Full-Scale Flammability Test Data for Validation of Aircraft Fire Mathematical Models

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Jerome F. Kuminecz and Richard W. Bricker

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SUMMARY

Twenty-five large-scale aircraft flammability tests were conducted in a Boeing 737 fuselage at the NASA Johnson Space Center (JSC). The objective of this test program was to provide a data base on the propagation of large-scale aircraft fires to support the validation of aircraft fire mathematical models. Variables in the test program included cabin volume, amount of fuel, fuel pan area, fire location, airflow rate, and cabin materials. A number of tests were conducted with Jet A-1 fuel only, while others were conducted with various Boeing 747-type cabin materials. These included urethane foam seats, passenger service units, stowage bins, and wall and ceiling panels. Two tests were also included using special urethane foam and polyimide foam seats. Tests were conducted with each cabin material individually, with various combinations of these materials, and finally, with all materials in the cabin. The data include information obtained from approximately 160 locations inside the fuselage. Measurements include temperature, visibility, heat flux, air velocity, rate of fuel and seat weight loss, and concentration of various gases. The data provided by this report include nearly 3000 curves (shown on 600 graphs). A matrix is included to quickly locate any particular graph. Approximately 50 before, during, and after test photographs are also included.

INTRODUCTION

Primary emphasis in aircraft fire safety activities over the last few years has been on materials development and flammability testing. Recently, aircraft fire modeling activities have generated models which address the full-scale aircraft fire, including propagation through the fuselage. One such model has been developed at the University of Dayton Research Institute (UDRI) for the Federal Aviation Administration (ref. 1). It consists of a simulation of a fire propagating through a wide-body aircraft fuselage from an ignition source. The model was developed to predict the temperatures, heat flux, smoke, and gas combustion products from burning interior materials in a full-scale aircraft cabin fire, using laboratory test data of the same materials. Validation of this type of model requires detailed fire data from full-scale tests. Previous full-scale tests in the industry were not sufficiently instrumented to provide the extensive data necessary.

A specific test program was developed by JSC in coordination with UDRI to provide the fire data necessary for validation of the UDRI model. The program obtained data on each element of the fire propagation path, including the ignition source and the fire buildup data for each major element of the aircraft interior materials. The locations and types of necessary instrumentation were determined through coordination with UDRI math modeling personnel. A total of 25 tests were included in the program. Detailed data from the fires produced in these tests form the basis of this report, which is primarily a data report, with limited data interpretation. Correlation with the UDRI model is not included. Although
these tests were originally conducted to support the UDRI model, this report was written with general applicability in mind.

TEST FACILITY

The test facility is a Boeing 737 aircraft fuselage (fig. 1). The fuselage has movable bulkheads which can provide a test compartment as short as 3 meters (10 feet), or as long as 17.1 meters (56 feet). The center section of the fuselage (6.1 meters (20 feet) long) as well as the aft bulkhead area, have been lined with a high-temperature insulation (Fiberfrax), and covered with a stainless steel skin to protect the aluminum structure and the external skin from damage. The remainder of the fuselage is fitted with bagged aircraft Fiberglas insulation and covered with aluminum skin. The fuselage interior is protected with a fire extinguishing system for terminating tests exceeding acceptable limits. A ventilation system and a computerized control and data acquisition system support the test facility.

TEST CONDITIONS

The primary test conditions under which these tests were conducted are shown in table I, and are described below. Twenty-five tests were conducted. Tests were numbered 1 through 28, with test numbers 7 through 9 omitted.

Cabin Size

Two different cabin lengths, 17.1 meters and 6.1 meters, were used. The cabin volume was 104 cubic meters (3700 cubic feet) in the large section, and 37 cubic meters (1320 cubic feet) in the small section. All but two of the tests were conducted in the large section.

Fire Location

As shown in figure 2, the fuel pan was located in one of three positions. Position A, the midline outboard wall position (beneath the center of the outboard seat), was used in most of the tests, including all the cabin materials tests.

Size of Ignition Source

In a previous test program conducted by JSC with the Boeing Commercial Aircraft Company (ref. 3), various sizes of fuel fires were evaluated to determine an optimum ignition source. The optimum test ignition source was defined to be that source which produces a free air temperature of 478 K (400° F), at 1.5 meters (5 feet) above the floor, at a distance of 2.4 meters (8 feet) from the center of the fire, in approximately 4 minutes.
after ignition. This temperature is considered the maximum human tolerance for short exposure times. The results of the test program with Boeing indicated that a 61-centimeter (2-foot) square fuel pan with 4.5 liters of Jet A-I fuel would produce the desired temperature.

Three ignition sources were used in the current test program. Four and 1/2 liters of Jet A-I fuel, in a 61-centimeter (2-foot) square fuel pan, were used in most of the fuel-only tests, and where wall and/or overhead panels were tested without seats. Two and 1/2 liters of Jet A-I fuel were also used, but only in the first two tests. One liter of Jet A-I fuel, in a 31-centimeter (1-foot) square fuel pan, was primarily used during tests with seats to limit the size of the fire produced.

Ventilation

Test air ventilation rates ranged from 14.2 to 65 m$^3$/min (500 to 2300 ft$^3$/min). The direction of airflow was from a diffuser in the forward bulkhead door (fig. 24) toward the open aft bulkhead door (fig. 25). The outside air pressure, temperature, and humidity conditions which existed for each test are shown in table V. Pre-test air velocity measurements, including outside wind velocity and direction, and natural and forced ventilation velocities, are shown in table VI.

Cabin Materials

Most of the materials used were Boeing 747-type aircraft cabin furnishings cut to size to fit inside the JSC Boeing 737 test section. Included were urethane foam seat assemblies and wall panels, as well as an assembly of nine overhead panels, which included two passenger service unit (PSU) panels, two stowage bin panels, and five ceiling panels. In addition, there were two tests using special urethane and polyimide foam seats. Tests generally progressed from those with no materials (Jet A-I fuel only), to single cabin components, to component combinations, and finally with all cabin materials installed (fig. 10).

INSTRUMENTATION

The instrumentation used in this test program is shown in figures 1 through 29. Identification numbers for the instrumentation are shown in table III, and figures 2 through 12. A brief description of the instrumentation is also given below.

Temperature

Chromel-alumel thermocouples were used to measure free-air and material temperatures. They were installed at over 130 locations (figs. 2, 7 to 9, 11, 12, and 17 to 21). Thermocouples which were installed on cabin materials were referred to by the designation "T/M".
Visibility

Six National Bureau of Standards (NBS) photometric smoke measurement systems (ref. 2) were installed to determine the loss of visibility resulting from the smoke generated by the fuel and the burning materials. Their locations are shown in figures 2 and 23. Scales for monitoring smoke stratification, and lamps for illuminating the scales, were also installed (fig. 17).

Heat Flux

Six water-cooled calorimeters were installed, as shown in figures 2 and 22, to determine the heat flux generated by the fire. Three were located on the midline of the fuselage, around the fire, while the remaining three were located near the aft end of the fuselage.

Air Velocity

To determine airflow velocity through the fuselage, three bidirectional gas velocity probes were installed, as shown in figures 3 and 25. Two were installed in the aft fuselage doorway, and one near the ceiling at thermocouple tree 5, just forward of the midsection of the fuselage. The probes used were similar to the one described in reference 4.

Fuel Weight

Fuel pan weight measurements were made continuously during the test to give an indication of the rate of fuel consumption. Fuel pan weight change was obtained through the use of a lever suspension system. The pan was mounted on the end of a balance arm, opposite a load cell, as shown in figures 26 and 27.

Seat Weight

To measure seat weight changes with time, a load cell was suspended from a bracket external to the fuselage directly over the seat position, as shown in figures 28 and 29. A steel cable connected to the load cell was passed through an opening in the fuselage to a bridle system, which held the seat assembly.

Gas Collection and Analysis

Two different systems were used to collect and analyze the products of combustion. The overall configuration of both systems is shown in figure 13. The dry gas system (console shown in figure 16) collected and analyzed gas samples from six sample port locations, shown in figure 4. The system included real-time gas analyzers, one for each of four non-hydrolyzable gases: carbon monoxide, carbon dioxide, oxygen, and light
hydrocarbons (up to six carbon atoms). Prior to installation of this sys-
tem (for the first six tests only), 32-liter stainless steel vessels were
used to collect gas samples, which were later analyzed. The wet gas sys-
tem, shown in figures 14 and 15, used glass bubblers filled with sodium hy-
droxide solution to collect three types of hydrolyzable gas ions (cyanides,
fluorides, and chlorides) from four sample port locations. The collection
lines were heated to 66° C (150° F) to avoid condensation losses, and the
test solutions collected were analyzed using solid-state specific ion
electrodes.

Visual Documentation

Visual documentation of the ignition and flame propagation in the
cabin was obtained using up to three motion picture cameras at different
angles. Still photography documented before, during, and after conditions
of the test specimens. Closed-circuit television was used for real-
time viewing. The relative locations of the cameras are shown in figure
2.

RESULTS

The results of this test program are presented in tables, photographs,
and graphs. A dash (-) symbol indicates which data in the tables were ap-
licable for a particular test, but were deleted because of equipment mal-
function, or were otherwise not available for inclusion in this report.
The test photographs and graphs of the data are grouped numerically, from
test 1 through 28, in separate sections at the end of this report.

Photographs

Photographs are included before the graphs for each test, except for
the first six fuel-only tests, which were not photographed. Three photo-
graphs are usually included for each test. The first photograph is the
pre-test configuration of the cabin materials. The second photograph
is usually the same view taken after the test to document the extent
of fire damage. The third photograph is one selected from photographs
taken by a camera inside the fuselage test section during the fire
itself. An attempt was made to select a photograph for each test which
showed the fire when the flame area was at or near its maximum visible
size.

Labels were used to identify instrumentation on selected test photo-
graphs. Although the majority of the pre-test photos have some labels,
most of the instrumentation seen in the photos have been identified on
three photos in particular. These are figures 189, 419, and 542, for
tests 13, 20, and 24, respectively.
Graphs

The order in which the graphs are presented for each test in this report is listed in Table III, which also includes instrument identification numbers. Applicable instrument numbers are listed in the legend on each graph. The types of graphs provided for each particular test are shown in Table IV. To locate any graph quickly, refer to the matrix of graph figure numbers at the end of the Table of Contents.

To minimize the size of this report, up to six curves were plotted on each graph. Wherever a curve on a graph indicated that an instrument was malfunctioning from the beginning of a test, the letters "N.A." were inserted in the legend of the graph to indicate which curve was deleted. Whenever a malfunction occurred sometime after the start of a test, only that portion of the curve was deleted which was obviously in error.

Visibility and Heat Flux

The visibility and heat flux data are shown in the graphs. There were no basic changes in the configuration of these instruments during the test program.

Temperature

All the temperature data (except for the ambient outside air temperatures given in Table V) are included in the graphs. The thermocouple tree and cabin materials' thermocouple positions were not basically changed during the test program. However, changes and/or additions of other thermocouples were made. There was only one thermocouple above the fuel pan for the first six tests, after which three thermocouples were used (Fig. 11). These thermocouples were usually located above the center of the fuel pan except when seats were tested, when they were located as close to the fuel pan as permitted by the seat assembly. The four ceiling and floor thermocouples were not added until after test 6. They were installed near the ceiling and the floor, at trees 1 and 4, to provide additional air temperature readings near cabin surfaces. In addition, two thermocouples shielded from direct radiation were installed next to two unshielded thermocouples to determine the effects of flame radiation on thermocouple readings; however, this was done only in the last three tests.

Ventilation

The outside air pressure, temperature, and humidity measurements taken just before each test run are shown in Table V. Beginning with test 14, pre-test air velocity measurements were also made of outside wind velocity and direction, as well as natural and forced ventilation velocities, which are shown in Table VI. The airflow rates which were used during each test are listed in Table I.

The air velocity measurements taken during the tests at the three velocity probe positions (V1 and V2 in the aft bulkhead doorway, and V3
forward of the fuselage midline) are shown in the graphs beginning after test 6, when the two aft velocity probes were installed. The probes used are bidirectional and are relatively insensitive to the angle of direction of airflow up to ±50 degrees. They are considered accurate to ±10 percent for air velocities above ±0.3 m/sec (0.9 ft/sec). Below this, their accuracy decreases significantly. The direction of airflow at V1 and V2 was almost always aft, which was designated as the positive (+) direction on the graphs. Airflow at V3 was usually negative, indicating forward flow.

The air inlet into the fuselage test section was a 20-centimeter (8-inch) diameter port to the right of the forward fuselage door for only the first six tests, after which a diffuser type of inlet port was installed in the center of the fuselage door. The exit port was always the open aft fuselage doorway. Tests 3 and 6 were natural ventilation tests with the blower off and both forward and aft doors open. Test 10 (at fuel pan location "C", next to the aft bulkhead) was the only test conducted with the aft vent door closed, with air vented out through the Boeing 737's floor vents, which were normally taped over.

Fuel Weight Loss

The fuel weight loss with time is shown in the graphs. When it was obvious that a piece of material fell into the fuel pan, this was noted on the graph. The earliest time for fuel depletion was 11 minutes in test 16. However, in most tests, when the test graphs were terminated after 14 minutes, there was usually still a small amount of burning fuel left. There exist no fuel weight loss data for the first three tests. Water was used in the fuel pan in these tests to help provide a constant burning area, with the fuel floating on it. However, when the water boiled, it also threw out some fuel, which affected the weight loss measurements. The water was deleted after the first three tests.

Cabin Materials Weight Loss

The total weight loss of the cabin materials used (seats, wall, and overhead panels) is shown in tables VIII and IX. Graphs of seat weight loss with time are also provided. Since the seats in tests 12 to 16 and test 18 did not include any significant weight of flammable material other than the foam seats themselves, the seat weight loss graphs for these six seat tests would tend to indicate the rate of consumption of just the foam itself with time. The other four tests with seats (tests 17, 24, 25, and 28) included a number of flammable materials in the seat assembly in addition to the foam seats. Therefore, the total weight loss of the entire seat assembly (test fixtures, foam armrests, plastic tray and back supports, instrumentation, and foam seats) was plotted in these four tests. In some tests, a large piece of burning material would fall off the seat assembly. The weight loss curve was usually deleted after this point.
Gas Collection and Analysis

Graphs of concentrations of products of combustion are provided. The maximum concentrations which were detected of each gas, as well as the minimum level of oxygen, are presented in table VII.

Hydrolyzable gases.—Hydrolyzable gases were collected by the wet gas collection system in glass bubblers filled with sodium hydroxide solutions, and were analyzed for cyanide, fluoride, and chloride ions. The usual sampling interval for each bubbler was 2 minutes, and six bubblers for each port provided for a total sample time of 12 minutes. The ports most often used were three aft ports (A8, A16, and A8L) and one forward port (F16). The numbers 8 and 16 indicate port distance in feet from the fuselage midline. Test 13 was the first test in which the wet gas collection was upgraded to cover four ports. Previous tests were limited to only two wet gas ports. Past experience has indicated that free cyanide, fluoride, and chloride ions collected in aircraft fires were primarily provided by the hydrolyzable gases, hydrogen cyanide, hydrogen fluoride, and hydrogen chloride. Therefore, the graphs (and table VII) indicate concentrations in these three gases.

Nonhydrolyzable gases.—Four nonhydrolyzable gases (carbon monoxide, carbon dioxide, oxygen, and light hydrocarbons) were collected and analyzed in real time by the dry gas collection system. Gas samples were collected and analyzed at each port every 60 seconds. Six dry gas collection ports were usually used, including three aft ports (A8, A16, and A8L) and three forward ports (F8, F16, and F8L). The real-time gas collection and analyzer system was not operational to provide coverage for six ports until after test 6. The first six tests were limited to only two dry gas ports, when samples were collected in 32-liter stainless steel vessels, which limited the total sampling time to only the first 5 minutes after ignition. In the two tests conducted in the 6.1-meter section, ports A4 and F4 were used instead of ports A16 and F16. The graphs of hydrocarbon concentrations were plotted in methane (CH₄) equivalent concentrations.

DISCUSSION

Fuel-Only Tests

As shown in table I, the fuel-only tests, with no cabin materials present, included nine tests (tests 1 to 6, 10, 11, and 22) in the 17.1-meter test section. There were also two fuel-only tests conducted in the 6.1-meter section (tests 26 and 27).

