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AIRCRAFT CARGO COMPARTMENT FIRE SACRAMENTO
TEST SIMULATION

CONTRACT NAS2-8699

DOUGLAS AIRCRAFT COMPANY



TENTATIVE AGENDA

- 10:00 - 10:30 Handouts and Brief Discussion
Questions to be answered by A. Binding at this time
- 10:30 - 11:00 Demonstration of Ignition Test
- 11:00 - Start Test
- 12:30 - 1:00 Leave for lunch - possibly after termination of test and withdrawal of cargo
- 2:00 Return to test site to inspect cargo and interior

CARGO AND BAGGAGE COMPARTMENT TESTS

TEST COMPARTMENT AND FACILITY DESCRIPTION

The cargo and baggage test compartment was designed and fabricated at Long Beach, then assembled at the Sacramento Test Center. A photograph of the fire test facility showing the instrumentation trailer, CO₂ back-up firex system, and the compartment-leakage air blower is presented in Figure 1. The cameras are shown in place with a tug in position to remove cargo after test completion. Figure 2 is a schematic of the facility showing the relationship of equipment and instrumentation to the compartment stations. The blower behind the compartment produces air flow in the tunnel external to the compartment which simulates the cabin air conditioning air flow. Figure 3 shows the inside of the 4500 ft³ test compartment and the movable bulkhead which varies the volume. The air inlet on the right slant and the outlet on the left slant side simulate the compartment vent valve and cargo door leakage, respectively. The compartment is lined with aircraft quality fiberglass sheet and sealed per production standards. Smoke, UV, UVIR, detectors as well as the back-up firex nozzles are located on approximately the ceiling centerline. (UV, UVIR, detectors not shown - ceiling in Figure 3 is configured as used in a previous test). The corrugated steel floor is sealed with a silicone potting material. Figure 4 shows the loading gate, that has camera windows and an access door, in the open position. A simulated cargo load is shown in the compartment (cargo load shown in not representative of loading used in test no. 1 or test no. 2). When the loading gate is closed, the continuous end seal compresses sealing the compartment.

