

FIRE QUALIFICATION TEST ON SILICONE FOAM FLOOR PENETRATION SEALS

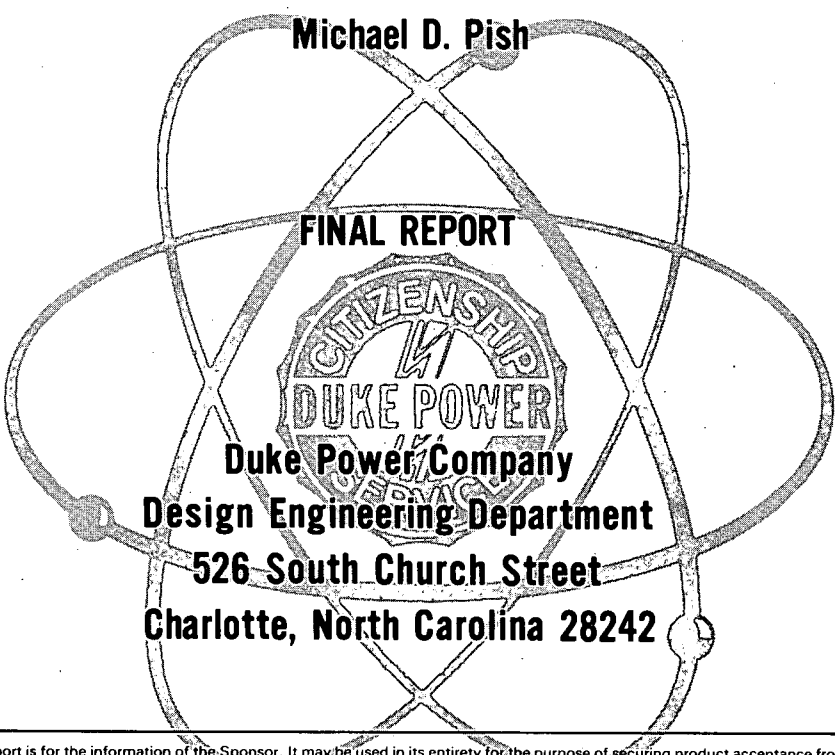
SLAB NO. 4

PROJECT NO. 03-5656-001

by

Michael D. Pish

FINAL REPORT

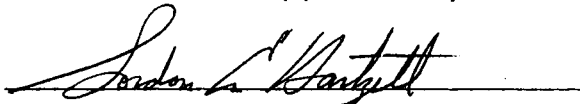


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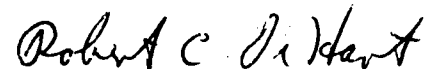


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SUMMARY

On May 10, 1978 eight cable tray and conduit pipe penetrations designed by Duke Power Company were exposed to a three-hour fire endurance qualification test following the ASTM E-119 time/temperature curve.

The purpose of this test was to obtain a three-hour fire rating for referenced seal designs which utilized a base layer of four (4) inches of cementitious foam, covered with six (6) inches of Chemtrol Corporation's Firewall 50. The test was conducted in accordance with ASTM E-119 time/temperature requirements and a cold side negative pressure of one (1) inch of water. In addition, a hose stream test as described in Appendix VI, Section 4.3.12 of IEEE P634/D4 was to be applied.

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DESCRIPTION

A series of eight (8) penetration openings were cast into the test slab. These consisted of six (6) conduit pipe openings and two (2) consisted of large cable tray openings. The conduit pipe openings were four (4) inches and twelve (12) inches in diameter. The cable tray openings were nine (9) sq ft and 23 sq ft. (See Figures 1 and 2)

All penetrations were cast into an 8 ft x 10 ft x 12 in. thick concrete slab.

For a listing of penetration loading see Figures 3 and 4, and Table 1. For a listing of cable identification see Tables 2 and 3.

The test slab was placed on a horizontal furnace and exposed to the standard ASTM E-119 time/temperature curve. After three hours of exposure, the test slab was lifed in a horizontal position for the hose stream test and then moved to an area adjacent to the furnace where it was put on blocks to cool and view.

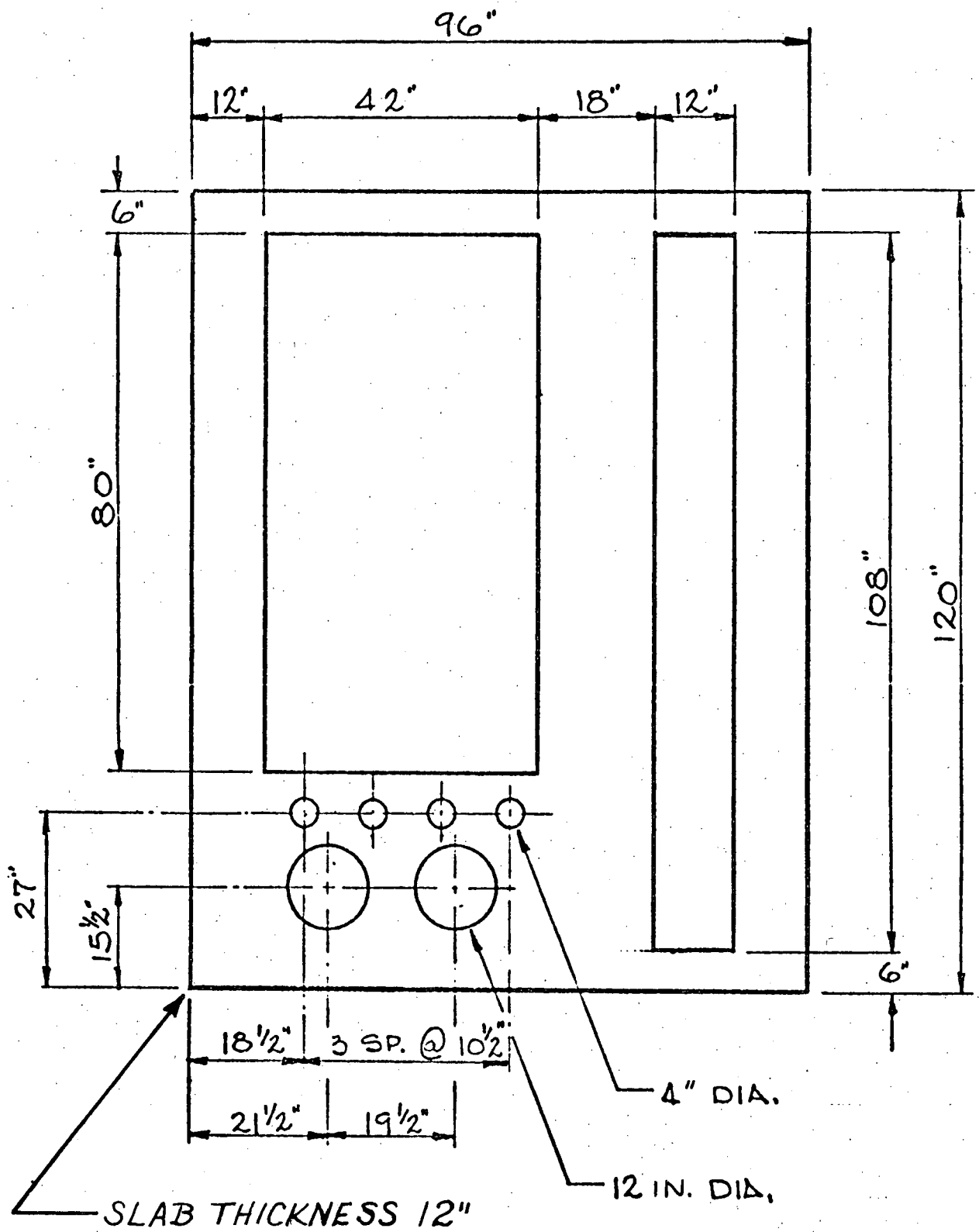
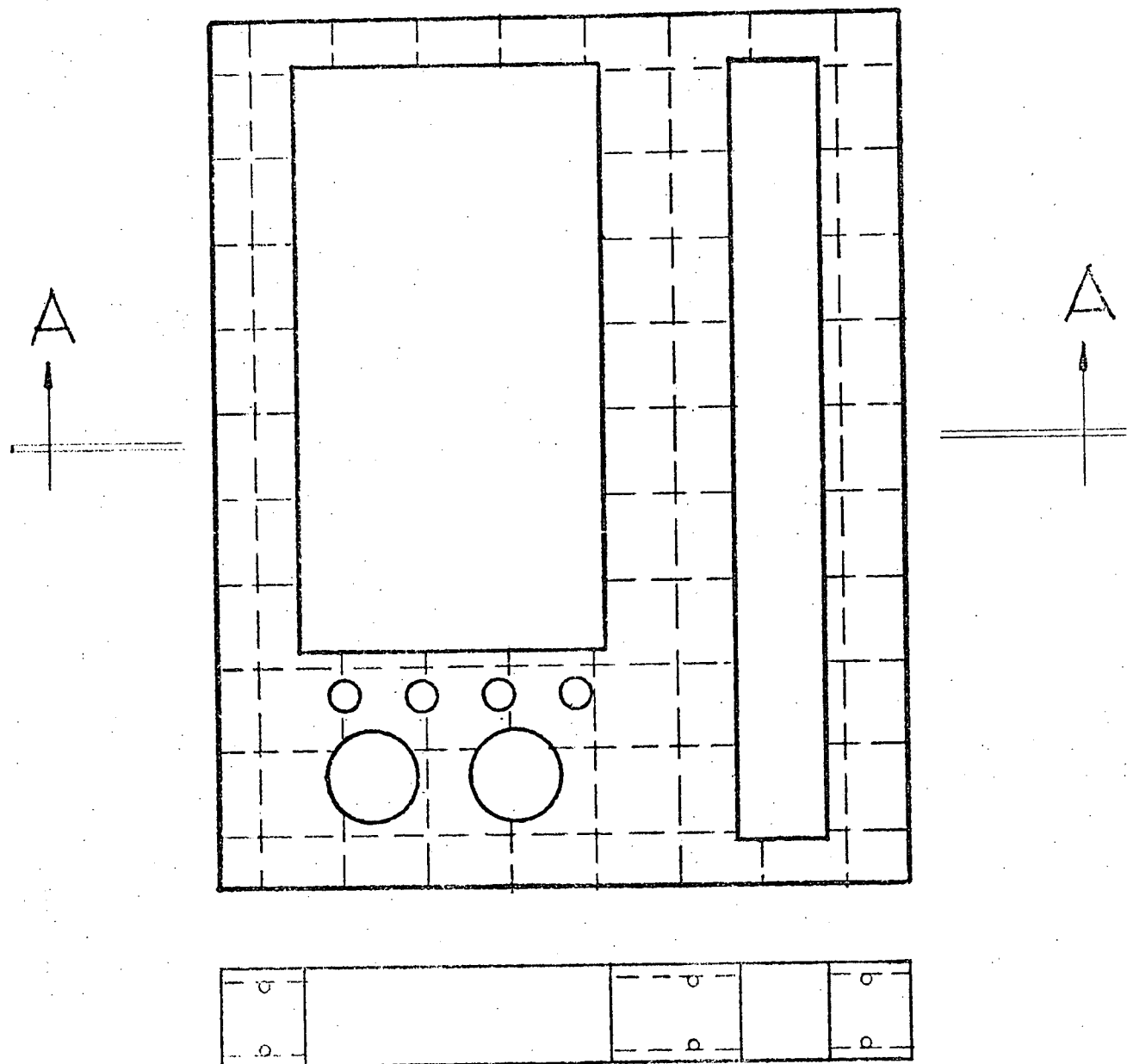


Figure 1. Slab Layout



SECTION A-A

Figure 2. Reinforcing Detail

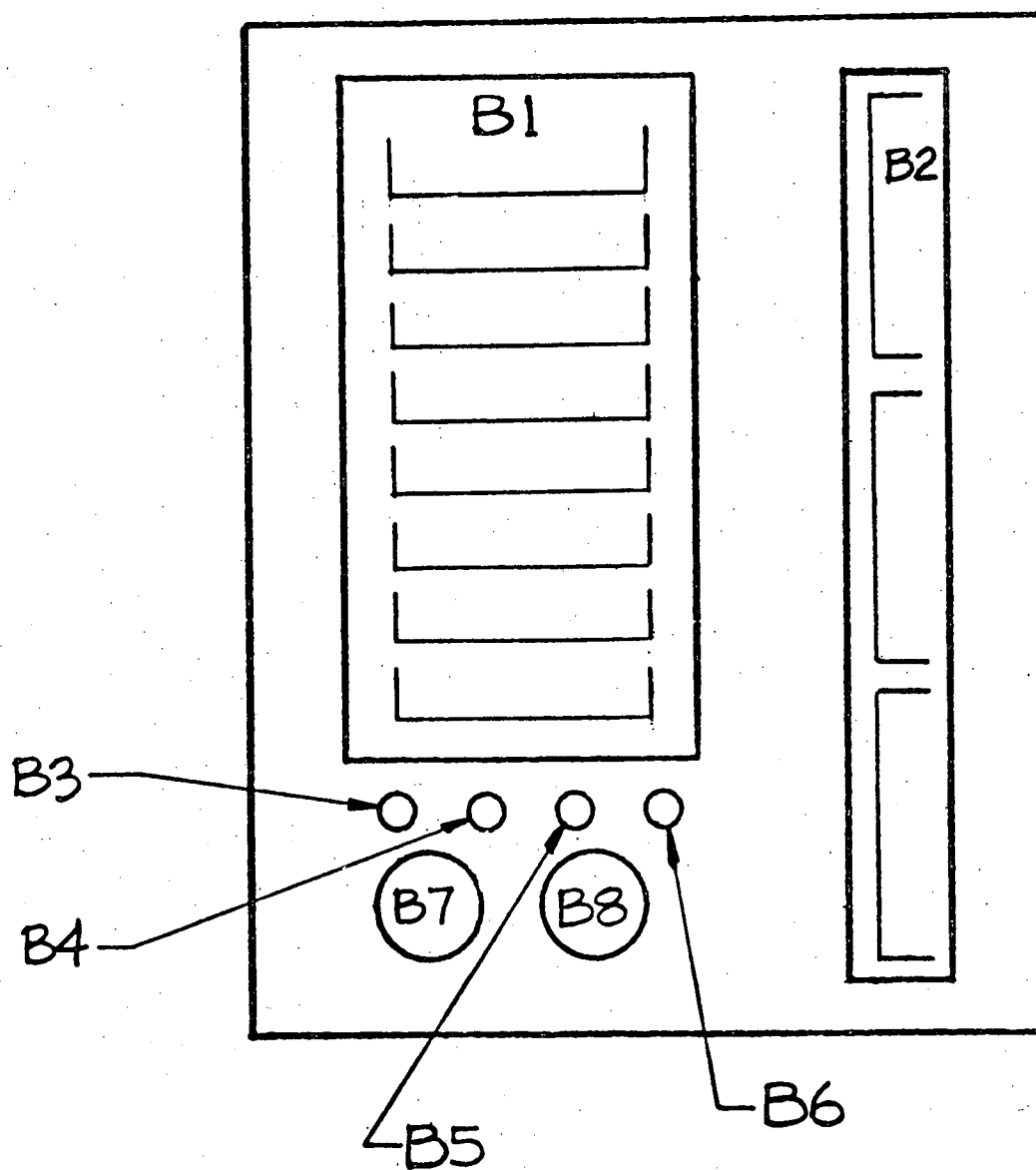


Figure 3. Cable And Tray Penetration
Opening Identification

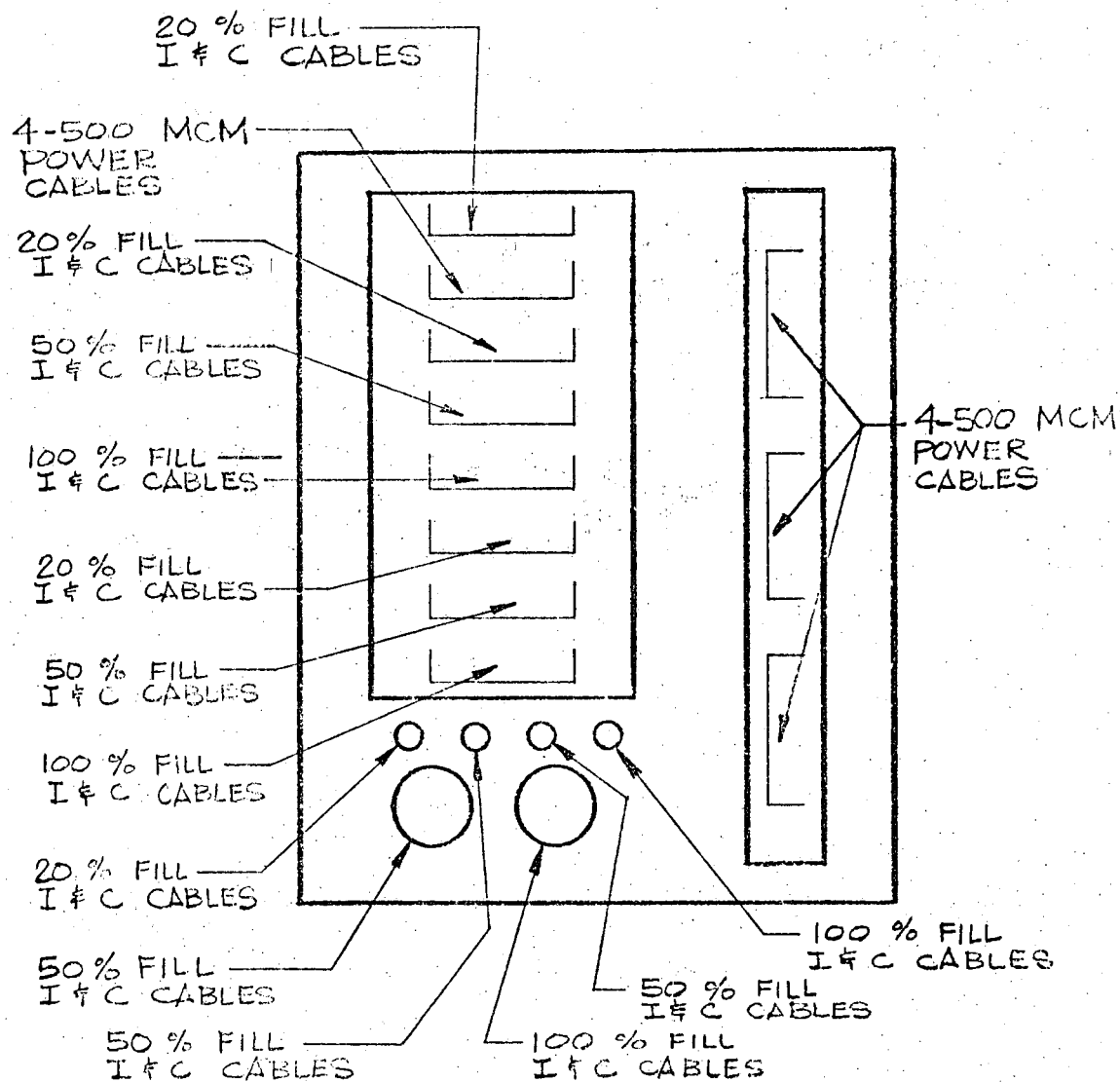


Figure 4. Penetration Loading

TABLE 1
PENETRATION LOCATION AND DESCRIPTION

Penetration	Area/Tray No.	Fill
B1	B1-1 B1-2 B1-3 B1-4 B1-5 B1-6 B1-7 B1-8	20% Instrument & Control 50% Instrument & Control 100% Instrument & Control 20% Instrument & Control 50% Instrument & Control 100% Instrument & Control
B2	B2-1 B2-2 B2-3	
B3	B3	1-500 MCM Power Cable
B4	B4	1-1/0 Power Cable
B5	B5	20% Instrument & Control
B6	B6	100% Instrument & Control
B7	B7	3-500 MCM Power Cable
B8	B8	100% Instrument & Control

SLAB #4 CABLE LISTING

Area	Tray	Group L to R	Cable's Group Total	Number of each Cable Color - Group	Cable Color	Cable Shield	Cable Size	Number of Conductors
B1	1	1	2	1	Black	Solid	1"	3
B1	1	2	1	1	Black	Solid	1"	3
B1	1	3	2	1	Black	Solid	1"	3
B1	1	4	1	1	Black	Solid	1"	3
B1	1	5	2	1	Black	Solid	3"	12
B1	2	6	1	1	Black	Solid	3"	12
B1	2	7	1	1	Black	Solid	3"	12
B1	2	8	1	1	Black	Solid	3"	12
B1	2	9	1	1	Black	Solid	3"	12
B1	3	10	6	5	Orange	Stranded	3/4"	4
B1	3	11	10	1	Yellow	Solid	3/4"	8
				4	Yellow	Stranded	3/4"	8
				4	Gray	Stranded	3/4"	12
				1	Black	Stranded	3/4"	6
				1	Yellow	Stranded	1/2"	3
B1	3	12	5	4	Orange	Solid	1"	14
B1	3	13	14	1	Gray	Stranded	3/4"	12
				8	Black	Solid	1/2"	3
B1	4	14	4	6	Yellow	Stranded	1/2"	1
				2	Orange	Solid	1"	14
B1	4	15	10	2	Yellow	Solid	3/4"	8
				2	Black	Solid	1"	3
				3	Black	Solid	1"	Mul Pair
B1	4	16	11	1	Orange	Solid	1"	14
				4	Black	Stranded	3/4"	6
				5	Gray	Stranded	3/4"	12
				2	Yellow	Stranded	3/4"	8
				2	Black	Solid	3/4"	9
				2	Black	Stranded	3/4"	Mul Pair
B1	4	17	16	3	Yellow	Stranded	3/4"	8
				7	Black	Stranded	3/4"	6
				4	Yellow	Stranded	1/2"	2
				1	Black	Stranded	3/4"	9
				1	Gray	Stranded	3/4"	12

SLAB #4 CABLE LISTING (Continued)

Area	Tray	Group L to R	Cable's Group Total	Number of each Cable Color - Group	Cable Color	Cable Shield	Cable Size	Number of Conductors
B1	4	18	15	4	Orange	Solid	3/4"	4
				2	Black	Solid	3/4"	9
				9	Yellow	Stranded	1/2"	1
B1	5	19	12	5	Orange	Solid	1"	14
				6	Black	Solid	3/4"	Mul Pair
				1	Black	Stranded	1/2"	6
B1	5	20		4	Orange	Solid	1"	14
				3	Yellow	Solid	3/4"	8
				6	Gray	Stranded	1/2"	12
				1	Black	Solid	1"	3
				1	Black	Solid	3/4"	Mul Pair
B1	5	21		3	Orange	Solid	1"	14
				4	Black	Solid	1"	3
				6	Gray	Stranded	1/2"	12
				1	Yellow	Stranded	3/4"	8
				1	Black	Solid	1/2"	Mul Pair
B1	5	22		7	Orange	Solid	1"	14
				5	Black	Stranded	1/2"	Mul Pair
				8	Gray	Stranded	3/4"	Mul Pair
				1	Yellow	Solid	3/4"	8
B1	5	23			Gray	Stranded	3/4"	12
					Black	Stranded	1/2"	6
B1	6	24	15	1	Orange	Solid	3/4"	4
				1	Black	Solid	1"	3
				2	Yellow	Solid	3/4"	8
				1	Black	Stranded	1/2"	6
				1	Black	Solid	3/4"	Mul Pair
				9	Yellow	Stranded	1/2"	1
B1	6	25	9		Orange	Solid	1"	14
					Orange	Solid	3/4"	4
					Yellow	Stranded	3/4"	8
B1	6	26	9	1	Black	Stranded	3/4"	6
B1	7	27	19	9	Orange	Solid	3/4"	4
				1	Yellow	Solid	3/4"	8
				3	Black	Solid	1"	8

SLAB #4 CABLE LISTING (Continued)

Area	Tray	Group L to R	Cable's Group Total	Number of each Cable Color - Group	Cable Color	Cable Shield	Cable Size	Number of Conductors
B1	7	28	16	3	Black	Stranded	3/4"	6
				3	Black	Stranded	3/4"	Mul Pair
				4	Orange	Solid	3/4"	4
				3	Orange	Solid	1"	14
				1	Yellow	Stranded	3/4"	8
				6	Gray	Stranded	3/4"	12
				1	Black	Stranded	3/4"	6
B1	7	29	12	1	Black	Solid	1"	8
				4	Orange	Solid	1"	14
				2	Black	Solid	1"	3
				4	Yellow	Stranded	3/4"	8
				2	Yellow	Stranded	1/2"	1
B1	8	30			Orange	Solid	1"	14
B1	8	31	24		Gray	Stranded	3/4"	12
					Black	None	3/4"	9
				4	Orange	Solid	1"	14
				4	Gray	Stranded	3/4"	12
				4	Black	Solid	1"	3
B1	8	32	24	6	Orange	Solid	3/4"	4
				5	Yellow	Stranded	1/2"	1
				1	Yellow	Solid	3/4"	8
				3	Orange	Solid	1"	14
				3	Black	Solid	1"	3
				8	Yellow	Solid	3/4"	8
				7	Yellow	Stranded	1/2"	1
B1	8	33	39	3	Orange	Solid	3/4"	4
				21	Orange	Solid	3/4"	4
				2	Yellow	Solid	3/4"	8
				16	Black	Stranded	3/4"	6
B3		34	4	4	Black	Stranded	3/4"	6
B4		35	8	3	Black	Stranded	3/4"	6
				2	Yellow	Solid	3/4"	12
				3	Orange	Solid	3/4"	4
B5		36	12	12	Black	Stranded	3/4"	6
B6		37	15	13	Black	Stranded	3/4"	6
				1	Gray	Stranded	3/4"	12

SLAB #4 CABLE LISTING (Continued)

Area	Tray	Group L to R	Cable's Group Total	Number of each Cable Color - Group	Cable Color	Cable Shield	Cable Size	Number of Conductors
B7		38	24	1	Black	None	1/2"	3
				4	Orange	Solid	1"	14
				5	Orange	Solid	3/4"	4
				7	Black	Stranded	3/4"	6
B8		39	49	8	Yellow	Stranded	1/2"	1
				15	Orange	Solid	1"	14
				17	Orange	Solid	3/4"	4
				15	Black	Stranded	3/4"	6
B2	1 2 3 4		4	2	Yellow	Solid	3/4"	8
				4	Black	Solid	3"	12

TABLE 3
CABLE IDENTIFICATION

Cable I.D.	Description
61SXJ16G.3 RED	61 conductor #16 AWG tinned copper conductor Ethylene Propylene rubber insulation; mylar asbestos binder tape; 5 MIL copper shield tape; Polyvinyl chloride jacket; galvanized steel interlocked armor; Polyvinyl chloride jacket.
3XJ12G1 8XJ12G1 19XJ12G1 12XJ12G1 37XJ12G1 3XJ10G1	3, 8, 12, 19, & 37 conductor #10 or 12 AWG tinned copper conductor; Neoprene Filled cotton binder tape; Galvanized steel inter- locked armor.
1SPA16G.3 2SPA16G.3 4SPA16G.3 20SPA16G.3	1, 2, 4, & 20 pair #16 AWG tinned copper con- ductor; Polyvinyl Chloride insulation; copper drain wire; aluminum - mylar drain wire, mylar binder tape; Polyvinyl chloride jacket; served wire armor; polyvinyl chloride jacket.
20PSA20G.3	20 pair #20 AWG tinned copper conductor; polyvinyl chloride insulation; mylar tape aluminum mylar tape shield; polyvinyl chlor- ide jacket; served wire armor polyvinyl chloride jacket overall.
RG62/U	Standard RG62/U, copper conductor poly- ethylene insulation; braided copper shield; polyvinyl chloride jacket.

TEST SPECIMENS

A. CONSTRUCTION

A floor section form (8 ft x 10 ft x 12 in. thick) was constructed of twelve-inch steel channel with a double mat of No. 8 rebar on 10-inch centers. A series of eight (8) penetration openings were cast into the slab. Six (6) were conduit pipe openings, 4 inches and 12 inches in diameter, and two (2) were cable tray openings, 9 sq ft and 23 sq ft.

The concrete ($f_c = 3000$ psi) was poured on January 30, 1978 and cured for one week at 400°F, using an enclosure constructed for this purpose. After the concrete had cured, the cable trays and pipe supports were welded to the basic framework.

Details of steel framing appear in Figure 5.

B. PENETRATION LOADING

Cable Tray Loading

Of the eleven (11) cable trays, all were the standard galvanized steel ladder back. These were installed and welded to the basic support framework. The assembled and loaded cable trays were installed in openings that were identified as penetrations B1 and B2. (See Figures 6 and 7).

Cable Loading in Pipe Sleeves

Six pipe sleeves with various cable loadings were evaluated. The size of the pipe sleeves were 4 1/2 inches and 12 inches, varying in loading size from 20 to 100 percent. Details of each penetration appear in Figures 8 through 13.

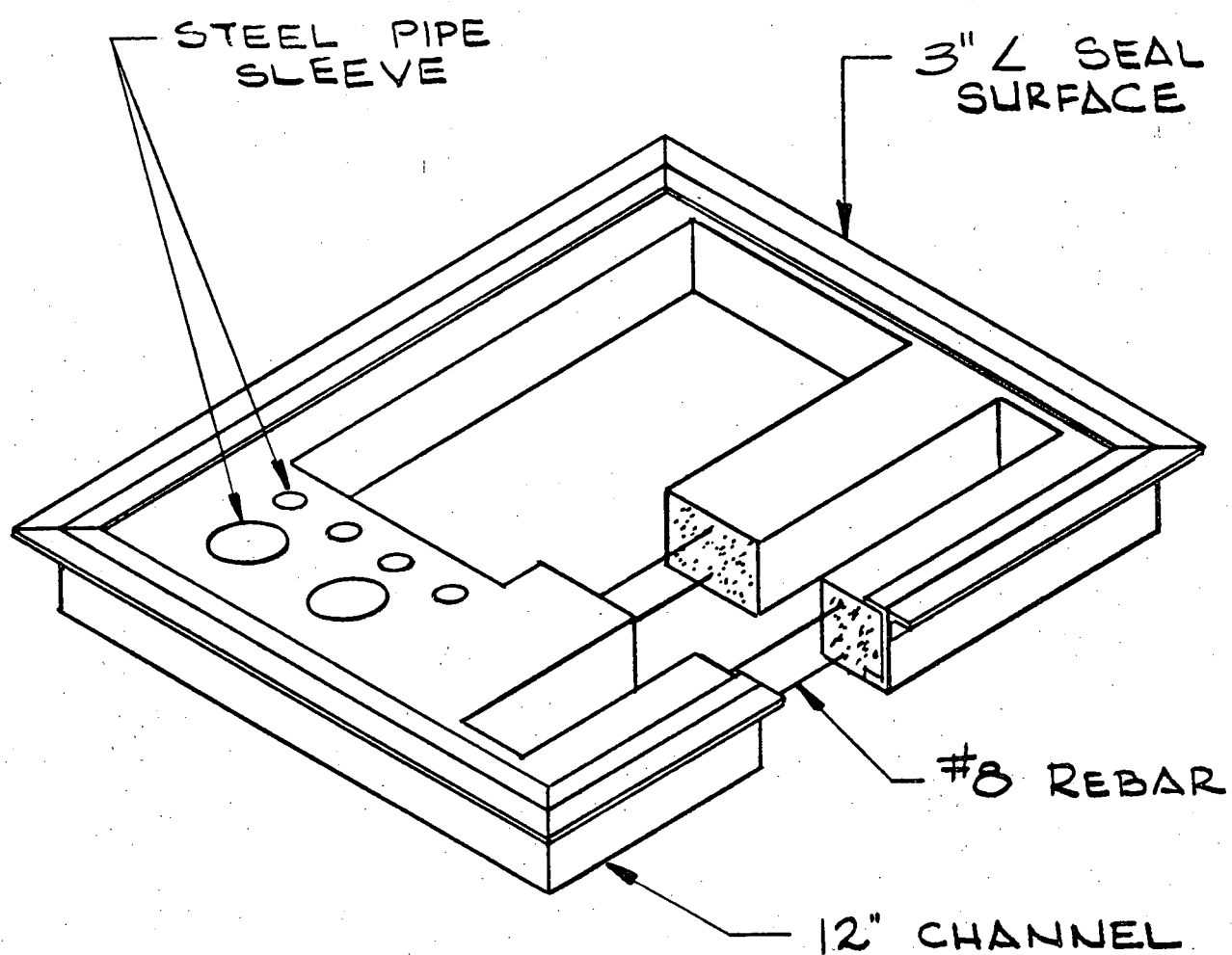


Figure 5. Schematic of Slab Layout

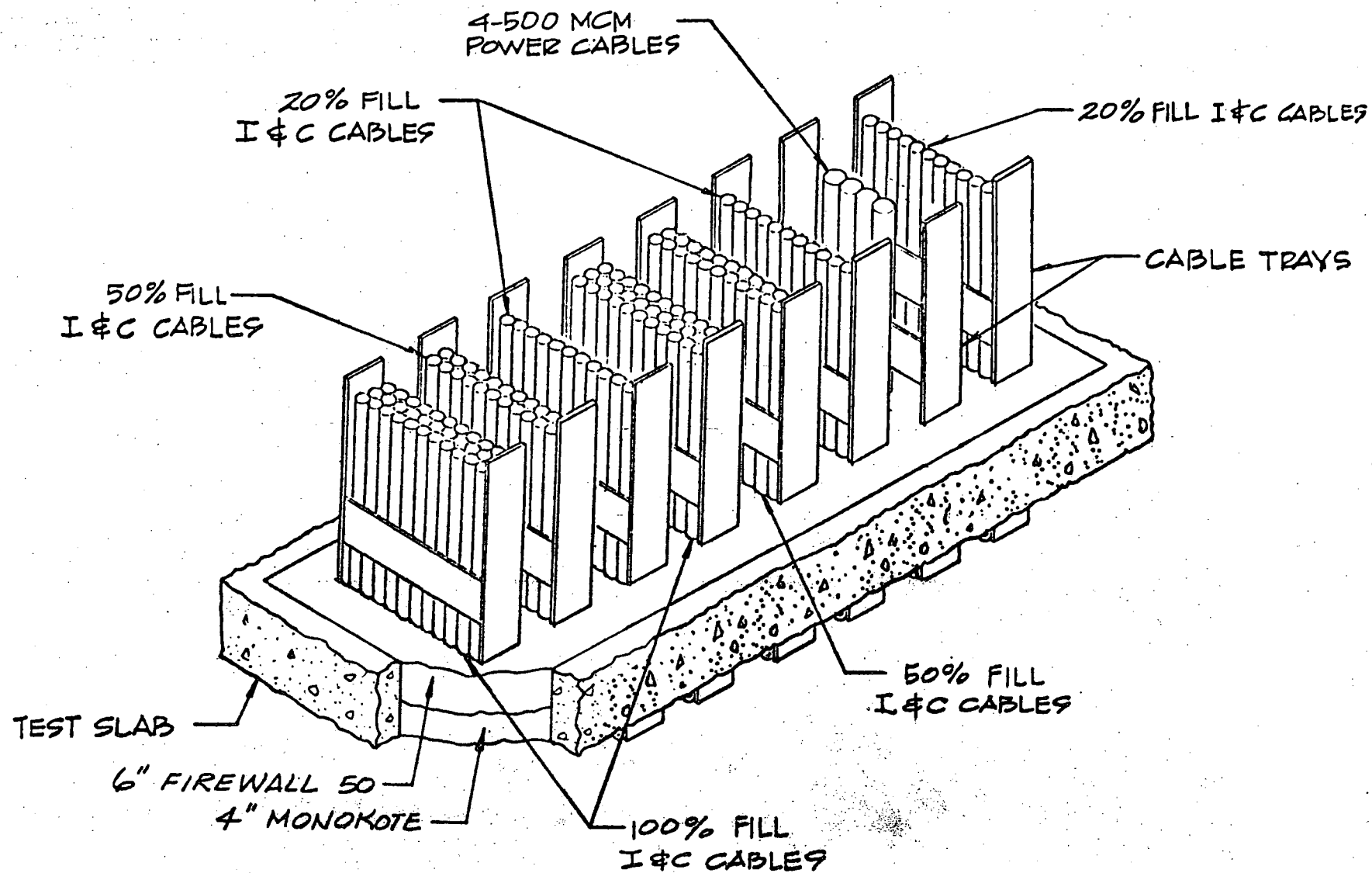


Figure 6. Penetration B1

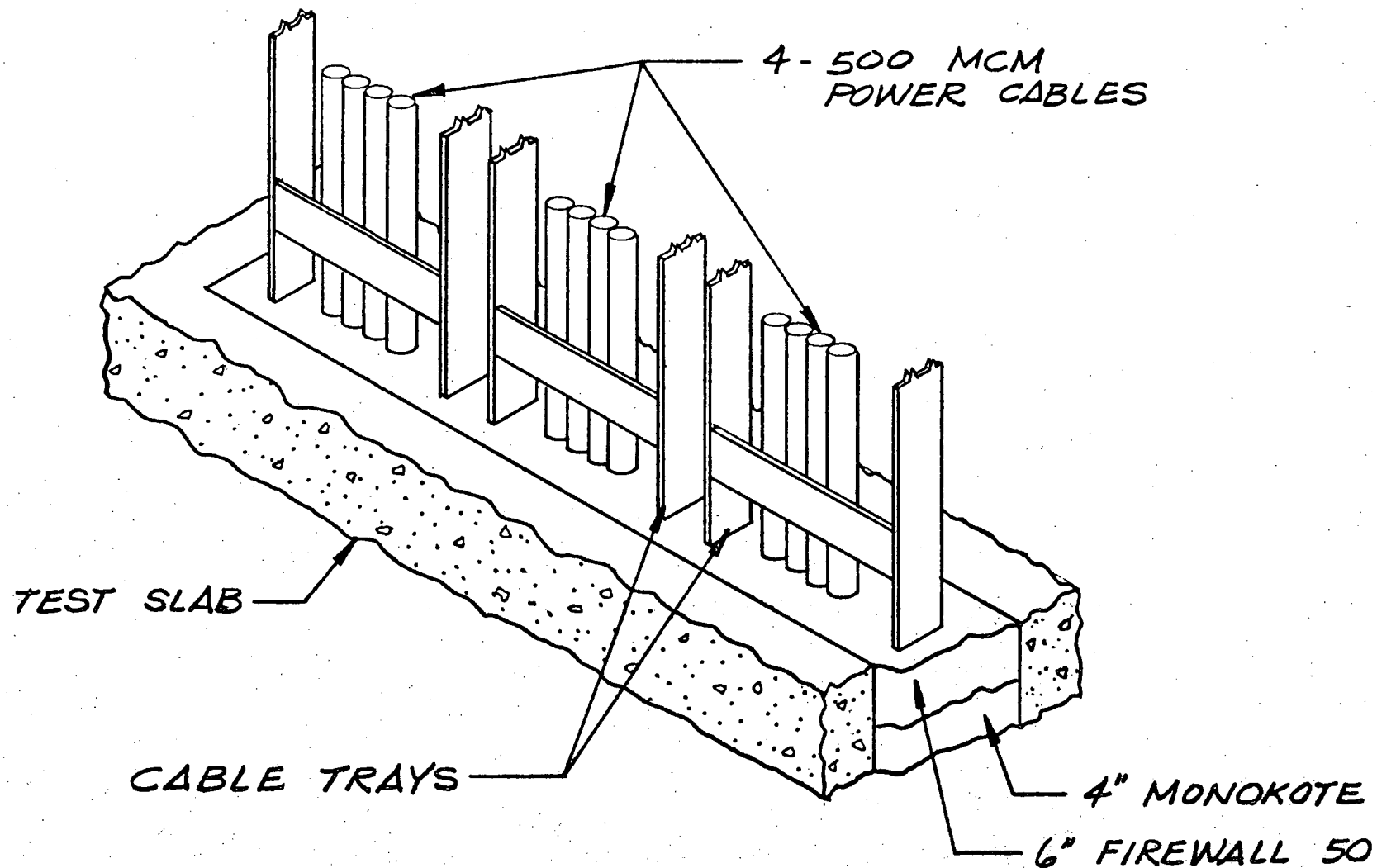


Figure 7. Penetration B2

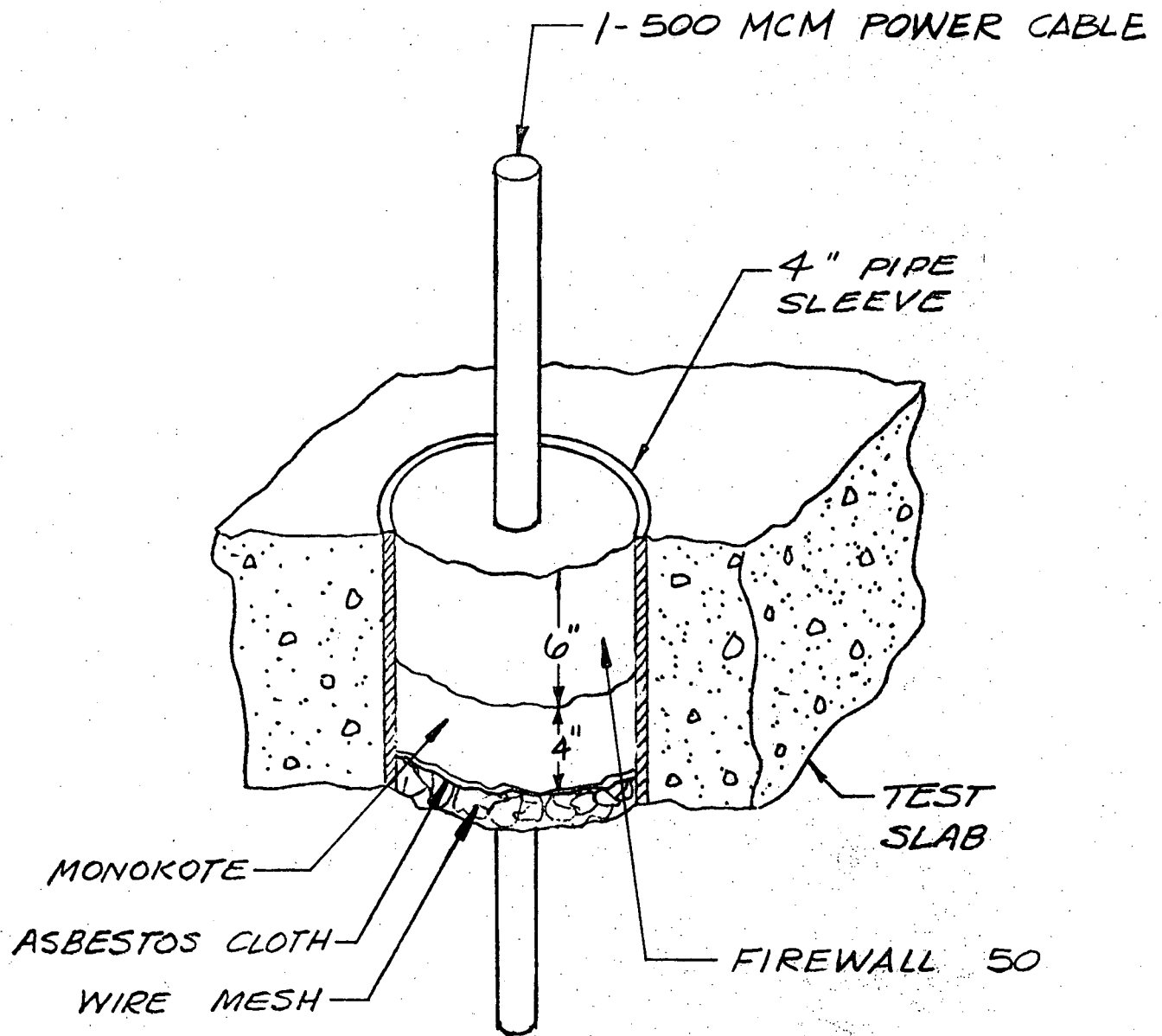


Figure 8. Penetration B3

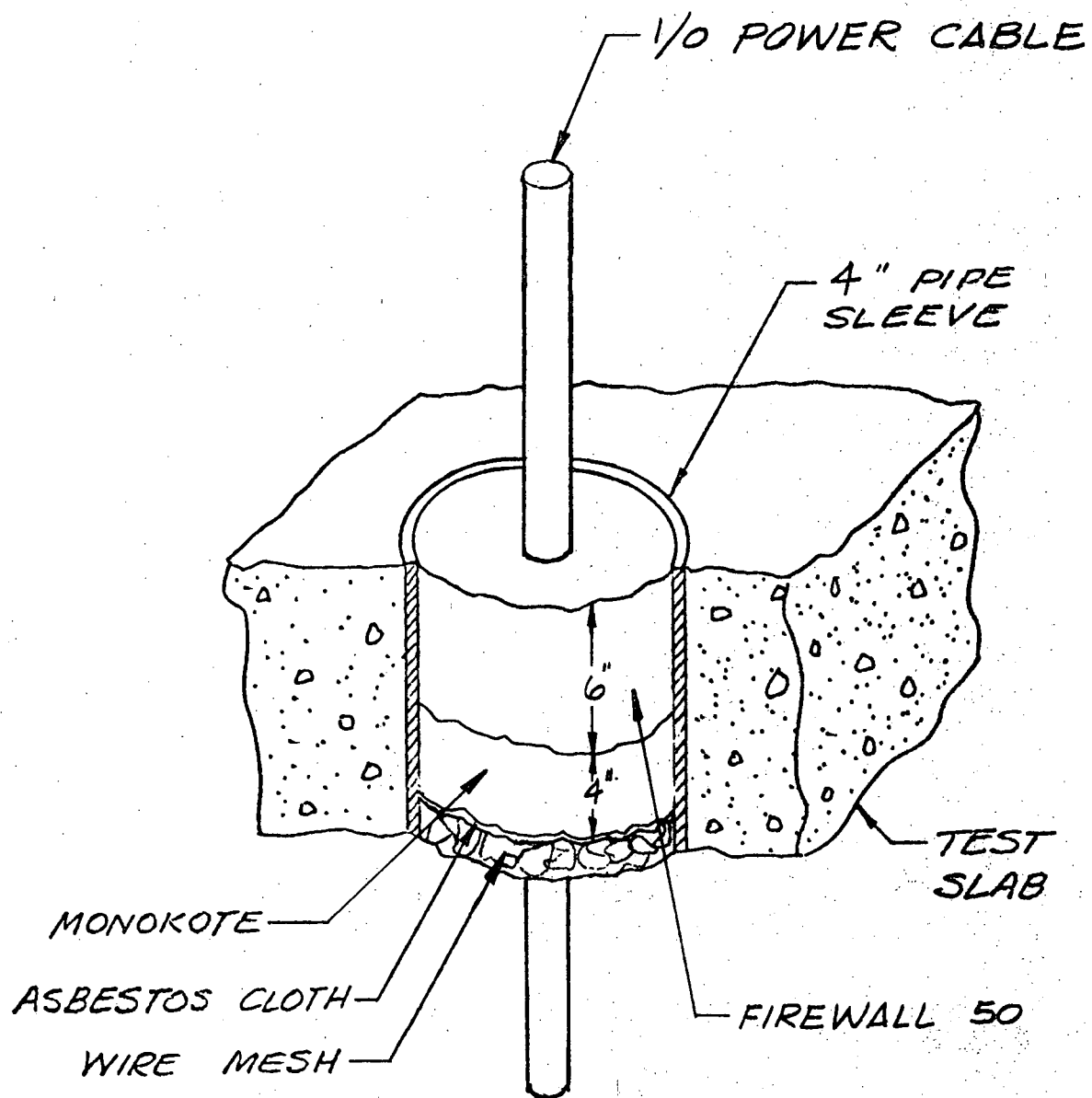


Figure 9. Penetration B4

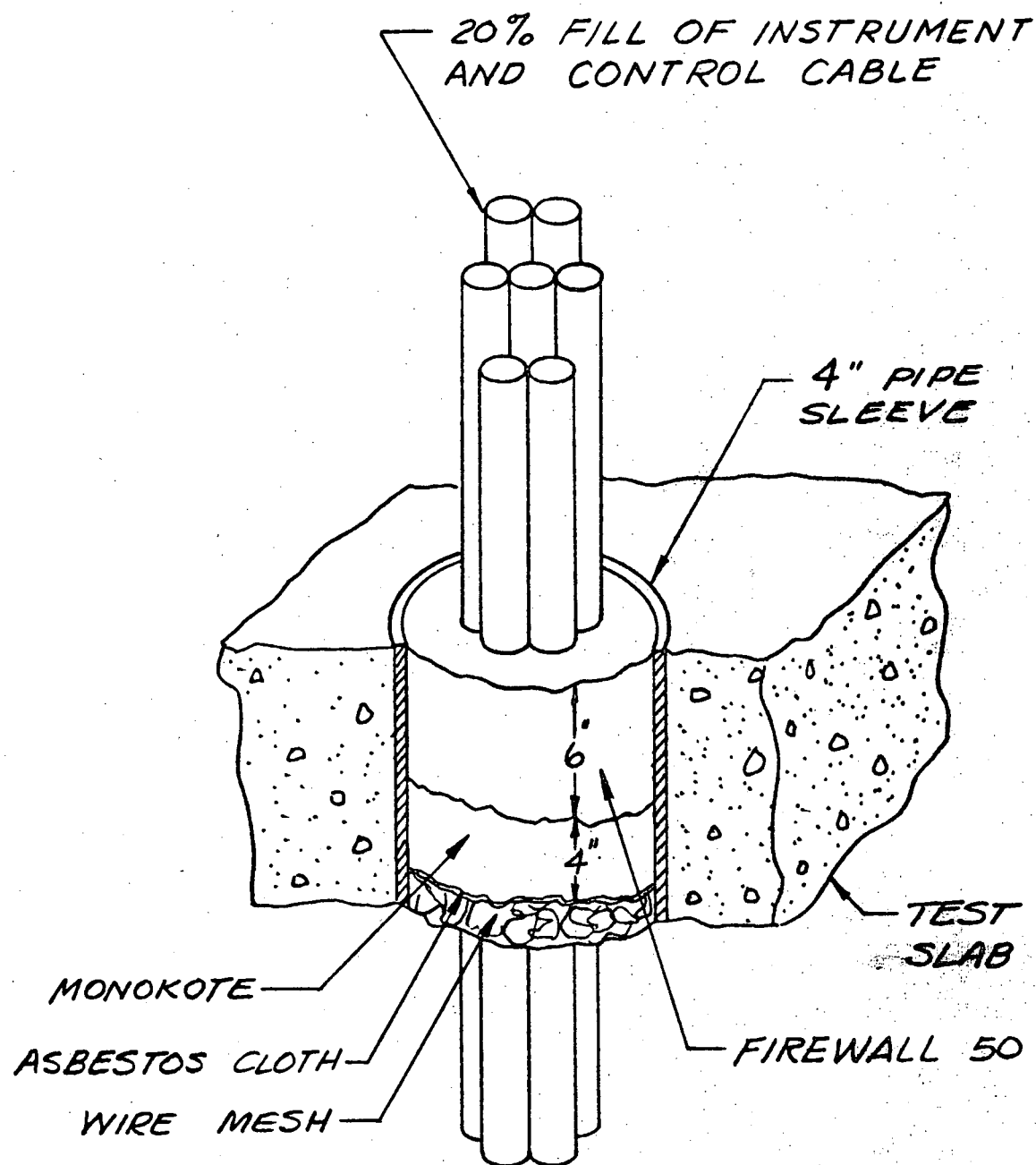


Figure 10. Penetration B5

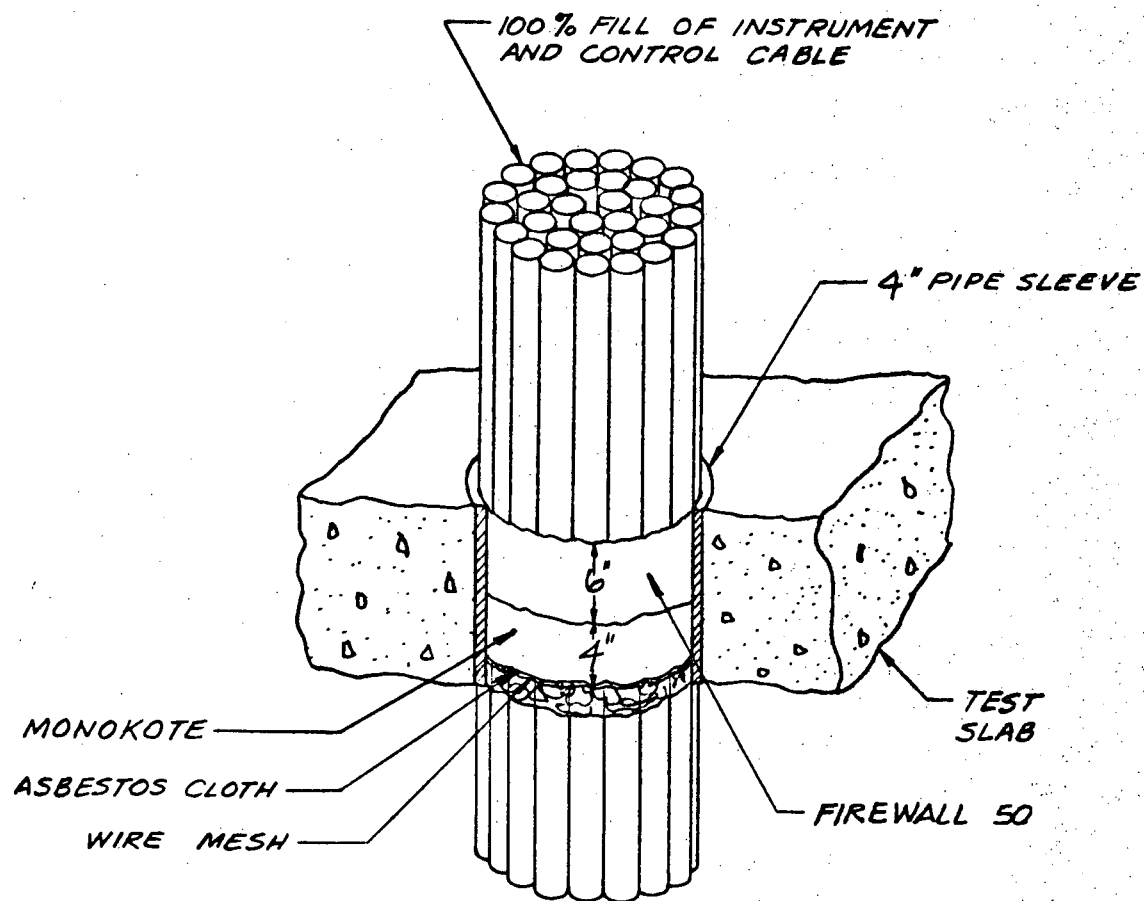


Figure 11. Penetration B6

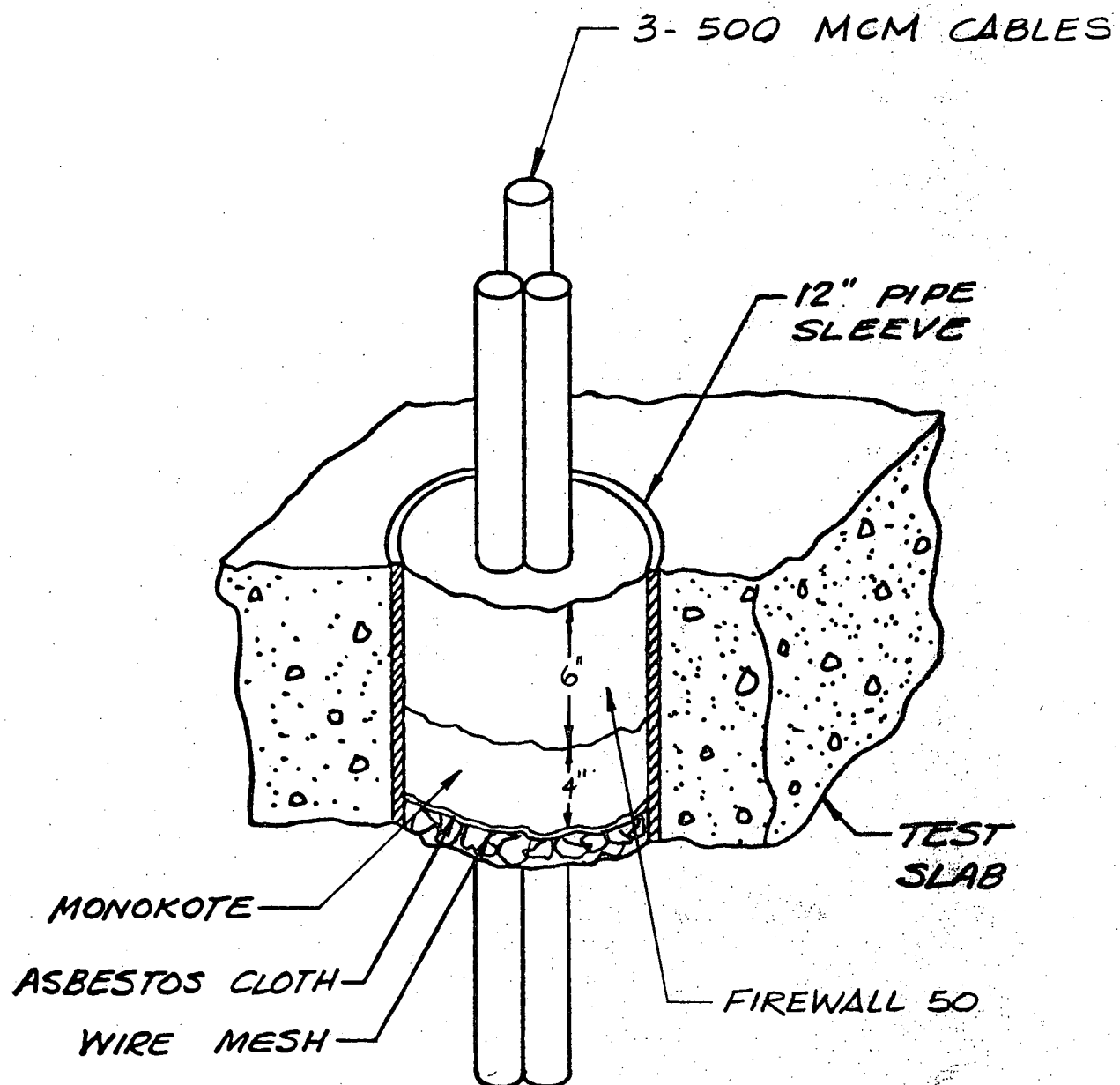


Figure 12. Penetration B7

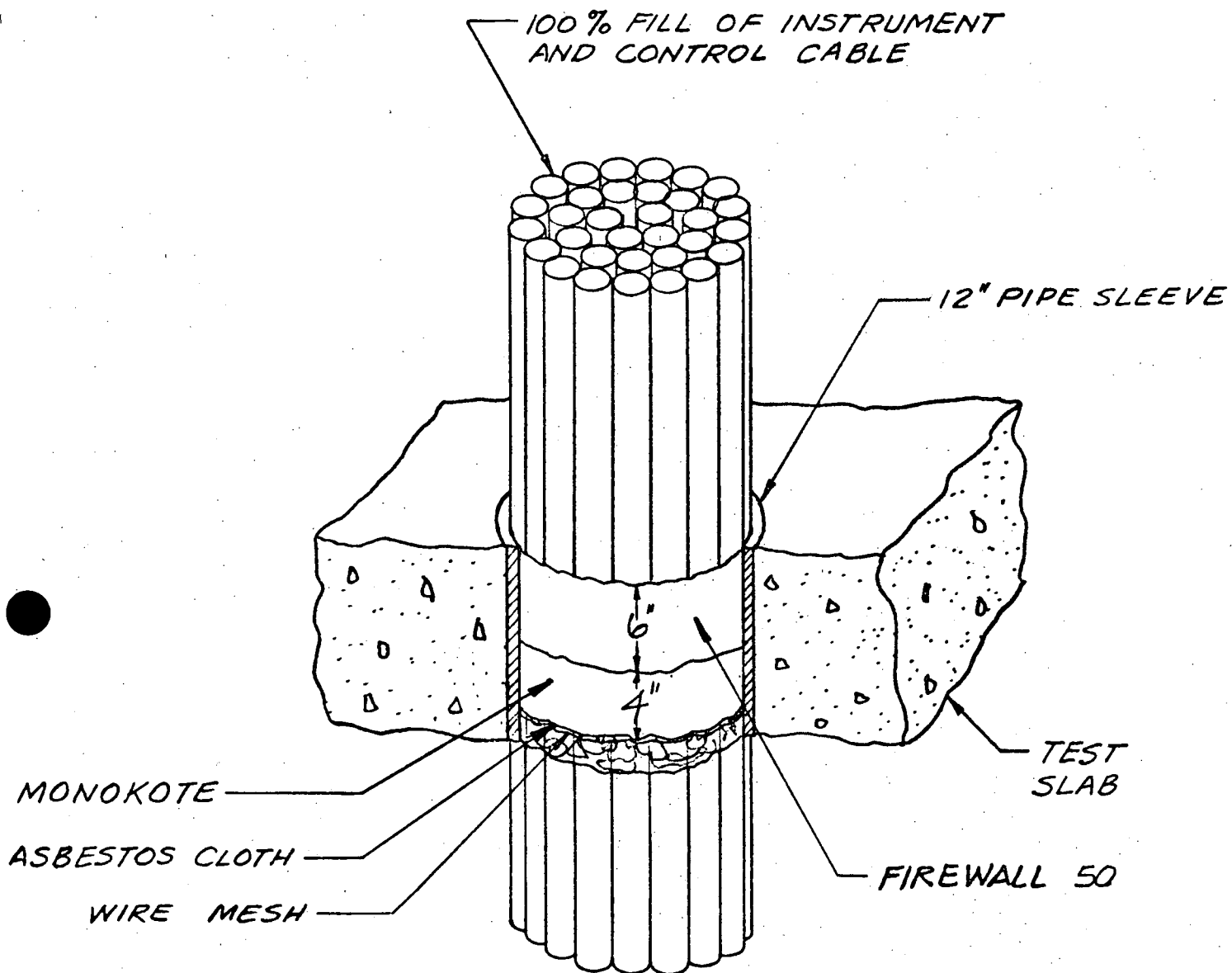


Figure 13. Penetration B8

C. SEALING OF PENETRATION

All cable trays and pipe penetrations were filled by Chemtrol Corporation personnel using the materials identified by Duke Power as Monokote[®] and Firewall 50.

