

NATIONAL FIRE DOOR FIRE TEST PROJECT
POSITIVE PRESSURE FURNACE FIRE TESTS

Technical Report

Prepared by

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FIRE RESEARCH

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Foreword

This report documents the positive pressure furnace fire tests conducted for the Research Foundation's National Fire Door Fire Test Project. Four fire door types were tested according to parameters specified by the project's technical advisory committee using positive pressure with neutral planes of 40" and 20" above the sill. A separate report, *National Fire Door Fire Test Project: Positive Pressure Room Burn Tests*, documents a subsequent room fire test series also conducted for the project.

The Building Code writers, manufacturers and public interests had sought independent test documentation of positive pressure parameters prior to moving forward with potential new provisions in the Codes. These interests were represented on the project's technical advisory committee in order to communicate questions to the project and information from it to code enforcers and industry at the earliest possible time.

The Research Foundation expresses gratitude to authors Michael van Geyn and Howard Grisack for their thorough testing and report. The Foundation and the authors thank the project's Technical Advisory Committee for their contribution in all respects: technical expertise, review, as well as financial resources to conduct this landmark initiative. Of course, participation does not necessarily constitute a participant's endorsement of every statement in the report.

**National Fire Door Fire Test
Research Project**

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REPORT OF
NATIONAL FIRE DOOR FIRE TEST PROJECT

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TABLE OF CONTENTS

	PAGE
INTRODUCTION	1
EQUIPMENT AND TEST PROTOCOL	2
DRAWING OF UNEXPOSED SURFACE THERMOCOUPLE LOCATIONS	6
EQUIPMENT AND TEST PROTOCOL	8
TEST DOOR DESCRIPTION	13
TEST ASSEMBLY CONSTRUCTION	15
FIGURE II	16
ACCEPTANCE CRITERIA OF FIRE AND HOSE STREAM TESTS	17
SUMMARY OF TEST RESULTS	21
 ADDENDUM TO REPORT NO. 6825	
 SUPPLEMENT TO REPORT NO. 6825	
 APPENDIX A - NUMERICAL TEST DATA	
 APPENDIX B - PHOTOGRAPHS	

INTRODUCTION

This report describes the test method and results obtained for conducting the National Fire Protection Research Foundation's National Fire Door Fire Test Project. The objective of the research project was to observe and compare the effects of fire testing four different types of fire doors under positive pressure (neutral pressure plane 40 in. \pm 2 in. above the sill) with the furnace operating with normally aspirated versus diffusion type burners.

The types of doors tested were 90 min. rated mineral core doors, 20 min. rated particle board core doors, 90 min. steel stiffened doors and 90 min. expanded polystyrene core steel skin doors. Two doors were tested in each test wall assembly; one door swinging into the furnace, one door swinging out of the furnace. The door constructions chosen had previously been fire tested and rated under positive pressure conditions.

The first fire test project was conducted from July 22 to July 30, 1994. The tests were conducted in accordance with NFPA 252, UBC Standard 43-2 1991 and British Standard BS 476 Parts 20 and 22, but with the neutral pressure plane elevation set at the latch level 40 in. above the sill of the doors.

The first series of four tests was conducted with the test furnace using normally aspirated burners. The second series of four tests was conducted with the test furnace operated with the primary combustion air inlets sealed simulating diffusion burner operation.

An extension of the fire test project was conducted from October 20 to October 21, 1994. This consisted of a series of two tests conducted with the test furnace simulating diffusion burners with the neutral pressure plane elevation set at 20 in. above the sill.

Warnock Hersey, Coquitlam, B.C. is accredited by ICBO Evaluation Service, Inc. for performing fire tests using our vertical full scale fire test furnace in normally aspirated burner mode and diffusion burner mode.

EQUIPMENT AND TEST PROTOCOL

The test protocol was developed by the National Fire Protection Research Foundation Technical Advisory Committee (TAC) and described in the National Fire Door Fire Test Project Request for Proposal.

The fire test and hose stream tests were conducted in accordance with NFPA 252, UBC Standard 43-2 1991 with the addition of a second door/frame assembly installed swinging out of the test furnace and the instrumentation required by British Standard BS 476 Part 20. Additionally, the following requirements were achieved for all tests:

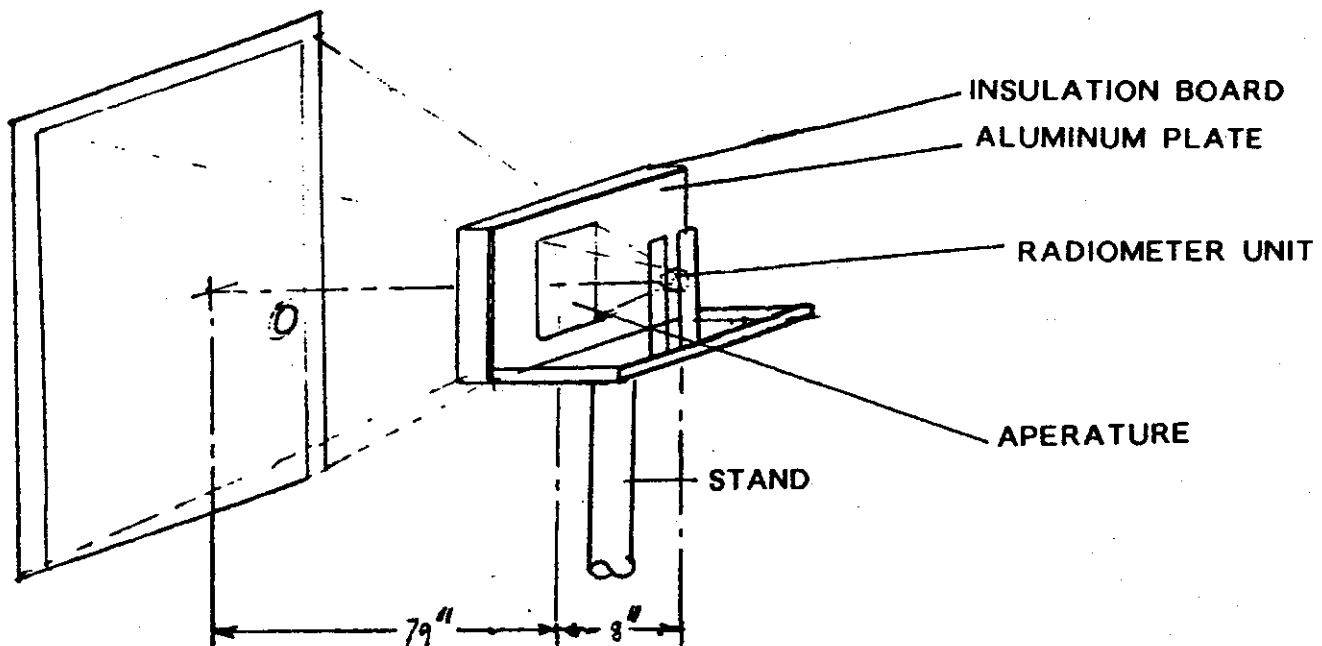
- Establishment of the neutral pressure plane at 40 in. above the door sill within 5 minutes from the start of the test.
- Monitoring of integrity using the cotton pad test specified in BS 476 Part 20.
- Measurement of the oxygen concentration in the furnace stack.
- Recording furnace temperatures using BS 476 Part 20 fast response thermocouples in addition to the standard type.
- Measurement of unexposed surface temperatures by both NFPA and British test standards.
- Measurement of radiant heat flux from unexposed face.
- Providing a video tape of each test.
- Providing still photos of each test.
- Environmental conditions.
- Measurement of door and frame deflections.
- Commencement of hose stream test within 60 seconds of termination of fire tests.

EQUIPMENT AND TEST PROTOCOL (Continued)

Following is a description of the equipment used for the tests:

Radiant Heat Flux Measurements

The radiant heat flux from the unexposed surface of each of the door assemblies was measured by means of two Medtherm Corporation Model No. 64-5-20 heat flux transducers, calibrated on June 16, 1994. The radiometers were mounted on specially constructed stands, such that the radiometer head was located at the centre elevation of the door and 79 in. \pm 0.5 in. from the door prior to the start of the test. The radiometers are water cooled and protected from receiving thermal radiation from heated surfaces other than the door assembly by an 1/8 in. aluminum baffle located 8 in. from the radiometer with heat aperture measuring 4 in. x 8.6 in. The 2 in. thick Insblock 19 high temperature insulating board was fastened to the aluminum baffle to ensure that its temperature rise above initial temperature remained below 18°C (see diagram below).



EQUIPMENT AND TEST PROTOCOL (Continued)

Oxygen Concentration Measurements

The oxygen concentration of the furnace exhaust was measured with a sampling probe of 1/4 in. ID stainless steel tube, 16 in. in length with eight sampling holes, 1/16 in. in diameter. The sampling probe was located in the centre damper plenum, 24 in. above the top of the furnace and 20 in. below the centre flue damper. An 8 ft. long stainless steel tube connects the flue sampling tube to the analyzer, allowing flue gas heat to dissipate before entering the analyzer. A moisture trap removes condensed water from the sampling tube.

Oxygen concentration was continuously analyzed with a Teledyne Max 5 Efficiency Monitor with readings noted every minute for 20 minute tests. For 90 minute tests, oxygen readings were taken every minute for the first 20 minutes, every 5 minutes for the next 30 minutes, and every 10 minutes for the remaining 40 minutes. The oxygen analyzer calibration program was activated prior to each test run.

Furnace Pressure Measurements

Furnace pressure measurements were conducted in accordance with the August 9, 1993 ICBO Evaluation Services, Inc. protocol with the exception that the probe shown below shall be used. This probe differs in that the ends are welded as opposed to the use of screw-on caps. A total of three pressure probes were used, located at the top of the door, 40 in. above the top of the sill and at the sill level of the door. The probes extend through the back wall of the furnace and can be mounted at different elevations in order to accommodate different sizes of doors. They are constructed from schedule 80 1/2 in. type 316 stainless steel pipe. There are nine holes 1/16 in. in diameter drilled into the pipe 2 in. from the exposed end. The exposed end is welded closed. The probes were positioned 6 in. \pm 1 in. from the test assembly.

Pressure probes were connected to Setra Systems, Inc. Model 264 electronic pressure transducers having a range of \pm 0.25 in. water column with an accuracy of \pm 1%. The transducers were located no more than 3 ft. vertically or 10 ft. horizontally from the probes.

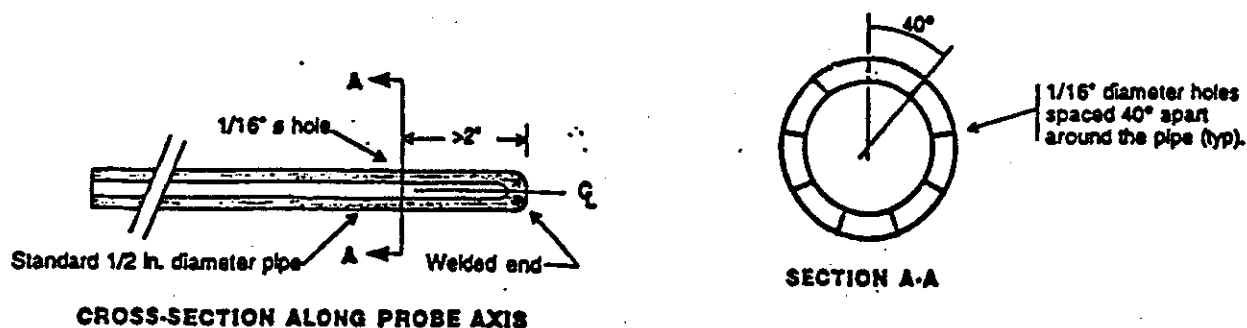


Fig. 2 TUBE SENSOR

EQUIPMENT AND TEST PROTOCOL (Continued)

Unexposed Surface Thermocouples as per NFPA 252 (UBC 43-2 1991)

Three unexposed surface thermocouples were fastened to each test door, one within 4 in. of the centre of the door and one on the door centreline 28 in. above the centreline and one 28 in. below the centreline. The thermocouples used were 20 gauge Type K with welded junctions. The thermocouples were centred under 6.125 in. square insulating pads, 0.4 in. thick and weighing 0.6 lbs/ft.². The pads were fastened with tape and stapled to wood skin doors and with screws and wires to steel skin doors. The surface temperatures were recorded every 15 seconds. All thermocouple lead wires and connections were of like-metals.

Unexposed Surface Thermocouples as per British Standard BS 476 Part 20

A total of eight thermocouples were fastened to each door/frame assembly. Five thermocouples to the door skin, one within 4 in. of the centre of the door, one in the centre of each of the four quarters. Three thermocouples were fastened to the face of the frame, one in the centre of the header, one in the centre at mid height on the hinge and latch legs of the frame. The thermocouples consisted of 24 gauge Type K thermocouples silver soldered to 12 mm copper discs. Over the discs were fastened ceramic felt pads measuring 30 mm square and 3 mm in thickness. The thermocouples were fastened to the assembly using furnace cement on the pad such that no cement would be interfering with the thermal contact of the copper disc to the test specimen.

A roving thermocouple was also prepared in a similar fashion but without the pad and connected to a copper tube 4 ft. in length. The thermocouple was held against locations of the test specimen that were suspected of being at a higher temperature than those measured by the eight fixed thermocouples.

Cotton Pad

The cotton pad consisted of new, undyed and soft cotton fibre material cut to form a pad 4 in. square by 3/4 in. thick and weighing between 3 and 4 grams. The cotton pad was installed in a support frame constructed from welded wire, with 1 in. legs and a long handle.

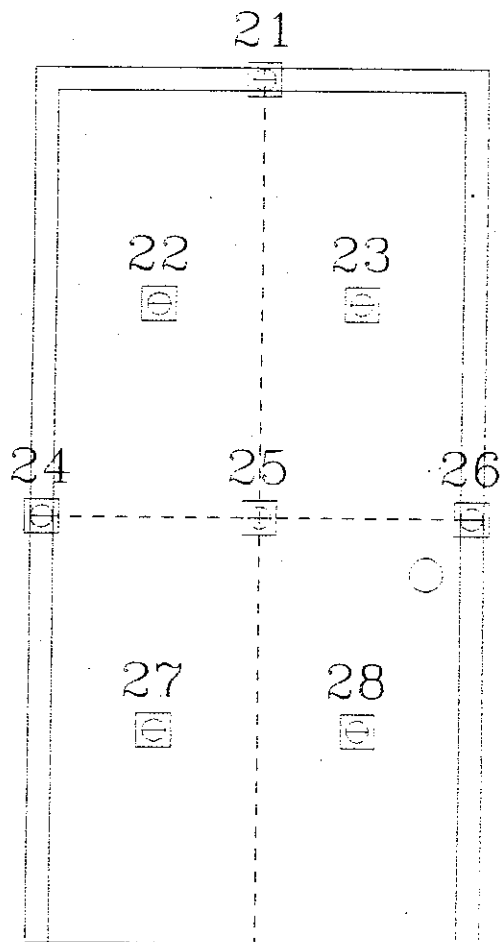
Ambient Temperature Measurement

An ambient temperature thermocouple was mounted to the rear outer corner of the furnace and shielded from radiant heat by being installed in the centre of a 1 in. ID tube 2-1/2 in. in length.

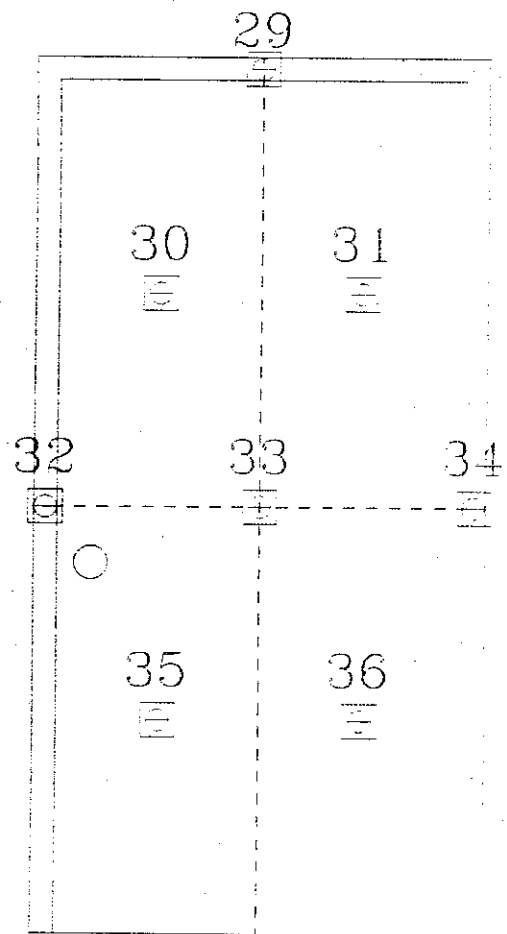
DRAWING OF UNEXPOSED SURFACE THERMOCOUPLE LOCATIONS

As per British Standard BS 476 Part 20. Refer to page 5 for a written description of the thermocouple locations.

Door Swinging Out of the Furnace



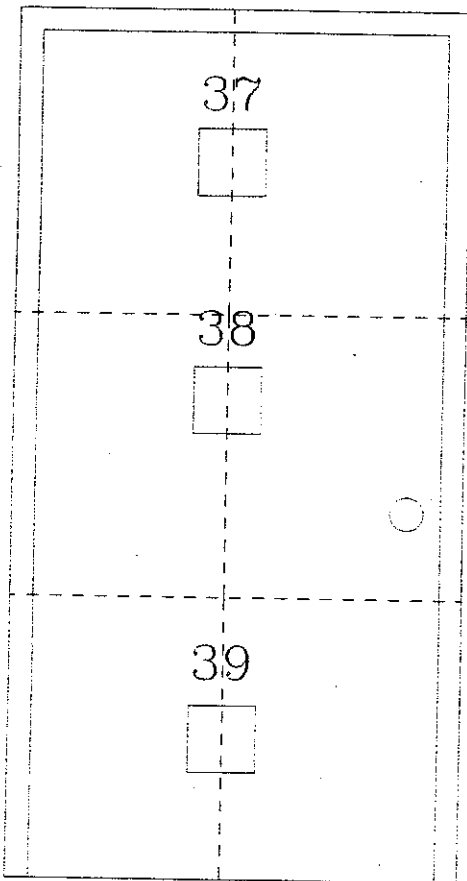
Door Swinging Into the Furnace



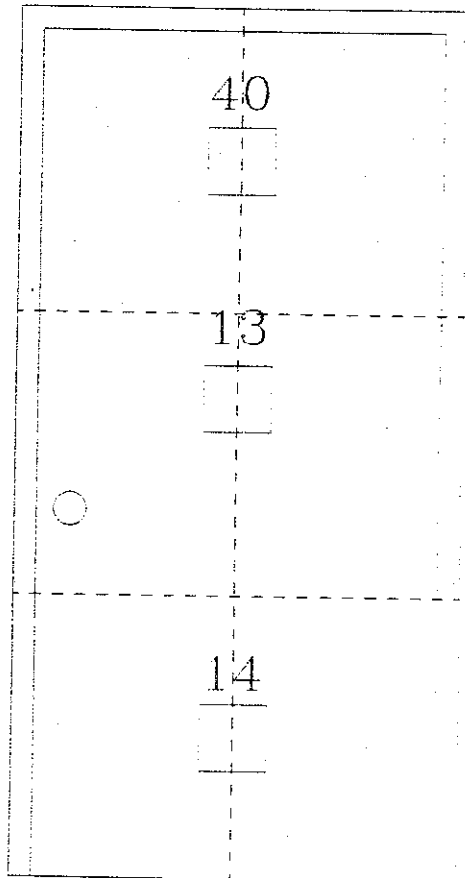
DRAWING OF UNEXPOSED SURFACE THERMOCOUPLE LOCATIONS - Continued

As per NFPA 252 (UBC 43-2 1991). Refer to page 5 for a written description of the thermocouple locations.

Door Swinging Out of the Furnace



Door Swinging Into the Furnace



EQUIPMENT AND TEST PROTOCOL (Continued)

FURNACE DESCRIPTION

The full scale vertical fire endurance test furnace at Warnock Hersey Coquitlam, B.C. is typically used for testing of fire closures and separations, such as per ASTM E-119, ASTM E-152, CAN/ULC S101, NFPA 252, and UBC standard 43-2.

The furnace is constructed of 0.25 in. steel plate and rectangular steel tubing. It is lined with 4 in. of ceramic fibre blanket insulation. The interior dimensions of the furnace are as follows; 13 ft. 6 in. in width, 10 ft. 6 in. in height and 2 ft. 6 in. in depth. Forty-two Ransome Manufacturing spread head 1-1/2 in. venturi, 1/8 in. orifice natural gas burners are located on the back wall of the furnace. Twelve secondary air inlet ports 3 in. in diameter are also located on the lower back wall of the furnace with manually controlled dampers (see Figure D).

There are three exhaust plenums which connect to vent ducts at the top of the furnace and contain dampers that can be incrementally opened and closed by the furnace operator to regulate the pressure inside the furnace.

TEST FRAME DESCRIPTION

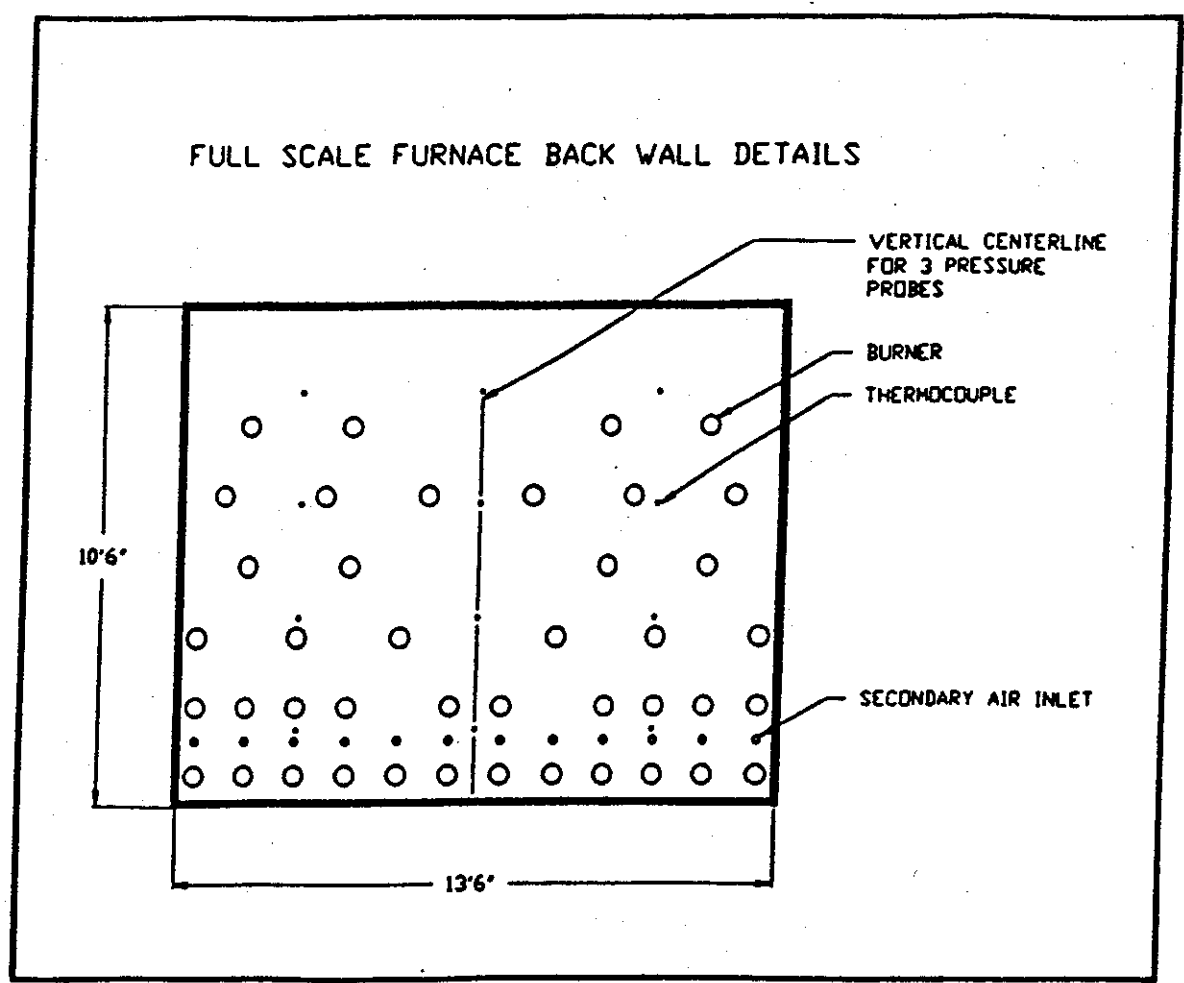
There is a single test frame of heavy I-Beam construction in which test partitions are constructed. It is connected to overhead trolleys and rolls on an I-beam for positioning for hose stream tests. The frame dimensions are as follows; 14 ft. 5 in. in width by 10 ft. 6 in. in height. The test frame is clamped to the furnace via two hydraulic cylinders.

FURNACE CONTROL

The furnace burners are controlled manually with individual ball valves. There are also manifold ball valves which control gas input to each of the 6 rows of burners. The main gas valve is used to regulate gas flow into the entire furnace. Due to the use of a PC to record temperatures to provide fast response, the temperature/time curve can be regulated to within 2%.

EQUIPMENT AND TEST PROTOCOL (Continued)

FIGURE I



**FURNACE THERMOCOUPLES
NFPA 252 (UBC 43-2 1991)**

Furnace temperatures are measured by 12 Type K thermocouples encased in a porcelain insulator, surrounded by a 7/8" O.D. Inconel sheath. These thermocouples extend to 6" from the test assembly (see Figure II).

EQUIPMENT AND TEST PROTOCOL (Continued)

DATA RECORDING EQUIPMENT

The standard furnace thermocouples are connected via analog connections to a personal computer. The computer records the readings every 3 seconds and saves them on disc every 15 seconds. The screen displays the time temperature curve, the average furnace temperature, the individual temperatures and pressures and the % of area under the time temperature curve. The display is updated every 3 seconds.

The 12 British Standard (BS 476) furnace thermocouples, the 16 British Standard (BS 476) unexposed face thermocouples, the roving thermocouple, the radiometers and radiometer baffles are recorded by two Fluke "Hydra" automatic data recorders having 20 channels each. The recorders are operated by a personal computer which records and displays the 40 readings every 15 seconds. All computer software was developed by Warnock Hersey staff.

MODES OF FURNACE OPERATION

Normally Aspirated Burner Mode:

The Ransome Manufacturing spread head burners have an adjustable venturi. The venturi was opened 1/8 in. for all normally aspirated burner fire tests. The normally aspirated mode produces a widespread blue flame which can extend to within 12 in. from the face of the vertical fire separation at maximum output conditions.

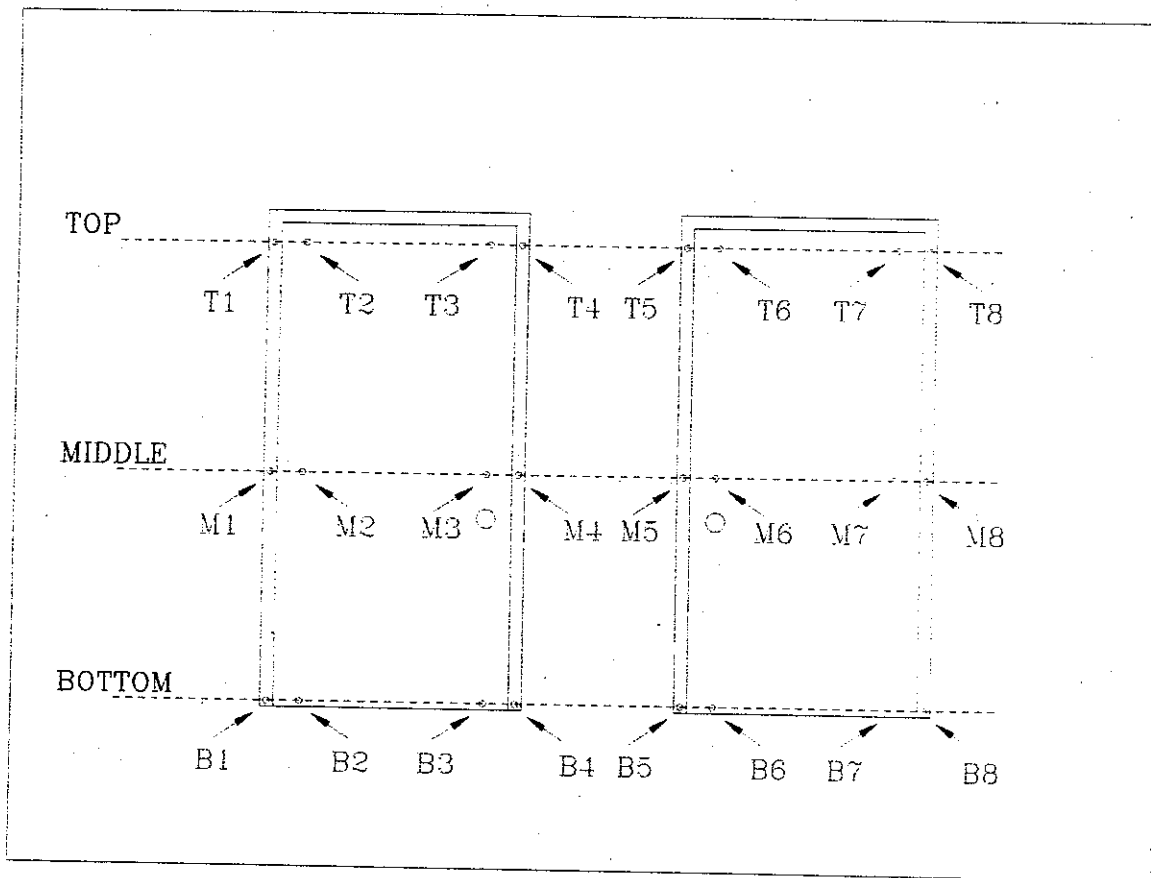
Diffusion Burner Mode:

The venturis on the Ransome Manufacturing spread head burners were completely closed and sealed with tape to prevent any air from mixing with the gas prior to exiting the burner. The diffusion burner mode produces a narrow and tall flame which only extends out from the burner a maximum distance of 12 in. The flame is very luminescent, orange in colour and can reach heights of 3 ft.

EQUIPMENT AND TEST PROTOCOL (Continued)

DEFLECTION MEASUREMENT LOCATIONS

Deflection measurement reference wires are connected to brackets welded to the test assembly mounting frame, hence the elevations and locations are identical for each test.



EQUIPMENT AND TEST PROTOCOL (Continued)

HOSE STREAM TEST

Within 60 seconds following the fire test, the test wall was uncoupled from the furnace and positioned for a standard hose stream test on the fire exposed face.

In accordance with the test standards, the fire tested assembly was subjected to the impact, erosion, and cooling effects of the hose stream.

The hose stream was delivered through a 2-1/2 in. hose discharging through a National Standard Playpipe of corresponding size equipped with a 1-1/8 in. discharge tip of the standard-taper smooth bore pattern without shoulder at the orifice. The discharge tip is located 19 ft. 6 in. from the centre of the assembly at 12° from horizontal. The water pressure at the base of the nozzle was 30 PSI.

The hose stream was applied for a period of 0.6 seconds per square foot of exposed area for 20 minute tests and 1.5 seconds per square foot for 90 minute tests. The exposed area for the calculation and for the hose stream application was the area of the entire test wall, resulting in required hose stream times of 1 minute, 24 seconds and 3 minutes, 30 seconds respectively. The hose stream was directed first at the centre of the assembly and then at all parts of the exposed surface, changing direction slowly.

TEST DOOR DESCRIPTION

The test sample doors and frames were submitted to Warnock Hersey by the manufacturers. The door constructions are proprietary and were not provided to Warnock Hersey. If more information is required contact the National Fire Protection Research Foundation. The test door frames were pressed steel, 16 gauge knock-down type (not welded). Following is a general description of the doors that were tested.

Test #1 and Test #7

Door Type: Mineral core of 90 minute specification with concealed intumescent strips in the stiles and exposed intumescent strip on the top rail; wood veneer faces

Marking: No markings

Manufacturer: Weyerhaeuser, Marshfield, Wisconsin

Nominal Size: 3'0" x 7'0" by 1-3/4" in thickness

Test #2 and Test #8

Door Type: Particle board core of 20 minute specification but with concealed intumescent strips in the stiles and exposed intumescent strip on the top rail; wood veneer faces.

Marking: No markings

Manufacturer: Weyerhaeuser, Marshfield, Wisconsin

Nominal Size: 3'0" x 7'0" by 1-3/4" in thickness

Test #3 and Test #5

Door Type: Hollow metal with steel stiffening ribs and fibreglass insulation.

Marking: Bears ULI certification label

Manufacturer: Habersham Metal Products Co., Cornelia, Georgia

Nominal Size: 3'0" x 7'0" by 1-3/4" in thickness

TEST DOOR DESCRIPTION (Continued)

Test #4 and Test #6

Door Type: Hollow metal type with expanded polystyrene slab core; steel end channels with vent holes in the bottom channel only.

Marking: Bears ULI certification label

Manufacturer: Curries, Inc., Mason City, Iowa

Hardware

Hinges: 4-1/2" x 4-1/2" x 0.134" ball bearing hinges, 3 per door

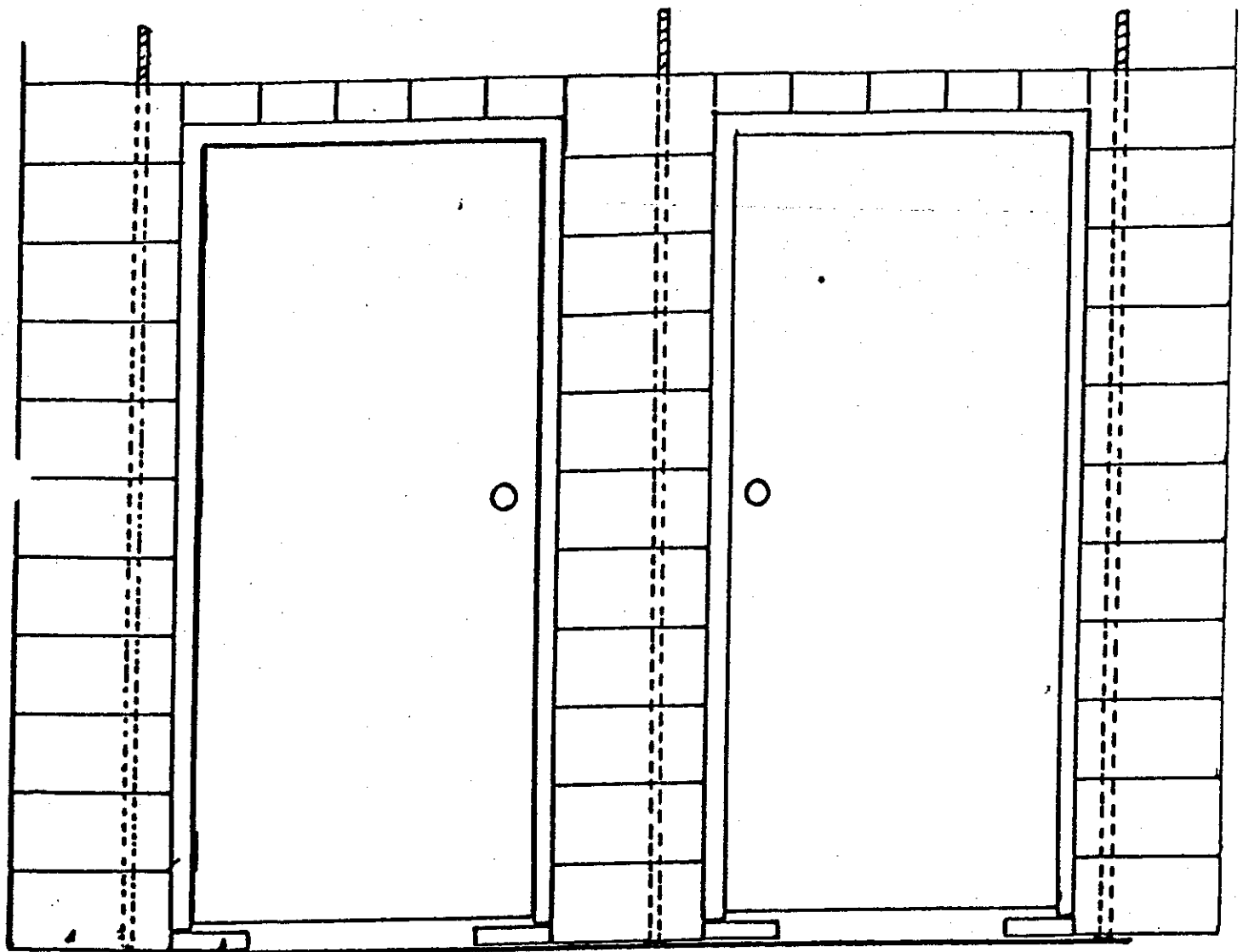
Latch: Sargent 18-7715 OB 32D Mortise latches

TEST ASSEMBLY CONSTRUCTION

The test door/frame assemblies were fully grouted in concrete block to form sub-assemblies as shown in Figure II. Each sub-assembly was allowed to cure for seven days prior to fire testing. This was accomplished by constructing a framework of 5/8 in. diameter steel reinforcing bar, fastened to a steel base strip. A single stack of 8 in. x 8 in. x 16 in. masonry units separated the two door assemblies, with the reinforcing steel contained in the voids of the block. A stack of block on each side of the assembly was reinforced and grouted by the same method. Prior to the test, each sub-assembly was placed on two base rows of concrete masonry units, sealed with fire clay. The wall area in the test frame was then completed in masonry units. The sill bricks were installed below the doors and the sill clearance adjusted by adding the required thickness of grout over the sill bricks. Steel shims were used at the top of the wall to wedge and restrain the completed wall assembly in the test frame.

To form a suitable seal between the wall assembly and the test furnace for developing a positive pressure, a 6 in. wide strip of 1 in. thick 6 lbs/ft.³ density ceramic fibre blanket insulation was glued to the test wall perimeter using silicone sealer. The gasket strip was applied to the top and sides of the assembly for the first six tests but also along the bottom for the last two diffusion burner tests.

FIGURE II
FIRE TEST SUB-ASSEMBLY CONSTRUCTION DETAILS



3/16 x 1 1/2" steel tie plate, 1" gap to be cut in centre in final test set-up.

First sill bricks in place, remainder added during test set-up.

Min. 5/8" Dia. re-bar in holes in Masonry Units, fully grouted.

8" x 8" x 16" Semi-Light weight Masonry Units, fully grouted with a Sand-Calcium Aluminate (FONDU) cement grout. All block voids to be filled.

ACCEPTANCE CRITERIA OF FIRE AND HOSE STREAM TESTS
BS 476:PART 20:1987

The acceptance criteria is defined as follows:

10.3 Integrity

10.3.1 *General.* A failure of the test construction to maintain integrity shall be deemed to have occurred when collapse or sustained flaming on the unexposed face occurs or the criteria given in 10.3.2 for impermeability are exceeded (see clause 2).

10.3.2 *Impermeability.* Failure shall be deemed to have occurred when one or other of the following conditions prevail.

a) For situations where the cotton pad (6.4.2.3) is suitable (see C10.3.2), failure shall be deemed to have occurred when flames and/or hot gases cause flaming or glowing of the cotton fibre pad.*

*Note: The use of the cotton pad shall be discontinued when the unexposed face of the construction indicates a temperature of 300°C in the vicinity of the gap being evaluated. After the use of the cotton pad has been discontinued, the integrity of the test construction shall be determined at such gaps by the means of gap gauges.

b) For situations where the use of the cotton pad is not suitable, failure shall be deemed to have occurred when either:

i) the 6 mm diameter gap gauge can penetrate a through gap such that the end of the gauge projects into the furnace and the gauge can be moved in the gap for a distance of at least 150 mm or

ii) the 25 mm diameter gap gauge can penetrate a through gap such that the end of the gauge projects into the furnace.

10.4 Insulation

Failure shall be deemed to have occurred when one of the following occurs:

a) If the mean unexposed face temperature increases by more than 140°C above its initial value;

ACCEPTANCE CRITERIA OF FIRE AND HOSE STREAM TESTS (Continued)
BS 476:PART 20:1987

10.4 Insulation (continued)

b) If the temperature recorded at any position on the unexposed face, either by a fixed thermocouple (see 6.4.2.1) or by the roving thermocouple subject to the following provisions (see 6.4.2.2) is in excess of 180°C above the initial mean unexposed face temperature.

c) When integrity failures as defined in 10.3 occur.

Temperatures measured by the roving thermocouple placed on a flat surface that has a minimum 12 mm diameter flat surface to which the disc can be applied shall be included in the evaluation of maximum temperature criterion.

Temperatures measured by the roving thermocouple, placed on small features that have a minimum 6 mm diameter flat surface, shall only be used in the evaluation of the maximum temperature criterion if the aggregate area of this or these features exceeds 0.1% of the specimen surface area within any 1 m² of surface area."

ACCEPTANCE CRITERIA OF FIRE AND HOSE STREAM TESTS (Continued)
UBC 43-2 (1991)

"Sec. 43.209.(a) General. A door assembly shall be considered as meeting the requirements for acceptable performance when it remains in the opening during the fire-endurance test and hose stream test within the following limitations:

1. The movement of swinging doors shall not permit any portion of the edges to move from the original position more than the thickness of the door, during the first half of the classification period or more than 1-1/2 times the thickness during the entire classification period.
2. An assembly consisting of a single swinging door shall not separate more than 1/2 in. at the latch location.
3. The test assembly shall have withstood the fire-endurance test and the hose stream test without developing openings anywhere through the assembly; except that dislodging of small portions of glass by the hose stream and within the limits specified in these requirements shall remain in place.
4. An opening is defined as a through hole in the assembly that can be seen from the unexposed side when viewed from the direction perpendicular to the plan of the assembly at the location of the suspected opening.

(b) Specific, All Doors

1. No flaming shall occur on the unexposed surface of a door assembly during the first 30 minutes of the classification period.
2. After 30 minutes, some intermittent light flames (approximately 6 in. long), for periods not exceeding five minute intervals, may occur along the edges of doors.
3. Light flaming may occur during the last 15 minutes of the classification period on the unexposed surface area of the door, provided it is contained within a distance of 1-1/2 in. from a vertical door edge and within 3 in. from the top edge of the door and within 3 in. from the top edge of the frame of a vision panel.
4. When hardware is to be evaluated for use on fire doors, it shall hold the door closed in accordance with the conditions of acceptance for the intended door assembly classification period and, in addition, the latch bolt shall remain projected and shall be intact after the test. The hardware need not be operable after test.

ACCEPTANCE CRITERIA OF FIRE AND HOSE STREAM TESTS (Continued)
UBC 43-2 (1991)

(c) **Swinging Doors**

1. The movement of swinging doors shall not result in any portion of the edges adjacent to the door frame moving from the original position in a direction perpendicular to the plane of the door more than the thickness of the door during the first half of the classification period, or more than one and one-half times the door thickness during the entire classification period or as a result of the hose stream test.
2. An assembly consisting of a single swinging door shall not separate more than 1/2 in. at the latch location.
3. Door frames to be evaluated with doors shall remain securely fastened to the wall on all sides and shall not permit through openings between frame and doors or between frame and adjacent wall."

