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# PARAMETRIC PERFORMANCE OF A TURBOJET ENGINE COMBUSTOR USING JET A AND A DIESEL FUEL

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15 Supplementary Notes

16 Abstract

The performance of a single-can JT8D combustor was evaluated with Jet A and a high-aromatic Diesel fuel over a parametric range of combustor-inlet conditions Performance parameters investigated were combustion efficiency, emissions of CO, unburned hydrocarbons, and $NO_x$, as well as liner temperatures and smoke At all conditions the use of Diesel fuel instead of Jet A resulted in increases in smoke numbers and liner temperatures, gaseous emissions, on the other hand, did not differ significantly between the 2 fuels

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## SUMMARY

The performance of a single-can JT8D combustor was evaluated over a parametric range of combustor-inlet conditions with Jet A and a broadened specification fuel in the Diesel range. Performance parameters investigated were combustion efficiency, emissions of CO, unburned hydrocarbons, and $NO_X$, as well as liner temperatures and smoke. At all conditions the use of Diesel fuel instead of Jet A resulted in increases in smoke numbers and liner temperatures. Increases in inlet temperature decreased CO emissions and increased $NO_X$ emissions and liner temperatures. Increases in pressure decreases CO and increased $NO_X$ emissions and smoke numbers. Increases in reference velocity increased CO emissions, but had no consistent effects on the other performance parameters.

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## INTRODUCTION

An experimental investigation was conducted to determine the effect on combustor performance of broadening of fuel specifications and of parametric variations of combustor-inlet conditions.

In the past, the petroleum industry has been able to supply aircraft operators with an adequate supply of jet fuel refined to rather narrow specifications, tailored to minimize the problems of fire hazard and of fuel freeze-up at altitude and to promote clean burning in the engines. The ever-increasing reliance on foreign crudes, some with rather high aromatic content, and the increasing demands on mid-distillate products, have made it difficult for the petroleum industry to supply adequate amounts of aviation turbine fuels refined to present specifications (ref. 1).

When aviation fuels have to be produced from many different sources of crudes, some very high in aromatic content, the cost of refining to narrow specifications rises sharply. If fuel specifications are to be relaxed so as to assure an adequate supply and still hold refinery costs to a reasonable level, problems with combustor performance, especially increased soot formation and increased liner temperatures may arise. In addition, increases in freezing point which may result from using more of the higher boiling fractions of the crude, could cause problems with fuel freeze-up at altitude. In a Workshop held at the NASA Lewis Research Center in June 1977, attended by representatives of the petroleum industry, engine manufacturers, universities, and government agencies including the military, specifications for an "Experimental Referee Broadened-Specification (ERBS) Aviation Turbine Fuel" were established (ref. 2). Such a fuel, in the opinion of refinery people, could be produced from available petroleum stocks without excessive processing cost penalties. The question then arises as to what effect these relaxed fuel specifications will have on combustor performance. Extensive combustor and engine tests will have to be performed over a period of several years by both industry and government groups to answer this question.

The present investigation was undertaken to determine the effect of systematic variations in combustor-inlet conditions on the performance of a single-can JT8D combustor. Inasmuch as the above mentioned referee fuel (ERBS) is not yet available, tests were conducted with a Jet-A and a commercially available high aromatic fuel in the Diesel boiling range. Although this fuel does not meet the ERBS specification in its entirety, the decreased hydrogen content and the increased final boiling point are in the direction of the ERBS specification. It is expected that the results of this investigation will point the way toward combustor modifications that will be necessary to accommodate the broadened-specification fuels.

## TEST FACILITY AND COMBUSTOR INSTALLATION

The tests were conducted with a single-can JT8D combustor housed in a circular high-pressure housing connected to the laboratory air supply and exhaust system. The test facility, shown schematically in figure 1, was capable of supplying the required flow rates at the specified combustor-inlet pressures and temperatures with nonvitiated air.

The JT8D combustor can, utilizing a standard duplex fuel nozzle was installed in the test facility as shown in figure 1. Although the use of circular housings did not provide the actual engine combustor-inlet and exit geometry, it was felt that this expedient would not compromise the combustor performance parameters of interest in this investigation.

The combustor instrumentation stations are shown in figure 2. Inlet-air temperatures were measured at station A-A with five chromel-alumel thermocouples while exit temperatures were measured at station B-B with eight five-point chromel-alumel thermocouple rakes. Combustor-inlet and exit static pressures were determined at stations A-A and B-B, respectively.

Exhaust-gas samples for gas analysis were obtained by means of four water-cooled sampling probes located at station C-C. Each probe had five sampling ports located at the centers of equal areas; the gas collected from all 20 ports was passed to a common manifold and from there through steam-heated lines to a gas analysis console. The exhaust gas was analyzed for concentrations of $CO_2$, CO, unburned hydrocarbons, and oxides of nitrogen in accord with the recommendations set forth in reference 3.

Smoke content of the exhaust gas was determined by passing metered volumes of gas through a filter paper with resultant deposition on the paper of the soot particles contained in the gas. The darkness of the stain on the paper, as determined by optical means, is a measure of the amount of soot in the sample. The smoke measurement technique is in accordance with SAE recommended practice, as described in reference 4.

Metal temperatures were measured with 17 chromel-alumel thermocouples installed on the liner. Five thermocouples were located on the dome and twelve on the liner. The position of six of the liner thermocouples is shown in figure 3; the other six thermocouples were located in similar axial positions, but displaced 180° circumferentially from the ones shown in the figure. The thermocouples were placed at locations where maximum liner temperatures were anticipated, based on previous experience. Since the number of thermocouples installed on the liner must necessarily be limited, it is possible that some locations on the liner experienced even higher temperatures than those surveyed. However, it was felt that there were sufficient thermocouples to represent liner hot spots and to indicate the trends resulting from the parametric variations of test conditions.

## TEST CONDITIONS

Tests were conducted at the combustor-inlet conditions shown in table I. The test matrix was chosen so as to give as great a variation in combustor-inlet conditions as possible within the limitations of the test facility and the combustor hardware. At each condition fuel-air ratios were varied over a wide range. Fuel splits between primary and secondary nozzles were adjusted such that low fuel flows were obtained through the primary nozzle only; when the capacity of the primary nozzle was insufficient to deliver the desired fuel flow, both passages were used.

## FUELS

Two fuels, a specification Jet A and a high-boiling, high-aromatic Diesel fuel were used in the investigation. The properties of the two fuels along with the specifications of the proposed referee fuel (ERBS), are listed in table II. It can be seen that, although the properties of the Diesel fuel differed somewhat from those of the proposed ERBS fuel, the Diesel fuel was more severe from a combustion standpoint, as indicated by the lower hydrogen content.

## RESULTS AND DISCUSSION

In a study in which a number of variables are changed parametrically it is difficult to isolate the effect of changes of a given variable on combustor performance. Increases in pressure may have a certain effect at one combustor-inlet temperature or fuel-air ratio, but a different or even opposite effect at another temperature or fuel-air ratio. In order to document completely the effect of changes of a given variable, it would be necessary to make many plots and crossplots, thus making it difficult to pick out the major impact of that variable.

In the following discussion an attempt has been made to present only the more significant effects on combustor performance, especially with regard to the impact of changes in fuel composition. Thus, as an example, the effect of fuel-air ratio on CO emissions is presented at a low combustor-inlet temperature while the effect of fuel-air ratio on $NO_X$ is presented at the 2 highest combustor-inlet temperatures. A complete listing of all the data including fuel-nozzle pressures is given in table III.

## CARBON MONOXIDE

The effect of fuel-air ratio on emissions of CO is shown in figure 4 for one combustor-inlet temperature, pressure, and reference velocity. As the fuel-air ratio was increased, emissions of CO decreased substantially. Increases in fuel-air ratio result in better fuel atomization and in increased reaction-zone temperatures, both of which tend to reduce CO formation.

Although one might have expected increased CO and hydrocarbon emissions with the Diesel fuel because of its substantially higher final boiling fractions, no such trends were observed. Differences between Jet A and the Diesel fuel were small at all conditions and generally within experimental errors. Similar trends were observed in reference 5 where it was shown that gaseous emissions were not affected by fuel hydrogen-content variations between 12.7 and 14.5 percent. In a previous investigation conducted with the JT8D combustor (ref. 6), CO emissions at a simulated idle condition increased only slightly as the hydrogen content of the fuel was decreased from about 15 to 11 percent.

The effects of variations in combustor-inlet pressure at 3 reference velocities and 4 combustor-inlet temperatures are shown in figure 5; the data were cross-plotted for a temperature rise of 500 K. The figure shows that emissions of CO generally decreased with increasing combustor-inlet pressure and temperature. At a combustor-inlet temperature of 700 K CO emissions increased slightly with increasing pressure, but the values of CO emission indices were too low to be significant. The decrease in CO emissions is primarily the result of increases in the rate of CO oxidation at the higher pressures and temperatures.

The effect of variations in reference velocity at 2 pressures and 2 temperatures at a combustor temperature rise of 500 K is shown in figure 6. CO emissions generally increased with increasing reference velocity, the result of decreased residence time available for CO oxidation.

## OXIDES OF NITROGEN

The effect of fuel-air ratio on emissions of $NO_X$ is shown in figure 7 for 2 combustor-inlet temperatures. As fuel-air ratio was increased, $NO_X$ emissions increased; the effect was more pronounced at the higher combustor-inlet temperature. Increases in overall fuel-air ratio increase the reaction-zone fuel-air ratio and temperature with resultant increases in $NO_X$ formation. No significant differences were observed between Jet A and the Diesel fuel.

The effect of variations in combustor-inlet pressure at 3 reference velocities and at 4 combustor-inlet temperatures are shown in figure 8 for a combustor temperature rise of 500 K. $NO_X$ emissions increased with increasing combustor-inlet pressure and temperature; the temperature effect was considerably greater than the pressure effect.

The effect of reference velocity on $NO_X$ emissions is shown in figure 9. For both fuels $NO_X$ emissions decreased with increasing reference velocity, probably the result of decreased residence time.

It has been shown by many investigators (e.g. refs. 7 and 8) that $NO_x$ formation increases greatly with increases in combustor-inlet temperature and to a lesser degree with increases in pressure and residence time. The data obtained in this investigation bear out these trends. In reference 8 a correlation, based on data from a TFE 731-2 turbofan engine, was developed which expressed $NO_x$ emissions as a function of combustor-inlet temperature and pressure, fuel-air ratio, and Mach number. The data obtained in the present investigation correlated in a similar way except that the exponent of the fuel-air ratio term had to be reduced from a value of 1.5 to 0.5. The following grouping of parameters was established:

$$\frac{e^{2\theta}\delta^{0.5}f^{0.5}}{M_R}$$

where:

$\theta$ combustor-inlet temperature normalized to standard sea-level temperature of 288 K.

$\delta$ combustor-inlet total pressure normalized to standard sea-level pressure of 10.13 $N/cm^2$

f fuel-air ratio

$M_R$ reference Mach number

The results of the correlation are shown in figure 10 for Jet A and in figure 11 for the Diesel fuel. Although there is considerable scatter, the data appear to define a reasonable correlation curve. In addition, comparison of figures 10 and 11 shows no significant difference in $NO_x$ emissions between Jet A and the Diesel fuel.

## SMOKE

The effect of fuel-air ratio on SAE smoke number is shown in figure 12 for one combustor-inlet temperature, pressure, and reference velocity. For both fuels smoke numbers increased with increasing fuel-air ratios. Although this trend prevailed for most test conditions, in a few cases smoke numbers decreased with increasing fuel air ratio. Smoke in the exhaust gas is the difference between the soot formed in the primary zone and the soot burned up in its passage through the flame. Increases in overall fuel-air ratios tend to increase both soot formation in the primary zone and soot burnup because of higher flame temperatures. The concentration of soot in the exhaust gas thus depends on which one of these 2 processes prevails at a given set of conditions. Similar results were reported in reference 9.

As shown in figure 12 smoke numbers obtained with the Diesel fuel were considerably higher than those obtained with Jet A. This trend prevailed at most test conditions. The increases in smoke number are the result of the substantially higher aromatic content of the Diesel fuel. Increases in smoke number with increasing aromatic content, or conversely, decreasing hydrogen content of the fuel have also been observed in references 5, 6, 10, 11, and 12.

The effects of variations in combustor-inlet pressure at 3 reference velocities and 4 combustor-inlet temperatures are shown in figure 13 for a combustor temperature rise of 500 K. Increases in combustor-inlet pressure produced substantial increases in smoke number at all velocities and combustor-inlet temperatures. The increases in exhaust smoke with increasing pressure has been well documented in the literature (e.g., refs. 5, 6, 9 to 12).

The effect of combustor-inlet temperature on smoke was not always consistent. For example, the data obtained with Jet A at a temperature of 700 K, a pressure of 104 $N/cm^2$ and a reference velocity of 22.86 m/s do not follow the expected trend; no obvious reason for this behavior could be found. Since the fuel split between primary and secondary nozzles was not closely controlled, it is possible that differences in fuel spray characteristics resulting from varying fuel nozzle pressures might have contributed to the unexpected behavior. However, in most cases the lowest smoke numbers were obtained at the highest combustor-inlet temperatures. Increases in combustor-inlet temperature could increase the effective primary-zone fuel-air ratio because of increased fuel vaporization, thus increasing soot formation. However, at a constant temperature rise increases in combustor-inlet temperature bring about corresponding increases in flame temperature with resultant increases in soot oxidation.

The effect of reference velocity on smoke numbers is shown in figure 14. No consistent trends were observed, but in most cases smoke numbers decreased slightly with increasing reference velocity. Increases in reference velocity can have two effects on smoke: one, improved turbulent mixing in the primary zone which should reduce soot formation, and two, reduced residence time in the flame and dilution zone resulting in reduced rates of soot burnup. Decreases in smoke number with increasing reference velocity were reported in reference 12.

## LINER TEMPERATURES

As discussed under "Combustor Installation," liner temperatures were measured in 17 locations. In general both maximum temperatures and the averages of all 17 temperatures followed the same trends. At low combustor-inlet temperatures and pressures the maximum liner temperatures were generally recorded by the 2 thermocouples located farthest downstream. As the combustion intensity increased, as the result of increased combustor-inlet temperature and pressure, maximum liner temperatures were observed further upstream, either on the dome or on the first portion of the primary zone. Even in those cases, however, the downstream temperatures were close to the maximum temperatures.

The effect of fuel-air ratio on both average and maximum liner temperatures is shown in figure 15 for one combustor-inlet temperature, pressure, and velocity. For both fuels, liner temperatures increased greatly with increasing fuel-air ratio. As fuel-air ratio is increased, reaction-zone temperatures increase resulting in greater heat transfer and flame radiation to the liner.

Both maximum and average liner temperatures were higher with the Diesel fuel than with Jet A, the result of increased radiative heat transfer from the high-aromatic Diesel fuel. At conditions where maximum liner temperatures were high, the difference in temperature obtained with Jet A and with the Diesel fuel were great enough to have a significant effect on liner durability. The increased radiative heat transfer resulting from reduced fuel hydrogen content, or conversely higher aromatic content, has been observed by other investigators (e.g. refs. 11 and 12).

The effects of combustor-inlet pressure on maximum liner temperatures are shown in figure 16 for 4 combustor-inlet temperatures and 3 reference velocities at a temperature rise of 500 K. The results were not consistent. At some conditions maximum liner temperatures decreased with increasing pressure while at other conditions slight increases were obtained. Similar trends were observed when the averages of all 17 liner temperatures were compared. Since smoke numbers increased appreciably with increasing pressure, one might have expected similar increases in liner temperatures because of the increased radiative heat transfer from the soot particles in the flame. This was not observed, however. The fact that the amount of soot found in the exhaust gas is only a small fraction of the soot in the flame makes it difficult to predict radiative heat transfer on the basis of exhaust gas soot concentrations or smoke numbers. In addition, increased convective cooling as the result of increases in pressure would be expected to partially offset the effect of increased radiative heat transfer.

As shown in figure 16, liner temperatures increased greatly with increases in combustor-inlet temperature. This is to be expected since increases in combustor-inlet temperature, at a constant temperature rise, increase flame temperatures and thus heat transfer to the walls of the liner. In addition, the effectiveness of the cooling air is reduced as the combustor-inlet temperature is increased.

The effect of reference velocity on maximum liner temperature is shown in figure 17, at a combustor temperature rise of 500 K. Increases in reference velocity decreased liner temperatures, probably because of increased cooling effectiveness brought about by the increases in velocity.

## OTHER PERFORMANCE PARAMETERS

Other performance parameters such as emissions of unburned hydrocarbons, combustion efficiency, and pattern factor were also evaluated at all test conditions. The values are listed in table III.

Emission indices of unburned hydrocarbons generally followed the same trends as those observed for carbon monoxide, except that the absolute values were substantially lower than those observed for carbon monoxide.

Combustion efficiency values were determined in two different ways: by gas analysis and from the measured values of enthalpy rise. Although absolute values obtained by the two methods were not always in close agreement, especially at low fuel-air ratios, the trends that were observed were similar. A greater density of sampling probes, both temperature and composition, would probably reduce the differences between the two methods considerably. In addition, thermocouple readings were not corrected for radiation errors. In all cases combustion efficiency trends closely paralleled those observed for emissions of carbon monoxide. For combustion efficiency values obtained by gas analysis, this is to be expected since efficiency values are computed from the emission indices of carbon monoxide and unburned hydrocarbons. Thus, whatever conclusions were drawn for carbon monoxide can also be applied to combustion efficiency, both with regard to changes in fuel properties and to changes in combustor operating conditions.

Combustor-exit pattern factors, as determined from 40 exhaust-gas thermocouples, were generally quite low, ranging between 0.15 and 0.28. Consequently no significant differences in pattern factor were observed, either as the result of changes in fuel properties or of changes in combustor operating conditions.

## SUMMARY OF RESULTS

The effects of parametric variations of combustor-inlet conditions on gaseous emissions, exhaust smoke, and maximum liner temperatures of a single-can JT8D combustor, operated with both Jet A and a high-aromatic Diesel fuel are listed below. The trends that were observed were the same for both fuels.

### CARBON MONOXIDE

(1) Emissions of CO decreased sharply with increases in combustor-inlet temperature and pressure and in fuel-air ratio.

(2) Emissions of CO increased with increases in reference velocity; however, where emission indices of CO were low, these trends were not very pronounced.

(3) Differences in emissions of CO obtained with Jet A and with the Diesel fuel were small and not always consistent.

### OXIDES OF NITROGEN

(1) Emissions of $NO_x$ increased sharply with increasing combustor-inlet temperature.

(2) In most cases emissions of $NO_x$ increased somewhat with increases in fuel-air ratio.

(3) Emissions of $NO_x$ increased with increasing combustor-inlet pressure; the effect was most noticeable at the highest combustor-inlet temperature.

(4) Emissions of $NO_x$ decreased slightly with increasing reference velocity.

(5) Differences in $NO_x$ emissions obtained with Jet A and with Diesel fuel were small.

(6) For both fuels emissions of $NO_x$ were correlated by the expression $e^{2\theta}\delta^{0.5}f^{0.5}M_R^{-1}$.

## EXHAUST SMOKE

(1) Smoke numbers increased greatly with increases in combustor-inlet pressure and in most cases with increases in fuel-air ratio.

(2) The effects of temperature on smoke number were not always consistent; however, the lowest smoke numbers were generally obtained at the highest combustor-inlet temperature.

(3) In most cases smoke numbers decreased somewhat with increases in reference velocity.

(4) Smoke numbers obtained with the Diesel fuel were generally substantially higher than those obtained with Jet A.

## MAXIMUM LINER TEMPERATURES

(1) Maximum liner temperatures increased greatly with increasing combustor-inlet temperature and with increases in fuel-air ratio.

(2) Changes in combustor-inlet pressure generally produced only moderate changes in maximum liner temperatures; the trends were not consistent.

(3) Increases in reference velocity produced small decreases in maximum liner temperatures. The effects were most pronounced at the high combustor-inlet temperatures.

(4) Maximum liner temperatures obtained with the Diesel fuel were generally higher than those obtained with Jet A.

## CONCLUDING REMARKS

The results of this investigation have provided further confirmation that the main impact of broadening of aviation jet fuel specifications on combustor performance would be the effects on smoke formation and on liner temperatures. The increases in both of these parameters resulting from the use of Diesel fuel instead of Jet A were considered to be significant.

Although, at certain conditions, the use of Diesel fuel might have adversely affected other performance parameters such as combustion efficiency, emissions or pattern factors, the overall effect was not large. However, if combustor modifications were to be made to overcome the adverse effects of the use of broadened-specification fuel on liner temperatures and on smoke, such as leaning out the primary combustion zone or the use of increased amounts of cooling air, the effect on the other performance parameters, such as emissions of CO or pattern factor, might no longer be insignificant. Future efforts should be directed toward determining the total impact that such modifications might have on combustor performance.

