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FIRE PERFORMANCE EVALUATION OF A 4-MM THICK POLYETHYLENE-BASED CORE SANDWICH PANEL WITH ALUMINUM SKINS (MATERIAL ID: fr405 TRADE NAME: ALPOLIC/fr), IN ACCORDANCE WITH ISO 9705:1993, "FIRE TESTS—FULL-SCALE ROOM TEST FOR SURFACE PRODUCTS"

FINAL REPORT

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ABSTRACT

This report describes the results of an ISO 9705 room test with 4-mm thick polyethylene-based core sandwich panels with aluminum skins. The wall panel that was evaluated is identified as Material ID: fr405, Trade Name: Alpolic/fr, manufactured by Mitsubishi Chemical Corporation. The test was conducted with the standard 100-300 kW ignition source described in Section A.1 of Annex A to ISO 9705:1993. The test was performed at Southwest Research Institute's (SwRI) Department of Fire Technology, located in San Antonio, Texas, on February 25, 1999.

1.0 INTRODUCTION

This report describes the results of a room fire test on a 4-mm thick polyethylene-based core sandwich panel with aluminum skins, conducted according to the International Standard Organization (ISO) 9705 standard, "Fire Tests—Full-Scale Room Test for Surface Products." The apparatus described in ISO 9705 consists of a room measuring 3.6 m deep by 2.4 m wide by 2.4 m high, with a single ventilation opening measuring 0.8 m wide by 2 m high in the front narrow wall. A hood is located in front of the room to collect all products of combustion generated by the fire and is connected to an exhaust duct and fan. All walls of the test room, except the front wall, and/or the ceiling are covered with the test material exposed to a propane burner (or other type of) ignition source, which is located in one of the rear corners of the room. Heat release rate is measured on the basis of oxygen consumption. Instrumentation for measuring rate of heat release and smoke production is installed in the exhaust duct.

This report describes the results an ISO 9705 room test on a self-supporting aluminum-clad interior wall system installed over standard high-density calcium silicate walls. The test was conducted with the standard 100-300 kW ignition source described in Section A.1 of Annex A to ISO 9705:1993. This test was performed at Southwest Research Institute's (SwRI) Department of Fire Technology air-conditioned high-bay facility located in San Antonio, Texas, on February 25, 1999.

The test method used for the evaluation described in this report is intended to measure and describe the properties of materials or products in response to heat and flame under controlled laboratory conditions. The results should not be used alone to describe or appraise the fire hazard or the fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test may be used as elements of a fire hazard assessment or a fire risk assessment, which takes into account all the factors that are pertinent to an assessment of the fire hazard or fire risk of a particular end use.

The results apply specifically to the specimens tested, in the manner tested, and not to the entire production of these or similar materials, nor to the performance when used in combination with other materials. This report shall not be reproduced except in full, without the written approval of SwRI.

2.0 MATERIAL TESTED

The material that was evaluated in this study was a 4-mm thick polyethylene-based core sandwich panel with aluminum skins, identified by the client as fr405, Alpolic/fr. The test specimen is self-supporting and attached to the room substrate by continuous "Z-bars"(see Figure A-1 in Appendix A). The panels installed to the substrate had a nominal thickness of 4 mm, and a nominal area density of 7.6 kg/m^2. The Alpolic/fr interior wall assembly was received on February 23, 1999, and installed by representatives of Southern Architectural Systems, Inc. of Houston, Texas. All hardware, fasteners, caulking, and panels were supplied by Southern Architectural Systems, Inc.

The installed test specimens were allowed to condition inside an air-conditioned building for approximately 2 days at a temperature of 23 ± 2°C and relative humidity of 60 ± 5% prior to testing.

3.0 ROOM TEST APPARATUS

The walls and ceiling of the test room consisted of 20-mm thick calcium silicate board with a nominal density of 750 kg/m^3. Only the back and side walls were coverd with the test material, and the ceiling was left exposed for the test.

The standard burner described in Section A.1.1 of Annex A to ISO 9705:1993 was used in this test. This burner is 0.17 m wide, has a square surface that is 0.17 m above the floor of the room, and is located in the right rear corner of the room (referred to as the Northeast corner). The burner is operated at a net heat output of 100 kW for 10 min, followed by 300 kW for 10 min.

The instrumentation prescribed by ISO 9705 was supplemented with seven thermocouples to measure gas temperatures in the ceiling and in the doorway. The hot junctions of six of the supplemental thermocouples were located at approximately 4 in. (100 mm) below the ceiling of the test room, above the burner, in the center of the ceiling, and at the four quadrants of the ceiling. The ceiling thermocouple locations are identified as Southeast (front right), Southwest (front left), *etc.*, with the burner thermocouple in the left rear corner close to the Northwest thermocouple. The seventh room thermocouple was located in the doorway, so that its hot junction was at 4 in. (100 mm) below the soffit along the centerline of the doorway.

4.0 TEST RESULTS

The room test was conducted on February 25, 1999, at 12:05 p.m. Present to witness testing were Mr. Tatsuo Ando of Mitsubishi Chemical Corporation and Mr. Donald Belles of Koffel Associates. Ambient temperature at the start of the test was 72°F (22.2°C) with the relative humidity at 63%. Figures B-1 through B-5 in Appendix B, show results for heat release rate, smoke production rate, heat flux to the floor, and room temperatures as a function of time. Figures C-1 through C-5 in Appendix C are photographs of the corner section of the test room, at various times during, and after termination of the test. Observations made during the test are presented in Table 1.

Table 1. Test Observations.

TIME (MIN:SEC)	OBSERVATIONS
00:00	Start of Test. Burner set at 100 kW.
00:10	Flames from the gas burner intermittently touching the ceiling.
00:30	Discoloration in the burner corner approximately 0.2 m wide along both walls up to the ceiling.
01:25	The aluminum skin in the burner corner is rippling and warping.
01:35	The paint coating on the aluminum skin is scorching and burning at direct flame impingement in the burner corner 0.15 m along both walls up to the 2.0-m level.
02:00	Surface flaking and soot from the burnt paint coating is falling away to the floor.
03:15	Light hazy smoke in the room interior down to the 1.6 m level.
05:30	The aluminum skin is warping at the burner corner approximately 0.4–0.45 m in width along both walls up to the 1.5-m level, smoke is a light grey haze down to the 1.5-m level.
08:00	Along the back and left walls 0.3 m down from the ceiling, the aluminum panels are warping in the upper heated regions of the ceiling.
10:00	Burner output increased to 300 kW.
10:20	Flames from the burning corner are 1.5–1.8 m across the ceiling towards the doorway. Flames are also flashing left and right 1.2–1.5 m along both walls at the wall/ceiling intersection away from the burner corner.
11:08	Light grey smoke in the room interior down to the 1.5-m level. The exposed layer of aluminum skin in the burner corner has melted (opened up) exposing the charred polyethylene and back layer of aluminum skin. The polyethylene core has fallen away to the floor of the test room and continues to burn on the floor.