SUMMARY OF TEST RESULTS (Continued)
TABLE II
OXYGEN CONCENTRATION MEASUREMENTS (%)

	TIME (minutes)								
	5	10	15	20	30	45	60	70	90
Mineral Core									
Test #1 (normal)	11.1	7.0	7.1	7.9	7.7	7.9	8.2	8.1	7.3
Test #7 (diffusion)	8.0	4.2	5.2	6.8	6.4	7.0	7.3	7.1	6.6
Wood Core									
Test #2 (normal)	12.1	6.7	8.7	8.6	-	-	-	-	-
Test #8 (diffusion)	10.0	7.1	8.8	7.5	-	-	-	-	-
Rib-Stiffened									
Test #3 (normal)	9.6	7.3	7.7	7.6	7.0	7.3	6.8	6.8	6.1
Test #5 (diffusion)	2.1	2.0	1.8	2.0	0.0	0.0	0.0	0.0	0.0
Metal, Foam Core									
Test #4 (normal)	10.1	8.5	8.8	8.0	7.5	6.4	6.1	6.1	5.8
Test #6 (diffusion)	11.4	0.9	1.2	2.3	1.2	2.9	3.6	3.1	3.0

Note: Ambient oxygen concentration is 20.9%.

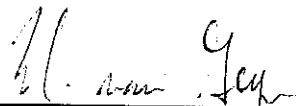
SUMMARY OF TEST RESULTS (Continued)
TABLE III
NATURAL GAS CONSUMPTION

Door Type	Test No.	Test Mode	Total BTU Consumption
Mineral Core	1	Normally Aspirated Diffusion Burner	5,687,000 BTU
	7		5,170,000 BTU
Wood Core	2	Normally Aspirated Diffusion Burner	1,551,000 BTU
	8		1,034,000 BTU
Rib-Stiffened	3	Normally Aspirated Diffusion Burner	6,204,000 BTU
	5		5,687,000 BTU
Metal, EPS Foam Core	4	Normally Aspirated Diffusion Burner	6,721,000 BTU
	6		5,170,000 BTU

Note: Meter accuracy is in cubic feet x 100 at 60 PSI gas pressure, hence the values noted above can be considered to be plus or minus 250,000 BTU.

WARNOCK HERSEY PROFESSIONAL SERVICES LTD.

Reported by:



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ADDENDUM TO REPORT NO. 6825
NATIONAL FIRE DOOR FIRE TEST PROJECT

TABLE OF CONTENTS

	PAGE
INTRODUCTION	1
EQUIPMENT AND TEST PROTOCOL	2
TEST DOOR DESCRIPTION	3
TEST ASSEMBLY CONSTRUCTION	4
SUMMARY OF TEST RESULTS	5

INTRODUCTION

As an extension of the National Fire Door Fire Test Project, two fire tests were conducted on October 20 and October 21, 1994. The objective of the tests was to demonstrate performance of mineral core composition doors and polystyrene core hollow metal doors with the furnace neutral pressure plane 20 inches above the sill. The tests are numbered Test #9 and Test #10 as they follow the eight tests described in Report No. 6825.

EQUIPMENT AND TEST PROTOCOL

The test protocol was identical to that described on Page 2 of Report No. 6825, with the following exceptions:

- a) Establishment of the neutral pressure plane at 20 in. instead of 40 in. above the door sill within 5 minutes from the start of the test.
- b) In addition to measurement of the oxygen concentration in the furnace stack, the furnace was controlled to maintain this concentration as practically as possible at 5% \pm 2% throughout the test.
- c) The furnace was operated in the diffusion burner mode only.

TEST DOOR DESCRIPTION

The test sample doors and frames were submitted to Warnock Hersey by the manufacturers. The door constructions are proprietary and were not provided to Warnock Hersey. If more information is required contact the National Fire Protection Research Foundation. The test door frames were pressed steel, 16 gauge knock-down type (not welded). Warnock Hersey visually verified that the doors were similar in construction to those tested in Report No. 6825. The mineral core doors had a tighter fit of the mortise lock to prevent the hose stream failures that occurred previously. Following is a general description of the doors that were tested.

Test #9

Door Type: Mineral core of 90 minute specification with concealed intumescent strips in the stiles and exposed intumescent strip on the top rail; wood veneer faces

Marking: No markings

Manufacturer: Weyerhaeuser, Marshfield, Wisconsin

Nominal Size: 3'0" x 7'0" by 1-3/4" in thickness

Test #10

Door Type: Hollow metal type with expanded polystyrene slab core; steel end channels with vent holes in the bottom channel only.

Marking: Bears ULI certification label

Manufacturer: Habersham Metal Products Co., Cornelia, Georgia

Nominal Size: 3'0" x 7'0" by 1-3/4" in thickness

Hardware

Hinges: 4-1/2" x 4-1/2" x 0.134" ball bearing hinges, 3 per door

Latch: Sargent 18-7715 OB 32D Mortise latches

TEST ASSEMBLY CONSTRUCTION

The test door/frame assemblies were fully grouted in concrete block to form sub-assemblies as shown in Figure II of Report No. 6825. Each sub-assembly was allowed to cure for seven days prior to fire testing. This was accomplished by constructing a framework of 5/8 in. diameter steel reinforcing bar, fastened to a steel base strip. A single stack of 8 in. x 8 in. x 16 in. masonry units separated the two door assemblies, with the reinforcing steel contained in the voids of the block. A stack of block on each side of the assembly was reinforced and grouted by the same method. Prior to the test, each sub-assembly was placed on two base rows of concrete masonry units, sealed with fire clay. The wall area in the test frame was then completed in masonry units. The sill bricks were installed below the doors and the sill clearance adjusted by adding the required thickness of grout over the sill bricks. Steel shims were used at the top of the wall to wedge and restrain the completed wall assembly in the test frame.

To form a suitable seal between the wall assembly and the test furnace for developing a positive pressure, a 6 in. wide strip of 1 in. thick 6 lbs/ft.³ density ceramic fibre blanket insulation was glued to the test wall perimeter using silicone sealer. The gasket strip was applied to the top and sides of the assembly.

**SUMMARY OF TEST RESULTS
 TABLE IA - GENERAL**

DOOR TEMPERATURE RISE °C						
Product	Mineral Core			EPS Foam Core		
Test No.	Test #1	Test #7	Test #9	Test #4	Test #6	Test #10
Burner Mode	NORM	DIFF	DIFF	NORM	DIFF	DIFF
UBC Avg. Rise @ 30 min	91	112	85	665	679	735
BS 476 Avg. Rise @ 30 min.	69	66	63	597	491	472
End of Test BS 476 Max.	195	224	186	628	621	688
End of Test BS 476 Avg.	167	167	177	601	576	547

* Neutral Pressure Plane at 20 in. above door sill

**SUMMARY OF TEST RESULTS
 TABLE 1B - GENERAL**

Product	Mineral Core			EPS Foam Core		
Test No.	Test #1	Test #7	Test #9	Test #4	Test #6	Test #10
Burner Mode	NORM	DIFF	DIFF	NORM	DIFF	DIFF
Maximum Radiometer (btu/sec/ft ²)	0.0315	0.0343	0.0308	0.2699	0.2583	0.2902
Cotton Pad Ignition	No	No	No	No	No	No
Occurrence of Flaming on Unexposed Side	None	None	None	None	None	None
Fire Test	Pass	Pass	Pass	Pass	Pass	Pass
Hose Stream Test	Fail	Fail	Pass/ Fail	Pass	Pass	Pass/ Fail

SUMMARY OF TEST RESULTS (Continued)
TABLE II
OXYGEN CONCENTRATION MEASUREMENTS (%)

	TIME (minutes)								
	5	10	15	20	30	45	60	70	90
Mineral Core									
Test #1 (normal)	11.1	7.0	7.1	7.9	7.7	7.9	8.2	8.1	7.3
Test #7 (diffusion)	8.0	4.2	5.2	6.8	6.4	7.0	7.3	7.1	6.6
Test #9 (diffusion)	20.5	3.0	5.2	4.4	3.0	5.8	6.1	5.6	5.1
Metal, Foam Core									
Test #4 (normal)	10.1	8.5	8.8	8.0	7.5	6.4	6.1	6.1	5.8
Test #6 (diffusion)	11.4	0.9	1.2	2.3	1.2	2.9	3.6	3.1	3.0
Test #10 (diffusion)	11.5	0.7	0.6	0.3	4.1	2.6	2.5	2.4	1.3

Note: Ambient oxygen concentration is 20.9%.


SUMMARY OF TEST RESULTS (Continued)
TABLE III
NATURAL GAS CONSUMPTION

Door Type	Test No.	Test Mode	Total BTU Consumption
Mineral Core	1	Normally Aspirated	5,687,000 BTU
	7	Diffusion Burner	5,170,000 BTU
	9	Diffusion Burner	4,136,000 BTU
Metal, EPS Foam Core	4	Normally Aspirated	6,721,000 BTU
	6	Diffusion Burner	5,170,000 BTU
	10	Diffusion Burner	3,619,000 BTU


Note: Meter accuracy is in cubic feet x 100 at 60 PSI gas pressure, hence the values noted above can be considered to be plus or minus 250,000 BTU.

WARNOCK HERSEY PROFESSIONAL SERVICES LTD.

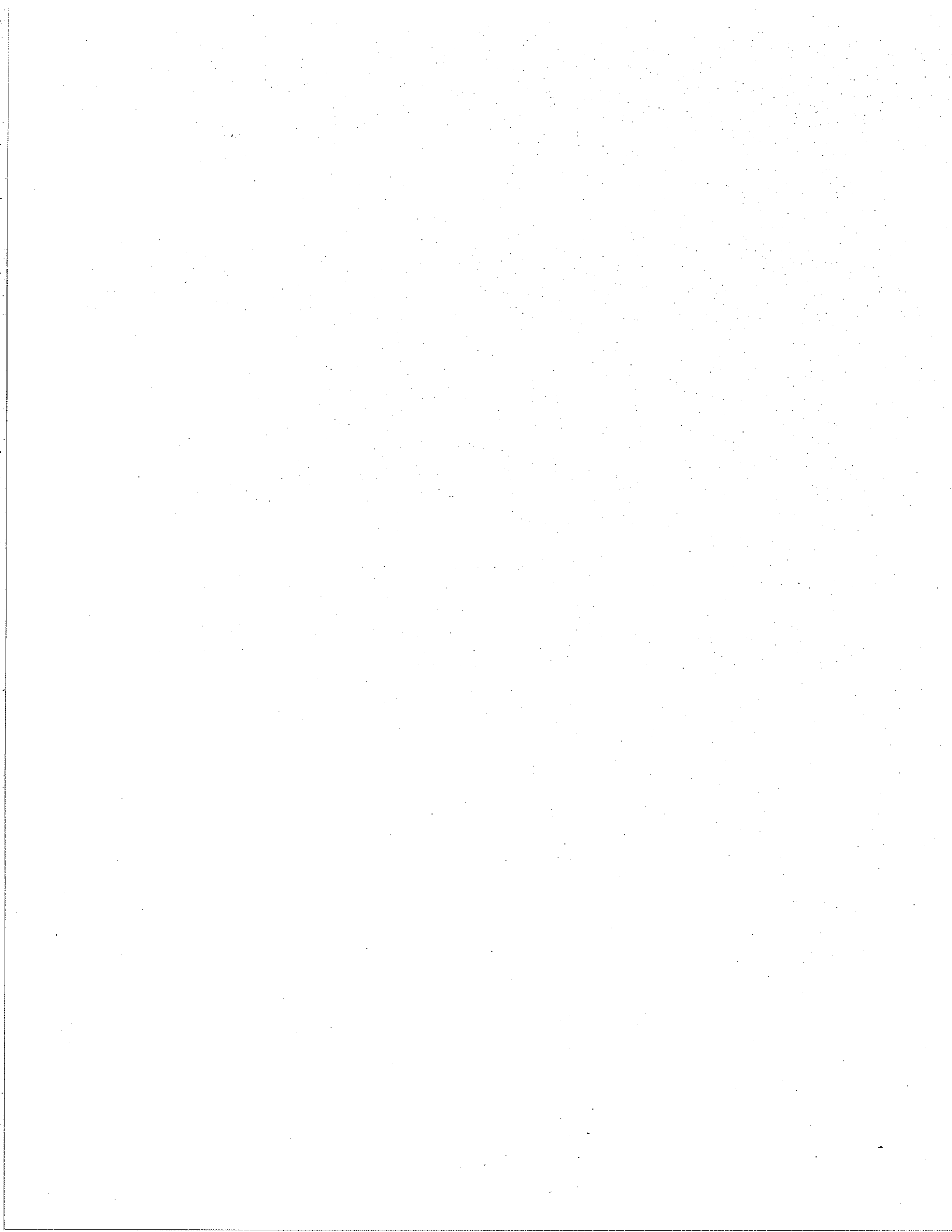
Reported by:


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SUPPLEMENT TO REPORT NO. 6825
NATIONAL FIRE DOOR FIRE TEST PROJECT

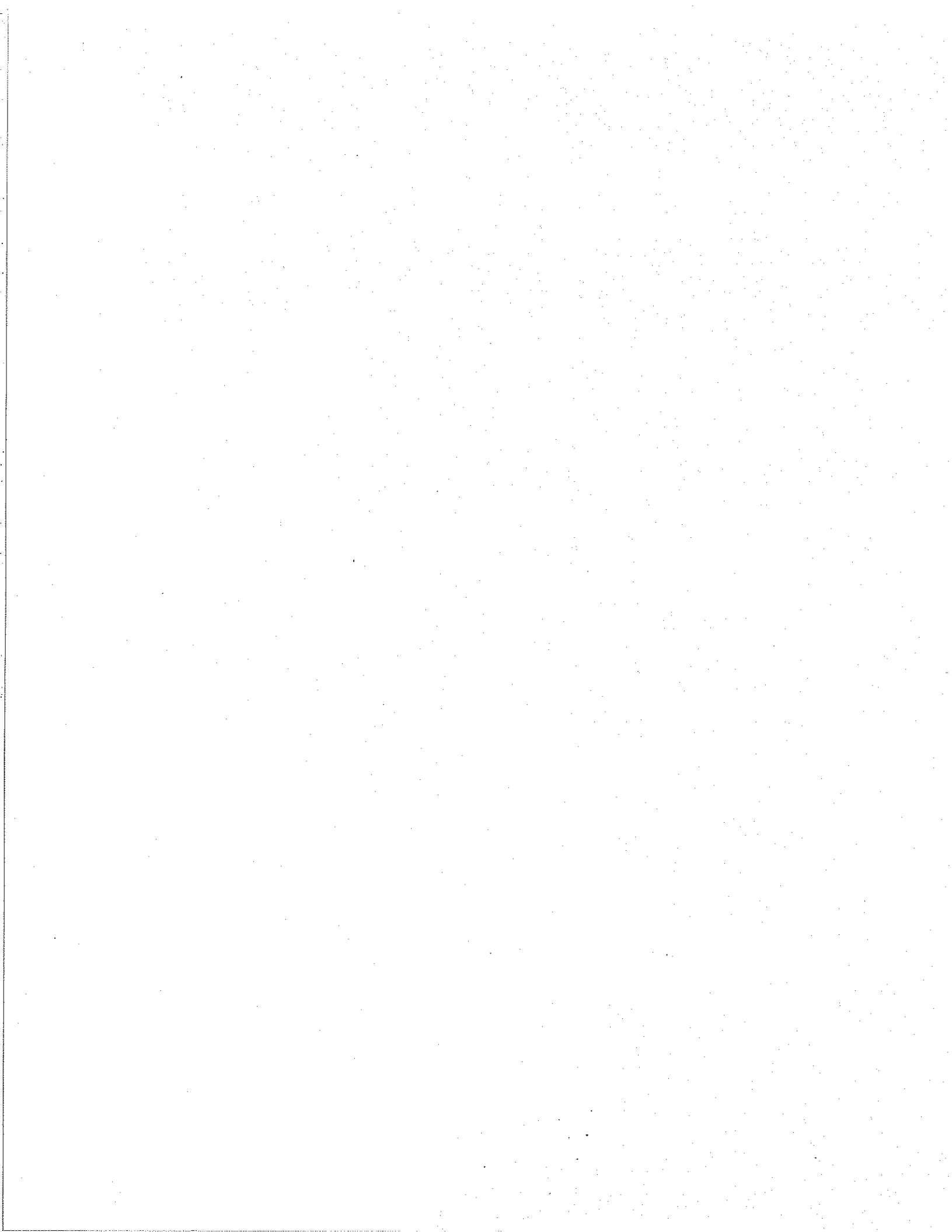
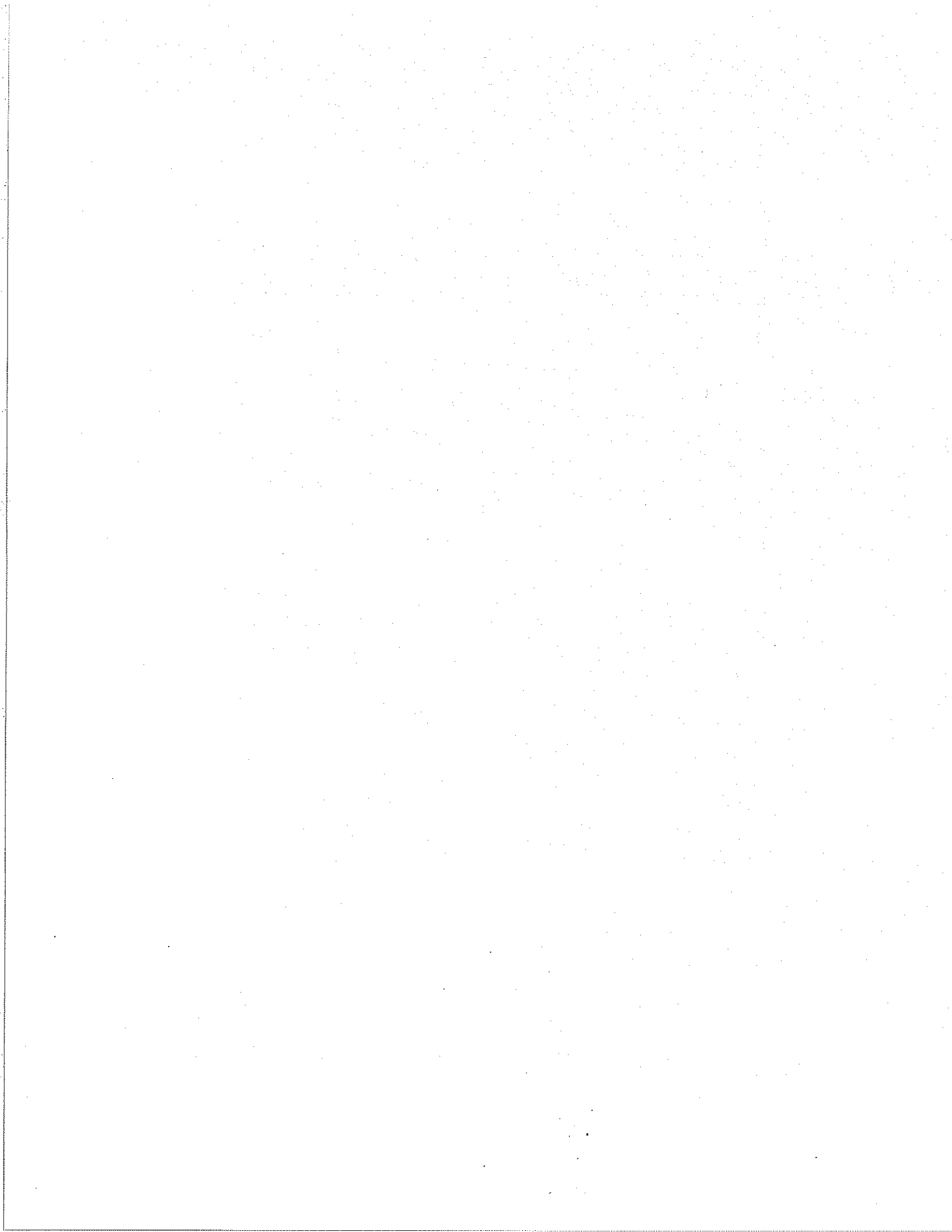


TABLE OF CONTENTS

	PAGE
TEST #1 .....	.1
TEST #2 .....	.14
TEST #3 .....	.27
TEST #4 .....	.40
TEST #5 .....	.53
TEST #6 .....	.66
TEST #7 .....	.79
TEST #8 .....	.92
TEST #9 .....	.104
TEST #10 .....	.117



TEST #1

TEST SAMPLE DESCRIPTION

Product Tested: Intumescent edged mineral core doors in knock down 16 gauge pressed steel frames, fully grouted. Two single swing doors in the test wall assembly.

Fire Test Duration: 90 min.

Fire Test Mode: Normally aspirated burners, positive pressure above latch level.

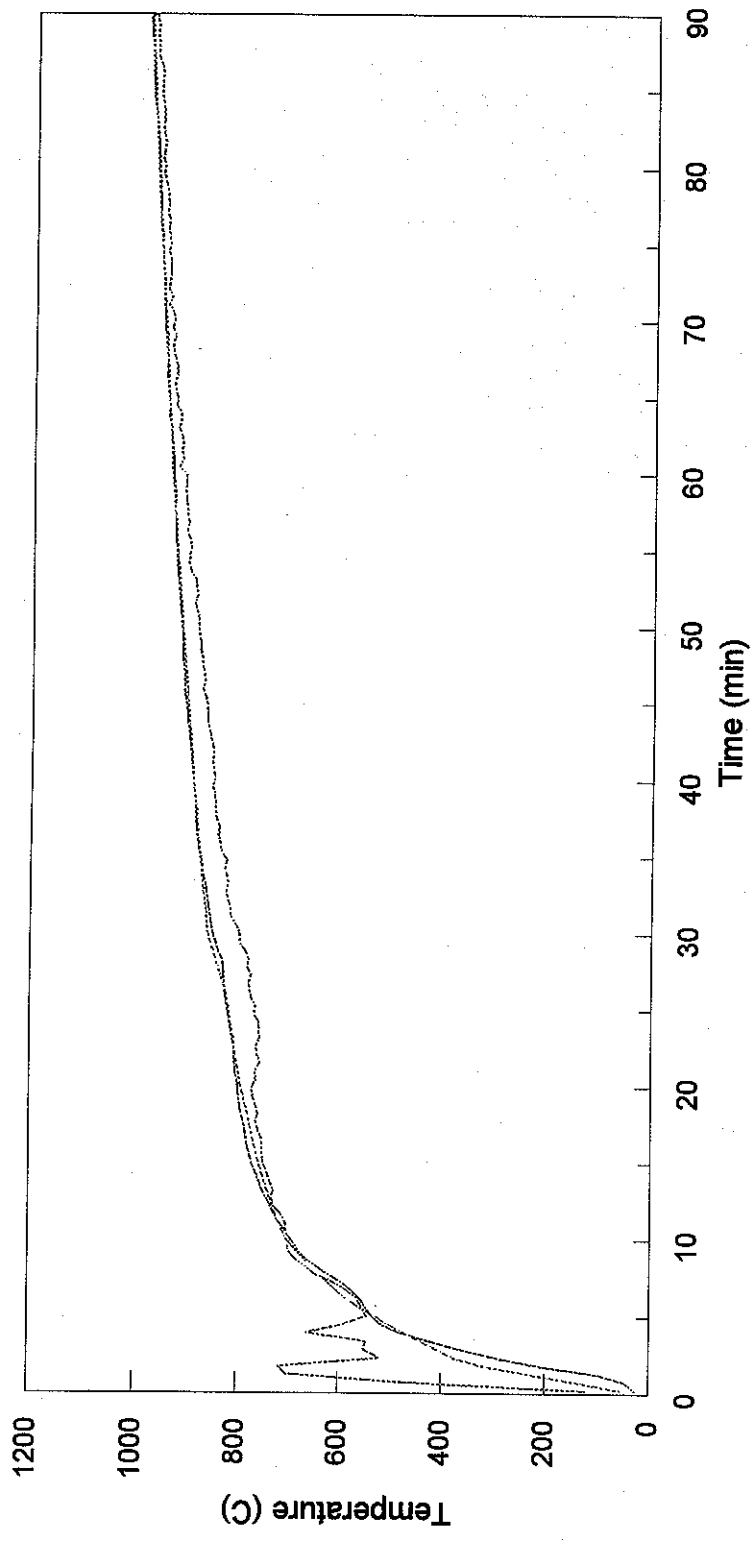
Note: Right side door opens into furnace, left side door opens out of furnace (viewed from unexposed side)

INITIAL CLEARANCES (INCHES)						
	LEFT DOOR			RIGHT DOOR		
	TOP	MIDDLE	BOTTOM	TOP	MIDDLE	BOTTOM
Hinge Edge	1/16	3/32	1/16	1/8	1/8	1/8
Latch Edge	1/16	1/32	1/16	1/16	1/16	1/16
	LEFT	CENTRE	RIGHT	LEFT	CENTRE	RIGHT
Top	1/8	3/16	1/4	1/8	1/8	1/8
Sill	1/2	3/8	3/8	3/16	3/8	7/16

NATURAL GAS CONSUMPTION

$1100 \text{ ft.}^3 \text{ (uncorrected)} \times 5170 \text{ btu/ft.}^3 \text{ (correct)} = 5,687,000 \text{ btu}$

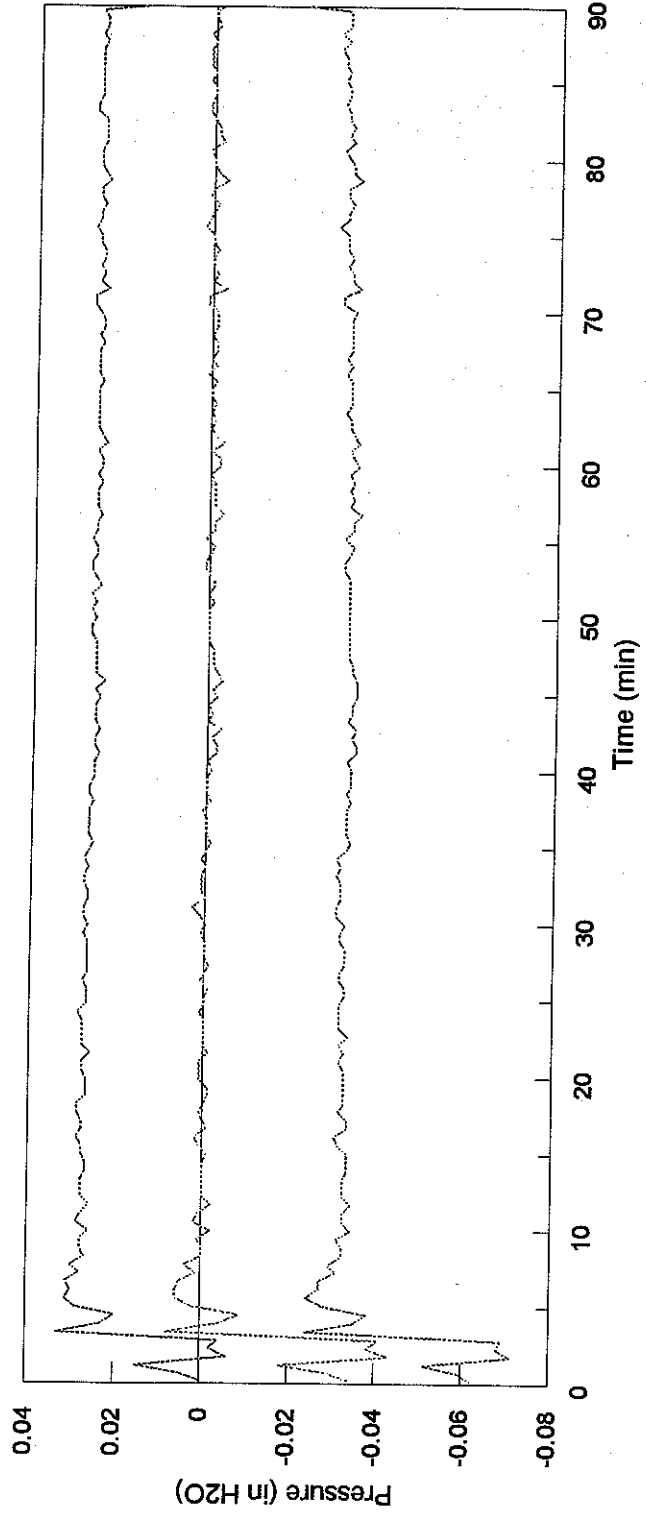
TEST 1
Furnace Temperatures vs. Time



--- Average Temperature - - - Required Temperature ···· BS 476 TC Temperature

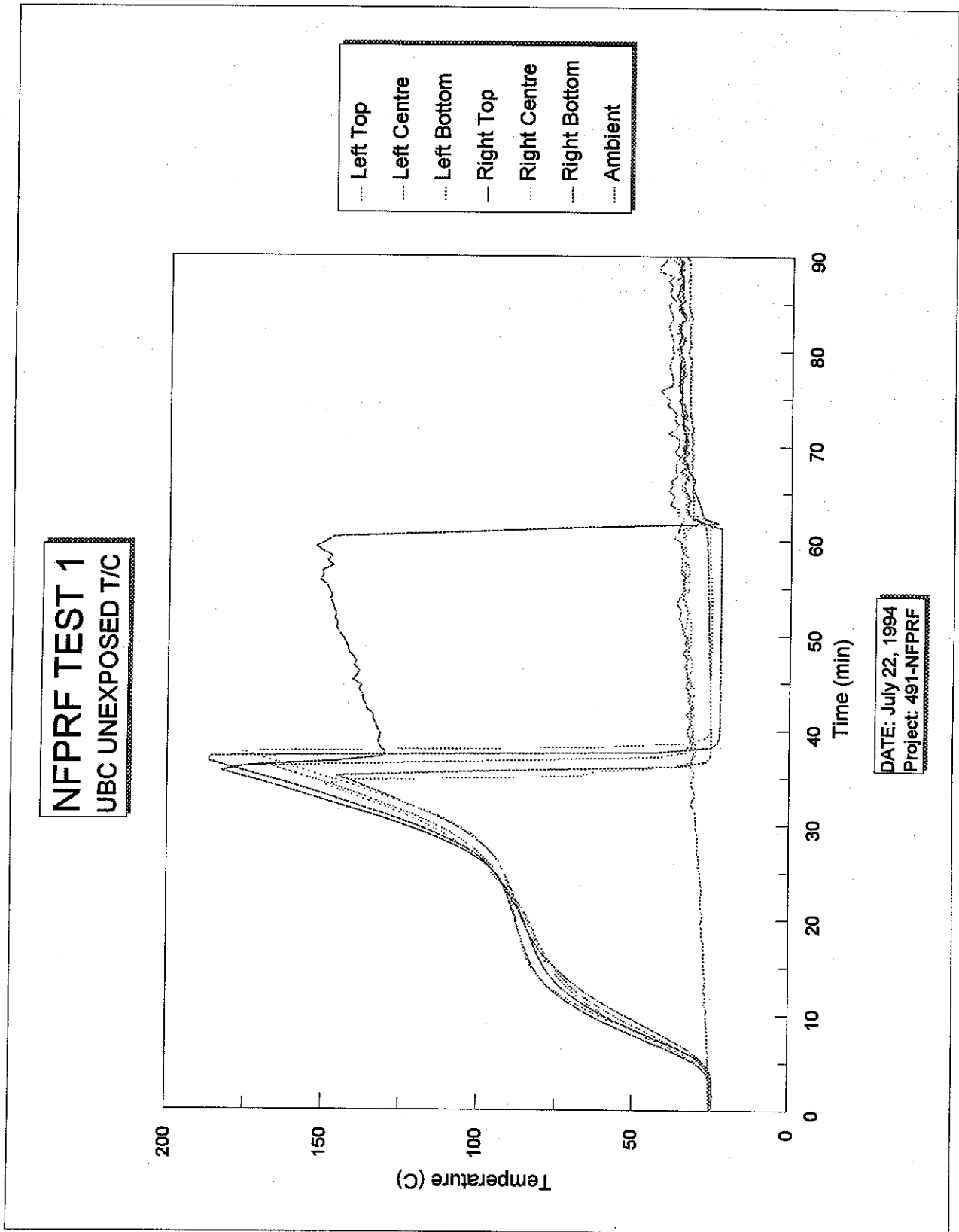
DATE: July 22, 1994
Project 491-NFPRF

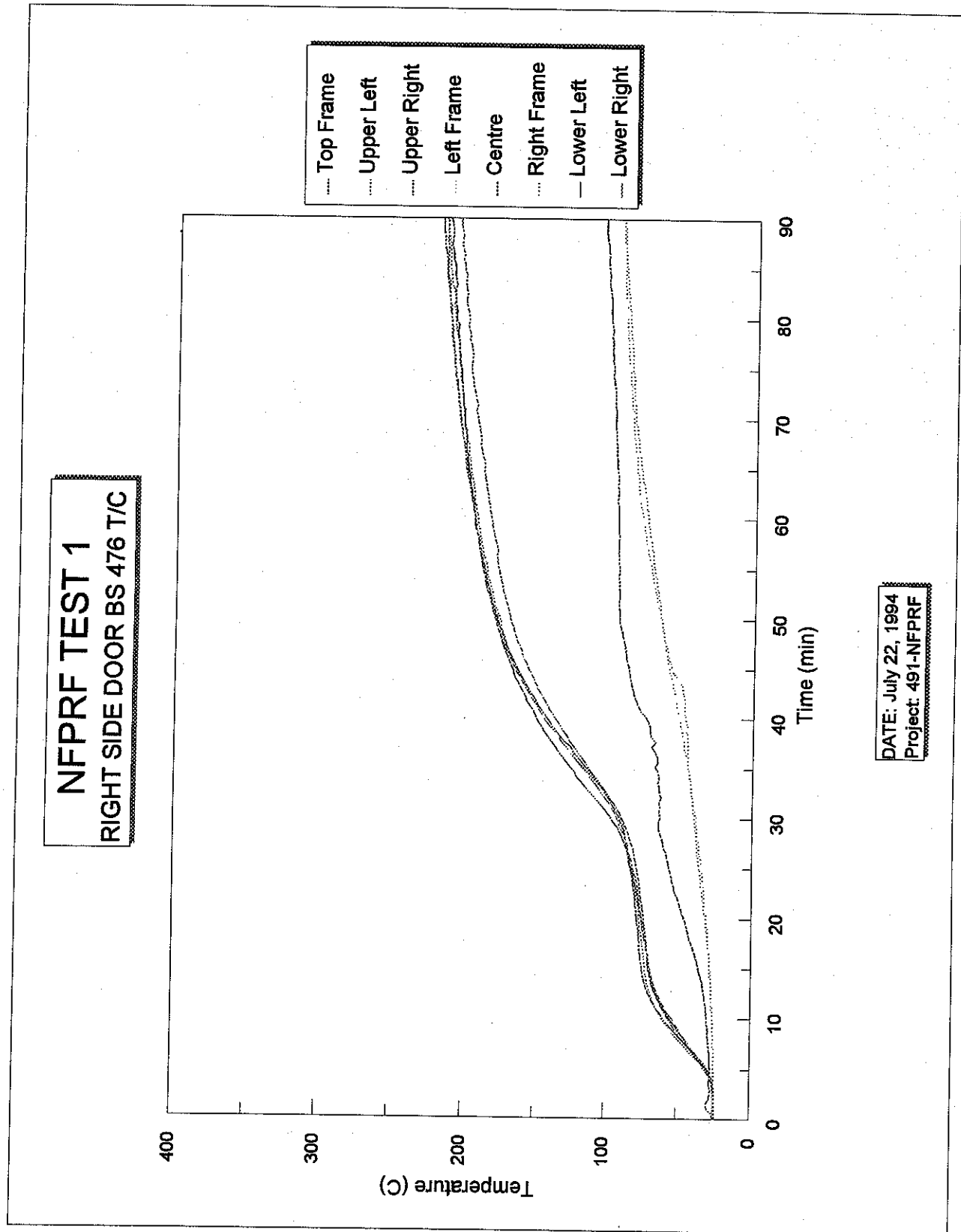
TEST 1
Furnace Pressures

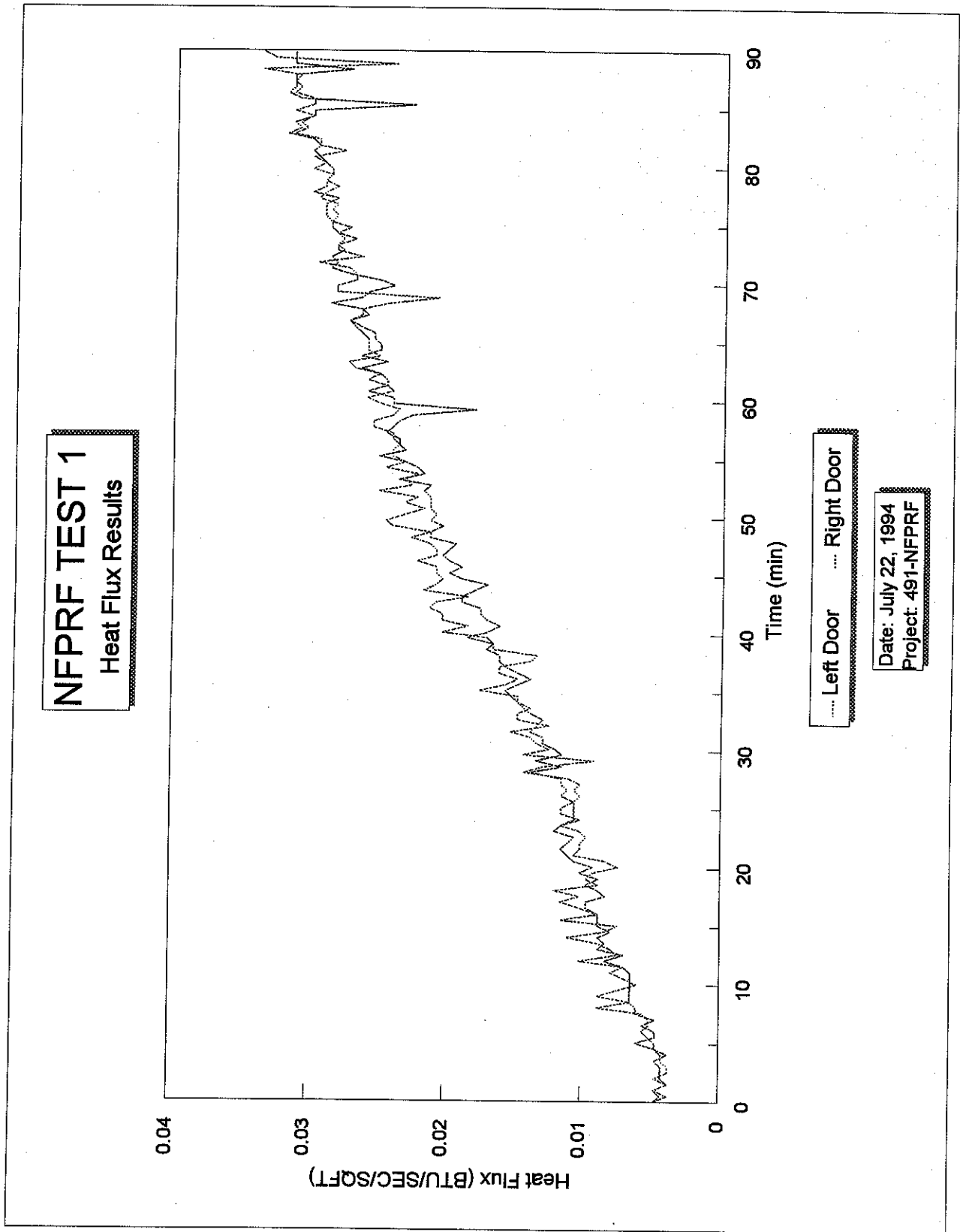


--- Header level Pressure Tap - - - 40" level Pressure Tap ··· Sill level Pressure Tap

Date: July 22, 1994
Project: 491-NFPRF1







TEST #1 (Continued)
DEFLECTION MEASUREMENTS (INCHES)

Data has been adjusted to show 0 in. as initial deflection. Positive direction is towards furnace, negative direction is away from furnace.

Location		Initial	5 min	10 min	15 min	30 min	45 min	60 min	75 min	90 min
Top	T1	0	1/8	1/4	1/4	1/2	1/2	5/8	5/8	5/8
	T2	0	0	1/8	1/8	3/8	3/8	1/2	1/2	1/2
	T3	0	0	1/4	3/8	3/4	3/4	3/4	7/8	7/8
	T4	0	1/8	1/4	3/8	1/2	5/8	5/8	3/4	3/4
	T5	0	1/8	1/4	3/8	5/8	3/4	4/8	7/8	7/8
	T6	0	1/8	3/8	1/2	1/2	3/4	7/8	1	1
	T7	0	0	1/4	3/8	1/2	5/8	3/4	3/4	7/8
	T8	0	1/4	1/4	3/8	5/8	7/8	7/8	7/8	1
Middle	M1	0	1/4	3/8	5/8	7/8	7/8	1	7/8	1
	M2	0	1/4	1/4	1/2	3/4	7/8	7/8	7/8	3/4
	M3	0	3/8	5/8	7/8	1	1-1/8	1-1/4	1-1/8	1-1/4
	M4	0	3/8	5/8	3/4	1	1-1/8	1-1/8	1-1/8	1-1/4
	M5	0	1/4	5/8	3/4	1-1/8	1-1/4	1-1/4	1-3/8	1-3/8
	M6	0	3/8	5/8	3/4	1	1-1/8	1-1/4	1-1/4	1-1/8
	M7	0	3/8	1/2	5/8	7/8	1	1	1-1/8	1-1/8
	M8	0	1/4	1/2	5/8	7/8	1-1/8	1-1/8	1-1/8	1-1/4
Bottom	B1	0	1/4	3/8	1/2	5/8	3/4	7/8	7/8	7/8
	B2	0	1/4	1/4	3/8	5/8	5/8	3/4	3/4	7/8
	B3	0	1/4	3/8	1/2	5/8	7/8	7/8	1	1
	B4	0	3/8	1/2	5/8	3/4	1	1	1	1-1/8
	B5	0	1/4	1/4	1/2	5/8	3/4	7/8	7/8	1
	B6	0	1/4	3/8	5/8	3/4	7/8	1	1-1/8	1-1/8
	B7	0	1/4	3/8	1/2	5/8	3/4	7/8	1	1
	B8	0	1/4	3/8	1/2	5/8	3/4	7/8	7/8	1

Note: Post test measurements not recorded.

TEST #1 (Continued)
FIRE TEST OBSERVATIONS

L.S. Door opens out of furnace, R.S. Door opens into furnace.