A detailed listing of installation procedures used during the preparation appears in Appendix I. Photographs of the cable loading and penetration seals are in Appendix II. Details of the quality control for the penetrations are in Appendix III. Drawings of penetration assemblies appear in Figures 6 through 13.

During the installation of the penetration seal assemblies, a problem was encountered in the Monokote[®] application. After installation, the Monokote[®] retained high levels of moisture (above 30%) for almost two months, despite the efforts to maintain an elevated temperature in the slab preparation building. To cure the Monokote[®], a procedure was formulated and tested in a lab-scale test. This procedure involved soaking the Monokote[®] with anhydrous methyl alcohol to strip away the trapped water and then to elevate the building temperature to vaporize the trapped methyl alcohol. This procedure proved successful with no effects on the Monokote[®] integrity and the moisture level was reduced below 10% in less than two days. This allowed for completion of the penetration seal assemblies. Eleven days after cure 6 inches of Firewall 50 were applied to the penetration seals.

TEST FACILITY

The floor penetration assembly fire resistance test was conducted using a horizontal furnace with an open area 9 ft x 6 ft (See Figure 14). A flue gas opening was provided on one end. Eight (8) Maxon self-aspirating burners were mounted in the sides of the furnace. Eight (8) furnace temperature thermocouples were located 2 1/2 ft inside each side wall at 2-ft centers with the first pair of thermocouples 1 1/2 ft from the flue end of the furnace at the 24-inch elevation. Twenty-four (24) thermocouples on the unexposed side were connected to a multipoint temperature recorder with a range of 0 - 2,000°F and a digital printout of 60 points per minute. (See Appendix IV and V). All gas flow to the burners was controlled manually as indicated by the average of six furnace temperature thermocouple readings taken at 12 inches from the exposed specimen surface. These were monitored continuously. These average temperatures are shown in Figure 15 and Table 4. The temperatures on the unexposed side are shown in Appendix IV.

To develop the desired differential pressure, a vacuum enclosure had been pre-calibrated using a Dayton 341 blower capable of delivering 2,500 cmf with pressure equivalent to 14 inches of water when applied to the unexposed side of the slab. This pressure was applied to the enclosure and throttled until the desired differential was achieved. Periodic readings of furnace pressure were to be taken to ensure that specified pressure was maintained. (See Table 4 and Appendix VI)

Since the tests were conducted out-of-doors, a building was erected around the furnace to meet ASTM E-119 standards. This structure was adequate to prevent excessive air currents over the unexposed surface. The temperature of the slab at the start of the test was approximately 75°F to 85°F. The final assembly of vacuum enclosure, test slab, extension sleeve and furnace is shown in Figure 16.

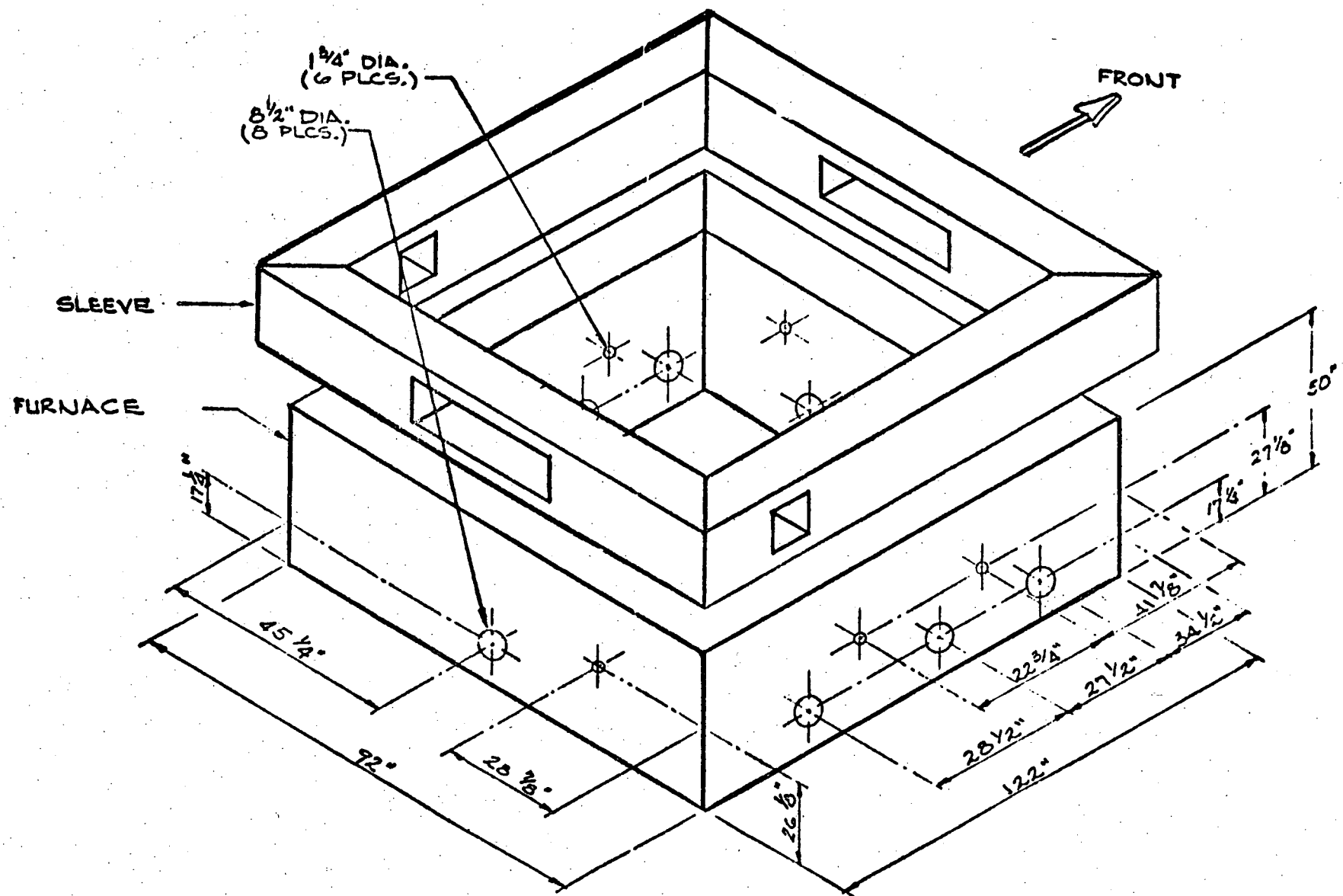


Figure 14. Test Furnace

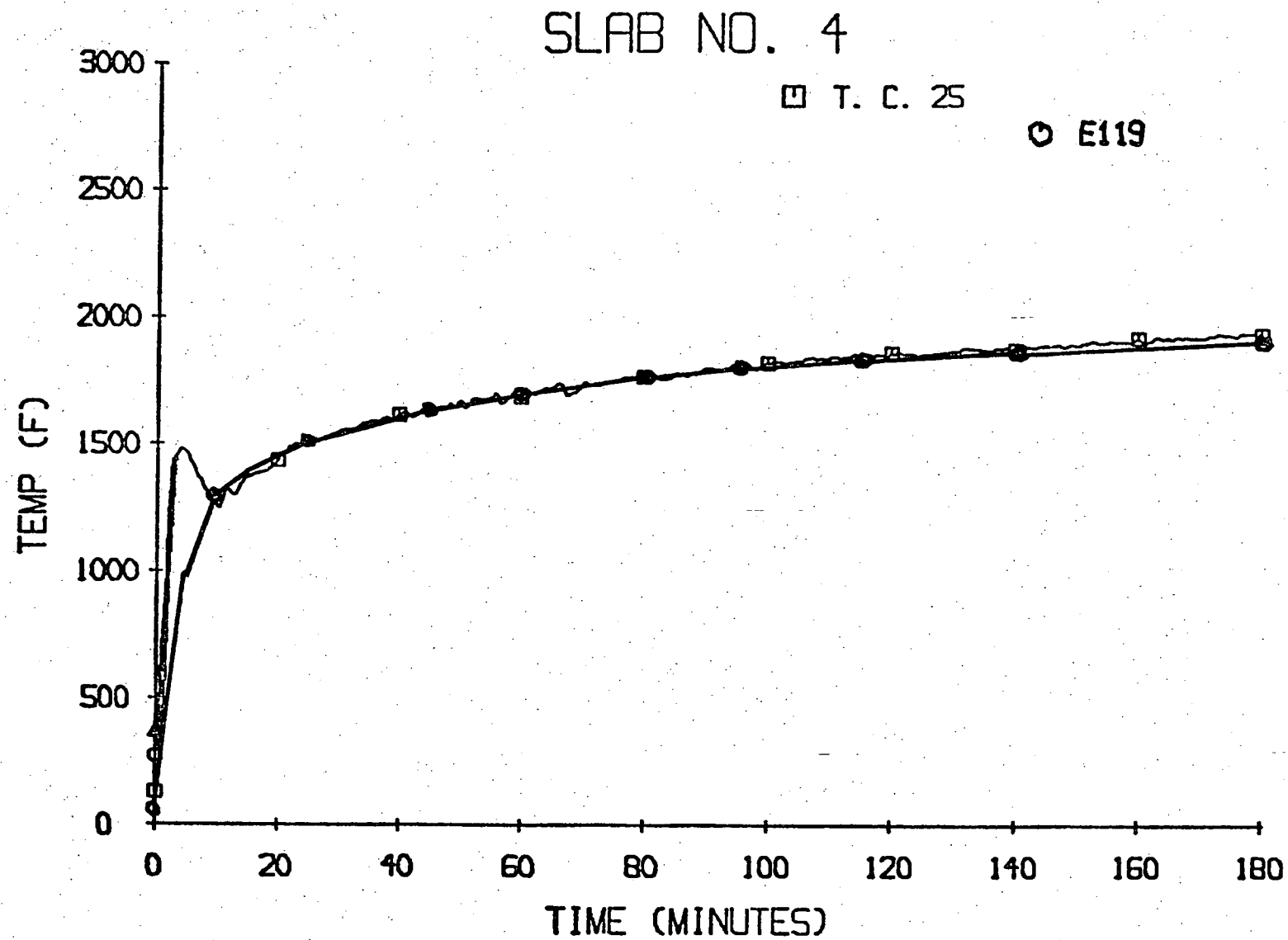
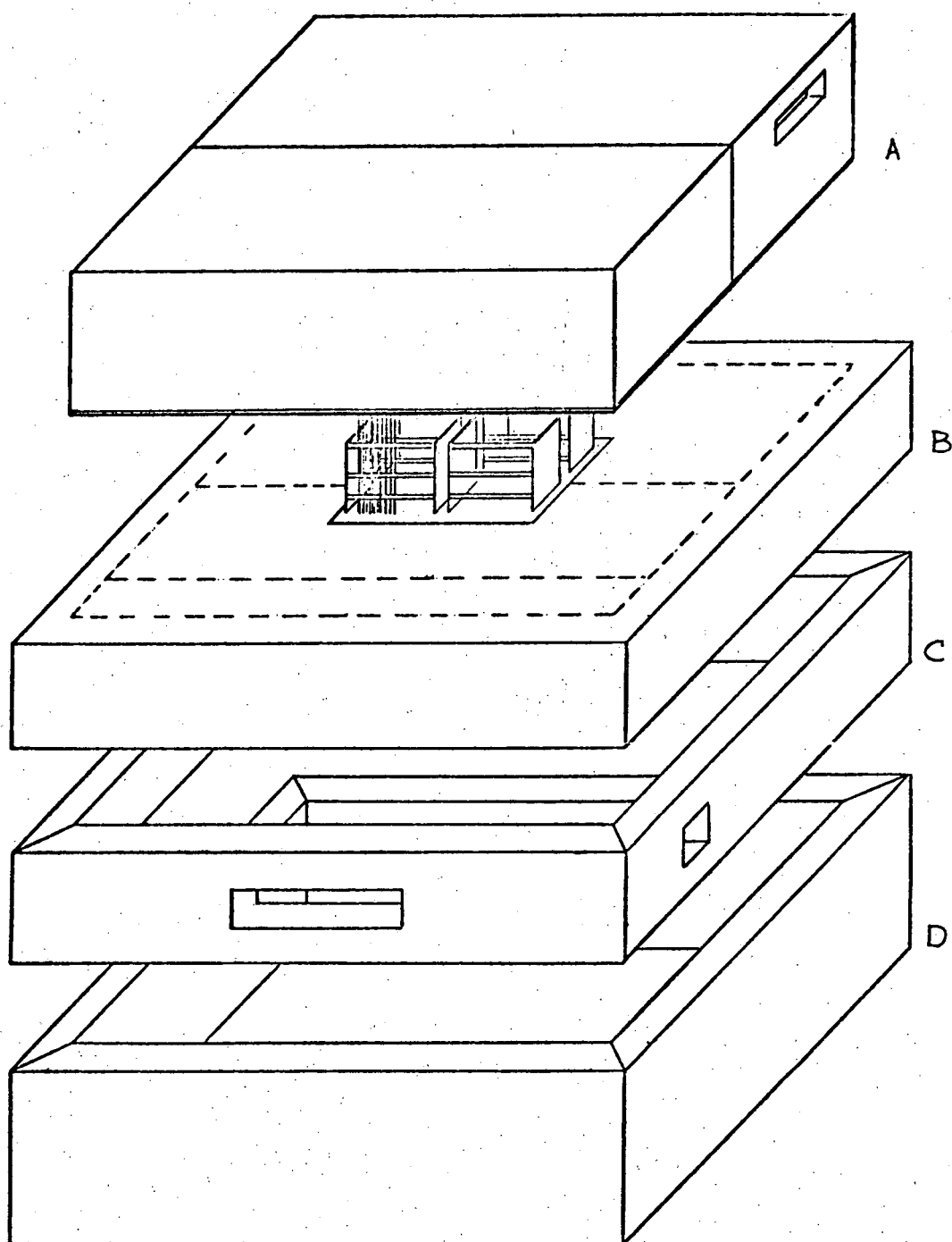


Figure 15. E-119 Furnace Temperature

TABLE 4

SLAB #4 (B1-B8)

TIME		FURNACE TEMPERATURE		REMARKS	PRESSURE	
Actual	Hr:Mins	Actual	Required		Δ P.L.	Δ P.R.
7:20	-5	79°F				
7:25	0	79°F		Smoke from inside	1.2	1.3
7:30	5	1445°F	1000°F	OK	1.1	1.3
7:35	10	1243°F	1300°F	OK	1.2	1.3
7:40	15	1370°F	1399°F	OK	1.1	1.3
7:45	20	1440°F	1462°F	Smoke clearing	1.1	1.3
7:50	25	1519°F	1510°F	OK	1.1	1.3
7:55	30	1545°F	1550°F	OK	1.1	1.3
8:00	35	1583°F	1584°F	OK	1.1	1.3
8:05	40	1610°F	1613°F	OK	1.1	1.3
8:10	45	1632°F	1638°F	OK	1.0	1.3
8:15	50	1655°F	1661°F	OK	1.0	1.2
8:20	55	1680°F	1681°F	OK	1.0	1.2
8:25	1:00	1692°F	1700°F	OK	0.95	1.15
8:30	1:05	1717°F	1718°F	OK	0.95	1.15
8:35	1:10	1739°F	1735°F	OK	0.95	1.15
8:40	1:15	1743°F	1750°F	OK	0.95	1.15
8:45	1:20	1759°F	1765°F	OK	0.90	1.15
8:50	1:25	1769°F	1779°F	Adjustment of Δ P.L.	1.0	1.3
8:55	1:30	1790°F	1792°F	OK	1.0	1.3
9:00	1:35	1800°F	1804°F	OK	1.0	1.2
9:05	1:40	1811°F	1815°F	OK	1.0	1.2
9:10	1:45	1822°F	1826°F	OK	1.0	1.2
9:15	1:50	1836°F	1835°F	OK	1.0	1.2
9:20	1:55	1845°F	1843°F	OK	1.0	1.2
9:25	2:00	1846°F	1850°F	OK	1.0	1.2
9:30	2:05	1848°F	1856°F	OK	1.0	1.2
9:35	2:10	1859°F	1862°F	OK	0.95	1.15
9:40	2:15	1862°F	1868°F	OK	0.95	1.15
9:45	2:20	1876°F	1875°F	OK	0.95	1.15
9:50	2:25	1880°F	1881°F	OK	0.95	1.15
9:55	2:30	1884°F	1888°F	OK	0.95	1.10
10:00	2:35	1895°F	1894°F	OK	0.95	1.10
10:05	2:40	1900°F	1900°F	OK	0.95	1.10
10:10	2:45	1908°F	1906°F	OK	0.95	1.10
10:15	2:50	1912°F	1912°F	OK	0.95	1.10
10:20	2:55	1906°F	1918°F	OK	0.95	1.10
10:25	3:00	1940°F	1925°F	OK	0.95	1.10



- A.) VACUUM ENCLOSURE
- B.) TEST SLAB (TYPICAL)
- C.) FURNACE EXTENSION SLEEVE
- D.) FURNACE

Figure 16. Exploded View of Test Assembly

TEST PROCEDURES

The prepared floor penetration slab with fire stop materials in place was placed in position on top of the furnace. The vacuum enclosure was installed next. The blower was started and allowed to reach steady state for five minutes. The temperature multipoint recorder was turned on, natural gas was fed to the burners, ignited, and the test clock was started. The unexposed surface was continually observed for penetration by flame or hot gases and its temperature monitored, by using the multipoint recorder. At the end of the three-hour exposure period, the fuel gas was shut off and, as quickly as possible, the vacuum enclosure was removed and the floor panel was lifted from the furnace, remaining horizontal. A spray stream from a 1 1/2-inch hose line with a 30° tip and 75 psi nozzle pressure was then directed at the floor penetration fire stops from a distance of 10 feet as prescribed in the hose stream test. The required hose stream application time for a 9 x 6 ft exposed area was 90 seconds. The time/temperature record of the test is shown in Figure 15 and Table 4. Figure 16 shows an exploded view of the test set-up.

TEST RESULTS

A fire stop 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 fire stop shall have withstood the fire endurance test without permitting passage of flame, or the occurrence of flaming on any element of the unexposed surface of the assembly for a period equal to the hourly classification for the fire stop.
2. The fire stop shall have withstood the fire endurance test and hose stream test without developing an opening that would permit a projection of water from the stream beyond the unexposed surface.
3. The transmission of heat through the fire stop during the fire endurance test shall not raise any recorded temperature on its unexposed surface more than 700°F above its initial temperature.

Accordingly, the following shows the performance of the penetrations for the test period of three hours:

Penetration Number	Condition			Remarks
	1	2	3	
B1	Passed	Passed	Passed	
B2	Passed	Passed	Passed	
B3	Passed	Passed	Passed	
B4	Passed	Passed	Passed	
B5	Passed	Passed	Passed	
B6	Passed	Passed	Passed	
B7	Passed	Passed	Passed	
B8	Passed	Passed	Passed	

All penetrations successfully met the test requirements as stated.

APPENDIX I

MATERIALS AND PROCEDURES

DUKE POWER COMPANY
GENERAL OFFICES
422 SOUTH CHURCH STREET
CHARLOTTE, N. C. 28242

I-2

TELEPHONE: AREA 704
373-4011

January 27, 1978

Mr. H. Russell, Vice President Operations
Chemtrol Corporation
530 North Belt East, Suites 105/112
Houston, Texas 77060

SUBJECT: Southwest Research Institute Fire Tests
File No. EGS-F-1.3, EGS-C-13.9, OS-72

Dear Mr. Russell:

Attached are the procedures used for monokote type cable penetration firestops to be tested at Southwest Research Institute week of February 6 and 15, 1978. We plan to test the slab with openings B9-B15 first, then the slab with openings B1-B8. For your information each opening should be prepared in accordance with the attached specification as follows:

OPENING NUMBERUNEXPOSED SIDEEXPOSED SIDE

NOTE: Interior of opening is filled with four inches of monokote.

B9

Monokote - 4 inches

Armstrong Armaflex No. 6416
(7/8") with Armstrong Adhesive
No. 520 and GE Silicone Sealant
No. 1203.

B10

Armstrong Armaflex
No. 6416 with
Armstrong Adhesive
No. 520 and GE Silicone
Sealant No. 1203

Armstrong Armaflex No. 6416
(7/8") with Armstrong Adhesive
No. 520 and GE Silicone Sealant
No. 1203.

B11

2 inches Chemtrol
Firewall over monokote

2 inches Chemtrol Firewall
over monokote

B12

1/8" Glastic over
monokote

1/8" Glastic with D-seal as
sealant over monokote

B13

7/8" Armaflex No.
6416 with Armstrong
Adhesive No. 520 and
GE Silicone Sealant
No. 1203.

Armaflex No. 6416 (7/8") with
Armstrong Adhesive No. 520 and
G.E. Silicone Sealant No. 1203.

Mr. H. Russell
January 27, 1978
Page 2

<u>OPENING NUMBER</u>	<u>UNEXPOSED SIDE</u>	<u>EXPOSED SIDE</u>
B14 & B15	Monokote	Wire Mesh Asbestos Cloth and monokote

SLAB NO. 2:

NOTE: If SLAB 1 fails modifications will be required for Slab No. 2.

B1	Armaflex No. 6416 with Armstrong Adhesive No. 520 and GE Silicone Sealant No. 1203.	Armaflex No. 6416 (7/8") with Armstrong Adhesive No. 520 and GE Silicone Sealant No. 1203.
B2	Monokote	1/8" glastic bottom held in place with metal strips. Monokote applied over glastic.
B3 - B8	Monokote	Wire Mesh Asbestos Cloth and monokote

The monokote design to be used for this test will be installed in accordance with the manufacturer's instructions. The material was trowelled in-place for the actual installation. No procedures are available. A thickness of four (4) inches should be used since this is the minimum specified in the attached specification.

Materials used in the openings are as follows:

1. Zonolite Monokote - 5 - Data Sheet No. MK-138, effective October 1, 1973 used after 1974.
2. Armstrong Armaflex - No. 6416 - 7/8 inches thick
3. Armstrong Adhesive - No. 520.
4. GE Silicone Sealant - No. 1203
5. 1/8 inch Glastic sheets
6. Duseal to seal around glastic
7. Dow Corning RTV 732 - packed around cables for air seal.
8. Asbestos Cloth
9. Chemtrol Firewall 50

Mr. H. Russell
January 27, 1978
Page 3

Should you have questions or need further information, please contact me at (704) 373-8414.

Yours truly,

C. J. Wylie, Chief Engineer
Electrical Division

RAP
BY: R. A. Pace
Design Engineer

CJW/RAP/kkm

cc: L. R. Johnston

April 11, 1975

C. J. Wylie

ELECTRICAL GENERAL
SUBJECT FILE C-13.9-9
TITLE: _____

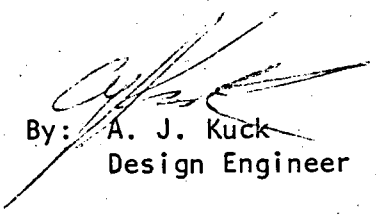
MEMO TO: C. J. Wylie

SUBJECT: Oconee Nuclear Station (OS-72)
Cable Installation Fire Stops

Attached is a copy of a sketch of how it is planned to provide fire stops for cable trays and cable at floor, wall or ceiling penetration at Oconee Nuclear Station.

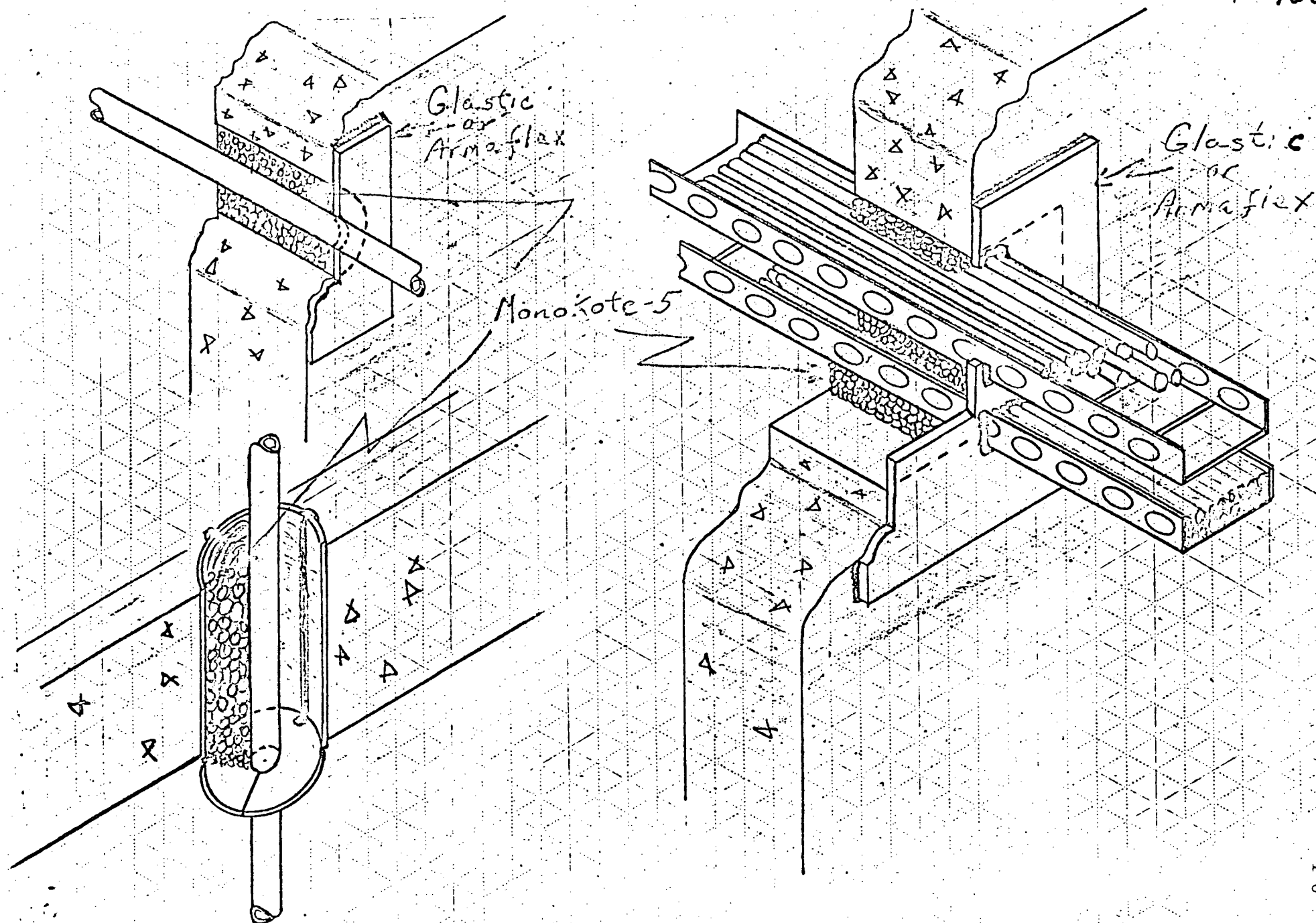
It is planned to use "Armsfelt" or gl^santic as the air seal on one side and "Monokote Five" as the firestop.

We are planning on doing the auxiliary-turbine building walls first and then have John Scanlan (Marsh & McLennon) to check this plus the other part of the plant before we do the other walls ie auxiliary to control building.


By: A. J. Kuck
Design Engineer

AJK/jfe

cc: G. M. Bostian
C. L. Sansbury



March 28, 1975

Memo to File

Re: Oconee Nuclear Station
Vacuum Seals for Cable Trays

A test was performed on March 26, 1975 on materials used in constructing vacuum seals around cables and tray in the Auxiliary Building. The materials tested were:

Armstrong Armaflex - No. 6416

Armstrong Adhesive - No. 520

GE Silicone Sealant - No. 1203

The test was conducted as follows:

Two (2) pieces of Armaflex were bonded together by the above adhesive and allowed to cure. A tube of silicone sealant was opened to cure. After a curing time of approximately 45 minutes, the materials were subjected to an open flame. The armaflex and adhesive showed no visible flame, although the affected area did deteriorate. The sealant burned with a smoldering effect with a very low flame, although it did not ignite. After the torch was removed, the flame went out. A small propane torch was used for the test.

The above materials show no indication of contributing to a fire.

J N Turner

J N Turner
Mechanical Inspector

JNT/ow

10 May 1-8

DUKE POWER COMPANY

CONSTRUCTION DEPARTMENT

OCONEE NUCLEAR 1-3

SENECA, S. C. 29678

P. O. BOX 1234

TELEPHONE: AREA 803
882-4631

April 21, 1975

Mr R L Dick

Re: Oconee 1-3
NML

Enclosed is a description, specification sheets, and sketches we propose to use to meet the NML requirements for protection of penetrations through fire walls. John Scanlon, Fire Protection Consultant, has requested we present our proposal to him. We are presently installing penetration plugs by the enclosed methods. Please review and comment.

J T Moore

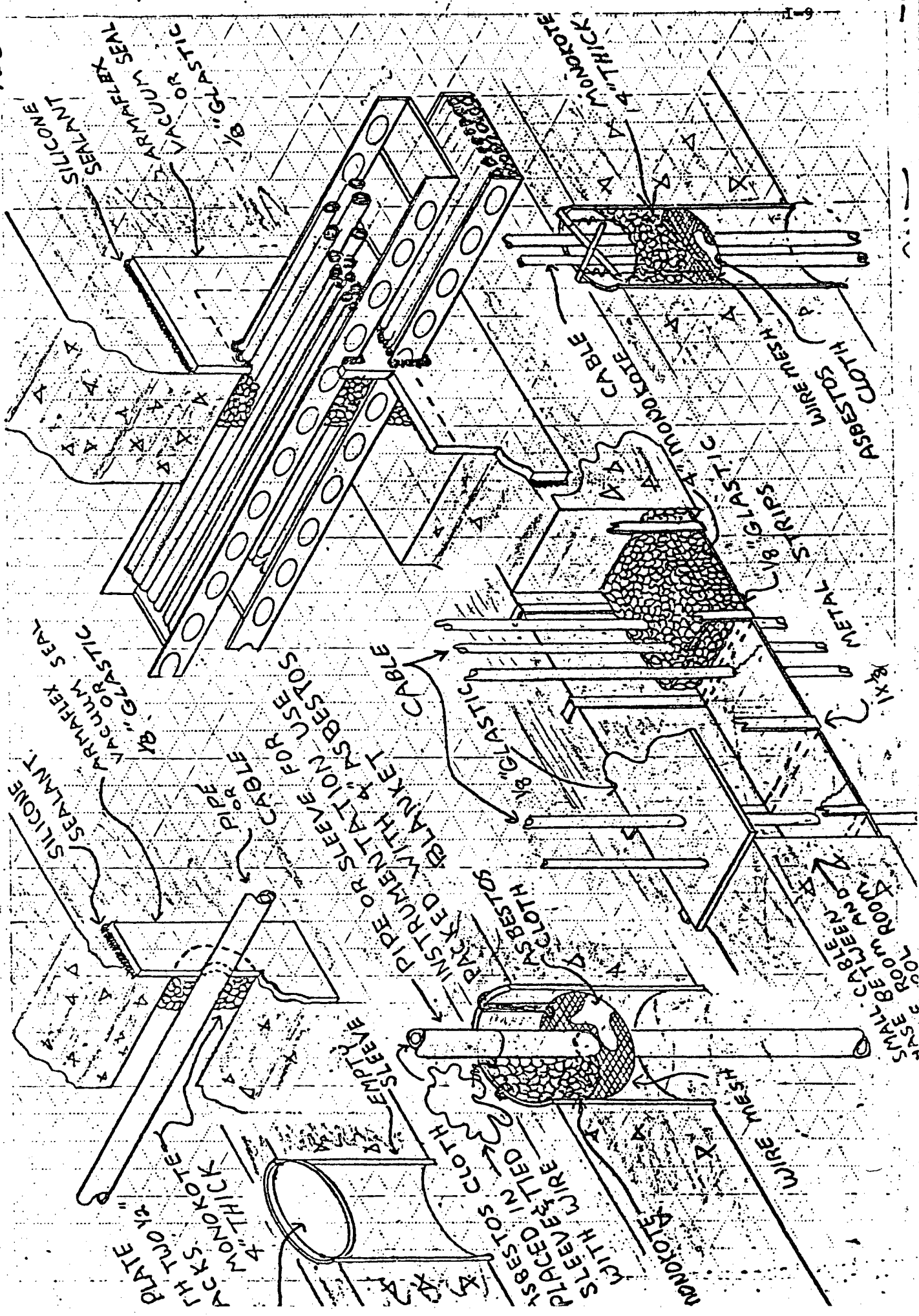
J T Moore
Project Manager

JWD/ow

Enclosure

cc C J Wylie W/Encl
S K Blackley W/Encl
J Ed Smith W/Encl
John C Scanlon W/Encl

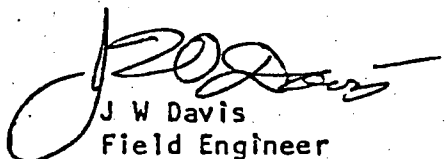
106



Fire Wall and Ceiling Seals

The methods and sketches listed below are proposed ways to seal fire walls and ceilings between: (a) Turbine Building to Auxiliary Building, (b) electrical equipment room walls, (c) electrical equipment room ceiling to cable room, (d) cable room walls, and (e) cable room ceiling to control room. Any method may be used for protection from fire or vacuum control. The Glastic and Armaflex are for vacuum seal.

1. Cable trays penetrating walls - Use Armaflex or 1/8" Glastic as air seal and use 4" minimum of Monokote for fire protection.
2. Empty pipe sleeves in floors or walls - 1/4" steel plate tacked two (2) places for later removal if required.
3. Pipe sleeves with cable, piping or instrument lines - 4" minimum of Monokote held in place by wire and steel supports. Certain pipe sleeves will have a 2" or 2 1/2" conduit installed for temporary instrumentation cables. These will be provided with asbestos cloth as packing.
4. Cable shafts will be plugged using 1/8" Glastic to seal and hold the Monokote in place. This only includes small shafts between cable room and control room. The main cable shafts will not be plugged.
5. Safety related control cables crossing power cable trays were sprayed with Flamemastic.


J W Davis
Field Engineer

A J Kuck
Field Project Coordinator

JWD/AJK/ow

By Samuel Chack & Henry Heller

Date 10-17-76

WR# 90614-A

QA Verifi. 10/14 Date 12/15/75

Approval [Signature] Date 12/15/75

SRC Review 12-15-75

CONTROL COPY

DUKE POWER COMPANY
OCONEE NUCLEAR STATION
REPAIR OR REPLACEMENT OF "FIRE STOPS" AND VACUUM CONTROL

1.0 Purpose

The purpose of this procedure is to maintain Fire Stops on cable trays and penetrations to the original specifications. This procedure applies to any work order that removes or alters an existing fire stop.

2.0 References

N/A

3.0 Personnel Requirements

Men _____

Hours _____

4.0 Safety Consideration

4.1 Health Physics consideration. All work to be performed under a radiation work permit as required.

5.0 Unit Status

5.1 Turbine Building - N/A

5.2 Auxiliary Building - N/A

5.3 Reactor Building - Unit at cold shutdown

6.0 Prerequisite

☒ 6.1 Obtain RWP from Health Physics as required.

☒ 6.2 Contact Shift Supervisor prior to beginning work.

☒ 6.3 Contact Operations QA prior to beginning work.

☒ 6.4 Record location of Fire Stop. LOCATION East penetration at 7.W.1

7.0 Repair Parts

7.1 1/8" thick Clastic, 1/8" thick Armaflex, Monokote-5, Flamemastic.

9.0 Acceptance Requirements

- ☒ 9.1 Penetration or cable tray sealed and fireproofed.

10.0 Interference Items

N/A

11.0 Procedure

- ☒ 11.1 For cable trays penetrating walls install armaflex or 1/8" thick Glastic as an air seal, apply 4" minimum thickness of Monokote against the 1/8" thick Glastic for fire protection.
- ☒ 11.2 For blank pipe sleeves in floors or walls, tack weld in (2) places a 1/4" steel plate over pipe sleeves.
- ☒ 11.3 Pipe sleeves with cable, piping or instrument lines; install steel wire or steel supports as required, then apply 4" minimum thickness of monokote. Certain pipe sleeves with 2" or 2 1/2" conduit installed for temporary instrumentation cables will be packed with asbestos cloth as packing.
- ☒ 11.4 Cable shafts between cable room and control room will be plugged using 1/8" thick Glastic to seal and hold the monokote in place. 4" minimum thickness monokote will be installed against 1/8" Glastic. The main cable shafts will not be plugged.
- ☒ 11.5 Safety related control cables crossing power cable trays ^{no cables crossing cables (H.M.)} will be sprayed with Flamesmastic.

- JMC* 11.6 QA inspection complete.

12.0 Restoration

- ☒ 12.1 Contact Shift Supervisor that work is complete.

13.0 Enclosures

13.1 Comment Sheet

13.2 Sketch showing application methods

13.3 Fire Barrier Test for cable wall penetrations.

13.4 Specification Sheet on Glastic material

13.5 Specification sheet for Monokote - 5

Preliminary Report

FIRE BARRIER TEST FOR CABLE WALL PENETRATIONS

Conducted by

FIRE RESEARCH LABORATORY, UNIVERSITY OF GHENT, BELGIUM

Professor Herpal, Director

TEST REPORT NO. 835/1

Test Date: April 23, 1970

PURPOSE: To determine the effectiveness of a fire barrier material, FLAMEMASTIC 71A Mastic, for cable wall penetrations.

PLACE: Fire Research Laboratory, University of Ghent, Belgium

WITNESSES: Professor Herpal - University of Ghent
Professor Minne - University of Ghent
Mr. Antoine - N.V. Applicom S.A.
Mr. Minnebo - N.V. Applicom S.A.
Mr. Vogt - Chemische Fabrik Gruenau GmbH
Mr. Eiermann - The Dyna-Therm Corporation

MATERIALS USED IN TEST: Section of closed-bottom sheet metal cable tray, 160 mm x 40 mm, 2 mm gauge with two welded angle flanges.

One set of short length of cable, comprising the following sizes and types:

- 2 - *VFVB (NBN 529) - 4 x 4 mm²
- 3 - VFVB (NBN 529) - 4 x 6 mm²
- 1 - VFVB (NBN 529) - 4 x 16 mm²

One quantity of fiberglass insulating wool—
One quantity of FLAMEMASTIC 71A Mastic

ARRANGEMENT OF TEST ITEMS:

As per drawing, two sections of cable tray, with the above-described cables, were placed through two openings in a four-inch thick firebrick wall. The cavity between the cable surface and the top of the wall was then stuffed with fiberglass insulating wool, to which FLAMEMASTIC 71A Mastic was applied on both sides at a thickness of approximately one-half inch. The exposed cables on both sides were then brush-coated with FLAMEMASTIC 71A.



The DYNATHERM Corporation

I-14

Report No. 835/1 (Cont.)

TEST METHOD:

The test method is described in Standard NBN 213.020 and follows in principle American Standard ASTM E-119. The fire wall is placed in front of the furnace. As per NBN 213 and ASTM E-119, multiple thermocouples are attached to the outside surface of the test specimen; in this case the outside of the FLAMEMASTIC coating, and to the cables themselves. The heat is then turned on and follows the time-temperature curve of ASTM E-119.

The test was discontinued at the customer's request after 120 minutes. During the test, the following observations were made:

- 18 min. Small smoke development appears through the mortar. (Not FLAMEMASTIC)
- 60 min. One of the thermocouples shows a maximum temperature of 68°C.
- 70 min. On the exposed ends of the FLAMEMASTIC-coated cables on the outside of the furnace, some softening of the insulation is noticeable.
- 90 min. Hottest spot at one point on the exterior is 115°C.
- 102 min. A thermocouple attached to one conductor of the cables on the outside registers 140°C.
- 112 min. Some of the cable insulation on the outside (under the FLAMEMASTIC coating) begins to melt.
- 118 min. Some discoloration on the outside of the FLAMEMASTIC is noticeable.
- 120 min. As the test is stopped, melted cable insulation is dripping from the exposed ends of the cables, but there has been no smoke or flame penetration to the exterior and the temperature of the thermocouples had not reached an average of 180°C.

RESULTS:

For the two-hour testing period, the FLAMEMASTIC flame barrier proved an effective means to contain a fire within a given area. The FLAMEMASTIC flame barrier, on the exterior side of the wall, was still physically intact at the end of the test.

VFVB is a multicore power cable consisting of PVC insulation steel tape armored.

Page 2 of 2

Quality Products Through Creative Research

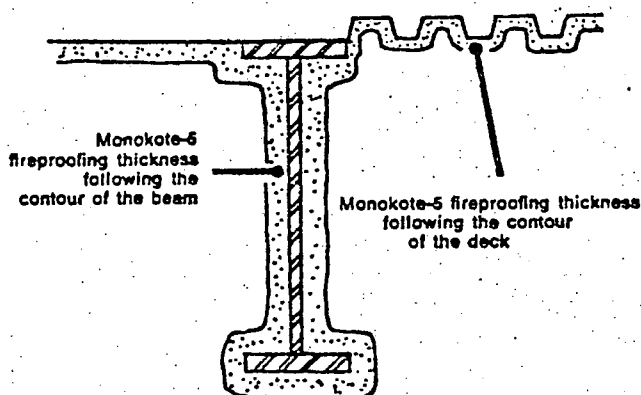


Fireproofing

Spray-Applied Plaster (Cementitious) Structural Fire Protection

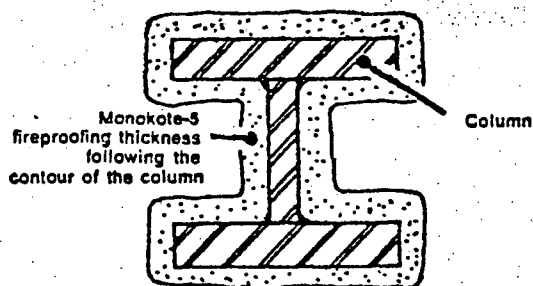
FIRE RATINGS

The Monokote-5 fireproofing thickness required to achieve a particular fire rating will depend upon local requirements. For the reasons described herein under "Fire Resistance," contact your nearest office of the Zonolite Construction Products Division, W. R. Grace & Co., or processing distributor for specific Monokote-5 fireproofing thicknesses and local fire resistance criteria.



Fire Resistance Rating Hr.	Required Beam Thickness		These thicknesses are based on ASTM E119 time-temperature criteria of 1100 F average and 1300 F maximum. Contact the nearest Zonolite representative for thickness requirements under criteria other than 1100/1300 F.
	Restrained	Unrestrained	
4	1 1/4"	2 1/4"	
3	7/8"	1 1/4"	
2	1/2"	7/8"	
1	3/8"	1/2"	

Fire Resistance Rating	Required Floor and Roof Thicknesses
4, 3, 2 or 1 hr.	Because the complexities of floor and roof assemblies and the varieties of steel floor configurations are too great to list, and because the 1973 ASTM E119 require both restrained and unrestrained ratings, contact the nearest Zonolite representative for thickness requirements.



Fire Resistance Rating	Required Column Thickness	
4 hr.	2 1/2"	1 1/4"†
3 hr.	1 3/4"	7/8"†
2 hr.	1 1/4"	3/4"†

†For columns W14 x 228 and larger.

MONOKOTE-5 FIREPROOFING

Monokote-5 fireproofing is the trade name for a fire protection material developed by Zonolite Construction Products Division, W. R. Grace & Co., specifically for fast application, high fire resistance, and low cost. The material is spray-applied by any one of several plastering machines. Monokote-5 fireproofing is a cementitious (plaster), mill-mixed material, requiring only the addition of water at the job. It is applied directly to steel, concrete and other surfaces requiring fire protection.

Monokote-5 fireproofing meets the requirements and is in compliance with the U.S. Environmental Protection (EPA) Regulation 40 C.F.R., Chapter 1, Subsection 61.22E, promulgated by EPA on April 6, 1973.

TECHNICAL DATA

FIRE RESISTANCE

Monokote-5 fireproofing has been fire tested and rated by Underwriters' Laboratories, Inc., in accordance with test method ASTM E119. Fire ratings up to 4 hours have been achieved. Each bag of material bears the UL label verifying compliance with UL's quality control inspection program and the appropriate fire resistance rating.

The 1973 revision to ASTM test method E119 in general (1) introduces a new system for rating the hourly performance of assemblies and structural members and (2) provides for two ratings from the same fire test. The Underwriters' Laboratories Index of Fire Resistance Ratings refers to two ratings — one based on time-temperature performance (unrestrained) and the other based on a combination of structural and lesser time-temperature performance criteria (restrained). Because local building codes may not yet have adopted the E119-73 criteria, contact the jurisdictional municipal authority for verification.

Monokote-5 fireproofing has been tested for other properties such as adhesion, corrosion resistance, deflection, bond impact, surface hardness, air erosion resistance, damageability resistance, etc. The test results comply with, and in most instances exceed, General Services Administration (GSA) requirements.

FIRE HAZARD

Tested and reported in accordance with ASTM E-84 by Underwriters' Laboratories, Inc. Flame Spread-10, Fuel Contributed-5, Smoke Developed-0.

DRY DENSITY

Approximately 18-20 pcf. Underwriters' Laboratories, Inc. lists 16 pcf as minimum density.

SPECIFICATION (SHORT FORM)

Sprayed fireproofing material shall be Monokote-5 fireproofing as manufactured by Zonolite Construction Products Division, W. R. Grace & Co., or its processing distributor. It shall be applied by machine to the thickness required by local codes and in the areas shown on the drawings. The method of mixing and application shall comply with the manufacturer's recommendations.

ZONOLITE® MONOKOTE®

Fireproofing

I-16

Data Sheet No. MK-141

Effective February 15, 1974
Supersedes all previous
Yield Data Sheets

Yield

In-place yield is governed by two factors:

1. The condition of the mix as it enters the pump
2. The nozzle settings at the moment of application.

Adjusting the Mix

MONOKOTE is formulated to pump and produce desired yield when a mixer density of 50-52 pcf is obtained. Overmixing causes poor pumping and undermixing lowers in-place yield. Water should be added until 5/8" of material can be applied in one pass on a vertical surface without sliding. A water meter aids in producing maximum yield on a repeatable basis. Once proper water content is determined, mixing time should be adjusted to give a thoroughly blended product in the density range of 50-52 pcf.

Adjusting the Nozzle

Proper nozzle adjustments are essential to obtain maximum product yield. Consistent with a workable nozzle pattern and an acceptable surface texture: (a) the orifice should be as large as possible, 9/16" to 5/8", (b) the air stem should be pulled back, and (c) the air pressure adjusted to the lowest possible level. A high pitched sound indicates improper adjustment. The system is properly adjusted when a dull "buzz" can be heard. With a small amount of practice, most plasterers can learn to properly hang a moderately textured surface. Nozzle adjustment can account for as much as a 20% change in yield.

Calculating Yield

Yield is determined by dividing the total weight of a batch (MONOKOTE + water) by the nozzle density.

EXAMPLE:

Total Weight

3 bags MK (45 lbs net)	= 135 lbs
36 gallons water (8.34 lbs/gal)	= 300 lbs
Total Weight	435 lbs

Nozzle Density (also applicable for mixer density)

Net weight of full 5 oz Dixie cup X 0.415	= Nozzle Density lbs/cu ft
Net weight of full 5 oz Dixie cup	= 138 grams
138 grams X 0.415	= 57 lbs/cu ft
Net weight of full 10 quart pail X 3	= Nozzle Density lbs/cu ft
Net weight of full 10 quart pail	= 19 lbs
19 lbs X 3	= 57 lbs/cu ft

Board Foot Yield

Cubic feet/batch

$$\frac{\text{Total Weight}}{\text{Nozzle Density}} = \frac{435 \text{ lbs}}{57 \text{ lbs/cu ft}} = 7.63 \text{ cu ft per batch}$$

Cubic feet/bag

$$\frac{\text{Cubic feet per batch}}{\text{MK bags per batch}} = \frac{7.63 \text{ cu ft/batch}}{3 \text{ bags/batch}} = 2.54 \text{ cu ft per bag}$$

Board feet/bag

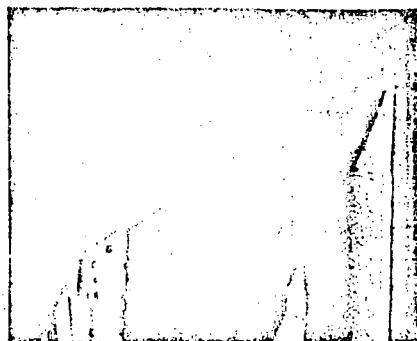
$$\begin{aligned} &\text{Cubic feet per bag X 12 bd ft per cubic foot} \\ &= 2.54 \text{ cu ft/bag X 12 bd ft/cu ft} = 30.48 \text{ bd ft/bag} \end{aligned}$$



MK-141

Copyright 1974. Zonolite and Monokote are registered trademarks of Construction Products Division, W. R. Grace & Co., 62 Whittemore Ave., Cambridge, Mass. 02140. We hope the information given here will be helpful. It is based on our best knowledge, and we believe it to be true and accurate. Please read all statements, recommendations or suggestions herein in conjunction with our conditions of sale which apply to all goods supplied by us. We assume no responsibility for the use of these statements, recommendations or suggestions, nor do we intend them as a recommendation for any use which would infringe any patent or copyright.

Printed in U.S.A. 2/74



1. Scope

a) Work Included

Provide all labor, materials and equipment required for complete installation of all sprayed fireproofing and related work as shown on the drawings or specified herein, and in accordance with all applicable requirements of the Contract Documents.

b) Work Not Included

1. Structural steel encased in concrete.
2. Trowelled plaster as specified under appropriate section.
3. The cleaning of the surfaces to receive sprayed fireproofing.

2. Material

a) The sprayed fireproofing material shall be MONOKOTE fireproofing as manufactured by the Construction Products Division, W.R. Grace & Co., or its processing distributors. All manufactured material shall be delivered in original, unopened packages bearing the name of the manufacturer, the brand, and the UL label verifying compliance with UL's quality control inspection program and the appropriate fire resistance ratings.

The materials shall be kept dry until ready for use. The packages of material shall be kept off the ground, under cover, and away from sweating walls and other damp surfaces. Material that has been exposed to water before actual use shall be discarded. Stock is to be rotated and used before its expiration date.

SPECIFICATIONS

b) Water shall be clean, fresh, suitable for domestic consumption, and free from such amounts of mineral or organic substance as would affect the set of the fireproofing material.

3. Acceptance and Performance Criteria

a) The sprayed fireproofing shall have been tested by Underwriters Laboratories in accordance with the procedures of ASTM E119. The structural steel members shall be protected with proper fireproofing thicknesses at densities to provide the following fire resistance ratings:

Steel columns	_____Hours
Primary steel members (Girders)	_____Hours (Restrained) _____Hours (Unrestrained)
Secondary steel members (Beams)	_____Hours (Restrained) _____Hours (Unrestrained)

b) The sprayed fireproofing beneath the deck assembly together with properly proportioned concrete fill above the metal decking shall provide a _____ hour (restrained/unrestrained) fire resistant deck assembly as substantiated by a fire test in accordance with the procedures of ASTM E119, and performed by Underwriters Laboratories or other such recognized testing agency.

c) The fireproofing material shall not be subject to losses from the finished application by sifting, flaking or dusting. This performance shall be measured by the results of a test for erosion resistance when subjected to high velocity air flow across the surface of dried samples.

The samples thus tested must be representative of

machine-applied material similar to that which can be expected on the project. The air velocity shall be not less than _____ feet per minute, and the duration of the test shall be at least _____ hours.

Note to Specifier: Recommended Quality Criteria

(i) The architect will select and the owner will pay an independent testing laboratory to sample and verify the density of the direct-to steel fireproofing as applied. The UL Fire Resistance Directory (1977) states: "Densities shown may be obtained by removing at least 6 inch square sections randomly selected from the building, subjecting them to 120 F in an oven to constant weight: usually 24 to 48 hours, followed by accurate weighing, measuring, and calculation of the density in lbs per cu ft."

(ii) Contractor shall control thickness, utilizing a workable depth guage to meet minimum thickness as required. He shall cooperate with the owner's inspector in furnishing samples for tests.

4. Installation

a) Application of sprayed fireproofing shall be in accordance with the printed instructions of the material manufacturer and the fire test report information.

b) All surfaces to which sprayed fireproofing will be applied shall be free of oil, grease, dirt, loose paint, mill scale or any other matter which would impair bond. Painted steel surfaces may require a test application of the sprayed fireproofing to determine that the paint formulation will not impair adhesion.

c) Application of sprayed fireproofing to the underside of the roof deck assemblies shall occur only after roofing application is complete and roof traffic has ceased.

d) All clips, hangers, supports, sleeves and other attachments to the fireproofing substrates, as covered under other sections of the specifications, are to be placed by others prior to the application of the fireproofing material, where these attachments can be anticipated in advance.

e) All patching and repairing of sprayed fireproofing, due to cutting by other trades, shall be performed under this section and paid for by the trade(s) that performed the cutting.

5. Temperature and Ventilation

When the outdoor temperature at the building site is less than 40 F, an air and substrate temperature to 40 F shall be maintained for 24 hours before and 24 hours after application of fireproofing material. Provisions shall be made for natural ventilation to properly dry the fireproofing during and subsequent to its application. In enclosed areas or buildings lacking openings for natural ventilation, interior air shall be circulated and exhausted to the outside by use of temporary circulators, exhaust fans, or the air-conditioning system.

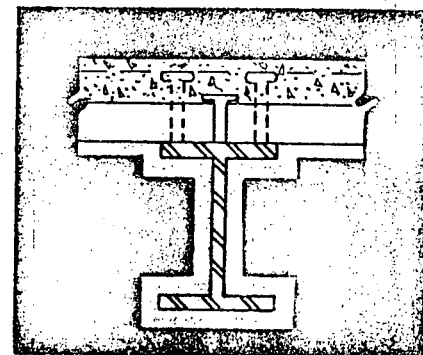
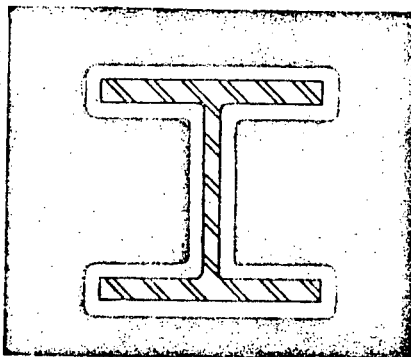
6. Clean-up

After completion of fireproofing work, equipment shall be removed and all exposed wall and floor areas cleaned of deposits of sprayed fireproofing materials.

Specification (short form)

Sprayed fireproofing material shall be MONOKOTE fireproofing as manufactured by the Construction Products Division, W.R. Grace & Co., or its processing distributor. It shall be applied by machine to the thickness required by local

code specifications and as indicated on all drawings. The method of mixing and application shall comply with the manufacturer's recommendations as set forth in current literature.



MAS-1003-2

DUKE POWER COMPANY
PROCEDURE MAJOR CHANGE
PROCESS RECORD

(1) ID No: MP/0/A/1500/3
Change No: 1
Permanent Restricted To _____

(2) STATION: Oconee

(3) PROCEDURE TITLE: Fire Stop and Vacuum Control Procedure

(4) SECTION(S) OF PROCEDURE AFFECTED: Sec 11.

(5) DESCRIPTION OF CHANGE: (Attach additional pages, if necessary.)

IN Sec 11. Add Note: Use Vinasco cable coating 1-A as needed for an air seal.

Change Date all references to Silicone Sealant on sketch (See attached) to Vinasco cable coating

(6) REASON FOR CHANGE:

Silicone sealant used previously burns per NCI #124

(7) PREPARED BY: Robert A. Kneen DATE: 12-30-77

(8) SAFETY EVALUATION

This change:

Yes ☐ No ☒ Represents a change to the station or procedures as described in the FSAR, or a test or experiment not described in the FSAR?
Yes ☐ No ☒ Requires a change to the station Technical Specifications?
Yes ☐ No ☒ Involves an unreviewed safety question?

If the answer to any of the above is "Yes", attach a detailed explanation.
As appropriate attach a completed "Nuclear Safety Evaluation Check List" form.

By: Robert A. Kneen Date: 12-30-77

(9) REVIEWED BY: L.W. [Signature] DATE: 12-30-77

Cross-Disciplinary Review By: _____ N/R: [Signature]

(10) TEMPORARY APPROVAL (IF NECESSARY):

By: _____ (SRO) Date: _____
By: _____ Date: _____

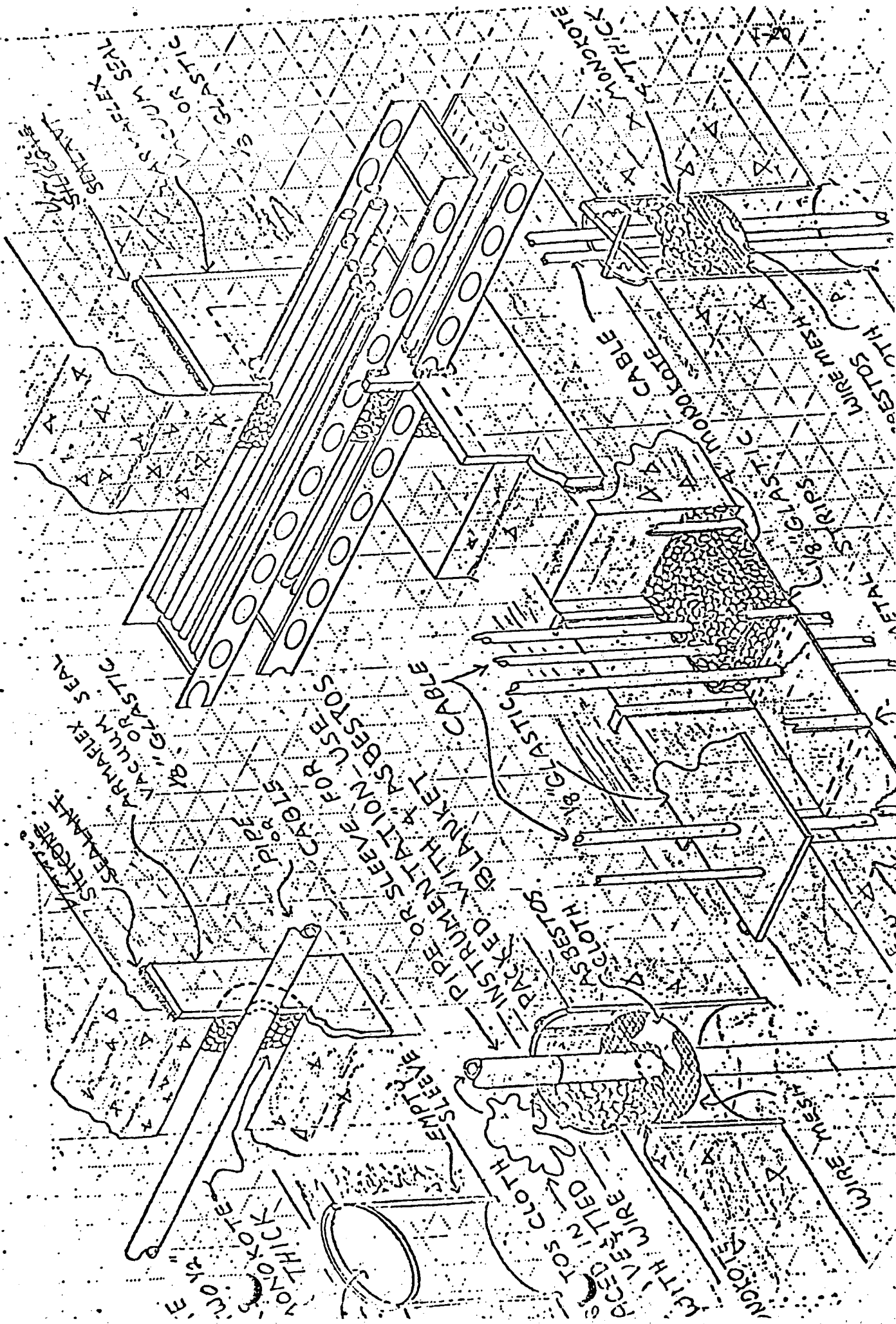
(11) APPROVED BY: [Signature] DATE: 1/4/78

(12) MISCELLANEOUS:

QA
Reviewed/Approved By: [Signature] Date: 1-4-78
Reviewed/Approved By: _____ Date: _____

(13) Page 1 of _____

901



QA Verif. _____ Date 21

Approval _____ Date _____

SRC Review _____

SRC 12B 12/15/75

DUKE POWER COMPANY
OCONEE NUCLEAR STATION
REPAIR OR REPLACEMENT OF "FIRE STOPS" AND VACUUM CONTROL

1.0 Purpose

The purpose of this procedure is to maintain Fire Stops on cable trays and penetrations to the original specifications. This procedure applies to any work order that removes or alters an existing fire stop.

2.0 References

N/A

3.0 Personnel Requirements

Men _____

Hours _____

4.0 Safety Consideration

4.1 Health Physics consideration. All work to be performed under a radiation work permit as ~~required~~ required.

5.0 Unit Status

5.1 Turbine Building - N/A

5.2 Auxiliary Building - N/A

5.3 Reactor Building - Unit at cold shutdown

6.0 Prerequisite

_____ 6.1 Obtain RWP from Health Physics as required.

_____ 6.2 Contact Shift Supervisor prior to beginning work.

_____ 6.3 Contact Operations QA prior to beginning work.

7.0 Repair Parts _____ 6.4 Record Location of Fire Stop. LOCATION _____

7.1 1/8" thick Glastic, 1/8" thick Armaflex, Monokote -5, Flamemastic.