Table 1(Con't.). Test Observations.

TIME (MIN:SEC)	OBSERVATIONS
11:44	Flames from the burner are burning 1.8–2.1 m along both walls at the ceiling. The caulking at both vertical wall joints away from the burner corner is burning 0.6 m down from the ceiling.
12:51	Flames from the burner are rolling 1.8–2.1 m across the ceiling towards the doorway, with flames also 1.8–2.1 m along both walls at the ceiling.
13:19	Grey layer of smoke in the room interior down to the 1.5-m level.
13:50	The caulking is burning at both vertical joints near the burner corner approximately 4.5 m down from the ceiling.
15:00	The caulking is burning at both vertical joints near the burner corner approximately 0.6 m down from the ceiling.
15:41	Flames are burning 2.1–2.4 m across the ceiling towards the doorway.
16:35	The aluminum skin in the burner corner from the 1.5-m level up to the ceiling has burned/melted away exposing the inner core and back layer of aluminum skin.
17:30	Smoke is now a dark grey color exiting the doorway with the polyethylene core falling away to the floor and continuing to burn on the floor. Flames are burning 2.1–2.4 m along both walls at the ceiling and across the ceiling towards the doorway.
19:48	The vertical caulked joints are burning 1 m down from the ceiling along both walls away from the burner corner.
20:00	End of fire exposure, burner extinguished.

Upon completion of the 20-min fire exposure, damage to the room interior was confined to the burner corner and the upper edges of the aluminum panels near the ceiling. Melt away in the burner corner measured approximately .25 m wide along both walls starting at the top of the burner and spreading over to 0.6 m at the 2.1-m level and from there spreading horizontally over to 1.2 m along both walls. Directly in the burner corner the second layer of aluminum skin had burned/melted away exposing the calcium silicate substrate. The remaining surface of the panels showed blistered paint with warping and buckling of the test panels.

APPENDIX A

TEST STRUCTURE, ISO 9705 ROOM TEST

(Consisting of 1 Page)

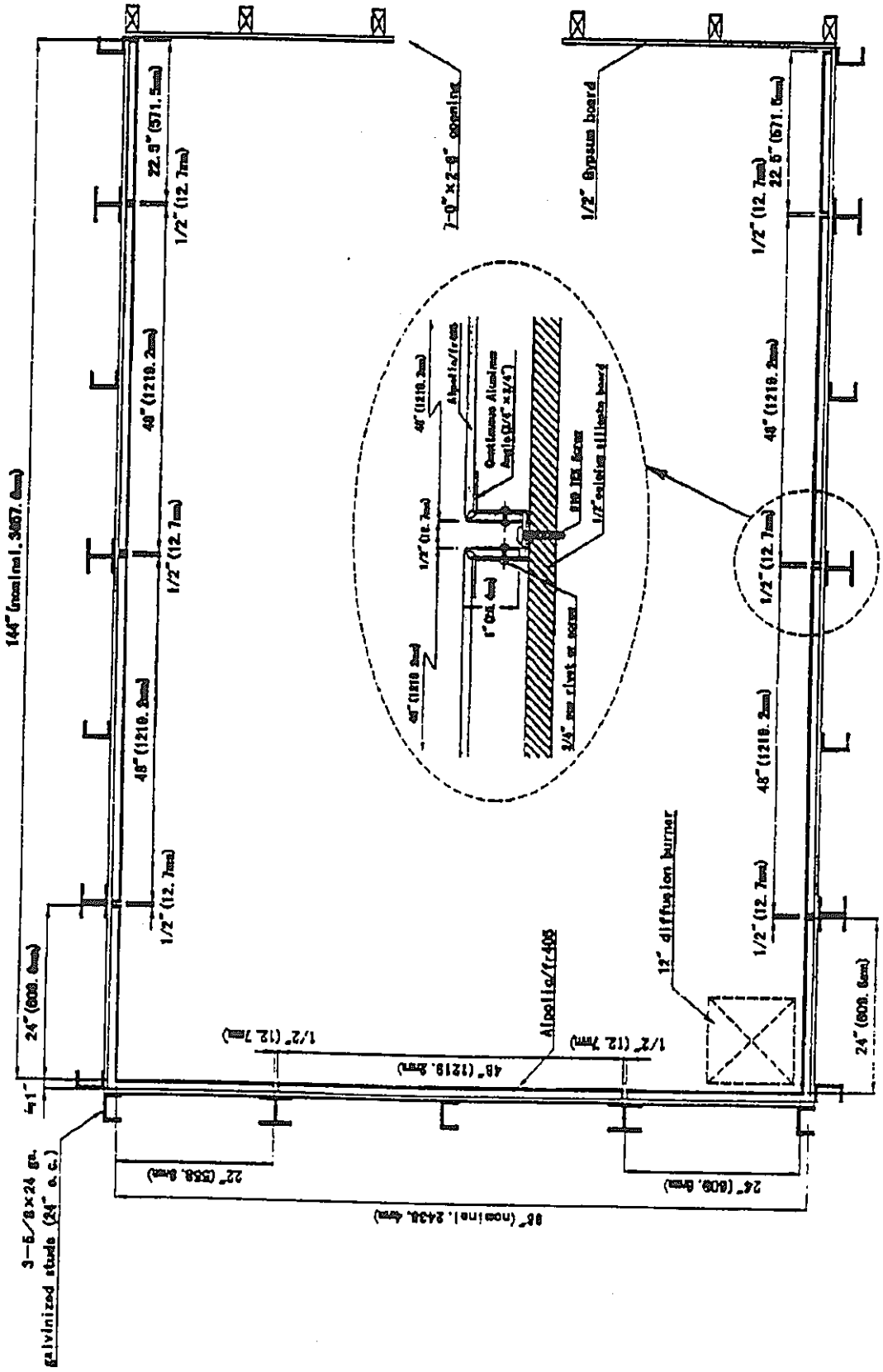

Figure A-1. ISO 19705 Test Structure.