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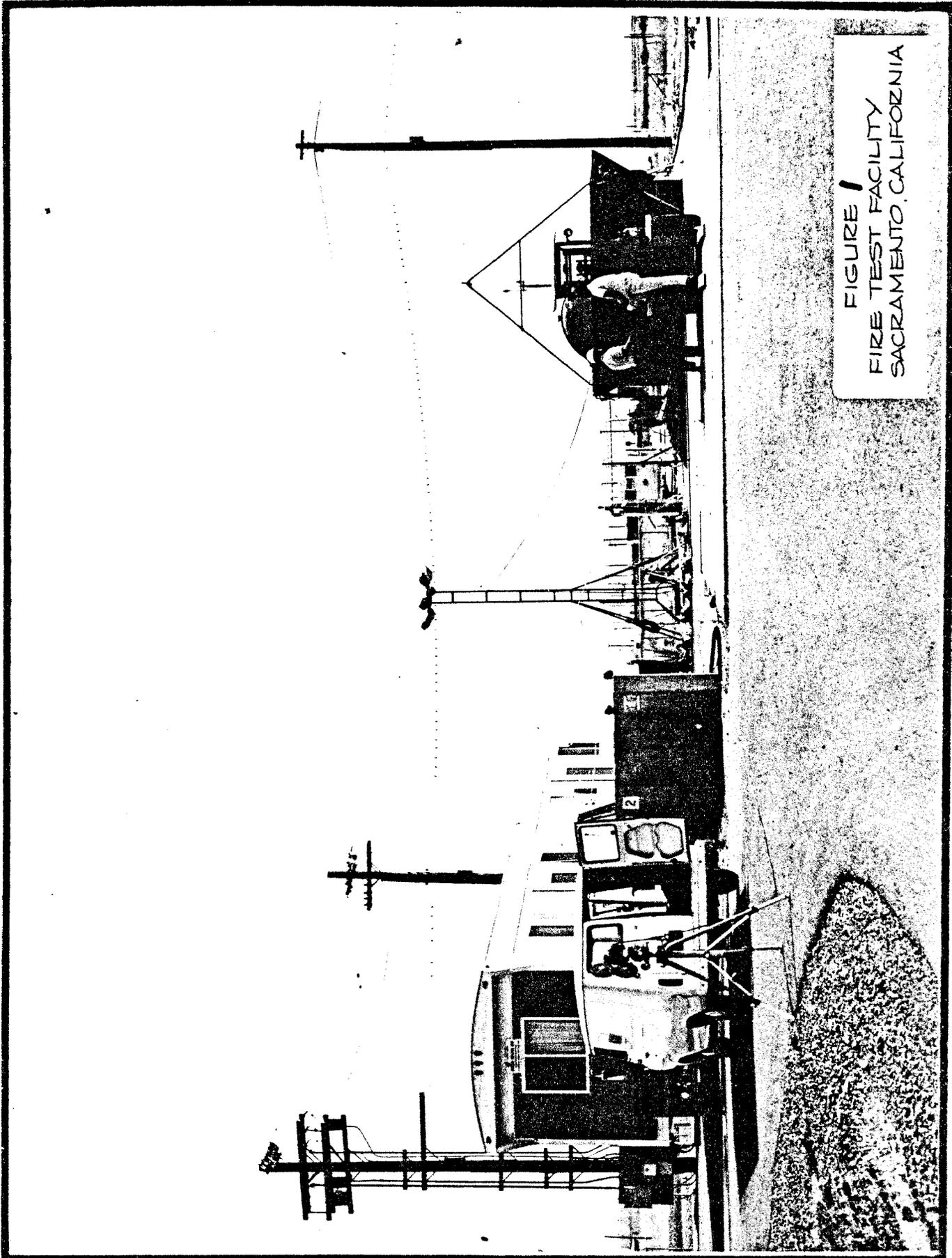
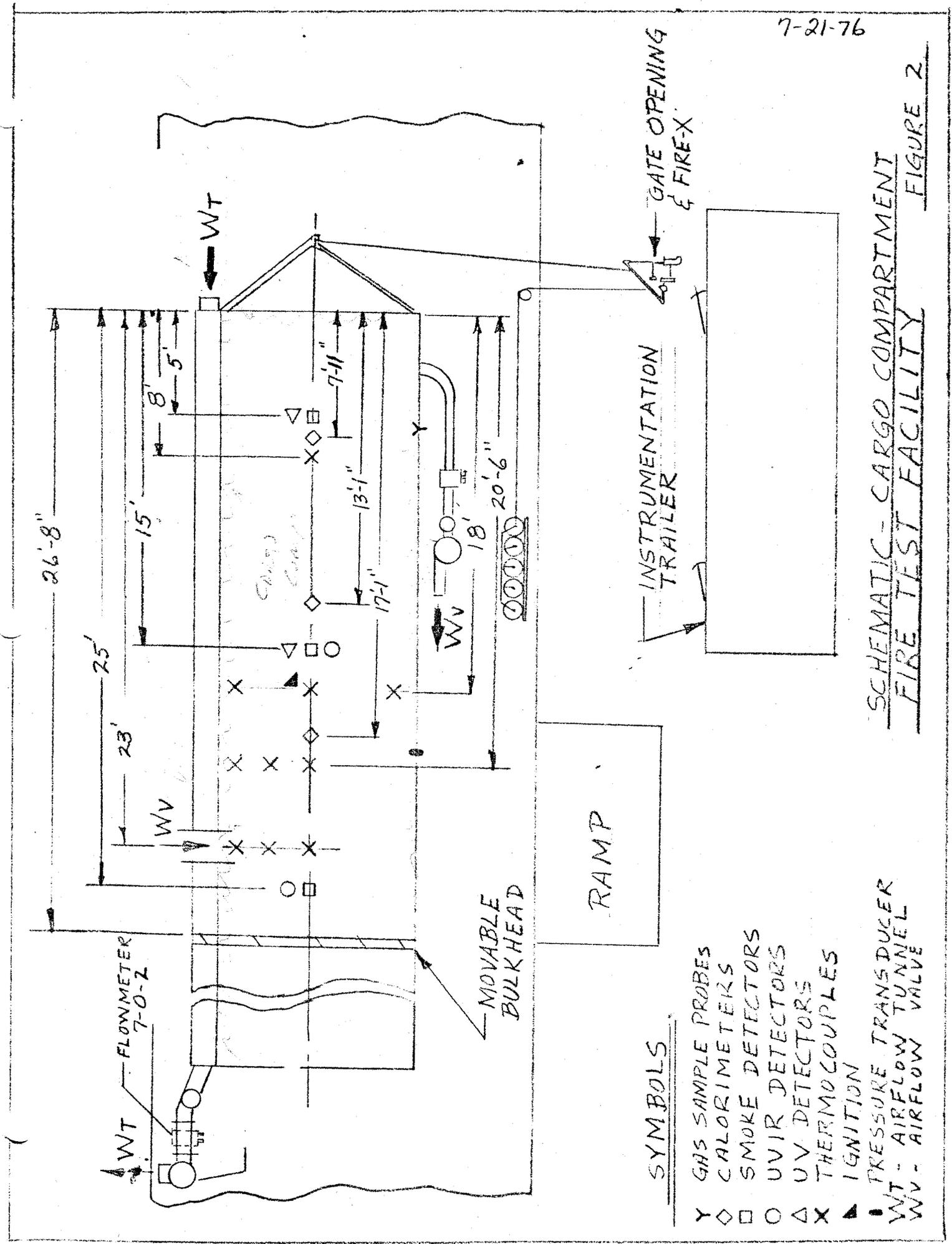


FIGURE 1
FIRE TEST FACILITY
SACRAMENTO, CALIFORNIA

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SYMBOLS

- Y GAS SAMPLE PROBES
- ◇ CALORIMETERS
- SMOKE DETECTORS
- UVIR DETECTORS
- △ UV DETECTORS
- X THERMOCOUPLES
- ▲ IGNITION
- PRESSURE TRANSDUCER
- WT - AIRFLOW TUNNEL
- WV - AIRFLOW VALVE

