.923	0.320	0.891	3.215	0.063	0.010	0.012	0.196	0.017	0.069
937	75	R1P2	14:10:39	14:14:31	25.743	0.76	0.452	0.139	1.885	0.321	0.658	3.240	0.066	0.014	0.015	0.215	0.019	0.057
938	30	R1P2	14:15:29	14:19:02	19.351	0.87	0.753	0.225	1.490	0.234	2.572	3.230	0.100	0.031	0.032	0.225	0.018	0.295

TABLE A-3.—PART C (Concluded)

Test Point No.[1]	Power	Probe ID[2]	MGA Time		Measured gaseous concentration							Gaseous emission index						
					SO_2	N_2O	Methane (CH_4)	1,3-Butadiene (C_4H_6)	Acetone (C_3H_6O)	Ethane (C_2H_6)	Propane (C_3H_8)	$EISO_2$	EIN_2O	$EICH_4$	EIC_4H_6	EIC_3H_6O	EIC_2H_6	EIC_3H_8
	%		Start	End	ppm							g/kg fuel						
939	7	R1P2	14:30:01	14:45:30	18.716	0.78	1.595	0.257	1.336	0.269	2.250	3.313	0.095	0.071	0.038	0.214	0.022	0.274
940	100	R1P2	14:46:38	14:46:57	29.744	0.84	0.293	0.128	1.762	0.355	1.451	3.239	0.063	0.008	0.012	0.174	0.018	0.109
941	85	R1P2	14:48:44	14:49:03	29.887	0.85	0.246	0.095	1.855	0.341	1.308	3.253	0.064	0.007	0.009	0.183	0.017	0.098
942	30	R1P2	14:50:21	14:53:44	19.450	0.86	0.692	0.251	1.495	0.272	2.450	3.270	0.100	0.029	0.036	0.228	0.021	0.283
943	7	R1P2	14:55:11	15:20:12	19.067	0.81	1.284	0.242	1.319	0.231	2.280	3.310	0.097	0.056	0.035	0.208	0.019	0.272
944	100	R1P2	15:21:11	15:21:19	29.968	0.84	0.256	0.077	2.180	0.295	1.143	3.262	0.063	0.007	0.007	0.215	0.015	0.086
945	85	R1P2	15:21:58	15:24:04	29.066	0.80	0.334	0.196	2.051	0.236	1.181	3.325	0.063	0.010	0.019	0.213	0.013	0.093
946	30	R1P2	15:25:12	15:28:25	19.340	0.86	0.730	0.240	1.342	0.264	2.368	3.281	0.100	0.031	0.034	0.206	0.021	0.276
947	7	R1P2	15:29:43	15:54:54	18.615	0.78	1.467	0.272	1.324	0.235	2.234	3.327	0.095	0.066	0.041	0.214	0.020	0.275
948	100	R1P2	15:55:52	15:56:12	29.337	0.88	0.289	0.187	1.805	0.297	1.740	3.264	0.067	0.008	0.018	0.182	0.016	0.133
949	85	R1P2	15:57:00	15:58:37	28.761	0.81	0.361	0.205	2.023	0.265	0.927	3.341	0.065	0.011	0.020	0.213	0.014	0.074
950	30	R1P2	16:00:05	16:02:59	18.924	0.83	0.743	0.237	1.521	0.332	2.410	3.313	0.100	0.033	0.035	0.241	0.027	0.290
951	7	R1P2	16:03:57	16:12:41	19.071	0.79	1.591	0.276	1.286	0.272	2.203	3.356	0.095	0.070	0.041	0.205	0.022	0.267

Note:

1. The test point No. defines the sequential engine testing conditions. It is a combination of the last digit in the date between April 20 and 29 and a sequence number of test point for that day. If the test point number is 305, the test point was for the 5th test point on April 23.
2. In probe ID, "R1" and "R2" stand for sampling rake at 1 m and 10 m sampling locations, respectively. G1 to 6 stands for gas sampling probe tip # 1 to 6.
3. The "EI" stands for emission index.

TABLE A-4.—AIRCRAFT CFM56-2-C1 ENGINE GAS EMISSION DATA MEASURED WITH THE ARI TUNABLE INFRARED LASER DIFFERENTIAL ABSORPTION SPECTROMETER (TILDAS) DURING APEX.

Test Point No.[1]	Power	Sampling time and probe location					CO_2 Conc by NDIR[4]	Gaseous emission index			
		Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	Probe Rake Location[2]	Probe Tip No[3]		formaldehyde (HCHO)	ethylene (C_2H_4)	nitrogen dioxide (NO_2)	nitrous acid (HONO)
	%						ppm	g/kg fuel	g/kg fuel	g/kg fuel	g NO2/kg fuel
301	7	301	9:23:27	9:26:01	1	P1	2081 ± 72.92	0.597 ± 0.030	0.797 ± 0.041	2.590 ± 0.126	0.027 ± 0.016
	7	302	9:27:00	9:28:30	1	P2	2235 ± 30.77	0.500 ± 0.010	0.788 ± 0.033	2.549 ± 0.046	-0.018 ± -0.015
	7	303	9:28:59	9:31:01	1	P3	2279 ± 50.53	0.393 ± 0.012	0.720 ± 0.042	2.329 ± 0.062	-0.032 ± -0.012
	7	304	9:31:29	9:33:31	1	P4	2144 ± 10.83	0.392 ± 0.010	0.840 ± 0.030	2.305 ± 0.022	-0.055 ± -0.011
	7	305	9:34:29	9:36:01	1	P5	2118 ± 28.72	0.421 ± 0.011	0.886 ± 0.033	2.330 ± 0.041	-0.068 ± -0.010
	7	306	9:36:59	9:38:31	1	P6	2203 ± 6.854	0.427 ± 0.012	0.984 ± 0.040	2.331 ± 0.029	-0.121 ± -0.021
	7	307	9:38:59	9:42:01	10	0	1502 ± 114.8	0.268 ± 0.010	0.641 ± 0.033	1.835 ± 0.542	0.174 ± 0.161
	7	308	9:42:59	9:45:01	30	0	389 ± 0.255	-3.904 ± -0.196	134.5 ± 6.721	0.329 ± 0.046	6.114 ± 0.886
302	30	309	9:48:30	9:50:31	1	P1	2619 ± 24.30	-0.003 ± -0.000	0.570 ± 0.017	0.923 ± 0.015	0.324 ± 0.007
	30	310	9:51:00	9:52:31	1	P2	3202 ± 20.73	0.001 ± 0.002	0.472 ± 0.014	0.891 ± 0.013	0.319 ± 0.007
	30	312	10:04:00	10:06:01	1	P1	2023 ± 18.37	-0.001 ± -0.002	0.742 ± 0.028	0.946 ± 0.015	0.417 ± 0.013
	30	313	10:06:59	10:08:31	1	P2	2444 ± 28.60	-0.004 ± -0.000	0.584 ± 0.022	0.938 ± 0.016	0.446 ± 0.011
	30	314	10:09:29	10:11:01	1	P3	2302 ± 7.872	0.001 ± 0.005	0.618 ± 0.017	0.983 ± 0.010	0.474 ± 0.005
	30	315	10:11:59	10:13:01	1	P4	1816 ± 11.09	0.017 ± 0.005	0.870 ± 0.025	1.086 ± 0.012	0.472 ± 0.007
	30	316	10:13:59	10:17:01	1	P5	1760 ± 6.539	0.025 ± 0.010	0.830 ± 0.040	1.151 ± 0.011	0.476 ± 0.008
	30	317	10:17:29	10:19:01	1	P6	2010 ± 12.78	0.019 ± 0.013	0.696 ± 0.027	1.102 ± 0.011	0.486 ± 0.024
	30	318	10:19:59	10:22:01	10	0	2448 ± 80.68	-0.008 ± -0.004	0.678 ± 0.043	0.887 ± 0.058	0.501 ± 0.083
	30	319	10:22:59	10:25:01	30	0	972 ± 57.98	-0.047 ± -0.005	2.161 ± 0.231	0.960 ± 0.034	0.376 ± 0.015
303	40	321	10:41:59	10:44:01	1	P1	2083 ± 26.92	0.002 ± 0.000	0.849 ± 0.030	0.993 ± 0.015	0.413 ± 0.011
	40	322	10:44:30	10:46:30	1	P2	2454 ± 22.95	0.006 ± 0.007	0.814 ± 0.025	0.975 ± 0.016	0.417 ± 0.024
	40	323	10:46:59	10:48:31	1	P3	2388 ± 11.64	0.003 ± 0.002	0.930 ± 0.027	1.013 ± 0.007	0.476 ± 0.005
	40	324	10:48:59	10:50:31	1	P4	1804 ± 18.88	0.026 ± 0.010	1.345 ± 0.036	1.119 ± 0.019	0.456 ± 0.011
	40	325	10:51:29	10:53:01	1	P5	1736 ± 5.479	0.038 ± 0.005	1.508 ± 0.030	1.195 ± 0.005	0.417 ± 0.014
	40	326	10:53:59	10:55:29	1	P6	1985 ± 18.66	0.031 ± 0.001	1.398 ± 0.023	1.147 ± 0.013	0.348 ± 0.015
	40	327	10:55:59	10:58:31	10	0	2635 ± 80.01	0.014 ± 0.000	1.377 ± 0.051	0.973 ± 0.059	0.258 ± 0.031
	40	328	10:59:00	11:02:31	30	0	955 ± 66.37	0.023 ± 0.003	4.998 ± 0.579	1.005 ± 0.018	-0.161 ± -0.096

TABLE A-4.—(Continued).

Test Point No.[1]	Power %	Sampling time and probe location: Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	Probe Rake Location[2]	Probe Tip No[3]	CO_2 Conc by NDIR[4] ppm	Gaseous emission index: formaldehyde (HCHO) g/kg fuel	ethylene (C_2H_4) g/kg fuel	nitrogen dioxide (NO_2) g/kg fuel	nitrous acid (HONO) g NO2/kg fuel
304	30	329	11:03:59	11:05:31	30	0	987 ± 64.37	0.032 ± 0.008	4.843 ± 0.514	1.133 ± 0.021	-0.279 ± -0.092
	30	330	11:06:00	11:09:01	10	0	2540 ± 83.66	0.013 ± 0.002	1.501 ± 0.059	0.847 ± 0.026	0.083 ± 0.024
	30	331	11:09:59	11:13:00	1	P2	2181 ± 20.10	0.012 ± 0.003	1.376 ± 0.019	1.057 ± 0.013	0.139 ± 0.064
305	7	332	11:14:00	11:18:31	1	P2	1800 ± 77.52	0.309 ± 0.028	2.138 ± 0.097	2.568 ± 0.149	-0.411 ± -0.027
	7	333	11:19:29	11:21:31	10	0	1703 ± 124.4	0.343 ± 0.072	2.850 ± 0.274	2.559 ± 0.086	-0.279 ± -0.107
	7	334	11:22:29	11:25:31	30	0	891 ± 213.6	0.379 ± 0.010	0.558 ± 0.009	2.893 ± 0.045	-0.245 ± -0.201
	7	335	11:28:30	11:31:30	1	P2	871 ± 8.114	0.361 ± 0.012	3.558 ± 0.045	2.702 ± 0.044	-0.328 ± -0.057
	7	336	11:32:59	11:36:01	1	P2	2476 ± 24.05	0.282 ± 0.009	1.573 ± 0.023	2.517 ± 0.040	-0.458 ± -0.034
	7	337	11:37:29	11:39:31	1	P2	4422 ± 114.7	0.292 ± 0.012	1.034 ± 0.032	2.184 ± 0.076	-0.247 ± -0.021
306	7	339	14:51:22	14:52:46	1	P3	1968 ± 34.32	1.014 ± 0.046	2.241 ± 0.080	2.962 ± 0.072	-0.751 ± -0.069
	7	340	14:54:29	14:56:01	1	P1	1509 ± 40.74	0.387 ± 0.018	1.444 ± 0.056	2.760 ± 0.113	-0.224 ± -0.024
	7	341	14:56:59	14:58:31	1	P6	1926 ± 9.883	0.349 ± 0.009	1.159 ± 0.034	2.609 ± 0.018	-0.254 ± -0.016
	7	342	14:59:59	15:02:31	10	0	2219 ± 57.33	0.411 ± 0.026	1.290 ± 0.054	3.011 ± 0.206	-0.175 ± -0.044
307	30	343	15:04:00	15:06:31	1	P1	1504 ± 57.85	0.025 ± 0.002	0.883 ± 0.047	1.115 ± 0.056	0.196 ± 0.019
	30	344	15:07:29	15:09:01	1	P2	1946 ± 12.38	0.013 ± 0.001	0.662 ± 0.027	1.107 ± 0.012	0.263 ± 0.014
	30	345	15:09:29	15:11:01	1	P3	1909 ± 12.77	0.018 ± 0.003	0.646 ± 0.023	1.147 ± 0.012	0.308 ± 0.012
	30	346	15:11:59	15:14:01	1	P4	1567 ± 12.18	0.031 ± 0.002	0.816 ± 0.035	1.239 ± 0.014	0.287 ± 0.011
	30	347	15:14:30	15:16:31	1	P5	1575 ± 6.678	0.052 ± 0.013	0.863 ± 0.060	1.305 ± 0.011	0.280 ± 0.011
	30	348	15:16:59	15:18:31	1	P6	1738 ± 26.57	0.039 ± 0.003	0.731 ± 0.038	1.280 ± 0.024	0.300 ± 0.012
	30	350	15:21:29	15:25:31	30	0	1103 ± 41.82	0.032 ± 0.003	1.572 ± 0.113	1.046 ± 0.025	0.262 ± 0.032
308	40	351	15:26:29	15:28:31	30	0	1182 ± 46.52	0.021 ± 0.002	1.383 ± 0.116	0.971 ± 0.028	0.348 ± 0.033
	40	352	15:29:29	15:32:00	10	0	3005 ± 139.2	0.013 ± 0.001	0.453 ± 0.038	0.871 ± 0.011	0.475 ± 0.014
308b	40	353	15:32:59	15:35:31	1	P1	1691 ± 18.85	0.019 ± 0.002	0.689 ± 0.038	1.050 ± 0.015	0.315 ± 0.015
	40	354	15:36:29	15:38:01	1	P2	2444 ± 33.12	0.012 ± 0.001	0.471 ± 0.027	1.016 ± 0.016	0.337 ± 0.011
	40	355	15:38:59	15:40:31	1	P3	2349 ± 66.82	0.011 ± 0.001	0.517 ± 0.033	1.043 ± 0.036	0.376 ± 0.016
308c	40	356	15:41:29	15:43:00	1	P4	1861 ± 36.78	0.029 ± 0.001	0.761 ± 0.029	1.144 ± 0.026	0.359 ± 0.018
	40	357	15:43:29	15:45:01	1	P5	1791 ± 34.38	0.046 ± 0.002	0.749 ± 0.031	1.235 ± 0.029	0.342 ± 0.013
	40	358	15:45:30	15:47:01	1	P6	2056 ± 33.17	0.035 ± 0.003	0.584 ± 0.029	1.187 ± 0.023	0.360 ± 0.022
309	30	359	15:48:00	15:50:01	1	P3	1747 ± 39.20	0.017 ± 0.001	0.674 ± 0.028	1.201 ± 0.035	0.303 ± 0.015
	30	360	15:50:59	15:55:01	10	0	2633 ± 64.37	0.018 ± 0.001	0.585 ± 0.024	0.887 ± 0.038	0.332 ± 0.014
	30	361	15:55:59	16:01:00	30	0	1113 ± 37.22	0.023 ± 0.002	1.470 ± 0.095	0.897 ± 0.028	0.248 ± 0.029

TABLE A-4.—(Continued).

Test Point No.[1]	Power	Sampling time and probe location					CO_2 Conc by NDIR[4]	Gaseous emission index			
		Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	Probe Rake Location[2]	Probe Tip No[3]		formaldehyde (HCHO)	ethylene (C_2H_4)	nitrogen dioxide (NO_2)	nitrous acid (HONO)
	%						ppm	g/kg fuel	g/kg fuel	g/kg fuel	g NO2/kg fuel
310	7	362	16:01:30	16:04:00	30	0	1039 ± 49.66	0.551 ± 0.087	2.275 ± 0.222	3.259 ± 0.089	-0.133 ± -0.026
	7	363	16:04:29	16:06:01	10	0	2253 ± 121.0	0.346 ± 0.014	1.113 ± 0.083	2.382 ± 0.079	0.082 ± 0.017
	7	364	16:06:59	16:09:31	1	P3	1359 ± 13.66	0.338 ± 0.008	1.251 ± 0.094	2.577 ± 0.041	-0.040 ± -0.013
	7	365	16:10:29	16:11:31	1	P3	1395 ± 5.794	0.869 ± 0.019	2.113 ± 0.038	2.989 ± 0.018	-0.247 ± -0.017
501	4	501	11:15:16	11:16:08	30	0	1091 ± 362.7	4.022 ± 3.796		2.234 ± 1.639	0.712 ± 0.747
	4	501	11:16:29	11:20:01	30	0	1063 ± 48.16	1.837 ± 0.090		2.596 ± 0.061	0.329 ± 0.116
502	65	502	11:22:59	11:25:01	1	P1	2096 ± 70.08	0.003 ± 0.000		1.079 ± 0.050	0.490 ± 0.024
	65	503	11:25:59	11:27:31	1	P2	2991 ± 50.33	0.001 ± 0.001		1.045 ± 0.025	0.517 ± 0.012
	65	504	11:28:29	11:29:31	1	P3	2924 ± 68.44	0.001 ± 0.000		1.040 ± 0.036	0.528 ± 0.018
	65	505	11:30:29	11:32:00	1	P4	2525 ± 52.56	0.009 ± 0.001		1.098 ± 0.029	0.533 ± 0.015
	65	506	11:32:29	11:34:30	1	P5	2043 ± 64.70	0.041 ± 0.002		1.282 ± 0.056	0.503 ± 0.025
	65	507	11:35:00	11:36:30	1	P6	2262 ± 30.09	0.034 ± 0.002		1.250 ± 0.030	0.482 ± 0.009
	65	508	11:36:59	11:39:31	10	0	3817 ± 121.4	0.013 ± 0.001		0.923 ± 0.063	0.514 ± 0.023
	65	509	11:39:59	11:42:31	30	0	1369 ± 46.89	0.027 ± 0.002		1.080 ± 0.033	0.618 ± 0.033
503	70	511	11:43:29	11:47:01	1	P3	1611 ± 72.63	0.033 ± 0.002		1.351 ± 0.092	0.529 ± 0.038
504	65	512	11:48:29	11:50:31	1	P3	1420 ± 38.75	0.032 ± 0.002		1.310 ± 0.058	0.533 ± 0.022
505	60	513	11:51:29	11:53:31	1	P3	1179 ± 63.97	0.033 ± 0.002		1.246 ± 0.093	0.490 ± 0.048
506	85	514	11:54:59	11:57:01	1	P3	2170 ± 85.04	0.028 ± 0.001		1.445 ± 0.072	0.488 ± 0.030
507	100	515	11:57:59	11:59:30	1	P3	2516 ± 62.15	0.023 ± 0.000		1.492 ± 0.052	0.465 ± 0.013
508	7	517	12:06:29	12:10:31	1	P3	2237 ± 16.88	0.280 ± 0.012		2.365 ± 0.022	0.138 ± 0.006
	7	518	12:16:29	12:18:31	1	P3	858 ± 23.65	0.235 ± 0.010		2.347 ± 0.090	-0.007 ± -0.015
	7	519	12:19:29	12:22:31	10	0	2298 ± 87.01	0.194 ± 0.011		2.057 ± 0.087	0.236 ± 0.019
509	100	520	12:24:00	12:24:31	10	0	5251 ± 88.53	0.005 ± 0.000		0.668 ± 0.080	0.462 ± 0.010
510	85	521	12:25:00	12:26:30	10	0	4890 ± 116.3	0.005 ± 0.000		0.800 ± 0.038	0.334 ± 0.026
511	85	524	13:22:29	13:24:31	10	0	5109 ± 103.0	0.011 ± 0.000		0.906 ± 0.043	0.399 ± 0.013
512	30	525	13:25:31	13:29:01	10	0	2624 ± 59.34	0.013 ± 0.001		0.950 ± 0.023	0.323 ± 0.014
513	7	526	13:30:29	13:34:31	10	0	2313 ± 84.41	0.338 ± 0.024		2.045 ± 0.078	-0.014 ± -0.021
	7	527	13:36:00	13:55:31	30	0	1036 ± 144.7	0.284 ± 0.002		2.799 ± 0.022	-0.309 ± -0.075
514	100	531	14:01:00	14:02:00	30	0	1630 ± 108.2	-0.002 ± -0.001		1.862 ± 0.100	0.641 ± 0.022
515	30	532	14:03:29	14:06:01	30	0	1146 ± 51.93	-0.000 ± -0.003		1.111 ± 0.026	0.325 ± 0.015
516	7	533	14:08:29	14:10:01	30	0	1013 ± 55.95	0.208 ± 0.012		2.511 ± 0.063	-0.107 ± -0.023
517	85	534	14:10:59	14:12:31	30	0	1694 ± 50.42	-0.001 ± -0.002		1.405 ± 0.072	0.453 ± 0.025

TABLE A-4.—(Continued).

Test Point No.[1]	Power	Sampling time and probe location					CO_2 Conc by NDIR[4]	Gaseous emission index			
		Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	Probe Rake Location[2]	Probe Tip No[3]		formaldehyde (HCHO)	ethylene (C_2H_4)	nitrogen dioxide (NO_2)	nitrous acid (HONO)
	%						ppm	g/kg fuel	g/kg fuel	g/kg fuel	g NO2/kg fuel
518	7	535	14:13:29	14:18:01	30	0	996 ± 73.15	0.196 ± 0.009		2.570 ± 0.031	-0.095 ± -0.027
	7	536	14:21:59	14:29:01	1	P3	1504 ± 10.92	0.156 ± 0.007		2.320 ± 0.029	0.091 ± 0.009
519	100	537	14:30:29	14:31:31	1	P3	2756 ± 155.8	-0.003 ± -0.000		1.443 ± 0.115	0.489 ± 0.033
520	85	538	14:31:59	14:35:01	1	P3	2008 ± 157.8	-0.005 ± -0.001		1.396 ± 0.162	0.518 ± 0.053
521	30	539	14:36:29	14:44:31	1	P3	2132 ± 114.6	0.002 ± 0.001		1.193 ± 0.088	0.382 ± 0.034
522	7	540	14:45:59	14:51:01	1	P3	1712 ± 28.49	0.158 ± 0.004		2.376 ± 0.057	0.146 ± 0.006
	7	541	14:51:59	14:57:01	1	P3	4768 ± 43.33	0.127 ± 0.004		2.042 ± 0.023	0.152 ± 0.003
	7	542	14:59:59	15:05:31	1	P3	2077 ± 9.095	0.148 ± 0.004		2.357 ± 0.015	0.175 ± 0.005
	7	543	15:06:59	15:12:01	1	P3	925 ± 8.802	0.135 ± 0.005		2.411 ± 0.033	0.201 ± 0.010
	7	544	15:15:29	15:19:01	1	P3	543 ± 9.897	0.132 ± 0.005		2.446 ± 0.061	0.247 ± 0.018
	7	545	15:20:29	15:24:01	1	P3	306 ± 8.221	0.132 ± 0.007		2.458 ± 0.087	0.364 ± 0.031
	7	546	15:25:29	15:29:01	1	P3	5.74 ± 3.213	-0.515 ± -1.391		-0.071 ± -0.430	5.607 ± 8.415
	7	547	15:29:59	15:34:31	10	0	2333 ± 74.21	0.206 ± 0.024		2.067 ± 0.059	0.325 ± 0.034
	7	548	15:36:59	15:41:31	10	0	1143 ± 39.61	0.104 ± 0.116		2.154 ± 0.711	0.053 ± 0.506
	7	549	15:42:59	15:47:31	10	0	513 ± 25.94	0.222 ± 0.017		2.043 ± 0.038	-0.177 ± -0.069
523	100	550	15:52:00	15:53:01	10	0	2275 ± 63.07	0.002 ± 0.006		1.425 ± 0.100	0.331 ± 0.316
524	85	551	15:53:29	15:55:31	10	0	2135 ± 43.35	0.001 ± 0.000		0.964 ± 0.071	0.490 ± 0.018
525	30	552	15:55:59	15:59:31	10	0	1197 ± 26.46	0.005 ± 0.001		0.848 ± 0.046	0.330 ± 0.018
526	7	553	16:00:48	16:04:01	10	0	1075 ± 32.67	0.208 ± 0.011		1.890 ± 0.049	0.017 ± 0.011
	7	554	16:05:29	16:09:01	10	0	252 ± 14.70	0.283 ± 0.026		2.092 ± 0.034	-0.414 ± -0.085
	7	555	16:09:59	16:13:01	10	0	161 ± 4.432	0.295 ± 0.017		2.345 ± 0.066	-0.957 ± -0.070
601	7	602	8:11:02	8:13:02	30	0	983 ± 34.70	0.762 ± 0.043		3.151 ± 0.108	-0.157 ± -0.040
	7	603	8:15:31	8:19:01	10	0	2029 ± 49.73	0.650 ± 0.061		3.050 ± 0.140	-0.511 ± -0.144
	7	604	8:20:01	8:23:02	10	0	1024 ± 21.34	0.517 ± 0.116		3.275 ± 0.148	-0.589 ± -0.344
	7	605	8:27:09	8:27:40	10	0	1988 ± 37.72	0.603 ± 0.018		2.440 ± 0.152	-0.346 ± -0.061
602	100	606	8:28:36	8:29:17	10	0	5109 ± 66.79	0.003 ± 0.002		1.004 ± 0.106	0.499 ± 0.017
603	85	607	8:29:30	8:31:30	10	0	4799 ± 73.75	0.006 ± 0.003		0.740 ± 0.035	0.511 ± 0.032
	30	608	8:32:32	8:36:31	10	0	2486 ± 41.54	0.014 ± 0.008		1.029 ± 0.039	0.481 ± 0.053

TABLE A-4.—(Continued).

Test Point No.[1]	Power %	Sampling time and probe location: Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	Probe Rake Location[2]	Probe Tip No[3]	CO_2 Conc by NDIR[4] ppm	Gaseous emission index: formaldehyde (HCHO) g/kg fuel	ethylene (C_2H_4) g/kg fuel	nitrogen dioxide (NO_2) g/kg fuel	nitrous acid (HONO) g NO2/kg fuel
605	7	609	8:37:30	8:41:01	10	0	2079 ± 61.05	0.732 ± 0.038		2.669 ± 0.059	0.186 ± 0.095
	7	610	8:43:00	8:47:30	10	0	526 ± 19.61	0.902 ± 0.048		2.494 ± 0.070	0.221 ± 0.343
	7	611	8:49:32	8:52:01	10	0	265 ± 13.31	0.544 ± 0.110		2.696 ± 0.104	0.475 ± 0.798
	7	612	8:53:31	8:57:01	1	P3	1447 ± 18.19	0.488 ± 0.011		2.854 ± 0.064	0.201 ± 0.066
	7	613	8:58:00	9:00:33	1	P6	1525 ± 7.375	0.509 ± 0.006		2.850 ± 0.023	-0.048 ± -0.047
	7	614	9:01:30	9:04:01	10	0	280 ± 26.09	0.544 ± 0.009		2.624 ± 0.027	0.142 ± 0.078
606	100	615	9:04:32	9:05:02	10	0	1016 ± 26.30	0.008 ± 0.001		0.844 ± 0.090	0.568 ± 0.022
607	85	616	9:05:31	9:07:32	10	0	897 ± 39.38	-0.007 ± -0.016		1.195 ± 0.038	0.560 ± 0.086
608	30	617	9:09:02	9:12:32	10	0	817 ± 19.99	-0.027 ± -0.003		0.983 ± 0.029	0.480 ± 0.031
609	7	618	9:14:02	9:17:31	10	0	994 ± 30.27	0.654 ± 0.033		2.442 ± 0.066	0.050 ± 0.039
	7	619	9:18:31	9:30:02	30	0	878 ± 43.10	0.400 ± 0.013		2.214 ± 0.045	-0.289 ± -0.107
610	100	620	9:39:31	9:40:01	1	P3	3663 ± 504.1	-0.000 ± -0.001		1.269 ± 0.228	0.422 ± 0.088
611	85	621	9:41:00	9:43:01	1	P3	1497 ± 57.89	-0.004 ± -0.000		1.361 ± 0.070	0.507 ± 0.025
612	30	622	9:45:00	9:48:01	1	P3	2155 ± 44.68	0.001 ± 0.000		1.261 ± 0.032	0.300 ± 0.008
613	7	623	9:50:00	9:52:01	1	P3	1835 ± 8.198	0.292 ± 0.003		2.629 ± 0.016	-0.042 ± -0.013
	7	624	9:53:31	10:14:33	30	0	878 ± 51.77	0.338 ± 0.005		2.861 ± 0.016	-0.325 ± -0.084
614	100	625	10:15:32	10:16:18	30	0	1804 ± 41.42	-0.009 ± -0.001		1.240 ± 0.102	0.384 ± 0.038
615	85	626	10:16:32	10:18:32	30	0	1653 ± 63.31	-0.010 ± -0.001		1.295 ± 0.024	0.315 ± 0.018
616	30	627	10:19:32	10:23:32	30	0	973 ± 36.64	-0.009 ± -0.004		1.198 ± 0.015	0.337 ± 0.017
617	7	628	10:24:01	10:27:02	30	0	764 ± 58.06	0.333 ± 0.086		2.628 ± 0.051	0.029 ± 0.030
	7	629	10:28:01	10:31:32	1	P1	1385 ± 75.59	0.298 ± 0.018		2.502 ± 0.226	0.124 ± 0.087
	7	630	10:32:11	10:34:32	1	P3	1756 ± 30.20	0.208 ± 0.005		2.355 ± 0.056	-0.013 ± -0.009
	7	631	10:36:06	10:37:32	1	P6	1853 ± 9.361	0.217 ± 0.004		2.356 ± 0.014	0.031 ± 0.013
618	4	632	11:53:32	11:59:32	30	0	1080 ± 129.1	0.947 ± 0.021		3.197 ± 0.031	0.022 ± 0.114
619	100	633	12:01:01	12:01:32	30	0	1731 ± 62.95	0.006 ± 0.001		1.267 ± 0.051	0.348 ± 0.033
620	85	634	12:02:33	12:05:02	30	0	1612 ± 62.02	0.006 ± 0.001		1.217 ± 0.029	0.413 ± 0.022
621	65	635	12:05:31	12:09:01	30	0	1424 ± 51.42	0.012 ± 0.001		1.337 ± 0.036	0.438 ± 0.017
622	40	636	12:10:02	12:13:31	30	0	1172 ± 60.61	0.024 ± 0.003		1.108 ± 0.013	0.449 ± 0.059
623	4	637	12:14:00	12:14:30	30	0	634 ± 205.0	1.108 ± 1.213		3.694 ± 3.916	0.344 ± 0.326
	4	638	12:17:30	12:19:31	10	0	369 ± 25.57	0.859 ± 0.018		2.747 ± 0.081	-0.027 ± -0.062
		639	12:19:30	12:20:00	1	P3	407 ± 413.9	0.965 ± 1.124		1.976 ± 2.186	0.205 ± 0.404

TABLE A-4.—(Continued).

Test Point No.[1]	Power	Sampling time and probe location					CO_2 Conc by NDIR[4]	Gaseous emission index			
		Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	Probe Rake Location[2]	Probe Tip No[3]		formaldehyde (HCHO)	ethylene (C_2H_4)	nitrogen dioxide (NO_2)	nitrous acid (HONO)
	%						ppm	g/kg fuel	g/kg fuel	g/kg fuel	g NO2/kg fuel
624	40	640	12:21:01	12:24:01	1	P3	1512 ± 33.90	0.013 ± 0.002		1.100 ± 0.033	0.451 ± 0.018
	40	641	12:25:01	12:28:01	1	P3	3433 ± 69.69	0.005 ± 0.001		1.079 ± 0.027	0.403 ± 0.018
	40	642	12:30:00	12:31:30	1	P3	315 ± 13.67	0.029 ± 0.005		0.965 ± 0.058	0.446 ± 0.042
	40	643	12:36:00	12:38:31	1	P3	712 ± 22.78	0.005 ± 0.002		1.238 ± 0.053	0.375 ± 0.023
	40	644	12:39:31	12:41:31	1	P3	3952 ± 63.30	-0.000 ± -0.000		1.092 ± 0.023	0.325 ± 0.007
625	30	645	12:43:31	12:46:30	1	P3	1728 ± 13.31	0.001 ± 0.001		1.321 ± 0.013	0.264 ± 0.014
626	15	646	12:47:30	12:50:01	1	P3	1343 ± 7.203	0.060 ± 0.005		1.841 ± 0.014	0.145 ± 0.021
627	7	647	12:51:01	12:54:30	1	P3	1290 ± 12.22	0.202 ± 0.004		2.497 ± 0.030	0.032 ± 0.013
628	5.5	648	12:55:30	12:59:02	1	P3	1328 ± 14.98	0.443 ± 0.012		3.110 ± 0.040	-0.003 ± -0.025
629	4	649	13:00:00	13:01:31	1	P3	1344 ± 7.814	0.692 ± 0.010		3.233 ± 0.023	0.012 ± 0.015
	4	651	13:07:31	13:11:00	30	0	1118 ± 106.8	0.823 ± 0.023		3.203 ± 0.029	0.072 ± 0.126
630	5.5	652	13:11:31	13:15:00	30	0	1017 ± 66.48	0.374 ± 0.016		3.318 ± 0.029	-0.076 ± -0.024
631	7	653	13:15:31	13:18:31	30	0	1000 ± 95.13	0.298 ± 0.009		2.966 ± 0.043	-0.008 ± -0.019
632	15	654	13:19:30	13:22:31	30	0	974 ± 80.12	0.051 ± 0.002		1.767 ± 0.019	0.199 ± 0.012
633	30	655	13:23:31	13:27:01	30	0	1155 ± 89.71	0.003 ± 0.002		1.240 ± 0.010	0.442 ± 0.009
634	4	656	13:27:31	13:35:01	30	0	1084 ± 90.77	0.795 ± 0.023		3.345 ± 0.031	-0.209 ± -0.095
635	40	657	13:39:01	13:42:31	30	0	1254 ± 62.93	0.009 ± 0.005		1.127 ± 0.013	0.216 ± 0.009
	40	658	13:43:02	13:47:31	10	0	3156 ± 82.82	0.011 ± 0.000		0.636 ± 0.023	0.159 ± 0.004
	40	659	13:49:31	13:53:00	10	0	1236 ± 26.51	0.014 ± 0.001		0.959 ± 0.015	0.200 ± 0.008
	40	660	13:53:31	13:57:31	10	0	466 ± 20.38	0.021 ± 0.004		1.029 ± 0.018	0.181 ± 0.019
636	30	661	13:59:01	14:02:31	10	0	1745 ± 52.73	0.012 ± 0.001		0.992 ± 0.020	0.179 ± 0.008
637	15	662	14:03:30	14:06:32	10	0	1492 ± 56.69	0.090 ± 0.007		1.255 ± 0.041	0.091 ± 0.013
638	7	663	14:08:00	14:11:30	10	0	1768 ± 52.22	0.381 ± 0.022		2.444 ± 0.071	0.045 ± 0.007
639	5.5	664	14:12:30	14:16:30	10	0	1734 ± 90.95	0.346 ± 0.015		2.841 ± 0.042	0.040 ± 0.032
640	4	665	14:18:31	14:21:00	10	0	1744 ± 71.21	0.589 ± 0.038		2.888 ± 0.054	0.017 ± 0.012
641	5.5	667	14:26:00	14:29:01	30	0	881 ± 100.1	0.397 ± 0.006		3.333 ± 0.038	0.062 ± 0.003
642	7	668	14:30:32	14:33:01	30	0	849 ± 88.12	0.242 ± 0.005		2.810 ± 0.043	0.064 ± 0.003
643	15	669	14:34:42	14:37:31	30	0	1095 ± 77.46	0.040 ± 0.002		1.638 ± 0.026	0.089 ± 0.004
701	4	701	8:03:30	8:08:30	10	0	726 ± 22.66	2.849 ± 0.302		2.594 ± 0.136	-0.568 ± -0.195
702	100	702	8:08:59	8:10:30	10	0	2059 ± 55.04	0.017 ± 0.001		0.844 ± 0.031	0.318 ± 0.026
703	85	703	8:11:00	8:13:30	10	0	1756 ± 36.16	0.017 ± 0.001		1.001 ± 0.021	0.523 ± 0.019
704	65	704	8:14:30	8:18:00	10	0	1402 ± 48.65	0.022 ± 0.001		1.009 ± 0.012	0.524 ± 0.013

TABLE A-4.—(Continued).

Test Point No.[1]	Power %	Sampling time and probe location: Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	Probe Rake Location[2]	Probe Tip No[3]	CO_2 Conc by NDIR[4] ppm	Gaseous emission index: formaldehyde (HCHO) g/kg fuel	ethylene (C_2H_4) g/kg fuel	nitrogen dioxide (NO_2) g/kg fuel	nitrous acid (HONO) g NO2/kg fuel
705	4	705	8:19:00	8:23:30	10	0	1981 ± 58.98	2.089 ± 0.089		2.343 ± 0.026	-0.164 ± -0.102
	4	706	8:24:30	8:27:30	1	P3	978 ± 8.921	1.689 ± 0.019		2.736 ± 0.069	-0.435 ± -0.088
706	100	707	8:28:00	8:29:30	1	P3	2858 ± 167.7	0.012 ± 0.001		1.268 ± 0.096	0.482 ± 0.040
707	85	708	8:29:30	8:32:30	1	P3	2312 ± 92.96	0.011 ± 0.001		1.256 ± 0.074	0.496 ± 0.026
708	70	709	8:33:30	8:36:30	1	P3	1448 ± 11.70	0.014 ± 0.001		1.143 ± 0.015	0.488 ± 0.020
709	65	710	8:37:30	8:40:00	1	P3	1224 ± 30.88	0.018 ± 0.001		1.096 ± 0.040	0.455 ± 0.023
710	60	711	8:42:00	8:44:00	1	P3	929 ± 28.60	0.022 ± 0.002		1.087 ± 0.046	0.419 ± 0.036
711	4	712	8:46:00	8:52:00	1	P3	2333 ± 96.15	1.435 ± 0.085		2.733 ± 0.151	-0.326 ± -0.081
	4	713	8:53:00	8:56:30	1	P3	6.36 ± 1.104	-0.339 ± -0.468		-0.423 ± -0.640	-0.649 ± -4.147
712	100	714	8:57:30	8:58:30	1	P3	2576 ± 47.61	-0.000 ± -0.000		1.304 ± 0.032	0.553 ± 0.020
713	85	715	8:59:30	9:01:00	1	P3	2103 ± 50.61	-0.002 ± -0.000		1.276 ± 0.049	0.576 ± 0.017
714	65	716	9:03:30	9:06:30	1	P3	1535 ± 58.09	-0.001 ± -0.001		1.089 ± 0.058	0.555 ± 0.031
715	4	717	9:08:00	9:11:30	1	P3	2190 ± 81.20	1.442 ± 0.084		2.718 ± 0.128	-0.176 ± -0.103
	4	718	9:12:00	9:15:30	10	0	1490 ± 45.17	1.730 ± 0.048		2.154 ± 0.040	-0.189 ± -0.041
716	100	719	9:16:30	9:17:30	10	0	1195 ± 31.03	-0.008 ± -0.001		1.051 ± 0.058	0.671 ± 0.056
717	85	720	9:18:30	9:21:00	10	0	1051 ± 40.45	-0.012 ± -0.001		1.124 ± 0.028	0.423 ± 0.014
718	65	721	9:22:30	9:24:30	10	0	1154 ± 41.82	-0.009 ± -0.001		1.027 ± 0.024	0.494 ± 0.022
719	4	722	9:25:30	9:28:30	10	0	1288 ± 40.17	1.618 ± 0.096		2.391 ± 0.041	0.522 ± 0.052
	4	723	9:29:00	9:32:30	30	0	931 ± 57.97	1.711 ± 0.022		2.788 ± 0.031	0.274 ± 0.132
720	100	724	9:33:30	9:34:30	30	0	1790 ± 53.66	0.018 ± 0.006		1.035 ± 0.056	0.663 ± 0.043
721	85	725	9:35:30	9:37:30	30	0	1694 ± 49.88	0.012 ± 0.002		1.186 ± 0.037	0.444 ± 0.014
722	70	726	9:38:30	9:41:30	30	0	1510 ± 45.30	0.013 ± 0.001		0.976 ± 0.023	0.508 ± 0.016
723	65	727	9:42:00	9:45:30	30	0	1458 ± 41.76	0.019 ± 0.001		0.934 ± 0.021	0.516 ± 0.020
724	60	728	9:47:00	9:49:30	30	0	1387 ± 38.68	0.029 ± 0.002		0.943 ± 0.018	0.637 ± 0.038
725	4	729	9:51:00	9:54:00	30	0	975 ± 40.86	1.420 ± 0.033		2.377 ± 0.045	0.317 ± 0.078
726	4	732	15:07:00	15:09:30	30	0	996 ± 57.37	0.869 ± 0.022	0.811 ± 0.027	2.997 ± 0.039	0.449 ± 0.012
727	100	733	15:11:00	15:12:30	30	0	1795 ± 55.79	-0.009 ± -0.001	0.033 ± 0.012	1.162 ± 0.037	0.547 ± 0.037
728	85	734	15:13:30	15:16:00	30	0	1674 ± 37.06	-0.012 ± -0.001	0.025 ± 0.012	1.060 ± 0.028	0.725 ± 0.036
729	65	735	15:16:30	15:20:00	30	0	1472 ± 41.23	-0.015 ± -0.001	0.007 ± 0.012	0.938 ± 0.023	0.459 ± 0.017
730	40	736	15:21:30	15:24:30	30	0	1192 ± 37.96	-0.021 ± -0.001	-0.009 ± -0.019	0.967 ± 0.017	0.460 ± 0.014
731	30	737	15:26:00	15:29:30	30	0	1124 ± 33.50	-0.019 ± -0.002	-0.004 ± -0.021	1.075 ± 0.019	0.384 ± 0.014
732	7	738	15:31:00	15:33:30	30	0	985 ± 43.96	0.332 ± 0.033	0.220 ± 0.042	2.392 ± 0.052	0.520 ± 0.041

TABLE A-4.—(Continued).

Test Point No.[1]	Power %	Sampling time and probe location: Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	Probe Rake Location[2]	Probe Tip No[3]	CO_2 Conc by NDIR[4] ppm	Gaseous emission index: formaldehyde (HCHO) g/kg fuel	ethylene (C_2H_4) g/kg fuel	nitrogen dioxide (NO_2) g/kg fuel	nitrous acid (HONO) g NO2/kg fuel
733	4	739	15:34:30	15:38:00	30	0	977 ± 50.18	0.820 ± 0.023	0.719 ± 0.029	3.027 ± 0.041	0.300 ± 0.012
	4	740	15:39:30	15:42:00	10	0	2631 ± 94.16	0.584 ± 0.027	0.475 ± 0.031	2.340 ± 0.051	0.527 ± 0.030
734	100	741	15:44:00	15:45:00	10	0	6573 ± 128.7	0.000 ± 0.000	0.012 ± 0.002	0.741 ± 0.021	0.385 ± 0.030
735	85	742	15:45:30	15:48:00	10	0	5939 ± 107.1	-0.001 ± -0.000	0.011 ± 0.003	0.769 ± 0.028	0.492 ± 0.012
736	65	743	15:48:30	15:52:30	10	0	4847 ± 107.3	-0.002 ± -0.000	0.004 ± 0.003	0.786 ± 0.023	0.392 ± 0.011
737	40	744	15:53:30	15:57:00	10	0	3336 ± 82.35	-0.003 ± -0.000	-0.007 ± -0.004	0.725 ± 0.023	0.399 ± 0.008
738	30	745	15:57:30	16:01:30	10	0	2870 ± 68.08	-0.001 ± -0.000	0.001 ± 0.006	0.996 ± 0.016	0.326 ± 0.008
739	7	746	16:02:30	16:06:00	10	0	2306 ± 83.08	0.291 ± 0.035	0.196 ± 0.018	2.128 ± 0.069	0.386 ± 0.028
740	4	747	16:06:30	16:08:30	10	0	2448 ± 259.7	0.769 ± 0.010	0.511 ± 0.010	2.627 ± 0.018	0.211 ± 0.012
	4	748	16:10:30	16:13:30	1	P3	1556 ± 17.18	0.641 ± 0.011	0.450 ± 0.015	2.761 ± 0.059	0.393 ± 0.028
741	100	749	16:15:00	16:16:00	1	P3	1698 ± 39.73	-0.005 ± -0.001	0.066 ± 0.013	1.436 ± 0.047	0.242 ± 0.009
742	85	750	16:16:30	16:20:00	1	P3	1688 ± 37.82	-0.009 ± -0.000	0.056 ± 0.011	1.374 ± 0.046	0.247 ± 0.007
743	70	751	16:21:30	16:24:00	1	P3	2247 ± 25.87	-0.006 ± -0.000	0.032 ± 0.007	1.189 ± 0.019	0.222 ± 0.003
744	65	752	16:25:00	16:28:00	1	P3	2029 ± 18.83	-0.005 ± -0.000	0.029 ± 0.007	1.177 ± 0.014	0.229 ± 0.007
745	60	753	16:29:30	16:31:30	1	P3	2561 ± 19.15	-0.001 ± -0.000	0.018 ± 0.005	1.128 ± 0.010	0.215 ± 0.002
746	40	754	16:33:00	16:35:30	1	P3	1844 ± 35.60	0.003 ± 0.000	0.014 ± 0.007	1.176 ± 0.028	0.212 ± 0.006
747	30	755	16:37:00	16:39:30	1	P3	1671 ± 16.20	0.002 ± 0.001	-0.187 ± -0.060	1.235 ± 0.013	0.198 ± 0.003
748	15	756	16:41:00	16:43:30	1	P3	2139 ± 23.46	0.058 ± 0.003	-0.122 ± -0.005	1.558 ± 0.018	0.109 ± 0.002
749	7	757	16:44:00	16:47:00	1	P3	2205 ± 107.7	0.188 ± 0.015	-0.043 ± -0.012	2.145 ± 0.143	0.075 ± 0.004
750	5.5	758	16:48:00	16:51:00	1	P3	2198 ± 20.08	0.342 ± 0.009	0.057 ± 0.010	2.550 ± 0.032	0.063 ± 0.001
751	4	759	16:52:00	16:54:30	1	P3	2259 ± 25.09	0.645 ± 0.032	0.284 ± 0.027	2.752 ± 0.034	0.054 ± 0.002
	4	801	8:02:31	8:05:01	1	P3	1574 ± 13.16	1.841 ± 0.073			0.021 ± 0.060
802	100	802	8:06:31	8:08:31	1	P3	1686 ± 73.39	0.002 ± 0.001			0.195 ± 0.016
803	85	803	8:09:01	8:11:31	1	P3	1697 ± 35.80	-0.003 ± -0.001			0.205 ± 0.004
804	65	804	8:12:32	8:16:01	1	P3	1181 ± 16.44	-0.005 ± -0.001			0.210 ± 0.005
805	40	805	8:17:01	8:22:02	1	P3	2526 ± 53.75	0.011 ± 0.000			0.170 ± 0.004
	40	806	8:22:31	8:26:32	1	P3	4620 ± 36.56	0.011 ± 0.000			0.148 ± 0.002
	40	807	8:28:31	8:32:31	1	P3	652 ± 35.02	0.020 ± 0.002			0.125 ± 0.013
806	30	809	8:37:30	8:40:32	1	P3	1151 ± 44.03	0.020 ± 0.001			0.155 ± 0.009
807	7	810	8:42:01	8:45:01	1	P3	1715 ± 25.47	0.373 ± 0.007			0.117 ± 0.006
808	4	811	8:46:01	8:48:32	1	P3	1797 ± 12.10	0.921 ± 0.015			0.197 ± 0.045
	4	812	8:50:02	8:52:31	10	0	1419 ± 67.20	1.081 ± 0.022	1.037 ± 0.029	2.603 ± 0.042	0.121 ± 0.048

TABLE A-4.—(Continued).

Test Point No.[1]	Power %	Sampling time and probe location: Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	Probe Rake Location[2]	Probe Tip No[3]	CO_2 Conc by NDIR[4] ppm	Gaseous emission index: formaldehyde (HCHO) g/kg fuel	ethylene (C_2H_4) g/kg fuel	nitrogen dioxide (NO_2) g/kg fuel	nitrous acid (HONO) g NO2/kg fuel
809	100	813	8:54:32	8:55:32	10	0	934 ± 31.43	0.007 ± 0.001	-0.105 ± -0.010	1.158 ± 0.055	0.157 ± 0.012
810	85	814	8:56:02	8:59:01	10	0	983 ± 34.35	0.002 ± 0.001	-0.108 ± -0.009	1.103 ± 0.023	0.259 ± 0.015
811	65	815	8:59:31	9:02:32	10	0	1052 ± 29.83	-0.000 ± -0.001	-0.021 ± -0.020	0.914 ± 0.024	0.241 ± 0.010
812	40	816	9:03:32	9:07:01	10	0	1214 ± 28.23	0.001 ± 0.002	0.081 ± 0.013	1.025 ± 0.017	0.368 ± 0.021
	40	817	9:07:31	9:12:30	10	0	3495 ± 93.60	0.003 ± 0.001	0.042 ± 0.008	1.073 ± 0.040	0.221 ± 0.036
	40	818	9:13:31	9:17:32	10	0	579 ± 27.94	0.003 ± 0.004	0.556 ± 0.078	1.047 ± 0.014	0.305 ± 0.022
	40	819	9:19:01	9:23:01	10	0	2252 ± 59.36	-0.003 ± -0.000	0.127 ± 0.027	0.930 ± 0.011	0.201 ± 0.005
813	30	820	9:24:01	9:27:31	10	0	1226 ± 30.74	-0.001 ± -0.002	-0.035 ± -0.048	1.117 ± 0.018	0.175 ± 0.010
814	7	821	9:28:31	9:32:02	10	0	1210 ± 31.37	0.460 ± 0.034	0.100 ± 0.050	2.756 ± 0.085	0.209 ± 0.032
815	4	822	9:32:31	9:36:01	10	0	1463 ± 78.74	0.915 ± 0.013	0.807 ± 0.019	2.706 ± 0.030	0.431 ± 0.024
	4	823	9:36:31	9:40:02	30	0	889 ± 41.63	1.029 ± 0.022	0.940 ± 0.023	3.122 ± 0.024	0.310 ± 0.062
816	100	824	9:41:01	9:42:01	30	0	1744 ± 47.67	-0.003 ± -0.001	-0.239 ± -0.011	1.249 ± 0.036	0.237 ± 0.013
817	85	825	9:42:31	9:45:31	30	0	1656 ± 51.73	-0.003 ± -0.001	-0.248 ± -0.013	1.204 ± 0.018	0.246 ± 0.007
818	70	826	9:46:32	9:49:31	30	0	1500 ± 35.70	0.000 ± 0.001	-0.252 ± -0.014	1.115 ± 0.019	0.260 ± 0.012
819	65	827	9:50:00	9:53:01	30	0	1453 ± 42.82	0.004 ± 0.001	-0.245 ± -0.014	1.048 ± 0.017	0.275 ± 0.010
820	60	828	9:53:32	9:56:31	30	0	1388 ± 36.58	0.004 ± 0.001	-0.231 ± -0.032	1.030 ± 0.017	0.235 ± 0.008
821	40	829	9:57:30	10:00:31	30	0	1209 ± 35.35	0.015 ± 0.002	-0.172 ± -0.022	1.056 ± 0.016	0.112 ± 0.014
822	30	830	10:02:02	10:05:00	30	0	1103 ± 30.60	0.028 ± 0.002	-0.160 ± -0.018	1.135 ± 0.017	0.022 ± 0.011
823	15	831	10:05:32	10:08:32	30	0	921 ± 39.95	0.174 ± 0.017	-0.135 ± -0.034	1.980 ± 0.030	0.117 ± 0.007
824	7	832	10:09:30	10:12:31	30	0	898 ± 34.71	0.332 ± 0.015	0.149 ± 0.036	2.835 ± 0.038	-0.131 ± -0.020
825	5.5	833	10:13:01	10:16:31	30	0	886 ± 33.09	0.687 ± 0.071	0.331 ± 0.052	3.058 ± 0.037	-0.066 ± -0.025
826	4	834	10:17:01	10:21:31	30	0	869 ± 53.77	0.999 ± 0.014	0.871 ± 0.021	3.014 ± 0.029	-0.002 ± -0.042
827	4	836	12:50:31	12:53:31	30	0	836 ± 112.3	1.354 ± 0.023	1.450 ± 0.024	2.806 ± 0.028	0.104 ± 0.005
828	100	837	12:54:32	12:55:32	30	0	1739 ± 42.84	0.017 ± 0.001	-0.064 ± -0.009	1.197 ± 0.050	0.257 ± 0.012
829	85	838	12:56:02	12:58:31	30	0	1612 ± 55.46	0.017 ± 0.001	-0.066 ± -0.009	1.181 ± 0.020	0.228 ± 0.009
830	65	839	12:59:31	13:02:31	30	0	1426 ± 38.22	0.027 ± 0.001	-0.084 ± -0.012	1.057 ± 0.022	0.248 ± 0.012
831	40	840	13:03:31	13:06:31	30	0	1163 ± 39.07	0.041 ± 0.002	-0.105 ± -0.018	0.965 ± 0.016	0.209 ± 0.012
832	30	841	13:07:31	13:10:31	30	0	1076 ± 40.43	0.051 ± 0.004	0.020 ± 0.031	1.069 ± 0.015	0.210 ± 0.008
833	7	842	13:11:01	13:15:01	30	0	803 ± 79.25	0.433 ± 0.010	0.388 ± 0.014	2.971 ± 0.027	-0.007 ± -0.017
834	4	843	13:15:32	13:18:31	30	0	797 ± 119.9	0.954 ± 0.012	0.805 ± 0.027	3.061 ± 0.027	0.045 ± 0.002
	4	844	13:19:32	13:24:32	10	0	1956 ± 369.1	0.831 ± 0.007	0.737 ± 0.012	2.666 ± 0.012	0.013 ± 0.038
835	100	845	13:25:01	13:26:31	10	0	1063 ± 77.95	0.029 ± 0.002	-0.309 ± -0.026	1.350 ± 0.032	0.202 ± 0.009
836	85	846	13:27:02	13:30:01	10	0	1280 ± 70.56	0.024 ± 0.001	-0.275 ± -0.018	1.305 ± 0.019	0.186 ± 0.007

TABLE A-4.—(Continued).

Test Point No.[1]	Power %	Sampling time and probe location: Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	Probe Rake Location[2]	Probe Tip No[3]	CO_2 Conc by NDIR[4] ppm	Gaseous emission index: formaldehyde (HCHO) g/kg fuel	ethylene (C_2H_4) g/kg fuel	nitrogen dioxide (NO_2) g/kg fuel	nitrous acid (HONO) g NO2/kg fuel
837	65	847	13:30:31	13:33:31	10	0	1844 ± 54.13	0.019 ± 0.001	-0.189 ± -0.010	0.978 ± 0.015	0.256 ± 0.006
838	40	848	13:35:02	13:38:31	10	0	1987 ± 77.76	0.027 ± 0.001	-0.167 ± -0.013	0.949 ± 0.018	0.214 ± 0.006
839	30	849	13:39:01	13:42:31	10	0	1869 ± 56.47	0.034 ± 0.001	-0.145 ± -0.015	1.030 ± 0.019	0.182 ± 0.006
840	7	850	13:43:01	13:47:01	10	0	1716 ± 297.8	0.378 ± 0.007	0.314 ± 0.007	2.566 ± 0.023	0.143 ± 0.002
841	4	851	13:47:01	13:49:31	10	0	2027 ± 275.2	0.744 ± 0.013	0.818 ± 0.022	2.478 ± 0.032	0.259 ± 0.005
	4	852	13:51:01	13:54:32	1	P3	2115 ± 67.04	0.859 ± 0.044	0.679 ± 0.035	2.682 ± 0.100	0.006 ± 0.014
842	100	853	13:55:32	13:57:01	1	P3	2015 ± 89.20	0.015 ± 0.001	0.006 ± 0.006	1.390 ± 0.076	0.237 ± 0.018
843	85	854	13:57:32	14:00:32	1	P3	1941 ± 33.72	0.013 ± 0.000	0.018 ± 0.005	1.341 ± 0.035	0.241 ± 0.005
844	100	855	14:10:31	14:12:02	1	P3	2204 ± 54.57	-0.004 ± -0.000	0.158 ± 0.006	1.379 ± 0.041	0.276 ± 0.013
845	85	856	14:12:31	14:16:02	1	P3	1799 ± 16.76	-0.006 ± -0.000	0.168 ± 0.010	1.341 ± 0.018	0.276 ± 0.004
846	70	857	14:17:02	14:20:02	1	P3	2130 ± 19.01	-0.003 ± -0.000	0.125 ± 0.005	1.173 ± 0.025	0.254 ± 0.008
847	65	858	14:20:31	14:23:32	1	P3	1928 ± 21.34	-0.002 ± -0.000	0.129 ± 0.007	1.147 ± 0.018	0.257 ± 0.005
848	60	859	14:24:02	14:27:32	1	P3	1769 ± 9.005	-0.002 ± -0.000	0.163 ± 0.007	1.136 ± 0.009	0.260 ± 0.003
849	40	860	14:28:32	14:32:01	1	P3	1914 ± 48.98	0.005 ± 0.000	0.122 ± 0.007	1.148 ± 0.039	0.235 ± 0.009
850	30	861	14:33:01	14:36:02	1	P3	2614 ± 42.18	0.008 ± 0.001	0.094 ± 0.005	1.171 ± 0.023	0.196 ± 0.005
851	15	862	14:37:01	14:40:00	1	P3	2539 ± 13.98	0.070 ± 0.003	0.140 ± 0.006	1.552 ± 0.011	0.115 ± 0.005
852	7	863	14:40:30	14:43:31	1	P3	2539 ± 17.88	0.282 ± 0.006	0.276 ± 0.010	2.306 ± 0.018	0.071 ± 0.008
853	5.5	864	14:44:02	14:47:01	1	P3	2578 ± 36.53	0.388 ± 0.015	0.353 ± 0.016	2.526 ± 0.040	0.080 ± 0.006
854	4	865	14:47:31	14:50:01	1	P3	2596 ± 19.19	0.788 ± 0.018	0.701 ± 0.022	2.650 ± 0.026	0.104 ± 0.011
	4	866	14:52:31	14:56:02	1	G4	1558 ± 260.4	0.917 ± 0.197	0.793 ± 0.165	2.455 ± 0.554	0.086 ± 0.030
855	100	867	14:57:31	14:58:32	1	G4	2710 ± 74.21	0.048 ± 0.006	0.055 ± 0.005	1.499 ± 0.057	0.202 ± 0.007
856	85	868	14:59:02	15:01:32	1	G4	1647 ± 73.49	0.048 ± 0.003	0.076 ± 0.009	1.453 ± 0.089	0.215 ± 0.012
857	65	869	15:02:31	15:05:31	1	G4	2610 ± 72.43	0.046 ± 0.001	0.021 ± 0.012	1.297 ± 0.045	0.205 ± 0.009
858	40	870	15:06:31	15:09:31	1	G4	2568 ± 60.98	0.043 ± 0.001	-0.017 ± -0.005	1.194 ± 0.037	0.206 ± 0.010
859	30	871	15:10:01	15:13:31	1	G4	2771 ± 58.50	0.038 ± 0.001	-0.019 ± -0.004	1.235 ± 0.039	0.189 ± 0.007
860	7	872	15:15:01	15:18:01	1	G4	2630 ± 48.38	0.273 ± 0.010	0.192 ± 0.009	2.180 ± 0.046	0.099 ± 0.004
861	4	873	15:19:01	15:22:31	1	G4	2707 ± 67.13	0.847 ± 0.040	0.696 ± 0.036	2.579 ± 0.084	0.123 ± 0.014
	4	901	8:51:42	8:54:28	1	P3	1932 ± 36.20	2.247 ± 0.121	1.783 ± 0.092	3.044 ± 0.076	0.238 ± 0.099
902	100	902	8:58:02	8:59:00	1	P3	2022 ± 46.03	0.020 ± 0.001	-0.034 ± -0.010	1.479 ± 0.041	0.414 ± 0.023
903	85	903	9:00:03	9:03:06	1	P3	1802 ± 41.31	0.018 ± 0.000	-0.016 ± -0.009	1.447 ± 0.051	0.434 ± 0.016
904	65	904	9:04:00	9:07:05	1	P3	2075 ± 42.88	0.014 ± 0.000	-0.011 ± -0.011	1.225 ± 0.037	0.435 ± 0.016
905	40	905	9:08:00	9:11:01	1	P3	2032 ± 36.41	0.018 ± 0.001	-0.056 ± -0.029	1.265 ± 0.032	0.344 ± 0.010
906	30	906	9:11:43	9:15:00	1	P3	2561 ± 17.59	0.024 ± 0.000	-0.122 ± -0.009	1.402 ± 0.014	0.283 ± 0.006

TABLE A-4.—(Continued).

Test Point No.[1]	Power	Sampling time and probe location					CO_2 Conc by NDIR[4]	Gaseous emission index			
		Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	Probe Rake Location[2]	Probe Tip No[3]		formaldehyde (HCHO)	ethylene (C_2H_4)	nitrogen dioxide (NO_2)	nitrous acid (HONO)
	%						ppm	g/kg fuel	g/kg fuel	g/kg fuel	g NO2/kg fuel
907	7	907	9:16:40	9:19:01	1	P3	2850 ± 20.58	0.434 ± 0.006	0.186 ± 0.017	2.838 ± 0.025	0.117 ± 0.012
908	4	908	9:19:54	9:22:01	1	P3	2829 ± 100.8	1.357 ± 0.057	0.942 ± 0.042	3.187 ± 0.146	0.214 ± 0.034
	4	909	9:23:37	9:27:19	10	0	2147 ± 93.07	1.615 ± 0.034	1.792 ± 0.086	2.896 ± 0.052	0.219 ± 0.056
909	100	910	9:29:34	9:30:30	10	0	1546 ± 26.91	0.013 ± 0.001	0.069 ± 0.010	1.684 ± 0.063	0.438 ± 0.041
910	85	911	9:31:00	9:33:02	10	0	1659 ± 35.01	0.010 ± 0.001	0.071 ± 0.008	1.452 ± 0.038	0.620 ± 0.035
911	65	912	9:34:30	9:37:27	10	0	1737 ± 39.07	0.015 ± 0.002	0.059 ± 0.009	1.161 ± 0.034	0.581 ± 0.026
912	40	913	9:38:00	9:43:00	10	0	2466 ± 62.21	0.019 ± 0.001	0.030 ± 0.006	1.099 ± 0.013	0.531 ± 0.022
913	30	914	9:43:56	9:47:38	10	0	2663 ± 46.71	0.028 ± 0.001	0.025 ± 0.005	1.305 ± 0.030	0.325 ± 0.014
914	7	915	9:48:36	9:52:18	10	0	2155 ± 63.89	0.690 ± 0.032	0.571 ± 0.027	3.085 ± 0.049	-0.121 ± -0.034
915	4	916	9:53:00	9:56:01	10	0	2245 ± 71.21	1.848 ± 0.056	1.596 ± 0.063	3.157 ± 0.052	-0.769 ± -0.096
	4	917	9:56:41	10:00:55	30	0	1030 ± 61.68	1.671 ± 0.026	1.643 ± 0.035	3.317 ± 0.048	-1.345 ± -0.227
916	100	918	10:02:00	10:03:12	30	0	1776 ± 46.01	0.045 ± 0.017	-0.013 ± -0.016	1.440 ± 0.071	0.490 ± 0.045
917	85	919	10:03:56	10:07:15	30	0	1633 ± 68.69	0.029 ± 0.002	-0.050 ± -0.008	1.396 ± 0.027	0.592 ± 0.016
918	70	920	10:08:01	10:11:31	30	0	1494 ± 44.98	0.031 ± 0.001	-0.064 ± -0.011	1.358 ± 0.030	0.594 ± 0.016
919	65	921	10:12:02	10:15:02	30	0	1451 ± 45.36	0.030 ± 0.002	-0.032 ± -0.011	1.070 ± 0.055	0.548 ± 0.021
920	60	922	10:16:02	10:20:01	30	0	1379 ± 47.73	0.029 ± 0.002	-0.041 ± -0.012	1.134 ± 0.020	0.561 ± 0.014
921	40	923	10:21:32	10:24:32	30	0	1181 ± 45.36	0.029 ± 0.002	-0.126 ± -0.022	1.173 ± 0.022	0.507 ± 0.020
922	30	924	10:25:32	10:28:32	30	0	1032 ± 58.39	0.046 ± 0.005	-0.202 ± -0.025	1.391 ± 0.021	0.466 ± 0.013
923	15	925	10:29:32	10:32:32	30	0	889 ± 69.09	0.183 ± 0.010	0.265 ± 0.013	2.357 ± 0.037	-0.251 ± -0.067
924	7	926	10:34:02	10:37:02	30	0	1003 ± 43.38	0.639 ± 0.019	0.585 ± 0.026	3.079 ± 0.117	-0.108 ± -0.039
925	5.5	927	10:38:02	10:41:02	30	0	981 ± 48.01	0.850 ± 0.025	0.846 ± 0.032	3.420 ± 0.058	-0.102 ± -0.048
926	4	928	10:42:02	10:45:32	30	0	986 ± 47.49	1.533 ± 0.040	1.626 ± 0.035	2.941 ± 0.061	0.049 ± 0.078
		929	10:47:02	10:50:31	1	G1	2149 ± 173.3	1.675 ± 0.186	1.257 ± 0.151	2.465 ± 0.281	0.135 ± 0.058
927	100	930	10:53:33	10:55:02	1	G1	1946 ± 328.1	0.110 ± 0.182	0.012 ± 0.005	1.324 ± 0.270	0.289 ± 0.078
928	85	931	10:56:32	10:58:33	1	G1	1971 ± 155.7	0.001 ± 0.001	0.023 ± 0.007	1.576 ± 0.187	0.195 ± 0.021
929	65	932	10:59:32	11:03:03	1	G1	2587 ± 82.95	-0.001 ± -0.000	0.023 ± 0.005	1.466 ± 0.071	0.162 ± 0.007
930	40	933	11:04:02	11:07:02	1	G1	2981 ± 121.5	-0.001 ± -0.000	0.026 ± 0.004	1.350 ± 0.069	0.155 ± 0.013
931	30	934	11:07:32	11:11:01	1	G1	3524 ± 664.4	0.001 ± 0.001	0.018 ± 0.004	1.348 ± 0.317	0.165 ± 0.055
932	7	935	11:12:02	11:15:32	1	G1	2930 ± 125.5	0.566 ± 0.035	0.386 ± 0.026	2.673 ± 0.152	-0.042 ± -0.028
933	4	936	11:16:33	11:20:01	1	G1	2941 ± 203.6	1.754 ± 0.127	1.364 ± 0.100	2.523 ± 0.249	-0.375 ± -0.314
934	7	937	13:49:33	13:52:49	30	0	739 ± 144.7	0.484 ± 0.006	0.337 ± 0.007	3.650 ± 0.030	0.254 ± 0.006
937	75	941	14:11:02	14:14:32	30	0	1326 ± 89.99	0.002 ± 0.001	-0.038 ± -0.018	1.430 ± 0.017	0.580 ± 0.010
938	30	942	14:15:18	14:18:00	30	0	855 ± 57.92	0.017 ± 0.006	-0.311 ± -0.054	1.605 ± 0.019	0.314 ± 0.062

TABLE A-4.—(Continued).

Test Point No.[1]	Power %	Sampling time and probe location: Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	Probe Rake Location[2]	Probe Tip No[3]	CO_2 Conc by NDIR[4] ppm	Gaseous emission index: formaldehyde (HCHO) g/kg fuel	ethylene (C_2H_4) g/kg fuel	nitrogen dioxide (NO_2) g/kg fuel	nitrous acid (HONO) g NO2/kg fuel
939	7	944	14:20:02	14:24:03	1	G1	2223 ± 26.87	0.323 ± 0.011	0.205 ± 0.021	2.336 ± 0.054	0.212 ± 0.015
	7	945	14:26:14	14:28:56	1	P3	2582 ± 31.45	0.278 ± 0.008	0.211 ± 0.006	2.731 ± 0.041	0.191 ± 0.008
	7	946	14:30:00	14:33:32	10	0	1861 ± 165.9	0.309 ± 0.007	0.231 ± 0.007	2.897 ± 0.023	0.377 ± 0.008
	7	947	14:34:00	14:38:31	30	0	634 ± 116.0	0.375 ± 0.002	0.279 ± 0.006	3.537 ± 0.022	0.283 ± 0.006
	7	948	14:41:33	14:44:04	1	G1	9240 ± 59.68	0.217 ± 0.017	0.150 ± 0.006	1.801 ± 0.018	0.104 ± 0.056
940	100	950	14:44:29	14:45:47	1	G1	2336 ± 43.50	0.341 ± 0.011	0.232 ± 0.007	2.491 ± 0.066	-0.013 ± -0.009
941	85	951	14:46:47	14:49:03	1	G1	2944 ± 500.7	0.012 ± 0.002	0.039 ± 0.007	1.720 ± 0.399	0.075 ± 0.030
942	30	952	14:50:03	14:53:32	1	G1	2492 ± 29.99	0.034 ± 0.001	0.034 ± 0.003	1.510 ± 0.029	0.130 ± 0.006
943	7	953	14:54:30	14:58:00	1	G1	2646 ± 17.70	0.230 ± 0.008	0.171 ± 0.008	2.363 ± 0.031	0.054 ± 0.008
	7	954	14:59:00	15:02:30	1	P3	2394 ± 27.63	0.167 ± 0.004	0.140 ± 0.005	2.540 ± 0.049	0.118 ± 0.007
	7	955	15:05:01	15:08:54	10	0	1615 ± 283.7	0.216 ± 0.002	0.152 ± 0.003	2.736 ± 0.014	0.240 ± 0.005
	7	957	15:15:45	15:19:31	1	P3	2795 ± 81.09	0.152 ± 0.010	0.123 ± 0.007	2.493 ± 0.114	0.110 ± 0.012
944	100	958	15:20:33	15:21:23	1	P3	2147 ± 92.13	0.028 ± 0.002	0.044 ± 0.004	1.726 ± 0.094	0.448 ± 0.036
945	85	959	15:21:31	15:23:47	1	P3	1721 ± 67.03	0.017 ± 0.002	0.044 ± 0.006	1.622 ± 0.086	0.434 ± 0.022
946	30	960	15:24:30	15:28:13	1	P3	2937 ± 50.35	0.021 ± 0.001	0.001 ± 0.004	1.479 ± 0.039	0.296 ± 0.010
947	7	961	15:29:02	15:35:30	1	P3	2877 ± 53.05	0.227 ± 0.011	0.124 ± 0.006	2.709 ± 0.062	0.094 ± 0.026
	7	962	15:37:00	15:44:31	10	0	1607 ± 290.2	0.273 ± 0.002	0.177 ± 0.002	3.157 ± 0.008	0.239 ± 0.008
	7	963	15:45:02	15:54:28	30	0	565 ± 75.60	0.295 ± 0.001	0.253 ± 0.008	3.402 ± 0.024	-0.335 ± -0.194
948	100	964	15:55:11	15:56:06	30	0	1519 ± 108.7	0.010 ± 0.002	-0.178 ± -0.028	1.756 ± 0.040	0.473 ± 0.015
949	85	965	15:56:15	15:58:30	30	0	1427 ± 62.73	0.013 ± 0.001	-0.210 ± -0.033	1.488 ± 0.033	0.511 ± 0.036
950	30	966	15:59:02	16:02:30	30	0	806 ± 44.82	0.038 ± 0.007	-0.741 ± -0.109	1.586 ± 0.026	0.406 ± 0.062
951	7	967	16:03:38	16:11:55	30	0	569 ± 95.83	0.386 ± 0.002	-1.376 ± -0.754	3.440 ± 0.021	-0.295 ± -0.180

TABLE A-4.—(Concluded).

Test Point No.[1]	Power %	Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	Probe Rake Location[2]	Probe Tip No[3]	CO_2 Conc by NDIR[4] ppm	formaldehyde (HCHO) g/kg fuel	ethylene (C_2H_4) g/kg fuel	nitrogen dioxide (NO_2) g/kg fuel	nitrous acid (HONO) g NO2/kg fuel
		Sampling time and probe location						Gaseous emission index			
Additional ARI test points without full engine operational data record	4	311	9:52:59	10:02:01	1	P2	1685 ± 135.8	1.837 ± 0.200	3.565 ± 0.357	2.494 ± 0.275	-1.556 ± -0.173
	7	320	10:39:00	10:40:00	1	P1	770 ± 1072	2.177 ± 4.587	3.013 ± 4.372	1.124 ± 1.879	0.151 ± 0.469
	4	338	14:43:36	14:44:21	1	P3	2083 ± 801.1	3.551 ± 2.864	4.192 ± 3.089	1.851 ± 1.148	-1.380 ± -1.126
	4	401	8:15:26	8:16:08	1	P3	2097 ± 708.1	4.927 ± 4.234		1.583 ± 0.979	2.167 ± 1.850
	4	401	8:16:29	8:18:31	1	P3	1435 ± 41.15	2.443 ± 0.101		2.577 ± 0.120	1.156 ± 0.103
	4	402	8:20:29	8:22:31	1	P3	2255 ± 70.48	-0.010 ± -0.001		1.039 ± 0.042	0.470 ± 0.020
	4	403	8:23:35	8:24:45	1	P3	791 ± 732.0	1.786 ± 2.471		2.605 ± 3.424	0.666 ± 1.160
	4	404	10:06:29	10:08:01	1	P1	1217 ± 19.40	2.532 ± 0.160		2.713 ± 0.067	-1.173 ± -0.139
	85	405	10:09:59	10:11:31	1	P1	2881 ± 74.59	-0.003 ± -0.000		1.269 ± 0.044	0.508 ± 0.016
	100	406	10:12:30	10:13:31	1	P1	3044 ± 70.35	-0.004 ± -0.000		1.331 ± 0.043	0.508 ± 0.017
	4	407	10:14:26	10:15:07	1	P1	450 ± 419.5	1.197 ± 1.528		3.103 ± 3.943	-0.609 ± -0.859
	4	516	12:00:33	12:01:20	1	P3	2207 ± 1041	0.872 ± 0.625		2.683 ± 1.906	0.402 ± 0.329
	4	516	12:01:29	12:05:01	1	P3	2475 ± 32.12	1.063 ± 0.020		2.838 ± 0.049	0.256 ± 0.064
	4	522	12:26:59	12:29:31	10	0	2369 ± 126.9	0.884 ± 0.107		2.337 ± 0.059	0.383 ± 0.040
	100	528	13:56:57	13:57:46	30	0	1373 ± 358.2	0.102 ± 0.156		1.902 ± 0.765	0.222 ± 0.313
	4	529	13:57:59	14:00:01	30	0	1158 ± 100.7	0.556 ± 0.040		2.417 ± 0.124	-0.299 ± -0.049
	4	601	8:08:02	8:09:02	30	0	969 ± 57.34	2.679 ± 0.162		2.414 ± 0.148	-1.050 ± -0.262
	30	670	14:39:01	14:42:00	30	0	1059 ± 80.94	-0.006 ± -0.003		1.267 ± 0.014	0.164 ± 0.003
	4	671	14:44:02	14:47:02	30	0	918 ± 121.3	0.932 ± 0.010		3.328 ± 0.039	-0.271 ± -0.070
	40	672	14:48:01	14:51:01	30	0	1292 ± 90.62	0.002 ± 0.002		1.098 ± 0.014	0.206 ± 0.005
	40	673	14:52:31	14:56:31	1	P3	2893 ± 47.73	0.002 ± 0.001		1.152 ± 0.024	0.160 ± 0.005
	40	674	14:58:02	15:02:02	10	0	3297 ± 119.4	0.002 ± 0.000		0.881 ± 0.008	0.196 ± 0.005
	4	675	15:03:30	15:07:02	10	0	2468 ± 139.8	0.730 ± 0.135		2.748 ± 0.048	0.129 ± 0.097
	30	835	12:43:31	12:50:01	30	0	893 ± 117.4	0.605 ± 0.624	0.261 ± 0.550	2.513 ± 0.766	0.099 ± 0.049

Note:

1. The test point No. defines the sequential engine testing conditions while the aerosol point number defines each aerosol measurement condition. Both of them are combinations of the last digit in the date between April 20 and 29 and a sequence number of point for that day. If the test point number is 305, the test point was for the 5th test point on April 23.
2. ARI gas data were measured from particle sampling probe tips located at 1, 10 and 30 m from the engine exhaust plane, except a few points sampled from a gas probe tip.
3. At 1 m and 10 m sampling locations, there were 6 particle probe tips (P1 to P6) and 6 gas probe tips (G1 to G6) held by a rake along the plume cross section. At 10 m location, particle samples were taken from two combined particle probes and at 30 m location, there was only one inlet tube used. At these two locations, the probe tip number is labeled "0".
4. NDIR stands for nondispersive inferred spectrometer.
5. Gas concentration and emission indexes in this table are reported as mean conc. ± one standard deviation.

TABLE A-5.—AIRCRAFT CFM56-2-C1 ENGINE GAS EMISSION DATA MEASURED WITH THE PROTON TRANSFER MASS SPECTROMETER (PTR-MS) DURING APEX, PART A.

Test Point No.[1]	Power	Sampling time and probe location					Gaseous emission index averages[4]								
		Aerosol Point No.[1]	Meaeasurement		Probe Rake Location[2]	Probe Tip No[3]	acetaldehyde	acetic acid	benzene	C2-benzene	C3-benzene	C4-benzene	C5-benzene	dimethyl naphthalene	methanol
	%		Start Time	End Time			g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel
301	7	301	9:23:27	9:26:01	1	P1	0.2093 ± 0.0162	0.0819 ± 0.0090	0.0941 ± 0.0106	0.0711 ± 0.0101	0.0740 ± 0.0122	0.0409 ± 0.0073	0.0196 ± 0.0052	0.0045 ± 0.0017	0.1065 ± 0.0098
	7	302	9:27:00	9:28:30	1	P2	0.1780 ± 0.0094	0.0761 ± 0.0074	0.0811 ± 0.0089	0.0485 ± 0.0032	0.0407 ± 0.0071	0.0223 ± 0.0028	0.0093 ± 0.0021	0.0025 ± 0.0010	0.0923 ± 0.0070
	7	303	9:28:59	9:31:01	1	P3	0.1384 ± 0.0083	0.0902 ± 0.0157	0.0622 ± 0.0075	0.0420 ± 0.0073	0.0339 ± 0.0060	0.0193 ± 0.0020	0.0082 ± 0.0021	0.0017 ± 0.0010	0.0718 ± 0.0072
	7	304	9:31:29	9:33:31	1	P4	0.1408 ± 0.0111	0.0979 ± 0.0131	0.0620 ± 0.0055	0.0402 ± 0.0057	0.0333 ± 0.0049	0.0149 ± 0.0029	0.0075 ± 0.0017	0.0019 ± 0.0012	0.0691 ± 0.0071
	7	305	9:34:29	9:36:01	1	P5	0.1552 ± 0.0062	0.0971 ± 0.0050	0.0649 ± 0.0052	0.0393 ± 0.0030	0.0329 ± 0.0052	0.0165 ± 0.0035	0.0078 ± 0.0015	0.0022 ± 0.0009	0.0728 ± 0.0046
	7	306	9:36:59	9:38:31	1	P6	0.1613 ± 0.0077	0.1007 ± 0.0086	0.0689 ± 0.0049	0.0408 ± 0.0054	0.0409 ± 0.0064	0.0161 ± 0.0022	0.0068 ± 0.0016	0.0020 ± 0.0013	0.0746 ± 0.0060
	7	307	9:38:59	9:42:01	10	0	0.2047 ± 0.0322	0.1359 ± 0.0307	0.0892 ± 0.0182	0.0644 ± 0.0117	0.0546 ± 0.0100	0.0214 ± 0.0042	0.0099 ± 0.0035	0.0033 ± 0.0014	0.0994 ± 0.0165
	7	308	9:42:59	9:45:01	30	0	3.6565 ± 0.4023	8.3113 ± 2.7988	0.3446 ± 0.2786	0.9951 ± 0.4889	1.3969 ± 0.4826	0.8174 ± 0.3907	0.5510 ± 0.4118	0.2426 ± 0.2458	1.6819 ± 0.5681
302	30	309	9:48:30	9:50:31	1	P1	0.0062 ± 0.0019	0.0231 ± 0.0043	0.0024 ± 0.0011	0.0063 ± 0.0020	0.0093 ± 0.0023	0.0071 ± 0.0011	0.0030 ± 0.0011	0.0005 ± 0.0003	0.0032 ± 0.0013
	30	310	9:51:00	9:52:31	1	P2	0.0045 ± 0.0008	0.0205 ± 0.0030	0.0020 ± 0.0011	0.0042 ± 0.0013	0.0055 ± 0.0016	0.0037 ± 0.0012	0.0015 ± 0.0007	0.0003 ± 0.0005	0.0032 ± 0.0015
	30	312	10:04:00	10:06:01	1	P1	0.0210 ± 0.0030	0.0431 ± 0.0078	0.0071 ± 0.0027	0.0183 ± 0.0038	0.0296 ± 0.0069	0.0244 ± 0.0055	0.0123 ± 0.0027	0.0036 ± 0.0018	0.0079 ± 0.0024
	30	313	10:06:59	10:08:31	1	P2	0.0098 ± 0.0017	0.0200 ± 0.0046	0.0032 ± 0.0011	0.0129 ± 0.0030	0.0185 ± 0.0031	0.0137 ± 0.0029	0.0085 ± 0.0019	0.0019 ± 0.0010	0.0049 ± 0.0010
	30	314	10:09:29	10:11:01	1	P3	0.0119 ± 0.0028	0.0549 ± 0.0152	0.0045 ± 0.0015	0.0176 ± 0.0093	0.0163 ± 0.0031	0.0106 ± 0.0018	0.0057 ± 0.0016	0.0019 ± 0.0008	0.0056 ± 0.0010
	30	315	10:11:59	10:13:01	1	P4	0.0196 ± 0.0032	0.0529 ± 0.0131	0.0061 ± 0.0026	0.0098 ± 0.0028	0.0152 ± 0.0036	0.0104 ± 0.0028	0.0065 ± 0.0009	0.0012 ± 0.0008	0.0077 ± 0.0015
	30	316	10:13:59	10:17:01	1	P5	0.0225 ± 0.0044	0.0322 ± 0.0075	0.0031 ± 0.0020	0.0077 ± 0.0021	0.0115 ± 0.0028	0.0083 ± 0.0027	0.0050 ± 0.0017	0.0013 ± 0.0011	0.0048 ± 0.0021
	30	317	10:17:29	10:19:01	1	P6	0.0146 ± 0.0018	0.0352 ± 0.0096	0.0038 ± 0.0020	0.0078 ± 0.0018	0.0119 ± 0.0038	0.0065 ± 0.0016	0.0037 ± 0.0013	0.0011 ± 0.0010	0.0046 ± 0.0018
	30	318	10:19:59	10:22:01	10	0	0.0210 ± 0.0026	0.1168 ± 0.0205	0.0091 ± 0.0030	0.0216 ± 0.0052	0.0302 ± 0.0038	0.0127 ± 0.0027	0.0074 ± 0.0025	0.0020 ± 0.0010	0.0095 ± 0.0026
	30	319	10:22:59	10:25:01	30	0	0.0548 ± 0.0098	0.1674 ± 0.0485	0.0102 ± 0.0070	0.0124 ± 0.0061	0.0210 ± 0.0084	0.0146 ± 0.0067	0.0101 ± 0.0047	0.0039 ± 0.0034	0.0245 ± 0.0103
303	40	321	10:41:59	10:44:01	1	P1	0.0033 ± 0.0015	0.0059 ± 0.0053	0.0009 ± 0.0011	0.0053 ± 0.0016	0.0090 ± 0.0025	0.0069 ± 0.0017	0.0035 ± 0.0017	0.0007 ± 0.0009	0.0037 ± 0.0015
	40	322	10:44:30	10:46:30	1	P2	0.0028 ± 0.0015	0.0058 ± 0.0037	0.0014 ± 0.0016	0.0049 ± 0.0023	0.0067 ± 0.0021	0.0055 ± 0.0017	0.0028 ± 0.0009	0.0005 ± 0.0005	0.0037 ± 0.0031
	40	323	10:46:59	10:48:31	1	P3	0.0033 ± 0.0012	0.0103 ± 0.0038	0.0009 ± 0.0010	0.0070 ± 0.0034	0.0069 ± 0.0020	0.0034 ± 0.0013	0.0022 ± 0.0011	0.0007 ± 0.0006	0.0031 ± 0.0016
	40	324	10:48:59	10:50:31	1	P4	0.0099 ± 0.0017	0.0134 ± 0.0027	0.0002 ± 0.0016	0.0048 ± 0.0020	0.0067 ± 0.0018	0.0047 ± 0.0013	0.0023 ± 0.0009	0.0005 ± 0.0008	0.0035 ± 0.0016
	40	325	10:51:29	10:53:01	1	P5	0.0135 ± 0.0018	0.0115 ± 0.0050	0.0008 ± 0.0021	0.0042 ± 0.0020	0.0059 ± 0.0023	0.0038 ± 0.0024	0.0027 ± 0.0019	0.0001 ± 0.0005	0.0030 ± 0.0014
	40	326	10:53:59	10:55:29	1	P6	0.0079 ± 0.0019	0.0148 ± 0.0062	0.0013 ± 0.0016	0.0028 ± 0.0010	0.0057 ± 0.0026	0.0031 ± 0.0016	0.0023 ± 0.0013	0.0005 ± 0.0005	0.0029 ± 0.0012
	40	327	10:55:59	10:58:31	10	0	0.0113 ± 0.0026	0.0903 ± 0.0177	0.0050 ± 0.0016	0.0139 ± 0.0046	0.0254 ± 0.0038	0.0085 ± 0.0027	0.0070 ± 0.0017	0.0016 ± 0.0009	0.0082 ± 0.0020
	40	328	10:59:00	11:02:31	30	0	0.0376 ± 0.0089	0.1350 ± 0.0668	0.0017 ± 0.0060	0.0062 ± 0.0035	0.0204 ± 0.0145	0.0097 ± 0.0064	0.0074 ± 0.0051	0.0027 ± 0.0028	0.0236 ± 0.0071
304	30	329	11:03:59	11:05:31	30	0	0.0316 ± 0.0079	0.0450 ± 0.0168	0.0020 ± 0.0059	0.0029 ± 0.0032	0.0087 ± 0.0032	0.0042 ± 0.0021	0.0018 ± 0.0031	0.0008 ± 0.0023	0.0224 ± 0.0076
	30	330	11:06:00	11:09:01	10	0	0.0120 ± 0.0031	0.0836 ± 0.0143	0.0044 ± 0.0020	0.0101 ± 0.0032	0.0203 ± 0.0047	0.0080 ± 0.0027	0.0062 ± 0.0025	0.0015 ± 0.0010	0.0084 ± 0.0024
	30	331	11:09:59	11:13:00	1	P2	0.0047 ± 0.0021	0.0385 ± 0.0118	0.0026 ± 0.0014	0.0036 ± 0.0016	0.0079 ± 0.0025	0.0052 ± 0.0016	0.0035 ± 0.0016	0.0010 ± 0.0009	0.0027 ± 0.0017
305	7	332	11:14:00	11:18:31	1	P2	0.1379 ± 0.0132	0.0825 ± 0.0101	0.0635 ± 0.0101	0.0355 ± 0.0049	0.0276 ± 0.0041	0.0139 ± 0.0025	0.0060 ± 0.0020	0.0013 ± 0.0011	0.0690 ± 0.0067
	7	333	11:19:29	11:21:31	10	0	0.1651 ± 0.0217	0.1344 ± 0.0236	0.0705 ± 0.0141	0.0445 ± 0.0105	0.0421 ± 0.0088	0.0182 ± 0.0050	0.0103 ± 0.0039	0.0028 ± 0.0019	0.0801 ± 0.0109
	7	334	11:22:29	11:25:31	30	0	0.1937 ± 0.1016	0.1731 ± 0.0782	0.0755 ± 0.0437	0.0477 ± 0.0260	0.0516 ± 0.0248	0.0241 ± 0.0124	0.0110 ± 0.0066	0.0038 ± 0.0033	0.0914 ± 0.0479
	7	335	11:28:30	11:31:30	1	P2	0.1498 ± 0.0114	0.1045 ± 0.0176	0.0679 ± 0.0114	0.0387 ± 0.0057	0.0347 ± 0.0068	0.0193 ± 0.0047	0.0082 ± 0.0030	0.0018 ± 0.0019	0.0746 ± 0.0099
	7	336	11:32:59	11:36:01	1	P2	0.1315 ± 0.0082	0.0796 ± 0.0073	0.0609 ± 0.0050	0.0321 ± 0.0029	0.0264 ± 0.0035	0.0122 ± 0.0023	0.0048 ± 0.0016	0.0012 ± 0.0009	0.0684 ± 0.0048
	7	337	11:37:29	11:39:31	1	P2	0.1045 ± 0.0079	0.0629 ± 0.0052	0.0482 ± 0.0040	0.0271 ± 0.0030	0.0196 ± 0.0031	0.0086 ± 0.0017	0.0041 ± 0.0010	0.0008 ± 0.0005	0.0516 ± 0.0034
306	7	339	14:51:22	14:52:46	1	P3	0.3453 ± 0.0221	0.0904 ± 0.0102	0.1771 ± 0.0145	0.1022 ± 0.0081	0.0891 ± 0.0091	0.0451 ± 0.0059	0.0201 ± 0.0036	0.0041 ± 0.0014	0.2148 ± 0.0199
	7	340	14:54:29	14:56:01	1	P1	0.1494 ± 0.0151	0.0692 ± 0.0066	0.0560 ± 0.0060	0.0374 ± 0.0047	0.0361 ± 0.0040	0.0200 ± 0.0044	0.0088 ± 0.0041	0.0021 ± 0.0014	0.0791 ± 0.0062
	7	341	14:56:59	14:58:31	1	P6	0.1336 ± 0.0077	0.0740 ± 0.0062	0.0524 ± 0.0056	0.0328 ± 0.0030	0.0294 ± 0.0043	0.0151 ± 0.0023	0.0056 ± 0.0015	0.0023 ± 0.0014	0.0680 ± 0.0056
	7	342	14:59:59	15:02:31	10	0	0.1533 ± 0.0108	0.1014 ± 0.0196	0.0647 ± 0.0065	0.0407 ± 0.0037	0.0436 ± 0.0041	0.0192 ± 0.0035	0.0093 ± 0.0028	0.0026 ± 0.0011	0.0779 ± 0.0100

TABLE A-5.—PART A (Continued).

Test Point No.[1]	Power %	Sampling time and probe location: Aerosol Point No.[1]	Meaeasurement Start Time	Meaeasurement End Time	Probe Rake Location[2]	Probe Tip No[3]	Gaseous emission index averages[4]: acetaldehyde g/kg fuel	acetic acid g/kg fuel	benzene g/kg fuel	C2-benzene g/kg fuel	C3-benzene g/kg fuel	C4-benzene g/kg fuel	C5-benzene g/kg fuel	dimethyl naphthalene g/kg fuel	methanol g/kg fuel
307	30	343	15:04:00	15:06:31	1	P1	0.0131 ± 0.0029	0.0560 ± 0.0173	0.0054 ± 0.0024	0.0090 ± 0.0026	0.0166 ± 0.0060	0.0114 ± 0.0036	0.0058 ± 0.0023	0.0018 ± 0.0012	0.0059 ± 0.0024
	30	344	15:07:29	15:09:01	1	P2	0.0067 ± 0.0013	0.0243 ± 0.0049	0.0022 ± 0.0011	0.0055 ± 0.0025	0.0083 ± 0.0021	0.0058 ± 0.0017	0.0041 ± 0.0020	0.0007 ± 0.0004	0.0048 ± 0.0018
	30	345	15:09:29	15:11:01	1	P3	0.0084 ± 0.0029	0.0231 ± 0.0045	0.0021 ± 0.0011	0.0084 ± 0.0032	0.0101 ± 0.0032	0.0069 ± 0.0017	0.0043 ± 0.0013	0.0011 ± 0.0008	0.0044 ± 0.0026
	30	346	15:11:59	15:14:01	1	P4	0.0128 ± 0.0030	0.0292 ± 0.0066	0.0033 ± 0.0019	0.0058 ± 0.0017	0.0085 ± 0.0027	0.0066 ± 0.0015	0.0039 ± 0.0016	0.0011 ± 0.0010	0.0053 ± 0.0023
	30	347	15:14:30	15:16:31	1	P5	0.0222 ± 0.0188	0.0264 ± 0.0068	0.0022 ± 0.0021	0.0057 ± 0.0025	0.0079 ± 0.0024	0.0058 ± 0.0018	0.0028 ± 0.0012	0.0007 ± 0.0007	0.0099 ± 0.0186
	30	348	15:16:59	15:18:31	1	P6	0.0158 ± 0.0033	0.0252 ± 0.0047	0.0035 ± 0.0021	0.0068 ± 0.0015	0.0095 ± 0.0023	0.0069 ± 0.0018	0.0026 ± 0.0012	0.0012 ± 0.0011	0.0046 ± 0.0014
	30	350	15:21:29	15:25:31	30	0	0.0379 ± 0.0059	0.0651 ± 0.0186	0.0025 ± 0.0042	0.0065 ± 0.0031	0.0157 ± 0.0080	0.0076 ± 0.0044	0.0050 ± 0.0037	0.0025 ± 0.0022	0.0214 ± 0.0052
308	40	351	15:26:29	15:28:31	30	0	0.0278 ± 0.0068	0.0323 ± 0.0089	0.0003 ± 0.0043	0.0033 ± 0.0020	0.0062 ± 0.0041	0.0040 ± 0.0028	0.0023 ± 0.0029	0.0013 ± 0.0015	0.0152 ± 0.0053
	40	352	15:29:29	15:32:00	10	0	0.0103 ± 0.0018	0.0432 ± 0.0058	0.0031 ± 0.0016	0.0077 ± 0.0020	0.0208 ± 0.0027	0.0075 ± 0.0016	0.0057 ± 0.0017	0.0012 ± 0.0007	0.0072 ± 0.0017
308b	40	353	15:32:59	15:35:31	1	P1	0.0081 ± 0.0027	0.0356 ± 0.0102	0.0025 ± 0.0021	0.0048 ± 0.0023	0.0113 ± 0.0039	0.0067 ± 0.0020	0.0048 ± 0.0021	0.0013 ± 0.0011	0.0048 ± 0.0021
	40	354	15:36:29	15:38:01	1	P2	0.0038 ± 0.0015	0.0140 ± 0.0024	0.0013 ± 0.0013	0.0024 ± 0.0013	0.0059 ± 0.0015	0.0034 ± 0.0013	0.0021 ± 0.0010	0.0008 ± 0.0005	0.0030 ± 0.0013
	40	355	15:38:59	15:40:31	1	P3	0.0049 ± 0.0013	0.0149 ± 0.0033	0.0010 ± 0.0011	0.0049 ± 0.0017	0.0071 ± 0.0017	0.0045 ± 0.0017	0.0024 ± 0.0012	0.0006 ± 0.0005	0.0032 ± 0.0013
308c	40	356	15:41:29	15:43:00	1	P4	0.0102 ± 0.0026	0.0165 ± 0.0032	0.0018 ± 0.0019	0.0032 ± 0.0010	0.0054 ± 0.0020	0.0044 ± 0.0014	0.0022 ± 0.0012	0.0007 ± 0.0005	0.0038 ± 0.0018
	40	357	15:43:29	15:45:01	1	P5	0.0167 ± 0.0018	0.0250 ± 0.0059	0.0011 ± 0.0018	0.0039 ± 0.0019	0.0071 ± 0.0020	0.0036 ± 0.0010	0.0019 ± 0.0012	0.0009 ± 0.0007	0.0042 ± 0.0027
	40	358	15:45:30	15:47:01	1	P6	0.0147 ± 0.0069	0.0188 ± 0.0045	0.0019 ± 0.0010	0.0036 ± 0.0012	0.0054 ± 0.0013	0.0040 ± 0.0012	0.0022 ± 0.0014	0.0006 ± 0.0005	0.0050 ± 0.0040
309	30	359	15:48:00	15:50:01	1	P3	0.0064 ± 0.0018	0.0150 ± 0.0067	0.0013 ± 0.0019	0.0042 ± 0.0014	0.0065 ± 0.0011	0.0048 ± 0.0015	0.0024 ± 0.0016	0.0010 ± 0.0007	0.0045 ± 0.0019
	30	360	15:50:59	15:55:01	10	0	0.0124 ± 0.0021	0.0319 ± 0.0050	0.0031 ± 0.0019	0.0081 ± 0.0027	0.0199 ± 0.0039	0.0074 ± 0.0019	0.0069 ± 0.0026	0.0014 ± 0.0008	0.0091 ± 0.0021
	30	361	15:55:59	16:01:00	30	0	0.0299 ± 0.0072	0.0384 ± 0.0160	-0.0000 ± -0.0030	0.0041 ± 0.0026	0.0116 ± 0.0060	0.0056 ± 0.0042	0.0048 ± 0.0039	0.0018 ± 0.0021	0.0190 ± 0.0063
310	7	362	16:01:30	16:04:00	30	0	0.1890 ± 0.0369	0.0769 ± 0.0163	0.0805 ± 0.0201	0.0451 ± 0.0101	0.0392 ± 0.0082	0.0201 ± 0.0059	0.0075 ± 0.0037	0.0022 ± 0.0021	0.0924 ± 0.0192
	7	363	16:04:29	16:06:01	10	0	0.1387 ± 0.0147	0.0629 ± 0.0116	0.0656 ± 0.0083	0.0353 ± 0.0060	0.0349 ± 0.0073	0.0137 ± 0.0050	0.0074 ± 0.0029	0.0014 ± 0.0008	0.0693 ± 0.0076
	7	364	16:06:59	16:09:31	1	P3	0.1182 ± 0.0105	0.0733 ± 0.0140	0.0504 ± 0.0092	0.0304 ± 0.0063	0.0289 ± 0.0039	0.0133 ± 0.0039	0.0065 ± 0.0022	0.0028 ± 0.0015	0.0593 ± 0.0052
	7	365	16:10:29	16:11:31	1	P3	0.2823 ± 0.0178	0.0942 ± 0.0126	0.1332 ± 0.0102	0.0761 ± 0.0103	0.0587 ± 0.0134	0.0262 ± 0.0038	0.0115 ± 0.0015	0.0029 ± 0.0013	0.1613 ± 0.0115
501	4	501	11:15:16	11:16:08	30	0	0.9009 ± 0.6947	0.0884 ± 0.0563	0.7702 ± 0.6922	0.4541 ± 0.3634	0.4405 ± 0.3856	0.2485 ± 0.2311	0.1189 ± 0.0989	0.0126 ± 0.0109	0.5660 ± 0.5149
	4	501	11:16:29	11:20:01	30	0	0.6038 ± 0.0638	0.1190 ± 0.0186	0.3619 ± 0.0577	0.2128 ± 0.0256	0.1930 ± 0.0245	0.0982 ± 0.0139	0.0434 ± 0.0099	0.0092 ± 0.0045	0.3705 ± 0.0429
502	65	502	11:22:59	11:25:01	1	P1	0.0126 ± 0.0035	0.0161 ± 0.0039	0.0026 ± 0.0016	0.0079 ± 0.0028	0.0131 ± 0.0039	0.0088 ± 0.0027	0.0035 ± 0.0016	0.0010 ± 0.0007	0.0032 ± 0.0017
	65	503	11:25:59	11:27:31	1	P2	0.0047 ± 0.0011	0.0065 ± 0.0024	0.0006 ± 0.0007	0.0025 ± 0.0008	0.0047 ± 0.0022	0.0033 ± 0.0013	0.0012 ± 0.0008	0.0005 ± 0.0004	0.0012 ± 0.0006
	65	504	11:28:29	11:29:31	1	P3	0.0043 ± 0.0013	0.0069 ± 0.0026	0.0009 ± 0.0007	0.0033 ± 0.0011	0.0044 ± 0.0027	0.0036 ± 0.0013	0.0014 ± 0.0008	0.0003 ± 0.0001	0.0014 ± 0.0012
	65	505	11:30:29	11:32:00	1	P4	0.0055 ± 0.0017	0.0098 ± 0.0030	0.0012 ± 0.0010	0.0025 ± 0.0010	0.0041 ± 0.0011	0.0024 ± 0.0010	0.0013 ± 0.0006	0.0002 ± 0.0004	0.0012 ± 0.0009
	65	506	11:32:29	11:34:30	1	P5	0.0165 ± 0.0028	0.0143 ± 0.0042	0.0012 ± 0.0013	0.0019 ± 0.0012	0.0038 ± 0.0018	0.0020 ± 0.0014	0.0010 ± 0.0010	0.0001 ± 0.0004	0.0009 ± 0.0019
	65	507	11:35:00	11:36:30	1	P6	0.0139 ± 0.0016	0.0117 ± 0.0045	0.0002 ± 0.0011	0.0022 ± 0.0015	0.0026 ± 0.0017	0.0019 ± 0.0013	0.0004 ± 0.0011	0.0000 ± 0.0004	0.0014 ± 0.0006
	65	508	11:36:59	11:39:31	10	0	0.0114 ± 0.0023	0.0246 ± 0.0029	0.0028 ± 0.0011	0.0095 ± 0.0029	0.0168 ± 0.0029	0.0064 ± 0.0017	0.0041 ± 0.0014	0.0005 ± 0.0005	0.0088 ± 0.0021
	65	509	11:39:59	11:42:31	30	0	0.0299 ± 0.0051	0.0374 ± 0.0158	0.0012 ± 0.0027	0.0045 ± 0.0041	0.0153 ± 0.0081	0.0069 ± 0.0038	0.0032 ± 0.0032	0.0004 ± 0.0013	0.0240 ± 0.0052
503	70	511	11:43:29	11:47:01	1	P3	0.0166 ± 0.0026	0.0192 ± 0.0069	0.0011 ± 0.0022	0.0016 ± 0.0014	0.0037 ± 0.0020	0.0022 ± 0.0018	0.0000 ± 0.0011	-0.0001 ± -0.0006	0.0014 ± 0.0018
504	65	512	11:48:29	11:50:31	1	P3	0.0161 ± 0.0018	0.0102 ± 0.0063	0.0001 ± 0.0017	0.0004 ± 0.0009	0.0016 ± 0.0018	0.0004 ± 0.0015	-0.0004 ± -0.0015	-0.0002 ± -0.0005	0.0017 ± 0.0026
505	60	513	11:51:29	11:53:31	1	P3	0.0128 ± 0.0034	0.0089 ± 0.0078	0.0003 ± 0.0022	-0.0003 ± -0.0016	0.0022 ± 0.0023	0.0005 ± 0.0014	-0.0005 ± -0.0013	-0.0004 ± -0.0008	0.0013 ± 0.0022
506	85	514	11:54:59	11:57:01	1	P3	0.0105 ± 0.0018	0.0048 ± 0.0033	0.0000 ± 0.0011	0.0005 ± 0.0010	0.0014 ± 0.0012	-0.0001 ± -0.0011	0.0002 ± 0.0011	-0.0002 ± -0.0005	0.0004 ± 0.0013
507	100	515	11:57:59	11:59:30	1	P3	0.0096 ± 0.0019	0.0047 ± 0.0027	0.0001 ± 0.0011	-0.0002 ± -0.0007	0.0005 ± 0.0012	-0.0000 ± -0.0004	-0.0004 ± -0.0008	-0.0004 ± -0.0002	0.0006 ± 0.0012
508	7	517	12:06:29	12:10:31	1	P3	0.1014 ± 0.0082	0.0503 ± 0.0066	0.0383 ± 0.0053	0.0241 ± 0.0036	0.0222 ± 0.0059	0.0108 ± 0.0035	0.0038 ± 0.0018	0.0007 ± 0.0009	0.0452 ± 0.0055
	7	518	12:16:29	12:18:31	1	P3	0.0814 ± 0.0093	0.0377 ± 0.0107	0.0277 ± 0.0055	0.0161 ± 0.0066	0.0114 ± 0.0064	0.0047 ± 0.0038	0.0009 ± 0.0022	-0.0006 ± -0.0009	0.0387 ± 0.0078
	7	519	12:19:29	12:22:31	10	0	0.0907 ± 0.0091	0.0430 ± 0.0087	0.0403 ± 0.0069	0.0266 ± 0.0044	0.0296 ± 0.0047	0.0122 ± 0.0022	0.0057 ± 0.0019	0.0009 ± 0.0010	0.0495 ± 0.0042
509	100	520	12:24:00	12:24:31	10	0	0.0068 ± 0.0012	0.0115 ± 0.0026	0.0010 ± 0.0006	0.0043 ± 0.0010	0.0111 ± 0.0010	0.0044 ± 0.0007	0.0027 ± 0.0007	0.0006 ± 0.0004	0.0060 ± 0.0007

TABLE A-5.—PART A (Continued).

Test Point No.[1]	Power %	Aerosol Point No.[1]	Meaeasurement Start Time	Meaeasurement End Time	Probe Rake Location[2]	Probe Tip No[3]	acetaldehyde g/kg fuel	acetic acid g/kg fuel	benzene g/kg fuel	C2-benzene g/kg fuel	C3-benzene g/kg fuel	C4-benzene g/kg fuel	C5-benzene g/kg fuel	dimethyl naphthalene g/kg fuel	methanol g/kg fuel
		Sampling time and probe location					Gaseous emission index averages[4]								
510	85	521	12:25:00	12:26:30	10	0	0.0070 ± 0.0013	0.0137 ± 0.0022	0.0013 ± 0.0009	0.0054 ± 0.0013	0.0141 ± 0.0025	0.0049 ± 0.0016	0.0037 ± 0.0007	0.0007 ± 0.0003	0.0067 ± 0.0011
511	85	524	13:22:29	13:24:31	10	0	0.0087 ± 0.0015	0.0171 ± 0.0024	0.0043 ± 0.0016	0.0150 ± 0.0033	0.0227 ± 0.0031	0.0146 ± 0.0015	0.0068 ± 0.0012	0.0013 ± 0.0006	0.0067 ± 0.0011
512	30	525	13:25:31	13:29:01	10	0	0.0093 ± 0.0034	0.0219 ± 0.0047	0.0041 ± 0.0022	0.0126 ± 0.0040	0.0263 ± 0.0076	0.0185 ± 0.0040	0.0112 ± 0.0030	0.0025 ± 0.0013	0.0102 ± 0.0027
513	7	526	13:30:29	13:34:31	10	0	0.1049 ± 0.0103	0.0485 ± 0.0059	0.0513 ± 0.0063	0.0313 ± 0.0033	0.0327 ± 0.0052	0.0188 ± 0.0034	0.0099 ± 0.0025	0.0020 ± 0.0010	0.0584 ± 0.0072
	7	527	13:36:00	13:55:31	30	0	0.1163 ± 0.0353	0.0518 ± 0.0218	0.0513 ± 0.0208	0.0302 ± 0.0111	0.0290 ± 0.0120	0.0171 ± 0.0083	0.0083 ± 0.0054	0.0021 ± 0.0021	0.0734 ± 0.0213
514	100	531	14:01:00	14:02:00	30	0	0.0069 ± 0.0040	0.0023 ± 0.0067	-0.0009 ± -0.0032	0.0002 ± 0.0022	0.0043 ± 0.0019	0.0041 ± 0.0022	0.0022 ± 0.0020	0.0001 ± 0.0008	0.0083 ± 0.0039
515	30	532	14:03:29	14:06:01	30	0	0.0063 ± 0.0061	-0.0018 ± -0.0073	-0.0004 ± -0.0044	-0.0005 ± -0.0037	0.0052 ± 0.0043	0.0047 ± 0.0038	0.0022 ± 0.0033	0.0004 ± 0.0015	0.0139 ± 0.0053
516	7	533	14:08:29	14:10:01	30	0	0.0875 ± 0.0130	0.0140 ± 0.0094	0.0377 ± 0.0123	0.0185 ± 0.0097	0.0137 ± 0.0065	0.0059 ± 0.0055	0.0031 ± 0.0045	0.0001 ± 0.0019	0.0542 ± 0.0085
517	85	534	14:10:59	14:12:31	30	0	0.0053 ± 0.0042	-0.0037 ± -0.0050	-0.0020 ± -0.0027	-0.0005 ± -0.0019	-0.0006 ± -0.0019	0.0004 ± 0.0017	0.0015 ± 0.0014	-0.0002 ± -0.0005	0.0086 ± 0.0036
518	7	535	14:13:29	14:18:01	30	0	0.0861 ± 0.0187	0.0114 ± 0.0127	0.0379 ± 0.0123	0.0162 ± 0.0079	0.0124 ± 0.0066	0.0058 ± 0.0040	0.0031 ± 0.0037	0.0003 ± 0.0025	0.0554 ± 0.0114
	7	536	14:21:59	14:29:01	1	P3	0.0526 ± 0.0049	0.0233 ± 0.0054	0.0244 ± 0.0056	0.0116 ± 0.0027	0.0090 ± 0.0037	0.0039 ± 0.0022	0.0021 ± 0.0018	0.0003 ± 0.0008	0.0312 ± 0.0044
519	100	537	14:30:29	14:31:31	1	P3	-0.0000 ± -0.0013	0.0053 ± 0.0032	0.0001 ± 0.0008	0.0020 ± 0.0010	0.0013 ± 0.0017	0.0015 ± 0.0008	0.0004 ± 0.0004	0.0002 ± 0.0004	0.0011 ± 0.0013
520	85	538	14:31:59	14:35:01	1	P3	-0.0015 ± -0.0015	0.0032 ± 0.0032	-0.0002 ± -0.0012	0.0007 ± 0.0011	0.0025 ± 0.0015	0.0018 ± 0.0011	0.0010 ± 0.0014	0.0001 ± 0.0007	0.0008 ± 0.0012
521	30	539	14:36:29	14:44:31	1	P3	-0.0005 ± -0.0018	0.0010 ± 0.0029	0.0001 ± 0.0014	0.0013 ± 0.0011	0.0021 ± 0.0013	0.0021 ± 0.0013	0.0005 ± 0.0009	0.0003 ± 0.0005	0.0018 ± 0.0014
522	7	540	14:45:59	14:51:01	1	P3	0.0513 ± 0.0116	0.0205 ± 0.0076	0.0238 ± 0.0069	0.0129 ± 0.0036	0.0087 ± 0.0028	0.0044 ± 0.0024	0.0018 ± 0.0015	0.0004 ± 0.0006	0.0328 ± 0.0075
	7	541	14:51:59	14:57:01	1	P3	0.0474 ± 0.0027	0.0238 ± 0.0024	0.0212 ± 0.0025	0.0109 ± 0.0014	0.0073 ± 0.0014	0.0030 ± 0.0008	0.0012 ± 0.0006	0.0002 ± 0.0002	0.0272 ± 0.0019
	7	542	14:59:59	15:05:31	1	P3	0.0583 ± 0.0044	0.0327 ± 0.0050	0.0258 ± 0.0044	0.0145 ± 0.0024	0.0105 ± 0.0030	0.0053 ± 0.0017	0.0021 ± 0.0014	0.0004 ± 0.0007	0.0332 ± 0.0029
	7	543	15:06:59	15:12:01	1	P3	0.0574 ± 0.0070	0.0370 ± 0.0105	0.0281 ± 0.0066	0.0153 ± 0.0050	0.0109 ± 0.0051	0.0081 ± 0.0034	0.0034 ± 0.0025	0.0004 ± 0.0011	0.0341 ± 0.0053
	7	544	15:15:29	15:19:01	1	P3	0.0605 ± 0.0110	0.0311 ± 0.0102	0.0288 ± 0.0091	0.0150 ± 0.0055	0.0109 ± 0.0062	0.0066 ± 0.0036	0.0047 ± 0.0041	0.0003 ± 0.0023	0.0330 ± 0.0073
	7	545	15:20:29	15:24:01	1	P3	0.0603 ± 0.0147	0.0326 ± 0.0228	0.0317 ± 0.0137	0.0139 ± 0.0086	0.0112 ± 0.0085	0.0068 ± 0.0052	0.0047 ± 0.0052	-0.0000 ± -0.0033	0.0381 ± 0.0091
	7	546	15:25:29	15:29:01	1	P3	0.1481 ± 0.5433	0.0234 ± 0.9233	0.1370 ± 0.5561	-0.0032 ± -0.2385	-0.0758 ± -0.4894	-0.0093 ± -0.3060	-0.0068 ± -0.2050	-0.0035 ± -0.1742	0.1057 ± 0.4369
	7	547	15:29:59	15:34:31	10	0	0.0763 ± 0.0062	0.0350 ± 0.0055	0.0326 ± 0.0054	0.0224 ± 0.0031	0.0274 ± 0.0049	0.0095 ± 0.0026	0.0061 ± 0.0024	0.0009 ± 0.0008	0.0424 ± 0.0051
	7	548	15:36:59	15:41:31	10	0	0.0922 ± 0.0088	0.0488 ± 0.0114	0.0379 ± 0.0080	0.0244 ± 0.0053	0.0338 ± 0.0065	0.0154 ± 0.0048	0.0110 ± 0.0042	0.0024 ± 0.0018	0.0456 ± 0.0059
	7	549	15:42:59	15:47:31	10	0	0.1182 ± 0.0178	0.0696 ± 0.0245	0.0416 ± 0.0144	0.0339 ± 0.0091	0.0472 ± 0.0135	0.0261 ± 0.0088	0.0196 ± 0.0083	0.0042 ± 0.0041	0.0650 ± 0.0135
523	100	550	15:52:00	15:53:01	10	0	0.0121 ± 0.0031	0.0110 ± 0.0042	0.0008 ± 0.0011	0.0048 ± 0.0013	0.0132 ± 0.0044	0.0069 ± 0.0027	0.0047 ± 0.0015	0.0010 ± 0.0010	0.0105 ± 0.0018
524	85	551	15:53:29	15:55:31	10	0	0.0131 ± 0.0030	0.0128 ± 0.0051	0.0007 ± 0.0011	0.0065 ± 0.0018	0.0136 ± 0.0032	0.0083 ± 0.0036	0.0069 ± 0.0022	0.0019 ± 0.0015	0.0115 ± 0.0024
525	30	552	15:55:59	15:59:31	10	0	0.0196 ± 0.0040	0.0195 ± 0.0079	0.0032 ± 0.0046	0.0075 ± 0.0032	0.0186 ± 0.0053	0.0142 ± 0.0031	0.0119 ± 0.0043	0.0028 ± 0.0022	0.0211 ± 0.0037
526	7	553	16:00:48	16:04:01	10	0	0.0821 ± 0.0078	0.0415 ± 0.0119	0.0315 ± 0.0070	0.0231 ± 0.0050	0.0244 ± 0.0059	0.0182 ± 0.0051	0.0091 ± 0.0042	0.0021 ± 0.0018	0.0526 ± 0.0074
	7	554	16:05:29	16:09:01	10	0	0.1342 ± 0.0303	0.0726 ± 0.0311	0.0489 ± 0.0221	0.0450 ± 0.0160	0.0702 ± 0.0284	0.0459 ± 0.0215	0.0324 ± 0.0155	0.0074 ± 0.0086	0.1102 ± 0.0204
	7	555	16:09:59	16:13:01	10	0	0.1276 ± 0.0376	0.0687 ± 0.0499	0.0522 ± 0.0320	0.0323 ± 0.0269	0.0644 ± 0.0325	0.0496 ± 0.0307	0.0485 ± 0.0260	0.0128 ± 0.0164	0.1225 ± 0.0421
601	7	602	8:11:02	8:13:02	30	0	0.2905 ± 0.0299	0.1472 ± 0.0253	0.1345 ± 0.0219	0.0942 ± 0.0173	0.0976 ± 0.0183	0.0527 ± 0.0116	0.0206 ± 0.0070	0.0079 ± 0.0039	0.1762 ± 0.0216
	7	603	8:15:31	8:19:01	10	0	0.2297 ± 0.0189	0.1223 ± 0.0105	0.1156 ± 0.0107	0.0720 ± 0.0081	0.0388 ± 0.0065	0.0164 ± 0.0033	0.0067 ± 0.0022	0.0018 ± 0.0012	0.1248 ± 0.0096
	7	604	8:20:01	8:23:02	10	0	0.2432 ± 0.0232	0.1612 ± 0.0213	0.1134 ± 0.0119	0.0924 ± 0.0104	0.0602 ± 0.0112	0.0269 ± 0.0064	0.0110 ± 0.0035	0.0028 ± 0.0020	0.1258 ± 0.0163
	7	605	8:27:09	8:27:40	10	0	0.2070 ± 0.0103	0.0935 ± 0.0082	0.0932 ± 0.0038	0.0650 ± 0.0046	0.0311 ± 0.0075	0.0089 ± 0.0020	0.0037 ± 0.0023	0.0015 ± 0.0006	0.1096 ± 0.0087
602	100	606	8:28:36	8:29:17	10	0	0.0055 ± 0.0006	0.0183 ± 0.0018	0.0032 ± 0.0014	0.0147 ± 0.0023	0.0083 ± 0.0011	0.0044 ± 0.0009	0.0018 ± 0.0004	0.0003 ± 0.0002	0.0074 ± 0.0007
603	85	607	8:29:30	8:31:30	10	0	0.0056 ± 0.0013	0.0178 ± 0.0017	0.0024 ± 0.0008	0.0133 ± 0.0019	0.0085 ± 0.0012	0.0045 ± 0.0011	0.0022 ± 0.0006	0.0005 ± 0.0003	0.0083 ± 0.0016
	30	608	8:32:32	8:36:31	10	0	0.0113 ± 0.0018	0.0256 ± 0.0046	0.0050 ± 0.0018	0.0167 ± 0.0035	0.0103 ± 0.0027	0.0054 ± 0.0014	0.0032 ± 0.0012	0.0009 ± 0.0010	0.0174 ± 0.0030
605	7	609	8:37:30	8:41:01	10	0	0.2216 ± 0.0169	0.1220 ± 0.0114	0.1088 ± 0.0113	0.0685 ± 0.0072	0.0470 ± 0.0048	0.0204 ± 0.0037	0.0078 ± 0.0017	0.0012 ± 0.0008	0.1139 ± 0.0078
	7	610	8:43:00	8:47:30	10	0	0.2632 ± 0.0251	0.2242 ± 0.0315	0.1260 ± 0.0194	0.1029 ± 0.0195	0.0879 ± 0.0197	0.0437 ± 0.0132	0.0201 ± 0.0071	0.0054 ± 0.0043	0.1272 ± 0.0203
	7	611	8:49:32	8:52:01	10	0	0.2863 ± 0.0296	0.2992 ± 0.0468	0.1411 ± 0.0269	0.1253 ± 0.0278	0.1078 ± 0.0400	0.0571 ± 0.0157	0.0232 ± 0.0102	0.0095 ± 0.0065	0.1379 ± 0.0277
	7	612	8:53:31	8:57:01	1	P3	0.1591 ± 0.0104	0.1126 ± 0.0099	0.0728 ± 0.0078	0.0384 ± 0.0051	0.0294 ± 0.0050	0.0128 ± 0.0031	0.0052 ± 0.0017	0.0016 ± 0.0013	0.0804 ± 0.0079
	7	613	8:58:00	9:00:33	1	P6	0.1663 ± 0.0093	0.1282 ± 0.0078	0.0748 ± 0.0066	0.0389 ± 0.0044	0.0308 ± 0.0050	0.0135 ± 0.0031	0.0050 ± 0.0022	0.0020 ± 0.0009	0.0846 ± 0.0067
	7	614	9:01:30	9:04:01	10	0	0.2843 ± 0.0532	0.3466 ± 0.0636	0.1426 ± 0.0355	0.1332 ± 0.0319	0.1050 ± 0.0264	0.0575 ± 0.0158	0.0262 ± 0.0144	0.0071 ± 0.0059	0.1361 ± 0.0304

TABLE A-5.—PART A (Continued).

Test Point No.[1]	Power	Sampling time and probe location					Gaseous emission index averages[4]								
		Aerosol Point No.[1]	Meaeasurement		Probe Rake Location[2]	Probe Tip No[3]	acetaldehyde	acetic acid	benzene	C2-benzene	C3-benzene	C4-benzene	C5-benzene	dimethyl naphthalene	methanol
	%		Start Time	End Time			g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel
606	100	615	9:04:32	9:05:02	10	0	0.0223 ± 0.0058	0.0611 ± 0.0070	0.0127 ± 0.0079	0.0230 ± 0.0054	0.0208 ± 0.0062	0.0094 ± 0.0043	0.0044 ± 0.0026	0.0024 ± 0.0011	0.0126 ± 0.0029
607	85	616	9:05:31	9:07:32	10	0	0.0259 ± 0.0070	0.0633 ± 0.0098	0.0130 ± 0.0050	0.0232 ± 0.0059	0.0245 ± 0.0063	0.0148 ± 0.0042	0.0072 ± 0.0031	0.0020 ± 0.0018	0.0133 ± 0.0052
608	30	617	9:09:02	9:12:32	10	0	0.0317 ± 0.0045	0.0664 ± 0.0101	0.0129 ± 0.0050	0.0244 ± 0.0069	0.0230 ± 0.0076	0.0141 ± 0.0048	0.0093 ± 0.0042	0.0020 ± 0.0017	0.0252 ± 0.0055
609	7	618	9:14:02	9:17:31	10	0	0.2187 ± 0.0181	0.1581 ± 0.0189	0.1019 ± 0.0122	0.0697 ± 0.0103	0.0546 ± 0.0071	0.0235 ± 0.0066	0.0124 ± 0.0033	0.0029 ± 0.0017	0.1151 ± 0.0116
	7	619	9:18:31	9:30:02	30	0	0.2096 ± 0.0293	0.1827 ± 0.0299	0.0960 ± 0.0198	0.0625 ± 0.0129	0.0556 ± 0.0113	0.0292 ± 0.0088	0.0146 ± 0.0052	0.0040 ± 0.0036	0.1527 ± 0.0224
610	100	620	9:39:31	9:40:01	1	P3	0.0033 ± 0.0014	0.0177 ± 0.0049	0.0021 ± 0.0012	0.0025 ± 0.0017	0.0030 ± 0.0009	0.0015 ± 0.0008	0.0007 ± 0.0003	0.0002 ± 0.0002	0.0025 ± 0.0008
611	85	621	9:41:00	9:43:01	1	P3	0.0052 ± 0.0024	0.0231 ± 0.0065	0.0050 ± 0.0016	0.0022 ± 0.0013	0.0044 ± 0.0022	0.0028 ± 0.0015	0.0018 ± 0.0012	0.0004 ± 0.0005	0.0031 ± 0.0018
612	30	622	9:45:00	9:48:01	1	P3	0.0060 ± 0.0017	0.0180 ± 0.0031	0.0043 ± 0.0019	0.0021 ± 0.0011	0.0026 ± 0.0012	0.0018 ± 0.0009	0.0014 ± 0.0008	0.0004 ± 0.0005	0.0046 ± 0.0014
613	7	623	9:50:00	9:52:01	1	P3	0.1023 ± 0.0070	0.0707 ± 0.0076	0.0462 ± 0.0068	0.0240 ± 0.0023	0.0175 ± 0.0038	0.0080 ± 0.0020	0.0030 ± 0.0010	0.0004 ± 0.0005	0.0578 ± 0.0046
	7	624	9:53:31	10:14:33	30	0	0.1506 ± 0.0246	0.1292 ± 0.0248	0.0620 ± 0.0147	0.0390 ± 0.0104	0.0319 ± 0.0100	0.0161 ± 0.0059	0.0080 ± 0.0044	0.0020 ± 0.0023	0.1121 ± 0.0188
614	100	625	10:15:32	10:16:18	30	0	0.0130 ± 0.0035	0.0302 ± 0.0080	0.0023 ± 0.0018	0.0025 ± 0.0020	0.0054 ± 0.0022	0.0041 ± 0.0022	0.0020 ± 0.0007	0.0000 ± 0.0008	0.0194 ± 0.0014
615	85	626	10:16:32	10:18:32	30	0	0.0125 ± 0.0033	0.0308 ± 0.0062	0.0015 ± 0.0020	0.0036 ± 0.0022	0.0036 ± 0.0022	0.0024 ± 0.0020	0.0018 ± 0.0010	0.0003 ± 0.0004	0.0222 ± 0.0023
616	30	627	10:19:32	10:23:32	30	0	0.0238 ± 0.0062	0.0570 ± 0.0141	0.0031 ± 0.0050	0.0055 ± 0.0032	0.0062 ± 0.0040	0.0040 ± 0.0023	0.0037 ± 0.0030	0.0003 ± 0.0018	0.0439 ± 0.0103
617	7	628	10:24:01	10:27:02	30	0	0.1361 ± 0.0322	0.1294 ± 0.0331	0.0605 ± 0.0227	0.0305 ± 0.0107	0.0288 ± 0.0089	0.0125 ± 0.0056	0.0075 ± 0.0049	0.0016 ± 0.0028	0.1162 ± 0.0251
	7	629	10:28:01	10:31:32	1	P1	0.1044 ± 0.0095	0.0835 ± 0.0101	0.0482 ± 0.0071	0.0248 ± 0.0042	0.0185 ± 0.0040	0.0077 ± 0.0031	0.0035 ± 0.0017	0.0009 ± 0.0011	0.0539 ± 0.0062
	7	630	10:32:11	10:34:32	1	P3	0.0744 ± 0.0062	0.0682 ± 0.0062	0.0346 ± 0.0049	0.0190 ± 0.0027	0.0149 ± 0.0042	0.0065 ± 0.0014	0.0032 ± 0.0012	0.0009 ± 0.0008	0.0409 ± 0.0051
	7	631	10:36:06	10:37:32	1	P6	0.0805 ± 0.0068	0.0721 ± 0.0076	0.0374 ± 0.0052	0.0168 ± 0.0036	0.0138 ± 0.0040	0.0058 ± 0.0012	0.0023 ± 0.0009	0.0008 ± 0.0006	0.0397 ± 0.0045
618	4	632	11:53:32	11:59:32	30	0	0.3564 ± 0.0888	0.1133 ± 0.0273	0.1740 ± 0.0460	0.1084 ± 0.0269	0.0872 ± 0.0229	0.0443 ± 0.0124	0.0176 ± 0.0069	0.0034 ± 0.0030	0.2134 ± 0.0520
619	100	633	12:01:01	12:01:32	30	0	0.0126 ± 0.0031	0.0223 ± 0.0055	0.0025 ± 0.0015	0.0074 ± 0.0016	0.0105 ± 0.0036	0.0086 ± 0.0018	0.0041 ± 0.0005	0.0013 ± 0.0015	0.0132 ± 0.0044
620	85	634	12:02:33	12:05:02	30	0	0.0106 ± 0.0034	0.0175 ± 0.0052	-0.0007 ± -0.0024	0.0039 ± 0.0014	0.0052 ± 0.0030	0.0035 ± 0.0022	0.0027 ± 0.0020	0.0002 ± 0.0009	0.0133 ± 0.0030
621	65	635	12:05:31	12:09:01	30	0	0.0099 ± 0.0030	0.0175 ± 0.0085	-0.0015 ± -0.0029	0.0028 ± 0.0025	0.0027 ± 0.0027	0.0026 ± 0.0021	0.0014 ± 0.0017	0.0001 ± 0.0012	0.0136 ± 0.0034
622	40	636	12:10:02	12:13:31	30	0	0.0112 ± 0.0053	0.0191 ± 0.0080	-0.0012 ± -0.0031	0.0025 ± 0.0027	0.0017 ± 0.0033	0.0027 ± 0.0021	0.0008 ± 0.0019	0.0000 ± 0.0013	0.0166 ± 0.0046
623	4	637	12:14:00	12:14:30	30	0	0.3136 ± 0.3320	0.1280 ± 0.1075	0.1764 ± 0.1895	0.1155 ± 0.1108	0.0941 ± 0.0810	0.0405 ± 0.0386	0.0310 ± 0.0351	-0.0003 ± -0.0031	0.2268 ± 0.2075
	4	638	12:17:30	12:19:31	10	0	0.3763 ± 0.0444	0.1679 ± 0.0297	0.1824 ± 0.0353	0.1193 ± 0.0195	0.1317 ± 0.0257	0.0600 ± 0.0141	0.0271 ± 0.0119	0.0074 ± 0.0049	0.2070 ± 0.0369
		639	12:19:30	12:20:00	1	P3	0.2480 ± 0.2716	0.1281 ± 0.1351	0.1279 ± 0.1336	0.0928 ± 0.0992	0.0953 ± 0.0976	0.0354 ± 0.0370	0.0261 ± 0.0279	0.0064 ± 0.0068	0.1438 ± 0.1549
624	40	640	12:21:01	12:24:01	1	P3	0.0106 ± 0.0028	0.0232 ± 0.0058	0.0033 ± 0.0018	0.0096 ± 0.0033	0.0122 ± 0.0033	0.0073 ± 0.0030	0.0041 ± 0.0016	0.0009 ± 0.0009	0.0068 ± 0.0024
	40	641	12:25:01	12:28:01	1	P3	0.0044 ± 0.0011	0.0113 ± 0.0018	0.0010 ± 0.0008	0.0036 ± 0.0009	0.0050 ± 0.0010	0.0034 ± 0.0011	0.0018 ± 0.0007	0.0005 ± 0.0004	0.0049 ± 0.0009
	40	642	12:30:00	12:31:30	1	P3	0.0271 ± 0.0059	0.0822 ± 0.0164	0.0089 ± 0.0074	0.0251 ± 0.0094	0.0263 ± 0.0124	0.0215 ± 0.0081	0.0136 ± 0.0070	0.0033 ± 0.0049	0.0216 ± 0.0092
	40	643	12:36:00	12:38:31	1	P3	0.0040 ± 0.0036	0.0199 ± 0.0101	0.0057 ± 0.0043	0.0033 ± 0.0025	0.0042 ± 0.0031	0.0055 ± 0.0035	0.0009 ± 0.0031	0.0009 ± 0.0016	0.0050 ± 0.0051
	40	644	12:39:31	12:41:31	1	P3	0.0021 ± 0.0007	0.0057 ± 0.0014	0.0009 ± 0.0008	0.0013 ± 0.0007	0.0011 ± 0.0009	0.0013 ± 0.0005	0.0005 ± 0.0004	0.0002 ± 0.0002	0.0024 ± 0.0003
625	30	645	12:43:31	12:46:30	1	P3	0.0038 ± 0.0019	0.0095 ± 0.0030	0.0026 ± 0.0020	0.0017 ± 0.0017	0.0016 ± 0.0011	0.0013 ± 0.0011	0.0001 ± 0.0009	0.0000 ± 0.0006	0.0033 ± 0.0014
626	15	646	12:47:30	12:50:01	1	P3	0.0224 ± 0.0038	0.0228 ± 0.0067	0.0118 ± 0.0032	0.0054 ± 0.0022	0.0035 ± 0.0026	0.0027 ± 0.0015	0.0000 ± 0.0007	0.0003 ± 0.0009	0.0133 ± 0.0036
627	7	647	12:51:01	12:54:30	1	P3	0.0688 ± 0.0052	0.0459 ± 0.0069	0.0331 ± 0.0055	0.0164 ± 0.0029	0.0122 ± 0.0030	0.0066 ± 0.0029	0.0004 ± 0.0015	0.0003 ± 0.0008	0.0367 ± 0.0056
628	5.5	648	12:55:30	12:59:02	1	P3	0.1467 ± 0.0085	0.0657 ± 0.0090	0.0665 ± 0.0076	0.0357 ± 0.0049	0.0269 ± 0.0063	0.0121 ± 0.0029	0.0039 ± 0.0019	0.0011 ± 0.0013	0.0846 ± 0.0090
629	4	649	13:00:00	13:01:31	1	P3	0.2227 ± 0.0087	0.0843 ± 0.0101	0.1126 ± 0.0126	0.0579 ± 0.0045	0.0429 ± 0.0054	0.0214 ± 0.0031	0.0074 ± 0.0034	0.0022 ± 0.0016	0.1336 ± 0.0106
	4	651	13:07:31	13:11:00	30	0	0.2959 ± 0.0553	0.1072 ± 0.0245	0.1449 ± 0.0305	0.0921 ± 0.0163	0.0785 ± 0.0158	0.0426 ± 0.0111	0.0179 ± 0.0069	0.0034 ± 0.0022	0.1781 ± 0.0356
630	5.5	652	13:11:31	13:15:00	30	0	0.2016 ± 0.0347	0.0974 ± 0.0188	0.0930 ± 0.0153	0.0613 ± 0.0120	0.0510 ± 0.0123	0.0304 ± 0.0079	0.0119 ± 0.0055	0.0025 ± 0.0022	0.1137 ± 0.0200
631	7	653	13:15:31	13:18:31	30	0	0.1046 ± 0.0224	0.0640 ± 0.0180	0.0509 ± 0.0115	0.0333 ± 0.0111	0.0261 ± 0.0094	0.0172 ± 0.0083	0.0061 ± 0.0041	0.0014 ± 0.0019	0.0646 ± 0.0230
632	15	654	13:19:30	13:22:31	30	0	0.0297 ± 0.0065	0.0236 ± 0.0112	0.0104 ± 0.0050	0.0088 ± 0.0053	0.0086 ± 0.0062	0.0066 ± 0.0047	0.0015 ± 0.0036	0.0008 ± 0.0021	0.0252 ± 0.0075
633	30	655	13:23:31	13:27:01	30	0	0.0067 ± 0.0058	0.0051 ± 0.0089	-0.0010 ± -0.0028	0.0027 ± 0.0022	0.0004 ± 0.0029	0.0021 ± 0.0025	-0.0006 ± -0.0027	0.0004 ± 0.0018	0.0131 ± 0.0055
634	4	656	13:27:31	13:35:01	30	0	0.2998 ± 0.0526	0.0826 ± 0.0220	0.1662 ± 0.0346	0.1031 ± 0.0188	0.0840 ± 0.0190	0.0449 ± 0.0115	0.0172 ± 0.0072	0.0040 ± 0.0027	0.1864 ± 0.0334

TABLE A-5.—PART A (Continued).

Test Point No.[1]	Power	Sampling time and probe location					Gaseous emission index averages[4]								
		Aerosol Point No.[1]	Meaeasurement		Probe Rake Location[2]	Probe Tip No[3]	acetaldehyde	acetic acid	benzene	C2-benzene	C3-benzene	C4-benzene	C5-benzene	dimethyl naphthalene	methanol
	%		Start Time	End Time			g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel
635	40	657	13:39:01	13:42:31	30	0	0.0063 ± 0.0032	0.0057 ± 0.0092	0.0011 ± 0.0030	0.0041 ± 0.0035	0.0078 ± 0.0053	0.0064 ± 0.0052	0.0027 ± 0.0034	0.0011 ± 0.0012	0.0118 ± 0.0051
	40	658	13:43:02	13:47:31	10	0	0.0017 ± 0.0014	0.0065 ± 0.0034	0.0005 ± 0.0009	0.0039 ± 0.0014	0.0083 ± 0.0037	0.0043 ± 0.0019	0.0023 ± 0.0020	0.0007 ± 0.0006	0.0036 ± 0.0018
	40	659	13:49:31	13:53:00	10	0	0.0024 ± 0.0024	0.0120 ± 0.0068	0.0016 ± 0.0039	0.0056 ± 0.0027	0.0129 ± 0.0028	0.0087 ± 0.0037	0.0054 ± 0.0029	0.0018 ± 0.0014	0.0030 ± 0.0034
	40	660	13:53:31	13:57:31	10	0	0.0016 ± 0.0081	0.0189 ± 0.0173	0.0089 ± 0.0101	0.0139 ± 0.0079	0.0303 ± 0.0121	0.0219 ± 0.0104	0.0126 ± 0.0078	0.0065 ± 0.0049	0.0007 ± 0.0080
636	30	661	13:59:01	14:02:31	10	0	0.0044 ± 0.0033	0.0048 ± 0.0046	0.0024 ± 0.0021	0.0046 ± 0.0020	0.0093 ± 0.0029	0.0085 ± 0.0025	0.0044 ± 0.0025	0.0014 ± 0.0012	0.0106 ± 0.0028
637	15	662	14:03:30	14:06:32	10	0	0.0315 ± 0.0066	0.0191 ± 0.0082	0.0194 ± 0.0056	0.0097 ± 0.0030	0.0145 ± 0.0050	0.0109 ± 0.0037	0.0044 ± 0.0033	0.0021 ± 0.0016	0.0234 ± 0.0049
638	7	663	14:08:00	14:11:30	10	0	0.1171 ± 0.0112	0.0515 ± 0.0106	0.0611 ± 0.0101	0.0330 ± 0.0040	0.0289 ± 0.0057	0.0158 ± 0.0053	0.0055 ± 0.0026	0.0029 ± 0.0015	0.0660 ± 0.0064
639	5.5	664	14:12:30	14:16:30	10	0	0.1781 ± 0.0176	0.0688 ± 0.0096	0.0899 ± 0.0115	0.0504 ± 0.0059	0.0452 ± 0.0079	0.0256 ± 0.0058	0.0097 ± 0.0040	0.0024 ± 0.0012	0.1009 ± 0.0129
640	4	665	14:18:31	14:21:00	10	0	0.2570 ± 0.0331	0.0860 ± 0.0133	0.1390 ± 0.0193	0.0840 ± 0.0122	0.0705 ± 0.0070	0.0358 ± 0.0058	0.0132 ± 0.0039	0.0024 ± 0.0010	0.1444 ± 0.0304
641	5.5	667	14:26:00	14:29:01	30	0	0.1406 ± 0.0407	0.0483 ± 0.0219	0.0761 ± 0.0247	0.0434 ± 0.0158	0.0379 ± 0.0127	0.0269 ± 0.0090	0.0077 ± 0.0063	0.0026 ± 0.0030	0.0932 ± 0.0237
642	7	668	14:30:32	14:33:01	30	0	0.0880 ± 0.0323	0.0280 ± 0.0198	0.0493 ± 0.0189	0.0326 ± 0.0137	0.0223 ± 0.0111	0.0175 ± 0.0067	0.0060 ± 0.0064	0.0028 ± 0.0041	0.0711 ± 0.0260
643	15	669	14:34:42	14:37:31	30	0	0.0104 ± 0.0062	-0.0007 ± -0.0104	0.0072 ± 0.0062	0.0034 ± 0.0028	0.0057 ± 0.0067	0.0042 ± 0.0033	-0.0004 ± -0.0031	0.0008 ± 0.0017	0.0168 ± 0.0067
701	4	701	8:03:30	8:08:30	10	0	0.9651	0.2381	0.6471	0.3520	0.3112	0.1710	0.0689	0.004	0.664
702	100	702	8:08:59	8:10:30	10	0	0.2997	0.0739	0.2009	0.1093	0.0966	0.0531	0.0214	0.001	0.206
703	85	703	8:11:00	8:13:30	10	0	0.3555	0.0877	0.2384	0.1296	0.1146	0.0630	0.0254	0.002	0.245
704	65	704	8:14:30	8:18:00	10	0	0.0349 ± 0.1080	0.0297 ± 0.0219	0.0212 ± 0.0730	0.0332 ± 0.0343	0.0244 ± 0.0316	0.0169 ± 0.0168	0.0140 ± 0.0056	0.0008 ± 0.0006	0.0316 ± 0.0724
705	4	705	8:19:00	8:23:30	10	0	0.5272 ± 0.0401	0.1700 ± 0.0227	0.3166 ± 0.0305	0.1972 ± 0.0273	0.1599 ± 0.0295	0.0743 ± 0.0151	0.0317 ± 0.0070	0.0041 ± 0.0021	0.3420 ± 0.0275
	4	706	8:24:30	8:27:30	1	P3	0.4812 ± 0.0513	0.1935 ± 0.0444	0.2628 ± 0.0217	0.1495 ± 0.0173	0.1220 ± 0.0195	0.0582 ± 0.0069	0.0307 ± 0.0061	0.0053 ± 0.0034	0.2888 ± 0.0681
706	100	707	8:28:00	8:29:30	1	P3	0.0104 ± 0.0015	0.0258 ± 0.0068	0.0035 ± 0.0014	0.0078 ± 0.0026	0.0101 ± 0.0013	0.0073 ± 0.0020	0.0038 ± 0.0010	0.0011 ± 0.0007	0.0045 ± 0.0012
707	85	708	8:29:30	8:32:30	1	P3	0.0091 ± 0.0018	0.0224 ± 0.0028	0.0031 ± 0.0018	0.0051 ± 0.0017	0.0062 ± 0.0017	0.0051 ± 0.0016	0.0036 ± 0.0011	0.0005 ± 0.0004	0.0040 ± 0.0012
708	70	709	8:33:30	8:36:30	1	P3	0.0088 ± 0.0017	0.0254 ± 0.0063	0.0030 ± 0.0025	0.0041 ± 0.0018	0.0057 ± 0.0020	0.0041 ± 0.0020	0.0035 ± 0.0016	0.0009 ± 0.0007	0.0054 ± 0.0020
709	65	710	8:37:30	8:40:00	1	P3	0.0088 ± 0.0016	0.0231 ± 0.0048	0.0032 ± 0.0030	0.0033 ± 0.0015	0.0048 ± 0.0019	0.0037 ± 0.0015	0.0021 ± 0.0013	0.0008 ± 0.0011	0.0054 ± 0.0019
710	60	711	8:42:00	8:44:00	1	P3	0.0104 ± 0.0028	0.0264 ± 0.0046	0.0047 ± 0.0036	0.0041 ± 0.0021	0.0054 ± 0.0025	0.0033 ± 0.0020	0.0020 ± 0.0016	0.0006 ± 0.0011	0.0067 ± 0.0024
711	4	712	8:46:00	8:52:00	1	P3	0.3985 ± 0.0357	0.1441 ± 0.0191	0.2198 ± 0.0217	0.1238 ± 0.0152	0.1014 ± 0.0156	0.0462 ± 0.0083	0.0193 ± 0.0041	0.0031 ± 0.0017	0.2518 ± 0.0337
	4	713	8:53:00	8:56:30	1	P3	3.2666 ± 1.3363	8.1690 ± 3.1618	1.6305 ± 0.9005	4.0322 ± 1.9792	6.1372 ± 3.1323	4.4410 ± 2.2299	2.2052 ± 0.8395	0.7358 ± 0.4048	1.1762 ± 0.5404
712	100	714	8:57:30	8:58:30	1	P3	0.0090 ± 0.0011	0.0220 ± 0.0040	0.0025 ± 0.0016	0.0060 ± 0.0013	0.0073 ± 0.0015	0.0056 ± 0.0016	0.0030 ± 0.0011	0.0008 ± 0.0007	0.0043 ± 0.0009
713	85	715	8:59:30	9:01:00	1	P3	0.0089 ± 0.0019	0.0191 ± 0.0038	0.0026 ± 0.0015	0.0043 ± 0.0012	0.0067 ± 0.0014	0.0056 ± 0.0016	0.0034 ± 0.0013	0.0006 ± 0.0009	0.0042 ± 0.0010
714	65	716	9:03:30	9:06:30	1	P3	0.0093 ± 0.0020	0.0223 ± 0.0039	0.0025 ± 0.0020	0.0039 ± 0.0017	0.0069 ± 0.0029	0.0059 ± 0.0016	0.0030 ± 0.0010	0.0005 ± 0.0008	0.0050 ± 0.0015
715	4	717	9:08:00	9:11:30	1	P3	0.4096 ± 0.0272	0.1561 ± 0.0194	0.2216 ± 0.0236	0.1275 ± 0.0162	0.1073 ± 0.0152	0.0520 ± 0.0088	0.0198 ± 0.0044	0.0036 ± 0.0014	0.2631 ± 0.0222
	4	718	9:12:00	9:15:30	10	0	0.5649 ± 0.0426	0.2392 ± 0.0210	0.3107 ± 0.0316	0.2077 ± 0.0200	0.1805 ± 0.0211	0.0903 ± 0.0108	0.0382 ± 0.0065	0.0074 ± 0.0026	0.3563 ± 0.0263
716	100	719	9:16:30	9:17:30	10	0	0.0513 ± 0.0076	0.0935 ± 0.0149	0.0156 ± 0.0044	0.0498 ± 0.0052	0.0739 ± 0.0134	0.0464 ± 0.0075	0.0225 ± 0.0049	0.0056 ± 0.0018	0.0210 ± 0.0049
717	85	720	9:18:30	9:21:00	10	0	0.0419 ± 0.0045	0.0802 ± 0.0146	0.0094 ± 0.0030	0.0352 ± 0.0072	0.0456 ± 0.0127	0.0347 ± 0.0066	0.0231 ± 0.0064	0.0065 ± 0.0030	0.0188 ± 0.0050
718	65	721	9:22:30	9:24:30	10	0	0.0326 ± 0.0038	0.0628 ± 0.0075	0.0073 ± 0.0035	0.0225 ± 0.0036	0.0298 ± 0.0053	0.0232 ± 0.0044	0.0137 ± 0.0029	0.0038 ± 0.0017	0.0198 ± 0.0035
719	4	722	9:25:30	9:28:30	10	0	0.4895 ± 0.0351	0.1947 ± 0.0215	0.2614 ± 0.0285	0.1739 ± 0.0203	0.1543 ± 0.0220	0.0801 ± 0.0134	0.0347 ± 0.0090	0.0062 ± 0.0025	0.3099 ± 0.0237
	4	723	9:29:00	9:32:30	30	0	0.5373 ± 0.1678	0.2575 ± 0.0542	0.3104 ± 0.0800	0.1988 ± 0.0752	0.1891 ± 0.0691	0.1061 ± 0.0367	0.0673 ± 0.0150	0.0097 ± 0.0041	0.3590 ± 0.1139
720	100	724	9:33:30	9:34:30	30	0	0.0311 ± 0.0034	0.0468 ± 0.0084	0.0052 ± 0.0041	0.0122 ± 0.0031	0.0174 ± 0.0063	0.0117 ± 0.0040	0.0096 ± 0.0034	0.0025 ± 0.0021	0.0349 ± 0.0034
721	85	725	9:35:30	9:37:30	30	0	0.0245 ± 0.0036	0.0433 ± 0.0061	0.0014 ± 0.0025	0.0076 ± 0.0033	0.0073 ± 0.0028	0.0076 ± 0.0034	0.0064 ± 0.0026	0.0019 ± 0.0013	0.0366 ± 0.0050
722	70	726	9:38:30	9:41:30	30	0	0.0232 ± 0.0033	0.0434 ± 0.0082	0.0015 ± 0.0031	0.0050 ± 0.0024	0.0072 ± 0.0028	0.0055 ± 0.0027	0.0052 ± 0.0021	0.0007 ± 0.0014	0.0391 ± 0.0061
723	65	727	9:42:00	9:45:30	30	0	0.0205 ± 0.0039	0.0425 ± 0.0096	0.0005 ± 0.0027	0.0048 ± 0.0019	0.0052 ± 0.0022	0.0037 ± 0.0018	0.0056 ± 0.0028	0.0003 ± 0.0008	0.0401 ± 0.0073
724	60	728	9:47:00	9:49:30	30	0	0.0184 ± 0.0040	0.0381 ± 0.0072	-0.0013 ± -0.0020	0.0044 ± 0.0018	0.0028 ± 0.0014	0.0037 ± 0.0019	0.0053 ± 0.0014	0.0000 ± 0.0010	0.0388 ± 0.0095
725	4	729	9:51:00	9:54:00	30	0	0.4815 ± 0.0610	0.1945 ± 0.0262	0.2730 ± 0.0380	0.1785 ± 0.0233	0.1559 ± 0.0193	0.0892 ± 0.0164	0.0427 ± 0.0107	0.0077 ± 0.0038	0.3525 ± 0.0407

TABLE A-5.—PART A (Continued).

Test Point No.[1]	Power %	Sampling time and probe location: Aerosol Point No.[1]	Meaeasurement: Start Time	Meaeasurement: End Time	Probe Rake Location[2]	Probe Tip No[3]	Gaseous emission index averages[4]: acetaldehyde g/kg fuel	acetic acid g/kg fuel	benzene g/kg fuel	C2-benzene g/kg fuel	C3-benzene g/kg fuel	C4-benzene g/kg fuel	C5-benzene g/kg fuel	dimethyl naphthalene g/kg fuel	methanol g/kg fuel
726	4	732	15:07:00	15:09:30	30	0	0.3032 ± 0.0428	0.0749 ± 0.0150	0.1640 ± 0.0259	0.0969 ± 0.0137	0.0833 ± 0.0140	0.0429 ± 0.0099	0.0187 ± 0.0057	0.0043 ± 0.0034	0.2062 ± 0.0325
727	100	733	15:11:00	15:12:30	30	0	0.0032 ± 0.0048	0.0057 ± 0.0051	0.0010 ± 0.0011	0.0046 ± 0.0022	0.0072 ± 0.0022	0.0058 ± 0.0021	0.0019 ± 0.0016	0.0006 ± 0.0009	0.0099 ± 0.0032
728	85	734	15:13:30	15:16:00	30	0	0.0038 ± 0.0040	0.0012 ± 0.0041	0.0008 ± 0.0014	0.0027 ± 0.0020	0.0037 ± 0.0034	0.0038 ± 0.0020	0.0007 ± 0.0015	0.0003 ± 0.0005	0.0100 ± 0.0029
729	65	735	15:16:30	15:20:00	30	0	-0.0019 ± -0.0033	-0.0016 ± -0.0050	-0.0002 ± -0.0020	0.0019 ± 0.0013	0.0025 ± 0.0021	0.0020 ± 0.0020	-0.0003 ± -0.0013	0.0003 ± 0.0006	0.0116 ± 0.0039
730	40	736	15:21:30	15:24:30	30	0	-0.0053 ± -0.0040	-0.0073 ± -0.0079	-0.0012 ± -0.0016	0.0017 ± 0.0025	0.0007 ± 0.0019	0.0017 ± 0.0016	-0.0000 ± -0.0023	0.0006 ± 0.0011	0.0108 ± 0.0038
731	30	737	15:26:00	15:29:30	30	0	-0.0050 ± -0.0043	-0.0084 ± -0.0070	0.0003 ± 0.0030	0.0013 ± 0.0020	0.0020 ± 0.0029	0.0008 ± 0.0020	-0.0016 ± -0.0020	0.0001 ± 0.0009	0.0147 ± 0.0060
732	7	738	15:31:00	15:33:30	30	0	0.0911 ± 0.0109	0.0278 ± 0.0122	0.0476 ± 0.0099	0.0267 ± 0.0069	0.0226 ± 0.0077	0.0116 ± 0.0045	0.0008 ± 0.0034	0.0012 ± 0.0013	0.0641 ± 0.0106
733	4	739	15:34:30	15:38:00	30	0	0.2159 ± 0.0326	0.0598 ± 0.0173	0.1093 ± 0.0194	0.0682 ± 0.0141	0.0558 ± 0.0111	0.0266 ± 0.0077	0.0089 ± 0.0050	0.0023 ± 0.0024	0.1487 ± 0.0253
	4	740	15:39:30	15:42:00	10	0	0.2136	0.0703	0.1160	0.0706	0.0534	0.0212	0.0081	0.0030	0.1299
734	100	741	15:44:00	15:45:00	10	0	0.0023 ± 0.0007	0.0082 ± 0.0017	0.0020 ± 0.0005	0.0066 ± 0.0012	0.0094 ± 0.0011	0.0063 ± 0.0015	0.0031 ± 0.0009	0.0007 ± 0.0004	0.0038 ± 0.0008
735	85	742	15:45:30	15:48:00	10	0	0.0018 ± 0.0007	0.0078 ± 0.0012	0.0013 ± 0.0006	0.0052 ± 0.0013	0.0080 ± 0.0016	0.0056 ± 0.0008	0.0034 ± 0.0006	0.0010 ± 0.0004	0.0044 ± 0.0008
736	65	743	15:48:30	15:52:30	10	0	0.0015 ± 0.0008	0.0070 ± 0.0018	0.0011 ± 0.0007	0.0049 ± 0.0013	0.0070 ± 0.0009	0.0057 ± 0.0011	0.0038 ± 0.0011	0.0012 ± 0.0006	0.0046 ± 0.0008
737	40	744	15:53:30	15:57:00	10	0	0.0013 ± 0.0012	0.0050 ± 0.0020	0.0010 ± 0.0011	0.0048 ± 0.0011	0.0062 ± 0.0013	0.0058 ± 0.0014	0.0039 ± 0.0014	0.0011 ± 0.0009	0.0059 ± 0.0016
738	30	745	15:57:30	16:01:30	10	0	0.0020 ± 0.0016	0.0063 ± 0.0033	0.0018 ± 0.0012	0.0053 ± 0.0017	0.0080 ± 0.0016	0.0066 ± 0.0017	0.0043 ± 0.0018	0.0013 ± 0.0007	0.0083 ± 0.0023
739	7	746	16:02:30	16:06:00	10	0	0.0850 ± 0.0099	0.0427 ± 0.0070	0.0456 ± 0.0065	0.0280 ± 0.0039	0.0251 ± 0.0043	0.0133 ± 0.0023	0.0062 ± 0.0021	0.0014 ± 0.0009	0.0512 ± 0.0052
740	4	747	16:06:30	16:08:30	10	0	0.2353 ± 0.0422	0.0770 ± 0.0170	0.1302 ± 0.0290	0.0691 ± 0.0119	0.0571 ± 0.0126	0.0269 ± 0.0059	0.0127 ± 0.0028	0.0021 ± 0.0007	0.1414 ± 0.0257
	4	748	16:10:30	16:13:30	1	P3	0.2071 ± 0.0141	0.1016 ± 0.0097	0.1032 ± 0.0095	0.0596 ± 0.0069	0.0534 ± 0.0081	0.0271 ± 0.0037	0.0121 ± 0.0033	0.0031 ± 0.0012	0.1220 ± 0.0092
741	100	749	16:15:00	16:16:00	1	P3	0.0071 ± 0.0029	0.0227 ± 0.0061	0.0059 ± 0.0021	0.0060 ± 0.0006	0.0099 ± 0.0021	0.0082 ± 0.0029	0.0037 ± 0.0021	0.0015 ± 0.0005	0.0045 ± 0.0017
742	85	750	16:16:30	16:20:00	1	P3	0.0037 ± 0.0019	0.0131 ± 0.0040	0.0046 ± 0.0012	0.0034 ± 0.0013	0.0064 ± 0.0028	0.0056 ± 0.0016	0.0035 ± 0.0018	0.0008 ± 0.0006	0.0037 ± 0.0026
743	70	751	16:21:30	16:24:00	1	P3	0.0030 ± 0.0022	0.0114 ± 0.0025	0.0041 ± 0.0013	0.0022 ± 0.0010	0.0050 ± 0.0015	0.0036 ± 0.0011	0.0014 ± 0.0013	0.0008 ± 0.0005	0.0032 ± 0.0011
744	65	752	16:25:00	16:28:00	1	P3	0.0036 ± 0.0017	0.0120 ± 0.0039	0.0031 ± 0.0015	0.0023 ± 0.0012	0.0038 ± 0.0012	0.0040 ± 0.0013	0.0012 ± 0.0009	0.0007 ± 0.0005	0.0023 ± 0.0015
745	60	753	16:29:30	16:31:30	1	P3	0.0035 ± 0.0016	0.0099 ± 0.0033	0.0032 ± 0.0014	0.0015 ± 0.0012	0.0027 ± 0.0009	0.0024 ± 0.0007	0.0011 ± 0.0009	0.0006 ± 0.0003	0.0022 ± 0.0012
746	40	754	16:33:00	16:35:30	1	P3	0.0079 ± 0.0022	0.0126 ± 0.0037	0.0037 ± 0.0020	0.0023 ± 0.0017	0.0037 ± 0.0020	0.0029 ± 0.0016	0.0005 ± 0.0010	0.0012 ± 0.0005	0.0028 ± 0.0014
747	30	755	16:37:00	16:39:30	1	P3	0.0080 ± 0.0025	0.0148 ± 0.0046	0.0049 ± 0.0022	0.0018 ± 0.0011	0.0038 ± 0.0023	0.0029 ± 0.0018	0.0008 ± 0.0013	0.0007 ± 0.0008	0.0035 ± 0.0015
748	15	756	16:41:00	16:43:30	1	P3	0.0238 ± 0.0028	0.0261 ± 0.0041	0.0118 ± 0.0022	0.0044 ± 0.0016	0.0046 ± 0.0014	0.0029 ± 0.0009	0.0002 ± 0.0008	0.0008 ± 0.0006	0.0109 ± 0.0026
749	7	757	16:44:00	16:47:00	1	P3	0.0657 ± 0.0070	0.0566 ± 0.0064	0.0307 ± 0.0045	0.0152 ± 0.0033	0.0134 ± 0.0030	0.0066 ± 0.0017	0.0022 ± 0.0013	0.0008 ± 0.0006	0.0351 ± 0.0040
750	5.5	758	16:48:00	16:51:00	1	P3	0.1122 ± 0.0060	0.0767 ± 0.0060	0.0484 ± 0.0050	0.0260 ± 0.0041	0.0202 ± 0.0036	0.0093 ± 0.0019	0.0023 ± 0.0012	0.0011 ± 0.0005	0.0622 ± 0.0052
751	4	759	16:52:00	16:54:30	1	P3	0.2023 ± 0.0137	0.1163 ± 0.0071	0.0966 ± 0.0095	0.0518 ± 0.0056	0.0398 ± 0.0050	0.0179 ± 0.0030	0.0062 ± 0.0016	0.0019 ± 0.0007	0.1206 ± 0.0092
	4	801	8:02:31	8:05:01	1	P3	0.4804 ± 0.0684	0.1762 ± 0.0456	0.2688 ± 0.0335	0.1561 ± 0.0246	0.1322 ± 0.0241	0.0735 ± 0.0154	0.0302 ± 0.0071	0.0063 ± 0.0014	0.2972 ± 0.0814
802	100	802	8:06:31	8:08:31	1	P3	0.0230 ± 0.0028	0.0479 ± 0.0120	0.0073 ± 0.0026	0.0210 ± 0.0052	0.0320 ± 0.0065	0.0212 ± 0.0049	0.0092 ± 0.0026	0.0023 ± 0.0016	0.0070 ± 0.0020
803	85	803	8:09:01	8:11:31	1	P3	0.0155 ± 0.0030	0.0305 ± 0.0050	0.0048 ± 0.0024	0.0126 ± 0.0025	0.0178 ± 0.0040	0.0131 ± 0.0016	0.0078 ± 0.0013	0.0013 ± 0.0007	0.0045 ± 0.0009
804	65	804	8:12:32	8:16:01	1	P3	0.0157 ± 0.0026	0.0314 ± 0.0059	0.0045 ± 0.0022	0.0083 ± 0.0021	0.0143 ± 0.0029	0.0118 ± 0.0037	0.0055 ± 0.0029	0.0015 ± 0.0011	0.0051 ± 0.0015
805	40	805	8:17:01	8:22:02	1	P3	0.0136 ± 0.0015	0.0181 ± 0.0032	0.0021 ± 0.0013	0.0031 ± 0.0011	0.0062 ± 0.0012	0.0045 ± 0.0015	0.0015 ± 0.0010	0.0005 ± 0.0004	0.0046 ± 0.0008
	40	806	8:22:31	8:26:32	1	P3	0.0089 ± 0.0008	0.0146 ± 0.0019	0.0012 ± 0.0007	0.0015 ± 0.0004	0.0024 ± 0.0006	0.0020 ± 0.0006	0.0010 ± 0.0006	0.0001 ± 0.0002	0.0030 ± 0.0004
	40	807	8:28:31	8:32:31	1	P3	0.0195 ± 0.0049	0.0495 ± 0.0144	0.0080 ± 0.0056	0.0055 ± 0.0035	0.0080 ± 0.0051	0.0067 ± 0.0033	0.0008 ± 0.0034	0.0004 ± 0.0013	0.0077 ± 0.0035
806	30	809	8:37:30	8:40:32	1	P3	0.0142 ± 0.0039	0.0192 ± 0.0042	0.0038 ± 0.0025	0.0024 ± 0.0017	0.0040 ± 0.0020	0.0030 ± 0.0016	-0.0022 ± -0.0013	0.0004 ± 0.0008	0.0065 ± 0.0020
807	7	810	8:42:01	8:45:01	1	P3	0.1209 ± 0.0351	0.0925 ± 0.0306	0.0480 ± 0.0141	0.0246 ± 0.0078	0.0166 ± 0.0057	0.0078 ± 0.0024	0.0014 ± 0.0019	0.0007 ± 0.0005	0.0617 ± 0.0203
808	4	811	8:46:01	8:48:32	1	P3	0.3029 ± 0.0141	0.2302 ± 0.0241	0.1338 ± 0.0068	0.0712 ± 0.0074	0.0550 ± 0.0078	0.0243 ± 0.0025	0.0073 ± 0.0019	0.0022 ± 0.0012	0.1772 ± 0.0106
	4	812	8:50:02	8:52:31	10	0	0.4354 ± 0.0399	0.2360 ± 0.0245	0.1971 ± 0.0252	0.1196 ± 0.0131	0.0994 ± 0.0159	0.0417 ± 0.0074	0.0120 ± 0.0051	0.0036 ± 0.0015	0.2483 ± 0.0244
809	100	813	8:54:32	8:55:32	10	0	0.0442 ± 0.0058	0.1028 ± 0.0134	0.0125 ± 0.0045	0.0286 ± 0.0068	0.0374 ± 0.0046	0.0209 ± 0.0028	0.0055 ± 0.0032	0.0028 ± 0.0020	0.0152 ± 0.0047
810	85	814	8:56:02	8:59:01	10	0	0.0360 ± 0.0046	0.0807 ± 0.0106	0.0096 ± 0.0045	0.0185 ± 0.0028	0.0301 ± 0.0032	0.0174 ± 0.0051	0.0044 ± 0.0042	0.0026 ± 0.0013	0.0131 ± 0.0030
811	65	815	8:59:31	9:02:32	10	0	0.0273 ± 0.0057	0.0613 ± 0.0098	0.0079 ± 0.0049	0.0131 ± 0.0040	0.0124 ± 0.0052	0.0094 ± 0.0038	0.0028 ± 0.0034	0.0014 ± 0.0018	0.0109 ± 0.0036

TABLE A-5.—PART A (Continued).

Test Point No.[1]	Power	Sampling time and probe location					Gaseous emission index averages[4]								
		Aerosol Point No.[1]	Meaeasurement		Probe Rake Location[2]	Probe Tip No[3]	acetaldehyde	acetic acid	benzene	C2-benzene	C3-benzene	C4-benzene	C5-benzene	dimethyl naphthalene	methanol
	%		Start Time	End Time			g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel
812	40	816	9:03:32	9:07:01	10	0	0.0255 ± 0.0047	0.0539 ± 0.0062	0.0062 ± 0.0029	0.0088 ± 0.0025	0.0105 ± 0.0033	0.0069 ± 0.0037	0.0003 ± 0.0018	0.0017 ± 0.0012	0.0148 ± 0.0035
	40	817	9:07:31	9:12:30	10	0	0.0083 ± 0.0014	0.0197 ± 0.0029	0.0013 ± 0.0010	0.0030 ± 0.0009	0.0036 ± 0.0011	0.0024 ± 0.0008	-0.0002 ± -0.0008	0.0003 ± 0.0003	0.0090 ± 0.0015
	40	818	9:13:31	9:17:32	10	0	0.0378 ± 0.0076	0.0884 ± 0.0159	0.0144 ± 0.0086	0.0117 ± 0.0046	0.0146 ± 0.0063	0.0078 ± 0.0043	-0.0066 ± -0.0046	0.0030 ± 0.0026	0.0248 ± 0.0048
	40	819	9:19:01	9:23:01	10	0	0.0126 ± 0.0019	0.0247 ± 0.0033	0.0018 ± 0.0014	0.0031 ± 0.0011	0.0042 ± 0.0016	0.0034 ± 0.0012	-0.0019 ± -0.0011	0.0004 ± 0.0006	0.0127 ± 0.0026
813	30	820	9:24:01	9:27:31	10	0	0.0207	0.0410	-0.0013	0.0060	0.0067	0.0059	-0.0038	0.0019	0.0266
814	7	821	9:28:31	9:32:02	10	0	0.1510 ± 0.0336	0.1170 ± 0.0225	0.0662 ± 0.0169	0.0344 ± 0.0082	0.0267 ± 0.0063	0.0111 ± 0.0042	0.0007 ± 0.0040	0.0011 ± 0.0011	0.0784 ± 0.0171
815	4	822	9:32:31	9:36:01	10	0	0.3061 ± 0.0400	0.1521 ± 0.0238	0.1449 ± 0.0204	0.0822 ± 0.0127	0.0611 ± 0.0103	0.0280 ± 0.0064	0.0062 ± 0.0034	0.0025 ± 0.0013	0.1736 ± 0.0328
	4	823	9:36:31	9:40:02	30	0	0.3538 ± 0.0430	0.2161 ± 0.0366	0.1628 ± 0.0275	0.1033 ± 0.0156	0.0965 ± 0.0160	0.0462 ± 0.0081	0.0111 ± 0.0086	0.0050 ± 0.0032	0.2285 ± 0.0342
816	100	824	9:41:01	9:42:01	30	0	0.0170 ± 0.0047	0.0333 ± 0.0053	0.0015 ± 0.0021	0.0051 ± 0.0022	0.0063 ± 0.0036	0.0045 ± 0.0023	-0.0036 ± -0.0013	0.0012 ± 0.0009	0.0135 ± 0.0036
817	85	825	9:42:31	9:45:31	30	0	0.0121 ± 0.0027	0.0255 ± 0.0059	0.0013 ± 0.0027	0.0008 ± 0.0018	0.0017 ± 0.0023	0.0017 ± 0.0014	-0.0053 ± -0.0014	0.0003 ± 0.0009	0.0162 ± 0.0033
818	70	826	9:46:32	9:49:31	30	0	0.0090 ± 0.0032	0.0213 ± 0.0064	-0.0000 ± -0.0022	-0.0001 ± -0.0014	0.0014 ± 0.0016	0.0005 ± 0.0012	-0.0081 ± -0.0014	0.0001 ± 0.0007	0.0166 ± 0.0036
819	65	827	9:50:00	9:53:01	30	0	0.0086 ± 0.0034	0.0207 ± 0.0068	-0.0003 ± -0.0028	-0.0004 ± -0.0016	-0.0002 ± -0.0012	0.0005 ± 0.0017	-0.0093 ± -0.0015	-0.0001 ± -0.0006	0.0173 ± 0.0041
820	60	828	9:53:32	9:56:31	30	0	0.0069 ± 0.0037	0.0194 ± 0.0079	-0.0000 ± -0.0022	-0.0013 ± -0.0020	-0.0007 ± -0.0015	-0.0003 ± -0.0010	-0.0081 ± -0.0027	0.0001 ± 0.0007	0.0158 ± 0.0043
821	40	829	9:57:30	10:00:31	30	0	0.0046 ± 0.0037	0.0140 ± 0.0063	-0.0007 ± -0.0025	-0.0017 ± -0.0020	-0.0008 ± -0.0016	-0.0012 ± -0.0013	-0.0111 ± -0.0026	0.0000 ± 0.0010	0.0193 ± 0.0056
822	30	830	10:02:02	10:05:00	30	0	0.0066 ± 0.0043	0.0142 ± 0.0086	-0.0005 ± -0.0030	-0.0021 ± -0.0023	-0.0009 ± -0.0029	-0.0002 ± -0.0023	-0.0130 ± -0.0036	0.0001 ± 0.0012	0.0205 ± 0.0058
823	15	831	10:05:32	10:08:32	30	0	0.0429 ± 0.0085	0.0335 ± 0.0130	0.0192 ± 0.0080	0.0054 ± 0.0051	0.0053 ± 0.0040	0.0008 ± 0.0038	-0.0210 ± -0.0035	0.0003 ± 0.0015	0.0428 ± 0.0096
824	7	832	10:09:30	10:12:31	30	0	0.1378 ± 0.0152	0.0787 ± 0.0176	0.0636 ± 0.0150	0.0334 ± 0.0088	0.0283 ± 0.0077	0.0107 ± 0.0049	-0.0166 ± -0.0041	0.0007 ± 0.0018	0.0970 ± 0.0137
825	5.5	833	10:13:01	10:16:31	30	0	0.2141 ± 0.0265	0.1006 ± 0.0185	0.0952 ± 0.0166	0.0536 ± 0.0121	0.0445 ± 0.0108	0.0215 ± 0.0072	-0.0174 ± -0.0045	0.0025 ± 0.0016	0.1332 ± 0.0187
826	4	834	10:17:01	10:21:31	30	0	0.3167 ± 0.0500	0.1212 ± 0.0256	0.1527 ± 0.0337	0.0896 ± 0.0217	0.0784 ± 0.0178	0.0372 ± 0.0125	-0.0090 ± -0.0053	0.0042 ± 0.0040	0.2039 ± 0.0408
827	4	836	12:50:31	12:53:31	30	0	0.4063 ± 0.1423	0.1027 ± 0.0396	0.1970 ± 0.0727	0.1331 ± 0.0466	0.1234 ± 0.0388	0.0757 ± 0.0271	0.0305 ± 0.0125	0.0067 ± 0.0051	0.2925 ± 0.0989
828	100	837	12:54:32	12:55:32	30	0	0.0063 ± 0.0023	0.0059 ± 0.0037	-0.0000 ± -0.0018	0.0049 ± 0.0018	0.0081 ± 0.0039	0.0078 ± 0.0031	0.0035 ± 0.0024	0.0012 ± 0.0011	0.0161 ± 0.0038
829	85	838	12:56:02	12:58:31	30	0	0.0067 ± 0.0024	0.0001 ± 0.0038	-0.0030 ± -0.0014	0.0022 ± 0.0018	0.0010 ± 0.0024	0.0017 ± 0.0027	0.0013 ± 0.0011	0.0000 ± 0.0008	0.0158 ± 0.0058
830	65	839	12:59:31	13:02:31	30	0	0.0046 ± 0.0030	0.0034 ± 0.0054	-0.0026 ± -0.0018	0.0011 ± 0.0013	-0.0016 ± -0.0022	0.0018 ± 0.0020	0.0003 ± 0.0022	-0.0001 ± -0.0008	0.0208 ± 0.0038
831	40	840	13:03:31	13:06:31	30	0	0.0050 ± 0.0039	-0.0011 ± -0.0054	-0.0041 ± -0.0022	0.0001 ± 0.0021	-0.0024 ± -0.0025	0.0013 ± 0.0020	-0.0013 ± -0.0022	0.0000 ± 0.0009	0.0279 ± 0.0043
832	30	841	13:07:31	13:10:31	30	0	0.0059 ± 0.0039	-0.0006 ± -0.0094	-0.0038 ± -0.0022	-0.0000 ± -0.0027	-0.0036 ± -0.0026	0.0000 ± 0.0017	-0.0027 ± -0.0017	-0.0002 ± -0.0011	0.0329 ± 0.0075
833	7	842	13:11:01	13:15:01	30	0	0.1316 ± 0.0378	0.0447 ± 0.0164	0.0466 ± 0.0195	0.0334 ± 0.0113	0.0208 ± 0.0103	0.0132 ± 0.0075	0.0011 ± 0.0037	-0.0005 ± -0.0019	0.1119 ± 0.0282
834	4	843	13:15:32	13:18:31	30	0	0.2837 ± 0.1191	0.0687 ± 0.0292	0.1093 ± 0.0455	0.0762 ± 0.0314	0.0574 ± 0.0309	0.0340 ± 0.0135	0.0085 ± 0.0059	0.0022 ± 0.0035	0.2197 ± 0.0821
	4	844	13:19:32	13:24:32	10	0	0.2349 ± 0.0686	0.0777 ± 0.0201	0.1037 ± 0.0311	0.0675 ± 0.0195	0.0559 ± 0.0152	0.0261 ± 0.0078	0.0106 ± 0.0038	0.0011 ± 0.0011	0.1420 ± 0.0416
835	100	845	13:25:01	13:26:31	10	0	0.0114 ± 0.0027	0.0179 ± 0.0064	0.0029 ± 0.0035	0.0183 ± 0.0029	0.0247 ± 0.0049	0.0169 ± 0.0038	0.0097 ± 0.0026	0.0013 ± 0.0012	0.0072 ± 0.0032
836	85	846	13:27:02	13:30:01	10	0	0.0093 ± 0.0023	0.0143 ± 0.0043	0.0005 ± 0.0019	0.0108 ± 0.0028	0.0125 ± 0.0049	0.0137 ± 0.0038	0.0074 ± 0.0025	0.0025 ± 0.0016	0.0085 ± 0.0030
837	65	847	13:30:31	13:33:31	10	0	0.0069 ± 0.0021	0.0082 ± 0.0036	0.0000 ± 0.0014	0.0046 ± 0.0018	0.0071 ± 0.0031	0.0084 ± 0.0019	0.0039 ± 0.0022	0.0018 ± 0.0010	0.0100 ± 0.0025
838	40	848	13:35:02	13:38:31	10	0	0.0079 ± 0.0019	0.0074 ± 0.0048	-0.0001 ± -0.0016	0.0040 ± 0.0022	0.0048 ± 0.0024	0.0073 ± 0.0022	0.0041 ± 0.0023	0.0013 ± 0.0010	0.0158 ± 0.0028
839	30	849	13:39:01	13:42:31	10	0	0.0081 ± 0.0023	0.0055 ± 0.0048	0.0004 ± 0.0019	0.0032 ± 0.0014	0.0035 ± 0.0025	0.0056 ± 0.0019	0.0029 ± 0.0017	0.0011 ± 0.0011	0.0167 ± 0.0031
840	7	850	13:43:01	13:47:01	10	0	0.1419 ± 0.0418	0.0651 ± 0.0168	0.0532 ± 0.0167	0.0367 ± 0.0094	0.0291 ± 0.0086	0.0166 ± 0.0050	0.0056 ± 0.0024	0.0018 ± 0.0010	0.0821 ± 0.0224
841	4	851	13:47:01	13:49:31	10	0	0.2913 ± 0.0815	0.0980 ± 0.0223	0.1300 ± 0.0308	0.0871 ± 0.0166	0.0751 ± 0.0160	0.0384 ± 0.0094	0.0151 ± 0.0038	0.0029 ± 0.0016	0.1816 ± 0.0497
	4	852	13:51:01	13:54:32	1	P3	0.2550 ± 0.0171	0.1053 ± 0.0071	0.1106 ± 0.0113	0.0668 ± 0.0062	0.0571 ± 0.0065	0.0296 ± 0.0035	0.0104 ± 0.0024	0.0024 ± 0.0009	0.1543 ± 0.0136
842	100	853	13:55:32	13:57:01	1	P3	0.0112 ± 0.0027	0.0221 ± 0.0059	0.0026 ± 0.0024	0.0069 ± 0.0013	0.0059 ± 0.0024	0.0091 ± 0.0032	0.0029 ± 0.0016	0.0014 ± 0.0007	0.0086 ± 0.0010
843	85	854	13:57:32	14:00:32	1	P3	0.0091 ± 0.0018	0.0150 ± 0.0040	0.0010 ± 0.0012	0.0036 ± 0.0013	0.0037 ± 0.0017	0.0059 ± 0.0016	0.0023 ± 0.0016	0.0008 ± 0.0007	0.0065 ± 0.0022
844	100	855	14:10:31	14:12:02	1	P3	0.0047 ± 0.0015	0.0044 ± 0.0025	-0.0001 ± -0.0013	0.0007 ± 0.0006	-0.0011 ± -0.0006	0.0017 ± 0.0012	0.0004 ± 0.0009	0.0001 ± 0.0004	0.0043 ± 0.0011
845	85	856	14:12:31	14:16:02	1	P3	0.0046 ± 0.0016	0.0033 ± 0.0038	-0.0001 ± -0.0014	0.0006 ± 0.0011	-0.0012 ± -0.0012	0.0021 ± 0.0012	-0.0006 ± -0.0008	0.0001 ± 0.0004	0.0043 ± 0.0013
846	70	857	14:17:02	14:20:02	1	P3	0.0035 ± 0.0015	0.0032 ± 0.0023	0.0006 ± 0.0008	0.0007 ± 0.0007	-0.0016 ± -0.0010	0.0013 ± 0.0006	-0.0003 ± -0.0006	0.0000 ± 0.0004	0.0042 ± 0.0014

TABLE A-5.—PART A (Continued).

Test Point No.[1]	Power	Sampling time and probe location					Gaseous emission index averages[4]								
		Aerosol Point No.[1]	Meaeasurement		Probe Rake Location[2]	Probe Tip No[3]	acetaldehyde	acetic acid	benzene	C2-benzene	C3-benzene	C4-benzene	C5-benzene	dimethyl naphthalene	methanol
	%		Start Time	End Time			g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel
847	65	858	14:20:31	14:23:32	1	P3	0.0050 ± 0.0016	0.0021 ± 0.0023	-0.0001 ± -0.0011	0.0004 ± 0.0010	-0.0019 ± -0.0012	0.0013 ± 0.0012	-0.0005 ± -0.0008	0.0001 ± 0.0005	0.0045 ± 0.0016
848	60	859	14:24:02	14:27:32	1	P3	0.0049 ± 0.0016	0.0018 ± 0.0035	-0.0002 ± -0.0013	0.0006 ± 0.0011	-0.0021 ± -0.0013	0.0012 ± 0.0016	-0.0008 ± -0.0012	0.0000 ± 0.0004	0.0041 ± 0.0014
849	40	860	14:28:32	14:32:01	1	P3	0.0084 ± 0.0022	0.0045 ± 0.0026	0.0001 ± 0.0012	0.0008 ± 0.0011	-0.0022 ± -0.0012	0.0009 ± 0.0008	-0.0012 ± -0.0009	0.0000 ± 0.0005	0.0053 ± 0.0009
850	30	861	14:33:01	14:36:02	1	P3	0.0093 ± 0.0017	0.0062 ± 0.0028	0.0003 ± 0.0010	0.0010 ± 0.0007	-0.0016 ± -0.0009	0.0009 ± 0.0006	-0.0010 ± -0.0006	0.0001 ± 0.0004	0.0049 ± 0.0009
851	15	862	14:37:01	14:40:00	1	P3	0.0279 ± 0.0020	0.0190 ± 0.0036	0.0075 ± 0.0018	0.0038 ± 0.0013	0.0001 ± 0.0017	0.0016 ± 0.0012	-0.0010 ± -0.0006	0.0000 ± 0.0005	0.0133 ± 0.0015
852	7	863	14:40:30	14:43:31	1	P3	0.0928 ± 0.0070	0.0520 ± 0.0069	0.0318 ± 0.0041	0.0166 ± 0.0023	0.0104 ± 0.0029	0.0055 ± 0.0013	0.0008 ± 0.0007	0.0002 ± 0.0004	0.0488 ± 0.0035
853	5.5	864	14:44:02	14:47:01	1	P3	0.1284 ± 0.0082	0.0704 ± 0.0060	0.0452 ± 0.0048	0.0252 ± 0.0025	0.0193 ± 0.0028	0.0089 ± 0.0019	0.0020 ± 0.0011	0.0007 ± 0.0008	0.0693 ± 0.0046
854	4	865	14:47:31	14:50:01	1	P3	0.2373 ± 0.0139	0.1070 ± 0.0056	0.0951 ± 0.0078	0.0575 ± 0.0056	0.0445 ± 0.0053	0.0233 ± 0.0043	0.0080 ± 0.0015	0.0016 ± 0.0006	0.1394 ± 0.0102
	4	866	14:52:31	14:56:02	1	G4	0.3564 ± 0.0759	0.2084 ± 0.0490	0.1632 ± 0.0372	0.0905 ± 0.0207	0.3586 ± 0.0654	0.0422 ± 0.0093	0.0132 ± 0.0040	0.0048 ± 0.0017	0.1750 ± 0.0378
855	100	867	14:57:31	14:58:32	1	G4	0.0500 ± 0.0065	0.0556 ± 0.0087	0.0201 ± 0.0028	0.0091 ± 0.0013	0.1716 ± 0.0123	0.0064 ± 0.0012	0.0004 ± 0.0008	0.0012 ± 0.0007	0.0096 ± 0.0013
856	85	868	14:59:02	15:01:32	1	G4	0.0576 ± 0.0051	0.0478 ± 0.0152	0.0251 ± 0.0053	0.0113 ± 0.0025	0.2296 ± 0.0372	0.0070 ± 0.0025	0.0011 ± 0.0010	0.0007 ± 0.0008	0.0112 ± 0.0034
857	65	869	15:02:31	15:05:31	1	G4	0.0426 ± 0.0056	0.0326 ± 0.0062	0.0147 ± 0.0020	0.0067 ± 0.0021	0.1548 ± 0.0217	0.0034 ± 0.0010	0.0001 ± 0.0007	0.0004 ± 0.0004	0.0074 ± 0.0016
858	40	870	15:06:31	15:09:31	1	G4	0.0401 ± 0.0034	0.0271 ± 0.0046	0.0128 ± 0.0019	0.0059 ± 0.0012	0.1689 ± 0.0118	0.0030 ± 0.0010	-0.0004 ± -0.0007	0.0005 ± 0.0004	0.0073 ± 0.0015
859	30	871	15:10:01	15:13:31	1	G4	0.0363 ± 0.0033	0.0230 ± 0.0043	0.0110 ± 0.0015	0.0055 ± 0.0013	0.1332 ± 0.0184	0.0019 ± 0.0007	-0.0004 ± -0.0003	0.0001 ± 0.0003	0.0065 ± 0.0015
860	7	872	15:15:01	15:18:01	1	G4	0.1102 ± 0.0180	0.0678 ± 0.0136	0.0387 ± 0.0069	0.0216 ± 0.0038	0.1704 ± 0.0242	0.0082 ± 0.0024	0.0010 ± 0.0009	0.0006 ± 0.0005	0.0416 ± 0.0095
861	4	873	15:19:01	15:22:31	1	G4	0.2853 ± 0.0219	0.1536 ± 0.0149	0.1125 ± 0.0100	0.0704 ± 0.0078	0.2257 ± 0.0167	0.0330 ± 0.0060	0.0116 ± 0.0027	0.0027 ± 0.0010	0.1511 ± 0.0134
	4	901	8:51:42	8:54:28	1	P3	0.5594 ± 0.0329	0.1859 ± 0.0117	0.2824 ± 0.0228	0.1986 ± 0.0153	0.2024 ± 0.0152	0.1133 ± 0.0107	0.0472 ± 0.0059	0.0099 ± 0.0022	0.3548 ± 0.0223
902	100	902	8:58:02	8:59:00	1	P3	0.0168 ± 0.0027	0.0334 ± 0.0064	0.0044 ± 0.0022	0.0130 ± 0.0033	0.0218 ± 0.0040	0.0182 ± 0.0030	0.0088 ± 0.0016	0.0020 ± 0.0006	0.0055 ± 0.0013
903	85	903	9:00:03	9:03:06	1	P3	0.0131 ± 0.0021	0.0238 ± 0.0044	0.0030 ± 0.0020	0.0092 ± 0.0014	0.0154 ± 0.0028	0.0127 ± 0.0029	0.0071 ± 0.0019	0.0013 ± 0.0007	0.0045 ± 0.0017
904	65	904	9:04:00	9:07:05	1	P3	0.0099 ± 0.0015	0.0192 ± 0.0036	0.0022 ± 0.0015	0.0063 ± 0.0015	0.0117 ± 0.0022	0.0095 ± 0.0022	0.0055 ± 0.0016	0.0013 ± 0.0007	0.0041 ± 0.0013
905	40	905	9:08:00	9:11:01	1	P3	0.0110 ± 0.0020	0.0153 ± 0.0044	0.0021 ± 0.0015	0.0057 ± 0.0012	0.0094 ± 0.0018	0.0077 ± 0.0020	0.0051 ± 0.0017	0.0009 ± 0.0007	0.0040 ± 0.0016
906	30	906	9:11:43	9:15:00	1	P3	0.0109 ± 0.0017	0.0151 ± 0.0018	0.0022 ± 0.0011	0.0036 ± 0.0012	0.0061 ± 0.0013	0.0055 ± 0.0012	0.0031 ± 0.0012	0.0007 ± 0.0005	0.0042 ± 0.0010
907	7	907	9:16:40	9:19:01	1	P3	0.1195 ± 0.0051	0.0850 ± 0.0071	0.0416 ± 0.0039	0.0278 ± 0.0034	0.0236 ± 0.0024	0.0116 ± 0.0018	0.0047 ± 0.0014	0.0007 ± 0.0004	0.0587 ± 0.0036
908	4	908	9:19:54	9:22:01	1	P3	0.3501 ± 0.0177	0.1546 ± 0.0102	0.1482 ± 0.0091	0.0879 ± 0.0075	0.0758 ± 0.0073	0.0366 ± 0.0050	0.0136 ± 0.0018	0.0023 ± 0.0010	0.2058 ± 0.0096
	4	909	9:23:37	9:27:19	10	0	0.4317 ± 0.0378	0.1576 ± 0.0129	0.1954 ± 0.0185	0.1346 ± 0.0113	0.1136 ± 0.0166	0.0522 ± 0.0092	0.0201 ± 0.0034	0.0043 ± 0.0013	0.2579 ± 0.0208
909	100	910	9:29:34	9:30:30	10	0	0.0297 ± 0.0044	0.0549 ± 0.0063	0.0063 ± 0.0019	0.0262 ± 0.0033	0.0380 ± 0.0049	0.0233 ± 0.0042	0.0114 ± 0.0037	0.0022 ± 0.0009	0.0092 ± 0.0020
910	85	911	9:31:00	9:33:02	10	0	0.0219 ± 0.0028	0.0408 ± 0.0064	0.0043 ± 0.0020	0.0187 ± 0.0035	0.0218 ± 0.0050	0.0166 ± 0.0027	0.0091 ± 0.0016	0.0028 ± 0.0008	0.0082 ± 0.0021
911	65	912	9:34:30	9:37:27	10	0	0.0173 ± 0.0026	0.0340 ± 0.0044	0.0034 ± 0.0017	0.0124 ± 0.0024	0.0134 ± 0.0032	0.0122 ± 0.0028	0.0046 ± 0.0013	0.0019 ± 0.0010	0.0090 ± 0.0010
912	40	913	9:38:00	9:43:00	10	0	0.0100 ± 0.0017	0.0197 ± 0.0035	0.0015 ± 0.0014	0.0074 ± 0.0014	0.0081 ± 0.0023	0.0062 ± 0.0015	0.0040 ± 0.0011	0.0010 ± 0.0005	0.0075 ± 0.0018
913	30	914	9:43:56	9:47:38	10	0	0.0098 ± 0.0021	0.0196 ± 0.0033	0.0021 ± 0.0009	0.0060 ± 0.0012	0.0057 ± 0.0018	0.0050 ± 0.0015	0.0024 ± 0.0011	0.0007 ± 0.0004	0.0090 ± 0.0018
914	7	915	9:48:36	9:52:18	10	0	0.1765 ± 0.0187	0.0935 ± 0.0117	0.0668 ± 0.0085	0.0449 ± 0.0059	0.0368 ± 0.0040	0.0168 ± 0.0034	0.0073 ± 0.0026	0.0014 ± 0.0008	0.0873 ± 0.0154
915	4	916	9:53:00	9:56:01	10	0	0.4187 ± 0.0294	0.1418 ± 0.0115	0.2036 ± 0.0215	0.1302 ± 0.0149	0.1145 ± 0.0173	0.0542 ± 0.0106	0.0196 ± 0.0034	0.0035 ± 0.0011	0.2527 ± 0.0205
	4	917	9:56:41	10:00:55	30	0	0.4957 ± 0.0743	0.2138 ± 0.0367	0.2230 ± 0.0405	0.1688 ± 0.0271	0.1742 ± 0.0287	0.1113 ± 0.0156	0.0462 ± 0.0112	0.0134 ± 0.0046	0.2979 ± 0.0592
916	100	918	10:02:00	10:03:12	30	0	0.0211 ± 0.0070	0.0356 ± 0.0064	0.0028 ± 0.0028	0.0104 ± 0.0044	0.0144 ± 0.0056	0.0127 ± 0.0040	0.0069 ± 0.0034	0.0026 ± 0.0016	0.0140 ± 0.0046
917	85	919	10:03:56	10:07:15	30	0	0.0141 ± 0.0030	0.0282 ± 0.0053	0.0011 ± 0.0012	0.0043 ± 0.0018	0.0067 ± 0.0031	0.0061 ± 0.0020	0.0039 ± 0.0023	0.0012 ± 0.0010	0.0133 ± 0.0038
918	70	920	10:08:01	10:11:31	30	0	0.0102 ± 0.0027	0.0240 ± 0.0052	-0.0001 ± -0.0017	0.0028 ± 0.0020	0.0040 ± 0.0024	0.0041 ± 0.0020	0.0033 ± 0.0023	0.0008 ± 0.0008	0.0116 ± 0.0037
919	65	921	10:12:02	10:15:02	30	0	0.0095 ± 0.0025	0.0200 ± 0.0050	-0.0000 ± -0.0018	0.0022 ± 0.0020	0.0023 ± 0.0019	0.0028 ± 0.0012	0.0022 ± 0.0012	0.0005 ± 0.0007	0.0131 ± 0.0034
920	60	922	10:16:02	10:20:01	30	0	0.0072 ± 0.0036	0.0176 ± 0.0057	-0.0002 ± -0.0015	0.0012 ± 0.0016	0.0021 ± 0.0020	0.0023 ± 0.0017	0.0016 ± 0.0017	0.0006 ± 0.0008	0.0122 ± 0.0031
921	40	923	10:21:32	10:24:32	30	0	0.0081 ± 0.0033	0.0194 ± 0.0070	-0.0007 ± -0.0039	0.0011 ± 0.0023	0.0010 ± 0.0019	0.0027 ± 0.0017	0.0002 ± 0.0014	0.0007 ± 0.0008	0.0151 ± 0.0048
922	30	924	10:25:32	10:28:32	30	0	0.0100 ± 0.0050	0.0185 ± 0.0088	0.0015 ± 0.0034	0.0025 ± 0.0028	0.0020 ± 0.0029	0.0023 ± 0.0024	0.0009 ± 0.0027	0.0003 ± 0.0010	0.0183 ± 0.0054
923	15	925	10:29:32	10:32:32	30	0	0.0650 ± 0.0124	0.0558 ± 0.0194	0.0253 ± 0.0099	0.0184 ± 0.0085	0.0153 ± 0.0068	0.0078 ± 0.0036	0.0017 ± 0.0030	0.0010 ± 0.0011	0.0510 ± 0.0117

TABLE A-5.—PART A (Continued).

Test Point No.[1]	Power %	Sampling time and probe location: Aerosol Point No.[1]	Meaeasurement Start Time	Meaeasurement End Time	Probe Rake Location[2]	Probe Tip No[3]	Gaseous emission index averages[4]: acetaldehyde g/kg fuel	acetic acid g/kg fuel	benzene g/kg fuel	C2-benzene g/kg fuel	C3-benzene g/kg fuel	C4-benzene g/kg fuel	C5-benzene g/kg fuel	dimethyl naphthalene g/kg fuel	methanol g/kg fuel
924	7	926	10:34:02	10:37:02	30	0	0.1822 ± 0.0220	0.1015 ± 0.0163	0.0695 ± 0.0119	0.0485 ± 0.0076	0.0444 ± 0.0063	0.0249 ± 0.0050	0.0097 ± 0.0035	0.0028 ± 0.0016	0.1003 ± 0.0109
925	5.5	927	10:38:02	10:41:02	30	0	0.2685 ± 0.0311	0.1323 ± 0.0178	0.1084 ± 0.0172	0.0789 ± 0.0143	0.0758 ± 0.0117	0.0393 ± 0.0073	0.0148 ± 0.0056	0.0034 ± 0.0024	0.1520 ± 0.0220
926	4	928	10:42:02	10:45:32	30	0	0.4340 ± 0.0522	0.1484 ± 0.0199	0.2003 ± 0.0281	0.1440 ± 0.0206	0.1445 ± 0.0214	0.0867 ± 0.0113	0.0376 ± 0.0101	0.0091 ± 0.0031	0.2711 ± 0.0319
		929	10:47:02	10:50:31	1	G1	0.5314 ± 0.0700	0.2036 ± 0.0230	0.2630 ± 0.0410	0.1620 ± 0.0219	0.2975 ± 0.0354	0.0884 ± 0.0108	0.0368 ± 0.0051	0.0097 ± 0.0023	0.2645 ± 0.0339
927	100	930	10:53:33	10:55:02	1	G1	0.0531 ± 0.0115	0.1287 ± 0.0915	0.0398 ± 0.0090	0.0157 ± 0.0037	0.2042 ± 0.0411	0.0145 ± 0.0035	0.0055 ± 0.0024	0.0029 ± 0.0013	0.0112 ± 0.0044
928	85	931	10:56:32	10:58:33	1	G1	0.0438 ± 0.0044	0.0404 ± 0.0072	0.0306 ± 0.0041	0.0121 ± 0.0024	0.1740 ± 0.0169	0.0093 ± 0.0018	0.0041 ± 0.0013	0.0013 ± 0.0006	0.0075 ± 0.0015
929	65	932	10:59:32	11:03:03	1	G1	0.0319 ± 0.0028	0.0243 ± 0.0036	0.0218 ± 0.0027	0.0080 ± 0.0015	0.1322 ± 0.0089	0.0062 ± 0.0014	0.0029 ± 0.0011	0.0011 ± 0.0005	0.0060 ± 0.0015
930	40	933	11:04:02	11:07:02	1	G1	0.0269 ± 0.0023	0.0201 ± 0.0027	0.0192 ± 0.0026	0.0065 ± 0.0011	0.1153 ± 0.0083	0.0041 ± 0.0013	0.0015 ± 0.0008	0.0007 ± 0.0004	0.0047 ± 0.0012
931	30	934	11:07:32	11:11:01	1	G1	0.0240 ± 0.0048	0.0173 ± 0.0038	0.0161 ± 0.0038	0.0056 ± 0.0015	0.1009 ± 0.0197	0.0033 ± 0.0011	0.0010 ± 0.0006	0.0004 ± 0.0002	0.0048 ± 0.0014
932	7	935	11:12:02	11:15:32	1	G1	0.1935 ± 0.0125	0.1437 ± 0.0103	0.0810 ± 0.0062	0.0470 ± 0.0046	0.1698 ± 0.0108	0.0197 ± 0.0028	0.0069 ± 0.0018	0.0021 ± 0.0006	0.0783 ± 0.0063
933	4	936	11:16:33	11:20:01	1	G1	0.4951 ± 0.0398	0.2738 ± 0.0235	0.2229 ± 0.0189	0.1595 ± 0.0142	0.2996 ± 0.0279	0.0912 ± 0.0113	0.0395 ± 0.0068	0.0097 ± 0.0032	0.2635 ± 0.0215
934	7	937	13:49:33	13:52:49	30	0	0.1110 ± 0.0720	0.0442 ± 0.0283	0.0566 ± 0.0384	0.0363 ± 0.0242	0.0233 ± 0.0165	0.0159 ± 0.0089	-0.0008 ± -0.0045	0.0022 ± 0.0031	0.0749 ± 0.0428
937	75	941	14:11:02	14:14:32	30	0	0.0103 ± 0.0044	0.0155 ± 0.0068	0.0027 ± 0.0022	0.0024 ± 0.0024	0.0156 ± 0.0077	0.0043 ± 0.0022	0.0008 ± 0.0022	0.0007 ± 0.0009	0.0042 ± 0.0031
938	30	942	14:15:18	14:18:00	30	0	0.0046 ± 0.0075	0.0110 ± 0.0154	0.0054 ± 0.0052	0.0033 ± 0.0046	0.0079 ± 0.0055	0.0049 ± 0.0029	-0.0032 ± -0.0024	0.0011 ± 0.0009	0.0069 ± 0.0074
939	7	944	14:20:02	14:24:03	1	G1	0.1313 ± 0.0075	0.0934 ± 0.0070	0.0739 ± 0.0074	0.0341 ± 0.0042	0.1347 ± 0.0103	0.0116 ± 0.0027	0.0030 ± 0.0013	0.0013 ± 0.0005	0.0514 ± 0.0042
	7	945	14:26:14	14:28:56	1	P3	0.0853 ± 0.0044	0.0760 ± 0.0069	0.0372 ± 0.0041	0.0191 ± 0.0021	0.0216 ± 0.0025	0.0074 ± 0.0011	0.0028 ± 0.0011	0.0010 ± 0.0007	0.0409 ± 0.0037
	7	946	14:30:00	14:33:32	10	0	0.1012 ± 0.0157	0.0784 ± 0.0120	0.0495 ± 0.0077	0.0315 ± 0.0059	0.0323 ± 0.0060	0.0158 ± 0.0035	0.0064 ± 0.0027	0.0017 ± 0.0009	0.0515 ± 0.0092
	7	947	14:34:00	14:38:31	30	0	0.1167 ± 0.0747	0.1255 ± 0.0737	0.0566 ± 0.0348	0.0370 ± 0.0224	0.0368 ± 0.0241	0.0196 ± 0.0112	0.0035 ± 0.0091	0.0032 ± 0.0046	0.0600 ± 0.0393
	7	948	14:41:33	14:44:04	1	G1	0.0746 ± 0.0048	0.0628 ± 0.0033	0.0359 ± 0.0028	0.0201 ± 0.0016	0.0587 ± 0.0030	0.0063 ± 0.0011	0.0026 ± 0.0005	0.0005 ± 0.0001	0.0327 ± 0.0024
940	100	950	14:44:29	14:45:47	1	G1	0.1390 ± 0.0084	0.1334 ± 0.0089	0.0682 ± 0.0071	0.0410 ± 0.0043	0.2284 ± 0.0132	0.0160 ± 0.0024	0.0075 ± 0.0011	0.0015 ± 0.0006	0.0521 ± 0.0047
941	85	951	14:46:47	14:49:03	1	G1	0.0306 ± 0.0057	0.0407 ± 0.0088	0.0200 ± 0.0044	0.0120 ± 0.0028	0.1710 ± 0.0319	0.0068 ± 0.0020	0.0033 ± 0.0013	0.0009 ± 0.0005	0.0032 ± 0.0011
942	30	952	14:50:03	14:53:32	1	G1	0.0369 ± 0.0028	0.0391 ± 0.0047	0.0217 ± 0.0026	0.0108 ± 0.0019	0.1922 ± 0.0111	0.0056 ± 0.0011	0.0022 ± 0.0014	0.0011 ± 0.0004	0.0045 ± 0.0012
943	7	953	14:54:30	14:58:00	1	G1	0.0948 ± 0.0057	0.0801 ± 0.0063	0.0443 ± 0.0037	0.0217 ± 0.0031	0.1899 ± 0.0122	0.0073 ± 0.0016	0.0024 ± 0.0013	0.0008 ± 0.0004	0.0348 ± 0.0036
	7	954	14:59:00	15:02:30	1	P3	0.0596 ± 0.0040	0.0670 ± 0.0063	0.0254 ± 0.0034	0.0120 ± 0.0019	0.0273 ± 0.0078	0.0049 ± 0.0012	0.0022 ± 0.0014	0.0007 ± 0.0004	0.0261 ± 0.0027
	7	955	15:05:01	15:08:54	10	0	0.0722 ± 0.0231	0.0735 ± 0.0217	0.0340 ± 0.0107	0.0246 ± 0.0078	0.0333 ± 0.0094	0.0144 ± 0.0046	0.0055 ± 0.0028	0.0014 ± 0.0010	0.0361 ± 0.0112
	7	957	15:15:45	15:19:31	1	P3	0.0496 ± 0.0050	0.0503 ± 0.0043	0.0219 ± 0.0029	0.0095 ± 0.0017	0.0085 ± 0.0022	0.0035 ± 0.0010	0.0009 ± 0.0007	0.0006 ± 0.0004	0.0245 ± 0.0022
944	100	958	15:20:33	15:21:23	1	P3	0.0168 ± 0.0027	0.0315 ± 0.0041	0.0072 ± 0.0006	0.0031 ± 0.0012	0.0046 ± 0.0017	0.0031 ± 0.0004	-0.0000 ± -0.0010	0.0002 ± 0.0004	0.0008 ± 0.0017
945	85	959	15:21:31	15:23:47	1	P3	0.0117 ± 0.0018	0.0322 ± 0.0055	0.0071 ± 0.0017	0.0033 ± 0.0016	0.0041 ± 0.0018	0.0035 ± 0.0012	-0.0001 ± -0.0010	0.0006 ± 0.0007	-0.0002 ± -0.0013
946	30	960	15:24:30	15:28:13	1	P3	0.0120 ± 0.0014	0.0231 ± 0.0031	0.0046 ± 0.0013	0.0021 ± 0.0007	0.0034 ± 0.0009	0.0021 ± 0.0006	0.0002 ± 0.0006	0.0003 ± 0.0003	0.0018 ± 0.0009
947	7	961	15:29:02	15:35:30	1	P3	0.0672 ± 0.0045	0.0622 ± 0.0058	0.0298 ± 0.0032	0.0131 ± 0.0017	0.0091 ± 0.0017	0.0043 ± 0.0012	0.0009 ± 0.0008	0.0004 ± 0.0003	0.0332 ± 0.0036
	7	962	15:37:00	15:44:31	10	0	0.0825 ± 0.0257	0.0684 ± 0.0195	0.0393 ± 0.0126	0.0229 ± 0.0073	0.0204 ± 0.0065	0.0113 ± 0.0039	0.0038 ± 0.0024	0.0013 ± 0.0009	0.0441 ± 0.0142
	7	963	15:45:02	15:54:28	30	0	0.0844 ± 0.0513	0.1165 ± 0.0705	0.0578 ± 0.0330	0.0311 ± 0.0214	0.0163 ± 0.0189	0.0175 ± 0.0121	-0.0067 ± -0.0098	0.0025 ± 0.0037	0.0536 ± 0.0320
948	100	964	15:55:11	15:56:06	30	0	0.0032 ± 0.0016	0.0118 ± 0.0068	0.0038 ± 0.0022	0.0003 ± 0.0013	-0.0012 ± -0.0024	0.0014 ± 0.0011	-0.0015 ± -0.0013	0.0003 ± 0.0007	0.0010 ± 0.0023
949	85	965	15:56:15	15:58:30	30	0	0.0002 ± 0.0027	0.0087 ± 0.0064	0.0030 ± 0.0021	0.0012 ± 0.0013	-0.0016 ± -0.0019	0.0017 ± 0.0013	-0.0020 ± -0.0015	0.0007 ± 0.0008	0.0019 ± 0.0031
950	30	966	15:59:02	16:02:30	30	0	-0.0040 ± -0.0064	0.0113 ± 0.0141	0.0061 ± 0.0033	0.0019 ± 0.0043	-0.0022 ± -0.0044	0.0028 ± 0.0024	-0.0054 ± -0.0036	0.0002 ± 0.0015	0.0033 ± 0.0074
951	7	967	16:03:38	16:11:55	30	0	0.0754 ± 0.0636	0.0679 ± 0.0559	0.0492 ± 0.0397	0.0284 ± 0.0224	0.0109 ± 0.0145	0.0124 ± 0.0106	-0.0078 ± -0.0078	0.0009 ± 0.0034	0.0688 ± 0.0481

TABLE A-5.—PART A (Concluded).

Test Point No.[1]	Power	Sampling time and probe location					Gaseous emission index averages[4]								
		Aerosol	Meaeasurement		Probe Rake	Probe	acetaldehyde	acetic acid	benzene	C2-benzene	C3-benzene	C4-benzene	C5-benzene	dimethyl naphthalene	methanol
	%	Point No.[1]	Start Time	End Time	Location[2]	Tip No[3]	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel	g/kg fuel
Additional ARI test points without full engine operational data record	4	311	9:52:59	10:02:01	1	P2	0.6116 ± 0.0708	0.1507 ± 0.0235	0.3747 ± 0.0492	0.2246 ± 0.0318	0.2032 ± 0.0355	0.1063 ± 0.0220	0.0478 ± 0.0117	0.0081 ± 0.0033	0.3793 ± 0.0454
	7	320	10:39:00	10:40:00	1	P1	0.2469 ± 0.4290	0.0196 ± 0.0408	0.1244 ± 0.2220	0.0697 ± 0.1148	0.0539 ± 0.0891	0.0256 ± 0.0426	0.0145 ± 0.0223	0.0020 ± 0.0033	0.2208 ± 0.3882
	4	338	14:43:36	14:44:21	1	P3	0.6760 ± 0.6811	0.0462 ± 0.0424	0.6865 ± 0.7176	0.3643 ± 0.2858	0.3237 ± 0.2489	0.1694 ± 0.1389	0.0712 ± 0.0551	0.0030 ± 0.0026	0.4806 ± 0.4845
	4	401	8:15:26	8:16:08	1	P3	1.1631 ± 0.8317	0.0957 ± 0.0639	1.2146 ± 1.0211	0.7930 ± 0.5986	0.9482 ± 0.7919	0.5780 ± 0.4821	0.2652 ± 0.2170	0.0040 ± 0.0031	0.8820 ± 0.6347
	4	401	8:16:29	8:18:31	1	P3	0.7839 ± 0.0469	0.1670 ± 0.0148	0.5200 ± 0.0327	0.3198 ± 0.0379	0.3269 ± 0.0562	0.1816 ± 0.0286	0.0826 ± 0.0133	0.0172 ± 0.0047	0.5255 ± 0.0403
	4	402	8:20:29	8:22:31	1	P3	0.0146 ± 0.0032	0.0245 ± 0.0061	0.0058 ± 0.0021	0.0194 ± 0.0052	0.0357 ± 0.0091	0.0267 ± 0.0050	0.0139 ± 0.0040	0.0024 ± 0.0011	0.0066 ± 0.0022
	4	403	8:23:35	8:24:45	1	P3	0.5848 ± 0.8070	0.1126 ± 0.1242	0.3405 ± 0.4716	0.2191 ± 0.2495	0.2379 ± 0.2634	0.1399 ± 0.1491	0.0659 ± 0.0667	0.0056 ± 0.0061	0.3795 ± 0.5407
	4	404	10:06:29	10:08:01	1	P1	0.7116 ± 0.0417	0.1480 ± 0.0083	0.4557 ± 0.0426	0.2688 ± 0.0354	0.2644 ± 0.0256	0.1281 ± 0.0157	0.0603 ± 0.0076	0.0099 ± 0.0019	0.4747 ± 0.0329
	85	405	10:09:59	10:11:31	1	P1	0.0067 ± 0.0013	0.0140 ± 0.0022	0.0028 ± 0.0007	0.0101 ± 0.0017	0.0146 ± 0.0031	0.0123 ± 0.0034	0.0061 ± 0.0020	0.0015 ± 0.0008	0.0030 ± 0.0015
	100	406	10:12:30	10:13:31	1	P1	0.0044 ± 0.0008	0.0088 ± 0.0011	0.0018 ± 0.0009	0.0044 ± 0.0015	0.0101 ± 0.0014	0.0080 ± 0.0025	0.0040 ± 0.0013	0.0008 ± 0.0005	0.0022 ± 0.0007
	4	407	10:14:26	10:15:07	1	P1	0.2754 ± 0.4121	0.0752 ± 0.0757	0.1382 ± 0.2045	0.0814 ± 0.1001	0.0809 ± 0.0850	0.0493 ± 0.0529	0.0219 ± 0.0222	0.0069 ± 0.0079	0.1671 ± 0.2518
	4	516	12:00:33	12:01:20	1	P3	0.2794 ± 0.2170	0.0381 ± 0.0336	0.1392 ± 0.1021	0.0604 ± 0.0454	0.0368 ± 0.0264	0.0153 ± 0.0105	0.0035 ± 0.0031	0.0001 ± 0.0009	0.1582 ± 0.1319
	4	516	12:01:29	12:05:01	1	P3	0.3212 ± 0.0192	0.0852 ± 0.0089	0.1668 ± 0.0122	0.0927 ± 0.0090	0.0757 ± 0.0104	0.0327 ± 0.0058	0.0100 ± 0.0021	0.0018 ± 0.0010	0.1872 ± 0.0122
	4	522	12:26:59	12:29:31	10	0	0.2590 ± 0.0383	0.0700 ± 0.0132	0.1399 ± 0.0191	0.0755 ± 0.0118	0.0675 ± 0.0078	0.0277 ± 0.0031	0.0162 ± 0.0039	0.0023 ± 0.0009	0.1475 ± 0.0228
	100	528	13:56:57	13:57:46	30	0	0.0492 ± 0.0780	0.0123 ± 0.0131	0.0254 ± 0.0451	0.0135 ± 0.0160	0.0106 ± 0.0121	0.0105 ± 0.0083	0.0040 ± 0.0033	0.0010 ± 0.0016	0.0312 ± 0.0343
	4	529	13:57:59	14:00:01	30	0	0.2325 ± 0.0494	0.0528 ± 0.0184	0.1325 ± 0.0279	0.0706 ± 0.0137	0.0483 ± 0.0126	0.0235 ± 0.0078	0.0085 ± 0.0054	0.0022 ± 0.0018	0.1451 ± 0.0317
	4	601	8:08:02	8:09:02	30	0	0.7611 ± 0.1104	0.1645 ± 0.0213	0.5258 ± 0.0609	0.3089 ± 0.0416	0.3005 ± 0.0452	0.1772 ± 0.0307	0.0778 ± 0.0134	0.0139 ± 0.0039	0.5150 ± 0.0864
	30	670	14:39:01	14:42:00	30	0	-0.0059 ± -0.0055	-0.0132 ± -0.0088	-0.0003 ± -0.0033	0.0001 ± 0.0038	-0.0009 ± -0.0043	0.0016 ± 0.0026	-0.0019 ± -0.0037	0.0008 ± 0.0015	0.0118 ± 0.0069
	4	671	14:44:02	14:47:02	30	0	0.2594 ± 0.0811	0.0513 ± 0.0241	0.1550 ± 0.0567	0.0875 ± 0.0309	0.0713 ± 0.0212	0.0356 ± 0.0118	0.0155 ± 0.0073	0.0031 ± 0.0030	0.1628 ± 0.0534
	40	672	14:48:01	14:51:01	30	0	-0.0067 ± -0.0031	-0.0039 ± -0.0059	0.0015 ± 0.0028	0.0041 ± 0.0030	0.0028 ± 0.0036	0.0036 ± 0.0035	0.0023 ± 0.0027	-0.0000 ± -0.0007	0.0088 ± 0.0052
	40	673	14:52:31	14:56:31	1	P3	0.0006 ± 0.0012	0.0049 ± 0.0027	0.0025 ± 0.0011	0.0016 ± 0.0012	0.0027 ± 0.0015	0.0016 ± 0.0011	0.0007 ± 0.0008	0.0004 ± 0.0005	0.0012 ± 0.0009
	40	674	14:58:02	15:02:02	10	0	0.0011 ± 0.0016	0.0040 ± 0.0025	0.0007 ± 0.0010	0.0023 ± 0.0008	0.0053 ± 0.0018	0.0024 ± 0.0011	0.0018 ± 0.0014	0.0006 ± 0.0005	0.0048 ± 0.0017
	4	675	15:03:30	15:07:02	10	0	0.2375 ± 0.0246	0.0674 ± 0.0085	0.1341 ± 0.0145	0.0744 ± 0.0078	0.0639 ± 0.0083	0.0303 ± 0.0062	0.0119 ± 0.0037	0.0020 ± 0.0012	0.1413 ± 0.0132
	30	835	12:43:31	12:50:01	30	0	0.1514 ± 0.1544	0.0396 ± 0.0312	0.0677 ± 0.0741	0.0517 ± 0.0489	0.0556 ± 0.0483	0.0323 ± 0.0247	0.0113 ± 0.0103	0.0027 ± 0.0032	0.1220 ± 0.0958

Note:

1. The test point No. defines the sequential engine testing conditions while the aerosol point number defines each aerosol measurement condition. Both of them are combinations of the last digit in the date between April 20 and 29 and a sequence number of point for that day. If the test point number is 305, the test point was for the 5th test point on April 23.
2. Probe locations were 1, 10 and 30 m from the engine exhaust plain.
3. At 1 m and 10 m sampling locations, there were 6 particle probe tips (P1 to P6) and 6 gas probe tips (G1 to G6) held by a rake along the plume cross section. At 10 m location, particle samples were taken from two combined particle probes and at 30 m location, there was only one inlet tube used. At these two locations, the probe tip number is labeled "0".
4. Gas emission indexes in this table are reported as mean ± one standard deviation.

TABLE A-5.—AIRCRAFT CFM56-2-C1 ENGINE GAS EMISSION DATA MEASURED WITH THE PROTON TRANSFER MASS SPECTROMETER (PTR-MS) DURING APEX, PART B.

Test Point No.[1]	Power %	Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	Probe Rake Location[2]	Probe Tip No[3]	methyl naphthalene g/kg fuel	naphthalene g/kg fuel	phenol g/kg fuel	propene g/kg fuel	styrene g/kg fuel	sum m57[4] g/kg fuel	sum m59[4] g/kg fuel	sum m73[4] g/kg fuel	toluene g/kg fuel
301	7	301	9:23:27	9:26:01	1	P1	0.01001 ± 0.00002	0.0161 ± 0.0034	0.0669 ± 0.0119	0.3025 ± 0.0243	0.0174 ± 0.0031	0.1745 ± 0.0175	0.1205 ± 0.0108	0.0658 ± 0.0065	0.0408 ± 0.0063
	7	302	9:27:00	9:28:30	1	P2	0.00545 ± 0.00001	0.0091 ± 0.0018	0.0386 ± 0.0055	0.2402 ± 0.0172	0.0114 ± 0.0019	0.1404 ± 0.0058	0.1020 ± 0.0069	0.0565 ± 0.0034	0.0280 ± 0.0041
	7	303	9:28:59	9:31:01	1	P3	0.00586 ± 0.00001	0.0103 ± 0.0023	0.0319 ± 0.0042	0.2033 ± 0.0166	0.0098 ± 0.0021	0.1039 ± 0.0095	0.0868 ± 0.0062	0.0478 ± 0.0051	0.0230 ± 0.0044
	7	304	9:31:29	9:33:31	1	P4	0.00567 ± 0.00001	0.0105 ± 0.0028	0.0292 ± 0.0057	0.2003 ± 0.0187	0.0083 ± 0.0019	0.1033 ± 0.0123	0.0857 ± 0.0053	0.0492 ± 0.0057	0.0224 ± 0.0029
	7	305	9:34:29	9:36:01	1	P5	0.00486 ± 0.00001	0.0124 ± 0.0025	0.0282 ± 0.0024	0.2149 ± 0.0129	0.0092 ± 0.0017	0.1154 ± 0.0096	0.0916 ± 0.0070	0.0534 ± 0.0050	0.0229 ± 0.0034
	7	306	9:36:59	9:38:31	1	P6	0.00410 ± 0.00001	0.0124 ± 0.0027	0.0280 ± 0.0043	0.2256 ± 0.0147	0.0087 ± 0.0019	0.1420 ± 0.0172	0.0960 ± 0.0038	0.0561 ± 0.0034	0.0260 ± 0.0036
	7	307	9:38:59	9:42:01	10	0	0.00631 ± 0.00002	0.0170 ± 0.0050	0.0344 ± 0.0074	0.3368 ± 0.0514	0.0139 ± 0.0036	0.4056 ± 0.2615	0.1358 ± 0.0274	0.0563 ± 0.0142	0.0345 ± 0.0090
	7	308	9:42:59	9:45:01	30	0	0.28162 ± 0.00207	0.4316 ± 0.2607	1.2259 ± 0.4836	10.410 ± 2.4890	0.2718 ± 0.2582	3.7245 ± 1.1568	3.3971 ± 0.5805	2.1267 ± 0.4581	0.1611 ± 0.1944
302	30	309	9:48:30	9:50:31	1	P1	0.00145 ± 0.00000	0.0026 ± 0.0013	0.0088 ± 0.0012	0.0247 ± 0.0035	0.0019 ± 0.0009	0.0123 ± 0.0013	0.0091 ± 0.0017	0.0054 ± 0.0011	0.0035 ± 0.0014
	30	310	9:51:00	9:52:31	1	P2	0.00066 ± 0.00000	0.0019 ± 0.0008	0.0062 ± 0.0018	0.0214 ± 0.0041	0.0009 ± 0.0005	0.0125 ± 0.0018	0.0068 ± 0.0012	0.0047 ± 0.0012	0.0026 ± 0.0010
	30	312	10:04:00	10:06:01	1	P1	0.00567 ± 0.00001	0.0089 ± 0.0024	0.0304 ± 0.0052	0.0586 ± 0.0106	0.0070 ± 0.0018	0.0254 ± 0.0035	0.0199 ± 0.0036	0.0156 ± 0.0035	0.0095 ± 0.0040
	30	313	10:06:59	10:08:31	1	P2	0.00366 ± 0.00001	0.0060 ± 0.0014	0.0178 ± 0.0017	0.0326 ± 0.0051	0.0046 ± 0.0016	0.0172 ± 0.0021	0.0126 ± 0.0015	0.0091 ± 0.0023	0.0055 ± 0.0015
	30	314	10:09:29	10:11:01	1	P3	0.00267 ± 0.00001	0.0053 ± 0.0019	0.0204 ± 0.0056	0.0513 ± 0.0137	0.0038 ± 0.0013	0.0139 ± 0.0021	0.0132 ± 0.0020	0.0099 ± 0.0023	0.0046 ± 0.0017
	30	315	10:11:59	10:13:01	1	P4	0.00215 ± 0.00001	0.0050 ± 0.0021	0.0169 ± 0.0028	0.0523 ± 0.0123	0.0031 ± 0.0008	0.0160 ± 0.0020	0.0185 ± 0.0027	0.0104 ± 0.0019	0.0056 ± 0.0027
	30	316	10:13:59	10:17:01	1	P5	0.00265 ± 0.00001	0.0060 ± 0.0022	0.0113 ± 0.0026	0.0384 ± 0.0100	0.0022 ± 0.0012	0.0203 ± 0.0060	0.0190 ± 0.0026	0.0114 ± 0.0025	0.0044 ± 0.0018
	30	317	10:17:29	10:19:01	1	P6	0.00160 ± 0.00000	0.0052 ± 0.0017	0.0099 ± 0.0020	0.0430 ± 0.0072	0.0022 ± 0.0011	0.0290 ± 0.0061	0.0145 ± 0.0026	0.0091 ± 0.0021	0.0044 ± 0.0019
	30	318	10:19:59	10:22:01	10	0	0.00539 ± 0.00001	0.0115 ± 0.0025	0.0163 ± 0.0025	0.1489 ± 0.0200	0.0051 ± 0.0014	0.1139 ± 0.0695	0.0258 ± 0.0043	0.0142 ± 0.0023	0.0085 ± 0.0029
	30	319	10:22:59	10:25:01	30	0	0.00607 ± 0.00003	0.0084 ± 0.0038	0.0219 ± 0.0081	0.1986 ± 0.0541	0.0047 ± 0.0027	0.0699 ± 0.0198	0.0587 ± 0.0083	0.0281 ± 0.0069	0.0104 ± 0.0061
303	40	321	10:41:59	10:44:01	1	P1	0.00137 ± 0.00000	0.0022 ± 0.0015	0.0101 ± 0.0023	0.0121 ± 0.0040	0.0016 ± 0.0009	0.0135 ± 0.0024	0.0073 ± 0.0016	0.0027 ± 0.0017	0.0039 ± 0.0015
	40	322	10:44:30	10:46:30	1	P2	0.00133 ± 0.00000	0.0016 ± 0.0010	0.0084 ± 0.0027	0.0115 ± 0.0055	0.0012 ± 0.0008	0.0116 ± 0.0032	0.0056 ± 0.0020	0.0028 ± 0.0014	0.0044 ± 0.0018
	40	323	10:46:59	10:48:31	1	P3	0.00091 ± 0.00000	0.0022 ± 0.0006	0.0078 ± 0.0022	0.0143 ± 0.0047	0.0011 ± 0.0010	0.0093 ± 0.0015	0.0059 ± 0.0012	0.0021 ± 0.0019	0.0040 ± 0.0016
	40	324	10:48:59	10:50:31	1	P4	0.00094 ± 0.00001	0.0019 ± 0.0015	0.0079 ± 0.0016	0.0189 ± 0.0066	0.0012 ± 0.0009	0.0136 ± 0.0020	0.0108 ± 0.0015	0.0040 ± 0.0016	0.0037 ± 0.0020
	40	325	10:51:29	10:53:01	1	P5	0.00123 ± 0.00001	0.0026 ± 0.0014	0.0070 ± 0.0013	0.0134 ± 0.0068	0.0009 ± 0.0009	0.0179 ± 0.0024	0.0141 ± 0.0021	0.0065 ± 0.0029	0.0025 ± 0.0017
	40	326	10:53:59	10:55:29	1	P6	0.00078 ± 0.00000	0.0029 ± 0.0014	0.0052 ± 0.0021	0.0194 ± 0.0056	0.0006 ± 0.0007	0.0195 ± 0.0038	0.0100 ± 0.0016	0.0046 ± 0.0018	0.0033 ± 0.0011
	40	327	10:55:59	10:58:31	10	0	0.00409 ± 0.00001	0.0078 ± 0.0016	0.0145 ± 0.0028	0.1181 ± 0.0173	0.0029 ± 0.0011	0.1276 ± 0.1046	0.0212 ± 0.0075	0.0102 ± 0.0026	0.0086 ± 0.0018
	40	328	10:59:00	11:02:31	30	0	0.00383 ± 0.00003	0.0041 ± 0.0047	0.0224 ± 0.0112	0.1678 ± 0.0750	0.0023 ± 0.0025	0.0655 ± 0.0352	0.0454 ± 0.0119	0.0178 ± 0.0089	0.0100 ± 0.0063
304	30	329	11:03:59	11:05:31	30	0	0.00041 ± 0.00003	0.0037 ± 0.0033	0.0073 ± 0.0048	0.0773 ± 0.0252	0.0008 ± 0.0017	0.0309 ± 0.0075	0.0378 ± 0.0105	0.0131 ± 0.0060	0.0057 ± 0.0051
	30	330	11:06:00	11:09:01	10	0	0.00319 ± 0.00001	0.0055 ± 0.0017	0.0132 ± 0.0027	0.1030 ± 0.0156	0.0026 ± 0.0011	0.1194 ± 0.0951	0.0192 ± 0.0054	0.0102 ± 0.0026	0.0075 ± 0.0019
	30	331	11:09:59	11:13:00	1	P2	0.00182 ± 0.00000	0.0026 ± 0.0012	0.0103 ± 0.0030	0.0362 ± 0.0103	0.0010 ± 0.0007	0.0182 ± 0.0042	0.0097 ± 0.0019	0.0040 ± 0.0018	0.0076 ± 0.0032
305	7	332	11:14:00	11:18:31	1	P2	0.00341 ± 0.00001	0.0069 ± 0.0023	0.0244 ± 0.0037	0.1962 ± 0.0227	0.0073 ± 0.0016	0.1108 ± 0.0114	0.0822 ± 0.0096	0.0433 ± 0.0046	0.0243 ± 0.0043
	7	333	11:19:29	11:21:31	10	0	0.00421 ± 0.00001	0.0097 ± 0.0025	0.0336 ± 0.0068	0.2980 ± 0.0337	0.0118 ± 0.0038	0.4637 ± 0.2951	0.1104 ± 0.0217	0.0484 ± 0.0099	0.0340 ± 0.0065
	7	334	11:22:29	11:25:31	30	0	0.00812 ± 0.00005	0.0148 ± 0.0087	0.0469 ± 0.0222	0.3452 ± 0.1582	0.0125 ± 0.0076	0.1719 ± 0.0856	0.1277 ± 0.0648	0.0644 ± 0.0315	0.0392 ± 0.0202
	7	335	11:28:30	11:31:30	1	P2	0.00597 ± 0.00002	0.0110 ± 0.0029	0.0334 ± 0.0055	0.2106 ± 0.0219	0.0084 ± 0.0033	0.1249 ± 0.0095	0.0969 ± 0.0103	0.0519 ± 0.0069	0.0282 ± 0.0037
	7	336	11:32:59	11:36:01	1	P2	0.00377 ± 0.00001	0.0075 ± 0.0017	0.0222 ± 0.0029	0.1869 ± 0.0152	0.0063 ± 0.0015	0.1028 ± 0.0078	0.0792 ± 0.0057	0.0433 ± 0.0048	0.0218 ± 0.0029
	7	337	11:37:29	11:39:31	1	P2	0.00271 ± 0.00000	0.0056 ± 0.0010	0.0175 ± 0.0019	0.1466 ± 0.0113	0.0058 ± 0.0011	0.0804 ± 0.0066	0.0622 ± 0.0037	0.0345 ± 0.0030	0.0170 ± 0.0022
306	7	339	14:51:22	14:52:46	1	P3	0.00970 ± 0.00002	0.0187 ± 0.0031	0.0896 ± 0.0060	0.6018 ± 0.0470	0.0248 ± 0.0030	0.3402 ± 0.0241	0.1979 ± 0.0138	0.1015 ± 0.0062	0.0735 ± 0.0074
	7	340	14:54:29	14:56:01	1	P1	0.00606 ± 0.00002	0.0100 ± 0.0022	0.0334 ± 0.0059	0.1978 ± 0.0213	0.0108 ± 0.0021	0.1261 ± 0.0134	0.0873 ± 0.0086	0.0518 ± 0.0055	0.0230 ± 0.0042
	7	341	14:56:59	14:58:31	1	P6	0.00443 ± 0.00001	0.0087 ± 0.0016	0.0249 ± 0.0028	0.1744 ± 0.0106	0.0076 ± 0.0019	0.1141 ± 0.0134	0.0813 ± 0.0047	0.0455 ± 0.0046	0.0182 ± 0.0038
	7	342	14:59:59	15:02:31	10	0	0.00519 ± 0.00001	0.0106 ± 0.0024	0.0314 ± 0.0053	0.2664 ± 0.0169	0.0112 ± 0.0024	1.5983 ± 2.2450	0.1610 ± 0.1117	0.0581 ± 0.0241	0.0303 ± 0.0045
307	30	343	15:04:00	15:06:31	1	P1	0.00288 ± 0.00001	0.0058 ± 0.0019	0.0168 ± 0.0056	0.0551 ± 0.0146	0.0036 ± 0.0014	0.0337 ± 0.0062	0.0163 ± 0.0037	0.0112 ± 0.0035	0.0069 ± 0.0023
	30	344	15:07:29	15:09:01	1	P2	0.00203 ± 0.00000	0.0033 ± 0.0014	0.0084 ± 0.0017	0.0272 ± 0.0049	0.0025 ± 0.0009	0.0258 ± 0.0122	0.0098 ± 0.0018	0.0063 ± 0.0017	0.0037 ± 0.0015
	30	345	15:09:29	15:11:01	1	P3	0.00223 ± 0.00001	0.0042 ± 0.0015	0.0101 ± 0.0019	0.0295 ± 0.0056	0.0020 ± 0.0009	0.0183 ± 0.0040	0.0102 ± 0.0021	0.0072 ± 0.0026	0.0042 ± 0.0014
	30	346	15:11:59	15:14:01	1	P4	0.00196 ± 0.00001	0.0046 ± 0.0018	0.0086 ± 0.0034	0.0299 ± 0.0089	0.0022 ± 0.0012	0.0204 ± 0.0031	0.0141 ± 0.0027	0.0077 ± 0.0025	0.0036 ± 0.0018
	30	347	15:14:30	15:16:31	1	P5	0.00268 ± 0.00001	0.0053 ± 0.0024	0.0071 ± 0.0025	0.0312 ± 0.0101	0.0022 ± 0.0013	0.0295 ± 0.0185	0.0182 ± 0.0090	0.0106 ± 0.0036	0.0039 ± 0.0014
	30	348	15:16:59	15:18:31	1	P6	0.00201 ± 0.00000	0.0056 ± 0.0018	0.0069 ± 0.0025	0.0317 ± 0.0068	0.0015 ± 0.0005	0.0289 ± 0.0072	0.0156 ± 0.0019	0.0087 ± 0.0016	0.0034 ± 0.0016
	30	350	15:21:29	15:25:31	30	0	0.00320 ± 0.00002	0.0047 ± 0.0042	0.0142 ± 0.0063	0.0918 ± 0.0245	0.0029 ± 0.0020	0.0500 ± 0.0171	0.0382 ± 0.0054	0.0177 ± 0.0046	0.0060 ± 0.0041

TABLE A-5.—PART B (Continued).

