carboline

PER

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April 17, 1979

TO: SLL/HDT/JFM/SLS/JRL/StL/Group Leaders/Retrieval System

TITLE: Thermal Transmission of Pyrocrete 241 at Varying Thicknesses

REFERENCE: Johns-Manville

D.O.C.: 07814

PURPOSE: To experimentally determine the time the back side temperature of Pyrocrete 241 coated steel panels reached 250°F above ambient, when applied at varying thicknesses, and exposed to the standard ASTM E-119 time/temperature curve.

CONCLUSION: The following thicknesses of Pyrocrete 241 reached 250°F above ambient at the following time periods shown:

1) 1/4 inch - 6 minutes
2) 1/2 inch - 10 minutes
3) 1 inch - 31 minutes
4) 1-1/2 inch - 73 minutes

(See Figure 1 - Best Fit Curve)

PROCEDURE:

I. System

A. Steel Plate 2' x 2' (16 gauge)
B. 3.4 galvanized metal lath spot welded to the steel panel
C. Pyrocrete 241

II. Application

Pyrocrete 241 spray applied at the following thicknesses: 1/4", 1/2", 1", and 1-1/2". Screeds were used to obtain exact thicknesses.

III. Cure

Pyrocrete 241 cured 30 days ambient laboratory.

IV. Tests

Expose Pyrocrete 241 to standard ASTM E-119 time/temperature curve.

A. Measure the temperature of the unexposed uninsulated back side of the steel panel with four thermocouples. Three thermocouples to be positioned so that an overall temperature is obtained and insulated with a 2" in diameter asbestos disc. One thermocouple to be uninsulated and positioned in the center of the panel.

B. Record time when overage thermocouples are 250°F above ambient or single thermocouple temperature of 325°F above ambient.

C. Record ambient temperature.

TABLE I

1/4 Inch Thick Pyrocrete 241

Time (Minutes)	Average Temperature (°F) of Four Thermocouples	Temperature (°F) of Highest Thermocouple	Furnace Temperature (°F)
5	290	320	1090
10	520	560	1250
20	790	870	1480
30	860	960	1570
40	890	990	1630
50	910	1020	1670
60	930	1040	1720
70	950	1060	1740

Ambient temperature 75°F.

TABLE II

1/2 Inch Thick Pyrocrete 241

Time (Minutes)	Average Temperature (°F) of Four Thermocouples	Temperature (°F) of Highest Thermocouple	Furnace Temperature (°F)
5	200	220	1165
10	330	390	1250
15	470	550	1380
20	590	690	1450
30	750	840	1550
40	810	890	1610
50	820	900	1660
60	830	920	1700
75	845	940	1730

Ambient temperature 75°F.

TABLE III

1 Inch Thick Pyrocrete 241

Time (Minutes)	Average Temperature (°F) of Four Thermocouples	Temperature (°F) of Highest Thermocouple	Furnace Temperature (°F)
5	80	90	960
10	170	190	1230
15	190	200	1350
20	210	220	1460
30	330	350	1600
40	440	470	1620
50	520	550	1630
60	570	610	1700
70	620	660	1750
80	640	690	1780
90	660	710	1800
100	670	720	1810
110	670	720	1820
120	680	725	1830
130	680	730	1860
140	680	730	1850

Ambient temperature 75°F.

TABLE IV

1-1/2 Inch Thick Pyrocrete 241

Time (Minutes)	Average Temperature (°F) of Four Thermocouples	Temperature (°F) of Highest Thermocouple	Furnace Temperature (°F)
5	70	-	970
10	80	-	1220
20	160	-	1500
30	220	-	1570
40	225	-	1640
50	230	-	1680
60	250	265	1700
70	315	340	1740
80	380	400	1770
90	430	455	1780
100	470	500	1770
110	505	530	1820
120	515	550	1820
130	540	570	1820
140	555	590	1840
150	575	610	1870
160	585	620	1880

Ambient temperature 75°F.

DISCUSSION
OF RESULTS: Post burn observations showed that there was no spalling or cracking of the Pyrocrete 241.

The thermal transmission Graph (Figure 1) is only suitable for a maximum of 73 minutes. Since most rating requirements are 2 and 3 hours, another test specimen with increased thickness will be tested. To extrapolate beyond 10% could result in an inaccurate rating endpoint.