TIME (MIN)	EXPOSED SIDE	UNEXPOSED SIDE
0:00	Timing started upon ignition of lowest row of burners	Door(s) latched, bolt fully extended
0:40	Ignition of door skins	
1:00	Full flaming in furnace	Venting at header, down to mid-height
1:30	Full flaming continues, dampers adjusted	Venting slightly at headers
2:00	Skins out, charred	
2:30	Char falling off door	
3:00	Achieveing neutral pressure at latch level	Increased venting
4:50	Achieved neutral pressure at latch level	Constant venting at headers and part way down edges of doors.
5:00	No flaming	
6:00		Slight bowing of wall, steam from blocks
7:00	No change	Venting at top, bottom hinge and latch of L.S. door, slight wisps at header of R.S. door
8:00		
9:00		
10:00	Burner flames luminous	Venting from joints in block wall, intumescent material visible along top of L.S. door and visible along door edges of R.S. door
15:00		
20:00		More wall deflection
25:00	Intumescent material visible along hinge edge of R.S. door	Water dripping from header, R.S. door, more intumescence visible, no venting
30:00		Intumescent action appears to be complete
35:00	No change	UBC thermocouples and pads removed

TEST #1 (Continued)
FIRE TEST OBSERVATIONS (Continued)

TIME (MIN)	EXPOSED SIDE	UNEXPOSED SIDE
40:00	Light flaming of exposed intumescent	Maximum 1/4 in. movement of doors from door stops, doors remained flat
45:00		Char appearing around latch knobs
50:00		Condensate dripping from top of R.S. door
55:00		Discoloration of skins around latch, shows shape of latch cut-out
60:00		Door edge discoloration on R.S. door
65:00	No change	No change
70:00		No change, no venting
75:00		Mortice lock door skin discoloration much darker
90:00	No change	No flaming, no burn-through, door remains latched and flat

BS 476 COTTON PAD TEST		
TIME (MIN)	LOCATION	RESULT
57:15	R.S. Door top left corner against frame	No ignition, no glowing, no discoloration of pad

TEST #1 (Continued)

HOSE STREAM TEST OBSERVATIONS

Hose Stream Test Duration: 1 minutes 25 seconds (to failure)

Time from end of fire test to application of hose stream test: 55 seconds

Observations: The top half of the door opening out of the furnace was pushed out of the opening. The remainder of the door stayed latched. The lock mortice on the door opening into the furnace was deeper than the lock itself. The area behind the mortice had become charred and a through opening approximately 1/2 in. in width developed allowing the passage of a stream of water through the assembly. The exposed concrete was dislodged from the stack of concrete block in the centre of the doors exposing the grouted core and frame anchors.

Criteria: The door shall remain in the opening during the hose stream test. A single swinging door shall not separate more than 1/2 in. at the latch location. There shall be no development of openings anywhere through the assembly. An opening is defined as a through hole in the assembly that can be seen from the unexposed side when viewed from the direction perpendicular to the plan of the assembly at the location of the suspected opening.

Conclusion: The door opening into the furnace did not meet the requirements of the hose stream test due to the opening developed around the mortice lock. The door opening out of the furnace did not meet the requirements of the hose stream test.

TEST #1 (Continued)

**SUMMARY OF TEST RESULTS
 RELATING TO NFPA 252/UBC 43-2 (1991)**

FIRE TEST	L.S. DOOR (OPENING OUT)	R.S. DOOR (OPENING IN)
Maximum movement of door from door frame	1/4 in.	1/4 in.
Maximum surface temperature rise at 30 min.	175°F 97°C	189°F 105°C
Average surface temperature rise at 30 min.	160°F 89°C	171°F 95°C
Flaming on unexposed side in first 30 min.	None	None
Flaming on unexposed side after 30 min.	None	None
Development of openings	None	None
Did separation at latch location exceed 1/2 in.	No	No
HOSE STREAM TEST		
Did doors remain latched and in the opening	No	Yes
Development of through openings - Door and Frame - Frame and Wall	Yes No	No No
Maximum movement of door from door frame	N/A	0 in.
Did separation at latch location exceed 1/2 in.	No	No

TEST #1 (Continued)

**SUMMARY OF TEST RESULTS
RELATING TO BS 476:PART 20:1987**

FIRE TEST	L.S. DOOR (OPENING OUT)	R.S. DOOR (OPENING IN)
Time; individual unexposed surface temperature rise of 180°C for door/frame assembly	67 min.	73 min.
Time; average unexposed surface temperature rise of 140°C ("insulation failure") door/frame assembly	54 min.	50 min.
Time; unexposed surface temperature rise of 300°C	Did not occur	Did not occur
Time; cotton pad ignition	None observed	None observed
Did through openings develop	No	No
Did sustained flaming occur on unexposed side	No	No
Time; "integrity" failure	Test duration	Test duration

TEST #2

TEST SAMPLE DESCRIPTION

Product Tested: Wood edged particle board core doors in knock down 16 gauge pressed steel frames, fully grouted. Two single swing doors mounted in the test wall assembly.

Fire Test Duration: 20 min.

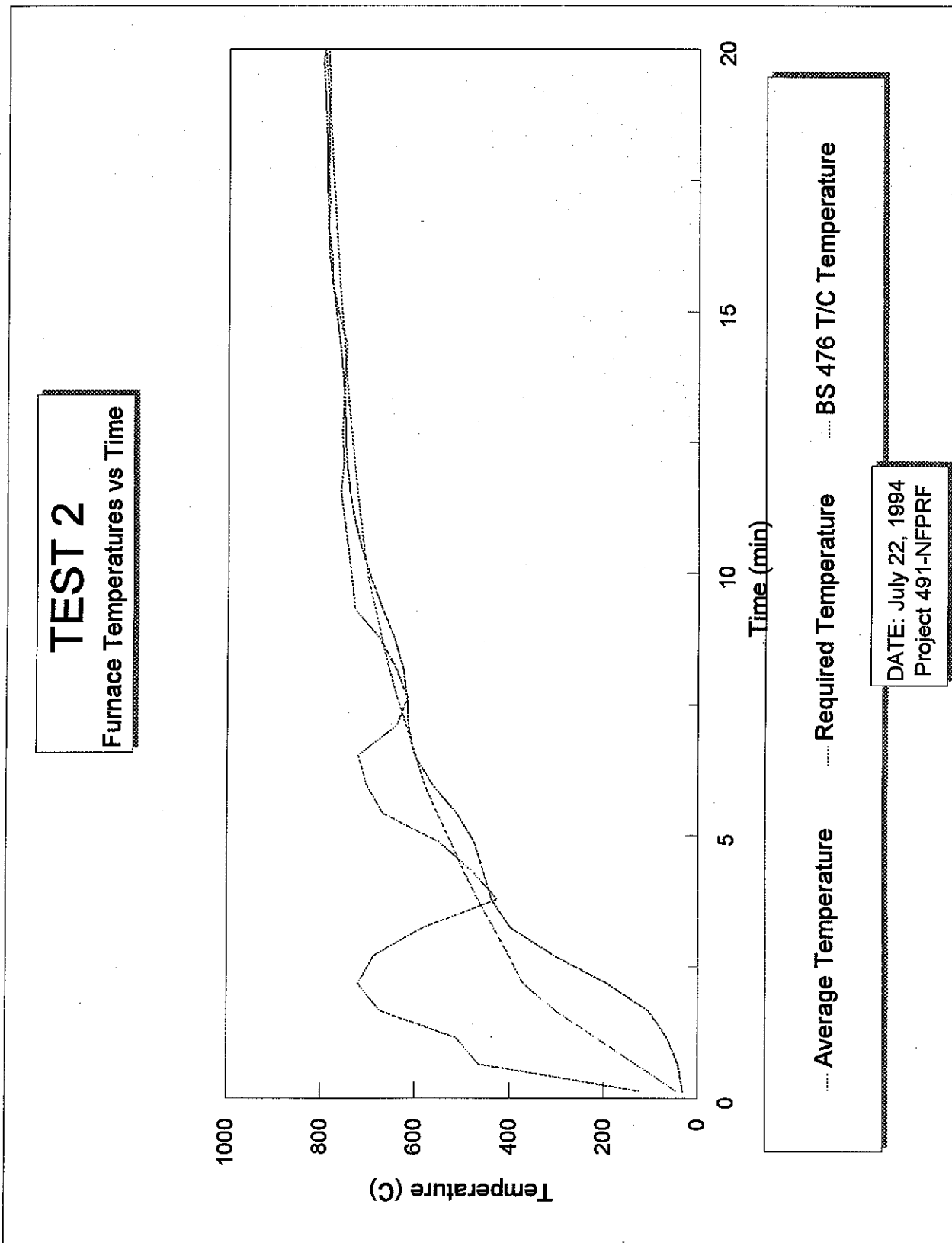
Fire Test Mode: Normally aspirated burners, positive pressure above latch level.

Note: Right side door opens into furnace, left side door opens out of furnace (viewed from unexposed side).

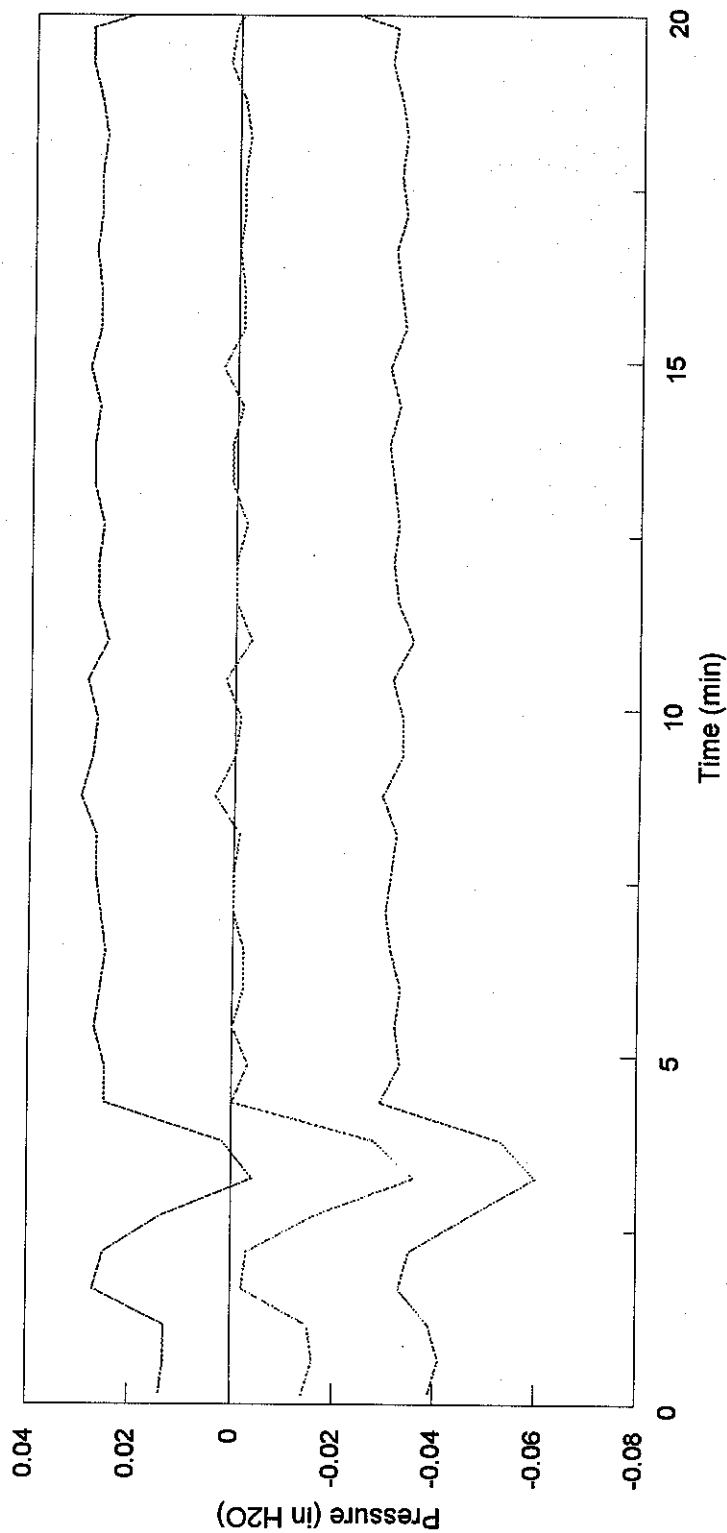
INITIAL CLEARANCES (INCHES)						
	LEFT DOOR			RIGHT DOOR		
	TOP	MIDDLE	BOTTOM	TOP	MIDDLE	BOTTOM
Hinge Edge	1/16	1/32	1/16	1/16	1/16	1/16
Latch Edge	3/16	1/16	1/16	1/8	3/32	3/32
	LEFT	CENTRE	RIGHT	LEFT	CENTRE	RIGHT
Top	1/8	1/8	1/4	1/16	1/16	1/8
Sill	3/8	3/8	3/8	3/8	7-16	3/8

NATURAL GAS CONSUMPTION

$300 \text{ ft.}^3 \text{ (uncorrected)} \times 5170 \text{ btu/ft.}^3 \text{ (corrected)} = 1,551,000 \text{ btu}$

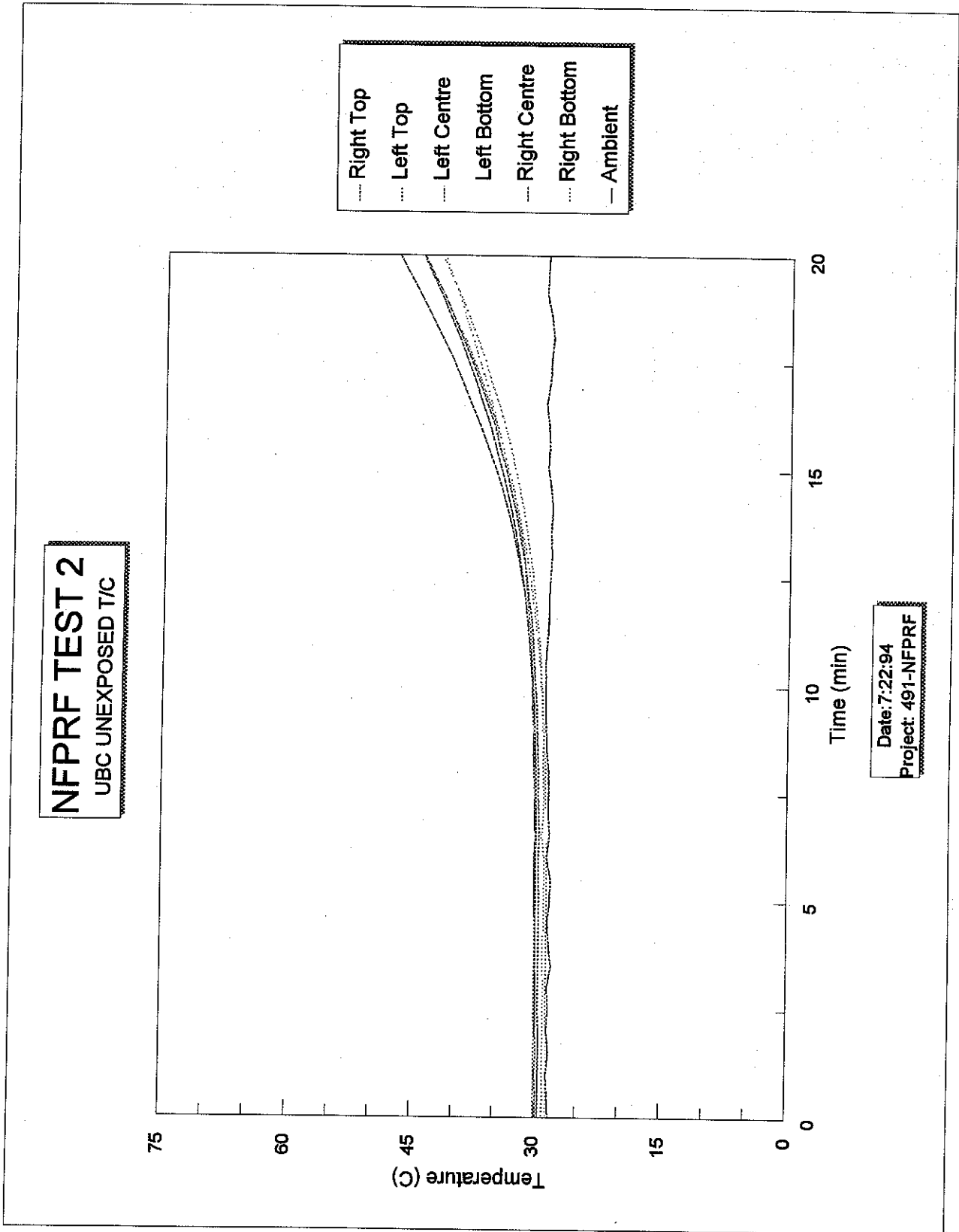


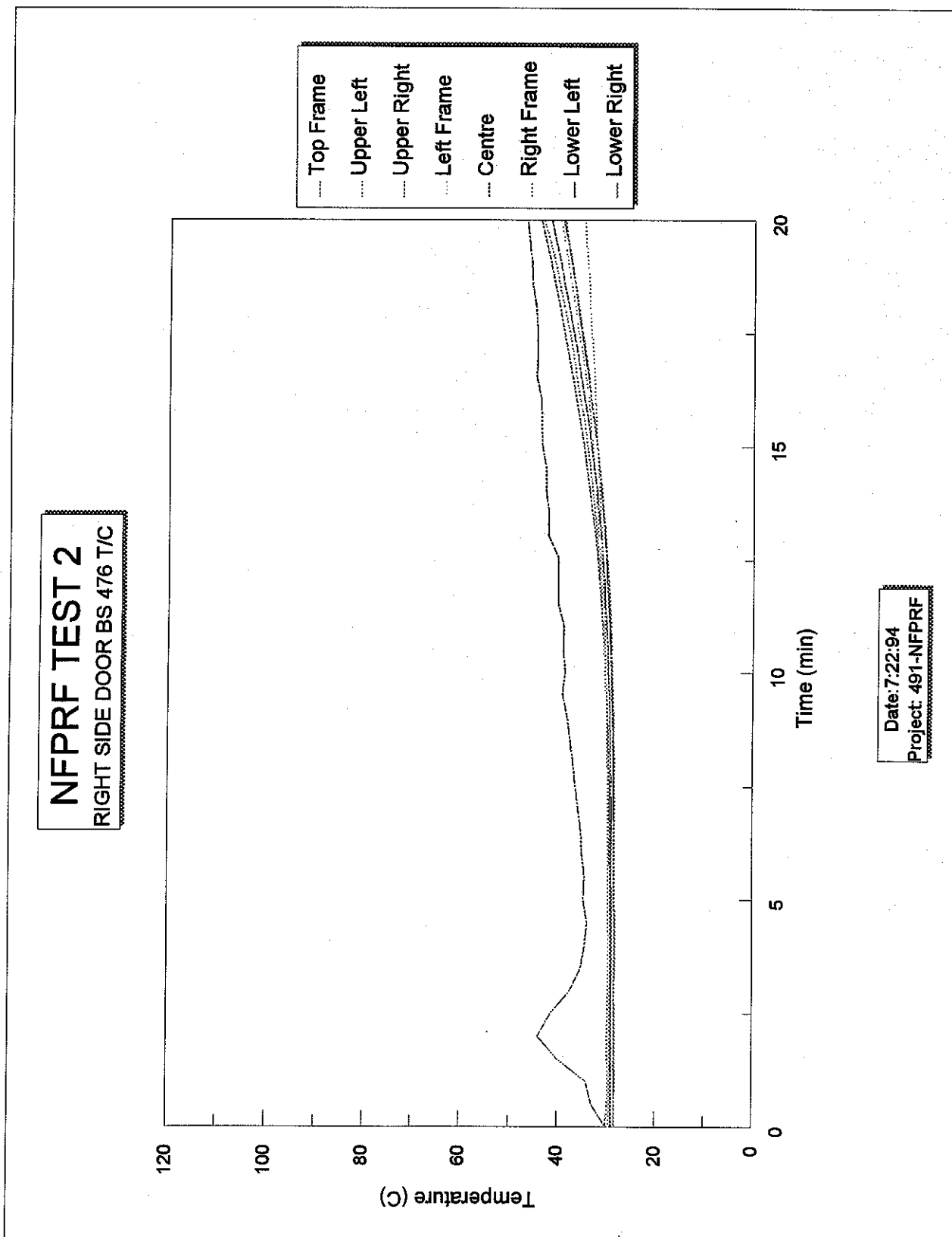
TEST 2
Furnace Pressures

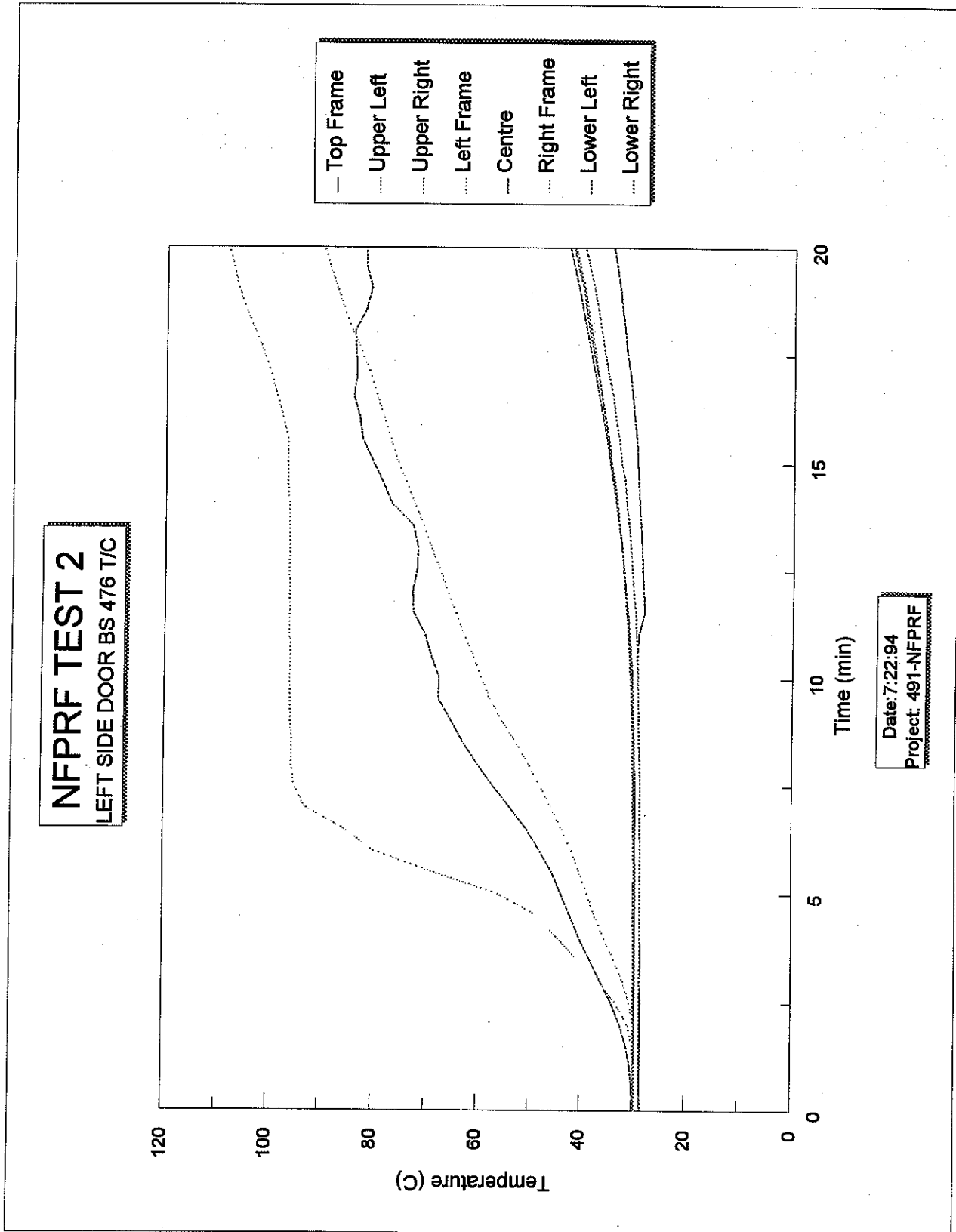


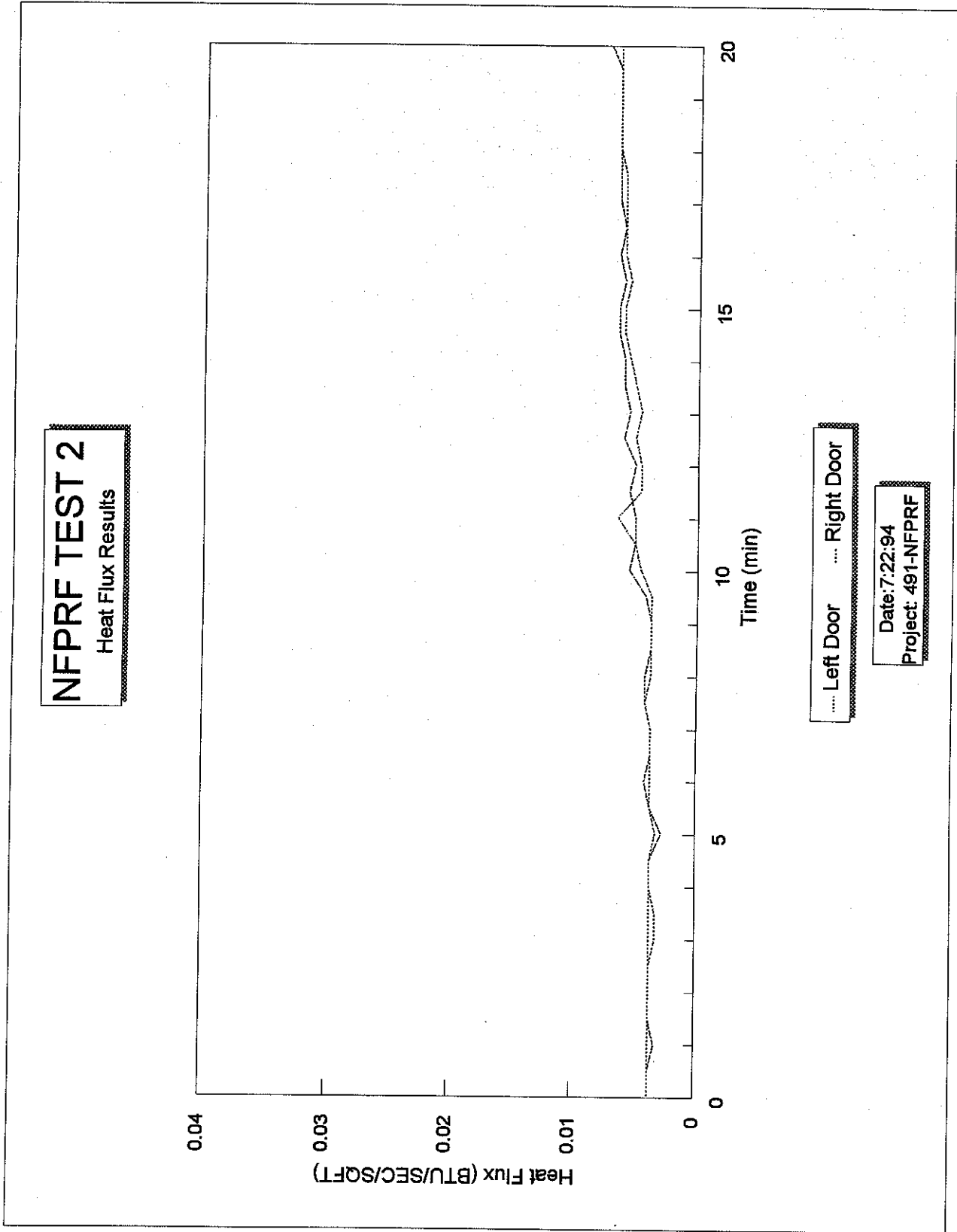
--- Header level Pressure Tap ... 40" level Pressure Tap Sill level Pressure Tap

Date: July 22, 1994
Project: 491-NFPRF









TEST #2 (Continued)
DEFLECTION MEASUREMENTS (INCHES)

Data has been adjusted to show 0 in. as initial deflection. Positive direction is towards furnace, negative direction is away from furnace.

Location		Initial	5 min	10 min	15 min	20 min
Top	T1	0	--3/8	--1/8	0	0
	T2	0	--1/4	--1/8	--1/8	0
	T3	0	--1/8	0	1/4	1/4
	T4	0	0	1/8	1/8	3/8
	T5	0	1/8	3/8	1/2	1/2
	T6	0	1/8	1/8	1/4	3/8
	T7	0	1/8	1/4	3/8	1/2
	T8	0	1/4	1/4	1/2	1/2
Middle	M1	0	1/8	3/8	1/2	1/2
	M2	0	1/8	1/4	1/2	1/2
	M3	0	3/8	5/8	3/4	7/8
	M4	0	1/2	3/4	7/8	7/8
	M5	0	3/8	1/2	3/4	3/4
	M6	0	1/2	5/8	3/4	7/8
	M7	0	1/4	1/2	5/8	5/8
	M8	0	1/4	1/2	1/2	3/4
Bottom	B1	0	1/8	3/8	1/2	-
	B2	0	1/8	3/8	3/8	-
	B3	0	1/8	3/8	3/8	-
	B4	0	1/8	3/8	1/4	-
	B5	0	0	1/4	3/8	-
	B6	0	1/8	3/8	3/8	-
	B7	0	1/8	1/4	3/8	-
	B8	0	1/8	1/4	3/8	-

Note: Post test observations not recorded.

TEST #2 (Continued)
FIRE TEST OBSERVATIONS

L.S. Door opens out of furnace, R.S. Door opens into furnace.

TIME (MIN)	EXPOSED SIDE	UNEXPOSED SIDE
0:00	Timing started upon ignition of lowest row of burners	Door(s) latched, bolt fully extended
0:30	Skins darkening	
1:25	Further darkening, ignition of door skins	
1:45	Full flaming in furnace	Brisk venting at top of doors and upper edges of doors
2:00	Furnace pressure positive at top of doors	
2:30	Negative pressure returned by opening dampers	Venting stopped
3:00	Skins flaming only lightly now	
4:14	Neutral pressure plane reaches 40 in.	Venting at header of R.S. door, mostly at edges of L.S. door
5:30	Doors flaming more intently	Venting
6:00	Skins burned off, core and edges flaming	Venting constant, but not excessive
7:00	Flaming reduced	No change
8:00	Flaming continues	Doors remain flat, no significant warpage
9:00	No change	No change
10:00	No change	Venting continues at headers of both doors and at top hinge of L.S. door
15:00		Slight warpage of wall, doors remain flat and against stops
16:00		Condensate dripping from top of L.S. door
20:00	No change	No change, no flaming has occurred, no burn-through

TEST #2 (Continued)
FIRE TEST OBSERVATIONS (Continued)

BS 476 COTTON PAD TEST		
TIME (MIN)	LOCATION	RESULT
18:00	Top corner of R.S. door in venting stream	No ignition or glowing

TEST #2 (Continued)

HOSE STREAM TEST OBSERVATIONS

Hose Stream Test Duration: 2 minutes, 6 seconds

Time from end of fire test to application of hose stream test: 42 seconds

Observations: Both doors remained closed and latched throughout hose stream test. Some distortion at header of frame of door opening out of furnace.

Criteria: The door shall remain in the opening during the hose stream test. A single swinging door shall not separate more than 1/2 in. at the latch location. There shall be no development of openings anywhere through the assembly. An opening is defined as a through hole in the assembly that can be seen from the unexposed side when viewed from the direction perpendicular to the plan of the assembly at the location of the suspected opening.

Conclusion: Both door/frame assemblies passed hose stream test.

TEST #2 (Continued)

**SUMMARY OF TEST RESULTS
 RELATING TO NFPA 252/UBC 43-2 (1991)**

FIRE TEST	L.S. DOOR (OPENING OUT)	R.S. DOOR (OPENING IN)
Maximum movement of door from door frame	1/8 in.	1/4 in.
Maximum surface temperature rise at 20 min.	34°F 19°C	32°F 18°C
Average surface temperature rise at 20 min.	29°F 16°C	27°F 15°C
Flaming on unexposed side in first 30 min.	None	None
Flaming on unexposed side after 30 min.	None	None
Development of openings	None	None
Did separation at latch location exceed 1/2 in.	No	No
HOSE STREAM TEST		
Did doors remain latched and in the opening	Yes	Yes
Development of through openings - Door and Frame - Frame and Wall	No No	No No
Maximum movement of door from door frame	Not recorded	Not recorded
Did separation at latch location exceed 1/2 in.	No	No

TEST #2 (Continued)

**SUMMARY OF TEST RESULTS
RELATING TO BS 476:PART 20:1987**

FIRE TEST	L.S. DOOR (OPENING OUT)	R.S. DOOR (OPENING IN)
Time; individual unexposed surface temperature rise of 180°C	Did not occur	Did not occur
Time; average unexposed surface temperature rise of 140°C ("insulation failure")	Did not occur	Did not occur
Time; unexposed surface temperature rise of 300°C	Did not occur	Did not occur
Time; cotton pad ignition	None observed	None observed
Did through openings develop	No	No
Did sustained flaming occur on unexposed side	No	No
Time; "integrity" failure	Test duration	Test duration

TEST #3

TEST SAMPLE DESCRIPTION

Product Tested: Hollow metal, rib stiffened and insulated fire doors, mounted in 16 gauge knock down (corners not welded) frames.

Fire Test Duration: 90 min.

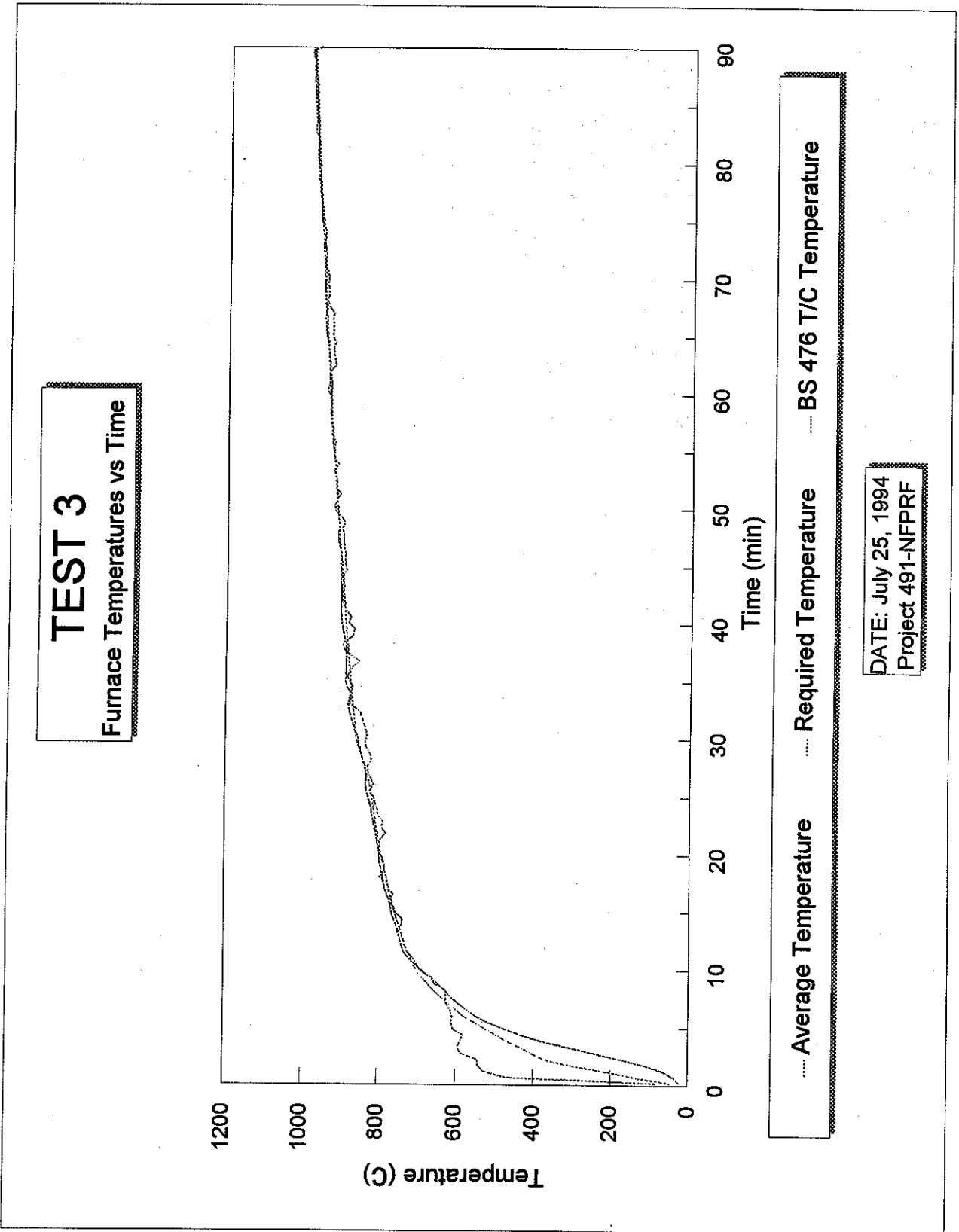
Fire Test Mode: Normally aspirated burners, positive pressure above latch level.

Note: Right side door opens into furnace, left side door opens out of furnace (viewed from unexposed side).

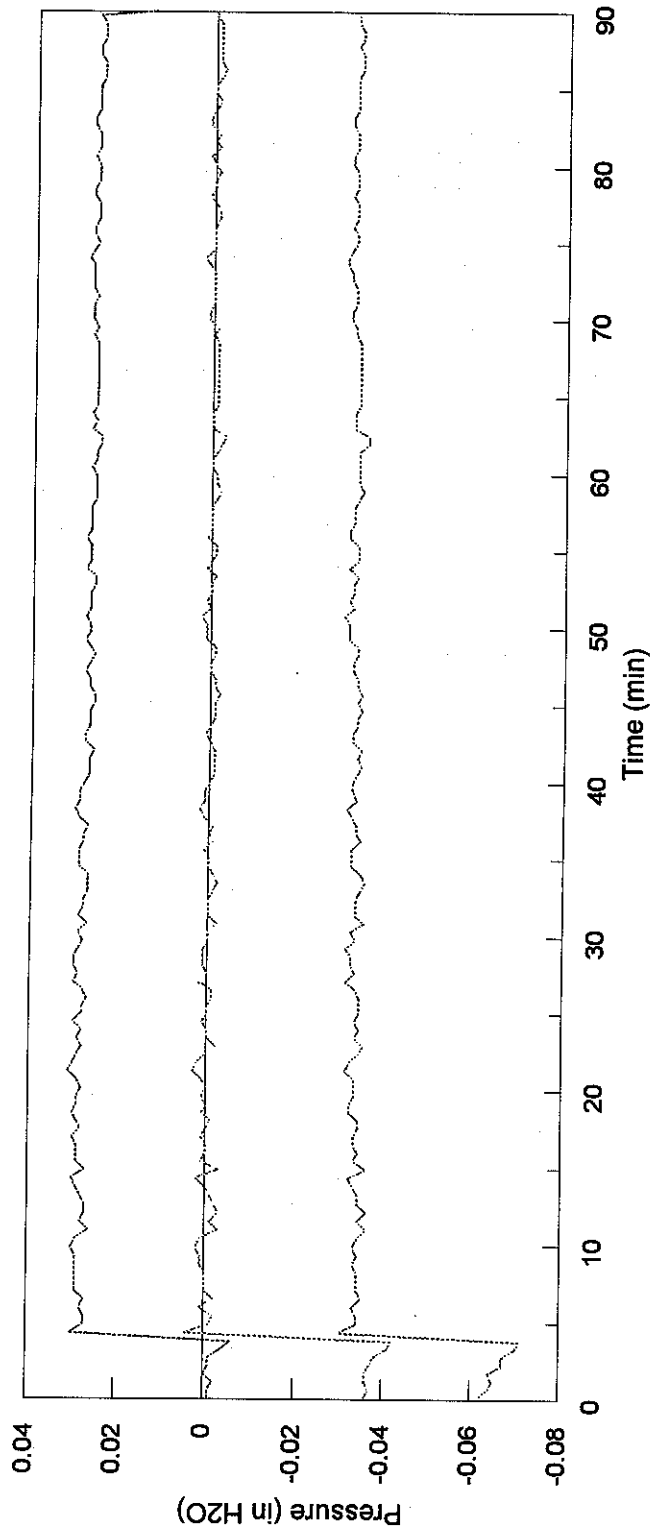
INITIAL CLEARANCES (INCHES)						
	LEFT DOOR			RIGHT DOOR		
	TOP	MIDDLE	BOTTOM	TOP	MIDDLE	BOTTOM
Hinge Edge	3/32	1/8	1/8	3/32	1/8	1/16
Latch Edge	1/8	1/16	1/16	3/32	1/16	1/16
	LEFT	CENTRE	RIGHT	LEFT	CENTRE	RIGHT
Top	1/16	1/16	3/32	1/16	1/16	1/32
Sill	3/8	3/8	3/8	3/8	3/8	3/8

NATURAL GAS CONSUMPTION

$1200 \text{ ft.}^3 \text{ (uncorrected)} \times 5170 \text{ btu/ft.}^3 \text{ (corrected)} = 6,204,000 \text{ btu}$