Test Point No.[1]	Power %	Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	Probe Rake Location[2]	Probe Tip No[3]	methyl naphthalene g/kg fuel	naphthalene g/kg fuel	phenol g/kg fuel	propene g/kg fuel	styrene g/kg fuel	sum m57[4] g/kg fuel	sum m59[4] g/kg fuel	sum m73[4] g/kg fuel	toluene g/kg fuel
308	40	351	15:26:29	15:28:31	30	0	0.00154 ± 0.00001	0.0032 ± 0.0030	0.0072 ± 0.0026	0.0551 ± 0.0132	0.0010 ± 0.0014	0.0317 ± 0.0044	0.0351 ± 0.0080	0.0135 ± 0.0052	0.0040 ± 0.0027
	40	352	15:29:29	15:32:00	10	0	0.00269 ± 0.00001	0.0055 ± 0.0014	0.0119 ± 0.0024	0.0619 ± 0.0075	0.0026 ± 0.0010	0.1016 ± 0.0680	0.0186 ± 0.0047	0.0095 ± 0.0020	0.0076 ± 0.0017
308b	40	353	15:32:59	15:35:31	1	P1	0.00241 ± 0.00001	0.0034 ± 0.0015	0.0118 ± 0.0033	0.0416 ± 0.0114	0.0015 ± 0.0009	0.0264 ± 0.0051	0.0167 ± 0.0033	0.0070 ± 0.0020	0.0078 ± 0.0019
	40	354	15:36:29	15:38:01	1	P2	0.00140 ± 0.00000	0.0017 ± 0.0009	0.0058 ± 0.0017	0.0178 ± 0.0040	0.0009 ± 0.0004	0.0138 ± 0.0017	0.0110 ± 0.0016	0.0038 ± 0.0015	0.0039 ± 0.0013
	40	355	15:38:59	15:40:31	1	P3	0.00198 ± 0.00000	0.0024 ± 0.0012	0.0073 ± 0.0013	0.0210 ± 0.0035	0.0011 ± 0.0006	0.0123 ± 0.0015	0.0102 ± 0.0020	0.0037 ± 0.0018	0.0033 ± 0.0014
308c	40	356	15:41:29	15:43:00	1	P4	0.00133 ± 0.00001	0.0028 ± 0.0014	0.0054 ± 0.0024	0.0217 ± 0.0052	0.0011 ± 0.0008	0.0151 ± 0.0016	0.0141 ± 0.0034	0.0059 ± 0.0021	0.0027 ± 0.0013
	40	357	15:43:29	15:45:01	1	P5	0.00142 ± 0.00001	0.0035 ± 0.0016	0.0058 ± 0.0017	0.0245 ± 0.0067	0.0011 ± 0.0010	0.0190 ± 0.0033	0.0193 ± 0.0047	0.0082 ± 0.0025	0.0036 ± 0.0019
	40	358	15:45:30	15:47:01	1	P6	0.00192 ± 0.00000	0.0039 ± 0.0016	0.0043 ± 0.0021	0.0255 ± 0.0045	0.0010 ± 0.0006	0.0338 ± 0.0293	0.0157 ± 0.0042	0.0070 ± 0.0019	0.0025 ± 0.0011
309	30	359	15:48:00	15:50:01	1	P3	0.00151 ± 0.00001	0.0031 ± 0.0014	0.0064 ± 0.0026	0.0197 ± 0.0050	0.0009 ± 0.0008	0.0163 ± 0.0021	0.0121 ± 0.0024	0.0044 ± 0.0013	0.0026 ± 0.0010
	30	360	15:50:59	15:55:01	10	0	0.00281 ± 0.00001	0.0049 ± 0.0018	0.0132 ± 0.0021	0.0553 ± 0.0100	0.0024 ± 0.0009	0.1340 ± 0.1545	0.0235 ± 0.0081	0.0105 ± 0.0034	0.0074 ± 0.0021
	30	361	15:55:59	16:01:00	30	0	0.00365 ± 0.00002	0.0037 ± 0.0027	0.0125 ± 0.0070	0.0719 ± 0.0251	0.0023 ± 0.0020	0.0391 ± 0.0126	0.0453 ± 0.0064	0.0148 ± 0.0064	0.0076 ± 0.0043
310	7	362	16:01:30	16:04:00	30	0	0.00742 ± 0.00004	0.0098 ± 0.0047	0.0350 ± 0.0116	0.2741 ± 0.0602	0.0127 ± 0.0039	0.1545 ± 0.0316	0.1218 ± 0.0208	0.0499 ± 0.0109	0.0329 ± 0.0069
	7	363	16:04:29	16:06:01	10	0	0.00404 ± 0.00001	0.0080 ± 0.0028	0.0257 ± 0.0059	0.2016 ± 0.0233	0.0097 ± 0.0031	0.3501 ± 0.2459	0.0949 ± 0.0189	0.0417 ± 0.0052	0.0271 ± 0.0065
	7	364	16:06:59	16:09:31	1	P3	0.00505 ± 0.00001	0.0087 ± 0.0030	0.0270 ± 0.0049	0.1741 ± 0.0200	0.0074 ± 0.0021	0.0986 ± 0.0066	0.0812 ± 0.0062	0.0426 ± 0.0054	0.0225 ± 0.0034
	7	365	16:10:29	16:11:31	1	P3	0.00684 ± 0.00001	0.0131 ± 0.0033	0.0582 ± 0.0057	0.4396 ± 0.0446	0.0157 ± 0.0031	0.2559 ± 0.0172	0.1690 ± 0.0108	0.0840 ± 0.0091	0.0565 ± 0.0049
501	4	501	11:15:16	11:16:08	30	0	0.02689 ± 0.00006	0.0561 ± 0.0413	0.3900 ± 0.3370	2.4784 ± 2.1847	0.1449 ± 0.1217	1.3752 ± 1.1109	0.4476 ± 0.3231	0.1654 ± 0.1210	0.4352 ± 0.4163
	4	501	11:16:29	11:20:01	30	0	0.04286 ± 0.00030	0.0390 ± 0.0072	0.1879 ± 0.0283	1.2217 ± 0.1426	0.0646 ± 0.0110	0.6213 ± 0.1391	0.3111 ± 0.0400	0.1264 ± 0.0170	0.1580 ± 0.0255
502	65	502	11:22:59	11:25:01	1	P1	0.00279 ± 0.00001	0.0034 ± 0.0009	0.0109 ± 0.0038	0.0283 ± 0.0067	0.0022 ± 0.0014	-0.0241 ± -0.0155	0.0119 ± 0.0026	0.0079 ± 0.0020	0.0031 ± 0.0006
	65	503	11:25:59	11:27:31	1	P2	0.00091 ± 0.00000	0.0013 ± 0.0006	0.0037 ± 0.0011	0.0131 ± 0.0038	0.0005 ± 0.0004	-0.0225 ± -0.0088	0.0059 ± 0.0009	0.0031 ± 0.0012	0.0012 ± 0.0010
	65	504	11:28:29	11:29:31	1	P3	0.00098 ± 0.00000	0.0016 ± 0.0008	0.0038 ± 0.0009	0.0105 ± 0.0040	0.0005 ± 0.0006	-0.0342 ± -0.0153	0.0050 ± 0.0010	0.0038 ± 0.0014	0.0011 ± 0.0008
	65	505	11:30:29	11:32:00	1	P4	0.00086 ± 0.00000	0.0015 ± 0.0010	0.0026 ± 0.0017	0.0163 ± 0.0039	0.0005 ± 0.0003	-0.0430 ± -0.0084	0.0062 ± 0.0011	0.0037 ± 0.0015	0.0009 ± 0.0006
	65	506	11:32:29	11:34:30	1	P5	0.00080 ± 0.00000	0.0013 ± 0.0008	0.0024 ± 0.0013	0.0169 ± 0.0073	0.0000 ± 0.0004	-0.0538 ± -0.0100	0.0110 ± 0.0019	0.0070 ± 0.0018	0.0006 ± 0.0012
	65	507	11:35:00	11:36:30	1	P6	0.00064 ± 0.00000	0.0018 ± 0.0009	0.0027 ± 0.0012	0.0160 ± 0.0067	0.0003 ± 0.0004	-0.0468 ± -0.0108	0.0101 ± 0.0024	0.0059 ± 0.0013	0.0015 ± 0.0009
	65	508	11:36:59	11:39:31	10	0	0.00272 ± 0.00000	0.0051 ± 0.0014	0.0096 ± 0.0016	0.0515 ± 0.0054	0.0021 ± 0.0007	0.2322 ± 0.3164	0.0233 ± 0.0187	0.0088 ± 0.0041	0.0060 ± 0.0016
	65	509	11:39:59	11:42:31	30	0	0.00203 ± 0.00001	0.0033 ± 0.0020	0.0120 ± 0.0063	0.0923 ± 0.0295	0.0023 ± 0.0019	0.0406 ± 0.0430	0.0331 ± 0.0052	0.0144 ± 0.0055	0.0057 ± 0.0028
503	70	511	11:43:29	11:47:01	1	P3	0.00095 ± 0.00001	0.0019 ± 0.0010	0.0045 ± 0.0024	0.0282 ± 0.0076	-0.0000 ± -0.0006	-0.0434 ± -0.0119	0.0128 ± 0.0022	0.0053 ± 0.0024	0.0027 ± 0.0020
504	65	512	11:48:29	11:50:31	1	P3	0.00055 ± 0.00000	0.0018 ± 0.0012	0.0030 ± 0.0023	0.0190 ± 0.0078	0.0001 ± 0.0006	-0.0417 ± -0.0140	0.0120 ± 0.0033	0.0051 ± 0.0015	0.0018 ± 0.0017
505	60	513	11:51:29	11:53:31	1	P3	-0.00018 ± -0.00001	0.0016 ± 0.0017	0.0020 ± 0.0026	0.0111 ± 0.0093	0.0000 ± 0.0009	-0.0420 ± -0.0110	0.0098 ± 0.0041	0.0021 ± 0.0024	0.0008 ± 0.0018
506	85	514	11:54:59	11:57:01	1	P3	0.00021 ± 0.00000	0.0007 ± 0.0008	0.0014 ± 0.0011	0.0118 ± 0.0035	-0.0001 ± -0.0005	0.0010 ± 0.0083	0.0078 ± 0.0022	0.0026 ± 0.0017	0.0003 ± 0.0010
507	100	515	11:57:59	11:59:30	1	P3	-0.00013 ± -0.00000	0.0004 ± 0.0007	0.0004 ± 0.0010	0.0102 ± 0.0035	-0.0003 ± -0.0004	0.0109 ± 0.0079	0.0071 ± 0.0019	0.0034 ± 0.0011	0.0006 ± 0.0009
508	7	517	12:06:29	12:10:31	1	P3	0.00287 ± 0.00001	0.0050 ± 0.0019	0.0174 ± 0.0047	0.1237 ± 0.0140	0.0050 ± 0.0013	0.0910 ± 0.0099	0.0559 ± 0.0050	0.0330 ± 0.0036	0.0127 ± 0.0024
	7	518	12:16:29	12:18:31	1	P3	0.00252 ± 0.00002	0.0010 ± 0.0027	0.0103 ± 0.0054	0.0931 ± 0.0194	0.0033 ± 0.0020	0.0865 ± 0.0185	0.0464 ± 0.0079	0.0301 ± 0.0040	0.0088 ± 0.0038
	7	519	12:19:29	12:22:31	10	0	0.00366 ± 0.00001	0.0054 ± 0.0022	0.0184 ± 0.0033	0.1538 ± 0.0161	0.0070 ± 0.0026	0.2546 ± 0.0599	0.0583 ± 0.0079	0.0260 ± 0.0043	0.0179 ± 0.0027
509	100	520	12:24:00	12:24:31	10	0	0.00185 ± 0.00000	0.0029 ± 0.0004	0.0054 ± 0.0013	0.0286 ± 0.0025	0.0019 ± 0.0005	0.0691 ± 0.0101	0.0108 ± 0.0009	0.0056 ± 0.0014	0.0034 ± 0.0010
510	85	521	12:25:00	12:26:30	10	0	0.00265 ± 0.00000	0.0030 ± 0.0010	0.0079 ± 0.0010	0.0325 ± 0.0042	0.0020 ± 0.0003	0.0724 ± 0.0056	0.0118 ± 0.0021	0.0057 ± 0.0011	0.0050 ± 0.0014
511	85	524	13:22:29	13:24:31	10	0	0.00414 ± 0.00000	0.0072 ± 0.0011	0.0208 ± 0.0034	0.0378 ± 0.0043	0.0047 ± 0.0008	0.0420 ± 0.0069	0.0096 ± 0.0020	0.0076 ± 0.0015	0.0072 ± 0.0013
512	30	525	13:25:31	13:29:01	10	0	0.00670 ± 0.00001	0.0084 ± 0.0020	0.0230 ± 0.0063	0.0544 ± 0.0110	0.0059 ± 0.0017	0.0733 ± 0.0089	0.0130 ± 0.0032	0.0093 ± 0.0026	0.0101 ± 0.0026
513	7	526	13:30:29	13:34:31	10	0	0.00602 ± 0.00001	0.0092 ± 0.0021	0.0314 ± 0.0040	0.1741 ± 0.0148	0.0105 ± 0.0025	0.1392 ± 0.0124	0.0646 ± 0.0071	0.0313 ± 0.0035	0.0250 ± 0.0044
	7	527	13:36:00	13:55:31	30	0	0.00615 ± 0.00004	0.0084 ± 0.0060	0.0271 ± 0.0115	0.1955 ± 0.0623	0.0099 ± 0.0050	0.1050 ± 0.0479	0.0910 ± 0.0280	0.0379 ± 0.0145	0.0207 ± 0.0100
514	100	531	14:01:00	14:02:00	30	0	0.00120 ± 0.00001	0.0012 ± 0.0016	0.0041 ± 0.0037	0.0268 ± 0.0083	0.0011 ± 0.0010	-0.0098 ± -0.0034	0.0152 ± 0.0037	0.0049 ± 0.0036	-0.0002 ± -0.0019
515	30	532	14:03:29	14:06:01	30	0	0.00109 ± 0.00002	0.0008 ± 0.0032	0.0040 ± 0.0047	0.0291 ± 0.0171	0.0003 ± 0.0018	-0.0218 ± -0.0105	0.0202 ± 0.0067	0.0041 ± 0.0036	-0.0005 ± -0.0025
516	7	533	14:08:29	14:10:01	30	0	0.00167 ± 0.00003	0.0013 ± 0.0024	0.0114 ± 0.0047	0.1414 ± 0.0282	0.0037 ± 0.0034	0.0335 ± 0.0152	0.0582 ± 0.0116	0.0180 ± 0.0091	0.0106 ± 0.0061

TABLE A-5.—PART B (Continued).

Test Point No.[1]	Power %	Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	Probe Rake Location[2]	Probe Tip No[3]	methyl naphthalene g/kg fuel	naphthalene g/kg fuel	phenol g/kg fuel	propene g/kg fuel	styrene g/kg fuel	sum m57[4] g/kg fuel	sum m59[4] g/kg fuel	sum m73[4] g/kg fuel	toluene g/kg fuel
517	85	534	14:10:59	14:12:31	30	0	0.00050 ± 0.00001	-0.0002 ± -0.0019	0.0003 ± 0.0020	0.0133 ± 0.0081	-0.0001 ± -0.0008	-0.0151 ± -0.0058	0.0119 ± 0.0038	0.0011 ± 0.0027	-0.0005 ± -0.0015
518	7	535	14:13:29	14:18:01	30	0	0.00190 ± 0.00002	0.0023 ± 0.0038	0.0127 ± 0.0055	0.1260 ± 0.0303	0.0051 ± 0.0033	0.0384 ± 0.0275	0.0530 ± 0.0146	0.0218 ± 0.0074	0.0123 ± 0.0071
	7	536	14:21:59	14:29:01	1	P3	0.00113 ± 0.00001	0.0030 ± 0.0024	0.0109 ± 0.0029	0.0717 ± 0.0098	0.0028 ± 0.0012	0.0369 ± 0.0086	0.0351 ± 0.0059	0.0172 ± 0.0044	0.0074 ± 0.0026
519	100	537	14:30:29	14:31:31	1	P3	0.00078 ± 0.00000	0.0002 ± 0.0005	0.0024 ± 0.0010	0.0089 ± 0.0024	0.0005 ± 0.0004	0.0000 ± 0.0022	0.0048 ± 0.0021	0.0013 ± 0.0013	0.0007 ± 0.0011
520	85	538	14:31:59	14:35:01	1	P3	0.00096 ± 0.00000	0.0014 ± 0.0011	0.0028 ± 0.0014	0.0073 ± 0.0058	0.0006 ± 0.0006	0.0026 ± 0.0029	0.0027 ± 0.0019	0.0001 ± 0.0013	0.0006 ± 0.0013
521	30	539	14:36:29	14:44:31	1	P3	0.00078 ± 0.00001	0.0010 ± 0.0009	0.0015 ± 0.0012	0.0052 ± 0.0043	0.0004 ± 0.0006	0.0168 ± 0.0036	0.0021 ± 0.0025	0.0008 ± 0.0016	0.0008 ± 0.0012
522	7	540	14:45:59	14:51:01	1	P3	0.00173 ± 0.00001	0.0025 ± 0.0014	0.0085 ± 0.0031	0.0635 ± 0.0152	0.0024 ± 0.0010	0.0539 ± 0.0085	0.0296 ± 0.0074	0.0173 ± 0.0038	0.0074 ± 0.0028
	7	541	14:51:59	14:57:01	1	P3	0.00118 ± 0.00000	0.0022 ± 0.0006	0.0070 ± 0.0013	0.0627 ± 0.0061	0.0024 ± 0.0005	0.0443 ± 0.0026	0.0285 ± 0.0023	0.0164 ± 0.0014	0.0063 ± 0.0011
	7	542	14:59:59	15:05:31	1	P3	0.00193 ± 0.00000	0.0043 ± 0.0015	0.0108 ± 0.0024	0.0791 ± 0.0094	0.0030 ± 0.0011	0.0464 ± 0.0041	0.0364 ± 0.0040	0.0211 ± 0.0034	0.0078 ± 0.0019
	7	543	15:06:59	15:12:01	1	P3	0.00301 ± 0.00003	0.0052 ± 0.0030	0.0129 ± 0.0044	0.0807 ± 0.0137	0.0037 ± 0.0019	0.0408 ± 0.0093	0.0415 ± 0.0070	0.0213 ± 0.0053	0.0080 ± 0.0029
	7	544	15:15:29	15:19:01	1	P3	0.00281 ± 0.00004	0.0041 ± 0.0056	0.0125 ± 0.0076	0.0753 ± 0.0257	0.0046 ± 0.0031	0.0255 ± 0.0147	0.0474 ± 0.0087	0.0189 ± 0.0050	0.0085 ± 0.0047
	7	545	15:20:29	15:24:01	1	P3	0.00145 ± 0.00005	0.0046 ± 0.0048	0.0127 ± 0.0114	0.0737 ± 0.0368	0.0028 ± 0.0039	-0.0074 ± -0.0217	0.0724 ± 0.0165	0.0209 ± 0.0110	0.0084 ± 0.0076
	7	546	15:25:29	15:29:01	1	P3	-0.07540 ± -0.00261	0.0569 ± 0.3018	-0.0071 ± -0.4071	-0.4290 ± -1.3448	-0.0529 ± -0.1664	-0.4402 ± -2.0778	0.1987 ± 0.5406	-0.0324 ± -0.3900	-0.0695 ± -0.2685
	7	547	15:29:59	15:34:31	10	0	0.00309 ± 0.00001	0.0061 ± 0.0018	0.0203 ± 0.0033	0.1155 ± 0.0117	0.0056 ± 0.0010	0.1242 ± 0.0323	0.0473 ± 0.0048	0.0216 ± 0.0031	0.0175 ± 0.0030
	7	548	15:36:59	15:41:31	10	0	0.00565 ± 0.00002	0.0099 ± 0.0035	0.0292 ± 0.0045	0.1459 ± 0.0172	0.0077 ± 0.0030	0.1137 ± 0.0112	0.0598 ± 0.0086	0.0320 ± 0.0044	0.0199 ± 0.0056
	7	549	15:42:59	15:47:31	10	0	0.01256 ± 0.00006	0.0185 ± 0.0079	0.0462 ± 0.0097	0.1907 ± 0.0389	0.0121 ± 0.0059	0.1861 ± 0.0256	0.1015 ± 0.0195	0.0484 ± 0.0128	0.0270 ± 0.0098
523	100	550	15:52:00	15:53:01	10	0	0.00220 ± 0.00001	0.0043 ± 0.0008	0.0095 ± 0.0023	0.0311 ± 0.0055	0.0026 ± 0.0010	0.0525 ± 0.0086	0.0254 ± 0.0031	0.0115 ± 0.0032	0.0042 ± 0.0018
524	85	551	15:53:29	15:55:31	10	0	0.00554 ± 0.00001	0.0061 ± 0.0019	0.0131 ± 0.0023	0.0398 ± 0.0083	0.0029 ± 0.0012	0.0602 ± 0.0044	0.0295 ± 0.0050	0.0123 ± 0.0029	0.0079 ± 0.0023
525	30	552	15:55:59	15:59:31	10	0	0.00739 ± 0.00002	0.0094 ± 0.0036	0.0228 ± 0.0051	0.0714 ± 0.0128	0.0045 ± 0.0022	0.0989 ± 0.0097	0.0563 ± 0.0082	0.0171 ± 0.0048	0.0132 ± 0.0044
526	7	553	16:00:48	16:04:01	10	0	0.00600 ± 0.00003	0.0100 ± 0.0036	0.0285 ± 0.0060	0.1426 ± 0.0209	0.0074 ± 0.0025	0.1391 ± 0.0155	0.1043 ± 0.0126	0.0382 ± 0.0071	0.0195 ± 0.0049
	7	554	16:05:29	16:09:01	10	0	0.01995 ± 0.00010	0.0295 ± 0.0097	0.0708 ± 0.0214	0.2562 ± 0.0564	0.0195 ± 0.0112	0.3703 ± 0.0578	0.2418 ± 0.0509	0.0709 ± 0.0208	0.0406 ± 0.0165
	7	555	16:09:59	16:13:01	10	0	0.02329 ± 0.00021	0.0289 ± 0.0222	0.0781 ± 0.0269	0.2495 ± 0.0653	0.0164 ± 0.0113	0.4121 ± 0.0469	0.2923 ± 0.0719	0.0673 ± 0.0254	0.0322 ± 0.0176
601	7	602	8:11:02	8:13:02	30	0	0.01564 ± 0.00003	0.0227 ± 0.0060	0.0739 ± 0.0147	0.7672 ± 0.0720	0.0235 ± 0.0059	0.3000 ± 0.0271	0.1645 ± 0.0254	0.0929 ± 0.0165	0.0584 ± 0.0099
	7	603	8:15:31	8:19:01	10	0	0.00453 ± 0.00001	0.0085 ± 0.0026	0.0310 ± 0.0052	0.5288 ± 0.0429	0.0133 ± 0.0025	0.2336 ± 0.0202	0.1291 ± 0.0088	0.0700 ± 0.0070	0.0424 ± 0.0053
	7	604	8:20:01	8:23:02	10	0	0.00650 ± 0.00002	0.0134 ± 0.0039	0.0451 ± 0.0077	0.5230 ± 0.0499	0.0141 ± 0.0036	0.2385 ± 0.0211	0.1357 ± 0.0142	0.0888 ± 0.0091	0.0455 ± 0.0080
	7	605	8:27:09	8:27:40	10	0	0.00376 ± 0.00000	0.0051 ± 0.0031	0.0225 ± 0.0034	0.4015 ± 0.0225	0.0113 ± 0.0018	0.2090 ± 0.0113	0.1145 ± 0.0118	0.0611 ± 0.0106	0.0342 ± 0.0065
602	100	606	8:28:36	8:29:17	10	0	0.00105 ± 0.00000	0.0020 ± 0.0009	0.0055 ± 0.0012	0.0452 ± 0.0047	0.0016 ± 0.0007	0.0144 ± 0.0018	0.0077 ± 0.0007	0.0053 ± 0.0009	0.0037 ± 0.0007
603	85	607	8:29:30	8:31:30	10	0	0.00126 ± 0.00000	0.0027 ± 0.0009	0.0063 ± 0.0011	0.0449 ± 0.0041	0.0011 ± 0.0004	0.0169 ± 0.0016	0.0084 ± 0.0014	0.0058 ± 0.0011	0.0036 ± 0.0009
	30	608	8:32:32	8:36:31	10	0	0.00199 ± 0.00001	0.0035 ± 0.0014	0.0087 ± 0.0020	0.0803 ± 0.0099	0.0014 ± 0.0007	0.0343 ± 0.0035	0.0153 ± 0.0024	0.0085 ± 0.0017	0.0064 ± 0.0015
605	7	609	8:37:30	8:41:01	10	0	0.00457 ± 0.00001	0.0104 ± 0.0031	0.0344 ± 0.0050	0.4304 ± 0.0348	0.0143 ± 0.0028	0.2210 ± 0.0166	0.1248 ± 0.0094	0.0679 ± 0.0068	0.0440 ± 0.0060
	7	610	8:43:00	8:47:30	10	0	0.01469 ± 0.00005	0.0268 ± 0.0078	0.0700 ± 0.0116	0.5335 ± 0.0634	0.0171 ± 0.0066	0.2660 ± 0.0291	0.1656 ± 0.0186	0.1094 ± 0.0162	0.0589 ± 0.0133
	7	611	8:49:32	8:52:01	10	0	0.01972 ± 0.00009	0.0439 ± 0.0120	0.0920 ± 0.0222	0.5654 ± 0.0712	0.0184 ± 0.0088	0.3002 ± 0.0335	0.1858 ± 0.0289	0.1327 ± 0.0229	0.0661 ± 0.0201
	7	612	8:53:31	8:57:01	1	P3	0.00453 ± 0.00001	0.0095 ± 0.0026	0.0232 ± 0.0037	0.2502 ± 0.0173	0.0075 ± 0.0020	0.1400 ± 0.0088	0.0992 ± 0.0060	0.0618 ± 0.0053	0.0267 ± 0.0039
	7	613	8:58:00	9:00:33	1	P6	0.00439 ± 0.00001	0.0090 ± 0.0027	0.0235 ± 0.0036	0.2673 ± 0.0202	0.0078 ± 0.0011	0.1416 ± 0.0088	0.1045 ± 0.0083	0.0667 ± 0.0063	0.0261 ± 0.0045
	7	614	9:01:30	9:04:01	10	0	0.01828 ± 0.00010	0.0411 ± 0.0136	0.0852 ± 0.0190	0.5861 ± 0.1093	0.0195 ± 0.0081	0.3146 ± 0.0669	0.2028 ± 0.0424	0.1483 ± 0.0344	0.0590 ± 0.0170
606	100	615	9:04:32	9:05:02	10	0	0.00439 ± 0.00003	0.0080 ± 0.0033	0.0173 ± 0.0057	0.0815 ± 0.0177	0.0032 ± 0.0013	0.0414 ± 0.0086	0.0292 ± 0.0040	0.0200 ± 0.0060	0.0068 ± 0.0014
607	85	616	9:05:31	9:07:32	10	0	0.00729 ± 0.00002	0.0112 ± 0.0034	0.0224 ± 0.0050	0.0858 ± 0.0145	0.0032 ± 0.0017	0.0495 ± 0.0087	0.0316 ± 0.0069	0.0224 ± 0.0061	0.0101 ± 0.0044
608	30	617	9:09:02	9:12:32	10	0	0.00697 ± 0.00003	0.0104 ± 0.0050	0.0202 ± 0.0054	0.1158 ± 0.0162	0.0035 ± 0.0018	0.0646 ± 0.0066	0.0440 ± 0.0066	0.0277 ± 0.0060	0.0123 ± 0.0039
609	7	618	9:14:02	9:17:31	10	0	0.00635 ± 0.00002	0.0167 ± 0.0041	0.0413 ± 0.0070	0.4101 ± 0.0410	0.0127 ± 0.0035	0.2203 ± 0.0175	0.1507 ± 0.0143	0.0826 ± 0.0091	0.0461 ± 0.0084
	7	619	9:18:31	9:30:02	30	0	0.01055 ± 0.00004	0.0199 ± 0.0070	0.0463 ± 0.0098	0.4259 ± 0.0609	0.0146 ± 0.0054	0.3166 ± 0.1334	0.1732 ± 0.0234	0.0905 ± 0.0148	0.0427 ± 0.0095
610	100	620	9:39:31	9:40:01	1	P3	0.00060 ± 0.00000	0.0014 ± 0.0006	0.0028 ± 0.0009	0.0140 ± 0.0024	0.0000 ± 0.0001	0.0084 ± 0.0029	0.0088 ± 0.0020	0.0059 ± 0.0017	0.0019 ± 0.0011
611	85	621	9:41:00	9:43:01	1	P3	0.00129 ± 0.00000	0.0024 ± 0.0014	0.0056 ± 0.0017	0.0211 ± 0.0059	0.0007 ± 0.0008	0.0111 ± 0.0023	0.0129 ± 0.0028	0.0062 ± 0.0021	0.0021 ± 0.0012
612	30	622	9:45:00	9:48:01	1	P3	0.00113 ± 0.00000	0.0019 ± 0.0007	0.0036 ± 0.0012	0.0167 ± 0.0030	0.0005 ± 0.0006	0.0133 ± 0.0019	0.0121 ± 0.0030	0.0066 ± 0.0015	0.0014 ± 0.0009
613	7	623	9:50:00	9:52:01	1	P3	0.00273 ± 0.00001	0.0055 ± 0.0022	0.0171 ± 0.0022	0.1553 ± 0.0091	0.0054 ± 0.0012	0.0843 ± 0.0070	0.0701 ± 0.0034	0.0441 ± 0.0043	0.0146 ± 0.0028
	7	624	9:53:31	10:14:33	30	0	0.00621 ± 0.00004	0.0127 ± 0.0051	0.0301 ± 0.0084	0.3320 ± 0.0583	0.0091 ± 0.0044	0.1801 ± 0.0389	0.1260 ± 0.0192	0.0656 ± 0.0135	0.0238 ± 0.0071

TABLE A-5.—PART B (Continued).

Test Point No.[1]	Power %	Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	Probe Rake Location[2]	Probe Tip No[3]	methyl naphthalene g/kg fuel	naphthalene g/kg fuel	phenol g/kg fuel	propene g/kg fuel	styrene g/kg fuel	sum m57[4] g/kg fuel	sum m59[4] g/kg fuel	sum m73[4] g/kg fuel	toluene g/kg fuel
614	100	625	10:15:32	10:16:18	30	0	0.00225 ± 0.00001	0.0033 ± 0.0020	0.0046 ± 0.0021	0.0537 ± 0.0060	0.0007 ± 0.0008	0.0166 ± 0.0034	0.0252 ± 0.0038	0.0128 ± 0.0020	0.0019 ± 0.0008
615	85	626	10:16:32	10:18:32	30	0	0.00073 ± 0.00000	0.0018 ± 0.0019	0.0041 ± 0.0018	0.0636 ± 0.0132	0.0007 ± 0.0007	0.0192 ± 0.0037	0.0283 ± 0.0054	0.0129 ± 0.0031	0.0015 ± 0.0012
616	30	627	10:19:32	10:23:32	30	0	0.00200 ± 0.00001	0.0039 ± 0.0025	0.0056 ± 0.0043	0.1057 ± 0.0179	0.0009 ± 0.0014	0.0559 ± 0.0071	0.0462 ± 0.0089	0.0224 ± 0.0056	0.0034 ± 0.0031
617	7	628	10:24:01	10:27:02	30	0	0.00450 ± 0.00003	0.0093 ± 0.0067	0.0252 ± 0.0098	0.2949 ± 0.0715	0.0074 ± 0.0047	0.1804 ± 0.0398	0.1282 ± 0.0280	0.0651 ± 0.0155	0.0215 ± 0.0068
	7	629	10:28:01	10:31:32	1	P1	0.00264 ± 0.00001	0.0058 ± 0.0021	0.0163 ± 0.0034	0.1558 ± 0.0131	0.0052 ± 0.0021	0.1010 ± 0.0097	0.0700 ± 0.0078	0.0454 ± 0.0058	0.0216 ± 0.0046
	7	630	10:32:11	10:34:32	1	P3	0.00228 ± 0.00001	0.0043 ± 0.0015	0.0126 ± 0.0025	0.1128 ± 0.0096	0.0037 ± 0.0011	0.0632 ± 0.0048	0.0509 ± 0.0048	0.0352 ± 0.0030	0.0126 ± 0.0019
	7	631	10:36:06	10:37:32	1	P6	0.00228 ± 0.00001	0.0058 ± 0.0019	0.0120 ± 0.0025	0.1237 ± 0.0130	0.0031 ± 0.0013	0.0643 ± 0.0077	0.0535 ± 0.0056	0.0373 ± 0.0037	0.0124 ± 0.0014
618	4	632	11:53:32	11:59:32	30	0	0.01267 ± 0.00005	0.0213 ± 0.0066	0.0865 ± 0.0208	0.6778 ± 0.1691	0.0291 ± 0.0085	0.3556 ± 0.0872	0.1890 ± 0.0443	0.0936 ± 0.0231	0.0709 ± 0.0189
619	100	633	12:01:01	12:01:32	30	0	0.00296 ± 0.00000	0.0024 ± 0.0017	0.0100 ± 0.0044	0.0633 ± 0.0106	0.0027 ± 0.0024	0.0123 ± 0.0031	0.0130 ± 0.0014	0.0102 ± 0.0025	0.0013 ± 0.0012
620	85	634	12:02:33	12:05:02	30	0	0.00148 ± 0.00001	0.0020 ± 0.0015	0.0031 ± 0.0024	0.0420 ± 0.0137	0.0010 ± 0.0014	0.0088 ± 0.0027	0.0100 ± 0.0042	0.0091 ± 0.0030	0.0005 ± 0.0013
621	65	635	12:05:31	12:09:01	30	0	0.00011 ± 0.00000	0.0015 ± 0.0014	0.0027 ± 0.0025	0.0393 ± 0.0156	0.0001 ± 0.0011	0.0073 ± 0.0023	0.0082 ± 0.0043	0.0093 ± 0.0034	-0.0004 ± -0.0015
622	40	636	12:10:02	12:13:31	30	0	-0.00026 ± -0.00001	0.0017 ± 0.0020	0.0007 ± 0.0028	0.0588 ± 0.0170	0.0008 ± 0.0014	0.0132 ± 0.0048	0.0057 ± 0.0054	0.0078 ± 0.0026	-0.0006 ± -0.0018
623	4	637	12:14:00	12:14:30	30	0	0.01520 ± 0.00012	0.0251 ± 0.0275	0.0829 ± 0.0792	0.6553 ± 0.6890	0.0326 ± 0.0306	0.3757 ± 0.3978	0.1515 ± 0.1742	0.0889 ± 0.0953	0.0941 ± 0.1105
	4	638	12:17:30	12:19:31	10	0	0.01576 ± 0.00009	0.0348 ± 0.0131	0.1116 ± 0.0178	0.7337 ± 0.0942	0.0326 ± 0.0103	0.5558 ± 0.0627	0.1848 ± 0.0309	0.1153 ± 0.0211	0.0772 ± 0.0139
		639	12:19:30	12:20:00	1	P3	0.01128 ± 0.00012	0.0267 ± 0.0317	0.0734 ± 0.0761	0.4940 ± 0.5462	0.0219 ± 0.0241	0.4858 ± 0.5249	0.1388 ± 0.1495	0.0935 ± 0.0988	0.0515 ± 0.0537
624	40	640	12:21:01	12:24:01	1	P3	0.00316 ± 0.00001	0.0045 ± 0.0017	0.0092 ± 0.0032	0.0412 ± 0.0121	0.0019 ± 0.0010	0.0391 ± 0.0047	0.0066 ± 0.0033	0.0079 ± 0.0023	0.0059 ± 0.0024
	40	641	12:25:01	12:28:01	1	P3	0.00159 ± 0.00000	0.0025 ± 0.0007	0.0044 ± 0.0010	0.0255 ± 0.0052	0.0010 ± 0.0006	0.0326 ± 0.0069	0.0074 ± 0.0018	0.0051 ± 0.0011	0.0038 ± 0.0012
	40	642	12:30:00	12:31:30	1	P3	0.00919 ± 0.00005	0.0098 ± 0.0063	0.0298 ± 0.0086	0.1024 ± 0.0315	0.0056 ± 0.0051	0.0984 ± 0.0141	0.0141 ± 0.0143	0.0207 ± 0.0100	0.0230 ± 0.0118
	40	643	12:36:00	12:38:31	1	P3	0.00257 ± 0.00002	0.0040 ± 0.0025	0.0043 ± 0.0035	0.0158 ± 0.0105	0.0008 ± 0.0013	0.0471 ± 0.0081	-0.0046 ± -0.0049	0.0034 ± 0.0038	-0.0012 ± -0.0024
	40	644	12:39:31	12:41:31	1	P3	0.00062 ± 0.00000	0.0004 ± 0.0003	0.0009 ± 0.0006	0.0079 ± 0.0025	0.0003 ± 0.0002	0.0121 ± 0.0009	0.0030 ± 0.0010	0.0023 ± 0.0006	0.0002 ± 0.0005
625	30	645	12:43:31	12:46:30	1	P3	0.00093 ± 0.00000	0.0014 ± 0.0010	0.0008 ± 0.0008	0.0109 ± 0.0046	0.0003 ± 0.0006	0.0165 ± 0.0040	-0.0023 ± -0.0026	0.0029 ± 0.0014	-0.0008 ± -0.0010
626	15	646	12:47:30	12:50:01	1	P3	0.00153 ± 0.00001	0.0018 ± 0.0011	0.0027 ± 0.0015	0.0349 ± 0.0083	0.0010 ± 0.0011	0.0300 ± 0.0047	0.0031 ± 0.0037	0.0087 ± 0.0032	0.0013 ± 0.0015
627	7	647	12:51:01	12:54:30	1	P3	0.00297 ± 0.00001	0.0044 ± 0.0019	0.0085 ± 0.0022	0.0891 ± 0.0095	0.0036 ± 0.0016	0.0618 ± 0.0049	0.0295 ± 0.0055	0.0250 ± 0.0038	0.0079 ± 0.0032
628	5.5	648	12:55:30	12:59:02	1	P3	0.00400 ± 0.00001	0.0073 ± 0.0032	0.0245 ± 0.0040	0.2043 ± 0.0166	0.0088 ± 0.0016	0.1279 ± 0.0070	0.0708 ± 0.0080	0.0485 ± 0.0052	0.0187 ± 0.0050
629	4	649	13:00:00	13:01:31	1	P3	0.00557 ± 0.00002	0.0133 ± 0.0029	0.0467 ± 0.0067	0.3515 ± 0.0277	0.0151 ± 0.0037	0.2118 ± 0.0072	0.1118 ± 0.0100	0.0683 ± 0.0056	0.0356 ± 0.0041
	4	651	13:07:31	13:11:00	30	0	0.01319 ± 0.00005	0.0197 ± 0.0059	0.0717 ± 0.0150	0.5289 ± 0.1011	0.0254 ± 0.0065	0.2953 ± 0.0586	0.1234 ± 0.0289	0.0808 ± 0.0175	0.0504 ± 0.0134
630	5.5	652	13:11:31	13:15:00	30	0	0.01027 ± 0.00004	0.0162 ± 0.0064	0.0403 ± 0.0115	0.3302 ± 0.0570	0.0160 ± 0.0038	0.1850 ± 0.0278	0.0682 ± 0.0175	0.0626 ± 0.0110	0.0250 ± 0.0083
631	7	653	13:15:31	13:18:31	30	0	0.00725 ± 0.00003	0.0133 ± 0.0051	0.0152 ± 0.0082	0.2004 ± 0.0402	0.0115 ± 0.0055	0.1135 ± 0.0289	0.0128 ± 0.0099	0.0372 ± 0.0102	0.0088 ± 0.0045
632	15	654	13:19:30	13:22:31	30	0	0.00385 ± 0.00002	0.0034 ± 0.0030	-0.0029 ± -0.0048	0.0819 ± 0.0286	0.0030 ± 0.0023	0.0397 ± 0.0080	-0.0354 ± -0.0102	0.0120 ± 0.0052	-0.0064 ± -0.0035
633	30	655	13:23:31	13:27:01	30	0	0.00131 ± 0.00002	0.0014 ± 0.0030	-0.0070 ± -0.0028	0.0331 ± 0.0182	0.0006 ± 0.0012	0.0193 ± 0.0065	-0.0379 ± -0.0081	0.0033 ± 0.0031	-0.0092 ± -0.0025
634	4	656	13:27:31	13:35:01	30	0	0.01182 ± 0.00004	0.0221 ± 0.0069	0.0773 ± 0.0184	0.5379 ± 0.1030	0.0275 ± 0.0077	0.3121 ± 0.0545	0.0946 ± 0.0218	0.0757 ± 0.0155	0.0594 ± 0.0147
635	40	657	13:39:01	13:42:31	30	0	0.00130 ± 0.00002	0.0029 ± 0.0022	-0.0027 ± -0.0033	0.0214 ± 0.0113	0.0021 ± 0.0019	0.0119 ± 0.0042	-0.0480 ± -0.0063	0.0034 ± 0.0034	-0.0080 ± -0.0030
	40	658	13:43:02	13:47:31	10	0	0.00227 ± 0.00001	0.0033 ± 0.0013	0.0025 ± 0.0017	0.0289 ± 0.0106	0.0013 ± 0.0006	0.0322 ± 0.0089	-0.0123 ± -0.0027	0.0020 ± 0.0014	0.0018 ± 0.0020
	40	659	13:49:31	13:53:00	10	0	0.00439 ± 0.00002	0.0070 ± 0.0030	0.0050 ± 0.0029	0.0369 ± 0.0156	0.0027 ± 0.0016	0.0600 ± 0.0098	-0.0393 ± -0.0053	0.0016 ± 0.0036	0.0025 ± 0.0034
	40	660	13:53:31	13:57:31	10	0	0.01454 ± 0.00008	0.0136 ± 0.0069	0.0081 ± 0.0090	0.0344 ± 0.0227	0.0060 ± 0.0038	0.1493 ± 0.0130	-0.0947 ± -0.0171	0.0010 ± 0.0088	-0.0037 ± -0.0067
636	30	661	13:59:01	14:02:31	10	0	0.00404 ± 0.00002	0.0046 ± 0.0020	0.0050 ± 0.0029	0.0403 ± 0.0113	0.0022 ± 0.0015	0.0591 ± 0.0054	-0.0035 ± -0.0067	0.0053 ± 0.0031	0.0014 ± 0.0024
637	15	662	14:03:30	14:06:32	10	0	0.00484 ± 0.00002	0.0048 ± 0.0034	0.0063 ± 0.0031	0.0860 ± 0.0170	0.0043 ± 0.0018	0.0892 ± 0.0089	0.0187 ± 0.0077	0.0145 ± 0.0040	0.0048 ± 0.0030
638	7	663	14:08:00	14:11:30	10	0	0.00472 ± 0.00001	0.0075 ± 0.0029	0.0229 ± 0.0049	0.1958 ± 0.0262	0.0106 ± 0.0027	0.1426 ± 0.0116	0.0650 ± 0.0111	0.0400 ± 0.0057	0.0202 ± 0.0050
639	5.5	664	14:12:30	14:16:30	10	0	0.00738 ± 0.00002	0.0112 ± 0.0033	0.0379 ± 0.0060	0.2865 ± 0.0359	0.0150 ± 0.0036	0.1954 ± 0.0179	0.0920 ± 0.0122	0.0581 ± 0.0067	0.0327 ± 0.0058
640	4	665	14:18:31	14:21:00	10	0	0.00992 ± 0.00002	0.0145 ± 0.0034	0.0642 ± 0.0067	0.4340 ± 0.0559	0.0240 ± 0.0052	0.2783 ± 0.0302	0.1331 ± 0.0187	0.0740 ± 0.0101	0.0560 ± 0.0080
641	5.5	667	14:26:00	14:29:01	30	0	0.00903 ± 0.00005	0.0095 ± 0.0051	0.0233 ± 0.0093	0.2285 ± 0.0724	0.0138 ± 0.0062	0.1508 ± 0.0404	0.0435 ± 0.0241	0.0491 ± 0.0155	0.0123 ± 0.0090
642	7	668	14:30:32	14:33:01	30	0	0.00427 ± 0.00004	0.0076 ± 0.0058	0.0005 ± 0.0073	0.1483 ± 0.0634	0.0104 ± 0.0043	0.1039 ± 0.0298	-0.0061 ± -0.0249	0.0229 ± 0.0116	0.0013 ± 0.0101
643	15	669	14:34:42	14:37:31	30	0	0.00143 ± 0.00003	0.0004 ± 0.0031	-0.0098 ± -0.0064	0.0390 ± 0.0229	0.0018 ± 0.0020	0.0300 ± 0.0061	-0.0413 ± -0.0119	0.0039 ± 0.0061	-0.0134 ± -0.0039

TABLE A-5.—PART B (Continued).

Test Point No.[1]	Power %	Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	Probe Rake Location[2]	Probe Tip No[3]	methyl naphthalene g/kg fuel	naphthalene g/kg fuel	phenol g/kg fuel	propene g/kg fuel	styrene g/kg fuel	sum m57[4] g/kg fuel	sum m59[4] g/kg fuel	sum m73[4] g/kg fuel	toluene g/kg fuel
701	4	701	8:03:30	8:08:30	10	0	0.03304 ±	0.032	0.258	2.618	0.095	1.347	0.505	0.233	0.331
702	100	702	8:08:59	8:10:30	10	0	0.01026 ±	0.010	0.080	0.813	0.029	0.418	0.157	0.072	0.103
703	85	703	8:11:00	8:13:30	10	0	0.01217 ±	0.012	0.095	0.964	0.035	0.496	0.186	0.086	0.122
704	65	704	8:14:30	8:18:00	10	0	0.00351 ± 0.00003	0.0058 ± 0.0030	0.0188 ± 0.0264	0.1082 ± 0.2895	0.0055 ± 0.0101	0.0656 ± 0.1465	0.0277 ± 0.0541	0.0162 ± 0.0242	0.0147 ± 0.0363
705	4	705	8:19:00	8:23:30	10	0	0.01240 ± 0.00003	0.0251 ± 0.0060	0.1363 ± 0.0237	1.2199 ± 0.1165	0.0494 ± 0.0081	0.6705 ± 0.0518	0.2834 ± 0.0227	0.1511 ± 0.0165	0.1445 ± 0.0151
	4	706	8:24:30	8:27:30	1	P3	0.01427 ± 0.00003	0.0286 ± 0.0051	0.1084 ± 0.0128	1.0231 ± 0.1498	0.0322 ± 0.0049	0.5700 ± 0.0490	0.2896 ± 0.0208	0.1619 ± 0.0160	0.1140 ± 0.0148
706	100	707	8:28:00	8:29:30	1	P3	0.00255 ± 0.00000	0.0037 ± 0.0017	0.0092 ± 0.0025	0.0279 ± 0.0052	0.0018 ± 0.0005	0.0147 ± 0.0024	0.0131 ± 0.0018	0.0117 ± 0.0025	0.0031 ± 0.0012
707	85	708	8:29:30	8:32:30	1	P3	0.00212 ± 0.00000	0.0032 ± 0.0012	0.0065 ± 0.0020	0.0236 ± 0.0046	0.0015 ± 0.0008	0.0125 ± 0.0024	0.0132 ± 0.0019	0.0098 ± 0.0019	0.0023 ± 0.0007
708	70	709	8:33:30	8:36:30	1	P3	0.00198 ± 0.00001	0.0028 ± 0.0017	0.0064 ± 0.0025	0.0262 ± 0.0075	0.0011 ± 0.0011	0.0155 ± 0.0021	0.0160 ± 0.0023	0.0099 ± 0.0016	0.0028 ± 0.0013
709	65	710	8:37:30	8:40:00	1	P3	0.00154 ± 0.00001	0.0028 ± 0.0013	0.0056 ± 0.0017	0.0242 ± 0.0065	0.0009 ± 0.0008	0.0153 ± 0.0027	0.0168 ± 0.0027	0.0091 ± 0.0025	0.0028 ± 0.0013
710	60	711	8:42:00	8:44:00	1	P3	0.00203 ± 0.00001	0.0032 ± 0.0021	0.0060 ± 0.0024	0.0275 ± 0.0078	0.0008 ± 0.0009	0.0165 ± 0.0035	0.0203 ± 0.0031	0.0092 ± 0.0037	0.0029 ± 0.0017
711	4	712	8:46:00	8:52:00	1	P3	0.01076 ± 0.00003	0.0207 ± 0.0044	0.0858 ± 0.0112	0.8309 ± 0.0803	0.0304 ± 0.0045	0.4431 ± 0.0357	0.2371 ± 0.0194	0.1336 ± 0.0132	0.0886 ± 0.0105
	4	713	8:53:00	8:56:30	1	P3	1.44868 ± 0.00668	2.3118 ± 0.8124	4.9959 ± 1.9906	10.288 ± 4.6602	1.1358 ± 0.6043	4.4664 ± 1.6194	3.5231 ± 1.0599	2.9534 ± 1.2291	1.3689 ± 0.7620
712	100	714	8:57:30	8:58:30	1	P3	0.00217 ± 0.00001	0.0031 ± 0.0010	0.0091 ± 0.0018	0.0228 ± 0.0028	0.0019 ± 0.0006	0.0081 ± 0.0018	0.0131 ± 0.0016	0.0076 ± 0.0011	0.0018 ± 0.0008
713	85	715	8:59:30	9:01:00	1	P3	0.00162 ± 0.00001	0.0037 ± 0.0013	0.0074 ± 0.0013	0.0228 ± 0.0042	0.0018 ± 0.0009	0.0067 ± 0.0017	0.0131 ± 0.0018	0.0074 ± 0.0015	0.0017 ± 0.0009
714	65	716	9:03:30	9:06:30	1	P3	0.00223 ± 0.00001	0.0039 ± 0.0015	0.0069 ± 0.0018	0.0239 ± 0.0050	0.0018 ± 0.0010	0.0101 ± 0.0021	0.0149 ± 0.0029	0.0087 ± 0.0024	0.0023 ± 0.0011
715	4	717	9:08:00	9:11:30	1	P3	0.01159 ± 0.00002	0.0232 ± 0.0035	0.0903 ± 0.0138	0.8618 ± 0.0719	0.0324 ± 0.0056	0.4506 ± 0.0363	0.2385 ± 0.0207	0.1334 ± 0.0119	0.0930 ± 0.0114
	4	718	9:12:00	9:15:30	10	0	0.02033 ± 0.00004	0.0387 ± 0.0074	0.1589 ± 0.0141	1.2712 ± 0.0985	0.0551 ± 0.0071	0.6976 ± 0.0553	0.3236 ± 0.0259	0.1874 ± 0.0176	0.1448 ± 0.0144
716	100	719	9:16:30	9:17:30	10	0	0.01498 ± 0.00002	0.0213 ± 0.0053	0.0543 ± 0.0074	0.1249 ± 0.0191	0.0126 ± 0.0027	0.0634 ± 0.0058	0.0493 ± 0.0055	0.0413 ± 0.0095	0.0221 ± 0.0041
717	85	720	9:18:30	9:21:00	10	0	0.01357 ± 0.00004	0.0223 ± 0.0088	0.0326 ± 0.0119	0.1150 ± 0.0140	0.0102 ± 0.0026	0.0531 ± 0.0134	0.0437 ± 0.0047	0.0333 ± 0.0049	0.0168 ± 0.0042
718	65	721	9:22:30	9:24:30	10	0	0.00965 ± 0.00003	0.0142 ± 0.0036	0.0235 ± 0.0053	0.0872 ± 0.0107	0.0050 ± 0.0017	0.0456 ± 0.0057	0.0393 ± 0.0042	0.0231 ± 0.0046	0.0145 ± 0.0026
719	4	722	9:25:30	9:28:30	10	0	0.01933 ± 0.00003	0.0338 ± 0.0047	0.1337 ± 0.0188	1.0740 ± 0.0770	0.0454 ± 0.0086	0.5864 ± 0.0373	0.2843 ± 0.0196	0.1581 ± 0.0166	0.1266 ± 0.0098
	4	723	9:29:00	9:32:30	30	0	0.03252 ± 0.00010	0.0476 ± 0.0101	0.1646 ± 0.0533	1.2003 ± 0.3597	0.0615 ± 0.0220	0.6716 ± 0.2022	0.3488 ± 0.0848	0.1818 ± 0.0533	0.1610 ± 0.0458
720	100	724	9:33:30	9:34:30	30	0	0.00530 ± 0.00002	0.0072 ± 0.0028	0.0130 ± 0.0044	0.0805 ± 0.0097	0.0044 ± 0.0014	0.0287 ± 0.0058	0.0446 ± 0.0069	0.0241 ± 0.0028	0.0095 ± 0.0020
721	85	725	9:35:30	9:37:30	30	0	0.00336 ± 0.00001	0.0046 ± 0.0015	0.0085 ± 0.0023	0.0721 ± 0.0095	0.0021 ± 0.0014	0.0214 ± 0.0036	0.0465 ± 0.0035	0.0208 ± 0.0027	0.0063 ± 0.0019
722	70	726	9:38:30	9:41:30	30	0	0.00246 ± 0.00001	0.0047 ± 0.0021	0.0049 ± 0.0026	0.0698 ± 0.0117	0.0019 ± 0.0011	0.0183 ± 0.0041	0.0469 ± 0.0046	0.0193 ± 0.0037	0.0053 ± 0.0021
723	65	727	9:42:00	9:45:30	30	0	0.00266 ± 0.00001	0.0026 ± 0.0017	0.0043 ± 0.0029	0.0700 ± 0.0120	0.0010 ± 0.0012	0.0134 ± 0.0045	0.0477 ± 0.0049	0.0198 ± 0.0033	0.0073 ± 0.0026
724	60	728	9:47:00	9:49:30	30	0	0.00171 ± 0.00001	0.0009 ± 0.0013	0.0036 ± 0.0018	0.0633 ± 0.0063	0.0014 ± 0.0013	0.0062 ± 0.0053	0.0497 ± 0.0075	0.0176 ± 0.0032	0.0076 ± 0.0027
725	4	729	9:51:00	9:54:00	30	0	0.02491 ± 0.00007	0.0402 ± 0.0099	0.1439 ± 0.0199	1.0697 ± 0.1325	0.0508 ± 0.0075	0.5732 ± 0.0718	0.2985 ± 0.0341	0.1617 ± 0.0209	0.1254 ± 0.0165
726	4	732	15:07:00	15:09:30	30	0	0.01374 ± 0.00003	0.0212 ± 0.0063	0.0948 ± 0.0158	0.6112 ± 0.0800	0.0281 ± 0.0060	0.3748 ± 0.0466	0.1375 ± 0.0212	0.0706 ± 0.0141	0.0697 ± 0.0146
727	100	733	15:11:00	15:12:30	30	0	0.00149 ± 0.00000	0.0022 ± 0.0017	0.0058 ± 0.0020	0.0668 ± 0.1545	0.0018 ± 0.0008	0.0191 ± 0.0029	0.0038 ± 0.0059	0.0037 ± 0.0019	0.0014 ± 0.0010
728	85	734	15:13:30	15:16:00	30	0	0.00104 ± 0.00000	0.0012 ± 0.0012	0.0020 ± 0.0016	0.1836 ± 0.1654	0.0006 ± 0.0006	0.0195 ± 0.0031	0.0066 ± 0.0079	0.0018 ± 0.0020	0.0010 ± 0.0013
729	65	735	15:16:30	15:20:00	30	0	0.00075 ± 0.00000	0.0014 ± 0.0014	0.0026 ± 0.0019	0.0266 ± 0.0112	0.0006 ± 0.0009	0.0211 ± 0.0035	-0.0044 ± -0.0037	0.0005 ± 0.0024	0.0007 ± 0.0015
730	40	736	15:21:30	15:24:30	30	0	0.00066 ± 0.00001	-0.0006 ± -0.0009	-0.0003 ± -0.0025	0.0157 ± 0.0097	0.0006 ± 0.0007	0.0233 ± 0.0045	-0.0108 ± -0.0027	-0.0011 ± -0.0029	-0.0003 ± -0.0010
731	30	737	15:26:00	15:29:30	30	0	0.00099 ± 0.00001	0.0001 ± 0.0018	-0.0017 ± -0.0022	0.0165 ± 0.0128	0.0005 ± 0.0011	0.0300 ± 0.0047	-0.0153 ± -0.0059	-0.0022 ± -0.0032	-0.0001 ± -0.0014
732	7	738	15:31:00	15:33:30	30	0	0.00290 ± 0.00002	0.0057 ± 0.0031	0.0136 ± 0.0052	0.1863 ± 0.0258	0.0086 ± 0.0037	0.1646 ± 0.0156	0.0270 ± 0.0101	0.0212 ± 0.0062	0.0137 ± 0.0052
733	4	739	15:34:30	15:38:00	30	0	0.00633 ± 0.00003	0.0123 ± 0.0044	0.0455 ± 0.0090	0.4039 ± 0.0573	0.0167 ± 0.0054	0.2888 ± 0.0338	0.0777 ± 0.0192	0.0516 ± 0.0100	0.0391 ± 0.0117
	4	740	15:39:30	15:42:00	10	0	0.0046	0.0134	0.0506	0.3673	0.0131	0.3392	0.1059	0.0528	0.0487
734	100	741	15:44:00	15:45:00	10	0	0.00196 ± 0.00000	0.0033 ± 0.0006	0.0074 ± 0.0010	0.0181 ± 0.0021	0.0020 ± 0.0004	0.0238 ± 0.0020	0.0011 ± 0.0007	0.0032 ± 0.0008	0.0031 ± 0.0010
735	85	742	15:45:30	15:48:00	10	0	0.00260 ± 0.00000	0.0030 ± 0.0006	0.0061 ± 0.0009	0.0178 ± 0.0027	0.0018 ± 0.0006	0.0244 ± 0.0017	0.0017 ± 0.0008	0.0030 ± 0.0007	0.0042 ± 0.0008
736	65	743	15:48:30	15:52:30	10	0	0.00304 ± 0.00000	0.0032 ± 0.0008	0.0060 ± 0.0009	0.0202 ± 0.0023	0.0016 ± 0.0006	0.0267 ± 0.0023	0.0021 ± 0.0009	0.0031 ± 0.0006	0.0046 ± 0.0013
737	40	744	15:53:30	15:57:00	10	0	0.00275 ± 0.00000	0.0036 ± 0.0014	0.0054 ± 0.0018	0.0191 ± 0.0040	0.0018 ± 0.0007	0.0349 ± 0.0045	0.0018 ± 0.0023	0.0032 ± 0.0011	0.0054 ± 0.0019
738	30	745	15:57:30	16:01:30	10	0	0.00265 ± 0.00001	0.0031 ± 0.0011	0.0060 ± 0.0021	0.0234 ± 0.0048	0.0021 ± 0.0007	0.0385 ± 0.0037	0.0057 ± 0.0028	0.0037 ± 0.0014	0.0065 ± 0.0017
739	7	746	16:02:30	16:06:00	10	0	0.00415 ± 0.00001	0.0062 ± 0.0013	0.0196 ± 0.0035	0.1443 ± 0.0170	0.0073 ± 0.0019	0.1180 ± 0.0139	0.0482 ± 0.0069	0.0302 ± 0.0045	0.0218 ± 0.0046

TABLE A-5.—PART B (Continued).

Test Point No.[1]	Power %	Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	Probe Rake Location[2]	Probe Tip No[3]	methyl naphthalene g/kg fuel	naphthalene g/kg fuel	phenol g/kg fuel	propene g/kg fuel	styrene g/kg fuel	sum m57[4] g/kg fuel	sum m59[4] g/kg fuel	sum m73[4] g/kg fuel	toluene g/kg fuel
740	4	747	16:06:30	16:08:30	10	0	0.00653 ± 0.00001	0.0118 ± 0.0031	0.0557 ± 0.0113	0.3939 ± 0.0732	0.0208 ± 0.0044	0.2609 ± 0.0474	0.1215 ± 0.0249	0.0670 ± 0.0133	0.0550 ± 0.0098
	4	748	16:10:30	16:13:30	1	P3	0.00750 ± 0.00002	0.0134 ± 0.0031	0.0516 ± 0.0053	0.3452 ± 0.0229	0.0161 ± 0.0024	0.2329 ± 0.0166	0.1180 ± 0.0106	0.0700 ± 0.0052	0.0370 ± 0.0051
741	100	749	16:15:00	16:16:00	1	P3	0.00385 ± 0.00001	0.0044 ± 0.0014	0.0093 ± 0.0023	0.0352 ± 0.0056	0.0023 ± 0.0006	0.0313 ± 0.0029	0.0070 ± 0.0054	0.0080 ± 0.0016	0.0002 ± 0.0023
742	85	750	16:16:30	16:20:00	1	P3	0.00325 ± 0.00001	0.0035 ± 0.0014	0.0042 ± 0.0016	0.0220 ± 0.0060	0.0016 ± 0.0006	0.0248 ± 0.0036	-0.0003 ± -0.0042	0.0040 ± 0.0021	-0.0006 ± -0.0016
743	70	751	16:21:30	16:24:00	1	P3	0.00211 ± 0.00001	0.0026 ± 0.0010	0.0012 ± 0.0011	0.0199 ± 0.0053	0.0012 ± 0.0005	0.0237 ± 0.0024	-0.0001 ± -0.0031	0.0033 ± 0.0017	-0.0015 ± -0.0012
744	65	752	16:25:00	16:28:00	1	P3	0.00172 ± 0.00000	0.0034 ± 0.0010	0.0011 ± 0.0019	0.0177 ± 0.0050	0.0011 ± 0.0005	0.0248 ± 0.0031	-0.0026 ± -0.0032	0.0030 ± 0.0010	-0.0022 ± -0.0017
745	60	753	16:29:30	16:31:30	1	P3	0.00149 ± 0.00000	0.0016 ± 0.0008	0.0000 ± 0.0011	0.0146 ± 0.0044	0.0008 ± 0.0004	0.0215 ± 0.0022	-0.0039 ± -0.0023	0.0025 ± 0.0011	-0.0021 ± -0.0010
746	40	754	16:33:00	16:35:30	1	P3	0.00216 ± 0.00001	0.0026 ± 0.0012	-0.0004 ± -0.0010	0.0206 ± 0.0051	0.0011 ± 0.0005	0.0289 ± 0.0031	-0.0062 ± -0.0031	0.0036 ± 0.0017	-0.0036 ± -0.0011
747	30	755	16:37:00	16:39:30	1	P3	0.00210 ± 0.00001	0.0031 ± 0.0013	-0.0018 ± -0.0019	0.0201 ± 0.0061	0.0014 ± 0.0007	0.0300 ± 0.0023	-0.0091 ± -0.0034	0.0039 ± 0.0018	-0.0047 ± -0.0011
748	15	756	16:41:00	16:43:30	1	P3	0.00181 ± 0.00000	0.0032 ± 0.0011	-0.0002 ± -0.0016	0.0364 ± 0.0057	0.0014 ± 0.0006	0.0369 ± 0.0031	-0.0002 ± -0.0033	0.0093 ± 0.0025	-0.0022 ± -0.0013
749	7	757	16:44:00	16:47:00	1	P3	0.00283 ± 0.00000	0.0050 ± 0.0011	0.0067 ± 0.0018	0.0924 ± 0.0113	0.0041 ± 0.0012	0.0662 ± 0.0078	0.0231 ± 0.0046	0.0240 ± 0.0034	0.0039 ± 0.0025
750	5.5	758	16:48:00	16:51:00	1	P3	0.00378 ± 0.00000	0.0064 ± 0.0011	0.0134 ± 0.0025	0.1551 ± 0.0130	0.0062 ± 0.0012	0.0998 ± 0.0060	0.0466 ± 0.0060	0.0380 ± 0.0029	0.0108 ± 0.0025
751	4	759	16:52:00	16:54:30	1	P3	0.00572 ± 0.00001	0.0103 ± 0.0023	0.0357 ± 0.0044	0.3054 ± 0.0301	0.0122 ± 0.0022	0.1895 ± 0.0151	0.0901 ± 0.0080	0.0606 ± 0.0061	0.0286 ± 0.0049
	4	801	8:02:31	8:05:01	1	P3	0.01479 ± 0.00003	0.0300 ± 0.0058	0.1169 ± 0.0177	1.1033 ± 0.1718	0.0424 ± 0.0072	0.5923 ± 0.0737	0.2826 ± 0.0319	0.1524 ± 0.0172	0.1166 ± 0.0144
802	100	802	8:06:31	8:08:31	1	P3	0.00586 ± 0.00001	0.0091 ± 0.0029	0.0264 ± 0.0049	0.0520 ± 0.0093	0.0048 ± 0.0014	0.0221 ± 0.0035	0.0179 ± 0.0032	0.0170 ± 0.0036	0.0050 ± 0.0022
803	85	803	8:09:01	8:11:31	1	P3	0.00363 ± 0.00001	0.0074 ± 0.0013	0.0128 ± 0.0038	0.0369 ± 0.0092	0.0028 ± 0.0022	0.0166 ± 0.0051	0.0147 ± 0.0032	0.0128 ± 0.0024	0.0029 ± 0.0013
804	65	804	8:12:32	8:16:01	1	P3	0.00332 ± 0.00001	0.0058 ± 0.0020	0.0113 ± 0.0032	0.0350 ± 0.0071	0.0018 ± 0.0011	0.0203 ± 0.0030	0.0132 ± 0.0025	0.0110 ± 0.0023	0.0024 ± 0.0016
805	40	805	8:17:01	8:22:02	1	P3	0.00137 ± 0.00000	0.0026 ± 0.0009	0.0052 ± 0.0012	0.0202 ± 0.0034	0.0008 ± 0.0005	0.0178 ± 0.0021	0.0112 ± 0.0014	0.0080 ± 0.0012	0.0009 ± 0.0007
	40	806	8:22:31	8:26:32	1	P3	0.00060 ± 0.00000	0.0012 ± 0.0004	0.0014 ± 0.0007	0.0146 ± 0.0019	0.0002 ± 0.0002	0.0108 ± 0.0018	0.0073 ± 0.0008	0.0061 ± 0.0008	0.0002 ± 0.0004
	40	807	8:28:31	8:32:31	1	P3	0.00334 ± 0.00002	0.0048 ± 0.0029	0.0053 ± 0.0046	0.0413 ± 0.0129	0.0012 ± 0.0016	0.0301 ± 0.0061	0.0165 ± 0.0049	0.0127 ± 0.0047	-0.0003 ± -0.0027
806	30	809	8:37:30	8:40:32	1	P3	0.00146 ± 0.00001	0.0027 ± 0.0013	0.0025 ± 0.0030	0.0141 ± 0.0066	0.0010 ± 0.0005	0.0226 ± 0.0032	0.0099 ± 0.0027	0.0076 ± 0.0021	-0.0021 ± -0.0009
807	7	810	8:42:01	8:45:01	1	P3	0.00228 ± 0.00001	0.0053 ± 0.0017	0.0104 ± 0.0035	0.1479 ± 0.0437	0.0048 ± 0.0014	0.0926 ± 0.0246	0.0746 ± 0.0208	0.0460 ± 0.0132	0.0138 ± 0.0051
808	4	811	8:46:01	8:48:32	1	P3	0.00669 ± 0.00001	0.0158 ± 0.0037	0.0386 ± 0.0065	0.4906 ± 0.0228	0.0149 ± 0.0026	0.2782 ± 0.0123	0.1849 ± 0.0116	0.1083 ± 0.0082	0.0454 ± 0.0040
	4	812	8:50:02	8:52:31	10	0	0.01101 ± 0.00003	0.0226 ± 0.0042	0.0694 ± 0.0084	0.8548 ± 0.0804	0.0294 ± 0.0043	0.4738 ± 0.0435	0.2452 ± 0.0229	0.1514 ± 0.0148	0.0782 ± 0.0120
809	100	813	8:54:32	8:55:32	10	0	0.00959 ± 0.00003	0.0167 ± 0.0052	0.0254 ± 0.0061	0.0942 ± 0.0087	0.0048 ± 0.0018	0.0571 ± 0.0069	0.0361 ± 0.0036	0.0367 ± 0.0060	0.0062 ± 0.0031
810	85	814	8:56:02	8:59:01	10	0	0.00898 ± 0.00002	0.0143 ± 0.0038	0.0190 ± 0.0054	0.0855 ± 0.0144	0.0046 ± 0.0020	0.0517 ± 0.0068	0.0299 ± 0.0044	0.0286 ± 0.0043	0.0043 ± 0.0019
811	65	815	8:59:31	9:02:32	10	0	0.00548 ± 0.00002	0.0075 ± 0.0036	0.0043 ± 0.0042	0.0619 ± 0.0126	0.0016 ± 0.0017	0.0363 ± 0.0071	0.0230 ± 0.0051	0.0210 ± 0.0050	0.0022 ± 0.0027
812	40	816	9:03:32	9:07:01	10	0	0.00421 ± 0.00002	0.0063 ± 0.0026	0.0024 ± 0.0035	0.0530 ± 0.0109	0.0011 ± 0.0010	0.0416 ± 0.0049	0.0352 ± 0.0052	0.0211 ± 0.0047	0.0019 ± 0.0025
	40	817	9:07:31	9:12:30	10	0	0.00149 ± 0.00000	0.0020 ± 0.0009	0.0009 ± 0.0009	0.0261 ± 0.0043	0.0007 ± 0.0003	0.0224 ± 0.0024	0.0210 ± 0.0026	0.0104 ± 0.0014	0.0020 ± 0.0010
	40	818	9:13:31	9:17:32	10	0	0.00798 ± 0.00003	0.0090 ± 0.0035	-0.0005 ± -0.0050	0.0862 ± 0.0212	0.0029 ± 0.0027	0.0697 ± 0.0104	0.1130 ± 0.0135	0.0428 ± 0.0101	0.0018 ± 0.0049
	40	819	9:19:01	9:23:01	10	0	0.00161 ± 0.00001	0.0026 ± 0.0013	-0.0002 ± -0.0013	0.0305 ± 0.0050	0.0006 ± 0.0006	0.0279 ± 0.0019	0.0408 ± 0.0041	0.0152 ± 0.0024	0.0018 ± 0.0020
813	30	820	9:24:01	9:27:31	10	0	-0.0001	0.0029	-0.0027	0.0575	0.0011	0.0491	0.0718	0.0266	0.0000
814	7	821	9:28:31	9:32:02	10	0	0.00381 ± 0.00001	0.0079 ± 0.0023	0.0124 ± 0.0053	0.2390 ± 0.0493	0.0069 ± 0.0022	0.1430 ± 0.0238	0.1129 ± 0.0125	0.0652 ± 0.0117	0.0254 ± 0.0070
815	4	822	9:32:31	9:36:01	10	0	0.00633 ± 0.00002	0.0129 ± 0.0036	0.0436 ± 0.0088	0.5728 ± 0.0861	0.0202 ± 0.0037	0.3260 ± 0.0484	0.1904 ± 0.0250	0.1086 ± 0.0138	0.0569 ± 0.0097
	4	823	9:36:31	9:40:02	30	0	0.01655 ± 0.00005	0.0269 ± 0.0069	0.0630 ± 0.0124	0.7092 ± 0.0982	0.0270 ± 0.0079	0.4077 ± 0.0474	0.2489 ± 0.0332	0.1340 ± 0.0190	0.0615 ± 0.0130
816	100	824	9:41:01	9:42:01	30	0	0.00219 ± 0.00001	0.0015 ± 0.0010	-0.0025 ± -0.0023	0.0427 ± 0.0075	0.0018 ± 0.0007	0.0187 ± 0.0025	0.0349 ± 0.0056	0.0172 ± 0.0023	-0.0023 ± -0.0015
817	85	825	9:42:31	9:45:31	30	0	0.00142 ± 0.00000	0.0023 ± 0.0017	-0.0054 ± -0.0022	0.0427 ± 0.0075	0.0006 ± 0.0008	0.0155 ± 0.0022	0.0355 ± 0.0046	0.0151 ± 0.0029	-0.0044 ± -0.0011
818	70	826	9:46:32	9:49:31	30	0	0.00086 ± 0.00000	0.0012 ± 0.0015	-0.0080 ± -0.0020	0.0378 ± 0.0102	0.0001 ± 0.0007	0.0158 ± 0.0027	0.0355 ± 0.0047	0.0119 ± 0.0031	-0.0062 ± -0.0017
819	65	827	9:50:00	9:53:01	30	0	0.00061 ± 0.00001	0.0008 ± 0.0013	-0.0098 ± -0.0022	0.0292 ± 0.0105	0.0005 ± 0.0006	0.0155 ± 0.0025	0.0325 ± 0.0062	0.0106 ± 0.0030	-0.0065 ± -0.0016
820	60	828	9:53:32	9:56:31	30	0	-0.0003 ± -0.0000	0.0006 ± 0.0012	-0.0087 ± -0.0031	0.0369 ± 0.0124	0.0001 ± 0.0008	0.0118 ± 0.0041	0.0259 ± 0.0077	0.0092 ± 0.0022	0.0011 ± 0.0058
821	40	829	9:57:30	10:00:31	30	0	0.00024 ± 0.00001	0.0012 ± 0.0012	-0.0132 ± -0.0023	0.0359 ± 0.0130	0.0000 ± 0.0009	0.0152 ± 0.0027	0.0266 ± 0.0060	0.0093 ± 0.0046	-0.0062 ± -0.0027
822	30	830	10:02:02	10:05:00	30	0	0.00049 ± 0.00001	0.0014 ± 0.0018	-0.0151 ± -0.0032	0.0325 ± 0.0123	-0.0001 ± -0.0010	0.0212 ± 0.0057	0.0194 ± 0.0045	0.0083 ± 0.0066	-0.0007 ± -0.0048
823	15	831	10:05:32	10:08:32	30	0	0.00048 ± 0.00001	0.0024 ± 0.0030	-0.0190 ± -0.0043	0.0737 ± 0.0256	0.0020 ± 0.0017	0.0724 ± 0.0082	0.0376 ± 0.0104	0.0204 ± 0.0076	-0.0052 ± -0.0052
824	7	832	10:09:30	10:12:31	30	0	0.00338 ± 0.00002	0.0084 ± 0.0049	-0.0049 ± -0.0063	0.2240 ± 0.0321	0.0094 ± 0.0050	0.1607 ± 0.0202	0.0897 ± 0.0165	0.0519 ± 0.0112	0.0074 ± 0.0093

TABLE A-5.—PART B (Continued).

Test Point No.[1]	Power %	Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	Probe Rake Location[2]	Probe Tip No[3]	methyl naphthalene g/kg fuel	naphthalene g/kg fuel	phenol g/kg fuel	propene g/kg fuel	styrene g/kg fuel	sum m57[4] g/kg fuel	sum m59[4] g/kg fuel	sum m73[4] g/kg fuel	toluene g/kg fuel
825	5.5	833	10:13:01	10:16:31	30	0	0.00683 ± 0.00003	0.0131 ± 0.0051	0.0102 ± 0.0071	0.3478 ± 0.0476	0.0153 ± 0.0042	0.2390 ± 0.0288	0.1236 ± 0.0214	0.0729 ± 0.0144	0.0196 ± 0.0107
826	4	834	10:17:01	10:21:31	30	0	0.01249 ± 0.00006	0.0240 ± 0.0057	0.0421 ± 0.0119	0.5710 ± 0.0953	0.0254 ± 0.0077	0.3759 ± 0.0554	0.1714 ± 0.0306	0.0995 ± 0.0173	0.0395 ± 0.0140
827	4	836	12:50:31	12:53:31	30	0	0.01782 ± 0.00006	0.0298 ± 0.0117	0.1017 ± 0.0340	0.7458 ± 0.2611	0.0383 ± 0.0139	0.4072 ± 0.1418	0.2087 ± 0.0654	0.1021 ± 0.0353	0.0867 ± 0.0328
828	100	837	12:54:32	12:55:32	30	0	0.00117 ± 0.00000	0.0008 ± 0.0019	0.0046 ± 0.0029	0.0247 ± 0.0083	0.0015 ± 0.0012	0.0035 ± 0.0020	0.0148 ± 0.0017	0.0058 ± 0.0012	0.0021 ± 0.0012
829	85	838	12:56:02	12:58:31	30	0	-0.00005 ± -0.00000	-0.0006 ± -0.0002	0.0018 ± 0.0017	0.0144 ± 0.0069	0.0000 ± 0.0006	-0.0006 ± -0.0032	0.0156 ± 0.0025	0.0052 ± 0.0040	0.0019 ± 0.0012
830	65	839	12:59:31	13:02:31	30	0	-0.00013 ± -0.00000	-0.0003 ± -0.0014	0.0000 ± 0.0018	0.0158 ± 0.0077	0.0001 ± 0.0006	0.0000 ± 0.0034	0.0158 ± 0.0039	0.0032 ± 0.0020	0.0008 ± 0.0014
831	40	840	13:03:31	13:06:31	30	0	-0.00034 ± -0.00001	-0.0016 ± -0.0015	-0.0001 ± -0.0021	0.0154 ± 0.0108	-0.0000 ± -0.0012	-0.0011 ± -0.0033	0.0170 ± 0.0050	0.0045 ± 0.0025	0.0005 ± 0.0022
832	30	841	13:07:31	13:10:31	30	0	-0.00040 ± -0.00001	-0.0029 ± -0.0019	-0.0016 ± -0.0028	0.0150 ± 0.0087	-0.0000 ± -0.0010	0.0004 ± 0.0038	0.0197 ± 0.0062	0.0041 ± 0.0033	0.0002 ± 0.0023
833	7	842	13:11:01	13:15:01	30	0	0.00175 ± 0.00002	0.0025 ± 0.0049	0.0133 ± 0.0072	0.2031 ± 0.0583	0.0083 ± 0.0040	0.1383 ± 0.0361	0.0916 ± 0.0220	0.0390 ± 0.0119	0.0194 ± 0.0080
834	4	843	13:15:32	13:18:31	30	0	0.00818 ± 0.00004	0.0134 ± 0.0073	0.0494 ± 0.0199	0.4677 ± 0.1995	0.0204 ± 0.0101	0.3077 ± 0.1209	0.1583 ± 0.0587	0.0731 ± 0.0294	0.0489 ± 0.0205
	4	844	13:19:32	13:24:32	10	0	0.00585 ± 0.00002	0.0102 ± 0.0037	0.0442 ± 0.0118	0.3902 ± 0.1146	0.0196 ± 0.0056	0.2535 ± 0.0694	0.1186 ± 0.0327	0.0639 ± 0.0178	0.0483 ± 0.0137
835	100	845	13:25:01	13:26:31	10	0	0.00545 ± 0.00002	0.0073 ± 0.0028	0.0223 ± 0.0056	0.0287 ± 0.0084	0.0040 ± 0.0012	0.0349 ± 0.0070	0.0177 ± 0.0055	0.0116 ± 0.0033	0.0126 ± 0.0029
836	85	846	13:27:02	13:30:01	10	0	0.00661 ± 0.00002	0.0057 ± 0.0025	0.0146 ± 0.0027	0.0333 ± 0.0078	0.0032 ± 0.0015	0.0269 ± 0.0045	0.0204 ± 0.0042	0.0081 ± 0.0019	0.0106 ± 0.0030
837	65	847	13:30:31	13:33:31	10	0	0.00419 ± 0.00001	0.0030 ± 0.0016	0.0087 ± 0.0019	0.0226 ± 0.0057	0.0026 ± 0.0008	0.0239 ± 0.0027	0.0228 ± 0.0047	0.0073 ± 0.0017	0.0092 ± 0.0020
838	40	848	13:35:02	13:38:31	10	0	0.00323 ± 0.00001	0.0028 ± 0.0016	0.0078 ± 0.0021	0.0249 ± 0.0065	0.0018 ± 0.0008	0.0306 ± 0.0034	0.0401 ± 0.0044	0.0102 ± 0.0027	0.0103 ± 0.0018
839	30	849	13:39:01	13:42:31	10	0	0.00271 ± 0.00001	0.0018 ± 0.0009	0.0070 ± 0.0017	0.0234 ± 0.0063	0.0017 ± 0.0008	0.0304 ± 0.0039	0.0486 ± 0.0062	0.0110 ± 0.0022	0.0101 ± 0.0027
840	7	850	13:43:01	13:47:01	10	0	0.00497 ± 0.00002	0.0068 ± 0.0030	0.0261 ± 0.0069	0.2165 ± 0.0605	0.0112 ± 0.0034	0.1402 ± 0.0375	0.1231 ± 0.0305	0.0525 ± 0.0142	0.0311 ± 0.0084
841	4	851	13:47:01	13:49:31	10	0	0.00882 ± 0.00002	0.0147 ± 0.0039	0.0585 ± 0.0137	0.5152 ± 0.1417	0.0244 ± 0.0050	0.3132 ± 0.0789	0.1812 ± 0.0419	0.0900 ± 0.0201	0.0681 ± 0.0139
	4	852	13:51:01	13:54:32	1	P3	0.00802 ± 0.00002	0.0142 ± 0.0021	0.0482 ± 0.0050	0.4343 ± 0.0319	0.0181 ± 0.0021	0.2598 ± 0.0182	0.1606 ± 0.0118	0.0840 ± 0.0070	0.0434 ± 0.0046
842	100	853	13:55:32	13:57:01	1	P3	0.00266 ± 0.00001	0.0033 ± 0.0016	0.0098 ± 0.0023	0.0298 ± 0.0069	0.0018 ± 0.0008	0.0138 ± 0.0021	0.0380 ± 0.0040	0.0113 ± 0.0023	0.0047 ± 0.0018
843	85	854	13:57:32	14:00:32	1	P3	0.00174 ± 0.00001	0.0020 ± 0.0011	0.0068 ± 0.0017	0.0222 ± 0.0054	0.0017 ± 0.0008	0.0120 ± 0.0023	0.0364 ± 0.0031	0.0092 ± 0.0017	0.0035 ± 0.0009
844	100	855	14:10:31	14:12:02	1	P3	0.00067 ± 0.00000	0.0001 ± 0.0008	0.0022 ± 0.0019	0.0065 ± 0.0028	0.0006 ± 0.0003	0.0064 ± 0.0016	0.0236 ± 0.0023	0.0043 ± 0.0011	0.0010 ± 0.0008
845	85	856	14:12:31	14:16:02	1	P3	0.00082 ± 0.00000	0.0002 ± 0.0009	0.0020 ± 0.0015	0.0083 ± 0.0064	0.0006 ± 0.0006	0.0069 ± 0.0015	0.0261 ± 0.0032	0.0050 ± 0.0013	0.0010 ± 0.0007
846	70	857	14:17:02	14:20:02	1	P3	0.00074 ± 0.00000	0.0004 ± 0.0009	0.0015 ± 0.0008	0.0064 ± 0.0037	0.0002 ± 0.0004	0.0064 ± 0.0022	0.0193 ± 0.0022	0.0034 ± 0.0010	0.0013 ± 0.0011
847	65	858	14:20:31	14:23:32	1	P3	0.00060 ± 0.00000	-0.0002 ± -0.0007	0.0011 ± 0.0016	0.0083 ± 0.0030	0.0001 ± 0.0004	0.0079 ± 0.0021	0.0191 ± 0.0019	0.0037 ± 0.0014	0.0009 ± 0.0010
848	60	859	14:24:02	14:27:32	1	P3	0.00035 ± 0.00000	-0.0002 ± -0.0011	0.0014 ± 0.0012	0.0063 ± 0.0038	0.0001 ± 0.0006	0.0102 ± 0.0018	0.0195 ± 0.0020	0.0037 ± 0.0014	0.0014 ± 0.0012
849	40	860	14:28:32	14:32:01	1	P3	0.00085 ± 0.00000	0.0000 ± 0.0009	0.0014 ± 0.0015	0.0103 ± 0.0046	0.0001 ± 0.0005	0.0130 ± 0.0017	0.0199 ± 0.0026	0.0053 ± 0.0012	0.0008 ± 0.0009
850	30	861	14:33:01	14:36:02	1	P3	0.00065 ± 0.00000	0.0001 ± 0.0008	0.0010 ± 0.0011	0.0103 ± 0.0035	0.0001 ± 0.0004	0.0144 ± 0.0020	0.0176 ± 0.0019	0.0053 ± 0.0015	0.0009 ± 0.0009
851	15	862	14:37:01	14:40:00	1	P3	0.00076 ± 0.00000	0.0006 ± 0.0010	0.0021 ± 0.0012	0.0310 ± 0.0052	0.0006 ± 0.0003	0.0256 ± 0.0025	0.0245 ± 0.0026	0.0112 ± 0.0013	0.0027 ± 0.0010
852	7	863	14:40:30	14:43:31	1	P3	0.00171 ± 0.00000	0.0026 ± 0.0009	0.0097 ± 0.0018	0.1175 ± 0.0109	0.0039 ± 0.0010	0.0725 ± 0.0068	0.0580 ± 0.0060	0.0313 ± 0.0040	0.0103 ± 0.0012
853	5.5	864	14:44:02	14:47:01	1	P3	0.00318 ± 0.00000	0.0053 ± 0.0013	0.0156 ± 0.0021	0.1738 ± 0.0145	0.0063 ± 0.0014	0.1001 ± 0.0068	0.0760 ± 0.0048	0.0419 ± 0.0031	0.0157 ± 0.0026
854	4	865	14:47:31	14:50:01	1	P3	0.00558 ± 0.00001	0.0114 ± 0.0017	0.0378 ± 0.0039	0.3830 ± 0.0223	0.0150 ± 0.0014	0.2198 ± 0.0127	0.1256 ± 0.0079	0.0718 ± 0.0050	0.0347 ± 0.0042
	4	866	14:52:31	14:56:02	1	G4	0.01590 ± 0.00003	0.0352 ± 0.0074	0.0576 ± 0.0130	0.6053 ± 0.1318	0.0217 ± 0.0054	0.3734 ± 0.0769	0.2119 ± 0.0407	0.1065 ± 0.0213	0.0472 ± 0.0125
855	100	867	14:57:31	14:58:32	1	G4	0.00402 ± 0.00000	0.0112 ± 0.0021	0.0084 ± 0.0025	0.1162 ± 0.0142	0.0028 ± 0.0007	0.0637 ± 0.0073	0.0509 ± 0.0042	0.0249 ± 0.0037	0.0029 ± 0.0011
856	85	868	14:59:02	15:01:32	1	G4	0.00488 ± 0.00001	0.0128 ± 0.0034	0.0065 ± 0.0023	0.1152 ± 0.0251	0.0027 ± 0.0017	0.0737 ± 0.0109	0.0576 ± 0.0117	0.0249 ± 0.0057	0.0042 ± 0.0019
857	65	869	15:02:31	15:05:31	1	G4	0.00339 ± 0.00001	0.0075 ± 0.0018	0.0042 ± 0.0022	0.0741 ± 0.0096	0.0016 ± 0.0007	0.0485 ± 0.0082	0.0418 ± 0.0044	0.0178 ± 0.0025	0.0023 ± 0.0010
858	40	870	15:06:31	15:09:31	1	G4	0.00330 ± 0.00001	0.0067 ± 0.0017	0.0040 ± 0.0014	0.0701 ± 0.0070	0.0017 ± 0.0008	0.0481 ± 0.0035	0.0434 ± 0.0030	0.0154 ± 0.0022	0.0023 ± 0.0010
859	30	871	15:10:01	15:13:31	1	G4	0.00228 ± 0.00001	0.0046 ± 0.0014	0.0028 ± 0.0013	0.0535 ± 0.0093	0.0015 ± 0.0006	0.0361 ± 0.0060	0.0347 ± 0.0052	0.0141 ± 0.0023	0.0020 ± 0.0005
860	7	872	15:15:01	15:18:01	1	G4	0.00370 ± 0.00001	0.0082 ± 0.0025	0.0116 ± 0.0027	0.1457 ± 0.0269	0.0052 ± 0.0015	0.0865 ± 0.0134	0.0728 ± 0.0097	0.0365 ± 0.0055	0.0104 ± 0.0025

TABLE A-5.—PART B (Continued).

Test Point No.[1]	Power %	Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	Probe Rake Location[2]	Probe Tip No[3]	methyl naphthalene g/kg fuel	naphthalene g/kg fuel	phenol g/kg fuel	propene g/kg fuel	styrene g/kg fuel	sum m57[4] g/kg fuel	sum m59[4] g/kg fuel	sum m73[4] g/kg fuel	toluene g/kg fuel
861	4	873	15:19:01	15:22:31	1	G4	0.01090 ± 0.00002	0.0213 ± 0.0038	0.0470 ± 0.0056	0.4569 ± 0.0445	0.0180 ± 0.0031	0.2618 ± 0.0226	0.1632 ± 0.0122	0.0872 ± 0.0085	0.0401 ± 0.0045
	4	901	8:51:42	8:54:28	1	P3	0.02531 ± 0.00002	0.0420 ± 0.0029	0.1325 ± 0.0085	1.3169 ± 0.0865	0.0557 ± 0.0058	0.6895 ± 0.0460	0.2830 ± 0.0162	0.1522 ± 0.0096	0.1214 ± 0.0107
902	100	902	8:58:02	8:59:00	1	P3	0.00427 ± 0.00001	0.0064 ± 0.0016	0.0186 ± 0.0055	0.0449 ± 0.0055	0.0045 ± 0.0016	0.0170 ± 0.0029	0.0127 ± 0.0014	0.0116 ± 0.0020	0.0042 ± 0.0010
903	85	903	9:00:03	9:03:06	1	P3	0.00302 ± 0.00001	0.0065 ± 0.0016	0.0114 ± 0.0023	0.0307 ± 0.0036	0.0031 ± 0.0006	0.0134 ± 0.0027	0.0106 ± 0.0019	0.0084 ± 0.0017	0.0040 ± 0.0013
904	65	904	9:04:00	9:07:05	1	P3	0.00270 ± 0.00000	0.0052 ± 0.0010	0.0092 ± 0.0021	0.0267 ± 0.0042	0.0023 ± 0.0007	0.0145 ± 0.0022	0.0084 ± 0.0016	0.0059 ± 0.0014	0.0024 ± 0.0011
905	40	905	9:08:00	9:11:01	1	P3	0.00285 ± 0.00001	0.0046 ± 0.0012	0.0072 ± 0.0016	0.0253 ± 0.0041	0.0017 ± 0.0007	0.0165 ± 0.0035	0.0083 ± 0.0023	0.0062 ± 0.0013	0.0023 ± 0.0012
906	30	906	9:11:43	9:15:00	1	P3	0.00169 ± 0.00000	0.0032 ± 0.0010	0.0048 ± 0.0013	0.0210 ± 0.0036	0.0013 ± 0.0005	0.0145 ± 0.0018	0.0087 ± 0.0009	0.0060 ± 0.0014	0.0018 ± 0.0008
907	7	907	9:16:40	9:19:01	1	P3	0.00316 ± 0.00000	0.0069 ± 0.0015	0.0142 ± 0.0021	0.1748 ± 0.0077	0.0062 ± 0.0010	0.0978 ± 0.0042	0.0630 ± 0.0045	0.0423 ± 0.0031	0.0142 ± 0.0020
908	4	908	9:19:54	9:22:01	1	P3	0.00833 ± 0.00001	0.0171 ± 0.0023	0.0492 ± 0.0040	0.6722 ± 0.0359	0.0224 ± 0.0016	0.3630 ± 0.0185	0.1818 ± 0.0095	0.1028 ± 0.0073	0.0560 ± 0.0041
	4	909	9:23:37	9:27:19	10	0	0.01135 ± 0.00002	0.0215 ± 0.0047	0.0770 ± 0.0093	0.9206 ± 0.0827	0.0354 ± 0.0049	0.5148 ± 0.0431	0.2078 ± 0.0174	0.1212 ± 0.0102	0.0857 ± 0.0083
909	100	910	9:29:34	9:30:30	10	0	0.00755 ± 0.00001	0.0131 ± 0.0035	0.0265 ± 0.0034	0.0718 ± 0.0132	0.0062 ± 0.0008	0.0471 ± 0.0039	0.0224 ± 0.0032	0.0203 ± 0.0037	0.0116 ± 0.0031
910	85	911	9:31:00	9:33:02	10	0	0.00650 ± 0.00001	0.0097 ± 0.0021	0.0165 ± 0.0033	0.0563 ± 0.0079	0.0046 ± 0.0013	0.0328 ± 0.0036	0.0187 ± 0.0027	0.0148 ± 0.0019	0.0088 ± 0.0022
911	65	912	9:34:30	9:37:27	10	0	0.00480 ± 0.00001	0.0072 ± 0.0014	0.0098 ± 0.0029	0.0445 ± 0.0057	0.0032 ± 0.0009	0.0277 ± 0.0025	0.0157 ± 0.0032	0.0133 ± 0.0030	0.0080 ± 0.0027
912	40	913	9:38:00	9:43:00	10	0	0.00249 ± 0.00000	0.0042 ± 0.0010	0.0060 ± 0.0013	0.0329 ± 0.0050	0.0013 ± 0.0006	0.0255 ± 0.0028	0.0153 ± 0.0020	0.0086 ± 0.0017	0.0060 ± 0.0013
913	30	914	9:43:56	9:47:38	10	0	0.00178 ± 0.00000	0.0028 ± 0.0006	0.0044 ± 0.0014	0.0314 ± 0.0041	0.0012 ± 0.0007	0.0238 ± 0.0040	0.0193 ± 0.0022	0.0082 ± 0.0017	0.0060 ± 0.0013
914	7	915	9:48:36	9:52:18	10	0	0.00429 ± 0.00001	0.0083 ± 0.0021	0.0209 ± 0.0045	0.2813 ± 0.0328	0.0114 ± 0.0023	0.1677 ± 0.0205	0.1012 ± 0.0084	0.0560 ± 0.0053	0.0333 ± 0.0028
915	4	916	9:53:00	9:56:01	10	0	0.01011 ± 0.00003	0.0202 ± 0.0040	0.0769 ± 0.0113	0.8589 ± 0.0736	0.0353 ± 0.0053	0.4844 ± 0.0325	0.2130 ± 0.0145	0.1176 ± 0.0127	0.0911 ± 0.0110
	4	917	9:56:41	10:00:55	30	0	0.02974 ± 0.00006	0.0505 ± 0.0095	0.1247 ± 0.0213	1.0861 ± 0.1709	0.0515 ± 0.0109	0.6046 ± 0.0936	0.2767 ± 0.0431	0.1581 ± 0.0218	0.1147 ± 0.0229
916	100	918	10:02:00	10:03:12	30	0	0.00463 ± 0.00002	0.0062 ± 0.0025	0.0115 ± 0.0042	0.0632 ± 0.0167	0.0033 ± 0.0015	0.0276 ± 0.0080	0.0343 ± 0.0054	0.0172 ± 0.0035	0.0066 ± 0.0029
917	85	919	10:03:56	10:07:15	30	0	0.00227 ± 0.00001	0.0043 ± 0.0019	0.0046 ± 0.0018	0.0501 ± 0.0081	0.0018 ± 0.0010	0.0175 ± 0.0045	0.0290 ± 0.0039	0.0146 ± 0.0022	0.0042 ± 0.0016
918	70	920	10:08:01	10:11:31	30	0	0.00178 ± 0.00001	0.0030 ± 0.0012	0.0028 ± 0.0021	0.0432 ± 0.0072	0.0008 ± 0.0008	0.0145 ± 0.0035	0.0269 ± 0.0045	0.0112 ± 0.0029	0.0028 ± 0.0018
919	65	921	10:12:02	10:15:02	30	0	0.00133 ± 0.00001	0.0027 ± 0.0017	0.0024 ± 0.0024	0.0379 ± 0.0104	0.0009 ± 0.0007	0.0142 ± 0.0032	0.0258 ± 0.0041	0.0093 ± 0.0029	0.0025 ± 0.0020
920	60	922	10:16:02	10:20:01	30	0	0.00169 ± 0.00001	0.0020 ± 0.0010	0.0008 ± 0.0015	0.0347 ± 0.0072	0.0007 ± 0.0009	0.0125 ± 0.0027	0.0250 ± 0.0034	0.0081 ± 0.0027	0.0012 ± 0.0016
921	40	923	10:21:32	10:24:32	30	0	0.00130 ± 0.00001	0.0023 ± 0.0019	0.0003 ± 0.0023	0.0348 ± 0.0094	0.0007 ± 0.0011	0.0123 ± 0.0051	0.0250 ± 0.0045	0.0088 ± 0.0028	0.0016 ± 0.0016
922	30	924	10:25:32	10:28:32	30	0	0.00154 ± 0.00001	0.0019 ± 0.0018	0.0010 ± 0.0020	0.0433 ± 0.0173	0.0003 ± 0.0010	0.0144 ± 0.0041	0.0298 ± 0.0061	0.0090 ± 0.0042	0.0022 ± 0.0024
923	15	925	10:29:32	10:32:32	30	0	0.00277 ± 0.00002	0.0067 ± 0.0044	0.0064 ± 0.0038	0.1369 ± 0.0352	0.0048 ± 0.0039	0.0636 ± 0.0142	0.0571 ± 0.0116	0.0266 ± 0.0100	0.0106 ± 0.0049
924	7	926	10:34:02	10:37:02	30	0	0.00749 ± 0.00003	0.0148 ± 0.0045	0.0272 ± 0.0047	0.3092 ± 0.0401	0.0128 ± 0.0041	0.1603 ± 0.0162	0.1063 ± 0.0118	0.0594 ± 0.0103	0.0277 ± 0.0064
925	5.5	927	10:38:02	10:41:02	30	0	0.01237 ± 0.00004	0.0209 ± 0.0049	0.0489 ± 0.0093	0.4587 ± 0.0625	0.0217 ± 0.0059	0.2548 ± 0.0319	0.1477 ± 0.0192	0.0861 ± 0.0131	0.0447 ± 0.0090
926	4	928	10:42:02	10:45:32	30	0	0.02401 ± 0.00005	0.0398 ± 0.0074	0.0978 ± 0.0152	0.8902 ± 0.1136	0.0448 ± 0.0079	0.4898 ± 0.0537	0.2238 ± 0.0286	0.1277 ± 0.0140	0.0886 ± 0.0132
		929	10:47:02	10:50:31	1	G1	0.02707 ± 0.00004	0.0449 ± 0.0069	0.0970 ± 0.0123	0.9644 ± 0.1190	0.0413 ± 0.0059	0.5716 ± 0.0714	0.2670 ± 0.0334	0.1448 ± 0.0175	0.0892 ± 0.0146
927	100	930	10:53:33	10:55:02	1	G1	0.00659 ± 0.00001	0.0160 ± 0.0035	0.0172 ± 0.0066	0.1289 ± 0.0446	0.0044 ± 0.0016	0.0631 ± 0.0133	0.0412 ± 0.0094	0.0315 ± 0.0175	0.0036 ± 0.0011
928	85	931	10:56:32	10:58:33	1	G1	0.00554 ± 0.00001	0.0126 ± 0.0023	0.0087 ± 0.0018	0.0795 ± 0.0098	0.0039 ± 0.0008	0.0457 ± 0.0042	0.0391 ± 0.0052	0.0130 ± 0.0025	0.0023 ± 0.0009
929	65	932	10:59:32	11:03:03	1	G1	0.00383 ± 0.00000	0.0088 ± 0.0017	0.0058 ± 0.0013	0.0570 ± 0.0060	0.0021 ± 0.0009	0.0326 ± 0.0025	0.0296 ± 0.0026	0.0094 ± 0.0016	0.0013 ± 0.0007
930	40	933	11:04:02	11:07:02	1	G1	0.00314 ± 0.00000	0.0069 ± 0.0014	0.0048 ± 0.0008	0.0473 ± 0.0059	0.0012 ± 0.0005	0.0274 ± 0.0019	0.0247 ± 0.0024	0.0073 ± 0.0015	0.0011 ± 0.0004
931	30	934	11:07:32	11:11:01	1	G1	0.00261 ± 0.00000	0.0058 ± 0.0016	0.0037 ± 0.0011	0.0400 ± 0.0085	0.0013 ± 0.0005	0.0233 ± 0.0046	0.0217 ± 0.0043	0.0064 ± 0.0017	0.0010 ± 0.0005
932	7	935	11:12:02	11:15:32	1	G1	0.00815 ± 0.00001	0.0170 ± 0.0022	0.0250 ± 0.0022	0.2636 ± 0.0148	0.0105 ± 0.0013	0.1490 ± 0.0112	0.1076 ± 0.0083	0.0624 ± 0.0047	0.0215 ± 0.0024
933	4	936	11:16:33	11:20:01	1	G1	0.02641 ± 0.00004	0.0455 ± 0.0048	0.1007 ± 0.0115	0.9782 ± 0.0841	0.0429 ± 0.0045	0.5247 ± 0.0420	0.2612 ± 0.0214	0.1433 ± 0.0116	0.0921 ± 0.0091
934	7	937	13:49:33	13:52:49	30	0	0.00697 ± 0.00005	0.0110 ± 0.0058	0.0187 ± 0.0139	0.1426 ± 0.1011	0.0071 ± 0.0060	0.1037 ± 0.0709	0.0569 ± 0.0394	0.0334 ± 0.0223	0.0178 ± 0.0129
937	75	941	14:11:02	14:14:32	30	0	0.00284 ± 0.00001	0.0067 ± 0.0030	0.0024 ± 0.0021	0.0292 ± 0.0118	0.0006 ± 0.0010	0.0153 ± 0.0064	0.0129 ± 0.0055	0.0044 ± 0.0027	0.0011 ± 0.0015
938	30	942	14:15:18	14:18:00	30	0	0.00414 ± 0.00003	0.0079 ± 0.0041	-0.0001 ± -0.0027	0.0214 ± 0.0195	0.0011 ± 0.0019	0.0251 ± 0.0076	0.0104 ± 0.0084	0.0036 ± 0.0047	0.0012 ± 0.0019
939	7	944	14:20:02	14:24:03	1	G1	0.00640 ± 0.00001	0.0123 ± 0.0018	0.0173 ± 0.0021	0.1798 ± 0.0114	0.0072 ± 0.0015	0.1137 ± 0.0048	0.0723 ± 0.0049	0.0505 ± 0.0041	0.0151 ± 0.0022
	7	945	14:26:14	14:28:56	1	P3	0.00318 ± 0.00000	0.0066 ± 0.0013	0.0123 ± 0.0022	0.1260 ± 0.0078	0.0041 ± 0.0011	0.0791 ± 0.0046	0.0478 ± 0.0036	0.0341 ± 0.0025	0.0135 ± 0.0021
	7	946	14:30:00	14:33:32	10	0	0.00601 ± 0.00001	0.0115 ± 0.0023	0.0215 ± 0.0048	0.1779 ± 0.0292	0.0072 ± 0.0021	0.1207 ± 0.0203	0.0572 ± 0.0101	0.0407 ± 0.0077	0.0234 ± 0.0047
	7	947	14:34:00	14:38:31	30	0	0.01160 ± 0.00007	0.0207 ± 0.0127	0.0280 ± 0.0188	0.2137 ± 0.1326	0.0086 ± 0.0072	0.1446 ± 0.0809	0.0640 ± 0.0394	0.0489 ± 0.0307	0.0332 ± 0.0215
	7	948	14:41:33	14:44:04	1	G1	0.00282 ± 0.00000	0.0069 ± 0.0008	0.0106 ± 0.0008	0.1106 ± 0.0083	0.0042 ± 0.0006	0.0585 ± 0.0029	0.0425 ± 0.0030	0.0343 ± 0.0020	0.0095 ± 0.0008

TABLE A-5.—PART B (Concluded).

Test Point No.[1]	Power %	Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	Probe Rake Location[2]	Probe Tip No[3]	methyl naphthalene g/kg fuel	naphthalene g/kg fuel	phenol g/kg fuel	propene g/kg fuel	styrene g/kg fuel	sum m57[4] g/kg fuel	sum m59[4] g/kg fuel	sum m73[4] g/kg fuel	toluene g/kg fuel
940	100	950	14:44:29	14:45:47	1	G1	0.00843 ± 0.00001	0.0206 ± 0.0035	0.0243 ± 0.0031	0.2117 ± 0.0157	0.0081 ± 0.0018	0.1117 ± 0.0068	0.0858 ± 0.0051	0.0609 ± 0.0058	0.0163 ± 0.0034
941	85	951	14:46:47	14:49:03	1	G1	0.00524 ± 0.00001	0.0114 ± 0.0026	0.0097 ± 0.0022	0.0629 ± 0.0135	0.0025 ± 0.0011	0.0301 ± 0.0054	0.0286 ± 0.0054	0.0127 ± 0.0032	0.0019 ± 0.0007
942	30	952	14:50:03	14:53:32	1	G1	0.00532 ± 0.00001	0.0114 ± 0.0017	0.0092 ± 0.0018	0.0664 ± 0.0065	0.0026 ± 0.0008	0.0323 ± 0.0029	0.0342 ± 0.0031	0.0147 ± 0.0014	0.0015 ± 0.0007
943	7	953	14:54:30	14:58:00	1	G1	0.00515 ± 0.00001	0.0131 ± 0.0019	0.0145 ± 0.0014	0.1325 ± 0.0103	0.0046 ± 0.0010	0.0694 ± 0.0051	0.0639 ± 0.0045	0.0375 ± 0.0023	0.0093 ± 0.0018
	7	954	14:59:00	15:02:30	1	P3	0.00301 ± 0.00001	0.0078 ± 0.0018	0.0097 ± 0.0015	0.0944 ± 0.0099	0.0030 ± 0.0009	0.0531 ± 0.0044	0.0388 ± 0.0034	0.0262 ± 0.0023	0.0079 ± 0.0018
	7	955	15:05:01	15:08:54	10	0	0.00649 ± 0.00002	0.0116 ± 0.0037	0.0181 ± 0.0051	0.1413 ± 0.0395	0.0060 ± 0.0025	0.0920 ± 0.0265	0.0434 ± 0.0134	0.0318 ± 0.0107	0.0165 ± 0.0053
	7	957	15:15:45	15:19:31	1	P3	0.00155 ± 0.00000	0.0036 ± 0.0012	0.0063 ± 0.0011	0.0699 ± 0.0086	0.0021 ± 0.0006	0.0422 ± 0.0027	0.0290 ± 0.0033	0.0216 ± 0.0021	0.0065 ± 0.0014
944	100	958	15:20:33	15:21:23	1	P3	0.00178 ± 0.00000	0.0035 ± 0.0007	0.0038 ± 0.0017	0.0237 ± 0.0060	0.0006 ± 0.0004	0.0067 ± 0.0017	0.0111 ± 0.0014	0.0090 ± 0.0011	0.0023 ± 0.0011
945	85	959	15:21:31	15:23:47	1	P3	0.00207 ± 0.00000	0.0039 ± 0.0016	0.0050 ± 0.0019	0.0232 ± 0.0072	0.0007 ± 0.0005	0.0054 ± 0.0015	0.0073 ± 0.0017	0.0063 ± 0.0025	0.0016 ± 0.0011
946	30	960	15:24:30	15:28:13	1	P3	0.00113 ± 0.00000	0.0025 ± 0.0007	0.0032 ± 0.0008	0.0207 ± 0.0043	0.0004 ± 0.0003	0.0135 ± 0.0018	0.0083 ± 0.0017	0.0066 ± 0.0011	0.0017 ± 0.0006
947	7	961	15:29:02	15:35:30	1	P3	0.00185 ± 0.00000	0.0040 ± 0.0010	0.0081 ± 0.0014	0.0956 ± 0.0070	0.0027 ± 0.0008	0.0511 ± 0.0037	0.0382 ± 0.0034	0.0273 ± 0.0029	0.0080 ± 0.0013
	7	962	15:37:00	15:44:31	10	0	0.00449 ± 0.00002	0.0094 ± 0.0031	0.0167 ± 0.0053	0.1435 ± 0.0408	0.0057 ± 0.0022	0.0893 ± 0.0255	0.0467 ± 0.0137	0.0332 ± 0.0103	0.0168 ± 0.0050
	7	963	15:45:02	15:54:28	30	0	0.00861 ± 0.00008	0.0190 ± 0.0133	0.0208 ± 0.0158	0.1691 ± 0.1006	0.0066 ± 0.0066	0.1076 ± 0.0628	0.0570 ± 0.0350	0.0353 ± 0.0251	0.0272 ± 0.0234
948	100	964	15:55:11	15:56:06	30	0	0.00095 ± 0.00000	0.0022 ± 0.0013	0.0003 ± 0.0010	0.0080 ± 0.0114	0.0000 ± 0.0009	-0.0015 ± -0.0019	0.0037 ± 0.0041	0.0026 ± 0.0054	-0.0005 ± -0.0008
949	85	965	15:56:15	15:58:30	30	0	0.00072 ± 0.00001	0.0021 ± 0.0010	0.0005 ± 0.0019	0.0072 ± 0.0099	0.0000 ± 0.0005	-0.0030 ± -0.0019	0.0040 ± 0.0032	0.0023 ± 0.0035	0.0006 ± 0.0013
950	30	966	15:59:02	16:02:30	30	0	0.00105 ± 0.00002	0.0041 ± 0.0036	-0.0002 ± -0.0038	-0.0059 ± -0.0154	0.0003 ± 0.0022	0.0061 ± 0.0085	0.0021 ± 0.0085	-0.0023 ± -0.0077	0.0004 ± 0.0024
951	7	967	16:03:38	16:11:55	30	0	0.00656 ± 0.00007	0.0129 ± 0.0111	0.0114 ± 0.0136	0.1456 ± 0.1137	0.0069 ± 0.0082	0.1232 ± 0.1624	0.0530 ± 0.0403	0.0294 ± 0.0264	0.0148 ± 0.0132
Additional ARI test points without full engine operational data record	4	311	9:52:59	10:02:01	1	P2	0.02295 ± 0.00005	0.0371 ± 0.0086	0.1914 ± 0.0306	1.3041 ± 0.1619	0.0574 ± 0.0098	0.7020 ± 0.0845	0.3432 ± 0.0383	0.1644 ± 0.0206	0.1700 ± 0.0259
	7	320	10:39:00	10:40:00	1	P1	0.00446 ± 0.00007	0.0101 ± 0.0184	0.0849 ± 0.1374	0.4128 ± 0.7601	0.0168 ± 0.0292	0.3371 ± 0.5483	0.1620 ± 0.2771	0.0772 ± 0.1287	0.0662 ± 0.1103
	4	338	14:43:36	14:44:21	1	P3	0.01684 ± 0.00014	0.0293 ± 0.0238	0.2455 ± 0.1874	2.2347 ± 2.6075	0.0807 ± 0.0664	1.0103 ± 1.0976	0.3444 ± 0.3470	0.1411 ± 0.1269	0.3530 ± 0.3444
	4	401	8:15:26	8:16:08	1	P3	0.03421 ± 0.00006	0.0705 ± 0.0466	0.5289 ± 0.4054	5.1104 ± 4.2548	0.1717 ± 0.1238	2.2589 ± 1.7440	0.6888 ± 0.4839	0.2901 ± 0.1965	0.7071 ± 0.6144
	4	401	8:16:29	8:18:31	1	P3	0.04020 ± 0.00029	0.0495 ± 0.0075	0.2517 ± 0.0277	2.0547 ± 0.1698	0.0774 ± 0.0077	1.0439 ± 0.0846	0.4774 ± 0.0304	0.2307 ± 0.0187	0.2453 ± 0.0215
	4	402	8:20:29	8:22:31	1	P3	0.00546 ± 0.00001	0.0075 ± 0.0021	0.0284 ± 0.0069	0.0465 ± 0.0086	0.0056 ± 0.0016	0.0252 ± 0.0054	0.0131 ± 0.0023	0.0112 ± 0.0029	0.0073 ± 0.0017
	4	403	8:23:35	8:24:45	1	P3	0.01694 ± 0.00016	0.0306 ± 0.0312	0.1631 ± 0.1731	1.3539 ± 1.7828	0.0475 ± 0.0555	0.7288 ± 0.9408	0.3816 ± 0.5109	0.1971 ± 0.2496	0.1626 ± 0.1992
	4	404	10:06:29	10:08:01	1	P1	0.02492 ± 0.00003	0.0449 ± 0.0061	0.2310 ± 0.0198	1.7065 ± 0.1274	0.0641 ± 0.0071	0.8935 ± 0.0839	0.4115 ± 0.0227	0.2075 ± 0.0152	0.2052 ± 0.0187
	85	405	10:09:59	10:11:31	1	P1	0.00284 ± 0.00001	0.0037 ± 0.0010	0.0137 ± 0.0025	0.0221 ± 0.0036	0.0033 ± 0.0009	0.0150 ± 0.0020	0.0073 ± 0.0015	0.0057 ± 0.0013	0.0038 ± 0.0009
	100	406	10:12:30	10:13:31	1	P1	0.00157 ± 0.00000	0.0026 ± 0.0009	0.0076 ± 0.0016	0.0166 ± 0.0029	0.0025 ± 0.0005	0.0106 ± 0.0015	0.0060 ± 0.0013	0.0036 ± 0.0009	0.0022 ± 0.0008
	4	407	10:14:26	10:15:07	1	P1	0.01272 ± 0.00012	0.0206 ± 0.0207	0.0737 ± 0.0811	0.5185 ± 0.7353	0.0146 ± 0.0172	0.3306 ± 0.4249	0.1886 ± 0.2702	0.1069 ± 0.1428	0.0543 ± 0.0797
	4	516	12:00:33	12:01:20	1	P3	0.00231 ± 0.00002	0.0064 ± 0.0045	0.0349 ± 0.0270	0.4194 ± 0.3270	0.0139 ± 0.0110	0.2807 ± 0.2050	0.1515 ± 0.1130	0.0658 ± 0.0494	0.0558 ± 0.0400
	4	516	12:01:29	12:05:01	1	P3	0.00678 ± 0.00002	0.0142 ± 0.0031	0.0695 ± 0.0067	0.5227 ± 0.0291	0.0218 ± 0.0031	0.3163 ± 0.0224	0.1719 ± 0.0080	0.0820 ± 0.0062	0.0670 ± 0.0070
	4	522	12:26:59	12:29:31	10	0	0.00696 ± 0.00001	0.0119 ± 0.0024	0.0670 ± 0.0107	0.4341 ± 0.0636	0.0213 ± 0.0033	0.3457 ± 0.0388	0.1315 ± 0.0200	0.0566 ± 0.0091	0.0615 ± 0.0085
	100	528	13:56:57	13:57:46	30	0	0.00132 ± 0.00002	0.0008 ± 0.0036	0.0135 ± 0.0104	0.1043 ± 0.1544	0.0042 ± 0.0055	0.0422 ± 0.0949	0.0379 ± 0.0377	0.0121 ± 0.0111	0.0112 ± 0.0198
	4	529	13:57:59	14:00:01	30	0	0.00769 ± 0.00003	0.0138 ± 0.0041	0.0589 ± 0.0113	0.3705 ± 0.0733	0.0173 ± 0.0064	0.1984 ± 0.0492	0.1323 ± 0.0248	0.0594 ± 0.0138	0.0495 ± 0.0135
	4	601	8:08:02	8:09:02	30	0	0.04347 ± 0.00009	0.0617 ± 0.0127	0.2712 ± 0.0301	2.3638 ± 0.4289	0.0927 ± 0.0179	1.1209 ± 0.1369	0.4071 ± 0.0544	0.1872 ± 0.0240	0.2369 ± 0.0314
	30	670	14:39:01	14:42:00	30	0	-0.00061 ± -0.00001	0.0010 ± 0.0034	-0.0136 ± -0.0049	-0.0001 ± -0.0160	0.0006 ± 0.0014	0.0165 ± 0.0067	-0.0599 ± -0.0103	-0.0040 ± -0.0040	-0.0137 ± -0.0038
	4	671	14:44:02	14:47:02	30	0	0.00936 ± 0.00005	0.0167 ± 0.0074	0.0498 ± 0.0206	0.4259 ± 0.1402	0.0247 ± 0.0082	0.2747 ± 0.0796	0.0573 ± 0.0332	0.0577 ± 0.0213	0.0454 ± 0.0213
	40	672	14:48:01	14:51:01	30	0	0.00260 ± 0.00001	0.0016 ± 0.0018	-0.0083 ± -0.0041	0.0080 ± 0.0154	0.0017 ± 0.0016	0.0116 ± 0.0048	-0.0341 ± -0.0074	-0.0031 ± -0.0034	-0.0049 ± -0.0026
	40	673	14:52:31	14:56:31	1	P3	0.00111 ± 0.00000	0.0015 ± 0.0009	-0.0001 ± -0.0014	0.0027 ± 0.0034	0.0007 ± 0.0006	0.0133 ± 0.0027	-0.0064 ± -0.0027	0.0009 ± 0.0012	0.0001 ± 0.0013
	40	674	14:58:02	15:02:02	10	0	0.00205 ± 0.00001	0.0026 ± 0.0014	0.0025 ± 0.0016	0.0218 ± 0.0089	0.0011 ± 0.0005	0.0234 ± 0.0044	-0.0023 ± -0.0030	0.0016 ± 0.0016	0.0044 ± 0.0020
	4	675	15:03:30	15:07:02	10	0	0.00646 ± 0.00002	0.0123 ± 0.0035	0.0634 ± 0.0080	0.3925 ± 0.0403	0.0212 ± 0.0036	0.2396 ± 0.0229	0.1109 ± 0.0118	0.0643 ± 0.0076	0.0594 ± 0.0081
	30	835	12:43:31	12:50:01	30	0	0.00752 ± 0.00007	0.0094 ± 0.0102	0.0392 ± 0.0333	0.2921 ± 0.2775	0.0161 ± 0.0161	0.1489 ± 0.1675	0.0952 ± 0.0728	0.0441 ± 0.0341	0.0351 ± 0.0346

Note:

1. The test point No. defines the sequential engine testing conditions while the aerosol point number defines each aerosol measurement condition. Both of them are combinations of the last digit in the date between April 20 and 29 and a sequence number of point for that day. If the test point number is 305, the test point was for the 5th test point on April 23.
2. Probe locations were 1, 10 and 30 m from the engine exhaust plain.
3. At 1 m and 10 m sampling locations, there were 6 particle probe tips (P1 to P6) and 6 gas probe tips (G1 to G6) held by a rake along the plume cross section. At 10 m location, particle samples were taken from two combined particle probes and at 30 m location, there was only one inlet tube used. At these two locations, the probe tip number is labeled "0".
4. Gas emission indexes in this table are reported as mean ± one standard deviation.

TABLE A-6.—PARTICLE MEASUREMENT ACCESSORY DATA RECORDED DURING APEX.

Test Point No.[1]	Fuel Type[2]	Power	Particle sampling accessory data[5]					Manifold pressure	CO_2 Conc.	CO_2 stdev[6]	Dilution gas flow rate
		%	Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	Probe Rake Location[3]	Probe Tip No[4]	Torr	ppm	ppm	LPM
301	base	7	301	9:16:54	9:26:06	1	P1	542	1757	273	34.1
	base	7	302	9:26:15	9:28:26	1	P2	536	2192	35	34.2
	base	7	303	9:28:35	9:31:00	1	P3	536	2236	49	34.1
	base	7	304	9:31:09	9:33:35	1	P4	535	2109	17	34.2
	base	7	305	9:33:44	9:36:21	1	P5	536	2090	27	34.4
	base	7	306	9:36:31	9:38:34	1	P6	538	2162	9	33.5
	base	7	307	9:38:43	9:42:12	10	0	513	1152	127	1.3
	base	7	308	9:42:59	9:45:01	30	0				
302	base	30	309	9:48:18	9:50:29	1	P1	545	2547	26	33.9
	base	30	310	9:50:38	9:52:22	1	P2	543	2988	33	34.5
	base	30	312	10:03:22	10:06:18	1	P1	568	2039	142	37.8
	base	30	313	10:06:27	10:08:53	1	P2	572	2407	26	37.8
	base	30	314	10:09:03	10:11:12	1	P3	572	2278	15	37.8
	base	30	315	10:11:23	10:13:22	1	P4	569	1820	18	37.7
	base	30	316	10:13:32	10:17:01	1	P5	570	1765	13	37.5
	base	30	317	10:17:10	10:19:17	1	P6	573	2003	15	38.0
	base	30	318	10:19:24	10:22:21	10	0	515	2022	115	1.2
	base	30	319	10:22:26	10:25:04	30	0	628	658	68	0.7
303	base	40	321	10:40:45	10:44:07	1	P1	579	2113	75	38.3
	base	40	322	10:44:17	10:46:21	1	P2	581	2444	26	38.0
	base	40	323	10:46:30	10:48:30	1	P3	581	2380	17	38.5
	base	40	324	10:48:39	10:50:47	1	P4	578	1827	44	38.7
	base	40	325	10:50:55	10:53:11	1	P5	578	1759	21	38.8
	base	40	326	10:53:22	10:55:35	1	P6	582	2012	68	37.9
	base	40	327	10:55:43	10:58:41	10	0	513	2204	92	0.8
	base	40	328	10:58:48	11:02:19	30	0	628	653	79	0.9
304	base	30	329	11:02:26	11:05:37	30	0	628	661	81	0.8
	base	30	330	11:05:41	11:09:04	10	0	515	2135	100	0.9
	base	30	331	11:09:14	11:12:59	1	P2	574	2243	312	39.2
305	base	7	332	11:13:31	11:18:59	1	P2	551	1687	220	35.7
	base	7	333	11:19:12	11:22:20	10	0	529	1191	400	1.0
	base	7	334	11:22:30	11:25:06	30	0	629	579	232	1.0
	base	7	335	11:27:59	11:31:27	1	P2	586	928	43	41.4
	base	7	336	11:32:15	11:36:20	1	P2	516	2410	63	31.8
	base	7	337	11:36:48	11:40:26	1	P2	462	3857	113	26.8
	base	7	338	14:43:36	14:44:21	1	P3				
306	base	7	339	14:44:08	14:53:18	1	P3	563	1905	114	36.2
	base	7	340	14:53:55	14:56:15	1	P1	558	1426	56	35.9
	base	7	341	14:56:26	14:58:49	1	P6	560	1818	31	35.8
	base	7	342	14:59:31	15:02:45	10	0	516	1703	71	1.0
307	base	30	343	15:03:04	15:07:01	1	P1	573	1515	170	37.9
	base	30	344	15:07:07	15:09:08	1	P2	581	1855	142	38.1
	base	30	345	15:09:18	15:11:16	1	P3	581	1804	14	38.7
	base	30	346	15:11:26	15:14:10	1	P4	579	1494	22	38.6
	base	30	347	15:14:19	15:16:31	1	P5	580	1503	14	38.9
	base	30	348	15:16:39	15:18:42	1	P6	586	1655	41	38.5
	base	30	349	15:18:52	15:21:04	10	0	518	2058	81	1.0
	base	30	350	15:21:09	15:25:46	30	0	628	726	48	0.8
308	base	40	351	15:25:50	15:28:46	30	0	628	818	58	1.1
	base	40	352	15:28:57	15:32:05	10	0	517	2359	150	0.8
	base	40	353	15:32:16	15:35:56	1	P1	588	1626	51	37.7
308b	base	40	354	15:36:05	15:38:23	1	P2	593	2286	32	38.9
	base	40	355	15:38:31	15:40:49	1	P3	593	2214	68	38.4
	base	40	356	15:40:58	15:42:56	1	P4	589	1759	37	38.3
	base	40	357	15:43:05	15:45:11	1	P5	588	1700	32	37.4
	base	40	358	15:45:21	15:47:18	1	P6	592	1943	30	39.1

TABLE A-6.—(Continued).

Test Point No.[1]	Fuel Type[2]	Power %	Particle sampling accessory data[5]: Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	Probe Rake Location[3]	Probe Tip No[4]	Manifold pressure Torr	CO_2 Conc. ppm	CO_2 stdev[6] ppm	Dilution gas flow rate LPM
309	base	30	359	15:47:48	15:50:23	1	P3	588	1662	40	38.4
	base	30	360	15:50:34	15:55:24	10	0	513	2042	72	1.0
	base	30	361	15:55:28	16:01:00	30	0	628	735	41	1.0
310	base	7	362	16:01:07	16:03:58	30	0	629	653	64	1.0
	base	7	363	16:04:09	16:06:13	10	0	517	1720	120	2.5
	base	7	364	16:06:19	16:11:48	1	P3	573	1314	60	38.6
	base	7	365	16:10:29	16:11:31	1	P3				
501	base	4	501	11:15:57	11:20:30	30	0	642	731	57	1.1
	base	4	501			30	0				
502	base	65	502	11:22:20	11:25:28	1	P1	617	2108	141	40.3
	base	65	503	11:25:41	11:27:43	1	P2	621	2816	39	41.5
	base	65	504	11:27:54	11:29:53	1	P3	620	2784	40	40.2
	base	65	505	11:30:04	11:31:56	1	P4	618	2467	56	41.6
	base	65	506	11:32:05	11:34:31	1	P5	616	2018	73	41.6
	base	65	507	11:34:40	11:36:37	1	P6	622	2220	57	40.8
	base	65	508	11:36:45	11:39:34	10	0	541	3159	117	0.9
	base	65	509	11:39:39	11:42:41	30	0	659	1041	60	0.9
	base	65	510	11:42:57	11:43:39	1	P3	656	1484	54	46.3
503	base	70	511	11:43:43	11:47:43	1	P3	659	1586	101	45.7
504	base	65	512	11:47:48	11:51:00	1	P3	660	1410	61	46.0
505	base	60	513	11:51:03	11:53:56	1	P3	658	1182	63	46.8
506	base	85	514	11:54:09	11:57:23	1	P3	670	2162	111	45.6
507	base	100	515	11:57:31	11:59:28	1	P3	673	2501	62	46.5
508	base	7	517	12:06:01	12:10:52	1	P3				
	base	7	518	12:16:06	12:18:40	1	P3	607	896	44	41.1
	base	7	519	12:18:53	12:23:07	10	0	534	1855	98	1.1
509	base	100	520	12:23:29	12:24:40	10	0	538	4148	345	0.9
510	base	85	521	12:24:48	12:26:29	10	0	535	4046	91	1.1
512	base	30	525	13:24:59	13:29:34	10	0	522	2147	72	1.1
513	base	7	526	13:29:46	13:35:00	10	0	519	1859	113	1.1
	base	7	527	13:35:07	13:56:53	30	0	638	707	145	1.0
514	base	100	531	14:01:00	14:01:53	30	0	637	1314	81	1.1
515	base	30	532	14:01:56	14:07:23	30	0	646	801	122	1.0
516	base	7	533	14:07:31	14:10:06	30	0	648	684	70	1.2
517	base	85	534	14:10:13	14:12:54	30	0	644	1349	95	1.2
518	base	7	535	14:12:59	14:18:19	30	0	648	665	84	1.2
	base	7	536	14:21:11	14:29:33	1	P3	575	1481	45	37.4
519	base	100	537	14:29:59	14:31:24	1	P3	688	2778	199	49.0
520	base	85	538	14:31:28	14:35:23	1	P3	703	2070	168	49.2
521	base	30	539	14:35:56	14:45:22	1	P3	570	2036	177	36.4
522	base	7	540	14:45:26	14:50:53	1	P3	565	1682	36	36.6
	base	7	541	14:51:17	14:57:50	1	P3	462	4293	421	25.3
	base	7	542	14:58:52	15:05:44	1	P3	545	2047	83	35.0
	base	7	543	15:06:13	15:12:01	1	P3	589	942	26	40.1
	base	7	544	15:14:51	15:19:05	1	P3	604	605	89	40.5
	base	7	545	15:20:06	15:24:22	1	P3	606	343	9	42.1
	base	7	546	15:25:29	15:29:01	1	P3				
	base	7	547	15:29:19	15:34:29	10	0	531	1898	86	1.2
	base	7	548	15:35:34	15:41:43	10	0	630	994	44	23.0
	base	7	549	15:46:19	15:47:12	10	0	672	498	31	35.9
	base	7	549	15:42:17	15:45:58	10	0	673	476	19	38.1
523	base	100	550	15:51:57	15:53:11	10	0	650	2103	96	23.9
524	base	85	551	15:53:19	15:55:30	10	0	648	1957	51	22.4
525	base	30	552	15:55:39	15:59:56	10	0	639	1042	32	23.0

TABLE A-6.—(Continued).

Test Point No.[1]	Fuel Type[2]	Power %	Particle sampling accessory data[5]								
			Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	Probe Rake Location[3]	Probe Tip No[4]	Manifold pressure Torr	CO_2 Conc. ppm	CO_2 stdev[6] ppm	Dilution gas flow rate LPM
526	base	7	553	15:59:58	16:02:09	10	0	636	897	94	21.8
	base	7	553	16:02:25	16:03:19	10	0	635	923	31	24.3
	base	7	554	16:05:00	16:08:53	10	0	682	279	17	43.7
	base	7	555	16:09:18	16:12:34	10	0	665	181	16	43.8
601	base	7	602	8:09:35	8:14:27	30	0	646	602	57	1.2
	base	7	603	8:14:37	8:19:13	10	0	578	1578	62	1.2
	base	7	604	8:19:56	8:23:12	10	0	642	822	26	24.1
	base	7	605	8:26:58	8:27:35	10	0	573	1539	50	1.4
602	base	100	606	8:27:37	8:28:59	10	0	564	3745	707	1.0
603	base	85	607	8:29:04	8:31:50	10	0	544	3950	202	1.4
604	base	30	608	8:32:02	8:36:35	10	0	532	1989	59	1.4
605	base	7	609	8:36:50	8:41:17	10	0	533	1604	73	1.7
	base	7	610	8:41:59	8:47:37	10	0	668	482	34	39.7
	base	7	611	8:48:33	8:52:02	10	0	684	275	23	48.2
	base	7	612	8:53:08	8:57:14	1	P3	573	1325	13	39.5
	base	7	613	8:57:31	9:00:39	1	P6	574	1401	8	40.1
	base	7	614	9:01:32	9:04:02	10	0	684	279	26	49.3
606	base	100	615	9:04:17	9:05:16	10	0	704	977	36	47.4
607	base	85	616	9:05:25	9:07:42	10	0	703	837	103	48.7
608	base	30	617	9:08:35	9:12:44	10	0	668	687	52	33.9
609	base	7	618	9:13:23	9:17:27	10	0	635	781	33	23.8
	base	7	619	9:17:32	9:30:14	30	0	653	486	47	1.5
610	base	100	620	9:39:25	9:40:28	1	P3	696	2454	447	56.0
611	base	85	621	9:40:45	9:43:01	1	P3	732	1457	59	56.0
612	base	30	622	9:44:03	9:47:51	1	P3	576	2000	78	38.6
613	base	7	623	9:48:32	9:52:25	1	P3	556	1704	40	38.7
	base	7	624	9:52:31	10:15:02	30	0	653	492	58	1.3
614	base	100	625	10:15:06	10:16:19	30	0	647	1360	83	1.5
615	base	85	626	10:16:26	10:18:44	30	0	647	1240	75	1.1
616	base	30	627	10:18:56	10:23:36	30	0	651	585	40	1.3
617	base	7	628	10:23:41	10:27:05	30	0	652	387	62	1.5
	base	7	629	10:27:43	10:31:38	1	P1	565	1306	81	36.8
	base	7	630	10:31:47	10:34:51	1	P3	559	1662	36	37.7
	base	7	631	10:35:05	10:38:36	1	P6	560	1721	86	37.1
618	base	4	632	11:52:29	11:59:54	30	0	654	685	145	0.8
619	base	100	633	12:00:09	12:02:18	30	0	648	1370	103	0.8
620	base	85	634	12:02:24	12:05:21	30	0	648	1240	72	0.9
621	base	65	635	12:05:26	12:09:14	30	0	647	1046	60	0.8
622	base	40	636	12:09:24	12:13:30	30	0	648	804	64	0.8
623	base	4	637	12:13:44	12:14:34	30	0	650	399	266	0.9
	base	4	638	12:17:10	12:19:33	10	0	680	353	28	42.0
	base	4	639	12:19:30	12:20:00	1	P3				
624	base	40	640	12:20:41	12:23:58	1	P3	684	1489	39	33.3
	base	40	641	12:24:21	12:28:40	1	P3	640	3365	699	18.2
	base	40	642	12:29:00	12:31:44	1	P3	706	328	18	49.3
	base	40	643	12:35:34	12:38:30	1	P3	641	706	21	44.7
	base	40	644	12:38:46	12:41:59	1	P3	523	3544	220	30.8
625	base	30	645	12:42:51	12:46:44	1	P3	579	1660	39	38.3
626	base	15	646	12:46:50	12:50:30	1	P3	576	1289	55	38.5
627	base	7	647	12:50:33	12:54:39	1	P3	576	1249	24	38.4
628	base	5.5	648	12:54:44	12:59:10	1	P3	574	1279	56	38.3
629	base	4	649	12:59:17	13:03:49	1	P3	573	1303	12	38.2
	base	4	650	13:06:03	13:07:05	1	P3	529	2183	201	33.7
	base	4	651	13:07:14	13:11:40	30	0	649	733	112	1.0
630	base	5.5	652	13:11:45	13:15:50	30	0	650	628	102	0.9
631	base	7	653	13:15:53	13:19:29	30	0	650	625	105	0.9

TABLE A-6.—(Continued).

Test Point No.[1]	Fuel Type[2]	Power %	Particle sampling accessory data[5] Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	Probe Rake Location[3]	Probe Tip No[4]	Manifold pressure Torr	CO_2 Conc. ppm	CO_2 stdev[6] ppm	Dilution gas flow rate LPM
632	base	15	654	13:19:36	13:23:03	30	0	650	619	83	0.8
633	base	30	655	13:23:08	13:26:53	30	0	649	780	92	0.4
634	base	4	656	13:26:56	13:38:10	30	0	656	702	100	0.9
635	base	40	657	13:38:12	13:42:16	30	0	648	885	78	0.9
	base	40	658	13:42:22	13:47:36	10	0	530	2594	84	1.0
	base	40	659	13:49:00	13:52:50	10	0	653	1063	33	26.3
	base	40	660	13:53:00	13:57:10	10	0	690	459	26	43.2
636	base	30	661	13:58:39	14:02:42	10	0	597	1442	62	13.1
637	base	15	662	14:02:50	14:06:49	10	0	593	1192	63	12.9
	base	15	662	14:07:09	14:07:49	10	0	571	1444	56	8.3
638	base	7	663	14:08:06	14:11:39	10	0	571	1413	64	8.6
639	base	5.5	664	14:11:47	14:17:10	10	0	571	1375	105	8.3
640	base	4	665	14:17:20	14:21:13	10	0	566	1349	132	8.3
	base	4	666	14:21:18	14:25:40	30	0	650	331	258	1.0
641	base	5.5	667	14:25:44	14:29:50	30	0	650	508	139	1.0
642	base	7	668	14:29:56	14:34:09	30	0	650	527	124	0.7
643	base	15	669	14:34:15	14:38:30	30	0	650	702	93	1.0
701	base	4	701	8:02:53	8:08:44	10	0	667	618	69	32.5
702	base	100	702	8:08:55	8:10:50	10	0	685	1861	106	32.1
703	base	85	703	8:10:56	8:13:49	10	0	681	1585	47	32.0
704	base	65	704	8:13:54	8:18:17	10	0	676	1242	53	32.6
705	base	4	705	8:18:43	8:23:51	10	0	538	1515	75	3.4
	base	4	706	8:24:33	8:27:17	1	P3	580	918	24	41.0
706	base	100	707	8:27:56	8:29:38	1	P3	676	2741	124	47.4
707	base	85	708	8:29:41	8:32:43	1	P3	680	2245	93	47.9
708	base	70	709	8:32:51	8:36:39	1	P3	675	1377	20	48.5
709	base	65	710	8:36:42	8:40:59	1	P3	675	1156	49	48.5
710	base	60	711	8:41:06	8:45:20	1	P3	672	888	45	49.3
711	base	4	712	8:45:51	8:52:18	1	P3	506	2125	101	32.4
	base	4	713	8:53:00	8:56:30	1	P3				
712	base	100	714	8:57:04	8:58:48	1	P3	690	2565	100	50.5
713	base	85	715	8:58:51	9:02:52	1	P3	693	2049	66	49.8
714	base	65	716	9:02:55	9:06:39	1	P3	662	1441	109	46.4
715	base	4	717	9:07:27	9:11:42	1	P3	523	1998	147	32.4
	base	4	718	9:11:59	9:15:47	10	0	587	1158	55	13.6
716	base	100	719	9:16:09	9:17:59	10	0	706	1149	71	45.0
717	base	85	720	9:18:05	9:21:12	10	0	706	1012	44	44.8
718	base	65	721	9:21:30	9:25:06	10	0	684	1043	42	37.5
719	base	4	722	9:25:18	9:28:44	10	0	608	1001	46	16.6
	base	4	723	9:29:03	9:32:54	30	0	647	542	61	1.0
720	base	100	724	9:33:05	9:34:06	30	0	643	1340	117	0.6
721	base	85	725	9:34:11	9:37:59	30	0	642	1285	71	0.9
722	base	70	726	9:38:05	9:41:59	30	0	643	1096	55	1.1
723	base	65	727	9:42:03	9:45:54	30	0	644	1040	48	0.9
724	base	60	728	9:45:59	9:50:07	30	0	644	979	49	1.0
725	base	4	729	9:50:13	9:56:48	30	0	647	577	58	1.0
726	sulfur	4	730	14:59:20	15:01:54	30	0	645	380	99	1.1
	sulfur	4	731	15:02:25	15:06:02	30	0	644	588	64	1.0
	sulfur	4	732	15:06:33	15:10:58	30	0	644	595	79	1.2
727	sulfur	100	733	15:11:00	15:13:10	30	0	640	1324	93	0.8
728	sulfur	85	734	15:13:12	15:16:10	30	0	640	1241	51	1.2
729	sulfur	65	735	15:16:18	15:20:33	30	0	641	1043	50	0.8
730	sulfur	40	736	15:20:42	15:25:09	30	0	642	791	46	1.4
731	sulfur	30	737	15:25:12	15:29:59	30	0	643	722	43	1.0
732	sulfur	7	738	15:30:06	15:33:59	30	0	644	582	52	1.3

TABLE A-6.—(Continued).

			Particle sampling accessory data[5]								
Test Point No.[1]	Fuel Type[2]	Power %	Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	Probe Rake Location[3]	Probe Tip No[4]	Manifold pressure Torr	CO_2 Conc. ppm	CO_2 stdev[6] ppm	Dilution gas flow rate LPM
733	sulfur	4	739	15:34:03	15:38:23	30	0	644	585	65	1.3
	sulfur	4	740	15:38:30	15:43:14	10	0	507	2046	127	0.9
734	sulfur	100	741	15:43:25	15:45:18	10	0	518	5187	396	1.5
735	sulfur	85	742	15:45:22	15:48:19	10	0	516	4889	93	0.4
736	sulfur	65	743	15:48:23	15:52:37	10	0	513	4035	115	1.2
737	sulfur	40	744	15:52:47	15:57:13	10	0	510	2759	104	1.4
738	sulfur	30	745	15:57:22	16:01:40	10	0	510	2279	78	1.3
739	sulfur	7	746	16:01:52	16:06:09	10	0	507	1768	121	1.5
740	sulfur	4	747	16:06:28	16:08:55	10	0	508	1927	242	1.8
	sulfur	4	748	16:10:07	16:13:34	1	P3	545	1430	43	36.8
741	sulfur	100	749	16:14:33	16:16:12	1	P3	704	1706	133	51.1
742	sulfur	85	750	16:16:37	16:20:49	1	P3	689	1622	77	46.7
743	sulfur	70	751	16:20:51	16:24:19	1	P3	622	2111	53	40.4
744	sulfur	65	752	16:24:24	16:28:09	1	P3	615	1922	45	40.1
745	sulfur	60	753	16:28:23	16:32:08	1	P3	576	2381	79	36.2
746	sulfur	40	754	16:32:15	16:36:09	1	P3	567	1736	43	36.9
747	sulfur	30	755	16:36:14	16:39:59	1	P3	562	1557	30	37.0
748	sulfur	15	756	16:40:06	16:43:44	1	P3	519	1952	53	32.7
749	sulfur	7	757	16:43:50	16:47:29	1	P3	513	2011	120	32.5
750	sulfur	5.5	758	16:47:31	16:51:28	1	P3	515	2012	47	31.7
751	sulfur	4	759	16:51:36	16:56:14	1	P3	513	2063	59	31.4
	sulfur	4	801	7:59:59	8:05:29	1	P3	554	1506	29	37.0
802	sulfur	100	802	8:06:25	8:08:21	1	P3	699	1717	147	52.4
803	sulfur	85	803	8:08:25	8:11:57	1	P3	691	1629	75	50.7
804	sulfur	65	804	8:12:23	8:16:27	1	P3	659	1140	22	47.6
805	sulfur	40	805	8:17:05	8:22:17	1	P3	530	2353	63	34.0
	sulfur	40	806	8:22:44	8:26:55	1	P3	451	4144	115	25.3
	sulfur	40	807	8:28:36	8:32:49	1	P3	626	648	48	45.6
	sulfur	40	808	8:36:26	8:37:57	1	P3	589	1196	69	41.3
806	sulfur	30	809	8:38:09	8:41:08	1	P3	592	1082	17	41.3
807	sulfur	7	810	8:41:31	8:45:32	1	P3	538	1603	59	35.0
808	sulfur	4	811	8:45:46	8:48:38	1	P3	532	1690	15	35.0
	sulfur	4	812	8:49:01	8:53:15	10	0	602	1186	97	18.0
809	sulfur	100	813	8:54:12	8:56:06	10	0	720	906	38	51.0
810	sulfur	85	814	8:56:11	8:59:12	10	0	711	968	34	47.8
811	sulfur	65	815	8:59:48	9:02:53	10	0	689	991	36	40.5
812	sulfur	40	816	9:03:17	9:07:00	10	0	654	1046	41	28.5
	sulfur	40	817	9:07:08	9:12:45	10	0	519	2876	87	1.3
	sulfur	40	818	9:13:27	9:17:35	10	0	688	576	36	44.9
	sulfur	40	819	9:19:04	9:23:13	10	0	592	1895	60	13.0
813	sulfur	30	820	9:23:21	9:28:01	10	0	643	1098	121	26.5
814	sulfur	7	821	9:28:39	9:32:30	10	0	623	992	59	23.0
815	sulfur	4	822	9:32:36	9:36:06	10	0	603	1195	79	18.3
	sulfur	4	823	9:36:14	9:40:23	30	0	641	520	47	1.0
816	sulfur	100	824	9:40:30	9:42:08	30	0	634	1347	63	0.9
817	sulfur	85	825	9:42:13	9:45:54	30	0	634	1251	60	0.8
818	sulfur	70	826	9:46:03	9:49:48	30	0	635	1096	42	0.7
819	sulfur	65	827	9:49:52	9:53:28	30	0	635	1051	53	0.8
820	sulfur	60	828	9:53:33	9:57:05	30	0	635	992	44	0.4
821	sulfur	40	829	9:57:10	10:01:02	30	0	637	818	40	0.7
822	sulfur	30	830	10:01:06	10:05:09	30	0	637	712	44	0.8
823	sulfur	15	831	10:05:17	10:08:58	30	0	640	540	44	0.5
824	sulfur	7	832	10:09:05	10:12:48	30	0	640	520	40	0.8
825	sulfur	5.5	833	10:12:53	10:16:38	30	0	641	507	41	0.9
826	sulfur	4	834	10:16:43	10:21:26	30	0	641	499	56	0.8
827	aromatic	4	836	12:50:24	12:54:06	30	0	632	475	112	0.4

TABLE A-6.—(Continued).

Test Point No.[1]	Fuel Type[2]	Power %	Particle sampling accessory data[5] Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	Probe Rake Location[3]	Probe Tip No[4]	Manifold pressure Torr	CO_2 Conc. ppm	CO_2 stdev[6] ppm	Dilution gas flow rate LPM
828	aromatic	100	837	12:54:10	12:55:52	30	0	628	1297	69	0.7
829	aromatic	85	838	12:55:56	12:58:58	30	0	629	1200	62	0.5
830	aromatic	65	839	12:59:04	13:02:48	30	0	630	1012	46	0.7
831	aromatic	40	840	13:02:52	13:06:37	30	0	631	769	56	0.6
832	aromatic	30	841	13:06:43	13:10:33	30	0	633	683	50	0.5
833	aromatic	7	842	13:10:37	13:13:17	30	0	635	449	71	0.7
834	aromatic	4	843	13:13:19	13:18:58	30	0	633	452	185	0.7
	aromatic	4	844	13:19:49	13:24:10	10	0	528	1511	366	4.8
835	aromatic	100	845	13:25:38	13:26:50	10	0	707	1044	55	45.6
836	aromatic	85	846	13:26:54	13:30:18	10	0	691	1195	83	40.2
837	aromatic	65	847	13:30:24	13:34:39	10	0	646	1592	119	25.3
838	aromatic	40	848	13:34:48	13:38:28	10	0	595	1645	79	14.5
839	aromatic	30	849	13:38:32	13:42:28	10	0	591	1548	70	14.7
840	aromatic	7	850	13:43:11	13:46:59	10	0	551	1321	289	8.7
841	aromatic	4	851	13:47:31	13:49:47	10	0	537	1571	280	5.2
	aromatic	4	852	13:50:24	13:54:45	1	P3	501	1912	108	32.7
842	aromatic	100	853	13:55:34	13:57:09	1	P3	672	1992	137	49.1
843	aromatic	85	854	13:57:17	14:01:01	1	P3	664	1806	179	46.9
844	aromatic	100	855	14:10:17	14:12:04	1	P3	671	2134	132	48.3
845	aromatic	85	856	14:12:12	14:16:17	1	P3	672	1737	25	47.9
846	aromatic	70	857	14:16:42	14:20:05	1	P3	612	2042	77	41.2
847	aromatic	65	858	14:20:10	14:23:37	1	P3	608	1831	23	41.1
848	aromatic	60	859	14:23:43	14:27:42	1	P3	605	1684	26	40.9
849	aromatic	40	860	14:27:52	14:31:48	1	P3	558	1769	72	36.4
850	aromatic	30	861	14:32:17	14:35:58	1	P3	496	2355	100	31.1
851	aromatic	15	862	14:36:02	14:40:05	1	P3	477	2307	59	29.6
852	aromatic	7	863	14:40:11	14:43:59	1	P3	474	2296	61	29.5
853	aromatic	5.5	864	14:44:07	14:47:57	1	P3	474	2334	100	29.3
854	aromatic	4	865	14:48:03	14:50:30	1	P3	470	2375	38	29.2
	aromatic	4	866	14:52:03	14:56:04	1	G4	550	1476	231	38.1
855	aromatic	100	867	14:57:18	14:58:39	1	G4	644	2630	82	45.5
856	aromatic	85	868	14:58:50	15:02:26	1	G4	634	1993	871	43.9
857	aromatic	65	869	15:02:33	15:05:57	1	G4	603	2502	95	39.9
858	aromatic	40	870	15:06:03	15:09:08	1	G4	570	2384	81	36.7
859	aromatic	30	871	15:09:13	15:13:34	1	G4	557	2576	112	35.1
860	aromatic	7	872	15:13:41	15:18:19	1	G4	543	2397	175	34.5
861	aromatic	4	873	15:18:36	15:22:36	1	G4	541	2516	66	34.6
	aromatic	4	901	8:54:21	8:54:47	1	P3	552	1751	11	33.4
902	aromatic	100	902	8:58:06	8:59:39	1	P3	709	2025	69	50.1
903	aromatic	85	903	8:59:53	9:03:17	1	P3	709	1785	57	49.1
904	aromatic	65	904	9:03:33	9:07:11	1	P3	628	1985	135	39.6
905	aromatic	40	905	9:07:24	9:11:07	1	P3	565	1921	80	34.0
906	aromatic	30	906	9:11:32	9:15:23	1	P3	512	2392	28	28.5
907	aromatic	7	907	9:16:02	9:19:30	1	P3	475	2627	50	24.7
908	aromatic	4	908	9:19:35	9:22:52	1	P3	465	2608	100	24.6
	aromatic	4	909	9:24:25	9:27:23	10	0	521	1680	108	0.5
909	aromatic	100	910	9:29:16	9:30:29	10	0	681	1416	42	32.3
910	aromatic	85	911	9:30:32	9:33:59	10	0	670	1492	73	29.7
911	aromatic	65	912	9:34:10	9:37:40	10	0	641	1519	49	22.6
912	aromatic	40	913	9:38:14	9:42:56	10	0	554	2031	73	4.8
913	aromatic	30	914	9:43:16	9:47:28	10	0	525	2144	72	0.7
914	aromatic	7	915	9:47:35	9:52:08	10	0	522	1688	141	0.8
915	aromatic	4	916	9:52:12	9:56:21	10	0	517	1752	122	0.7
	aromatic	4	917	9:56:37	10:01:04	30	0	639	659	65	0.8
916	aromatic	100	918	10:01:19	10:03:03	30	0	635	1369	83	0.8
917	aromatic	85	919	10:03:08	10:07:28	30	0	636	1258	79	0.6

TABLE A-6.—(Continued).

Test Point No.[1]	Fuel Type[2]	Power	Particle sampling accessory data[5]								
		%	Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	Probe Rake Location[3]	Probe Tip No[4]	Manifold pressure (Torr)	CO_2 Conc. (ppm)	CO_2 stdev[6] (ppm)	Dilution gas flow rate (LPM)
918	aromatic	70	920	10:07:34	10:11:39	30	0	636	1109	55	0.7
919	aromatic	65	921	10:11:49	10:15:28	30	0	636	1056	59	0.7
920	aromatic	60	922	10:15:32	10:20:27	30	0	636	991	55	0.7
921	aromatic	40	923	10:20:38	10:24:58	30	0	637	801	55	0.6
922	aromatic	30	924	10:25:03	10:28:40	30	0	638	674	64	0.7
923	aromatic	15	925	10:28:47	10:32:59	30	0	639	534	69	0.5
924	aromatic	7	926	10:33:10	10:36:58	30	0	638	616	67	1.0
925	aromatic	5.5	927	10:37:04	10:40:58	30	0	638	618	53	0.8
926	aromatic	4	928	10:41:01	10:45:31	30	0	639	612	58	0.7
	aromatic	4	929	10:46:18	10:50:49	1	G1	575	2053	161	34.1
927	aromatic	100	930	10:53:55	10:54:57	1	G1	736	2119	221	50.5
928	aromatic	85	931	10:56:05	10:58:38	1	G1	724	1962	159	47.7
929	aromatic	65	932	10:58:56	11:03:26	1	G1	676	2524	249	41.6
930	aromatic	40	933	11:03:42	11:07:06	1	G1	634	2810	97	37.7
931	aromatic	30	934	11:07:29	11:10:49	1	G1	603	3269	546	33.4
932	aromatic	7	935	11:11:14	11:15:58	1	G1	568	2783	192	31.2
933	aromatic	4	936	11:16:03	11:20:17	1	G1	566	2767	179	31.4
934	sulfur	7	937	13:46:02	13:52:50	30	0	641	232	118	0.9
	sulfur	7	938	13:54:08	13:57:53	1	P3	640	2216	58	1.8
	sulfur	7	939	13:59:53	14:04:40	1	P3	565	2322	1	15.0
	sulfur	7	940	14:04:51	14:05:27	1	P3	564	3347	22	15.8
937	sulfur	75	941	14:10:32	14:12:19	30	0	637	1044	80	0.3
938	sulfur	30	942	14:12:23	14:15:59	30	0	639	833	252	0.7
939	sulfur	7	943	14:16:02	14:17:58	30	0	640	560	62	1.0
	sulfur	7	944	14:19:23	14:24:07	1	G1	567	2272	114	19.0
	sulfur	7	945	14:25:10	14:29:06	1	P3	491	2509	101	29.1
	sulfur	7	946	14:29:39	14:33:36	10	0	493	1489	195	0.7
	sulfur	7	947	14:33:45	14:38:39	30	0	641	310	124	0.5
	sulfur	7	948	14:39:06	14:44:01	1	G1	560	8045	705	26.9
	sulfur	7	949	14:44:19	14:45:30	1	G1	567	2380	74	36.8
940	sulfur	100	950	14:45:47	14:46:59	1	G1	538	5714	3436	31.5
941	sulfur	85	951	14:47:27	14:48:59	1	G1	543	2926	156	35.8
942	sulfur	30	952	14:49:33	14:53:29	1	G1	564	2535	44	37.2
943	sulfur	7	953	14:53:34	14:57:57	1	G1	565	2645	113	36.1
	sulfur	7	954	14:59:33	15:04:10	1	P3	501	2362	107	31.2
	sulfur	7	955	15:06:07	15:08:49	10	0	490	1427	168	37.3
	sulfur	7	956	15:08:59	15:09:39	10	0	633	581	93	67.8
	sulfur	7	957	15:15:17	15:19:38	1	P3	486	2733	95	28.3
944	sulfur	100	958	15:20:30	15:21:20	1	P3	654	2261	107	48.1
945	sulfur	85	959	15:21:29	15:23:55	1	P3	665	1777	114	47.1
946	sulfur	30	960	15:24:04	15:28:24	1	P3	481	2750	84	27.6
947	sulfur	7	961	15:28:42	15:35:59	1	P3	463	2781	56	27.6
	sulfur	7	962	15:39:19	15:44:30	10	0	489	1064	136	0.5
	sulfur	7	962	15:37:02	15:38:31	10	0	489	1319	286	0.7
	sulfur	7	963	15:44:33	15:54:56	30	0	641	247	82	0.9
948	sulfur	100	964	15:55:02	15:56:12	30	0	637	1169	183	0.7
949	sulfur	85	965	15:56:17	15:58:28	30	0	637	1129	75	0.8
950	sulfur	30	966	15:58:35	16:02:54	30	0	640	517	80	0.7
951	sulfur	7	967	16:02:58	16:13:16	30	0	636	270	113	0.6

TABLE A-6.—(Concluded).

Test Point No.[1]	Fuel Type[2]	Power	Particle sampling accessory data[5]								
		Power	Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	Probe Rake Location[3]	Probe Tip No[4]	Manifold pressure	CO_2 Conc.	CO_2 stdev[6]	Dilution gas flow rate
		%						Torr	ppm	ppm	LPM
Additional aerosol test points without full engine operational data record	base	7	001	14:14:22	14:19:51	30	0	630	168	100	1.4
	base	7	002	14:21:08	14:24:43	1	P3	551	2424	137	35.0
	base	7	003	14:27:34	14:29:14	1	P4	585	800	23	42.5
	base	30	004	14:33:23	14:36:15	1	P4	570	1291	36	41.0
	base	45	005	14:36:59	14:39:38	1	P4	588	965	88	42.7
	base	65	006	14:39:48	14:40:06	1	P4	593	1394	74	44.3
	base	7	007	14:40:28	14:47:38	1	P4	579	974	69	41.8
	base	4	311	9:52:32	10:02:36	1	P2				
	base	7	320	10:39:33	10:40:21	1	P1				
	base	4	401	8:16:08	8:18:50	1	P3				
	base	4	401			1	P3				
	base	4	402	8:20:15	8:22:48	1	P3				
	base	4	403	8:23:35	8:24:45	1	P3				
	base	4	404	10:06:38	10:08:17	1	P1				
	base	85	405	10:09:46	10:12:09	1	P1				
	base	100	406	10:12:12	10:13:54	1	P1				
	base	4	516	12:01:09	12:10:53	1	P3				
	base	4	522	12:26:50	12:29:42	10	0				
	base	7	523	13:14:39	13:21:51	10	0				
	base	85	524	13:22:05	13:24:52	10	0				
	base	100	528	13:56:55	13:57:21	30	0				
	base	4	529	13:57:28	14:00:13	30	0				
	base	30	530	14:00:15	14:00:56	30	0				
	base	4	601	8:07:18	8:09:29	30	0				
	base	30	670	14:39:01	14:42:00	30	0				
	base	4	671	14:44:02	14:47:02	30	0				
	base	40	672	14:48:01	14:51:01	30	0				
	base	40	673	14:52:31	14:56:31	1	P3				
	base	40	674	14:57:08	15:02:00	10	0				
	base	4	675	15:02:08	15:08:52	10	0				
	aromatic	30	835	12:41:52	12:50:19	30	0				

Note:

1. The test point No. defines the sequential engine testing conditions while the aerosol point number defines each aerosol measurement condition. Both of them are combinations of the last digit in the date between April 20 and 29 and a sequence number of point for that day. If the test point number is 305, the test point was for the 5th test point on April 23.
2. Three types of fuel were used: base for base JP-8 fuel, aromatic for high aromatic fuel, and sulfur for base fuel with sulfur additive.
3. Probe locations were 1, 10 and 30 m from the engine exhaust plain.
4. At 1 m and 10 m sampling locations, there were 6 particle probe tips (P1 to P6) and 6 gas probe tips (G1 to G6) held by a rake along the plume cross section. At 10 m location, particle samples were taken from two combined particle probes and at 30 m location, there was only one inlet tube used. At these two locations, the probe tip number is labeled "0".
5. During APEX, instruments of NASA, UMR and ARI were pulling sample from a central sample distribution manifold. The accessory data in this table are for data measured by those three institutions (see Table 9 – 12).
6. Stdev stands for one standard deviation

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TABLE A-7.—AIRCRAFT CFM56-2-C1 ENGINE PARTICLE EMISSION PROPERTIES MEASURED BY NASA DURING THE AIRCRAFT PARTICLE EMISSIONS EXPERIMENT (APEX).

Test Point No.[2]	Aerosol Point No.[2]	Fuel Type[3]	Power	NASA unheated[1] particle properties: Number EI[4] by CPC 3022[5]	Number EI by CPC 7610[5]	Unheated Mass EI	Unheated mode	Unheated GMD[6]	Unheated VMD[7]	Unheated Sigma	Black Carbon EI by PSAP[5]	NASA heated[1] particle properties: Heated Number EI	Heated Mass EI	Heated Mode	Heated GMD[6]	Heated VMD[7]	Heated Sigma	Particle number ratio
			%	#/kg fuel	#/kg fuel	mg/kg fuel	nm	nm	nm		mg/kg fuel	#/kg fuel	mg/kg fuel	nm	nm	nm		Heated / unheated
301	301	base	7	1.34E+15	1.05E+15	97.8	20.6	22.4	50.3	1.61	67.39	9.48E+14	89.3	19.1	23.2	52.8	1.64	0.90
	302	base	7	5.58E+14	4.08E+14	25.8	11.3	18.6	46.1	1.62	22.65	3.62E+14	20.6	11.3	21.8	47.2	1.62	0.89
	303	base	7	5.85E+14	4.38E+14	23.2	16.0	20.6	44.4	1.53	17.02	3.13E+14	10.8	16.5	18.4	41.7	1.64	0.72
	304	base	7	8.44E+14	5.91E+14	16.6	10.6	16.1	38.1	1.55	12.55	3.16E+14	12.5	11.5	17.2	41.5	1.61	0.53
	305	base	7	2.25E+15	2.13E+15	40.8	14.2	16.9	37.5	1.49	12.55	3.49E+14	13.5	9.2	17.0	41.6	1.66	0.16
	306	base	7	3.44E+15	3.17E+15	45.4	12.1	14.4	38.7	1.47	14.71	5.16E+14	16.4	12.0	19.3	44.8	1.55	0.16
	307	base	7	2.86E+15	2.30E+15	22.6	13.8	15.4	33.8	1.44	17.73	5.80E+14	22.1	9.9	14.3	56.8	1.61	0.25
302	309	base	30	4.14E+14	3.10E+14	45.3	27.7	24.5	54.7	1.65	27.16	2.80E+14	36.1	27.5	26.5	56.6	1.63	0.90
	310	base	30	7.71E+14	6.34E+14	53.1	20.5	24.1	50.5	1.66	28.13	3.36E+14	29.8	24.0	27.1	53.4	1.59	0.53
	312	base	30	6.94E+14	5.48E+14	56.8	15.1	22.0	51.8	1.72	31.75	4.19E+14	33.5	13.8	24.3	55.1	1.71	0.76
	313	base	30	5.10E+14	3.98E+14	49.0	16.8	23.8	53.0	1.67	29.19	3.13E+14	36.0	16.6	23.0	55.0	1.76	0.79
	314	base	30	6.23E+14	5.07E+14	39.7	15.1	22.2	43.7	1.57	17.99	2.73E+14	19.8	9.2	15.2	45.5	1.71	0.54
	315	base	30	5.40E+14	3.81E+14	24.1	12.7	19.7	45.4	1.63	16.08	2.48E+14	21.0	10.1	20.3	49.6	1.74	0.65
	316	base	30	2.70E+15	2.59E+15	43.7	15.4	17.3	36.4	1.47	14.67	2.69E+14	18.2	11.7	20.0	49.2	1.67	0.10
	317	base	30	2.21E+15	1.91E+15						14.88	2.88E+14	22.4	9.2	13.3	49.0	1.62	0.15
	318	base	30	6.52E+14	4.35E+14	13.7	14.0	19.8	44.4	1.62	13.90	2.22E+14	13.2	12.1	21.0	48.9	1.66	0.51
	319	base	30	8.32E+15	7.99E+15	59.0	11.5	16.2	37.4	1.56	27.85	7.53E+14	18.0	10.6	17.0	47.8	1.61	0.09
303	321	base	40	4.83E+14	3.43E+14	61.0	13.6	24.2	59.0	1.70	30.04	3.08E+14	42.9	25.0	28.8	58.7	1.68	0.90
	322	base	40	4.16E+14	3.19E+14	52.8	24.3	26.7	55.1	1.63	31.29	2.89E+14	42.7	24.3	27.3	53.3	1.58	0.91
	323	base	40	4.24E+14	3.26E+14	28.9	19.7	22.3	46.0	1.53	21.51	2.48E+14	20.3	9.2	16.1	50.9	1.77	0.76
	324	base	40	1.31E+15	1.15E+15	44.0	11.4	17.7	43.9	1.65	18.80	3.15E+14	25.7	18.3	24.1	50.1	1.62	0.27
	325	base	40	1.95E+15	1.81E+15	31.8	18.0	18.8	40.4	1.50	15.64	2.53E+14	21.7	9.2	17.3	57.1	1.87	0.14
	326	base	40	2.20E+15	1.90E+15	106.7	16.8	19.5	43.5	1.66	16.89	3.10E+14	29.6	9.2	16.2	50.4	1.74	0.16
	327	base	40	4.41E+14	3.01E+14	18.0	14.3	20.9	50.0	1.63	15.15	2.08E+14	17.5	14.5	22.9	56.2	1.67	0.69
	328	base	40	9.64E+15	9.31E+15	59.6	18.5	17.7	30.9	1.37	26.04	6.23E+14	15.8	10.7	17.1	48.9	1.67	0.07
304	329	base	30	1.21E+16	1.19E+16	58.2	15.5	15.2	24.2	1.33	14.03	5.77E+14	13.4	11.4	17.5	47.4	1.58	0.05
	330	base	30	6.36E+14	4.61E+14	16.0	17.1	22.2	49.2	1.61	12.24	2.05E+14	12.4	17.3	25.6	51.9	1.59	0.45
	331	base	30	4.05E+14	3.07E+14	31.8	17.4	22.8	51.4	1.63	17.20	2.41E+14	31.1	14.3	25.0	57.3	1.70	0.78
305	332	base	7	2.02E+14	1.38E+14	4.4	17.2	18.8	35.9	1.44	6.87	1.20E+14	6.1	9.9	14.1	42.4	1.52	0.88
	333	base	7	1.44E+15	1.36E+15	21.2	14.1	16.8	33.9	1.45	10.13	4.32E+14	13.2	10.0	14.9	49.7	1.74	0.32
	334	base	7	1.64E+16	1.68E+16	186.9	17.2	19.9	27.7	1.40	15.23	6.63E+15	26.6	12.4	13.4	23.9	1.35	0.39
	335	base	7	2.42E+14	1.62E+14	6.7	11.0	16.4	34.1	1.51	5.25	1.42E+14	15.0	12.3	16.2	63.6	1.63	0.87
	336	base	7	1.77E+14	1.28E+14	5.7	17.1	19.5	40.6	1.53	3.52	1.11E+14	6.4	10.6	17.4	55.2	1.58	0.87
	337	base	7	1.67E+14	1.23E+14	3.1	13.7	17.7	39.5	1.52	3.82	1.07E+14	0.0	17.9	20.1	40.5	1.60	0.87
306	339	base	7	1.72E+15	1.52E+15	43.5	13.6	18.0	37.6	1.52	26.20	4.95E+14	39.3	9.5	15.6	56.8	1.71	0.32
	340	base	7	6.94E+14	5.09E+14	23.8	11.9	17.2	38.8	1.58	16.84	4.27E+14	27.5	9.3	14.9	49.9	1.70	0.84
	341	base	7	1.29E+15	8.81E+14	18.5	10.6	16.0	38.3	1.51	12.20	3.01E+14	18.5	10.7	17.7	50.9	1.72	0.34
	342	base	7	6.31E+14	4.07E+14	16.1	10.3	15.7	36.4	1.56	10.38	2.64E+14	23.9	10.7	17.4	70.9	1.66	0.65

TABLE A-7.—(Continued).

Test Point No.[2]	Aerosol Point No.[2]	Fuel Type[3]	Power	NASA unheated[1] particle properties: Number EI[4] by CPC 3022[5]	Number EI by CPC 7610[5]	Unheated Mass EI	Unheated mode	Unheated GMD[6]	Unheated VMD[7]	Unheated Sigma	Black Carbon EI by PSAP[5]	NASA heated[1] particle properties: Heated Number EI	Heated Mass EI	Heated Mode	Heated GMD[6]	Heated VMD[7]	Heated Sigma	Particle number ratio
			%	#/kg fuel	#/kg fuel	mg/kg fuel	nm	nm	nm		mg/kg fuel	#/kg fuel	mg/kg fuel	nm	nm	nm		Heated / unheated
307	343	base	30	5.70E+14	4.16E+14	64.5	20.1	23.5	54.6	1.66	31.04	3.54E+14	52.7	9.8	19.9	62.2	1.91	0.85
	344	base	30	4.02E+14	2.93E+14	38.0	15.3	22.2	51.8	1.66	24.83	2.67E+14	33.3	9.8	19.2	58.1	1.80	0.91
	345	base	30	3.63E+14	2.54E+14	29.6	20.0	23.4	51.3	1.61	18.42	2.19E+14	0.0	10.2	19.5	59.9	1.77	0.86
	346	base	30	5.32E+14	3.58E+14	19.5	12.6	18.6	46.1	1.61	11.94	1.97E+14	22.3	10.7	18.7	61.1	1.68	0.55
	347	base	30	2.06E+15	1.59E+15	23.7	11.6	13.7	34.2	1.42	11.06	2.13E+14	15.2	12.4	20.9	50.3	1.64	0.13
	348	base	30	1.56E+15	9.98E+14	19.3	9.7	13.2	37.7	1.51	10.57	2.00E+14	19.0	13.7	20.9	58.8	1.72	0.20
	349	base	30	6.45E+14	4.39E+14	14.7	15.8	19.8	46.2	1.55	11.30	1.95E+14	16.4	14.2	20.0	62.1	1.70	0.44
	350	base	30	1.19E+16	1.14E+16	93.4	17.9	16.8	25.5	1.36	16.91	1.00E+15	22.5	10.0	12.5	56.3	1.49	0.09
308	351	base	40	1.14E+16	1.10E+16	102.5	17.1	17.5	28.3	1.38	20.41	1.16E+15	29.4	9.3	12.7	64.0	1.60	0.11
	352	base	40	7.86E+14	5.66E+14	16.5	12.0	18.6	47.0	1.60	16.51	1.88E+14	19.0	9.3	14.8	55.6	1.77	0.33
	353	base	40	7.21E+14	5.52E+14	53.5	22.9	24.4	53.1	1.65	27.98	2.89E+14	40.7	13.5	19.7	57.9	1.79	0.52
308b	354	base	40	3.60E+14	2.64E+14	40.3	18.0	24.0	54.3	1.67	29.37	2.40E+14	39.9	9.3	19.0	59.0	1.87	0.91
	355	base	40	4.08E+14	2.97E+14	47.8	17.2	23.7	53.9	1.66	28.07	2.65E+14	35.0	15.9	22.2	55.5	1.81	0.89
	356	base	40	5.80E+14	4.07E+14	34.3	25.8	23.2	49.6	1.61	20.24	2.28E+14	22.0	10.8	19.1	62.3	1.69	0.56
	357	base	40	3.84E+15	3.55E+15	122.3	18.4	21.2	36.2	1.52	17.65	2.63E+14	19.0	9.3	14.0	41.7	1.66	0.07
	358	base	40	1.58E+15	1.13E+15	28.2	11.3	16.2	40.8	1.57	15.60	2.05E+14	20.9	9.3	15.6	54.8	1.79	0.18
309	359	base	30	3.20E+14	2.06E+14	12.5	15.5	21.2	45.4	1.55	9.72	1.41E+14	15.1	14.2	19.7	57.5	1.67	0.69
	360	base	30	3.05E+14	2.16E+14	12.6	15.4	20.7	47.6	1.60	9.57	1.68E+14	13.9	12.8	19.5	59.3	1.71	0.78
	361	base	30	1.24E+16	1.18E+16	70.5	16.2	16.2	23.8	1.34	14.67	8.32E+14	21.2	9.4	12.6	56.9	1.57	0.07
310	362	base	7	1.74E+16	1.70E+16	165.1	22.2	19.8	28.3	1.37	21.27	5.00E+15	45.1	10.8	13.3	30.2	1.36	0.29
	363	base	7	3.05E+15	2.53E+15	38.3	17.3	18.1	27.9	1.40	6.64	1.07E+15	14.3	12.1	14.0	39.0	1.41	0.42
	364	base	7	3.77E+14	2.42E+14	8.6	11.5	17.0	36.5	1.51	7.04	1.97E+14	23.6	9.9	14.8	69.6	1.67	0.81
501	501	base	4	4.07E+16	3.30E+16	339.4	15.1	16.9	32.6	1.43	83.60	9.48E+15	109.8	9.5	12.4	37.2	1.44	0.29
502	502	base	65	4.57E+14	3.22E+14	107.9	17.4	25.7	66.0	1.82	65.63	2.96E+14	83.7	20.0	24.4	67.6	1.79	0.92
	503	base	65	3.27E+14	2.29E+14	56.8	17.2	25.5	61.0	1.72	35.17	2.08E+14	45.8	16.6	24.4	63.8	1.84	0.91
	504	base	65	3.88E+14	2.81E+14	60.3	22.4	25.6	60.9	1.68	37.37	2.45E+14	46.5	24.0	25.5	64.1	1.77	0.87
	505	base	65	5.16E+14	3.91E+14	84.2	21.1	26.4	60.1	1.66	47.00	3.03E+14	62.6	17.3	25.6	64.5	1.76	0.78
	506	base	65	3.13E+15	2.12E+15	69.2	9.1	16.1	58.8	1.82	36.90	2.69E+14	42.5	9.1	18.2	62.7	1.93	0.13
	507	base	65	2.57E+15	1.58E+15						37.38	2.86E+14	40.6	13.7	20.7	58.0	1.79	0.18
	508	base	65	3.49E+14	2.45E+14	34.2	19.6	25.9	62.5	1.71	34.68	2.13E+14	31.2	22.8	24.8	65.7	1.84	0.87
	509	base	65	1.08E+16	8.22E+15	63.8	9.8	11.6	38.2	1.31	39.82	3.80E+14	37.8	14.8	22.7	60.3	1.90	0.05
	510	base	65	1.64E+15	5.74E+14						44.98	2.99E+14						0.52
503	511	base	70	6.44E+14	4.39E+14	91.5	18.5	24.5	62.3	1.75	53.04	3.18E+14	69.8	14.1	24.8	63.9	1.82	0.73
504	512	base	65	5.67E+14	3.86E+14	57.0	10.9	21.7	59.0	1.73	35.90	2.51E+14	42.9	19.5	23.7	61.0	1.73	0.65
505	513	base	60	4.82E+14	3.34E+14	29.4	12.7	19.7	52.2	1.66	16.07	1.54E+14	23.2	14.8	23.7	56.9	1.71	0.46
506	514	base	85	5.92E+14	4.24E+14	154.5	22.5	27.2	71.3	1.84	95.97	3.58E+14	108.5	19.5	30.3	74.6	1.87	0.84
507	515	base	100	5.97E+14	4.46E+14	233.8	27.4	34.1	74.3	1.76	130.19	3.87E+14	155.0	31.9	34.5	75.3	1.78	0.87
	518	base	7	3.78E+14	2.00E+14	8.2	14.0	18.2	35.5	1.45	6.45	1.65E+14	18.7	14.4	18.6	58.3	1.75	0.82
	519	base	7	1.17E+15	7.46E+14	11.5	10.2	14.9	33.9	1.49	8.19	3.35E+14	20.3	9.9	12.9	58.9	1.59	0.45
509	520	base	100	6.02E+14	4.48E+14	168.5	31.8	32.2	77.9	1.86	124.95	4.07E+14	121.5	36.7	33.2	78.7	1.93	0.91
510	521	base	85	5.43E+14	3.96E+14	132.2	16.6	30.0	74.8	1.89	109.24	3.62E+14	98.4	16.7	29.8	77.1	2.01	0.91

TABLE A-7.—(Continued).

Test Point No.[2]	Aerosol Point No.[2]	Fuel Type[3]	Power	NASA unheated[1] particle properties: Number EI[4] by CPC 3022[5]	Number EI by CPC 7610[5]	Unheated Mass EI	Unheated mode	Unheated GMD[6]	Unheated VMD[7]	Unheated Sigma	Black Carbon EI by PSAP[5]	NASA heated[1] particle properties: Heated Number EI	Heated Mass EI	Heated Mode	Heated GMD[6]	Heated VMD[7]	Heated Sigma	Particle number ratio
			%	#/kg fuel	#/kg fuel	mg/kg fuel	nm	nm	nm		mg/kg fuel	#/kg fuel	mg/kg fuel	nm	nm	nm		Heated / unheated
512	525	base	30	3.00E+14	1.80E+14	8.6	13.7	19.4	52.6	1.57	8.10	1.25E+14	8.9	11.1	18.9	54.8	1.73	0.69
513	526	base	7	1.06E+15	6.73E+14	11.4	13.7	16.3	35.7	1.47	7.90	3.17E+14	15.7	10.5	15.2	52.4	1.63	0.47
	527	base	7	2.34E+16	1.89E+16	91.4	13.9	15.2	24.3	1.36	17.09	4.17E+15	40.2	9.8	11.9	42.6	1.36	0.22
514	531	base	100	4.36E+15	2.35E+15	198.4	10.6	19.1	75.4	2.07	143.86	6.34E+14	155.7	9.4	18.8	81.5	2.02	0.27
515	532	base	30	1.55E+16	1.13E+16	32.9	10.3	12.2	23.2	1.30	22.01	1.06E+15	19.1	9.4	13.4	56.8	1.70	0.09
516	533	base	7	2.68E+16	2.03E+16	68.0	11.5	13.2	22.2	1.32	15.73	3.30E+15	21.5	10.1	11.5	30.3	1.34	0.16
517	534	base	85	2.69E+15	1.59E+15	239.3	14.3	21.9	69.9	1.97	163.65	7.17E+14	152.2	16.3	28.5	76.8	1.97	0.45
518	535	base	7	2.44E+16	1.75E+16	64.1	11.0	13.4	23.4	1.33	21.98	2.67E+15	26.7	9.7	11.4	36.6	1.37	0.15
	536	base	7	3.89E+14	2.26E+14	12.4	14.1	18.9	38.4	1.50	7.23	1.95E+14	16.9	10.4	15.8	52.1	1.66	0.86
519	537	base	100	9.88E+14	6.17E+14	320.5	28.0	33.8	72.4	1.83	250.52	5.75E+14	229.1	34.6	36.9	79.2	1.81	0.93
520	538	base	85	1.86E+15	1.15E+15	277.5	28.6	32.9	72.5	1.84	384.49	1.06E+15	184.8	17.9	31.2	77.5	1.94	0.92
521	539	base	30	1.91E+14	1.15E+14	11.6	14.2	21.0	45.2	1.58	6.10	9.19E+13	9.6	11.4	17.8	51.2	1.67	0.80
522	540	base	7	4.34E+14	2.14E+14	13.2	12.4	17.1	39.4	1.54	7.61	1.86E+14	13.6	15.4	19.7	50.6	1.57	0.87
	541	base	7	3.13E+14	1.49E+14	34.5	13.3	17.9	39.8	1.56	5.20	1.22E+14	55.7	10.8	15.1	56.1	1.68	0.82
	542	base	7	5.50E+14	2.41E+14	21.2	10.4	16.4	39.5	1.57	8.52	2.06E+14	13.5	11.2	17.6	47.8	1.65	0.86
	543	base	7	4.13E+14	2.35E+14	15.3	13.0	18.0	40.7	1.54	9.14	2.03E+14	16.8	10.7	16.9	47.1	1.72	0.86
	544	base	7	3.96E+14	2.11E+14	15.6	11.5	17.8	39.0	1.53	9.02	1.86E+14	0.0	11.2	15.8	57.9	1.71	0.88
	545	base	7	3.65E+14	1.90E+14						11.07	1.63E+14						0.86
	547	base	7	1.15E+15	4.49E+14	20.7	12.3	18.4	45.1	1.60	13.98	3.30E+14	21.5	11.1	17.9	52.4	1.67	0.74
	548	base	7	1.78E+15	7.29E+14	29.7	12.1	18.0	41.7	1.55	17.39	4.37E+14	31.1	12.1	17.6	50.5	1.65	0.60
	549	base	7	1.90E+15	7.25E+14						17.97	4.28E+14						0.59
	549	base	7	8.51E+14	4.97E+14	29.9	15.0	19.1	39.6	1.51	16.35	3.45E+14	60.7	10.9	15.3	64.4	1.65	0.69
523	550	base	100	1.27E+15	6.27E+14	313.4	24.0	29.1	72.1	1.92	189.99	5.29E+14	236.9	22.3	30.1	84.9	2.03	0.84
524	551	base	85	1.18E+15	5.71E+14	247.6	28.5	32.1	71.7	1.87	161.10	4.81E+14	204.9	21.8	31.8	84.6	1.96	0.84
525	552	base	30	2.47E+14	1.54E+14	13.1	14.8	22.2	50.0	1.56	9.45	1.10E+14						0.71
526	553	base	7	1.29E+15	5.06E+14						14.72	2.98E+14						0.59
	553	base	7	1.37E+15	5.11E+14	15.1	10.7	16.7	46.3	1.52	11.63	2.60E+14	27.9	9.7	15.5	67.3	1.76	0.51
	554	base	7	6.68E+14	3.88E+14						16.80	2.00E+14						0.51
	555	base	7	8.49E+14	4.27E+14						23.94	1.91E+14						0.45
601	602	base	7	5.16E+16	4.61E+16	173.1	16.0	15.5	22.4	1.33	35.08	8.14E+15	31.1	9.6	10.8	25.9	1.32	0.18
	603	base	7	3.38E+15	2.98E+15	26.4	9.9	14.3	31.3	1.47	11.26	7.21E+14	13.5	9.5	13.5	39.2	1.51	0.24
	604	base	7	3.38E+15	2.81E+15	17.4	10.4	13.8	32.0	1.41	10.24	6.11E+14	19.3	9.7	13.8	48.9	1.58	0.22
	605	base	7	3.26E+15	2.86E+15						9.70	6.08E+14						0.21
602	606	base	100	8.17E+14	7.27E+14						149.74	5.90E+14						0.81
603	607	base	85	6.21E+14	5.66E+14	122.8	26.9	31.5	73.0	1.86	158.71	5.12E+14	91.0	27.3	29.7	75.4	1.96	0.90
604	608	base	30	3.47E+14	2.77E+14	10.7	13.8	19.4	46.5	1.62	9.55	1.83E+14	10.8	11.0	17.7	57.3	1.77	0.66

TABLE A-7.—(Continued).

Test Point No.[2]	Aerosol Point No.[2]	Fuel Type[3]	Power	NASA unheated[1] particle properties: Number EI[4] by CPC 3022[5]	Number EI by CPC 7610[5]	Unheated Mass EI	Unheated mode	Unheated GMD[6]	Unheated VMD[7]	Unheated Sigma	Black Carbon EI by PSAP[5]	NASA heated[1] particle properties: Heated Number EI	Heated Mass EI	Heated Mode	Heated GMD[6]	Heated VMD[7]	Heated Sigma	Particle number ratio
			%	#/kg fuel	#/kg fuel	mg/kg fuel	nm	nm	nm		mg/kg fuel	#/kg fuel	mg/kg fuel	nm	nm	nm		Heated / unheated
605	609	base	7	2.55E+15	2.12E+15	11.3	9.3	12.0	33.4	1.41	8.16	4.00E+14	11.3	9.4	13.7	52.4	1.55	0.19
	610	base	7	2.34E+15	1.98E+15	13.2	9.4	12.2	28.3	1.38	7.08	3.50E+14	22.8	9.7	14.6	59.0	1.71	0.18
	611	base	7	1.95E+15	1.78E+15		9.1	12.1	37.8	1.52	7.76	3.12E+14		9.1	12.6	70.5	1.93	0.17
	612	base	7	3.36E+14	2.12E+14	5.3	10.7	15.8	31.1	1.46	4.32	1.89E+14	14.7	9.1	13.4	63.9	1.62	0.89
	613	base	7	1.58E+15	9.19E+14	6.6	10.4	13.2	29.3	1.44	5.21	2.38E+14	8.7	9.1	14.3	45.3	1.65	0.26
	614	base	7	1.84E+15	1.61E+15						7.68	3.52E+14						0.22
606	615	base	100	2.05E+15	2.04E+15	240.4	27.2	33.4	75.3	1.77	520.47	1.83E+15	171.1	9.1	26.4	74.5	2.02	0.90
607	616	base	85	1.74E+15	1.72E+15	154.4	18.7	30.5	73.3	1.81	397.95	1.55E+15	161.5	9.1	19.8	76.3	2.10	0.90
608	617	base	30	3.35E+14	2.91E+14	9.4	14.3	18.1	45.4	1.56	9.05	1.99E+14	14.5	12.0	19.2	55.9	1.88	0.68
609	618	base	7	2.19E+15	1.75E+15	10.0	9.5	12.2	32.0	1.40	7.15	3.41E+14	14.0	10.3	13.9	49.6	1.58	0.20
	619	base	7	5.00E+16	4.63E+16	92.9	14.1	14.0	19.5	1.30	15.68	7.72E+15	19.7	9.2	10.3	26.9	1.26	0.17
610	620	base	100	1.22E+15	1.09E+15	237.3	9.1	16.8	74.3	2.13	346.57	9.98E+14	184.6	9.1	15.5	77.8	2.14	0.92
611	621	base	85	1.64E+15	1.55E+15	218.3	27.5	31.3	74.9	1.84	419.47	1.41E+15	154.4	22.6	31.2	75.5	1.89	0.91
612	622	base	30	1.23E+14	1.47E+14	7.9	14.0	18.8	41.5	1.57	6.19	1.29E+14	8.1	12.8	18.4	51.8	1.70	0.88
613	623	base	7	2.12E+14	2.29E+14	7.2	12.8	16.7	36.5	1.50	5.78	2.01E+14	9.3	11.9	16.8	49.9	1.69	0.88
	624	base	7	3.83E+16	3.68E+16	77.6	13.7	13.8	20.5	1.30	19.48	6.37E+15	20.9	9.2	10.6	30.6	1.30	0.17
614	625	base	100	7.36E+15	6.82E+15	268.5	9.7	13.6	67.6	1.71	218.63	1.07E+15	158.1	18.2	22.5	77.5	1.99	0.16
615	626	base	85	3.99E+15	3.59E+15	203.8	9.1	14.2	72.8	1.85	180.03	9.04E+14	130.2	18.2	27.3	77.1	1.98	0.25
616	627	base	30	2.59E+16	2.55E+16	35.8	10.5	12.0	19.1	1.24	15.07	4.15E+14	12.9	10.0	15.2	50.7	1.62	0.02
617	628	base	7	3.75E+16	3.72E+16	55.6	12.9	13.2	19.4	1.27	18.04	4.96E+15	16.9	9.5	10.7	24.4	1.30	0.13
	629	base	7	2.67E+14	1.61E+14	5.9	11.0	16.0	33.5	1.47	4.88	1.39E+14	11.1	9.4	13.2	48.9	1.54	0.87
	630	base	7	1.82E+14	2.01E+14	5.7	10.1	16.0	33.9	1.52	5.11	1.77E+14	5.4	11.1	17.5	39.8	1.67	0.88
	631	base	7	7.73E+14	5.16E+14	14.0	9.4	14.2	30.3	1.48	6.84	2.82E+14	8.1	14.0	16.7	42.9	1.58	0.55
618	632	base	4	3.03E+16	2.69E+16	170.4	15.4	16.5	27.2	1.42	33.51	8.61E+15	46.5	10.1	12.7	28.8	1.37	0.32
619	633	base	100	2.71E+15	2.01E+15	185.7	9.2	19.4	74.2	2.03	180.07	8.61E+14	123.6	10.3	24.8	76.6	2.06	0.43
620	634	base	85	1.60E+15	1.07E+15	124.6	9.8	20.0	72.7	1.99	115.95	6.10E+14	85.5	13.6	26.4	73.6	1.91	0.57
621	635	base	65	2.81E+15	2.06E+15	33.7	10.0	12.4	49.3	1.50	34.16	3.67E+14	26.9	10.7	18.4	66.0	1.88	0.18
622	636	base	40	9.27E+15	9.05E+15	23.8	9.8	11.6	21.2	1.27	10.12	3.40E+14	11.7	10.6	16.6	48.0	1.67	0.04
623	637	base	4	2.90E+16	2.61E+16	111.8	9.2	15.1	29.0	1.59	22.06	8.29E+15	37.3	9.2	11.8	65.8	1.55	0.32
	638	base	4	1.86E+15	1.59E+15		10.2	14.7	32.3	1.48	13.32	6.82E+14		9.9	12.8	75.3	1.61	0.43
624	640	base	40	2.02E+14	2.00E+14	14.5	12.9	19.0	46.4	1.65	8.31	1.49E+14	25.9	9.2	13.4	64.2	1.74	0.75
	641	base	40	2.55E+14	2.49E+14	13.7	12.8	19.8	46.0	1.61	7.74	1.61E+14	13.5	10.0	17.6	54.8	1.78	0.65
	642	base	40	7.74E+14	4.38E+14						26.06	3.39E+14						0.77
	643	base	40	2.69E+14	1.98E+14	14.6	15.2	20.4	47.2	1.62	7.32	1.26E+14	17.8	10.1	17.1	60.1	1.77	0.64
	644	base	40	1.28E+14	1.32E+14	8.8	13.8	20.3	46.6	1.60	5.94	1.09E+14	8.5	10.8	18.7	57.5	1.78	0.83
625	645	base	30	1.69E+14	1.26E+14	6.5	14.7	20.2	42.4	1.55	3.92	9.28E+13	8.4	13.2	17.8	57.6	1.75	0.74
626	646	base	15	1.73E+14	1.07E+14	4.6	13.3	19.2	36.1	1.53	3.05	9.30E+13	8.1	10.2	14.5	57.3	1.64	0.87
627	647	base	7	2.44E+14	1.40E+14	4.0	13.6	17.3	32.9	1.46	3.52	1.22E+14	8.6	11.3	14.9	58.3	1.58	0.87
628	648	base	5.5	4.08E+14	3.67E+14	8.0	10.9	15.7	36.5	1.51	8.51	3.12E+14	11.1	11.2	17.2	50.8	1.67	0.85
	650	base	4	3.84E+14	3.42E+14	11.7	11.6	16.0	38.9	1.53	8.14	2.81E+14	14.3	9.2	14.1	51.1	1.64	0.82
	651	base	4	2.44E+16	2.16E+16	148.7	14.7	16.4	28.2	1.43	31.94	6.79E+15	55.3	9.5	12.7	38.5	1.39	0.31

TABLE A-7.—(Continued).

Test Point No.[2]	Aerosol Point No.[2]	Fuel Type[3]	Power	NASA unheated[1] particle properties: Number EI[4] by CPC 3022[5]	Number EI by CPC 7610[5]	Unheated Mass EI	Unheated mode	Unheated GMD[6]	Unheated VMD[7]	Unheated Sigma	Black Carbon EI by PSAP[5]	NASA heated[1] particle properties: Heated Number EI	Heated Mass EI	Heated Mode	Heated GMD[6]	Heated VMD[7]	Heated Sigma	Particle number ratio
			%	#/kg fuel	#/kg fuel	mg/kg fuel	nm	nm	nm		mg/kg fuel	#/kg fuel	mg/kg fuel	nm	nm	nm		Heated / unheated
630	652	base	5.5	2.76E+16	2.43E+16	90.0	14.5	14.8	23.3	1.33	22.46	5.26E+15	39.8	9.5	11.4	37.6	1.33	0.22
631	653	base	7	2.12E+16	1.99E+16	85.4	10.7	14.9	25.1	1.41	15.70	4.40E+15	30.9	9.5	11.8	34.2	1.36	0.22
632	654	base	15	1.74E+16	1.64E+16	43.6	10.4	13.1	21.2	1.33	8.83	1.35E+15	18.3	10.0	11.9	48.9	1.43	0.08
633	655	base	30	1.24E+16	1.15E+16	37.7	10.6	12.7	23.1	1.32	12.21	6.21E+14	16.1	9.3	12.1	51.4	1.54	0.05
634	656	base	4	2.39E+16	2.38E+16	155.7	14.7	16.4	27.4	1.42	26.02	7.14E+15	47.9	9.8	12.5	30.4	1.36	0.30
635	657	base	40	1.11E+16	9.30E+15	35.9	10.4	12.6	27.4	1.34	19.48	8.81E+14	23.8	10.3	13.4	60.9	1.55	0.09
	658	base	40	2.29E+14	1.79E+14	10.7	14.8	20.9	50.5	1.62	8.88	1.41E+14	11.7	10.0	17.6	60.0	1.81	0.79
	659	base	40	2.36E+14	1.99E+14	13.6	14.1	22.3	50.8	1.62	10.10	1.69E+14	18.6	10.5	17.6	64.8	1.80	0.85
	660	base	40	2.92E+14	1.78E+14	13.6	14.3	20.3	47.5	1.61	9.57	1.51E+14	21.4	9.8	14.7	70.1	1.73	0.85
636	661	base	30	3.94E+14	2.97E+14	10.2	12.2	17.7	43.1	1.55	6.28	1.57E+14	11.3	9.9	15.1	57.4	1.69	0.53
637	662	base	15	6.04E+14	4.28E+14	8.2	12.6	16.4	39.4	1.49	5.18	1.88E+14	12.6	10.1	14.1	61.4	1.63	0.44
	662	base	15	1.16E+15	8.37E+14	15.0	14.5	17.7	37.0	1.49	8.26	4.30E+14	15.0	9.4	15.0	47.5	1.66	0.51
638	663	base	7	8.60E+14	5.68E+14	9.4	11.1	16.8	34.0	1.51	6.25	3.08E+14	14.9	9.4	13.2	52.9	1.61	0.54
639	664	base	5.5	1.40E+15	9.37E+14	15.3	11.6	16.2	36.2	1.52	10.08	4.79E+14	17.6	10.6	14.6	49.8	1.58	0.51
640	665	base	4	1.95E+15	1.25E+15	21.1	10.9	15.8	35.9	1.51	12.85	6.32E+14	17.3	12.0	16.3	41.5	1.55	0.50
	666	base	4	2.91E+16	2.15E+16	151.2	21.5	19.3	28.7	1.40	27.02	6.59E+15	30.6	12.7	14.7	30.5	1.39	0.31
641	667	base	5.5	3.22E+16	2.22E+16	84.3	13.0	14.9	23.5	1.37	18.07	4.28E+15	26.0	10.0	11.9	27.0	1.32	0.19
642	668	base	7	3.29E+16	2.28E+16	81.4	13.1	14.6	23.6	1.35	15.39	3.78E+15	20.5	9.5	11.5	27.0	1.31	0.17
643	669	base	15	2.10E+16	1.39E+16	67.1	10.5	13.7	26.1	1.40	17.34	1.42E+15	25.5	9.9	12.0	44.2	1.41	0.10
701	701	base	4	7.71E+15	6.38E+15	126.4	10.3	14.8	38.0	1.53	90.60	2.40E+15	0.0	126.1	107.4	85.8	1.60	0.38
702	702	base	100	9.14E+14	8.56E+14	300.2	32.8	31.3	76.5	1.90	255.95	7.71E+14	382.4	140.9	122.7	91.2	1.64	0.90
703	703	base	85	7.58E+14	7.09E+14	186.3	28.3	31.6	72.8	1.77	171.26	6.36E+14	534.8	141.7	123.6	97.3	1.58	0.90
704	704	base	65	3.58E+14	3.44E+14	42.9	15.5	25.4	60.8	1.71	42.12	2.99E+14	38.6	85.0	52.1	62.6	2.21	0.87
705	705	base	4	4.73E+15	4.11E+15	37.5	11.0	13.7	30.9	1.42	27.36	1.15E+15	25.1	9.8	14.0	39.2	1.54	0.28
	706	base	4	8.13E+14	6.45E+14	23.1	11.3	14.9	34.1	1.50	18.58	5.49E+14	19.5	12.2	16.0	41.6	1.58	0.85
706	707	base	100	5.58E+14	5.23E+14	213.1	18.2	30.0	73.2	1.86	133.62	4.79E+14	161.3	36.2	36.5	76.3	1.72	0.92
707	708	base	85	5.60E+14	5.21E+14	175.2	30.0	30.0	70.4	1.78	116.97	4.78E+14	133.6	33.9	34.7	74.7	1.74	0.92
708	709	base	70	3.36E+14	3.26E+14	71.5	22.7	26.1	61.6	1.69	48.21	3.00E+14	65.8	16.6	24.0	66.2	1.86	0.92
709	710	base	65	2.14E+14	2.28E+14	37.8	16.7	24.5	56.5	1.67	24.38	2.09E+14	28.4	13.0	20.9	60.2	1.88	0.92
710	711	base	60	2.76E+14	1.96E+14	28.6	17.8	23.2	51.4	1.64	17.61	1.79E+14	21.1	14.5	21.5	57.4	1.83	0.92
711	712	base	4	7.00E+14	6.04E+14	13.2	10.1	14.7	32.8	1.49	11.26	4.52E+14	12.9	9.4	15.0	45.1	1.60	0.75
712	714	base	100	5.73E+14	5.49E+14	212.0	36.6	31.4	75.1	1.85	127.98	5.04E+14	137.1	39.0	35.2	75.3	1.76	0.92
713	715	base	85	5.71E+14	5.40E+14	179.0	26.9	31.1	70.7	1.77	113.97	4.95E+14	129.8	25.2	30.3	73.1	1.89	0.92
714	716	base	65	2.42E+14	2.47E+14	39.5	18.3	24.6	58.1	1.71	27.98	2.26E+14	31.9	14.1	24.1	62.2	1.82	0.91
715	717	base	4	7.68E+14	7.37E+14	17.9	10.8	14.4	34.1	1.50	12.01	5.07E+14	13.4	10.2	14.9	39.8	1.52	0.69
	718	base	4	4.38E+15	4.35E+15	47.4	10.2	13.5	33.3	1.44	25.16	1.38E+15	26.9	10.8	15.2	40.4	1.54	0.32
716	719	base	100	1.87E+15	1.82E+15	190.9	35.2	32.9	75.4	1.79	392.04	1.64E+15	161.2	29.6	31.2	77.0	1.94	0.90
717	720	base	85	1.73E+15	1.72E+15	178.3	28.6	31.3	75.0	1.82	333.84	1.55E+15	140.7	21.3	30.9	75.5	1.88	0.90
718	721	base	65	3.25E+14	3.43E+14	43.0	23.2	27.5	62.2	1.67	33.74	2.98E+14	41.6	12.4	20.9	63.5	1.88	0.87

TABLE A-7.—(Continued).

Test Point No.[2]	Aerosol Point No.[2]	Fuel Type[3]	Power	NASA unheated[1] particle properties: Number EI[4] by CPC 3022[5]	Number EI by CPC 7610[5]	Unheated Mass EI	Unheated mode	Unheated GMD[6]	Unheated VMD[7]	Unheated Sigma	Black Carbon EI by PSAP[5]	NASA heated[1] particle properties: Heated Number EI	Heated Mass EI	Heated Mode	Heated GMD[6]	Heated VMD[7]	Heated Sigma	Particle number ratio
			%	#/kg fuel	#/kg fuel	mg/kg fuel	nm	nm	nm		mg/kg fuel	#/kg fuel	mg/kg fuel	nm	nm	nm		Heated / unheated
719	722	base	4	3.50E+15	3.32E+15	39.1	9.9	13.6	33.9	1.44	22.44	1.17E+15	26.9	10.2	14.1	40.2	1.58	0.35
	723	base	4	5.01E+16	4.57E+16	186.4	16.1	16.3	25.0	1.36	50.37	1.23E+16	51.1	9.4	11.2	31.2	1.31	0.27
720	724	base	100	1.01E+16	9.13E+15	173.8	10.5	12.5	56.9	1.47	123.18	9.78E+14	128.0	36.4	29.4	76.6	1.93	0.11
721	725	base	85	8.88E+15	8.11E+15	173.3	10.1	12.7	60.8	1.52	132.78	8.89E+14	111.9	10.7	24.3	74.2	2.00	0.11
722	726	base	70	1.40E+16	1.28E+16	90.7	9.9	11.9	40.3	1.33	58.27	6.20E+14	55.9	11.7	21.9	67.7	1.87	0.05
723	727	base	65	1.56E+16	1.41E+16	63.7	10.0	12.0	32.1	1.30	36.05	4.95E+14	38.3	11.4	18.5	64.0	1.88	0.04
724	728	base	60	1.71E+16	1.54E+16	51.4	9.8	11.9	26.0	1.27	22.65	3.73E+14	26.5	12.1	18.3	60.3	1.76	0.02
725	729	base	4	4.94E+16	4.46E+16	178.0	16.1	16.2	24.6	1.35	42.86	1.14E+16	43.0	9.7	11.3	27.0	1.30	0.26
726	730	sulfur	4	3.79E+16	3.49E+16	121.5	16.6	15.8	24.8	1.37	46.00	9.65E+15	41.0	9.7	12.0	31.8	1.35	0.28
	731	sulfur	4	4.85E+16	3.84E+16	158.3	16.8	16.3	24.0	1.35	35.54	1.42E+16	42.2	10.0	12.4	23.3	1.30	0.37
	732	sulfur	4	5.02E+16	3.85E+16	171.2	16.4	16.7	23.7	1.35	31.84	1.49E+16	44.6	10.5	12.4	23.1	1.30	0.39
727	733	sulfur	100	5.62E+15	4.12E+15	214.8	10.2	15.2	67.3	1.86	216.27	1.11E+15	134.1	9.9	21.6	76.7	2.01	0.27
728	734	sulfur	85	3.38E+15	2.43E+15	167.2	10.3	15.4	66.6	1.86	158.71	7.15E+14	98.0	11.7	26.2	74.0	1.95	0.29
729	735	sulfur	65	1.26E+16	1.04E+16	64.6	11.3	13.4	35.0	1.37	41.16	5.48E+14	29.7	9.8	15.9	59.9	1.77	0.05
730	736	sulfur	40	3.92E+16	2.85E+16	107.0	15.6	15.3	21.0	1.32	12.43	7.10E+14	13.2	9.4	11.0	43.4	1.41	0.02
731	737	sulfur	30	5.51E+16	3.82E+16	133.7	16.4	15.5	20.6	1.32	9.85	6.81E+14	12.6	9.5	11.3	44.9	1.41	0.02
732	738	sulfur	7	7.02E+16	4.74E+16	166.6	17.4	16.2	20.9	1.32	14.32	1.31E+16	27.2	10.1	11.7	20.3	1.22	0.28
733	739	sulfur	4	6.21E+16	4.11E+16	177.6	17.1	16.8	22.6	1.34	26.36	1.44E+16	46.9	11.2	12.5	24.7	1.27	0.35
	740	sulfur	4	1.77E+15	1.04E+15	14.4	11.6	14.9	33.5	1.46	10.89	4.78E+14	13.9	10.0	14.0	47.2	1.55	0.46
734	741	sulfur	100	5.14E+14	3.62E+14	92.0	32.5	33.5	72.6	1.80	99.25	3.27E+14	67.8	30.3	36.2	81.7	1.80	0.91
735	742	sulfur	85	4.61E+14	3.15E+14	80.4	32.4	32.8	71.8	1.83	80.35	2.85E+14	58.0	17.0	30.4	79.9	1.97	0.91
736	743	sulfur	65	2.55E+14	1.58E+14	20.0	22.5	26.5	62.4	1.76	21.90	1.40E+14	16.5	13.4	24.2	65.4	1.87	0.89
737	744	sulfur	40	1.69E+14	1.12E+14	6.6	18.1	21.9	46.9	1.57	6.28	9.38E+13	6.7	11.9	18.3	59.1	1.75	0.84
738	745	sulfur	30	1.80E+14	1.14E+14	4.4	13.7	20.1	42.5	1.59	4.56	9.12E+13	5.4	10.2	15.3	54.0	1.66	0.80
739	746	sulfur	7	7.83E+14	3.46E+14	6.4	10.9	14.3	34.7	1.46	4.34	1.33E+14	6.0	12.2	15.0	58.2	1.55	0.39
740	747	sulfur	4	1.85E+15	1.00E+15	13.4	11.2	14.6	35.1	1.48	10.77	4.17E+14	12.6	11.2	15.1	48.7	1.59	0.42
	748	sulfur	4	6.66E+14	3.37E+14	17.4	10.0	16.0	35.5	1.54	7.81	2.52E+14	13.2	12.1	16.7	53.2	1.61	0.75
741	749	sulfur	100	1.86E+15	1.11E+15	232.2	37.1	35.9	72.2	1.76	332.07	9.84E+14	167.1	9.6	28.9	82.3	2.06	0.89
742	750	sulfur	85	7.37E+14	4.30E+14	178.5	30.4	31.9	71.3	1.82	110.16	3.77E+14	128.9	24.9	31.9	80.0	1.90	0.88
743	751	sulfur	70	3.93E+14	2.14E+14	47.8	22.9	27.6	62.0	1.71	28.51	1.81E+14	36.7	14.2	26.8	70.6	1.84	0.85
744	752	sulfur	65	3.20E+14	1.75E+14	32.5	20.8	25.0	59.4	1.73	18.66	1.46E+14	25.3	15.1	22.9	66.1	1.81	0.83
745	753	sulfur	60	2.39E+14	1.36E+14	18.4	19.4	23.4	52.8	1.65	10.93	1.09E+14	14.7	10.0	19.5	61.4	1.87	0.80
746	754	sulfur	40	2.25E+14	1.54E+14	10.5	12.6	19.7	44.0	1.60	6.65	1.02E+14	10.7	10.7	18.4	60.0	1.74	0.66
747	755	sulfur	30	1.76E+14	1.25E+14	10.1	11.7	17.7	39.9	1.61	4.77	8.26E+13	9.4	12.0	18.2	61.2	1.70	0.66
748	756	sulfur	15	1.54E+14	1.16E+14	7.7	10.9	15.5	36.4	1.56	3.37	6.80E+13	4.8	13.0	18.3	55.5	1.63	0.59
749	757	sulfur	7	2.19E+14	1.68E+14	6.4	11.8	15.5	35.6	1.49	3.60	9.11E+13	7.7	9.7	13.1	58.1	1.59	0.54
750	758	sulfur	5.5	4.21E+14	2.75E+14	14.6	11.1	15.3	34.2	1.51	4.88	1.34E+14	8.3	12.3	18.3	54.6	1.65	0.49
751	759	sulfur	4	7.76E+14	4.85E+14	20.2	10.5	15.2	36.0	1.52	7.87	2.24E+14	12.1	10.9	15.3	47.6	1.60	0.46
	801	sulfur	4	1.80E+15	1.53E+15	48.4	10.9	16.1	41.3	1.57	45.34	1.07E+15						0.70

TABLE A-7.—(Continued).

Test Point No.[2]	Aerosol Point No.[2]	Fuel Type[3]	Power	NASA unheated[1] particle properties: Number EI[4] by CPC 3022[5]	Number EI by CPC 7610[5]	Unheated Mass EI	Unheated mode	Unheated GMD[6]	Unheated VMD[7]	Unheated Sigma	Black Carbon EI by PSAP[5]	NASA heated[1] particle properties: Heated Number EI	Heated Mass EI	Heated Mode	Heated GMD[6]	Heated VMD[7]	Heated Sigma	Particle number ratio
			%	#/kg fuel	#/kg fuel	mg/kg fuel	nm	nm	nm		mg/kg fuel	#/kg fuel	mg/kg fuel	nm	nm	nm		Heated / unheated
802	802	sulfur	100	1.39E+15	1.32E+15	229.9	27.4	31.9	73.7	1.80	411.71	1.20E+15						0.91
803	803	sulfur	85	5.99E+14	5.71E+14	186.3	27.2	30.2	72.5	1.83	148.08	5.15E+14						0.90
804	804	sulfur	65	2.26E+14	2.48E+14	41.2	17.2	23.7	59.5	1.74	29.16	2.22E+14						0.89
805	805	sulfur	40	3.51E+14	2.45E+14	11.1	10.9	17.9	44.8	1.63	9.74	1.43E+14	9.3	90.9	29.1	52.9	2.58	0.58
	806	sulfur	40	1.03E+15	9.39E+14	34.9	10.2	12.5	35.3	1.39	6.26	8.21E+13	28.6	10.1	16.3	50.7	1.83	0.09
	807	sulfur	40	3.82E+14	3.50E+14	12.7	13.4	19.4	42.9	1.55	8.99	1.58E+14	15.7	16.1	20.2	57.1	1.70	0.45
	808	sulfur	40	2.83E+14	2.65E+14	6.9	17.1	19.5	38.8	1.53	6.73	1.45E+14	10.2	18.1	19.7	53.3	1.66	0.55
806	809	sulfur	30	2.57E+14	2.18E+14	7.1	13.0	18.8	38.7	1.52	4.99	1.36E+14	9.0	10.5	18.0	50.1	1.67	0.63
807	810	sulfur	7	2.56E+14	2.51E+14	4.6	11.0	15.2	31.9	1.46	4.37	1.74E+14	5.7	11.6	16.1	44.1	1.60	0.69
808	811	sulfur	4	6.84E+14	6.58E+14	10.1	9.7	13.4	29.8	1.48	8.93	4.28E+14	9.7	9.6	14.8	37.5	1.57	0.65
	812	sulfur	4	4.11E+15	4.31E+15	21.5	10.1	13.0	28.2	1.38	14.04	1.18E+15	16.5	9.8	13.5	36.1	1.50	0.27
809	813	sulfur	100	1.88E+15	1.70E+15	163.4	27.6	31.1	76.2	1.86	472.99	1.52E+15	167.2	23.8	32.5	74.7	1.83	0.89
810	814	sulfur	85	1.81E+15	1.50E+15	124.7	15.0	27.8	73.6	1.94	321.71	1.29E+15	123.8	21.9	30.8	74.4	1.90	0.86
811	815	sulfur	65	4.05E+14	2.81E+14	28.1	16.3	24.4	59.4	1.75	28.74	2.27E+14	30.8	9.1	16.6	59.7	1.91	0.81
812	816	sulfur	40	2.69E+14	2.31E+14	9.3	11.9	18.1	45.7	1.62	8.20	1.72E+14	10.6	9.6	16.7	51.8	1.72	0.75
	817	sulfur	40	2.35E+14	2.16E+14	7.7	11.3	18.2	47.8	1.67	7.72	1.45E+14	7.8	12.4	19.4	53.0	1.69	0.67
	818	sulfur	40	2.88E+14	1.92E+14	12.5	15.1	21.0	55.4	1.61	9.82	1.66E+14	19.0	9.4	15.0	61.5	1.73	0.87
	819	sulfur	40	2.64E+14	2.52E+14	10.0	14.5	21.1	47.2	1.62	10.42	1.84E+14	10.5	14.1	21.3	52.3	1.67	0.73
813	820	sulfur	30	3.12E+14	2.82E+14	12.4	11.8	17.6	44.8	1.60	7.15	1.71E+14	11.4	10.3	17.3	55.0	1.71	0.61
814	821	sulfur	7	2.01E+15	1.65E+15	8.0	9.8	12.0	26.8	1.38	4.95	3.24E+14	9.1	10.3	13.2	52.1	1.55	0.20
815	822	sulfur	4	3.26E+15	3.11E+15	18.9	9.9	12.9	28.8	1.42	14.74	9.53E+14	21.1	9.4	13.2	44.5	1.53	0.31
	823	sulfur	4	6.09E+16	5.20E+16	163.7	17.8	16.5	22.1	1.33	32.82	1.93E+16	35.0	9.9	11.5	19.1	1.25	0.37
816	824	sulfur	100	2.07E+16	1.73E+16	220.7	12.9	13.5	43.5	1.40	177.77	1.56E+15	114.6	9.1	15.2	70.6	1.86	0.09
817	825	sulfur	85	1.90E+16	1.62E+16	175.1	13.0	14.5	45.8	1.41	131.56	7.74E+14	89.2	9.6	22.6	72.6	1.97	0.05
818	826	sulfur	70	3.04E+16	2.55E+16	135.7	15.2	15.0	30.3	1.35	56.21	5.53E+14	42.7	10.8	19.7	63.7	1.84	0.02
819	827	sulfur	65	3.35E+16	2.80E+16	121.0	15.5	15.3	24.2	1.33	36.16	4.44E+14	28.1	9.6	16.4	62.1	1.79	0.02
820	828	sulfur	60	3.68E+16	3.07E+16	116.3	15.5	15.4	22.0	1.33	20.30	3.13E+14	17.0	10.9	16.8	61.2	1.73	0.01
821	829	sulfur	40	5.44E+16	4.51E+16	153.0	15.9	15.6	20.4	1.32	16.87	3.73E+14	13.7	9.6	14.3	50.0	1.67	0.01
822	830	sulfur	30	6.55E+16	5.43E+16	172.4	15.8	15.6	20.3	1.32	14.94	3.89E+14	12.6	9.1	12.7	45.9	1.57	0.01
823	831	sulfur	15	6.98E+16	5.79E+16	135.0	15.8	14.8	19.2	1.32	14.47	3.55E+15	14.3	9.1	12.1	49.3	1.49	0.06
824	832	sulfur	7	7.13E+16	5.92E+16	149.6	17.0	15.1	19.9	1.33	18.86	1.41E+16	21.9	9.7	10.6	17.0	1.19	0.24
825	833	sulfur	5.5	6.41E+16	5.36E+16	146.1	16.2	16.0	20.8	1.30	25.65	1.59E+16	29.9	9.9	11.1	19.3	1.22	0.30
826	834	sulfur	4	5.93E+16	5.06E+16	156.1	16.5	16.2	22.1	1.33	33.81	1.72E+16	36.8	9.8	11.5	19.9	1.24	0.34
827	836	aromatic	4	3.68E+16	3.65E+16	95.9	12.3	14.1	22.2	1.35	31.82	1.05E+16	36.0	9.8	11.3	26.7	1.30	0.29
828	837	aromatic	100	7.65E+15	7.48E+15	194.0	9.8	12.6	70.5	1.60	211.11	9.00E+14	134.0	9.8	23.5	76.9	2.16	0.12
829	838	aromatic	85	5.66E+15	5.45E+15	134.8	9.4	12.3	65.9	1.57	152.95	7.01E+14	97.4	26.4	29.5	75.0	1.89	0.13
830	839	aromatic	65	1.12E+16	1.10E+16	52.4	9.8	11.3	36.8	1.29	44.50	4.09E+14	32.4	15.4	21.9	61.9	1.80	0.04
831	840	aromatic	40	2.30E+16	2.21E+16	34.4	10.0	11.7	17.8	1.24	12.58	2.97E+14	15.3	13.1	19.3	55.3	1.68	0.01
832	841	aromatic	30	2.98E+16	2.84E+16	47.3	9.9	11.9	17.2	1.25	9.61	3.10E+14	13.2	11.7	17.4	54.6	1.61	0.01
833	842	aromatic	7	4.05E+16	3.92E+16	113.3	11.8	12.6	19.7	1.27	12.64	4.54E+15	19.7	9.1	10.3	34.3	1.24	0.12

TABLE A-7.—(Continued).

Test Point No.[2]	Aerosol Point No.[2]	Fuel Type[3]	Power	NASA unheated[1] particle properties: Number EI[4] by CPC 3022[5]	Number EI by CPC 7610[5]	Unheated Mass EI	Unheated mode	Unheated GMD[6]	Unheated VMD[7]	Unheated Sigma	Black Carbon EI by PSAP[5]	NASA heated[1] particle properties: Heated Number EI	Heated Mass EI	Heated Mode	Heated GMD[6]	Heated VMD[7]	Heated Sigma	Particle number ratio
			%	#/kg fuel	#/kg fuel	mg/kg fuel	nm	nm	nm		mg/kg fuel	#/kg fuel	mg/kg fuel	nm	nm	nm		Heated / unheated
834	843	aromatic	4	3.44E+16	3.34E+16	71.7	12.9	13.2	20.3	1.28	17.63	5.50E+15	23.9	9.5	10.5	26.7	1.25	0.16
	844	aromatic	4	1.13E+15	9.22E+14	12.9	10.6	13.9	36.4	1.47	11.47	4.85E+14	11.6	9.9	14.5	41.6	1.54	0.53
835	845	aromatic	100	1.79E+15	1.66E+15	211.3	25.5	31.9	78.0	1.89	454.65	1.49E+15	175.2	27.5	34.7	80.1	1.79	0.90
836	846	aromatic	85	5.65E+14	5.28E+14	130.7	18.6	29.4	74.2	1.85	126.02	4.77E+14	107.1	19.3	28.8	74.7	1.91	0.90
837	847	aromatic	65	2.55E+14	2.36E+14	30.9	19.4	25.6	61.9	1.72	27.93	2.09E+14	29.1	15.6	24.3	65.3	1.84	0.89
838	848	aromatic	40	1.62E+14	1.63E+14	9.2	12.8	18.9	48.4	1.63	7.59	1.42E+14	9.2	13.6	18.2	53.2	1.67	0.87
839	849	aromatic	30	2.17E+14	1.65E+14						6.18	1.41E+14						0.85
840	850	aromatic	7	4.12E+14	3.09E+14						5.73	1.72E+14						0.56
841	851	aromatic	4	1.09E+15	8.60E+14						10.43	4.80E+14						0.56
	852	aromatic	4	4.28E+14	3.76E+14	9.4	11.7	15.3	34.6	1.47	7.09	2.76E+14	8.9	11.6	15.2	45.1	1.53	0.73
842	853	aromatic	100	5.31E+14	4.91E+14	212.9	20.3	24.0	73.1	1.75	148.29	4.54E+14	164.8	36.4	35.3	78.0	1.77	0.92
843	854	aromatic	85	4.93E+14	4.53E+14	173.8	20.4	30.0	73.8	1.86	117.54	4.17E+14	129.7	26.6	33.2	75.6	1.80	0.92
844	855	aromatic	100	5.07E+14	4.57E+14	187.5	29.7	32.7	73.4	1.76	130.80	4.22E+14	147.5	39.2	36.0	75.9	1.76	0.92
845	856	aromatic	85	4.95E+14	4.52E+14	164.8	27.0	30.7	74.3	1.82	109.67	4.16E+14	125.3	23.0	30.4	75.6	1.91	0.92
846	857	aromatic	70	2.59E+14	2.29E+14	42.2	21.7	26.7	62.7	1.70	27.84	2.00E+14	34.1	20.4	26.3	65.3	1.78	0.87
847	858	aromatic	65	1.70E+14	1.71E+14	25.0	20.4	25.2	56.5	1.67	16.76	1.55E+14	23.1	14.6	20.7	61.7	1.85	0.91
848	859	aromatic	60	1.32E+14	1.39E+14	16.1	15.8	23.5	53.0	1.63	11.43	1.26E+14	15.2	15.5	21.9	58.1	1.76	0.90
849	860	aromatic	40	1.87E+14	1.40E+14	8.8	14.5	21.0	44.9	1.61	6.39	1.07E+14	7.5	11.9	19.9	50.1	1.68	0.76
850	861	aromatic	30	1.54E+14	1.06E+14	4.1	12.1	16.7	36.4	1.54	3.95	7.64E+13	4.2	9.2	12.3	44.6	1.59	0.72
851	862	aromatic	15	1.26E+14	7.35E+13	1.8	16.0	18.8	29.4	1.41	2.91	5.69E+13						0.77
852	863	aromatic	7	1.82E+14	1.09E+14	3.4	10.2	14.3	31.5	1.49	2.90	8.17E+13	3.6	10.7	15.7	48.4	1.61	0.75
853	864	aromatic	5.5	2.53E+14	1.73E+14	4.2	11.7	15.5	36.5	1.47	4.26	1.30E+14	5.9	10.7	14.2	55.5	1.59	0.75
854	865	aromatic	4	3.53E+14	3.03E+14	12.5	9.9	14.7	31.8	1.49	5.52	2.06E+14	8.3	10.1	14.9	41.6	1.51	0.68
	866	aromatic	4	6.79E+14	6.42E+14	25.1	27.9	26.4	36.7	1.36	7.13	4.85E+14	13.1	19.3	18.8	35.3	1.44	0.75
855	867	aromatic	100	3.43E+14	3.17E+14	132.4	39.2	40.0	80.6	1.68	81.58	2.68E+14	95.4	13.3	32.1	83.5	2.01	0.85
856	868	aromatic	85	3.23E+14	3.09E+14	112.7	34.7	43.9	81.5	1.66	63.15	2.51E+14	77.0	9.7	23.2	80.9	2.11	0.81
857	869	aromatic	65	4.58E+14	4.30E+14	28.4	22.9	24.8	51.6	1.48	16.01	3.23E+14	19.8	13.2	17.5	57.9	1.61	0.75
858	870	aromatic	40	6.25E+14	5.96E+14	15.7	21.6	22.4	32.9	1.34	4.71	4.24E+14	8.5	13.5	15.5	37.9	1.42	0.71
859	871	aromatic	30	8.11E+14	7.71E+14	17.9	22.9	22.8	30.4	1.31	3.81	5.42E+14	8.1	13.8	15.6	32.5	1.39	0.70
860	872	aromatic	7	7.38E+14	7.01E+14	15.1	22.2	21.8	29.2	1.32	3.01	4.89E+14	6.7	13.7	15.7	31.2	1.36	0.70
861	873	aromatic	4	8.35E+14	7.93E+14	20.5	23.3	23.3	32.1	1.35	5.94	5.66E+14	9.9	15.6	16.2	33.3	1.44	0.71
	901	aromatic	4	1.34E+15	1.19E+15						34.49	1.01E+15						0.85
902	902	aromatic	100	1.99E+15	1.89E+15	337.5	31.4	34.2	77.3	1.81	595.06	1.73E+15	229.0	31.5	34.7	79.1	1.84	0.92
903	903	aromatic	85	1.91E+15	1.77E+15	245.8	30.8	32.0	73.2	1.81	494.65	1.63E+15	190.8	28.0	33.0	76.1	1.85	0.92
904	904	aromatic	65	3.17E+14	3.07E+14	57.1	24.6	25.8	59.1	1.71	41.37	2.80E+14	46.3	25.3	28.6	62.9	1.70	0.91
905	905	aromatic	40	1.84E+14	1.92E+14	15.6	13.3	19.1	44.7	1.64	10.45	1.61E+14	11.8	16.3	22.5	52.7	1.66	0.84
906	906	aromatic	30	1.60E+14	1.65E+14	7.2	11.8	18.5	40.1	1.59	7.00	1.30E+14	6.2	15.1	20.8	46.0	1.61	0.78
907	907	aromatic	7	1.76E+14	1.71E+14	3.8	11.1	15.2	32.4	1.47	4.87	1.32E+14	3.4	12.4	16.9	39.5	1.58	0.77
908	908	aromatic	4	6.78E+14	6.21E+14	10.4	11.1	14.6	32.6	1.47	10.10	4.05E+14	7.4	10.9	16.3	36.1	1.56	0.65
	909	aromatic	4	5.18E+15	5.56E+15	33.4	10.9	13.9	29.4	1.42	24.52	1.60E+15	20.9	9.7	13.5	38.5	1.52	0.29

TABLE A-7.—(Continued).