SCHEMATIC - CARGO COMPARTMENT
FIRE TEST FACILITY FIGURE 2

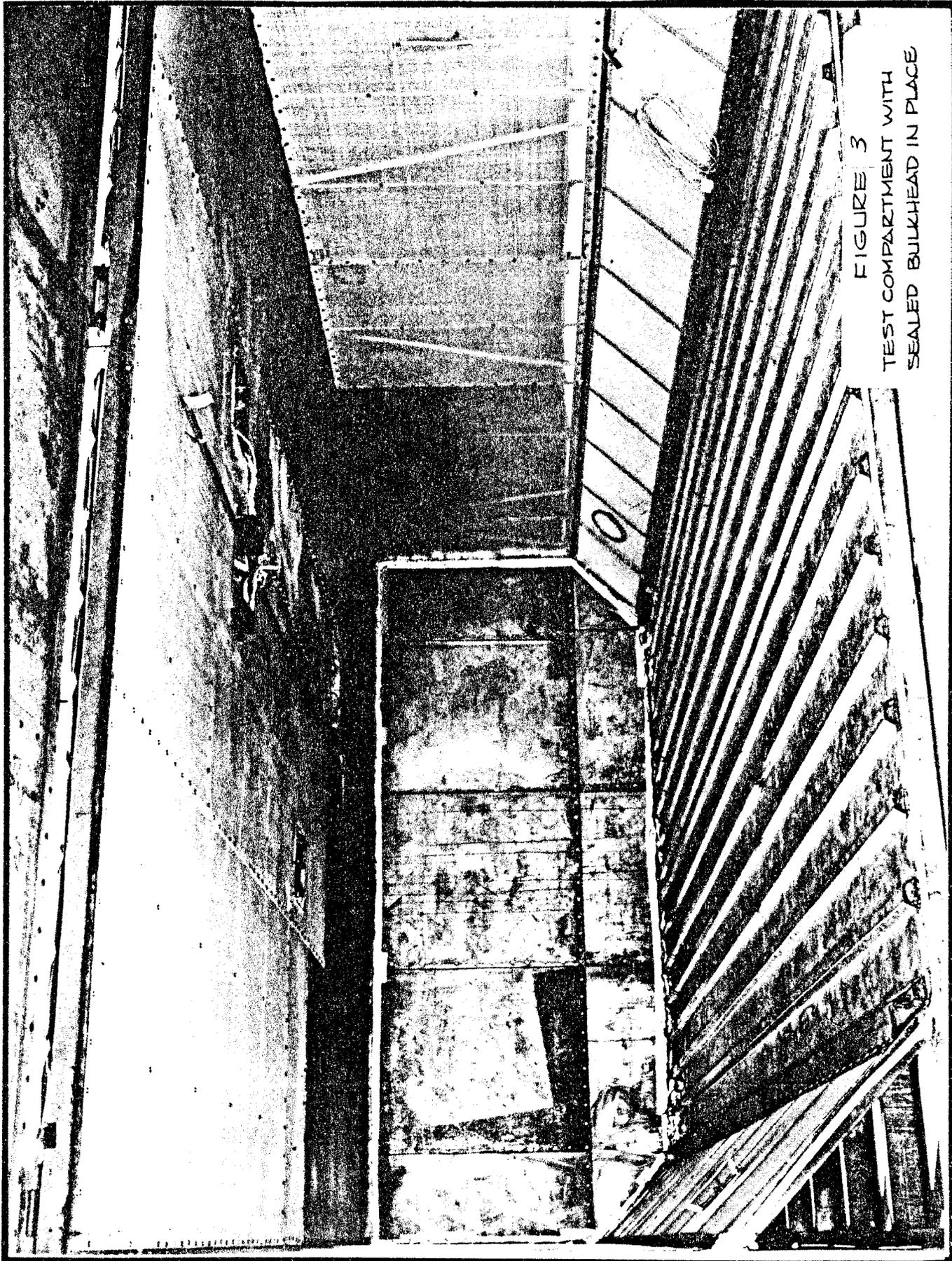


FIGURE 3
TEST COMPARTMENT WITH
SEALED BULKHEAD IN PLACE

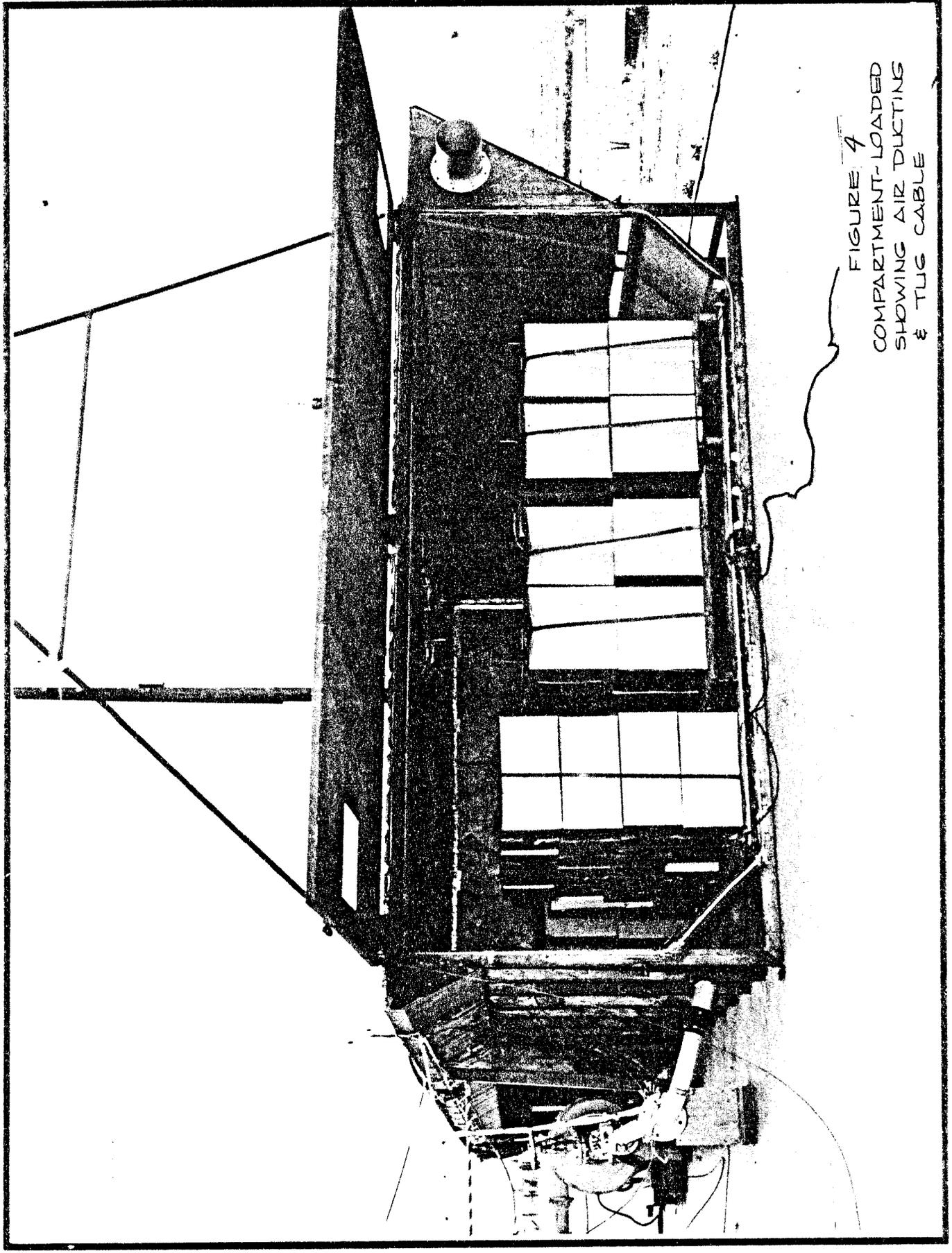


FIGURE 4
COMPARTMENT-LOADED
SHOWING AIR DUCTING
& TUG CABLE

CONFIGURATION TEST NO. 1

- o Length: 26' 8"
- o Height: 5' 7"
- o Width: 13' 7"
- o Volume: 2000 ft³
- o Ventilation: 21 changes/hr = 3013 lbs/hr @ 90°F
- o Tunnel flow: 12,000 lb/hr
- o CO₂ firex backup system 300 lbs.
- o Ignition source: gas soaked rag and hot wire
- o Cargo load 50% gross compartment volume
- o Cargo composition: 18" x 18" x 18" cardboard cartons loosely filled with a current commercial type packing material (e.g., rubberized hair, polyethylene, polyurethane, cellular film, fiber board, and Kim Pac)
- o Cargo liner: .023 epoxy fiberglass per DMS 1946

INSTRUMENTATION TEST NO. 1

- o Three pyrotector smoke detectors, P/N 30-231-17
- o Four chromel-alumel air temperature thermocouples (1" below ceiling)
- o Four chromel-alumel liner temperature thermocouples (on ceiling)
- o Two chromel-alumel structure temperature thermocouples (above ceiling)
- o One 0-0.5 psi ΔP pressure transducer in sidewall
- o One each O_2 , CO_2 , CO gas analyzers
- o Two orifice plate flow meters for tunnel flow and ventilation
- o Two 16 mm motion picture cameras plus still photos
- o Total hydrocarbon samples
- o Two calorimeters
- o Smoke recorder - photo diode