8.0 Special Tools

N/A

9.0 Acceptance Requirements

_____ 9.1 Penetration or cable tray sealed and fireproofed.

10.0 Interference Items

N/A

11.0 Procedure

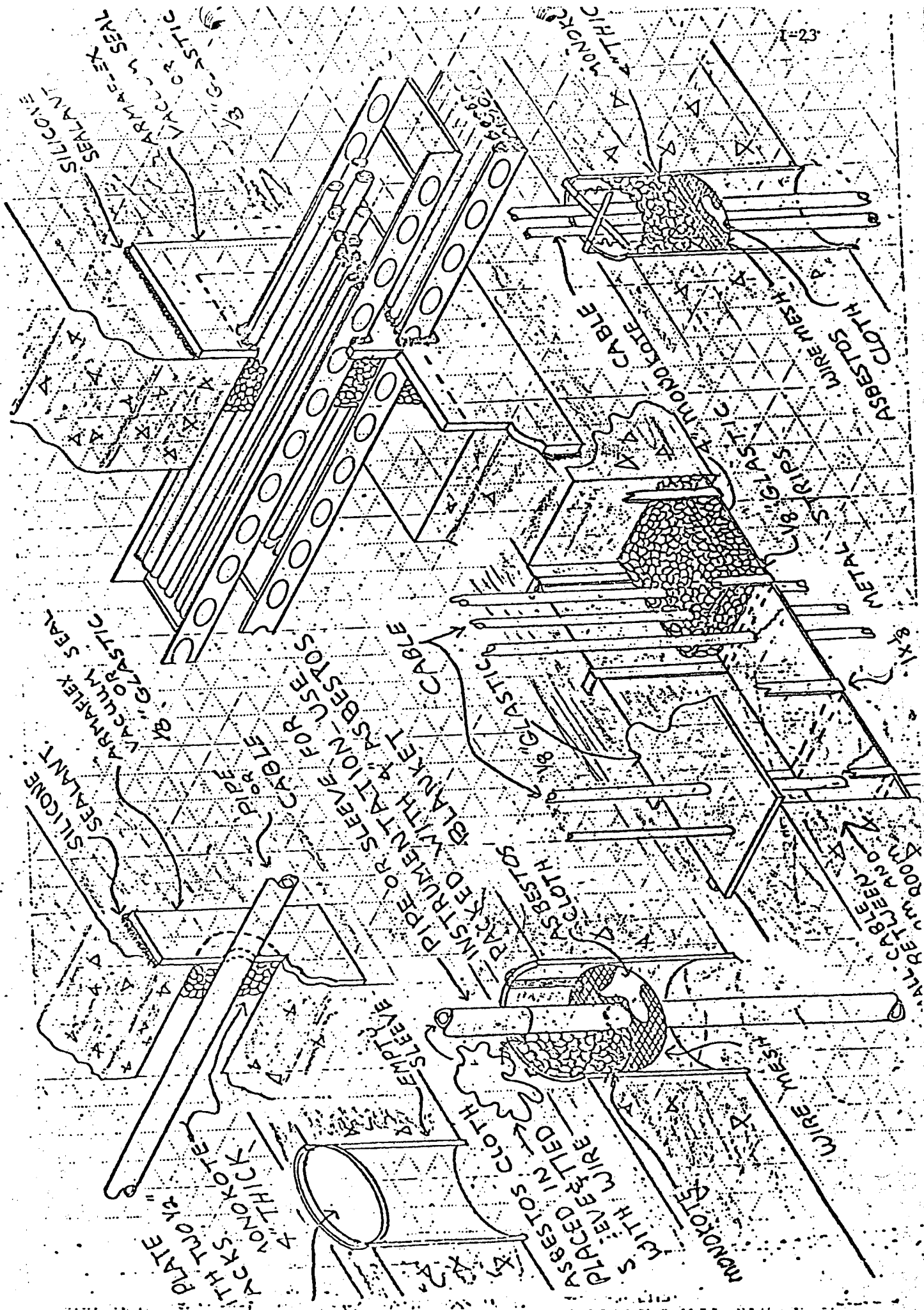
- _____ 11.1 For cable trays penetrating walls install armaflex or 1/8" thick Glastic as an air seal, apply 4" minimum thickness of Monokote against the 1/8" thick Glastic for fire protection.
- _____ 11.2 For blank pipe sleeves in floors or walls, tack weld in (2) places a 1/4" steel plate over pipe sleeves.
- _____ 11.3 Pipe sleeves with cable, piping or instrument lines; install steel wire or steel supports as required, then apply 4" minimum thickness of monokote. Certain pipe sleeves with 2" or 2 1/2" conduit installed for temporary instrumentation cables will be packed with asbestos cloth as packing.
- _____ 11.4 Cable shafts between cable room and control room will be plugged using 1/8" thick Glastic to seal and hold the monokote in place. 4" minimum thickness monokote will be installed against 1/8" Glastic. The main cable shafts will not be plugged.
- _____ 11.5 Safety related control cables crossing power cable trays will be sprayed with Flamemastic.

12.0 Restoration *11.6 QA inspection complete.*

- _____ 12.1 Contact Shift Supervisor that work is complete.

13.0 Enclosures

- 13.1 Comment Sheet
- 13.2 Sketch showing application methods
- 13.3 Fire Barrier Test for cable wall penetrations
- 13.4 Specification Sheet on Glastic material
- 13.5 Specification sheet for Monokote - 5





ARMSTRONG 520 ADHESIVE

Armstrong 520 Adhesive is an air drying contact adhesive that is excellent for joining seams and butt joints of Armaflex® Pipe and Sheet Insulations for line temperatures up to 220 F. The adhesive may also be used to apply Armaflex Sheet Insulation to flat or curved metal surfaces that will operate at temperatures up to 180 F. In addition, 520 Adhesive may be used for bonding a wide variety of materials to many clean, dry surfaces.

OTHER USES

520 Adhesive is excellent for sealing laps of vapor-barrier jackets on pipe insulation. It can also be used for bonding rubber or plastic extruded

gasket seals to metal, plastic, or wood surfaces; leather or fabric-backed vinyl roll goods to wood, metal, plastic, or composition bases; thin gauge metal-to-metal or other rigid bases; fibrous glass, cork, felt, or urethane foam insulation to metal surfaces.

This all-purpose adhesive is moisture resistant, and it increases in strength and resistance to deterioration as it ages. 520 Adhesive meets Military Specification MIL-A-24179A and Amend-1 as Type II, Class 1. 520 Adhesive also meets flammability classification requirements not to exceed 25 for flame spread and 50 for smoke developed by ASTM E84 method of test.



ARMSTRONG 520 ADHESIVE

PROPERTIES

Color

Light tan

Net Weight

6.9 lb per gallon

Composition

Synthetic rubber base with synthetic resins and fillers added; hydrocarbon- and ketone-type solvents

Solids Content

Approximately 25% by weight

Coverage

200 sq ft per gallon max, single coat (depending upon porosity of materials bonded)

Shelf Life

1 year in original sealed container

Minimum Drying Time

3-5 minutes under normal conditions

Temperature Limits

220 F—Armaflex Pipe Insulation seams and joints

180 F—full-bonding Armaflex Sheet Insulation

Container Sizes

Half-pint and pint brush top cans and half-pint, pint, quart, and gallon containers

Flammability

Wet: Flash point below 20 F (TOC)
Dry:

ASTM E84 Method

Applied on Asbestos Cement Board

Flame Spread Classification... <5

Smoke Developed... 0

APPLICATION INSTRUCTIONS

DANGER—Extremely flammable mixture, vapors may cause flash fire; vapors may ignite explosively; prevent buildup of vapors—open all windows and doors—use only with cross ventilation; keep away from heat, sparks, and open flame; do not smoke, extinguish all flames and pilot lights, and turn off stoves, heaters, electric motors, and other sources of ignition during use and until all vapors are gone; close container after use; avoid prolonged breathing of vapor and prolonged contact with skin; keep out of the reach of children.

Agitate contents of the container and apply only to clean, dry, oil-free surfaces. For best results, the adhesive should be brush-applied in a thin, uniform coat to both bonding surfaces. Allow the adhesive to dry until dry to the touch but tacky under slight pressure before joining surfaces. Open time of more than 20 minutes must be avoided. 520 Adhesive bonds instantly, so pieces must be positioned accurately as contact is made. Moderate pressure should then be applied to the entire bonding area to insure complete contact.

It is recommended that the adhesive be applied at temperatures above 40 F and not on heated surfaces. Where application between 32 F and 40 F cannot be avoided, exercise more care in applying the adhesive and closing the joint. Applications below 32 F are not recommended.

Where lines and tanks that are insulated will operate at hot temperatures, 520 Adhesive must cure a minimum of 36 hours at room temperature to attain heat resistance for insulated pipe to 220 F and insulated tanks and equipment to 180 F.

Adhesive-bonded seams and joints of Armaflex Pipe Insulation must cure before solvent-base finishes are applied. Where the insulation is installed by adhering seams and butt joints, the adhesive must cure 24 to 36 hours.

Adhesive-bonded seams and joints of Armaflex Sheet must cure before solvent-base finishes are applied. Where the insulation is installed by adhering seams and butt joints only, the adhesive must cure 24 to 36 hours. Where the insulation is installed against surfaces with full adhesive coverage, requiring wet adhesive at joints, the adhesive must cure seven days.

Where it is necessary to reduce viscosity, 520 Adhesive may be thinned by slowly adding methyl ethyl ketone with thorough mixing. Lacquer thinners should not be used for this purpose. Thinning is not recommended to recover 520 Adhesive that has become thick due to solvent evaporation.

Either methyl ethyl ketone or most lacquer thinners can be used to clean fresh residue from tools and workpieces.

Armstrong
CORK COMPANY
Lancaster, Pennsylvania

ARMSTRONG 520 ADHESIVEDESCRIPTION

- 520 Adhesive is an air drying solvent type synthetic rubber-resin base adhesive. Light tan in color, it is furnished in a viscosity suitable for brush application. The completed bond is resistant to aging and is resilient, moisture-resistant and heat-resistant.

PRINCIPAL USES

- Primarily formulated to be used as adhesive to join slit seams and butt joints of Armaflex 22 Pipe Insulation for pipe temperature up to 220F.
- Used to adhere seams and butt joints of Armaflex 22 Pre-Cut Pipe Insulation and Armaflex 22 Sheet Insulation installed as pipe insulation or fitting covers for pipe temperature up to 220F.
- Used to adhere Armaflex 22 Sheet with full bonding to flat or curved metal surfaces that will operate up to 180F.
- May be used for bonding almost any clean, dry surfaces. 520 Adhesive is excellent for sealing the laps of vapor barrier jackets on pipe covering. Also, it may be used for bonding rubber or plastic extruded gasket seals to metal, plastic or wood surfaces. Additional uses: leather, or fabric backed vinyl roll goods to wood, metal, plastic, or composition bases; thin gauge metal to metal or other rigid bases; fibrous glass, cork, felt, or urethane foam insulation to metal surfaces.

GENERAL INFORMATION

1. Strength - 520 Adhesive properly applied will produce a bond stronger than Armaflex insulations themselves. It makes a resilient, heat-resistant bond with a variety of materials.
2. Serviceability - 520 Adhesive is resistant to water and moisture vapor and has excellent aging properties. It has fair resistance to oil and is resistant to most aliphatic hydrocarbon solvents but is affected by aromatic solvents.
3. Non-Phasing - 520 Adhesive is a non-phasing type adhesive; however, shaking or stirring will be beneficial prior to use.
4. Shelf Life - One year if stored in original sealed container at temperatures between 60F and 80F.
5. Flammability
 - Wet - Flash point below 20F (TOC)
 - Dry - ASTM E162 Method
National Bureau of Standards Radiant Panel
Applied on Asbestos Cement Board
 - Flame Spread Index <5
 - Optical Density of Deposited Smoke 0
6. Coverage - 200 sqft per gallon max, depending on porosity of surface.

SPECIAL INFORMATION

1. Bonding - Mating surfaces must be free of dirt, dust, water and oil. Apply an adequate but thin, uniform brush coat to both surfaces. Allow adhesive films to air dry until dry to touch but tacky under slight pressure before joining surfaces.

TECHNICAL
SALES SERVICE
BULLETIN

(REQUISITION BY THIS NUMBER)
IP-MKT-10-3/71



INDUSTRY PRODUCTS DIVISION
INDUSTRIAL INSULATION

MAA-101, PAGE 1
DATE - 3/18/71

520 ADHESIVE
PRODUCT SALES DATA
MIL-A-24179A, Type II, Class I

520 Adhesive is an instant bonding contact cement; therefore, surfaces to be joined must be positioned accurately. Moderate pressure must be applied to entire joint area to insure complete contact.

- a. Minimum drying time - 3 to 5 minutes under normal conditions. Ambient temperatures, conditions of ventilation and moisture content of the air are factors that may vary the drying time. Avoid open time in excess of 20 minutes.
 - b. Application temperature - For best results, the 520 Adhesive temperature should be between 60F and 80F and application made at air temperatures above 40F and not on heated surfaces. Applications below 40F are to be avoided; however, where application is necessary between 32F and 40F, exercise additional caution in applying the adhesive and exercise more care in closing the joint. Applications at air temperatures below 32F are not recommended.
2. Heat Resistance - 520 Adhesive resists continuous metal temperature of 180F. It is entirely satisfactory to adhere joints of pipe insulation for temperatures to 220F because of the method of application and the temperature gradient that exists through the insulation thickness. It has very good initial grab; however, it must cure a minimum of 36 hours at room temperature before turning heat into Armaflex insulated lines and equipment to attain heat resistance of 220F.
 3. Thinning - 520 Adhesive is manufactured to a viscosity suitable for brush applications; therefore, thinning for brush application is not necessary. It may be thinned with Methyl Ethyl Ketone added slowly with thorough mixing when necessary.

Note - Thinning is not recommended to recover 520 Adhesive that has exceeded its shelf life or become thick due to solvent evaporation.

4. Cleaning - Tools and work may be cleaned with Methyl Ethyl Ketone or most lacquer thinners. (Do not use lacquer thinners for thinning 520 Adhesive.)
5. Military Specification Compliance - MIL-A-24179A, Amend 1, as Type II, Class 1

SALES DATA

1. Color - Light tan.
2. Composition - Synthetic rubber; synthetic resins; fillers added; hydrocarbon and ketone type solvents.
3. Solids Content - Approximately 25% by weight.
4. Net Weight - 6.9 lb per gallon.
5. Brookfield Viscosity - 200-300 cps, #1 spindle at 10 rmp at 77F.
6. Caution - Extremely flammable mixture vapors may cause flash fire; use adequate ventilation -- open doors and windows -- keep air circulating; prohibit smoking; extinguish all flames - pilot lights, blowtorches, etc.; avoid heat and sparks; keep container closed; do not take internally; avoid prolonged breathing or vapor and prolonged contact with skin. Keep away from children.
7. ICC Classification - Adhesives NOIBN (Flammable Liquid)
8. Container Sizes - 1/2 Pints, 1 Pint, 1 Quart, 1 Gallon in friction top cans.
1/2 Pints, 1 Pint in brush top cans.

MAA-101, PAGE 2
DATE - 3/18/71

520 ADHESIVE
PRODUCT SALES DATA

MIL-A-24179A, Type II, Class 1



INDUSTRY PRODUCTS DIVISION

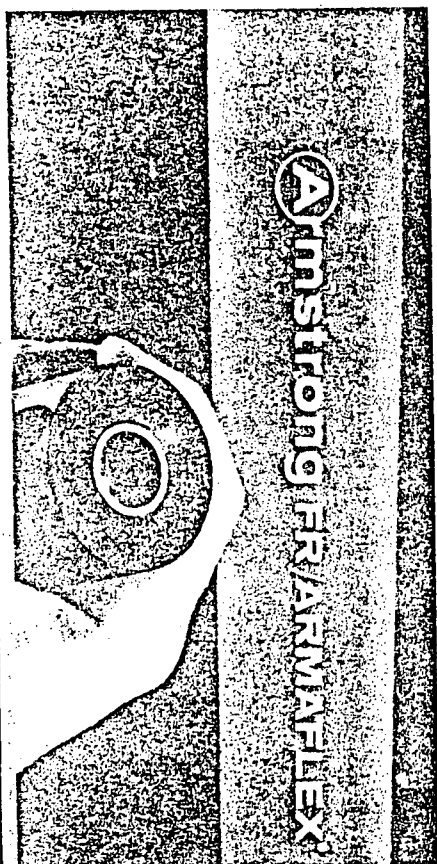
INDUSTRIAL INSULATION

TECHNICAL
SALES SERVICE
BULLETIN

(REQUISITION BY THIS NUMBER
IP-MKT-10-3/71



FR/Armaflex Pipe Insulation



DESCRIPTION

FR/Armaflex Pipe Insulation is a flexible, elastomeric thermal insulation, black in color, supplied as slit or unslit tubing, in nominal wall thicknesses of $\frac{3}{8}$ " and $\frac{1}{2}$ ", in sizes ranging from $\frac{3}{8}$ " ID to 5" IPS. Pre-Cut FR/Armaflex Pipe Insulation, supplied in flat sheet form is available in nominal wall thicknesses of $\frac{1}{2}$ " and $\frac{3}{4}$ " for 6", 8", and 10" IPS sizes. The expanded closed-cell structure of FR/Armaflex Pipe Insulation makes it an efficient insulation, and because of its low water vapor permeance, it is considered a vapor barrier in itself.

USES

FR/Armaflex Pipe Insulation is used to retard heat gain and prevent condensation or frost formation on cold-water plumbing, chilled-water, and refrigeration lines. It also efficiently reduces heat flow for hot-water plumbing and liquid-heating and dual-temperature piping. The recommended temperature usage range for FR/Armaflex Pipe Insulation is -40°F to $+220^{\circ}\text{F}$.

For use on cold pipes, FR/Armaflex Pipe Insulation thicknesses have been calculated to prevent condensation, as shown in the table of thickness recommendations.

APPLICATION

FR/Armaflex Pipe Insulation in unslit tubular form can be slipped on to piping before it is connected, or it can be slit lengthwise and applied to piping already connected. Pre-Cut FR/Armaflex Pipe Insulation in flat sheet form is wrapped around the pipe. In all cases, butt joints and longitudinal seams are to be sealed with Armstrong 520 Adhesive. 520 Adhesive is a contact adhesive; therefore, in all cases, both surfaces to be joined are coated with adhesive.

Indoors, no protective finish is required but may be desirable. Outdoors, a weather-resistant protective finish is to be applied. The recommended protective finish is Armstrong Armaflex[®] Finish; however, other compatible finish systems are not ruled out.

SPECIFICATION COMPLIANCE

FR/Armaflex can be supplied upon request to meet:

- ASTM C534, Type I-Tubular
- ASTM D1056, SBE 41-42
- MIL-C-3133B (MIL STD 670B), Grade SBE 3
- HH-I-573B, Class T-Tubular
- HH-I-1751/2
- MIL-P-15280E & Amendment 1, Form T-Tubular

FLAMMABILITY

FR/Armaflex is an organic material specially compounded to be a fire-retardant insulation. The flammability of this insulation has been tested by exposing a 25-ft-long sample to the ASTM E84 method of test. The ASTM E84 test entitled "Surface Burning Characteristics of Building Materials" is a measure of the tendency of a material to spread flame and develop smoke; it is not a measure of total involvement in a fire.

Flame spread (available nominal thicknesses)	25 — ASTM E84
--	---------------

Smoke developed (available nominal thicknesses)	— ASTM E84
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$\frac{3}{8}$ "	110
$\frac{1}{2}$ "	150



Industry Products Division, Lancaster, Pa. 17604

FR/Armaflex Pipe Insulation

Average physical properties*			Test Method (See note 4)
Pipe Size	Properties	Values	
Density, lb/cu ft	6.0		ASTM D1622
Thermal conductivity, Btu/hr sq ft (F deg/in.)			
75 F mean temp	0.27		ASTM C177
90 F mean temp	0.276		or C518
Upper use limit, deg F (See note 1)	220		—
Lower use limit, deg F (See note 2)	-40		—
Thermal stability, % shrinkage			
7 days, 200 F	5.0		ASTM C548
7 days, 220 F	5.6		
Water vapor permeability, wet cup, perm-in.	0.24		ASTM C355
Water absorption, % by weight	4.6		ASTM D1056
Ozone resistance	GOOD		—
Odor	NEGLIGIBLE		—
Sizes			
Wall thickness, inches (nominal)(See note 3)	3/8, 1/2, 3/4		—
Inside diameter, tubular form	3/8" ID to 5" IPS		—
Length of sections, feet, tubular form	6		—
Inside diameter, Pre-Cut, sheet form	6" to 10" IPS		—
Length of section, feet, Pre-Cut, sheet form	4		—

Notes

1On the heating cycle, Armaflex Pipe Insulations will withstand temperatures as high as 220 F. Where the pipe size is greater than 5" IPS and Armaflex Pre-Cut Pipe Insulation and Armaflex Sheet are installed by adhering butt joints and seams only, the upper temperature limit is 220 F. 520 Adhesive may be used with pipe insulation applications up to 220 F.

2At -20 F, flexible Armaflex Insulations become hard and, as temperatures drop below -20 F, will be increasingly brittle; however, this hardening characteristic does not affect thermal efficiency or water vapor permeability. Application below -40 F is at user's discretion.

3FR/Armaflex tubular form insulation is not manufactured in nominal 3/4" wall series. Only Pre-Cut Pipe Insulation is available in nominal 3/4" series for 6" to 10" IPS.

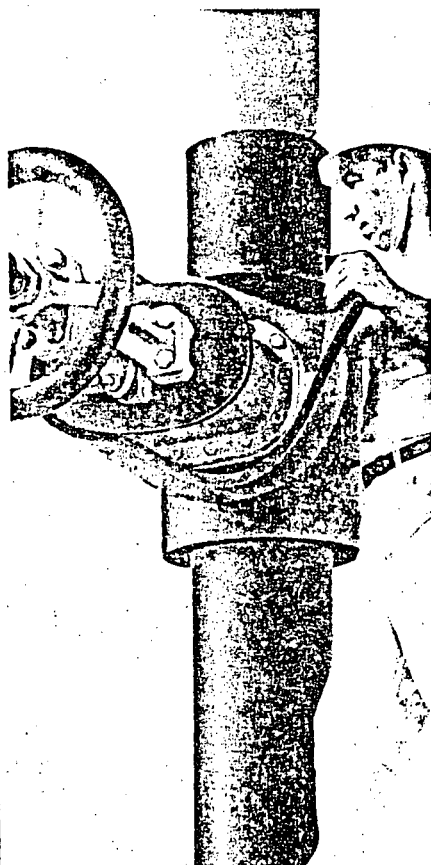
4ASTM method, in some cases, may be modified slightly to make results more meaningful for end-use application. If details are required, contact Armstrong Cork Company.

*Average values are not to be used for writing material specifications. Contact Armstrong for specification ranges.

Thickness recommendations			
Pipe Size	Line Temperatures		
	50 F	35 F	0 F
BASED ON NORMAL DESIGN CONDITIONS*	Nom 3/8"	Nom 1/2"	...
3/8" ID thru 3" IPS	Nom 1/2"	Nom 1/2"	...
Over 3" IPS thru 5" IPS	Nom 1/2"	Nom 1/2"	Nom 3/4"
6" IPS thru 10" IPS †	3/8" Sheet	3/8" Sheet	1" Sheet
Over 10" IPS			
BASED ON MILD DESIGN CONDITIONS**	Nom 3/8"	Nom 3/8"	Nom 1/2"
3/8" ID thru 3" IPS	Nom 1/2"	Nom 1/2"	Nom 1/2"
Over 3" IPS thru 10" IPS †	3/8" Sheet	3/8" Sheet	1/2" Sheet
Over 10" IPS			
BASED ON SEVERE DESIGN CONDITIONS***	Nom 3/4"	Nom 3/4"	...
6" IPS thru 10" IPS †	3/4" Sheet	1 1/4" Sheet	...
Over 10" IPS			
<p>* Armaflex in the thicknesses noted and within the specified temperature ranges will prevent condensation on indoor piping under normal design conditions, a maximum severity of 85 F and 70% RH. Armstrong research and field experience indicate that indoor conditions anywhere in the United States seldom exceed this degree of severity.</p> <p>** Armaflex in the thicknesses noted and within the specified temperature ranges will prevent condensation on indoor piping under mild design conditions, a maximum severity of 80 F and 50% RH. Typical of these conditions are most air-conditioned spaces and arid climates.</p> <p>*** Armaflex in the thicknesses noted and within the specified temperature ranges will prevent condensation on indoor piping under severe design conditions, a maximum severity of 90 F and 80% RH. Typical of these conditions are indoor areas in which excessive moisture is introduced or in poorly ventilated confined areas where the temperature may be depressed below ambient.</p> <p>† Pipe sizes 6" IPS thru 10" IPS refer to Pre-Cut Pipe Insulation.</p>			
OFFICES			
CHARLOTTE, NC 28204 1341 E. Morehead Street			
CHICAGO, IL 422 Northwest Highway Park Ridge, IL 60068			
CINCINNATI, OH 45241 4100 Executive Park Drive			
NEW YORK, NY Park 80 Plaza West—One Garden State Parkway at Interstate 80 Saddle Brook, NJ 07662			
ST. LOUIS, MO 63105 222 South Meramec Avenue			
SAN FRANCISCO, CA 1814 Ogden Drive Burlingame, CA 94010			



FR/Armaflex Sheet Insulation



DESCRIPTION

FR/Armaflex Sheet Insulation is a flexible, elastomeric thermal insulation, black in color, supplied as flat sheets 36" x 48", in thicknesses $\frac{1}{8}$ " through 1" in $\frac{1}{8}$ " increments (except $\frac{3}{16}$ "). It is furnished with a smooth skin one side which forms the outer, exposed insulation surface. The expanded, closed cell structure of FR/Armaflex Sheet makes it an efficient insulation, and because of its low water vapor permeance, it is considered a vapor barrier in itself.

USES

FR/Armaflex Sheet is used for all applications that cannot be accomplished by the preformed tubular insulation also available. It is particularly adaptable for insulating ductwork, large piping, tanks, and vessels. Its flexibility allows application to curved and irregular surfaces. FR/Armaflex Sheet is very adaptable to making all types of fitting cover insulations.

The recommended temperature usage range for FR/Armaflex Sheet is -40 F to +220 F according to method of application. With full adhesive coverage attachment, the surface to which it is applied may operate to a limit of 180 F. When used for pipe insulation with adhesive adhering seams and joints only, FR/Armaflex Sheet can be applied to lines that will operate to a limit of 220 F.

For use on cold surfaces, FR/Armaflex Sheet thicknesses have been calculated to prevent condensation, as shown in the table of thickness recommendations.

APPLICATION

FR/Armaflex Sheet is installed using Armstrong 520 Adhesive, a heat-resistant and water vapor-resistant contact adhesive. For application to large flat or curved metal surfaces such as ducts, very large pipes, tanks, and vessels, full adhesive coverage attachment is used. For application as pipe insulation and fitting covers, only the seams and joints are adhered with adhesive. 520 Adhesive is a contact adhesive; therefore, in all cases, both surfaces to be joined are coated with adhesive.

Indoors, no protective finish is required but may be desirable. Outdoors, a weather-resistant protective finish is to be applied. The recommended protective finish is Armstrong Armaflex Finish; however, other compatible finish systems are not ruled out.

SPECIFICATION COMPLIANCE

FR/Armaflex can be supplied upon request to meet:

- ASTM C534, Type II
- ASTM D1056 SBE 41-42
- MIL-C-3133B (MIL STD 670B) Grade SBE 3
- HH-I-573B, Class S
- MIL-P-15280E & Amendment 1, Form S-Sheet

FLAMMABILITY

FR/Armaflex is an organic material specially compounded to be a fire-retardant insulation. The flammability of this insulation has been tested by exposing a 25-ft-long sample to the ASTM E84 method of test. The ASTM E84 test, entitled "Surface Burning Characteristics of Building Materials," is a measure of the tendency of a material to spread flame and develop smoke; it is not a measure of total involvement in a fire.

Flame spread (available thicknesses 1" or less)	25 — ASTM E84
---	---------------

Smoke developed (available thicknesses)	— ASTM E84
$\frac{1}{8}$ "	75
$\frac{3}{8}$ "	110
$\frac{1}{2}$ "	150
$\frac{3}{4}$ "	225
1"	290



Industry Products Division, Lancaster, Pa. 17604

FR/Armaflex Sheet Insulation

Average physical properties*

		Test Method (See note 3)
Density, lb/cu ft	6.0	ASTM D1622
Thermal conductivity Btu/hr sq ft (F deg/in.)		
75 F mean temp	0.28	ASTM C177
90 F mean temp	0.286	or C518
Upper use limit, deg F (See note 1)	220	—
Lower use limit, deg F (See note 2)	-40	—
Thermal stability, % shrinkage		
7 days, 200 F	5.0	ASTM C548
7 days, 220 F	6.1	—
Water vapor permeability, wet cup, perm-in.	0.17	ASTM C355
Water absorption, % by weight	8.4	ASTM D1056
Ozone resistance	GOOD	—
Odor	NEGLIGIBLE	—
Sizes	36 x 48	—
Width and length, inches	1/4 to 1	—
Thickness, inches (See note 4)	(1/8 increments)	—

Notes

¹When Armaflex Sheet is installed by airthering butt joints and seams only, the upper temperature limit is 220 F using 520 Adhesive. Armaflex Sheet adhered with complete adhesive coverage on flat or curved metal surfaces may be applied to surfaces that will operate as high as 180 F using 520 Adhesive.

²At -20 F, flexible Armaflex Insulations become hard and, as temperatures drop below -20 F, will be increasingly brittle; however, this hardening characteristic does not affect thermal efficiency and resistance to water vapor permeability. Application below -40 F is at user's discretion.

³ASTM method, in some cases, may be modified slightly to make results more meaningful for end-use application. If details are required, contact Armstrong Cork Company.

⁴Armaflex Sheet in 1/4" thickness not available.

*Average values are not to be used for writing material specifications. Contact Armstrong for specification ranges.

Thickness recommendations

BASED ON NORMAL DESIGN CONDITIONS
Armaflex in the thicknesses noted and within the specified temperature ranges will prevent condensation indoors under normal design conditions, a maximum severity of 85 F and 70% RH. Armstrong research and field experience indicate that indoor conditions anywhere in the United States seldom exceed this degree of severity.

BASED ON MILD DESIGN CONDITIONS
Armaflex in the thicknesses noted and within the specified temperature ranges will prevent condensation indoors under mild design conditions, a maximum severity of 80 F and 50% RH. Typical of these conditions are most air-conditioned spaces and arid climates.

BASED ON SEVERE DESIGN CONDITIONS
Armaflex in the thicknesses noted and within the specified temperature ranges will prevent condensation indoors under severe design conditions, a maximum severity of 90 F and 80% RH. Typical of these conditions are indoor areas in which excessive moisture is introduced or in poorly ventilated, confined areas where the temperature may be depressed below ambient.

Ducts—Tanks—Vessels—Equipment Metal-Surface Temperature

50 F 3/4"	35 F 1/2"	0 F 1"
1/2"	1/4"	1/2"
3/4"	1 1/4"†	1 1/2"†

† multiple layer

OFFICES

CHARLOTTE, NC 28204
1341 E. Morehead Street

CHICAGO, IL
422 Northwest Highway
Park Ridge, IL 60068

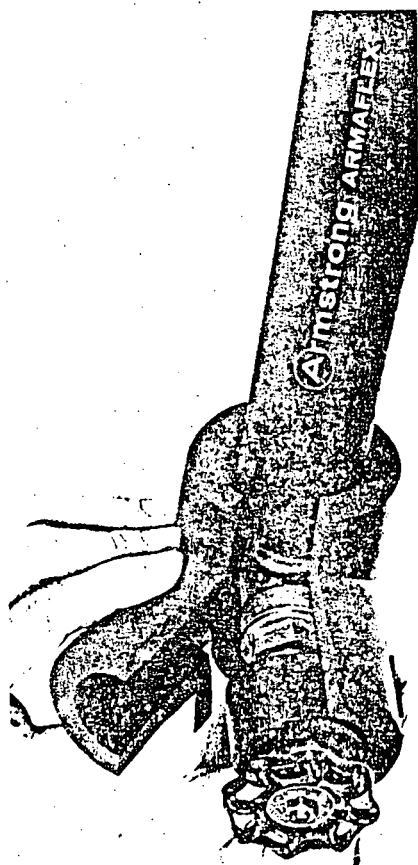
CINCINNATI, OH 45241
4100 Executive Park Drive

NEW YORK, NY
Park 80 Plaza West—One
Garden State Parkway at Interstate 80
Saddle Brook, NJ 07662

ST. LOUIS, MO 63105
222 South Meramec Avenue

SAN FRANCISCO, CA
1814 Ogden Drive
Burlingame, CA 94010

Standard Armaflex Pipe Insulation



DESCRIPTION

Standard Armaflex Pipe Insulation is a flexible, elastomeric thermal insulation, black in color, supplied as slit or unslit tubing, in nominal wall thicknesses of $\frac{3}{8}$ ", $\frac{1}{2}$ ", and $\frac{3}{4}$ ", in sizes ranging from $\frac{3}{8}$ " ID to 5" IPS. Standard Pre-Cut Armaflex Pipe Insulation in flat sheet form is available in nominal wall thicknesses of $\frac{1}{2}$ " and $\frac{3}{4}$ " for 6", 8", and 10" IPS sizes. The expanded closed-cell structure of Armaflex Pipe Insulation makes it an efficient insulation, and because of its low water vapor permeance, it is considered a vapor barrier in itself.

USES

Standard Armaflex Pipe Insulation is used to retard heat gain and prevent condensation or frost formation on cold-water plumbing, chilled-water, and refrigeration lines. It also efficiently reduces heat flow for hot-water plumbing and liquid-heating and dual-temperature piping. The recommended temperature usage range for Armaflex Pipe Insulation is -40 F to +220 F.

For use on cold pipes, Armaflex Pipe Insulation thicknesses have been calculated to prevent condensation, as shown in the table of thickness recommendations.

Standard Armaflex Pipe Insulation is chemically acceptable to USDA Consumer and Marketing Services.

APPLICATION

Standard Armaflex Pipe Insulation in unslit tubular form can be slipped on to piping before it is connected, or it can be slit lengthwise and applied to piping already connected. Pre-Cut Armaflex Pipe Insulation in flat sheet form is wrapped around the pipe. In all cases, butt joints and longitudinal seams are to be sealed with Armstrong 520 Adhesive. 520 Adhesive is a contact adhesive; therefore, in all cases, both surfaces to be joined are coated with adhesive.

Indoors, no protective finish is required but may be desirable. Outdoors, a weather-resistant protective finish is to be applied. The recommended protective finish is Armstrong Armaflex™ Finish; however, other compatible finish systems are not ruled out.

SPECIFICATION COMPLIANCE

Standard Armaflex can be supplied upon request to meet:

- ASTM C534, Type I-Tubular
- ASTM D1056, SBE 41-42
- MIL-C-3133B (MIL STD 670B), Grade SBE 3
- HH-I-573B, Class T-Tubular

FLAMMABILITY

Standard Armaflex is an organic material specially compounded to retard burning. The flammability of this insulation has been tested by exposing samples 6" long x 2" wide x $\frac{1}{2}$ " thick to procedures of the ASTM D1692 method of test entitled, "Flammability of Plastic Sheet and Cellular Plastics." During this test, the sample is positioned horizontally. This test method is not intended to be a criterion of fire hazard; it is not a measure of total involvement in a fire. By this test, burning ceased in an average of 59 seconds, and the burning length averaged 1.1" distance from the flame-source end.



Industry Products Division, Lancaster, Pa. 17604

Standard Armaflex Pipe Insulation

Average physical properties*

		Test Method (See note 4)
Density, lb/cu ft	5.4	ASTM D1622
Thermal conductivity, Btu·hr sq ft (F deg/in.)		
75 F mean temp	0.253	ASTM C177
90 F mean temp	0.258	or C518
Upper use limit, deg F (See note 1)	220	—
Lower use limit, deg F (See note 2)	-40	—
Thermal stability, % shrinkage		
7 days, 200 F	5.8	ASTM C548
7 days, 220 F	6.6	—
Water vapor permeability, wet cup, perm-in.	0.1	ASTM C355
Water absorption, % by weight	3.0	ASTM D1056
Ozone resistance	GOOD	—
Odor	NEGLIGIBLE	—
Sizes		
Wall thickness, inches (nominal)	3/8, 1/2, 3/4	—
Inside diameter, tubular form	3/8" ID to 5" IPS	—
Length of sections, feet, tubular form (See note 3)	6	—
Inside diameter, Pre-Cut, sheet form	6" to 10" IPS	—
Length of section, feet, Pre-Cut, sheet form	4	—

Notes

¹On the heating cycle, Armaflex Pipe Insulations will withstand temperatures as high as 220 F. Where the pipe size is greater than 5" IPS and Armaflex Pre-Cut Pipe Insulation and Armaflex Sheet are installed by adhering butt joints and seams only, the upper temperature limit is 220 F. 520 Adhesive may be used with pipe insulation applications up to 220 F.

²At -20 F, flexible Armaflex Insulations become hard and, as temperatures drop below -20 F, will be increasingly brittle; however, this hardening characteristic does not affect thermal efficiency or water vapor permeability. Application below -40 F is at user's discretion.

³Armaflex in selected wall thickness and inside diameters available in 50-ft continuous lengths.

⁴ASTM method, in some cases, may be modified slightly to make results more meaningful for end-use application. If details are required, contact Armstrong Cork Company.

*Average values are not to be used for writing material specifications. Contact Armstrong for specification ranges.

Thickness recommendations

Pipe size	Line temperatures		
	50 F	35 F	0 F
BASED ON NORMAL DESIGN CONDITIONS*			
3/8" ID thru 3" IPS	Nom 3/8"	Nom 1/2"	Nom 3/4"
Over 3" IPS thru 10" IPS†	Nom 1/2"	Nom 1/2"	Nom 3/4"
Over 10" IPS	3/4" Sheet	3/4" Sheet	1" Sheet
BASED ON MILD DESIGN CONDITIONS**			
3/8" ID thru 3" IPS	Nom 3/8"	Nom 3/8"	Nom 1/2"
Over 3" IPS thru 10" IPS†	Nom 1/2"	Nom 1/2"	Nom 1/2"
Over 10" IPS	3/4" Sheet	3/4" Sheet	1/2" Sheet
BASED ON SEVERE DESIGN CONDITIONS***			
3/8" ID thru 10" IPS†	Nom 1/4"	Nom 3/4"
Over 10" IPS	3/4" Sheet	1 1/4" Sheet

Armaflex in the thicknesses noted and within the specified temperature ranges will prevent condensation on indoor piping under **normal** design conditions, a maximum severity of **85 F and 70% RH**. Armstrong research and field experience indicate that indoor conditions anywhere in the United States seldom exceed this degree of severity.

Armaflex in the thicknesses noted and within the specified temperature ranges will prevent condensation on indoor piping under **mild** design conditions, a maximum severity of **80 F and 50% RH**. Typical of these conditions are most air-conditioned spaces and arid climates.

Armaflex in the thicknesses noted and within the specified temperature ranges will prevent condensation on indoor piping under **severe** design conditions, a maximum severity of **90 F and 80% RH**. Typical of these conditions are indoor areas in which excessive moisture is introduced or in poorly ventilated confined areas where the temperature may be depressed below ambient.

NOTE: Thicknesses for zero F lines available on request.

†Pipe sizes 6" IPS thru 10" IPS refer to Pre Cut Pipe Insulation.

OFFICES

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1341 E. Morehead Street

CHICAGO, IL
422 Northwest Highway
Park Ridge, IL 60068

CINCINNATI, OH 45241
4100 Executive Park Drive

NEW YORK, NY
Park 80 Plaza West—One
Garden State Parkway at Interstate 80
Saddle Brook, NJ 07662

ST. LOUIS, MO 63105
222 South Meramec Avenue

SAN FRANCISCO, CA
1814 Ogden Drive
Burlingame, CA 94010

Armstrong

Standard Armaflex Sheet Insulation



DESCRIPTION

Armaflex Sheet Insulation is a flexible, elastomeric thermal insulation, black in color, supplied as flat sheets 36" x 48", in thicknesses $\frac{1}{8}$ " through 1" in $\frac{1}{8}$ " increments. It is furnished with a smooth skin one side which forms the outer, exposed insulation surface. The expanded, closed-cell structure of Armaflex Sheet makes it an efficient insulation, and because of its low water vapor permeance, it is considered a vapor barrier in itself.

USES

Armaflex Sheet is used for all applications that cannot be accomplished by the preformed tubular insulation also available. It is particularly adaptable for insulating ductwork, large piping, tanks, and vessels. Its flexibility allows application to curved and irregular surfaces. Armaflex Sheet is very adaptable to making all types of fitting cover insulations.

The recommended temperature usage range for Armaflex Sheet is -40 F to +220 F according to method of application. With full adhesive coverage attachment, the surface to which it is applied may operate to a limit of 180 F. When used for pipe insulation with adhesive adhering seams and joints only, Armaflex Sheet can be applied to lines that will operate to a limit of 220 F.

For use on cold surfaces, Armaflex Sheet thicknesses have been calculated to prevent condensation, as shown in the table of thickness recommendations.

APPLICATION

Armaflex Sheet is installed using Armstrong 520 Adhesive, a heat-resistant and water-vapor-resistant contact adhesive. For application to large flat or curved metal surfaces such as ducts, very large pipes, tanks, and vessels, full adhesive coverage attachment is used. For application as pipe insulation and fitting covers, only the seams and joints are adhered with adhesive. 520 Adhesive is a contact adhesive; therefore, in all cases, both surfaces to be joined are coated with adhesive.

Indoors, no protective finish is required but may be desirable.

Outdoors, a weather-resistant protective finish is to be applied. The recommended protective finish is Armstrong Armaflex™ Finish; however, other compatible finish systems are not ruled out.

SPECIFICATION COMPLIANCE

Standard Armaflex Sheet can be supplied upon request to meet:

ASTM C534, Type II
ASTM D1056 SBE 41-42
MIL-C-3133B (MIL STD 670B),
Grade SBE 3
HH-I-573B, Class S

FLAMMABILITY

Standard Armaflex is an organic material specially compounded to retard burning. The flammability of this insulation has been tested by exposing samples 6" long x 2" wide x $\frac{1}{2}$ " thick to procedures of the ASTM D1692 method of test entitled "Flammability of Plastic Sheeting and Cellular Plastics." During this test, the sample is positioned horizontally. This test method is not intended to be a criterion of fire hazard; it is not a measure of total involvement in a fire. By this test, burning ceased in an average of 65 seconds, and the burning length averaged 1.1" distance from the flame-source end.



Industry Products Division, Lancaster, Pa. 17604

Standard Armaflex Sheet Insulation

Average physical properties*

		Test Method (See note 3)
Density, lb/cu ft	5.7	ASTM D1622
Thermal conductivity Btu/hr sq ft (F deg/in.)		
75 F mean temp	0.27	ASTM C177
90 F mean temp	0.276	or C518
Upper use limit, deg F (See note 1)	220	—
Lower use limit, deg F (See note 2)	-40	—
Thermal stability, % shrinkage		
7 days, 200 F	1.0	ASTM C548
7 days, 220 F	5.0	—
Water vapor permeability, wet cup, perm-in.	0.1	ASTM C355
Water absorption, % by weight	4.9	ASTM D1056
Ozone resistance	GOOD	—
Odor	NEGLIGIBLE	—
Sizes		
Width and length, inches	36 x 48	—
Thickness, inches (See note 4)	1/8 to 1 (1/8 increments)	—

Notes

*When Armaflex Sheet is installed by adhering butt joints and seams only, the upper temperature limit is 220 F using 520 Adhesive. Armaflex Sheet adhered with complete adhesive coverage on flat or curved metal surfaces may be applied to surfaces that will operate as high as 180 F using 520 Adhesive.

*At -20 F, flexible Armaflex Insulations become hard and, as temperatures drop below -20 F, will be increasingly brittle; however, this hardening characteristic does not affect thermal efficiency and resistance to water vapor permeability. Application below -40 F is at user's discretion.

*ASTM method, in some cases, may be modified slightly to make results more meaningful for end-use application. If details are required, contact Armstrong Cork Company.

*Armaflex Sheet in 1/4" thickness not available.

Average values are not to be used for writing material specifications. Contact Armstrong for specification ranges.

Thickness recommendations

BASED ON NORMAL DESIGN CONDITIONS
Armaflex in the thicknesses noted and within the specified temperature ranges will prevent condensation indoors under normal design conditions, a maximum severity of 85 F and 70% RH. Armstrong research and field experience indicate that indoor conditions anywhere in the United States seldom exceed this degree of severity.

BASED ON MILD DESIGN CONDITIONS
Armaflex in the thicknesses noted and within the specified temperature ranges will prevent condensation indoors under mild design conditions, a maximum severity of 80 F and 50% RH. Typical of these conditions are most air-conditioned spaces and arid climates.

BASED ON SEVERE DESIGN CONDITIONS
Armaflex in the thicknesses noted and within the specified temperature ranges will prevent condensation indoors under severe design conditions, a maximum severity of 90 F and 80% RH. Typical of these conditions are indoor areas in which excessive moisture is introduced or in poorly ventilated, confined areas where the temperature may be depressed below ambient.

Ducts—Tanks—Vessels—Equipment Metal-Surface Temperature

50 F 3/8"	35 F 3/8"	0 F 1"
1/8"	1/4"	1/2"
3/4"	1 1/4"†	1 3/4"†

† multiple layer

OFFICES

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Garden State Parkway at Interstate 90
Saddle Brook, NJ 07662

ST. LOUIS, MO 63105
222 South Meramec Avenue

SAN FRANCISCO, CA
1814 Ogden Drive
Burlingame, CA 94010

DESCRIPTION

Armaflex Finish is a vinyl lacquer-type coating for use over Armstrong Standard Armaflex[®] and FR/Armaflex Pipe and Sheet Insulation. This coating provides a high gloss protective finish for both indoor and outdoor installations. It brushes on easily and may also be airless-sprayed or roller-coated. Chemically acceptable to USDA Consumer and Marketing Service.

COLORS

Armaflex Finish is available in white and gray standard colors. In situations where a custom pastel shade is desired, white Armaflex Finish can be tinted with selected pigment pastes recommended for shading or coloring commercial paints. Suggested pigment suppliers can be obtained from the nearest Armstrong district office. Standard colors are shipped in quart, gallon, and 5-gallon containers.

ADVANTAGES

Excellent Adhesion

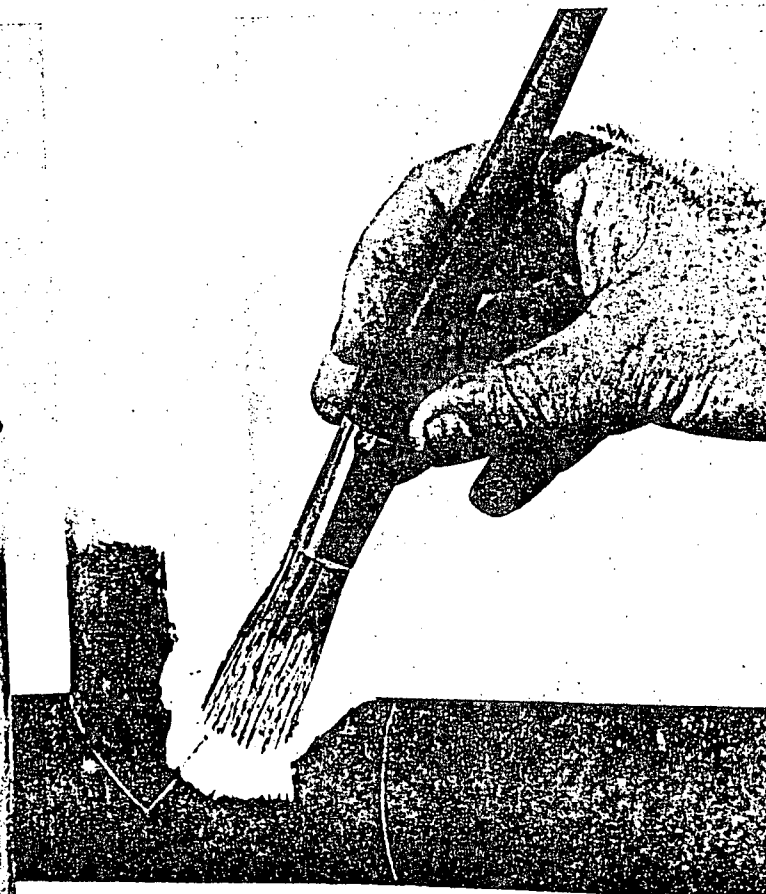
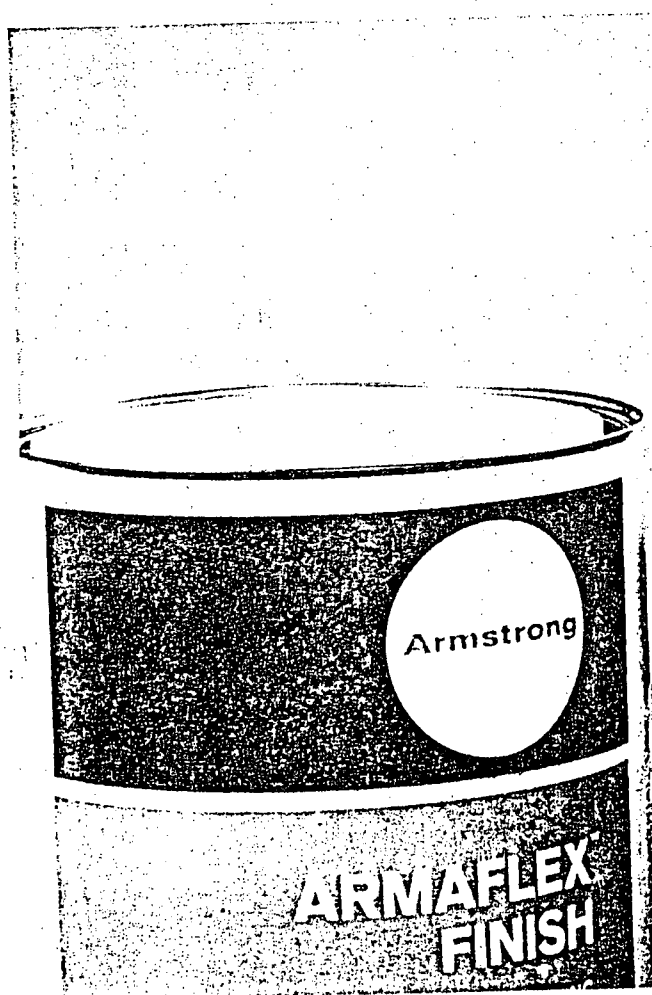
Armaflex Finish dries to a durable film which adheres tightly to clean Armaflex Insulation surfaces.

High Flexibility

The dried finish has approximately the same degree of flexibility as Armaflex. In both indoor and outdoor applications, it will deform with the Armaflex without cracking. Armaflex Finish maintains this flexibility upon aging and at exposure to low temperatures.

Self-Extinguishing

Armaflex Finish has self-extinguishing properties. When used on Standard Armaflex and FR/Armaflex, Armaflex Finish has negligible effect on their fire-safety characteristics.



DESCRIPTION

Color:
standard white and gray

Net Weight:
8.8 lb per gallon

Composition:
pigmented plasticized vinyl lacquer

Viscosity:
heavy-bodied, easy brushing

Application:
brush, roller, or airless spray

Coverage:
300 sq ft per gallon per single brush coat

Drying Time:
2 hours minimum for second coat

Container Sizes:
1-qt and 1-gal cans, 5-gal pails

Flammability:
wet: flash point 64 F (TOC)
dry: self-extinguishing

WARNING—FLAMMABLE MIXTURE. DO NOT USE NEAR FIRE OR FLAME.

Use adequate ventilation—keep air circulating ■ Prohibit smoking ■ Extinguish all flames—pilot lights, blowtorches, etc. ■ Avoid heat and sparks ■ Keep container closed ■ Avoid prolonged breathing of vapor and prolonged contact with skin ■ In case of excessive inhalation remove subject to fresh air ■ Do not take internally ■ If swallowed, do not induce vomiting; call physician immediately ■ Contains xylene ■ Keep away from children

APPLICATION

Armaflex Finish is applied directly to clean, dry Armaflex Insulations in two coats. For best results, the Armaflex surface should be wiped with a cloth dampened with a nonoily solvent before the first coat is applied. The second coat may then be applied after this coat has dried. Drying time will vary with conditions, but a minimum of two hours should be allowed. No reinforcing mesh is needed for outdoor applications. Indoors, coverage is approximately 300 sq ft per gallon in single brush coat.

Where Armaflex must be sealed around metal rods and projections, use a commercially available latex caulk. Armaflex Finish should not be used over asphaltic surfaces, as discoloration will occur.

WHEN TO APPLY

Armaflex Finish should not be applied over joints freshly cemented with Armstrong 520 Adhesive. Drying time must be allowed as follows:

- 24 to 36 hours for adhesive joints of Armaflex Pipe Insulation and Armaflex Sheet where adhesive is applied only to joints and seams.
- 7 days where Armaflex Sheet is applied with full adhesive bonding.

EFFECT OF TEMPERATURE

Although low temperatures will cause Armaflex Finish to become more viscous in the container, the product is not deteriorated by cold. Thickening, however, does lower covering capacity, and it may be necessary to thin with xylol in cold weather to maintain normal covering capacity and ease of application.

DRYING

If Armaflex Finish becomes wet soon after application, water spotting may occur. The spots will disappear as the finish dries.

In cool, poorly ventilated areas, solvent odors may persist for as long as a week after application of Armaflex Finish. Any foods that will suffer from odor contamination should be removed during this period.

In most cases, Armaflex Finish should not be used over conventional insulations, other flexible insulations, or other building or structural materials. A test coat applied to a small area will usually determine the acceptability of the material under question. If you have any additional questions about application to surfaces other than Armaflex Insulations, consult your nearest Armstrong district office or write Armstrong Cork Company, Industry Products Division, Lancaster, Pennsylvania 17604.

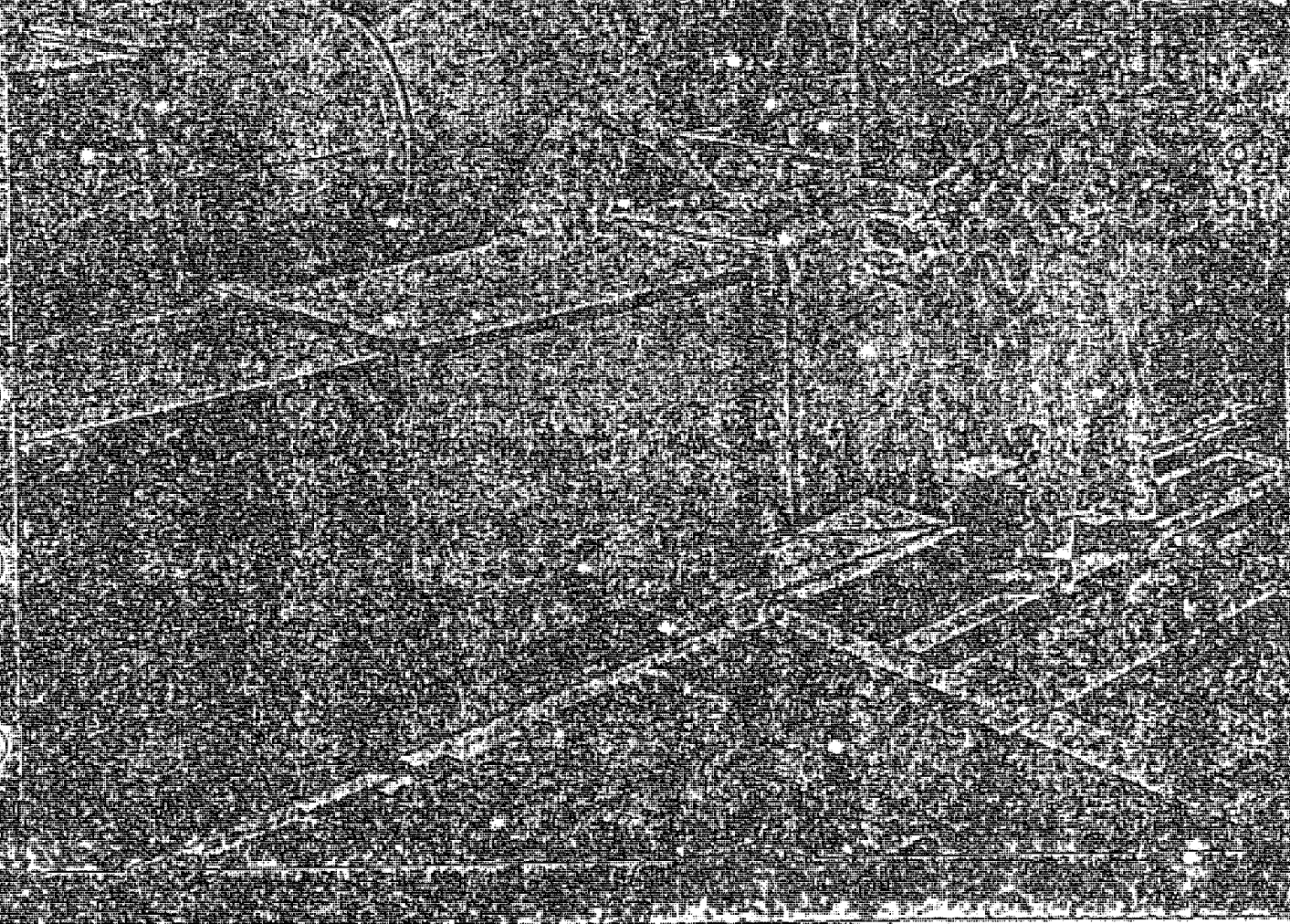
To clean fresh Finish from work and tools, use methyl ethyl ketone, xylol, aromatic naphtha, or methylene chloride.

Armstrong
CORK COMPANY
Lancaster, Pennsylvania

Armstrong

SHEET INSULATION

FR/Armaflex and Standard Armaflex



both materials are similar except for superior fire-retardant characteristics of the FR material.

Armaflex Sheet is particularly adaptable to insulating of large tanks of all shapes, ductwork, irregular vessels, and large piping. Armaflex Sheet may be applied with full adhesive coverage to metal surfaces that will operate as high as 180 F. When used within recommended usage ranges, Armaflex Sheet thicknesses have been calculated to prevent condensation on cold surfaces. Temperatures below zero may require application of Armaflex Sheet in multiple layers.

When used for pipe insulation, with adhesive at seams and joints only, Armaflex Sheet can be applied to lines that will operate as high as 220 F.

Flammability—FR/Armaflex Sheet

FR/Armaflex is an organic material specially compounded to be a fire-retardant insulation. The flammability of this insulation has been tested by exposing a 25-ft-long sample to the ASTM E84 method of test. The ASTM E84 test, entitled "Surface Burning Characteristics of Building Materials," is a measure of the ability of a material to spread flame and develop smoke; it is not a measure of total involvement in a fire.

Flame spread (available thicknesses 1" or less)	25	—	ASTM E84
Smoke developed (available thicknesses)	—	—	ASTM E84
1/4"	75		
3/8"	110		
1/2"	150		
3/4"	225		
1"	290		

Flammability—Standard Armaflex Sheet

Standard Armaflex is an organic material specially compounded to retard burning. The flammability of this insulation has been tested by exposing samples 6" long x 2" wide x 1/2" thick to procedures of the ASTM D1692 method of test, entitled "Flammability of Plastic Sheeting and Cellular Plastics." This test method is not intended to be a criterion of fire hazard; it can be of considerable value in comparing flammability of different materials. By this test, burning ceased in an average of 65 seconds, and the burning length averaged 1.1" distance from the flame-source end.

Armaflex Sheet Insulations average physical properties*

	FR/Armaflex Sheet Insulation	Standard Armaflex Sheet Insulation	Test Method (See note 3)
Density, lb/cu ft	0.9	0.7	ASTM D1622
Thermal conductivity, Btu/hr sq ft (F deg-in)			
75 F mean temp	0.28	0.27	ASTM C177 or C518
90 F mean temp	0.286	0.276	
Upper use limit, deg F (See note 1)	220	220	—
Lower use limit, deg F (See note 2)	-40	-40	—
Thermal stability, % shrinkage			
7 days, 200 F	5.0	1.0	ASTM C548
7 days, 220 F	6.1	5.0	
Water vapor permeability, wet cup, perm-in.	0.17	0.1	ASTM C355
Water absorption, %, by weight	8.4	4.9	ASTM D1056
Ozone resistance	GOOD	GOOD	—
Odor	NEGLECTIBLE	NEGLECTIBLE	—
Sizes			
Width and length, inches	36 x 48	36 x 48	—
Thickness, inches (See note 4)	1/4 to 1 (1/4 increments)	1/4 to 1 (1/4 increments)	—

1When Armaflex Sheet is installed by adhering butt joints and seams only, the upper temperature limit is 220 F using 520 Adhesive. Armaflex Sheet adhered with complete adhesive coverage on flat or curved metal surfaces may be applied to surfaces that will operate as high as 180 F using 520 Adhesive.

2At -20 F, flexible Armaflex Insulations become hard and, as temperatures drop below -20 F, will be increasingly brittle; however, this hardening characteristic does not affect thermal efficiency and resistance to water vapor permeability. Application below -40 F is at user's discretion.

3ASTM method, in some cases, may be modified slightly to make results more meaningful for end-use application. If details are required, contact Armstrong Cork Company.

4Armaflex Sheet in 1/4" thickness not available.

*Average values are not to be used for writing material specifications. Contact Armstrong for specification ranges.

Armaflex Sheet Insulation thickness recommendations

	Ducts—Tanks—Vessels—Equipment Metal-Surface Temperature		
	50 F 3/8"	35 F 3/8"	0 F 1"
BASED ON NORMAL DESIGN CONDITIONS Armaflex in the thicknesses noted and within the specified temperature ranges will prevent condensation indoors under normal design conditions, a maximum severity of 85 F and 70% RH. Armstrong research and field experience indicate that indoor conditions anywhere in the United States seldom exceed this degree of severity.			
BASED ON MILD DESIGN CONDITIONS Armaflex in the thicknesses noted and within the specified temperature ranges will prevent condensation indoors under mild design conditions, a maximum severity of 80 F and 50% RH. Typical of these conditions are most air-conditioned spaces and arid climates.	1/4"	1/4"	1/2"
BASED ON SEVERE DESIGN CONDITIONS Armaflex in the thicknesses noted and within the specified temperature ranges will prevent condensation indoors under severe design conditions, a maximum severity of 90 F and 80% RH. Typical of these conditions are indoor areas in which excessive moisture is introduced or in poorly ventilated, confined areas where the temperature may be depressed below ambient.	3/4"	1 1/4"	1 3/4"

DESCRIPTION

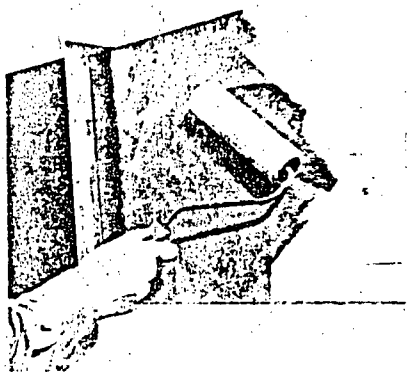
Armstrong Armaflex Sheet Insulation is a flexible, elastomeric thermal insulation material incorporating the three most desirable properties of a low-to-medium-temperature

insulation: high insulation efficiency, high resistance to transmission of water vapor, and ease of application.