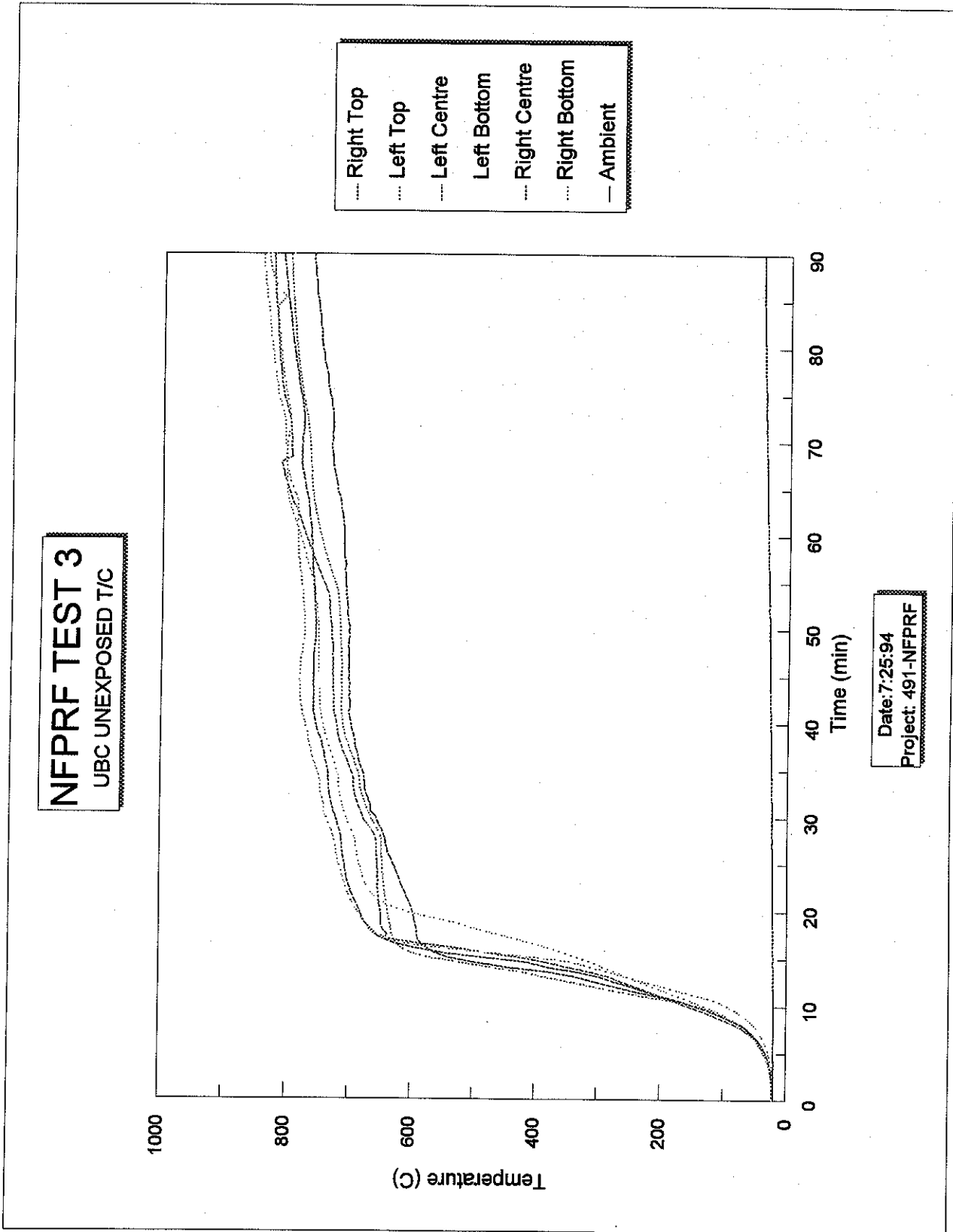


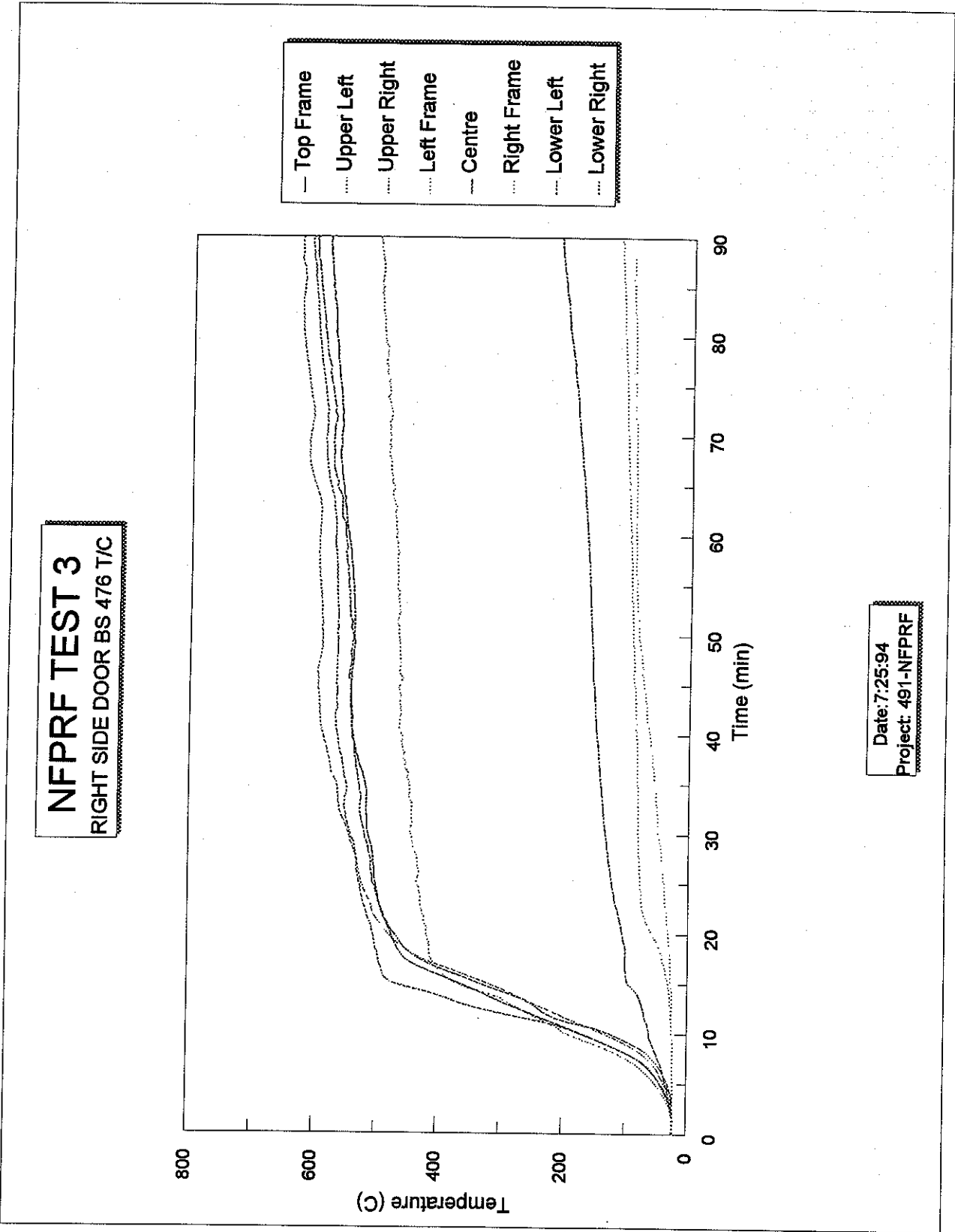
TEST 3
Furnace Pressures

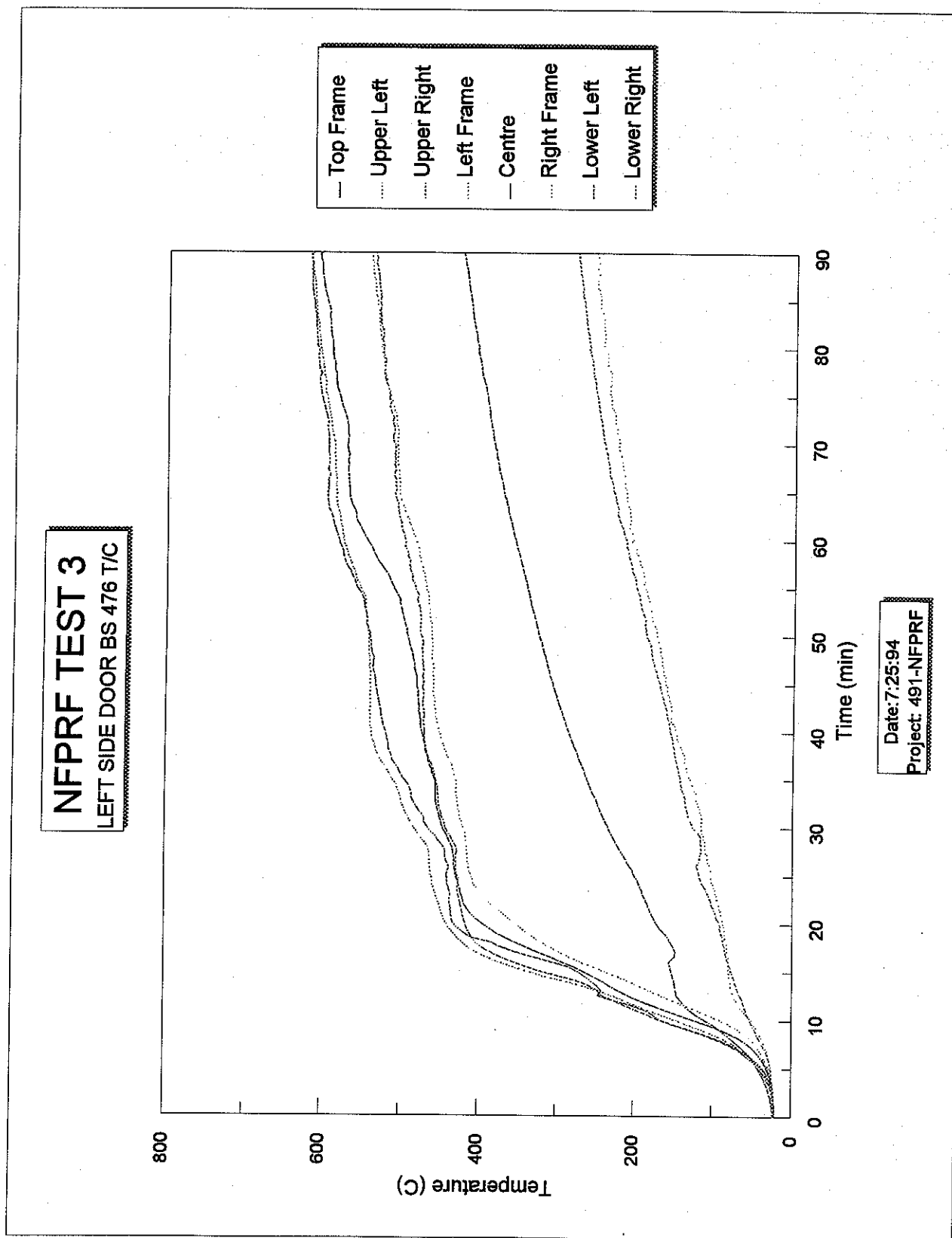


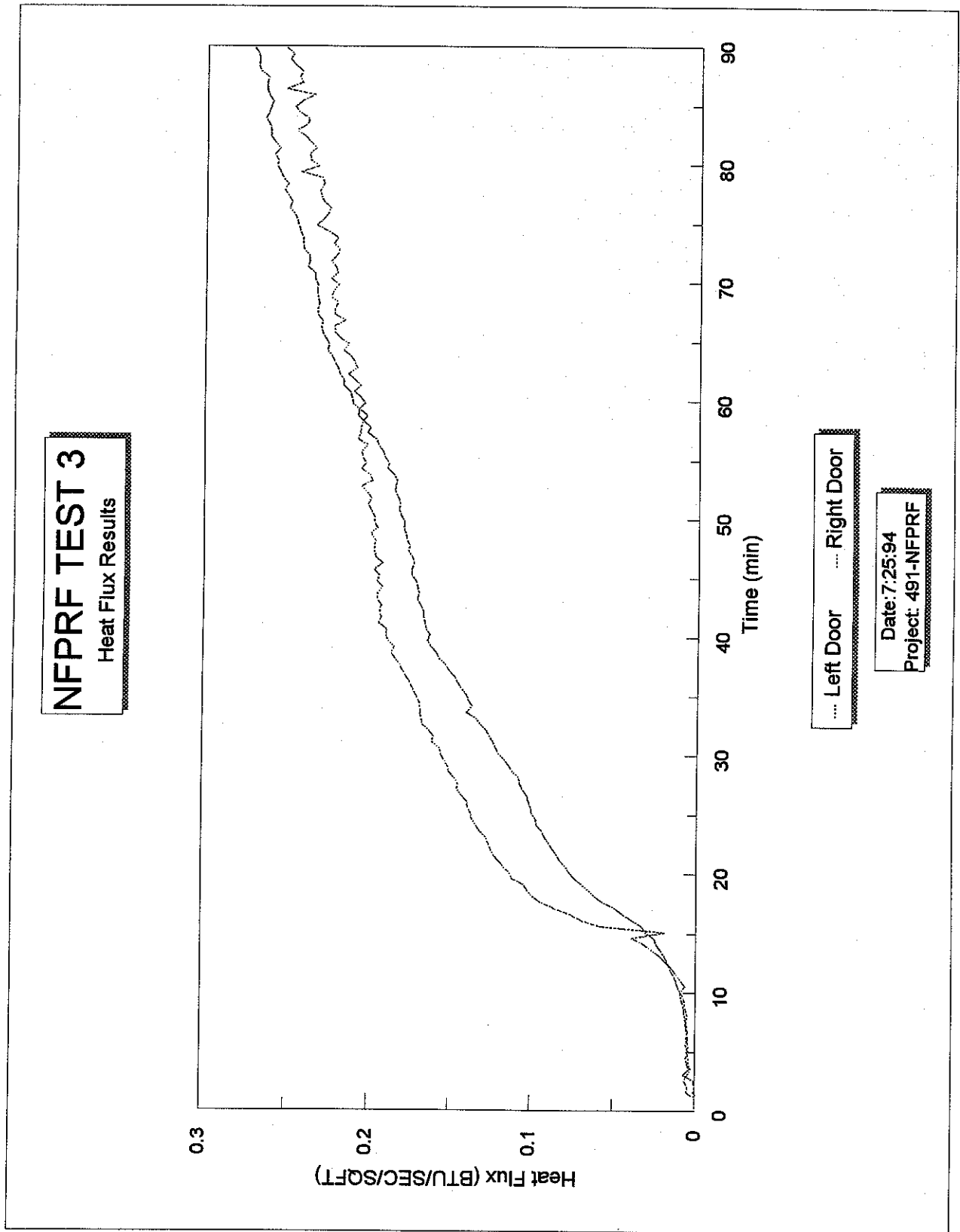
— Header level Pressure Tap ··· 40" level Pressure Tap --- Sill level Pressure Tap

Date: July 25, 1994
Project: 491-NFPRF









TEST #3 (Continued)
DEFLECTION MEASUREMENTS (INCHES)

Data has been adjusted to show 0 in. as initial deflection. Positive direction is towards furnace, negative direction is away from furnace.

Location	Initial	5 min	10 min	15 min	30 min	45 min	60 min	75 min	85 min	Post Test
Top T1	0	1/8	1/8	1/8	3/8	1/2	1	1	5/8	-1/8
T2	0	0	-1/8	0	1/8	0	0	0	1/2	-1/4
T3	0	-1/4	-1/8	0	1/4	0	7/8	1	3/8	-5/8
T4	0	1/4	3/8	1/8	1/2	3/4	1-1/4	1-1/4	7/8	0
T5	0	1/4	1/4	1/2	3/4	7/8	1	1	1	0
T6	0	3/8	3/8	1/2	3/4	7/8	7/8	1	1	1-1/4
T7	0	1/4	1/2	5/8	3/4	7/8	1-1/8	1	1	1/4
T8	0	3/8	1/2	5/8	5/8	3/4	3/4	1	7/8	1/4
Middle M1	0	3/8	1/2	3/4	7/8	1	1-1/8	1-1/8	1-1/8	1/4
M2	0	3/8	5/8	7/8	5/8	1	1-1/8	1-1/4	1-1/8	-1/8
M3	0	7/8	1	1-1/8	1-1/4	1-3/8	1-1/2	1-1/2	1-1/8	-1/8
M4	0	5/8	3/4	1	1-1/8	1-1/4	1-1/4	1-3/8	1-1/4	-1/4
M5	0	5/8	3/4	1	1-1/8	1-1/2	1-1/2	1-1/2	1-1/2	0
M6	0	3/4	7/8	7/8	1-1/2	1-1/2	1-5/8	1-3/4	1-5/8	1/4
M7	0	5/8	3/4	7/8	1-3/8	1-3/8	1-5/8	1-5/8	-	1/8
M8	0	1/8	3/4	3/4	1-3/8	1-3/8	1	1-5/8	7/8	1/8
Bottom B1	0	1/4	3/8	1/2	1/2	3/4	1	1	1	1/8
B2	0	1/8	5/8	1/4	5/8	5/8	3/4	3/4	7/8	3/8
B3	0	-3/8	-1/4	-3/8	-1/8	0	1/8	1/4	1/8	-1/4
B4	0	1/2	1/2	7/8	7/8	7/8	1	1-1/8	1-1/8	1/4
B5	0	3/8	3/8	5/8	5/8	5/8	7/8	1	1-1/8	1/4
B6	0	1/2	1/2	3/4	1	1	1	1-1/8	1-1/2	1-1/8
B7	0	3/8	3/8	1/2	3/4	3/4	3/4	7/8	1	1/2
B8	0	3/8	1/2	5/8	3/4	7/8	7/8	7/8	7/8	1/4

TEST #3 (Continued)
FIRE TEST OBSERVATIONS

L.S. Door opens out of furnace, R.S. Door opens into furnace.

TIME (MIN)	EXPOSED SIDE	UNEXPOSED SIDE
0:00	Timing started upon ignition of lowest row of burners	Door(s) latched, bolt fully extended
1:00		Snapping sounds
1:30	Skins buckling	
2:30		Doors bowing slightly
3:00	More distortion of skins	
4:30	Neutral pressure at 40 in. achieved	Doors bowing more, top corner of L.S. Door deflected out about 1 in.
5:00		Gases venting at tops of doors
6:00		Gases venting strongly at header of R.S. Door
7:00		Gases venting also at centre hinge of R.S. Door, no venting from L.S. Door (opening out)
8:00		
9:00	Skins turning red in centre	Doors are wedging in opening
10:00		Buckling and discoloration at top of both doors
15:00	No change	Door opening out has warped to 1 in. out at bottom, skins turning blue, smoke from UBC pads
20:00		Doors bowing into furnace over 1 in. at centre
25:00		
30:00	Skins glowing orange	Doors resting on sill
35:00		Doors black, conditions are stable

TEST #3 (Continued)
FIRE TEST OBSERVATIONS (Continued)

TIME (MIN)	EXPOSED SIDE	UNEXPOSED SIDE
40:00	No change	No change
45:00		Red glow behind the ISO thermocouple pads
53:00		Weld popped in door
58:00		Weld popped in door
60:00	No change	R.S. Door - door edges turning red in positive pressure zone
65:00		
70:00	Flame on sill - green - from metal from latch	More areas turning colour - edges glowing brighter
75:00		
80:00		Rib pattern visible in door skins
85:00		R.S. Door appears hotter than left side door
90:00		No through openings, no flaming has occurred on fire exposed side

BS 476 COTTON PAD TEST		
TIME	LOCATION	RESULT
5:00	L.S. Door top left corner	No ignition, no charring
18:40	R.S. Door latch side	No ignition
22:00	R.S. Door - field area	Cotton pad ignition - glowing

TEST #3 (Continued)

HOSE STREAM TEST OBSERVATIONS

Hose Stream Test Duration: 2 minutes, 6 seconds

Time from end of fire test to application of hose stream test: 34 seconds

Observations: The header deflected downward on door opening out, door opening remained straight. At end of test doors remain bowed in direction of furnace. Doors remained latched with no excessive separation of doors from frame, nor excessive deflection.

Criteria: The door shall remain in the opening during the hose stream test. A single swinging door shall not separate more than 1/2 in. at the latch location. There shall be no development of openings anywhere through the assembly. An opening is defined as a through hole in the assembly that can be seen from the unexposed side when viewed from the direction perpendicular to the plan of the assembly at the location of the suspected opening.

Conclusion: Both door/frame assemblies passed the hose stream test.

TEST #3 (Continued)

**SUMMARY OF TEST RESULTS
 RELATING TO NFPA 252/UBC 43-2 (1991)**

FIRE TEST	L.S. DOOR (OPENING OUT)	R.S. DOOR (OPENING IN)
Maximum movement of door from door frame stop	1 in.	3/8 in.
Maximum surface temperature rise at 30 min.	1183°F 659°C	1289°F 716°C
Average surface temperature rise at 30 min.	815°F 452°C	886°F 492°C
Flaming on unexposed side in first 30 min.	None	None
Flaming on unexposed side after 30 min.	None	None
Development of openings	None	None
Did separation at latch location exceed 1/2 in.	No	No
HOSE STREAM TEST		
Did doors remain latched and in the opening	Yes	Yes
Development of through openings - Door and Frame - Frame and Wall	No No	No No
Maximum movement of door from door frame stop	.5/8 in.	1-1/4 in.
Did separation at latch location exceed 1/2 in.	No	No

TEST #3 (Continued)

**SUMMARY OF TEST RESULTS
RELATING TO BS 476:PART 20:1987**

FIRE TEST	L.S. DOOR (OPENING OUT)	R.S. DOOR (OPENING IN)
Time; individual unexposed surface temperature rise of 180°C	11:05	11:05
Time; average unexposed surface temperature rise of 140°C ("insulation failure")	10:55	10:03
Time; unexposed surface temperature rise of 300°C	14:56	12:55
Time; cotton pad ignition	None observed	None observed
Did through openings develop	No	No
Did sustained flaming occur on unexposed side	No	No
Time; "integrity" failure	Test duration	Test duration

TEST #4

TEST SAMPLE DESCRIPTION

Product Tested: Hollow metal but with expanded polystyrene foam slab core, in knock down 16 gauge pressed steel frames, fully grouted.

Fire Test Duration: 90 min.

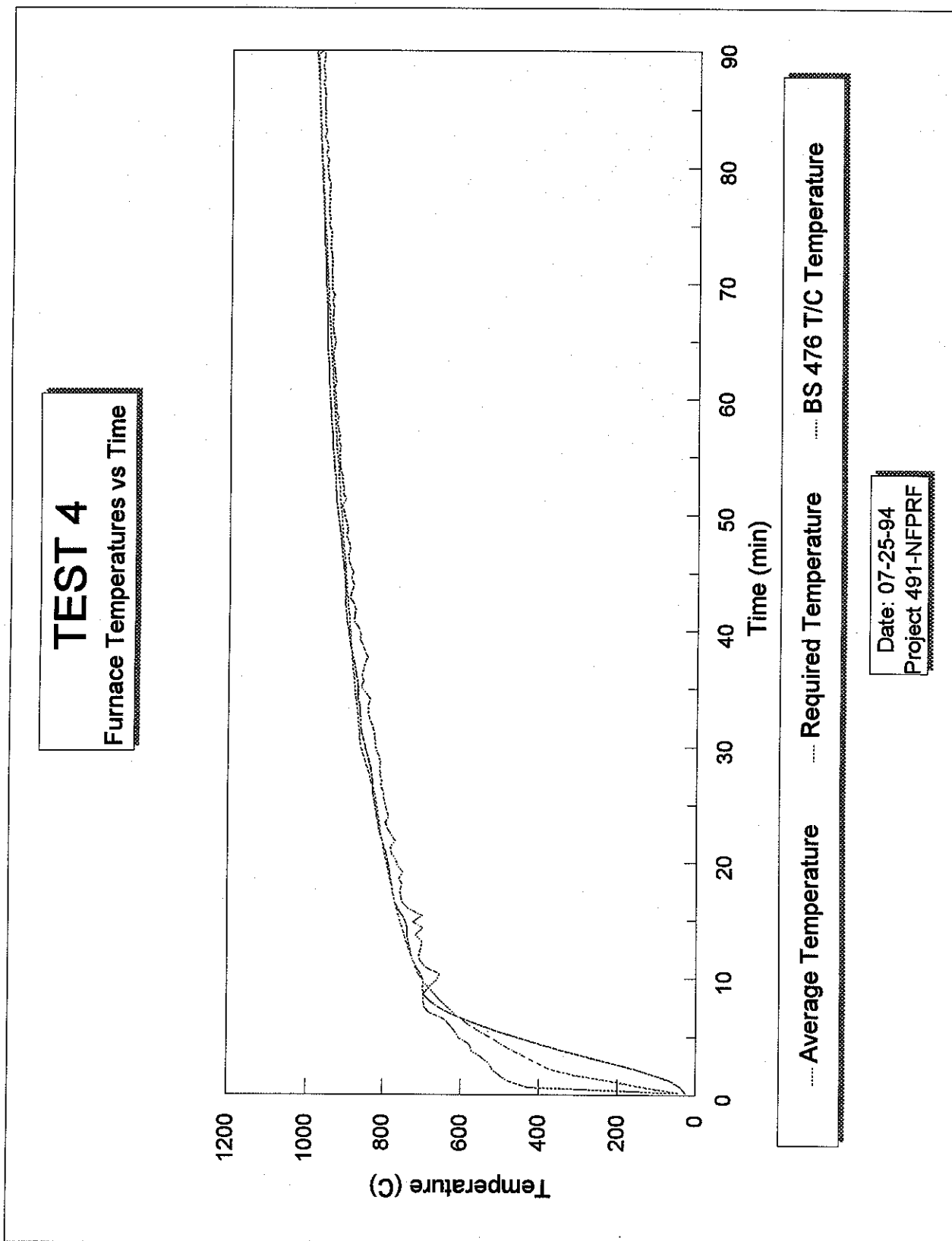
Fire Test Mode: Normally aspirated burners, positive pressure above latch level.

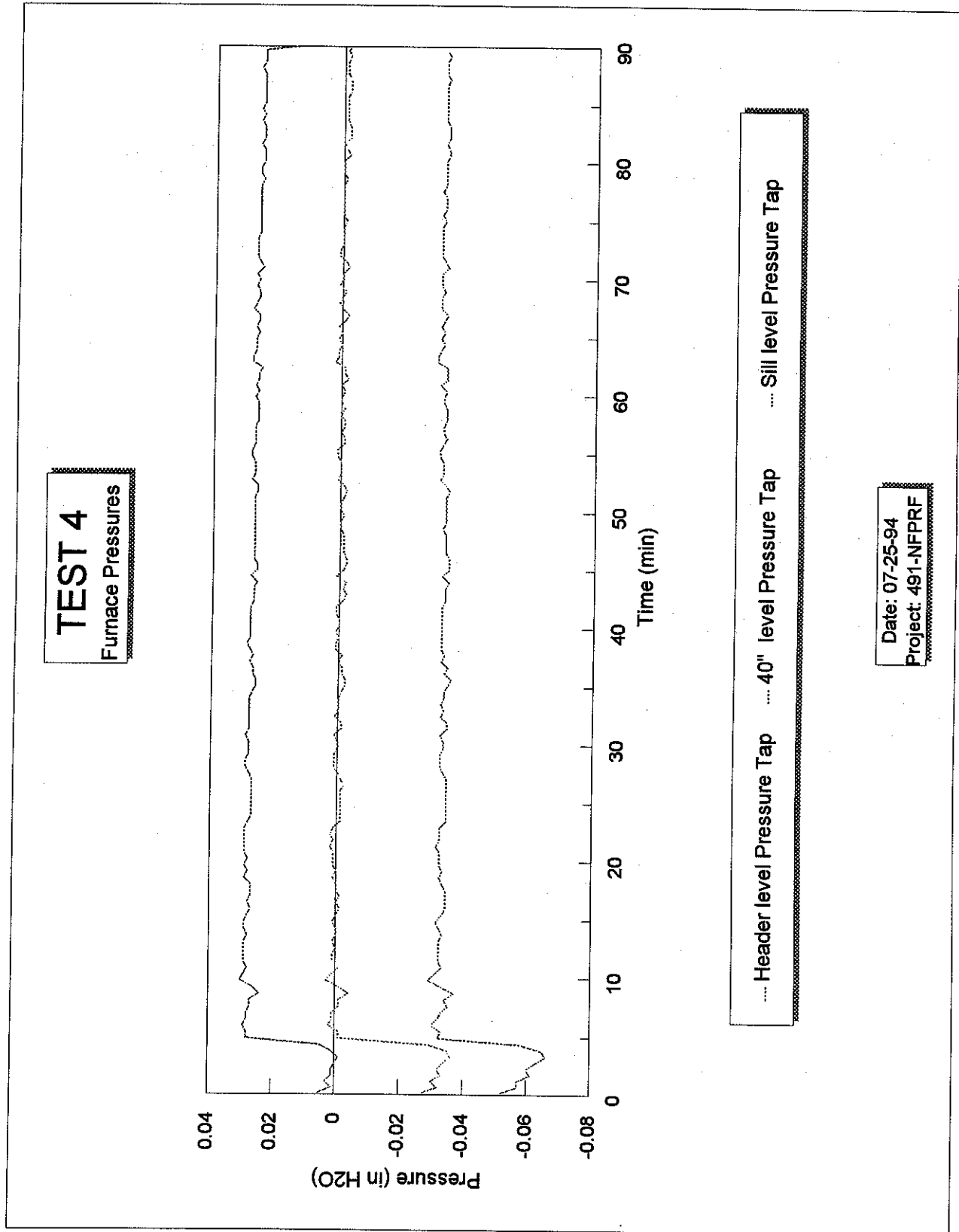
Note: Right side door opens into furnace, left side door opens out of furnace (viewed from unexposed side).

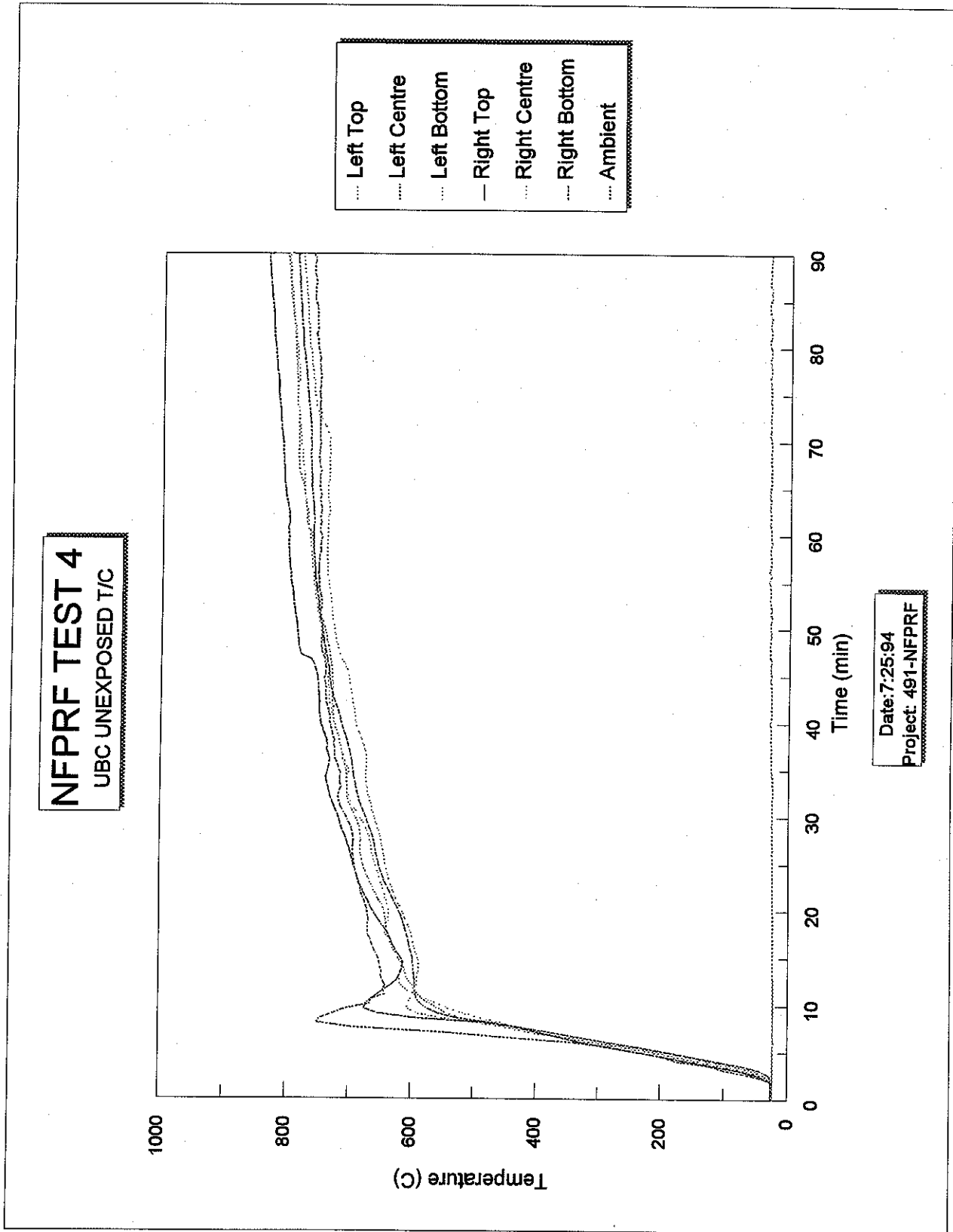
INITIAL CLEARANCES (INCHES)						
	LEFT DOOR			RIGHT DOOR		
	TOP	MIDDLE	BOTTOM	TOP	MIDDLE	BOTTOM
Hinge Edge	1/16	1/16	1/16	1/8	1/8	1/16
Latch Edge	3/16	1/16	1/16	1/16	1/16	1/16
	LEFT	CENTRE	RIGHT	LEFT	CENTRE	RIGHT
Top	1/16	1/16	1/8	1/8	1/16	1/32
Sill	3/8	3/8	3/8	3/8	1/4	3/8

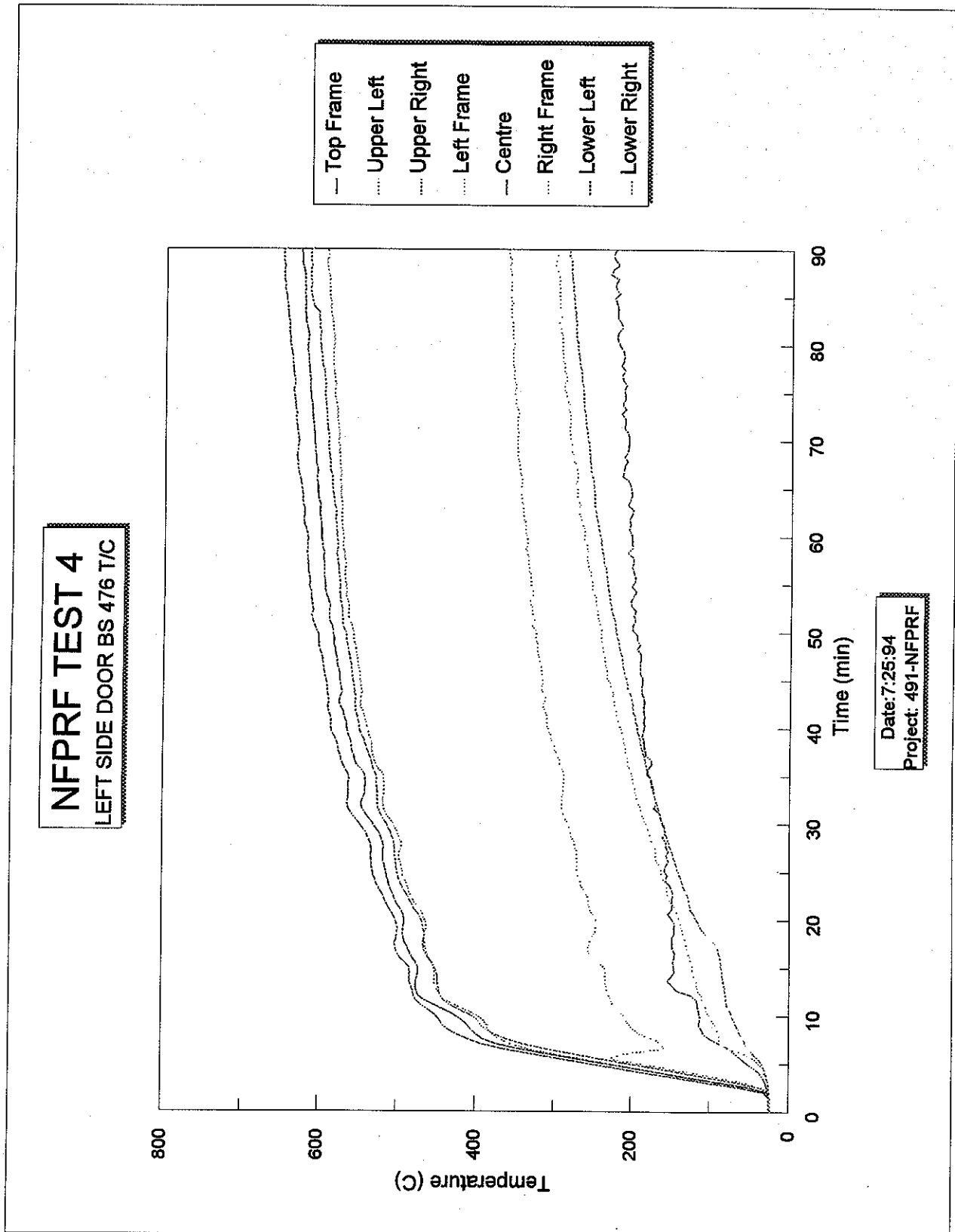
NATURAL GAS CONSUMPTION

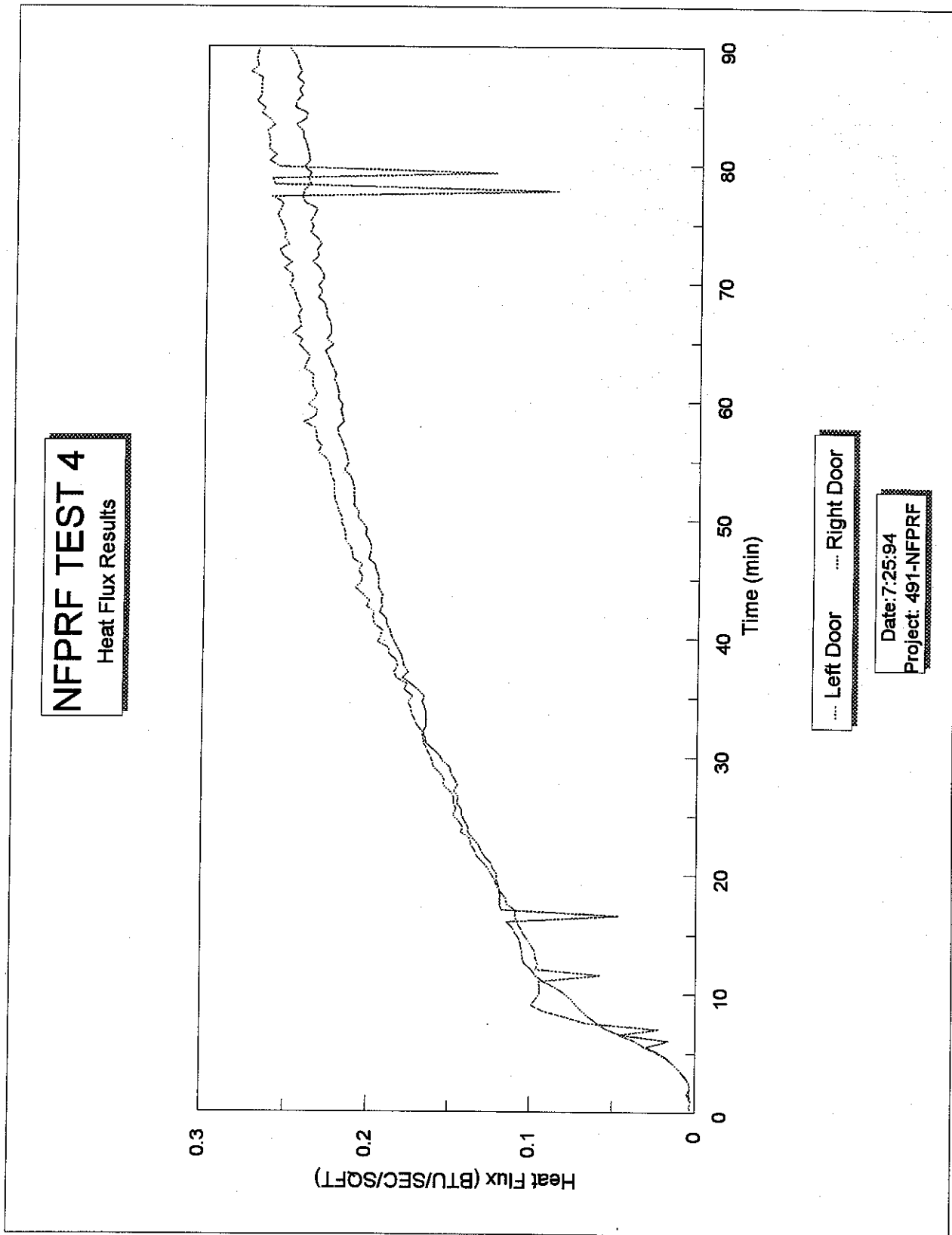
$$1300 \text{ ft.}^3 \text{ (uncorrected)} \times 5170 \text{ btu/ft.}^3 \text{ (corrected)} = 6,721,000 \text{ btu}$$











TEST #4 (Continued)
DEFLECTION MEASUREMENTS (INCHES)

Data has been adjusted to show 0 in. as initial deflection. Positive direction is towards furnace, negative direction is away from furnace.

Location	Initial	5 min	10 min	15 min	30 min	45 min	60 min	75 min	Post Test
Top T1	0	1/8	1/4	3/8	1/2	1/4	1/4	1/4	--1/2
T2	0	1/8	1/2	1/4	3/8	1/4	1/4	1/4	--1/2
T3	0	0	1/4	3/8	5/8	1/2	3/4	3/4	--1-1/2
T4	0	0	1/4	1/4	1/2	5/8	3/4	3/4	0
T5	0	1/4	1/4	1/2	3/4	1	1	1-1/8	1/4
T6	0	0	1/4	1/2	1/2	3/4	1	1	1/8
T7	0	1/4	1/4	1/2	1/2	1/2	3/4	3/4	1/8
T8	0	1/8	1/8	1/8	1/8	1/8	7/8	3/4	0
Middle M1	0	1/4	1/2	5/8	3/4	3/4	1-1/8	7/8	1/8
M2	0	1/2	5/8	3/4	1	1	1	1	--1/8
M3	0	1/2	7/8	1	1-3/8	1-3/8	1-1/2	1-1/2	1/4
M4	0	3/8	5/8	1	1-1/4	1-3/8	1-1/8	1-3/8	5/8
M5	0	1/2	5/8	3/4	1-1/4	1-3/8	1-3/4	1-3/4	1/2
M6	0	1/2	3/4	1	1-3/8	1-1/8	7/8	7/8	3/8
M7	0	3/8	1/2	3/4	7/8	7/8	7/8	7/8	0
M8	0	1/4	3/8	1/2	3/4	1	1-1/8	1-1/8	1/8
Bottom B1	0	1/8	1/4	3/8	5/8	5/8	7/8	5/8	1/4
B2	0	1/8	1/4	1/4	5/8	5/8	3/4	5/8	1/2
B3	0	--1/8	--1/8	1/4	3/8	5/8	5/8	5/8	--1-1/8
B4	0	1/8	1/8	3/8	7/8	3/4	3/4	1-1/8	3/8
B5	0	1/4	1/4	1/2	3/4	1	1-1/4	1-1/4	1/2
B6	0	0	1/4	1/2	3/4	3/4	3/4	1	3/4
B7	0	0	1/4	1/4	1/2	3/4	7/8	3/4	5/8
B8	0	1/4	1/4	3/8	5/8	5/8	3/4	3/4	1/2

TEST #4 (Continued)
FIRE TEST OBSERVATIONS

L.S. Door opens out of furnace, R.S. Door opens into furnace.

TIME (MIN)	EXPOSED SIDE	UNEXPOSED SIDE
0:00	Timing started upon ignition of lowest row of burners	Door(s) latched, bolt fully extended
0:30		
1:00	Slight buckling of skins	
1:30	Skins darkening	Slight movement of L.S. Door top of latch side
2:00	Buckling increasing	
3:00	Gases venting from doors	Doors bowing into furnace
3:21		Puff of smoke at header of L.S. Door
4:00	Ignition of gases at hinge of R.S. Door	More venting
4:30	Neutral pressure at 40 in. achieved	Heavy venting at top of L.S. Door
5:00		Venting to middle hinge L.S. Door
6:45	Flames jetting in at bottom of door	Very heavy venting from both doors, paint smoking from door surface
7:00	Flaming on sill	Venting heavily, L.S. Door but no flaming
8:00	Full flaming due to gases exiting bottom of door burning	Venting at bottom of R.S. Door, door skins discoloured
9:00	Heavy contribution and flaming	Venting much reduced - now mostly from bottom corner of L.S. Door, latch edge of R.S. Door
10:00	Flaming continues	Liquid running down from knobs, venting at top of L.S. Door and from latch
15:00	Flaming reduced, still at bottom of doors	Doors wedged in frames, venting less
20:00	No change	Door skins warped, L.S. Door even, R.S. Door in a wave shape
25:00	No change	Water dripping from header, R.S. Door
30:00	No change	Venting minimal, mostly along door edges
35:00	No change	No venting - doors are wedged in frames

TEST #4 (Continued)
FIRE TEST OBSERVATIONS (Continued)

TIME (MIN)	EXPOSED SIDE	UNEXPOSED SIDE
40:00	Slight flaming at bottom corner of R.S. Door	Conditions stable
45:00	No change	Wall bowing more severely
50:00		
55:00		
60:00	Door knobs glowing and sagging	Door skins glowing red under thermocouple pads
65:00	No flaming	Paint ash falling from door skin
70:00		
75:00		
80:00		
90:00	No change	No through-openings have developed, no flaming has occurred

BS 476 COTTON PAD TEST		
TIME	LOCATION	RESULT
5:00	L.S. Door, top	No ignition
11:30	L.S. Door, top	No ignition
14:00	L.S. Door, top	No ignition

TEST #4 (Continued)

HOSE STREAM TEST OBSERVATIONS

Hose Stream Test Duration: 3 minutes, 26 seconds

Time from end of fire test to application of hose stream test: 39 seconds

Observations: Door/frame assembly opening out of furnace shows severe deflection of frame header and frame header and frame sides, frame has pulled from wire anchors and door is past frame edge at bottom corner. The door/frame assembly opening into furnace remains straight and square. Both doors stayed latched, no development of openings. Door skins still buckled severely.