Test Point No.[2]	Aerosol Point No.[2]	Fuel Type[3]	Power	NASA unheated[1] particle properties: Number EI[4] by CPC 3022[5]	Number EI by CPC 7610[5]	Unheated Mass EI	Unheated mode	Unheated GMD[6]	Unheated VMD[7]	Unheated Sigma	Black Carbon EI by PSAP[5]	NASA heated[1] particle properties: Heated Number EI	Heated Mass EI	Heated Mode	Heated GMD[6]	Heated VMD[7]	Heated Sigma	Particle number ratio
			%	#/kg fuel	#/kg fuel	mg/kg fuel	nm	nm	nm		mg/kg fuel	#/kg fuel	mg/kg fuel	nm	nm	nm		Heated / unheated
909	910	aromatic	100	8.44E+14	8.25E+14	257.8	27.4	32.0	76.5	1.91	268.46	7.53E+14	221.3	29.5	35.9	79.6	1.85	0.91
910	911	aromatic	85	7.41E+14	7.02E+14	185.4	33.2	31.5	73.9	1.84	191.14	6.39E+14	164.8	21.9	32.6	77.0	1.87	0.91
911	912	aromatic	65	3.95E+14	3.94E+14	55.9	21.9	27.0	65.0	1.77	57.75	3.54E+14	52.9	12.9	25.3	65.7	1.85	0.90
912	913	aromatic	40	2.39E+14	2.29E+14	8.9	17.3	21.6	46.4	1.61	10.81	1.91E+14	9.1	15.7	20.9	50.8	1.67	0.83
913	914	aromatic	30	3.50E+14	2.95E+14	7.4	10.3	16.5	44.1	1.62	7.79	1.81E+14	6.6	12.4	17.6	43.3	1.64	0.61
914	915	aromatic	7	2.30E+15	2.29E+15	7.9	9.8	12.5	26.0	1.37	7.86	4.53E+14	6.2	9.1	13.6	39.0	1.56	0.20
915	916	aromatic	4	5.15E+15	5.87E+15	30.5	10.0	13.6	28.1	1.40	21.76	1.73E+15	21.9	10.3	13.7	40.5	1.52	0.30
	917	aromatic	4	5.77E+16	4.89E+16	265.2	18.1	18.1	25.6	1.37	55.49	1.82E+16	58.0	9.7	11.9	28.5	1.30	0.37
916	918	aromatic	100	1.39E+16	1.24E+16	275.2	12.9	14.2	65.7	1.57	235.13	2.23E+15	182.6	9.1	19.5	77.7	2.12	0.18
917	919	aromatic	85	1.04E+16	9.81E+15	215.0	10.1	13.0	61.9	1.51	207.73	9.94E+14	136.8	9.8	23.1	76.7	2.08	0.10
918	920	aromatic	70	1.75E+16	1.60E+16	102.3	10.0	12.5	39.5	1.35	84.11	7.06E+14	63.4	12.4	22.7	68.7	1.89	0.04
919	921	aromatic	65	1.96E+16	1.77E+16	75.6	10.9	12.7	31.0	1.32	53.67	5.63E+14	37.2	11.6	21.0	64.2	1.88	0.03
920	922	aromatic	60	2.21E+16	2.00E+16	57.0	11.0	12.8	23.8	1.29	29.66	4.19E+14	22.5	11.3	20.2	59.4	1.76	0.02
921	923	aromatic	40	3.32E+16	3.03E+16	58.6	12.0	12.9	18.5	1.27	16.09	4.28E+14	12.6	11.6	18.4	51.0	1.67	0.01
922	924	aromatic	30	3.94E+16	3.66E+16	54.9	12.0	12.7	17.6	1.27	13.44	4.62E+14	10.1	12.7	19.2	46.0	1.63	0.01
923	925	aromatic	15	4.63E+16	4.32E+16	67.7	13.8	13.4	17.1	1.27	13.26	4.14E+15	11.2	9.4	10.2	26.2	1.23	0.10
924	926	aromatic	7	5.67E+16	5.04E+16	125.9	15.5	14.9	19.4	1.31	20.63	1.17E+16	16.7	9.2	10.6	19.6	1.21	0.23
925	927	aromatic	5.5	5.56E+16	4.92E+16	148.1	15.9	15.6	21.4	1.33	31.92	1.30E+16	24.6	9.8	10.9	21.3	1.24	0.26
926	928	aromatic	4	5.88E+16	5.08E+16	198.4	17.8	16.9	23.4	1.34	44.82	1.70E+16	36.2	9.9	11.5	22.6	1.28	0.33
	929	aromatic	4	3.42E+14	3.48E+14	18.2	19.5	22.3	46.1	1.53	11.02	3.10E+14	16.2	14.0	20.7	51.1	1.70	0.89
927	930	aromatic	100	6.21E+14	5.93E+14	168.3	59.6	55.3	88.2	1.62	329.58	5.51E+14	134.1	36.6	43.9	89.4	2.10	0.93
928	931	aromatic	85	5.28E+14	5.20E+14	99.5	47.6	46.9	82.3	1.65	235.87	4.83E+14	88.5	35.2	39.3	84.6	2.05	0.93
929	932	aromatic	65	8.26E+13	8.70E+13	15.5	32.7	32.6	62.6	1.64	15.72	8.06E+13	14.1	15.3	27.7	66.0	1.91	0.93
930	933	aromatic	40	8.60E+13	9.49E+13	9.3	26.5	29.3	53.2	1.55	8.15	8.82E+13	9.3	19.7	25.3	58.5	1.88	0.93
931	934	aromatic	30	9.88E+13	1.06E+14	9.4	23.1	27.1	51.7	1.57	7.90	9.88E+13	9.3	19.4	26.2	59.0	1.73	0.93
932	935	aromatic	7	1.19E+14	1.00E+14	2.2	14.6	17.5	32.8	1.47	2.51	8.51E+13	3.1	14.5	17.6	48.7	1.63	0.85
933	936	aromatic	4	6.41E+14	6.51E+14	26.8	19.0	22.1	41.5	1.48	15.81	5.71E+14	21.3	18.6	20.5	45.4	1.56	0.88
934	937	sulfur	7	7.74E+16	7.24E+16	124.6	14.8	14.9	22.4	1.33	61.03	1.94E+16	29.8	9.7	11.2	24.7	1.28	0.27
	938	sulfur	7	3.25E+15	3.39E+15	33.7	15.9	16.3	27.9	1.41	9.77	1.19E+15	15.9	9.6	13.0	31.3	1.47	0.35
	939	sulfur	7	9.36E+14	9.47E+14	27.0	22.8	22.6	34.2	1.39	10.06	7.40E+14	14.9	19.5	19.3	33.5	1.43	0.78
	940	sulfur	7	7.38E+14	7.53E+14	21.7	24.0	23.3	34.8	1.35	7.63	5.62E+14						0.75
937	941	sulfur	75	2.14E+16	1.88E+16	165.8	13.9	14.2	44.3	1.40	132.91	8.07E+14	83.4	11.9	23.1	71.1	1.95	0.04
938	942	sulfur	30	3.87E+16	3.32E+16	177.4	14.5	14.5	31.6	1.35	103.11	8.39E+14	60.1	11.9	20.5	58.1	1.80	0.03
939	943	sulfur	7	6.72E+16	5.71E+16	142.5	14.9	14.6	18.9	1.31	9.84	4.39E+14	7.5	9.2	11.9	38.4	1.53	0.01
	944	sulfur	7	7.09E+14	7.10E+14	26.1	27.1	26.5	36.5	1.36	6.39	5.64E+14	14.0	21.0	20.9	35.3	1.44	0.79
	945	sulfur	7	1.87E+14	1.88E+14	7.7	10.9	15.9	36.8	1.54	5.51	1.54E+14	4.9	14.7	17.5	39.8	1.59	0.82
	946	sulfur	7	1.64E+15	1.32E+15	9.9	9.4	12.9	32.3	1.43	7.61	3.39E+14	6.0	11.0	15.1	41.6	1.54	0.26
	947	sulfur	7	5.23E+16	5.00E+16	99.6	14.5	14.8	20.0	1.31	15.73	1.09E+16	14.9	10.0	11.0	18.3	1.21	0.22
	948	sulfur	7	1.10E+15	1.13E+15	17.6	20.2	20.0	30.4	1.38	6.18	6.96E+14	8.6	15.3	15.7	30.3	1.42	0.62
	949	sulfur	7	9.04E+14	8.68E+14	32.2	29.7	28.1	36.3	1.31	6.35	6.21E+14	14.0	17.4	18.7	34.4	1.46	0.72

TABLE A-7.—(Continued).

Test Point No.[2]	Aerosol Point No.[2]	Fuel Type[3]	Power	NASA unheated[1] particle properties: Number EI[4] by CPC 3022[5]	Number EI by CPC 7610[5]	Unheated Mass EI	Unheated mode	Unheated GMD[6]	Unheated VMD[7]	Unheated Sigma	Black Carbon EI by PSAP[5]	NASA heated[1] particle properties: Heated Number EI	Heated Mass EI	Heated Mode	Heated GMD[6]	Heated VMD[7]	Heated Sigma	Particle number ratio
			%	#/kg fuel	#/kg fuel	mg/kg fuel	nm	nm	nm		mg/kg fuel	#/kg fuel	mg/kg fuel	nm	nm	nm		Heated / unheated
940	950	sulfur	100	2.81E+14	2.64E+14	162.3	48.3	49.7	83.7	1.66	133.41	2.37E+14	101.1	55.9	47.7	83.8	1.66	0.90
941	951	sulfur	85	2.20E+14	2.16E+14	145.2	48.7	52.1	86.0	1.63	132.16	1.99E+14	92.7	48.5	47.0	86.9	1.79	0.92
942	952	sulfur	30	5.35E+14	5.50E+14	14.6	22.5	23.0	33.3	1.32	5.43	3.35E+14	7.6	13.2	15.8	39.2	1.45	0.61
943	953	sulfur	7	8.01E+14	7.94E+14	28.5	27.1	26.8	35.9	1.31	6.20	5.26E+14	9.3	17.4	17.5	32.3	1.42	0.66
	954	sulfur	7	2.24E+14	2.29E+14	8.0	11.2	16.0	35.5	1.54	6.39	1.78E+14	7.8	12.3	18.5	45.5	1.60	0.78
	955	sulfur	7	1.27E+15	9.47E+14	8.1	10.2	13.5	34.7	1.44	7.94	2.54E+14	7.1	10.6	16.2	44.8	1.63	0.27
	956	sulfur	7	1.65E+15	1.18E+15						7.24	3.27E+14						0.28
	957	sulfur	7	2.31E+14	2.25E+14	8.9	12.5	17.4	39.5	1.53	6.49	1.84E+14	6.8	13.2	18.8	45.1	1.60	0.82
944	958	sulfur	100	5.52E+14	5.24E+14	252.1	29.7	33.7	76.5	1.79	165.21	4.71E+14	171.5	20.5	35.0	79.3	1.91	0.90
945	959	sulfur	85	5.66E+14	5.21E+14	228.0	27.8	32.5	74.3	1.79	162.41	4.71E+14	163.5	27.7	33.2	77.9	1.88	0.90
946	960	sulfur	30	1.65E+14	1.24E+14	5.4	13.2	19.7	42.0	1.54	5.69	8.73E+13	4.8	11.7	17.7	54.1	1.74	0.70
947	961	sulfur	7	2.13E+14	2.06E+14	6.7	10.4	16.0	38.2	1.56	6.37	1.64E+14	6.4	12.5	17.6	47.5	1.63	0.79
	962	sulfur	7	2.04E+15	1.60E+15	12.1	9.9	13.4	34.2	1.48	10.64	3.81E+14	12.9	9.7	14.4	50.1	1.65	0.24
	962	sulfur	7	1.53E+15	1.23E+15	17.0	9.2	11.6	38.7	1.42	10.83	3.73E+14						0.30
	963	sulfur	7	4.21E+16	4.29E+16	62.1	13.4	13.9	20.5	1.31	20.60	5.99E+15	13.7	9.4	10.7	29.0	1.27	0.14
948	964	sulfur	100	2.09E+16	1.76E+16	308.7	13.9	14.4	53.8	1.46	226.48	8.93E+14	172.5	10.6	30.9	83.0	1.99	0.05
949	965	sulfur	85	1.65E+16	1.44E+16	250.2	13.4	14.2	55.7	1.46	208.39	8.27E+14	133.8	12.1	26.8	78.6	2.01	0.06
950	966	sulfur	30	5.82E+16	5.02E+16	136.2	14.6	14.4	22.9	1.31	21.63	3.38E+14	12.6	10.4	14.7	58.6	1.70	0.01
951	967	sulfur	7	5.07E+16	4.84E+16	72.3	13.7	14.0	20.1	1.31	21.37	8.47E+15	14.6	9.6	10.9	28.5	1.28	0.18

TABLE A-7.—(Continued).

Test Point No.[2]	Aerosol Point No.[2]	Fuel Type[3]	Power	NASA unheated[1] particle properties: Number EI[4] by CPC 3022[5]	Number EI by CPC 7610[5]	Unheated Mass EI	Unheated mode	Unheated GMD[6]	Unheated VMD[7]	Unheated Sigma	Black Carbon EI by PSAP[5]	NASA heated[1] particle properties: Heated Number EI	Heated Mass EI	Heated Mode	Heated GMD[6]	Heated VMD[7]	Heated Sigma	Particle number ratio
			%	#/kg fuel	#/kg fuel	mg/kg fuel	nm	nm	nm		mg/kg fuel	#/kg fuel	mg/kg fuel	nm	nm	nm		Heated / unheated
Additional aerosol test points without full engine operational data record	001	base	7	1.54E+16	1.51E+16		19.6	21.5	35.1	1.44	67.82	9.78E+15		11.3	14.1	36.2	1.41	0.65
	002	base	7	8.61E+14	7.32E+14	68.2	15.6	20.8	47.4	1.63	35.86	6.44E+14	60.8	12.1	21.0	51.4	1.73	0.88
	003	base	7	1.45E+15	1.12E+15	54.6	15.1	19.5	46.0	1.59	35.21	8.45E+14	47.1	14.4	20.7	49.4	1.66	0.75
	004	base	30	6.17E+14	4.61E+14	27.2	9.9	16.3	41.3	1.61	16.49	3.88E+14	27.9	10.5	18.8	53.9	1.71	0.84
	005	base	45	4.88E+14	3.61E+14	22.5	17.1	20.9	48.2	1.56	17.96	3.08E+14	41.8	9.2	19.8	55.2	1.85	0.85
	006	base	65	2.36E+14	1.78E+14						8.04	1.52E+14						0.85
	007	base	7	1.09E+15	7.88E+14	36.2	10.8	16.7	38.3	1.56	21.53	6.39E+14	28.8	15.7	20.9	44.7	1.64	0.81
	311	base	4			47.8	12.6	18.8	42.5	1.57	33.297936							
	320	base	7				48.6	61.5	101.6	1.80	43.46174							
	401	base	4								98.31993							
	402	base	4								124.35411							
	404	base	4								74.92953							
	405	base	85								376.2792							
	406	base	100								565.9708							
	516	base	4			15.2	10.2	13.5	30.5	1.45	9.779334							
	522	base	4			25.5	10.2	15.3	33.4	1.49	16.355325							
	523	base	7			42.1	10.1	14.7	36.5	1.51	24.1881108							
	524	base	85			154.1	29.9	35.8	76.8	1.75	146.89552							
	528	base	100								96.60608							
	529	base	4			160.3	15.1	16.6	29.3	1.43	31.75942							
	530	base	30								43.185475							
	601	base	4			374.7	19.3	19.3	32.0	1.40	128.09655							
	674	base	40			10.8	15.9	21.1	49.0	1.62	8.183915							
	675	base	4			18.5	12.2	16.4	34.1	1.51	11.368122							
	835	aromatic	30			146.6	13.6	14.7	25.0	1.34	45.294088							

Note:

1. During this experiment, NASA used dual aerosol sampling channels, one with heat applied to 300 °C (heated) and one without heating (unheated).
2. The test point No. defines the sequential engine testing conditions while the aerosol point number defines each aerosol measurement condition. Both of them are combinations of the last digit in the date between April 20 and 29 and a sequence number of point for that day. If the test point number is 305, the test point was for the 5th test point on April 23.
3. Three types of fuel were used: base for base JP-8 fuel, aromatic for high aromatic fuel, and sulfur for base fuel with sulfur additive.
4. EI standards for emission index.
5. Particle measurement instruments: Condensation Particle Counters (CPC 3022, 7610), Particle Soot Absorption Photometer (PSAP).
6. Number based geometric mean diameter.
7. Volume based geometric mean diameter.

TABLE A-8.—NASA UNHEATED PARTICLE SIZE DISTRIBUTION DATA MEASURED FROM THE EXHAUST OF AIRCRAFT CFM56-2-C1 ENGINE DURING APEX.

Test Point	301	301	301	301	301	301	301	302	302	302
Date	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	7	7	7	7	7	7	7	30	30	30
Aerosol Point #	301	302	303	304	305	306	307	309	310	312
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	4.8E+13	4.7E+13	5.9E+13	5.8E+13	7.4E+13	6.7E+13	1.2E+14	3.6E+13	5.3E+13	4.6E+13
10	3.1E+14	0.0E+00	0.0E+00	2.2E+15	2.8E+15	7.0E+15	6.1E+15	0.0E+00	1.0E+15	1.3E+15
12	1.1E+15	1.7E+15	4.5E+14	2.0E+15	3.4E+15	7.6E+15	4.3E+15	2.6E+14	1.7E+14	8.3E+14
14	1.8E+15	1.1E+15	7.9E+14	2.1E+15	5.2E+15	9.9E+15	7.0E+15	5.8E+14	3.3E+14	4.3E+14
16	1.8E+15	6.8E+14	1.1E+15	1.0E+15	5.9E+15	9.4E+15	6.9E+15	5.5E+14	8.7E+14	6.5E+14
18	2.3E+15	9.0E+14	1.3E+15	1.0E+15	5.4E+15	7.8E+15	6.3E+15	4.8E+14	9.5E+14	8.9E+14
21	2.0E+15	8.7E+14	1.2E+15	1.2E+15	4.2E+15	4.1E+15	6.0E+15	5.5E+14	9.1E+14	1.1E+15
24	2.2E+15	6.6E+14	1.1E+15	1.1E+15	3.1E+15	3.4E+15	3.3E+15	6.4E+14	1.2E+15	8.7E+14
27	2.1E+15	7.3E+14	8.7E+14	8.0E+14	2.1E+15	1.7E+15	1.8E+15	5.6E+14	1.1E+15	9.4E+14
31	1.9E+15	6.7E+14	6.7E+14	6.4E+14	1.4E+15	9.4E+14	1.4E+15	7.1E+14	1.2E+15	8.6E+14
36	1.5E+15	4.2E+14	6.5E+14	4.2E+14	7.9E+14	4.4E+14	9.2E+14	5.6E+14	1.2E+15	8.3E+14
41	1.3E+15	3.8E+14	4.3E+14	3.4E+14	5.5E+14	6.7E+14	5.2E+14	5.2E+14	1.0E+15	6.6E+14
48	9.7E+14	2.6E+14	3.0E+14	2.0E+14	3.4E+14	3.7E+14	2.4E+14	3.8E+14	7.9E+14	5.3E+14
55	7.4E+14	2.0E+14	1.9E+14	1.7E+14	1.9E+14	4.0E+14	3.8E+14	2.7E+14	6.2E+14	4.3E+14
63	4.9E+14	8.8E+13	1.6E+14	9.6E+13	1.7E+14	3.9E+14	1.2E+14	2.1E+14	3.7E+14	3.3E+14
73	3.2E+14	7.9E+13	7.0E+13	4.2E+13	9.5E+13	2.0E+14	1.4E+14	1.3E+14	1.9E+14	2.2E+14
84	1.9E+14	6.0E+13	3.0E+13	2.1E+13	6.4E+13	2.6E+14	4.8E+13	7.5E+13	1.3E+14	1.0E+14
97	1.1E+14	1.9E+13	3.4E+13	1.2E+13	2.4E+13	4.9E+13	2.9E+13	4.3E+13	8.0E+13	5.4E+13
113	6.0E+13	1.7E+13	1.6E+13	8.5E+12	1.9E+13	0.0E+00	1.9E+13	3.2E+13	1.9E+13	3.0E+13
131	2.5E+13	0.0E+00	1.7E+12	2.0E+12	5.1E+12	0.0E+00	4.5E+12	9.1E+12	1.1E+13	9.4E+12
153	9.8E+12	2.1E+12	3.4E+12	0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.2E+12	5.1E+12	2.1E+12
178	4.2E+12	2.3E+12	1.9E+12	2.0E+12	2.5E+12	6.6E+12	8.7E+12	0.0E+00	0.0E+00	0.0E+00
209	5.8E+11	0.0E+00	0.0E+00	0.0E+00	1.5E+13	0.0E+00	4.3E+12	0.0E+00	1.9E+12	0.0E+00
245	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.4E+12	0.0E+00	0.0E+00	0.0E+00

Note:

1. PARTICLE SIZE DISTRIBUTION DATA ARE REPORTED AS PARTICLE NUMBER EMISSION INDEX (EIN) IN EACH CHANNEL IN THE FORM OF D(EIN)/DLOGDP.

TABLE A-8.—(Continued).

Test Point	302	302	302	302	302	302	303	303	303	303
Date	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	30	30	30	30	30	30	40	40	40	40
Aerosol Point #	313	314	315	316	318	319	321	322	323	324
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	4.0E+13	3.7E+13	4.3E+13	6.3E+13	9.5E+13	1.1E+14	4.0E+13	4.0E+13	3.5E+13	5.4E+13
10	2.3E+14	8.7E+14	8.9E+14	3.3E+15	0.0E+00	3.1E+16	0.0E+00	0.0E+00	0.0E+00	2.8E+15
12	3.0E+14	5.8E+14	1.0E+15	5.2E+15	2.3E+15	1.3E+16	6.8E+14	1.8E+14	1.4E+14	1.6E+15
14	6.0E+14	1.7E+14	5.8E+14	5.7E+15	5.1E+14	1.7E+16	5.8E+14	3.4E+14	4.1E+14	1.8E+15
16	5.4E+14	4.6E+14	7.3E+14	6.9E+15	1.2E+15	1.7E+16	3.0E+14	3.2E+14	7.6E+14	1.9E+15
18	6.0E+14	6.6E+14	7.8E+14	6.1E+15	8.8E+14	1.8E+16	7.1E+14	4.2E+14	8.2E+14	2.9E+15
21	8.3E+14	1.0E+15	7.8E+14	5.4E+15	8.8E+14	1.5E+16	5.8E+14	5.6E+14	8.0E+14	2.2E+15
24	7.3E+14	1.3E+15	8.3E+14	3.2E+15	8.8E+14	9.0E+15	7.7E+14	7.1E+14	8.0E+14	1.7E+15
27	7.8E+14	1.3E+15	7.2E+14	2.2E+15	9.4E+14	5.7E+15	7.0E+14	6.9E+14	6.7E+14	1.5E+15
31	8.2E+14	1.1E+15	6.4E+14	1.5E+15	7.4E+14	2.7E+15	7.5E+14	7.3E+14	6.9E+14	1.3E+15
36	6.0E+14	9.1E+14	5.1E+14	1.1E+15	5.4E+14	1.3E+15	6.1E+14	6.0E+14	4.9E+14	9.3E+14
41	5.9E+14	6.1E+14	3.5E+14	9.4E+14	4.6E+14	1.3E+15	5.3E+14	5.8E+14	4.0E+14	7.6E+14
48	5.0E+14	3.9E+14	2.1E+14	5.6E+14	3.2E+14	7.2E+14	4.6E+14	4.9E+14	2.9E+14	5.3E+14
55	3.5E+14	2.0E+14	2.1E+14	3.1E+14	2.6E+14	5.5E+14	3.6E+14	3.5E+14	2.0E+14	4.5E+14
63	2.3E+14	1.7E+14	1.6E+14	2.2E+14	1.9E+14	2.8E+14	2.6E+14	2.9E+14	1.1E+14	3.2E+14
73	1.8E+14	8.3E+13	7.7E+13	1.3E+14	1.3E+14	2.5E+14	1.6E+14	1.5E+14	7.2E+13	1.6E+14
84	1.2E+14	4.3E+13	4.0E+13	6.7E+13	5.2E+13	8.6E+13	9.7E+13	9.2E+13	1.8E+13	1.1E+14
97	5.0E+13	2.4E+13	2.3E+13	3.2E+13	1.9E+13	7.1E+13	4.7E+13	5.3E+13	2.8E+13	4.9E+13
113	1.8E+13	7.1E+12	9.2E+12	1.0E+13	6.4E+12	4.5E+13	3.8E+13	2.8E+13	7.8E+12	4.4E+12
131	1.1E+13	4.9E+12	4.5E+12	2.9E+12	2.9E+12	1.5E+13	2.6E+13	1.2E+13	6.0E+12	3.7E+12
153	3.8E+12	3.0E+12	0.0E+00	2.4E+12	0.0E+00	8.9E+12	1.0E+13	4.0E+12	1.4E+12	4.0E+12
178	0.0E+00	1.6E+12	0.0E+00	1.4E+12	0.0E+00	0.0E+00	6.4E+12	0.0E+00	0.0E+00	0.0E+00
209	0.0E+00	1.6E+12	0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.6E+12	0.0E+00	0.0E+00	0.0E+00
245	8.2E+11	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	9.4E+11	0.0E+00	0.0E+00	0.0E+00

TABLE A-8.—(Continued).

Test Point	303	303	303	303	304	304	304	305	305	305
Date	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	40	40	40	40	30	30	30	7	7	7
Aerosol Point #	325	326	327	328	329	330	331	332	333	334
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	6.2E+13	4.5E+13	6.6E+13	1.3E+14	1.2E+14	1.1E+14	4.4E+13	5.7E+13	4.3E+13	1.5E+14
10	3.3E+15	4.9E+15	4.4E+14	7.8E+15	1.6E+16	0.0E+00	4.0E+14	0.0E+00	1.5E+15	1.7E+16
12	2.5E+15	3.0E+15	5.2E+14	1.4E+16	2.3E+16	8.9E+14	2.2E+14	2.8E+14	2.6E+15	6.7E+15
14	5.2E+15	2.2E+15	5.9E+14	2.6E+16	3.0E+16	8.6E+14	2.8E+14	3.7E+14	2.6E+15	1.8E+16
16	4.9E+15	2.0E+15	7.1E+14	2.8E+16	3.6E+16	1.0E+15	5.1E+14	5.2E+14	3.9E+15	2.2E+16
18	4.7E+15	2.0E+15	6.1E+14	2.7E+16	3.3E+16	1.1E+15	6.3E+14	4.1E+14	3.9E+15	2.5E+16
21	2.5E+15	2.4E+15	8.1E+14	2.2E+16	2.6E+16	1.2E+15	5.6E+14	3.9E+14	3.3E+15	3.8E+16
24	1.7E+15	2.7E+15	7.2E+14	1.4E+16	1.4E+16	9.1E+14	5.9E+14	4.5E+14	2.5E+15	3.9E+16
27	1.4E+15	3.0E+15	5.3E+14	7.2E+15	8.1E+15	8.1E+14	7.6E+14	2.4E+14	1.1E+15	3.6E+16
31	1.3E+15	3.3E+15	4.7E+14	2.9E+15	2.9E+15	8.0E+14	6.8E+14	1.5E+14	6.4E+14	2.7E+16
36	1.1E+15	2.9E+15	4.6E+14	1.6E+15	1.5E+15	6.6E+14	5.3E+14	1.6E+14	3.2E+14	1.7E+16
41	8.6E+14	2.6E+15	3.2E+14	1.2E+15	7.8E+14	5.3E+14	4.1E+14	9.5E+13	2.1E+14	9.7E+15
48	4.8E+14	1.7E+15	2.9E+14	6.3E+14	5.8E+14	4.8E+14	3.0E+14	5.9E+13	1.0E+14	3.2E+15
55	3.9E+14	1.2E+15	2.3E+14	5.5E+14	3.6E+14	3.5E+14	1.9E+14	4.3E+13	7.9E+13	1.3E+15
63	2.2E+14	6.6E+14	1.3E+14	3.7E+14	2.0E+14	2.0E+14	1.5E+14	1.7E+13	4.3E+13	2.6E+14
73	1.1E+14	2.4E+14	9.5E+13	2.1E+14	1.2E+14	1.0E+14	1.1E+14	1.4E+13	4.1E+13	8.0E+13
84	4.7E+13	9.9E+13	4.4E+13	1.4E+14	4.7E+13	8.8E+13	5.7E+13	4.3E+12	1.5E+13	2.7E+13
97	3.3E+13	3.9E+13	2.0E+13	7.7E+13	5.8E+12	3.2E+13	2.6E+13	3.6E+12	5.9E+12	4.6E+13
113	1.4E+13	1.3E+13	1.8E+13	9.4E+12	2.4E+13	2.6E+13	1.8E+13	1.4E+12	5.9E+12	1.7E+13
131	1.1E+13	1.2E+13	7.4E+12	1.9E+13	5.4E+12	5.0E+12	6.5E+12	0.0E+00	0.0E+00	0.0E+00
153	0.0E+00	2.7E+12	1.4E+12	4.2E+12	5.0E+12	2.3E+12	3.7E+12	0.0E+00	0.0E+00	0.0E+00
178	0.0E+00	1.5E+12	1.4E+12	4.6E+12	0.0E+00	0.0E+00	1.6E+12	0.0E+00	0.0E+00	1.4E+13
209	0.0E+00	1.5E+12	1.5E+12	1.3E+13	0.0E+00	0.0E+00	8.2E+11	0.0E+00	1.2E+12	0.0E+00
245	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.5E+12	0.0E+00	0.0E+00	0.0E+00

TABLE A-8.—(Continued).

Test Point	305	305	306	306	306	306	307	307	307	307
Date	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	7	7	7	7	7	7	30	30	30	30
Aerosol Point #	335	336	339	340	341	342	343	344	345	346
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	3.6E+13	5.6E+13	5.3E+13	4.0E+13	6.3E+13	6.9E+13	3.5E+13	3.2E+13	4.2E+13	4.7E+13
10	5.9E+14	0.0E+00	1.8E+15	2.0E+15	4.9E+15	1.5E+15	0.0E+00	6.2E+14	0.0E+00	8.3E+14
12	6.9E+14	2.3E+14	2.0E+15	1.1E+15	3.0E+15	1.6E+15	7.9E+14	2.9E+14	2.3E+14	1.3E+15
14	4.0E+14	3.2E+14	2.6E+15	6.8E+14	3.2E+15	1.3E+15	5.6E+14	4.1E+14	3.9E+14	8.6E+14
16	1.6E+14	3.6E+14	3.3E+15	1.1E+15	2.4E+15	1.0E+15	7.0E+14	3.9E+14	5.7E+14	1.0E+15
18	5.3E+14	3.7E+14	4.0E+15	1.3E+15	1.6E+15	8.6E+14	6.1E+14	5.4E+14	4.6E+14	5.7E+14
21	4.0E+14	3.3E+14	3.6E+15	1.1E+15	1.2E+15	9.7E+14	9.9E+14	6.8E+14	6.6E+14	7.2E+14
24	3.1E+14	2.2E+14	3.1E+15	1.0E+15	1.0E+15	7.0E+14	9.1E+14	6.2E+14	5.1E+14	7.7E+14
27	2.5E+14	3.1E+14	2.4E+15	7.1E+14	7.8E+14	6.4E+14	9.0E+14	6.0E+14	5.5E+14	5.3E+14
31	1.1E+14	1.9E+14	1.7E+15	7.1E+14	7.5E+14	5.2E+14	8.7E+14	5.2E+14	6.6E+14	4.9E+14
36	1.5E+14	1.7E+14	9.8E+14	4.5E+14	4.3E+14	3.3E+14	6.5E+14	4.9E+14	4.9E+14	4.1E+14
41	1.2E+14	1.2E+14	6.5E+14	3.3E+14	3.3E+14	2.6E+14	5.7E+14	3.4E+14	3.8E+14	2.7E+14
48	6.0E+13	5.8E+13	4.4E+14	2.0E+14	3.1E+14	1.5E+14	4.7E+14	2.7E+14	3.1E+14	2.3E+14
55	3.4E+13	5.6E+13	2.8E+14	1.8E+14	1.7E+14	7.7E+13	3.7E+14	2.3E+14	2.0E+14	1.9E+14
63	2.7E+13	3.0E+13	1.7E+14	1.2E+14	1.3E+14	7.4E+13	2.5E+14	1.5E+14	1.5E+14	1.1E+14
73	8.0E+12	2.9E+13	9.6E+13	3.8E+13	7.9E+13	3.7E+13	1.9E+14	1.1E+14	8.3E+13	6.2E+13
84	7.2E+12	8.1E+12	5.5E+13	3.1E+13	2.5E+13	2.5E+13	1.3E+14	4.8E+13	6.0E+13	3.6E+13
97	2.0E+12	5.4E+12	2.3E+13	1.3E+13	1.8E+13	5.8E+12	5.4E+13	3.0E+13	3.7E+13	1.1E+13
113	0.0E+00	1.4E+12	6.7E+12	5.5E+12	4.7E+12	2.0E+12	2.7E+13	1.5E+13	1.3E+13	8.9E+12
131	0.0E+00	0.0E+00	7.5E+12	0.0E+00	2.1E+12	0.0E+00	9.6E+12	6.9E+12	6.8E+12	5.3E+12
153	0.0E+00	0.0E+00	1.2E+12	0.0E+00	2.2E+12	0.0E+00	7.9E+12	2.1E+12	2.6E+12	1.5E+12
178	0.0E+00	0.0E+00	1.7E+12	0.0E+00	0.0E+00	0.0E+00	2.3E+12	0.0E+00	1.3E+12	1.5E+12
209	0.0E+00	0.0E+00	1.6E+12	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
245	0.0E+00	0.0E+00	6.1E+11	0.0E+00	0.0E+00	1.9E+12	0.0E+00	0.0E+00	0.0E+00	0.0E+00

TABLE A-8.—(Continued).

Test Point	307	307	307	307	308	308	308	308b	308b	308b
Date	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	30	30	30	30	40	40	40	40	40	40
Aerosol Point #	347	348	349	350	351	352	353	354	355	356
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	3.9E+13	4.8E+13	8.8E+13	9.6E+13	9.9E+13	6.1E+13	5.2E+13	3.5E+13	3.1E+13	6.2E+13
10	1.2E+16	9.9E+15	0.0E+00	1.4E+16	2.1E+16	2.0E+15	3.8E+14	0.0E+00	4.5E+14	0.0E+00
12	4.9E+15	4.0E+15	1.4E+15	1.8E+16	1.5E+16	2.0E+15	6.1E+14	3.4E+14	1.5E+14	7.1E+14
14	4.5E+15	2.9E+15	1.1E+15	2.2E+16	1.8E+16	1.1E+15	4.5E+14	3.8E+14	3.3E+14	4.3E+14
16	4.1E+15	2.2E+15	9.8E+14	2.7E+16	2.4E+16	1.7E+15	5.5E+14	5.0E+14	5.2E+14	6.1E+14
18	2.0E+15	9.4E+14	1.2E+15	3.1E+16	2.6E+16	1.5E+15	8.5E+14	4.2E+14	4.6E+14	7.3E+14
21	1.5E+15	1.0E+15	1.2E+15	3.0E+16	2.5E+16	1.2E+15	8.8E+14	5.7E+14	6.1E+14	1.1E+15
24	9.7E+14	8.8E+14	1.2E+15	2.1E+16	1.9E+16	7.2E+14	1.1E+15	5.4E+14	7.5E+14	1.0E+15
27	6.4E+14	7.7E+14	8.7E+14	1.4E+16	1.4E+16	5.5E+14	1.2E+15	5.2E+14	6.5E+14	1.1E+15
31	5.9E+14	6.0E+14	8.5E+14	7.0E+15	9.4E+15	4.3E+14	1.3E+15	5.7E+14	5.8E+14	8.3E+14
36	4.9E+14	4.8E+14	3.9E+14	2.9E+15	5.3E+15	3.7E+14	1.3E+15	4.7E+14	5.3E+14	8.2E+14
41	3.6E+14	3.6E+14	3.5E+14	1.1E+15	2.2E+15	2.8E+14	1.0E+15	3.6E+14	3.9E+14	6.0E+14
48	2.3E+14	2.4E+14	2.3E+14	4.9E+14	8.8E+14	2.0E+14	6.5E+14	3.8E+14	3.3E+14	4.4E+14
55	1.6E+14	1.8E+14	1.9E+14	3.3E+14	3.8E+14	1.4E+14	4.4E+14	2.4E+14	2.3E+14	3.3E+14
63	7.4E+13	9.3E+13	1.7E+14	2.1E+14	2.2E+14	1.0E+14	2.8E+14	1.7E+14	1.9E+14	2.2E+14
73	4.8E+13	6.4E+13	7.0E+13	6.9E+13	1.9E+14	7.8E+13	1.6E+14	1.2E+14	1.3E+14	1.1E+14
84	2.7E+13	2.7E+13	6.7E+13	4.4E+13	1.1E+14	3.9E+13	1.3E+14	6.8E+13	8.8E+13	8.9E+13
97	1.8E+13	7.0E+12	4.0E+13	3.1E+13	4.7E+13	3.0E+13	5.9E+13	4.7E+13	4.2E+13	5.7E+13
113	1.0E+13	3.4E+12	8.5E+12	2.9E+13	1.2E+13	1.4E+13	3.2E+13	2.3E+13	1.9E+13	1.5E+13
131	2.3E+12	5.9E+12	7.3E+12	3.6E+12	1.4E+13	0.0E+00	1.9E+13	4.3E+12	6.4E+12	7.3E+12
153	0.0E+00	1.8E+12	0.0E+00	7.8E+12	1.5E+13	3.5E+12	8.2E+12	2.8E+12	3.5E+12	2.2E+12
178	0.0E+00	0.0E+00	0.0E+00	4.0E+12	0.0E+00	1.1E+12	5.7E+12	0.0E+00	0.0E+00	0.0E+00
209	0.0E+00	0.0E+00	0.0E+00	7.5E+12	1.0E+13	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
245	0.0E+00	0.0E+00	0.0E+00	0.0E+00	3.9E+12	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

TABLE A-8.—(Continued).

Test Point	308b	308b	309	309	309	310	310	310	501	502
Date	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/25/2004	4/25/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	40	40	30	30	30	7	7	7	4	65
Aerosol Point #	357	358	359	360	361	362	363	364	501	502
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	4.9E+13	6.2E+13	5.4E+13	6.2E+13	1.1E+14	1.5E+14	6.5E+13	5.1E+13	1.5E+14	2.9E+13
10	2.9E+15	3.9E+15	0.0E+00	0.0E+00	1.7E+16	9.1E+15	2.3E+15	0.0E+00	2.6E+16	6.8E+14
12	1.9E+15	4.8E+15	3.7E+14	4.8E+14	2.2E+16	1.4E+16	2.8E+15	1.3E+15	5.7E+16	2.2E+14
14	4.7E+15	2.6E+15	5.6E+14	3.6E+14	2.5E+16	2.0E+16	3.5E+15	5.9E+14	7.1E+16	2.2E+14
16	5.5E+15	2.9E+15	2.9E+14	4.8E+14	3.1E+16	2.3E+16	4.6E+15	8.5E+14	9.0E+16	3.9E+14
18	6.2E+15	2.0E+15	7.3E+14	7.3E+14	3.2E+16	3.5E+16	6.5E+15	7.1E+14	1.0E+17	5.0E+14
21	7.4E+15	1.9E+15	4.6E+14	5.4E+14	2.8E+16	4.2E+16	8.2E+15	5.8E+14	9.6E+16	5.7E+14
24	6.8E+15	1.5E+15	5.6E+14	4.2E+14	2.0E+16	4.5E+16	7.4E+15	5.1E+14	8.0E+16	5.1E+14
27	6.8E+15	1.4E+15	4.9E+14	4.2E+14	1.2E+16	3.9E+16	5.8E+15	4.3E+14	5.4E+16	6.2E+14
31	5.8E+15	1.3E+15	5.6E+14	3.3E+14	5.9E+15	2.5E+16	3.9E+15	3.2E+14	3.1E+16	6.1E+14
36	5.0E+15	9.8E+14	4.2E+14	2.8E+14	2.4E+15	1.5E+16	1.9E+15	2.6E+14	1.7E+16	5.9E+14
41	3.9E+15	6.7E+14	2.3E+14	2.6E+14	8.4E+14	6.0E+15	9.6E+14	1.9E+14	9.5E+15	5.2E+14
48	2.2E+15	4.1E+14	1.9E+14	2.0E+14	5.4E+14	2.2E+15	2.3E+14	8.9E+13	5.9E+15	4.5E+14
55	1.0E+15	3.2E+14	6.1E+13	1.5E+14	2.9E+14	9.4E+14	1.2E+14	6.0E+13	3.6E+15	3.9E+14
63	4.3E+14	1.9E+14	6.6E+13	7.5E+13	1.8E+14	2.5E+14	5.0E+13	4.2E+13	2.2E+15	3.2E+14
73	2.0E+14	1.3E+14	4.5E+13	5.2E+13	9.6E+13	2.0E+14	2.7E+13	1.5E+13	1.3E+15	2.5E+14
84	8.3E+13	5.5E+13	2.3E+13	2.5E+13	4.0E+13	3.8E+13	4.8E+12	7.1E+12	7.9E+14	1.6E+14
97	4.9E+13	2.8E+13	1.6E+13	1.2E+13	1.7E+13	8.7E+13	9.5E+12	2.8E+12	4.3E+14	1.2E+14
113	1.2E+13	1.1E+13	6.3E+12	6.9E+12	6.1E+12	1.8E+13	4.4E+12	5.2E+12	2.1E+14	6.3E+13
131	2.5E+12	5.6E+12	5.6E+12	1.8E+12	5.3E+12	0.0E+00	0.0E+00	1.2E+12	1.2E+14	3.3E+13
153	0.0E+00	2.0E+12	0.0E+00	2.8E+12	2.9E+12	3.4E+13	0.0E+00	0.0E+00	6.4E+13	2.0E+13
178	2.7E+12	0.0E+00	0.0E+00	0.0E+00	5.7E+12	0.0E+00	0.0E+00	0.0E+00	2.3E+13	7.9E+12
209	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	8.3E+12	4.0E+12
245	0.0E+00	0.0E+00	0.0E+00	9.9E+11	0.0E+00	0.0E+00	0.0E+00	0.0E+00	9.4E+12	2.0E+12

TABLE A-8.—(Continued).

Test Point	502	502	502	502	502	502	503	504	505	506
Date	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	65	65	65	65	65	65	70	65	60	85
Aerosol Point #	503	504	505	506	508	509	511	512	513	514
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	3.0E+13	3.3E+13	3.3E+13	1.1E+14	5.6E+13	6.6E+13	3.7E+13	3.6E+13	3.9E+13	2.9E+13
10	0.0E+00	0.0E+00	0.0E+00	2.1E+16	0.0E+00	5.3E+16	0.0E+00	5.6E+14	0.0E+00	3.0E+14
12	5.1E+14	1.0E+14	2.4E+14	5.8E+15	4.1E+14	4.7E+16	8.4E+14	1.0E+15	1.3E+15	6.4E+14
14	2.4E+14	3.9E+14	2.2E+14	2.6E+15	2.5E+14	3.4E+16	7.8E+14	7.6E+14	6.1E+14	3.4E+14
16	2.8E+14	5.5E+14	6.9E+14	2.0E+15	2.7E+14	2.1E+16	6.2E+14	6.2E+14	1.0E+15	4.5E+14
18	3.2E+14	4.5E+14	4.6E+14	2.2E+15	4.0E+14	9.1E+15	7.9E+14	8.0E+14	4.9E+14	6.4E+14
21	4.7E+14	5.2E+14	8.6E+14	2.2E+15	6.2E+14	2.2E+15	8.9E+14	7.2E+14	6.5E+14	6.1E+14
24	4.6E+14	6.2E+14	8.6E+14	2.1E+15	5.0E+14	1.3E+15	8.8E+14	7.6E+14	6.4E+14	7.3E+14
27	4.7E+14	6.5E+14	8.4E+14	2.1E+15	4.2E+14	9.0E+14	7.7E+14	6.9E+14	8.3E+14	7.3E+14
31	4.3E+14	5.8E+14	8.5E+14	1.6E+15	5.7E+14	9.4E+14	8.5E+14	6.6E+14	5.2E+14	7.6E+14
36	4.1E+14	5.8E+14	6.9E+14	1.8E+15	4.7E+14	7.1E+14	8.3E+14	5.2E+14	4.2E+14	7.2E+14
41	3.9E+14	4.3E+14	6.6E+14	1.3E+15	3.7E+14	5.5E+14	7.8E+14	4.8E+14	3.4E+14	6.9E+14
48	3.4E+14	3.6E+14	5.4E+14	1.5E+15	3.1E+14	5.7E+14	6.2E+14	3.9E+14	2.6E+14	6.1E+14
55	2.6E+14	2.4E+14	4.1E+14	1.2E+15	3.0E+14	2.9E+14	5.3E+14	3.0E+14	1.9E+14	6.2E+14
63	2.4E+14	2.6E+14	3.0E+14	8.8E+14	2.2E+14	3.1E+14	3.4E+14	2.8E+14	1.6E+14	4.7E+14
73	1.4E+14	1.8E+14	2.0E+14	6.7E+14	1.7E+14	1.9E+14	2.7E+14	1.8E+14	8.9E+13	3.6E+14
84	1.0E+14	1.2E+14	1.8E+14	4.4E+14	1.2E+14	1.5E+14	1.8E+14	1.2E+14	6.6E+13	2.6E+14
97	5.6E+13	7.0E+13	9.4E+13	2.7E+14	8.5E+13	1.0E+14	9.7E+13	6.2E+13	3.2E+13	1.8E+14
113	3.8E+13	4.7E+13	5.1E+13	1.1E+14	3.4E+13	6.5E+13	7.1E+13	3.5E+13	2.5E+13	1.2E+14
131	1.7E+13	1.9E+13	3.1E+13	7.0E+13	2.2E+13	4.1E+13	3.4E+13	2.0E+13	5.9E+12	6.8E+13
153	7.9E+12	7.7E+12	9.0E+12	3.2E+13	8.2E+12	2.1E+13	2.3E+13	1.3E+13	3.6E+12	4.4E+13
178	3.6E+12	1.0E+12	9.4E+12	1.5E+13	6.5E+12	7.9E+12	5.8E+12	2.5E+12	0.0E+00	2.1E+13
209	0.0E+00	2.2E+12	2.6E+12	2.2E+13	0.0E+00	4.3E+12	0.0E+00	9.3E+11	0.0E+00	6.3E+12
245	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.2E+12	0.0E+00	4.5E+12	0.0E+00	0.0E+00	3.1E+12

TABLE A-8.—(Continued).

Test Point	507	508	508	509	510	512	513	513	514	515
Date	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	100	7	7	100	85	30	7	7	100	30
Aerosol Point #	515	518	519	520	521	525	526	527	531	532
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	2.8E+13	5.4E+13	7.6E+13	4.7E+13	4.3E+13	8.4E+13	1.0E+14	1.6E+14	1.6E+14	1.3E+14
10	3.5E+14	0.0E+00	3.9E+15	0.0E+00	5.8E+14	0.0E+00	1.3E+15	4.1E+16	1.2E+16	5.1E+16
12	1.1E+14	0.0E+00	2.3E+15	1.9E+14	3.9E+14	5.6E+14	2.1E+15	5.0E+16	1.6E+16	6.9E+16
14	2.3E+14	1.5E+15	2.7E+15	5.4E+14	1.9E+14	5.2E+14	1.9E+15	6.1E+16	5.7E+15	5.1E+16
16	3.6E+14	6.4E+14	2.0E+15	5.4E+14	1.9E+14	5.9E+14	2.6E+15	6.6E+16	1.7E+15	3.6E+16
18	4.1E+14	9.8E+14	1.8E+15	4.0E+14	3.4E+14	7.8E+14	2.3E+15	5.4E+16	2.7E+15	1.6E+16
21	4.5E+14	8.1E+14	1.8E+15	6.2E+14	5.3E+14	5.2E+14	2.1E+15	3.9E+16	2.5E+15	9.2E+15
24	5.3E+14	7.0E+14	1.3E+15	5.9E+14	6.3E+14	4.1E+14	1.5E+15	2.4E+16	2.3E+15	5.0E+15
27	6.8E+14	4.4E+14	9.6E+14	6.1E+14	7.1E+14	2.6E+14	9.9E+14	1.6E+16	3.3E+15	2.7E+15
31	7.9E+14	2.7E+14	6.8E+14	7.3E+14	6.9E+14	2.8E+14	6.3E+14	9.6E+15	2.5E+15	1.7E+15
36	8.3E+14	3.0E+14	5.1E+14	8.5E+14	6.8E+14	2.4E+14	5.0E+14	5.5E+15	2.9E+15	1.0E+15
41	9.7E+14	1.9E+14	3.1E+14	8.1E+14	7.1E+14	1.9E+14	3.8E+14	2.7E+15	3.3E+15	6.4E+14
48	8.5E+14	7.5E+13	1.6E+14	6.8E+14	6.9E+14	1.5E+14	1.6E+14	1.2E+15	3.1E+15	3.6E+14
55	7.4E+14	3.3E+13	1.1E+14	7.0E+14	5.1E+14	9.4E+13	1.3E+14	6.1E+14	2.7E+15	2.3E+14
63	6.1E+14	1.7E+13	5.9E+13	6.2E+14	5.1E+14	8.5E+13	7.8E+13	3.4E+14	2.5E+15	1.7E+14
73	5.1E+14	3.3E+13	3.5E+13	4.5E+14	3.9E+14	2.2E+13	3.5E+13	1.7E+14	1.9E+15	6.6E+13
84	3.9E+14	2.2E+13	2.9E+13	4.3E+14	3.0E+14	2.0E+13	3.7E+13	8.4E+13	1.5E+15	5.4E+13
97	2.8E+14	6.3E+12	1.0E+13	2.8E+14	2.3E+14	1.4E+13	1.3E+13	4.8E+13	1.1E+15	3.7E+13
113	1.7E+14	0.0E+00	0.0E+00	2.3E+14	1.8E+14	3.3E+12	8.1E+12	2.7E+13	5.8E+14	2.9E+13
131	1.2E+14	0.0E+00	5.8E+12	1.2E+14	8.9E+13	6.3E+12	2.9E+12	6.6E+12	5.5E+14	1.5E+13
153	6.1E+13	0.0E+00	0.0E+00	8.1E+13	4.7E+13	6.3E+12	0.0E+00	7.0E+12	2.4E+14	0.0E+00
178	3.2E+13	0.0E+00	0.0E+00	3.4E+13	1.7E+13	0.0E+00	3.1E+12	2.1E+12	2.8E+14	0.0E+00
209	1.6E+13	0.0E+00	0.0E+00	2.2E+13	8.2E+12	1.7E+12	1.4E+12	3.0E+12	5.6E+13	0.0E+00
245	5.4E+12	0.0E+00	0.0E+00	1.3E+13	4.4E+12	0.0E+00	0.0E+00	2.3E+12	0.0E+00	0.0E+00

TABLE A-8.—(Continued).

Test Point	516	517	518	518	519	520	521	522	522	522
Date	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	7	85	7	7	100	85	30	7	7	7
Aerosol Point #	533	534	535	536	537	538	539	540	541	542
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	1.5E+14	8.2E+13	1.7E+14	5.1E+13	3.8E+13	8.1E+13	4.0E+13	4.5E+13	1.4E+13	4.7E+13
10	8.3E+16	1.1E+16	5.9E+16	0.0E+00	0.0E+00	7.8E+14	1.8E+14	8.5E+14	7.4E+14	1.8E+15
12	7.9E+16	6.7E+15	6.8E+16	5.3E+14	7.5E+14	6.1E+14	1.6E+14	7.0E+14	5.6E+14	1.2E+15
14	8.4E+16	2.4E+15	8.0E+16	8.3E+14	2.8E+14	6.2E+14	2.5E+14	8.0E+14	4.5E+14	8.1E+14
16	6.7E+16	1.6E+15	6.7E+16	8.8E+14	5.6E+14	1.1E+15	3.1E+14	7.0E+14	5.3E+14	8.4E+14
18	5.1E+16	2.2E+15	5.0E+16	6.9E+14	5.7E+14	1.6E+15	3.5E+14	7.7E+14	5.4E+14	8.1E+14
21	2.6E+16	2.1E+15	2.9E+16	7.5E+14	8.1E+14	1.7E+15	2.9E+14	8.1E+14	4.4E+14	7.6E+14
24	1.5E+16	1.9E+15	1.6E+16	6.8E+14	1.0E+15	1.9E+15	3.1E+14	6.5E+14	4.4E+14	6.3E+14
27	9.9E+15	1.9E+15	8.1E+15	5.4E+14	1.2E+15	2.2E+15	2.7E+14	4.8E+14	3.9E+14	5.0E+14
31	5.9E+15	2.2E+15	4.7E+15	4.6E+14	1.5E+15	2.4E+15	2.7E+14	3.8E+14	2.4E+14	3.6E+14
36	2.7E+15	1.8E+15	2.2E+15	3.0E+14	1.3E+15	2.7E+15	1.8E+14	2.5E+14	2.2E+14	3.6E+14
41	1.3E+15	1.8E+15	1.4E+15	2.0E+14	1.4E+15	2.5E+15	1.8E+14	1.5E+14	1.6E+14	2.1E+14
48	8.5E+14	1.7E+15	1.0E+15	1.2E+14	1.3E+15	2.3E+15	1.1E+14	1.5E+14	1.2E+14	1.9E+14
55	4.0E+14	1.3E+15	4.7E+14	7.8E+13	1.2E+15	2.2E+15	7.4E+13	8.0E+13	6.0E+13	1.1E+14
63	3.0E+14	1.2E+15	3.5E+14	7.3E+13	1.0E+15	1.9E+15	4.9E+13	4.5E+13	3.4E+13	5.1E+13
73	1.7E+14	1.1E+15	1.7E+14	2.9E+13	8.1E+14	1.5E+15	2.3E+13	2.6E+13	2.9E+13	2.6E+13
84	7.1E+13	8.6E+14	4.3E+13	1.2E+13	6.7E+14	1.2E+15	1.5E+13	7.4E+12	1.6E+13	1.4E+13
97	9.6E+13	5.7E+14	6.7E+13	7.5E+12	5.1E+14	8.5E+14	9.2E+12	1.6E+13	7.5E+12	1.7E+13
113	2.2E+13	4.2E+14	1.7E+13	3.1E+12	3.0E+14	6.4E+14	3.7E+12	3.9E+12	2.2E+12	4.6E+12
131	0.0E+00	2.8E+14	2.5E+13	6.7E+11	2.3E+14	4.1E+14	2.0E+12	1.3E+12	2.6E+12	1.3E+12
153	7.2E+12	1.1E+14	1.1E+13	0.0E+00	1.4E+14	2.5E+14	0.0E+00	0.0E+00	0.0E+00	1.3E+12
178	0.0E+00	7.1E+13	1.1E+13	0.0E+00	8.7E+13	1.1E+14	4.2E+11	0.0E+00	4.2E+11	0.0E+00
209	0.0E+00	6.1E+13	4.7E+12	0.0E+00	1.4E+13	4.5E+13	4.7E+11	7.3E+11	0.0E+00	0.0E+00
245	0.0E+00	2.3E+13	0.0E+00	7.8E+11	2.9E+12	1.0E+13	3.7E+11	0.0E+00	0.0E+00	7.0E+11

TABLE A-8.—(Continued).

Test Point	522	522	522	522	522	523	524	525	526	601
Date	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/26/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	7	7	7	7	7	100	85	30	7	7
Aerosol Point #	543	544	547	548	549	550	551	552	553	602
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	4.0E+13	3.9E+13	1.1E+14	9.8E+13	1.2E+14	4.6E+13	6.1E+13	7.8E+13	1.2E+14	2.1E+14
10	6.7E+14	0.0E+00	1.9E+15	2.4E+15	0.0E+00	1.2E+15	0.0E+00	0.0E+00	0.0E+00	4.1E+16
12	8.7E+14	1.1E+15	1.8E+15	2.1E+15	2.2E+15	1.8E+15	8.9E+14	0.0E+00	5.2E+15	6.9E+16
14	6.9E+14	1.3E+15	2.3E+15	4.1E+15	4.2E+15	1.8E+15	7.9E+14	4.6E+14	2.4E+15	9.8E+16
16	5.6E+14	4.6E+14	1.9E+15	3.2E+15	3.9E+15	1.5E+15	9.2E+14	5.3E+14	1.4E+15	1.4E+17
18	8.8E+14	6.1E+14	1.8E+15	3.3E+15	4.2E+15	1.1E+15	8.6E+14	4.9E+14	3.5E+15	1.5E+17
21	6.3E+14	3.9E+14	1.9E+15	3.0E+15	3.5E+15	1.0E+15	1.1E+15	5.2E+14	1.9E+15	1.4E+17
24	5.1E+14	6.8E+14	1.5E+15	2.6E+15	2.9E+15	1.0E+15	1.1E+15	3.4E+14	2.2E+15	9.6E+16
27	5.5E+14	4.5E+14	1.3E+15	2.1E+15	2.9E+15	9.6E+14	1.6E+15	4.1E+14	8.8E+14	5.1E+16
31	3.7E+14	5.4E+14	1.1E+15	1.8E+15	2.1E+15	1.0E+15	1.3E+15	2.6E+14	1.1E+15	2.0E+16
36	2.7E+14	2.4E+14	9.1E+14	1.3E+15	1.3E+15	1.2E+15	1.6E+15	3.1E+14	4.9E+14	7.2E+15
41	1.8E+14	1.3E+14	5.7E+14	8.0E+14	1.2E+15	1.5E+15	1.5E+15	2.1E+14	5.8E+14	3.1E+15
48	1.6E+14	1.2E+14	4.3E+14	5.2E+14	7.1E+14	1.1E+15	1.4E+15	1.3E+14	1.3E+14	1.9E+15
55	6.4E+13	9.0E+13	3.6E+14	4.0E+14	4.4E+14	1.2E+15	1.3E+15	1.0E+14	1.7E+14	1.2E+15
63	6.2E+13	3.9E+13	2.5E+14	2.3E+14	2.4E+14	1.0E+15	1.1E+15	6.6E+13	2.3E+14	6.8E+14
73	4.2E+13	4.9E+13	1.1E+14	1.5E+14	2.2E+14	7.9E+14	1.1E+15	3.1E+13	8.2E+13	3.3E+14
84	2.3E+13	8.4E+12	7.6E+13	7.5E+13	7.9E+13	5.7E+14	6.8E+14	3.8E+13	8.1E+13	2.1E+14
97	1.0E+13	3.8E+12	3.2E+13	5.3E+13	3.3E+13	4.8E+14	5.8E+14	1.4E+13	0.0E+00	7.2E+13
113	1.2E+12	6.6E+12	2.4E+13	2.4E+13	0.0E+00	3.1E+14	3.5E+14	8.9E+12	0.0E+00	3.7E+13
131	1.3E+12	0.0E+00	9.7E+12	6.2E+12	1.5E+13	1.9E+14	2.0E+14	6.2E+12	4.4E+13	2.1E+13
153	0.0E+00	0.0E+00	2.0E+12	3.8E+12	7.1E+12	1.0E+14	1.3E+14	0.0E+00	0.0E+00	1.7E+13
178	0.0E+00	0.0E+00	1.8E+12	0.0E+00	0.0E+00	6.5E+13	7.6E+13	0.0E+00	0.0E+00	2.2E+13
209	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.1E+13	3.4E+13	0.0E+00	0.0E+00	1.6E+13
245	0.0E+00	0.0E+00	0.0E+00	2.0E+12	0.0E+00	2.6E+13	1.6E+13	6.1E+12	0.0E+00	6.0E+12

TABLE A-8.—(Continued).

Test Point	601	601	603	604	605	605	605	605	605	606
Date	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	7	7	85	30	7	7	7	7	7	100
Aerosol Point #	603	604	607	608	609	610	611	612	613	615
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	9.5E+13	1.0E+14	5.7E+13	8.9E+13	9.4E+13	8.3E+13	1.1E+14	4.9E+13	1.2E+14	1.2E+14
10	8.7E+15	4.3E+15	4.5E+14	3.9E+14	1.5E+16	1.2E+16	1.6E+16	0.0E+00	3.4E+15	0.0E+00
12	8.6E+15	1.3E+16	1.4E+14	7.6E+14	8.6E+15	8.4E+15	0.0E+00	1.2E+15	9.6E+15	0.0E+00
14	7.9E+15	9.5E+15	3.6E+14	5.1E+14	4.8E+15	4.9E+15	3.5E+15	6.9E+14	2.0E+15	8.8E+14
16	6.6E+15	8.9E+15	2.4E+14	4.9E+14	3.6E+15	4.2E+15	4.5E+15	6.7E+14	2.7E+15	1.1E+15
18	5.7E+15	5.5E+15	4.5E+14	4.4E+14	2.5E+15	2.8E+15	1.4E+15	7.0E+14	1.5E+15	2.1E+15
21	4.9E+15	3.8E+15	6.2E+14	4.1E+14	1.5E+15	1.9E+15	1.3E+15	5.4E+14	2.0E+15	1.3E+15
24	3.6E+15	2.3E+15	5.9E+14	6.4E+14	1.3E+15	9.7E+14	1.3E+15	5.3E+14	1.1E+15	1.9E+15
27	2.9E+15	2.6E+15	6.8E+14	4.4E+14	9.4E+14	6.8E+14	5.0E+14	3.7E+14	9.2E+14	3.5E+15
31	1.9E+15	1.3E+15	8.1E+14	3.8E+14	6.6E+14	4.7E+14	7.6E+14	2.4E+14	4.9E+14	3.6E+15
36	1.3E+15	1.0E+15	8.3E+14	3.0E+14	4.0E+14	3.7E+14	0.0E+00	1.0E+14	4.3E+14	2.5E+15
41	6.7E+14	3.7E+14	8.9E+14	2.7E+14	2.8E+14	2.1E+14	3.9E+14	1.0E+14	2.9E+14	3.2E+15
48	4.1E+14	2.6E+14	7.4E+14	1.7E+14	2.2E+14	1.4E+14	5.4E+14	6.7E+13	2.9E+14	2.8E+15
55	2.1E+14	2.0E+14	6.9E+14	1.1E+14	1.1E+14	6.5E+13	8.5E+13	3.9E+13	1.3E+14	2.1E+15
63	1.1E+14	1.4E+14	6.6E+14	7.4E+13	6.7E+13	3.7E+13	8.0E+13	1.8E+13	4.0E+13	1.8E+15
73	9.6E+13	7.9E+13	5.8E+14	4.5E+13	3.3E+13	4.1E+13	0.0E+00	1.4E+13	3.5E+13	1.6E+15
84	4.3E+13	8.4E+13	4.0E+14	3.3E+13	1.5E+13	2.3E+13	0.0E+00	7.0E+12	5.6E+12	1.3E+15
97	2.4E+13	9.2E+12	3.1E+14	1.7E+13	1.4E+13	7.7E+12	1.2E+14	2.8E+12	5.8E+12	9.4E+14
113	1.6E+13	0.0E+00	1.8E+14	6.4E+12	9.7E+12	7.2E+12	0.0E+00	0.0E+00	5.5E+12	7.8E+14
131	6.5E+12	7.5E+12	9.8E+13	2.2E+12	6.7E+12	6.2E+12	0.0E+00	0.0E+00	0.0E+00	5.0E+14
153	1.4E+12	8.1E+12	6.7E+13	3.5E+12	5.4E+12	0.0E+00	0.0E+00	0.0E+00	0.0E+00	2.1E+14
178	2.8E+12	0.0E+00	3.2E+13	5.9E+12	3.6E+12	0.0E+00	5.1E+13	0.0E+00	0.0E+00	1.9E+14
209	1.3E+12	0.0E+00	1.4E+13	1.2E+12	0.0E+00	0.0E+00	5.1E+13	0.0E+00	0.0E+00	3.6E+13
245	1.4E+12	0.0E+00	1.4E+13	2.4E+12	0.0E+00	6.7E+12	0.0E+00	0.0E+00	0.0E+00	1.1E+14

TABLE A-8.—(Continued).

Test Point	607	608	609	609	610	611	612	613	613	614
Date	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	85	30	7	7	100	85	30	7	7	100
Aerosol Point #	616	617	618	619	620	621	622	623	624	625
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	1.1E+14	4.7E+13	9.6E+13	2.3E+14	2.9E+13	7.9E+13	2.3E+13	3.2E+13	2.1E+14	5.5E+13
10	0.0E+00	1.7E+15	1.0E+16	7.3E+16	9.6E+15	0.0E+00	4.9E+14	2.7E+14	5.7E+16	5.8E+16
12	5.5E+14	7.8E+14	9.1E+15	9.4E+16	5.3E+14	1.4E+15	5.6E+13	3.5E+14	8.3E+16	1.4E+16
14	1.6E+15	3.8E+14	5.7E+15	1.3E+17	3.5E+14	8.3E+14	1.0E+14	4.0E+14	1.1E+17	1.5E+16
16	1.8E+15	3.7E+14	3.2E+15	1.5E+17	2.3E+14	1.0E+15	1.5E+14	5.1E+14	1.2E+17	9.6E+15
18	1.1E+15	3.3E+14	2.0E+15	1.5E+17	5.4E+14	9.1E+14	2.1E+14	4.3E+14	1.1E+17	5.1E+15
21	1.6E+15	3.2E+14	1.0E+15	1.1E+17	6.0E+14	1.8E+15	1.8E+14	4.0E+14	7.2E+16	2.3E+15
24	2.0E+15	2.8E+14	9.3E+14	5.5E+16	6.7E+14	1.6E+15	1.9E+14	2.5E+14	3.3E+16	1.4E+15
27	2.4E+15	2.5E+14	7.4E+14	1.8E+16	8.1E+14	2.0E+15	1.5E+14	2.0E+14	1.3E+16	1.2E+15
31	2.1E+15	2.8E+14	5.9E+14	5.1E+15	8.7E+14	2.0E+15	1.2E+14	1.8E+14	4.9E+15	1.4E+15
36	2.2E+15	1.9E+14	4.2E+14	1.9E+15	7.6E+14	2.3E+15	1.0E+14	1.2E+14	2.4E+15	1.3E+15
41	2.1E+15	1.9E+14	3.4E+14	1.1E+15	7.0E+14	2.3E+15	7.6E+13	9.1E+13	1.3E+15	1.3E+15
48	2.6E+15	7.3E+13	1.8E+14	7.3E+14	7.9E+14	2.1E+15	6.0E+13	6.5E+13	7.0E+14	1.3E+15
55	2.0E+15	9.9E+13	8.9E+13	4.6E+14	7.1E+14	1.9E+15	3.1E+13	4.2E+13	4.4E+14	1.2E+15
63	1.5E+15	5.7E+13	6.3E+13	2.4E+14	6.1E+14	1.5E+15	2.8E+13	1.9E+13	2.2E+14	1.0E+15
73	1.3E+15	2.6E+13	4.4E+13	1.5E+14	5.0E+14	1.3E+15	1.6E+13	1.0E+13	1.4E+14	7.9E+14
84	1.1E+15	2.2E+13	2.5E+13	8.4E+13	3.6E+14	1.1E+15	7.1E+12	4.0E+12	8.1E+13	6.6E+14
97	6.4E+14	1.4E+13	4.4E+12	4.5E+13	3.2E+14	7.4E+14	3.0E+12	2.8E+12	3.4E+13	5.0E+14
113	4.8E+14	1.4E+12	2.0E+12	2.2E+13	1.8E+14	5.4E+14	6.4E+11	0.0E+00	4.7E+13	3.8E+14
131	3.1E+14	0.0E+00	1.8E+12	7.1E+12	1.3E+14	3.2E+14	3.0E+11	1.3E+12	1.7E+13	2.0E+14
153	1.9E+14	2.6E+12	5.9E+12	1.7E+13	7.3E+13	1.9E+14	3.2E+11	4.8E+11	1.3E+13	1.2E+14
178	9.0E+13	0.0E+00	5.8E+12	7.4E+12	4.4E+13	1.0E+14	0.0E+00	0.0E+00	7.4E+12	7.0E+13
209	1.9E+13	0.0E+00	0.0E+00	1.8E+13	2.3E+13	3.0E+13	0.0E+00	0.0E+00	8.2E+12	4.9E+13
245	6.4E+12	0.0E+00	0.0E+00	1.0E+13	5.1E+12	1.1E+13	0.0E+00	0.0E+00	4.2E+12	2.3E+13

TABLE A-8.—(Continued).

Test Point	615	616	617	617	617	617	618	619	620	621
Date	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	85	30	7	7	7	7	4	100	85	65
Aerosol Point #	626	627	628	629	630	631	632	633	634	635
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	7.4E+13	1.5E+14	2.1E+14	4.4E+13	2.9E+13	4.8E+13	1.7E+14	9.3E+13	8.5E+13	7.1E+13
10	2.4E+16	7.8E+16	5.5E+16	3.9E+14	3.2E+14	3.8E+15	3.3E+16	9.0E+15	5.8E+15	1.9E+16
12	1.3E+16	9.6E+16	1.1E+17	1.2E+15	5.5E+14	1.8E+15	4.4E+16	5.7E+15	3.3E+15	9.8E+15
14	6.0E+15	9.7E+16	1.2E+17	5.1E+14	4.0E+14	1.7E+15	5.5E+16	3.3E+15	1.6E+15	4.8E+15
16	3.3E+15	7.4E+16	1.2E+17	2.6E+14	1.9E+14	1.1E+15	6.9E+16	2.7E+15	1.4E+15	3.6E+15
18	1.5E+15	4.3E+16	1.0E+17	3.1E+14	3.3E+14	1.0E+15	7.2E+16	2.8E+15	1.3E+15	1.7E+15
21	1.3E+15	1.4E+16	5.6E+16	3.6E+14	2.6E+14	8.2E+14	6.5E+16	2.1E+15	1.4E+15	1.2E+15
24	1.6E+15	3.4E+15	1.8E+16	4.8E+14	2.1E+14	5.6E+14	5.2E+16	2.2E+15	1.1E+15	8.9E+14
27	1.5E+15	1.4E+15	5.7E+15	2.4E+14	2.3E+14	4.5E+14	3.9E+16	2.0E+15	1.1E+15	6.5E+14
31	1.6E+15	1.1E+15	2.1E+15	1.5E+14	1.4E+14	3.1E+14	2.5E+16	1.8E+15	1.1E+15	5.9E+14
36	1.4E+15	6.7E+14	1.3E+15	1.3E+14	1.1E+14	2.4E+14	1.3E+16	1.9E+15	1.1E+15	4.7E+14
41	1.6E+15	4.8E+14	8.3E+14	6.1E+13	6.7E+13	1.9E+14	6.9E+15	1.7E+15	1.2E+15	4.3E+14
48	1.4E+15	3.7E+14	5.1E+14	5.7E+13	3.0E+13	1.1E+14	3.3E+15	1.6E+15	1.1E+15	3.3E+14
55	1.3E+15	2.2E+14	4.2E+14	3.9E+13	2.5E+13	4.9E+13	1.8E+15	1.4E+15	1.0E+15	3.1E+14
63	1.1E+15	1.8E+14	1.7E+14	1.1E+13	2.0E+13	1.8E+13	7.1E+14	1.2E+15	8.3E+14	2.1E+14
73	7.8E+14	1.0E+14	1.2E+14	1.3E+13	6.8E+12	1.8E+13	3.4E+14	1.1E+15	6.3E+14	1.6E+14
84	6.3E+14	2.1E+13	4.0E+13	3.7E+12	4.8E+12	6.2E+12	2.1E+14	8.2E+14	4.9E+14	8.9E+13
97	5.9E+14	2.0E+13	2.7E+13	2.4E+12	1.3E+12	1.0E+12	8.2E+13	6.5E+14	3.4E+14	5.4E+13
113	3.8E+14	7.7E+12	8.6E+13	6.8E+11	0.0E+00	0.0E+00	3.8E+13	3.6E+14	2.1E+14	3.3E+13
131	2.1E+14	2.0E+13	1.5E+13	0.0E+00	5.2E+11	1.7E+12	1.1E+13	2.6E+14	1.7E+14	2.6E+13
153	1.5E+14	1.4E+13	0.0E+00	6.7E+11	0.0E+00	0.0E+00	9.2E+12	1.5E+14	8.3E+13	7.5E+12
178	7.2E+13	3.5E+12	0.0E+00	0.0E+00	0.0E+00	0.0E+00	3.6E+12	7.8E+13	5.3E+13	1.2E+12
209	2.7E+13	6.5E+12	0.0E+00	0.0E+00	0.0E+00	0.0E+00	6.0E+12	3.7E+13	2.0E+13	0.0E+00
245	8.3E+12	0.0E+00	8.5E+12	8.3E+11	0.0E+00	5.6E+12	3.8E+12	2.4E+13	7.6E+12	1.1E+12

TABLE A-8.—(Continued).

Test Point	622	623	623	624	624	624	624	625	626	627
Date	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	40	4	4	40	40	40	40	30	15	7
Aerosol Point #	636	637	638	640	641	643	644	645	646	647
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	8.6E+13	2.6E+14	6.0E+13	2.9E+13	4.0E+13	4.3E+13	3.1E+13	4.6E+13	6.1E+13	6.2E+13
10	4.2E+16	1.6E+17	4.5E+15	2.3E+14	1.1E+14	0.0E+00	1.3E+14	0.0E+00	3.2E+14	0.0E+00
12	4.2E+16	1.6E+16	5.2E+15	5.2E+14	2.9E+14	4.9E+14	1.3E+14	2.6E+14	8.4E+13	5.7E+14
14	2.8E+16	2.1E+16	5.2E+15	2.0E+14	4.8E+14	4.8E+14	1.9E+14	2.7E+14	2.7E+14	4.9E+14
16	1.9E+16	4.0E+16	3.4E+15	3.1E+14	5.0E+14	5.1E+14	1.7E+14	3.1E+14	2.8E+14	5.0E+14
18	8.4E+15	4.7E+16	2.9E+15	2.7E+14	4.4E+14	3.1E+14	2.7E+14	2.8E+14	3.0E+14	7.2E+14
21	3.3E+15	3.0E+16	2.4E+15	3.0E+14	4.5E+14	4.6E+14	2.1E+14	3.4E+14	2.9E+14	4.0E+14
24	1.8E+15	3.2E+16	1.7E+15	2.6E+14	3.3E+14	3.8E+14	1.8E+14	3.0E+14	3.4E+14	3.6E+14
27	8.8E+14	4.1E+16	1.5E+15	2.7E+14	3.3E+14	3.2E+14	2.0E+14	2.2E+14	2.7E+14	2.7E+14
31	6.8E+14	3.4E+16	1.1E+15	2.2E+14	2.9E+14	3.0E+14	1.3E+14	2.0E+14	1.5E+14	1.5E+14
36	5.1E+14	2.4E+16	6.2E+14	1.7E+14	2.4E+14	3.0E+14	1.1E+14	1.6E+14	1.5E+14	1.6E+14
41	3.7E+14	1.2E+16	3.0E+14	1.5E+14	2.0E+14	2.4E+14	1.1E+14	1.3E+14	1.1E+14	1.1E+14
48	2.0E+14	4.6E+15	2.9E+14	9.7E+13	1.5E+14	2.0E+14	7.7E+13	9.7E+13	9.1E+13	6.3E+13
55	1.6E+14	1.0E+15	1.7E+14	7.3E+13	1.0E+14	1.2E+14	4.4E+13	4.6E+13	4.8E+13	3.7E+13
63	7.6E+13	3.5E+14	1.3E+14	5.9E+13	6.8E+13	5.9E+13	3.5E+13	3.4E+13	1.8E+13	2.6E+13
73	4.7E+13	3.4E+14	5.6E+13	3.4E+13	4.1E+13	4.4E+13	2.0E+13	2.1E+13	1.2E+13	8.7E+12
84	2.9E+13	9.1E+13	2.0E+13	1.9E+13	2.2E+13	3.1E+13	1.4E+13	9.8E+12	6.1E+12	3.3E+12
97	9.0E+12	0.0E+00	8.6E+12	9.3E+12	1.1E+13	1.7E+13	7.2E+12	2.7E+12	2.1E+12	2.9E+12
113	1.1E+13	0.0E+00	1.2E+13	4.1E+12	4.0E+12	1.5E+12	1.8E+12	1.7E+12	0.0E+00	0.0E+00
131	2.1E+12	3.5E+13	0.0E+00	8.6E+11	1.2E+12	5.5E+12	1.2E+12	2.0E+12	0.0E+00	0.0E+00
153	2.0E+12	3.2E+13	0.0E+00	3.9E+11	1.1E+12	0.0E+00	2.3E+11	0.0E+00	0.0E+00	0.0E+00
178	0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.0E+11	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
209	0.0E+00	0.0E+00	0.0E+00	4.3E+11	2.0E+11	0.0E+00	0.0E+00	0.0E+00	1.0E+12	0.0E+00
245	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

TABLE A-8.—(Continued).

Test Point	628	629	629	629	630	631	632	633	634	635
Date	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	5.5	4	4	4	5.5	7	15	30	4	40
Aerosol Point #	648	649	650	651	652	653	654	655	656	657
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	5.0E+13	0.0E+00	4.0E+13	1.7E+14	1.7E+14	1.7E+14	1.4E+14	1.2E+14	1.4E+14	1.2E+14
10	1.2E+15	0.0E+00	5.9E+14	3.1E+16	3.0E+16	4.6E+16	4.9E+16	3.8E+16	2.7E+16	3.7E+16
12	7.8E+14	0.0E+00	9.6E+14	4.0E+16	5.5E+16	4.1E+16	5.8E+16	4.7E+16	3.6E+16	4.2E+16
14	8.3E+14	0.0E+00	8.6E+14	5.0E+16	7.0E+16	5.2E+16	5.2E+16	4.2E+16	4.6E+16	3.7E+16
16	7.8E+14	0.0E+00	8.4E+14	5.1E+16	8.1E+16	5.1E+16	4.7E+16	3.0E+16	5.5E+16	2.5E+16
18	6.0E+14	0.0E+00	6.1E+14	5.6E+16	7.9E+16	4.4E+16	2.9E+16	1.7E+16	5.8E+16	1.4E+16
21	6.2E+14	0.0E+00	5.9E+14	4.9E+16	5.8E+16	3.6E+16	1.7E+16	1.0E+16	5.2E+16	7.6E+15
24	4.2E+14	0.0E+00	4.2E+14	3.9E+16	3.3E+16	2.5E+16	9.8E+15	5.8E+15	4.0E+16	4.6E+15
27	3.7E+14	0.0E+00	3.3E+14	2.7E+16	1.6E+16	1.8E+16	6.9E+15	3.4E+15	2.8E+16	3.3E+15
31	3.0E+14	0.0E+00	3.0E+14	1.9E+16	7.2E+15	1.2E+16	3.6E+15	2.2E+15	1.8E+16	2.0E+15
36	2.0E+14	0.0E+00	2.0E+14	1.2E+16	3.9E+15	5.8E+15	1.9E+15	1.0E+15	1.1E+16	1.1E+15
41	1.3E+14	0.0E+00	1.3E+14	6.3E+15	1.9E+15	3.1E+15	9.2E+14	5.8E+14	5.5E+15	6.9E+14
48	1.0E+14	0.0E+00	1.1E+14	3.2E+15	9.5E+14	1.6E+15	4.9E+14	3.7E+14	2.6E+15	4.8E+14
55	5.0E+13	0.0E+00	6.9E+13	1.2E+15	5.6E+14	7.2E+14	2.2E+14	2.8E+14	1.3E+15	3.3E+14
63	2.3E+13	0.0E+00	3.4E+13	6.9E+14	3.8E+14	3.1E+14	1.3E+14	1.3E+14	6.1E+14	2.4E+14
73	1.8E+13	0.0E+00	2.7E+13	3.7E+14	1.5E+14	1.0E+14	6.5E+13	9.5E+13	2.5E+14	1.3E+14
84	6.9E+12	0.0E+00	8.8E+12	2.3E+14	8.0E+13	9.2E+13	2.8E+13	6.9E+13	1.4E+14	7.2E+13
97	3.3E+12	0.0E+00	6.7E+12	8.3E+13	7.5E+13	3.3E+13	1.3E+13	1.1E+13	5.7E+13	3.6E+13
113	1.3E+12	0.0E+00	3.7E+12	2.7E+13	3.5E+13	1.8E+13	1.2E+13	9.8E+12	2.5E+13	2.5E+13
131	0.0E+00	0.0E+00	0.0E+00	1.4E+13	1.8E+13	3.2E+12	7.6E+12	2.3E+12	2.0E+13	1.0E+13
153	1.8E+12	0.0E+00	1.3E+12	8.6E+12	5.4E+12	6.7E+12	2.8E+12	4.9E+12	4.5E+12	5.7E+12
178	0.0E+00	0.0E+00	0.0E+00	5.8E+12	2.7E+12	3.1E+12	0.0E+00	4.2E+12	1.2E+12	3.7E+12
209	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.1E+13	3.0E+12	2.5E+12	0.0E+00	9.9E+11	1.7E+12
245	0.0E+00	0.0E+00	0.0E+00	3.4E+12	0.0E+00	0.0E+00	0.0E+00	2.7E+12	2.7E+12	0.0E+00

TABLE A-8.—(Continued).

Test Point	635	635	635	636	637	637	638	639	640	640
Date	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	40	40	40	30	15	15	7	5.5	4	4
Aerosol Point #	658	659	660	661	662	662	663	664	665	666
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	5.0E+13	5.6E+13	5.9E+13	5.9E+13	5.3E+13	1.7E+14	9.9E+13	1.1E+14	9.6E+13	2.8E+14
10	5.4E+14	0.0E+00	4.9E+14	1.3E+15	0.0E+00	2.3E+15	7.5E+14	2.3E+15	4.2E+15	1.7E+16
12	4.0E+14	3.1E+14	4.2E+14	5.5E+14	1.6E+15	2.6E+15	2.2E+15	3.0E+15	4.8E+15	2.0E+16
14	4.3E+14	2.4E+14	3.3E+14	6.6E+14	8.3E+14	3.1E+15	1.8E+15	2.6E+15	3.1E+15	2.4E+16
16	3.8E+14	4.0E+14	4.7E+14	6.8E+14	8.3E+14	1.9E+15	1.3E+15	2.8E+15	3.6E+15	3.8E+16
18	3.2E+14	4.2E+14	4.4E+14	6.7E+14	1.6E+15	2.0E+15	1.7E+15	2.5E+15	3.6E+15	7.7E+16
21	2.8E+14	3.3E+14	3.7E+14	5.5E+14	1.6E+15	1.6E+15	1.5E+15	2.5E+15	3.2E+15	8.0E+16
24	2.4E+14	3.4E+14	4.2E+14	4.2E+14	9.2E+14	1.5E+15	1.2E+15	1.9E+15	2.7E+15	6.4E+16
27	2.2E+14	3.2E+14	3.4E+14	3.6E+14	6.0E+14	9.8E+14	1.0E+15	1.5E+15	1.9E+15	5.8E+16
31	1.9E+14	3.9E+14	3.5E+14	2.9E+14	6.0E+14	8.5E+14	8.5E+14	1.1E+15	1.3E+15	4.1E+16
36	1.8E+14	2.9E+14	3.2E+14	2.4E+14	3.2E+14	5.7E+14	5.5E+14	7.8E+14	9.7E+14	2.2E+16
41	1.5E+14	2.2E+14	2.1E+14	1.6E+14	2.1E+14	2.7E+14	3.3E+14	4.7E+14	6.4E+14	1.1E+16
48	9.9E+13	1.5E+14	1.5E+14	1.3E+14	1.5E+14	3.0E+14	1.9E+14	2.9E+14	3.7E+14	4.9E+15
55	8.3E+13	1.4E+14	1.3E+14	9.1E+13	8.8E+13	1.6E+14	1.2E+14	1.8E+14	2.5E+14	1.9E+15
63	6.2E+13	9.6E+13	8.5E+13	5.8E+13	8.5E+13	1.0E+14	6.8E+13	9.9E+13	1.2E+14	8.5E+14
73	3.7E+13	4.0E+13	3.9E+13	3.1E+13	4.3E+13	6.1E+13	2.9E+13	7.3E+13	8.5E+13	5.8E+14
84	2.1E+13	3.0E+13	3.3E+13	2.2E+13	1.9E+13	3.2E+13	1.5E+13	2.7E+13	3.7E+13	3.0E+14
97	7.6E+12	1.4E+13	1.0E+13	8.3E+12	1.5E+13	2.3E+13	1.1E+13	1.6E+13	2.0E+13	8.7E+13
113	5.3E+12	5.3E+12	5.1E+12	5.2E+12	2.4E+12	1.1E+13	1.3E+12	1.2E+13	1.7E+13	3.8E+13
131	3.4E+12	6.5E+12	3.0E+12	1.7E+12	0.0E+00	3.9E+12	1.2E+12	3.0E+12	4.6E+12	1.9E+13
153	1.0E+12	1.7E+12	1.6E+12	6.1E+11	1.9E+12	2.0E+12	1.2E+12	2.4E+12	2.5E+12	1.9E+13
178	7.8E+11	1.7E+12	0.0E+00	0.0E+00	2.0E+12	3.7E+12	1.1E+12	2.3E+12	0.0E+00	0.0E+00
209	4.7E+11	8.1E+11	0.0E+00	1.1E+12	0.0E+00	2.1E+12	0.0E+00	0.0E+00	0.0E+00	0.0E+00
245	8.4E+11	0.0E+00	1.7E+12	6.6E+11	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

TABLE A-8.—(Continued).

Test Point	641	642	643	701	702	703	704	705	705	706
Date	4/26/2004	4/26/2004	4/26/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	5.5	7	15	4	100	85	65	4	4	100
Aerosol Point #	667	668	669	701	702	703	704	705	706	707
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	2.2E+14	2.4E+14	1.9E+14	6.2E+13	3.9E+13	4.1E+13	4.2E+13	7.3E+13	2.8E+13	2.4E+13
10	5.3E+16	3.6E+16	7.4E+16	2.0E+16	5.8E+14	0.0E+00	0.0E+00	1.2E+16	3.6E+15	5.5E+14
12	6.6E+16	7.6E+16	5.4E+16	2.0E+16	3.3E+14	1.3E+14	3.4E+14	1.3E+16	1.4E+15	1.3E+14
14	7.9E+16	1.0E+17	5.7E+16	1.8E+16	5.2E+14	4.6E+14	2.8E+14	1.4E+16	1.3E+15	2.4E+14
16	8.2E+16	9.9E+16	4.3E+16	1.5E+16	6.1E+14	5.3E+14	3.9E+14	1.1E+16	1.4E+15	4.1E+14
18	7.9E+16	8.3E+16	3.2E+16	1.2E+16	7.2E+14	5.8E+14	4.1E+14	8.6E+15	1.1E+15	4.3E+14
21	6.4E+16	5.2E+16	2.7E+16	1.0E+16	8.0E+14	9.2E+14	4.5E+14	5.6E+15	1.2E+15	5.4E+14
24	4.0E+16	3.2E+16	1.9E+16	7.2E+15	9.3E+14	8.8E+14	5.7E+14	3.5E+15	8.4E+14	6.1E+14
27	2.3E+16	2.0E+16	1.2E+16	5.9E+15	1.0E+15	9.6E+14	5.6E+14	2.4E+15	6.4E+14	6.4E+14
31	1.1E+16	1.1E+16	7.3E+15	4.8E+15	1.1E+15	1.1E+15	5.0E+14	1.8E+15	5.4E+14	7.1E+14
36	6.3E+15	5.9E+15	4.2E+15	3.4E+15	1.2E+15	1.0E+15	4.7E+14	1.1E+15	2.9E+14	7.1E+14
41	3.2E+15	2.9E+15	2.0E+15	2.4E+15	1.1E+15	9.9E+14	4.3E+14	7.7E+14	2.2E+14	7.0E+14
48	1.7E+15	1.5E+15	1.1E+15	1.6E+15	1.1E+15	9.6E+14	3.8E+14	5.2E+14	1.6E+14	7.3E+14
55	7.2E+14	7.8E+14	6.4E+14	1.0E+15	9.8E+14	8.8E+14	2.8E+14	3.0E+14	9.1E+13	6.3E+14
63	3.7E+14	3.1E+14	4.1E+14	6.0E+14	9.1E+14	7.3E+14	2.1E+14	1.9E+14	4.8E+13	5.3E+14
73	2.3E+14	1.4E+14	1.8E+14	4.0E+14	7.6E+14	6.1E+14	1.7E+14	1.1E+14	2.8E+13	4.3E+14
84	8.0E+13	1.2E+14	1.2E+14	2.2E+14	6.0E+14	4.8E+14	1.0E+14	4.8E+13	1.6E+13	3.2E+14
97	5.3E+13	4.2E+13	5.9E+13	1.2E+14	4.6E+14	2.8E+14	7.1E+13	2.8E+13	1.0E+13	2.3E+14
113	2.8E+13	6.1E+13	2.5E+13	5.5E+13	3.1E+14	2.1E+14	3.9E+13	1.7E+13	0.0E+00	1.5E+14
131	1.4E+13	1.8E+13	2.0E+13	3.4E+13	1.9E+14	1.3E+14	1.6E+13	4.7E+12	1.6E+12	9.3E+13
153	3.4E+12	1.3E+13	1.9E+13	1.1E+13	1.2E+14	7.6E+13	1.0E+13	4.2E+12	7.5E+11	5.4E+13
178	5.7E+12	1.2E+13	9.1E+12	4.7E+12	6.6E+13	3.9E+13	4.5E+12	1.1E+12	0.0E+00	2.1E+13
209	6.8E+12	1.0E+13	1.0E+13	2.2E+12	3.6E+13	1.4E+13	1.3E+12	2.2E+12	0.0E+00	9.2E+12
245	0.0E+00	4.5E+12	3.6E+12	1.3E+12	1.3E+13	2.7E+12	1.0E+12	0.0E+00	0.0E+00	2.1E+12

TABLE A-8.—(Continued).

Test Point	707	708	709	710	711	712	713	714	715	715
Date	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	85	70	65	60	4	100	85	65	4	4
Aerosol Point #	708	709	710	711	712	714	715	716	717	718
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	2.6E+13	2.5E+13	2.4E+13	3.2E+13	4.0E+13	2.95E+13	2.83E+13	2.68E+13	3.98E+13	6.83E+13
10	1.4E+14	0.0E+00	0.0E+00	3.2E+14	1.7E+15	3.19E+14	0.00E+00	1.79E+14	2.79E+15	1.15E+16
12	2.7E+14	1.9E+14	2.0E+14	1.5E+14	1.9E+15	1.08E+14	3.24E+14	1.17E+14	1.84E+15	1.48E+16
14	2.4E+14	2.6E+14	1.6E+14	2.1E+14	1.6E+15	3.61E+14	2.89E+14	2.52E+14	1.81E+15	1.24E+16
16	3.8E+14	3.4E+14	2.9E+14	3.3E+14	1.4E+15	2.85E+14	3.68E+14	2.61E+14	1.23E+15	1.01E+16
18	5.0E+14	3.9E+14	2.4E+14	3.8E+14	1.1E+15	3.95E+14	4.33E+14	2.99E+14	1.13E+15	6.48E+15
21	6.2E+14	4.8E+14	3.2E+14	3.8E+14	8.9E+14	5.91E+14	5.26E+14	3.07E+14	8.56E+14	4.18E+15
24	6.5E+14	5.1E+14	3.2E+14	4.7E+14	7.3E+14	6.78E+14	6.73E+14	3.41E+14	7.52E+14	3.10E+15
27	7.6E+14	5.8E+14	3.2E+14	4.3E+14	5.4E+14	6.55E+14	7.54E+14	3.17E+14	5.80E+14	2.24E+15
31	7.7E+14	5.2E+14	3.3E+14	3.7E+14	3.9E+14	7.19E+14	8.52E+14	3.41E+14	4.30E+14	1.68E+15
36	7.9E+14	4.5E+14	2.9E+14	3.9E+14	2.5E+14	7.96E+14	8.13E+14	3.13E+14	2.58E+14	1.06E+15
41	7.4E+14	4.0E+14	2.7E+14	2.5E+14	2.1E+14	7.57E+14	7.86E+14	3.00E+14	2.00E+14	7.36E+14
48	7.2E+14	3.5E+14	1.8E+14	2.3E+14	1.2E+14	7.74E+14	7.52E+14	2.59E+14	1.39E+14	4.96E+14
55	6.3E+14	2.7E+14	1.6E+14	1.7E+14	6.8E+13	6.39E+14	6.63E+14	1.90E+14	9.00E+13	2.98E+14
63	5.0E+14	2.1E+14	1.3E+14	1.1E+14	4.5E+13	5.41E+14	5.41E+14	1.36E+14	3.18E+13	2.16E+14
73	4.0E+14	1.5E+14	7.9E+13	8.3E+13	2.7E+13	4.51E+14	4.49E+14	1.01E+14	2.44E+13	1.17E+14
84	2.9E+14	1.0E+14	5.2E+13	4.5E+13	9.7E+12	3.68E+14	3.24E+14	6.26E+13	1.41E+13	4.82E+13
97	2.1E+14	6.9E+13	2.9E+13	2.5E+13	3.3E+12	2.45E+14	2.25E+14	3.52E+13	6.28E+12	3.12E+13
113	1.2E+14	4.1E+13	1.4E+13	1.1E+13	3.2E+12	1.87E+14	1.43E+14	2.10E+13	3.07E+12	1.85E+13
131	7.7E+13	1.8E+13	7.4E+12	4.4E+12	8.1E+11	1.06E+14	8.10E+13	1.01E+13	1.37E+12	4.74E+12
153	4.1E+13	9.7E+12	3.7E+12	2.1E+12	0.0E+00	6.37E+13	4.06E+13	3.88E+12	4.42E+11	8.26E+12
178	1.8E+13	4.7E+12	1.4E+12	2.0E+12	0.0E+00	3.33E+13	1.95E+13	9.01E+11	0.00E+00	4.34E+12
209	6.8E+12	2.7E+11	3.2E+11	1.1E+12	0.0E+00	1.47E+13	8.16E+12	0.00E+00	0.00E+00	3.58E+12
245	2.1E+12	2.9E+11	0.0E+00	5.8E+11	0.0E+00	3.22E+12	3.24E+12	0.00E+00	0.00E+00	2.50E+12

TABLE A-8.—(Continued).

Test Point	716	717	718	719	719	720	721	722	723	724
Date	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	100	85	65	4	4	100	85	70	65	60
Aerosol Point #	719	720	721	722	723	724	725	726	727	728
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	1.12E+14	1.09E+14	4.30E+13	6.37E+13	2.17E+14	6.40E+13	7.30E+13	7.81E+13	8.47E+13	8.70E+13
10	0.00E+00	0.00E+00	0.00E+00	8.75E+15	3.72E+16	3.58E+16	3.11E+16	5.69E+16	5.01E+16	5.82E+16
12	6.04E+14	9.30E+14	5.82E+13	1.22E+16	5.71E+16	4.29E+16	3.99E+16	5.34E+16	6.52E+16	7.02E+16
14	9.46E+14	1.27E+15	3.09E+14	9.65E+15	8.57E+16	3.11E+16	2.82E+16	5.02E+16	5.62E+16	6.19E+16
16	1.42E+15	1.11E+15	2.33E+14	7.81E+15	1.16E+17	2.41E+16	1.73E+16	3.34E+16	4.27E+16	4.51E+16
18	1.44E+15	1.46E+15	3.61E+14	5.55E+15	1.46E+17	9.93E+15	7.17E+15	1.52E+16	1.95E+16	2.26E+16
21	1.80E+15	1.45E+15	4.83E+14	3.38E+15	1.36E+17	3.24E+15	2.62E+15	4.68E+15	6.16E+15	7.01E+15
24	1.93E+15	1.76E+15	4.97E+14	2.47E+15	1.06E+17	1.77E+15	1.89E+15	1.57E+15	1.73E+15	1.83E+15
27	2.22E+15	2.36E+15	4.80E+14	1.87E+15	6.19E+16	1.82E+15	1.83E+15	1.27E+15	1.21E+15	1.01E+15
31	2.67E+15	2.37E+15	5.17E+14	1.31E+15	2.78E+16	2.14E+15	1.87E+15	1.29E+15	1.05E+15	7.48E+14
36	2.30E+15	2.47E+15	4.67E+14	8.41E+14	1.06E+16	1.48E+15	1.68E+15	9.89E+14	9.38E+14	6.69E+14
41	2.80E+15	2.27E+15	4.93E+14	6.61E+14	4.92E+15	1.38E+15	1.52E+15	8.46E+14	7.16E+14	5.10E+14
48	2.54E+15	2.19E+15	3.58E+14	4.56E+14	2.41E+15	1.20E+15	1.36E+15	7.52E+14	6.09E+14	4.47E+14
55	2.04E+15	1.92E+15	2.73E+14	2.36E+14	1.41E+15	1.06E+15	1.15E+15	5.60E+14	4.90E+14	3.01E+14
63	1.82E+15	1.58E+15	2.05E+14	1.56E+14	7.67E+14	8.62E+14	9.65E+14	4.83E+14	3.68E+14	2.34E+14
73	1.75E+15	1.28E+15	1.68E+14	8.73E+13	4.06E+14	6.34E+14	7.25E+14	3.37E+14	2.73E+14	1.63E+14
84	1.17E+15	1.04E+15	1.12E+14	6.06E+13	1.89E+14	5.08E+14	5.42E+14	2.56E+14	1.75E+14	1.18E+14
97	9.18E+14	7.89E+14	7.04E+13	2.97E+13	1.67E+14	4.18E+14	4.20E+14	1.50E+14	9.14E+13	6.78E+13
113	5.56E+14	5.09E+14	3.69E+13	1.74E+13	6.38E+13	2.44E+14	2.54E+14	1.03E+14	5.35E+13	5.22E+13
131	4.14E+14	3.63E+14	2.72E+13	8.49E+12	4.56E+13	1.56E+14	1.50E+14	6.37E+13	4.28E+13	1.45E+13
153	2.03E+14	1.70E+14	6.81E+12	2.23E+12	3.37E+13	6.03E+13	1.04E+14	3.23E+13	1.64E+13	9.83E+12
178	8.81E+13	8.48E+13	3.34E+12	1.22E+12	3.29E+13	4.88E+13	5.39E+13	1.87E+13	1.21E+13	9.54E+12
209	4.28E+13	4.33E+13	2.76E+12	0.00E+00	2.63E+13	2.50E+13	1.72E+13	5.24E+12	6.79E+12	3.60E+12
245	1.04E+13	2.19E+13	0.00E+00	2.38E+12	1.13E+13	1.20E+13	1.12E+13	4.26E+12	3.30E+12	7.07E+12

TABLE A-8.—(Continued).

Test Point	725	726	726	726	727	728	729	730	731	732
Date	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004
Fuel	base	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur
Power (%)	4	4	4	4	100	85	65	40	30	7
Aerosol Point #	729	730	731	732	733	734	735	736	737	738
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	2.03E+14	2.24E+14	2.16E+14	2.21E+14	1.00E+14	8.73E+13	1.10E+14	1.73E+14	2.10E+14	2.56E+14
10	3.60E+16	3.75E+16	4.30E+16	2.98E+16	2.12E+16	1.17E+16	3.25E+16	4.11E+16	6.34E+16	6.09E+16
12	5.91E+16	5.76E+16	5.66E+16	5.90E+16	2.05E+16	1.52E+16	3.48E+16	6.30E+16	7.91E+16	7.70E+16
14	8.61E+16	8.15E+16	9.10E+16	8.68E+16	1.28E+16	7.46E+15	3.74E+16	8.42E+16	1.03E+17	1.25E+17
16	1.20E+17	9.54E+16	1.20E+17	1.15E+17	9.86E+15	3.11E+15	3.68E+16	1.06E+17	1.43E+17	1.70E+17
18	1.45E+17	1.04E+17	1.37E+17	1.45E+17	4.55E+15	1.72E+15	2.77E+16	1.13E+17	1.60E+17	2.05E+17
21	1.37E+17	9.02E+16	1.34E+17	1.40E+17	2.34E+15	1.30E+15	1.61E+16	1.03E+17	1.51E+17	2.04E+17
24	9.88E+16	6.67E+16	9.11E+16	1.07E+17	1.82E+15	1.15E+15	6.21E+15	6.67E+16	1.03E+17	1.51E+17
27	5.91E+16	3.42E+16	5.41E+16	6.52E+16	1.62E+15	1.32E+15	2.39E+15	3.12E+16	5.12E+16	8.10E+16
31	2.54E+16	1.67E+16	2.42E+16	2.97E+16	1.71E+15	1.37E+15	1.44E+15	9.08E+15	1.44E+16	2.88E+16
36	9.23E+15	8.27E+15	9.87E+15	1.11E+16	2.06E+15	1.52E+15	1.11E+15	2.30E+15	3.69E+15	7.52E+15
41	3.98E+15	4.33E+15	4.38E+15	4.58E+15	1.85E+15	1.45E+15	1.09E+15	1.34E+15	1.44E+15	2.01E+15
48	1.92E+15	2.23E+15	2.23E+15	2.40E+15	1.85E+15	1.37E+15	8.17E+14	8.29E+14	8.11E+14	9.04E+14
55	1.06E+15	1.14E+15	1.41E+15	1.20E+15	1.59E+15	1.22E+15	6.62E+14	4.14E+14	4.21E+14	4.66E+14
63	5.77E+14	8.19E+14	7.02E+14	5.38E+14	1.53E+15	1.04E+15	5.05E+14	2.81E+14	2.18E+14	1.72E+14
73	3.29E+14	3.51E+14	2.72E+14	2.64E+14	1.19E+15	8.84E+14	3.24E+14	1.13E+14	8.47E+13	7.17E+13
84	1.67E+14	2.66E+14	1.64E+14	1.94E+14	9.88E+14	6.24E+14	2.38E+14	8.14E+13	5.62E+13	2.66E+13
97	1.45E+14	5.65E+13	7.80E+13	6.47E+13	6.40E+14	4.48E+14	1.38E+14	4.30E+13	3.94E+13	4.05E+13
113	6.75E+13	9.94E+12	4.31E+13	2.66E+13	4.51E+14	2.76E+14	7.87E+13	2.16E+13	2.26E+13	1.84E+13
131	7.16E+13	1.51E+13	2.66E+13	2.09E+13	3.14E+14	2.02E+14	3.82E+13	1.02E+13	1.35E+13	1.28E+13
153	3.19E+13	0.00E+00	7.13E+12	1.10E+13	2.04E+14	1.17E+14	2.38E+13	9.49E+12	0.00E+00	7.88E+12
178	1.92E+13	0.00E+00	3.29E+12	6.73E+12	9.64E+13	7.04E+13	1.82E+13	2.08E+12	7.90E+12	0.00E+00
209	2.36E+12	0.00E+00	3.64E+12	3.83E+12	5.25E+13	2.58E+13	3.28E+12	2.04E+12	0.00E+00	0.00E+00
245	1.27E+13	0.00E+00	0.00E+00	6.82E+12	1.70E+13	9.52E+12	0.00E+00	0.00E+00	5.30E+12	4.33E+12

TABLE A-8.—(Continued).

Test Point	733	733	734	735	736	737	738	739	740	740
Date	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004
Fuel	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur
Power (%)	4	4	100	85	65	40	30	7	4	4
Aerosol Point #	739	740	741	742	743	744	745	746	747	748
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	2.50E+14	9.45E+13	7.62E+13	7.50E+13	8.01E+13	8.29E+13	8.91E+13	1.42E+14	1.05E+14	7.18E+13
10	5.55E+16	2.81E+15	0.00E+00	0.00E+00	1.67E+14	0.00E+00	4.92E+14	2.50E+15	8.70E+15	1.35E+15
12	6.25E+16	4.85E+15	7.70E+13	2.67E+14	1.31E+14	1.84E+14	8.35E+13	2.54E+15	4.42E+15	1.56E+15
14	9.40E+16	4.43E+15	2.82E+14	2.31E+14	2.41E+14	1.07E+14	1.89E+14	2.17E+15	3.60E+15	1.55E+15
16	1.34E+17	4.39E+15	3.61E+14	2.98E+14	2.65E+14	3.66E+14	2.53E+14	1.39E+15	3.31E+15	1.04E+15
18	1.77E+17	3.68E+15	4.84E+14	4.60E+14	3.15E+14	3.22E+14	3.12E+14	1.03E+15	2.34E+15	1.22E+15
21	1.77E+17	2.68E+15	5.19E+14	4.70E+14	2.99E+14	3.16E+14	2.69E+14	7.61E+14	1.83E+15	8.24E+14
24	1.41E+17	1.82E+15	5.40E+14	4.68E+14	3.26E+14	2.51E+14	2.65E+14	6.12E+14	1.56E+15	7.84E+14
27	8.69E+16	1.19E+15	6.78E+14	4.98E+14	3.31E+14	2.58E+14	1.80E+14	4.40E+14	1.27E+15	7.06E+14
31	3.78E+16	7.79E+14	7.20E+14	6.32E+14	3.38E+14	2.21E+14	2.44E+14	3.30E+14	7.95E+14	5.31E+14
36	1.19E+16	5.11E+14	7.18E+14	5.96E+14	3.34E+14	2.10E+14	1.99E+14	1.81E+14	5.71E+14	4.17E+14
41	4.06E+15	3.55E+14	7.11E+14	6.03E+14	3.03E+14	1.58E+14	1.20E+14	1.78E+14	3.72E+14	2.42E+14
48	1.66E+15	2.41E+14	6.39E+14	5.64E+14	2.69E+14	1.16E+14	9.90E+13	1.29E+14	2.53E+14	1.45E+14
55	7.61E+14	1.58E+14	5.64E+14	5.20E+14	2.20E+14	6.62E+13	8.32E+13	5.72E+13	1.66E+14	1.08E+14
63	4.57E+14	8.73E+13	4.50E+14	4.58E+14	1.66E+14	5.06E+13	3.70E+13	4.65E+13	1.14E+14	5.26E+13
73	2.27E+14	6.35E+13	4.16E+14	3.78E+14	1.29E+14	2.90E+13	1.52E+13	2.39E+13	5.24E+13	1.33E+13
84	1.32E+14	2.66E+13	3.39E+14	3.05E+14	8.44E+13	1.36E+13	9.14E+12	1.85E+13	2.20E+13	1.59E+13
97	6.03E+13	1.09E+13	2.32E+14	2.07E+14	6.01E+13	8.18E+12	6.80E+12	4.90E+12	2.62E+13	5.03E+12
113	2.61E+13	6.87E+12	1.89E+14	1.46E+14	3.93E+13	4.88E+12	1.89E+12	1.28E+12	1.63E+12	3.37E+12
131	8.20E+12	2.39E+12	1.18E+14	1.01E+14	1.61E+13	2.61E+12	9.42E+11	2.29E+12	6.32E+12	3.11E+12
153	0.00E+00	0.00E+00	6.18E+13	6.11E+13	8.18E+12	4.78E+11	1.70E+12	2.11E+12	1.58E+12	1.59E+12
178	1.67E+13	7.86E+11	3.80E+13	3.24E+13	3.35E+12	1.03E+12	0.00E+00	2.28E+12	1.69E+12	0.00E+00
209	8.72E+12	0.00E+00	1.65E+13	1.07E+13	1.26E+12	0.00E+00	9.00E+11	0.00E+00	0.00E+00	1.05E+13
245	4.17E+12	8.09E+11	1.21E+13	4.80E+12	0.00E+00	1.06E+12	0.00E+00	1.25E+12	0.00E+00	1.68E+12

TABLE A-8.—(Continued).

Test Point	741	742	743	744	745	746	747	748	749	750
Date	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004
Fuel	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur
Power (%)	100	85	70	65	60	40	30	15	7	5.5
Aerosol Point #	749	750	751	752	753	754	755	756	757	758
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	1.15E+14	4.44E+13	5.51E+13	5.04E+13	4.66E+13	4.29E+13	3.78E+13	3.55E+13	4.15E+13	5.85E+13
10	0.00E+00	2.13E+14	0.00E+00	0.00E+00	4.13E+14	2.71E+14	5.54E+14	7.29E+14	7.91E+14	1.09E+15
12	0.00E+00	3.80E+14	1.68E+14	3.48E+14	7.16E+13	3.14E+14	2.62E+14	2.60E+14	3.80E+14	1.59E+15
14	9.67E+14	3.68E+14	3.53E+14	4.08E+14	1.65E+14	3.70E+14	1.95E+14	2.74E+14	5.43E+14	5.69E+14
16	7.21E+14	4.75E+14	4.08E+14	4.28E+14	3.33E+14	3.73E+14	2.14E+14	2.71E+14	3.17E+14	6.79E+14
18	1.30E+15	5.74E+14	4.41E+14	3.35E+14	3.10E+14	2.91E+14	2.54E+14	1.53E+14	4.61E+14	7.53E+14
21	1.81E+15	8.00E+14	4.28E+14	4.13E+14	3.94E+14	3.74E+14	2.92E+14	1.52E+14	3.39E+14	5.39E+14
24	1.80E+15	8.00E+14	6.09E+14	4.60E+14	3.46E+14	3.30E+14	2.59E+14	1.50E+14	1.36E+14	4.34E+14
27	2.30E+15	9.24E+14	6.05E+14	4.56E+14	3.05E+14	3.34E+14	1.90E+14	1.21E+14	1.52E+14	3.22E+14
31	2.65E+15	1.03E+15	6.08E+14	4.07E+14	3.02E+14	2.56E+14	1.91E+14	1.22E+14	1.18E+14	1.96E+14
36	2.46E+15	9.45E+14	5.56E+14	4.09E+14	2.82E+14	2.00E+14	1.25E+14	7.82E+13	8.99E+13	1.90E+14
41	2.90E+15	9.87E+14	4.92E+14	3.81E+14	2.97E+14	1.40E+14	1.02E+14	5.07E+13	6.04E+13	1.02E+14
48	2.60E+15	8.80E+14	4.32E+14	2.97E+14	1.83E+14	1.23E+14	5.92E+13	3.00E+13	3.71E+13	8.79E+13
55	2.39E+15	8.15E+14	3.43E+14	2.14E+14	1.40E+14	8.70E+13	4.72E+13	2.88E+13	1.15E+13	6.54E+13
63	2.11E+15	6.70E+14	2.69E+14	1.81E+14	1.02E+14	3.75E+13	2.33E+13	9.95E+12	1.14E+13	2.49E+13
73	1.55E+15	5.82E+14	2.12E+14	1.42E+14	6.45E+13	3.48E+13	2.05E+13	5.46E+12	6.87E+12	9.75E+12
84	1.36E+15	4.44E+14	1.21E+14	9.38E+13	4.20E+13	2.19E+13	5.59E+12	4.54E+12	2.47E+12	1.35E+13
97	1.07E+15	3.21E+14	9.45E+13	4.85E+13	2.40E+13	9.60E+12	2.31E+12	2.22E+12	2.46E+12	8.74E+11
113	5.46E+14	2.14E+14	6.09E+13	3.75E+13	1.09E+13	1.62E+12	2.22E+12	5.36E+11	3.72E+12	1.66E+12
131	4.53E+14	1.40E+14	2.44E+13	1.37E+13	5.15E+12	4.85E+11	1.59E+12	9.08E+11	3.99E+12	7.40E+11
153	1.85E+14	7.01E+13	1.52E+13	7.31E+12	3.19E+12	1.56E+12	0.00E+00	0.00E+00	1.43E+12	0.00E+00
178	1.58E+14	3.84E+13	3.40E+12	9.79E+11	1.19E+12	0.00E+00	0.00E+00	4.89E+11	1.42E+12	7.75E+11
209	7.20E+13	1.64E+13	4.69E+11	4.68E+11	3.76E+11	0.00E+00	8.12E+11	0.00E+00	0.00E+00	3.77E+12
245	4.43E+13	4.25E+12	1.05E+12	1.06E+12	4.28E+11	0.00E+00	4.58E+11	2.11E+12	0.00E+00	5.11E+12

TABLE A-8.—(Continued).

Test Point	751	751	802	803	804	805	805	805	805	806
Date	4/27/2004	4/27/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004
Fuel	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur
Power (%)	4	4	100	85	65	40	40	40	40	30
Aerosol Point #	759	801	802	803	804	805	806	807	808	809
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	5.73E+13	5.22E+13	6.32E+13	2.97E+13	2.46E+13	5.84E+13	1.22E+13	4.93E+13	6.06E+13	4.82E+13
10	2.28E+15	4.21E+15	0.00E+00	1.75E+14	1.95E+14	8.82E+14	3.44E+15	6.08E+14	0.00E+00	6.04E+14
12	2.04E+15	3.57E+15	7.09E+14	3.54E+14	2.22E+14	5.64E+14	4.80E+15	4.56E+14	5.60E+14	1.02E+14
14	1.59E+15	3.86E+15	5.52E+14	2.73E+14	1.95E+14	5.14E+14	3.32E+15	4.91E+14	4.57E+14	2.80E+14
16	1.35E+15	3.15E+15	6.81E+14	4.73E+14	2.13E+14	4.19E+14	1.83E+15	6.75E+14	4.90E+14	4.06E+14
18	1.17E+15	2.99E+15	1.36E+15	5.17E+14	2.44E+14	5.17E+14	9.76E+14	5.81E+14	4.03E+14	6.52E+14
21	1.11E+15	2.28E+15	1.41E+15	5.41E+14	3.36E+14	5.17E+14	4.73E+14	6.54E+14	4.72E+14	3.77E+14
24	8.18E+14	2.13E+15	1.53E+15	6.79E+14	3.39E+14	4.64E+14	3.44E+14	6.11E+14	4.73E+14	4.46E+14
27	5.77E+14	1.83E+15	1.83E+15	7.72E+14	2.92E+14	3.88E+14	2.78E+14	5.75E+14	5.72E+14	3.51E+14
31	4.83E+14	1.33E+15	1.88E+15	8.25E+14	3.20E+14	3.59E+14	3.22E+14	3.79E+14	3.48E+14	2.84E+14
36	2.99E+14	9.93E+14	1.87E+15	7.42E+14	2.65E+14	3.15E+14	2.00E+14	3.30E+14	2.18E+14	1.86E+14
41	2.58E+14	7.15E+14	1.80E+15	8.28E+14	2.42E+14	2.15E+14	1.22E+14	2.58E+14	2.14E+14	1.53E+14
48	1.18E+14	5.78E+14	1.72E+15	7.22E+14	2.13E+14	1.47E+14	8.30E+13	1.99E+14	1.18E+14	8.63E+13
55	9.33E+13	3.34E+14	1.65E+15	6.54E+14	1.48E+14	1.02E+14	5.86E+13	9.60E+13	7.64E+13	4.00E+13
63	3.65E+13	2.53E+14	1.45E+15	5.61E+14	1.39E+14	7.18E+13	4.06E+13	5.52E+13	2.04E+13	5.52E+13
73	4.28E+13	1.49E+14	1.11E+15	4.49E+14	9.17E+13	4.28E+13	2.64E+13	4.60E+13	3.67E+13	3.49E+13
84	2.64E+13	7.88E+13	8.62E+14	3.40E+14	6.51E+13	2.83E+13	1.51E+13	2.94E+13	2.27E+13	1.90E+13
97	1.13E+13	3.97E+13	5.97E+14	2.46E+14	2.88E+13	7.06E+12	1.05E+13	1.49E+13	1.11E+13	1.24E+12
113	3.94E+12	1.93E+13	4.48E+14	1.56E+14	2.25E+13	6.57E+12	2.23E+12	6.93E+12	0.00E+00	1.21E+12
131	5.05E+12	1.17E+13	2.37E+14	1.04E+14	1.08E+13	3.10E+12	2.62E+12	2.45E+12	0.00E+00	0.00E+00
153	4.54E+12	2.66E+12	1.55E+14	5.38E+13	4.75E+12	1.42E+12	2.40E+12	0.00E+00	0.00E+00	0.00E+00
178	3.12E+12	5.76E+11	7.11E+13	2.89E+13	1.72E+12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
209	1.55E+12	0.00E+00	4.27E+13	1.12E+13	1.05E+12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
245	7.00E+11	0.00E+00	9.21E+12	4.15E+12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE A-8.—(Continued).

Test Point	807	808	808	809	810	811	812	812	812	812
Date	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004
Fuel	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur
Power (%)	7	4	4	100	85	65	40	40	40	40
Aerosol Point #	810	811	812	813	814	815	816	817	818	819
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	4.17E+13	3.81E+13	7.91E+13	1.34E+14	1.36E+14	6.47E+13	4.80E+13	6.49E+13	7.07E+13	6.74E+13
10	5.33E+14	3.65E+15	1.30E+16	0.00E+00	3.44E+15	7.35E+14	9.76E+14	6.76E+14	0.00E+00	0.00E+00
12	5.96E+14	1.51E+15	1.44E+16	1.94E+15	1.02E+15	2.26E+14	2.12E+14	4.85E+14	4.85E+14	3.43E+14
14	6.59E+14	1.19E+15	1.22E+16	5.61E+14	8.10E+14	3.78E+14	2.78E+14	2.42E+14	3.81E+14	4.37E+14
16	5.30E+14	1.09E+15	9.12E+15	1.26E+15	1.14E+15	3.19E+14	4.21E+14	2.57E+14	4.34E+14	3.51E+14
18	4.55E+14	9.49E+14	5.62E+15	1.50E+15	1.23E+15	3.48E+14	4.02E+14	2.93E+14	5.82E+14	4.81E+14
21	3.57E+14	6.89E+14	4.01E+15	1.95E+15	1.40E+15	3.99E+14	3.61E+14	2.86E+14	5.08E+14	3.58E+14
24	2.86E+14	5.70E+14	2.41E+15	1.95E+15	1.59E+15	5.50E+14	3.43E+14	3.19E+14	4.52E+14	4.21E+14
27	2.01E+14	4.10E+14	1.51E+15	2.17E+15	2.46E+15	5.71E+14	3.56E+14	2.59E+14	3.21E+14	4.34E+14
31	1.52E+14	3.09E+14	1.05E+15	2.45E+15	1.94E+15	6.01E+14	2.35E+14	2.29E+14	3.50E+14	3.59E+14
36	1.22E+14	1.83E+14	7.21E+14	2.39E+15	2.13E+15	5.26E+14	1.99E+14	1.80E+14	2.79E+14	2.66E+14
41	6.59E+13	1.22E+14	4.82E+14	2.48E+15	2.31E+15	4.32E+14	1.67E+14	1.67E+14	2.32E+14	2.28E+14
48	3.62E+13	8.53E+13	3.08E+14	2.54E+15	2.00E+15	3.66E+14	1.13E+14	1.11E+14	1.49E+14	1.80E+14
55	3.38E+13	6.48E+13	1.63E+14	2.27E+15	1.78E+15	3.14E+14	7.56E+13	8.90E+13	1.27E+14	1.35E+14
63	1.13E+13	2.19E+13	1.15E+14	1.69E+15	1.40E+15	2.28E+14	4.65E+13	5.88E+13	1.26E+14	8.12E+13
73	9.36E+12	1.32E+13	6.74E+13	1.31E+15	1.36E+15	1.66E+14	3.96E+13	3.67E+13	5.13E+13	5.73E+13
84	9.14E+12	6.59E+12	2.49E+13	1.13E+15	9.76E+14	1.32E+14	2.51E+13	1.61E+13	3.04E+13	3.06E+13
97	1.38E+12	2.85E+12	1.14E+13	8.22E+14	6.92E+14	6.77E+13	1.04E+13	1.01E+13	2.30E+13	1.55E+13
113	6.02E+11	2.04E+12	7.49E+12	6.01E+14	4.80E+14	3.15E+13	3.72E+12	4.24E+12	1.77E+13	7.86E+12
131	0.00E+00	0.00E+00	1.87E+12	4.90E+14	3.06E+14	2.49E+13	3.21E+12	3.42E+12	8.59E+12	1.56E+12
153	0.00E+00	0.00E+00	4.88E+12	2.07E+14	1.50E+14	4.02E+12	0.00E+00	1.15E+12	5.50E+12	1.13E+12
178	0.00E+00	6.18E+11	1.02E+12	1.17E+14	4.06E+13	5.32E+12	0.00E+00	2.26E+12	1.76E+12	1.13E+12
209	0.00E+00	0.00E+00	8.50E+11	2.25E+13	5.15E+13	1.33E+12	0.00E+00	0.00E+00	0.00E+00	0.00E+00
245	0.00E+00	0.00E+00	0.00E+00	2.19E+13	1.24E+13	0.00E+00	0.00E+00	3.08E+11	0.00E+00	0.00E+00

TABLE A-8.—(Continued).

Test Point	813	814	815	815	816	817	818	819	820	821
Date	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004
Fuel	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur
Power (%)	30	7	4	4	100	85	70	65	60	40
Aerosol Point #	820	821	822	823	824	825	826	827	828	829
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	5.35E+13	9.08E+13	7.58E+13	2.50E+14	4.27E+13	9.64E+13	1.24E+14	1.25E+14	1.26E+14	1.65E+14
10	1.42E+15	1.20E+16	1.32E+16	4.28E+16	2.13E+17	3.34E+16	3.50E+16	3.07E+16	3.76E+16	3.80E+16
12	5.31E+14	6.05E+15	1.05E+16	5.82E+16	2.09E+16	3.86E+16	5.00E+16	5.09E+16	5.69E+16	8.24E+16
14	3.83E+14	5.26E+15	7.96E+15	9.96E+16	1.20E+16	4.61E+16	6.66E+16	7.06E+16	7.34E+16	1.02E+17
16	3.44E+14	2.77E+15	6.45E+15	1.33E+17	1.63E+16	5.53E+16	8.35E+16	8.80E+16	9.34E+16	1.43E+17
18	3.67E+14	2.25E+15	4.41E+15	1.75E+17	1.63E+16	5.13E+16	8.99E+16	1.00E+17	1.05E+17	1.59E+17
21	4.46E+14	9.76E+14	3.10E+15	1.82E+17	1.92E+16	3.69E+16	7.54E+16	8.92E+16	9.71E+16	1.49E+17
24	2.75E+14	8.03E+14	1.99E+15	1.41E+17	1.60E+16	1.93E+16	4.65E+16	5.96E+16	6.89E+16	1.06E+17
27	2.63E+14	6.70E+14	1.41E+15	8.67E+16	6.50E+15	7.20E+15	2.12E+16	2.83E+16	3.53E+16	5.69E+16
31	2.44E+14	4.05E+14	9.31E+14	3.22E+16	2.51E+15	2.75E+15	6.51E+15	8.49E+15	1.11E+16	1.95E+16
36	2.47E+14	2.95E+14	6.34E+14	1.11E+16	1.15E+15	2.08E+15	2.30E+15	2.29E+15	2.35E+15	3.80E+15
41	1.26E+14	1.84E+14	4.87E+14	3.38E+15	1.03E+15	1.78E+15	1.50E+15	1.22E+15	8.41E+14	9.76E+14
48	9.76E+13	1.41E+14	2.73E+14	1.53E+15	8.33E+14	1.71E+15	1.25E+15	9.03E+14	6.65E+14	6.96E+14
55	8.25E+13	6.51E+13	1.83E+14	6.83E+14	8.14E+14	1.43E+15	9.41E+14	6.26E+14	3.99E+14	3.45E+14
63	5.22E+13	5.52E+13	1.06E+14	2.86E+14	5.91E+14	1.11E+15	6.83E+14	5.35E+14	3.05E+14	1.97E+14
73	3.37E+13	2.09E+13	5.35E+13	2.08E+14	4.93E+14	9.12E+14	5.15E+14	3.07E+14	1.68E+14	1.17E+14
84	1.93E+13	1.43E+13	4.06E+13	1.08E+14	3.74E+14	6.89E+14	3.36E+14	2.42E+14	9.39E+13	8.12E+13
97	1.08E+13	3.52E+12	3.14E+12	6.43E+13	2.93E+14	4.20E+14	2.07E+14	1.16E+14	6.06E+13	3.43E+13
113	3.16E+12	1.64E+12	6.87E+12	2.98E+13	1.83E+14	3.34E+14	1.76E+14	6.59E+13	4.08E+13	1.74E+13
131	2.35E+12	2.87E+12	1.23E+12	1.30E+13	1.14E+14	1.87E+14	1.00E+14	3.99E+13	2.20E+13	6.49E+12
153	8.80E+11	0.00E+00	1.33E+12	1.36E+13	4.61E+13	1.05E+14	6.57E+13	1.37E+13	1.45E+13	4.63E+12
178	1.49E+12	0.00E+00	0.00E+00	1.40E+13	3.01E+13	4.32E+13	1.81E+13	1.03E+13	3.62E+12	9.22E+12
209	0.00E+00	1.43E+12	0.00E+00	1.28E+13	1.65E+13	3.51E+13	1.32E+13	6.55E+12	5.13E+12	2.19E+12
245	8.87E+11	1.63E+12	0.00E+00	5.20E+12	9.43E+12	4.93E+12	1.51E+12	1.89E+12	1.94E+12	2.43E+12

TABLE A-8.—(Continued).

Test Point	822	823	824	825	826	827	828	829	830	831
Date	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004
Fuel	sulfur	sulfur	sulfur	sulfur	sulfur	aromatic	aromatic	aromatic	aromatic	aromatic
Power (%)	30	15	7	5.5	4	4	100	85	65	40
Aerosol Point #	830	831	832	833	834	836	837	838	839	840
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	2.00E+14	2.11E+14	2.43E+14	2.49E+14	2.44E+14	1.82E+14	7.79E+13	6.90E+13	7.88E+13	1.07E+14
10	4.68E+16	9.36E+16	1.04E+17	2.22E+16	3.85E+16	7.58E+16	3.73E+16	3.23E+16	5.72E+16	1.00E+17
12	9.65E+16	1.16E+17	1.06E+17	8.85E+16	6.93E+16	7.91E+16	3.44E+16	2.59E+16	5.06E+16	8.30E+16
14	1.31E+17	1.46E+17	1.31E+17	1.23E+17	1.02E+17	9.03E+16	1.96E+16	1.41E+16	3.55E+16	7.54E+16
16	1.65E+17	1.85E+17	1.75E+17	1.66E+17	1.49E+17	9.60E+16	1.16E+16	5.34E+15	2.01E+16	5.76E+16
18	1.96E+17	2.05E+17	1.98E+17	1.93E+17	1.72E+17	9.45E+16	3.69E+15	1.65E+15	7.79E+15	3.34E+16
21	1.78E+17	1.77E+17	1.95E+17	1.90E+17	1.66E+17	6.96E+16	1.48E+15	1.00E+15	2.09E+15	1.03E+16
24	1.29E+17	1.14E+17	1.31E+17	1.33E+17	1.29E+17	4.16E+16	1.30E+15	1.04E+15	8.88E+14	2.03E+15
27	6.92E+16	5.28E+16	6.51E+16	7.01E+16	7.43E+16	2.03E+16	1.22E+15	9.91E+14	8.47E+14	9.07E+14
31	2.23E+16	1.45E+16	1.92E+16	2.20E+16	2.91E+16	8.65E+15	1.36E+15	1.09E+15	7.08E+14	6.02E+14
36	4.28E+15	2.38E+15	3.89E+15	5.47E+15	8.25E+15	4.02E+15	1.32E+15	1.08E+15	6.17E+14	3.67E+14
41	9.63E+14	5.23E+14	1.21E+15	1.86E+15	2.75E+15	1.78E+15	1.43E+15	1.04E+15	5.20E+14	3.22E+14
48	4.88E+14	2.87E+14	5.05E+14	5.34E+14	1.31E+15	1.21E+15	1.41E+15	9.67E+14	4.54E+14	2.59E+14
55	3.14E+14	1.61E+14	2.25E+14	4.50E+14	5.68E+14	5.64E+14	1.17E+15	8.56E+14	3.28E+14	1.32E+14
63	1.83E+14	9.08E+13	7.43E+13	2.67E+14	3.66E+14	3.98E+14	1.17E+15	6.74E+14	2.69E+14	8.36E+13
73	9.79E+13	7.83E+13	8.37E+13	1.38E+14	1.94E+14	1.92E+14	8.67E+14	5.56E+14	1.89E+14	9.18E+13
84	9.68E+13	2.82E+13	6.32E+13	6.86E+13	1.42E+14	1.20E+14	6.83E+14	4.04E+14	1.44E+14	2.99E+13
97	2.81E+13	1.82E+13	3.65E+13	4.34E+13	9.44E+13	5.40E+13	5.01E+14	3.06E+14	8.40E+13	1.27E+13
113	9.89E+12	2.06E+13	1.08E+13	1.47E+13	2.74E+13	4.41E+13	3.67E+14	2.43E+14	5.66E+13	1.88E+13
131	8.53E+12	1.46E+13	2.95E+13	1.76E+13	2.78E+13	1.19E+13	2.45E+14	1.18E+14	3.22E+13	8.48E+12
153	1.54E+13	1.15E+13	1.08E+13	1.92E+13	8.29E+12	3.96E+12	1.79E+14	8.62E+13	2.50E+13	4.55E+12
178	6.14E+12	1.51E+13	1.56E+13	9.13E+12	1.23E+13	1.32E+13	8.88E+13	4.60E+13	9.04E+12	2.24E+12
209	2.31E+13	3.78E+12	1.98E+13	4.36E+12	7.50E+12	1.68E+13	3.14E+13	1.38E+13	3.21E+12	0.00E+00
245	3.25E+12	0.00E+00	5.52E+12	0.00E+00	1.32E+13	0.00E+00	5.93E+12	5.63E+12	0.00E+00	0.00E+00

TABLE A-8.—(Continued).

Test Point	832	833	834	834	835	836	837	838	841	842
Date	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004
Fuel	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic
Power (%)	30	7	4	4	100	85	65	40	4	100
Aerosol Point #	841	842	843	844	845	846	847	848	852	853
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	1.36E+14	2.06E+14	1.70E+14	6.87E+13	1.12E+14	4.30E+13	4.41E+13	4.18E+13	3.78E+13	7.99E+12
10	1.08E+17	1.20E+17	7.35E+16	4.55E+15	1.76E+15	6.24E+14	0.00E+00	5.28E+14	1.29E+15	5.73E+15
12	1.09E+17	1.31E+17	9.84E+16	3.13E+15	4.69E+14	2.77E+14	1.22E+14	1.27E+14	8.93E+14	4.20E+14
14	1.00E+17	1.28E+17	9.96E+16	2.34E+15	9.48E+14	3.03E+14	3.01E+14	2.28E+14	1.07E+15	6.54E+13
16	7.81E+16	1.24E+17	1.07E+17	2.14E+15	8.06E+14	3.53E+14	3.16E+14	1.71E+14	7.33E+14	9.07E+13
18	5.15E+16	7.98E+16	8.26E+16	1.61E+15	1.03E+15	5.11E+14	3.38E+14	2.09E+14	7.46E+14	1.13E+14
21	1.79E+16	3.65E+16	5.22E+16	1.25E+15	1.47E+15	6.51E+14	3.48E+14	2.40E+14	6.04E+14	1.19E+14
24	5.01E+15	1.25E+16	1.95E+16	8.14E+14	2.00E+15	5.44E+14	3.51E+14	2.09E+14	4.73E+14	1.88E+14
27	1.02E+15	4.97E+15	6.91E+15	6.21E+14	1.74E+15	6.45E+14	3.69E+14	2.23E+14	3.22E+14	1.95E+14
31	8.05E+14	1.98E+15	2.67E+15	4.97E+14	2.31E+15	6.54E+14	3.86E+14	1.75E+14	2.51E+14	2.07E+14
36	4.32E+14	1.33E+15	1.17E+15	3.54E+14	2.35E+15	7.21E+14	3.14E+14	1.35E+14	1.49E+14	1.97E+14
41	2.84E+14	8.78E+14	6.19E+14	2.26E+14	2.50E+15	6.88E+14	2.93E+14	1.07E+14	1.07E+14	1.98E+14
48	2.71E+14	3.86E+14	3.39E+14	1.54E+14	2.42E+15	6.27E+14	2.16E+14	7.36E+13	7.13E+13	1.97E+14
55	1.26E+14	1.20E+14	2.20E+14	7.42E+13	2.01E+15	5.99E+14	2.40E+14	5.80E+13	4.01E+13	1.67E+14
63	8.57E+13	8.20E+13	1.57E+14	4.99E+13	1.78E+15	4.86E+14	1.64E+14	3.49E+13	2.55E+13	1.55E+14
73	6.22E+13	4.81E+13	7.96E+13	3.01E+13	1.41E+15	4.07E+14	1.11E+14	1.74E+13	2.08E+13	1.16E+14
84	2.73E+13	4.56E+13	6.85E+13	1.68E+13	1.04E+15	2.95E+14	7.57E+13	1.27E+13	4.27E+12	9.00E+13
97	3.00E+13	1.70E+13	4.22E+13	6.29E+12	7.78E+14	2.26E+14	5.35E+13	5.28E+12	2.59E+12	7.05E+13
113	1.76E+13	2.29E+13	1.37E+13	4.81E+12	6.69E+14	1.52E+14	3.45E+13	6.37E+12	1.83E+12	5.14E+13
131	6.45E+12	4.29E+13	2.50E+13	5.81E+12	3.87E+14	1.10E+14	1.29E+13	1.88E+12	1.16E+12	2.73E+13
153	8.75E+12	3.68E+13	3.27E+13	3.25E+12	2.71E+14	5.05E+13	5.67E+12	9.51E+11	7.66E+11	1.72E+13
178	1.72E+13	1.47E+13	1.27E+13	7.49E+11	1.14E+14	2.71E+13	1.33E+12	8.55E+11	3.38E+11	7.32E+12
209	4.10E+12	7.07E+12	1.69E+13	0.00E+00	5.49E+13	1.02E+13	2.28E+12	4.73E+11	0.00E+00	2.32E+12
245	1.19E+13	2.38E+13	3.01E+12	1.54E+12	2.88E+13	4.99E+12	1.01E+12	0.00E+00	0.00E+00	1.25E+12

TABLE A-8.—(Continued).

Test Point	843	844	845	846	847	848	849	850	851	852
Date	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004
Fuel	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic
Power (%)	85	100	85	70	65	60	40	30	15	7
Aerosol Point #	854	855	856	857	858	859	860	861	862	863
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	2.69E+13	2.76E+13	2.87E+13	3.57E+13	3.01E+13	2.68E+13	4.73E+13	3.33E+13	6.79E+13	4.50E+13
10	4.46E+14	0.00E+00	2.24E+14	0.00E+00	0.00E+00	0.00E+00	2.65E+14	7.57E+14	0.00E+00	8.58E+14
12	2.44E+14	6.62E+13	1.63E+14	1.88E+14	8.55E+13	1.23E+14	3.06E+14	1.85E+14	0.00E+00	4.26E+14
14	1.96E+14	3.47E+14	2.53E+14	1.33E+14	2.01E+14	1.53E+14	1.57E+14	2.74E+14	3.03E+14	2.69E+14
16	2.80E+14	2.74E+14	3.16E+14	2.64E+14	1.74E+14	1.65E+14	2.68E+14	2.46E+14	3.05E+14	3.07E+14
18	3.61E+14	3.70E+14	4.70E+14	3.22E+14	2.55E+14	1.76E+14	1.77E+14	1.90E+14	3.24E+14	2.78E+14
21	5.03E+14	5.86E+14	5.15E+14	3.82E+14	2.46E+14	2.40E+14	2.95E+14	1.81E+14	2.35E+14	1.89E+14
24	5.53E+14	5.40E+14	5.60E+14	3.55E+14	2.13E+14	2.20E+14	3.27E+14	1.32E+14	2.32E+14	1.53E+14
27	6.65E+14	7.12E+14	6.60E+14	4.05E+14	2.69E+14	1.74E+14	2.70E+14	1.40E+14	2.46E+14	1.32E+14
31	6.39E+14	7.06E+14	6.43E+14	3.94E+14	2.56E+14	2.03E+14	2.67E+14	9.73E+13	1.83E+14	9.82E+13
36	6.16E+14	6.94E+14	6.80E+14	3.58E+14	2.37E+14	1.63E+14	1.90E+14	8.70E+13	5.59E+13	7.54E+13
41	6.21E+14	7.33E+14	6.30E+14	3.07E+14	1.87E+14	1.33E+14	1.38E+14	5.77E+13	4.57E+13	4.13E+13
48	6.08E+14	7.06E+14	5.65E+14	2.79E+14	1.83E+14	1.12E+14	1.31E+14	4.48E+13	3.57E+13	2.96E+13
55	5.29E+14	5.88E+14	5.23E+14	2.35E+14	1.28E+14	9.25E+13	6.80E+13	2.50E+13	3.28E+13	1.24E+13
63	4.43E+14	5.09E+14	5.05E+14	1.62E+14	1.03E+14	6.13E+13	5.20E+13	1.90E+13	7.28E+12	1.36E+13
73	3.59E+14	3.86E+14	3.68E+14	1.29E+14	6.72E+13	3.82E+13	3.27E+13	7.12E+12	0.00E+00	2.78E+12
84	2.81E+14	3.06E+14	2.89E+14	8.53E+13	4.39E+13	2.21E+13	1.64E+13	5.63E+12	0.00E+00	1.09E+12
97	2.00E+14	2.19E+14	1.92E+14	4.55E+13	2.62E+13	1.30E+13	9.68E+12	7.92E+11	0.00E+00	9.82E+11
113	1.26E+14	1.36E+14	1.37E+14	2.79E+13	1.38E+13	5.18E+12	2.53E+12	3.24E+11	0.00E+00	8.69E+11
131	7.99E+13	8.58E+13	7.69E+13	1.88E+13	5.03E+12	3.37E+12	1.02E+12	0.00E+00	0.00E+00	0.00E+00
153	4.52E+13	4.92E+13	5.22E+13	8.49E+12	1.33E+12	1.11E+12	0.00E+00	0.00E+00	0.00E+00	0.00E+00
178	2.57E+13	2.27E+13	1.81E+13	3.52E+12	9.15E+11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
209	8.76E+12	1.28E+13	7.69E+12	8.72E+11	0.00E+00	0.00E+00	5.17E+11	0.00E+00	0.00E+00	0.00E+00
245	3.04E+12	3.90E+12	2.22E+12	4.60E+11	3.53E+11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE A-8.—(Continued).

Test Point	853	854	854	855	856	857	858	859	860	861
Date	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004
Fuel	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic
Power (%)	5.5	4	4	100	85	65	40	30	7	4
Aerosol Point #	864	865	866	867	868	869	870	871	872	873
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	5.42E+13	3.11E+13	7.70E+13	4.09E+13	5.37E+13	4.93E+13	5.51E+13	5.86E+13	6.42E+13	7.47E+13
10	5.39E+14	8.36E+14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.77E+14
12	6.58E+14	1.14E+15	0.00E+00	0.00E+00	0.00E+00	8.54E+13	4.04E+13	3.72E+13	7.87E+13	4.76E+13
14	6.23E+14	7.13E+14	1.31E+14	0.00E+00	1.74E+13	1.31E+14	2.40E+14	2.42E+14	3.46E+14	1.63E+14
16	5.10E+14	8.05E+14	2.82E+14	6.98E+13	3.90E+13	3.17E+14	4.89E+14	3.74E+14	6.61E+14	3.94E+14
18	4.04E+14	5.15E+14	5.12E+14	1.25E+14	1.10E+14	4.59E+14	9.96E+14	1.17E+15	1.18E+15	8.86E+14
21	4.51E+14	3.84E+14	8.67E+14	3.50E+14	2.13E+14	9.10E+14	1.43E+15	1.90E+15	1.74E+15	1.69E+15
24	2.33E+14	3.45E+14	1.38E+15	4.60E+14	3.14E+14	1.24E+15	1.97E+15	2.42E+15	2.23E+15	2.47E+15
27	1.78E+14	2.36E+14	1.78E+15	4.89E+14	3.33E+14	1.20E+15	1.88E+15	2.55E+15	2.17E+15	2.65E+15
31	1.49E+14	2.76E+14	1.94E+15	5.61E+14	4.07E+14	1.07E+15	1.47E+15	2.24E+15	1.73E+15	2.18E+15
36	1.03E+14	1.08E+14	1.70E+15	4.73E+14	4.72E+14	6.39E+14	7.37E+14	1.16E+15	9.45E+14	1.42E+15
41	6.56E+13	9.74E+13	1.16E+15	4.38E+14	4.39E+14	4.16E+14	3.18E+14	4.68E+14	3.96E+14	6.64E+14
48	4.31E+13	5.60E+13	5.91E+14	4.38E+14	4.43E+14	2.59E+14	1.48E+14	1.58E+14	1.39E+14	2.77E+14
55	2.15E+13	4.62E+13	2.26E+14	4.13E+14	4.37E+14	1.58E+14	7.77E+13	6.34E+13	5.03E+13	1.15E+14
63	1.32E+13	2.39E+13	1.15E+14	3.55E+14	4.51E+14	1.40E+14	4.94E+13	3.16E+13	2.14E+13	5.27E+13
73	1.08E+13	8.23E+12	5.69E+13	3.72E+14	4.29E+14	9.04E+13	3.44E+13	2.54E+13	1.08E+13	3.48E+13
84	6.12E+12	3.19E+12	2.39E+13	3.09E+14	3.36E+14	7.26E+13	1.74E+13	8.54E+12	4.59E+12	1.65E+13
97	3.50E+12	2.34E+12	6.76E+12	2.15E+14	2.67E+14	3.58E+13	6.03E+12	6.15E+12	3.07E+12	4.40E+12
113	2.97E+12	1.42E+12	2.36E+12	1.65E+14	1.76E+14	2.39E+13	1.58E+12	1.78E+12	1.87E+12	0.00E+00
131	6.18E+11	0.00E+00	1.35E+12	9.27E+13	1.22E+14	9.15E+12	0.00E+00	4.31E+11	4.62E+11	5.80E+11
153	0.00E+00	0.00E+00	1.34E+12	6.50E+13	6.59E+13	6.78E+12	9.43E+11	0.00E+00	4.44E+11	5.42E+11
178	0.00E+00	4.68E+11	1.30E+12	2.86E+13	3.56E+13	1.89E+12	5.14E+11	0.00E+00	4.54E+11	5.62E+11
209	0.00E+00	0.00E+00	0.00E+00	1.25E+13	1.69E+13	4.67E+11	0.00E+00	0.00E+00	0.00E+00	5.93E+11
245	0.00E+00	0.00E+00	0.00E+00	6.76E+12	4.63E+12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE A-8.—(Continued).

Test Point	902	903	904	905	906	907	908	908	909	910
Date	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004
Fuel	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic
Power (%)	100	85	65	40	30	7	4	4	100	85
Aerosol Point #	902	903	904	905	906	907	908	909	910	911
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	7.95E+13	7.92E+13	2.91E+13	2.59E+13	3.35E+13	3.43E+13	4.49E+13	8.57E+13	4.36E+13	4.44E+13
10	0.00E+00	5.13E+14	0.00E+00	3.70E+14	2.31E+14	6.12E+14	1.30E+15	1.22E+16	4.30E+14	2.98E+14
12	7.48E+14	7.16E+14	3.28E+14	2.05E+14	1.97E+14	3.63E+14	2.25E+15	1.42E+16	3.64E+14	3.31E+14
14	8.64E+14	9.47E+14	2.25E+14	2.60E+14	2.12E+14	3.30E+14	1.81E+15	1.43E+16	4.86E+14	3.88E+14
16	6.06E+14	1.03E+15	3.22E+14	3.08E+14	3.13E+14	3.52E+14	1.28E+15	1.25E+16	5.98E+14	4.44E+14
18	1.54E+15	1.48E+15	3.61E+14	2.03E+14	2.60E+14	2.88E+14	1.31E+15	9.96E+15	5.95E+14	6.15E+14
21	1.85E+15	1.69E+15	4.03E+14	2.83E+14	2.77E+14	2.23E+14	7.71E+14	6.22E+15	6.53E+14	7.26E+14
24	1.98E+15	1.96E+15	4.35E+14	2.65E+14	2.54E+14	1.96E+14	5.85E+14	4.26E+15	7.63E+14	7.27E+14
27	2.52E+15	2.46E+15	4.54E+14	2.12E+14	1.74E+14	1.37E+14	4.93E+14	2.95E+15	9.16E+14	9.09E+14
31	2.78E+15	2.56E+15	4.81E+14	2.20E+14	1.76E+14	1.06E+14	3.36E+14	1.87E+15	1.08E+15	9.20E+14
36	2.97E+15	2.81E+15	4.15E+14	1.69E+14	1.50E+14	7.41E+13	2.48E+14	1.47E+15	9.99E+14	9.53E+14
41	2.67E+15	2.59E+15	3.97E+14	1.38E+14	9.55E+13	3.71E+13	1.61E+14	8.73E+14	1.03E+15	9.37E+14
48	2.45E+15	2.51E+15	3.57E+14	1.04E+14	8.15E+13	2.91E+13	1.04E+14	5.26E+14	1.05E+15	9.42E+14
55	2.35E+15	2.34E+15	2.79E+14	7.39E+13	4.76E+13	1.93E+13	5.62E+13	3.59E+14	1.06E+15	8.96E+14
63	2.04E+15	1.90E+15	2.04E+14	5.44E+13	3.21E+13	1.38E+13	3.06E+13	1.99E+14	9.60E+14	7.32E+14
73	1.91E+15	1.55E+15	1.42E+14	2.25E+13	1.97E+13	4.14E+12	1.68E+13	1.00E+14	7.22E+14	6.21E+14
84	1.41E+15	1.18E+15	1.03E+14	1.47E+13	1.11E+13	1.04E+12	1.32E+13	5.99E+13	5.76E+14	4.84E+14
97	1.11E+15	8.88E+14	5.77E+13	3.86E+12	3.73E+12	6.87E+11	4.84E+12	1.53E+13	4.11E+14	3.44E+14
113	8.06E+14	6.06E+14	3.42E+13	5.61E+12	3.60E+11	3.24E+11	1.58E+12	1.13E+13	2.61E+14	2.07E+14
131	4.29E+14	3.52E+14	1.49E+13	1.04E+12	3.54E+11	3.00E+11	9.90E+11	2.13E+12	2.19E+14	1.44E+14
153	3.08E+14	1.70E+14	6.61E+12	2.92E+11	0.00E+00	2.74E+11	4.53E+11	3.81E+12	1.03E+14	7.54E+13
178	1.61E+14	7.90E+13	3.73E+12	5.36E+11	0.00E+00	0.00E+00	0.00E+00	2.08E+12	6.64E+13	3.49E+13
209	6.99E+13	4.50E+13	1.15E+12	1.54E+12	0.00E+00	2.98E+11	0.00E+00	0.00E+00	2.62E+13	1.82E+13
245	1.98E+13	1.68E+13	6.48E+11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.87E+13	7.32E+12

TABLE A-8.—(Continued).

Test Point	911	912	913	914	915	915	916	917	918	919
Date	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004
Fuel	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic
Power (%)	65	40	30	7	4	4	100	85	70	65
Aerosol Point #	912	913	914	915	916	917	918	919	920	921
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	4.67E+13	6.73E+13	7.36E+13	9.38E+13	8.85E+13	2.17E+14	1.02E+14	7.39E+13	9.06E+13	9.70E+13
10	2.51E+14	1.38E+14	9.06E+14	9.13E+15	1.15E+16	2.88E+16	3.07E+16	3.86E+16	6.15E+16	5.38E+16
12	2.50E+14	2.19E+14	8.23E+14	9.32E+15	1.62E+16	4.51E+16	3.75E+16	3.52E+16	5.59E+16	6.20E+16
14	2.91E+14	2.66E+14	6.80E+14	5.98E+15	1.36E+16	6.54E+16	4.62E+16	3.23E+16	5.52E+16	6.35E+16
16	3.99E+14	3.34E+14	5.42E+14	4.29E+15	1.31E+16	9.88E+16	4.06E+16	2.59E+16	4.74E+16	5.94E+16
18	4.07E+14	3.76E+14	3.26E+14	2.75E+15	9.29E+15	1.35E+17	2.57E+16	1.32E+16	3.08E+16	4.02E+16
21	4.12E+14	3.77E+14	5.39E+14	1.73E+15	6.53E+15	1.62E+17	1.17E+16	4.56E+15	1.31E+16	1.91E+16
24	5.06E+14	3.81E+14	3.59E+14	1.02E+15	3.95E+15	1.50E+17	3.93E+15	1.80E+15	4.48E+15	5.16E+15
27	5.10E+14	3.41E+14	3.46E+14	7.97E+14	2.74E+15	1.14E+17	3.25E+15	1.64E+15	1.92E+15	2.14E+15
31	5.42E+14	3.49E+14	2.89E+14	6.47E+14	1.83E+15	6.76E+16	3.34E+15	1.77E+15	1.57E+15	1.43E+15
36	5.32E+14	2.72E+14	2.12E+14	3.67E+14	1.20E+15	2.96E+16	3.21E+15	1.67E+15	1.22E+15	1.13E+15
41	4.53E+14	2.40E+14	1.72E+14	1.78E+14	6.99E+14	1.13E+16	2.71E+15	1.45E+15	1.19E+15	9.51E+14
48	4.35E+14	1.93E+14	1.36E+14	1.28E+14	4.52E+14	4.78E+15	2.67E+15	1.41E+15	9.52E+14	7.89E+14
55	3.64E+14	1.23E+14	8.99E+13	8.73E+13	2.76E+14	1.75E+15	2.18E+15	1.22E+15	8.74E+14	6.21E+14
63	2.93E+14	8.18E+13	5.31E+13	4.01E+13	1.40E+14	8.48E+14	1.82E+15	1.03E+15	6.37E+14	4.94E+14
73	2.32E+14	5.45E+13	3.60E+13	2.51E+13	9.87E+13	4.30E+14	1.54E+15	9.28E+14	4.84E+14	3.48E+14
84	1.75E+14	1.73E+13	2.32E+13	1.65E+13	4.66E+13	2.44E+14	1.30E+15	7.01E+14	3.54E+14	2.33E+14
97	1.02E+14	1.24E+13	1.18E+13	5.39E+12	1.97E+13	1.14E+14	9.29E+14	5.42E+14	2.17E+14	1.47E+14
113	5.57E+13	5.45E+12	2.17E+12	0.00E+00	1.45E+13	5.60E+13	5.90E+14	3.54E+14	1.47E+14	9.21E+13
131	2.41E+13	3.36E+12	1.92E+12	1.75E+12	1.61E+12	2.33E+13	5.04E+14	2.11E+14	8.85E+13	4.75E+13
153	1.98E+13	7.75E+11	1.54E+12	9.51E+11	3.51E+12	1.22E+13	2.72E+14	1.19E+14	3.74E+13	1.63E+13
178	1.02E+13	0.00E+00	5.19E+11	1.89E+12	0.00E+00	5.92E+12	1.59E+14	7.55E+13	1.46E+13	1.16E+13
209	2.83E+12	0.00E+00	1.04E+12	0.00E+00	8.38E+11	0.00E+00	4.51E+13	3.78E+13	1.17E+13	5.47E+12
245	1.40E+12	0.00E+00	0.00E+00	0.00E+00	8.11E+11	0.00E+00	2.91E+13	1.44E+13	2.29E+12	2.51E+12

TABLE A-8.—(Continued).

Test Point	920	921	922	923	924	925	926	926	927	928
Date	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004
Fuel	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic
Power (%)	60	40	30	15	7	5.5	4	4	100	85
Aerosol Point #	922	923	924	925	926	927	928	929	930	931
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	1.00E+14	1.39E+14	1.57E+14	1.85E+14	2.01E+14	2.09E+14	2.21E+14	5.55E+13	1.18E+14	1.16E+14
10	5.80E+16	8.06E+16	1.02E+17	8.50E+16	6.69E+16	5.62E+16	3.12E+16	0.00E+00	0.00E+00	0.00E+00
12	6.48E+16	8.82E+16	1.14E+17	1.17E+17	9.27E+16	7.39E+16	5.86E+16	1.87E+14	0.00E+00	0.00E+00
14	6.89E+16	1.03E+17	1.23E+17	1.30E+17	1.18E+17	9.87E+16	9.25E+16	2.27E+14	0.00E+00	0.00E+00
16	6.89E+16	1.09E+17	1.24E+17	1.44E+17	1.58E+17	1.44E+17	1.29E+17	4.04E+14	0.00E+00	3.15E+13
18	4.89E+16	8.29E+16	9.37E+16	1.31E+17	1.72E+17	1.64E+17	1.62E+17	6.99E+14	6.20E+13	1.23E+14
21	2.59E+16	4.20E+16	4.84E+16	8.31E+16	1.49E+17	1.52E+17	1.71E+17	7.89E+14	7.90E+13	1.78E+14
24	8.34E+15	1.41E+16	1.46E+16	3.16E+16	8.77E+16	1.07E+17	1.36E+17	7.24E+14	1.76E+14	2.19E+14
27	2.34E+15	3.49E+15	3.43E+15	8.52E+15	4.05E+16	5.55E+16	8.86E+16	6.30E+14	3.08E+14	4.23E+14
31	1.19E+15	1.39E+15	1.30E+15	1.57E+15	1.08E+16	2.10E+16	4.12E+16	5.31E+14	4.32E+14	5.41E+14
36	9.77E+14	8.17E+14	8.12E+14	5.73E+14	2.35E+15	5.72E+15	1.27E+16	3.44E+14	6.89E+14	7.31E+14
41	6.94E+14	5.72E+14	5.07E+14	2.82E+14	7.97E+14	2.12E+15	5.14E+15	3.03E+14	6.34E+14	8.07E+14
48	5.62E+14	4.19E+14	2.92E+14	2.37E+14	4.42E+14	1.01E+15	2.20E+15	2.08E+14	9.33E+14	8.32E+14
55	3.78E+14	2.73E+14	2.30E+14	1.31E+14	2.44E+14	5.96E+14	1.33E+15	1.58E+14	9.77E+14	8.61E+14
63	2.84E+14	1.84E+14	1.68E+14	7.99E+13	1.67E+14	3.71E+14	5.77E+14	1.04E+14	1.06E+15	8.76E+14
73	2.07E+14	1.23E+14	6.94E+13	6.10E+13	5.18E+13	1.93E+14	3.80E+14	6.11E+13	1.10E+15	7.07E+14
84	1.39E+14	3.78E+13	5.59E+13	1.97E+13	2.36E+13	1.10E+14	2.09E+14	3.23E+13	1.01E+15	7.31E+14
97	6.54E+13	1.77E+13	3.26E+13	6.71E+12	1.01E+13	3.51E+13	7.83E+13	1.70E+13	8.58E+14	4.91E+14
113	4.46E+13	2.37E+13	1.18E+13	6.57E+12	3.47E+12	1.99E+13	4.18E+13	1.08E+13	6.06E+14	3.48E+14
131	1.95E+13	4.78E+12	3.91E+12	2.77E+12	1.17E+13	3.41E+13	1.51E+13	2.21E+12	4.12E+14	2.38E+14
153	1.01E+13	8.84E+12	8.80E+12	1.17E+13	1.86E+13	6.18E+12	6.55E+12	2.01E+12	2.83E+14	1.30E+14
178	5.05E+12	1.72E+12	0.00E+00	8.88E+12	2.90E+12	3.12E+12	9.58E+12	0.00E+00	1.58E+14	6.63E+13
209	4.73E+12	0.00E+00	2.02E+12	2.66E+12	2.72E+12	6.00E+12	3.05E+12	4.48E+11	6.49E+13	3.07E+13
245	0.00E+00	5.49E+12	0.00E+00	3.38E+12	3.11E+12	0.00E+00	0.00E+00	0.00E+00	2.07E+13	1.52E+13

TABLE A-8.—(Continued).

Test Point	929	930	931	932	933	934	934	934	934	937
Date	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004
Fuel	aromatic	aromatic	aromatic	aromatic	aromatic	sulfur	sulfur	sulfur	sulfur	sulfur
Power (%)	65	40	30	7	4	7	7	7	7	75
Aerosol Point #	932	933	934	935	936	937	938	939	940	941
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	4.26E+13	4.78E+13	4.58E+13	4.79E+13	6.09E+13	3.37E+14	6.42E+13	6.02E+13	6.10E+13	1.12E+14
10	0.00E+00	0.00E+00	0.00E+00	1.11E+14	1.07E+14	9.08E+16	3.40E+15	2.16E+14	0.00E+00	3.58E+16
12	0.00E+00	0.00E+00	1.80E+13	2.06E+14	1.91E+14	1.29E+17	4.44E+15	7.51E+13	0.00E+00	4.91E+16
14	2.83E+13	1.35E+13	7.05E+13	2.07E+14	3.79E+14	1.79E+17	6.05E+15	3.01E+14	1.66E+14	6.00E+16
16	6.74E+13	5.49E+13	5.91E+13	2.74E+14	7.36E+14	2.29E+17	7.32E+15	9.24E+14	4.99E+14	6.04E+16
18	5.35E+13	6.87E+13	9.35E+13	2.31E+14	1.07E+15	2.35E+17	8.36E+15	1.32E+15	9.96E+14	5.76E+16
21	5.15E+13	1.44E+14	1.56E+14	2.70E+14	1.60E+15	1.77E+17	7.78E+15	1.91E+15	1.68E+15	3.95E+16
24	9.57E+13	1.21E+14	1.66E+14	1.93E+14	1.48E+15	1.03E+17	5.92E+15	2.53E+15	1.96E+15	1.77E+16
27	1.12E+14	1.49E+14	1.98E+14	1.61E+14	1.27E+15	4.79E+16	3.72E+15	2.56E+15	2.24E+15	5.45E+15
31	1.45E+14	1.59E+14	1.68E+14	9.73E+13	1.11E+15	1.87E+16	2.11E+15	2.18E+15	1.92E+15	2.98E+15
36	1.43E+14	1.32E+14	1.47E+14	4.57E+13	7.30E+14	8.07E+15	1.14E+15	1.33E+15	1.08E+15	2.22E+15
41	1.46E+14	1.68E+14	1.47E+14	4.16E+13	5.65E+14	4.45E+15	6.57E+14	7.85E+14	6.47E+14	2.24E+15
48	1.16E+14	1.19E+14	1.12E+14	2.63E+13	3.47E+14	2.33E+15	3.26E+14	3.79E+14	2.65E+14	1.76E+15
55	1.09E+14	8.57E+13	8.52E+13	1.37E+13	2.55E+14	1.25E+15	1.72E+14	1.65E+14	1.59E+14	1.61E+15
63	8.42E+13	7.05E+13	7.12E+13	1.02E+13	1.65E+14	8.11E+14	9.80E+13	9.47E+13	3.27E+13	1.24E+15
73	6.36E+13	3.66E+13	3.25E+13	2.30E+12	8.67E+13	4.11E+14	6.63E+13	4.86E+13	2.98E+13	9.01E+14
84	4.84E+13	2.69E+13	2.57E+13	1.50E+12	4.86E+13	2.73E+14	2.36E+13	2.37E+13	2.30E+13	6.76E+14
97	2.57E+13	8.75E+12	9.31E+12	1.10E+12	2.34E+13	1.15E+14	1.72E+13	1.58E+13	1.32E+13	4.71E+14
113	1.25E+13	5.44E+12	7.35E+12	3.27E+11	9.67E+12	8.17E+13	7.86E+12	4.40E+12	4.68E+12	2.81E+14
131	5.33E+12	1.96E+12	8.48E+11	0.00E+00	5.18E+12	1.95E+13	1.60E+12	4.06E+11	4.66E+12	1.49E+14
153	2.64E+12	8.40E+11	4.03E+11	0.00E+00	7.68E+11	1.91E+13	7.90E+11	4.05E+11	0.00E+00	1.12E+14
178	1.01E+12	4.27E+11	0.00E+00	0.00E+00	6.83E+11	1.02E+13	7.23E+11	0.00E+00	0.00E+00	4.07E+13
209	2.42E+11	0.00E+00	1.90E+11	0.00E+00	0.00E+00	8.64E+12	0.00E+00	4.17E+11	0.00E+00	5.77E+12
245	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.15E+12

TABLE A-8.—(Continued).

Test Point	938	939	939	939	939	939	939	939	940	941
Date	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004
Fuel	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur
Power (%)	30	7	7	7	7	7	7	7	100	85
Aerosol Point #	942	943	944	945	946	947	948	949	950	951
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	1.54E+14	1.95E+14	6.82E+13	3.06E+13	8.48E+13	2.42E+14	6.91E+13	7.72E+13	4.31E+13	4.21E+13
10	5.05E+16	9.78E+16	0.00E+00	7.79E+14	7.73E+15	5.94E+16	3.05E+14	0.00E+00	0.00E+00	0.00E+00
12	8.06E+16	1.25E+17	1.40E+14	3.22E+14	4.65E+15	8.60E+16	5.92E+14	0.00E+00	5.63E+13	0.00E+00
14	9.89E+16	1.48E+17	1.03E+14	3.14E+14	4.18E+15	1.17E+17	1.06E+15	0.00E+00	0.00E+00	0.00E+00
16	1.11E+17	1.86E+17	1.99E+14	2.91E+14	3.63E+15	1.52E+17	1.64E+15	1.25E+14	1.50E+13	0.00E+00
18	1.11E+17	1.91E+17	4.90E+14	2.53E+14	1.92E+15	1.52E+17	2.29E+15	3.52E+14	1.81E+13	1.62E+13
21	8.42E+16	1.58E+17	7.85E+14	2.34E+14	1.22E+15	1.37E+17	2.87E+15	8.51E+14	5.03E+13	4.17E+13
24	4.31E+16	1.02E+17	1.36E+15	2.25E+14	7.63E+14	8.12E+16	2.80E+15	1.49E+15	1.05E+14	8.58E+13
27	1.66E+16	4.23E+16	1.87E+15	1.48E+14	6.50E+14	3.21E+16	2.46E+15	2.37E+15	1.24E+14	1.27E+14
31	5.53E+15	1.20E+16	2.28E+15	1.25E+14	3.77E+14	8.27E+15	1.76E+15	2.95E+15	2.57E+14	1.90E+14
36	2.76E+15	2.38E+15	1.89E+15	9.74E+13	3.47E+14	2.40E+15	9.20E+14	2.92E+15	3.27E+14	2.12E+14
41	2.25E+15	9.79E+14	1.20E+15	6.76E+13	2.24E+14	1.27E+15	4.39E+14	1.89E+15	3.65E+14	3.02E+14
48	1.69E+15	4.74E+14	5.58E+14	5.21E+13	1.35E+14	6.24E+14	1.93E+14	8.84E+14	4.66E+14	3.59E+14
55	1.38E+15	2.24E+14	2.34E+14	2.86E+13	1.23E+14	2.98E+14	1.00E+14	3.09E+14	5.64E+14	3.90E+14
63	1.18E+15	1.26E+14	7.18E+13	1.78E+13	6.83E+13	2.27E+14	5.12E+13	1.13E+14	4.85E+14	3.90E+14
73	7.99E+14	5.80E+13	4.26E+13	8.76E+12	3.18E+13	8.72E+13	2.81E+13	4.64E+13	4.71E+14	3.55E+14
84	5.55E+14	4.34E+13	1.95E+13	6.56E+12	1.29E+13	2.59E+13	1.56E+13	2.52E+13	3.75E+14	3.11E+14
97	3.44E+14	0.00E+00	8.94E+12	2.04E+12	1.50E+13	6.88E+12	5.76E+12	1.39E+13	3.02E+14	2.57E+14
113	2.20E+14	2.25E+13	5.57E+12	1.24E+12	1.12E+12	1.22E+13	3.07E+12	3.98E+12	1.85E+14	1.99E+14
131	1.14E+14	1.19E+13	3.05E+12	0.00E+00	2.04E+12	1.33E+13	1.79E+12	2.05E+12	1.43E+14	1.19E+14
153	5.54E+13	0.00E+00	9.76E+11	0.00E+00	2.50E+12	1.90E+13	4.10E+11	0.00E+00	7.69E+13	7.50E+13
178	3.82E+13	1.11E+13	0.00E+00	2.44E+11	0.00E+00	9.68E+12	0.00E+00	0.00E+00	4.48E+13	4.41E+13
209	6.08E+12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.31E+13	0.00E+00	0.00E+00	1.57E+13	1.26E+13
245	2.26E+12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.54E+12	9.58E+12

TABLE A-8.—(Continued).

Test Point	942	943	943	943	943	944	945	946	947	947
Date	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004
Fuel	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur
Power (%)	30	7	7	7	7	100	85	30	7	7
Aerosol Point #	952	953	954	955	957	958	959	960	961	962
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	5.34E+13	7.15E+13	2.94E+13	8.44E+13	3.67E+13	2.79E+13	2.63E+13	5.41E+13	3.56E+13	1.24E+14
10	0.00E+00	0.00E+00	5.43E+14	5.43E+15	8.65E+13	0.00E+00	1.21E+14	1.08E+14	6.00E+14	8.72E+15
12	3.86E+13	0.00E+00	6.25E+14	4.71E+15	6.52E+14	1.77E+14	7.49E+13	1.59E+14	4.96E+14	7.59E+15
14	1.79E+14	1.63E+13	4.32E+14	3.41E+15	3.79E+14	2.95E+14	2.86E+14	2.43E+14	3.45E+14	3.70E+15
16	2.16E+14	1.61E+14	3.77E+14	1.67E+15	5.42E+14	2.40E+14	3.15E+14	3.45E+14	3.11E+14	3.10E+15
18	6.34E+14	3.26E+14	3.10E+14	1.12E+15	4.27E+14	4.14E+14	4.45E+14	3.33E+14	3.79E+14	2.39E+15
21	1.16E+15	9.26E+14	3.15E+14	1.16E+15	3.75E+14	5.34E+14	6.38E+14	2.74E+14	3.06E+14	2.12E+15
24	1.81E+15	1.79E+15	2.40E+14	7.93E+14	2.98E+14	6.04E+14	6.01E+14	2.76E+14	2.41E+14	1.32E+15
27	1.81E+15	2.36E+15	2.08E+14	4.92E+14	2.72E+14	6.31E+14	7.19E+14	2.38E+14	1.92E+14	1.01E+15
31	1.39E+15	2.85E+15	1.58E+14	4.66E+14	2.10E+14	7.67E+14	8.18E+14	1.85E+14	1.66E+14	7.76E+14
36	6.47E+14	2.13E+15	1.30E+14	3.07E+14	1.43E+14	7.83E+14	7.93E+14	1.50E+14	1.24E+14	5.40E+14
41	2.91E+14	1.14E+15	9.44E+13	2.06E+14	1.01E+14	8.14E+14	7.45E+14	1.08E+14	8.79E+13	4.08E+14
48	1.43E+14	5.23E+14	5.33E+13	1.66E+14	7.19E+13	7.57E+14	7.70E+14	7.44E+13	5.29E+13	3.00E+14
55	6.99E+13	2.76E+14	3.67E+13	8.04E+13	4.49E+13	6.64E+14	6.60E+14	5.31E+13	3.84E+13	1.76E+14
63	5.61E+13	1.30E+14	2.05E+13	5.42E+13	3.13E+13	5.55E+14	5.61E+14	3.10E+13	2.62E+13	1.01E+14
73	2.32E+13	5.11E+13	9.55E+12	5.19E+13	1.59E+13	4.78E+14	4.65E+14	2.23E+13	1.13E+13	3.74E+13
84	1.89E+13	2.26E+13	5.51E+12	7.75E+12	1.18E+13	3.42E+14	3.63E+14	1.29E+13	5.60E+12	4.92E+13
97	3.59E+12	1.64E+13	2.77E+12	2.42E+12	4.44E+12	2.72E+14	2.43E+14	3.65E+12	3.84E+12	2.20E+13
113	2.20E+12	5.92E+12	6.56E+11	5.60E+12	1.35E+12	1.80E+14	1.74E+14	1.38E+12	1.57E+12	7.81E+12
131	8.93E+11	4.74E+11	2.21E+11	6.67E+12	1.39E+12	1.09E+14	1.05E+14	3.44E+11	4.91E+11	2.48E+12
153	8.83E+11	1.05E+12	0.00E+00	0.00E+00	0.00E+00	7.60E+13	5.41E+13	6.90E+11	1.58E+11	0.00E+00
178	0.00E+00	0.00E+00	2.02E+11	0.00E+00	2.59E+11	4.10E+13	2.35E+13	0.00E+00	0.00E+00	0.00E+00
209	0.00E+00	4.84E+11	0.00E+00	0.00E+00	2.85E+11	2.08E+13	1.17E+13	3.46E+11	0.00E+00	0.00E+00
245	0.00E+00	0.00E+00	2.41E+11	0.00E+00	0.00E+00	8.17E+12	2.94E+12	0.00E+00	0.00E+00	0.00E+00

TABLE A-8.—(Continued).

Test Point	947	947	948	949	950	951				
Date	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/20/2004	4/20/2004	4/20/2004	4/20/2004
Fuel	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	base	base	base	base
Power (%)	7	7	100	85	30	7	7	7	7	30
Aerosol Point #	962	963	964	965	966	967	001	002	003	004
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	5.42E+13	2.81E+14	8.59E+13	8.69E+13	2.02E+14	3.02E+14	1.59E+14	3.34E+13	5.33E+13	2.92E+13
10	1.15E+16	7.10E+16	4.78E+16	3.12E+16	6.89E+16	9.93E+16	0.00E+00	1.58E+15	2.40E+15	2.56E+15
12	4.31E+15	9.19E+16	4.08E+16	4.15E+16	1.24E+17	1.08E+17	4.24E+15	9.65E+14	1.79E+15	1.23E+15
14	2.63E+15	1.20E+17	4.61E+16	4.71E+16	1.41E+17	1.20E+17	1.56E+16	8.66E+14	2.45E+15	9.90E+14
16	1.82E+15	1.27E+17	6.06E+16	4.89E+16	1.70E+17	1.39E+17	2.73E+16	1.24E+15	2.17E+15	5.51E+14
18	8.70E+14	1.14E+17	5.36E+16	4.08E+16	1.67E+17	1.38E+17	3.00E+16	1.08E+15	2.46E+15	7.06E+14
21	8.07E+14	7.79E+16	3.91E+16	2.46E+16	1.33E+17	1.07E+17	3.04E+16	1.35E+15	2.29E+15	7.69E+14
24	7.77E+14	3.98E+16	1.91E+16	9.13E+15	7.70E+16	5.71E+16	3.24E+16	1.22E+15	2.02E+15	7.31E+14
27	4.72E+14	1.64E+16	6.72E+15	3.58E+15	3.05E+16	2.48E+16	3.00E+16	1.28E+15	1.91E+15	5.67E+14
31	3.65E+14	5.46E+15	3.61E+15	2.41E+15	7.30E+15	7.46E+15	2.81E+16	1.06E+15	1.62E+15	5.41E+14
36	1.30E+14	2.12E+15	2.25E+15	2.18E+15	2.05E+15	2.43E+15	2.17E+16	7.84E+14	1.19E+15	3.38E+14
41	2.56E+14	1.33E+15	2.42E+15	1.97E+15	9.31E+14	1.09E+15	1.20E+16	7.44E+14	9.47E+14	3.01E+14
48	1.13E+14	9.25E+14	2.25E+15	1.80E+15	6.47E+14	7.20E+14	6.67E+15	5.30E+14	7.17E+14	2.21E+14
55	4.77E+13	5.13E+14	1.79E+15	1.76E+15	4.52E+14	4.77E+14	3.49E+15	3.87E+14	3.67E+14	1.12E+14
63	5.02E+13	2.65E+14	1.64E+15	1.40E+15	2.87E+14	2.27E+14	1.03E+15	2.47E+14	3.02E+14	6.86E+13
73	3.40E+13	1.76E+14	1.31E+15	1.14E+15	2.23E+14	1.40E+14	8.12E+14	1.51E+14	1.85E+14	6.17E+13
84	2.66E+13	7.11E+13	9.74E+14	9.15E+14	1.62E+14	6.78E+13	1.58E+14	8.55E+13	9.01E+13	2.02E+13
97	1.85E+13	3.46E+13	6.76E+14	6.67E+14	1.11E+14	3.48E+13	3.72E+14	4.14E+13	7.10E+13	1.32E+13
113	0.00E+00	2.28E+13	4.25E+14	4.34E+14	1.29E+14	1.95E+13	7.52E+13	2.50E+13	2.67E+13	4.53E+12
131	5.40E+12	1.34E+13	3.60E+14	2.73E+14	5.87E+13	2.09E+13	4.94E+13	9.45E+12	7.05E+12	0.00E+00
153	5.34E+12	9.96E+12	2.11E+14	1.48E+14	4.12E+13	7.48E+12	0.00E+00	7.34E+11	7.34E+12	2.33E+12
178	9.73E+12	1.21E+13	1.18E+14	8.28E+13	3.00E+13	0.00E+00	0.00E+00	1.31E+12	0.00E+00	4.22E+12
209	0.00E+00	0.00E+00	9.52E+13	3.13E+13	8.94E+12	7.54E+12	0.00E+00	0.00E+00	0.00E+00	0.00E+00
245	0.00E+00	3.47E+12	3.12E+13	2.06E+13	5.76E+12	3.75E+12	0.00E+00	7.53E+11	0.00E+00	0.00E+00

TABLE A-8.—(Concluded).

Test Point		
Date	4/20/2004	4/20/2004
Fuel	base	base
Power (%)	45	7
Aerosol Point #	005	007
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	5.17E+13	3.76E+13
10	0.00E+00	1.87E+15
12	0.00E+00	2.71E+15
14	1.13E+15	1.71E+15
16	7.12E+14	1.93E+15
18	9.83E+14	1.87E+15
21	1.30E+15	1.70E+15
24	8.42E+14	1.54E+15
27	6.67E+14	1.07E+15
31	4.89E+14	9.26E+14
36	4.13E+14	5.66E+14
41	3.96E+14	5.42E+14
48	2.43E+14	3.31E+14
55	1.94E+14	2.12E+14
63	2.14E+14	1.31E+14
73	9.84E+13	7.01E+13
84	6.77E+12	4.35E+13
97	3.79E+13	1.30E+13
113	2.21E+13	5.62E+12
131	5.48E+12	2.87E+12
153	0.00E+00	9.55E+11
178	0.00E+00	1.74E+12
209	0.00E+00	0.00E+00
245	0.00E+00	0.00E+00

TABLE A-9.—NASA HEATED PARTICLE SIZE DISTRIBUTION DATA MEASURED FROM THE EXHAUST OF AIRCRAFT CFM56-2-C1 ENGINE DURING APEX.

Test Point	301	301	301	301	301	301	301	302	302	302
Date	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	7	7	7	7	7	7	7	30	30	30
Aerosol Point #	301	302	303	304	305	306	307	309	310	312
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	7.70E+14	0.00E+00	8.46E+14	1.07E+15	1.41E+15	0.00E+00	2.73E+15	0.00E+00	0.00E+00	0.00E+00
10	5.98E+14	4.73E+14	2.36E+14	3.34E+14	0.00E+00	0.00E+00	1.19E+15	1.38E+14	0.00E+00	4.73E+14
12	9.17E+14	4.58E+14	3.67E+14	4.08E+14	3.11E+14	1.50E+15	1.03E+15	2.19E+14	3.11E+14	1.99E+14
14	1.05E+15	3.36E+14	2.87E+14	5.30E+14	4.74E+14	1.30E+15	1.32E+15	2.05E+14	3.33E+14	9.74E+14
16	1.20E+15	7.07E+14	3.20E+14	5.31E+14	6.82E+14	1.08E+15	6.11E+14	3.01E+14	3.34E+14	4.50E+14
18	1.48E+15	4.97E+14	6.56E+14	4.13E+14	6.52E+14	7.76E+14	4.30E+14	3.51E+14	4.34E+14	4.14E+14
21	1.53E+15	7.05E+14	5.29E+14	4.54E+14	5.06E+14	1.00E+15	4.02E+14	4.45E+14	5.76E+14	4.23E+14
24	1.50E+15	5.24E+14	5.60E+14	3.18E+14	3.54E+14	7.46E+14	3.59E+14	4.46E+14	6.06E+14	6.79E+14
27	1.49E+15	5.28E+14	3.31E+14	2.70E+14	3.27E+14	5.02E+14	3.52E+14	5.54E+14	5.22E+14	5.04E+14
31	1.12E+15	3.90E+14	2.70E+14	2.40E+14	2.47E+14	4.08E+14	2.30E+14	4.15E+14	5.19E+14	6.09E+14
36	9.93E+14	3.30E+14	2.27E+14	1.44E+14	1.94E+14	2.93E+14	1.33E+14	3.96E+14	5.42E+14	6.35E+14
41	7.18E+14	3.34E+14	1.15E+14	1.02E+14	1.44E+14	1.91E+14	1.29E+14	2.91E+14	3.96E+14	3.50E+14
48	5.81E+14	1.99E+14	1.03E+14	7.04E+13	1.06E+14	1.43E+14	5.69E+13	2.63E+14	2.86E+14	2.94E+14
55	4.23E+14	1.14E+14	4.88E+13	5.07E+13	4.95E+13	8.51E+13	5.75E+13	1.73E+14	1.78E+14	2.48E+14
63	2.83E+14	5.77E+13	2.92E+13	3.19E+13	3.83E+13	5.94E+13	2.70E+13	1.10E+14	1.55E+14	2.10E+14
73	1.95E+14	4.79E+13	3.04E+13	1.98E+13	3.17E+13	3.51E+13	2.66E+13	6.04E+13	6.05E+13	8.29E+13
84	9.20E+13	2.96E+13	1.20E+13	8.80E+12	1.57E+13	1.40E+13	4.68E+13	3.44E+13	4.79E+13	6.34E+13
97	4.55E+13	8.30E+12	0.00E+00	4.17E+12	0.00E+00	0.00E+00	5.26E+13	2.19E+13	9.31E+12	2.18E+13
113	2.55E+13	0.00E+00	2.38E+12	0.00E+00	0.00E+00	5.72E+12	1.09E+13	1.03E+13	1.46E+13	1.69E+13
131	2.23E+13	2.59E+12	0.00E+00	0.00E+00	0.00E+00	6.11E+12	5.60E+12	6.35E+12	1.76E+12	0.00E+00
153	4.79E+12	0.00E+00	0.00E+00	5.77E+12	0.00E+00	1.21E+13	1.90E+12	0.00E+00	0.00E+00	0.00E+00
178	1.08E+12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.72E+13	1.90E+12	0.00E+00	0.00E+00	0.00E+00
209	1.02E+12	2.53E+12	2.52E+12	1.91E+12	0.00E+00	6.65E+12	2.06E+12	0.00E+00	0.00E+00	0.00E+00
245	1.22E+12	3.08E+12	3.08E+12	0.00E+00	0.00E+00	7.12E+12	2.33E+12	1.89E+12	4.06E+12	0.00E+00

Note:
1. Particle size distribution data are reported as particle number emission index (EIn) in each channel in the form of d(EIn)/dlogDp.

TABLE A-9.—(Continued).

Test Point	302	302	302	302	302	302	302	303	303	303
Date	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	30	30	30	30	30	30	30	40	40	40
Aerosol Point #	313	314	315	316	317	318	319	321	322	323
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	7.92E+14	1.54E+15	5.32E+14	4.25E+14	1.80E+15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E+15
10	1.19E+14	3.18E+14	4.38E+14	2.36E+14	7.50E+14	3.56E+14	2.55E+15	0.00E+00	0.00E+00	4.86E+14
12	2.27E+14	3.31E+14	8.19E+13	4.38E+14	4.61E+14	4.91E+14	2.08E+15	2.02E+14	1.85E+14	3.71E+14
14	1.85E+14	3.08E+14	2.36E+14	5.26E+14	2.49E+14	3.00E+14	1.68E+15	2.21E+14	2.09E+14	1.66E+14
16	3.53E+14	2.37E+14	2.31E+14	3.74E+14	2.10E+14	2.70E+14	1.09E+15	3.11E+14	3.09E+14	3.01E+14
18	3.63E+14	3.21E+14	4.36E+14	3.40E+14	1.99E+14	2.39E+14	7.87E+14	4.98E+14	5.24E+14	2.05E+14
21	4.28E+14	2.24E+14	2.94E+14	3.55E+14	2.32E+14	3.62E+14	8.38E+14	4.49E+14	4.85E+14	2.23E+14
24	4.59E+14	2.26E+14	3.15E+14	3.49E+14	8.97E+13	2.61E+14	5.38E+14	5.56E+14	5.58E+14	2.02E+14
27	4.08E+14	2.43E+14	3.08E+14	3.08E+14	1.34E+14	2.91E+14	6.46E+14	4.62E+14	5.13E+14	2.18E+14
31	3.60E+14	1.66E+14	2.80E+14	2.62E+14	1.35E+14	3.27E+14	3.76E+14	5.50E+14	4.54E+14	1.91E+14
36	3.33E+14	1.28E+14	2.61E+14	2.17E+14	9.63E+13	2.19E+14	4.88E+14	4.23E+14	2.92E+14	1.67E+14
41	2.95E+14	1.13E+14	2.11E+14	1.60E+14	9.66E+13	1.38E+14	3.61E+14	3.49E+14	3.63E+14	1.21E+14
48	2.42E+14	7.51E+13	9.85E+13	1.04E+14	4.89E+13	1.07E+14	2.09E+14	2.87E+14	2.94E+14	6.35E+13
55	1.74E+14	3.99E+13	8.04E+13	6.99E+13	2.31E+13	8.87E+13	1.11E+14	2.10E+14	1.72E+14	5.40E+13
63	8.72E+13	2.27E+13	6.72E+13	4.43E+13	2.52E+13	5.57E+13	8.06E+13	1.43E+14	1.14E+14	4.13E+13
73	6.66E+13	1.72E+13	3.24E+13	2.51E+13	7.59E+12	1.07E+13	3.92E+13	8.51E+13	6.23E+13	1.81E+13
84	4.06E+13	5.47E+12	1.46E+13	1.83E+13	3.82E+12	0.00E+00	3.27E+13	4.87E+13	3.98E+13	1.12E+13
97	2.01E+13	7.28E+12	7.24E+12	5.68E+12	8.60E+12	0.00E+00	7.96E+12	3.39E+13	7.74E+12	4.35E+12
113	8.59E+12	1.75E+12	4.42E+12	3.51E+12	1.53E+12	4.41E+12	1.61E+13	8.67E+12	4.70E+12	5.59E+12
131	6.07E+11	0.00E+00	0.00E+00	1.13E+12	1.66E+12	4.04E+12	0.00E+00	5.26E+12	2.51E+12	0.00E+00
153	7.49E+11	0.00E+00	9.89E+11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.40E+12	0.00E+00	1.82E+12
178	1.50E+12	0.00E+00	0.00E+00	2.53E+12	0.00E+00	4.48E+12	1.48E+13	5.32E+12	0.00E+00	0.00E+00
209	0.00E+00	0.00E+00	0.00E+00	2.86E+12	0.00E+00	0.00E+00	0.00E+00	2.12E+13	0.00E+00	0.00E+00
245	0.00E+00	2.03E+12	0.00E+00	7.63E+12	0.00E+00	0.00E+00	0.00E+00	2.44E+13	2.76E+12	2.33E+12

TABLE A-9.—(Continued).

Test Point	303	303	303	303	303	304	304	304	305	305
Date	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	40	40	40	40	40	30	30	30	7	7
Aerosol Point #	324	325	326	327	328	329	330	331	332	333
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	0.00E+00	1.32E+15	1.29E+15	0.00E+00	3.66E+15	0.00E+00	0.00E+00	0.00E+00	1.08E+15	2.11E+15
10	0.00E+00	2.63E+14	5.77E+14	3.40E+14	5.25E+14	1.23E+15	0.00E+00	2.56E+14	1.13E+14	8.65E+14
12	5.16E+14	2.30E+14	4.03E+14	1.52E+14	9.72E+14	2.01E+15	2.46E+14	1.60E+14	9.95E+13	9.46E+14
14	4.02E+14	2.34E+14	2.73E+14	1.66E+14	9.24E+14	1.48E+15	1.32E+14	3.12E+14	9.56E+13	1.13E+15
16	4.51E+14	1.69E+14	4.66E+14	3.65E+14	2.46E+14	8.15E+14	4.32E+14	2.99E+14	5.72E+13	3.31E+14
18	5.49E+14	2.60E+14	2.89E+14	4.65E+14	5.28E+14	5.39E+14	3.62E+14	3.57E+14	1.43E+14	4.20E+14
21	5.10E+14	2.54E+14	2.92E+14	3.31E+14	5.28E+14	7.89E+14	3.47E+14	3.11E+14	8.61E+13	2.60E+14
24	5.27E+14	2.28E+14	2.28E+14	3.21E+14	5.27E+14	5.06E+14	2.54E+14	3.37E+14	5.46E+13	2.05E+14
27	5.00E+14	2.63E+14	3.05E+14	2.01E+14	4.90E+14	4.87E+14	3.22E+14	3.85E+14	5.88E+13	1.84E+14
31	4.41E+14	1.86E+14	2.49E+14	2.35E+14	4.96E+14	4.23E+14	2.67E+14	3.41E+14	3.36E+13	1.05E+14
36	3.47E+14	1.83E+14	1.48E+14	2.10E+14	3.40E+14	3.04E+14	3.24E+14	3.44E+14	3.19E+13	8.48E+13
41	3.01E+14	1.57E+14	1.26E+14	1.58E+14	2.24E+14	2.28E+14	2.11E+14	2.54E+14	1.74E+13	4.93E+13
48	1.63E+14	7.59E+13	1.35E+14	1.23E+14	1.64E+14	1.09E+14	1.07E+14	1.73E+14	2.27E+13	3.82E+13
55	1.03E+14	6.86E+13	5.50E+13	8.44E+13	1.47E+14	1.37E+14	8.09E+13	1.09E+14	1.41E+12	1.96E+13
63	8.96E+13	3.54E+13	3.36E+13	5.27E+13	5.04E+13	2.98E+13	9.82E+13	6.38E+13	7.12E+12	7.90E+12
73	5.29E+13	2.22E+13	2.57E+13	4.39E+13	1.41E+13	1.68E+13	4.48E+13	4.37E+13	1.11E+12	8.92E+12
84	1.59E+13	1.05E+13	1.46E+13	2.33E+13	1.42E+13	8.64E+12	3.31E+13	3.18E+13	1.51E+12	5.01E+12
97	1.17E+13	9.30E+12	9.34E+12	1.18E+13	1.80E+13	6.93E+12	3.05E+12	1.81E+13	1.32E+12	7.64E+12
113	0.00E+00	5.57E+12	2.26E+12	4.10E+12	0.00E+00	2.21E+13	0.00E+00	5.20E+12	9.74E+11	3.31E+12
131	4.75E+12	4.45E+12	1.18E+12	1.91E+12	6.09E+12	0.00E+00	0.00E+00	4.03E+12	0.00E+00	2.33E+12
153	4.14E+12	5.12E+12	1.06E+12	0.00E+00	0.00E+00	7.35E+12	0.00E+00	1.87E+12	2.09E+12	4.27E+12
178	2.33E+12	7.21E+12	0.00E+00	2.11E+12	0.00E+00	6.89E+12	0.00E+00	5.38E+12	0.00E+00	8.76E+12
209	6.74E+12	1.11E+13	1.19E+12	2.06E+12	6.89E+12	0.00E+00	0.00E+00	3.11E+12	1.95E+12	2.45E+13
245	5.29E+12	3.91E+12	0.00E+00	2.17E+12	1.45E+13	8.23E+12	0.00E+00	5.04E+12	0.00E+00	3.98E+13

TABLE A-9.—(Continued).

Test Point	305	305	305	306	306	306	306	307	307	307
Date	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	7	7	7	7	7	7	7	30	30	30
Aerosol Point #	334	335	336	339	340	341	342	343	344	345
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	1.02E+16	0.00E+00	0.00E+00	2.09E+15	2.58E+15	5.20E+14	0.00E+00	1.42E+15	6.90E+14	2.75E+14
10	2.41E+16	6.08E+14	3.85E+14	1.12E+15	5.94E+14	1.11E+15	1.17E+15	5.09E+14	5.27E+14	5.93E+14
12	1.95E+16	3.74E+14	2.44E+14	7.40E+14	5.01E+14	3.66E+14	2.65E+14	1.20E+14	3.06E+14	3.29E+14
14	1.88E+16	4.08E+14	1.73E+14	7.08E+14	4.29E+14	3.20E+14	6.32E+14	2.88E+14	2.37E+14	1.61E+14
16	1.61E+16	1.80E+14	1.82E+14	5.92E+14	3.17E+14	4.30E+14	5.32E+14	2.94E+14	3.13E+14	2.55E+14
18	8.41E+15	8.64E+13	1.67E+14	5.53E+14	4.50E+14	3.12E+14	2.64E+14	3.53E+14	2.99E+14	2.93E+14
21	4.12E+15	1.15E+14	1.63E+14	4.14E+14	4.49E+14	3.61E+14	2.89E+14	4.10E+14	3.20E+14	2.78E+14
24	1.77E+15	1.41E+14	1.19E+14	3.98E+14	3.88E+14	3.27E+14	3.52E+14	4.36E+14	2.93E+14	3.02E+14
27	7.25E+14	5.93E+13	1.08E+14	3.25E+14	3.38E+14	3.07E+14	8.75E+13	3.69E+14	3.24E+14	2.03E+14
31	3.34E+14	6.61E+13	6.82E+13	2.66E+14	2.39E+14	2.28E+14	1.70E+14	2.81E+14	2.32E+14	2.13E+14
36	3.27E+14	2.99E+13	7.35E+13	2.00E+14	1.69E+14	1.45E+14	1.69E+14	3.27E+14	1.94E+14	1.45E+14
41	1.46E+14	8.43E+13	3.12E+13	1.46E+14	1.00E+14	1.18E+14	6.60E+13	2.54E+14	1.55E+14	1.61E+14
48	1.07E+14	3.02E+13	1.47E+13	9.30E+13	8.64E+13	7.07E+13	5.68E+13	1.77E+14	1.27E+14	8.90E+13
55	5.88E+13	1.04E+13	9.51E+12	6.25E+13	4.52E+13	3.93E+13	4.51E+13	1.51E+14	8.47E+13	6.84E+13
63	4.93E+13	1.64E+13	1.13E+13	4.10E+13	4.02E+13	2.61E+13	1.90E+13	7.46E+13	6.28E+13	3.81E+13
73	2.09E+13	5.65E+12	2.00E+12	2.52E+13	2.38E+13	2.41E+13	2.40E+13	5.51E+13	2.74E+13	2.10E+13
84	2.38E+13	1.11E+13	5.07E+12	1.79E+13	1.03E+13	5.16E+12	1.21E+13	3.03E+13	2.26E+13	1.44E+13
97	7.47E+12	7.38E+12	1.78E+12	1.56E+13	8.13E+12	3.42E+12	0.00E+00	1.52E+13	8.58E+12	7.88E+12
113	0.00E+00	4.70E+12	1.53E+12	9.15E+12	7.75E+12	3.34E+12	7.10E+12	1.40E+13	1.61E+12	4.88E+12
131	5.35E+12	2.45E+12	3.29E+12	5.31E+12	0.00E+00	3.02E+12	1.63E+13	5.89E+12	5.37E+12	4.72E+12
153	1.73E+13	2.21E+12	0.00E+00	4.74E+12	7.40E+12	6.48E+12	3.24E+12	8.77E+12	2.21E+12	7.91E+11
178	5.35E+13	2.49E+12	1.68E+12	7.73E+12	1.41E+12	1.39E+13	1.45E+13	6.61E+12	3.28E+12	4.25E+12
209	1.14E+14	2.39E+12	0.00E+00	1.46E+13	0.00E+00	1.26E+13	0.00E+00	8.70E+12	6.68E+12	4.01E+12
245	1.40E+14	0.00E+00	1.77E+12	1.04E+13	1.87E+12	2.33E+13	0.00E+00	1.02E+13	1.02E+12	4.71E+12

TABLE A-9.—(Continued).

Test Point	307	307	307	307	307	308	308	308	308b	308b
Date	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	30	30	30	30	30	40	40	40	40	40
Aerosol Point #	346	347	348	349	350	351	352	353	354	355
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.53E+15	8.33E+15	1.36E+15	1.02E+15	1.09E+15	6.76E+14
10	7.20E+14	6.77E+14	4.34E+14	2.87E+14	4.99E+15	2.56E+15	3.09E+14	4.20E+14	1.92E+14	1.24E+14
12	3.35E+14	0.00E+00	2.57E+14	5.46E+14	2.25E+15	2.56E+15	2.68E+14	3.51E+14	1.85E+14	1.58E+14
14	3.59E+14	3.99E+14	3.43E+14	5.40E+14	1.25E+15	1.46E+15	1.16E+14	4.52E+14	2.43E+14	3.51E+14
16	2.54E+14	3.78E+14	3.60E+14	1.70E+14	8.64E+14	5.76E+14	1.21E+14	4.27E+14	1.98E+14	2.98E+14
18	2.12E+14	4.96E+14	3.40E+14	2.23E+14	4.44E+14	4.62E+14	1.18E+14	2.19E+14	2.46E+14	2.52E+14
21	2.06E+14	2.60E+14	3.20E+14	2.58E+14	3.43E+14	1.76E+14	9.56E+13	2.56E+14	2.82E+14	3.34E+14
24	2.12E+14	1.85E+14	2.44E+14	1.51E+14	2.87E+14	4.25E+14	1.04E+14	2.53E+14	2.22E+14	3.93E+14
27	2.66E+14	3.17E+14	2.54E+14	2.58E+14	2.73E+14	5.00E+14	1.31E+14	2.41E+14	2.47E+14	3.63E+14
31	1.23E+14	2.00E+14	1.66E+14	1.67E+14	1.74E+14	4.29E+14	7.71E+13	2.09E+14	2.36E+14	2.93E+14
36	1.66E+14	1.72E+14	1.24E+14	1.60E+14	1.38E+14	3.41E+14	7.51E+13	2.03E+14	2.00E+14	2.99E+14
41	1.03E+14	1.08E+14	8.72E+13	9.71E+13	8.19E+13	1.68E+14	6.04E+13	1.62E+14	1.61E+14	2.11E+14
48	6.73E+13	6.29E+13	7.71E+13	1.05E+14	6.77E+13	1.44E+14	5.51E+13	1.24E+14	1.12E+14	1.83E+14
55	5.36E+13	4.01E+13	6.03E+13	4.68E+13	3.99E+13	9.11E+13	2.68E+13	1.03E+14	6.22E+13	1.07E+14
63	2.39E+13	4.10E+13	2.60E+13	2.56E+13	2.87E+13	7.53E+13	2.63E+13	5.99E+13	5.54E+13	7.43E+13
73	6.60E+12	9.11E+12	3.10E+13	1.69E+13	3.73E+13	5.42E+13	9.49E+12	3.54E+13	3.39E+13	3.97E+13
84	3.28E+12	4.16E+12	7.97E+12	7.18E+12	8.16E+12	7.89E+12	7.51E+12	2.03E+13	1.76E+13	1.86E+13
97	2.79E+12	1.06E+13	9.22E+12	9.88E+12	1.17E+13	1.47E+13	5.26E+12	6.56E+12	7.42E+12	1.05E+13
113	0.00E+00	0.00E+00	7.20E+12	1.04E+13	6.29E+12	7.58E+12	1.57E+12	4.38E+12	2.18E+12	3.62E+12
131	1.08E+13	2.05E+12	2.10E+12	3.18E+12	1.27E+13	2.76E+13	5.72E+11	3.13E+12	4.71E+12	2.39E+12
153	2.72E+12	1.87E+12	2.93E+12	3.43E+12	4.55E+12	7.50E+12	1.02E+12	3.20E+12	2.89E+12	4.42E+12
178	0.00E+00	3.90E+12	6.61E+12	3.28E+12	9.36E+12	0.00E+00	1.75E+12	2.65E+12	1.47E+12	1.53E+12
209	0.00E+00	4.46E+12	7.92E+12	0.00E+00	9.65E+12	0.00E+00	2.86E+12	8.77E+12	6.89E+12	2.67E+12
245	0.00E+00	1.43E+13	1.40E+13	4.22E+12	1.32E+13	3.66E+13	3.25E+12	6.07E+12	6.41E+12	8.42E+12

TABLE A-9.—(Continued).

Test Point	308b	308b	308b	309	309	309	310	310	310	501
Date	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/25/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	40	40	40	30	30	30	7	7	7	4
Aerosol Point #	356	357	358	359	360	361	362	363	364	501
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	0.00E+00	1.85E+15	1.03E+15	6.79E+14	5.35E+14	5.97E+15	1.49E+16	3.04E+15	1.21E+15	4.54E+16
10	8.20E+14	4.04E+14	5.70E+14	9.86E+13	2.42E+14	2.58E+15	1.87E+16	4.19E+15	4.78E+14	2.99E+16
12	2.25E+14	1.14E+14	1.22E+14	1.35E+14	2.65E+14	1.24E+15	1.40E+16	3.53E+15	2.53E+14	2.67E+16
14	5.24E+14	3.53E+14	1.96E+14	1.57E+14	1.79E+14	6.58E+14	1.22E+16	2.84E+15	2.02E+14	1.65E+16
16	2.81E+14	2.24E+14	2.01E+14	1.52E+14	1.65E+14	4.96E+14	8.98E+15	1.58E+15	1.83E+14	9.25E+15
18	3.13E+14	2.95E+14	1.51E+14	1.96E+14	1.79E+14	4.91E+14	5.16E+15	9.44E+14	1.76E+14	6.56E+15
21	3.63E+14	1.69E+14	1.92E+14	2.14E+14	2.24E+14	3.58E+14	2.81E+15	3.39E+14	1.85E+14	4.33E+15
24	1.84E+14	1.70E+14	1.75E+14	1.24E+14	2.12E+14	3.07E+14	9.03E+14	2.07E+14	1.23E+14	3.29E+15
27	2.12E+14	1.59E+14	1.65E+14	1.16E+14	1.84E+14	3.36E+14	4.48E+14	6.74E+13	7.16E+13	2.38E+15
31	2.22E+14	1.63E+14	1.35E+14	9.56E+13	1.42E+14	2.21E+14	4.35E+14	8.23E+13	6.87E+13	2.02E+15
36	1.72E+14	9.37E+13	6.43E+13	1.04E+14	1.14E+14	1.48E+14	2.19E+14	5.07E+13	5.56E+13	1.37E+15
41	6.54E+13	5.55E+13	8.11E+13	5.12E+13	6.89E+13	1.19E+14	1.29E+14	2.33E+13	2.57E+13	8.37E+14
48	8.28E+13	6.45E+13	4.13E+13	4.25E+13	5.75E+13	8.83E+13	8.49E+13	2.43E+13	2.01E+13	5.66E+14
55	6.37E+13	2.59E+13	5.97E+13	2.44E+13	3.27E+13	6.00E+13	6.87E+13	1.94E+13	1.04E+13	4.88E+14
63	3.03E+13	1.78E+13	3.45E+13	1.69E+13	1.97E+13	4.09E+13	4.78E+13	1.25E+13	1.32E+13	3.89E+14
73	2.16E+13	7.53E+12	6.05E+12	1.20E+13	1.06E+13	2.96E+13	2.97E+13	3.36E+12	1.24E+13	1.98E+14
84	6.72E+12	5.20E+12	5.60E+12	6.33E+12	8.48E+12	9.25E+12	3.99E+13	6.84E+12	1.01E+13	1.33E+14
97	3.32E+12	0.00E+00	7.46E+12	1.05E+13	3.57E+12	1.10E+13	1.33E+13	4.90E+12	4.49E+12	5.86E+13
113	3.02E+12	0.00E+00	3.40E+12	0.00E+00	1.79E+12	8.35E+12	1.07E+13	1.81E+12	1.47E+12	2.19E+13
131	9.01E+12	0.00E+00	0.00E+00	1.15E+12	4.61E+12	6.16E+12	0.00E+00	2.77E+12	4.89E+12	7.14E+12
153	3.27E+12	1.71E+12	0.00E+00	1.12E+12	3.52E+12	4.29E+12	1.31E+13	8.43E+12	3.71E+12	1.32E+13
178	3.12E+12	0.00E+00	7.03E+12	3.77E+12	4.58E+12	6.63E+12	2.04E+13	5.82E+12	1.01E+13	5.12E+12
209	0.00E+00	0.00E+00	1.89E+12	1.36E+12	4.08E+12	1.15E+13	5.50E+13	2.00E+13	2.27E+12	1.07E+13
245	3.90E+12	0.00E+00	4.41E+12	2.86E+12	2.27E+12	1.03E+13	3.82E+13	1.32E+13	2.63E+12	3.21E+13

TABLE A-9.—(Continued).

Test Point	502	502	502	502	502	502	502	502	503	504
Date	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	65	65	65	65	65	65	65	65	70	65
Aerosol Point #	502	503	504	505	506	507	508	509	511	512
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	0.00E+00	2.80E+14	0.00E+00	0.00E+00	1.30E+15	7.03E+14	6.41E+14	7.45E+14	3.84E+14	0.00E+00
10	1.62E+15	2.19E+14	3.68E+14	3.26E+14	9.47E+13	2.07E+14	2.03E+14	6.47E+14	3.14E+14	4.48E+14
12	3.97E+14	1.48E+14	1.41E+14	1.68E+14	3.10E+14	5.17E+14	1.63E+14	4.56E+14	3.48E+14	3.07E+14
14	2.08E+14	1.44E+14	2.14E+14	4.14E+14	2.28E+14	1.92E+14	9.78E+13	4.52E+14	2.25E+14	2.97E+14
16	1.50E+14	2.55E+14	3.41E+14	4.28E+14	3.03E+14	2.54E+14	1.98E+14	4.27E+14	3.30E+14	3.14E+14
18	2.56E+14	2.65E+14	2.22E+14	3.92E+14	2.57E+14	4.88E+14	1.45E+14	3.74E+14	2.74E+14	3.30E+14
21	2.43E+14	2.18E+14	3.18E+14	3.84E+14	1.96E+14	3.89E+14	1.97E+14	3.58E+14	4.47E+14	3.37E+14
24	2.30E+14	2.80E+14	4.20E+14	3.91E+14	2.89E+14	2.65E+14	2.64E+14	3.91E+14	4.34E+14	3.15E+14
27	2.56E+14	2.53E+14	3.69E+14	4.41E+14	2.61E+14	2.95E+14	2.35E+14	4.00E+14	4.15E+14	3.71E+14
31	2.70E+14	1.99E+14	3.05E+14	4.18E+14	1.93E+14	2.53E+14	2.39E+14	3.36E+14	3.72E+14	3.23E+14
36	2.12E+14	2.35E+14	3.01E+14	3.15E+14	1.85E+14	2.34E+14	2.60E+14	3.31E+14	3.50E+14	2.49E+14
41	2.05E+14	2.13E+14	2.35E+14	2.95E+14	1.66E+14	2.04E+14	1.78E+14	2.57E+14	3.25E+14	2.07E+14
48	1.98E+14	1.90E+14	2.10E+14	2.26E+14	1.60E+14	1.76E+14	1.63E+14	2.43E+14	2.56E+14	1.64E+14
55	1.37E+14	1.33E+14	1.40E+14	2.15E+14	1.16E+14	1.29E+14	1.48E+14	1.59E+14	1.74E+14	1.02E+14
63	1.07E+14	1.11E+14	1.04E+14	1.28E+14	6.52E+13	1.03E+14	9.78E+13	1.32E+14	1.46E+14	8.21E+13
73	7.66E+13	7.31E+13	7.12E+13	1.13E+14	5.35E+13	5.77E+13	4.10E+13	7.21E+13	9.82E+13	5.09E+13
84	5.67E+13	3.52E+13	5.07E+13	7.35E+13	3.14E+13	3.61E+13	3.24E+13	6.62E+13	6.60E+13	2.84E+13
97	4.09E+13	3.07E+13	3.65E+13	4.78E+13	2.60E+13	2.01E+13	2.59E+13	3.50E+13	4.57E+13	2.97E+13
113	1.99E+13	1.12E+13	2.03E+13	1.44E+13	1.11E+13	7.77E+12	1.84E+13	1.42E+13	1.78E+13	9.91E+12
131	8.42E+12	6.58E+12	6.05E+12	1.09E+13	5.54E+12	3.06E+12	7.95E+12	2.79E+12	8.77E+12	8.78E+12
153	4.25E+12	4.04E+12	6.39E+12	5.93E+12	7.09E+12	2.18E+12	3.11E+12	7.87E+12	6.11E+12	4.81E+12
178	4.94E+12	1.73E+12	2.05E+12	2.45E+12	1.13E+12	3.36E+12	5.81E+12	1.44E+13	5.71E+12	2.65E+12
209	3.79E+12	8.55E+11	4.30E+12	0.00E+00	2.38E+12	4.37E+12	4.88E+12	3.85E+13	5.80E+12	5.13E+12
245	1.46E+12	2.38E+12	3.28E+12	1.38E+12	2.58E+12	0.00E+00	6.24E+12	7.81E+13	7.76E+12	5.10E+12

TABLE A-9.—(Continued).

Test Point	505	506	507	508	508	509	510	512	513	513
Date	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	60	85	100	7	7	100	85	30	7	7
Aerosol Point #	513	514	515	518	519	520	521	525	526	527
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	0.00E+00	3.12E+14	0.00E+00	0.00E+00	2.37E+15	0.00E+00	4.92E+14	0.00E+00	1.34E+15	2.54E+16
10	1.67E+14	8.47E+13	1.72E+14	6.60E+14	1.06E+15	4.51E+14	2.74E+14	5.53E+14	7.42E+14	1.49E+16
12	6.38E+13	3.16E+14	1.72E+14	2.76E+14	3.64E+14	2.93E+14	1.93E+14	1.97E+14	7.70E+14	9.57E+15
14	3.34E+14	2.29E+14	1.21E+14	2.16E+14	3.33E+14	1.86E+14	1.78E+14	1.70E+14	5.65E+14	6.25E+15
16	3.30E+14	3.56E+14	3.11E+14	2.89E+14	2.50E+14	2.36E+14	1.97E+14	1.43E+14	3.75E+14	3.91E+15
18	1.29E+14	3.02E+14	3.18E+14	2.35E+14	1.86E+14	2.67E+14	2.68E+14	1.55E+14	2.58E+14	2.24E+15
21	2.29E+14	3.85E+14	3.77E+14	1.98E+14	1.80E+14	3.00E+14	3.68E+14	1.30E+14	2.12E+14	1.31E+15
24	1.47E+14	4.40E+14	4.48E+14	1.70E+14	1.38E+14	4.72E+14	4.20E+14	1.54E+14	1.98E+14	7.71E+14
27	2.35E+14	4.37E+14	6.05E+14	8.80E+13	1.21E+14	5.16E+14	4.19E+14	9.31E+13	1.45E+14	5.67E+14
31	2.11E+14	4.53E+14	5.78E+14	1.69E+14	9.86E+13	4.84E+14	4.12E+14	9.38E+13	1.08E+14	3.49E+14
36	1.75E+14	4.18E+14	5.45E+14	7.01E+13	5.15E+13	5.32E+14	4.22E+14	1.04E+14	7.67E+13	2.27E+14
41	1.01E+14	4.37E+14	5.43E+14	9.69E+13	4.89E+13	5.25E+14	4.09E+14	5.70E+13	7.46E+13	1.76E+14
48	1.21E+14	3.90E+14	4.80E+14	3.23E+13	2.74E+13	4.98E+14	3.49E+14	4.61E+13	5.39E+13	1.12E+14
55	7.29E+13	3.10E+14	3.85E+14	1.47E+13	2.05E+13	4.31E+14	3.69E+14	3.38E+13	2.14E+13	8.04E+13
63	4.30E+13	2.62E+14	3.24E+14	2.80E+13	6.05E+12	3.73E+14	3.02E+14	1.62E+13	1.92E+13	4.83E+13
73	3.50E+13	1.89E+14	2.53E+14	6.32E+12	1.22E+13	2.73E+14	2.31E+14	9.62E+12	1.09E+13	3.19E+13
84	1.08E+13	1.49E+14	1.92E+14	1.06E+13	7.70E+12	2.41E+14	1.47E+14	1.99E+12	9.74E+12	2.12E+13
97	5.50E+12	8.35E+13	1.24E+14	7.89E+12	5.76E+12	1.60E+14	1.23E+14	2.40E+12	3.18E+12	2.40E+13
113	3.78E+12	5.48E+13	7.46E+13	7.12E+12	5.01E+12	7.74E+13	6.67E+13	1.71E+12	6.54E+12	2.22E+13
131	5.65E+12	3.68E+13	4.54E+13	2.55E+12	5.86E+12	6.09E+13	3.75E+13	2.38E+12	1.87E+12	1.43E+13
153	3.39E+12	1.91E+13	2.48E+13	2.51E+12	6.31E+12	3.79E+13	2.58E+13	3.99E+12	7.02E+12	1.44E+13
178	3.83E+12	6.93E+12	1.30E+13	1.44E+13	7.50E+12	2.63E+13	1.22E+13	3.50E+12	1.26E+13	1.77E+13
209	6.05E+12	9.58E+12	1.84E+13	1.37E+13	1.01E+13	9.37E+12	1.62E+13	4.26E+12	1.09E+13	2.30E+13
245	8.72E+12	7.69E+12	1.50E+13	1.18E+13	6.02E+12	4.04E+12	1.34E+13	2.46E+12	8.34E+12	2.51E+13

TABLE A-9.—(Continued).

Test Point	514	515	516	517	518	518	519	520	521	522
Date	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	100	30	7	85	7	7	100	85	30	7
Aerosol Point #	531	532	533	534	535	536	537	538	539	540
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	4.60E+15	8.10E+15	2.22E+16	4.14E+14	2.14E+16	8.17E+14	0.00E+00	1.11E+15	4.08E+14	3.41E+14
10	1.06E+15	2.54E+15	1.35E+16	9.42E+14	9.73E+15	5.52E+14	0.00E+00	5.36E+14	1.78E+14	1.94E+14
12	2.09E+14	5.87E+14	6.99E+15	6.55E+14	4.90E+15	3.06E+14	4.82E+14	5.08E+14	1.12E+14	3.78E+14
14	3.09E+14	1.03E+15	4.39E+15	5.12E+14	2.17E+15	2.65E+14	2.02E+14	6.70E+14	1.08E+14	2.59E+14
16	3.10E+14	5.80E+14	1.35E+15	6.36E+14	1.37E+15	2.53E+14	2.05E+14	9.08E+14	1.05E+14	3.35E+14
18	3.52E+14	6.49E+14	1.59E+15	8.31E+14	7.10E+14	1.94E+14	7.17E+14	9.51E+14	1.04E+14	3.70E+14
21	3.03E+14	7.77E+14	7.37E+14	7.97E+14	5.82E+14	1.70E+14	6.85E+14	1.22E+15	1.05E+14	2.69E+14
24	3.10E+14	6.28E+14	4.48E+14	8.53E+14	4.71E+14	1.50E+14	7.05E+14	1.25E+15	9.85E+13	2.54E+14
27	4.03E+14	5.80E+14	4.90E+14	8.55E+14	2.83E+14	1.08E+14	7.68E+14	1.33E+15	6.74E+13	1.69E+14
31	3.10E+14	3.45E+14	2.23E+14	7.90E+14	2.26E+14	8.66E+13	1.00E+15	1.40E+15	4.97E+13	1.23E+14
36	3.77E+14	2.04E+14	2.04E+14	6.91E+14	1.42E+14	6.16E+13	7.93E+14	1.40E+15	4.14E+13	9.57E+13
41	3.49E+14	2.29E+14	1.26E+14	6.93E+14	1.45E+14	3.28E+13	7.48E+14	1.26E+15	2.55E+13	5.97E+13
48	3.01E+14	1.81E+14	5.30E+13	6.80E+14	6.14E+13	2.85E+13	7.29E+14	1.19E+15	2.05E+13	4.40E+13
55	2.40E+14	6.16E+13	4.67E+13	5.98E+14	4.15E+13	2.13E+13	6.14E+14	9.78E+14	1.24E+13	1.84E+13
63	2.07E+14	4.87E+13	2.87E+13	4.69E+14	2.73E+13	1.10E+13	4.76E+14	6.95E+14	6.91E+12	1.03E+13
73	1.51E+14	3.81E+13	9.36E+12	3.59E+14	1.62E+13	7.89E+12	3.43E+14	5.48E+14	4.97E+12	6.09E+12
84	9.50E+13	2.30E+13	8.77E+12	2.60E+14	1.13E+13	3.62E+12	2.32E+14	3.77E+14	1.45E+12	7.34E+12
97	7.08E+13	9.17E+12	4.18E+12	1.54E+14	1.47E+13	2.67E+12	1.67E+14	2.41E+14	8.28E+11	2.40E+12
113	4.65E+13	3.29E+13	8.55E+12	9.04E+13	6.38E+12	2.93E+12	9.79E+13	1.35E+14	1.39E+12	2.87E+12
131	2.73E+13	1.65E+13	7.83E+12	3.85E+13	7.39E+12	3.51E+12	6.77E+13	7.33E+13	1.02E+12	1.17E+12
153	1.10E+13	3.49E+13	1.23E+13	3.08E+13	7.35E+12	3.45E+12	2.96E+13	3.40E+13	8.43E+11	2.44E+12
178	5.72E+12	1.78E+13	1.63E+13	1.67E+13	1.04E+13	2.42E+12	1.02E+13	2.07E+13	1.47E+12	1.82E+12
209	1.33E+13	4.62E+13	8.90E+12	7.53E+12	1.82E+13	2.99E+12	4.38E+12	9.63E+12	1.46E+12	1.30E+12
245	4.24E+12	2.65E+12	0.00E+00	1.18E+13	2.17E+13	6.61E+12	4.34E+13	3.34E+13	1.60E+12	1.61E+12

TABLE A-9.—(Continued).

Test Point	522	522	522	522	522	522	522	523	524	526
Date	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	7	7	7	7	7	7	7	100	85	7
Aerosol Point #	541	542	543	544	547	548	549	550	551	553
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	8.29E+14	6.07E+14	8.57E+14	1.10E+15	1.22E+15	1.74E+15	3.53E+15	7.72E+14	3.21E+14	1.98E+15
10	1.99E+14	3.13E+14	3.69E+14	1.40E+14	2.58E+14	4.70E+14	1.12E+15	2.60E+14	4.92E+14	0.00E+00
12	1.37E+14	4.15E+14	2.21E+14	5.04E+14	5.10E+14	7.35E+14	4.23E+14	6.71E+14	3.67E+14	5.74E+14
14	1.16E+14	3.56E+14	3.44E+14	2.24E+14	5.86E+14	7.68E+14	4.09E+14	4.64E+14	1.97E+14	3.58E+14
16	1.53E+14	2.84E+14	3.20E+14	2.99E+14	5.78E+14	7.58E+14	3.77E+14	4.74E+14	1.93E+14	2.55E+14
18	1.12E+14	2.83E+14	2.34E+14	1.90E+14	5.49E+14	5.43E+14	2.16E+14	5.78E+14	6.32E+14	4.68E+14
21	8.54E+13	2.53E+14	2.54E+14	1.15E+14	3.54E+14	4.80E+14	1.52E+14	4.69E+14	6.77E+14	2.74E+14
24	9.11E+13	2.17E+14	1.65E+14	1.17E+14	3.44E+14	4.67E+14	1.59E+14	4.81E+14	5.56E+14	2.64E+14
27	5.93E+13	1.85E+14	1.47E+14	5.24E+13	2.49E+14	2.84E+14	1.01E+14	5.37E+14	6.26E+14	1.73E+14
31	4.46E+13	1.30E+14	8.39E+13	4.50E+13	1.64E+14	2.01E+14	7.58E+13	5.57E+14	6.57E+14	1.09E+14
36	3.56E+13	8.41E+13	8.34E+13	2.05E+13	1.60E+14	1.65E+14	5.96E+13	5.63E+14	5.66E+14	7.47E+13
41	2.50E+13	4.78E+13	4.69E+13	2.61E+13	9.16E+13	1.13E+14	3.68E+13	5.93E+14	5.51E+14	2.28E+13
48	1.37E+13	3.57E+13	2.84E+13	1.94E+13	6.33E+13	7.42E+13	3.31E+13	5.71E+14	4.61E+14	3.77E+13
55	1.07E+13	1.77E+13	1.66E+13	1.72E+13	4.24E+13	3.98E+13	1.72E+13	4.14E+14	4.07E+14	4.10E+13
63	4.14E+12	1.79E+13	5.87E+12	1.56E+13	2.37E+13	2.93E+13	1.36E+13	3.37E+14	3.36E+14	1.52E+13
73	4.47E+12	7.54E+12	4.59E+12	1.18E+13	1.47E+13	1.43E+13	6.65E+12	2.52E+14	2.33E+14	8.98E+12
84	3.32E+12	4.77E+12	3.72E+12	7.83E+12	4.39E+12	1.22E+13	9.67E+12	1.65E+14	1.52E+14	1.90E+13
97	1.72E+12	1.05E+12	2.57E+12	0.00E+00	4.92E+12	4.73E+12	5.83E+12	1.01E+14	9.93E+13	8.05E+12
113	1.50E+12	1.72E+12	1.03E+12	1.60E+12	4.10E+12	2.31E+12	5.88E+12	5.84E+13	5.23E+13	4.00E+12
131	1.49E+12	1.70E+12	2.88E+12	5.13E+12	2.45E+12	3.83E+12	9.13E+12	3.61E+13	1.80E+13	1.11E+13
153	2.46E+12	2.09E+12	4.10E+12	7.21E+12	1.82E+12	8.09E+12	3.95E+12	2.44E+13	2.31E+13	8.20E+12
178	3.21E+12	5.14E+12	1.03E+13	1.16E+13	8.52E+12	1.68E+13	8.37E+12	1.08E+13	7.28E+12	1.29E+13
209	2.99E+12	3.12E+12	9.36E+12	1.90E+13	5.72E+12	9.97E+12	1.02E+13	4.64E+12	3.64E+12	9.55E+12
245	1.81E+12	1.79E+12	7.28E+12	0.00E+00	1.49E+12	6.84E+12	8.34E+12	0.00E+00	0.00E+00	0.00E+00

TABLE A-9.—(Continued).

Test Point	601	601	601	603	604	605	605	605	605	605
Date	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	7	7	7	85	30	7	7	7	7	7
Aerosol Point #	602	603	604	607	608	609	610	611	612	613
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	5.76E+16	2.54E+15	1.80E+15	6.26E+14	7.29E+14	2.65E+15	1.16E+15	2.59E+15	1.15E+15	1.18E+15
10	3.25E+16	2.23E+15	2.42E+15	3.24E+14	3.87E+14	9.33E+14	1.38E+15	6.80E+14	1.77E+14	4.92E+14
12	1.97E+16	1.57E+15	1.16E+15	2.03E+14	2.11E+14	4.86E+14	7.70E+14	5.51E+14	4.75E+14	3.40E+14
14	8.26E+15	1.47E+15	1.12E+15	3.18E+14	1.07E+14	4.22E+14	6.12E+14	1.75E+14	2.34E+14	4.29E+14
16	3.82E+15	1.21E+15	8.10E+14	3.61E+14	1.93E+14	5.05E+14	3.82E+14	2.21E+14	2.50E+14	2.02E+14
18	2.01E+15	7.07E+14	6.55E+14	4.17E+14	2.26E+14	3.59E+14	1.63E+14	6.85E+13	1.80E+14	2.14E+14
21	1.56E+15	4.54E+14	4.25E+14	4.87E+14	1.74E+14	1.98E+14	2.95E+14	5.00E+13	1.44E+14	2.31E+14
24	9.09E+14	3.41E+14	3.35E+14	5.40E+14	2.23E+14	2.32E+14	1.14E+14	0.00E+00	8.32E+13	2.22E+14
27	7.99E+14	2.53E+14	3.07E+14	5.85E+14	1.82E+14	1.89E+14	1.90E+14	8.53E+13	7.33E+13	1.54E+14
31	7.09E+14	2.14E+14	1.18E+14	6.55E+14	1.20E+14	1.19E+14	1.10E+14	2.34E+13	8.27E+13	9.11E+13
36	3.94E+14	1.73E+14	1.08E+14	5.76E+14	1.04E+14	7.57E+13	6.53E+13	1.78E+14	4.46E+13	7.72E+13
41	2.57E+14	1.07E+14	1.24E+14	6.26E+14	7.33E+13	6.49E+13	5.92E+13	3.05E+13	3.19E+13	3.88E+13
48	1.53E+14	6.26E+13	1.00E+14	5.60E+14	4.80E+13	3.06E+13	5.66E+13	5.45E+13	1.88E+13	2.32E+13
55	1.30E+14	4.05E+13	6.18E+13	5.16E+14	3.71E+13	1.90E+13	2.91E+13	2.43E+13	1.24E+13	2.06E+13
63	6.76E+13	1.83E+13	5.46E+13	3.90E+14	2.10E+13	1.04E+13	3.74E+13	0.00E+00	1.01E+13	1.85E+13
73	3.83E+13	1.45E+13	2.49E+13	3.18E+14	1.89E+13	1.13E+13	1.48E+13	1.94E+13	4.96E+12	6.65E+12
84	4.03E+13	1.01E+13	7.48E+12	2.45E+14	7.65E+12	9.36E+12	1.74E+13	1.80E+13	5.25E+12	0.00E+00
97	1.50E+13	3.99E+12	6.20E+12	1.61E+14	8.31E+12	4.93E+12	1.60E+13	1.58E+13	4.45E+12	1.25E+12
113	1.98E+13	4.11E+12	6.60E+12	9.81E+13	5.52E+12	5.06E+12	7.37E+12	7.86E+12	5.94E+12	5.36E+12
131	0.00E+00	2.70E+12	6.55E+12	5.67E+13	4.25E+12	6.08E+12	3.36E+12	7.84E+12	6.48E+12	1.33E+12
153	3.93E+12	3.12E+12	3.01E+12	3.17E+13	3.29E+12	6.57E+12	7.98E+12	2.87E+13	1.17E+12	4.84E+12
178	8.95E+12	4.83E+12	3.37E+12	1.50E+13	4.34E+12	3.12E+12	1.53E+13	2.38E+13	3.29E+12	5.40E+12
209	2.00E+14	6.51E+12	2.80E+13	9.00E+12	1.22E+13	3.27E+12	2.70E+13	3.35E+13	2.78E+12	7.07E+12
245	1.95E+13	1.55E+13	7.45E+12	5.61E+12	1.17E+13	8.24E+12	2.11E+13	7.23E+13	4.43E+12	9.13E+12

TABLE A-9.—(Continued).

Test Point	606	607	608	609	609	610	611	612	613	613
Date	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	100	85	30	7	7	100	85	30	7	7
Aerosol Point #	615	616	617	618	619	620	621	622	623	624
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	3.55E+15	9.89E+15	5.33E+14	2.40E+15	6.56E+16	9.50E+15	9.99E+14	4.50E+14	4.29E+14	5.04E+16
10	0.00E+00	6.21E+14	5.33E+14	6.89E+14	3.43E+16	2.06E+14	2.75E+14	2.07E+14	4.23E+14	2.82E+16
12	1.63E+15	4.92E+14	2.97E+14	4.51E+14	1.26E+16	7.68E+13	1.12E+15	2.07E+14	3.70E+14	1.12E+16
14	1.73E+15	4.56E+14	3.05E+14	4.78E+14	4.53E+15	1.46E+14	6.21E+14	1.31E+14	3.63E+14	4.49E+15
16	1.08E+15	1.58E+15	2.42E+14	3.49E+14	1.61E+15	2.35E+14	1.10E+15	1.48E+14	4.72E+14	2.27E+15
18	2.49E+15	1.11E+15	1.79E+14	2.14E+14	1.12E+15	3.55E+14	1.25E+15	1.82E+14	2.39E+14	1.30E+15
21	1.87E+15	9.90E+14	1.75E+14	1.94E+14	7.61E+14	4.70E+14	1.53E+15	1.25E+14	1.84E+14	8.63E+14
24	1.86E+15	1.17E+15	1.69E+14	1.51E+14	6.18E+14	5.38E+14	1.68E+15	1.19E+14	1.87E+14	6.65E+14
27	1.80E+15	1.18E+15	1.64E+14	1.58E+14	4.32E+14	5.17E+14	1.53E+15	1.31E+14	1.44E+14	5.33E+14
31	2.13E+15	1.09E+15	1.23E+14	9.55E+13	2.74E+14	5.04E+14	1.87E+15	1.05E+14	9.87E+13	3.27E+14
36	1.72E+15	1.08E+15	1.12E+14	6.30E+13	2.02E+14	4.95E+14	1.93E+15	6.90E+13	9.07E+13	2.59E+14
41	1.76E+15	8.03E+14	5.89E+13	6.58E+13	1.36E+14	5.98E+14	1.66E+15	5.85E+13	4.26E+13	1.76E+14
48	1.76E+15	8.75E+14	6.92E+13	3.45E+13	1.07E+14	4.62E+14	1.55E+15	3.77E+13	3.49E+13	1.27E+14
55	1.47E+15	8.69E+14	3.29E+13	1.73E+13	5.69E+13	4.24E+14	1.45E+15	2.23E+13	2.38E+13	8.51E+13
63	1.43E+15	6.93E+14	2.08E+13	1.25E+13	4.20E+13	3.56E+14	1.12E+15	1.56E+13	1.16E+13	4.75E+13
73	9.97E+14	4.17E+14	1.69E+13	4.64E+12	2.64E+13	2.86E+14	8.68E+14	9.43E+12	1.14E+13	3.27E+13
84	6.36E+14	4.82E+14	9.93E+12	3.38E+12	2.37E+13	2.36E+14	7.07E+14	6.70E+12	5.89E+12	1.70E+13
97	4.97E+14	2.97E+14	1.86E+13	3.57E+12	1.51E+13	1.68E+14	4.30E+14	1.91E+12	7.20E+12	1.44E+13
113	2.36E+14	1.91E+14	9.50E+11	8.16E+12	1.05E+13	1.14E+14	2.57E+14	1.91E+12	1.26E+12	1.14E+13
131	1.85E+14	1.09E+14	2.82E+12	2.90E+12	7.62E+12	6.47E+13	1.68E+14	2.16E+12	2.53E+12	1.29E+13
153	8.86E+13	6.12E+13	7.77E+12	4.79E+12	1.46E+13	5.02E+13	1.14E+14	1.38E+12	7.08E+12	1.01E+13
178	5.72E+13	5.36E+13	8.79E+12	5.19E+12	2.80E+13	2.39E+13	4.57E+13	7.43E+11	7.80E+12	1.78E+13
209	2.21E+13	2.25E+13	2.58E+13	7.70E+12	3.35E+13	1.20E+13	2.22E+13	5.58E+12	2.16E+13	2.91E+13
245	9.29E+13	1.12E+13	4.60E+13	7.94E+12	4.24E+13	1.18E+12	3.63E+13	7.45E+12	1.25E+13	5.44E+13

TABLE A-9.—(Continued).