Paul E. Robinson
Developmental Engineer
Fireproofing

Chris F. Magdalin
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Fireproofing Products

PER:CFM/mbn:R

THICKNESS OF PYR[redacted]RETE 241 FOR VARIOUS FIR[redacted]NDURANCE RATINGS

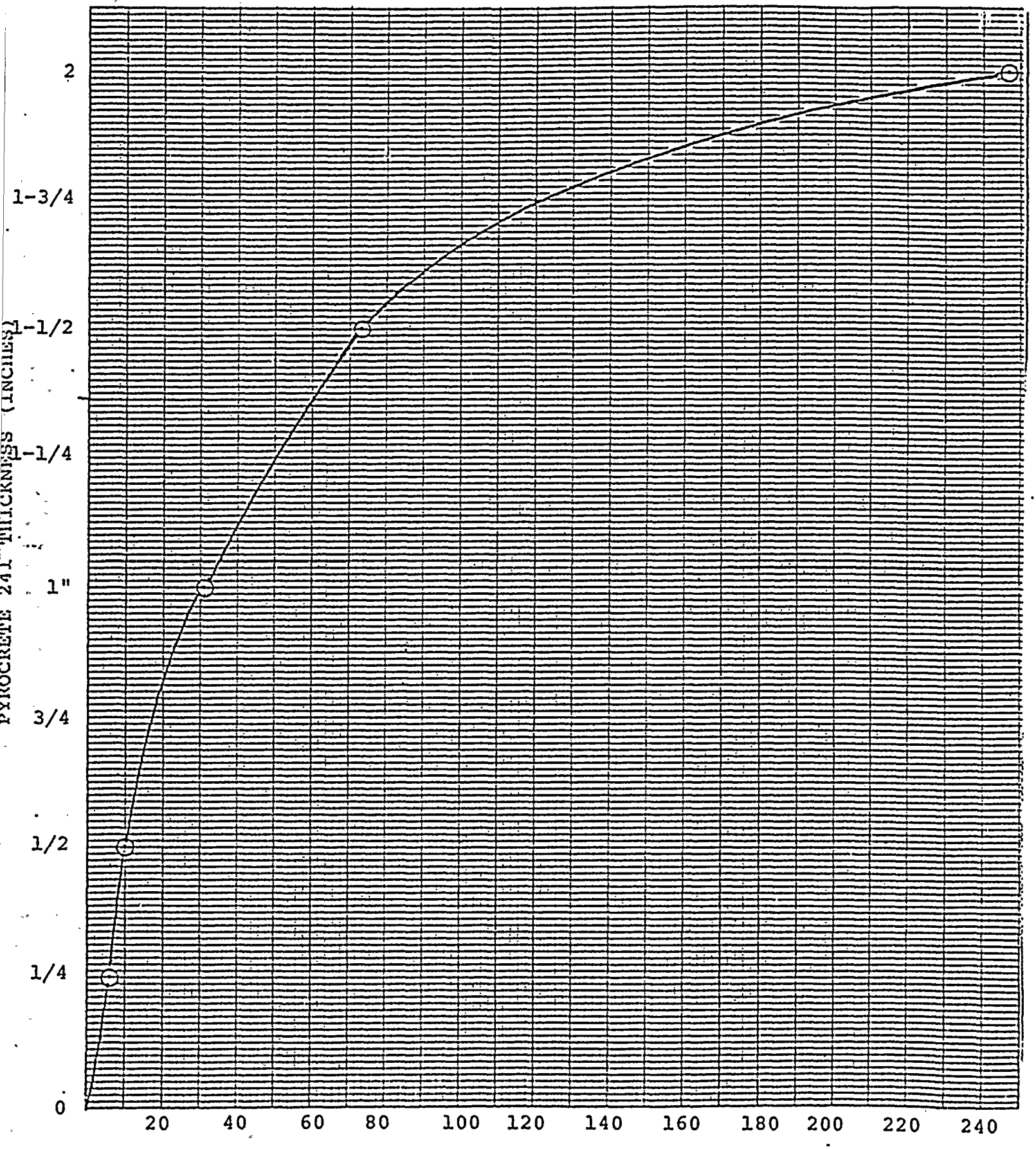


FIGURE 1

Thermal Transmission
Pyrocrete 241

250°F Temperature Rise above Initial