Criteria: The door shall remain in the opening during the hose stream test. A single swinging door shall not separate more than 1/2 in. at the latch location. There shall be no development of openings anywhere through the assembly. An opening is defined as a through hole in the assembly that can be seen from the unexposed side when viewed from the direction perpendicular to the plan of the assembly at the location of the suspected opening.

Conclusion: Both door/frame assemblies passed the hose stream test.

TEST #4 (Continued)

**SUMMARY OF TEST RESULTS
 RELATING TO NFPA 252/UBC 43-2 (1991)**

FIRE TEST	L.S. DOOR (OPENING OUT)	R.S. DOOR (OPENING IN)
Maximum movement of door from door frame stop	1/2 in.	7/8 in.
Maximum surface temperature rise at 30 min.	1228°F 682°C	1206°F 670°C
Average surface temperature rise at 30 min.	1245°F 692°C	1240°F 689°C
Flaming on unexposed side in first 30 min.	None	None
Flaming on unexposed side after 30 min.	None	None
Development of openings	None	None
Did separation at latch location exceed 1/2 in.	No	No
HOSE STREAM TEST		
Did doors remain latched and in the opening	Yes	Yes
Development of through openings - Door and Frame - Frame and Wall	No	No
	No	No
Maximum movement of door from door frame stop	1-1/2 in.	1/4 in.
Did separation at latch location exceed 1/2 in.	No	No

TEST #4 (Continued)

**SUMMARY OF TEST RESULTS
RELATING TO BS 476:PART 20:1987**

FIRE TEST	L.S. DOOR (OPENING OUT)	R.S. DOOR (OPENING IN)
Time; individual unexposed surface temperature rise of 180°C	4:20	4:20
Time; average unexposed surface temperature rise of 140°C ("insulation failure")	4:01	4:01
Time; unexposed surface temperature rise of 300°C	6:03	6:03
Time; cotton pad ignition	None observed	None observed
Did through openings develop	No	No
Did sustained flaming occur on unexposed side	No	No
Time; "integrity" failure	Test duration	Test duration

TEST #5

TEST SAMPLE DESCRIPTION

Product Tested: Hollow metal, rib stiffened, insulated doors, in knock down 16 gauge pressed steel frames, fully grouted.

Fire Test Duration: 90 min.

Fire Test Mode: Diffusion burners, positive pressure above latch level.

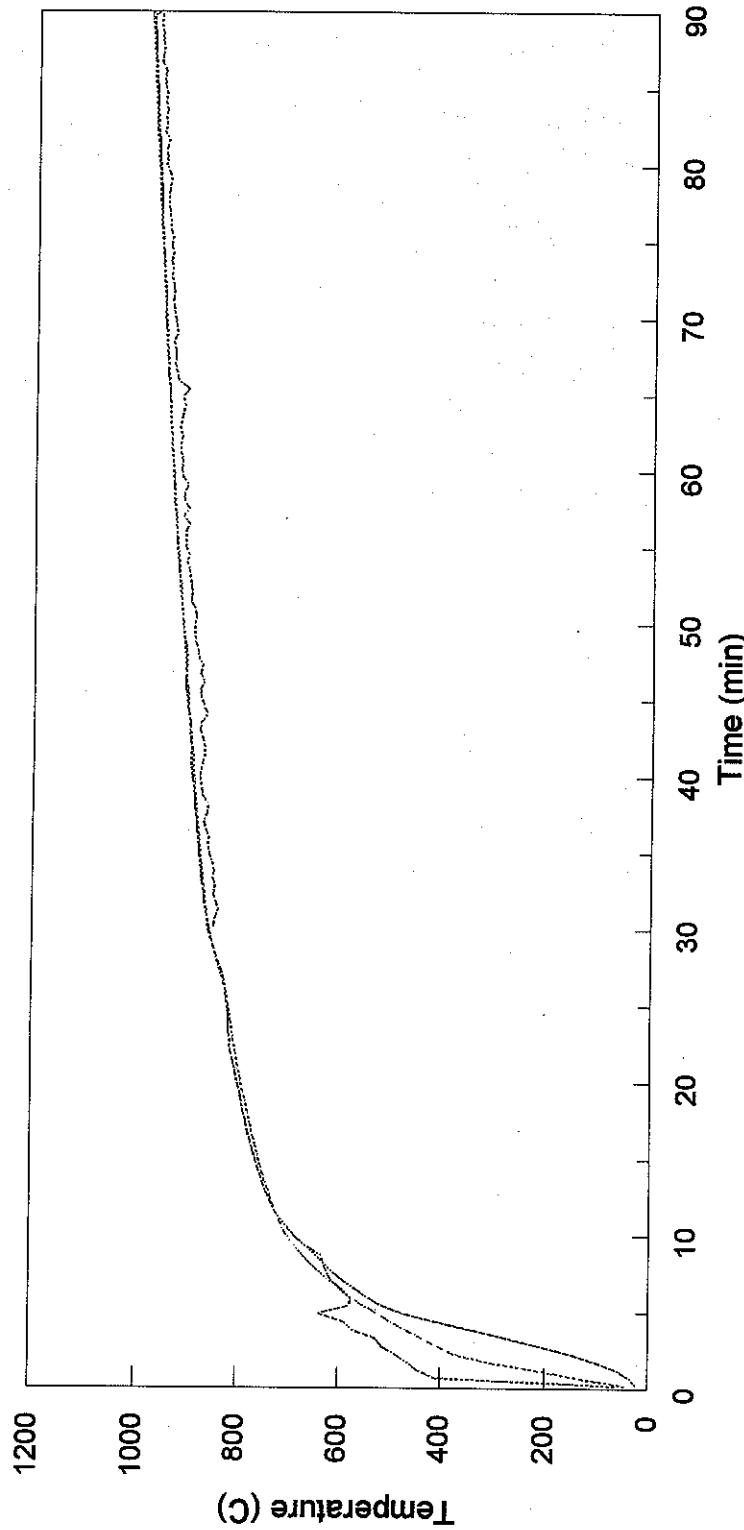
Note: Right side door opens into furnace, left side door opens out of furnace (viewed from unexposed side).

INITIAL CLEARANCES (INCHES)						
	LEFT DOOR			RIGHT DOOR		
	TOP	MIDDLE	BOTTOM	TOP	MIDDLE	BOTTOM
Hinge Edge	3/16	1/8	1/32	3/10	1/8	1/8
Latch Edge	3/16	1/16	1/32	1/8	1/32	1/32
	LEFT	CENTRE	RIGHT	LEFT	CENTRE	RIGHT
Top	1/8	1/8	1/16	1/8	1/8	1/8
Sill	3/8	1/4	3/8	1/4	1/4	1/4

NATURAL GAS CONSUMPTION

$$1300 \text{ ft.}^3 \text{ (uncorrected)} \times 5170 \text{ btu/ft.}^3 \text{ (corrected)} = 5,687,000 \text{ btu}$$

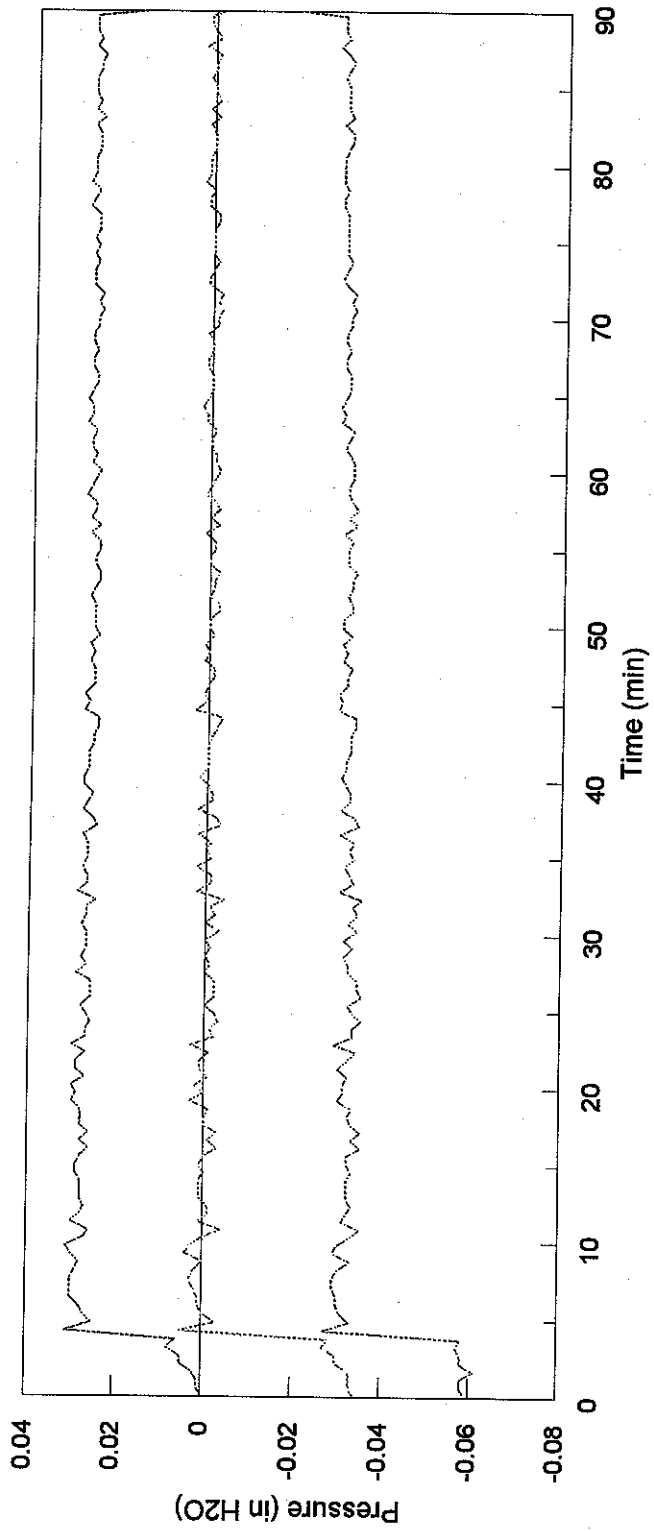
TEST 5
Furnace Temperatures vs Time



..... Average Temperature Required Temperature BS 476 T/C Temperature

Date: 07-26-94
Project 491-NFPRF

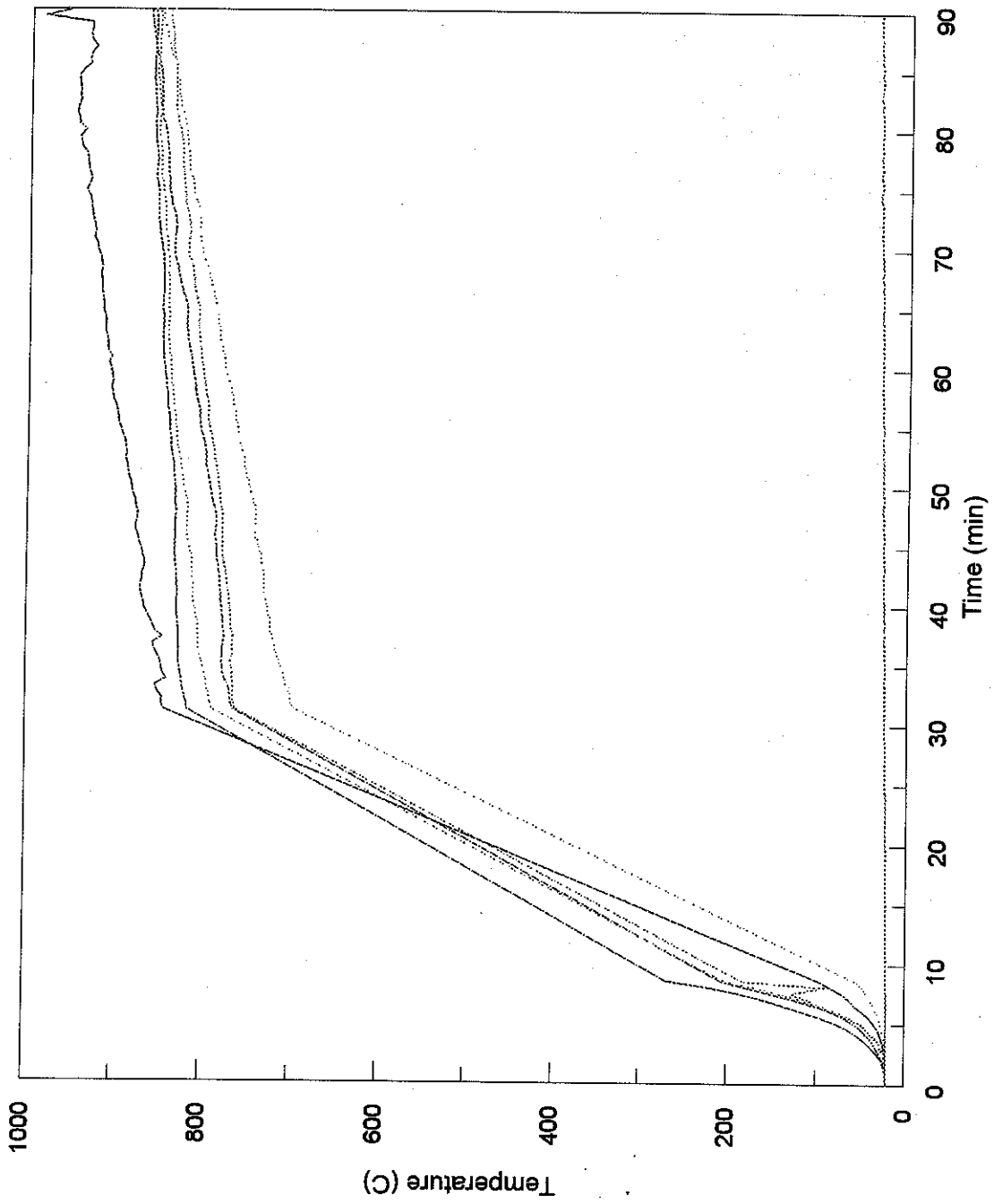
TEST 5
Furnace Pressures



.... Header level Pressure Tap ... 40" level Pressure Tap Sill level Pressure Tap

Date: 07-26-94
Project: 491-NFPRF

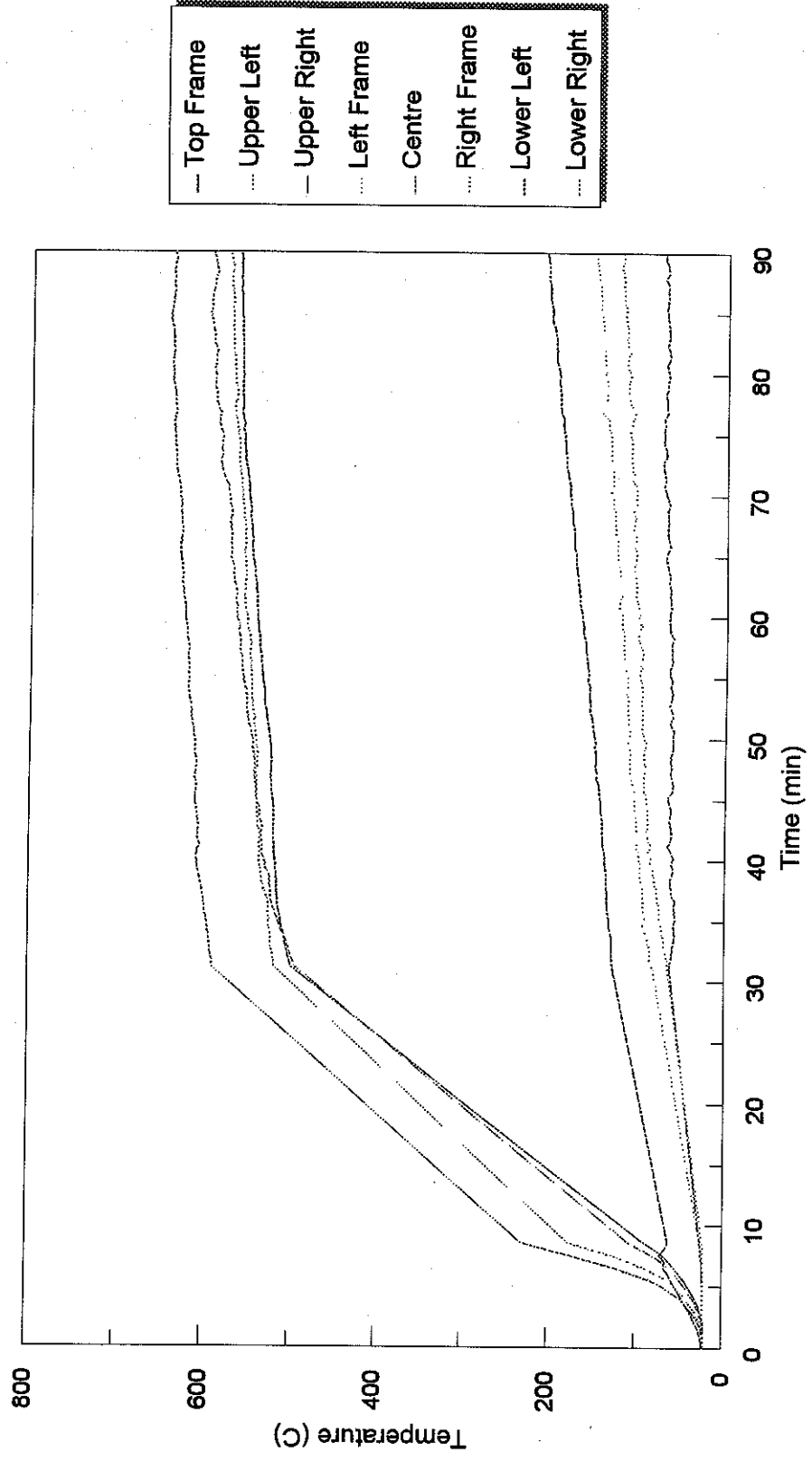
NFPRF TEST 5
UBC UNEXPOSED T/C



- Left Top
- Left Centre
- Left Bottom
- Right Top
- Right Centre
- Right Bottom
- Ambient

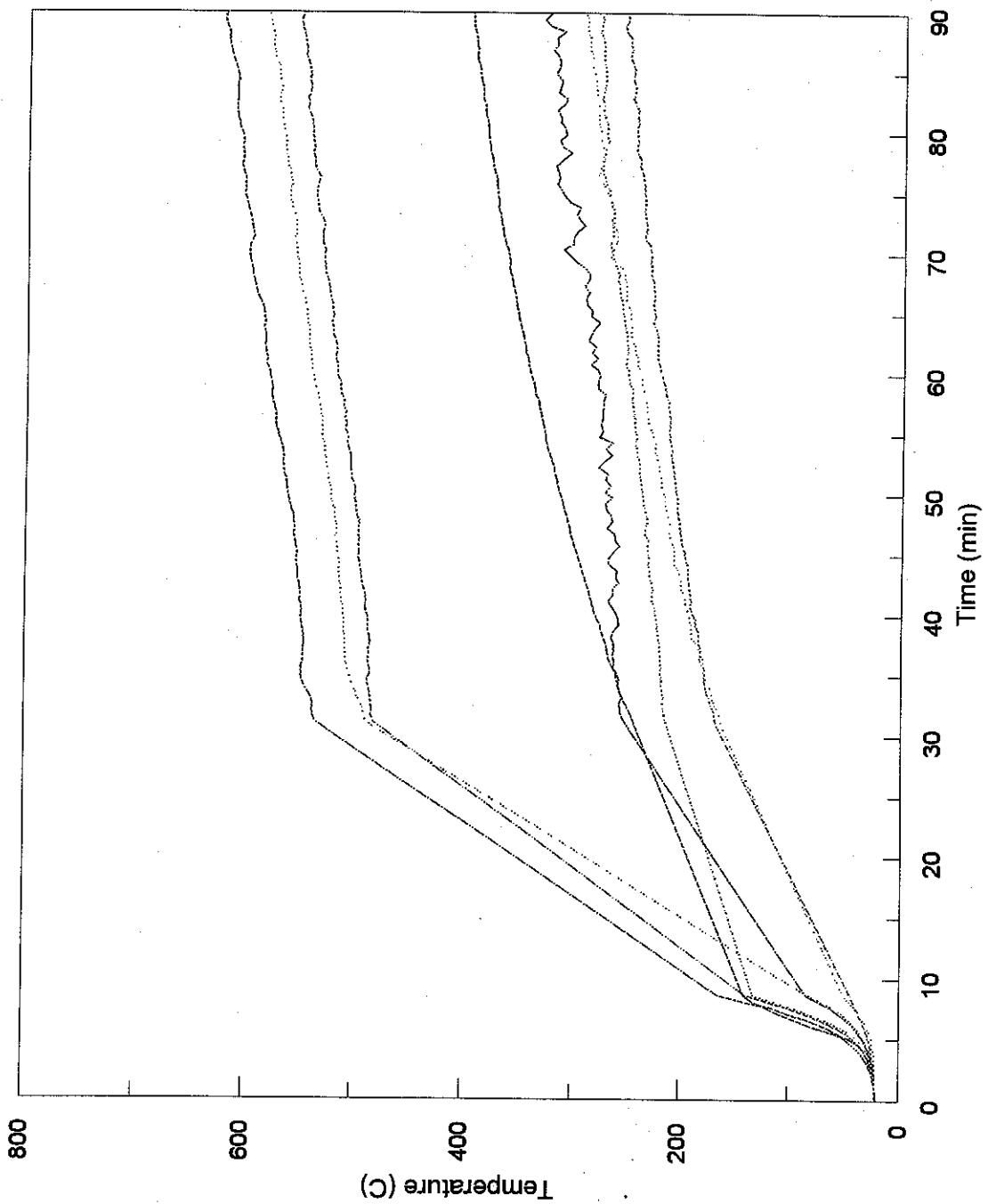
Date: 7:27:94
Project: 491-NFPRF

NFPRF TEST 5
RIGHT SIDE DOOR BS 476 T/C



Date: 7:27:94
Project: 491-NFPRF

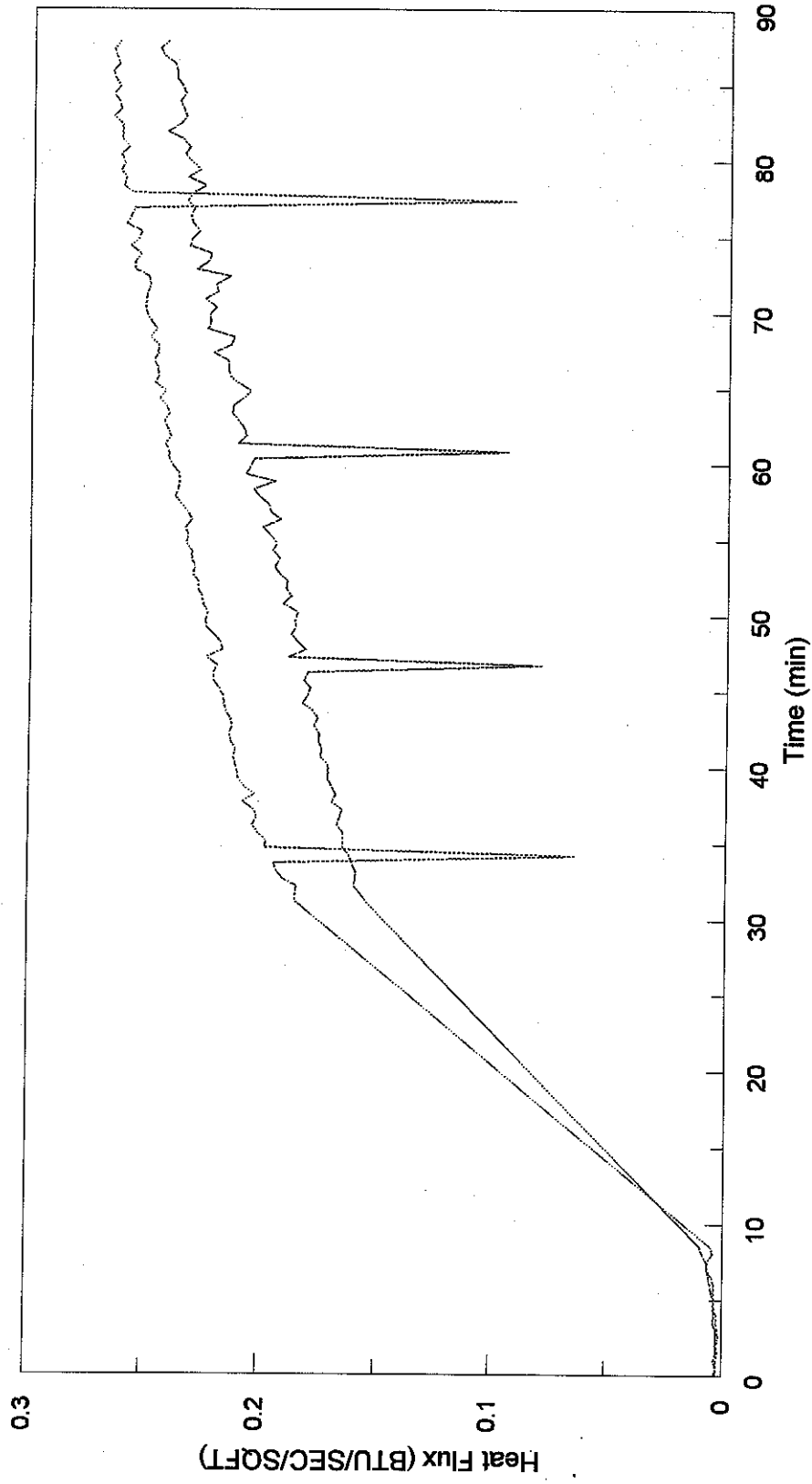
NFPRF TEST 5
LEFT SIDE DOOR BS 476 T/C



— Top Frame
... Upper Left
— Upper Right
... Left Frame
— Centre
... Right Frame
— Lower Left
... Lower Right

Date: 7:27:94
Project: 491-NFPRF

NFPRF TEST 5
Heat Flux Results



--- Left Door Right Door

Date: 7:27:94
Project: 491-NFPRF

TEST #5 (Continued)
DEFLECTION MEASUREMENTS (INCHES)

Data has been adjusted to show 0 in. as initial deflection. Positive direction is towards furnace, negative direction is away from furnace.

Location	Initial	5 min	10 min	15 min	30 min	45 min	60 min	75 min	
Top	T1	0	1/8	1/4	3/8	1/2	1/2	3/4	3/4
	T2	0	0	1/8	1/4	3/8	1/2	7/8	7/8
	T3	0	-1/4	0	1/4	1/4	3/8	1/2	1/2
	T4	0	1/4	3/8	5/8	5/8	3/4	7/8	1
	T5	0	1/4	1/2	5/8	7/8	1-1/8	1	1
	T6	0	1/8	1/8	1/2	3/4	7/8	7/8	1-1/8
	T7	0	1/4	1/2	5/8	5/8	7/8	7/8	1
	T8	0	1/8	3/8	3/8	5/8	3/4	1/2	3/4
Middle	M1	0	3/8	1	7/8	1	1	1-1/8	1-1/4
	M2	0	3/8	5/8	7/8	1	1	1-1/8	1-1/4
	M3	0	3/4	3/4	1-1/4	1-5/8	1-3/4	1-7/8	2-1/8
	M4	0	1/2	7/8	1-1/4	1-1/4	1-1/2	1 1/2	1-3/4
	M5	0	5/8	1	1-3/8	1-3/8	1-3/8	1-7/8	1-7/8
	M6	0	3/4	1-1/8	1-1/2	1-3/4	2-3/8	2-1/8	2-1/8
	M7	0	1/4	5/8	7/8	1-1/8	1-1/8	1-1/4	1-3/8
	M8	0	1/4	5/8	3/4	7/8	1	1-1/4	1-1/8
Bottom	B1	0	1/8	3/8	1/4	5/8	5/8	3/4	7/8
	B2	0	-1/8	0	0	1/4	3/8	1/2	1/2
	B3	0	-5/8	-5/8	-1/2	0	0	0	1/2
	B4	0	0	1/4	3/8	3/4	3/4	1	1
	B5	0	1/8	1/2	5/8	7/8	7/8	1-1/8	1-1/8
	B6	0	1/8	3/8	-1/8	1/8	3/4	3/8	1-1/4
	B7	0	1/8	-1/8	1/4	3/8	1/2	5/8	3/4
	B8	0	1/8	1/4	1/4	1/2	5/8	5/8	3/4

Note: Post test deflection measurements not recorded.

TEST #5 (Continued)
FIRE TEST OBSERVATIONS

L.S. Door opens out of furnace, R.S. Door opens into furnace.

TIME (MIN)	EXPOSED SIDE	UNEXPOSED SIDE
0:00	Timing started upon ignition of lowest row of burners	Door(s) latched, bolt fully extended
0:30	Fire very bright, luminous	
1:00		
1:30	Doors bowing	
2:00		
2:45	Large "pop" sound	
3:00	Flames luminous, using up back wall to full height	More "pop" sounds, slight deflection of doors
4:33	Neutral pressure plane 40 in. above sill achieved	Venting, most at hinge side of R.S. Door
5:00	Door skins warped to about 2 in., discolouration patterns	Top corner of L.S. Door moving out from stop
6:00		
7:00		
8:00	Data recording failure	Venting at top edges of R.S. Door, no venting of L.S. Door
9:00		Discolouration at top of doors, rib pattern showing
10:00		Doors bowing
15:00	Skins black in colour	L.S. Door about 1 in. from stop at bottom corner
20:00	Conditions stable	
25:00		
31:30	Data recording commences	Doors wedged in openings, resting on sills
35:00		

TEST #5 (Continued)
FIRE TEST OBSERVATIONS (Continued)

TIME (MIN)	EXPOSED SIDE	UNEXPOSED SIDE
40:00		R.S. Door remains against stop on latch side top and bottom corners
45:00		Door skins glowing under UBC thermocouple pads and at top of doors - ribs visible
50:00		
55:00	Flaming material from latch on sill	Door skins glowing dull red, rib pattern visible for full length of doors
60:00		
65:00		
70:00	Gassing from door knob	No change
75:00		
90:00	No change	No through-openings, no flaming has occurred

BS 476 COTTON PAD TEST		
TIME	LOCATION	RESULT
8:00	R.S. Door, top	No glowing or ignition
11:28	L.S. Door, top	No glowing or ignition
18:43	Centre of R.S. Door	Pad ignition

TEST #5 (Continued)

HOSE STREAM TEST OBSERVATIONS

Hose Stream Test Duration: 3 minutes, 24 seconds

Time from end of fire test to application of hose stream test: 47 seconds

Observations: Distortion of L.S. frame (opening out) evident almost immediately. Door opening into furnace remains straight. Sections of block surface falling from wall. Doors remain closed and latched.

Criteria: The door shall remain in the opening during the hose stream test. A single swinging door shall not separate more than 1/2 in. at the latch location. There shall be no development of openings anywhere through the assembly. An opening is defined as a through hole in the assembly that can be seen from the unexposed side when viewed from the direction perpendicular to the plan of the assembly at the location of the suspected opening.

Conclusion: Both doors passed the hose stream test.

TEST #5 (Continued)

**SUMMARY OF TEST RESULTS
 RELATING TO NFPA 252/UBC 43-2 (1991)**

FIRE TEST	L.S. DOOR (OPENING OUT)	R.S. DOOR (OPENING IN)
Maximum movement of door from door frame	1/2 in.	1/4 in.
Maximum surface temperature rise at 30 min.	1431°F 795°C	1449°F 805°C
Average surface temperature rise at 30 min.	1406°F 781°C	1385°F 769°C
Flaming on unexposed side in first 30 min.	None	None
Flaming on unexposed side after 30 min.	None	None
Development of openings	None	None
Did separation at latch location exceed 1/2 in.	No	No
HOSE STREAM TEST		
Did doors remain latched and in the opening	Yes	Yes
Development of through openings - Door and Frame - Frame and Wall	No No	No No
Maximum movement of door from door frame	Not recorded	Not recorded
Did separation at latch location exceed 1/2 in.	No	No

TEST #5 (Continued)

**SUMMARY OF TEST RESULTS
RELATING TO BS 476:PART 20:1987**

FIRE TEST	L.S. DOOR (OPENING OUT)	R.S. DOOR (OPENING IN)
Time; individual unexposed surface temperature rise of 180°C	Est. 15 min.*	Est. 15 min.*
Time; average unexposed surface temperature rise of 140°C ("insulation failure")	Est 12 min.*	Est. 12 min.*
Time; unexposed surface temperature rise of 300°C	Not observed*	Not observed
Time; cotton pad ignition	None observed	None observed
Did through openings develop	No	No
Did sustained flaming occur on unexposed side	No	No
Time; "integrity" failure	Test duration	Test duration

*Data not available from 8:53 to 30 minutes due to equipment fault.

TEST #6

TEST SAMPLE DESCRIPTION

Product Tested: Hollow metal but with expanded polystyrene foam slab core, in knock down 16 gauge pressed steel frames, fully grouted.

Fire Test Duration: 90 min.

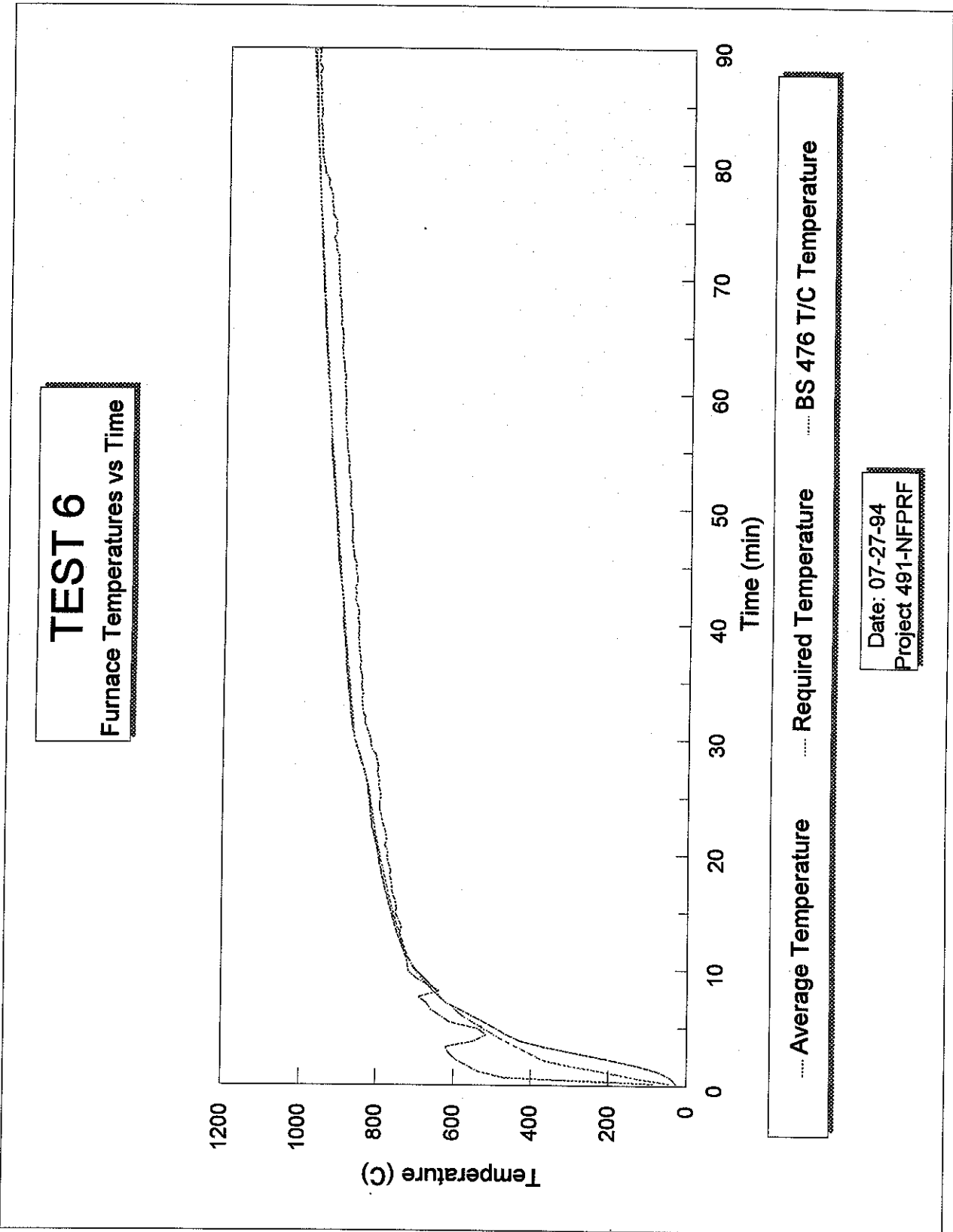
Fire Test Mode: Diffusion burners, positive pressure above latch level.

Note: Right side door opens into furnace, left side door opens out of furnace (viewed from unexposed side).

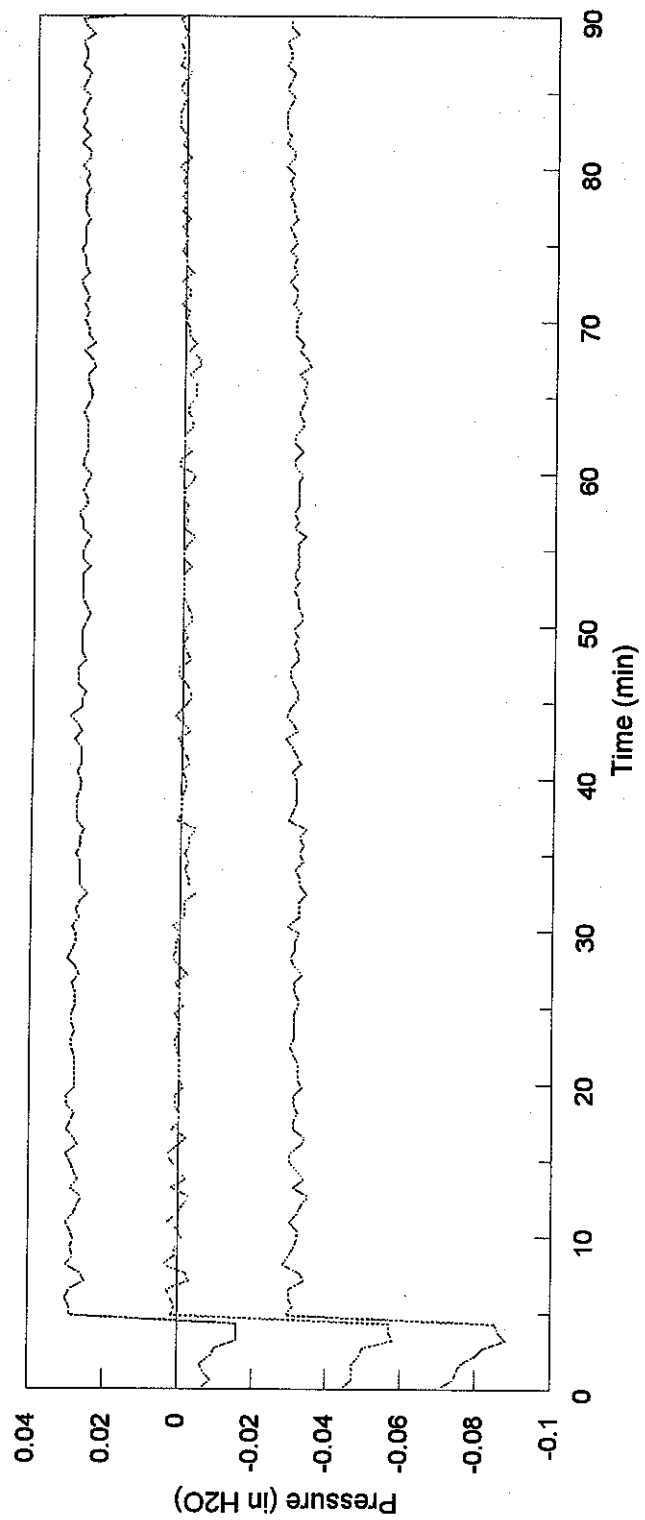
INITIAL CLEARANCES (INCHES)						
	LEFT DOOR			RIGHT DOOR		
	TOP	MIDDLE	BOTTOM	TOP	MIDDLE	BOTTOM
Hinge Edge	1/8	1/16	1/32	1/8	1/8	1/16
Latch Edge	1/8	1/32	1/32	1/8	1/32	1/32
	LEFT	CENTRE	RIGHT	LEFT	CENTRE	RIGHT
Top	1/8	1/8	1/32	1/8	1/8	1/32
Sill	3/8	3/8	3/8	3/8	3/8	3/8

NATURAL GAS CONSUMPTION

$1300 \text{ ft.}^3 \text{ (uncorrected)} \times 5170 \text{ btu/ft.}^3 \text{ (corrected)} = 5,170,000 \text{ btu}$