Test Point	614	615	616	617	617	617	617	618	619	620
Date	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	100	85	30	7	7	7	7	4	100	85
Aerosol Point #	625	626	627	628	629	630	631	632	633	634
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	7.51E+15	7.09E+14	2.29E+15	4.15E+16	1.02E+15	3.64E+14	4.46E+14	2.88E+16	1.94E+15	1.42E+15
10	4.96E+14	1.01E+15	1.67E+15	2.19E+16	5.11E+14	3.11E+14	9.31E+14	3.09E+16	4.09E+14	5.52E+14
12	5.29E+14	7.08E+14	6.68E+14	7.44E+15	1.06E+14	2.92E+14	5.12E+14	2.46E+16	6.70E+14	4.02E+14
14	3.46E+14	5.81E+14	2.72E+14	2.33E+15	8.19E+13	2.79E+14	4.78E+14	1.85E+16	1.02E+15	4.03E+14
16	6.33E+14	9.05E+14	2.54E+14	1.77E+15	6.10E+13	2.73E+14	4.81E+14	1.38E+16	1.04E+15	3.13E+14
18	5.14E+14	8.80E+14	2.83E+14	1.11E+15	9.90E+13	3.06E+14	3.74E+14	8.35E+15	8.20E+14	5.80E+14
21	5.69E+14	1.06E+15	1.63E+14	7.61E+14	8.40E+13	2.20E+14	3.19E+14	4.74E+15	7.79E+14	7.43E+14
24	6.60E+14	9.31E+14	2.42E+14	5.41E+14	8.63E+13	2.23E+14	2.83E+14	2.63E+15	8.06E+14	7.48E+14
27	7.84E+14	1.14E+15	2.08E+14	5.71E+14	4.51E+13	1.59E+14	1.91E+14	1.49E+15	8.08E+14	6.86E+14
31	6.36E+14	8.68E+14	1.81E+14	2.46E+14	4.61E+13	1.33E+14	1.79E+14	1.01E+15	7.35E+14	7.05E+14
36	6.49E+14	9.92E+14	9.38E+13	2.10E+14	2.42E+13	6.59E+13	9.62E+13	6.41E+14	7.63E+14	5.35E+14
41	7.00E+14	9.31E+14	9.65E+13	7.89E+13	1.74E+13	5.64E+13	5.82E+13	3.68E+14	7.77E+14	6.24E+14
48	6.06E+14	8.13E+14	5.21E+13	1.02E+14	8.46E+12	4.18E+13	3.82E+13	2.54E+14	7.22E+14	4.42E+14
55	6.12E+14	6.85E+14	2.11E+13	9.22E+13	1.79E+12	2.17E+13	2.38E+13	1.70E+14	6.31E+14	4.17E+14
63	4.93E+14	6.64E+14	3.34E+13	2.10E+13	4.04E+12	1.39E+13	1.96E+13	1.01E+14	5.39E+14	3.66E+14
73	3.50E+14	4.88E+14	1.30E+13	9.35E+12	1.53E+12	4.43E+12	3.88E+12	5.03E+13	3.72E+14	2.62E+14
84	3.63E+14	3.20E+14	1.99E+13	3.90E+12	8.90E+11	5.29E+12	4.91E+12	4.24E+13	3.12E+14	2.06E+14
97	2.17E+14	2.66E+14	8.79E+12	4.06E+12	2.30E+12	3.40E+12	3.29E+12	1.67E+13	2.07E+14	1.06E+14
113	1.30E+14	1.62E+14	0.00E+00	7.52E+12	1.68E+12	0.00E+00	2.34E+12	1.37E+13	1.35E+14	9.08E+13
131	8.21E+13	1.11E+14	3.93E+12	0.00E+00	1.15E+12	0.00E+00	2.20E+12	1.21E+13	7.78E+13	3.81E+13
153	6.32E+13	5.12E+13	0.00E+00	7.71E+12	1.76E+12	3.29E+12	4.75E+12	1.37E+13	3.26E+13	2.53E+13
178	2.61E+13	4.32E+13	0.00E+00	7.87E+12	9.29E+11	7.10E+12	0.00E+00	1.25E+13	2.47E+13	1.03E+13
209	5.72E+12	1.98E+13	4.25E+12	1.92E+13	1.35E+12	1.21E+13	6.31E+12	3.59E+13	2.48E+13	9.51E+12
245	8.83E+12	1.85E+13	1.17E+13	0.00E+00	2.58E+12	1.19E+13	1.50E+13	2.33E+13	1.86E+13	5.71E+12

TABLE A-9.—(Continued).

Test Point No.	621	622	623	623	624	624	624	624	625	626
Date	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	65	40	4	4	40	40	40	40	30	15
Aerosol Point #	635	636	637	638	640	641	643	644	645	646
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	1.34E+15	6.51E+14	7.78E+16	4.45E+15	1.01E+15	6.44E+14	4.79E+14	3.76E+14	5.05E+14	6.01E+14
10	5.97E+14	9.14E+14	3.87E+15	2.30E+15	4.09E+14	2.78E+14	2.57E+14	1.17E+14	9.59E+13	1.43E+14
12	6.32E+14	8.39E+14	1.45E+16	1.03E+15	1.93E+14	1.67E+14	2.53E+14	1.31E+14	8.84E+13	1.30E+14
14	3.38E+14	2.61E+14	8.90E+15	8.08E+14	8.47E+13	1.63E+14	1.76E+14	1.25E+14	8.69E+13	8.89E+13
16	2.27E+14	6.49E+14	9.61E+15	4.50E+14	1.27E+14	1.85E+14	6.87E+13	1.51E+14	9.62E+13	9.26E+13
18	3.45E+14	3.64E+14	3.03E+15	4.21E+14	6.22E+13	1.64E+14	7.49E+13	1.03E+14	1.07E+14	1.01E+14
21	2.78E+14	4.33E+14	2.38E+15	3.09E+14	1.09E+14	1.66E+14	1.20E+14	1.47E+14	1.06E+14	7.80E+13
24	3.76E+14	2.84E+14	2.04E+15	2.32E+14	6.36E+13	1.66E+14	1.16E+14	1.28E+14	7.43E+13	9.47E+13
27	3.89E+14	2.87E+14	1.64E+15	2.49E+14	6.07E+13	1.56E+14	1.18E+14	8.39E+13	7.86E+13	2.89E+13
31	2.66E+14	1.82E+14	1.93E+15	9.87E+13	5.41E+13	1.22E+14	9.99E+13	9.95E+13	6.57E+13	3.88E+13
36	2.61E+14	1.30E+14	1.49E+15	9.20E+13	5.37E+13	1.05E+14	7.07E+13	7.73E+13	5.17E+13	2.18E+13
41	1.56E+14	1.20E+14	1.43E+15	7.52E+13	3.72E+13	8.27E+13	4.48E+13	6.54E+13	2.95E+13	1.29E+13
48	1.80E+14	9.86E+13	1.14E+15	3.91E+13	3.07E+13	5.74E+13	4.26E+13	3.78E+13	3.10E+13	1.32E+13
55	1.22E+14	7.45E+13	3.98E+14	2.69E+13	1.84E+13	3.53E+13	1.68E+13	3.46E+13	1.74E+13	7.51E+12
63	1.13E+14	3.36E+13	2.53E+14	3.62E+13	1.57E+13	2.26E+13	2.87E+13	1.64E+13	1.05E+13	4.38E+12
73	6.96E+13	1.84E+13	1.08E+14	2.58E+13	7.35E+12	1.67E+13	1.35E+13	7.49E+12	6.26E+12	2.43E+12
84	4.26E+13	9.12E+12	1.58E+14	2.13E+13	5.35E+12	7.27E+12	7.23E+12	7.77E+12	4.58E+12	4.82E+12
97	3.02E+13	6.25E+12	1.48E+14	2.47E+13	5.52E+12	6.02E+12	9.14E+11	4.25E+12	2.35E+12	1.08E+12
113	1.64E+13	3.73E+12	2.14E+14	2.42E+13	4.59E+12	2.92E+12	9.30E+11	3.19E+12	3.02E+12	1.97E+12
131	1.32E+13	2.04E+12	1.84E+14	2.23E+13	3.23E+12	2.42E+12	5.40E+12	2.37E+12	1.77E+12	1.59E+12
153	5.51E+12	3.96E+12	4.52E+13	1.88E+13	3.18E+12	2.99E+12	2.54E+12	1.03E+12	6.78E+11	3.66E+12
178	1.16E+13	1.94E+12	1.29E+14	1.11E+13	4.79E+12	2.33E+12	2.67E+12	9.84E+11	2.85E+12	2.01E+12
209	3.57E+12	1.26E+13	4.84E+13	2.40E+13	3.74E+12	4.73E+12	6.75E+12	1.95E+12	1.21E+12	5.68E+11
245	1.66E+13	1.14E+13	5.42E+13	3.06E+13	4.51E+12	4.23E+12	9.86E+11	5.65E+12	6.30E+12	1.23E+12

TABLE A-9.—(Continued).

Test Point No.	627	628	629	629	629	630	631	632	633	634
Date	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	7	5.5	4	4	4	5.5	7	15	30	4
Aerosol Point #	647	648	649	650	651	652	653	654	655	656
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	6.48E+14	7.41E+14	0.00E+00	1.71E+15	3.18E+16	3.25E+16	2.68E+16	8.61E+15	4.67E+15	3.19E+16
10	3.33E+14	5.03E+14	0.00E+00	2.67E+14	2.16E+16	2.17E+16	1.43E+16	4.80E+15	1.74E+15	2.48E+16
12	1.74E+14	8.23E+14	0.00E+00	5.66E+14	1.61E+16	1.33E+16	9.03E+15	2.99E+15	1.12E+15	1.87E+16
14	1.16E+14	5.33E+14	0.00E+00	3.91E+14	1.26E+16	6.81E+15	7.48E+15	1.95E+15	4.19E+14	1.45E+16
16	1.59E+14	4.91E+14	0.00E+00	3.22E+14	9.51E+15	3.80E+15	5.03E+15	9.37E+14	4.23E+14	9.59E+15
18	1.11E+14	3.87E+14	0.00E+00	3.22E+14	6.58E+15	1.93E+15	3.08E+15	6.33E+14	3.72E+14	5.73E+15
21	9.72E+13	3.78E+14	0.00E+00	2.20E+14	3.63E+15	1.09E+15	1.62E+15	4.90E+14	2.26E+14	3.26E+15
24	7.24E+13	2.60E+14	0.00E+00	1.43E+14	2.13E+15	6.65E+14	8.70E+14	2.40E+14	1.97E+14	1.76E+15
27	7.66E+13	2.33E+14	0.00E+00	1.64E+14	1.33E+15	4.83E+14	5.03E+14	2.08E+14	1.94E+14	1.09E+15
31	4.70E+13	1.88E+14	0.00E+00	9.38E+13	8.72E+14	3.22E+14	3.63E+14	1.23E+14	1.10E+14	5.94E+14
36	2.93E+13	1.24E+14	0.00E+00	6.46E+13	4.59E+14	2.79E+14	1.95E+14	1.44E+14	1.18E+14	4.19E+14
41	1.89E+13	7.64E+13	0.00E+00	6.33E+13	3.53E+14	1.46E+14	1.32E+14	8.45E+13	9.86E+13	2.67E+14
48	8.19E+12	3.82E+13	0.00E+00	4.42E+13	2.12E+14	1.22E+14	9.35E+13	5.31E+13	4.25E+13	2.05E+14
55	1.34E+13	5.36E+13	0.00E+00	1.93E+13	1.25E+14	6.98E+13	7.75E+13	3.78E+13	3.66E+13	1.03E+14
63	5.64E+12	2.20E+13	0.00E+00	1.31E+13	1.03E+14	5.84E+13	4.04E+13	2.08E+13	2.34E+13	6.72E+13
73	1.92E+12	9.88E+12	0.00E+00	1.14E+13	5.45E+13	3.53E+13	2.66E+13	1.62E+13	2.25E+13	3.78E+13
84	1.57E+12	1.04E+13	0.00E+00	7.09E+12	3.21E+13	2.57E+13	1.23E+13	1.55E+13	1.10E+13	1.98E+13
97	3.26E+12	7.07E+12	0.00E+00	4.23E+12	5.04E+13	1.26E+13	1.30E+13	1.36E+13	8.35E+12	1.76E+13
113	2.24E+12	5.62E+12	0.00E+00	1.35E+12	4.24E+13	2.34E+13	1.22E+13	1.46E+13	5.96E+12	1.57E+13
131	2.74E+12	3.97E+12	0.00E+00	3.85E+12	2.14E+13	1.70E+13	1.46E+13	6.14E+12	2.65E+12	1.06E+13
153	6.79E+11	5.83E+12	0.00E+00	9.51E+12	1.33E+13	1.32E+13	1.51E+13	1.12E+13	3.55E+12	1.73E+13
178	9.91E+11	2.35E+12	0.00E+00	2.33E+12	1.70E+13	1.73E+13	1.49E+13	1.97E+13	5.55E+12	1.72E+13
209	2.92E+12	5.35E+12	0.00E+00	4.93E+12	3.12E+13	2.14E+13	1.92E+13	2.01E+13	9.55E+12	2.85E+13
245	3.48E+12	4.23E+13	0.00E+00	1.08E+13	3.99E+13	3.44E+13	1.80E+13	2.10E+13	7.76E+12	2.00E+13

TABLE A-9.—(Continued).

Test Point No.	635	635	635	635	636	637	637	638	639	640
Date	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	40	40	40	40	30	15	15	7	5.5	4
Aerosol Point #	657	658	659	660	661	662	662	663	664	665
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	5.73E+15	5.26E+14	5.02E+14	1.66E+15	1.09E+15	1.23E+15	2.28E+15	2.43E+15	2.06E+15	1.48E+15
10	3.31E+15	3.61E+14	5.27E+14	1.47E+14	2.46E+14	4.78E+14	3.84E+14	5.37E+14	1.41E+15	1.55E+15
12	1.78E+15	1.57E+14	2.93E+14	1.07E+14	2.13E+14	3.63E+14	1.00E+15	3.82E+14	1.04E+15	1.26E+15
14	8.52E+14	1.23E+14	1.89E+14	6.07E+13	1.32E+14	1.57E+14	5.75E+14	3.11E+14	7.47E+14	1.24E+15
16	4.79E+14	1.48E+14	1.32E+14	7.27E+13	1.32E+14	1.85E+14	4.85E+14	3.35E+14	6.06E+14	1.08E+15
18	3.15E+14	1.51E+14	1.75E+14	4.86E+13	1.16E+14	1.05E+14	5.05E+14	2.24E+14	4.63E+14	9.73E+14
21	3.19E+14	1.25E+14	1.49E+14	5.69E+13	1.28E+14	9.88E+13	4.55E+14	1.72E+14	3.91E+14	7.63E+14
24	2.83E+14	1.31E+14	1.40E+14	4.65E+13	9.54E+13	1.03E+14	2.67E+14	1.41E+14	2.56E+14	5.50E+14
27	2.40E+14	1.27E+14	1.42E+14	4.52E+13	9.70E+13	7.31E+13	2.66E+14	9.87E+13	1.72E+14	3.63E+14
31	1.51E+14	1.02E+14	1.09E+14	3.34E+13	6.46E+13	4.39E+13	1.81E+14	6.84E+13	1.40E+14	2.62E+14
36	1.35E+14	7.53E+13	8.44E+13	2.92E+13	5.63E+13	5.55E+13	1.37E+14	5.36E+13	1.02E+14	2.36E+14
41	1.28E+14	6.83E+13	6.65E+13	2.48E+13	3.75E+13	2.43E+13	1.22E+14	3.51E+13	6.21E+13	1.04E+14
48	6.92E+13	5.50E+13	4.55E+13	1.58E+13	2.59E+13	2.19E+13	5.49E+13	2.51E+13	4.07E+13	7.75E+13
55	4.69E+13	3.29E+13	3.81E+13	1.39E+13	2.01E+13	1.21E+13	3.44E+13	1.72E+13	2.82E+13	2.82E+13
63	4.43E+13	2.15E+13	1.93E+13	6.31E+12	1.30E+13	6.10E+12	2.32E+13	8.43E+12	1.54E+13	2.80E+13
73	2.32E+13	1.15E+13	1.35E+13	6.45E+12	8.21E+12	6.44E+12	7.42E+12	6.90E+12	1.43E+13	1.12E+13
84	1.26E+13	8.24E+12	1.18E+13	4.40E+12	3.55E+12	6.23E+12	6.59E+12	4.97E+12	9.37E+12	6.76E+12
97	7.27E+12	3.16E+12	6.63E+12	2.78E+12	2.86E+12	3.50E+12	7.37E+12	6.74E+12	7.07E+12	6.63E+12
113	1.12E+13	2.88E+12	2.35E+12	4.30E+12	1.03E+12	2.33E+12	4.73E+12	3.32E+12	5.49E+12	3.56E+12
131	1.20E+13	2.75E+12	4.74E+12	1.98E+12	1.89E+12	2.50E+12	1.67E+12	6.38E+12	3.46E+12	6.03E+12
153	4.43E+12	2.38E+12	3.11E+12	1.93E+12	3.13E+12	2.98E+12	7.47E+12	4.01E+12	6.87E+12	2.41E+12
178	8.23E+12	3.56E+12	5.65E+12	2.76E+12	2.39E+12	4.16E+12	3.03E+12	3.71E+12	9.58E+12	3.65E+12
209	7.61E+12	3.46E+12	6.21E+12	3.18E+12	3.60E+12	5.56E+12	1.07E+13	5.69E+12	1.11E+13	4.87E+12
245	9.92E+12	4.50E+12	1.08E+13	2.02E+12	1.97E+12	3.25E+12	5.55E+12	7.33E+12	9.99E+12	5.51E+12

TABLE A-9.—(Continued).

Test Point No.	640	641	642	643	701	702	703	704	705	705
Date	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	4	5.5	7	15	4	100	85	65	4	4
Aerosol Point #	666	667	668	669	701	702	703	704	705	706
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	5.42E+15	2.49E+16	2.70E+16	9.93E+15	2.61E+14	0.00E+00	0.00E+00	1.20E+14	4.68E+15	1.52E+15
10	2.37E+16	1.67E+16	1.33E+16	5.03E+15	2.05E+14	1.13E+13	8.87E+12	1.20E+14	2.87E+15	1.18E+15
12	1.81E+16	1.12E+16	8.55E+15	2.99E+15	2.13E+14	2.21E+13	5.43E+12	8.30E+13	2.54E+15	9.78E+14
14	1.87E+16	6.64E+15	5.34E+15	1.61E+15	2.01E+14	2.23E+13	1.59E+13	1.20E+14	1.82E+15	9.76E+14
16	1.43E+16	3.68E+15	2.60E+15	8.97E+14	1.83E+14	2.92E+13	1.95E+13	1.12E+14	1.60E+15	7.84E+14
18	1.06E+16	1.91E+15	1.20E+15	7.01E+14	1.43E+14	3.67E+13	2.72E+13	1.48E+14	1.28E+15	7.95E+14
21	6.50E+15	1.09E+15	7.81E+14	3.51E+14	1.25E+14	5.25E+13	2.32E+13	1.52E+14	9.69E+14	6.12E+14
24	3.17E+15	6.12E+14	5.23E+14	2.33E+14	1.00E+14	6.00E+13	2.65E+13	1.55E+14	7.29E+14	5.20E+14
27	1.59E+15	3.82E+14	2.69E+14	2.25E+14	7.57E+13	7.24E+13	3.11E+13	1.49E+14	5.45E+14	4.75E+14
31	9.63E+14	2.18E+14	2.06E+14	1.49E+14	6.23E+13	6.41E+13	2.89E+13	1.30E+14	4.41E+14	3.22E+14
36	6.70E+14	1.98E+14	1.12E+14	1.26E+14	4.66E+13	6.87E+13	3.01E+13	1.24E+14	3.07E+14	1.80E+14
41	3.59E+14	1.07E+14	5.71E+13	7.03E+13	3.42E+13	6.85E+13	2.81E+13	1.08E+14	1.80E+14	1.41E+14
48	2.39E+14	4.77E+13	5.44E+13	4.84E+13	2.48E+13	6.62E+13	2.64E+13	9.18E+13	1.20E+14	9.83E+13
55	6.01E+13	3.58E+13	3.87E+13	4.08E+13	1.89E+13	5.80E+13	2.41E+13	6.43E+13	6.66E+13	5.71E+13
63	4.86E+13	2.31E+13	1.30E+13	2.86E+13	1.72E+13	4.98E+13	1.92E+13	4.79E+13	4.10E+13	2.64E+13
73	2.00E+13	2.49E+13	1.43E+13	1.97E+13	2.17E+13	3.99E+13	1.62E+13	3.28E+13	2.14E+13	1.35E+13
84	1.81E+13	1.21E+13	1.97E+12	7.55E+12	4.27E+13	3.23E+13	1.32E+13	2.09E+13	1.50E+13	1.05E+13
97	8.53E+12	7.19E+12	8.91E+12	8.14E+12	9.83E+13	2.32E+13	1.03E+13	1.11E+13	1.07E+13	4.10E+12
113	1.69E+13	5.73E+12	4.61E+12	8.07E+12	2.46E+14	2.46E+13	1.78E+13	6.19E+12	5.21E+12	1.93E+12
131	0.00E+00	6.13E+12	7.66E+12	4.73E+12	6.69E+14	5.18E+13	5.76E+13	4.71E+12	3.65E+12	4.49E+12
153	1.70E+13	3.88E+12	4.86E+12	8.35E+12	1.89E+15	2.28E+14	2.41E+14	1.27E+13	3.42E+12	0.00E+00
178	4.80E+13	1.04E+13	8.47E+12	9.60E+12	5.56E+15	1.06E+15	1.01E+15	1.09E+14	4.45E+12	4.11E+12
209	5.65E+13	9.12E+12	9.31E+12	7.20E+12	1.28E+16	3.92E+15	3.30E+15	8.18E+14	1.21E+13	9.04E+12
245	3.52E+13	1.45E+13	5.93E+12	6.32E+12	1.51E+16	6.18E+15	5.11E+15	2.00E+15	2.30E+13	1.52E+13

TABLE A-9.—(Continued).

Test Point No.	706	707	708	709	710	711	712	713	714	715
Date	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	100	85	70	65	60	4	100	85	65	4
Aerosol Point #	707	708	709	710	711	712	714	715	716	717
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	0.00E+00	0.00E+00	1.07E+15	7.14E+14	6.77E+14	1.68E+15	0.00E+00	4.40E+14	2.71E+14	2.38E+15
10	0.00E+00	0.00E+00	3.62E+13	2.36E+14	3.02E+14	9.63E+14	7.43E+13	2.92E+14	2.29E+14	2.13E+15
12	7.22E+13	2.29E+14	1.60E+14	1.81E+14	8.19E+13	7.41E+14	1.78E+14	2.39E+14	2.19E+14	8.61E+14
14	2.09E+14	1.55E+14	1.57E+14	1.86E+14	9.89E+13	6.99E+14	2.47E+14	2.84E+14	1.98E+14	5.84E+14
16	3.00E+14	4.29E+14	2.53E+14	1.51E+14	8.23E+13	6.58E+14	2.38E+14	3.09E+14	2.01E+14	4.08E+14
18	3.89E+14	3.66E+14	2.73E+14	1.60E+14	1.54E+14	6.41E+14	4.48E+14	4.08E+14	2.88E+14	3.97E+14
21	4.71E+14	4.91E+14	3.25E+14	2.30E+14	1.79E+14	4.75E+14	6.41E+14	4.82E+14	3.00E+14	3.25E+14
24	6.57E+14	6.78E+14	3.33E+14	2.38E+14	2.36E+14	4.17E+14	6.41E+14	5.87E+14	2.56E+14	3.07E+14
27	6.90E+14	6.41E+14	3.83E+14	2.01E+14	2.29E+14	2.87E+14	6.83E+14	6.67E+14	2.90E+14	2.06E+14
31	6.60E+14	7.15E+14	3.72E+14	2.31E+14	1.50E+14	2.01E+14	6.93E+14	6.36E+14	2.76E+14	1.64E+14
36	7.24E+14	7.33E+14	3.46E+14	2.05E+14	1.89E+14	1.31E+14	7.14E+14	6.46E+14	2.53E+14	1.01E+14
41	6.61E+14	6.41E+14	2.55E+14	1.58E+14	1.46E+14	9.69E+13	7.10E+14	6.17E+14	2.16E+14	6.20E+13
48	6.77E+14	6.27E+14	2.24E+14	1.22E+14	1.07E+14	6.01E+13	6.40E+14	5.53E+14	1.81E+14	4.57E+13
55	5.88E+14	5.04E+14	1.79E+14	1.09E+14	6.68E+13	3.75E+13	5.52E+14	4.98E+14	1.50E+14	2.71E+13
63	4.74E+14	4.73E+14	1.39E+14	7.20E+13	5.81E+13	2.35E+13	4.95E+14	3.95E+14	9.17E+13	1.75E+13
73	3.68E+14	3.16E+14	1.05E+14	5.29E+13	3.68E+13	1.64E+13	3.62E+14	2.90E+14	6.07E+13	6.87E+12
84	2.59E+14	2.29E+14	6.02E+13	2.77E+13	2.41E+13	6.71E+12	2.63E+14	2.03E+14	4.77E+13	5.34E+12
97	1.66E+14	1.63E+14	4.29E+13	1.61E+13	9.76E+12	4.76E+12	1.78E+14	1.31E+14	2.66E+13	5.02E+12
113	1.21E+14	1.12E+14	2.60E+13	6.64E+12	5.65E+12	4.91E+12	1.16E+14	7.87E+13	1.02E+13	1.18E+12
131	6.61E+13	4.76E+13	9.15E+12	4.23E+12	2.06E+12	3.90E+12	5.27E+13	4.38E+13	6.10E+12	1.43E+12
153	3.88E+13	2.54E+13	6.29E+12	3.47E+12	4.46E+12	1.62E+12	3.36E+13	2.22E+13	3.57E+12	7.72E+11
178	1.48E+13	8.08E+12	3.36E+12	1.53E+12	4.75E+12	2.96E+12	2.32E+13	1.08E+13	2.59E+12	1.99E+12
209	3.41E+12	8.44E+12	2.81E+12	5.97E+12	2.22E+12	6.47E+12	1.05E+13	8.92E+12	3.08E+12	5.03E+12
245	2.71E+12	3.14E+12	1.11E+12	5.35E+12	0.00E+00	1.34E+13	5.33E+12	8.63E+12	3.47E+12	2.48E+12

TABLE A-9.—(Continued).

Test Point No.	715	716	717	718	719	719	720	721	722	723
Date	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	4	100	85	65	4	4	100	85	70	65
Aerosol Point #	718	719	720	721	722	723	724	725	726	727
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	1.93E+15	2.23E+15	0.00E+00	1.21E+15	5.52E+15	7.49E+16	0.00E+00	1.32E+15	6.39E+14	2.53E+15
10	4.11E+15	6.06E+14	1.31E+15	2.23E+14	3.02E+15	4.79E+16	8.64E+14	1.20E+15	1.02E+15	3.74E+14
12	4.34E+15	8.27E+14	7.24E+14	2.01E+14	2.06E+15	3.23E+16	1.07E+15	7.20E+14	1.07E+15	4.13E+14
14	2.92E+15	1.23E+15	1.69E+15	2.03E+14	1.60E+15	1.88E+16	1.08E+15	7.69E+14	8.53E+14	6.19E+14
16	2.05E+15	1.03E+15	1.50E+15	2.78E+14	1.40E+15	8.59E+15	9.31E+14	1.06E+15	7.45E+14	4.52E+14
18	1.63E+15	1.27E+15	1.34E+15	3.12E+14	1.23E+15	4.32E+15	9.10E+14	8.26E+14	5.55E+14	5.18E+14
21	1.39E+15	1.62E+15	1.59E+15	3.07E+14	1.03E+15	2.42E+15	9.03E+14	9.06E+14	6.14E+14	4.33E+14
24	9.60E+14	1.44E+15	1.48E+15	3.03E+14	8.26E+14	1.71E+15	9.62E+14	8.82E+14	6.71E+14	3.59E+14
27	8.06E+14	2.01E+15	2.02E+15	3.25E+14	6.27E+14	1.15E+15	9.88E+14	8.69E+14	5.97E+14	4.26E+14
31	5.87E+14	1.98E+15	2.09E+15	2.78E+14	3.69E+14	6.11E+14	1.03E+15	9.76E+14	6.06E+14	3.36E+14
36	3.75E+14	1.94E+15	1.94E+15	2.44E+14	2.75E+14	6.52E+14	1.26E+15	7.93E+14	5.36E+14	3.04E+14
41	2.93E+14	1.94E+15	1.78E+15	2.15E+14	2.08E+14	3.65E+14	1.25E+15	7.78E+14	4.45E+14	2.58E+14
48	1.93E+14	1.75E+15	1.62E+15	1.83E+14	1.76E+14	2.79E+14	9.14E+14	7.05E+14	4.02E+14	2.38E+14
55	1.08E+14	1.62E+15	1.53E+15	1.61E+14	8.25E+13	1.21E+14	8.34E+14	6.45E+14	3.28E+14	1.89E+14
63	5.42E+13	1.37E+15	1.17E+15	1.09E+14	6.62E+13	1.14E+14	7.58E+14	4.87E+14	2.76E+14	1.53E+14
73	4.13E+13	1.02E+15	1.02E+15	7.33E+13	2.81E+13	7.66E+13	5.60E+14	3.98E+14	1.79E+14	7.22E+13
84	2.36E+13	7.82E+14	7.25E+14	4.56E+13	1.13E+13	5.13E+13	4.93E+14	2.92E+14	1.19E+14	7.42E+13
97	1.41E+13	6.14E+14	4.79E+14	2.78E+13	1.28E+13	2.60E+13	3.17E+14	1.87E+14	6.32E+13	3.70E+13
113	4.42E+12	3.42E+14	2.42E+14	1.31E+13	7.19E+12	2.45E+13	1.89E+14	1.22E+14	4.91E+13	2.11E+13
131	6.09E+12	1.77E+14	1.83E+14	9.25E+12	1.13E+12	2.82E+13	9.44E+13	6.85E+13	2.78E+13	1.09E+13
153	6.52E+12	9.26E+13	7.16E+13	3.72E+12	5.90E+12	1.30E+13	6.96E+13	3.68E+13	9.24E+12	4.19E+12
178	6.73E+12	4.86E+13	2.61E+13	2.56E+12	1.47E+13	1.39E+13	3.77E+13	2.07E+13	8.77E+12	6.39E+12
209	3.49E+13	6.83E+13	5.70E+13	1.85E+12	2.37E+13	2.76E+13	1.07E+13	2.07E+13	7.13E+12	1.11E+13
245	2.39E+13	5.58E+13	6.62E+13	4.18E+12	3.07E+13	3.02E+13	1.17E+13	2.87E+13	2.34E+13	2.71E+13

TABLE A-9.—(Continued).

Test Point No.	724	725	726	726	726	727	728	729	730	731
Date	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004
Fuel	base	base	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur
Power (%)	60	4	4	4	4	100	85	65	40	30
Aerosol Point #	728	729	730	731	732	733	734	735	736	737
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	1.01E+15	6.37E+16	4.65E+16	5.44E+16	5.87E+16	6.25E+15	1.31E+15	4.05E+15	7.81E+15	7.18E+15
10	7.75E+14	5.04E+16	3.99E+16	5.33E+16	5.27E+16	1.79E+15	6.07E+14	9.66E+14	1.42E+15	1.73E+15
12	3.74E+14	3.11E+16	2.86E+16	4.77E+16	4.82E+16	5.00E+14	5.38E+14	4.42E+14	4.62E+14	5.94E+14
14	4.86E+14	1.59E+16	1.76E+16	3.62E+16	3.77E+16	8.13E+14	7.98E+14	4.38E+14	3.48E+14	2.47E+14
16	4.57E+14	7.81E+15	8.40E+15	1.78E+16	2.18E+16	7.07E+14	6.87E+14	3.75E+14	2.74E+14	2.61E+14
18	6.65E+14	4.13E+15	3.92E+15	7.61E+15	8.36E+15	6.82E+14	7.07E+14	3.56E+14	2.09E+14	1.76E+14
21	3.21E+14	2.43E+15	2.88E+15	3.19E+15	3.35E+15	7.38E+14	7.67E+14	3.18E+14	2.20E+14	1.51E+14
24	3.68E+14	1.76E+15	1.72E+15	1.93E+15	1.76E+15	7.58E+14	7.29E+14	3.02E+14	1.44E+14	1.43E+14
27	3.24E+14	1.19E+15	1.17E+15	1.29E+15	1.19E+15	7.11E+14	7.85E+14	3.25E+14	1.01E+14	1.02E+14
31	2.37E+14	7.53E+14	7.61E+14	1.09E+15	6.99E+14	7.68E+14	8.42E+14	2.72E+14	8.17E+13	6.42E+13
36	2.11E+14	4.88E+14	4.59E+14	6.20E+14	3.99E+14	7.40E+14	7.05E+14	2.29E+14	6.15E+13	4.43E+13
41	2.00E+14	3.03E+14	4.37E+14	2.84E+14	3.24E+14	7.04E+14	6.93E+14	1.77E+14	4.06E+13	2.59E+13
48	1.49E+14	2.02E+14	2.32E+14	2.11E+14	1.86E+14	5.58E+14	5.82E+14	1.26E+14	2.73E+13	2.86E+13
55	1.11E+14	1.42E+14	1.79E+14	1.38E+14	8.45E+13	5.43E+14	4.88E+14	1.21E+14	1.87E+13	1.19E+13
63	7.36E+13	8.69E+13	6.60E+13	6.69E+13	5.07E+13	4.27E+14	3.69E+14	7.58E+13	1.29E+13	1.32E+13
73	5.65E+13	4.51E+13	5.06E+13	3.35E+13	3.30E+13	3.32E+14	2.70E+14	4.96E+13	8.10E+12	8.03E+12
84	3.49E+13	2.06E+13	2.10E+13	1.81E+13	2.16E+13	2.17E+14	2.02E+14	2.39E+13	6.75E+12	5.62E+12
97	2.29E+13	1.91E+13	1.63E+13	1.02E+13	1.15E+13	1.54E+14	1.22E+14	1.56E+13	3.05E+12	2.84E+12
113	9.60E+12	1.77E+13	2.22E+13	1.12E+13	1.92E+13	1.02E+14	7.08E+13	9.02E+12	2.66E+12	3.22E+12
131	8.83E+12	1.39E+13	1.30E+13	5.67E+12	8.88E+12	4.61E+13	4.27E+13	4.92E+12	1.95E+12	2.42E+12
153	2.61E+12	1.11E+13	6.52E+12	1.15E+13	3.21E+13	3.06E+13	2.22E+13	3.55E+12	2.94E+12	2.88E+12
178	4.35E+12	3.65E+12	2.29E+13	1.61E+13	2.53E+13	1.78E+13	1.39E+13	5.11E+12	2.39E+12	4.24E+12
209	3.39E+12	1.86E+13	2.61E+13	1.70E+13	1.58E+13	7.39E+12	1.64E+12	4.62E+12	3.04E+12	2.71E+12
245	8.77E+12	2.51E+13	2.87E+13	8.41E+12	1.50E+13	2.47E+12	3.25E+12	4.85E+12	2.80E+12	4.66E+12

TABLE A-9.—(Continued).

Test Point No.	732	733	733	734	735	736	737	738	739	740
Date	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004
Fuel	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur
Power (%)	7	4	4	100	85	65	40	30	7	4
Aerosol Point #	738	739	740	741	742	743	744	745	746	747
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	5.93E+16	4.47E+16	2.66E+15	0.00E+00	2.40E+14	3.22E+14	4.50E+14	5.92E+14	8.76E+14	1.79E+15
10	6.00E+16	5.69E+16	1.29E+15	0.00E+00	3.52E+14	1.98E+14	1.97E+14	1.90E+14	3.89E+14	1.01E+15
12	4.87E+16	5.53E+16	9.26E+14	1.79E+14	1.56E+14	1.07E+14	9.56E+13	8.99E+13	5.97E+13	8.66E+14
14	2.67E+16	3.97E+16	8.27E+14	2.57E+14	1.35E+14	1.02E+14	8.61E+13	1.19E+14	2.84E+14	7.02E+14
16	9.62E+15	2.01E+16	5.51E+14	2.70E+14	2.57E+14	1.57E+14	7.93E+13	7.27E+13	1.02E+14	4.72E+14
18	2.28E+15	6.12E+15	3.55E+14	3.04E+14	2.38E+14	1.46E+14	9.94E+13	7.20E+13	9.68E+13	4.30E+14
21	6.28E+14	2.43E+15	2.46E+14	3.92E+14	2.91E+14	1.46E+14	1.07E+14	7.44E+13	8.85E+13	4.70E+14
24	3.78E+14	9.68E+14	2.25E+14	4.23E+14	3.62E+14	1.74E+14	8.73E+13	6.02E+13	6.86E+13	2.66E+14
27	2.74E+14	7.65E+14	1.61E+14	5.25E+14	3.84E+14	1.65E+14	8.72E+13	4.91E+13	3.74E+13	1.46E+14
31	1.58E+14	3.22E+14	1.19E+14	3.94E+14	3.34E+14	1.64E+14	5.87E+13	4.20E+13	3.67E+13	1.62E+14
36	1.07E+14	2.75E+14	8.25E+13	5.18E+14	3.45E+14	1.35E+14	4.03E+13	2.96E+13	2.59E+13	1.09E+14
41	3.85E+13	1.48E+14	5.30E+13	4.00E+14	3.25E+14	1.28E+14	2.90E+13	2.00E+13	1.53E+13	6.70E+13
48	4.50E+13	8.44E+13	2.82E+13	3.94E+14	2.87E+14	9.00E+13	2.24E+13	8.86E+12	1.16E+13	4.90E+13
55	3.33E+13	5.24E+13	1.57E+13	3.29E+14	2.48E+14	6.78E+13	1.43E+13	7.74E+12	3.85E+12	2.67E+13
63	1.69E+13	3.66E+13	1.15E+13	2.74E+14	2.07E+14	4.65E+13	1.08E+13	5.23E+12	4.56E+12	8.62E+12
73	1.28E+13	2.36E+13	8.28E+12	1.99E+14	1.40E+14	3.36E+13	5.78E+12	5.12E+12	3.05E+12	5.23E+12
84	1.56E+13	2.76E+13	5.61E+12	1.38E+14	1.02E+14	1.50E+13	2.86E+12	8.16E+11	1.84E+12	7.07E+12
97	2.11E+13	6.06E+13	3.68E+12	8.25E+13	6.13E+13	8.74E+12	1.84E+12	7.64E+11	9.05E+11	1.68E+12
113	1.10E+13	1.54E+13	3.14E+12	6.16E+13	3.70E+13	3.54E+12	2.49E+12	1.23E+12	2.51E+12	5.29E+12
131	1.09E+13	8.28E+12	1.93E+12	2.96E+13	1.30E+13	3.65E+12	3.07E+12	4.85E+11	1.79E+12	4.43E+12
153	9.17E+12	7.20E+12	1.99E+12	1.52E+13	7.81E+12	1.74E+12	1.63E+12	2.27E+12	2.72E+12	2.57E+12
178	7.92E+12	1.36E+13	2.02E+12	3.97E+12	5.73E+12	1.50E+12	1.67E+12	7.87E+11	9.64E+11	1.94E+12
209	1.09E+13	2.15E+13	3.17E+12	2.81E+12	1.97E+12	2.12E+12	5.13E+11	2.33E+12	4.11E+12	5.29E+12
245	2.64E+13	2.88E+13	2.81E+12	3.40E+12	1.70E+12	2.29E+12	4.94E+12	3.56E+11	0.00E+00	7.35E+12

TABLE A-9.—(Continued).

Test Point No.	740	741	742	743	744	745	746	747	748	749
Date	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004
Fuel	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur
Power (%)	4	100	85	70	65	60	40	30	15	7
Aerosol Point #	748	749	750	751	752	753	754	755	756	757
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	6.72E+14	2.78E+15	2.54E+14	1.06E+14	3.46E+14	4.95E+14	3.82E+14	1.61E+14	0.00E+00	7.68E+14
10	8.11E+14	0.00E+00	2.15E+14	2.01E+14	2.26E+14	1.55E+14	1.24E+14	3.03E+14	1.58E+14	1.90E+14
12	5.55E+14	2.49E+14	2.21E+14	1.83E+14	1.14E+14	5.71E+13	2.02E+14	1.58E+14	2.94E+14	9.28E+13
14	5.03E+14	4.75E+14	2.89E+14	1.55E+14	1.35E+14	1.07E+14	1.17E+14	8.20E+13	1.23E+14	7.93E+13
16	3.11E+14	7.80E+14	3.25E+14	2.21E+14	1.51E+14	1.18E+14	1.28E+14	1.22E+14	1.02E+14	8.56E+13
18	2.95E+14	8.23E+14	3.52E+14	2.30E+14	2.02E+14	1.29E+14	1.13E+14	1.04E+14	8.22E+13	5.02E+13
21	2.22E+14	1.24E+15	4.46E+14	2.48E+14	1.80E+14	1.07E+14	1.25E+14	9.43E+13	9.80E+13	5.51E+13
24	1.70E+14	1.00E+15	5.02E+14	2.71E+14	1.65E+14	1.12E+14	1.16E+14	6.70E+13	4.87E+13	4.51E+13
27	1.45E+14	1.18E+15	5.30E+14	2.41E+14	1.92E+14	1.19E+14	7.42E+13	6.59E+13	6.25E+13	2.11E+13
31	1.09E+14	1.16E+15	5.34E+14	2.63E+14	1.66E+14	9.38E+13	7.95E+13	4.91E+13	4.67E+13	1.61E+13
36	5.81E+13	1.28E+15	4.62E+14	1.87E+14	1.19E+14	6.93E+13	4.75E+13	2.61E+13	1.03E+13	9.93E+12
41	4.01E+13	1.31E+15	4.55E+14	1.64E+14	1.08E+14	5.67E+13	4.22E+13	2.52E+13	2.04E+13	8.83E+12
48	4.00E+13	9.18E+14	3.95E+14	1.43E+14	7.12E+13	4.05E+13	2.28E+13	1.60E+13	8.79E+12	3.89E+12
55	1.28E+13	7.68E+14	3.40E+14	8.75E+13	5.36E+13	2.59E+13	1.61E+13	8.34E+12	5.22E+12	2.66E+12
63	1.21E+13	5.01E+14	2.46E+14	6.85E+13	3.50E+13	1.77E+13	8.53E+12	1.20E+13	2.22E+12	3.75E+12
73	1.20E+13	4.75E+14	1.74E+14	4.00E+13	2.04E+13	7.84E+12	3.56E+12	4.31E+12	5.20E+12	9.25E+11
84	3.25E+12	3.07E+14	1.13E+14	2.60E+13	9.38E+12	4.53E+12	1.75E+12	2.31E+12	1.90E+12	1.36E+12
97	3.21E+12	1.96E+14	6.67E+13	1.48E+13	8.37E+12	2.45E+12	2.41E+12	1.52E+12	1.76E+12	2.87E+12
113	2.54E+12	1.01E+14	3.35E+13	7.17E+12	2.96E+12	1.82E+12	2.10E+12	2.62E+12	3.74E+12	4.04E+11
131	1.88E+12	4.87E+13	1.38E+13	2.32E+12	1.36E+12	1.77E+12	1.97E+12	2.57E+12	9.20E+11	2.75E+12
153	3.69E+12	1.07E+13	7.36E+12	5.84E+12	5.68E+11	1.58E+12	1.99E+12	9.20E+11	1.76E+12	1.90E+12
178	4.72E+12	7.41E+12	4.73E+12	4.24E+12	1.12E+12	1.97E+12	3.11E+12	1.61E+12	2.02E+12	2.05E+12
209	5.71E+12	0.00E+00	4.64E+12	3.16E+12	1.88E+12	2.13E+12	8.55E+11	1.89E+12	5.84E+11	1.19E+12
245	5.66E+12	1.45E+13	3.08E+12	3.45E+12	0.00E+00	4.53E+12	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE A-9.—(Continued).

Test Point No.	750	751	805	805	805	805	806	807	808	808
Date	4/27/2004	4/27/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004
Fuel	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur
Power (%)	5.5	4	40	40	40	40	30	7	4	4
Aerosol Point #	758	759	805	806	807	808	809	810	811	812
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	1.73E+14	1.13E+15	2.67E+14	6.27E+14	0.00E+00	0.00E+00	5.91E+14	6.15E+14	1.86E+15	4.70E+15
10	4.07E+14	4.93E+14	3.47E+14	1.13E+14	8.31E+14	3.45E+14	9.33E+13	3.50E+14	6.53E+14	4.06E+15
12	2.10E+14	3.44E+14	7.50E+13	6.36E+13	1.25E+14	1.47E+14	2.32E+14	2.16E+14	7.29E+14	2.25E+15
14	3.40E+14	2.84E+14	1.42E+14	1.09E+14	2.59E+14	1.70E+14	1.14E+14	2.59E+14	7.80E+14	1.89E+15
16	2.45E+14	3.11E+14	9.58E+13	5.18E+13	1.24E+14	2.64E+14	1.89E+14	2.83E+14	6.04E+14	1.53E+15
18	1.74E+14	2.83E+14	1.63E+14	5.86E+13	1.77E+14	4.01E+14	2.08E+14	2.25E+14	4.61E+14	1.07E+15
21	1.65E+14	2.37E+14	1.00E+14	4.44E+13	1.18E+14	2.18E+14	1.49E+14	2.11E+14	5.17E+14	9.42E+14
24	1.22E+14	1.56E+14	7.52E+13	4.35E+13	1.27E+14	2.25E+14	1.54E+14	1.91E+14	3.71E+14	6.69E+14
27	9.87E+13	1.16E+14	7.80E+13	4.63E+13	1.79E+14	6.03E+13	1.02E+14	1.35E+14	2.12E+14	4.72E+14
31	6.34E+13	7.59E+13	7.79E+13	3.38E+13	9.85E+13	1.20E+14	1.04E+14	7.96E+13	2.16E+14	4.15E+14
36	3.54E+13	4.13E+13	5.12E+13	2.92E+13	1.52E+14	1.05E+14	6.30E+13	6.82E+13	1.68E+14	2.74E+14
41	1.84E+13	2.68E+13	3.77E+13	2.13E+13	1.05E+14	7.40E+13	3.96E+13	3.16E+13	9.00E+13	1.70E+14
48	1.66E+13	1.77E+13	2.75E+13	1.30E+13	8.69E+13	6.46E+13	3.38E+13	3.27E+13	5.44E+13	1.26E+14
55	1.17E+13	9.82E+12	3.03E+13	8.10E+12	4.03E+13	1.81E+13	3.92E+13	2.45E+13	2.83E+13	6.51E+13
63	4.50E+12	6.35E+12	1.27E+13	6.25E+12	2.63E+13	3.23E+13	2.57E+13	9.45E+12	1.33E+13	4.57E+13
73	4.43E+12	5.07E+12	8.34E+12	3.65E+12	1.19E+13	1.81E+13	8.65E+12	2.33E+12	7.11E+12	2.57E+13
84	3.00E+12	2.96E+12	5.21E+12	2.07E+12	1.41E+13	1.81E+13	5.82E+12	3.04E+12	2.81E+12	6.79E+12
97	4.21E+12	2.46E+12	2.67E+12	1.80E+12	1.08E+13	0.00E+00	3.34E+12	2.13E+12	3.90E+12	5.77E+12
113	4.84E+12	2.43E+12	1.66E+12	1.13E+12	1.81E+12	7.87E+12	2.02E+12	3.16E+12	2.36E+12	2.70E+12
131	1.26E+12	2.48E+12	1.53E+12	5.66E+11	4.96E+12	0.00E+00	9.70E+11	6.67E+11	1.09E+12	2.39E+12
153	3.53E+12	3.45E+12	1.63E+12	6.01E+11	1.78E+12	0.00E+00	0.00E+00	3.36E+12	1.24E+12	2.68E+12
178	8.52E+12	3.46E+12	9.75E+12	1.06E+12	1.80E+12	3.93E+12	1.06E+12	1.40E+12	0.00E+00	4.55E+12
209	6.33E+12	2.97E+12	1.28E+14	2.96E+12	3.56E+12	3.81E+12	4.16E+12	6.58E+11	3.68E+12	3.55E+12
245	0.00E+00	0.00E+00	5.27E+14	1.94E+13	4.12E+12	4.54E+12	1.25E+12	6.45E+12	1.17E+13	3.66E+12

TABLE A-9.—(Continued).

Test Point No.	809	810	811	812	812	812	812	813	814	815
Date	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004
Fuel	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur
Power (%)	100	85	65	40	40	40	40	30	7	4
Aerosol Point #	813	814	815	816	817	818	819	820	821	822
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	0.00E+00	0.00E+00	1.43E+15	8.17E+14	4.83E+14	1.13E+15	0.00E+00	8.24E+14	1.86E+15	4.56E+15
10	1.32E+15	1.15E+15	1.09E+14	3.32E+14	2.38E+14	2.93E+14	3.97E+14	1.47E+14	1.21E+15	3.05E+15
12	0.00E+00	7.13E+14	1.34E+14	1.97E+14	1.40E+14	1.64E+14	2.20E+14	1.75E+14	3.87E+14	1.41E+15
14	6.71E+14	1.36E+15	1.97E+14	1.60E+14	1.81E+14	1.39E+14	2.25E+14	2.01E+14	3.72E+14	1.57E+15
16	1.38E+15	9.74E+14	2.30E+14	2.04E+14	1.61E+14	1.75E+14	2.68E+14	2.17E+14	1.87E+14	1.20E+15
18	1.75E+15	1.43E+15	1.86E+14	1.96E+14	1.81E+14	1.68E+14	3.64E+14	2.45E+14	2.32E+14	8.33E+14
21	1.61E+15	1.31E+15	1.23E+14	2.07E+14	1.71E+14	8.78E+13	2.51E+14	1.99E+14	2.76E+14	6.74E+14
24	2.44E+15	1.41E+15	1.56E+14	1.45E+14	1.34E+14	8.63E+13	2.69E+14	1.33E+14	1.66E+14	5.18E+14
27	1.65E+15	1.82E+15	2.33E+14	1.37E+14	1.50E+14	8.01E+13	2.03E+14	1.59E+14	1.10E+14	4.13E+14
31	1.90E+15	1.43E+15	1.58E+14	8.17E+13	1.16E+14	6.53E+13	1.72E+14	9.74E+13	1.18E+14	2.89E+14
36	1.95E+15	1.73E+15	1.51E+14	6.49E+13	1.09E+14	7.65E+13	1.63E+14	7.37E+13	6.40E+13	2.06E+14
41	1.69E+15	1.52E+15	1.51E+14	6.70E+13	7.62E+13	4.19E+13	1.15E+14	6.34E+13	3.87E+13	1.32E+14
48	1.66E+15	1.23E+15	1.08E+14	3.69E+13	6.66E+13	4.13E+13	9.74E+13	5.20E+13	3.82E+13	9.91E+13
55	1.71E+15	1.04E+15	8.23E+13	3.33E+13	3.68E+13	3.24E+13	7.57E+13	3.90E+13	2.30E+13	5.45E+13
63	1.24E+15	9.85E+14	5.50E+13	1.42E+13	2.12E+13	1.35E+13	3.48E+13	2.85E+13	2.05E+13	2.81E+13
73	1.15E+15	8.09E+14	4.76E+13	1.20E+13	1.41E+13	1.12E+13	3.06E+13	2.08E+13	1.38E+12	2.52E+13
84	8.19E+14	5.04E+14	2.51E+13	7.22E+12	8.29E+12	4.69E+12	1.64E+13	9.16E+12	7.05E+12	1.43E+13
97	4.71E+14	3.52E+14	8.12E+12	4.88E+12	6.04E+12	4.25E+12	6.66E+12	5.31E+12	3.83E+12	1.58E+13
113	2.95E+14	2.34E+14	8.71E+12	2.78E+12	4.01E+12	4.85E+12	5.62E+12	2.00E+12	5.77E+12	5.68E+12
131	1.62E+14	1.35E+14	3.73E+12	1.70E+12	1.29E+12	5.19E+12	8.98E+11	4.07E+12	4.96E+12	7.09E+12
153	1.02E+14	7.56E+13	5.10E+12	9.14E+11	4.58E+11	2.38E+12	2.37E+12	4.03E+12	2.50E+12	3.31E+12
178	7.45E+13	3.28E+13	0.00E+00	4.70E+12	9.42E+11	8.07E+11	2.41E+12	2.35E+12	1.15E+12	3.36E+12
209	1.45E+13	2.10E+13	0.00E+00	2.74E+12	2.32E+12	2.35E+12	4.19E+12	2.58E+12	3.85E+12	4.88E+12
245	1.76E+13	2.44E+14	0.00E+00	4.70E+12	1.66E+12	6.06E+12	1.29E+12	2.59E+12	4.28E+12	6.63E+12

TABLE A-9.—(continued).

Test Point No.	815	816	817	818	819	820	821	822	823	824
Date	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004
Fuel	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur
Power (%)	4	100	85	70	65	60	40	30	15	7
Aerosol Point #	823	824	825	826	827	828	829	830	831	832
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	7.51E+16	1.73E+16	1.57E+15	1.16E+15	1.69E+15	1.51E+15	2.49E+15	3.02E+15	2.75E+16	9.67E+16
10	8.17E+16	2.38E+15	1.18E+15	1.14E+15	1.35E+15	4.04E+14	5.55E+14	7.61E+14	4.31E+15	6.20E+16
12	7.00E+16	3.01E+14	4.53E+14	8.00E+14	4.78E+14	4.58E+14	4.14E+14	5.55E+14	5.33E+15	4.10E+16
14	4.52E+16	4.54E+14	8.90E+14	7.29E+14	5.72E+14	3.93E+14	3.42E+14	2.76E+14	7.36E+15	1.70E+16
16	2.09E+16	1.90E+14	8.05E+14	6.41E+14	4.25E+14	3.77E+14	4.24E+14	3.29E+14	3.41E+15	4.81E+15
18	6.46E+15	3.77E+14	7.57E+14	5.15E+14	3.47E+14	2.89E+14	4.22E+14	2.54E+14	2.52E+15	1.35E+15
21	2.44E+15	4.65E+14	8.29E+14	6.07E+14	3.77E+14	2.83E+14	2.47E+14	2.48E+14	1.58E+15	5.04E+14
24	1.40E+15	3.87E+14	8.51E+14	5.69E+14	3.09E+14	2.27E+14	2.33E+14	2.13E+14	1.24E+15	3.14E+14
27	8.58E+14	4.10E+14	7.19E+14	4.20E+14	3.10E+14	2.38E+14	2.07E+14	1.26E+14	5.64E+14	2.96E+14
31	5.36E+14	3.99E+14	6.94E+14	4.20E+14	2.85E+14	1.83E+14	1.69E+14	1.25E+14	9.65E+14	2.15E+14
36	4.11E+14	4.07E+14	7.00E+14	3.89E+14	2.09E+14	1.19E+14	1.24E+14	8.31E+13	3.67E+14	5.64E+13
41	2.53E+14	3.76E+14	6.07E+14	3.38E+14	1.77E+14	1.41E+14	8.78E+13	6.17E+13	5.19E+14	5.52E+13
48	1.60E+14	2.98E+14	5.08E+14	2.65E+14	1.46E+14	1.10E+14	5.68E+13	3.37E+13	1.64E+14	2.76E+13
55	9.92E+13	2.57E+14	4.76E+14	2.19E+14	1.16E+14	9.72E+13	4.84E+13	3.05E+13	0.00E+00	1.77E+13
63	5.84E+13	2.32E+14	3.75E+14	1.83E+14	8.67E+13	4.17E+13	3.60E+13	2.30E+13	2.02E+14	7.95E+12
73	2.54E+13	1.69E+14	3.13E+14	1.60E+14	6.28E+13	2.73E+13	1.93E+13	1.29E+13	0.00E+00	1.36E+13
84	1.06E+13	1.30E+14	2.19E+14	9.59E+13	4.90E+13	1.66E+13	1.05E+13	7.75E+12	5.47E+13	1.06E+13
97	1.19E+13	8.65E+13	1.41E+14	4.94E+13	2.25E+13	1.05E+13	4.45E+12	3.89E+12	5.35E+13	7.96E+12
113	1.30E+13	5.61E+13	8.11E+13	3.60E+13	2.26E+13	1.68E+13	3.27E+12	6.97E+11	9.21E+13	3.75E+12
131	1.06E+13	3.56E+13	5.63E+13	1.36E+13	5.54E+12	6.88E+12	4.88E+12	2.99E+12	0.00E+00	1.09E+13
153	7.43E+12	2.02E+13	3.18E+13	1.01E+13	1.96E+12	8.94E+11	2.50E+12	2.98E+12	0.00E+00	9.33E+12
178	1.32E+13	6.07E+12	1.62E+13	4.76E+12	2.61E+12	2.75E+12	4.20E+12	2.87E+12	0.00E+00	7.60E+12
209	9.16E+12	3.61E+12	9.47E+12	5.66E+12	1.31E+12	2.72E+12	3.23E+12	6.27E+12	4.86E+13	7.37E+12
245	1.26E+13	2.67E+12	7.17E+12	7.15E+12	8.51E+12	1.07E+13	1.12E+13	1.76E+12	5.75E+13	2.22E+12

TABLE A-9.—(Continued).

Test Point No.	825	826	827	828	829	830	831	832	833	834
Date	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004
Fuel	sulfur	sulfur	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic
Power (%)	5.5	4	4	100	85	65	40	30	7	4
Aerosol Point #	833	834	836	837	838	839	840	841	842	843
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	8.12E+16	6.77E+16	6.22E+16	2.99E+15	0.00E+00	7.17E+14	1.15E+15	1.54E+15	3.59E+16	4.30E+16
10	7.08E+16	7.54E+16	4.54E+16	1.10E+15	6.02E+14	8.06E+14	3.70E+14	1.54E+14	2.39E+16	2.53E+16
12	5.51E+16	6.24E+16	2.80E+16	5.74E+14	5.24E+14	3.78E+14	4.08E+14	3.09E+14	7.63E+15	9.83E+15
14	2.94E+16	3.92E+16	1.42E+16	5.32E+14	5.94E+14	3.68E+14	4.82E+14	5.36E+14	2.06E+15	4.00E+15
16	1.02E+16	1.70E+16	6.21E+15	7.67E+14	6.70E+14	4.38E+14	3.03E+14	5.10E+14	4.56E+14	1.81E+15
18	2.74E+15	6.06E+15	3.59E+15	5.12E+14	8.86E+14	4.23E+14	3.46E+14	4.53E+14	6.84E+14	1.24E+15
21	1.14E+15	2.27E+15	2.36E+15	5.32E+14	7.85E+14	5.86E+14	3.10E+14	2.97E+14	4.23E+14	6.51E+14
24	7.70E+14	1.10E+15	1.70E+15	5.99E+14	8.72E+14	4.62E+14	2.37E+14	2.45E+14	3.29E+14	4.03E+14
27	3.54E+14	7.73E+14	9.72E+14	7.24E+14	7.99E+14	4.20E+14	1.94E+14	2.50E+14	2.18E+14	3.08E+14
31	2.35E+14	4.24E+14	7.00E+14	8.59E+14	7.46E+14	4.07E+14	2.55E+14	2.20E+14	1.20E+14	2.34E+14
36	2.02E+14	2.84E+14	5.07E+14	8.46E+14	8.04E+14	3.18E+14	1.98E+14	1.18E+14	1.16E+14	1.74E+14
41	2.27E+14	2.78E+14	3.52E+14	8.22E+14	7.39E+14	3.33E+14	1.39E+14	1.08E+14	8.35E+13	9.84E+13
48	8.33E+13	1.52E+14	1.74E+14	7.17E+14	7.37E+14	2.73E+14	8.96E+13	6.75E+13	6.68E+13	7.06E+13
55	4.66E+13	8.00E+13	1.33E+14	6.94E+14	6.21E+14	1.63E+14	7.48E+13	3.34E+13	3.14E+13	4.75E+13
63	3.22E+13	4.18E+13	1.37E+14	5.80E+14	5.15E+14	1.38E+14	4.29E+13	1.46E+13	3.72E+13	2.05E+13
73	2.26E+13	3.22E+13	4.92E+13	4.33E+14	4.22E+14	1.07E+14	6.24E+13	1.64E+13	2.32E+13	1.98E+13
84	2.25E+13	2.26E+13	2.07E+13	4.11E+14	3.15E+14	6.48E+13	1.62E+13	1.40E+13	7.62E+12	1.34E+13
97	1.20E+13	2.64E+13	2.12E+13	2.52E+14	1.76E+14	3.54E+13	6.52E+12	9.50E+12	7.28E+12	1.25E+13
113	1.36E+13	7.20E+12	1.21E+13	1.41E+14	1.38E+14	2.27E+13	5.99E+12	3.29E+12	6.23E+12	7.51E+12
131	8.27E+12	1.02E+13	1.04E+13	8.50E+13	7.01E+13	8.91E+12	5.69E+12	8.80E+12	2.02E+13	6.59E+12
153	4.76E+12	9.09E+12	1.07E+13	5.72E+13	4.32E+13	1.04E+13	0.00E+00	1.76E+12	1.99E+13	5.35E+12
178	1.29E+13	5.90E+12	1.33E+13	4.18E+13	2.14E+13	2.47E+12	3.96E+12	0.00E+00	6.85E+12	9.13E+12
209	3.26E+12	4.44E+12	1.61E+13	1.41E+13	2.75E+13	0.00E+00	2.22E+12	5.69E+12	0.00E+00	1.12E+13
245	9.43E+12	5.36E+12	1.75E+13	1.04E+13	1.73E+13	7.42E+12	7.69E+12	1.98E+12	7.70E+12	2.02E+13

TABLE A-9.—(Continued).

Test Point No.	834	835	836	837	838	841	842	843	844	845
Date	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004
Fuel	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic
Power (%)	4	100	85	65	40	4	100	85	100	85
Aerosol Point #	844	845	846	847	848	852	853	854	855	856
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	2.31E+15	0.00E+00	2.68E+14	3.63E+14	3.94E+14	1.58E+15	0.00E+00	0.00E+00	0.00E+00	5.15E+14
10	1.15E+15	0.00E+00	4.68E+14	9.69E+13	2.88E+14	5.54E+14	1.79E+14	1.42E+14	9.12E+13	1.28E+14
12	8.40E+14	8.01E+14	4.07E+14	2.17E+14	1.74E+14	4.34E+14	6.69E+13	1.45E+14	1.54E+14	2.32E+14
14	6.76E+14	7.52E+14	2.35E+14	1.48E+14	1.40E+14	3.09E+14	2.15E+14	2.52E+14	1.60E+14	2.52E+14
16	6.30E+14	1.29E+15	3.70E+14	2.40E+14	1.78E+14	3.67E+14	2.26E+14	3.81E+14	2.52E+14	2.81E+14
18	5.72E+14	1.24E+15	4.59E+14	2.26E+14	1.77E+14	2.77E+14	4.27E+14	4.55E+14	2.70E+14	3.19E+14
21	4.34E+14	1.59E+15	5.31E+14	2.49E+14	1.58E+14	2.39E+14	5.39E+14	4.60E+14	5.07E+14	4.28E+14
24	2.85E+14	1.84E+15	5.35E+14	2.86E+14	1.96E+14	1.80E+14	5.48E+14	5.17E+14	4.63E+14	5.37E+14
27	2.31E+14	2.71E+15	5.86E+14	2.63E+14	1.48E+14	1.40E+14	5.74E+14	5.52E+14	6.13E+14	5.05E+14
31	2.09E+14	1.82E+15	5.73E+14	2.54E+14	1.34E+14	1.03E+14	6.80E+14	5.44E+14	5.90E+14	5.13E+14
36	1.10E+14	2.13E+15	5.55E+14	2.19E+14	7.72E+13	5.55E+13	7.08E+14	5.23E+14	6.35E+14	5.04E+14
41	8.56E+13	1.71E+15	5.20E+14	1.99E+14	5.90E+13	4.80E+13	5.82E+14	5.38E+14	6.05E+14	5.16E+14
48	6.01E+13	1.52E+15	4.99E+14	1.70E+14	4.53E+13	3.23E+13	5.66E+14	4.94E+14	5.12E+14	4.52E+14
55	3.52E+13	1.59E+15	4.13E+14	1.22E+14	2.87E+13	2.29E+13	4.73E+14	4.56E+14	5.06E+14	3.84E+14
63	1.74E+13	1.40E+15	3.67E+14	8.46E+13	2.06E+13	1.01E+13	4.22E+14	3.64E+14	4.02E+14	3.13E+14
73	1.28E+13	9.68E+14	2.74E+14	6.41E+13	9.51E+12	4.21E+12	3.33E+14	2.66E+14	3.20E+14	2.38E+14
84	7.85E+12	8.06E+14	1.94E+14	5.71E+13	8.96E+12	2.91E+12	2.49E+14	2.03E+14	2.72E+14	1.88E+14
97	2.87E+12	5.59E+14	1.35E+14	2.85E+13	3.00E+12	4.85E+12	1.87E+14	1.55E+14	1.33E+14	1.17E+14
113	1.87E+12	4.32E+14	7.98E+13	1.48E+13	2.99E+12	9.21E+11	1.04E+14	7.42E+13	1.12E+14	7.66E+13
131	3.54E+12	2.76E+14	5.28E+13	6.76E+12	2.79E+12	2.93E+12	7.21E+13	4.90E+13	4.19E+13	4.59E+13
153	1.47E+12	1.52E+14	2.68E+13	5.03E+12	9.45E+11	6.45E+11	2.72E+13	2.92E+13	3.19E+13	3.06E+13
178	2.08E+12	5.48E+13	1.38E+13	2.28E+12	1.31E+12	9.28E+11	1.27E+13	1.36E+13	1.13E+13	1.27E+13
209	2.31E+12	4.34E+13	9.05E+12	2.23E+12	2.93E+12	2.89E+12	4.14E+12	2.54E+12	4.97E+12	5.81E+12
245	7.15E+12	0.00E+00	6.80E+12	4.50E+12	1.04E+12	1.53E+12	1.17E+12	3.26E+12	3.12E+12	5.30E+12

TABLE A-9.—(Continued).

Test Point No.	846	847	848	849	850	852	853	854	854	855
Date	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004
Fuel	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic
Power (%)	70	65	60	40	30	7	5.5	4	4	100
Aerosol Point #	857	858	859	860	861	863	864	865	866	867
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	3.03E+14	4.88E+14	3.15E+14	2.80E+14	7.05E+14	3.45E+14	8.13E+14	8.37E+14	6.70E+14	3.34E+14
10	4.59E+13	1.53E+14	9.89E+13	1.57E+14	1.12E+14	1.88E+14	2.01E+14	7.09E+14	3.43E+14	0.00E+00
12	1.30E+14	1.16E+14	1.00E+14	8.90E+13	5.89E+13	1.49E+14	1.93E+14	2.56E+14	4.56E+14	1.93E+14
14	1.73E+14	1.62E+14	1.83E+14	7.34E+13	7.18E+13	7.10E+13	1.19E+14	3.31E+14	6.90E+14	1.19E+14
16	2.18E+14	1.97E+14	1.13E+14	1.58E+14	4.54E+13	1.46E+14	1.65E+14	2.49E+14	1.11E+15	2.88E+14
18	2.34E+14	1.62E+14	1.33E+14	1.65E+14	3.53E+13	9.05E+13	1.60E+14	2.75E+14	1.44E+15	3.93E+14
21	2.54E+14	1.12E+14	1.40E+14	1.51E+14	4.04E+13	4.95E+13	1.25E+14	1.94E+14	1.07E+15	2.77E+14
24	2.86E+14	1.66E+14	1.61E+14	1.37E+14	2.00E+13	5.84E+13	7.21E+13	1.25E+14	8.39E+14	2.51E+14
27	2.86E+14	1.49E+14	1.52E+14	1.13E+14	4.22E+13	5.79E+13	5.70E+13	9.14E+13	5.04E+14	2.06E+14
31	2.67E+14	2.14E+14	1.38E+14	1.31E+14	2.80E+13	5.90E+13	4.66E+13	6.07E+13	2.33E+14	2.54E+14
36	1.99E+14	1.24E+14	1.39E+14	4.98E+13	1.37E+13	2.40E+13	3.59E+13	5.43E+13	1.42E+14	2.45E+14
41	2.01E+14	1.23E+14	1.05E+14	6.77E+13	1.52E+13	1.86E+13	2.36E+13	3.40E+13	6.93E+13	2.52E+14
48	1.72E+14	9.07E+13	7.32E+13	4.20E+13	1.27E+13	7.61E+12	1.32E+13	2.81E+13	4.93E+13	2.58E+14
55	1.34E+14	7.07E+13	5.67E+13	3.13E+13	4.54E+12	1.02E+13	7.97E+12	8.88E+12	2.27E+13	2.84E+14
63	9.01E+13	5.72E+13	3.29E+13	1.68E+13	2.67E+12	4.15E+12	8.25E+12	8.55E+12	1.63E+13	2.21E+14
73	7.78E+13	3.01E+13	2.05E+13	1.02E+13	1.01E+12	1.36E+12	5.59E+12	3.78E+12	2.25E+13	2.24E+14
84	4.51E+13	1.67E+13	1.56E+13	5.03E+12	1.41E+12	3.71E+12	3.99E+12	2.00E+12	6.20E+12	1.70E+14
97	2.15E+13	1.04E+13	9.56E+12	2.70E+12	8.09E+11	2.16E+12	3.83E+12	1.02E+12	4.84E+12	1.21E+14
113	1.04E+13	6.63E+12	3.11E+12	2.45E+12	0.00E+00	0.00E+00	3.17E+12	0.00E+00	1.22E+12	7.49E+13
131	1.12E+13	5.10E+12	2.86E+12	8.67E+11	4.09E+11	1.08E+12	1.31E+12	9.41E+11	0.00E+00	4.47E+13
153	4.21E+12	1.68E+12	1.78E+12	8.58E+11	0.00E+00	9.78E+11	9.00E+11	0.00E+00	1.11E+12	2.27E+13
178	5.54E+12	6.44E+11	1.68E+12	2.44E+12	8.75E+11	1.09E+12	2.28E+12	3.08E+12	2.86E+12	1.30E+13
209	3.99E+12	2.19E+12	1.14E+12	1.85E+12	0.00E+00	4.63E+12	8.71E+11	3.25E+12	4.66E+12	7.25E+12
245	6.17E+12	3.54E+12	4.21E+11	1.96E+12	4.99E+11	2.35E+12	2.33E+12	0.00E+00	0.00E+00	4.46E+12

TABLE A-9.—(Continued).

Test Point No.	856	857	858	859	860	861	902	903	904	905
Date	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004
Fuel	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic
Power (%)	85	65	40	30	7	4	100	85	65	40
Aerosol Point #	868	869	870	871	872	873	902	903	904	905
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	1.24E+15	5.45E+14	8.59E+14	8.57E+14	9.11E+14	8.25E+14	0.00E+00	1.01E+15	0.00E+00	0.00E+00
10	2.93E+14	5.22E+14	4.53E+14	7.56E+14	6.13E+14	8.43E+14	8.26E+14	4.66E+14	1.30E+14	1.58E+14
12	1.04E+14	3.39E+14	8.22E+14	9.58E+14	9.26E+14	1.04E+15	1.68E+14	3.00E+14	1.31E+14	1.28E+14
14	2.29E+14	6.75E+14	1.15E+15	1.40E+15	1.43E+15	1.19E+15	1.42E+15	8.37E+14	1.91E+14	2.62E+14
16	2.40E+14	8.66E+14	1.32E+15	1.69E+15	1.40E+15	1.52E+15	1.31E+15	1.12E+15	3.12E+14	3.35E+14
18	1.58E+14	7.22E+14	9.59E+14	1.35E+15	1.13E+15	1.41E+15	1.43E+15	1.55E+15	3.70E+14	2.44E+14
21	1.44E+14	4.30E+14	5.49E+14	8.27E+14	6.76E+14	9.90E+14	1.66E+15	1.66E+15	3.85E+14	2.52E+14
24	1.33E+14	2.13E+14	2.41E+14	3.79E+14	3.39E+14	5.10E+14	2.21E+15	1.92E+15	4.08E+14	2.59E+14
27	1.36E+14	1.77E+14	1.18E+14	1.46E+14	1.33E+14	2.84E+14	1.79E+15	2.08E+15	4.33E+14	2.14E+14
31	1.38E+14	1.33E+14	6.77E+13	8.31E+13	7.54E+13	1.21E+14	2.39E+15	2.26E+15	3.95E+14	1.85E+14
36	1.50E+14	1.10E+14	5.92E+13	4.90E+13	4.36E+13	8.25E+13	2.34E+15	2.10E+15	4.28E+14	1.47E+14
41	1.81E+14	1.11E+14	3.80E+13	3.29E+13	3.20E+13	5.65E+13	2.15E+15	2.07E+15	3.30E+14	1.33E+14
48	1.61E+14	8.47E+13	3.66E+13	2.32E+13	1.73E+13	3.93E+13	2.23E+15	2.03E+15	2.98E+14	9.18E+13
55	1.70E+14	6.91E+13	2.23E+13	1.80E+13	9.42E+12	2.59E+13	1.85E+15	1.61E+15	2.33E+14	5.25E+13
63	1.41E+14	4.73E+13	1.78E+13	9.48E+12	5.15E+12	8.89E+12	1.62E+15	1.49E+15	1.49E+14	3.92E+13
73	1.27E+14	3.34E+13	5.25E+12	5.92E+12	3.57E+12	5.26E+12	1.43E+15	1.17E+15	1.08E+14	2.51E+13
84	8.87E+13	2.12E+13	7.95E+12	4.66E+12	2.75E+12	6.45E+12	9.67E+14	8.48E+14	5.78E+13	9.31E+12
97	6.64E+13	1.50E+13	2.39E+12	2.69E+12	1.75E+12	2.48E+12	5.99E+14	5.81E+14	4.15E+13	6.80E+12
113	3.56E+13	7.44E+12	3.37E+12	2.88E+12	8.84E+11	1.43E+12	5.77E+14	3.26E+14	1.80E+13	4.19E+12
131	2.43E+13	3.74E+12	6.66E+11	8.57E+11	2.11E+12	1.34E+12	2.55E+14	2.05E+14	1.10E+13	2.73E+12
153	1.53E+13	1.67E+12	6.38E+11	1.54E+12	2.47E+12	1.79E+12	1.71E+14	8.46E+13	5.47E+12	4.50E+11
178	5.10E+12	6.51E+11	6.55E+11	4.24E+12	2.67E+12	1.73E+12	6.79E+13	3.00E+13	3.01E+12	9.94E+11
209	4.68E+12	1.02E+12	2.52E+12	2.30E+12	3.71E+12	1.09E+13	3.56E+13	2.94E+13	7.29E+12	4.51E+12
245	3.04E+12	2.37E+12	1.51E+12	4.27E+12	7.30E+12	1.01E+13	1.10E+13	2.53E+13	6.27E+12	8.78E+12

TABLE A-9.—(Continued).

Test Point No.	906	907	908	908	909	910	911	912	913	914
Date	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004
Fuel	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic
Power (%)	30	7	4	4	100	85	65	40	30	7
Aerosol Point #	906	907	908	909	910	911	912	913	914	915
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	0.00E+00	3.56E+14	6.04E+14	6.74E+15	0.00E+00	2.96E+14	5.53E+14	5.86E+14	6.93E+14	2.36E+15
10	2.16E+14	1.48E+14	8.57E+14	4.97E+15	3.02E+14	2.00E+14	3.36E+14	2.23E+14	3.97E+14	8.98E+14
12	2.11E+14	2.65E+14	8.50E+14	2.82E+15	1.65E+14	2.92E+14	3.05E+14	1.71E+14	2.72E+14	8.64E+14
14	1.60E+14	2.26E+14	8.26E+14	2.60E+15	4.69E+14	3.55E+14	2.67E+14	1.65E+14	2.33E+14	8.10E+14
16	1.93E+14	1.96E+14	8.08E+14	2.06E+15	5.18E+14	4.55E+14	2.61E+14	2.31E+14	2.38E+14	6.02E+14
18	2.66E+14	2.61E+14	5.61E+14	1.68E+15	7.75E+14	6.26E+14	3.68E+14	2.53E+14	1.81E+14	4.10E+14
21	1.96E+14	1.81E+14	4.86E+14	1.35E+15	5.49E+14	6.63E+14	4.10E+14	2.43E+14	2.06E+14	2.99E+14
24	2.08E+14	1.35E+14	4.52E+14	9.51E+14	7.37E+14	7.38E+14	4.41E+14	2.58E+14	1.35E+14	2.39E+14
27	1.77E+14	1.03E+14	3.09E+14	7.17E+14	9.70E+14	8.27E+14	4.24E+14	2.29E+14	1.32E+14	2.20E+14
31	1.31E+14	8.41E+13	2.64E+14	5.52E+14	1.04E+15	8.44E+14	4.22E+14	1.84E+14	9.91E+13	1.38E+14
36	9.61E+13	4.48E+13	1.69E+14	3.41E+14	9.61E+14	8.03E+14	4.37E+14	1.51E+14	7.35E+13	1.16E+14
41	7.00E+13	3.66E+13	1.02E+14	1.82E+14	1.03E+15	7.57E+14	3.52E+14	1.03E+14	7.88E+13	6.92E+13
48	4.25E+13	2.09E+13	4.11E+13	1.80E+14	9.23E+14	7.63E+14	3.17E+14	8.05E+13	5.39E+13	6.39E+13
55	3.72E+13	1.18E+13	3.36E+13	9.59E+13	8.53E+14	6.65E+14	2.47E+14	6.92E+13	2.80E+13	4.78E+13
63	1.62E+13	6.38E+12	1.64E+13	6.27E+13	7.70E+14	5.51E+14	1.55E+14	3.53E+13	1.93E+13	1.97E+13
73	1.04E+13	3.70E+12	1.69E+13	3.31E+13	6.39E+14	4.31E+14	1.23E+14	1.91E+13	6.43E+12	6.37E+12
84	8.55E+12	1.91E+12	2.93E+12	2.50E+13	4.36E+14	3.27E+14	7.91E+13	9.15E+12	4.09E+12	0.00E+00
97	2.24E+12	1.66E+12	1.93E+12	8.78E+12	3.22E+14	2.30E+14	6.19E+13	5.42E+12	2.37E+12	5.97E+12
113	4.69E+11	1.27E+12	2.09E+12	4.63E+12	2.13E+14	1.44E+14	2.90E+13	3.58E+12	1.60E+12	2.57E+12
131	9.36E+11	4.20E+11	0.00E+00	4.69E+12	1.33E+14	8.26E+13	1.08E+13	2.09E+12	0.00E+00	8.66E+11
153	1.70E+12	7.80E+11	6.41E+11	0.00E+00	6.74E+13	4.64E+13	7.54E+12	6.97E+11	3.66E+11	0.00E+00
178	1.42E+12	1.28E+12	1.40E+12	6.05E+12	4.04E+13	2.24E+13	3.62E+12	2.61E+12	2.06E+12	1.68E+12
209	4.45E+12	5.77E+12	7.23E+12	8.13E+11	2.01E+13	7.67E+12	3.81E+12	2.99E+12	6.08E+12	6.39E+12
245	5.33E+12	5.24E+12	1.27E+13	1.18E+13	2.55E+13	9.60E+12	7.66E+12	4.49E+12	6.40E+12	4.88E+12

TABLE A-9.—(Continued).

Test Point No.	915	915	916	917	918	919	920	921	922	923
Date	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004
Fuel	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic
Power (%)	4	4	100	85	70	65	60	40	30	15
Aerosol Point #	916	917	918	919	920	921	922	923	924	925
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	6.06E+15	7.46E+16	9.87E+15	3.25E+15	1.92E+15	1.51E+15	1.13E+15	1.11E+15	0.00E+00	3.71E+16
10	5.87E+15	6.30E+16	4.16E+15	1.18E+15	8.70E+14	7.10E+14	7.36E+14	8.15E+14	1.10E+15	2.04E+16
12	3.84E+15	6.04E+16	2.19E+15	7.76E+14	7.39E+14	6.25E+14	3.98E+14	7.65E+14	9.10E+14	5.03E+15
14	3.11E+15	4.46E+16	1.21E+15	5.88E+14	4.76E+14	5.20E+14	3.96E+14	4.31E+14	7.10E+14	1.03E+15
16	2.29E+15	2.49E+16	1.43E+15	7.43E+14	7.77E+14	6.14E+14	5.64E+14	5.29E+14	6.93E+14	4.35E+14
18	1.73E+15	1.04E+16	1.67E+15	7.79E+14	6.91E+14	4.61E+14	5.70E+14	6.46E+14	7.07E+14	3.63E+14
21	1.35E+15	4.59E+15	1.40E+15	7.59E+14	7.04E+14	6.05E+14	4.16E+14	4.86E+14	6.66E+14	2.78E+14
24	9.45E+14	2.29E+15	1.33E+15	8.80E+14	7.55E+14	6.50E+14	4.24E+14	4.35E+14	7.04E+14	3.19E+14
27	6.92E+14	1.46E+15	1.50E+15	9.47E+14	7.06E+14	5.70E+14	4.33E+14	3.93E+14	5.60E+14	2.31E+14
31	5.58E+14	1.01E+15	1.37E+15	9.05E+14	6.58E+14	5.65E+14	3.54E+14	3.41E+14	3.55E+14	1.07E+14
36	3.37E+14	6.98E+14	1.51E+15	8.29E+14	6.02E+14	4.83E+14	3.36E+14	2.69E+14	2.86E+14	7.15E+13
41	2.19E+14	5.53E+14	1.41E+15	7.95E+14	5.71E+14	4.35E+14	2.40E+14	1.65E+14	2.06E+14	1.03E+14
48	1.63E+14	3.32E+14	1.35E+15	7.47E+14	4.76E+14	3.27E+14	1.86E+14	1.24E+14	1.75E+14	4.12E+13
55	8.69E+13	1.80E+14	1.33E+15	6.70E+14	3.75E+14	2.60E+14	1.66E+14	1.17E+14	1.18E+14	3.62E+13
63	7.37E+13	1.26E+14	1.10E+15	5.92E+14	3.12E+14	2.16E+14	1.14E+14	5.25E+13	3.96E+13	1.07E+13
73	4.95E+13	7.28E+13	8.65E+14	4.37E+14	2.14E+14	1.58E+14	6.63E+13	3.88E+13	3.29E+13	6.55E+12
84	2.23E+13	5.71E+13	5.98E+14	3.24E+14	1.52E+14	1.08E+14	4.99E+13	1.84E+13	1.11E+13	1.12E+13
97	1.14E+13	5.34E+13	4.30E+14	2.37E+14	8.68E+13	5.58E+13	3.20E+13	8.44E+12	9.70E+12	3.52E+12
113	1.06E+13	4.58E+13	3.08E+14	1.50E+14	5.94E+13	3.00E+13	9.78E+12	2.51E+12	0.00E+00	3.45E+12
131	6.44E+12	3.68E+13	1.87E+14	9.30E+13	3.23E+13	1.49E+13	8.04E+12	7.50E+12	5.83E+12	6.60E+12
153	6.94E+12	3.19E+13	1.01E+14	4.61E+13	1.40E+13	8.69E+12	3.71E+12	6.72E+12	3.58E+12	0.00E+00
178	7.11E+12	2.48E+13	5.73E+13	2.82E+13	9.11E+12	6.29E+12	5.78E+12	7.46E+12	1.17E+13	1.19E+13
209	1.39E+13	3.06E+13	1.69E+13	1.38E+13	1.22E+13	9.31E+11	1.13E+13	1.84E+13	1.63E+13	1.98E+13
245	4.34E+13	4.65E+13	3.86E+13	6.15E+12	5.71E+12	8.85E+12	2.66E+12	8.52E+12	6.43E+12	2.13E+13

TABLE A-9.—(Continued).

Test Point No.	924	925	926	926	927	928	929	930	931	932
Date	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004
Fuel	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic
Power (%)	7	5.5	4	4	100	85	65	40	30	7
Aerosol Point #	926	927	928	929	930	931	932	933	934	935
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	7.47E+16	7.53E+16	7.79E+16	4.59E+14	1.09E+15	5.35E+14	1.64E+14	2.12E+14	1.45E+14	2.63E+14
10	5.88E+16	6.58E+16	7.25E+16	2.38E+14	3.59E+14	4.46E+14	1.20E+14	7.49E+13	7.75E+13	2.52E+13
12	3.12E+16	3.56E+16	5.28E+16	3.81E+14	8.40E+13	5.24E+13	8.79E+12	5.74E+13	3.41E+13	2.15E+14
14	1.37E+16	1.74E+16	3.48E+16	2.97E+14	8.58E+13	1.32E+14	2.77E+13	5.59E+13	7.38E+13	1.45E+14
16	3.20E+15	5.83E+15	1.66E+16	5.83E+14	3.08E+13	1.91E+14	1.40E+13	6.77E+13	5.67E+13	1.84E+14
18	1.45E+15	2.37E+15	6.55E+15	5.38E+14	1.47E+14	8.37E+13	6.59E+13	1.03E+14	1.18E+14	1.78E+14
21	7.56E+14	1.18E+15	3.37E+15	4.80E+14	6.95E+13	1.40E+14	6.25E+13	9.12E+13	1.29E+14	5.52E+13
24	5.67E+14	7.54E+14	1.82E+15	4.72E+14	1.21E+14	2.29E+14	8.34E+13	9.77E+13	1.56E+14	7.38E+13
27	3.52E+14	6.77E+14	1.20E+15	3.85E+14	3.23E+14	3.65E+14	1.08E+14	1.09E+14	1.77E+14	6.51E+13
31	2.58E+14	3.39E+14	7.47E+14	2.51E+14	4.18E+14	4.74E+14	1.13E+14	1.09E+14	1.32E+14	4.79E+13
36	1.63E+14	2.99E+14	4.84E+14	2.83E+14	4.76E+14	5.62E+14	9.94E+13	1.09E+14	1.20E+14	2.29E+13
41	7.51E+13	1.98E+14	2.98E+14	1.84E+14	6.00E+14	6.38E+14	1.04E+14	8.93E+13	1.05E+14	2.63E+13
48	6.57E+13	1.19E+14	2.04E+14	1.31E+14	7.79E+14	7.72E+14	9.03E+13	7.23E+13	8.63E+13	1.67E+13
55	3.89E+13	9.57E+13	1.71E+14	8.92E+13	7.89E+14	6.40E+14	7.58E+13	4.85E+13	5.59E+13	1.04E+13
63	2.53E+13	4.52E+13	1.03E+14	4.88E+13	8.25E+14	6.75E+14	5.25E+13	2.85E+13	3.95E+13	5.43E+12
73	1.11E+13	4.77E+13	5.30E+13	3.13E+13	7.13E+14	5.53E+14	3.96E+13	2.00E+13	2.99E+13	2.96E+12
84	1.59E+13	2.07E+13	3.83E+13	1.56E+13	5.96E+14	4.03E+14	2.38E+13	1.34E+13	1.11E+13	2.70E+12
97	1.38E+13	1.17E+13	2.47E+13	9.86E+12	5.16E+14	3.15E+14	9.86E+12	9.12E+12	6.27E+12	1.13E+12
113	1.78E+12	1.24E+13	7.44E+12	6.53E+12	3.11E+14	2.11E+14	9.38E+12	3.46E+12	5.08E+12	1.81E+12
131	1.06E+13	4.64E+12	1.17E+13	3.91E+12	2.14E+14	1.26E+14	2.89E+12	7.56E+11	2.83E+12	5.99E+11
153	4.81E+12	2.74E+12	8.26E+12	4.12E+12	9.83E+13	5.97E+13	1.21E+12	6.97E+11	7.70E+11	1.09E+12
178	5.25E+12	2.32E+13	2.39E+13	7.84E+12	5.72E+13	2.78E+13	1.33E+12	1.95E+12	1.35E+12	2.99E+11
209	2.23E+13	4.53E+13	5.02E+13	1.10E+13	3.16E+13	1.36E+13	2.77E+11	1.55E+13	4.31E+12	9.45E+11
245	0.00E+00	3.95E+13	6.40E+13	1.57E+13	1.78E+13	1.79E+13	1.74E+12	1.03E+13	2.30E+12	4.84E+12

TABLE A-9.—(Continued).

Test Point No.	933	934	934	934	937	938	939	939	939	939
Date	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004
Fuel	aromatic	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur
Power (%)	4	7	7	7	75	30	7	7	7	7
Aerosol Point #	936	937	938	939	941	942	943	944	945	946
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	3.09E+14	1.14E+17	5.27E+15	1.46E+14	1.91E+15	2.51E+15	3.14E+15	1.53E+14	4.74E+14	8.82E+14
10	3.62E+14	8.11E+16	4.09E+15	6.23E+14	1.13E+15	1.33E+15	1.69E+15	2.53E+14	3.42E+14	1.21E+15
12	4.51E+14	5.64E+16	2.46E+15	6.97E+14	6.39E+14	4.37E+14	4.08E+14	3.80E+14	1.98E+14	7.14E+14
14	9.46E+14	3.18E+16	1.82E+15	1.33E+15	4.99E+14	7.72E+14	3.69E+14	6.40E+14	1.63E+14	6.67E+14
16	1.06E+15	1.21E+16	1.17E+15	1.67E+15	9.14E+14	1.14E+15	2.42E+14	9.64E+14	2.41E+14	4.27E+14
18	1.36E+15	5.46E+15	1.10E+15	1.88E+15	7.13E+14	9.13E+14	3.48E+14	1.35E+15	2.81E+14	4.46E+14
21	1.22E+15	2.39E+15	8.96E+14	2.03E+15	8.29E+14	7.33E+14	7.41E+13	1.57E+15	1.86E+14	1.78E+14
24	8.96E+14	1.59E+15	7.14E+14	1.37E+15	8.12E+14	7.22E+14	1.36E+14	1.37E+15	1.37E+14	2.39E+14
27	7.01E+14	1.17E+15	5.35E+14	8.35E+14	8.28E+14	8.01E+14	1.38E+14	1.10E+15	1.29E+14	1.64E+14
31	5.64E+14	7.55E+14	3.19E+14	4.60E+14	7.56E+14	7.47E+14	1.80E+14	5.99E+14	9.20E+13	1.13E+14
36	3.99E+14	6.40E+14	1.73E+14	2.94E+14	7.97E+14	6.93E+14	6.71E+13	2.66E+14	6.58E+13	1.22E+14
41	2.73E+14	4.11E+14	1.13E+14	1.64E+14	6.84E+14	6.00E+14	6.05E+13	1.10E+14	5.80E+13	6.85E+13
48	2.09E+14	3.45E+14	7.39E+13	9.83E+13	6.03E+14	4.69E+14	3.20E+13	6.81E+13	2.84E+13	7.44E+13
55	1.38E+14	2.07E+14	3.54E+13	6.39E+13	5.23E+14	4.40E+14	2.59E+13	4.13E+13	2.16E+13	2.49E+13
63	7.87E+13	1.28E+14	3.15E+13	3.35E+13	3.30E+14	2.82E+14	2.45E+13	2.30E+13	7.63E+12	2.11E+13
73	5.17E+13	6.69E+13	1.24E+13	1.85E+13	2.96E+14	2.18E+14	7.30E+12	1.09E+13	5.26E+12	1.08E+13
84	2.12E+13	6.12E+13	1.13E+13	5.89E+12	2.18E+14	1.83E+14	0.00E+00	1.15E+13	1.77E+12	4.39E+12
97	1.07E+13	1.98E+13	2.84E+12	2.98E+12	1.54E+14	1.60E+14	6.52E+12	6.81E+12	2.25E+12	2.98E+12
113	7.99E+12	1.42E+13	6.31E+11	2.36E+12	6.75E+13	5.47E+13	0.00E+00	2.81E+12	0.00E+00	9.90E+11
131	3.95E+12	7.75E+12	0.00E+00	4.30E+11	4.34E+13	4.11E+13	0.00E+00	1.74E+12	3.92E+11	1.64E+12
153	1.34E+12	5.81E+12	0.00E+00	4.66E+11	2.30E+13	2.36E+13	0.00E+00	9.07E+11	1.71E+12	9.01E+11
178	1.41E+12	1.49E+13	6.30E+11	2.35E+12	1.95E+13	9.75E+12	6.10E+12	4.72E+12	2.18E+12	9.20E+11
209	2.61E+12	4.02E+13	3.59E+12	9.84E+12	1.18E+13	1.81E+13	5.80E+12	1.04E+13	2.12E+12	3.94E+12
245	7.42E+12	4.87E+13	2.31E+12	8.67E+12	1.31E+13	6.73E+12	6.94E+12	1.76E+13	5.11E+12	1.17E+12

TABLE A-9.—(Continued).

Test Point No.	939	939	939	940	941	942	943	943	943	943
Date	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004
Fuel	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur
Power (%)	7	7	7	100	85	30	7	7	7	7
Aerosol Point #	947	948	949	950	951	952	953	954	955	957
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	5.62E+16	9.58E+14	7.55E+14	0.00E+00	0.00E+00	5.12E+14	4.29E+14	3.62E+14	1.18E+15	2.76E+14
10	5.68E+16	1.19E+15	4.81E+14	0.00E+00	7.04E+13	4.58E+14	6.31E+14	3.75E+14	3.66E+14	3.54E+14
12	3.42E+16	1.43E+15	2.89E+14	0.00E+00	1.13E+14	7.70E+14	7.09E+14	1.88E+14	4.52E+14	1.68E+14
14	1.63E+16	1.68E+15	1.10E+15	0.00E+00	5.05E+13	8.03E+14	1.03E+15	2.79E+14	1.42E+14	2.88E+14
16	5.41E+15	1.72E+15	1.24E+15	5.05E+13	0.00E+00	8.89E+14	1.32E+15	2.72E+14	4.35E+14	2.96E+14
18	1.58E+15	1.51E+15	1.40E+15	9.79E+13	4.54E+13	7.52E+14	1.41E+15	2.73E+14	3.82E+14	3.40E+14
21	7.12E+14	1.06E+15	1.53E+15	1.04E+14	1.04E+14	4.35E+14	1.21E+15	2.60E+14	1.79E+14	3.14E+14
24	5.08E+14	6.75E+14	1.33E+15	1.81E+14	1.14E+14	2.50E+14	6.80E+14	2.16E+14	2.80E+14	2.64E+14
27	3.50E+14	3.53E+14	8.56E+14	2.39E+14	1.69E+14	1.40E+14	4.07E+14	1.91E+14	1.66E+14	1.85E+14
31	2.43E+14	1.81E+14	4.04E+14	2.69E+14	2.16E+14	9.42E+13	2.06E+14	1.25E+14	1.75E+14	1.36E+14
36	8.37E+13	1.12E+14	2.36E+14	3.86E+14	2.32E+14	6.28E+13	1.22E+14	1.09E+14	8.93E+13	1.09E+14
41	9.19E+13	7.44E+13	1.02E+14	4.15E+14	2.80E+14	5.67E+13	7.12E+13	5.92E+13	5.81E+13	6.29E+13
48	4.89E+13	4.51E+13	6.44E+13	3.77E+14	3.34E+14	3.70E+13	5.08E+13	3.85E+13	6.76E+13	4.56E+13
55	3.21E+13	2.74E+13	3.10E+13	4.18E+14	3.07E+14	2.05E+13	2.65E+13	2.85E+13	1.25E+13	2.73E+13
63	1.90E+13	1.56E+13	2.44E+13	3.43E+14	2.85E+14	1.22E+13	1.50E+13	1.42E+13	1.47E+13	1.67E+13
73	9.25E+12	8.56E+12	1.51E+13	2.86E+14	2.63E+14	5.92E+12	8.04E+12	9.44E+12	5.27E+12	9.67E+12
84	1.62E+13	4.54E+12	2.87E+12	2.18E+14	2.09E+14	7.76E+12	3.30E+12	8.75E+12	8.95E+12	7.32E+12
97	4.78E+12	1.77E+12	2.78E+12	1.41E+14	1.57E+14	2.29E+12	1.91E+12	3.48E+12	4.52E+12	3.71E+12
113	0.00E+00	1.29E+12	4.12E+12	1.16E+14	8.80E+13	1.71E+12	3.21E+12	1.63E+12	0.00E+00	1.21E+12
131	6.69E+12	6.47E+11	1.26E+12	6.23E+13	7.31E+13	1.38E+12	3.20E+11	6.05E+11	1.97E+12	8.74E+11
153	2.60E+12	6.03E+11	1.34E+12	2.68E+13	2.89E+13	2.17E+12	2.07E+12	1.32E+12	2.12E+12	8.59E+11
178	4.61E+12	7.55E+11	1.40E+12	2.29E+13	1.58E+13	2.07E+12	1.38E+12	1.63E+12	6.60E+12	1.27E+12
209	1.09E+13	8.17E+11	4.05E+12	9.35E+12	6.86E+12	2.38E+12	2.16E+12	4.91E+12	2.10E+12	3.04E+12
245	1.56E+13	7.68E+11	0.00E+00	3.13E+12	0.00E+00	2.12E+12	4.38E+12	2.69E+12	0.00E+00	7.53E+12

TABLE A-9.—(Continued).

Test Point No.	944	945	946	947	947	947	948	949	950	951
Date	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004
Fuel	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur
Power (%)	100	85	30	7	7	7	100	85	30	7
Aerosol Point #	958	959	960	961	962	963	964	965	966	967
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	4.58E+14	3.70E+14	4.30E+14	5.24E+14	2.38E+15	5.05E+16	0.00E+00	1.25E+15	1.51E+15	5.24E+16
10	0.00E+00	1.20E+14	8.91E+13	2.34E+14	7.77E+14	2.06E+16	1.17E+15	5.80E+14	1.02E+15	4.23E+16
12	2.44E+14	1.79E+14	5.37E+13	2.69E+14	5.94E+14	1.29E+16	4.39E+14	7.85E+14	5.30E+14	2.32E+16
14	1.33E+14	2.60E+14	7.17E+13	2.59E+14	3.41E+14	5.51E+15	1.02E+15	7.00E+14	5.13E+14	9.49E+15
16	1.86E+14	3.15E+14	1.33E+14	2.20E+14	4.67E+14	2.19E+15	7.54E+14	8.13E+14	4.23E+14	3.09E+15
18	2.74E+14	4.29E+14	1.12E+14	2.64E+14	2.60E+14	1.05E+15	8.70E+14	9.62E+14	3.09E+14	1.36E+15
21	4.44E+14	5.21E+14	1.08E+14	1.76E+14	2.49E+14	7.23E+14	8.29E+14	8.13E+14	1.58E+14	8.62E+14
24	5.21E+14	4.78E+14	9.29E+13	1.78E+14	1.77E+14	5.03E+14	8.93E+14	8.40E+14	2.59E+14	4.54E+14
27	6.13E+14	5.89E+14	6.78E+13	1.34E+14	2.45E+14	3.02E+14	6.84E+14	8.07E+14	1.33E+14	4.27E+14
31	6.49E+14	6.11E+14	6.70E+13	1.07E+14	1.61E+14	2.47E+14	1.09E+15	7.58E+14	9.79E+13	1.62E+14
36	6.40E+14	5.47E+14	5.18E+13	7.86E+13	1.06E+14	1.79E+14	9.87E+14	7.38E+14	8.97E+13	9.77E+13
41	6.51E+14	5.91E+14	3.49E+13	4.95E+13	9.63E+13	1.38E+14	9.18E+14	8.09E+14	7.19E+13	1.06E+14
48	5.58E+14	5.76E+14	2.50E+13	4.16E+13	7.46E+13	6.11E+13	9.06E+14	7.24E+14	5.36E+13	6.92E+13
55	5.35E+14	4.95E+14	1.27E+13	2.55E+13	3.33E+13	3.40E+13	9.48E+14	6.58E+14	4.33E+13	5.14E+13
63	4.73E+14	4.24E+14	9.87E+12	1.55E+13	3.11E+13	2.63E+13	7.81E+14	5.20E+14	1.41E+13	2.90E+13
73	3.38E+14	3.15E+14	4.63E+12	7.67E+12	2.11E+13	3.61E+13	5.78E+14	4.75E+14	1.73E+13	2.58E+13
84	2.82E+14	2.68E+14	3.26E+12	2.50E+12	7.79E+12	1.32E+13	4.53E+14	3.26E+14	4.69E+13	1.75E+13
97	1.91E+14	1.67E+14	3.89E+12	2.80E+12	4.52E+12	1.96E+13	2.81E+14	2.06E+14	1.07E+13	7.53E+12
113	1.20E+14	1.00E+14	6.17E+11	1.92E+12	3.26E+12	3.74E+12	2.44E+14	1.55E+14	1.23E+12	1.14E+13
131	7.17E+13	6.10E+13	1.80E+12	1.75E+12	3.95E+12	1.10E+13	1.87E+14	9.88E+13	5.12E+12	1.68E+13
153	4.70E+13	3.30E+13	1.21E+12	9.49E+11	1.05E+12	1.73E+12	8.94E+13	4.45E+13	5.11E+12	1.58E+13
178	2.62E+13	1.44E+13	9.26E+11	1.90E+12	3.15E+12	1.24E+13	5.27E+13	2.46E+13	4.90E+12	2.93E+13
209	1.27E+13	9.56E+12	3.17E+12	4.33E+12	5.39E+12	1.39E+13	0.00E+00	2.17E+13	8.35E+12	5.42E+13
245	9.87E+12	7.51E+12	6.48E+12	5.61E+12	3.78E+12	2.81E+13	9.99E+12	1.62E+13	3.78E+13	1.00E+14

TABLE A-9.—(Concluded).

Test Point No.						
Date	4/20/2004	4/20/2004	4/20/2004	4/20/2004	4/20/2004	4/20/2004
Fuel	base	base	base	base	base	base
Power (%)	7	7	7	30	45	7
Aerosol Point #	001	002	003	004	005	007
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
9	7.21E+15	1.17E+15	0.00E+00	0.00E+00	1.44E+15	0.00E+00
10	3.99E+16	4.12E+14	2.47E+15	1.60E+15	0.00E+00	8.77E+14
12	2.98E+16	6.79E+14	7.51E+14	6.24E+14	0.00E+00	6.77E+14
14	2.99E+16	7.53E+14	7.64E+14	3.60E+14	2.02E+14	1.12E+15
16	1.61E+16	8.46E+14	1.61E+15	5.44E+14	2.57E+14	1.32E+15
18	1.18E+16	8.14E+14	1.89E+15	3.46E+14	2.75E+14	1.30E+15
21	6.75E+15	1.02E+15	1.11E+15	4.35E+14	5.14E+14	1.11E+15
24	4.61E+15	9.25E+14	9.86E+14	3.89E+14	4.32E+14	9.88E+14
27	1.98E+15	8.72E+14	9.51E+14	5.36E+14	3.85E+14	8.76E+14
31	2.09E+15	7.35E+14	9.20E+14	3.36E+14	4.09E+14	5.16E+14
36	1.70E+15	5.83E+14	5.60E+14	2.85E+14	3.12E+14	4.64E+14
41	1.17E+15	4.53E+14	5.18E+14	3.03E+14	2.14E+14	3.04E+14
48	7.30E+14	3.55E+14	3.53E+14	1.57E+14	1.98E+14	1.99E+14
55	6.90E+14	2.33E+14	1.98E+14	7.93E+13	7.96E+13	1.22E+14
63	1.84E+14	1.63E+14	9.69E+13	7.83E+13	4.43E+13	8.58E+13
73	3.08E+14	9.13E+13	8.27E+13	1.28E+13	5.79E+13	3.05E+13
84	1.78E+14	4.04E+13	1.29E+13	3.92E+13	5.30E+13	3.39E+13
97	7.13E+13	2.70E+13	4.47E+13	1.25E+13	4.75E+12	1.04E+13
113	2.14E+13	9.99E+12	7.66E+12	1.07E+13	1.72E+13	7.20E+12
131	0.00E+00	6.14E+12	1.04E+13	5.74E+12	0.00E+00	2.47E+12
153	0.00E+00	6.84E+12	9.42E+12	0.00E+00	0.00E+00	7.29E+12
178	0.00E+00	6.30E+12	1.55E+13	5.85E+12	4.76E+12	0.00E+00
209	0.00E+00	6.13E+12	2.24E+13	0.00E+00	0.00E+00	7.48E+13
245	0.00E+00	1.50E+13	2.77E+13	0.00E+00	0.00E+00	1.67E+13

Note:
1. Particle size distribution data are reported as particle number emission index (EIn) in each channel in the form of d(EIn)/dlogDp.

TABLE A-10.—AIRCRAFT CFM56-2-C1 ENGINE PARTICLE EMISSION DATA MEASURED BY UMR USING THE DMS 500 DURING THE AIRCRAFT PARTICLE EMISSIONS EXPERIMENT (APEX).

Test Point No.[2]	Fuel Type[3]	Power	Aerosol Point No.[2]	CO_2 data[1] MissionCO$_2$ Diluted ARI	MissionCO$_2$ Undiluted_NASA	Particle size distribution parameters GMD[4]	GMD[4] Stdev[5]	Sigma	Sigma Stdev[5]	Mean areal diameter	Mean Volume Diameter	MMD[6]	MMD[6] Stdev[5]	Particle concentration Number Conc.	Mass Conc.	Particle emission index Number EI[7]	Number EI Stdev[5]	Mass EI[7]	Mass EI Stdev[5]
		%		ppm	ppm	(nm)	(nm)			(nm)	(nm)	(nm)	(nm)	(#/cc)	(mg/m3)	(#/kg fuel)	(#/kg fuel)	(g/kg fuel)	(g/kg fuel)
301	base	7	301	2051	25307	19.40	0.23	1.63	0.01	25.53	30.27	53.65	1.77	1.74E+07	2.53E-01	1.21E+15	1.90E+14	1.76E-02	5.30E-04
	base	7	302	2199	25307	18.73	0.30	1.64	0.01	25.29	31.05	62.44	2.46	1.10E+07	1.72E-01	7.61E+14	1.03E+14	1.19E-02	3.64E-04
	base	7	303	2242	25307	17.45	0.35	1.61	0.02	23.63	30.11	70.20	3.40	9.06E+06	1.29E-01	6.29E+14	5.26E+13	8.99E-03	2.67E-04
	base	7	304	2112	25307	17.24	0.28	1.59	0.01	23.13	29.40	68.69	4.15	1.07E+07	1.42E-01	7.43E+14	4.68E+13	9.88E-03	1.80E-04
	base	7	305	2087	25307	16.21	0.43	1.58	0.01	21.82	28.03	67.75	3.45	1.32E+07	1.52E-01	9.16E+14	6.40E+13	1.06E-02	2.17E-04
	base	7	306	2169	25307	15.54	0.74	1.57	0.03	20.88	26.91	65.81	3.92	1.43E+07	1.46E-01	9.92E+14	8.88E+13	1.01E-02	2.89E-04
	base	7	307	1489	25307	13.65	0.34	1.44	0.04	17.47	23.33	67.96	7.50	3.07E+07	2.04E-01	2.13E+15	5.53E+14	1.42E-02	2.20E-04
	base	7	308	388	25307	18.00	1.68	2.07	0.14	40.55	59.22	154.53	7.43	2.05E+06	2.23E-01	1.42E+14	4.67E+13	1.55E-02	2.26E-03
302	base	30	309	2567	30460	22.53	0.16	1.67	0.01	29.78	34.80	58.13	1.23	1.43E+07	3.15E-01	8.24E+14	9.15E+13	1.82E-02	5.94E-04
	base	30	310	3120	30460	20.58	0.51	1.67	0.00	27.57	32.48	55.16	1.78	1.49E+07	2.67E-01	8.59E+14	8.65E+13	1.54E-02	3.43E-04
	base	30	312	1994	30460	22.76	0.26	1.66	0.01	29.48	33.15	46.34	1.44	1.79E+07	3.41E-01	1.03E+15	4.07E+13	1.97E-02	2.78E-04
	base	30	313	2400	30460	22.84	0.22	1.66	0.01	29.53	33.17	46.19	0.91	1.86E+07	3.56E-01	1.07E+15	1.61E+14	2.05E-02	7.18E-04
	base	30	314	2263	30460	19.68	0.96	1.64	0.01	25.53	28.91	41.21	0.84	1.39E+07	1.76E-01	8.02E+14	1.13E+14	1.01E-02	9.90E-05
	base	30	315	1795	30460	18.90	0.82	1.63	0.02	24.63	28.10	40.97	0.88	1.62E+07	1.88E-01	9.33E+14	2.27E+14	1.08E-02	2.94E-04
	base	30	316	1740	30460	17.68	0.88	1.65	0.02	23.58	27.23	40.94	0.71	1.93E+07	2.04E-01	1.11E+15	1.56E+14	1.18E-02	1.72E-04
	base	30	317	1982	30460	19.52	0.89	1.64	0.01	25.43	28.84	41.25	0.74	1.37E+07	1.72E-01	7.91E+14	1.14E+14	9.94E-03	1.05E-04
	base	30	318	2404	30460	21.56	0.24	1.63	0.00	27.58	30.89	42.60	0.38	1.02E+07	1.58E-01	5.90E+14	3.51E+13	9.10E-03	7.57E-05
	base	30	319	968	30460	12.51	0.33	1.46	0.01	15.94	19.29	35.06	1.54	4.14E+07	1.56E-01	2.39E+15	1.60E+14	8.98E-03	7.36E-04

TABLE A-10.—(Continued).

Test Point No.[2]	Fuel Type[3]	Power	Aerosol Point No.[2]	CO_2 data[1] MissionCO$_2$ Diluted ARI	MissionCO$_2$ Undiluted_NASA	Particle size distribution parameters GMD[4]	GMD[4] Stdev[5]	Sigma	Sigma Stdev[5]	Mean areal diameter	Mean Volume Diameter	MMD[6]	MMD[6] Stdev[5]	Particle concentration Number Conc.	Mass Conc.	Particle emission index Number EI[7]	Number EI Stdev[5]	Mass EI[7]	Mass EI Stdev[5]
		%		ppm	ppm	(nm)	(nm)			(nm)	(nm)	(nm)	(nm)	(#/cc)	(mg/m3)	(#/kg fuel)	(#/kg fuel)	(g/kg fuel)	(g/kg fuel)
303	base	40	321	2053	31892	24.07	0.35	1.66	0.01	31.19	35.23	50.58	1.32	1.57E+07	3.60E-01	8.65E+14	4.02E+13	1.98E-02	1.38E-04
	base	40	322	2410	31892	23.73	0.27	1.67	0.01	30.81	34.77	49.54	1.13	1.51E+07	3.33E-01	8.34E+14	2.06E+14	1.83E-02	1.18E-03
	base	40	323	2346	31892	20.31	0.48	1.66	0.02	26.76	30.78	47.21	3.27	1.32E+07	2.01E-01	7.27E+14	2.94E+14	1.11E-02	1.15E-03
	base	40	324	1783	31892	19.89	0.52	1.65	0.01	26.16	30.46	49.52	3.25	1.21E+07	1.80E-01	6.69E+14	1.29E+14	9.90E-03	3.53E-04
	base	40	325	1717	31892	19.26	1.12	1.66	0.01	25.58	29.75	47.51	2.28	1.37E+07	1.88E-01	7.53E+14	1.16E+14	1.04E-02	2.10E-04
	base	40	326	1958	31892	20.00	0.50	1.64	0.01	26.19	30.17	46.79	4.19	1.17E+07	1.69E-01	6.46E+14	7.94E+13	9.30E-03	2.56E-04
	base	40	327	2583	31892	22.03	0.26	1.64	0.01	28.40	32.35	48.48	3.58	8.37E+06	1.48E-01	4.61E+14	1.64E+13	8.18E-03	1.39E-04
	base	40	328	951	31892	14.66	0.90	1.59	0.04	20.10	25.26	53.64	6.82	1.47E+07	1.24E-01	8.11E+14	2.22E+14	6.84E-03	1.74E-03
304	base	30	329	982	28753	14.74	0.75	1.58	0.04	19.97	24.98	52.73	7.68	1.06E+07	8.63E-02	6.46E+14	2.39E+14	5.27E-03	9.68E-04
	base	30	330	2491	28753	21.75	0.24	1.62	0.01	27.85	31.65	47.21	3.28	7.83E+06	1.30E-01	4.79E+14	3.17E+13	7.95E-03	9.16E-05
	base	30	331	2148	28753	21.85	0.48	1.64	0.00	28.14	31.93	46.89	3.20	1.03E+07	1.75E-01	6.30E+14	4.35E+13	1.07E-02	3.07E-04
305	base	7	332	1779	24746	16.83	0.38	1.52	0.01	20.91	24.23	40.17	8.05	3.81E+06	2.84E-02	2.71E+14	2.81E+13	2.02E-03	6.17E-05
	base	7	333	1685	24746	13.82	0.76	1.43	0.06	16.81	20.03	37.71	6.78	1.66E+07	6.99E-02	1.18E+15	6.39E+14	4.96E-03	1.44E-04
	base	7	334	887	24746	13.26	0.77	1.28	0.03	14.39	15.57	21.94	3.08	1.13E+08	2.24E-01	8.03E+15	5.09E+15	1.59E-02	3.30E-03
	base	7	335	868	24746	17.40	0.65	1.57	0.02	22.47	26.72	47.85	11.69	4.27E+06	4.27E-02	3.04E+14	5.47E+13	3.03E-03	1.04E-04
	base	7	336	2430	24746	17.49	0.28	1.55	0.01	22.17	26.17	46.77	8.02	3.70E+06	3.47E-02	2.63E+14	4.30E+13	2.47E-03	8.30E-05
	base	7	337	4258	24746	19.09	0.44	1.57	0.01	24.13	27.59	42.35	5.87	4.26E+06	4.68E-02	3.02E+14	5.94E+13	3.33E-03	1.51E-04
306	base	7	339	1900	25045	17.98	0.19	1.57	0.01	22.94	26.88	46.06	5.35	7.98E+06	8.11E-02	5.60E+14	4.14E+13	5.69E-03	1.26E-04
	base	7	340	1496	25045	18.47	0.12	1.57	0.01	23.24	26.39	39.34	1.97	1.58E+07	1.52E-01	1.11E+15	1.49E+14	1.07E-02	3.22E-04
	base	7	341	1901	25045	17.23	0.16	1.58	0.01	22.18	26.06	44.33	3.71	1.02E+07	9.45E-02	7.16E+14	2.89E+13	6.63E-03	1.08E-04
	base	7	342	2184	25045	17.38	0.38	1.58	0.01	22.57	27.01	49.71	8.87	9.20E+06	9.50E-02	6.46E+14	8.29E+13	6.66E-03	1.97E-04
307	base	30	343	1491	28454	23.94	0.33	1.66	0.01	30.92	34.98	50.59	1.96	1.66E+07	3.71E-01	1.02E+15	6.77E+13	2.29E-02	3.73E-04
	base	30	344	1921	28454	22.81	0.27	1.64	0.01	29.34	33.12	47.52	1.90	1.52E+07	2.89E-01	9.40E+14	3.79E+13	1.79E-02	3.06E-04
	base	30	345	1885	28454	21.14	0.57	1.63	0.01	27.20	30.93	45.80	2.91	8.37E+06	1.30E-01	5.17E+14	2.18E+13	8.01E-03	1.42E-04
	base	30	346	1553	28454	18.44	1.52	1.62	0.02	24.08	27.93	44.33	4.90	1.13E+07	1.29E-01	7.00E+14	1.79E+14	7.99E-03	1.80E-04
	base	30	347	1560	28454	18.33	1.34	1.64	0.01	24.20	28.07	43.95	4.13	1.16E+07	1.35E-01	7.18E+14	1.54E+14	8.32E-03	2.17E-04
	base	30	348	1719	28454	17.37	1.59	1.59	0.04	22.31	25.83	41.04	5.42	2.03E+07	1.83E-01	1.25E+15	2.08E+15	1.13E-02	1.87E-03
	base	30	349	2600	28454	18.06	0.94	1.62	0.02	23.87	27.86	44.62	3.76	1.05E+07	1.18E-01	6.46E+14	1.03E+14	7.31E-03	9.68E-05
	base	30	350	1097	28454	13.25	0.26	1.44	0.04	16.51	20.23	40.93	7.55	2.51E+07	1.09E-01	1.55E+15	4.84E+14	6.72E-03	8.35E-04
308	base	40	351	1175	31165	14.96	0.41	1.61	0.03	20.65	25.53	49.44	3.16	1.78E+07	1.55E-01	1.00E+15	1.54E+14	8.72E-03	6.10E-04
	base	40	352	2934	31165	22.13	0.81	1.67	0.02	29.00	33.02	48.54	2.38	9.15E+06	1.72E-01	5.16E+14	3.81E+13	9.72E-03	1.15E-04
	base	40	353	1673	25515	24.65	0.59	1.67	0.01	32.01	36.37	53.71	3.19	1.08E+07	2.72E-01	7.45E+14	3.45E+13	1.88E-02	3.67E-04
308b	base	40	354	2400	25515	24.33	0.23	1.66	0.01	31.49	35.58	51.13	1.38	1.14E+07	2.69E-01	7.86E+14	7.56E+13	1.85E-02	4.72E-04
	base	40	355	2309	25515	23.19	0.24	1.66	0.01	30.10	34.07	49.19	2.36	1.03E+07	2.13E-01	7.09E+14	1.40E+14	1.47E-02	8.28E-04
	base	40	356	1838	25250	20.13	1.33	1.66	0.02	26.64	30.75	47.37	3.95	1.10E+07	1.67E-01	7.65E+14	2.09E+14	1.16E-02	7.73E-04
	base	40	357	1770	25250	17.08	1.23	1.65	0.04	23.25	27.59	46.09	2.44	1.45E+07	1.59E-01	1.01E+15	2.90E+14	1.11E-02	2.91E-04
	base	40	358	2027	25250	17.45	1.69	1.66	0.04	23.83	28.22	46.84	3.61	1.38E+07	1.63E-01	9.62E+14	2.96E+14	1.13E-02	2.41E-04
309	base	30	359	1728	27161	20.31	0.60	1.59	0.01	25.40	28.25	38.33	0.72	5.82E+06	6.87E-02	3.76E+14	2.34E+13	4.44E-03	4.76E-05
	base	30	360	2581	27161	18.15	1.59	1.61	0.02	23.54	26.90	39.53	1.40	9.01E+06	9.19E-02	5.83E+14	1.20E+14	5.95E-03	1.01E-04
	base	30	361	1107	27161	14.69	0.14	1.57	0.01	19.35	22.86	37.65	1.90	9.96E+06	6.23E-02	6.44E+14	8.11E+13	4.03E-03	3.92E-04

TABLE A-10.—(Continued).

Test Point No.[2]	Fuel Type[3]	Power	Aerosol Point No.[2]	CO_2 data[1] MissionCO$_2$ Diluted ARI	MissionCO$_2$ Undiluted_NASA	Particle size distribution parameters GMD[4]	GMD[4] Stdev[5]	Sigma	Sigma Stdev[5]	Mean areal diameter	Mean Volume Diameter	MMD[6]	MMD[6] Stdev[5]	Particle concentration Number Conc.	Mass Conc.	Particle emission index Number EI[7]	Number EI Stdev[5]	Mass EI[7]	Mass EI Stdev[5]
		%		ppm	ppm	(nm)	(nm)			(nm)	(nm)	(nm)	(nm)	(#/cc)	(mg/m3)	(#/kg fuel)	(#/kg fuel)	(g/kg fuel)	(g/kg fuel)
310	base	7	362	1034	24529	12.19	0.25	1.24	0.02	13.01	13.85	17.59	1.07	1.38E+08	1.92E-01	9.90E+15	1.00E+15	1.38E-02	7.63E-04
	base	7	363	2217	24529	16.14	0.18	1.53	0.01	20.12	22.80	33.08	0.87	7.78E+06	4.83E-02	5.57E+14	1.02E+14	3.46E-03	3.64E-05
	base	7	364	1349	24529	17.45	0.32	1.51	0.01	21.19	23.46	31.61	0.70	5.19E+06	3.51E-02	3.72E+14	3.98E+13	2.52E-03	6.03E-05
501	base	4	501	1057	27440	14.08	0.23	1.37	0.02	16.13	17.93	25.53	1.55	2.07E+08	6.25E-01	1.33E+16	9.80E+14	4.01E-02	1.38E-03
502	base	65	502	2065	36172	30.46	0.45	1.59	0.02	37.68	41.59	55.24	1.23	1.79E+07	6.74E-01	8.69E+14	6.48E+13	3.28E-02	1.06E-03
	base	65	503	2921	36172	29.01	0.93	1.58	0.05	35.82	39.51	52.36	3.26	1.26E+07	4.06E-01	6.10E+14	2.14E+14	1.97E-02	3.21E-03
	base	65	504	2857	36172	26.99	0.52	1.64	0.01	34.27	38.18	51.93	1.59	1.48E+07	4.32E-01	7.20E+14	1.22E+14	2.10E-02	1.13E-03
	base	65	505	2477	36172	26.07	1.35	1.69	0.06	34.13	38.55	54.60	4.34	1.94E+07	5.81E-01	9.41E+14	1.48E+14	2.82E-02	1.32E-03
	base	65	506	2014	36172	22.80	2.00	1.70	0.07	30.11	33.98	47.60	1.86	1.86E+07	3.83E-01	9.06E+14	2.18E+14	1.86E-02	1.18E-03
	base	65	507	2225	36172	18.44	2.35	1.60	0.06	23.77	27.15	40.02	4.48	5.79E+07	6.06E-01	2.81E+15	7.58E+15	2.95E-02	8.39E-03
	base	65	508	3697	36172	30.06	0.72	1.61	0.04	37.44	41.34	54.85	1.32	1.08E+07	3.98E-01	5.23E+14	5.70E+13	1.93E-02	5.44E-04
	base	65	509	1359	36172	14.30	0.24	1.63	0.03	20.49	25.30	45.56	1.75	2.82E+07	2.39E-01	1.37E+15	1.52E+14	1.16E-02	7.35E-04
503	base	70	511	1595	34832	27.32	1.28	1.64	0.06	34.66	38.51	51.90	1.30	2.03E+07	6.07E-01	1.02E+15	1.13E+14	3.06E-02	1.13E-03
504	base	65	512	1409	35790	25.41	2.53	1.65	0.08	32.39	35.97	48.30	2.05	1.56E+07	3.81E-01	7.67E+14	1.44E+14	1.87E-02	1.37E-03
505	base	60	513	1172	31602	22.32	3.65	1.61	0.10	27.83	30.56	39.71	1.95	7.15E+06	1.07E-01	3.98E+14	1.42E+14	5.95E-03	5.77E-04
506	base	85	514	2137	37889	31.25	1.00	1.70	0.02	41.26	46.82	67.21	2.83	2.79E+07	1.50E+00	1.29E+15	1.37E+14	6.94E-02	3.13E-03
507	base	100	515	2469	39016	32.15	0.57	1.74	0.01	43.43	49.79	73.57	1.91	3.39E+07	2.19E+00	1.53E+15	1.12E+14	9.86E-02	4.29E-03
508	base	7	517	2202	25094	17.40	0.65	1.43	0.03	19.87	21.21	25.63	0.91	4.17E+06	2.08E-02	2.92E+14	6.20E+13	1.46E-03	4.61E-05
	base	7	518	855	25094	20.08	0.19	1.26	0.01	21.24	21.85	23.76	0.36	2.08E+06	1.13E-02	1.45E+14	1.22E+13	7.93E-04	1.75E-05
	base	7	519	2260	25094	14.79	0.25	1.45	0.02	17.79	20.26	30.83	1.08	2.13E+07	9.25E-02	1.49E+15	2.75E+14	6.48E-03	1.13E-04
509	base	100	520	5016	41129	33.50	0.50	1.76	0.02	45.58	52.42	78.48	2.98	3.75E+07	2.83E+00	1.60E+15	2.29E+14	1.21E-01	2.42E-03
510	base	85	521	4687	38624	32.10	0.61	1.75	0.02	43.54	50.02	74.70	3.07	3.15E+07	2.06E+00	1.43E+15	8.36E+13	9.39E-02	2.37E-03
512	base	30	525	2572	28141	18.86	1.43	1.61	0.02	24.37	28.22	45.21	6.00	6.43E+06	7.56E-02	4.01E+14	1.20E+14	4.72E-03	9.86E-05
513	base	7	526	2275	26775	14.86	0.41	1.46	0.03	18.08	20.70	32.01	2.51	1.87E+07	8.69E-02	1.23E+15	2.22E+14	5.70E-03	9.75E-05
	base	7	527	1031	26775	13.41	0.49	1.33	0.03	15.00	16.52	23.39	1.63	1.03E+08	2.43E-01	6.76E+15	1.05E+15	1.59E-02	1.01E-03
514	base	100	531	1361	40830	14.71	2.07	1.41	0.18	17.60	20.41	33.73	12.75	9.48E+07	4.22E-01	4.08E+15	3.91E+15	1.82E-02	9.61E-03
515	base	30	532	1140	28911	13.90	0.59	1.49	0.05	17.52	20.61	34.05	1.75	1.41E+07	6.45E-02	8.55E+14	2.67E+14	3.92E-03	2.95E-04
516	base	7	533	1008	27369	12.93	0.21	1.32	0.01	14.49	16.03	22.95	0.75	7.06E+07	1.52E-01	4.54E+15	5.58E+14	9.78E-03	5.11E-04
517	base	85	534	1676	40626	30.10	1.09	1.77	0.01	41.72	48.71	76.51	1.72	3.56E+07	2.15E+00	1.54E+15	1.35E+14	9.31E-02	5.91E-03
518	base	7	535	991	27990	12.83	0.28	1.33	0.04	14.59	16.35	24.35	2.97	5.55E+07	1.27E-01	3.49E+15	9.40E+14	7.97E-03	4.15E-04
	base	7	536	1491	27990	17.99	0.20	1.52	0.01	21.90	24.23	32.53	0.69	8.34E+06	6.21E-02	5.24E+14	4.92E+13	3.90E-03	7.32E-05
519	base	100	537	2698	43156	33.81	1.25	1.77	0.02	46.46	53.91	83.07	4.63	5.04E+07	4.13E+00	2.05E+15	3.25E+14	1.68E-01	2.00E-02
520	base	85	538	1980	40417	32.14	0.71	1.76	0.02	44.09	51.22	79.42	1.82	4.41E+07	3.10E+00	1.92E+15	3.08E+14	1.35E-01	1.22E-02
521	base	30	539	2100	26370	20.76	0.51	1.54	0.01	25.13	27.51	35.70	0.56	4.24E+06	4.62E-02	2.83E+14	1.22E+13	3.08E-03	3.36E-05

TABLE A-10.—(Continued).

Test Point No.[2]	Fuel Type[3]	Power	Aerosol Point No.[2]	CO_2 data[1]		Particle size distribution parameters								Particle concentration		Particle emission index			
				MissionCO$_2$ Diluted ARI	MissionCO$_2$ Undiluted_NASA	GMD[4]	GMD[4] Stdev[5]	Sigma	Sigma Stdev[5]	Mean areal diameter	Mean Volume Diameter	MMD[6]	MMD[6] Stdev[5]	Number Conc.	Mass Conc.	Number EI[7]	Number EI Stdev[5]	Mass EI[7]	Mass EI Stdev[5]
		%		ppm	ppm	(nm)	(nm)			(nm)	(nm)	(nm)	(nm)	(#/cc)	(mg/m3)	(#/kg fuel)	(#/kg fuel)	(g/kg fuel)	(g/kg fuel)
522	base	7	540	1693	28279	17.80	0.42	1.52	0.01	21.55	23.78	31.72	0.91	8.06E+06	5.68E-02	5.01E+14	2.75E+13	3.53E-03	7.48E-05
	base	7	541	4575	28279	19.21	0.33	1.55	0.01	23.68	26.32	35.74	1.03	8.07E+06	7.71E-02	5.02E+14	5.86E+13	4.79E-03	6.24E-05
	base	7	542	2047	28279	18.31	0.23	1.53	0.01	22.33	24.72	33.20	0.51	9.61E+06	7.60E-02	5.97E+14	2.74E+13	4.72E-03	6.53E-05
	base	7	543	921	28279	18.56	0.48	1.52	0.01	22.42	24.65	32.51	0.64	8.91E+06	6.99E-02	5.54E+14	4.34E+13	4.34E-03	7.16E-05
	base	7	544	542	28279	19.11	0.65	1.48	0.02	22.50	24.40	30.89	0.94	6.68E+06	5.08E-02	4.15E+14	3.09E+13	3.16E-03	6.81E-05
	base	7	545	304	28279	22.11	1.28	1.36	0.04	24.36	25.57	29.52	1.35	3.45E+06	3.02E-02	2.14E+14	4.92E+13	1.88E-03	1.17E-04
	base	7	547	2293	28279	18.61	0.26	1.57	0.02	23.34	26.21	36.68	1.39	1.38E+07	1.30E-01	8.55E+14	1.01E+14	8.06E-03	1.54E-04
	base	7	548	1136	28279	16.13	0.87	1.55	0.03	20.42	23.35	34.65	1.83	2.26E+07	1.51E-01	1.41E+15	5.10E+14	9.37E-03	1.74E-04
	base	7	549	512	28279	16.66	1.24	1.53	0.09	20.57	23.07	32.29	2.65	1.84E+07	1.18E-01	1.15E+15	3.92E+14	7.36E-03	4.53E-04
523	base	100	550	2238	42863	33.61	0.20	1.77	0.01	46.22	53.63	82.65	1.00	5.10E+07	4.12E+00	2.09E+15	1.54E+14	1.69E-01	6.59E-03
524	base	85	551	2103	40989	32.22	0.36	1.76	0.02	44.12	51.16	78.86	1.56	4.56E+07	3.20E+00	1.96E+15	1.06E+14	1.37E-01	4.30E-03
525	base	30	552	1190	27719	20.23	0.67	1.53	0.02	24.50	26.87	35.10	1.15	4.16E+06	4.23E-02	2.64E+14	1.38E+13	2.68E-03	8.17E-05
526	base	7	553	1070	28609	15.99	0.33	1.51	0.01	19.62	21.95	30.56	0.37	1.35E+07	7.46E-02	8.27E+14	7.12E+13	4.58E-03	4.57E-05
	base	7	554	251	28609	16.73	1.53	1.46	0.03	19.50	21.06	26.37	1.33	7.58E+06	3.71E-02	4.66E+14	1.04E+14	2.28E-03	1.43E-04
	base	7	555	159	28609	17.38	2.49	1.41	0.08	19.61	20.78	24.63	1.53	4.58E+06	2.15E-02	2.81E+14	1.54E+14	1.32E-03	1.37E-04
601	base	7	602	979	25347	14.14	0.11	1.28	0.01	15.35	16.91	26.53	0.61	3.23E+08	8.17E-01	2.24E+16	1.26E+15	5.67E-02	1.07E-03
	base	7	603	2001	25347	14.39	0.07	1.44	0.00	17.54	21.66	49.63	2.33	5.95E+07	3.16E-01	4.12E+15	1.90E+14	2.19E-02	1.86E-04
	base	7	604	1019	25347	13.38	0.06	1.42	0.00	16.76	22.27	66.18	2.36	5.25E+07	3.04E-01	3.64E+15	1.43E+14	2.11E-02	1.59E-04
602	base	100	606	4886	42421	34.94	0.64	1.80	0.01	48.23	55.64	83.91	0.98	4.90E+07	4.42E+00	2.03E+15	4.40E+13	1.83E-01	2.51E-03
603	base	85	607	4604	38965	33.30	0.72	1.77	0.01	45.40	52.22	78.37	1.68	3.66E+07	2.73E+00	1.65E+15	1.46E+14	1.23E-01	4.09E-03
604	base	30	608	2440	27606	19.79	0.28	1.67	0.01	28.06	36.77	89.72	3.84	8.76E+06	2.28E-01	5.58E+14	2.92E+13	1.45E-02	1.56E-04
605	base	7	609	2049	24450	13.35	0.07	1.43	0.01	17.35	24.33	81.30	3.84	3.11E+07	2.34E-01	2.23E+15	1.26E+14	1.68E-02	1.61E-04
	base	7	610	525	24450	12.93	0.12	1.48	0.01	18.74	28.88	111.86	2.76	3.16E+07	3.99E-01	2.27E+15	1.06E+14	2.87E-02	4.10E-04
	base	7	611	263	24450	13.27	0.14	1.56	0.02	21.46	34.04	128.30	3.92	3.27E+07	6.75E-01	2.35E+15	1.55E+14	4.85E-02	1.25E-03
	base	7	612	1435	24450	16.87	0.14	1.62	0.01	25.10	35.89	109.98	4.31	7.04E+06	1.71E-01	5.06E+14	1.79E+13	1.23E-02	2.57E-04
	base	7	613	1511	24450	15.85	0.26	1.59	0.01	22.90	32.52	101.25	3.45	1.00E+07	1.81E-01	7.20E+14	4.94E+13	1.30E-02	1.20E-04
606	base	100	615	1011	42494	31.80	0.69	1.85	0.00	45.76	53.98	87.01	1.22	5.87E+07	4.83E+00	2.43E+15	2.36E+14	2.00E-01	1.23E-02
607	base	85	616	894	38987	30.11	0.31	1.84	0.01	43.39	51.46	84.78	0.61	4.69E+07	3.35E+00	2.12E+15	1.40E+14	1.51E-01	4.27E-03
608	base	30	617	814	27702	18.90	0.18	1.74	0.01	29.72	41.58	114.81	3.59	9.88E+06	3.72E-01	6.27E+14	3.22E+13	2.36E-02	5.39E-04
609	base	7	618	990	24006	13.08	0.11	1.48	0.01	18.68	28.26	106.06	2.08	2.48E+07	2.93E-01	1.82E+15	1.06E+14	2.15E-02	1.73E-04
	base	7	619	874	24006	13.35	0.07	1.26	0.00	14.49	16.71	34.36	1.23	2.75E+08	6.73E-01	2.02E+16	1.18E+15	4.93E-02	7.40E-04
610	base	100	620	3551	41999	32.93	0.21	1.81	0.01	46.34	54.15	85.01	2.14	3.09E+07	2.57E+00	1.29E+15	1.26E+14	1.08E-01	8.05E-03
611	base	85	621	1484	40287	31.14	0.40	1.82	0.01	44.26	52.12	84.01	0.77	4.68E+07	3.47E+00	2.04E+15	2.10E+14	1.52E-01	8.99E-03
612	base	30	622	2123	25970	19.46	0.19	1.66	0.01	27.65	36.74	94.18	4.58	6.60E+06	1.71E-01	4.47E+14	2.75E+13	1.16E-02	1.86E-04
613	base	7	623	1812	26394	17.23	0.15	1.60	0.01	24.76	34.67	103.29	4.64	8.38E+06	1.83E-01	5.58E+14	5.38E+13	1.22E-02	2.42E-04
	base	7	624	875	26394	13.19	0.08	1.27	0.00	14.53	17.30	40.21	3.40	1.90E+08	5.15E-01	1.27E+16	1.62E+15	3.43E-02	1.05E-03
614	base	100	625	1783	42838	20.67	2.72	2.02	0.05	36.26	45.96	86.80	2.34	8.28E+07	4.21E+00	3.39E+15	6.92E+14	1.73E-01	1.44E-02
615	base	85	626	1636	40776	27.71	0.52	1.92	0.01	41.93	50.06	82.45	0.73	4.43E+07	2.91E+00	1.91E+15	1.80E+14	1.25E-01	5.63E-03
616	base	30	627	968	26684	11.92	0.07	1.25	0.00	13.19	16.12	41.19	7.41	1.20E+08	2.63E-01	7.90E+15	1.06E+15	1.73E-02	9.61E-04

TABLE A-10.—(Continued).

Test Point No.[2]	Fuel Type[3]	Power	Aerosol Point No.[2]	CO_2 data[1]		Particle size distribution parameters								Particle concentration		Particle emission index			
				MissionCO_2 Diluted ARI	MissionCO_2 Undiluted_NASA	GMD[4]	GMD[4] Stdev[5]	Sigma	Sigma Stdev[5]	Mean areal diameter	Mean Volume Diameter	MMD[6]	MMD[6] Stdev[5]	Number Conc.	Mass Conc.	Number EI[7]	Number EI Stdev[5]	Mass EI[7]	Mass EI Stdev[5]
		%		ppm	ppm	(nm)	(nm)			(nm)	(nm)	(nm)	(nm)	(#/cc)	(mg/m3)	(#/kg fuel)	(#/kg fuel)	(g/kg fuel)	(g/kg fuel)
617	base	7	628	762	26623	12.67	0.11	1.25	0.01	13.71	15.75	31.61	3.01	1.92E+08	3.93E-01	1.27E+16	2.49E+15	2.60E-02	1.45E-03
	base	7	629	1374	26623	17.26	0.12	1.59	0.02	23.80	32.19	89.77	13.53	6.05E+06	1.06E-01	4.00E+14	2.68E+13	6.98E-03	3.60E-04
	base	7	630	1736	26623	17.37	0.15	1.56	0.02	22.56	28.14	62.74	19.16	7.21E+06	8.42E-02	4.76E+14	3.85E+13	5.56E-03	3.94E-04
	base	7	631	1830	26623	16.40	0.59	1.56	0.02	21.59	27.47	65.20	9.82	1.14E+07	1.24E-01	7.56E+14	1.15E+14	8.21E-03	2.41E-04
618	base	4	632	1074	27631	14.13	0.39	1.35	0.02	16.04	18.47	33.71	2.05	1.73E+08	5.71E-01	1.10E+16	2.42E+15	3.63E-02	2.95E-03
619	base	100	633	1712	41463	28.75	2.32	1.89	0.06	43.00	51.43	85.66	0.72	3.54E+07	2.52E+00	1.50E+15	1.78E+14	1.07E-01	3.24E-03
620	base	85	634	1596	38858	29.48	0.68	1.81	0.02	42.19	50.11	83.05	0.94	2.32E+07	1.53E+00	1.05E+15	8.83E+13	6.91E-02	2.66E-03
621	base	65	635	1412	33203	22.21	1.95	1.79	0.02	32.93	41.51	85.44	2.98	1.03E+07	3.87E-01	5.47E+14	8.61E+13	2.05E-02	8.14E-04
622	base	40	636	1165	29751	15.28	0.93	1.62	0.05	22.39	31.11	89.97	5.44	9.67E+06	1.53E-01	5.72E+14	1.72E+14	9.01E-03	8.13E-04
	base	4	638	368	28198	15.56	0.26	1.52	0.02	21.15	29.23	87.91	8.01	1.97E+07	2.58E-01	1.23E+15	1.91E+14	1.61E-02	8.16E-04
624	base	40	640	1498	32347	19.06	1.04	1.69	0.01	26.70	33.66	72.98	3.85	9.96E+06	1.99E-01	5.41E+14	5.93E+13	1.08E-02	2.56E-04
	base	40	641	3338	32347	19.37	0.86	1.66	0.01	26.05	31.25	57.14	4.09	9.09E+06	1.45E-01	4.94E+14	5.22E+13	7.89E-03	1.46E-04
	base	40	643	710	32347	20.28	1.88	1.67	0.02	28.07	35.29	75.86	10.55	7.98E+06	1.84E-01	4.33E+14	1.05E+14	9.97E-03	5.64E-04
	base	40	644	3823	32347	22.51	0.27	1.61	0.01	28.58	32.40	48.22	5.18	5.42E+06	9.65E-02	2.94E+14	1.07E+13	5.24E-03	8.16E-05
625	base	30	645	1709	28295	19.69	1.68	1.59	0.02	24.94	28.39	42.35	4.97	4.26E+06	5.10E-02	2.64E+14	7.65E+13	3.17E-03	8.37E-05
626	base	15	646	1333	26145	19.18	0.87	1.51	0.02	23.16	25.74	35.97	6.59	2.84E+06	2.53E-02	1.91E+14	2.68E+13	1.70E-03	6.12E-05
627	base	7	647	1281	25152	17.47	0.51	1.49	0.01	20.84	22.84	29.94	0.93	3.68E+06	2.30E-02	2.57E+14	2.41E+13	1.60E-03	1.56E-05
628	base	5.5	648	1318	26774	16.98	0.30	1.51	0.01	20.60	22.81	30.75	0.55	6.68E+06	4.15E-02	4.39E+14	3.26E+13	2.73E-03	3.04E-05
629	base	4	649	1334	28499	16.97	0.24	1.53	0.02	21.11	24.16	37.80	12.21	1.14E+07	8.42E-02	7.03E+14	6.78E+13	5.19E-03	3.10E-04
	base	4	651	1111	28499	14.44	0.33	1.36	0.01	16.32	17.83	24.09	0.79	1.36E+08	4.04E-01	8.39E+15	1.78E+15	2.49E-02	1.86E-03
630	base	5.5	652	1012	26807	12.86	0.56	1.30	0.03	14.17	15.43	21.04	1.88	1.19E+08	2.29E-01	7.82E+15	1.28E+15	1.50E-02	9.60E-04
631	base	7	653	995	26800	13.53	0.48	1.33	0.02	15.06	16.36	21.80	1.78	8.39E+07	1.92E-01	5.50E+15	7.83E+14	1.26E-02	8.38E-04
632	base	15	654	970	26012	13.02	0.44	1.32	0.02	14.52	15.93	22.17	1.67	3.65E+07	7.72E-02	2.46E+15	8.03E+14	5.22E-03	6.55E-04
633	base	30	655	1148	29354	13.79	0.47	1.43	0.05	16.86	19.80	33.45	3.21	2.29E+07	9.29E-02	1.37E+15	4.56E+14	5.56E-03	3.36E-04
634	base	4	656	1078	27866	14.37	0.19	1.36	0.01	16.18	17.68	24.03	0.43	1.53E+08	4.42E-01	9.63E+15	1.33E+15	2.79E-02	1.12E-03
635	base	40	657	1246	32472	14.94	0.89	1.59	0.06	20.53	25.64	51.99	6.87	1.58E+07	1.39E-01	8.54E+14	3.39E+14	7.53E-03	7.35E-04
	base	40	658	3077	32472	22.82	0.60	1.64	0.02	29.42	33.47	49.70	4.44	6.27E+06	1.23E-01	3.39E+14	2.47E+13	6.66E-03	1.22E-04
	base	40	659	1228	32472	21.85	0.53	1.66	0.02	28.78	33.42	53.46	7.29	7.36E+06	1.44E-01	3.98E+14	2.55E+13	7.79E-03	2.92E-04
	base	40	660	465	32472	22.26	2.09	1.68	0.04	29.99	35.45	59.89	9.75	6.87E+06	1.60E-01	3.72E+14	5.88E+13	8.68E-03	5.83E-04
636	base	30	661	1726	27699	16.92	0.71	1.61	0.02	22.51	26.56	43.64	3.52	7.92E+06	7.77E-02	5.02E+14	7.41E+13	4.93E-03	7.41E-05
637	base	15	662	1479	26278	14.57	0.53	1.50	0.03	18.52	22.08	38.57	1.98	1.04E+07	5.88E-02	6.97E+14	2.27E+14	3.93E-03	9.09E-05
638	base	7	663	1747	26773	15.17	0.12	1.47	0.01	18.55	21.41	34.14	1.62	1.45E+07	7.47E-02	9.54E+14	2.07E+14	4.90E-03	1.24E-04
639	base	5.5	664	1715	27228	14.78	0.28	1.45	0.02	17.94	20.74	33.51	1.50	2.74E+07	1.28E-01	1.77E+15	2.61E+14	8.26E-03	1.19E-04
640	base	4	665	1724	27736	15.24	0.38	1.48	0.03	18.73	21.55	33.75	2.13	2.57E+07	1.35E-01	1.63E+15	5.51E+14	8.52E-03	2.53E-04
641	base	5.5	667	878	26563	13.11	0.47	1.30	0.03	14.45	15.86	22.81	2.32	1.00E+08	2.10E-01	6.64E+15	1.50E+15	1.39E-02	9.75E-04
642	base	7	668	846	26295	12.70	0.44	1.29	0.02	14.06	15.79	25.67	4.23	8.34E+07	1.72E-01	5.58E+15	1.09E+15	1.15E-02	8.32E-04
643	base	15	669	1089	26733	13.61	0.26	1.38	0.03	16.10	18.95	34.33	3.74	4.49E+07	1.60E-01	2.95E+15	5.41E+14	1.05E-02	7.58E-04
701	base	4	701	724	26660	14.81	0.12	1.55	0.01	19.88	25.51	59.95	14.51	1.40E+08	1.22E+00	9.21E+15	4.65E+14	8.01E-02	4.38E-03

TABLE A-10.—(Continued).

Test Point No.[2]	Fuel Type[3]	Power	Aerosol Point No.[2]	CO_2 data[1]		Particle size distribution parameters								Particle concentration		Particle emission index			
				MissionCO_2 Diluted ARI	MissionCO_2 Undiluted_NASA	GMD[4]	GMD[4] Stdev[5]	Sigma	Sigma Stdev[5]	Mean areal diameter	Mean Volume Diameter	MMD[6]	MMD[6] Stdev[5]	Number Conc.	Mass Conc.	Number EI[7]	Number EI Stdev[5]	Mass EI[7]	Mass EI Stdev[5]
		%		ppm	ppm	(nm)	(nm)			(nm)	(nm)	(nm)	(nm)	(#/cc)	(mg/m3)	(#/kg fuel)	(#/kg fuel)	(g/kg fuel)	(g/kg fuel)
702	base	100	702	2030	42444	33.55	0.25	1.84	0.00	48.04	56.47	89.84	0.71	7.65E+07	7.21E+00	3.17E+15	1.01E+14	2.99E-01	2.98E-03
703	base	85	703	1736	40623	30.79	0.19	1.84	0.01	44.35	52.59	86.39	1.35	5.82E+07	4.43E+00	2.52E+15	1.37E+14	1.92E-01	3.41E-03
704	base	65	704	1391	31598	23.96	0.30	1.81	0.01	36.09	46.00	96.78	3.78	2.17E+07	1.10E+00	1.21E+15	5.49E+13	6.14E-02	1.44E-03
705	base	4	705	1954	25822	14.31	0.07	1.49	0.01	18.96	25.60	73.74	4.99	7.00E+07	6.15E-01	4.77E+15	2.58E+14	4.19E-02	5.89E-04
	base	4	706	973	25822	16.78	0.09	1.64	0.01	25.60	36.82	111.52	1.71	2.86E+07	7.48E-01	1.95E+15	1.17E+14	5.09E-02	6.91E-04
706	base	100	707	2795	41476	32.47	0.37	1.82	0.01	45.81	53.73	85.48	1.03	5.19E+07	4.21E+00	2.20E+15	2.28E+14	1.78E-01	6.12E-03
707	base	85	708	2274	40139	30.54	0.68	1.81	0.03	43.29	51.09	83.25	3.56	4.82E+07	3.36E+00	2.11E+15	1.61E+14	1.47E-01	6.47E-03
708	base	70	709	1436	33863	25.89	0.58	1.82	0.02	38.34	47.62	92.24	4.69	2.42E+07	1.37E+00	1.25E+15	7.25E+13	7.09E-02	2.45E-03
709	base	65	710	1216	33506	22.83	0.73	1.86	0.03	36.93	49.15	114.02	6.29	2.03E+07	1.26E+00	1.07E+15	1.64E+14	6.62E-02	6.00E-03
710	base	60	711	925	30244	22.59	0.85	1.85	0.03	36.86	49.75	119.38	7.67	1.55E+07	9.96E-01	8.98E+14	1.02E+14	5.79E-02	3.73E-03
711	base	4	712	2294	25973	16.66	0.07	1.54	0.02	21.45	26.24	53.95	17.59	1.82E+07	1.72E-01	1.23E+15	1.06E+14	1.16E-02	6.43E-04
712	base	100	714	2526	42592	33.87	0.34	1.79	0.00	47.11	54.87	85.39	0.58	5.82E+07	5.03E+00	2.40E+15	1.61E+14	2.08E-01	8.28E-03
713	base	85	715	2072	39611	31.83	0.33	1.79	0.01	44.42	51.90	81.88	0.59	5.01E+07	3.67E+00	2.22E+15	1.15E+14	1.63E-01	4.07E-03
714	base	65	716	1521	31490	25.69	0.42	1.74	0.01	35.79	43.34	79.83	2.66	1.49E+07	6.36E-01	8.33E+14	7.80E+13	3.55E-02	1.01E-03
715	base	4	717	2156	26051	16.55	0.08	1.54	0.01	21.21	25.47	48.11	5.52	2.18E+07	1.88E-01	1.47E+15	6.21E+13	1.27E-02	1.61E-04
	base	4	718	1477	26051	14.28	0.06	1.49	0.01	18.33	22.81	49.20	6.62	6.27E+07	3.90E-01	4.23E+15	2.32E+14	2.63E-02	5.67E-04
716	base	100	719	1187	42057	31.85	0.24	1.84	0.00	46.02	54.56	89.29	0.67	6.31E+07	5.37E+00	2.64E+15	1.60E+14	2.24E-01	4.67E-03
717	base	85	720	1045	40577	31.07	0.50	1.83	0.01	44.69	53.08	87.75	0.89	5.53E+07	4.33E+00	2.40E+15	1.14E+14	1.88E-01	4.08E-03
718	base	65	721	1148	32457	25.36	0.35	1.77	0.01	36.20	44.18	82.22	2.40	2.25E+07	1.02E+00	1.22E+15	1.23E+14	5.51E-02	1.95E-03
719	base	4	722	1279	26051	14.39	0.18	1.51	0.01	18.93	24.37	59.11	2.56	5.62E+07	4.26E-01	3.79E+15	2.78E+14	2.88E-02	2.30E-04
	base	4	723	928	26051	13.43	0.06	1.29	0.00	14.91	17.29	34.15	2.63	2.98E+08	8.07E-01	2.01E+16	2.39E+15	5.44E-02	1.66E-03
720	base	100	724	1769	41549	19.26	1.20	1.95	0.02	33.17	42.76	85.59	1.17	9.01E+07	3.69E+00	3.81E+15	1.74E+14	1.56E-01	1.09E-02
721	base	85	725	1676	39957	17.97	0.57	1.91	0.03	30.79	39.99	82.12	1.21	7.84E+07	2.62E+00	3.45E+15	2.36E+14	1.15E-01	5.96E-03
722	base	70	726	1497	33842	13.60	0.15	1.59	0.02	20.51	28.19	73.21	1.03	8.22E+07	9.63E-01	4.27E+15	3.02E+14	5.00E-02	1.35E-03
723	base	65	727	1446	34361	12.82	0.06	1.48	0.01	17.95	24.89	70.76	1.83	9.39E+07	7.58E-01	4.80E+15	2.73E+14	3.88E-02	5.91E-04
724	base	60	728	1376	30282	12.19	0.05	1.38	0.01	15.79	22.09	71.07	2.89	8.82E+07	4.98E-01	5.12E+15	3.58E+14	2.89E-02	5.73E-04
725	base	4	729	971	26921	13.24	0.07	1.29	0.00	14.63	16.83	32.07	1.20	2.99E+08	7.47E-01	1.95E+16	1.22E+15	4.87E-02	1.02E-03
	sulfur	4	732	991	28201	13.66	0.14	1.28	0.00	14.81	15.97	21.91	1.09	3.05E+08	6.51E-01	1.90E+16	2.18E+15	4.06E-02	1.55E-03
727	sulfur	100	733	1774	43762	30.38	1.12	1.88	0.03	44.96	53.52	87.96	1.39	3.88E+07	3.12E+00	1.56E+15	1.19E+14	1.25E-01	7.02E-03
728	sulfur	85	734	1657	40890	28.21	0.77	1.86	0.02	41.64	49.80	83.38	0.84	3.01E+07	1.95E+00	1.29E+15	5.28E+13	8.36E-02	2.54E-03
729	sulfur	65	735	1459	32594	12.65	0.17	1.43	0.03	16.63	22.41	61.67	3.45	7.46E+07	4.40E-01	4.02E+15	7.39E+14	2.37E-02	6.87E-04
730	sulfur	40	736	1185	29071	12.01	0.04	1.22	0.00	12.78	14.08	22.92	2.21	2.09E+08	3.05E-01	1.26E+16	9.63E+14	1.84E-02	4.50E-04
731	sulfur	30	737	1117	24918	11.92	0.07	1.20	0.00	12.55	13.64	21.09	1.68	1.99E+08	2.64E-01	1.41E+16	1.40E+15	1.87E-02	4.71E-04
732	sulfur	7	738	981	26358	12.80	0.07	1.23	0.09	13.48	14.19	18.09	1.34	2.96E+08	4.43E-01	1.97E+16	1.46E+15	2.95E-02	7.79E-04
733	sulfur	4	739	973	25803	13.50	0.14	1.26	0.00	14.47	15.44	20.32	0.89	2.98E+08	5.75E-01	2.03E+16	1.07E+15	3.91E-02	7.23E-04
	sulfur	4	740	2579	28190	15.17	0.18	1.51	0.01	19.17	22.63	38.98	4.43	2.18E+07	1.32E-01	1.36E+15	9.34E+13	8.25E-03	7.61E-05
734	sulfur	100	741	6200	42780	34.82	0.15	1.79	0.00	47.92	55.29	83.55	0.50	2.79E+07	2.47E+00	1.15E+15	5.09E+13	1.01E-01	1.17E-03
735	sulfur	85	742	5636	40074	33.68	0.45	1.77	0.00	45.98	52.98	79.97	0.96	2.30E+07	1.79E+00	1.01E+15	4.22E+13	7.86E-02	1.19E-03

TABLE A-10.—(Continued).

Test Point No.[2]	Fuel Type[3]	Power	Aerosol Point No.[2]	CO_2 data[1]		Particle size distribution parameters								Particle concentration		Particle emission index			
				MissionCO$_2$ Diluted ARI	MissionCO$_2$ Undiluted_NASA	GMD[4]	GMD[4] Stdev[5]	Sigma	Sigma Stdev[5]	Mean areal diameter	Mean Volume Diameter	MMD[6]	MMD[6] Stdev[5]	Number Conc.	Mass Conc.	Number EI[7]	Number EI Stdev[5]	Mass EI[7]	Mass EI Stdev[5]
		%		ppm	ppm	(nm)	(nm)			(nm)	(nm)	(nm)	(nm)	(#/cc)	(mg/m3)	(#/kg fuel)	(#/kg fuel)	(g/kg fuel)	(g/kg fuel)
736	sulfur	65	743	4648	32595	26.99	0.34	1.73	0.01	36.60	42.87	70.37	1.53	8.34E+06	3.44E-01	4.50E+14	3.55E+13	1.86E-02	4.27E-04
737	sulfur	40	744	3246	29247	21.49	0.45	1.65	0.01	28.27	33.31	57.72	6.26	4.64E+06	8.97E-02	2.79E+14	2.22E+13	5.39E-03	1.12E-04
738	sulfur	30	745	2806	25131	19.94	0.46	1.63	0.01	26.08	30.60	51.68	9.37	3.61E+06	5.41E-02	2.52E+14	1.61E+13	3.78E-03	1.01E-04
739	sulfur	7	746	2268	26317	15.23	0.23	1.52	0.01	19.60	23.94	47.73	10.42	5.95E+06	4.27E-02	3.97E+14	3.24E+13	2.85E-03	9.57E-05
740	sulfur	4	747	2403	26607	15.18	0.28	1.51	0.01	19.13	22.62	39.70	5.09	1.88E+07	1.14E-01	1.24E+15	1.55E+14	7.54E-03	1.55E-04
	sulfur	4	748	1541	28162	16.77	0.16	1.55	0.01	21.28	24.66	39.40	5.36	1.03E+07	8.07E-02	6.41E+14	4.37E+13	5.04E-03	9.49E-05
741	sulfur	100	749	1679	43806	33.93	0.27	1.82	0.01	47.94	56.15	88.88	0.93	3.90E+07	3.62E+00	1.57E+15	8.99E+13	1.45E-01	5.84E-03
742	sulfur	85	750	1670	41077	31.99	0.47	1.81	0.01	44.90	52.61	83.75	1.08	3.60E+07	2.74E+00	1.54E+15	7.87E+13	1.17E-01	2.36E-03
743	sulfur	70	751	2211	34106	26.97	0.38	1.77	0.01	37.58	44.51	75.13	1.70	1.17E+07	5.40E-01	6.03E+14	5.11E+13	2.78E-02	9.78E-04
744	sulfur	65	752	2001	34623	25.51	0.44	1.75	0.01	35.59	42.98	78.91	2.65	9.62E+06	4.00E-01	4.88E+14	2.35E+13	2.03E-02	3.05E-04
745	sulfur	60	753	2512	30800	24.04	0.44	1.72	0.01	32.99	39.69	72.88	3.89	6.53E+06	2.14E-01	3.73E+14	1.45E+13	1.22E-02	2.10E-04
746	sulfur	40	754	1822	28772	20.40	0.60	1.67	0.02	27.49	33.17	62.55	8.48	5.59E+06	1.07E-01	3.42E+14	4.17E+13	6.53E-03	1.97E-04
747	sulfur	30	755	1653	25156	19.62	0.47	1.65	0.02	26.14	31.30	57.38	12.36	3.81E+06	6.12E-02	2.66E+14	2.77E+13	4.28E-03	1.73E-04
748	sulfur	15	756	2107	25767	17.47	0.25	1.58	0.01	22.92	27.67	51.86	10.07	3.42E+06	3.79E-02	2.33E+14	1.19E+13	2.59E-03	7.23E-05
749	sulfur	7	757	2170	25128	16.43	0.12	1.54	0.01	21.26	26.15	53.99	14.25	4.08E+06	3.82E-02	2.86E+14	2.91E+13	2.67E-03	1.16E-04
750	sulfur	5.5	758	2164	27148	16.68	0.23	1.54	0.01	21.22	24.99	43.13	6.63	6.45E+06	5.27E-02	4.17E+14	1.81E+13	3.41E-03	6.07E-05
751	sulfur	4	759	2222	27146	17.10	0.25	1.55	0.01	21.70	25.20	40.79	5.67	1.08E+07	9.02E-02	6.97E+14	5.42E+13	5.84E-03	1.58E-04
	sulfur	4	801	1559	27389	17.76	0.13	1.60	0.01	23.38	28.39	55.65	5.75	3.05E+07	3.65E-01	1.96E+15	1.36E+14	2.35E-02	4.03E-04
802	sulfur	100	802	1669	42265	33.21	0.48	1.79	0.02	46.06	53.49	82.66	0.99	4.50E+07	3.60E+00	1.87E+15	9.30E+13	1.50E-01	3.24E-03
803	sulfur	85	803	1679	40338	30.65	0.25	1.80	0.01	42.88	50.19	79.90	0.79	4.07E+07	2.70E+00	1.78E+15	6.65E+13	1.17E-01	1.66E-03
804	sulfur	65	804	1174	31622	25.07	0.35	1.69	0.02	33.07	37.72	55.84	4.05	1.20E+07	3.38E-01	6.69E+14	3.37E+13	1.88E-02	4.50E-04
805	sulfur	40	805	2479	27934	20.38	0.40	1.60	0.01	25.61	28.47	38.50	0.94	5.92E+06	7.15E-02	3.72E+14	3.33E+13	4.50E-03	6.50E-05
	sulfur	40	806	4440	28162	20.45	0.16	1.60	0.01	25.87	28.89	39.65	0.95	5.69E+06	7.19E-02	3.55E+14	4.24E+13	4.49E-03	8.22E-05
	sulfur	40	807	650	28287	17.72	1.26	1.62	0.03	23.11	26.73	41.94	8.14	8.88E+06	8.88E-02	5.52E+14	1.22E+14	5.52E-03	3.06E-04
806	sulfur	30	809	1145	27641	17.78	1.15	1.59	0.04	22.85	26.75	45.54	17.74	5.81E+06	5.83E-02	3.70E+14	1.22E+14	3.71E-03	4.26E-04
807	sulfur	7	810	1696	24980	16.07	0.15	1.50	0.02	19.90	23.52	43.46	16.60	3.79E+06	2.58E-02	2.67E+14	4.81E+13	1.82E-03	1.48E-04
808	sulfur	4	811	1776	26295	16.02	0.08	1.50	0.00	19.51	21.81	30.36	0.47	9.56E+06	5.19E-02	6.39E+14	9.65E+13	3.47E-03	8.42E-05
	sulfur	4	812	1407	26295	13.10	0.14	1.40	0.01	15.44	17.51	26.43	1.12	3.80E+07	1.07E-01	2.54E+15	2.37E+14	7.14E-03	1.10E-04
809	sulfur	100	813	930	42318	30.91	0.38	1.83	0.01	43.94	51.66	82.72	1.29	4.55E+07	3.28E+00	1.89E+15	2.12E+14	1.36E-01	5.90E-03
810	sulfur	85	814	979	39940	29.08	0.37	1.81	0.01	41.16	48.47	78.43	1.25	3.83E+07	2.28E+00	1.69E+15	1.13E+14	1.01E-01	2.72E-03
811	sulfur	65	815	1047	35887	23.75	0.39	1.73	0.01	32.74	39.05	68.41	2.48	1.49E+07	4.64E-01	7.29E+14	3.35E+13	2.27E-02	4.57E-04
812	sulfur	40	816	1206	28286	19.12	0.43	1.63	0.01	24.72	28.03	40.28	1.39	7.35E+06	8.48E-02	4.57E+14	3.09E+13	5.27E-03	8.31E-05
	sulfur	40	817	3396	28286	20.66	0.22	1.62	0.00	26.35	29.57	41.21	1.17	6.02E+06	8.14E-02	3.74E+14	1.33E+13	5.06E-03	3.93E-05
	sulfur	40	818	577	28286	19.39	0.45	1.65	0.01	25.54	29.33	43.90	2.32	8.14E+06	1.07E-01	5.06E+14	4.81E+13	6.68E-03	2.05E-04
	sulfur	40	819	2215	28651	20.18	0.24	1.64	0.01	26.15	29.70	43.16	2.77	7.55E+06	1.04E-01	4.63E+14	1.82E+13	6.36E-03	1.09E-04
813	sulfur	30	820	1219	26024	18.18	0.27	1.60	0.01	23.23	26.29	37.64	1.16	6.07E+06	5.78E-02	4.10E+14	2.19E+13	3.90E-03	4.92E-05
814	sulfur	7	821	1202	24877	13.38	0.11	1.43	0.01	16.16	18.62	29.56	2.29	1.09E+07	3.69E-02	7.72E+14	3.70E+13	2.61E-03	5.40E-05

TABLE A-10.—(Continued).

Test Point No.[2]	Fuel Type[3]	Power	Aerosol Point No.[2]	CO_2 data[1]		Particle size distribution parameters								Particle concentration		Particle emission index			
				MissionCO_2 Diluted ARI	MissionCO_2 Undiluted_NASA	GMD[4]	GMD[4] Stdev[5]	Sigma	Sigma Stdev[5]	Mean areal diameter	Mean Volume Diameter	MMD[6]	MMD[6] Stdev[5]	Number Conc.	Mass Conc.	Number EI[7]	Number EI Stdev[5]	Mass EI[7]	Mass EI Stdev[5]
		%		ppm	ppm	(nm)	(nm)			(nm)	(nm)	(nm)	(nm)	(#/cc)	(mg/m3)	(#/kg fuel)	(#/kg fuel)	(g/kg fuel)	(g/kg fuel)
815	sulfur	4	822	1451	26928	13.66	0.16	1.44	0.01	16.55	18.99	29.31	0.64	3.53E+07	1.26E-01	2.30E+15	1.63E+14	8.25E-03	6.86E-05
	sulfur	4	823	886	26928	13.22	0.10	1.25	0.00	14.05	14.71	17.38	0.42	6.83E+08	1.14E+00	4.46E+16	1.37E+15	7.42E-02	7.93E-04
816	sulfur	100	824	1725	40880	14.50	0.67	1.71	0.06	23.69	32.08	74.20	1.15	3.55E+08	6.13E+00	1.53E+16	9.89E+14	2.64E-01	3.45E-03
817	sulfur	85	825	1639	40023	14.19	0.17	1.67	0.02	22.40	30.08	69.08	1.30	2.89E+08	4.13E+00	1.27E+16	3.40E+14	1.81E-01	1.92E-03
818	sulfur	70	826	1487	36676	12.08	0.04	1.36	0.01	14.97	19.48	49.22	2.23	4.38E+08	1.69E+00	2.10E+16	4.48E+14	8.12E-02	5.74E-04
819	sulfur	65	827	1440	33975	11.80	0.03	1.29	0.01	13.78	17.29	42.02	2.11	4.50E+08	1.22E+00	2.33E+16	4.30E+14	6.30E-02	4.44E-04
820	sulfur	60	828	1377	34963	11.55	0.02	1.23	0.01	12.69	15.05	32.60	4.25	5.15E+08	9.20E-01	2.59E+16	4.68E+14	4.62E-02	4.55E-04
821	sulfur	40	829	1202	28477	11.47	0.01	1.19	0.00	12.15	13.28	19.89	0.49	4.81E+08	5.90E-01	2.97E+16	5.68E+14	3.64E-02	2.07E-04
822	sulfur	30	830	1097	27840	11.41	0.01	1.18	0.00	11.96	12.92	18.99	4.01	4.92E+08	5.56E-01	3.10E+16	7.52E+14	3.51E-02	4.98E-04
823	sulfur	15	831	917	25012	11.57	0.04	1.17	0.00	11.97	12.50	15.38	0.58	5.13E+08	5.24E-01	3.60E+16	1.15E+15	3.68E-02	3.78E-04
824	sulfur	7	832	894	25248	12.31	0.06	1.21	0.00	12.87	13.37	15.59	0.53	6.54E+08	8.18E-01	4.56E+16	7.36E+14	5.70E-02	3.52E-04
825	sulfur	5.5	833	883	26347	12.77	0.06	1.23	0.06	13.47	14.08	16.70	0.51	6.90E+08	1.01E+00	4.60E+16	1.24E+15	6.73E-02	5.69E-04
826	sulfur	4	834	866	26647	13.08	0.12	1.25	0.00	13.93	14.69	18.05	0.61	6.50E+08	1.08E+00	4.29E+16	2.18E+15	7.12E-02	1.15E-03
827	aromatic	4	836	833	28861	12.93	0.09	1.29	0.00	14.36	16.53	31.18	3.30	4.67E+08	1.10E+00	2.84E+16	2.36E+15	6.72E-02	1.21E-03
828	aromatic	100	837	1719	43727	30.91	0.70	1.84	0.03	44.34	52.26	84.00	0.88	6.77E+07	5.06E+00	2.72E+15	5.66E+13	2.03E-01	3.87E-03
829	aromatic	85	838	1596	40633	29.09	0.74	1.81	0.02	41.26	48.72	79.49	0.82	4.97E+07	3.01E+00	2.15E+15	6.22E+13	1.30E-01	2.27E-03
830	aromatic	65	839	1414	36421	17.41	0.82	1.79	0.02	27.06	35.31	79.88	2.33	5.05E+07	1.16E+00	2.44E+15	1.25E+14	5.62E-02	1.70E-03
831	aromatic	40	840	1156	29236	12.45	0.16	1.42	0.02	16.31	22.81	74.49	5.84	7.31E+07	4.54E-01	4.39E+15	1.95E+14	2.73E-02	6.61E-04
832	aromatic	30	841	1070	28375	12.00	0.13	1.35	0.02	14.97	20.94	72.49	5.14	8.59E+07	4.13E-01	5.32E+15	3.11E+14	2.56E-02	6.11E-04
833	aromatic	7	842	801	26310	11.74	0.13	1.23	0.02	13.05	16.74	52.23	11.07	1.97E+08	4.83E-01	1.31E+16	1.28E+15	3.22E-02	4.45E-04
834	aromatic	4	843	794	26297	12.27	0.06	1.26	0.01	13.53	16.02	35.34	9.58	2.72E+08	5.86E-01	1.82E+16	2.26E+15	3.92E-02	1.34E-03
	aromatic	4	844	1929	27645	15.89	0.28	1.52	0.01	20.02	23.94	44.95	6.32	1.39E+07	1.00E-01	8.84E+14	2.76E+14	6.35E-03	2.95E-04
835	aromatic	100	845	1058	43145	31.14	0.16	1.80	0.01	43.84	51.56	83.10	1.11	5.66E+07	4.06E+00	2.30E+15	2.02E+14	1.65E-01	5.95E-03
836	aromatic	85	846	1271	40337	29.88	0.41	1.79	0.01	41.76	49.13	79.68	1.13	4.23E+07	2.62E+00	1.84E+15	1.00E+14	1.14E-01	2.96E-03
837	aromatic	65	847	1822	32315	24.82	0.33	1.72	0.01	33.95	40.79	74.06	1.93	1.43E+07	5.10E-01	7.80E+14	3.47E+13	2.77E-02	5.04E-04
838	aromatic	40	848	1960	28704	20.55	0.34	1.61	0.01	26.92	32.66	64.45	5.26	6.44E+06	1.17E-01	3.94E+14	2.14E+13	7.19E-03	1.48E-04
839	aromatic	30	849	1846	24930	19.79	0.35	1.59	0.01	25.58	30.66	57.74	7.87	4.82E+06	7.27E-02	3.40E+14	2.00E+13	5.13E-03	1.33E-04
840	aromatic	7	850	1696	25697	16.40	0.18	1.53	0.01	21.07	25.93	53.62	10.02	5.39E+06	4.92E-02	3.69E+14	8.41E+13	3.36E-03	1.44E-04
841	aromatic	4	851	1998	26082	15.51	0.16	1.49	0.01	19.18	22.50	39.37	4.77	1.71E+07	1.02E-01	1.15E+15	2.11E+14	6.85E-03	1.76E-04
	aromatic	4	852	2083	27881	16.67	0.19	1.50	0.01	20.22	22.50	30.88	0.39	1.17E+07	7.00E-02	7.41E+14	3.84E+13	4.42E-03	2.10E-05
842	aromatic	100	853	1988	43329	32.82	0.30	1.76	0.01	44.74	51.78	79.52	1.09	5.11E+07	3.71E+00	2.07E+15	1.14E+14	1.51E-01	4.44E-03
843	aromatic	85	854	1916	38708	31.82	0.30	1.75	0.01	43.18	49.92	76.66	0.94	4.15E+07	2.70E+00	1.88E+15	4.64E+13	1.23E-01	1.17E-03
844	aromatic	100	855	2169	43056	32.95	0.45	1.75	0.01	44.80	51.86	79.73	1.52	4.45E+07	3.25E+00	1.82E+15	1.96E+14	1.33E-01	8.21E-03
845	aromatic	85	856	1778	40239	31.17	0.70	1.76	0.02	42.52	49.29	76.32	0.98	4.18E+07	2.62E+00	1.83E+15	7.25E+13	1.15E-01	1.58E-03
846	aromatic	70	857	2098	33733	26.50	1.17	1.69	0.02	35.31	41.49	70.03	4.05	1.42E+07	5.32E-01	7.41E+14	8.44E+13	2.77E-02	5.66E-04
847	aromatic	65	858	1903	34262	25.09	0.33	1.67	0.01	33.12	39.06	67.88	4.18	1.07E+07	3.35E-01	5.51E+14	3.22E+13	1.72E-02	4.63E-04
848	aromatic	60	859	1749	36117	23.98	0.43	1.65	0.02	31.68	38.04	71.73	5.50	9.15E+06	2.64E-01	4.45E+14	1.71E+13	1.28E-02	3.25E-04
849	aromatic	40	860	1890	28924	21.57	0.74	1.57	0.02	26.76	30.10	44.07	7.12	5.49E+06	7.84E-02	3.34E+14	3.76E+13	4.77E-03	1.06E-04

TABLE A-10.—(Continued).

Test Point No.[2]	Fuel Type[3]	Power	Aerosol Point No.[2]	CO_2 data[1]		Particle size distribution parameters								Particle concentration		Particle emission index			
				MissionCO_2 Diluted ARI	MissionCO_2 Undiluted_NASA	GMD[4]	GMD[4] Stdev[5]	Sigma	Sigma Stdev[5]	Mean areal diameter	Mean Volume Diameter	MMD[6]	MMD[6] Stdev[5]	Number Conc.	Mass Conc.	Number EI[7]	Number EI Stdev[5]	Mass EI[7]	Mass EI Stdev[5]
		%		ppm	ppm	(nm)	(nm)			(nm)	(nm)	(nm)	(nm)	(#/cc)	(mg/m3)	(#/kg fuel)	(#/kg fuel)	(g/kg fuel)	(g/kg fuel)
850	aromatic	30	861	2563	27962	20.71	0.48	1.55	0.01	25.36	27.97	37.18	1.52	3.92E+06	4.50E-02	2.47E+14	1.97E+13	2.83E-03	1.77E-05
851	aromatic	15	862	2491	25430	18.50	0.60	1.52	0.01	22.33	24.55	32.34	0.70	2.37E+06	1.84E-02	1.64E+14	1.34E+13	1.27E-03	1.36E-05
852	aromatic	7	863	2491	25285	17.52	0.16	1.51	0.01	21.16	23.36	31.24	0.68	3.37E+06	2.25E-02	2.34E+14	1.38E+13	1.56E-03	1.01E-05
853	aromatic	5.5	864	2529	26967	17.06	0.27	1.51	0.01	20.84	23.23	32.01	0.95	5.30E+06	3.48E-02	3.46E+14	3.58E+13	2.27E-03	2.87E-05
854	aromatic	4	865	2546	27260	16.56	0.14	1.50	0.00	20.14	22.46	31.04	0.32	1.05E+07	6.21E-02	6.75E+14	2.62E+13	4.01E-03	2.01E-05
	aromatic	4	866	1542	28347	18.68	1.21	1.44	0.02	21.53	23.22	29.15	0.57	1.44E+07	9.45E-02	8.94E+14	1.04E+14	5.86E-03	3.69E-04
855	aromatic	100	867	2654	43173	33.90	1.17	1.96	0.02	50.84	59.66	93.01	1.13	2.45E+07	2.73E+00	9.99E+14	7.03E+13	1.11E-01	2.82E-03
856	aromatic	85	868	1630	37719	32.94	1.44	1.92	0.04	48.65	57.11	89.96	3.33	1.91E+07	1.86E+00	8.88E+14	8.17E+13	8.66E-02	2.23E-03
857	aromatic	65	869	2558	34427	18.87	0.29	1.62	0.01	26.07	32.52	65.88	2.36	2.25E+07	4.06E-01	1.15E+15	6.47E+13	2.07E-02	3.80E-04
858	aromatic	40	870	2519	26410	15.99	0.20	1.41	0.00	18.69	21.21	33.48	4.10	2.02E+07	1.01E-01	1.34E+15	5.15E+13	6.72E-03	9.04E-05
859	aromatic	30	871	2712	26616	16.33	0.19	1.37	0.00	18.37	19.92	26.32	0.33	2.65E+07	1.10E-01	1.75E+15	1.16E+14	7.24E-03	1.11E-04
860	aromatic	7	872	2578	24491	15.03	0.65	1.35	0.01	16.76	18.06	23.28	0.75	1.77E+07	5.46E-02	1.27E+15	2.79E+14	3.92E-03	1.95E-04
861	aromatic	4	873	2651	25259	16.39	0.54	1.40	0.01	18.66	20.25	26.42	0.55	2.29E+07	9.97E-02	1.59E+15	2.12E+14	6.94E-03	2.40E-04
	aromatic	4	901	1907	26313	18.41	0.28	1.61	0.01	23.89	27.34	40.39	1.16	4.22E+07	4.52E-01	2.82E+15	7.58E+13	3.02E-02	5.58E-04
902	aromatic	100	902	1994	43174	35.24	0.33	1.79	0.01	48.75	56.47	86.23	1.11	6.71E+07	6.32E+00	2.73E+15	1.28E+14	2.57E-01	8.82E-03
903	aromatic	85	903	1781	41638	32.86	0.34	1.80	0.01	45.83	53.30	82.53	0.76	6.10E+07	4.83E+00	2.57E+15	1.43E+14	2.04E-01	5.88E-03
904	aromatic	65	904	2045	32947	26.67	0.75	1.73	0.02	36.11	41.88	65.65	4.79	1.73E+07	6.67E-01	9.25E+14	7.18E+13	3.56E-02	1.55E-03
905	aromatic	40	905	2003	28820	21.95	0.69	1.59	0.03	27.32	30.21	40.24	1.66	7.54E+06	1.09E-01	4.60E+14	5.54E+13	6.63E-03	1.06E-04
906	aromatic	30	906	2512	24348	20.37	0.97	1.60	0.07	26.43	31.73	60.22	23.37	4.87E+06	8.15E-02	3.51E+14	6.32E+13	5.88E-03	6.04E-04
907	aromatic	7	907	2788	24221	17.01	0.58	1.48	0.03	20.18	22.08	28.77	1.18	3.93E+06	2.22E-02	2.85E+14	5.24E+13	1.61E-03	3.19E-05
908	aromatic	4	908	2767	24646	16.57	0.19	1.51	0.00	20.34	22.81	32.04	0.33	1.50E+07	9.34E-02	1.07E+15	4.21E+13	6.66E-03	2.92E-05
	aromatic	4	909	2114	25887	13.85	0.11	1.43	0.01	16.66	19.07	29.33	0.49	7.15E+07	2.60E-01	4.85E+15	4.91E+14	1.76E-02	1.28E-04
909	aromatic	100	910	1532	43470	34.32	0.35	1.82	0.00	48.41	56.55	88.34	0.50	6.50E+07	6.15E+00	2.63E+15	5.67E+14	2.49E-01	2.02E-02
910	aromatic	85	911	1642	40598	32.04	0.46	1.80	0.00	44.80	52.16	80.95	1.04	5.26E+07	3.91E+00	2.28E+15	9.59E+13	1.69E-01	3.52E-03
911	aromatic	65	912	1718	33620	26.69	0.37	1.73	0.01	36.06	41.52	62.81	1.45	2.13E+07	8.00E-01	1.12E+15	7.41E+13	4.18E-02	1.38E-03
912	aromatic	40	913	2421	28884	21.29	0.25	1.62	0.01	27.07	30.27	41.58	0.58	7.90E+06	1.15E-01	4.81E+14	2.43E+13	6.98E-03	6.71E-05
913	aromatic	30	914	2609	24336	19.61	0.42	1.61	0.01	25.04	28.12	39.03	0.49	5.63E+06	6.55E-02	4.07E+14	2.29E+13	4.73E-03	3.44E-05
914	aromatic	7	915	2122	24624	13.99	0.13	1.42	0.01	16.54	18.57	26.76	0.42	1.42E+07	4.75E-02	1.01E+15	5.32E+13	3.39E-03	2.36E-05
915	aromatic	4	916	2209	24629	13.86	0.19	1.43	0.02	16.69	19.15	29.70	0.85	6.69E+07	2.46E-01	4.77E+15	4.14E+14	1.75E-02	1.10E-04
	aromatic	4	917	1025	26521	14.09	0.16	1.29	0.01	15.29	16.24	20.07	0.31	7.32E+08	1.64E+00	4.85E+16	2.54E+15	1.09E-01	1.71E-03
916	aromatic	100	918	1755	43173	22.59	1.88	2.03	0.02	38.28	47.61	86.03	1.10	1.63E+08	9.19E+00	6.62E+15	3.76E+14	3.74E-01	1.14E-02
917	aromatic	85	919	1617	40731	23.09	0.43	1.99	0.01	37.62	46.08	80.44	1.00	1.06E+08	5.41E+00	4.56E+15	1.53E+14	2.34E-01	5.65E-03
918	aromatic	70	920	1481	33868	15.52	0.25	1.74	0.02	24.28	31.25	63.79	1.07	1.15E+08	1.84E+00	5.98E+15	1.80E+14	9.56E-02	1.86E-03
919	aromatic	65	921	1439	33995	14.32	0.37	1.64	0.03	21.15	27.15	55.96	1.72	1.25E+08	1.31E+00	6.47E+15	1.33E+14	6.78E-02	1.72E-03
920	aromatic	60	922	1368	30732	13.00	0.10	1.48	0.02	17.30	21.82	44.55	1.92	1.19E+08	6.49E-01	6.83E+15	2.01E+14	3.71E-02	7.79E-04
921	aromatic	40	923	1174	28973	11.96	0.07	1.33	0.01	13.98	16.39	28.48	0.82	1.28E+08	2.96E-01	7.78E+15	2.49E+14	1.79E-02	2.71E-04
922	aromatic	30	924	1027	24622	11.69	0.02	1.28	0.01	13.17	15.04	24.45	0.83	1.08E+08	1.93E-01	7.74E+15	3.54E+14	1.38E-02	3.32E-04
923	aromatic	15	925	886	24312	11.44	0.05	1.17	0.00	11.80	12.10	13.30	0.19	2.75E+08	2.55E-01	1.98E+16	1.30E+15	1.84E-02	4.47E-04

TABLE A-10.—(Continued).

Test Point No.[2]	Fuel Type[3]	Power	Aerosol Point No.[2]	CO_2 data[1] MissionCO$_2$ Diluted ARI	MissionCO$_2$ Undiluted_NASA	Particle size distribution parameters GMD[4]	GMD[4] Stdev[5]	Sigma	Sigma Stdev[5]	Mean areal diameter	Mean Volume Diameter	MMD[6]	MMD[6] Stdev[5]	Particle concentration Number Conc.	Mass Conc.	Particle emission index Number EI[7]	Number EI Stdev[5]	Mass EI[7]	Mass EI Stdev[5]
		%		ppm	ppm	(nm)	(nm)			(nm)	(nm)	(nm)	(nm)	(#/cc)	(mg/m3)	(#/kg fuel)	(#/kg fuel)	(g/kg fuel)	(g/kg fuel)
924	aromatic	7	926	998	23771	12.33	0.06	1.22	0.00	12.93	13.41	15.37	0.10	5.45E+08	6.88E-01	4.03E+16	1.38E+15	5.09E-02	5.53E-04
925	aromatic	5.5	927	977	25749	12.72	0.06	1.24	0.00	13.52	14.23	17.20	0.11	6.45E+08	9.73E-01	4.40E+16	1.33E+15	6.64E-02	6.37E-04
926	aromatic	4	928	982	26800	13.56	0.10	1.28	0.00	14.61	15.49	19.11	0.21	7.65E+08	1.49E+00	5.02E+16	1.49E+15	9.76E-02	1.00E-03
	aromatic	4	929	2116	26800	21.89	0.65	1.54	0.02	26.71	29.50	39.37	0.89	9.80E+06	1.32E-01	6.42E+14	7.28E+13	8.63E-03	2.47E-04
927	aromatic	100	930	1920	43049	51.09	1.66	1.59	0.00	63.36	70.31	95.39	2.35	2.11E+07	3.83E+00	8.59E+14	6.44E+13	1.56E-01	1.11E-02
928	aromatic	85	931	1944	39431	45.87	0.75	1.60	0.01	57.38	64.07	88.71	1.40	1.50E+07	2.06E+00	6.68E+14	7.88E+13	9.20E-02	6.92E-03
929	aromatic	65	932	2537	33285	34.16	0.40	1.53	0.01	41.15	45.01	58.42	1.18	4.33E+06	2.07E-01	2.29E+14	2.06E+13	1.09E-02	5.97E-04
930	aromatic	40	933	2911	29545	29.01	0.36	1.49	0.02	34.05	36.75	45.90	0.56	3.52E+06	9.14E-02	2.09E+14	2.21E+13	5.44E-03	2.08E-04
931	aromatic	30	934	3420	24537	27.91	0.55	1.51	0.01	33.05	35.78	45.03	0.33	3.20E+06	7.68E-02	2.29E+14	2.67E+13	5.50E-03	1.66E-04
932	aromatic	7	935	2863	24760	17.39	1.68	1.45	0.03	20.11	21.62	26.65	1.52	1.33E+06	7.05E-03	9.46E+13	3.70E+13	5.00E-04	1.52E-05
933	aromatic	4	936	2873	24706	20.45	0.69	1.55	0.02	25.32	28.30	39.28	1.98	1.72E+07	2.04E-01	1.23E+15	2.48E+14	1.45E-02	1.06E-03
934	sulfur	7	937	737	28550	12.50	0.51	1.27	0.04	13.74	15.69	28.86	8.34	2.98E+08	6.02E-01	1.83E+16	3.73E+15	3.70E-02	2.87E-03
	sulfur	7	939		28550	17.99	0.22	1.46	0.01	21.12	23.29	32.15	1.95						
937	sulfur	75	941	1317	42142	15.69	0.57	1.78	0.03	25.43	33.33	71.40	1.65	1.63E+08	3.15E+00	6.78E+15	4.56E+14	1.31E-01	3.29E-03
938	sulfur	30	942	852	25445	11.44	0.02	1.23	0.01	12.61	15.21	36.49	6.34	1.75E+08	3.22E-01	1.21E+16	6.60E+14	2.23E-02	4.86E-04
	sulfur	7	944	2188	26208	19.48	0.37	1.45	0.01	22.45	24.37	32.23	2.29	2.11E+07	1.60E-01	1.41E+15	9.65E+13	1.07E-02	1.90E-04
	sulfur	7	945	2532	26208	18.24	0.36	1.55	0.01	22.89	26.47	43.50	7.27	6.62E+06	6.43E-02	4.44E+14	2.99E+13	4.31E-03	1.34E-04
	sulfur	7	946	1838	26208	14.79	0.33	1.50	0.02	18.61	22.27	41.81	6.97	1.59E+07	9.20E-02	1.07E+15	1.03E+14	6.17E-03	1.37E-04
	sulfur	7	947	632	26208	12.16	0.10	1.22	0.00	12.90	14.00	21.16	4.48	4.96E+08	7.13E-01	3.33E+16	3.42E+15	4.78E-02	1.30E-03
	sulfur	7	948	8509	26208	15.42	0.11	1.40	0.00	17.77	19.65	27.82	1.14	2.86E+07	1.13E-01	1.92E+15	8.25E+13	7.60E-03	6.73E-05
940	sulfur	100	950	2296		43.17	4.25	1.70	0.04	56.50	63.88	91.12	4.08						
941	sulfur	85	951	2874	40044	46.44	0.48	1.64	0.01	58.72	65.44	89.70	0.79	2.00E+07	2.94E+00	8.79E+14	6.03E+13	1.29E-01	3.40E-03
942	sulfur	30	952	2446	25453	15.60	0.21	1.44	0.01	18.61	21.41	35.26	3.51	1.87E+07	9.62E-02	1.29E+15	8.05E+13	6.64E-03	9.03E-05
943	sulfur	7	953	2593	26319	16.53	0.16	1.44	0.00	19.30	21.51	31.72	4.05	2.27E+07	1.18E-01	1.51E+15	6.13E+13	7.88E-03	1.20E-04
	sulfur	7	954	2352	26319	18.27	0.20	1.55	0.01	22.85	26.24	41.76	6.23	7.88E+06	7.46E-02	5.26E+14	3.18E+13	4.98E-03	9.49E-05
	sulfur	7	955	1598	26319	16.00	0.33	1.54	0.01	20.39	24.32	44.96	8.58	1.43E+07	1.08E-01	9.54E+14	1.42E+14	7.19E-03	1.38E-04
	sulfur	7	957	2735	26319	18.33	0.20	1.56	0.01	22.92	26.14	40.24	5.93	8.65E+06	8.09E-02	5.78E+14	4.24E+13	5.40E-03	1.22E-04
944	sulfur	100	958	2115	42437	33.50	0.47	1.78	0.01	46.18	53.55	82.50	1.12	4.36E+07	3.50E+00	1.81E+15	1.35E+14	1.45E-01	5.88E-03
945	sulfur	85	959	1702	40603	32.15	0.46	1.77	0.00	44.01	50.94	78.26	1.31	4.68E+07	3.24E+00	2.03E+15	8.93E+13	1.40E-01	1.60E-03
946	sulfur	30	960	2870	26309	20.35	0.28	1.59	0.01	25.70	29.26	44.71	7.09	4.42E+06	5.81E-02	2.96E+14	1.79E+13	3.88E-03	7.52E-05
947	sulfur	7	961	2813	26670	18.02	0.21	1.54	0.01	22.33	25.43	39.13	5.32	8.21E+06	7.07E-02	5.41E+14	4.38E+13	4.66E-03	8.36E-05
	sulfur	7	962	1590	26670	16.16	0.36	1.54	0.01	20.64	24.43	43.21	7.19	1.52E+07	1.16E-01	1.00E+15	2.54E+14	7.67E-03	2.38E-04
	sulfur	7	963	563	26670	11.94	0.07	1.24	0.02	13.13	15.79	37.85	10.37	2.81E+08	5.78E-01	1.85E+16	2.06E+15	3.81E-02	8.49E-04
948	sulfur	100	964	1505	41323	18.50	1.39	1.97	0.04	32.69	42.24	84.19	1.19	1.99E+08	7.84E+00	8.45E+15	5.04E+14	3.33E-01	9.24E-03
949	sulfur	85	965	1415	39521	21.62	0.95	1.98	0.01	35.68	44.30	80.56	1.03	1.05E+08	4.76E+00	4.65E+15	1.98E+14	2.12E-01	3.99E-03
950	sulfur	30	966	803	25495	11.42	0.01	1.23	0.01	12.64	15.45	39.09	6.00	1.64E+08	3.16E-01	1.13E+16	4.61E+14	2.18E-02	5.95E-04
951	sulfur	7	967	568	25840	11.97	0.11	1.22	0.01	12.72	13.93	21.89	9.12	3.46E+08	4.89E-01	2.35E+16	4.35E+15	3.33E-02	1.52E-03

TABLE A-10.—(Concluded).

Test Point No.[2]	Fuel Type[3]	Power	Aerosol Point No.[2]	CO_2 data[1]		Particle size distribution parameters								Particle concentration		Particle emission index			
				MissionCO_2 Diluted ARI	MissionCO_2 Undiluted_NASA	GMD[4]	GMD[4] Stdev[5]	Sigma	Sigma Stdev[5]	Mean areal diameter	Mean Volume Diameter	MMD[6]	MMD[6] Stdev[5]	Number Conc.	Mass Conc.	Number EI[7]	Number EI Stdev[5]	Mass EI[7]	Mass EI Stdev[5]
		%		ppm	ppm	(nm)	(nm)			(nm)	(nm)	(nm)	(nm)	(#/cc)	(mg/m3)	(#/kg fuel)	(#/kg fuel)	(g/kg fuel)	(g/kg fuel)
	base	85	524	4886	40457	34.00	0.37	1.72	0.01	45.29	51.77	76.47	0.97	3.85E+07	2.80E+00	1.67E+00	3.31E-01	1.22E-01	6.77E-03
	base	30	670	1054		14.37	0.72	1.51	0.06	18.82	23.56	50.43	12.96						
	base	4	671	914		13.24	0.32	1.30	0.02	14.48	15.67	21.21	1.48						
	base	40	672	1283		13.81	0.50	1.43	0.04	17.20	21.53	48.70	5.89						
	base	40	673	2828		23.14	0.52	1.64	0.01	30.04	34.65	54.91	5.25						
	base	40	674	3210		20.20	1.22	1.68	0.02	27.37	32.59	57.48	6.05						
	base	4	675	2423		15.54	0.14	1.46	0.01	18.73	21.48	34.47	2.86						

Note:

1. Diluted and undiluted CO_2 concentrations were used to calculate the exhaust dilution factor.
2. The test point No. defines the sequential engine testing conditions while the aerosol point number defines each aerosol measurement condition. Both of them are combinations of the last digit in the date between April 20 and 29 and a sequence number of point for that day. If the test point number is 305, the test point was for the 5th test point on April 23.
3. Three types of fuel were used: base for base JP-8 fuel, aromatic for high aromatic fuel, and sulfur for base fuel with sulfur additive.
4. Number based geometric mean diameter.
5. One standard deviation.
6. Mass based geometric mean diameter.
7. Emission index.

TABLE A-11.—UMR PARTICLE SIZE DISTRIBUTION DATA MEASURED USING THE DMS500 FROM THE EXHAUST OF AIRCRAFT CFM56-2-C1 ENGINE DURING APEX.

Test Point No.	301	301	301	301	301	301	301	301	302	302
Date	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	7	7	7	7	7	7	7	7	30	30
Aerosol Point No.	301	302	303	304	305	306	307	308	309	310
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	1.83E+15	1.35E+15	1.35E+15	1.63E+15	2.60E+15	3.31E+15	8.32E+15	5.02E+14	8.46E+14	1.24E+15
11.5	2.56E+15	1.82E+15	1.75E+15	2.12E+15	3.04E+15	3.65E+15	1.04E+16	5.58E+14	1.22E+15	1.66E+15
13.3	2.15E+15	1.41E+15	1.28E+15	1.53E+15	1.87E+15	2.00E+15	5.34E+15	3.51E+14	1.12E+15	1.35E+15
15.4	1.99E+15	1.25E+15	1.07E+15	1.27E+15	1.47E+15	1.47E+15	3.32E+15	1.49E+14	1.10E+15	1.25E+15
17.8	1.84E+15	1.11E+15	9.14E+14	1.08E+15	1.21E+15	1.17E+15	2.09E+15	3.87E+13	1.08E+15	1.17E+15
20.5	1.71E+15	1.01E+15	7.93E+14	9.29E+14	1.01E+15	9.73E+14	1.30E+15	2.45E+13	1.10E+15	1.13E+15
23.7	1.62E+15	9.38E+14	7.07E+14	8.21E+14	8.72E+14	8.36E+14	8.80E+14	3.71E+13	1.19E+15	1.14E+15
27.4	1.52E+15	8.70E+14	6.28E+14	7.24E+14	7.54E+14	7.23E+14	6.94E+14	7.60E+13	1.25E+15	1.14E+15
31.6	1.31E+15	7.50E+14	5.19E+14	5.94E+14	6.12E+14	5.87E+14	5.65E+14	8.18E+13	1.19E+15	1.04E+15
36.5	1.04E+15	5.92E+14	3.91E+14	4.46E+14	4.56E+14	4.39E+14	4.34E+14	7.41E+13	1.02E+15	8.71E+14
42.2	7.56E+14	4.32E+14	2.73E+14	3.08E+14	3.15E+14	3.04E+14	3.15E+14	6.68E+13	7.95E+14	6.68E+14
48.7	4.98E+14	2.86E+14	1.72E+14	1.92E+14	1.96E+14	1.91E+14	2.07E+14	4.96E+13	5.60E+14	4.66E+14
56.2	2.92E+14	1.71E+14	9.65E+13	1.06E+14	1.10E+14	1.07E+14	1.21E+14	3.96E+13	3.52E+14	2.91E+14
64.9	1.53E+14	9.42E+13	5.20E+13	5.50E+13	5.83E+13	5.69E+13	6.79E+13	4.69E+13	1.96E+14	1.63E+14
75.0	7.14E+13	4.98E+13	2.96E+13	2.96E+13	3.25E+13	3.13E+13	4.16E+13	5.42E+13	9.49E+13	8.05E+13
86.6	2.95E+13	2.53E+13	1.77E+13	1.70E+13	1.90E+13	1.80E+13	2.72E+13	4.92E+13	3.82E+13	3.36E+13
100.0	9.64E+12	1.07E+13	9.05E+12	8.47E+12	9.50E+12	8.95E+12	1.56E+13	3.01E+13	1.10E+13	1.04E+13
115.0	1.76E+12	2.58E+12	2.72E+12	2.46E+12	2.80E+12	2.67E+12	5.89E+12	1.02E+13	1.64E+12	1.69E+12
133.0	0.00E+00	7.70E+10	2.35E+11	1.82E+11	2.30E+11	2.43E+11	9.12E+11	1.21E+12	0.00E+00	0.00E+00
154.0	2.70E+11	2.24E+11	2.93E+11	1.58E+11	4.41E+11	3.35E+11	6.83E+11	2.50E+12	3.81E+11	8.94E+10
178.0	1.59E+12	1.62E+12	1.74E+12	1.65E+12	2.15E+12	1.85E+12	3.09E+12	9.03E+12	1.75E+12	1.08E+12
205.0	3.05E+12	3.13E+12	3.26E+12	3.50E+12	3.81E+12	3.46E+12	5.55E+12	1.30E+13	3.12E+12	2.26E+12
237.0	3.30E+12	3.29E+12	3.41E+12	3.96E+12	3.92E+12	3.71E+12	5.88E+12	1.16E+13	3.37E+12	2.54E+12

Note:

1. PARTICLE SIZE DISTRIBUTION DATA ARE REPORTED AS PARTICLE NUMBER EMISSION INDEX (EIN) IN EACH CHANNEL IN THE FORM OF D(EIN)/DLOGDP.

TABLE A-11.—(Continued).

Test Point No.	302	302	302	302	302	302	302	302	303	303
Date	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	30	30	30	30	30	30	30	30	40	40
Aerosol Point No.	312	313	314	315	316	317	318	319	321	322
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	1.00E+15	1.03E+15	1.33E+15	1.73E+15	3.21E+15	1.42E+15	5.73E+14	1.96E+16	6.48E+14	6.90E+14
11.5	1.38E+15	1.41E+15	1.58E+15	2.04E+15	2.94E+15	1.61E+15	9.48E+14	8.87E+15	9.55E+14	9.73E+14
13.3	1.34E+15	1.39E+15	1.31E+15	1.65E+15	1.75E+15	1.29E+15	8.73E+14	2.30E+15	1.04E+15	1.03E+15
15.4	1.38E+15	1.43E+15	1.22E+15	1.49E+15	1.51E+15	1.18E+15	8.65E+14	1.30E+15	1.11E+15	1.08E+15
17.8	1.40E+15	1.46E+15	1.16E+15	1.37E+15	1.38E+15	1.11E+15	8.59E+14	1.11E+15	1.14E+15	1.10E+15
20.5	1.46E+15	1.52E+15	1.12E+15	1.27E+15	1.29E+15	1.08E+15	8.64E+14	1.03E+15	1.20E+15	1.15E+15
23.7	1.56E+15	1.63E+15	1.10E+15	1.20E+15	1.24E+15	1.07E+15	8.88E+14	9.55E+14	1.31E+15	1.25E+15
27.4	1.60E+15	1.68E+15	1.05E+15	1.12E+15	1.17E+15	1.02E+15	8.86E+14	8.59E+14	1.39E+15	1.32E+15
31.6	1.50E+15	1.58E+15	9.21E+14	9.62E+14	1.03E+15	8.99E+14	8.08E+14	7.08E+14	1.34E+15	1.27E+15
36.5	1.28E+15	1.35E+15	7.38E+14	7.64E+14	8.24E+14	7.22E+14	6.65E+14	5.41E+14	1.17E+15	1.11E+15
42.2	1.00E+15	1.05E+15	5.43E+14	5.59E+14	6.09E+14	5.32E+14	4.99E+14	3.82E+14	9.40E+14	8.86E+14
48.7	7.12E+14	7.45E+14	3.60E+14	3.71E+14	4.07E+14	3.54E+14	3.38E+14	2.45E+14	6.88E+14	6.45E+14
56.2	4.53E+14	4.73E+14	2.12E+14	2.20E+14	2.42E+14	2.09E+14	2.02E+14	1.43E+14	4.53E+14	4.23E+14
64.9	2.54E+14	2.65E+14	1.08E+14	1.14E+14	1.26E+14	1.07E+14	1.04E+14	7.59E+13	2.65E+14	2.45E+14
75.0	1.22E+14	1.26E+14	4.60E+13	5.02E+13	5.49E+13	4.54E+13	4.40E+13	3.64E+13	1.34E+14	1.23E+14
86.6	4.64E+13	4.83E+13	1.46E+13	1.72E+13	1.82E+13	1.42E+13	1.38E+13	1.49E+13	5.52E+13	4.97E+13
100.0	1.19E+13	1.25E+13	2.54E+12	3.68E+12	3.50E+12	2.37E+12	2.36E+12	4.39E+12	1.62E+13	1.42E+13
115.0	1.48E+12	1.59E+12	9.96E+10	3.28E+11	2.21E+11	7.40E+10	2.02E+10	6.49E+11	2.37E+12	2.03E+12
133.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.44E+09	0.00E+00	0.00E+00	2.42E+10	0.00E+00	1.58E+10
154.0	6.67E+10	6.96E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.58E+11	7.72E+10
178.0	1.31E+11	1.25E+11	0.00E+00	2.25E+09	0.00E+00	0.00E+00	0.00E+00	4.40E+10	4.33E+11	3.16E+11
205.0	1.35E+11	1.05E+11	0.00E+00	1.09E+09	7.78E+09	0.00E+00	0.00E+00	6.63E+10	6.42E+11	4.77E+11
237.0	1.16E+11	6.24E+10	0.00E+00	0.00E+00	2.44E+10	0.00E+00	0.00E+00	4.05E+10	9.17E+11	6.11E+11

TABLE A-11.—(Continued).

Test Point No.	303	303	303	303	303	303	304	304	304	305
Date	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	40	40	40	40	40	40	30	30	30	7
Aerosol Point No.	323	324	325	326	327	328	329	330	331	332
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	1.17E+15	1.09E+15	1.48E+15	1.03E+15	4.04E+14	4.27E+15	3.42E+15	4.17E+14	6.52E+14	5.45E+14
11.5	1.33E+15	1.27E+15	1.57E+15	1.20E+15	6.80E+14	2.85E+15	2.13E+15	7.15E+14	8.89E+14	7.30E+14
13.3	1.13E+15	1.08E+15	1.24E+15	1.05E+15	6.67E+14	1.28E+15	9.39E+14	6.98E+14	8.98E+14	5.98E+14
15.4	1.07E+15	1.03E+15	1.14E+15	9.96E+14	6.82E+14	7.78E+14	6.66E+14	7.22E+14	9.24E+14	5.32E+14
17.8	1.01E+15	9.76E+14	1.05E+15	9.45E+14	6.81E+14	6.43E+14	6.03E+14	7.29E+14	9.26E+14	4.60E+14
20.5	9.87E+14	9.38E+14	9.87E+14	9.07E+14	6.81E+14	6.03E+14	5.51E+14	7.32E+14	9.33E+14	3.86E+14
23.7	9.95E+14	9.21E+14	9.58E+14	8.91E+14	6.98E+14	5.80E+14	5.00E+14	7.42E+14	9.59E+14	3.20E+14
27.4	9.79E+14	8.82E+14	9.18E+14	8.55E+14	7.00E+14	5.33E+14	4.40E+14	7.31E+14	9.56E+14	2.60E+14
31.6	8.81E+14	7.74E+14	8.13E+14	7.55E+14	6.43E+14	4.48E+14	3.58E+14	6.60E+14	8.69E+14	1.96E+14
36.5	7.24E+14	6.23E+14	6.60E+14	6.10E+14	5.35E+14	3.49E+14	2.71E+14	5.39E+14	7.20E+14	1.35E+14
42.2	5.46E+14	4.61E+14	4.94E+14	4.54E+14	4.07E+14	2.52E+14	1.92E+14	4.03E+14	5.45E+14	8.45E+13
48.7	3.73E+14	3.09E+14	3.35E+14	3.06E+14	2.80E+14	1.66E+14	1.23E+14	2.72E+14	3.74E+14	4.63E+13
56.2	2.27E+14	1.86E+14	2.03E+14	1.84E+14	1.71E+14	1.01E+14	7.29E+13	1.62E+14	2.28E+14	2.15E+13
64.9	1.22E+14	9.93E+13	1.09E+14	9.76E+13	9.15E+13	5.73E+13	4.01E+13	8.40E+13	1.21E+14	9.12E+12
75.0	5.62E+13	4.61E+13	5.09E+13	4.45E+13	4.16E+13	3.02E+13	2.06E+13	3.68E+13	5.43E+13	4.36E+12
86.6	2.07E+13	1.76E+13	1.94E+13	1.62E+13	1.50E+13	1.43E+13	9.52E+12	1.27E+13	1.88E+13	2.55E+12
100.0	5.08E+12	4.65E+12	5.15E+12	3.90E+12	3.41E+12	5.33E+12	3.44E+12	2.83E+12	3.96E+12	1.27E+12
115.0	6.00E+11	5.99E+11	6.74E+11	4.35E+11	2.67E+11	1.22E+12	8.20E+11	2.74E+11	3.28E+11	3.31E+11
133.0	3.92E+09	1.61E+10	0.00E+00	0.00E+00	0.00E+00	1.73E+11	2.37E+11	2.04E+10	0.00E+00	1.78E+10
154.0	1.34E+11	1.18E+11	9.45E+10	2.86E+10	1.04E+11	2.77E+11	6.34E+11	6.85E+10	1.20E+11	3.20E+10
178.0	3.73E+11	4.38E+11	2.99E+11	2.20E+11	3.41E+11	7.96E+11	1.10E+12	2.86E+11	3.58E+11	1.41E+11
205.0	5.81E+11	8.75E+11	5.92E+11	4.86E+11	5.41E+11	1.18E+12	1.08E+12	5.15E+11	5.24E+11	2.20E+11
237.0	7.69E+11	1.28E+12	9.86E+11	8.15E+11	6.34E+11	1.35E+12	7.68E+11	6.07E+11	5.98E+11	1.67E+11

TABLE A-11.—(Continued).

Test Point No.	305	305	305	305	305	306	306	306	306	307
Date	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	7	7	7	7	7	7	7	7	7	30
Aerosol Point No.	333	334	335	336	337	339	340	341	342	343
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	4.41E+15	2.79E+16	6.58E+14	4.57E+14	3.21E+14	1.06E+15	1.88E+15	1.69E+15	1.33E+15	7.49E+14
11.5	5.57E+15	3.24E+16	7.35E+14	6.84E+14	6.87E+14	1.30E+15	2.37E+15	1.88E+15	1.80E+15	1.12E+15
13.3	2.89E+15	2.66E+16	6.14E+14	5.53E+14	5.74E+14	1.07E+15	2.04E+15	1.39E+15	1.29E+15	1.22E+15
15.4	1.85E+15	1.91E+16	5.58E+14	4.99E+14	5.48E+14	9.85E+14	1.94E+15	1.22E+15	1.11E+15	1.32E+15
17.8	1.24E+15	1.17E+16	4.93E+14	4.43E+14	5.16E+14	9.05E+14	1.82E+15	1.08E+15	9.78E+14	1.38E+15
20.5	8.54E+14	6.00E+15	4.28E+14	3.83E+14	4.74E+14	8.23E+14	1.70E+15	9.60E+14	8.63E+14	1.46E+15
23.7	6.16E+14	2.62E+15	3.71E+14	3.27E+14	4.29E+14	7.40E+14	1.55E+15	8.48E+14	7.63E+14	1.59E+15
27.4	4.75E+14	1.09E+15	3.14E+14	2.73E+14	3.79E+14	6.42E+14	1.36E+15	7.29E+14	6.62E+14	1.67E+15
31.6	3.61E+14	4.35E+14	2.44E+14	2.13E+14	3.13E+14	5.15E+14	1.10E+15	5.85E+14	5.37E+14	1.59E+15
36.5	2.57E+14	2.00E+14	1.75E+14	1.53E+14	2.36E+14	3.79E+14	8.15E+14	4.32E+14	3.98E+14	1.37E+15
42.2	1.71E+14	1.29E+14	1.16E+14	1.01E+14	1.63E+14	2.54E+14	5.49E+14	2.94E+14	2.71E+14	1.09E+15
48.7	1.02E+14	8.77E+13	6.90E+13	5.95E+13	1.02E+14	1.52E+14	3.29E+14	1.79E+14	1.65E+14	7.83E+14
56.2	5.33E+13	5.11E+13	3.76E+13	3.08E+13	5.54E+13	7.85E+13	1.69E+14	9.54E+13	8.77E+13	5.06E+14
64.9	2.52E+13	2.50E+13	2.08E+13	1.46E+13	2.61E+13	3.36E+13	7.16E+13	4.33E+13	4.01E+13	2.91E+14
75.0	1.17E+13	1.10E+13	1.24E+13	6.78E+12	1.07E+13	1.13E+13	2.25E+13	1.62E+13	1.63E+13	1.45E+14
86.6	5.76E+12	5.04E+12	7.28E+12	3.21E+12	3.88E+12	2.96E+12	4.15E+12	5.18E+12	6.90E+12	6.05E+13
100.0	2.60E+12	2.28E+12	3.27E+12	1.30E+12	1.19E+12	1.20E+12	4.64E+11	2.15E+12	4.04E+12	1.97E+13
115.0	7.90E+11	9.06E+11	7.86E+11	3.04E+11	2.32E+11	1.43E+12	8.56E+11	1.89E+12	3.12E+12	4.70E+12
133.0	1.26E+11	5.22E+11	5.93E+10	1.34E+10	0.00E+00	1.63E+12	1.37E+12	1.91E+12	2.38E+12	1.14E+12
154.0	1.92E+11	7.37E+11	0.00E+00	5.32E+10	1.72E+10	1.35E+12	1.24E+12	1.51E+12	1.66E+12	9.40E+11
178.0	5.04E+11	1.09E+12	2.55E+11	2.43E+11	1.10E+11	9.02E+11	7.62E+11	9.18E+11	1.12E+12	9.78E+11
205.0	6.39E+11	1.07E+12	4.25E+11	4.09E+11	2.24E+11	5.96E+11	3.94E+11	4.82E+11	8.05E+11	8.60E+11
237.0	4.36E+11	7.10E+11	3.49E+11	3.82E+11	2.19E+11	4.36E+11	1.65E+11	2.88E+11	6.19E+11	7.96E+11

TABLE A-11.—(Continued).

Test Point No.	307	307	307	307	307	307	307	308	308	308
Date	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	30	30	30	30	30	30	30	40	40	40
Aerosol Point No.	344	345	346	347	348	349	350	351	352	353
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	8.40E+14	6.12E+14	1.46E+15	1.69E+15	3.23E+15	1.25E+15	8.41E+15	5.09E+15	5.28E+14	5.07E+14
11.5	1.17E+15	7.91E+14	1.59E+15	1.68E+15	3.11E+15	1.75E+15	6.40E+15	3.39E+15	8.24E+14	7.49E+14
13.3	1.22E+15	7.67E+14	1.25E+15	1.21E+15	2.22E+15	1.27E+15	3.47E+15	1.61E+15	7.29E+14	8.44E+14
15.4	1.29E+15	7.75E+14	1.11E+15	1.07E+15	1.95E+15	1.07E+15	1.99E+15	1.01E+15	7.09E+14	9.14E+14
17.8	1.33E+15	7.76E+14	1.01E+15	9.78E+14	1.81E+15	9.11E+14	1.23E+15	8.22E+14	6.97E+14	9.60E+14
20.5	1.39E+15	7.80E+14	9.39E+14	9.19E+14	1.71E+15	7.87E+14	8.45E+14	7.64E+14	7.04E+14	1.03E+15
23.7	1.47E+15	7.92E+14	8.88E+14	8.83E+14	1.57E+15	7.16E+14	6.51E+14	7.36E+14	7.40E+14	1.15E+15
27.4	1.50E+15	7.72E+14	8.20E+14	8.27E+14	1.38E+15	6.67E+14	5.35E+14	6.84E+14	7.62E+14	1.23E+15
31.6	1.39E+15	6.85E+14	6.98E+14	7.13E+14	1.10E+15	5.87E+14	4.27E+14	5.86E+14	7.18E+14	1.19E+15
36.5	1.17E+15	5.52E+14	5.43E+14	5.63E+14	8.00E+14	4.74E+14	3.22E+14	4.65E+14	6.11E+14	1.04E+15
42.2	8.96E+14	4.07E+14	3.88E+14	4.08E+14	5.33E+14	3.52E+14	2.26E+14	3.42E+14	4.75E+14	8.34E+14
48.7	6.24E+14	2.71E+14	2.49E+14	2.67E+14	3.17E+14	2.36E+14	1.44E+14	2.31E+14	3.35E+14	6.11E+14
56.2	3.89E+14	1.59E+14	1.41E+14	1.54E+14	1.66E+14	1.39E+14	8.17E+13	1.42E+14	2.11E+14	4.05E+14
64.9	2.14E+14	8.14E+13	6.95E+13	7.79E+13	7.60E+13	7.14E+13	4.18E+13	8.06E+13	1.18E+14	2.41E+14
75.0	1.01E+14	3.51E+13	2.89E+13	3.39E+13	3.10E+13	3.09E+13	1.99E+13	4.22E+13	5.70E+13	1.27E+14
86.6	3.87E+13	1.21E+13	9.90E+12	1.26E+13	1.16E+13	1.10E+13	9.81E+12	2.07E+13	2.33E+13	5.82E+13
100.0	1.09E+13	3.09E+12	3.05E+12	4.26E+12	4.54E+12	3.41E+12	5.81E+12	9.74E+12	7.54E+12	2.19E+13
115.0	1.95E+12	8.88E+11	1.40E+12	1.69E+12	2.49E+12	1.39E+12	4.01E+12	4.46E+12	1.80E+12	6.26E+12
133.0	4.63E+11	7.77E+11	1.11E+12	9.68E+11	1.68E+12	9.95E+11	2.60E+12	1.83E+12	3.24E+11	1.10E+12
154.0	6.59E+11	7.64E+11	8.46E+11	6.05E+11	1.01E+12	7.10E+11	1.38E+12	5.64E+11	1.39E+11	9.47E+10
178.0	7.11E+11	5.25E+11	5.07E+11	3.33E+11	5.32E+11	3.90E+11	6.30E+11	1.97E+11	1.19E+11	4.99E+10
205.0	5.43E+11	2.84E+11	3.31E+11	2.17E+11	4.12E+11	2.28E+11	3.75E+11	4.03E+11	1.84E+11	4.91E+11
237.0	4.22E+11	2.18E+11	3.59E+11	2.36E+11	4.92E+11	2.25E+11	2.84E+11	9.91E+11	4.63E+11	1.70E+12

TABLE A-11.—(Continued).

Test Point No.	308b	308b	308b	308b	308b	309	309	309	310	310
Date	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004	4/23/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	40	40	40	40	40	30	30	30	7	7
Aerosol Point No.	354	355	356	357	358	359	360	361	362	363
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	5.56E+14	6.37E+14	1.24E+15	3.16E+15	2.89E+15	4.38E+14	1.04E+15	3.52E+15	5.11E+16	1.37E+15
11.5	8.19E+14	8.56E+14	1.41E+15	2.76E+15	2.56E+15	5.97E+14	1.55E+15	2.05E+15	4.87E+16	1.86E+15
13.3	9.25E+14	9.08E+14	1.24E+15	1.82E+15	1.70E+15	6.22E+14	1.17E+15	8.76E+14	3.07E+16	1.22E+15
15.4	9.94E+14	9.51E+14	1.17E+15	1.48E+15	1.36E+15	6.31E+14	9.88E+14	6.46E+14	1.60E+16	9.58E+14
17.8	1.03E+15	9.70E+14	1.09E+15	1.23E+15	1.14E+15	6.13E+14	8.40E+14	6.06E+14	6.90E+15	7.89E+14
20.5	1.09E+15	1.01E+15	1.04E+15	1.05E+15	1.02E+15	5.92E+14	7.29E+14	5.61E+14	2.49E+15	6.65E+14
23.7	1.21E+15	1.08E+15	1.03E+15	9.63E+14	9.69E+14	5.81E+14	6.68E+14	5.16E+14	8.66E+14	5.69E+14
27.4	1.28E+15	1.12E+15	1.00E+15	9.09E+14	9.28E+14	5.51E+14	6.26E+14	4.59E+14	4.92E+14	4.80E+14
31.6	1.23E+15	1.05E+15	8.94E+14	8.04E+14	8.26E+14	4.73E+14	5.49E+14	3.73E+14	3.91E+14	3.77E+14
36.5	1.08E+15	9.00E+14	7.33E+14	6.60E+14	6.78E+14	3.68E+14	4.38E+14	2.79E+14	3.36E+14	2.70E+14
42.2	8.63E+14	7.06E+14	5.53E+14	5.01E+14	5.14E+14	2.59E+14	3.20E+14	1.92E+14	2.56E+14	1.76E+14
48.7	6.30E+14	5.05E+14	3.79E+14	3.46E+14	3.55E+14	1.61E+14	2.09E+14	1.18E+14	1.45E+14	1.01E+14
56.2	4.16E+14	3.25E+14	2.34E+14	2.16E+14	2.21E+14	8.55E+13	1.18E+14	6.41E+13	5.59E+13	4.86E+13
64.9	2.45E+14	1.86E+14	1.28E+14	1.21E+14	1.24E+14	3.72E+13	5.68E+13	3.06E+13	1.11E+13	1.89E+13
75.0	1.26E+14	9.29E+13	6.21E+13	5.99E+13	6.15E+13	1.19E+13	2.19E+13	1.29E+13	8.16E+11	5.54E+12
86.6	5.50E+13	3.88E+13	2.58E+13	2.56E+13	2.63E+13	2.19E+12	6.14E+12	4.91E+12	0.00E+00	1.26E+12
100.0	1.88E+13	1.25E+13	8.87E+12	8.71E+12	9.14E+12	1.94E+11	1.10E+12	1.98E+12	6.46E+11	3.35E+11
115.0	4.40E+12	2.67E+12	2.51E+12	2.04E+12	2.32E+12	6.66E+10	2.53E+11	9.28E+11	9.08E+11	1.01E+11
133.0	5.13E+11	3.35E+11	6.08E+11	2.61E+11	3.72E+11	3.83E+10	2.02E+11	4.36E+11	5.36E+11	1.48E+10
154.0	2.79E+10	3.85E+10	1.64E+11	1.64E+10	4.42E+10	7.68E+09	1.13E+11	1.57E+11	1.12E+11	0.00E+00
178.0	3.05E+10	1.45E+10	9.41E+10	0.00E+00	1.45E+10	0.00E+00	2.55E+10	4.16E+10	7.22E+09	0.00E+00
205.0	2.46E+11	2.01E+11	1.96E+11	1.23E+11	2.24E+11	0.00E+00	0.00E+00	6.28E+09	0.00E+00	0.00E+00
237.0	1.05E+12	7.20E+11	7.65E+11	8.57E+11	8.74E+11	0.00E+00	0.00E+00	3.31E+08	0.00E+00	0.00E+00

TABLE A-11.—(Continued).

Test Point No.	310	501	502	502	502	502	502	502	502	502
Date	4/23/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	7	4	65	65	65	65	65	65	65	65
Aerosol Point No.	364	501	502	503	504	505	506	507	508	509
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	6.37E+14	4.00E+16	0.00E+00	3.69E+13	1.69E+14	5.01E+14	1.07E+15	5.60E+15	2.25E+13	7.81E+15
11.5	8.69E+14	4.80E+16	1.34E+14	1.46E+14	4.39E+14	7.92E+14	1.22E+15	5.80E+15	1.31E+14	5.59E+15
13.3	8.11E+14	4.22E+16	4.91E+14	4.01E+14	6.92E+14	9.90E+14	1.18E+15	5.11E+15	3.34E+14	2.49E+15
15.4	7.42E+14	3.20E+16	8.24E+14	6.40E+14	8.54E+14	1.12E+15	1.20E+15	4.82E+15	5.16E+14	8.84E+14
17.8	6.53E+14	2.08E+16	1.02E+15	7.75E+14	9.37E+14	1.18E+15	1.18E+15	4.48E+15	6.15E+14	4.52E+14
20.5	5.63E+14	1.18E+16	1.17E+15	8.76E+14	1.02E+15	1.25E+15	1.20E+15	4.12E+15	6.87E+14	5.54E+14
23.7	4.88E+14	6.49E+15	1.39E+15	1.01E+15	1.14E+15	1.39E+15	1.26E+15	3.74E+15	7.95E+14	6.93E+14
27.4	4.12E+14	4.02E+15	1.58E+15	1.12E+15	1.23E+15	1.50E+15	1.31E+15	3.27E+15	9.07E+14	7.31E+14
31.6	3.17E+14	2.67E+15	1.62E+15	1.12E+15	1.21E+15	1.48E+15	1.25E+15	2.65E+15	9.49E+14	6.94E+14
36.5	2.19E+14	1.87E+15	1.52E+15	1.03E+15	1.10E+15	1.35E+15	1.11E+15	2.01E+15	9.03E+14	6.06E+14
42.2	1.35E+14	1.29E+15	1.31E+15	8.72E+14	9.18E+14	1.14E+15	9.06E+14	1.42E+15	7.89E+14	4.91E+14
48.7	7.01E+13	7.90E+14	1.05E+15	6.75E+14	7.06E+14	8.85E+14	6.75E+14	9.22E+14	6.33E+14	3.72E+14
56.2	2.82E+13	4.10E+14	7.66E+14	4.77E+14	4.97E+14	6.33E+14	4.57E+14	5.47E+14	4.64E+14	2.63E+14
64.9	7.83E+12	1.66E+14	5.11E+14	3.03E+14	3.18E+14	4.13E+14	2.74E+14	2.94E+14	3.08E+14	1.68E+14
75.0	1.31E+12	4.47E+13	3.04E+14	1.67E+14	1.78E+14	2.40E+14	1.36E+14	1.38E+14	1.80E+14	9.10E+13
86.6	1.58E+11	7.21E+12	1.54E+14	7.57E+13	8.21E+13	1.20E+14	5.06E+13	5.12E+13	8.86E+13	3.74E+13
100.0	1.85E+10	7.88E+11	5.95E+13	2.50E+13	2.71E+13	4.72E+13	1.08E+13	1.14E+13	3.25E+13	8.67E+12
115.0	0.00E+00	6.55E+10	1.38E+13	5.46E+12	4.77E+12	1.39E+13	9.34E+11	1.37E+12	6.97E+12	7.48E+11
133.0	0.00E+00	1.65E+09	1.24E+12	6.36E+11	5.86E+11	2.83E+12	0.00E+00	9.57E+10	3.69E+11	0.00E+00
154.0	0.00E+00	0.00E+00	2.25E+09	2.91E+10	1.77E+11	5.89E+11	0.00E+00	4.03E+09	0.00E+00	0.00E+00
178.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.48E+10	2.63E+11	0.00E+00	0.00E+00	0.00E+00	0.00E+00
205.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.09E+11	0.00E+00	0.00E+00	0.00E+00	0.00E+00
237.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.44E+11	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE A-11.—(Continued).

Test Point No.	503	504	505	506	507	508	508	508	509	510
Date	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	70	65	60	85	100	7	7	7	100	85
Aerosol Point No.	511	512	513	514	515	517	518	519	520	521
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	3.32E+14	5.22E+14	4.46E+14	1.78E+14	3.06E+14	3.29E+14	0.00E+00	4.29E+15	3.77E+14	3.89E+14
11.5	6.17E+14	6.25E+14	4.73E+14	5.68E+14	7.03E+14	6.12E+14	0.00E+00	5.63E+15	7.75E+14	7.87E+14
13.3	9.09E+14	7.53E+14	4.68E+14	9.23E+14	1.05E+15	6.68E+14	1.36E+14	3.78E+15	1.00E+15	9.90E+14
15.4	1.11E+15	8.92E+14	5.38E+14	1.14E+15	1.26E+15	6.69E+14	3.98E+14	2.92E+15	1.16E+15	1.13E+15
17.8	1.24E+15	9.71E+14	5.69E+14	1.27E+15	1.38E+15	6.09E+14	5.14E+14	2.20E+15	1.28E+15	1.24E+15
20.5	1.39E+15	1.06E+15	5.87E+14	1.45E+15	1.59E+15	5.29E+14	4.75E+14	1.58E+15	1.47E+15	1.41E+15
23.7	1.61E+15	1.19E+15	6.31E+14	1.76E+15	1.95E+15	4.59E+14	3.91E+14	1.12E+15	1.84E+15	1.72E+15
27.4	1.78E+15	1.29E+15	6.60E+14	2.05E+15	2.31E+15	3.80E+14	2.73E+14	8.06E+14	2.26E+15	2.08E+15
31.6	1.77E+15	1.26E+15	6.25E+14	2.17E+15	2.48E+15	2.57E+14	1.18E+14	5.74E+14	2.54E+15	2.30E+15
36.5	1.61E+15	1.13E+15	5.28E+14	2.11E+15	2.45E+15	1.22E+14	1.95E+13	3.88E+14	2.62E+15	2.33E+15
42.2	1.35E+15	9.30E+14	3.91E+14	1.90E+15	2.25E+15	3.55E+13	0.00E+00	2.48E+14	2.49E+15	2.16E+15
48.7	1.04E+15	6.94E+14	2.49E+14	1.59E+15	1.93E+15	5.10E+12	0.00E+00	1.44E+14	2.19E+15	1.87E+15
56.2	7.35E+14	4.70E+14	1.34E+14	1.25E+15	1.55E+15	4.18E+11	0.00E+00	7.33E+13	1.81E+15	1.51E+15
64.9	4.71E+14	2.80E+14	5.29E+13	9.13E+14	1.17E+15	0.00E+00	0.00E+00	3.22E+13	1.38E+15	1.13E+15
75.0	2.65E+14	1.39E+14	1.15E+13	6.22E+14	8.31E+14	0.00E+00	0.00E+00	1.22E+13	9.88E+14	7.85E+14
86.6	1.22E+14	5.06E+13	9.24E+11	3.91E+14	5.50E+14	0.00E+00	0.00E+00	4.46E+12	6.55E+14	5.05E+14
100.0	3.88E+13	1.06E+13	1.22E+09	2.23E+14	3.36E+14	0.00E+00	0.00E+00	1.99E+12	4.01E+14	2.99E+14
115.0	5.08E+12	8.78E+11	0.00E+00	1.12E+14	1.88E+14	0.00E+00	0.00E+00	1.09E+12	2.27E+14	1.63E+14
133.0	1.70E+11	6.98E+09	0.00E+00	4.49E+13	9.13E+13	0.00E+00	0.00E+00	4.95E+11	1.16E+14	7.95E+13
154.0	0.00E+00	0.00E+00	0.00E+00	1.18E+13	3.57E+13	0.00E+00	0.00E+00	1.47E+11	5.35E+13	3.45E+13
178.0	0.00E+00	0.00E+00	0.00E+00	1.04E+12	8.83E+12	0.00E+00	0.00E+00	2.41E+10	2.12E+13	1.27E+13
205.0	0.00E+00	0.00E+00	0.00E+00	1.34E+10	6.67E+11	0.00E+00	0.00E+00	2.77E+09	6.49E+12	3.54E+12
237.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.77E+12	1.35E+12

TABLE A-11.—(Continued).