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TABLE I. - AIR FLOW RATES (kg/s) REQUIRED TO

MEET TEST CONDITIONS

| Temperature, K | Reference velocity, m/s | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 15.24 | | | 22.86 | | | 30.48 | | |
| | Pressure, $N/cm^2$ | | | | | | | | |
| | 34.5 | 104.0 | 172.3 | 34.5 | 104.0 | 172.3 | 34.5 | 104.0 | 172.3 |
| 311 | 2.66 | 7.99 | | 4.00 | | | | | |
| 394 | 2.10 | 6.30 | | 3.15 | 9.45 | | 4.20 | | |
| 533 | 1.55 | 4.66 | 7.90 | 2.33 | 6.99 | | 3.10 | 9.32 | |
| 700 | 1.18 | 3.55 | 5.91 | 1.78 | 5.33 | | 2.37 | 7.10 | |

TABLE II. - FUEL ANALYSES

| Specifications | Jet A | Diesel | ERBS |
|---|---|---|---|
| A. S. T. M. disillation, °C | | | |
| Initial boiling point | 138 | 177 | Report |
| Percent evaporated | | | |
| 10 | 178 | 214 | 204, max. |
| 50 | 206 | 254 | Report |
| 90 | 244 | 309 | 260, max. |
| Final boiling point | 258 | 324 | Report |
| Flash point, °C | 67 | 93 | --------- |
| Specific gravity at 15.5° C | 0.8124 | 0.8756 | Report |
| Freeze point, °C | -47 | -32 | -29 |
| Viscosity at -23° C, $m^2/s x 10^6$ | 7.2 | 19.5 | 12, max. |
| Surface tension, $N/cm x 10^5$ | 29.4 | 32.4 | --------- |
| Net heat of combustion, cal/g | 10,350 | 10,179 | Report |
| Thermal stability: | | | |
| JFTOT, break point temperature, °C (TDR, 13; and $\Delta P$, 25 mm) | | | |
| Hydrogen, percent by weight | 13.9 | 12.4 | 12.8 |
| Aromatics, percent by volume | 17.2 | 38.0 | Report |
| Sulfur, total - percent by weight | 0.020 | 0.197 | 0.3, max. |
| Naphthalenes, percent by volume | | | |
| Smoke point | 21 | 10 | --------- |
| Luminometer number | 40.0 | 13.0 | |

TABLE III. - COMBUSTOR PERFORMANCE DATA

| Run | Combustor inlet | | Reference velocity, m/s | Air flow rate, kg/s | Fuel air ratio | Fuel-nozzle pressure drop, $N/cm^2$ | | Combustor exit temperature, K | Combustion efficiency, percent | | Combustor total pressure loss, ΔP/P, percent, | SAF smoke number | Pattern factor | Maximum liner temperature, K | Average liner temperature, K | Emission index, g/kg of fuel | | | | Fuel |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Temperature, K | Pressure, $N/cm^2$ | | | | Primary | Secondary | | gas analysis | enthalpy rise basis | | | | | | Unburned hydrocarbons | CO | NO* | $NO_x$* | |
| 1 | 307 | 34.5 | 15.1 | 2.67 | 0.0096 | 336 | --- | 657 | 93.7 | 89.4 | 5.31 | 10.3 | 0.121 | 554 | 380 | 46.8 | 88.7 | 1.1 | ---- | Jet A |
| 2 | 307 | 34.6 | 15.0 | 2.67 | .0096 | 334 | --- | 657 | 93.6 | 89.6 | 5.22 | | .121 | 555 | 381 | 49.4 | 88.3 | ---- | 2.4 | " |
| 3 | 306 | 34.6 | 14.9 | 2.66 | .0140 | 330 | --- | 814 | 95.2 | 91.8 | 5.84 | 15.0 | .150 | 678 | 398 | 34.1 | 78.5 | 1.2 | ---- | " |
| 4 | 306 | 34.8 | 14.8 | 2.66 | .0145 | 322 | --- | 827 | 95.4 | 91.1 | 5.84 | | .169 | 683 | 399 | 31.3 | 75.5 | ---- | 2.4 | " |
| 5 | 307 | 34.5 | 15.1 | 2.67 | .0208 | 322 | 15 | 1059 | 97.8 | 95.2 | 6.86 | 4.7 | .197 | 766 | 420 | 8.5 | 63.9 | 1.5 | ---- | " |
| 6 | 307 | 34.4 | 15.1 | 2.67 | .0207 | 309 | 15 | 1054 | 97.8 | 94.8 | 6.96 | | .198 | 763 | 419 | 8.9 | 65.3 | ---- | 2.5 | " |
| 7 | 306 | 34.8 | 15.1 | 2.71 | .0252 | 305 | 30 | 1204 | 98.7 | 96.1 | 7.69 | 4.1 | .240 | 814 | 421 | 3.3 | 49.4 | 1.6 | ---- | " |
| 8 | 307 | 34.7 | 15.3 | 2.72 | .0248 | 308 | 29 | 1188 | 98.6 | 95.4 | 7.83 | | .241 | 803 | 421 | 3.7 | 51.7 | ---- | 2.4 | " |
| 9 | 312 | 34.3 | 15.1 | 2.61 | .0107 | 251 | --- | 689 | 94.2 | 88.5 | 5.15 | 42.6 | .143 | 579 | 400 | 38.2 | 90.5 | 1.0 | ---- | Diesel |
| 10 | 310 | 34.3 | 15.0 | 2.62 | .0106 | 251 | --- | 683 | 94.1 | 88.0 | 5.41 | | .144 | 575 | 397 | 39.8 | 91.0 | ---- | 2.1 | " |
| 11 | 309 | 34.7 | 14.8 | 2.62 | .0156 | 241 | 6 | 864 | 96.6 | 91.8 | 5.87 | 34.3 | .213 | 686 | 424 | 20.7 | 66.0 | 1.1 | ---- | " |
| 12 | 308 | 34.5 | 14.8 | 2.62 | .0156 | 241 | 6 | 862 | 96.7 | 91.6 | 5.86 | | .216 | 684 | 423 | 19.3 | 66.4 | ---- | 2.5 | " |
| 13 | 311 | 34.6 | 14.9 | 2.62 | .0227 | 243 | 31 | 1094 | 97.8 | 93.0 | 6.94 | 29.4 | .273 | 763 | 447 | 10.6 | 56.2 | 1.4 | ---- | " |
| 14 | 311 | 34.5 | 15.1 | 2.64 | .0225 | 244 | 31 | 1091 | 98.0 | 93.4 | 6.93 | | .271 | 762 | 446 | 8.7 | 57.3 | ---- | 2.6 | " |
| 15 | 312 | 34.6 | 14.9 | 2.62 | .0280 | 263 | 51 | 1261 | 98.7 | 94.0 | 7.55 | 27.0 | .176 | 884 | 459 | 4.9 | 39.8 | 1.9 | ---- | " |
| 16 | 312 | 34.7 | 14.9 | 2.61 | .0281 | 264 | 51 | 1259 | 98.8 | 93.5 | 7.70 | | .176 | 885 | 457 | 3.9 | 40.1 | ---- | 2.7 | " |
| 17 | 396 | 34.8 | 15.1 | 2.09 | .0077 | 173 | --- | 675 | 95.2 | 89.0 | 3.92 | 16.5 | .135 | 567 | 470 | 34.0 | 70.5 | 1.3 | ---- | Jet A |
| 18 | 396 | 34.8 | 15.1 | 2.09 | .0077 | 174 | --- | 676 | 95.3 | 90.2 | 3.80 | | .136 | 567 | 470 | 33.5 | 71.2 | ---- | 3.3 | " |
| 19 | 395 | 34.8 | 15.1 | 2.10 | .0122 | 252 | --- | 842 | 97.3 | 93.6 | 4.14 | 15.0 | .148 | 709 | 503 | 15.4 | 55.4 | 1.7 | ---- | " |
| 20 | 395 | 34.8 | 15.1 | 2.09 | .0121 | 252 | --- | 840 | 97.4 | 93.8 | 4.05 | | .142 | 709 | 503 | 14.4 | 54.7 | ---- | 3.6 | " |
| 21 | 395 | 34.8 | 15.0 | 2.09 | .0183 | 322 | 1 | 1050 | 98.8 | 94.4 | 4.60 | 10.3 | .172 | 869 | 525 | 3.7 | 39.1 | 1.6 | ---- | " |
| 22 | 396 | 34.9 | 15.2 | 2.11 | .0181 | 296 | 2 | 1052 | 98.8 | 95.9 | 4.71 | | .185 | 863 | 528 | 3.4 | 39.9 | ---- | 4.1 | " |
| 23 | 395 | 34.9 | 15.2 | 2.12 | .0233 | 276 | 11 | 1223 | ---- | 96.6 | 5.11 | 7.6 | .193 | 956 | 535 | 0.6 | 27.6 | ---- | 3.6 | " |
| 24 | 395 | 34.7 | 15.2 | 2.11 | .0236 | 275 | 11 | 1219 | 99.4 | 95.3 | 5.31 | | .183 | 950 | 534 | 0.6 | 26.2 | 2.2 | ---- | " |

*expressed as grams of $NO_2$/kg of fuel

TABLE III. - CONTINUED.

| Run | Combustor inlet | | Reference velocity, m/s | Air flow rate, kg/s | Fuel air ratio | Fuel-nozzle pressure drop, $N/cm^2$ | | Combustor exit temperature, K | Combustion efficiency, percent | | Combustor total pressure loss, ΔP/P, percent, | SAE smoke number | Pattern factor | Maximum liner temperature, K | Average liner temperature, K | Emission index, g/kg of fuel | | | | Fuel |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Temperature, K | Pressure, $N/cm^2$ | | | | Primary | Secondary | | gas analysis | enthalpy rise basis | | | | | | Unburned hydrocarbons | CO | NO* | $NO_x$* | |
| 25 | 394 | 34.7 | 15.1 | 2.10 | 0.0085 | 191 | --- | 699 | 94.9 | 90.9 | 3.71 | 37.7 | 0.125 | 592 | 489 | 39.6 | 72.5 | 2.1 | ---- | Diesel |
| 26 | 393 | 34.5 | 15.0 | 2.08 | .0086 | 191 | --- | 700 | 94.8 | 90.3 | 3.85 | | .125 | 590 | 487 | 40.2 | 72.3 | ---- | 3.3 | " |
| 27 | 394 | 34.5 | 15.1 | 2.08 | .0133 | 196 | --- | 871 | 97 6 | 93.2 | 4.11 | 32.3 | .131 | 727 | 526 | 14.7 | 49.9 | 2.9 | ---- | " |
| 28 | 394 | 34.3 | 15.1 | 2.08 | .0133 | 197 | --- | 872 | 97.6 | 93.3 | 4.02 | | .129 | 733 | 525 | 14.4 | 51.0 | ---- | 3.9 | " |
| 29 | 394 | 34.5 | 15.1 | 2.09 | .0199 | 190 | 10 | 1087 | 99.0 | 94.1 | 4.80 | 31 7 | .182 | 870 | 569 | 2.6 | 36.0 | 3.8 | ---- | " |
| 30 | 393 | 34.2 | 15.0 | 2.06 | 0201 | 191 | 10 | 1087 | 99.0 | 93.6 | 4.61 | | .184 | 873 | 568 | 2.3 | 33.2 | ---- | 3.9 | " |
| 31 | 392 | 34.3 | 15.0 | 2.06 | .0261 | 194 | 27 | 1264 | 99 5 | 93.2 | 5.20 | 39.3 | .228 | 994 | 596 | .5 | 20.7 | 3.1 | ---- | " |
| 32 | 393 | 34.5 | 15.1 | 2.09 | .0257 | 195 | 26 | 1259 | 99.5 | 94.2 | 5.12 | | 222 | 986 | 596 | .4 | 20.6 | ---- | 3.8 | " |
| 33 | 534 | 34.9 | 15.2 | 1.57 | .0043 | 28 | --- | 684 | 98.2 | 83.4 | 2.74 | 6.6 | .163 | 620 | 582 | 10.7 | 36.9 | 2.0 | ---- | Jet A |
| 34 | 533 | 35.0 | 15.2 | 1 57 | .0043 | 28 | --- | 684 | 98.2 | 83.6 | 2.64 | | 165 | 618 | 582 | 10.8 | 39.6 | 2 0 | ---- | " |
| 35 | 533 | 34.9 | 15.3 | 1.58 | 0042 | 28 | --- | 684 | 98 2 | 86.3 | 2.71 | | .161 | 619 | 582 | 10.9 | 39 4 | ---- | 5.3 | " |
| 36 | 534 | 34.8 | 15.2 | 1.56 | 0090 | 144 | --- | 867 | 99 0 | 95.2 | 2.90 | | .139 | 747 | 650 | 4.6 | 28 9 | 3.1 | ---- | " |
| 37 | 533 | 34.8 | 15 0 | 1.55 | .0089 | 129 | --- | 855 | 98 9 | 93.2 | 2.88 | | 144 | 739 | 647 | 5 1 | 29 7 | ---- | 5.9 | " |
| 38 | 534 | 34.8 | 15.1 | 1 55 | 0088 | 129 | --- | 851 | 98 9 | 93.0 | 2.97 | 11 6 | 145 | 737 | 646 | 5 1 | 29 8 | 2.9 | ---- | " |
| 39 | 535 | 34.6 | 15.4 | 1 57 | .0087 | 129 | --- | 849 | 98 8 | 92 9 | 2.84 | | 147 | 733 | 643 | 5 3 | 30.6 | ---- | 5.9 | " |
| 40 | 534 | 34.9 | 15.0 | 1 55 | .0149 | 131 | --- | 1063 | 99 7 | 95.3 | 3.29 | 13 3 | .134 | 894 | 711 | 0 6 | 12 4 | 6 0 | ---- | " |
| 41 | 534 | 34.8 | 15.0 | 1.54 | 0151 | 142 | --- | 1066 | 99 7 | 94 8 | 3.07 | | .141 | 897 | 710 | 0 5 | 11 9 | ---- | 7.2 | " |
| 42 | 535 | 34.6 | 15.1 | 1.54 | 0200 | 114 | 2 | 1219 | 99 8 | 94.4 | 3.31 | 15 1 | 150 | 1006 | 747 | 0 1 | 7.3 | 6.0 | ---- | " |
| 43 | 535 | 34.8 | 14.9 | 1.53 | 0201 | 116 | 3 | 1227 | 99 8 | 95.1 | 3.21 | | 141 | 1011 | 752 | 0.1 | 7.1 | ---- | 6.9 | " |
| 44 | 530 | 34.7 | 14 9 | 1 54 | 0043 | 24 | --- | 683 | 97 7 | 84.2 | 2.47 | 24 3 | 146 | 626 | 592 | 15.2 | 41 5 | 2.5 | ---- | Diesel |
| 45 | 530 | 34 8 | 15 2 | 1 58 | .0042 | 24 | --- | 682 | 97 6 | 86 0 | 2.46 | | .149 | 626 | 591 | 16 6 | 43.2 | ---- | 5.4 | " |
| 46 | 531 | 34.8 | 15.0 | 1.55 | 0097 | 139 | --- | 877 | 98 7 | 93.9 | 2.54 | 32.0 | .117 | 783 | 678 | 6 2 | 33 9 | 3 9 | ---- | " |
| 47 | 534 | 34.7 | 15 2 | 1 55 | .0097 | 140 | --- | 878 | 98 7 | 93 5 | 2.74 | | .118 | 778 | 678 | 6.1 | 34 2 | ---- | 6.5 | " |
| 48 | 532 | 34.6 | 15.2 | 1 56 | 0164 | 272 | --- | 1102 | 99 7 | 95.1 | 2.88 | 28.0 | 126 | 932 | 748 | 0 4 | 12.7 | 12.7 | ---- | " |
| 49 | 532 | 34 7 | 15.2 | 1 56 | 0172 | 271 | | 1128 | 99 7 | 95.4 | 3 02 | | .116 | 947 | 788 | 0 3 | 12 8 | ---- | 8 1 | " |

*expressed as grams of $NO_2$/kg of fuel

TABLE III. - CONTINUED.

| Run | Combustor inlet | | Reference velocity, m/s | Air flow rate, kg/s | Fuel air ratio | Fuel-nozzle pressure drop, $N/cm^2$ | | Combustor exit temperature, K | Combustion efficiency, percent | | Combustor total pressure loss, ΔP/P, percent, | SAE smoke number | Pattern factor | Maximum liner temperature, K | Average liner temperature, K | Emission index, g/kg of fuel | | | | Fuel |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Temperature, K | Pressure, $N/cm^2$ | | | | Primary | Secondary | | gas analysis | enthalpy rise basis | | | | | | Unburned hydrocarbons | CO | $NO^*$ | $NO_x^*$ | |
| 50 | 534 | 34.7 | 15.2 | 1.56 | 0.0218 | 244 | 2 | 1264 | 99.8 | 94.5 | 2.91 | 38.2 | 0.128 | 1042 | 788 | 0.1 | 6.9 | 6.9 | ---- | Diesel |
| 51 | 534 | 34.6 | 15.3 | 1.56 | .0220 | 246 | 2 | 1266 | 99.9 | 94.2 | 3.11 | | .130 | 1043 | 787 | .1 | 6.3 | ---- | 7.1 | " |
| 52 | 702 | 34.3 | 15.2 | 1.17 | .0042 | 9 | --- | 818 | 99.4 | 66.0 | 1.87 | | .145 | 775 | 740 | 4.0 | 7.4 | 9.0 | ---- | Jet A |
| 53 | 700 | 34.9 | 15.2 | 1.19 | .0041 | 10 | --- | 820 | 99.6 | 68.8 | 1.84 | 8.0 | .149 | 775 | 740 | 1.6 | 10.5 | 9.1 | ---- | " |
| 54 | 700 | 34.7 | 14.9 | 1.17 | .0042 | 9 | --- | 818 | 99.5 | 67.8 | 1.84 | | .148 | 768 | 739 | 1.5 | 12.5 | ---- | 10.0 | " |
| 55 | 702 | 34.9 | 15.1 | 1.19 | .0101 | 87 | --- | 1022 | 99.8 | 86.3 | 1.99 | 2.2 | .120 | 975 | 846 | .6 | 6.7 | 13.4 | ---- | " |
| 56 | 702 | 34.4 | 15.3 | 1.18 | .0101 | 87 | --- | 1021 | 99.8 | 85.7 | 2.13 | | .117 | 968 | 842 | .6 | 6.3 | ---- | 14.2 | " |
| 57 | 701 | 34.7 | 15.0 | 1.17 | .0157 | 242 | --- | 1219 | 99.9 | 92.6 | 2.05 | 4.7 | .116 | 1115 | 949 | .3 | 3.0 | 16.7 | ---- | " |
| 58 | 702 | 34.8 | 15.1 | 1.18 | .0156 | 239 | --- | 1219 | 99.9 | 92.7 | 2.19 | | .114 | 1110 | 946 | .3 | 3.5 | ---- | 17.1 | " |
| 59 | 701 | 34.9 | 14.9 | 1.17 | .0172 | 261 | --- | 1254 | 99.9 | 92.0 | 2.11 | 22.8 | .100 | 1290 | 1025 | .1 | 3.0 | 14.3 | ---- | Diesel |
| 60 | 701 | 35.0 | 15.0 | 1.18 | .0170 | 261 | --- | 1258 | 99.9 | 93.8 | 1.99 | | .099 | 1293 | 1029 | .1 | 3.1 | ---- | 15.1 | " |
| 61 | 701 | 34.5 | 15.0 | 1.17 | .0111 | 116 | --- | 1090 | 99.8 | 97.1 | 1.95 | 11.0 | .103 | 1108 | 928 | .2 | 7.7 | 14.6 | ---- | " |
| 62 | 702 | 34.3 | 15.2 | 1.17 | .0111 | 116 | --- | 1091 | 99.8 | 97.6 | 2.01 | | .104 | 1112 | 930 | .2 | 7.9 | ---- | 16.7 | " |
| 63 | 702 | 34.6 | 14.9 | 1.16 | .0046 | 16 | --- | 857 | 99.5 | 80.3 | 1.75 | 8.0 | .148 | 839 | 780 | 1.5 | 17.3 | 8.9 | ---- | " |
| 64 | 701 | 34.5 | 14.8 | 1.15 | .0046 | 16 | --- | 858 | 99.5 | 80.8 | 1.80 | | .142 | 839 | 780 | 1.3 | 17.6 | ---- | 11.6 | " |
| 65 | 316 | 103.8 | 15.3 | 7.91 | .0098 | 157 | 56 | 680 | 96.1 | 91.4 | 5.27 | 36.4 | .148 | 556 | 387 | 27.1 | 51.6 | 7.6 | ---- | Jet A |
| 66 | 316 | 103.4 | 15.3 | 7.87 | .0098 | 155 | 56 | 678 | 96.2 | 90.4 | 5.28 | | .173 | 552 | 385 | 26.5 | 51.4 | ---- | 2.8 | " |
| 67 | 316 | 103.3 | 15.3 | 7.90 | .0098 | 156 | 56 | 682 | 96.3 | 91.5 | 5.32 | | .153 | 551 | 385 | 25.0 | 50.1 | 2.5 | ---- | " |
| 68 | 315 | 103.3 | 15.3 | 7.88 | .0099 | 155 | 56 | 680 | 96.3 | 91.0 | 5.23 | | .163 | 553 | 384 | 24.6 | 50.8 | ---- | 2.9 | " |
| 69 | 316 | 103.8 | 15.3 | 7.91 | .0144 | 213 | 139 | 854 | 98.6 | 94.7 | 5.85 | 45.4 | .137 | 701 | 410 | 7.1 | 31.8 | ---- | 3.3 | " |
| 70 | 316 | 103.7 | 15.3 | 7.93 | .0144 | 212 | 139 | 855 | 98.6 | 95.1 | 5.89 | | .138 | 694 | 410 | 6.5 | 31.5 | 2.9 | ---- | " |
| 71 | 317 | 103.6 | 15.3 | 7.88 | .0210 | 305 | --- | 1084 | 99.4 | 96.2 | 6.82 | 57.2 | .162 | 777 | 430 | 1.1 | 22.8 | 3.3 | ---- | " |
| 72 | 317 | 103.2 | 15.3 | 7.83 | .0209 | 297 | --- | 1076 | 99.4 | 95.9 | 6.97 | | .179 | 779 | 430 | 1.0 | 22.9 | ---- | 3.4 | " |