Four and 1/2-liter and 2-1/2-liter fuel tests.—The data indicate that most of the results from tests 1 to 6 and 10 were very consistent and repeatable. The peak gas concentrations for these seven fuel-only tests were particularly consistent. The maximum carbon monoxide (CO) concentrations varied only from 401 to 517 ppm, the maximum carbon dioxide (CO₂) concentrations from 1.43 to 2.09 percent, and the minimum oxygen (O₂) concentrations from 17.8 to 18.9 percent. Hydrocarbon concentrations were
not determined for the first six tests. As would be expected, no cyanides, fluorides, or chlorides were found in the fuel-only tests. The fact that similar gas concentrations and other results were also produced by the two 2-1/2-liter fuel tests (tests 1 and 2) was probably due to the first two tests having a much lower ventilation rate, as shown in table I, which would increase the buildup of heat and combustion products.

The peak temperature on thermocouple tree 4 at the fuselage midline is usually the highest measured air temperature in the fuselage, except for directly over the fuel pan itself. This peak temperature was similar in four of six fuel tests. (No additional data on the seventh test in the series (test 10) are available, and it will not be discussed further.) Tests 1 to 3 and test 5 had maximum thermocouple tree temperatures between 510° and 565° C (950° and 1050° F), while tests 4 and 6 had maximum temperatures of approximately 288° C (550° F). While this difference is large, it should be noted that these are peak temperatures at thermocouple tree 4, which is nearest the fire, and as such are subject to much greater variation than at other thermocouple trees. In fact, the maximum temperatures at the other tree locations were consistent in all six tests, with most maximum temperatures between 204° and 260° C (400° and 500° F). All six tests had peak heat fluxes (except for a single brief higher spike) between 1.2 to 2.7 x 10⁴ W/m². All six tests resulted in approximately 90 percent loss of visibility due to smoke about 1 minute after ignition, with 98 to 100 percent loss by 2 minutes. (The 1-liter fuel tests also generated much smoke from the Jet A-1 fuel used, which was expected because of the nature of the fuel. However, 1 liter alone did not cause more than 80 percent visibility loss at any time, and much less most of the time.)

One-liter fuel tests.- Data from both 1-liter tests in the 17.1-meter section (tests 11 and 22) were generally consistent. As would be expected, much lower levels in all test parameters were produced compared to the 2-1/2-liter and 4-1/2-liter fuel-only tests.

Small cabin fuel tests.- Two tests (tests 26 and 27) were conducted in the 6.1-meter test section. The only difference between these tests was that test 26 was conducted with 4.5 liters of fuel in the large fuel pan, and test 27 with 1 liter in the small pan. As expected, the effects of this large difference in amount of fuel and pan size was substantial, and is clearly indicated by the differences in peak values. The maximum gas concentrations produced in tests 26 and 27 were 3.53 and 0.92 percent CO₂, and 304 and 89 ppm light hydrocarbons; and the minimum oxygen levels were 15.4 to 19.6 percent, respectively. The maximum CO level in test 26 was 604 ppm. CO data for test 27 were not available. The temperatures and heat flux also varied similarly. The maximum thermocouple tree air temperature was 592° C (1100° F) in test 26, and 193° C (380° F) in test 27. The maximum heat flux was 5.5 x 10⁴ W/m² in test 26, and 0.9 x 10⁴ W/m² in test 27.

Cabin Materials Tests

Full-up materials configuration.- Tests 24 and 28 were the only two tests conducted in the full-up materials configuration, in which all cabin
material components were installed (seats, wall panel, and overhead panels). As expected, these tests usually produced the highest gas concentrations, temperatures, heat flux, damage, and other parameter levels of any of the tests conducted in this test program, with test 28 generally producing the much higher of the two. The highest peak levels were produced in test 28 because 4.5 liters of fuel were used in this test, while test 24 was conducted with only 1 liter of fuel. The maximum gas concentrations in test 28 were extremely high. Since gas concentrations were usually collected in 1- or 2-minute intervals, actual maximum concentrations were probably greater than shown. The maximum concentrations determined in test 28 were: 1230 ppm hydrogen cyanide (HCN), 780 ppm hydrogen fluoride (HF), 2040 ppm hydrogen chloride (HCl), 11 500 ppm CO, 9.69 percent CO₂, and 7339 ppm light hydrocarbons. The minimum oxygen level was 9.6 percent.

The maximum thermocouple tree air temperature in test 28 was approximately 1038 °C (1900 °F). The maximum seat temperature was approximately 982 °C (1800 °F), the peak wall panel temperature was approximately 815 °C (1500 °F), and the peak overhead panel temperature was approximately 982 °C. The maximum heat flux recorded in test 28 was approximately 13 × 10⁴ W/m² before all 6 calorimeters became inoperable.

Individual components.—As expected, the tests conducted on individual cabin components (seats, wall panel, or overhead panels) produced much lower values than in the full-up tests in nearly all test parameters. The seats usually had a greater effect on conditions than the panels because of their greater volume of material in close proximity to the flames, enabling continuous direct flame impingement throughout most of the test.

Polyimide vs. urethane foam.—Differences between the polyimide and urethane foams tested were large, as indicated in the results of tests 18 and 15. Test 18 was a seats-only test with bare IH-1720 polyimide foam provided by International Harvester Corporation. Test 15 was a bare seats-only test conducted with the standard fire-retardant urethane foam used throughout this test program. It is typical of the urethane foam in use in many commercial wide-body aircraft. The amount of fuel, pan size and location, airflow rate, and most other test conditions were similar in both tests. The maximum gas concentrations for the polyimide foam were extremely low, both when compared to the urethane foam, and in absolute terms. In fact, they were just above the levels produced by 1 liter of Jet A-1 fuel itself. The peak hydrogen cyanide concentrations were 165 ppm for the urethane seats, compared to 6 ppm for the polyimide seats. The peak hydrogen chloride concentrations were 570 ppm for urethane, and were not detected (<6 ppm) for polyimide. Maximum carbon monoxide concentrations were 3209 and 294 ppm, carbon dioxide levels were 2.33 and 0.46 percent, light hydrocarbon levels were 1200 and 189 ppm, and minimum oxygen levels were 18.5 and 20.2 percent, respectively.

The maximum thermocouple tree air temperature was 732 °C (1350 °F) for the urethane foam, compared to 121 °C (250 °F) for the polyimide foam. The maximum temperatures reached by most of the thermocouples on the urethane foam were approximately 870 °C (1600 °F), but below 204 °C (400 °F) in most areas of the polyimide foam. The maximum heat flux produced by the polyimide foam was 0.7 × 10⁴ W/m². Maximum heat flux data for the urethane foam were not available. The loss in visibility was total with the urethane foam seats, but only a maximum of 80 percent with the poly-
imide foam. This is about the same loss in visibility that 1 liter of Jet A-1 fuel would produce by itself. The weight loss of the urethane foam seats was 83 percent. While the exact weight loss figures for the poly-imide foam were not available, the post-test photograph (fig. 354) indicates that only about 10 to 15 percent of the total weight of the three seats was consumed. A post-test photograph of the urethane foam seats is shown in figure 255.

Distribution of Peak Gas Concentrations

The distribution of the peak concentrations of each of the seven gases analyzed (HCN, HF, HCl, CO, CO₂, O₂, and light hydrocarbons) at each of the six primary gas collection port locations (A8, A16, A8L, F8, F16, and F8L) was checked after most of the tests. As expected, certain ports usually collected higher concentrations of most of the gases than other ports. About 80 percent of the time, aft port A16 collected the highest concentrations of gases. When not the highest concentration port, it was rarely below second highest. The aft ports would be expected to receive the highest gas concentrations due to the direction of forced air ventilation from forward to aft. The A16 port would usually have higher gas concentrations than either of the other two aft ports (A8 and A8L) because the updraft and turbulence of air near the fire would tend to reduce the amount of gas products which would reach these two ports near the fire. The further away from the fire, and also the nearer the bulkheads were, the lower one would expect layers of hot gases to settle. The second highest port was usually A8, and the third and fourth highest ports were usually F16 and F8. The two ports which usually had the lowest gas concentrations were A8L and F8L. This was expected, since these two ports were at a height of only 0.8 meters (2.5 feet), compared to a height of 1.5 meters (5 feet) for the other four ports. Lesser amounts of combustion products would tend to reach this lower height, especially so close to the updraft of the fire.

CONCLUDING REMARKS

The results indicate that the objectives of this test program have been accomplished. The data contained in this report are considered to be at a level of detail and consistency to provide a significant data base for supporting the validation of aircraft fire mathematical models.

Some general observations are included below. Although these results were expected, they tend to indicate some of the overall consistency of the great majority of data provided by this test program.

1. Peak values of all test parameters were much greater in the 4-1/2-liter fuel tests in the large fuel pan, compared to the 1-liter fuel tests in the small fuel pan. It was expected that the amount and the area of the liquid fuel available to a fire would have a major effect.

2. Peak values in tests with all materials present were much greater than where only one material component was used, as expected.
3. Lower air ventilation rates provided higher peak values in most parameters than higher ventilation rates, because of the slower venting of hot and toxic gases.

4. The standard aircraft urethane foam seats tested provided much higher peak values in all test parameters than did polyimide foam seats.

Users of this report can contact Mr. Jerome Kuminecz of the Materials Technology Branch, NASA Lyndon B. Johnson Space Center, Houston, Texas, 77058, if any additional information is desired on this test program.

Lyndon B. Johnson Space Center
National Aeronautics and Space Administration
Houston, Texas, February 9, 1982
534-05-00-61-72
REFERENCES


### TABLE I.- TEST CONDITIONS

<table>
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<th>Test No.</th>
<th>Pan size</th>
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<td>26k/l</td>
<td>2</td>
<td>A</td>
<td>14.2 (500)</td>
<td>None - fuel only</td>
</tr>
<tr>
<td>27k</td>
<td>1</td>
<td>A</td>
<td>14.2 (500)</td>
<td>None - fuel only</td>
</tr>
<tr>
<td>28</td>
<td>2</td>
<td>A</td>
<td>14.2 (500)</td>
<td>Covered urethane foam seats and wall, PSU, bin, and ceiling panels</td>
</tr>
</tbody>
</table>

---

*aThe number 2 indicates the 61- by 61-centimeter (2- by 2-foot) fuel pan size, which contained 4.5 liters of fuel. The number 1 indicates the 31- by 31-centimeter (1- by 1-foot) pan size, which contained 1.0 liters of fuel.

*bRefer to test configuration schematic for locations of fuel pan (fig. 2).

*cOnly 2.5 liters of fuel were used in tests 1 and 2.

*dNatural ventilation was used for tests 3 and 6.

*eBegan fuel weight loss with time measurements in test 4 (to 28).

*fTests 7 to 9 were not part of this test program.

*gThe following additions were made which apply to test 10 (to 28): increased number of thermocouples above fuel pan from 1 to 3; provided ceiling and floor thermocouples at trees 1 and 4; and installed two flow meters in aft doorway.

*hThe fuel pan was under the center seat in test 12.

*iExcept for tests 16 and 18, seats used were fire-retardant urethane foam aircraft seats of the type used in many wide-body aircraft (manufactured by Hartman Co.).

*jThe seat covers used in all the covered seat tests were a 90-percent wool/10-percent nylon blend.

*kAll tests (except for tests 26 and 27 in the 6.1-meter (20.0-foot) section) were conducted in the 17.1-meter (56.0-foot) section.

*lProvided two shrouded thermocouples in test 26 (to 28).
<table>
<thead>
<tr>
<th>TABLE II.- CABIN PANEL MATERIALS (BOEING 747-TYPE MATERIALS)</th>
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</thead>
<tbody>
<tr>
<td>Side wall panel and stowage bin panels</td>
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</tr>
<tr>
<td>Polyvinyl fluoride (PVF)</td>
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<tr>
<td></td>
</tr>
<tr>
<td>Ink overprint</td>
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<tr>
<td></td>
</tr>
<tr>
<td>PVF</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>2-ply, epoxy/Fiberglass prepreg</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Polyamide honeycomb core</td>
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<tr>
<td>2-ply, epoxy/Fiberglass prepreg</td>
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</tr>
<tr>
<td>Back</td>
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<tr>
<td></td>
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<tr>
<td>Ceiling panels</td>
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<td>PVF</td>
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<tr>
<td>Perforated polyamide paper</td>
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<tr>
<td>Dacron fabric</td>
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<tr>
<td>1-ply, epoxy/Fiberglass prepreg</td>
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<tr>
<td>Polyamide honeycomb core</td>
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<td>1-ply, epoxy/Fiberglass prepreg</td>
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<tr>
<td>Back</td>
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<tr>
<td>Passenger Service Unit (PSU) panels</td>
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<td>GE Lexan 9600 Polycarbonate</td>
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## TABLE III.- ORDER OF GRAPHS PRESENTED FOR EACH TEST
(PLUS INSTRUMENTATION DESIGNATIONS)

<table>
<thead>
<tr>
<th>Graphs</th>
<th>Instrument designations</th>
</tr>
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<tbody>
<tr>
<td><strong>Tree temperatures</strong></td>
<td>(T/C's 1 to 42)</td>
</tr>
<tr>
<td>T/C tree 1</td>
<td>T/C 1-2-3-4-5-6</td>
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<tr>
<td>T/C tree 2</td>
<td>T/C 7-8-9-10-11-12</td>
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<tr>
<td>T/C tree 3</td>
<td>T/C 13-14-15-16-17-18</td>
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<tr>
<td>T/C tree 4</td>
<td>T/C 19-20-21-22-23-24</td>
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<tr>
<td>T/C tree 5</td>
<td>T/C 25-26-27-28-29-30</td>
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<tr>
<td>T/C tree 6</td>
<td>T/C 31-32-33-34-35-36</td>
</tr>
<tr>
<td>T/C tree 7</td>
<td>T/C 37-38-39-40-41-42</td>
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<tr>
<td><strong>Overhead panel temperatures</strong></td>
<td>(T/M's 1 to 30)</td>
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<tr>
<td>PSU</td>
<td>T/M 7-12-13-18-19-24</td>
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<tr>
<td>Stowage bins</td>
<td>T/M 8-11-14-17-20-23</td>
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<tr>
<td>Ceiling panels (aft)</td>
<td>T/M 1-2-3-4-5-6</td>
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<tr>
<td>Ceiling panels (center)</td>
<td>T/M 9-10-15-16-21-22</td>
</tr>
<tr>
<td>Ceiling panels (forward)</td>
<td>T/M 25-26-27-28-29-30</td>
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<tr>
<td><strong>Wall panel temperatures</strong></td>
<td>(T/M's 31 to 49)</td>
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<tr>
<td>Side wall panel (top)</td>
<td>T/M 31-32-33-34</td>
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<tr>
<td>Side wall panel (center)</td>
<td>T/M 35-36-37-38-39</td>
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<tr>
<td>Side wall panel (bottom)</td>
<td>T/M 40-41-42-43-44</td>
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<tr>
<td>Side wall panel (rear)</td>
<td>T/M 45-46-47-48-49</td>
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<tr>
<td><strong>Seat cushion temperatures</strong></td>
<td>(T/M's 50 to 63)</td>
</tr>
<tr>
<td>Seat cushions (top + bottom)</td>
<td>T/M 50-51-52-61-62-63</td>
</tr>
<tr>
<td>Seat cushions (edges)</td>
<td>T/M 53-54-55-56-57-58-59-60</td>
</tr>
<tr>
<td><strong>Seat back temperatures</strong></td>
<td>(T/M's 64 to 82)</td>
</tr>
<tr>
<td>Seat backs (rear)</td>
<td>T/M 64-65-66-67-68-69</td>
</tr>
<tr>
<td>Seat backs (edges)</td>
<td>T/M 70-71-72-73-74-75-76</td>
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<tr>
<td>Seat backs (front)</td>
<td>T/M 77-78-79-80-81-82</td>
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<td><strong>Other temperatures</strong></td>
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<tr>
<td>Above fuel pan</td>
<td>TF HI, TF MID, TF LOW</td>
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<tr>
<td>Inlet + exit</td>
<td>TIN, TEX</td>
</tr>
<tr>
<td>Ceiling + floor (trees 1 + 4)</td>
<td>TC4, TC1, TF4, TF1</td>
</tr>
<tr>
<td>Shielded vs. unshielded T/C's</td>
<td>TF HI, TF HI-S, TC 13, TC 13-S</td>
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<tr>
<td>Graphs</td>
<td>Instrument designations</td>
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<tr>
<td>--------------------------------------------</td>
<td>------------------------------------------</td>
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<tr>
<td>Various instrumentation data</td>
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<tr>
<td>Light transmission</td>
<td>S1-S2-S3-S4-S5-S6</td>
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<tr>
<td>Heat flux, aft</td>
<td>C1-C2-C3</td>
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<tr>
<td>Heat flux, midsection</td>
<td>C4-C5-C6</td>
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<tr>
<td>Air velocity</td>
<td>V1-V2-V3</td>
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<tr>
<td>Fuel weight loss</td>
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<td>Seat weight loss</td>
<td>(NA)</td>
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<tr>
<td>Gas concentrations</td>
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<td>Hydrogen cyanide concentrations</td>
<td>Usually A8-A16-A8L-F16</td>
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<tr>
<td>Hydrogen fluoride concentrations</td>
<td>Usually A8-A16-A8L-F16</td>
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<tr>
<td>Hydrogen chloride concentrations</td>
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<td>Carbon monoxide concentrations, aft</td>
<td>A8-A16-A8L</td>
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<td>Carbon monoxide concentrations, fore</td>
<td>F8-F16-F8L</td>
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<td>Carbon dioxide concentrations, aft</td>
<td>(Same)</td>
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<td>Carbon dioxide concentrations, fore</td>
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<td>Oxygen concentrations, fore</td>
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<td>Hydrocarbons concentrations, aft</td>
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<td>Hydrocarbons concentrations, fore</td>
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<td>Cabin materials</td>
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<tr>
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</tr>
<tr>
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</tr>
<tr>
<td>7</td>
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<td>9</td>
<td>Seats (backs)</td>
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<td>Seats (cushions)</td>
</tr>
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<td>11</td>
<td>Seats (backs)</td>
</tr>
<tr>
<td>12</td>
<td>Seats (Upjohn)</td>
</tr>
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<td>Seats (Upjohn)</td>
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<td>14</td>
<td>Seats (polyimide)</td>
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<td>15</td>
<td>Wall panel</td>
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<tr>
<td>16</td>
<td>Overhead panels</td>
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<tr>
<td>17</td>
<td>Overhead panels</td>
</tr>
<tr>
<td>18</td>
<td>None - fuel only</td>
</tr>
<tr>
<td>19</td>
<td>All panels</td>
</tr>
<tr>
<td>20</td>
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<td>Test No.</td>
<td>Barometric pressure, mmHg</td>
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<td>763</td>
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<td>26</td>
<td>759</td>
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<tr>
<td>27</td>
<td>758</td>
</tr>
<tr>
<td>28</td>
<td>770</td>
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### TABLE VI. - PRE-TEST AIR VELOCITY MEASUREMENTS