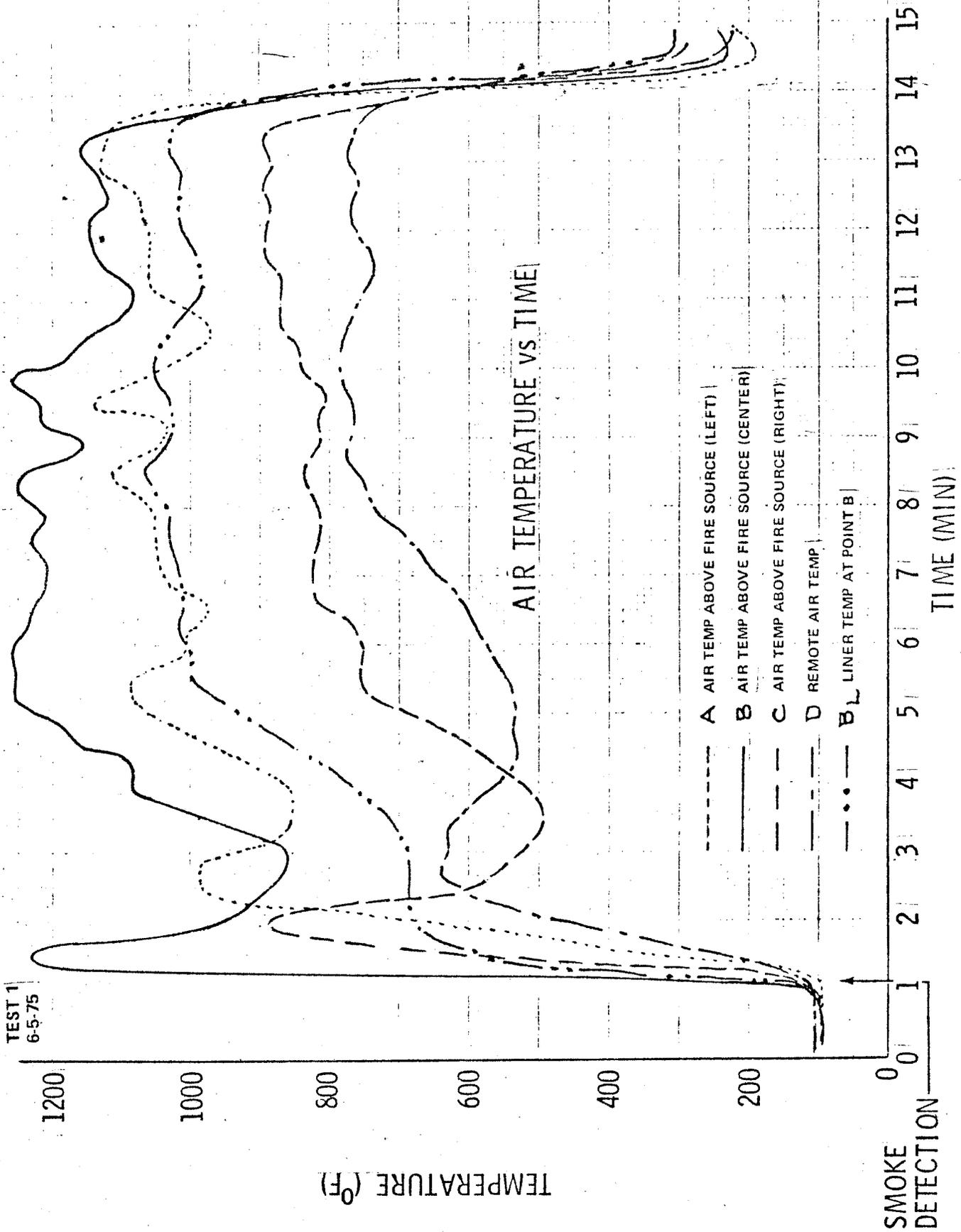
RESULTS OF TEST NO. 1

The first baseline test of the Aircraft Cargo Compartment Fire Test Simulation Program was conducted to help define the development of a fire in a medium-sized aircraft cargo compartment. The compartment was tested with an uncommonly large continuous airflow. This airflow was not shut down on fire detection as is mandatory in aircraft emergency procedures but was maintained to allow clear definition of air flow effects. Air, liner, and structural temperatures were measured, gas samples were taken, BTU/ft² was recorded, pressure and smoke density were monitored, and movies were taken.

During the test, a burnthrough of the ceiling liner occurred. Data indicates that temperature peaks were in excess of 1250°F. Oxygen concentration dropped to 1% after 9 minutes and carbon dioxide reached 14% by 3 minutes.

Refer to figures 5, 6, 7, 8 and 9, for results in graphical form.

TEST RESULTS (Fig. 2)

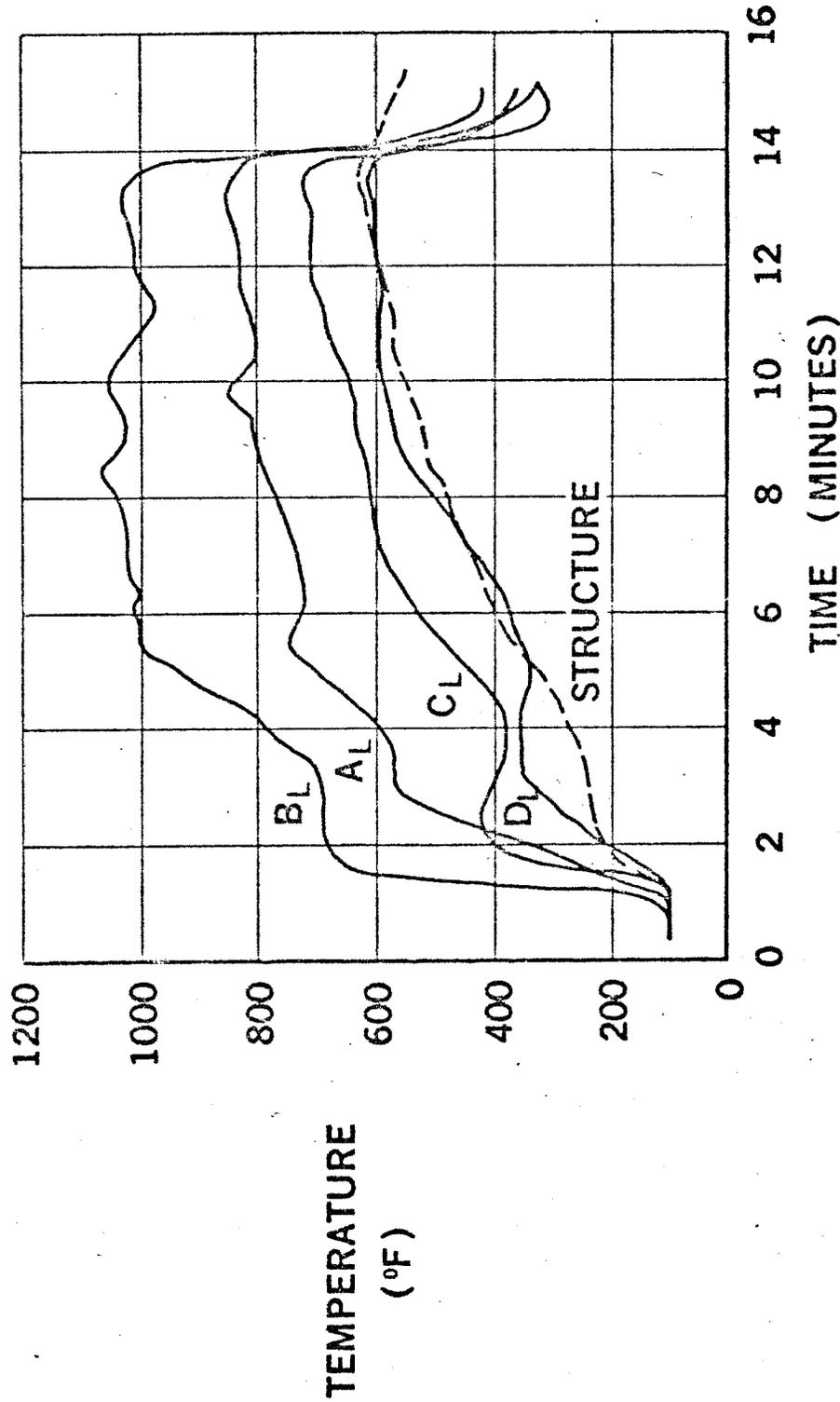


TEST NO. 1

FIGURE 5

STRUCTURE AND LINER TEMPERATURE VS TIME (Fig. 3)