APPENDIX B

TEST DATA

(Consisting of 5 Pages)

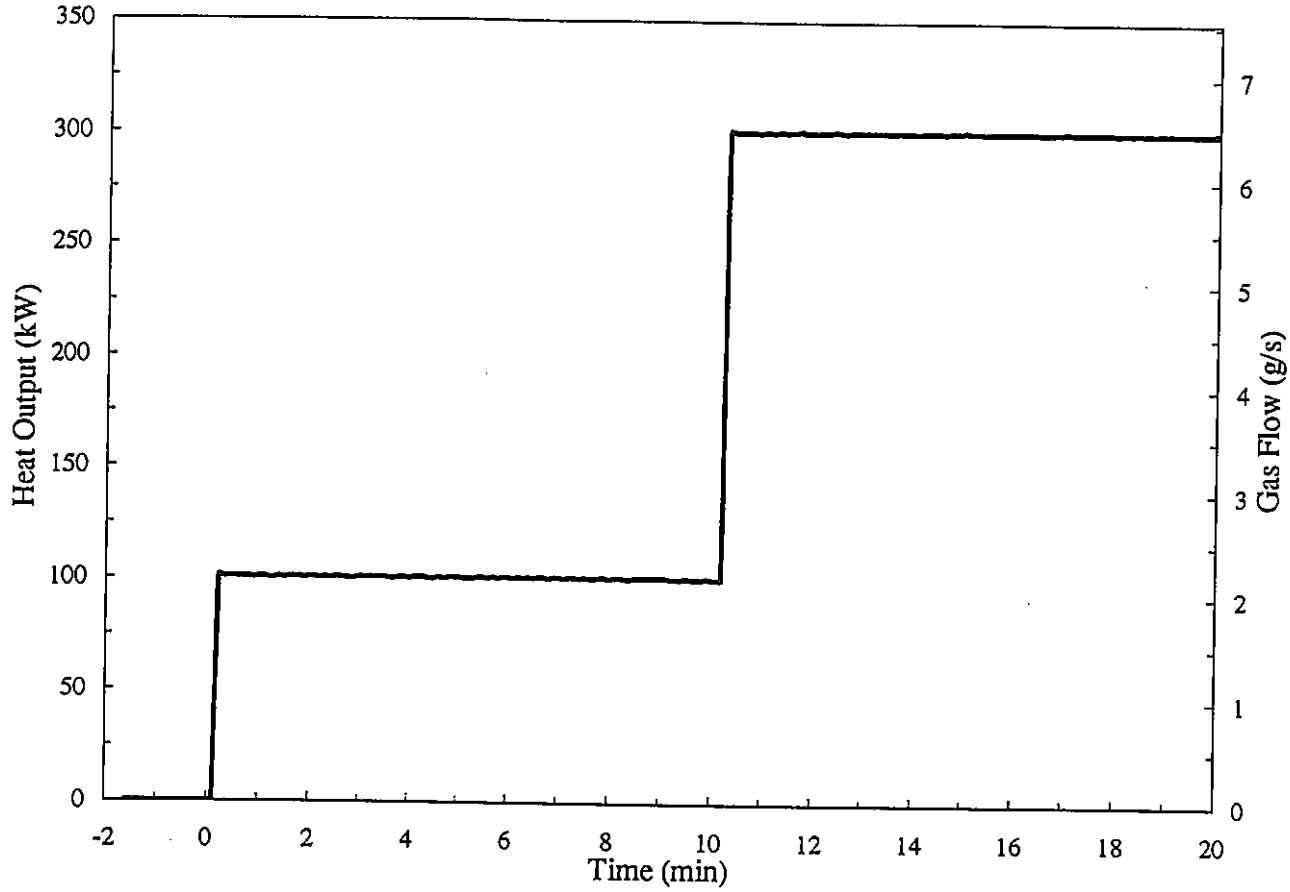

Figure B.1 Burner Heat Output and Gas Flow vs. Time

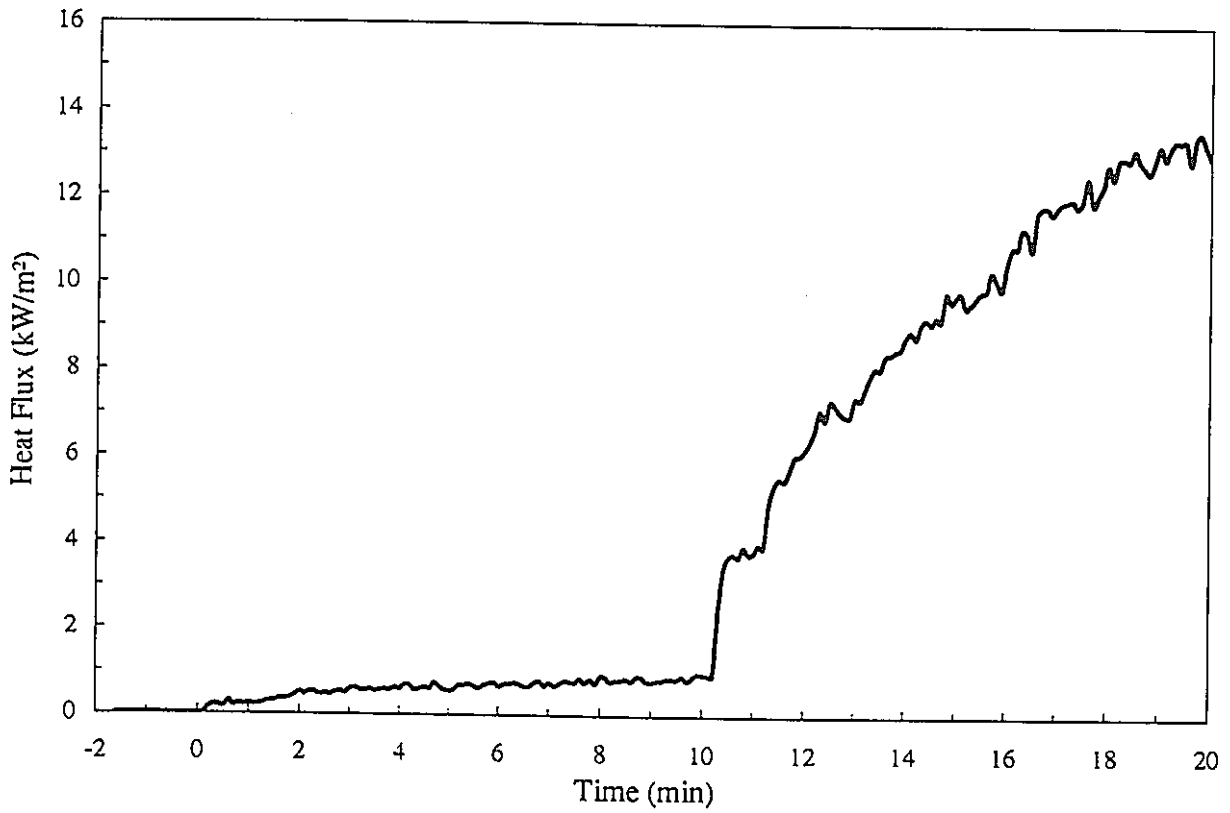

Figure B.2 Total Heat Flux to Floor