<table>
<thead>
<tr>
<th>Test No.</th>
<th>Av velocity, Av direction&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Outside wind Av velocity, m/min (ft/min)</th>
<th>Av velocity - natural vent&lt;sup&gt;b,c&lt;/sup&gt;, m/min (ft/min)</th>
<th>Av velocity - forced vent&lt;sup&gt;b,d&lt;/sup&gt;, m/min (ft/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kph (mph) deg</td>
<td>At V1</td>
<td>At V2</td>
<td>At V1</td>
</tr>
<tr>
<td>1 to 13</td>
<td>These measurements were not taken for tests 1 to 13.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>27 (17) 150</td>
<td>53 (175)</td>
<td>61 (200)</td>
<td>61 (200)</td>
</tr>
<tr>
<td>15</td>
<td>22 (14) 300</td>
<td>12 (40)</td>
<td>9 (30)</td>
<td>47 (155)</td>
</tr>
<tr>
<td>16</td>
<td>29 (18) 160</td>
<td>27 (90)</td>
<td>38 (125)</td>
<td>35 (115)</td>
</tr>
<tr>
<td>17</td>
<td>11 (7) 160</td>
<td>61 (200)</td>
<td>33 (110)</td>
<td>--</td>
</tr>
<tr>
<td>18</td>
<td>5 (3) 120</td>
<td>12 (40)</td>
<td>12 (40)</td>
<td>36 (120)</td>
</tr>
<tr>
<td>19</td>
<td>2 (1) 360</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>43 (140)</td>
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<td>-- --</td>
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</tr>
<tr>
<td>21</td>
<td>10 (6) 150</td>
<td>61 (200)</td>
<td>91 (300)</td>
<td>8 (25)</td>
</tr>
<tr>
<td>22</td>
<td>5 (3) 340</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>35 (115)</td>
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<tr>
<td>23</td>
<td>2 (1) 210</td>
<td>0 (0)</td>
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<td>24</td>
<td>8 (5) 45</td>
<td>35 (115)</td>
<td>35 (115)</td>
<td>6 (20)</td>
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<tr>
<td>25</td>
<td>8 (5) 110</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>15 (50)</td>
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<td>-- --</td>
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</tr>
<tr>
<td>27</td>
<td>10 (6) 120</td>
<td>26 (85)</td>
<td>33 (110)</td>
<td>18 (60)</td>
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<td>28</td>
<td>-- --</td>
<td>--</td>
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</tbody>
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<sup>a</sup>The azimuth of the forward fuselage centerline was 340°.

<sup>b</sup>These measurements were made next to air velocity probes (V1 and V2) in aft bulkhead doorway, using handheld anemometers.

<sup>c</sup>Both forward and aft fuselage doors were open.

<sup>d</sup>Blower was on, forward door was closed, and aft door was open.
<table>
<thead>
<tr>
<th>Test No.</th>
<th>Cabin materials</th>
<th>Cyanide (as HCN), ppm</th>
<th>Fluoride (as HF), ppm</th>
<th>Chloride (as HCl), ppm</th>
<th>Carbon monoxide, ppm</th>
<th>Carbon dioxide, percent</th>
<th>Carbon oxygen, percent</th>
<th>Minimum Hydrocarbons (as CH$_4$), ppm</th>
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<td>1</td>
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<td>&lt;12</td>
<td>&lt;24</td>
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<td>&lt;12</td>
<td>&lt;24</td>
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<td>2.09</td>
<td>17.8</td>
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<td>&lt;12</td>
<td>&lt;24</td>
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<td>1.50</td>
<td>18.5</td>
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<td>&lt;12</td>
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<td>&lt;12</td>
<td>&lt;24</td>
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<td>18.2</td>
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<td>&lt;12</td>
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<td>18.9</td>
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<td>&lt;6</td>
<td>&lt;12</td>
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<td>.35</td>
<td>20.7</td>
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<td>19.4</td>
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<td>1.21</td>
<td>19.6</td>
<td>213</td>
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<td>19.5</td>
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<td>720</td>
<td>3359</td>
<td>2.22</td>
<td>18.5</td>
<td>2006</td>
</tr>
<tr>
<td>18</td>
<td>Seats (polyimide)</td>
<td>6</td>
<td>&lt;3</td>
<td>&lt;6</td>
<td>294</td>
<td>.46</td>
<td>20.2</td>
<td>189</td>
</tr>
<tr>
<td>19</td>
<td>Wall panel</td>
<td>11</td>
<td>105</td>
<td>20</td>
<td>1134</td>
<td>1.34</td>
<td>19.1</td>
<td>466</td>
</tr>
<tr>
<td>20</td>
<td>Overhead panels</td>
<td>&lt;3</td>
<td>&lt;3</td>
<td>&lt;6</td>
<td>319</td>
<td>1.15</td>
<td>19.3</td>
<td>129</td>
</tr>
<tr>
<td>21</td>
<td>Overhead panels</td>
<td>&lt;3</td>
<td>33</td>
<td>20</td>
<td>989</td>
<td>2.14</td>
<td>18.0</td>
<td>394</td>
</tr>
<tr>
<td>22</td>
<td>None - fuel only</td>
<td>&lt;3</td>
<td>&lt;3</td>
<td>&lt;6</td>
<td>--</td>
<td>.42</td>
<td>20.5</td>
<td>--</td>
</tr>
<tr>
<td>23</td>
<td>Wall and overhead panels</td>
<td>21</td>
<td>177</td>
<td>87</td>
<td>2664</td>
<td>3.01</td>
<td>15.9</td>
<td>1736</td>
</tr>
<tr>
<td>24</td>
<td>Seats, wall, and overhead panels</td>
<td>420</td>
<td>480</td>
<td>2580</td>
<td>8269</td>
<td>4.52</td>
<td>14.8</td>
<td>4651</td>
</tr>
<tr>
<td>25</td>
<td>Seats</td>
<td>420</td>
<td>57</td>
<td>1770</td>
<td>5389</td>
<td>4.26</td>
<td>15.6</td>
<td>1644</td>
</tr>
<tr>
<td>26</td>
<td>None - fuel only</td>
<td>&lt;3</td>
<td>&lt;3</td>
<td>&lt;6</td>
<td>604</td>
<td>3.53</td>
<td>15.4</td>
<td>304</td>
</tr>
<tr>
<td>27</td>
<td>None - fuel only</td>
<td>&lt;3</td>
<td>&lt;3</td>
<td>&lt;6</td>
<td>--</td>
<td>.92</td>
<td>19.6</td>
<td>89</td>
</tr>
<tr>
<td>28</td>
<td>Seats, wall, and overhead panels</td>
<td>1230</td>
<td>780</td>
<td>2040</td>
<td>11 500</td>
<td>9.69</td>
<td>9.6</td>
<td>7339</td>
</tr>
</tbody>
</table>

*aHydrocarbon concentrations include only light hydrocarbons up to C$_6$. Concentrations are in methane (CH$_4$) equivalents.

*bTest 10 was the first test in which a real-time dry gas collection and analyzer system (for CO-CO$_2$-O$_2$-HC) was available to cover six dry gas ports. Previous tests were limited to 32-liter (8-gallon) gas samples from only two dry gas ports.

*cTest 13 was the first test in which wet gas collection system (for HCN-HF-HCl) was upgraded to cover four wet gas ports. Previous tests were limited to only two wet gas ports.
TABLE VIII.- SEAT AND WALL PANEL WEIGHT LOSS

<table>
<thead>
<tr>
<th>Test No.</th>
<th>Cabin materials</th>
<th>Three foam seats</th>
<th>Wall panel</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Pre-test weight,</td>
<td>Pre-test weight,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>kg (lb)</td>
<td>weight, kg (lb)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Weight loss,</td>
<td>Weight loss,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>percent</td>
<td>percent</td>
</tr>
<tr>
<td>1 to 11</td>
<td>None - fuel only</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>12</td>
<td>Seats (cushions only)</td>
<td>4.0 (8.8)</td>
<td>48</td>
</tr>
<tr>
<td>13</td>
<td>Seats (backs only)</td>
<td>1.8 (4.0)</td>
<td>83</td>
</tr>
<tr>
<td>14</td>
<td>Seats (cushions only)</td>
<td>4.0 (8.8)</td>
<td>80</td>
</tr>
<tr>
<td>15</td>
<td>Seats</td>
<td>5.8 (12.7)</td>
<td>83</td>
</tr>
<tr>
<td>16</td>
<td>Seats (Upjohn)</td>
<td>5.9 (12.8)</td>
<td>70</td>
</tr>
<tr>
<td>17</td>
<td>Seats</td>
<td>-- a</td>
<td>--</td>
</tr>
<tr>
<td>18</td>
<td>Seats (polyimide)</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>19</td>
<td>Wall panel</td>
<td>NA</td>
<td>3.1 (6.9)</td>
</tr>
<tr>
<td>20</td>
<td>Overhead panels</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>21</td>
<td>Overhead panels</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>22</td>
<td>None - fuel only</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>23</td>
<td>Wall and overhead panels</td>
<td>NA</td>
<td>3.1 (6.9)</td>
</tr>
<tr>
<td>24</td>
<td>Seats, wall, and overhead panels</td>
<td>--</td>
<td>3.0 (6.6)</td>
</tr>
<tr>
<td>25</td>
<td>Seats</td>
<td>--</td>
<td>NA</td>
</tr>
<tr>
<td>26</td>
<td>None - fuel only</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>27</td>
<td>None - fuel only</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>28</td>
<td>Seats, wall, and overhead panels</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

A dash (--) symbol implies that the data were not taken, were lost, or were otherwise not available.
### TABLE IX.- OVERHEAD PANEL WEIGHT LOSS

<table>
<thead>
<tr>
<th>Test No.</th>
<th>No. 1 ceiling panel</th>
<th>No. 2 ceiling panel</th>
<th>No. 3 PSU</th>
<th>No. 4 stowage bin</th>
<th>No. 5 ceiling panel</th>
<th>No. 6 stowage bin</th>
<th>No. 7 PSU</th>
<th>No. 8 ceiling panel</th>
<th>No. 9 ceiling panel</th>
<th>All nine overhead panels</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 19</td>
<td>No overhead panels were used in these tests</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>(All panels had less than 2 percent weight loss)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;2</td>
</tr>
<tr>
<td>21</td>
<td>34 (All other panels had less than 2 percent weight loss)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>22</td>
<td>No overhead panels were used in this test</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>2</td>
<td>4</td>
<td>71</td>
<td>33</td>
<td>8</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>24</td>
<td>20</td>
<td>20</td>
<td>81</td>
<td>57</td>
<td>54</td>
<td>29</td>
<td>32</td>
<td>14</td>
<td>6</td>
<td>33</td>
</tr>
<tr>
<td>25 to 27</td>
<td>No overhead panels were used in these tests</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>(Data were not available)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>--</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Average pre-test panel weights, kg (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.3 (5.0) 2.3 (5.0) 1.9 (4.2) 1.0 (2.2) 2.3 (5.0) 1.0 (2.2) 1.9 (4.2) 2.3 (5.0) 2.3 (5.0) 17.1 (37.8)</td>
</tr>
</tbody>
</table>

aRefer to figure 7 for locations of panels.
CONFIGURATION OF TEST INSTRUMENTATION
PART A

OVERALL CONFIGURATION AND IDENTIFICATION OF INSTRUMENTATION
Figure 1 - Boeing 737 Fuselage Test Section
Figure 2. - Overall Configuration of Tree T/C's, Calorimeters, Smoke Meters, Fuel Pans, and Cameras*
Velocity Probe V3 was located 3 cm (1 in) from ceiling at T/C Tree 5.

Figure 3. - Air Velocity Probes
The lower ports, 0.8 m (2.5 ft) high, are only at F8L and A8L.

**Used only in 6.1 m (20 ft) tests.**

(o) = gas collection port locations (1 wet and 1 dry port at each location).

Figure 4. - Gas Collection Ports
Figure 5  - Fuselage Instrumentation (View Facing Aft)
Figure 6. - Fuselage Instrumentation (View Facing Forward)
Figure 7. - Overhead and Wall Panel T/C's
Figure 8. - Seat Cushion T/C's
Figure 9. - Seat Back T/C's
Figure 10 - Full-up Cabin Materials Configuration (Seats, and Wall, PSU, Bin, and Ceiling Panels)
Notes: (1) In tests 1 to 6, there was only 1 T/C, about 15 cm (6 in) above fuel pan.

(2) In most tests, 3 T/C's were over center of fuel pan. In seat tests, due to obstruction by seats, T/C's were positioned as close to fuel pan as practical.

Figure 11. - Fuel Pan T/C's
<table>
<thead>
<tr>
<th>Instrument Designations</th>
<th>Locations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>a) Inlet and Exit T/C's</strong></td>
<td>(Installed in all tests)</td>
</tr>
<tr>
<td>$T_{IN}$</td>
<td>Inlet air T/C located near center of air inlet diffuser on forward bulkhead door</td>
</tr>
<tr>
<td>$T_{EX}$</td>
<td>Exit air T/C located near center of aft bulkhead doorway</td>
</tr>
<tr>
<td><strong>b) Ceiling and Floor T/C's</strong></td>
<td>(Installed after Test 6)</td>
</tr>
<tr>
<td>TC4</td>
<td>3 cm (1 in) from ceiling at T/C Tree 4</td>
</tr>
<tr>
<td>TC1</td>
<td>3 cm (1 in) from ceiling at T/C Tree 1</td>
</tr>
<tr>
<td>TF4</td>
<td>3 cm (1 in) from floor at T/C Tree 4</td>
</tr>
<tr>
<td>TF1</td>
<td>3 cm (1 in) from floor at T/C Tree 1</td>
</tr>
<tr>
<td><strong>c) Shielded vs. Unshielded T/C's</strong></td>
<td>(Shielded T/C's were only installed in Tests 26 thru 28)</td>
</tr>
<tr>
<td>TF HI</td>
<td>Unshielded (High) Fuel Pan T/C</td>
</tr>
<tr>
<td>TF HI-S</td>
<td>Shielded (High) Fuel Pan T/C</td>
</tr>
<tr>
<td>TC 13</td>
<td>Unshielded T/C 13 (on Tree 3)</td>
</tr>
<tr>
<td>TC 13-S</td>
<td>Shielded T/C 13 (on Tree 3)</td>
</tr>
</tbody>
</table>

Figure 12. - Other T/C's
PART B

GAS COLLECTION AND ANALYSIS SYSTEMS
Figure 13. - Overall Configuration of Gas Collection Systems
Figure 14. - Components of Wet Gas Collection System (50% of total system shown)
Figure 15. - Wet Gas Collection System (Plus Early Dry Gas Collection System)

*(Dry gas system shown was used only for first 6 tests)*
Figure 16 - Dry Gas Collection and Analysis System Console
PART C

ADDITIONAL THERMOCOUPLE DETAILS
Figure 17. - Thermocouple Tree T/C Locations (and Overhead Panel Heights)
Figure 18. - Thermocouple Tree Locations
Figure 19. - Overhead Panel T/C Locations
Side View

1.2 m (4 ft)

15 cm (6 in)

25 cm (10 in) Typ

1.6 m (62 in)

5 cm (2 in)

0.3 m (1 ft)

0.3 m (1 ft)

0.6 m (2 ft)

Figure 20. - Wall Panel T/C Locations
Figure 21. - Seat Cushion and Back T/C Locations
PART D

ADDITIONAL DETAILS — OTHER INSTRUMENTATION
Cabin section at midpoint (or at fire position for end cabin fire)

(Total of 6 calorimeters)

Figure 22. - Calorimeter Locations
Total of 6 Smoke Meters
Points A and D - smoke meters at 0.75 m (30 in) and 1.5 m (60 in) from floor.