Test Point No.	Ac	512	513	513	514	515	516	517	518	518
Date	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	85	30	7	7	100	30	7	85	7	7
Aerosol Point No.	524	525	526	527	531	532	533	534	535	536
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	2.54E-01	6.25E+14	3.50E+15	2.47E+16	1.06E+16	4.20E+15	2.06E+16	4.77E+14	1.69E+16	8.00E+14
11.5	6.27E-01	9.36E+14	4.83E+15	2.73E+16	1.33E+16	3.31E+15	1.97E+16	9.71E+14	1.55E+16	1.13E+15
13.3	9.35E-01	7.38E+14	3.06E+15	2.12E+16	1.26E+16	1.89E+15	1.33E+16	1.35E+15	9.93E+15	1.08E+15
15.4	1.16E+00	6.62E+14	2.30E+15	1.47E+16	1.02E+16	1.10E+15	8.04E+15	1.53E+15	5.55E+15	1.02E+15
17.8	1.32E+00	6.06E+14	1.72E+15	9.03E+15	7.11E+15	7.23E+14	4.58E+15	1.58E+15	2.95E+15	9.31E+14
20.5	1.55E+00	5.62E+14	1.26E+15	5.01E+15	4.30E+15	5.66E+14	2.59E+15	1.70E+15	1.66E+15	8.34E+14
23.7	1.97E+00	5.32E+14	9.22E+14	2.65E+15	2.47E+15	4.90E+14	1.49E+15	1.97E+15	1.06E+15	7.36E+14
27.4	2.46E+00	4.93E+14	6.91E+14	1.47E+15	1.53E+15	4.22E+14	8.98E+14	2.25E+15	7.54E+14	6.24E+14
31.6	2.78E+00	4.21E+14	5.09E+14	8.54E+14	1.02E+15	3.37E+14	5.56E+14	2.37E+15	5.34E+14	4.85E+14
36.5	2.86E+00	3.25E+14	3.55E+14	5.22E+14	7.19E+14	2.50E+14	3.47E+14	2.31E+15	3.66E+14	3.41E+14
42.2	2.69E+00	2.30E+14	2.34E+14	3.30E+14	5.22E+14	1.71E+14	2.15E+14	2.09E+15	2.34E+14	2.14E+14
48.7	2.35E+00	1.46E+14	1.40E+14	1.96E+14	3.69E+14	1.05E+14	1.27E+14	1.77E+15	1.32E+14	1.15E+14
56.2	1.91E+00	8.02E+13	7.32E+13	1.05E+14	2.42E+14	5.90E+13	6.99E+13	1.41E+15	6.62E+13	4.92E+13
64.9	1.44E+00	3.84E+13	3.30E+13	5.10E+13	1.46E+14	3.05E+13	3.60E+13	1.05E+15	3.02E+13	1.52E+13
75.0	1.01E+00	1.61E+13	1.23E+13	2.28E+13	7.88E+13	1.42E+13	1.67E+13	7.34E+14	1.30E+13	2.53E+12
86.6	6.57E-01	6.14E+12	3.65E+12	9.64E+12	3.76E+13	5.43E+12	6.33E+12	4.78E+14	5.10E+12	9.23E+10
100.0	3.91E-01	2.24E+12	8.31E+11	3.64E+12	1.51E+13	1.24E+12	1.35E+12	2.87E+14	1.34E+12	0.00E+00
115.0	2.15E-01	7.73E+11	1.77E+11	1.01E+12	4.80E+12	1.12E+11	1.11E+11	1.59E+14	1.32E+11	0.00E+00
133.0	1.05E-01	2.00E+11	4.89E+10	1.75E+11	1.06E+12	0.00E+00	0.00E+00	7.89E+13	0.00E+00	0.00E+00
154.0	4.66E-02	3.54E+10	2.80E+10	3.32E+10	1.66E+11	0.00E+00	0.00E+00	3.49E+13	0.00E+00	0.00E+00
178.0	1.80E-02	8.42E+10	3.71E+10	4.79E+10	5.31E+10	0.00E+00	0.00E+00	1.38E+13	0.00E+00	0.00E+00
205.0	6.01E-03	2.84E+11	8.56E+10	1.08E+11	4.06E+10	0.00E+00	0.00E+00	5.99E+12	0.00E+00	0.00E+00
237.0	2.67E-03	5.23E+11	1.13E+11	1.18E+11	2.65E+10	0.00E+00	0.00E+00	4.80E+12	0.00E+00	0.00E+00

TABLE A-11.—(Continued).

Test Point No.	519	520	521	522	522	522	522	522	522	522
Date	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	100	85	30	7	7	7	7	7	7	7
Aerosol Point No.	537	538	539	540	541	542	543	544	545	547
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	5.08E+14	5.93E+14	2.05E+14	7.68E+14	4.61E+14	8.06E+14	6.87E+14	3.27E+14	8.49E+12	1.18E+15
11.5	9.10E+14	9.78E+14	3.77E+14	1.11E+15	1.04E+15	1.27E+15	1.05E+15	6.31E+14	3.16E+13	1.90E+15
13.3	1.24E+15	1.30E+15	4.60E+14	1.06E+15	9.81E+14	1.22E+15	1.11E+15	8.32E+14	1.64E+14	1.69E+15
15.4	1.44E+15	1.49E+15	5.04E+14	9.94E+14	9.48E+14	1.16E+15	1.11E+15	9.06E+14	4.41E+14	1.57E+15
17.8	1.58E+15	1.62E+15	5.10E+14	8.99E+14	8.92E+14	1.07E+15	1.03E+15	8.58E+14	5.72E+14	1.43E+15
20.5	1.88E+15	1.90E+15	4.98E+14	7.95E+14	8.21E+14	9.62E+14	9.30E+14	7.64E+14	5.57E+14	1.29E+15
23.7	2.41E+15	2.40E+15	4.84E+14	6.93E+14	7.43E+14	8.52E+14	8.28E+14	6.81E+14	5.29E+14	1.16E+15
27.4	2.96E+15	2.88E+15	4.51E+14	5.83E+14	6.54E+14	7.30E+14	7.13E+14	5.90E+14	4.73E+14	1.02E+15
31.6	3.29E+15	3.11E+15	3.79E+14	4.50E+14	5.36E+14	5.77E+14	5.59E+14	4.55E+14	3.39E+14	8.43E+14
36.5	3.34E+15	3.08E+15	2.85E+14	3.13E+14	3.99E+14	4.12E+14	3.95E+14	3.09E+14	1.94E+14	6.35E+14
42.2	3.15E+15	2.83E+15	1.91E+14	1.94E+14	2.70E+14	2.65E+14	2.48E+14	1.81E+14	9.03E+13	4.39E+14
48.7	2.76E+15	2.43E+15	1.09E+14	1.00E+14	1.62E+14	1.46E+14	1.29E+14	8.07E+13	2.53E+13	2.71E+14
56.2	2.28E+15	1.96E+15	5.03E+13	3.99E+13	8.19E+13	6.49E+13	5.18E+13	2.29E+13	3.40E+12	1.44E+14
64.9	1.76E+15	1.48E+15	1.71E+13	1.04E+13	3.28E+13	2.10E+13	1.42E+13	3.42E+12	2.47E+11	6.40E+13
75.0	1.27E+15	1.04E+15	3.09E+12	1.29E+12	8.69E+12	3.55E+12	2.00E+12	1.90E+11	1.28E+10	2.13E+13
86.6	8.63E+14	6.88E+14	8.81E+10	2.71E+10	9.07E+11	3.23E+10	6.32E+10	0.00E+00	0.00E+00	4.16E+12
100.0	5.47E+14	4.23E+14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.02E+11
115.0	3.24E+14	2.41E+14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
133.0	1.77E+14	1.26E+14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
154.0	8.84E+13	5.95E+13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
178.0	3.89E+13	2.50E+13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
205.0	1.49E+13	1.01E+13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
237.0	6.66E+12	6.55E+12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE A-11.—(Continued).

Test Point No.	522	522	523	524	525	526	526	526	601	601
Date	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/25/2004	4/26/2004	4/26/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	7	7	100	85	30	7	7	7	7	7
Aerosol Point No.	548	549	550	551	552	553	554	555	602	603
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	4.24E+15	2.92E+15	5.03E+14	5.42E+14	2.18E+14	2.45E+15	9.03E+14	3.75E+14	4.68E+16	1.51E+16
11.5	3.94E+15	2.79E+15	9.42E+14	9.81E+14	3.66E+14	2.29E+15	1.04E+15	4.84E+14	7.29E+16	1.50E+16
13.3	3.03E+15	2.46E+15	1.30E+15	1.33E+15	4.63E+14	1.80E+15	1.08E+15	5.87E+14	8.08E+16	9.65E+15
15.4	2.47E+15	2.15E+15	1.51E+15	1.54E+15	5.01E+14	1.48E+15	1.01E+15	6.83E+14	7.04E+16	7.43E+15
17.8	2.00E+15	1.84E+15	1.66E+15	1.68E+15	4.87E+14	1.23E+15	8.55E+14	6.32E+14	4.76E+16	5.80E+15
20.5	1.63E+15	1.55E+15	1.94E+15	1.95E+15	4.59E+14	1.03E+15	7.15E+14	5.34E+14	2.46E+16	4.41E+15
23.7	1.37E+15	1.33E+15	2.47E+15	2.44E+15	4.38E+14	8.72E+14	6.36E+14	4.87E+14	9.89E+15	3.19E+15
27.4	1.16E+15	1.10E+15	3.01E+15	2.92E+15	4.03E+14	7.24E+14	5.40E+14	4.00E+14	3.23E+15	2.20E+15
31.6	9.24E+14	8.39E+14	3.33E+15	3.17E+15	3.32E+14	5.54E+14	3.71E+14	2.15E+14	7.40E+14	1.43E+15
36.5	6.89E+14	5.96E+14	3.38E+15	3.15E+15	2.47E+14	3.87E+14	2.03E+14	7.57E+13	1.86E+14	8.60E+14
42.2	4.74E+14	3.86E+14	3.18E+15	2.90E+15	1.63E+14	2.40E+14	8.50E+13	2.23E+13	2.86E+14	4.81E+14
48.7	2.91E+14	2.13E+14	2.79E+15	2.49E+15	9.03E+13	1.24E+14	1.82E+13	3.08E+12	3.82E+14	2.45E+14
56.2	1.57E+14	9.96E+13	2.29E+15	2.00E+15	4.06E+13	5.03E+13	1.46E+12	1.39E+11	3.12E+14	1.16E+14
64.9	7.06E+13	3.55E+13	1.77E+15	1.51E+15	1.38E+13	1.36E+13	3.50E+10	0.00E+00	1.75E+14	5.63E+13
75.0	2.35E+13	6.91E+12	1.29E+15	1.07E+15	2.77E+12	1.48E+12	0.00E+00	0.00E+00	6.27E+13	3.24E+13
86.6	4.17E+12	5.62E+11	8.74E+14	7.09E+14	2.99E+11	0.00E+00	0.00E+00	0.00E+00	9.48E+12	2.26E+13
100.0	2.57E+11	1.29E+10	5.53E+14	4.37E+14	1.54E+10	0.00E+00	0.00E+00	0.00E+00	4.29E+11	1.63E+13
115.0	0.00E+00	0.00E+00	3.26E+14	2.49E+14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.14E+12	1.11E+13
133.0	0.00E+00	0.00E+00	1.75E+14	1.29E+14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.33E+12	7.38E+12
154.0	0.00E+00	0.00E+00	8.54E+13	5.94E+13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.58E+12	5.74E+12
178.0	0.00E+00	0.00E+00	3.67E+13	2.41E+13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.16E+12	5.33E+12
205.0	0.00E+00	0.00E+00	1.42E+13	9.30E+12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.41E+12	5.11E+12
237.0	0.00E+00	0.00E+00	7.23E+12	5.78E+12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.66E+12	4.60E+12

TABLE A-11.—(Continued).

Test Point No.	601	602	603	604	605	605	605	605	605	606
Date	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	7	100	85	30	7	7	7	7	7	100
Aerosol Point No.	604	606	607	608	609	610	611	612	613	615
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	1.97E+16	5.51E+14	4.49E+14	8.44E+14	1.00E+16	1.59E+16	1.69E+16	1.30E+15	2.34E+15	1.57E+15
11.5	1.32E+16	9.96E+14	8.67E+14	1.17E+15	1.10E+16	7.99E+15	7.57E+15	1.42E+15	2.29E+15	1.63E+15
13.3	7.77E+15	1.22E+15	1.07E+15	9.17E+14	5.05E+15	3.92E+15	3.69E+15	1.05E+15	1.46E+15	1.75E+15
15.4	5.36E+15	1.35E+15	1.21E+15	8.61E+14	2.96E+15	2.30E+15	2.14E+15	8.91E+14	1.19E+15	1.82E+15
17.8	3.83E+15	1.45E+15	1.30E+15	8.28E+14	1.93E+15	1.56E+15	1.50E+15	7.58E+14	9.83E+14	1.90E+15
20.5	2.74E+15	1.65E+15	1.48E+15	8.02E+14	1.37E+15	1.20E+15	1.24E+15	6.42E+14	8.09E+14	2.17E+15
23.7	1.95E+15	2.08E+15	1.84E+15	7.78E+14	1.02E+15	9.73E+14	1.09E+15	5.45E+14	6.68E+14	2.71E+15
27.4	1.37E+15	2.61E+15	2.27E+15	7.27E+14	7.71E+14	7.70E+14	9.28E+14	4.53E+14	5.45E+14	3.26E+15
31.6	9.27E+14	3.04E+15	2.58E+15	6.23E+14	5.59E+14	5.67E+14	7.16E+14	3.50E+14	4.18E+14	3.59E+15
36.5	5.93E+14	3.24E+15	2.68E+15	4.84E+14	3.79E+14	3.85E+14	5.01E+14	2.46E+14	2.94E+14	3.64E+15
42.2	3.58E+14	3.18E+15	2.57E+15	3.45E+14	2.42E+14	2.46E+14	3.33E+14	1.60E+14	1.93E+14	3.43E+15
48.7	1.99E+14	2.90E+15	2.28E+15	2.24E+14	1.43E+14	1.46E+14	2.05E+14	9.39E+13	1.15E+14	3.03E+15
56.2	1.05E+14	2.47E+15	1.88E+15	1.29E+14	8.01E+13	8.77E+13	1.30E+14	5.05E+13	6.27E+13	2.51E+15
64.9	5.75E+13	1.96E+15	1.44E+15	7.00E+13	4.80E+13	6.86E+13	1.14E+14	3.15E+13	3.77E+13	1.96E+15
75.0	3.61E+13	1.44E+15	1.02E+15	3.86E+13	3.48E+13	6.55E+13	1.17E+14	2.68E+13	2.91E+13	1.44E+15
86.6	2.59E+13	9.91E+14	6.69E+14	2.38E+13	2.84E+13	6.07E+13	1.10E+14	2.51E+13	2.52E+13	9.95E+14
100.0	1.87E+13	6.29E+14	4.02E+14	1.59E+13	2.20E+13	4.63E+13	8.23E+13	2.00E+13	1.94E+13	6.39E+14
115.0	1.29E+13	3.70E+14	2.21E+14	1.07E+13	1.49E+13	2.85E+13	4.79E+13	1.25E+13	1.18E+13	3.81E+14
133.0	9.24E+12	1.97E+14	1.09E+14	7.22E+12	9.37E+12	1.63E+13	2.56E+13	6.37E+12	6.05E+12	2.10E+14
154.0	7.97E+12	9.58E+13	4.87E+13	5.88E+12	7.08E+12	1.31E+13	2.17E+13	4.42E+12	4.35E+12	1.07E+14
178.0	7.83E+12	4.13E+13	1.99E+13	5.85E+12	6.94E+12	1.48E+13	2.68E+13	5.30E+12	5.34E+12	5.14E+13
205.0	7.57E+12	1.50E+13	7.75E+12	5.94E+12	7.04E+12	1.60E+13	3.06E+13	6.51E+12	6.54E+12	2.51E+13
237.0	6.84E+12	5.23E+12	4.13E+12	5.61E+12	6.52E+12	1.55E+13	2.97E+13	6.85E+12	6.76E+12	1.66E+13

TABLE A-11.—(Continued).

Test Point No.	607	608	609	609	610	611	612	613	613	614
Date	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	85	30	7	7	100	85	30	7	7	100
Aerosol Point No.	616	617	618	619	620	621	622	623	624	625
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	1.63E+15	1.72E+15	1.17E+16	5.98E+16	6.14E+14	1.27E+15	7.68E+14	1.25E+15	4.22E+16	1.12E+16
11.5	1.59E+15	1.21E+15	7.02E+15	7.72E+16	7.35E+14	1.34E+15	9.08E+14	1.51E+15	5.06E+16	9.04E+15
13.3	1.69E+15	9.79E+14	3.31E+15	7.41E+16	8.50E+14	1.49E+15	7.52E+14	1.14E+15	4.50E+16	5.21E+15
15.4	1.74E+15	8.88E+14	1.90E+15	5.75E+16	9.13E+14	1.57E+15	7.02E+14	9.95E+14	3.32E+16	2.79E+15
17.8	1.80E+15	8.29E+14	1.26E+15	3.42E+16	9.72E+14	1.66E+15	6.63E+14	8.74E+14	1.92E+16	1.85E+15
20.5	2.03E+15	7.97E+14	9.52E+14	1.42E+16	1.14E+15	1.93E+15	6.34E+14	7.58E+14	7.89E+15	1.84E+15
23.7	2.48E+15	7.82E+14	7.80E+14	3.72E+15	1.46E+15	2.41E+15	6.14E+14	6.49E+14	2.21E+15	2.19E+15
27.4	2.92E+15	7.33E+14	6.38E+14	5.66E+14	1.78E+15	2.88E+15	5.74E+14	5.40E+14	5.43E+14	2.56E+15
31.6	3.14E+15	6.17E+14	4.89E+14	3.62E+13	1.99E+15	3.13E+15	4.89E+14	4.18E+14	1.91E+14	2.78E+15
36.5	3.11E+15	4.74E+14	3.46E+14	2.09E+14	2.03E+15	3.12E+15	3.78E+14	2.97E+14	2.96E+14	2.82E+15
42.2	2.87E+15	3.38E+14	2.29E+14	4.08E+14	1.92E+15	2.89E+15	2.67E+14	1.95E+14	4.00E+14	2.67E+15
48.7	2.48E+15	2.18E+14	1.39E+14	3.70E+14	1.70E+15	2.51E+15	1.70E+14	1.16E+14	3.20E+14	2.39E+15
56.2	2.01E+15	1.32E+14	8.13E+13	2.11E+14	1.41E+15	2.04E+15	9.51E+13	6.20E+13	1.69E+14	2.02E+15
64.9	1.53E+15	8.53E+13	5.58E+13	7.67E+13	1.09E+15	1.55E+15	4.93E+13	3.35E+13	5.70E+13	1.61E+15
75.0	1.10E+15	6.27E+13	4.73E+13	1.06E+13	7.99E+14	1.11E+15	2.61E+13	2.20E+13	9.50E+12	1.21E+15
86.6	7.35E+14	4.87E+13	4.20E+13	4.07E+11	5.46E+14	7.46E+14	1.58E+13	1.76E+13	5.00E+12	8.61E+14
100.0	4.55E+14	3.40E+13	3.24E+13	1.26E+13	3.49E+14	4.66E+14	1.06E+13	1.40E+13	1.25E+13	5.74E+14
115.0	2.60E+14	2.01E+13	2.09E+13	2.03E+13	2.08E+14	2.71E+14	7.13E+12	9.85E+12	1.60E+13	3.59E+14
133.0	1.36E+14	1.16E+13	1.26E+13	1.96E+13	1.15E+14	1.46E+14	4.93E+12	6.52E+12	1.44E+13	2.08E+14
154.0	6.79E+13	9.98E+12	1.00E+13	1.57E+13	5.81E+13	7.38E+13	4.40E+12	5.39E+12	1.16E+13	1.09E+14
178.0	3.42E+13	1.18E+13	1.08E+13	1.23E+13	2.65E+13	3.54E+13	4.85E+12	5.77E+12	9.66E+12	4.95E+13
205.0	2.03E+13	1.30E+13	1.14E+13	1.02E+13	1.12E+13	1.80E+13	5.31E+12	6.28E+12	8.56E+12	1.87E+13
237.0	1.68E+13	1.27E+13	1.09E+13	8.56E+12	5.99E+12	1.24E+13	5.34E+12	6.23E+12	7.56E+12	6.71E+12

TABLE A-11.—(Continued).

Test Point No.	615	616	617	617	617	617	618	619	620	621
Date	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	85	30	7	7	7	7	4	100	85	65
Aerosol Point No.	626	627	628	629	630	631	632	633	634	635
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	2.64E+15	4.74E+16	5.30E+16	9.10E+14	9.93E+14	2.03E+15	3.14E+16	1.33E+15	5.39E+14	8.73E+14
11.5	2.19E+15	3.95E+16	5.53E+16	1.02E+15	1.19E+15	2.20E+15	3.78E+16	1.56E+15	8.08E+14	8.94E+14
13.3	1.73E+15	2.25E+16	4.36E+16	7.94E+14	9.61E+14	1.58E+15	3.50E+16	1.50E+15	9.70E+14	7.86E+14
15.4	1.57E+15	1.00E+16	2.87E+16	7.06E+14	8.66E+14	1.32E+15	2.80E+16	1.40E+15	1.04E+15	7.08E+14
17.8	1.57E+15	3.53E+15	1.49E+16	6.31E+14	7.75E+14	1.12E+15	1.90E+16	1.34E+15	1.05E+15	6.49E+14
20.5	1.72E+15	1.12E+15	5.23E+15	5.58E+14	6.84E+14	9.44E+14	1.12E+16	1.40E+15	1.11E+15	6.37E+14
23.7	2.03E+15	5.02E+14	1.06E+15	4.87E+14	5.97E+14	7.98E+14	6.10E+15	1.62E+15	1.28E+15	6.78E+14
27.4	2.34E+15	4.42E+14	2.05E+14	4.08E+14	5.04E+14	6.65E+14	3.37E+15	1.87E+15	1.46E+15	7.08E+14
31.6	2.51E+15	4.18E+14	1.41E+14	3.16E+14	3.93E+14	5.19E+14	1.85E+15	2.00E+15	1.54E+15	6.70E+14
36.5	2.49E+15	3.62E+14	2.85E+14	2.25E+14	2.80E+14	3.74E+14	1.05E+15	2.00E+15	1.51E+15	5.87E+14
42.2	2.32E+15	2.68E+14	3.46E+14	1.46E+14	1.82E+14	2.47E+14	6.08E+14	1.86E+15	1.37E+15	4.79E+14
48.7	2.02E+15	1.60E+14	2.39E+14	8.49E+13	1.04E+14	1.46E+14	3.35E+14	1.63E+15	1.17E+15	3.64E+14
56.2	1.66E+15	8.11E+13	1.01E+14	4.31E+13	5.06E+13	7.50E+13	1.70E+14	1.35E+15	9.38E+14	2.60E+14
64.9	1.29E+15	3.63E+13	2.03E+13	1.93E+13	2.04E+13	3.27E+13	8.12E+13	1.05E+15	7.09E+14	1.77E+14
75.0	9.37E+14	1.75E+13	1.35E+12	8.32E+12	6.81E+12	1.22E+13	4.03E+13	7.71E+14	5.04E+14	1.16E+14
86.6	6.41E+14	1.17E+13	1.47E+11	4.64E+12	2.37E+12	4.63E+12	2.33E+13	5.31E+14	3.35E+14	7.08E+13
100.0	4.09E+14	1.02E+13	4.29E+12	4.18E+12	1.72E+12	3.23E+12	1.55E+13	3.41E+14	2.06E+14	3.93E+13
115.0	2.44E+14	9.46E+12	9.39E+12	4.62E+12	2.22E+12	3.76E+12	1.10E+13	2.04E+14	1.17E+14	1.93E+13
133.0	1.34E+14	8.31E+12	1.14E+13	4.89E+12	2.70E+12	4.22E+12	8.10E+12	1.12E+14	6.11E+13	8.56E+12
154.0	6.62E+13	6.82E+12	1.01E+13	4.60E+12	2.68E+12	3.96E+12	6.45E+12	5.67E+13	2.97E+13	4.60E+12
178.0	2.84E+13	5.28E+12	7.18E+12	3.88E+12	2.19E+12	3.19E+12	5.51E+12	2.64E+13	1.44E+13	4.36E+12
205.0	1.04E+13	4.00E+12	4.54E+12	3.06E+12	1.54E+12	2.38E+12	4.79E+12	1.24E+13	8.53E+12	5.51E+12
237.0	4.86E+12	3.18E+12	3.06E+12	2.53E+12	1.14E+12	1.90E+12	4.16E+12	8.06E+12	7.55E+12	6.86E+12

TABLE A-11.—(Continued).

Test Point No.	622	623	624	624	624	624	625	626	627	628
Date	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	40	4	40	40	40	40	30	15	7	5.5
Aerosol Point No.	636	638	640	641	643	644	645	646	647	648
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	2.50E+15	3.40E+15	1.32E+15	1.01E+15	6.58E+14	1.83E+14	3.07E+14	1.75E+14	3.82E+14	8.34E+14
11.5	1.88E+15	3.68E+15	1.03E+15	9.34E+14	7.54E+14	3.68E+14	4.69E+14	3.15E+14	5.77E+14	1.12E+15
13.3	1.11E+15	3.26E+15	8.90E+14	8.16E+14	7.39E+14	4.25E+14	4.93E+14	3.80E+14	5.84E+14	9.98E+14
15.4	7.30E+14	2.60E+15	7.94E+14	7.52E+14	6.93E+14	4.54E+14	4.86E+14	3.95E+14	5.49E+14	8.83E+14
17.8	5.48E+14	1.90E+15	7.09E+14	6.90E+14	6.18E+14	4.56E+14	4.43E+14	3.66E+14	4.75E+14	7.42E+14
20.5	4.68E+14	1.36E+15	6.69E+14	6.52E+14	5.78E+14	4.55E+14	3.99E+14	3.26E+14	3.98E+14	6.13E+14
23.7	4.39E+14	1.03E+15	6.78E+14	6.47E+14	6.04E+14	4.68E+14	3.81E+14	3.00E+14	3.44E+14	5.24E+14
27.4	4.04E+14	8.11E+14	6.64E+14	6.24E+14	6.10E+14	4.72E+14	3.63E+14	2.71E+14	2.96E+14	4.50E+14
31.6	3.33E+14	5.86E+14	5.78E+14	5.45E+14	5.26E+14	4.32E+14	3.07E+14	2.14E+14	2.24E+14	3.52E+14
36.5	2.52E+14	3.98E+14	4.60E+14	4.37E+14	4.09E+14	3.55E+14	2.34E+14	1.48E+14	1.48E+14	2.46E+14
42.2	1.76E+14	2.49E+14	3.37E+14	3.21E+14	2.89E+14	2.66E+14	1.61E+14	9.01E+13	8.45E+13	1.49E+14
48.7	1.11E+14	1.36E+14	2.21E+14	2.13E+14	1.80E+14	1.79E+14	9.65E+13	4.43E+13	3.69E+13	7.39E+13
56.2	6.63E+13	7.14E+13	1.33E+14	1.27E+14	1.05E+14	1.06E+14	5.06E+13	1.68E+13	1.07E+13	2.76E+13
64.9	4.08E+13	4.63E+13	7.59E+13	6.85E+13	6.33E+13	5.52E+13	2.39E+13	5.11E+12	1.61E+12	5.93E+12
75.0	2.75E+13	3.97E+13	4.31E+13	3.34E+13	4.22E+13	2.46E+13	1.08E+13	1.93E+12	1.03E+11	3.73E+11
86.6	1.96E+13	3.55E+13	2.47E+13	1.48E+13	2.91E+13	8.84E+12	4.89E+12	1.34E+12	1.36E+11	0.00E+00
100.0	1.32E+13	2.66E+13	1.33E+13	5.82E+12	1.76E+13	2.18E+12	2.15E+12	8.73E+11	1.16E+11	0.00E+00
115.0	7.93E+12	1.60E+13	6.26E+12	2.14E+12	8.21E+12	2.76E+11	8.43E+11	3.65E+11	4.46E+10	0.00E+00
133.0	4.54E+12	8.46E+12	2.57E+12	9.74E+11	2.54E+12	3.77E+10	3.07E+11	8.23E+10	9.91E+09	0.00E+00
154.0	3.19E+12	5.83E+12	1.49E+12	8.52E+11	7.29E+11	7.56E+10	1.56E+11	3.04E+10	2.58E+09	0.00E+00
178.0	3.10E+12	6.11E+12	1.87E+12	1.01E+12	9.15E+11	1.53E+11	1.07E+11	4.66E+10	3.63E+08	0.00E+00
205.0	3.45E+12	6.76E+12	2.77E+12	1.21E+12	2.23E+12	2.75E+11	7.65E+10	4.67E+10	0.00E+00	0.00E+00
237.0	3.87E+12	6.73E+12	3.81E+12	1.50E+12	4.11E+12	5.13E+11	7.07E+10	2.73E+10	0.00E+00	0.00E+00

TABLE A-11.—(Continued).

Test Point No.	629	629	630	631	632	633	634	635	635	635
Date	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	4	4	5.5	7	15	30	4	40	40	40
Aerosol Point No.	649	651	652	653	654	655	656	657	658	659
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	1.48E+15	2.24E+16	3.37E+16	2.00E+16	1.08E+16	5.68E+15	2.63E+16	3.80E+15	2.36E+14	4.33E+14
11.5	1.85E+15	2.76E+16	3.41E+16	2.11E+16	1.03E+16	5.37E+15	3.19E+16	3.02E+15	4.36E+14	5.58E+14
13.3	1.53E+15	2.57E+16	2.46E+16	1.69E+16	7.32E+15	3.79E+15	2.95E+16	1.78E+15	4.73E+14	5.96E+14
15.4	1.33E+15	2.10E+16	1.54E+16	1.21E+16	4.76E+15	2.46E+15	2.40E+16	1.07E+15	4.94E+14	5.92E+14
17.8	1.13E+15	1.51E+16	8.41E+15	7.81E+15	2.80E+15	1.47E+15	1.71E+16	7.32E+14	4.95E+14	5.64E+14
20.5	9.57E+14	9.63E+15	4.02E+15	4.56E+15	1.49E+15	8.61E+14	1.09E+16	6.07E+14	5.00E+14	5.61E+14
23.7	8.25E+14	5.73E+15	1.87E+15	2.51E+15	7.83E+14	5.81E+14	6.50E+15	5.75E+14	5.26E+14	6.02E+14
27.4	7.03E+14	3.34E+15	1.05E+15	1.39E+15	4.60E+14	4.74E+14	3.75E+15	5.41E+14	5.41E+14	6.17E+14
31.6	5.52E+14	1.87E+15	6.70E+14	7.57E+14	2.86E+14	3.88E+14	2.06E+15	4.61E+14	5.02E+14	5.50E+14
36.5	3.93E+14	1.01E+15	4.75E+14	4.16E+14	1.87E+14	3.07E+14	1.08E+15	3.63E+14	4.17E+14	4.45E+14
42.2	2.52E+14	5.34E+14	3.36E+14	2.30E+14	1.20E+14	2.23E+14	5.36E+14	2.65E+14	3.16E+14	3.30E+14
48.7	1.40E+14	2.63E+14	2.00E+14	1.21E+14	6.84E+13	1.43E+14	2.40E+14	1.77E+14	2.17E+14	2.19E+14
56.2	6.60E+13	1.25E+14	9.79E+13	6.12E+13	3.41E+13	8.08E+13	1.00E+14	1.11E+14	1.33E+14	1.34E+14
64.9	2.42E+13	5.93E+13	3.76E+13	2.87E+13	1.40E+13	3.94E+13	4.73E+13	6.98E+13	7.45E+13	8.06E+13
75.0	5.64E+12	2.92E+13	1.12E+13	1.20E+13	4.92E+12	1.73E+13	3.07E+13	4.37E+13	3.86E+13	4.82E+13
86.6	7.27E+11	1.39E+13	3.10E+12	3.87E+12	1.55E+12	8.40E+12	2.24E+13	2.54E+13	1.82E+13	2.69E+13
100.0	1.93E+11	5.18E+12	9.39E+11	7.85E+11	3.68E+11	3.59E+12	1.27E+13	1.15E+13	6.87E+12	1.11E+13
115.0	3.08E+11	1.21E+12	4.25E+11	1.53E+11	1.03E+11	8.66E+11	4.28E+12	2.97E+12	1.48E+12	2.13E+12
133.0	4.94E+11	1.74E+11	2.53E+11	7.42E+10	7.76E+10	9.66E+10	4.83E+11	2.68E+11	2.85E+10	1.35E+11
154.0	5.56E+11	5.13E+10	1.14E+11	5.36E+10	7.87E+10	3.52E+10	4.24E+09	0.00E+00	0.00E+00	0.00E+00
178.0	4.68E+11	2.57E+10	2.76E+10	1.95E+10	4.51E+10	3.77E+10	0.00E+00	8.85E+10	1.66E+10	3.77E+10
205.0	3.37E+11	3.73E+09	2.48E+09	2.17E+09	6.21E+09	3.41E+10	8.60E+09	6.31E+11	1.76E+11	3.98E+11
237.0	2.62E+11	1.79E+07	0.00E+00	0.00E+00	0.00E+00	3.86E+10	1.06E+10	1.20E+12	5.12E+11	1.01E+12

TABLE A-11.—(Continued).

Test Point No.	635	636	637	638	639	640	641	642	643	701
Date	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/26/2004	4/27/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	40	30	15	7	5.5	4	5.5	7	15	4
Aerosol Point No.	660	661	662	663	664	665	667	668	669	701
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	3.66E+14	1.37E+15	2.68E+15	2.72E+15	5.47E+15	4.78E+15	2.61E+16	2.58E+16	1.13E+16	4.25E+16
11.5	5.00E+14	1.42E+15	2.58E+15	3.20E+15	6.29E+15	5.50E+15	2.75E+16	2.50E+16	1.17E+16	2.77E+16
13.3	5.79E+14	1.05E+15	1.64E+15	2.39E+15	4.46E+15	3.90E+15	2.12E+16	1.71E+16	8.85E+15	1.84E+16
15.4	5.67E+14	8.20E+14	1.15E+15	1.91E+15	3.50E+15	3.11E+15	1.43E+16	1.02E+16	6.01E+15	1.39E+16
17.8	5.00E+14	6.48E+14	8.13E+14	1.47E+15	2.64E+15	2.43E+15	8.43E+15	5.42E+15	3.66E+15	1.07E+16
20.5	4.86E+14	5.38E+14	5.87E+14	1.09E+15	1.90E+15	1.83E+15	4.31E+15	2.65E+15	2.06E+15	8.31E+15
23.7	5.66E+14	4.95E+14	4.61E+14	8.03E+14	1.34E+15	1.39E+15	2.03E+15	1.29E+15	1.19E+15	6.72E+15
27.4	6.10E+14	4.66E+14	3.85E+14	6.01E+14	9.60E+14	1.06E+15	1.02E+15	7.14E+14	7.96E+14	5.51E+15
31.6	5.29E+14	3.98E+14	3.01E+14	4.29E+14	6.68E+14	7.75E+14	5.33E+14	4.26E+14	5.58E+14	4.34E+15
36.5	4.15E+14	3.08E+14	2.17E+14	2.85E+14	4.41E+14	5.29E+14	3.13E+14	2.74E+14	4.00E+14	3.27E+15
42.2	3.00E+14	2.19E+14	1.45E+14	1.76E+14	2.77E+14	3.37E+14	2.03E+14	1.81E+14	2.82E+14	2.32E+15
48.7	1.90E+14	1.38E+14	8.56E+13	9.71E+13	1.59E+14	1.93E+14	1.21E+14	1.06E+14	1.81E+14	1.52E+15
56.2	1.20E+14	7.79E+13	4.60E+13	4.74E+13	8.41E+13	9.75E+13	6.42E+13	5.66E+13	1.08E+14	9.23E+14
64.9	8.82E+13	4.31E+13	2.66E+13	2.40E+13	4.46E+13	4.69E+13	3.48E+13	3.29E+13	6.29E+13	5.16E+14
75.0	6.85E+13	2.51E+13	1.81E+13	1.50E+13	2.61E+13	2.40E+13	2.23E+13	2.35E+13	3.79E+13	2.69E+14
86.6	4.58E+13	1.47E+13	1.25E+13	1.05E+13	1.62E+13	1.32E+13	1.58E+13	1.76E+13	2.27E+13	1.36E+14
100.0	1.94E+13	6.80E+12	6.44E+12	5.70E+12	8.54E+12	6.07E+12	9.07E+12	1.03E+13	1.15E+13	7.21E+13
115.0	2.54E+12	1.66E+12	1.76E+12	1.75E+12	2.91E+12	1.52E+12	3.24E+12	3.70E+12	3.96E+12	4.58E+13
133.0	9.25E+10	1.25E+11	1.60E+11	1.93E+11	4.18E+11	8.70E+10	4.28E+11	4.10E+11	5.17E+11	3.41E+13
154.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.45E+10	0.00E+00	6.50E+10	2.69E+13
178.0	0.00E+00	2.81E+10	0.00E+00	0.00E+00	2.22E+10	3.39E+10	9.43E+10	3.01E+11	3.77E+11	2.12E+13
205.0	5.00E+11	6.47E+10	0.00E+00	0.00E+00	3.00E+10	6.12E+10	1.31E+11	5.49E+11	5.35E+11	1.68E+13
237.0	1.56E+12	8.48E+10	0.00E+00	0.00E+00	2.20E+10	5.96E+10	1.30E+11	5.74E+11	4.62E+11	1.42E+13

TABLE A-11.—(Continued).

Test Point No.	702	703	704	705	705	706	707	708	709	710
Date	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	100	85	65	4	4	100	85	70	65	60
Aerosol Point No.	702	703	704	705	706	707	708	709	710	711
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	1.52E+15	1.64E+15	1.73E+15	1.77E+16	5.25E+15	1.08E+15	1.34E+15	1.44E+15	2.04E+15	1.62E+15
11.5	1.86E+15	1.83E+15	1.53E+15	2.08E+16	5.71E+15	1.34E+15	1.50E+15	1.37E+15	1.62E+15	1.37E+15
13.3	2.09E+15	1.96E+15	1.43E+15	1.09E+16	4.05E+15	1.50E+15	1.63E+15	1.33E+15	1.36E+15	1.20E+15
15.4	2.21E+15	2.04E+15	1.39E+15	7.32E+15	3.33E+15	1.59E+15	1.70E+15	1.31E+15	1.22E+15	1.11E+15
17.8	2.32E+15	2.12E+15	1.38E+15	5.25E+15	2.78E+15	1.68E+15	1.78E+15	1.31E+15	1.15E+15	1.04E+15
20.5	2.69E+15	2.39E+15	1.44E+15	3.89E+15	2.32E+15	1.95E+15	2.02E+15	1.40E+15	1.17E+15	1.04E+15
23.7	3.39E+15	2.92E+15	1.58E+15	2.96E+15	1.95E+15	2.48E+15	2.50E+15	1.60E+15	1.28E+15	1.12E+15
27.4	4.15E+15	3.45E+15	1.67E+15	2.30E+15	1.62E+15	3.03E+15	2.98E+15	1.77E+15	1.35E+15	1.16E+15
31.6	4.67E+15	3.75E+15	1.62E+15	1.76E+15	1.28E+15	3.38E+15	3.25E+15	1.80E+15	1.31E+15	1.10E+15
36.5	4.83E+15	3.75E+15	1.46E+15	1.27E+15	9.53E+14	3.45E+15	3.24E+15	1.67E+15	1.17E+15	9.59E+14
42.2	4.64E+15	3.48E+15	1.21E+15	8.69E+14	6.65E+14	3.25E+15	2.98E+15	1.45E+15	9.75E+14	7.77E+14
48.7	4.17E+15	3.03E+15	9.42E+14	5.51E+14	4.32E+14	2.86E+15	2.56E+15	1.16E+15	7.53E+14	5.84E+14
56.2	3.52E+15	2.47E+15	6.79E+14	3.20E+14	2.61E+14	2.35E+15	2.05E+15	8.66E+14	5.42E+14	4.10E+14
64.9	2.79E+15	1.88E+15	4.57E+14	1.72E+14	1.53E+14	1.80E+15	1.53E+15	6.04E+14	3.70E+14	2.78E+14
75.0	2.08E+15	1.35E+15	2.90E+14	9.02E+13	9.48E+13	1.30E+15	1.07E+15	3.95E+14	2.41E+14	1.85E+14
86.6	1.46E+15	9.10E+14	1.75E+14	5.12E+13	6.79E+13	8.76E+14	6.96E+14	2.43E+14	1.54E+14	1.23E+14
100.0	9.68E+14	5.76E+14	1.02E+14	3.50E+13	5.60E+13	5.53E+14	4.24E+14	1.42E+14	9.73E+13	8.17E+13
115.0	6.03E+14	3.45E+14	6.13E+13	2.88E+13	4.93E+13	3.29E+14	2.43E+14	8.10E+13	6.38E+13	5.53E+13
133.0	3.51E+14	1.93E+14	3.92E+13	2.53E+13	4.32E+13	1.83E+14	1.32E+14	4.70E+13	4.54E+13	3.99E+13
154.0	1.89E+14	1.02E+14	2.82E+13	2.20E+13	3.71E+13	9.54E+13	6.82E+13	3.01E+13	3.64E+13	3.26E+13
178.0	9.17E+13	5.11E+13	2.31E+13	1.83E+13	3.11E+13	4.62E+13	3.47E+13	2.26E+13	3.23E+13	2.98E+13
205.0	3.98E+13	2.62E+13	2.12E+13	1.45E+13	2.59E+13	2.15E+13	1.90E+13	2.00E+13	3.07E+13	2.90E+13
237.0	1.88E+13	1.77E+13	2.11E+13	1.16E+13	2.22E+13	1.26E+13	1.42E+13	2.01E+13	3.07E+13	2.94E+13

TABLE A-11.—(Continued).

Test Point No.	711	712	713	714	715	715	716	717	718	719
Date	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004
Fuel	base	base	base	base	base	base	base	base	base	base
Power (%)	4	100	85	65	4	4	100	85	65	4
Aerosol Point No.	712	714	715	716	717	718	719	720	721	722
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	2.43E+15	7.96E+14	1.03E+15	6.79E+14	3.23E+15	1.82E+16	1.49E+15	1.37E+15	1.23E+15	1.71E+16
11.5	3.99E+15	1.18E+15	1.34E+15	8.15E+14	4.62E+15	1.63E+16	1.73E+15	1.64E+15	1.27E+15	1.36E+16
13.3	2.70E+15	1.48E+15	1.57E+15	8.95E+14	3.20E+15	9.01E+15	1.95E+15	1.86E+15	1.33E+15	7.84E+15
15.4	2.24E+15	1.64E+15	1.69E+15	9.39E+14	2.67E+15	6.23E+15	2.06E+15	1.96E+15	1.37E+15	5.54E+15
17.8	1.90E+15	1.77E+15	1.80E+15	9.62E+14	2.25E+15	4.59E+15	2.15E+15	2.03E+15	1.39E+15	4.15E+15
20.5	1.59E+15	2.10E+15	2.09E+15	1.04E+15	1.87E+15	3.49E+15	2.44E+15	2.30E+15	1.50E+15	3.20E+15
23.7	1.33E+15	2.71E+15	2.64E+15	1.19E+15	1.55E+15	2.74E+15	3.02E+15	2.84E+15	1.70E+15	2.56E+15
27.4	1.09E+15	3.35E+15	3.19E+15	1.31E+15	1.28E+15	2.19E+15	3.59E+15	3.36E+15	1.84E+15	2.07E+15
31.6	8.56E+14	3.75E+15	3.50E+15	1.28E+15	9.98E+14	1.68E+15	3.91E+15	3.61E+15	1.79E+15	1.59E+15
36.5	6.19E+14	3.85E+15	3.51E+15	1.16E+15	7.21E+14	1.22E+15	3.92E+15	3.58E+15	1.61E+15	1.15E+15
42.2	4.12E+14	3.66E+15	3.26E+15	9.63E+14	4.84E+14	8.27E+14	3.67E+15	3.30E+15	1.34E+15	7.77E+14
48.7	2.48E+14	3.25E+15	2.83E+15	7.40E+14	2.95E+14	5.16E+14	3.23E+15	2.86E+15	1.04E+15	4.83E+14
56.2	1.30E+14	2.70E+15	2.29E+15	5.28E+14	1.60E+14	2.93E+14	2.68E+15	2.33E+15	7.62E+14	2.78E+14
64.9	5.82E+13	2.10E+15	1.73E+15	3.51E+14	7.76E+13	1.56E+14	2.10E+15	1.79E+15	5.27E+14	1.54E+14
75.0	2.29E+13	1.53E+15	1.23E+15	2.17E+14	3.47E+13	8.03E+13	1.55E+15	1.30E+15	3.45E+14	8.71E+13
86.6	9.22E+12	1.05E+15	8.10E+14	1.23E+14	1.52E+13	4.24E+13	1.08E+15	8.92E+14	2.11E+14	5.22E+13
100.0	5.05E+12	6.73E+14	4.99E+14	6.35E+13	6.83E+12	2.31E+13	7.04E+14	5.71E+14	1.17E+14	3.18E+13
115.0	4.10E+12	4.05E+14	2.88E+14	2.98E+13	3.33E+12	1.30E+13	4.30E+14	3.41E+14	5.85E+13	1.91E+13
133.0	3.90E+12	2.27E+14	1.55E+14	1.35E+13	2.04E+12	7.82E+12	2.44E+14	1.89E+14	2.64E+13	1.17E+13
154.0	3.57E+12	1.17E+14	7.75E+13	7.54E+12	1.87E+12	5.68E+12	1.29E+14	9.81E+13	1.31E+13	8.35E+12
178.0	2.99E+12	5.38E+13	3.55E+13	6.47E+12	1.95E+12	4.75E+12	6.33E+13	4.88E+13	1.01E+13	7.11E+12
205.0	2.34E+12	2.15E+13	1.58E+13	7.57E+12	1.85E+12	3.96E+12	3.17E+13	2.67E+13	1.16E+13	6.35E+12
237.0	1.90E+12	9.95E+12	1.03E+13	1.01E+13	1.71E+12	3.30E+12	2.19E+13	2.14E+13	1.50E+13	5.69E+12

TABLE A-11.—(Continued).

Test Point No.	719	720	721	722	723	724	725	726	727	728
Date	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004
Fuel	base	base	base	base	base	base	base	sulfur	sulfur	sulfur
Power (%)	4	100	85	70	65	60	4	4	100	85
Aerosol Point No.	723	724	725	726	727	728	729	732	733	734
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	6.37E+16	1.33E+16	1.40E+16	2.45E+16	2.91E+16	3.28E+16	6.66E+16	5.19E+16	1.20E+15	1.20E+15
11.5	7.80E+16	1.10E+16	1.13E+16	1.98E+16	2.38E+16	2.68E+16	7.84E+16	6.97E+16	1.29E+15	1.25E+15
13.3	7.00E+16	6.01E+15	5.70E+15	9.32E+15	1.13E+16	1.25E+16	6.76E+16	6.78E+16	1.27E+15	1.20E+15
15.4	5.27E+16	3.16E+15	2.53E+15	2.98E+15	3.50E+15	3.63E+15	4.91E+16	5.40E+16	1.33E+15	1.23E+15
17.8	3.18E+16	2.31E+15	1.59E+15	9.02E+14	8.19E+14	5.21E+14	2.87E+16	3.40E+16	1.38E+15	1.27E+15
20.5	1.46E+16	2.49E+15	1.82E+15	1.03E+15	8.15E+14	4.81E+14	1.27E+16	1.62E+16	1.50E+15	1.35E+15
23.7	5.30E+15	2.83E+15	2.24E+15	1.46E+15	1.21E+15	8.91E+14	4.35E+15	5.99E+15	1.75E+15	1.53E+15
27.4	2.02E+15	3.01E+15	2.49E+15	1.59E+15	1.32E+15	9.81E+14	1.62E+15	2.08E+15	2.01E+15	1.70E+15
31.6	9.67E+14	3.00E+15	2.53E+15	1.53E+15	1.24E+15	8.87E+14	8.16E+14	7.62E+14	2.16E+15	1.78E+15
36.5	7.89E+14	2.84E+15	2.39E+15	1.33E+15	1.04E+15	7.00E+14	7.31E+14	5.21E+14	2.16E+15	1.73E+15
42.2	7.65E+14	2.56E+15	2.13E+15	1.09E+15	8.14E+14	5.08E+14	7.27E+14	5.34E+14	2.03E+15	1.58E+15
48.7	5.77E+14	2.20E+15	1.81E+15	8.51E+14	6.15E+14	3.60E+14	5.39E+14	4.25E+14	1.79E+15	1.35E+15
56.2	3.26E+14	1.82E+15	1.46E+15	6.43E+14	4.53E+14	2.59E+14	2.93E+14	2.33E+14	1.49E+15	1.10E+15
64.9	1.40E+14	1.43E+15	1.12E+15	4.64E+14	3.24E+14	1.87E+14	1.17E+14	8.05E+13	1.18E+15	8.41E+14
75.0	4.82E+13	1.06E+15	8.09E+14	3.17E+14	2.19E+14	1.32E+14	3.55E+13	9.94E+12	8.79E+14	6.07E+14
86.6	2.23E+13	7.45E+14	5.50E+14	2.00E+14	1.38E+14	8.59E+13	1.66E+13	9.27E+10	6.18E+14	4.11E+14
100.0	2.19E+13	4.88E+14	3.47E+14	1.14E+14	7.74E+13	4.94E+13	1.91E+13	0.00E+00	4.08E+14	2.60E+14
115.0	2.33E+13	2.99E+14	2.04E+14	5.89E+13	3.85E+13	2.46E+13	2.07E+13	1.01E+12	2.53E+14	1.53E+14
133.0	2.03E+13	1.69E+14	1.10E+14	2.77E+13	1.75E+13	1.13E+13	1.76E+13	2.41E+12	1.44E+14	8.22E+13
154.0	1.54E+13	8.84E+13	5.55E+13	1.38E+13	9.21E+12	6.92E+12	1.29E+13	2.96E+12	7.46E+13	4.03E+13
178.0	1.11E+13	4.28E+13	2.69E+13	9.30E+12	7.51E+12	6.93E+12	9.11E+12	2.57E+12	3.48E+13	1.84E+13
205.0	8.16E+12	2.02E+13	1.41E+13	8.63E+12	8.11E+12	8.13E+12	6.60E+12	1.80E+12	1.52E+13	9.19E+12
237.0	6.46E+12	1.19E+13	1.03E+13	9.31E+12	9.26E+12	9.34E+12	4.86E+12	1.18E+12	8.33E+12	7.00E+12

TABLE A-11.—(Continued).

Test Point No.	729	730	731	732	733	733	734	735	736	737
Date	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004
Fuel	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur
Power (%)	65	40	30	7	4	4	100	85	65	40
Aerosol Point No.	735	736	737	738	739	740	741	742	743	744
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	2.32E+16	6.62E+16	7.56E+16	7.15E+16	5.65E+16	3.89E+15	2.64E+14	2.34E+14	2.42E+14	2.85E+14
11.5	2.02E+16	6.48E+16	7.30E+16	8.53E+16	7.63E+16	5.60E+15	5.59E+14	5.09E+14	4.41E+14	4.74E+14
13.3	1.03E+16	4.05E+16	4.47E+16	7.21E+16	7.41E+16	3.11E+15	6.92E+14	6.43E+14	4.46E+14	4.07E+14
15.4	3.69E+15	1.97E+16	2.11E+16	4.99E+16	5.86E+16	2.22E+15	7.81E+14	7.35E+14	4.71E+14	3.98E+14
17.8	1.08E+15	7.36E+15	7.49E+15	2.63E+16	3.60E+16	1.69E+15	8.42E+14	7.98E+14	4.93E+14	4.00E+14
20.5	7.53E+14	1.87E+15	1.73E+15	8.83E+15	1.61E+16	1.34E+15	9.54E+14	9.03E+14	5.34E+14	4.09E+14
23.7	9.06E+14	2.47E+14	1.73E+14	1.17E+15	5.03E+15	1.08E+15	1.19E+15	1.11E+15	6.11E+14	4.21E+14
27.4	9.30E+14	1.55E+14	6.62E+13	3.12E+13	1.21E+15	8.79E+14	1.49E+15	1.38E+15	6.90E+14	4.16E+14
31.6	8.46E+14	2.69E+14	1.69E+14	0.00E+00	1.79E+14	6.89E+14	1.73E+15	1.57E+15	7.14E+14	3.75E+14
36.5	6.97E+14	3.37E+14	2.50E+14	1.14E+14	2.16E+14	5.02E+14	1.84E+15	1.64E+15	6.71E+14	3.04E+14
42.2	5.34E+14	3.02E+14	2.38E+14	2.10E+14	4.15E+14	3.41E+14	1.80E+15	1.57E+15	5.79E+14	2.27E+14
48.7	3.94E+14	1.81E+14	1.43E+14	1.66E+14	3.84E+14	2.11E+14	1.63E+15	1.40E+15	4.61E+14	1.54E+14
56.2	2.84E+14	7.34E+13	5.24E+13	6.98E+13	2.11E+14	1.16E+14	1.38E+15	1.16E+15	3.38E+14	9.30E+13
64.9	1.97E+14	1.65E+13	6.81E+12	8.92E+12	6.61E+13	5.60E+13	1.09E+15	8.96E+14	2.27E+14	5.07E+13
75.0	1.30E+14	1.84E+12	2.03E+11	0.00E+00	7.30E+12	2.41E+13	8.00E+14	6.40E+14	1.39E+14	2.52E+13
86.6	7.81E+13	3.04E+12	2.12E+12	0.00E+00	0.00E+00	9.64E+12	5.46E+14	4.24E+14	7.66E+13	1.14E+13
100.0	4.17E+13	6.22E+12	4.82E+12	0.00E+00	0.00E+00	3.84E+12	3.44E+14	2.58E+14	3.69E+13	4.45E+12
115.0	1.92E+13	6.24E+12	5.36E+12	1.40E+12	7.63E+10	1.67E+12	2.02E+14	1.45E+14	1.49E+13	1.26E+12
133.0	7.40E+12	3.93E+12	3.95E+12	2.68E+12	7.67E+11	8.05E+11	1.06E+14	7.27E+13	4.51E+12	1.75E+11
154.0	3.09E+12	1.74E+12	2.23E+12	2.78E+12	1.70E+12	4.88E+11	5.13E+13	3.32E+13	1.25E+12	4.89E+10
178.0	2.85E+12	9.26E+11	1.34E+12	2.02E+12	2.05E+12	4.17E+11	2.20E+13	1.37E+13	1.27E+12	1.97E+11
205.0	4.24E+12	1.32E+12	1.37E+12	1.17E+12	1.73E+12	4.37E+11	8.37E+12	5.48E+12	2.41E+12	6.51E+11
237.0	5.78E+12	2.12E+12	1.76E+12	8.36E+11	1.18E+12	4.26E+11	3.65E+12	3.33E+12	3.72E+12	1.34E+12

TABLE A-11.—(Continued).

Test Point No.	738	739	740	740	741	742	743	744	745	746
Date	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004
Fuel	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur
Power (%)	30	7	4	4	100	85	70	65	60	40
Aerosol Point No.	745	746	747	748	749	750	751	752	753	754
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	3.27E+14	1.18E+15	3.55E+15	1.46E+15	7.20E+14	7.72E+14	5.02E+14	4.57E+14	3.68E+14	5.28E+14
11.5	5.25E+14	1.64E+15	5.06E+15	1.87E+15	8.51E+14	9.37E+14	5.86E+14	5.34E+14	4.78E+14	6.46E+14
13.3	4.14E+14	8.58E+14	2.83E+15	1.34E+15	9.68E+14	1.07E+15	5.83E+14	5.17E+14	4.40E+14	5.23E+14
15.4	3.86E+14	6.03E+14	2.04E+15	1.14E+15	1.03E+15	1.15E+15	5.95E+14	5.26E+14	4.41E+14	4.89E+14
17.8	3.75E+14	4.75E+14	1.57E+15	9.80E+14	1.09E+15	1.22E+15	6.11E+14	5.38E+14	4.49E+14	4.74E+14
20.5	3.71E+14	3.98E+14	1.25E+15	8.44E+14	1.29E+15	1.42E+15	6.70E+14	5.83E+14	4.77E+14	4.73E+14
23.7	3.66E+14	3.39E+14	1.01E+15	7.21E+14	1.67E+15	1.79E+15	7.90E+14	6.71E+14	5.31E+14	4.79E+14
27.4	3.47E+14	2.81E+14	8.18E+14	6.02E+14	2.09E+15	2.17E+15	8.99E+14	7.43E+14	5.70E+14	4.67E+14
31.6	2.99E+14	2.18E+14	6.33E+14	4.71E+14	2.37E+15	2.39E+15	9.28E+14	7.42E+14	5.54E+14	4.14E+14
36.5	2.33E+14	1.53E+14	4.55E+14	3.38E+14	2.47E+15	2.41E+15	8.76E+14	6.77E+14	4.88E+14	3.35E+14
42.2	1.65E+14	9.75E+13	3.03E+14	2.25E+14	2.37E+15	2.26E+15	7.64E+14	5.70E+14	3.97E+14	2.49E+14
48.7	1.06E+14	5.55E+13	1.83E+14	1.34E+14	2.13E+15	1.97E+15	6.17E+14	4.44E+14	2.96E+14	1.69E+14
56.2	6.00E+13	2.70E+13	9.71E+13	7.04E+13	1.79E+15	1.61E+15	4.62E+14	3.20E+14	2.03E+14	1.03E+14
64.9	3.06E+13	1.23E+13	4.55E+13	3.31E+13	1.41E+15	1.23E+15	3.21E+14	2.14E+14	1.28E+14	5.75E+13
75.0	1.50E+13	7.04E+12	1.96E+13	1.48E+13	1.04E+15	8.76E+14	2.07E+14	1.33E+14	7.47E+13	3.04E+13
86.6	7.55E+12	5.59E+12	8.75E+12	7.04E+12	7.20E+14	5.84E+14	1.21E+14	7.47E+13	3.93E+13	1.51E+13
100.0	3.84E+12	4.45E+12	4.40E+12	3.46E+12	4.66E+14	3.62E+14	6.34E+13	3.64E+13	1.74E+13	6.35E+12
115.0	1.67E+12	2.70E+12	2.27E+12	1.39E+12	2.82E+14	2.09E+14	2.87E+13	1.42E+13	5.70E+12	1.75E+12
133.0	4.89E+11	1.05E+12	9.94E+11	3.31E+11	1.59E+14	1.11E+14	1.06E+13	3.57E+12	8.85E+11	1.89E+11
154.0	1.30E+11	2.91E+11	4.70E+11	7.95E+10	8.21E+13	5.45E+13	3.58E+12	8.29E+11	3.55E+09	2.59E+09
178.0	1.55E+11	1.92E+11	4.05E+11	1.06E+11	3.92E+13	2.54E+13	2.51E+12	2.03E+12	7.97E+11	1.65E+11
205.0	3.37E+11	2.78E+11	4.74E+11	1.69E+11	1.90E+13	1.31E+13	3.92E+12	4.55E+12	2.43E+12	9.53E+11
237.0	5.52E+11	3.31E+11	5.08E+11	2.00E+11	1.27E+13	1.04E+13	5.93E+12	7.04E+12	4.28E+12	2.20E+12

TABLE A-11.—(Continued).

Test Point No.	747	748	749	750	751	751	802	803	804	805
Date	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/27/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004
Fuel	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur
Power (%)	30	15	7	5.5	4	4	100	85	65	40
Aerosol Point No.	755	756	757	758	759	801	802	803	804	805
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	4.48E+14	4.51E+14	6.32E+14	8.84E+14	1.35E+15	3.95E+15	7.38E+14	1.08E+15	5.46E+14	4.12E+14
11.5	5.55E+14	6.61E+14	9.32E+14	1.30E+15	2.04E+15	5.05E+15	1.00E+15	1.23E+15	6.56E+14	6.64E+14
13.3	4.28E+14	4.77E+14	6.26E+14	8.99E+14	1.47E+15	3.85E+15	1.21E+15	1.35E+15	7.18E+14	6.03E+14
15.4	3.87E+14	4.06E+14	5.09E+14	7.47E+14	1.26E+15	3.39E+15	1.32E+15	1.41E+15	7.67E+14	5.95E+14
17.8	3.76E+14	3.54E+14	4.31E+14	6.39E+14	1.10E+15	2.99E+15	1.40E+15	1.47E+15	8.07E+14	5.84E+14
20.5	3.78E+14	3.11E+14	3.67E+14	5.48E+14	9.48E+14	2.63E+15	1.63E+15	1.68E+15	8.79E+14	5.70E+14
23.7	3.77E+14	2.75E+14	3.09E+14	4.65E+14	8.13E+14	2.32E+15	2.09E+15	2.09E+15	9.94E+14	5.58E+14
27.4	3.56E+14	2.39E+14	2.52E+14	3.85E+14	6.81E+14	2.03E+15	2.58E+15	2.52E+15	1.08E+15	5.33E+14
31.6	3.05E+14	1.94E+14	1.92E+14	2.98E+14	5.36E+14	1.68E+15	2.91E+15	2.76E+15	1.06E+15	4.71E+14
36.5	2.38E+14	1.42E+14	1.33E+14	2.11E+14	3.87E+14	1.28E+15	2.99E+15	2.77E+15	9.45E+14	3.78E+14
42.2	1.70E+14	9.57E+13	8.44E+13	1.37E+14	2.58E+14	9.08E+14	2.85E+15	2.56E+15	7.78E+14	2.72E+14
48.7	1.10E+14	5.79E+13	4.80E+13	8.00E+13	1.55E+14	5.86E+14	2.52E+15	2.20E+15	5.87E+14	1.73E+14
56.2	6.32E+13	3.05E+13	2.36E+13	4.08E+13	8.16E+13	3.37E+14	2.09E+15	1.76E+15	4.02E+14	9.31E+13
64.9	3.40E+13	1.53E+13	1.14E+13	1.93E+13	3.84E+13	1.71E+14	1.61E+15	1.31E+15	2.49E+14	3.83E+13
75.0	1.81E+13	8.90E+12	7.42E+12	1.00E+13	1.73E+13	7.45E+13	1.16E+15	9.08E+14	1.37E+14	9.78E+12
86.6	9.86E+12	6.38E+12	6.24E+12	6.27E+12	8.40E+12	2.74E+13	7.77E+14	5.80E+14	6.62E+13	9.22E+11
100.0	4.84E+12	4.38E+12	4.74E+12	3.89E+12	4.27E+12	8.47E+12	4.83E+14	3.41E+14	2.72E+13	0.00E+00
115.0	1.67E+12	2.18E+12	2.50E+12	1.74E+12	1.83E+12	3.17E+12	2.78E+14	1.85E+14	9.57E+12	1.51E+10
133.0	2.69E+11	5.79E+11	7.09E+11	3.80E+11	4.90E+11	2.76E+12	1.47E+14	9.29E+13	3.15E+12	3.73E+10
154.0	1.23E+10	7.51E+10	1.07E+11	2.57E+10	9.68E+10	3.53E+12	7.12E+13	4.41E+13	1.48E+12	4.01E+10
178.0	1.46E+11	1.22E+11	1.78E+11	5.65E+10	1.03E+11	4.31E+12	3.13E+13	2.13E+13	1.10E+12	2.38E+10
205.0	5.48E+11	2.74E+11	4.03E+11	1.86E+11	2.28E+11	4.81E+12	1.35E+13	1.25E+13	8.65E+11	6.22E+09
237.0	1.09E+12	3.71E+11	5.58E+11	3.43E+11	3.58E+11	4.92E+12	8.67E+12	1.11E+13	5.68E+11	0.00E+00

TABLE A-11.—(Continued).

Test Point No.	805	805	806	807	808	808	809	810	811	812
Date	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004
Fuel	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur
Power (%)	40	40	30	7	4	4	100	85	65	40
Aerosol Point No.	806	807	809	810	811	812	813	814	815	816
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	3.29E+14	1.47E+15	8.26E+14	6.34E+14	1.52E+15	1.36E+16	1.21E+15	1.25E+15	8.63E+14	9.07E+14
11.5	7.16E+14	1.31E+15	8.86E+14	8.46E+14	2.06E+15	1.09E+16	1.31E+15	1.33E+15	8.67E+14	8.51E+14
13.3	5.77E+14	9.74E+14	6.89E+14	6.02E+14	1.44E+15	5.36E+15	1.44E+15	1.45E+15	8.92E+14	7.74E+14
15.4	5.61E+14	8.32E+14	6.09E+14	4.99E+14	1.19E+15	3.30E+15	1.50E+15	1.50E+15	8.94E+14	7.29E+14
17.8	5.51E+14	7.39E+14	5.49E+14	4.15E+14	9.92E+14	2.22E+15	1.55E+15	1.53E+15	8.81E+14	6.77E+14
20.5	5.38E+14	6.79E+14	4.99E+14	3.42E+14	8.15E+14	1.58E+15	1.77E+15	1.70E+15	9.17E+14	6.37E+14
23.7	5.25E+14	6.44E+14	4.58E+14	2.79E+14	6.63E+14	1.18E+15	2.20E+15	2.07E+15	1.02E+15	6.15E+14
27.4	4.99E+14	6.02E+14	4.12E+14	2.26E+14	5.32E+14	8.85E+14	2.63E+15	2.41E+15	1.09E+15	5.78E+14
31.6	4.44E+14	5.25E+14	3.47E+14	1.73E+14	4.05E+14	6.44E+14	2.87E+15	2.56E+15	1.05E+15	4.98E+14
36.5	3.58E+14	4.17E+14	2.65E+14	1.20E+14	2.82E+14	4.39E+14	2.87E+15	2.50E+15	9.27E+14	3.94E+14
42.2	2.61E+14	2.97E+14	1.82E+14	7.28E+13	1.76E+14	2.75E+14	2.66E+15	2.26E+15	7.57E+14	2.85E+14
48.7	1.71E+14	1.87E+14	1.09E+14	3.77E+13	9.46E+13	1.52E+14	2.31E+15	1.91E+15	5.67E+14	1.84E+14
56.2	9.58E+13	9.78E+13	5.35E+13	1.51E+13	3.97E+13	6.89E+13	1.87E+15	1.51E+15	3.92E+14	1.04E+14
64.9	4.30E+13	3.90E+13	1.93E+13	4.02E+12	1.06E+13	2.27E+13	1.43E+15	1.11E+15	2.51E+14	5.05E+13
75.0	1.35E+13	1.02E+13	4.58E+12	6.35E+11	1.16E+12	3.83E+12	1.02E+15	7.64E+14	1.48E+14	2.04E+13
86.6	2.08E+12	1.39E+12	1.02E+12	6.11E+10	0.00E+00	1.42E+11	6.78E+14	4.89E+14	7.90E+13	6.36E+12
100.0	0.00E+00	1.92E+11	6.29E+11	5.96E+10	0.00E+00	0.00E+00	4.22E+14	2.89E+14	3.59E+13	1.29E+12
115.0	0.00E+00	6.99E+11	6.51E+11	2.50E+11	0.00E+00	1.30E+11	2.44E+14	1.58E+14	1.29E+13	1.46E+11
133.0	1.57E+10	1.22E+12	7.20E+11	5.17E+11	0.00E+00	2.45E+11	1.31E+14	7.97E+13	3.71E+12	9.18E+09
154.0	4.41E+10	1.17E+12	7.67E+11	6.60E+11	0.00E+00	2.19E+11	6.53E+13	3.84E+13	2.29E+12	2.76E+10
178.0	4.54E+10	6.82E+11	7.12E+11	5.71E+11	0.00E+00	9.66E+10	3.06E+13	1.87E+13	3.40E+12	5.51E+10
205.0	2.44E+10	2.29E+11	5.16E+11	3.31E+11	0.00E+00	1.82E+10	1.46E+13	1.04E+13	4.19E+12	3.83E+10
237.0	5.12E+09	2.93E+10	2.34E+11	9.84E+10	0.00E+00	7.95E+08	9.32E+12	7.97E+12	4.36E+12	4.84E+09

TABLE A-11.—(Continued).

Test Point No.	812	812	812	813	814	815	815	816	817	818
Date	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004
Fuel	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur
Power (%)	40	40	40	30	7	4	4	100	85	70
Aerosol Point No.	817	818	819	820	821	822	823	824	825	826
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	4.12E+14	1.04E+15	7.01E+14	9.26E+14	4.33E+15	1.13E+16	1.38E+17	7.89E+16	6.88E+16	1.32E+17
11.5	6.79E+14	9.15E+14	8.32E+14	8.57E+14	2.94E+15	9.15E+15	1.78E+17	6.89E+16	5.83E+16	1.14E+17
13.3	5.91E+14	8.36E+14	7.38E+14	7.34E+14	1.47E+15	4.82E+15	1.62E+17	3.40E+16	2.75E+16	5.36E+16
15.4	5.77E+14	7.75E+14	7.08E+14	6.73E+14	9.64E+14	3.18E+15	1.22E+17	1.16E+16	8.70E+15	1.50E+16
17.8	5.65E+14	7.11E+14	6.78E+14	6.14E+14	7.07E+14	2.27E+15	7.16E+16	3.60E+15	2.50E+15	1.66E+15
20.5	5.54E+14	6.75E+14	6.59E+14	5.66E+14	5.49E+14	1.71E+15	2.97E+16	3.53E+15	2.99E+15	1.30E+15
23.7	5.50E+14	6.74E+14	6.57E+14	5.32E+14	4.36E+14	1.32E+15	7.77E+15	5.01E+15	4.42E+15	2.95E+15
27.4	5.34E+14	6.54E+14	6.36E+14	4.86E+14	3.41E+14	1.03E+15	1.23E+15	5.83E+15	5.04E+15	3.38E+15
31.6	4.78E+14	5.71E+14	5.64E+14	4.08E+14	2.50E+14	7.69E+14	9.10E+13	6.07E+15	5.09E+15	3.17E+15
36.5	3.86E+14	4.53E+14	4.54E+14	3.10E+14	1.68E+14	5.36E+14	4.49E+14	5.78E+15	4.69E+15	2.57E+15
42.2	2.84E+14	3.31E+14	3.34E+14	2.15E+14	1.02E+14	3.45E+14	8.27E+14	5.15E+15	4.05E+15	1.92E+15
48.7	1.88E+14	2.13E+14	2.20E+14	1.31E+14	5.26E+13	1.97E+14	6.75E+14	4.39E+15	3.35E+15	1.40E+15
56.2	1.07E+14	1.21E+14	1.27E+14	6.62E+13	2.05E+13	9.57E+13	2.98E+14	3.56E+15	2.65E+15	1.02E+15
64.9	5.15E+13	6.48E+13	6.39E+13	2.82E+13	6.63E+12	3.87E+13	5.35E+13	2.73E+15	1.98E+15	7.26E+14
75.0	1.94E+13	3.42E+13	2.78E+13	1.02E+13	3.32E+12	1.30E+13	2.76E+12	1.96E+15	1.38E+15	4.85E+14
86.6	5.01E+12	1.76E+13	1.05E+13	3.69E+12	3.19E+12	4.07E+12	0.00E+00	1.31E+15	8.86E+14	2.93E+14
100.0	6.13E+11	6.71E+12	3.25E+12	1.34E+12	2.16E+12	1.30E+12	0.00E+00	8.08E+14	5.19E+14	1.51E+14
115.0	5.34E+09	9.36E+11	7.47E+11	3.06E+11	6.56E+11	2.92E+11	0.00E+00	4.60E+14	2.75E+14	6.11E+13
133.0	1.19E+10	6.63E+10	1.38E+11	2.59E+10	6.63E+10	2.35E+10	1.02E+11	2.37E+14	1.29E+14	1.68E+13
154.0	4.80E+10	8.45E+10	9.38E+10	0.00E+00	0.00E+00	0.00E+00	3.37E+11	1.12E+14	5.58E+13	4.74E+12
178.0	7.64E+10	1.27E+11	1.48E+11	0.00E+00	0.00E+00	0.00E+00	3.60E+11	4.87E+13	2.45E+13	6.40E+12
205.0	5.79E+10	6.46E+10	1.32E+11	0.00E+00	0.00E+00	0.00E+00	1.66E+11	2.04E+13	1.27E+13	9.35E+12
237.0	1.74E+10	4.75E+09	4.96E+10	0.00E+00	0.00E+00	0.00E+00	2.26E+10	1.03E+13	9.00E+12	9.81E+12

TABLE A-11.—(Continued).

Test Point No.	819	820	821	822	823	824	825	826	827	828
Date	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004
Fuel	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	aromatic	aromatic
Power (%)	65	60	40	30	15	7	5.5	4	4	100
Aerosol Point No.	827	828	829	830	831	832	833	834	836	837
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	1.50E+17	1.71E+17	1.95E+17	2.06E+17	2.20E+17	2.05E+17	1.72E+17	1.43E+17	1.14E+17	1.91E+15
11.5	1.29E+17	1.47E+17	1.69E+17	1.77E+17	1.99E+17	2.19E+17	2.02E+17	1.76E+17	1.25E+17	1.81E+15
13.3	6.05E+16	6.79E+16	7.97E+16	8.31E+16	1.07E+17	1.57E+17	1.65E+17	1.55E+17	9.28E+16	1.89E+15
15.4	1.68E+16	1.83E+16	2.26E+16	2.32E+16	3.97E+16	9.22E+16	1.12E+17	1.12E+17	5.93E+16	2.24E+15
17.8	1.84E+15	1.96E+15	2.52E+15	2.54E+15	8.99E+15	4.18E+16	5.93E+16	6.43E+16	3.24E+16	2.44E+15
20.5	8.94E+14	3.14E+14	0.00E+00	0.00E+00	9.36E+14	1.19E+16	2.08E+16	2.60E+16	1.48E+16	2.67E+15
23.7	2.32E+15	1.49E+15	1.22E+15	9.54E+14	1.48E+14	1.29E+15	3.48E+15	6.60E+15	6.25E+15	3.14E+15
27.4	2.68E+15	1.85E+15	1.58E+15	1.22E+15	3.70E+14	0.00E+00	2.00E+14	1.00E+15	3.24E+15	3.68E+15
31.6	2.47E+15	1.69E+15	1.41E+15	1.09E+15	4.87E+14	0.00E+00	0.00E+00	7.50E+13	2.08E+15	4.00E+15
36.5	1.93E+15	1.22E+15	9.13E+14	6.77E+14	3.70E+14	1.92E+14	4.03E+14	5.05E+14	1.58E+15	4.02E+15
42.2	1.35E+15	7.35E+14	4.28E+14	2.60E+14	1.79E+14	3.71E+14	7.03E+14	9.00E+14	1.21E+15	3.75E+15
48.7	9.28E+14	4.25E+14	1.65E+14	4.01E+13	4.45E+13	3.05E+14	5.51E+14	7.30E+14	7.61E+14	3.28E+15
56.2	6.53E+14	2.73E+14	8.26E+13	5.27E+12	4.10E+12	1.32E+14	2.30E+14	3.31E+14	3.70E+14	2.69E+15
64.9	4.62E+14	2.04E+14	7.91E+13	3.77E+13	0.00E+00	1.80E+13	3.09E+13	6.73E+13	1.29E+14	2.07E+15
75.0	3.13E+14	1.56E+14	8.22E+13	6.22E+13	1.35E+13	0.00E+00	0.00E+00	4.69E+12	2.77E+13	1.50E+15
86.6	1.92E+14	1.07E+14	6.74E+13	5.95E+13	2.71E+13	0.00E+00	0.00E+00	0.00E+00	9.04E+12	1.01E+15
100.0	9.68E+13	5.70E+13	3.89E+13	3.72E+13	2.60E+13	4.77E+12	0.00E+00	4.50E+11	1.74E+13	6.43E+14
115.0	3.52E+13	1.99E+13	1.37E+13	1.43E+13	1.43E+13	6.50E+12	1.61E+12	2.00E+12	2.54E+13	3.82E+14
133.0	6.11E+12	2.51E+12	1.70E+12	2.84E+12	3.86E+12	4.25E+12	2.44E+12	3.10E+12	2.58E+13	2.09E+14
154.0	9.67E+11	8.59E+10	0.00E+00	9.18E+11	4.77E+11	1.89E+12	2.07E+12	2.95E+12	2.05E+13	1.05E+14
178.0	4.99E+12	3.59E+12	3.14E+11	1.35E+12	2.24E+10	5.49E+11	1.08E+12	1.60E+12	1.37E+13	4.80E+13
205.0	8.37E+12	6.46E+12	3.08E+11	1.18E+12	0.00E+00	6.40E+10	2.48E+11	3.42E+11	8.26E+12	2.13E+13
237.0	8.65E+12	6.56E+12	5.51E+10	3.89E+11	0.00E+00	0.00E+00	1.83E+10	2.14E+10	5.06E+12	1.28E+13

TABLE A-11.—(Continued).

Test Point No.	829	830	831	832	833	834	834	835	836	837
Date	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004
Fuel	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic
Power (%)	85	65	40	30	7	4	4	100	85	65
Aerosol Point No.	838	839	840	841	842	843	844	845	846	847
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	1.71E+15	1.00E+16	2.90E+16	3.65E+16	8.04E+16	9.30E+16	2.22E+15	1.19E+15	9.98E+14	6.41E+14
11.5	1.52E+15	7.18E+15	2.16E+16	2.75E+16	7.10E+16	9.01E+16	3.01E+15	1.50E+15	1.29E+15	8.12E+14
13.3	1.60E+15	3.40E+15	8.79E+15	1.13E+16	3.66E+16	5.56E+16	1.97E+15	1.74E+15	1.50E+15	8.98E+14
15.4	1.98E+15	2.09E+15	2.71E+15	3.12E+15	1.35E+16	2.83E+16	1.59E+15	1.85E+15	1.61E+15	9.46E+14
17.8	2.18E+15	1.83E+15	1.03E+15	7.76E+14	3.63E+15	1.23E+16	1.31E+15	1.94E+15	1.69E+15	9.66E+14
20.5	2.34E+15	1.93E+15	1.18E+15	9.49E+14	1.35E+15	5.04E+15	1.08E+15	2.22E+15	1.91E+15	1.02E+15
23.7	2.68E+15	2.10E+15	1.42E+15	1.26E+15	1.09E+15	2.29E+15	8.75E+14	2.76E+15	2.32E+15	1.14E+15
27.4	3.05E+15	2.16E+15	1.31E+15	1.15E+15	8.69E+14	1.41E+15	6.99E+14	3.30E+15	2.72E+15	1.22E+15
31.6	3.22E+15	2.03E+15	1.06E+15	8.93E+14	6.34E+14	1.03E+15	5.28E+14	3.58E+15	2.89E+15	1.18E+15
36.5	3.14E+15	1.77E+15	7.68E+14	6.09E+14	3.87E+14	7.71E+14	3.68E+14	3.56E+15	2.82E+15	1.05E+15
42.2	2.84E+15	1.44E+15	5.11E+14	3.74E+14	1.91E+14	5.39E+14	2.37E+14	3.29E+15	2.55E+15	8.61E+14
48.7	2.41E+15	1.09E+15	3.25E+14	2.26E+14	8.98E+13	3.14E+14	1.37E+14	2.84E+15	2.15E+15	6.49E+14
56.2	1.91E+15	7.70E+14	2.03E+14	1.43E+14	5.84E+13	1.51E+14	6.81E+13	2.29E+15	1.69E+15	4.51E+14
64.9	1.41E+15	5.10E+14	1.27E+14	9.55E+13	5.31E+13	6.10E+13	2.86E+13	1.73E+15	1.25E+15	2.89E+14
75.0	9.78E+14	3.13E+14	7.92E+13	6.40E+13	5.04E+13	2.74E+13	1.00E+13	1.22E+15	8.55E+14	1.68E+14
86.6	6.29E+14	1.76E+14	4.91E+13	4.20E+13	4.39E+13	2.21E+13	3.55E+12	8.07E+14	5.46E+14	8.84E+13
100.0	3.75E+14	8.91E+13	3.04E+13	2.77E+13	3.57E+13	2.45E+13	2.31E+12	4.96E+14	3.23E+14	4.08E+13
115.0	2.08E+14	4.14E+13	1.99E+13	2.02E+13	2.90E+13	2.53E+13	2.51E+12	2.85E+14	1.78E+14	1.66E+13
133.0	1.06E+14	1.95E+13	1.42E+13	1.65E+13	2.41E+13	2.23E+13	2.59E+12	1.51E+14	9.01E+13	6.40E+12
154.0	5.10E+13	1.27E+13	1.11E+13	1.39E+13	1.96E+13	1.68E+13	2.18E+12	7.43E+13	4.25E+13	3.62E+12
178.0	2.42E+13	1.25E+13	9.31E+12	1.12E+13	1.47E+13	1.10E+13	1.46E+12	3.47E+13	2.00E+13	4.02E+12
205.0	1.37E+13	1.45E+13	8.76E+12	8.81E+12	9.74E+12	6.27E+12	7.55E+11	1.86E+13	1.23E+13	5.66E+12
237.0	1.19E+13	1.73E+13	9.69E+12	7.65E+12	5.87E+12	3.46E+12	3.27E+11	1.64E+13	1.26E+13	7.79E+12

TABLE A-11.—(Continued).

Test Point No.	838	839	840	841	841	842	843	844	845	846
Date	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004
Fuel	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic
Power (%)	40	30	7	4	4	100	85	100	85	70
Aerosol Point No.	848	849	850	851	852	853	854	855	856	857
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	4.54E+14	4.15E+14	8.65E+14	3.13E+15	1.34E+15	5.97E+14	5.87E+14	4.50E+14	6.82E+14	3.95E+14
11.5	6.23E+14	5.82E+14	1.09E+15	3.98E+15	2.23E+15	1.00E+15	9.87E+14	8.35E+14	1.05E+15	6.09E+14
13.3	6.35E+14	5.92E+14	8.04E+14	2.61E+15	1.66E+15	1.32E+15	1.30E+15	1.15E+15	1.33E+15	7.39E+14
15.4	6.44E+14	5.96E+14	6.82E+14	2.09E+15	1.44E+15	1.52E+15	1.48E+15	1.34E+15	1.49E+15	8.26E+14
17.8	6.38E+14	5.79E+14	5.87E+14	1.70E+15	1.25E+15	1.66E+15	1.61E+15	1.47E+15	1.60E+15	8.74E+14
20.5	6.27E+14	5.52E+14	4.99E+14	1.37E+15	1.06E+15	1.96E+15	1.86E+15	1.73E+15	1.84E+15	9.52E+14
23.7	6.16E+14	5.21E+14	4.12E+14	1.09E+15	8.74E+14	2.50E+15	2.34E+15	2.21E+15	2.29E+15	1.09E+15
27.4	5.77E+14	4.71E+14	3.27E+14	8.42E+14	6.99E+14	3.05E+15	2.83E+15	2.70E+15	2.73E+15	1.21E+15
31.6	4.90E+14	3.87E+14	2.41E+14	6.19E+14	5.24E+14	3.38E+15	3.09E+15	2.98E+15	2.96E+15	1.22E+15
36.5	3.78E+14	2.91E+14	1.63E+14	4.20E+14	3.58E+14	3.41E+15	3.08E+15	3.00E+15	2.94E+15	1.11E+15
42.2	2.67E+14	1.99E+14	1.02E+14	2.63E+14	2.21E+14	3.17E+15	2.84E+15	2.79E+15	2.69E+15	9.28E+14
48.7	1.69E+14	1.22E+14	5.69E+13	1.46E+14	1.19E+14	2.75E+15	2.43E+15	2.42E+15	2.29E+15	7.14E+14
56.2	9.50E+13	6.57E+13	2.81E+13	6.91E+13	5.12E+13	2.23E+15	1.93E+15	1.95E+15	1.82E+15	5.03E+14
64.9	4.76E+13	3.11E+13	1.29E+13	2.69E+13	1.58E+13	1.68E+15	1.43E+15	1.47E+15	1.34E+15	3.24E+14
75.0	2.17E+13	1.33E+13	6.59E+12	8.46E+12	2.47E+12	1.18E+15	9.83E+14	1.03E+15	9.15E+14	1.88E+14
86.6	9.46E+12	5.70E+12	4.52E+12	2.69E+12	0.00E+00	7.73E+14	6.25E+14	6.77E+14	5.78E+14	9.64E+13
100.0	4.43E+12	3.13E+12	3.75E+12	1.86E+12	0.00E+00	4.70E+14	3.66E+14	4.12E+14	3.35E+14	4.18E+13
115.0	2.55E+12	2.41E+12	3.10E+12	2.17E+12	0.00E+00	2.65E+14	1.98E+14	2.33E+14	1.79E+14	1.45E+13
133.0	1.77E+12	2.02E+12	2.34E+12	2.26E+12	0.00E+00	1.37E+14	9.70E+13	1.21E+14	8.71E+13	3.70E+12
154.0	1.38E+12	1.53E+12	1.63E+12	1.87E+12	0.00E+00	6.48E+13	4.33E+13	5.75E+13	3.86E+13	1.48E+12
178.0	1.28E+12	1.04E+12	9.97E+11	1.21E+12	0.00E+00	2.75E+13	1.80E+13	2.46E+13	1.62E+13	2.59E+12
205.0	1.54E+12	7.90E+11	4.83E+11	5.67E+11	0.00E+00	1.15E+13	8.67E+12	1.04E+13	8.43E+12	4.65E+12
237.0	2.16E+12	9.35E+11	1.66E+11	1.77E+11	0.00E+00	7.92E+12	7.78E+12	7.24E+12	8.27E+12	6.89E+12

TABLE A-11.—(Continued).

Test Point No.	847	848	849	850	851	852	853	854	854	855
Date	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004
Fuel	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic
Power (%)	65	60	40	30	15	7	5.5	4	4	100
Aerosol Point No.	858	859	860	861	862	863	864	865	866	867
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	3.30E+14	2.96E+14	2.21E+14	1.78E+14	1.68E+14	3.15E+14	5.39E+14	1.18E+15	6.27E+14	5.26E+14
11.5	5.18E+14	4.64E+14	4.16E+14	3.71E+14	3.57E+14	6.26E+14	1.03E+15	2.21E+15	1.31E+15	7.94E+14
13.3	6.15E+14	5.44E+14	5.10E+14	4.03E+14	3.40E+14	5.11E+14	7.71E+14	1.53E+15	1.77E+15	9.18E+14
15.4	6.75E+14	5.93E+14	5.65E+14	4.27E+14	3.28E+14	4.55E+14	6.65E+14	1.29E+15	2.05E+15	9.04E+14
17.8	7.09E+14	6.17E+14	5.78E+14	4.34E+14	3.03E+14	4.10E+14	5.80E+14	1.10E+15	2.11E+15	7.92E+14
20.5	7.61E+14	6.50E+14	5.70E+14	4.29E+14	2.72E+14	3.66E+14	5.00E+14	9.32E+14	1.96E+15	7.11E+14
23.7	8.52E+14	7.08E+14	5.60E+14	4.14E+14	2.40E+14	3.17E+14	4.21E+14	7.71E+14	1.62E+15	7.59E+14
27.4	9.15E+14	7.38E+14	5.30E+14	3.81E+14	2.05E+14	2.61E+14	3.45E+14	6.21E+14	1.19E+15	9.22E+14
31.6	8.84E+14	6.90E+14	4.59E+14	3.21E+14	1.64E+14	1.99E+14	2.65E+14	4.71E+14	7.94E+14	1.12E+15
36.5	7.77E+14	5.88E+14	3.60E+14	2.43E+14	1.17E+14	1.37E+14	1.87E+14	3.25E+14	4.73E+14	1.28E+15
42.2	6.28E+14	4.60E+14	2.58E+14	1.67E+14	7.33E+13	8.30E+13	1.18E+14	2.03E+14	2.48E+14	1.35E+15
48.7	4.64E+14	3.27E+14	1.64E+14	1.01E+14	3.86E+13	4.26E+13	6.56E+13	1.10E+14	1.09E+14	1.33E+15
56.2	3.13E+14	2.12E+14	9.06E+13	5.11E+13	1.54E+13	1.71E+13	2.96E+13	4.81E+13	3.88E+13	1.21E+15
64.9	1.91E+14	1.25E+14	4.16E+13	2.04E+13	3.71E+12	4.49E+12	9.75E+12	1.50E+13	1.06E+13	1.03E+15
75.0	1.05E+14	6.51E+13	1.43E+13	5.36E+12	1.87E+11	4.39E+11	1.76E+12	2.34E+12	1.95E+12	8.12E+14
86.6	4.94E+13	2.85E+13	2.89E+12	6.00E+11	0.00E+00	1.89E+10	8.50E+10	0.00E+00	2.10E+11	5.95E+14
100.0	1.83E+13	9.04E+12	1.67E+11	1.48E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.48E+10	4.03E+14
115.0	4.35E+12	1.40E+12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.64E+09	2.53E+14
133.0	4.33E+11	1.98E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.43E+14
154.0	8.91E+10	2.21E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.28E+13
178.0	9.61E+11	6.81E+11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.22E+13
205.0	2.91E+12	2.72E+12	1.01E+11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.27E+13
237.0	5.47E+12	5.64E+12	6.27E+11	2.02E+10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.62E+12

TABLE A-11.—(Continued).

Test Point No.	856	857	858	859	860	861	861	902	903	904
Date	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/28/2004	4/29/2004	4/29/2004	4/29/2004
Fuel	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic
Power (%)	85	65	40	30	7	4	4	100	85	65
Aerosol Point No.	868	869	870	871	872	873	901	902	903	904
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	4.57E+14	1.35E+15	2.01E+15	2.03E+15	2.36E+15	2.04E+15	4.97E+15	7.59E+14	1.16E+15	6.43E+14
11.5	7.12E+14	2.22E+15	3.41E+15	3.88E+15	3.88E+15	3.76E+15	6.87E+15	1.19E+15	1.46E+15	8.52E+14
13.3	8.42E+14	2.59E+15	3.78E+15	4.67E+15	3.78E+15	4.18E+15	5.37E+15	1.53E+15	1.70E+15	9.26E+14
15.4	8.37E+14	2.61E+15	3.66E+15	4.85E+15	3.45E+15	4.19E+15	4.80E+15	1.71E+15	1.82E+15	9.71E+14
17.8	7.28E+14	2.29E+15	3.06E+15	4.35E+15	2.75E+15	3.71E+15	4.29E+15	1.85E+15	1.92E+15	1.00E+15
20.5	6.52E+14	1.81E+15	2.23E+15	3.41E+15	1.89E+15	2.92E+15	3.83E+15	2.22E+15	2.25E+15	1.09E+15
23.7	7.08E+14	1.35E+15	1.43E+15	2.30E+15	1.13E+15	2.04E+15	3.47E+15	2.92E+15	2.90E+15	1.27E+15
27.4	8.70E+14	1.01E+15	8.32E+14	1.33E+15	5.92E+14	1.28E+15	3.12E+15	3.69E+15	3.57E+15	1.44E+15
31.6	1.05E+15	7.87E+14	4.62E+14	6.66E+14	2.81E+14	7.26E+14	2.65E+15	4.23E+15	4.00E+15	1.46E+15
36.5	1.19E+15	6.30E+14	2.54E+14	2.82E+14	1.20E+14	3.72E+14	2.08E+15	4.42E+15	4.09E+15	1.36E+15
42.2	1.23E+15	5.10E+14	1.46E+14	9.21E+13	4.73E+13	1.68E+14	1.51E+15	4.27E+15	3.86E+15	1.17E+15
48.7	1.19E+15	4.09E+14	9.65E+13	2.70E+13	2.29E+13	6.92E+13	1.01E+15	3.85E+15	3.41E+15	9.23E+14
56.2	1.06E+15	3.14E+14	6.93E+13	1.92E+13	1.54E+13	2.95E+13	5.99E+14	3.25E+15	2.81E+15	6.72E+14
64.9	8.83E+14	2.25E+14	4.69E+13	2.22E+13	1.05E+13	1.53E+13	3.14E+14	2.57E+15	2.17E+15	4.50E+14
75.0	6.76E+14	1.45E+14	2.62E+13	1.89E+13	5.81E+12	8.84E+12	1.39E+14	1.91E+15	1.56E+15	2.76E+14
86.6	4.76E+14	8.30E+13	1.05E+13	1.05E+13	2.27E+12	4.48E+12	4.78E+13	1.33E+15	1.05E+15	1.54E+14
100.0	3.05E+14	3.99E+13	2.18E+12	3.16E+12	5.15E+11	1.51E+12	1.03E+13	8.68E+14	6.60E+14	7.58E+13
115.0	1.77E+14	1.51E+13	9.87E+10	3.42E+11	3.98E+10	2.63E+11	8.82E+11	5.31E+14	3.87E+14	3.28E+13
133.0	9.10E+13	3.72E+12	0.00E+00	0.00E+00	0.00E+00	1.56E+10	3.09E+10	3.02E+14	2.10E+14	1.20E+13
154.0	4.18E+13	6.72E+11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.71E+10	1.56E+14	1.04E+14	4.28E+12
178.0	1.82E+13	1.22E+12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.12E+10	6.94E+13	4.54E+13	2.36E+12
205.0	1.01E+13	2.97E+12	8.84E+10	0.00E+00	0.00E+00	0.00E+00	6.11E+09	2.43E+13	1.73E+13	2.57E+12
237.0	9.80E+12	4.98E+12	6.06E+11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.12E+12	8.49E+12	3.62E+12

TABLE A-11.—(Continued).

Test Point No.	905	906	907	908	908	909	910	911	912	913
Date	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004
Fuel	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic
Power (%)	40	30	7	4	4	100	85	65	40	30
Aerosol Point No.	905	906	907	908	909	910	911	912	913	914
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	3.38E+14	3.60E+14	3.94E+14	1.86E+15	1.80E+16	8.78E+14	9.74E+14	7.27E+14	4.71E+14	5.57E+14
11.5	5.84E+14	6.26E+14	7.92E+14	3.63E+15	2.31E+16	1.33E+15	1.39E+15	1.01E+15	7.36E+14	8.61E+14
13.3	6.72E+14	5.85E+14	6.68E+14	2.44E+15	1.15E+16	1.67E+15	1.66E+15	1.14E+15	7.49E+14	7.09E+14
15.4	7.26E+14	5.88E+14	6.00E+14	2.02E+15	7.40E+15	1.83E+15	1.79E+15	1.21E+15	7.58E+14	6.54E+14
17.8	7.35E+14	5.71E+14	5.17E+14	1.71E+15	5.11E+15	1.93E+15	1.87E+15	1.24E+15	7.37E+14	6.08E+14
20.5	7.31E+14	5.44E+14	4.30E+14	1.42E+15	3.65E+15	2.23E+15	2.11E+15	1.33E+15	7.17E+14	5.71E+14
23.7	7.37E+14	5.24E+14	3.58E+14	1.17E+15	2.69E+15	2.82E+15	2.62E+15	1.53E+15	7.20E+14	5.54E+14
27.4	7.28E+14	4.99E+14	2.99E+14	9.55E+14	2.04E+15	3.49E+15	3.17E+15	1.72E+15	7.10E+14	5.32E+14
31.6	6.63E+14	4.39E+14	2.31E+14	7.45E+14	1.52E+15	3.95E+15	3.50E+15	1.75E+15	6.42E+14	4.72E+14
36.5	5.44E+14	3.46E+14	1.50E+14	5.32E+14	1.07E+15	4.11E+15	3.55E+15	1.63E+15	5.26E+14	3.78E+14
42.2	4.02E+14	2.44E+14	7.92E+13	3.46E+14	7.14E+14	3.95E+15	3.33E+15	1.40E+15	3.92E+14	2.75E+14
48.7	2.62E+14	1.53E+14	3.30E+13	1.98E+14	4.32E+14	3.55E+15	2.91E+15	1.11E+15	2.62E+14	1.78E+14
56.2	1.46E+14	8.12E+13	9.23E+12	9.29E+13	2.29E+14	3.00E+15	2.38E+15	8.13E+14	1.53E+14	9.82E+13
64.9	6.39E+13	3.53E+13	8.97E+11	3.18E+13	1.02E+14	2.38E+15	1.82E+15	5.48E+14	7.58E+13	4.43E+13
75.0	1.93E+13	1.18E+13	0.00E+00	5.79E+12	3.45E+13	1.77E+15	1.30E+15	3.39E+14	2.99E+13	1.47E+13
86.6	3.02E+12	3.01E+12	0.00E+00	0.00E+00	6.85E+12	1.24E+15	8.72E+14	1.91E+14	8.24E+12	2.73E+12
100.0	7.47E+10	1.13E+12	0.00E+00	0.00E+00	2.19E+11	8.24E+14	5.46E+14	9.62E+13	1.15E+12	7.96E+10
115.0	0.00E+00	1.50E+12	0.00E+00	0.00E+00	0.00E+00	5.15E+14	3.20E+14	4.35E+13	1.79E+10	0.00E+00
133.0	2.09E+10	2.20E+12	0.00E+00	0.00E+00	2.43E+09	3.00E+14	1.73E+14	1.73E+13	7.97E+09	0.00E+00
154.0	4.48E+10	2.40E+12	0.00E+00	0.00E+00	1.96E+09	1.59E+14	8.46E+13	6.07E+12	1.21E+10	0.00E+00
178.0	4.40E+10	2.02E+12	0.00E+00	0.00E+00	0.00E+00	7.37E+13	3.58E+13	1.88E+12	4.65E+09	0.00E+00
205.0	2.48E+10	1.38E+12	0.00E+00	0.00E+00	0.00E+00	2.81E+13	1.25E+13	9.01E+11	1.85E+08	0.00E+00
237.0	1.28E+10	8.55E+11	0.00E+00	0.00E+00	0.00E+00	1.02E+13	5.27E+12	1.75E+12	0.00E+00	0.00E+00

TABLE A-11.—(Continued).

Test Point No.	914	915	915	916	917	918	919	920	921	922
Date	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004
Fuel	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic
Power (%)	7	4	4	100	85	70	65	60	40	30
Aerosol Point No.	915	916	917	918	919	920	921	922	923	924
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	3.60E+15	1.73E+16	1.10E+17	1.83E+16	1.20E+16	2.94E+16	3.53E+16	4.11E+16	5.30E+16	5.50E+16
11.5	4.62E+15	2.31E+16	1.63E+17	1.52E+16	9.33E+15	2.29E+16	2.72E+16	3.21E+16	4.06E+16	4.13E+16
13.3	2.37E+15	1.14E+16	1.70E+17	8.45E+15	5.19E+15	1.08E+16	1.24E+16	1.47E+16	1.72E+16	1.69E+16
15.4	1.65E+15	7.30E+15	1.45E+17	4.97E+15	3.47E+15	4.66E+15	4.77E+15	5.40E+15	4.68E+15	4.24E+15
17.8	1.20E+15	5.00E+15	9.80E+16	3.95E+15	3.04E+15	2.69E+15	2.44E+15	2.16E+15	8.52E+14	4.62E+14
20.5	8.61E+14	3.54E+15	5.22E+16	4.31E+15	3.30E+15	2.74E+15	2.58E+15	1.89E+15	1.06E+15	7.07E+14
23.7	6.18E+14	2.59E+15	2.26E+16	5.18E+15	3.92E+15	3.22E+15	3.06E+15	2.18E+15	1.64E+15	1.30E+15
27.4	4.56E+14	1.98E+15	8.78E+15	5.99E+15	4.52E+15	3.49E+15	3.19E+15	2.22E+15	1.64E+15	1.30E+15
31.6	3.31E+14	1.49E+15	3.12E+15	6.43E+15	4.83E+15	3.46E+15	3.02E+15	2.01E+15	1.37E+15	1.05E+15
36.5	2.24E+14	1.06E+15	1.33E+15	6.43E+15	4.80E+15	3.15E+15	2.63E+15	1.67E+15	9.87E+14	7.15E+14
42.2	1.39E+14	7.10E+14	1.00E+15	6.03E+15	4.45E+15	2.69E+15	2.14E+15	1.29E+15	6.35E+14	4.19E+14
48.7	7.53E+13	4.33E+14	8.47E+14	5.34E+15	3.88E+15	2.15E+15	1.65E+15	9.37E+14	3.81E+14	2.25E+14
56.2	3.22E+13	2.31E+14	5.62E+14	4.47E+15	3.18E+15	1.62E+15	1.20E+15	6.48E+14	2.22E+14	1.20E+14
64.9	9.33E+12	1.05E+14	2.68E+14	3.54E+15	2.45E+15	1.14E+15	8.21E+14	4.25E+14	1.26E+14	6.74E+13
75.0	1.29E+12	3.79E+13	7.90E+13	2.65E+15	1.78E+15	7.46E+14	5.18E+14	2.58E+14	6.36E+13	3.61E+13
86.6	1.70E+10	9.27E+12	1.11E+13	1.87E+15	1.21E+15	4.46E+14	2.96E+14	1.38E+14	2.41E+13	1.48E+13
100.0	0.00E+00	9.95E+11	4.62E+11	1.24E+15	7.62E+14	2.39E+14	1.47E+14	5.82E+13	3.97E+12	2.73E+12
115.0	0.00E+00	0.00E+00	0.00E+00	7.73E+14	4.48E+14	1.13E+14	6.06E+13	1.60E+13	1.58E+11	1.56E+11
133.0	0.00E+00	0.00E+00	0.00E+00	4.44E+14	2.40E+14	4.53E+13	1.85E+13	1.71E+12	0.00E+00	0.00E+00
154.0	0.00E+00	0.00E+00	0.00E+00	2.31E+14	1.16E+14	1.62E+13	3.69E+12	0.00E+00	0.00E+00	0.00E+00
178.0	0.00E+00	0.00E+00	0.00E+00	1.04E+14	4.82E+13	6.30E+12	9.80E+11	0.00E+00	0.00E+00	0.00E+00
205.0	0.00E+00	0.00E+00	0.00E+00	3.86E+13	1.70E+13	4.50E+12	1.95E+12	1.49E+11	0.00E+00	0.00E+00
237.0	0.00E+00	0.00E+00	0.00E+00	1.32E+13	7.64E+12	6.34E+12	4.10E+12	1.13E+12	0.00E+00	0.00E+00

TABLE A-11.—(Continued).

Test Point No.	923	924	925	926	926	927	928	929	930	931
Date	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004
Fuel	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic	aromatic
Power (%)	15	7	5.5	4	4	100	85	65	40	30
Aerosol Point No.	925	926	927	928	929	930	931	932	933	934
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	1.30E+17	1.82E+17	1.74E+17	1.41E+17	2.36E+14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
11.5	1.11E+17	1.92E+17	1.96E+17	1.88E+17	6.34E+14	0.00E+00	2.51E+10	0.00E+00	3.52E+11	2.38E+13
13.3	5.43E+16	1.37E+17	1.54E+17	1.79E+17	1.00E+15	2.26E+12	3.78E+12	2.03E+13	8.40E+13	1.41E+14
15.4	1.76E+16	8.10E+16	1.01E+17	1.41E+17	1.20E+15	8.16E+13	1.33E+14	1.38E+14	2.07E+14	2.62E+14
17.8	2.72E+15	3.77E+16	5.30E+16	8.77E+16	1.23E+15	1.28E+14	1.88E+14	1.95E+14	2.75E+14	3.23E+14
20.5	1.63E+14	1.16E+16	1.94E+16	4.08E+16	1.18E+15	2.18E+14	2.75E+14	2.42E+14	3.21E+14	3.63E+14
23.7	5.07E+14	1.34E+15	3.99E+15	1.42E+16	1.12E+15	4.24E+14	4.85E+14	3.40E+14	3.92E+14	4.23E+14
27.4	6.27E+14	0.00E+00	5.09E+14	4.48E+15	1.03E+15	7.28E+14	7.62E+14	4.38E+14	4.49E+14	4.72E+14
31.6	4.91E+14	7.33E+12	3.04E+14	1.50E+15	8.75E+14	1.07E+15	1.02E+15	4.75E+14	4.44E+14	4.62E+14
36.5	2.51E+14	3.27E+14	8.52E+14	1.15E+15	6.80E+14	1.37E+15	1.20E+15	4.61E+14	3.92E+14	4.05E+14
42.2	7.03E+13	5.24E+14	1.12E+15	1.31E+15	4.84E+14	1.57E+15	1.27E+15	4.08E+14	3.11E+14	3.20E+14
48.7	7.47E+12	3.72E+14	7.86E+14	1.07E+15	3.08E+14	1.65E+15	1.24E+15	3.29E+14	2.20E+14	2.24E+14
56.2	0.00E+00	1.33E+14	3.08E+14	5.74E+14	1.71E+14	1.59E+15	1.13E+15	2.45E+14	1.37E+14	1.38E+14
64.9	0.00E+00	1.65E+13	4.07E+13	1.83E+14	8.11E+13	1.43E+15	9.50E+14	1.69E+14	7.36E+13	7.22E+13
75.0	0.00E+00	0.00E+00	0.00E+00	2.16E+13	2.99E+13	1.18E+15	7.41E+14	1.06E+14	3.17E+13	2.95E+13
86.6	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.88E+12	8.97E+14	5.33E+14	5.81E+13	9.14E+12	7.66E+12
100.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.37E+11	6.23E+14	3.50E+14	2.55E+13	1.07E+12	8.68E+11
115.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.93E+14	2.09E+14	7.37E+12	0.00E+00	0.00E+00
133.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.21E+14	1.12E+14	7.46E+11	0.00E+00	0.00E+00
154.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E+14	5.21E+13	2.17E+10	0.00E+00	0.00E+00
178.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.46E+13	2.03E+13	0.00E+00	0.00E+00	0.00E+00
205.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.49E+13	6.65E+12	0.00E+00	0.00E+00	0.00E+00
237.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.87E+12	3.33E+12	0.00E+00	0.00E+00	0.00E+00

TABLE A-11.—(Continued).

Test Point No.	932	933	934	937	938	939	939	939	939	939
Date	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004
Fuel	aromatic	aromatic	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur
Power (%)	7	4	7	75	30	7	7	7	7	7
Aerosol Point No.	935	936	937	941	942	944	945	946	947	948
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	1.20E+14	8.46E+14	8.61E+16	3.37E+16	8.75E+16	1.06E+15	6.13E+14	3.28E+15	1.65E+17	4.03E+15
11.5	2.01E+14	1.68E+15	8.73E+16	2.62E+16	6.70E+16	1.82E+15	1.10E+15	4.88E+15	1.66E+17	5.67E+15
13.3	2.21E+14	2.17E+15	5.79E+16	1.19E+16	2.70E+16	2.23E+15	8.67E+14	2.33E+15	1.08E+17	5.09E+15
15.4	2.16E+14	2.41E+15	3.22E+16	4.68E+15	5.91E+15	2.71E+15	8.09E+14	1.56E+15	5.72E+16	4.59E+15
17.8	1.86E+14	2.39E+15	1.54E+16	2.58E+15	5.03E+14	3.11E+15	7.55E+14	1.19E+15	2.45E+16	3.80E+15
20.5	1.54E+14	2.21E+15	6.42E+15	2.91E+15	6.62E+14	3.24E+15	6.88E+14	9.70E+14	7.72E+15	2.85E+15
23.7	1.37E+14	1.99E+15	2.74E+15	3.59E+15	1.25E+15	2.95E+15	6.10E+14	8.03E+14	1.56E+15	1.94E+15
27.4	1.22E+14	1.73E+15	1.65E+15	3.93E+15	1.19E+15	2.31E+15	5.20E+14	6.56E+14	4.98E+14	1.22E+15
31.6	8.79E+13	1.41E+15	1.22E+15	3.92E+15	9.26E+14	1.58E+15	4.15E+14	5.09E+14	5.43E+14	7.11E+14
36.5	4.69E+13	1.06E+15	9.56E+14	3.61E+15	5.93E+14	9.26E+14	3.02E+14	3.67E+14	6.96E+14	3.81E+14
42.2	1.77E+13	7.43E+14	7.01E+14	3.12E+15	3.15E+14	4.56E+14	2.02E+14	2.45E+14	6.57E+14	1.87E+14
48.7	3.72E+12	4.73E+14	4.13E+14	2.56E+15	1.62E+14	1.69E+14	1.21E+14	1.48E+14	3.98E+14	8.57E+13
56.2	2.03E+11	2.70E+14	1.87E+14	1.99E+15	9.93E+13	3.63E+13	6.21E+13	7.90E+13	1.46E+14	3.91E+13
64.9	0.00E+00	1.36E+14	6.16E+13	1.44E+15	6.98E+13	2.76E+12	2.58E+13	3.54E+13	2.04E+13	1.96E+13
75.0	0.00E+00	5.82E+13	1.62E+13	9.78E+14	4.78E+13	0.00E+00	7.42E+12	1.20E+13	2.57E+11	1.08E+13
86.6	0.00E+00	1.90E+13	7.44E+12	6.11E+14	2.83E+13	6.29E+11	1.05E+12	2.47E+12	0.00E+00	5.64E+12
100.0	0.00E+00	3.62E+12	8.71E+12	3.49E+14	1.45E+13	1.28E+12	0.00E+00	2.32E+11	4.90E+11	2.25E+12
115.0	0.00E+00	2.14E+11	9.91E+12	1.83E+14	8.08E+12	1.43E+12	1.04E+11	3.81E+11	3.58E+12	5.45E+11
133.0	0.00E+00	0.00E+00	9.07E+12	8.61E+13	6.26E+12	1.21E+12	4.09E+11	7.90E+11	6.86E+12	5.48E+10
154.0	0.00E+00	0.00E+00	7.22E+12	3.74E+13	5.68E+12	8.27E+11	6.76E+11	9.96E+11	7.21E+12	6.65E+10
178.0	0.00E+00	0.00E+00	5.63E+12	1.65E+13	4.85E+12	4.93E+11	6.82E+11	9.23E+11	5.50E+12	1.53E+11
205.0	0.00E+00	0.00E+00	4.65E+12	1.09E+13	4.03E+12	3.50E+11	5.14E+11	7.67E+11	4.01E+12	1.91E+11
237.0	0.00E+00	0.00E+00	3.93E+12	1.30E+13	3.89E+12	3.45E+11	3.50E+11	6.67E+11	3.57E+12	1.82E+11

TABLE A-11.—(Continued).

Test Point No.	941	942	943	943	943	943	944	945	946	947
Date	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004
Fuel	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur
Power (%)	85	30	7	7	7	7	100	85	30	7
Aerosol Point No.	951	952	953	954	955	957	958	959	960	961
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	0.00E+00	2.65E+15	2.44E+15	7.37E+14	2.34E+15	7.59E+14	5.84E+14	7.34E+14	2.79E+14	6.89E+14
11.5	4.00E+13	3.80E+15	3.67E+15	1.28E+15	3.64E+15	1.44E+15	9.14E+14	1.11E+15	5.56E+14	1.41E+15
13.3	1.26E+14	3.49E+15	3.62E+15	1.03E+15	1.97E+15	1.14E+15	1.14E+15	1.37E+15	4.86E+14	1.10E+15
15.4	2.06E+14	3.13E+15	3.53E+15	9.58E+14	1.51E+15	1.05E+15	1.27E+15	1.53E+15	4.84E+14	1.02E+15
17.8	2.70E+14	2.53E+15	3.19E+15	8.93E+14	1.28E+15	9.72E+14	1.37E+15	1.66E+15	4.79E+14	9.39E+14
20.5	3.68E+14	1.83E+15	2.65E+15	8.15E+14	1.10E+15	8.85E+14	1.59E+15	1.93E+15	4.66E+14	8.43E+14
23.7	5.61E+14	1.21E+15	1.99E+15	7.26E+14	9.40E+14	7.89E+14	2.03E+15	2.42E+15	4.51E+14	7.36E+14
27.4	8.46E+14	7.68E+14	1.36E+15	6.24E+14	7.86E+14	6.83E+14	2.51E+15	2.94E+15	4.23E+14	6.19E+14
31.6	1.17E+15	4.84E+14	8.46E+14	4.99E+14	6.19E+14	5.52E+14	2.83E+15	3.25E+15	3.67E+14	4.87E+14
36.5	1.45E+15	3.04E+14	4.79E+14	3.65E+14	4.49E+14	4.07E+14	2.93E+15	3.29E+15	2.87E+14	3.50E+14
42.2	1.61E+15	1.93E+14	2.42E+14	2.43E+14	3.00E+14	2.74E+14	2.78E+15	3.06E+15	2.05E+14	2.29E+14
48.7	1.64E+15	1.23E+14	1.08E+14	1.44E+14	1.80E+14	1.65E+14	2.47E+15	2.65E+15	1.30E+14	1.34E+14
56.2	1.53E+15	7.68E+13	4.35E+13	7.25E+13	9.37E+13	8.40E+13	2.04E+15	2.14E+15	7.11E+13	6.57E+13
64.9	1.33E+15	4.32E+13	1.70E+13	2.90E+13	4.01E+13	3.40E+13	1.57E+15	1.60E+15	3.18E+13	2.54E+13
75.0	1.05E+15	2.00E+13	6.96E+12	7.78E+12	1.24E+13	9.03E+12	1.12E+15	1.11E+15	1.02E+13	6.33E+12
86.6	7.68E+14	6.52E+12	2.95E+12	9.44E+11	2.11E+12	9.83E+11	7.47E+14	7.18E+14	1.74E+12	5.63E+11
100.0	5.10E+14	1.05E+12	1.13E+12	0.00E+00	6.40E+10	0.00E+00	4.64E+14	4.29E+14	1.95E+10	1.82E+10
115.0	3.08E+14	6.60E+09	5.05E+11	1.06E+11	4.30E+11	1.57E+10	2.69E+14	2.39E+14	2.51E+10	1.17E+11
133.0	1.63E+14	3.21E+11	4.99E+11	3.72E+11	1.24E+12	1.24E+11	1.44E+14	1.23E+14	1.30E+11	3.03E+11
154.0	7.47E+13	6.48E+11	6.22E+11	6.03E+11	1.68E+12	2.91E+11	7.04E+13	5.73E+13	2.50E+11	4.32E+11
178.0	2.83E+13	6.36E+11	6.17E+11	6.38E+11	1.50E+12	3.86E+11	3.09E+13	2.40E+13	2.88E+11	4.33E+11
205.0	8.51E+12	4.39E+11	4.94E+11	5.07E+11	1.04E+12	4.07E+11	1.28E+13	9.93E+12	2.96E+11	3.46E+11
237.0	3.78E+12	3.23E+11	3.73E+11	3.50E+11	7.17E+11	4.02E+11	7.86E+12	7.18E+12	3.70E+11	2.63E+11

TABLE A-11.—(Concluded).

Test Point No.	947	947	948	949	950	951
Date	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004	4/29/2004
Fuel	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur
Power (%)	7	7	100	85	30	7
Aerosol Point No.	962	963	964	965	966	967
Middle Point Diameter (nm)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)	d(EIn)/dlogDp (#/kg fuel)
10.0	2.36E+15	1.06E+17	3.44E+16	1.42E+16	8.30E+16	1.28E+17
11.5	3.75E+15	9.66E+16	2.76E+16	1.06E+16	6.25E+16	1.22E+17
13.3	2.10E+15	5.36E+16	1.32E+16	5.50E+15	2.45E+16	7.23E+16
15.4	1.63E+15	2.29E+16	5.63E+15	3.47E+15	4.97E+15	3.40E+16
17.8	1.37E+15	7.88E+15	3.39E+15	3.03E+15	3.79E+14	1.26E+16
20.5	1.17E+15	2.92E+15	3.86E+15	3.33E+15	6.10E+14	3.80E+15
23.7	9.92E+14	1.67E+15	4.93E+15	3.90E+15	1.15E+15	1.13E+15
27.4	8.33E+14	1.28E+15	5.71E+15	4.40E+15	1.10E+15	7.13E+14
31.6	6.63E+14	1.01E+15	6.09E+15	4.62E+15	8.73E+14	6.73E+14
36.5	4.87E+14	7.38E+14	6.03E+15	4.51E+15	5.74E+14	6.15E+14
42.2	3.31E+14	4.75E+14	5.59E+15	4.12E+15	3.18E+14	4.64E+14
48.7	2.04E+14	2.69E+14	4.92E+15	3.55E+15	1.69E+14	2.58E+14
56.2	1.10E+14	1.43E+14	4.09E+15	2.88E+15	1.01E+14	1.01E+14
64.9	5.04E+13	7.48E+13	3.22E+15	2.20E+15	6.71E+13	2.45E+13
75.0	1.79E+13	4.07E+13	2.38E+15	1.58E+15	4.41E+13	6.68E+12
86.6	4.12E+12	2.50E+13	1.65E+15	1.06E+15	2.64E+13	4.84E+12
100.0	4.51E+11	1.98E+13	1.07E+15	6.60E+14	1.49E+13	6.42E+12
115.0	4.61E+11	2.05E+13	6.55E+14	3.85E+14	9.51E+12	7.91E+12
133.0	9.60E+11	2.14E+13	3.67E+14	2.05E+14	7.49E+12	7.62E+12
154.0	1.18E+12	1.90E+13	1.87E+14	9.88E+13	6.26E+12	5.69E+12
178.0	1.04E+12	1.35E+13	8.43E+13	4.28E+13	4.93E+12	3.65E+12
205.0	8.16E+11	7.60E+12	3.48E+13	1.87E+13	4.12E+12	2.50E+12
237.0	7.15E+11	3.89E+12	1.85E+13	1.33E+13	4.33E+12	1.98E+12

TABLE A-12.—AIRCRAFT CFM56-2-C1 ENGINE PARTICLE EMISSION DATA MEASURED BY ARI DURING THE AIRCRAFT PARTICLE EMISSIONS EXPERIMENT (APEX).

Test Point No.[1]	Date	Fuel Type[2]	Power %	Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	CO_2 Conc. CO_2 Conc. ppm	CO_2 Conc. CO_2 Conc. Sdev[3] ppm	Particle Emission Index Black Carbon EI[5] by MAAP[4] mg/kg fuel	Number EI by CPC #/kg fuel	Mass EI by AMS[4] mg/kg fuel	Organic EI by AMS[4] mg/kg fuel	Sulfate EI by AMS[4] mg/kg fuel
301	4/23/2004	base	7	301	9:23:27	9:26:01	2081.1	72.9	6.402				
	4/23/2004	base	7	302	9:27:00	9:28:30	2235.2	30.8	3.326				
	4/23/2004	base	7	303	9:28:59	9:31:01	2280.0	50.5	1.966				
	4/23/2004	base	7	304	9:31:29	9:33:31	2144.7	10.8	2.485				
	4/23/2004	base	7	305	9:34:29	9:36:01	2118.6	28.7	2.075				
	4/23/2004	base	7	306	9:36:59	9:38:31	2203.4	6.9	2.301				
	4/23/2004	base	7	307	9:38:59	9:42:01	1502.6	114.8	2.509				
	4/23/2004	base	7	308	9:42:59	9:45:01	389.6	0.3					
302	4/23/2004	base	30	309	9:48:30	9:50:31	2619.4	24.3	5.532				
	4/23/2004	base	30	310	9:51:00	9:52:31	3202.3	20.7	5.260	5.45E+14	1.011	1.060	-0.005
	4/23/2004	base	30	312	10:04:00	10:06:01	2023.0	18.4	5.765	3.24E+14	0.314	0.305	-0.001
	4/23/2004	base	30	313	10:06:59	10:08:31	2444.9	28.6	6.489				
	4/23/2004	base	30	314	10:09:29	10:11:01	2302.0	7.9	2.952				
	4/23/2004	base	30	315	10:11:59	10:13:01	1816.9	11.1	2.975				
	4/23/2004	base	30	316	10:13:59	10:17:01	1760.4	6.5	3.278				
	4/23/2004	base	30	317	10:17:29	10:19:01	2010.2	12.8	3.168				
	4/23/2004	base	30	318	10:19:59	10:22:01	2448.9	80.7	2.698				
	4/23/2004	base	30	319	10:22:59	10:25:01	972.5	58.0	2.233				
303	4/23/2004	base	40	321	10:41:59	10:44:01	2083.7	26.9	10.093				
	4/23/2004	base	40	322	10:44:30	10:46:30	2454.9	23.0	8.611	3.93E+14	0.545	0.525	0.004
	4/23/2004	base	40	323	10:46:59	10:48:31	2388.1	11.6	4.731				
	4/23/2004	base	40	324	10:48:59	10:50:31	1804.8	18.9	4.170				
	4/23/2004	base	40	325	10:51:29	10:53:01	1736.6	5.5	4.193				
	4/23/2004	base	40	326	10:53:59	10:55:29	1985.0	18.7	3.974				
	4/23/2004	base	40	327	10:55:59	10:58:31	2635.8	80.0	2.929				
	4/23/2004	base	40	328	10:59:00	11:02:31	955.6	66.4	6.761				
304	4/23/2004	base	30	329	11:03:59	11:05:31	987.1	64.4	4.925				
	4/23/2004	base	30	330	11:06:00	11:09:01	2540.0	83.7	2.923				
	4/23/2004	base	30	331	11:09:59	11:13:00	2181.8	20.1	4.637				
305	4/23/2004	base	7	332	11:14:00	11:18:31	1800.7	77.5	0.931				
	4/23/2004	base	7	333	11:19:29	11:21:31	1703.7	124.4	1.144				
	4/23/2004	base	7	334	11:22:29	11:25:31	891.1	213.7	3.526				
	4/23/2004	base	7	335	11:28:30	11:31:30	871.3	8.1	0.845	1.57E+14	0.054	0.020	-0.030
	4/23/2004	base	7	336	11:32:59	11:36:01	2476.0	24.1	0.656				
	4/23/2004	base	7	337	11:37:29	11:39:31	4422.3	114.8	0.421				
	4/23/2004	base	7	338	14:43:36	14:44:21	2083.8	801.1	29.483				
306	4/23/2004	base	7	339	14:51:22	14:52:46	1968.5	34.3	4.763				
	4/23/2004	base	7	340	14:54:29	14:56:01	1510.0	40.7	3.313				
	4/23/2004	base	7	341	14:56:59	14:58:31	1926.0	9.9	2.493				
	4/23/2004	base	7	342	14:59:59	15:02:31	2219.1	57.3	2.145				
307	4/23/2004	base	30	343	15:04:00	15:06:31	1504.8	57.9	6.733				
	4/23/2004	base	30	344	15:07:29	15:09:01	1946.6	12.4	6.314				
	4/23/2004	base	30	345	15:09:29	15:11:01	1909.8	12.8	3.021				
	4/23/2004	base	30	346	15:11:59	15:14:01	1567.9	12.2	2.528				
	4/23/2004	base	30	347	15:14:30	15:16:31	1575.2	6.7	3.214				
	4/23/2004	base	30	348	15:16:59	15:18:31	1738.8	26.6	2.690				
	4/23/2004	base	30	350	15:21:29	15:25:31	1103.8	41.8	4.632				
308	4/23/2004	base	40	351	15:26:29	15:28:31	1182.9	46.5	5.871				
	4/23/2004	base	40	352	15:29:29	15:32:00	3005.5	139.3	3.299				
	4/23/2004	base	40	353	15:32:59	15:35:31	1692.0	18.9	7.303				
308b	4/23/2004	base	40	354	15:36:29	15:38:01	2444.6	33.1	7.127				
	4/23/2004	base	40	355	15:38:59	15:40:31	2349.2	66.8	4.909				
	4/23/2004	base	40	356	15:41:29	15:43:00	1861.5	36.8	3.519				
	4/23/2004	base	40	357	15:43:29	15:45:01	1791.6	34.4	3.989				
	4/23/2004	base	40	358	15:45:30	15:47:01	2056.9	33.2	3.895				
309	4/23/2004	base	30	359	15:48:00	15:50:01	1747.8	39.2	1.741				
	4/23/2004	base	30	360	15:50:59	15:55:01	2633.5	64.4	2.068				
	4/23/2004	base	30	361	15:55:59	16:01:00	1114.0	37.2	3.333				
310	4/23/2004	base	7	362	16:01:30	16:04:00	1039.8	49.7	5.801				
	4/23/2004	base	7	363	16:04:29	16:06:01	2253.6	121.0	1.421				
	4/23/2004	base	7	364	16:06:59	16:09:31	1359.3	13.7	1.423				
	4/23/2004	base	7	365	16:10:29	16:11:31	1395.7	5.8	3.031				
501	4/25/2004	base	4	501	11:15:16	11:16:08	1091.5	362.8	52.735				
	4/25/2004	base	4	501	11:16:29	11:20:01	1063.1	48.2	25.963				

TABLE A-12.—(Continued).

Test Point No.[1]	Date	Fuel Type[2]	Power %	Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	CO_2 Conc. CO_2 Conc. ppm	CO_2 Conc. CO_2 Conc. Sdev[3] ppm	Particle Emission Index Black Carbon EI[5] by MAAP[4] mg/kg fuel	Particle Emission Index Number EI by CPC #/kg fuel	Particle Emission Index Mass EI by AMS[4] mg/kg fuel	Particle Emission Index Organic EI by AMS[4] mg/kg fuel	Particle Emission Index Sulfate EI by AMS[4] mg/kg fuel
502	4/25/2004	base	65	502	11:22:59	11:25:01	2096.6	70.1	27.677				
	4/25/2004	base	65	503	11:25:59	11:27:31	2991.4	50.3	11.414				
	4/25/2004	base	65	504	11:28:29	11:29:31	2924.4	68.4	12.874				
	4/25/2004	base	65	505	11:30:29	11:32:00	2525.2	52.6	18.183				
	4/25/2004	base	65	506	11:32:29	11:34:30	2043.4	64.7	12.939				
	4/25/2004	base	65	507	11:35:00	11:36:30	2262.0	30.1	13.771				
	4/25/2004	base	65	508	11:36:59	11:39:31	3817.5	121.5	10.340				
	4/25/2004	base	65	509	11:39:59	11:42:31	1369.8	46.9	18.416				
503	4/25/2004	base	70	511	11:43:29	11:47:01	1611.4	72.6	21.588				
504	4/25/2004	base	65	512	11:48:29	11:50:31	1420.7	38.8	14.328				
505	4/25/2004	base	60	513	11:51:29	11:53:31	1179.1	64.0	6.378				
506	4/25/2004	base	85	514	11:54:59	11:57:01	2170.6	85.0	50.853				
507	4/25/2004	base	100	515	11:57:59	11:59:30	2516.4	62.2	69.789				
508	4/25/2004	base	7	517	12:06:29	12:10:31	2237.9	16.9	-0.030				
	4/25/2004	base	7	518	12:16:29	12:18:31	858.7	23.7	-0.286				
	4/25/2004	base	7	519	12:19:29	12:22:31	2298.6	87.0	2.297				
509	4/25/2004	base	100	520	12:24:00	12:24:31	5251.9	88.5	50.940				
510	4/25/2004	base	85	521	12:25:00	12:26:30	4890.6	116.3	35.725				
512	4/25/2004	base	30	525	13:25:31	13:29:01	2624.6	59.3	2.306				
513	4/25/2004	base	7	526	13:30:29	13:34:31	2313.9	84.4	1.928				
	4/25/2004	base	7	527	13:36:00	13:55:31	1036.7	144.8	7.300				
514	4/25/2004	base	100	531	14:01:00	14:02:00	1630.9	108.2	78.883				
515	4/25/2004	base	30	532	14:03:29	14:06:01	1146.7	51.9	4.185				
516	4/25/2004	base	7	533	14:08:29	14:10:01	1013.0	56.0	6.330				
517	4/25/2004	base	85	534	14:10:59	14:12:31	1694.6	50.4	92.620				
518	4/25/2004	base	7	535	14:13:29	14:18:01	996.4	73.2	7.009				
	4/25/2004	base	7	536	14:21:59	14:29:01	1504.7	10.9	2.092				
519	4/25/2004	base	100	537	14:30:29	14:31:31	2756.5	155.8	114.864				
520	4/25/2004	base	85	538	14:31:59	14:35:01	2008.3	157.8	88.394				
521	4/25/2004	base	30	539	14:36:29	14:44:31	2132.6	114.6	0.696				
522	4/25/2004	base	7	540	14:45:59	14:51:01	1712.0	28.5	2.299				
	4/25/2004	base	7	541	14:51:59	14:57:01	4768.4	43.3	1.457				
	4/25/2004	base	7	542	14:59:59	15:05:31	2077.7	9.1	2.284				
	4/25/2004	base	7	543	15:06:59	15:12:01	925.6	8.8	2.334				
	4/25/2004	base	7	544	15:15:29	15:19:01	543.7	9.9	2.880				
	4/25/2004	base	7	545	15:20:29	15:24:01	306.1	8.2	0.610				
	4/25/2004	base	7	546	15:25:29	15:29:01	5.7	3.2	120.781				
	4/25/2004	base	7	547	15:29:59	15:34:31	2333.3	74.2	4.432				
	4/25/2004	base	7	548	15:36:59	15:41:31	1143.4	39.6	6.264				
	4/25/2004	base	7	549	15:42:59	15:47:31	513.5	25.9	7.289				
523	4/25/2004	base	100	550	15:52:00	15:53:01	2275.2	63.1	117.157				
524	4/25/2004	base	85	551	15:53:29	15:55:31	2135.0	43.4	99.477				
525	4/25/2004	base	30	552	15:55:59	15:59:31	1197.7	26.5	6.858				
526	4/25/2004	base	7	553	16:00:48	16:04:01	1075.9	32.7	4.800				
	4/25/2004	base	7	554	16:05:29	16:09:01	252.8	14.7	-0.737				
	4/25/2004	base	7	555	16:09:59	16:13:01	161.3	4.4	6.651				
601	4/26/2004	base	7	602	8:11:02	8:13:02	983.9	34.7	10.459	2.90E+16	7.763	6.342	0.994
	4/26/2004	base	7	603	8:15:31	8:19:01	2029.5	49.7	3.670	3.12E+15	2.646	2.085	0.316
	4/26/2004	base	7	604	8:20:01	8:23:02	1024.1	21.3	4.323				
	4/26/2004	base	7	605	8:27:09	8:27:40	1988.4	37.7	2.565				
602	4/26/2004	base	100	606	8:28:36	8:29:17	5109.4	66.8	73.753	1.32E+15	5.298	4.879	0.217
603	4/26/2004	base	85	607	8:29:30	8:31:30	4799.4	73.8	64.846	1.18E+15	4.783	4.443	0.185
604	4/26/2004	base	30	608	8:32:32	8:36:31	2486.4	41.5	3.166	2.29E+14	2.216	1.705	0.326
605	4/26/2004	base	7	609	8:37:30	8:41:01	2079.8	61.1	2.045				
	4/26/2004	base	7	610	8:43:00	8:47:30	526.8	19.6	-2.138				
	4/26/2004	base	7	611	8:49:32	8:52:01	265.3	13.3	2.595	2.36E+15	1.807	0.693	1.052
	4/26/2004	base	7	612	8:53:31	8:57:01	1447.7	18.2	1.313				
	4/26/2004	base	7	613	8:58:00	9:00:33	1525.1	7.4	1.911				
	4/26/2004	base	7	614	9:01:30	9:04:01	280.2	26.1	2.319	2.19E+15	1.643	1.070	0.204
606	4/26/2004	base	100	615	9:04:32	9:05:02	1016.5	26.3	198.711	1.31E+15	12.353	11.982	0.075
607	4/26/2004	base	85	616	9:05:31	9:07:32	897.9	39.4	132.869	1.15E+15	7.138	6.950	0.034
608	4/26/2004	base	30	617	9:09:02	9:12:32	817.4	20.0	6.545	3.65E+14	1.666	1.191	0.252
609	4/26/2004	base	7	618	9:14:02	9:17:31	994.6	30.3	3.108	1.51E+15	1.921	1.519	0.267
	4/26/2004	base	7	619	9:18:31	9:30:02	878.2	43.1	6.376	3.52E+16	11.411	8.953	1.590
610	4/26/2004	base	100	620	9:39:31	9:40:01	3663.3	504.1	105.603				

TABLE A-12.—(Continued).

Test Point No.[1]	Date	Fuel Type[2]	Power %	Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	CO_2 Conc. CO_2 Conc. ppm	CO_2 Conc. CO_2 Conc. Sdev[3] ppm	Particle Emission Index Black Carbon EI[5] by MAAP[4] mg/kg fuel	Particle Emission Index Number EI by CPC #/kg fuel	Particle Emission Index Mass EI by AMS[4] mg/kg fuel	Particle Emission Index Organic EI by AMS[4] mg/kg fuel	Particle Emission Index Sulfate EI by AMS[4] mg/kg fuel
611	4/26/2004	base	85	621	9:41:00	9:43:01	1497.7	57.9	114.011				
612	4/26/2004	base	30	622	9:45:00	9:48:01	2156.0	44.7	1.882	1.38E+14	0.331	0.305	-0.004
613	4/26/2004	base	7	623	9:50:00	9:52:01	1835.1	8.2	2.147	1.91E+14	0.261	0.235	0.001
	4/26/2004	base	7	624	9:53:31	10:14:33	878.5	51.8	8.465				
614	4/26/2004	base	100	625	10:15:32	10:16:18	1804.7	41.4	128.728				
615	4/26/2004	base	85	626	10:16:32	10:18:32	1653.5	63.3	116.013	3.19E+15	6.317	4.544	1.211
616	4/26/2004	base	30	627	10:19:32	10:23:32	973.1	36.6	7.896	2.38E+16	4.114	2.843	0.865
617	4/26/2004	base	7	628	10:24:01	10:27:02	764.9	58.1	7.432				
	4/26/2004	base	7	629	10:28:01	10:31:32	1385.1	75.6	1.969				
	4/26/2004	base	7	630	10:32:11	10:34:32	1756.3	30.2	1.237	1.80E+14	0.290	0.247	-0.003
	4/26/2004	base	7	631	10:36:06	10:37:32	1853.5	9.4	1.686				
618	4/26/2004	base	4	632	11:53:32	11:59:32	1080.4	129.1	12.367	2.50E+16	6.521	5.468	0.816
619	4/26/2004	base	100	633	12:01:01	12:01:32	1732.0	63.0	95.686	5.88E+15	6.149	4.256	1.578
620	4/26/2004	base	85	634	12:02:33	12:05:02	1612.4	62.0	64.553	1.40E+15	4.193	2.576	1.276
621	4/26/2004	base	65	635	12:05:31	12:09:01	1424.3	51.4	14.684				
622	4/26/2004	base	40	636	12:10:02	12:13:31	1172.0	60.6	4.987	8.00E+15	2.052	1.260	0.487
623	4/26/2004	base	4	637	12:14:00	12:14:30	634.0	205.0	12.487	3.43E+16	11.071	9.286	0.718
	4/26/2004	base	4	638	12:17:30	12:19:31	370.0	25.6	-93.361	2.12E+15	0.397	0.229	0.133
	4/26/2004	base	4	639	12:19:30	12:20:00	407.5	413.9	-78.186	1.71E+15	7.915	7.810	0.311
624	4/26/2004	base	40	640	12:21:01	12:24:01	1512.5	33.9	0.342	2.76E+14	0.473	0.422	0.064
	4/26/2004	base	40	641	12:25:01	12:28:01	3433.5	69.7	3.374	2.57E+14	0.548	0.439	0.035
	4/26/2004	base	40	642	12:30:00	12:31:30	315.4	13.7	3.883				
	4/26/2004	base	40	643	12:36:00	12:38:31	712.3	22.8	2.534	2.86E+14	0.587	0.731	0.003
	4/26/2004	base	40	644	12:39:31	12:41:31	3952.5	63.3	1.615	1.28E+14	0.460	0.461	0.003
625	4/26/2004	base	30	645	12:43:31	12:46:30	1728.5	13.3	1.496				
626	4/26/2004	base	15	646	12:47:30	12:50:01	1343.6	7.2	0.706	1.44E+14	0.652	0.600	0.000
627	4/26/2004	base	7	647	12:51:01	12:54:30	1290.7	12.2	0.939	1.87E+14	0.450	0.387	0.013
628	4/26/2004	base	5.5	648	12:55:30	12:59:02	1328.2	15.0	1.017	2.71E+14	0.225	0.220	-0.020
629	4/26/2004	base	4	649	13:00:00	13:01:31	1344.0	7.8	2.468				
	4/26/2004	base	4	651	13:07:31	13:11:00	1118.1	106.9	11.333	2.37E+16	6.355	4.682	1.405
630	4/26/2004	base	5.5	652	13:11:31	13:15:00	1017.2	66.5	7.598	2.75E+16	4.020	2.559	0.814
631	4/26/2004	base	7	653	13:15:31	13:18:31	1000.4	95.1	6.792	2.77E+16	5.367	3.697	1.198
632	4/26/2004	base	15	654	13:19:30	13:22:31	974.4	80.1	2.837				
633	4/26/2004	base	30	655	13:23:31	13:27:01	1155.1	89.7	5.739	1.59E+16	2.829	1.246	1.343
634	4/26/2004	base	4	656	13:27:31	13:35:01	1084.6	90.8	9.771	2.49E+16	6.164	4.965	0.786
635	4/26/2004	base	40	657	13:39:01	13:42:31	1254.7	62.9	6.153				
	4/26/2004	base	40	658	13:43:02	13:47:31	3156.7	82.8	2.282	2.15E+14	0.731	0.573	0.115
	4/26/2004	base	40	659	13:49:31	13:53:00	1236.3	26.5	5.971	3.66E+14	1.508	1.000	0.342
	4/26/2004	base	40	660	13:53:31	13:57:31	466.3	20.4	5.374	3.96E+14	1.490	1.421	0.124
636	4/26/2004	base	30	661	13:59:01	14:02:31	1745.9	52.7	2.481	4.90E+14	0.776	0.489	0.181
637	4/26/2004	base	15	662	14:03:30	14:06:32	1492.5	56.7	1.539	7.65E+14	1.425	0.884	0.379
638	4/26/2004	base	7	663	14:08:00	14:11:30	1768.1	52.2	2.031				
639	4/26/2004	base	5.5	664	14:12:30	14:16:30	1734.5	91.0	3.008	1.38E+15	1.310	0.858	0.166
640	4/26/2004	base	4	665	14:18:31	14:21:00	1744.1	71.2	3.102	1.64E+15	1.366	1.003	0.256
641	4/26/2004	base	5.5	667	14:26:00	14:29:01	881.7	100.2	4.841				
642	4/26/2004	base	7	668	14:30:32	14:33:01	849.1	88.1	5.660	3.66E+16	6.779	2.374	3.762
643	4/26/2004	base	15	669	14:34:42	14:37:31	1095.5	77.5	6.155				
701	4/27/2004	base	4	701	8:03:30	8:08:30	727.0	22.7	29.480				
702	4/27/2004	base	100	702	8:08:59	8:10:30	2059.8	55.0	181.044				
703	4/27/2004	base	85	703	8:11:00	8:13:30	1756.2	36.2	124.327				
704	4/27/2004	base	65	704	8:14:30	8:18:00	1402.6	48.7	22.554				
705	4/27/2004	base	4	705	8:19:00	8:23:30	1981.0	59.0	3.423				
	4/27/2004	base	4	706	8:24:30	8:27:30	978.2	8.9	4.926				
706	4/27/2004	base	100	707	8:28:00	8:29:30	2858.6	167.8	82.818				
707	4/27/2004	base	85	708	8:29:30	8:32:30	2312.9	93.0	75.094				
708	4/27/2004	base	70	709	8:33:30	8:36:30	1448.4	11.7	22.367				
709	4/27/2004	base	65	710	8:37:30	8:40:00	1224.1	30.9	11.903				
710	4/27/2004	base	60	711	8:42:00	8:44:00	929.6	28.6	8.596				
711	4/27/2004	base	4	712	8:46:00	8:52:00	2334.0	96.2	1.859				
	4/27/2004	base	4	713	8:53:00	8:56:30	6.4	1.1	44.017				
712	4/27/2004	base	100	714	8:57:30	8:58:30	2576.2	47.6	94.624				
713	4/27/2004	base	85	715	8:59:30	9:01:00	2103.4	50.6	79.985				
714	4/27/2004	base	65	716	9:03:30	9:06:30	1535.8	58.1	11.848				
715	4/27/2004	base	4	717	9:08:00	9:11:30	2190.1	81.2	2.920				
	4/27/2004	base	4	718	9:12:00	9:15:30	1490.2	45.2	3.950				

TABLE A-12.—(Continued).

Test Point No.[1]	Date	Fuel Type[2]	Power %	Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	CO_2 Conc. CO_2 Conc. ppm	CO_2 Conc. CO_2 Conc. Sdev[3] ppm	Particle Emission Index Black Carbon EI[5] by MAAP[4] mg/kg fuel	Particle Emission Index Number EI by CPC #/kg fuel	Particle Emission Index Mass EI by AMS[4] mg/kg fuel	Particle Emission Index Organic EI by AMS[4] mg/kg fuel	Particle Emission Index Sulfate EI by AMS[4] mg/kg fuel
716	4/27/2004	base	100	719	9:16:30	9:17:30	1195.2	31.0	156.255				
717	4/27/2004	base	85	720	9:18:30	9:21:00	1051.1	40.5	124.876				
718	4/27/2004	base	65	721	9:22:30	9:24:30	1154.7	41.8	22.969				
719	4/27/2004	base	4	722	9:25:30	9:28:30	1288.4	40.2	7.291				
	4/27/2004	base	4	723	9:29:00	9:32:30	931.9	58.0					
720	4/27/2004	base	100	724	9:33:30	9:34:30	1790.2	53.7	31.682				
721	4/27/2004	base	85	725	9:35:30	9:37:30	1694.4	49.9	81.232				
722	4/27/2004	base	70	726	9:38:30	9:41:30	1510.9	45.3	29.400				
723	4/27/2004	base	65	727	9:42:00	9:45:30	1458.9	41.8	19.074				
724	4/27/2004	base	60	728	9:47:00	9:49:30	1387.8	38.7	10.941				
725	4/27/2004	base	4	729	9:51:00	9:54:00	975.3	40.9	14.045				
	4/27/2004	sulfur	4	732	15:07:00	15:09:30	996.4	57.4	10.880				
727	4/27/2004	sulfur	100	733	15:11:00	15:12:30	1795.7	55.8	102.699	1.10E+16	9.169	4.827	3.837
728	4/27/2004	sulfur	85	734	15:13:30	15:16:00	1675.0	37.1	80.671				
729	4/27/2004	sulfur	65	735	15:16:30	15:20:00	1472.1	41.2	17.147				
730	4/27/2004	sulfur	40	736	15:21:30	15:24:30	1192.3	38.0	4.365	2.16E+16	4.729	2.591	1.665
731	4/27/2004	sulfur	30	737	15:26:00	15:29:30	1124.0	33.5	5.120				
732	4/27/2004	sulfur	7	738	15:31:00	15:33:30	986.0	44.0	5.758				
733	4/27/2004	sulfur	4	739	15:34:30	15:38:00	977.3	50.2	8.420	2.94E+16	6.861	4.502	2.075
	4/27/2004	sulfur	4	740	15:39:30	15:42:00	2631.7	94.2	-0.310	1.04E+15	0.839	0.577	0.125
734	4/27/2004	sulfur	100	741	15:44:00	15:45:00	6573.6	128.8	39.263				
735	4/27/2004	sulfur	85	742	15:45:30	15:48:00	5939.5	107.1	29.625				
736	4/27/2004	sulfur	65	743	15:48:30	15:52:30	4847.6	107.3	6.684				
737	4/27/2004	sulfur	40	744	15:53:30	15:57:00	3336.1	82.4	2.037				
738	4/27/2004	sulfur	30	745	15:57:30	16:01:30	2870.3	68.1	0.689				
739	4/27/2004	sulfur	7	746	16:02:30	16:06:00	2307.0	83.1	1.080				
740	4/27/2004	sulfur	4	747	16:06:30	16:08:30	2448.2	259.8	2.201				
	4/27/2004	sulfur	4	748	16:10:30	16:13:30	1556.4	17.2		3.50E+14	0.043	0.055	-0.003
741	4/27/2004	sulfur	100	749	16:15:00	16:16:00	1698.2	39.7	97.317	1.02E+15	1.442	1.368	0.104
742	4/27/2004	sulfur	85	750	16:16:30	16:20:00	1688.6	37.8	73.633				
743	4/27/2004	sulfur	70	751	16:21:30	16:24:00	2247.2	25.9	11.689				
744	4/27/2004	sulfur	65	752	16:25:00	16:28:00	2029.9	18.8	7.996				
745	4/27/2004	sulfur	60	753	16:29:30	16:31:30	2561.8	19.2	3.835	1.68E+14	0.147	0.184	0.000
746	4/27/2004	sulfur	40	754	16:33:00	16:35:30	1844.9	35.6	1.628				
747	4/27/2004	sulfur	30	755	16:37:00	16:39:30	1671.5	16.2	1.304				
748	4/27/2004	sulfur	15	756	16:41:00	16:43:30	2139.2	23.5	0.604	1.15E+14	0.025	-0.011	0.001
749	4/27/2004	sulfur	7	757	16:44:00	16:47:00	2205.4	107.7	1.124				
750	4/27/2004	sulfur	5.5	758	16:48:00	16:51:00	2198.8	20.1	1.454				
751	4/27/2004	sulfur	4	759	16:52:00	16:54:30	2259.1	25.1	1.423				
	4/27/2004	sulfur	4	801	8:02:31	8:05:01	1574.3	13.2	8.705	1.05E+15	0.554	0.527	0.004
802	4/28/2004	sulfur	100	802	8:06:31	8:08:31	1687.0	73.4	126.215	1.48E+15	2.014	1.971	0.035
803	4/28/2004	sulfur	85	803	8:09:01	8:11:31	1697.3	35.8	85.177	1.18E+15	1.667	1.585	0.041
804	4/28/2004	sulfur	65	804	8:12:32	8:16:01	1181.5	16.4	14.135	3.29E+14	0.551	0.535	0.008
805	4/28/2004	sulfur	40	805	8:17:01	8:22:02	2526.9	53.8	2.788	1.98E+14	0.469	0.469	0.004
	4/28/2004	sulfur	40	806	8:22:31	8:26:32	4620.7	36.6	1.548	4.29E+14	0.817	0.781	0.003
	4/28/2004	sulfur	40	807	8:28:31	8:32:31	652.2	35.0	5.082	4.45E+14	1.321	1.295	0.025
806	4/28/2004	sulfur	30	809	8:37:30	8:40:32	1151.8	44.0	1.025				
807	4/28/2004	sulfur	7	810	8:42:01	8:45:01	1715.4	25.5	1.096	2.06E+14	0.169	0.160	-0.001
808	4/28/2004	sulfur	4	811	8:46:01	8:48:32	1797.9	12.1	2.764	4.97E+14	0.272	0.301	-0.003
	4/28/2004	sulfur	4	812	8:50:02	8:52:31	1419.4	67.2	4.892	4.66E+15	1.590	1.069	0.210
809	4/28/2004	sulfur	100	813	8:54:32	8:55:32	934.0	31.4	208.054	1.12E+15	14.479	13.703	0.463
810	4/28/2004	sulfur	85	814	8:56:02	8:59:01	983.9	34.4	135.722	9.24E+14	9.476	8.826	0.299
811	4/28/2004	sulfur	65	815	8:59:31	9:02:32	1052.8	29.8	23.239	4.06E+14	1.970	1.706	0.195
812	4/28/2004	sulfur	40	816	9:03:32	9:07:01	1214.2	28.2	4.375	3.01E+14	0.934	0.741	0.138
	4/28/2004	sulfur	40	817	9:07:31	9:12:30	3495.5	93.6	2.380	1.83E+14	0.830	0.551	0.155
	4/28/2004	sulfur	40	818	9:13:31	9:17:32	579.1	27.9	9.313	3.31E+14	0.794	0.374	0.197
	4/28/2004	sulfur	40	819	9:19:01	9:23:01	2252.1	59.4	4.111	2.74E+14	1.021	0.679	0.162
813	4/28/2004	sulfur	30	820	9:24:01	9:27:31	1226.9	30.7	4.019	3.59E+14	0.833	0.711	0.137
814	4/28/2004	sulfur	7	821	9:28:31	9:32:02	1210.5	31.4	2.054	1.66E+15	1.065	0.557	0.499
815	4/28/2004	sulfur	4	822	9:32:31	9:36:01	1463.8	78.7	4.603	2.97E+15	1.389	1.023	0.256
	4/28/2004	sulfur	4	823	9:36:31	9:40:02	889.3	41.6	-0.961				
816	4/28/2004	sulfur	100	824	9:41:01	9:42:01	1745.0	47.7	109.280	1.29E+16	10.929	6.134	4.295
817	4/28/2004	sulfur	85	825	9:42:31	9:45:31	1656.5	51.7	75.786	1.37E+16	9.098	4.387	4.194
818	4/28/2004	sulfur	70	826	9:46:32	9:49:31	1500.8	35.7	23.715	1.57E+16	6.315	3.450	2.539
819	4/28/2004	sulfur	65	827	9:50:00	9:53:01	1453.1	42.8	15.982				

TABLE A-12.—(Continued).

Test Point No.[1]	Date	Fuel Type[2]	Power %	Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	CO_2 Conc. CO_2 Conc. ppm	CO_2 Conc. CO_2 Conc. Sdev[3] ppm	Particle Emission Index Black Carbon EI[5] by MAAP[4] mg/kg fuel	Particle Emission Index Number EI by CPC #/kg fuel	Particle Emission Index Mass EI by AMS[4] mg/kg fuel	Particle Emission Index Organic EI by AMS[4] mg/kg fuel	Particle Emission Index Sulfate EI by AMS[4] mg/kg fuel
820	4/28/2004	sulfur	60	828	9:53:32	9:56:31	1388.1	36.6	8.389	1.74E+16	6.179	3.448	2.171
821	4/28/2004	sulfur	40	829	9:57:30	10:00:31	1209.8	35.4	5.897	2.11E+16	7.933	3.837	3.402
822	4/28/2004	sulfur	30	830	10:02:02	10:05:00	1103.9	30.6	6.271	2.42E+16	7.992	4.189	2.961
823	4/28/2004	sulfur	15	831	10:05:32	10:08:32	921.6	40.0	5.322	3.24E+16	9.206	5.024	3.285
824	4/28/2004	sulfur	7	832	10:09:30	10:12:31	898.1	34.7	6.787				
825	4/28/2004	sulfur	5.5	833	10:13:01	10:16:31	886.8	33.1	6.843				
826	4/28/2004	sulfur	4	834	10:17:01	10:21:31	869.3	53.8	11.726	3.59E+16	9.499	6.643	1.978
827	4/28/2004	aromatic	4	836	12:50:31	12:53:31	836.3	112.4	11.464	3.64E+16	9.501	6.896	1.469
828	4/28/2004	aromatic	100	837	12:54:32	12:55:32	1739.3	42.8	115.303	8.12E+15	8.528	5.663	2.524
829	4/28/2004	aromatic	85	838	12:56:02	12:58:31	1612.9	55.5	78.624	4.35E+15	6.577	4.234	1.874
830	4/28/2004	aromatic	65	839	12:59:31	13:02:31	1426.3	38.2	16.757				
831	4/28/2004	aromatic	40	840	13:03:31	13:06:31	1163.4	39.1	6.489	2.22E+16	4.967	2.787	1.552
832	4/28/2004	aromatic	30	841	13:07:31	13:10:31	1076.1	40.4	5.120	2.52E+16	7.052	3.230	2.993
833	4/28/2004	aromatic	7	842	13:11:01	13:15:01	803.8	79.3	3.595	3.88E+16	9.391	5.469	3.094
834	4/28/2004	aromatic	4	843	13:15:32	13:18:31	797.3	120.0	9.199	3.78E+16	10.854	7.644	2.071
	4/28/2004	aromatic	4	844	13:19:32	13:24:32	1956.9	369.2	2.460	8.98E+14	1.819	1.268	0.387
835	4/28/2004	aromatic	100	845	13:25:01	13:26:31	1063.9	78.0	183.246	1.02E+15	12.130	11.449	0.386
836	4/28/2004	aromatic	85	846	13:27:02	13:30:01	1280.2	70.6	108.137	9.79E+14	8.105	7.520	0.313
837	4/28/2004	aromatic	65	847	13:30:31	13:33:31	1844.5	54.1	18.734	3.55E+14	1.887	1.644	0.092
838	4/28/2004	aromatic	40	848	13:35:02	13:38:31	1987.9	77.8	3.209	2.06E+14	1.905	1.407	0.258
839	4/28/2004	aromatic	30	849	13:39:01	13:42:31	1869.1	56.5	2.110	1.96E+14	1.609	1.057	0.344
840	4/28/2004	aromatic	7	850	13:43:01	13:47:01	1716.1	297.9	2.008	3.38E+14	1.821	1.162	0.503
841	4/28/2004	aromatic	4	851	13:47:01	13:49:31	2027.9	275.2	1.870	7.67E+14	1.620	1.174	0.277
	4/28/2004	aromatic	4	852	13:51:01	13:54:32	2115.1	67.0		3.14E+14	0.172	0.281	-0.002
842	4/28/2004	aromatic	100	853	13:55:32	13:57:01	2016.0	89.2	50.817	1.15E+15	2.207	2.121	0.021
843	4/28/2004	aromatic	85	854	13:57:32	14:00:32	1941.4	33.7	74.535	9.81E+14	1.897	1.834	0.024
844	4/28/2004	aromatic	100	855	14:10:31	14:12:02	2204.1	54.6	86.439	1.06E+15	2.023	1.917	0.032
845	4/28/2004	aromatic	85	856	14:12:31	14:16:02	1799.7	16.8	71.129	9.25E+14	1.867	1.828	0.000
846	4/28/2004	aromatic	70	857	14:17:02	14:20:02	2130.3	19.0	14.388	2.78E+14	0.778	0.733	0.031
847	4/28/2004	aromatic	65	858	14:20:31	14:23:32	1928.2	21.3	7.568	2.12E+14	0.474	0.527	-0.004
848	4/28/2004	aromatic	60	859	14:24:02	14:27:32	1769.4	9.0	5.270	1.78E+14	0.515	0.506	0.002
849	4/28/2004	aromatic	40	860	14:28:32	14:32:01	1914.6	49.0	1.671				
850	4/28/2004	aromatic	30	861	14:33:01	14:36:02	2614.7	42.2	1.733				
851	4/28/2004	aromatic	15	862	14:37:01	14:40:00	2539.2	14.0	0.505				
852	4/28/2004	aromatic	7	863	14:40:30	14:43:31	2539.7	17.9	0.661	1.07E+14	0.385	0.334	-0.002
853	4/28/2004	aromatic	5.5	864	14:44:02	14:47:01	2578.9	36.5	1.352	1.36E+14	0.300	0.282	0.008
854	4/28/2004	aromatic	4	865	14:47:31	14:50:01	2596.7	19.2	-0.205	2.63E+14	0.363	0.366	-0.004
	4/28/2004	aromatic	4	866	14:52:31	14:56:02	1558.1	260.5	0.995				
855	4/28/2004	aromatic	100	867	14:57:31	14:58:32	2710.1	74.2	59.707	6.23E+14	8.847	8.732	-0.094
856	4/28/2004	aromatic	85	868	14:59:02	15:01:32	1647.9	73.5	42.843	3.99E+14	11.102	11.071	-0.168
857	4/28/2004	aromatic	65	869	15:02:31	15:05:31	2610.2	72.4	7.715	6.92E+14	1.812	1.794	-0.023
858	4/28/2004	aromatic	40	870	15:06:31	15:09:31	2568.7	61.0	1.753	9.24E+14	0.970	0.889	0.001
859	4/28/2004	aromatic	30	871	15:10:01	15:13:31	2771.7	58.5	0.926	1.35E+15	1.107	1.093	-0.009
860	4/28/2004	aromatic	7	872	15:15:01	15:18:01	2630.7	48.4	0.880	8.07E+14	0.691	0.694	0.003
861	4/28/2004	aromatic	4	873	15:19:01	15:22:31	2707.1	67.1	1.449	1.07E+15	1.118	1.092	-0.003
	4/28/2004	aromatic	4	901	8:51:42	8:54:28	1932.2	36.2	10.181	1.03E+15	0.087	0.095	0.000
902	4/29/2004	aromatic	100	902	8:58:02	8:59:00	2022.3	46.0	139.049	1.68E+15	1.854	1.772	0.034
903	4/29/2004	aromatic	85	903	9:00:03	9:03:06	1802.8	41.3	117.718	1.53E+15	1.653	1.621	0.033
904	4/29/2004	aromatic	65	904	9:04:00	9:07:05	2075.3	42.9	16.652	3.46E+14	0.636	0.600	0.018
905	4/29/2004	aromatic	40	905	9:08:00	9:11:01	2032.1	36.4	2.725	1.80E+14	0.087	0.082	0.002
906	4/29/2004	aromatic	30	906	9:11:43	9:15:00	2561.3	17.6	1.912	1.27E+14	0.121	0.110	0.007
907	4/29/2004	aromatic	7	907	9:16:40	9:19:01	2850.7	20.6	0.708				
908	4/29/2004	aromatic	4	908	9:19:54	9:22:01	2829.4	100.8	3.009	3.11E+14	0.297	0.292	0.005
	4/29/2004	aromatic	4	909	9:23:37	9:27:19	2147.1	93.1	4.520				
909	4/29/2004	aromatic	100	910	9:29:34	9:30:30	1546.6	26.9	206.082	1.64E+15	8.878	8.043	0.219
910	4/29/2004	aromatic	85	911	9:31:00	9:33:02	1659.9	35.0	134.543	1.27E+15	6.198	5.754	0.223
911	4/29/2004	aromatic	65	912	9:34:30	9:37:27	1737.6	39.1	27.175	4.60E+14	1.669	1.363	0.327
912	4/29/2004	aromatic	40	913	9:38:00	9:43:00	2466.2	62.2	4.440	1.93E+14	0.367	0.271	0.029
913	4/29/2004	aromatic	30	914	9:43:56	9:47:38	2663.7	46.7	2.454	1.98E+14	0.363	0.312	0.046
914	4/29/2004	aromatic	7	915	9:48:36	9:52:18	2155.5	63.9	2.089	1.60E+15	0.410	0.338	0.083
915	4/29/2004	aromatic	4	916	9:53:00	9:56:01	2245.9	71.2	5.095				
	4/29/2004	aromatic	4	917	9:56:41	10:00:55	1030.9	61.7	21.144	2.70E+16	8.713	8.159	0.323
916	4/29/2004	aromatic	100	918	10:02:00	10:03:12	1776.3	46.0	152.903	1.26E+16	8.000	5.982	1.703
917	4/29/2004	aromatic	85	919	10:03:56	10:07:15	1634.0	68.7	101.350	1.39E+16	4.509	3.118	1.320
918	4/29/2004	aromatic	70	920	10:08:01	10:11:31	1494.6	45.0	33.412				

TABLE A-12.—(Continued).

Test Point No.[1]	Date	Fuel Type[2]	Power %	Aerosol Point No.[1]	Measurement Start Time	Measurement End Time	CO_2 Conc. CO_2 Conc. ppm	CO_2 Conc. CO_2 Conc. Sdev[3] ppm	Particle Emission Index Black Carbon EI[5] by MAAP[4] mg/kg fuel	Number EI by CPC #/kg fuel	Mass EI by AMS[4] mg/kg fuel	Organic EI by AMS[4] mg/kg fuel	Sulfate EI by AMS[4] mg/kg fuel
919	4/29/2004	aromatic	65	921	10:12:02	10:15:02	1451.9	45.4	22.961	1.64E+16	2.420	1.590	0.577
920	4/29/2004	aromatic	60	922	10:16:02	10:20:01	1379.3	47.7	11.734	1.76E+16	1.872	1.145	0.610
921	4/29/2004	aromatic	40	923	10:21:32	10:24:32	1181.8	45.4	5.584	2.19E+16	1.865	1.245	0.359
922	4/29/2004	aromatic	30	924	10:25:32	10:28:32	1032.4	58.4	4.328	2.69E+16	3.415	1.326	0.642
923	4/29/2004	aromatic	15	925	10:29:32	10:32:32	889.5	69.1	-1.934	3.44E+16	2.792	2.021	0.482
924	4/29/2004	aromatic	7	926	10:34:02	10:37:02	1003.0	43.4	6.208	2.82E+16	4.392	3.254	0.801
925	4/29/2004	aromatic	5.5	927	10:38:02	10:41:02	981.8	48.0	12.960	2.91E+16	5.363	4.786	0.396
926	4/29/2004	aromatic	4	928	10:42:02	10:45:32	986.6	47.5	12.115	2.89E+16	6.212	5.613	0.375
	4/29/2004	aromatic	4	929	10:47:02	10:50:31	2149.7	173.3	0.640	2.65E+14	-0.010	-0.060	0.010
927	4/29/2004	aromatic	100	930	10:53:33	10:55:02	1946.9	328.1	73.686	3.13E+14	1.239	1.228	0.007
928	4/29/2004	aromatic	85	931	10:56:32	10:58:33	1971.5	155.8	59.817	3.09E+14	0.753	0.716	0.024
929	4/29/2004	aromatic	65	932	10:59:32	11:03:03	2587.8	83.0	7.481	1.13E+14	0.110	0.088	0.005
930	4/29/2004	aromatic	40	933	11:04:02	11:07:02	2981.0	121.6	2.858	9.88E+13	0.046	-0.012	0.009
931	4/29/2004	aromatic	30	934	11:07:32	11:11:01	3524.8	664.4	2.804	9.78E+13	0.102	0.084	0.007
932	4/29/2004	aromatic	7	935	11:12:02	11:15:32	2930.4	125.6	0.586	7.60E+13	0.002	-0.018	-0.005
933	4/29/2004	aromatic	4	936	11:16:33	11:20:01	2941.3	203.6	4.193	5.69E+14	0.126	0.125	0.005
934	4/29/2004	sulfur	7	937	13:49:33	13:52:49	739.4	144.7	52.419	4.66E+16	4.984	3.711	0.991
937	4/29/2004	sulfur	75	941	14:11:02	14:14:32	1326.9	90.0	337.878	1.85E+16	8.241	4.791	3.009
938	4/29/2004	sulfur	30	942	14:15:18	14:18:00	855.5	57.9	31.729	3.69E+16	6.901	4.200	2.396
	4/29/2004	sulfur	7	944	14:20:02	14:24:03	2223.6	26.9	9.031				
	4/29/2004	sulfur	7	945	14:26:14	14:28:56	2582.0	31.5	8.318	1.48E+14	0.189	0.125	-0.006
	4/29/2004	sulfur	7	946	14:30:00	14:33:32	1861.4	165.9	14.569	1.21E+15	0.479	0.183	0.168
	4/29/2004	sulfur	7	947	14:34:00	14:38:31	634.6	116.0	53.418	6.32E+16	7.626	5.700	1.646
	4/29/2004	sulfur	7	948	14:41:33	14:44:04	9240.5	59.7	7.615	1.71E+15	0.390	0.367	0.001
940	4/29/2004	sulfur	100	950	14:44:29	14:45:47	2336.0	43.5	15.953	3.96E+15	1.625	1.616	0.017
941	4/29/2004	sulfur	85	951	14:46:47	14:49:03	2944.2	500.8	579.666	2.82E+14	4.256	4.183	0.037
942	4/29/2004	sulfur	30	952	14:50:03	14:53:32	2493.0	30.0	30.547	8.07E+14	0.502	0.491	0.008
943	4/29/2004	sulfur	7	953	14:54:30	14:58:00	2646.2	17.7	32.077	1.18E+15	1.003	0.960	0.010
	4/29/2004	sulfur	7	954	14:59:00	15:02:30	2394.7	27.6	27.118				
	4/29/2004	sulfur	7	955	15:05:01	15:08:54	1615.6	283.8	50.393				
	4/29/2004	sulfur	7	957	15:15:45	15:19:31	2795.1	81.1	1.828				
944	4/29/2004	sulfur	100	958	15:20:33	15:21:23	2147.6	92.1	98.553	1.23E+15	1.795	1.782	0.052
945	4/29/2004	sulfur	85	959	15:21:31	15:23:47	1721.5	67.0	88.156	1.12E+15	1.426	1.323	0.051
946	4/29/2004	sulfur	30	960	15:24:30	15:28:13	2937.6	50.4	1.509	9.34E+13	0.156	0.165	0.012
947	4/29/2004	sulfur	7	961	15:29:02	15:35:30	2877.7	53.1	1.611	1.49E+14	0.109	0.087	0.015
	4/29/2004	sulfur	7	962	15:37:00	15:44:31	1607.7	290.2	3.458				
	4/29/2004	sulfur	7	963	15:45:02	15:54:28	565.1	75.6	9.677	7.32E+16	6.746	4.463	1.393
948	4/29/2004	sulfur	100	964	15:55:11	15:56:06	1519.2	108.7	108.170				
949	4/29/2004	sulfur	85	965	15:56:15	15:58:30	1427.1	62.7	108.880	1.68E+16	7.530	3.424	3.886
950	4/29/2004	sulfur	30	966	15:59:02	16:02:30	806.5	44.8	4.301	4.11E+16	6.814	3.889	2.453
951	4/29/2004	sulfur	7	967	16:03:38	16:11:55	569.9	95.8	10.816	7.32E+16	6.736	4.595	1.230
	4/23/2004	base	4	311	9:52:59	10:02:01	1685.6	135.8	5.328				
	4/23/2004	base	7	320	10:39:00	10:40:00	770.6	1072.9	5.017				
	4/24/2004	base	4	401	8:15:26	8:16:08	2097.6	708.1	63.545				
	4/24/2004	base	4	401	8:16:29	8:18:31	1435.6	41.2	23.349				
	4/24/2004	base	4	402	8:20:29	8:22:31	2255.3	70.5	40.775	8.21E+14	0.602	0.643	-0.037
	4/24/2004	base	4	403	8:23:35	8:24:45	791.4	732.1	9.966				
	4/24/2004	base	4	404	10:06:29	10:08:01	1217.9	19.4	0.494				
	4/24/2004	base	85	405	10:09:59	10:11:31	2881.5	74.6	109.217				
	4/24/2004	base	100	406	10:12:30	10:13:31	3044.3	70.4	119.173	1.69E+15	1.520	1.468	-0.001
	4/25/2004	base	4	516	12:00:33	12:01:20	2207.6	1042.0	3.607				
	4/25/2004	base	4	522	12:26:59	12:29:31	2369.7	126.9	5.307				
	4/25/2004	base	85	524	13:22:29	13:24:31	5109.0	103.0	49.834				
	4/25/2004	base	100	528	13:56:57	13:57:46	1373.3	358.2	-0.308				
	4/25/2004	base	4	529	13:57:59	14:00:01	1158.3	100.8	11.466				
	4/26/2004	base	4	601	8:08:02	8:09:02	969.2	57.3	41.900	2.98E+16	14.072	12.210	0.934
	4/26/2004	base	30	670	14:39:01	14:42:00	1059.6	80.9	4.780	1.70E+16	3.906	2.124	1.486
	4/26/2004	base	4	671	14:44:02	14:47:02	918.0	121.4	6.578	3.25E+16	6.921	4.924	1.543
	4/26/2004	base	40	672	14:48:01	14:51:01	1293.0	90.6	6.585	1.58E+16	3.842	2.104	1.472
	4/26/2004	base	40	673	14:52:31	14:56:31	2893.5	47.7	2.110	2.26E+14	0.688	0.701	-0.018
	4/26/2004	base	40	674	14:58:02	15:02:02	3297.9	119.4	2.078	2.99E+14	0.817	0.622	0.125
	4/26/2004	base	4	675	15:03:30	15:07:02	2468.9	139.8	2.310				
	4/28/2004	aromatic	30	835	12:43:31	12:50:01	893.7	117.5	9.125	3.33E+16	8.511	5.377	2.137

Note:
1. The test point No. defines the sequential engine testing conditions while the aerosol point number defines each aerosol measurement condition. Both of them are combinations of the last digit in the date between April 20 and 29 and a sequence number of point for that day. If the test point number is 305, the test point was for the 5th test point on April 23.
2. Three types of fuel were used: base for base JP-8 fuel, aromatic for high aromatic fuel, and sulfur for base fuel with sulfur additive.

3. One standard deviation.
4. Instruments: aerosol mass spectrometer (AMS) and Multi-angle absorption photometer (MAAP).
5. Emission index.

TABLE A-13.—AIRCRAFT CFM56-2-C1 ENGINE PARTICLE MASS EMISSION DATA MEASURED WITH TEOM BY WPAFB DURING THE AIRCRAFT PARTICLE EMISSIONS EXPERIMENT (APEX).

Test Point No.[1]	Fuel Type[2]	Power %	Aerosol Point No.[1]	Probe Rake Location[3]	Probe Tip No[3]	Measurement Date	Measurement Start Time	Measurement End Time	Averaged Mass Conc. (mg/m^3)	Mass Conc. Stdev[4]	n	CO_2 Conc. %	Mass EI[4] g/kg fuel
601	base	7	603	1m	GG1	26-Apr-04	8:15:30	8:27:12	0.11	0.017	309	2.3896	0.0080
604	base	30	608	1m	GG1	26-Apr-04	8:34:30	8:36	0.886	0.083	89	2.569	0.0596
605	base	7	610	1m	GG1	26-Apr-04	8:40:16	8:03:09	0.092	0.031	336	2.3272	0.0068
608	base	30	617	1m	GG1	26-Apr-04	9:10	9:12	0.787	0.14	108	2.5804	0.0527
609	base	7	619	1m	GG1	26-Apr-04	9:19:50	9:38:45	0.091	0.028	347	2.2975	0.0068
612	base	30	622	1m	GG1	26-Apr-04	9:46	9:47	0.618	0.04	61	2.5214	0.0424
613	base	7	624	1m	GG1	26-Apr-04	9:55	10:10	0.134	0.038	241	2.5157	0.0092
616	base	30	627	1m	GG1	26-Apr-04	10:21:37	10:23	0.734	0.09	66	2.5984	0.0488
618	base	4	632	1m	GG1	26-Apr-04	11:55:16	12:00	0.919	0.117	180	2.7631	0.0575
621	base	65	635	1m	GG1	26-Apr-04	12:08	12:08:19	0.512	0.085	21	3.4526	0.0256
622	base	40	636	1m	GG1	26-Apr-04	12:11:57	12:12:55	0.496	0.074	30	2.9004	0.0296
623	base	4	638	1m	GG1	26-Apr-04	12:16	12:19	0.336	0.059	48	2.853	0.0204
631	base	7	653	1m	GG1	26-Apr-04	13:15	13:18:55	0.185	0.032	14	2.68	0.0119
634	base	4	656	1m	GG1	26-Apr-04	13:29:25	13:37:38	0.21	0.048	107	2.808	0.0129
640	base	4	665	1m	GG1	26-Apr-04	14:20:20	14:24:45	0.145	0.024	52	2.7326	0.0092
640	base	4	666	1m	GG1	27-Apr-04	8:22	8:27:40	0.79	0.138	343	2.5452	0.0537
707	base	85	708	1m	GG1	27-Apr-04	8:31:45	8:32:50	0.927	0.046	66	3.8441	0.0417
711	base	4	712	1m	GG1	27-Apr-04	8:50	8:56:37	0.689	0.089	398	2.5446	0.0468
713	base	85	715	1m	GG1	27-Apr-04	9:01:46	9:02:46	0.472	0.053	61	3.859	0.0211
715	base	4	717	1m	GG1	27-Apr-04	9:09:39	9:15:55	0.683	0.058	378	2.5375	0.0465
717	base	85	720	1m	GG1	27-Apr-04	9:20:42	9:21:00	0.394	0.021	19	3.9245	0.0174
719	base	4	723	1m	GG1	27-Apr-04	9:28:17	9:33	0.643	0.055	285	2.5339	0.0439
730	sulfur	40	736	1m	GG1	27-Apr-04	15:23:52	15:25:25	0.617	0.0323	95	2.7789	0.0384
732	sulfur	7	738	1m	GG1	27-Apr-04	15:32:22	15:34	0.317	0.0147	110	2.563	0.0214
733	sulfur	4	739	1m	GG1	27-Apr-04	15:35:15	15:41:33	0.368	0.053	379	2.7351	0.0233

TABLE A-13.—(Continued).

Test Point No.[1]	Fuel Type[2]	Power %	Aerosol Point No.[1]	Probe Rake Location[3]	Probe Tip No[3]	Measurement Date	Measurement Start Time	Measurement End Time	Averaged Mass Conc. (mg/m^3)	Mass Conc. Stdev[4]	n	CO_2 Conc. %	Mass EI[4] g/kg fuel
738	sulfur	30	745	1m	GG1	27-Apr-04	16:00:17	16:00:35	0.451	0.046	19	2.6055	0.0299
739	sulfur	7	746	1m	GG1	27-Apr-04	16:04:10	16:06:14	0.365	0.0254	134	2.5825	0.0244
740	sulfur	4	747	1m	GG1	27-Apr-04	16:07:45	16:12:49	0.492	0.03	306	2.7385	0.0311
746	sulfur	40	754	1m	GG1	27-Apr-04	16:34:38	16:36:13	0.979	0.041	96	2.7744	0.0610
749	sulfur	7	757	1m	GG1	27-Apr-04	16:44:47	16:46:48	0.451	0.134	132	2.5514	0.0306
750	sulfur	5.5	758	1m	GG1	27-Apr-04	16:49:21	16:51:38	0.463	0.048	138	2.6681	0.0300
751	sulfur	4	801	1m	GG1	28-Apr-04	8:01:48	8:06:08	0.907	0.058	261	2.7388	0.0572
803	sulfur	85	803	1m	GG1	28-Apr-04	8:10:18	8:11:24	1.507	0.312	44	3.84	0.0678
804	sulfur	65	804	1m	GG1	28-Apr-04	8:14:39	8:15:04	0.342	0.025	22	3.2776	0.0180
805	sulfur	40	805	1m	GG1	28-Apr-04	8:19:27	8:28:09	0.66	0.077	523	2.7311	0.0418
808	sulfur	4	812	1m	GG1	28-Apr-04	8:48:36	8:53:32	0.245	0.048	240	2.6411	0.0160
812	sulfur	40	817	1m	GG1	28-Apr-04	9:07:28	9:22	0.427	0.176	479	2.7217	0.0271
841	aromatic	4	852	1m	GG1	28-Apr-04	13:53:40	13:54:24	0.387	0.045	45	2.6982	0.0248
843	aromatic	85	854	1m	GG1	28-Apr-04	13:59:06	14:00:31	1.077	0.078	86	3.8708	0.0481
845	aromatic	85	856	1m	GG1	28-Apr-04	14:13:38	14:16:01	1.05	0.116	144	3.8994	0.0465
847	aromatic	65	858	1m	GG1	28-Apr-04	14:22:06	14:23:56	0.428	0.037	111	3.5215	0.0210
848	aromatic	60	859	1m	GG1	28-Apr-04	14:24:26	14:26:14	0.623	0.115	109	3.4603	0.0311
849	aromatic	40	860	1m	GG1	28-Apr-04	14:31:23	14:31:14	0.548	0.009	10	2.7962	0.0339
854	aromatic	4	866	1m	GG1	28-Apr-04	14:52	14:53	0.488	0.071	21	2.7803	0.0303
856	aromatic	85	868	1m	GG1	28-Apr-04	14:58:10	15:01:16	1.67	0.315	187	3.8814	0.0744
861	aromatic	4	873	1m	GG1	28-Apr-04	15:21	15:22	0.271	0.021	126	2.5651	0.0183
908	aromatic	4	908	1m	GG1	29-Apr-04	9:22:32	9:28:23	0.291	0.049	167	2.5266	0.0199
910	aromatic	85	911	1m	GG1	29-Apr-04	9:32:06	9:32:44	1.4	0.252	30	3.9377	0.0615
915	aromatic	4	916	1m	GG1	29-Apr-04	9:53:56	10:00:21	0.325	0.036	209	2.5575	0.0220
917	aromatic	85	919	1m	GG1	29-Apr-04	10:04	10:06:44	1.67	0.349	103	2.68	0.1077
926	aromatic	4	928	1m	GG1	29-Apr-04	10:43:15	10:48:56	0.315	0.018	274	2.6806	0.0203

Note:

1. The test point No. defines the sequential engine testing conditions while the aerosol point number defines each aerosol measurement condition. Both of them are combinations of the last digit in the date between April 20 and 29 and a sequence number of point for that day. If the test point number is 305, the test point was for the 5th test point on April 23.
2. Three types of fuel were used: base for base JP-8 fuel, aromatic for high aromatic fuel, and sulfur for base fuel with sulfur additive.
3. The TEOM was sampling from an external gas probe (GG1) at 1 m location without any dilution.
4. Emission index.

Appendix B
Fuel Technology Support for NASA Aircraft Particle Emissions Experiment (APEX)*

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SOUTHWEST RESEARCH INSTITUTE[§]

FUEL TECHNOLOGY SUPPORT FOR NASA AIRCRAFT PARTICLE EMISSIONS EXPERIMENT

(APEX)

FINAL REPORT

SwRI Project No. 08-10114.01.042

Prepared by:

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Southwest Research Institute

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December 2004

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SOUTHWEST RESEARCH INSTITUTE

FUEL TECHNOLOGY SUPPORT FOR NASA AIRCRAFT PARTICLE EMISSIONS EXPERIMENT (APEX)

FINAL REPORT

SwRI Project No. 08-10114.01.042

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December 2004

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Engine and Vehicle Research Division

Executive Summary

Support has been provided to the NASA Aircraft Particle Emissions experiment (APEX) in order to provide tests fuels with varying sulfur and aromatic content and to provide analyses of the those fuels to aid in the analyses of the particulate-emissions data. The test matrix consisted of three jet fuels that allowed for independent variation of sulfur and aromatic content. Other properties that could affect atomization, fuel-air ratio, and combustion efficiency were almost identical so that sulfur and aromatics were the only significant fuel variables. The fuels were also speciated for hydrocarbon composition for comparison with exhaust hydrocarbons. Fuel samples taken from the test engine were analyzed to look for the presence of the previous fuel following a fuel change. The possibility of contamination existed in the pretest sample of two of the fuels, but it may have just existed in the fuel line. Later samples were nominal. This was just a cautionary measure in case initial emissions measurement did not agree with reruns.

1.0 Objectives

There were two objectives for this support effort.

The *first objective* was to recommend tests fuels for the APEX project that would provide a variation in sulfur content and aromatic content for the purpose of evaluating the effects of fuel chemistry on particulate formation and aging.

The *second objective* was to provide analyses of fuel properties to provide the following support for the analyses of the gaseous and particulate emissions data:

- identify significant differences in the fuels that could affect combustion and particulate
- formation
- provide data on fuel chemistry for correlating exhaust particulates
- provide detailed hydrocarbon speciation of the fuel for comparison with speciation of the
- exhaust hydrocarbons
- identify any potential for contamination from residual fuel during fuel changes

2.0 Results

2.1 Test Fuels

The project team agreed upon the following matrix of three test fuels:

- base fuel with low to moderate aromatics and sulfur
- a fuel that was low in aromatics but high in sulfur relative to the base fuel
- a fuel that was low in sulfur but high in aromatics relative to the base fuel

Decisions on the selection and procurement of these fuels were constrained by the lack of fuel storage facilities at the NASA Dryden test site. As the test site was located on Edwards AFB, it was decided to use the locally available JP-8 fuel as the base fuel. This presented a somewhat awkward situation for the other two fuels, as it was not possible to know exactly the aromatic and sulfur content of this fuel prior to securing it for the test. Edwards receives several shipments a month by pipeline from the Defense Fuel Support Point (DFSP) in San Pedro, California. These shipments can come from several refinery sources and are co-mingled in the bulk storage tanks at Edwards AFB. Thus sampling and analyzing the fuel in order to define the baseline ahead of time was not practical.

A review of the fuel shipments to Edwards AFB for last two years revealed that the sulfur content is almost always less than 500 ppm while the aromatic content generally varies from 15 to 20 %(vol.). It was, therefore, decided to simply add an organic sulfur compound to the base fuel at the rate of 1000 ppm; this would result in a significant increase in sulfur with little chance of exceeding the specification limit for sulfur of 3000 ppm. The sulfur compound chosen was tertiary butyl di-sulfide, C12H18S2. Di-sulfides are a common form of sulfur in jet fuel. TBDS has a molecular weight that puts it well within the boiling range of jet fuel and it is readily available. Another advantage was that adding this small amount would not change any other relevant properties of the fuel, and any changes in particulates could be attributed to the sulfur content.

This approach was not practical for the high-aromatic fuel. It is possible to procure aromatic solvents in the jet fuel boiling range, e.g., Exxon Aromatic 150 solvent. The requirement would be something on the order of 250 gallons of solvent. There were no facilities at the test site to handle large containers such as this for blending into large quantities of base fuel. As an alternative approach, a search of California refineries identified a source of commercial jet fuel, Jet A, that was said to have an aromatic content around 23 %(v) and a sulfur content around 500 ppm. This fuel was procured and delivered to the test site.

Table B-1 summarizes the aromatic and sulfur contents of the test fuels after analysis at Southwest Research Institute (SwRI); other properties will be presented later. The variation in sulfur content is in line with expectations, but the variation in aromatic content is not as great as hoped for. The aromatic content of the base fuel was a little higher than average for Edwards AFB, and the aromatic content of the purchased fuel was a little lower than indicated by the refinery. The slight decrease in aromatic content of the high-sulfur fuel is due primarily to the addition of the sulfur compound.

TABLE B-1.—SUMMARY OF SULFUR AND AROMATIC CONTENTS OF TEST FUELS

Test Fuel	Sulfur Content ppm	Aromatic Content, %(v)
Base fuel	383	17.6
High-sulfur fuel	1595	17.3
High-aromatic fuel	530	21.6

Figures B-1 and B-2 compare the sulfur and aromatic contents of the test fuels with the annual survey by the Defense Energy Support Center for the year 2002, the most recent available. (1) It is seen that all three fuels are within the specification limits on these properties. The base fuel is very close to the mean of the survey. For the “high-sulfur fuel”, the aromatic content is close to the mean, and the increase in sulfur content is significant, relative to the population of the survey. Similarly for the “high-aromatic fuel”, the sulfur content is close to the mean, while the increase in aromatics is significant within the population, although technically, it would have better to have it up in the range of 23 to 25 %(v).

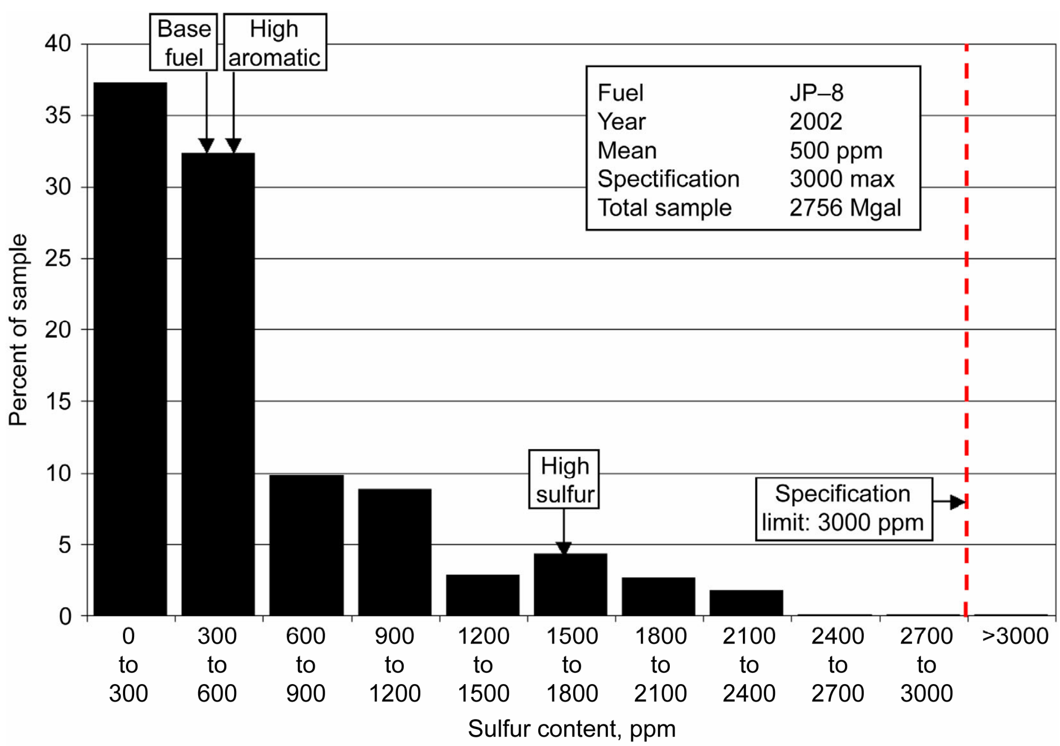

Figure B–1.—Comparison of test fuels with DESC JP-8 survey: sulfur content.

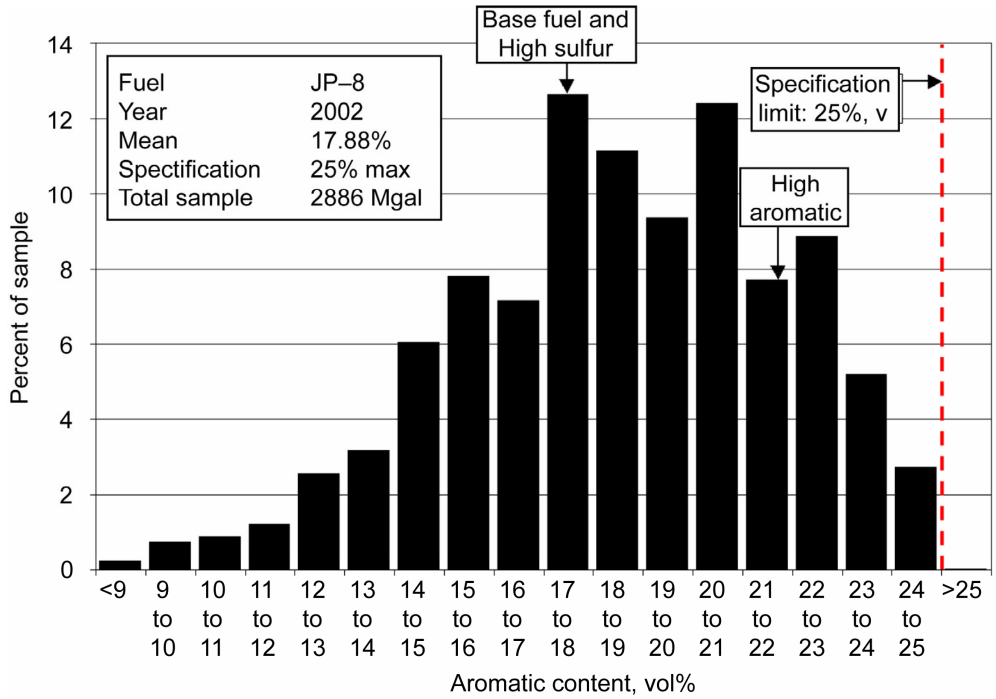

Figure B–2.—Comparison of test fuels with DESC JP-8 survey: aromatic content.

2.2 Fuel Sampling

After the engine emissions test was completed at the Dryden test site, 12 fuel samples were shipped to SwRI. The volume of the individual samples varied, but was on the order of 500 to 700 ml. It is understood that these samples were taken at or near the engine. Table B-2 summarizes the information provided about these samples in terms of the date, time, and test fuel loaded on the aircraft.

TABLE B-2. SUMMARY OF FUEL SAMPLES

Sample #	Date	Time	Fuel	Notes on bottle
1	April 20, 2004	–	Base fuel	N817NA JP-8
2	April 23, 2004	–	Base fuel	(none)
3	April 25, 2004	–	Base fuel	(none)
4	April 27, 2004	10:15 am	Base fuel	(none)
5	April 27, 2004	10:15 am	Base fuel	(none)
6	April 27, 2004	–	High sulfur	Before test
7	April 27, 2004	–	High sulfur	After test
8	April 28, 2004	11:00 am	High sulfur	After morning test
9	April 28, 2004	12:30 pm	High aromatic	Before afternoon test
10	April 28, 2004	3:25 pm	High aromatic	After afternoon test
11	April 29, 2004	11:25 am	High Aromatic	After morning test
12	April 29, 2004	4:25 pm	High sulfur	After EPA test

2.3 Fuel Analysis for Possible Carry-Over

Selected fuel samples were analyzed for sulfur content as an indicator of possible carry-over of residual fuel following a defueling and subsequent refueling with a new test fuel. Sulfur analysis was chosen as a metric for this evaluation because of the sensitivity of the test method. Table B-3 summarizes these results.

TABLE B-3.—ANALYSIS FOR POSSIBLE CARRY-OVER FOLLOWING FUEL CHANGES

Sample #	Date	Time	Fuel	Sulfur, ppm	Apparent Carry-Over
4	April17	10:15 am	Base fuel	383	0 %
6	April27	–	High sulfur	1595	0%
7	April 27	–	High sulfur	1595	
8	April 28	11:00 am	High sulfur	1599	
9	April 28	12:30 pm	High aromatic	645	10.7%
10	April 28	3:25 pm	High aromatic	533	
11	April 29	11:25 am	High aromatic	526	
12	April 29	4:25 pm	High sulfur	1556	4.1 %

These results suggest a possible carry-over in fuel samples 9 and 12. It is possible that these contaminations existed in the fuel line and were very short in duration so that the bulk of the engine tests on the high-aromatic fuel were uncontaminated and the same for the engine tests on the high-sulfur fuel on April 29. These data are provided as a caution in case the initial tests after these fuel changes don't agree with other data.

2.4 Fuel Analysis for Possible Effects on Combustion and Soot Formation

2.4.1 General Comments

There are a number of fuel properties, both chemical and physical, that directly affect the combustion process and therefore could have an effect on the gaseous emissions and soot formation. It is important to be aware of these possibilities so that variations are not wrongly associated with the two project variables, sulfur and aromatics. The major factors are those that could affect fuel atomization, fuel-air ratio, combustion efficiency, or the chemistry of soot formation. Another factor of interest is the hydrocarbon speciation of the fuel itself for comparison with that of the exhaust hydrocarbons.

2.4.2 Properties Affecting Atomization, Fuel/Air, and Combustion Efficiency

Fuel atomization has a significant effect on CO and unburned hydrocarbons, especially at the idle condition where combustion temperatures are lower and mixing is not as good. Fuel atomization can also affect soot formation in that soot is formed in fuel rich regions of the primary zone of the combustor and poorer atomization can increase these regions. Generally, this is not an issue with aircraft gas turbines and conventional fuels. The fuel properties, which can effect atomization, are viscosity, surface tension, and density. Increases in the values of these properties can lead to larger droplets in the fuel spray. The relative importance of these properties depends upon the type of atomizer design, but viscosity is the most important because there can be a greater variation among fuels and with fuel temperature.

The boiling point distribution of the fuel can affect the unburned hydrocarbons, especially at idle and other low power conditions. A fuel that has a higher end point, i.e., more components with higher molecular weights can produce more unburned hydrocarbons, as these components are less likely to get burned at these conditions of lower combustion temperature and poorer mixing.

The density of the fuel along with the heat of combustion affect the fueling rate and hence the fuel-air ratio. Any increase in fuel-air ratio can lead to an increase in soot formation rate at high power conditions and unburned hydrocarbons at idle.

Figure B-3 compares the viscosity, surface tension, density, and heat of combustion for the three test fuels. It is seen that there is very little difference. It is therefore concluded that these fuels should have produced the same degree of atomization. Furthermore, there should not have been any difference in the fueling rates due to the fuel properties.

Figure B-4 compares the boiling point distributions of the three test fuels. As would be expected, the base fuel and the high-sulfur fuel are identical. The high-aromatic fuel has slightly higher temperatures in the upper half of the distribution meaning it contains somewhat larger molecules and it takes higher temperatures to boil off that fraction. The high aromatic fuel might produce higher unburned hydrocarbons at idle conditions; CO could be higher also.

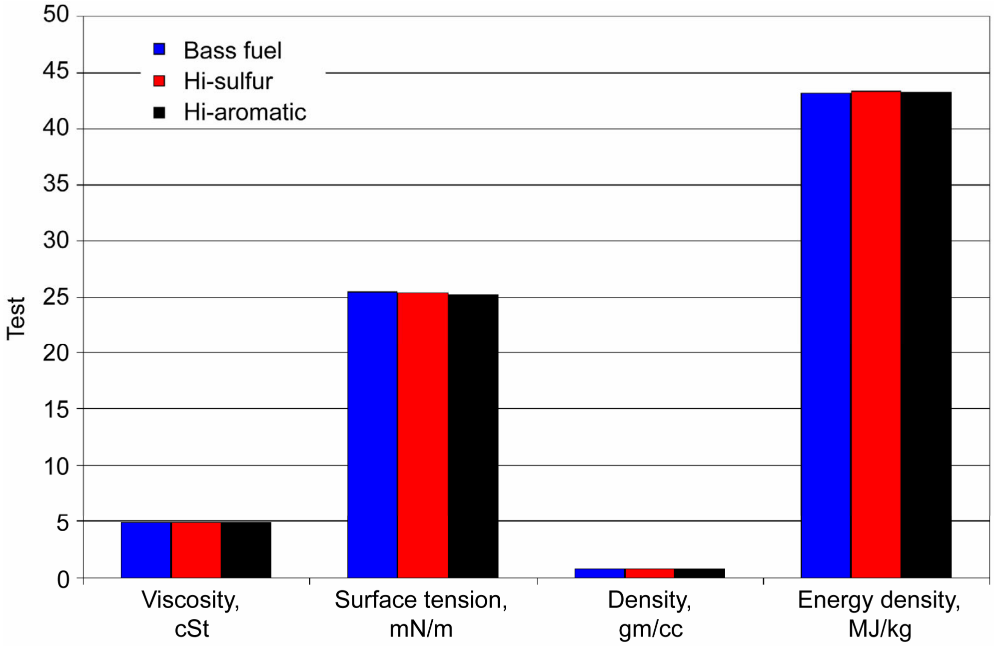

Figure B–3.—Comparison of bulk physical properties of test fuels.

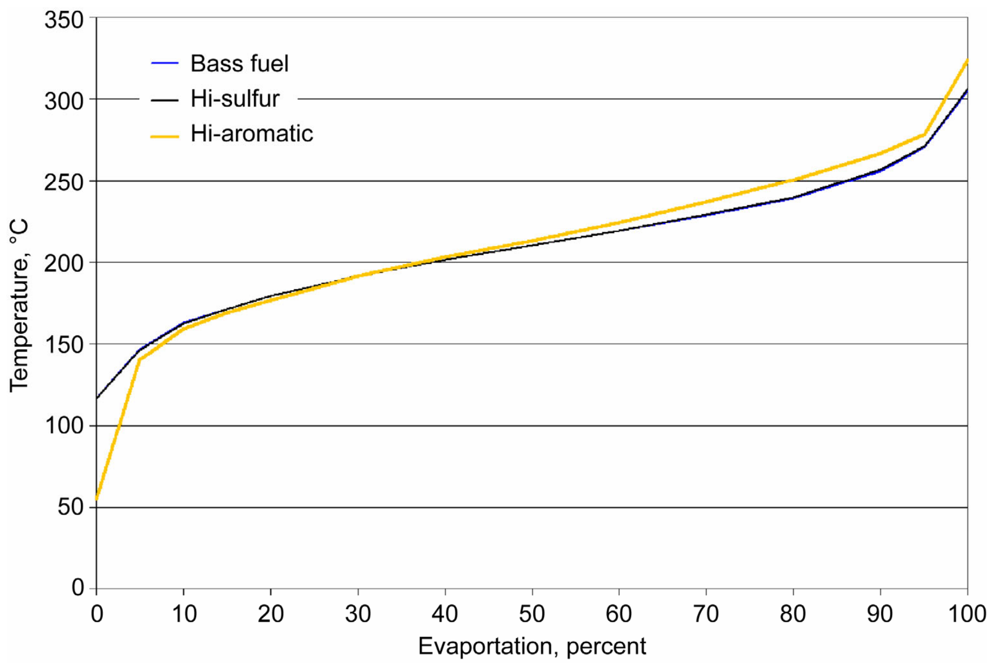

Figure B–4.—Comparison of boiling point distributions of test fuels.

It is concluded from these data that the essential differences in the three test fuels are the sulfur and aromatic content. Any differences in the particulates should be related to these properties. The high-aromatic fuel might produce slightly higher unburned hydrocarbons.

2.4.3 Properties Affecting Soot Formation

There are several fuel parameters that are considered to be related to soot formation during the combustion process:

- total aromatic content (single- and double-ring aromatics)
- naphthalene content (double-ring aromatics)
- hydrogen content or hydrogen-carbon ratio
- smoke point

There is redundancy within in the first three because the aromatic molecules have a significantly lower hydrogen-carbon ratio than the other families of hydrocarbons in the fuel. The naphthalenes, two-ring aromatics, have even less hydrogen per carbon atom than the single-ring aromatics and are limited to 3.0 %(v) of the fuel for this reason. Hydrogen content is an effective indicator of combustion quality because it is independent of details of molecular structure. Smoke point is a performance test of combustion quality using a wick lamp; the higher the wick can be without smoking, the cleaner burning the fuel. Table B-4 summarizes these properties of combustion cleanliness for the three test fuels. It is surprising that the higharomatic fuel has essentially the same hydrogen content and smoke point as the base fuel given the difference in aromatic content; the lower naphthalene content apparently offsets this. It will be interesting to see how the particulate measurements at the engine exit plane compare. It is speculated that there will not be much difference.

TABLE B-4.—SUMMARY OF FUEL PARAMETERS RELATED TO SOOT FORMATION

Test Fuel %(v)	Aromatics %(v)	Naphthalenes %(wt)	Hydrogen mm	Smoke Point
Base fuel	17.6	1.34	13.69	19.9
High-sulfur	17.3	1.31	13.67	19.5
High-aromatic	21.6	0.93	13.70	20.0

Figure B-6 illustrates how the hydrocarbons of a given carbon number are distributed throughout the fuels. In general the fuels are quite similar.

THERE ARE 2 FIGURE B-5s

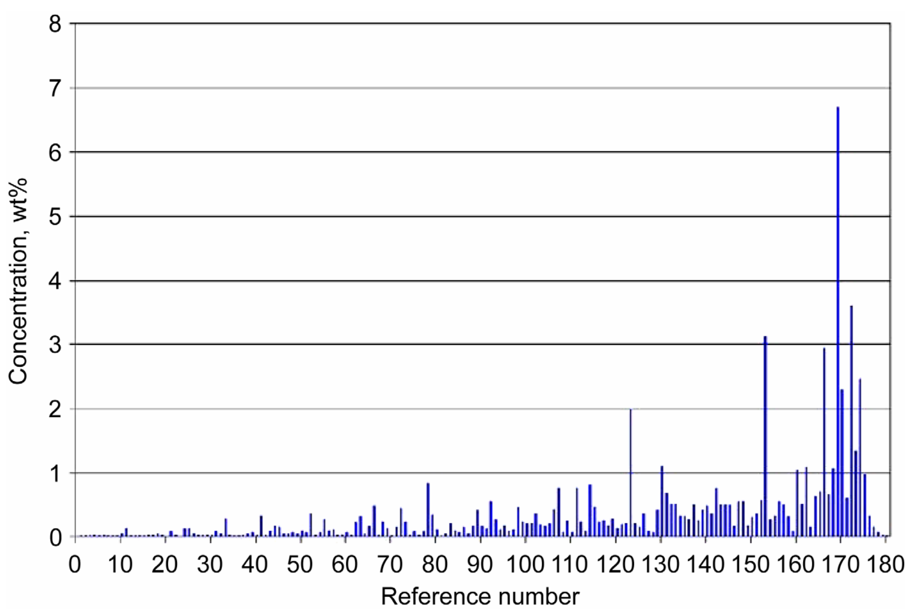

Figure B–5.—Chromatogram of hydrocarbon speciation for the base fuel.

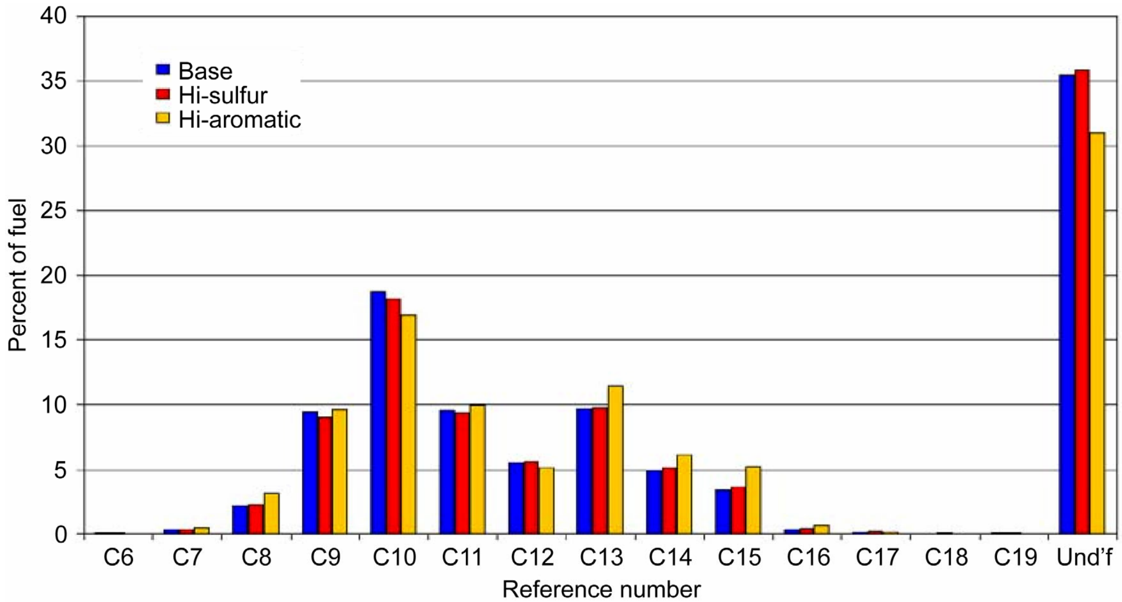

Figure B–5.—Distribution of hydrocarbons in test fuels.

2.4.5 Fuel Specification Tests

It was decided that it was not necessary to analyze the test fuels for all of the properties in the fuel specification. The fuels were purchased as specification fuels and the only change was the sulfur compound added to the base fuel to create the high-sulfur fuel. Therefore, only the tests that have already been reported were conducted. These are summarized in table B-5 along with the identification of the ASTM test methods and the specification limits for reference.

TABLE B-5.—SUMMARY OF SPECIFICATION TESTS FOR THE TEST FUELS

Specification Tests	**ASTM Method**	**Limit**	**Base Fuel**	**High-S Fuel**	**High-A Fuel**
Density @ 15C, kg/3m	D4502	775 to 840	819.9	819.4	811.4
Viscosity @ -20C, cSt	D445	8.0 max	4.86	4.86	4.88
Smoke Point, mm	D1322	18 max	19.9	19.5	20.0
Heat of Combustion, MJ/kg	D4809	42.8 min	43.22	43.33	43.27
Sulfur, ppm	D5453	3000 max	383	1595	530
Aromatics, vol%	D1840	25 max	17.6	17.3	21.6
Naphthalenes, vol%	D1319	3.0 max	1.34	1.31	0.93
Non-specification Tests					
Hydrogen Content, wt%	D3701	–	13.69	13.67	13.7
Surface Tension @ 10C	D1331	–	27.66	27.66	27.72
@ 40C		–	25.38	25.38	25.42

Specification tests not conducted were as follows:

acidity
mercaptan sulfur
flash point
vapor pressure
freeze point
thermal stability
copper strip corrosion
existent gum
water separation
conductivity (electrical)

3.0 Summary

Three test fuels were provided to support the NASA APEX test at the NASA Dryden facility located at Edwards AFB, CA. These test fuels were specification jet fuels, which provided variations in sulfur and aromatic content. Fuel analyses showed that other properties, which could affect atomization, combustion, and soot formation, were virtually identical so that changes in emissions could be related to sulfur and aromatics with a high degree of confidence.

References

1. Petroleum Quality Information System: 2002, published by Defense Energy Support Center, Fort Belvoir, VA. http://www.desc.dla.mil/DCM/Files/2002PQISreport.pdf

Appendix—Detailed Hydrocarbon Speciation of Test Fuels

					Test Fuel
Ref. No.	Carbon No.	Component Name	Hi-Aromatic	Hi-Sulfur	Base
1	6	N-Hexane	nd	0.01	0.01
2	6	Methylcyclopentane	0.01	0.01	0.01
3	6	Cyclohexane	0.01	0.02	0.02
4	7	2-Methylhexane	0.01	0.01	0.02
5	7	2,3-Dimethylpentane	0.01	0.01	0.01
6	7	3-Methylhexane	0.02	0.02	0.02
7	7	Cis-1,3-dimethylcyclopentane	0.01	0.01	0.01
8	7	Trans-1,3-dimethylcyclopentane	0.01	0.01	0.01
9	7	Trans-1,2-dimethylcyclopentane	0.01	0.01	0.01
10	7	N-Heptane	0.06	0.06	0.06
11	7	Methylcyclohexane	0.18	0.14	0.14
12	8	1,1,3-Trimethylcyclopentane	nd	0.01	0.01
13	7	Ethylcyclopentane	0.03	0.02	0.01
14	8	2,5-Dimethylhexane	0.02	0.01	0.01
15	8	2,4-Dimethylhexane	0.02	0.01	0.01
16	8	Trans,cis-1,2,4-trimethylcyclopentane	0.03	0.02	0.02
17	8	Trans,cis-1,2,3-trimethylcyclopentane	0.03	0.02	0.02
18	7	Toluene	0.12	0.06	0.05
19	8	2,3-Dimethylhexane	0.04	0.02	0.02
20	8	2-Methyl-3-Ethylpentane	0.01	nd	nd
21	8	2-Methylheptane	0.17	0.10	0.09
22	8	4-Methylheptane	0.05	0.03	0.03
23	8	Cis,trans,1,2,4-trimethylcyclopentane	0.01	nd	nd
24	8	Cis-1,3 dimethylcyclohexane	0.16	0.12	0.12
25	8	3-Methylheptane	0.21	0.14	0.12
26	8	Trans-1,4-dimethylcyclohexane	0.08	0.06	0.06
27	8	1,1-Dimethylcyclohexane	0.02	0.02	0.02
28	8	Trans-1-ethyl-3-methylcyclopentane	0.05	0.04	0.03
29	8	Cis-1-ethyl-3-methylcyclopentane	0.05	0.03	0.03
30	8	Trans-1-ethyl-2-methylcyclopentane	0.06	0.03	0.03
31	8	Trans-1,2,dimethylcyclohexane	0.10	0.09	0.09
32	8	Cis-1,4-dimethylcyclohexane	0.05	0.05	0.05
33	8	N-Octane	0.57	0.31	0.28
34	8	Isopropylcyclopentane	0.03	0.03	0.03
35	9	2,3,4-Trimethylhexane	0.01	0.01	0.01
36	9	2,3,5-Trimethylhexane	0.01	0.01	0.01
37	8	Cis-1-ethyl-2-methylcyclopentane	0.02	0.02	0.02
38	8	Cis-1,2-dimethylcyclohexane	0.04	0.05	0.05
39	9	2,4-Dimethylheptane	0.11	0.07	0.07
40	9	Cis,cis,1-3-5,trimethylcyclohexane	0.02	0.03	0.02
41	8	Ethylcyclohexane	0.33	0.32	0.33
42	8	n-Propylcyclopentane	0.02	0.02	0.02
43	9	2,6-Dimethylheptane	0.12	0.09	0.09
44	9	1,1,3-Trimethylcyclohexane	0.18	0.17	0.16
45	9	2,5-Dimethylheptane	0.22	0.15	0.15
46	9	3,5-Dimethylheptane	0.07	0.02	0.05
47	9	C9 Naphthene	0.03	0.04	0.05
48	9	C9 Naphthene	0.06	0.07	0.08
49	9	C9 Naphthene	0.04	0.05	0.05
50	8	Ethylbenzene	0.18	0.11	0.10
51	9	Trans,trans,1,2,4-trimethylcyclohexane	0.11	0.08	0.08
52	9	Cis,trans,1,3,5-trimethylcyclohexane	0.21	0.34	0.37
53	9	C9 Naphthene	0.02	0.02	0.02
54	9	2,3,4,Trimethylhexane	0.04	0.08	0.08
55	8	Meta-Xylene	0.35	0.26	0.26

					Test Fuel
Ref. No.	Carbon No.	Component Name	Hi-Aromatic	Hi-Sulfur	Base
56	8	Para-Xylene	0.14	0.10	0.10
57	9	2,3-Dimethylheptane	0.23	0.12	0.11
58	9	3,4-Dimethylheptane D/L	0.08	0.02	0.02
59	9	3,4-Dimethylheptane L/D	0.12	0.04	0.04
60	9	4-Ethylheptane	0.06	0.07	0.07
61	9	Bicyclononane	0.02	0.03	0.03
62	9	4-Methyloctane	0.25	0.22	0.22
63	9	2-Methyloctane	0.32	0.30	0.31
64	9	Trans,cis,1,2,4,trimethylcyclohexane	0.04	0.05	0.05
65	9	3-Ethylheptane	0.11	0.15	0.16
66	9	3-Methyloctane	0.45	0.46	0.48
67	9	Cis,trans,1,2,4,trimethylcyclohexane	0.02	0.03	0.03
68	8	Ortho-Xylene	0.33	0.24	0.23
69	9	Cis,cis,1,2,4,trimethylcyclohexane	0.06	0.11	0.12
70	10	2,4,6 Trimethyl heptane	0.02	0.01	0.01
71	9	Cis-1-ethyl-3-methylcyclohexane	0.16	0.15	0.15
72	9	Trans-1-ethyl-4-methylcyclohexane	0.30	0.41	0.44
73	9	Isobutylcyclopentane	0.16	0.20	0.22
74	9	C9 Naphthene	0.03	0.03	0.03
75	9	1-Ethyl-1-methylcyclohexane	0.07	0.09	0.09
76	9	Cis,trans,1,2,3,trimethylcyclohexane	0.03	0.03	0.03
77	9	Trans,trans,1,2,3,trimethylcyclohexane	0.05	0.08	0.09
78	9	N-Nonane	1.40	0.87	0.84
79	9	Trans-1-ethyl-3-methylcyclohexane	0.24	0.32	0.34
80	9	Trans-1-ethyl-2-methylcyclohexane	0.08	0.11	0.11
81	9	Cis-1-ethyl-4-methylcyclohexane	0.01	0.01	0.01
82	9	Isopropylbenzene	0.07	0.05	0.05
83	9	Isopropylcyclohexane	0.17	0.19	0.20
84	9	Bicyclononane	0.08	0.10	0.10
85	10	1-methyl-trans-4-isopropylcyclohexane	0.07	0.07	0.07
86	10	2,4-Dimethyloctane	0.16	0.15	0.15
87	10	2,7-Dimethyloctane	0.04	0.06	0.06
88	10	2,5-Dimethyloctane	0.13	0.15	0.16
89	9	N-propylcyclohexane	0.49	0.41	0.42
90	9	N-butylcyclopentane	0.17	0.15	0.16
91	9	C9 Naphthene	0.10	0.11	0.13
92	10	2,6-Dimethyloctane	0.51	0.50	0.55
93	9	n-Propylbenzene	0.28	0.24	0.27
94	10	3,5-Dimethyloctane	0.10	0.09	0.11
95	10	3,6-Dimethyloctane	0.25	0.16	0.18
96	9	Cis-1-ethyl-2-methylcyclohexane	0.05	0.07	0.09
97	10	3-methyl-5-ethylheptane	0.07	0.10	0.11
98	9	1-Methyl-3-ethylbenzene	0.48	0.40	0.45
99	9	1-Methyl-4-ethylbenzene	0.20	0.20	0.22
100	10	4,5-Dimethyloctane	0.13	0.18	0.20
101	10	2,3-Dimethyloctane	0.12	0.19	0.21
102	9	1,3,5-Trimethylbenzene	0.35	0.34	0.36
103	10	4-Ethyloctane	0.17	0.18	0.19
104	10	C10 Naphthene	0.09	0.15	0.16
105	10	5-Methylnonane	0.26	0.20	0.20
106	10	4-Methylnonane	0.49	0.42	0.43
107	10	2-Methylnonane	0.78	0.75	0.77
108	9	1-Methyl-2-ethylbenzene	0.12	0.10	0.08
109	10	3-Ethyloctane	0.18	0.23	0.24
110	10	1,2,3,5 Tet-methylcyclohexane	0.05	0.06	0.07
111	10	3-Methylnonane	0.78	0.75	0.77
112	10	1,2,3,4 Tet-methylcyclohexane	0.13	0.21	0.23
113	10	C10 Paraffin	0.05	0.09	0.09
114	9	1,2,4-Trimethylbenzene	0.87	0.80	0.82

					Test Fuel
Ref. No.	Carbon No.	Component Name	Hi-Aromatic	Hi-Sulfur	Base
115	10	Cis-1-methyl-3-propylcyclohexane	0.29	0.44	0.47
116	10	Cis 1,3 diethylcyclohexane	0.15	0.23	0.23
117	10	Trans 1,4 diethylcyclohexane	0.27	0.24	0.25
118	10	Trans-1-methyl-3-propylcyclohexane	0.12	0.17	0.18
119	10	1-Ethyl-2,3-dimethylcyclohexane	0.04	0.22	0.28
120	10	Cis-1-methyl-4-propylcyclohexane	0.16	0.13	0.14
121	10	Isobutylbenzene	0.16	0.18	0.19
122	10	sec-Butylbenzene	0.17	0.20	0.21
123	10	N-Decane	2.79	2.03	2.00
124	10	1,2,3,4 Tet-methylcyclohexane	0.13	0.20	0.21
125	10	Trans 1,3 diethylcyclohexane	0.07	0.14	0.15
126	9	1,2,3-Trimethylbenzene	0.36	0.36	0.37
127	10	Trans 1,2 diethylcyclohexane	0.15	0.09	0.09
128	10	Cis 1,4 diethylcyclohexane	0.12	0.08	0.08
129	9	Indan (2,3-Dihydroindene)	0.30	0.39	0.41
130	10	Sec-butylcyclohexane	0.80	1.05	1.10
131	10	Butylcyclohexane	0.41	0.66	0.68
132	10	1,3-Diethylbenzene	0.26	0.50	0.51
133	11	C11 Naphthene	0.49	0.50	0.51
134	11	Trans 1-methyl 4-ter-butylcyclohexane	0.35	0.32	0.33
135	10	1,4-Diethylbenzene	0.28	0.30	0.31
136	10	1-Methyl-4-n-propylbenzene	0.24	0.25	0.26
137	10	1,3-Dimethyl-5-ethylbenzene	0.38	0.47	0.50
138	10	Trans-decalin	0.19	0.24	0.25
139	10	1-Methyl-2-n-propylbenzene	0.50	0.42	0.42
140	11	Cis 1-methyl 4-ter-butylcyclohexane	0.54	0.47	0.48
141	11	5-Methyldecane	0.48	0.38	0.37
142	11	4-Methyldecane	0.50	0.72	0.76
143	11	2-Methyldecane	0.60	0.47	0.50
144	10	1,4-Dimethyl-2-ethylbenzene	0.57	0.49	0.50
145	10	1,3-Dimethyl-4-ethylbenzene	0.59	0.49	0.49
146	11	3-ethyl nonane	nd	0.14	0.16
147	11	3-Methyldecane	0.74	0.56	0.55
148	10	1,2-Dimethyl-4-ethylbenzene	0.50	0.53	0.55
149	10	1,3-Dimethyl-2-ethylbenzene	0.18	0.17	0.18
150	10	Tricyclodecane	0.30	0.28	0.30
151	10	2-Methylindan	0.23	0.35	0.35
152	10	1,2-Dimethyl-3-Ethylbenzene	0.50	0.55	0.57
153	11	N-Undecane	3.55	3.08	3.11
154	10	1,2,4,5-Tetramethylbenzene	0.27	0.27	0.27
155	11	2-Methylbutylbenzene	0.30	0.32	0.33
156	10	4-Methylindan	0.39	0.54	0.55
157	10	5-Methylindan	0.40	0.50	0.50
158	10	1,2,3,4-Tetramethylbenzene	0.23	0.32	0.31
159	10	Tetralin	0.08	0.09	0.09
160	12	5-Methylundecane	0.60	1.07	1.04
161	12	4-Methylundecane	0.56	0.52	0.52
162	12	2-Methylundecane	0.91	1.07	1.09
163	11	Pentylbenzene	0.13	0.15	0.15
164	10	Naphthalene	0.40	0.63	0.63
165	13	3-Methylundecane	0.69	0.67	0.70
166	12	N-Dodecane	3.13	2.97	2.93
167	11	2,4 Dimethylindan	0.68	0.61	0.67
168	11	2-Methylnaphthalene	1.01	1.07	1.07
169	13	Methyldodecanes	7.90	6.72	6.70
170	13	N-Tridecane	2.84	2.39	2.29
171	11	1-Methylnaphthalene	0.61	0.60	0.60
172	14	Methyltridecanes	3.90	3.65	3.60
173	14	N-Tetradecane	2.22	1.52	1.35

			Test Fuel		
Ref. No.	Carbon No.	Component Name	Hi-Aromatic	Hi-Sulfur	Base
174	15	Methyltetradecanes	3.26	2.52	2.45
175	15	N-Pentadecane	1.95	1.16	0.97
176	16	N-Hexadecane	0.66	0.39	0.33
177	17	N-Heptadecane	0.16	0.18	0.15
178	19	Pristane	0.02	0.06	0.07
179	18	N-Octadecane	0.03	0.04	0.03
180	19	N-Nonadecane	0.01	0.01	0.01
		Unidentified (greater than C12)	31.00	36.04	35.62

Appendix C
Gas Phase Emissions Measurements During the APEX*

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Gas Phase Emissions Measurements During the APEX

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1. Objectives

A suite of conventional gas analyzers (CGA) was used to measure the major and minor gas-phase species emissions from an aircraft-mounted, CFM56-2C1 engine that was being operated in a ground-based run-up facility. The instrument suite and sampling system were tailored to provide the emission parameters that are archived in the International Civil Aviation Organization (ICAO) database in order to confirm that the engine was operating within its certified emission limits; to (using multi-port sampling rakes) map the spatial distribution of emissions across the engine exhaust plume at the 1 and 10 m sampling locations; to provide baseline plume information for interpreting the particle emission observations; and to provide the information necessary for calculating emission indices (EI). A Fourier Transform Infrared-based, multi-gas analyzer (MGA), deployed to the experiment for evaluation purposes, was used to measure a variety of additional trace gas species that are listed as hazardous for local air quality.

2. Experimental Setup

The data discussed below were recorded during the NASA Aircraft Particle Emission Experiment (APEX) which was conducted at Dryden Flight Research Center (DFRC) in late April, 2004. APEX specifically examined emissions from the right inboard engine on the NASA Dryden Flight Facility DC-8 aircraft. Three sampling probe stands were anchored at 1, 10, and 30 m downstream of the engine exit plane (fig. C-1). Exhaust samples were drawn continuously from the 1 and 10 m probes and assayed using NASA's gas measurement systems.

In order to investigate the effect of fuel composition upon trace gas and particle emissions, three different fuels were used during APEX: baseline JP8 fuel from Edwards Air Force Base; high-sulfur fuel created from baseline fuel doped with tertiary butyl disulfide ($C_{12}H_{18}S_2$); and high aromatic Jet-A fuel purchased from a California refinery.

Two different test matrices were employed to examine the relationship between operating conditions and engine emissions. The "NASA" matrix was designed to parametrically study the effects of engine operation parameters on exhaust emissions and including approximately 4 min sampling time at thrust levels of ground idle (approximately 4%), 5.5, 7, 15, 30, 40, 60, 65, 70, 85, and 100% (actual maximum permitted was 93%). The "EPA" matrix was intended to simulate airport operations. It ran four repeated ICAO-defined Landing-Take-Off (LTO) cycles of 26 min at idle (7%), 0.7 min at takeoff (100%), 2.2 min at climb (85%), and 4 min at approach (30%).

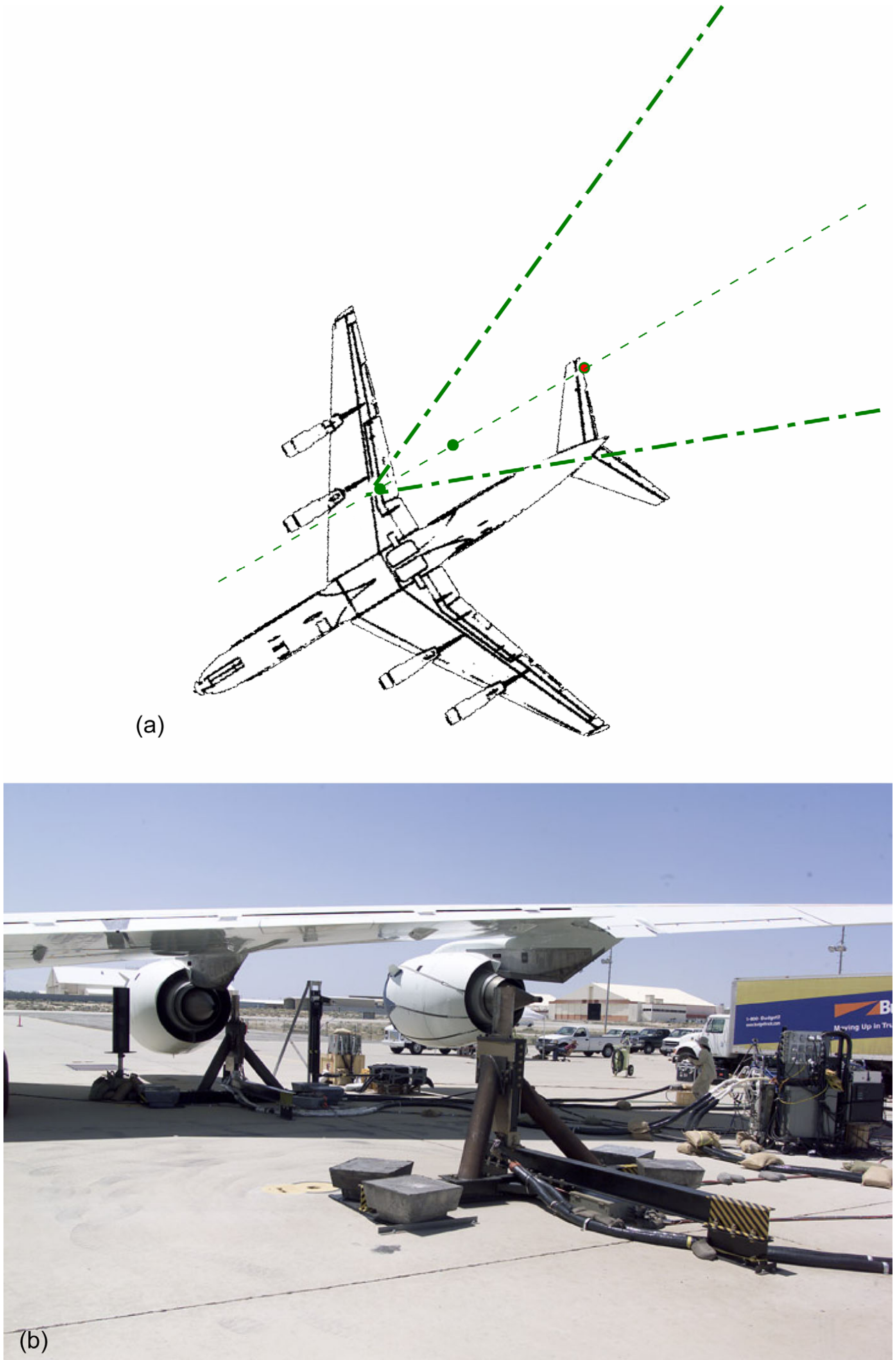

Figure C–1.—Experimental setup (a) Schematic of aircraft and 3 sample stands (red dots) at 1 m, 10 m, and 30 m downstream of the engine exit (b) Starboard side of NASA DC-8 aircraft with CFM56-2C1 engines, and 1 m and 10 m stands with multiple sample probes/lines connected to distribution box.

3. Sampling System

The 1 and 10 m stands each held sample rakes that contained six gas probes and six particle probes that were alternatively positioned. The 1 m rake also supported six external, large-diameter gas probes to supply sample air to measurement systems that had high flow demands. A shroud was installed on the rake to protect the externally connected probes. Thermocouples were attached to each external probe and temperatures were recorded. Designation of these probes included rake location, probe type, and probe position. For example, R1G2 was the second gas probe from the top of the 1 m rake. Figure C-2 shows photos and schematic of the 1m sample rake.

Figure C-3 shows a schematic of the gas sample system. Sample air was drawn through the sample inlet probes, 12.2 m of 9.5 mm stainless steel (SS) sample lines, the heated valve selection box (with computer-controlled valve operation to determine which probe of which rake the sample came from), heated boost pumps, another 18 m of 9.5 mm SS sample line, to the measurement systems. All sample lines and valve box were heated to 150 °C with electric heater tape according to Society of Automotive Engineers (SAE) Aerospace Recommended Practice (ARP) 1286B. The rake was cooled with water from an outdoor faucet to protect the o-rings that vacuum-sealed the inlet probes inside their mounting brackets. Because a high-pressure pump is required to force water through the narrow passages in the gas probes, we suspect that the cooling flow had a minimal effect on sample gas temperatures.