*expressed as grams of $NO_2$/kg of fuel

TABLE III. - CONTINUED.

| Run | Combustor inlet | | Reference velocity, m/s | Air flow rate, kg/s | Fuel air ratio | Fuel-nozzle pressure drop, $N/cm^2$ | | Combustor exit temperature, K | Combustion efficiency, percent | | Combustor total pressure loss, ΔP/P, percent, | SAE smoke number | Pattern factor | Maximum liner temperature, K | Average liner temperature, K | Emission index, g/kg of fuel | | | | Fuel |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Temperature, K | Pressure, $N/cm^2$ | | | | Primary | Secondary | | gas analysis | enthalpy rise basis | | | | | | Unburned hydrocarbons | CO | NO* | $NO_x$* | |
| 73 | 312 | 103 8 | 15.1 | 7 93 | 0 0104 | 244 | 53 | 688 | 96.2 | 90 4 | 5 17 | 34.3 | 0 150 | 552 | 399 | 24.1 | 56.6 | 2.5 | ---- | Diesel |
| 74 | 313 | 103 7 | 15.1 | 7 88 | 0105 | 243 | 53 | 686 | 96 1 | 89 4 | 5.33 | | .150 | 553 | 399 | 24 2 | 57.2 | ---- | 2.8 | " |
| 75 | 314 | 103 3 | 15 1 | 7 85 | .0157 | 222 | 152 | 874 | 97 8 | 92.4 | 5.80 | 41.9 | .168 | 686 | 434 | 13.8 | 33 4 | 3.3 | ---- | " |
| 76 | 314 | 103 6 | 15 1 | 7 84 | .0158 | 225 | 152 | 877 | 98.1 | 92 4 | 5.81 | | 158 | 691 | 434 | 11 0 | 32.7 | ---- | 3 5 | " |
| 77 | 315 | 103 2 | 15 2 | 7 82 | .0225 | 431 | --- | 1114 | 99.3 | 95.5 | 6.61 | 79 2 | 242 | 782 | 463 | 1.7 | 24.3 | 3.7 | ---- | " |
| 78 | 316 | 103 5 | 15 3 | 7 88 | 0226 | 435 | --- | 1092 | 99 3 | 92.7 | 6 83 | | .244 | 773 | 458 | 1 4 | 23 6 | ---- | 3 7 | " |
| 79 | 395 | 102 4 | 15 4 | 6.31 | 0076 | 164 | 9 | 679 | 98 3 | 92 8 | 3 97 | 34.3 | .167 | 558 | 472 | 9.3 | 35 4 | 2 7 | ---- | Jet A |
| 80 | 394 | 103.6 | 15 3 | 6.32 | 0075 | 163 | 9 | 678 | 98 2 | 93 1 | 3 86 | | 145 | 555 | 471 | 9 7 | 36 6 | ---- | 4 2 | " |
| 81 | 394 | 103 4 | 15 3 | 6 32 | 0121 | 151 | 52 | 844 | 99 1 | 94 8 | 4.24 | 51 3 | 143 | 681 | 514 | 3 3 | 25 4 | 4.0 | ---- | " |
| 82 | 393 | 103 0 | 15 2 | 6 26 | 0122 | 151 | 52 | 843 | 99 1 | 94 0 | 4.32 | | 133 | 683 | 513 | 3 2 | 24 6 | ---- | 4 9 | " |
| 83 | 394 | 102 8 | 15 4 | 6 33 | 0184 | 148 | 153 | 1062 | 99 5 | 96.1 | 4 80 | 64.5 | 155 | 830 | 557 | .8 | 17 2 | 3.8 | ---- | " |
| 84 | 394 | 102 9 | 15 5 | 6 38 | 0183 | 148 | 152 | 1063 | 99 5 | 96 6 | 4 96 | | .165 | 827 | 556 | 7 | 16.4 | ---- | 4.9 | " |
| 85 | 394 | 102 9 | 15 4 | 6 33 | 0234 | 201 | --- | 1229 | 99 7 | 97.2 | 5 51 | 72 3 | 184 | 924 | 581 | 2 | 11 8 | 4 2 | ---- | " |
| 86 | 394 | 102 8 | 15 3 | 6 27 | .0236 | 201 | --- | 1228 | 99 7 | 96 3 | 5 34 | | 154 | 926 | 581 | 2 | 11 5 | ---- | 4 8 | " |
| 87 | 394 | 103 1 | 15 2 | 6 29 | 0083 | 222 | 9 | 692 | 98 1 | 90 5 | 3.97 | 52 6 | 156 | 584 | 490 | 10 4 | 32 7 | 2 3 | ---- | Diesel |
| 88 | 394 | 102.7 | 15 4 | 6 34 | 0082 | 222 | 9 | 691 | 98 1 | 91 2 | 3 95 | | 151 | 581 | 487 | 10.6 | 33.0 | ---- | 4 5 | " |
| 89 | 394 | 103 1 | 15 3 | 6 32 | 0128 | 194 | 51 | 853 | 99 2 | 93 2 | 4 34 | 63 1 | 130 | 682 | 530 | 3 3 | 17 3 | 4 1 | ---- | " |
| 90 | 394 | 102 7 | 15 5 | 6 37 | 0126 | 197 | 49 | 847 | 99 4 | 93 3 | 4 22 | | 129 | 681 | 528 | 2 3 | 15 5 | ---- | 5 6 | " |
| 91 | 394 | 103 2 | 15 3 | 6 30 | 0196 | 194 | 154 | 1074 | 99 7 | 93 5 | 4.76 | 79 3 | 153 | 843 | 584 | 7 | 11 1 | 5 3 | ---- | " |
| 92 | 394 | 103 4 | 15 3 | 6 34 | 0195 | 195 | 155 | 1076 | 99 7 | 94 2 | 4 71 | | 173 | 837 | 581 | 5 | 10 5 | ---- | 6.0 | " |
| 93 | 394 | 102 8 | 15 4 | 6 35 | 0254 | 224 | --- | 1270 | 99 8 | 96 2 | 5.42 | 88 2 | 153 | 938 | 617 | 2 | 8 0 | 5 6 | ---- | " |
| 94 | 394 | 103 2 | 15 3 | 6 33 | 0255 | 226 | --- | 1280 | 99 8 | 96 6 | 5 53 | | 177 | 957 | 618 | 2 | 8 1 | ---- | 5 7 | " |

*expressed as grams of $NO_2$/kg of fuel

TABLE III. - CONTINUED

| Run | Combustor inlet | | Reference velocity, m/s | Air flow rate, kg/s | Fuel air ratio | Fuel-nozzle pressure drop, $N/cm^2$ | | Combustor exit temperature, K | Combustion efficiency, percent | | Combustor total pressure loss, ΔP/P, percent, | SAE smoke number | Pattern factor | Maximum liner temperature, K | Average liner temperature, K | Emission index, g/kg of fuel | | | | Fuel |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Temperature, K | Pressure, $N/cm^2$ | | | | Primary | Secondary | | gas analysis | enthalpy rise basis | | | | | | Unburned hydrocarbons | CO | NO* | $NO_x$* | |
| 95 | 537 | 103 5 | 15.5 | 4 73 | 0 0042 | 274 | --- | 695 | 99.8 | 90.0 | 2 68 | 14 6 | 0 144 | 646 | 588 | 1 3 | 5.1 | 5 4 | ---- | Jet A |
| 96 | 534 | 103 7 | 15.5 | 4 74 | 0042 | 272 | --- | 694 | 99 7 | 90 8 | 2 59 | | 147 | 645 | 586 | 1 3 | 7 0 | ---- | 8.2 | " |
| 97 | 533 | 103.2 | 15.4 | 4 69 | 0086 | 264 | --- | 852 | 99 9 | 96 0 | 2 71 | 36.6 | 121 | 829 | 658 | 0 3 | 3 6 | 7.8 | ---- | " |
| 98 | 533 | 104.3 | 15.3 | 4 71 | 0085 | 263 | --- | 851 | 99 9 | 96 1 | 2 73 | | 123 | 829 | 658 | 3 | 3 3 | ---- | 9.9 | " |
| 99 | 531 | 103 7 | 15 2 | 4 69 | 0150 | 258 | 33 | 1072 | 99 9 | 96 9 | 2 91 | 55.3 | 144 | 894 | 729 | 1 | 3 3 | 9 5 | ---- | " |
| 100 | 532 | 103 8 | 15 2 | 4 68 | 0150 | 261 | 33 | 1073 | 99 9 | 96.8 | 2.93 | | 126 | 896 | 730 | 1 | 3 0 | ---- | 11.5 | " |
| 101 | 533 | 103 1 | 15 4 | 4.70 | .0201 | 220 | 79 | 1243 | 99.9 | 97 5 | 3.39 | 66 7 | 200 | 1025 | 762 | 1 | 2 7 | 8.5 | ---- | " |
| 102 | 533 | 102 8 | 15.3 | 4.65 | .0203 | 221 | 79 | 1245 | 99 9 | 96 8 | 3 29 | | 204 | 1023 | 762 | .1 | 3.1 | ---- | 9.4 | " |
| 103 | 534 | 103 5 | 15 2 | 4.63 | .0046 | 272 | --- | 707 | 99 7 | 88 9 | 2 68 | 30 4 | 142 | 648 | 603 | 1.7 | 8 1 | 6 0 | ---- | Diesel |
| 104 | 535 | 103 3 | 15.2 | 4 62 | .0046 | 271 | --- | 708 | 99.7 | 89 0 | 2 46 | | 143 | 649 | 604 | 1 7 | 8 3 | ---- | 8.7 | " |
| 105 | 534 | 103.1 | 15 3 | 4.65 | 0094 | 223 | 7 | 873 | 99 8 | 94 8 | 2 85 | 49 0 | 136 | 820 | 669 | 8 | 7 8 | 8.0 | ---- | " |
| 106 | 535 | 103 6 | 15 2 | 4.64 | 0094 | 223 | 7 | 873 | 99 8 | 94.7 | 2 85 | | 140 | 820 | 670 | 8 | 6 5 | ---- | 10.3 | " |
| 107 | 536 | 103.4 | 15.2 | 4 64 | .0159 | 215 | 54 | 1086 | 99 9 | 94 9 | 3 00 | 64 6 | 115 | 964 | 743 | 2 | 4 9 | 10.4 | ---- | " |
| 108 | 535 | 103.4 | 15 2 | 4 65 | 0159 | 215 | 55 | 1087 | 99 9 | 95 3 | 2 98 | | 111 | 968 | 745 | 2 | 5 2 | ---- | 11 2 | " |
| 109 | 534 | 103 7 | 15 2 | 4 64 | 0215 | 207 | 92 | 1264 | 99 9 | 95.6 | 3.17 | 73.1 | .108 | 1071 | 781 | 1 | 3 3 | 9.7 | ---- | " |
| 110 | 534 | 103 3 | 15 2 | 4 63 | 0216 | 208 | 92 | 1263 | 99 9 | 95.0 | 3 27 | | 120 | 1074 | 784 | 1 | 3 1 | ---- | 10.4 | " |
| 111 | 701 | 103.4 | 15 1 | 3 51 | 0044 | 163 | --- | 856 | 99 7 | 84 8 | 1 71 | 18.3 | .151 | 836 | 772 | 1 3 | 8 4 | 13 5 | ---- | Jet A |
| 112 | 701 | 104 5 | 15 0 | 3 54 | 0043 | 161 | --- | 856 | 99 7 | 85.0 | 1.77 | | .157 | 835 | 772 | 1 2 | 7.7 | ---- | 17.8 | " |
| 113 | 702 | 103 6 | 15 2 | 3 54 | 0107 | 151 | 4 | 1076 | 99 9 | 95 5 | 1 98 | 21.4 | 119 | 1108 | 900 | 1 | 4 5 | 22 9 | ---- | " |
| 114 | 702 | 103 6 | 15 1 | 3.52 | 0107 | 152 | 4 | 1076 | 99.9 | 95.1 | 1 91 | | 122 | 1105 | 900 | 1 | 4 3 | ---- | 25.9 | " |
| 115 | 703 | 104 1 | 15 1 | 3 52 | .0158 | 148 | 19 | 1237 | 99 9 | 95 0 | 2 04 | 24 9 | 167 | 1130 | 970 | 1 | 4.3 | 25 4 | ---- | " |
| 116 | 703 | 102 9 | 15.4 | 3 55 | .0156 | 148 | 19 | 1237 | 99.9 | 95 8 | 2 13 | | 151 | 1128 | 971 | 1 | 4 4 | ---- | 29 8 | " |

*expressed as grams of $NO_2$/kg of fuel

TABLE III. - CONTINUED

| Run | Combustor inlet | | Reference velocity, m/s | Air flow rate, kg/s | Fuel air ratio | Fuel-nozzle pressure drop, $N/cm^2$ | | Combustor exit temperature, K | Combustion efficiency, percent | | Combustor total pressure loss, ΔP/P, percent, | SAE smoke number | Pattern factor | Maximum liner temperature, K | Average liner temperature, K | Emission index, g/kg of fuel | | | | Fuel |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Temperature, K | Pressure, $N/cm^2$ | | | | Primary | Secondary | | gas analysis | enthalpy rise basis | | | | | | Unburned hydrocarbons | CO | NO* | $NO_x$* | |
| 117 | 700 | 103.8 | 15 3 | 3.58 | 0.0048 | 195 | --- | 865 | 99 7 | 82.2 | 1 94 | 11.9 | 0.167 | 855 | 789 | 1.8 | 6.6 | 12.8 | ---- | Diesel |
| 118 | 701 | 103.5 | 15.4 | 3 59 | 0048 | 194 | --- | 865 | 99 7 | 81 9 | 1.94 | | 164 | 855 | 789 | 1 8 | 5 8 | ---- | 17.4 | " |
| 119 | 704 | 103 7 | 15.4 | 3.58 | 0114 | 195 | 4 | 1083 | 99 9 | 92 7 | 2.03 | 33.0 | 130 | 1093 | 890 | 3 | 4 6 | 24.5 | ---- | " |
| 120 | 701 | 103.5 | 15.3 | 3 57 | 0114 | 201 | 4 | 1083 | 99 9 | 93 1 | 1.96 | | 130 | 1094 | 889 | .3 | 4.9 | ---- | 27.5 | " |
| 121 | 702 | 103 2 | 15 4 | 3 57 | 0169 | 203 | 23 | 1252 | 99 9 | 93.1 | 2.17 | 46.7 | 084 | 1214 | 957 | 1 | 3 1 | 26.5 | ---- | " |
| 122 | 701 | 103 6 | 15 4 | 3.58 | 0169 | 203 | 23 | 1253 | 99 9 | 93 3 | 2.08 | | 087 | 1213 | 957 | 1 | 3 3 | ---- | 28 8 | " |
| 123 | 534 | 172.6 | 15.5 | 7.90 | 0042 | 104 | 1 | 678 | 99 6 | 82 3 | 2 67 | 33 1 | .228 | 593 | 570 | 1 6 | 8 9 | 7.2 | ---- | Jet A |
| 124 | 534 | 171.3 | 15 6 | 7 91 | 0041 | 104 | 1 | 678 | 99 7 | 82 8 | 2.68 | | 236 | 592 | 569 | 1.6 | 8.3 | ---- | 8.1 | " |
| 125 | 533 | 172 0 | 15 5 | 7 89 | 0086 | 85 | 45 | 829 | 99 9 | 89 1 | 2 89 | 43.3 | 199 | 728 | 611 | 5 | 2 9 | 10.2 | ---- | " |
| 126 | 534 | 172 3 | 15.5 | 7 88 | 0085 | 86 | 44 | 830 | 99 9 | 89 6 | 2 77 | | 200 | 727 | 610 | .5 | 2 6 | ---- | 10.8 | " |
| 127 | 534 | 172 1 | 15.4 | 7 83 | 0150 | 90 | 165 | 1038 | 99 9 | 90 3 | 2 98 | 61 3 | 131 | 833 | 660 | 3 | 4 0 | 10.7 | ---- | " |
| 128 | 534 | 171 1 | 15.6 | 7 88 | .0149 | 90 | 167 | 1037 | 99 9 | 90.7 | 3.17 | | 138 | 831 | 659 | .3 | 4 3 | ---- | 11 8 | " |
| 129 | 532 | 170 7 | 15 7 | 7.96 | 0198 | 377 | --- | 1204 | 99 9 | 93 6 | 3.45 | 77 6 | .141 | 871 | 676 | 2 | 4 5 | 10.7 | ---- | " |
| 130 | 532 | 172 2 | 15 5 | 7 90 | 0199 | 377 | --- | 1205 | 99 9 | 93 3 | 3 32 | | 142 | 869 | 676 | 2 | 4 2 | ---- | 11.0 | " |
| 131 | 533 | 172 0 | 15 6 | 7.95 | 0206 | 380 | --- | 1206 | 99.9 | 91 8 | 3.35 | 82.7 | 151 | 869 | 686 | .1 | 4 5 | 11 7 | ---- | Diesel |
| 132 | 533 | 171 7 | 15 5 | 7 88 | 0208 | 379 | --- | 1206 | 99 9 | 91 0 | 3 34 | | 150 | 869 | 686 | 1 | 3.8 | ---- | 12.0 | " |
| 133 | 532 | 172 0 | 15 5 | 7 92 | 0161 | 184 | 169 | 1051 | 99 7 | 88.3 | 3.09 | 73 8 | 173 | 856 | 666 | 2 1 | 5 4 | 11.1 | ---- | " |
| 134 | 531 | 172 0 | 15 5 | 7 92 | 0161 | 182 | 168 | 1056 | 99.7 | 89 3 | 3 14 | | 181 | 857 | 667 | 1.3 | 5 2 | ---- | 12 4 | " |
| 135 | 533 | 172 4 | 15 4 | 7 86 | 0093 | 91 | 50 | 846 | 99 7 | 88 3 | 2 69 | 57.5 | 170 | 769 | 620 | 1.7 | 6 2 | 10.2 | ---- | " |
| 136 | 533 | 172.8 | 15 3 | 7 82 | .0094 | 91 | 50 | 846 | 99.7 | 87 9 | 2 83 | | 188 | 771 | 621 | 1 8 | 4 9 | ---- | 11.0 | " |
| 137 | 534 | 172 4 | 15 4 | 7 84 | 0046 | 91 | 3 | 689 | 99 2 | 81 1 | 2 60 | 43.2 | 200 | 629 | 578 | 4 4 | 14 3 | 7 5 | ---- | " |
| 138 | 534 | 171 6 | 15 6 | 7.90 | 0045 | 91 | 3 | 685 | 99 2 | 80 7 | 2.66 | | 225 | 626 | 577 | 3 9 | 15 9 | ---- | 8.1 | " |

*expressed as grams of $NO_2$/kg of fuel.