Points B and C - smoke meters at 1.5 m (60 in) from floor.

Figure 23. - Smoke Meter Locations
Figure 24. - Air Inlet Diffuser (Forward Bulkhead Door)
Figure 25. - Aft Air Velocity Probes
Figure 26. - Components of Fuel Ignition and Fuel Weighing Systems
Figure 27 - View of Fuel Ignition and Fuel Weighing Systems
Figure 28. - Dimensions of Seat Assembly Weighing System

Width = 1.6 m (62 in)

A/C ceiling
Suspension cables
Fuel pan shown

0.5 m (18 in)
0.4 m (14 in)
0.9 m (36 in)
1.3 m (50 in)
15 cm (6 in)
0.5 m (20 in)
30 cm (1 ft) sq.
Figure 29. - View of Seat Assembly Weighing System
TEST GRAPHS AND PHOTOGRAPHS
NO PHOTOS WERE TAKEN FOR TEST 1
FIGURE 30. - TEMPERATURES, T/C TREE 1
TEST 1

THERMOCOUPLES
1 TC1  4 TC4
2 TC2  5 TC5
3 TC3  6 TC6
FIGURE 31. - TEMPERATURES, T/C TREE 2
TEST 1
FIGURE 32 - TEMPERATURES, T/C TREE 3
TEST 1
FIGURE 33 - TEMPERATURES, T/C TREE 4
TEST 1
FIGURE 34 - TEMPERATURES, T/C TREE 5
TEST 1
FIGURE 35 - TEMPERATURES, T/C TREE 6
TEST 1
FIGURE 36 - TEMPERATURES, T/C TREE 7
TEST 1
FIGURE 37. - TEMPERATURE, ABOVE FUEL PAN
TEST 1
FIGURE 38  - TEMPERATURES, INLET + EXIT
TEST 1
FIGURE 39 - LIGHT TRANSMISSION TEST 1
FIGURE 40 - HEAT FLUX, AFT TEST 1
FIGURE 40 - HEAT FLUX, AFT - CONTINUED
TEST 1
FIGURE 41 - HEAT FLUX, MIDSECTION
TEST 1
FIGURE 41. - HEAT FLUX, MIDSECTION - CONTINUED
TEST 1
DATA NOT AVAILABLE
THE FOLLOWING HYDROLYZABLE GASES WERE NOT DETECTED IN THIS TEST

ABOVE THE LEVELS STATED BELOW:

HYDROGEN CYANIDE - < 12 PPM
HYDROGEN FLUORIDE - < 12 PPM
HYDROGEN CHLORIDE - < 24 PPM

FIGURE 42 - HYDROGEN CYANIDE, FLUORIDE, AND CHLORIDE CONCENTRATIONS
TEST 1
FIGURE 43 - CARBON MONOXIDE CONCENTRATIONS

TEST 1
FIGURE 44 - CARBON DIOXIDE CONCENTRATIONS
TEST 1
FIGURE 45 - OXYGEN CONCENTRATIONS

TEST 1
TEST 2
FUEL ONLY
NO PHOTOS WERE TAKEN FOR TEST 2
FIGURE 46  - TEMPERATURES, T/C TREE 1
TEST 2
FIGURE 47 - TEMPERATURES, T/C TREE 2
TEST 2
FIGURE 48 - TEMPERATURES, T/C TREE 3
TEST 2
FIGURE 49 - TEMPERATURES, T/C TREE 4
TEST 2
FIGURE 49 - TEMPERATURES, T/C TREE 4 - CONTINUED
TEST 2
FIGURE 50 - TEMPERATURES, T/C TREE 5
TEST 2
Figure 52 - Temperatures, T/C Tree 7
Test 2
FIGURE 53 - TEMPERATURE, Above FUEL PAN
TEST 2
FIGURE 54. - TEMPERATURES, INLET + EXIT
TEST 2
FIGURE 55 - LIGHT TRANSMISSION
TEST 2
FIGURE 56 - HEAT FLUX, AFT TEST 2
FIGURE 56 - HEAT FLUX, AFT - CONT.
TEST 2
FIGURE 57. - HEAT FLUX, MIDSECTION TEST 2
DATA NOT AVAILABLE

FUEL WEIGHT LOSS
TEST 2
THE FOLLOWING HYDROLYZABLE GASES WERE NOT DETECTED IN THIS TEST

ABOVE THE LEVELS STATED BELOW:

- HYDROGEN CYANIDE - <12 PPM
- HYDROGEN FLUORIDE - <12 PPM
- HYDROGEN CHLORIDE - <24 PPM

FIGURE 58 - HYDROGEN CYANIDE, FLUORIDE, AND CHLORIDE CONCENTRATIONS
TEST 2
FIGURE 59 - CARBON MONOXIDE CONCENTRATIONS
TEST 2
FIGURE 60 - CARBON DIOXIDE CONCENTRATIONS
TEST 2
FIGURE 61 - OXYGEN CONCENTRATIONS
TEST 2
NO PHOTOS WERE TAKEN FOR TEST 3
Figure 62: Temperatures, T/C Tree 1
Test 3
FIGURE 63 - TEMPERATURES, T/C TREE 2
TEST 3
FIGURE 64. - TEMPERATURES, T/C TREE 3
TEST 3
FIGURE 65 - TEMPERATURES, T/C TREE 4 - CONTINUED
TEST 3
FIGURE 66 - TEMPERATURES, T/C TREE 5
TEST 3
FIGURE 67 - TEMPERATURES, T/C TREE 6
TEST 3
FIGURE 68 - TEMPERATURES, T/C TREE 7
TEST 3
FIGURE 69 - TEMPERATURE, ABOVE FUEL PAN
TEST 3
FIGURE 70 - TEMPERATURES; INLET + EXIT
TEST 3
FIGURE 71 - LIGHT TRANSMISSION
TEST 3
FIGURE 72 - HEAT FLUX, AFT TEST 3
FIGURE 72 - HEAT FLUX, AFT - CONTINUED
TEST 3
FIGURE 73 - HEAT FLUX, MIDSECTION
TEST 3
FIGURE 73 - HEAT FLUX, MIDSECTION - CONTINUED
TEST 3
DATA NOT AVAILABLE

FUEL WEIGHT LOSS
TEST 3
THE FOLLOWING HYDROLYZABLE GASES WERE NOT DETECTED IN THIS TEST ABOVE THE LEVELS STATED BELOW:

- HYDROGEN CYANIDE - < 12 PPM
- HYDROGEN FLUORIDE - < 12 PPM
- HYDROGEN CHLORIDE - < 24 PPM

FIGURE 74 - HYDROGEN CYANIDE, FLUORIDE, AND CHLORIDE CONCENTRATIONS TEST 3
FIGURE 75 - CARBON MONOXIDE CONCENTRATIONS
TEST 3

PORT
3 - A16 2 - F8

O2L CARBON MONOXIDE, PPM

TIME, MINUTES
FIGURE 76 - CARBON DIOXIDE CONCENTRATIONS
TEST 3
FIGURE 77, OXYGEN CONCENTRATIONS
TEST 3
TEST 4

FUEL ONLY
NO PHOTOS WERE TAKEN FOR TEST 4
FIGURE 78 - TEMPERATURES, T/C TREE 1
TEST 4
FIGURE 79 - TEMPERATURES, T/C TREE 2
TEST 4
FIGURE 80 - TEMPERATURES, T/C TREE 3
TEST 4
FIGURE 81 - TEMPERATURES, T/C TREE 4
TEST 4
FIGURE 82 - TEMPERATURES, T/C TREE 5
TEST 4
Figure 83 - Temperatures, T/C Tree 6
Test 4
FIGURE 85 - TEMPERATURE, ABOVE FUEL PAN
TEST 4
FIGURE 86. - TEMPERATURES, INLET + EXIT
TEST 4
FIGURE 87 - LIGHT TRANSMISSION
TEST 4
FIGURE 88 - HEAT FLUX, AFT TEST 4
FIGURE 88. - HEAT FLUX, AFT - CONTINUED
TEST 4
Figure 68 - Heat Flux, AFT - Continued

Test 4
FIGURE 89 - HEAT FLUX, MIDSECTION TEST 4
FIGURE 89 - HEAT FLUX, MIDSECTION - CONTINUED
TEST 4
FIGURE 89. - HEAT FLUX, MIDSECTION - CONTINUED
   TEST 4
FIGURE 90. -- FUEL WEIGHT LOSS
TEST 4
THE FOLLOWING HYDROLYZABLE GASES WERE NOT DETECTED IN THIS TEST ABOVE THE LEVELS STATED BELOW:

- HYDROGEN CYANIDE - < 12 PPM
- HYDROGEN FLUORIDE - < 12 PPM
- HYDROGEN CHLORIDE - < 24 PPM

FIGURE 91 - HYDROGEN CYANIDE, FLUORIDE, AND CHLORIDE CONCENTRATIONS TEST 4
FIGURE 92 - CARBON MONOXIDE CONCENTRATIONS
TEST 4
FIGURE 93 - CARBON DIOXIDE CONCENTRATIONS
TEST 4
FIGURE 94 - OXYGEN CONCENTRATIONS

TEST 4
TEST 5
---------
FUEL ONLY
NO PHOTOS WERE TAKEN FOR TEST 5
FIGURE 95: TEMPERATURES, T/C TREE 1
TEST 5
FIGURE 96. - TEMPERATURES, T/C TREE 2
TEST 5
FIGURE 97 - TEMPERATURES, T/C TREE 3
TEST 5
FIGURE 98 - TEMPERATURES, T/C TREE 4
TEST 5
FIGURE 99 - TEMPERATURES, T/C TREE 5
TEST 5
FIGURE 100. - TEMPERATURES, T/C TREE 6
TEST 5
FIGURE 101 - TEMPERATURES, T/C TREE 7
TEST 5
FIGURE 102. - TEMPERATURE, ABOVE FUEL PAN
TEST 5
THERMOCOUPLES
1 TIN
2 TEX

FIGURE 103. - TEMPERATURES, INLET + EXIT
TEST 5
FIGURE 104 - LIGHT TRANSMISSION TEST 5
FIGURE 105 - HEAT FLUX, AFT
TEST 5
FIGURE 105 - HEAT FLUX, AFT - CONTINUED
TEST 5
FIGURE 105. - HEAT FLUX, AFT - CONTINUED
TEST 5
FIGURE 106 - HEAT FLUX, MIDSECTION
TEST 5
FIGURE 106. - HEAT FLUX, MIDSECTION - CONTINUED
TEST 5
Figure 107 - Fuel Weight Loss
Test 5
THE FOLLOWING HYDROLYZABLE GASES WERE NOT DETECTED IN THIS TEST ABOVE THE LEVELS STATED BELOW:

HYDROGEN CYANIDE - <12 PPM
HYDROGEN FLUORIDE - <12 PPM
HYDROGEN CHLORIDE - <24 PPM

FIGURE 108 - HYDROGEN CYANIDE, FLUORIDE, AND CHLORIDE CONCENTRATIONS TEST 5
FIGURE 109 - CARBON MONOXIDE CONCENTRATIONS
TEST 5
Figure 110 - Carbon Dioxide Concentrations

Test 5
FIGURE 111, - OXYGEN CONCENTRATIONS
TEST 5
TEST 6

FUEL ONLY
NO PHOTOS WERE TAKEN FOR TEST 6
FIGURE 112 - TEMPERATURES, T/C TREE 1
TEST 6
FIGURE 73 - TEMPERATURES, T/C TREE 2
TEST 6
FIGURE 114 - TEMPERATURES, T/C TREE 3
TEST 6
FIGURE 115 - TEMPERATURES, T/C TREE 4
TEST 6
FIGURE 116 - TEMPERATURES, T/C TREE 5
TEST 6
FIGURE 117 - TEMPERATURES, T/C TREE 6
TEST 6
FIGURE 118 - TEMPERATURES, T/C TREE 7
TEST 6
FIGURE 179 - TEMPERATURE, ABOVE FUEL PAN
TEST 6
FIGURE 120 - TEMPERATURES, INLET + EXIT
TEST 6
FIGURE 121 . - LIGHT TRANSMISSION
TEST 6
Figure 122 - Heat Flux, AFT
Test 6
FIGURE 122. - HEAT FLUX, AFT - CONTINUED
TEST 6
FIGURE 123 - HEAT FLUX, MIDSECTION
TEST 6
FIGURE 123. - HEAT FLUX, MIDSECTION - CONTINUED
TEST 6
FIGURE 124 - FUEL WEIGHT LOSS
TEST 6
The following hydrolyzable gases were not detected in this test above the levels stated below:

- Hydrogen cyanide - < 12 PPM
- Hydrogen fluoride - < 12 PPM
- Hydrogen chloride - < 24 PPM

Figure 125. - Hydrogen cyanide, fluoride, and chloride concentrations test 6
FIGURE 126 - CARBON MONOXIDE CONCENTRATIONS
TEST 6
FIGURE 127 - CARBON DIOXIDE CONCENTRATIONS
TEST 6
FIGURE 128 - OXYGEN CONCENTRATIONS
TEST 6
TESTS 7-8-9

These 3 test numbers were not used in this test program.
TEST 10
FUEL ONLY
FIGURE 129 - PRE-TEST CONFIGURATION, TEST 10
NO POST-TEST PHOTO WAS TAKEN FOR TEST 10
FIGURE 130 - FIRE DURING TEST 10
MOST OF THE DATA FOR TEST 10 WAS NOT AVAILABLE, 
WITH THE EXCEPTION OF THE GAS ANALYSIS DATA.