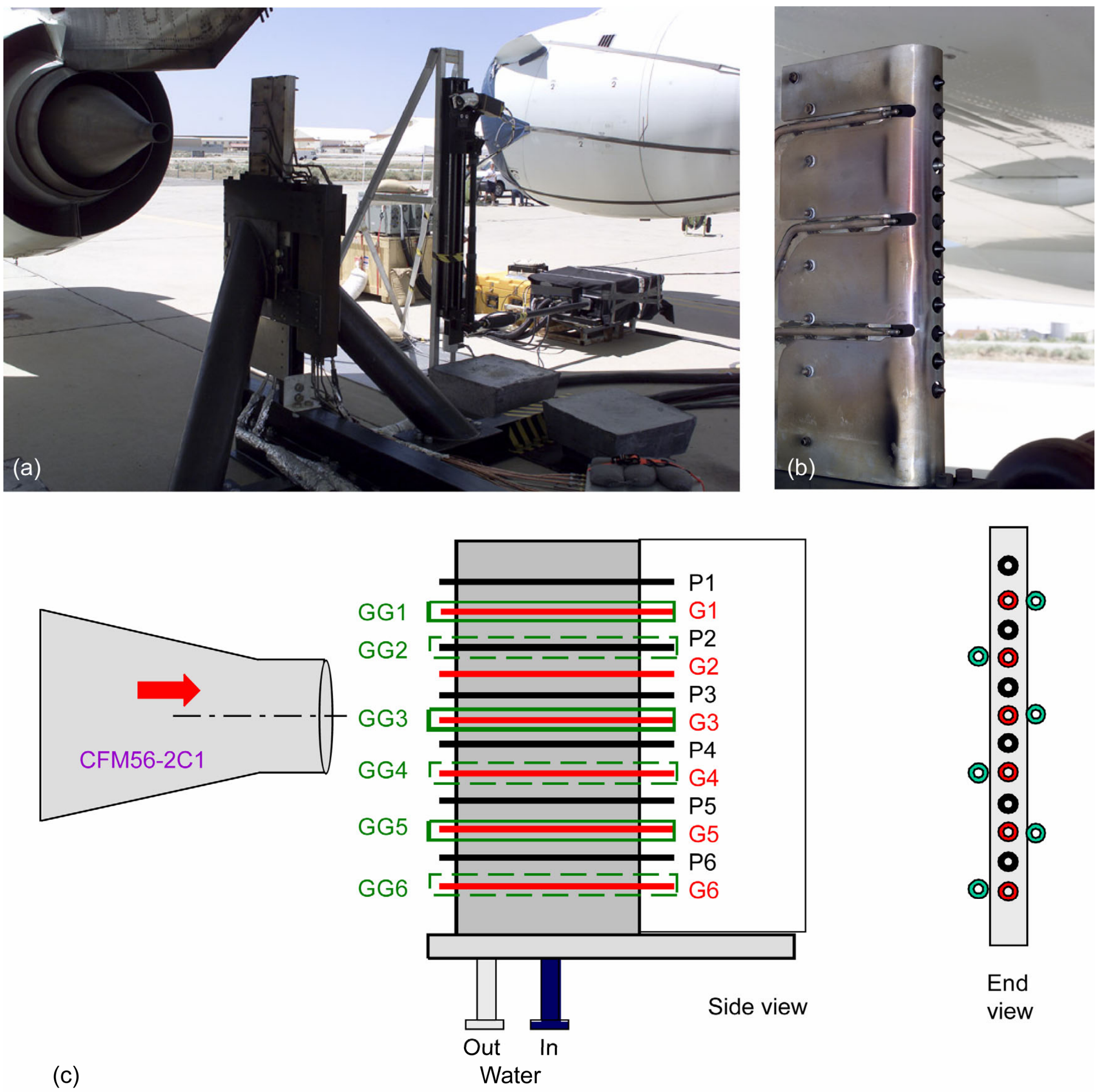

Figure C–2.—Photos and a schematic of the sampling system showing (a) the 1-m sample stand; (b) the1-m sample rake with 6 gas, 6 particle, and 6 external "gas" probes; and (c) plumbing details of the 1-m sample rake with probe orientation and designation.

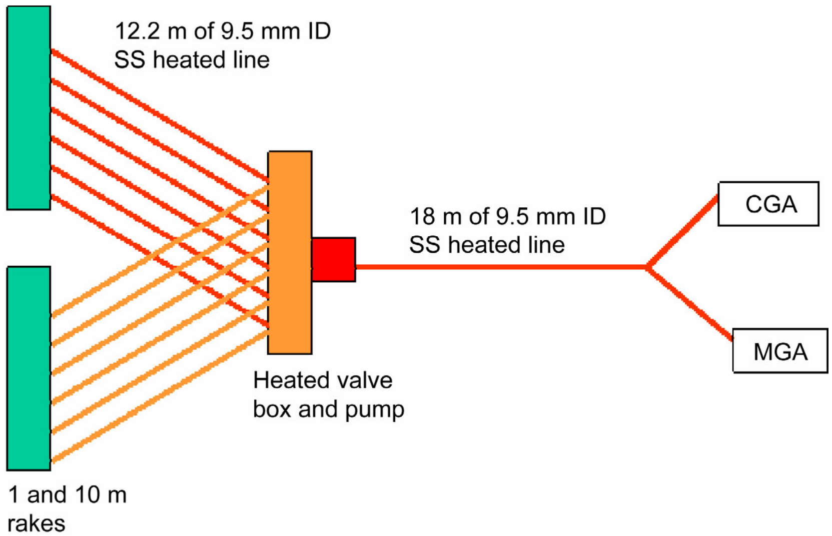

Figure C–3.—Schematic of the gas sample systems. The 6 gas probes on each rake were connected to a heated switch box that allowed the operator to select sample from any given probe. Flow from the valves converged into a single, 9.5 mm O.D. heated line which transported sample to gas measurement systems (CGA and MGA).

4. Measurement Systems

Two different systems were used to acquire gas species measurements: the CGA and MGA. The capabilities of these systems, such as operation range and detection limits, are listed in table C-1.

TABLE C-1.—CAPABILITIES OF THE CONVENTIONAL GAS ANALYZER (CGA) AND MULTI-GAS ANALYZER (MGA) SYSTEMS

Species	Instrument	Concentration Range	Resolution (s)
NO	Eco Physics- CLD 700 EL ht	0 to 10000 ppm (multi range)	0.5% of range used
NO_X	Eco Physics- CLD 700 EL ht	0 to 10000 ppm (multi range)	0.5% of range used
CO	Siemens - Ultramat 23	0 to 5000 ppm (multi-range)	0.5% of range used
CO_2	Siemens - Ultramat 23	0 to 10% (multi-range)	0.5% of range used
O_2	Siemens - Ultramat 23	0 to 25%	0.5% of range used
UHC	Signal – 300HM	0 to 4000 ppm (multi-range)	1% of range used
Species	Instrument Multi-Gas Analyzer (MGA)	Concentration Range	Detection Limit ppm
N_2O	AFR-2010	0 to 200 ppm	0.3
CH_4	AFR-2010	0 to 10000 ppm	1.0
HCHO	AFR-2010	0 to 350 ppm	0.15
C_2H_4	AFR-2010	0 to 550 ppm	0.1
CH_3OH	AFR-2010	0 to 520 ppm	0.15
HCOOH	AFR-2010	0 to 15 ppm	0.1
Jet Fuel	AFR-2010	0 to 2000 ppm	2.0
SO_2	AFR-2010	0 to 2000 ppm	1.50
H_2O	AFR-2010	0 to 50%	85
CO_2	AFR-2010	0 to 20%	25
CO	AFR-2010	0 to 200000 ppm	0.2
NO	AFR-2010	0 to 2500 ppm	0.5
NO_2	AFR-2010	0 to 400 ppm	0.19

4.1. Conventional Gas Analyzers

Used as the primary gas-measurement system, the CGA employed standard methods recommended by ICAO Annex 16 Volume 2 and SAE ARP1256B. It measured a variety of major and minor gas species including carbon monoxide (CO), carbon dioxide (CO_2), oxygen (O_2), total unburned hydrocarbon (THC), and nitrogen oxides (NO_X), which is the sum of nitric oxide (NO) and nitrogen dioxide (NO_2). The requirements of CGA are listed in table C-2.

TABLE C-2.—DATA QUALITY INSURANCE GOALS FOR EXIT PLANE

Experimental Parameter	Measurement Method	Precision	Accuracy	Completeness	Detection Limit or Measurement Range
CO_2	Nondispersive infrared	± 2%	± 1%	95 %	0 to 5% 0 to 15%
CO	Nondispersive infrared	± 2%	± 1%	95 %	0 to 1000 ppm 0 to 5000 ppm
O_2	Electrochemical cell	± 1%	± 0.5%	95 %	0 to 25%
NO_x	Chemiluminescence	± 2%	± 1%	95 %	0 to 10 ppm 0 to 100 ppm 0 to 1000 ppm
THC	Heated flame ionization	± 2%	± 1%	95 %	0 to 100 ppm 0 to 1000 ppm
Ambient temperature	Thermocouple	± 2%	± 1%	95 %	–200 to 1250 °C
Ambient pressure	Pressure transducer	± 1%	± 0.11%	95 %	0 to 25 psia

A flow diagram of gas sample flow and the analyzers is shown in figure C-4. Each analyzer had its own pump to control and meter the sample flow rate. An auxiliary heated pump could be added to the main sample line if the total sample flow rate was too low. A quality assurance plan was developed for the CGA system. Individual components of the CGA system were individually calibrated before the experiment, and then the entire system was calibrated again after installation was completed. All pre-campaign, post-campaign, pre-test, and post-test calibration procedures were performed using the calibration schedule shown in table C-3. The pre-campaign calibration procedures for the gas analyzers are stated in 40CFR 86 Subpart D. Different calibration procedures were given for the different detection methods used by the analyzers. The pre-test and post-test calibration procedures are stated in 40 CFR 86. They do not differentiate between analyzers. The acceptance criteria are also stated in table C-3.

Analog range and signal outputs from the CGA were recorded in a notebook computer through two analog-to-digital converters (Data Translation USB 9804). In addition, sample pressure and temperature, ambient pressure and temperature, and ambient air dew point were measured and recorded in the data acquisition system (DAS). The DAS provided an instantaneous display of analyzer responses as well as saved averaged data at a 1 Hz frequency. The functionality of the DAS was checked frequently using a documenting process calibrator (Fluke 701). The following sections are descriptions of all analyzers.

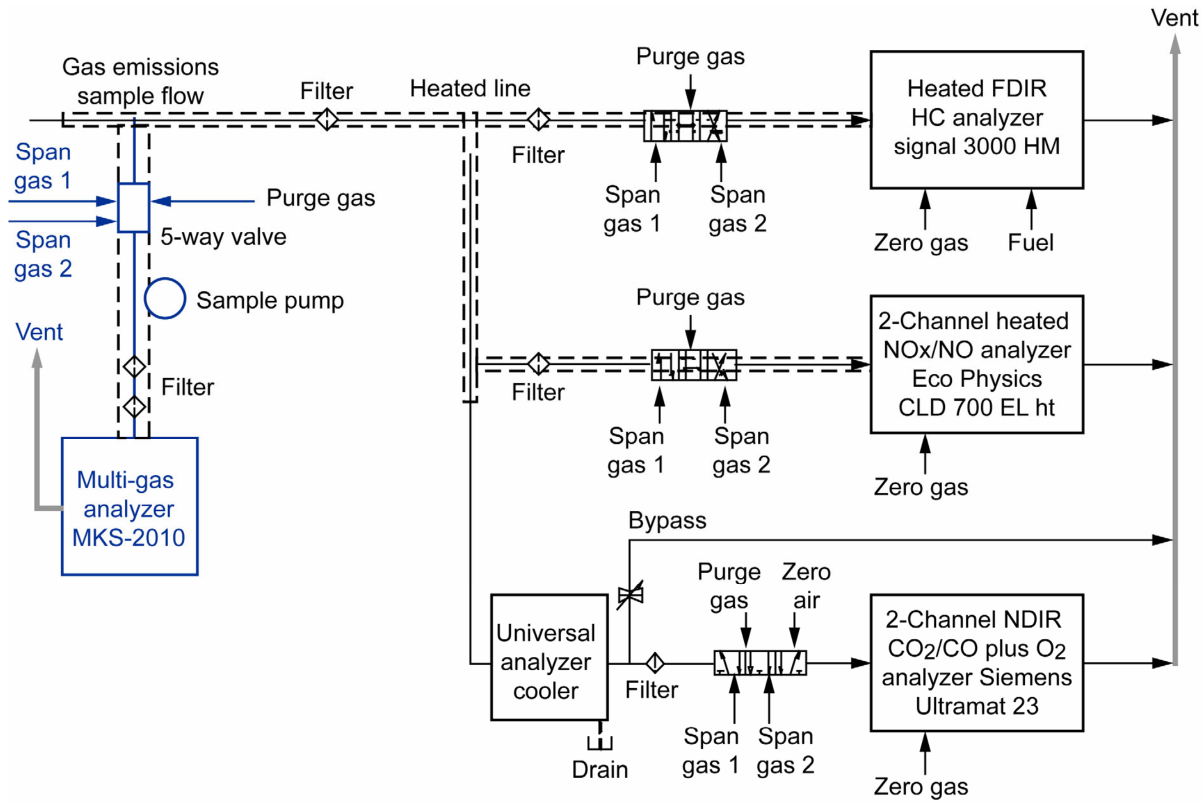

Figure C–4.—Flow diagram of the gas measurement systems. A 5-way valve is used to switch between the CGA, the MGA and, at times, to the standard gases to that were used to calibrate both measurement systems.

TABLE C-3.—CALIBRATION PROCEDURES AND REQUIREMENTS OF THE CGA SYSTEM

Experimental Parameter	Instrument	QC Check(s)	Frequency	Acceptance Criterion
CO	Siemens AG Model Ultramat 23	Zero and span checks Flow rate check	Before/after each test and every hr during test Before/after each test	± 2% ± 10% of required flow
CO_2	Siemens AG Model Ultramat 23	Zero and span checks Flow rate check	Before/after each test and every hr during test Before/after each test	± 2% ± 10% of required flow
O_2	Siemens AG Model Ultramat 23	Zero and span checks Flow rate check	Before/after each test and every hr during test Before/after each test	± 2% ± 10% of required flow
NO_x	Eco Physics AG Model CLD 700 EL ht	Zero and span checks Flow rate check	Before/after each test and every hr during test Before/after each test	± 2% ± 10% of required flow
THC	Signal Instruments Model 3000HM	Zero and span checks Flow rate check	Before/after each test and every hr during test Before/after each test	± 2% ± 10% of required flow
Ambient temperature	Thermocouple	Calibration against primary standard	Before test campaign	± 2%
Barometric Pressure	Setra Model 204 Pressure Transducer	Calibration against primary standard	Before test campaign	± 0.5%

4.1.1 CO_2/CO/O_2 Analyzer

A Siemens Model Ultramat 23 analyzer was used to continuously monitor CO_2, CO, and O_2 concentrations. Measurement of CO_2 and CO is based on the principle of non-dispersive absorption of infrared (IR) radiation in parallel reference and sample gas cells. The wavelength-dependent, differential attenuation of the instrument's source light as it passes through the reference/sample cells provides a measure of the gas species of interest. The oxygen sensor operates according to the principle of a fuel cell. The oxygen molecule is reduced to the hydroxyl ion (OH) at the boundary layer between cathode (gold) and electrolyte (acetic acid). During the reduction process, four electrons are required for each oxygen molecule ($O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$). These electrons are produced by the simultaneous oxidation of the lead anode ($2Pb + 4OH^- \rightarrow 2PbO + 2H_2O + 4e^-$); the resulting current is proportional to the concentration of O_2. The instrument has two IR channels with separate gas paths for the O_2 measurement, and its internal sample gas pump can be turned on or off during the measurement. Sample gas was passed through a filter and dryer to prevent contamination of the instrument's flow system and optical components. To remove water vapor, a Universal Analyzers Model 520 sample cooler was used to reduce the sample gas dew point to < 5 °C. An analysis filter (2 µm) was installed immediately after the chiller.

4.1.2 NO_X Analyzer

An Eco Physics heated chemiluminescence analyzer (CLD 700 EL ht) automatically and continuously measured nitric oxide (NO) and nitrogen oxides (NO_X) concentrations. The instrument has two parallel reaction chambers capable of simultaneously measuring and displaying NO, NO_X, and NO_2. It can measure hot, moist sample gas directly from the source. Pressure variations which typically occurred in the sample flow were regulated by a motorized bypass system. The analyzer has its own vacuum pump, bypass pump, and ozone scrubber. Sample flow rate of the analyzer was about 1.5 liter/minute.

4.1.3 THC Analyzer

A Signal Instrument Model 3000 HM that included a Flame Ionization Detector (FID) was used to detect volatile organic compounds within the sample gas stream. The instrument includes a clean air generator with a built-in hydrocarbon scrubber for the FID burner, zero calibration gas, and a built-in sample pump. The detector output is proportional to the concentration of organic molecules with a carbon-hydrogen bond that are present in the sample gas. The response is proportional to the carbon number along any series of compounds; oxygenated compounds typically have a lower response. The unit of the measured values was Total Hydro-Carbon (THC) and was displayed as parts per million in volume (ppm) or % units. The analyzer was scaled to report THC in methane equivalence.

4.2. Multi-Gas Analyzer

Deployed as a secondary system, MGA is based on FT-IR spectroscopic principles and has been proposed to the SAE as an alternate method for measuring aircraft engine gas-phase emissions. To evaluate the performance of this relatively new instrument, its CO, CO_2, THC (by summing up all hydrocarbons), and NO_X (by summing up NO and NO_2) measurements were compared to those provided by the CGA.

The MGA (AFR-2010 or MKS-2010) has a library that provides calibration curves and reference spectra for sulfur dioxide (SO_2), nitrous oxide (N_2O), nitric acid (HONO), and 14 hydrocarbon species including methane (CH_4), formaldehyde (HCHO), methanol (CH_3OH), formic acid (HCOOH), ethane (C_2H_6), ethylene (C_2H_4), acetylene (C_2H_2), propane (C_3H_8), propylene (C_3H_6), 1-butene (C_4H_8), 1,3-butadiene (C_4H_6), benzene (C_6H_6), toluene (C_7H_8), and o-xylene (C_8H_{10}). Figures C-5 (a) and (b) shows example reference spectra for these species.

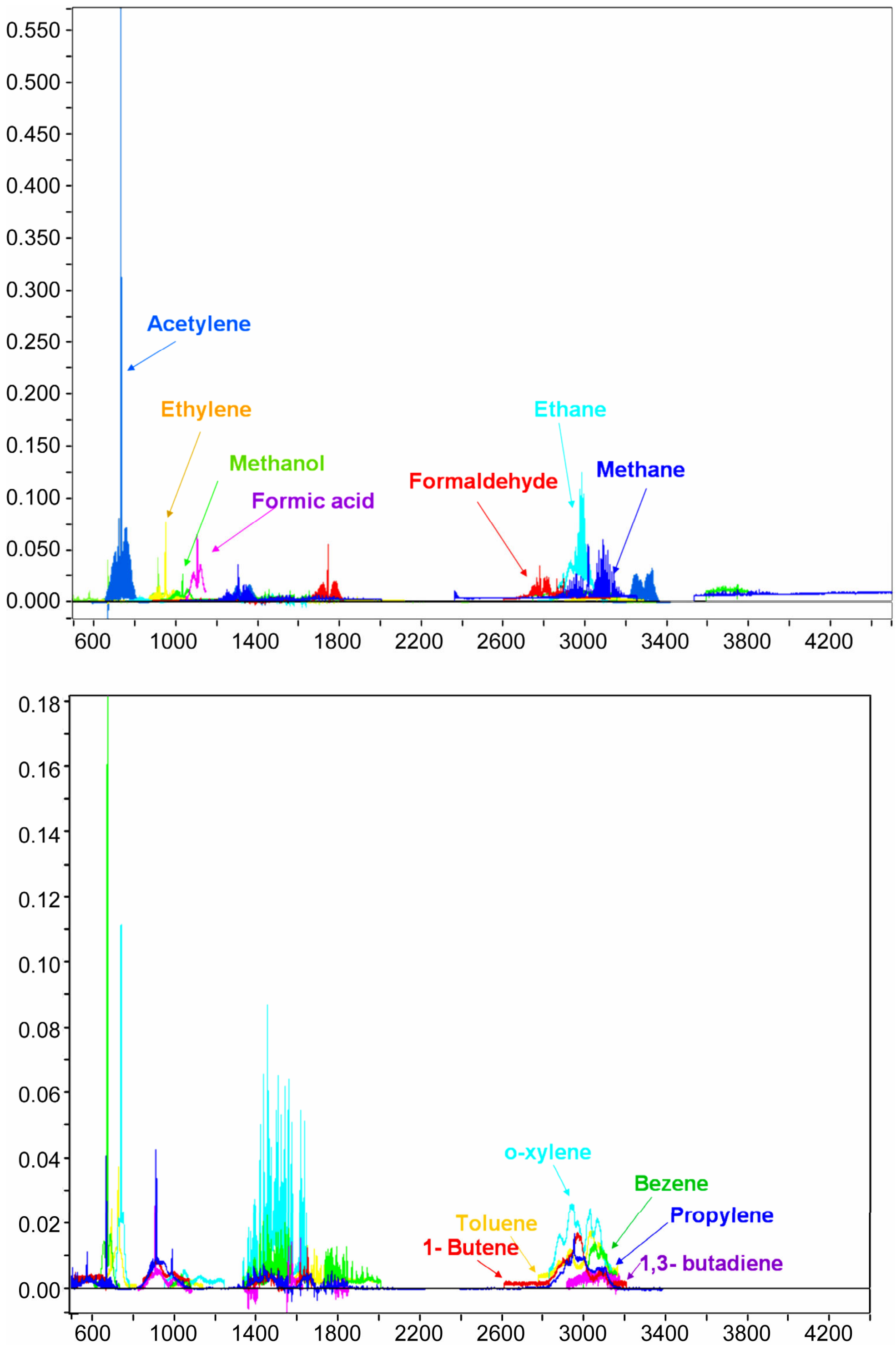

Figure C–5.—Ideal spectra of hydrocarbon species from MGA.

5. Calculation of Emission Parameters

Emission indices (EI), fuel/air ratios (FAR), and combustion efficiency can be calculated from the measured gas species concentrations. EI of a constituent i, EI*i*, is the ratio of the mass of constituent i to the mass of fuel, multiplied by 1000. It is commonly referred to as the mass of i per 1000 mass of fuel, i.e., g-i/kg-fuel.

Combustion of hydrocarbon fuel and air can be expressed as the following chemical reaction:

$$C_mH_n + x(RO_2 + SN_2 + TCO_2 + hH_2O) \Rightarrow n_1CO_2 + n_2N_2 + n_3O_2 + n_4H_2O + n_5CO + n_6C_xH_y + n_7NO_2 + n_8NO$$

where n_1 through n_8 are the number of moles of CO_2, N_2, O_2, H_2O, CO, C_xH_y, NO_2 and NO, respectively; R, S and T are mole fraction of O_2, N_2 and CO_2, respectively, of the inlet dry air; R=0.20948, S=0.7902, T=0.00032 for standard air (with O_2-N_2-CO_2 components) in the United States; and h is the molar humidity of the inlet air

For a known fuel carbon-hydrogen ratio and air composition (i.e., m, n, R, S, T, and h are known), the above combustion process can be solved for 10 unknowns (n_1 through n_8, n_T which is the sum of n_1 through n_8, and x) with ten simultaneous equations. With the combustion process solved, FAR, EI*i*, and combustion efficiency can be calculated using the methodology described in ICAO Annex 16. SAE ARP1533[†], which describes the detailed procedures.

However this method is quite complicated and the calculations must be performed by a computer. Therefore a rather accurate approximation method was developed based on the observations that, in modern high-efficiency engines, the concentrations of CO, hydrocarbons and NO_X are negligible compared to that of CO_2.

Assuming complete combustion (100% combustion efficiency), the combustion reaction is simplified as below:

$$C_mH_n + X(O_2 + sN_2 + tCO_2 + h'H_2O) \Rightarrow (m + tX)CO_2 + (\frac{n}{2} + h'X)H_2O + sXN_2 + (X - m - \frac{n}{4})O_2$$

where:

$$s = \frac{S}{R} = 3.7722, \quad t = \frac{T}{R} = 0.00153, \quad h' = \frac{h}{R} = 4.7747\ h$$

The X can be determined from the measured CO_2 concentration,

$$[CO_2] = \frac{m + Xt}{N}; \quad \text{where } N = m + tX + \frac{n}{2} + h'X + sX + X - m - \frac{n}{4} = \frac{n}{4} + X(1 + s + t + h')$$

The FAR (fuel/air ratio) is calculated as:

$$FAR = \frac{\text{mass of fuel}}{\text{mass of air}} = \frac{1 \cdot \text{MW of } C_mH_n}{X(MW_{O_2} + sMW_{N_2} + tMW_{CO_2} + h'MW_{H_2O})}$$

[†] SAE Aerospace Recommended Practice 1533, "procedure for the Calculation of Gaseous Emissions from Aircraft Turbine Engines," 1996

An example of using the Jet-A fuel ($C_{12}H_{23}$) at the standard humidity (specific humidity=0.00629) condition (i.e., m=12, n=23, and h=0.01):

$$[CO_2] = \frac{m + Xt}{N} = \frac{12 + 0.00153X}{5.75 + 4.8215X} \quad \rightarrow \quad X = \frac{12 - 5.75[CO_2]}{4.8215[CO_2] - 0.00153}$$

$$FAR = \frac{167.3}{138.6X} = \frac{1.207}{X}$$

$$\text{Thus, if } [CO_2] = 3.88\% \text{ then } FAR = 0.019$$

The emission index of pollutant i can be calculated directly from the definition:

$$EI\textit{i} \equiv \frac{\text{g of pollution i}}{\text{kg of fuel}} = \frac{MW_i}{28.964} \cdot ppm_i \cdot 0.001 \cdot \frac{(1 + FAR)}{FAR} \qquad (g/kg - fuel)$$

Where ppm_i is the concentration of pollutant i in units of ppm and MW_i is the molecular weight of pollutant i.

EI*i* can also be calculated from the equation below, following the same philosophy of a simplified version using $EICO_2$:

$$\frac{EI\textit{i}}{EICO_2} = \frac{MW_i}{MW_{CO_2}} \cdot \frac{ppm_i}{ppm_{CO_2}}$$

$$EI\textit{i} = EICO_2 \cdot \frac{MW_i}{44} \cdot \frac{ppm_i}{ppm_{CO_2}}$$

$EICO_2$ varies with the combustion efficiency. However its value varies only slightly for very high combustion efficiency which is true for most of the aircraft engine operation except ground idle (4%) and idle (7%) power conditions. A value of 3160 g/kg-fuel is typically adopted for $EICO_2$. This value can lead to errors up to only 0.5% for combustion efficiency higher than 99.5 and to about 5% for combustion efficiency of 96%.

With $EICO_2$ = 3160, then $EI\textit{i} = 71.8 \cdot MW_i \cdot \frac{ppm_i}{ppm_{CO_2}}$

Figure C-6 shows a comparison of $EICO_2$ calculated using the fully-analyzed measured data from 1 m rake, the simple approximation, and a constant value (3160). Figure C-7 compares EI*i* calculated from the approximate method and the SAE ARP1533 method. The NASA gas emissions analyses including emissions indices, fuel/air ratios and combustion efficiencies were calculated using the SAE ARP1533 method.

This approximation is fairly accurate when applied to emissions sampled from 1m rake where no significant mixing with (diluting by) ambient air occurs. For emissions sampled from 10m rake, more factors need to be considered when applying this approximation method. For example, strong cross-winds sometimes caused the exhaust plume to waver back and forth across the inlet probe causing samples to be very dilute (sampled plume edge or even missed the plume entirely). It is also challenging in this situation to define ambient CO_2 concentration for background correction.

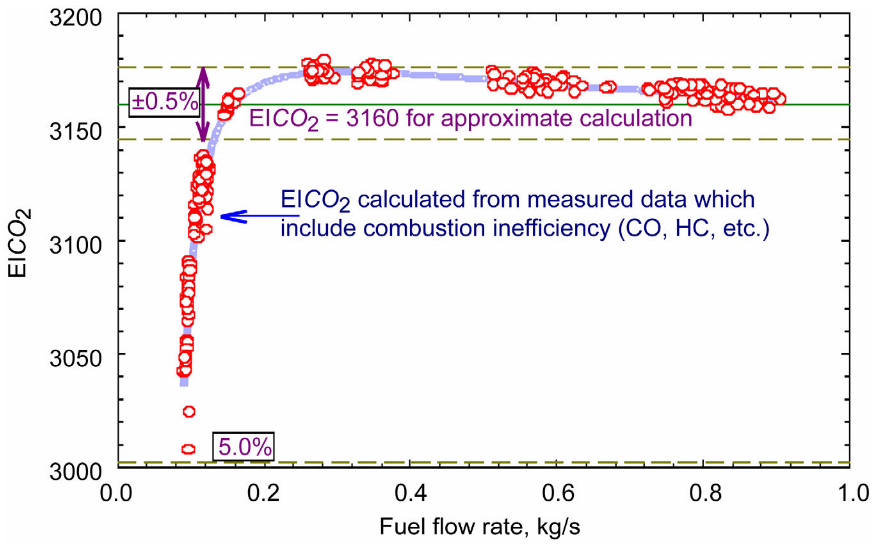

Figure C–6.—EICO_2 versus fuel flow rate. A constant EICO_2 (3160) value is plotted (green line) for comparison with the simple approximationed and experimental values. For most of the tested engine conditions (engine power higher than idle), the error is lower than 0.5%. However, the error can approach 5% at ground idle conditions.

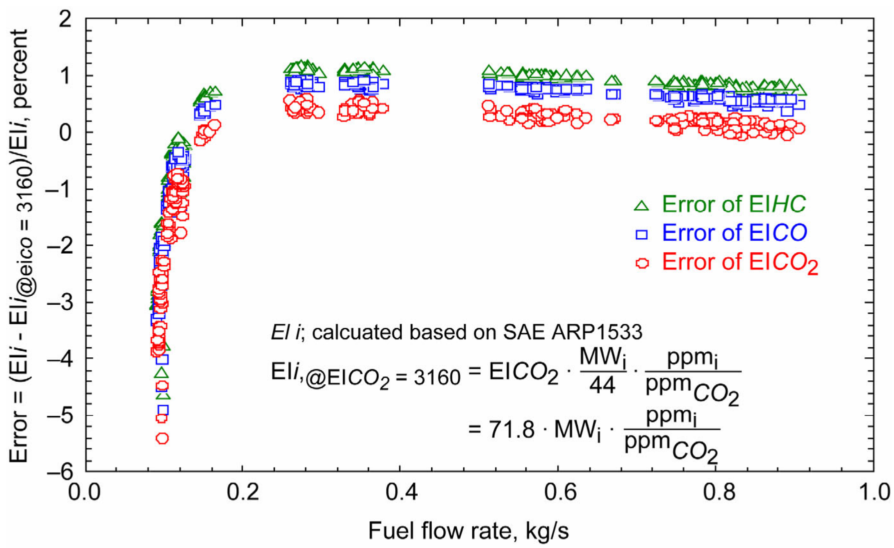

Figure C–7.—Comparisons of EI*CO* and EI*HC* values calculated using the standard method and simple approximation approach.

6. Results

Gas emissions measured from the 1-m probe were compared to CFM56-2-C5 engine certification data from the ICAO database (CFM56-2-C1 data were not included in the database) as well as emissions predicted by the General Electrics Aircraft Engine (GEAE) Company. They agreed very well with both. Complete gas emissions data are listed in appendix A, tables A-2 and A-3. Sample FAR calculated from measured data was compared with GEAE cycle calculations, and values at each point were within 10% of the expected core flow value throughout the experiment (fig. C-8).

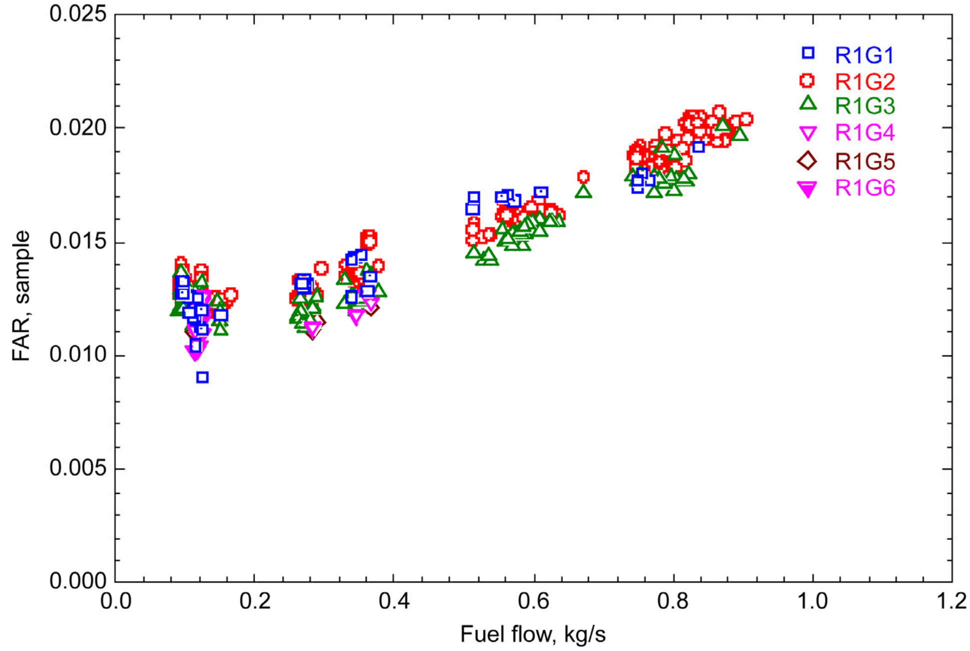

Figure C–8.—Fuel/air ratio (FAR) versus engine flow rate. Sample FAR calculated from measured data was within 10% of the expected core flow value throughout the experiment.

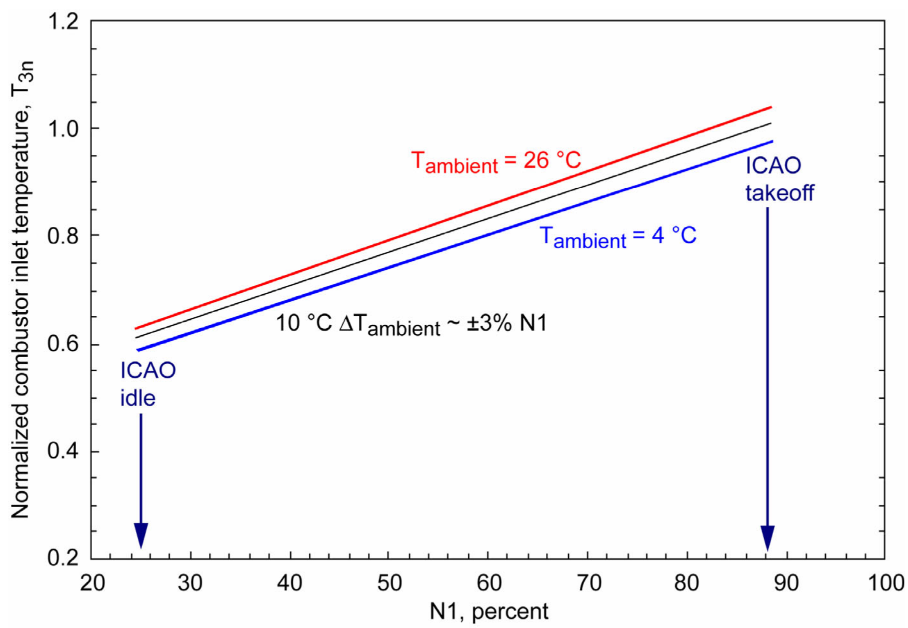

Figure C–9.—Effect of ambient temperature on combustor inlet temperature and engine fan speed (Dodds, 2004). Ambient temperature varied up to 20 °C during APEX, leading to significant variation of engine operating parameters.

For any given thrust level, engine operation and gaseous emissions were influenced by ambient conditions. Although pressure was constant at ~930 mb throughout the tests, ambient temperature varied by up to 20 °C and significantly effected engine operating parameters as shown in figure C-9. Because of the inlet temperature (T_3) variations (fig. C-10a), several different fuel flow rates were employed to achieve the same engine fan speeds (fig. C-10a), engine core speeds (fig. C-10b), and corresponding exhaust gas temperature (fig. C-10c), reflecting the fact that, as air density changes, different amounts of fuel are required to obtain the FAR that corresponds to a specific engine power setting..

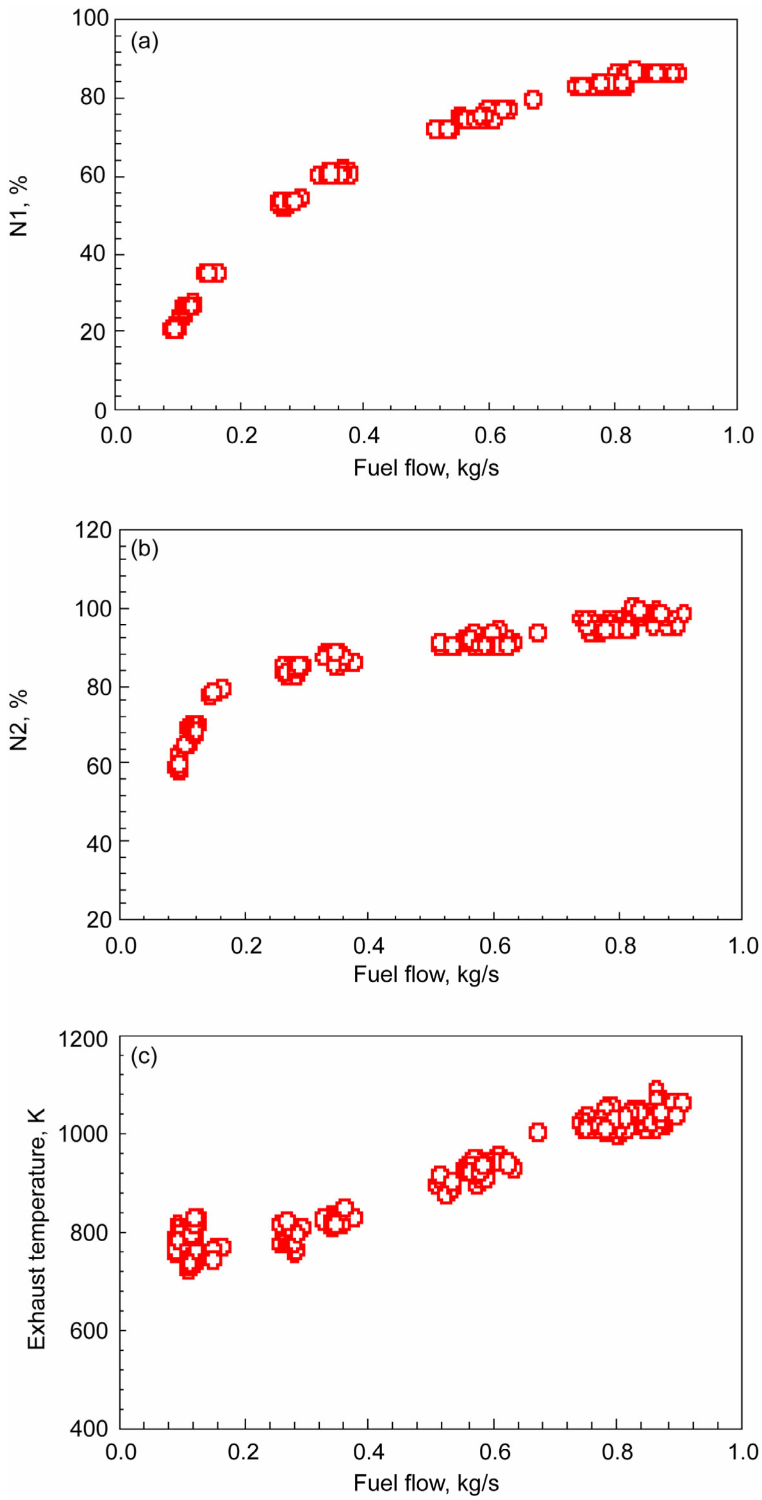

Figure C–10.—Ambient temperature affects combustor inlet temperature which leads to fuel flow rate change at the same engine power level. Ambient temperature varied up to 20 °C during APEX, leading to significant variation of engine operating parameters. (a) Engine fan speed. (b) Engine core speed. (c) Engine exhaust temperature.

To discuss engine operation without revealing proprietary information, parameters were normalized relative to their value at 100% thrust on a standard day. For example, the normalized combustor inlet temperature is defined as $T_{3n} = T_3/T_{3\text{at 100\% thrust on a standard day}}$, normalized combustor inlet pressure as $P_{3n} = P_3/P_{3\text{at 100\% thrust on a standard day}}$, and normalized combustor fuel/air ratio as $FAR_{36n} = FAR_{36}/FAR_{36\text{ at 100\% thrust on a standard day}}$.

Engine parameters can be corrected for ambient temperature variations using the parameter, θ, which is defined as $T_{ambient,R}/518.67$. Figures C-11 to C-13 show the comparisons of corrected and uncorrected engine parameters as functions of fuel flow rats. Figure C-14 illustrates that each corrected engine operating parameter corresponds to a unique fuel flow rate. Therefore, the engine fuel flow rates were as the representative engine operating parameter when evaluating the variation of gas emissions with thrust. By plotting the data as a function of fuel flow rate instead of per cent power, we avoid leaving the potentially misleading impression that the gas species EIs exhibited large variations at any specific power setting.

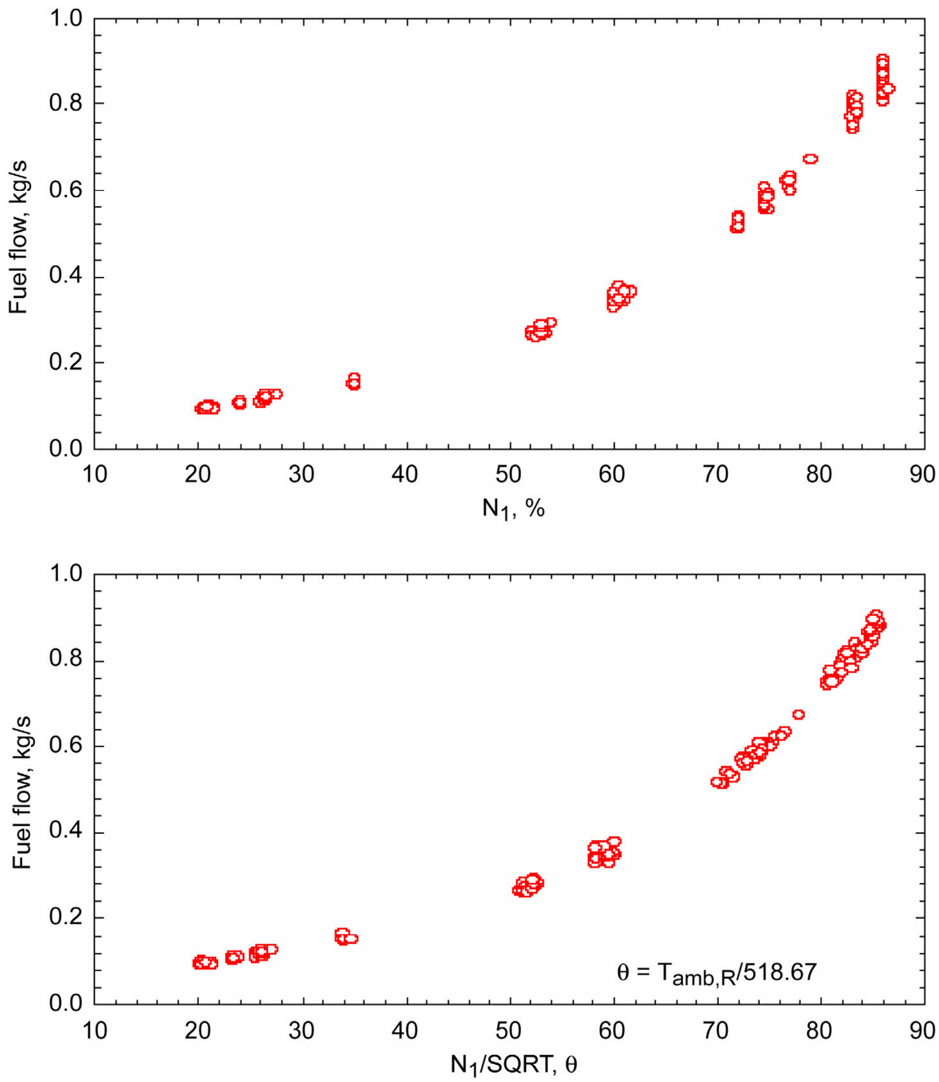

Figure C–11.—Variation in fuel flow rate with corrected engine fan speed.

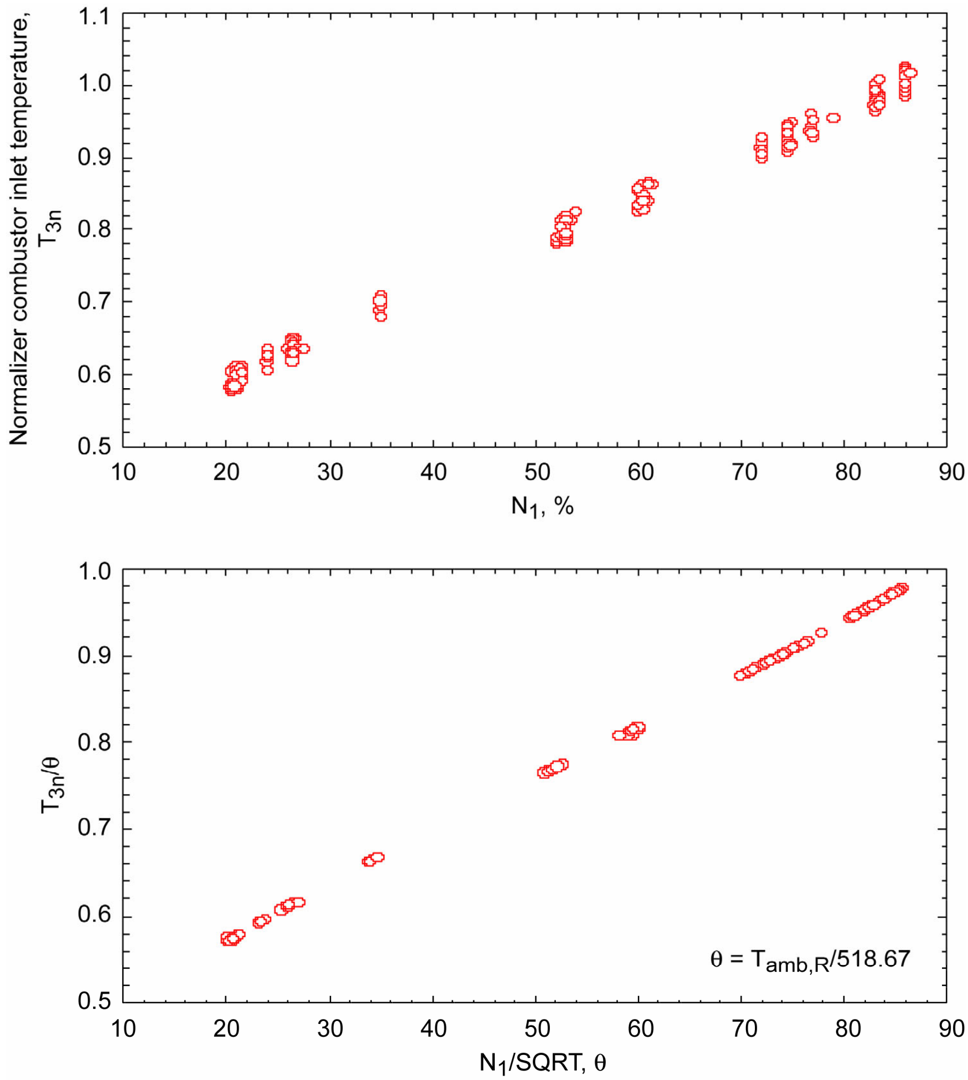

Figure C–12.—Normalized combustor inlet temperature (T_{3n}, top) and corrected inlet temperature (T_{3n}/θ, bottom) plotted as functions of fuel flow rate.

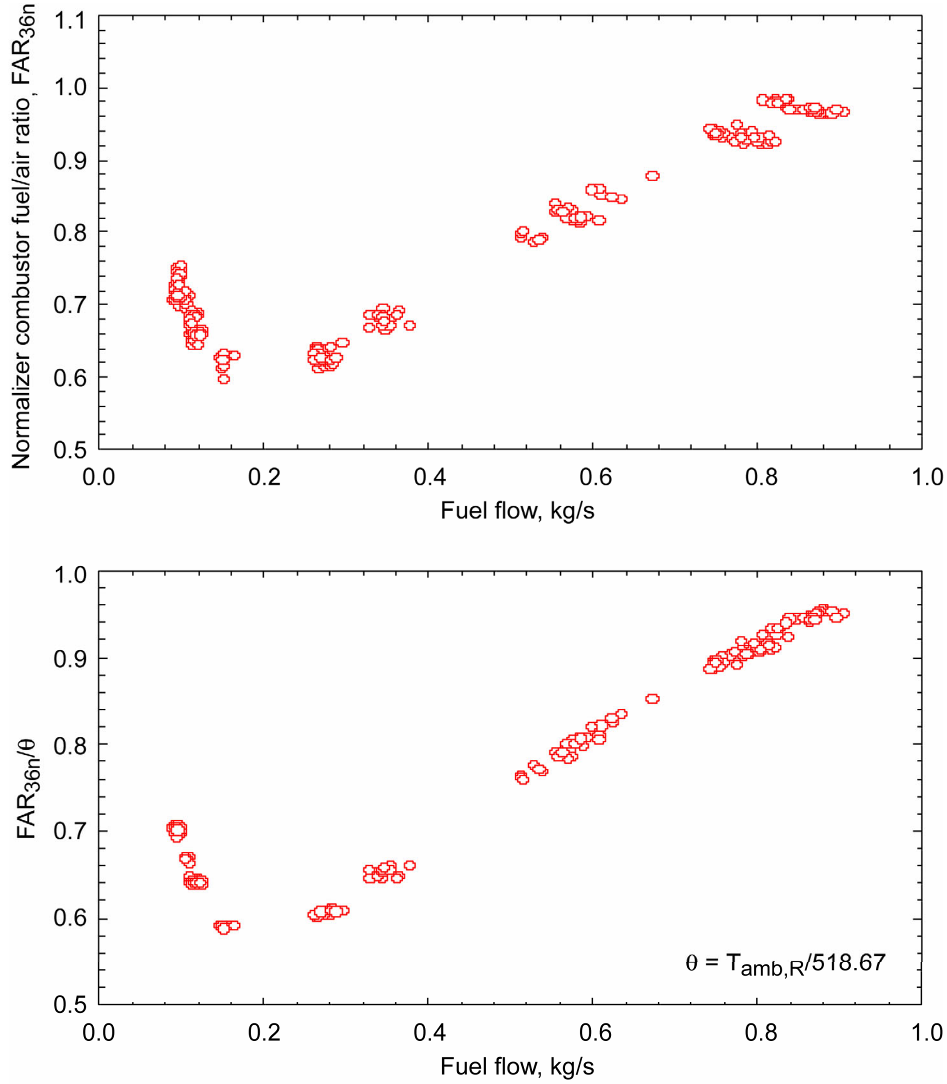

Figure C–13.—Normalized combustor FAR (top) and corrected, normalized combustor FAR (bottom) plotted as functions of fuel flow rate.

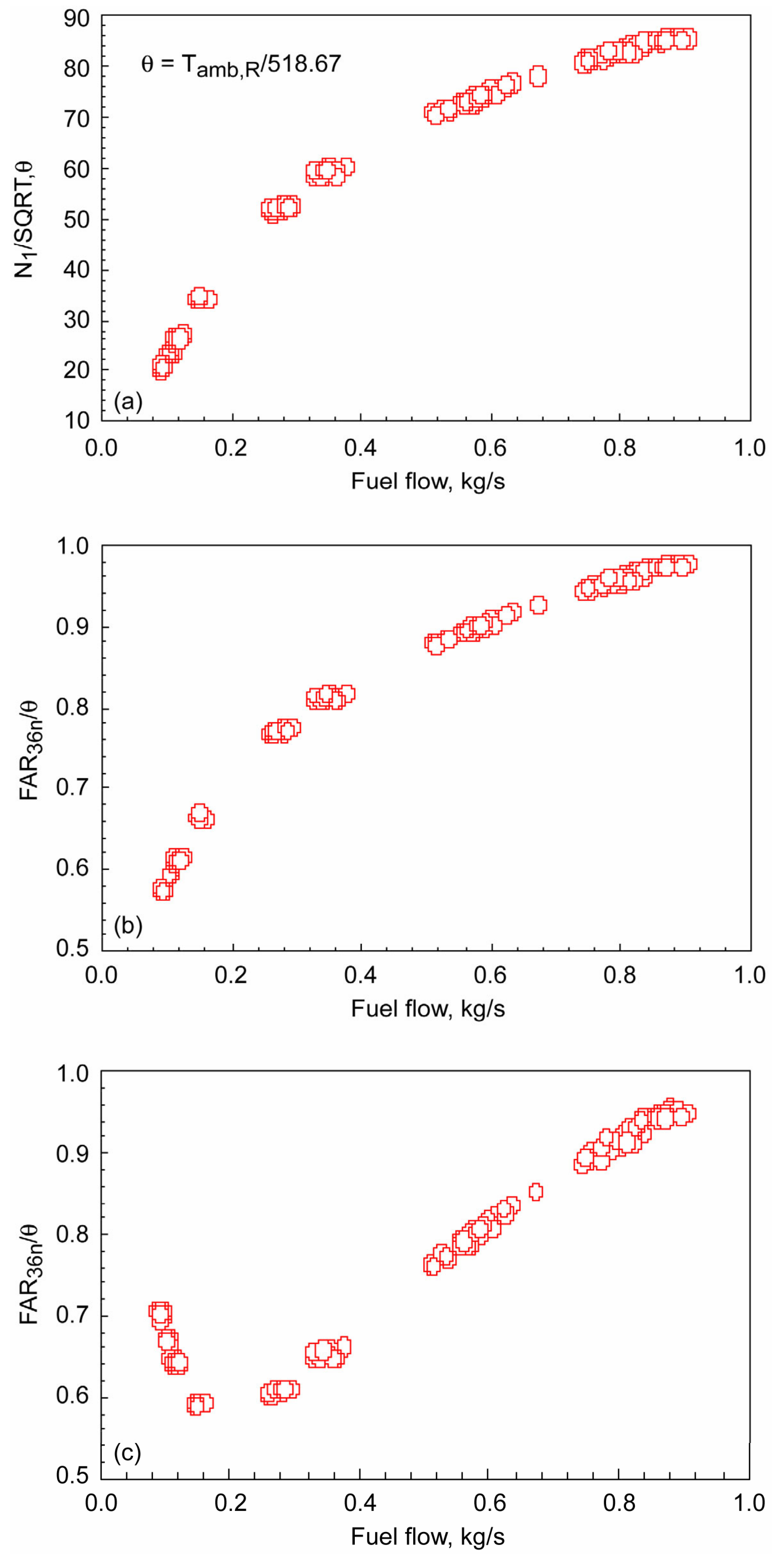

Figure C–14.—Corrected (a) fanspeed, (b) normalized combustor inlet temperature, and (c) normalized fuel/air ratio plotted as functions of fuel flow rate. Note that each corrected engine operating parameter corresponds to a unique fuel flow rate.

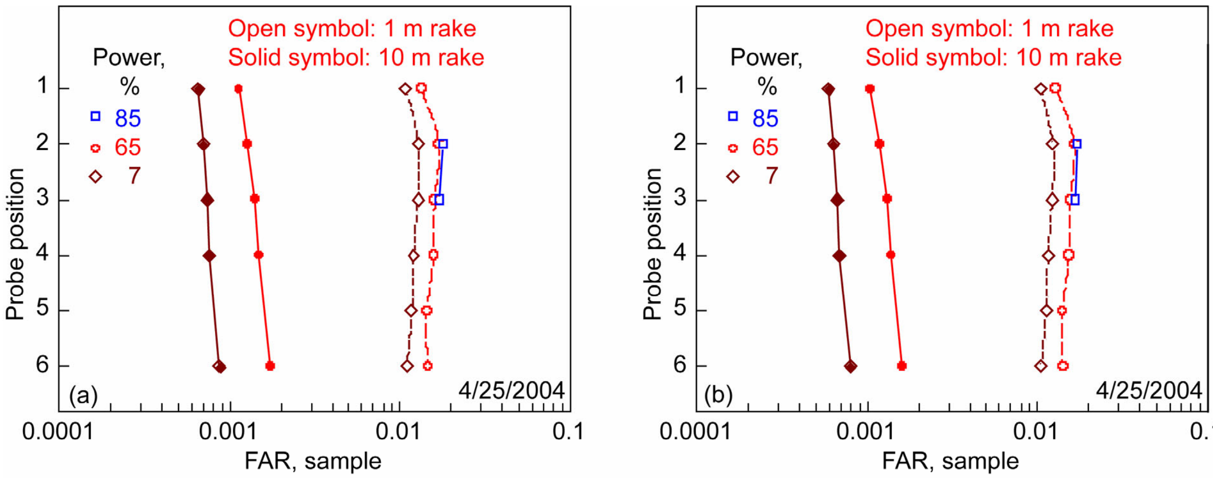

Figure C–15.—Fuel-air-ratio vs. probe positions at 1-m and 10-m stands. Outer probes are diluted with fan air by approximately 5–10% at low power conditions, but EI's are in reasonable agreement with other probes on the 1-m stand. Data from the 10-m stand exhibits a similar trend, but with higher variations.

Although as illustrated in figure C-15, all probes on the 1 m rake were within the core engine exhaust, some of the outer probes exhibited greater levels of variability than the others. In particular, samples collected from probes R1G5 and R1G6 were often observed to be diluted by 5 to 10% with fan air at low power conditions. However, their EI's were in reasonable agreement with other probes. A similar trend was observed from the 10 m rake, although the standard deviations of measurements made at this downstream position were greater because of fluctuations in plume location and dilution caused ambient wind effects. In spite of being 10 times more dilute, samples drawn from the 10 m stand exhibited the same emission trends as those from the 1-m stand (fig. C–16). Overall, engine operation seemed to be normal and gas emissions data agreed very well with the expected values for this engine type.

Caution should be exercised when using the 10 m data. Although uncertainties for the 1 m data were typically less than 5%, those for the 10 m data were typically much higher, especially for the hydrocarbon species. The higher uncertainties were caused by several reasons: (1) The CGA system was optimized and calibrated for measuring gas concentration levels expected from 1 m stand, not for the 10m stand where mixing ratios were typically a factor of 10 lower; (2) analyzers needed a longer time to process signals at extremely low concentration ranges; (3) entrainment of ambient air containing non-negligible amounts of the species of interest influenced accuracy; (4) the dwell time at each test and sampling condition was often insufficient for the signals to stabilize after high to low concentrations.

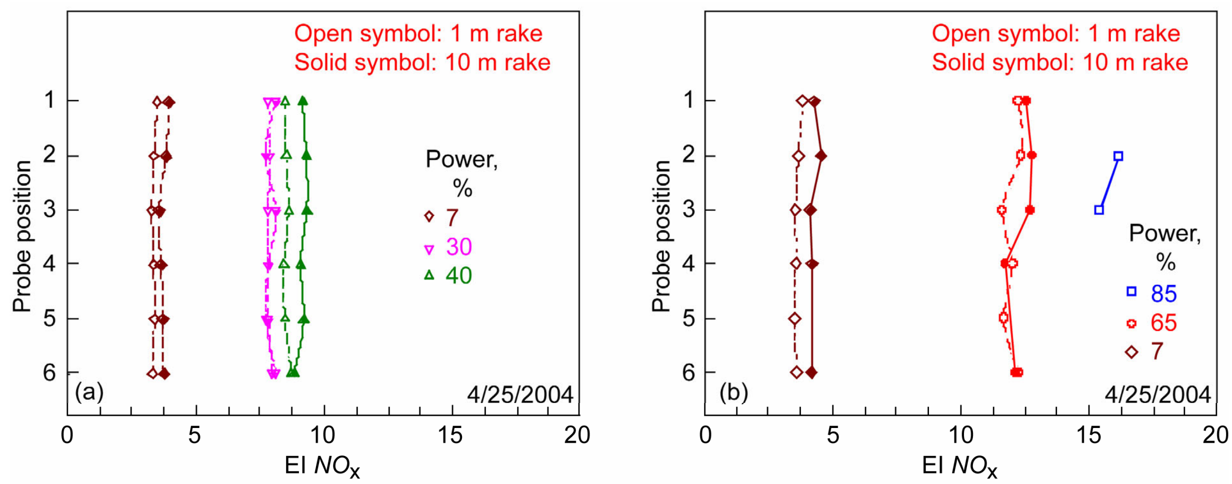

Figure C–16.—EI NO_x vs. probe position on the 1-m and 10-m stands.

6.1. CGA Data

6.1.1 NO_X

Figure C-17 shows the oxides of nitrogen emissions that were measured in samples collected from the 1-m rake. The values, plotted as EINO_x and identified either by probe location (fig. C-17 (a)) or by fuel type (fig. C-17 (b), are in good agreement with the ICAO certification data and GEAE predictions as shown in figure C-17. EINO_x is also plotted against the normalized combustor inlet temperature (Dodds, 2004) in figure C-18 and demonstrates good agreement with cycle calculation performed by GEAE (Dodds, 2004[‡]).

EINO_x, corrected for humidity to the standard atmospheric condition (0.00629 kg-water/kg-dry air), was calculated based on the equation:

$$KH(NO_x)\text{, humidity corrected EI}NO_x = \text{EI}NO_x * \exp(19*(h_s-0.00629))$$

where h_s = specific humidity of ambient air

Humidity correction factors for APEX ranged from 0.93 to 0.95. The regression equation for EINO_X was derived from the normalized P_3 and T_3. It follows the typical P_3-T_3 equation, which was used by system analysis to predict the NO_x emissions:

$$\text{EI}NO_x = 17.5 * P_{3n}{}^{0.35} * T_{3n}{}^{2}; \qquad R^2 = 0.99$$

The measured EINO_x agrees very well with the EINO_X calculated from above regression as shown in figure C-19.

It is well known that nitrogen tends to be oxidized more to NO_2 at low power conditions. Figure C-20 shows that the NO_2 fraction of NO_x is much higher at low power conditions. Note that the ratio of EINO_2 to EINO_x was above 0.8 at ground idle and rapidly decreased to about 0.1 starting from about 30% power.

‡ W. Dodds, APEX Conference, November, 2004

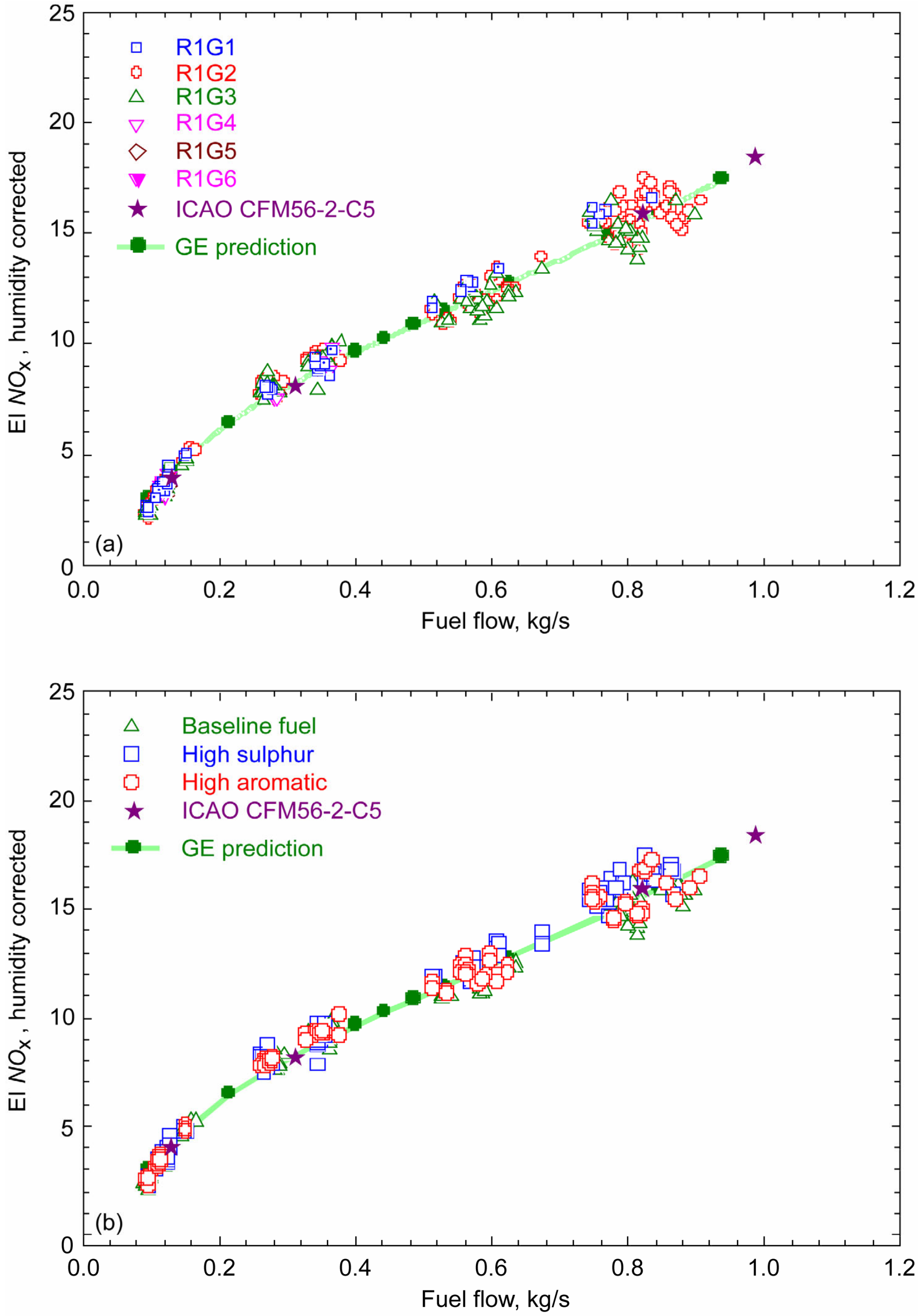

Figure C–17.—EI NO_X as a function of fuel flow rate for (a) the individual probes and (b) different fuel types. Measured data are in good agreement with the ICAO certification data and GEAE predictions.

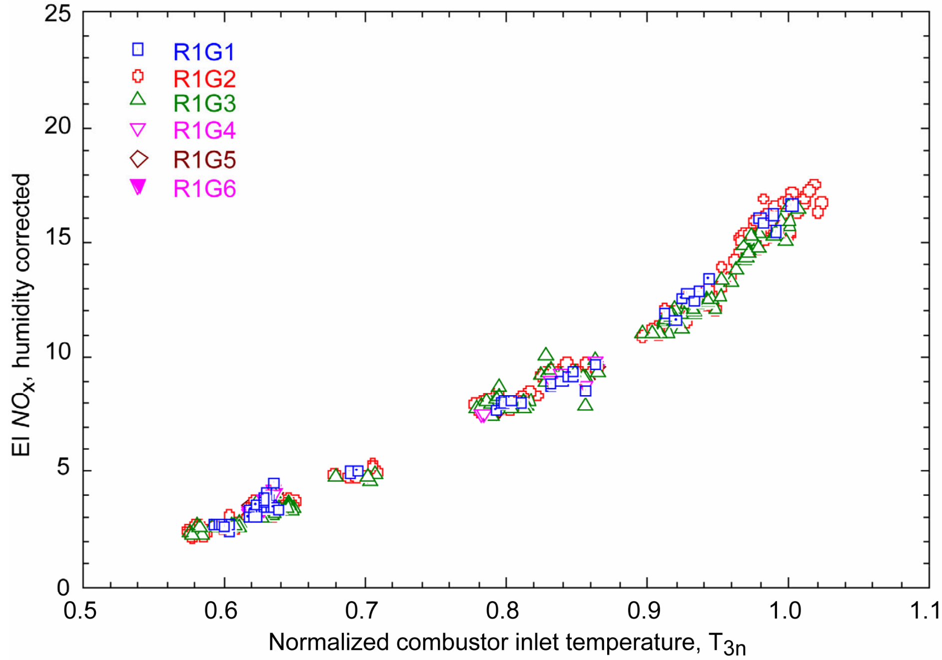

Figure C–18.—EI NO_x versus normalized T_3. Measured data are in good agreement with GEAE cycle calculation.

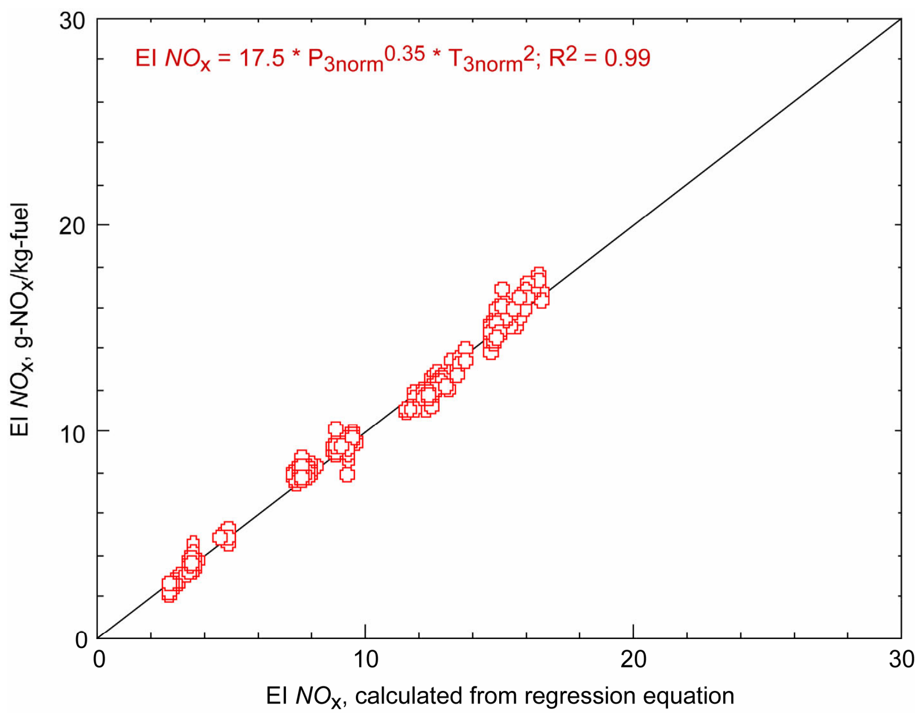

Figure C–19.—EI NO_x versus normalized T_3. Measured data are in good agreement with those calulated from the regression equation.

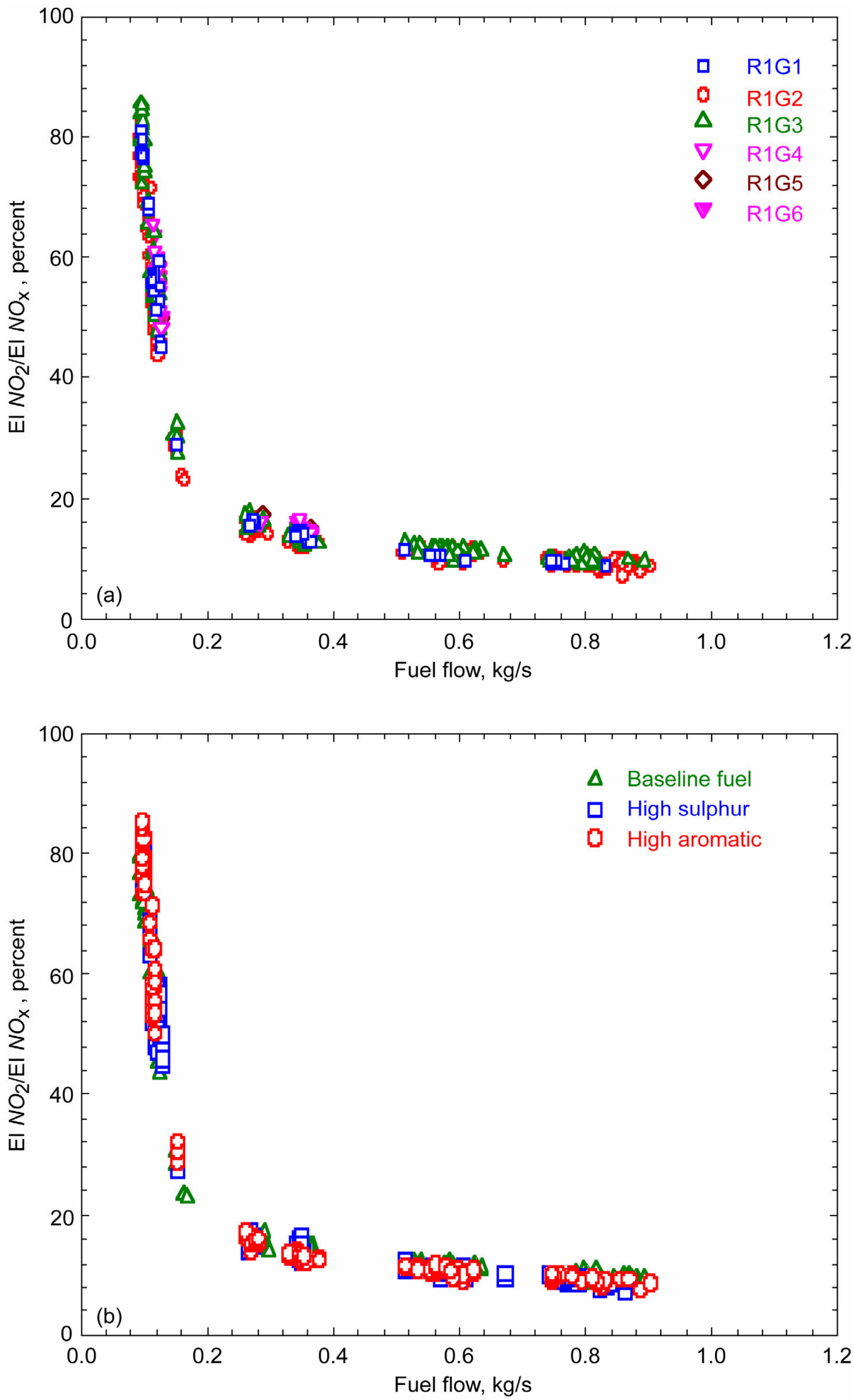

Figure C–20.—Ratio of EI NO_2/EI NO_x as a function of engine fuel flow rate for (a) individual probes and (b) the different fuel types.

6.1.2 CO

As shown in figure C-21, the measured EI*CO* were in very good agreement with ICAO data as well as with GEAE predictions. The correlation between EI*CO* and normalized combustor inlet temperature also is as expected (fig. C-22).

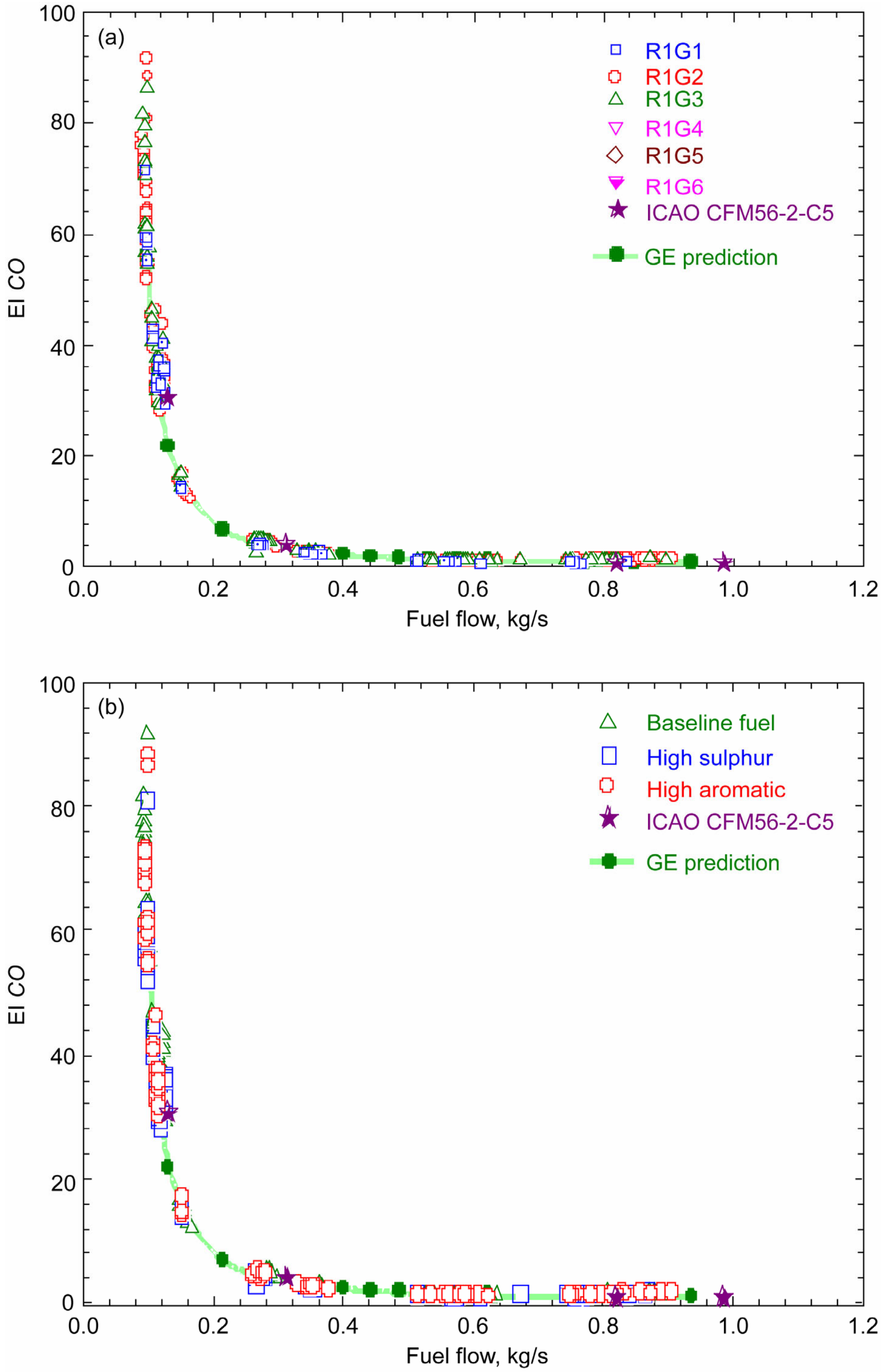

Figure C–21.—EI *CO* as a function of engine fuel flow rate for (a) the individual probes (b) and different fuel types. Measured data are in excellent agreement with ICAO data and GEAE predicted values.

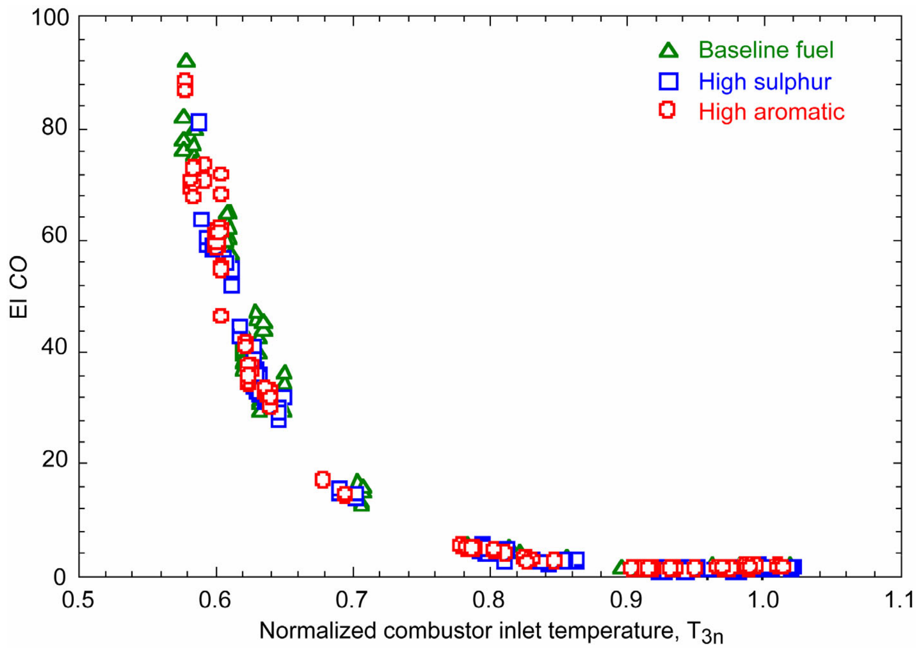

Figure C–22.—EI CO_x versus normalized T_3.

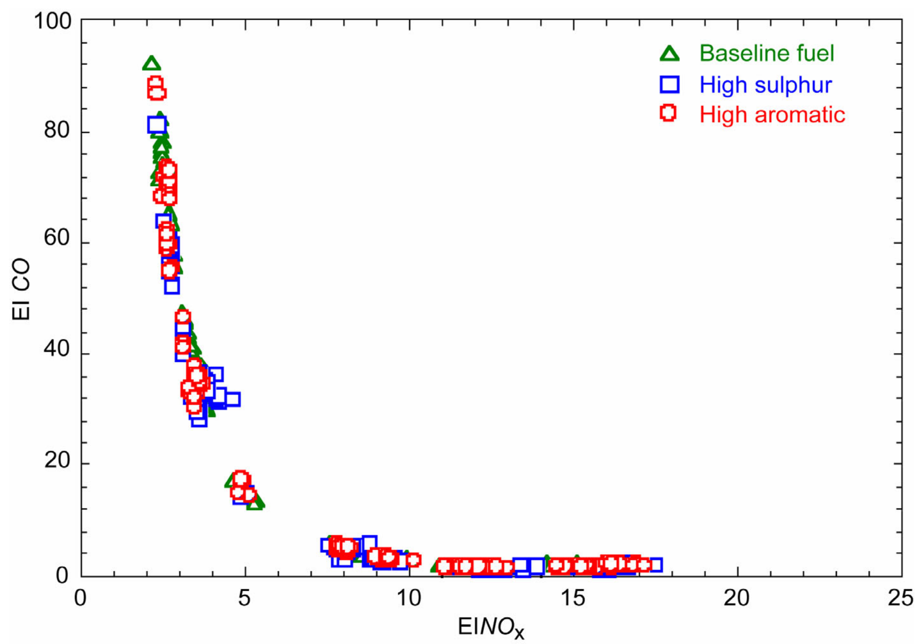

Figure C–23.—EICO_x versus EINO_x. EI*CO* is highest at lowest power conditions, and EINO_x is typically highest at highest power conditions.

EI*CO* has a negative correlation with EINO_x, i.e., EI*CO* increases when EINO_x decreases, as shown in figure C-23. Because combustors are typically designed to operate most efficiently at high thrust levels, it is a well established fact that EI*CO* is highest at the lowest power conditions. On the other hand, EINO_x was typically a maximum at takeoff power because the combustor flame temperature peaked under these conditions.

6.1.3 HC

Because CO and the HC are formed by similar reaction chemistry within the combustor, EI*HC* exhibited the same trend as EI*CO*. However, concentrations of unburned hydrocarbon were significantly more sensitive to engine operating temperature than CO as is readily apparent in figures C-24 and C-25, which illustrate the effects of fuel type and engine operating temperature on EI*HC* and combustion efficiency.

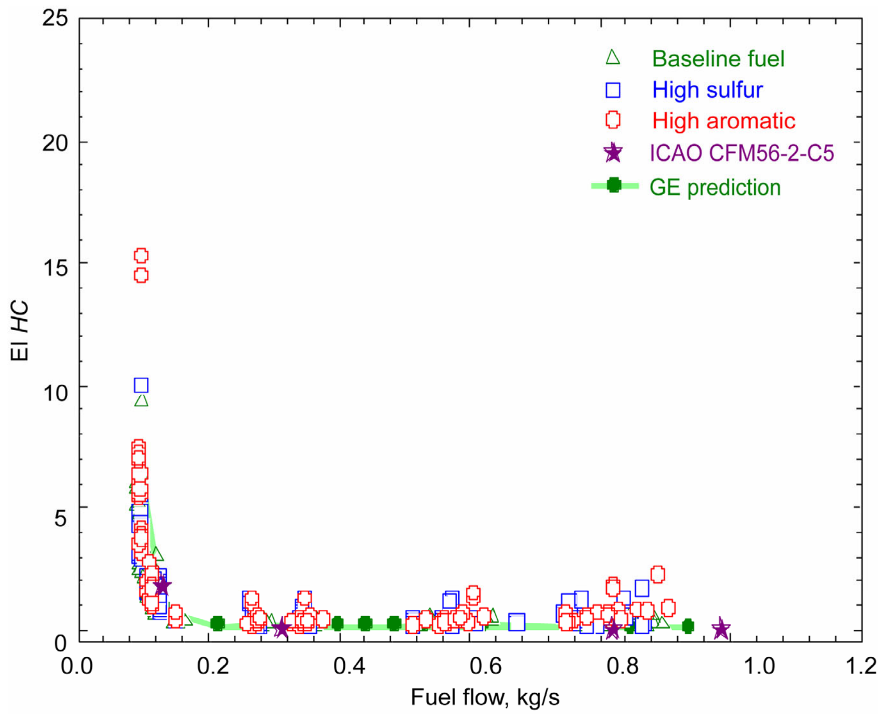

Figure C–24.—EI *HC* as a function of engine fuel flow rate. EI *HC* does not appear to have any dependency on fuel composition for the three fuels tested.

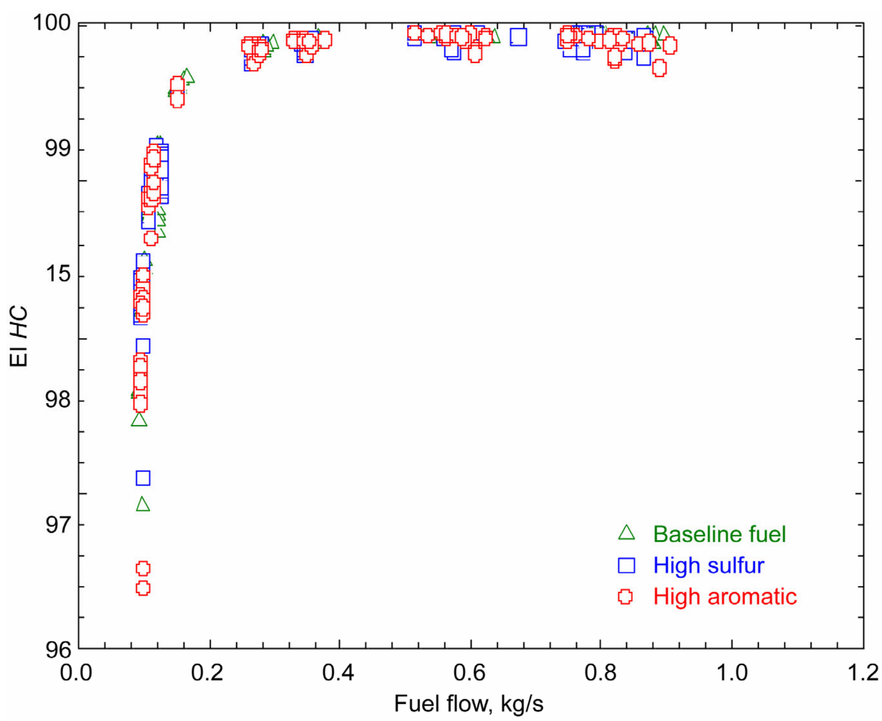

Figure C–25.—Combustion efficiency as a function of engine fuel flow rate. Combustion efficiency does not appear to depend on fuel types for the three fuels tested.

In addition, HC emission levels were higher when the engine was cold (during the initial run up from start to 93% thrust). A consistent finding throughout the experiment, similar effects were noted in GEAE's early emissions variability testing of the CF6-50 (Dodds, 2004). Note that certification data were typically acquired on warm engines. Figures C-26, C-27 and C-28 demonstrate that EI*HC* are at the highest values at engine cold-start and decrease with time for the same power conditions (with warmer engine). This phenomenon can be observed more clearly when EI*HC* data are grouped by cold and warm engine conditions as shown in figure C-29. EI*CO* exhibits the same trend, as shown in figure C-30, and reinforces the generally accepted fact that both CO and HC are affected by engine operation temperature. Ambient temperature also contributes to this effect because it impacts the combustor operation temperature, as discussed above and illustrated in figure C-9. This effect is more clearly demonstrated in figure C-31 by plotting EI*HC* against normalized combustor inlet temperature instead of ambient temperature or fuel flow rate as well as excluding the first set data of each test series (cold engine). Note that the effect of combustor inlet temperature (T_3) on EI*HC* becomes much less significant at engine powers $\geq$15% of maximum thrust.

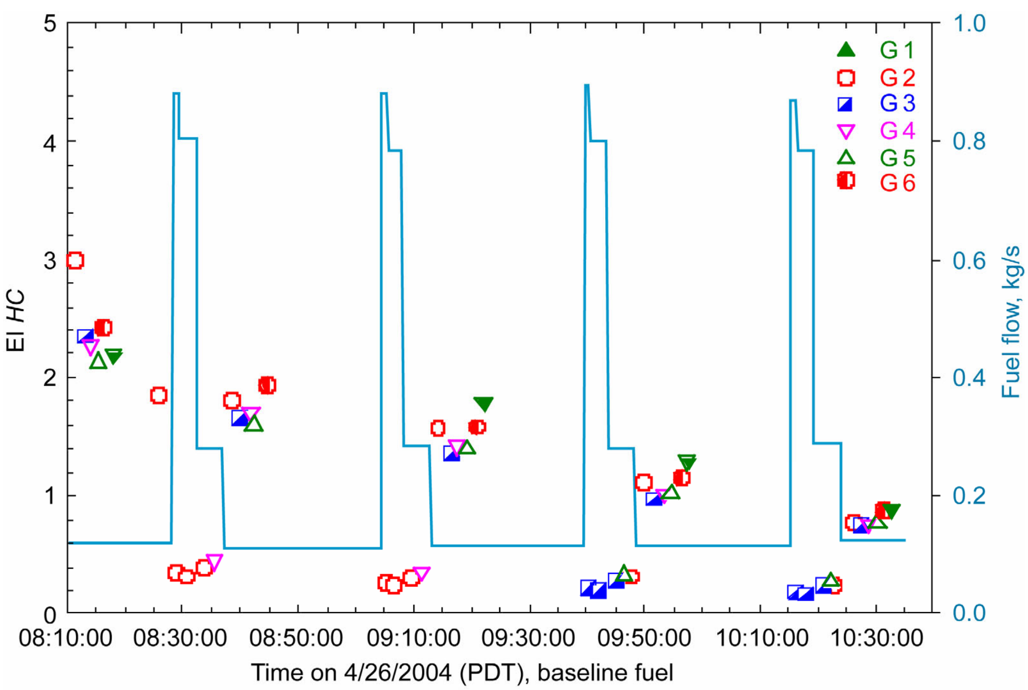

Figure C–26.—EI *HC* from individual gas probes during NASA test matrix with baseline fuel. EI *HC* is highest at engine cold-start, and decreases as the engine warms up.

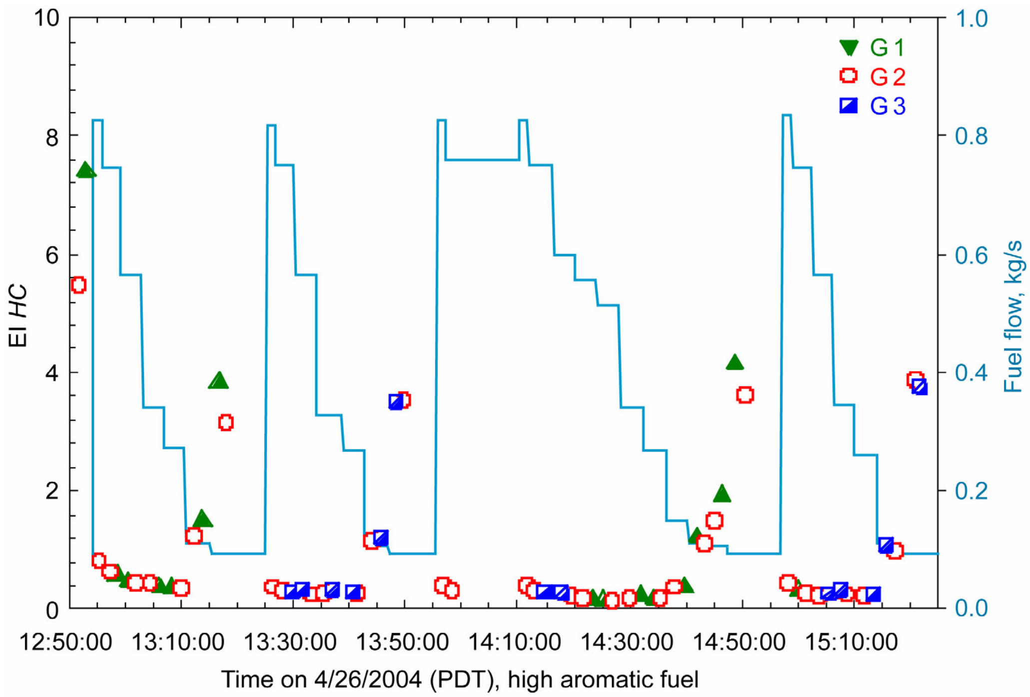

Figure C–27.—EI *HC* from individual gas probes during NASA test matrix with high aromatic fuel.

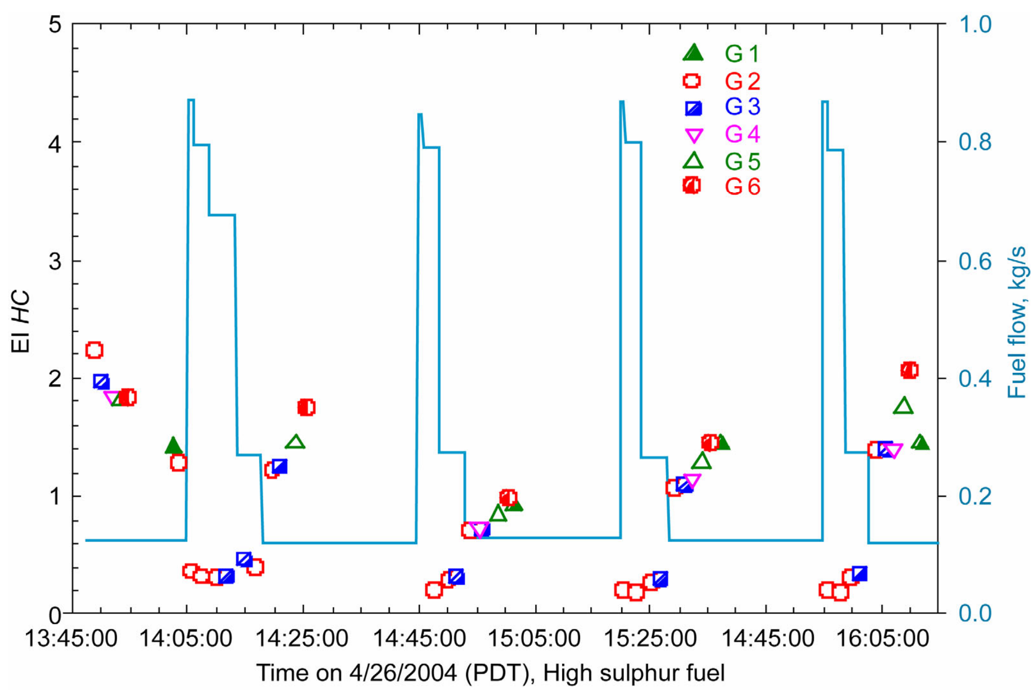

Figure C–28.—EI *HC* from individual gas probes during NASA test matrix with high sulfur fuel.

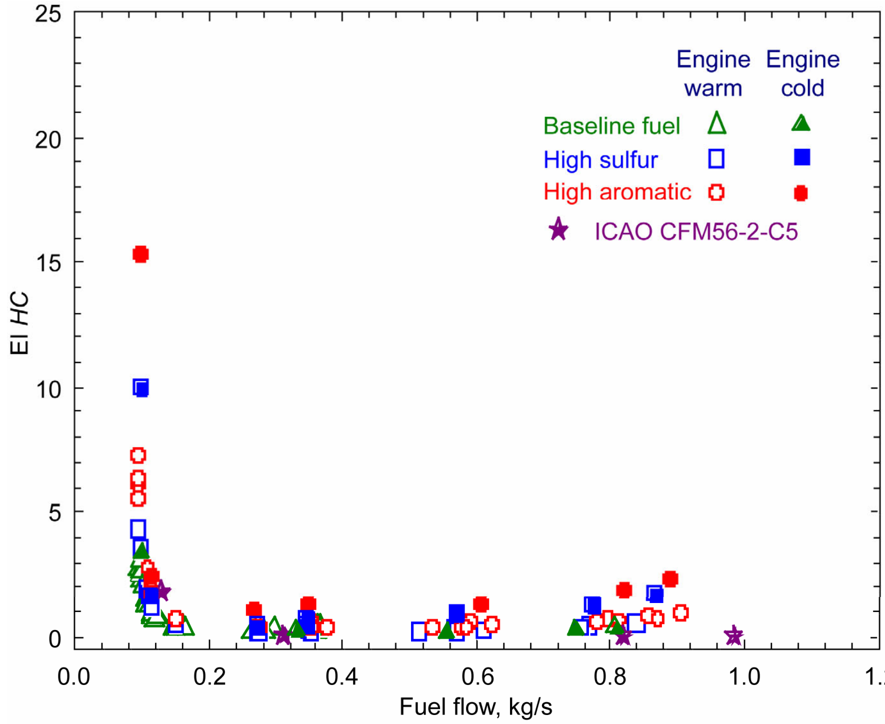

Figure C–29.—Effect of engine temperature on EI *HC* (data from probe R1G2). EI *HC* is higher with colder engine.

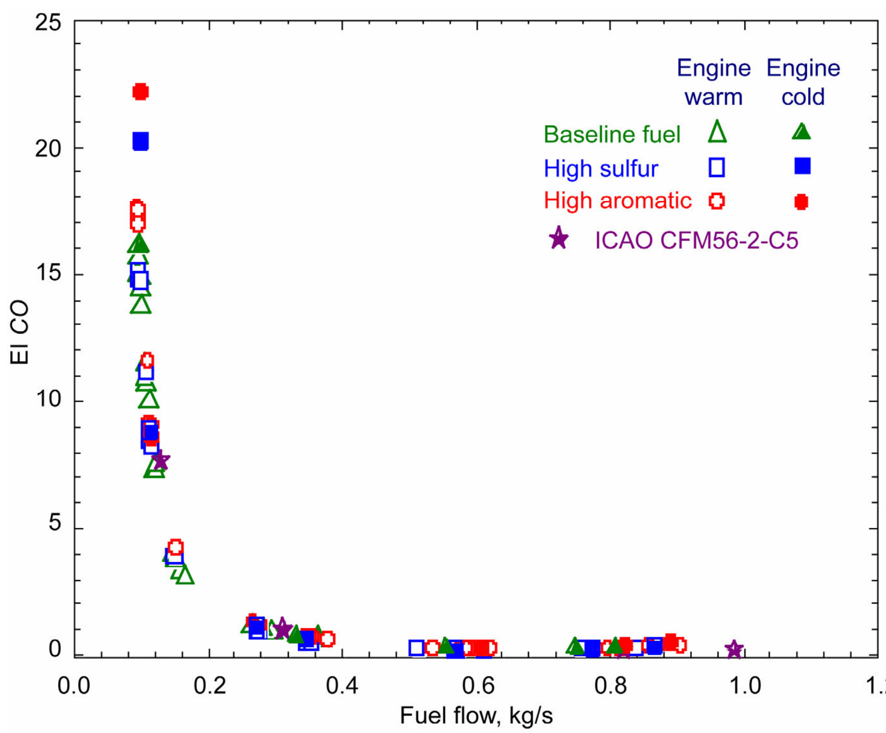

Figure C–30.—Effect of engine temperature on EI *CO* (data from probe R1G2).

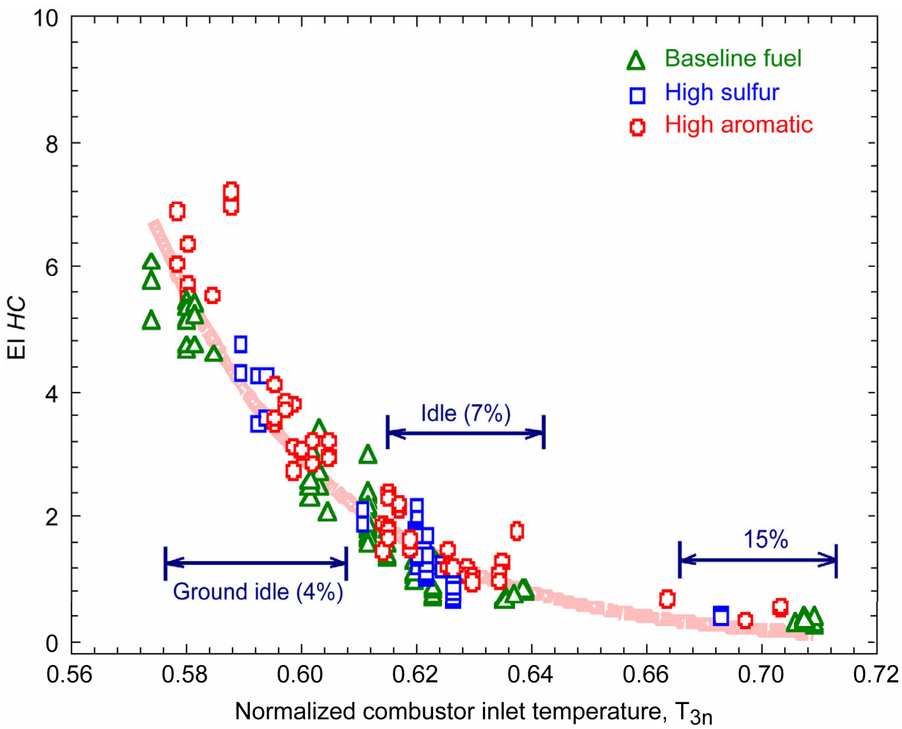

Figure C–31.—Effect of combustor inlet temperature on EI *HC* for lower power conditions (from ground idle to 15%).

6.2 MGA Data

Deriving accurate trace species concentrations from MGA spectral measurements is very challenging for many reasons, such as: the spectra were dominated by the water vapor and CO_2 lines related to combustion emissions (fig. C-32), the spectra of heavier hydrocarbon species overlapped significantly (fig. C-33), and the absorption lines of the individual of species often overlapped and were difficult to decouple from one another. Even though the instrument's reference library contained spectra for $C_1 – C_8$ hydrocarbons, data for heavier hydrocarbons were not included because of their significant uncertainties.

Table C-4 shows an example of the various analysis options. All available hydrocarbon species were chosen to be analyzed simultaneously in Case A, $C_1 – C_4$ were chosen (nothing higher) for Case B, and only $C_1 – C_3$ for Case C. We found the best agreement with CGA data was obtained when the heavier hydrocarbons were excluded from the analysis. A similar conclusion was reached when analyzing SO_2 and HONO. Special cautions and high uncertainties must be applied when using these data.

6.2.1 SO_2

Sulfuric acid (H_2SO_4), formed from oxidation of fuel sulfur contaminants, is of well-known environmental concern. Lacking successful methods for measuring this species directly at high temperatures where it exists as SO_3, an effort was made to measure SO_2 and fuel sulfur more accurately in order to place an upper bound on the fraction the sulfur emissions that were sequestered as S(VI) species. EISO_2 was relatively independent of engine power, but varied in proportion to fuel sulfur content (fig. C-33). Although the instrumental uncertainties are relatively high, the measurements indicate that >90% of fuel sulfur content was converted to SO_2.

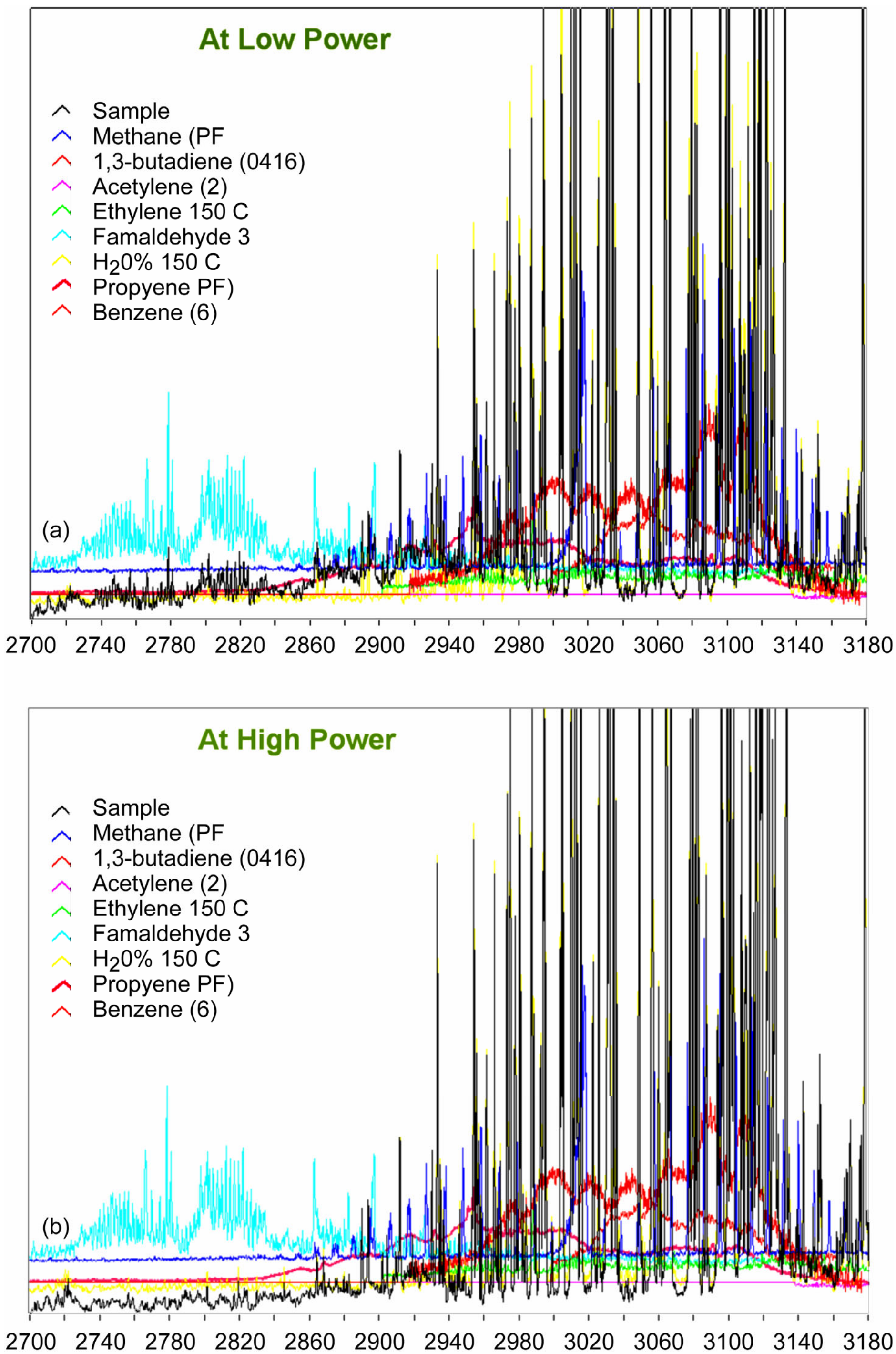

Figure C–32.—Sample combustion emission spectra recorded at (a) high and (b) low engine powers illustrating that CO_2 and H_2O absorption peaks often obscure spectra of less concentrated trace species.

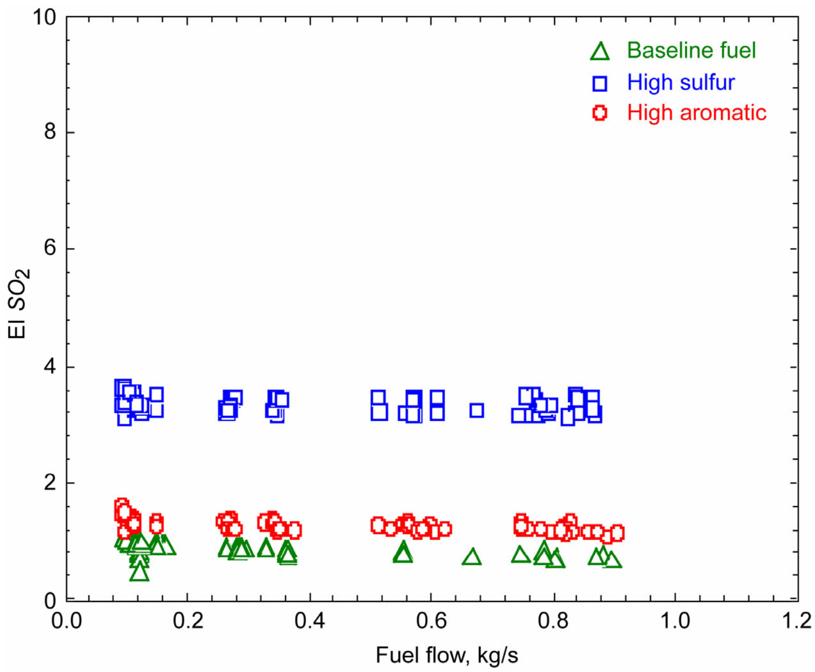

Figure C–33.—EI SO_2 for the three fuel types as measured over the entire course of the experiment. ***see comment #9***

TABLE C-4.—ANALYSIS SCENARIOS OF REFERENCE SPECTRUMS AND RESULTS

Hydrocarbon spectrums included in the reference library: C_1: methane, formaldehyde, formic acid, methanol C_2: acetylene, ethane, ethylene C_3: propane, propylene C_4: butane, 1-butene, 1,3-butadiene C_6: benzene C_7: toluene C_8: o-xylene					
Scenario A: All (C_1 – C_8) reference spectra are used to analyze data. THC measured by MGA is calculated by summing up a subset of C_i concentrations (ppm) in different cases (e.g., C_1- C_4). THC measured by CGA is listed for comparison.					
Thrust, %	THC by CGA	C_1-C_8	C_1-C_4	C_1-C_3	C_1-C_2
100	1.59	92.04	4.64	4.47	1.36
85	1.33	86.38	3.26	3.20	0.69
30	5.34	72.28	8.50	8.45	1.86
7	36.32	131.98	31.45	30.36	20.97
Scenario B: Only (C_1 – C_4) reference spectra are used to analyze data.					
Thrust, %	THC by CGA		C_1-C_4	C_1-C_3	C_1-C_2
100	1.59		6.97	2.18	1.06
85	1.33		4.19	1.67	0.72
30	5.34		7.08	6.34	1.63
7	36.32		29.47	25.88	20.87
Scenario C: Only (C_1 – C_3) reference spectra are used to analyze data.					
Thrust, %	THC by CGA			C_1-C_3	C_1-C_2
100	1.59			1.04	1.04
85	1.33			0.66	0.66
30	5.34			1.58	1.58
7	36.32			23.64	20.76

6.2.2 Hydrocarbons

Many of the hydrocarbon species emitted by aircraft are toxic to humans and other animal life, may promote ozone formation, and are active as green house gases. In addition, they can form volatile particles, which also present health hazards and are a detriment to air quality and climate. It is well-known that engine hydrocarbon emissions decrease with increasing power because combustors are typically designed to operate most efficiently at higher power. All hydrocarbons analyzed followed this trend.

6.2.3 CH_4

Methane has a larger global warming potential than that of carbon dioxide. It also plays an important role in determining tropospheric hydroxyl radical (OH) concentrations. As shown in figure C-34, CH_4 concentrations were less than the ambient background levels (2 ~ 3 ppm) at all power conditions except at ground idle (4%) and idle (7%). Figure C-35 shows the same trend of sharp decreasing EI with increasing power.

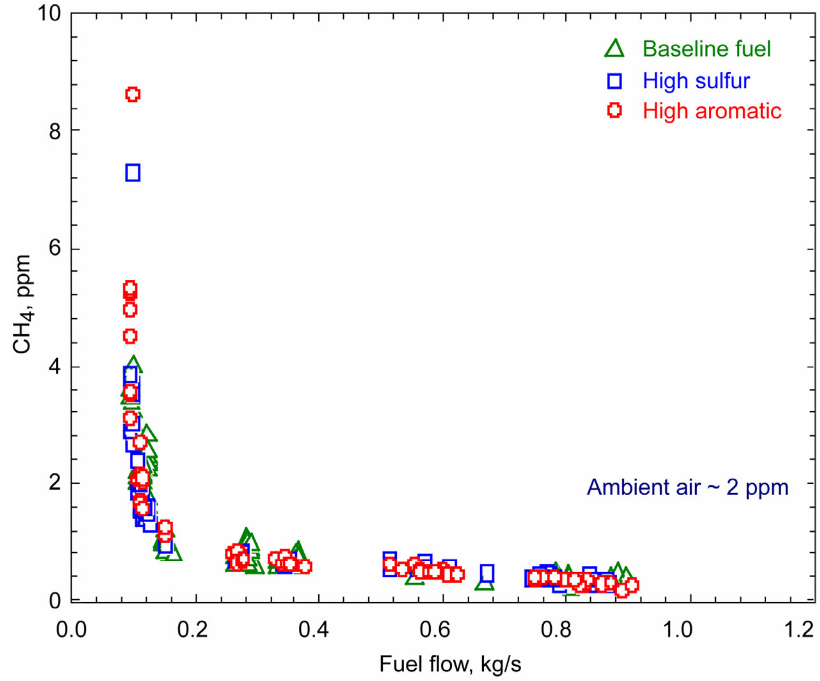

Figure C–34.—CH_4 concentrations for each fuel type as measured over the course of the experiment.

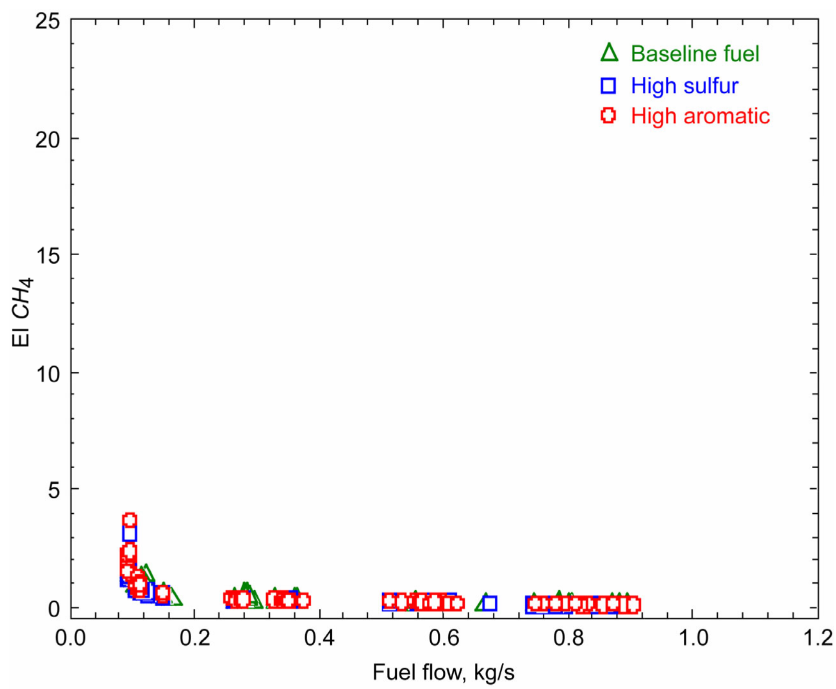

Figure C–35.—EI CH_4 for the three fuel types as measured over the course of the experiment.

6.2.4 N_2O

Nitrous oxide has an even higher global warming potential than CH_4 has a very long atmospheric lifetime. It is also one of the primary sources of stratospheric nitrogen monoxide (NO). The N_2O concentration of ambient air is around 0.3 ppm and the concentration from the aircraft exhaust is from 0.7 to 0.8 ppm as shown in figure C-36. It seems that the absolute concentration of N_2O is not significantly dependent on fuel flow rate.

6.2.5 HCHO, HCOOH, CH_3OH, C_2H_4, C_2H_6

As shown in figures C-37, C-38, C-39, C-40 and C-41, these species exhibited similar trends with engine power. Note that EI*HCHO*, EI*HCOOH*, EICH_3OH, EIC_2H_4 and EIC_2H_6 were all below 0.1 at most power conditions except for ground idle and idle.

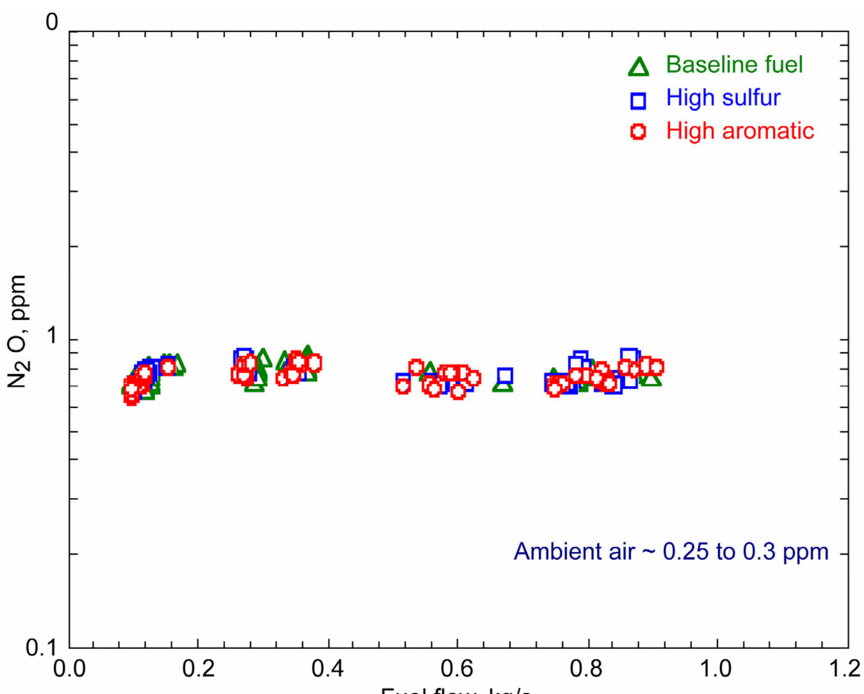

Figure C–36.—N_2 O concentrations as measured for the three fuel types.

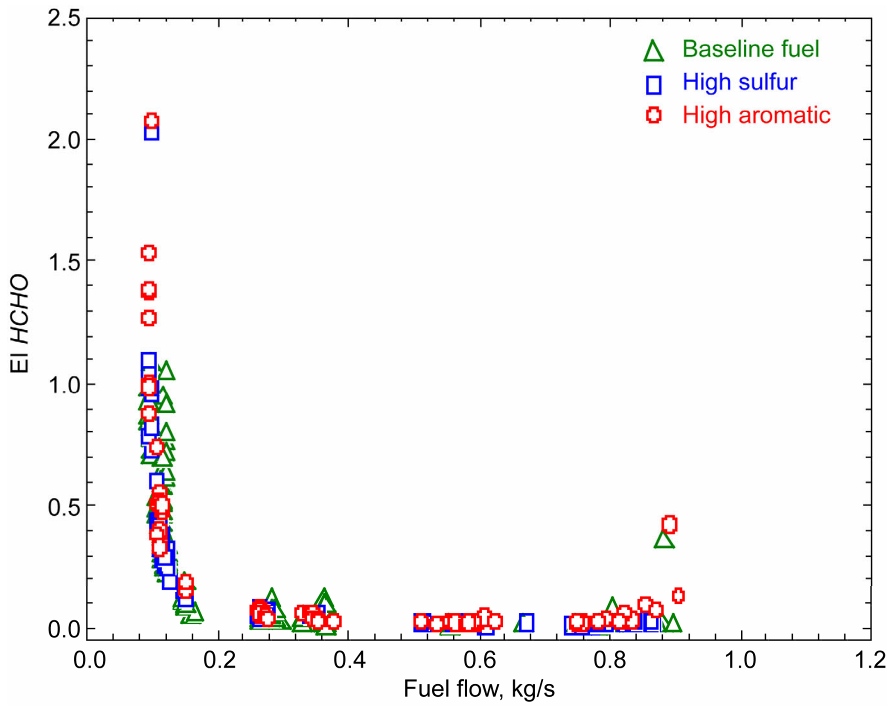

Figure C–37.—EI *HCHO* for the three fuel types as measured over the course of the experiment.

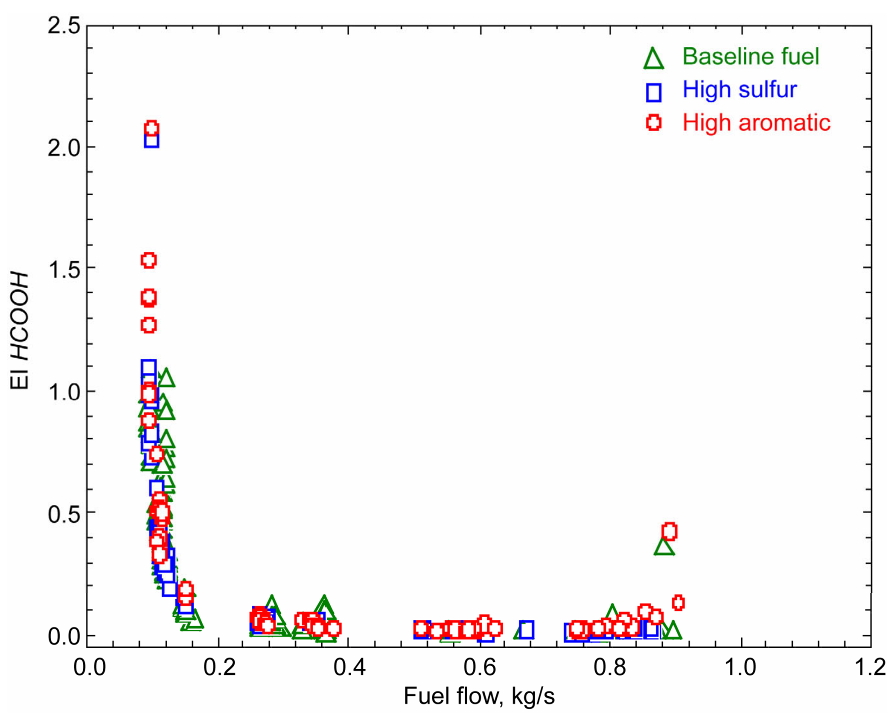

Figure C–38.—EI *HCOOH* for the three fuel types as measured over the course of the experiment.

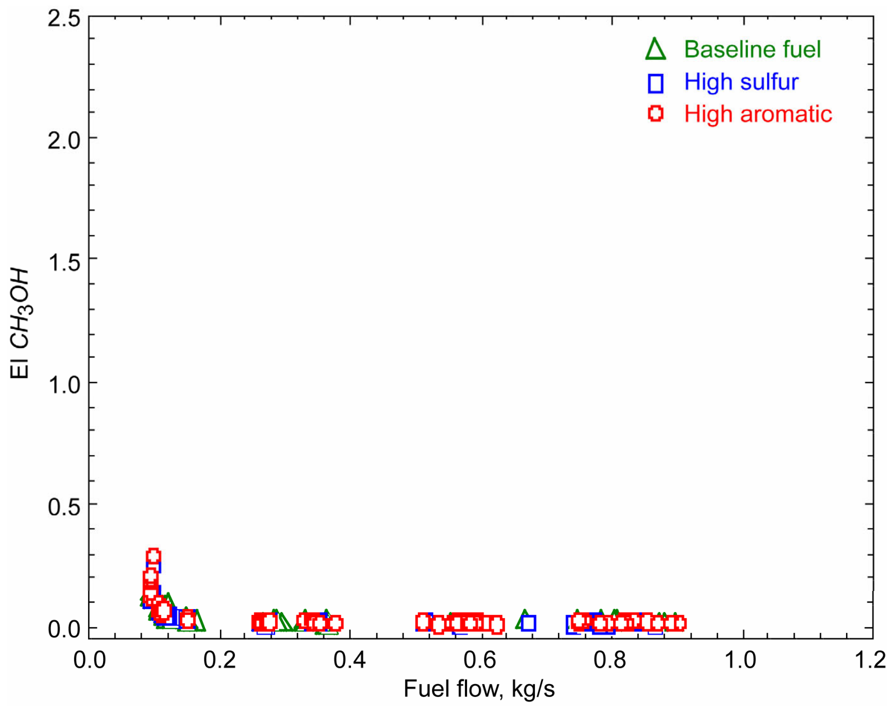

Figure C–39.—EI CH_3OH for the three fuel types as measured over the course of the experiment.

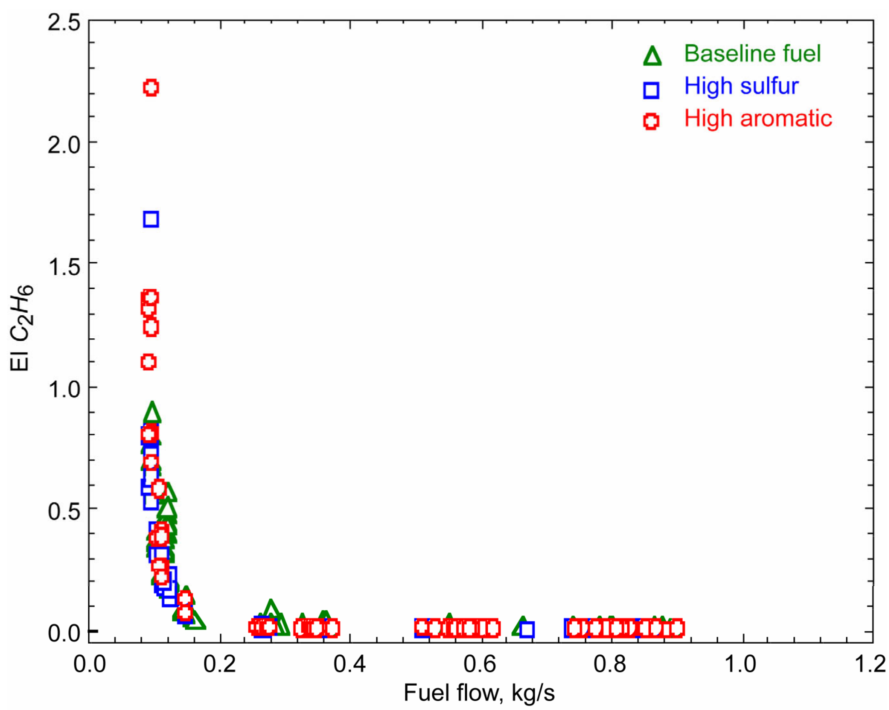

Figure C–40.—EI C_2H_4 for the three fuel types as measured over the course of the experiment.

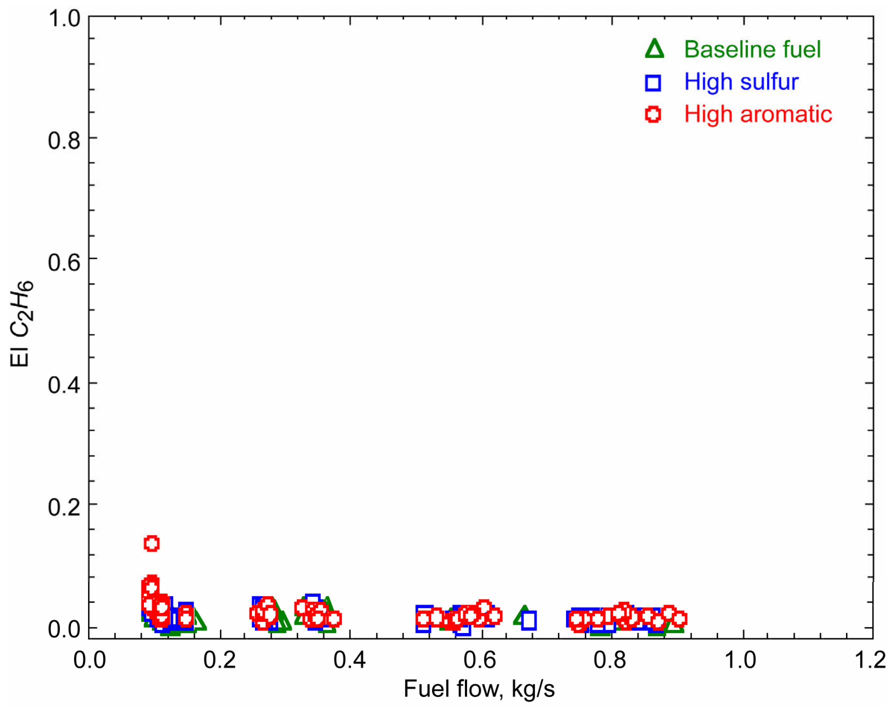

Figure C–41.—EI C_2H_6 for the three fuel types as measured over the course of the experiment.

6.3 Comparisons of MGA and CGA

For CO, CO2, NO/NO2/NOx, the MGA measurements were in reasonable agreement with CGA values when concentrations were not extremely low. Although the MGA gave valuable information on light hydrocarbon speciation, THC values obtained by summing the individual hydrocarbon concentrations were dependent on the data analysis approach and were often significantly different from those measured with the CGA system. The reader is thus cautioned to use these instruments and the data they provide with caution.

6.3.1 CO, CO_2

As shown in figure C-42, MGA and CGA CO values agreed quite well except at low concentrations (<20 ppm). The CO_2 data was also quite comparable at the 1 m location, but showed slight differences at 10 m (fig. C-43), possibly because of the much lower concentrations present within the plume at this downstream position.

6.3.2 NO/NO_2 vs. NO/NO_X

As illustrated in figure C-44, the sum of NO and NO_2 from the MGA typically agrees well with CGA NO_x . However, values vary significantly at low NO_2 concentration (< 5 ppm). This variation might be caused by the higher uncertainties at the lower concentration range for both systems. The manual of the Eco Physics CL700 analyzer (CGA system) indicates that the analyzer needs a longer processing time at lower concentrations in order to reach a reasonable result. The analyzer processing time limited to the duration of the sampling point, which may have been insufficient for measuring the lower concentrations associated with the 10 m samples. Therefore, increases in uncertainty for the lower concentration range were mainly due to the characteristics of the sampling and engine run time.

When measuring extremely low concentrations, the MGA analyzer also needs a longer scanning time to increase the signal noise ratios (SNR). Hence the limited scanning time available for 10 m probe sampling also led to larger error bars on concentrations measured by this instrument.

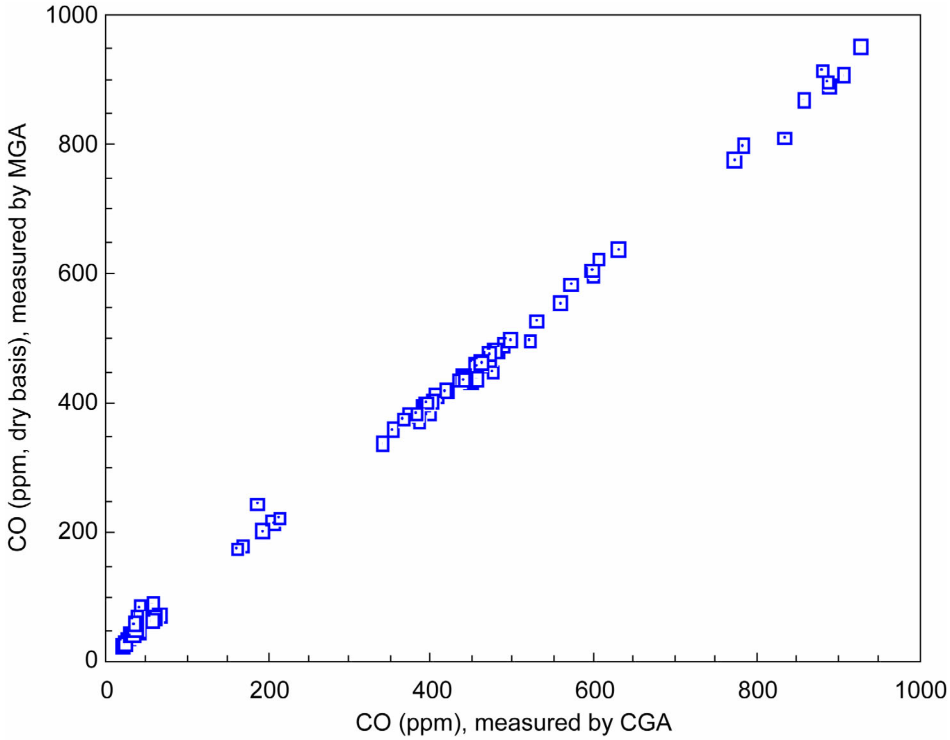

Figure C–42.—Comparison of CO, measured by CGA and MGA systems, demonstrates good agreement.

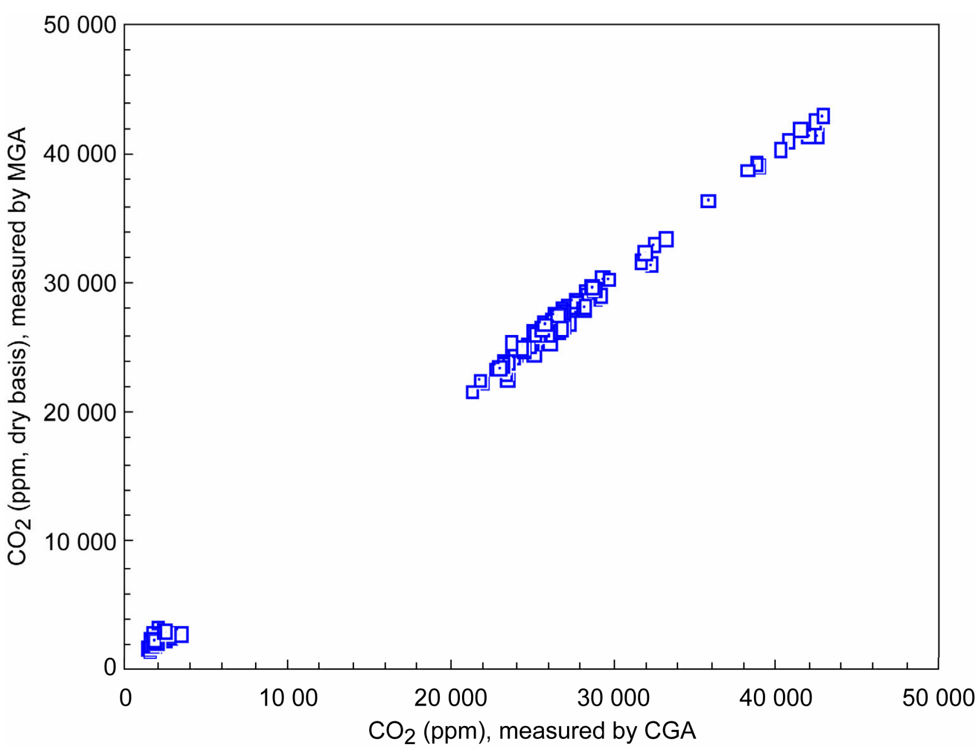

Figure C–43.—Comparison of CO_2, measured by CGA and MGA systems, demonstrates good agreement.

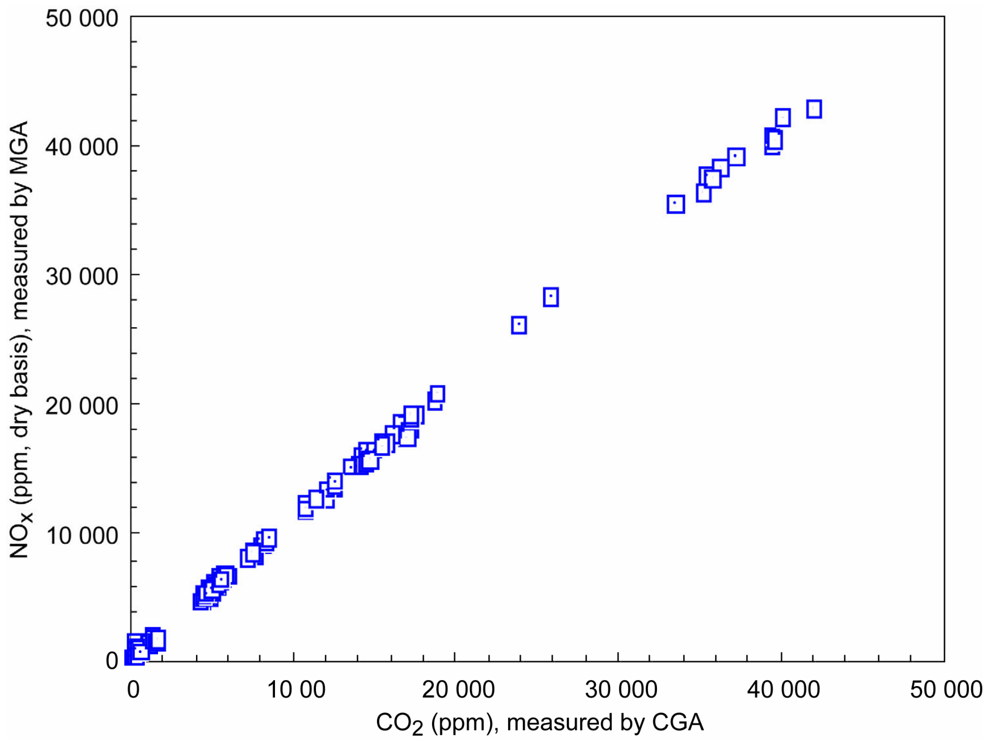

Figure C–44.—Comparison of NO_x, measured by CGA and MGA systems, demonstrates good agreement.

6.3.3 THC

Depending on the reference spectra selected, THC values calculated by summing of all the MGA HC measurements varied up to a couple orders of magnitude relative to the CGA when all light and heavy hydrocarbons were included in the analysis. The differences were approximately a factor of 5 or 6 when only the lighter hydrocarbons were selected to be analyzed.

We encountered a number of problems and limitations in processing the MGA data. Most notably, the spectral resolution of the instrument is 0.5 cm^{-1} (wavenumber), which appears to be inadequate for effectively resolving the heavier hydrocarbon compounds. A survey of spectral data suggests that a resolution of ~0.2 cm^{-1} or better is required for de-convolving the absorption peaks of these species. The instrument's lack of sensitivity was particularly a problem for assaying HC concentrations in dilute samples or those collected at high engine powers where the concentrations were particularly low (about or below the detection limits in these cases). We note that the FTIR concentrations are presented in units of ppm-m (concentration per unit path length), which implies the instrument's detection limit could be improved by an order of magnitude by increasing its path length from 1 to 10 m. The instruments precision is also compromised by a lack of spectral information applicable to engine emission applications; clearly, a complete library of reference spectra should be established for 150 °C operating conditions. A sound analytical strategy for separating the overpowering water vapor (H_2O) and CO peaks from the recorded spectra is also needed.

7. Conclusion

Gas emissions measured in samples drawn from multiple probe tips on rakes placed 1- and 10-m downstream of the CFM56-2C1 engine exit plane provided information on the engine operation and exhaust plume characteristics that was essential for interpreting simultaneous particle emission measurements. Two systems, a CGA and an MGA, were deployed to the experiment. Engine operation was in reasonable agreement with GEAE's prediction. Gas emissions, EINO_X, EI*CO*, and EI*HC*, agreed well with the ICAO database and GEAE's prediction. EI*CO* and EINO_X at 10 m had the same trends as at 1 m, with concentrations a factor of 10 lower. EIs for the major and minor species (CO, CO_2, NO, NO_X) were not dependent upon fuel type, but THC and CO emissions tended by be highly sensitive to variations in ambient temperature. For the major and minor species, the MGA yielded concentrations that agreed reasonably well with CGA. Both instruments exhibited varying degrees of difficulty in measuring low species concentrations, and the two approaches gave significantly different results in quantifying extremely low CO concentrations. The greatest uncertainties exist with the MGA speciated HC data; depending on the spectral analysis approach taken, THC EIs inferred from the data were often significantly different than those measured by the CGA.

Appendix D
Gas Sampling System, Gas Phase Emissions, Smoke Number, and Laser Induced Incandescence*

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Gas Sampling System, Gas Phase Emissions, Smoke Number, and Laser Induced Incandescence

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1. Objectives

The Arnold Engineering Development Center (AEDC) group was tasked to coordinate the installation and operation of the gas sample distribution system to provide sampled exhaust to a host of diagnostic instruments from extraction probes located at the Rake 1, Rake 10 and Rake 30 axial locations (fig. D-1). AEDC also performed engine exit plane smoke number measurements at Rake 1. Three multi-gas analyzers (MGA) based on Fourier Transform Infrared (FT-IR) technology, were used to complement the NASA measurements described in appendix C. Three MGA instruments allowed simultaneous measurements at all three rake locations, except during times that one MGA was used for ambient air measurements. A prototype Laser Induced Incandescence (LII) system developed for non-intrusive measurements of non-volatile mass was evaluated during the last engine test period.

2. Experimental Setup

Measurements were performed on the inboard, starboard engine of a NASA-owned DC-8 aircraft, fitted with GE CFM56-2c1 engines. The aircraft was parked on a pad just off the runway at the NASA Dryden Flight Research Center (DFRC). Primary data were acquired from the engine exhaust using sample extraction probes located at three axial locations, approximately 1-, 10- and 30-m, downstream of the engine exit plane (fig. D-1). Trailers were stationed just off the wing of the aircraft to house instruments of participating investigators.

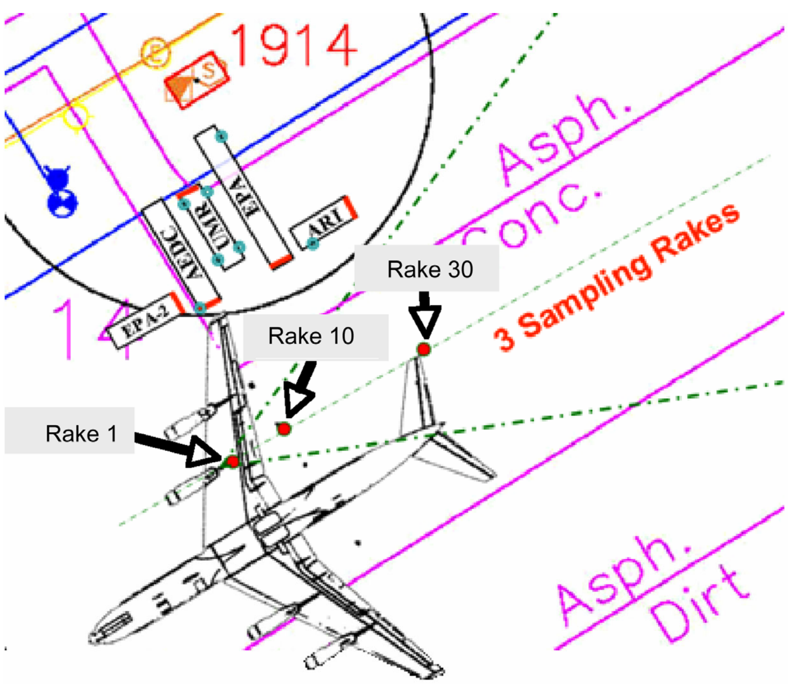

Figure D–1.—APEX Experiment Layout (approximately to scale).

Several test periods were conducted throughout the test program. For each test period, the engine was cycled through one of two sets of engine power conditions defined for either NASA or EPA measurement objectives, although all investigators acquired data during all test periods. NASA describes the nominal engine power settings and time at condition for the NASA and EPA run cycles in appendix C. Three fuel formulations were used during the test program. The fuel formulations included JP8 procured from Edwards Air Force Base, a high-sulfur fuel formed by doping the JP8 fuel with tertiary butyl disulfide ($C_{12}H_{18}S_2$), and a high aromatic Jet-A fuel procured from a California refinery.

3. Gas Sampling System

The Arnold Engineering Development Center (AEDC) group coordinated the planning, installation and the operation of an exhaust sample distribution system that provided continuous engine exhaust sample to several investigators from gas sampling probes mounted on three rakes. The relative layout of the trailers, aircraft, engine, and rake systems is depicted in figure D-1. The rakes are denoted by the red dots and are labeled Rake 1, Rake 10 and Rake 30, where 1, 10 and 30 refer roughly to the axial distances in meters of the rake locations referenced to the engine exit plane.

The rakes are illustrated schematically in figure D-2. The figure shows the probe-labeling scheme. Rake 1 had internally mounted probes, labeled "G" for gas or "P" for particle, and externally mounted gas-sampling probes labeled "GG". Rakes 1 and 10 included both gas and particle sampling probes. Specialized probes that introduce a diluent gas to the exhaust sample within the probe tip are referred to as particle sampling probes. These probes were used to provide sampled exhaust to instruments for characterization of particulate matter. The concept of the particle sampling probe is illustrated in the left of figure D-3. The inlet 1 mm diameter orifice extends about 19 mm before opening up to 7.1 mm. The particle probes, dilution control, and particle probe sample distribution system are discussed further in Appendices H and I of this report. The gas sampling probe concept, typical of probe designs used for certification measurements, is shown in the right of figure D-3. The gas sampling probes do not introduce a diluent gas to the sample stream. And, unlike the particle probe, the sample expands almost immediately to 7.1 mm. The entrance orifice of each gas-sampling probe mounted internally to the rake was about 1.6 mm. The gas sampling probes were used to provide sampled exhaust to analyzers for characterization of species in the gaseous state and particle analyzer systems traditionally operated without the addition of sample dilution gas.

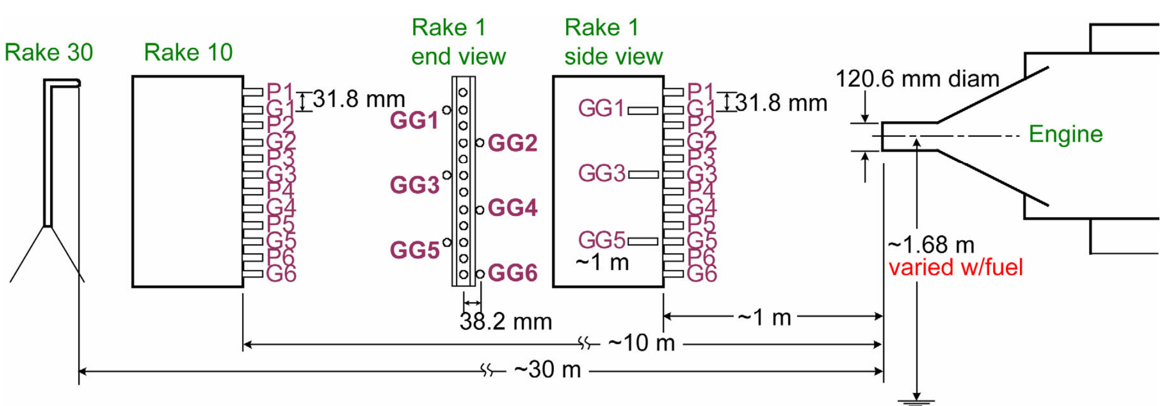

Figure D–2.—Schematic of the probe rake systems and labeling scheme (not to scale).

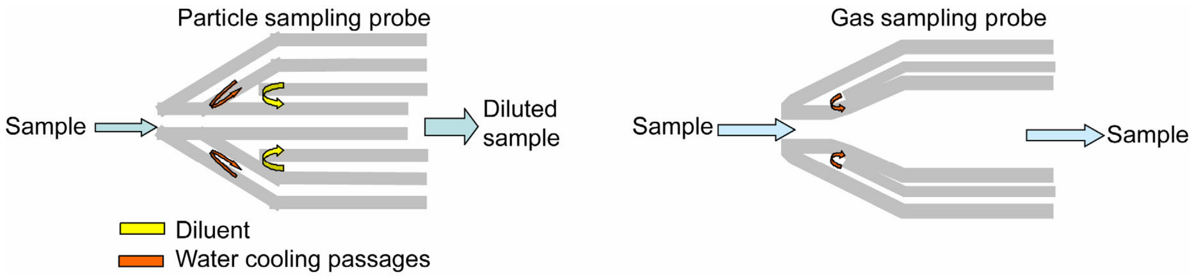

Figure D–3.—Design concepts of the internally mounted particle and gas-sampling probes (not to scale).

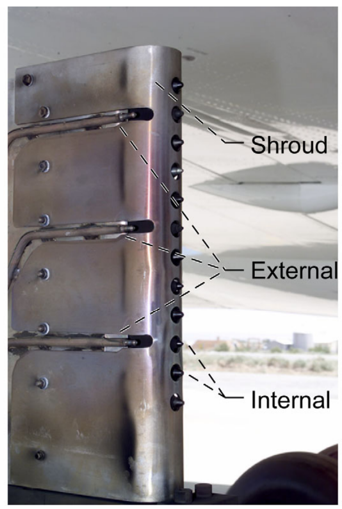

Figure D–4.—Photograph of rake 1 showing internal and external probes and protective shroud.

Gas sampling probes, mounted internally to Rakes 1 and 10 (G1, G2, etc.) and externally (GG1, GG2, etc.) to Rake 1 (see fig. D-2), were originally designed for much hotter flow environments (augmentor conditions) requiring water cooling inlet pressures of a few MPa (several hundred psi). These rakes and the internally mounted probes could have survived the total gas temperature 593 °C at the nozzle exit plane without water cooling. However, a low-pressure water flow protected the o-rings used for both the gas and particle sampling probes mounted internally to Rakes 1 and 10. Rakes 1 and 10 and the internally mounted particle and gas sampling probes were cooled using low pressure (~0.4 MPa) water at a flow rate of 7.6 – 11.4 liter/minute.

There were a large number of instruments of many investigators that required simultaneous sampling, and some individual instruments required excessive sample flow rates, especially techniques based upon filter extraction. To meet the high flow rate demand, six additional probes designed with large (3.2 mm) diameter entrance orifices were mounted externally to Rake 1. These probes were welded to flat stainless steel plates and attached to either side of Rake 1 (see figs. D-2 and D-4). These probes were not water cooled. During the first engine runs at higher power settings, the stainless steel plates began to separate from the rakes. A shroud, with holes for internal and external probe tips, was manufactured in the field and fitted over the front of the rake (fig. D-4) to deflect the exhaust from the interface of the flat plates to the sides of the rake. This prevented further separation, but produced a slight venturi affect in front of the externally mounted probe tips that limited, and even reduced, the probe inlet ram pressure at the highest engine power conditions.

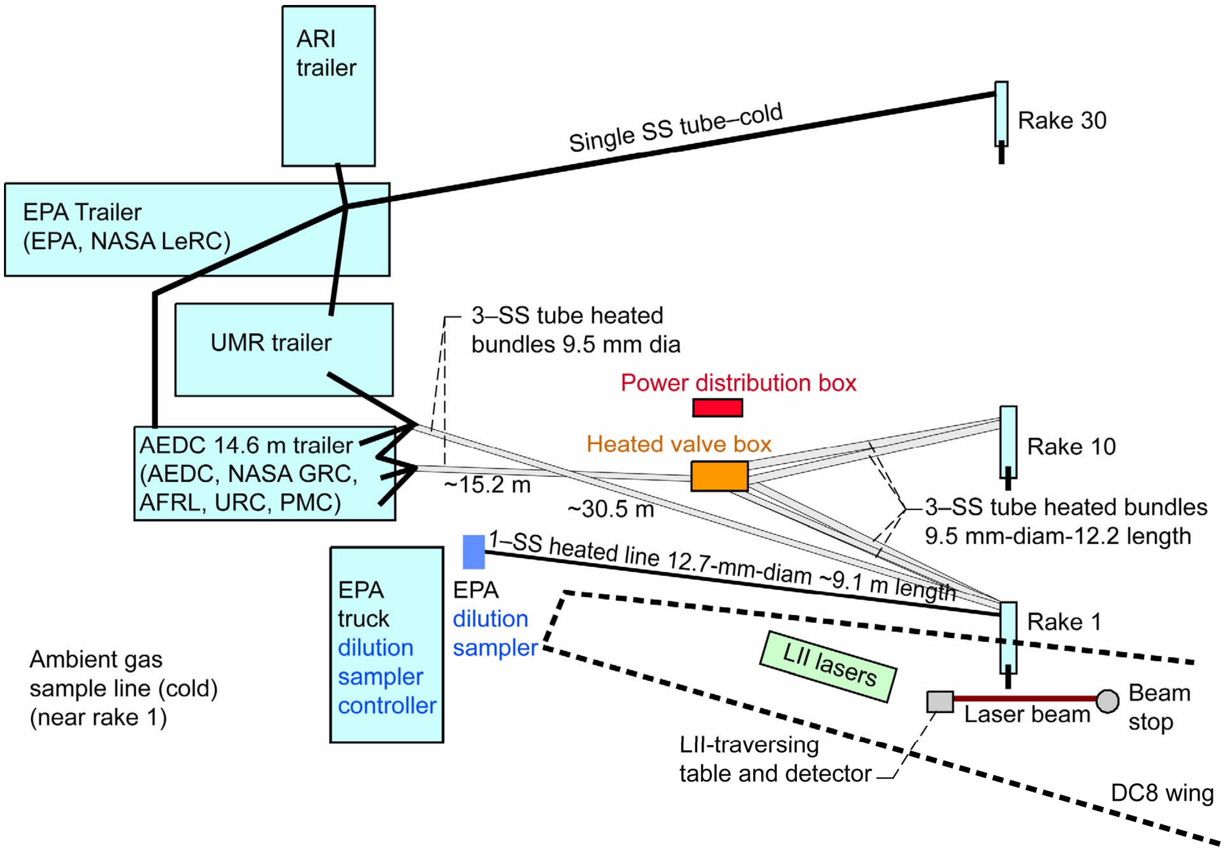

Figure D–5.— Schematic layout and routing of the gas sample lines (not to scale).

Figures D-5 through D-7 show the layout and routing of the gas sample lines from the rakes to the instruments of respective investigators and other hardware items and measurement systems located outside the trailers. All gas sample lines were stainless steel. The diameters of the sample lines from the probe tips to the bases of the Rake 1 and Rake 10 mounting stands were 7.1 mm. Because of the proximity to the engine exhaust, the exhaust and the heat transfer from the extracted sample heated this section of sample line. From the base of the rakes, the lines were transitioned to 9.5 mm diameter except for the 12.7 mm line from Rake 1 to the EPA dilution sampler. All gas sample lines from the bases of Rakes 1 and 10 were electrically heated to 150 °C to maintain a constant sample line temperature and prevent water condensation within the lines.

For convenience, several 3-core heated bundles were purchased as a unit, maintaining line independency with respect to sampling. At Rake 30, the exhaust was sufficiently diluted by the DFRC desert ambient air to prevent water condensation within the lines. The primary sample line from Rake 30 was split out to several lines to carry exhaust sample to both particle and gas analyzers. Multiple sample lines from probes located on Rakes 1 and 10 were routed to a heated-valve distribution box (heated to 150 °C) that allowed remote switching of individual or ganged (combined) probe samples to different instruments simultaneously. The heated valve box was plumbed with 6.4 mm remotely-actuated valves and several feet of 6.4 mm stainless steel lines. A non-heated sample line (not shown on the fig.) was routed from a location upstream of Rake 1 for ambient air sampling.

AEDC operated three multi-gas analyzers (MGA), three conventional total hydrocarbon (THC) analyzers and one SAE Smoke Meter. AEDC intended to make measurements using an optical smoke meter (OSM), but the instrument's internal pump failed during the first test and produced no usable data. The NASA Glenn Research Center (GRC) operated an assortment of conventional gas analyzers for measuring NO, NO_x, CO, CO_2, THC and a MGA (app. C). The Air Force Research Laboratory (AFRL) operated a tapered element oscillating microbalance (TEOM) for measurements of particle mass. Process Metrix operated an instrument under development through the Air Force SBIR Program designed to provide an optical smoke number utilizing a particle scattering mass measurement method (app. J). The University of Missouri-Rolla (UMR) operated CO_2 gas analyzers for the measurement of CO_2 in the undiluted gas sample line (app. I). The University of California-Riverside (UCR) operated an assortment of filter collection devices. UMR measurements are detailed in appendix I.

Figure D-8 shows a sample log for the gas sample system operation. During steady state engine conditions, the sample to an instrument was often directed from probe to probe and/or rake to rake.

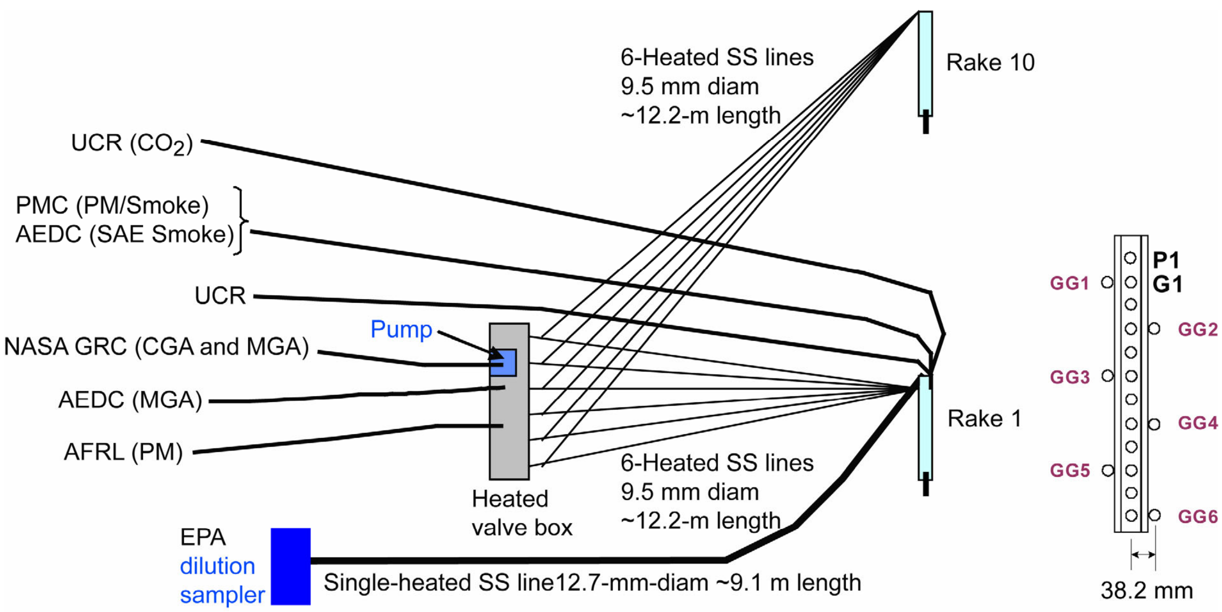

Figure D–6.—Additional schematic detail of the gas sample line routing. (not to scale).

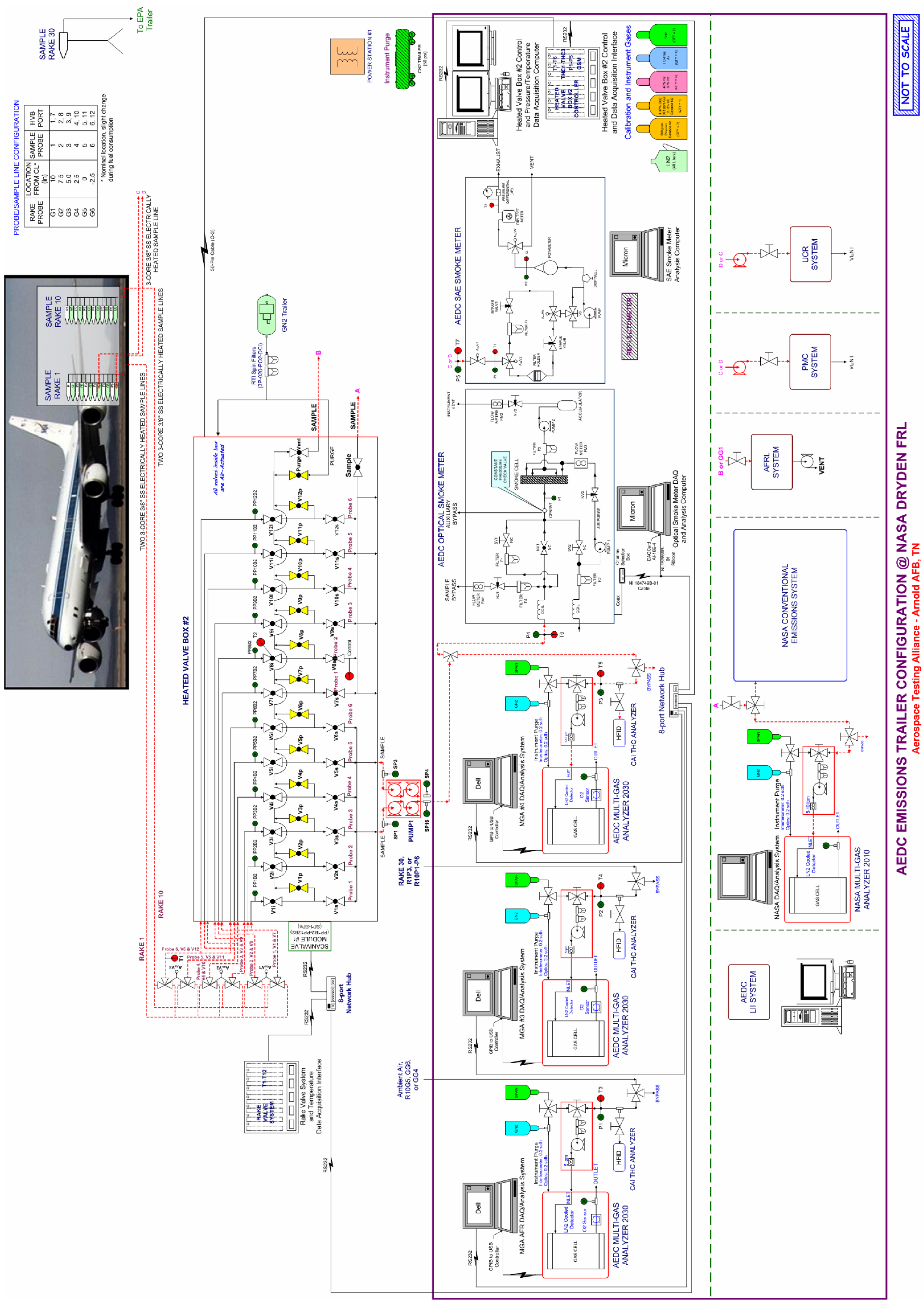

Figure D–7.—Schematic of the Gas Sample Line Layout for APEX.

				AEDC HVB VALVE SELECTION, PROBE																				
				AEDC MGA #3, OSM						NASA Conventional						AFRL								
Time	Power Setting (%)	6-Trak Data Point	Rake	1, G1	2, G2	3, G3	4, G4	5, G5	6, G6	7, G1	8, G2	9, G3	10, G4	11, G5	12, G6	Probe	AEDC MGA #1	AEDC MGA #2	AEDC SAESM	NASA MGA	UMR	PMC	UCR	Remarks
13:04:30	100%	53	1			X					X					GG1	R10G5	R30	GG4	HVB	GG2	GG4	GG6	No stable data acquired
13:04:35	100 - 4%	53	1			X					X					GG1	R10G5	R30	GG4	HVB	GG2	GG4	GG6	
13:11:40	5.5%	54	1			X					X					GG1	R10G5	R30	GG4	HVB	GG2	GG4	GG6	
13:13:20	5.5%	55	10				X								X	GG1	R10G5	R30	GG4	HVB	GG2	GG4	GG6	
13:15:30	7%	56	1			X					X					GG1	R10G5	R30	GG4	HVB	GG2	GG4	GG6	
13:17:00	7%	57	10				X								X	GG1	R10G5	R30	GG4	HVB	GG2	GG4	GG6	
13:19:20	15%	59	1			X					X					GG1	R10G5	R30	GG4	HVB	GG2	GG4	GG6	
13:21:00	15%	60	10				X								X	GG1	R10G5	R30	GG4	HVB	GG2	GG4	GG6	
13:23:20	30%	62	1			X					X					GG1	R10G5	R30	GG4	HVB	GG2	GG4	GG6	
13:25:00	30%	63	10				X								X	GG1	R10G5	R30	GG4	HVB	GG2	GG4	GG6	
13:27:15	4%	65	1			X					X					GG1	R10G5	R30	GG4	HVB	GG2	GG4	GG6	
13:29:50	4%	66	10				X								X	GG1	R10G5	R30	GG4	HVB	GG2	GG4	GG6	
13:31:30	4%	67	1			X					X					GG1	R10G5	R30	GG6	HVB	GG2	GG6	GG4	Moved UCR, PMC, SAESM
13:38:55	40%	68	1			X					X					GG1	R10G5	R30	GG6	HVB	GG2	GG6	GG4	
13:40:25	40%	68	1		X							X				GG1	R10G5	R30	GG6	HVB	GG2	GG6	GG4	
13:42:30	40%	70	1	X							X					GG1	R10G5	R30	GG6	HVB	GG2	GG6	GG4	
13:43:45	40%	70	1		X							X				GG1	R10G5	R30	GG6	HVB	GG2	GG6	GG4	
13:45:00	40%	70	1			X							X			GG1	R10G5	R30	GG6	HVB	GG2	GG6	GG4	
13:46:15	40%	70	1				X							X		GG1	R10G5	R30	GG6	HVB	GG2	GG6	GG4	
13:47:30	40%	70	1					X							X	GG1	R10G5	R30	GG6	HVB	GG2	GG6	GG4	
13:48:45	40%	70	1						X	X						GG1	R10G5	R30	GG6	HVB	GG2	GG6	GG4	
13:50:15	40%	71	10	X							X					GG1	R10G5	R30	GG6	HVB	GG2	GG6	GG4	
13:51:30	40%	71	10		X							X				GG1	R10G5	R30	GG6	HVB	GG2	GG6	GG4	
13:52:45	40%	71	10			X							X			GG1	R10G5	R30	GG6	HVB	GG2	GG6	GG4	
13:54:00	40%	71	10				X								X	GG1	R10G5	R30	GG6	HVB	GG2	GG6	GG4	

Figure D–8.—Sample log for gas sample probe system operation.

4. Measurement Systems

AEDC performed measurements using three multi-gas analyzer (MGA) systems, three total hydrocarbon (THC) analyzers and one SAE-type smoke meter. During the last engine run period, AEDC evaluated a non-intrusive Laser Induced Incandescence measurement system for in situ measurements of non-volatile particle mass. AEDC also brought to the test an optical smoke meter, but it failed before useable data were acquired.

4.1 Gas Phase Analyzers

AEDC, with the assistance of scientists from Advanced Fuel Research (AFR), utilized three MKS Instruments Model 2030 Multi-Gas Analyzers (MGA) capable of measuring a large number of infrared-active gas species (CO, CO_2, H_2O, NO, NO_2, SO_2, and the lighter hydrocarbons from CH_4 to C_4H_{10}). These MGA analyzers were also equipped with fast-response zirconium oxide limiting-current-type O_2 sensors (installed internally downstream of the gas cell) and paralleled with total hydrocarbon (THC) analyzers. The THC analyzers were Model 300 Heated Flame Ionization Detector (HFID) total hydrocarbon analyzers made by California Analytical Instruments and capable of measuring residual hydrocarbon levels up to 30,000 ppmC. But for this test program, the THC analyzers were configured for a maximum of 3000 ppmC.

Example MGA data, fuel-to-air ratio (FAR) and local combustion efficiency (ETAb) calculated from these data, are presented in figures D-9 through D-16. Figures D-9 through D-12 show species concentration data versus gas-probe (spatial position) for probes mounted internal to Rake 1. These data were acquired at the 40% engine power setting using the high sulfur fuel mixture on April 28, 2004. Figure D-9 shows CO_2 and O_2 concentrations versus probe location. The highest CO_2 concentration at probe G1 indicates this probe received the greatest amount of engine combustion core exhaust. Sample collected by the other probes were more dilute due to the core exhaust mixing with the engine bypass air. The next three figures show corresponding concentrations of CO, NO, H_2O and NO_x. Figures D-13 and D-14 show the FAR and ETAb calculated from these MGA measurements for each probe position. These values are consistent with expected values for this engine. Figures D-15 and D-16 show data from a test period on April 29, 2004 versus engine power for the aromatic fuel mixture. Figure D-15 compares the MGA CO_2 concentrations measured at Rakes 1, 10 and 30. The CO_2 concentration decreased with axial distance as the engine bypass air and ambient air mixed with and diluted the core exhaust. Rake 30 had only a single probe. On windy test days, the plume at Rake 30 was blown around significantly and thus the measured concentrations of the chemical and particle constituents varied significantly as well. Figure D-16 shows THC (HFID analyzer) data acquired from Rake 1 versus engine power setting. As expected, unburned hydrocarbons were greater at the lower power settings and extremely low at higher power settings where the engine combustor is optimized for maximum combustion efficiency; and this was true for all fuel formulations.

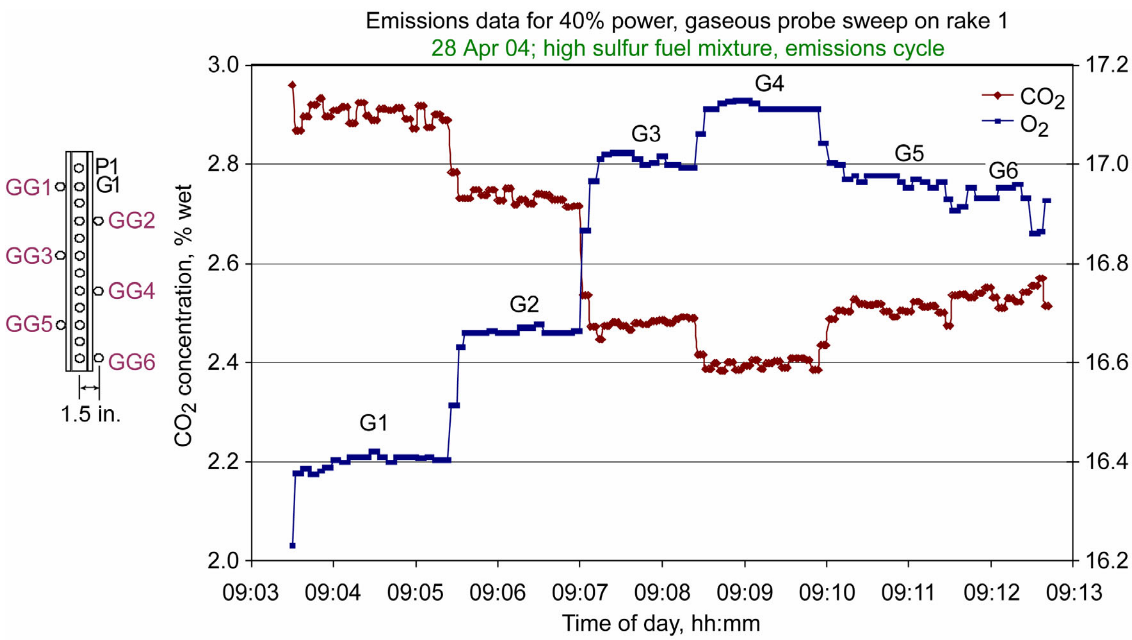

Figure D–9.—MGA CO_2 and O_2 data versus probe location for a steady-state engine power.

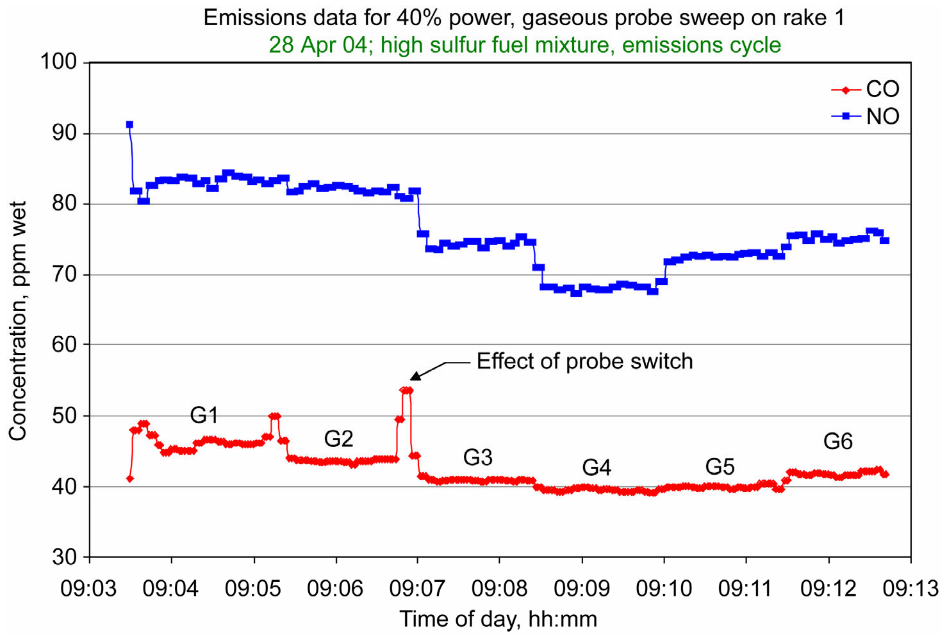

Figure D–10.—MGA NO and CO data versus probe location for a steady-state engine power.

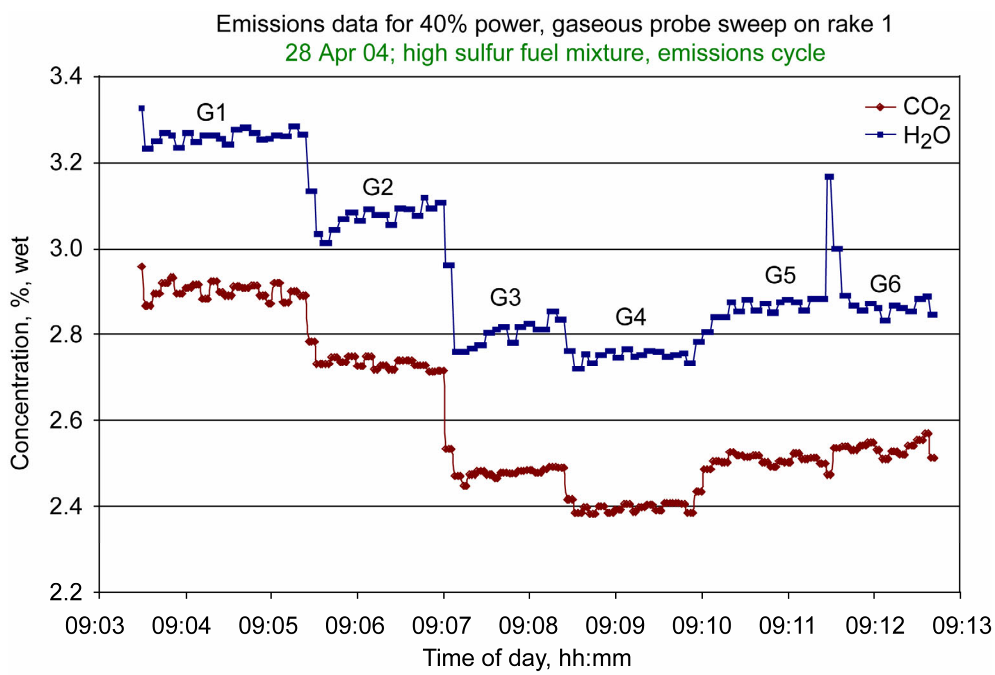

Figure D–11.—CO_2 and H_2O data versus probe location for a steady-state engine power.

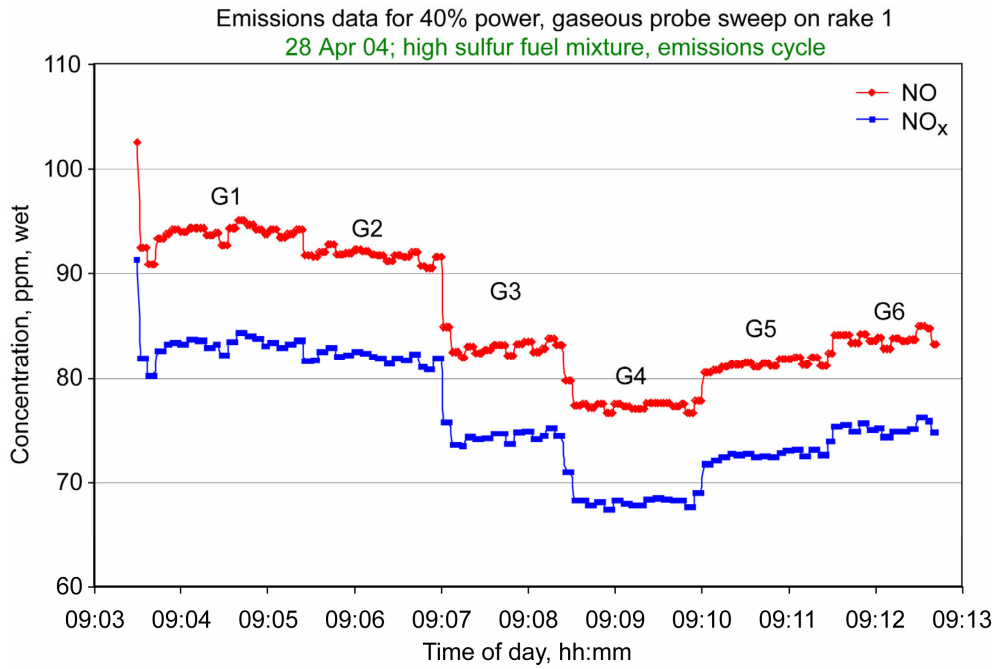

Figure D–12.—NO and NO_X data versus probe location for a steady-state engine power.

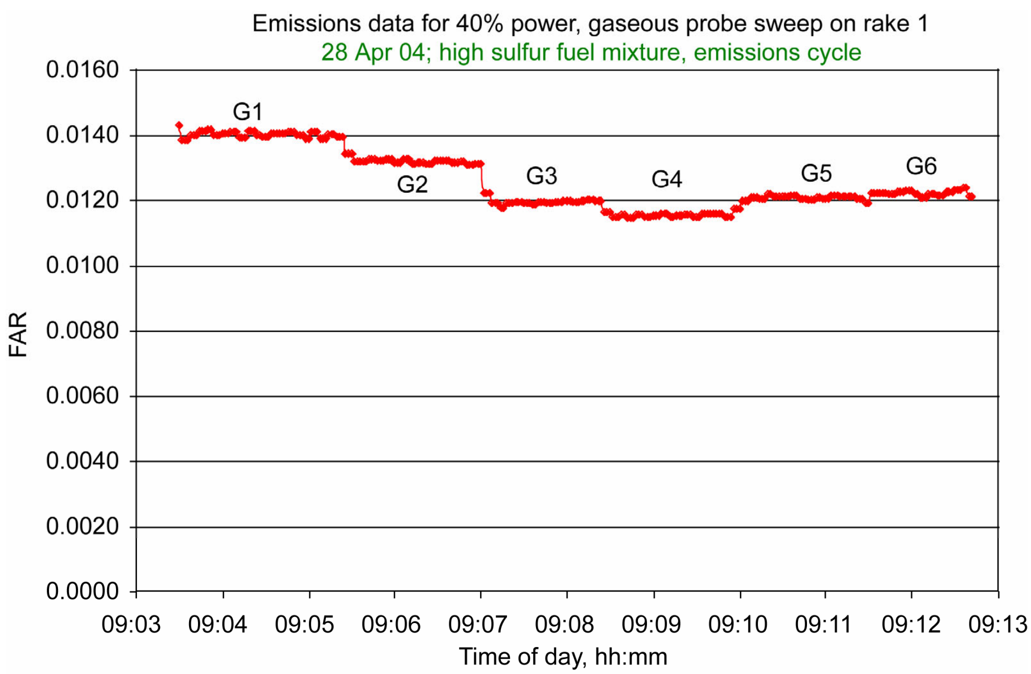

Figure D–13.—Fuel-air ratio versus probe location for a steady-state engine power.

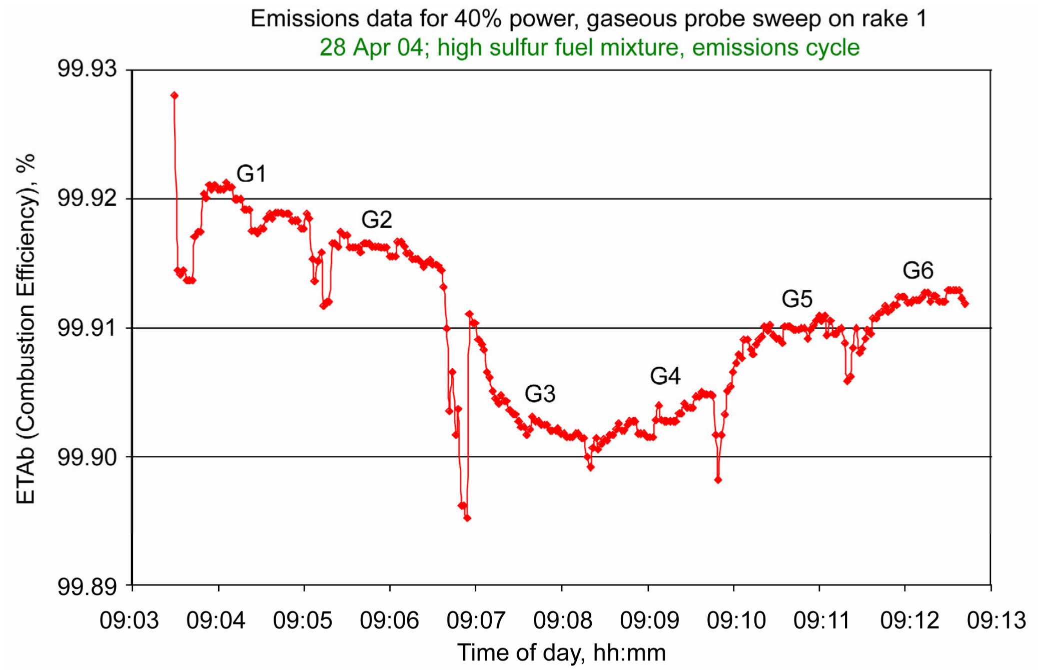

Figure D–14.—Local combustion efficiency versus probe location for a steady-state engine power.

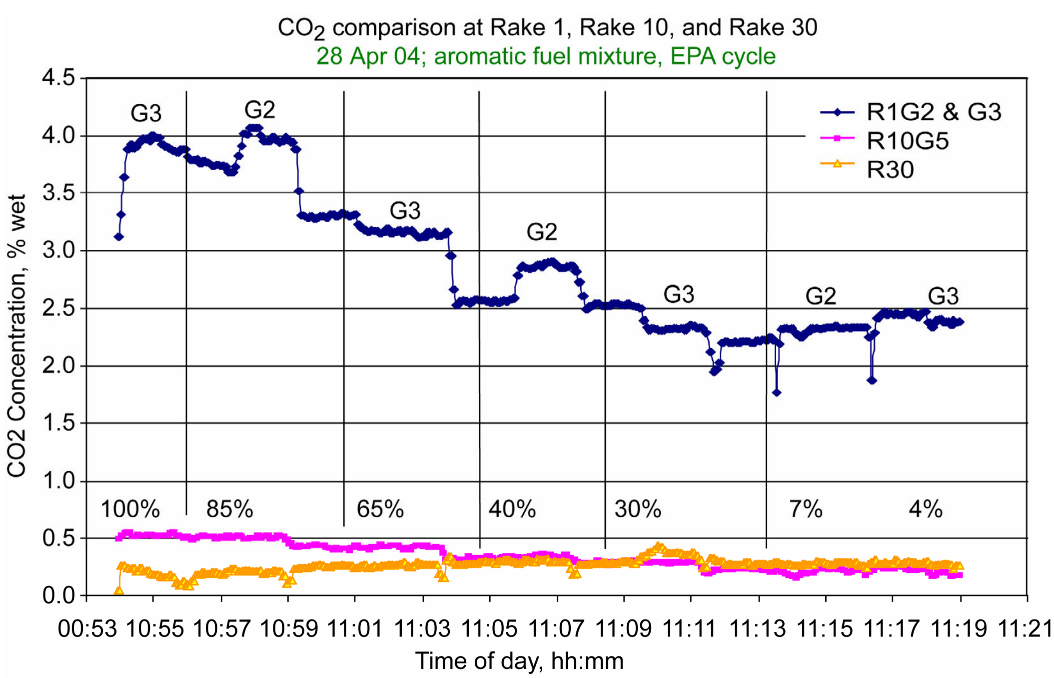

Figure D–15.—CO_2 data from Rake 1, 10, and 30 versus engine power.

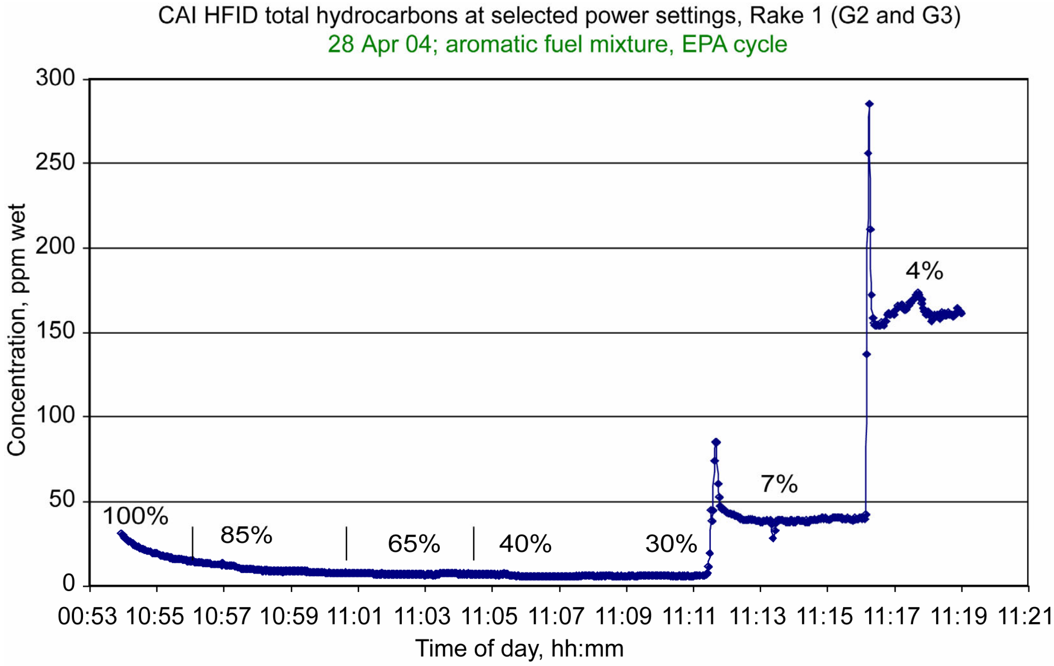

Figure D–16.—THC data at Rake 1 versus engine power.

4.2 SAE Smoke Number Measurements

Smoke number (SN) measurements were acquired during the APEX Program. SN is not a direct measure of PM mass, concentration or size. However an extreme variation from certification data would indicate an anomalous behavior of this particular engine, or the engine data, with respect to PM emissions. These SN measurements and particle mass measurements of other investigators also provide supplementary data to support FAA's effort to define a First Order Approximation (FOA) for correlation of SN to particle mass for turbine engine exhaust emissions.

Point-wise SN measurements were acquired at a spatial region within the flow consisting primarily of engine core exhaust. The instrument was operated according to SAE recommendations (SAE Aerospace Recommended Practices 1179), but measurements were acquired only at a small spatial region and not spatially integrated/averaged across the nozzle exit flow field in a manner required for FAA engine certification. Although these SN measurements should not be interpreted strictly as "representative" of this engine type, the data are reasonably consistent with certification data.

SN measurements (table D-1) were performed only at probes GG4 and GG6 on Rake 1. Smoke Number measurements were a low priority during the first days of the test program. During the early test periods the engine run time was limited at the high steady-state power settings. To assure completion of the measurements at these powers, the data acquisition was initiated almost immediately upon reaching an engine power setting, without waiting for the full sample transport time to purge the sample line. This introduced an unquantifiable uncertainty for the measurements on Apr 26-28 because the data included exhaust from the transient engine power. The data acquired on April 29 are reliable because more time allotted per steady-state power allowed time to purge the sample line with steady-state exhaust before beginning data acquisition. Smoke number measurements were seldom repeated during a given steady-state condition, except for long steady-state engine run times (> 5 min) at the lower engine power settings.

TABLE D-1.—SUMMARY OF SMOKE NUMBER MEASUREMENTS FOR THE APEX TEST PROGRAM

DATE	START TIME	FUEL TYPE	POWER, %	SN	PROBE	COMMENTS
26-Apr-04	9:05:35	Jet A	85	13.2*	R1GG6	
	13:59:00	Jet A	30	0.0*	R1GG6	5 min sample (2.2 min nominal)
27-Apr-04	8:58:56	High Sulfur	85	9.5*	R1GG6	
	9:03:09	High Sulfur	65	0.0*	R1GG6	
	16:16:30	High Sulfur	85	10.0*	R1GG4	First 3 min on condition
	16:20:40	High Sulfur	70	1.0*	R1GG4	First 2 min on condition
	16:24:38	High Sulfur	65	0.5*	R1GG4	First 2 min on condition
28-Apr-04	8:56:30	High Sulfur	85	3.0*	R1GG4	
	9:40:42	High Sulfur	100	5.0*	R1GG4	
	14:10:23	Aromatic	100	10.0*	R1GG4	
	14:12:02	Aromatic	85	7.0*	R1GG4	
	14:16:34	Aromatic	70	3.6*	R1GG4	
29-Apr-04	**10:03:20**	**Aromatic**	**85**	**7.8**	**R1GG4**	**Sample Bypass for 1 min**
	10:07:39	**Aromatic**	**70**	**3.0**	**R1GG4**	
	10:11:54	**Aromatic**	**65**	**1.4**	**R1GG4**	
	10:51:52	**Aromatic**	**60**	**1.0**	**R1GG4**	
	14:10:12	**High Sulfur**	**N1 = 79**	**5.2**	**R1GG4**	

Did not allow for sample transport time before beginning data collection.

The SN ranged from zero at lower engine power settings to about 13 at the higher engine power settings. Smoke number readings were zero for all power settings below 60% nominal rated thrust. This was validated by zero smoke number measurements using twice the prescribed filter exposure time (twice the volume of sample gas flow through the filter) at several low power settings.

It should be noted that smoke number data is typically quoted with an uncertainty of ±3. Within this degree of uncertainty, one could argue that all the SN data agree for repeated steady-state engine conditions, even for the different fuel types.

4.3 Laser Induced Incandescence

During the last test period, AEDC evaluated an in situ Laser Induced Incandescence (LII) diagnostic system developed by MetroLaser, Inc. under the Air Force Small Business Innovative Research (SBIR) Program. The LII system was developed for non-intrusive measurements of non-volatile particle mass in turbine engine exhaust (Ref. D-1, D-2). LII offers the possibility of non-intrusive spatial and temporal non-volatile particle mass measurements independent of sampling issues inherent to extractive methodologies. Figure D-17 shows a schematic of the LII system. A 5-nsec, near infrared, pulsed laser beam (indicated by the red line) heats the particles to an incandescence temperature of approximately 4000 K. An intensified camera is gated to integrate the incandescent radiation for about 50 nsec. For better S/N ratio, 10 or more multiple pulses are usually integrated per image. The incandescence is proportional to the non-volatile ("soot") mass. Thus, this LII system should provide spatial measurements of PM mass along the beam and can be traversed to provide a planar profile across the plume. For these measurements, the laser beam traversed the plume at an axial location of ~1 m downstream from the nozzle exit (i.e., just in upstream of Rake 1 probe tips).

Figure D-18 shows a photograph of the AEDC LII system installed at the NASA APEX test program near the exit plane of the GE CFM56-2C1 engine. Figure D-19 is an LII image along the laser beam acquired across the nozzle exit plane during the APEX test. The color-enhanced image depicts relative beam intensity, where the bright red represents the strongest signal. These are raw data images and have not been corrected for optical field-of-view effects on the measurement. Therefore, until the data are reduced and analyzed, one cannot interpret the higher signal levels as higher concentrations of particle mass. The image represents a one-meter long path through the exhaust with a diameter of about 10 mm. The AEDC LII system is still a relatively immature system. An improved calibration system is required to obtain quantitative measurement of particle mass. Data acquired during APEX using the LII system are encouraging, but qualitative, at present time.

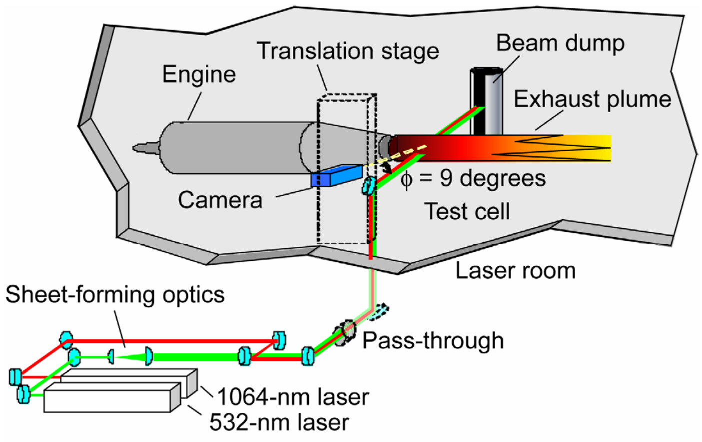

Figure D–17.—AEDC LII system layout.

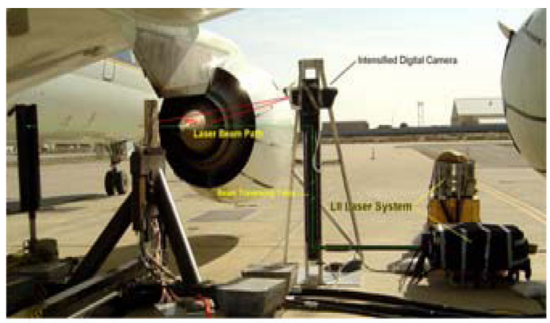

Figure D–18.—Photograph of the AEDC LII system installed at APEX.

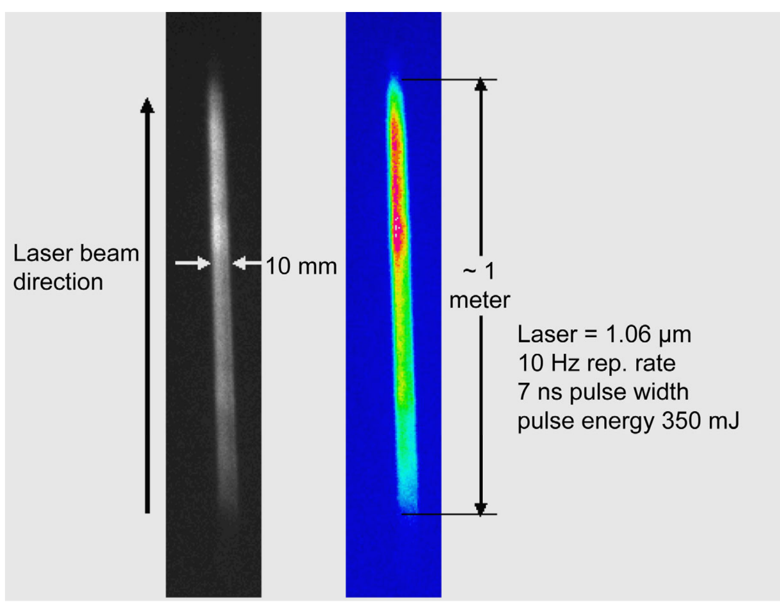

Figure D–19.—LII Image during APEX.

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D-2. Jenkins, Thomas P., and et al, “A Non-Intrusive System for Monitoring Soot in Aircraft Engine Exhausts”, 48th International Instrumentation Symposium, San Diego, CA, May 5-9, 2002.

Acknowledgements

The authors would like to express gratitude to the entire APEX team. Under the leadership of Dr. Chowen Wey, the lead principal investigators, scientists, engineers and technicians from all participating organizations worked together to plan, organize, install, setup and execute a complex test program. The teaming spirit was especially important in implementing real time modifications to the test plan and sampling hardware that occurred throughout the test program execution. The authors acknowledge several individuals that contributed significantly to the work reported herein: Roy Carroll and Brad Besheres (AEDC) for installation and operation of the gas sample system and assisting in operation of AEDC instrumentation; Russ Arey (GE-AE) for providing advise on the sampling system during planning and test execution; Paul Penko (NASA GRC) for engineering the in-field correction to the side mount probe assemblies; Patrick Bush (AFR, Inc.) for assistance in operation of the AEDC MGA systems; and Katie Stephens, Ron Porter, Mike Forsythe (AEDC) and Dr. Tom Jenkins (MetroLaser, Inc.) for evaluation measurements of the LII system. The authors also express special gratitude to Dave Lux who superbly coordinated our activities with the NASA DFRC Facility.

Appendix E
Nitrogen Oxide ($NO/NO_2/HONO$) Emissions Measurements in Aircraft Exhausts*

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Nitrogen Oxide (NO/NO_2/HONO) Emissions Measurements in Aircraft Exhausts

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Abstract

We present measurements of the emissions of the nitrogen oxide species NO (nitric oxide), NO_2 (nitrogen dioxide) and HONO (nitrous acid) in aircraft engine exhausts. In the APEX (Aircraft Particle Emissions eXperiment) test series, NO_x (sum of NO and NO_2) emissions were measured to be consistent with ICAO certification measurements for a CFM56-2C1 engine, and the NO_x Emission Index (EI) increases with increasing engine thrust. At low powers, NO_2 represents up to 80% of the total NO_x emissions for that engine but this fraction decreases to 7% at the highest thrust setting. HONO, though a minor constituent (up to 7%) compared to NO_x, is in part formed in the turbine through reaction with hydroxyl radical. It is therefore a sensitive monitor of exhaust chemistry, through which chemical kinetic models capable of predicting concentrations of other important species such as SO_x, can be validated. The HONO measurements for the CFM56 are compared to HONO measurements from other engine types observed in previous tests, and a strong dependence on engine type is observed for both the HONO EI and its contribution to the total EI NO_y (sum of all reactive gaseous nitrogen oxides). HONO EI increases with increasing engine thrust, but the ratio of EIs of HONO to NO_2 decreases with increasing thrust for the CFM56.

1. Introduction

For more than ten years, concerns over the environmental effects of aircraft exhausts[1-5] have motivated a series of measurements of the trace gas and particulate emissions of aircraft. Included in these programs has been the development and application of a wide variety of new measurement techniques. This is the case even in the measurements reported here, of nitrogen oxides, an area in which conventional techniques are well established. The results presented here were obtained in a series of tests in which sampling probes delivered exhaust to an array of trace gas and particulate measurement instruments, including conventional NO_x analyzers and tunable infrared differential absorption (TILDAS) instruments capable of measuring a variety of gas-phase species including NO, NO_2 and HONO.[6-10] These sampling studies follow earlier measurement programs which utilized line of sight laser absorption.[11-14]

Tunable laser absorption spectroscopy has several advantages over conventional trace gas measurement methods, including fast time response allowing transient measurements, and a first-principles calibration based on tabulated infrared line strengths. However, in the data sets treated in this paper the major new capability brought by the laser instruments is the sensitivity and species specificity to measure concentrations of HONO (nitrous acid). Although HONO is a relatively small fraction of the total NO_y (NO_y denotes the sum of all reactive gaseous nitrogen oxides) emission at any engine power setting, it has considerable importance as a diagnostic of the reactive trace species evolution in aircraft engine exhausts.[7] Reference 7 compares the first HONO observations, made at the NASA/QinetiQ tests, with detailed fluid dynamic/chemical kinetic modeling calculations. The clearest observed trend presented there was a substantial increase in HONO downstream of the combustor. Model calculations including

HONO production by NO oxidation via the hydroxyl (OH) radical agreed with observed HONO concentrations to within the uncertainty of the measurements, suggesting that the model is valid not only for HONO but for other species whose evolution is governed by OH. It is a major purpose of the present paper to put those first observations in the context of data obtained in subsequent tests, in which different engines, more power settings, and different sampling distances behind the engine were used.

2. Measurement Instrumentation

We will describe in detail the nitrogen oxide measurement instrumentation used in the APEX (Aircraft Particle Emissions eXperiment) carried out on 23-29 April, 2004 at NASA Dryden Flight Research Center. Instrumentation similar in concept, though differing in many details, was used in the NASA/Qinetic[6-7] and EXCAVATE[8-10] test programs whose data sets will be presented here as points of comparison to the larger APEX data set (and similar instrumentation was again used in the JETS/APEX2 and APEX3 tests, whose results will be presented in future papers).

Measurements were made behind one of the CFM56-2C1 engines of the NASA Dryden DC-8-72 Airborne Laboratory Program aircraft. The aircraft was held in a fixed position on the tarmac, and could only be operated at high powers when crosswinds and tailwinds were negligible (although intended to protect the aircraft, this had the effect of aiding sample collection at downstream positions). Sampling probes were located at 1, 10 and 30 m behind the engine exit plane. The exhaust had been substantially cooled and diluted by mixing with the atmosphere by the time it was sampled by the 30 m probe, so this sample could be used directly without any measures (such as further dilution or heating of the sample line) to prevent water vapor condensation. The 10 m probe was an intermediate case, with samples sometimes used undiluted and sometimes being diluted with nitrogen by factors of up to 15. Sampling at 1 m was done using a probe rake that carried both “gas probes” whose samples were not diluted and whose sampling lines were heated, and “particle probes” whose samples were diluted using nitrogen added at the probe tip, after which the sampling line was not heated. After preliminary mapping studies, a single probe tip from each rake was selected as providing a representative sample of the undiluted exhaust. Typically for 1 m measurements, the laser spectrometers and all the particle instrumentation received sample from the selected 1 m particle probe, while the other gaseous species instruments, including a suite of conventional gas analysis instruments operated by NASA Glenn Research Center which yielded the NO_x data reported here, received sample from the 1 m gas probe.

The suite of particle and trace gas measurement instruments operated by Aerodyne at APEX was housed by the Aerodyne Mobile Laboratory, a panel truck specially modified for this purpose.[15-18] A sample line entered the truck whose flow was split isokinetically into three main fractions, one directed to NDIR CO_2 measurement instruments, one to the suite of particulate characterization instruments, and one to the trace gas instruments including the TILDAS instruments making the NO_x measurements presented here.

The laser spectrometers used in APEX were based on lasers of two different types. Tunable lead-salt diode lasers operate in a continuous mode and at near liquid nitrogen temperatures. In addition to the aircraft exhaust measurements already cited, these TDL instruments have been applied at Aerodyne to a variety of other applications, the most relevant being measurements of atmospheric NO_x species.[19-22] The second type of laser spectrometer was based on quantum cascade lasers, which operate in a pulsed mode and at temperatures allowing thermoelectric cooling rather than a liquid nitrogen dewar. APEX was the first aircraft exhaust study to use QCL instruments, but they have been applied by Aerodyne to a number of other studies, and the system descriptions already published[23,24] also apply to the instruments used at APEX.

At APEX, a TDL system was used to measure NO_2 in the spectral region of 1590 cm^{-1}. In a separate trailer and, as mentioned above, taking sample from a separate sampling probe on the rake 1 m behind the engine, NASA Glenn Research Center operated a suite of conventional trace gas measurement instruments, including measurements of NO and NO_x using an Eco Physics CLD 700 EL two-channel chemiluminescence nitrogen oxide analyzer. Two laser systems collected spectra in regions containing HONO lines, a TDL system around 1726 cm^{-1} and a QCL system around 1693 cm^{-1}.

To quantify trace gas species concentrations, the TILDAS systems perform a real-time least-squares fit to a spectral model of the laser intensity and all the absorption lines in the region being scanned. For the major species such as CO_2 and H_2O, and for species studied in our previous work such as NO and NO_2, the spectral model parameters are easily obtainable from the HITRAN database.[25] For HONO, we use a partial line list obtained from M. Herman[26-29] in which relative intensities have been scaled to the absolute values in the ATMOS database[30] which have been checked with more recent laboratory measurements.[31-32] The absorption lines in the TDL spectral region are those of the *trans* isomer of HONO, while those below 1700 cm^{-1} are those of the *cis* isomer. The line strengths we use incorporate an assumption of the equilibrium distribution of isomers (and it has been pointed out that this is a significant source of uncertainty[32]) to directly yield concentrations of the total HONO.

Error limits in TILDAS measurements of trace gases may have contributions not only from uncertainties in the spectral and thermodynamic parameters but also from the effects of overlapping absorption lines, either those of major species, or of other trace species. In the tests reviewed here prior to APEX, the presence of strong water lines in each spectral region had both advantages (a precise wavelength reference was available even when HONO lines were not easily seen) and disadvantages (the baseline for some HONO lines is on the wing of a strong water line and so has a rapidly changing slope). The 1726 cm^{-1} region which was the primary one used in APEX, on the other hand, had little interference from water lines, but did have a more significant interference from the trace species formaldehyde. Indeed, in our pre-test planning this spectral region was only intended to provide formaldehyde measurements, and it was only during the tests that we noticed the overlapping HONO lines.

As can be seen in Figure E-1, several of the formaldehyde and HONO lines in the center of the scan overlap very closely, so that only lines at the two sides of the scan can be used for easy distinction of which species is a major one. It can also be seen that at high engine power, it is in fact HONO that is the major contributor to the spectrum, while at low engine power it is formaldehyde. Once again, this spectral overlap leads to advantages and disadvantages—we get two trace species concentrations from a single laser measurement, but for some engine powers the uncertainties in one species concentration or the other are larger. Still, this “bonus” turned out to be very welcome, since the originally planned 1693 cm^{-1} region QC laser suffered from a malfunctioning temperature controller during this test, yielding data which was useful for confirming the TDL results but which had much higher signal-to-noise ratios.

Trace gas levels are reported as emission indices, where an emission index is the grams of trace gas emitted per kg of fuel consumed. The fuel consumption and CO_2 emission are proportional, so we can derive trace gas emission indices from the trace gas concentration and CO_2 concentration observed in our sample. The CO_2 concentration we use must have the contribution due to ambient CO_2 subtracted out, and if the sample has been diluted, that dilution factor must be known before the subtraction of the ambient CO_2 can be carried out. The formula we use to convert trace gas concentrations in parts per million by volume (ppm_v) is

$$\text{Emission Index (trace gas)} = \frac{3160\ MW_t\ (\text{trace gas concentration, } ppm_v)}{44.01((CO_2\ \text{concentration, } ppm_v) - (\text{ambient } CO_2,\ ppm_v)/\text{dilution})}$$

where 3160 is the CO_2 emission index, g CO_2 per kg of fuel, MW_t is the molecular weight (g/mole) of the trace gas, and 44.01 is the molecular weight of CO_2. For the emission index of nitrogen oxides, NO, NO_2 and HONO, MW_t is taken to be 46.01, that is, the NO and HONO emission indices are reported as equivalent g NO_2 per kg of fuel. In cases where the sample was not diluted we subtracted an ambient CO_2 concentration of 380 ppm_v, while for samples which were diluted by a factor of 2 we subtracted 190 ppm_v, and so on. For some of the 10 and 30 m sampling data, where fluctuations in observed concentrations were large, a different procedure was used, in which a regression of trace gas concentration against CO_2 concentration was used to simultaneously derive the emission index (from the slope) and the term “(ambient CO_2, ppm_v)/dilution” (from the intercept). For time histories in which the relative variance of the trace gas concentration is large this is the preferred method, while when the relative variance is small it is preferable to average the records of trace gas and CO_2 concentrations over the time for a given engine condition and use the averages in the above formula.

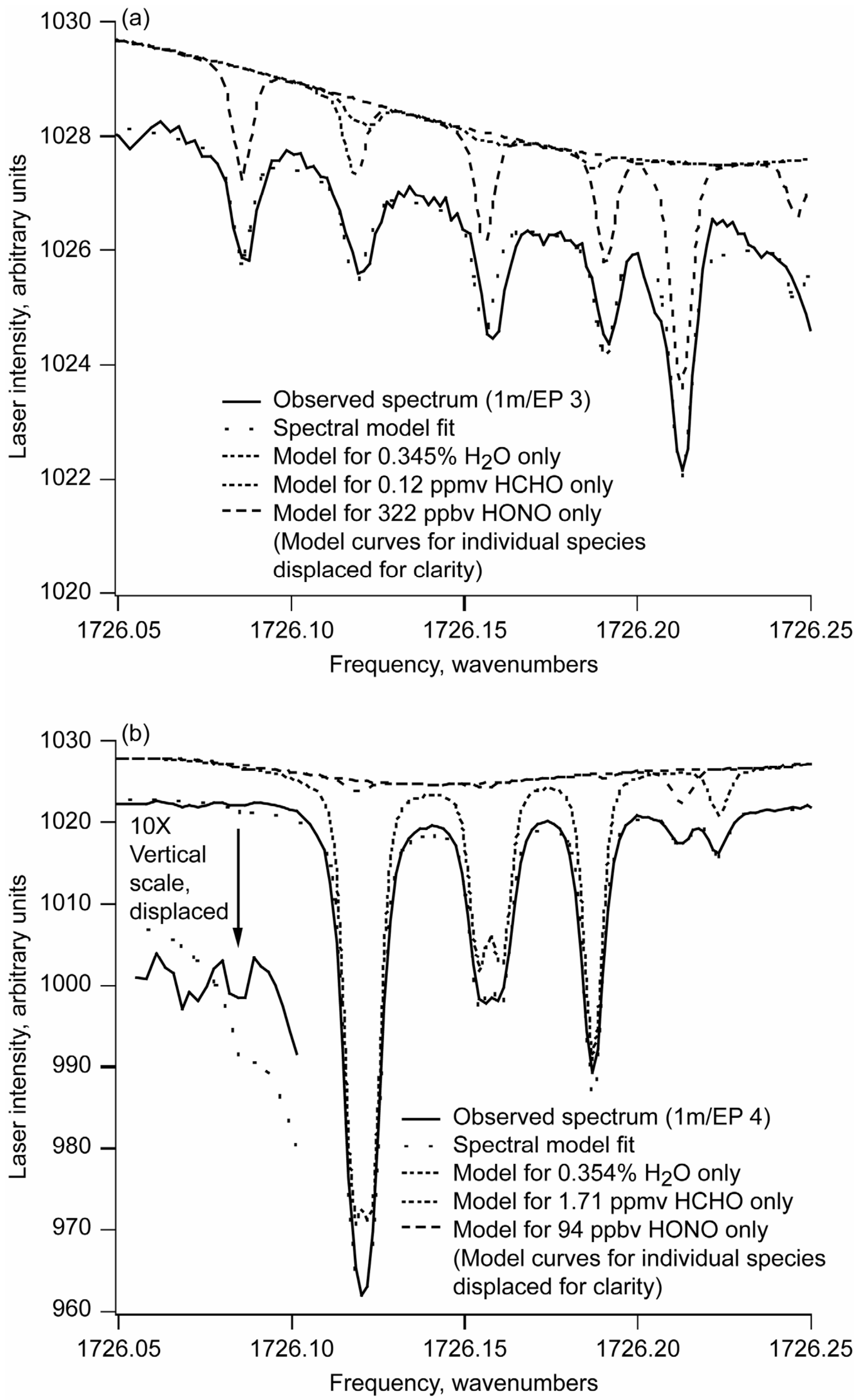

Figure E–1.—Primary spectral region for TDL spectrometer measurements of HONO and formaldehyde at APEX tests. (a) High engine power setting, 93% of rated thrust (HONO predominates). (b) Low engine power setting, 4% of rated thrust (formaldehyde predominates).

3. Results

As a first example of the nitrogen oxide measurements at APEX, figure E-2 presents a summary of the results from the 1 m sampling position for NO (measured by NASA Glenn), NO_2 and HONO (both from the Aerodyne TDL measurements), as a function of engine power. Error limits for these instruments will be addressed in subsequent figures. A semilog scale is used in figure E-2 to allow the magnitude of each contribution to be readable, since throughout much of the engine power range the emissions of these three species each differ by the better part of an order of magnitude. Also shown in figure E-2 are the nominal NO_x emission index values from the ICAO (International Civil Aviation Organization) database.[33] Good agreement between the ICAO total NO_x and APEX NO_y emission indices (within 10%) is seen at each power setting.

To consider examples of the uncertainties in the data of figure E-2 we turn to figure E-3, which presents NO_2 emission index measurements at the 1 m sampling point in APEX, now of three types: the Aerodyne TDL measurements on sample taken with the particle probe (the data set shown in fig. E-2), the results of the few Aerodyne TDL measurements taken with sample from the 1 m gas probe, and the NASA Glenn values (differences between measured NO_x and NO), also measured through the gas probe at 1 m. For each data point, bars indicate the size of 95% confidence limits in the mean. Considering random errors alone, we would estimate these confidence limits by $Z\sigma/n^{1/2}$ where σ is the standard deviation in a set of repeated measurements, n is the number of measurements, and Z, obtained from the Student's *t* table,[34] is 1.64487 for very large n and larger for smaller values of n. To generate the error limits in figure E-3, we added an estimate of systematic errors of 5%, independent of number of samples

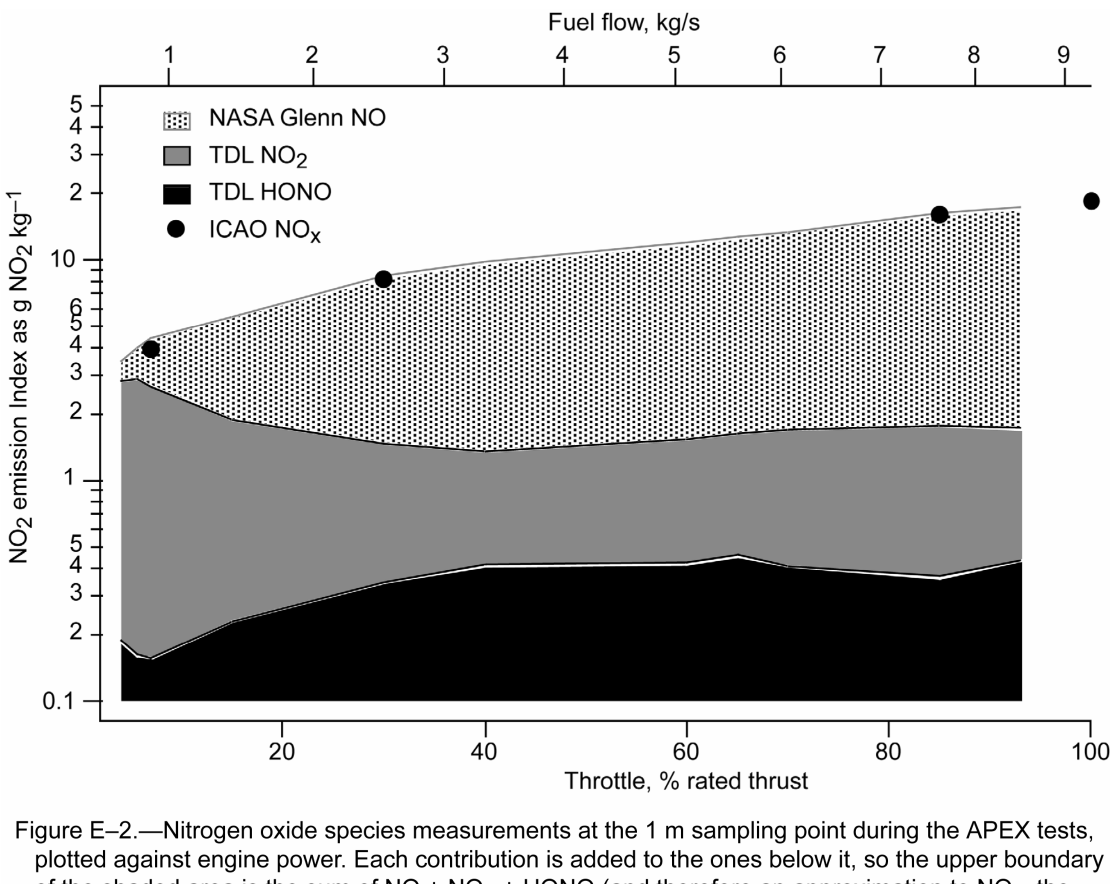

Figure E–2.—Nitrogen oxide species measurements at the 1 m sampling point during the APEX tests, plotted against engine power. Each contribution is added to the ones below it, so the upper boundary of the shaded area is the sum of NO + NO_2 + HONO (and therefore an approximation to NO_y, the total of all gaseous nitrogen oxide species). Also plotted is the nominal NO_x emission index for this engine from the ICAO database.

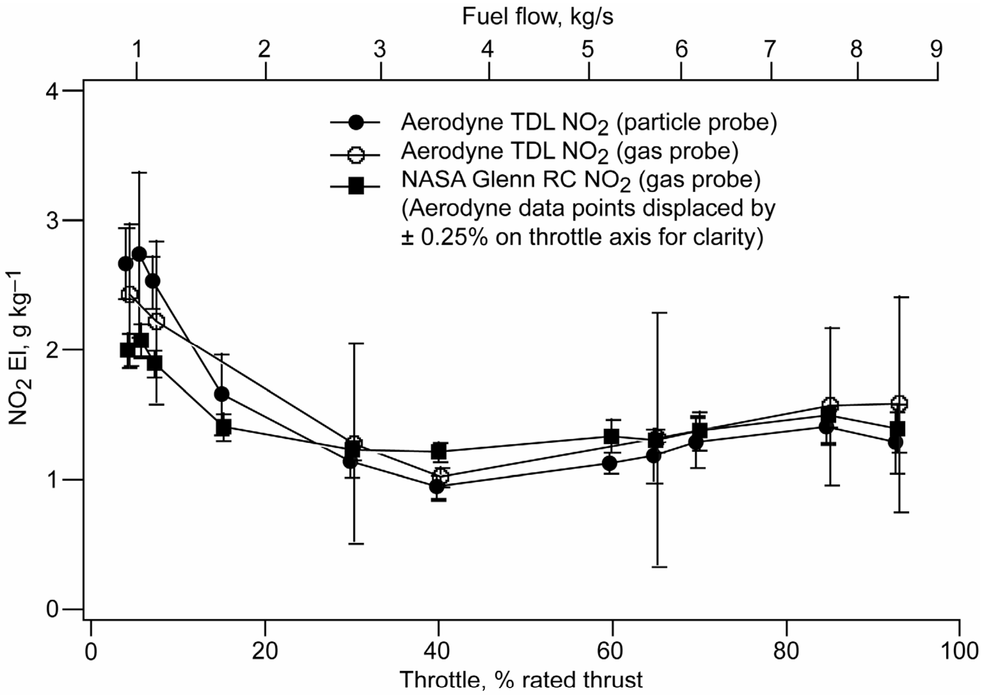

Figure E–3.—NO_2 emission indices measured 1 m behind the engine during the APEX tests, plotted against engine power, by three different methods: NASA Glenn Research Center taking sample through the gas probe and using a chemiluminescence analyzer, and Aerodyne Research using a tunable diode laser spectrometer taking sample through either the particle probe or (for a few data points) through the gas probe.

or measurement technique. The resulting error limits on the TDL/particle probe points range from 7 to 23% of the means. The error limits for the NASA Glenn NO_2 measurements range from 5 to 13% of the means (at low powers, the absolute standard deviations in NASA Glenn NO values are similar to those contributing to the error bars shown for NO_2, while at throttle settings above 15% the relative standard deviations in NASA Glenn NO data sets range from 3 to 6%). The large error bars for several of the Aerodyne TDL/gas probe points are due to the very few points in these data sets.

It can be seen in figure E-3 that for the two well-measured low power points, throttle settings of 4 and 7% of rated thrust, the NASA Glenn and Aerodyne TDL/particle probe means differ significantly (the Aerodyne value is a bit over 33% higher in each case). Of the rest, only the 40% of rated thrust points differ significantly, with the Aerodyne value being 22% lower. It is reasonable to expect that some of the discrepancy at low powers originates in errors in calibration and analysis of the two data sets, and that some has to do with the differences in the sampling probes used by the Aerodyne and NASA Glenn measurements. The fact that the Aerodyne measurements using the probe used throughout by NASA Glenn lie halfway between the other two data sets suggests that both sources contribute to the discrepancy.

Figure E-4 presents the same APEX HONO at 1 m data set shown in figure E-2, now with added error bars and with two additional data sets, the APEX measurements of samples taken at 10 and 30 m behind the engine exit plane. As before, the error bars are intended to represent 95% confidence limits in the mean, this time with the assumption of 20% systematic errors added in quadrature to estimates of random errors based on standard deviations of repeated measurements. Once again, particularly large error bars are related to particularly small numbers of repeated measurements. Because of the lower signal-to-noise ratios in the HONO spectra and the larger potential systematic errors, the error bars in figure E-4 are substantially larger than those for NO_2 in figure E-3. One result of these large error bars is that it is not possible to say with certainty that there is a systematic trend in HONO emission index with sampling distance behind the engine exit plane (see fig. E-5). It is clear, as previously reported,[6,8-10] that HONO emissions are larger at high power than at low power. Whether there is a smaller but perhaps significant increase in HONO emission index also at the very lowest power observed relative to the low HONO levels at 5 and 7% is less certain, but a possibility.

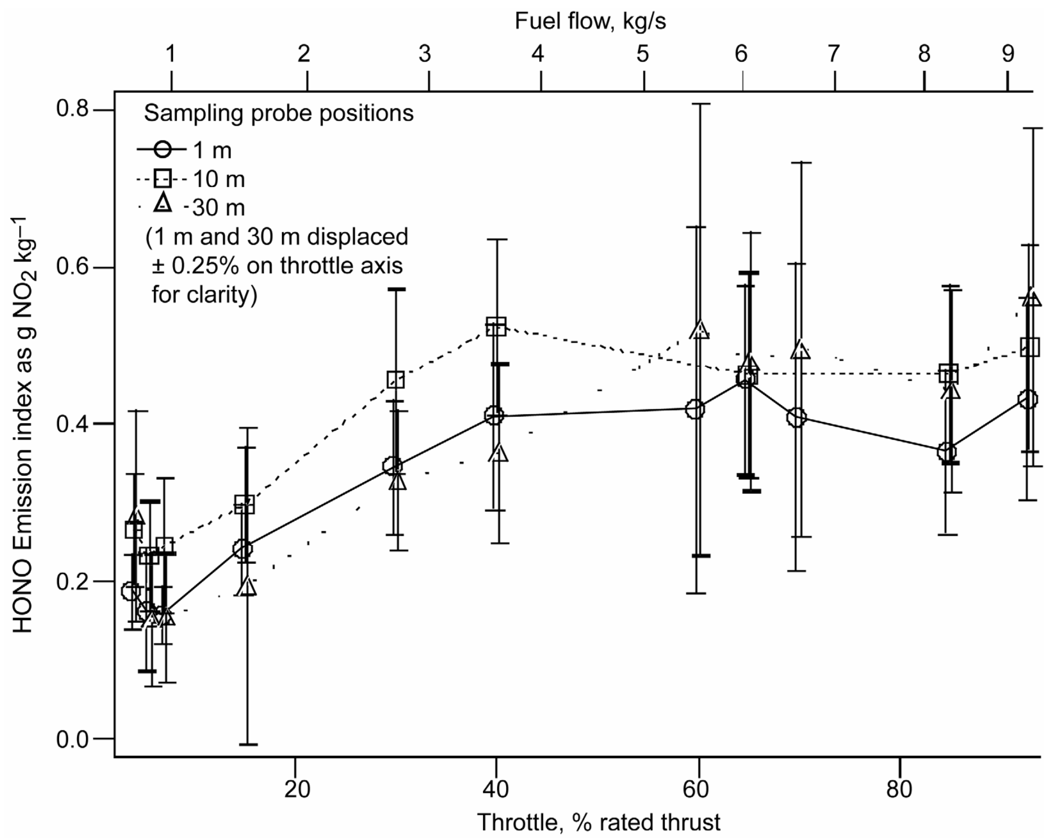

Figure E–4.—HONO measurements at the APEX test for all three sampling distances behind the engine, plotted against engine power.

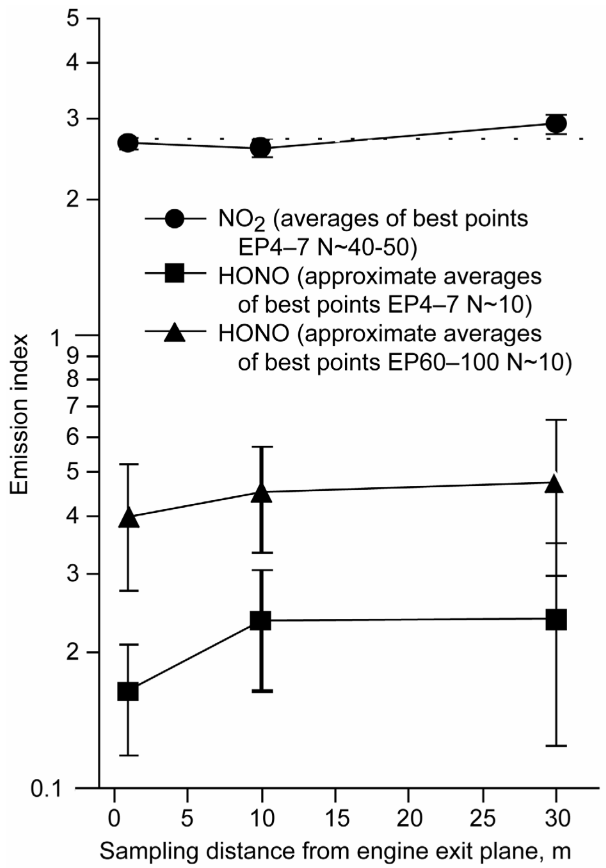

Figure E–5.—An attempt to discern possible trends with sampling probe position at APEX by averaging selections of the Aerodyne data sets for NO_2 at low power, and for HONO at low power and at high power. The values plotted are quite sensitive to exactly which points are selected to be included in these subsets, so although some points lie outside the error bars of adjacent points, it will be difficult to make a compelling case for significant trends with sampling position without data sets with lower variances.