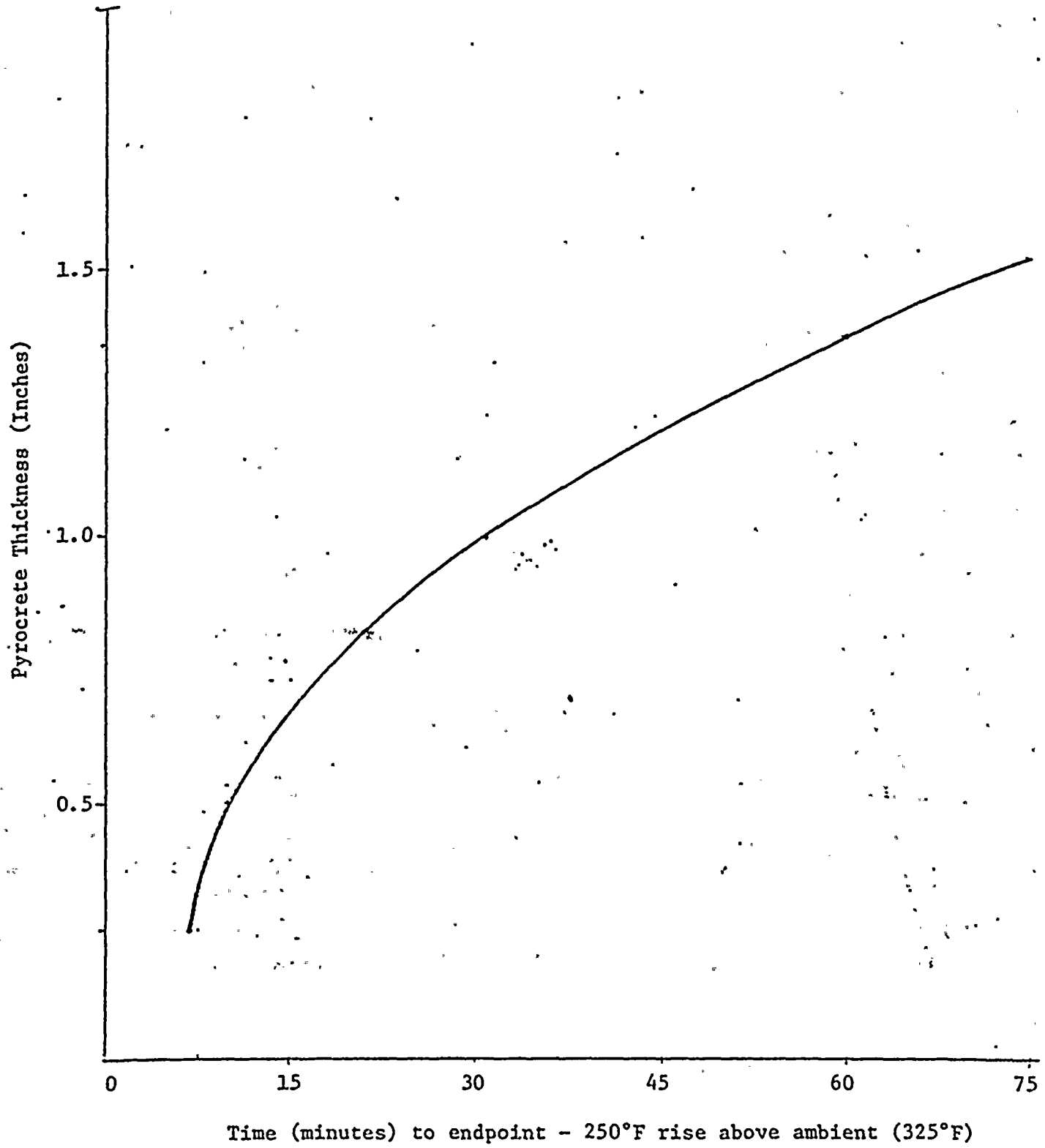


FIGURE 2

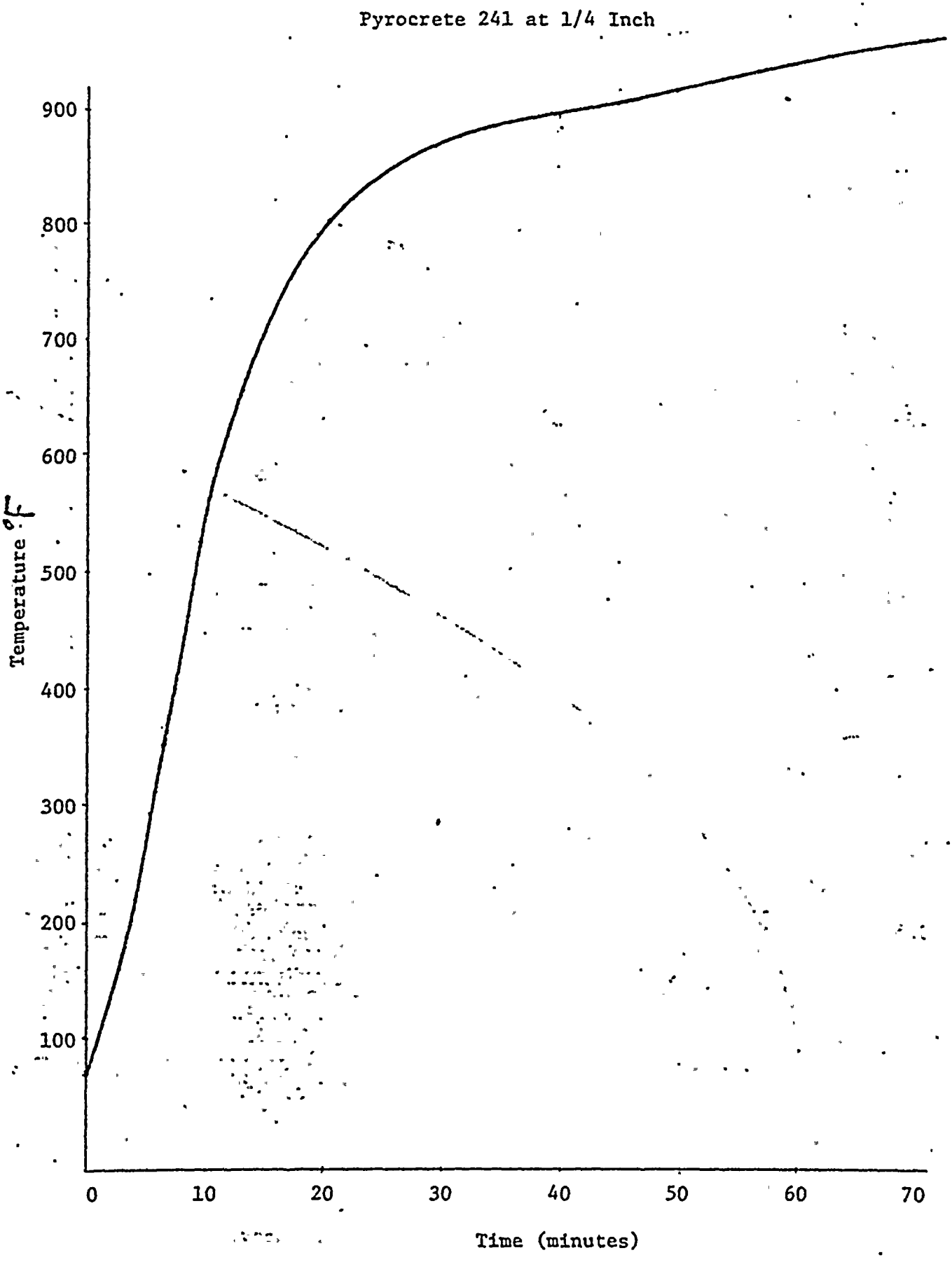

Pyrocrete 241 at 1/4 Inch
900
800
700
600
500
400
300
200
100
Temperature °F
0
10
20
30
40
50
60
70
Time (minutes)