NON-AVAILABLE DATA

TEST 10
THE FOLLOWING HYDROLYZABLE GASES WERE NOT DETECTED IN THIS TEST

ABOVE THE LEVELS STATED BELOW:

HYDROGEN CYANIDE - < 6 PPM
HYDROGEN FLUORIDE - < 6 PPM
HYDROGEN CHLORIDE - < 12 PPM

FIGURE 131. - HYDROGEN CYANIDE, FLUORIDE, AND CHLORIDE CONCENTRATIONS TEST 10
FIGURE 132 - CARBON MONOXIDE CONCENTRATIONS, AFT TEST 10
Figure 133 - Carbon Monoxide Concentrations, Fore Test 10
FIGURE 134 - CARBON DIOXIDE CONCENTRATIONS, AFT
TEST 10
FIGURE 135 - CARBON DIOXIDE CONCENTRATIONS, FORE
TEST 10
FIGURE 136. - OXYGEN CONCENTRATIONS, AFT
TEST 10
FIGURE 137, - OXYGEN CONCENTRATIONS, FORE

TEST 10
FIGURE 138 - HYDROCARBONS CONCENTRATIONS, AFT
TEST 10
FIGURE 139 - HYDROCARBONS CONCENTRATIONS, FORE
TEST 10
TEST 11
FUEL ONLY
NO PHOTOS WERE TAKEN FOR TEST 11
FIGURE 140 - TEMPERATURES, T/C TREE 1
TEST 11
FIGURE 141. - TEMPERATURES, T/C TREE 2
TEST 11
FIGURE 142 - TEMPERATURES, T/C TREE 3
TEST 11
FIGURE 143 - TEMPERATURES, T/C TREE 4
TEST 11
FIGURE 144 - TEMPERATURES, T/C TREE 5
TEST 11
FIGURE 145 - TEMPERATURES, T/C TREE 6
TEST 11
FIGURE 146  - TEMPERATURES, T/C TREE 7
TEST 11
FIGURE 147 - TEMPERATURES, ABOVE FUEL PAN TEST 11
FIGURE 148 - TEMPERATURES, INLET + EXIT
TEST 11
FIGURE 149 - TEMPERATURES, CEILING + FLOOR (TREES 1+4)
TEST 11
FIGURE 150  - LIGHT TRANSMISSION TEST 11
Figure 150 - Light Transmission - Cont.
Test 11
FIGURE 151 - HEAT FLUX, AFT TEST 11
FIGURE 151. - HEAT FLUX, AFT - CONTINUED
TEST 11
FIGURE 152 - HEAT FLUX, MIDSECTION TEST 11
FIGURE 152 – HEAT FLUX, MIDSECTION-CONT.
TEST 11

HEAT FLUX, BTU/SQ.FT-SEC

TIME, MINUTES

CALORIMETERS
5 C5
6 C6

1.0X10^4

.8

.6

.4

.2

0.0
FIGURE 153 - AIR VELOCITY
TEST 11
FIGURE 153: AIR VELOCITY - CONT.
TEST 11
FIGURE 153 - AIR VELOCITY - CONT.
TEST 11
FIGURE 154. - FUEL WEIGHT LOSSES
TEST 11
THE FOLLOWING HYDROLYZABLE GASES WERE NOT DETECTED IN THIS TEST
ABOVE THE LEVELS STATED BELOW:

- HYDROGEN CYANIDE - < 6 PPM
- HYDROGEN FLUORIDE - < 6 PPM
- HYDROGEN CHLORIDE - < 12 PPM

FIGURE 155: HYDROGEN CYANIDE, FLUORIDE, AND CHLORIDE CONCENTRATIONS
TEST II
DUE TO EQUIPMENT PROBLEMS, ONLY THE PEAK VALUES WERE OBTAINED IN THIS TEST FOR THE NON-HYDROLYZABLE GASES, AS SHOWN BELOW:

- Maximum Carbon Monoxide Concentration: 54 ppm
- Maximum Carbon Dioxide Concentration: 0.35%
- Minimum Oxygen Concentration: 20.7%
- Maximum Hydrocarbon Concentration: 29 ppm

FIGURE 156 - CO, CO₂, O₂, and HYDROCARBONS CONCENTRATIONS

TEST II
TEST 12

BARE URETHANE FOAM SEATS (CUSHIONS ONLY)
TEST 12

BARE URETHANE FOAM SEATS (CUSHIONS ONLY)

FIGURE 157. - PRE-TEST CONFIGURATION, TEST 12

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FIGURE 158 - POST-TEST CONFIGURATION, TEST 12
FIGURE 160 - TEMPERATURES, T/C TREE 1
TEST 12
FIGURE 161 - TEMPERATURES, T/C TREE 2
TEST 12
FIGURE 162 - TEMPERATURES, T/C TREE 3
TEST 12
Figure 163 - Temperatures, T/C Tree 4
Test 12
FIGURE 163 - TEMPERATURES, T/C TREE 4 - CONTINUED
TEST 12
FIGURE 164 - TEMPERATURES, T/C TREE 5
TEST 12
FIGURE 165 - TEMPERATURES, T/C TREE 6
TEST 12
FIGURE 166 - TEMPERATURES, T/C TREE 7
TEST 12
FIGURE 167. - TEMPERATURES, SEAT CUSHIONS (TOP + BOTTOM)
TEST 12
FIGURE 168  - TEMPERATURES, SEAT CUSHIONS (EDGES)
TEST 12

THERMOCOUPLES
1 TM53  4 TM56
2 TM54
3 TM55
FIGURE 168. - TEMPERATURES, SEAT CUSHIONS (EDGES)-CONT.
TEST 12
FIGURE 169 - TEMPERATURES, ABOVE FUEL PAN
TEST 12

THERMOCOUPLES
1 TF HI
2 TF MID
3 TF LOW
FIGURE 170 - TEMPERATURES, INLET + EXIT
TEST 12
FIGURE 171 - TEMPERATURES, CEILING + FLOOR (TREES 1+4) TEST 12
FIGURE 172 - LIGHT TRANSMISSION
TEST 12

TIME, MINUTES

LIGHT TRANSMISSION, PERCENT

SMOKE METERS
1 S1  4 S4
2 S2  5 S5
3 S3  6 S6
FIGURE 173 - HEAT FLUX, AFT TEST 12
Figure 17.4 - Heat Flux, Midsection
Test 12
HEAT FLUX, BTU/SQ. FT-SEC

TIME, MINUTES

FIGURE 174 - HEAT FLUX, MIDSECTION - CONTINUED
TEST 12
FIGURE 175 - AIR VELOCITY
TEST 12
FIGURE 176: FUEL WEIGHT LOSS
TEST 12
FIGURE 177 - SEAT WEIGHT LOSS
TEST 12
FIGURE 178: HYDROGEN CYANIDE CONCENTRATIONS
TEST 12
THE FOLLOWING HYDROLYZABLE GASES WERE NOT DETECTED IN THIS TEST

ABOVE THE LEVELS STATED BELOW:

HYDROGEN FLUORIDE - < 6 PPM

FIGURE 179 - HYDROGEN FLUORIDE CONCENTRATIONS
TEST 12
FIGURE 180: HYDROGEN CHLORIDE CONCENTRATIONS
TEST 12
FIGURE 181. - CARBON MONOXIDE CONCENTRATIONS, AFT TEST 12
FIGURE 182 - CARBON MONOXIDE CONCENTRATIONS, FORE
TEST 12
FIGURE 183 - CARBON DIOXIDE CONCENTRATIONS, AFT
TEST 12
Figure 184 - Carbon Dioxide Concentrations, Fore Test 12

Legend:
- 2 - F8
- 4 - F16
- 6 - F8(L)

TIME, MINUTES

CARBON DIOXIDE, PERCENT
FIGURE 185 - OXYGEN CONCENTRATIONS, AFT
TEST 12
FIGURE 186 - OXYGEN CONCENTRATIONS, FORE TEST 12
Figure 187 - Hydrocarbons Concentrations, AFT

Test 12
FIGURE 188 - HYDROCARBONS CONCENTRATIONS, FORE
TEST 12

PORT
2 - F8
4 - F16
6 - F8(L)
TEST 13

BARE URETHANE FOAM SEATS (BACKS ONLY)
TEST 13

BARE URETHANE FOAM SEATS (BACKS ONLY)

FIGURE 189 - PRE-TEST CONFIGURATION, TEST 13
FIGURE 190 - POST-TEST CONFIGURATION, TEST 13
FIGURE 191 - FIRE DURING TEST 13

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FIGURE 192 - TEMPERATURES, T/C TREE 1
TEST 13
FIGURE 193 - TEMPERATURES, T/C TREE 2
TEST 13
FIGURE 194 - TEMPERATURES, T/C TREE 3
TEST 13
FIGURE 195  -  TEMPERATURES, T/C TREE 4
TEST 13
Figure 196 - Temperatures, T/C Tree 5
Test 13
FIGURE 197 - TEMPERATURES, T/C TREE 6
TEST 13
FIGURE 197 - TEMPERATURES, T/C TREE 6 - CONT.
TEST 13
FIGURE 196: TEMPERATURES, T/C TREE 7
TEST 13
FIGURE 199 - TEMPERATURES, SEAT BACKS (REAR)
TEST 13
FIGURE 137 - TEMPERATURES, SEAT BACKS (REAR) - CONT.
TEST 13
TEMPERATURES, SEAT BACKS (EDGES)
TEST 13

FIGURE 200
FIGURE 200. - TEMPERATURES, SEAT BACKS (EDGES) - CONT.
TEST 13
FIGURE 200. - TEMPERATURES, SEAT BACKS (EDGES) - CONT.
TEST 13
FIGURE 200. - TEMPERATURES, SEAT BACKS (EDGES) - CONT.
TEST 13
FIGURE 201 - TEMPERATURES, SEAT BACKS (FRONT)
TEST 13
FIGURE 201. - TEMPERATURES, SEAT BACKS (FRONT) - CONT.
TEST 13
FIGURE 202 - TEMPERATURES, ABOVE FUEL PAN
TEST 13

THERMOCOUPLES
1 TF HI
2 TF MID
3 TF LOW
FIGURE 203 - TEMPERATURES, INLET + EXIT
TEST 13
FIGURE 204 - TEMPERATURES, CEILING + FLOOR (TREES 1+4) TEST 13
FIGURE 205 - LIGHT TRANSMISSION
TEST 13
FIGURE 206 - HEAT FLUX, AFT
TEST 13
FIGURE 207 - HEAT FLUX, MIDSECTION TEST 13
FIGURE 207. - HEAT FLUX, MIDSECTION - CONTINUED
TEST 13
FIGURE 208. - AIR VELOCITY TEST 13
FIGURE 209 - FUEL WEIGHT LOSS
TEST 13
FIGURE 210 - SEAT WEIGHT LOSS
TEST 13
FIGURE 217: HYDROGEN CYANIDE CONCENTRATIONS
TEST 13
THE FOLLOWING HYDROLYZABLE GASES WERE NOT DETECTED IN THIS TEST ABOVE THE LEVELS STATED BELOW:

HYDROGEN FLUORIDE - < 3 PPM

FIGURE 212 - HYDROGEN FLUORIDE CONCENTRATIONS
TEST 13
FIGURE 213: HYDROGEN CHLORIDE CONCENTRATIONS

TEST 13
FIGURE 214 - CARBON MONOXIDE CONCENTRATIONS, AFT TEST 13
FIGURE 215 - CARBON MONOXIDE CONCENTRATIONS, FÖRE TEST 13
FIGURE 216 - CARBON DIOXIDE CONCENTRATIONS, AFT TEST 13
FIGURE 217 - CARBON DIOXIDE CONCENTRATIONS, FØRE TEST 13
FIGURE 218 - OXYGEN CONCENTRATIONS, AFT TEST 13
FIGURE 219. - ØXYGEN CONCENTRATIONS, FØRE
TEST 13
Figure 220 - Hydrocarbons Concentrations, Aft Test 13
FIGURE 221 - HYDROCARBONS CONCENTRATIONS, FORE TEST 13
TEST 14

BARE URETHANE FOAM SEATS (CUSHIONS ONLY)
FIGURE 222. - PRE-TEST CONFIGURATION, TEST 14
FIGURE 223. - POST-TEST CONFIGURATION, TEST 14
FIGURE 224 - FIRE DURING TEST 14

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FIGURE 225 - TEMPERATURES, T/C TREE 1
TEST 14
FIGURE 226. - TEMPERATURES, T/C TREE 2
TEST 14
FIGURE 227 - TEMPERATURES, T/C TREE 3
TEST 14

THERMOCOUPLES
1 TC13 4 TC16
2 TC14 5 TC17
3 TC15 6 TC18
FIGURE 228. - TEMPERATURES, T/C TREE 4
TEST 14.
FIGURE 229. - TEMPERATURES, T/C TREE 5
TEST 14
FIGURE 230 - TEMPERATURES, T/C TREE 6
TEST 14
FIGURE 231 - TEMPERATURES, T/C TREE 7
TEST 14
FIGURE 232. - TEMPERATURES, SEAT CUSHIONS (TOP + BOTTOM) TEST 14
FIGURE 233 - TEMPERATURES, SEAT CUSHIONS (EDGES)
TEST 14
FIGURE 233 - TEMPERATURES, SEAT CUSHIONS (EDGES) - CONT.
TEST 14
FIGURE 234: TEMPERATURES, ABOVE FUEL PAN
TEST 14
FIGURE 2.35 - TEMPERATURES, INLET + EXIT
TEST 14
FIGURE 236  .  - TEMPERATURES, CEILING + FLOOR (TREES 1+4)
TEST 14
FIGURE 237 - LIGHT TRANSMISSION TEST 14

SMØKE METERS
1 S1  4 S4
2 S2  5 S5
3 S3  6 S6
FIGURE 238 - HEAT FLUX, AFT TEST 14
FIGURE 239 - HEAT FLUX, MIDSECTION
TEST 14
FIGURE 240 - AIR VELOCITY
TEST 14
FIGURE 241 - FUEL WEIGHT LOSS
TEST 14
FIGURE 242  -  SEAT WEIGHT LOSS
TEST 14
FIGURE 243: HYDROGEN CYANIDE CONCENTRATIONS
TEST 14
THE FOLLOWING HYDROLYZABLE GASES WERE NOT DETECTED IN THIS TEST
ABOVE THE LEVELS STATED BELOW:

HYDROGEN FLUORIDE - < 3 PPM

FIGURE 244 - HYDROGEN FLUORIDE CONCENTRATIONS
TEST 14
FIGURE 245: HYDROGEN CHLORIDE CONCENTRATIONS
TEST 14
FIGURE 246 - CARBON MONOXIDE CONCENTRATIONS, AFT TEST 14
FIGURE 247 - CARBON MONOXIDE CONCENTRATIONS, FIRE TEST 14
FIGURE 248 - CARBON DIOXIDE CONCENTRATIONS, AFT TEST 14
FIGURE 249 - CARBON DIOXIDE CONCENTRATIONS, FØRE TEST 14
FIGURE 250 - OXYGEN CONCENTRATIONS, AFT TEST 14
FIGURE 251. - OXYGEN CONCENTRATIONS, FØRE TEST 14
FIGURE 252 - HYDROCARBONS CONCENTRATIONS, AFT TEST 14
FIGURE 253 - HYDROCARBONS CONCENTRATIONS, FØRE TEST 14

TIME, MINUTES

HYDROCARBONS, PPM

2 - F8
4 - F16
6 - F8(L)
TEST 15

BARE URETHANE FOAM SEATS
FIGURE 254 - PRE-TEST CONFIGURATION, TEST 15
FIGURE 256 - FIRE DURING TEST 15
FIGURE 257 - TEMPERATURES, T/C TREE 1
TEST 15
DATA NOT AVAILABLE

TEMPERATURES, T/C TREE 2
TEST 15
FIGURE 258 - TEMPERATURES, T/C TREE 3
TEST 15
FIGURE 259 - TEMPERATURES, T/C TREE 4
TEST 15
TEMPERATURES, T/C TREE 6
TEST 15
FIGURE 261 - TEMPERATURES, T/C TREE 7
TEST 15
FIGURE 262 - TEMPERATURES, SEAT CUSHIONS (TOP + BOTTOM)
TEST 15
FIGURE 262 - TEMPERATURES, SEAT CUSHIONS (TOP + BOTTOM) - CONT.
TEST 15
FIGURE 263 - TEMPERATURES, SEAT CUSHIONS (EDGES)
TEST 15
FIGURE 263. - TEMPERATURES, SEAT CUSHIONS (EDGES)-CONT.
TEST 15
FIGURE 26 - TEMPERATURES, SEAT BACKS (REAR) TEST 15

THERMOCOUPLES
1 TM64
2 TM65
3 TM66
FIGURE 264. - TEMPERATURES, SEAT BACKS (REAR) - CONT.
TEST 15
FIGURE 265 - TEMPERATURES, SEAT BACKS (EDGES)
TEST 15

THERMOCOUPLES
1 TM70  4 TM73
2 TM71
3 TM72
FIGURE 265 - TEMPERATURES, SEAT BACKS (EDGES) - CONT.
TEST 15
FIGURE 266 - TEMPERATURES, SEAT BACKS (FRONT)
TEST 15
FIGURE 266: TEMPERATURES, SEAT BACKS (FRONT)—CONT.
TEST 15
Figure 267 - Temperatures, Above Fuel Pan
Test 15
FIGURE 268 - TEMPERATURES, INLET + EXIT
TEST 15
FIGURE 269 - TEMPERATURES, CEILING + FLoor (TREES 1+4)
TEST 15
FIGURE 270 - LIGHT TRANSMISSION
TEST 15

SMOKE METERS
1 S1   4 S4
2 S2   5 S5
3 S3   6 S6
FIGURE 271 - HEAT FLUX, AFT TEST 15

CALORIMETERS
1 C1
2 C2 - NA.
3 C3
FIGURE 272 - HEAT FLUX, MIDSECTION
TEST 15
FIGURE 273. - AIR VELOCITY
TEST 15
Material Fell
Into Fuel