TEST 1 6-5-75



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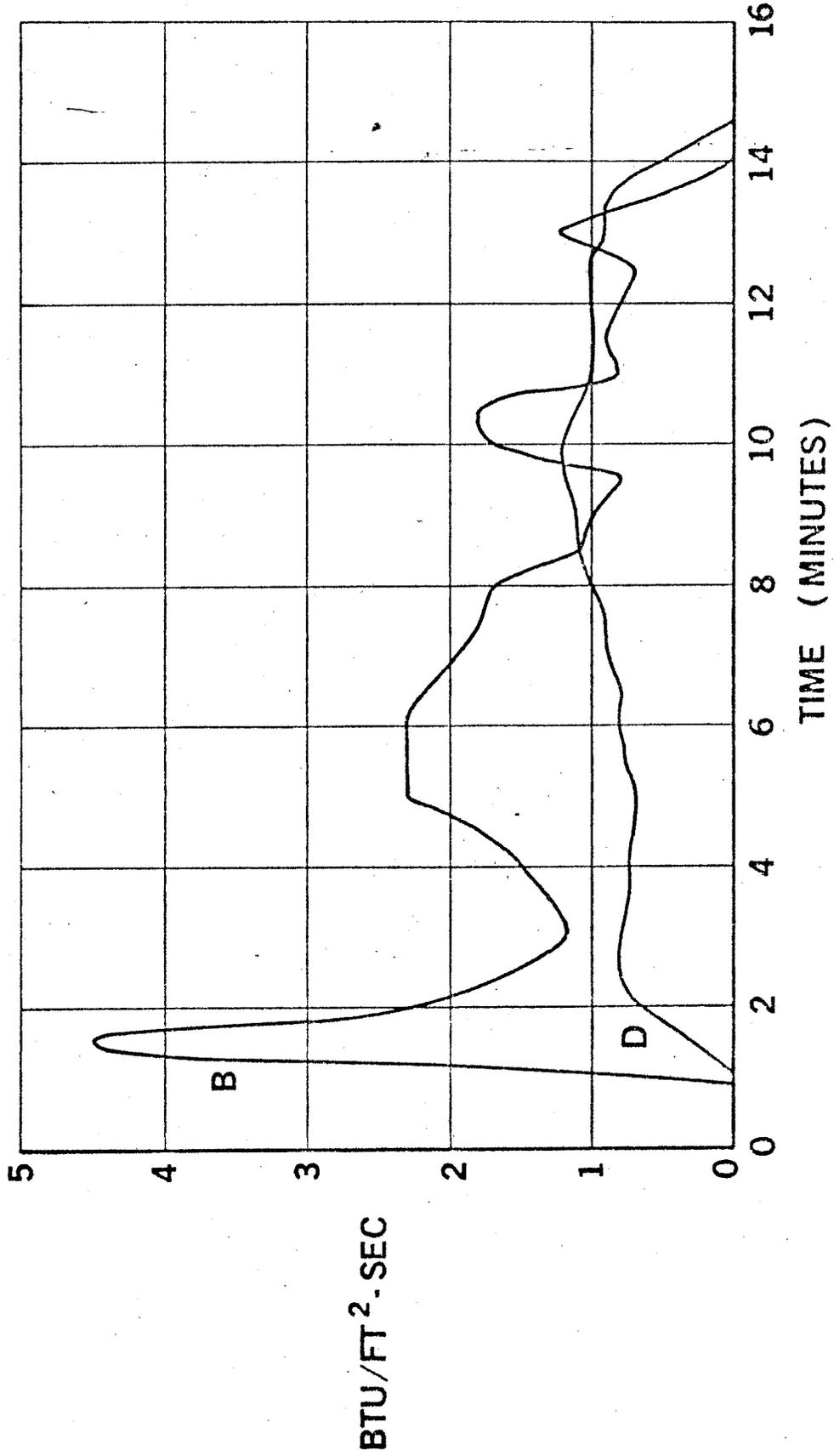
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TEST NO. 1.

FIGURE 6

BTU/FT² VS TIME (FIG. 4)