FIGURE 3

Pyrocrete 241 at 1/2 Inch

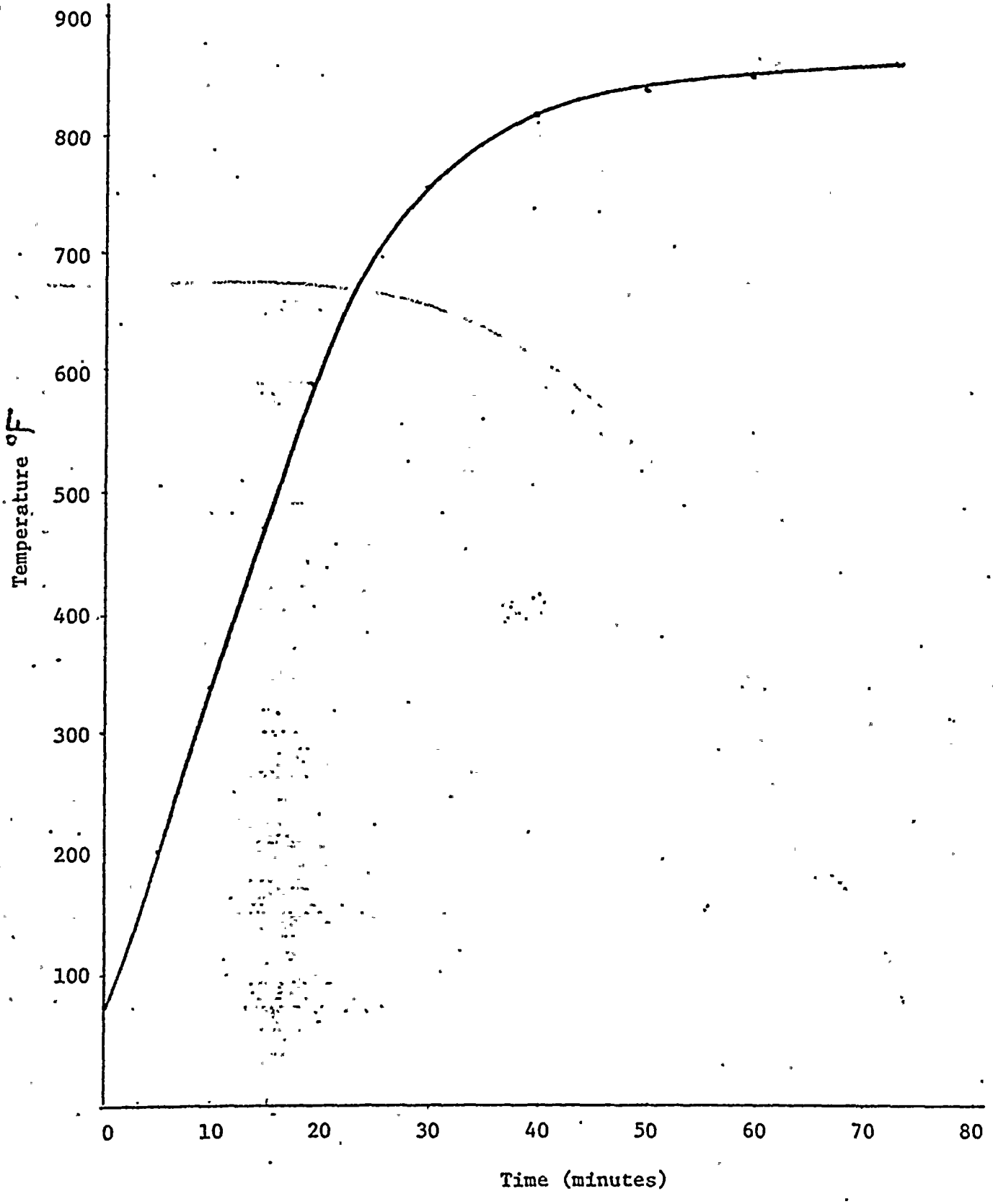