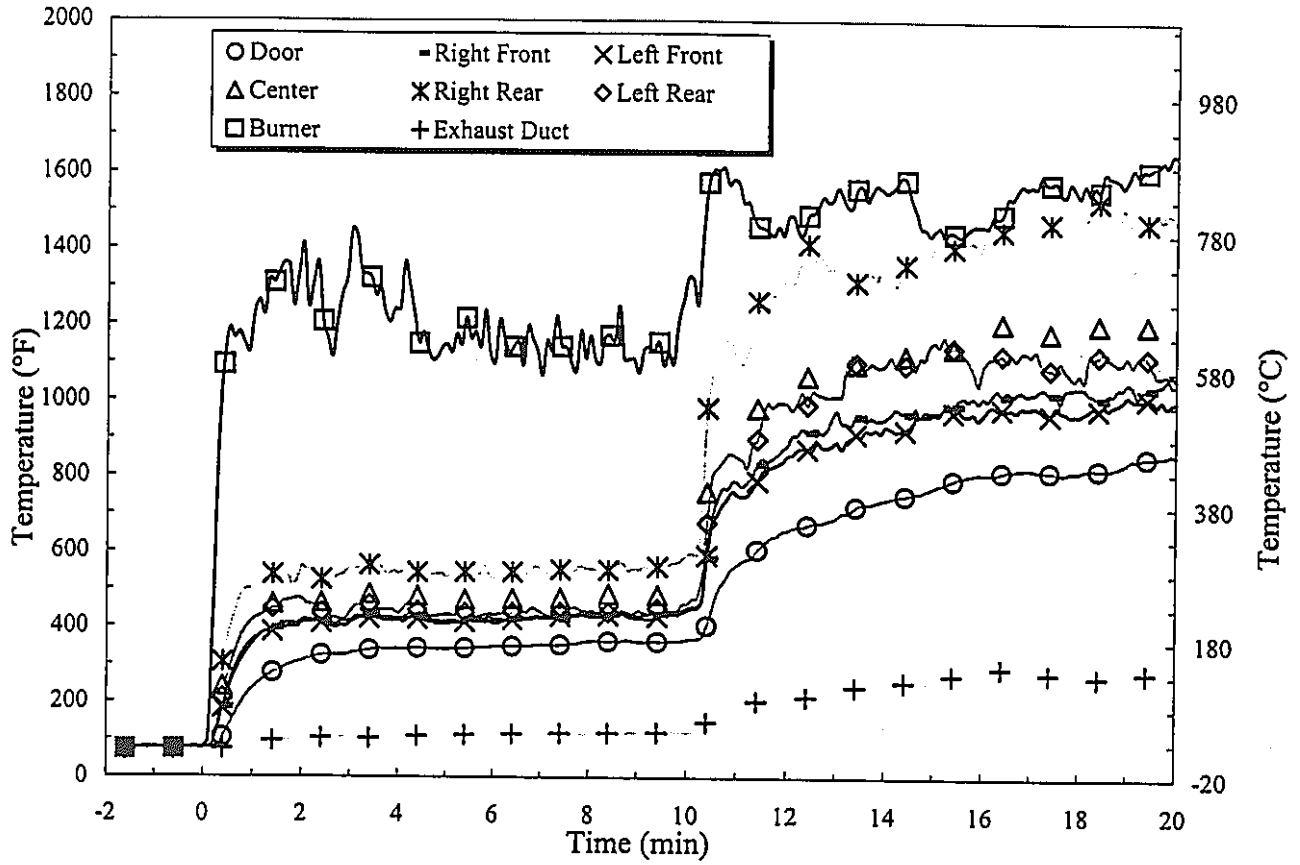

Figure B.3 Room Temperatures vs. Time

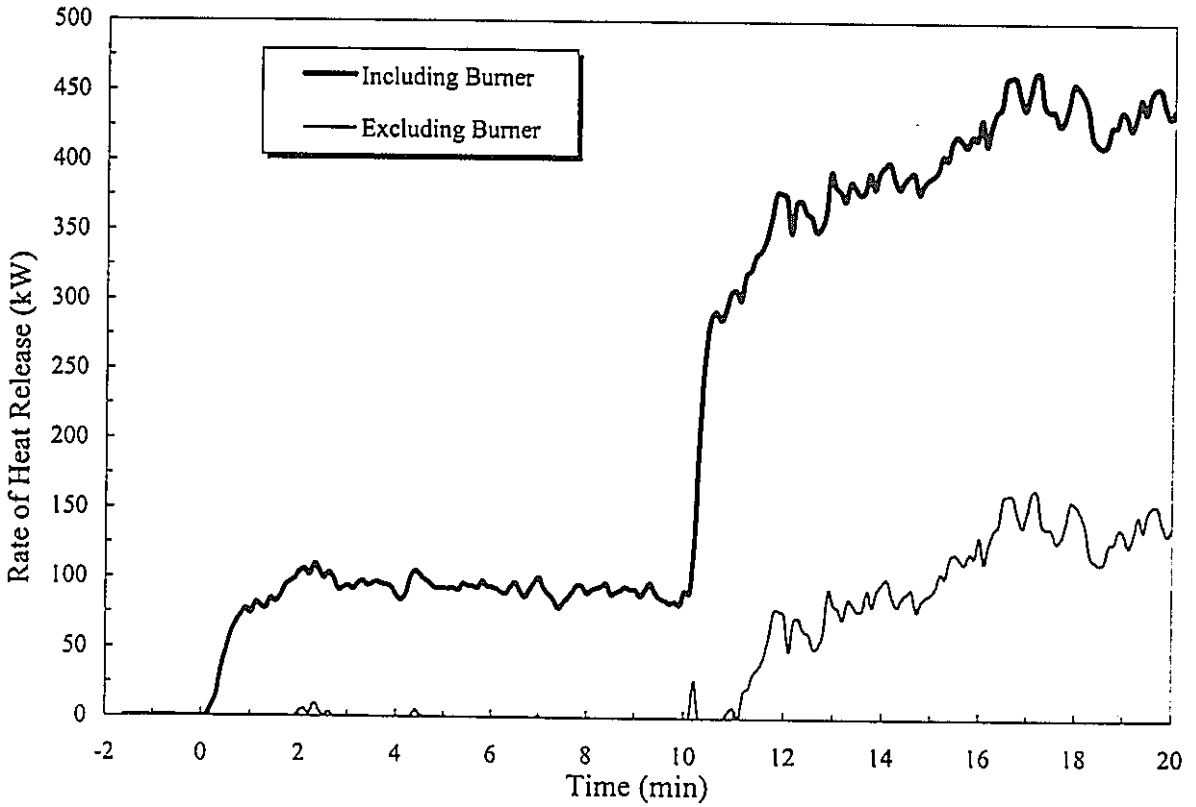

Figure B.4 Rate of Heat Release vs. Time

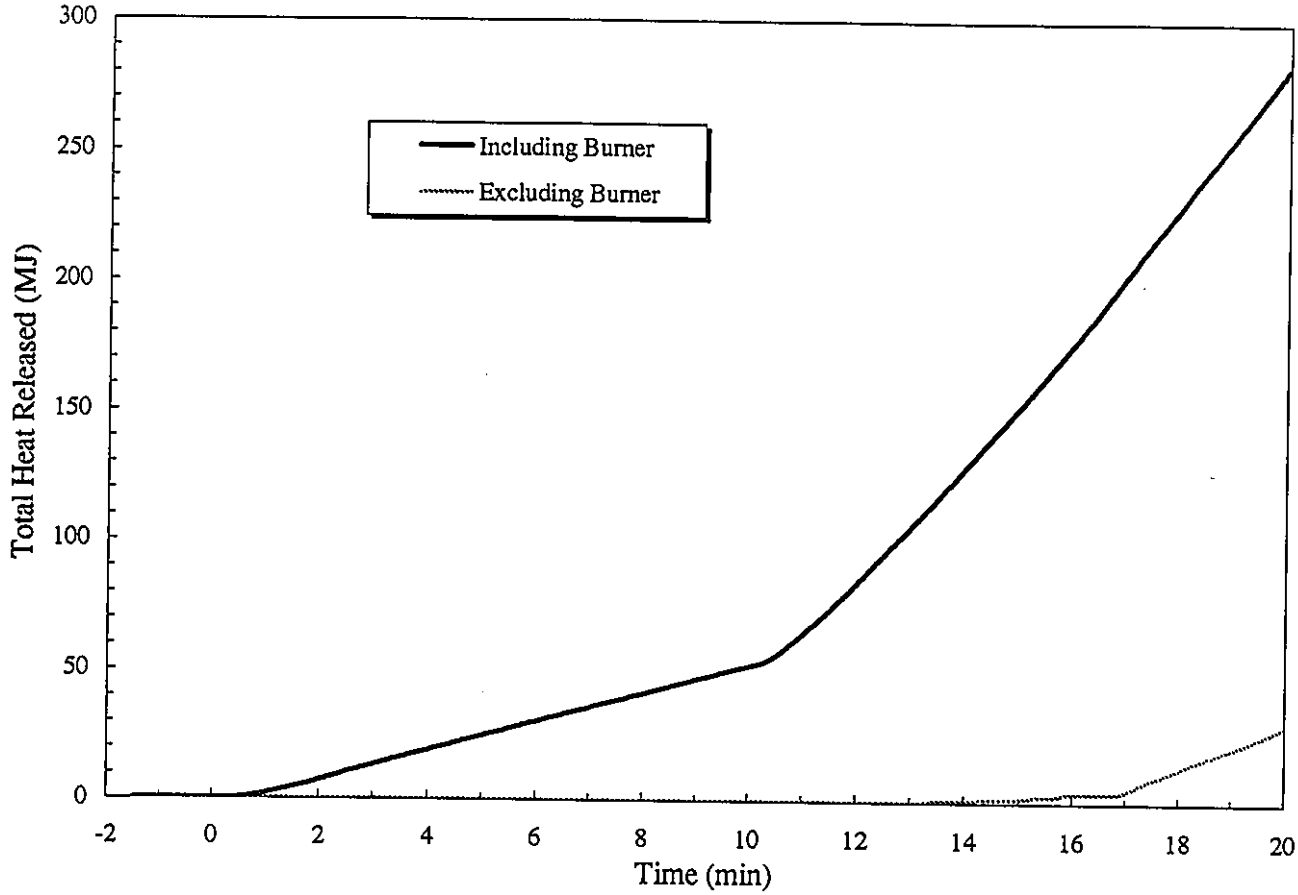