FIGURE 274 - FUEL WEIGHT LOSS
TEST 15
FIGURE 275 - SEAT WEIGHT LOSS
TEST 15
FIGURE 276: HYDROGEN CYANIDE CONCENTRATIONS
TEST 15
THE FOLLOWING HYDROLYZABLE GASES WERE NOT DETECTED IN THIS TEST

ABOVE THE LEVELS STATED BELOW:

HYDROGEN FLUORIDE - < 3 PPM

FIGURE 277. - HYDROGEN FLUORIDE CONCENTRATIONS
TEST 15
TIME, MINUTES

FIGURE 278 - HYDROGEN CHLORIDE CONCENTRATIONS
TEST 15
FIGURE 279. - CARBON MONOXIDE CONCENTRATIONS, AFT TEST 15
FIGURE 280 - CARBON MONOXIDE CONCENTRATIONS, FORE TEST 15
Figure 281. - Carbon dioxide concentrations, after test 15.
Figure 282 - Carbon Dioxide Concentrations, Førre Test 15
Figure 283 - Oxygen Concentrations, AFT Test 15
Figure 284 - Oxygen Concentrations, Førøe Test 15
FIGURE 285 - HYDROCARBONS CONCENTRATIONS, AFTER TEST 15
Figure 286. Hydrocarbons Concentrations, Føre Test 15

- PORT
- 2 - F8
- 4 - F16
- 6 - F8(L)
TEST 16

BARE UPJOHN 9700 WFR FOAM SEATS
Gas sample ports (l-wet, l-dry)

FIGURE 287 - PRE-TEST CONFIGURATION, TEST 16
FIGURE 288 - POST-TEST CONFIGURATION, TEST 16
FIGURE 289 - FIRE DURING TEST 16
FIGURE 290 - TEMPERATURES, T/C TREE 1
TEST 16
DATA NOT AVAILABLE

TEMPERATURES, T/C TREE 2
TEST 16
FIGURE 291 - TEMPERATURES, T/C TREE 3
TEST 16
FIGURE 292 - TEMPERATURES, T/C TREE 4
TEST 16
FIGURE 293 - TEMPERATURES, T/C TREE 5
TEST 16
TEMPERATURES, T/C TREE 6
TEST 16
FIGURE 294. - TEMPERATURES, T/C TREE 7
TEST 16
FIGURE 295. - TEMPERATURES, SEAT CUSHIONS (TOP + BOTTOM)
TEST 16
FIGURE 296 - TEMPERATURES, SEAT CUSHIONS (EDGES)
TEST 16
FIGURE 296 - TEMPERATURES, SEAT CUSHIONS (EDGES)- CONT.
TEST 16
FIGURE 297. - TEMPERATURES, SEAT BACKS (REAR)
TEST 16
FIGURE 298 - TEMPERATURES, SEAT BACKS (EDGES)
TEST 16
FIGURE 298 - TEMPERATURES, SEAT BACK (EDGES) - CONT.
TEST 16
FIGURE 299 - TEMPERATURES, SEAT BACKS (FRONT)

TEST 16
FIGURE 300 - TEMPERATURES, ABOVE FUEL PAN
TEST 16

TEMPERATURE, DEG F

0 100 200 300 400 500

TIME, MINUTES

00 04 08 12

THERMOCOUPLES
1 TF HI
2 TF MID
3 TF LOW-NA.
FIGURE 301 - TEMPERATURES, INLET + EXIT
TEST 16
FIGURE 302 - TEMPERATURES, CEILING + Floor (TREES 1+4)
TEST 16
FIGURE 303 - LIGHT TRANSMISSION
TEST 16
FIGURE 304 - HEAT FLUX, AFT TEST 16
FIGURE 305 - HEAT FLUX, MIDSECTION TEST 16
FIGURE 306. - AIR VELOCITY TEST 16
FIGURE 306 - AIR VELOCITY - CONT.
TEST 16
FIGURE 307 - FUEL WEIGHT LOSS
TEST 16
DATA NOT AVAILABLE

SEAT WEIGHT LOSS
TEST 16
FIGURE 308: HYDROGEN CYANIDE CONCENTRATIONS
TEST 16
THE FOLLOWING HYDROLYZABLE GASES WERE NOT DETECTED IN THIS TEST
ABOVE THE LEVELS STATED BELOW:

HYDROGEN FLUORIDE - < 3 PPM
HYDROGEN CHLORIDE - < 6 PPM
FIGURE 310 - CARBON MONOXIDE CONCENTRATIONS, AFT TEST 16
FIGURE 311 - CARBON MONOXIDE CONCENTRATIONS, FORE TEST 16
PORT
1 - A8L
3 - A16
5 - A8

FIGURE 312 - CARBON DIOXIDE CONCENTRATIONS, AFT TEST 16
FIGURE 313 - CARBON DIOXIDE CONCENTRATIONS, FÖRE TEST 16
FIGURE 314 - OXYGEN CONCENTRATIONS, AFT TEST 16
Figure 315 - Oxygen concentrations, fore test 16
FIGURE 316 - HYDROCARBONS CONCENTRATIONS, AFT TEST 16
FIGURE 317 - HYDROCARBONS CONCENTRATIONS, FØRE TEST 18
TEST 17

COVERED URETHANE FOAM SEATS
FIGURE 318.- PRE-TEST CONFIGURATION (FRONT VIEW), TEST 17
FIGURE 319. - POST-TEST CONFIGURATION (FRONT VIEW), TEST 17
FIGURE 320 - PRE-TEST CONFIGURATION (REAR VIEW), TEST 17
FIGURE 321 - POST-TEST CONFIGURATION (REAR VIEW), TEST 17
FIGURE 322 - FIRE DURING TEST 17

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FIGURE 323 - TEMPERATURES, T/C TREE 1
TEST 17
TEMPERATURES, T/C TREE 2
TEST 17
FIGURE 324 - TEMPERATURES, T/C TREE 3
TEST 17
FIGURE 325 - TEMPERATURES, T/C TREE 4
TEST 17
FIGURE 326 - TEMPERATURES, T/C TREE 5
TEST 17
TEMPERATURES, T/C TREE 6
TEST 17
FIGURE 327 - TEMPERATURES, T/C TREE 7
TEST 17
FIGURE 328 - TEMPERATURES, SEAT CUSHIONS (TOP + BOTTOM)
TEST 17
FIGURE 329 - TEMPERATURES, SEAT CUSHIONS (EDGES)
TEST 17
FIGURE 329. - TEMPERATURES, SEAT CUSHIONS (EDGES) - CONT.
TEST 17

THERMOCOUPLES
5 TM57 8 TM60
6 TM58
7 TM59
FIGURE 330 - TEMPERATURES, SEAT BACKS (REAR)
TEST 17
FIGURE 331 - TEMPERATURES, SEAT BACKS (EDGES)
TEST 17

THERMOCOUPLES
1 TM70 4 TM73
2 TM71
3 TM72
FIGURE 331 - TEMPERATURES, SEAT BACKS (EDGES) - CONT.
TEST 17
FIGURE 332 - TEMPERATURES, SEAT BACKS (FRONT)
TEST 17

THERMOCOUPLES
1 TM77  4 TM80
2 TM78  5 TM81
3 TM79  6 TM82
FIGURE 333 - TEMPERATURES, ABOVE FUEL PAN
TEST 17

THERMOCOUPLES
1 TF HI
2 TF MID
3 TF LOW-NA.
FIGURE 334 - TEMPERATURES, INLET + EXIT
TEST 17
FIGURE 335 - TEMPERATURES, CEILING + FLOOR (TREES 1+4) TEST 17
FIGURE 336 - LIGHT TRANSMISSION
TEST 17
Figure 337 - Heat Flux, AFT Test 17

**CALORIMETERS**
1 C1
2 C2 - N.A.
3 C3
FIGURE 338 - HEAT FLUX, MIDSECTION
TEST 17
FIGURE 339 - AIR VELOCITY TEST 17

VELOCITY, FEET/MINUTE

TIME, MINUTES

VELØCITY, METERS/SECOND

VELØCITY PROBE
FIGURE 340 - FUEL WEIGHT LOSS
TEST 17
* Includes Entire Seat Assembly

FIGURE 341 - SEAT WEIGHT LOSS
TEST 17
FIGURE 342: HYDROGEN CYANIDE CONCENTRATIONS
TEST 17
THE FOLLOWING HYDROLYZABLE GASES WERE NOT DETECTED IN THIS TEST
ABOVE THE LEVELS STATED BELOW:

HYDROGEN FLUORIDE - < 3 PPM

FIGURE 343 - HYDROGEN FLUORIDE CONCENTRATIONS
TEST 17
FIGURE 344: HYDROGEN CHLORIDE CONCENTRATIONS
TEST 17

PORT
1 - A8
3 - A16
5 - A8L
4 - F15

TIME, MINUTES

HYDROGEN CHLORIDE, PPM

0 100 200 300 400 500 600 700 800 900 1000

00 04 08 12 16

TEST 17
FIGURE 345. - CARBON MONOXIDE CONCENTRATIONS, AFT TEST 17
FIGURE 346 - CARBON MONOXIDE CONCENTRATIONS, FIRE TEST 17
FIGURE 347. - CARBON DIOXIDE CONCENTRATIONS, AFT TEST 17
FIGURE 348 - CARBON DIOXIDE CONCENTRATIONS, FØRE TEST 17
FIGURE 349 - OXYGEN CONCENTRATIONS, AFT TEST 17
FIGURE 350 - OXYGEN CONCENTRATIONS, FØRE TEST 17
FIGURE 351 - HYDROCARBONS CONCENTRATIONS, AFT TEST 17

- PORT
  1 - A8L
  3 - A16
  5 - A8
FIGURE 352 - HYDROCARBONS CONCENTRATIONS, FØRE TEST 17
TEST 18

BARE IH-1720 POLYIMIDE FOAM SEATS
TEST 18

BARE IH-1720 POLYIMIDE FOAM SEATS

FIGURE 353. - PRE-TEST CONFIGURATION, TEST 18

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FIGURE 354 - POST-TEST CONFIGURATION, TEST 18
FIGURE 355. - FIRE DURING TEST 18
FIGURE 356 - TEMPERATURES, T/C TREE 1
TEST 18
FIGURE 357 - TEMPERATURES, T/C TREE 2
TEST 18
FIGURE 358 - TEMPERATURES, T/C TREE 3
TEST 18
Figure 359. - Temperatures, T/C Tree 4
Test 18
FIGURE 360 - TEMPERATURES, T/C TREE 5
TEST 18
Fig. 361 – Temperatures, T/C Tree 6
Test 18
FIGURE 362 . - TEMPERATURES, T/C TREE 7
TEST 18
FIGURE 363 - TEMPERATURES, SEAT CUSHIONS (TOP + BOTTOM)
TEST 18
FIGURE 364 - TEMPERATURES, SEAT CUSHIONS (EDGES)
TEST 18
FIGURE 364 - TEMPERATURES, SEAT CUSHIONS (EDGES) - CONT.
TEST 18
FIGURE 365. - TEMPERATURES, SEAT BACKS (REAR)
TEST 18
FIGURE 366 - TEMPERATURES, SEAT BACKS (EDGES)
TEST 18
FIGURE 366 - TEMPERATURES, SEAT BACK (EDGES) - CONT.
TEST 18
FIGURE 367  -  TEMPERATURES, SEAT BACKS (FRONT)
TEST 18
FIGURE 368 - TEMPERATURES, ABOVE FUEL PAN
TEST 18
FIGURE 369 - TEMPERATURES, INLET + EXIT
TEST 18
FIGURE 370 - TEMPERATURES, CEILING + FL00R (TREES 1+4)
TEST 18
FIGURE 371. - LIGHT TRANSMISSION TEST 18
FIGURE 371. - LIGHT TRANSMISSION - CONT.
TEST 18
FIGURE 372: HEAT FLUX, AFT TEST 18
Figure 373 - Heat Flux, Midsection Test 18
FIGURE 373 - HEAT FLUX, MIDSECTION - CONT.
TEST 18
VELOCITY PROBE
2 V2 VI-NA
3 V3-NA

FIGURE 374 . - AIR VELOCITY
TEST 18
FIGURE 375 - FUEL WEIGHT LOSS
TEST 18
DATA NOT AVAILABLE

SEAT WEIGHT LOSS
TEST 18
FIGURE 376: HYDROGEN CYANIDE CONCENTRATIONS
TEST 18
THE FOLLOWING HYDROLYZABLE GASES WERE NOT DETECTED IN THIS TEST
ABOVE THE LEVELS STATED BELOW:

HYDROGEN FLUORIDE - < 3 PPM
HYDROGEN CHLORIDE - < 6 PPM

FIGURE 377 - HYDROGEN FLUORIDE AND CHLORIDE CONCENTRATIONS
TEST 18
FIGURE 378. - CARBON MONOXIDE CONCENTRATIONS, AFT TEST 18
FIGURE 379 - CARBON MONOXIDE CONCENTRATIONS, FØRE TEST 18
FIGURE 380. - CARBON DIOXIDE CONCENTRATIONS, AFTER TEST 18
FIGURE 381 - CARBON DIOXIDE CONCENTRATIONS, FORE TEST 18
Figure 382 - Oxygen Concentrations, AFT TEST 18
Figure 383. - Oxygen Concentrations, Fore Test 18
FIGURE 384 - HYDRÖCARBÖNS CONCENTRATÖNS, AFT TEST 18
FIGURE 385: HYDROCARBONS CONCENTRATIONS, BEFORE TEST 18
TEST 19
WALL PANEL
FIGURE 386. - PRE-TEST CONFIGURATION, TEST 19
FIGURE 387 - POST-TEST CONFIGURATION, TEST 19
FIGURE 388 - FIRE DURING TEST 19

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Figure 389 - Temperatures, T/C Tree 1
Test 19
FIGURE 390 - TEMPERATURES, T/C TREE 2
TEST 19
FIGURE 391 - TEMPERATURES, T/C TREE 3
TEST 19
FIGURE 392 - TEMPERATURES, T/C TREE 4
TEST 19
FIGURE 393 - TEMPERATURES, T/C TREE 5
TEST 19
FIGURE 394 - TEMPERATURES, T/C TREE 6
TEST 19
FIGURE 395 - TEMPERATURES, T/C TREE 7
TEST 19
FIGURE 396 - TEMPERATURES, SIDEWALL PANEL (TOP)
TEST 19
FIGURE 397. - TEMPERATURES, SIDEWALL PANEL (CENTER)
TEST 19
FIGURE 398 - TEMPERATURES, SIDEWALL PANEL (BOTTOM)
TEST 19
FIGURE 399. - TEMPERATURES, SIDEWALL PANEL (REAR)
TEST 19
FIGURE 400  - TEMPERATURES, ABOVE FUEL PAN
TEST 19
FIGURE 401 - TEMPERATURES, INLET + EXIT
TEST 19
FIGURE 402  -  TEMPERATURES, CEILING + FL00R (TREES 1+4)  
TEST 19
FIGURE 403 - LIGHT TRANSMISSION
TEST 19
FIGURE 404 - HEAT FLUX, AFT TEST 19

CALORIMETERS
1 C1
2 C2 - N.A.
3 C3
FIGURE 405 - HEAT FLUX, MIDSECTION TEST 19
FIGURE 405 - HEAT FLUX, MIDSECTION - CONT.
TEST 19
FIGURE 405 - HEAT FLUX, MIDSECTION - CONT.
TEST 19
FIGURE 406 - AIR VELOCITY TEST 19
FIGURE 407 - FUEL WEIGHT LOSS
TEST 19
Figure 408: Hydrogen Cyanide Concentrations

Test 19
FIGURE 409: HYDROGEN FLUORIDE CONCENTRATIONS

TEST 19
FIGURE 410 - HYDROGEN CHLORIDE CONCENTRATIONS
TEST 19
FIGURE 411. - CARBON MONOXIDE CONCENTRATIONS, AFT TEST 19
FIGURE 412 - CARBON MONOXIDE CONCENTRATIONS, FORE TEST 19
FIGURE 413 - CARBON DIOXIDE CONCENTRATIONS, AFT TEST 19
FIGURE 414 - CARBON DIoxide CONCENTRATIONs, FØRE TEST 19
FIGURE 415 - OXYGEN CONCENTRATIONS, AFT TEST 19
Figure 416 - Oxygen Concentrations, Before Test 19
Figure 417. - Hydrocarbons Concentrations, Aft Test 19
FIGURE 418 - HYDROCARBONS CONCENTRATIONS, FORE TEST 19
TEST 20