FIGURE 4

Pyrocrete 241 at 1 Inch

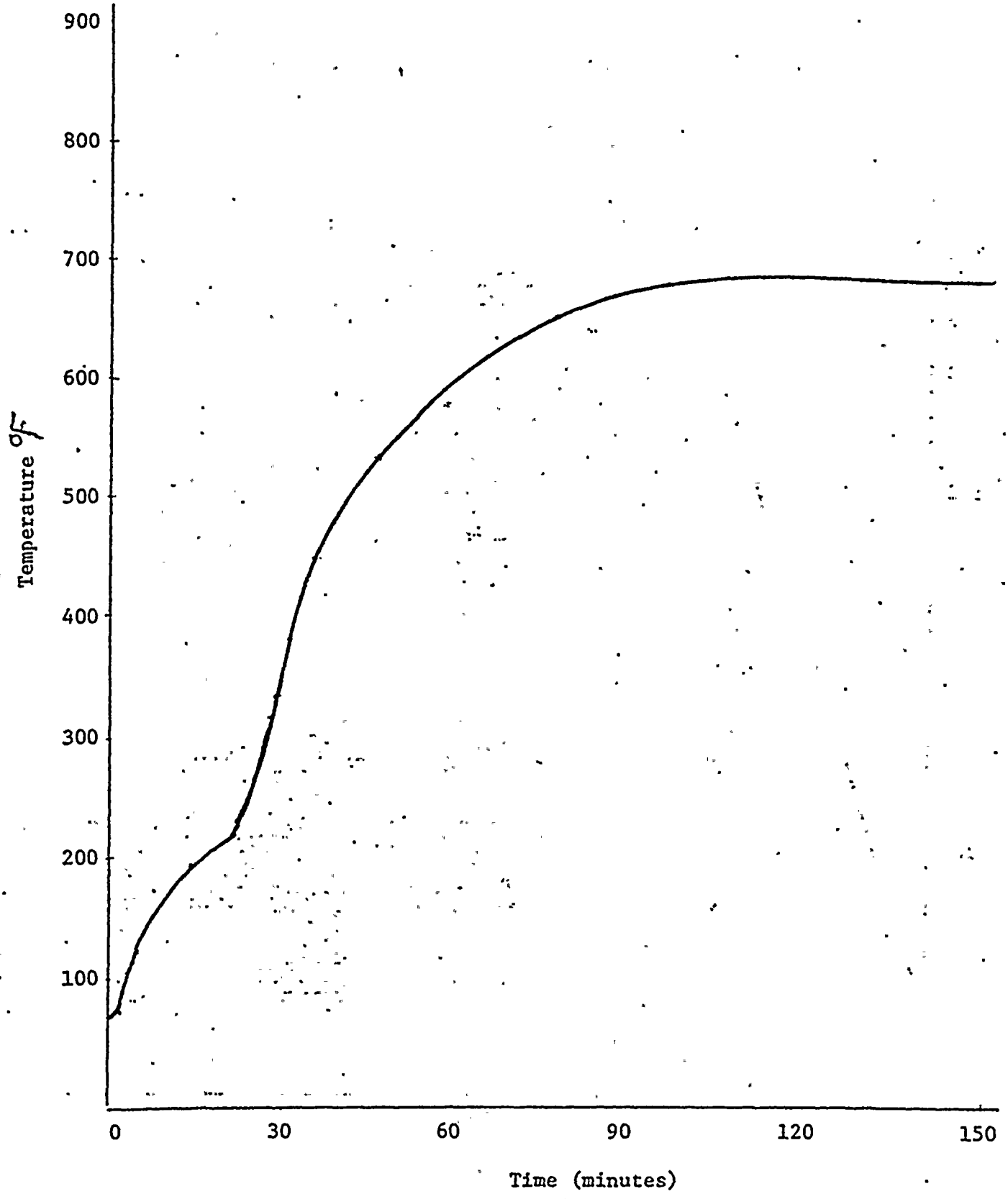
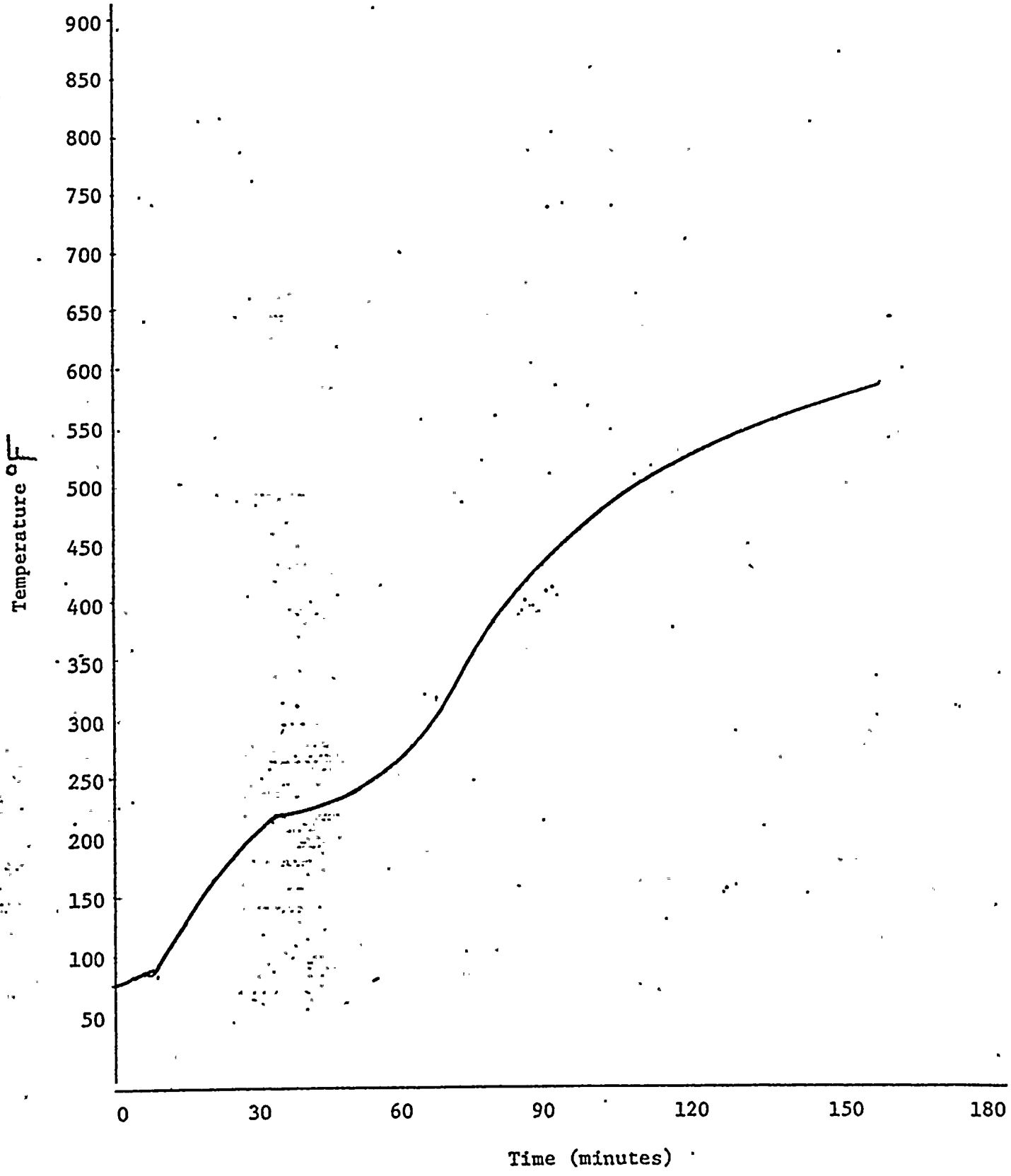