Figure B.5 Total Heat Released vs. Time

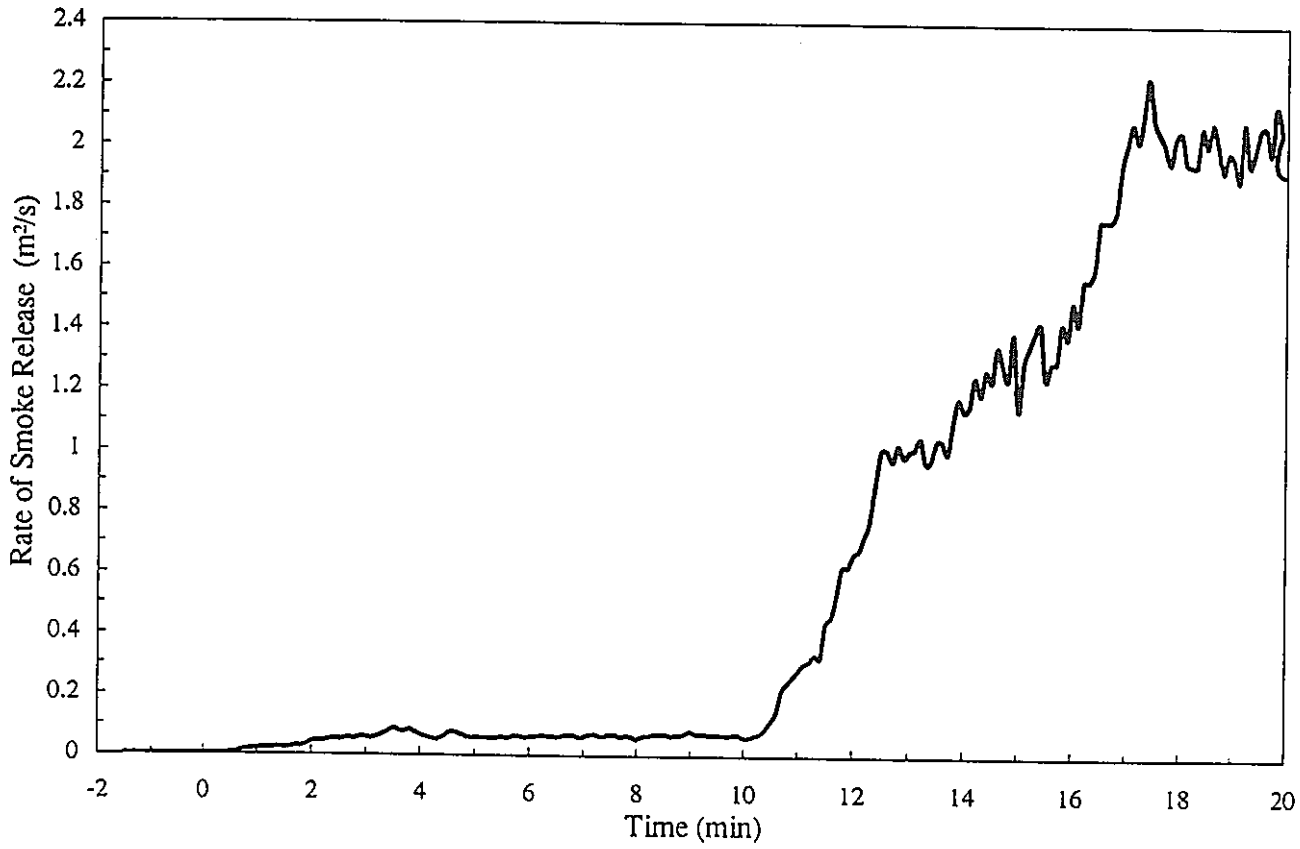

Figure B.6 Rate of Smoke Release vs. Time

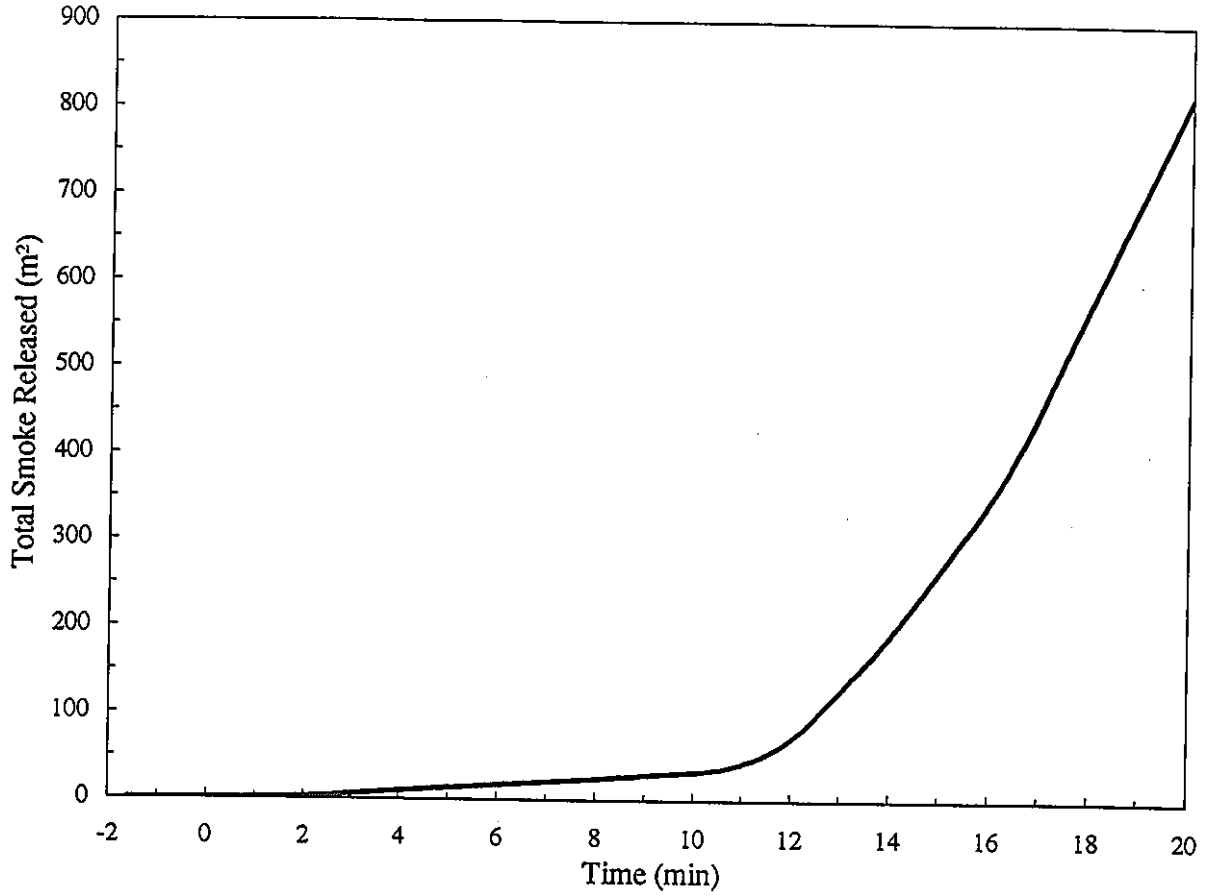