TEST 1 6-5-75

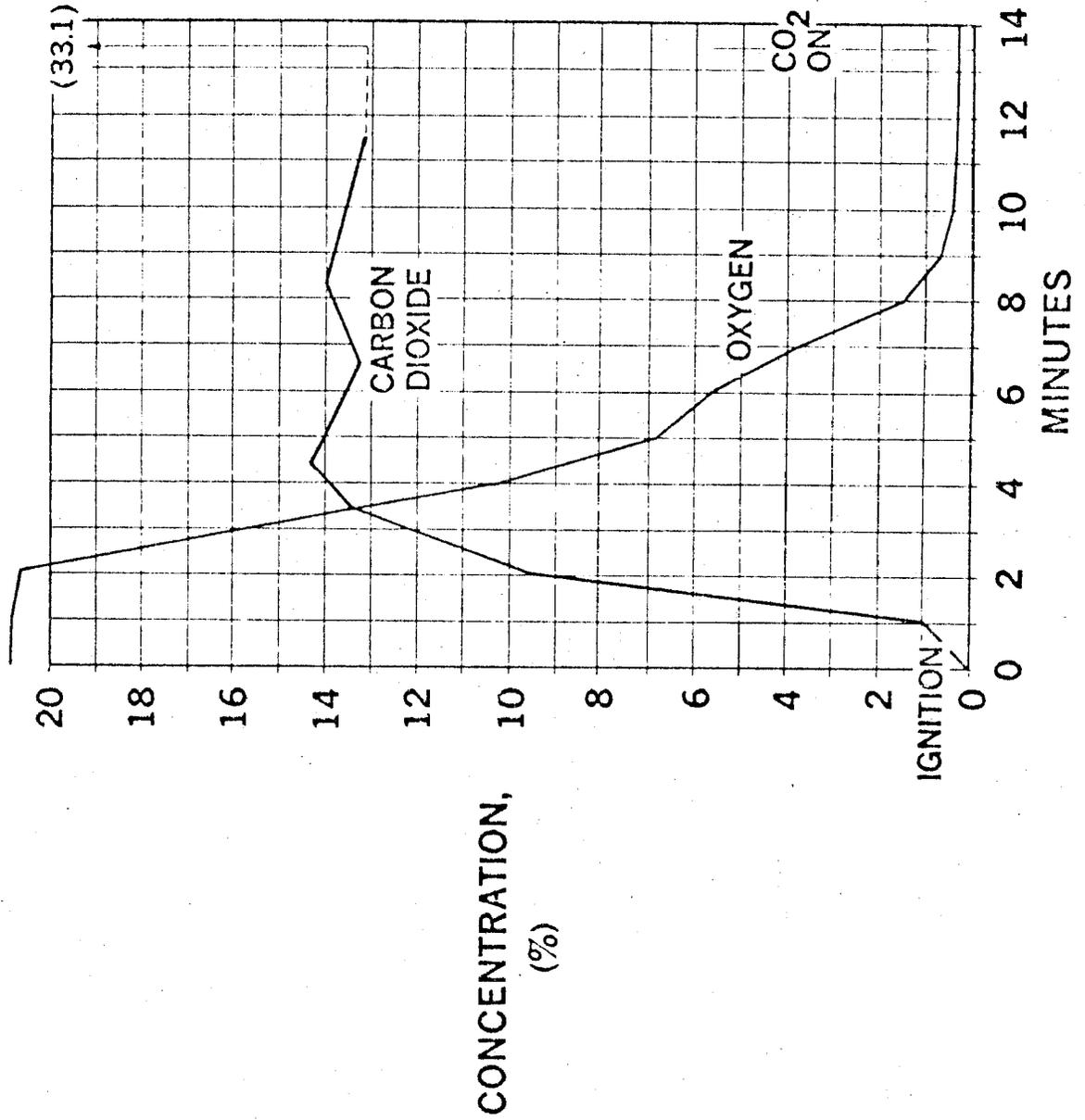


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FIGURE 7

TEST NO. 1

OXYGEN AND CARBON DIOXIDE CONCENTRATIONS (Fig. 5)



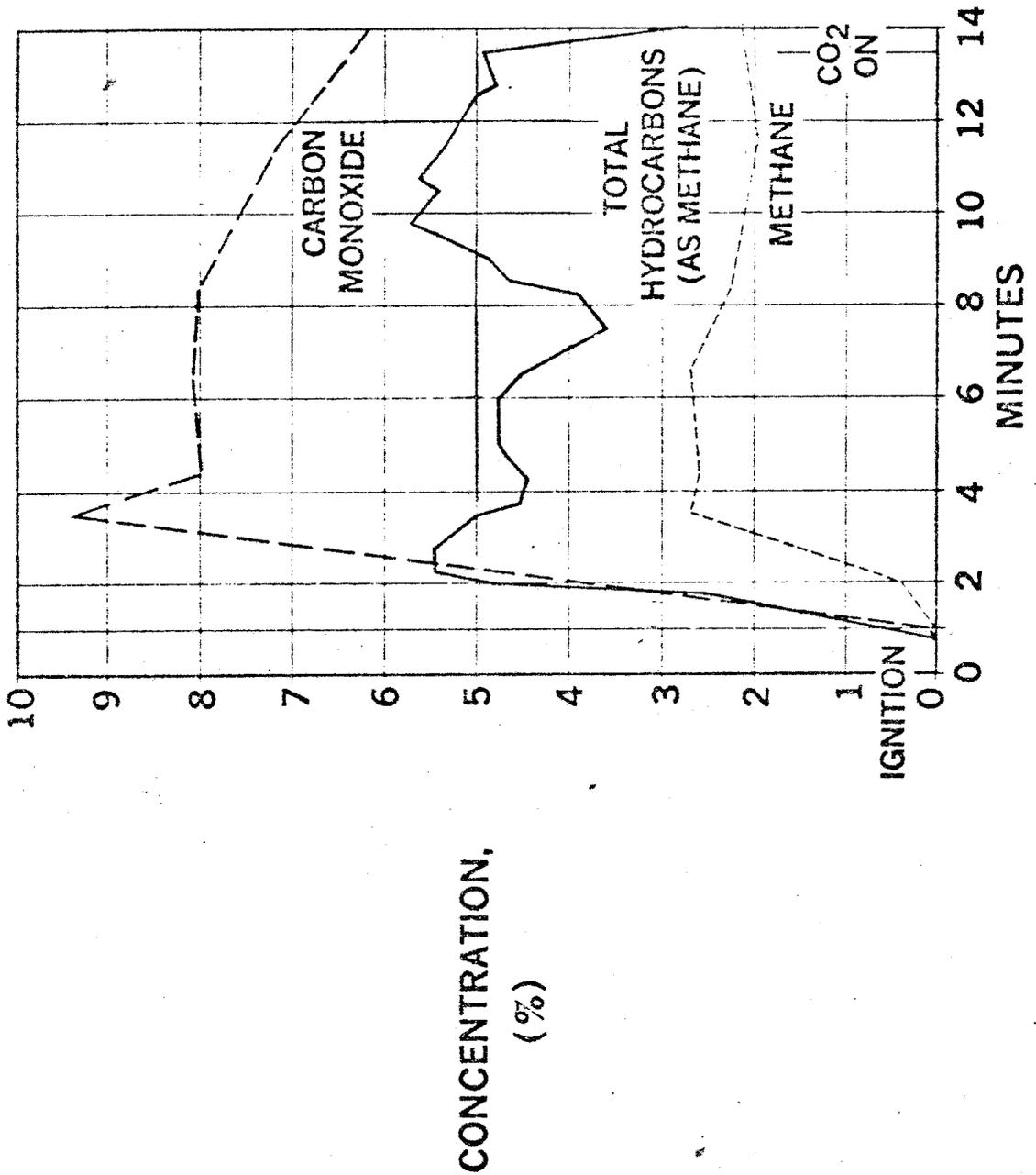
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TEST NO. 1