TABLE III. - CONTINUED

| Run | Combustor inlet | | Reference velocity, m/s | Air flow rate, kg/s | Fuel air ratio | Fuel-nozzle pressure drop, N/cm$^2$ | | Combustor exit temperature, K | Combustion efficiency, percent | | Combustor total pressure loss, $\Delta P/P$, percent, | SAE smoke number | Pattern factor | Maximum liner temperature, K | Average liner temperature, K | Emission index, g/kg of fuel | | | | Fuel |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Temperature, K | Pressure, N/cm$^2$ | | | | Primary | Secondary | | gas analysis | enthalpy rise basis | | | | | | Unburned hydrocarbons | CO | NO* | $NO_x$* | |
| 139 | 700 | 170.9 | 15.2 | 5 86 | 0 0044 | 144 | --- | 839 | 99 7 | 75 8 | 1 91 | 15 8 | 0 288 | 816 | 775 | 2 3 | 3 5 | 19 8 | ---- | Jet A |
| 140 | 700 | 171 5 | 15 4 | 5 93 | 0043 | 141 | --- | 837 | 99 7 | 76 3 | 1 81 | | 292 | 815 | 773 | 1 8 | 3 8 | ---- | 20 4 | " |
| 141 | 699 | 171 8 | 15 2 | 5 90 | 0104 | 97 | 30 | 1034 | 99 8 | 87 8 | 2 02 | 25 5 | 273 | 1034 | 880 | 1 2 | 3 6 | 27 5 | ---- | " |
| 142 | 699 | 169 6 | 15 4 | 5 90 | 0105 | 100 | 30 | 1037 | 99 9 | 88 0 | 2 08 | | 283 | 1034 | 879 | 5 | 2 7 | ---- | 27.8 | " |
| 143 | 698 | 172 3 | 15 1 | 5 89 | 0154 | 102 | 84 | 1191 | 99.9 | 89 4 | 2.21 | 29 9 | 230 | 1125 | 946 | 6 | 2 2 | 32 2 | ---- | " |
| 144 | 699 | 171 7 | 15 1 | 5 85 | 0156 | 103 | 85 | 1195 | 99 9 | 89 4 | 2 03 | | 219 | 1136 | 947 | 3 | 2 1 | ---- | 32 8 | " |
| 145 | 698 | 172 0 | 15 2 | 5 91 | 0167 | 104 | 90 | 1208 | 99 9 | 87 5 | 2 21 | 37 4 | 248 | 1172 | 981 | 3 | 1 8 | 32 9 | ---- | Diesel |
| 146 | 696 | 172.2 | 15.1 | 5 88 | 0167 | 112 | 91 | 1204 | 99 9 | 87 1 | 2 01 | | 234 | 1125 | 953 | 2 | 2 2 | ---- | 33 0 | " |
| 147 | 696 | 171 7 | 15.1 | 5 87 | 0112 | 105 | 31 | 1042 | 99 8 | 85.9 | 2 01 | 28 8 | .275 | 1085 | 907 | 5 | 6 4 | 25 8 | ---- | " |
| 148 | 699 | 171 4 | 15.0 | 5 81 | 0012 | 104 | 30 | 1044 | 99 8 | 85 5 | 2 02 | | 307 | 1075 | 911 | 5 | 6 0 | ---- | 28.5 | " |
| 149 | 697 | 172 2 | 15 0 | 5 85 | 0048 | 105 | --- | 845 | 99 6 | 74 3 | 1 80 | 18 7 | 280 | 851 | 782 | 1 8 | 10 1 | 18 3 | ---- | " |
| 150 | 697 | 172 5 | 15 0 | 5 86 | 0049 | 104 | --- | 847 | 99.7 | 74 0 | 1 77 | | 296 | 849 | 785 | 1 4 | 6 1 | ---- | 18.9 | " |
| 151 | 310 | 34 1 | 22 4 | 3 87 | 0098 | 225 | 2 | 646 | 89.5 | 84 4 | 12 29 | 9 0 | 176 | 533 | 364 | 74.7 | 127 7 | 1 6 | ---- | Jet A |
| 152 | 310 | 34 1 | 22 5 | 3 89 | 0097 | 226 | 2 | 641 | 89 0 | 83 9 | 12 45 | | 178 | 528 | 363 | 78 3 | 129 7 | ---- | 1.6 | " |
| 153 | 309 | 34 0 | 22.6 | 3 92 | 0145 | 205 | 21 | 822 | 94 2 | 89.5 | 14 47 | 4 7 | 200 | 643 | 382 | 33 2 | 101 1 | 1 8 | ---- | " |
| 154 | 309 | 33 8 | 22 6 | 3 89 | 0146 | 205 | 21 | 826 | 94.3 | 89.7 | 14 28 | | 200 | 645 | 383 | 32 8 | 101 9 | ---- | 1 9 | " |
| 155 | 310 | 34 3 | 22.3 | 3.88 | 0212 | 209 | 61 | 1046 | 96.1 | 91.6 | 16 07 | 11 7 | .204 | 752 | 395 | 14 3 | 104 0 | 1.9 | ---- | " |
| 156 | 311 | 34 0 | 22 6 | 3 90 | 0210 | 212 | 89 | 1046 | 96.2 | 92 2 | 16 72 | | 213 | 758 | 397 | 13 5 | 102.9 | ---- | 2.1 | " |
| 157 | 310 | 33 8 | 22 7 | 3 90 | 0268 | 205 | 115 | 1213 | 96 8 | 91 6 | 19 60 | 13 3 | 264 | 769 | 394 | 9 3 | 99.3 | 1 8 | ---- | " |
| 158 | 310 | 33 9 | 22 7 | 3 91 | 0264 | 207 | 111 | 1203 | 96 7 | 91 8 | 19 47 | | 299 | 772 | 394 | 9 6 | 102 6 | ---- | 1.8 | " |
| 159 | 310 | 33 3 | 23 0 | 3 90 | 0107 | 235 | 3 | 651 | 89 2 | 80.4 | 13 36 | 28 2 | 215 | 544 | 364 | 71 6 | 133 3 | 1 6 | ---- | Diesel |
| 160 | 309 | 33 7 | 22 7 | 3 90 | 0106 | 237 | 3 | 651 | 88 5 | 80.4 | 12 91 | | 160 | 540 | 363 | 77 0 | 136 4 | ---- | 1 6 | " |
| 161 | 311 | 34 3 | 22 8 | 3 96 | 0155 | 231 | 22 | 826 | 92 9 | 86.1 | 14 61 | 24 1 | 175 | 668 | 386 | 41 2 | 112 9 | 1.8 | ---- | " |
| 162 | 312 | 33 7 | 23 1 | 3 94 | 0166 | 232 | 22 | 830 | 93.2 | 86 2 | 14 96 | | 170 | 667 | 385 | 39 0 | 114 9 | ---- | 1 9 | " |
| 163 | 311 | 34 1 | 22 6 | 3 90 | 0224 | 229 | 63 | 1046 | 95 0 | 88 4 | 16 77 | 26 1 | 191 | 722 | 392 | 21 9 | 110 2 | 2 1 | ---- | " |

*expressed as grams of $NO_2$/kg of fuel

TABLE III. - CONTINUED

| Run | Combustor inlet | | Reference velocity, m/s | Air flow rate, kg/s | Fuel air ratio | Fuel-nozzle pressure drop, $N/cm^2$ | | Combustor exit temperature, K | Combustion efficiency, percent | | Combustor total pressure loss, ΔP/P, percent, | SAE smoke number | Pattern factor | Maximum liner temperature, K | Average liner temperature, K | Emission index, g/kg of fuel | | | | Fuel |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Temperature, K | Pressure, $N/cm^2$ | | | | Primary | Secondary | | gas analysis | enthalpy rise basis | | | | | | Unburned hydrocarbons | CO | NO* | $NO_x$* | |
| 164 | 311 | 34 0 | 22 8 | 3 93 | 0.0221 | 230 | 63 | 1045 | 95 0 | 89.1 | 17 01 | | 0 184 | 721 | 391 | 21.1 | 110.2 | ---- | 2.2 | Diesel |
| 165 | 310 | 34.1 | 22.5 | 3 92 | .0281 | 227 | 114 | 1213 | 96 6 | 89 1 | 18 42 | | .191 | 707 | 387 | 12 7 | 91 6 | 2.3 | ---- | " |
| 166 | 310 | 33.9 | 22.8 | 3 94 | .0280 | 228 | 115 | 1207 | 96.5 | 88 7 | 19 48 | | 193 | 701 | 386 | 13.6 | 91 1 | ---- | 2 3 | " |
| 167 | 394 | 34.1 | 23.0 | 3.13 | .0231 | 178 | 53 | 1210 | 99 1 | 95 9 | 11 96 | 2 1 | 179 | ---- | ---- | 9 | 35 6 | 2.3 | ---- | Jet A |
| 168 | 393 | 34.1 | 23.0 | 3 14 | .0231 | 179 | 53 | 1210 | 99.1 | 96 1 | 12 03 | | 175 | ---- | ---- | 9 | 36 1 | ---- | 2.7 | " |
| 169 | 394 | 34 2 | 23.0 | 3.15 | .0180 | 193 | 27 | 1052 | 98 4 | 96 6 | 11 17 | 5.4 | .135 | ---- | ---- | 3 8 | 50.1 | 1.9 | ---- | " |
| 170 | 394 | 34 1 | 22.9 | 3 12 | .0180 | 194 | 26 | 1047 | 98 4 | 95.9 | 11 14 | | .132 | ---- | ---- | 4 1 | 50 5 | ---- | 2.8 | " |
| 171 | 395 | 34 0 | 23.1 | 3 15 | .0120 | 214 | 5 | 842 | 96 8 | 94.7 | 9 54 | 6 0 | 123 | ---- | ---- | 17 0 | 64.5 | 1 5 | ---- | " |
| 172 | 395 | 33 9 | 23.2 | 3 14 | .0119 | 214 | 5 | 835 | 96.6 | 94.0 | 9 81 | | 168 | ---- | ---- | 18 0 | 67.4 | ---- | 2 4 | " |
| 173 | 394 | 34.0 | 23.1 | 3 15 | 0076 | 230 | --- | 668 | 93 1 | 89.4 | 8.59 | 7 8 | 270 | ---- | ---- | 50.2 | 105.2 | 1.5 | ---- | " |
| 174 | 393 | 33 9 | 23 2 | 3 15 | 0075 | 230 | --- | 664 | 92 3 | 89 1 | 8 83 | | 235 | ---- | ---- | 52 2 | 105 9 | ---- | 2.2 | " |
| 175 | 393 | 34 5 | 22 6 | 3 13 | 0084 | 212 | --- | 690 | 92 6 | 89.1 | 8 45 | 34.5 | 235 | ---- | ---- | 46.5 | 102 8 | 2.2 | ---- | Diesel |
| 176 | 393 | 34 2 | 22.6 | 3 11 | 0084 | 214 | --- | 687 | 92 4 | 88.1 | 8.66 | | 261 | ---- | ---- | 48.4 | 105 0 | ---- | 2.4 | " |
| 177 | 392 | 34.4 | 22 7 | 3.13 | .0132 | 198 | 7 | 860 | 96 7 | 91.9 | 9 33 | 26.4 | 171 | ---- | ---- | 16.8 | 65 1 | 2.6 | ---- | " |
| 178 | 393 | 34 3 | 22 8 | 3.14 | 0131 | 197 | 7 | 862 | 96 7 | 93 1 | 9 40 | | 147 | ---- | ---- | 16 8 | 65.8 | ---- | 2 8 | " |
| 179 | 393 | 34 0 | 22.9 | 3.12 | 0200 | 175 | 34 | 1088 | 98 2 | 94 0 | 10.98 | 26 4 | 126 | ---- | ---- | 4.2 | 54.9 | 2 9 | ---- | " |
| 180 | 393 | 34 1 | 22 7 | 3 11 | 0200 | 175 | 33 | 1083 | 98 3 | 93.5 | 11 08 | | .134 | ---- | ---- | 3.8 | 54.8 | ---- | 3.1 | " |
| 181 | 397 | 34 2 | 23 0 | 3 13 | 0254 | 168 | 63 | 1250 | 99 1 | 93.8 | 12 15 | 17 9 | 167 | ---- | ---- | .9 | 32 5 | 3 1 | ---- | " |
| 182 | 398 | 34 4 | 23 1 | 3 15 | 0255 | 172 | 64 | 1259 | 99 2 | 94.2 | 12 20 | | 171 | ---- | ---- | .7 | 30.9 | ---- | 3.3 | " |
| 183 | 532 | 34.0 | 23 0 | 2 32 | .0042 | 62 | --- | 683 | 97 0 | 86.6 | 5.77 | 9 8 | 228 | ---- | ---- | 17.0 | 58.3 | 2.9 | ---- | Jet A |
| 184 | 534 | 34 1 | 23 1 | 2.32 | 0041 | 62 | --- | 685 | 97 0 | 86 6 | 5 61 | | 221 | ---- | ---- | 16.8 | 60.1 | ---- | 4.2 | " |
| 185 | 533 | 34 2 | 22 9 | 2 32 | 0086 | 251 | --- | 855 | 99 1 | 96 3 | 5 98 | 7 1 | 261 | ---- | ---- | 2 9 | 23.8 | 3.7 | ---- | " |
| 186 | 533 | 34 2 | 22.7 | 2 30 | 0086 | 252 | --- | 852 | 99 1 | 95 2 | 5 94 | | 243 | ---- | ---- | 3.2 | 24.0 | ---- | 4.9 | " |
| 187 | 534 | 34 1 | 23.0 | 2 32 | 0146 | 233 | 1 | 1072 | 99 7 | 98 4 | 6 52 | 2 4 | .247 | ---- | ---- | 5 | 12.5 | 4.4 | ---- | " |
| 188 | 534 | 33 7 | 23 3 | 2 32 | 0146 | 234 | 1 | 1071 | 99 7 | 98 2 | 6 83 | | .257 | ---- | ---- | 5 | 12 6 | ---- | 5 5 | " |

*expressed as grams of $NO_2$/kg of fuel

TABLE III. - CONTINUED.

| Run | Combustor inlet | | Reference velocity, m/s | Air flow rate, kg/s | Fuel air ratio | Fuel-nozzle pressure drop, $N/cm^2$ | | Combustor exit temperature, K | Combustion efficiency, percent | | Combustor total pressure loss, $\Delta P/P$, percent, | SAE smoke number | Pattern factor | Maximum liner temperature, K | Average liner temperature, K | Emission index, g/kg of fuel | | | | Fuel |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Temperature, K | Pressure, $N/cm^2$ | | | | Primary | Secondary | | gas analysis | enthalpy rise basis | | | | | | Unburned hydrocarbons | CO | NO* | $NO_x$* | |
| 189 | 534 | 34 3 | 22 9 | 2 32 | 0 0196 | 218 | 10 | 1234 | 99 8 | 98 6 | 7 04 | 5 2 | 0 187 | ---- | ---- | 0 1 | 8 9 | 5 2 | ---- | Jet A |
| 190 | 533 | 34 1 | 23 0 | 2 32 | 0194 | 219 | 10 | 1226 | 99.8 | 98 1 | 7.11 | | 198 | ---- | ---- | 1 | 9 3 | ---- | 5.7 | " |
| 191 | 535 | 34 5 | 23 0 | 2 33 | 0215 | 191 | 17 | 1276 | 99 8 | 97 1 | 7 10 | 31.4 | 182 | ---- | ---- | 2 | 7 3 | 5 9 | ---- | Diesel |
| 192 | 534 | 34 4 | 22 9 | 2 33 | 0214 | 191 | 17 | 1270 | 99 8 | 96.8 | 7 25 | | 155 | ---- | ---- | 1 | 8.0 | ---- | 6.3 | " |
| 193 | 534 | 34 3 | 23 0 | 2 33 | 0161 | 203 | 5 | 1105 | 99 7 | 96.9 | 6 77 | 23.4 | 187 | ---- | ---- | .2 | 10.5 | 5 4 | ---- | " |
| 194 | 534 | 34 4 | 22 9 | 2.33 | .0161 | 204 | 4 | 1106 | 99 7 | 97 6 | 6 54 | | 215 | ---- | ---- | .2 | 10 9 | ---- | 6.1 | " |
| 195 | 534 | 34.5 | 22 8 | 2 32 | .0097 | 220 | --- | 893 | 99 2 | 97 3 | 5 99 | 26 6 | 245 | ---- | ---- | 2.5 | 25.4 | 4.0 | ---- | " |
| 196 | 534 | 34.0 | 23 1 | 2 32 | .0094 | 220 | --- | 883 | 99 1 | 97 7 | 6.08 | | 238 | ---- | ---- | 2.7 | 25 8 | ---- | 5 3 | " |
| 197 | 535 | 34 1 | 22 9 | 2 30 | .0048 | 81 | --- | 713 | 97 3 | 88.5 | 5 67 | 22 2 | 232 | ---- | ---- | 14 1 | 59 7 | 3 0 | ---- | " |
| 198 | 535 | 34.5 | 22 7 | 2 31 | .0048 | 81 | --- | 690 | 97 2 | 89.2 | 5 60 | | 234 | ---- | ---- | 14 3 | 59 4 | ---- | 4 8 | " |
| 199 | 701 | 34.4 | 23 2 | 1 80 | 0057 | 77 | --- | 907 | 99 9 | 96 1 | 4.44 | 1.3 | 176 | ---- | ---- | 5 | 3 9 | 9.6 | ---- | Jet A |
| 200 | 700 | 34.3 | 23 3 | 1 80 | 0057 | 77 | --- | 906 | 99 8 | 96 2 | 4 24 | | 198 | ---- | ---- | 5 | 5.5 | ---- | 10.2 | " |
| 201 | 699 | 34.1 | 23 1 | 1.78 | 0108 | 283 | --- | 1080 | 99.9 | 96.6 | 4 57 | 2 8 | 186 | ---- | ---- | 2 | 1 7 | 11 1 | ---- | " |
| 202 | 700 | 34.0 | 23 5 | 1 80 | .0106 | 282 | --- | 1081 | 99.9 | 98 0 | 4.59 | | 178 | ---- | ---- | .2 | 3 0 | ---- | 12.0 | " |
| 203 | 702 | 33.9 | 23 8 | 1 81 | 0171 | 327 | --- | 1298 | 99.9 | 98 5 | 5 05 | 5 3 | 190 | ---- | ---- | 2 | 2 0 | 11.9 | ---- | " |
| 204 | 701 | 33 9 | 23 6 | 1 80 | 0170 | 328 | --- | 1294 | 99.9 | 98.4 | 4 84 | | .217 | ---- | ---- | .1 | 2.3 | ---- | 12.3 | " |
| 205 | 700 | 34 3 | 23 9 | 1 84 | 0187 | 170 | 4 | 1336 | 99 9 | 98.5 | 5.01 | 21 6 | 149 | ---- | ---- | .1 | 2.5 | 11 3 | ---- | Diesel |
| 206 | 698 | 34 1 | 23 8 | 1 84 | .0186 | 172 | 4 | 1332 | 99 9 | 98 4 | 4 90 | | 169 | ---- | ---- | .1 | 2.4 | ---- | 11.8 | " |
| 207 | 701 | 34.0 | 23 9 | 1 83 | .0112 | 188 | --- | 1102 | 99.9 | 99 2 | 4 75 | 14 3 | 193 | ---- | ---- | .1 | 2.1 | 11 3 | ---- | " |
| 208 | 701 | 34.1 | 23 9 | 1 83 | 0115 | 189 | --- | 1109 | 99 9 | 99.0 | 4.88 | | 179 | ---- | ---- | 1 | 1.8 | ---- | 11.3 | " |
| 209 | 700 | 34 4 | 23 7 | 1 84 | 0063 | 96 | --- | 938 | 99 8 | 101 4 | 4 44 | 7.8 | 183 | ---- | ---- | 2 | 6 3 | 9 6 | ---- | " |
| 210 | 700 | 34 2 | 23 9 | 1 84 | .0063 | 96 | --- | 937 | 99 9 | 100 9 | 4 62 | | 184 | ---- | ---- | 2 | 5 3 | ---- | 10 3 | " |
| 211 | 394 | 102 7 | 22 9 | 9.43 | .0076 | 159 | 42 | 663 | 95.4 | 87 5 | 8 64 | 12 7 | 176 | 491 | 430 | 30 8 | 59 8 | 2 8 | ---- | Jet A |
| 212 | 393 | 103 3 | 22 7 | 9 41 | .0076 | 157 | 42 | 662 | 95.4 | 87 4 | 8 46 | | 166 | 494 | 430 | 30.9 | 62 7 | ---- | 3.1 | " |
| 213 | 393 | 103 4 | 22 6 | 9.35 | 0122 | 144 | 147 | 827 | 98.7 | 90 3 | 9 75 | 21 8 | .114 | 584 | 453 | 6 4 | 28 2 | 2 9 | ---- | " |