To compare the HONO observations in the APEX test with those of previous tests, we turn to table E-1 and to figure E-6. Table E-1 begins by specifying the engines observed in each test. The QinetiQ TRACE engine is a generic engine typical of CAEP 4 compliant engines currently in use, and is fitted with 10 turbo-annular combustors which allow flexible simulation of modern annular combustors. The EXCAVATE test made measurements on the NASA ARIES (Airborne Research Integrated Experiments System) Boeing 757-200 and on the NASA Langley T-38A Talon. The ranges quoted of HONO and ratios of HONO to NO_2 and NO_x are related to the ranges of engine power settings which happened to be used in the various tests, and are not intended to replace the detailed reporting of test data in this paper and ref. 7. Furthermore, while HONO emission index has been seen to increase with increasing power, the HONO/NO_x ratio typically decreases with power (so in table E-1 HONO/NO_x of 0.07 is for a throttle setting of 4%, with high power values of the ratio approaching 0.02), and, as seen in figure E-6, the HONO/NO_2 ratio also is lower at higher powers. Table E-1 also specifies some of the measurement details, including the source of the NO_2 and NO_x emission indices used in the ratios, and the spectroscopic details of the HONO observations. (The group making the conventional trace gas measurements of the TRACE combustor and engine was the same, but between the two tests that group at the Defense Evaluation and Research Agency, DERA, was privatized and became part of QinetiQ Ltd.)

It can be seen in both table E-1 and figure E-6 that there are substantial variations in HONO emission index with engine type. In figure E-6, the high power HONO/NO_x ratio observed in APEX is more than twice the maximum observed from the 757 in EXCAVATE, and that level is in turn about twice that seen from the TRACE engine in the NASA/QinetiQ tests. But table E-1 shows the most significant difference in HONO emission with engine type, since for the Langley T-38 observed in EXCAVATE, the HONO was below the detection limit. This means that the HONO concentration in the T-38 exhaust was at least 20 times lower than the concentrations seen in high power cases with the 757. All other parameters of the two observations, the instrumentation, the sampling lines, probes, and techniques, the ambient conditions, and so forth, remained the same.

TABLE E-1.—HONO MEASUREMENTS IN AIRCRAFT EXHAUSTS: RANGES OF OBSERVED EMISSION INDICES, RATIOS TO NO_2 AND NO_X, AND SPECTROSCOPIC REGIONS

	NASA/QinetiQ Combustor	NASA/QinetiQ Engine	EXCAVATE B757	EXCAVATE T-38	APEX DC-8
Engine	TRACE	TRACE	RB-211-535E4 Turbofan	J85-GE-5A Turbojet	CFM56-2C1 Turbofan
HONO EI	0.021-0.032	0.03-0.108	0.03-0.24	<0.01*	0.13-0.43
HONO/NO_2	0.05-0.1	0.07-0.18	-	-	0.05-0.45
NO_2 Values:	DERA	QinetiQ	--	-	Aerodyne
HONO/NO_x	0.0025-0.005	0.007-0.018	0.004-0.01	-	0.02-0.07
NO_x Values:	DERA	QinetiQ	ICAO	-	NASA Glenn RC
HONO Region					
Frequency, cm^{-1}	1666.173	1666.173	1666.46	1666.46	1726.193 (1692.88)

* Below detection limit at all engine powers.

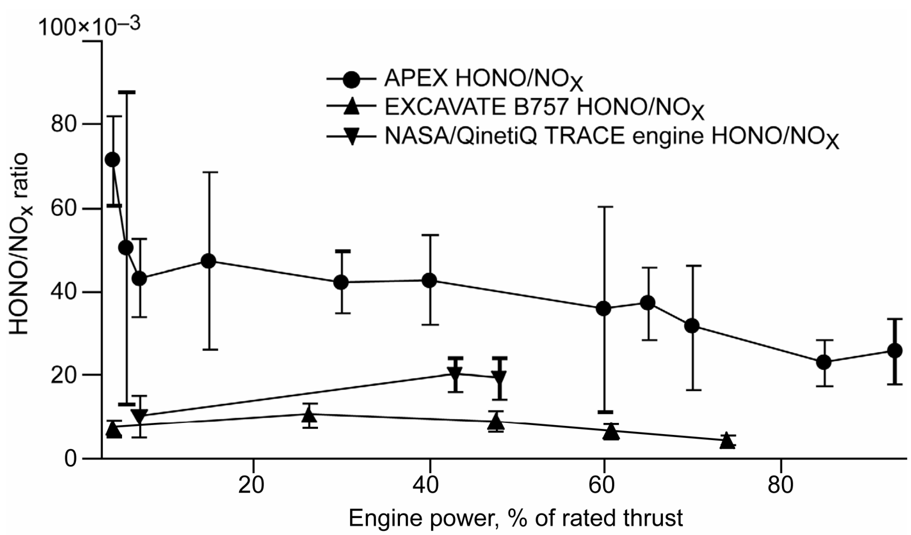

Figure E–6.—Ratios of HONO and NO_X emission indices for sampling at 1 m downstream positions at three aircraft exhaust tests, APEX, EXCAVATE, and NASA/QinetiQ, plotted against engine power.

It is known that HONO formation from other nitrogen oxides on surfaces is possible, especially in the presence of water. The large change in HONO emission with engine type is one of three observations that lead us to the conclusion that much of the HONO we observed is a true exhaust constituent, and is not formed in the probe or sampling line. The other two points of evidence are the reproducible trends with engine power, and the lack of significant trends with sampling position. It can be argued, on the one hand, that while the NO and NO_2 exhaust concentrations change dramatically from low to high power, and the exhaust temperatures and water contents are always in the range that could promote HONO formation on surfaces, the HONO concentrations do not track either the NO or NO_2 concentrations, but follow their own trend, as if the measured HONO is not governed by a simple formation process in the sampling system. On the other hand, the characteristics of the exhaust sampled at the 1, 10 and 30 m points change dramatically, as the temperature, water content, and nitrogen oxide concentrations all drop, yet no dramatic change in HONO emission index is seen. If future tests produce data sets with smaller error limits, this may allow us to discern trends in HONO emission index with sampling position, and that in turn may allow the estimation of contributions from formation in the probe and/or sampling line to the observed HONO.

4. Summary

While at higher powers aircraft NO_x is dominated by NO, at low powers NO_2 can contribute more than 80% of the total NO_x. HONO can also be significant (up to 7% of NO_x in the observations presented here.) More importantly, HONO can be a useful diagnostic of exhaust chemistry. Key assumptions underlying this statement are that observed HONO concentrations are representative of the true exhaust composition, and that differences in engine chemistry are indeed manifested as differences in HONO emissions. The work presented here documenting measurements of NO, NO_2 and HONO for a variety of engines, power levels and sampling distances provides support for both assumptions.

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Appendix F
Chemical Speciation of Hydrocarbon Emissions from a Commercial Aircraft Engine During the NASA APEX Measurement Campaign*

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Chemical Speciation of Hydrocarbon Emissions from a Commercial Aircraft Engine during the NASA APEX Measurement Campaign

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Abstract

In April 2004, the Aerodyne Mobile Laboratory measured trace gas and particle emissions from a CMF56-2C1 high-bypass-ratio turbofan engine used to power the NASA DC-8 aircraft as part of the Aircraft Particle Emissions eXperiment (APEX). This report focuses on the measured hydrocarbon species which include formaldehyde, ethylene, acetaldehyde, benzene, toluene and several higher aromatic species. Formaldehyde and ethylene were measured by tunable-infrared-laser differential absorption spectroscopy, and the other species were measured by proton-transfer mass spectroscopy. Continuous samples were taken at 1, 10, and 30 m downstream of the engine-exit plane of the grounded aircraft and analyzed at a frequency of up to 1 Hz. The engine power was scanned from ground idle up to take-off power, and three fuel types (a baseline JP-8, a high-aromatic fuel, and a high-sulfur fuel) were investigated. Fuel type and plume age were shown to have only a minor impact on hydrocarbon emissions within the ranges studied in this experiment; however, ambient temperature was shown to have a substantial effect on these emissions. The sum of these speciated measurements agreed favorably with separate measurements of the total hydrocarbon emissions by flame ionization. The fast time response of the speciated measurements revealed interesting variability and transient behavior on a several-second timescale.

1. Introduction

Measurements of total hydrocarbons from commercial aircraft engines, which are required for certification by the International Civil Aviation Organization (ICAO), have been reported for a broad range of engines [1]. However, measurements of individual chemical species which contribute the total hydrocarbon emissions are rare. These speciated measurements are important for understanding the impact of air travel on global climate and local air quality [2-4]. The most comprehensive previous study of speciated hydrocarbons was performed by Spicer and coworkers [5, 6], who studied ten turbine engines in the 1980s including the CFM56 engine. Those experiments examined grab samples of aircraft exhaust using gas chromatography. Slemr et al. [7] measured a number of hydrocarbon species from an in-flight DLR research aircraft using FTIR. Vay et al. [8] also measured trace gases, including CO and CH_4, from several in-flight aircraft using differential laser absorption. More recently, Anderson et al. [9] measured hydrocarbons from the Rolls Royce RB211 turbofan engine using grab sampling and gas chromatography, and Herndon et al. [10] measured advected plumes from various airplane operations at Boston Logan airport.

This study represents the first real-time, ground-level measurements of speciated hydrocarbon emissions from a commercial aircraft engine. A good deal of information about the variability and transient nature of these emissions is available from these measurements because of the fast response time of the instruments. Also ground-level tests allow a detailed examination of different power conditions in addition to the cruise conditions studied during in-flight measurements. Results are represented as emissions indices (mass of pollutant formed per mass of fuel consumed) which are deduced from the hydrocarbon concentrations and the measured concentration of CO_2 from a non-dispersive infrared instrument.

The instruments and sampling system are briefly discussed in the Experimental Section along with a discussion of the data analysis procedure. The Results and Discussion section describes the effect of fuel type, downstream distance, and engine power on hydrocarbon emission indices. Also discussed is the variability in measured hydrocarbons, the interfering effects of ambient temperature, and the transient behavior of these emissions during changes in engine power.

A detailed description of APEX measurement campaign [11] and sampling system [12] is presented elsewhere. More details about the PTR-MS measurement procedure and analysis of data are given by Knighton et al. [13]. Concurrent measurements of nitrogen oxides [14] and particulate species [15] using the Aerodyne Mobile Laboratory are addressed in separate publications.

2. Experimental Section

During April 23-29, 2004 the Aerodyne Mobile Laboratory was parked on a pad at Dryden Field on Edwards Air Force Base (Mojave Desert, California) next to the NASA DC-8 aircraft and approximately 30 m from the CFM56-2C1 engine that was measured. Trailers belonging to other researchers including the University of Missouri-Rolla, AEDC and EPA were lined up next to the Aerodyne vehicle. The airplane remained grounded and stationary during these tests. Sample gases were taken continuously from different positions downstream of the engine exit. Three fuels were examined: 1) a baseline JP-8 fuel from Edwards AFB, 2) a high-sulfur fuel (1600 ppm sulfur) obtained by doping the baseline fuel with tertiary butyl disulfide, 3) a high-aromatic Jet A fuel purchased from a California refinery. Sampling, measurement, and data analysis procedures used during APEX are described below.

Sampling System. Probe stands were located at 1 m, 10 m and 30 m downstream of the engine exit plane. The 1 m and 10 m probe stands supported rakes of six conventional gas probes and six dilution probes aligned vertically. After some preliminary testing of the spatial variability of the emissions, one central probe tip was selected for the 1 m probe rake, and the probe tips were ganged on the 10 m probe rake. All measurements reported here used samples drawn from the dilution probes. The stainless steel sample lines were unheated and the majority of the approximately 30 m of line length was ¾ in (19 mm) OD tubing. The sample gas was diluted at the probe tip with dry nitrogen to a dilution ratio of approximately 10:1. Two valve boxes were used to select (or gang) the probe tips and to distribute the sample gas between researchers. The 30 m probe stand consisted of a single undiluted probe tip and a ¾ in (19 mm) OD unheated stainless steel sample line. The sample residence times were estimated by bulk flow calculations to be 6.2 s (1 m probe), 5.4 s (10 m probe) and 2.7 s (30 m probe) [12].

Gaseous Measurements. Formaldehyde (HCHO) and ethylene (C_2H_4) were measured by tunable infrared laser differential absorption spectroscopy (TILDAS). The TILDAS instrument directs an IR laser beam through a multipass cell and onto a detector. The light source was a tunable lead-salt diode laser (TDL) for the HCHO measurement and a quantum-cascade laser (QCL) [16, 17] for the C_2H_4 measurement. The frequency of the lasers was swept over a narrow region of the spectrum (< 1 cm^{-1}) at a high repetition rate (>3 kHz). Features of the resulting rotational-vibrational transmission spectra were fit to a Voigt line shape model using line strengths and other line parameters from Herndon et al. [18] for HCHO or the HITRAN database [19] for C_2H_4. The spectral feature used to measure HCHO was located at 1725.8 cm^{-1}, and several individual features in the range 954-958 cm^{-1} were used to measure C_2H_4 on different days of the experiment. The 1-s root mean square (rms) precision for these measurements was 700 pptv (HCHO) and 2 ppbv (C_2H_4). Numerous factors influence the accuracy of these measurements including the laser line width, interferences in the transmission spectra from other species, and uncertainties in the reported line strengths used to fit the spectra. The laser line widths for these experiments (< 0.001 cm^{-1}) were acceptably narrow and the most significant spectral interference reported in the HITRAN database was approximately 1000 times smaller than the features of interest, so the largest source of error is believed to be the uncertainty in the reported line strengths. Smith et al. [20] report estimated uncertainties of 7% (HCHO) and <10% (C_2H_4) for these compounds and these values give an idea of the accuracy of these measurements. The response time of this instrument is determined by the flowrate through the sample cell under the conditions of this experiment and is estimated to be approximately 1 s.

Acetaldehyde, benzene, toluene and other aromatic compounds were measured by proton transfer mass spectrometry (PTR-MS). The PTR-MS (Ionicon Analytic GMBH) uses a chemical ionization mass spectrometer that uses hydromium ions (H_3O^+) to ionize species in the sample gas that are then mass selected and analyzed by a quadrupole mass spectrometer. The H_3O^+ ions transfer an H^+ via proton transfer reactions to species having a proton affinity greater than that of water. Species present in aircraft exhaust which meet this criterion for detection by PTR-MS include unsaturated hydrocarbons, carbonyls and aromatics. Aromatic species are particularly well resolved by PTR-MS because they resist fragmentation when ionized and have little interference at the mass-to-charge ratios where they are detected. The assignment of species to mass-to-charge (m/z) ratios drew on measurements of fragmentation patterns, proton affinities, and prior gas chromatographic analysis of exhaust from a CFM56 engine performed by Spicer et al. [6]. Some m/z ratios cannot be attributed to a single chemical species and in those cases the several species most likely to contribute to that signal are given. Twenty-one (21) signals have been attributed to 26 chemical species (or sets of isomers) using PTR-MS including propene, acetaldehyde, benzene and toluene. The detection limit, defined as three times the rms precision of a measured background signal, was found to be in the range of 0.3 to 1.2 ppbv for the compounds reported here. The detection limits of methanol (2.8 ppbv), propene (3.4 ppbv), acetaldehyde (2.7 ppbv) and acetic acid (3.4 ppbv) are slightly higher due to higher persistent instrument noise for these ion masses. The time response of the PTR-MS was approximately 4 s during this measurement campaign.

Carbon dioxide (CO_2) was measured using a commercial non-dispersive infrared instrument (Licor 6262) to allow calculation of emission indices for the measured hydrocarbons. The published calibration range of this instrument is 0 to 3000 ppmv, and the manufactures quoted accuracy is ±0.5% under the conditions of this experiment. The Licor instrument was calibrated with an 800 ppmv gas standard tank. Occasionally the CO_2 mixing ratio in the diluted exhaust stream exceeded 3000 ppmv, and in those cases a correction was applied to the Licor-measured mixing ratio based on the high-range CO_2 measurement of B. Anderson. This correction was always less than 5% (the value at 5000 ppmv) and usually less than 3% (the value at 4000 ppmv). The time response for the Licor instrument was approximately 1 s.

Data Analysis. The emission index (mass pollutant formed per mass fuel consumed) is the accepted form for reporting emissions from combustion sources and it was calculated using the following formula.

$$\mathrm{EI}_x[\mathrm{g}\,x/\mathrm{kg\,fuel}] = \mathrm{ER}_x[\mathrm{mol}\,x/\mathrm{mol\,CO_2}]\left(\mathrm{MW}_x \big/ \mathrm{MW_{CO_2}}\right)\left(3160\,\mathrm{g\,CO_2} \big/ \mathrm{kg\,fuel}\right) \qquad (1)$$

Eq. 1 uses above-ambient concentrations of CO_2 as a tracer for the exhaust plume [21-23]. The conversion factor of 3160 g CO_2/kg fuel is based on complete combustion of a jet fuel with a C/H ratio of 1.9 and is good to 3 significant figures for the fuels used in this experiment. Because the combustion efficiency of the measured CFM56 engine was always greater than 96% and usually greater than 99%, the error associated with assuming complete combustion is small. The emission ratio (ER) can be calculated in one of two ways. First, a simple average (corrected for background signals) can be computed over the time period corresponding to a given experimental condition using,

$$\mathrm{ER}_x = \frac{\bar{c}_x - c_{x,b}/d}{\bar{c}_{\mathrm{CO}_2} - c_{\mathrm{CO}_2,b}/d} \tag{2}$$

where $\bar{c}_x$ and $\bar{c}_{\mathrm{CO}_2}$ are the average concentrations of species x and CO_2; $c_{x,b}$ and $c_{\mathrm{CO}_2,b}$ are the background concentrations of species x and CO_2; and d is the dilution ratio in the sample line. Because the background concentrations of HCHO and C_2H_4 are small compared to the levels in the aircraft exhaust the $c_{x,b}$ term was neglected. For the 1 m probe location, the correction for background CO_2 was also neglected because it is of minor importance. As a result, the dilution ratio, d, was not needed for the 1 m data. Also, the 30 m probe was not diluted so d=1 for that data. For the 10 m probe, d was estimated by comparing the measured CO_2 concentration to an average undiluted CO_2 concentration 10 m downstream of the engine at the specified engine power.

An alterative to this averaging method is to plot c_x versus c_{CO_2} and perform a linear least-squares regression; the resulting slope being an estimate of ER_x. This approach, which has recently been applied to advected aircraft plume measurements by Herndon et al. [24], has two potential advantages. First, apparent variability in the measured mixing ratios caused by changing winds is removed. As a result, the calculated uncertainties are a better measure of the variability in the instrument and emissions source rather than the weather conditions. Second, the dilution ratio and background concentrations are not needed for this method. Figure F-1 demonstrates the slope method of determining emission ratios for a 7-min period of data from the 10 m probe when the engine was at idle (7% engine power). Notice that the CO_2 concentration varies over a substantial range from 1000 to 2200 ppmv and the accuracy of the slope

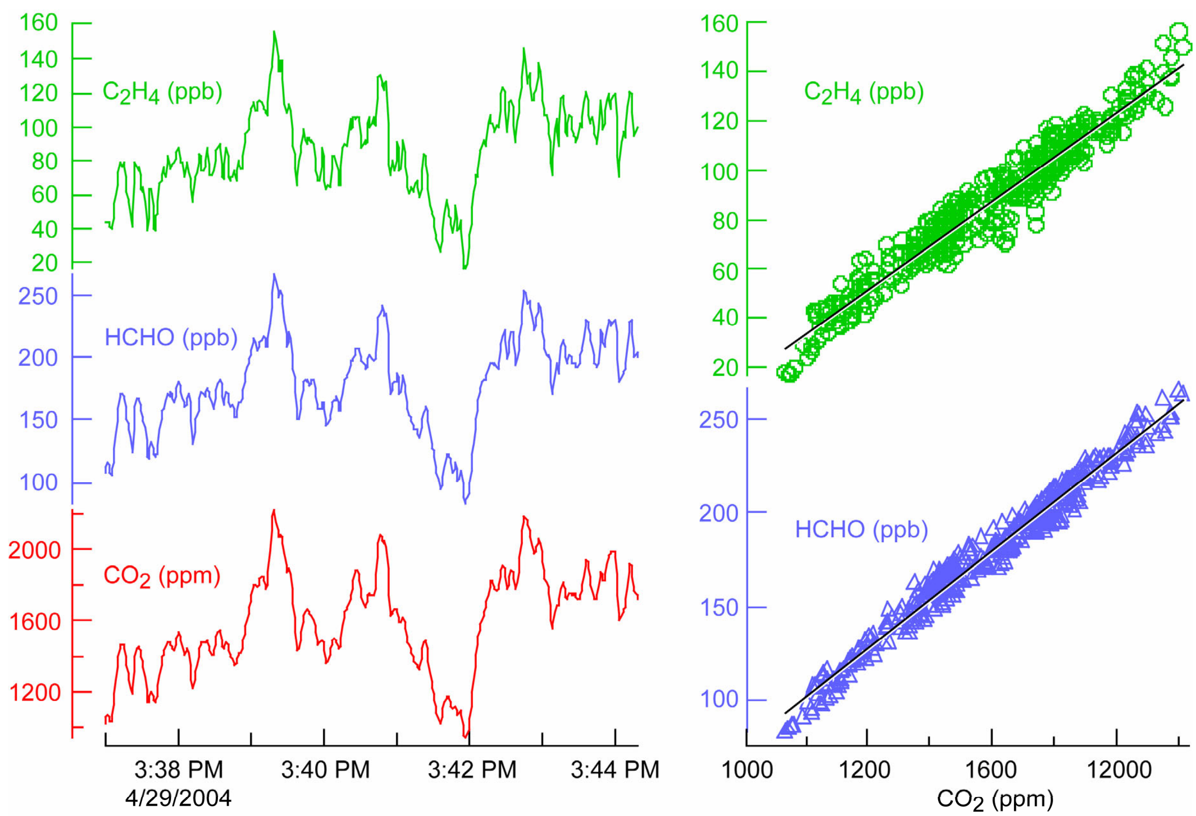

Figure F–1.—Concentration of formaldehyde (HCHO), ethylene (C_2H_4), and carbon dioxide (CO_2) sampled at 10 m downstream of the engine-exit plane (7% engine power; high sulfur fuel). The left pane shows the temporal data stream (archived at 1 Hz), and the right pane shows the correlation between HCHO, C_2H_4, and CO_2 (m = slope ± 1σ).

is quite good. This wind-induced variability is not seen for the 1 m probe, so the averaging method is used exclusively to analyze that data. The slope method can also give least-squares fits of unsatisfactory accuracy at the 10 and 30 m locations when the winds are steady. For this data set, the slope method was only used when the Pearson's R value was greater than 0.75. This criterion resulted in standard deviations (σ) of the slope that were always smaller than the standard deviation resulting from the averaging method, which was calculated as the quadratic sum of the standard deviations of the CO_2 and hydrocarbon mixing fractions.

It should be noted that the ER calculated by the two methods agree quite well, and only the error bars are noticeably different because the slope method removes artificial variability caused by the wind. This remark is addressed by figure F-2, which shows a parity plot comparing the methods. The horizontal error bars (averaging method) are larger than the vertical error bars (slope method), but the regression line is quite close to the line *y*=*x*.

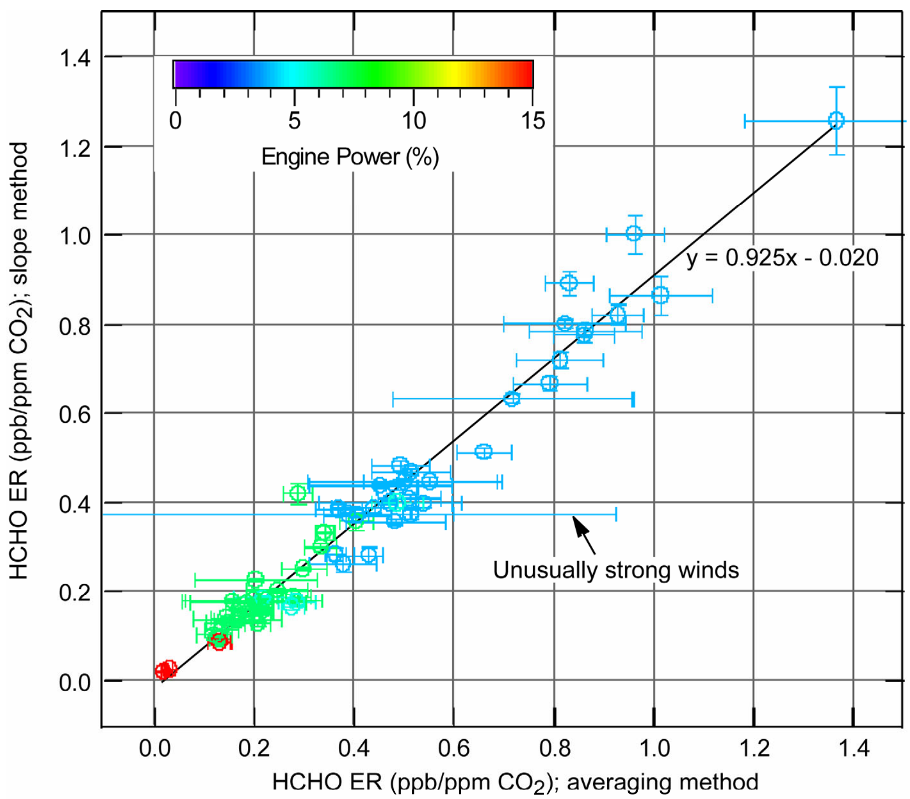

Figure F–2.—Comparison of the formaldehyde (HCHO) emission ration (ER) calculated by two different methods (10 and 30 m downstream; all fuels). Only intervals that show strong correlations (R > 0.75) between HCHO and CO_2 are included. Both methods give similar magnitudes for the emission ratio, but the error bars (1 σ) are much smaller for the slope method because variability due to changing winds has been removed.

3. Results and Discussion

Effect of Fuel and Downstream Distance. Fuel type was not expected to have a significant effect on hydrocarbon emission indices because of the similar C/H ratios of the fuels and that was confirmed by this dataset. Downstream distance in the range studied (1 to 30 m) also did not have a noticeable effect on hydrocarbon emissions. Figure F-3 demonstrates these observations by showing the emission ratio of HCHO, generally the most abundant hydrocarbon in aircraft exhaust, as a function of distance downstream and fuel type at 4% engine power (ground idle). The data points are colored by ambient temperature, which varied in the range 11 to 34˚C during the measurements, and this shows a strong correlation between temperature and the emission ratio of formaldehyde. Figure F-4 shows this dependence of ER_{HCHO} on ambient temperature explicitly for three engine power settings. Most likely the ambient temperature (T_{amb}) is affecting the hydrocarbon emissions by influencing T_3, the combustor inlet temperature. Combustion efficiency generally increases with increasing T_3, which is directly proportional to T_{amb}. So it is reasonable that hydrocarbon emission indices decrease with increasing ambient temperature, and it is noteworthy that the temperature effect is greater than two of the factors explored under this campaign.

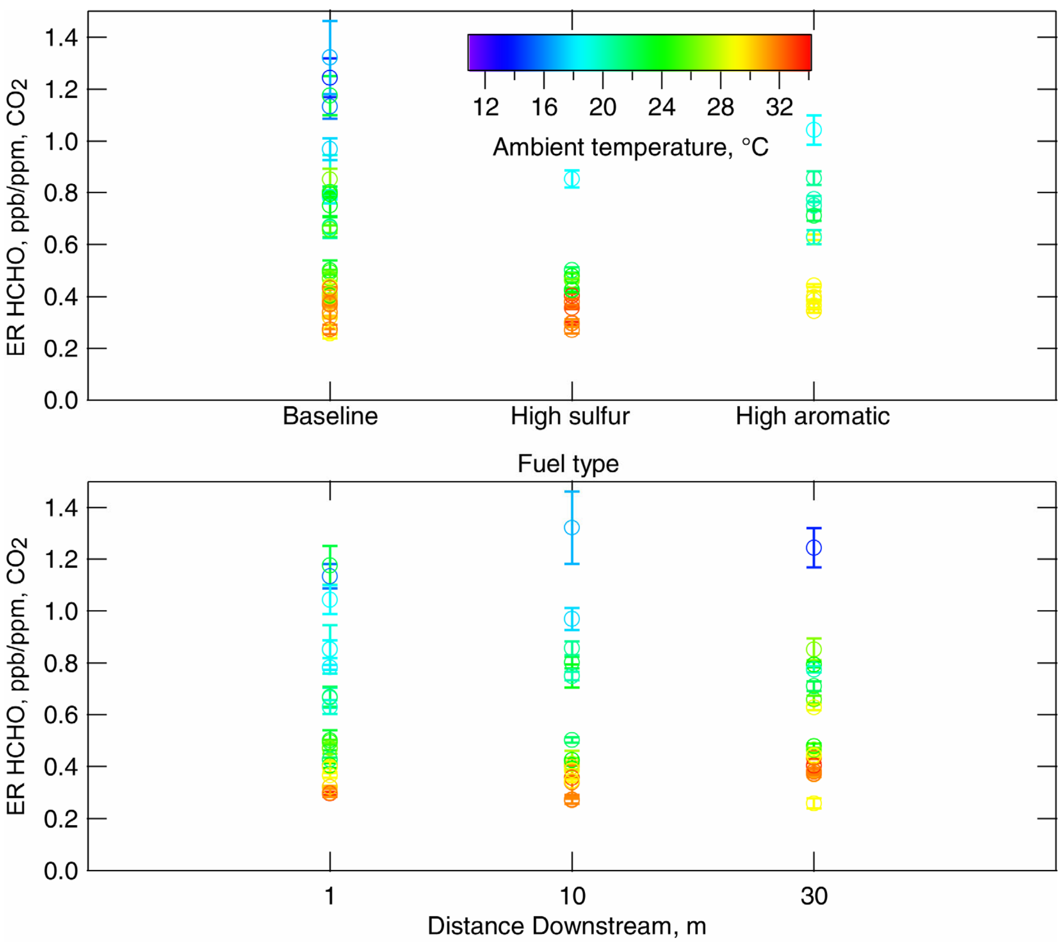

Figure F–3.—Emission ratio of formaldehyde at ground idle (4% engine power) plotted versus distance downstream and fuel type. Data points are colored by the ambient temperature, which appears to have a stronger effect than either fuel type or downstream distance.

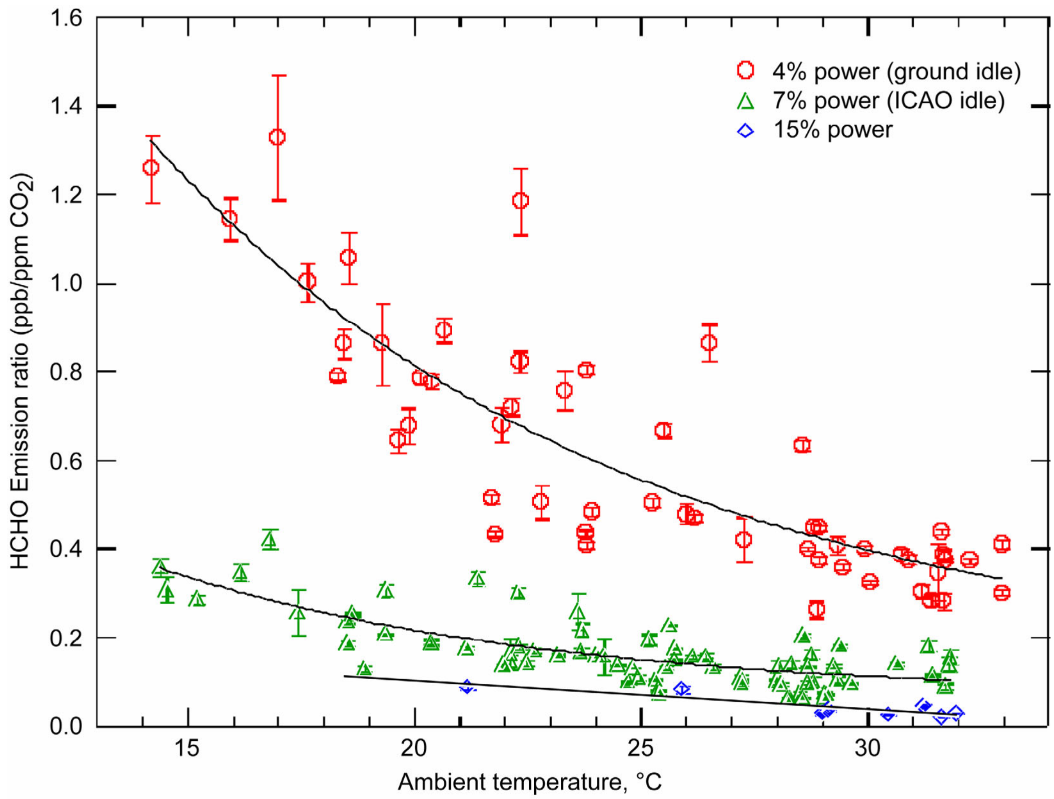

Figure F–4.—Effect of ambient temperature on formaldehyde emission ratio for three engine powers (all fuels; all downstream distances). For a given engine power, lower ambient temperatures resulted in lower HCHO emissions.

Variation with Engine Power. Spicer and coworkers [5, 6] and others have shown that hydrocarbon emissions from aircraft are a strong nonlinear function of engine power. This behavior was also observed for the CFM56 engine during these measurements. Figure F-5 shows that the HCHO emission ratio decreased by two orders-of-magnitude as the engine power is increased from 4% power (ground idle) to 93% power (take-off). The scatter in the data at high engine powers (>30%) shows that the HCHO mixing ratios were approaching the detection limit of the TILDAS instrument, as operated at APEX. Again fluctuations in ambient temperature appear responsible for some of the variability in the data; however, in this case the effect of engine power was larger than that of ambient temperature. The top axis shows several of the nominal power conditions sampled during the APEX campaign and the lower axis shows the fuel flowrate. The horizontal scatter in the data points shows that the fuel flowrate for a given nominal power condition varied for the different test cycles. This variability in fuel flow likely contributes to the observed scatter in figures F-3 and F-4 in addition to variability in ambient temperature. The behavior of the other hydrocarbons was qualitatively similar to that of HCHO.

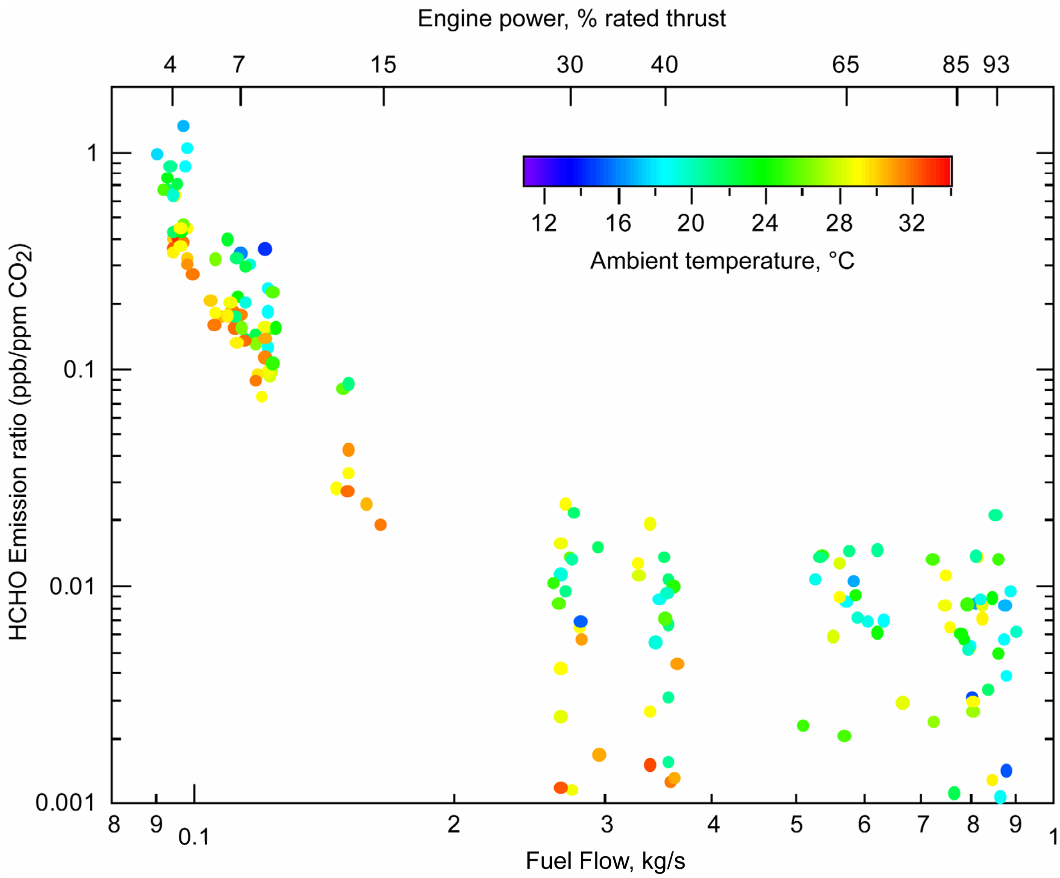

Figure F–5.—Variation of formaldehyde emission ratio with fuel flow (or engine power) for the CFM56-2C1 engine. Variability in emission ratio at low power (≤15%) is due to changes in ambient temperature. At higher engine power, variability arises because the low HCHO concentration is approaching the detection limit of the TILDAS instrument, as operated at APEX.

Speciation of Engine Exhaust. This section summarizes all the hydrocarbon emissions that were measured by the TILDAS and PTR-MS instruments during the APEX measurement campaign. Because the effects of downstream distance and fuel type on hydrocarbon emissions were not significant relative to the temperature effect, the data were averaged over all fuels and all probe locations. Table F-1 shows 20 hydrocarbon emissions at 4, 5.5, 7 and 15% engine power. The emissions at engine powers greater than 15% was usually below the detection limits of the instruments. When an ion mass from the PTR-MS could not be assigned to a single hydrocarbon compound, the set of compounds or isomers corresponding to that ion mass is given. The results are presented as a carbon emission ratio, ER_C (moles of carbon in a given HC emitted per mole of CO_2 produced), which was calculated by multiplying the ER ratio calculated by Eq. 2 by the number of C-atoms per hydrocarbon (N_C). For ion masses where the number of carbons per molecule is not clear (e.g., m/z 57 can be C_3H_4O or C_4H_8), N_C was assigned based on the more abundant species as measured by Spicer [6] for the CFM56 engine. Since the combustion efficiency of the engine is always close to unity, the carbon emission ratio (units of ppbC HC/ppm CO_2) is essentially 1000 times the fraction of carbon atoms in the fuel that are emitted as a given hydrocarbon. In terms of carbon emission ratio, ethylene is the most abundant hydrocarbon at idle, followed by formaldehyde (the most abundant on a simple molar basis), m/z 57 (acrolein + butenes), and m/z 43 (propene + fragments of petenes). These measurements show that the hydrocarbon emissions are dominated by carbonyls and olefins at idle power conditions where hydrocarbon emissions are most important.

TABLE F-1.—HYDROCARBON SPECIATION OF THE EXHAUST GAS OF THE CFM56-2C1 ENGINE (ALL FUELS; ALL DOWNSTREAM DISTANCES). DATA SHOWN ARE CARBON EMISSION RATIOS (PPBC/PPM CO_2) AND REPRESENT AVERAGES OVER SEVERAL MEASUREMENT PERIODS (SEE FOOTNOTES). THE ERRORS SHOWN ARE ONE STANDARD DEVIATION (1 σ) AND QUANTIFY VARIABILITY CAUSED BY THE AMBIENT CONDITIONS, ENGINE OPERATING CONDITIONS, AND MEASUREMENT UNCERTAINTY. THE NUMBERS IN PARENTHESES ARE THE FRACTIONAL ERRORS. THE SUM INCLUDES SOME HIGH-UNCERTAINTY DATA LEFT AS BLANKS IN THE TABLE.

	Engine Power (% rated thrust)			
Species or Signal	4%	5.5%	7%	15%
HCHO[a]	0.6 ± 0.3 (46%)	0.22 ± 0.09 (39%)	0.16 ± 0.08 (48%)	0.04 ± 0.03 (61%)
C_2H_4[b]	1.0 ± 0.5 (47%)	0.4 ± 0.3 (82%)	0.2 ± 0.4 (187%)	
m/z 41[c,d]	0.2 ± 0.1 (53%)	0.09 ± 0.03 (36%)	0.07 ± 0.04 (67%)	0.02 ± 0.01 (49%)
m/z 43[c,e]	0.4 ± 0.2 (56%)	0.15 ± 0.06 (37%)	0.12 ± 0.08 (64%)	0.04 ± 0.02 (57%)
acetaldehyde[c]	0.2 ± 0.1 (38%)	0.11 ± 0.03 (30%)	0.08 ± 0.04 (48%)	0.02 ± 0.01 (51%)
m/z 57[c,f]	0.6 ± 0.3 (47%)	0.22 ± 0.08 (35%)	0.2 ± 0.3 (120%)	0.06 ± 0.03 (48%)
m/z 59[c,g]	0.10 ± 0.05 (45%)	0.04 ± 0.02 (43%)	0.04 ± 0.03 (63%)	
higher alkenes[c,h]	0.4 ± 0.2 (50%)	0.15 ± 0.06 (41%)	0.12 ± 0.07 (59%)	
m/z 73[c,i]	0.07 ± 0.03 (39%)	0.03 ± 0.01 (28%)	0.03 ± 0.01 (55%)	0.008 ± 0.004 (53%)
benzene[c]	0.2 ± 0.1 (50%)	0.08 ± 0.02 (29%)	0.06 ± 0.03 (50%)	0.015 ± 0.007 (46%)
m/z 83[c,j]	0.13 ± 0.08 (63%)	0.04 ± 0.01 (36%)	0.03 ± 0.02 (66%)	0.007 ± 0.004 (52%)
toluene[c]	0.09 ± 0.05 (59%)	0.02 ± 0.01 (51%)	0.02 ± 0.02 (63%)	
phenol[c]	0.09 ± 0.05 (59%)	0.03 ± 0.01 (52%)	0.02 ± 0.02 (76%)	
styrene[c]	0.04 ± 0.02 (53%)	0.015 ± 0.006 (41%)	0.010 ± 0.005 (54%)	
m/z 107[c,k]	0.12 ± 0.06 (51%)	0.04 ± 0.02 (39%)	0.03 ± 0.02 (67%)	0.007 ± 0.005 (67%)
m/z 121[c,l]	0.12 ± 0.07 (59%)	0.04 ± 0.02 (46%)	0.03 ± 0.02 (68%)	0.008 ± 0.006 (73%)
m/z 135[c,l]	0.08 ± 0.05 (65%)	0.03 ± 0.01 (50%)	0.02 ± 0.02 (74%)	0.006 ± 0.005 (73%)
m/z 149[c,l]	0.04 ± 0.03 (78%)		0.01 ± 0.01 (127%)	
naphthalene[c]	0.03 ± 0.02 (51%)	0.015 ± 0.007 (47%)	0.01 ± 0.01 (80%)	0.004 ± 0.003 (71%)
methyl naphthalene[c]	0.02 ± 0.01 (61%)	0.009 ± 0.004 (47%)	0.007 ± 0.006 (81%)	0.003 ± 0.002 (70%)
Sum	4.65 ± 0.73 (16%)	1.76 ± 0.37 (21%)	1.31 ± 0.49 (37%)	0.28 ± 0.21 (75%)

[a]Measured by tunable diode laser (TDL) absorption spectroscopy. Replicates: 53 (4%), 8 (5.5%), 72 (7%), 8 (15%).
[b]Measured by quantum cascade laser (QCL) absorption spectroscopy. Replicates: 22 (4%), 4 (5.5%), 24 (7%), 4 (15%).
[c]Measured by proton-transfer mass spectrometry (PTR-MS). Replicates: 51 (4%), 8 (5.5%), 72 (7%), 8 (15%).
[d]fragment of propene
[e]propene and fragments of pentene isomers
[f]acrolein + butenes
[g]glyoxal + propanal + acetone
[h]sum of m/z 71, 85, 99, 113 and 127 representing pentene isomers through nonene isomers.
[i]methyl glyoxal + butanal/crotonaldehyde
[j]possibly hexnal, cyclohexene, or hexadiene
[k]benzaldehyde + xylene
[l]variously substituted benzene isomers

The sum of the individual HC emissions measured by TILDAS and PTR-MS was compared to the total non-methane hydrocarbons (NMHC) emissions data of Wey [25] measured by a continuous flame-ionization detector (FID). Both techniques show that the hydrocarbon emissions decrease steeply with increasing engine power (see fig. F-6). The sum of the TILDAS/PTR-MS hydrocarbons agrees with the total NMHC measured by FID to within about 10%. The carbon emission ratio, ER_C, is particularly useful for comparing speciated HC measurements to THC measurements because the continuous FID is essentially a carbon counting instrument. At higher engine powers (≥30%) the signals are below the detection limit of the TILDAS and PTR-MS instruments, as operated at APEX.

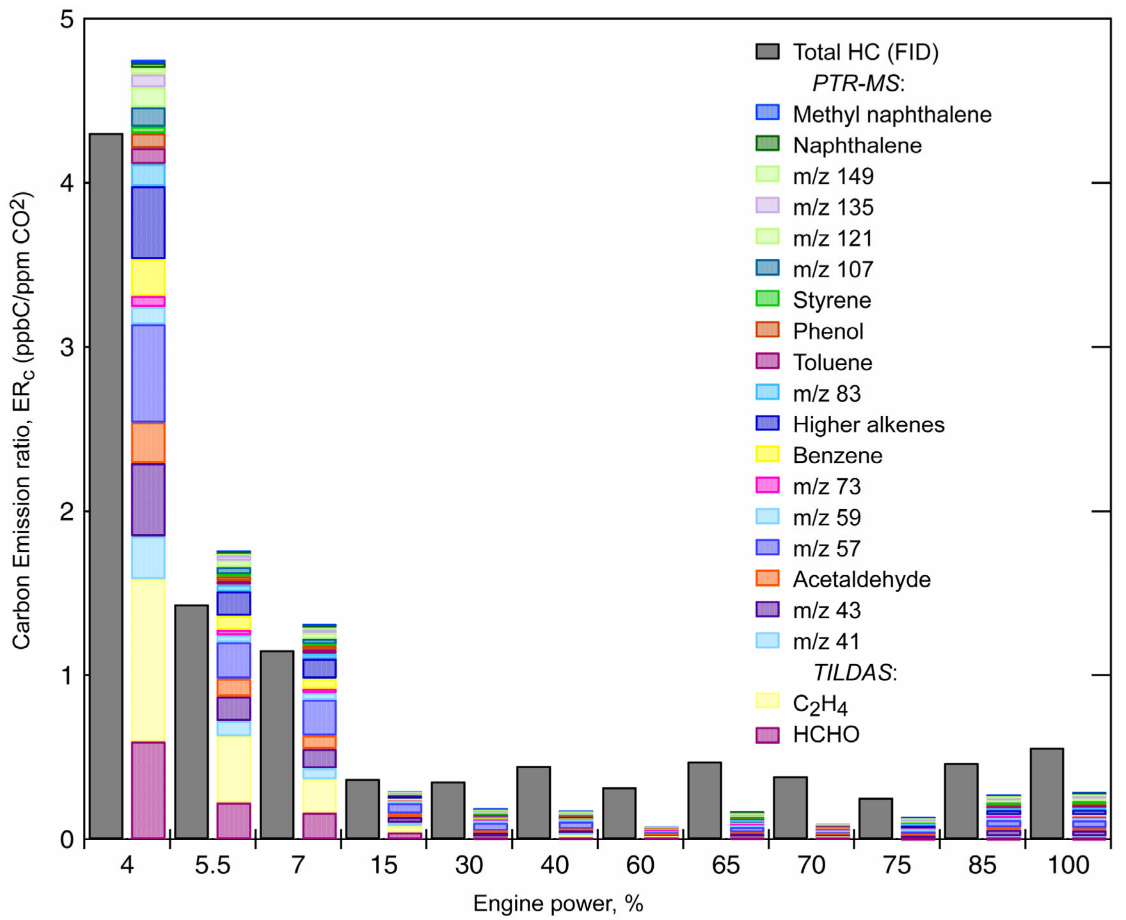

Figure F–6.—Comparison of the sum of speciated hydrocarbons from the QCL, TDL, and PTR-MS with the total hydrocarbon measurement from the continuous FID of C. Wey [25] (all fuels; all downstream distances).

Engine-Related Hydrocarbon Emissions Variability. Because of the high time-resolution of the instruments, the 1-m probe measurements elucidated some interesting characteristics of the engine, which are discussed in the next two figures. Unlike the 10 and 30 m locations, wind has a negligible effect on the measurements at the 1 m probe, so the variability at 1 m can be attributed to the engine itself. Figure F-7 shows a 3-min segment of 1-s HCHO and CO_2 data sampled from 1 m downstream of the engine while the engine was at the ICAO idle condition (7% engine power). The peaks in the CO_2 trace correspond quite well to the troughs in the HCHO trace, and it appears that the two signals are strongly anti-correlated. The HCHO concentration varies by approximately 10% during this interval, which results in a 10% or larger variability in the HCHO emission index. This high-frequency oscillation in EI_{HCHO} was not obvious in all the 1-m probe data, and it is unclear what causes this variability; however, we believe the variability is engine-related rather than instrument/sampling-related because CO_2 and HCHO are measured on separate instruments and follow opposite trends. To our knowledge, this is the first time that this several-second variability in hydrocarbon emissions has been reported. Also, assuming HCHO emissions are indicative of total hydrocarbon emissions, the periods of low HCHO and high CO_2 emissions (e.g., 14:41:00) correspond to periods of relatively high combustion efficiency, so there could be noticeable variability in the combustion efficiency of the engine on this several-second timescale.

The high time-response of the instruments (1 s for TILDAS; ~7 s for PTR-MS) also allowed the hydrocarbon emissions to be analyzed for transient engine powers between stable measurement points. Figure F-8 shows the emissions of benzene, toluene, formaldehyde, ethylene, and CO_2 during a transition from 7% engine power (ICAO idle) to 4% engine power (ground idle). The emission ratios for the four hydrocarbon species during this 15 s transient period peaks at a value that is approximately twice as high at the steady-state value for 4% engine power. Peaks for hydrocarbon emission indices were not observed for all changes in power conditions, and the degree of the excursion during the transient varied. Further measurements are need to determine whether emissions during transient power conditions are consistently different from the emissions at steady-state power conditions bounding the transient powers levels.

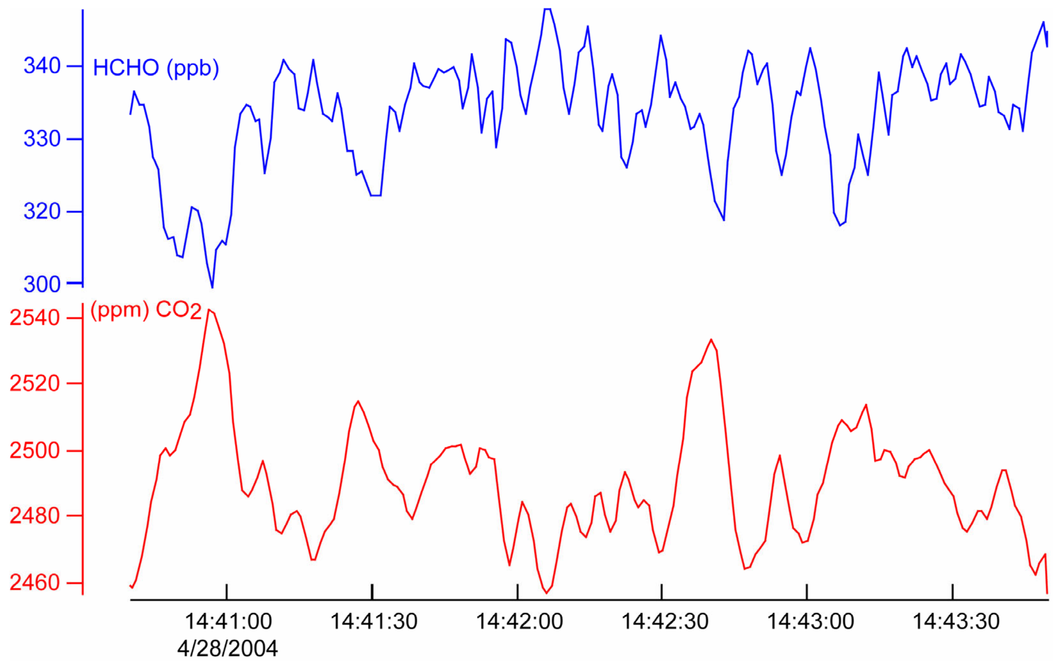

Figure F–7.—Variability in formaldehyde concentration sampled for a fixed engine condition (1 m downstream; high aromatic fuel; 7% engine power). HCHO and CO_2 are strongly anti-correlated showing high-frequency variability in engine combustion efficiency.

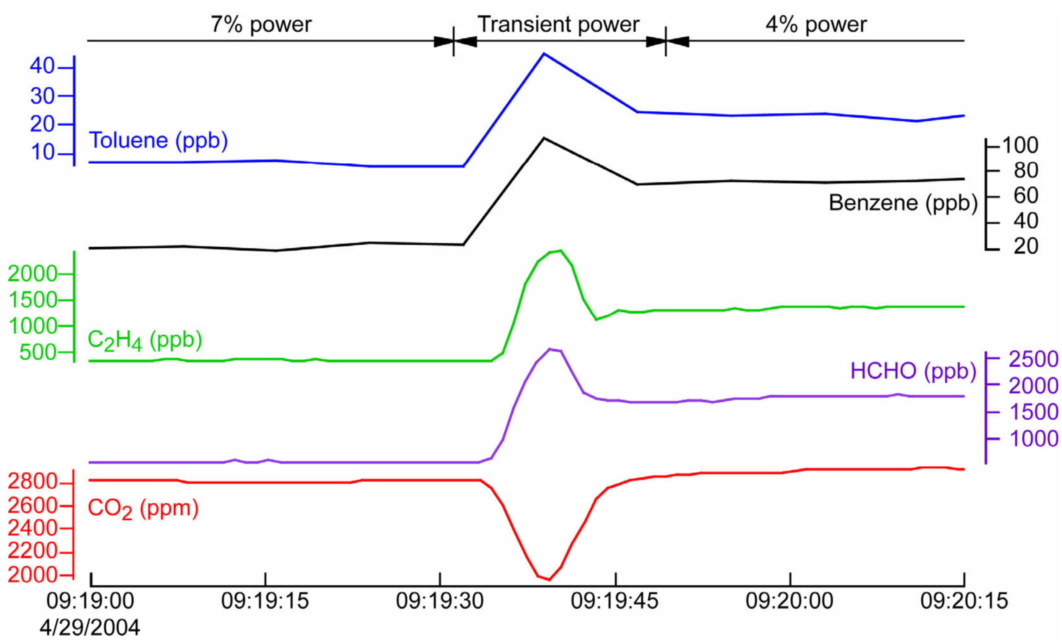

Figure F–8.—Hydrocarbon emissions during an engine power transient between ICAO idle (7% power) and ground idle (4% power); 1 m downstream, high aromatic fuel. Hydrocarbon emissions reached peak values during this transient. Benzene and toluene measured by PTR-MS; HCHO and C_2H_4 measured by TILDAS; CO_2 measured by NDIR.

Conclusions

- Emissions of formaldehyde, ethylene, acetaldehyde, benzene, toluene, and other hydrocarbons from a commercial high-bypass-ratio turbofan engine (CFM56-2C1) have been measured for various fuel formulations, plume ages (distances downstream), and engine powers using sensitive, fast time-response trace gas analyzers. These speciated measurements provide information about the individual air toxics and greenhouse gases emitted by aircraft, and the sum of these speciated measurements agrees favorably with separate measurements of the total hydrocarbon emissions.
- Fuel sulfur and aromatic content did not have a quantifiable effect on hydrocarbon emissions in the range studied (400 to 1600 ppm sulfur, 18 to 22 vol. % aromatics). Similarly, plume age (or distance downstream) did not have a quantifiable effect on hydrocarbon emissions in the range studied (1 to 30 m downstream of the engine-exit plane). Ambient temperature was shown to have a significant effect on hydrocarbon emissions, which obscured any lesser effects of fuel composition or plume age.
- Hydrocarbon emission indices are highest at idle and decrease rapidly at higher engine powers. Variability in the measured emission index at a given nominal engine power was mostly due to variability in the ambient temperature and fuel flowrate.
- Fast time-response measurements of the individual hydrocarbon species emitted by the engine led to some interesting observations about the transient behavior of the engine. Variations in formaldehyde emissions (±10 %) at 1 m downstream of the engine-exit plane were strongly anti-correlated with CO_2 emissions on a several second timescale. Also, hydrocarbon emissions during transients in engine power were occasionally observed to be higher than the emissions in both the stable beginning and ending states.

Acknowledgements

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Appendix G
Application of Proton Transfer Reaction Mass Spectrometry (PTR-MS) to Measurement of Volatile Organic Trace Gas Emissions from Aircraft*

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Application of Proton Transfer Reaction Mass Spectrometry (PTR-MS) to Measurement of Volatile Organic Trace Gas Emissions from Aircraft

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Abstract

A proton transfer reaction mass spectrometer (PTR-MS) was used to measure the concentrations of selected volatile organic compounds (VOC) in the exhaust of a commercial turbofan aircraft engine as part of the Aircraft Particle Emissions eXperiment (APEX). Nine different compounds including methanol, acetaldehyde, acetic acid, benzene, toluene, phenol, styrene, naphthalene, and the methylnaphthalenes were identified as components in the engine exhaust matrix that can be reliably quantified by the PTR-MS. The emission characteristics of the CFM-56 engine examined in this study were comparable to those previously reported by Spicer et al.[1]. The PTR-MS measurements helped corroborate the variability of the hydrocarbon (HC) emission indices with ambient temperature. We observed that plots of the HC versus formaldehyde emission indices were linear and essentially independent of power setting and fuel composition. This result suggests that all of HC emissions scale with combustor efficiency and that the HC speciation is not significantly altered as a function of fuel or power setting. The PTR-MS technique provided on-line measurements of the volatile organic compounds emitted from a commercial aircraft turbine engine and was demonstrated to be a rapid, sensitive and reliable quantitative technique for monitoring selective hydrocarbon emissions within the engine exhaust matrix.

1. Introduction

The impact of commercial aircraft operations on local air quality is coming under increasing scrutiny. To accurately assess the effect of aircraft emissions on the health of workers, patrons and residents in and around airport terminal areas, detailed information on the concentrations and chemical speciation of aircraft-generated pollutants is needed. While commercial aircraft engines are emission certified to meet standards set by the International Civil Aviation Organization (ICAO) this process only documents the levels of CO, NOx, total hydrocarbons and smoke number in engine exhaust. The certification process fails to adequately address the air toxic component of the HC emissions and smoke number is poor indicator of fine particle emissions. Both the fine particle emissions and the air toxic component of the HC emissions are of particular importance in relationship to human health.

Incomplete combustion of fuel in aircraft gas turbine engines results in the emission of unburned, cracked and partially oxidized HC products, and fine particles comprised of solid carbonaceous material, non-volatile compounds as well as contributions from volatile organics that condense as the exhaust cools[1-4]. The emission indices, grams of pollutant per kg of fuel burned, for the HC emission components are highly power dependent[1,3-5] and may also depend on fuel composition[5]. THC emissions from gas turbine engines are the highest at low engine power settings (idle) even compared to takeoff conditions which has the highest fuel consumption[1]. Depending on the nature of the chemical composition of the HC emission products, this may be of concern since operating commercial aircraft spend the bulk of their time at airports under low engine power conditions like taxiing or at idle. Only a limited number of studies of have addressed the chemical speciation of the HC emissions at relevant airport operating conditions[1,5]. One of these studies has raised concern because it suggests that at engine idle the air toxics formaldehyde, acetaldehyde, acrolein, 1,3-butadiene and benzene comprise a significant fraction (~26%) of the total non-methane HC emissions[1].

All of the previous studies that provided chemical speciation of the non-methane HC emissions from aircraft have relied on a limited number of samples. While these studies have provided considerable insight into the non-methane HC emissions from aircraft, these contributions point to the need for more measurements in order to further understand the power and fuel dependencies. In this paper, we describe the first use of the PTR-MS technique for the examination of the HC emissions from a gas turbine engine under well defined operating conditions. The PTR-MS has sufficient sensitivity and selectivity to quantify selected HC exhaust components in a diluted exhaust sample in real time (~ 8 s). Whole air samples can be directly analyzed, since only those components in the sample having proton affinities greater than that of water react with the H_3O^+ reagent ions. The permanent gases and small alkanes all have proton affinities less than that of water while the olefins, aromatics and most oxygenated hydrocarbons have proton affinities greater than water and can be detected using the PTR-MS. The capability to directly analyze a diluted exhaust stream is important because it allows the PTR-MS to continuously monitor the exhaust products emitted under stable operating conditions as well as during the transitions between these conditions. The limitation of the PTR-MS method is that the ion signals provide only mass-to-charge information that is often insufficient for complete compound identification. A major focus of this paper is to critically evaluate the observed PTR-MS ion signature and to examine which aircraft exhaust HC components can be accurately quantified using the PTR-MS technique. We will show that the PTR-MS is a reliable high temporal-response technique for monitoring numerous HC emission components in jet turbine engine exhaust, which is capable of addressing the impact of fuel composition and engine power on the chemical speciation of the exhaust emissions.

2. Experimental Section

The emission measurements discussed below were recorded during the NASA-sponsored, Aircraft Particle Emission Experiment (APEX), which was conducted at NASA's Dryden Flight Research Center during April 2004. The focus of APEX was to characterize the aerosol and trace gas emissions from a large, commercial-class airliner as a function of engine power, plume age, and fuel composition. The NASA DC-8 was selected as the source platform for APEX because its CFM56-2-C1 engines are operationally representative of many of the modern turbo-fan engines used in the current commercial fleet. For the tests, the aircraft was chocked in a run-up area and sample extraction probes were positioned at 1, 10, and 30 m down steam of its right inboard engine (fig. G-1). The 1 and 10 m probes contained multiple gas and aerosol sampling tips to facilitate "mapping" pollution concentration fields across the engine exhaust plane. Dry N_2 dilution gas was provided to the 1 and 10 m aerosol inlet tips to reduce water and aerosol precursor concentrations to prevent condensation and formation of secondary aerosols within the sample transport lines. Dilution ratios were varied from 3 to 100 to examine the impact of concentration on aerosol microphysical properties, but were nominally held near 10:1 for routine sampling. Sample streams from the gas inlet tips were undiluted, but heated according to ICAO Annex 16 regulations. Air collected at 30 m was typically diluted by factors of 40 or more by entrainment of ambient air into the high velocity exhaust plume. From the probes, aerosol sample air was drawn though unheated stainless steel tubing to analytical instruments housed in trailers positioned just off the aircraft's right wingtip, a distance that ranged from 25 to 35 m, depending on probe selection (fig. G-1). Sample residence times within the tubing varied from about 5 to 10 s and depended on sample dilution ratio, probe selection, sample pressure, the number of analytical instruments drawing flow, and the position of the instrument along the sampling train. Although we occasionally analyzed samples from the gas-probe stream, the PTR-MS and other trace-gas and aerosol instruments housed in the ARI trailer were set up to draw samples from the APEX aerosol sample distribution manifold.

Formaldehyde (HCHO) was measured by tunable infrared laser differential absorption spectroscopy (TILDAS). The TILDAS instrument directs an IR laser beam through a multipass cell and onto a detector. The light source was a tunable lead-salt diode laser (TDL). The frequency of the laser was swept over a narrow region of the spectrum (< 1 cm^{-1}) at a high repetition rate (>3 kHz). The spectral feature used to measure HCHO was located at 1725.8 cm^{-1} and concentrations were determined by fitting the measured rotational-vibrational transmission spectra to a Voigt line shape model using line strength and other line parameters from Herndon et al.[6]. The 1 s root mean square (rms) precision for these HCHO measurements was typically less than 700 pptv and the absolute uncertainty is estimated at 7%[7]. The response time of this instrument is determined by the flowrate through the sample cell under the conditions of this experiment and is estimated to be approximately 1 s.

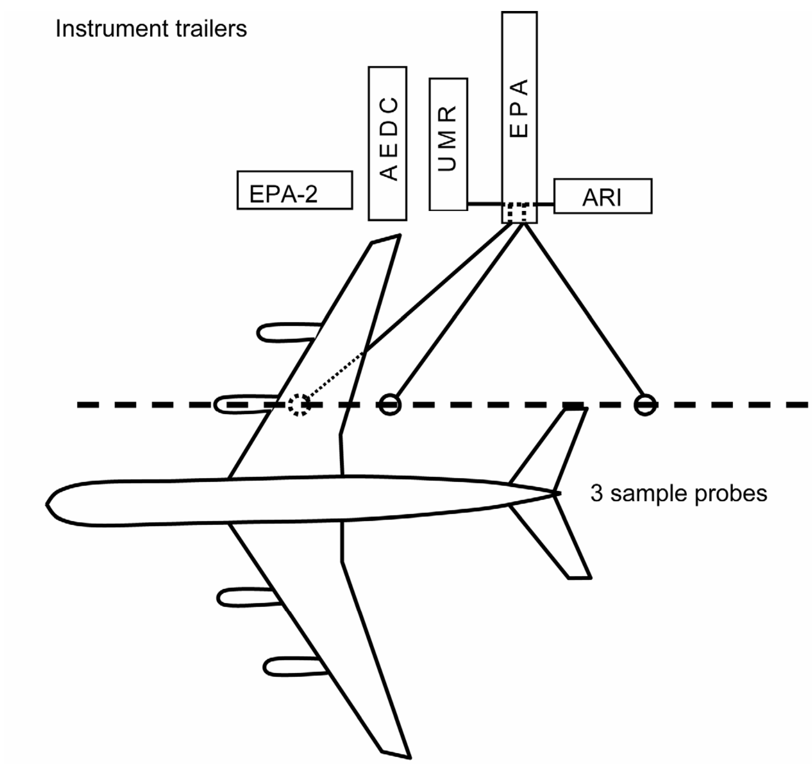

Figure G–1.—Schematic of the experimental setup for the emission measurement performed on NASA's DC-8 aircraft equipped with CFM56-2-C1 engines. The plane was chocked on the tarmac with the three sample probes located at 1, 10 and 30 meters downstream of the exit of the starboard side inboard engine. The 30 meter probe sampled the exhaust stream without further conditioning. Sampling from the 1 and 10 meter probes was from the particle probes where the sample stream was diluted immediately in the probe tip prior to distribution to various instrumentation packages.

Two, non-dispersive infrared absorption instruments were used to detect CO_2: a Licor-6262 for concentrations up to 4000 ppmv and a Licor-820 values up to 20,000 ppmv. Both instruments were calibrated with NIST traceable standards. The time response for these instruments is approximately 1 s.

The PTR-MS (Ionicon Analytic GMBH) is a chemical ionization based mass spectrometry method that utilizes H_3O^+ as a reagent ion. This instrument has been described in considerable detail by a number of authors[8-11], so that only a brief description of the relevant details is provided here. The instrument consists of an ion source, a drift tube reaction region and a quadrupole mass spectrometer. H_3O^+ reagent ions formed in the hollow cathode discharge ion source are electrostatically injected into the drift tube through which the sampled air stream is continuously passed at reduced pressure, 1.9 mbar. These H_3O^+ reagent ions are pulled through the air sample by an electric field where they can react via proton transfer reactions with those components in the sample having proton affinities greater than that of water. The reagent ions and the resulting proton transfer reaction products are mass selected and detected using the mass spectrometer.

The PTR-MS sampled the exhaust stream from the main sample inlet through a short length of 3.2 mm o.d. Teflon tubing via a high temporal response pressure-controlled inlet[9]. A fraction of the sampled exhaust enters the drift tube reaction region where those components of the sample having proton affinities greater than that of water undergo proton transfer reactions with H_3O^+ reagent ions. The mass spectrometer monitored a selected set of 32 ions at 0.2 s per mass, along with the drift tube pressure and temperature, which yielded a cycle measurement time of approximately 8 s. The ions monitored included the reagent ions H_3O^+ (m/z 21 O-18 isotope) and $H_3O^+(H_2O)$ (m/z 39 O-18 isotope), the diagnostic ions NO^+ (m/z 31) and O_2^+ (m/z 32) and 28 sample ions. The sampled exhaust flow stream was periodically diverted through a heated Pt catalyst (400 °C) to provide a VOC free gas stream for determining the instrumental background. In many cases the Pt catalyst did not efficiently remove the VOCs from the exhaust sample stream and this reduced efficiency has been attributed to poisoning of the catalyst due to the high sulfur content of the fuel. Under circumstances where the catalyst appeared to be compromised, instrumental background measurements were determined when the main inlet was purged with N_2 blow off from a liquid N_2 dewar. The instrumental background is non-zero for most masses and the reported concentrations reflect the difference between the sample and background signals.

The concentration of a HC emission component (R) can be deduced from the measured ion signals using relationships derived either from simple reaction kinetics or from calibrated response factors. For a limited number of components calibrated response factors have been determined and the relationship between the response factors and the volumetric mixing ratio (VMR) is given by Eq. 1[9].

$$VMR_R = \left(\frac{1}{S_R}\right)\left(\frac{I_{RH^+}}{I_{H_3O^+} + X_R \bullet I_{H_3O^+(H_2O)}}\right)\left(\frac{T^2}{P^2}\right) \tag{1}$$

Where I_{RH+}, I_{H3O+} and $I_{H3O+(H2O)}$ represent the raw measured ion intensities, T is the drift tube temperature and P is drift tube pressure. S_R represents the overall sensitivity while X_R compensates for the reaction efficiency of $H_3O^+(H_2O)$ reagent ion. Sensitivity factors, S_R, are determined from the slopes of calibration curves created through dilution of a certified high pressure multi-component gas mixture (Apel-Reimer Environmental Inc. Denver, CO) and were checked periodically throughout the measurement period. The X_R terms employed were the same as those determined previously[9,10] and are included in table G-1 along with the sensitivity factors used in this study. We recently discovered that that negative X_R values reported for the toluene, p-xylene and 1,2,4-trimethylbenzene in table G-1 do not accurately reflect the reactivities of these compounds with $H_3O^+(H_2O)$[10]. This error is only significant when the reagent ion distribution observed during the calibration procedure is substantially different than that measured when sampling the exhaust stream. The bulk of the sampling occurred from the diluted particle probes where the $I_{H3O+(H2O)}$ signal was about 8-13% of the I_{H3O+} signal, which is similar to conditions under which the calibrations were performed. In this case, the error in using the incorrect X_R term is no larger than 10% for the C2 and C3-benzenes and even smaller for toluene. However, while sampling under the highest water partial pressures the $I_{H3O+H2O}$ increased to about 25% of the I_{H3O+}, which results in an overestimation of the C2 and C3-benzene concentrations by up to 20%.

TABLE G-1.—COMPOUNDS MONITORED WITHIN THE EXHAUST EMISSION MATRIX. THEIR PROTON TRANSFER REACTION PRODUCTS AND RELATIVE ABUNDANCE. THE ION USED FOR QUANTIFICATION WHERE IN PARENTHESES IS SHOWN THE BRANCHING FRACTION OR THE CALIBRATION COMPOUND. CALIBRATION FACTORS AND REACTION RATE COEFFICIENTS USED FOR QUANTIFICATION. SEE TEXT FOR MORE DETAIL.

Compound	Ions formed (abundance)	Ion quantified (branching fraction)	S_R	X_R	k (mL/s) x 10^9
Methanol	(a) 33 (100%)	33 (methanol)	0.3	0.38	2.33
Propene	(a) 41 (31%), 43 (69%)	43 (0.69)	-	-	1.58
Acetaldehyde	(a) 45 (100%)	45 (acetaldehyde)	0.73	0.6	3.36
Butenes	(b) 57 (100%)	57 (1.0)	-	-	1.73
Acrolein	(c) 57 (100%)	57 (1.0)	-	-	3.35
Acetone	(a) 43 (3%) 59 (97%)	59 (acetone)	1.05	0.7	3.00
Propanal	(b) 59 (100%)	59 (acetone cal)	1.15	0.7	3.44
Glyoxal	(c) 59 (100%)	59 (acetone cal)	0.47	0.7	1.34
Acetic acid	(a) 43 (40%), 61(60%)	61 (0.60)	-	-	2.27
1-Pentene	(a) 41 (13%), 43 (53%), 71 (34%)	71 (0.34)	-	-	1.87
Butanal	(b) 55 (57%), 73 (43%)	73 (1.0)	-	-	3.49
Methylglyoxal	(c) 73 (100%)	73 (1.0)	-	-	-
Benzene	(a) 79 (100%)	79 (benzene)	0.51	-0.4	1.97
1-Hexene	(a) 41 (13%), 43 (50%), 57 (13%), 85 (24%)	85 (0.24)	-	-	2.02
Toluene	(a) 93 (100%)	93 (toluene)	0.72	-0.4	2.12
Phenol	(d) 95 (100%)	95 (1.0)	-	-	2.52
1-heptene	(a) 41 (6%), 57 (92%), 99 (2%)	99 (0.02)	-	-	2.14
Styrene	(a) 105 (100%)	105 (1.0)	-	-	2.33
o,m,p-xylene	(a) 107 (100%)	107 (p-xylene cal)	0.80	-0.4	2.27
Ethylbenzene	(a) 79 (30%) 107 (70%)	107 (p-xylene cal)	-	-	2.25
Benzaldehyde	(b) 107 (100%)	107 (p-xylene cal)	-	-	4.12
C3-benzenes	(a) 121 (100%) propyl- benzene 79(70%) 121(30%)	121 (1,2,4 $(CH_3)_3$-C_6H_6)	0.75	-0.4	2.4
Naphthalene	(c) 129 (100%)	129 (1.0)	-	-	2.59
C4-benzenes	(b,c) 135(isomer dependent) 79 (isomer dependent)	135 (1.0)	-	-	2.5
Methyl-naphthalenes	(c) 143 (100%)	143 (1.0)	-	-	2.71
C5-benzenes	(c) 135(isomer dependent) 79 (isomer dependent)	149 (1.0)	-	-	2.6[e]
Dimethyl-naphthalenes	(c) 157 (100%)	157 (1.0)	-	-	2.9[e]

Reaction rate coefficients are taken from the compilation of J. Zhao and R. Zhang, Atmos. Environ. 38 (2004) 2177.
(a) This study, ambient temperature and drift tube pressure = 1.93 mbar.
(b) Drift tube pressure = 2.4 mbar Warneke et al. Environ. Sci. Technol., 37 (2003) 2494.
(c) Anticipated product distribution.
(d) Christian et al. J. Geophys. Res., 109, D02311, doi:10.1029/2003JD003874, 2004
(e) Estimated reaction rate coefficient.

For compounds where calibration gas standards were not available, then the concentrations were calculated assuming simple reaction kinetics apply[11] and the following relationship was used.

$$VMR_R = \left(\frac{I_{RH^+} / BF}{I_{H_3O^+} k_c t} \right) \left(\frac{1}{N_{tot}} \right) \qquad (2)$$

I_{RH+}, I_{H3O+} are the respective transmission corrected ion intensities, *BF* is the product branching fraction, t is the drift time of the reagent ions, k_c is the reaction rate constant and N_{tot} is the total number density (molecules/mL). For polar compounds capable of reacting with the $H_3O^+(H_2O)$ ion via a ligand switching reaction [12], I_{H3O+} represents the sum of H_3O^+ and $H_3O^+(H_2O)$. Reaction rate constants, k_c, used in this study were taken from the compilation of Zhao and Zhang[13] and are reported in table G-1. The branching fractions, included in table G-1, account for the loss of signal intensity to the ion of interest due to fragmentation of the pseudo-molecular ion. Inherently there are greater uncertainties associated with the concentrations derived using Eq. 2 stemming from uncertainties in the value of the reaction rate constant[14] and the correction factors for the ion detection and transmission characteristics of the instrument[15,16]. Table G-2 compares the concentrations determined by the two methods for the components present in the calibration gas mixture, where the ratio represents the concentration calculated assuming simple reaction kinetics (Eq. 2) relative to that determined using calibrated response factors (Eq. 1). With the exception of benzene, the variation from the calibrated value is within ± 25% which is considered to be good agreement. Benzene appears to be lower than the other compounds for several reasons. Benzene is the only compound that does not react with $H_3O^+(H_2O)$ reagent ion[17,18]. Also, the distribution of H_3O^+ and $H_3O^+(H_2O)$ exiting the drift tube is altered by collision induced dissociation reactions occurring between the drift tube and the quadrupole mass spectrometer[16,19]. Similar results can be expected for non-polar hydrocarbon components having proton affinities less than or equal to that of benzene since these compounds also do not react with $H_3O^+(H_2O)$, which includes propene and the 2-butenes[20]. On the basis of the benzene result and the additional uncertainty associated with correcting for fragmentation, the concentrations calculated using Eq. 2 are considered to be accurate within ± 40%.

TABLE G-2.—RATIO OF CALCULATED TO MEASURED CONCENTRATIONS FOR THE COMPONENTS CONTAINED WITHIN THE CALIBRATION GAS STANDARD.

Compound	Ratio	Compound	Ratio
Methanol	0.81 ± 0.04	Benzene	0.65 ± 0.02
Acetaldehyde	0.92 ± 0.04	Toluene	0.84 ± 0.03
Acetone	1.08 ± 0.05	p-Xylene	0.87 ± 0.03
Isoprene	0.78 ± 0.06	1,2,4-trimethylbenzene	0.77 ± 0.03
Methacrolein	0.83 ± 0.06	Alpha-pinene	0.80 ± 0.03

Limits of detection (LD) for most of the compounds in this study are on the order of 0.3 – 1.2 ppbv for the 0.2 s ion integration times. These LD's are defined as three times the signal-to-noise ratio (S/N) where the S/N is taken as the 1σ scatter in the measured background signals. Compounds detected at ion masses having higher persistent instrumental backgrounds have proportionately higher LD's, shown in parentheses, and include methanol (2.8 ppbv), propene (3.4 ppbv), acetaldehyde (2.7 ppbv) and acetic acid (3.4 ppbv).

3. Results

Figure G-2 shows a time series of the emission profiles of CO_2, formaldehyde and benzene observed from the 1-m probe as the engine power is stepped down from 100% rated thrust to 4% rated thrust. The sampled gas stream has been diluted and the extent of dilution is reflected by the CO_2 level shown in the top part of the trace. The shaded zones represent the times over which the engine operating condition was considered to be stable. The concentration traces of benzene and formaldehyde both show low, nearly zero, values from high power until the engine reaches 15% rated thrust, at which point the concentrations increase very rapidly as the engine power is further reduced to 4%. The large increase in the hydrocarbon emissions at reduced engines powers is consistent with that observed in previous studies[1,5].

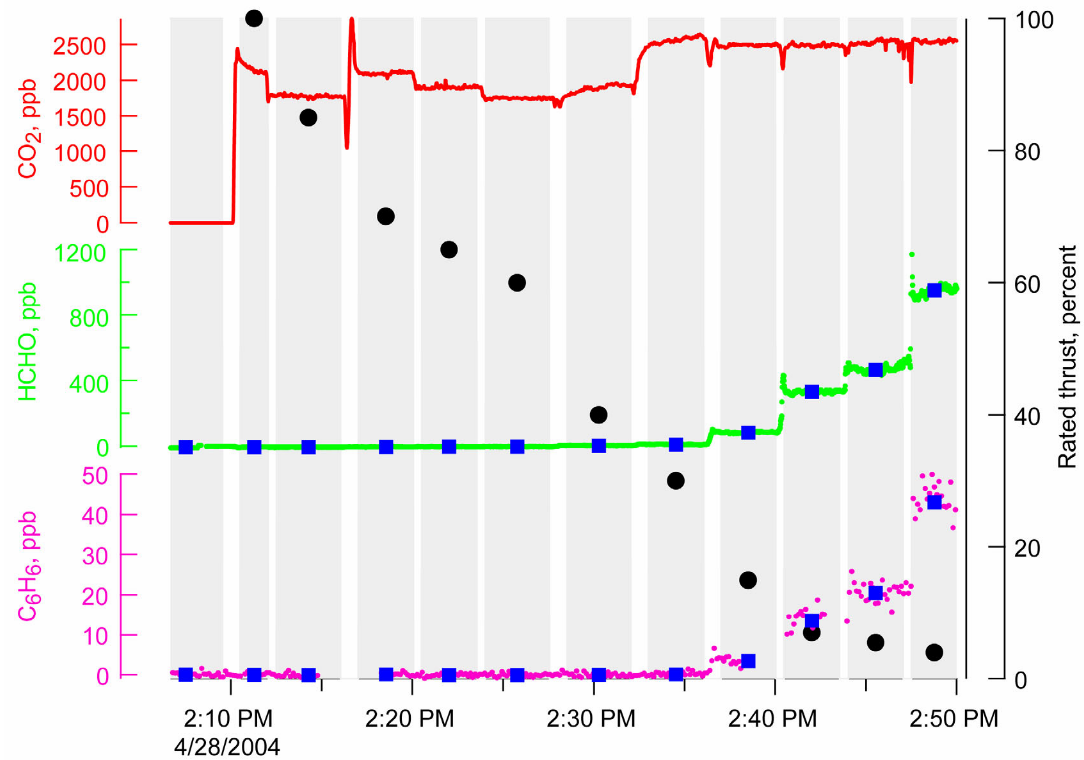

Figure G–2.—Time series showing CO_2, HCHO and C_6H_6 concentrations as a function of engine power setting. Black dots indicate the engine power setting as a percentage of the rated thrust and the shaded regions indicate the time periods of stable engine operation. The blue squares represent the averaged analyte concentration for each time period. Gaps in the C_6H_6 data are time periods during which the instrument background was determined.

Engine emissions are typically reported in terms of an emission index (*EI*), which reflects the mass of pollutant emitted per mass of fuel consumed. In the current study emission indices were computed from emission ratios (*ER*) determined from data like that shown in figure G-2. Values were derived for the different engine power settings using concentrations of the individual components and CO_2 averaged over the stable operating times. These ratios, in turn, were converted into equivalent emission indices using Eq. 3 [5,21]

$$EI(g_x / kg_{fuel}) = ER(mole_x / mole_{CO_2})\left(\frac{MW_x}{MW_{CO_2}}\right)\left(\frac{3160 g_{CO_2}}{kg_{fuel}}\right) \quad (3)$$

where MW_x and MW_{CO2} are the molecular weights of component X and CO_2, respectively and (3160 g CO_2/ kg fuel) is the average emission index of CO_2, assuming 100% efficient combustion of JP-8 fuel. Figure G-3 exhibits emission index values at power settings of 4 and 7% rated engine thrust derived from all of formaldehyde and benzene measurements recorded during the campaign. Both low power settings refer to “idle” conditions with 4% rated thrust being ground idle and 7% rated thrust is the defined idle condition for ICAO engine certification tests. For comparison, the reported emission indices for formaldehyde and benzene measured at 4% rated thrust reported by Spicer et al.[1] have been included in figure G-3. Although the emission indices for both benzene and formaldehyde reported by Spicer et al.[1] fall within the range of the values determined here, it is difficult to make any meaningful comparison between the different data sets due to the large variability in the present measurements. The large variability in the emission indices for both benzene and formaldehyde is surprising since under these conditions neither of the measurements is sensitivity limited, which implies that the observed variability, reflects real changes in HC emissions from the engine. In a companion article [22], we show that this emission variability is primarily caused by changes in ambient temperature and pressure. While examining the variability in the respective benzene and formaldehyde measurements, we found that a plot of the benzene emission indices versus the formaldehyde emission indices showed a strong linear relationship that was independent of power setting and fuel composition (fig. G-3). We also noted that the slope of this plot is the same as the ratio of the benzene and formaldehyde emission indices reported by Spicer et al. [1]. Plots of the emission indices of the other hydrocarbon components relative to that of formaldehyde revealed similar linear relationships. This common behavior suggests that all of the hydrocarbons emissions scale similarly with combustor efficiency. Normalizing the emission data relative to that of formaldehyde provides a convenient means by which to remove the effect of ambient temperature from the data and allows us to examine the relative distribution of the different hydrocarbon emission products present in the exhaust.

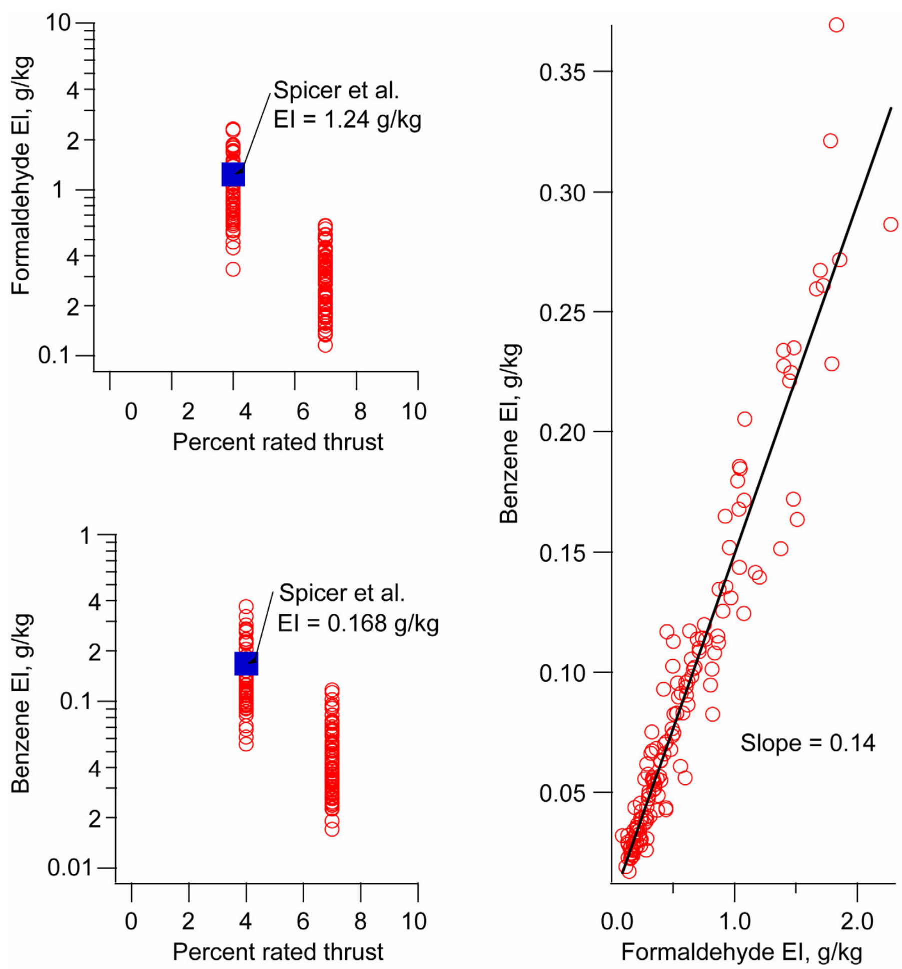

Figure G–3.—Summary of benzene and formaldehyde emission indices determined under low engine power conditions. The highly correlated scatter plot of the benzene emission indices versus the formaldehyde emission indices indicates that the variability in the individual emission indices reflects real compositional changes in exhaust. Note that the slope of the plot is equal ratio of benzene to formaldehyde emission indices reported by Spicer et al.[1]. See text for additional discussion.

Aircraft turbine engine exhaust contains a complex mixture of hydrocarbons. Spicer et al.[1] identified 57 different organic compounds in their study of the exhaust of a CFM-56 engine of which 45 are expected to be ionized and detected by the PTR-MS. Many of these components do not provide unique ion signatures in the PTR-MS and thus are not distinguishable or identifiable on the basis of ion mass alone. Interpretation of the PTR-MS analysis of aircraft turbine engine exhaust is aided considerably and shaped heavily by detailed chemical composition information taken from studies like that of Spicer et al.[1]. By knowing what compounds are present along with the ionization dynamics for those compounds, it is possible to interpret the mass spectrum and reasonable decisions can be made regarding which exhaust compounds can be accurately quantified using the PTR-MS. Table G-3 provides a compilation of the compounds and their emission data that were examined by the PTR-MS technique during the APEX campaign. In the following section, each of the compounds in table G-3 is critically evaluated in terms of which neutral components contribute to the intensity of that ion signal. Where possible, an estimate of the fraction of the signal attributable to the different components is also provided. Chemical composition information is taken from the studies of Spicer et al.[1], Slemr et al.[3,4] and Anderson et al.[5]. Proton transfer reaction product branching fractions are taken primarily from independent laboratory studies performed under experimental conditions similar to those experienced during the APEX measurement campaign. However, in some cases the branching fractions and ionization efficiencies are taken from other studies determined under different experimental conditions and are not necessarily totally reflective of the measurements of this study.

TABLE G-3.—COMPARISON OF PTR-MS MEASUREMENTS WITH THAT OF SPICER ET AL. FOR CFM-56 ENGINE AT IDLE.

Neutrals	ER_x/ER_{HCHO} PTR-MS	ER_x/ER_{HCHO} Spicer et al.	% Deviation	EI_x[#] g/kg	LD[*] g/kg
Methanol	0.15 ± 0.01	Na	Na	0.20	0.003
Propene	0.35 ± 0.01	0.26	34	0.61	0.01
Acetaldehyde	0.23 ± 0.02	0.24	-2	0.42	0.01
butenes + acrolein	0.15 ± 0.01	0.18	-20	0.36	0.002
acetone + propanal + glyoxal	0.090 ± 0.007	0.122	-26	0.22	0.004
acetic acid	0.036 ± 0.007	Na	Na	0.09	0.01
pentenes	0.21 ± 0.01	0.056	282	NR	-
butanal + methylglyoxal	0.046 ± 0.005	0.065	-29	0.14	0.004
Benzene	0.054 ± 0.004	0.053	2	0.17	0.004
hexenes	0.13 ± 0.01	0.021	520	NR	-
Toluene	0.020 ± 0.002	0.017	19	0.076	0.002
Phenol	0.025 ± 0.003	0.005	386	0.096	0.003
heptenes	0.96 ± 0.14	0.011	8697	NR	-
Styrene	0.0067 ± 0.0006	0.0073	-7	0.029	0.001
C2-benzenes + benzaldehyde	0.028 ± 0.003	0.025	13	0.12	0.002
C3-benzenes	0.023 ± 0.003	Na	Na	0.11	0.002
Naphthalene	0.0052 ± 0.0007	0.01	-50	0.027	0.001
C4-benzenes	0.011 ± 0.002	0.0038	189	0.061	0.001
Methylnaphthalenes	0.0024 ± 0.0004	0.0078	-69	0.014	0.001
C5-benzenes	0.0044 ± 0.001	0.0035	25	0.026	0.002
Dimethyl-naphthalenes	0.0012 ± 0.0002	Na	Na	0.008	0.001

Spicer, C. W.; Holdren, M. W.; Riggin, R. M.; Lyon, T. F. Chemical-Composition and Photochemical Reactivity of Exhaust from Aircraft Turbine-Engines. *Annales Geopphysicae-Atmospheres Hydrospheres and Space Sciences* **1994**, 12(10-11), 944-955.
Na – no data available NR – not reported
based on ER of formaldehyde of 5.72 x 10^{-4} (mole HCHO)/(mole CO_2) from Spicer et al.
* calculated based on the PTR-MS detection limit and a $\Delta CO2$ = 2000 ppmv

***Methanol*.**—Proton transfer to methanol results only in the formation of the pseudo-molecular ion (m/z 33) and is the only VOC known to react in the PTR-MS to form an ion at m/z 33, so its presence in aircraft exhaust can be deduced directly from the presence of this ion in the mass spectrum. This ion does not suffer from any hydrocarbon interferences and only the oxygen-17 isotope of O_2^+ provides any interference to the measurement. The contribution of this ion interference is evaluated during the instrumental background measurement and leads to an elevated detection limit for this compound. This is the first report that identifies methanol as a component of aircraft exhaust.

***Propene*.**—Proton transfer to propene produces two product ions, the pseudo-molecular ion m/z 43 that constitutes approximately 68% of the ion signal and a fragment ion m/z 41. It is not possible to confirm the presence of propene in the exhaust stream solely on the presence of ion intensity at m/z 43 as other exhaust components such as acetic acid, pentenes, hexenes and the larger alkanes (>C7) are also known to contribute intensity to this ion. The total intensity measured at m/z 43 (I^{tot}) reflects the sum of the contributions from each of the different compounds. The relative contribution from each component can be expressed as the normalized emission ratio weighted by the reaction rate constant and the branching fraction, Eq. 4,

$$I_{43}^{tot} \propto \sum \left(\frac{ER_x}{ER_{HCHO}} \right) BF_{43}^{x} k_c^{x} \tag{4}$$

where ER_X and ER_{HCHO} represent the respective emission ratios of component X and HCHO, BR represents the fraction of the ion signal detected at m/z 43 that comes from component X and k_c is the reaction rate constant for component X. The fraction of the signal attributable to propene is then equal to $I^{propene}/I^{tot}$ and can be evaluated using the normalized emission ratios reported for the alkenes by Spicer et al.[1] and acetic acid by the PTR-MS in table G-3 along with the branching fractions and reaction rate constants in table G-1. The alkane (>C7) contribution can only be approximated but is expected to be small because the molar concentrations of these species are low[1]. This alkane contribution can be estimated from Spicer et al.[1] where the sum of the alkanes > C7 yields a normalized emission ratio of 0.037 and from Jobson et al.[15] who provide a reaction rate constant of 1×10^{-9} mL/s and an approximate branching fraction (0.23). The relative contributions from each of the components are then as follows: propene 68%, acetic acid 10%, pentenes 14%, hexenes 6% and the alkanes 2%. Presently, all of the intensity at m/z 43 has been quantified as if it came from propene and the normalized emission ratio measurement reported in table G-3 of 0.35 is 34% higher than that reported by Spicer et al.[1] We note that 68% of the reported propene emission ratio (0.24) is attributable to presence of propene, which is the same result reported by Spicer et al.[1]. Quantification of propene using the PTR-MS technique has a number of caveats as discussed above and results reported in table G-3 represent a practical upper limit to the actual value.

***Acetaldehyde*.**—Proton transfer to acetaldehyde produces only protonated acetaldehyde (m/z 45). Acetaldehyde is known to be a significant aircraft emission product and the majority of the measured ion intensity is attributed to this compound. There are no known hydrocarbon constituents of aircraft exhaust that are expected to interfere with the measurement of acetaldehyde, but CO_2 does produce a weak response in the PTR-MS[23]. The magnitude of the CO_2 interference has been determined to be 1 pptv acetaldehyde equivalent per ppmv of CO_2 and this factor was used to compensate for the CO_2 interference. The acetaldehyde concentrations were derived from calibrated response factors. The acetaldehyde measurements made in this study are in excellent agreement with those reported by Spicer et al.[1].

***Butenes + acrolein*.**—The isomeric butenes and acrolein are both expected to form pseudo-molecular ions and be detected at m/z 57 and thus cannot be separately quantified. This is unfortunate because acrolein is an important air toxic and its potential presence in commercial aircraft exhaust raises considerable concern. Because the relative molar contributions of these two substances in the exhaust are thought to be similar, butenes (45%) and acrolein (55%) and a weighted average rate constant of 2.6×10^{-9}

mL/s ($0.45*1.75\times10^{-9}$ mL/s + $0.55*3.35\times10^{-9}$ mL/s) was used to quantify the sum of these two components. Since there are also a number of higher molecular weight alkenes and alkanes that produce fragment ions at m/z 57, the potential contributions from these components and their relative importance should be addressed. Using Eq. 4 as discussed above the relative contributions from the different components to the intensity measured at m/z 57 are estimated as follows: butenes 24%, acrolein 65%, hexene 1%, heptene 4%, >C7 alkenes 3% and >C7 alkanes 3%. The contributions from the larger alkenes and alkanes were estimated using normalized emission ratios of >C7 alkanes (0.037), >C7 alkenes (0.014), m/z 57 branching fractions for the >C7 alkenes and >C7 alkanes of 0.5 [15] and reaction rate constants of $2.5\text{x}10^{-9}$ mL/s and $1\text{x}10^{-9}$ mL/s respectively. The normalized emission ratio measurement determined here is about 20% lower than the result predicted from the work of Spicer et al.[1]. It is not possible to make any strong conclusions regarding the amount of acrolein present in the exhaust stream although the fact that the PTR-MS result is low suggests that there is probably less acrolein present than previously reported.

Acetone + propanal + glyoxal.—Three known aircraft emission components contribute to the ion intensity monitored at m/z 59. There are no known mass spectral interferences from other substances and the greatest error in quantifying the concentration sum should be related to the uncertainty in the value of the response factor. The signal at m/z 59 was quantified using a weighted average response factor of 0.71. The calibration factors reported in table G-1 for propanal and glyoxal were estimated by scaling the calibrated acetone response factor by the ratio of the reaction rate constants (for example the response factor for glyoxal ($1.34\times10^{-9}/3.00\times10^{-9})*1.05 = 0.47$). The relative proportions of acetone (0.125), propanal (0.25) and glyoxal (0.625) were taken from Spicer et al.[1] The normalized emission ratio reported here is low (-26%) but still in reasonable agreement with that derived from Spicer et al.[1] for these compounds.

Acetic Acid.—The ion detected at m/z 61 has been attributed to protonated acetic acid. This assertion is based on molecular weight and a persistent ion signal that was slow to clean up when the instrument was purged with clean nitrogen. The sluggish time response is indicative of a highly polar compound, which allows us to eliminate less-polar species having the same molecular weight such as methylformate and methoxyethane. Glycolaldehyde can not be eliminated and may be a constituent of aircraft exhaust. The signal at m/z 61 was quantified assuming 52% of acetic acid is detected as the pseudo-molecular ion. The correlation between the acetic acid signal and that of formaldehyde is not as high as it is for the all of the other compounds studied. The apparent nonlinear behavior at low concentrations is currently attributed to sampling problems associated with this compound. Acetic acid has not been previously detected in aircraft exhaust and this study indicates that it is present in significant amounts.

Pentenes.—Proton transfer to 1-pentene results in a significant amount of fragmentation at 1.9 mbar with only 34% of the product being detected at the pseudo-molecular ion, m/z 71. Based on the work of Warneke et al.[23], we assume that the other pentene isomers fragment to a similar extent. The ion at m/z 71 is not a unique indicator of the presence of pentene in the exhaust as higher molecular weight alkanes and alkenes will also contribute some ion intensity at this mass. Proton transfer to >C7 alkenes[15,24] and >C7 alkanes[15] reportedly produce fragment ions at m/z 71. Spanel and Smith[25] indicate that O_2^+ reactions with large alkanes yields fragment ions at m/z 71. However, O_2^+ levels in the PTR-MS are generally small (a few percent of the total ion intensity) so that these reactions can be ignored. The contributions from the larger alkenes and alkanes were estimated using normalized emission ratios of >C7 alkanes (0.037), >C7 alkenes (0.014), m/z 71 branching fractions for the >C7 alkenes and >C7 alkanes of 0.20[15] and reaction rate constants of 2.5×10^{-9} mL/s and 1×10^{-9} mL/s respectively. The estimated contributions from the different components to the intensity measured at m/z 71 are as follows: pentenes 70%, >C7 alkenes 16% and >C7 alkanes 14%. Ignoring the contributions from these higher molecular weight components and quantifying the signal at m/z 71 as if all of the ion intensity arises from proton transfer reactions to the various pentenes leads to a normalized emission ratio for the pentenes that is almost a factor four larger than that derived from Spicer et al.[1] Although the low branching fraction magnifies small errors, this large discrepancy indicates that some unknown component(s) contribute additional ion intensity to this mass. We note that Spicer et al.[1] were only able to identify about 70% of the total hydrocarbon emissions in their exhaust study. Unsaturated 4 carbon aldehydes and ketones are potential candidates for compounds that might be present in the exhaust matrix that would also be detected at m/z 71. Because of these uncertainties, deriving the pentene concentration from the ion intensity at m/z 71 is not considered to be reliable in the present study, and no value is reported for the emission index of this compound in table G-2.

Butanal + methylglyoxal.—There are two previously reported emission components that are expected to react via proton transfer to form ions at m/z 73. Methylglyoxal is expected to only form the pseudo-molecular ion, while butanal is known to fragment at 2.4 mbar with only 43% of its ion intensity being detected at m/z 73. It is uncertain to what extent butanal will fragment under the conditions of the present experiment. A reaction rate constant of 2×10^{-9} mL/s has been assumed for the quantification of the sum of these two compounds since the reaction rate constant for methylglyoxal is not known. The normalized emission ratio determined for these compounds is observed to be low (-23%) relative to that reported by Spicer et al.[1]. The reasonably close agreement between these two measurements may be circumstantial and at best the measurement reported here is viewed as an estimate since the rate constant for methylglyoxal is not known and we have not accounted for the fragmentation of butanal.

Benzene.—Proton transfer to benzene forms only the pseudo-molecular ion that is detected at m/z 79. Benzene is expected to be the most dominant aromatic component in aircraft exhaust and so virtually all of the ion intensity detected at m/z 79 can be attributed to benzene. Spectral interference from the fragmentation of ethyl and propylbenzene is not expected to affect this measurement based on their relatively low concentrations in the exhaust matrix. The normalized emission ratio measurement reported here for benzene is in excellent agreement with that of Spicer et al.[1].

1-hexene.—Proton transfer to 1-hexene produces a variety of ionic products with only 24% of ion intensity being detected at the pseudo-molecular ion m/z 85. This mass is not unique and there are higher molecular weight alkanes and alkenes that will contribute intensity to this mass[15]. Assuming that all of the ion intensity detected at m/z 85 is derived solely from 1-hexene produces a normalized emission ratio approximately 6 times larger than that reported by Spicer et al.[1] and suggests previously unidentified hydrocarbon species are present in the exhaust samples. Unresolved large alkane and alkene compounds are the most likely candidates but unsaturated five carbon carbonyl compounds are also plausible exhaust components that would contribute intensity to this ion mass. The PTR-MS measurement of 1-hexene in this study is not considered reliable and an emission index for this compound is not reported.

Toluene.—Proton transfer to toluene produces only the pseudo-molecular ion that is detected at m/z 93. There are no other previously identified compounds in the exhaust matrix that interfere with the measurement of toluene. The normalized emission ratio determined for toluene in this study is slightly (20%) higher but is still in good agreement with that derived from Spicer et al.[1].

Phenol.—Proton transfer to phenol is expected to produce only the pseudo-molecular ion, m/z 95. Phenol has been previously identified as an aircraft emission product[1]. This ion mass is reasonably unique and there are only a few compounds that would potentially interfere. Vinyl furan and dimethyldisulfide represent potential interferences but there is not evidence for their presence in aircraft exhaust. The normalized emission ratio determined in this study for phenol is approximately 5 times larger than that reported by Spicer et al.[1]. Christian et al.[26] have measured phenol using both PTR-MS and FTIR methods and observed good agreement between the two methods. Because of the polarity and low volatility of phenol sampling loses of phenol in the canister samples appears to be the most likely reason for the discrepancy in the data sets.

1-heptene.—Proton transfer to 1-heptene produces only a very small amount (2%) of the pseudo-molecular ion at m/z 99. As a result this ion mass is not a good indicator of the presence of this exhaust component. The proton transfer reaction products of the higher alkane and alkene components are the most likely contributors to the ion intensity at this mass. The PTR-MS measurement of 1-heptene is not considered to be reliable and the emission index for this compound is not reported.

Styrene.—Proton transfer to styrene produces only the pseudo-molecular ion, m/z 105. Styrene has been previously identified as an aircraft exhaust emission product and there are no other emission components that are expected to interfere with this measurement. The proton transfer reaction products of peroxy isobutyryl nitrate[27] are detected at m/z 105. However, because previous studies show that peroxyacyl nitrate species are present in engine exhaust plumes at exceedingly small concentrations[5], we do not expect any significant interference from this compound. The normalized emission ratio determined for styrene appears to be in excellent agreement with that of Spicer et al.[1].

C2-benzenes + benzaldehyde.—The isomeric xylenes and ethyl benzene are referred to as the C2-benzenes. Benzaldehyde is detected along with the C2-benzenes, as it has the same nominal molecular weight. All of these compounds form pseudo-molecular ions and are detected at m/z 107. There are several minor perturbations towards quantifying this collection of compounds. Ethylbenzene fragments upon ionization and only 70% of the intensity of this ion is detected at m/z 107. A single calibration factor based on the response of p-xylene is assumed to apply to all of these compounds. While the reaction rate constants for all of the C2-benzenes are quite similar the proton transfer reaction rate constant for benzaldehyde is substantially larger[13]. The use of a single sensitivity factor may not be totally appropriate since the predicted benzaldehyde concentration is only slightly less than that of the C2-benzenes. However, Warneke et al.[23] have measured the sensitivity factors for the C2-benzenes and benzaldehyde and report that the sensitivity factor for benzaldehyde is lower than that of C2-benzenes. No correction has been made to the data, however. If the sensitivity factor was adjusted to compensate for benzaldehyde the new sensitivity factor would be equal to 1.06. Without any correction to the data the normalized emission ratio for this collection of compounds is 13% higher than that reported by Spicer et al.[1]. Application of the new sensitivity factor would reduce the normalized emission ratio to 0.21 which would then be 16% lower than the reported value. Regardless of which result is used both are considered to agree within the stated uncertainty of the method.

C3, C4, C5-benzenes.—These designations are not exact as they represent the sum of all the compounds that have the same molecular weight as the parent hydrocarbon, ie C_9H_{12} for the C3-benzenes plus the isobaric (same molecular weight different molecular formula) aldehydes and ketones. For the C3-benzenes, 13 compounds contribute ion intensity to m/z 121, which includes the eight isomeric forms of C_9H_{12} plus the five isomeric carbonyl compounds C_8H_8O. The C4-benzenes actually represents the sum of all isomeric forms of $C_{10}H_{14}$ and $C_9H_{10}O$ while the C5-benzenes will reflect the contributions of the $C_{11}H_{16}$ and $C_{10}H_{12}O$ isomers. We quantified these species by assuming that a single sensitivity factor or reaction rate constant adequately reflects the reactivity of all of the components. Most of these compounds are expected to only form the pseudo-molecular ion. The singly substituted forms like propyl and isopropylbenzene do fragment substantially in the PTR-MS and their contributions, although minor, will not be properly represented in the current measurements. Comparison with previous studies has only limited utility because only a small number of these components are typically resolved during gas chromatographic analysis[1,5]. Comparison with the data reported by Spicer et al.[1] shows that the PTR-MS results are larger by about a factor of three for the C4-benzenes but are only slightly higher (25%) for the C5-benzenes. No data was reported by Spicer et al.[1] for any of the C3-benzenes. The PTR-MS results indicate that some of the unidentified mass component of the Spicer et al.[1] study contains aromatic components within this group.

Naphthalene and substituted naphthalenes.—The naphthalenes were the only polycyclic aromatic compounds monitored using the PTR-MS and proton transfer to these compounds exclusively forms pseudo-molecular ions. These compounds have been previously reported as exhaust emission components and there are no other emission components that are expected to interfere with these measurements. The naphthalenes are an important class of compounds because they are present in both the particle and gas phase and understanding their emission characteristics may provide insight into the gas-to-particle conversion mechanism. The normalized emission ratios determined here for naphthalene and the methylnaphthalene are considerably lower, by factors of two and three respectively, than those reported by Spicer et al.[1]. The emission ratios for these components are quite small so that it is uncertain as to whether these differences are related to experimental errors or reflect real differences in the emissions.

4. Conclusion

The PTR-MS technique was applied as on-line monitor of the volatile organic compounds emitted from a commercial aircraft turbine engine. This approach was demonstrated to be a rapid, sensitive and reliable quantitative approach for determining selective hydrocarbon emissions within the engine exhaust matrix. The PTR-MS measurements helped corroborate the variability of the HC emission indices with ambient temperature. We observed that plots of the HC emission indices versus that of the emission index determined for formaldehyde (normalized plots) were linear and essentially independent of power setting and fuel composition. This result suggests that all of HC emissions scale with combustor efficiency and that the HC speciation is not significantly altered as a function of fuel or power setting even as the magnitude of the HC emissions vary dramatically. Normalizing the emission data relative to that formaldehyde provided a convenient means for removing the effect of ambient temperature from the data and allowed us to compare our observations with those from previous studies that were conducted under potentially quite different environmental conditions. The emission characteristics of the CMF-56 engine examined in this study were found to be in excellent agreement with the results of Spicer et al.[1]. Eighteen ion masses were quantified, representing individual compounds or grouping of compounds, and the emission indices derived from these measurements agreed with Spicer et al.[1] to within ± 35% for all but three components. Nine different compounds including methanol, acetaldehyde, acetic acid, benzene, toluene, phenol, styrene, naphthalene, and the methylnaphthalenes were identified as components in the engine exhaust matrix that can be reliably quantified by the PTR-MS. Two new compounds, methanol and acetic acid, have been tentatively identified for the first time as turbo-fan aircraft exhaust emission products. The PTR-MS represents a new and valuable quantitative on-line analysis tool for studying the hydrocarbon emissions from commercial aircraft turbofan engines.

Future effort will be needed to address the question regarding the level of the acrolein present in the exhaust. Acrolein is an important air toxic compound and its reported presence in commercial aircraft exhaust has raised considerable concern. While the conventional PTR-MS approach results does not provide quantitative information about acrolein, since it is incapable of resolving the $C_4H_9^+$ and $C_3H_5O^+$ species, ion trap proton transfer reaction based methods[28] might be capable of resolving these ions and thus provide needed quantitative information for this species. Resolution of the acrolein content also has important consequences to measurement of the total alkene content within the exhaust. Considerable effort was expended in interpreting the PTR-MS ion masses at m/z 43, 57, 71 and 85, which reflect the presence of the alkene, large (>C7) alkane and unsaturated carbonyl compounds (ie. acrolein) in the exhaust matrix. The anticipated concentration distribution of these components, alkenes (76%), large alkanes (6%) and acrolein (18%) allows us to dismiss the alkane contribution (on the basis of concentration bias and low ionization efficiency) to these ion masses. Should the contribution from acrolein be found to be less important, then the sum of signals at m/z 43, 57, 71 and 85 could be used to provide quantitative information about the total alkene concentration within the exhaust. Alkene emissions are important because they are photochemically reactive species that lead to the formation of ozone and secondary aerosol particles.

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Appendix H
Concentrations and Physical Properties of Particles Within the Exhaust of a CFM-56 Engine*

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Concentrations and Physical Properties of Particles Within the Exhaust of a CFM-56 Engine

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1. Background

Atmospheric aerosols greatly influence local and regional air quality and participate in many processes that impact climate. And, although aerosols arise from many sources, the burning of fossil fuels for energy production and transportation is the largest single source of anthropogenic aerosols to the atmosphere. Mid- to high-temperature combustion not only produces soot as a primary emission, but releases large quantities of low volatility organic, sulfur and nitrogen compounds that can condense to form "secondary" aerosols. Aircraft are a prolific source of aerosol particles, but, until recently, their emissions received relatively less attention because they account for only a small fraction of the global fossil fuel usage. ICAO does regulate a variety of aircraft emissions, but the limits on particle production are primarily aimed at eliminating visible exhaust plumes and haze, not at reducing health and climate impacts. ICAO mandates that jet engine "smoke numbers" (a qualitative measure of soot emissions) be less than a given amount in order for them to be certified for use on commercial airliners. Although all manufacturers comply with these standards, recent studies show that aircraft generate more small particles (< 200 nm in diameter) per unit mass of fuel burned than any other mode of transportation. Such particles are particularly adept at penetrating deep into the lungs of exposed animal life, are highly efficient at absorbing and scattering radiation, and are active as cloud and ice forming nuclei. The impact of aircraft on climate and upper-level processes are further enhanced by the fact that aircraft spend most of their operational time at altitudes where emitted aerosols have significantly greater lifetimes and may be directly entrained into cloud-forming air parcels. Impacts to local air quality may be equally insidious because large numbers of aircraft typically operate from relatively small, urban-based locations.

In recent years, the realization that aircraft emissions pose human health risks and can potentially alter climate coupled with the projected growth in airline travel spurred a flurry of research activity within the U.S. and Europe aimed at characterizing gas-turbine emissions and their atmospheric impacts. At home, NASA took a leadership role in this effort, sponsoring the Atmospheric Effects of Aviation Project (AEAP), which funded a variety of investigations to delineate the climatic and chemical impacts of gaseous and particulate emissions from subsonic aircraft. A number of important and successful field and laboratory investigations were conducted under AEAP before it was terminated due to budgetary constraints in FY2000. Results from these studies have greatly advanced our understanding of aviation impacts on ozone and cirrus clouds and have led to development and significant improvement of 3-D climate and atmospheric chemical models. Despite these advances, many important questions were left unanswered. Particularly lacking were information on the concentrations and characteristics of aircraft emitted aerosol and aerosol precursors and a conceptual understanding of the factors that control these emissions. These data are critical not only for assessing the climatic impacts of aviation, but also for establishing sampling/measurement methodologies to replace the out-dated and quantitatively useless "smoke number" standard, and evaluating the effects of airports and flight operations on local air quality

To fill this information gap, the environmental assessment focus area of NASA's Ultra-Efficient Engine Technology program (managed by Chowen Wey at NASA GRC) has sponsored a series of recent ground-based emission studies on commercial aircraft parked in terminal area run-up facilities. The first of these, the Experiment to Characterize Aircraft Volatile Aerosol and Trace Species Emissions (EXCAVATE), was conducted in January 2002 and focused on examining the soot and volatile aerosol emissions of the NASA B757 aircraft as a function of engine power and plume age. Aerosol and gas-phase measurements were obtained on samples extracted from probes placed 1, 10, 25 and 35 m downstream of the RB211 engine exhaust plane as the aircraft burned three different fuels and operated at thrust levels ranging from idle to climb. Results indicated that although soot dominated aerosol mass loading directly behind the engine, large numbers of organic and sulphate particles formed very rapidly within the cooling exhaust plume and soon dominated total number emissions and comprised a large fraction of the total mass [Anderson et al., 2003; 2005]. Fuel sulfur content and non-equilibrium thermal conditions within the engine were determined to be significant factors in regulating the secondary aerosol emissions.

The success of EXCAVATE coupled with the pressing need to provide accurate data for assessing aircraft impacts on local air quality motivated NASA to conduct the more detailed and broader-scoped, Aircraft Particle Emission Experiment (APEX), which is the subject of this report. Conducted in April 2004 at the NASA Dryden Flight Research Facility in Edwards CA, APEX focused on evaluating exhaust sampling approaches; gathering "source profile" data to be used in modeling airport PM2.5 contributions; and examining the roles of fuel aromatic and sulfur contents in regulating primary and secondary particle emissions, respectively. Using the NASA DC-8 aircraft, which has four, CFM56-2C1 engines, as the source platform, emission measurements were recorded from inlets positioned 1, 10, and 30 m behind the engine as it was operated at 4, 5.5, 7, 15, 30, 45, 60, 65, 70, 85, and 100% of maximum power and burned three different types of fuel: baseline, high sulfur, and high aromatic. Over a two-week experiment period, 34 hours of engine emission data were collected under a variety of ambient conditions. An overview of APEX is presented in the main body of this report. This document focuses specifically upon the aerosol characterization study performed by our group and provides details of our measurement approach along with a summary of important findings.

2. Experiment

2.1 Instruments

Figure H-1 shows a diagram of the LaRC aerosol characterization system. Important components include 1) a TSI 3022 condensation nuclei counter (CNC) to measure total aerosol number density; 2) a pair of TSI 3760 CNCs to determine the fraction of particles >12 nm that are volatile at temperatures below 300 °C; 3) a dual, differential mobility analyzer (dDMA) to provide 60-s resolution, particle size distributions over the 0.01 to 0.250 µm diameter range; 4) an optical particle counter to measure aerosol size distributions in the 0.1 to 3 µm range; and 5) a particle soot absorption photometer (PSAP) for total aerosol absorption (i.e., carbon

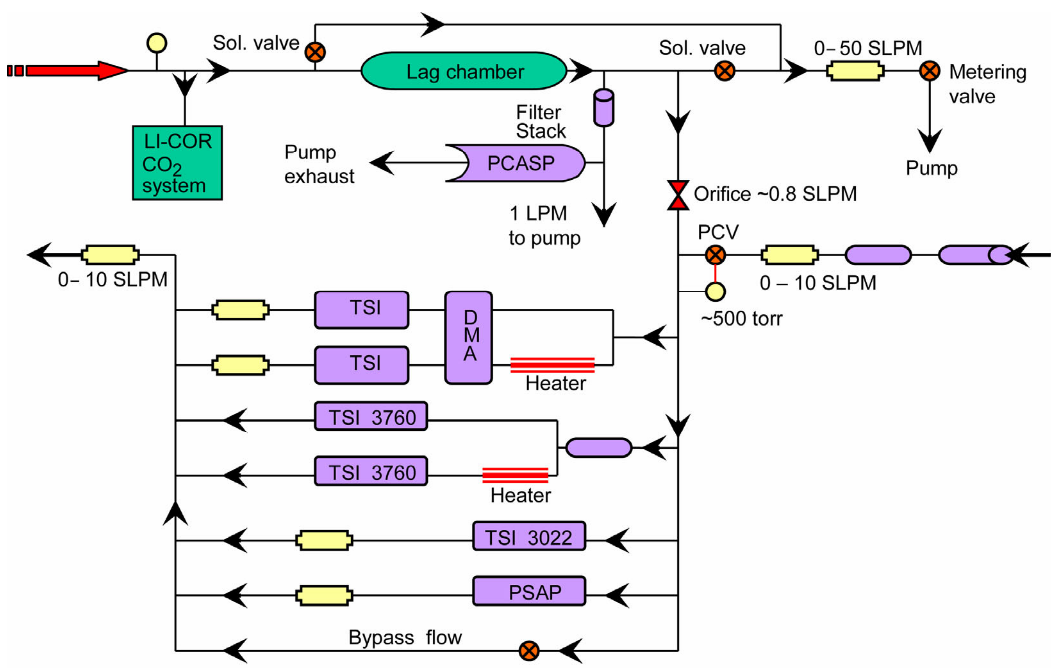

Figure H–1.—Layout of NASA instruments and plumbing.

black) measurements. The specific parameters measured by these instruments along with their anticipated precisions and accuracies are listed in tables H-1 and H-2; brief descriptions are provided below.

TABLE H-1.—IN SITU AEROSOL INSTRUMENTATION

Measured parameter	Instrument	Size range (micrometers)	Response (s)	Precision
Total CN	TSI 3022	0.01 to 1.00	1	20%
Total and Nonvolatile Aerosols	TSI 3760	0.012 to 1.00	1	20%
Fine Aerosol Size	Dual DMA w/TSI3025	0.006 to 0.25	60	20%
Fine, Coarse Aerosol Size Distribution	PCASP	0.1 to 3.0	1	20%
Aerosol Absorption	PSAP	< 1.0	5 sec	$10^{-7}m^{-1}$

TABLE H-2.—DERIVED AEROSOL PARAMETERS

Parameter	Symbol	Units	Temporal Resolution	Estimated Precision
Aerosol Volume	V	μm^3 cm^{-3}	60 s	25%
Aerosol Mass	M	mg m^{-3}	60 s	50%
Geometric Mean Diameter	GMD or d_g	nm	60 s	< 5 nm
Volume Mean Diameter	VMD	nm	60 s	< 5 nm
Geometric Standard Deviation	σ_g	-		
Number Emission Index	EIn	particles kg^{-1}	1 s	20%
Mass Emission Index	EIm	mg kg^{-1}	60 s	30%
Black Carbon Emission Index	EIbc	mg kg^{-1}	60 s	20%

Total aerosol concentrations were monitored with a TSI3022 CNC because, unlike the single particle counting units like the TSI3025 and 3760, it has a photometric, ensemble sampling mode that extends its dynamic range to $>10^7$ cm^{-3}. This is particularly important because the exhaust samples often contained $>10^6$ cm^{-3} particles, even after a 10-fold dilution. This CNC has a 50% cut size of ~7 nm at sea level pressure and a response time of < 5 s.

Cofer et al., [1999] describes the identical CNCs (TSI3760 CNCs) that were used to determine the fractional volatility of aerosol samples and discusses their calibration and performance at sub-ambient pressures. These instruments provided a means for distinguishing soot from condensed hydrocarbon and sulfate particles.

The dual differential mobility analyzer (dDMA) used to record total and nonvolatile nucleation and accumulation mode size distributions was composed of two TSI long-DMA columns (lDMA), both connected to the same voltage sweep generator and input particle neutralizer. Output from the DMAs were routed to identical TSI 3025 CNCs. Both systems provided 25 channels of logarithmically-spaced sizing data over the 9 to 240 nm diameter range. The particle transfer functions for the DMAs were determined for 500 Torr operation and were applied to the voltage sweeps to obtain size distributions appropriate for the pressure and temperature of operation. Size distributions were derived using the technique described by Wang and Flagan [1989] and the accuracy of the inversions were verified by comparing integrated number densities to those recorded by a CNC that continuously monitored number densities in the sample stream. Size scans recorded during times when concentrations changed by more than 50% were rejected as bad data. An in-line heater was placed on the input of one DMA to discriminate the portion of the observed aerosol size distribution that could be attributed to soot from that related to condensed hydrocarbons and sulfates.

Aerosol size in the 0.1 to 3 µm size range was determined using a Particle Measuring Systems (PMS), Passive Cavity Aerosol Spectrometer Probe (PCASP). Based on Mie scattering principle, this instrument sizes particles by measuring the hemispheric side-scatter from particles passing through focus of a 683 nm wavelength, helium-neon laser. The instrument provides 30 bins of size data that are updated continuously. It was calibrated for size sensitivity using latex spheres and for concentration by comparison to a CNC for measuring the number density of monodisperse particles output by a DMA. Aerosol absorption coefficients were determined with a Radiance Research Particle Soot Absorption Spectrometer (PSAP). Composed of a light source, filter, and photodector, the instrument is based on the generally accepted integrating plate (IP) technique in which the change in optical transmission of a filter caused by particle deposition is related to the optical absorption coefficient using Beer's law and a calibration transfer coefficient. In practice, the instrument employs a vacuum pump to draw a metered amount of sample air through a translucent, quartz filter. Using a chopper, it alternately measures the attenuation of 565 nm light through a clean portion of the filter and the portion where sample is being collected. The difference in measured light intensity along the two paths is due to the absorption by particles. A microprocessor within the instrument applies a factory-determined calibration equation to convert the measured changes in filter transmission into an absorption coefficient with units of inverse meters (m^{-1}). We applied additional corrections described by Bond et al. [1999] to account for reflectance of the filter, the change in response of the instrument as a function of filter transmission, and effects of scattering from non-absorbing particles.

The instruments shown in figure H-1 and described above were plumbed to a common sampling manifold. In order to provide immunity to the frequently changing inlet pressure and to add a 10-fold or so dilution, the entire system was operated at sub-ambient pressure by drawing sample through a small-diameter orifice, then adding a concentric flow of filtered air via a pressure-controlled valve. Sample flow rate was determined by subtracting the measured dilution flow from the total system flow and the dilution ratio was found by dividing the total flow by sample flow. Dilution ratios varied from ~9 to 15, depending on the pressure in the common sampling line leading in from the selected aerosol inlet.

The aerosol instruments and their associated control units and power supplies were mounted within a standard, double-bay aircraft instrument rack and placed inside the EPA instrument trailer that was parked about 10 m off the DC-8 right wing tip. Sample air from one of a selection of aerosol inlets placed in the exhaust was delivered to the system through a common sampling line that also supplied sample air to complementary aerosol characterization systems operated by Aerodyne (app. J) and the University of Missouri at Rolla (app. I). Pressure and CO_2 concentration within the sampling line were continuously recorded to provide a means for subsequently determining fuel-burn normalized statistics of engine emission parameters.

2.2 Calculated Parameters

Data acquired from the LaRC instruments were corrected for sampling pressure, dilution, and known system losses and used to calculate the secondary variables listed in table H-2. Values for aerosol mass were found by integrating volume-size distributions over a specific size range, then multiplying the resulting volumes by an appropriate aerosol mass density. Because the particles sampled during APEX were often a superposition of soot and condensed sulfates and hydrocarbons with poorly-defined morphologies, we assumed a mass density of 1 g cm^{-3}. Absorption coefficients measured by the PSAP were converted into mass of black carbon using a mass absorption coefficient of 6.6 m^2g^{-1} [Petzold et al., 1998].

Aerosol size statistics were derived from the measured size distributions using formulas discussed by Hinds [1999]. The number "mode" corresponds to the peak in the size distribution when plotted as a function of dN/dLog(Dp) vs. Dp. The geometric mean diameter is found using the following formula:

$$GMD = EXP\{\Sigma[(n_i/dLog(Dp_i)) * Log(d_i)]/\Sigma[n_i/dLog(Dp_i)]\} \quad (1)$$

where n_i, d_i, and dLog(Dpi) are the number density, mean diameter, and normalized width in/of the i^{th} size channel. Similarly, the volume mean diameter is calculated using the formula

$$VMD = EXP\{\Sigma[(v_i/dLog(Dp_i)) * Log(d_i)]/\Sigma[v_i/dLog(Dp_i)]\} \quad (2)$$

where v_i is the total volume calculated for the i^{th} channel as given by $v_i = n_i * \pi * d_i^3 / 6$.

Assuming the aerosols are log normally distributed in a single mode, i.e., unimodal, the geometric standard deviation of the size distribution is given by

$$\sigma_g = EXP\{[\Sigma\, n_i\,(\log(d_i) - \log(GMD))^2]/(N-1)\}^{0.5} \quad (3)$$

In conjunction with the GMD, the geometric standard deviation is useful for modeling aerosol emissions and represents the broadness or spread of the log normal function in that 95% of the particles within a log normal distribution fall within the size range defined by $EXP[\log (GMD) \pm 2 * \log(\sigma_g)]$.

Emission indices (EIs) are fundamental parameters used to describe the amount of pollutants emitted by a combustion source per unit of fuel consumed. Values were calculated for aerosol number density, mass and black carbon as follows:

$$EI[X]\ (kg^{-1}\text{ fuel burned}) = (\Delta X/\Delta CO2) * EI[CO2] * M_{air}/(\rho * M_{co2}) \quad (4)$$

Where ΔX and $\Delta CO2$ are the enhancements above background concentration for parameter X and CO_2, M_{air} and M_{CO2} are the molar masses of air and CO2, respectively, and ρ is the density of air. For our calculations, we assumed the fuel contained ~86% carbon which yields a $EI[CO_2]$ of ~3160 g (CO_2) kg^{-1} fuel burned.

2.3 Potential Errors and Background Corrections

One potential source of uncertainty in the measured parameters is the contribution from particles and compounds residing in background ambient air. The best approach to account for these effects is to continuously monitor background concentrations and apply corrections to the exhaust plume measurements. However, we did not have duplicate instruments and the ones we deployed were calibrated for the very high concentrations encountered within engine exhaust plumes, making them relatively insensitive to the sometimes low concentrations of nucleation and accumulation mode particles found near the experiment site. The fact that background air provided such poor signal caused us to assume that it did not contribute significantly to the measured particle emission indices or size parameters.

To test this assumption, we examined the plume concentrations in relation to some typical background aerosol values. At the 1-m sampling position, the exhaust samples were diluted right at the probe tip with dry nitrogen to prevent water-vapor condensation and nucleation of secondary aerosols. Unless we were specifically investigating the impact of dilution, samples were diluted >ten-fold so that ambient air seldom comprised >10 % of the total sample volume. From scant, poor quality data recorded from the 30-m probe before and after engine starts and stops, we roughly estimated that, unless other aircraft were passing upwind of our sampling probes, the background air generally contained about 10,000 particles cm^{-3} and from 1 to 3 $\mu g\ m^{-3}$ aerosol mass in the 10 to 300 nm size range. Particle concentrations were typically $>10^7\ cm^{-3}$ (translates to an EIn of $4\times10^{14}\ kg^{-1}$ at a fuel/air ratio of 0.02) in the exhaust at 1 m, so background particle number densities would represent about 0.01% of the total. Indeed, background CN concentrations would have to approach $10^6\ cm^{-3}$ before they introduced even a 1% error in EIn for this case. In terms of particle mass, the plumes typically contained $>250\ \mu g\ m^{-3}$ (EIm of 10 mg/kg at FAR of 0.02) so that ambient particles would enhance calculated EIm values by between 0.03 and 0.1%.

Ambient aerosols generated much greater measurement uncertainty for downstream sampling locations. As demonstrated in figure H-2, in the near-field behind the aircraft the core exhaust plume entrains bypass and ambient air at a rate that produces roughly 1 factor of dilution for each meter of distance. For example, at high engine powers we observed an approximate 10-fold dilution at 10 m and a 30-fold dilution at 30 m.

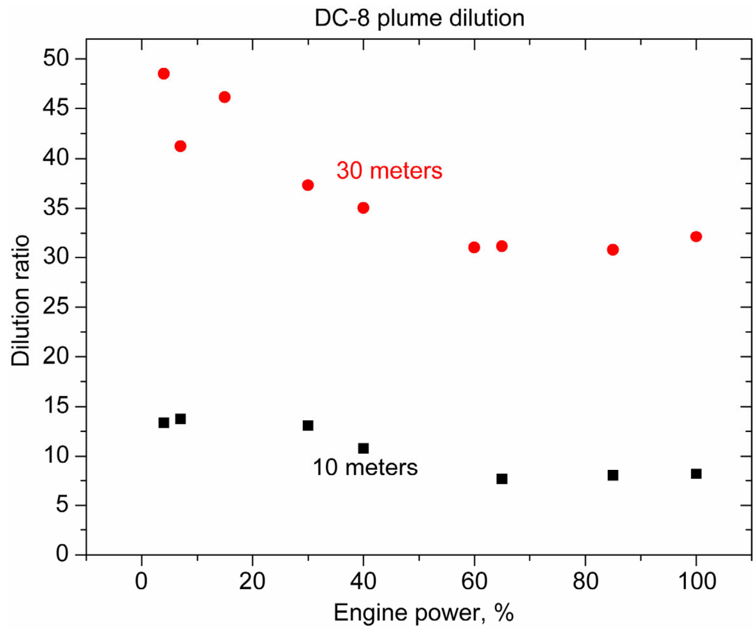

Figure H–2.—Average dilution of the CFM56-2C1 exhaust plume by ambient air at 10 and 30 m as a function of engine power.

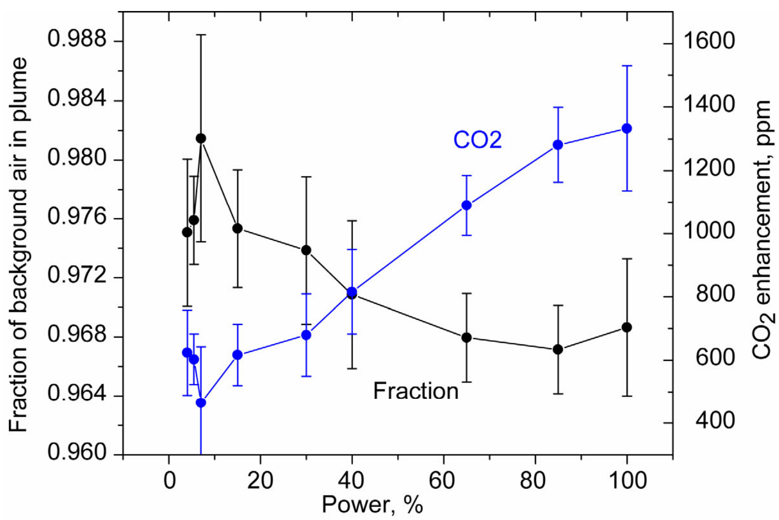

Figure H-3.—Fraction of background air and the average CO_2 enhancement within the exhaust plume at 30 m. Error bars represent + 1 sigma.

For the 10-m samples, the same number and mass calculations performed on the 1-m probe above yields typical ambient contributions of 1% and 3 to 10% to measured EIn and EIm values, respectively. Although these are large, they are still less than the inherit precision of the measurement.

For the 30-m measurement, ambient air typically accounts for 96% or more of the plume volume which introduces another difficulty: variations in background CO_2 concentration can cause errors in the calculated EIs. For example, a 10 ppm increase in CO_2 unrelated to the aircraft emissions results in an apparent 10% reduction in particle EIs for a plume that exhibits an overall 100 ppm CO2 enhancement. For this reason, we rejected all plume data for cases with corresponding ΔCO_2 values <200 ppm. For particles, the interference from ambient aerosols is not as bad as the ciphering performed on the 1 and 10 m probe would suggest. Low volatility gases--presumably sulfuric acid and hydrocarbon species—condense within the cooling plume to form new aerosols and perhaps coat existing soot particles. As a result, samples collected from the 30 m probe typically contained >10^6 cm^{-3} particles and >10 μg m^{-3} aerosol mass. Thus the error produced by our assumed levels of background aerosols amount to < 1% in EIn (fig. H-4), but to as much as 30% in EIm in the more dilute plume cases (fig. H-5). To partially account for this effect, we applied a 1μg m^{-3} background correction to all the EIm values presented in the following tables and charts.

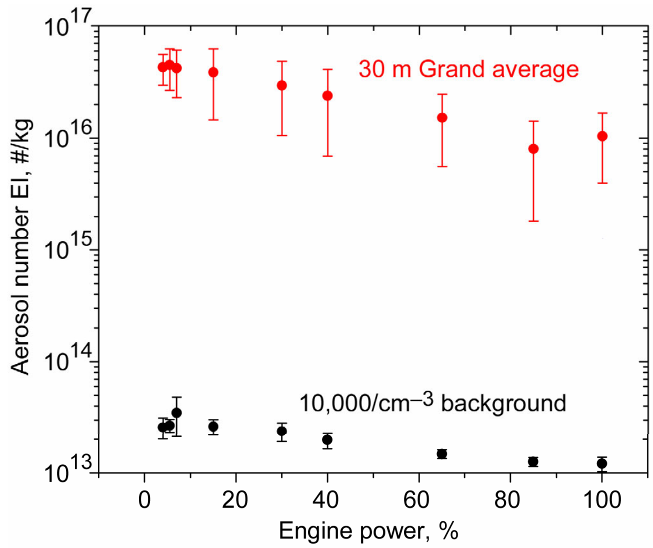

Figure H-4.—Average error in EIn at 30 m caused by 10,000 cm−3 ambient particles compared to the measured 30 m EIn values.

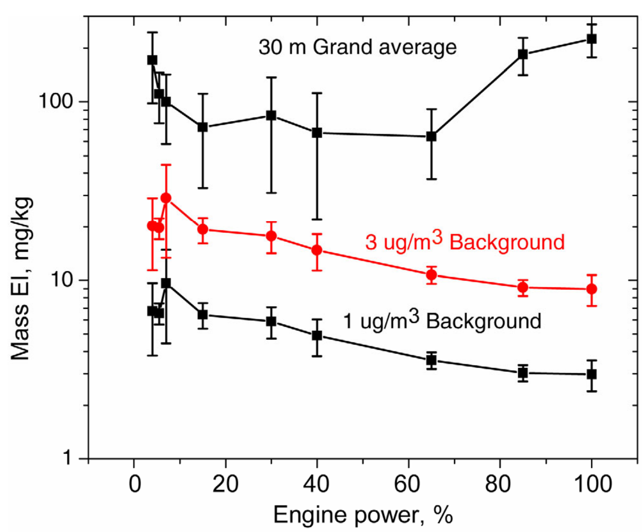

Figure H–5.—Average error in EIn at 30 m caused by 1 and 3 μm−3 ambient particles compared to the measured 30 m EIn values.

Because jet engine exhaust plumes contain a great deal of nanometer-sized particles and condensable material (i.e., water, sulfuric acid, organics), we have observed that measured aerosol characteristics are highly dependent upon the details of sample collection and dilution. For example, experiments conducted at Langley in the Summer of 1999 indicated that the T-38 aircraft EIn values at any given power setting could be manipulated by a factor of eight by turning on and off the cooling water supplied to the sample collection probe that was positioned 1 m downstream of the engine exhaust plane [Cofer et al., 2001]. To assess probe effects during APEX, we alternately sampled flow from an aerosol inlet probe that introduced dilution air just behind the inlet tip and flow from a gas probe/heated sample line to which dilution air was added 12 m downstream of the inlet. Results of the tests are shown in figure H-6 and suggest that both EIn and EIm are systematically lower behind the gas probe, in some cases a factor of two, than downstream of the aerosol inlet. Thus use of the expensive and tedious-to-deploy, aerosol inlet probes was justified. The effects of sample dilution were also evaluated at the 1 and 10 m sampling probes (fig. H-7). At 1 m, dilutions below a factor of 10 sometimes promoted formation of new particles within the sample lines; dilution ratios between 10 and 50 affected very little change in calculated EIn values. At 10 m, the plume had already been diluted by a factor of 10 to 15 (fig. H-2), but further dilution did seem to suppress the low-level nucleation processes that were occurring within that sampling system.

In addition to the possible losses and errors described above, we suspect that losses within the sample transport systems attached to each of the inlet probes greatly impacted both our particle number and mass measurements. The University of Missouri at Rolla, an APEX participant, performed post-mission tests to evaluate the size dependent penetration of particles through the 1 and 10 m sample probes and transport tubes. Results are presented in both the APEX overview and in appendix I. UMR fit the experimental data with a 4th order polynomial with Log(Dp) as the variable; we have used that penetration to correct our number and mass-based measurements. The corrections are quite significant—factors of 2 to 4 in mass depending on power setting—and greatly exceed those predicted by theory. The precision of these correction factors is an issue that is still under investigation.

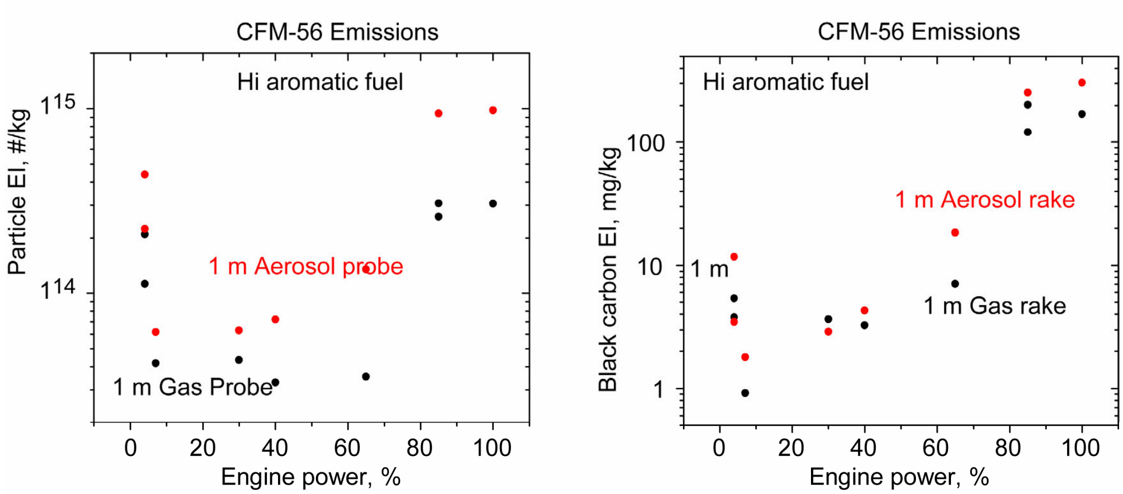

Figure H–6.—Aerosol EIn and EIm for black carbon measured downstream of a specially designed aerosol dilution probe (black points) and a standard gas inlet and heated sample line.

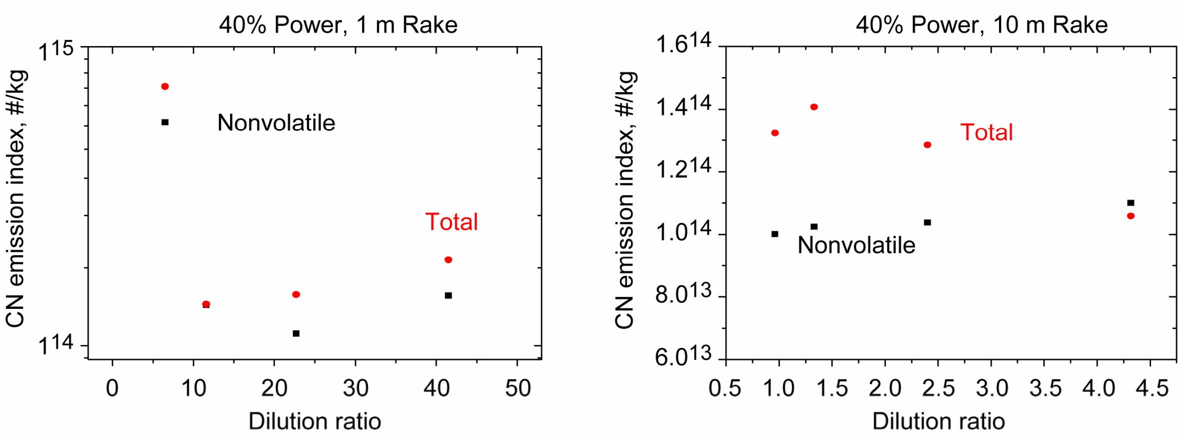

Figure H–7.—Aerosol EIn values as a function of dilution at 40% power as measured a tthe 1- (top) and 10-m (bottom) inlet probes.

2.4 Test Plan

Apex was conducted on a large engine run-up area located adjacent to an active taxi-way on Edwards Air Force Base Field. On the first day of the experiment, the DC-8 was pulled onto the middle of the pad, aligned into the predicted wind direction, and chocked into place for the duration of the test. Three separate sampling rakes/inlets were then placed 1, 10, and 30 m downstream of the right inboard engine centerline. The probe stands were bolted to the concrete pad to prevent them from being blown across the desert by the high velocity exhaust plume. Instrument trailers were lined up along the aircraft's right wingtip and electrically connected to the Edwards power grid to prevent sample contamination by generator exhaust. Stainless steel sample lines were run from the rakes/inlets to a distribution manifold located in the U.S. EPA's equipment trailer. A short length (< 1 m) of stainless tubing was used to connect the NASA instrument rack to the manifold.

Air temperatures during APEX were typically around 15 °C in the morning when testing began, warming up to >30 °C in the mid-afternoon. Winds were light to moderate, but the presence of tail winds caused testing to be curtailed on several days early in the mission due to concern over potential engine compressor stalls On these tail-wind days, engine power was limited to thrust levels <40 % of maximum.

Three different fuels were burned in the aircraft to examine fuel effects on particle emissions. The "baseline" fuel (BASE) was simply JP-5 provided by the Edwards AFB fuel depot. Subsequent tests showed that it contained 383 ppm S and about 17.6% aromatic compounds. Tertiary butyl disulfide ($C_{12}H_{18}S_2$) was introduced to a tanker truck filled with this fuel to produce the "high sulfur" fuel (HS), which contained 1595 ppm S and 17.3% aromatics. To examine hydrocarbon impacts on soot production, a Jet-A fuel containing 21.6% aromatics (HA) and 530 ppm S was purchased from a nearby oil refinery.

Several different engine/probe operating patterns were employed to address project objectives. The "blow-down" tests conducted on April 20th and 24th simply involved incrementally ramping engine power up to determine whether the downstream equipment could survive the hot exhaust blast for extended periods of time. The "mapping" tests carried out on April 23rd and 25th involved alternately drawing air from each of the 6 aerosol inlet probes on the 1 and 10 m rakes to examine the variability in emissions across the breadth of the plume to identify the most representative inlet tips and to verify that our probe locations were not directly downstream of an engine oil vent.

The bulk of the data was collected using the so-called "NASA" and "EPA" test cycles. The former was developed to systematically examine engine emissions as a function of power and was employed to gather both fundamental source profile data and to assess the impact of fuel composition on primary and secondary particle emissions. It involved ramping the engine power up or down, holding at each of the pre-selected thrust levels (i.e., 4, 7, 30, 40, 65, 85, and 100) for several minutes to allow sufficient time for obtaining particle size distribution scans from slow response instruments. A complete test required repeating the power ramp at least three times to facilitate collecting sample from each of the downstream sampling probes (fig. H-8). Two complete NASA sequences were recorded for each of the tested fuels. As illustrated in figure H-8, the EPA test matrix was designed to simulate the ICAO airport LTO cycle of 26 min at idle (7%), 0.7 min at takeoff (100%), 2.2 min at climb (85%), and 4 min at approach (30%). This power sequence was typically repeated four times to maximize filter collection time. During the long periods at idle, a number of secondary tests were conducted to evaluate the effects of sample dilution and plume aging upon the measured aerosol quantities.

Including all the test sequences described above, aerosol physical characteristics were determined during over 400 tests points. These "runs" averaged 3.5 min in duration, but were typically around 1 min for takeoff thrust levels and slightly longer than the average for idle conditions. The distribution of test points at each power setting as a function of fuel type and sampling probe is show in figure H-9. The aircraft burned base fuel during the blow-down and mapping experiments, which resulted in more than half of all runs being associated with this type of fuel.

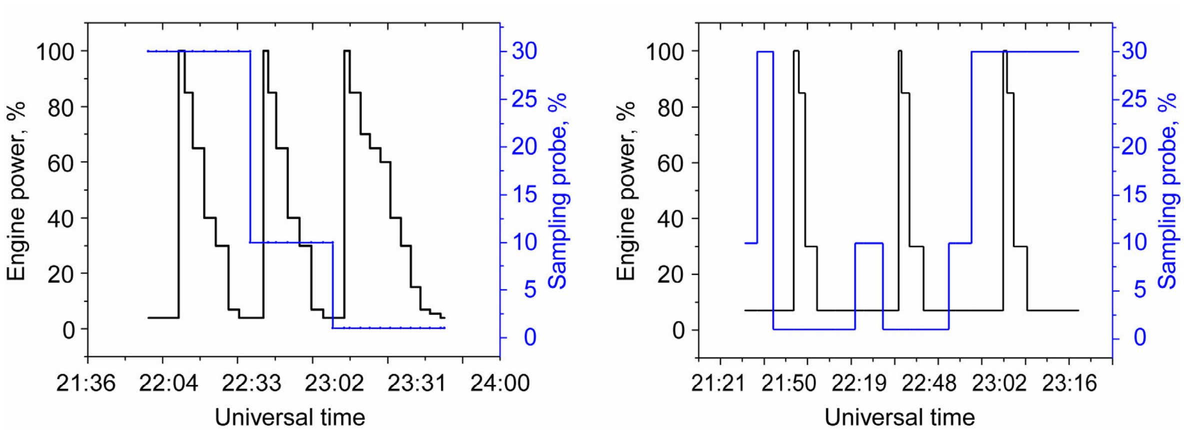

Figure H–8.—Representative power and sampling probe sequences for the "NASA" (left) and "EPA" (right) test cycles.

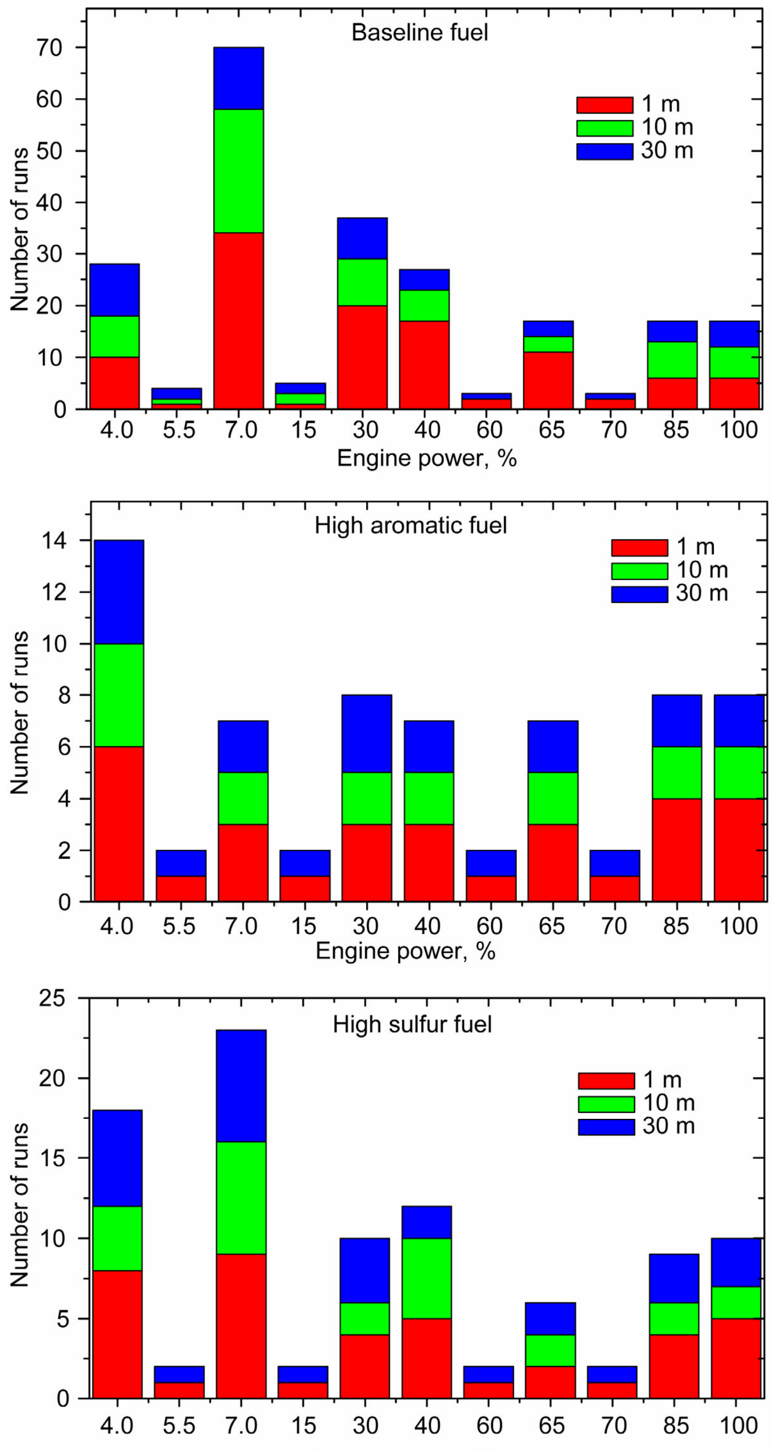

Figure H–9.—Number of test points at 1, 10, and 30 m for the baseline (top), high aromatic (middle) and high sulfur (bottom) fuels.

3.0 Results and Discussion

Aerosol parameter statistics for the entire data set are provided in table H-3, whereas those for the individual fuels are shown in tables 4 through 6. The data are listed in order of increasing sampling distance and engine power setting; results for nonvolatile particles are provided in the "a" tables and those for total aerosols are shown in "b". Average fuel flow rates are presented for each thrust level to facilitate comparisons to emission parameters archived in the ICAO database. This parameter also provides a measure of the actual throttle setting needed to achieve a specific thrust condition. The "N" values listed in the tables refer to the number of SMPS scans included in the statistical analyses. Values reported for Number EI were derived from continuous, TSI3022 CN data and thus are representative of the total particles > 7 nm in diameter. Black carbon EIs were calculated from the integrated change in filter attenuation across each run. Nonvolatile fraction refers to the ratio of nonvolatile to total aerosol EIn. Mass EI and the size distribution parameters (mode, GMD, and VMD) were calculated from the long DMA observations (i.e., over the range from ~9 to 245 nm) and assuming a mass density of 1 g cm^{-3} for the measured aerosol that was constant across the size spectrum.

As can be seen from the tables, particle emissions from the CFM56-2C1 engine were highly variable and depended on power setting, fuel composition, plume age, engine run time, background temperature and pressure, and perhaps other unknown effects. Ambient conditions particularly contributed to the large standard deviations associated with the parameters listed in the tables. For example, figure H-10 exhibits data recorded over a period of time when ambient temperature increased by 10 °C and shows EIn at ground idle dropping by 50% over the course of the test sequence. This effect was even more pronounced in the gaseous hydrocarbon species data (app. F), causing us to suspect that the gas and primary particle phase emissions do not vary independently.

Despite the broad variability in the data set, several trends were clear and consistent throughout the runs. For example, at the 1-m sampling position particle size was always a minimum at idle and increased with increasing engine thrust. This result, which is consistent with our previous observations behind an RB11 engine (Anderson et al., 2003, 2005), is illustrated in figure H-11, a set of grand averaged particle size distributions representing four different power settings between idle and takeoff. You'll note that the particles occupy a single mode that becomes broader and shifts to progressively larger diameters with power. The changes in nonvolatile particle characteristics with power is quite apparent in the grand average plots of figure H-12, which shows GMD values increasing from ~15 nm at idle to around 35 nm at takeoff. VMD climbed from about 45 to 80 nm and sigma increased from ~1.6 to 1.8 over the same power range. A comparison between the hot and cold CN and SMPS measurements indicate that nonvolatile particles compose over 90% of the total mass and number concentrations under these sampling conditions (table H-3b). This is expected since temperatures 1 m behind the engine exceed those where sulfate and most organic species condense and sample flow was typically diluted 10-fold with dry nitrogen at the probe tip while the sample temperature was still quite high.

The observations also suggest that nonvolatile particle mass emissions are a minimum at approach-level power settings and a maximum at takeoff (table H-3; fig. H-13). This may be related to the fact that fuel/air ratios and combustor temperatures follow approximately the same trend. Poor fuel distribution and reduced mixing within the combustor may also contribute to the slight increase in emissions seen at idle. In terms of values, average EIm ranged from ~6 mg m^{-3} at 15% power to > 200 mg m^{-3} at 100%. Black carbon and total aerosol EIm from the 1-m probe followed the same trend and were typically within 20% of the nonvolatile EIm values. Total aerosol EIn did not exhibit a clear power-related trend, but tended to be slightly higher, around 10^{15} kg^{-1}, at idle and takeoff settings.

TABLE H-3A.—SUMMARY STATISTICS FOR ALL NONVOLATILE PARTICLE PARAMETERS MEASURED DURING APEX.

					Nonvolatile Particles														
Rake	Thrust	Fuel Flow (kg/s)			GMD (nm)			VMD (nm)			Standard Dev.			Mass EI (mg/kg)			Black Carbon (mg/kg)		
m	%	Avg	Std	N	Avg	Med	Std	Avg	Med	Std	Avg	Med	Std	Avg	Med	Std	Avg	Med	Std
1	4	0.096	0.002	18	16	15	1	45	45	6	1.58	1.60	0.04	14	13	8	30	11	36
	5.5	0.105	0.001	3	17	17	2	54	55	3	1.64	1.65	0.04	8	8	3	6	5	2
	7	0.120	0.004	42	17	17	3	49	48	8	1.63	1.62	0.07	15	12	16	11	7	12
	15	0.149	0.003	3	16	16	3	56	56	1	1.63	1.63	0.01	6	6	2	3	3	0
	30	0.284	0.017	24	20	20	4	54	55	5	1.70	1.70	0.07	19	19	13	15	13	9
	40	0.356	0.009	24	20	19	4	55	55	5	1.77	1.74	0.19	23	21	11	16	16	9
	65	0.587	0.017	14	23	24	3	63	63	3	1.81	1.80	0.06	43	43	17	36	36	12
	85	0.783	0.030	12	32	32	2	76	76	2	1.87	1.89	0.06	145	132	27	221	133	150
	100	0.853	0.028	12	33	35	7	78	78	2	1.86	1.79	0.14	175	166	31	278	208	172
10	4	0.096	0.002	16	20	14	24	48	42	14	1.56	1.55	0.03	19	20	8	21	14	19
	5.5	0.105	0.001	1	15	15	0	50	50	0	1.58	1.58	0.00	18	18	0	10	10	0
	7	0.120	0.004	33	15	14	1	53	52	9	1.62	1.61	0.10	18	15	12	11	10	5
	15	0.149	0.003	2	15	15	1	54	54	10	1.64	1.64	0.01	14	14	2	7	7	2
	30	0.284	0.017	13	19	19	3	55	55	5	1.70	1.70	0.08	11	11	3	9	9	3
	40	0.356	0.009	13	18	18	3	57	56	6	1.72	1.73	0.05	13	11	5	10	10	3
	65	0.587	0.017	7	27	24	12	64	65	2	1.91	1.87	0.13	34	31	11	35	34	12
	85	0.783	0.030	11	39	31	28	79	77	7	1.90	1.91	0.13	164	124	129	200	161	103
	100	0.853	0.028	10	43	33	30	80	80	5	1.87	1.85	0.12	189	171	88	293	262	156
30	4	0.096	0.002	20	12	12	1	30	29	10	1.34	1.31	0.08	45	40	20	42	33	25
	5.5	0.105	0.001	4	11	11	0	26	24	8	1.28	1.28	0.05	27	25	7	25	24	6
	7	0.120	0.004	21	11	11	1	29	29	7	1.31	1.30	0.08	18	16	9	23	18	15
	15	0.149	0.003	4	12	12	1	42	47	11	1.39	1.42	0.11	14	13	6	13	14	4
	30	0.284	0.017	15	15	14	3	51	51	6	1.59	1.60	0.11	18	12	15	26	15	24
	40	0.356	0.009	8	15	15	3	53	51	7	1.61	1.67	0.10	14	12	6	17	16	5
	65	0.587	0.017	7	19	19	3	63	62	2	1.84	1.88	0.06	31	31	5	41	40	7
	85	0.783	0.030	9	26	26	2	75	75	2	1.97	1.97	0.06	113	110	24	161	159	33
	100	0.853	0.028	10	23	23	5	77	77	3	2.02	2.01	0.09	143	133	23	183	196	48

TABLE H-3B.—SUMMARY STATISTICS FOR ALL TOTAL AEROSOL PARTICLE PARAMETERS MEASURED DURING APEX.

				Total Particles																		
Rake	Thrust	Fuel Flow (kg/s)		GMD (nm)			VMD (nm)			Standard Dev.			Mass EI (mg/kg)			Number EI (#/kg)			Nonvolatile Fraction			
m	%	Avg	Std	Avg	Med	Std	Avg	Med	Std	Avg	Med	Std	Avg	Med	Std	Avg	Med	Std	Avg	Med	Std	
1	4	0.096	0.002	15	15	1	35	34	4	1.51	1.50	0.04	20	15	13	1.1E+15	7.8E+14	6.5E+14	0.73	0.75	0.16	
	5.5	0.105	0.001	16	15	1	36	37	1	1.50	1.51	0.02	9	8	5	3.6E+14	4.1E+14	9.3E+13	0.70	0.75	0.19	
	7	0.120	0.004	18	17	7	38	37	11	1.51	1.51	0.07	17	9	18	8.3E+14	3.8E+14	1.2E+15	0.72	0.82	0.22	
	15	0.149	0.003	18	19	2	34	36	4	1.50	1.53	0.08	5	5	3	1.5E+14	1.5E+14	2.4E+13	0.74	0.77	0.14	
	30	0.284	0.017	20	20	3	45	45	6	1.59	1.59	0.07	27	24	19	6.7E+14	4.1E+14	7.1E+14	0.64	0.71	0.25	
	40	0.356	0.009	20	20	3	46	45	6	1.60	1.61	0.07	35	29	30	7.7E+14	4.1E+14	8.7E+14	0.58	0.64	0.28	
	65	0.587	0.017	24	25	3	60	59	2	1.72	1.72	0.05	56	57	23	7.9E+14	3.6E+14	9.5E+14	0.74	0.88	0.27	
	85	0.783	0.030	31	31	2	73	72	2	1.82	1.82	0.03	198	179	39	9.5E+14	6.0E+14	5.7E+14	0.91	0.92	0.02	
	100	0.853	0.028	31	33	6	74	74	2	1.83	1.80	0.11	243	232	46	1.1E+15	7.9E+14	6.1E+14	0.91	0.92	0.02	
10	4	0.096	0.002	14	14	1	33	33	3	1.46	1.46	0.04	33	23	29	3.2E+15	2.7E+15	1.9E+15	0.40	0.40	0.10	
	5.5	0.105	0.001	16	16	0	36	36	0	1.52	1.52	0.00	15	15	0	1.4E+15	1.4E+15	0.0E+00	0.51	0.51	0.00	
	7	0.120	0.004	15	14	2	35	34	5	1.46	1.46	0.06	17	14	10	1.8E+15	1.6E+15	8.5E+14	0.38	0.32	0.17	
	15	0.149	0.003	17	17	1	38	38	2	1.49	1.49	0.00	12	12	5	8.8E+14	8.8E+14	3.9E+14	0.48	0.48	0.05	
	30	0.284	0.017	19	20	2	46	46	3	1.59	1.59	0.03	11	12	3	3.8E+14	3.4E+14	1.6E+14	0.64	0.66	0.13	
	40	0.356	0.009	20	21	1	49	48	3	1.62	1.62	0.02	11	11	3	3.1E+14	2.6E+14	1.6E+14	0.74	0.79	0.15	
	65	0.587	0.017	26	26	1	62	62	2	1.73	1.72	0.03	36	34	12	3.3E+14	3.5E+14	6.1E+13	0.87	0.87	0.03	
	85	0.783	0.030	31	31	2	74	74	1	1.84	1.84	0.05	154	154	44	9.8E+14	7.4E+14	5.3E+14	0.90	0.90	0.02	
	100	0.853	0.028	32	32	1	76	76	2	1.85	1.86	0.06	215	211	71	1.3E+15	1.1E+15	5.9E+14	0.89	0.90	0.03	
30	4	0.096	0.002	16	16	1	26	25	3	1.38	1.36	0.06	171	155	73	4.3E+16	4.5E+16	1.3E+16	0.31	0.32	0.05	
	5.5	0.105	0.001	15	15	1	22	22	1	1.34	1.33	0.03	111	111	35	4.5E+16	4.4E+16	1.8E+16	0.24	0.24	0.05	
	7	0.120	0.004	15	15	2	23	21	4	1.33	1.32	0.04	100	87	42	4.2E+16	4.0E+16	1.9E+16	0.22	0.18	0.13	
	15	0.149	0.003	14	14	1	21	20	4	1.33	1.32	0.05	72	61	39	3.9E+16	3.4E+16	2.4E+16	0.09	0.09	0.02	
	30	0.284	0.017	14	15	2	24	23	5	1.33	1.32	0.08	84	59	53	3.0E+16	2.6E+16	1.9E+16	0.06	0.05	0.06	
	40	0.356	0.009	14	14	2	23	21	5	1.31	1.32	0.05	67	54	45	2.4E+16	1.7E+16	1.7E+16	0.05	0.03	0.04	
	65	0.587	0.017	13	12	1	35	35	8	1.35	1.32	0.07	64	60	27	1.5E+16	1.3E+16	9.6E+15	0.06	0.04	0.05	
	85	0.783	0.030	15	14	3	64	66	9	1.68	1.57	0.23	184	172	43	8.0E+15	5.7E+15	6.2E+15	0.22	0.13	0.18	
	100	0.853	0.028	15	14	3	64	67	10	1.68	1.60	0.25	224	212	47	1.0E+16	8.9E+15	6.4E+15	0.18	0.16	0.11	

TABLE H-4A.—SUMMARY STATISTICS FOR NONVOLATILE PARAMETERS MEASURED DURING ENGINE RUNS EMPLOYING BASELINE FUEL.

					Nonvolatile Particles														
Rake	Thrust	Fuel Flow (kg/s)			GMD (nm)			VMD (nm)			Standard Dev.			Mass EI (mg/kg)			Black Carbon (mg/kg)		
m	%	Avg	Std	N	Avg	Med	Std	Avg	Med	Std	Avg	Med	Std	Avg	Med	Std	Avg	Med	Std
1	4	0.096	0.002	6	16	15	2	46	45	5	1.60	1.60	0.00	19	15	9	43	19	44
	5.5	0.105	0.001	1	17	17	-	51	51	-	1.70	1.70	-	11	11	-	9	9	-
	7	0.120	0.004	31	17	17	3	51	50	8	1.60	1.60	0.10	18	14	18	14	9	14
	15	0.149	0.003	1	15	15	-	57	57	-	1.60	1.60	-	8	8	-	3	3	-
	30	0.284	0.017	20	20	20	4	55	55	5	1.70	1.70	0.10	23	21	13	17	16	9
	40	0.356	0.009	16	19	18	4	56	56	6	1.70	1.80	0.10	27	24	11	19	19	9
	65	0.587	0.017	9	23	24	3	63	63	3	1.80	1.80	0.10	47	43	17	36	37	14
	85	0.783	0.030	5	32	31	2	75	75	2	1.90	1.90	0.10	142	134	29	251	247	157
	100	0.853	0.028	5	32	35	9	77	76	2	1.80	1.80	0.20	173	161	35	259	192	174
10	4	0.096	0.002	7	15	14	1	54	46	18	1.60	1.60	0.00	24	26	5	27	19	26
	5.5	0.105	0.001	1	15	15	-	50	50	-	1.60	1.60	-	18	18	-	10	10	-
	7	0.120	0.004	17	15	14	2	54	52	10	1.60	1.60	0.10	22	20	12	12	10	5
	15	0.149	0.003	2	15	15	1	55	55	10	1.60	1.60	0.00	14	14	2	7	7	2
	30	0.284	0.017	8	20	19	3	56	57	4	1.70	1.70	0.10	13	13	2	10	10	2
	40	0.356	0.009	6	18	18	3	61	59	6	1.80	1.80	0.10	16	18	4	11	10	4
	65	0.587	0.017	3	23	23	3	64	64	2	2.00	1.90	0.20	37	39	5	37	35	5
	85	0.783	0.030	7	30	30	5	81	77	8	1.90	2.00	0.20	136	130	43	211	161	109
	100	0.853	0.028	5	30	31	3	81	79	7	1.90	1.90	0.20	173	166	48	272	223	155
30	4	0.096	0.002	10	13	12	1	36	33	11	1.40	1.40	0.10	53	48	25	48	33	33
	5.5	0.105	0.001	2	12	12	0	32	32	8	1.30	1.30	0.00	30	30	10	20	20	3
	7	0.120	0.004	11	12	12	1	31	30	6	1.30	1.30	0.00	24	23	9	23	18	15
	15	0.149	0.003	2	12	12	0	47	47	3	1.40	1.40	0.00	19	14	5	13	13	6
	30	0.284	0.017	7	14	13	2	53	51	4	1.60	1.60	0.10	15	-2	4	21	16	10
	40	0.356	0.009	4	15	15	2	55	55	8	1.60	1.60	0.10	18	0	8	19	20	7
	65	0.587	0.017	3	20	19	2	63	64	3	1.90	1.90	0.00	32	5	6	37	36	3
	85	0.783	0.030	4	27	27	2	75	76	2	2.00	2.00	0.00	118	79	28	148	148	29
	100	0.853	0.028	4	24	24	5	78	77	2	2.00	2.00	0.10	140	92	18	153	144	48

TABLE H-4B.—SUMMARY STATISTICS FOR TOTAL AEROSOL PARAMETERS MEASURED DURING ENGINE RUNS EMPLOYING BASELINE FUEL.

				Total Particles																			
Rake	Thrust	Fuel Flow (kg/s)		GMD (nm)			VMD (nm)			Standard Dev.			Mass EI (mg/kg)			Number EI (#/kg)			Nonvolatile Fraction		
m	%	Avg	Std	Avg	Med	Std	Avg	Med	Std	Avg	Med	Std	Avg	Med	Std	Avg	Med	Std	Avg	Med	Std
1	4	0.096	0.002	16	15	2	36	34	4	1.50	1.50	0.00	22	17	14	1.2E+15	8.1E+14	7.47E+14	0.80	0.80	0.20
	5.5	0.105	0.001	16	16	-	37	37	-	1.50	1.50	-	8	8	-	4.1E+14	4.1E+14	-	0.80	0.80	-
	7	0.120	0.004	19	17	8	40	38	12	1.50	1.50	0.10	22	15	22	9.3E+14	4.3E+14	1.24E+15	0.70	0.90	0.20
	15	0.149	0.003	19	19	-	36	36	-	1.50	1.50	-	5	5	-	1.7E+14	1.7E+14	-	0.90	0.90	-
	30	0.284	0.017	20	21	3	46	45	6	1.60	1.60	0.10	32	30	17	7.9E+14	5.4E+14	7.33E+14	0.60	0.70	0.30
	40	0.356	0.009	21	21	3	48	47	6	1.60	1.60	0.10	44	37	32	9.4E+14	4.8E+14	9.77E+14	0.60	0.60	0.30
	65	0.587	0.017	24	25	3	60	60	3	1.70	1.70	0.10	64	59	23	9.4E+14	4.6E+14	1.03E+15	0.70	0.90	0.30
	85	0.783	0.030	31	31	2	72	71	2	1.80	1.80	0.00	201	179	49	1.1E+15	9.7E+14	5.92E+14	0.90	0.90	0.00
	100	0.853	0.028	29	31	7	74	74	1	1.90	1.90	0.10	243	234	45	9.9E+14	7.9E+14	5.61E+14	0.90	0.90	0.00
10	4	0.096	0.002	15	15	1	34	34	2	1.50	1.50	0.00	45	38	37	3.5E+15	2.8E+15	2.06E+15	0.40	0.40	0.10
	5.5	0.105	0.001	16	16	-	36	36	-	1.50	1.50	-	15	15	-	1.4E+15	1.4E+15	-	0.50	0.50	-
	7	0.120	0.004	15	16	2	36	34	5	1.50	1.50	0.10	20	17	10	1.9E+15	1.8E+15	9.16E+14	0.40	0.40	0.20
	15	0.149	0.003	17	17	1	38	38	2	1.50	1.50	0.00	12	12	5	8.8E+14	8.8E+14	3.90E+14	0.50	0.50	0.10
	30	0.284	0.017	20	20	2	47	47	3	1.60	1.60	0.00	12	13	3	4.3E+14	3.5E+14	1.66E+14	0.60	0.70	0.10
	40	0.356	0.009	21	21	1	49	50	2	1.60	1.60	0.00	14	14	3	4.0E+14	3.4E+14	2.09E+14	0.70	0.70	0.20
	65	0.587	0.017	26	26	1	62	62	1	1.70	1.70	0.00	40	43	5	3.4E+14	3.5E+14	1.70E+13	0.90	0.90	0.00
	85	0.783	0.030	32	32	2	74	73	2	1.80	1.80	0.10	168	154	42	1.0E+15	7.6E+14	5.21E+14	0.90	0.90	0.00
	100	0.853	0.028	32	32	2	75	75	2	1.80	1.90	0.10	243	240	64	1.3E+15	1.1E+15	5.91E+14	0.90	0.90	0.00
30	4	0.096	0.002	17	17	1	28	28	3	1.40	1.40	0.10	191	159	87	3.5E+16	3.0E+16	1.15D+16	0.30	0.30	0.00
	5.5	0.105	0.001	15	15	0	23	23	0	1.40	1.40	0.00	81	81	4	3.0E+16	3.0E+16	3.28E+15	0.20	0.20	0.00
	7	0.120	0.004	16	15	3	24	24	4	1.30	1.30	0.00	98	79	47	3.0E+16	2.6E+16	1.25D+16	0.20	0.20	0.10
	15	0.149	0.003	13	13	1	24	24	4	1.40	1.40	0.10	49	49	17	1.9E+16	1.9E+16	2.56E+15	0.10	0.10	0.00
	30	0.284	0.017	15	15	2	25	24	6	1.40	1.30	0.10	50	52	22	1.4E+16	1.2E+16	5.19E+15	0.10	0.10	0.00
	40	0.356	0.009	15	15	3	27	28	4	1.30	1.40	0.10	51	43	35	1.0E+16	1.0E+16	1.05E+15	0.10	0.10	0.00
	65	0.587	0.017	12	12	0	40	38	9	1.40	1.30	0.10	50	60	17	9.8E+15	1.1E+16	6.46E+15	0.10	0.00	0.10
	85	0.783	0.030	17	17	4	69	71	6	1.80	1.90	0.20	182	186	49	4.3E+15	3.3E+15	3.21E+15	0.30	0.40	0.20
	100	0.853	0.028	16	16	4	69	71	9	1.80	1.90	0.30	204	189	43	7.0E+15	7.4E+15	3.41E+15	0.20	0.20	0.10

TABLE H-5A.—SUMMARY STATISTICS FOR NONVOLATILE PARAMETERS MEASURED DURING RUNS EMPLOYING HIGH AROMATIC FUEL.

					Nonvolatile Particles														
Rake	Thrust	Fuel Flow (kg/s)			GMD (nm)			VMD (nm)			Standard Dev.			Mass EI (mg/kg)			Black Carbon (mg/kg)		
m	%	Avg	Std	N	Avg	Med	Std	Avg	Med	Std	Avg	Med	Std	Avg	Med	Std	Avg	Med	Std
1	4	0.096	0.002	3	15	15	1	41	42	5	1.53	1.53	0.03	8	8	1	14	9	14
	5.5	0.105	0.001	1	14	14	-	56	56	-	1.59	1.59	-	6	6	-	4	4	-
	7	0.120	0.004	2	16	16	1	44	44	6	1.60	1.60	0.02	3	3	0	4	4	1
	15	0.149	0.003	0	-	-	-	-	-	-	-	-	-	-	-	-	3	3	-
	30	0.284	0.017	2	17	17	6	45	45	1	1.60	1.60	0.02	5	5	1	5	5	2
	40	0.356	0.009	2	21	21	2	51	51	2	1.67	1.67	0.01	10	10	3	8	8	3
	65	0.587	0.017	2	25	25	6	62	62	1	1.77	1.77	0.11	35	35	16	29	29	17
	85	0.783	0.030	3	32	33	2	76	76	0	1.85	1.85	0.05	149	130	37	241	118	220
	100	0.853	0.028	3	35	35	1	78	78	2	1.79	1.77	0.04	180	165	43	291	148	263
10	4	0.096	0.002	3	14	14	1	40	41	2	1.53	1.52	0.01	18	21	6	17	17	7
	5.5	0.105	0.001	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	7	0.120	0.004	1	14	14	-	39	39	-	1.56	1.56	-	6	6	-	7	7	2
	15	0.149	0.003	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	30	0.284	0.017	1	18	18	-	43	43	-	1.64	1.64	-	7	7	-	7	7	1
	40	0.356	0.009	2	20	20	2	52	52	2	1.67	1.67	0.00	9	9	0	9	9	2
	65	0.587	0.017	2	25	25	1	66	66	0	1.84	1.84	0.00	41	41	17	43	43	21
	85	0.783	0.030	2	31	31	3	76	76	2	1.89	1.89	0.03	136	136	41	159	159	46
	100	0.853	0.028	2	35	35	1	80	80	0	1.82	1.82	0.04	198	198	33	362	362	132
30	4	0.096	0.002	4	11	11	1	26	27	3	1.29	1.29	0.02	35	34	14	37	38	16
	5.5	0.105	0.001	1	11	11	-	21	21	-	1.24	1.24	-	21	22	-	32	32	-
	7	0.120	0.004	2	10	10	0	27	27	10	1.22	1.22	0.02	15	15	2	17	17	6
	15	0.149	0.003	1	10	10	-	26	26	-	1.23	1.23	-	8	4	-	13	13	-
	30	0.284	0.017	3	16	17	4	46	46	8	1.54	1.61	0.13	22	-6	23	23	13	20
	40	0.356	0.009	2	19	19	1	53	53	3	1.67	1.67	0.00	12	-6	2	14	14	2
	65	0.587	0.017	2	21	21	1	63	63	2	1.84	1.84	0.06	33	2	3	49	49	6
	85	0.783	0.030	2	26	26	5	76	76	1	1.99	1.99	0.13	116	75	28	180	180	39
	100	0.853	0.028	2	22	22	3	77	77	1	2.14	2.14	0.03	157	108	34	223	223	17

TABLE H-5B.—SUMMARY STATISTICS FOR TOTAL AEROSOL PARTICLE PARAMETERS MEASURED DURING RUNS EMPLOYING HIGH AROMATIC FUEL.

				Total Particles																	
Rake	Thrust	Fuel Flow (kg/s)		GMD (nm)			VMD (nm)			Standard Dev.			Mass EI (mg/kg)			Number EI (#/kg)			Nonvolatile Fraction		
m	%	Avg	Std	Avg	Med	Std	Avg	Med	Std	Avg	Med	Std	Avg	Med	Std	Avg	Med	Std	Avg	Med	Std
1	4	0.096	0.002	15	15	0	33	33	1	1.47	1.47	0.01	11	10	2	7.0E+14	5.5E+14	4.5E+14	0.73	0.71	0.09
	5.5	0.105	0.001	15	15	-	37	37	-	1.47	1.47	-	4	4	-	2.5E+14	2.5E+14	-	0.75	0.75	-
	7	0.120	0.004	15	15	1	32	32	1	1.48	1.48	0.01	4	4	0	1.8E+14	1.8E+14	4.6E+12	0.76	0.76	0.02
	15	0.149	0.003	19	19	-	29	29	-	1.41	1.41	-	2	2	-	1.3E+14	1.3E+14	-	0.77	0.77	-
	30	0.284	0.017	18	18	1	38	38	3	1.56	1.56	0.03	6	6	2	1.6E+14	1.6E+14	3.8E+12	0.75	0.75	0.05
	40	0.356	0.009	20	20	1	45	45	0	1.62	1.62	0.02	12	12	5	1.9E+14	1.9E+14	2.6E+12	0.80	0.80	0.05
	65	0.587	0.017	25	25	0	58	58	2	1.69	1.69	0.02	41	41	23	2.4E+14	2.4E+14	1.0E+14	0.91	0.91	0.00
	85	0.783	0.030	31	31	1	74	74	1	1.83	1.82	0.03	195	174	44	9.7E+14	4.9E+14	8.2E+14	0.92	0.92	0.00
	100	0.853	0.028	30	33	6	75	73	2	1.77	1.76	0.03	246	213	80	1.0E+15	5.3E+14	8.5E+14	0.92	0.92	0.00
10	4	0.096	0.002	14	14	0	31	29	4	1.43	1.42	0.04	26	30	11	3.1E+15	3.1E+15	2.3E+15	0.42	0.41	0.15
	5.5	0.105	0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	7	0.120	0.004	13	13	-	26	26	-	1.37	1.37	-	8	8	-	1.4E+15	1.4E+15	1.3E+15	0.38	0.38	0.25
	15	0.149	0.003	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	30	0.284	0.017	17	17	-	44	44	-	1.62	1.62	-	7	7	-	2.8E+14	2.8E+14	9.4E+13	0.73	0.73	0.17
	40	0.356	0.009	20	20	2	47	47	1	1.62	1.62	0.01	9	9	0	2.0E+14	2.0E+14	5.4E+13	0.85	0.85	0.02
	65	0.587	0.017	26	26	1	63	63	2	1.74	1.74	0.03	43	43	18	3.3E+14	3.3E+14	9.9E+13	0.89	0.89	0.01
	85	0.783	0.030	30	30	1	74	74	0	1.84	1.84	0.01	158	158	39	6.5E+14	6.5E+14	1.2E+14	0.91	0.91	0.00
	100	0.853	0.028	32	32	0	77	77	1	1.90	1.90	0.01	235	235	33	1.3E+15	1.3E+15	6.7E+14	0.90	0.90	0.01
30	4	0.096	0.002	16	15	2	23	23	2	1.34	1.35	0.04	151	140	90	4.7E+16	4.7E+16	1.3E+16	0.29	0.31	0.09
	5.5	0.105	0.001	16	16	-	21	21	-	1.33	1.33	-	142	142	-	5.6E+16	5.6E+16	-	0.26	0.26	-
	7	0.120	0.004	14	14	2	20	20	0	1.29	1.29	0.03	114	114	9	4.9E+16	4.9E+16	1.1E+16	0.17	0.17	0.08
	15	0.149	0.003	13	13	-	17	17	-	1.27	1.27	-	61	61	-	4.6E+16	4.6E+16	-	0.10	0.10	-
	30	0.284	0.017	13	13	1	20	18	4	1.28	1.27	0.05	77	49	55	3.8E+16	3.9E+16	7.8E+15	0.07	0.01	0.11
	40	0.356	0.009	12	12	1	18	18	0	1.26	1.26	0.02	42	42	17	2.8E+16	2.8E+16	7.2E+15	0.01	0.01	0.00
	65	0.587	0.017	12	12	1	34	34	4	1.31	1.31	0.02	60	60	16	1.5E+16	1.5E+16	5.9E+15	0.03	0.03	0.00
	85	0.783	0.030	13	13	1	64	64	3	1.54	1.54	0.04	172	172	57	8.0E+15	8.0E+15	3.3E+15	0.11	0.11	0.02
	100	0.853	0.028	13	13	1	68	68	3	1.58	1.58	0.02	232	232	57	1.1E+16	1.1E+16	4.4E+15	0.15	0.15	0.04

TABLE H-6A.—SUMMARY STATISTICS FOR NONVOLATILE PARTICLE PARAMETERS MEASURED DURING RUNS EMPLOYING HIGH SULFUR FUEL.

					Nonvolatile Particles														
Rake	Thrust	Fuel Flow (kg/s)			GMD (nm)			VMD (nm)			Standard Dev.			Mass EI (mg/kg)			Black Carbon (mg/kg)		
m	%	Avg	Std	N	Avg	Med	Std	Avg	Med	Std	Avg	Med	Std	Avg	Med	Std	Avg	Med	Std
1	4	0.096	0.002	3	16	15	1	46	48	8	1.59	1.60	0.02	12	12	2	17	8	19
	5.5	0.105	0.001	1	18	18	-	55	55	-	1.65	1.65	-	8	8	-	5	5	-
	7	0.120	0.004	8	17	18	2	43	45	8	1.56	1.60	0.07	9	7	4	7	6	2
	15	0.149	0.003	1	18	18	-	55	55	-	1.63	1.63	-	5	5	-	3	3	-
	30	0.284	0.017	3	18	18	0	55	54	6	1.70	1.70	0.04	8	9	3	5	5	0
	40	0.356	0.009	5	21	20	5	55	53	4	1.90	1.74	0.39	15	11	8	8	7	2
	65	0.587	0.017	1	23	23	-	66	66	-	1.81	1.81	-	25	25	-	24	24	7
	85	0.783	0.030	2	33	33	1	79	79	1	1.89	1.89	0.01	146	146	24	140	148	27
	100	0.853	0.028	2	32	32	4	81	81	2	1.99	1.99	0.11	169	169	3	303	332	126
10	4	0.096	0.002	4	14	14	1	44	46	6	1.54	1.54	0.04	16	15	4	13	12	2
	5.5	0.105	0.001	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	7	0.120	0.004	5	15	15	1	49	50	6	1.59	1.55	0.05	8	7	3	8	8	3
	15	0.149	0.003	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	30	0.284	0.017	2	16	16	1	55	55	1	1.69	1.69	0.04	8	8	4	6	6	2
	40	0.356	0.009	5	18	18	2	56	53	4	1.71	1.72	0.03	11	11	5	8	8	2
	65	0.587	0.017	2	20	20	5	63	63	4	1.89	1.89	0.03	24	24	10	25	25	5
	85	0.783	0.030	2	31	31	0	77	77	4	1.93	1.93	0.05	91	91	47	201	201	171
	100	0.853	0.028	2	34	34	3	78	78	5	1.82	1.82	0.02	117	117	70	286	286	264
30	4	0.096	0.002	6	12	12	0	24	23	5	1.28	1.28	0.04	38	40	5	34	33	6
	5.5	0.105	0.001	1	11	11	-	19	19	-	1.22	1.22	-	27	27	-	26	26	-
	7	0.120	0.004	7	11	11	1	25	25	8	1.28	1.27	0.11	16	11	8	23	19	17
	15	0.149	0.003	1	12	12	-	49	49	-	1.49	1.49	-	11	7	-	14	14	-
	30	0.284	0.017	4	15	14	4	52	52	7	1.62	1.64	0.17	22	-7	24	37	18	44
	40	0.356	0.009	2	13	13	2	47	47	5	1.54	1.54	0.19	11	-7	0	15	15	3
	65	0.587	0.017	2	16	16	0	61	61	2	1.78	1.78	0.01	27	-4	1	39	39	4
	85	0.783	0.030	3	25	26	2	75	74	3	1.97	1.97	0.03	106	56	24	166	159	39
	100	0.853	0.028	3	23	22	8	77	77	6	1.95	1.99	0.08	139	84	29	207	216	26

TABLE H-6B.—SUMMARY STATISTICS FOR TOTAL AEROSOL PARTICLE PARAMETERS MEASURED DURING RUNS EMPLOYING HIGH SULFUR FUEL.

				Total Particles																	
Rake	Thrust	Fuel Flow (kg/s)		GMD (nm)			VMD (nm)			Standard Dev.			Mass EI (mg/kg)			Number EI (#/kg)			Nonvolatile Fraction		
m	%	Avg	Std	Avg	Med	Std	Avg	Med	Std	Avg	Med	Std	Avg	Med	Std	Avg	Med	Std	Avg	Med	Std
1	4	0.096	0.002	15	16	1	36	36	5	1.53	1.53	0.04	24	19	17	9.8E+14	7.3E+14	5.5E+14	0.64	0.68	0.13
	5.5	0.105	0.001	15	15	-	34	34	-	1.51	1.51	-	15	15	-	4.2E+14	4.2E+14	-	0.49	0.49	-
	7	0.120	0.004	18	16	3	35	36	3	1.47	1.49	0.08	14	8	11	7.0E+14	2.3E+14	1.0E+15	0.70	0.78	0.16
	15	0.149	0.003	15	15	-	36	36	-	1.56	1.56	-	8	8	-	1.5E+14	1.5E+14	-	0.59	0.59	-
	30	0.284	0.017	19	19	1	40	40	2	1.56	1.54	0.04	8	7	2	2.0E+14	1.8E+14	5.0E+13	0.66	0.66	0.04
	40	0.356	0.009	18	19	3	41	43	4	1.54	1.55	0.09	15	11	11	4.5E+14	3.5E+14	3.3E+14	0.47	0.55	0.22
	65	0.587	0.017	24	24	1	59	59	0	1.73	1.73	0.01	37	37	6	2.7E+14	2.7E+14	6.7E+13	0.86	0.86	0.04
	85	0.783	0.030	32	32	1	73	72	2	1.81	1.82	0.02	198	186	27	6.3E+14	6.0E+14	9.0E+13	0.89	0.90	0.02
	100	0.853	0.028	34	34	2	74	74	2	1.78	1.79	0.02	238	232	12	1.3E+15	1.4E+15	6.6E+14	0.90	0.90	0.01
10	4	0.096	0.002	14	14	1	31	31	3	1.44	1.44	0.04	17	17	4	2.8E+15	2.6E+15	1.1E+15	0.36	0.36	0.08
	5.5	0.105	0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	7	0.120	0.004	13	13	1	34	34	4	1.43	1.43	0.03	10	9	4	1.6E+15	1.6E+15	4.4E+14	0.27	0.27	0.06
	15	0.149	0.003	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	30	0.284	0.017	19	19	2	44	44	2	1.59	1.59	0.01	8	8	6	2.5E+14	2.5E+14	9.3E+13	0.70	0.70	0.14
	40	0.356	0.009	20	21	2	49	47	4	1.62	1.62	0.04	9	9	2	2.5E+14	2.6E+14	4.6E+13	0.77	0.75	0.08
	65	0.587	0.017	25	25	1	61	61	2	1.75	1.75	0.01	24	24	6	3.3E+14	3.3E+14	1.1E+14	0.85	0.85	0.06
	85	0.783	0.030	30	30	4	73	73	1	1.88	1.88	0.08	103	103	31	1.1E+15	1.1E+15	9.5E+14	0.88	0.88	0.03
	100	0.853	0.028	32	32	2	74	74	3	1.83	1.83	0.04	128	128	51	1.2E+15	1.2E+15	9.7E+14	0.90	0.90	0.01
30	4	0.096	0.002	16	16	0	23	23	1	1.34	1.35	0.01	151	154	20	5.3E+16	5.5E+16	9.4E+15	0.35	0.36	0.04
	5.5	0.105	0.001	16	16	-	21	21	-	1.30	1.30	-	140	140	-	6.4E+16	6.4E+16	-	0.30	0.30	-
	7	0.120	0.004	15	15	1	20	20	1	1.32	1.31	0.01	111	119	40	6.2E+16	6.7E+16	1.31D+16	0.19	0.22	0.09
	15	0.149	0.003	15	15	-	19	19	-	1.32	1.32	-	129	129	-	7.0E+16	7.0E+16	-	0.06	0.06	-
	30	0.284	0.017	15	15	1	24	22	5	1.33	1.32	0.02	149	148	23	5.4E+16	5.7E+16	1.13D+16	0.01	0.01	0.01
	40	0.356	0.009	15	15	0	21	21	0	1.32	1.32	0.00	125	125	33	4.7E+16	4.7E+16	1.07D+16	0.02	0.02	0.01
	65	0.587	0.017	14	14	1	30	30	8	1.35	1.35	0.03	89	89	40	2.3E+16	2.3E+16	1.48D+16	0.03	0.03	0.03
	85	0.783	0.030	15	14	1	56	56	10	1.58	1.46	0.24	195	172	46	1.3E+16	1.7E+16	8.4E+15	0.13	0.06	0.14
	100	0.853	0.028	14	14	1	55	54	12	1.57	1.46	0.25	245	218	53	1.6E+16	2.1E+16	8.8E+15	0.14	0.09	0.12

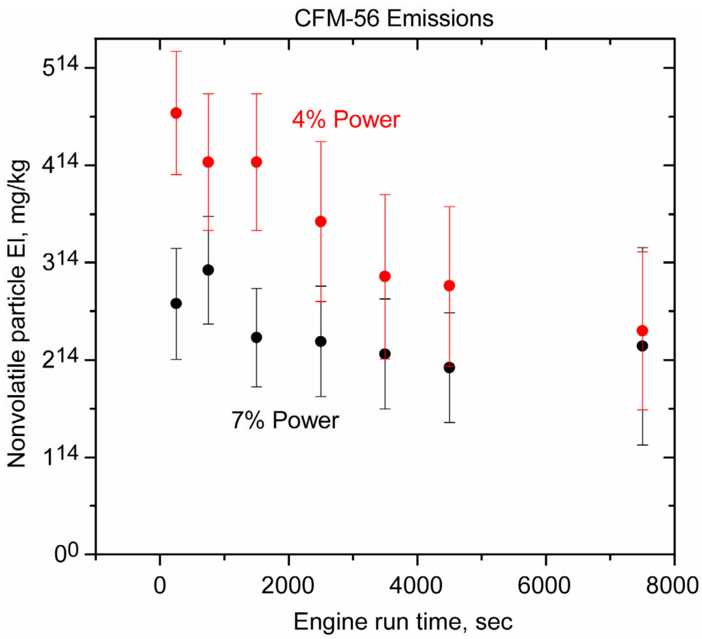

Figure H–10.—EIn at 4 and 7% power for baseline fuel as a function of time since engine start. The variations are most likely caused by an increase in ambient temperature.

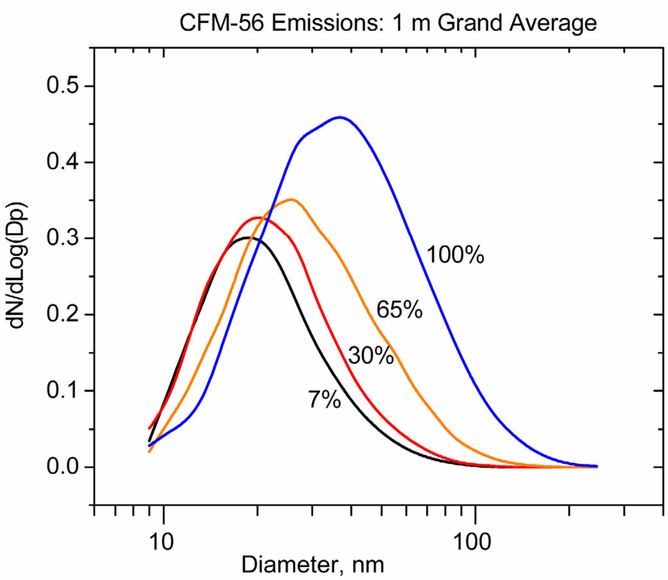

Figure H–11.—Average 1-m aerosol size distributions for 7, 30, 65, and 100% power illustrating the shift in particlen size with combustor temperature and pressure.

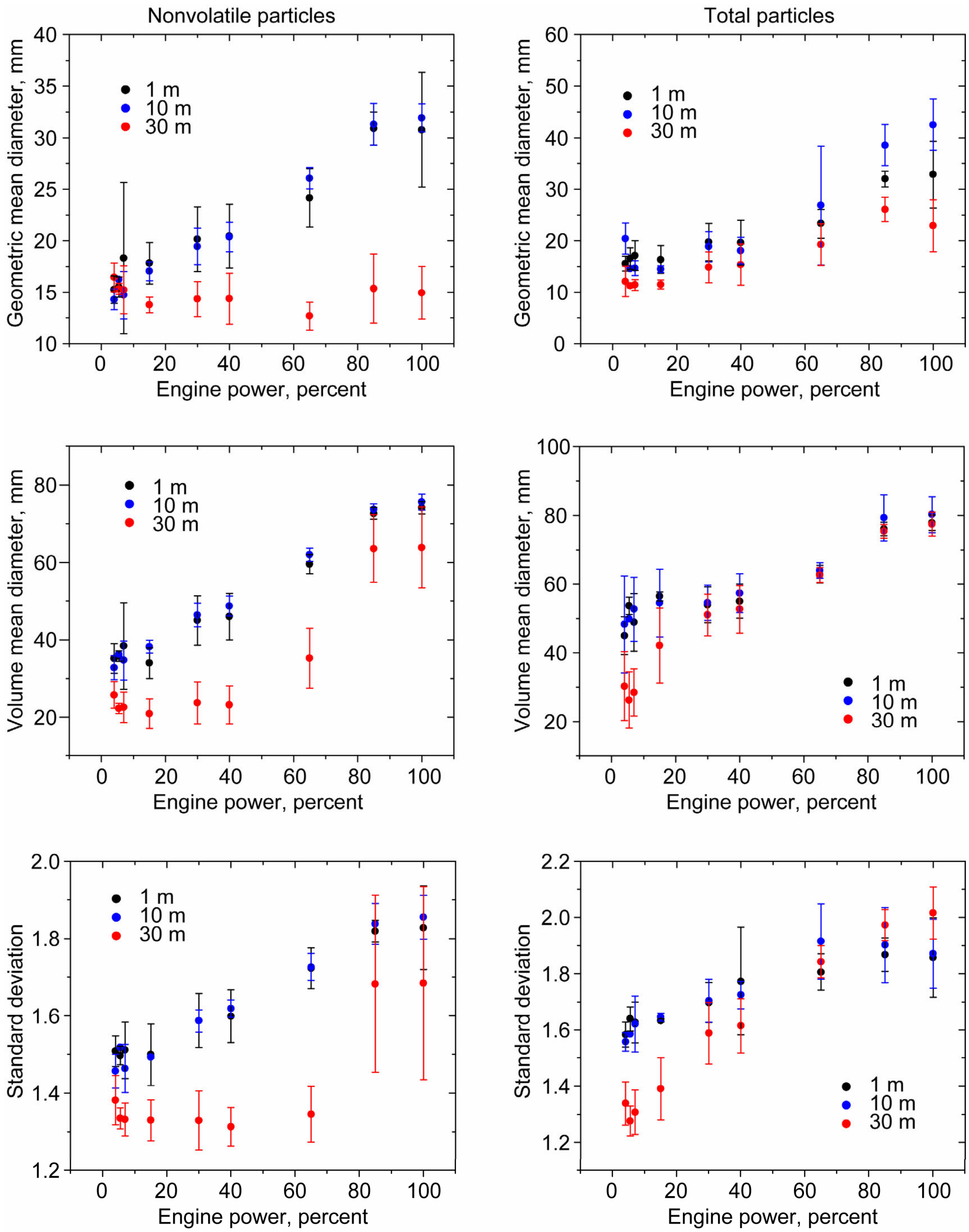

Figure H–12.—Nonvolatile and total particle GMD (top), VMD (middle), and standard deviation of size as functions of engine power for the 1–, 10–, and 30–m sampling probes.

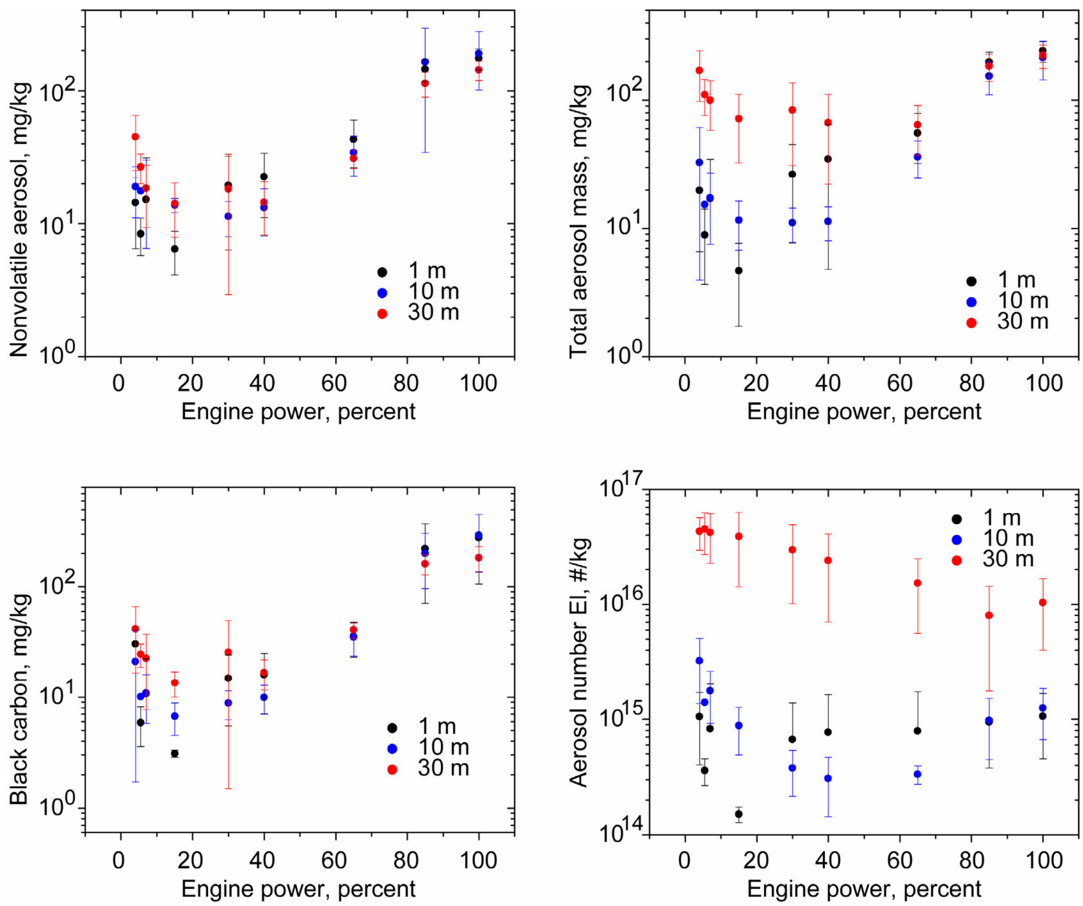

Figure H–13.—Grand average nonvolatile particle EIm (top left), total aerosol EIm (top right), black carbon EIm (bottom left), and total aerosol EIn as functions of engine power for the 1–, 10–, and 30–m sampling probes.

Another consistent finding was that particle number densities always increased with plume age reflecting the fact that low volatility materials are present at high saturation levels in the exhaust and that they rapidly condense to form new particles as the plume cools and dilutes with background air. This homogeneous nucleation process has been observed in during many previous experiments (i.e., Anderson et al., 1998; 1999; 2005) and is clearly evident in particle size distribution recorded on progressively more aged exhaust samples. For example, figure H-14 shows SMPS scans performed on samples collected using the 1-, 10-, 30-m probes as the aircraft was burning HS fuel and operating at idle power. Ancillary data indicate that at 10 m behind the engine, the plume had diluted by more than 15-fold (fig. H-2) and its temperature had dropped to < 70 °C. At the 30-m sampling location the plume had undergone an additional 3-fold dilution and its temperature was only a few degrees above ambient. A small nucleation mode peaking at ~10 nm is evident in the 10 m spectrum. At 30 m, the mode has increased in diameter and completely dominates the measured number densities. The relative importance of this nucleation mode diminished with increasing engine power which may reflect a reduced availability of condensable species (i.e., total hydrocarbons EIs are typically 1 to 2 orders of magnitude lower at takeoff thrust than at idle), a shift in equilibrium between new particle formation and existing particle growth, or that plume temperatures are higher and residence times are shorter, each of which would tend to suppress new particle formation. Increasing concentrations of 100 to 200 nm particles are also evident in the downstream size distributions and may be due to the growth of the soot mode by accretion of smaller particles or condensable gases or to the increasing contribution of background aerosols as the plume becomes more dilute.

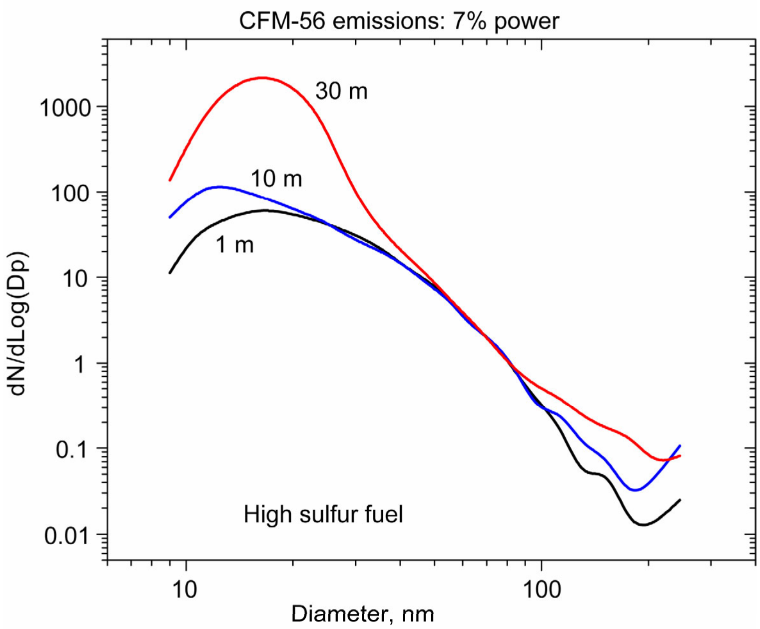

Figure H–14.—Aerosol size distributions from the 1–, 10–, and 30–m probes for high sulfur fuel and 7% engine power. The mode that forms below 30 nm in the more aged samples is presumably due to nucleation of sulfuric acid whereas the increase in number seen above 100 nm is potentially caused by condensation of low volatility hydrocarbon compounds onto the surface of soot.

Nucleation and condensation processes occurring within the plume greatly influenced total aerosol parameters measured at the 30-m sampling position (table H-3; figs. H-15 and H-16). For example, because of the nucleation mode particles, apparent GMD values were typically < 15 nm at all power settings, which represents a two-fold decrease in average particle size at the higher power settings (fig. H-15). VMD were similarly reduced, dropping from 35 to 20 nm at idle and from 75 to 65 nm at takeoff. Almost mono-disperse sigma values of 1.3 were calculated for the lower power runs which reflects the fact that our SMPS abruptly truncates the size distributions at 9 nm as seen in figure H-14. Although nonvolatile and black carbon EIm values were slightly enhanced at the downstream location, total aerosol EIm at idle was only slightly less than that observed at takeoff thrust, ranging from about 150 to 180 mg kg^{-1}, which has significant implications for air quality in airport terminal areas where dozens of aircraft are idling on the ramp and along taxiways. Similarly, EIn were enhanced a minimum of 10-fold across the entire power spectrum, with the values at idle being almost 50 times higher than seen in the 1 m samples. These levels of enhancement are consistent with numerous previous observations and are quite similar to those observed in flight (Anderson et al., 1998, 2000).

Although power changes greatly affected primary particle characteristics, changes in the fuel matrix seemed to have no clear and consistent impact. As shown in the left panels of figure H-14, 1-m GMD, VMD and sigma values were not significantly different for any of the three fuels tested. The base fuel does appear to produce slightly higher EI values for black carbon, mass and number density (fig. H-15), but a great deal of the data included in these averages were recorded after cold starts and on mornings where temperatures were several degrees lower than for the other fuel types. Indeed, because the baseline and high sulfur fuels had essentially the same hydrocarbon matrix, there is no physical reason why the black carbon emissions should be different between the two cases.

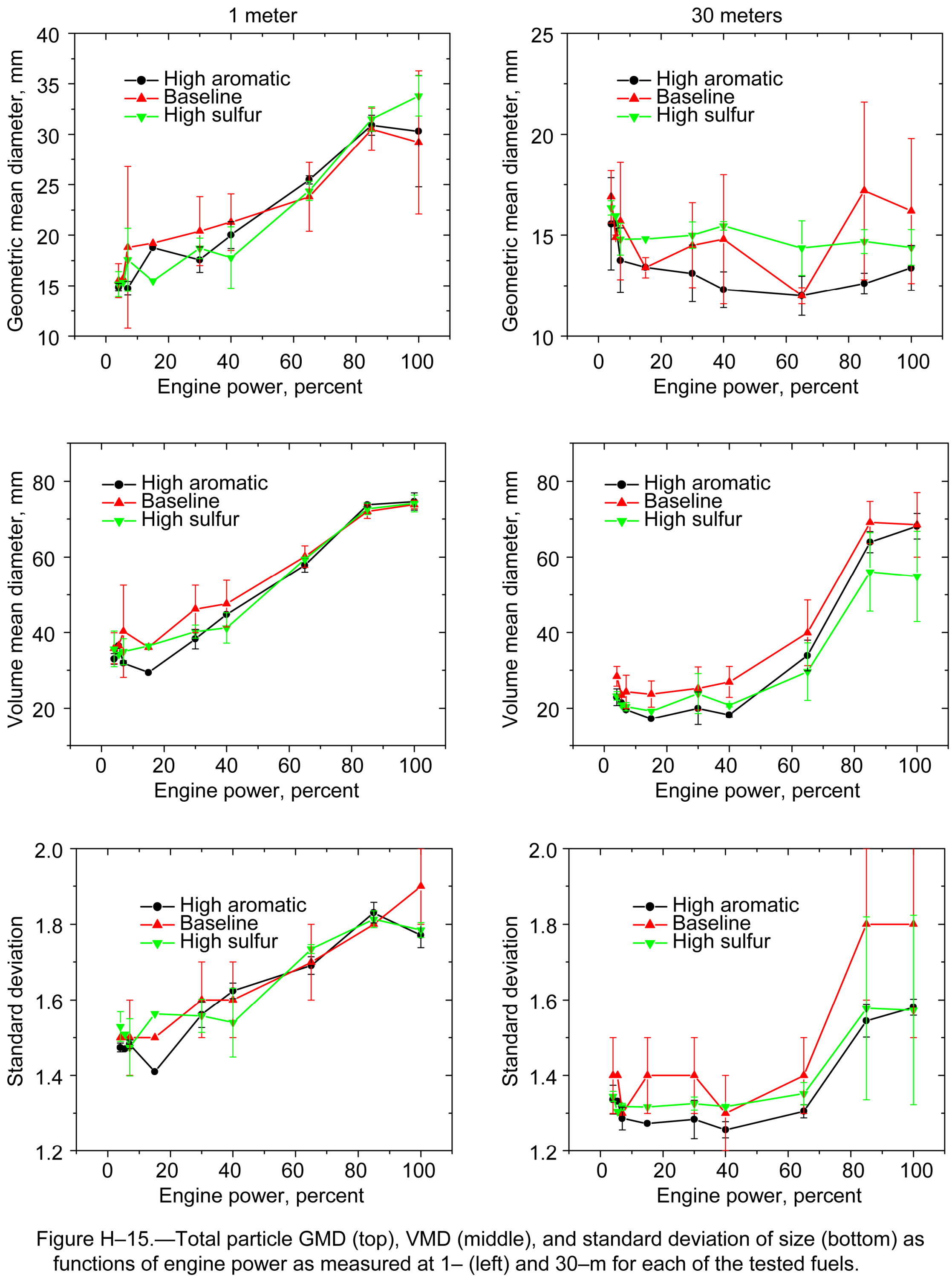

Figure H–15.—Total particle GMD (top), VMD (middle), and standard deviation of size (bottom) as functions of engine power as measured at 1– (left) and 30–m for each of the tested fuels.

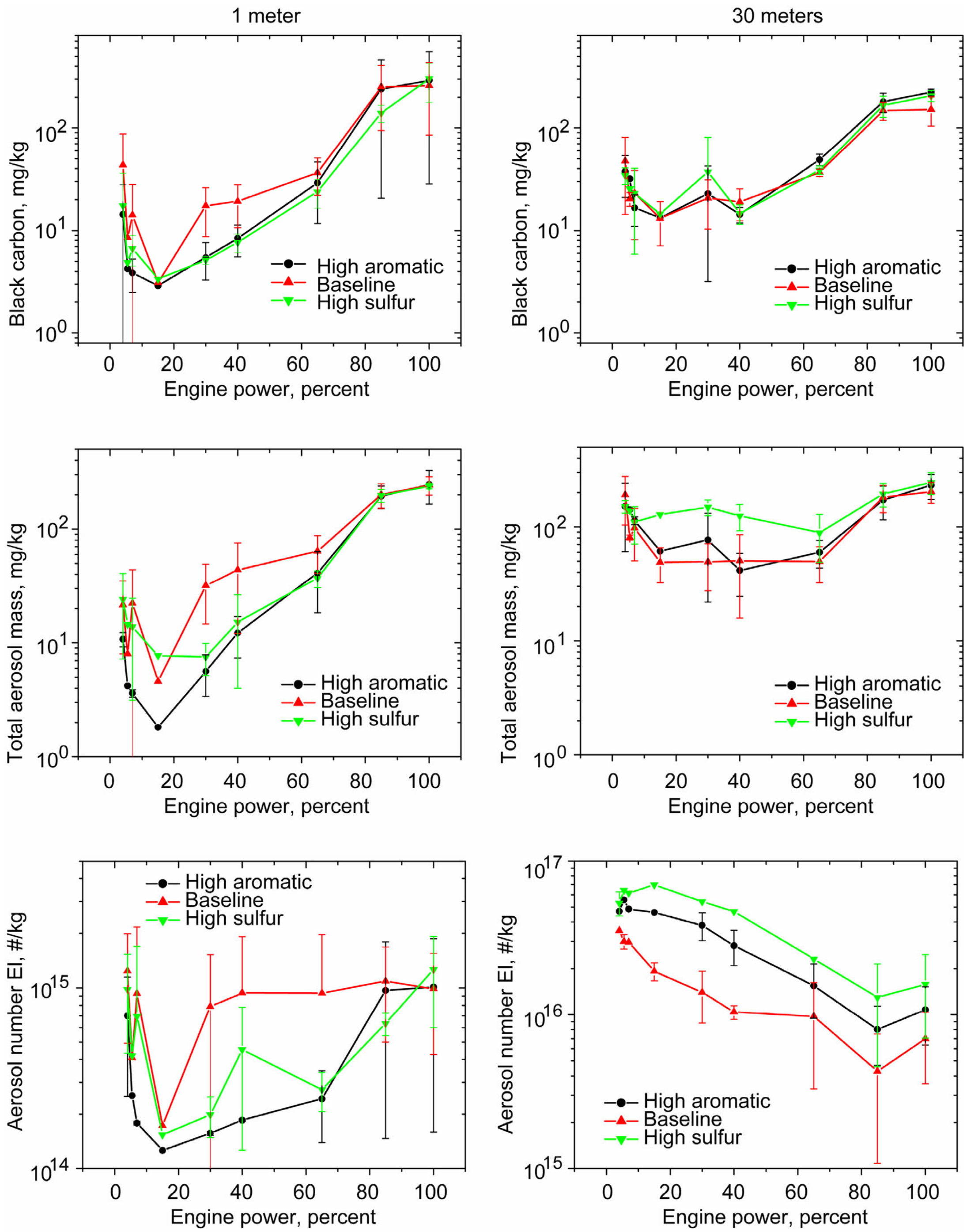

Figure H–16.—Black carbon EIm (top), total aerosol EIm (middle) and total aerosol EIn (bottom) as measured from the 1– (left) and 30–m (right) sampling probes for each of the fuels tested.

As illustrated in the left panels of figures H-15 and H-16, fuel composition did have a significant effect on secondary aerosol concentrations and characteristics in the aged plumes. Recall that the HS, HA, and BASE fuels contained 383, 530, and 1595 ppm S, respectively, then note that EIn and EIm values are consistently higher for the HS fuel and that the values are typically ordered HS>HA>BASE. The differences are particularly notable in EIn, where values for the HS fuel exceed those for the BASE fuel by factors of 2 to 5 across the entire thrust range.

Using total and nonvolatile EIm values for the various sampling distance/fuel S combinations, it is possible to estimate the relative contributions of organic and sulfate aerosols to overall aerosol mass loadings. Excluding data recorded at 4% power which tended be highly variable, EIm and EIn averaged 52 mg kg^{-1} and ~3×10^{16} kg^{-1} higher for the HS fuel than for the BASE fuel. Using an average sulfate aerosol molecular weight of 150 g $mole^{-1}$ to make allowances for hydration and partial neutralization of sulfuric acid by ambient ammonia, a 52 mg kg^{-1} EIm enhancement produced by the extra 1212 ppmS contained in HS fuel corresponds to a fuel S conversion factor, ε, of ~1.0% which is consistent with many previous observations [i.e., Schumann et al., 2002]. For a sanity check, if we assume that the enhanced nucleation mode particles seen in the HS fuel case have an average diameter of 12 nm and a mass density of 1.5 g cm^{-3}, we calculate that the increased fuel S produced an ΔEIm of 41 mg kg-1 which corresponds to an ε value of 0.8. If we use an ε value of 1% to calculate sulfate EIm values for each of the test points, subtract this and the nonvolatile EIm from the total aerosol EIm, we obtain an estimate of the organic carbon EIm for each of the fuels as functions of engine power. Shown in figure H-17, results of this analysis are fairly consistent between the fuel types and suggest that organic aerosol emissions are a minimum at medium power settings and increase at low and high thrust settings. Values range from around 0 at 65% power to >100 mg kg^{-1} at ground idle. The increase at low powers is understandable since the engine is relatively inefficient at idle, but the increase at high power is somewhat surprising given that THC EI values monotonically decrease with increasing combustor temperature and pressure; the cause for this behavior is still under investigation.

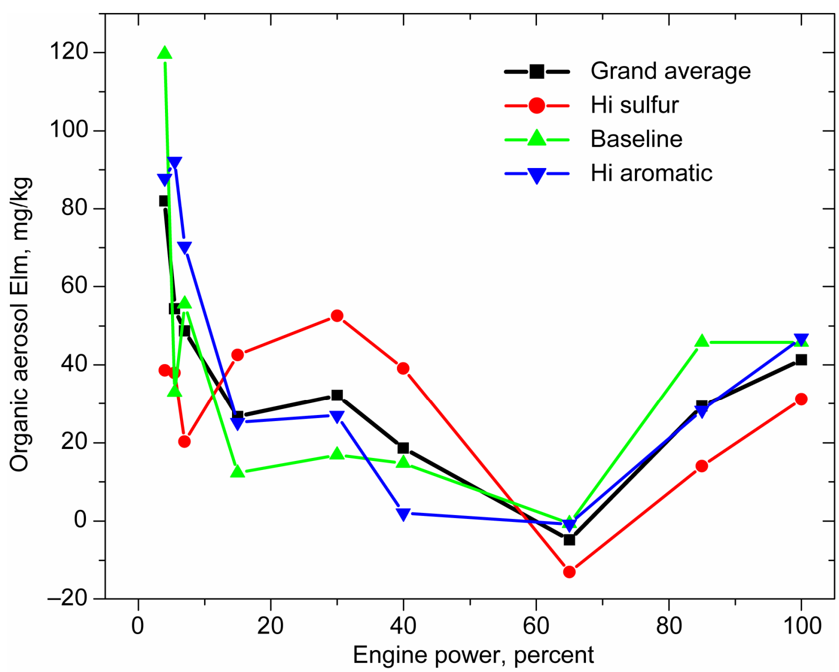

Figure H–17.—Organic aerosol EIm values inferred from the difference in total aerosol EIm and nonvolatile + sulfate EIm, assuming the fuel sulfur is converted to S(VI) with a 1% efficiency.

4.0 Summary

Detailed measurements of particle emissions from the NASA DC-8 aircraft were recorded over a 10-day period in April 2004. Analyses were performed on samples collected at 1-, 10-, and 30-m downstream of the exhaust plane as the engine burned fuels containing different levels of aromatic hydrocarbon and sulfur contaminants and was operated at power settings ranging from ground idle to 100% of maximum thrust. In addition, tests were conducted to evaluate probe and sample dilution effects and analyses were performed to assess the impact of background aerosols on calculated emission parameters, to determine sulfur oxidation efficiency, and to estimate organic aerosol emissions.

Overall, our observations are consistent with results from previous airborne and ground-based test venues which indicate turbofan engines produce, as a primary emission, copious quantities of nonvolatile particles that occupy a single size mode which spans the diameter range between 10 and 300 nm. The CFM56-2C1 tested in APEX generated about 10^{15} such particles kg^{-1} fuel burned. The mean diameter of these particles increased from ~15 nm to ~35 nm as engine power was increased from idle to takeoff. Corresponding nonvolatile EIm values were a minimum of <10 mg kg^{-1} at about 15% power, increased slightly in going to lower powers, but reached values in excess of 200 mg kg^{-1} at 100% of maximum rated thrust. Variations in fuel hydrocarbon content did not appear to significantly influence the characteristics of the nonvolatile emissions.

Processes occurring within the exhaust plume as it cooled and mixed with background air had a significant effect on aerosol loadings measured at the downstream sampling locations. Size spectra recorded on samples from the 10-m probe showed that a nucleation mode was forming at sizes below 20 nm that significantly enhanced EIn values under some circumstances. By the time the plume reached the 30-m probe and subsequently passed through the long length of transport tubing which connected the inlet with our analytical instrument, this nucleation mode had grown to the point that it completely dominated EIn and contributed significantly to total aerosol EIm, particularly for the low power test points. The enhancements in EIn were especially noteworthy as values approached 10^{17} kg-1 fuel burned in several cases. In addition to this nucleation mode, it appeared that a fraction of the condensable material coated the nonvolatile particles causing number densities in the 100 to 200 nm range to increase above values observed in the hot exhaust plume. The equilibrium between new particle formation and condensation on existing particles is undoubtedly dependent on the availability of aerosol surface area, which may account for the fact that EIn tended to decrease with engine thrust, even though the calculated amount of volatile aerosol mass remained relatively high across the entire power spectrum.

The number and mass of volatile aerosols in the aged exhaust plume clearly depended on fuel sulfur content. Assuming a linear relationship between fuel sulfur and secondary sulfate mass EI and capitalizing on the variation of sulfur concentration between the baseline and high sulfur fuels, we used two different approaches to estimate that the fraction of fuel sulfur converted to S(VI) species in the near-field behind the aircraft was approximately 1%. Adopting this as a value for ε, we further inferred that more than 100 mg kg^{-1} of low volatility organic compounds condense in the plume at low engine power settings.

Fundamental tests conducted during APEX suggest that diluting the 1 m samples by at least a factor of 10 directly behind the inlet probe tip significantly improves the fidelity of measured aerosol parameters when compared with data obtained using a standard gas sampling system that introduced dilution >15 m downstream of the collection point.

Although APEX greatly advanced our understanding of gas and particle emissions from modern commercial turbofan engines, a great number of questions and challenges remain. Particularly important investigations include efforts to:

- Establish the absolute penetration characteristics of inlet probes and transport lines under actual (i.e., high temperature and velocity) operating conditions
- Determine the density of aircraft generated soot as a function of particle size so that mass concentrations can be more accurately estimated from SMPS scans

- Formally inter-compare the various new and existing instruments that are being deployed to measure aircraft exhaust particle concentrations and properties.
- Further evaluate the impact of fuel composition on primary and secondary particle formation and characteristics, especially focusing on the effects of fuel hydrogen and polycyclic aromatic content on particle production and obtaining additional insight into the species that contribute to organic aerosol formation
- Observe plume evolution over longer time scales to provide information for validating plume processing models
- Obtain detailed gas and particle-phase emission characteristics of additional aircraft engines to develop a broader understanding of the links between combustor design/operation and soot formation and a data base for PM emission estimates.

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Appendix I
Physical Characterization of Aerosol Emissions from a Commercial Gas Turbine Engine—Project APEX*

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Physical Characterization Of Aerosol Emissions From a Commercial Gas Turbine Engine—Project APEX

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1. Introduction

Jet engines are a significant source of soot particles in the atmosphere, which in contrast to most other combustion sources are injected not only into the planetary boundary layer, but also into the upper troposphere and lower stratosphere (Schlager et al., 1997; Hagen and Whitefield, 1996; Penner et al., 1999). Here their atmospheric residence time and hence their potential environmental impact are enhanced. Soot particles contribute to climate forcing both directly by strongly absorbing solar radiation, and indirectly through water-uptake and cloud activation (Haywood and Shine, 1995; Kärcher et al., 1996, DeMott et al., 1997; Heymsfield et al., 1998; Detwiler and Pratt, 1984; Grassel, 1990; Sassen, 1997; Schumann et al., 1996; Friedl, 1997; King et al., 1992; Minnis et al., 1998; Fortuin et al., 1995; Ponater et al., 1996). They can interact with gaseous chemical species, especially in the near field plume, and play a significant role in atmospheric chemistry (Pueschel et al., 1992; Solomon et al., 1997). Some modeling results indicate that the current commercial fleet of aircraft could be a noticeable source of soot near the tropopause at northern mid-latitudes (Bekki, 1997; Danilin et al., 1998). An additional concern, primarily in the vicinity of airports, is the contribution of aircraft emissions to the formation of photochemical smog and the delivery (through inhalation) of highly concentrated irritants into human beings (Samet et al., 2000; Dutton et al., 2002). As a consequence of the complex role of aviation-induced particles in the atmosphere, the physical and chemical characteristics of the particles emitted by turbine engines have received attention under recent research programs, e.g., the NASA (National Aeronautics and Space Administration) High Speed Research and Ultra Efficient Engine Technology programs, and the European Community's AERONOX program. Among the key measurement parameters are size–resolved particle number distribution, total number density, and particle morphology, which are converted into size-resolved particle surface area and mass as well as emission indices. These size distribution dependent characteristics control the particulate matter (PM) emissions' evolution in the atmosphere and their ability to influence the above processes. Project APEX (Aircraft Particle Emissions eXperiment) is a recent multi-agency sponsored program aimed at further addressing some of these issues.

The University of Missouri - Rolla Center of Excellence for Aerospace Particulate Emissions Reduction Research (UMR COE) was a team member for Project APEX performed at the NASA Dryden Flight Research Center in April 2004. This report summarizes and describes the results of Project APEX from the UMR perspective, in terms of the physical characterization of total (non-volatile plus volatile) aerosol emissions by extractive sampling from a NASA DC-8 aircraft with General Electric CFM56-2C1 engines. Samples were extracted immediately downstream (1 m) of the exhaust nozzle as well as locations 10 and 30 m downstream. Three different fuels were used in this study – a baseline JP-8 fuel (Base Fuel), base fuel doped with sulfur compounds (High Sulfur Fuel), and a fuel which had a considerably higher aromatic content than the two other fuels used (High Aromatic Fuel). These aerosol measurements were designed to measure the emissions in the plume at the probe tip location. However, the extractive sampling process may result in sample modification due to inertial, thermophoretic, and diffusional effects. Corrections to account for some of these processes are discussed below, but further studies are needed, especially to address effects at the probe tip. Finally, a discussion on the inter-comparison between a fast differential mobility spectrometer and conventional instruments used for these types of measurements and one comparing gas vs. particulate sampling trains is also included.

The instrumentation onboard the UMR mobile laboratory consisted of the Cambustion DMS 500, a state-of-the-art fast particulate spectrometer, to gather real–time size distribution information and total concentration of engine exhaust particulates; a differential mobility analyzer (DMA), a traditional and slower instrument to measure aerosol size distributions; a TSI Condensation Nucleus Counter (CNC) to measure total number concentration; a fast response CO_2 detector to monitor sample dilution and establish emission factors; a deliquescence system to measure the total soluble mass fraction; a hygrometer to measure the sample's water content; and a weather station to monitor the ambient conditions temperature, relative humidity, pressure, and wind speed and direction. Traditional aerosol sizing techniques are either slow or have insufficient resolution to provide the data base needed by modelers. Increased measurement speed is required since engine on-time for sampling is expensive, and some engine conditions, e.g., take-off power, can be made available only for short times. Fast response instruments are required to make observations of engine transients between stable operating conditions. Project APEX was the first application of a new fast mobility spectrometer to gas turbine emissions characterization.