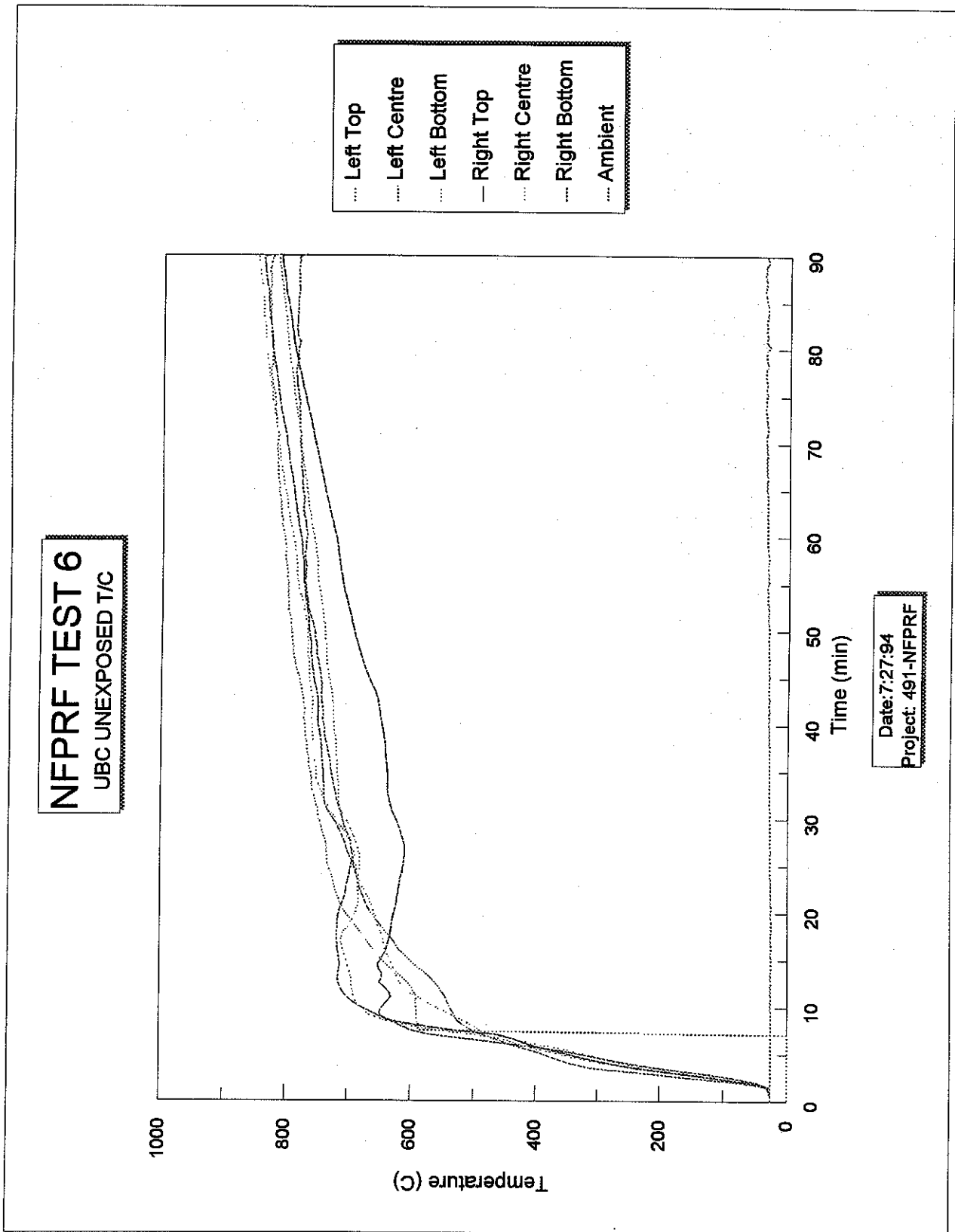


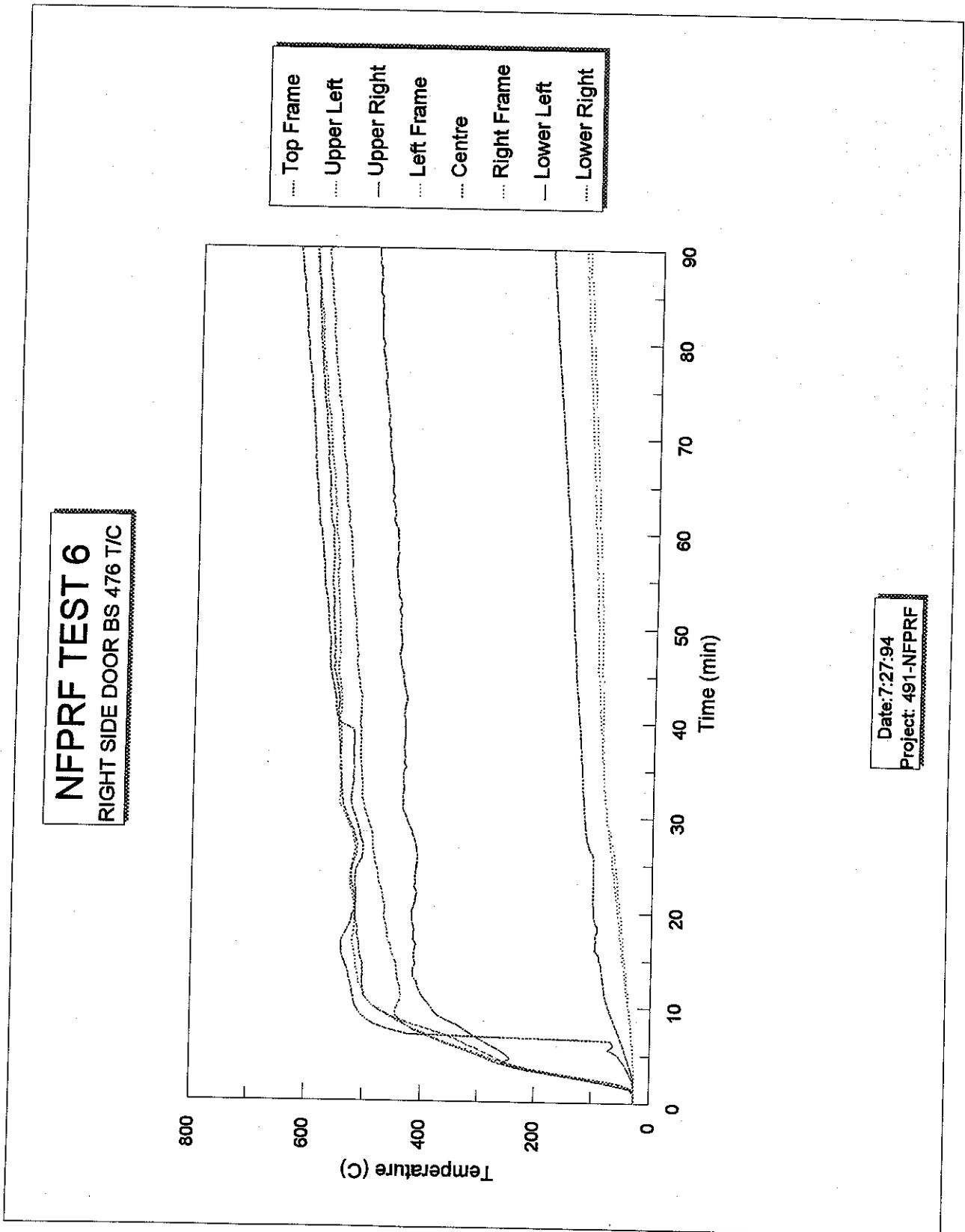
TEST 6
Furnace Pressures

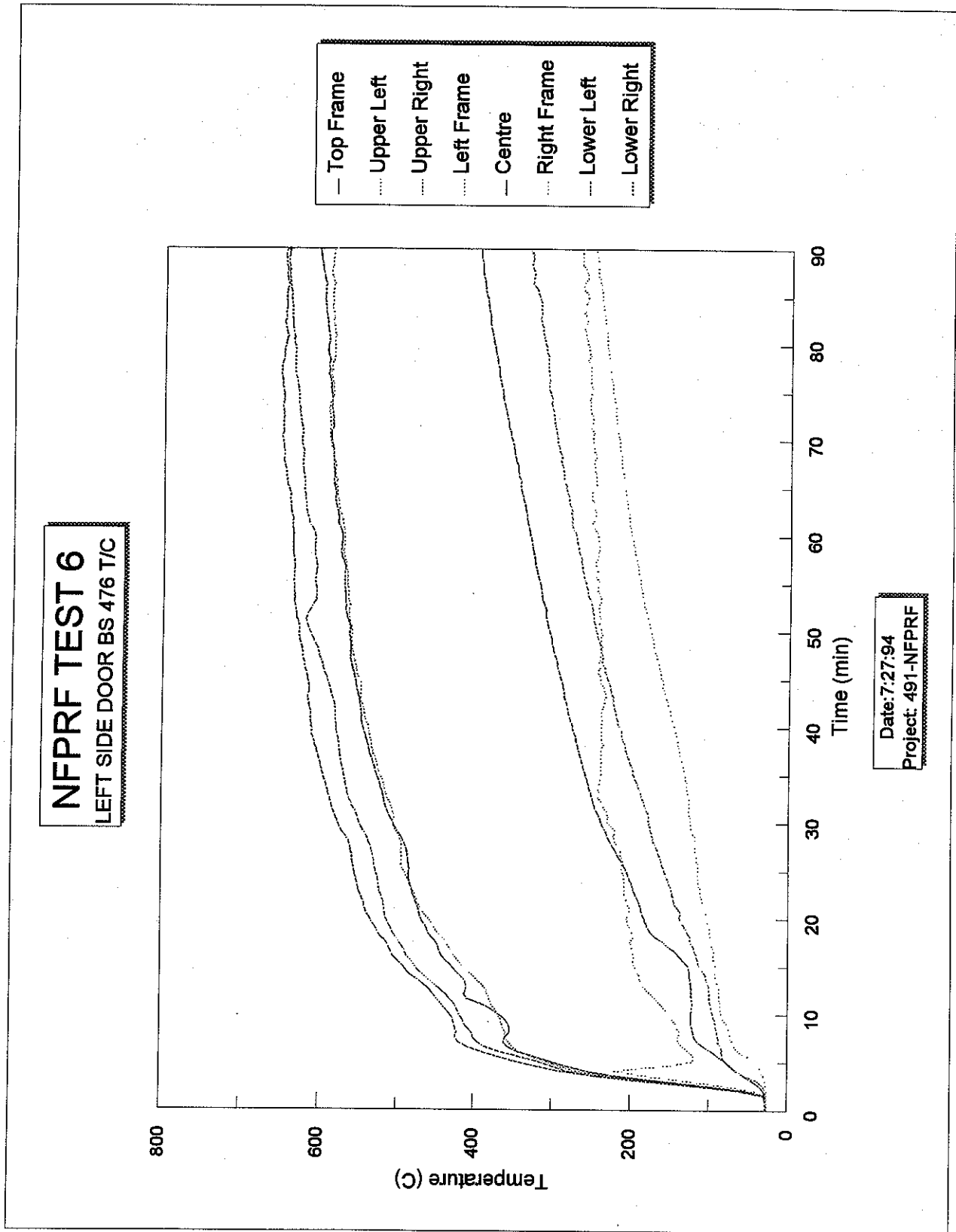


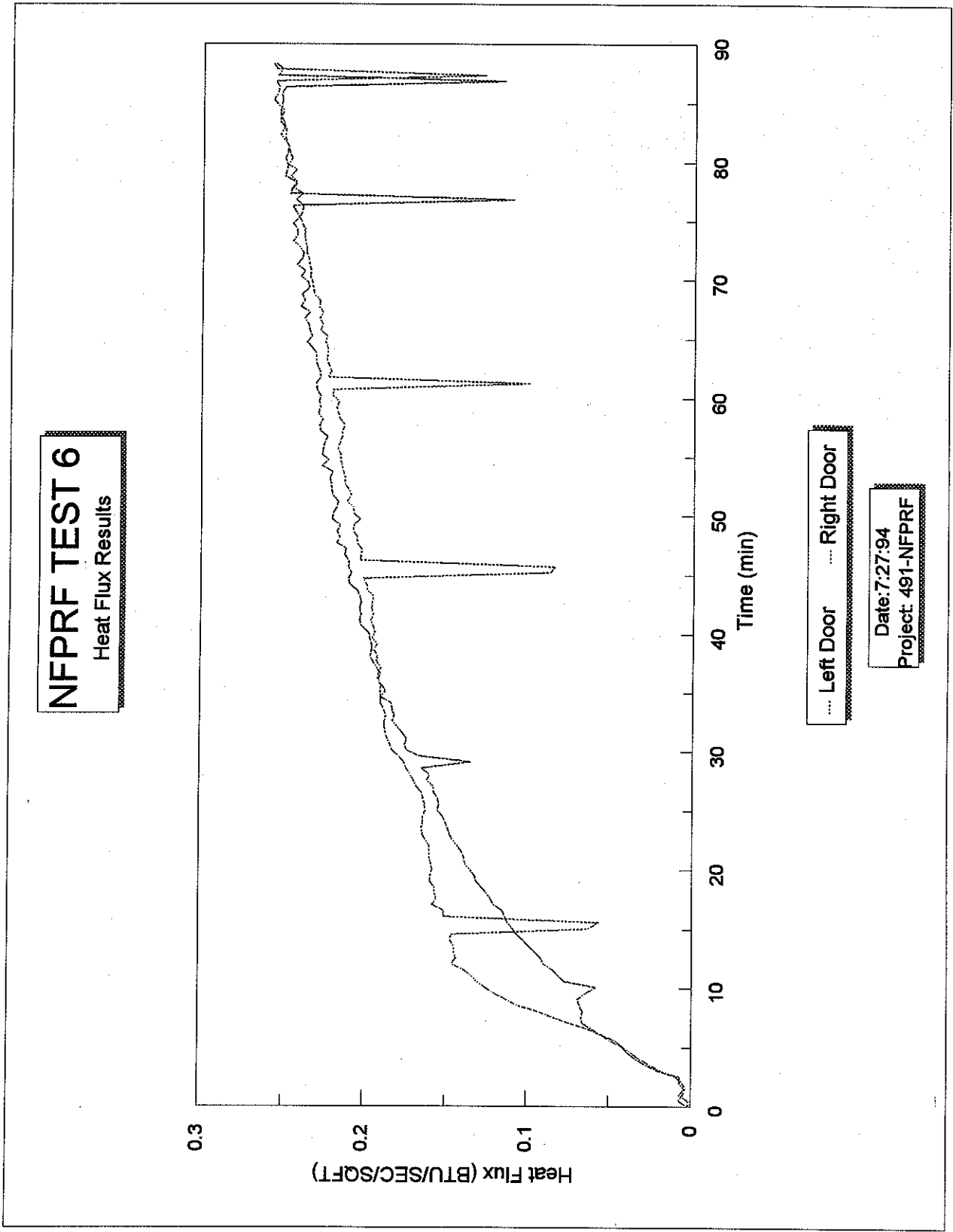
.... Header level Pressure Tap - - - 40" level Pressure Tap ... Sill level Pressure Tap

Date: 07-27-94
Project: 491-NFPRF









TEST #6 (Continued)
DEFLECTION MEASUREMENTS (INCHES)

Data has been adjusted to show 0 in. as initial deflection. Positive direction is towards furnace, negative direction is away from furnace.

Location	Initial	5 min	10 min	15 min	30 min	45 min	60 min	75 min	90 min	Post Test
Top T1	0	0	1/8	1/8	1/8	1/4	3/8	1/4	1/4	0
T2	0	-1/8	0	0	0	1/8	1/8	1/8	1/8	0
T3	0	-1/8	-1/8	-1/8	3/8	1/8	1/8	1/4	3/8	-1/8
T4	0	-1/8	-1/8	0	1/8	1/4	3/8	3/8	3/8	0
T5	0	1/8	1/8	1/8	1/4	5/8	5/8	5/8	5/8	1/8
T6	0	0	0	1/4	3/8	1/2	5/8	7/8	5/8	1
T7	0	1/8	1/8	3/8	5/8	7/8	7/8	1-1/8	1-1/8	3/4
T8	0	0	0	1/8	1/2	5/8	1/2	3/4	1	1/2
Middle M1	0	1/8	3/8	1/2	1/2	5/8	5/8	3/4	3/4	1/2
M2	0	1/8	1-4	3/8	1/2	1/2	1/2	5/8	5/8	1/4
M3	0	5/8	5/8	5/8	3/4	3/4	3/4	7/8	7/8	-1/4
M4	0	3/8	1/2	7/8	3/4	3/4	3/4	7/8	7/8	3/8
M5	0	1/4	5/8	5/8	7/8	1-1/8	1-1/8	1-1/8	1-1/4	3/4
M6	0	5/8	3/4	7/8	1	1	1-1/8	1-1/8	1-1/8	5/8
M7	0	1/4	1/4	5/8	3/4	3/4	7/8	1-1/4	1	5/8
M8	0	1/8	1/4	1/2	5/8	7/8	7/8	1	1	3/4
Bottom B1	0	-3/8	-3/8	-3/8	-3/8	-1/8	-1/4	0	-1/4	-1/8
B2	0	-1/8	-1/8	-1/8	-1/8	0	0	1/8	1/8	0
B3	0	-1/4	1/8	-1/4	-1/4	1/4	1-4	1/4	1/4	-3/4
B4	0	1/8	1/8	1/4	1/8	3/8	1/2	5/8	5/8	5/8
B5	0	0	1/4	0	1/2	5/8	1/2	5/8	3/4	1
B6	0	1/4	5/8	3/8	3/4	3/4	7/8	7/8	3/4	1-1/2
B7	0	1/8	1/2	3/8	5/8	3/4	3/4	3/4	3/4	1-1/4
B8	0	0	1/4	1/4	1/2	1/2	5/8	5/8	5/8	1

TEST #6 (Continued)
FIRE TEST OBSERVATIONS

L.S. Door opens out of furnace, R.S. Door opens into furnace.

TIME (MIN)	EXPOSED SIDE	UNEXPOSED SIDE
0:00	Timing started upon ignition of lowest row of burners	Door(s) latched, bolt fully extended
0:30		
1:00	Snapping sounds, buckling of skins	No change
1:30	Flaming of paint	
2:00		
2:30		Doors bowing into furnace, smoke from paint venting at top, mostly from L.S. Door
3:00	No contribution yet	
4:52	Neutral pressure at 40 in. above sill achieved	
5:00	Liquid plastic running out of bottom of doors onto sill	Venting heavily at top of doors and edges, skins darkening and smoking
6:17	Ignition of plastic liquid on sills of both doors	
7:00	Brisk flaming	Venting at sills, L.S. Door venting heavier than R.S. Door
8:00	Liquid remains on sill	Venting from latches and at top of L.S. door and at edges in positive pressure zone
9:00	Flaming lightly at door sills	Doors bowing more and turning white
10:00	No change	Venting continues
11:00	Liquid plastic is bubbling on sills	Liquid plastic has run out on unexposed side of sills and hardened
15:00	Flaming jets out bottom of doors	Very little venting from R.S. Door
20:00	Soot and ash circulating above sill	Slight venting of L.S. Door, mostly at latch and centre hinge

TEST #6 (Continued)
FIRE TEST OBSERVATIONS (Continued)

TIME (MIN)	EXPOSED SIDE	UNEXPOSED SIDE
30:00	Severe buckling of L.S. Door at latch, flaming at corners of sill	Conditions stable, no venting R.S. Door
35:00	Paint residue on skins white in colour	Doors resting on sills, plastic remains on sills
40:00		Doors resting on sills, plastic remains on sills
45:00		
50:00		
55:00		
60:00	No change	No change
65:00	Knobs melted off of L.S. Door	Doors remain close to stops in frame
70:00		
75:00		Paint flaking off door surface
90:00	No change	No change, no flaming has occurred, no through-openings developed

BS 476 COTTON PAD TEST		
TIME	LOCATION	RESULT
4:11	L.S. Door, top right hand corner	No ignition
6:26	L.S. Door, top right hand corner	No ignition
9:00	L.S. Door, top right hand corner	No ignition
13:52	L.S. Door, top right hand corner	No ignition
17:36	Middle top R.S. Door	No ignition

TEST #6 (Continued)

HOSE STREAM TEST OBSERVATIONS

Hose Stream Test Duration: 3 minutes, 30 seconds

Time from end of fire test to application of hose stream test: 42 seconds

Observations: L.S. Frame distortion evident as per prior tests. Both doors have moved from stops about 1 in. especially top corner of door opening out of furnace. Door skins severely buckled.

Criteria: The door shall remain in the opening during the hose stream test. A single swinging door shall not separate more than 1/2 in. at the latch location. There shall be no development of openings anywhere through the assembly. An opening is defined as a through hole in the assembly that can be seen from the unexposed side when viewed from the direction perpendicular to the plan of the assembly at the location of the suspected opening.

Conclusion: Both door/frame assemblies passed hose stream test.

TEST #6 (Continued)

**SUMMARY OF TEST RESULTS
 RELATING TO NFPA 252/UBC 43-2 (1991)**

FIRE TEST	L.S. DOOR (OPENING OUT)	R.S. DOOR (OPENING IN)
Maximum movement of door from door frame	3/8 in.	1/8 in.
Maximum surface temperature rise at 30 min.	1298°F 721°C	1254°F 698°C
Average surface temperature rise at 30 min.	1310°F 728°C	1240°F 689°C
Flaming on unexposed side in first 30 min.	None	None
Flaming on unexposed side after 30 min.	None	None
Development of openings	None	None
Did separation at latch location exceed 1/2 in.	No	No
HOSE STREAM TEST		
Did doors remain latched and in the opening	Yes	Yes
Development of through openings - Door and Frame - Frame and Wall	No No	No No
Maximum movement of door from door frame	1 in.	1 in.
Did separation at latch location exceed 1/2 in.	No	No

TEST #6 (Continued)

**SUMMARY OF TEST RESULTS
RELATING TO BS 476:PART 20:1987**

FIRE TEST	L.S. DOOR (OPENING OUT)	R.S. DOOR (OPENING IN)
Time; individual unexposed surface temperature rise of 180°C	3:25	3:20
Time; average unexposed surface temperature rise of 140°C ("insulation failure")	3:00	3:00
Time; unexposed surface temperature rise of 300°C	5:52	4:52
Time; cotton pad ignition	None observed	None observed
Did through openings develop	No	No
Did sustained flaming occur on unexposed side	No	No
Time; "integrity" failure	Test duration	Test duration

TEST #7

TEST SAMPLE DESCRIPTION

Product Tested: Hollow metal but with expanded polystyrene foam slab core, in knock down 16 gauge pressed steel frames, fully grouted.

Fire Test Duration: 90 min.

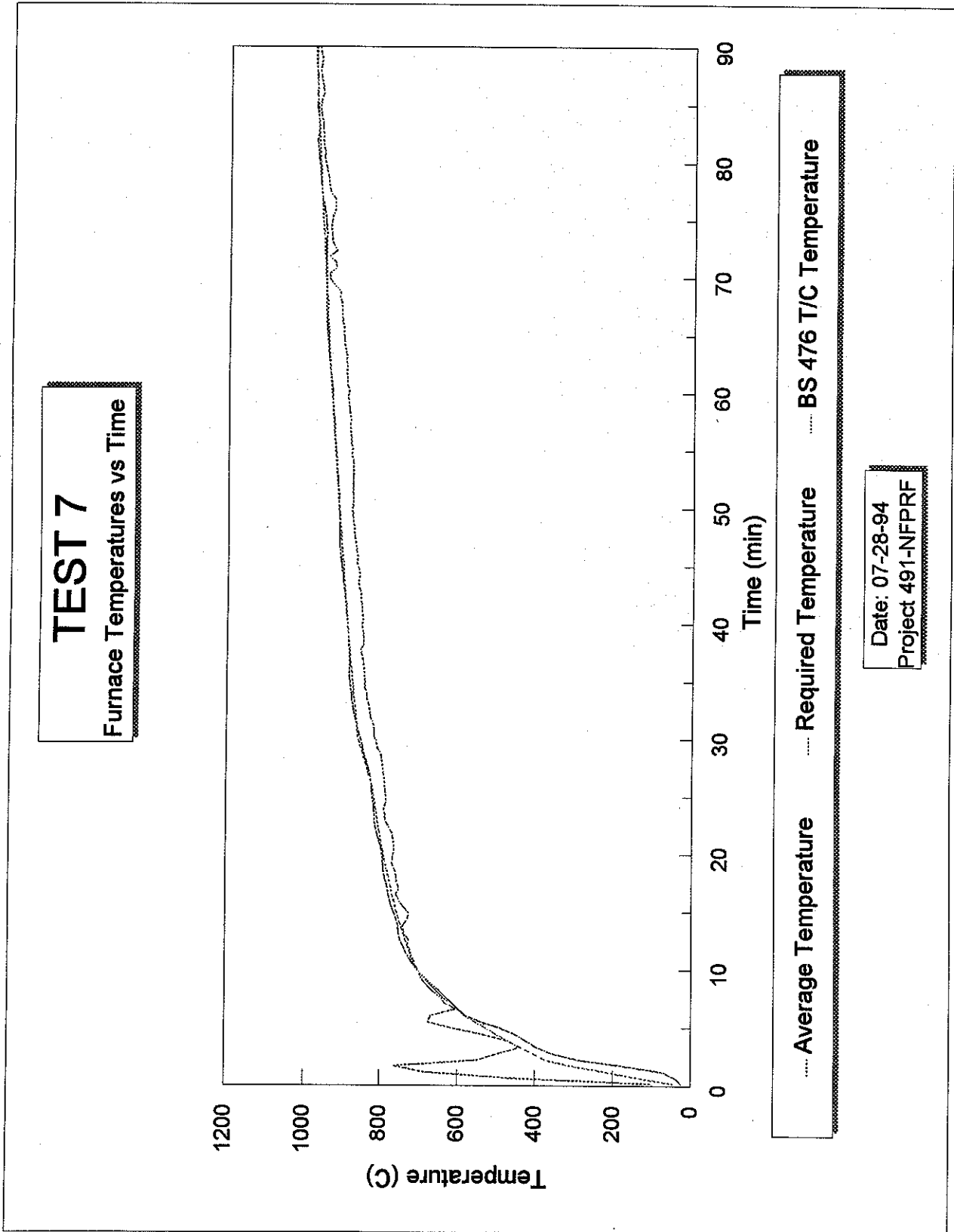
Fire Test Mode: Diffusion burners, positive pressure above latch level.

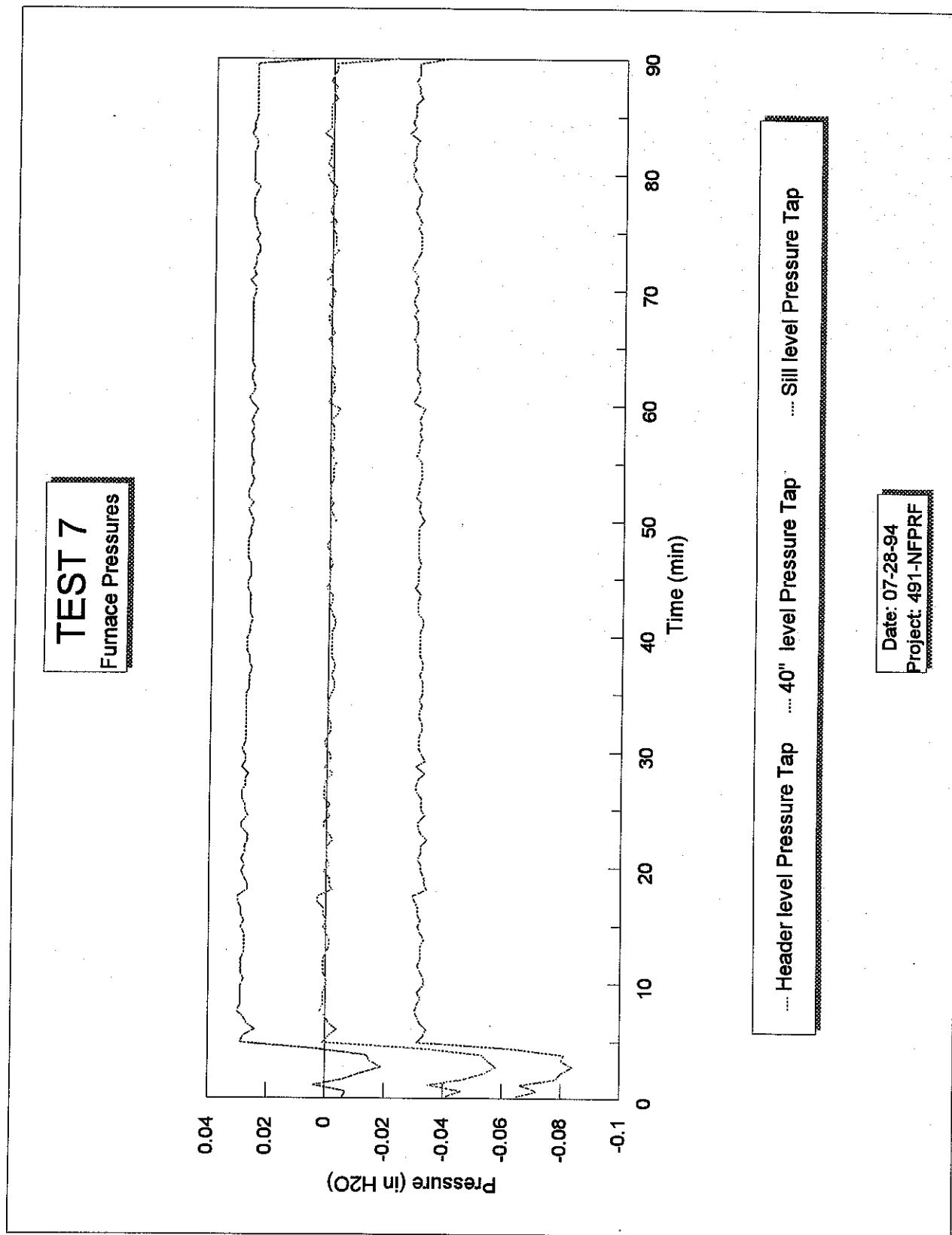
Note: Right side door opens into furnace, left side door opens out of furnace (viewed from unexposed side).

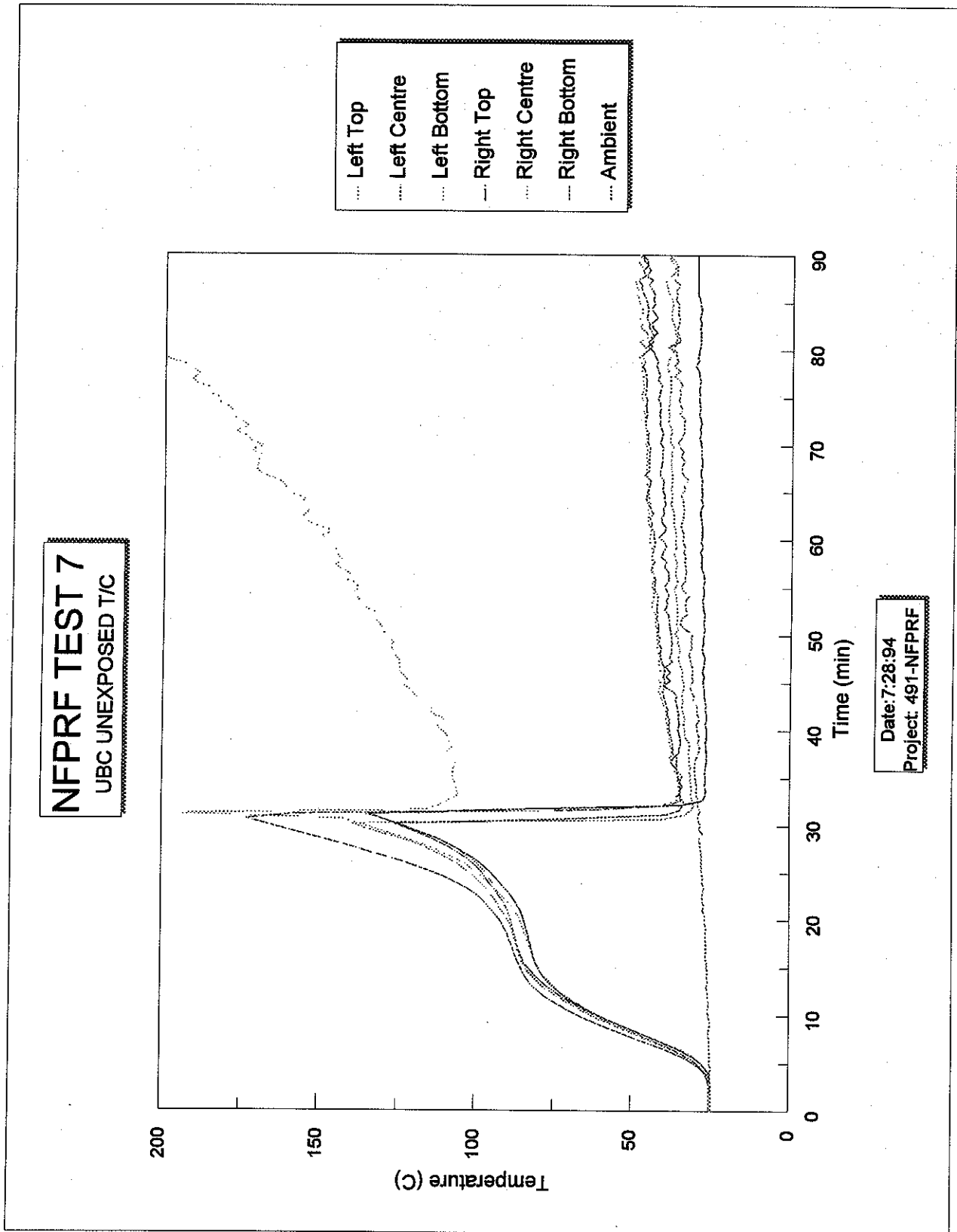
INITIAL CLEARANCES (INCHES)						
	LEFT DOOR			RIGHT DOOR		
	TOP	MIDDLE	BOTTOM	TOP	MIDDLE	BOTTOM
Hinge Edge	3/32	1/16	1/16	3/32	1/16	1/32
Latch Edge	3/16	1/16	3/32	3/16	1/16	3/32
	LEFT	CENTRE	RIGHT	LEFT	CENTRE	RIGHT
Top	1/8	1/8	1/8	1/16	1/16	1/16
Sill	3/8	3/8	3/8	3/8	3/8	3/8

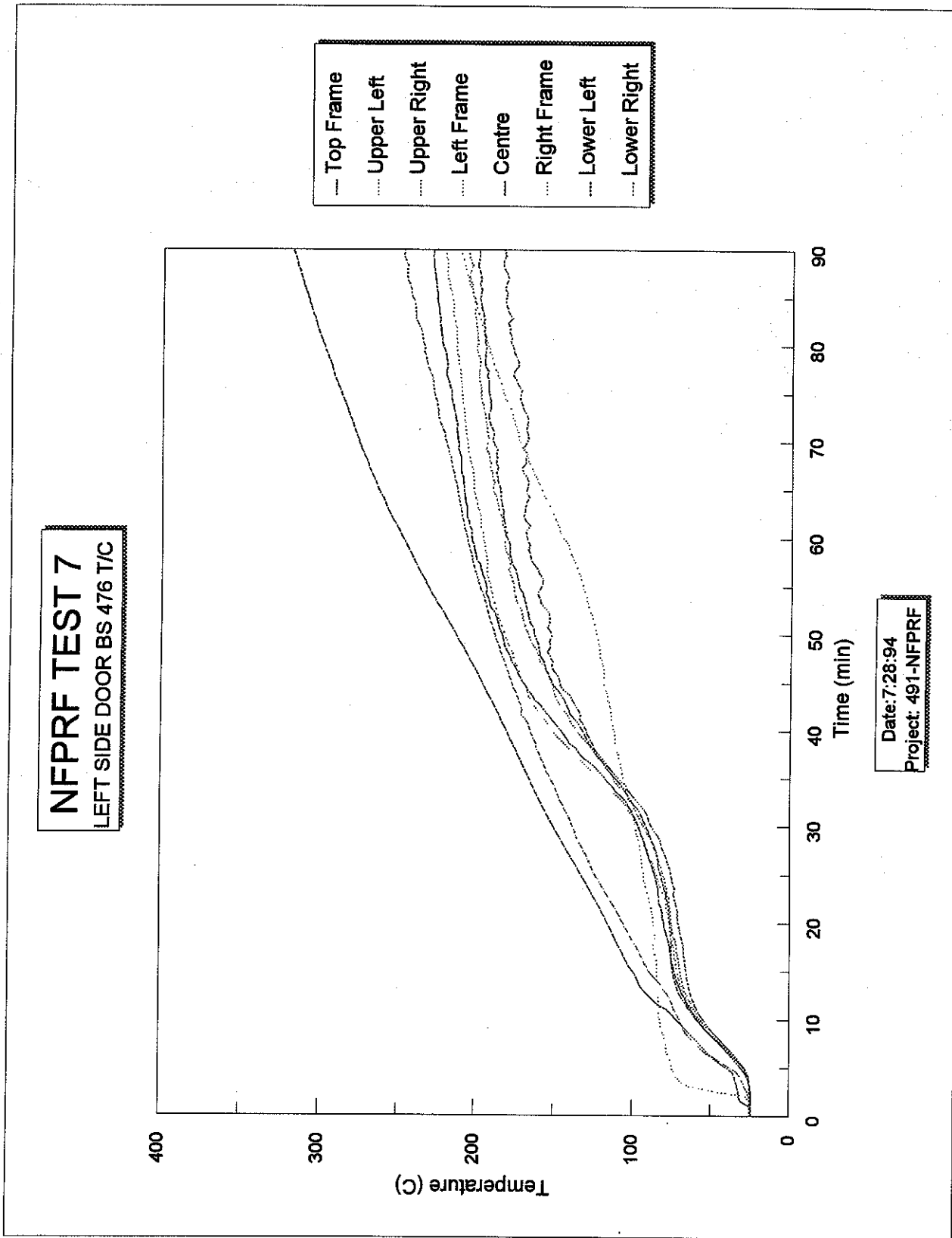
NATURAL GAS CONSUMPTION

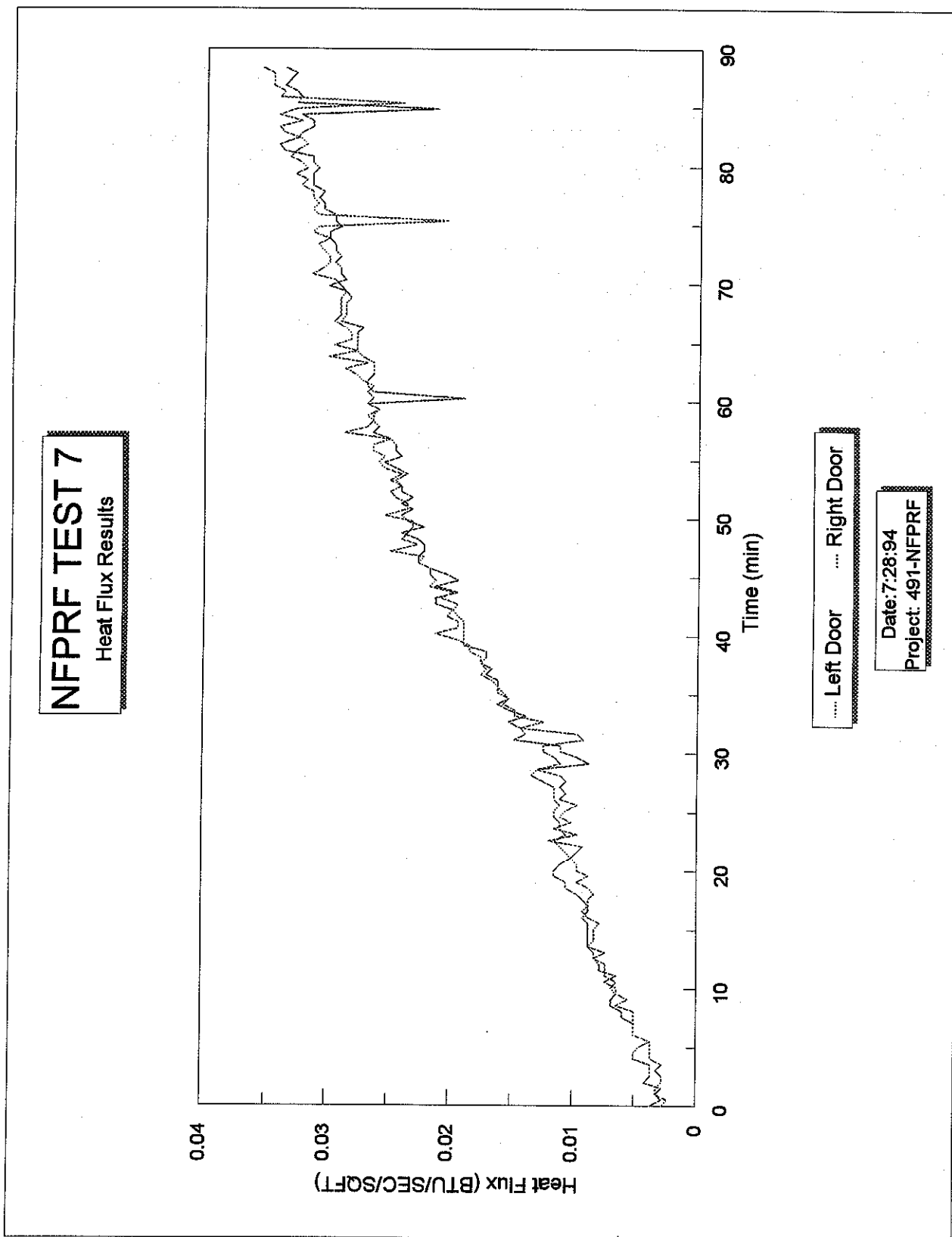
$$1300 \text{ ft.}^3 \text{ (uncorrected)} \times 5170 \text{ btu/ft.}^3 \text{ (corrected)} = 5,170,000 \text{ btu}$$











TEST #7 (Continued)
DEFLECTION MEASUREMENTS (INCHES)

Data has been adjusted to show 0 in. as initial deflection. Positive direction is towards furnace, negative direction is away from furnace.

Location	Initial	5 min	10 min	15 min	30 min	45 min	60 min	75 min	85 min
Top T1	0	-1/8	0	0	1/8	1/8	1/4	3/8	3/8
T2	0	-1/8	0	0	1/8	1/8	1/4	1/4	1/4
T3	0	0	1/8	1/4	1/2	1/2	1/2	1/2	3/4
T4	0	1/8	1/8	1/4	3/8	3/8	5/8	5/8	3/4
T5	0	1/4	3/8	3/8	5/8	3/4	7/8	7/8	7/8
T6	0	0	1/8	1/4	3/8	1/2	5/8	7/8	1
T7	0	0	1/8	3/8	5/8	5/8	3/4	1	1-1/8
T8	0	1/8	1/4	3/8	1/2	3/4	7/8	1	1
Middle M1	0	1/8	1/8	3/8	1/2	1/2	1/2	3/4	3/4
M2	0	1/8	1/8	1/4	3/8	3/8	3/8	1/2	5/8
M3	0	1/4	1/4	1/4	1/2	1/2	1/2	5/8	5/8
M4	0	1/4	3/8	1/2	5/8	5/8	5/8	3/4	3/4
M5	0	1/8	3/8	1/2	5/8	3/4	3/4	7/8	1
M6	0	1/4	3/8	3/8	5/8	3/4	3/4	7/8	3/4
M7	0	1/8	3/8	3/8	5/8	3/4	3/4	1	1
M8	0	1/4	3/8	3/8	3/4	7/8	7/8	1-1/8	1-1/8
Bottom B1	0	1/8	1/8	1/8	1/8	1/4	1/4	3/8	1/4
B2	0	0	0	0	1/8	1/8	1/4	1/4	1/4
B3	0	0	1/8	1/8	1/8	1/8	1/8	1/4	3/8
B4	0	1/4	1/4	1/4	3/8	1/4	1/4	3/8	3/8
B5	0	1/4	1/8	1/4	1/4	1/4	1/4	3/8	1/4
B6	0	1/4	3/8	1/2	1/2	5/8	5/8	3/4	5/8
B7	0	0	1/4	1/4	3/8	1/2	5/8	3/4	7/8
B8	0	0	1/8	1/4	1/2	1/2	1/2	5/8	5/8

TEST #7 (Continued)
FIRE TEST OBSERVATIONS

TIME (MIN)	EXPOSED SIDE	UNEXPOSED SIDE
0:00	Timing started upon ignition of lowest row of burners	Door(s) latched, bolt fully extended
0:30	Luminous flames to full height of furnace	
1:00		Venting from top of doors
1:30	Ignition of door skins	
1:50	Flaming out except a bit at top	Venting ceased
2:00		
2:30	Char falling from R.S. Door	
3:00		
4:40	Neutral pressure plane at 40 in. above sill established	Venting - top of R.S. Door and along edges of L.S. Door
5:00		Venting briskly
6:00		Venting somewhat reduced
7:30	Intumescent action visible at one location on R.S. Door	
8:00	Conditions stable, no flaming	Venting reduced
9:00		Slight venting at centre hinge of R.S. Door, venting only at latch and hinges of L.S. Door
10:00		Intumescent material has sealed door top and edges
15:00		Venting continues at latch and hinges
20:00		Discolouration at top of R.S. Door
25:00	No change	Doors remain flat
30:00		Intumescent material becoming visible along latch edge of L.S. Door
35:00		More intumescent material visible

TEST #7 (Continued)
FIRE TEST OBSERVATIONS (Continued)

TIME (MIN)	EXPOSED SIDE	UNEXPOSED SIDE
40:00	Conditions stable, no flaming	Slight venting at top corner of L.S. Door, steaming at bottom corner of both doors
45:00		Glowing at latch
50:00		Mortice lock shape visible in darkening of skins
55:00		
60:00	No change	Doors remain flat and in contact with frame stops, char to 1/4 in. from latch rose - R.S. Door
65:00		Char extends to frame and to 1/2 in. to right of right side latch
70:00		
75:00		
80:00		Skins darkening - all over surface
85:00		Glowing around latch of R.S. Door
90:00	No change	No through-openings, no flaming has occurred on the unexposed side.