*expressed as grams of $NO_2$/kg of fuel

TABLE III. - CONTINUED

| Run | Combustor inlet | | Reference velocity, m/s | Air flow rate, kg/s | Fuel air ratio | Fuel-nozzle pressure drop, $N/cm^2$ | | Combustor exit temperature, K | Combustion efficiency, percent | | Combustor total pressure loss, ΔP/P, percent, | SAE smoke number | Pattern factor | Maximum liner temperature, K | Average liner temperature, K | Emission index, g/kg of fuel | | | | Fuel |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Temperature, K | Pressure, $N/cm^2$ | | | | Primary | Secondary | | gas analysis | enthalpy rise basis | | | | | | Unburned hydrocarbons | CO | NO* | $NO_x$* | |
| 214 | 393 | 103.5 | 22.7 | 9.42 | 0.0122 | 145 | 147 | 832 | 98.8 | 91.7 | 9.50 | | 0.111 | 585 | 453 | 6.1 | 26.5 | ---- | 3.9 | Jet A |
| 215 | 394 | 103.5 | 23.0 | 9.51 | 0182 | 438 | --- | 1032 | 99.3 | 92.8 | 11.09 | 36.2 | .148 | 683 | 469 | 1.9 | 21.7 | 3.3 | ---- | " |
| 216 | 393 | 103.7 | 22.9 | 9.50 | 0181 | 435 | --- | 1031 | 99.2 | 92.8 | 11.04 | | .158 | 682 | 469 | 2.1 | 23.6 | ---- | 4.0 | " |
| 217 | 391 | 103.1 | 22.9 | 9.50 | 0080 | 266 | 37 | 667 | 96.4 | 86.6 | 8.80 | 33.0 | 153 | 502 | 434 | 22.5 | 58.8 | 2.6 | ---- | Diesel |
| 218 | 390 | 103.9 | 22.5 | 9.46 | 0081 | 265 | 38 | 666 | 96.3 | 85.8 | 8.53 | | .154 | 503 | 434 | 22.8 | 60.9 | ---- | 3.3 | " |
| 219 | 392 | 102.3 | 23.0 | 9.46 | 0132 | 251 | 148 | 846 | 98.8 | 89.8 | 9.83 | 52.5 | 140 | 595 | 469 | 5.0 | 25.8 | 3.9 | ---- | " |
| 220 | 392 | 103.4 | 22.7 | 9.46 | 0132 | 253 | 149 | 848 | 99.0 | 89.9 | 9.71 | | .129 | 591 | 469 | 3.8 | 24.3 | ---- | 4.4 | " |
| 221 | 532 | 103.8 | 22.5 | 6.92 | 0203 | 219 | 226 | 1202 | 99.8 | 91.4 | 7.18 | 59.6 | 168 | 851 | 658 | .1 | 5.6 | 8.1 | ---- | Jet A |
| 222 | 533 | 103.8 | 22.6 | 6.95 | 0202 | 219 | 225 | 1201 | 99.9 | 91.5 | 7.07 | | .162 | 848 | 659 | 1 | 5.1 | ---- | 8.0 | " |
| 223 | 533 | 103.0 | 22.9 | 6.96 | 0148 | 242 | 107 | 1043 | 99.9 | 92.3 | 6.58 | 44.4 | 139 | 770 | 638 | .2 | 5.3 | 8.4 | ---- | " |
| 224 | 534 | 102.7 | 23.0 | 6.97 | .0147 | 241 | 106 | 1040 | 99.9 | 92.1 | 6.88 | | .165 | 768 | 637 | 2 | 5.9 | ---- | 8.6 | " |
| 225 | 534 | 103.0 | 22.8 | 6.91 | 0088 | 222 | 24 | 843 | 99.8 | 90.7 | 6.07 | 28.8 | 166 | 672 | 597 | 6 | 8.0 | 7.5 | ---- | " |
| 226 | 534 | 102.7 | 22.9 | 6.94 | 0089 | 221 | 25 | 841 | 99.8 | 89.7 | 6.10 | | 184 | 673 | 597 | 6 | 8.2 | ---- | 7.8 | " |
| 227 | 534 | 103.0 | 23.0 | 6.98 | 0042 | 134 | --- | 680 | 99.0 | 83.4 | 5.72 | 16.4 | 203 | 588 | 558 | 4.8 | 26.7 | 5.4 | ---- | " |
| 228 | 534 | 102.9 | 22.9 | 6.95 | 0042 | 133 | --- | 678 | 99.0 | 82.2 | 5.86 | | 226 | 588 | 558 | 5.0 | 24.7 | ---- | 6.3 | " |
| 229 | 534 | 103.5 | 22.7 | 6.94 | 0047 | 136 | --- | 694 | 99.0 | 81.4 | 5.68 | 23.6 | .218 | 613 | 576 | 4.0 | 26.5 | 5.8 | ---- | Diesel |
| 230 | 532 | 103.2 | 22.6 | 6.91 | 0046 | 137 | --- | 687 | 98.9 | 80.6 | 5.65 | | 224 | 609 | 571 | 4.5 | 27.0 | ---- | 6.5 | " |
| 231 | 532 | 103.0 | 22.8 | 6.95 | 0095 | 117 | 34 | 853 | 99.6 | 88.7 | 6.00 | 43.3 | .187 | 740 | 618 | 1.0 | 11.5 | 7.7 | ---- | " |
| 232 | 532 | 103.5 | 22.6 | 6.93 | 0095 | 118 | 34 | 853 | 99.6 | 88.7 | 5.90 | | 184 | 742 | 618 | 1.0 | 10.8 | ---- | 8.5 | " |
| 233 | 533 | 103.1 | 22.8 | 6.96 | 0164 | 111 | 138 | 1072 | 99.8 | 90.2 | 6.73 | 65.0 | 151 | 839 | 663 | .3 | 7.3 | 8.6 | ---- | " |
| 234 | 533 | 102.8 | 22.7 | 6.89 | .0165 | 112 | 136 | 1070 | 99.8 | 89.5 | 6.81 | | 151 | 840 | 663 | .3 | 6.9 | ---- | 9.0 | " |
| 235 | 533 | 103.3 | 22.7 | 6.92 | 0216 | 306 | 226 | 1219 | 99.8 | 89.4 | 7.05 | 73.2 | 139 | 874 | 680 | .2 | 6.3 | 8.3 | ---- | " |
| 236 | 533 | 103.7 | 22.6 | 6.94 | 0216 | 307 | 227 | 1220 | 99.8 | 89.8 | 7.02 | | .142 | 875 | 680 | .2 | 5.9 | ---- | 8.6 | " |

*expressed as grams of $NO_2$/kg of fuel

TABLE III. - CONTINUED.

| Run | Combustor inlet | | Reference velocity, m/s | Air flow rate, kg/s | Fuel air ratio | Fuel-nozzle pressure drop, $N/cm^2$ | | Combustor exit temperature, K | Combustion efficiency, percent | | Combustor total pressure loss, $\Delta P/P$, percent, | SAE smoke number | Pattern factor | Maximum liner temperature, K | Average liner temperature, K | Emission index, g/kg of fuel | | | | Fuel |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Temperature, K | Pressure, $N/cm^2$ | | | | Primary | Secondary | | gas analysis | enthalpy rise basis | | | | | | Unburned hydrocarbons | CO | NO* | $NO_x$* | |
| 237 | 699 | 103 8 | 22.6 | 5 30 | 0 0044 | 86 | --- | 841 | 99.6 | 77.2 | 4 33 | 36 9 | 0 220 | 798 | 740 | 2 8 | 10 6 | 12.4 | ---- | Jet A |
| 238 | 699 | 103.4 | 22.5 | 5 26 | .0044 | 87 | --- | 837 | 99 5 | 72 5 | 4 30 | | 251 | 799 | 742 | 3 0 | 11 4 | ---- | 13.3 | " |
| 239 | 700 | 103.5 | 22.5 | 5 25 | .0044 | 87 | --- | 837 | 99 5 | 73 2 | 4 41 | | 252 | 800 | 744 | 2 9 | 8.9 | 12.3 | ---- | " |
| 240 | 698 | 103.6 | 22 6 | 5 28 | .0109 | 70 | 30 | 1049 | 99 8 | 88 4 | 4 65 | 43 8 | 188 | 944 | 833 | .7 | 7 3 | 18.0 | ---- | " |
| 241 | 699 | 103.3 | 22 6 | 5 27 | 0109 | 70 | 30 | 1052 | 99 7 | 88.8 | 4 69 | | 181 | 949 | 834 | 7 | 8 2 | ---- | 19.8 | " |
| 242 | 699 | 104 1 | 22 5 | 5 29 | 0157 | 68 | 76 | 1199 | 99 8 | 89 5 | 4 85 | 45 7 | 137 | 1047 | 887 | 3 | 6 4 | 19 8 | ---- | " |
| 243 | 699 | 103.1 | 22 8 | 5 30 | .0157 | 69 | 77 | 1200 | 99 8 | 89 4 | 5 05 | | 140 | 1047 | 888 | 3 | 6.9 | ---- | 21.3 | " |
| 244 | 698 | 103.6 | 22 7 | 5 30 | .0169 | 71 | 82 | 1209 | 99.8 | 86 7 | 5.01 | 41 3 | .153 | 1122 | 910 | 2 | 6 0 | 21.2 | ---- | Diesel |
| 245 | 698 | 103 5 | 22 7 | 5 31 | .0169 | 71 | 83 | 1207 | 99 8 | 86 3 | 4 97 | | 149 | 1121 | 909 | 2 | 5.4 | ---- | 22.9 | " |
| 246 | 698 | 103 5 | 22 6 | 5.29 | 0116 | 110 | 27 | 1058 | 99 7 | 86 3 | 4 80 | 34 1 | 181 | 1003 | 852 | 6 | 8 1 | 19 6 | ---- | " |
| 247 | 698 | 104.0 | 22.7 | 5 32 | .0114 | 110 | 27 | 1051 | 99 7 | 85 8 | 4 69 | | 187 | 1003 | 852 | 6 | 8 8 | ---- | 22.5 | " |
| 248 | 699 | 103 7 | 22.8 | 5.33 | .0047 | 95 | --- | 848 | 99 5 | 75 5 | 4.39 | 16 7 | 231 | 812 | 763 | 2 2 | 11 9 | 12.6 | ---- | " |
| 249 | 700 | 103 6 | 22 8 | 5 33 | 0047 | 113 | --- | 848 | 99 5 | 73 8 | 4 33 | | 254 | 811 | 763 | 2 3 | 11.9 | ---- | 14 3 | " |
| 250 | 395 | 33 9 | 30 3 | 4 11 | .0078 | 123 | --- | 656 | 89.6 | 83 5 | 16.82 | 3 5 | 216 | 560 | 434 | 70 9 | 133 4 | 1.9 | ---- | Jet A |
| 251 | 394 | 34 2 | 30.3 | 4 14 | 0077 | 122 | --- | 654 | 89 5 | 83 6 | 16.82 | | 211 | 559 | 434 | 72.3 | 135.4 | ---- | 2.0 | " |
| 252 | 394 | 33 8 | 30 2 | 4 08 | 0124 | 111 | 17 | 828 | 95 0 | 88 9 | 18 84 | 3 4 | 202 | 681 | 458 | 27.2 | 92 1 | 2.1 | ---- | " |
| 253 | 394 | 33 7 | 30 7 | 4 13 | .0122 | 111 | 17 | 827 | 95 0 | 89 9 | 19 04 | | 203 | 677 | 457 | 27.0 | 94.9 | ---- | 2.2 | " |
| 254 | 395 | 33 8 | 30.6 | 4 13 | 0185 | 108 | 58 | 1036 | 97 0 | 91.9 | 21 86 | 2.3 | 174 | 826 | 479 | 9.3 | 87 1 | 2.4 | ---- | " |
| 255 | 395 | 33 7 | 30.4 | 4 09 | .0187 | 108 | 59 | 1045 | 97 0 | 91.9 | 21.98 | | 157 | 815 | 479 | 8 8 | 89 3 | ---- | 2.5 | " |
| 256 | 393 | 33 8 | 30.4 | 4 12 | .0238 | 109 | 109 | 1205 | 98 0 | 92.9 | 24 42 | 4 7 | 148 | 871 | 480 | 2.9 | 76.6 | 2.3 | ---- | " |
| 257 | 394 | 33 8 | 30.1 | 4 08 | .0241 | 110 | 109 | 1210 | 97.7 | 92.5 | 24 25 | | .139 | 868 | 476 | 3.9 | 84 5 | ---- | 2.3 | " |
| 258 | 393 | 33 7 | 30 6 | 4 13 | 0084 | 100 | 2 | 657 | 88 1 | 78 8 | 17.45 | 18 3 | 185 | 549 | 432 | 77.5 | 151 4 | 1 9 | ---- | Diesel |
| 259 | 394 | 34 1 | 30 4 | 4 14 | 0084 | 100 | 2 | 656 | 88 5 | 78.8 | 17 10 | | 171 | 549 | 433 | 74.1 | 149 9 | ---- | 2 0 | " |
| 260 | 394 | 34.1 | 30.4 | 4 14 | .0132 | 98 | 20 | 832 | 93 9 | 86 3 | 19 27 | 20 5 | 177 | 691 | 459 | 33 7 | 107.9 | 2 3 | ---- | " |
| 261 | 394 | 34 2 | 30.3 | 4 13 | .0133 | 98 | 21 | 838 | 94 2 | 86.6 | 19 05 | | .170 | 694 | 459 | 31 2 | 105.3 | ---- | 2.4 | " |

*expressed as grams of $NO_2$/kg of fuel

TABLE III. - CONTINUED

| Run | Combustor inlet | | Reference velocity, m/s | Air flow rate, kg/s | Fuel air ratio | Fuel-nozzle pressure drop, N/cm$^2$ | | Combustor exit temperature, K | Combustion efficiency, percent | | Combustor total pressure loss, $\Delta P/P$, percent, | SAE smoke number | Pattern factor | Maximum liner temperature, K | Average liner temperature, K | Emission index, g/kg of fuel | | | | Fuel |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Temperature, K | Pressure, N/cm$^2$ | | | | Primary | Secondary | | gas analysis | enthalpy rise basis | | | | | | Unburned hydrocarbons | CO | NO* | $NO_x$* | |
| 262 | 394 | 33.9 | 30 4 | 4.11 | 0.0203 | 91 | 68 | 1068 | 96 0 | 90.1 | 21.95 | 18 4 | 0.258 | 823 | 478 | 13.0 | 106.7 | 2.6 | ---- | Diesel |
| 263 | 393 | 34.0 | 30 5 | 4.15 | .0201 | 92 | 68 | 1060 | 96 1 | 89.7 | 22.59 | | .338 | 815 | 476 | 12.5 | 108.6 | ---- | 2.7 | " |
| 264 | 394 | 33 7 | 30.5 | 4.12 | .0258 | 93 | 120 | 1231 | 97 1 | 90.4 | 25 17 | 18 0 | .211 | 835 | 476 | 5.9 | 94.4 | 2.6 | ---- | " |
| 265 | 394 | 34.1 | 30.2 | 4 11 | .0259 | 93 | 120 | 1229 | 97.2 | 90.1 | 24 54 | | 178 | 832 | 476 | 5.3 | 93 0 | ---- | 2.7 | " |
| 266 | 534 | 34 1 | 30.7 | 3.08 | .0043 | 124 | --- | 686 | 95 8 | 84 8 | 10.44 | 4.3 | 244 | ---- | ---- | 24.0 | 80.6 | 2.2 | ---- | Jet A |
| 267 | 533 | 34 0 | 30 5 | 3.07 | .0043 | 124 | --- | 686 | 95.8 | 84.2 | 10.30 | | .226 | ---- | ---- | 24 3 | 80.5 | ---- | 3.4 | " |
| 268 | 534 | 34.4 | 30.4 | 3.08 | .0086 | 240 | --- | 848 | 98 4 | 94 2 | 11.14 | 5 6 | 288 | ---- | ---- | 6.3 | 42.2 | 2.6 | ---- | " |
| 269 | 534 | 34 3 | 30.1 | 3.05 | .0087 | 241 | --- | 849 | 98 4 | 94.0 | 11 23 | | 289 | ---- | ---- | 6.3 | 42.6 | ---- | 3 9 | " |
| 270 | 534 | 34.5 | 30 2 | 3 08 | .0148 | 217 | 9 | 1069 | 99.3 | 96.8 | 12 48 | 4.6 | 214 | ---- | ---- | 1 1 | 23.9 | 3.4 | ---- | " |
| 271 | 534 | 34.4 | 30.1 | 3 06 | .0147 | 218 | 8 | 1061 | 99.3 | 96.1 | 12.41 | | 208 | ---- | ---- | 1.1 | 24 4 | ---- | 4.4 | " |
| 272 | 533 | 34 3 | 30 4 | 3.08 | .0200 | 203 | 28 | 1228 | 99 6 | 95.7 | 13 42 | 1 9 | 206 | ---- | ---- | .2 | 17.4 | 3.9 | ---- | " |
| 273 | 533 | 34.4 | 30 5 | 3.09 | .0196 | 203 | 26 | 1216 | 99 6 | 95.9 | 13 29 | | 217 | ---- | ---- | 2 | 18.2 | ---- | 4 5 | " |
| 274 | 533 | 33 8 | 30 7 | 3.06 | 0048 | 148 | --- | 706 | 95 6 | 85.3 | 10 22 | 13 8 | 198 | ---- | ---- | 25 9 | 89.8 | 2.9 | ---- | Diesel |
| 275 | 533 | 33.8 | 30 8 | 3 08 | .0048 | 148 | --- | 705 | 95 4 | 85.5 | 10.48 | | 200 | ---- | ---- | 26 0 | 88.9 | ---- | 3.8 | " |
| 276 | 532 | 34 2 | 30.1 | 3.04 | .0096 | 180 | --- | 876 | 98 1 | 94.7 | 10.97 | 17.9 | 203 | ---- | ---- | 7 2 | 47.2 | 3.3 | ---- | " |
| 277 | 532 | 34.0 | 30 3 | 3 05 | 0096 | 181 | --- | 874 | 98 2 | 94.3 | 11 05 | | 203 | ---- | ---- | 7.0 | 46.9 | ---- | 4.4 | " |
| 278 | 534 | 34 0 | 30.4 | 3.05 | 0162 | 162 | 17 | 1099 | 99 3 | 95 3 | 12 00 | 14.2 | 167 | ---- | ---- | 9 | 25.3 | 4.2 | ---- | " |
| 279 | 534 | 34 1 | 30 4 | 3.05 | .0160 | 165 | 16 | 1091 | 99 3 | 95.2 | 12 32 | | 184 | ---- | ---- | 1.1 | 24.8 | ---- | 5.0 | " |
| 280 | 533 | 34 3 | 30 0 | 3 03 | 0224 | 175 | 42 | 1278 | 94 0 | 99.6 | 13.15 | | 170 | ---- | ---- | 2 | 15.5 | 4.7 | ---- | " |
| 281 | 532 | 33.8 | 30.7 | 3 07 | 0222 | 178 | 42 | 1280 | 99 6 | 95 1 | 13.60 | 16 7 | 222 | ---- | ---- | 2 | 16.5 | ---- | 5.0 | " |
| 282 | 698 | 34.3 | 30 7 | 2 37 | 0046 | 87 | --- | 863 | 99 7 | 86.6 | 7.53 | 0.1 | 177 | ---- | ---- | 7 | 9.8 | 7.6 | ---- | Jet A |
| 283 | 702 | 34 4 | 30.8 | 2.38 | 0046 | 86 | --- | 866 | 99 7 | 86 2 | 7.39 | | 179 | ---- | ---- | .7 | 10.3 | ---- | 8.6 | " |
| 284 | 698 | 34.0 | 30.9 | 2.37 | .0107 | 337 | --- | 1078 | 99 9 | 97.0 | 8.38 | 2.0 | .176 | ---- | ---- | .2 | 4 6 | 9.8 | ---- | " |
| 285 | 699 | 34 0 | 30 6 | 2 34 | 0109 | 337 | --- | 1087 | 99.9 | 97.0 | 8.20 | | .203 | ---- | ---- | .2 | 3 4 | ---- | 10.3 | " |

*expressed as grams of $NO_2$/kg of fuel.