FIGURE 5

Pyrocrete 241 at 1-1/2 Inches



INDUSTRIAL TESTING LABORATORIES inc.

Chemists
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Report No. 79-9-40 September 6, 1979

Determination of Thermal Transmission characteristics of a two-inch thick "Pyrocrete 241" coating.

Carboline Company
350 Hanley Industrial Court
St. Louis, Mo. 63144

Attn: Mr. Chris F. Magdalin
Technical Director
Fireproofing Products DIV.

REF: Public Service Electric and Gas Company

TEST REPORT

A. INTRODUCTION

The purpose of this investigation was to determine the time required for the unexposed side of "Pyrocrete 241" to reach 250° F. above ambient when exposed to the standard ASTM E-119 Time/Temperature curve.

B. MATERIAL DATA

1. System:
   a. Steel plate 2' x 2' (16 gauge).
   b. 3.4 galvanized metal lath wrapped completely around panel.
   c. "Pyrocrete 241."

2 Application:

"Pyrocrete 241" trowel applied to a thickness of two inches.

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3. Cure:

Thirty (30) days at +70° ±5° F. and 50-60% relative humidity.

C. TEST PROCEDURE:

1. Expose "Pyrocrete 241" to the standard ASTM E-119 Time/Temperature curve.
2. Record ambient temperature.
3. Measure the temperature of unexposed uninsulated back side of the steel panel with five thermocouples (thermocouples covered with 2" x 2" insulating refractory).
4. Position of the thermocouples - see Diagram #1.
5. Record that time the average of all five thermocouples reached 250° F. above ambient.

D. SUMMARY

During the fire tests, thermocouple measurements were made of both furnace and specimen temperatures.

According to ASTM E-119, both the furnace control and the area developed under the Time/Temperature curve be achieved by averaging the thermocouple readings within the noted limitations: (1) 10 percent of the corresponding area under the standard curves, Time/Temperature curve, for fire tests of one hour or less fire durations; (2) 7.5 percent for fire duration over

one hour and not more than two hours; (3) and within five percent for tests exceeding two hours.

Examination of the furnace temperature charts (Chart 1) revealed that the requirements for furnace control were achieved.

The specimen temperature was measured by means of five thermocouples positioned as shown on the temperature chart (Chart 2).

Approximately 195 minutes into the fire test, thermocouple #14 started to read slightly cooler than the other four thermocouples. After 210 minutes, thermocouple #4 was 19° F. cooler than the average of the other four; however, there was no indication that the thermocouple was reading incorrectly during the test.

If thermocouple #4 were not to be included in the average, the specimen would have been considered to have failed after 257 minutes.

Examination of the "Pyrocrete 241" at the conclusion of the fire test revealed there to be no cracking or spalling and only a lightly ablated surface.

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E. CONCLUSION

Based on results of tests conducted and observations made, it is our opinion that the two-inch thickness of "Pyrocrete 241" reached 250 ° F. above ambient at 264 minutes.

Respectfully submitted,

INDUSTRIAL TESTING LABORATORIES, INC.

Allan M. Siegel, P.E.
Director

AMS/mn

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TEST DATA:

TABLE 1

Time in Minutes	Average Temp. (°F) of five Thermocouples	Temp. (°F) of Highest Thermocouples	Temp. (°F) of Aug. Furnace	ASTM E-119 Curve (°F.)
5	79	79	1233	1000
10	79	80	1368	1300
15	82	83	1488	1399
30	129	144	1586	1550
45	186	199	1668	1638
60	196	201	1739	1700
75	197	202	1782	1750
90	197	202	1824	1792
105	198	203	1856	1826
120	198	203	1862	1850
135	199	203	1900	--
150	199	204	1910	1888
165	200	204	1932	--
180	200	204	1928	1925
195	202	207	1952	--
210	216	237	1970	1962
225	239	276	1973	--
240	272	311	2002	2000
255	311	340	2004	--
264	327	344	--	2025

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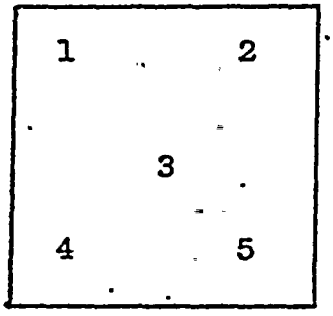
DIAGRAM #1

THERMOCOUPLE POSITIONS OF FURNACE AND THERMAL TRANSMISSION PANEL



1. Unless otherwise specified, furnace thermocouples were positioned to within 12 inches of the test specimen.

2. Furnace thermocouples consisted of 14-gauge Type K single bead ceramic thermocouples in inconel tubes.

3. Panel thermocouples were chromel-aluminel Type K 20-gauge wire with the ends twisted together. They were held against the panel by two pounds of weight separated from the thermocouple by insulation.

4. Panel thermocouple positions were determined by the size of the panel. Number 3 was positioned in the center of the panel with the other four being at the centers of the squares resulting from dividing the panel into four equal areas.