Figure B.7 Total Smoke Released vs. Time

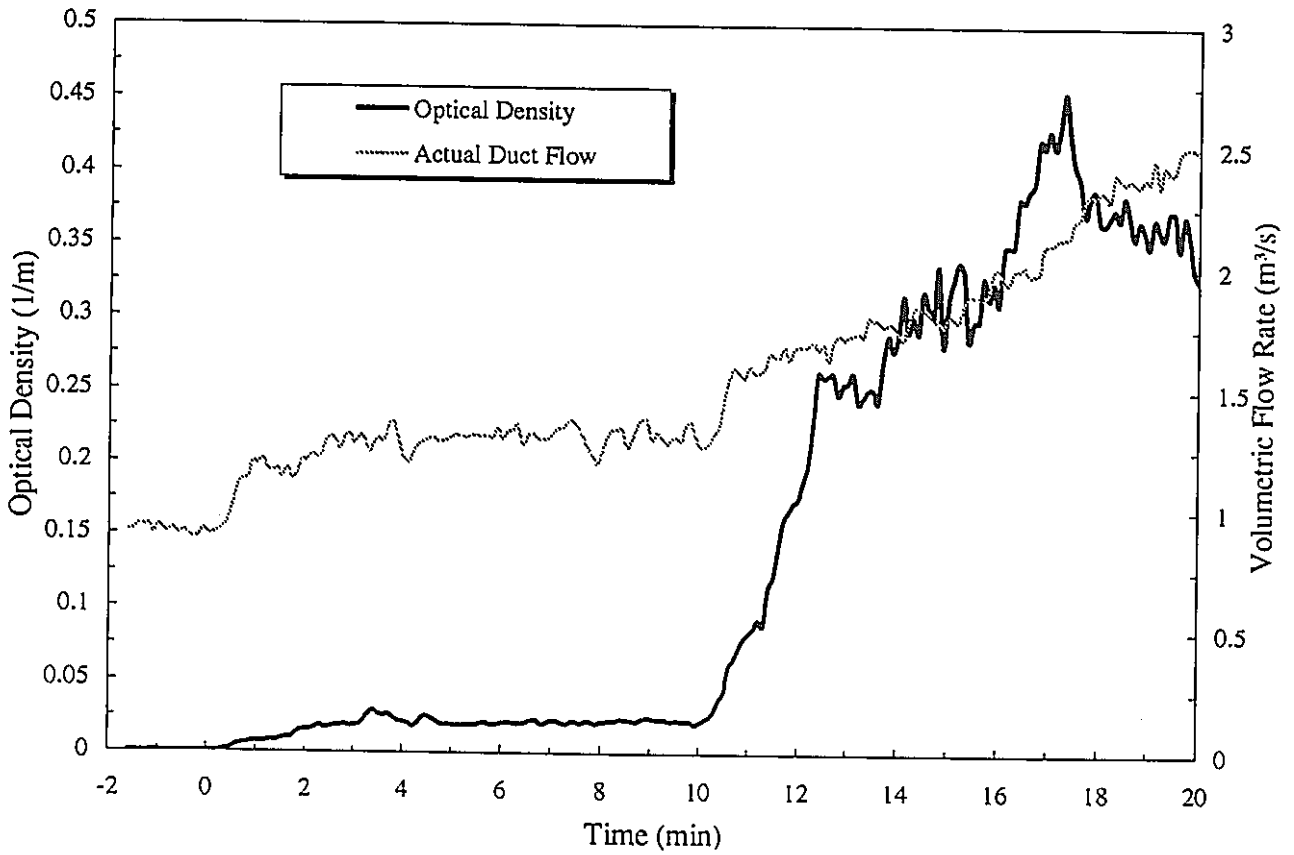

Figure B.8 Optical Density with Volumetric Flow Rate vs. Time

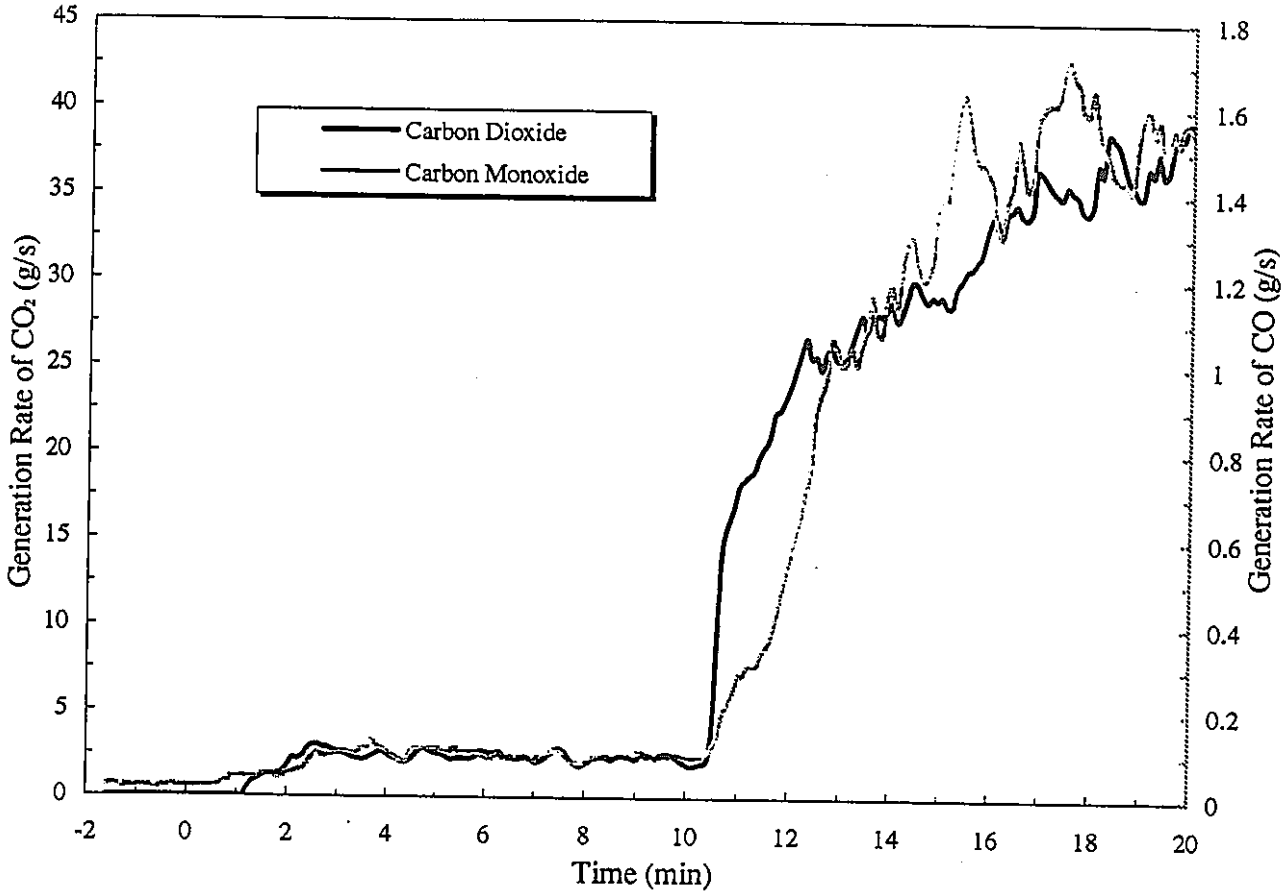

Figure B.9 Generation Rates of CO2 and CO vs. Time