TABLE III. - CONTINUED.

| Run | Combustor inlet | | Reference velocity, m/s | Air flow rate, kg/s | Fuel air ratio | Fuel-nozzle pressure drop, $N/cm^2$ | | Combustor exit temperature, K | Combustion efficiency, percent | | Combustor total pressure loss, $\Delta P/P$, percent, | SAE smoke number | Pattern factor | Maximum liner temperature, K | Average liner temperature, K | Emission index, g/kg of fuel | | | | Fuel |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Temperature, K | Pressure, $N/cm^2$ | | | | Primary | Secondary | | gas analysis | enthalpy rise basis | | | | | | Unburned hydrocarbons | CO | NO* | $NO_x$* | |
| 286 | 698 | 34.3 | 30.7 | 2.38 | 0.0170 | 313 | 4 | 1287 | 99.9 | 97.8 | 8.89 | 1.5 | 0.170 | ---- | ---- | 0.1 | 3.6 | 9.9 | ---- | Jet A |
| 287 | 699 | 34.2 | 31.3 | 3.41 | .0165 | 314 | 3 | 1274 | 99.9 | 98.0 | 9.02 | | 192 | ---- | ---- | 1 | 3.9 | ---- | 10.5 | " |
| 288 | 702 | 34.4 | 30.7 | 2.37 | .0187 | 373 | 4 | 1326 | 99.9 | 96.3 | 8.70 | 14.6 | 183 | ---- | ---- | 1 | 3.5 | 10.3 | ---- | Diesel |
| 289 | 702 | 34.2 | 30.9 | 2.37 | 0185 | 374 | 3 | 1320 | 99.9 | 96.2 | 9.03 | | 190 | ---- | ---- | 1 | 3.1 | ---- | 10.6 | " |
| 290 | 699 | 33.9 | 30.8 | 2.36 | 0115 | 400 | --- | 1097 | 99.9 | 96.3 | 8.29 | 9.8 | 168 | ---- | ---- | 1 | 3.6 | 9.9 | ---- | " |
| 291 | 700 | 34.0 | 31.0 | 2.37 | 0114 | 399 | --- | 1098 | 99.9 | 96.8 | 8.20 | | 166 | ---- | ---- | 1 | 3.3 | ---- | 10.3 | " |
| 292 | 702 | 34.4 | 30.8 | 2.38 | 0051 | 105 | --- | 890 | 99.7 | 98.2 | 7.56 | 3.1 | 180 | ---- | ---- | 3 | 11.2 | 8.2 | ---- | " |
| 293 | 699 | 34.2 | 30.8 | 2.37 | 0051 | 105 | --- | 887 | 99.7 | 98.1 | 7.54 | | 197 | ---- | ---- | 4 | 12.9 | ---- | 9.1 | " |
| 294 | 533 | 103.4 | 30.0 | 9.19 | 0187 | 437 | --- | 1168 | 99.6 | 93.2 | 12.89 | 43.6 | 224 | 813 | 623 | 8 | 12.3 | 5.6 | ---- | Jet A |
| 295 | 534 | 103.7 | 30.2 | 9.24 | 0186 | 438 | --- | 1165 | 99.6 | 93.6 | 12.90 | | 143 | 812 | 625 | 8 | 12.5 | ---- | 7.0 | " |
| 296 | 535 | 103.5 | 30.1 | 9.16 | 0151 | 196 | 216 | 1039 | 99.6 | 89.7 | 12.21 | 54.5 | 140 | 759 | 614 | 1.3 | 11.0 | 5.7 | ---- | " |
| 297 | 536 | 103.3 | 30.3 | 9.21 | 0149 | 195 | 215 | 1027 | 99.6 | 88.2 | 12.23 | | 170 | 760 | 614 | 1.3 | 10.8 | ---- | 7.2 | " |
| 298 | 534 | 102.9 | 30.5 | 9.25 | 0087 | 195 | 54 | 842 | 99.5 | 91.4 | 11.33 | 35.0 | 161 | 653 | 580 | 2.1 | 16.0 | 5.4 | ---- | " |
| 299 | 534 | 103.3 | 30.3 | 9.22 | 0087 | 194 | 52 | 833 | 99.4 | 89.2 | 11.29 | | 193 | 650 | 579 | 2.1 | 16.0 | ---- | 6.7 | " |
| 300 | 534 | 103.1 | 30.3 | 9.22 | 0042 | 153 | --- | 675 | 98.0 | 80.6 | 10.28 | 22.9 | 221 | 587 | 553 | 10.2 | 44.1 | 3.6 | ---- | " |
| 301 | 534 | 103.4 | 30.2 | 9.20 | 0041 | 151 | --- | 671 | 98.0 | 80.3 | 10.38 | | 226 | 585 | 552 | 10.7 | 42.7 | ---- | 5.2 | " |
| 302 | 535 | 103.1 | 30.5 | 9.25 | 0046 | 107 | 2 | 685 | 98.0 | 78.0 | 10.59 | 29.0 | 237 | 590 | 559 | 9.3 | 42.1 | 4.9 | ---- | Diesel |
| 303 | 536 | 103.4 | 30.2 | 9.19 | 0046 | 107 | 2 | 685 | 98.1 | 77.6 | 10.57 | | 230 | 591 | 560 | 8.9 | 41.7 | ---- | 5.6 | " |
| 304 | 533 | 103.1 | 30.4 | 9.26 | .0093 | 98 | 69 | 840 | 99.3 | 86.4 | 11.41 | 38.5 | 206 | 662 | 591 | 2.2 | 18.3 | 6.4 | ---- | " |
| 305 | 531 | 103.3 | 30.1 | 9.22 | 0094 | 99 | 68 | 844 | 99.4 | 87.5 | 11.16 | | 202 | 663 | 590 | 2.1 | 17.0 | ---- | 7.4 | " |
| 306 | 531 | 103.3 | 30.2 | 9.26 | 0161 | 109 | 247 | 1055 | 99.6 | 89.3 | 12.34 | 58.2 | 141 | 764 | 628 | 1.2 | 12.2 | 6.6 | ---- | " |
| 307 | 531 | 102.4 | 30.1 | 9.13 | 0163 | 109 | 248 | 1045 | 99.6 | 86.4 | 12.28 | | 186 | 765 | 628 | 1.1 | 12.3 | ---- | 7.5 | " |
| 308 | 531 | 103.4 | 30.0 | 9.20 | 0190 | 431 | --- | 1135 | 99.6 | 88.5 | 12.71 | 69.3 | 182 | 810 | 640 | 7 | 13.4 | 6.6 | ---- | " |
| 309 | 531 | 103.3 | 30.1 | 9.21 | .0190 | 434 | --- | 1144 | 99.6 | 89.7 | 12.79 | | 170 | 810 | 639 | 7 | 13.2 | ---- | 7.5 | " |

*expressed as grams of $NO_2$/kg of fuel

TABLE III. - CONTINUED.

| Run | Combustor inlet | | Reference velocity, m/s | Air flow rate, kg/s | Fuel air ratio | Fuel-nozzle pressure drop, N/cm$^2$ | | Combustor exit temperature, K | Combustion efficiency, percent | | Combustor total pressure loss, ΔP/P, percent, | SAE smoke number | Pattern factor | Maximum liner temperature, K | Average liner temperature, K | Emission index, g/kg of fuel | | | | Fuel |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Temperature, K | Pressure, N/cm$^2$ | | | | Primary | Secondary | | gas analysis | enthalpy rise basis | | | | | | Unburned hydrocarbons | CO | NO* | $NO_x$* | |
| 310 | 698 | 103.2 | 30.1 | 7.01 | 0 0156 | 220 | 121 | 1194 | 99 7 | 86 0 | 8 81 | 34 1 | 0.183 | 1026 | 858 | 0 3 | 11.9 | 15 8 | ---- | Jet A |
| 311 | 699 | 103.7 | 30.0 | 7.00 | .0157 | 219 | 122 | 1196 | 99 7 | 88.6 | 8.68 | ---- | 169 | 1026 | 860 | 3 | 12 2 | ---- | 18 2 | " |
| 312 | 699 | 103.4 | 30 2 | 7 05 | 0105 | 254 | 36 | 1042 | 99 5 | 89 9 | 8 37 | 18 2 | 194 | 936 | 807 | 1 4 | 15.8 | 13.1 | ---- | " |
| 313 | 700 | 103.8 | 30 2 | 7 05 | .0104 | 250 | 35 | 1034 | 99 5 | 87 7 | 8 27 | ---- | 217 | 934 | 806 | 1.5 | 16 6 | ---- | 17 1 | " |
| 314 | 699 | 103 7 | 30.1 | 7 04 | .0044 | 242 | --- | 838 | 98.8 | 75 5 | 7 74 | 8 0 | 235 | 799 | 738 | 7 6 | 20 2 | 7 8 | ---- | " |
| 315 | 699 | 103.7 | 30 0 | 7 02 | 0044 | 273 | --- | 837 | 98 7 | 73 7 | 7 75 | ---- | 247 | 798 | 738 | 8.3 | 21 6 | ---- | 11 3 | " |
| 316 | 700 | 102 9 | 30 5 | 7 06 | 0048 | 106 | --- | 847 | 99 2 | 73.7 | 8 01 | 12 7 | 238 | 811 | 751 | 4 5 | 13 7 | 9 7 | ---- | Diesel |
| 317 | 700 | 103.6 | 30 1 | 7 02 | .0047 | 106 | --- | 844 | 99 2 | 73.5 | 7 87 | ---- | .245 | 808 | 750 | 4 6 | 13.8 | ---- | 12 0 | " |
| 318 | 700 | 103 6 | 30 0 | 6 99 | 0115 | 86 | 58 | 1051 | 99.7 | 84 7 | 8.29 | 24 2 | .211 | 961 | 833 | 8 | 8.8 | 15 6 | ---- | " |
| 319 | 700 | 102.6 | 30.4 | 7 01 | 0114 | 87 | 57 | 1051 | 99 7 | 85.8 | 8 59 | ---- | 198 | 955 | 831 | .8 | 9.0 | ---- | 18 2 | " |
| 320 | 700 | 104.1 | 30.2 | 7.06 | 0170 | 228 | 134 | 1221 | 99 7 | 87.9 | 8 85 | 38 3 | 144 | 1055 | 885 | 3 | 10 7 | 17 3 | ---- | " |
| 321 | 700 | 103.6 | 30 0 | 7 01 | 0171 | 227 | 134 | 1220 | 99 7 | 87 2 | 8 97 | ---- | 156 | 1055 | 884 | 3 | 10 4 | ---- | 19 0 | " |
| 322 | 393 | 34 5 | 22.4 | 3 10 | .0084 | 340 | --- | 688 | ---- | 86 9 | 8 54 | ---- | 176 | 586 | 447 | ---- | ----- | ---- | ---- | Jet A |
| 323 | 394 | 34 3 | 22 5 | 3 09 | .0084 | 342 | --- | 689 | ---- | 87.1 | 8 66 | ---- | 169 | 585 | 447 | ---- | ----- | ---- | ---- | " |
| 324 | 392 | 34.5 | 22 3 | 3 10 | .0121 | 342 | --- | 821 | ---- | 89 9 | 9 27 | ---- | 187 | 691 | 466 | ---- | ----- | ---- | ---- | " |
| 325 | 394 | 34.4 | 22 6 | 3 11 | 0122 | 355 | --- | 826 | ---- | 90.2 | 9.26 | ---- | .197 | 693 | 468 | ---- | ----- | ---- | ---- | " |
| 326 | 392 | 34 4 | 22 5 | 3 11 | 0189 | 374 | 18 | 1049 | ---- | 92.2 | 10 85 | ---- | 215 | 836 | 487 | ---- | ----- | ---- | ---- | " |
| 327 | 395 | 34.3 | 22 6 | 3.10 | 0187 | 383 | 17 | 1051 | ---- | 92.7 | 10 80 | ---- | .228 | 835 | 489 | ---- | ----- | ---- | ---- | " |
| 328 | 395 | 34 4 | 22 7 | 3.11 | .0240 | 303 | 44 | 1209 | ---- | 92.6 | 11 87 | ---- | 204 | 886 | 494 | ---- | ----- | ---- | ---- | " |
| 329 | 393 | 34 2 | 22 9 | 3.15 | 0234 | 305 | 42 | 1194 | ---- | 93.0 | 12.05 | ---- | 205 | 873 | 490 | ---- | ----- | ---- | ---- | " |
| 330 | 394 | 34 9 | 22 7 | 3 17 | .0090 | 241 | --- | 704 | ---- | 87 7 | 9.12 | ---- | 160 | 590 | 456 | ---- | ----- | ---- | ---- | Diesel |
| 331 | 394 | 34.9 | 22 8 | 3 18 | 0092 | 240 | --- | 712 | ---- | 87 9 | 9 17 | ---- | 158 | 595 | 458 | ---- | ----- | ---- | ---- | " |
| 332 | 396 | 34.4 | 23 3 | 3.20 | .0129 | 230 | 4 | 848 | ---- | 91 2 | 10 05 | ---- | 154 | 701 | 483 | ---- | ----- | ---- | ---- | " |
| 333 | 396 | 34 3 | 23 2 | 3 17 | 0130 | 230 | 4 | 851 | ---- | 91 0 | 10 16 | ---- | 158 | 702 | 484 | ---- | ----- | ---- | ---- | " |
| 334 | 395 | 34 5 | 23 4 | 3 22 | .0197 | 230 | 25 | 1066 | ---- | 92 1 | 12 00 | ---- | 189 | 849 | 508 | ---- | ----- | ---- | ---- | " |

*expressed as grams of $NO_2$/kg of fuel

TABLE III. - CONTINUED

| Run | Combustor inlet | | Reference velocity, m/s | Air flow rate, kg/s | Fuel air ratio | Fuel-nozzle pressure drop, N/cm$^2$ | | Combustor exit temperature, K | Combustion efficiency, percent | | Combustor total pressure loss, ΔP/P, percent, | SAE smoke number | Pattern factor | Maximum liner temperature, K | Average liner temperature, K | Emission index, g/kg of fuel | | | | Fuel |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Temperature, K | Pressure, N/cm$^2$ | | | | Primary | Secondary | | gas analysis | enthalpy rise basis | | | | | | Unburned hydrocarbons | CO | NO* | $NO_x$* | |
| 335 | 395 | 34 4 | 23.7 | 3.24 | 0 0194 | 230 | 25 | 1066 | ---- | 93 2 | 12 01 | ---- | 0 182 | 849 | 507 | ---- | ----- | ---- | ---- | Diesel |
| 336 | 395 | 34.3 | 23 4 | 3 20 | 0251 | 351 | 45 | 1226 | ---- | 92 1 | 13 24 | ---- | 185 | 897 | 500 | ---- | ----- | ---- | ---- | " |
| 337 | 395 | 34 0 | 23.4 | 3 18 | 0253 | 351 | 45 | 1230 | ---- | 91 8 | 13 16 | ---- | .187 | 896 | 500 | ---- | ----- | ---- | ---- | " |
| 338 | 533 | 34 3 | 22 7 | 2 30 | 0040 | 42 | --- | 651 | ---- | 69 5 | 5 57 | ---- | 221 | 603 | 561 | ---- | ----- | ---- | ---- | Jet A |
| 339 | 533 | 34 4 | 22.8 | 2.32 | 0040 | 42 | --- | 650 | ---- | 69.0 | 5 61 | ---- | .222 | 602 | 560 | ---- | ----- | ---- | ---- | " |
| 340 | 535 | 34 4 | 22.9 | 2.32 | 0085 | 282 | --- | 826 | ---- | 88 2 | 6 02 | ---- | 190 | 726 | 602 | ---- | ----- | ---- | ---- | " |
| 341 | 535 | 34 3 | 22.8 | 2.30 | 0086 | 285 | --- | 831 | ---- | 88 5 | 5 99 | ---- | 172 | 726 | 602 | ---- | ----- | ---- | ---- | " |
| 342 | 534 | 34.4 | 22.6 | 2.30 | 0150 | 228 | 1 | 1042 | ---- | 91.0 | 6 47 | ---- | .148 | 874 | 643 | ---- | ----- | ---- | ---- | " |
| 343 | 533 | 34 4 | 22.7 | 2.31 | 0150 | 230 | 2 | 1044 | ---- | 91 7 | 6.41 | ---- | 147 | 873 | 643 | ---- | ----- | ---- | ---- | " |
| 344 | 531 | 34 2 | 22.8 | 2.31 | 0199 | 221 | 10 | 1191 | ---- | 91 4 | 7 14 | ---- | 158 | 976 | 661 | ---- | ----- | ---- | ---- | " |
| 345 | 534 | 34.3 | 22.6 | 2.29 | 0200 | 222 | 10 | 1194 | ---- | 91.2 | 7.49 | ---- | 153 | 978 | 663 | ---- | ----- | ---- | ---- | " |
| 346 | 534 | 34 7 | 22.2 | 2 27 | .0044 | 62 | --- | 681 | ---- | 79 1 | 5 60 | ---- | 186 | 618 | 569 | ---- | ----- | ---- | ---- | Diesel |
| 347 | 534 | 34.2 | 22.4 | 2 26 | 0044 | 62 | --- | 682 | ---- | 79 5 | 5.49 | ---- | 188 | 619 | 569 | ---- | ----- | ---- | ---- | " |
| 348 | 535 | 34 2 | 22.8 | 2.30 | 0094 | 199 | --- | 859 | ---- | 90 7 | 6 24 | ---- | 146 | 745 | 626 | ---- | ----- | ---- | ---- | " |
| 349 | 536 | 34.3 | 23.0 | 2.32 | 0092 | 215 | --- | 857 | ---- | 91 1 | 6 57 | ---- | .146 | 745 | 627 | ---- | ----- | ---- | ---- | " |
| 350 | 536 | 34.5 | 22.8 | 2.31 | .0163 | 216 | 3 | 1078 | ---- | 91 2 | 7 13 | ---- | 139 | 919 | 695 | ---- | ----- | ---- | ---- | " |
| 351 | 536 | 34 2 | 22.7 | 2.28 | 0166 | 249 | 2 | 1087 | ---- | 91 5 | 6 68 | ---- | 140 | 929 | 699 | ---- | ----- | ---- | ---- | " |
| 352 | 534 | 34.4 | 22 7 | 2.31 | 0217 | 279 | 10 | 1234 | ---- | 91.2 | 7.44 | ---- | 206 | 1054 | 727 | ---- | ----- | ---- | ---- | " |
| 353 | 533 | 34 3 | 22.8 | 2.32 | 0216 | 284 | 10 | 1228 | ---- | 91 0 | 7 39 | ---- | 145 | 1054 | 722 | ---- | ----- | ---- | ---- | " |
| 354 | 699 | 34.5 | 22.5 | 1.75 | 0042 | 24 | --- | 805 | ---- | 60 2 | 4 24 | ---- | 301 | 759 | 730 | ---- | ----- | ---- | ---- | Jet A |
| 355 | 700 | 34 3 | 22.7 | 1.76 | 0042 | 26 | --- | 807 | ---- | 61.5 | 4 20 | ---- | 306 | 761 | 731 | ---- | ----- | ---- | ---- | " |
| 356 | 700 | 34 5 | 22 7 | 1.77 | .0106 | 263 | --- | 1035 | ---- | 86 3 | 4 57 | ---- | 212 | 910 | 819 | ---- | ----- | ---- | ---- | " |
| 357 | 701 | 34 4 | 23.0 | 1.78 | .0105 | 265 | --- | 1044 | ---- | 89.1 | 4.36 | ---- | 191 | 911 | 819 | ---- | ----- | ---- | ---- | " |
| 358 | 701 | 34 4 | 22.9 | 1.77 | 0157 | 248 | --- | 1197 | ---- | 88.8 | 4 89 | ---- | 176 | 1014 | 882 | ---- | ----- | ---- | ---- | " |
| 359 | 701 | 34 5 | 22.9 | 1.77 | .0156 | 249 | --- | 1200 | ---- | 89.6 | 4 82 | ---- | .176 | 1013 | 881 | ---- | ----- | ---- | ---- | " |