Armaflex Sheet is available in both Fire-Retardant (FR) and Standard types. Physical characteristics of



When Armaflex Sheet is used with full adhesive coverage, adhesive is easily applied with brush or roller.



A thin coating of adhesive also is applied to large surfaces that will be insulated with Armaflex Sheet.



When adhesive on sheet and surface has dried to the touch, the sheet is carefully positioned as contact bond is made.

Specification Compliance

- FR/Armaflex and
- Standard Armaflex Sheet can be supplied upon request to meet:
 - ASTM C534, Type II
 - ASTM D1056 SBE 41-42
 - MIL-C-3133B (MIL STD 670B) Grade SBE 3
 - HH-I-573B, Class S
- FR/Armaflex Sheet can be supplied upon request to meet:
 - MIL-P-15280E & Amendment 1, Form S-Sheet

ADVANTAGES

Armaflex is not a thermoplastic. It is a vulcanized synthetic elastomer and will not melt or drip during exposure to heat.

High Insulating Efficiency

The closed cellular structure of Armaflex gives it a low average "k" value. Armaflex resists moisture and deterioration, so thermal efficiency remains high in service.

Resistance to Moisture Vapor

The uniformly sized, closed cells of Armaflex reduce moisture vapor permeability to a very low level.

Dimensional Stability

When Armaflex Sheet Insulation is tested at a soaking heat of 220 F for 7 days, shrinkage is about 5% for Standard material and 6% for FR material. (See table page 2.) In application, only the inner surface is exposed to 220 F, so shrinkage is considerably less than the test figure.

Wide Temperature Range

Armaflex Sheet has a wide usage range from -40 F to +180 F or

+220 F, depending on method of installation.

Smooth Surface

Armaflex has an exceptionally smooth, uniform outer surface finish. This results in a neat-looking installation, whether the surface is left unfinished or given a protective coating.

Fast, Easy Application

Armaflex Sheet can be applied directly to clean, dry metal surfaces with Armstrong 520 Adhesive. Conventional mechanical supports are unnecessary. Low moisture vapor permeability eliminates the need for a separate vapor barrier, but outdoor installations should be protected against weather with Armstrong Armaflex™ Finish, a vinyl-lacquer-type coating.

APPLICATION OF FR/ARMAFLEX SHEET

Note: These specifications refer throughout to FR/Armaflex. Standard Armaflex can be installed by the same application techniques.

1. Sheet Insulation

1.1 General

1.1.1 Insulation shall be flexible, closed-cell, elastomeric thermal sheet insulation, Armstrong FR/Armaflex or approved equal. Insulation shall have a flame spread rating of 25 or less when tested by ASTM E84 method.

1.1.2 FR/Armaflex Sheet shall be applied with the smooth or skin side out. It is to be applied to metal surfaces that will operate as high as 180 F with full surface bonding of 520 Adhesive.

1.1.3 FR/Armaflex Sheet shall be adhered with a thin but adequate coat of 520 Adhesive applied to both surfaces to be joined.

Before pressing surfaces together, the adhesive shall be allowed to dry until dry to the touch but tacky under slight pressure. 520 Adhesive is an instant-bonding type; therefore, surfaces are to be positioned accurately as contact is made.

1.1.4 Metal surfaces shall be clean, dry, and free of all dirt, scale, loose paint, plaster, oil, etc. If the metal surface has been primed, a test area of approximately two square feet shall be coated with 520 Adhesive to determine whether the solvent in the adhesive will loosen or lift the primer. If there is any indication of loosening or lifting the primer, FR/Armaflex Sheet shall not be applied until the primer is removed or replaced with acceptable material.

1.1.5 FR/Armaflex Sheet is not to be applied over asphaltic surfaces where surface bonding is necessary, since 520 Adhesive will not bond to asphalt.

1.1.6 Where special corrosion-resistant coatings are specified for metal surfaces, they shall be compatible with Armstrong 520 Adhesive.

1.2 Application

1.2.1 APPLICATION TO METAL TANK, VESSEL, AND EQUIPMENT SURFACES BY COMPRESSION-FIT METHOD

1.2.1.1 A coat of 520 Adhesive shall be applied with brush or short-nap paint roller to the surface to be insulated, covering enough area to receive one FR/Armaflex Sheet.

1.2.1.2 A coat of 520 Adhesive shall be applied with brush or short-nap paint roller to the back of the FR/Armaflex Sheet, leaving a 1/2"-wide uncoated border around the perimeter of the sheet.

1.2.1.3 The adhesive shall be allowed to dry until dry to the touch but tacky under slight pressure before bringing the two surfaces into contact.

1.2.1.4 The sheet being installed is to be positioned in such manner that it overlaps the edges of the previously applied sheet or sheets by 1/2". While held in this position, the center of the sheet shall be spot-adhered. The butt edges of the sheets are to be compressed into place to achieve a tight joint. The remainder of the sheet shall then be bonded by pressing firmly into place. A small hand roller is useful for applying pressure.

1.2.1.5 The sheet joint is to be spread apart and, by means of a small brush, 520 Adhesive shall be applied to both butt edges which are then aligned for good appearance.

1.2.1.6 Vertical joints are to be staggered where FR/Armaflex Sheet is applied to vertical tanks. In the case of horizontal tanks, the horizontal joints are to be staggered.

1.2.2 APPLICATION TO METAL DUCT SURFACES

1.2.2.1 FR/Armaflex Sheet shall be adhered to the duct surface using 520 Adhesive. Adjacent sheets shall be applied using the compression-fit method (see Paragraph 1.2.1). The adhesive is to be applied on both surfaces to be joined with a brush or short-nap paint roller. The adhesive shall be allowed to dry until dry to the touch but tacky under slight pressure before bringing the two surfaces together.

1.2.2.2 For square and rectangular ducts, FR/Armaflex Sheet shall be applied first on the bottom surface, neatly fitted to the width. The side insulation shall then be extended over the edges of the bottom insulation. The top insulation shall extend over the top of the insulation on both sides.

1.2.2.3 Standing metal duct seams shall be insulated with the same FR/Armaflex Insulation thickness as installed on the duct surface.

1.2.2.3.1 Alternate: Half sections of FR/Armaflex Pipe Insulation of proper wall thickness may be used to insulate standing metal duct seams.

1.3 Finishes

1.3.1 INDOOR FINISH*

*(specifier shall choose one finish)
(specifier is cautioned that only Armaflex Finish will withstand excessive flexing after drying)*

1.3.1.1 No finish shall be applied over FR/Armaflex Sheet Insulation.

1.3.1.2 Two coats of Armaflex Finish shall be applied directly to the FR/Armaflex Sheet.

1.3.1.3 Two coats of Armstrong Insulcolor® shall be applied directly to the FR/Armaflex Sheet.

1.3.1.4 Commercially available (high-quality interior enamel) (latex enamel paint) shall be applied directly to the FR/Armaflex Sheet.

1.3.2 OUTDOOR FINISH*

*(specifier shall choose one finish)
(specifier is cautioned that only Armaflex Finish will withstand excessive flexing after drying)*

1.3.2.1 Two coats of Armaflex Finish shall be applied directly to the FR/Armaflex Sheet.

1.3.2.2 Two coats of Armstrong Insulcolor shall be applied over white glass mesh adhered to the FR/Armaflex Sheet surface with Insulcolor Lagging Adhesive.

1.3.2.3 Two coats of Armstrong Weatherproof Plastic shall be applied directly to the FR/Armaflex Sheet with black glass mesh embedded in the first coat while wet.

***CAUTION:** Only Armaflex Finish will withstand excessive flexing after drying. For best results, wipe the surface of FR/Armaflex Sheet with a damp cloth, preferably dampened with a nonoil solvent to remove powdered lubricant before applying finish coatings. The commercial finishes are to be tested by the user for compatibility with FR/Armaflex.

Adhesive-bonded seams and joints of FR/Armaflex Sheet must cure before solvent-base finishes are applied. Where the insulation is installed by adhering seams and butt joints only, the adhesive must cure 24 to 36 hours. Where the insulation is installed against surfaces with full adhesive coverage, requiring wet adhesive at joints, the adhesive must cure seven days.

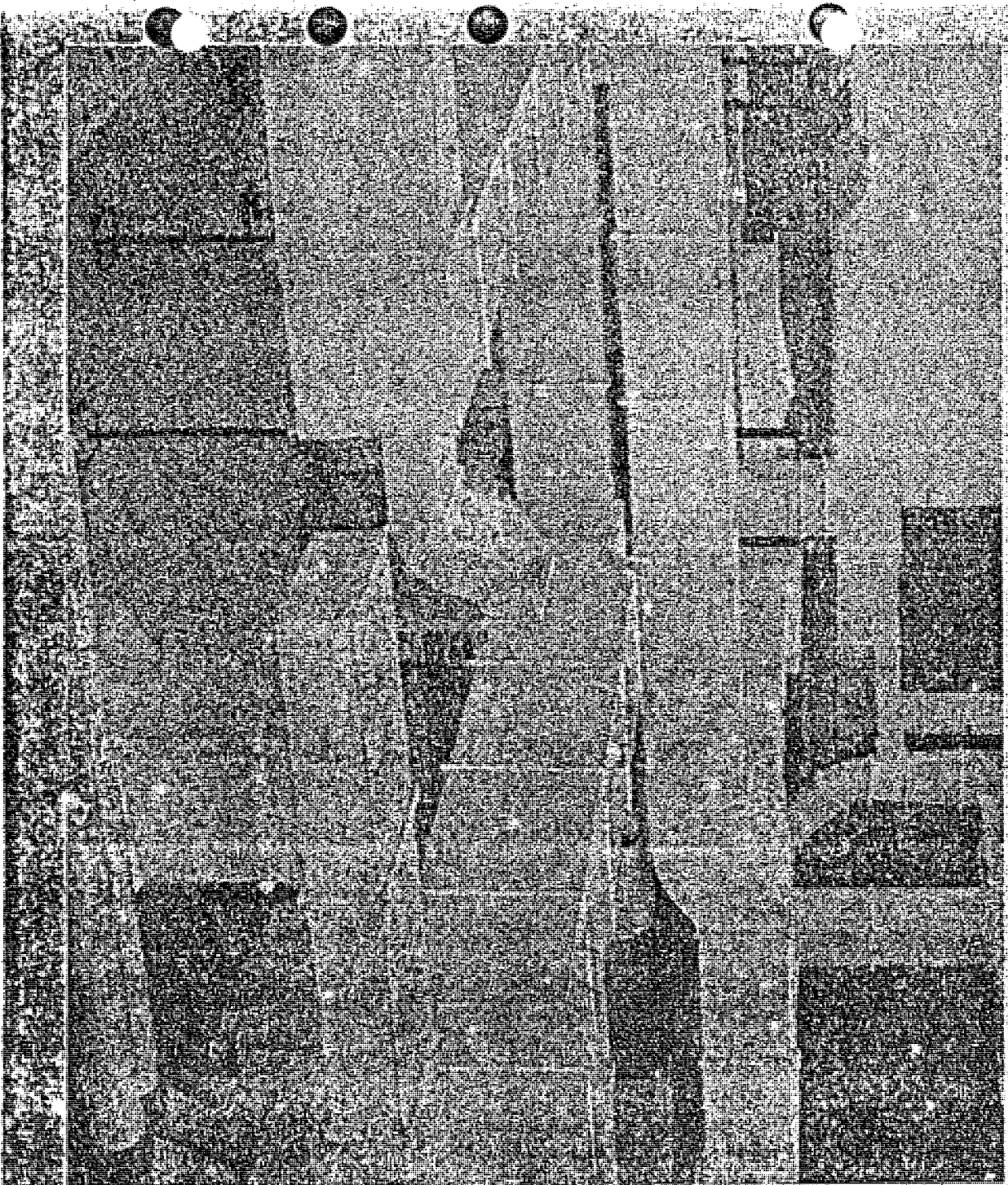


LANCASTER, PA.

Armstrong

How to Use
Armalex Sheet
Insulation
on Cold-
water
ductwork

and why you should



Armaflex Sheet is the best insulation for outdoor sheet-metal ducts. It is the most efficient. It is the easiest to install. Its installed cost is lower. It looks better. And it needs far less maintenance.

We'll prove it to you.

Armaflex Sheet is the best insulation.

A single thickness—usually 1/2"—is all that's required. Armaflex is a closed-cell elastomeric thermal insulation that doesn't require a separate vapor barrier.

Armaflex is the most efficient.

Armaflex Sheet has a low average thermal conductivity of 0.27 Btu/hr sq ft (F deg/in.) at 75 F mean temperature. Efficiency remains high because the material has excellent resistance to water vapor and air transmission.

Armaflex is easiest to install.

Armaflex comes in convenient sheets 36" x 48". It can be cut with a knife. It conforms easily to contours. It can be adhered with brush- or roller-applied contact-type 520 Adhesive, without clips or pins, and without a separate vapor barrier.

Armaflex costs less installed.

On many jobs, Armaflex can save upwards of 30% on installed costs for insulating outdoor ductwork, as opposed to the cost of the most commonly used conventional specification: foil-faced fibrous glass board, secured with clips on welded pins and finished with weather-resistant vapor-barrier mastic, reinforced with glass mesh.

Armaflex looks better.

The smooth flat surface of Armaflex Sheet conforms closely to the metal surface. In finished form, ducts which have been insulated with Armaflex Sheet are difficult to distinguish from uninsulated painted ductwork.

Armaflex needs far less maintenance.

Two coats of Armaflex™ Finish are all that are required for outdoor installation. Armaflex is not affected by extremes of weather and will not crack to allow entrance of damaging moisture. Wind and hail damage is minimal, and the vapor barrier of Armaflex is not destroyed by accidental bumps or punctures.

How to Install Armaflex Sheet on Metal Duct Surfaces

The preferred method for square and rectangular ducts is to cut and fit the sheets, using full coverage of Armstrong 520 Adhesive to adhere the insulation.



1. Measure—Sheets should be sized with the following application sequence in mind. Cut the bottom piece first, making it the same width as the duct. Then cut the two side pieces, so that they extend down over the edges of the bottom insulation; keep top edges flush with the top of the duct. The top insulation should be sized so that it extends over the side insulations.



2. Cut—A sharp knife and a straight-edge are the only tools required. Armaflex Sheet cuts cleanly, leaves no loose fibers.

Dow Corning CORPORATION

ELASTOMERS BUSINESS

ELIZABETHTOWN PLANT • ELIZABETHTOWN, KENTUCKY 42701



CERTIFICATE OF COMPLIANCE

SHIPPED TO

Chemtrol Corp.
Space C
14911 Steubner Arln
Houston, Texas 77069

DATE 1/31/78

ATTN: Bruce Robson

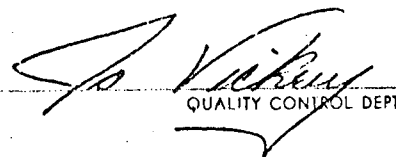
CUSTOMER P. O. NO.	DOW CORNING INV. NO.	CUSTOMER SPECIFICATION
1680	EK606400E1	None
PRODUCT	LOT NUMBER	QUANTITY
DOW CORNING® 96-081 RTV Adhesive Sealant	ER097133	8 x 12x16 oz.

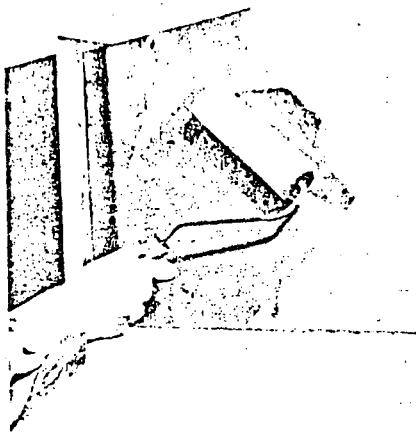
TEST REPORTS

Color	Pass
Uniformity	Pass
Extrusion rate, gpm	310
Skin over time	6 minutes
Flow, inches	Nil
Thin Section Cure	R&D
Cure Time	72 hrs/RT
Durometer, Shore A	61
Specific Gravity	1.41
Cure Time	7 days/RT
Durometer, Shore A	61
Tensile strength, psi	578
Elongation, %	150
Tear strength, lb/in	40
Flame Test	
Weight Loss, %	.1
Self Extinguishing	8 seconds

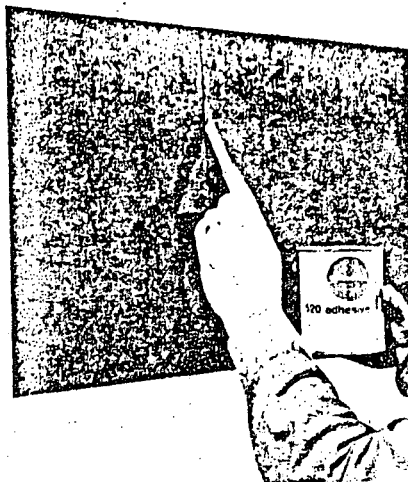
It is hereby certified that the articles listed above comply with all applicable specification requirements. Test reports are on file subject to examination.

DOW CORNING CORPORATION

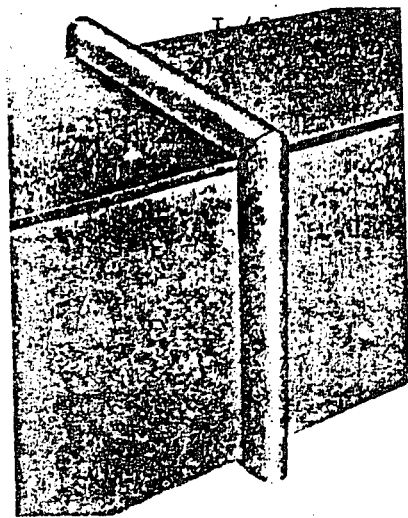

QUALITY CONTROL DEPT.



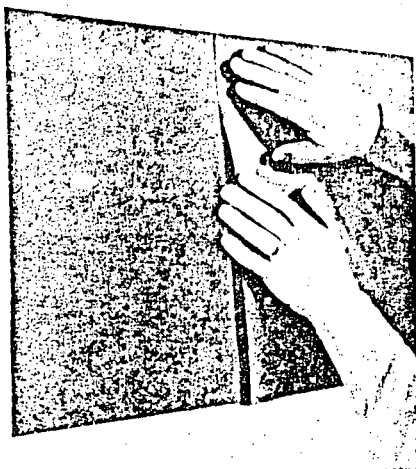
3. Apply Adhesive—First brush- or roller-coat 520 Adhesive on the metal duct surface. Then coat the back side of the Armaflex Sheet, leaving a 1/2"-wide uncoated border around the outside edges of the sheet. Allow the adhesive to dry to the touch but still tacky under slight pressure before joining surfaces.



5. Adhere Joints—Spread the joint, and with a small brush apply 520 Adhesive to both butt edges. Do not fill joint with adhesive. Align carefully for good appearance, and apply pressure to joint.



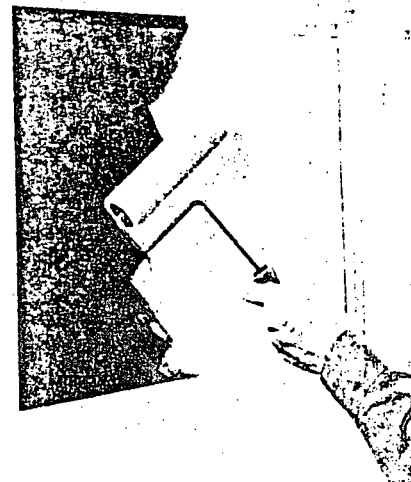
7. Alternate Method—Standing seams can also be insulated with half sections of Armaflex Pipe Insulation, corresponding in thickness to the sheet used on the duct surface. Ends should be miter-cut to insure tight fit when bonded.



4. Bond—Position the sheet so that it overlaps the edges of previously installed sheet or sheets by 1/8". Hold the sheet in this position, and spot-adhere it in the center. Compress the butt edges into place for a tight joint with adjoining sheets. Then bond the remainder of the sheet by pressing it firmly into place. A small hand roller will help apply pressure.



6. Standing Seams—These can be insulated with strips of Armaflex Sheet, generally cut from scrap.



8. Apply Armaflex Finish—Two coats of Armaflex Finish, a vinyl-lacquer-type coating, are all that are required to provide a high-gloss protective finish for either outdoor or indoor installations. Armaflex Finish can be brushed, roller-coated, or airless-sprayed.



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Division Offices**

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1341 E. Morehead Street

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Park Ridge, IL 60068

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Saddle Brook, NJ 07662

ST. LOUIS, MO 63105
222 South Meramec Avenue

SAN FRANCISCO, CA
1814 Ogden Drive
Burlingame, CA 94010

**Armaflex Sheet
Insulation
thickness
recommendations**

Ducts—Tanks—Vessels—Equipment
Metal-Surface Temperature

based on
normal
design conditions

Armaflex in the thicknesses noted and within the specified temperature ranges will prevent condensation indoors under normal design conditions, a maximum severity of 85 F and 70% RH. Armstrong research and field experience indicate that indoor conditions anywhere in the United States seldom exceed this degree of severity.

50 F 35 F 0 deg F

$\frac{3}{8}$ " $\frac{5}{8}$ " 1"

based on
mild
design conditions

Armaflex in the thicknesses noted and within the specified temperature ranges will prevent condensation indoors under mild design conditions, a maximum severity of 80 F and 50% RH. Typical of these conditions are most air-conditioned spaces and arid climates.

$\frac{1}{8}$ " $\frac{1}{4}$ " $\frac{1}{2}$ "

based on
severe
design conditions

Armaflex in the thicknesses noted and within the specified temperature ranges will prevent condensation indoors under severe design conditions, a maximum severity of 90 F and 80% RH. Typical of these conditions are indoor areas in which excessive moisture is introduced or in poorly ventilated, confined areas where the temperature may be depressed below ambient.

$\frac{3}{4}$ " 1 $\frac{1}{4}$ " 1 $\frac{7}{8}$ "

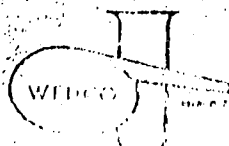
Armaflex Sheet carton contents

(All Sheets 36" x 48")

Thickness (In.)	Sheets per Carton	Sq Ft per Carton
$\frac{1}{8}$	32	384
$\frac{1}{4}$	16	192
$\frac{3}{8}$	12	144
$\frac{1}{2}$	8	96
$\frac{5}{8}$	7	84
$\frac{3}{4}$	6	72
1	4	48



LANCASTER, PA. 176



WESTERN CHEMICAL & MANUFACTURING COMPANY

MAIN OFFICE

1270 East Washington Boulevard
Los Angeles, California 90021
Phone: (213) 269-0191

BRANCH OFFICE

215 Amey Avenue
Madera, Calif. 93646
Phone: (805) 263-2836

Nov. 4, 1977

Chemtrol Corp.
530 N. Belt East, Suite 105
Houston, Texas 77060

We certify that the material described below complies with the following specifications:

MATERIAL FIRE-WALL 50 Part #CT-355-C

The general ingredients are as follows:

39.75% Magnesium Oxy Sulfate

6.50% CM-10

19.00% 80-ML

34.75% P-76 Product 76

100.00%

BATCH NO. 11377 and 11477

QUANTITY 250 bags 50# each

DATE OF MANUFACTURE Nov. 13 and 14, 1977

DATE OF TESTING Nov. 13 & 14, 1977 TESTED BY M.E.H. and H.G.

DATE SHIPPED Nov. 14, 1977

CONTRACTOR Chemtrol Corp.

JOB IDENTIFICATION 3 Mile Island Nuclear Power Plant #2

JOB ADDRESS on the Hisquehawna River, Middletown, Pa. 17057

COMMENTS: In the chemical analysis sheets of the raw materials, chlorides are listed only as a trace in some, and not at all in others. Therefore, we can state that the Halogen content in Fire-Wall 50 is a "trace".

Certified correct.

WESTERN CHEMICAL & MFG. COMPANY

By-

M. E. H. H. H.
Technical Director

MEH:cl



Johns-Manville
Sales Corporation

Industrial Products Division

Manville, New Jersey 08835
(201) 725 5000

I-48

January 13, 1978

CERTIFICATION NO. CF-8001

Chemtrol Corp.
530 N. Belt East
Suite 105
Houston, Texas 77060

Attn: Mr. J. Shute

THIS IS TO CERTIFY THAT OUR STANDARD INSPECTION PROCEDURE
HAS BEEN USED IN THE INSPECTION OF THE MATERIAL SUPPLIED ON
J-M ORDER NO. T54 ZM60195 Prt. 2 AND PURSUANT TO CUSTOMER'S
ORDER NO. 1623. THIS INSPECTION INDICATES
THAT THE MATERIAL COMPLIES WITH THE APPLICABLE FINISHED
PRODUCT REQUIREMENTS OF THE JOHNS-MANVILLE CORPORATION.

MATERIAL
Ceraform Board
J-M P/N CF-11439-5

SIZE
1 x 24 x 36

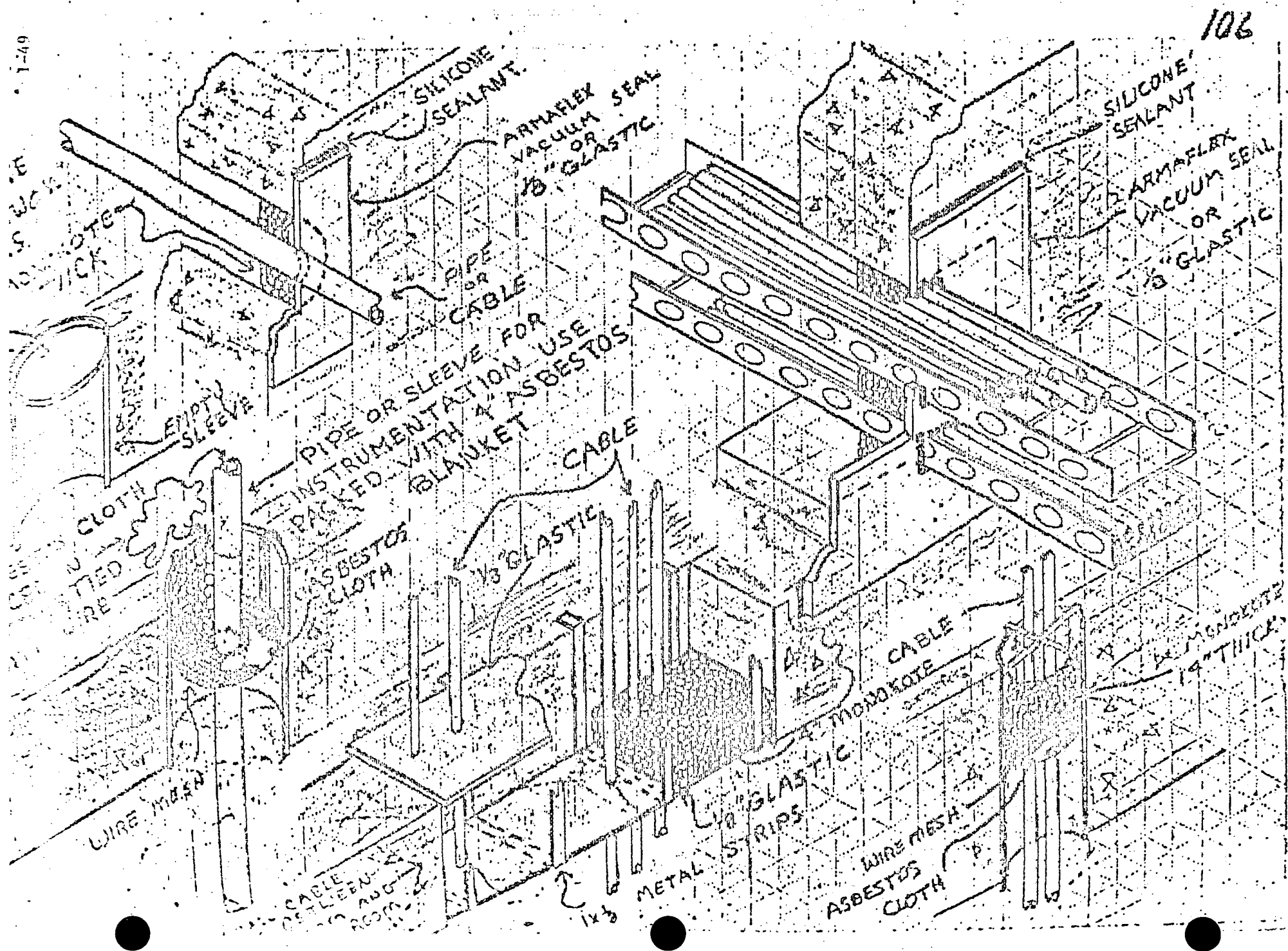
QUANTITY
1020 Sq. Ft.

JOHNS-MANVILLE SALES CORPORATION

Jerome C. Krefski

Quality Control Department

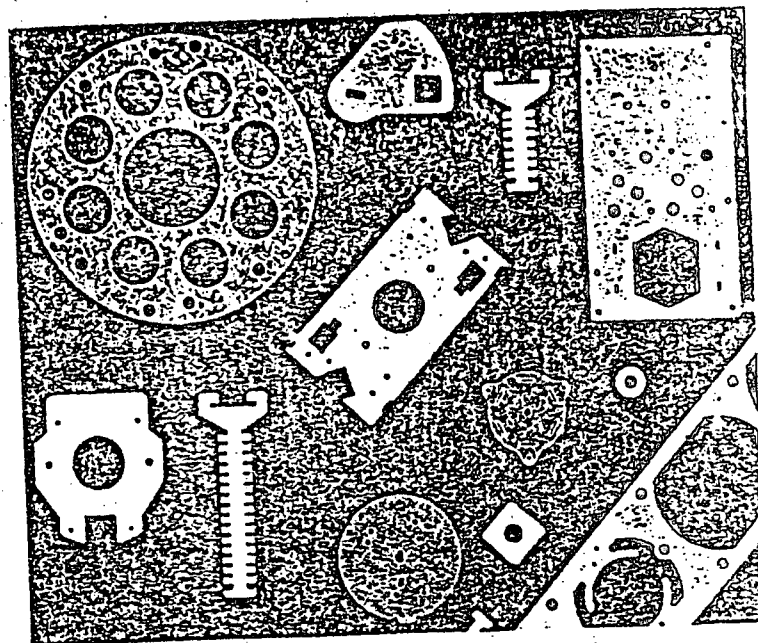
APPROVED: Jerome C. Krefski





UTS (Grade 1478)

This UL recognized flame retardant glass mat polyester laminate meets NEMA GPO 2 requirements. Recent developments in mat construction permit outstanding punching characteristics. Recognition by UL (E 23525) of general temperature rating 130° C electrical, 160° C mechanical. This laminate offers design in applications where flame retardance is mandatory, and higher retention of properties after heat aging is desired.



PROPERTY	CONDITIONING	TEST METHOD	UNITS	VALUES
				UTS
Perpendicular Electric Strength, S.T., 1/16" in air	A	ASTM D-229	VPM	400
Perpendicular Electric Strength, S.T., 1/32" in air	A	ASTM D-229	VPM	500
Perpendicular Electric Strength after heat, S.T., 1/16" in air	600 hrs. @ 150°C.	ASTM D-229	VPM	350
Perpendicular Electric Strength after heat, S.T., 1/16" in air	200 hrs. @ 200°C.	ASTM D-229	VPM	200
Parallel Electric Strength, S. x S.	A	ASTM D-229	KV	40
Parallel Electric Strength after water, S. x S.	D 48/50	ASTM D-229	KV	15
Arc Resistance	A	ASTM D-495	seconds	120
Carbon Tracking Resistance	A	ASTM D-2302-64T(8)	minutes	25
Power Factor, 60 cycle	A	ASTM D-150-59T	%	2.5
Impact Strength	A	ASTM D-229	FL-Lbs./In. Notch	8.5
Flexural Strength	A	ASTM D-229	P.S.I.	18,000
Flexural Strength tested @ 130°C.	1 hr. @ 130°C.	ASTM D-229	P.S.I.	9,000
Compressive Strength	A	ASTM D-229	P.S.I.	30,000
Water Absorption @ 23°C.	1 hr. @ 105°C.	ASTM D-229	% in 24 hrs.	1.0
Water Absorption after heat	1000 hrs. @ 150°C.	ASTM D-229	% in 24 hrs.	1.0
Flame Resistance—1/2" and over	A	NEMA 5-21-1962	Sec. ign/sec. burn	75/ 85
Flame Resistance—1/16" to under 1/2"	A	ASTM D-229 Method I	Secs.	15
Specific Gravity	A	ASTM D-792		1.75
U. L. Recognition Number				E23525
N.E.M.A. Grade Designation				GPO-2
Standard Color				red

Where testing procedure is applicable, all testing has been done on 1/4" thick material. All test specimens have been taken from standard production runs. The property values shown are conservative, but because no warranty is implied, test by the user should be done to determine the best material for his application.

1. PRODUCT NAME

One-part, Silicone Rubber Sealant,
General Electric Silicone Construction
1200 Sealant.

2. MANUFACTURER

General Electric Company
Silicone Products Department
Waterford, New York 12188
Phone: (518) 237-3330

3. PRODUCT DESCRIPTION

Basic Use: Silicone Construction 1200 Sealant is used to seal building joints to prevent the penetration of rain, air, dust, and noise. Silicone Construction Sealant effectively weather-proofs junctions of building materials and leads to effective structure continuity. Silicone Construction 1200 Sealant has been used for sealing curtain wall joints, mullion joints, and many other building construction joints. It is also used for glazing steel and aluminum windows (both operating and fixed), wood windows, interior glass partitions and skylights.

General Electric Silicone Construction 1200 Sealant has *resealed* many structures successfully after failures by other sealants. For maintenance, silicone sealant can be used indoors as well as outdoors; for example, as a sealant around wall fixtures and window sills. It has also been used to gasket and seal fixtures and machinery.

Permanent, watertight bonds, can be made with this sealant, in combination with glass, ceramic, steel, granite, aluminum and most plastics, and painted surfaces.

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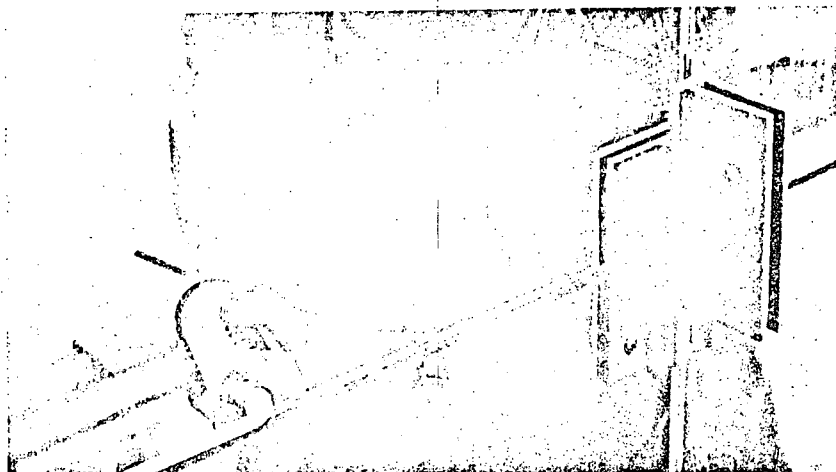


TABLE I. TYPICAL PROPERTIES†

AFTER 7 DAYS AT 77°F (25°C) AND 50% RELATIVE HUMIDITY

PROPERTY	VALUE	TEST METHOD
Hardness (Shore A Scale)	35	ASTM D 2240-68
Ultimate Tensile Strength (at Maximum Elongation)	400 psi (28.1 kgf/cm ²)	ASTM D 412-68
Peel Strength (Glass)	20 lb/inch (3.57 kg/cm)	TT-S-001543A (COM-NBS) CGSB 19-GP-9
Staining	None	TT-S-001543A (COM-NBS)
Weathering (after 10,000 hours in Atlas Weatherometer)	No Change in Hardness or Color	Weatherometer
UV Resistance	Excellent	ASTM G 23-69
Ozone Resistance	Excellent	ASTM D 698-70 (Method B)
Compression Set (1/2" (12.7 mm) Thick Rod 1" Diameter, under 50% Compression for 1 Year)	10%	
Tear Strength (Die B, after 1 Year Exposure)	35 lb/inch (6.25 kg/cm)	ASTM D 624-54 (1970)
Tack-Free Time	<1 hour	
Curing Time	5 to 7 Days at 75°F (25°C), 1/4" (6.4 mm) Section	
Sag; Slump	None	

† These values are not intended for use in preparing specifications.