PSU, BIN, AND CEILING PANELS
TEST 20

PSU, BIN, AND CEILING PANELS

FIGURE 419. - PRE-TEST CONFIGURATION, TEST 20
FIGURE 420. - POST-TEST CONFIGURATION, TEST 20
FIGURE 421 - FIRE DURING TEST 20
Figure 422 - Temperatures, T/C Tree 1
Test 20
THERMOCOUPLES
1 TC7 4 TC10
2 TC8 5 TC11
3 TC9 6 TC12

FIGURE 423. - TEMPERATURES, T/C TREE 2
TEST 20
FIGURE 424 - TEMPERATURES, T/C TREE 3
TEST 20
FIGURE 425 - TEMPERATURES, T/C TREE 4
TEST 20
FIGURE 426. - TEMPERATURES, T/C TREE 5
TEST 20
FIGURE 427 - TEMPERATURES, T/C TREE 6
TEST 20
Figure 428 - Temperatures, T/C Tree 7
Test 20
FIGURE 429 - TEMPERATURES, PSU
TEST 20

THERMOCOUPLES
1 TM7  4 TM18
2 TM12 5 TM19
3 TM13 6 TM24
FIGURE 430 - TEMPERATURES, STOWAGE BINS
TEST 20
FIGURE 431. - TEMPERATURES, CEILING PANELS (AFT)
TEST 20
FIGURE 432. - TEMPERATURES, CEILING PANEL (CENTER) TEST 20
FIGURE 433  -  TEMPERATURES, CEILING PANELS (FORWARD)
TEST 20

THERMOCOUPLES
1 TM25  4 TM28
2 TM26  5 TM29
3 TM27  6 TM30
FIGURE 434 - TEMPERATURES, ABOVE FUEL PAN
TEST 20
FIGURE 435. - TEMPERATURES, INLET + EXIT
TEST 20
FIGURE 436 - TEMPERATURES, CEILING + FLOOR (TREES 1+4) TEST 20
FIGURE 437 - LIGHT TRANSMISSION
TEST 20

SMOKE METERS
1 S1 4 S4
2 S2 5 S5
3 S3 6 S6
FIGURE 438 - HEAT FLUX, AFT TEST 20

CALORIMETERS
1 C1
2 C2 - N.A.
3 C3
FIGURE 439 - HEAT FLUX, MIDSECTION
TEST 20
FIGURE 439. - HEAT FLUX, MIDSECTION - CONT.
TEST 20
FIGURE 440  - AIR VELOCITY
TEST 20
FIGURE 441 - FUEL WEIGHT LOSS
TEST 20
THE FOLLOWING HYDROLYZABLE GASES WERE NOT DETECTED IN THIS TEST

ABOVE THE LEVELS STATED BELOW:

HYDROGEN CYANIDE - < 3 PPM
HYDROGEN FLUORIDE - < 3 PPM
HYDROGEN CHLORIDE - < 6 PPM

FIGURE 442 - HYDROGEN CYANIDE, FLUORIDE, AND CHLORIDE CONCENTRATIONS
TEST 20
FIGURE 443. - CARBON MONOXIDE CONCENTRATIONS, AFT TEST 20
FIGURE 444. - CARBON MONOXIDE CONCENTRATIONS, FORE TEST 20
FIGURE 445.- CARBON DIOXIDE CONCENTRATIONS, AFT TEST 20
Figure 446 - Carbon dioxide concentrations, before test 20.
FIGURE 447. - OXYGEN CONCENTRATIONS, AFT
TEST 20
FIGURE 448 - OXYGEN CONCENTRATIONS, Føre
TEST 20
FIGURE 449. - HYDROCARBONS CONCENTRATIONS, AFT TEST 20
FIGURE 450. HYDROCARBONS CONCENTRATIONS, FØRE TEST 20
TEST 21
PSU, BIN, AND CEILING PANELS
NO PRE-TEST PHOTO WAS TAKEN FOR TEST 21
FIGURE 451. - POST-TEST CONFIGURATION, TEST 21
FIGURE 452. - FIRE DURING TEST 21

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FIGURE 453 - TEMPERATURES, T/C TREE 1
TEST 21
FIGURE 454 - TEMPERATURES, T/C TREE 2
TEST 21
FIGURE 455 - TEMPERATURES, T/C TREE 3
TEST 21
Figure 456. - Temperatures, T/C Tree 4
Test 21
FIGURE 457. - TEMPERATURES, T/C TREE 5
TEST 21
FIGURE 458. - TEMPERATURES, T/C TREE 6
TEST 21
FIGURE 459. - TEMPERATURES, T/C TREE 7
TEST 21
FIGURE 460 - TEMPERATURES, PSU
TEST 21
FIGURE 461 - TEMPERATURES, STOWAGE BINS
TEST 21
FIGURE 462 - TEMPERATURES, CEILING PANELS (AFT) TEST 21
FIGURE 463 - TEMPERATURES, CEILING PANEL (CENTER)
TEST 21
FIGURE 464 - TEMPERATURES, CEILING PANELS (FORWARD)
TEST 21
FIGURE 465 - TEMPERATURES, ABOVE FUEL PAN
TEST 21
Figure 466. Temperatures, inlet + exit test 21
FIGURE 467 - TEMPERATURES, CEILING + FLOOR (TREES 1+4)
TEST 21
FIGURE 468 - LIGHT TRANSMISSION
TEST 21
FIGURE 469 - HEAT FLUX, AFT
TEST 21

CALORIMETERS
1 C1
2 C2 - N.A.
3 C3
FIGURE 470 - HEAT FLUX, MIDSECTION
TEST 21
FIGURE 4-10. - HEAT FLUX, MIDSECTION-CONT.
TEST 21
FIGURE 471 - AIR VELOCITY
TEST 21
FIGURE 4-71 - AIR VELOCITY - CONT.
TEST 21
Material Fell Into Fuel

FIGURE 472  - FUEL WEIGHT LOSS
TEST 21
THE FOLLOWING HYDROLYZABLE GASES WERE NOT DETECTED IN THIS TEST
ABOVE THE LEVELS STATED BELOW:

HYDROGEN CYANIDE - < 3 PPM
Figure 474: Hydrogen fluoride concentrations

Test 21
FIGURE 475: HYDROGEN CHLORIDE CONCENTRATIONS
TEST 21
FIGURE 477 - CARBON MONOXIDE CONCENTRATIONS, FÖRE TEST 21
FIGURE 478 - CARBON DIOXIDE CONCENTRATIONS, AFT TEST 21
Figure 479. - Carbon dioxide concentrations, Före test 21
FIGURE 480 - OXYGEN CONCENTRATIONS, AFT TEST 21
FIGURE 481 - OXYGEN CONCENTRATIONS, FORE TEST 21
FIGURE 482. HYDROCARBONS CONCENTRATIONS, AFT
TEST 21
Figure 483 - Hydrocarbons Concentrations, Føre Test 21
TEST 22
FUEL ONLY
NO PHOTOS WERE TAKEN FOR TEST 22
FIGURE 484 - TEMPERATURES, T/C TREE 1
TEST 22
FIGURE 485 - TEMPERATURES, T/C TREE 2
TEST 22
FIGURE 486 - TEMPERATURES, T/C TREE 3
TEST 22

THERMOCOUPLES
1 TC13 4 TC16
2 TC14 5 TC17
3 TC15 6 TC18
FIGURE 487 - TEMPERATURES, T/C TREE 4
TEST 22
FIGURE 488 - TEMPERATURES, T/C TREE 5
TEST 22
FIGURE 489 - TEMPERATURES, T/C TREE 6
TEST 22
FIGURE 490 - TEMPERATURES, T/C TREE 7
TEST 22
FIGURE 491 - TEMPERATURES, ABOVE FUEL PAN
TEST 22
FIGURE 492 - TEMPERATURES, INLET + EXIT
TEST 22
FIGURE 493 - TEMPERATURES, CEILING + FLOOR (TREES 1+4)
TEST 22
FIGURE 494

LIGHT TRANSMISSION
TEST 22
FIGURE 494. - LIGHT TRANSMISSION - CONT.
TEST 22
FIGURE 495 - HEAT FLUX, AFT
TEST 22

CALORIMETERS
1 C1
2 C2 - N.A.
3 C3 - N.A.
FIGURE 496. - HEAT FLUX, MIDSECTION TEST 22
FIGURE 496 - HEAT FLUX, MIDSECTION - CONT.
TEST 22
FIGURE 497 - AIR VELOCITY
TEST 22
FIGURE 498 - FUEL WEIGHT LOSS
TEST 22
THE FOLLOWING HYDROLYZABLE GASES WERE NOT DETECTED IN THIS TEST
ABOVE THE LEVELS STATED BELOW:

HYDROGEN CYANIDE - < 3 PPM
HYDROGEN FLUORIDE - < 3 PPM
HYDROGEN CHLORIDE - < 6 PPM

FIGURE 499 - HYDROGEN CYANIDE, FLUORIDE, AND CHLORIDE CONCENTRATIONS
TEST 22
DUE TO EQUIPMENT PROBLEMS, THE CONCENTRATIONS OF THE FOLLOWING NON-HYDROLYZABLE GASES WERE NOT OBTAINED IN THIS TEST:

- CARBON MONOXIDE
- HYDROCARBONS

CARBON MONOXIDE AND HYDROCARBONS CONCENTRATIONS

TEST 22
FIGURE 500 - CARBON DIOXIDE CONCENTRATIONS, AFT TEST 22
FIGURE 501 - CARBON DIOXIDE CONCENTRATIONS, FORE TEST 22
FIGURE 502 - OXYGEN CONCENTRATIONS, AFT TEST 22
FIGURE 503 - OXYGEN CONCENTRATIONS, FØRE TEST 22
TEST 23

WALL, PSU, BIN, AND CEILING PANELS
FIGURE 504. - PRE-TEST CONFIGURATION, TEST 23

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FIGURE 505 - POST-TEST CONFIGURATION, TEST 23
FIGURE 506. - FIRE DURING TEST 23
Figure 507. - Temperatures, T/C Tree 1
Test 23
FIGURE 508. - TEMPERATURES, T/C TREE 2
TEST 23
FIGURE 509 - TEMPERATURES, T/C TREE 3
TEST 23
FIGURE 510. - TEMPERATURES, T/C TREE 4
TEST 23
Figure 511 - Temperatures, T/C Tree 5
Test 23
FIGURE 512 - TEMPERATURES, T/C TREE 6
TEST 23
FIGURE 513 - TEMPERATURES, T/C TREE 7
TEST 23

THERMOCOUPLES
1 TC37 4 TC40
2 TC38 5 TC41
3 TC39 6 TC42
FIGURE 514 - TEMPERATURES, PSU
TEST 23
FIGURE 515 - TEMPERATURES, STOWAGE BINS
TEST 23
FIGURE 516 - TEMPERATURES, CEILING PANELS (AFT)
TEST 23
FIGURE 517 - TEMPERATURES, CEILING PANEL (CENTER) - TEST 23
FIGURE 518. - TEMPERATURES, CEILING PANELS (FORWARD)
TEST 23
FIGURE 519. - TEMPERATURES, SIDEWALL PANEL (TOP)
TEST 23
FIGURE 520 - TEMPERATURES, SIDEWALL PANEL (CENTER) TEST 23
FIGURE 521. - TEMPERATURES, SIDEWALL PANEL (BOTTOM)
TEST 23
FIGURE 522. - TEMPERATURES, SIDEWALL PANEL (REAR)
TEST 23
FIGURE 523 - TEMPERATURES, ABOVE FUEL PAN TEST 23
FIGURE 523 - TEMPERATURES, ABOVE FUEL PAN - CONT.
TEST 23
FIGURE 524 - TEMPERATURES, INLET + EXIT
TEST 23
FIGURE 525. - TEMPERATURES, CEILING + FLOOR (TREES 1+4) TEST 23

THERMOCOUPLES
1 TC1
2 TC1
3 TF4

TIME, MINUTES

TEMPERATURE, DEG F

0 150. 300. 450. 600. 750.

TEMPERATURE, DEG C

0 150. 300. 450. 600. 750.

TIME, MINUTES
FIGURE 526 - LIGHT TRANSMISSION
TEST 23
FIGURE 527 - HEAT FLUX, AFT
TEST 23
FIGURE 528. - HEAT FLUX, MIDSECTION  
TEST 23
Figure 529: Air Velocity Test 23
FIGURE 530 - FUEL WEIGHT LOSS
TEST 23
FIGURE 531: HYDROGEN CYANIDE CONCENTRATIONS
TEST 23
FIGURE 532: HYDROGEN FLUORIDE CONCENTRATIONS
TEST 23
FIGURE 533: HYDROGEN CHLORIDE CONCENTRATIONS
TEST 23
FIGURE 534. CARBON MONOXIDE CONCENTRATIONS, AFT TEST 23
FIGURE 535 - CARBON MONOXIDE CONCENTRATIONS, FORE
TEST 23
FIGURE 536 - CARBON DIOXIDE CONCENTRATIONS, AFT TEST 23
FIGURE 537. - CARBON DIOXIDE CONCENTRATIONS, FORE TEST 23
FIGURE 539 - OXYGEN CONCENTRATIONS, Føre
TEST 23
FIGURE 540. - HYDROCARBONS CONCENTRATIONS, AFTER TEST 23
FIGURE 541 - HYDROCARBON CONCENTRATIONS, FORE TEST 23
TEST 24

COVERED URETHANE FOAM SEATS & WALL, PSU, BIN, AND CEILING PANELS
FIGURE 542. - PRE-TEST CONFIGURATION (FRONT VIEW), TEST 24
FIGURE 543. - POST-TEST CONFIGURATION (FRONT VIEW), TEST 24
FIGURE 544 - PRE-TEST CONFIGURATION (REAR VIEW), TEST 24
FIGURE 545. - POST-TEST CONFIGURATION (REAR VIEW), TEST 24
FIGURE 546 - FIRE DURING TEST 24
FIGURE 547 - TEMPERATURES, T/C TREE 1
TEST 24
FIGURE 548 - TEMPERATURES, T/C TREE 2
TEST 24
FIGURE 549 - TEMPERATURES, T/C TREE 3
TEST 24

THERMOCOUPLES
1 TC13 4 TC16
2 TC14 5 TC17
3 TC15 6 TC18
FIGURE 550. - TEMPERATURES, T/C TREE 4
TEST 24
FIGURE 551 - TEMPERATURES, T/C TREE 5
TEST 24
FIGURE 552 - TEMPERATURES, T/C TREE 6
TEST 24
FIGURE 553 - TEMPERATURES, T/C TREE 7
TEST 24
FIGURE 554 - TEMPERATURES, PSU
TEST 24
FIGURE 555 - TEMPERATURES, STOWAGE BINS
TEST 24
FIGURE 556 - TEMPERATURES, CEILING PANELS (AFT)
TEST 24
FIGURE 557  - TEMPERATURES, CEILING PANEL (CENTER)  
TEST 24
FIGURE 558. - TEMPERATURES, CEILING PANELS (FORWARD) TEST 24
FIGURE 559 - TEMPERATURES, SIDEWALL PANEL (TOP)
TEST 24
FIGURE 560 - TEMPERATURES, SIDEWALL PANEL (CENTER)
TEST 24
FIGURE 561 - TEMPERATURES, SIDEWALL PANEL (BOTTOM)
TEST 24
FIGURE 562 - TEMPERATURES, SIDEWALL PANEL (REAR)
TEST 24

THERMOCOUPLES
1 TM45 4 TM48
2 TM46 5 TM49
3 TM47
FIGURE 563 - TEMPERATURES, SEAT CUSHIONS (TOP + BOTTOM)  TEST 24
FIGURE 564 - TEMPERATURES, SEAT CUSHIONS (EDGES) TEST 24
FIGURE 564 - TEMPERATURES, SEAT CUSHIONS (EDGES)-CONT.
TEST 24
FIGURE 565 - TEMPERATURES, SEAT BACKS (REAR)
TEST 24
FIGURE 566 - TEMPERATURES, SEAT BACKS (EDGES)
TEST 24
FIGURE 566. - TEMPERATURES, SEAT BACK (EDGES)-CONT.
TEST 24
FIGURE 567 - TEMPERATURES, SEAT BACKS (FRONT)
TEST 24
FIGURE 568 - TEMPERATURES, ABOVE FUEL PAN
TEST 24
FIGURE 569 - TEMPERATURES, INLET + EXIT
TEST 24
FIGURE 570 - TEMPERATURES, CEILING + FLOOR (TREES 1+4) TEST 24
FIGURE 571  - LIGHT TRANSMISSION
TEST 24
FIGURE 572 — HEAT FLUX, AFT TEST 24