*expressed as grams of $NO_2$/kg of fuel

TABLE III. - CONTINUED

| Run | Combustor inlet | | Reference velocity, m/s | Air flow rate, kg/s | Fuel air ratio | Fuel-nozzle pressure drop, $N/cm^2$ | | Combustor exit temperature, K | Combustion efficiency, percent | | Combustor total pressure loss, $\Delta P/P$, percent, | SAE smoke number | Pattern factor | Maximum liner temperature, K | Average liner temperature, K | Emission index, g/kg of fuel | | | | Fuel |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Temperature, K | Pressure, $N/cm^2$ | | | | Primary | Secondary | | gas analysis | enthalpy rise basis | | | | | | Unburned hydrocarbons | CO | NO* | $NO_x$* | |
| 360 | 701 | 34.3 | 23 0 | 1.78 | 0 0045 | 37 | --- | 840 | ---- | 73.8 | 4 53 | ---- | 0 209 | 780 | 749 | ---- | ----- | ---- | ---- | Diesel |
| 361 | 702 | 34 2 | 23.3 | 1 79 | 0044 | 37 | --- | 841 | ---- | 74 3 | 4 52 | ---- | 210 | 781 | 750 | ---- | ----- | ---- | ---- | " |
| 362 | 702 | 34 3 | 23 2 | 1 78 | 0016 | 288 | --- | 1077 | ---- | 90 2 | 4 77 | ---- | 162 | 1031 | 885 | ---- | ----- | ---- | ---- | " |
| 363 | 703 | 34 0 | 23 3 | 1 78 | 0116 | 289 | --- | 1080 | ---- | 90.6 | 4 85 | ---- | 173 | 1028 | 885 | ---- | ----- | ---- | ---- | " |
| 364 | 702 | 34 4 | 23 2 | 1.79 | 0168 | 229 | --- | 1235 | ---- | 90 8 | 5 10 | ---- | 280 | 1170 | 949 | ---- | ----- | ---- | ---- | " |
| 365 | 702 | 34 6 | 23 0 | 1.79 | 0168 | 245 | --- | 1234 | ---- | 90 8 | 5 21 | ---- | 166 | 1172 | 951 | ---- | ----- | ---- | ---- | " |
| 366 | 535 | 34 2 | 30.3 | 3 05 | 0043 | 115 | --- | 682 | ---- | 80.8 | 10.53 | ---- | 181 | 639 | 565 | ---- | ----- | ---- | ---- | Jet A |
| 367 | 535 | 34 2 | 30.4 | 3 07 | 0043 | 113 | --- | 679 | ---- | 79 9 | 10 57 | ---- | 181 | 636 | 564 | ---- | ----- | ---- | ---- | " |
| 368 | 535 | 34.4 | 30.0 | 3 04 | 0087 | 292 | --- | 835 | ---- | 89 0 | 11.27 | ---- | 168 | 724 | 592 | ---- | ----- | ---- | ---- | " |
| 369 | 533 | 34 2 | 30 1 | 3 05 | .0087 | 330 | --- | 836 | ---- | 90 1 | 11 25 | ---- | 167 | 725 | 591 | ---- | ----- | ---- | ---- | " |
| 370 | 533 | 34 3 | 30.1 | 3.05 | 0151 | 314 | 6 | 1040 | ---- | 90 2 | 12 21 | ---- | 155 | 874 | 625 | ---- | ----- | ---- | ---- | " |
| 371 | 533 | 34 2 | 30 1 | 3.07 | 0150 | 315 | 6 | 1043 | ---- | 91 3 | 12 39 | ---- | 148 | 874 | 625 | ---- | ----- | ---- | ---- | " |
| 372 | 534 | 34 2 | 30 3 | 3 06 | 0201 | 311 | 23 | 1199 | ---- | 91 5 | 13 44 | ---- | 153 | 974 | 643 | ---- | ----- | ---- | ---- | " |
| 373 | 534 | 34 5 | 30.0 | 3 05 | 0198 | 312 | 22 | 1191 | ---- | 91 3 | 13 39 | ---- | 152 | 970 | 643 | ---- | ----- | ---- | ---- | " |
| 374 | 535 | 34 4 | 30 1 | 3 05 | 0048 | 131 | --- | 692 | ---- | 78 8 | 10 42 | ---- | 174 | 633 | 568 | ---- | ----- | ---- | ---- | Diesel |
| 375 | 533 | 34 5 | 30 0 | 3 06 | 0048 | 131 | --- | 689 | ---- | 78 4 | 10 48 | ---- | .176 | 632 | 566 | ---- | ----- | ---- | ---- | " |
| 376 | 535 | 34 4 | 30 2 | 3.06 | 0094 | 197 | --- | 854 | ---- | 89.4 | 11 15 | ---- | 151 | 741 | 604 | ---- | ----- | ---- | ---- | " |
| 377 | 534 | 34 5 | 30 3 | 3 08 | 0095 | 220 | --- | 857 | ---- | 89 9 | 11 43 | ---- | 148 | 743 | 604 | ---- | ----- | ---- | ---- | " |
| 378 | 533 | 34 6 | 29.6 | 3 03 | 0164 | 244 | 10 | 1070 | ---- | 90 0 | 12 49 | ---- | 132 | 891 | 648 | ---- | ----- | ---- | ---- | " |
| 379 | 533 | 34 5 | 29 9 | 3 05 | 0162 | 245 | 10 | 1069 | ---- | 90 4 | 12.60 | ---- | 124 | 887 | 647 | ---- | ----- | ---- | ---- | " |
| 380 | 533 | 34 3 | 30 1 | 3 05 | .0218 | 259 | 29 | 1231 | ---- | 90 6 | 13 58 | ---- | 154 | 999 | 668 | ---- | ----- | ---- | ---- | " |
| 381 | 533 | 34 5 | 29.9 | 3 06 | .0216 | 260 | 29 | 1232 | ---- | 91 2 | 13 72 | ---- | 147 | 994 | 668 | ---- | ----- | ---- | ---- | " |

*expressed as grams of $NO_2$/kg of fuel

TABLE III. - CONCLUDED

| Run | Combustor inlet | | Reference velocity, m/s | Air flow rate, kg/s | Fuel air ratio | Fuel-nozzle pressure drop, $N/cm^2$ | | Combustor exit temperature, K | Combustion efficiency, percent | | Combustor total pressure loss, ΔP/P, percent, | SAE smoke number | Pattern factor | Maximum liner temperature, K | Average liner temperature, K | Emission index, g/kg of fuel | | | | Fuel |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Temperature, K | Pressure, $N/cm^2$ | | | | Primary | Secondary | | gas analysis | enthalpy rise basis | | | | | | Unburned hydrocarbons | CO | NO* | $NO_x$* | |
| 382 | 700 | 34 5 | 30.7 | 2.38 | 0 0045 | 73 | --- | 836 | ---- | 72 4 | 8 10 | ---- | 0 258 | 780 | 735 | ---- | ----- | ---- | ---- | Jet A |
| 383 | 702 | 34 3 | 30 8 | 2 37 | 0045 | 73 | --- | 836 | ---- | 71 6 | 7 92 | ---- | 271 | 781 | 736 | ---- | ----- | ---- | ---- | " |
| 384 | 700 | 34.4 | 30 5 | 2 36 | 0107 | 239 | --- | 1044 | ---- | 88 1 | 8.65 | ---- | 187 | 906 | 791 | ---- | ----- | ---- | ---- | " |
| 385 | 700 | 34 4 | 30 6 | 2 36 | .0107 | 235 | --- | 1046 | ---- | 88 3 | 8.62 | ---- | 189 | 908 | 792 | ---- | ----- | ---- | ---- | " |
| 386 | 701 | 34.5 | 30.5 | 2 37 | .0157 | 222 | 3 | 1197 | ---- | 88 9 | 8 93 | ---- | 156 | 1000 | 831 | ---- | ----- | ---- | ---- | " |
| 387 | 701 | 34.3 | 30 8 | 2 38 | 0155 | 233 | 2 | 1195 | ---- | 89 4 | 8 84 | ---- | 154 | 998 | 830 | ---- | ----- | ---- | ---- | " |
| 388 | 699 | 34 5 | 30 2 | 2 35 | 0050 | 86 | --- | 861 | ---- | 77 4 | 7 99 | ---- | .266 | 791 | 746 | ---- | ----- | ---- | ---- | Diesel |
| 389 | 700 | 34 3 | 30 6 | 2.36 | 0049 | 85 | --- | 859 | ---- | 77 0 | 8 30 | ---- | 268 | 790 | 746 | ---- | ----- | ---- | ---- | " |
| 390 | 700 | 34 5 | 30 2 | 2.35 | .0116 | 182 | --- | 1076 | ---- | 90.5 | 8 46 | ---- | 168 | 934 | 839 | ---- | ----- | ---- | ---- | " |
| 391 | 700 | 34.8 | 29.8 | 2 33 | .0115 | 182 | --- | 1075 | ---- | 90 8 | 8 25 | ---- | 171 | 937 | 840 | ---- | ----- | ---- | ---- | " |
| 392 | 700 | 34.6 | 30.3 | 2 36 | 0171 | 206 | 4 | 1239 | ---- | 90 2 | 9 06 | ---- | 148 | 1041 | 897 | ---- | ----- | ---- | ---- | " |
| 393 | 701 | 34 5 | 30 1 | 2 33 | 0173 | 206 | 4 | 1237 | ---- | 89 1 | 8 88 | ---- | 143 | 1042 | 897 | ---- | ----- | ---- | ---- | " |

*expressed as grams of $NO_2$/kg of fuel.

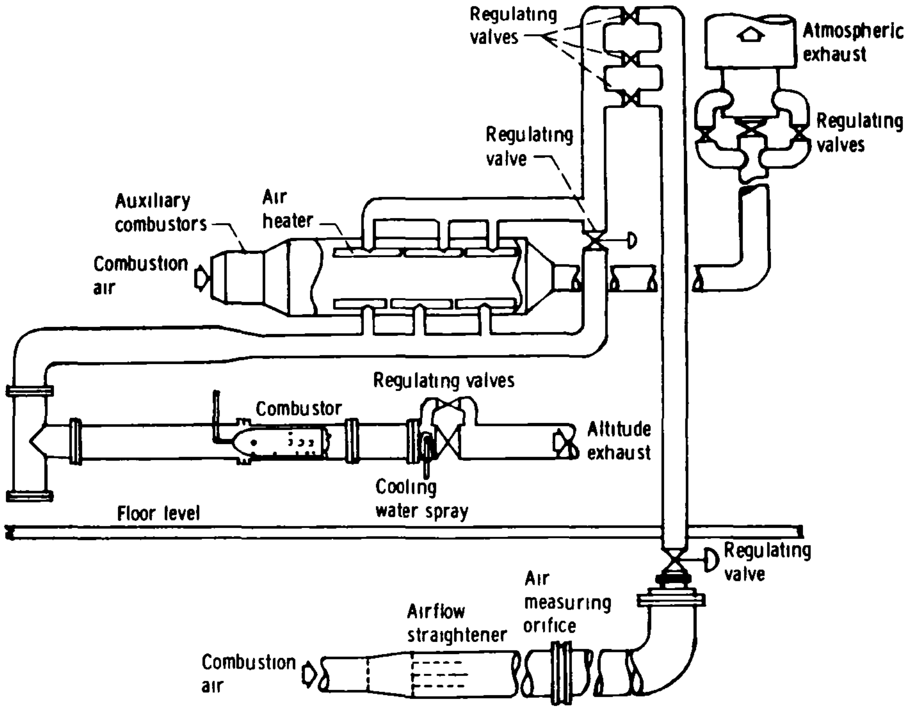



Figure 1 - Test facility and auxiliary equipment

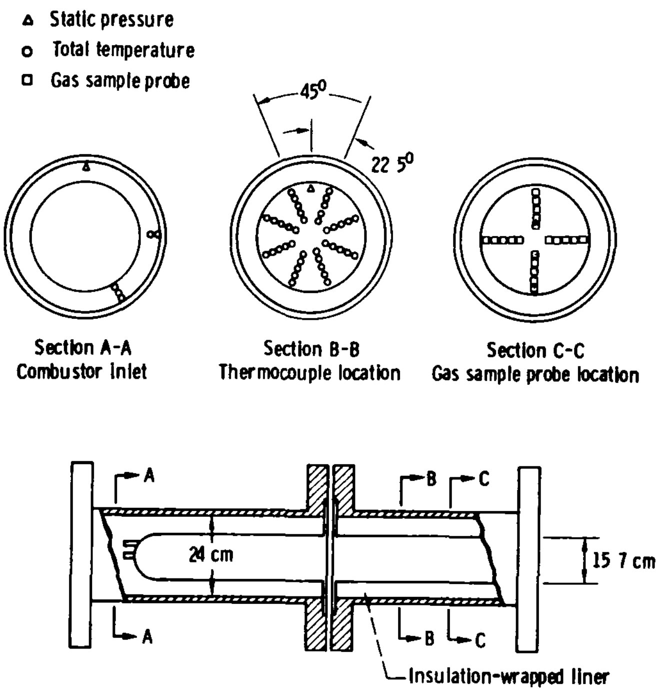



Figure 2 - Combustor assembly and instrumentation sections

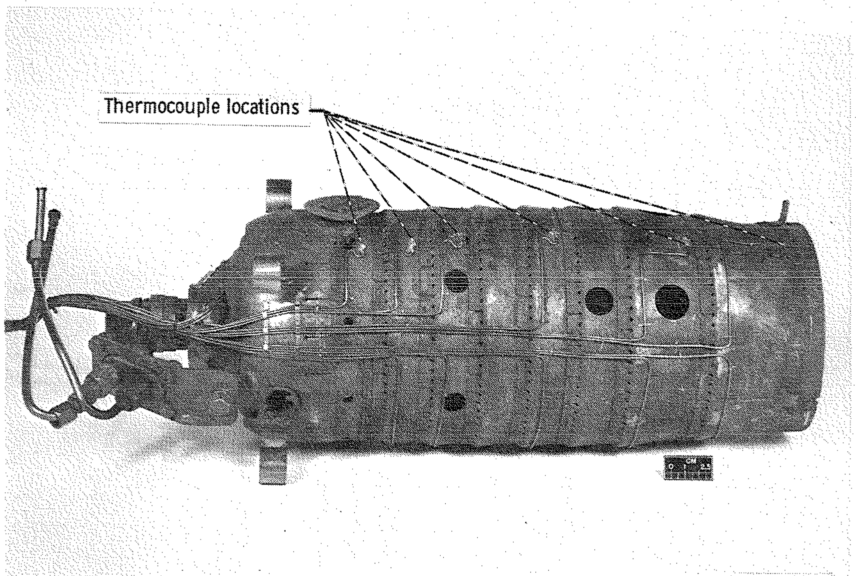



Figure 3. - Location of thermocouples on liner.

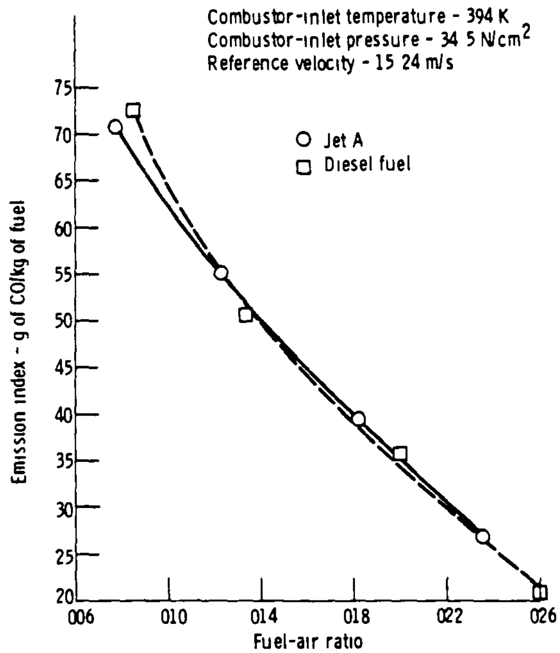
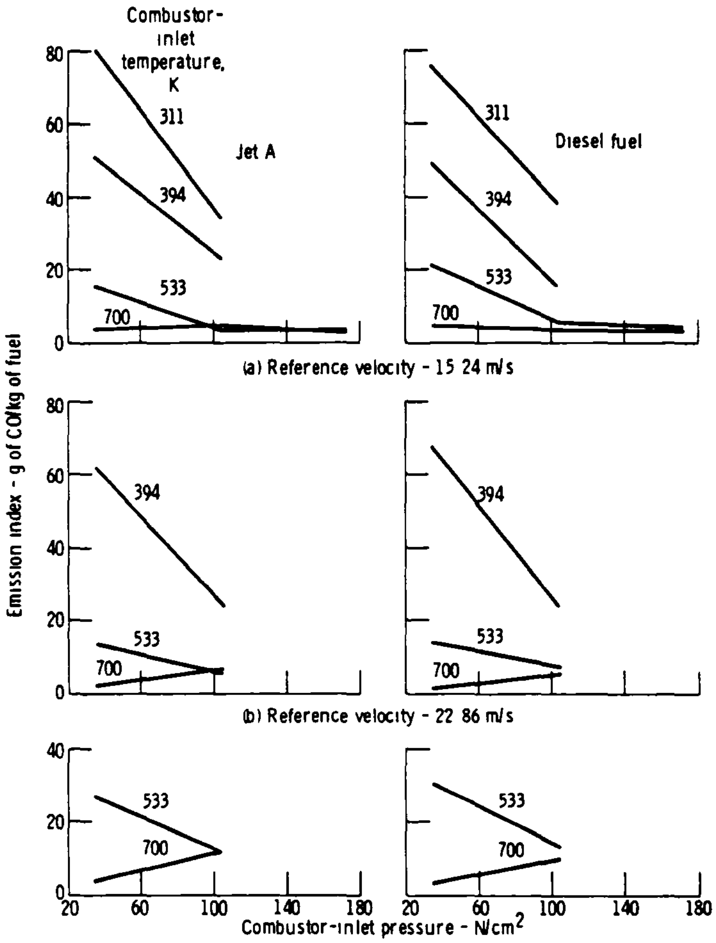



Figure 4 - Effect of fuel-air ratio on emissions of CO




(c) Reference velocity - 30 48 m/s

Figure 5 - Effect of combustor-inlet pressure on emissions of CO; temperature rise, 500 K.

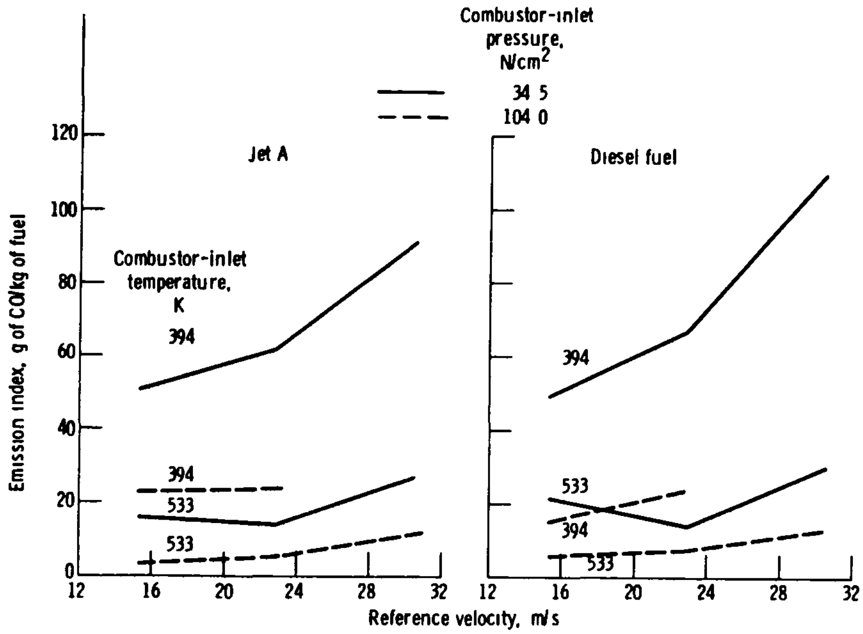



Figure 6 - Effect of reference velocity on emissions of CO, combustor temperature rise, 500 K

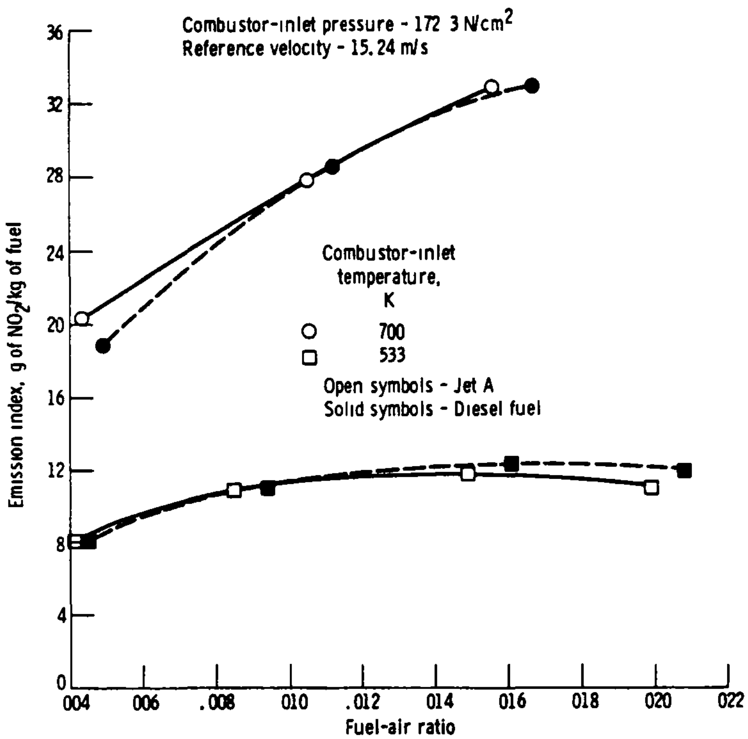



Figure 7 - Effect of fuel-air ratio on emissions of $NO_x$.