PHOTOGRAPHS OF INSTALLATIONS AND FIRE EXPOSURE PERIOD

TEST SLAB LAYOUT



FIGURE 1. PLACEMENT OF PENETRATION OPENINGS

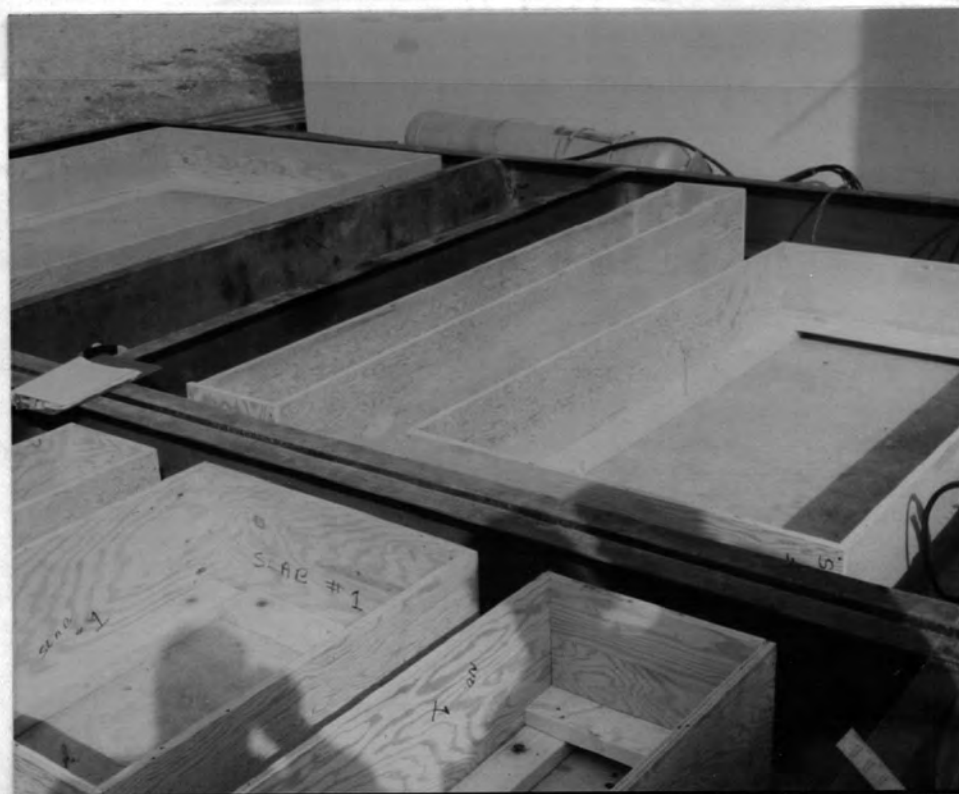


FIGURE 2. PLACEMENT OF PENETRATION OPENINGS



FIGURE 3. PLACEMENT OF PIPE PENETRATION AND REBAR

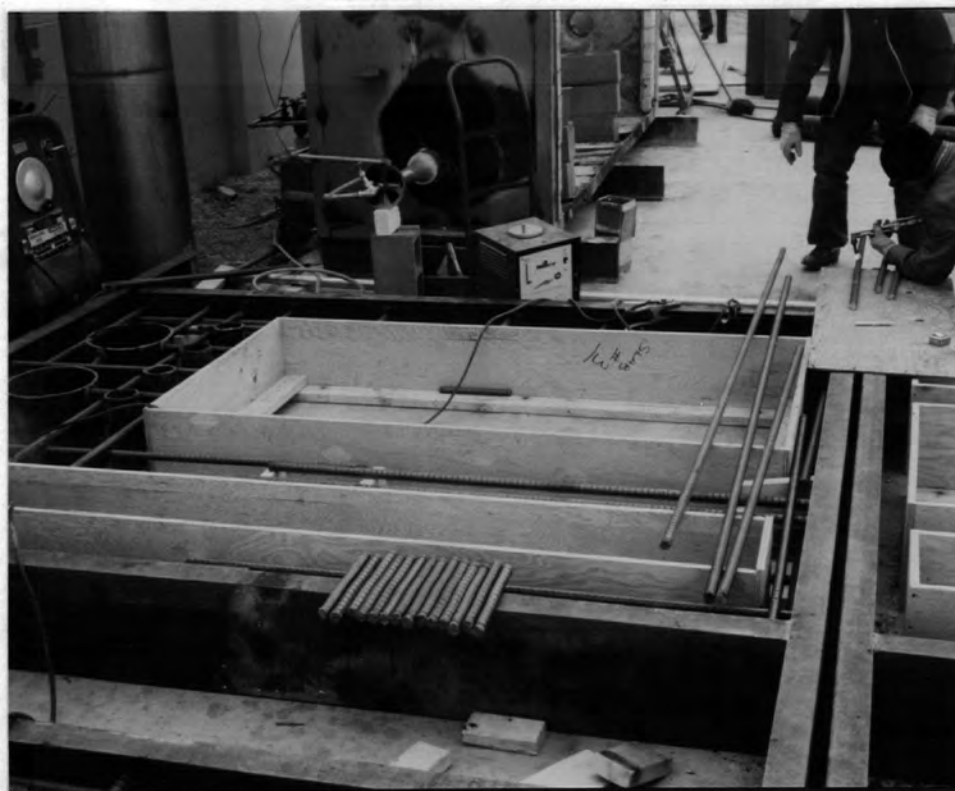


FIGURE 4. PLACEMENT OF PIPE PENETRATION AND REBAR



FIGURE 5. VIEW OF REBAR IN PLACE



FIGURE 6. OVERALL VIEW OF SLAB BEFORE POUR AND CURE

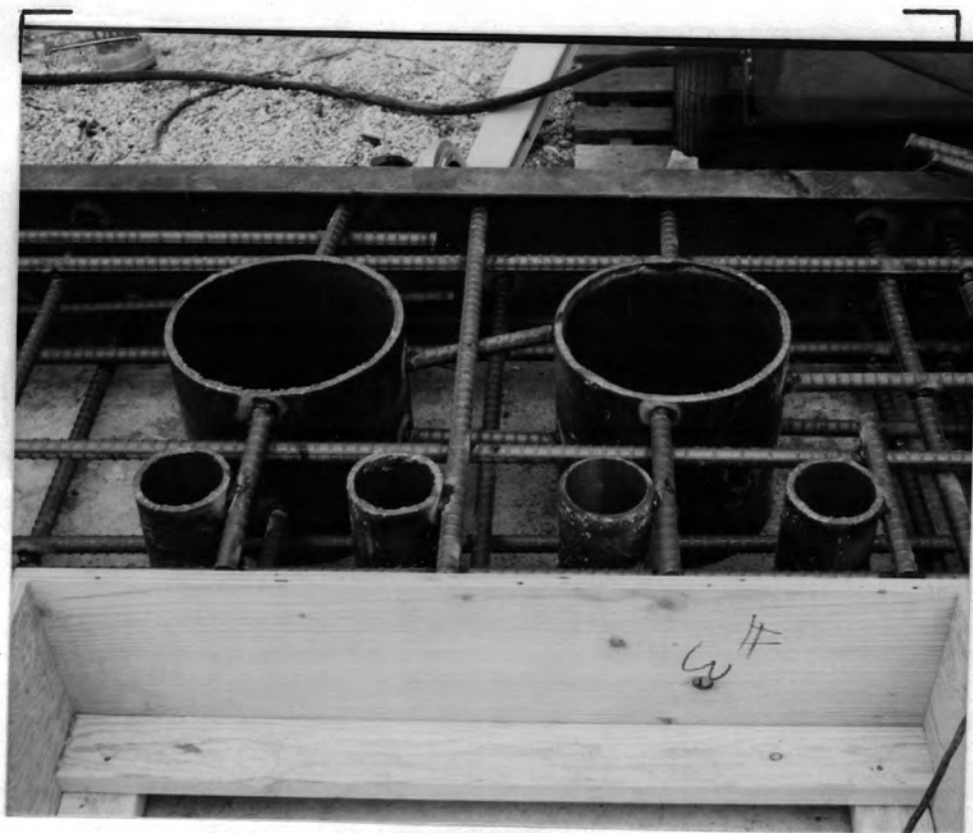


FIGURE 7. OVERALL VIEW OF PIPE PENETRATIONS



FIGURE 8. VIEW OF REBAR PLACEMENT

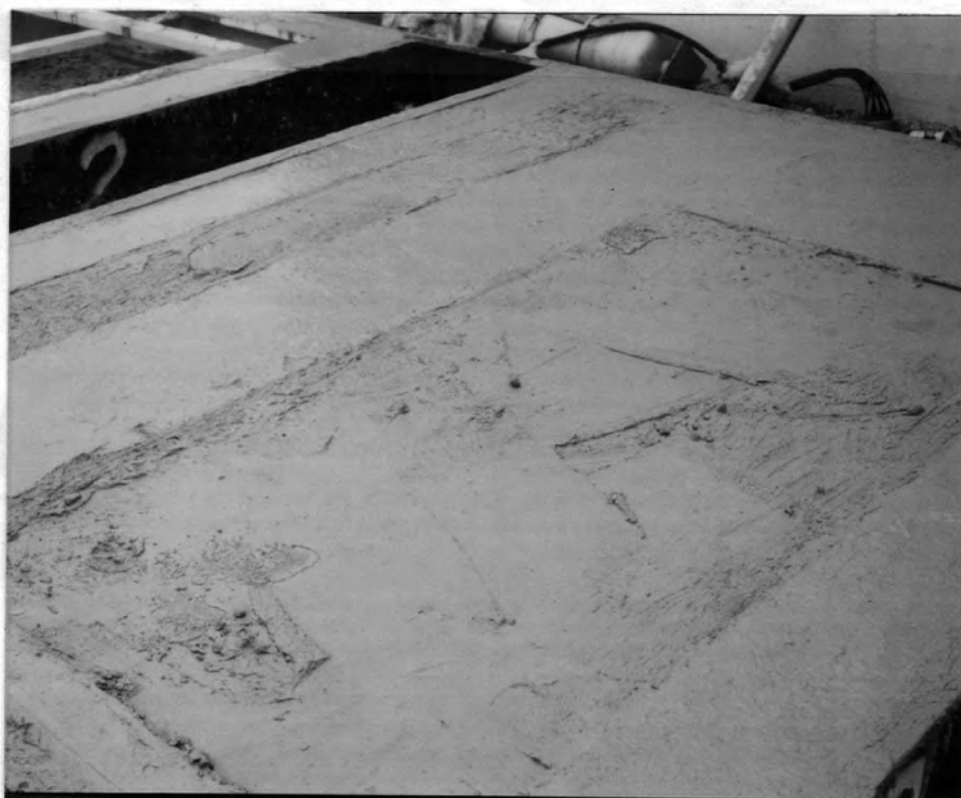


FIGURE 9. VIEW OF SLAB AFTER POUR



FIGURE 10. VIEW OF SLAB AFTER POUR AND CURE

CABLE TRAYS



FIGURE 11. CABLE AND CABLE TRAY, BEFORE LOADING



FIGURE 12. PLACEMENT OF CABLE AND CABLE TRAY



FIGURE 13. PLACEMENT OF CABLE AND CABLE TRAY



FIGURE 14. PLACEMENT OF CABLE AND CABLE TRAY

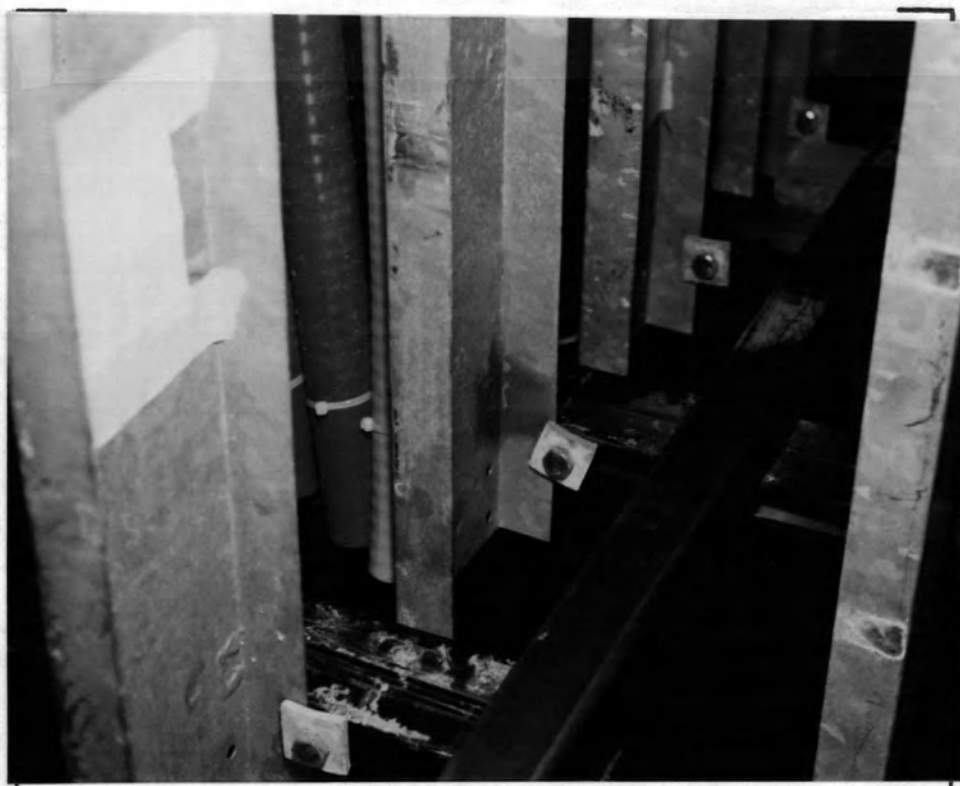


FIGURE 15. PLACEMENT OF CABLE AND CABLE TRAY

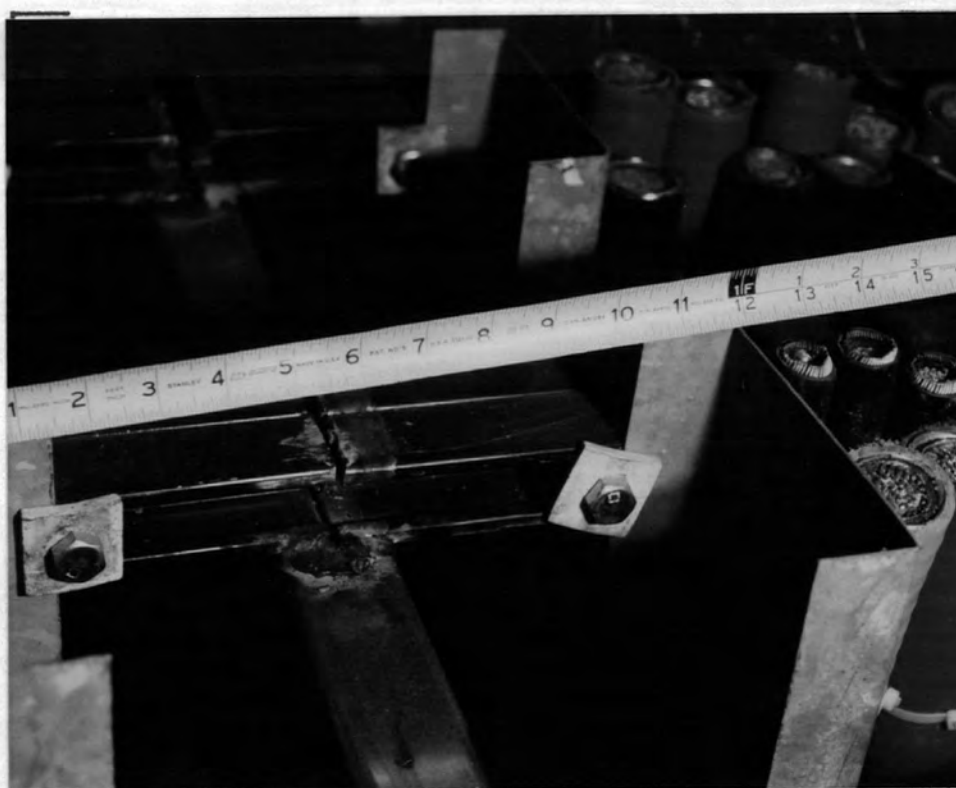


FIGURE 16. PLACEMENT OF CABLE AND CABLE TRAY



FIGURE 17. VIEW OF SEALING OF CABLES, UNEXPOSED SIDE

PENETRATION SEAL



FIGURE 18. UNEXPOSED SURFACE OF SEAL

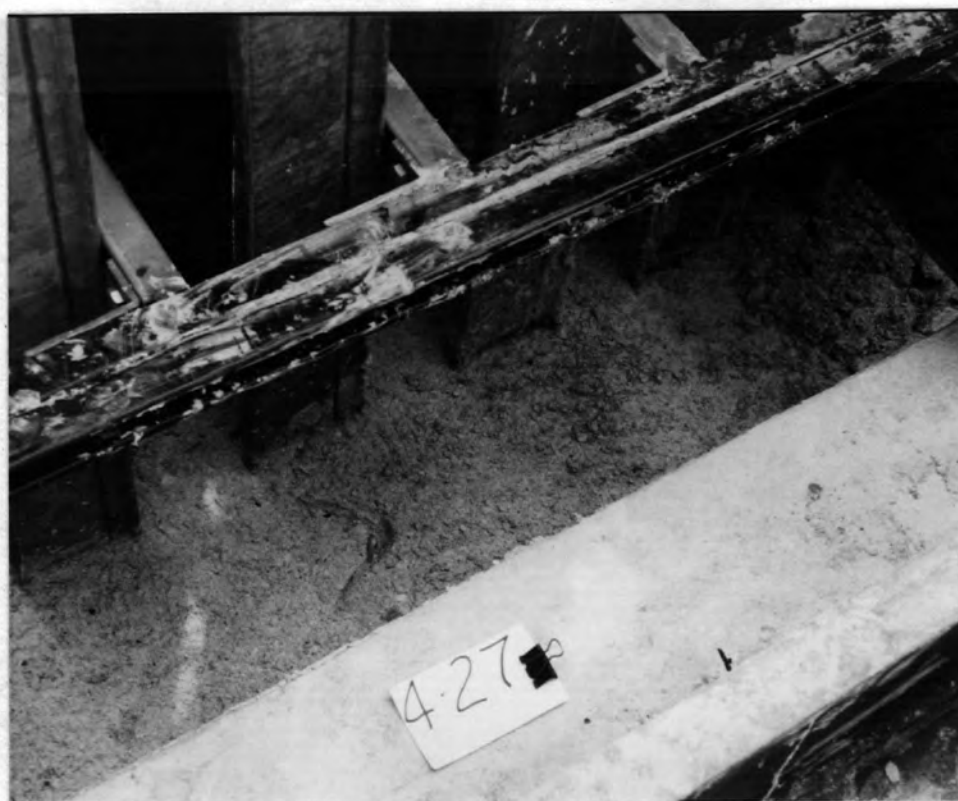


FIGURE 19. UNEXPOSED SURFACE OF SEAL

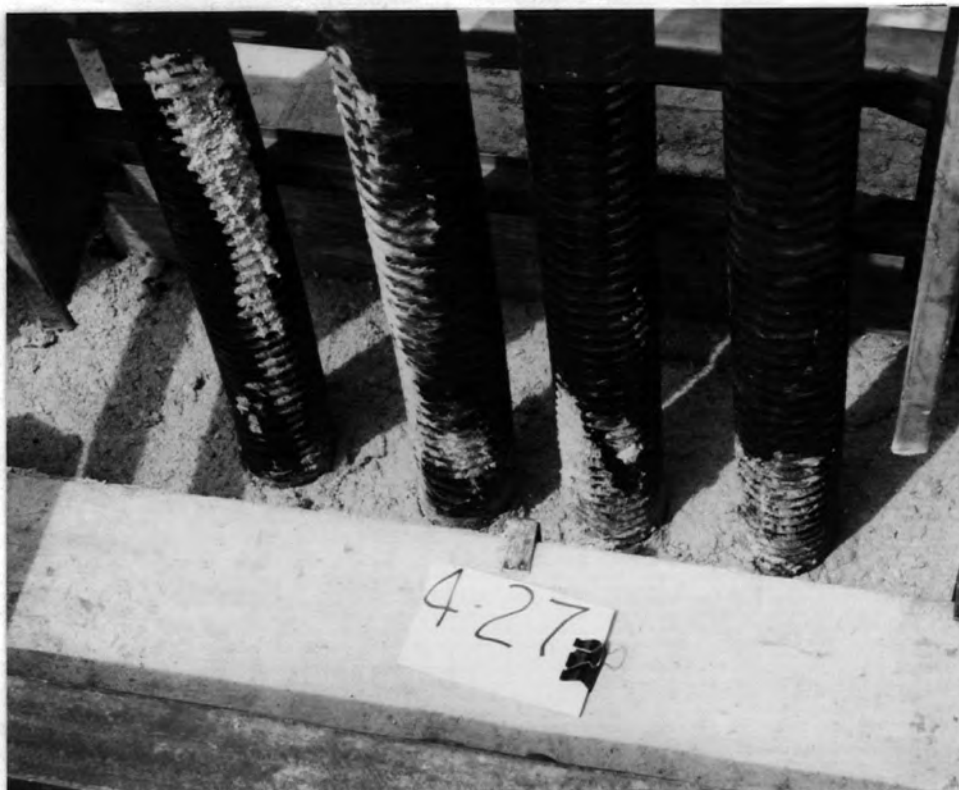


FIGURE 20. UNEXPOSED SURFACE OF SEAL



FIGURE 21. APPLICATION AREA

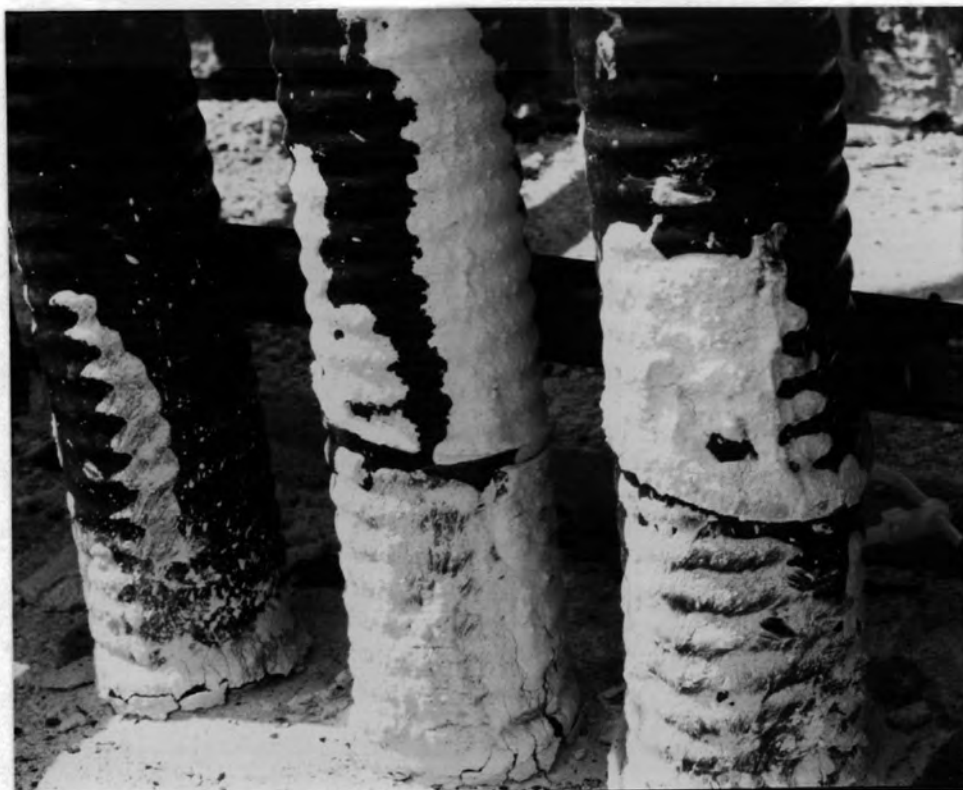


FIGURE 22. UNEXPOSED SURFACE OF SEAL



FIGURE 23. EXPOSED SURFACE OF SEAL

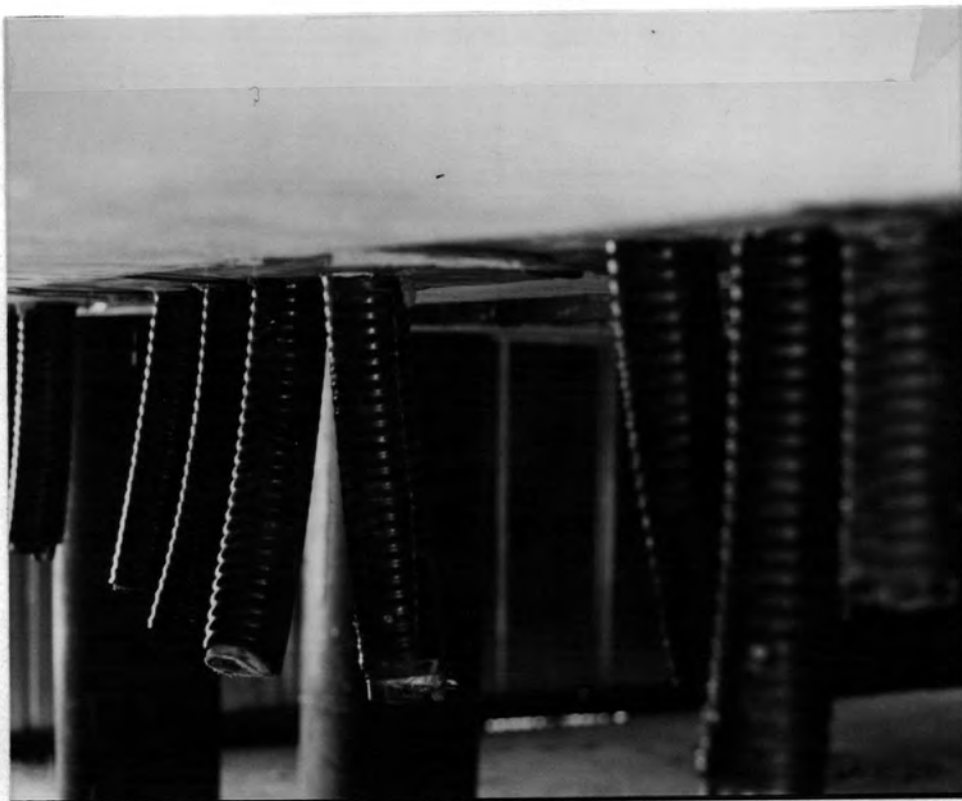


FIGURE 24. EXPOSED SURFACE OF SEAL



FIGURE 25. EXPOSED SURFACE OF SEAL

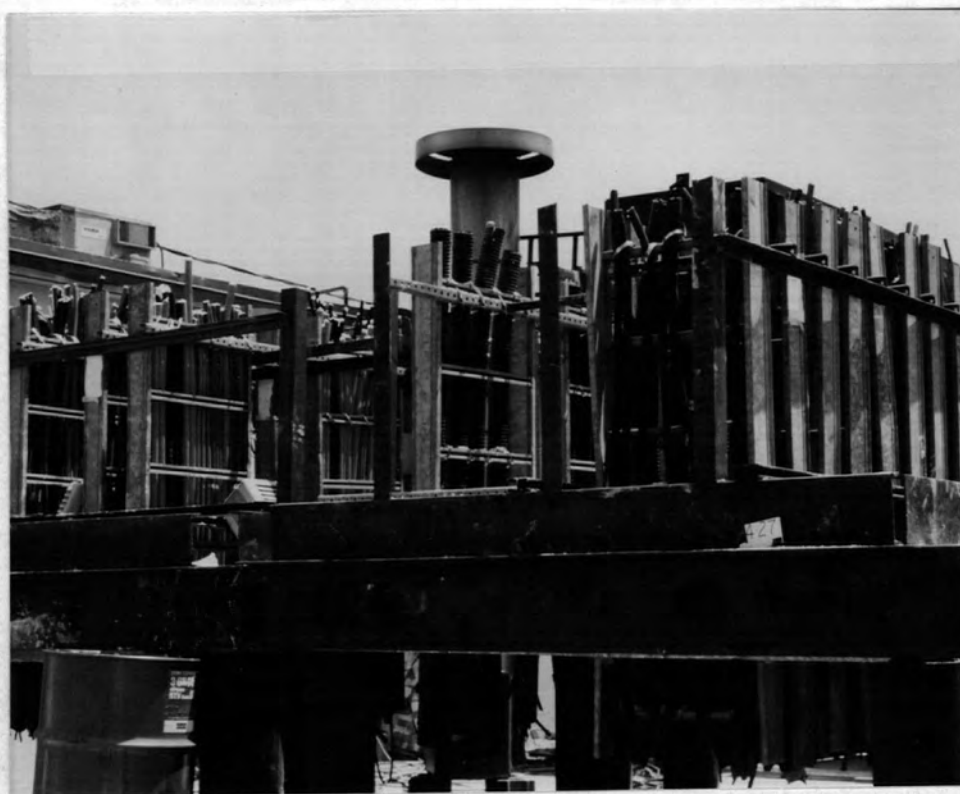


FIGURE 26. OVERALL VIEW OF SLAB AFTER ASSEMBLY

ALCOHOL APPLICATION



FIGURE 27. BREATHING APPARATUS



FIGURE 28. APPLICATION OF ALCOHOL



FIGURE 29. APPLICATION OF ALCOHOL

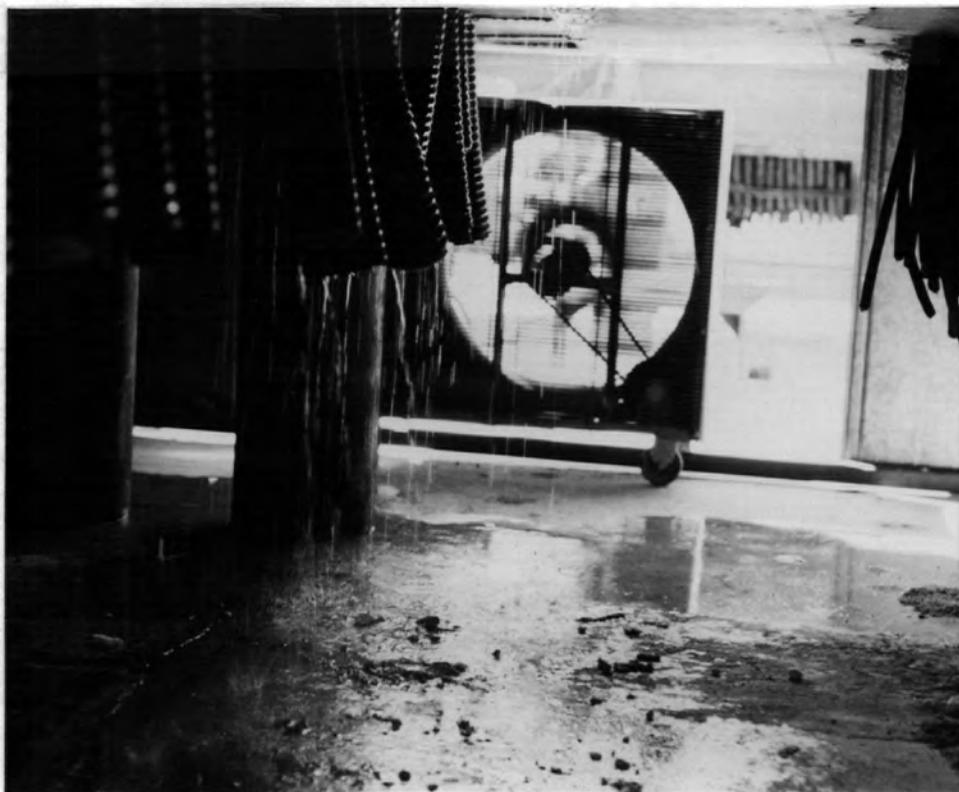


FIGURE 30. APPLICATION OF ALCOHOL



FIGURE 31. SPILL AREA



FIGURE 32. SPILL AREA



FIGURE 33. AIR CIRCULATION



FIGURE 34. APPLICATION OF ALCOHOL



FIGURE 35. APPLICATION OF ALCOHOL



FIGURE 35. APPLICATION OF ALCOHOL

PRE-TESTING



FIGURE 37. MEASUREMENT OF THE INSIDE OF THE FURNACE



FIGURE 38. VERIFY THE PLACEMENT OF THE THERMOCOUPLE PROBE



FIGURE 39. VIEW OF CABLE TRAYS PLACEMENT INTO TEST SLAB



FIGURE 40. VIEW OF CABLE TRAYS PLACEMENT INTO TEST SLAB

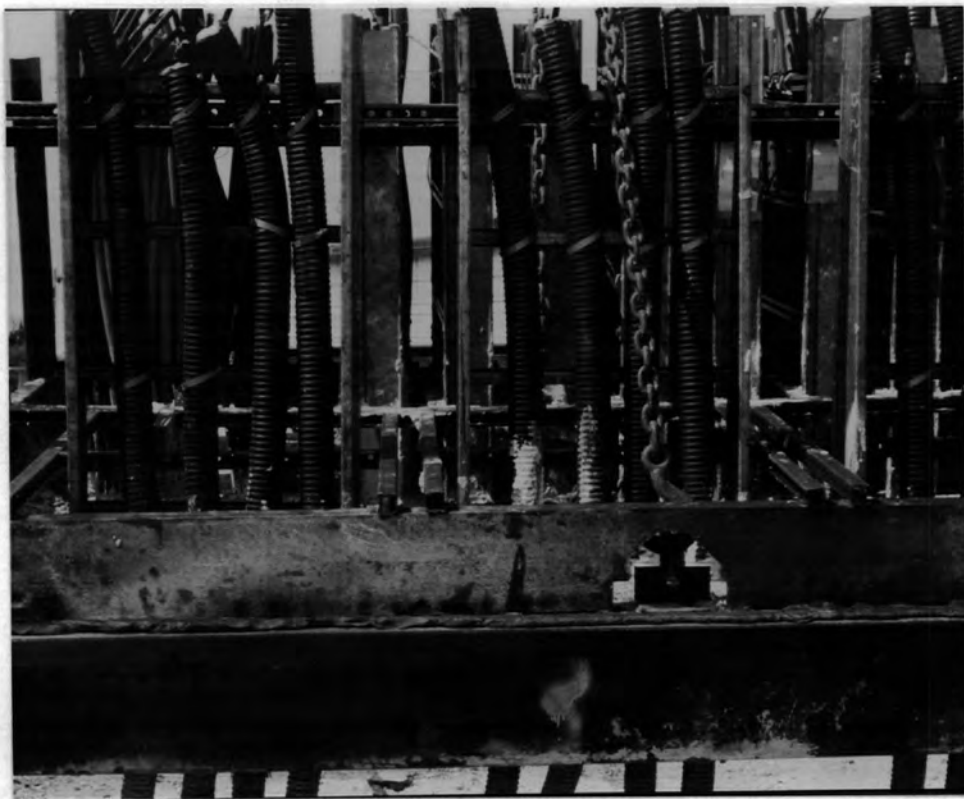


FIGURE 41. VIEW OF CABLE TRAYS PLACEMENT INTO TEST SLAB

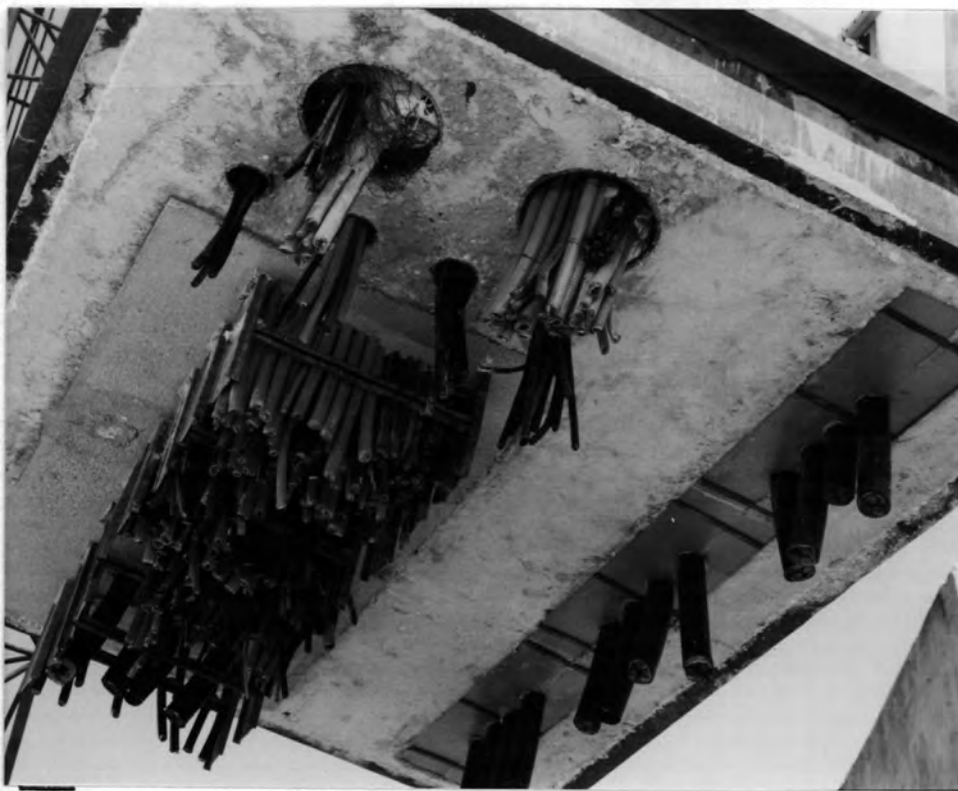


FIGURE 42. OVERALL VIEW OF TEST SLAB EXPOSED SIDE

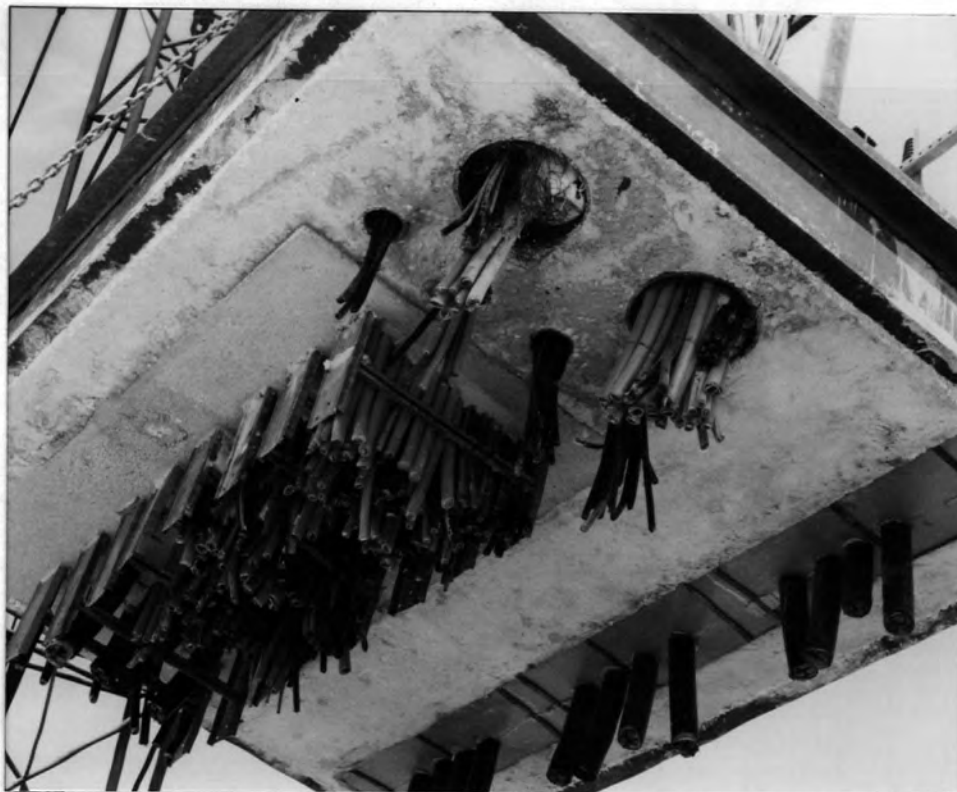


FIGURE 43. OVERALL VIEW OF TEST SLAB EXPOSED SIDE



FIGURE 44. OVERALL VIEW OF TEST SLAB EXPOSED SIDE



FIGURE 45. PLACEMENT OF TEST SLAB ONTO FURNACE



FIGURE 46. SLAB READY FOR INSTALLATION ON FURNACE



FIGURE 47. PLACEMENT OF TEST SLAB ONTO FURNACE



FIGURE 48. PLACEMENT OF TEST SLAB ONTO FURNACE



FIGURE 49. PLACEMENT OF TEST SLAB ONTO FURNACE



FIGURE 50. PLACEMENT OF TEST SLAB ONTO FURNACE



FIGURE 51. OVERALL VIEW OF TEST SLAB PLACED ONTO FURNACE

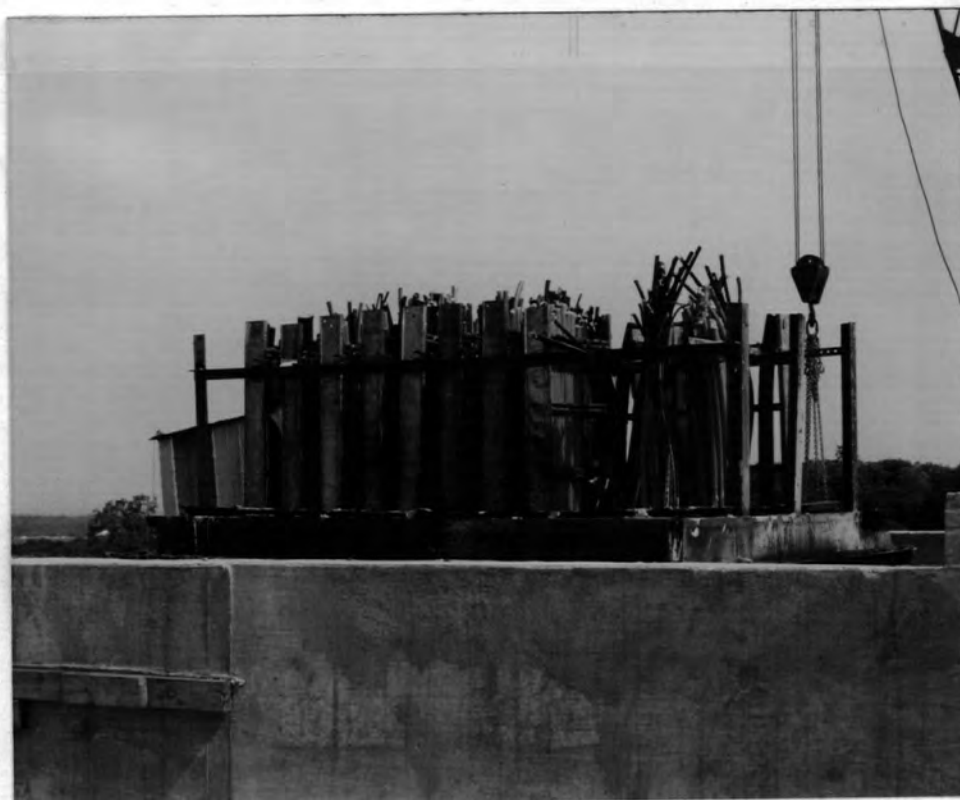


FIGURE 52. OVERALL VIEW OF TEST SLAB PLACED ONTO FURNACE

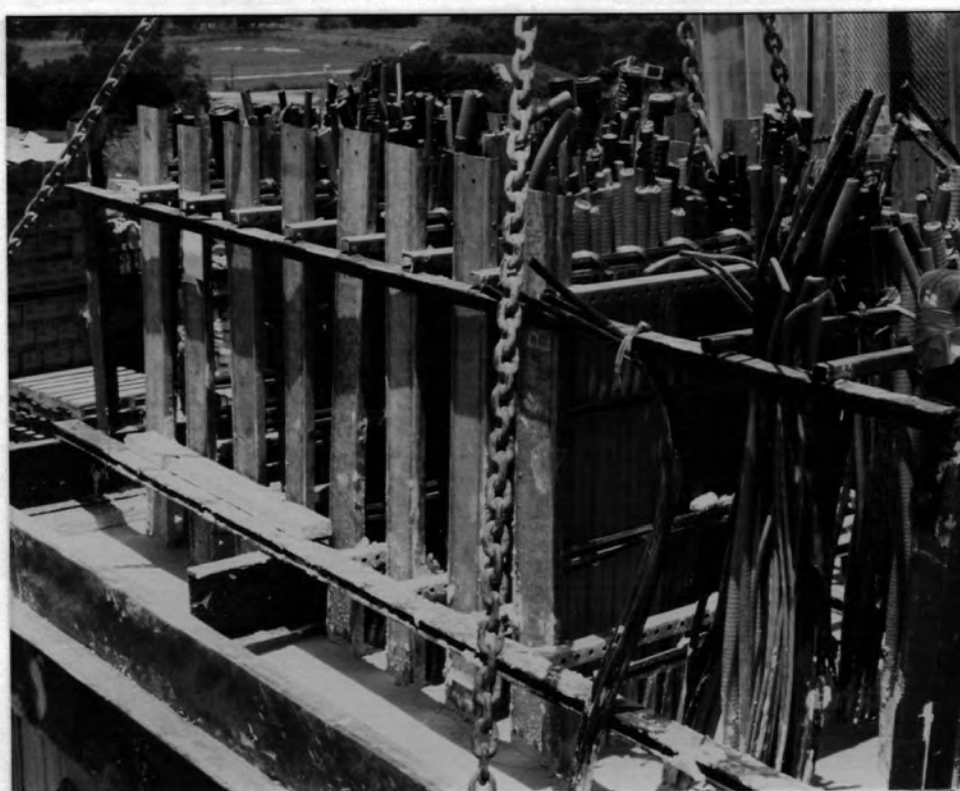


FIGURE 53. OVERALL VIEW OF TEST SLAB PLACED ONTO FURNACE

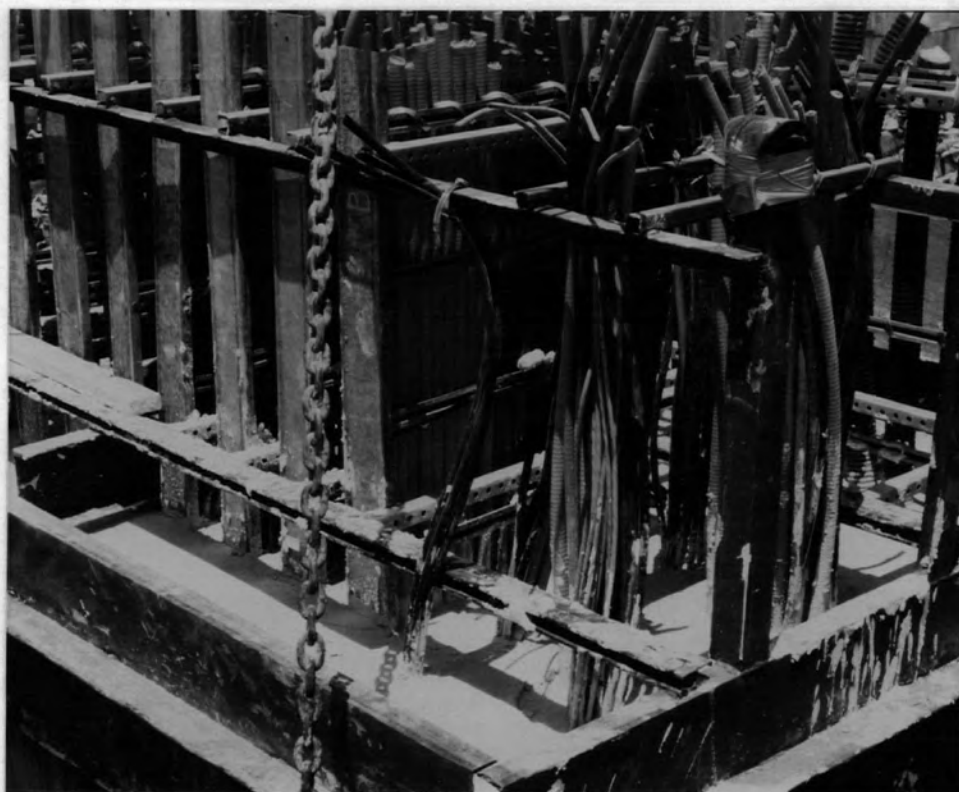


FIGURE 54. OVERALL VIEW OF TEST SLAB PLACED ONTO FURNACE

DURING TEST



FIGURE 55. SMOKE AT START OF TEST



FIGURE 56. SMOKE AT START OF TEST



FIGURE 57. 30 MINUTES INTO TEST



FIGURE 58. 40 MINUTES INTO TEST



FIGURE 59. 50 MINUTES INTO TEST



FIGURE 60. VIEW OF EXPOSED SIDE OF TEST SLAB



FIGURE 61. VIEW OF EXPOSED SIDE OF TEST SLAB



FIGURE 62. VIEW OF EXPOSED SIDE OF TEST SLAB



FIGURE 63. VIEW OF EXPOSED SIDE OF TEST SLAB



FIGURE 64. VIEW OF EXPOSED SIDE OF TEST SLAB

AFTER TEST



FIGURE 65. OVERALL VIEW OF CABLES, UNEXPOSED SIDE



FIGURE 66. OVERALL VIEW OF CABLES, EXPOSED SIDE



FIGURE 67. OVERALL VIEW OF CABLES, EXPOSED SIDE



FIGURE 68. OVERALL VIEW OF CABLES, EXPOSED SIDE



FIGURE 69. OVERALL VIEW OF TEST SLAB, EXPOSED SIDE



FIGURE 70. OVERALL VIEW OF TEST SLAB, EXPOSED SIDE

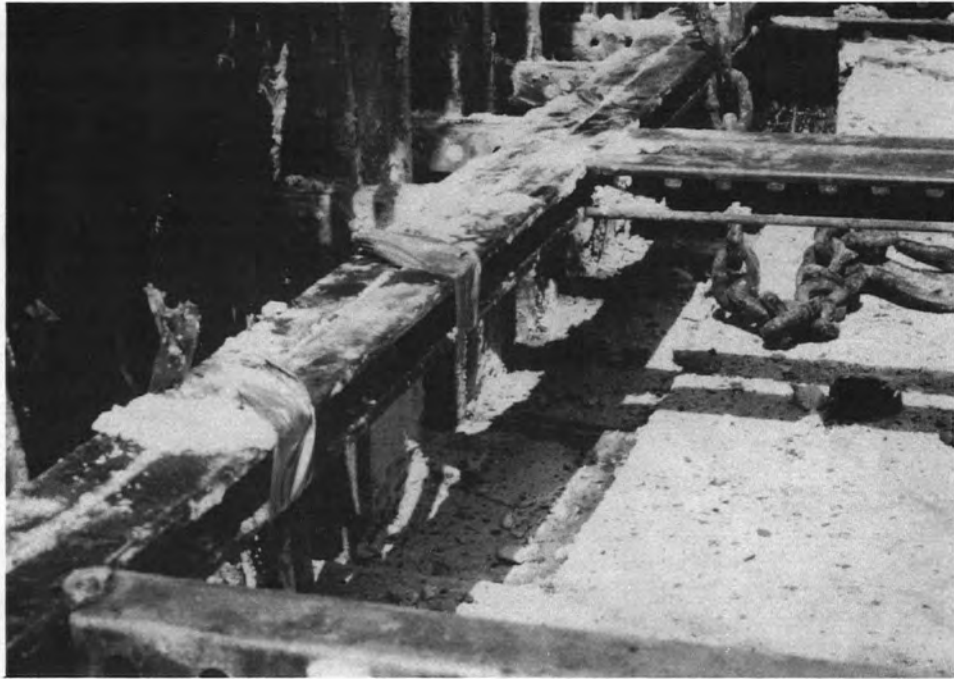


FIGURE 71. UNEXPOSED SIDE AFTER TEST

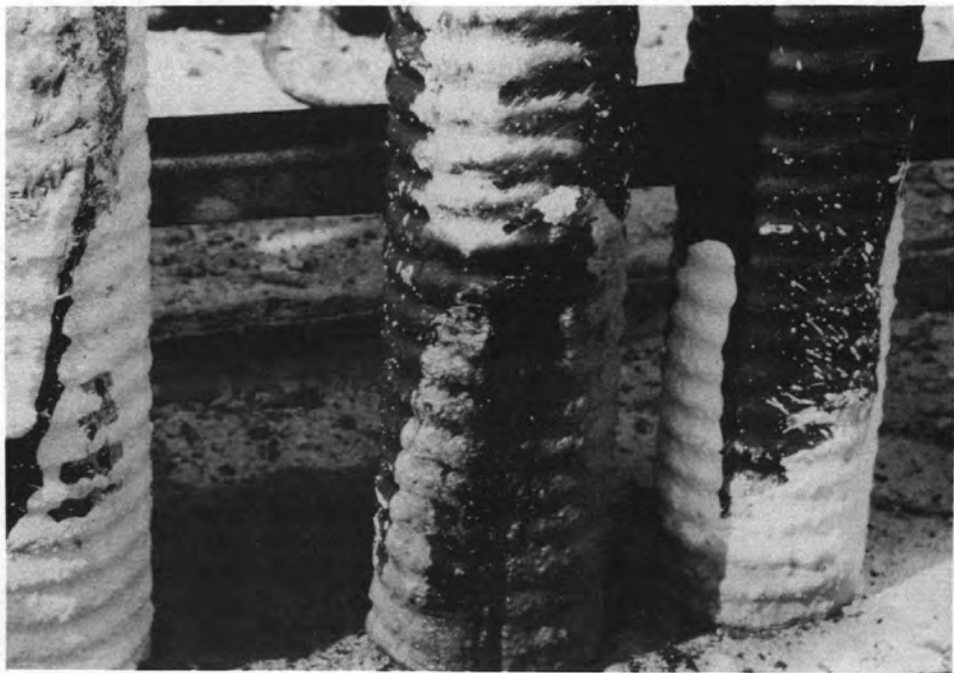


FIGURE 72. UNEXPOSED SIDE AFTER TEST



FIGURE 73. HOSE STREAM TEST

QUALITY CONTROL DOCUMENTATION



Chemtrol Corporation

530 North Belt East, Suites 105/112
Houston, Texas 77060

III-2

Area Code 713/447 6818

TWX: 910 881 6223

Cable: CHEMTROL

QUALITY CONTROL INSPECTION SHEET

DUKE POWER COMPANY FIRE TEST NUMBER II

Drawing Number: _____ Slab Number: #4

Penetration Number: B-1 Date of Installation: 3/2/78

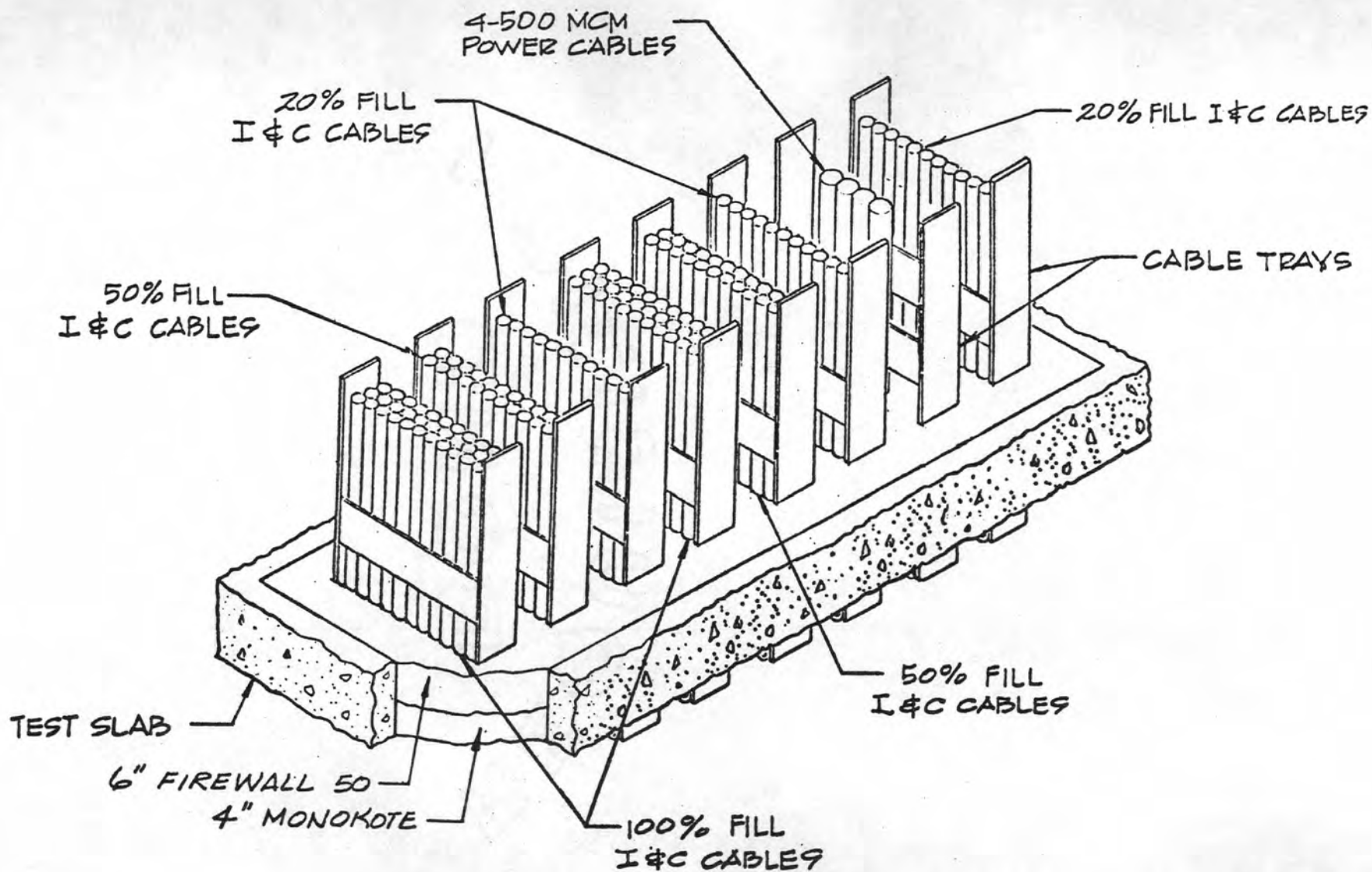
Date of Inspection: _____ Material: Monokote

Installed By: J. Philiabaum/G. Colstrom Inspected By: Rod Warfield

Comments: Installed Monokote in penetration to a depth of 4 inches. Cables
in trays spread where possible to facilitate flow of material. Samples taken
for density verification. Heat applied to slab to speed cure of material.

Moisture content still above 30%. All Monokote must be fully cured before
slab can be burned. Have continued heat for several weeks! Material still
above 30% moisture content. 4/14/78 Methanol (CH₃OH) 99% absolute added to
penetration to facilitate cure of Monokote. 4/17/78 Monokote shows that
moisture content less than 10%. Can proceed with slab completion. On 4/28/78
decision made to add 6" firewall 50 to all penetrations. Ok'd by Bob Pace,
Duke Power. 5/1/78 added 6" firewall 50 to penetration. Cables spread where
possible to facilitate flow of material. Sample taken for density verification.
Material will have 10-day cure before test penetration complete.

* RETYPED FROM ROUGH ORIGINALS.



Penetration B1



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QUALITY CONTROL INSPECTION SHEET

DUKE POWER COMPANY FIRE TEST NUMBER II

Drawing Number: _____ Slab Number: #4

Penetration Number: B-2 Date of Installation: 3/1/78

Date of Inspection: 3/2/78 Material: Glastic 1/8" Metal Bands

1/8" x 1" Monokote 4"

Installed By: G. Colstrom/J. Philiabaum Inspected By: Rod Warfield

Comments: Glastic 1/8 inch installed in bottom of penetration flush with exposed

side. Held in place by metal bands 1/8" x 1". Monokote installed to a depth
of 4 inches. Cables spread where possible to facilitate flow of material.

Placed infrared heat lamps on both sides to speed cure of Monokote. Monokote

curing very slowly. Will add additional heat to speed cure. Material still

curing very slowly. Moisture content still above 30%. Will cure continuously

using heat and infrared lights. 4/14/78. Methanol (CH₃OH) 99% absolute added

to penetration to facilitate cure of Monokote. 4/17/78 Moisture content still

22%. Probable cause is the glastic on the bottom of the penetration retaining

the moisture. Will continue to check moisture content. 4/21/78 Moisture

below 10% can proceed with penetration completion. On 4/28/78 decision made

* RETYPED FROM ROUGH ORIGINALS.

Drawing Number: Pene. #B-2 Slab Number:

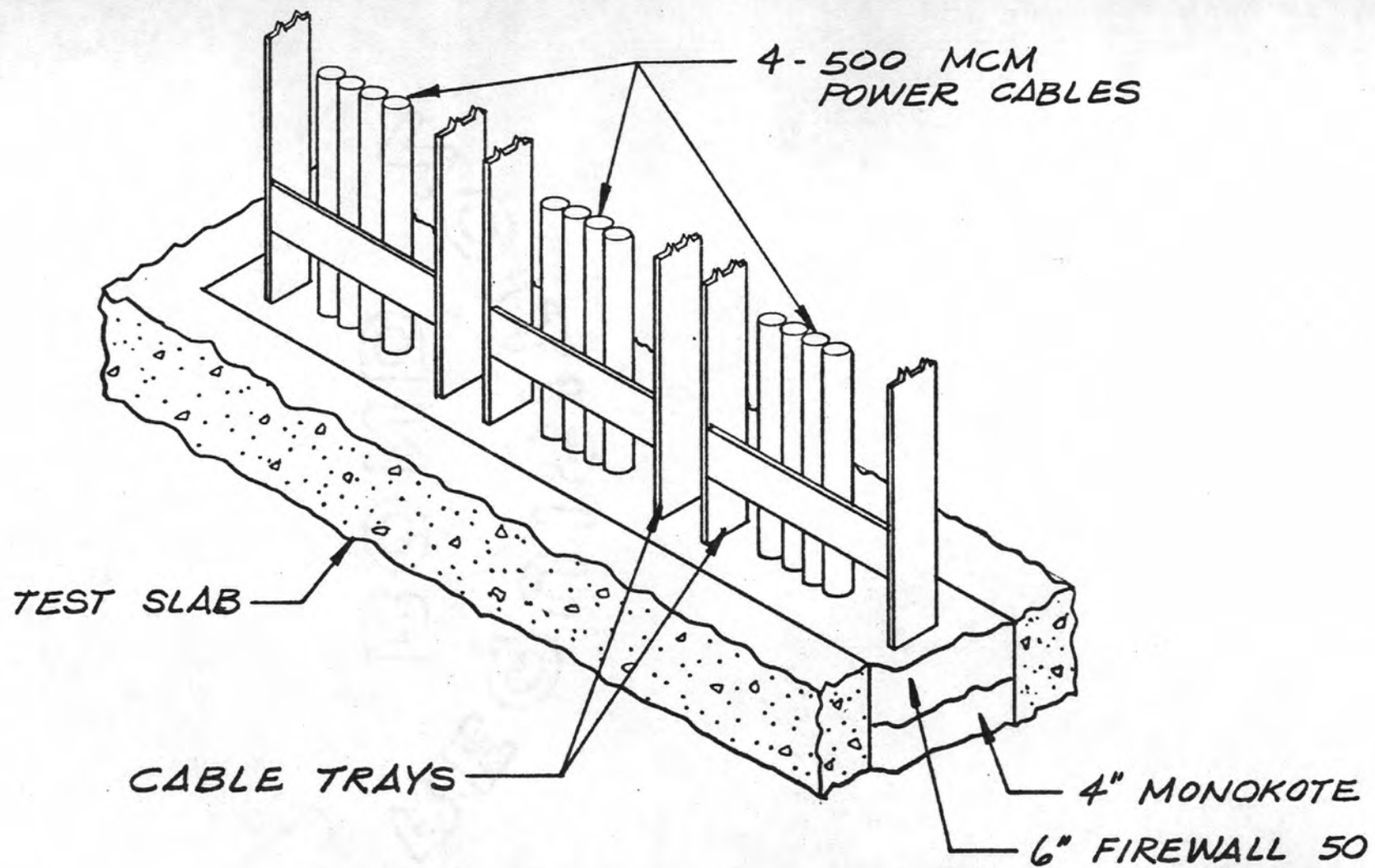
Comments (Cont.) to add 6" firewall 50 to penetration. Ok'd by Bob Pace,

Duke Power. 5/1/78 added 6" firewall 50 to penetration. Cables spread where

possible to allow flow of materials. Density sample taken for verification.

Material will have 10-day cure before test penetration complete.

* RETYPED FROM ROUGH ORIGINALS



Penetration B2



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III-7

Area Code 713/447-6818

TWX: 910 881 6223

Cable: CHEMTROL

QUALITY CONTROL INSPECTION SHEET

DUKE POWER COMPANY FIRE TEST NUMBER II

Drawing Number: _____ Slab Number: #4

Penetration Number: B-3 Date of Installation: 3/1/78

Date of Inspection: _____ Material: Wire mesh, asbestos cement

cloth, Monokote

Installed By: G.Colstrom/J.Philiabaum Inspected By: Rod Warfield

Comments: Pipe sleeve - 25% cable loading c wire mesh installed then asbestos

cloth, then 4" Monokote installed. Cables spread to facilitate flow of

material. Infrared heat lamps added to both sides of slab to speed cure.

Moisture content still above 30%. Will add additional heat in order to speed

cure. After several weeks Monokote still above 30% moisture content. Will

continue heat and infrared lamps till material is fully cured. 4/14/78 Methanol

(CH₃OH) 99% absolute added to penetration to facilitate cure of Monokote material.

April 17, 1978 moisture content below 10%. Can now proceed with penetration

completion. 4/28/78 Decision made to add 6" firewall 50 to penetration. Ok'd

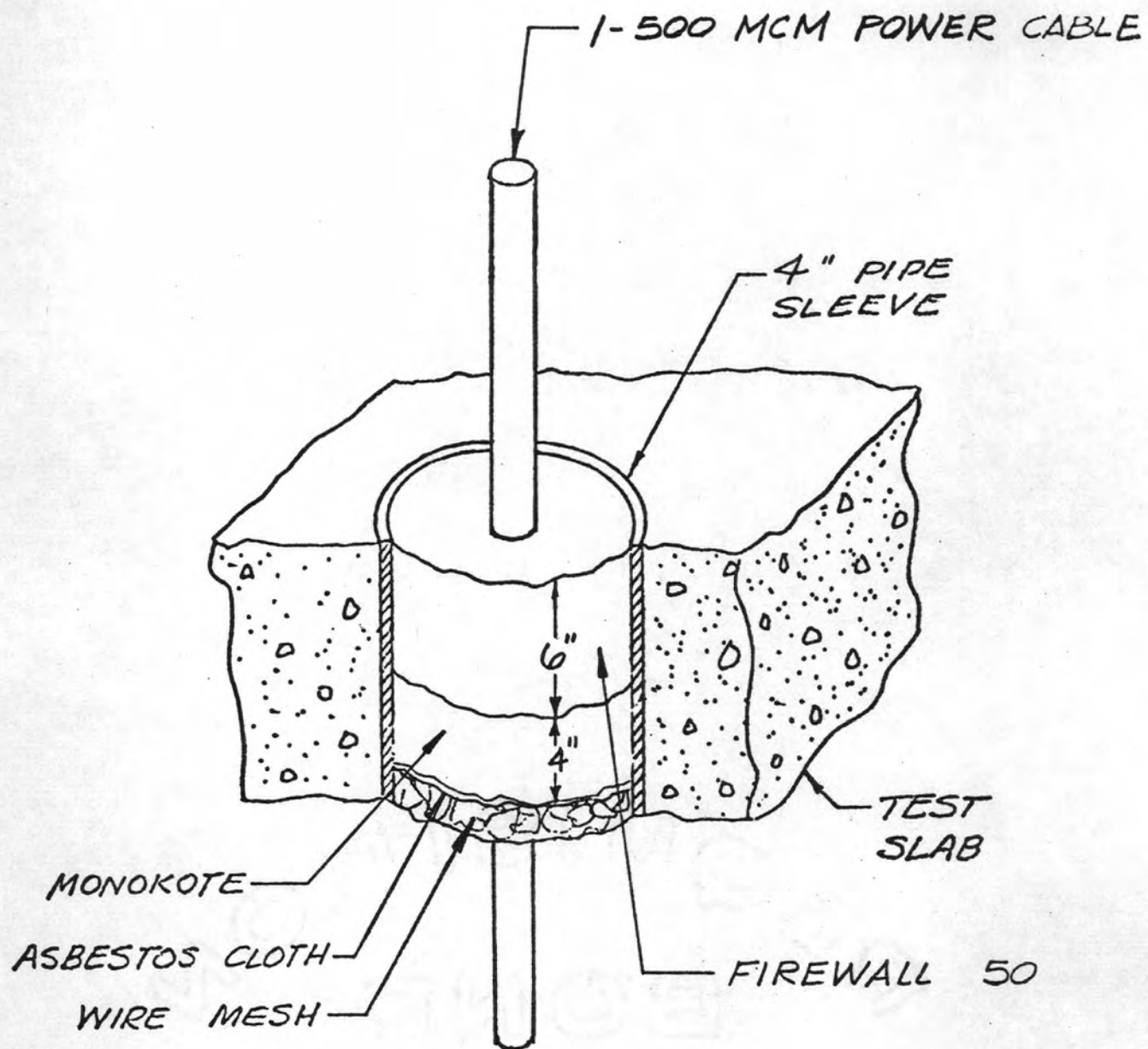
by Bob Pace, Duke Power Co. 5/1/78 6 inches firewall 50 added to penetration.

Cables spread to facilitate flow of material. Density sample taken for veri-

* RETYPED FROM ROUGH ORIGINALS.

penetration complete.

* RETYPED FROM ROUGH ORIGINALS





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Houston, Texas 77060

III-10

Area Code 713/447-6818
TWX: 910 881 6223
Cable: CHEMTROL

QUALITY CONTROL INSPECTION SHEET

DUKE POWER COMPANY FIRE TEST NUMBER II

Drawing Number: _____ Slab Number: #4

Penetration Number: B-4 Date of Installation: 3/1/78

Date of Inspection: _____ Material: Wire mesh, asbestos

cloth, Monokote

Installed By: G. Colstrom/J. Philiabaum Inspected By: Rod Warfield

Comments: Pipe sleeve with 50% cable fill. Added wire mesh then asbestos

cloth, then 4 inches Monokote. Cables spread where possible to facilitate

flow of material. Infrared heat added to speed the cure of the Monokote.

Monokote cure very slow. Will add additional heat to speed cure of material.

Moisture content above 30%, must reduce moisture level before addition of

finish material. After several weeks of heat cure, material still above 25%

moisture level. Must continue heat cure. 4/14/78 methanol (CH_3OH) 99% absolute

added to penetration to facilitate cure of Monokote material. April 17, 1978

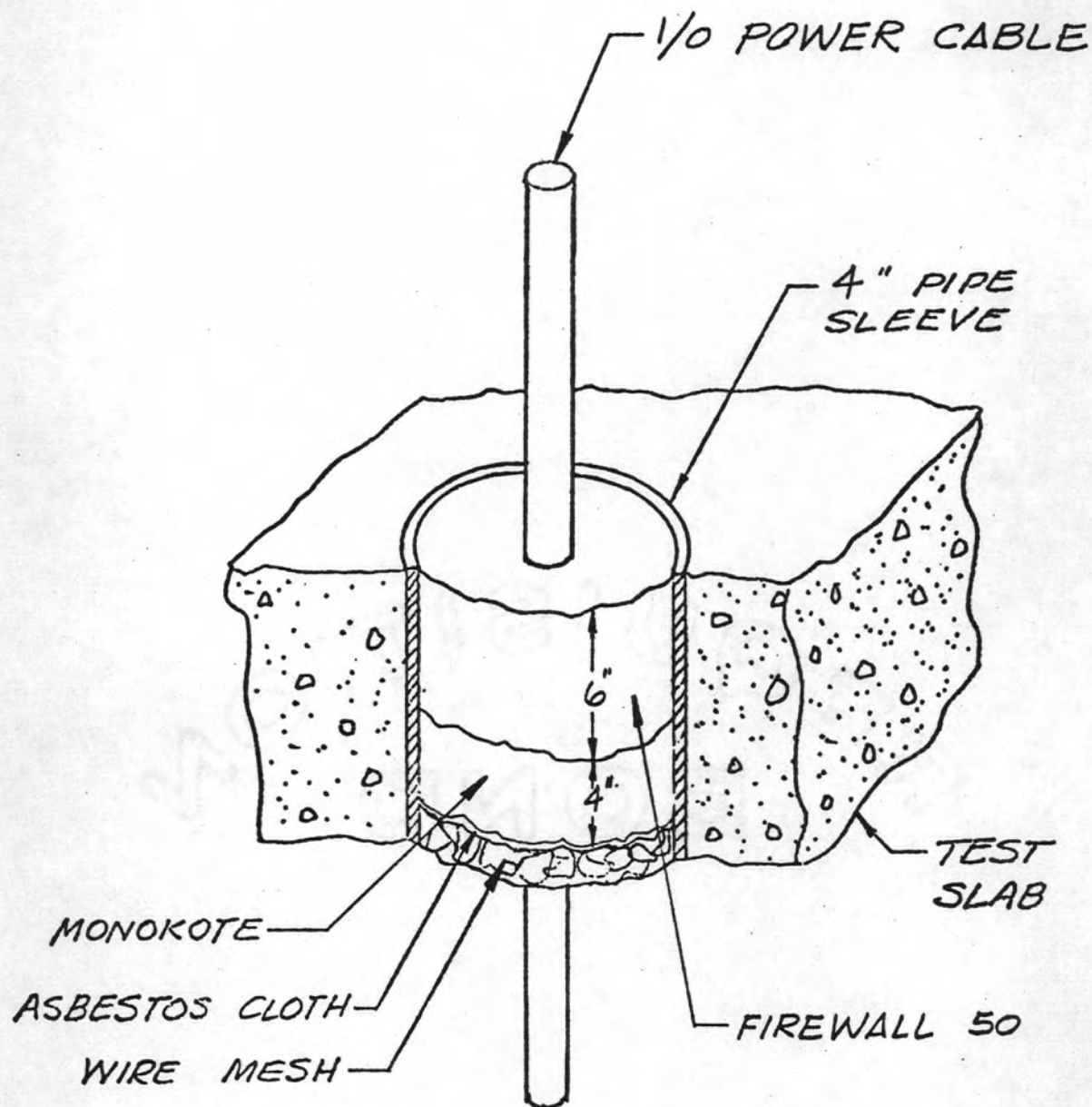
moisture content now below 10%. Will proceed with penetration completion.

4/28/78. Decision made to add 6 inches firewall 50 to penetration. Ok'd by

Bob Pace, Duke Power Co. 5/1/78 6 inches firewall 50 added to penetration.

* RETYPED FROM ROUGH ORIGINALS.

Comments (Cont.) Cables spread to allow flow of material. Slab will have 10-day
cure before test. Penetration complete.





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Houston, Texas 77060

III-13

Area Code 713/447-6818

TWX: 910 881 6223

Cable: CHEMTRON

QUALITY CONTROL INSPECTION SHEET

DUKE POWER COMPANY FIRE TEST NUMBER II

Drawing Number: _____ Slab Number: #4

Penetration Number: B-5 Date of Installation: 3/1/78

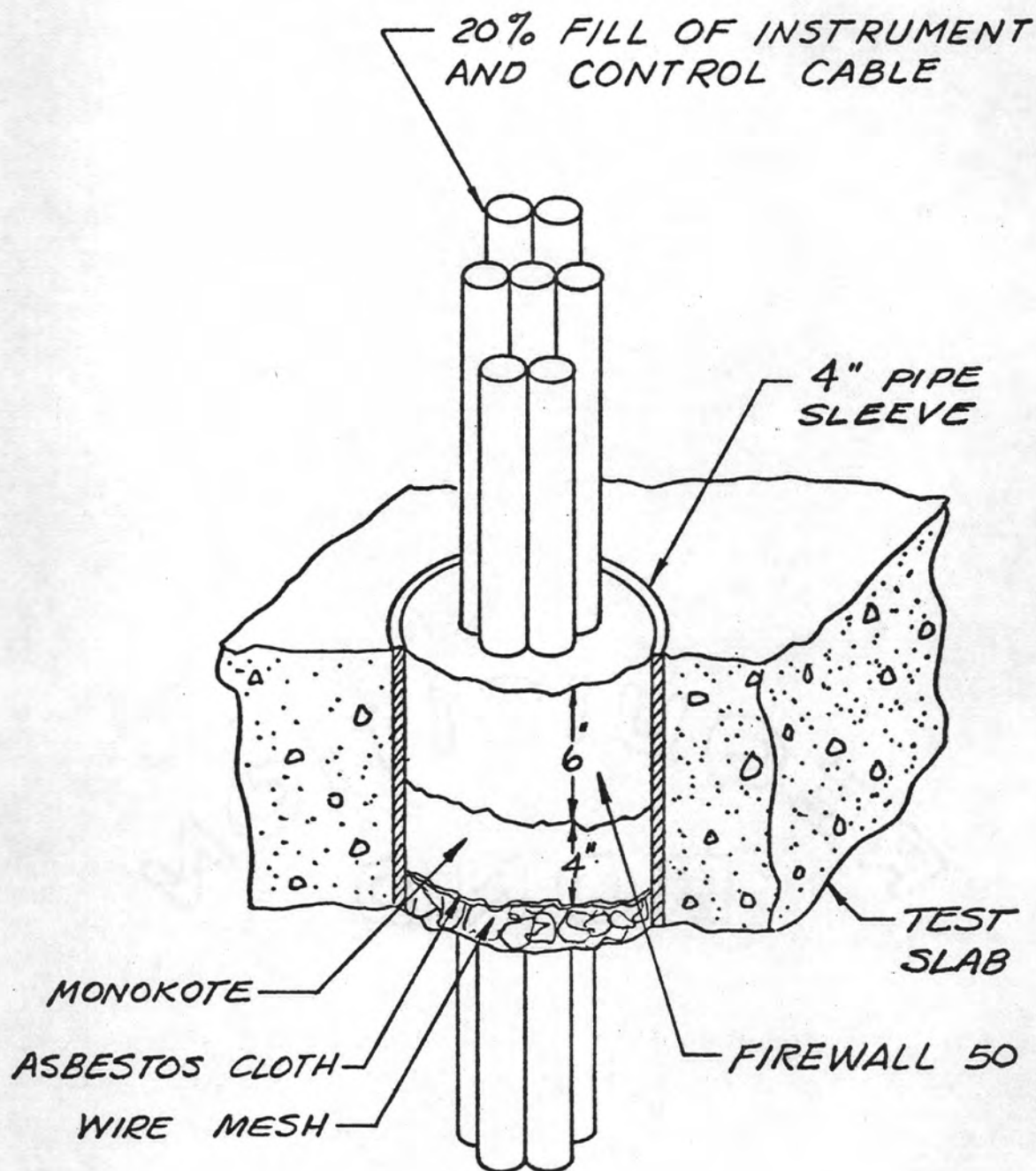
Date of Inspection: _____ Material: Wire mesh, asbestos cloth,

Monokote

Installed By: G.Colstrom/J.Philiabaum Inspected By: Rod Warfield

Comments: Pipe sleeve 75% fill (Cable) wire mesh placed first, then asbestos
cloth, then Monokote to a depth of 4 inches. Infrared heat lamps to speed
cure of Monokote. Cables spread where possible to facilitate flow of material.
Monokote curing very slowly. Will add additional heat to speed cure of Monokote.
After several weeks of heat cure, Monokote moisture level still above 30%.
Will continue heat. 4/14/78 Methanol (CH₃OH) 99% absolute added to penetration
to speed cure of Monokote. April 17, 1978 moisture content below 10%. Can
proceed with final preparation. 4/28/78 decision made to add 6 inches firewall 50
to penetration. Cables spread where possible to facilitate flow of material.
10-day cure on material before burn. Penetration complete.

* RETYPED FROM ROUGH ORIGINALS.



Chemtrol Corporation

530 North Bell La. 3, Dallas, 105/112

Phone: 105/112

III-15

Area Code 713/447-0413

TWX: 910 881 6123

Cable: CHEMTROL

QUALITY CONTROL INSPECTION SHEET

DUKE POWER COMPANY FIRE TEST NUMBER II

Drawing Number: _____ Slab Number: #4

Penetration Number: B-6 Date of Installation: 3/1/78

Date of Inspection: _____ Material: Wire mesh, asbestos cloth
and Monokote

Installed By: G. Colstrom/J. Philiabaum Inspected By: Rod Warfield

Comments: Pipe sleeve 100% cable fill, wire mesh placed first, then asbestos
cloth rolled, then 4 inches Monokote. Heat applied to speed cure of Monokote.

Cables spread where possible to facilitate flow of material. Monokote curing

very slowly. Infrared heat lamps to speed cure of material. Material curing

very slowly. Moisture content above 30%. Will continue heat and infrared

lamps until moisture level is 10% or less. 4/14/78 Methonol (CH_3OH) 99%

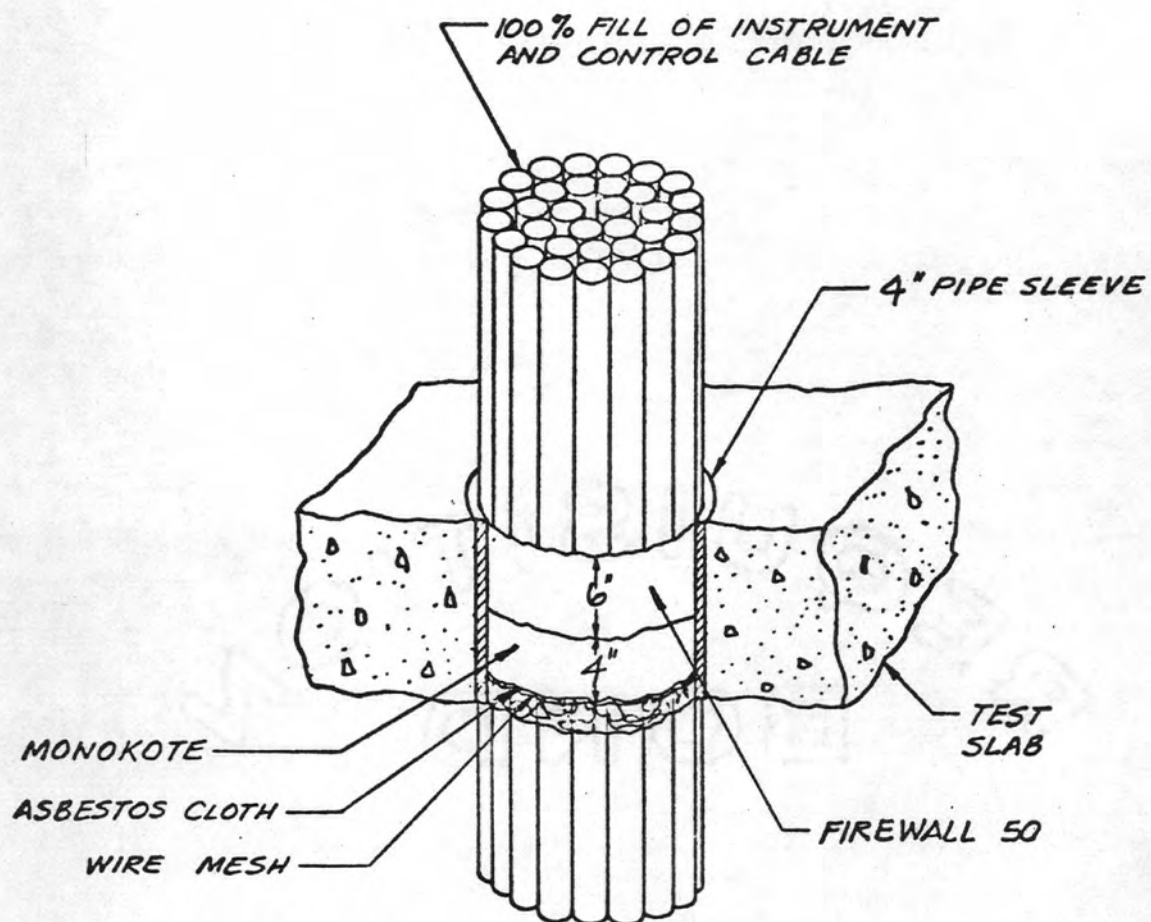
absolute added to penetration to speed cure of Monokote material. April 17, 1978

moisture content below 10%. 4/28/78 decision made to add 6 inches firewall 50

to penetration. Cables spread where possible to allow flow of material.

10-day cure on material before burn. Penetration complete.

* RETYPED FROM ROUGH ORIGINALS.





Chemtrol Corporation

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Houston, Texas 77060

Area Code ~~713~~ 417 6818
TWX 910 681 6211
Cable: CHEMTROL

QUALITY CONTROL INSPECTION SHEET

DUKE POWER COMPANY FIRE TEST NUMBER II

Drawing Number: _____ Slab Number: _____

Penetration Number: B7 Date of Installation: 2/17/78

Date of Inspection: _____ Material: Monokote, Asbestos Cloth,

Wire Mesh

Installed By: G. Colstrom Inspected By: Rod Warfield

Comments: Pipe sleeve 12.75 O.D. 50% fill with wire mesh flush with

exposed side of slab. Asbestos cloth added to top of wire mesh. 4 inches

Monokote on top of asbestos cloth. Will take at least 48-72 hours of heat

to properly cure Monokote. Cable spread where possible to facilitate flow

of material. 2/20/78 Monokote still very wet after 48 hours of heat cure.