CALORIMETERS
1 C1
2 C2 - N.A.
3 C3
FIGURE 573 - HEAT FLUX, MIDSECTION TEST 24
FIGURE 574 - AIR VELOCITY TEST 24
FIGURE 574. - AIR VELOCITY - CONT.
TEST 24
DATA NOT AVAILABLE

SEAT WEIGHT LOSS
TEST 24
FIGURE 576: HYDROGEN CYANIDE CONCENTRATIONS
TEST 24
FIGURE 577: HYDROGEN FLUORIDE CONCENTRATIONS
TEST 24
FIGURE 578: HYDROGEN CHLORIDE CONCENTRATIONS
TEST 24
FIGURE 579 - CARBON MONOXIDE CONCENTRATIONS, AFT TEST 24
FIGURE 580 - CARBON MONOXIDE CONCENTRATIONS, FØRE TEST 24
Figure 581. - Carbon Dioxide Concentrations, After Test 24
FIGURE 582 - CARBON DIOXIDE CONCENTRATIONS, FORE TEST 24
Figure 583 - Oxygen Concentrations, AFT Test 24

- Port 1 - A8
- Port 3 - A16
- Port 5 - A8 (L)
FIGURE 584 - OXYGEN CONCENTRATIONS, FØRE TEST 24
FIGURE 585 - HYDROCARBONS CONCENTRATIONS, AFT TEST 24
FIGURE 586 - HYDROCARBONS CONCENTRATIONS, FÖRE TEST 24
TEST 25

COVERED URETHANE FOAM SEATS
FIGURE 587 - PRE-TEST CONFIGURATION, TEST 25
FIGURE 588. - POST-TEST CONFIGURATION, TEST 25
FIGURE 589 - FIRE DURING TEST 25
FIGURE 590 - TEMPERATURES, T/C TREE 1
TEST 25
FIGURE 591 - TEMPERATURES, T/C TREE 2
TEST 25
FIGURE 592 - TEMPERATURES, T/C TREE 3
TEST 25
FIGURE 593 - TEMPERATURES, T/C TREE 4
TEST 25
FIGURE 594 - TEMPERATURES, T/C TREE 5
TEST 25
FIGURE 595 - TEMPERATURES, T/C TREE 6
TEST 25

THERMOCOUPLES
1 TC31 4 TC34
2 TC32 5 TC35
3 TC33 6 TC36
FIGURE 596. - TEMPERATURES, T/C TREE 7
TEST 25
FIGURE 597. - TEMPERATURES, SEAT CUSHIONS (TOP + BOTTOM) TEST 25
FIGURE 598 - TEMPERATURES, SEAT CUSHIONS (EDGES)  
TEST 25
FIGURE 508. - TEMPERATURES, SEAT CUSHIONS (EDGES)-CONT.
TEST 25
FIGURE 599 - TEMPERATURES, SEAT BACKS (REAR)
TEST 25
FIGURE 600 - TEMPERATURES, SEAT BACKS (EDGES)
TEST 25
FIGURE 600. - TEMPERATURES, SEAT BACK (EDGES)-CONT.
TEST 25
FIGURE 601 - TEMPERATURES, SEAT BACKS (FRONT)
TEST 25
Figure 602 - Temperatures above fuel pan
Test 25
FIGURE 603 - TEMPERATURES, INLET + EXIT TEST 25
FIGURE 604 - TEMPERATURES, CEILING + FLOOR (TREES 1+4)
TEST 25
FIGURE 605 - LIGHT TRANSMISSION
TEST 25
FIGURE 606 - HEAT FLUX, AFT
TEST 25
FIGURE 607 - HEAT FLUX, MIDSECTION
TEST 25
FIGURE 607. - HEAT FLUX, MIDSECTION - CONT.
TEST 25
FIGURE 608 - AIR VELOCITY
TEST 25
FIGURE 609 - FUEL WEIGHT LOSS
TEST 25
Material Fell Into Fuel

* Includes Entire Seat Assembly

FIGURE 610. - SEAT WEIGHT LOSS
TEST 25
FIGURE 611: HYDROGEN CYANIDE CONCENTRATIONS

TEST 25
FIGURE 612: HYDROGEN FLUORIDE CONCENTRATIONS
TEST 25
FIGURE 613: - HYDROGEN CHLORIDE CONCENTRATIONS
TEST 25
Figure 614. - Carbon monoxide concentrations, AFT test 25
FIGURE 615 - CARBON MONOXIDE CONCENTRATIONS, FØRE TEST 25
FIGURE 616 - CARBON DIOXIDE CONCENTRATIONS, AFT TEST 25
Figure 617: Carbon Dioxide Concentrations, Føre Test 25
Figure 618 - Oxygen Concentrations, AFT Test 25

Port:
1 - A8
3 - A16
5 - A8(L)

Time, Minutes

Oxygen, Percent

16.00
18.00
20.00
22.00
24.00

00 02 04 06 08 10 12 14 16
Figure 619 - Oxygen Concentrations, Førø Test 25
FIGURE 620 - HYDROCARBONS CONCENTRATIONS, AFT TEST 25
FIGURE 621.- HYDROCARBONS CONCENTRATIONS, FØRE TEST 25
TEST 26
FUEL ONLY
FIGURE 622. - PRE-TEST CONFIGURATION, TEST 26
FIGURE 623. - POST-TEST CONFIGURATION, TEST 26

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FIGURE 624. - FIRE DURING TEST 26
FIGURE 626 - TEMPERATURES, T/C TREE 3
TEST 26
FIGURE 627 - TEMPERATURES, T/C TREE 4
TEST 26
FIGURE 628 - TEMPERATURES, T/C TREE 5
TEST 26
Figure 629 - Temperatures, T/C Tree 6
Test 26
FIGURE 630 - TEMPERATURES, ABOVE FUEL PAN
TEST 26
FIGURE 631 - TEMPERATURES, INLET + EXIT
TEST 26

TEMPERATURE, DEG F

TEMPERATURE, DEG C

TIME, MINUTES
FIGURE 632 – TEMPERATURES, CEILING + FLOOR (TREES 2+4)
TEST 26

THERMOCOUPLES
1 TC4  4 TF2
2 TC2 - N.A.
3 TF4
FIGURE 633 - TEMPERATURES. SHIELDED VS UNSHIELDED T/C'S
TEST 26
FIGURE 634 - LIGHT TRANSMISSION
TEST 26
FIGURE 635 - HEAT FLUX, AFT
TEST 26
FIGURE 636 - HEAT FLUX, MIDSECTION
TEST 26
FIGURE 637 - FUEL WEIGHT LOSS
TEST 26
THE FOLLOWING HYDROLYZABLE GASES WERE NOT DETECTED IN THIS TEST ABOVE THE LEVELS STATED BELOW:

HYDROGEN CYANIDE - < 3 PPM
HYDROGEN FLUORIDE - < 3 PPM
HYDROGEN CHLORIDE - < 6 PPM
FIGURE 639 - CARBON MONOXIDE CONCENTRATIONS, AFT TEST 26
FIGURE 640. - CARBON MONOXIDE CONCENTRATIONS, FbRE TEST 26
FIGURE 641 - CARBON DIOXIDE CONCENTRATIONS, AFT
TEST 26
Figure 62 - Carbon Dioxide Concentrations, Føre Test 26
FIGURE 643.

OXYGEN CONCENTRATIONS, AFT
TEST 26
Figure 6.44 - Oxygen Concentrations, Førre Test 2G
Figure 645. - Hydrøcarbons Concentrations, Aft Test 26
HYDROCARBONS, PPM

TIME, MINUTES

FIGURE 646 - HYDROCARBONS CONCENTRATIONS, FØRE TEST 26
FIGURE 647 - PRE-TEST CONFIGURATION, TEST 27

20-foot section bulkhead
Ignitor
Fuel pan T/C support
1-liter fuel pan
FIGURE 648. - POST-TEST CONFIGURATION, TEST 27
FIGURE 649 - FIRE DURING TEST 27
FIGURE 650 - TEMPERATURES, T/C TREE 2
TEST 27
FIGURE 651 - TEMPERATURES, T/C TREE 3
TEST 27
FIGURE 652 - TEMPERATURES, T/C TREE 4
TEST 27
FIGURE 653 - TEMPERATURES, T/C TREE 5
TEST 27
FIGURE 654 - TEMPERATURES, T/C TREE 6
TEST 27
FIGURE 655. - TEMPERATURES, ABOVE FUEL PAN
TEST 27
THERMOCOUPLES
1 TIN
2 TEX

FIGURE 656 - TEMPERATURES, INLET + EXIT
TEST 27
FIGURE 657 - TEMPERATURES, CEILING + FLOOR (TREES 2+4) TEST 27
FIGURE 658 - TEMPERATURES, SHIELDED VS UNSHIELDED T/C'S
TEST 27
FIGURE 659 - LIGHT TRANSMISSION
TEST 27
FIGURE 660 - HEAT FLUX, AFT
TEST 27
FIGURE 661. - HEAT FLUX, MIDSECTION
TEST 27
DATA NOT AVAILABLE

VEL0CITY PROBE
1 V1
2 V2
3 V3

TIME, MINUTES

VELOCITY, FEET/MINUTE

VELOCITY, METERS/SECOND

AIR VELOCITY
TEST 27
FIGURE 662 - FUEL WEIGHT LOSS
TEST 27
THE FOLLOWING HYDROLYZABLE GASES WERE NOT DETECTED IN THIS TEST

ABOVE THE LEVELS STATED BELOW:

HYDROGEN CYANIDE - < 3 PPM
HYDROGEN FLUORIDE - < 3 PPM
HYDROGEN CHLORIDE - < 6 PPM

FIGURE 663 - HYDROGEN CYANIDE, FLUORIDE, AND CHLORIDE CONCENTRATIONS
TEST 27
DUE TO EQUIPMENT PROBLEMS, THE CONCENTRATIONS OF THE FOLLOWING NON-HYDROLYZABLE GASES WERE NOT OBTAINED IN THIS TEST:

- CARBON MONOXIDE
Figure 664 - Carbon Dioxide Concentrations, AFT Test 27
Figure 667 - Oxygen Concentrations, Føre Test 27
FIGURE 668 - HYDROCARBONS CONCENTRATIONS, AFT TEST 27
FIGURE 669 - HYDROCARBONS CONCENTRATIONS, FÖRE TEST 27
TEST 28

COVERED URETHANE FOAM SEATS & WALL, PSU, BIN, AND CEILING PANELS
NO PRE-TEST OR DURING-FIRE PHOTOS WERE TAKEN FOR TEST 28

(REFER TO TEST 24 PRE-TEST PHOTOS AS A REFERENCE)
TEST 28

COVERED URETHANE FOAM SEATS & WALL, PSU, BIN, AND CEILING PANELS

FIGURE 670 - POST-TEST CONFIGURATION, TEST 28
FIGURE 671 - TEMPERATURES, T/C TREE 1
TEST 28
FIGURE 672 - TEMPERATURES, T/C TREE 2
TEST 28
FIGURE 673 - TEMPERATURES, T/C TREE 3
TEST 28
FIGURE 674 - TEMPERATURES, T/C TREE 4
TEST 28
FIGURE 675 - TEMPERATURES, T/C TREE 5
TEST 28
FIGURE 676 - TEMPERATURES, T/C TREE 6
TEST 28
FIGURE 677. - TEMPERATURES, T/C TREE 7
TEST 28
FIGURE 678 - TEMPERATURES, PSU
TEST 28
FIGURE 679. - TEMPERATURES, STOWAGE BINS
TEST 28
FIGURE 680 - TEMPERATURES, CEILING PANELS (AFT)
TEST 28
FIGURE 680. - TEMPERATURES, CEILING PANELS (AFT)-CONT.
TEST 28
FIGURE 681 - TEMPERATURES, CEILING PANEL (CENTER)
TEST 28
FIGURE 682. - TEMPERATURES, CEILING PANELS (FORWARD)
TEST 28
FIGURE 683 - TEMPERATURES, SIDEWALL PANEL (TOP)
TEST 28
THERMOCOUPLES
1 TM35  4 TM38
2 TM36  5 TM39
3 TM37

FIGURE 684. - TEMPERATURES, SIDEWALL PANEL (CENTER)
TEST 28
THERMOCOUPLES
1 TM40  4 TM43
2 TM41  5 TM44
3 TM42

FIGURE 685 - TEMPERATURES, SIDEWALL PANEL (BOTTOM)
TEST 28
FIGURE 686 — TEMPERATURES, SIDEWALL PANEL (REAR)
TEST 28
FIGURE 687. - TEMPERATURES, SEAT CUSHIONS (TOP + BOTTOM)
TEST 28
FIGURE 688 - TEMPERATURES, SEAT CUSHIONS (EDGES)
TEST 28
FIGURE 683 - TEMPERATURES, SEAT CUSHIONS (EDGES) - CONT.
TEST 28
FIGURE 689 - TEMPERATURES, SEAT BACKS (REAR)
TEST 28
FIGURE 690 - TEMPERATURES, SEAT BACKS (EDGES)
TEST 28
FIGURE 690. - TEMPERATURES, SEAT BACKS (EDGES) - CONT.
TEST 28
FIGURE 691 - TEMPERATURES, SEAT BACKS (FRONT)
TEST 28

THERMOCOUPLES
1 TM77 4 TM80
2 TM78 5 TM81
3 TM79 NA 6 TM82
FIGURE 692. TEMPERATURES, ABOVE FUEL PAN
TEST 28
FIGURE 693 - TEMPERATURES, INLET + EXIT
TEST 28
FIGURE 694 - TEMPERATURES, CEILING + FLOOR (TREES 1+4)
TEST 28
FIGURE 695 - TEMPERATURES, SHIELDED VS UNSHIELDED T/C'S
TEST 28
FIGURE 696. - LIGHT TRANSMISSION
TEST 28
FIGURE 697 - HEAT FLUX, AFT
TEST 28
FIGURE 698 - HEAT FLUX, MIDSECTION
TEST 28

CALORIMETERS
4 C4
5 C5
6 C6
FIGURE 699 - AIR VELOCITY
TEST 28
DUE TO EQUIPMENT PROBLEMS, IT WAS NOT POSSIBLE TO OBTAIN ANY DATA IN THIS TEST FOR:

- FUEL WEIGHT LOSS
- SEAT WEIGHT LOSS

FUEL AND SEAT WEIGHT LOSS

TEST 28
FIGURE 700 - HYDROGEN CYANIDE CONCENTRATIONS
TEST 28
FIGURE 701 - HYDROGEN FLUORIDE CONCENTRATIONS
TEST 28
FIGURE 702 - HYDROGEN CHLORIDE CONCENTRATIONS

TEST 28
FIGURE 703 - CARBON MONOXIDE CONCENTRATIONS, AFT TEST 28
Figure 704 - Carbon Monoxide Concentrations, Fire Test 28

- Port 2 - F8
- Port 4 - F16
- Port 6 - F8(L)
FIGURE 705 — CARBON DIOXIDE CONCENTRATIONS, AFT TEST 28
**Figure 706** - Carbon Dioxide Concentrations, Före

**Port**
- 2 - F8
- 4 - F16
- 6 - F8 (L)

**Time, Minutes**

**Figure 706** - Carbon Dioxide Concentrations, Före

Test 28
FIGURE 707 - OXYGEN CONCENTRATIONS, AFT
TEST 28
FIGURE 708: OXYGEN CONCENTRATIONS, FØRE
TEST 28
FIGURE 709 - HYDROCARBONS CONCENTRATIONS, AFT TEST 28
FIGURE 710: HYDROCARBONS CONCENTRATIONS, FØRE

TEST 28
Abstract

Twenty-five large-scale aircraft flammability tests were conducted in a Boeing 737 fuselage at the NASA Johnson Space Center (JSC). The objective of this test program was to provide a data base on the propagation of large-scale aircraft fires to support the validation of aircraft fire mathematical models.

Variables in the test program included cabin volume, amount of fuel, fuel pan area, fire location, air flow rate, and cabin materials. A number of tests were conducted with Jet A-1 fuel only, while others were conducted with various Boeing 747-type cabin materials. These included urethane foam seats, passenger service units, stowage bins, and wall and ceiling panels. Two tests were also included using special urethane foam and polyimide foam seats. Tests were conducted with each cabin material individually, with various combinations of these materials, and finally, with all materials in the cabin. The data include information obtained from approximately 160 locations inside the fuselage. Measurements include temperature, visibility, heat flux, air velocity, rate of fuel and seat-weight loss, and concentration of various gases. The data provided by this report include nearly 3000 curves (shown on 600 graphs). A matrix is included to quickly locate any particular graph. Approximately 50 before, during, and after test photographs are also included.