APPENDIX C

PHOTOGRAPHS, ISO 9705 ROOM TEST

(Consisting of 4 Pages)

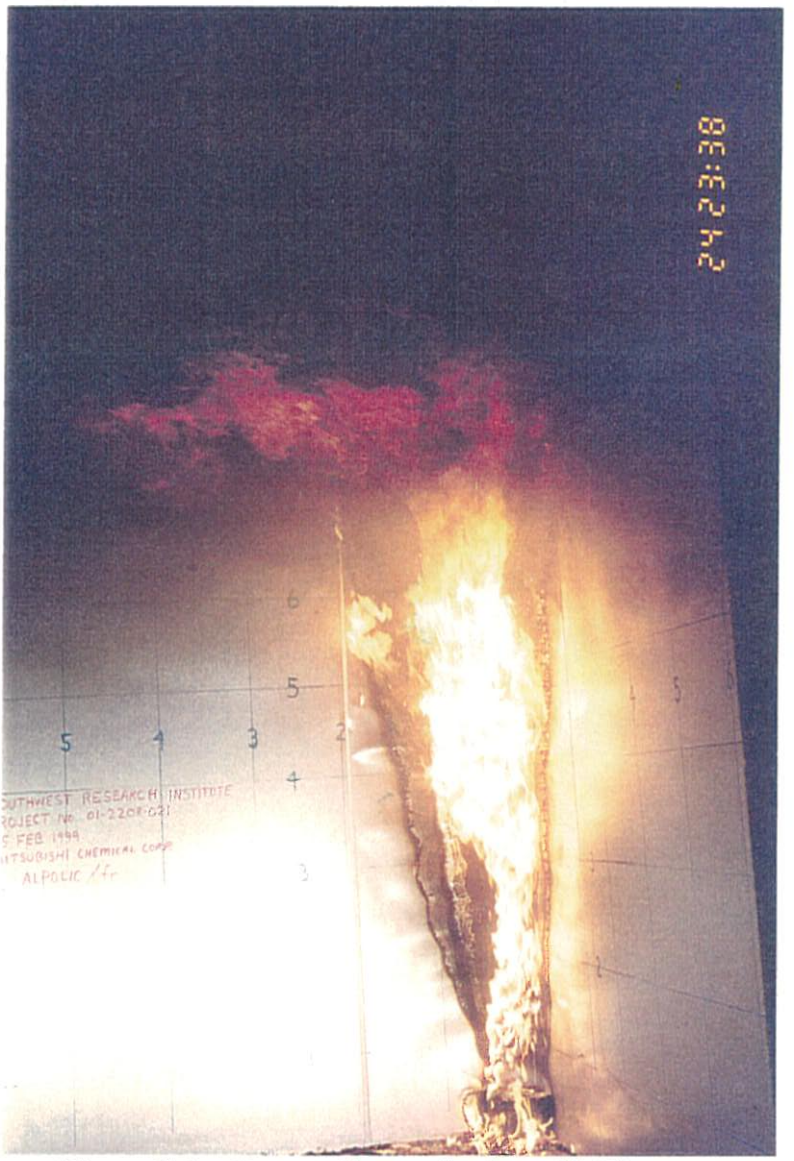

Figure C-1. Burner Corner Section with Flames 1.2–1.5 m Across Ceiling.