Will continue heat cure. Unable to finish slab due to material moisture

content. 2/21/78 Moisture meter check shows over 30% moisture at depth

of 2 inches or middle of Monokote. Will continue to heat cure. 2/22/78

Moisture check shows 30% moisture still remaining. Will continue to heat

cure. 2/23/78 Moisture check shows over 30% moisture remaining. Will con-

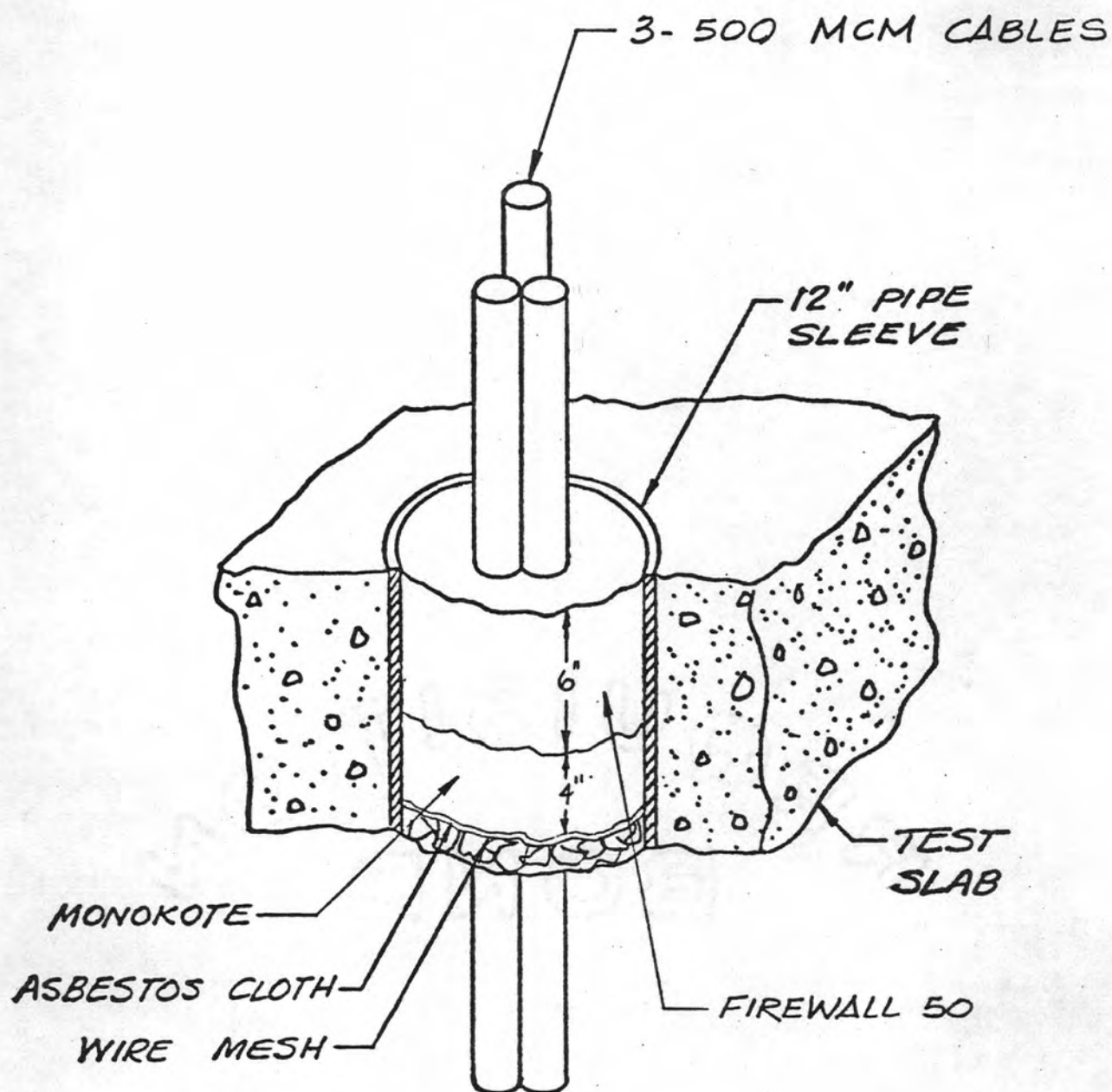
tinue to heat cure. 2/24/78 Moisture check still remains over 30% moisture.

* RETYPED FROM ROUGH ORIGINALS.

Drawing Number: B7 Slab Number: _____

Comments (Cont.) Added infrared heat lamps to speed cure. Will check on
2/27/78 after 48 hours of infrared heat cure. 2/27/78 Moisture check still
shows over 30% moisture after 48 hours of infrared heat cure. Unable to
finish slab until full cure is reached on Monokote. Decision made to allow
Monokote to fully cure before work will proceed. 4/14/78 Methanol (CH₃OH)
99% Absolute added to penetration to facilitate cure of material. Heat
added to speed cure. 4/17/78 Moisture indicator shows moisture content
less than 10%. Penetration B7 complete.

* RETYPED FROM ROUGH ORIGINALS





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Houston, Texas 77060

III-20
Area Code 713/447-6818
TWX: 910 881 6223
Cable: CHEMTROL

QUALITY CONTROL INSPECTION SHEET

DUKE POWER COMPANY FIRE TEST NUMBER II

Drawing Number: _____ Slab Number: _____

Penetration Number: B8 Date of Installation: 2/17/78

Date of Inspection: _____ Material: Monokote, Asbestos Cloth,

Wire Mesh

Installed By: G. Colstrom Inspected By: Rod Warfield

Comments: Pipe sleeve 12.75 O.D. 100% fill with wire mesh flush with exposed
side of slab. Asbestos cloth added to top of wire mesh. 4 inches of Monokote
added to top of asbestos cloth. Cable spread where possible to facilitate
flow of material. Will take at least 48-72 hours of heat to properly cure
Monokote material. 2/20/78 After 48 hours of high heat cure Monokote still
very wet. Will continue heat in hopes of rapid cure. 2/21/78 Moisture meter
check shows moisture content 2 inches or middle of penetration shows moisture
over 30%. Will continue heat cure. 2/22/78 Moisture check shows over 30%
moisture remaining. Will continue heat cure. 2/23/78 Moisture check shows
over 30% moisture. Will continue heat cure. 2/24/78 Moisture check shows
over 30% moisture. Added infrared heat lamps in hopes of speeding cure.

* RETYPED FROM ROUGH ORIGINALS.

Drawing Number: B8 Slab Number: _____

Comments (Cont.) Will check moisture on 2/27/78 after 48 hours of infrared

heat cure. 2/27/78 After 48 hours of infrared heat, moisture still over

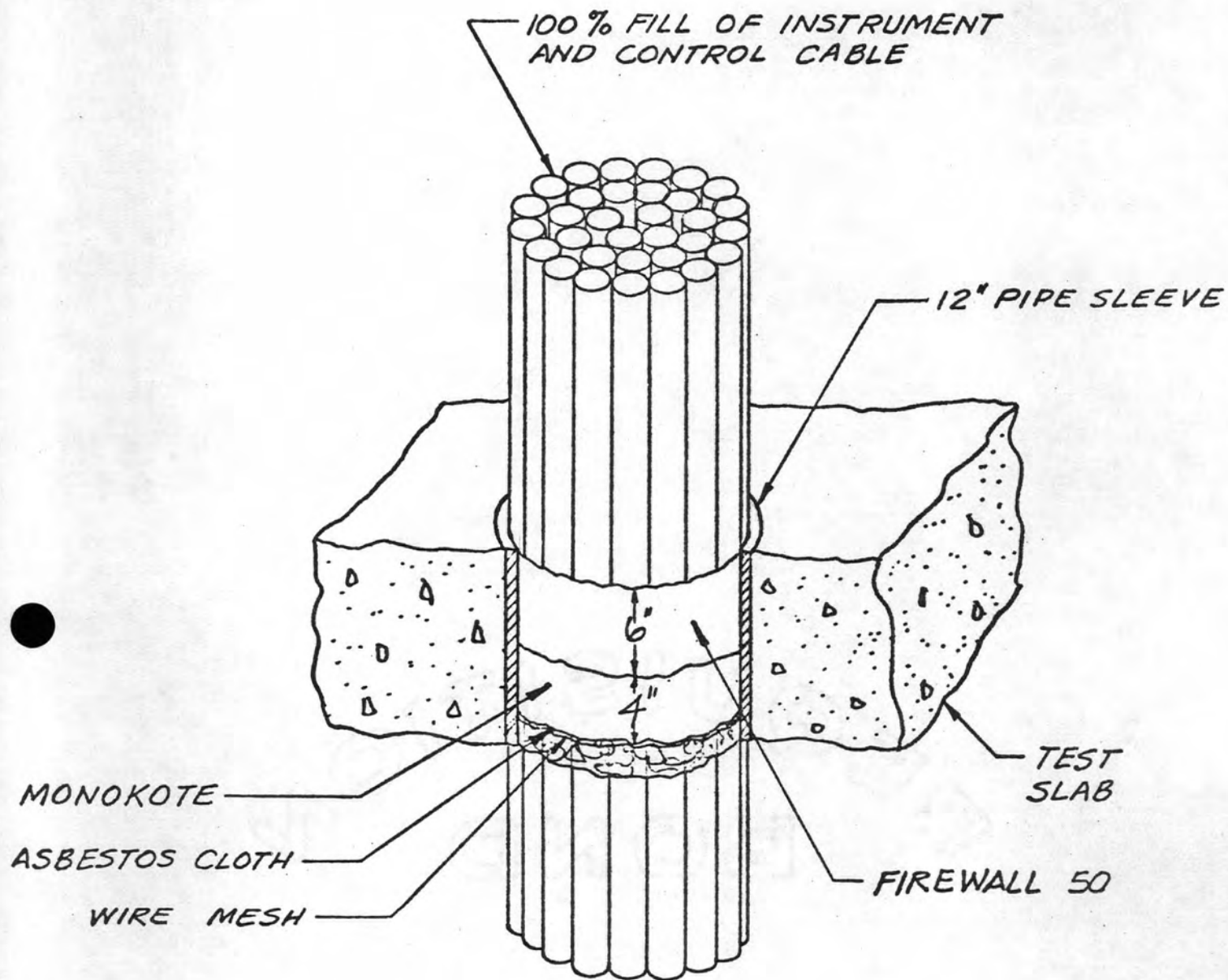
30%. Unable to complete work on slab until full cure on Monokote is achieved.

4/14/78 Methanol (CH₃OH) 99% Absolute added to penetration to facilitate

cure. Heat added to speed cure. 4/17/78 Moisture indicator shows moisture

level less than 10%. Penetration B8 complete.

* RETYPED FROM ROUGH ORIGINALS





Chemtrol Corporation

330 North Belt East
Houston, Texas 77060

PROJECT NAME Duke Power

LOG NUMBER 01

PROJECT LOCATION SwRI

RECORDED BY Rod Warfield

SEALING MATERIAL TRACEABILITY LOG

PROJECT NUMBER _____

CT/QC-3
Revised 6/1/78

PENETRATION NO	DAMMING			SEALING MATERIAL						ACCEPTANCE				REMARKS/DEVIATIONS	
	DAMMING DATE	DAMMING DEPTH	INSPECTED BY	SYSTEM NO CT/QC-1	DATE OF APPLICATION	MATERIAL TYPE	VISUAL INSPECTION			CHEMTROL QC		CUSTOMER			
							PASS	HOLD	QC-4	INSPECTOR	DATE	INSPECTOR	DATE		
B-3	3/2/78	4"	RW	M-01	3/2/78	Mono	X				RW <i>[Signature]</i>	3/3			
B-4	3/1/78	4"	RW	M-01	3/2/78	Mono	X				RW <i>[Signature]</i>	3/3			
B-5	3/1/78	4"	RW	M-01	3/2/78	Mono	X				RW <i>[Signature]</i>	3/3			
B-6	3/1/78	4"	RW	M-01	3/2/78	Mono	X				RW <i>[Signature]</i>	3/3			
B-7	3/1/78	4"	RW	M-02	3/2/78	Mono	X				RW <i>[Signature]</i>	3/3			
B-8	3/1/78	4"	RW	M-02	3/2/78	Mono	X				RW <i>[Signature]</i>	3/3			
B-3	5/1/78	6"	RW	01-001	5/1/78	FW50	X				RW <i>[Signature]</i>	5/1			
B-4	5/1/78	6"	RW	01-001	5/1/78	FW50	X				RW <i>[Signature]</i>	5/1			
B-5	5/1/78	6"	RW	01-001	5/1/78	FW50	X				RW <i>[Signature]</i>	5/1			
B-6	5/1/78	6"	RW	01-002	5/1/78	FW50	X				RW <i>[Signature]</i>	5/1			
B-7	5/1/78	6"	RW	01-002	5/1/78	FW50	X				RW <i>[Signature]</i>	5/1			
B-8	5/1/78	6"	RW	01-002	5/1/78	FW50	X				RW <i>[Signature]</i>	5/1			



Chemtrol Corporation

330 North Belt East
Houston, Texas 77060

PROJECT NAME Duke Power

PROJECT LOCATION SwRI

PROJECT NUMBER: _____

LOG NUMBER _____/01

RECORDED BY

Rod Warfield

COMPONENT TRACEABILITY LOG
(SYSTEM IDENTIFICATION REGISTER)

CT/QC-1
Rev. 6/1/78

[illegible]



Chemtrol Corporation

330 North Belt East
Houston, Texas 77060

PROJECT NAME Duke Power

PROJECT LOCATION SwRI

PROJECT NUMBER _____

LOG NUMBER

RECORDED BY

02

Rod Warfield

COMPONENT TRACEABILITY LOG
(SYSTEM IDENTIFICATION REGISTER)

CT/QC-1
Rev. 6/1/78

[illegible]



Chemtrol Corporation

330 North Bell East
Houston, Texas 77060

PROJECT NAME: Duke Power

PROJECT LOCATION SwRI

PROJECT NUMBER:

LOG NUMBER: 4 01

INSPECTOR:

Rod Warfield

MATERIAL DENSITY VERIFICATION LOG

Form CT/QC-2
Rev. 6/01/78

[illegible]



Form CT/QC-2
Rev. 6/01/78

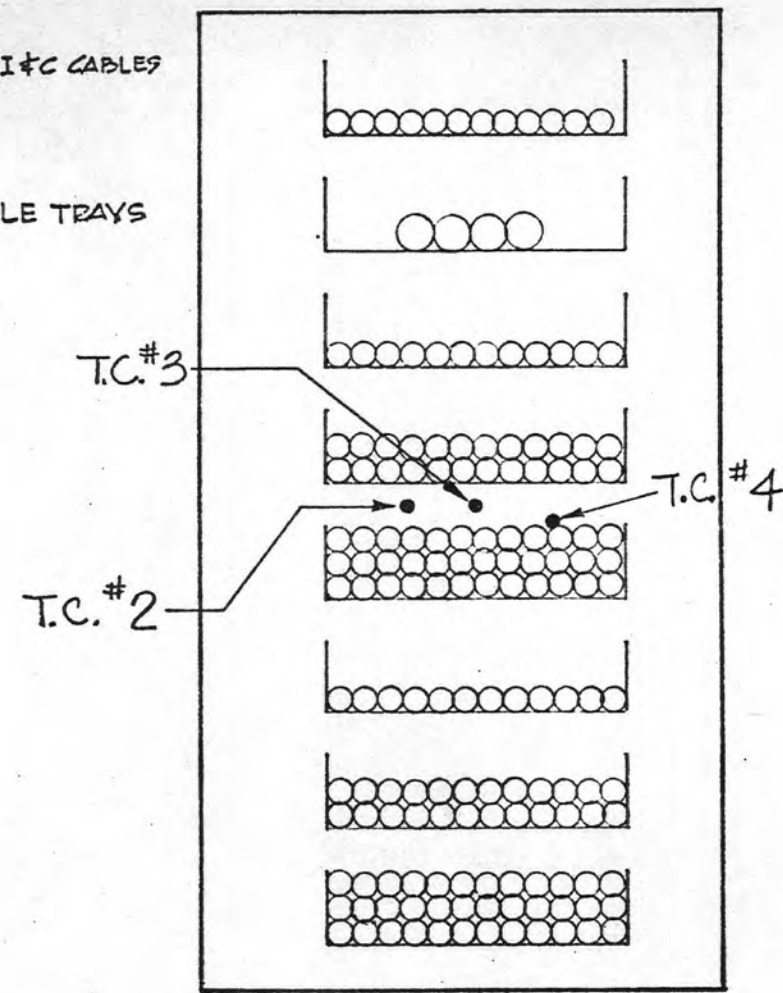
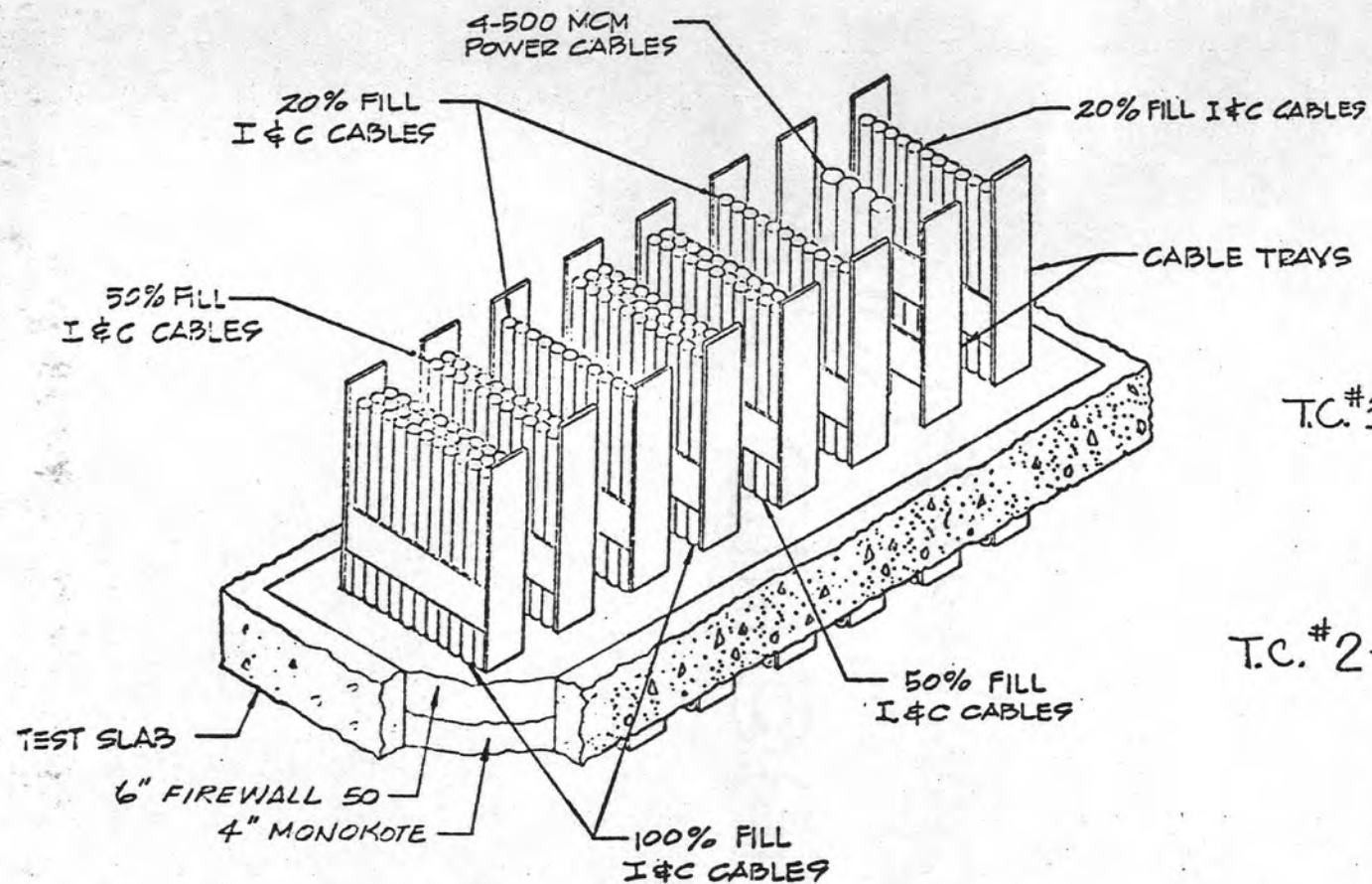
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UNEXPOSED SURFACE THERMOCOUPLE DATA

THERMOCOUPLE LOCATIONS

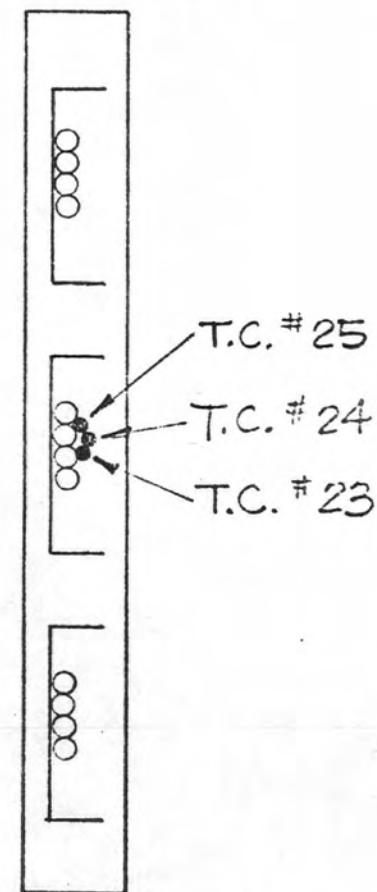
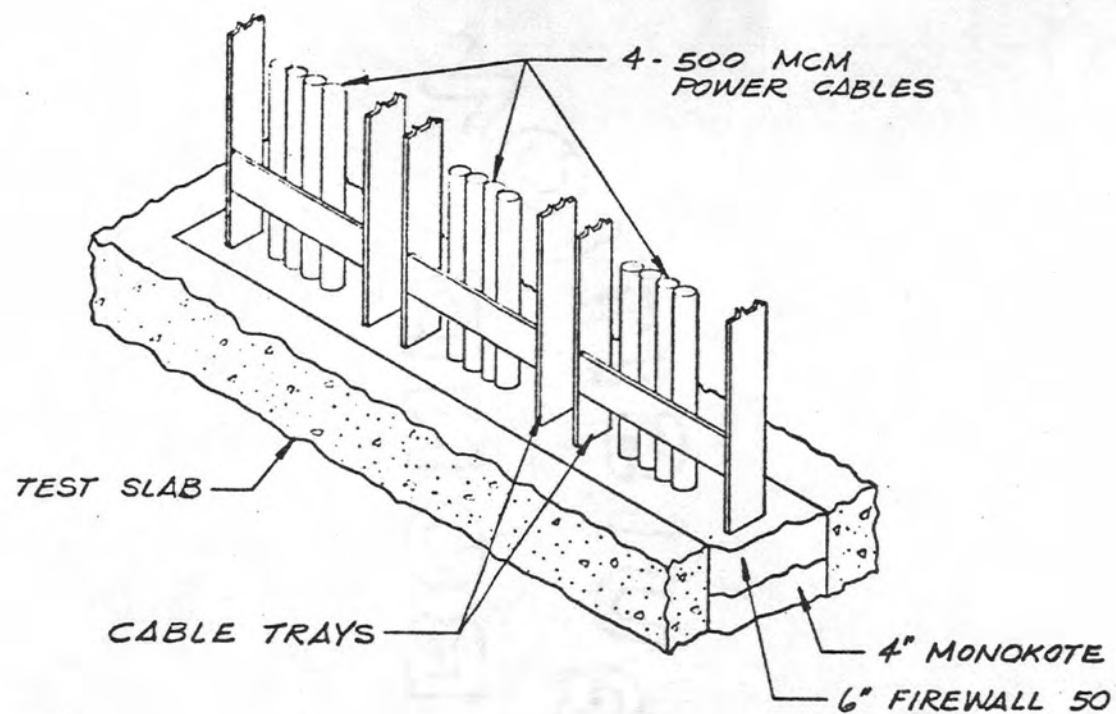
Slab #4

Channel Number	Thermocouple Number	Penetration Number/Type	Location
1	2	B1	Middle of field
2	3		At the interface
3	4		3" up on the cable
4	5	B6	Middle of field
5	6		At the interface
6	7		3" up on the cable
7	8	B5	Middle of field
8	9		At the interface
9	10		3" up on the cable
10	11	B4	Middle of field
11	12		At the interface
12	13		3" up on the cable
13	14	B3	Middle of field
14	15		At the interface
15	16		3" up on the cable
16	17	B8	Middle of field
17	18		At the interface
18	19		3" up on the cable
19	20	B7	Middle of field
20	21		At the interface
21	22		3" up on the cable
22	23	B2	Middle of field
23	24		At the interface
24	25		6" up and inside the cable about 1"
25			Furnace Average



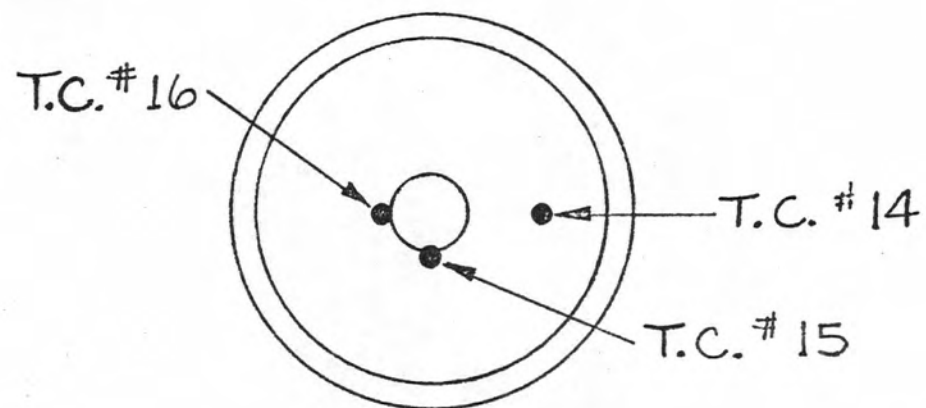
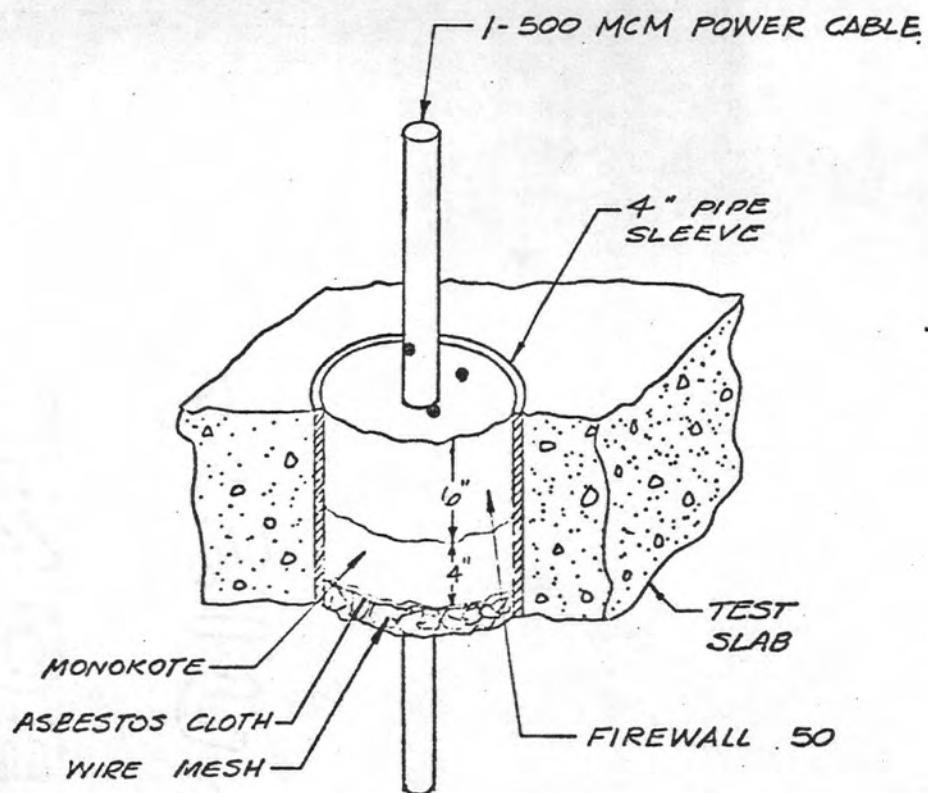
PLAN VIEW

Figure IV-1. Penetration B1



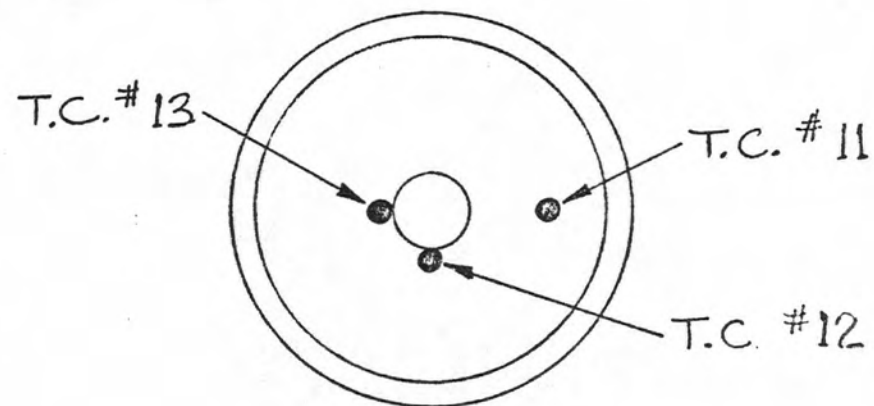
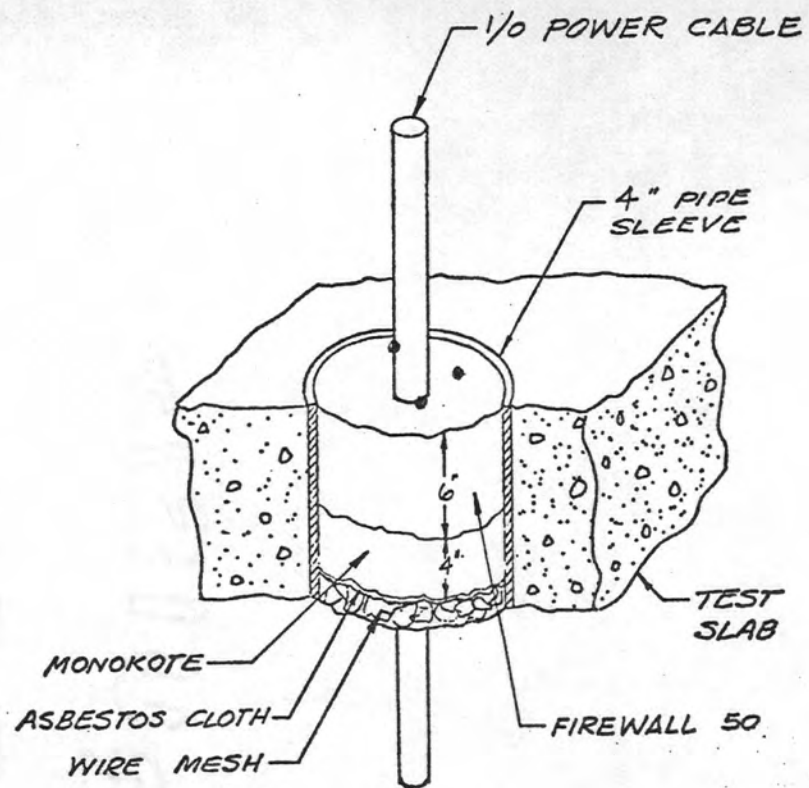
PLAN VIEW

Figure IV-2. Penetration B2



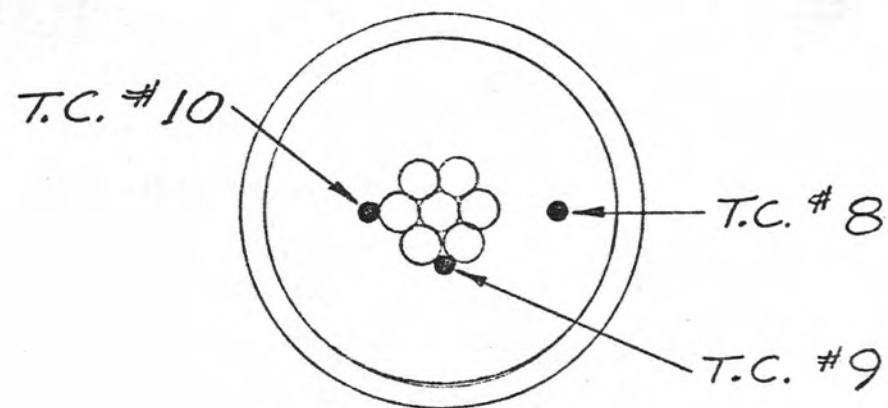
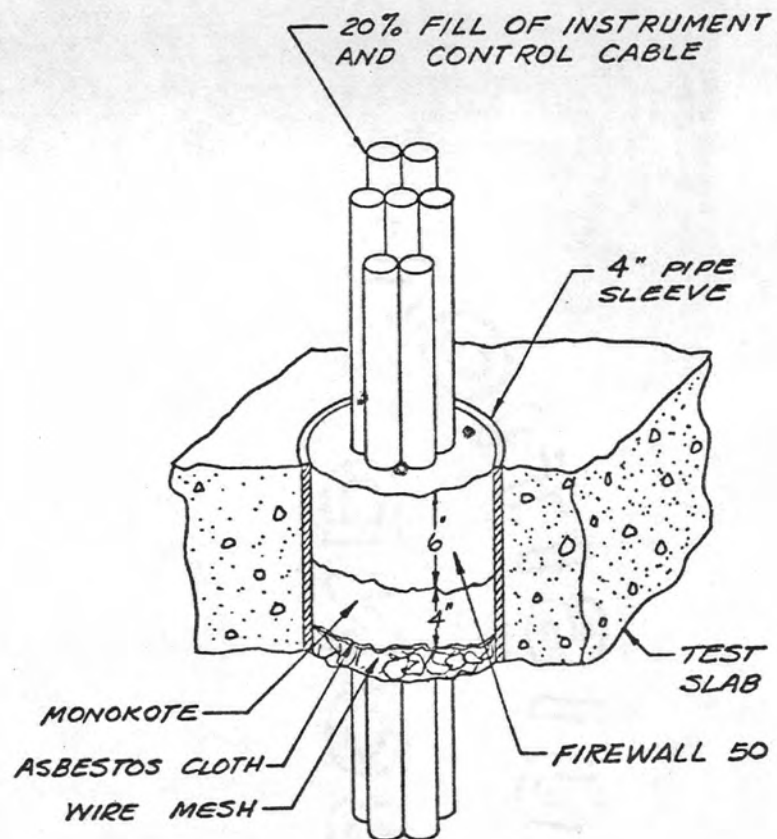
PLAN VIEW

Figure IV-3. Penetration B3



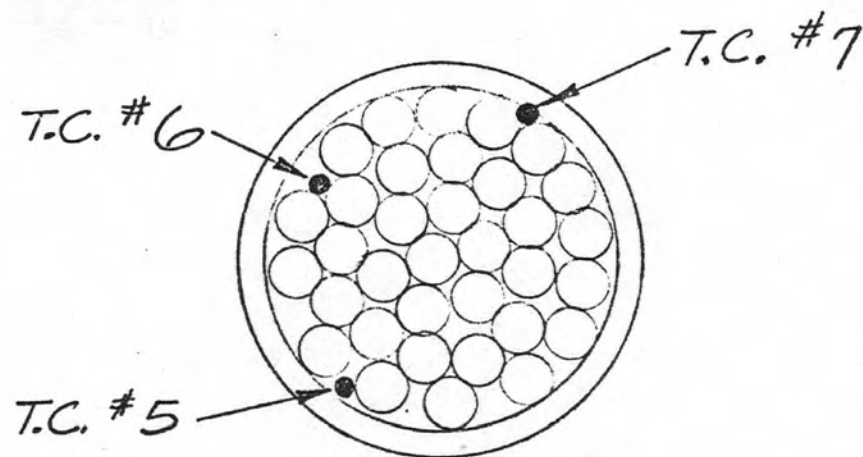
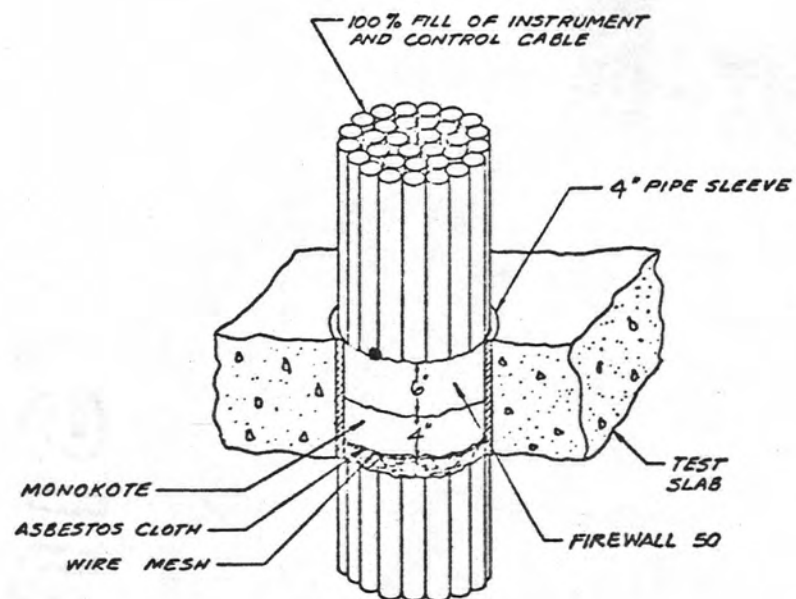
PLAN VIEW

Figure IV-4. Penetration B4



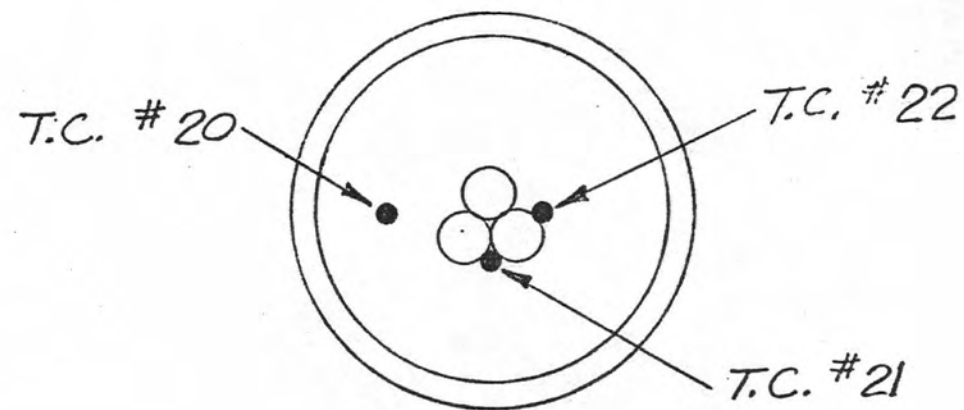
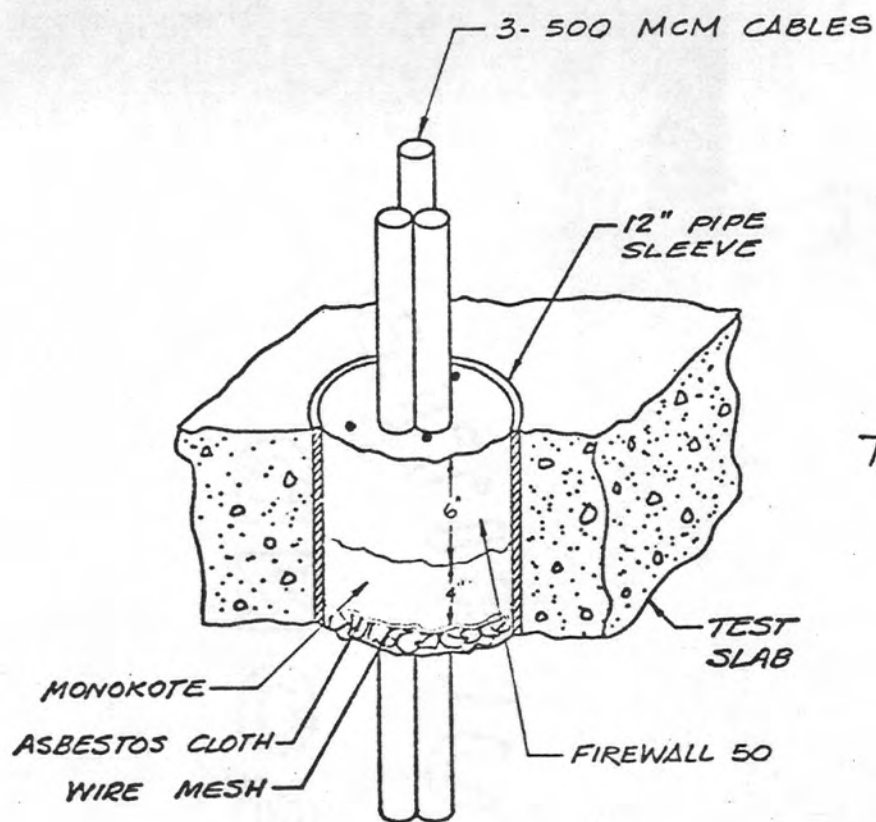
PLAN VIEW

Figure IV-5. Penetration B5



PLAN VIEW

Figure IV-6. Penetration B6



PLAN VIEW

Figure IV-7. Penetration B7

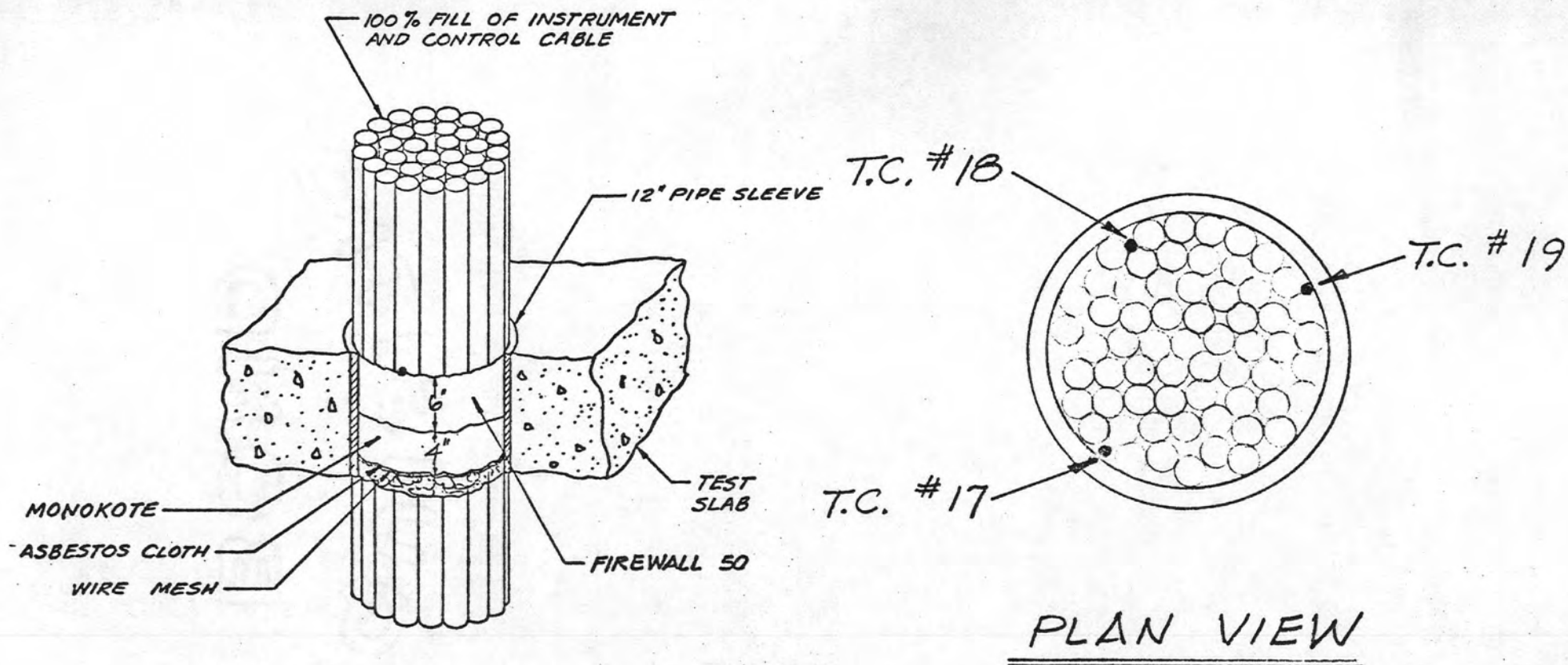
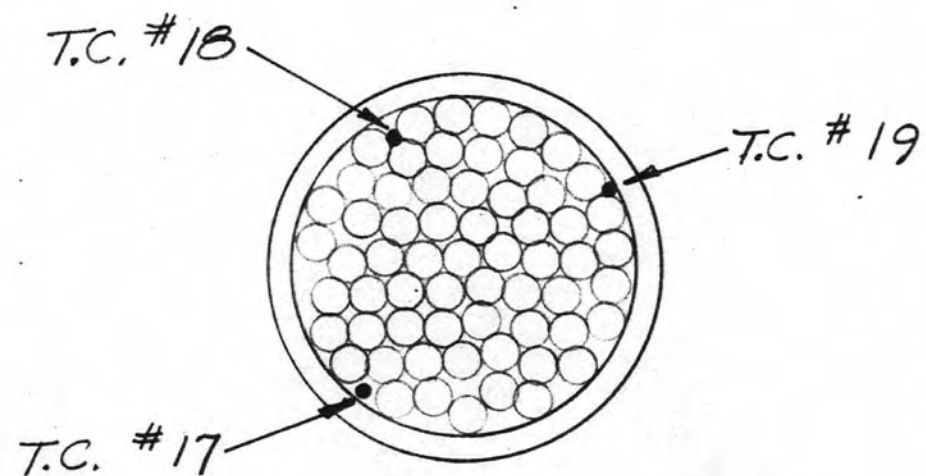
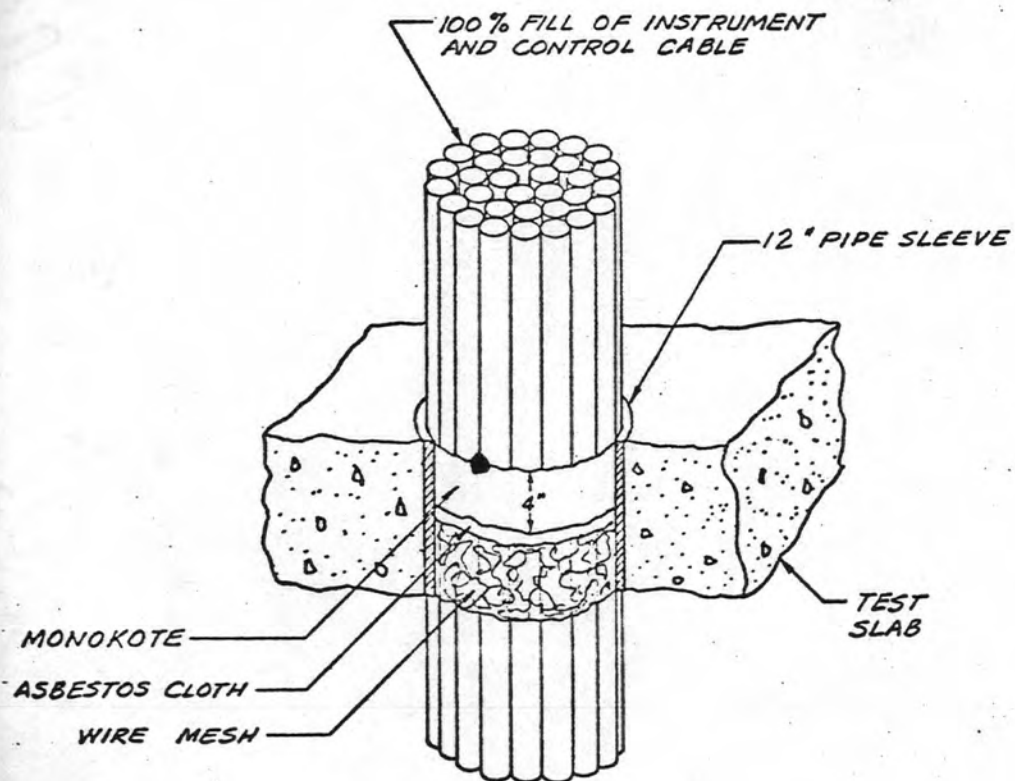


Figure IV-8. Penetration B8



PLAN VIEW

Figure IV-8. Penetration B8

TEMPERATURE DATA

Note: Channels 26, 27, and 28 are not part of the test data.

LENGTH - 180 MINUTES

DATE RUN 10 MAY 78

PAGE 1

TIME M S	HRS	CH 1	CH 2	CH 3	CH 4	CH 5	CH 6	CH 7	CH 8	CH 9	CH10	CH11	CH12	CH13	CH14
0 1		84	80	80	79	80	77	79	77	76	76	78	76	78	75
0 16		88	81	82	79	79	77	79	78	77	77	78	76	79	76
0 31		91	82	84	80	80	77	79	79	78	77	79	77	79	77
0 46		95	83	85	80	80	78	80	79	78	78	79	77	79	78
1 1		92	84	85	80	84	79	80	80	79	78	79	77	79	78
1 16		90	86	87	81	82	79	80	80	80	79	80	78	79	78
1 31		93	87	87	82	85	82	80	82	81	79	80	78	80	79
1 46		91	87	87	82	84	82	80	82	81	80	81	79	80	79
2 1		95	88	88	82	86	82	80	82	81	80	81	79	80	79
2 16		96	89	88	82	87	81	80	82	81	80	81	79	80	79
2 31		96	91	90	82	84	82	81	82	82	80	81	79	80	79
2 46		99	92	91	82	84	82	81	82	82	80	81	79	80	80
3 1		97	94	93	83	84	82	81	82	82	80	81	80	80	80
3 16		101	97	94	82	84	82	81	82	81	80	81	80	80	80
3 31		97	97	91	82	86	82	81	82	81	80	82	80	80	80
3 46		100	97	93	82	86	82	81	83	82	81	82	80	81	80
4 1		98	99	94	83	87	83	81	83	82	81	82	80	81	80
4 16		99	101	95	83	87	83	81	83	82	81	82	80	81	80
4 31		101	101	95	83	89	83	81	83	82	81	82	81	81	80
4 46		99	102	97	83	87	83	81	83	83	81	82	80	81	80
5 1		94	104	96	83	85	83	81	83	82	81	82	80	81	80
5 16		95	105	97	83	84	83	81	83	82	81	82	80	81	80
5 31		100	104	95	83	86	83	81	83	82	81	82	80	81	80
5 46		101	104	97	83	86	83	81	83	82	81	82	80	81	80
6 1		101	103	95	83	87	83	81	83	81	81	82	81	81	80
6 16		100	103	95	83	88	85	82	83	82	81	83	81	81	80
6 31		102	103	95	83	90	84	82	83	82	81	84	81	81	80
6 46		104	103	96	83	89	84	82	83	82	81	84	81	81	80
7 1		100	102	95	83	87	84	82	83	82	81	83	81	81	80
7 16		99	102	96	83	88	85	82	84	82	81	83	81	81	81
7 31		101	102	94	83	89	85	82	84	83	81	83	81	81	81
7 46		99	102	94	83	87	84	82	83	82	81	83	81	81	80
8 1		98	102	93	83	87	84	82	83	82	81	83	81	81	80
8 16		97	101	94	83	86	84	82	83	82	81	83	81	81	80
8 31		97	100	94	83	86	84	82	83	82	81	83	81	81	80
8 46		97	100	93	83	85	84	82	83	82	81	83	81	81	80
9 1		96	99	92	83	85	84	82	83	81	81	83	81	81	80
9 16		97	98	94	83	85	84	82	83	82	81	83	81	81	80
9 31		95	98	94	83	85	84	82	83	82	81	83	81	81	80
9 46		92	99	94	83	84	83	82	83	82	81	82	81	81	80
10 1		92	99	93	83	84	82	82	82	82	80	82	80	81	80
10 16		91	99	93	82	84	82	82	82	82	80	82	81	81	80
10 31		92	99	92	82	84	82	82	82	82	80	82	81	81	80
10 46		92	98	92	82	84	83	82	82	82	81	82	81	81	80
11 1		92	98	92	83	85	83	82	83	82	81	82	81	81	80
11 16		90	98	93	83	84	83	82	83	82	81	82	81	81	80
11 31		92	98	93	83	84	82	82	82	82	81	82	81	81	80
11 46		91	98	92	83	84	83	82	83	82	80	82	81	81	80
12 1		92	98	93	83	84	82	82	83	82	81	82	81	81	80
12 16		91	98	93	83	84	82	82	82	82	80	82	81	81	80

TIME		HRS	CH 1	CH 2	CH 3	CH 4	CH 5	CH 6	CH 7	CH 8	CH 9	CH10	CH11	CH12	CH13	CH14
M	S															
12	31		93	98	93	82	84	82	82	82	82	81	82	81	81	80
12	46		92	98	92	83	84	82	82	82	82	81	83	81	81	80
13	1		91	98	91	83	84	83	82	83	82	81	83	81	82	80
13	16		91	98	93	83	84	82	82	82	82	81	83	81	82	80
13	31		91	98	92	82	84	82	82	82	82	81	83	81	82	81
13	46		91	98	92	83	84	82	82	82	82	81	83	81	82	80
14	1		91	98	92	83	84	82	82	82	82	81	83	81	82	80
14	16		93	97	92	83	84	82	82	83	82	81	83	81	82	80
14	31		91	97	92	83	84	82	82	83	82	81	83	81	82	81
14	46		91	97	92	83	84	82	82	83	83	81	83	81	82	80
15	1		92	98	93	83	85	83	82	83	83	81	83	81	82	81
15	16		91	98	93	83	84	82	82	83	83	81	83	81	82	81
15	31		91	98	92	83	84	83	82	83	82	81	83	81	82	80
15	46		90	97	91	83	84	83	82	83	82	81	83	81	82	80
16	1		91	98	91	83	84	83	82	83	83	81	83	81	82	81
16	16		91	98	91	83	85	83	82	83	83	81	83	81	82	81
16	31		92	98	92	83	85	83	82	83	83	81	84	81	82	81
16	46		92	98	92	83	85	83	82	83	83	81	84	81	82	81
17	1		91	98	92	83	85	83	83	83	83	81	84	81	82	81
17	16		91	99	92	83	85	83	83	83	84	81	84	81	82	81
17	31		91	99	92	83	85	82	83	83	83	81	84	81	82	81
17	46		91	99	92	83	85	82	83	83	83	81	84	81	82	81
18	1		91	99	91	83	85	82	83	83	83	81	84	81	82	81
18	16		91	99	92	83	85	82	83	83	83	81	84	81	82	81
18	31		91	99	92	83	84	82	83	83	83	82	84	81	82	81
18	46		90	99	92	83	84	82	83	83	83	82	84	82	82	81
19	1		92	100	93	83	84	82	83	83	83	82	84	81	82	81
19	16		91	100	92	83	84	82	83	83	83	81	84	81	82	81
19	31		92	100	92	83	85	82	83	83	83	82	85	81	82	81
19	46		92	100	93	83	84	82	83	83	83	82	85	82	82	81
20	1		91	100	93	83	85	82	83	83	84	82	85	82	82	81
20	16		90	100	93	84	85	82	83	83	84	82	85	81	82	81
20	31		91	100	91	84	85	83	83	83	83	81	85	81	82	81
20	46		92	100	91	84	84	82	83	83	83	81	85	81	82	81
21	1		91	100	92	84	85	82	83	83	83	81	85	81	82	81
21	16		92	100	93	84	85	83	83	84	84	82	85	82	82	81
21	31		91	100	92	84	85	83	83	84	84	82	85	81	82	81
21	46		93	101	92	84	85	83	84	84	84	82	85	82	82	81
22	1		92	101	91	84	85	83	84	84	84	82	85	82	82	81
22	16		91	101	91	84	85	83	84	84	84	82	85	82	82	81
22	31		91	100	90	84	85	83	84	84	84	82	86	82	82	81
22	46		92	101	92	84	85	82	84	84	84	82	86	82	82	81
23	1		93	101	93	84	85	82	84	84	84	82	86	82	82	81
23	16		92	101	91	84	85	83	84	84	84	82	86	82	83	81
23	31		92	101	92	84	85	83	84	84	84	82	86	82	82	81
23	46		91	101	90	84	85	83	84	84	84	82	86	82	82	81
24	1		91	101	91	84	85	82	84	84	84	82	86	82	82	81
24	16		92	101	92	84	85	83	84	84	84	82	86	82	83	82
24	31		93	101	92	84	85	83	84	84	84	83	86	82	83	82
24	46		92	101	90	84	85	83	84	84	84	82	86	82	83	81
25	1		92	100	90	84	85	83	84	84	84	82	87	82	83	81
25	16		92	101	91	85	84	83	84	84	85	82	87	82	83	81
25	31		92	101	91	84	85	83	84	84	84	83	87	82	83	81
25	46		91	102	91	84	85	83	84	84	84	82	86	82	83	81
26	1		92	101	90	84	85	83	85	84	84	82	87	82	83	81

TIME		HRS	CH 1	CH 2	CH 3	CH 4	CH 5	CH 6	CH 7	CH 8	CH 9	CH10	CH11	CH12	CH13	CH14
M	S															
26	16		92	101	89	85	85	83	85	84	84	82	87	81	83	81
26	31		92	101	89	85	85	83	85	84	84	82	87	82	83	81
26	46		91	101	91	84	85	82	85	84	84	82	84	82	83	81
27	1		92	102	92	85	85	83	85	85	85	83	87	82	83	81
27	16		92	102	91	85	84	83	85	84	85	83	87	82	83	81
27	31		92	102	91	85	84	83	85	84	84	83	88	82	83	81
27	46		92	102	89	85	85	83	85	85	84	83	88	82	83	81
28	1		92	102	89	85	85	83	85	85	84	83	88	82	83	81
28	16		93	102	91	85	84	83	85	85	85	83	88	82	83	81
28	31		93	102	90	85	84	83	85	85	85	83	88	82	83	81
28	46		92	102	89	85	84	83	86	85	85	83	88	82	83	81
29	1		93	102	89	85	84	83	86	85	85	83	89	82	83	81
29	16		92	102	89	84	84	83	86	85	85	83	89	82	83	81
29	31		93	103	91	85	84	83	86	85	85	84	89	83	84	82
29	46		93	104	91	84	87	84	86	85	86	84	89	83	84	82
30	1		92	104	91	86	87	84	86	86	86	84	89	83	84	82
30	16		92	104	91	86	87	84	86	86	86	84	89	83	84	82
30	31		93	104	90	86	87	84	86	86	86	84	90	83	84	82
30	46		93	104	90	86	87	84	87	86	86	84	90	83	84	82
31	1		93	105	91	86	86	83	87	86	86	84	90	83	84	82
31	16		92	104	89	86	87	83	87	85	86	85	90	84	85	83
31	31		92	104	89	87	87	84	87	86	87	85	91	84	85	84
31	46		91	104	88	87	87	84	87	86	87	85	91	84	85	83
32	1		91	104	87	87	87	84	87	86	87	85	91	85	85	84
32	16		91	104	88	87	88	84	87	86	87	86	91	85	85	83
32	31		93	105	91	87	87	84	87	86	87	86	91	84	85	83
32	46		92	106	90	86	86	84	87	87	86	85	90	84	85	83
33	1		94	107	92	86	86	83	87	86	86	85	90	84	85	83
33	16		94	107	92	86	86	83	87	86	86	85	91	84	85	83
33	31		93	108	91	86	86	83	87	86	86	85	91	84	85	83
33	46		93	107	89	87	87	84	88	87	87	86	91	84	86	84
34	1		93	108	91	87	87	84	88	87	86	86	92	85	86	83
34	16		93	108	92	86	86	83	88	87	86	86	90	85	86	83
34	31		94	108	93	86	86	83	88	87	86	86	91	84	86	83
34	46		94	109	93	86	85	83	87	87	86	85	90	84	86	83
35	1		95	110	93	86	86	83	88	87	86	85	91	84	86	83
35	16		94	110	94	86	86	83	88	87	86	86	91	84	86	84
35	31		93	110	93	86	86	83	88	87	86	86	91	84	86	83
35	46		94	110	92	86	86	83	88	87	86	86	91	85	86	83
36	1		95	110	94	86	86	83	88	87	86	86	92	85	86	84
36	16		95	111	94	87	86	83	88	87	86	86	92	85	86	84
36	31		95	111	94	87	87	84	89	87	87	86	92	85	86	84
36	46		95	111	93	87	87	84	89	87	87	87	93	85	86	84
37	1		94	110	91	88	88	84	89	88	87	87	93	85	87	85
37	16		93	110	93	87	86	83	89	88	87	86	92	85	87	83
37	31		93	110	91	87	86	84	89	88	87	86	93	85	87	84
37	46		93	110	93	87	86	83	89	88	87	87	92	85	87	84
38	1		94	110	91	88	87	84	89	88	87	87	93	85	87	83
38	16		93	109	89	88	87	84	90	88	87	87	94	85	87	84
38	31		94	109	89	88	88	84	90	88	88	87	94	85	87	84
38	46		94	110	90	88	88	84	90	88	88	87	94	85	87	84
39	1		93	110	92	88	87	84	90	88	87	87	93	85	87	83
39	16		93	110	92	88	87	84	90	88	87	87	93	85	87	84
39	31		94	111	93	87	86	84	90	89	87	87	93	85	87	84
39	46		94	111	91	88	87	84	90	89	87	87	94	85	88	84

TIME		HRS	CH 1	CH 2	CH 3	CH 4	CH 5	CH 6	CH 7	CH 8	CH 9	CH 10	CH 11	CH 12	CH 13	CH 14
M	S															
40	1		94	111	91	89	88	85	90	89	88	88	94	86	88	84
40	14		94	112	94	88	86	84	90	89	87	88	92	85	88	84
40	31		94	113	94	87	86	84	90	90	87	87	93	85	88	84
40	46		94	112	90	88	87	84	91	89	88	88	95	86	88	83
41	1		94	112	89	89	87	85	91	89	88	87	95	85	88	84
41	16		94	112	92	89	87	84	91	89	87	88	95	85	88	84
41	31		94	113	93	88	87	84	91	89	87	88	95	85	88	84
41	46		94	113	91	89	87	84	92	89	88	88	96	86	88	85
42	1		95	113	90	90	88	85	92	90	88	88	96	86	89	84
42	16		95	113	90	90	88	85	92	90	89	88	97	86	89	85
42	31		94	113	89	90	89	85	93	90	89	88	97	86	89	85
42	46		95	113	92	90	88	85	93	90	88	89	96	86	89	85
43	1		95	114	94	89	87	84	93	90	87	89	96	86	89	85
43	16		94	115	93	89	88	84	94	90	88	89	97	86	89	85
43	31		95	115	90	90	88	85	94	90	89	89	97	86	89	85
43	46		95	115	92	90	89	85	94	91	89	89	98	87	89	86
44	1		96	116	93	91	89	86	95	92	90	90	98	87	90	86
44	16		95	116	95	90	89	85	95	91	89	90	97	87	90	85
44	31		96	117	95	90	89	85	96	91	89	90	98	87	90	86
44	46		96	118	94	91	89	86	96	91	90	90	99	88	90	86
45	1		96	118	95	91	89	86	96	92	90	90	99	87	90	85
45	16		96	118	94	91	89	86	95	91	90	90	100	87	90	86
45	31		97	119	94	92	90	86	95	92	91	90	100	88	90	86
45	46		97	119	93	92	90	86	95	92	90	91	100	88	90	87
46	1		97	119	96	92	90	86	95	93	90	91	100	88	91	87
46	16		98	120	97	92	90	86	95	93	90	91	100	88	91	87
46	31		95	119	98	90	88	85	94	93	89	91	99	87	91	86
46	46		96	119	95	91	89	86	95	93	89	91	99	88	91	86
47	1		97	119	97	91	89	86	95	94	90	91	100	88	91	86
47	16		97	119	93	92	89	86	95	93	90	91	100	87	91	86
47	31		97	118	92	92	89	86	94	94	90	91	98	88	91	87
47	46		95	119	95	91	88	86	93	95	90	91	96	88	91	86
48	1		94	119	96	91	88	86	94	95	90	91	98	88	91	86
48	16		96	119	97	91	89	85	94	94	89	91	99	88	92	86
48	31		96	119	98	91	88	86	93	94	89	91	98	88	92	86
48	46		97	120	98	91	89	85	94	93	89	91	100	88	92	86
49	1		97	121	98	92	90	86	96	93	90	92	101	88	92	87
49	16		98	120	94	93	90	86	96	92	92	92	102	88	92	87
49	31		98	121	95	94	91	87	97	92	92	92	102	88	92	87
49	46		99	119	94	94	91	87	97	92	91	92	103	88	92	87
50	1		99	119	93	95	91	87	98	93	92	93	103	89	92	87
50	16		99	119	95	95	92	87	98	94	92	93	103	89	93	89
50	31		99	119	93	95	92	88	99	94	92	93	104	89	93	88
50	46		98	118	93	96	92	88	99	96	94	93	105	90	93	89
51	1		99	118	93	96	93	88	99	94	93	94	105	90	93	89
51	16		99	118	92	96	93	88	100	95	93	94	105	90	93	88
51	31		98	117	91	96	93	88	100	95	93	94	105	90	94	89
51	46		99	117	91	96	93	89	101	95	93	94	106	91	94	90
52	1		99	117	92	97	94	89	101	95	93	95	107	91	94	89
52	16		99	117	93	97	94	89	102	96	93	95	107	90	94	89
52	31		99	117	95	96	93	89	102	98	93	95	106	91	95	90
52	46		100	119	95	97	93	89	103	97	94	96	107	91	95	91
53	1		100	120	96	98	94	89	103	95	94	97	108	91	95	90
53	16		100	119	94	98	94	89	104	96	94	96	108	91	95	89
53	31		100	120	96	97	93	89	104	97	96	96	107	91	95	89