FIGURE 8

CARBON MONOXIDE, TOTAL HYDROCARBONS AND METHANE CONCENTRATIONS (Fig. 6)



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TEST NO 1.

FIGURE 9

TEST PLAN TEST NO. 2

The second baseline test will be a natural extension of the first test conducted on 6/5/75. The phenomenon under investigation will be control of the fire by ventilation reduction at the time of detection by the aircraft type smoke detectors. Whereas during the first test a constant ventilation rate of approximately 21 changes per hour was maintained throughout, the flow will be reduced to a typical leakage rate of .6 changes per hour upon detection.

The physical configuration will be exactly the same as before. The same compartment volume, compartment lining, cargo volume, cargo composition, ignition source, and initial ventilation rate will be used. Additional thermocouples will be installed and other types of detectors will be studied. Otherwise, the instrumentation will essentially remain unchanged.

Temperatures will be monitored during the test and should a hazardous condition arise, or an obvious burnthrough occur, the test will be terminated. However, with the ventilation reduction of this test, it is possible that these conditions will not be reached in short order. If that be the case, it is planned to continue the test for up to three hours which is half the typical duration of a long over water flight.

Additional detectors will be tested for a comparison with the previously tested smoke detectors. The detection will consist of "off-the-shelf" infra-red and a combined IR and ultraviolet detection unit.

Two Hour Test

OBSERVERS
CONCLUSION -

TEST RESULTS :

- IGNITION ABOUT 12 NOON
- FIRE DETECTED IN 3 MIN - TEMP ABOUT 1500°F
- DETECTORS FAILED - 11 MIN
- 15 MIN - TEMP RANGE OF THERMO COUPLES 400-1000 APPROX
- 33 MIN - FLASH TYPE FLASHOVERS - TEMP 1000-1500°F
- 50 MIN - O₂ DOWN TO 2 1/2%
- LINER TEMP ABOUT 900° . AIR TEMP 1400°
- LOAD REMOVED AFTER 2 HOURS . FIRE EXTINGUISHED WITH CO₂ - 1ST 3 MIN DISCHARGE - FIRST, WATER SPRAY AFTER REMOVAL

OBSERVERS CONCLUSION -

- LINER STOOD UP WELL
- FIRE CONTROLLED BUT
- RAD. HEAT INTO CABIN - THROUGH LOW
- AFFECT ON MAIN FUSEL STRUCTURE A LUM. STRENGTH SCREEN CHIPPED

LOAD CONDITION →

CONFIGURATION TEST NO. 2

- o Length: 26' 8"
- o Height: 5' 7"
- o Width: 13' 7"
- o Volume: 2000 ft³
- o Ventilation: 20 changes/hr = 3060 lbs/hr
- o Ventilation: .6 changes/hr = 92 lbs/hr upon detection
- o Tunnel Flow: 12,000 lbs/hr
- o CO₂ firex backup system, 300 lbs.
- o Ignition source: Gas soaked rags (2) and hot wires(2)
- o Cargo Load: 50% gross compartment volume
- o Cargo composition: 18" x 18" x 18" cardboard cartons loosely filled with current commercial type packing material (eg, rubberized hair, polyethylene, polyurethane, cellular film, fiber board, and Kim Pac)
- o Cargo Liner: .023 epoxy fiberglass per DMS 1946

TEST INFO:

- TEST BOX LOAD - 304 BOXES
- 3 BOX HIGH, 5 WIDE, ABOUT 20 DEEP
- 19 INCH ON BOTTOM BOX (TOP) WITH OPEN SPACE ABOVE. LIKE CHIMNEY ABOUT 3/4 LENGTH TO REAR OF LOAD
- THREE DETECTORS IN CEILING

INSTRUMENTATION TEST NO. 2

- o Three pyrotector smoke detectors
- o Two Fenwall U.V. detectors
- o Two pyrotector UVIR detectors
- o Ten chromel-alumel air temperature thermocouples (1" below ceiling)
- o Eight chromel-alumel liner temperature thermocouples (on ceiling)
- o Two chromel-alumel structure temperature thermocouples (above ceiling)
- o One 0-0.5 psi ΔP pressure transducer in sidewall
- o One each O_2 , CO_2 , CO gas analyzers - Ev. 30 seconds
- o Two orifice plate flow meters for tunnel flow and ventilation
- o Two 16 mm motion picture cameras plus still photos
- o Total hydrocarbon samples - GC SAMPLING EACH 30 SEC
- o Two calorimeters