BS 476 COTTON PAD TEST		
TIME	LOCATION	RESULT
5:10	Top centre edge of R.S. Door	No ignition
12:50	Top right hand corner of R.S. Door	No ignition
45:42	Top right hand corner of R.S. Door	No ignition

TEST #7 (Continued)

HOSE STREAM TEST OBSERVATIONS

Hose Stream Test Duration: 3 minutes, 30 seconds

Time from end of fire test to application of hose stream test: 42 seconds

Observations: 20 seconds - top half of L.S. Door (opening out) dislodged

1 minute - more of door removed

1 minute, 20 seconds - remainder of L.S. Door removed

R.S. Door remains closed and latched

Criteria: The door shall remain in the opening during the hose stream test. A single swinging door shall not separate more than 1/2 in. at the latch location. There shall be no development of openings anywhere through the assembly. An opening is defined as a through hole in the assembly that can be seen from the unexposed side when viewed from the direction perpendicular to the plan of the assembly at the location of the suspected opening.

Conclusion: Door opening into furnace is closed and latched but has a 1/2 in. through-opening around mortice lock. Door opening out dislodged and does not remain in opening. Both doors failed hose stream test. Performance is identical to Test #1.

TEST #7 (Continued)

**SUMMARY OF TEST RESULTS
 RELATING TO NFPA 252/UBC 43-2 (1991)**

FIRE TEST	L.S. DOOR (OPENING OUT)	R.S. DOOR (OPENING IN)
Maximum movement of door from door frame	1/8 in.	1/4 in.
Maximum surface temperature rise at 30 min.	256°F 142°C	201°F 112°C
Average surface temperature rise at 30 min.	214°F 119°C	187°F 104°C
Flaming on unexposed side in first 30 min.	None	None
Flaming on unexposed side after 30 min.	None	None
Development of openings	None	None
Did separation at latch location exceed 1/2 in.	No	No
HOSE STREAM TEST		
Did doors remain latched and in the opening	Yes	Yes
Development of through openings - Door and Frame - Frame and Wall	No No	No No
Maximum movement of door from door frame	Not recorded	Not recorded
Did separation at latch location exceed 1/2 in.	No	No

TEST #7 (Continued)

**SUMMARY OF TEST RESULTS
RELATING TO BS 476:PART 20:1987**

FIRE TEST	L.S. DOOR (OPENING OUT)	R.S. DOOR (OPENING IN)
Time; individual unexposed surface temperature rise of 180°C	59:45	53:45
Time; average unexposed surface temperature rise of 140°C ("insulation failure")	46:12	42:10
Time; unexposed surface temperature rise of 300°C	Test duration	Test Duration
Time; cotton pad ignition	None observed	None observed
Did through openings develop	No	No
Did sustained flaming occur on unexposed side	No	No
Time; "integrity" failure	Test duration	Test duration

TEST #8

TEST SAMPLE DESCRIPTION

Product Tested: Hollow metal but with expanded polystyrene foam slab core, in knock down 16 gauge pressed steel frames, fully grouted.

Fire Test Duration: 90 min.

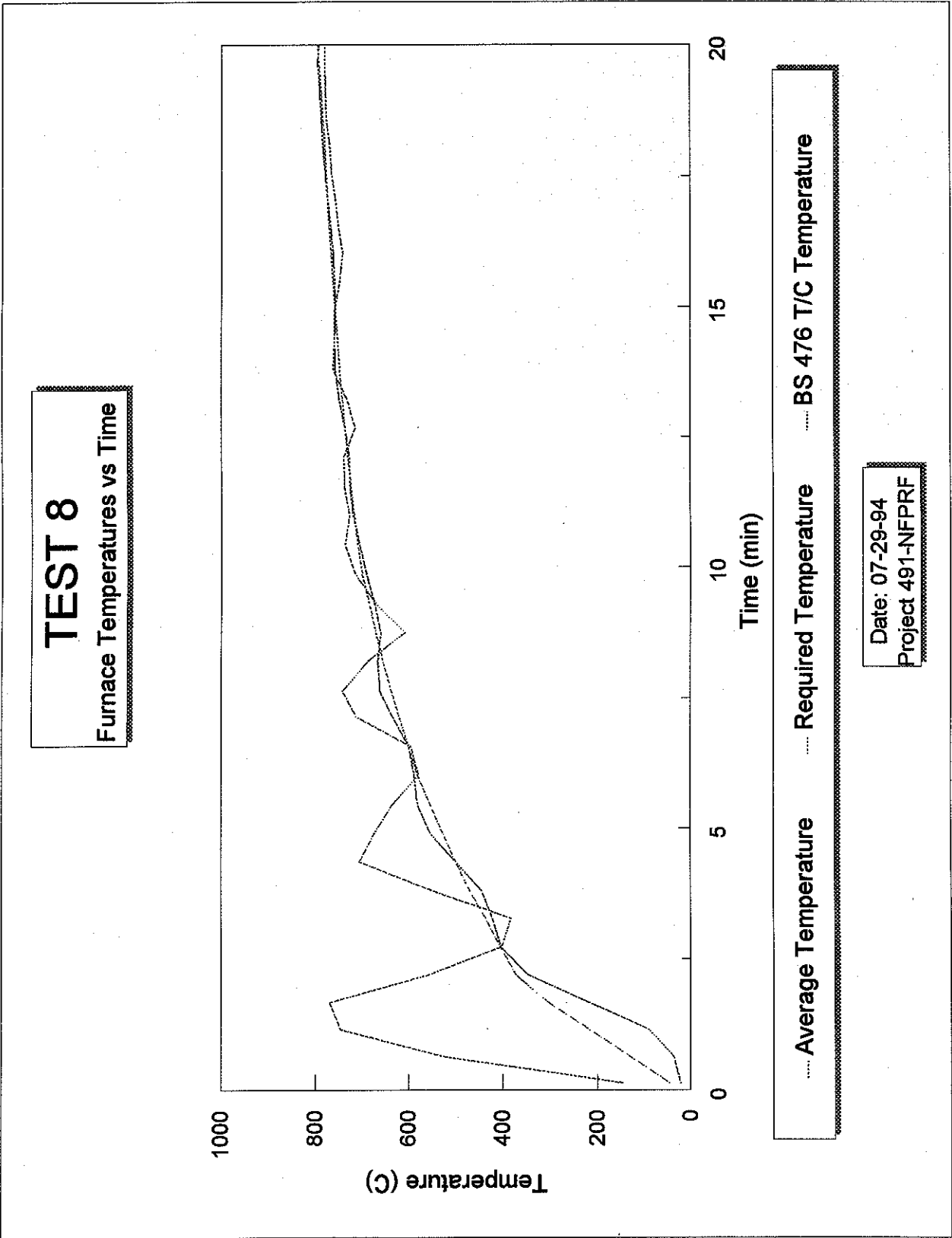
Fire Test Mode: Normally aspirated burners, positive pressure above latch level.

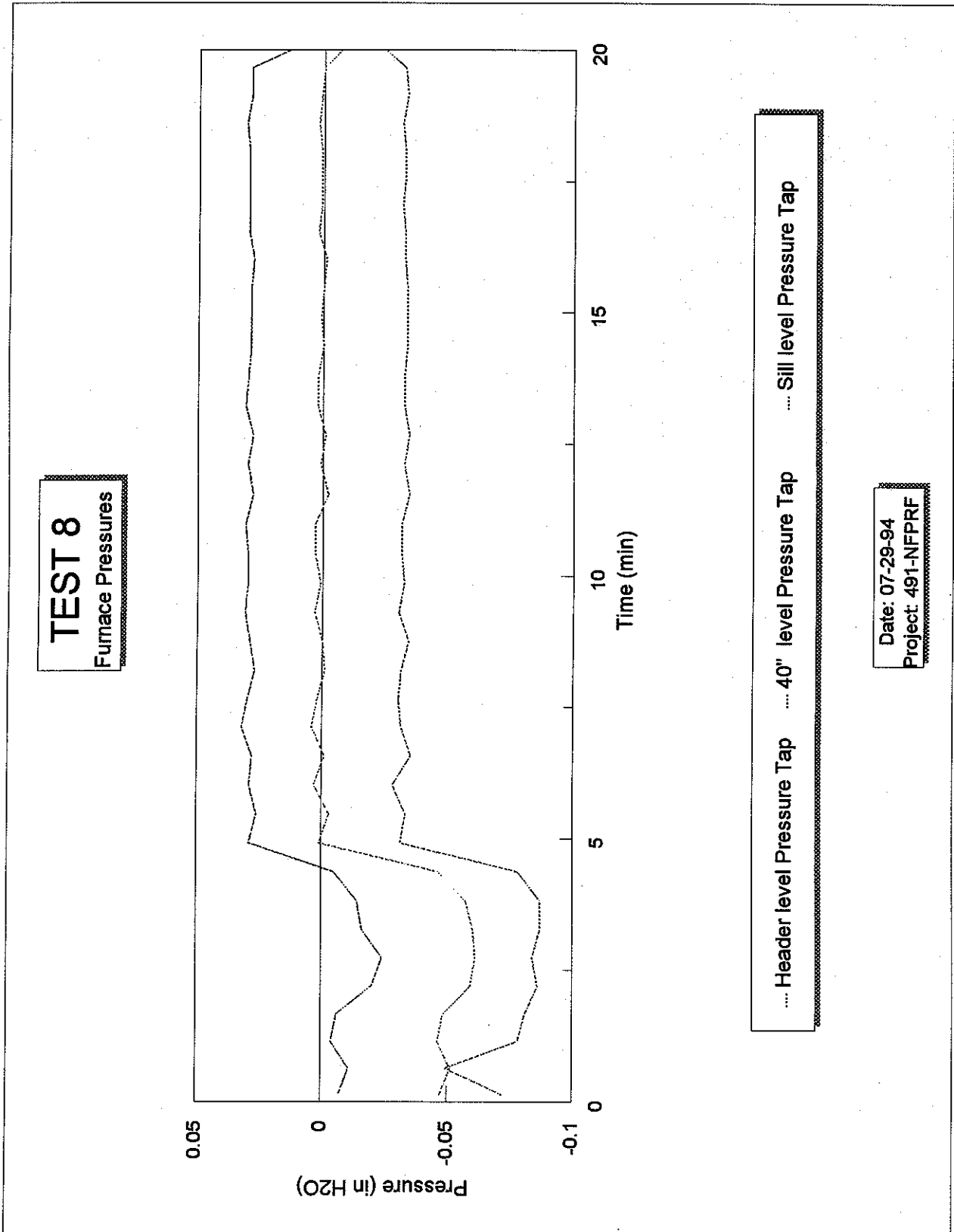
Note: Right side door opens into furnace, left side door opens out of furnace (viewed from unexposed side).

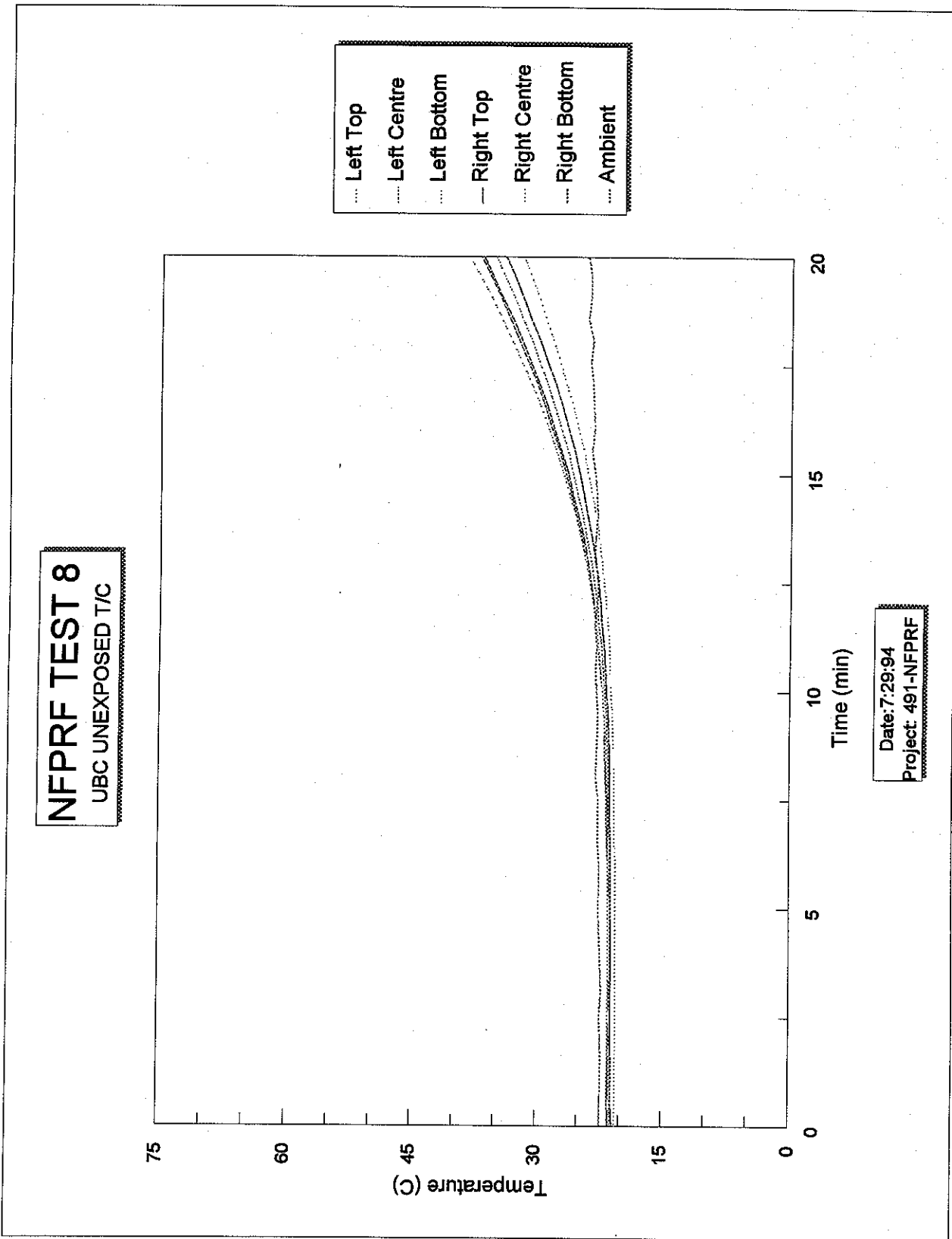
INITIAL CLEARANCES (INCHES)						
	LEFT DOOR			RIGHT DOOR		
	TOP	MIDDLE	BOTTOM	TOP	MIDDLE	BOTTOM
Hinge Edge	1/16	1/16	1/16	1/32	1/16	1/32
Latch Edge	3/16	1/16	1/16	3/16	3/32	3/32
	LEFT	CENTRE	RIGHT	LEFT	CENTRE	RIGHT
Top	3/32	1/8	1/8	1/8	3/32	3/32
Sill	3/8	3/8	3/8	3/8	3/8	3/8

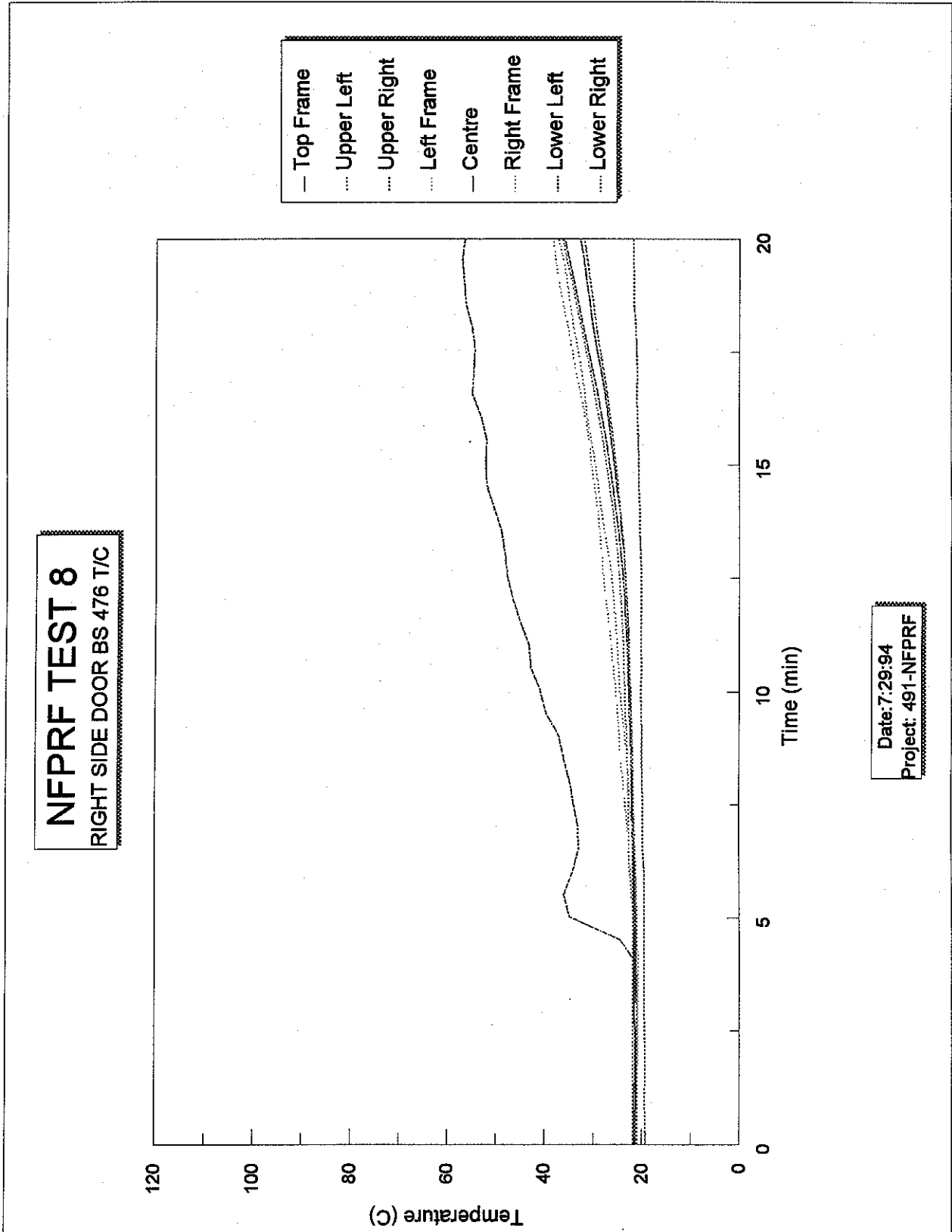
NATURAL GAS CONSUMPTION

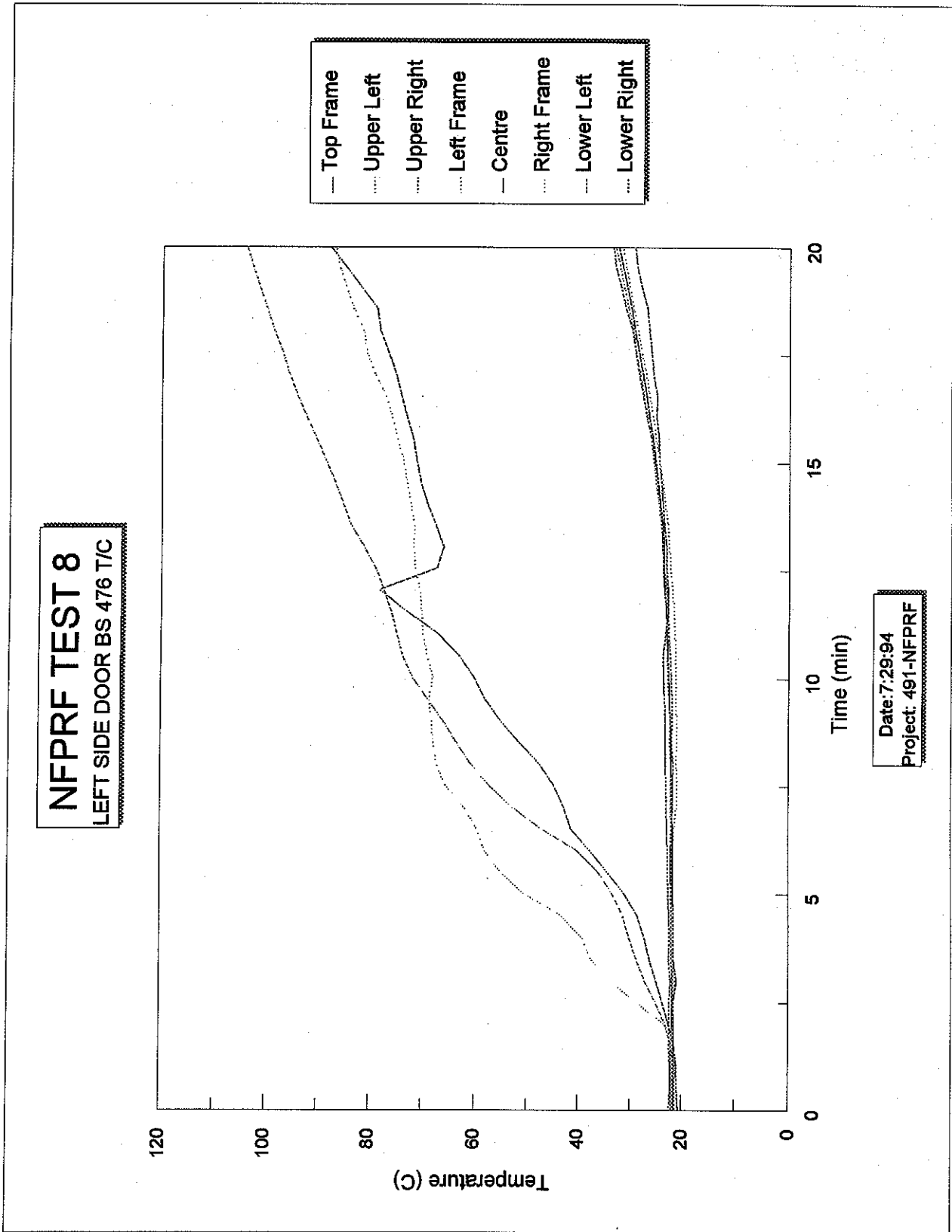
$1300 \text{ ft.}^3 \text{ (uncorrected)} \times 5170 \text{ btu/ft.}^3 \text{ (corrected)} = 6,721,000 \text{ btu}$

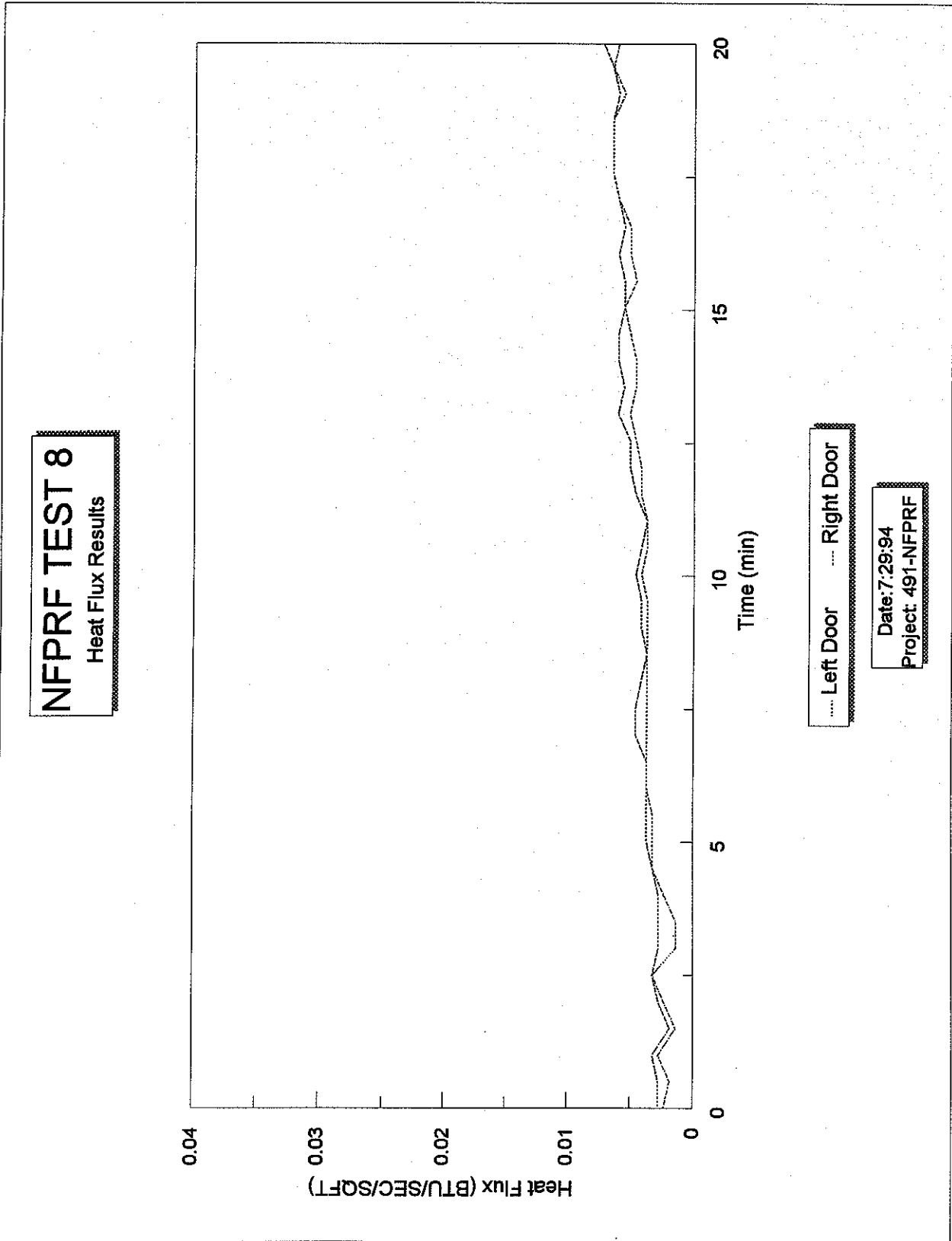












TEST #8 (Continued)
DEFLECTION MEASUREMENTS (INCHES)

Data has been adjusted to show 0 in. as initial deflection. Positive direction is towards furnace, negative direction is away from furnace.

Location	Initial	5 min	10 min	15 min	18 min	Post Test
Top T1	0	1/8	1/8	1/4	1/4	1/8
T2	0	1/4	1/8	1/4	1/4	1/4
T3	0	5/8	1/4	1/4	1/4	1/8
T4	0	1/8	1/4	3/8	3/8	1/4
T5	0	1/8	1/4	1/2	1/2	1/4
T6	0	1/4	3/8	1/2	1/2	3/8
T7	0	1/8	1/8	3/8	1/2	1/4
T8	0	1/8	1/8	1/4	3/8	1/8
Middle M1	0	1/4	3/8	1/2	1/2	3/8
M2	0	1/8	1/4	3/8	3/8	1/4
M3	0	1/4	1/2	1/2	1/2	1/8
M4	0	1/4	3/8	3/8	1/2	0
M5	0	1/8	1/4	1/2	1/2	1/4
M6	0	1/4	3/8	1/2	1/2	3/8
M7	0	1/4	3/8	3/8	1/2	1/8
M8	0	1/8	3/8	3/8	1/2	1/4
Bottom B1	0	-1/8	0	0	0	0
B2	0	1/8	1/4	1/4	1/4	1/4
B3	0	1/8	1/8	1/4	1/4	1/8
B4	0	1/4	1/4	1/4	1/4	1/4
B5	0	1/4	3/8	1/2	1/2	1/4
B6	0	1/2	3/8	1/2	5/8	1/4
B7	0	1/8	1/8	3/8	3/8	1/4
B8	0	1/8	1/4	3/8	3/8	3/8

TEST #8 (Continued)
FIRE TEST OBSERVATIONS

L.S. Door opens out of furnace, R.S. Door opens into furnace.

TIME (MIN)	EXPOSED SIDE	UNEXPOSED SIDE
0:00	Timing started upon ignition of lowest row of burners	Door(s) latched, bolt fully extended
0:38	Ignition of door skin R.S. Door	
0:52	Ignition of door skin L.S. Door	
1:00	Full flaming of doors	
1:55	Flaming of skins continue	No venting
2:00	Flaming out	
4:00	Flaming of skins resumes	
4:46	Positive pressure achieved	Venting heavily from tops of both doors
5:00	Skins still flaming	Venting continues
8:00		Venting from latch and centre hinge area of L.S. Door, smoke staining at top of R.S. Door
9:00	Crackling noises, flaming continues	
10:00	Intumescent action visible	Venting reduced
15:00	More intumescent material visible at door/frame connections	Still venting lightly at hinges and latch
20:00	Flaming continues	No change, no flaming has occurred, no through openings developed

BS 476 COTTON PAD TEST		
TIME	LOCATION	RESULT
13:00	Top corner of R.S. Door	No ignition

TEST #8 (Continued)

HOSE STREAM TEST OBSERVATIONS

Hose Stream Test Duration: 1 minute 24 seconds

Time from end of fire test to application of hose stream test: 43 seconds

Observations: Doors remain flat, tight throughout the hose stream test. The latch holds the door closed on both doors.

Criteria: The door shall remain in the opening during the hose stream test. A single swinging door shall not separate more than 1/2 in. at the latch location. There shall be no development of openings anywhere through the assembly. An opening is defined as a through hole in the assembly that can be seen from the unexposed side when viewed from the direction perpendicular to the plan of the assembly at the location of the suspected opening.

Conclusion: Both door/frame assemblies passed the hose stream test.

TEST #8 (Continued)

**SUMMARY OF TEST RESULTS
 RELATING TO NFPA 252/UBC 43-2 (1991)**

FIRE TEST	L.S. DOOR (OPENING OUT)	R.S. DOOR (OPENING IN)
Maximum movement of door from door frame	1/4 in.	1/8 in.
Maximum surface temperature rise at 20 min.	29°F 16°C	32°F 18°C
Average surface temperature rise at 20 min.	29°F 16°C	25°F 14°C
Flaming on unexposed side in first 30 min.	None	None
Flaming on unexposed side after 30 min.	None	None
Development of openings	None	None
Did separation at latch location exceed 1/2 in.	No	No
HOSE STREAM TEST		
Did doors remain latched and in the opening	Yes	Yes
Development of through openings - Door and Frame - Frame and Wall	No No	No No
Maximum movement of door from door frame	1/4 in.	1/4 in.
Did separation at latch location exceed 1/2 in.	No	No

TEST #8 (Continued)

**SUMMARY OF TEST RESULTS
RELATING TO BS 476:PART 20:1987**

FIRE TEST	L.S. DOOR (OPENING OUT)	R.S. DOOR (OPENING IN)
Time; individual unexposed surface temperature rise of 180°C	Did not occur	Did not occur
Time; average unexposed surface temperature rise of 140°C ("insulation failure")	Did not occur	Did not occur
Time; unexposed surface temperature rise of 300°C	Did not occur	Did not occur
Time; cotton pad ignition	None observed	None observed
Did through openings develop	No	No
Did sustained flaming occur on unexposed side	No	No
Time; "integrity" failure	Test duration	Test duration

TEST #9

TEST SAMPLE DESCRIPTION

Product Tested: Intumescent edged mineral core doors in knock down 16 gauge pressed steel frames, fully grouted. Two single swing doors in the test wall assembly.

Fire Test Duration: 90 min.

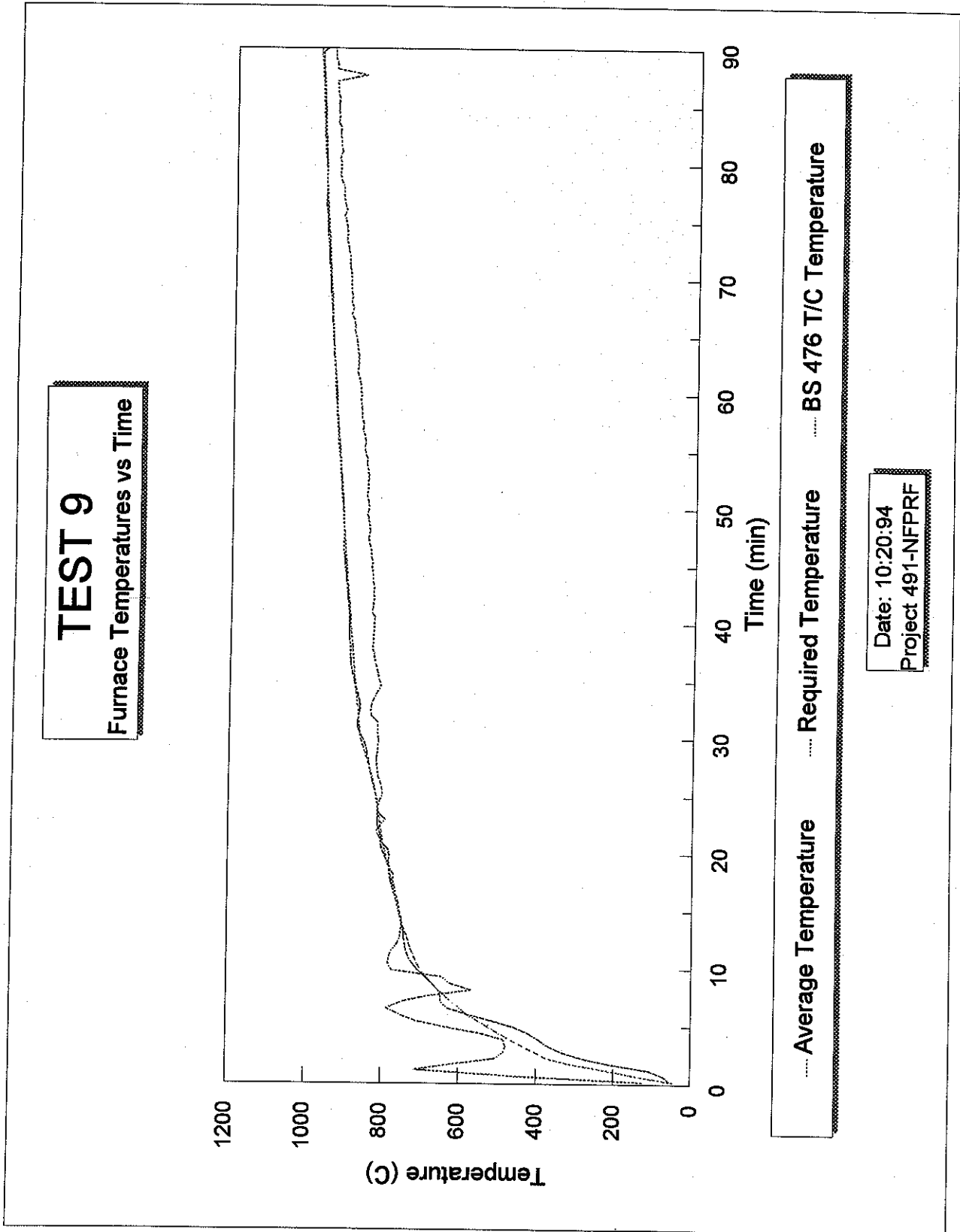
Fire Test Mode: Diffusion burners, positive pressure above latch level.

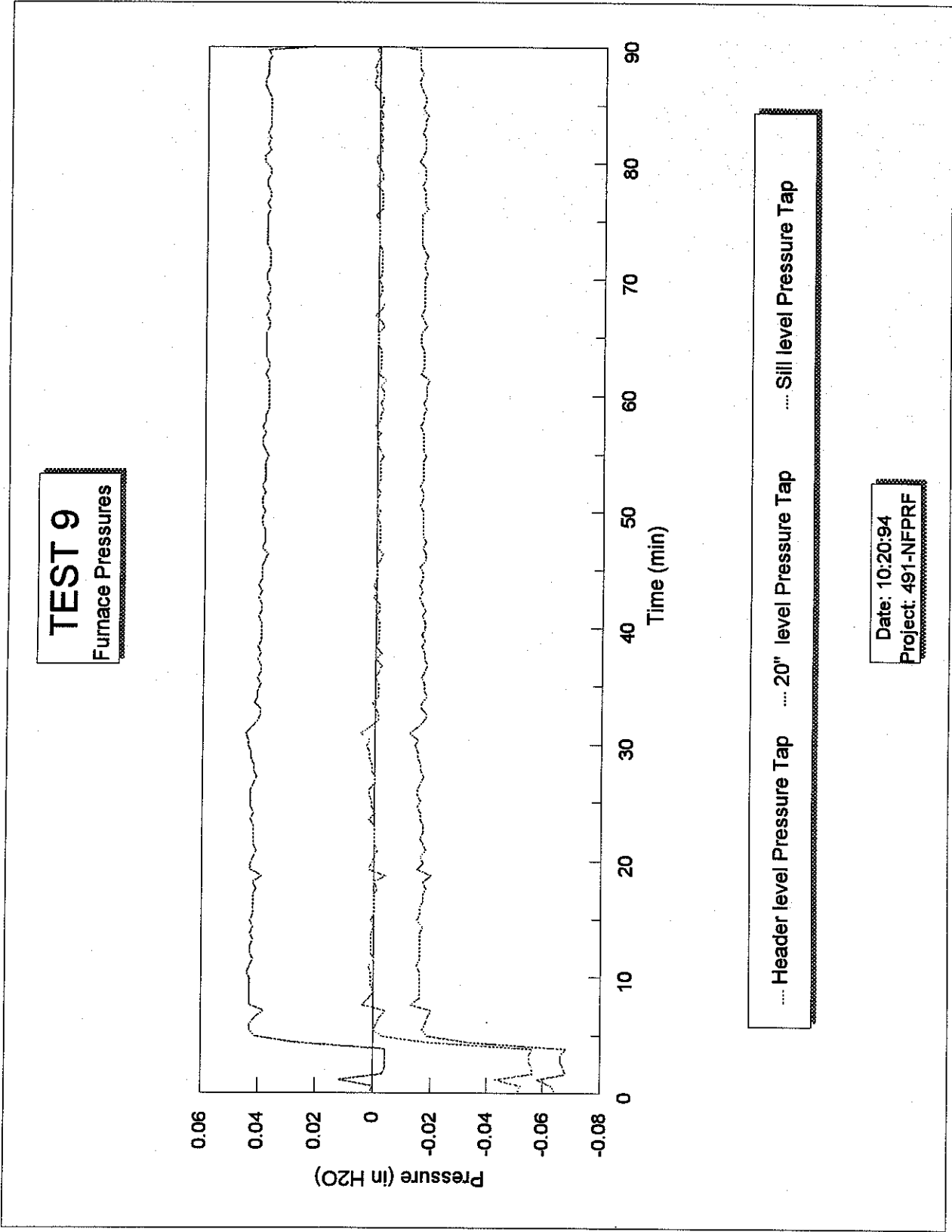
Note: Left side door opens into furnace, right side door opens out of furnace (viewed from unexposed side).