TIME		HRS	CH 1	CH 2	CH 3	CH 4	CH 5	CH 6	CH 7	CH 8	CH 9	CH 10	CH 11	CH 12	CH 13	CH 14
M	S															
53	46		100	119	95	98	94	89	104	97	95	96	109	91	95	90
54	1		100	120	94	98	94	90	105	96	95	97	109	92	96	91
54	16		101	120	98	98	94	90	105	97	96	97	108	92	96	91
54	31		101	121	98	99	95	90	105	99	96	97	109	92	96	91
54	46		101	121	98	99	95	90	105	99	95	97	108	92	97	91
55	1		101	121	100	97	94	90	105	102	94	97	106	92	96	90
55	16		101	122	103	97	93	89	104	99	94	97	105	92	96	90
55	31		101	123	104	97	93	89	105	98	94	97	107	92	96	90
55	46		102	123	100	99	94	89	105	96	94	97	106	92	96	90
56	1		101	123	102	97	93	89	105	100	93	97	107	92	96	90
56	16		102	123	103	96	92	89	104	99	94	97	105	92	97	90
56	31		102	124	100	98	94	89	105	97	95	97	107	91	96	89
56	46		102	123	101	97	93	89	105	101	93	97	107	92	97	89
57	1		101	123	102	97	93	89	105	98	94	97	108	92	97	89
57	16		102	124	99	98	94	89	106	99	95	97	108	92	97	90
57	31		102	124	100	98	94	90	107	99	95	98	108	93	98	91
57	46		103	124	103	98	95	90	107	100	95	98	108	93	98	92
58	1		104	125	104	99	95	91	107	98	96	100	109	93	98	91
58	16		104	125	102	100	95	91	107	100	96	99	110	93	98	90
58	31		103	125	99	100	96	91	108	98	97	99	109	93	98	91
58	46		103	125	98	101	96	91	108	99	96	99	110	93	98	91
59	1		104	124	100	98	94	91	107	103	96	99	107	92	98	91
59	16		103	124	100	97	94	91	107	103	95	99	106	93	98	91
59	31		102	124	104	98	94	91	107	100	95	99	109	93	99	91
59	46		103	125	101	100	96	91	108	99	96	99	110	93	99	91
60	1		104	125	98	100	95	91	109	100	96	99	111	93	99	91
60	16		104	125	98	101	96	91	109	99	97	99	113	93	99	91
60	31		104	124	97	101	96	92	110	102	96	100	110	94	99	91
60	46		103	125	101	99	95	91	109	103	95	100	108	93	99	91
61	1		103	126	103	99	95	91	108	102	95	100	108	94	100	91
61	16		104	127	103	100	96	91	109	102	96	101	105	94	100	92
61	31		105	127	105	97	94	91	108	102	96	100	108	94	100	92
61	46		105	127	105	98	94	92	108	102	95	101	107	94	100	92
62	1		105	128	105	99	94	92	108	103	96	101	107	94	100	92
62	16		105	128	105	96	93	91	108	102	96	101	104	94	100	91
62	31		103	128	106	97	93	91	108	102	95	101	106	94	100	91
62	46		104	129	105	96	94	91	109	102	95	101	105	94	100	91
63	1		102	128	106	97	94	91	109	100	94	101	108	94	100	91
63	16		104	129	107	96	93	91	109	103	95	101	104	94	100	91
63	31		103	129	107	98	95	91	109	100	95	101	107	94	100	91
63	46		104	129	107	99	94	91	110	103	95	102	105	94	100	90
64	1		103	129	107	100	94	91	110	102	95	101	107	93	101	90
64	16		103	129	106	100	95	91	111	103	96	101	109	93	101	90
64	31		105	128	101	104	96	92	113	99	97	102	112	94	101	91
64	46		105	129	102	104	96	92	113	102	97	102	111	95	101	91
65	1		105	128	101	103	96	93	113	102	97	103	107	96	102	92
65	16		104	129	104	101	96	92	113	102	99	102	110	94	102	91
65	31		105	129	104	98	95	92	113	104	97	103	104	95	102	91
65	46		104	130	105	98	94	92	112	103	99	101	108	93	102	91
66	1		105	130	103	99	94	92	112	104	96	102	105	94	102	91
66	16		104	131	102	99	94	92	111	102	97	102	107	94	102	91
66	31		105	130	101	102	96	93	113	102	97	102	111	94	102	91
66	46		106	131	103	101	96	93	112	105	96	103	110	94	102	91
67	1		106	131	101	102	96	93	114	103	98	102	111	94	102	91
67	16		106	131	101	104	97	93	114	104	100	102	108	94	102	91

TIME		HRS	CH 1	CH 2	CH 3	CH 4	CH 5	CH 6	CH 7	CH 8	CH 9	CH10	CH11	CH12	CH13	CH14
M	S															
67	31		105	131	105	99	95	93	113	103	97	102	108	94	102	91
67	46		105	132	107	102	96	93	114	104	99	103	107	95	103	92
68	1		106	133	104	101	96	95	114	104	98	103	111	95	103	92
68	16		107	132	105	103	97	94	115	103	99	103	112	95	103	92
68	31		107	132	102	105	98	95	116	101	99	103	113	95	103	92
68	46		107	132	103	106	98	94	116	105	98	105	109	96	104	92
69	1		107	132	105	103	98	94	115	106	101	104	112	95	103	92
69	16		106	131	106	101	98	94	116	107	100	104	112	96	104	92
69	31		106	132	106	99	97	94	115	105	99	106	111	97	104	92
69	46		107	133	108	100	97	94	115	105	98	106	109	96	104	92
70	1		106	133	108	102	97	94	115	106	97	104	112	95	104	91
70	16		106	134	110	99	96	94	115	106	97	105	109	95	104	92
70	31		107	134	107	100	96	94	115	104	97	105	109	96	104	92
70	46		107	134	107	102	97	95	115	105	98	105	112	95	105	92
71	1		107	133	104	104	99	97	116	103	100	105	114	96	105	92
71	16		107	132	105	102	98	96	116	107	101	106	110	96	105	92
71	31		106	133	103	105	98	96	117	105	100	105	112	96	105	93
71	46		107	133	107	102	99	95	116	107	98	106	111	96	105	92
72	1		107	133	109	99	97	95	115	108	98	106	111	96	105	92
72	16		107	135	110	99	97	95	115	107	99	106	109	97	106	93
72	31		107	135	110	103	98	96	116	105	98	106	113	97	106	93
72	46		109	135	110	104	98	96	117	105	99	106	114	97	107	93
73	1		109	135	106	108	99	96	118	103	101	107	111	97	107	94
73	16		109	136	109	100	96	96	116	107	98	107	107	98	107	93
73	31		107	136	111	103	97	96	116	108	98	106	110	97	107	93
73	46		106	136	113	98	95	96	114	107	98	107	107	97	107	93
74	1		107	136	109	101	98	97	115	107	100	106	114	96	107	92
74	16		108	135	109	108	98	96	117	107	100	106	115	96	107	92
74	31		108	135	106	107	99	97	118	106	100	106	116	96	107	92
74	46		109	136	108	105	99	97	118	106	100	106	115	97	107	93
75	1		109	133	104	107	101	97	119	106	104	106	117	97	107	92
75	16		109	133	102	108	101	100	120	104	102	107	119	97	108	94
75	31		109	134	104	103	99	93	119	108	100	108	112	98	108	94
75	46		110	135	103	106	99	97	119	109	101	108	118	98	108	94
76	1		110	135	104	109	102	100	120	103	101	108	119	97	109	93
76	16		110	134	102	108	103	100	120	103	101	108	120	98	108	94
76	31		111	134	105	108	101	99	121	105	103	109	120	98	109	94
76	46		111	135	103	112	101	100	121	106	104	107	120	99	108	94
77	1		110	134	102	111	103	100	122	109	102	110	121	100	108	94
77	16		111	135	106	106	101	98	121	111	103	110	114	100	109	94
77	31		109	136	108	104	99	98	117	109	103	110	113	99	109	94
77	46		108	135	109	103	98	98	117	111	101	110	113	98	109	93
78	1		107	134	109	105	98	98	116	111	103	108	117	97	109	93
78	16		109	135	104	107	100	98	119	110	101	108	118	98	109	94
78	31		110	135	105	110	102	98	120	110	101	108	118	98	109	94
78	46		109	136	110	103	99	98	118	110	99	110	115	99	110	94
79	1		110	137	112	106	100	98	119	108	99	110	117	99	110	94
79	16		110	137	112	105	99	98	118	111	100	110	114	99	110	94
79	31		109	138	111	104	98	99	118	111	101	110	118	97	110	93
79	46		110	139	110	104	99	98	119	109	101	110	114	99	111	94
80	1		109	138	113	101	97	98	116	111	100	110	113	99	110	94
80	16		109	138	112	101	97	98	115	107	99	110	116	98	111	94
80	31		109	138	112	103	98	98	118	111	103	109	118	98	110	94
80	46		110	138	109	108	100	99	120	111	103	110	122	98	111	95
81	1		111	137	106	112	101	100	121	111	102	110	121	99	111	95

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TIME		HRS	CH 1	CH 2	CH 3	CH 4	CH 5	CH 6	CH 7	CH 8	CH 9	CH10	CH11	CH12	CH13	CH14
M	S															
81	16		111	137	106	111	102	101	122	111	102	110	119	99	111	95
81	31		111	137	109	106	100	99	120	110	103	110	117	99	112	95
81	46		110	137	111	106	100	100	120	112	104	110	120	99	112	95
82	1		111	137	107	109	101	101	121	112	104	111	121	99	112	96
82	16		111	137	110	107	99	100	120	111	102	111	114	99	112	95
82	31		109	137	112	105	99	99	118	111	100	111	118	99	112	95
82	46		108	138	114	110	100	99	120	111	100	111	121	99	112	95
83	1		110	138	115	109	101	100	122	111	103	111	123	100	113	96
83	16		112	139	108	114	103	103	123	107	104	112	124	101	113	97
83	31		112	138	106	111	106	104	125	110	103	113	124	101	113	96
83	46		112	138	109	109	103	102	123	112	103	113	118	102	113	96
84	1		112	139	111	112	104	102	123	109	103	113	123	101	114	97
84	16		113	139	111	110	103	101	124	109	104	113	124	100	114	96
84	31		113	140	109	116	104	102	125	109	106	113	124	100	114	95
84	46		114	139	107	115	105	101	126	112	105	112	122	100	114	95
85	1		115	140	111	111	104	102	123	114	105	114	119	100	114	96
85	16		115	139	109	112	104	103	123	113	105	112	117	100	114	97
85	31		115	140	111	103	98	102	119	113	103	112	116	101	114	96
85	46		114	140	113	108	101	101	120	112	103	113	120	99	114	95
86	1		114	140	111	113	102	102	122	113	103	113	119	101	114	96
86	16		112	139	114	108	102	101	121	111	102	114	123	101	115	96
86	31		114	140	113	115	103	104	124	108	105	114	125	101	115	96
86	46		115	140	113	117	105	104	125	108	106	114	126	101	115	97
87	1		115	140	108	115	105	108	126	107	106	114	128	101	115	97
87	16		115	139	106	116	107	106	128	111	105	114	125	102	116	98
87	31		116	139	111	109	104	103	123	114	105	114	123	102	116	97
87	46		115	139	111	111	106	103	125	110	105	114	125	101	115	98
88	1		115	139	113	108	103	102	125	113	104	114	121	103	116	97
88	16		116	140	114	108	102	102	125	110	104	114	122	104	116	97
88	31		116	140	112	115	104	104	127	115	105	114	126	103	116	98
88	46		116	140	114	113	105	104	126	116	104	115	126	102	116	97
89	1		116	140	110	117	107	106	128	115	105	116	129	102	117	97
89	16		116	139	109	117	108	107	129	114	105	117	129	102	116	97
89	31		117	139	110	117	110	107	130	112	111	115	128	101	117	97
89	46		117	139	113	113	106	104	129	115	108	115	126	101	117	97
90	1		116	138	107	116	107	107	129	116	112	115	129	100	116	97
90	16		116	138	108	116	109	106	129	115	108	114	127	100	115	97
90	31		116	138	109	112	106	104	128	114	108	115	123	101	116	97
90	46		116	139	111	104	101	104	124	113	108	116	122	101	116	97
91	1		116	139	110	104	100	104	123	114	104	116	122	101	116	96
91	16		116	140	113	108	102	103	124	114	106	116	123	101	116	96
91	31		116	141	112	113	107	108	126	114	108	115	128	101	117	96
91	46		117	140	111	118	105	105	127	113	107	115	129	100	117	97
92	1		117	139	110	118	109	105	128	112	109	114	129	102	115	97
92	16		117	138	109	117	109	112	131	114	111	116	130	103	117	98
92	31		117	138	109	117	107	109	131	117	110	118	124	103	117	97
92	46		116	138	111	112	106	104	128	116	108	117	127	102	118	97
93	1		117	139	110	118	107	106	130	114	111	117	131	102	119	98
93	16		117	138	110	116	109	107	131	114	109	118	126	103	119	98
93	31		117	139	113	109	105	104	129	114	109	118	126	102	119	97
93	46		116	140	113	107	102	104	126	116	107	117	123	103	119	97
94	1		117	140	113	111	103	105	127	115	107	117	124	102	119	97
94	16		116	140	112	107	101	104	123	114	108	117	125	101	118	96
94	31		117	139	111	116	104	106	126	114	109	117	125	101	118	97
94	46		116	139	112	114	105	110	126	114	109	116	129	100	116	96

TIME		HRS	CH 1	CH 2	CH 3	CH 4	CH 5	CH 6	CH 7	CH 8	CH 9	CH10	CH11	CH12	CH13	CH14
M	S															
95	1		117	138	110	116	107	107	129	116	110	117	130	100	117	96
95	16		117	138	112	113	106	105	129	114	107	116	128	100	118	96
95	31		117	138	112	111	104	106	128	115	110	117	124	102	118	97
95	46		118	140	111	115	106	112	128	118	109	117	125	102	119	97
96	1		118	139	112	108	102	106	124	116	104	117	125	102	119	97
96	16		118	139	111	112	102	106	127	117	107	118	126	102	119	97
96	31		117	139	113	113	106	107	129	117	108	116	129	101	118	96
96	46		117	137	113	111	106	106	131	115	108	116	129	100	118	97
97	1		117	138	112	113	106	106	132	113	109	117	130	101	119	97
97	16		118	139	114	109	104	105	128	115	107	117	126	102	119	97
97	31		117	139	112	112	106	107	130	114	107	118	127	102	120	97
97	46		117	140	114	116	107	112	131	118	113	117	132	101	120	97
98	1		117	139	111	118	110	112	133	117	110	118	131	102	120	98
98	16		118	139	113	117	111	108	133	118	112	117	133	101	121	98
98	31		118	139	109	121	111	115	133	118	114	117	136	101	121	98
98	46		118	138	110	119	110	119	135	116	115	118	135	102	122	98
99	1		118	138	107	120	113	118	136	120	115	117	137	101	122	98
99	16		119	137	109	109	107	106	133	117	110	119	129	103	122	98
99	31		119	138	113	112	107	105	133	117	111	119	131	102	122	98
99	46		119	138	108	119	110	116	135	116	112	118	135	102	121	98
100	1		118	138	110	118	109	105	133	118	110	119	129	103	122	98
100	16		118	139	113	110	104	108	129	119	109	120	124	103	122	99
100	31		119	139	112	115	106	109	130	116	111	120	130	101	119	98
100	46		118	138	111	116	107	110	134	116	112	119	134	102	120	98
101	1		118	139	111	116	109	111	136	118	113	119	133	102	119	98
101	16		117	137	110	119	113	123	137	119	113	119	136	101	121	98
101	31		118	137	108	119	111	117	138	122	113	119	136	101	122	97
101	46		118	137	105	122	110	119	138	120	115	118	136	102	123	99
102	1		119	138	109	123	113	115	139	118	118	119	138	103	123	100
102	16		119	138	111	115	110	117	137	119	114	119	134	103	122	99
102	31		119	138	112	119	111	110	138	119	111	121	132	104	124	100
102	46		120	139	115	115	109	105	137	118	111	122	131	103	124	99
103	1		119	140	112	121	112	108	138	118	109	121	133	104	124	99
103	16		119	141	112	121	116	116	139	124	113	121	136	104	123	100
103	31		118	139	112	120	111	120	141	120	118	121	137	104	123	101
103	46		118	137	111	123	112	112	141	121	116	121	137	104	123	101
104	1		120	139	113	121	112	116	142	125	115	121	136	104	120	101
104	16		119	138	113	119	113	114	142	122	118	122	137	104	121	101
104	31		120	139	114	111	106	104	136	123	113	122	133	106	123	100
104	46		120	139	117	112	106	105	136	119	114	123	135	104	124	100
105	1		120	140	116	108	105	107	133	120	112	122	130	105	125	101
105	16		121	141	114	114	108	109	137	117	114	122	134	104	125	100
105	31		120	142	112	122	115	122	140	119	118	122	138	104	125	101
105	46		121	141	110	120	113	125	142	120	117	122	139	104	124	100
106	1		120	140	108	120	113	125	143	124	114	122	138	104	122	100
106	16		120	139	111	123	116	118	143	123	116	122	138	106	124	102
106	31		120	139	115	115	108	107	138	121	112	122	132	106	126	101
106	46		119	141	119	110	109	107	137	118	113	124	135	105	126	100
107	1		120	141	115	119	111	113	141	120	112	123	134	105	126	100
107	16		121	141	117	114	110	112	139	121	115	123	134	105	124	100
107	31		120	141	113	119	117	119	141	119	114	123	136	105	125	99
107	46		120	141	113	118	112	109	141	121	111	123	134	106	126	100
108	1		120	142	116	116	111	112	141	117	115	123	137	107	126	100
108	16		121	142	111	124	117	123	144	119	120	124	139	105	127	101
108	31		121	141	112	122	117	130	144	122	116	125	136	107	126	101

TIME		HRS	CH 1	CH 2	CH 3	CH 4	CH 5	CH 6	CH 7	CH 8	CH 9	CH10	CH11	CH12	CH13	CH14
M	S															
108	46		121	139	114	124	113	117	143	119	123	123	140	106	124	102
109	1		120	139	110	122	122	129	144	123	120	124	140	106	125	101
109	16		121	140	113	120	113	112	142	122	118	123	134	106	127	102
109	31		121	141	114	115	112	112	139	122	116	124	139	106	126	101
109	46		121	141	115	117	113	114	142	124	116	124	139	106	127	101
110	1		121	142	114	122	115	119	144	124	120	124	142	106	129	102
110	16		122	142	112	123	115	124	145	123	123	124	141	106	130	102
110	31		122	141	111	127	115	121	143	127	119	124	138	107	130	102
110	46		121	142	113	122	115	120	144	123	122	124	141	105	128	101
111	1		122	142	112	122	115	121	143	123	122	124	141	106	128	101
111	16		121	141	112	120	117	122	146	124	123	124	142	108	129	103
111	31		122	142	114	120	114	113	143	124	121	124	142	106	130	102
111	46		123	142	112	125	118	126	144	123	120	124	140	106	130	102
112	1		123	142	111	119	116	118	143	127	121	124	142	106	130	103
112	16		123	141	113	119	114	110	144	124	118	125	139	107	131	102
112	31		123	143	114	113	112	110	140	121	117	124	137	106	130	101
112	46		122	143	112	119	114	117	143	121	123	124	140	105	128	101
113	1		122	143	112	116	115	116	145	123	119	125	137	108	129	102
113	16		123	144	116	116	113	114	143	123	116	125	137	108	131	103
113	31		124	145	115	118	118	121	145	125	121	125	139	108	132	103
113	46		123	145	117	116	115	114	144	125	115	126	136	109	132	103
114	1		124	146	116	115	116	116	143	123	119	126	139	108	131	102
114	16		123	147	115	120	116	119	144	123	121	125	137	108	133	103
114	31		124	147	117	116	112	111	140	121	117	126	136	109	133	103
114	46		124	147	120	109	108	109	137	121	115	127	133	109	133	102
115	1		123	148	118	113	114	116	141	123	121	127	138	108	130	102
115	16		123	145	115	119	118	121	143	123	120	126	142	108	129	103
115	31		123	144	112	121	120	120	145	124	121	127	146	109	132	104
115	46		123	145	113	122	121	131	147	125	122	127	146	110	131	104
116	1		124	144	115	123	116	113	148	126	124	126	145	108	130	104
116	16		124	145	114	123	115	126	148	124	125	126	146	108	131	104
116	31		124	146	112	129	123	131	147	123	126	126	147	110	132	104
116	46		125	147	115	129	120	126	148	125	123	128	146	110	134	105
117	1		125	149	115	130	119	129	149	125	124	128	147	110	133	105
117	16		125	150	115	132	120	119	149	122	123	129	145	110	134	104
117	31		125	150	116	133	118	121	150	123	125	128	145	110	133	106
117	46		125	150	115	134	122	128	151	122	128	129	148	110	135	106
118	1		125	143	115	133	123	116	148	125	126	129	148	110	134	106
118	16		125	142	113	134	121	125	148	124	130	129	149	110	136	108
118	31		125	139	114	134	121	129	150	125	127	129	149	111	135	107
118	46		125	137	117	134	121	118	149	125	125	129	150	110	134	107
119	1		126	140	117	132	118	114	147	123	123	130	148	112	136	107
119	16		126	140	119	132	123	119	150	124	122	132	149	111	135	107
119	31		126	144	118	134	121	123	151	126	121	130	150	113	137	107
119	46		127	142	120	133	119	114	145	124	122	131	142	111	138	107
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120	16		127	140	118	133	119	124	149	125	120	131	150	111	138	106
120	31		127	137	120	131	119	113	149	124	124	131	147	111	136	106
120	46		128	140	119	133	118	130	150	123	121	130	149	112	135	106
121	1		127	144	118	136	122	131	150	125	123	131	148	112	134	106
121	16		127	139	118	139	119	131	152	124	123	131	150	112	136	108
121	31		128	135	118	136	119	126	154	125	122	131	151	114	138	108
121	46		128	137	119	137	120	129	153	124	124	131	152	114	139	109
122	1		128	135	117	138	123	132	152	126	126	132	153	112	138	108
122	16		127	132	117	138	123	127	152	126	125	133	147	114	137	107

TIME		HRS	CH 1	CH 2	CH 3	CH 4	CH 5	CH 6	CH 7	CH 8	CH 9	CH10	CH11	CH12	CH13	CH14
M	S															
122	31		127	134	122	133	121	119	148	126	124	132	147	113	137	107
122	46		127	138	120	135	125	128	150	126	124	132	152	112	137	106
123	1		127	134	115	139	126	123	150	127	127	131	152	111	137	106
123	16		126	135	118	137	121	124	152	125	129	131	152	111	134	107
123	31		127	131	115	139	126	137	152	128	129	131	154	113	134	108
123	46		127	131	115	140	128	130	152	128	129	133	153	112	135	108
124	1		127	129	117	138	120	115	144	127	124	133	147	114	139	109
124	16		128	136	120	134	121	117	145	126	124	133	149	114	139	108
124	31		128	139	120	137	121	121	150	124	128	133	156	113	137	107
124	46		123	123	117	139	121	113	151	126	127	133	159	113	137	109
125	1		123	130	118	142	124	130	150	127	134	133	160	115	140	111
125	16		126	134	117	143	132	135	151	129	134	134	155	116	142	112
125	31		128	135	120	137	121	117	145	127	126	134	153	117	142	112
125	46		128	139	122	135	122	113	144	126	123	135	155	115	141	109
126	1		128	141	118	139	131	135	147	126	128	134	151	113	138	109
126	16		128	140	118	140	124	117	148	128	125	134	150	115	139	110
126	31		128	138	117	138	127	124	150	126	123	134	152	115	140	109
126	46		128	138	116	139	126	130	151	127	125	134	152	114	140	109
127	1		128	134	115	141	125	137	153	129	131	135	151	115	139	110
127	16		126	133	119	143	127	127	155	130	128	136	152	115	137	109
127	31		128	139	118	144	125	132	154	129	131	136	155	116	137	109
127	46		128	134	120	141	123	122	151	130	130	135	153	114	137	111
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128	31		129	141	120	137	122	125	150	128	125	136	153	116	141	110
128	46		129	136	119	140	121	132	153	128	126	137	151	116	142	109
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129	16		130	136	122	141	124	123	152	129	125	136	153	119	144	109
129	31		130	134	125	138	124	116	149	130	122	138	151	117	144	110
129	46		130	140	120	142	131	133	150	134	132	136	154	115	143	109
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130	46		128	139	119	140	129	123	150	132	126	136	155	116	145	110
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131	46		130	138	120	147	128	131	153	133	130	137	157	116	146	110
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133	1		131	142	121	148	128	134	153	136	130	138	159	119	142	111
133	16		131	138	122	148	132	132	153	137	132	138	159	118	146	111
133	31		132	141	124	143	123	116	139	138	128	137	149	118	148	112
133	46		132	144	122	143	124	127	148	136	129	138	153	117	145	110
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134	16		131	139	122	147	128	129	151	138	131	138	158	118	141	111
134	31		131	141	120	148	128	138	155	138	131	139	159	119	145	112
134	46		131	139	125	150	128	135	153	138	130	139	159	118	141	111
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135	16		130	138	123	150	130	134	154	142	134	138	158	118	139	112
135	31		131	139	124	151	129	138	154	141	134	139	161	118	143	113
135	46		132	138	123	151	132	130	152	139	134	138	160	118	144	114
136	1		132	138	123	152	131	130	155	141	134	138	163	120	147	114

TIME		HRS	CH 1	CH 2	CH 3	CH 4	CH 5	CH 6	CH 7	CH 8	CH 9	CH 10	CH 11	CH 12	CH 13	CH 14
M	S															
136	16		132	138	123	150	131	135	152	140	134	140	162	118	143	113
136	31		132	137	120	152	136	134	151	140	138	139	162	117	144	112
136	46		132	137	121	152	133	124	151	139	136	138	160	118	145	112
137	1		133	140	123	147	128	125	149	139	132	138	157	117	145	112
137	16		131	139	122	147	120	136	149	139	132	139	158	117	144	111
137	31		131	138	122	149	128	124	142	139	132	130	153	120	146	112
137	46		132	141	123	146	125	133	147	140	130	139	158	119	146	112
138	1		132	141	121	149	132	133	147	142	133	139	160	119	147	112
138	16		132	139	123	151	134	135	149	142	133	140	161	122	146	113
138	31		132	139	124	150	131	132	148	142	135	142	160	121	146	113
138	46		132	139	122	151	130	131	147	141	134	142	160	121	146	115
139	1		132	147	122	152	129	137	148	141	135	142	161	120	147	113
139	16		132	139	119	153	130	128	150	141	134	141	160	120	146	113
139	31		132	140	122	154	130	130	148	144	138	141	164	119	146	113
139	46		132	137	117	153	132	132	148	144	134	139	164	117	143	112
140	1		129	129	119	152	129	127	150	143	133	140	162	118	146	113
140	16		130	135	121	152	129	124	144	143	130	140	158	120	147	113
140	31		132	140	119	150	129	128	148	143	132	141	164	120	148	113
140	46		132	136	123	148	129	123	147	142	132	141	162	118	147	113
141	1		131	141	120	152	133	131	145	142	135	139	166	117	147	113
141	16		131	140	121	154	134	134	147	142	136	139	164	119	150	115
141	31		131	139	119	156	132	136	150	145	136	141	164	120	150	114
141	46		131	132	117	157	139	137	148	145	139	142	166	121	150	116
142	1		132	139	121	158	138	134	150	146	139	142	166	122	147	116
142	16		133	141	123	158	134	134	149	146	138	142	164	122	147	115
142	31		133	140	120	159	137	134	148	146	140	143	169	121	148	115
142	46		133	139	122	158	134	136	150	147	138	144	165	122	150	115
143	1		134	138	122	158	135	129	145	146	138	142	160	124	151	117
143	16		135	146	126	150	129	122	138	144	135	142	151	124	154	117
143	31		136	152	126	146	126	126	139	143	133	142	158	124	154	116
143	46		135	147	125	152	129	140	146	143	134	145	162	124	153	114
144	1		134	144	124	152	130	133	146	143	134	144	162	122	150	114
144	16		134	145	126	155	131	125	145	143	135	144	157	123	153	115
144	31		135	144	130	148	128	123	143	141	130	144	158	121	152	114
144	46		134	145	127	150	130	131	147	143	134	143	163	122	151	115
145	1		134	145	126	155	134	137	147	145	139	144	164	121	150	116
145	16		134	142	124	157	134	132	145	145	139	143	161	124	151	115
145	31		135	143	126	147	127	126	143	142	133	143	157	124	153	116
145	46		134	143	130	146	128	123	142	143	131	143	154	122	154	115
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146	16		135	146	128	145	127	124	143	141	135	142	162	119	148	114
146	31		130	139	124	151	128	127	148	141	134	141	162	122	149	114
146	46		131	140	127	150	131	131	147	142	135	142	164	120	149	114
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147	16		132	138	122	157	133	133	151	144	139	144	166	122	148	113
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147	46		130	136	124	158	131	132	153	144	137	145	166	122	147	114
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148	16		131	136	124	154	129	125	149	144	139	141	159	122	149	115
148	31		134	141	125	152	130	134	151	144	137	144	165	122	150	115
148	46		133	141	121	155	132	128	151	143	139	143	167	124	152	116
149	1		134	142	124	158	135	133	153	145	138	145	166	123	154	115
149	16		134	142	125	154	131	126	150	145	134	142	162	124	155	115
149	31		134	144	125	153	131	128	151	145	137	143	165	122	154	115
149	46		134	144	122	157	135	137	152	146	139	143	166	123	152	115

TIME		HRS	CH 1	CH 2	CH 3	CH 4	CH 5	CH 6	CH 7	CH 8	CH 9	CH10	CH11	CH12	CH13	CH14
M	S															
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150	16		134	144	121	160	133	120	155	146	138	144	168	122	153	115
150	31		134	142	123	158	134	135	155	145	139	143	169	122	151	115
150	46		134	141	123	159	134	133	157	144	139	144	167	123	153	116
151	1		134	142	122	159	135	130	157	143	139	146	165	125	154	118
151	16		136	146	127	151	131	125	151	143	136	143	159	126	155	118
151	31		136	148	126	154	135	131	154	144	135	143	166	126	156	117
151	46		135	145	123	158	136	133	156	146	135	146	165	124	156	117
152	1		134	140	125	158	139	132	157	147	136	146	169	124	154	117
152	16		134	144	125	161	137	144	159	148	138	148	166	127	151	119
152	31		134	141	121	162	138	136	161	149	137	149	168	126	151	118
152	46		135	140	122	161	139	140	161	147	140	149	169	127	154	118
153	1		135	141	123	162	138	134	159	148	141	147	168	124	154	116
153	16		135	143	122	163	137	135	160	148	140	146	170	123	151	116
153	31		136	142	124	162	137	134	160	147	141	145	167	124	150	118
153	46		134	140	126	156	134	130	159	148	138	146	164	125	151	119
154	1		135	145	126	159	138	132	161	148	140	146	164	126	153	119
154	16		136	145	127	157	136	129	158	147	138	145	164	126	154	119
154	31		137	146	128	157	134	127	160	144	135	146	164	125	154	118
154	46		135	146	128	158	134	133	162	147	138	145	167	126	156	117
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155	16		134	141	123	163	136	138	163	148	144	145	170	123	153	117
155	31		134	139	121	163	138	135	163	149	139	146	168	124	153	117
155	46		136	137	127	158	134	127	159	147	138	144	167	126	154	118
156	1		137	143	125	157	137	132	161	148	139	146	168	125	156	117
156	16		136	142	125	158	138	129	161	147	138	146	166	125	157	117
156	31		135	141	132	153	133	126	160	145	134	144	157	128	159	119
156	46		135	142	134	149	130	123	158	145	132	145	160	125	159	117
157	1		135	146	131	149	131	128	159	144	134	145	162	123	157	116
157	16		135	140	129	155	134	133	162	146	140	145	164	124	158	117
157	31		136	139	126	160	136	136	165	151	140	146	169	125	155	119
157	46		136	136	127	160	137	128	164	150	138	147	166	127	157	118
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158	16		137	143	131	153	134	126	162	146	135	148	168	128	159	118
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158	46		139	142	133	152	134	127	162	146	137	145	165	126	157	119
159	1		137	143	128	156	135	130	164	147	136	146	163	128	157	118
159	16		138	140	128	157	135	135	164	148	138	148	166	127	158	117
159	31		137	139	127	159	137	135	166	149	139	148	168	126	158	117
159	46		137	137	128	161	137	141	167	151	140	146	167	126	159	118
160	1		138	140	128	161	136	131	167	150	140	147	168	128	159	118
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160	31		140	143	133	158	137	130	166	148	140	146	167	125	160	117
160	46		138	142	128	159	135	128	164	147	141	147	164	127	159	118
161	1		138	138	131	153	136	130	165	147	141	147	166	124	158	116
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161	31		137	141	126	162	139	137	169	153	143	148	170	124	156	117
161	46		136	142	123	165	140	147	172	156	144	148	173	126	159	117
162	1		138	140	127	164	140	138	172	156	144	147	169	126	158	117
162	16		138	141	131	159	135	127	171	155	142	146	169	128	160	117
162	31		138	146	130	160	137	138	173	155	143	146	170	125	161	119
162	46		138	144	128	163	138	136	174	153	144	146	170	127	163	119
163	1		138	138	130	160	137	128	173	151	140	148	173	127	162	119
163	16		140	136	133	159	139	138	174	149	140	146	171	127	161	118
163	31		139	137	128	158	135	142	174	151	142	146	172	127	162	118

TIME		HRS	CH 1	CH 2	CH 3	CH 4	CH 5	CH 6	CH 7	CH 8	CH 9	CH10	CH11	CH12	CH13	CH14
M	S															
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164	1		140	136	132	161	136	131	173	154	142	147	171	120	159	120
164	16		138	133	132	162	139	144	175	156	145	147	170	127	160	118
164	31		139	136	131	161	138	130	177	155	141	147	169	125	160	117
164	46		140	136	133	153	132	125	171	153	136	148	167	128	160	117
165	1		140	135	135	152	134	135	174	153	137	147	170	130	160	118
165	16		140	134	131	159	136	140	176	154	137	149	169	129	156	117
165	31		140	133	130	162	137	145	178	155	139	148	172	128	155	117
165	46		139	132	132	164	142	139	179	156	140	149	174	127	158	116
166	1		140	135	132	162	139	140	179	156	138	146	173	130	156	117
166	16		140	136	131	162	130	134	179	155	137	147	171	128	158	118
166	31		140	136	130	163	142	143	179	156	143	147	174	127	160	119
166	46		141	136	131	166	140	143	180	156	140	147	175	129	160	119
167	1		142	135	132	165	140	141	182	156	140	148	176	128	159	119
167	16		141	134	133	168	139	143	183	157	140	147	175	129	159	119
167	31		141	134	133	168	140	144	183	158	139	148	174	128	161	117
167	46		141	135	131	169	140	135	182	158	139	148	175	129	163	117
168	1		141	135	130	167	141	140	181	158	142	148	174	128	162	118
168	16		142	135	136	163	139	135	179	156	142	148	175	129	160	119
168	31		142	135	135	162	139	140	181	156	139	147	174	129	162	119
168	46		141	135	132	164	142	142	180	156	139	147	176	130	161	120
169	1		142	133	131	165	142	144	180	157	142	148	177	130	162	120
169	16		140	133	133	163	143	139	179	157	145	148	176	128	162	120
169	31		140	135	132	164	141	132	178	154	142	148	175	128	162	118
169	46		141	135	133	164	140	142	180	155	144	147	176	126	160	119
170	1		141	136	132	165	140	137	180	155	143	147	175	127	160	120
170	16		142	135	133	166	142	143	181	155	144	147	175	130	160	121
170	31		142	134	132	166	142	147	182	156	139	147	176	129	161	119
170	46		142	135	132	168	144	146	182	157	140	147	178	133	165	119
171	1		143	135	138	165	142	137	182	155	139	148	176	132	162	120
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171	31		143	138	132	166	142	141	183	157	138	149	177	131	165	119
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172	1		139	133	129	168	142	140	184	157	146	149	176	131	162	120
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172	31		141	136	134	162	141	138	180	156	145	148	175	127	156	119
172	46		141	138	131	164	140	144	183	156	147	148	174	128	158	120
173	1		141	139	133	163	141	135	181	156	144	148	174	130	160	119
173	16		142	143	133	168	145	141	184	154	143	148	175	129	162	119
173	31		142	140	130	170	145	142	183	157	147	149	176	130	162	121
173	46		142	140	131	168	142	136	183	158	146	148	173	131	162	120
174	1		143	141	133	163	139	134	180	155	144	150	175	129	162	120
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174	46		143	146	135	158	138	139	178	156	144	149	173	130	163	119
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175	31		141	140	134	171	142	140	184	159	145	149	173	133	163	122
175	46		142	144	139	163	140	134	179	157	141	150	173	133	165	120
176	1		143	145	138	163	141	143	183	157	140	151	174	134	166	119
176	16		143	143	131	167	143	139	182	159	145	150	176	132	166	118
176	31		144	139	136	161	141	134	179	157	142	151	176	134	166	118
176	46		144	139	136	161	140	134	179	156	139	151	173	135	166	119
177	1		143	149	134	163	141	141	181	158	144	151	177	134	166	119
177	16		145	150	139	161	141	139	179	157	142	151	175	133	166	119

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TIME		HRS	CH 1	CH 2	CH 3	CH 4	CH 5	CH 6	CH 7	CH 8	CH 9	CH10	CH11	CH12	CH13	CH14
M	S															
177	31		143	152	133	165	142	151	182	159	145	152	177	135	164	121
177	46		144	158	133	168	141	147	186	160	145	152	178	137	164	123
178	1		143	150	133	168	144	142	185	160	146	153	177	136	162	121
178	16		144	147	137	167	146	141	184	158	144	153	180	137	160	122
178	31		144	146	139	165	144	141	185	157	146	152	179	133	160	121
178	46		144	145	136	169	147	147	185	159	146	150	177	132	163	122
179	1		143	142	134	166	142	137	181	158	147	150	178	131	162	120
179	16		144	146	132	166	147	139	179	158	147	149	177	130	161	119
179	31		143	149	133	169	145	139	181	158	142	147	175	136	164	121
179	46		144	150	134	167	146	137	182	157	145	149	176	131	160	121
180	1		143	153	132	169	146	144	184	160	145	149	179	133	160	121
180	16		145	150	138	164	141	135	395	644	976	1237	1452	132	163	121
180	31		543	766	947	1162	1457	1729	1896	2228	2648	2936	3093	3320	3398	3415
180	46		3433	3438	3440	3444	3448	3448	3449	3450	3452	3454	3455	3457	3458	3459
181	1		3462	3463	3463	3464	3465	3466	3467	3468	3470	3470	3471	3472	3472	3473

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LENGTH - 180 MINUTES

DATE RUN 10 MAY 78

PAGE 1

TIME M S	HRS	CH15	CH16	CH17	CH18	CH19	CH20	CH21	CH22	CH23	CH24	CH25	CH26	CH27	CH28
0 1		79	79	80	77	77	78	76	79	80	80	132	274	369	530
0 16		79	79	80	78	78	79	77	80	80	80	170	318	418	580
0 31		80	79	80	78	79	79	78	81	81	80	224	376	477	638
0 46		80	80	81	79	80	80	79	82	81	81	296	456	560	736
1 1		80	80	81	80	80	80	80	82	81	81	387	570	703	904
1 16		81	80	81	81	81	80	80	82	82	81	503	696	835	1039
1 31		81	80	82	81	81	81	81	84	82	82	642	800	900	1065
1 46		81	81	82	82	81	81	81	84	82	82	795	945	1035	1188
2 1		82	81	82	82	82	81	81	84	82	83	958	1114	1216	1383
2 16		82	81	82	82	82	81	81	84	82	83	1110	1258	1346	1499
2 31		82	81	82	82	82	81	81	84	82	83	1239	1384	1470	1624
2 46		82	81	83	84	82	81	82	84	83	84	1345	1487	1571	1724
3 1		82	81	83	84	82	82	82	84	82	83	1414	1560	1654	1823
3 16		82	81	83	83	82	81	82	84	82	83	1457	1607	1707	1879
3 31		82	81	83	83	82	81	81	84	82	83	1478	1626	1726	1896
3 46		82	81	83	82	82	81	82	84	83	83	1484	1629	1724	1892
4 1		82	81	83	83	82	82	82	84	83	83	1483	1621	1708	1866
4 16		82	82	83	83	82	82	82	84	83	84	1478	1618	1717	1891
4 31		82	81	83	84	82	82	82	84	83	84	1474	1628	1740	1928
4 46		82	82	83	84	82	82	82	85	83	85	1464	1638	1772	1989
5 1		83	82	83	84	82	82	82	85	83	85	1454	1653	1820	2078
5 16		82	82	83	83	82	82	82	84	83	85	1442	1688	1920	2259
5 31		82	82	83	83	82	82	82	84	83	86	1427	1694	1955	2327
5 46		82	82	83	83	82	82	82	84	83	86	1415	1699	1981	2380
6 1		82	82	83	82	82	82	82	84	83	86	1404	1693	1979	2381
6 16		82	82	83	82	82	82	82	85	83	86	1391	1680	1964	2362
6 31		83	82	83	83	82	82	82	85	83	87	1379	1663	1940	2328
6 46		83	82	83	82	82	82	82	85	83	87	1369	1658	1942	2339
7 1		83	82	83	82	82	82	82	85	83	87	1359	1659	1964	2389
7 16		83	82	83	82	82	82	82	85	83	87	1346	1650	1960	2391
7 31		83	82	83	83	82	82	82	85	83	88	1335	1644	1959	2398
7 46		83	82	83	83	82	82	82	85	83	88	1324	1639	1961	2407
8 1		83	82	83	82	82	82	82	85	83	89	1315	1630	1952	2396
8 16		83	82	83	82	82	82	82	84	83	89	1306	1623	1947	2394
8 31		83	82	83	82	82	82	82	86	83	90	1298	1531	1751	2076
8 46		83	82	83	83	82	82	82	86	83	90	1289	1522	1748	2076
9 1		83	82	83	82	81	82	81	85	83	91	1279	1515	1742	2068
9 16		83	82	83	83	82	82	82	86	83	92	1270	1502	1724	2038
9 31		83	82	83	83	82	82	82	86	83	92	1261	1497	1724	2048
9 46		83	82	84	83	82	82	81	86	83	93	1252	1531	1813	2204
10 1		83	82	83	83	81	82	81	86	83	93	1248	1533	1827	2234
10 16		83	82	83	83	81	82	81	87	83	94	1254	1552	1861	2284
10 31		83	82	84	83	81	82	81	86	83	94	1270	1578	1894	2327
10 46		83	82	83	83	81	82	81	87	83	95	1289	1596	1912	2350
11 1		83	82	83	82	82	82	82	87	83	96	1308	1619	1940	2385
11 16		83	82	84	83	82	82	82	86	83	97	1320	1632	1951	2392
11 31		83	83	84	84	82	82	82	86	83	97	1322	1604	1865	2240
11 46		83	83	84	84	82	82	82	87	83	98	1316	1581	1842	2204
12 1		83	82	84	84	82	82	82	87	83	99	1308	1595	1872	2251
12 16		83	83	84	83	82	82	81	87	83	100	1300	1559	1801	2143

TIME		HRS	CH15	CH16	CH17	CH18	CH19	CH20	CH21	CH22	CH23	CH24	CH25	CH26	CH27	CH28
M	S															
12	31		03	03	04	04	02	02	01	07	03	100	1297	1580	1849	2221
12	46		03	03	04	04	02	02	01	07	03	101	1300	1596	1889	2291
13	1		03	03	04	03	02	02	02	07	03	102	1311	1567	1808	2146
13	16		03	03	04	04	02	02	02	07	03	102	1321	1607	1888	2277
13	31		03	03	05	04	02	02	02	07	03	103	1332	1592	1821	2151
13	46		03	03	04	03	02	02	02	07	03	104	1344	1621	1882	2239
14	1		03	03	05	04	02	02	02	07	03	105	1353	1623	1884	2254
14	16		03	03	05	03	02	02	02	07	03	106	1361	1644	1917	2291
14	31		03	03	05	03	02	02	02	07	03	107	1367	1646	1917	2295
14	46		03	03	05	04	02	02	02	07	03	108	1371	1657	1937	2327
15	1		03	03	05	03	02	02	02	07	03	109	1373	1657	1938	2331
15	16		03	03	05	04	02	02	02	07	03	110	1375	1669	1959	2363
15	31		03	03	05	03	02	02	02	07	03	111	1379	1673	1964	2374
15	46		03	03	05	03	02	02	02	07	03	112	1382	1688	1991	2412
16	1		03	03	05	03	02	02	02	07	03	114	1384	1693	1998	2421
16	16		03	03	05	03	02	02	02	08	03	115	1385	1696	2000	2422
16	31		04	03	05	03	02	02	02	08	03	116	1387	1697	1998	2417
16	46		04	03	05	03	02	02	02	08	03	117	1388	1700	2001	2420
17	1		04	04	06	03	02	03	02	08	03	118	1390	1699	2002	2424
17	16		04	04	06	04	02	03	02	08	03	119	1391	1699	2000	2416
17	31		04	04	06	05	02	03	02	08	03	120	1394	1698	1995	2406
17	46		04	04	06	04	02	02	02	08	03	121	1396	1702	2003	2418
18	1		04	04	06	05	02	02	02	08	03	123	1399	1700	1991	2396
18	16		04	04	06	05	02	03	02	08	03	124	1404	1667	1913	2251
18	31		04	04	07	05	02	03	02	09	03	125	1408	1670	1915	2259
18	46		04	04	07	06	02	03	02	09	03	126	1412	1702	1981	2366
19	1		04	04	07	05	02	03	02	09	03	127	1416	1713	2003	2406
19	16		04	04	07	04	02	03	02	09	03	129	1421	1727	2029	2450
19	31		04	04	07	05	02	03	02	09	03	130	1427	1739	2049	2476
19	46		04	04	07	04	02	03	02	09	03	131	1436	1745	2050	2472
20	1		04	05	07	05	02	03	03	09	03	133	1445	1725	1992	2359
20	16		04	05	07	05	02	03	03	09	03	134	1452	1747	2038	2445
20	31		04	05	08	04	02	03	02	09	03	135	1460	1766	2066	2483
20	46		04	05	07	04	02	03	03	09	03	137	1466	1775	2078	2499
21	1		04	05	07	04	02	03	03	09	03	139	1472	1755	2019	2388
21	16		04	05	08	05	03	03	03	09	03	140	1478	1748	1994	2340
21	31		04	05	08	05	03	03	03	09	03	141	1485	1792	2087	2501
21	46		04	05	08	05	02	03	03	09	03	142	1490	1807	2114	2544
22	1		04	05	08	06	03	03	03	09	03	143	1494	1816	2124	2553
22	16		04	05	08	06	03	03	03	09	03	145	1499	1823	2132	2564
22	31		04	05	08	05	02	03	03	09	03	146	1503	1820	2120	2539
22	46		04	05	08	05	02	03	03	09	03	147	1502	1823	2125	2547
23	1		04	05	09	06	03	03	03	09	03	148	1498	1823	2130	2559
23	16		04	06	09	05	03	03	04	09	03	149	1495	1810	2105	2521
23	31		04	06	09	05	03	03	03	09	03	152	1493	1814	2118	2542
23	46		04	06	09	05	02	03	04	09	03	153	1492	1813	2119	2544
24	1		04	06	09	06	02	03	04	09	03	155	1495	1819	2127	2556
24	16		04	06	09	06	03	03	04	09	03	156	1502	1826	2135	2567
24	31		04	06	09	06	03	04	04	09	03	158	1508	1830	2138	2569
24	46		05	06	09	06	03	04	04	09	03	159	1517	1840	2150	2583
25	1		04	06	09	05	03	03	04	09	03	161	1525	1853	2166	2603
25	16		04	06	09	05	03	03	04	09	03	162	1526	1844	2143	2561
25	31		04	06	09	06	03	04	04	09	03	164	1522	1841	2137	2549
25	46		04	07	09	06	03	03	04	09	03	166	1516	1835	2131	2541
26	1		04	07	09	05	02	04	04	09	03	167	1514	1831	2121	2527

TIME M S	HRS	CH15	CH16	CH17	CH18	CH19	CH20	CH21	CH22	CH23	CH24	CH25	CH26	CH27	CH28
26 16		84	86	90	85	82	83	84	95	84	169	1515	1841	2143	2562
26 31		84	86	91	86	82	83	84	96	84	170	1517	1842	2138	2549
26 46		84	87	90	85	82	84	84	96	84	171	1520	1843	2139	2550
27 1		84	87	91	87	83	84	85	98	84	173	1522	1844	2136	2543
27 16		85	87	91	86	83	84	85	97	84	173	1525	1843	2131	2529
27 31		84	87	92	86	83	84	85	97	84	174	1528	1846	2134	2538
27 46		85	87	91	86	83	84	84	97	84	175	1531	1857	2159	2579
28 1		85	87	91	85	83	84	84	97	84	175	1532	1865	2174	2606
28 16		85	88	92	87	83	84	85	98	84	177	1535	1858	2159	2579
28 31		85	88	92	87	83	84	85	98	84	178	1536	1856	2150	2561
28 46		85	88	92	86	83	84	85	97	84	178	1540	1863	2160	2575
29 1		85	88	93	87	83	84	85	98	84	179	1544	1869	2167	2583
29 16		85	88	93	87	83	84	85	97	84	179	1547	1875	2176	2593
29 31		85	88	93	87	83	84	85	99	84	180	1549	1887	2202	2642
29 46		85	89	93	87	84	85	86	99	86	182	1551	1779	1922	2131
30 1		86	89	94	87	84	85	86	99	85	183	1552	1731	1842	2021
30 16		86	89	94	88	85	86	86	99	85	185	1555	1724	1826	1995
30 31		86	90	95	83	84	86	87	99	85	187	1557	1724	1825	1993
30 46		86	90	95	89	84	86	87	99	85	188	1559	1730	1834	2005
31 1		86	90	95	89	85	86	87	99	85	190	1560	1727	1827	1994
31 16		86	90	95	88	85	86	87	98	85	191	1558	1725	1823	1989
31 31		86	91	96	90	86	87	88	99	85	193	1558	1724	1822	1987
31 46		87	91	96	91	86	87	88	98	85	194	1558	1723	1820	1984
32 1		87	91	96	90	86	87	89	99	85	196	1558	1724	1821	1985
32 16		87	92	97	91	86	87	89	99	85	197	1560	1725	1822	1985
32 31		87	92	97	92	87	88	89	100	85	198	1563	1728	1824	1986
32 46		87	93	98	91	86	87	87	101	85	200	1566	1730	1824	1987
33 1		87	92	96	90	86	87	87	101	85	201	1571	1734	1834	2003
33 16		87	93	97	90	86	87	88	101	85	202	1574	1734	1830	1994
33 31		87	93	97	89	86	87	88	100	85	204	1577	1756	1877	2077
33 46		87	92	97	89	86	87	88	102	86	205	1581	1779	1921	2143
34 1		87	93	98	91	87	88	89	101	85	206	1581	1764	1880	2061
34 16		87	93	98	90	87	88	88	102	85	207	1583	1753	1852	2018
34 31		87	92	98	91	86	88	88	101	85	209	1586	1750	1844	2001
34 46		87	92	97	89	86	87	87	101	85	210	1588	1755	1850	2011
35 1		87	93	97	90	86	88	88	103	85	211	1590	1760	1856	2020
35 16		87	94	98	90	87	88	88	102	85	212	1590	1763	1861	2025
35 31		88	95	99	91	87	88	88	102	85	213	1590	1764	1862	2027
35 46		88	95	98	91	86	88	88	102	85	214	1591	1766	1865	2030
36 1		88	96	99	92	87	88	88	104	85	216	1590	1764	1863	2027
36 16		88	96	100	91	87	89	89	103	85	217	1591	1767	1866	2030
36 31		88	96	100	92	87	89	90	104	86	218	1593	1769	1871	2045
36 46		88	96	101	93	87	89	90	103	86	219	1597	1791	1925	2113
37 1		88	96	101	92	88	89	90	103	86	221	1601	1798	1922	2128
37 16		89	96	100	90	88	89	89	102	86	222	1604	1815	1953	2170
37 31		88	96	100	90	87	89	89	100	86	223	1607	1820	1961	2178
37 46		88	96	101	91	87	89	89	102	86	224	1606	1829	1980	2212
38 1		88	96	101	91	87	89	89	101	86	226	1603	1836	2002	2248
38 16		88	96	101	91	87	89	90	101	86	227	1599	1840	2015	2272
38 31		88	96	102	92	88	90	91	103	86	228	1599	1844	2023	2283
38 46		89	97	102	92	88	90	91	103	86	229	1602	1849	2029	2290
39 1		89	98	102	91	88	90	90	104	86	230	1604	1855	2039	2305
39 16		89	97	102	91	88	90	90	103	86	231	1608	1857	2050	2339
39 31		89	96	101	91	87	89	89	103	86	232	1614	1904	2153	2491
39 46		89	97	102	90	87	89	89	103	86	233	1616	1879	2091	2394

TIME		HRS	CH15	CH16	CH17	CH18	CH19	CH20	CH21	CH22	CH23	CH24	CH25	CH26	CH27	CH28
M	S															
40	1		89	97	103	92	88	90	90	105	87	235	1617	1879	2083	2391
40	16		89	99	102	90	88	89	89	104	86	236	1621	1942	2227	2633
40	31		89	98	102	90	87	90	89	103	86	237	1626	1963	2269	2706
40	46		89	98	103	91	88	90	90	103	86	238	1629	1977	2295	2753
41	1		89	99	103	90	88	90	90	103	86	239	1624	1974	2295	2752
41	16		89	99	103	91	88	90	90	103	86	240	1616	1966	2286	2740
41	31		89	100	104	93	88	91	90	102	86	241	1610	1963	2288	2749
41	46		89	100	104	92	88	90	90	103	86	242	1609	1966	2293	2756
42	1		90	100	106	93	88	90	90	102	87	244	1611	1965	2287	2745
42	16		90	100	107	95	89	92	92	104	87	244	1614	1974	2306	2779
42	31		90	101	107	94	89	91	92	103	87	246	1619	1970	2289	2744
42	46		90	100	107	95	89	92	92	103	86	246	1622	1972	2290	2744
43	1		90	101	105	92	89	92	91	104	86	247	1627	1984	2312	2781
43	16		90	102	105	92	89	92	91	103	86	248	1630	1987	2316	2786
43	31		90	101	106	92	89	92	92	104	87	249	1635	1998	2335	2813
43	46		90	102	107	95	90	92	93	105	87	250	1636	1999	2338	2824
44	1		91	102	109	96	91	93	93	104	87	251	1637	1998	2335	2817
44	16		91	103	109	96	90	92	92	106	87	252	1641	2000	2335	2814
44	31		91	103	109	95	90	93	93	106	87	253	1643	1996	2327	2801
44	46		91	104	111	99	91	94	94	106	87	254	1641	1993	2326	2804
45	1		92	105	112	99	91	94	94	106	88	254	1641	1992	2080	2341
45	16		91	105	112	98	91	94	94	106	87	255	1639	1902	2143	2512
45	31		91	105	112	97	90	94	94	105	88	256	1637	1976	2300	2773
45	46		92	105	113	99	91	94	95	107	88	256	1638	1993	2333	2822
46	1		92	105	112	97	91	94	94	108	88	257	1643	1958	2233	2607
46	16		92	106	112	99	91	94	95	108	88	258	1646	2007	2354	2844
46	31		92	108	110	96	91	94	93	106	87	259	1647	1967	2251	2647
46	46		92	107	111	96	91	94	94	105	88	260	1647	1979	2268	2650
47	1		92	106	111	99	91	95	95	106	88	261	1646	1887	2063	2311
47	16		93	107	112	97	91	95	95	106	88	262	1646	1844	1975	2181
47	31		92	106	112	97	91	94	95	104	88	262	1646	1851	2000	2223
47	46		92	106	111	96	90	93	92	108	88	263	1653	1863	2008	2223
48	1		93	104	111	95	91	94	93	107	88	264	1660	1856	1980	2174
48	16		93	107	112	97	91	94	93	108	88	265	1657	1840	1951	2132
48	31		93	108	111	95	91	94	93	109	88	266	1648	1833	1944	2124
48	46		93	107	111	95	91	95	93	108	88	266	1645	1831	1944	2125
49	1		93	108	114	99	92	95	95	109	89	267	1648	1832	1941	2118
49	16		93	109	115	99	92	96	96	109	89	267	1657	1863	2008	2232
49	31		94	109	117	100	92	95	95	109	89	268	1666	1902	2072	2315
49	46		93	109	116	97	91	95	95	109	90	268	1674	1894	2055	2304
50	1		93	108	116	98	92	96	97	108	90	269	1666	1864	1993	2192
50	16		94	109	117	99	92	96	97	108	90	270	1651	1839	1961	2153
50	31		95	109	115	97	92	96	96	107	90	271	1642	1845	1989	2260
50	46		95	109	117	97	93	96	97	106	90	272	1645	1921	2157	2496
51	1		95	110	120	101	93	97	97	107	90	273	1652	1968	2255	2674
51	16		95	109	119	99	92	96	96	108	90	273	1661	2020	2355	2835
51	31		95	110	118	99	93	96	97	107	90	274	1666	2031	2379	2872
51	46		95	110	119	99	93	97	98	106	90	275	1676	2045	2393	2882
52	1		96	111	121	101	94	97	98	108	91	277	1682	2021	2315	2736
52	16		96	111	120	100	93	97	98	109	91	277	1682	2042	2379	2859
52	31		96	112	120	102	94	98	99	111	90	278	1681	2048	2396	2887
52	46		96	114	120	103	95	99	100	110	90	280	1679	1928	2110	2373
53	1		97	114	123	106	95	99	100	110	91	281	1678	1895	2043	2265
53	16		97	114	123	103	94	98	99	110	91	282	1677	1892	2038	2261
53	31		96	114	123	103	94	100	100	109	91	283	1678	1881	2015	2218