2. Line Loss Calibration Experiment

Modification of the aerosol size spectrum due to line loss is an artifact associated with extractive sampling which must be accounted for with calibration experiments. On the final day of Project APEX, UMR and ARI (Aerodyne Research Inc) participated in a study to establish the penetration function of particles in the sampling train. This experiment was performed using a mono-disperse NaCl aerosol as the calibration source. It was generated by atomizing a NaCl solution and then selecting a certain size aerosol using a DMA. TSI CNCs were used to measure the concentration of the mono-dispersed aerosol at three locations for the 1 m sampling train: the probe tip and the ends of the sampling train to UMR and to ARI. The ratio of the concentration of aerosol at the end of either sampling train to the concentration at the probe tip provided the penetration factor for the selected aerosol size. This experiment was repeated a number of times for different aerosol sizes (20 to 300 nm). The results of this experiment are shown in figure I-1.

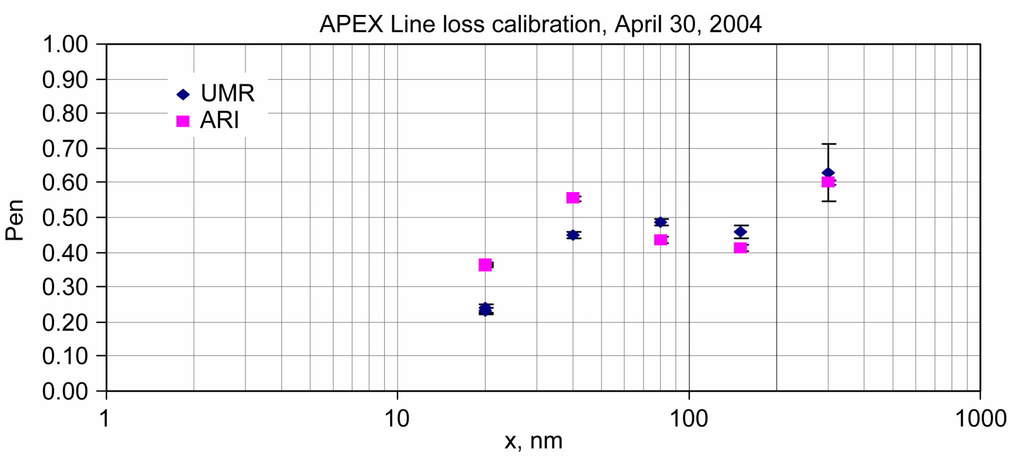

Figure I–1.—Results of the line loss calibration experiment performed at NASA DFRC.

While this experiment provided a crude estimate of the penetration function, it was decided that a thorough analysis be performed after the field test at UMR. The entire APEX probe assembly and sampling train was setup at UMR and the line loss experiment was repeated. For this more detailed penetration study a combustion source and NaCl aerosols were used for the calibration experiment. Several line loss calibrations were performed. The first was for the section of the sample train from probe tip to the NASA central distribution manifold. This segment was common to all aerosol samplers. The remainders were from the central distribution manifold to each of the UMR aerosol monitoring instruments. The total penetration function for a given instrument is the product of the penetration functions for the common segment and that between the distribution manifold and the instrument. The DMS 500 was used to obtain the transmission as a function of size. It provided distinct advantages for such calibration measurements. With the DMS 500, a poly-dispersed source could be employed to provide fast simultaneous size dependent losses for particle diameters ranging from 5 to 1000 nm. As a consistency check, the line loss experiments were also repeated at selected sizes using a mono-disperse NaCl aerosol and CNCs as was done at NASA Dryden Flight Research Center (DFRC). Figure I-2 illustrates the comparison of the penetration as a function of size using the two different sources for the common segment from the inlet of the probe tip to the central distribution manifold. The results of both post-test experiments and those performed at DFRC are in good agreement with each other. The fitted penetration function for the common sampling train segment based on all calibration data is presented in figure I-3. This function was provided to all aerosol experimenters for use in correcting their data for line loss.

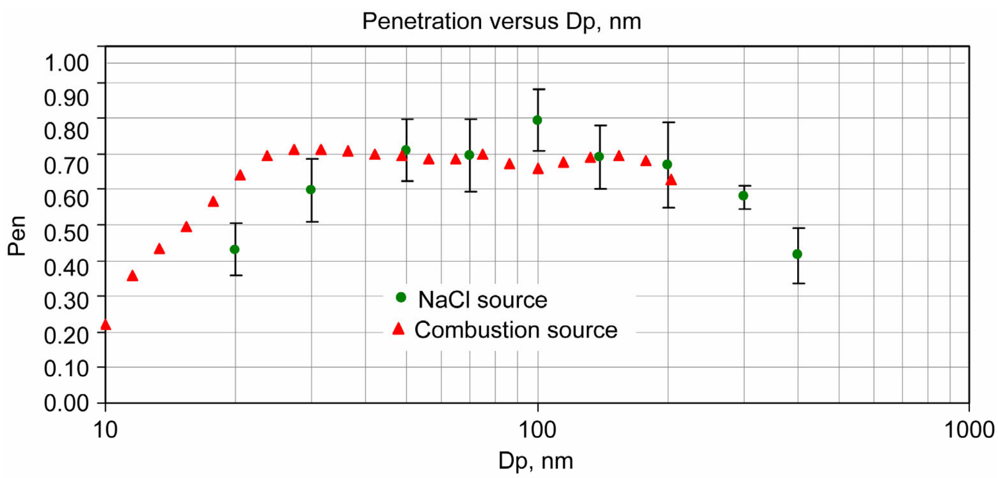

Figure I–2.—Comparison of the common segment penetration function using NaCl and combustion sources.

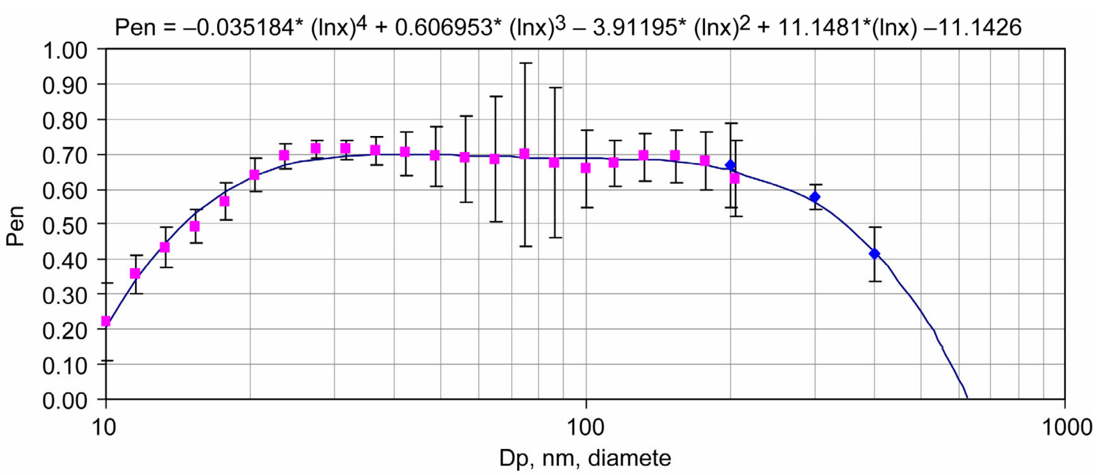

Figure I–3.—APEX Penetration function – probe tip to LaRC distribution manifold.

3. Instrument Inter-comparison

One task in Project APEX was to perform an intercomparison between the new DMS 500 instrument and traditional instruments for measuring jet engine exhaust particle concentrations and size distributions. Here a CNC was used for total particle concentration measurement, and a differential mobility analyzer (DMA) (TSI model 3071) with a condensation particle counter (TSI model 3022) as detector was used in scanning mode for size distribution measurement. These were employed in a standard configuration (Schmid, et al., 2004) which had been used on previous jet engine emissions sampling campaigns (Hagen, et al., 1989, 1992, 1996, 1997, 1998, 1999, 2003, Petzold, 1997, Whitefield, et al., 1999). In the DMA system the sample aerosol particles are electrically charged, segmented into different sized bins based on electrical mobility, and then each bin is counted with a condensation particle counter (Hagen and Alofs, 1983). The bin counting is done sequentially, and a time period of order 100 s is taken for size distribution measurement; during this time the sample must be held constant.

The Cambustion DMS500 instrument also depends on electrical mobility for particle sizing, is a new device, designed specifically for engine exhaust sampling. In this instrument the aerosol sample is passed through a cyclone separator to remove particles larger than 1 μm, electrically charged with a corona charger, inserted into a clean laminar flow air stream, and subjected to an electric field which will deflect (in a size dependent manner) the particles' trajectories toward electrometer rings. The currents resulting from the charge transported to the electrometer rings by the particles are measured and the current-electrometer data matrix is converted into particle number and size classification. Since the various electrometers are measured simultaneously rather than sequentially, the measurement is fast, up to 10 Hz. In general the time needed for a size distribution measurement is dictated by (1) time smear associated with the difference in streamlines created as the sample is transported from probe to instrumentation and by (2) the need to collect a statistically meaningful sample, i.e., sufficient concentration in each size bin. In the APEX studies, the time needed for a size distribution measurement was typically 7 s.

Exhaust sample was collected for analysis using three sampling probes at different distances downstream of the engine exit plane: 1, 10, and 30 m. Data taken with the 1 m sampling probe was used for this intercomparison analysis. The 10 and 30 m probes were excluded since they exhibited lower signal to noise ratios and more time variation due to cross wind interference. Two series of runs were performed during this experiment: one using NASA selected run criteria and one using EPA (Environmental Protection Agency) selected criteria. Both were included in this analysis.

The particulate sample from the 1 m probe was distributed to several research groups (fig. I-4a), including UMR. Calibration experiments were performed to determine size dependent line losses for each segment of the sampling train. For the intercomparison study the crucial line losses are those between the subject instruments (DMS500, DMA, and CNC) and the distribution plenum in the UMR trailer (fig. I-4b), since the line loss between the UMR distribution plenum and the probe is common to all the instruments (see above). The DMS total concentration is simply the sum of all the individual bin concentrations. To adjust the CNC total concentration for line losses, the DMS500's size distribution is used to develop a correction factor as follows. The DMS 500 size distribution is adjusted for line losses to give a size distribution at the CNC instrument location. Then, this size distribution at the CNC is corrected back to the probe tip. The correction factor is the ratio of the computed concentration at the probe tip to that at the CNC location. This correction factor when multiplied by the CNC's recorded total concentration, at the CNC, yields a value for total concentration at the probe tip. This value is then compared to that from the DMS500 bin summation.

During project APEX, 154 emission sampling runs were performed using the 1 m probe. In order to quantify the differences between instruments, three aerosol characterization parameters were chosen for intercomparison, and a weighted average over the data set was computed for each parameter. The percentage difference was computed for each parameter and relevant instrument pair. The aerosol parameters were number based geometric mean diameter, mass based geometric mean diameter, and total concentration. A weight function is employed to account for time variations of emissions within a sampling interval and experimental noise. The intent of the sampling program for a given test point is to

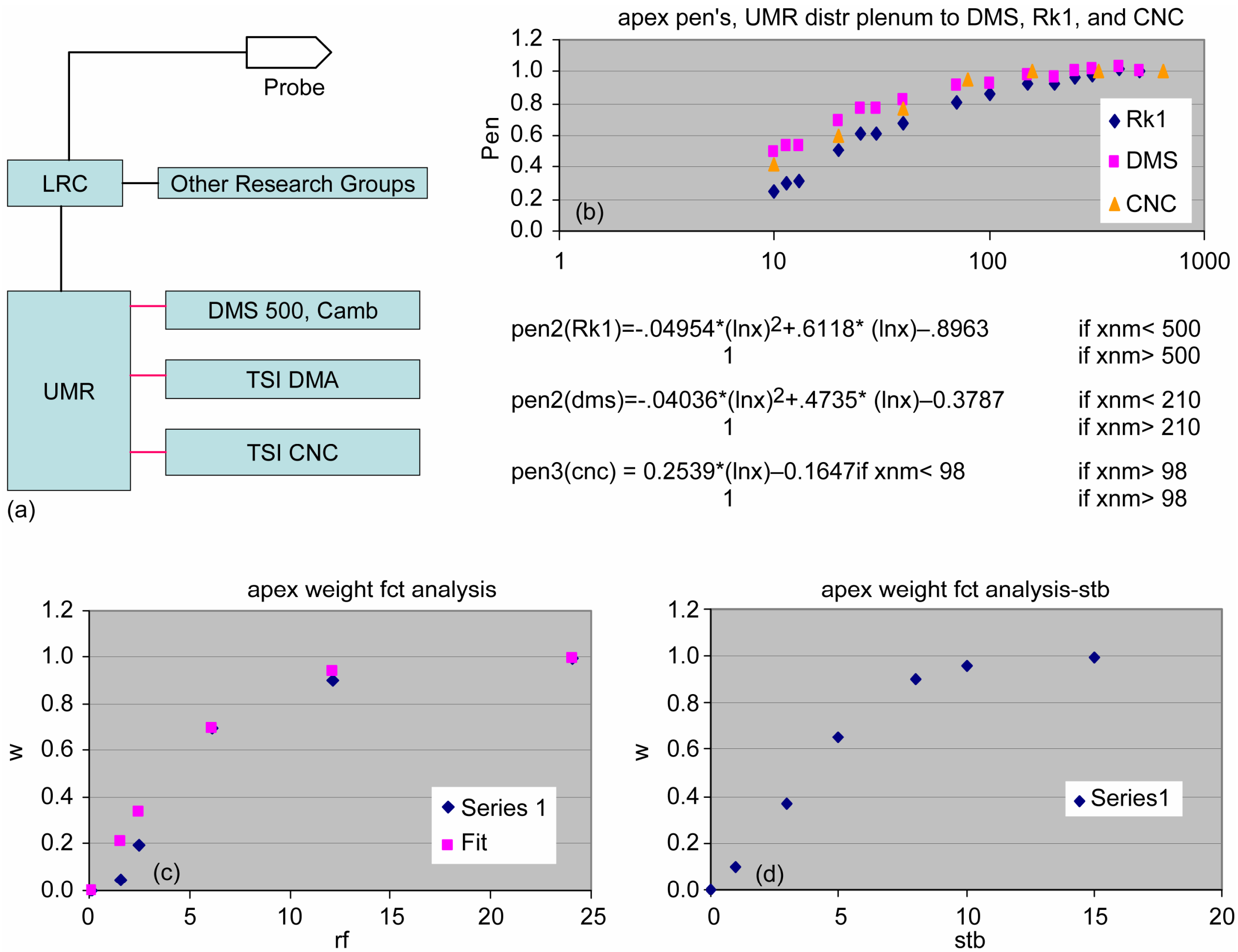

Figure I–4.—(a) Instrumentation schematic. (b) Sample line penetration functions.(c) Reciprocal fractional error weight function. (d) Signal to background weight function.

bring the engine to a stable operating condition, hold it constant for several minutes, and take emissions data under these stable conditions. If temporal variations in the emissions are detected by the measuring instruments, then the weight function reduces the contribution of this test point to the average. Background aerosol measurements are taken periodically throughout the measurement campaign. For some runs the signal to background ratio was small, perhaps due to large background readings or low sample concentrations. The weight function reduces the contributions from these test points to the averages.

The weight function was developed as follows. The time variation component was quantified using DMA and DMS data. The DMA typically took two size sweeps at each test condition. The quantity 100 divided by the percentage difference in geometric mean diameters (PctDg) between these two runs gave a reciprocal fractional error representing time variation as seen by the DMA; smaller time variation was indicated by larger values of this reciprocal fractional error. The DMS, on the other hand, typically recorded about 20 size sweeps during a stable sampling period. The corresponding reciprocal fractional error for the DMS was given by the average in geometric mean diameter, <Dgeom>, divided by its standard deviation (σg). The weight function was designed to depend on the reciprocal fractional error as follows. More weight in the average was to be given to better quality data, i.e., data with a larger reciprocal fractional error. The weight function went to zero as the reciprocal fractional error went to zero (very large time variations), and it converged to unity as the reciprocal fractional error became large (very good data). The function

$$w\_f = \tanh\left(\frac{rf}{const}\right), \text{ const} = 5.765,$$

where rf denotes the reciprocal fractional error, was chosen to represent these dependencies. Figure I-4c shows a plot of this function.

The weight function for signal to background was chosen to have the properties that it went to zero as the signal to background ratio went to zero, it increased as this ratio increased, and it asymptotically went to unity as the ratio became large. The function

$$w\_stb = \frac{\tanh\left(\frac{stb}{c1 - c2}\right) + \tanh(c2)}{1 + \tanh(c2)}$$

with c1 = 4.02775, and c2 = 0.783, and stb denoting the signal to background ratio, was found to represent these dependencies. Figure I-4d shows a plot of this function. A global weight function (w_Dgn), based on the geometric mean diameter, having one value per run was taken to be the product of the three weight functions.

$$w\_Dgn = w\_\left(\frac{100}{PctDg}\right) * w\_\left(\frac{< Dgeom >}{\Phi_g}\right) * w\_stb$$

Using this function, a weighted average percent difference between the two instruments is calculated along with a corresponding rms (root mean square) percent difference. The average percent difference gives a measure of the systematic difference between instruments and the rms differences gives a measure of the random scatter between them.

$$< PctDgn >= \frac{\sum PctDgn * w\_Dgn}{\sum w\_Dgn}$$

$$RmsPctDgn = \sqrt{\frac{\sum PctDgn^2 * w\_Dgn}{\sum w\_Dgn}}$$

The summations run over the entire data set from the 1 m probe. Here the calculation is shown for the percent difference for geometric mean diameter, Dgeom, between the DMS and the DMA instruments. The same weight function is used for the percent differences for mass based geometric mean diameter, DgeomM, and total concentration, TCN. The primary results of the intercomparison are shown in table I-1. The intercomparison for Dgeom and DgeomM are between the DMS and the DMA. The total concentration intercomparison is between the DMS and the CNC.

TABLE I-1.—APEX DMS INTERCOMPARISON RESULTS

Parameter	Avg. Pct Diff	RMS Pct Diff
Dgeom	-3	12
DgeomM	-8	15
TCN	16	31

The DMS agreed well in this test with the traditional and slower DMA and the CNC instrumentation. For the number based geometric mean diameter, Dgeom, the intercomparison revealed a small difference. The DMS tended to be slightly below the DMA, by 3% on average with a 12% scatter. For the mass weighted geometric mean diameter, the differences were again small; the DMS was systematically low by

8% on average, with an rms difference of 15%. Regarding total particle concentration, the DMS was systematically high during APEX by 16% in comparison to the TSI model 3022 CNC, with an rms difference of 31%. The DMS/CNC agreement improved for total concentration intercomparisons done in a laboratory environment offering better control over time variation and experimental noise. During pre-APEX intercomparison tests in a laboratory setting using a gasoline engine as the source, the DMS and TSI 3022 agreed to within 11%, and during post-APEX intercomparison tests, again in a laboratory setting, involving two DMS 500's and the TSI 3022 with a diesel engine source, the instruments agreed to within 14%. This is good agreement for total concentration measurements on a variety of combustion sources. As a consequence of the good agreement between the DMS and conventional instrumentation for aerosol physical characterization, all the data and analysis presented in this report is based upon the data set from the DMS 500 unless otherwise specified.

4. Results and Discussion of the APEX Data Set

Size Distributions.—Valuable information can be acquired from the size distributions obtained with the DMS 500. As shown in figure I-5, the shape of the size distribution changes quite dramatically as the engine operating conditions change. It is from these size distributions that shape parameters like number and mass based geometric mean diameters and geometric standard deviation can be calculated. Also since the CO_2 concentration in the exhaust stream is known, number based emission index (EIn) and mass based emission index (EIm) can also be determined.

Mapping Sequence.—The mapping sequence was performed to study the spatial variation of the emissions across the engine's exit plane, and to determine the optimal probe tip position from which to sample. This study was limited to the fixed locations and dimensions of the 1 m sampling rake. Figure I-6a details the variation in the aerosol parameters: geometric mean diameter (Dgeom), geometric standard deviation (Sigma), number and mass based emission indices (EIn and EIm), for the different probe tip positions on the 1 m rake as a function of fuel flow rate. Some spatial variation of aerosol parameters was observed. Probe tip position 3 was determined to be the optimal location for aerosol sampling. This decision was based on a comparison of the aerosol parameters as a function of fuel flow rate for probe tip position 3 with respect to the overall average values for all probes. These data are presented in figure I-6b.

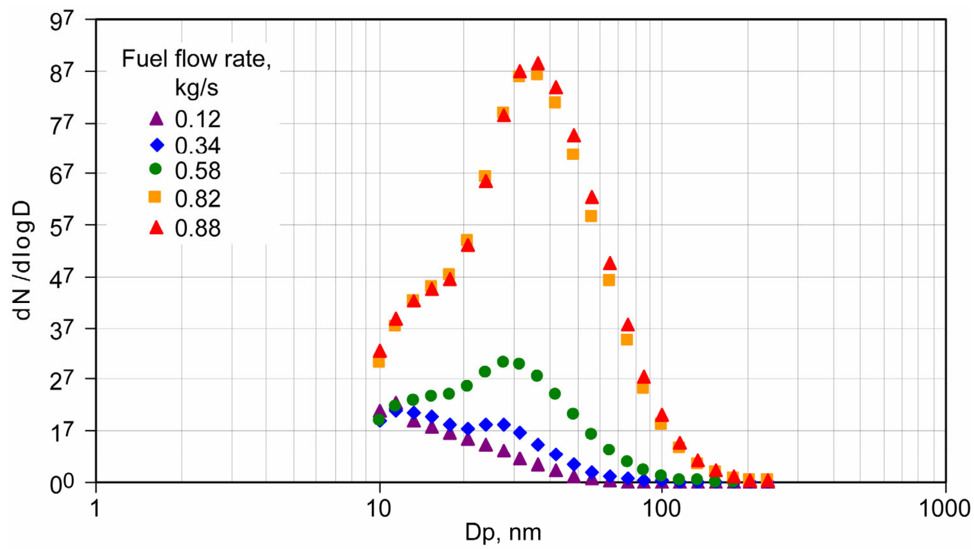

Figure I–5.—Variation of size distributions with changes in engine operating conditions.

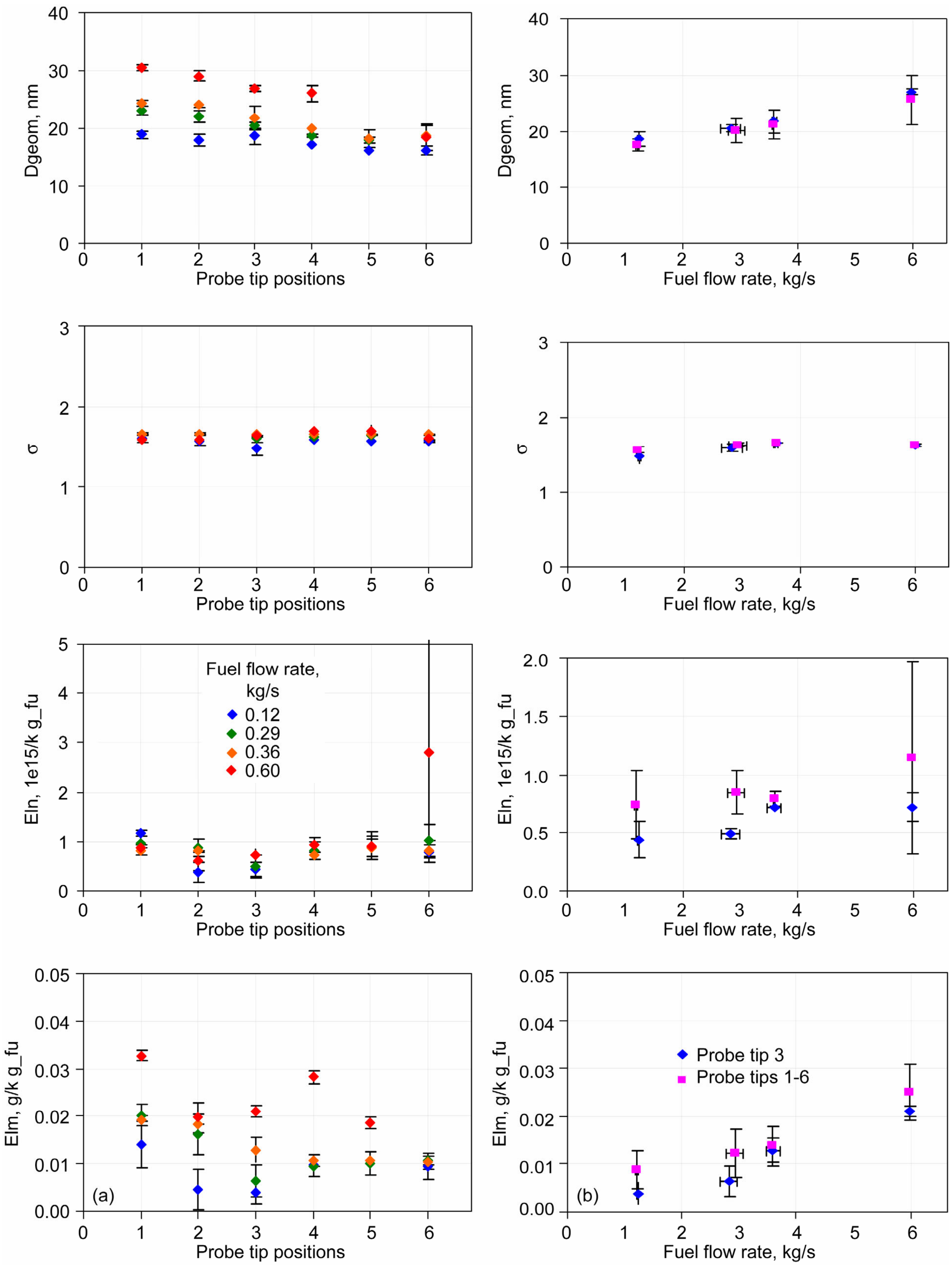

Figure I–6.—(a) Variation in aerosol parameters for the different probe tip positions on the 1 m rake as a function of fuel flow rate (b) Comparison of parameters as a function of fuel flow rate for different probe tips.

EPA Sequences.—There were three EPA sampling sequences. They followed the LTO cycle with the following matrix of power conditions and sampling durations: 7% (17 min) -100% (0.7 min) - 85% (2.2 min) - 30% (4 min) - 7% (9 min). The first two EPA sequences were performed using the Base Fuel and the third used High Sulfur Fuel.

NASA Sequences.—There were a total of 6 NASA sampling sequences. They consisted of a parametric study that included the following sequence of power conditions and sample duration times: 4% (4 min) -100% (1.5 min) - 85% (4 min) - 70% (4 min) - 65% (4 min) - 40% (4 min) - 30% (4 min) -15% (4 min) - 7% (4 min) - 4% (4 min). Sequences 1 and 2 utilized the Base Fuel, sequences 3 and 4 used High Sulfur Fuel and sequences 5 and 6 used High Aromatic Fuel.

Figures I-7 to I-9 represent the variation in parameters measured as a function of fuel flow rate for the three different fuels. The entire set of runs encompassing both the NASA and EPA sequences are represented in these plots.

Geometric Mean Diameter (Dgeom) (figs. I-7a, I-8a, and I-9a).—Dgeom generally increases with increasing fuel flow rate for all three fuels and all three probe locations and ranges from 12 to 35 nm. For the 1 and 10 m data, Dgeom is approximately linear with respect to fuel flow rate. A linear fit yields the following results in table I-2.

TABLE I-2.—COMPARISON OF SLOPE OF R^2 VALUES FOR THE 1 M AND 10 M PROBE DATA

Probe location	Fuel	Slope	R^2
1 m	Base	19.9 ± 0.3	0.82
	High Sulfur	21.5 ± 0.3	0.96
	High Aromatic	21.6 ± 0.4	0.98
10 m	Base	24.7 ± 0.2	0.96
	High Sulfur	25.0 ± 0.3	0.95
	High Aromatic	23.4 ± 0.2	0.99

Data from the 10 m probe exhibits a larger slope than that for the 1 m probe. This is driven by the fact that the geometric mean diameter at low fuel flow rate conditions is significantly smaller at 10 m than at 1 m (~14 and ~17nm, respectively), while their values do not differ significantly under intermediate and high fuel flow rate conditions.

For the data from the 30 m probe location this linear relationship is not observed. At low fuel flow rate, ≤ 0.6 kg/sec, Dgeom is small (~ 12 nm) and relatively constant. It increases significantly at fuel flow rates > 0.6 kg/sec, rising to ~18 nm at 0.8 kg/sec for most measurements and to 27 nm in some cases. These observations are compatible with the onset of gas-to-particle conversion in the near field plume. Low fuel flow rates correspond to relatively low linear velocities in the exhaust flow and longer residence times before the flow reaches the 30 m probe. Hence at low fuel flow rates more time is allowed for nucleation processes to boost the aerosol population at the small size end of the spectrum canceling out the increase in mean size with increasing fuel flow rate observed at 1 and 10 m. At high fuel flow rates, the residence time in the plume is less and the exhaust gas temperature is higher, both conditions tend to suppress nucleation. The data is similar for the 1 and 10 m locations, suggesting that the gas-to-particle processes become significant in the near field plume downstream of the 10 m probe. At higher fuel flow rates, two sets of Dgeom are observed in the 30 m data. This observation is also compatible with nucleation being active in the near field plume. For the runs exhibiting the larger Dgeom, the ambient temperature was significantly higher (see fig. I-10a, b, c, d, e). This higher temperature air, when entrained into the plume, would suppress nucleation, lowering the population of the nucleation small particle mode, and thereby increasing Dgeom.

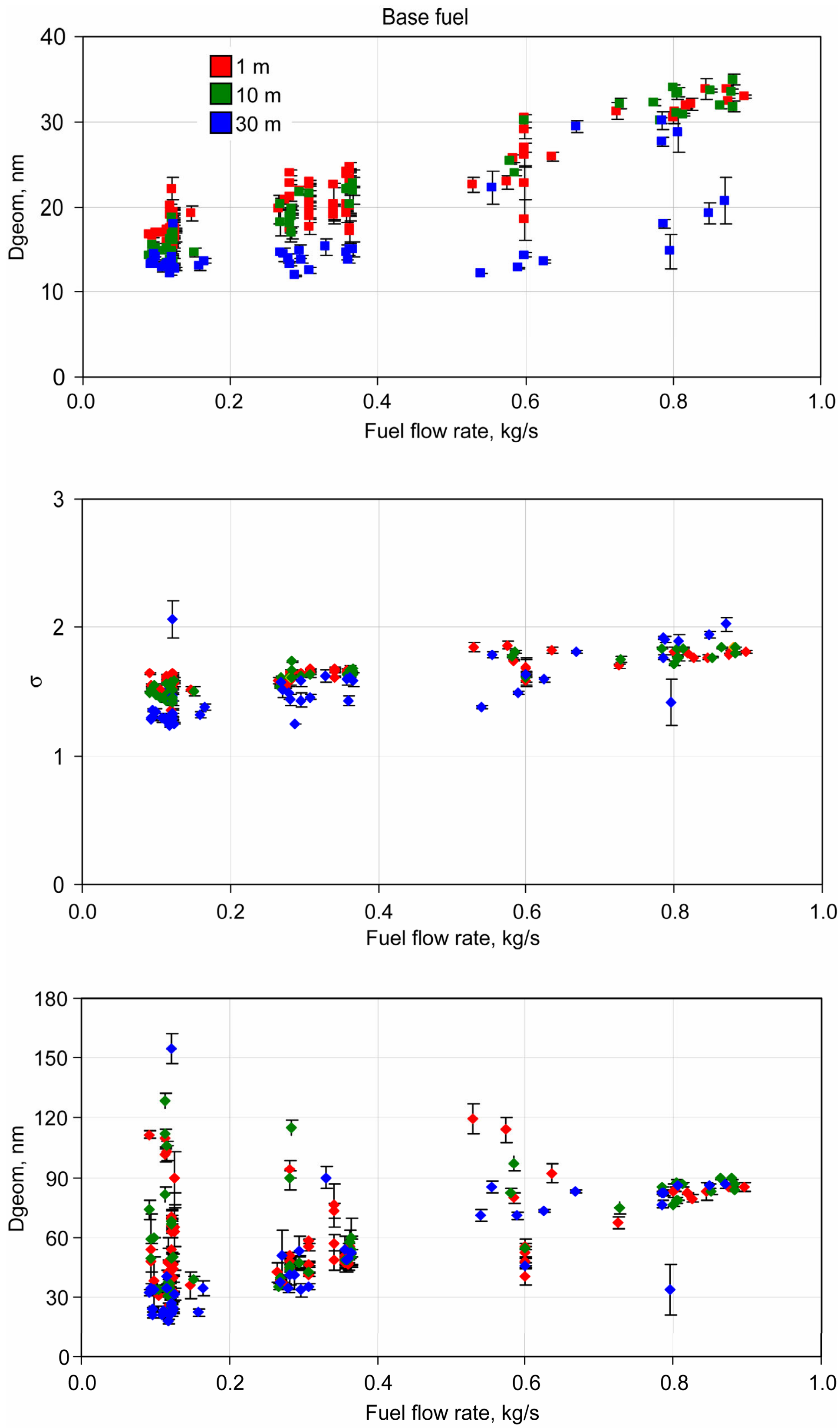

Figure I–7.—(a) Variation in Dgeom, sigma and DgeomM with fuel flow rate for the for the entire set of runs performed using the base fuel (NASA and EPA sequences).

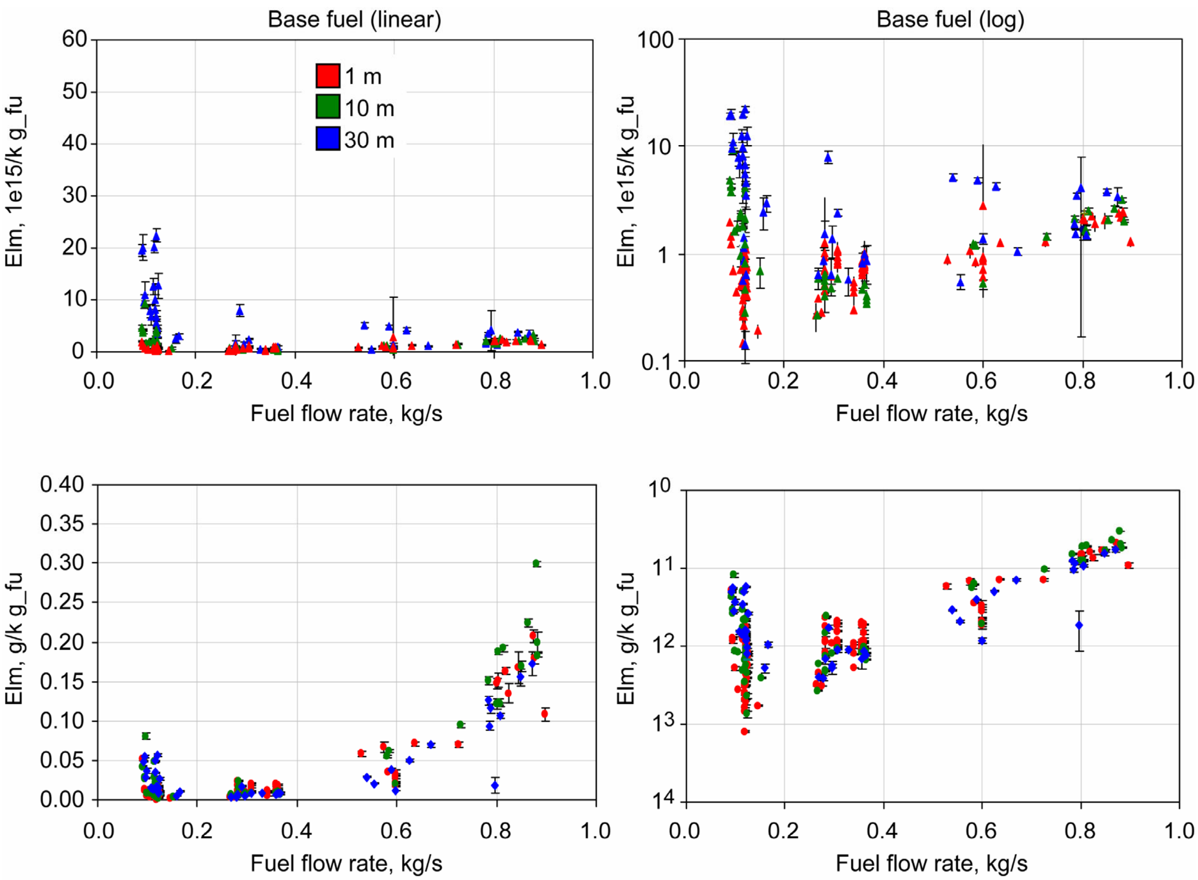

Figure I–7.—(b) Variation in EIn and EIm with fuel flow rate (linear and log plots) for the entire set of runs performed using the base fuel (NASA and EPA sequences).

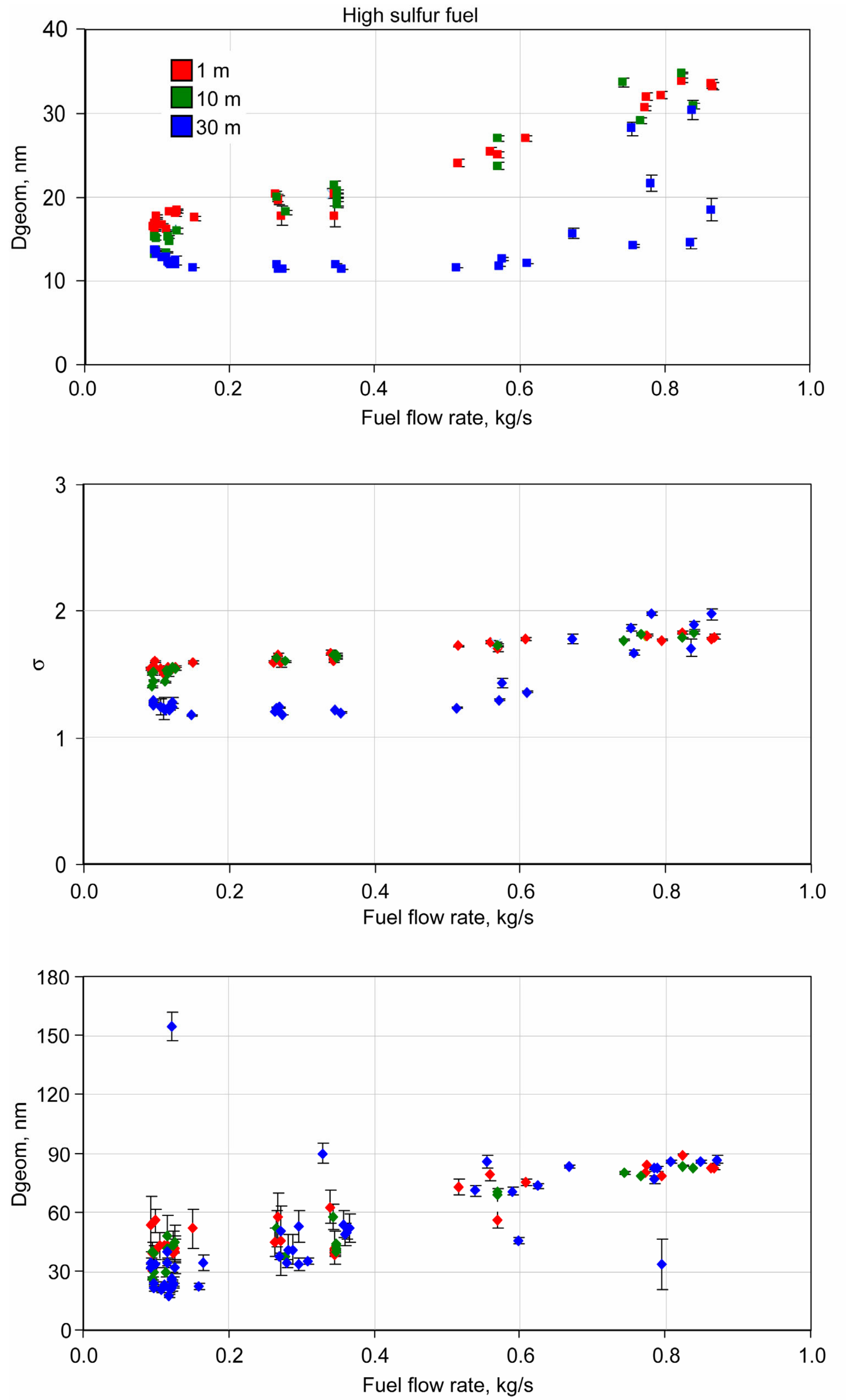

Figure I–8.—(a) Variation in Dgeom, sigma and DgeomM with fuel flow rate for the for the entire set of runs performed using the sulfur fuel (NASA and EPA sequences).

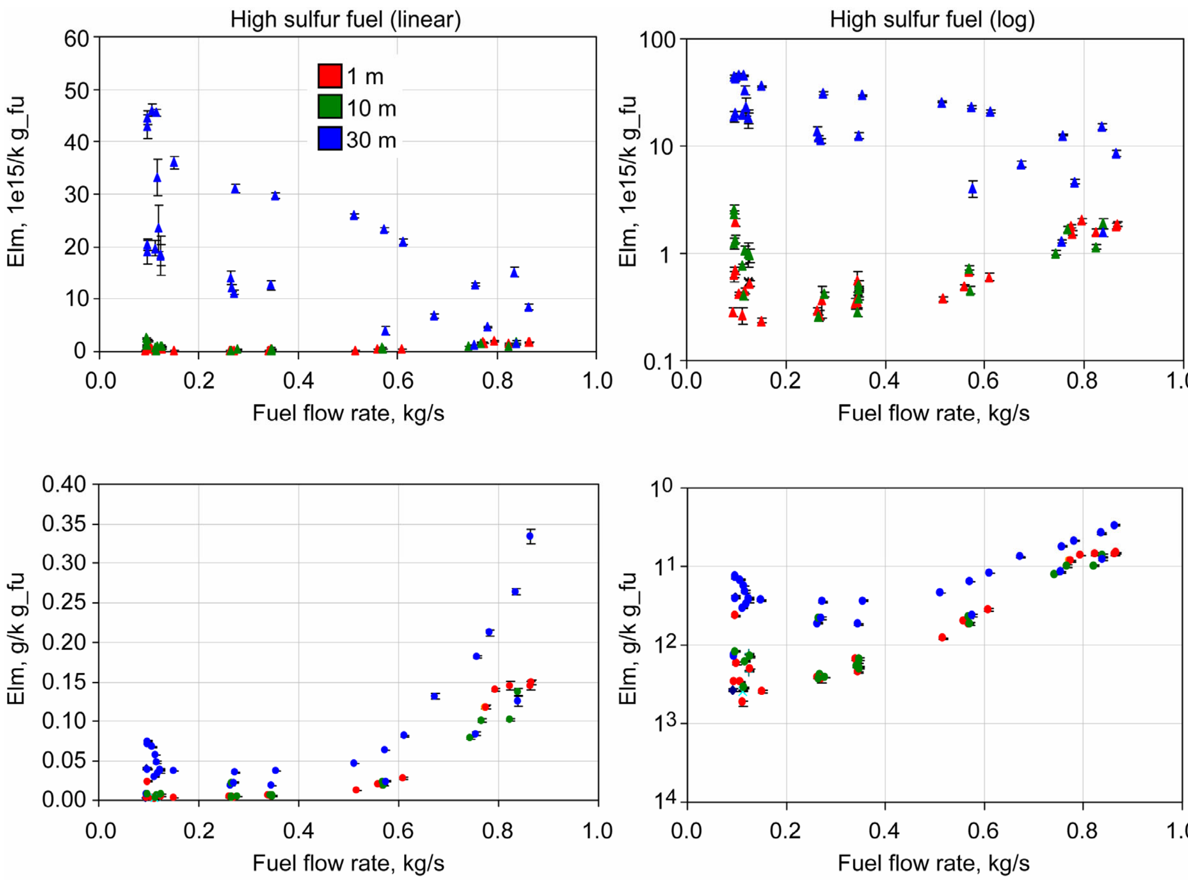

Figure I–8.—(b) Variation in EIn and EIm with fuel flow rate (linear and log plots) for the entire set of runs performed using the high sulfur fuel (NASA and EPA sequences).

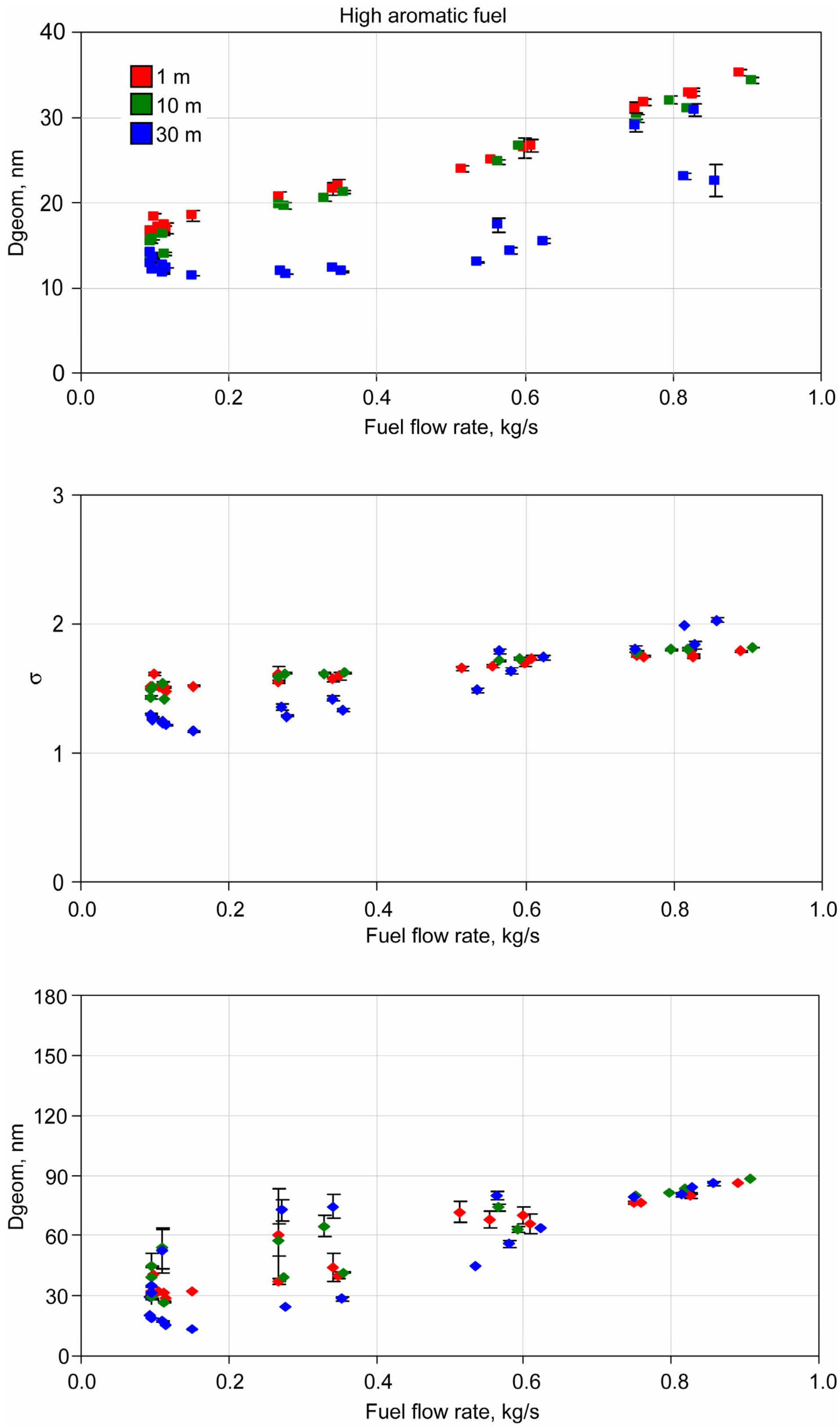

Figure I–9.—(a) Variation in Dgeom, sigma and DgeomM with fuel flow rate for the for the entire set of runs performed using the high aromatic fuel (NASA and EPA sequences).

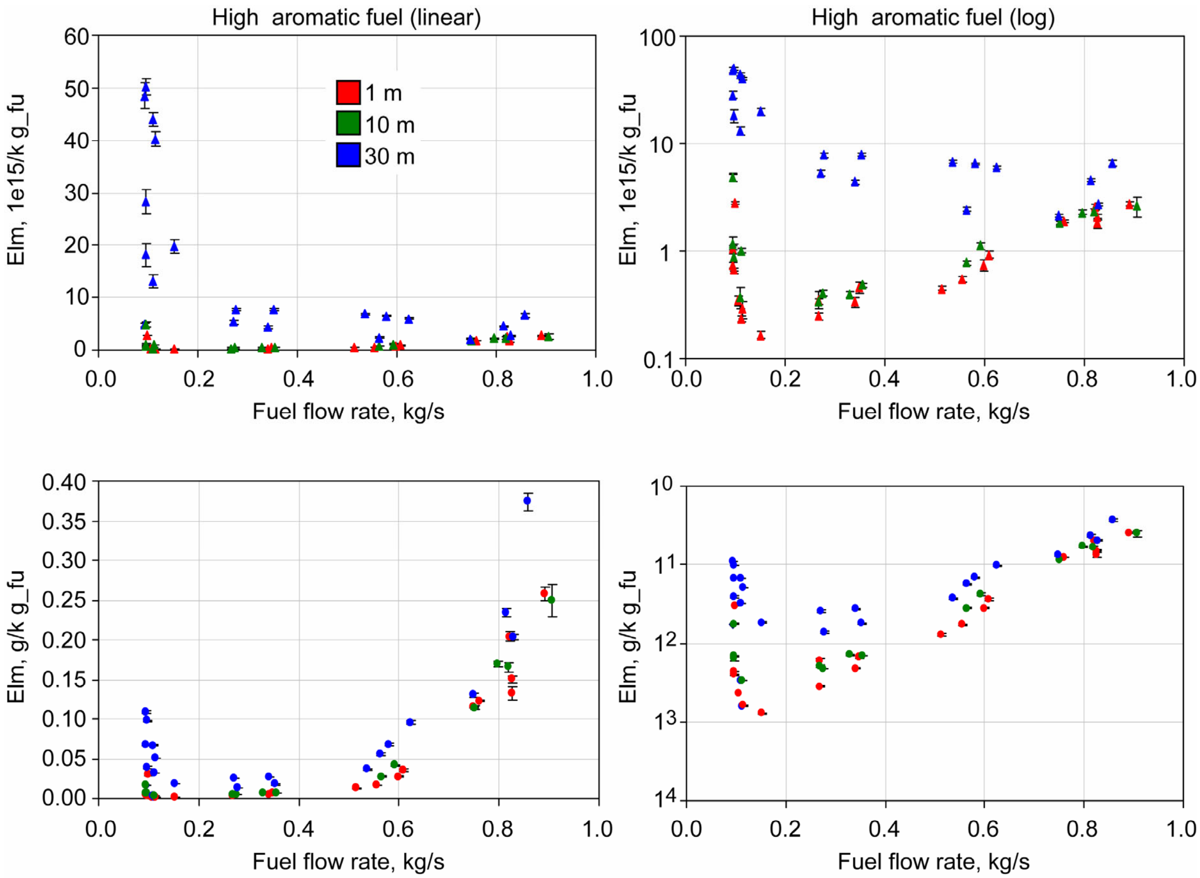

Figure I–9.—(b) Variation in EIn and EIm with fuel flow rate (linear and log plots) for the entire set of runs performed using the high aromatic fuel (NASA and EPA sequences).

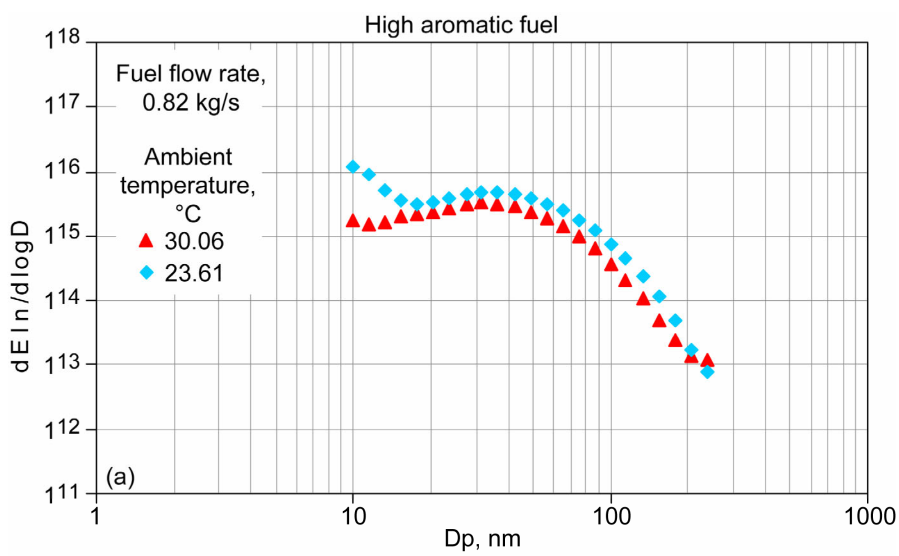

Figure I–10.—(a) Variation in particle size distributions of two independent runs performed using the high aromatic fuel at the same fuel flow rate but different ambient temperatures at the 30 m probe location.

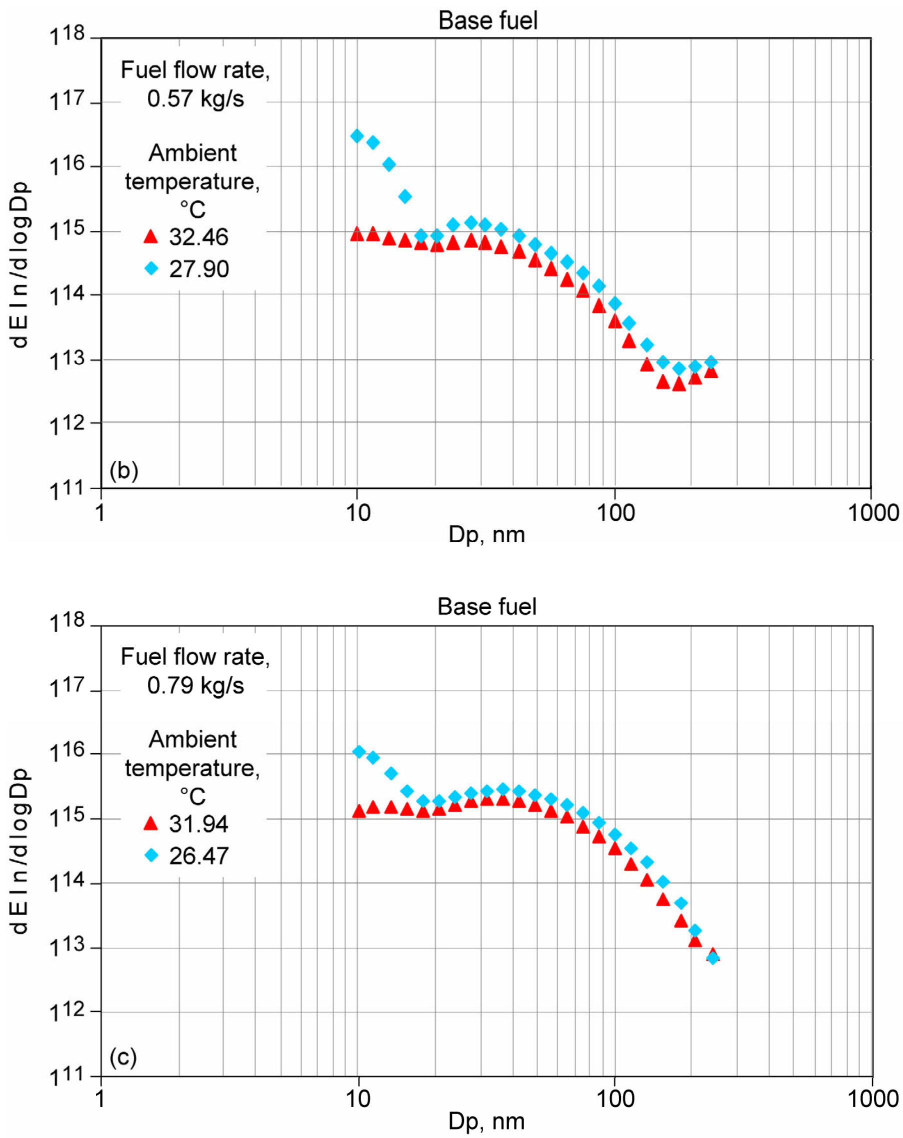

Figure I–10.—(b) and (c) Variation in particle size distributions of two independent runs performed using the base fuel at the same fuel flow rate but different ambient temperatures at the 30 m probe location.

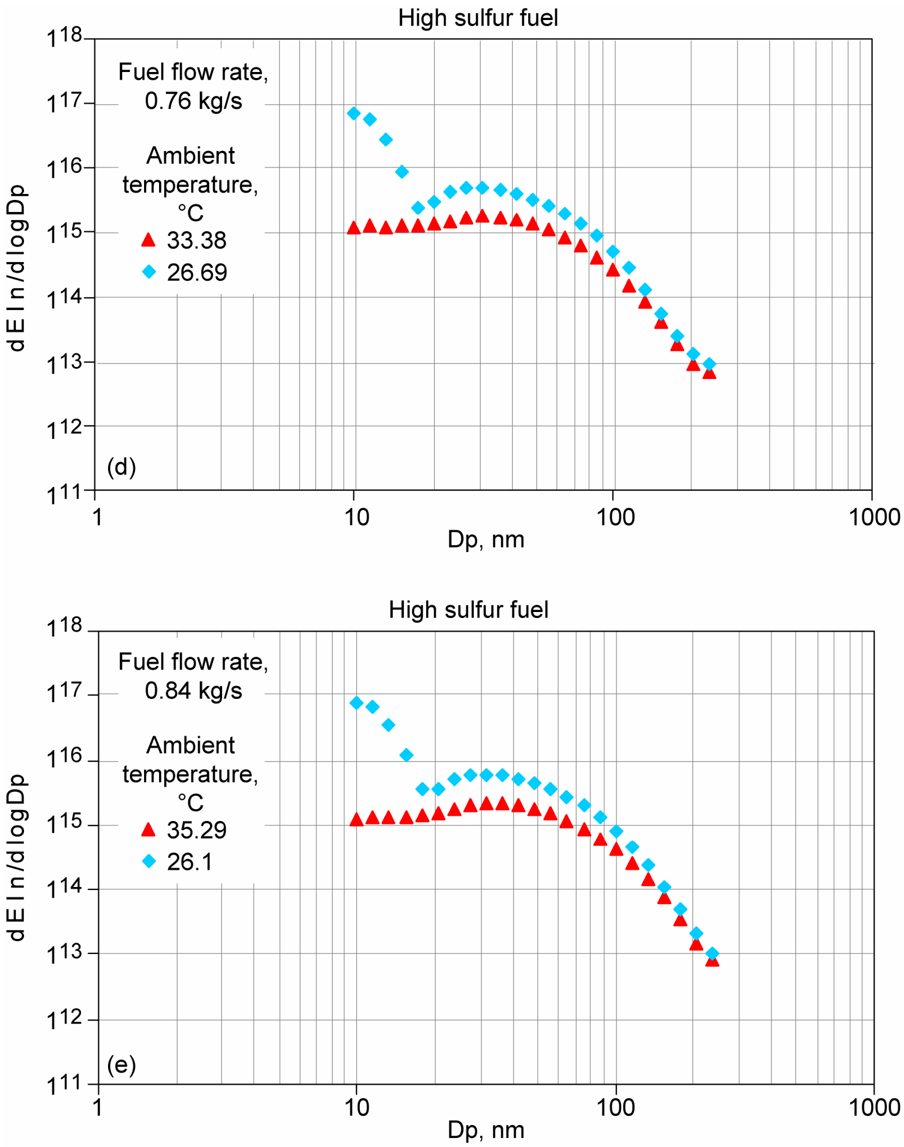

Figure I–10.—(d) and (e) Variation in particle size distributions of two independent runs performed using the high sulfur fuel at the same fuel flow rate but different ambient temperatures at the 30 m probe location.

Geometric Standard Deviation (Sigma) (figs. I-7a, I-8a, I-9a).—The geometric standard deviation is related to the width of the size distribution:

$$\text{Half width} = \text{Dgeom (Sigma-1)}$$

Sigma shows fuel flow dependencies similar to those for Dgeom. At 1 m and 10 m it tends to increase with increasing fuel flow rate and is independent of fuel type. At 30 m it tends to be constant at low fuel flow rate but increases significantly at high fuel flow rate. Nucleation arguments similar to those given above for Dgeom can be made for Sigma. When the nucleation increases the population of small particles, while keeping the large particle population constant, the size distribution widens. Sigma generally varies from 1.2 – 2.0. This increase in Sigma represents a 2.8nm-34nm change in half width.

Mass based Geometric Mean Diameter (DgeomM) (figs. I-7a, I-8a, I-9a).— DgeomM generally increases with increasing fuel flow rate for all three probe locations and all three fuels. This is consistent with the Dgeom behavior. Also there is more scatter in the data in the low to medium fuel flow rate regime, whereas there is little scatter at high fuel flow rate, an effect not observed in Dgeom. This can be attributed to the onset of nucleation in the near field plume. At low to medium fuel flow rate Dgeom and Sigma are small. The small size end of the size spectrum is the place where nucleation and fluctuations in nucleation have their largest impact on its DgeomM. At high fuel flow rate Dgeom and Sigma are relatively large. Since DgeomM is more heavily weighted toward the large size end of the size spectrum, nucleation has a lower impact. In this size range it produces few large particles, and those that it does produce have a reduced impact on DgeomM because of the relatively large Sigma at high fuel flow rate.

Number based emission index (EIn) (figs. I-7b, I-8b, I-9b).—For all three fuels, at the 1 and 10 m locations, EIn is higher at the lower fuel flow rates (0.1 kg/s) and highest fuel flow rates (0.85 kg/s) with a minimum occurring between 0.2 to 0.4 kg/s. The variation in EIn at 1 m and 10 m for different fuel flow rates is not statistically significant. There is however a difference in EIn between the 1 and 30 m probe locations. At the 30 m probe location, EIn is highest at the lowest fuel flow rates, and is an order of magnitude higher than that for the 1 and 10 m cases. It then decreases with increasing fuel flow rate until ~0.75 kg/s is reached, where it becomes constant. The greatest differences between the 1 and 30 m data are observed at low fuel flow rates where the residence time in the plume affords more opportunity for gas-to-particle conversion to occur resulting in larger EIns.

Mass based emission index (EIm) (figs. I-7b, I-8b, I-9b).—For all three fuels, at all three probe locations, EIm tends to increase with fuel flow rate, with a low fuel flow rate minimum between 0.1 and 0.25 kg/s, and a high fuel flow rate maximum between 0.75 and 0.9 kg/s. The variation in EIm at 1 and 10 m for different fuel flow rates is not statistically significant. At high fuel flow rates, the EIms for the 1 and 30 m cases converge suggesting that the mass at these higher fuel flow rates is dominated by the non-volatile component of the aerosol. See DgeomM behavior discussed above.

5. Deliquescence

The evolution of combustion particles in the atmosphere is strongly influenced by their ability to interact with water vapor. This characteristic was investigated with a deliquescence technique, where a tandem DMA with an intermediate saturator is used to measure the particles' dry and wet diameters. From this information the particles' critical super-saturation or Soluble Mass Fraction (SMF) can be determined. In this study two classes of particles were measured. These had dry diameters of approximately 40 and 60 nm. The deliquescence results for both classes of particle diameters over all fuel flow rates and plume sampling locations are combined in figure I-11.

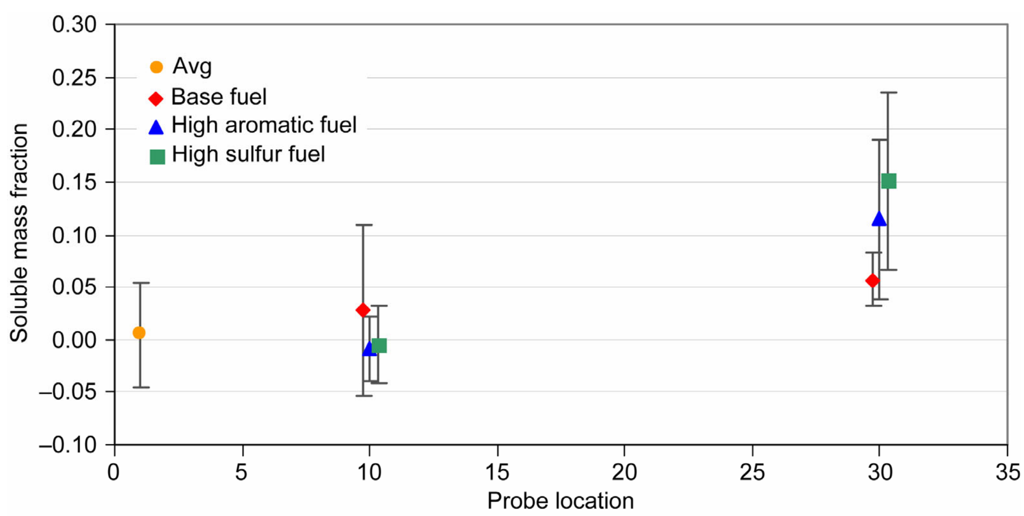

Figure I–11.—Results of the deliquescence experiment.

The SMF increases with distance from the engine exit plane. This is reasonable, as the longer the residence time in the plume, the greater is the opportunity for gas-to-particle conversion. Increasing fuel aromatic and sulfur content are observed to increase the SMF. At the engine exit plane (~1 m) the particles contain essentially no soluble material since it is too hot for condensation processes to occur. Furthermore the sample is diluted before it is allowed to cool in the sampling train thus preventing any condensation downstream during sample transport. There was no statistical difference in SMF between the 1 and 10 m probe locations, which is consistent with the absence of gas-to-particle conversion in the 1-10 m regime of the plume. Evidence of gas-to-particle conversion is observed at the 30 m probe. Here the average SMF's and their standard deviations are: 0.057 ± 0.026 for the Base Fuel, 0.115 ± 0.076 for the High Aromatic Fuel, and 0.151 ± 0.085 for the High Sulfur Fuel. For the Base Fuel there is no statistically significant change in the SMF with distance downstream of the exit plane. For the other fuels, however, there is a significant change, by an order of magnitude, between the 10 and 30 m locations.

6. Comparison of Particle Probe and Gas Probe Data

For a set of runs during the NASA High Aromatic Fuel sequences, aerosol emissions were sampled using two gaseous probes – R1-G1 and R1-G4. The gas probe R1-G4 was closest to the 1 m particle probe that was used for all other particulate measurements. It should be noted that the gas sampling train did not provide probe tip dilution. Instead diluent was added at a point approximately 2 m downstream of the probe tip, where the diluted sample was introduced into a heated sample line. The variation of aerosol parameters with fuel flow rate for these runs is presented in figures I-12a and I-12b. A comparison of these parameters for R1-G4 and the 1 m particle probe are shown in table I-3.

TABLE I-3.—COMPARISON OF AEROSOL PARAMETERS FOR DATA FROM THE 1 m PARTICLE PROBE AND R1-G4

	Differences between sampling trains		Particle probe uncertainties		Gas probe uncertainties	
Parameter	**Avg. Pct Diff**	**RMS Pct Diff**	**Avg. Pct Diff**	**RMS Pct Diff**	**Avg. Pct Diff**	**RMS Pct Diff**
Dgeom	-7.2	14.9	2.1	2.4	3.2	3.7
Sigma	-4.4	10.2	0.9	1.3	0.9	1.1
Dgeom M	-10.0	22.8	5.3	9.6	3.7	5.0
EIn	24.7	80.1	7.7	8.9	9.9	11.3
EIm	-4.5	59.3	2.4	3.2	3.1	3.5

For the sampling train intercomparison, for a given aerosol parameters listed in the above table, y (y = Dgeom, Sigma, etc.), the percent difference is defined by

$$PctDiff = \left[\frac{(y\_gas - y\_particle)}{(y\_gas + y\_particle)/2} \right] * 100$$

Dgeom shows a RMS percent difference of 14.9% (scatter) with an average percent difference of -7.2%, where the negative value implies that the gas sampling train mean particle size is systematically 7.2% smaller. This systematic difference is larger than the sum of the uncertainties in the gas and particle mean diameters, as expressed by their rms percent uncertainties shown in the above table, hence this systematic difference is statistically significant. Similar relationships hold for the magnitudes of the average differences and uncertainties for sigma and EIn. In the cases of DgeomM and EIm, the average differences are not statistically significant, since for these parameters their systematic differences are smaller than the sum of the uncertainties in their corresponding gas and particle values.

These results suggest that the use of a gas rather than a particle sampling train influences the resulting data. In the gas sampling train the undiluted gas sample cools as it is transported to the heated section of the sample train where the diluent is also introduced.

These conditions are conducive to gas-to-particle conversion in the undiluted section. Gas-to-particle conversion would enhance the small particle concentration thus reducing Dgeom and sigma and increasing EIn, which is observed. Thus it is unwise to employ particulate sampling without adequate probe tip dilution.

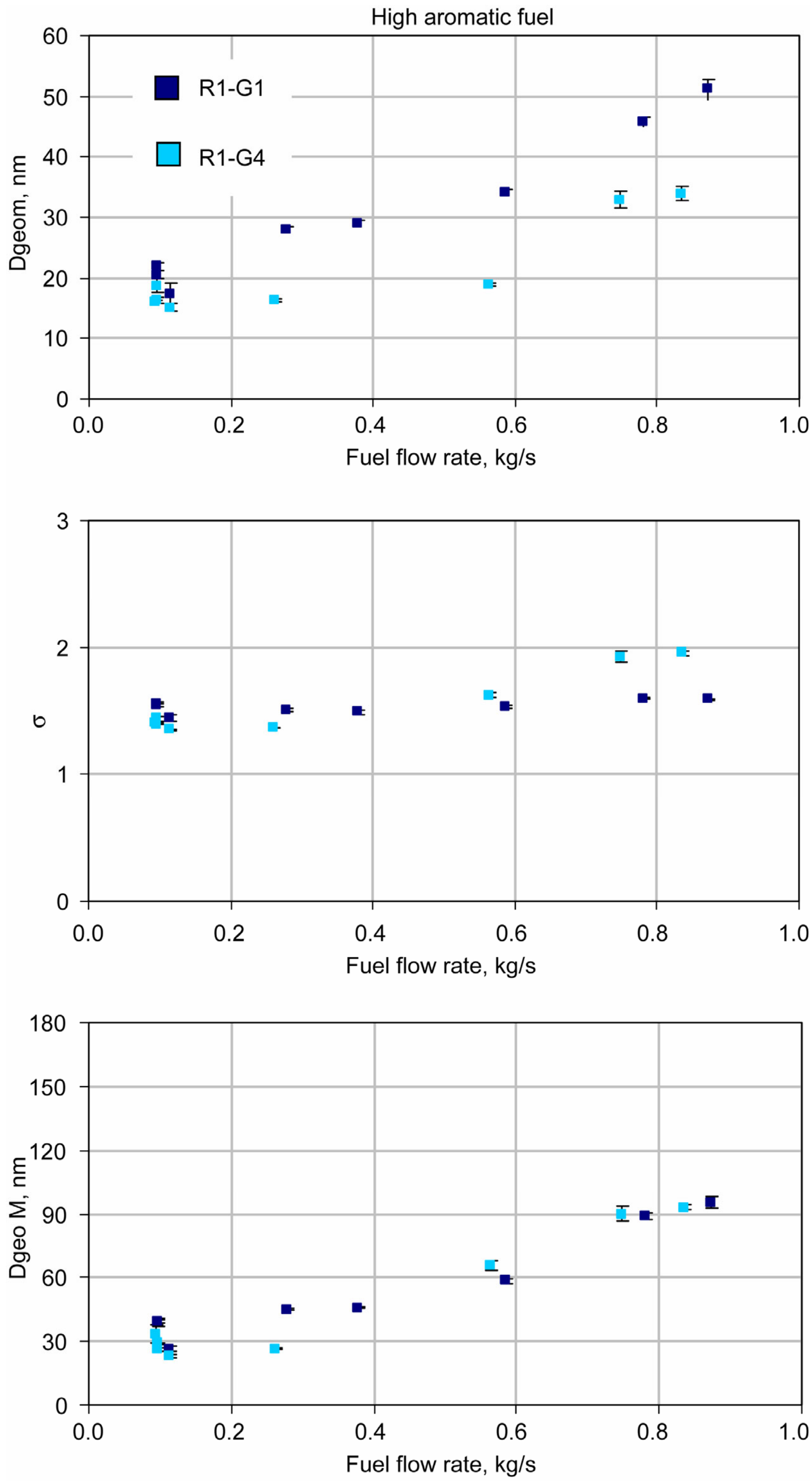

Figure I–12.—(a) Variation in Dgeom, sigma and DgeomM with fuel flow rate for the for the entire set of runs performed using gaseous probes and the high aromatic fuel.

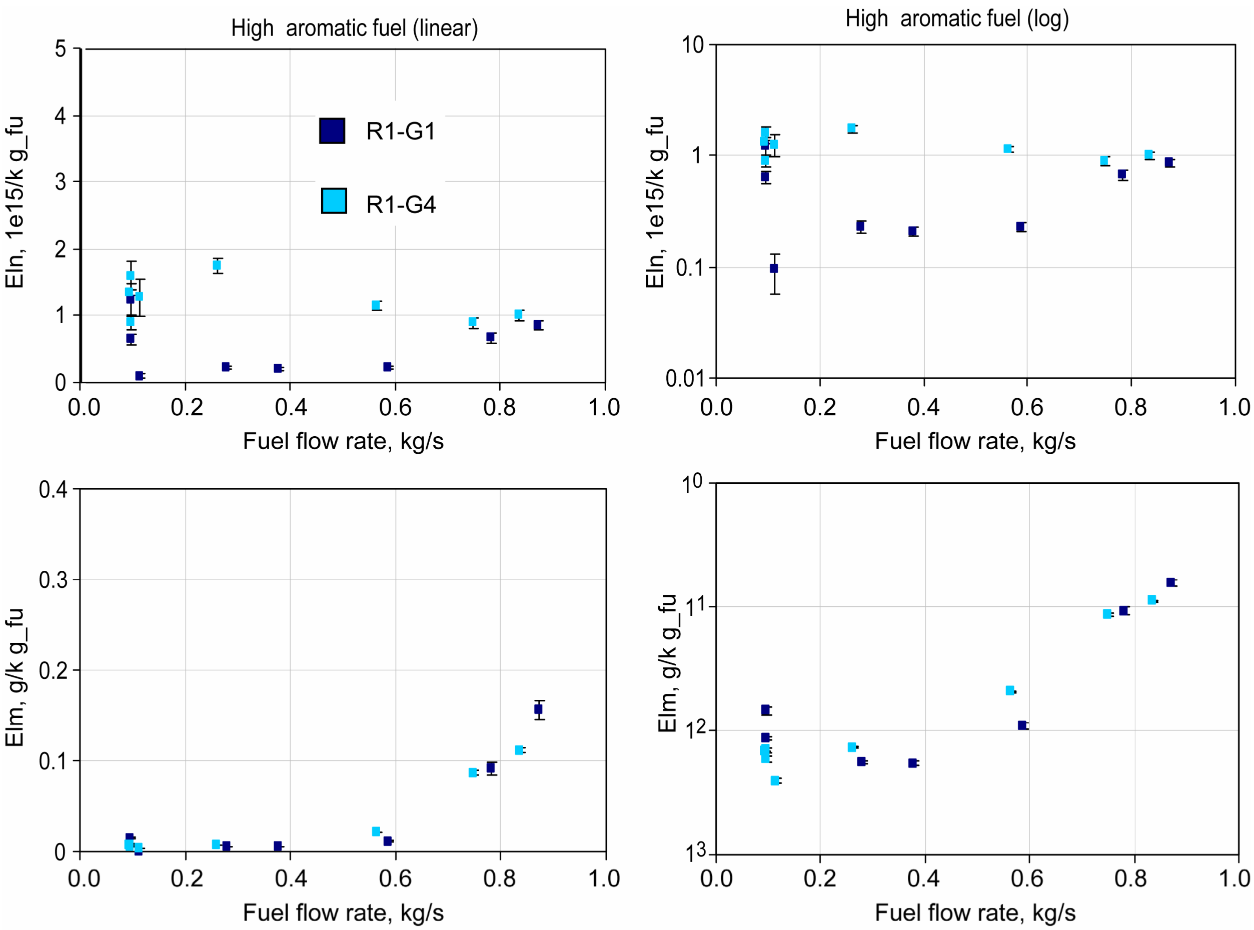

Figure I–12.—(b) Variation in EIn and EIm with fuel flow rate (linear and log plots) for the entire set of runs performed using gaseous probes and the high aromatic fuel.

7. Conclusions

1) Data shown here represents 1st detailed study of the physical characteristics of the PM emissions from a current in-service commercial class gas turbine engine (CFM56-2C1) as a function of engine operating condition and fuel composition.

2) The goal of these aerosol measurements was to determine the nature of the emissions in the plume at the probe location. However extractive sampling may result in sample modification due to inertial, thermophoretic, and diffusional processes. In this study considerable advances have been made in the treatment of these processes, as evidenced by line loss corrections, but further studies are needed, especially to address effects at the probe tip.

3) Project APEX afforded the first opportunity to apply a novel fast aerosol sizing instrument to the PM emissions from a gas turbine engine. The differential mobility spectrometer (Cambustion DMS 500), previously proven in diesel applications and other laboratory situations, demonstrated excellent agreement with traditional aerosol instrumentation under field test conditions. Its primary innovation, a fast size distribution measurement rate (≤ 10 Hz) greatly enhanced the statistical reliability of size parameter measurement and afforded the opportunity to observe transient behavior in the engine emissions.

4) The property ranges for total aerosol observed in Project APEX by UMR are summarized in table I-4.

TABLE I-4.—RANGES FOR TOTAL AEROSOL PARAMETERS OBSERVED DURING PROJECT APEX BY UMR

Parameter	Range
Dgeom (nm)	12 to 35
Sigma	1.17 to 2.07
Dgeom M (nm)	13 to 154
EIn (10^{15}/kg fuel)	0.14 to 50
EIm (g/kg fuel)	0.001 to 0.37

These aerosol properties were calculated for the entire aerosol size distribution and not individual modes. Size distributions for exit plane and 10 m were generally lognormal. Strong and sometimes non-linear dependencies were observed with fuel flow rate, and no statistically significant dependencies were observed for fuel composition. The onset of gas-to-particle conversion was apparent at 30 m for low to medium fuel flow rates. In this data non-lognormal size distributions were often observed, where the mean sizes decreased and EIn increased relative to the 1 and 10 m size distributions. For high fuel flow rate data gathered under higher ambient temperature conditions gas-to-particle conversion was not observed. This result can be explained by shorter plume residence time and warmer ambient air, both of which mitigate against nucleation.

5) The SMF was found to increase with distance from the engine exit plane. Increasing fuel aromatic and sulfur content are observed to increase the SMF. At both the engine exit plane and at 10 m the particles contain essentially no soluble material. Evidence of gas-to-particle conversion was observed at 30 m for the aromatic and high sulfur fuels.

6) The intercomparison between gas and particle sampling trains showed that gas-to-particle conversion is a serious sample train artifact for gas sampling trains where dilution cannot be achieved at the probe tip.

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Appendix J
Chemical Properties of Aircraft Engine Exhaust Aerosols Sampled During APEX*

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Chemical Properties of Aircraft Engine Exhaust Aerosols Sampled During APEX

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1. Background

Emissions from aircraft are coming under increasing scrutiny. While airplanes consume only a few percent of fossil fuel currently being used, they represent a major fraction of the fuel used in and around airports, and may be significant local contributors of emissions to urban airsheds. With the continued growth of commercial air traffic, aviation emissions are anticipated to become an increasing contribution to pollution on local, regional, and global scales.

Particulate matter emissions have become the focus of much international attention, as anthropogenic particles have been observed to impact human health and atmospheric processes locally and regionally, as well as affecting global climate change. Relatively little is known about the emissions of particles and aerosol precursor gases from aircraft engines, so a number of recent studies (EXCAVATE, NASA/QinetiQ, PartEmis) have been directed at improving understanding of these emissions and how they may contribute to particles in the atmosphere.

APEX (Aircraft Particle Emissions experiment) was conducted on 23-29 April 2004 at NASA Dryden Flight Research Center (DFRC) at Edwards Air Force Base, CA to characterize the particulate emissions of an in-use aircraft, the NASA DC-8 with four CFM56-2C1 engines. The inboard right engine was sampled while the airplane was chocked in place on the ground under a range of operating conditions from ground idle through full take-off power. The variations in particle emissions performance were quantified across this range of thrust conditions, measuring number, size, and mass. Gas phase emissions were measured in parallel and are reported separately. In addition to varying the engine power, three different aviation fuels were employed during APEX, to determine how fuel properties could affect the resulting particle emissions.

Aerodyne Research, Inc. participated in APEX by operating a suite of instruments dedicated to measuring particle chemical composition as a function of particle size for different engine operating conditions and fuel properties. Aerodyne also measured a wide variety of gas phase species, including some that could be considered aerosol precursors, which are reported in a separate report. The text below provides a description of the Aerodyne particle instruments and sampling procedures and a summary of observations. Results from collaborators at NASA - Langley Research Center (NASA) and the University of Missouri - Rolla (UMR) are included in the analysis.

2. Experiment

Aerodyne Research, Inc. deployed a mobile laboratory during APEX. The Aerodyne mobile laboratory houses state-of-the-art instrumentation for measuring trace gas species and aerosol particle properties [*Kolb et al.*, 2004]. All instruments were operated off of the same inlet sampling line and are depicted in figure J-1. This report focuses on the particle measurements listed in table J-1.

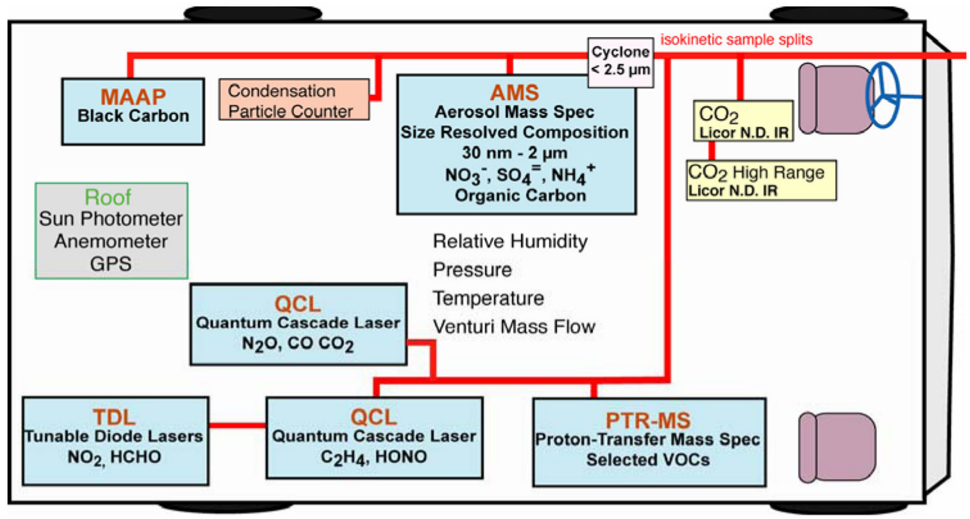

Figure J–1.—Schematic of the Aerodyne Mobile Laboratory configuration deployed during APEX. The particle instruments were located on the left-hand-side of the truck and isokinetically sampled aerosol behind a PM2.5 cyclone. All instruments in the mobile lab sampled from the same inlet line.

TABLE J-1.—AERODYNE AEROSOL INSTRUMENTATION DEPLOYED AT APEX

Instrument	Measurement	Units	Size range (µm)	Response (sec)
Aerosol Mass Spectrometer (AMS)	Size-resolved nonfractory PM mass loadings and chemical composition	µg/m^3	0.04 to 1.00	30
Multi-Angle Aerosol Photometer (MAAP)	Black carbon mass loading	µg/m^3	0.01 to 2.5	1
TSI model 3022a Condensation Particle Counter (CPC)	Particle number concentration	#/cm^3	0.007 to 2.5	10

Gas phase measurements obtained in the AML are reported in Appendices F and G. Aerodyne Aerosol Mass Spectrometer (AMS) was used to characterize the nonrefractory chemical compositions and chemically-speciated size distributions. A Condensation Particle Counters (CPC; TSI) was used to measure the total particle concentration and a modified Multiangle Aerosol Photometer (MAAP; Thermo Electron) was used to measure the aerosol absorption and derive black carbon concentrations. The particle instruments were operated downstream of a PM2.5 (UGI) cyclone to remove large particles.

2.1 Aerosol Mass Spectrometer

The Aerodyne Aerosol Mass Spectrometer (AMS) has been described in detail in the literature [*Jayne et al.*, 2000; *Jiménez et al.*, 2003]. The AMS sampled aerosols into a high vacuum and focuses the particles into a tight beam using an aerodynamic lens. The focused particle beam exiting the lens was directed through a particle-sizing chamber and impacted on a 3.8 mm circular vaporizer held at 600 °C. By mechanically modulating the particle beam with a chopper and using the time-of-flight (TOF) of particles between the chopper and the detector, the particle velocity and the vacuum aerodynamic diameter were obtained. The particle detection scheme consisted of a vaporizer that was coupled into the ionizer cage of a quadrupole mass spectrometer (MS). When the particles struck the vaporizer surface, the nonrefractory (volatile and semi-volatile) components of particles flash vaporized. The vaporization plume was ionized using standard 70 eV electron impact ionization techniques and extracted into the mass spectrometer, which was scanned over a range of 1 to 300 atomic mass units. The AMS was operated during this study with a time-resolution of 30 s, alternating every 15 s between a TOF mode (particle mass distributions as a function of size) and a MS mode (particle chemical speciation and quantitative mass loadings).

Quantitative mass calibration of the instrument was performed by using a pure ammonium nitrate aerosol source. Particles were generated with an atomizer (TSI, model 3076, USA), dried using silica gel, size-selected using a differential mobility analyzer (TSI, model DMA 3071) and sampled simultaneously by the AMS and a CPC (TSI, model 3022a). Multiply charged particles were eliminated using an impactor upstream of the DMA's and the AMS isokinetically sampled from the CPC aerosol flow to ensure identical size distributions. The well-characterized aerosol sample calibrated the electron multiplier signals at m/z 30 and 46 for nitrate (NO_3^+) and 15, 16, and 17 for ammonium (NH_4^+). The AMS analysis uses relative ionization efficiencies measured in previous laboratory studies to calibrate for the chemical species present in aircraft exhaust (sulfates and organics). During this experiment, the AMS had a nitrate ionization efficiency of 6.9×10^{-6} ions/molecule and detection limits (three times the standard deviation) of 0.024 and 0.26 μg/m^3, respectively for sulfates and organics.

2.2 Multiangle Aerosol Photometer

Aerosol black carbon concentrations were derived with a Thermo Electron Multi-Angle Aerosol Photometer (MAAP). A detailed description is provided in the literature [*Petzold et al.*, 2002; *Petzold and Schönlinner*, 2004]. The MAAP is a filter-based photometer that deposits aerosol onto a 2 cm^2 spot on a quartz fiber filter tape. A 630 nm wavelength LED shines on the spot and multiple photodetectors measure the transmission and scattering/reflection of the light from the depositing aerosol layer and the underlying filter. A two stream radiation transfer calculation is used to separate the absorption of the light by the aerosol layer from the scattering of light by the particles and filter matrix [*Petzold and Schönlinner*, 2004]. A narrow range of values of σ_{abs} (~6.4-6.6 m^2 g^{-1}) is reported to provide a decent fit for commercially-produced black carbon particles and urban particles containing black carbon collected at several sites [*Petzold and Schönlinner*, 2004]. A value of σ_{abs} = 6.6 m^2 g^{-1} is currently used to calculate the instantaneous black carbon mass loading on the filter at a rate of 1 Hz. The MAAP was operated with a flowrate of 8 lpm using custom plumbing. The precision of the MAAP for deriving black carbon mass loadings under these operating conditions is ± 2.4 μg/m^3.

2.3 Condensation Particle Counter

The total aerosol concentration was measured with a Condensation Particle Counter (CPC; TSI model 3022a). The CPC supersaturates a sample flow with butanol vapor, causing submicron particles to grow in size into the supermicron size range where the particles are detected via individual light scattering pulses at low concentrations and via ensemble particle scattering at high concentrations. The CPC has a 50% cut size of 7 nm at atmospheric pressure, a response time of < 10 s for 90% step change, and can sample particle concentrations up to 10^7 cm^{-3}.

2.4 Collaborators' Particle Instruments

The analysis in this report includes near real-time results from two close collaborators during APEX: NASA and UMR. Details from their measurements are found in their reports. Briefly, the results from NASA include averaged black carbon mass loadings derived from a Particle Soot Absorption Photometer (PSAP), particle number concentrations from two different CPCs (TSI models 3022a and 7061), and two scanning mobility particle size (SMPS) instruments (sample stream was heated on one SMPS to 300 °C to remove nonrefractory compounds from the particles prior to size distribution measurements). The results from UMR include averaged CPC particle number concentration measurements and SMPS size distribution measurements.

2.5 Emission Indices

A LiCor infrared absorption instrument was used to measure the gas phase CO_2 concentration in the sampled plume. The gas phase CO_2 concentration was used to relate the measured particulate mass loading to fuel-based particulate mass emission indices (EI's), with units of milligrams of PM per kilograms of fuel burned (mg per kg fuel). Following the methodology described in Herndon et al. [*Herndon et al.*, 2005], for a given exhaust component concentration, X, the EI(X) is calculated by

$$EI(x) = (\Delta X/\Delta CO_2) \times EI(CO_2) \times M_{air}/M_{CO_2} \times (1/\rho_{air}),$$

where $\Delta X/\Delta CO_2$ is the emission ratio for the exhaust component, M_{air} is the molar mass of air, M_{CO_2} is the molar mass of CO_2, and ρ_{air} is the density of air at ambient conditions. Further, this expression is based on 100% of the carbon in the fuel being converted to CO_2 and while corrections for CO and hydrocarbon emissions can be made, they are within experimental uncertainties for the measurements reported here, and the $EI(CO_2)$ equals 3160 g CO_2 $(kg\ fuel)^{-1}$ for the fuels used during these tests (refer to table J-3). EI's are also calculated for particle number concentrations (number per kg fuel) using a slightly modified version of this formula.

2.6 Sampling Conditions

The engine tests were conducted over several days in April at NASA DFRC's aircraft facility, located on the Edwards Air Force Base, on a large concrete pad designed for engine run-up tests. The aircraft was parked and chocked on the pad and held in place with onboard brakes during the tests. Measurements were made behind the right in-board CFM56-2-C1 engine on the wing of the NASA DFRC DC-8-72 Airborne Laboratory Program aircraft at three different probe distances in the downstream exhaust flow (1, 10, and 30 m). Engine exhaust was characterized for 11 engine power conditions from ground idle (4% maximum thrust) to take-off power (100% maximum thrust) and three different fuel chemical compositions, base JP8 fuel, high sulfur fuel (base JP8 fuel with tertiary butyl disulfide additive), and high aromatic fuel. Table J-2 summarizes the different conditions varied during APEX.

TABLE J-2.—APEX SAMPLING CONDITIONS

Variables:	Conditions:
Fuel Type	JP-8 (BaseA), Jet-A (High Aromatic), JP-8 (High Sulfur)
Sampling Distance	1 m (diluted), 10 m (diluted), 30 m (undiluted)
Engine Thrust	3-100% of maximum rated thrust, including ICAO standardized LTO cycle (7% taxing, 30% approach, 85% climb-out, and 100% take-off), 4% ground idle, and a few intermediate powers (5.5, 15, 40, 60, 65, and 70%).

Three different fuel compositions were used during APEX in an attempt to study the effect of variable fuel composition (sulfur and aromatics) on the resulting particulate emissions. The differences in fuel compositions were obtained two different ways. The base fuel was chosen to be the JP8 fuel that is the standard JP8 fuel used at NASA DFRC and Edwards Air Force Base. Regional fuel suppliers were canvassed to obtain a fuel with a higher aromatic content (within aviation fuel specifications, but with higher aromatic content). A supplier of Jet-A fuel was found with a higher aromatic content than the base JP8. The final fuel composition used, high sulfur content, was the base JP8 fuel doped with several gallons of tertiary butyl disulfide additive. Table J-3 shows the measured compositions of the fuels burned during APEX.

TABLE 3.—APEX FUEL SAMPLE COMPOSITIONS

Fuel Type:	Fuel Label:	Sulfur (ppm)	Aromatics (vol%)	Hydrogen (wt%)
JP8	Base	383	17.6	13.69
JP8	High sulfur	1595	17.3	13.67
Jet-A	High aromatics	530	21.8	13.7

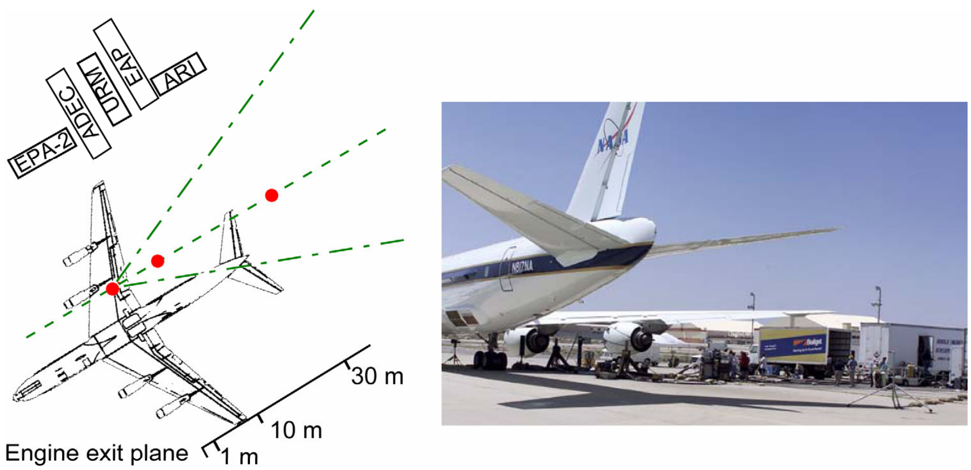

Figure J–2.—The left image is a diagram of the sampling arrangement with respect to the DC-8 aircraft, the location of the probes (red dots), and the location of the instrument trucks and trailers. The right image shows the tail of the DC-8 aircraft with the installed probes and several of the instrument trucks/trailers.

Sampling probes were located at downstream distances of 1, 10, and 30 m behind the engine exit plane. Figure J-2 shows a schematic and picture of the experimental setup.

Anchors were embedded at numerous places in the pad to provide restraining points to secure the sampling probe test stands and sample/electric lines to prevent them from being blown back by the exhaust blast. The sampling probes at 1 and 10 m consisted of a probe rake with multiple (6 each) gas and particle probe tips located in a vertical line and several extra gas/temperature/pressure probes located on the side of the probe rake . The particle sampling probe tips used at 1 and 10 m were designed for sampling aircraft exhaust at 1 m behind the engine exit plane. These probe tips allow for dilution of the exhaust flow at the entrance of the probe tip to avoid water, sulfates, and Volatile Organic Compound (VOC) condensation inside the unheated sampling lines during rapid cooling of the hot exhaust. Compressed nitrogen was used to dilute the 1 and 10 m samples. NASA researchers monitored and controlled the dilution based on measured CO_2 levels. The tips were designed for near-isokinetic sampling over the full range in exhaust flow rates at the different engine power conditions. The particle sample transfer lines were unheated. The gas probe lines were heated, undiluted, and used for whole sample gas phase measurements. The gas probes were sampled with the particle instruments a few times during APEX as a test of the effects of sampling undiluted exhaust on the measured particle properties.

The temperature of the exhaust emissions was high enough at the 1 m downstream sampling location (380 to 590 °C for idle to take-off power conditions) that nonrefractory PM components are not expected to condense prior to sampling by the 1 m probe tip. Once in the probe, the exhaust emissions were diluted by a factor of 8 to 10 with dry, compressed nitrogen to eliminate the condensation of water, sulfates, and organics into particles or onto the walls of the sampling lines. Thus, the engine exhaust emissions measured at 1 m should contain only the refractory components. The #3 probe tip was chosen based on the results from the mapping experiment discussed below to be the main probe tip used at 1 m during the bulk of the APEX experiments. At 10 m, the exhaust emission has entrained ambient air, diluted, and cooled such that the exhaust sample is nearly subsaturated with respect to water (sulfate and VOC) vapor inside the sample lines. The 10 m probe was sampled with and without added nitrogen dilution during testing. Two (or more) nearby probe tips in the 10 m probe rake were combined for sampling to lower the pressure drop at the probe tips as the exhaust flow at 10 m is not as rapid and the dynamic pressure is lower. The 30 m probe had a different design than either the 1 or 10 m probes. The 30 m probe consisted of a single forward facing tube with no dilution. The exhaust flow at 30 m downstream had entrained ambient air and cooled to near ambient temperatures (30 to 50 °C).

The Aerodyne mobile laboratory, including particle and gas phase instruments, drew sample through the particle probes only during routine operation. All of the particle probe samples were drawn through sampling lines from the probe tips, out beyond the end of the aircraft wing to the mobile research laboratories, and through a distribution manifold located in a nearby truck trailer operated by NASA researchers. The manifold was operated at sub-ambient pressures and was setup to provide ready access to any particular particle probe for a given engine condition. Probes that were not being sampled were static with no flow. This fact may have resulted in some spurious measurements, specifically when switching from the 10 or 30 m probes to the 1 m probe, where PM may have collected in the forward facing probe tip through virtual impaction while no flow was being drawn.

The CFM56-2-C1 engines have an oil system breather that exhausts aft from a conical vent along the engine axis. An initial test was conducted as a function of the vertical probe positions to gauge whether the vent affected the primary particle concentrations due to possible oil vapors being entrained into the exhaust stream from the center vent. The test was conducted with the 1 m probe located on engine center. Sample was drawn through the six particle probe tips consecutively for a few minutes each and sampled by real-time aerosol instruments starting at the #1 probe position (top of the rake) and progressing down the rake to the #6 position. Position #5 was located near the center of the engine axis. This test was done at idle, 7% engine thrust, and at two intermediate thrust settings (30 and 40%). Figure J-3 shows the resulting emission ratio ($\Delta X/\Delta CO_2$) matrix for organic aerosol composition as measured by the AMS. Figure J-3 shows an increase in the organic PM emission ratio centered at the #5 probe position. Based on this data and collaborating data from CPC instruments, the decision was made to use probe tip #3 on the 1 m probe and to orient the probe rake ~3 in. off the axis of the engine. This ensured that the particle sample was drawn away from any influence of the center vent, but still within the core flow (i.e., air that passed through the engine combustor) exiting the engine.

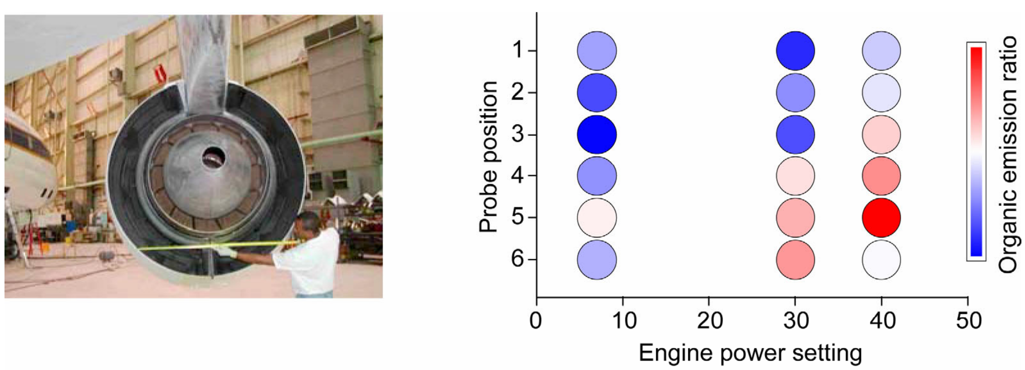

Figure J–3.—The image on the left shows the back of the CFM56-2-C1 engine with the external ducting. The schematic on the right shows the results from an experiment conducted to map the emissions measured at 1 meter downstream of the engine exit plane of the DC–8 CFM inboard engine. The color scale indicates the organic PM emission ratio (ratio of the change in organic PM to the change in gas phase CO_2) as a function of probe tip position and engine power setting. For these initial tests only, the probe rake was centered on the engine axis, with probe tip 5 located on the center line, directly behind the exit of the center, externally ducted vent of the CFM engine. During testing, the probe was shifted 3-in.-off axis.

2.7 Particle Transmission Through Sampling Lines

A series of tests were conducted on the transmission of the sampling lines as a function of particle size. The main concerns for the transmission of submicron diameter particles were deposition at the probe tip for large (>100 nm) particles and diffusion to the sampling tube walls for small (<100 nm) diameter particles. Two sets of tests were conducted. The first set was done on the tarmac during the experiments and the second was done on recreated sampling configurations at the University of Missouri-Rolla (UMR) after the experiment. The first set of tests consisted of atomizing a dilute sodium chloride salt solution and size selecting a series of monodisperse aerosols (20 to 300 nm diameter) with a Differential Mobility Analyzer (DMA) into a nitrogen flow spiked with 848 ±5ppm of CO_2. The resulting number concentration for this monodisperse aerosol was monitored with a CPC prior to entering the 1 m probe tip (same configuration as the 10 m probe tip). The test aerosol was sampled by CPC and CO_2 instruments located inside the NASA trailer, inside the Aerodyne mobile laboratory, and inside the UMR trailer after passing through the 1 m probe tip, distribution manifold, and sampling lines. The CO_2 measurement was used to account for the amount of dilution added in the sampling lines and the CPC measurement before the 1 m probe tip was used to determine the initial particle number concentration. Figure J-4 shows the Aerodyne results from the first series of tests conducted on site plotted as symbols. The results indicate a nearly constant dilution factor of 8.8 and a particle transmission efficiency ranging from ~37% for 20 nm particles to ~60% for 300 nm particles, with some scatter in the observations. The scatter in the data was also observed in the same measurements made by UMR (not shown in fig. J-4). The average transmission efficiency over this size range is ~45%. This study was constrained by time and may be complicated by varying number of doubly charged particles passing through the DMA for any given size selected.

The second set of particle transmission tests were conducted in Missouri by UMR. They recreated the sampling configuration and sampled challenge aerosols of sodium chloride and diesel truck exhaust from the probe tips to the NASA sampling manifold which split the particle sampling lines to the three collaborators (ARI, NASA, and UMR), the secondary UMR manifold, and finally through to the UMR instruments. The results from these tests are also shown in figure J-4 as fits to the actual data, rather than the individual measurements. The combination of the transmission tests tells an obvious, though complicated story. From probe tip to NASA distribution manifold, the average transmission efficiency of particles from 20 to 230 nm is ~70%. Below 20 nm the transmission falls off to ~20% at 10 nm. Adding in the additional tubing from the central NASA distribution manifold to the UMR secondary manifold

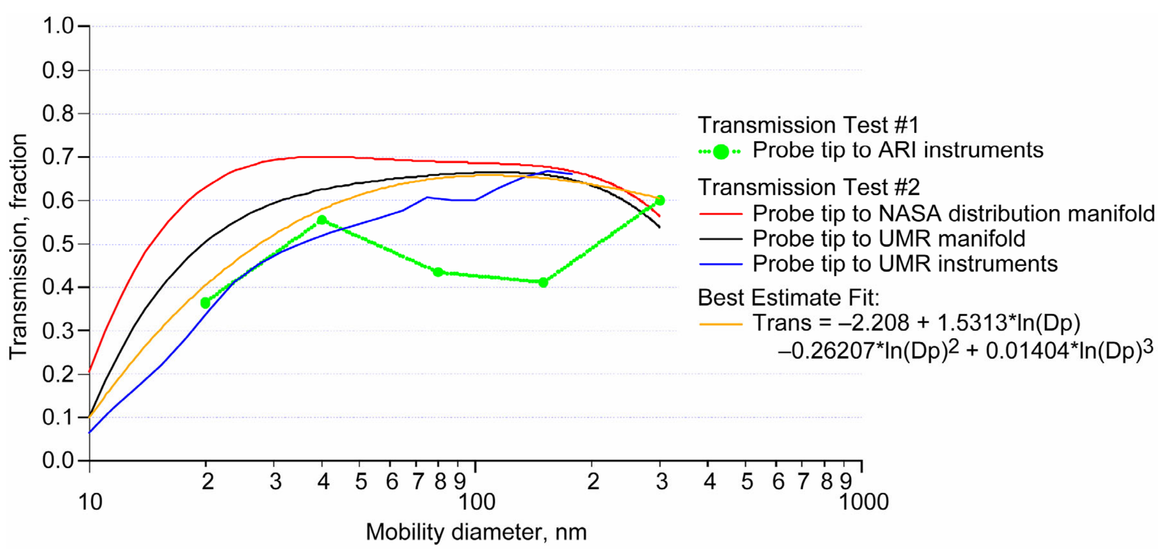

Figure J–4.—Results from sampling probe particle transmission experiments. Two tests were done to characterize the particle loss due to impaction and deposition inside the probe tips, sampling lines, and distribution manifold used during APEX. These results were obtained for the 1 meter probe tip #3, used for most of APEX sampling.

(presumably similar to the sampling lines running from the NASA manifold to the ARI instruments), the particle transmission is observed to drop ~10% for all particles < 60 nm and 2 to 5% for particles greater than 60 nm. The final particle transmission from probe tip to UMR instruments indicates another ~10% decrease in particle transmission for particles <90 nm due to more tubing related to UMR's secondary manifold system (ARI instruments did not operate with a secondary manifold system). The initial tests to the ARI instruments appears to fall in between these final two test results for particles <80 nm.

The results from the first test generally agree with the second set of tests with the exception of two results obtained during test 1 for particle sizes 80 and 150 nm diameter. These two points were significantly lower in the first set of tests done on site. The reason for this discrepancy is not known. Above 200 nm there were only three data points obtained during both transmission studies. Two points at 300 nm indicate a transmission of ~60%. A final point at 400 nm obtained during the second set of transmission tests appears to indicate a decrease in particle transmission to 40%. Due to the lack of more information, the transmission efficiency above 200 nm is uncertain.

These particle transmission studies underscore the importance and difficulty in making quantitative particle measurements in aircraft engine exhaust. The combination of these results suggests a potentially different particle transmission correction for each research group, due to the various sampling line lengths and configurations, especially for the smaller particles (<50 nm). Above 50 nm, the transmission efficiency is less dependent upon individual sampling line configurations.

Based on these tests, a best estimate particle transmission curve for particles sampled by Aerodyne particle instruments starts at ~10% transmission at 10 nm, increases to a constant maximum of 65% covering the range from 60 to 250 nm, and starts to fall back to 60% around 300 nm. This curve is shown in figure J-4. The effects of this particle transmission curve on the measured number- and mass-based emission indices depends strongly on the distribution of number and mass as a function of particle size for the actual particles in the exhaust, as well as for the specific particle transmission functions each instrument. For example, based on their final particle transmission curve shown in figure J-4, UMR researchers have estimated correction factors for PM mass loadings measured by their instrumentation for different engine test conditions that range from 2.5 to 3.5, depending upon the distribution of mass as a function of size in the exhaust. However, these correction factors only apply for instruments that measure particle mass over similar size ranges as the UMR instrument. These correction factors will change for different instruments.

For the purposes of this report on PM mass and chemical composition, the data have been compared and discussed prior to including particle transmission loss corrections. The potential effects these corrections may have on the data will be discussed within the context of the actual measurements reported in this report.

3. Results and Discussion

The exhaust plume from the inboard right-side CFM56-2C1 engine on the NASA DFRC DC-8 aircraft was sampled on April 23-29, 2004 at NASA DFRC. The key aspects of the exhaust emissions characterized in this report pertain to physical properties (particle size and number), mass loadings, and size-resolved chemical composition of the PM emissions and the effects of engine operating conditions, exhaust probe sampling distance, and aircraft fuel types have on these properties of the exhaust. The results will be presented in three sections that correlate with observations from the 1, 10, and 30 m probes. This comparison uses data from both NASA and UMR researchers on the physical properties of exhaust PM and attempts to provide an overview of the physical and chemical properties of the exhaust PM as a function of plume age, dilution, and temperature (sampling distance). The results will include information on the number-based emission index (EIn), mass-based emission index (EIm), and the derived volume-based (same as mass for an assumed particle density of unity) emission index (EIv) distributions as a function of particle mobility diameter. The focus of the discussion will be on the nonrefractory PM chemical composition, primarily as measured by the Aerodyne Aerosol Mass Spectrometer. Specific effects of the three fuel types sampled will be addressed.

3.1 Engine Exit Plane (1 m Probe)

Figure J-5 shows the average volume-based emission index (EIv) size distributions and the average number-based emission indices (EIn) results measured from the 1 m probe. All of the data in figure J-4 were obtained during times when the engine was burning high aromatic fuel. The size data was obtained by NASA researchers. The volume-based emission index (EIv with units of cm^3 per kg fuel, which is equivalent to g per kg fuel for particles with unit density) distributions are monomodal and exhibit an increasing mode diameter (~50 to 100 nm) with engine power (7 to 100%). The average EIn increased by a factor of approximately 10 (10^{14} to 10^{15} particles per kg fuel) with increasing engine power (7 to 100%), at the same time that the particle EIv mode diameter increased. The largest increase in EIn occurred for engine power conditions above 80% maximum rated thrust. The largest variation in EIn was observed at low (7%) engine power. This high variation coincides with the largest gas phase concentrations of volatile organic compounds (VOCs).

Aircraft exhaust is known to contain refractory black carbon (soot) and metals. During APEX, only the black carbon content and heated SMPS size distributions were monitored in real-time as methods for detecting the refractory PM components. Figure J-6 shows the black carbon mass-based emission indices (EIm) as a function of engine power for the three different fuels sampled and for the three different probe distances. All of the data in figure J-6 are derived from the absorption measurement of the Multiangle Aerosol Photometer (MAAP) instrument. Within the variation of measurements for a given fuel type, the black carbon EI's remain constant as a function of probe distance. Thus, the black carbon is being diluted at the same rate as the CO_2, as expected. Further, the black carbon EI's did not vary significantly with fuel type combusted in the engine. Figure J-6d shows the black carbon EI averaged over all fuel types and probe distances. The EIm start at ~8 mg/kg fuel at the low engine powers (4 to 7%), drops to 2 to 5 mg/kg fuel at intermediate engine powers (20 to 60%), and dramatically increases to >100 mg/kg fuel at maximum rated thrust (100%). Figure J-6d exhibits rather surprising variability at high and low engine powers.

The variability in the black carbon EIm measurements are examined in figure J-7. The top left panel shows the EIm measurements for all fuel types colored by probe distance and plotted versus engine power. The bottom left panel shows the same data plotted versus the recorded fuel flow rate. The change in axis from nominal engine power to fuel flow rate minimizes the variability observed at high engine powers. The top right panel in figure J-7 shows the fuel flow rate plotted versus the ambient temperature and colored by the engine power. This comparison shows that as the ambient temperature drifted from 17 to 37 °C, the conditions the aircraft engine was operated at under nominal high engine powers changed. This slight change in engine conditions at nominal high power settings accounts for most of the

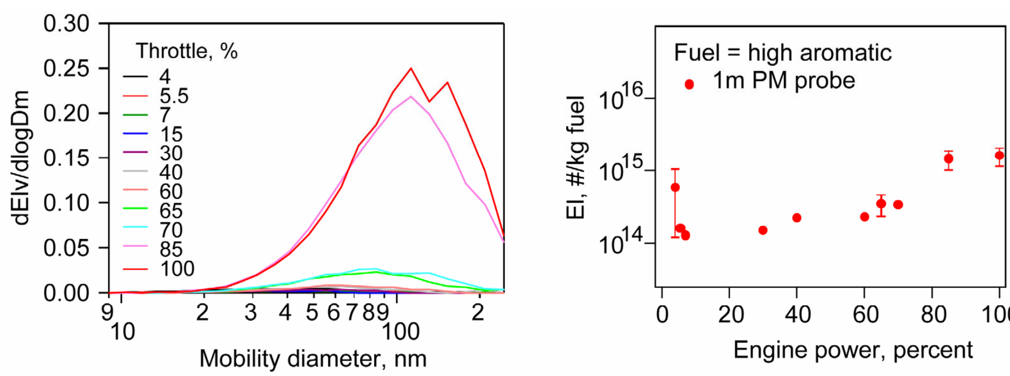

Figure J–5.—The left plot shows the average volume-weighted size distributions obtained by NASA researchers at the 1 meter probe as a function of engine power. The volume-weighted size distributions are monomodal exhibit an increasing mode diameter with engine power. The right plot shows the average emission index for the particle number (EIn) as a function of engine power. The particle emission index increases with increasing engine power, at the same time that the particle volume-weighted mode diameter increased. All data shown in this Figure J-were obtained for the high aromatic fuel case.

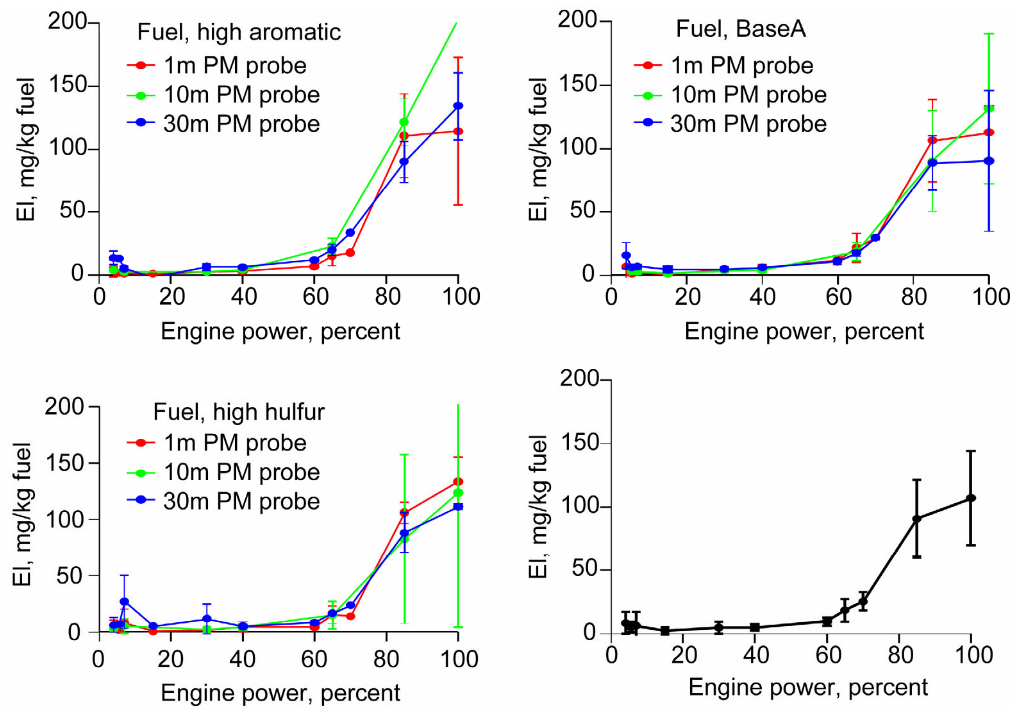

Figure J–6.—The black carbon emission indices as a function of fuel type, probe distance, and engine power. The first three plots indicate that the black carbon emission indices are independent of the fuel type and probe distance. The bottom right plot shows the black carbon mass-based emission indices averaged over all conditions. The black carbon decreases slightly from idle conditions to mid-power conditions and then increases dramatically at high engine powers. The larger variance bars at high power reflect the shorter sampling times.

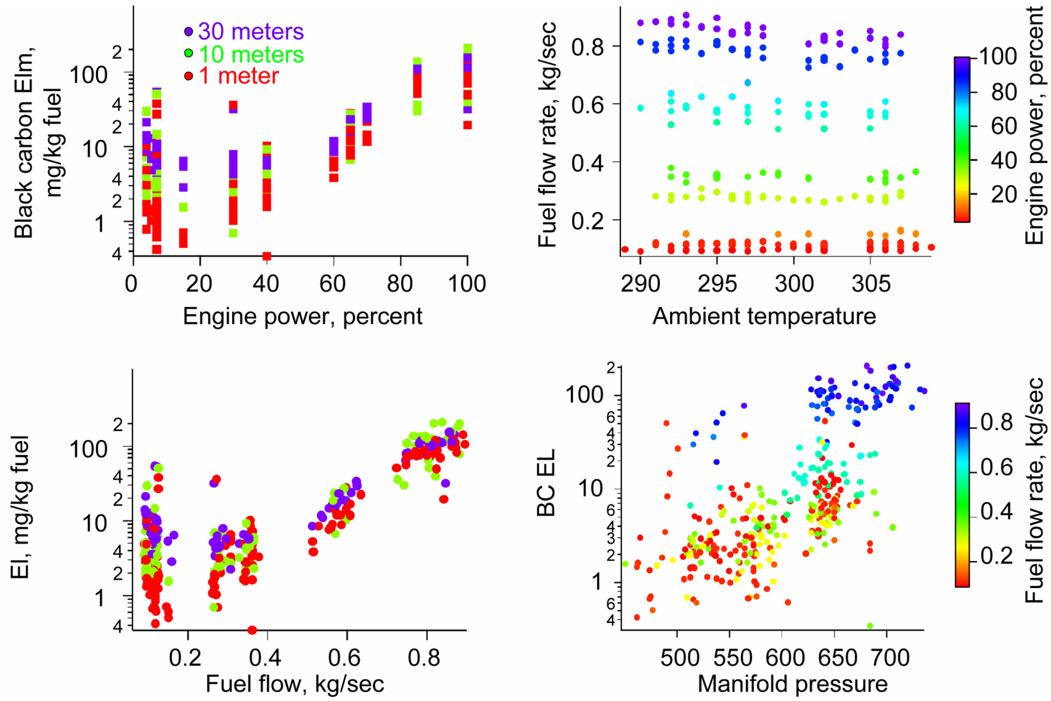

Figure J–7.—The black carbon emission indices for all fuel types plotted in the top left two panels as a function of engine power. The large apparent variability observed at high engine power is due in large part to variations in fuel flow rates, as observed in bottom left panel. The top right panel shows the change in fuel flow rate with ambient temperature and the nominal engine power settings. However, as the bottom left panel shows, the fuel flow rate does not account for the large variation in the data at low engine powers. The bottom right panel shows the black carbon emission index versus the aerosol sampling manifold.

variability observed in the black carbon EIm (and EIn) at high engine power settings. Thus, the fuel flow rate is a better independent variable to use compared with the nominal engine power settings that were chosen during APEX. Future experiments should use fuel flow rates as the designated power settings rather than estimated percent thrust levels. For the purpose of this report, the nominal engine power settings will still be used as the primary independent variable as this was chosen during the planning stages of APEX and makes direct comparisons between measurements simple.

The sensitivity in fuel flow rate with ambient temperature does not appear to be as great under low engine power settings. Thus, the variation observed in the black carbon EIm and EIn at low engine settings is not caused by a shifting definition of the nominal engine power. The bottom right panel in figure J-7 shows the EIm plotted versus the NASA sampling manifold pressure. This pressure is a function of the engine exhaust flowrate and the dilution flow added inside the 1 and 10 m probe tips. The manifold pressure was constant at 650 Torr when sampling from the 30 m probe, under all engine power settings. Sampling from the 1 and 10 m probes, however, the manifold pressure changed dramatically (<500 to > 700 Torr). The change in manifold pressure (including engine exhaust flow rate and/or sample dilution rate), appears to have caused changes in the measured EIm for black carbon by the MAAP. This appears to account for a significant fraction of the variability observed in the EIm measurements. The reason behind this change with manifold pressure is not clear at the present. It is not known if this is due to instrument (MAAP) response to pressure changes or differences in the responses of the black carbon measurements compared with the CO_2 measurements (EIm calculations require the ratio of two instrument measurements). The response in EIn with manifold pressure does not show a similar trend with manifold pressure.

Combining these measurements (EIn, EIv, and EIm) provides a relatively simple picture of the particulate emissions of this CFM56-2C1 engine at 1 m behind the engine exit plane. At low engine powers the soot particles generated in the combustors are small (~40 nm volume-weighted mobility diameter) and have a variable number-based emission index ranging from 1.0 to 5.0×10^{14} particles per kg fuel and a mass-based emission index of 8 mg/kg fuel. At moderate engine powers 20-60%, the soot exhaust particles increase in size to 60 to 70 nm (volume-weighted mobility diameter), while the EIn decreased to below 3×10^{14} particles per kg fuel and the mass-based EI decreased to 2 to 5 mg/kg fuel. At high engine thrust levels (80 to 100%), a significant increase in soot generation is observed. The soot particles have a larger diameter (~100 nm volume-weighted mobility diameters), a higher EIn (~1.5×10^{15} particles per kg fuel), and a mass-based EI of ~100 mg/kg fuel.

As the temperatures in the 1 m probe ranged from 380 to 590 °C and the sampled exhaust flow was diluted by a factor of 8-13, volatile and semi-volatile (i.e., nonrefractory) compounds should not have condensed on the soot particles. Several measurements were conducted to verify that nonrefractory compounds were not condensing in the 1 m probe onto the soot particles or via homogeneous nucleation.

The AMS measures the nonrefractory compounds in and on the surface of particles. Thus, the AMS is sensitive to semi-volatile material that may have condensed on the soot mode. Figure J-8 shows an average over all fuel types of the total AMS mass measurements in units of mg/kg fuel obtained as a function of engine power. The results suggest that the measured mass-based emission index for nonrefractory components increases from 0.3 to 2 mg/kg fuel as the aircraft engine power increases from 4 to 100% thrust. The AMS signal is almost purely dominated by organic composition. The sensitivity limit for the AMS measurements of organic PM during APEX, described as 3 times the standard deviation of the signal when sampling filtered air, is 0.26 $\mu g/m^3$. Assuming a typical CO_2 concentration of 1500 ppm in the sampled exhaust flow, the detection limit of the AMS for organic components is ~0.3 mg/kg fuel. This detection limit is shown in figure J-8 as a dashed line. A comparison between this detection limit and the averaged AMS total nonrefractory PM EI for sampled exhaust at 1 m suggests that the results are at or below the detection limit for engine powers ranging from 7 to 30%. Above 30% there is some indication of organic PM mass on the exhaust particles and there is measurable organic PM for engine powers >80% thrust. This result, small as it was, was not expected

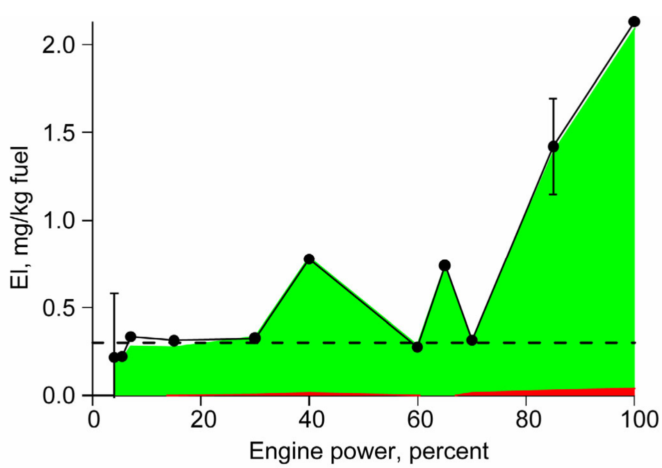

Figure J–8.—This plot shows the mass-based emission indices for the nonrefractory aerosol components measured by the AMS from the 1 meter probe and plotted as a function of engine power. The black filled circles indicate the total non-refractory EI and the solid colors indicate that the majority of the measured mass was organic with an insignificant amount of sulfate. The dashed black line indicates a reasonable approximation of the detection limit of the AMS for the measurement of organic composition.

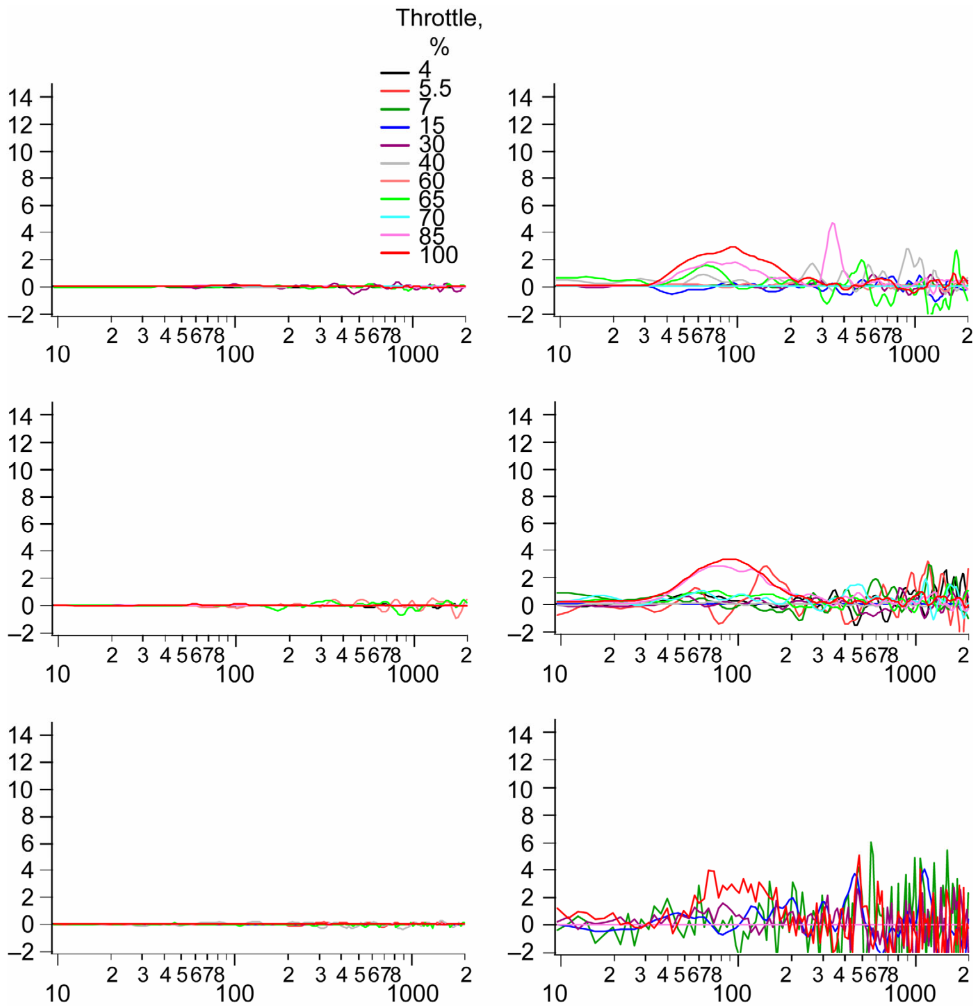

Figure J–9.—AMS size-resolved emission indices measurements for sulfate (left three panels) and organics (right three panels) as a function of fuel and throttle setting. The top row results are from the high sulfur fuel, the middle row from high aromatic fuel, and the bottom from the base fuel. There is no evidence for sulfate on the particles at 1 meter (within AMS detection limits). In contrast, the AMS does show measurable organic material condensed on the soot mode at the high engine powers (65–100%).

Figure J-9 shows the size-resolved emission indices for sulfate and organic particulate material from the AMS as a function of fuel type and engine throttle. Figure J-9 confirms that measurable nonrefractory particle mass observed by the AMS is indeed organic and is only present during high engine throttle settings (>65%). Furthermore, this particle mass is present in a single size mode. The implication of these observations is that organic PM condensed onto the particle soot mode, likely during transit through the sampling lines.

The temperatures measured at the 1 m probe, especially at high engine powers, are ~600 °C, which is similar to the AMS vaporizer temperature (600 °C) inside the AMS. Most nonrefractory organic and inorganic compounds that may condense in the atmosphere will not condense until the temperature has decreased below ~300 °C. Thus, the nonrefractory material measured by the AMS must have condensed after the exhaust had cooled significantly below ~600 °C, which could only have happened inside the sampling lines. This result indicates that the dilution of the exhaust samples at the probe tip was not adequate at these high levels of thrust and some fraction of the semi-volatile gaseous components condensed onto the soot particles. To further pursue this issue, future experiments should vary (increase) the sample dilution at the 1 m probe above the factor of 8 to 13 used during APEX.

The unexpected observation of the condensation of organic matter on the soot mode in the sample lines allows the AMS to derive a vacuum aerodynamic diameter for the soot mode. The size axes in figure J-9 show the particle vacuum aerodynamic diameter (d_{va}; nm) rather than the particle mobility diameter (d_m; nm) as shown in figure J-5a. The relationship between the vacuum aerodynamic and mobility diameters is,

$$d_{va} \sim \rho \, d_m / \chi^b \qquad (1)$$

where ρ and χ are particle density and dynamic shape factor, respectively, and b varies between 1.5 (free molecular) and 2 (continuum) depending on the flow regime in the DMA. [*DeCarlo et al.*, 2004; *Slowik et al.*, 2004]. Equation 1 can be simplified to,

$$d_{va} \sim \rho_{eff} \, d_m \qquad (2)$$

where ρ_{eff} is the effective density ($\rho_{eff} = \rho / \chi^b$). The dynamic shape factor accounts for the effect of nonspherical shape on the particle drag force, equals 1 for spherical particles, and is almost always greater than 1 for nonspherical particles [*Baron et al.*, 2001; *Hinds*, 1999]. Thus, the vacuum aerodynamic diameter measured by the AMS is proportional to the mobility diameter measured by the SMPS instruments times the effective density of the particles. Simultaneous measurement of both diameters for a well defined size distribution can provide information on the particles' effective density and particle shape.

To directly compare the AMS and SMPS, the mass distributions measured by the AMS must be corrected for varying pressure differences in the sampling line. The particle vacuum aerodynamic diameters measured by the AMS are derived from particle time-of-flight (i.e., particle velocity) measurements inside the AMS. The velocity of the particles as they exit the aerodynamic lens in the AMS is dependent upon the pressure inside the lens. The pressure inside the sampling lens of the AMS is directly related to the sampling pressure inside the exhaust sampling lines. Figure J-10 shows the AMS lens pressure as a function of sampling conditions. The conditions vary most significantly during 1 m probe sampling due to the varying pressures inside the sampling lines caused by the large range of exhaust flow rates from the engine as a function of engine power and the large range of dilution flow required to control the dilution rates within the probe tip. Due to the difficulty of pressure-dependent size calibrations, this procedure was not done during the APEX mission, but rather later in the laboratory. The pressure-dependent size calibration was done on a different AMS than used during APEX, however, the laboratory based instrument had the same basic aerodynamic lens and chamber configuration as the instrument used during APEX. For our purposes here, the laboratory calibration will be applied to the mode of the measured particle mass distributions.

Figure J-11 compares the soot mobility EIv distribution measured by SMPS instruments with the corrected vacuum aerodynamic organic particulate EIm distribution observed by the AMS. The AMS and SMPS data are plotted on separate y-axes, focusing on the diameter comparison rather than the magnitudes of the distributions. The obvious implication of figure J-11 is that the effective density of the soot mode generated at high engine throttle is approximately 1 g/cm^3.

The material density of black carbon soot is typically in the range of 1.8 to 2.1 g/cm3 [*Slowik et al.*, 2004]. The material density of the organic component may be assumed to be ~0.9 g/cm3 based on the densities of fuel and lubricating oil components. However, at these high engine powers, the mass of black carbon soot is much larger than the observed condensed organic particulate matter and thus the material density of the slightly coated soot particles must be close to 2 g/cm3. If the material density of the soot particles can be assumed to be ~2 g/cm3, then the effective density can only be observed to be near unity if the value of $(1 / \chi^b)$ is approximately 0.5. The SMPS instruments were operated in the continuum flow regime during APEX, such that the coefficient of the dynamic shape factor, b, is 2. Solving for the dynamic shape factor obtains $\chi \sim 1.4$ for $d_m \sim 100$ nm soot particles. Thus, the black carbon soot particles generated by the CFM56-2-C1 engine is nonspherical.

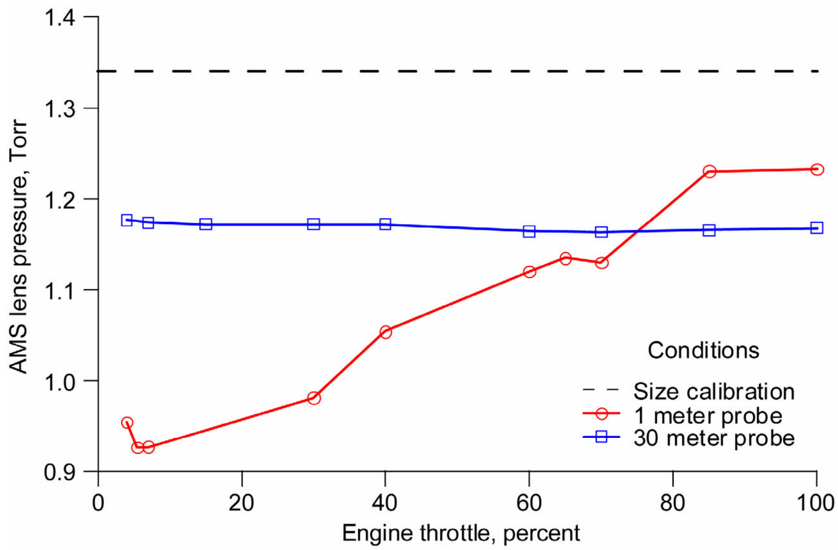

Figure J–10.—The pressure inside the AMS aerodynamic sampling lens during the size calibration procedure conducted on the tarmac just prior to APEX aircraft measurements and during 1 and 30 meter sampling.

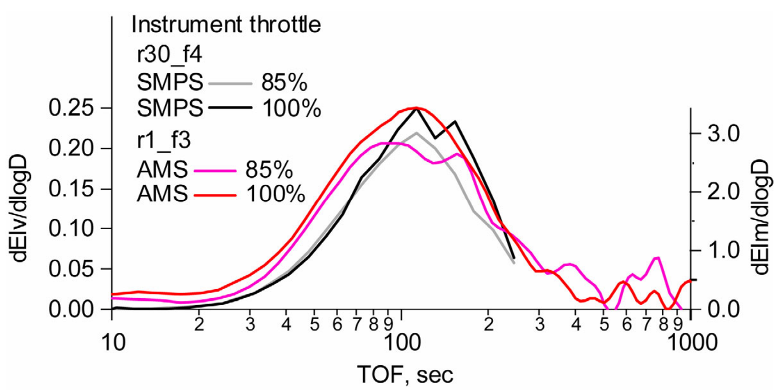

Figure J–11.—The soot mode measured at 1 meter by the SMPS instrument (right axis) and the AMS (left axis) averaged over all samples of the exhaust from high aromatic fuel. The SMPS volume-weighted size distribution is plotted versus the particle mobility diameter and the AMS mass distribution is plotted versus the particle vacuum aerodynamic diameter.

As detailed in Slowik et al. [*Slowik et al.*], the dynamic shape factor of premixed laboratory flame and diesel engine generated black carbon soot particles is a function of the particle mobility diameter. In particular, figure J-11 from Slowik et al. [*Slowik et al.*] shows derived dynamic shape factors for fractal and spherical soot particles from flame and diesel soot as a function of particle mobility diameter. Figure J-12 shows a recreation of Slowik's figure J-11 with the current aircraft data included. This exercise has been done for several measurements of the soot mode from the 1 and 30 m probes for the high aromatic fuel case. It turns out that the soot mode is only readily resolvable in the AMS under high engine power settings (85 to 100%), limiting the range in mobility diameter from this data set that can be utilized. The comparison in figure J-12 indicates that the soot particles generated by the CFM56-2-C1 aircraft engine are likely fractal in nature and not significantly different in morphology from soot generated by premixed flames and diesel engines. At the observed mobility diameters, the soot particles are not fluffy, large soot particles dramatically different from spherical ($\chi \sim 1.4$ compared with $\chi \sim 1.0$ for spherical particles), but are likely small, compact conglomerates of a few fairly large of primary nodes.

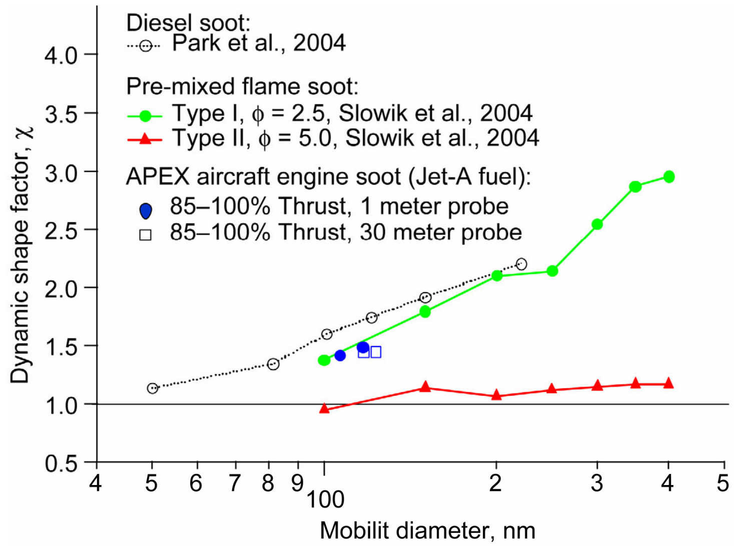

Figure J–12.—The dynamic shape factor plotted versus the mobility diameter for the soot mode for the high aromatic fuel case (Jet-A) at 1 and 30 meters. The results are compared to diesel soot morphology measurements obtained by Park et al., 2004 and premixed laboratory flame soot obtained by Slowik et al., 2004.

3.2 Downstream (10 m Probe)

The 10 m probe represents the first downstream probe distance used during APEX. Figure J-13 shows the volume- and mass-weighted emission index (EIv and EIm) distributions and number-based emission indices (EIn) for measurements obtained sampling through the 10 m probe for the base fuel case. The results for the number-based emission indices at 10 m are very similar to those observed at the 1 m probe for engine powers greater than 20%. This indicates that the particle number concentration is dominated by the soot mode at both the 1 and 10 m probe distances. At low power (4 to 7%), the results from the 10 m probe indicate a consistently higher (10×) EIn, compared with the majority of the results observed at 1 m. These results suggest a new source of particles is present at the exhaust flow at low engine powers at the 10 m probe.

At 10 m distance, the exhaust plume has been cooled and diluted with a mixture of by-pass flow and ambient air prior to being extracted into the sampling probe. A potential source of particles may be gas-to-particle nucleation occurring at the 10 m probe distance at low engine powers. While the volume-weighted emission index distributions in figure J-13 do not register the presence of the nucleation mode, the number-weight size distributions plainly show that this is the case (not shown). In fact, upon close examination, the nucleation mode is present during all engine power conditions at 10 m. The particle number and volume of the nucleation mode decrease significantly at higher engine thrusts and thus are not readily observable in the averaged EIn values shown in figure J-13. Although the distance of the 10 m probe is constant, the time the exhaust travels to the probe and the exhaust temperature vary with engine thrust. The velocity and temperature of the plume is dictated by the engine thrust level and, thus, the higher the engine power the shorter the plume age and the hotter the exhaust prior to sampling at the 10 m probe. This change in plume age and temperature with engine power is a potential reason why new particle generation is a significant contributor to the total particle number only at low engine powers at the 10 m probe. It is not known if these particles are nucleating in the exhaust flow at 10 m or inside the diluted sampling lines similar to observations in the 1 m probe.

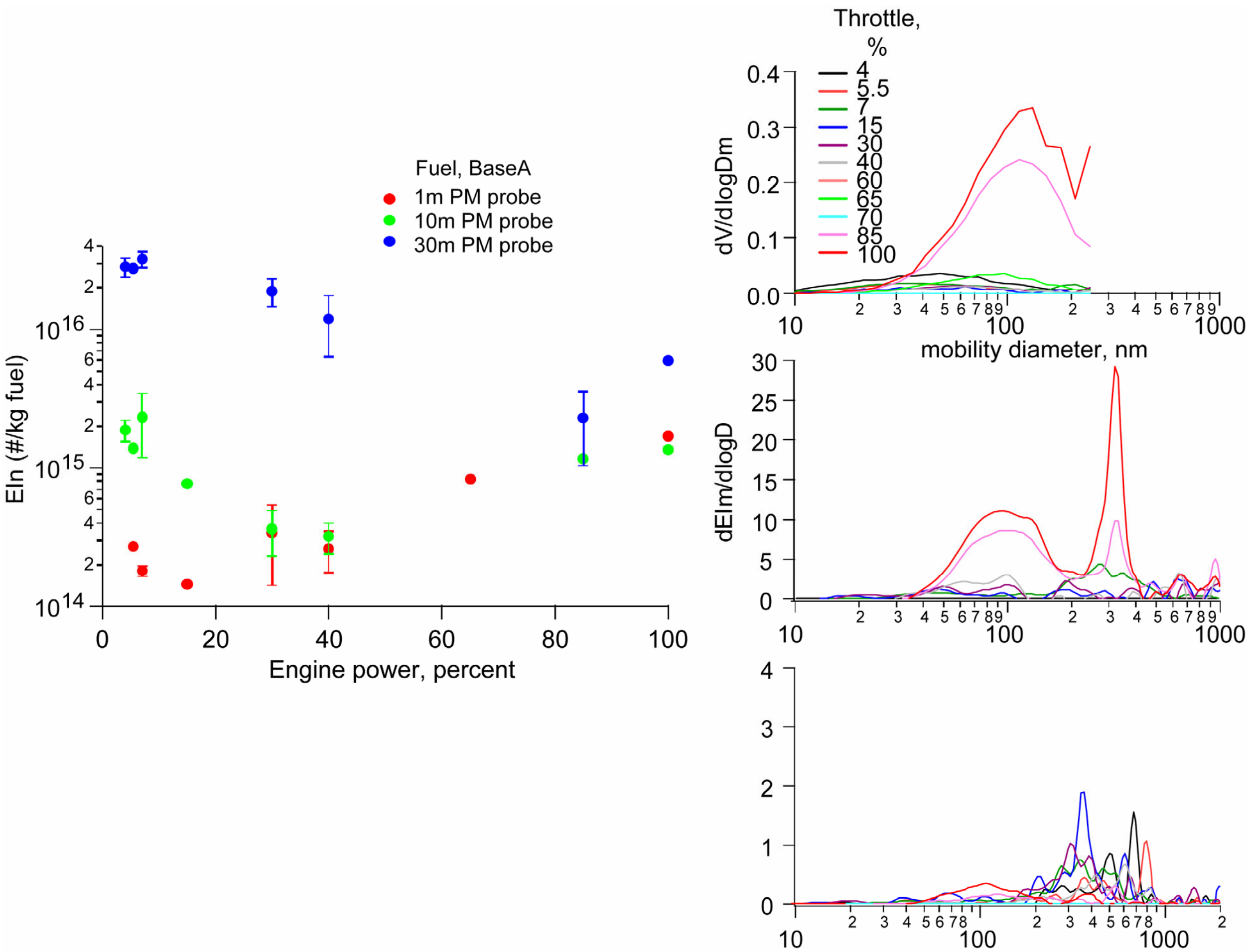

Figure J–13.—The left panel shows the EIn measured at 1, 10, and 30 meters for the base fuel case. The top right panel shows the volume-weighted emission index distributions as a function of mobility diameter, the middle right panel shows the nonrefractory particulate organic mass-based emission index distributions, and the bottom right panel shows the nonrefractory particulate sulfate distributions as a function of vacuum aerodynamic diameter. The AMS size distributions shown are uncorrected for the varying sample pressure, which would shift the mode diameters by 20-40 nm to larger sizes. All data are for base fuel case.

The SMPS volume-weighted emission index distribution measurements show a similar result as obtained from the 1 m probe: single soot mode that increases in mode size and total volume with engine power. The AMS mass-weighted size distributions also show similar results as obtained from the 1 m probe. The condensed particulate organic matter on the dominant soot mode is greater at 10 m compared to 1 m. There is also measurable organic and sulfate particulate matter in a mode located ~300 nm vacuum aerodynamic diameter. This larger mode, not present in samples from the 1 m probe, is evidence for the entrainment of ambient particles into the exhaust stream prior to sampling through the 10 m probe.

Figure J-14 shows the background aerosol mass loadings and size-resolved chemical composition from mid-day on April 21 to the morning of April 22, 2004. This time period covers a morning and afternoon time period on two days when testing was delayed due to probe issues. Figure J-14 shows the large variations in chemical composition and mass loadings in time and their corresponding average size distribution. The average background organic and sulfate PM mass loadings for this time frame was 0.31 and 0.41 μg/m^3, respectively. The accumulation mode appears to be internally mixed particles composed of organic, sulfate, nitrate, and ammonium with a vacuum aerodynamic mode size of ~350 nm. This mode is the same as observed in the sulfate and organic mass index distributions shown in figure J-13 measured at the 10 m probe.

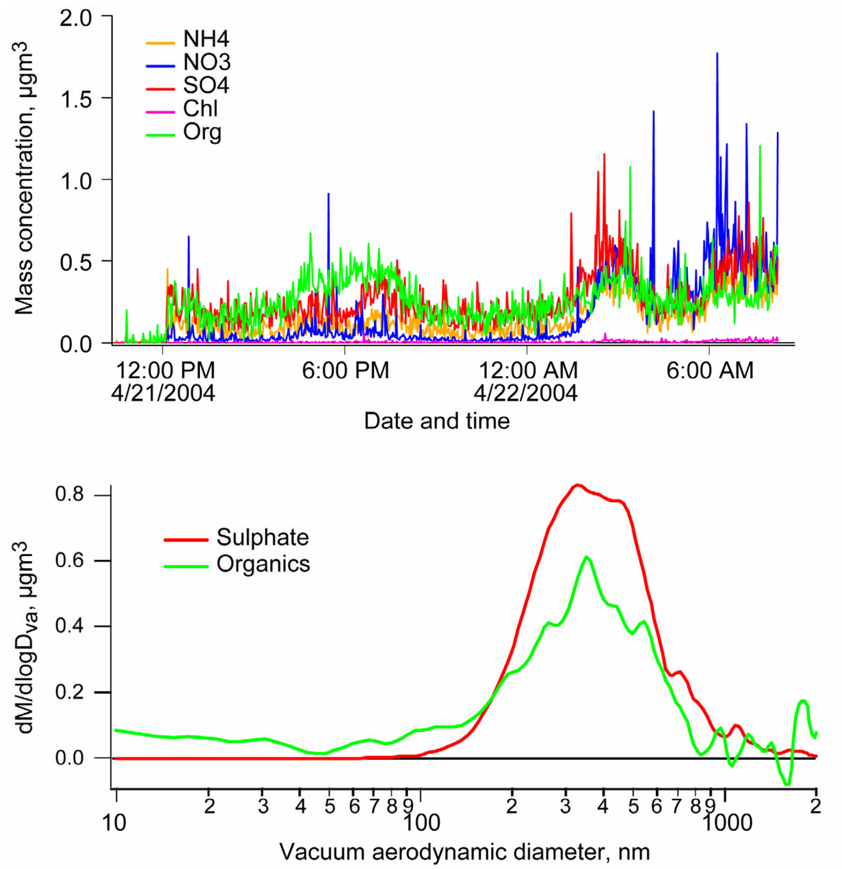

Figure J–14.—Background nonrefractory aerosol chemical composition and size distributions measured by the AMS during April 21-22, 2004. The top panel shows the mass loadings as a function of time. The bottom panel shows the average organic and sulfate mass distributions for this time period.

The high variation in the background aerosol, which was not monitored while sampling aircraft exhaust, due to two sources of dilution (ambient entrainment prior to sampling through the probe tip and particle-free nitrogen inside the probe tip), and the potential influence of the hot exhaust temperatures on the particle equilibria complicates our ability to quantify and remove the entrained ambient aerosol from the exhaust measurements. To first order, this size mode will be subtracted from the total EI calculated for the different test conditions. The problems that arise with this method of data analysis is that the entrained ambient aerosol do represent particle surface area upon which gas phase species may condense as the exhaust cools. A prime example of this is the organic component that is observed at the 10 m probe on the soot mode. This same component likely also condenses on the ambient particles. The SMPS instruments used to sample the aircraft exhaust focused on the small particles being emitted from the aircraft and thus do not have a full size distribution measurements of the entrained ambient particle mode. Full size distributions would help compare the effective surface areas available for condensation in the soot and accumulation modes. Finally, while the ambient mode starts to show up in the 10 m probe data, the largest influence occurs in the 30 m probe results.

3.3 Downstream (30 m Probe)

Further downstream in the engine exhaust flow at the 30 m probe, there is a significant change in the microphysical properties of the exhaust PM. Figure J-15 shows the volume-weighted emission index (EIv) distributions and number-based emission indices (EIn) for measurements obtained sampling at the 30 m probe. The results in figure J-15, like figure J-5, contain data for the high aromatic fuel type. The

EIv distributions show a distinctly bimodal distribution, compared with the monomodal distribution shown in figure J-5 observed 1 m beyond the engine exit plane. A close comparison of figures 15 and 5 shows that the larger mode observed at 30 m is very similar in size and trends with engine power to the single soot mode observed at 1 and 10 m. The soot mode mobility diameter increases from 70 to 100 nm over the range from 65 to 100% thrust. The EIv distributions are dominated at low engine power settings by the smaller mode. The nucleation/growth mode diameter (volume-weighted mobility diameter) of the smaller mode is approximately 20 nm at 7% idle, appears to decrease slightly through intermediate engine powers and increases again at higher powers, though the overall changes are less than 20%. The EIv in the small mode is highest at 7% idle and smallest at 100% thrust.

The EIn results for all three probe distances are also shown in figure J-15. The dramatic change observed in the EIn shown in figure J-15 is the difference in generated particle numbers observed at the 30 m probe, compared with the 1 and 10 m probes. At the 30 m probe, the EIn starts at $3x10^{16}$ particles per kg fuel at low engine powers (>2 orders of magnitude compared with 1 m probe results) and slowly decreases to $1x10^{15}$ particles per kg fuel at 100% power. This dramatic increase in EIn at 30 m is a result of gas-to-particle condensation and growth as the exhaust plume cools through dilution with ambient air. The slight decrease in total particle number generated is likely related to the increase in the soot particle number and size, such that the increased surface area of the black carbon soot particles decreases the supersaturation of the cooling vapors through heterogeneous condensation. Another potential explanation is the decreased plume age measured at the 30 m probe under high engine power conditions compared with low engine power conditions. It is important to note that the sampled exhaust has a much longer residence time inside the sampling lines for all sampling conditions during APEX. Thus, it is likely that the time factor is less important and, furthermore, its possible that the condensation/nucleation observed at 30 m is happening in the sampling lines, as observed in the 1 m case.

The results from the 30 m probes are much different from the 1 and 10 m results. The obvious difference is that the exhaust plume has diluted and cooled significantly (dilution factors of >10 and temperatures just above ambient ~30 °C). The dilution of the exhaust plume with ambient air mixes in ambient aerosols with potentially important surface areas and the plume cooling causes the semi-volatile, nonrefractory components to condense onto pre-existing particles and homogenously nucleating new particles.

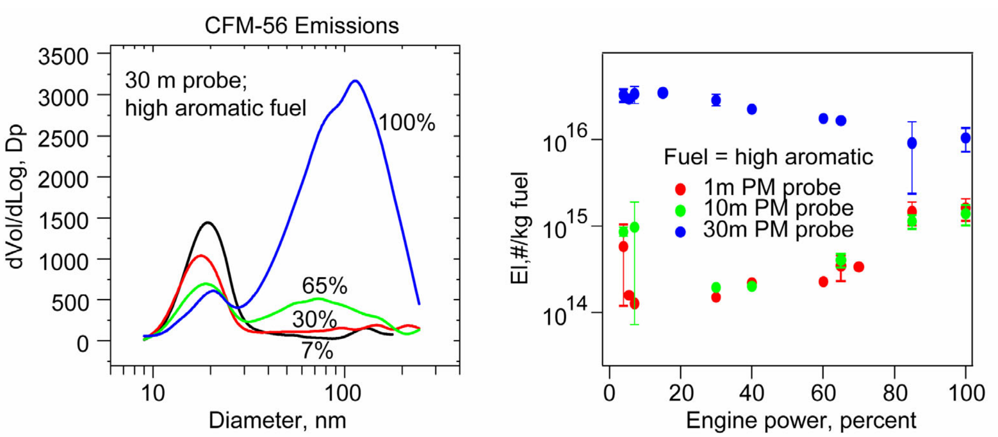

Figure J–15.—The left plot shows the average volume-weighted emission index (EIv) distributions obtained by NASA researchers at the 30 meter probe as a function of engine power. The EIv distributions are bimodal with the larger mode similar in size and trend with engine power to the single mode observed at 1 meter. The second mode in the distributions appears at small particle sizes (15-20 nm diameter) and exhibits an increasing mode diameter and a decreasing EIv with engine power. The right plot shows the average number-based emission index (EIn) as a function of engine power for all three probe distances. The 1 and 10 meter probe results show similar EIn as a function of engine power. In contrast, the 30 meter probe results indicate a significant (>100X) increase in the EIn for all engine power conditions. All data shown in this Figure J-were obtained for the high aromatic fuel case.

Figure J-16 shows the averaged total nonrefractory mass-based emission index (EIm) distributions measured by the AMS for the high sulfur fuel at the 30 m probe as a function of engine power compared with the average SMPS EIv distributions. The SMPS distributions are plotted versus mobility diameter, whereas the AMS mass distributions are plotted versus vacuum mobility diameter. The SMPS distributions exhibit two volume-weighted modes: a ~20 nm mode and a ~120 nm mode. The AMS distributions show three mass modes: a ~40 nm mode, a ~100 nm mode, and a ~350 nm mode. From the results obtained at 1 and 10 m probes, these modes are readily assigned as the nucleation/growth mode, the soot mode, and an entrained accumulation mode from ambient aerosols. The low counting statistics at the larger particles sizes causes the lower signal-to-noise levels in the accumulation mode.

The particle transmission into the AMS instrument on the low particle size causes a significant number of small particles in the nucleation/growth mode to go undetected by the AMS. Recent laboratory tests indicate that the transmission curve for the AMS drops below 100% around 100 nm and falls below 50% transmission below 60 nm in vacuum aerodynamic diameter. Thus, the AMS cannot quantitatively measure the emission index from the nucleation/growth mode. However, the AMS can provide important information on the chemistry of this mode. The soot mode lies completely within the high transmission efficiency range of the AMS, indicating that the AMS can quantitatively measure the EIm of the nonrefractory components condensed on the soot mode.

The nonrefractory composition of the sampled aircraft exhaust consisted of only organic and sulfate compounds in both the nucleation/growth and soot modes shown in figure J-16. The sulfate component is acidic. To better understand the chemistry of the exhaust particles, the AMS EIm distribution data was fit using lognormal curves to deconvolve the fraction of particulate mass in each of the three modes.

Figure J-17 shows the sulfate (left three plots) and organic (right three plots) emission index (EIm) as a function of engine power for the three types of fuels burned in the aircraft, measured at the 30 m probe. The bottom two plots show the sulfate (left) and organic (right) aerosol EIm for the base fuel case. The grey color indicates the mass measured in the soot mode, the colored (red and green, respectively) trace indicates the mass measured in the nucleation/growth mode, and the difference between the sum of these two curves and the total AMS (black line in each plot) indicates the fraction of EIm observed in the accumulation mode. The middle two plots are for the high aromatic fuel case and the top two plots are averages for the high sulfur fuel case.

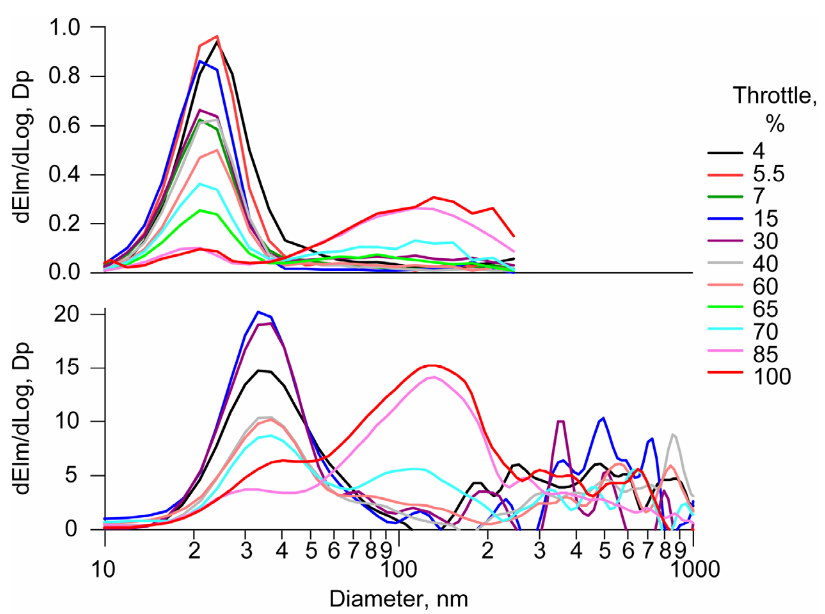

Figure J–16.—The EIv (SMPS) and EIm (AMS) distributions for the high sulfur case at the 30 meter probe. The AMS distributions (bottom plot) show three distinct modes (nucleation, soot, and entrained ambient).

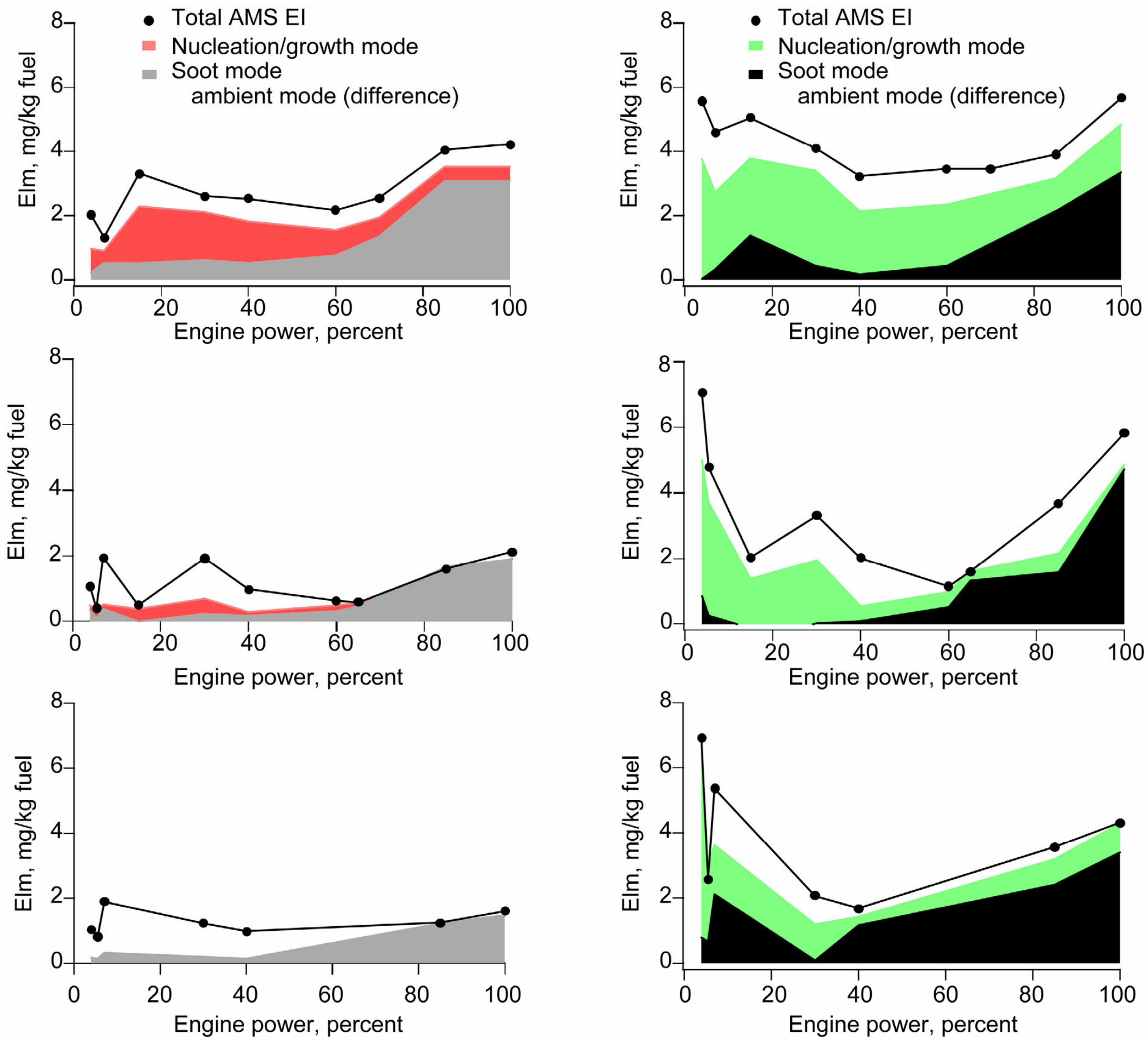

Figure J–17.—Nonrefractory EIm for sulfate and organic components in aircraft exhaust measured by the AMS. The left three plots show the sulfate EIm as a function of engine power. The right three plots show the organic EIm as a function of engine power. The top row are averaged for the high sulfur fuel case, the middle row for the high aromatic case, and the bottom row for the base fuel case. The grey (black) represents the EIm for the sulfate (organics) condensed on the soot mode. The color (red and green) represents the sulfate/organic on measured in the nucleation/growth mode, and the black lines are the sum of the EIm for each species from the three modes (nucleation/growth, soot, and accumulation mode).

In all cases, the nonrefractory organic composition is the dominant component, with the exception of the high sulfur fuel case where the measured composition is ~50% organic. The amount of sulfate and organic condensed on the soot mode increases from a small fraction at low engine powers to a large fraction of the total at high engine powers. This indicates that the surface area of the soot mode is dramatically increasing with engine power and more gas phase components are condensing on the pre-existing surface area. At low engine power conditions, the particulate exhaust appears to be dominated by the nucleation/growth mode. The base and high aromatic fuel cases exhibit very similar results for both the sulfate and organic components, compared with the high sulfur fuel case. The high sulfur fuel case shows more sulfate mass present in the AMS EIm distributions compared to the lower sulfur fuel cases. Interestingly, the high sulfur fuel case appears to also have more organic mass present in the nucleation/growth mode. The organic condensed on the soot mode is very constant for each fuel case, indicating that the overall amount of organic matter that could condense on the particles in similar in all three cases. The larger nucleation/growth mode EIm observed under the high sulfur fuel case may be an artifact caused by a larger growth mode size due to more sulfate condensing shifting more particle mass into the size range that the AMS can efficiently sample.

With little observed difference in the base and high aromatic fuel cases, figure J-18 shows the average low sulfur (base and high aromatic fuel cases) nonrefractory EIm compared with the volatile EIv measured by the SMPS (left plot). The grey and black are the sulfate and organic condensed on the soot mode, respectively, and the red and green are the sulfate and organic in the nucleation/growth mode, respectively. The blue line is the integrated EIv from the SMPS measurements for the volatile component. This number is derived by subtracting the heated SMPS measurements from the unheated SMPS measurements and represents the total particle volume of nonrefractory (300 °C) material present on the aircraft exhaust over the measured mobility size range (10-300 nm). The total EIm measured by the AMS agrees well with the total EIv measured by the SMPS at high engine powers for the low sulfur fuel cases (left plot in fig. J-18). Furthermore, the AMS and SMPS distribution results indicate that most of the nonrefractory mass is condensed on the soot mode in these cases. It is unclear whether this is entirely due to the increase in soot surface area, or if the shorter times from engine exit plane to sampling probe (due to faster flow at higher powers) is important. This result is further observed in the lower EIn at higher engine powers at 30 m observed for the base fuel case (fig. J-13), where the EIn at high engine powers is similar to what is at 1 and 10 m from the soot particles.

At engine powers less than 70%, the nonrefractory EIv measured by the SMPS instruments for the low sulfur fuel cases increases faster than what is measured by the AMS (fig. J-18, left plot). The AMS measures a small, and increasing, fraction of nonrefractory mass in the nucleation/growth mode, but the comparison indicates that the AMS is unable to measure most of the particulate mass in the nucleation/growth mode due to the small size of these particles. The AMS qualitatively observes more organic material in the nucleation/growth modes at low engine powers than sulfate.

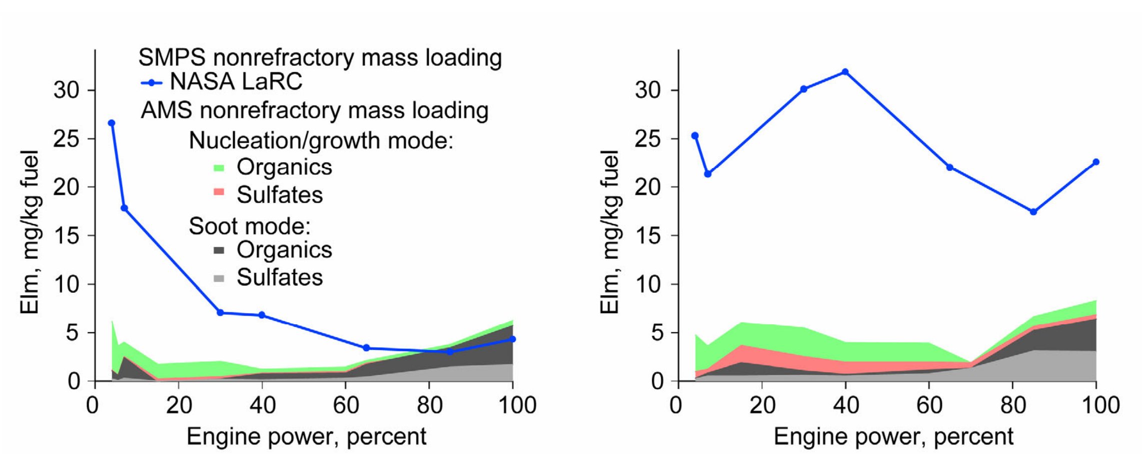

Figure J–18.—The left plot shows a comparison between the AMS measured nonrefractory EIm and the SMPS measured EIv averaged for the low sulfur fuel cases (base and high aromatic fuels). The right plot shows the same for the high sulfur fuel case. The grey (black) is the sulfate (orgnics) condensed on the soot mode, the red (green) is the sulfate (organics) measured by the AMS in the nucleation/growth mode, and the blue lines are the EIv derived from the difference between the heated and unheated SMPS scans.

The amount of sulfate present in the exhaust is presumed to be due to fuel sulfur content and combustor exhaust (post combustor, but prior to engine exit plane) radical chemistry that converts SO_2 into SO_3 and H_2SO_4 molecules. The H_2SO_4 molecules condense onto pre-existing aerosol surfaces or nucleate new particles directly from the gas phase as the exhaust cools after passing the engine exit plane. Observations during APEX suggest that it requires at least ~10 m to condense and grow into ~10 nm diameter particles or greater. The SO_3 can react rapidly with water after exiting the engine exit plane, converting more sulfur to sulfate. After passing the engine exit plane, gaseous SO_2 oxidation is not believed to be fast enough to matter on the time scales of the APEX study. The average sulfate measured by the AMS under high engine power conditions and condensed on the soot mode indicates that the amount of EIm sulfate generated from the low sulfur fuel cases is ~1.5 mg/kg fuel. If this holds true for the low engine power settings, this suggests that most of the nonrefractory composition at low engine powers is composed of organic compounds. This increase in nonrefractory particulate organic composition may be correlated with the presence of higher volatile organic compounds (VOCs) observed in the gas phase at low engine power conditions [*Knighton et al.*, 2006].

Figure J-18 (right) also shows the AMS and SMPS measurements for nonrefractory particulate emission index (EIm and EIv) for the high sulfur fuel case. The comparison between low and high fuel sulfur contents is dramatic. The organic EIm measured by the AMS at high engine powers is similar, however, the sulfate mass on the soot mode is greater. More dramatic is the increase in the total nonrefractory EIv measured by the SMPS for all engine powers. Since the AMS should quantitatively measure the amount of condensed matter on the soot mode, the discrepancy between the AMS and SMPS measurements in the high sulfur fuel implies that there is significantly more mass present in the nucleation/growth mode for all engine power conditions. If this were true, then there must be more particles observed in the high sulfur fuel case, compared to the low sulfur fuel cases. Indeed, a comparison between the EIn measured at the 30 m probe in figure J-15 for high engine powers is greater than the EIn measured for the base fuel case (fig. J-13).

The AMS shows that the nucleation/growth mode contains both sulfate and organic mass for all fuels, with the possible exception of the base fuel case which has the lowest fuel sulfur content. Figure J-18 shows that for fuel with high sulfur content, the nonrefractory composition is strongly influenced by the increase in sulfate present. In the case (more typical of aircraft fuels used for commercial flights) of lower sulfur fuels, the nonrefractory aerosol composition appears to be dominated by organic compounds and is significantly higher at the lower engine power conditions typically used for moving around airports.

Combining the nonrefractory and refractory EIm for the low sulfur and high sulfur fuel cases, figure J-19 shows the chemical composition of the aircraft engine exhaust as a function of engine power. The left plot shows the base fuel case. The right plot shows the high sulfur fuel case. The AMS measurements for sulfate and organics are shown in red and green, and the MAAP measurements of the black carbon soot are shown in black. These EIm measurements are directly compared with the blue line showing the EIv measurements for the unheated SMPS measurements. The red line shows the nonrefractory fraction of the total SMPS EIv. This measurement is derived from the difference between the unheated and heated (300 °C) SMPS measurements.

The dominant feature of both of these plots is the magnitude of the refractory black carbon fraction at high engine powers. The nonrefractory components (sulfate and organics) represent a significant fraction of the exhaust at low engine powers for both high and low sulfur fuel cases (50 to 80%). The bulk of the nonrefractory components at low engine powers for the low sulfur fuel case is present in the nucleation/growth mode, where the SMPS can measure, but the AMS has limited capabilities (<60 nm d_{va}). For the high sulfur fuel case, there is a significant, and nearly constant, amount of nonrefractory particulate material over a much wider range of engine powers than the low sulfur fuel cases. Again, most of this nonrefractory particulate material appears to reside in the nucleation/growth mode. It is important to note that the particle loss experiments indicate that the magnitude of the mass in the nucleation/growth modes may be under-represented by these uncorrected SMPS measurements by 40 to 90%.

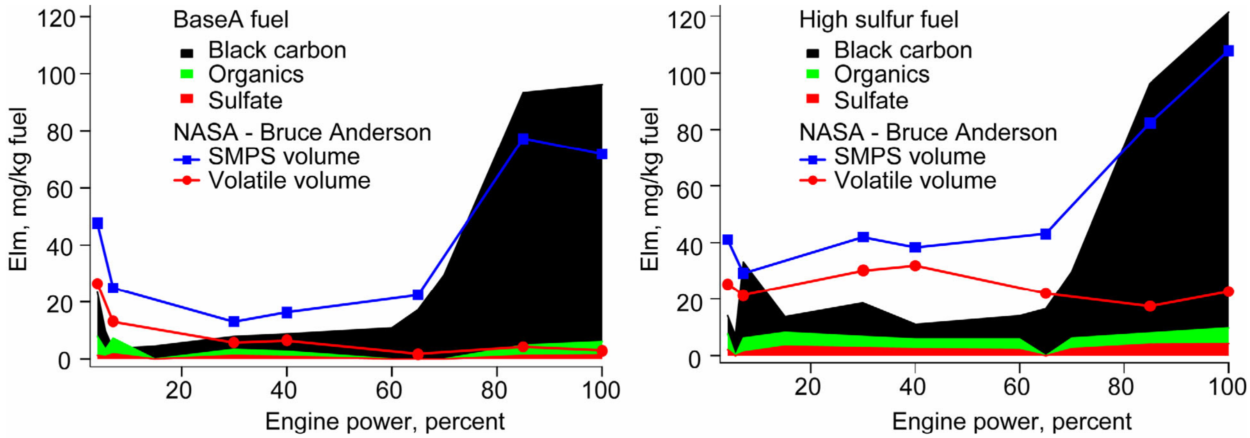

Figure J–19.—Chemical composition of the aircraft engine exhaust for the base fuel case (left plot) and the high sulfur fuel case (right plot). The black represents the black carbon EIm measured by the MAAP, the green and red represents the organics and sulfates measured by the AMS, the blue lines represent the unheated SMPS EIv, and the red lines represent the difference between the unheated and heated SMPS scans.

The results from figures 18 and 19 suggest that for low sulfur fuel, aircraft exhaust from a CFM56-2-C1 engine are dominated by black carbon soot at high engine powers and nucleating organic nonrefractory particulate matter at low engine powers. There is evidence for sulfate in most all modes. It is unknown if the sulfate is the sole nucleating species, or if the organic compounds can nucleate new particles without sulfate. Under high sulfur fuel cases (not typical of modern commercial fleet fuels), the refractory black carbon soot still dominates at high engine powers, but the nonrefractory component is significant over the full engine power range and larger than the low sulfur fuel case for all but the lowest engine powers. The additional nonrefractory particulate material is present in the nucleation/growth mode and contains a higher fraction of sulfate.

4. Summary

The exhaust emissions from an in-use commercial aircraft engine were characterized in April 2004 as part of Aircraft Particle Emissions eXperiment (APEX) at NASA DFRC (Edwards Air Force Base, CA). The Aerodyne Mobile Laboratory was deployed with an onboard suite of particle instruments: Aerosol Mass Spectrometer (AMS); Condensation Particle Counter (CPC); and Multi-Angle Aerosol Photometer (MAAP). The AMS measured the non-refractory PM_1 chemically-speciated and size-resolved aerosol mass. The CPC provided a particle number emission index and the MAAP provided the black carbon content. Size distribution measurements were conducted with multiple Scanning Mobility Particle Sizers (SMPS) operated by NASA and UMR.

The test aircraft was a DC-8 equipped with four CFM56-2-C1 engines and was parked on a runway pad during all of the testing. The test matrix included eleven different engine throttle levels (varying from ground idle to take-off, 4 to 93% of maximum rated thrust), three fuel compositions (nominal, high sulfur, and high aromatic), and three sampling distances behind the inboard, right side engine (1, 10, and 30 m).

At 1 m behind the engine exit plane, the aircraft exhaust contained only the primary black carbon soot particles. The black carbon soot formed a single mode that increased in volume-weighted diameter with engine power. The EIm and EIn for black carbon also increased with engine power and were observed to be independent of fuel type or probe distance. The black carbon soot particles were observed to be fractal and have similar physical properties as diesel and premixed flame soot of the same mobility diameters. The observed range in mobility diameter is much smaller for aircraft soot compared with the larger size ranges generated from diesel and premixed flames.

Down stream at 30 m, the further down stream measured during APEX, the exhaust contained three particle modes: a nucleation/growth mode, the soot mode, and an accumulation mode. The nucleation/growth mode dominated at low engine powers and consisted of nonrefractory sulfate and organic compounds. The organics were the dominate composition of this mode for low sulfur fuels. The soot mode, including condensed nonrefractory sulfate and organic compounds, dominated the emissions under high engine power conditions. The particulate emissions (refractory and nonrefractory) were minimized under throttle levels of 30 to 60%.

The aromatic content (but not the hydrogen content) of the fuel was varied and resulted in no significant changes in the organic or black carbon aerosol emissions. The sulfur content of the fuel was varied and exhibited a significant change on the particulate exhaust emissions. The high sulfur fuel exhibited a significantly larger number and mass of nonrefractory particulate material in the nucleation/growth mode compared with two other lower sulfur fuel types.

Tests conducted during and after the study indicated that the long sampling lines used for extractive sampling from the fast, hot exhaust flows caused significant particle losses, especially for smaller particles. The observations from this report are derived from uncorrected results and in most cases may be ~20 to 30% low in absolute magnitude. Significant differences between the uncorrected and actual measurements are likely to be problematic in the quantification of the nucleation/growth mode.

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Appendix K
Two Angle Ratio Light Scattering Method for Mass Concentration and Smoke Number Measurement of Black Carbon Soot Agglomerates: Measurements at APEX, 2004*

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Two Angle Ratio Light Scattering Method for Mass Concentration and Smoke Number Measurement of Black Carbon Soot Agglomerates: Measurements at APEX, 2004

1.0 Introduction

Process Metrix is pursuing development of a light scattering instrument, known as STAR (Scattering by Two Angle Ratio) for soot mass concentration measurements. This paper presents measurement results for mass concentrations 1 m downstream of the gas turbine exhaust, comparing the results with filter absorption and smoke number measurements.

The analysis used to interpret the measured scattering results is based on established theories for soot light scattering using Polydisperse Fractal Aggregate Theory, (PFA) and Rayleigh-Debye-Gans (RDG) scattering theory. We have developed this new analysis method based on the formation of aggregate soot particles from primary elemental carbon particle (typical diameter of 25 to 35nm), which have reasonably well-defined values (from the published literature) of primary particle size, density, and refractive index for elemental carbon, independent of the specific combustion process.

Using the average of the product of these literature values in the theory gives good agreement for the mass concentration for the scattering and absorption measurements. The measured smoke number (SN) values are generally less than our theory based on mass concentration. Arguments are presented suggesting that the measured SN depends on the nature of the non-uniform filter substrate and agglomerate particle size, and face velocity. More measurements are required to confirm that the traditional smoke number measurements underestimate the mass concentration.

In addition to relating all the measurements to the mass concentration, we can also compute the total number of primary particles and surface area based on the mass concentration and primary particle properties. Given the "open" fractal nature of the soot agglomerates, the majority of the primary particle surface area is accessible, similar to "independent" high concentration nucleate particles measured by mobility methods.

It is known that the population of fine nucleate particles (<30 nm) is generally 1 to 2 orders greater than that of the agglomerate particles which dominate the total mass. However, if we compute the number (on the order of 10 to 100 primary particles per agglomerate) and surface area of primary particles in the agglomerates, we find that both the number and surface area of the agglomerate primary particles are comparable to or can exceed that of nucleate particle concentrations. Even if we correct or "discount" for particle overlap within an agglomerate and lower deposition rates of larger agglomerates, the primary particle population within agglomerates should be considered as a significant factor in quantifying the total particle number population and active surface area.

If this is the case, then it is important to compare the primary particle parameters, number, surface area to mobility measurements of these parameters. For agglomerates, one can show (below) that number and surface area are essentially related through the total mass. The effect of various agglomerate diameters will change the transport and deposition by a factor of 2 to 3, but otherwise, it is preferable to think of soot particles in terms of primary particle characteristics, which do not materially change over a variety of combustion systems and conditions. The important engineering objective of this work is to develop a quantitative measurement method that relates to the classical soot measurements of total mass and smoke number, while at the same time improving measurement speed, accuracy, and ease of use.

We believe the scattering two angle ratio (STAR) method is a simple and robust technique for measuring both mean agglomerate particle size and mass concentrations in various combustion systems, including diesel and gas turbine exhausts. Currently, the STAR lower limit for accurate concentration measurements is > 100 μg/m^3, but this lower limit can be reduced to 1 μg/m^3 or lower, by using phase-locked detection. Although we need to make assumptions about the primary particle diameter, density, and agglomerate size distribution, previous work and the analysis below will show that overall determination of the size and mass concentration is relatively insensitive to typical variations in the parameter product group.

2.0 Summary of Theory for STAR

Rayleigh-Debye-Gans (RDG) theory describing light scattering by fractal aggregates has been comprehensively reviewed by Sorensen.[1] The theory has been developed for a wide range of hydrocarbon combustion systems by other workers as well, and has been shown to be applicable to laminar or turbulent flame systems in laboratories, and in high pressure systems such as diesel and gasoline engines.[2] At present, there is limited fundamental work on gas turbine soot, but measurements by the University of Minnesota and University of Missouri, Rolla show similar size distribution characteristics (Scanning Mobility Particle Sizing (SMPS) measurements) obtained from aircraft gas turbines as those obtained from diesel engines.[3,4] The main difference is that the mean size of resulting agglomerates are smaller for gas turbines compared to diesel engines and the absolute concentrations for non-volatile carbon may be a factor of 100 lower for gas turbines. This result is not entirely surprising given that the temperature-time combustion histories for gas turbine combustors and diesel engines are not vastly different. The key advantage of RDG scattering theory for soot agglomerates is that it is based on the superposition of scattering from constituent primary particles whose fundamental material properties of refractive index, size, and density are relatively invariant over a wide range of combustion conditions. From the primary particle basis, agglomerate sizes with widely varying scattering properties are formed depending on the specific temperature-time history of a combustion process. RDG theory has broad applicability and has been successfully applied to non-hydrocarbon soots, such as Silica and Titania.[5]

Combining RDG with particle fractal aggregate (PFA) theory allows one to describe the scattering from soot aggregates. The process of soot formation is based on nuclei formation and growth of nearly spherical primary particles through coagulation to a value that experimentally has been shown to vary over a rather narrow range. Typical mean values of the primary particle diameter, d_p, range from 25 to 35 nm, and with a narrow distribution width for a variety of materials and combustion conditions. Theoretical analyses have tended to corroborate this result, showing that coagulation followed by aggregation generates particles of constant primary particle size.[6]

The derivation of the following equation is developed separately,[7] but the mass C_m, or volume f_v, concentration of soot is given by:

$$f_v = C_m/\rho_p = \{(4\lambda^2/3\pi^3 L d_p)(P_{T\theta} / [P_l\,(f(\underline{m})(1+\cos^2\theta)]\ \Omega\ \}\ C_m\# \qquad (1)$$

where

ρ_p (g/cm^3)	=	primary particle density,
λ (cm)	=	illumination wavelength.
L (cm)	=	Sample volume length
d_p (cm)	=	primary particle diameter
$P_{T\theta}$ (watts)	=	total measured scattering signal at a given angle θ.
P_l (watts)	=	laser power
$f(\underline{m})$	=	$\lvert(\underline{m}^2-1)/(\underline{m}^2+2)\rvert^2$ = scattering refractive index function
$\underline{m}$	=	complex refractive index of primary particle
θ	=	scattering angle of a given detector
Ω (Sr)	=	receiver lens aperture for scattered light
$C_m\#$	=	non-dimensional scattering number.

We have derived and defined the $C_m\#$**,** which is a function only of the mean mobility diameter and specified fractal dimensions as:

$$C_m\# = \{(M_1/M_{2\theta})/[(d_p/\lambda)^{2-Df} k_o(d_{mo}/\lambda)^{Df} S(qd_{mo})\} \quad (2)$$

where,

d_{mo} (cm)	=	volume mean mobility diameter of agglomerate
D_f	=	fractal dimension, 2.27 and 1.8
k_o	=	scattering constant = 1 for D_f = 2.27, and = 1.4 for D_f = 1.8.
$S(qd_m)$	=	structure factor correcting for interactions of primary particles in agglomerate soot particle.
q	=	$(4\pi d_m/\lambda)\sin^2(\theta/2)$ = scattering wave vector at scattering angle, θ
$M_1/M_{2\theta}$	=	ratio of mass and scattering moments at a given scattering angle, dependent on the agglomerate size distribution and fractal dimensions.

The primary reason for arranging the mass concentration expression in this form is to derive a direct expression for the C_m# in terms of the mobility diameter, which in turn is a function only of the measured scattering ratio, $R_{90/30}$, where 90° and 30° are the two angles chosen for the STAR instrument. The C_m# can be evaluated for any choice of scattering angles, fractal dimensions, and agglomerate size distributions. We have shown that evaluation of the C_m# is insensitive to the range of typical fractal dimensions and size distributions measured in a variety of combustion systems.[7] Using typical values for the fractal dimensions and distribution widths of soot agglomerates for 90° and 30° scattering angles used in STAR, the curve fit for this function is:

$$C_m\# = 336194\,(R_{90/30})^6 - 563403\,(R_{90/30})^5 + 375917\,(R_{90/30})^4 - 125768\,(R_{90/30})^3 + 22393\,(R_{90/30})^2 - 2002.5\,(R_{90/30}) + 87.09 \quad (3)$$

The second primary relationship is the scattering ratio for the two detectors. Ratioing equation 1 in terms of the scattering at 90° and 30°, all terms except those explicitly dependent on the scattering angle divide out to give and implicit solution for the mean volume mobility diameter, d_{mo} :

$$R_{90/30} = P_{T90}/P_{T30} = \{S_{90}(q_{90}\, d_{mo})\, M_{2,90}\, (1+\cos^2 90)\}\ \{S_{30}(q_{30}\, d_{mo})\, M_{2,30}\, (1+\cos^2 30)\} \quad (4)$$

An explicit solution for the mean volume mobility diameter for particles less than 300 nm is given by the curve fit relation:

$$d_{mo} = 830\exp(-5.3\, R_{90/30}). \quad (5\ )$$

We have shown that the scattering model based on RDG theory agrees with a porous sphere coupled dipole scattering model, with agreement better than 10% for soot mobility diameters up to 350 nm at 90° and 30° scattering angles.[7] Above this diameter, Mie Scattering assumes a "hard" edge for the sphere which is not physically true, and thus overestimates agglomerate scattering interference. Thus RDG provides a more accurate estimate of the superposition of scattering from the agglomerate primary particles, and gives an explicit *sensitivity analysis* to uncertainties in the primary particle size, density, refractive index, and agglomerate parameters, diameter, fractal dimension, and size distribution.

2.1 Overall Measurement Uncertainty

Table K-1. summarizes the standard instrument parameters, and accuracy and precision uncertainty estimates for $\mathbf{C_m}$**.**

TABLE K-1.—STAR PARAMETERS, INSTRUMENT VALUES, AND ESTIMATED MASS CONCENTRATION UNCERTAINTY AS A FUNCTION OF INPUT PARAMETERS AND MEASURABLES.

Parameter	Instrument values	Accuracy %	Precision %
P_t	watts	5	5
P_l	watts	3	3
$R_{90/30}$	-	5	5
$\rho_p/f(\underline{m})$	6.56 gm/cm^3	15	0
Θ	90 deg	5	0
Ω	0.268 Sr		0
d_p	35 nm	15	0
Λ	670 nm	0	0
L	0.95 cm	4	0
C_m#	-	15	12
	Total C_m uncertainty	±28%	±14%

The largest contributors to absolute accuracy are the uncertainties in refractive index and primary particle size. Even if we could measure the primary particle size to ±5%, we would only reduce the overall C_m uncertainty by 4% to ±24%. Experimental measurement uncertainties add only 1% to the overall uncertainty. The primary experimental uncertainty in the C_m# propagates through the measurement of $R_{90/30}$ and ranges from 5% for large particles to 12% at $R_{90/30} = 0.5$, increasing further at higher ratios. This effectively defines the lower size limit of feasible measurements with STAR, i.e., for soot particles with volume mean mobility diameters above 60nm, which corresponds to a number mean lower limit of 25 nm.

In addition to primary particle properties, we have the uncertainties of the fractal dimension, D_f and distribution width, σ in defining the C_m#. Variations in the distribution width tend to cancel out in the ratio of the moment functions. Similarly, variations in the power D_f also tend to divide out dimensionally in the C_m#. Overall, variations in D_f = of ±7% give less than ±10% variation in the computed C_m#. This is one of the most useful features of the C_m# analysis, showing that uncertainties in the parameters σ and D_f tend to cancel out, reducing sensitivity to their precise measurement. For specific types of combustion systems, the variance in σ and D_f may be even less. Similarly, it is likely that the primary particle size variance for a given combustion device is less than the range of measured values measured over a wide range of flames and engines.

The accuracy of the mobility diameter, d_{mo}, measurement is similar to that of the C_m#, with the uncertainty varying from 5% at large particles (< 400 nm) and increasing to 12% at 60 nm. The underlying accuracy of the theory is primarily based on the structure function, which is estimated to be on the order of 10%. Thus the overall uncertainty of the size measurement is ±10 to 15%, increasing for smaller particles.

In summary, table K-1 provides a framework to test the validity of the STAR method as we perform additional experimental measurements. This analysis clearly points to the need for a definitive resolution of the large discrepancy in the value of k_o reported in the literature. Evaluation of the refractive index for combustion soots combined with density would also lead to more accurate measurements, but the apparent uncertainty for scattering measurements is less than previously assumed because we use the ratio $f(\underline{m})/\rho_p$ to compute the mass concentration rather than the volume fraction.

Although the primary particle diameter, d_p must be assumed for low concentration applications where extinction measurements are infeasible, there are many results showing that the variance of d_p is small. Indeed, the basic optical and physical properties of primary particles appear as a product, $[\rho_p/(d_p f(\underline{m}))]$ in equation 1. We have reasoned that the variance of the ratio $f(\underline{m})/\rho_p$ (proportional to $\rho_p^{0.9}$) is less than the individual measured variances of each parameter. Similarly, there is evidence that larger primary particles have lower densities, particularly in cases where there is condensation of lighter hydrocarbons during post-combustion mixing with ambient air.[8] In other words, the variance of the product $[\rho_p/(d_p f(\underline{m}))$ 90°

and 30° is less than the independent measured variances for each of the primary particle parameters, because all three parameters have not been measured simultaneously This is a conjecture that will be tested as we obtain additional measurements with STAR for Gas Turbines and Diesel engines. In table K-1, we have conservatively assumed that $f(\underline{m})/\rho_p$ is not correlated with d_p.

The value of this sensitivity analysis has been two-fold. First, determination of the absolute value of scattering using literature values of refractive index is probably within ±28% of the true value. Determination of a more accurate value requires detailed mass comparisons with filter measurements, although one needs to be mindful of intrinsic errors in gravimetric measurements. Of equal importance, the analytical RDG theory shows that sensitivity to variations in the fundamental primary particle parameters are relatively minor and may offset. Similarly, variation with changes in the fractal dimension and particle distribution width tend to cancel out.

Some researchers have used values of constant average density to convert mobility measurements of particle volume to an equivalent mass measurement. This is not desirable or necessary, and there is sufficient evidence now to use PFA to define the density distribution and integrate it with SMPS measurements.

3.0 Gas Turbine Measurements with STAR

Figure K-1 shows the general optical layout for a two-angle scattering geometry. For the agglomerate size range of interest in gas turbines and diesel engines, we have used light collection angles of 90° and 30°, which have an optimal size range of 50 – 400 nm. Use of a smaller near-forward angle would provide somewhat more sensitivity for larger particles, but for large particles, the C_m# becomes a constant, so there is minimal benefit. Currently we are using compact Hammamatsu R-7400U photo-multipliers for both detectors with large aperture (0.268 Sr) receiver lenses masked by 1 mm wide slits, with aperture length of 0.95 cm. Depending on the needs of the application, these can be replaced with solid state diodes for low speed measurements (<100 hz). Increased sensitivity at low concentrations (1 μg/m^3) can be obtained by using phase-lock detection methods. Currently, background stray light drift dictates the ultimate low limit of sensitivity and accuracy (>100 μg/m^3). Figure K-2 shows a sectional drawing of the instrument layout.

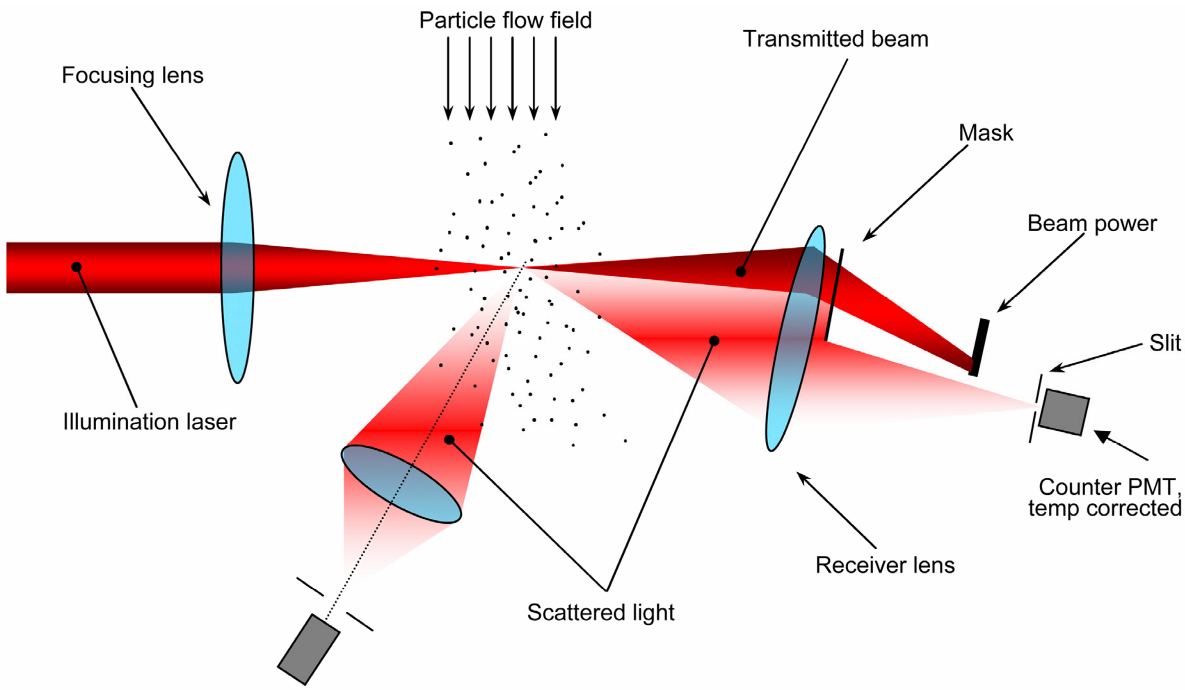

Figure K–1.—Schematic drawing of optical configuration for STAR.

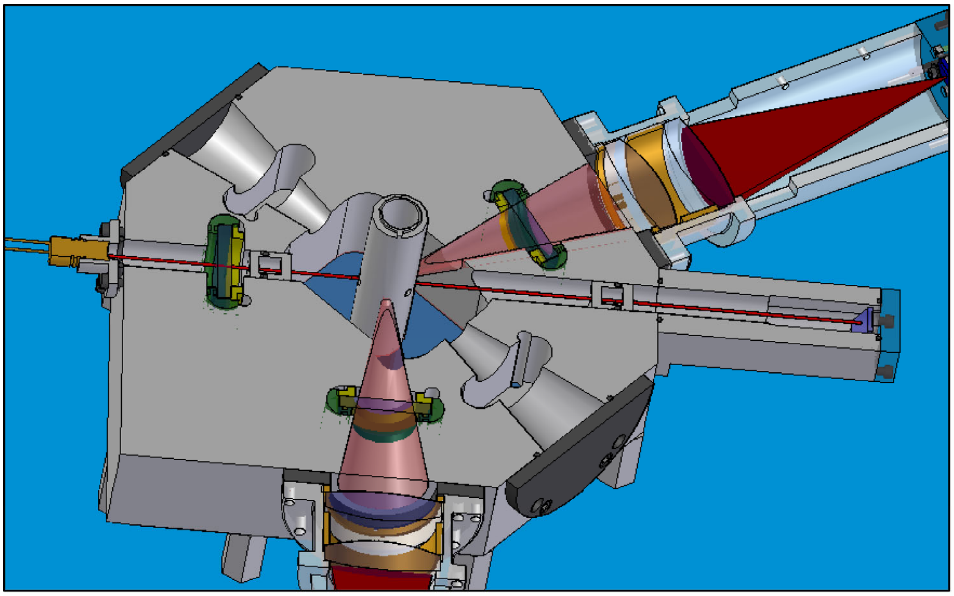

Figure K–2.—Design layout of STAR instrument, showing vertical sample flowpath, and optical layout with option for 3rd detector.

The detectors are calibrated directly in terms of responsivity (volts/watt) by using a reference light pulser, (BNC 6010). The output of a CW single mode fiber is measured by a calibrated Newport power meter (model 1815-C), and then the fiber tip is traversed through the sample volume using micrometer-controlled stages to map out the light collection and absolute response for each receiver/detector. The ratio of the response for both detectors has been separately verified by flowing Propane through the sample volume and measuring the Rayleigh scattering from both detectors simultaneously. This method eliminates any alignment errors in determination of the sample volume, detector apertures, and relative responsivity, and confirms the accuracy of the detailed optical fiber measurements within ±5%. We have verified the stability of the detector responsivity (±5%) before and after each series of measurements.

We used a prototype STAR instrument to acquire approximately 500 measurements (manual 5 s averages for each) at the exit (fig. K-3) of a CFM56-2 engine during the weeklong NASA APEX tests.[9] STAR measurements were obtained over a range of power settings from idle to full power, and were taken at the engine centerline, 1 m from the engine exit, with a water-cooled sampling rake system. Thirty m long sample lines (heated to approximately 100 °C) with a residence time of 1 to 2 s were used to transport sampled gas to the STAR and other APEX instruments. Three basic fuels were tested:

1. Base Fuel – JP8, with 383 ppm sulfur, 17.6% aromatics,
2. High Sulfur Fuel – doped base fuel with 1595 ppm sulfur, 17.3% aromatics,
3. High Aromatic Fuel - Jet A with 530 ppm sulfur, 21.6% aromatics.

Measurement times were approximately 4 min for each fuel and power condition, (11 discrete values), except for 1.5 min at the 100% thrust condition.

Figure K-4 shows the temporal sequence of measurements over the range of fuels and power settings. Each data point is an average of 3-5 STAR measurements at a given run condition. The error bars represent the actual measurement variance within a run condition, with an average measured value for the standard deviation of ±20% for concentrations above 100 $\mu g/m^3$. Note that the variance over different runs at the nominal same power settings have a wider variance on the order of 35%. This is shown as an average over all conditions for each fuel in figure K-5. This graph shows a sharp increase in emissions concentration for power levels greater than 60 to 65%, which corresponds to cruise conditions. Secondly, these results show minimal effects (within measurement error) of various fuel types on the resulting particle emissions.

Figure K–3.—Photograph of CFM56–2 engine and sample rake at NASA APEX. All STAR measurements were taken at engine centerline, 1 meter from engine exit with water cooled sampling rake system. Thirty meter long sample lines to the STAR instrument were heated to approximately 90 °C.

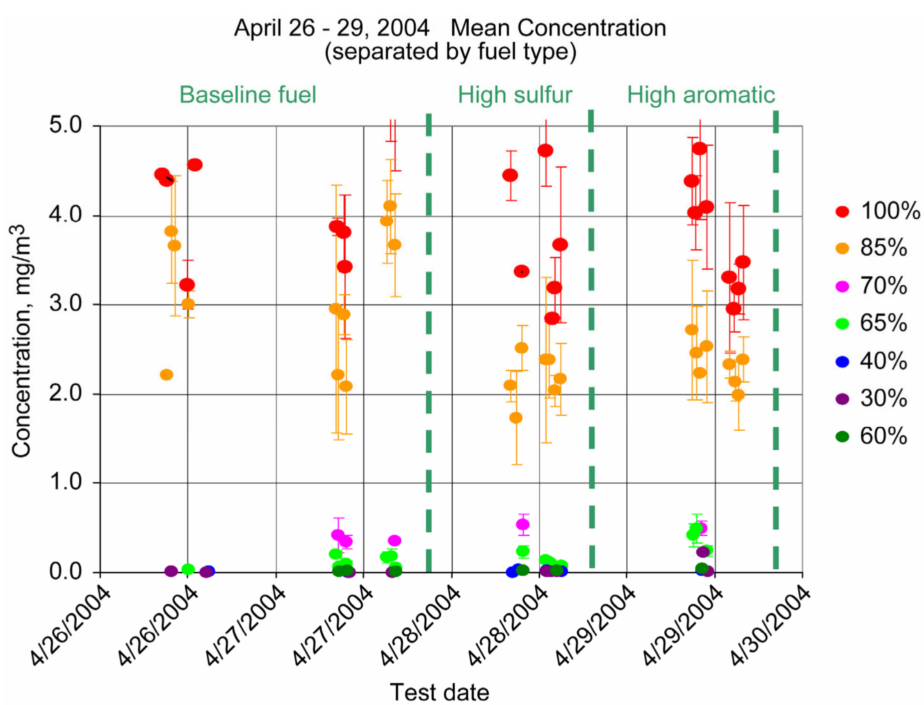

Figure K–4.—Temporal sequence of measurements (at T_m = 90 °C) over range of fuels and power settings. Each data point is an average of 3-5 STAR measurements at a given run condition. The error bars represent the actual measurement variance within a run.

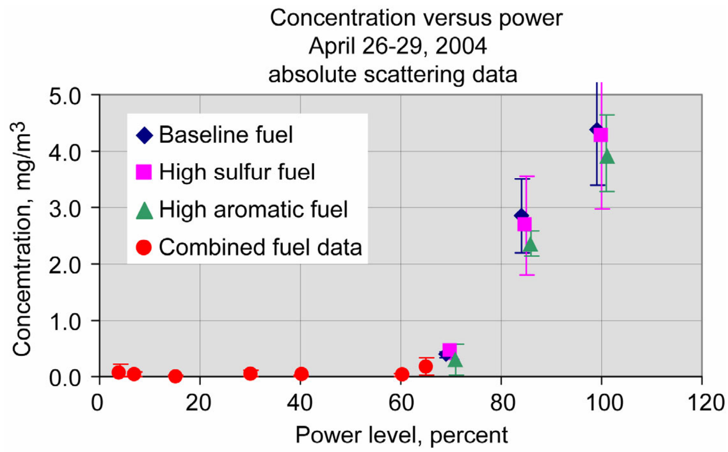

Figure K–5.—Mean values of mass concentration for each fuel at T_m (90 °C) averaged over all run conditions at a given power setting.

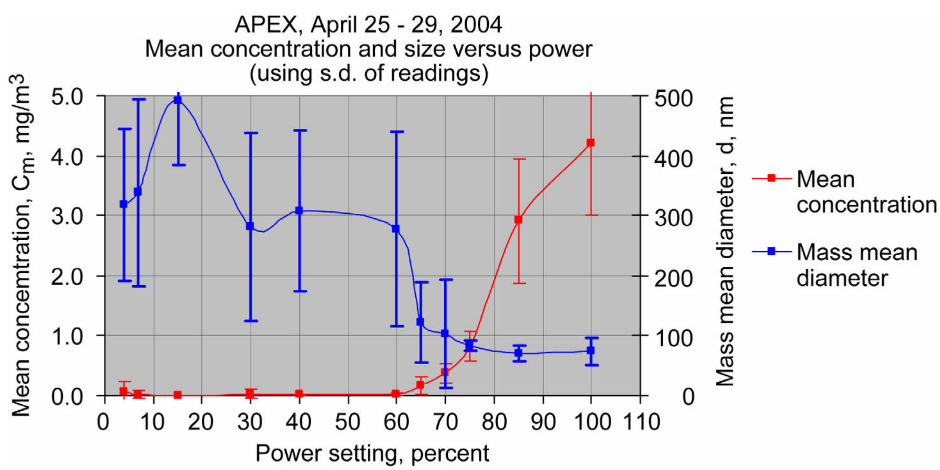

Figure K–6.—Values of mass concentrations and volume mean mobility equivalent diameters at T_m (90 °C), averaged over all fuels and repeat runs, as a function of the engine power levels.

Figure K-6 shows values of mass concentrations and volume mean mobility equivalent diameters at T_m = 90C, averaged over all fuels and repeat runs, as a function of the engine power levels. The mobility volume diameters for power settings above 65% approach a uniform value of 70 to 110 nm. Consistent with low signal levels for power levels below 65%, we find large % uncertainties for both the mobility diameters and concentration measurements at the lower power levels.

To compare results at various axial conditions among researchers, we convert the mass concentration measurements to values of emission index, EI, defined by the emissions rate (mg-soot per kg-fuel). The emissions index is normalized by the local CO_2 concentration referenced to Normal Temperature/Pressure (NTP), and is given by:

$$\text{EI (mg-soot)/kg-fuel} = 1.6\,[C_m/\chi_{CO2}]\,(T_m/293\text{K}), \quad (6)$$

where χ_{CO2} is the local CO_2 mole fraction, and T_m is the measured sample temperature at the STAR instrument. The CO_2 concentrations were measured by other APEX researchers,[9] varying from 23,000 ppm at idle to 43,000 ppm at 100% power with a standard deviation of ±10%. We used an average correlation to specify χ_{CO2} as a function of the power setting.

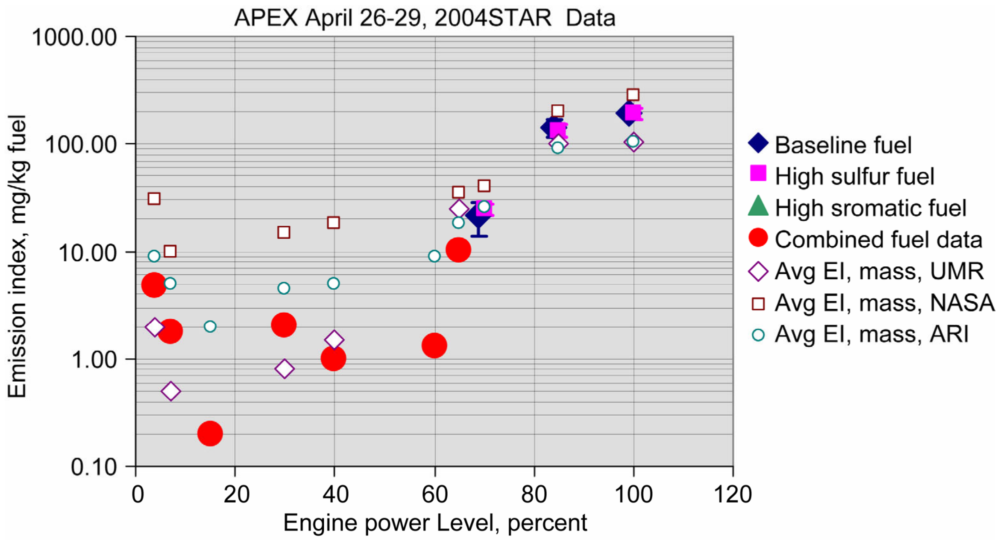

Figure K–7.—Values of the STAR mass emissions index for the APEX experiments[10]. Results compared with black carbon filter absorption instruments[11,13], and mobility[12] with assumed constant density = 1 gm/cm^3.

Figure K-7 shows the average measured results obtained by STAR compared with filter absorption and mobility size distribution measurements during the APEX tests.[9-13] All mass concentration measurements have been converted to Emission Index (EI) values (mg-soot/kg-fuel) and include comparisons with filter absorption, and mobility measurements using an average agglomerate density value of 1 g/cm^3. The STAR results are bracketed by the three other measurement results. As expected, the measurement accuracy for STAR is poor below concentrations of 100 μg/m^3 (EI < 5), because of measurement accuracy limitations described above. However, there is a great deal of scatter for all methods at low emissions levels.

For the high power setting measurements, the volume mean diameters for STAR (70 to 110 nm) are comparable to the volume mean diameters measured by mobility (60 to 110 nm). STAR measurements at lower concentrations are not sufficiently accurate to provide a useful measurement of size or concentration. If we use the known sizes from mobility, the mass concentration measurements of STAR would be increased by factors of 5-10, which would be consistent with filter absorption measurements. The current design objectives for STAR are for concentration measurements above 100 μg/m^3, directly in the engine exhaust.

3.2 Tradeoffs in filter absorption vs. scattering:

Filter absorption techniques are able to give the total mass concentration of soot independent of the primary particle size for Rayleigh scatterers, i.e., particles less than 100 nm, (which is clearly satisfied for primary particles). For scattering measurements, there is an agglomerate structure correction which becomes important for larger agglomerates, whereas the model for absorption is based only on the refractive index and total mass. Using Maxwell-Garnet theory relating the refractive index to particle density, one can show that the ratio of $E(\underline{m})/\rho_p$ is essentially constant and gives a value of $\sigma_a = 5.0$ m^2/g, using the same refractive index as we have used for our evaluation of $f(\underline{m})/\rho_p$ for scattering, (app. A). This calculated value for σ_a is within 20% of the actual value used to interpret the filter absorption measurements, and one could argue that the filter absorption values of C_m should be corrected 20% upwards to be consistent with the maximum refractive index possible for EC. At the same time, this correction would not materially change the level of agreement between all measurement methods. The STAR results showed good agreement over repeat measurements on separate days, and no significant differences for the various doped fuels.

For quantitative determination of C_m from scattering, one needs to know the mean soot agglomerate diameter, determined from the scattering angle ratio. From the point of view of particle transport, one also needs to know the mean agglomerate diameter. Therefore gas phase scattering provides two significant pieces of information, not just total mass concentration. The uncertainty in scattering to the refractive index is comparable to that for absorption, while there is an additional uncertainty because the primary particle diameter must also be specified or measured. However, filter absorption methods suffer from the variable particle/filter scattering interactions which need to be corrected. Overall, we conclude that the accuracy and precision of both optical methods are comparable.

3.3 Calculation of Primary Particle Number and Surface Area from C_m

It has been conjectured that the particle number or possibly surface area is as important or more so than the total particle mass in correlating health effects. Because of the fractal structure of the agglomerates, we assume that the reduced surface area due to "necking" contact is negligible, and that the majority of each primary particle is exposed to the environment. Kazakov and Frenklach make this assumption in their calculations[6] supported by Rosner and Tandon,[14] who show that diffusion limitations through the aggregate are negligible. Although transport of the agglomerate will differ from individual primary particles, we propose that it is appropriate to count the total number and surface area of primary particles in the agglomerates when totaling the particle number. Mobility measurements count agglomerates as one particle, and thus underestimate the contribution of primary particles tied up in particles larger than the nominal primary particle size.

Calculating the total number of primary particles in agglomerates is straightforward, namely:

$$N_{pt} = C_m/m_p = 6C_m/(\pi \rho_p d_p^3) \quad (7)$$

Using the relation for C_m, the number is inversely proportional to d_p^{6-Df}, or approximately the 4th power. Figure K-8 shows a newly-defined 'primary particle number' emission index for STAR obtained during the APEX measurements.[10] These results are compared with Scanning Mobility Particle Size (SMPS) measurement by other researchers[11-13] taken at the same location 1 m downstream of the exhaust exit. Note that for high power settings above 65% the primary particle number exceeds that of the particle distributions measured by the mobility instruments. STAR always underestimates the total particle count, because RDG scattering theory ignores the contribution of particles smaller than the primary particle size. Figure K-8 clearly shows that the contributions of large agglomerates to the total number count should

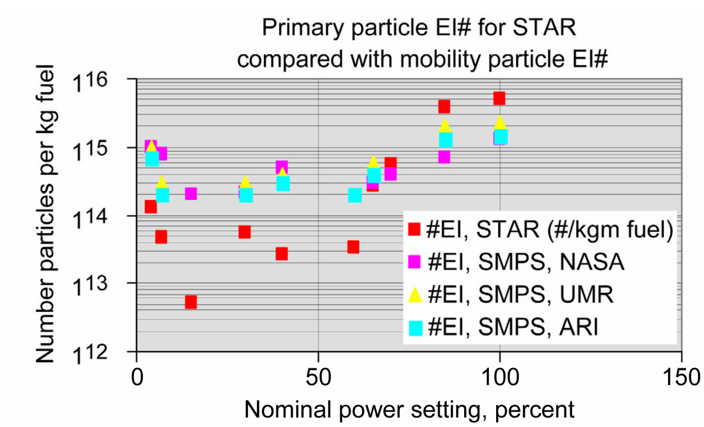

Figure K–8.—Primary particle number emissions index for the APEX STAR measurements, using updated parameters for RDG scattering theory[10]. Results are compared with UMR, ARI, and NASA SMPS #EI[11–13]. Results are averaged for all fuels.

not be ignored. Below concentrations of 100 μg/m^3, STAR clearly underestimates the particle count because of inaccuracies in the size measurement contribution to the mass measurement described above, and also because the volume mean sizes of the distribution are smaller than the primary particle size. The total particle projected surface area is given by:

$$A_{pt} = N_{pt}\, \pi d_p^2/4 = 3C_m/(2\rho_p d_p) \quad (8)$$

and is inversely proportional to d_p^{4-Df}, or approximately the 2nd power of primary particle diameter. Total surface area will be a factor of four times the surface area. For agglomerates, there is some primary particle overlap, but we can develop a good estimate for surface area based on the following analysis of smoke number, which intrinsically measures the "non-overlapped agglomerate" projected surface area. As we show below, the overlap fraction is less than 35%.

4.0 Relationship of Mass Concentration to Smoke Number

We have also developed a theory that relates smoke number to mass concentration, which accounts for the transparency of primary soot particles, and particle overlap of agglomerates along with internal primary particle overlap within an agglomerate.[7,15,16] Our analysis gives the following expression for the smoke number:

$$SN = 26.1\, \eta_p\, \eta_e\, C_m / (1 + 0.16\, \eta_p\, C_m) \quad (9)$$

For this equation, the units are mg/m^3 for C_m and % units for SN. The quantity η_p is the efficiency of particle overlap within an agglomerate, and for the range of typical soots η_p ranges from 0.67 to 0.79 for d_m = 75 to 800 nm, giving an average value of 0.73 ± 8%.

Although we have accounted for particle overlap of primary particles and agglomerates, we also need to determine the degree of light absorption and reflection to determine the light extinction efficiency parameters $\eta_p\eta_e$. The standard theory for smoke number[17] assumes that light absorption is 100% for any filter surface area coverage, i.e., any surface area covered by a soot particle extinguishes 100% of the reflected light. However, a simple estimate of the incident light absorbed by a single layer of primary particles using the extinction coefficient defined in appendix C, shows that > 85% of the light is transmitted through a primary particle of thickness equal to the diameter in the range of 25 to 35 nm. The assumption of complete extinction for a soot particle is thus entirely incorrect! Using this value for primary particle light extinction, and accounting for primary particle overlap and reflection within an agglomerate, we obtain an estimate of the overall average value for the total light extinction efficiency of an agglomerate, $\eta_e\eta_p$ = 0.22 ± 10%, a constant for agglomerate sizes of interest.[7]

Equation 9 is shown plotted in figure K-9 below for a typical range of efficiency parameters estimated above. There is minimal variation of the calculated smoke number within the range of the estimated efficiency parameters. Comparison smoke number Measurements have been taken at APEX[10] and AEDC.[15]

The key difference from the conventional assumption of 100% extinction for surface area coverage is that the layer thickness of particle coverage (for low smoke numbers <30) is on the order of the primary particle diameter, not the agglomerate diameters (>100 nm), which would give higher extinctions, but still less than 100%. Secondly, the actual filter is rather porous, and it appears that smaller agglomerates can be "pulled" further into the filter mat. Filter penetration is not necessarily a problem for filter absorption measurements because the only requirement is that the filter have a high collection efficiency to measure total light absorption, even if the collection is below the top surface. However, if particles are trapped below more reflective top surface fibers in the smoke number filter, this could reduce the reflectivity extinction, giving smaller values of the measured smoke number. Jalbert, and Zaccardi observed a decrease in measured SN with an increase in "filter face velocity",[18] which would be consistent with the conjecture above.

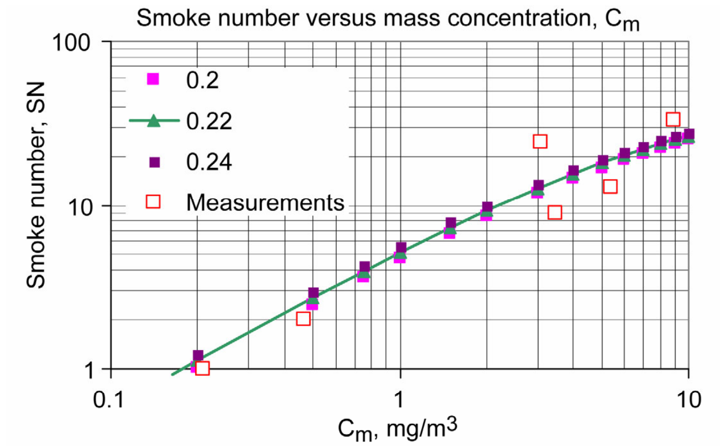

Figure K–9.—Smoke Number, SN, as a function of C_m (mg/m3), primary particle efficiencies, and primary particle extinction estimates, where legend numbers refer to the extinction efficiency $\eta_p\eta_e$. Measurements have been taken at APEX[10] and AEDC[15].

Equation 9 accounts for primary particle and agglomerate overlap, and reduced extinction for single and double layer primary particles, which seems to provide a reasonable comparison with the measured smoke numbers. It is clear that the estimate of $\eta_p\eta_e$ (which is only 22% extinction efficiency) is the most important factor in attaining the level of agreement shown. The degree of agglomerate overlap is relatively minor.

The measured smoke numbers that fall below eq. 9 are all small particles (<100 nm), while the two points above are in the range of 200 to 300 nm). In general we expect that smaller agglomerates will tend to give lower values of measured SN than given by equation 9, which does not account for deposition and trapping of particles below the filter surface layer.

Further work will be required to confirm dependence of measured smoke number on soot agglomerate diameter in addition to the estimated primary particle overlap and reduced extinction of reflected light. If this size effect is true, then the smoke number measurement underestimates the mass concentration emissions, and gives progressively lower values for smaller agglomerates. In this sense, the smoke number is less quantitative than absorption or scattering measurements because SN depends on the filter surface characteristics and interaction with agglomerate size, making it difficult to interpret a quantitative mass concentration from smoke numbers.

5.0 Primary Particle Number, Effective Surface Area, and Particle Transport for Agglomerates

We have shown that there is some particle overlap, and thus not all the particle number or surface area will contact the ultimate deposit surface area. Therefore, comparison of the number of primary particles in the mass agglomerates to nucleate particle (<30 nm) populations should probably be partially discounted by the overlap factor described above. In addition, the relative transport and deposition efficiency of independent small particles (<30 nm), is approximately two-three times greater than for agglomerates in the size range of 100 to 500 nm as shown by the schematic figure K-10.[19] Thus the agglomerate number of primary particles should probably be discounted by a factor of two- three relative to independent fine particle count, when we assess respiratory particle deposition in the lower lung. Despite this transport factor discounting, the APEX measurements at the higher power settings of figure K-8 show that the agglomerate primary particle number and certainly the particle surface area will exceed that of the smaller “individual” particles measured by mobility.

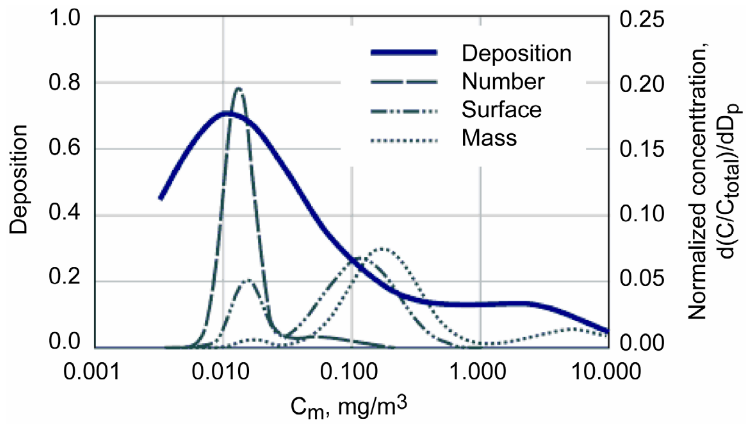

Figure K–10.—Respiratory deposition of particulates from diesel net[15].

6.0 Conclusions

Absorption and scattering measurements of the mass concentration can be reconciled quantitatively, deriving algebraic relationships based on the fundamental primary particle properties of refractive index, density and diameter. We have developed direct analytical expressions for the mass concentration (eqs. 1,2,3), and mean mobility size (eqs. 4,5) in terms of the measured scattering powers at 90° and 30°. This formulation shows minimal sensitivity to the potential range of agglomerate distribution widths and fractal dimensions. Overall accuracy and precision estimates for the mass concentration are ±28% and ±14% respectively. Using mean literature values of the optical properties for soot, we found agreement with STAR measurements (for concentrations above 100 μg/m^3) compared to filter absorption measurements obtained during the NASA APEX experiments. No empirical corrections to the STAR theory were used.

Scattering measurements can provide additional information on the agglomerate diameter, and can also be performed in situ, which allows minimization of sample line losses. Absorption measurements are intrinsically simpler and are theoretically less dependent on optical properties and primary particle size, although questions remain as to the true value of the absorption coefficient for particles embedded in a filter substrate. Absorption also has the practical advantage of being normalized, ratioing out variations in laser power and detector gains. These can be addressed in a scattering technique, but require additional referencing electronics.

Although we can give a reasonable rationale for interpreting Smoke Number measurements in terms of mass concentration, the interpretation is inherently more uncertain, and could be dependent on the interaction between the SAE smoke number filter surface, face velocity, and agglomerate size.

Overall, this note derives a coherent picture that connects the 3 major methods of optical measurement of soot concentrations through PFA and RDG scattering theories. Using the primary particle size as the essential building block, one can then relate primary particle number and surface area to the total mass concentration of black carbon. Although the PFA and RDG theories have not been validated by detailed experimental measurements in gas turbines, the fundamental relations have been validated in a variety of research flames, and in diesel engines, which have similar temperature-time histories. The end result comparisons with filter absorption measurements confirm that the analysis based on PFA and RDG is valid for gas turbines as well.

Appendix: Extinction Measurements

Filter Absorption (FA) measurements (Aethelometer and MAAP for black carbon) provide another optical method for measuring soot concentrations. The FA approach is relatively simple and an attractive method for quasi-real-time mass sampling measurements. The STAR method, however, has the advantage of obtaining real-time mean agglomerate size measurements, and can also be configured for in situ measurements. Similar to STAR, one of the key instrument parameters is the specification of the light absorption coefficient. Again, a range of values are given in the literature, although a more limited set has been recommended, ranging from $\sigma_e = 6.1 - 8.3$ m^2/gm.[20,21] To compare scattering results with absorption on an equal basis, it would be useful to know the refractive index on which this empirical value is based. From RDG theory there is a simple relationship for the absorption coefficient,

$$\sigma_a = 6\pi E(m)/\rho_p\lambda \qquad \text{(A1)}$$

The extinction coefficient is given by,

$$\sigma_e = \sigma_a/(1-\rho_{se}), \qquad \text{(A2)}$$

where the scattering/extinction ratio (albedo) $\boldsymbol{\rho_{se}}$ is approximately constant in the range of 0.2 to 0.25.[22] For filter absorption measurements, the mass concentration is given by:

$$C_m = A_f/(\sigma_e V_s)(-\ln(I/I_o)), \qquad \text{(A3)}$$

where,

A_f	=	collection filter area (cm^2)
V_s	=	gas sample volume (cm^3)
I/I_o	=	light transmittance through sample.

Elemental carbon has a maximum particle density of 2.0 gm/cm^3, so this places an upper bound on primary particle soot density. Recent measurements by Park[2] indicate that the primary particle soot density is on the order of 1.7 gm/cm^3, although it is unclear whether this is elemental carbon. Most probable values of E(m) (from Sorensen[1]) indicate E(m) is in the range of 0.25 to 0.36. The laser wavelength used for the Multi-angle absorption photometer, (MAAP) manufactured by Thermo Electron is $\lambda = .67$ μm. For the APEX experiment, Aerodyne and NASA Lewis researchers used an attenuation coefficient of 6.1 m^2/g, which empirically accounts for non-ideal scattering/attenuation effects from the filter itself along with unknown absorption and scattering properties of atmospheric or spark discharged black carbon.[20]

We do not know which density is associated with a given refractive index, although we know that E(m) is proportional to the density. Therefore the ratio E(m)/ρ_p is essentially a fundamental constant for elemental carbon and thus σ_a is independent of variations in refractive index and primary particle density for actual soot particles. Using the optical properties (m = 1.7 - .7i) and density (ρ_p = 2.0 gm/cm^3) for elemental carbon, or the most probable values for soot refractive index along with a lower density, σ_e = 5.1 m^2/g for λ = 0.67 μm, approximately 20% lower than that used in the MAAP measurements. Thus to compare STAR measurements with MAAP filter absorption measurements on an equivalent basis, we need to increase MAAP results by 20%.

Following the same rationale for STAR, we choose a value for f(m) used in the scattering measurements, based on the fundamental refractive index of elemental carbon. We also use the density associated with elemental carbon (2.0 gm/cm^3) to compute the ratio f(m)/ρ_p, this despite the fact that we have used a value of ρ_p = 1.7 as the reference value for comparing the density correlation as a function of agglomerate mobility diameter. In effect we are choosing a more likely value for soot of f(m) = .26, with a density = 1.7 gm/cm^3, similar to choosing the mean value for σ_e.

In both cases, we have evaluated the ratios E(m)/ρ_p and f(m)/ρ_p, based on elemental carbon, which gives an upper bound for both these optical properties, and thus a lower bound on C_m, for both absorption and scattering measurements. As we develop better information on the scattering or absorption properties of soot, we can use this improved information in our measurements of mass concentration through equations (1,2,3) and (A3).

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13. ABSTRACT *(Maximum 200 words)*

APEX systematically investigated the gas-phase and particle emissions from a CFM56-2C1 engine on NASA's DC-8 aircraft as functions of engine power, fuel composition, and exhaust plumage. Emissions parameters were measured at 11 engine power, settings, ranging from idle to maximum thrust, in samples collected at 1, 10, and 30 m downstream of the exhaust plane as the aircraft burned three fuels to stress relevant chemistry. Gas-phase emission indices measured at 1 m were in good agreement with the ICAO data and predictions provided by GEAE empirical modeling tools. Soot particles emitted by the engine exhibited a log-normal size distribution peaked between 15 and 40 nm, depending on engine power. Samples collected 30 m downstream of the engine exhaust plane exhibited a prominent nucleation mode.

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