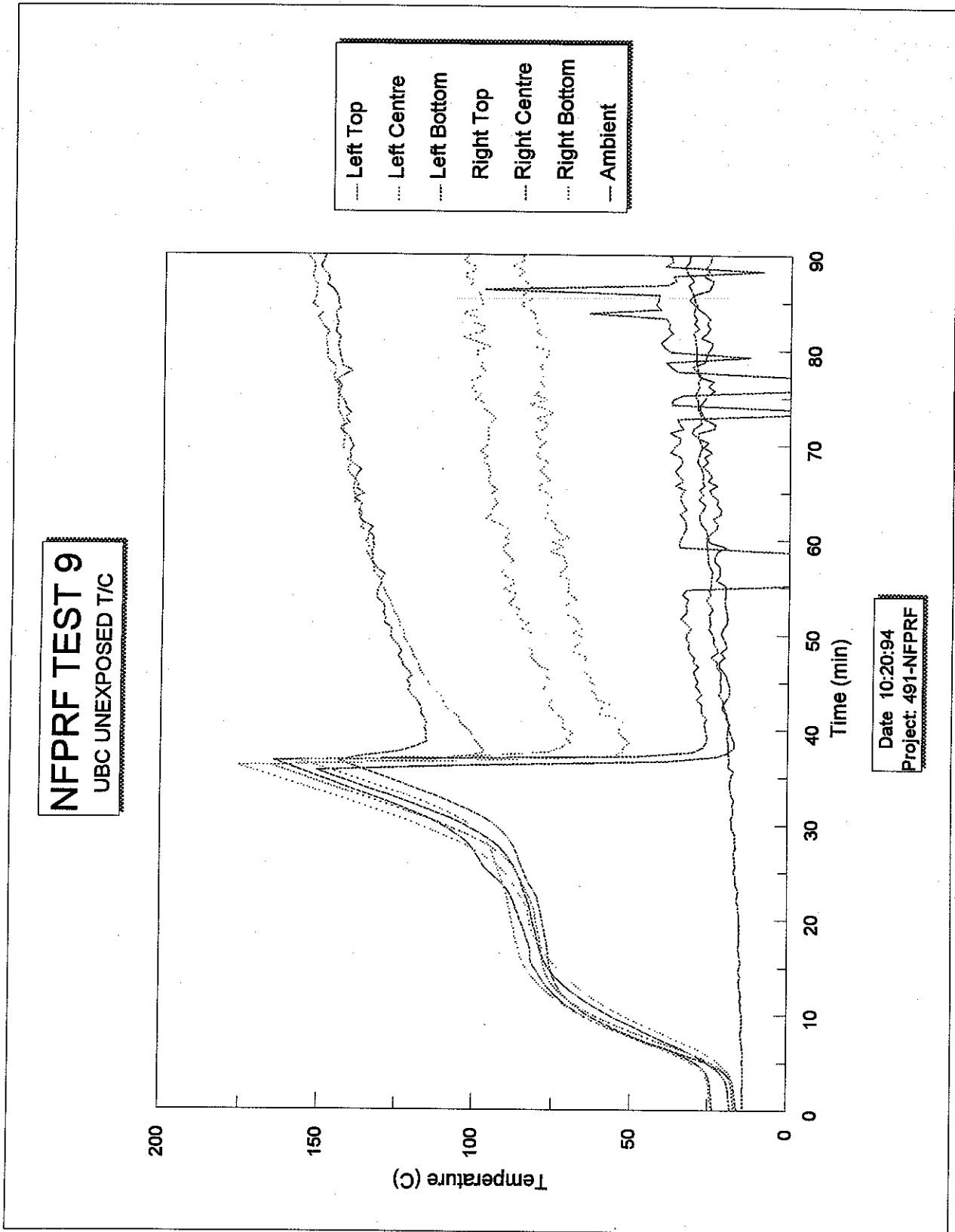
INITIAL CLEARANCES (INCHES)						
	LEFT DOOR			RIGHT DOOR		
	TOP	MIDDLE	BOTTOM	TOP	MIDDLE	BOTTOM
Hinge Edge	1/8	1/8	1/8	1/8	1/8	1/8
Latch Edge	1/16	1/16	1/16	1/16	1/16	1/16
	LEFT	CENTRE	RIGHT	LEFT	CENTRE	RIGHT
Top	1/8	1/8	1/8	1/16	1/16	1/16
Sill	3/8	3/8	3/8	3/8	3/8	3/8

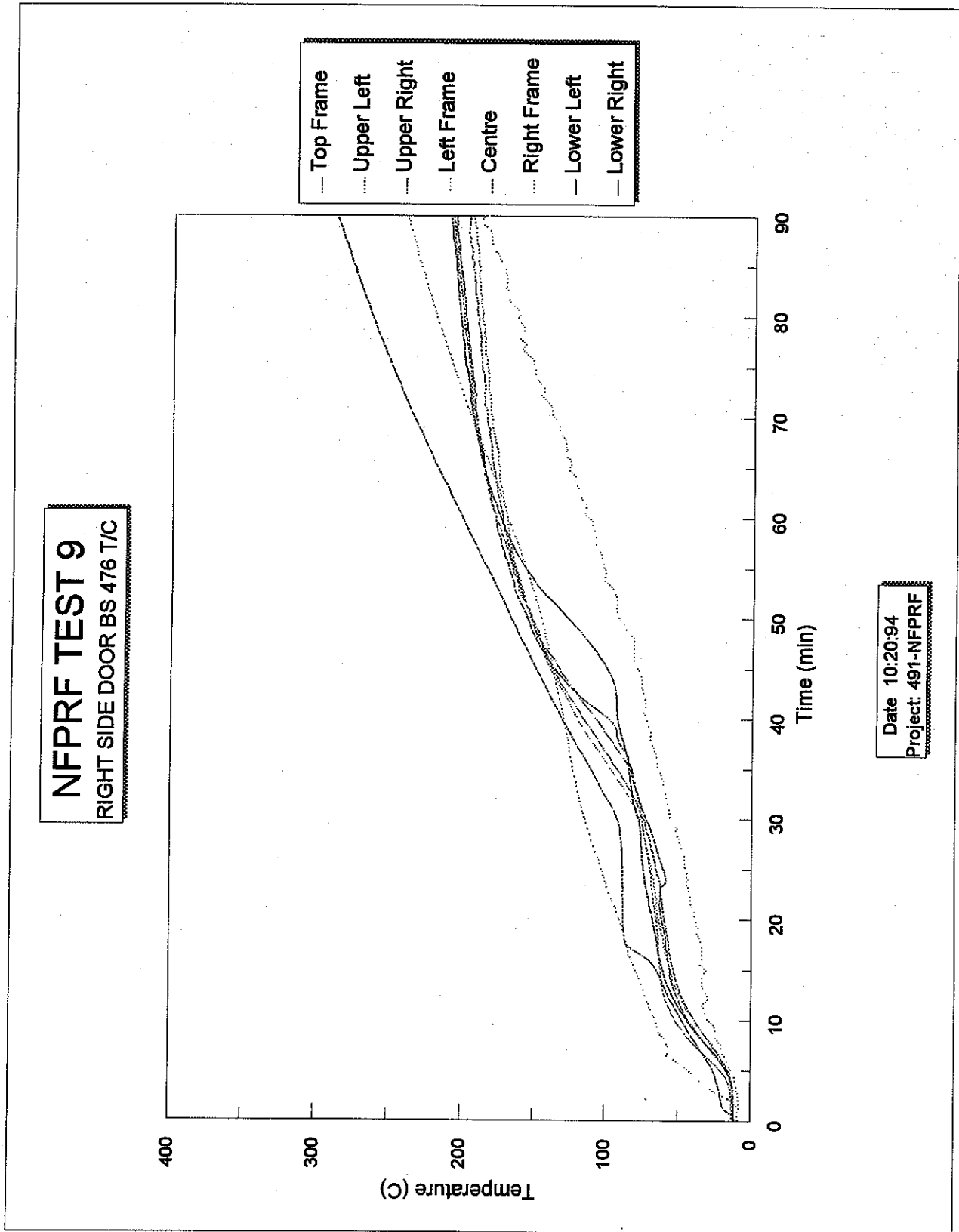
NATURAL GAS CONSUMPTION

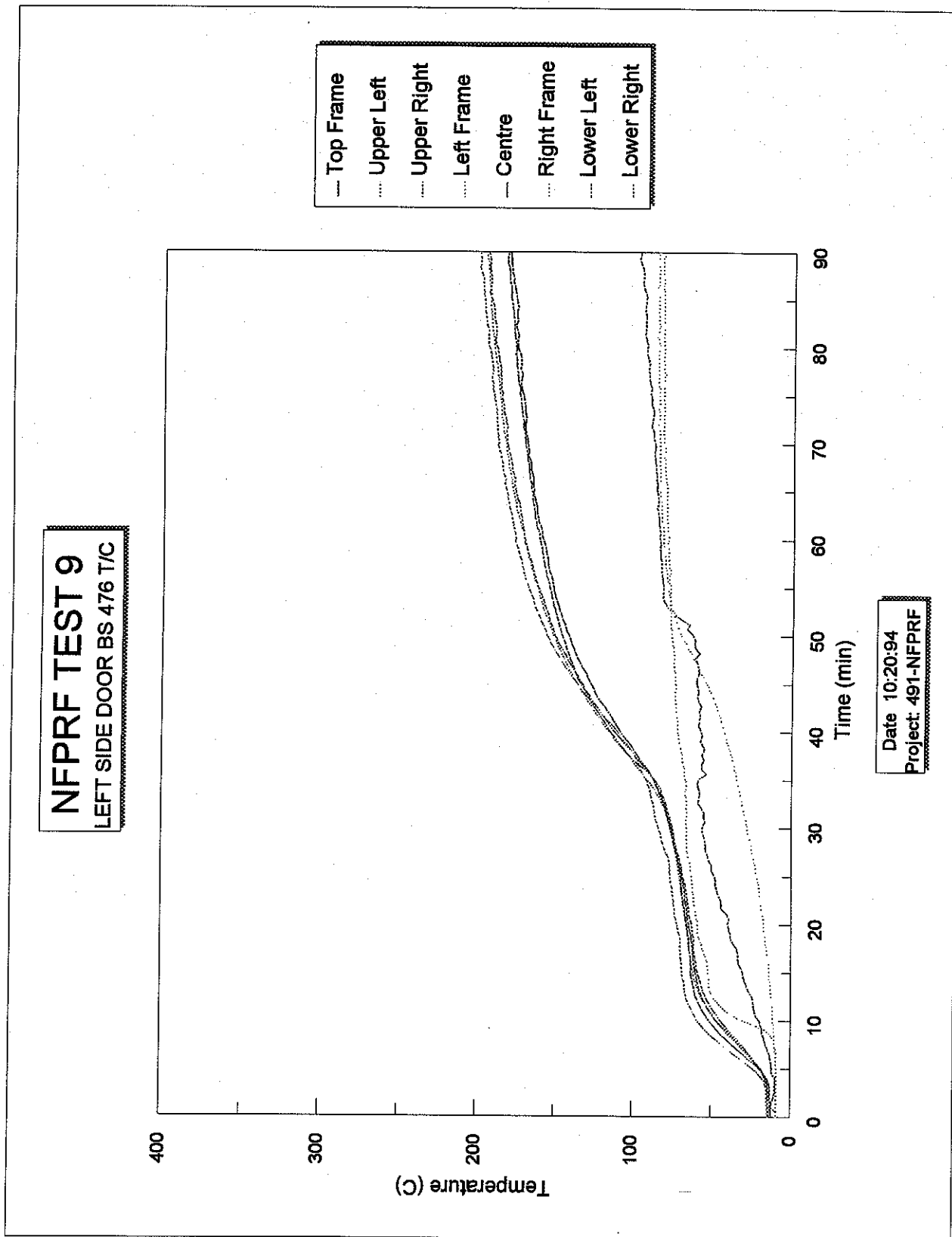
$800 \text{ ft.}^3 \text{ (uncorrected)} \times 5170 \text{ btu/ft.}^3 \text{ (corrected)} = 4,136,000 \text{ btu}$

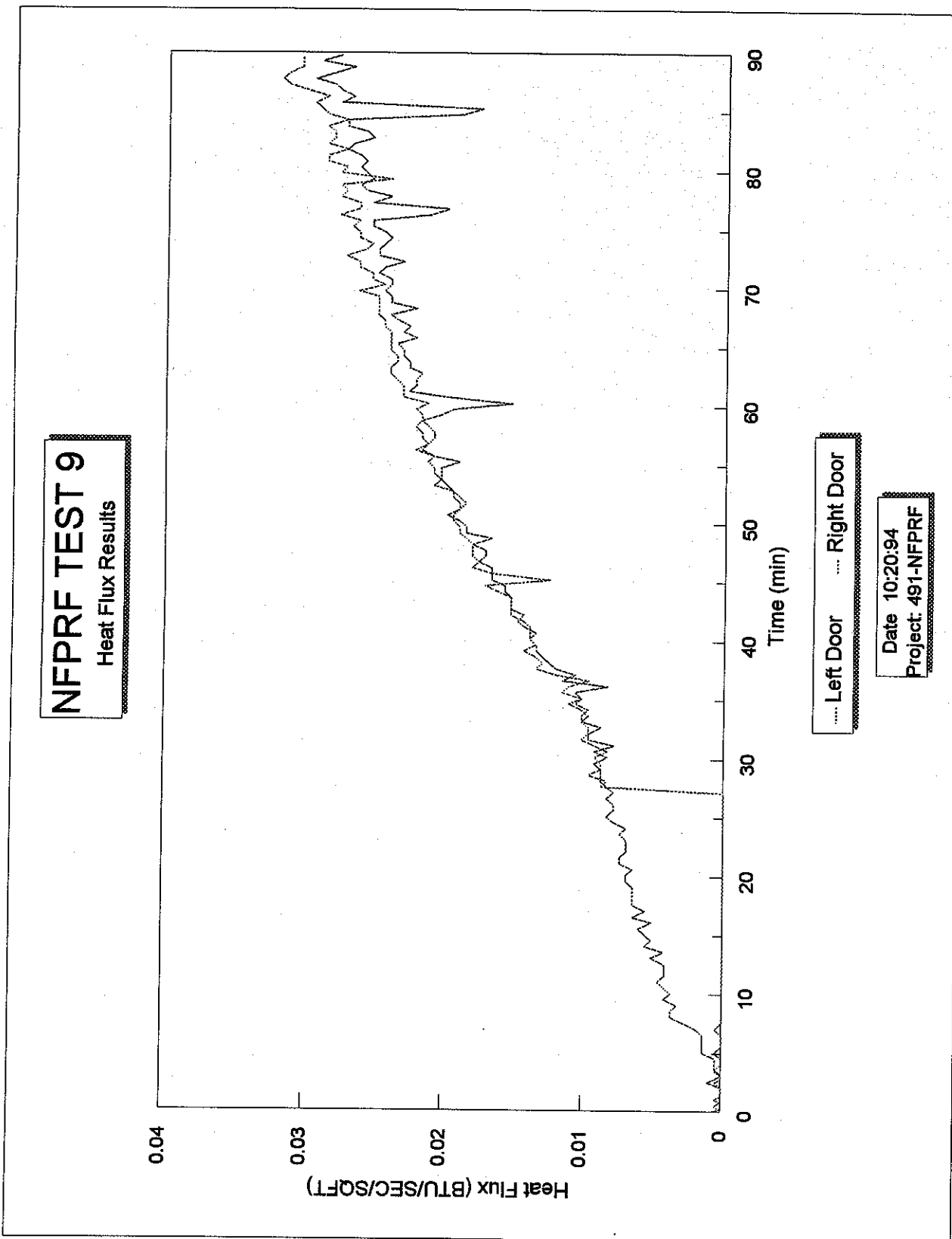












TEST #9 (Continued)
DEFLECTION MEASUREMENTS (INCHES)

Data has been adjusted to show 0 in. as initial deflection. Positive direction is towards furnace, negative direction is away from furnace.

Location	Initial	5 min	10 min	15 min	30 min	45 min	60 min	75 min	85 min
Top T1	0	1/4	3/8	1/2	3/4	7/8	1	1	1
T2	0	1/8	1/4	1/2	3/4	5/8	5/8	7/8	7/8
T3	0	0	1/8	3/8	3/4	7/8	1	1	1
T4	0	0	3/8	5/8	7/8	1	1-1/8	1-1/4	1-1/8
T5	0	1/8	3/8	1/2	7/8	7/8	1	1	1
T6	0	1/8	3/8	1/2	7/8	7/8	1-1/8	1-1/8	1
T7	0	1/4	3/8	1/2	3/4	7/8	1	1	7/8
T8	0	0	1/8	1/4	5/8	5/8	3/4	3/4	3/4
Middle M1	0	3/8	1/2	3/4	1	1-1/4	1-1/4	1-1/2	1-1/2
M2	0	1/4	3/8	5/8	7/8	1-1/8	1-1/4	1-1/4	1-1/4
M3	0	5/8	3/4	1	1-1/4	1-1/2	1-5/8	1-3/4	1-5/8
M4	0	1/2	3/4	7/8	1-3/8	1-3/8	1-1/2	1-1/2	1-1/2
M5	0	3/8	5/8	7/8	1-1/4	1	1-3/8	1-1/2	1-1/2
M6	0	3/8	5/8	7/8	1-1/8	1-1/4	1-1/4	1-3/8	1-1/4
M7	0	1/4	1/2	5/8	3/4	1	1	1	1
M8	0	1/4	1/2	3/4	3/4	1	1	1-1/8	1-1/8
Bottom B1	0	1/4	3/8	1/2	3/4	7/8	1	1	1-1/8
B2	0	1/8	1/4	3/8	5/8	1/2	7/8	1-1/8	1-1/4
B3	0	1/8	1/4	7/8	1-1/8	1-1/4	1-1/2	1-1/2	1-1/2
B4	0	3/4	1	1	1-1/8	1-3/8	1-1/2	1-1/2	1-3/8
B5	0	3/8	5/8	1-3/8	1-5/8	1-3/8	1-3/8	1-1/2	1-7/8
B6	0	3/8	1/2	1-3/8	1-5/8	1-1/2	1-1/2	1-1/2	1-7/8
B7	0	1/2	3/8	1-1/8	1-1/4	1-1/8	1-1/8	1-1/8	1-3/8
B8	0	3/8	3/8	1	1-1/8	1	1	1	1-1/4

TEST #9 (Continued)
FIRE TEST OBSERVATIONS

TIME (MIN)	EXPOSED SIDE	UNEXPOSED SIDE
0:00	Timing started upon ignition of lowest row of burners	Door(s) latched, bolt fully extended
0:30	Luminous flames to full height of furnace	
0:45	Ignition of door skins	Venting from top of doors
1:30	Door skins burning briskly	
1:50	Flaming out except a bit at top	Venting lightly
2:00		
2:30	Char falling from R.S. Door	
3:00		
4:30	Neutral pressure plane at 20 in. above sill established	Venting - top and along edges of both doors
5:00		Venting briskly
8:00	Conditions stable, no flaming	Venting reduced, warpage of door opening out
9:00		Slight venting at centre hinge of R.S. Door, venting only at latch and hinges of L.S. Door
15:00		Venting continues at latch and hinges
20:00	Flames extend to 18 in. from furnace rear wall	Discolouration at top of R.S. Door
25:00	No change	Intumescent material visible at top of R.S. Door
30:00		Intumescent material becoming visible along latch edge of R.S. Door
35:00		More intumescent material visible, UBC thermocouple pads removed

TEST #9 (Continued)
FIRE TEST OBSERVATIONS (Continued)

TIME (MIN)	EXPOSED SIDE	UNEXPOSED SIDE
40:00		Intumescent material visible at top of door opening in
45:00	No change	"Shadow" visible showing shape of mortise lock cut-outs, some venting
60:00	No flaming or deterioration of stiles and rails	Venting lightly at header corners of doors
70:00	No change	Shadow of latch cut-outs getting darker
75:00		Glowing between latch and frame on L.S. Door along frame
85:00		Glowing at top left hand corner of L.S. Door
90:00	No change	No flaming has occurred, no burn through

BS 476 COTTON PAD TEST		
TIME (MIN)	LOCATION	RESULT
15:00	R.S. Door top left corner over door/frame joint	No ignition, no glowing, no discoloration of pad

TEST #9 (Continued)

HOSE STREAM TEST OBSERVATIONS

Hose Stream Test Duration: 3 minutes, 30 seconds

Time from end of fire test to application of hose stream test: 50 seconds

Observations: 26 seconds - top half of R.S. Door (opening out) dislodged

1 minute, 45 seconds - remainder of R.S. Door removed

L.S. Door remains closed and latched

Criteria: The door shall remain in the opening during the hose stream test. A single swinging door shall not separate more than 1/2 in. at the latch location. There shall be no development of openings anywhere through the assembly. An opening is defined as a through hole in the assembly that can be seen from the unexposed side when viewed from the direction perpendicular to the plan of the assembly at the location of the suspected opening.

Conclusion: Door opening into furnace is closed and latched. Door opening out dislodged and does not remain in opening so, consequently, failed hose stream test.

TEST #9 (Continued)

**SUMMARY OF TEST RESULTS
 RELATING TO NFPA 252/UBC 43-2 (1991)**

FIRE TEST	L.S. DOOR (OPENING IN)	R.S. DOOR (OPENING OUT)
Maximum movement of door from door frame	1/4 in.	1/4 in.
Maximum surface temperature rise at 30 min.	162°F 90°C	178°F 99°C
Average surface temperature rise at 30 min.	149°F 83°C	157°F 87°C
Flaming on unexposed side in first 30 min.	None	None
Flaming on unexposed side after 30 min.	None	None
Development of openings	None	None
Did separation at latch location exceed 1/2 in.	No	No
HOSE STREAM TEST		
Did doors remain latched and in the opening	Yes	No
Development of through openings - Door and Frame - Frame and Wall	No No	No No
Maximum movement of door from door frame	Not recorded	Not recorded
Did separation at latch location exceed 1/2 in.	No	No

TEST #9 (Continued)

**SUMMARY OF TEST RESULTS
RELATING TO BS 476:PART 20:1987**

FIRE TEST	L.S. DOOR (OPENING IN)	R.S. DOOR (OPENING OUT)
Time; individual unexposed surface temperature rise of 180°C	59:45	53:45
Time; average unexposed surface temperature rise of 140°C ("insulation failure")	46:12	42:10
Time; unexposed surface temperature rise of 300°C	Test duration	Test Duration
Time; cotton pad ignition	None observed	None observed
Did through openings develop	No	No
Did sustained flaming occur on unexposed side	No	No
Time; "integrity" failure	Test duration	Test duration

TEST #10

TEST SAMPLE DESCRIPTION

Product Tested: Hollow metal but with expanded polystyrene foam slab core, in knock down 16 gauge pressed steel frames, fully grouted.

Fire Test Duration: 90 min.

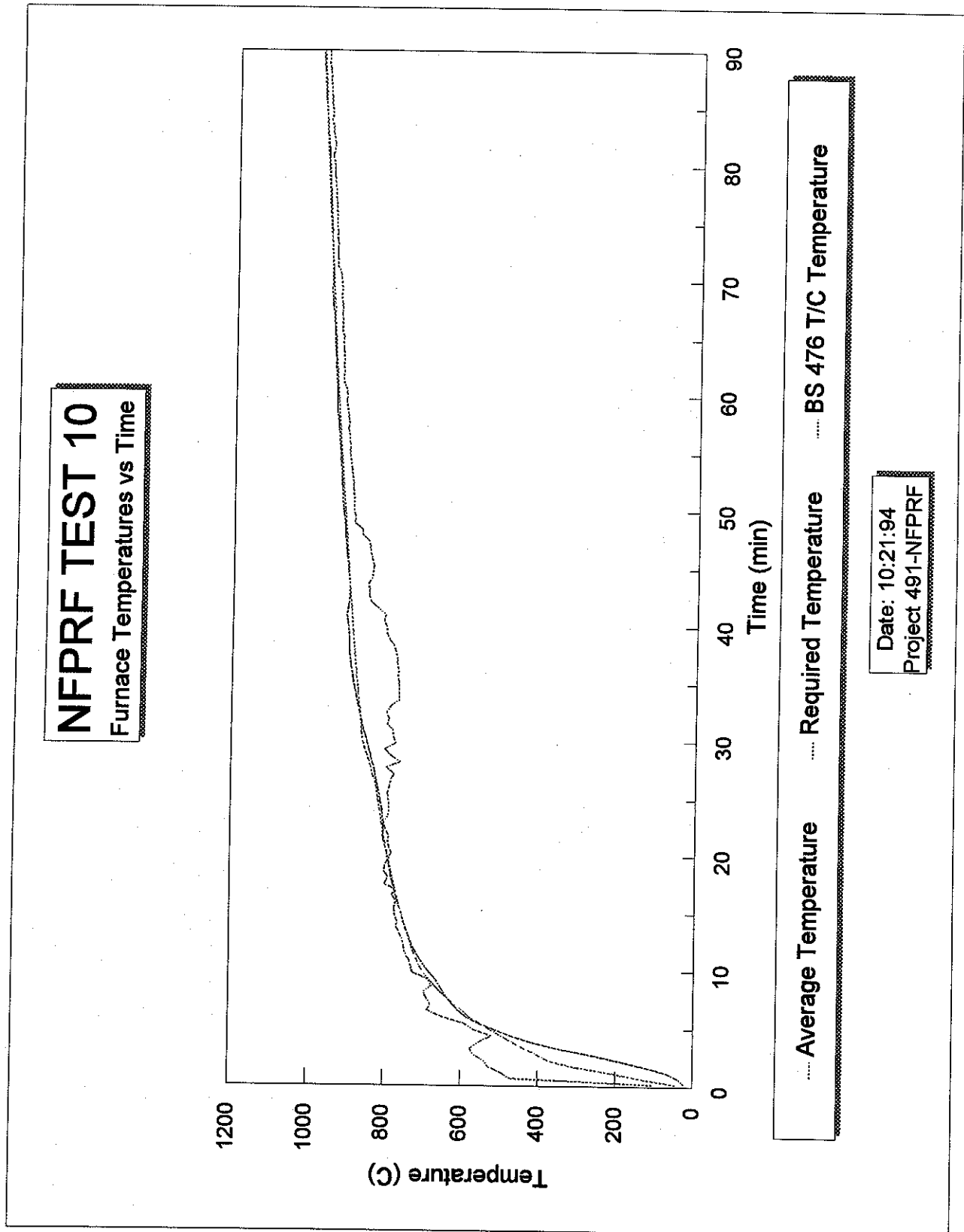
Fire Test Mode: Diffusion burners, positive pressure above latch level.

Note: Right side door opens into furnace, left side door opens out of furnace (viewed from unexposed side).

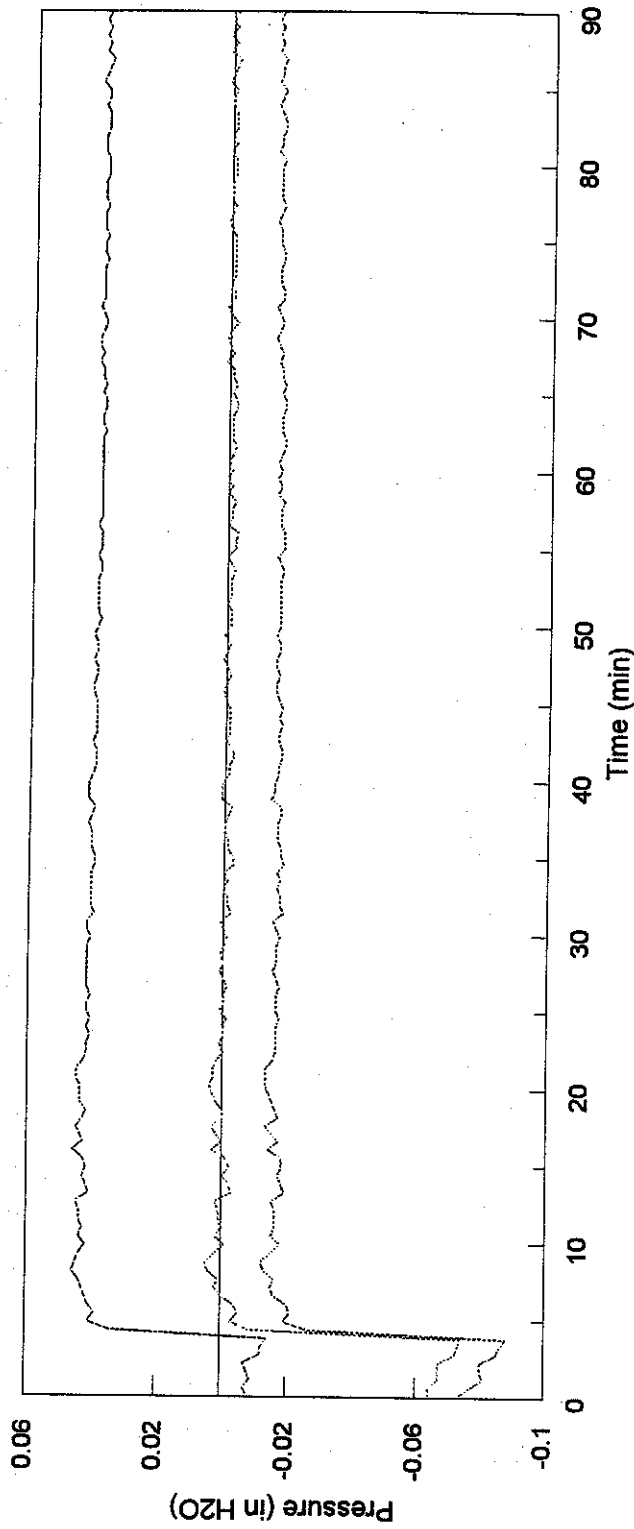
INITIAL CLEARANCES (INCHES)						
	LEFT DOOR			RIGHT DOOR		
	TOP	MIDDLE	BOTTOM	TOP	MIDDLE	BOTTOM
Hinge Edge	1/8	1/16	1/16	1/8	1/8	1/16
Latch Edge	1/16	1/16	1/16	1/16	1/16	1/16
	LEFT	CENTRE	RIGHT	LEFT	CENTRE	RIGHT
Top	1/8	1/16	1/32	1/8	3/32	1/16
Sill	3/8	1/2	3/8	1/2	1/2	3/8

NATURAL GAS CONSUMPTION

$700 \text{ ft.}^3 \text{ (uncorrected)} \times 5170 \text{ btu/ft.}^3 \text{ (corrected)} = 3,619,000 \text{ btu}$

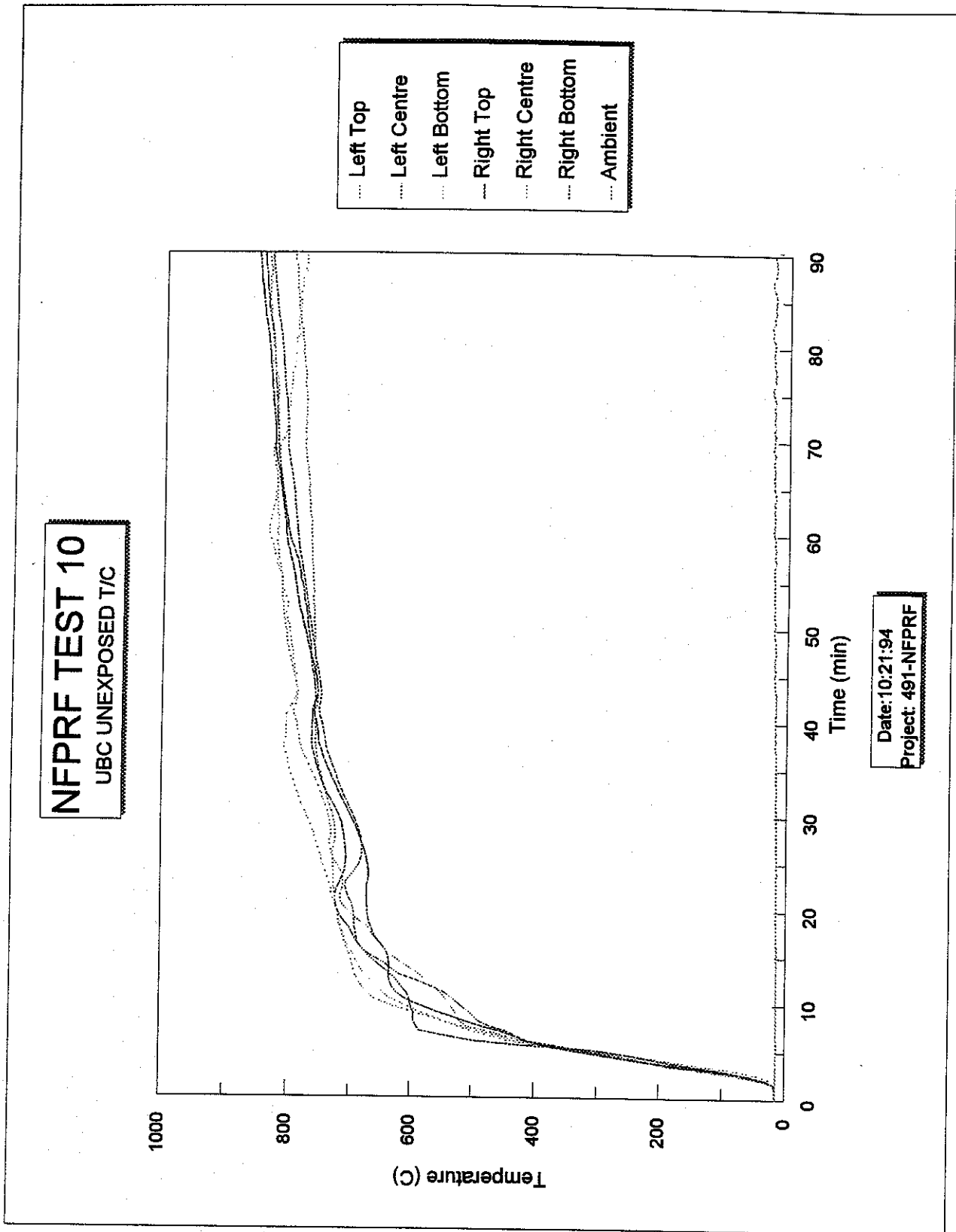


NFPRF TEST 10
Furnace Pressures

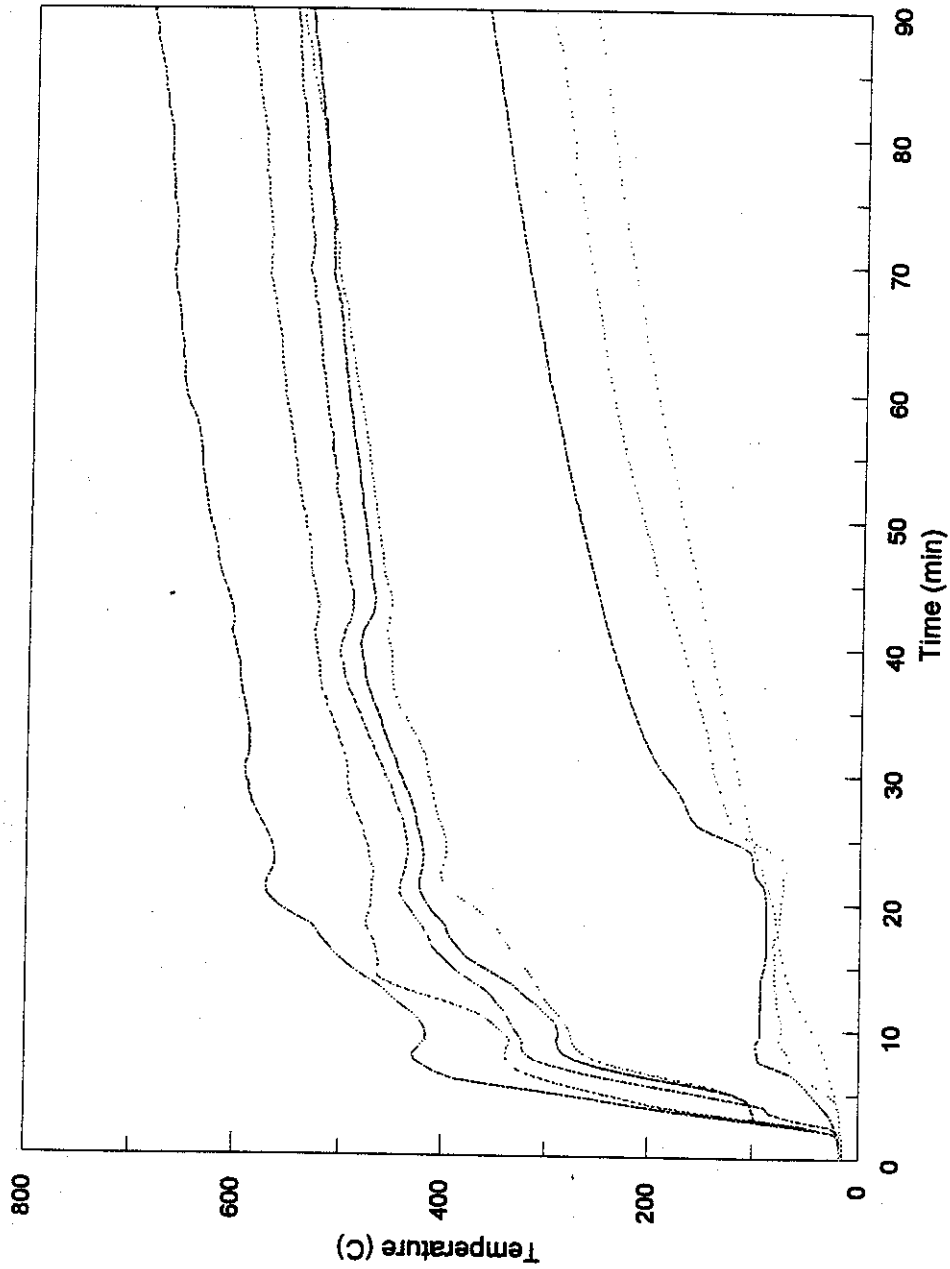


..... Header level Pressure Tap - - - 20" level Pressure Tap Sill level Pressure Tap

Date: 10:21:94
Project: 491-NFPRF

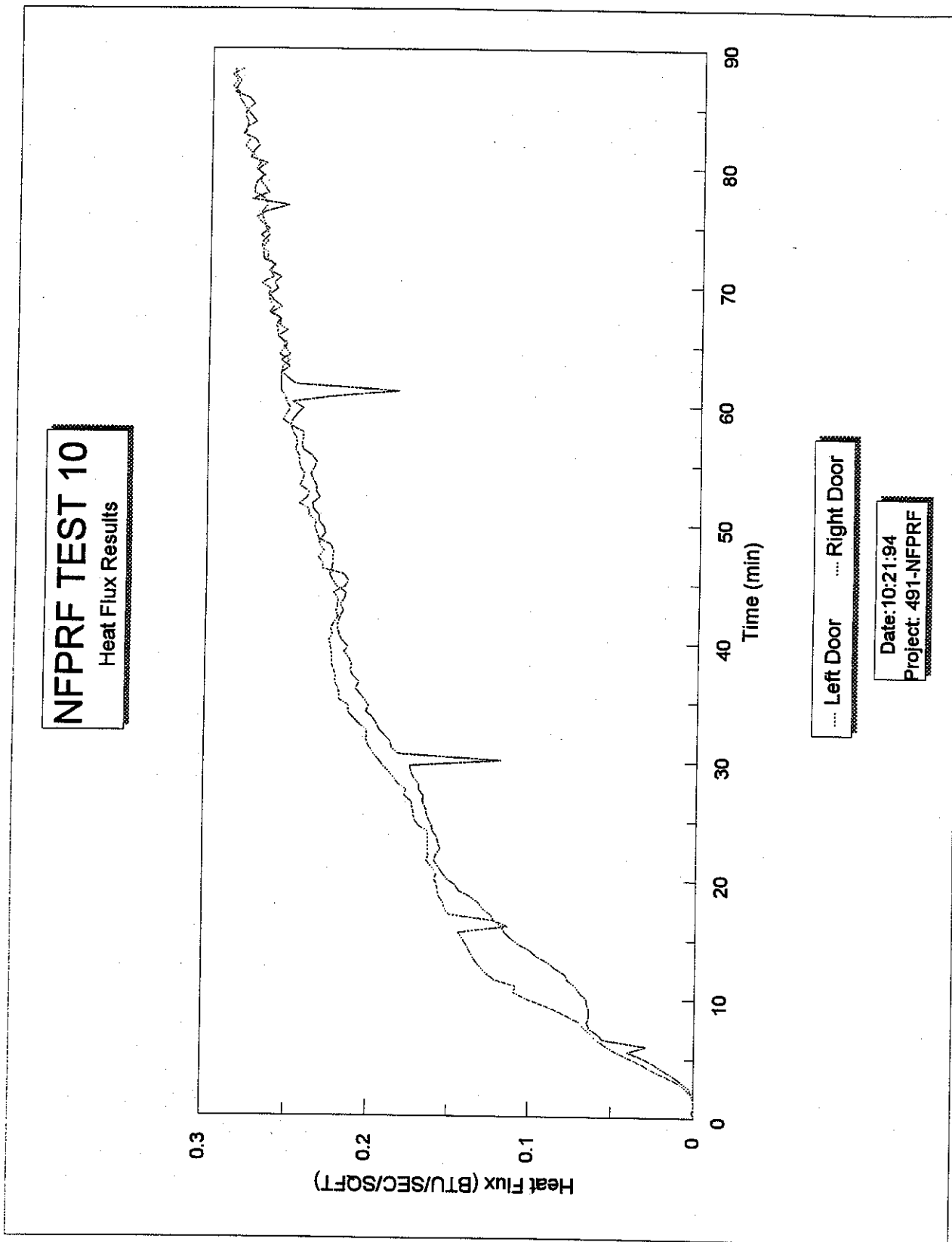


NFPRF TEST 10
LEFT SIDE DOOR BS 476 T/C



— Top Frame
... Upper Left
... Upper Right
... Left Frame
— Centre
... Right Frame
— Lower Left
... Lower Right

Date: 10:21:94
Project: 491-NFPRF



TEST #10 (Continued)
DEFLECTION MEASUREMENTS (INCHES)

Data has been adjusted to show 0 in. as initial deflection. Positive direction is towards furnace, negative direction is away from furnace.

Location	Initial	5 min	10 min	15 min	30 min	45 min	60 min	75 min	85 min
Top T1	0	1/8	-3/8	-3/8	3/8	3/8	1/2	1/2	3/4
T2	0	1/8	-1/2	1/8	1/4	3/8	1/2	1/2	1/2
T3	0	1/8	0	0	3/8	3/4	3/4	7/8	7/8
T4	0	0	1/8	3/8	5/8	7/8	1	1	1
T5	0	0	1/4	3/8	7/8	1-1/8	1-1/4	1-1/4	1-3/8
T6	0	3/4	7/8	1	1-3/8	1-5/8	1-3/4	1-3/4	1-7/8
T7	0	1/4	1/8	3/8	5/8	7/8	7/8	7/8	7/8
T8	0	0	0	1/8	1/2	5/8	3/4	7/8	3/4
Middle M1	0	1/8	1/4	3/8	3/4	7/8	1	1-1/8	1-1/8
M2	0	1/8	1/4	3/8	5/8	7/8	7/8	1	1
M3	0	0	1/4	1/2	3/4	1	1-1-8	1-1/4	1-3/8
M4	0	0	1/4	5/8	5/8	1-1/8	1-3/8	1-1/2	1-1/2
M5	0	1/8	1/4	5/8	1	1-1/4	1-1/2	1-5/8	1-5/8
M6	0	3/8	1/2	3/4	1	1-1/4	1-3/8	1-1/2	1-1/2
M7	0	1/4	3/8	1/2	3/4	7/8	7/8	1-1/8	1-1/8
M8	0	1/8	1/4	1/2	3/4	1-1/8	1-1/4	1-1/2	1-1/2
Bottom B1	0	0	-1/8	1/4	1/4	3/8	3/8	1/4	1/4
B2	0	1/8	0	3/8	3/8	1/2	1/2	1/2	1/2
B3	0	-1/2	-1/4	-1/4	1/8	1/4	1/4	3/8	3/8
B4	0	0	0	-1/8	1/2	5/8	5/8	7/8	7/8
B5	0	-1/8	-1/8	1/4	3/8	3/8	5/8	5/8	5/8
B6	0	-1/8	-1/4	1/8	1/4	3/8	1/2	1/2	1/2
B7	0	0	1/4	1/4	3/8	5/8	5/8	3/4	3/4
B8	0	1/8	3/8	1/8	1/2	5/8	5/8	1/2	1/2

TEST #10 (Continued)
FIRE TEST OBSERVATIONS

TIME (MIN)	EXPOSED SIDE	UNEXPOSED SIDE
0:00	Timing started upon ignition of lowest row of burners	Door(s) latched, bolt fully extended
0:30	Luminous flames to full height of furnace	
1:00	Warping of skins	
1:30	Gassing at bottom of doors into furnace	
2:00	Discoloration of skins	Doors warping and bowing towards furnace
3:00	More distortion	Skins smoking
4:45	Neutral pressure plane at 45 in. above sill established	Venting heavily at top of both doors
5:00	Liquid plastic running onto door sills and dripping to furnace floor	Venting briskly from latch level up
5:43	Plastic on sill flaming, flames impinging on door	Venting somewhat reduced
8:00		Plastic running out onto unexposed side of sill and hardening
9:00	Plastic boiling and burning on sills	Venting continues, crackling sound inside door
10:00	No change	Venting at centre hinge of L.S. Door
13:00	Brisk flaming on sill	
15:00	Less flaming on sills	Bowing more severe
20:00	Some flaming on sills of L.S. Door	Venting at edges only, doors are wedging in
30:00	Conditions stable	Very slight venting from door perimeter
60:00	No change	Venting negligible
90:00	No change	No burnthrough, no flaming has occurred on the unexposed side

TEST #10 (Continued)
FIRE TEST OBSERVATIONS (Continued)

BS 476 COTTON PAD TEST		
TIME (MIN)	LOCATION	RESULT
7:04	Top of L.S. Door	No ignition
12:00	Top of L.S. Door	No ignition

TEST #10 (Continued)

HOSE STREAM TEST OBSERVATIONS

Hose Stream Test Duration: 3 minutes, 30 seconds

Time from end of fire test to application of hose stream test: 45 seconds

Observations: 10 seconds - latch top corner pushed out about 6 in. on door opening out of furnace
45 seconds door released and opened

R.S. Door remains closed and latched (door opening into furnace)

Criteria: The door shall remain in the opening during the hose stream test. A single swinging door shall not separate more than 1/2 in. at the latch location. There shall be no development of openings anywhere through the assembly. An opening is defined as a through hole in the assembly that can be seen from the unexposed side when viewed from the direction perpendicular to the plan of the assembly at the location of the suspected opening.

Conclusion: Door opening into furnace stayed closed and latched. Door opening out opened and consequently

failed hose stream test. Observation of the door and frame revealed no significant distortion or other reason for causing the door to become unlatched. We concluded that the door most likely was not fully latched at the start of the test.

TEST #10 (Continued)

**SUMMARY OF TEST RESULTS
 RELATING TO NFPA 252/UBC 43-2 (1991)**

FIRE TEST	L.S. DOOR (OPENING OUT)	R.S. DOOR (OPENING IN)
Maximum movement of door from door frame	1/4 in.	1/2 in.
Maximum surface temperature rise at 30 min.	1283°F 713°C	1355°F 753°C
Average surface temperature rise at 30 min.	1255°F 697°C	1292°F 718°C
Flaming on unexposed side in first 30 min.	None	None
Flaming on unexposed side after 30 min.	None	None
Development of openings	None	None
Did separation at latch location exceed 1/2 in.	No	No
HOSE STREAM TEST		
Did doors remain latched and in the opening	No	Yes
Development of through openings - Door and Frame - Frame and Wall	No No	No No
Maximum movement of door from door frame	Not recorded	Not recorded
Did separation at latch location exceed 1/2 in.	No	No

TEST #10 (Continued)

**SUMMARY OF TEST RESULTS
RELATING TO BS 476:PART 20:1987**

FIRE TEST	L.S. DOOR (OPENING OUT)	R.S. DOOR (OPENING IN)
Time; individual unexposed surface temperature rise of 180°C	3:55	3:55
Time; average unexposed surface temperature rise of 140°C ("insulation failure")	4:20	3:50
Time; unexposed surface temperature rise of 300°C	5:17	5:51
Time; cotton pad ignition	None observed	None observed
Did through openings develop	No	No
Did sustained flaming occur on unexposed side	No	No
Time; "integrity" failure	Test duration	Test duration