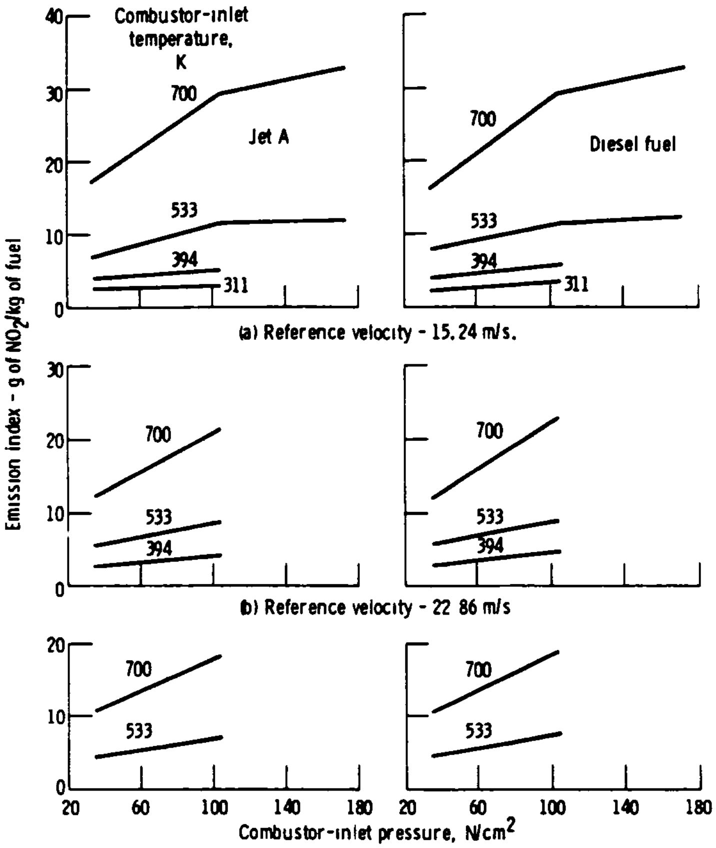



Figure 8 - Effect of combustor-inlet pressure on emissions of $NO_x$, temperature rise, 500 K.

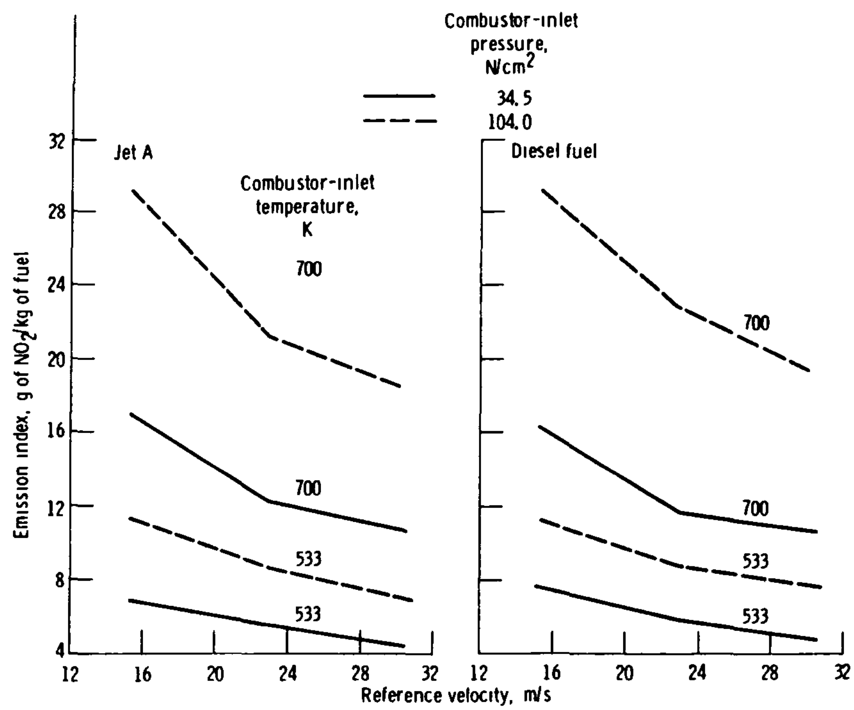



Figure 9 - Effect of reference velocity on emissions of $NO_X$, combustor temperature rise, 500 K

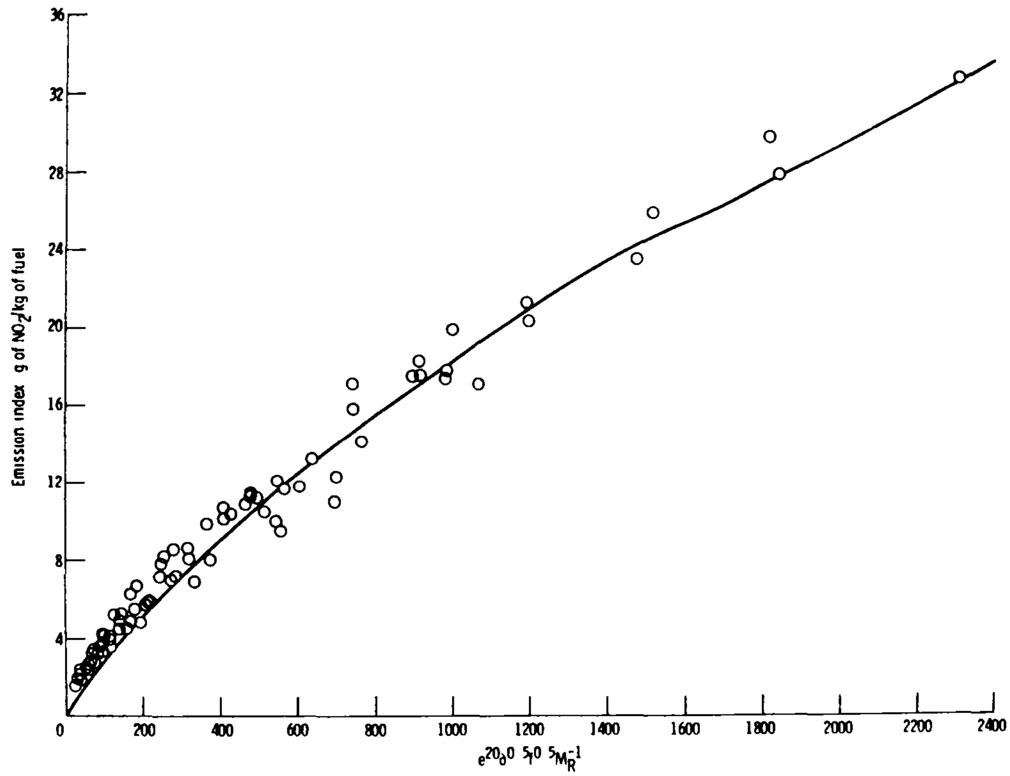



Figure 10 - Oxides of nitrogen correlation parameter for Jet A

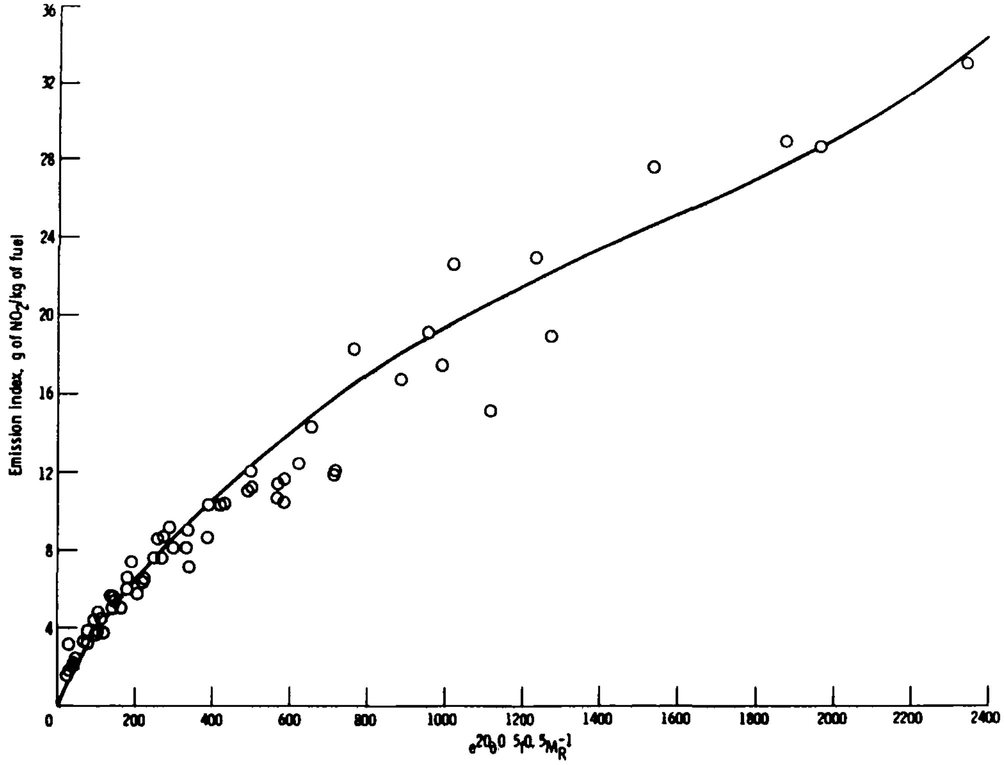



Figure 11 - Oxides of nitrogen correlation parameter for Diesel fuel

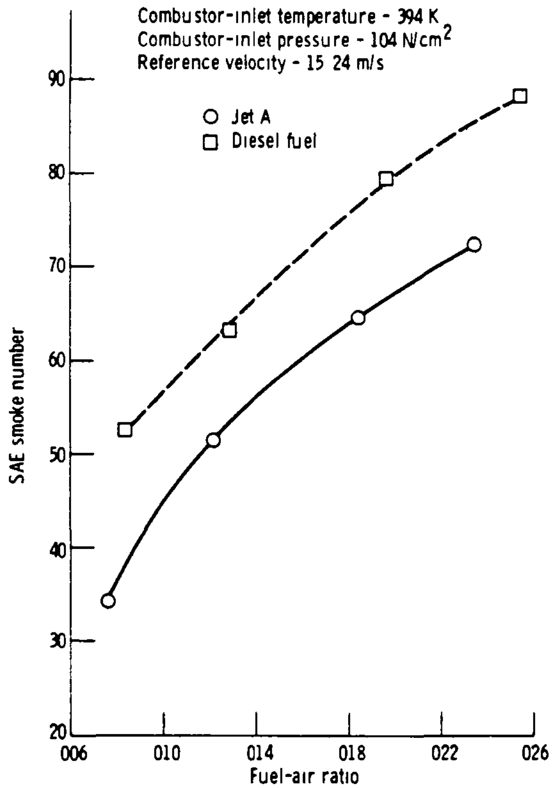



Figure 12 - Effect of fuel-air ratio on SAE smoke number.

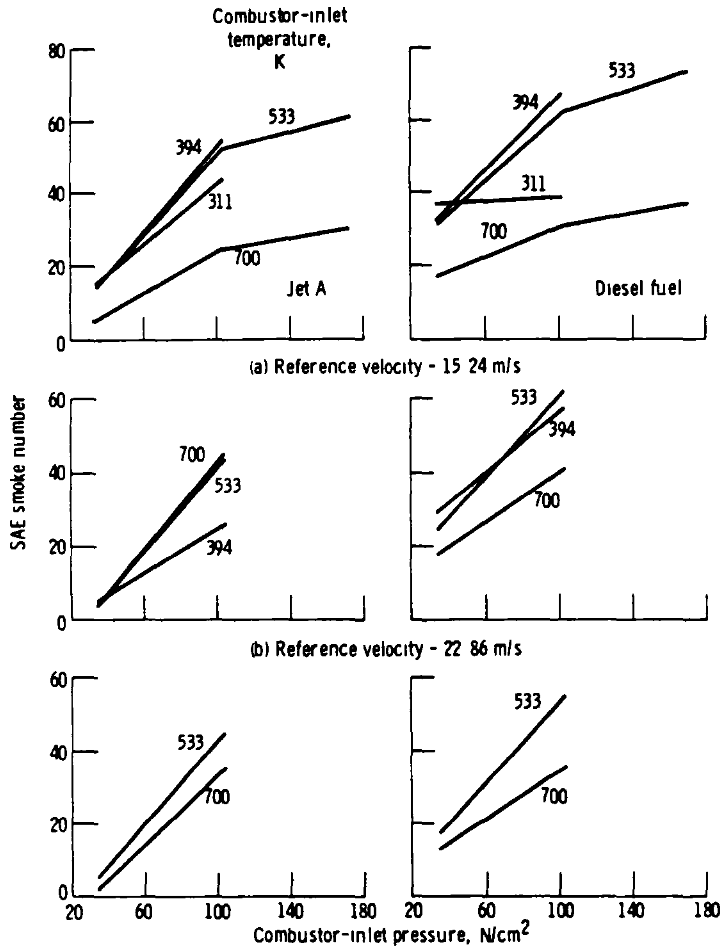



Figure 13. - Effect of combustor-inlet pressure on SAE smoke number, combustor temperature rise, 500 K

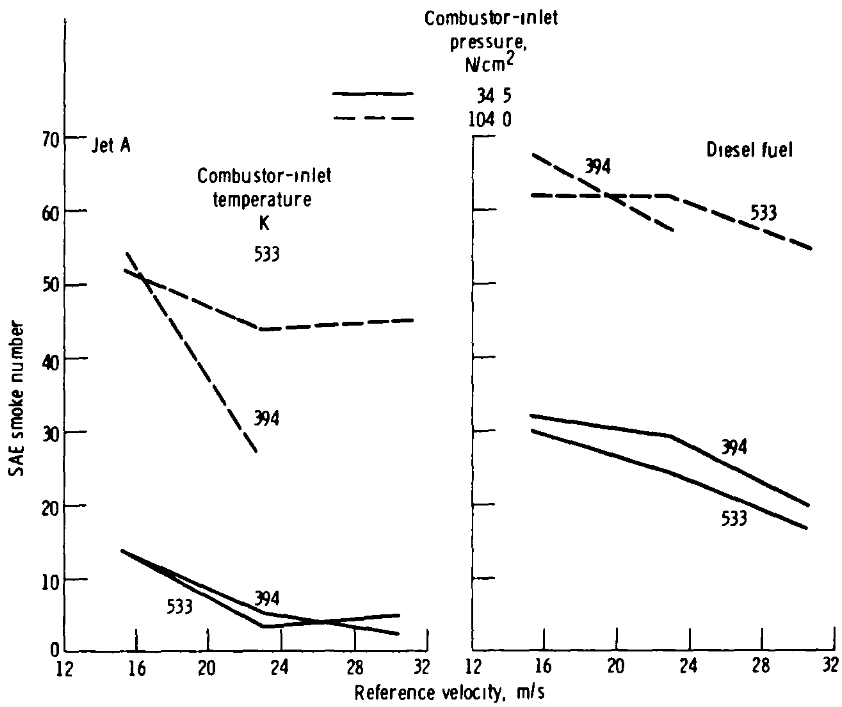



Figure 14 - Effect of reference velocity on SAE smoke number, combustor temperature rise, 500 K

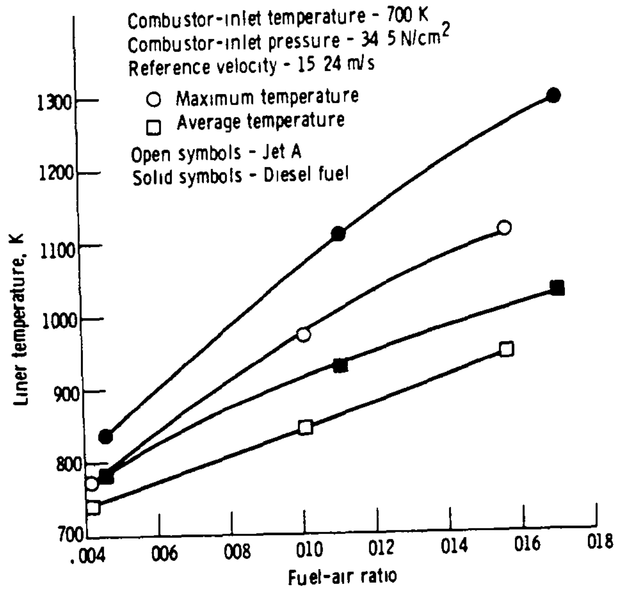
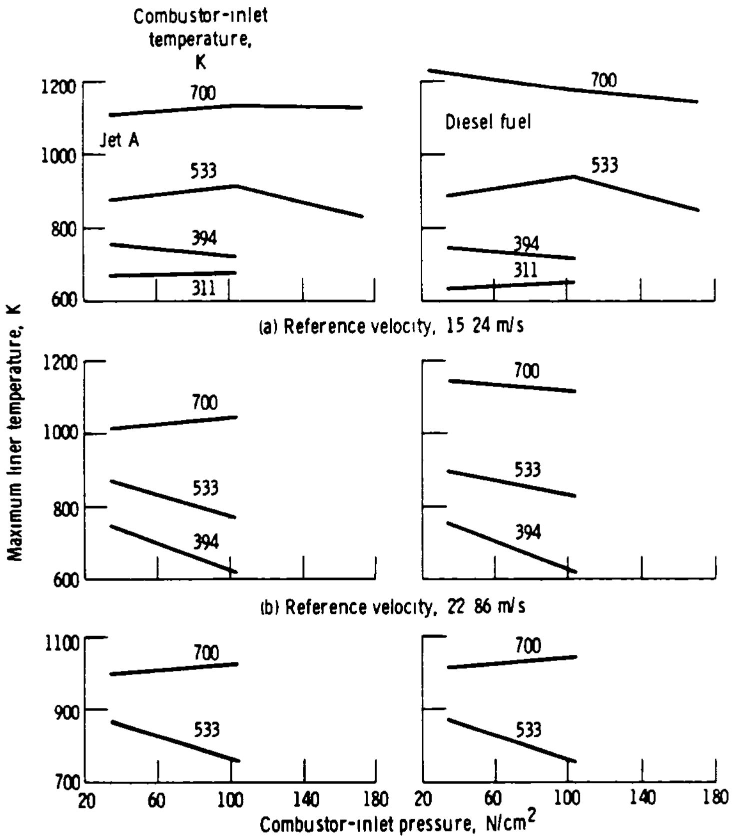



Figure 15 - Effect of fuel-air ratio on average and maximum liner temperatures




(c) Reference velocity, 30 48 m/s

Figure 16 - Effect of combustor-inlet pressure on maximum liner temperatures, combustor temperature rise, 500 K

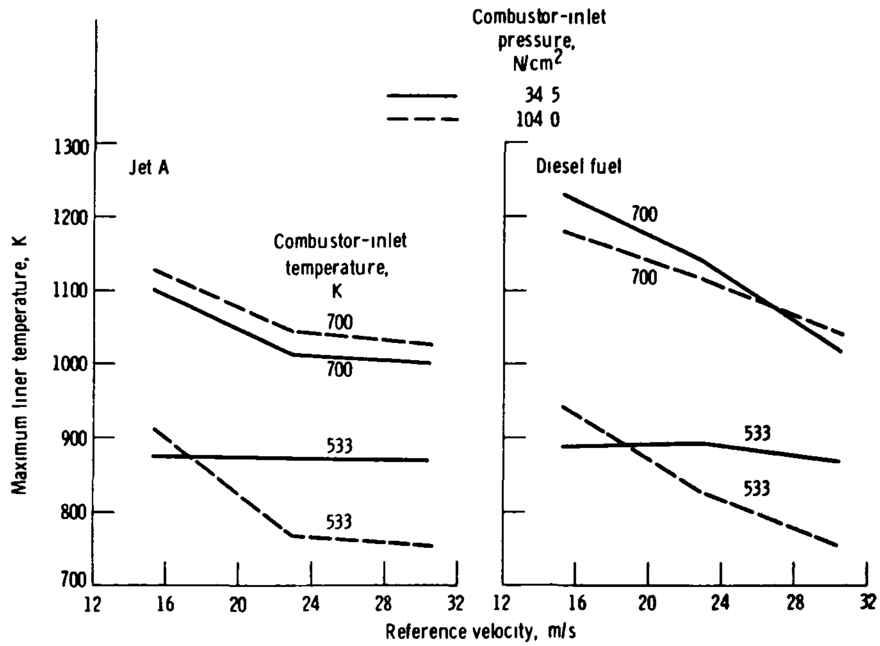



Figure 17 - Effect of reference velocity on maximum liner temperatures, combustor temperature rise, 500 K

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