Figure C-2. **Burner Corner Section at the End of 300-kW Exposure.**

Figure C-3. **Room Interior Showing Left and Back Walls. Note blistering and flaking of paint coating on aluminum skin.**

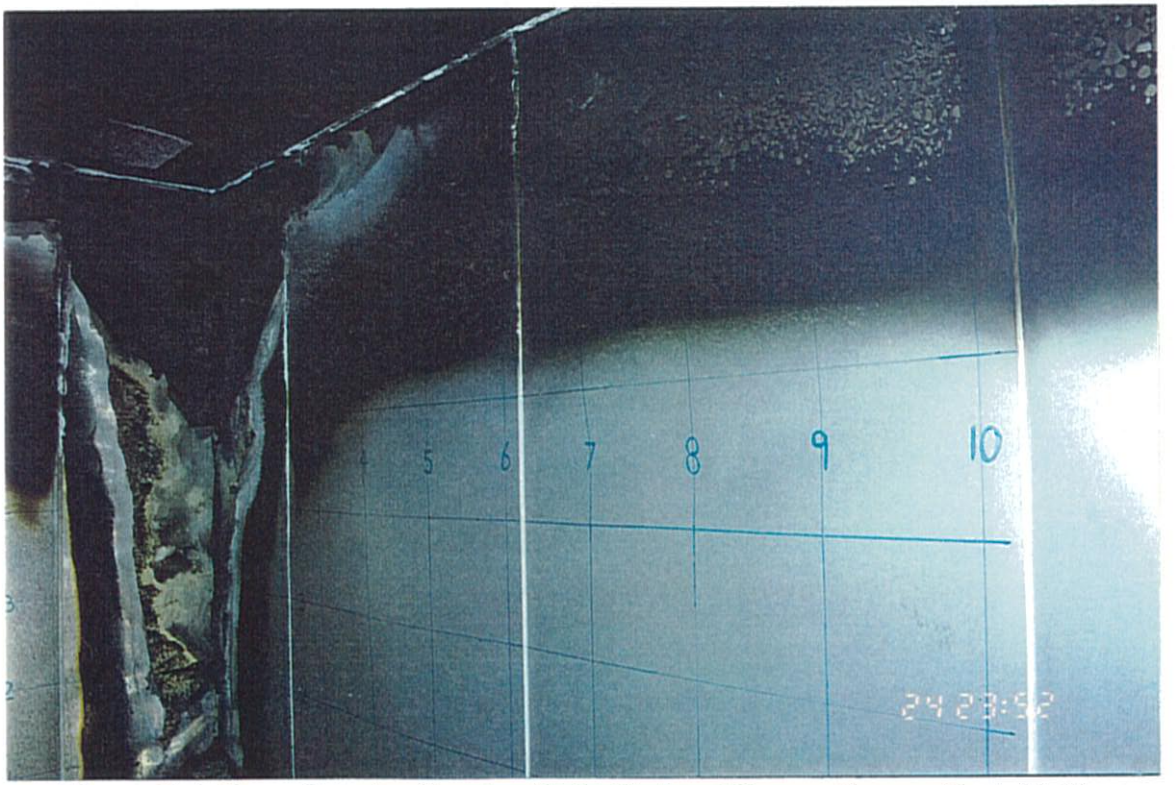

Figure C-4. Room Interior Showing Right Wall and Burner Corner (Back Wall).

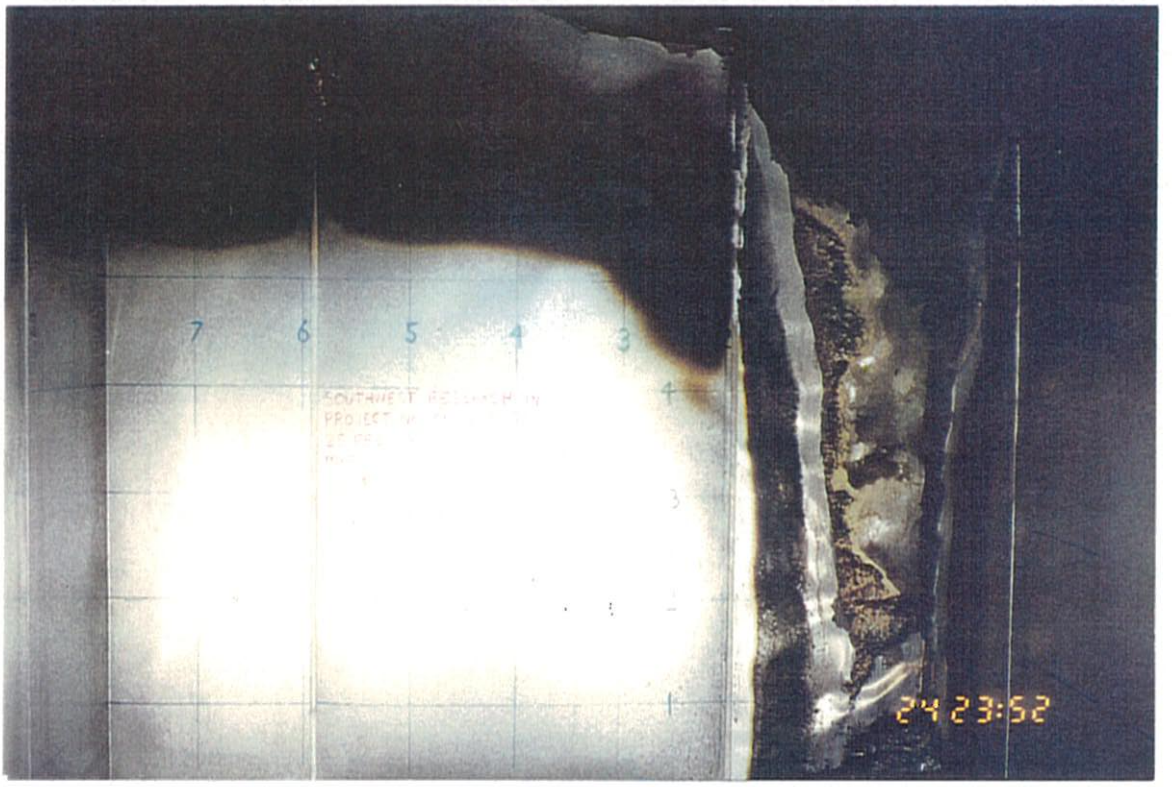

Figure C-5. Room Interior Showing Back Wall Burner Corner.

Figure C-6. Close-up of Burner Corner. Note first and second layers of aluminum skin consumed.