TIME		HRS	CH15	CH16	CH17	CH18	CH19	CH20	CH21	CH22	CH23	CH24	CH25	CH26	CH27	CH28
M	S															
53	46		96	113	123	100	94	99	100	109	91	284	1677	1937	2128	2416
54	1		97	114	123	102	95	100	102	109	90	285	1678	1946	2157	2456
54	16		97	116	123	105	96	101	101	111	91	285	1681	1977	2226	2571
54	31		98	116	124	106	96	101	102	111	91	287	1684	1916	2076	2307
54	46		98	116	125	106	96	101	101	110	91	287	1686	1876	1993	2179
55	1		98	116	123	104	96	99	99	112	91	288	1689	1919	2105	2395
55	16		97	114	121	103	95	99	98	113	91	289	1694	2023	2327	2776
55	31		97	116	121	107	95	100	99	113	91	290	1702	2041	2357	2820
55	46		97	116	124	106	95	100	99	112	92	291	1699	1966	2172	2454
56	1		97	117	123	106	95	100	99	109	91	292	1680	1877	2004	2200
56	16		97	116	121	104	95	100	98	112	91	293	1663	1842	1992	2285
56	31		97	117	123	104	94	100	99	112	91	293	1660	2004	2328	2797
56	46		97	117	124	102	95	100	99	111	91	295	1664	2018	2351	2831
57	1		97	117	122	100	94	100	99	110	91	296	1670	2029	2365	2844
57	16		97	117	124	100	94	100	98	110	91	296	1677	2049	2401	2894
57	31		98	118	126	105	96	101	101	112	91	297	1683	2039	2362	2821
57	46		98	119	127	106	96	102	101	112	91	298	1689	2049	2381	2857
58	1		99	120	127	109	97	103	102	112	91	299	1693	2050	2377	2844
58	16		98	119	127	107	96	102	102	110	92	300	1701	2064	2396	2862
58	31		98	119	129	107	96	103	102	111	92	300	1701	2064	2396	2868
58	46		99	120	130	107	97	103	103	109	92	301	1692	2058	2384	2819
59	1		99	121	130	107	97	102	101	113	92	302	1680	1915	2078	2313
59	31		99	119	126	106	96	102	101	114	92	303	1677	1865	1978	2158
59	46		100	120	128	107	96	103	102	112	92	304	1685	1869	1976	2150
60	1		100	118	128	103	95	102	102	110	92	305	1696	1887	2001	2183
60	16		100	119	131	105	96	102	102	111	92	305	1707	1942	2116	2378
60	31		100	118	130	103	96	102	102	110	93	306	1714	1971	2165	2449
60	46		100	120	130	107	97	103	102	112	92	306	1711	1984	2196	2502
61	1		100	121	128	106	97	103	103	114	92	307	1706	1969	2168	2449
61	16		100	122	128	107	98	104	102	114	92	308	1702	1956	2143	2404
61	31		100	121	128	104	98	103	101	113	92	309	1700	1936	2106	2357
61	46		101	119	128	106	97	103	101	117	93	310	1699	1923	2077	2304
62	1		101	120	130	107	97	104	101	114	93	309	1699	1914	2054	2270
62	16		101	121	126	105	97	103	100	117	93	310	1701	1923	2069	2287
62	31		101	116	124	103	96	102	100	112	92	311	1705	1912	2042	2245
62	46		100	119	128	103	97	103	99	115	92	312	1710	1911	2036	2231
63	1		100	120	126	102	97	103	100	113	92	313	1714	1915	2037	2232
63	16		101	121	129	106	97	103	99	115	93	313	1716	1919	2041	2232
63	31		101	120	128	105	97	103	100	115	93	314	1718	1904	2011	2185
63	46		101	121	128	107	97	103	99	115	93	314	1721	1907	2011	2182
64	1		101	121	127	105	97	103	99	113	92	314	1721	1906	2008	2178
64	16		101	121	129	103	97	103	99	113	93	316	1720	1903	2005	2174
64	31		101	122	133	104	97	105	102	113	93	316	1719	1901	2001	2169
64	46		101	123	131	104	98	105	103	111	93	318	1720	1903	2003	2171
65	1		102	124	134	106	99	107	105	113	93	319	1725	1909	2011	2179
65	16		102	124	131	109	98	105	103	113	93	319	1733	1957	2107	2339
65	31		102	123	131	106	98	105	102	113	93	319	1736	1996	2185	2462
65	46		102	123	126	102	98	104	101	113	93	320	1740	2018	2221	2513
66	1		101	121	127	103	97	104	100	115	93	320	1741	2028	2240	2540
66	16		102	120	130	104	97	104	100	115	93	319	1738	2037	2262	2579
66	31		102	122	138	104	98	105	102	114	93	320	1727	2039	2277	2607
66	46		102	122	134	107	97	104	101	116	93	322	1715	2012	2250	2580
67	1		102	124	137	104	98	106	103	112	93	323	1704	2019	2255	2580
67	16		102	125	139	104	99	107	104	112	93	324	1693	1997	2231	2554
67	31		102	122	134	103	98	105	101	118	94	324	1695	2013	2251	2579

TIME M S	HRS	CH15	CH16	CH17	CH18	CH19	CH20	CH21	CH22	CH23	CH24	CH25	CH26	CH27	CH28
67 46		102	124	140	106	99	106	102	118	94	325	1700	2018	2257	2583
68 1		103	123	136	106	98	106	102	117	94	327	1705	2027	2272	2603
68 16		103	124	138	105	99	107	104	114	94	327	1707	2031	2279	2614
68 31		103	126	142	105	100	108	106	114	94	328	1708	2029	2272	2600
68 46		103	126	143	108	100	108	106	115	94	328	1711	2026	2260	2566
69 1		104	126	140	107	100	108	106	118	94	329	1715	1975	2152	2395
69 16		104	127	136	105	101	108	106	118	94	330	1721	2012	2223	2504
69 31		104	127	133	104	100	107	104	120	94	331	1731	1985	2151	2386
69 46		104	125	140	106	99	107	104	120	95	332	1739	1990	2154	2386
70 1		104	124	141	103	99	107	104	118	94	332	1747	2005	2167	2397
70 16		104	124	135	104	99	107	102	120	94	333	1747	1972	2109	2309
70 31		104	124	139	103	100	107	103	118	95	333	1743	1961	2090	2282
70 46		104	124	139	106	100	107	104	117	94	334	1739	1955	2081	2270
71 1		104	126	143	106	101	108	106	116	95	334	1736	1950	2076	2263
71 16		105	126	141	106	101	109	105	117	95	334	1735	1949	2074	2260
71 31		105	125	137	104	100	109	106	116	95	335	1734	1948	2073	2259
71 46		105	126	139	105	101	109	105	120	95	335	1736	1950	2074	2260
72 1		105	125	130	103	100	108	103	122	95	336	1738	1952	2076	2261
72 16		105	125	136	105	101	109	103	123	95	337	1737	1951	2075	2261
72 31		105	126	135	104	101	110	105	118	94	336	1739	1954	2079	2264
72 46		105	128	137	107	101	110	105	120	95	336	1743	1956	2079	2264
73 1		105	129	143	108	100	110	106	120	95	337	1745	1959	2082	2267
73 16		106	126	134	107	100	108	103	124	96	337	1747	1961	2084	2269
73 31		106	126	139	108	100	109	104	125	95	339	1746	1959	2083	2267
73 46		106	125	135	106	100	108	102	128	96	339	1745	1958	2081	2266
74 1		106	124	140	106	100	108	102	120	95	341	1750	1965	2089	2275
74 16		106	126	143	106	101	109	105	119	95	340	1753	1968	2093	2279
74 31		106	128	146	109	100	109	106	121	95	341	1754	1969	2093	2279
74 46		106	129	143	109	101	111	107	121	96	342	1753	1969	2093	2280
75 1		107	129	145	108	101	110	107	120	96	343	1752	1968	2091	2277
75 16		107	129	149	108	101	110	107	120	97	343	1753	1969	2093	2279
75 31		107	130	142	107	103	111	106	120	96	344	1755	1972	2096	2283
75 46		107	129	143	108	101	111	107	123	96	344	1758	1975	2100	2286
76 1		108	130	150	111	101	111	108	122	97	346	1760	1975	2099	2284
76 16		108	128	152	109	101	111	108	123	97	347	1763	1978	2101	2286
76 31		108	129	145	108	101	111	108	123	97	347	1766	1981	2104	2289
76 46		108	129	149	108	101	111	108	123	97	350	1767	1981	2104	2289
77 1		108	129	151	109	102	113	109	124	97	350	1764	1979	2102	2287
77 16		108	131	146	108	103	113	109	124	96	351	1762	1977	2100	2286
77 31		108	127	141	104	102	111	105	125	96	351	1761	1979	2104	2291
77 46		108	126	140	104	102	111	105	127	96	353	1763	1982	2109	2297
78 1		108	123	137	102	102	111	105	123	96	355	1766	1984	2111	2299
78 16		108	126	143	103	102	112	107	123	96	354	1767	1987	2115	2304
78 31		109	130	146	107	103	113	108	124	96	355	1764	1988	2120	2316
78 46		109	128	140	106	103	112	105	131	96	356	1766	1984	2111	2301
79 1		109	131	141	109	103	113	107	128	96	357	1769	1985	2109	2296
79 16		109	130	141	108	103	113	106	129	96	359	1772	1988	2112	2300
79 31		109	127	140	107	102	112	106	128	96	359	1770	1987	2112	2299
79 46		108	130	139	105	103	113	106	129	96	360	1766	1984	2110	2300
80 1		109	127	137	105	103	112	104	134	97	361	1768	2007	2152	2364
80 16		109	125	137	107	102	110	102	135	97	361	1772	2012	2160	2375
80 31		110	128	139	106	103	112	106	127	96	363	1778	2023	2174	2392
80 46		110	130	143	105	104	113	108	127	97	363	1780	2027	2179	2399
81 1		110	130	150	107	104	115	110	127	97	365	1775	2007	2159	2377
81 16		110	131	146	106	104	114	109	127	97	366	1769	2018	2176	2399

TIME		HRS	CH15	CH16	CH17	CH18	CH19	CH20	CH21	CH22	CH23	CH24	CH25	CH26	CH27	CH28
M	S															
81	31		110	128	140	105	104	114	107	126	97	367	1764	1996	2135	2336
81	46		110	128	140	109	104	114	108	131	98	368	1763	1985	2115	2308
82	1		111	130	145	109	104	114	109	129	98	367	1762	1983	2113	2304
82	16		111	127	141	108	103	113	107	135	98	370	1759	1981	2110	2301
82	31		111	127	139	109	103	113	105	133	98	372	1757	1981	2111	2303
82	46		110	131	139	106	104	114	108	130	97	373	1756	1979	2108	2299
83	1		110	132	141	108	105	116	110	130	98	374	1757	1981	2111	2302
83	16		111	133	149	112	106	117	112	129	98	375	1762	1986	2117	2309
83	31		112	134	149	113	106	116	111	130	99	376	1764	1990	2122	2315
83	46		112	133	144	110	107	117	110	134	99	377	1765	1990	2120	2312
84	1		111	132	145	109	106	116	111	132	99	378	1768	1992	2122	2314
84	16		112	135	144	114	106	117	110	134	99	379	1772	1996	2125	2317
84	31		112	132	148	112	104	115	110	131	99	380	1780	2003	2132	2324
84	46		112	131	150	113	103	115	110	129	99	381	1784	2011	2144	2339
85	1		111	134	148	111	104	116	110	134	99	382	1780	2004	2134	2327
85	16		113	130	147	107	105	115	109	132	99	383	1775	1999	2129	2322
85	31		112	128	141	107	103	113	104	137	100	384	1776	2013	2157	2369
85	46		112	130	138	106	105	115	107	135	99	384	1776	2027	2184	2409
86	1		112	129	146	107	105	116	108	136	99	385	1775	2040	2211	2447
86	16		112	128	143	108	105	116	108	140	99	386	1772	2050	2235	2492
86	31		113	133	145	111	106	118	111	135	99	387	1774	2060	2253	2515
86	46		113	134	150	114	108	119	113	136	100	387	1779	2066	2261	2526
87	1		114	136	149	113	108	120	115	132	100	388	1780	2067	2260	2524
87	16		113	136	154	115	107	119	113	134	101	388	1780	2064	2255	2514
87	31		114	133	145	115	107	117	110	136	100	389	1782	2050	2226	2466
87	46		114	132	143	110	106	117	111	136	100	389	1783	2050	2226	2470
88	1		114	133	145	109	106	117	110	140	101	390	1784	2054	2231	2477
88	16		114	134	148	112	106	117	109	137	100	390	1788	2037	2192	2411
88	31		114	132	154	111	105	116	110	136	100	391	1791	2028	2172	2379
88	46		115	136	143	112	107	118	111	138	101	392	1790	2024	2164	2367
89	1		115	133	158	111	106	117	111	136	101	392	1792	2024	2163	2363
89	16		115	131	151	111	105	117	111	134	101	392	1797	2029	2167	2366
89	31		115	129	153	108	105	117	110	134	101	393	1800	2032	2169	2369
89	46		115	132	146	109	106	118	112	141	102	394	1800	2032	2169	2368
90	1		115	133	156	110	107	119	115	136	101	395	1802	2032	2168	2366
90	16		114	134	147	108	107	119	114	135	101	395	1800	2032	2169	2367
90	31		114	131	141	106	106	118	112	137	101	395	1800	2031	2169	2369
90	46		115	129	147	106	105	116	108	143	101	396	1799	2034	2174	2377
91	1		115	129	143	108	105	115	106	142	102	396	1798	2030	2167	2366
91	16		115	129	146	110	106	117	108	144	101	397	1796	2026	2162	2360
91	31		115	130	148	108	107	119	111	142	102	397	1797	2028	2164	2362
91	46		114	132	146	108	107	119	112	142	102	398	1797	2029	2165	2363
92	1		115	133	148	110	107	119	113	140	102	398	1796	2028	2165	2363
92	16		115	133	157	110	107	119	112	138	102	398	1798	2028	2164	2362
92	31		116	133	155	110	107	119	113	140	102	399	1800	2032	2168	2366
92	46		115	131	144	107	107	119	110	143	102	399	1801	2033	2171	2369
93	1		115	133	152	109	108	120	112	138	103	400	1803	2035	2173	2371
93	16		116	134	150	113	108	120	113	142	103	400	1804	2037	2176	2375
93	31		117	131	145	111	108	119	111	141	102	400	1806	2040	2179	2378
93	46		116	132	145	109	107	118	109	139	102	401	1810	2044	2183	2383
94	1		116	131	149	108	107	119	109	142	102	401	1817	2052	2193	2393
94	16		116	125	137	106	105	117	106	144	102	402	1822	2056	2193	2392
94	31		116	128	145	109	106	118	109	138	102	402	1818	2049	2185	2382
94	46		116	127	141	106	106	117	108	141	103	402	1809	2037	2170	2365
95	1		115	128	142	107	107	119	110	140	102	403	1803	2029	2161	2354

TIME		HRS	CH15	CH16	CH17	CH18	CH19	CH20	CH21	CH22	CH23	CH24	CH25	CH26	CH27	CH28
M	S															
95	16		115	133	139	109	107	120	111	143	102	403	1801	2025	2154	2346
95	31		116	133	140	108	107	119	110	142	102	404	1806	2033	2165	2358
95	46		117	131	142	109	107	119	109	141	103	404	1813	2041	2173	2368
96	1		116	127	139	109	106	118	107	144	103	404	1820	2051	2187	2384
96	16		117	130	144	113	107	119	109	144	103	405	1820	2053	2190	2387
96	31		117	130	138	108	107	119	111	144	103	405	1814	2046	2182	2380
96	46		117	132	137	108	107	120	112	141	102	406	1805	2039	2176	2375
97	1		117	133	144	111	107	120	112	144	103	406	1801	2036	2174	2374
97	16		118	135	144	109	108	120	110	147	103	407	1797	2033	2171	2371
97	31		117	132	142	109	107	120	110	147	103	407	1798	2034	2173	2372
97	46		117	133	140	111	108	120	111	142	103	408	1800	2037	2176	2377
98	1		117	134	147	111	108	121	113	141	103	408	1803	2042	2183	2385
98	16		119	137	144	111	108	121	112	139	103	408	1809	2048	2190	2394
98	31		119	138	143	110	109	122	114	139	103	409	1813	2053	2195	2399
98	46		119	138	150	114	109	122	115	145	105	409	1818	2059	2203	2407
99	1		119	139	143	111	109	122	114	140	104	409	1821	2062	2206	2410
99	16		119	137	141	108	109	121	112	145	105	410	1824	2063	2206	2409
99	31		119	137	144	111	109	121	113	146	104	410	1825	2064	2206	2408
99	46		120	138	146	111	109	122	115	142	105	410	1824	2062	2203	2404
100	1		120	139	142	114	109	123	114	143	105	411	1822	2056	2194	2392
100	16		120	133	138	110	108	120	110	148	105	411	1826	2063	2205	2407
100	31		120	130	139	108	108	121	111	141	104	411	1830	2071	2214	2421
100	46		119	134	144	109	108	121	112	136	103	412	1829	2097	2264	2498
101	1		120	136	145	110	108	122	113	144	104	412	1829	2119	2306	2566
101	16		119	135	145	111	108	122	114	141	105	412	1829	2126	2324	2589
101	31		119	135	148	111	109	122	114	138	105	413	1827	2138	2348	2627
101	46		120	135	148	110	109	122	114	138	105	413	1825	2147	2367	2660
102	1		120	140	148	115	110	124	116	140	105	413	1822	2149	2369	2672
102	16		121	139	146	115	110	124	115	144	105	414	1821	2146	2370	2675
102	31		121	140	152	118	111	124	115	148	106	414	1821	2149	2377	2681
102	46		121	139	145	112	111	123	113	151	106	414	1822	2148	2372	2674
103	1		121	140	149	112	111	123	114	148	105	415	1824	2155	2388	2697
103	16		121	140	150	117	111	124	116	147	106	415	1825	2136	2349	2624
103	31		122	139	156	115	112	124	117	144	106	416	1826	2101	2279	2522
103	46		122	139	152	113	111	125	116	145	107	416	1826	2105	2288	2535
104	1		122	140	150	115	111	125	117	150	107	416	1829	2110	2292	2538
104	16		121	140	153	114	112	126	119	146	107	417	1832	2113	2297	2547
104	31		122	139	150	111	110	123	113	152	107	417	1831	2110	2291	2536
104	46		122	137	149	111	111	123	113	151	106	417	1830	2091	2257	2483
105	1		123	137	147	109	111	123	112	151	107	418	1832	2085	2242	2459
105	16		123	134	141	113	111	123	113	152	107	418	1834	2084	2239	2453
105	31		123	137	150	116	111	124	115	152	107	419	1839	2090	2244	2457
105	46		123	139	149	113	112	126	117	146	108	419	1840	2090	2253	2482
106	1		123	139	148	114	112	125	117	143	108	419	1841	2102	2265	2493
106	16		123	138	152	114	112	126	118	143	108	420	1840	2093	2249	2465
106	31		124	140	149	116	113	126	116	154	108	420	1844	2092	2243	2454
106	46		124	135	141	111	111	124	113	152	108	420	1845	2092	2242	2451
107	1		123	136	148	113	111	125	116	143	107	421	1841	2086	2234	2443
107	16		124	137	147	115	111	125	114	148	108	421	1837	2083	2232	2440
107	31		124	138	150	114	111	125	116	147	108	422	1838	2083	2232	2440
107	46		124	138	152	114	112	125	116	148	107	422	1838	2084	2232	2439
108	1		125	135	150	116	112	124	114	151	108	422	1843	2087	2234	2440
108	16		125	136	154	118	112	125	116	148	108	423	1843	2088	2235	2442
108	31		125	140	150	116	113	128	118	146	109	423	1841	2085	2231	2437
108	46		124	141	152	116	113	127	118	148	109	423	1838	2082	2227	2433

TIME		HRS	CH15	CH16	CH17	CH18	CH19	CH20	CH21	CH22	CH23	CH24	CH25	CH26	CH27	CH28
M	S															
109	1		124	143	156	117	113	127	119	145	109	424	1837	2080	2225	2430
109	16		125	141	154	116	113	128	118	149	108	424	1837	2079	2223	2429
109	31		125	135	150	112	112	125	115	150	109	424	1840	2083	2229	2435
109	46		125	138	154	114	113	126	118	149	109	425	1846	2090	2236	2442
110	1		126	140	157	116	112	126	118	144	108	425	1847	2091	2237	2444
110	16		127	142	156	117	113	128	120	144	109	425	1847	2098	2243	2449
110	31		127	143	155	116	114	129	121	149	110	425	1846	2090	2238	2444
110	46		126	142	155	116	114	128	119	151	110	426	1845	2088	2234	2441
111	1		127	142	153	115	114	128	120	150	109	427	1845	2090	2237	2444
111	16		126	143	160	119	113	128	120	146	110	427	1844	2089	2236	2443
111	31		127	141	153	116	115	129	120	148	109	428	1844	2088	2236	2443
111	46		127	145	154	115	115	130	121	147	110	428	1844	2088	2235	2442
112	1		128	144	154	114	115	130	121	146	110	429	1845	2089	2235	2441
112	16		128	145	154	116	115	129	120	149	109	429	1845	2090	2237	2445
112	31		127	143	152	114	115	128	118	153	110	429	1846	2091	2239	2447
112	46		128	139	151	113	114	127	118	148	111	430	1847	2093	2243	2452
113	1		126	141	155	116	113	128	119	150	110	430	1849	2095	2243	2450
113	16		127	143	154	115	114	129	118	152	110	430	1853	2098	2247	2455
113	31		129	144	154	116	113	129	120	150	111	430	1855	2102	2251	2460
113	46		129	144	155	114	114	129	119	152	111	430	1855	2102	2252	2461
114	1		129	140	155	115	114	128	118	152	111	430	1853	2100	2249	2458
114	16		129	142	156	117	114	129	119	153	111	430	1852	2099	2248	2457
114	31		129	143	153	115	114	128	117	154	111	430	1853	2100	2249	2458
114	46		129	138	146	111	113	127	114	159	112	430	1855	2103	2253	2463
115	1		129	135	154	114	114	127	116	152	111	430	1858	2106	2256	2466
115	16		128	138	152	114	114	128	117	147	111	431	1858	2105	2255	2465
115	31		129	139	156	120	114	129	120	148	112	432	1853	2100	2250	2459
115	46		130	144	158	119	116	131	121	147	112	433	1852	2097	2245	2453
116	1		130	142	158	120	116	131	121	151	112	433	1848	2093	2240	2447
116	16		129	145	154	119	115	130	121	151	112	434	1846	2089	2234	2440
116	31		130	144	158	118	116	131	123	148	113	434	1845	2087	2231	2435
116	46		131	145	161	121	117	133	124	153	113	434	1848	2088	2231	2435
117	1		132	147	159	122	116	132	123	154	114	434	1852	2093	2236	2440
117	16		131	144	160	119	114	130	122	152	112	435	1856	2097	2240	2444
117	31		132	144	160	121	116	130	122	154	113	435	1859	2100	2243	2446
117	46		133	143	166	121	116	131	122	154	113	435	1859	2099	2240	2442
118	1		134	143	160	121	118	132	123	152	113	436	1857	2096	2236	2438
118	16		133	144	159	120	118	132	124	154	114	436	1854	2093	2233	2435
118	31		133	144	159	120	117	131	123	155	114	436	1851	2090	2230	2431
118	46		134	143	162	122	117	132	123	152	114	437	1848	2086	2226	2427
119	1		134	145	156	120	118	132	123	155	115	437	1847	2087	2227	2428
119	16		134	148	162	123	117	132	123	152	115	437	1850	2091	2232	2434
119	31		135	145	159	121	116	132	122	150	115	437	1859	2102	2244	2447
119	46		135	143	155	118	117	131	121	152	114	437	1863	2106	2248	2452
120	1		135	140	151	115	116	130	120	149	114	437	1858	2095	2237	2442
120	16		135	140	152	117	116	132	122	147	114	438	1859	2110	2257	2465
120	31		135	142	155	120	117	133	121	153	115	438	1864	2115	2264	2473
120	46		135	144	161	121	116	132	121	151	115	438	1866	2118	2269	2480
121	1		134	143	155	118	116	132	122	152	116	438	1864	2117	2268	2479
121	16		135	143	164	119	115	132	122	145	115	438	1862	2116	2268	2480
121	31		137	144	155	120	116	131	122	149	115	438	1859	2113	2266	2478
121	46		136	145	163	120	116	132	122	150	115	438	1856	2112	2264	2476
122	1		137	146	162	124	117	133	123	149	116	439	1856	2111	2263	2476
122	16		136	145	157	120	117	133	123	146	115	439	1859	2117	2270	2483
122	31		137	144	156	118	117	132	122	152	114	439	1860	2119	2271	2484

TIME		HRS	CH15	CH16	CH17	CH18	CH19	CH20	CH21	CH22	CH23	CH24	CH25	CH26	CH27	CH28
M	S															
122	46		137	148	162	120	117	133	123	151	115	440	1858	2120	2271	2483
123	1		137	147	163	120	117	132	123	149	115	440	1857	2113	2264	2476
123	16		136	147	170	123	117	132	124	150	115	441	1855	2098	2248	2458
123	31		135	146	164	121	117	133	125	149	116	441	1851	2081	2228	2436
123	46		136	146	161	122	119	135	126	152	117	441	1849	2102	2253	2465
124	1		137	145	166	123	119	134	124	157	117	441	1849	2103	2255	2466
124	16		139	143	158	121	118	132	123	161	117	442	1853	2107	2259	2471
124	31		139	145	164	122	119	133	124	158	116	442	1856	2111	2264	2477
124	46		139	145	165	125	118	134	125	157	117	442	1857	2112	2265	2477
125	1		140	146	162	126	119	134	126	157	118	443	1857	2113	2265	2478
125	16		142	146	161	125	120	135	128	160	118	443	1858	2113	2267	2479
125	31		142	146	158	123	122	135	125	163	118	444	1857	2112	2265	2478
125	46		142	145	157	122	120	133	122	165	118	444	1855	2111	2264	2477
126	1		142	147	162	125	119	133	124	156	117	444	1855	2111	2265	2479
126	16		141	147	162	124	119	134	125	156	117	445	1856	2114	2268	2482
126	31		142	150	161	123	120	135	125	153	117	445	1860	2117	2271	2485
126	46		142	151	166	123	120	135	126	160	117	445	1863	2120	2275	2489
127	1		141	147	163	123	120	135	126	154	118	445	1864	2121	2275	2490
127	16		140	146	164	124	120	135	126	157	118	446	1862	2121	2276	2491
127	31		140	144	165	124	120	135	126	157	119	446	1861	2119	2274	2489
127	46		140	146	164	126	120	136	127	154	118	447	1861	2120	2276	2491
128	1		140	146	159	121	120	134	123	157	118	447	1863	2122	2279	2495
128	16		142	142	160	121	120	133	122	161	118	447	1867	2127	2285	2502
128	31		140	144	163	121	120	135	125	156	118	448	1866	2127	2286	2503
128	46		141	146	166	125	120	135	126	158	119	448	1864	2126	2284	2502
129	1		142	149	167	125	120	135	126	159	118	449	1866	2128	2286	2505
129	16		143	148	162	123	119	135	126	155	118	449	1869	2132	2292	2510
129	31		144	148	160	123	121	136	125	161	118	449	1873	2135	2294	2512
129	46		145	150	163	122	121	137	126	156	118	450	1870	2133	2292	2509
130	1		144	149	162	121	122	137	126	158	119	450	1867	2128	2286	2504
130	16		144	148	159	123	120	136	126	163	120	450	1870	2133	2292	2510
130	31		144	148	161	119	120	135	125	163	120	451	1873	2135	2293	2511
130	46		144	147	161	120	119	135	126	160	119	451	1874	2136	2294	2512
131	1		145	148	166	125	120	137	127	159	119	452	1879	2141	2301	2519
131	16		145	150	175	126	120	137	126	157	121	452	1882	2144	2304	2522
131	31		145	150	163	127	120	136	127	155	120	453	1882	2142	2300	2517
131	46		145	147	164	125	119	137	128	149	120	453	1882	2142	2300	2516
132	1		145	147	163	124	119	137	127	149	120	453	1880	2141	2299	2515
132	16		145	150	163	126	120	137	128	156	120	454	1879	2141	2299	2516
132	31		145	149	166	124	119	137	128	157	120	454	1881	2143	2301	2519
132	46		144	150	166	126	119	137	128	159	120	454	1879	2142	2302	2521
133	1		145	150	168	127	120	138	128	155	120	455	1877	2141	2301	2519
133	16		144	148	165	124	120	138	129	151	120	455	1879	2143	2303	2521
133	31		146	147	160	125	119	136	125	159	121	456	1878	2141	2300	2517
133	46		145	144	158	121	119	135	125	158	121	456	1878	2139	2297	2514
134	1		144	145	168	125	119	136	126	158	121	457	1877	2136	2291	2507
134	16		144	146	167	125	121	137	127	153	121	457	1874	2135	2292	2509
134	31		144	147	168	126	122	138	128	156	122	458	1872	2132	2290	2507
134	46		145	147	165	128	122	138	128	159	122	458	1870	2132	2290	2507
135	1		143	149	167	126	121	138	129	164	122	458	1870	2133	2292	2509
135	16		142	147	166	126	121	138	129	157	122	459	1872	2135	2293	2511
135	31		142	148	177	130	122	139	130	164	123	459	1873	2137	2296	2514
135	46		145	152	172	131	123	140	131	164	122	459	1874	2138	2298	2516
136	1		147	152	166	132	123	140	131	167	123	460	1874	2138	2297	2516
136	16		147	153	172	128	124	141	131	162	123	460	1877	2141	2301	2519

TIME		HRS	CH15	CH16	CH17	CH18	CH19	CH20	CH21	CH22	CH23	CH24	CH25	CH26	CH27	CH28
M	S															
136	31		146	152	173	130	123	140	131	156	122	461	1880	2145	2306	2525
136	46		147	152	168	128	122	139	130	152	120	461	1881	2147	2307	2526
137	1		147	153	165	127	123	139	129	161	121	461	1880	2146	2307	2527
137	16		147	150	166	125	122	139	130	158	122	461	1880	2146	2306	2525
137	31		144	152	174	126	123	141	130	157	122	462	1881	2146	2305	2524
137	46		148	149	164	125	122	138	129	163	122	462	1882	2147	2307	2526
138	1		147	148	163	125	123	140	130	157	122	462	1882	2147	2308	2527
138	16		148	149	167	125	122	140	130	159	123	463	1885	2152	2314	2534
138	31		147	150	170	127	122	140	131	158	122	463	1885	2152	2314	2534
138	46		147	151	171	127	123	140	131	163	123	463	1882	2150	2312	2533
139	1		151	152	172	130	124	141	131	165	124	463	1880	2147	2309	2529
139	16		148	151	175	128	124	140	131	158	123	464	1878	2147	2309	2530
139	31		151	151	171	130	125	142	131	161	122	464	1877	2144	2307	2528
139	46		149	152	170	126	124	141	131	152	122	464	1879	2149	2312	2534
140	1		145	150	170	126	124	140	131	157	123	464	1887	2157	2321	2542
140	16		148	151	167	130	123	140	129	158	124	465	1895	2165	2330	2552
140	31		150	149	169	127	124	140	130	155	123	465	1897	2166	2328	2549
140	46		149	152	170	125	124	142	131	160	121	465	1894	2163	2325	2545
141	1		148	154	170	126	124	141	132	165	121	466	1891	2160	2322	2543
141	16		147	154	166	126	124	141	132	157	123	466	1889	2158	2320	2542
141	31		149	151	170	129	124	141	133	162	124	466	1888	2158	2322	2543
141	46		149	150	170	130	126	142	134	162	125	466	1885	2155	2318	2539
142	1		151	153	172	132	127	143	135	163	126	467	1883	2152	2315	2537
142	16		148	153	171	132	126	143	135	161	124	467	1885	2155	2318	2539
142	31		149	152	171	129	125	143	134	158	125	467	1886	2156	2320	2541
142	46		149	153	171	128	126	144	134	157	125	468	1887	2157	2321	2543
143	1		150	153	175	129	126	143	135	161	125	468	1888	2158	2322	2544
143	16		153	149	166	126	126	140	129	171	127	468	1890	2161	2325	2547
143	31		154	142	162	122	123	136	125	171	127	469	1890	2162	2328	2550
143	46		154	145	177	128	123	138	128	158	126	469	1893	2165	2331	2553
144	1		153	146	168	125	123	140	130	156	125	470	1894	2167	2332	2555
144	16		153	149	170	125	124	142	132	165	126	470	1895	2169	2334	2557
144	31		152	148	163	121	124	141	130	172	125	470	1894	2168	2335	2558
144	46		150	150	165	125	125	141	131	161	125	471	1894	2168	2335	2559
145	1		152	148	173	128	126	143	133	158	127	471	1893	2167	2333	2557
145	16		150	154	171	131	127	144	135	156	126	471	1892	2165	2332	2555
145	31		152	148	166	122	124	140	128	166	127	471	1894	2168	2335	2559
145	46		157	148	165	124	124	140	129	171	127	471	1893	2167	2334	2558
146	1		154	141	157	120	123	138	124	169	126	471	1894	2169	2337	2562
146	16		151	145	164	122	123	140	128	160	125	472	1895	2171	2341	2567
146	31		150	149	168	124	123	141	131	159	125	473	1897	2173	2343	2569
146	46		152	153	169	125	125	142	131	164	125	473	1895	2172	2342	2568
147	1		153	152	169	126	125	142	132	162	124	473	1892	2168	2338	2564
147	16		152	151	172	129	126	142	133	158	126	473	1889	2165	2335	2561
147	31		147	151	177	130	125	142	133	157	127	473	1888	2162	2330	2554
147	46		149	149	171	130	125	142	134	157	126	474	1889	2163	2330	2554
148	1		150	151	170	127	125	142	134	158	125	474	1891	2166	2332	2556
148	16		149	154	171	126	126	143	134	163	126	474	1894	2168	2334	2558
148	31		158	150	170	125	126	142	131	166	126	475	1897	2171	2338	2561
148	46		152	151	171	128	126	143	133	165	127	475	1897	2171	2337	2561
149	1		153	154	177	131	128	143	134	165	127	475	1895	2169	2336	2559
149	16		154	155	169	127	127	144	134	170	127	476	1894	2168	2335	2559
149	31		154	153	171	124	127	143	133	166	127	476	1893	2168	2335	2560
149	46		154	155	173	127	127	143	134	162	127	476	1893	2167	2334	2559
150	1		153	155	174	128	127	144	134	159	127	477	1895	2171	2339	2564

TIME		HRS	CH15	CH16	CH17	CH18	CH19	CH20	CH21	CH22	CH23	CH24	CH25	CH26	CH27	CH28
M	S															
150	16		154	155	176	130	127	144	135	159	126	478	1899	2174	2342	2568
150	31		156	156	177	129	127	144	135	159	126	478	1901	2176	2344	2569
150	46		152	154	181	131	126	144	134	163	127	478	1903	2177	2345	2569
151	1		155	155	180	133	128	145	136	166	128	479	1903	2176	2342	2566
151	16		156	155	171	127	128	143	130	173	129	479	1902	2176	2342	2566
151	31		156	152	171	126	127	143	131	170	129	479	1905	2179	2345	2568
151	46		158	152	172	129	127	144	134	168	130	480	1909	2183	2349	2572
152	1		153	153	172	129	127	144	135	163	128	480	1911	2185	2351	2574
152	16		155	152	175	132	127	145	135	161	129	480	1911	2186	2352	2576
152	31		152	154	173	130	128	144	135	156	128	481	1911	2186	2354	2578
152	46		153	152	175	132	128	146	136	159	129	481	1909	2186	2354	2578
153	1		154	152	173	134	129	146	137	165	130	481	1904	2181	2349	2574
153	16		151	153	174	133	129	145	137	158	129	481	1903	2181	2351	2577
153	31		153	152	176	131	128	145	136	163	129	481	1901	2179	2348	2574
153	46		156	151	171	129	128	143	135	168	129	482	1901	2180	2349	2575
154	1		160	152	176	131	129	145	136	171	130	482	1902	2180	2350	2576
154	16		154	152	172	129	129	146	136	172	130	482	1904	2183	2352	2578
154	31		155	155	171	127	128	145	136	171	129	482	1906	2185	2355	2581
154	46		157	156	175	129	126	144	135	163	128	483	1908	2187	2358	2584
155	1		157	153	173	129	127	144	134	164	129	483	1912	2191	2362	2588
155	16		156	153	178	131	127	145	135	162	128	483	1913	2193	2363	2589
155	31		154	153	175	129	128	146	136	161	129	483	1910	2189	2359	2585
155	46		156	153	173	128	129	145	134	171	130	484	1909	2187	2357	2584
156	1		157	150	175	127	127	144	134	168	130	484	1908	2187	2357	2583
156	16		155	154	174	128	129	145	135	173	130	484	1908	2186	2356	2582
156	31		157	153	172	126	129	143	133	176	132	485	1905	2184	2355	2581
156	46		159	149	172	125	127	141	131	179	132	485	1905	2183	2354	2581
157	1		156	147	172	121	126	142	131	175	131	485	1906	2185	2357	2584
157	16		153	151	176	129	128	144	135	168	132	486	1907	2186	2357	2584
157	31		158	152	173	130	129	146	136	168	132	486	1908	2186	2358	2585
157	46		155	154	177	130	129	146	136	163	131	487	1908	2187	2359	2586
158	1		158	151	176	126	128	145	134	173	131	487	1906	2186	2357	2585
158	16		159	152	174	129	128	144	135	175	131	488	1906	2186	2358	2585
158	31		157	153	170	126	128	145	134	175	132	488	1906	2186	2358	2585
158	46		160	151	172	123	127	144	133	172	131	489	1907	2187	2359	2587
159	1		153	152	172	125	126	145	134	166	132	488	1913	2193	2364	2592
159	16		154	153	175	126	125	143	133	164	131	488	1918	2198	2369	2597
159	31		158	151	175	129	127	144	134	166	131	488	1921	2201	2372	2600
159	46		155	152	176	130	128	146	135	165	132	489	1922	2200	2370	2597
160	1		157	152	177	132	129	146	136	172	133	489	1916	2195	2364	2590
160	16		158	155	173	129	130	146	136	174	133	489	1909	2188	2357	2583
160	31		158	153	174	129	128	144	134	168	131	490	1905	2184	2353	2578
160	46		154	153	177	127	129	145	135	170	133	490	1904	2181	2349	2574
161	1		158	150	175	126	129	145	135	168	131	490	1904	2182	2350	2575
161	16		157	152	177	129	129	145	135	160	131	491	1907	2186	2353	2578
161	31		157	154	178	130	128	145	136	166	132	491	1910	2189	2356	2581
161	46		154	152	176	132	129	146	137	160	132	492	1913	2190	2357	2581
162	1		161	152	176	132	129	146	137	162	132	492	1916	2194	2360	2584
162	16		159	154	183	132	129	146	135	168	132	492	1922	2198	2364	2588
162	31		162	156	182	130	129	146	135	165	132	492	1927	2205	2372	2597
162	46		158	155	180	132	129	146	137	165	133	492	1928	2206	2374	2599
163	1		157	153	178	129	130	147	137	169	132	493	1927	2204	2371	2596
163	16		157	156	176	130	129	147	137	169	133	493	1922	2199	2365	2589
163	31		160	153	179	127	128	145	134	163	133	493	1919	2197	2363	2586
163	46		157	153	179	128	128	146	135	159	133	494	1920	2197	2363	2586

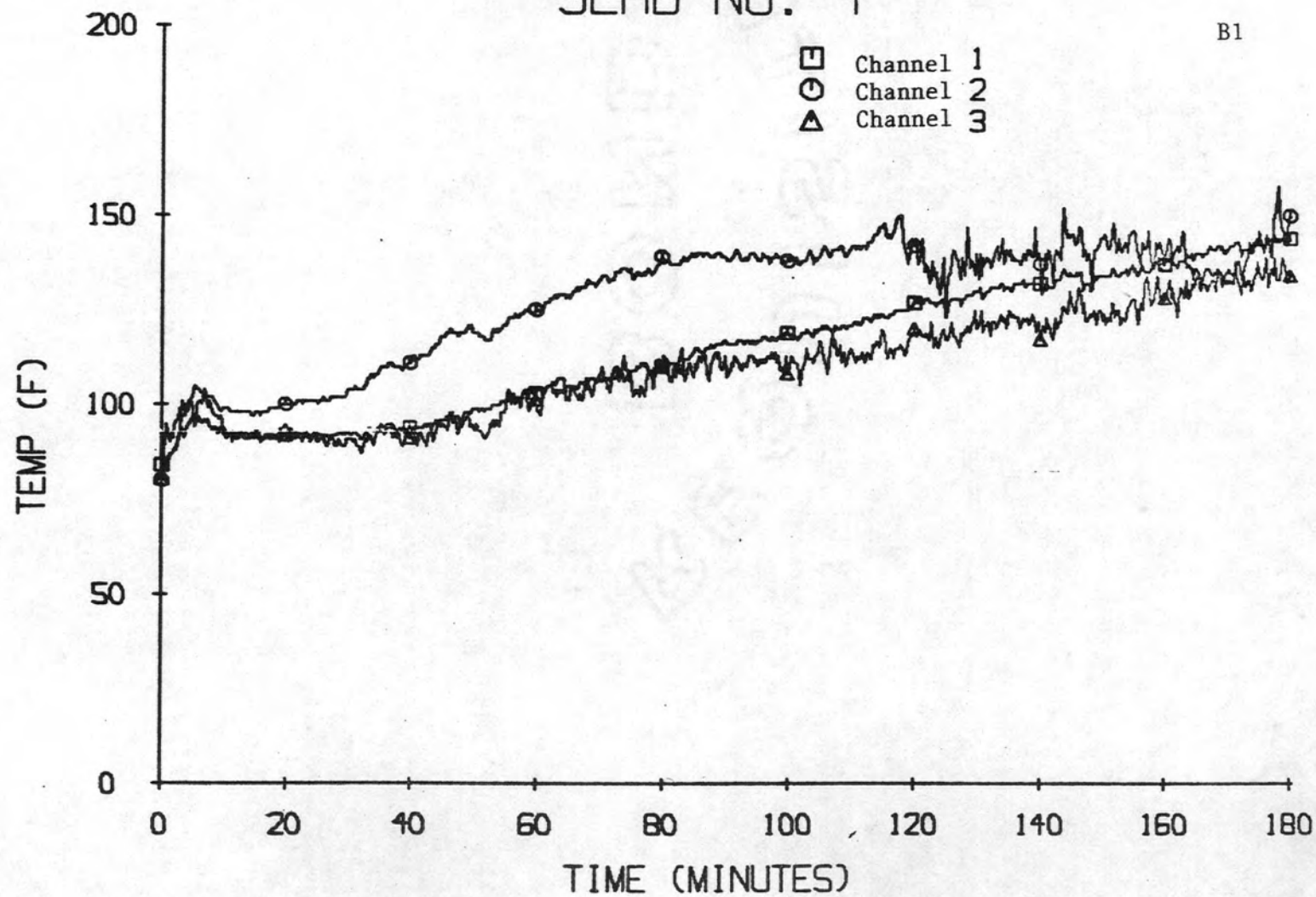
TIME		HRS	CH15	CH16	CH17	CH18	CH19	CH20	CH21	CH22	CH23	CH24	CH25	CH26	CH27	CH28
M	S															
164	1		158	153	177	127	128	147	135	161	132	494	1922	2199	2365	2588
164	16		156	153	174	125	126	146	135	157	132	494	1924	2203	2369	2592
164	31		160	153	176	127	127	146	135	161	132	495	1925	2203	2369	2593
164	46		164	153	171	125	128	146	134	173	133	495	1921	2199	2365	2589
165	1		159	153	172	124	128	145	134	165	133	495	1916	2193	2359	2582
165	16		154	152	175	123	127	146	134	160	133	495	1918	2195	2361	2583
165	31		153	152	178	125	127	146	134	161	133	495	1922	2198	2363	2585
165	46		160	152	179	125	126	146	134	157	132	496	1925	2203	2368	2591
166	1		162	154	179	126	127	147	134	159	133	496	1925	2204	2370	2594
166	16		160	154	178	125	127	146	134	162	133	496	1925	2204	2370	2594
166	31		163	153	179	129	128	146	134	165	135	496	1923	2202	2369	2593
166	46		155	154	182	130	128	146	135	161	134	497	1922	2202	2370	2596
167	1		162	152	180	127	127	147	135	159	134	497	1924	2206	2375	2601
167	16		157	152	181	127	127	146	136	157	133	497	1925	2207	2377	2604
167	31		164	150	177	129	127	145	135	152	133	498	1926	2208	2377	2604
167	46		159	148	179	130	126	146	135	160	134	498	1926	2208	2377	2604
168	1		157	151	179	131	127	147	136	160	133	498	1926	2208	2377	2605
168	16		159	153	178	129	128	147	136	168	134	498	1923	2205	2377	2604
168	31		164	156	180	132	127	147	135	162	134	499	1923	2203	2373	2600
168	46		157	155	181	132	128	146	135	162	134	499	1924	2205	2375	2603
169	1		155	156	182	129	129	148	137	167	135	499	1925	2207	2377	2605
169	16		158	154	181	129	131	148	137	170	135	499	1924	2207	2378	2605
169	31		166	155	184	131	130	148	136	172	134	499	1923	2206	2376	2604
169	46		167	156	184	130	130	147	136	175	135	500	1922	2205	2376	2605
170	1		160	154	185	131	130	148	137	173	135	501	1921	2205	2377	2606
170	16		161	157	186	133	129	148	136	170	135	501	1921	2204	2376	2605
170	31		162	156	187	128	128	147	135	161	135	501	1924	2208	2380	2609
170	46		157	157	186	129	129	148	136	164	135	501	1929	2215	2388	2617
171	1		166	156	183	131	129	148	137	170	135	501	1931	2216	2388	2617
171	16		163	155	186	131	129	148	136	163	135	502	1932	2217	2390	2620
171	31		162	153	183	130	129	148	137	169	135	502	1933	2218	2390	2620
171	46		165	155	185	131	131	148	138	169	136	502	1931	2216	2388	2618
172	1		158	154	187	131	130	148	138	161	134	503	1931	2216	2389	2619
172	16		166	153	184	131	131	148	137	171	135	503	1936	2222	2395	2625
172	31		167	157	182	129	130	148	137	167	135	503	1940	2226	2398	2630
172	46		154	159	186	131	130	149	138	167	135	503	1939	2226	2400	2631
173	1		159	158	183	128	131	148	138	170	135	504	1937	2223	2396	2627
173	16		163	156	186	132	131	149	138	172	136	504	1936	2221	2394	2623
173	31		163	157	189	133	132	150	139	169	136	504	1932	2218	2391	2621
173	46		160	159	188	133	132	151	139	166	135	504	1931	2217	2391	2621
174	1		162	157	184	129	132	149	138	172	136	505	1935	2222	2396	2627
174	16		170	159	186	131	132	150	139	177	137	505	1936	2222	2397	2629
174	31		167	155	185	128	131	149	137	182	138	505	1934	2221	2395	2627
174	46		173	153	177	124	130	147	136	176	137	505	1932	2218	2391	2623
175	1		154	156	182	127	132	148	136	169	137	506	1931	2218	2392	2623
175	16		163	158	182	129	131	149	138	178	136	506	1928	2216	2390	2622
175	31		162	157	187	131	131	150	139	168	137	506	1928	2216	2390	2621
175	46		167	154	181	128	131	147	136	172	137	506	1933	2220	2394	2625
176	1		171	153	184	128	130	148	136	172	136	507	1937	2225	2399	2631
176	16		166	152	186	129	130	148	136	163	136	507	1940	2228	2402	2634
176	31		164	153	183	126	129	149	135	165	135	507	1942	2230	2405	2638
176	46		161	152	184	127	129	146	135	168	137	507	1941	2228	2402	2634
177	1		163	152	184	127	129	148	136	161	136	507	1942	2229	2403	2635
177	16		164	152	183	126	130	148	136	171	137	507	1943	2229	2401	2633
177	31		170	153	186	130	132	149	138	163	137	508	1942	2229	2401	2633

TIME		HRS	CH15	CH16	CH17	CH18	CH19	CH20	CH21	CH22	CH23	CH24	CH25	CH26	CH27	CH28
M	S															
177	46		165	155	189	132	133	151	140	163	137	508	1943	2229	2401	2631
178	1		171	156	188	132	133	151	140	164	137	508	1943	2228	2400	2631
178	16		166	159	188	133	133	151	139	168	138	509	1942	2229	2401	2632
178	31		163	160	187	134	133	151	139	169	137	509	1943	2229	2401	2632
178	46		162	160	190	134	133	151	140	167	137	509	1942	2228	2401	2632
179	1		162	156	186	129	132	149	139	166	136	509	1941	2228	2401	2632
179	16		166	157	186	127	132	149	139	166	135	510	1939	2227	2402	2635
179	31		164	159	189	129	131	150	139	171	137	510	1934	2224	2399	2632
179	46		164	160	186	133	133	151	139	175	138	510	1936	2226	2402	2637
180	1		162	157	189	132	132	150	139	163	137	511	1939	2229	2404	2639
180	16		169	159	187	130	133	150	139	173	1025	511	1925	2212	2387	2619
180	31		165	159	188	161	2	267	596	861	1116	1315	1870	2162	2335	2571
180	46		3061	3217	3324	3370	3382	3391	3399	3403	3407	3408	1810	2105	2278	2514
181	1		3044	3206	3322	3367	3380	3391	3398	3402	3407	3408	1756	2049	2220	2456

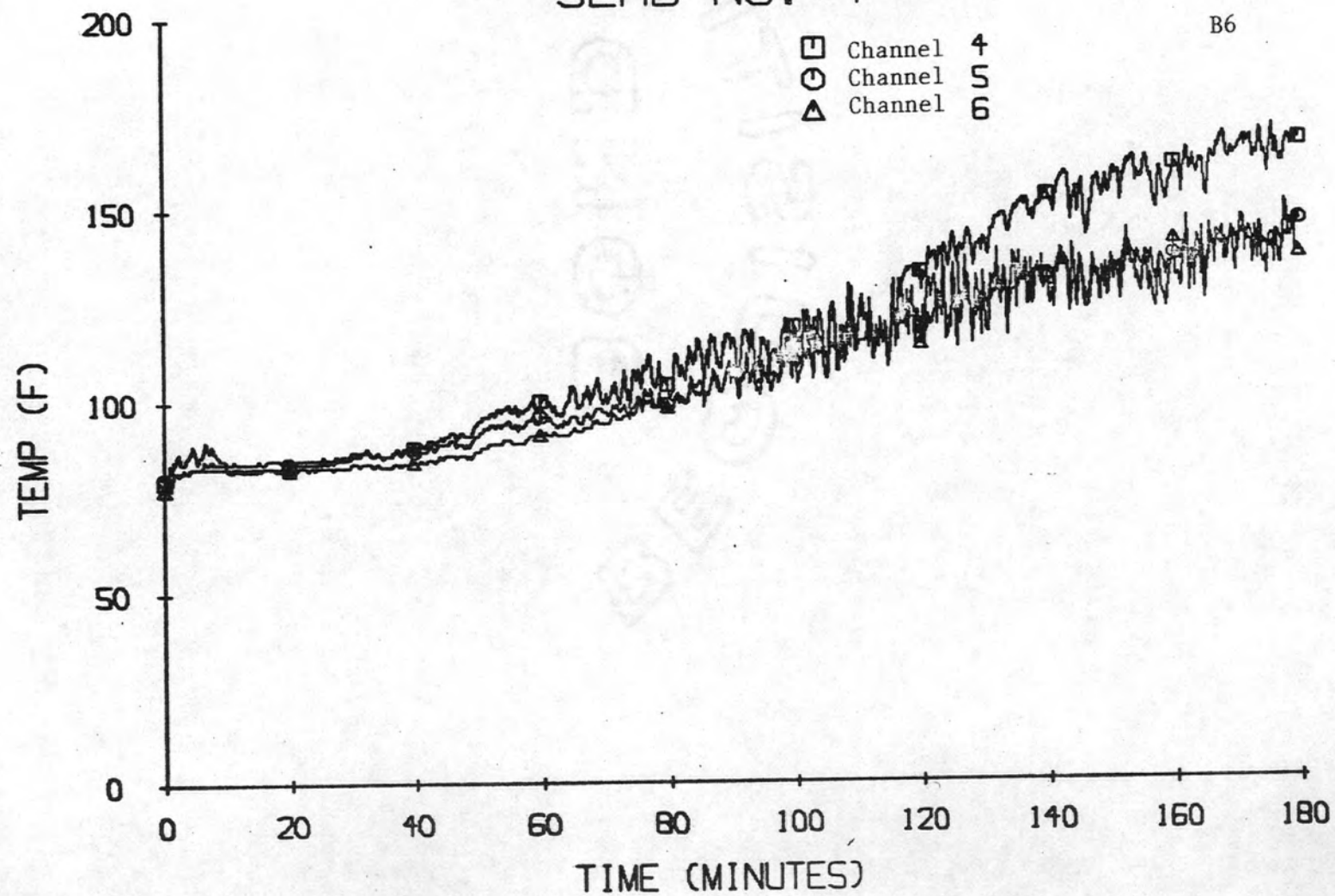
TEMPERATURE GRAPHS

SLAB NO. 4

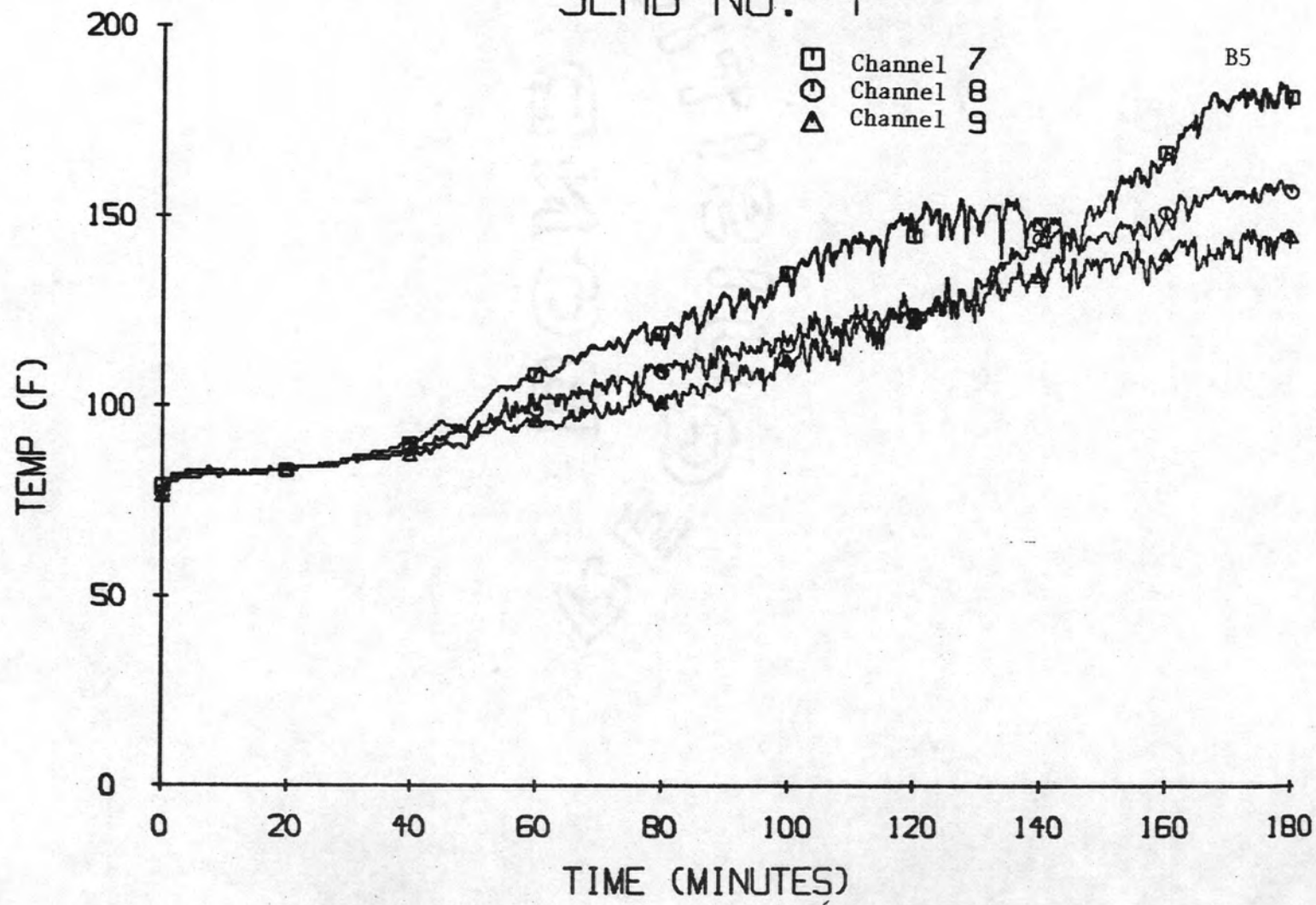
B1



SLAB NO. 4

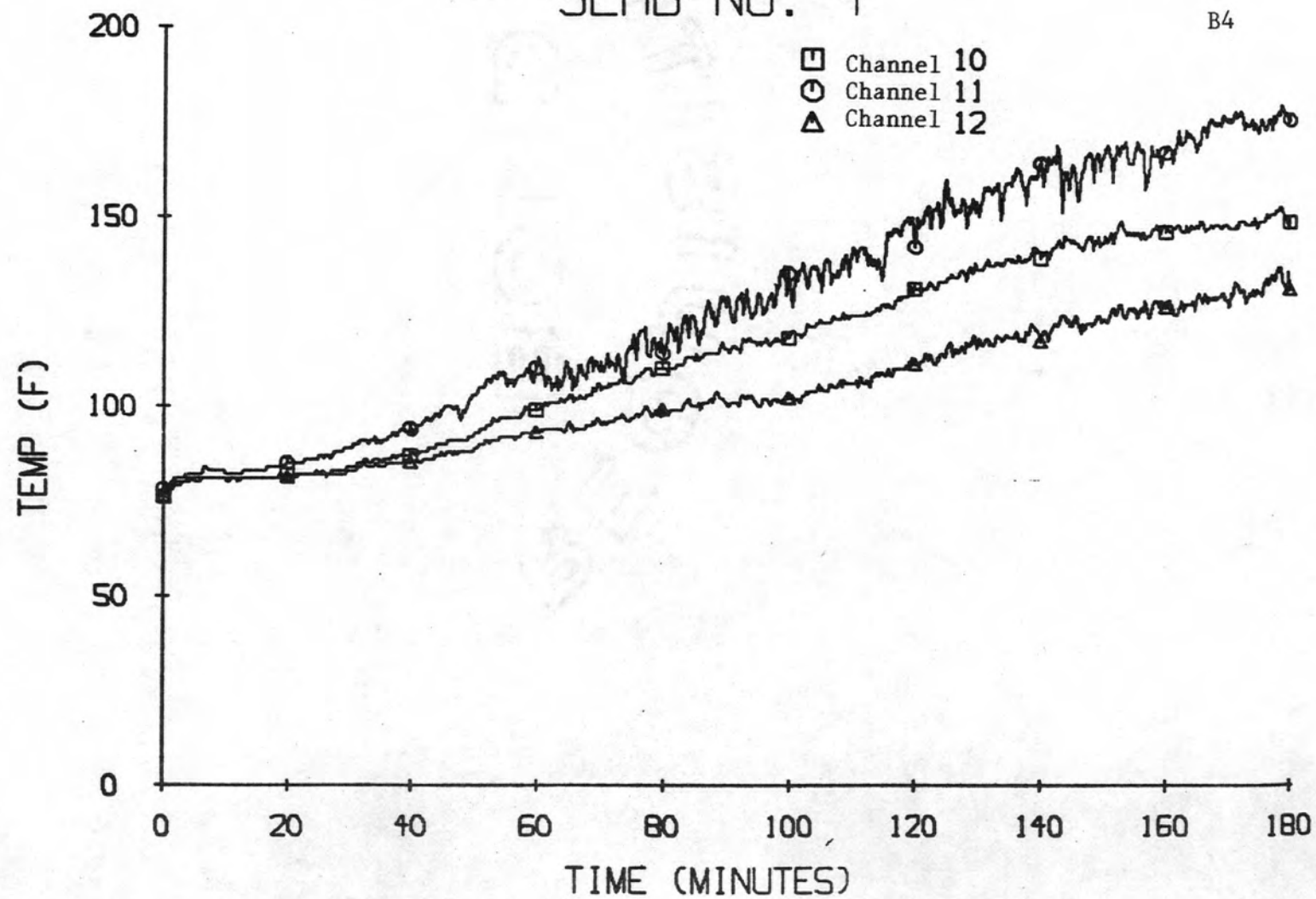


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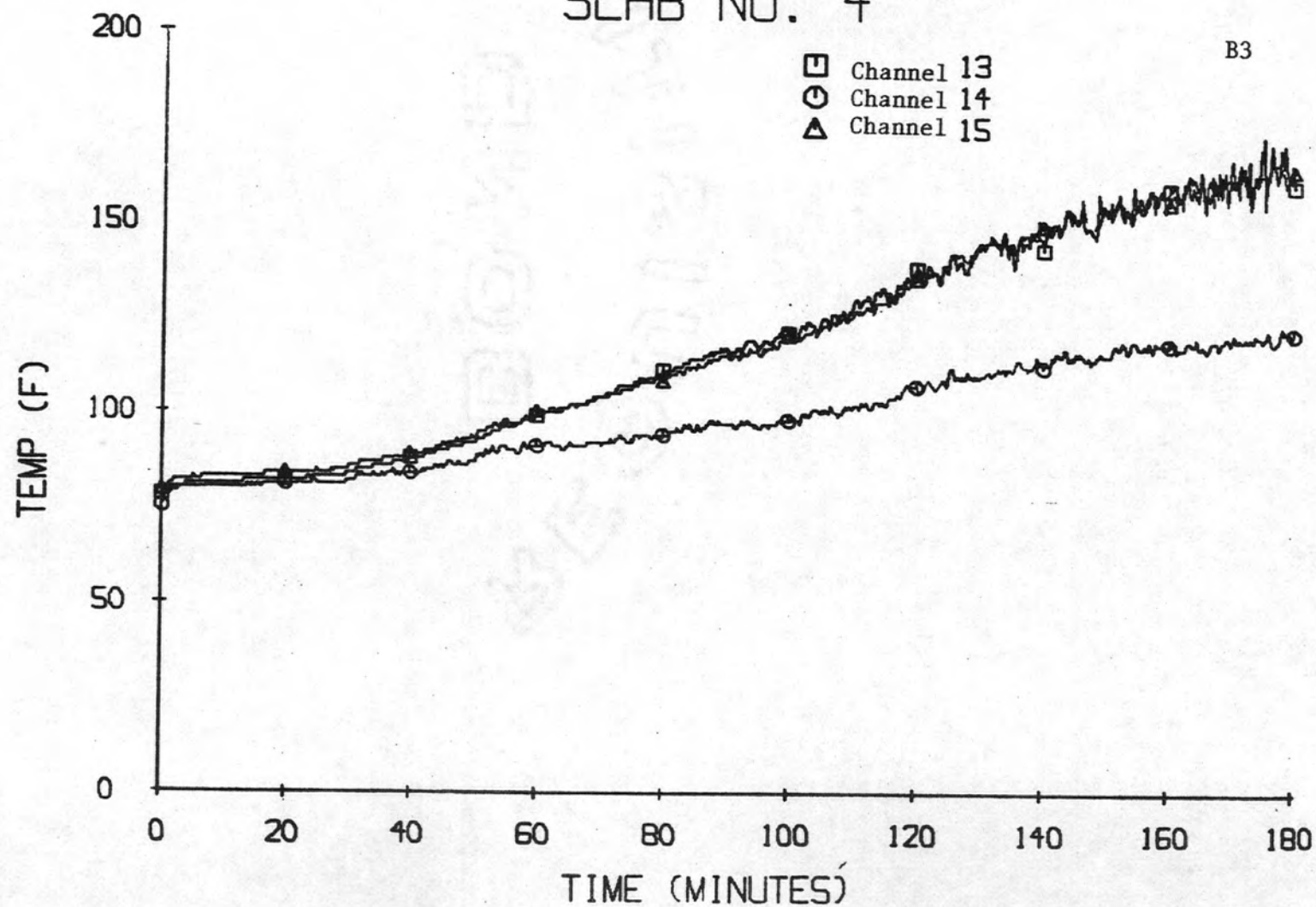


SLAB NO. 4

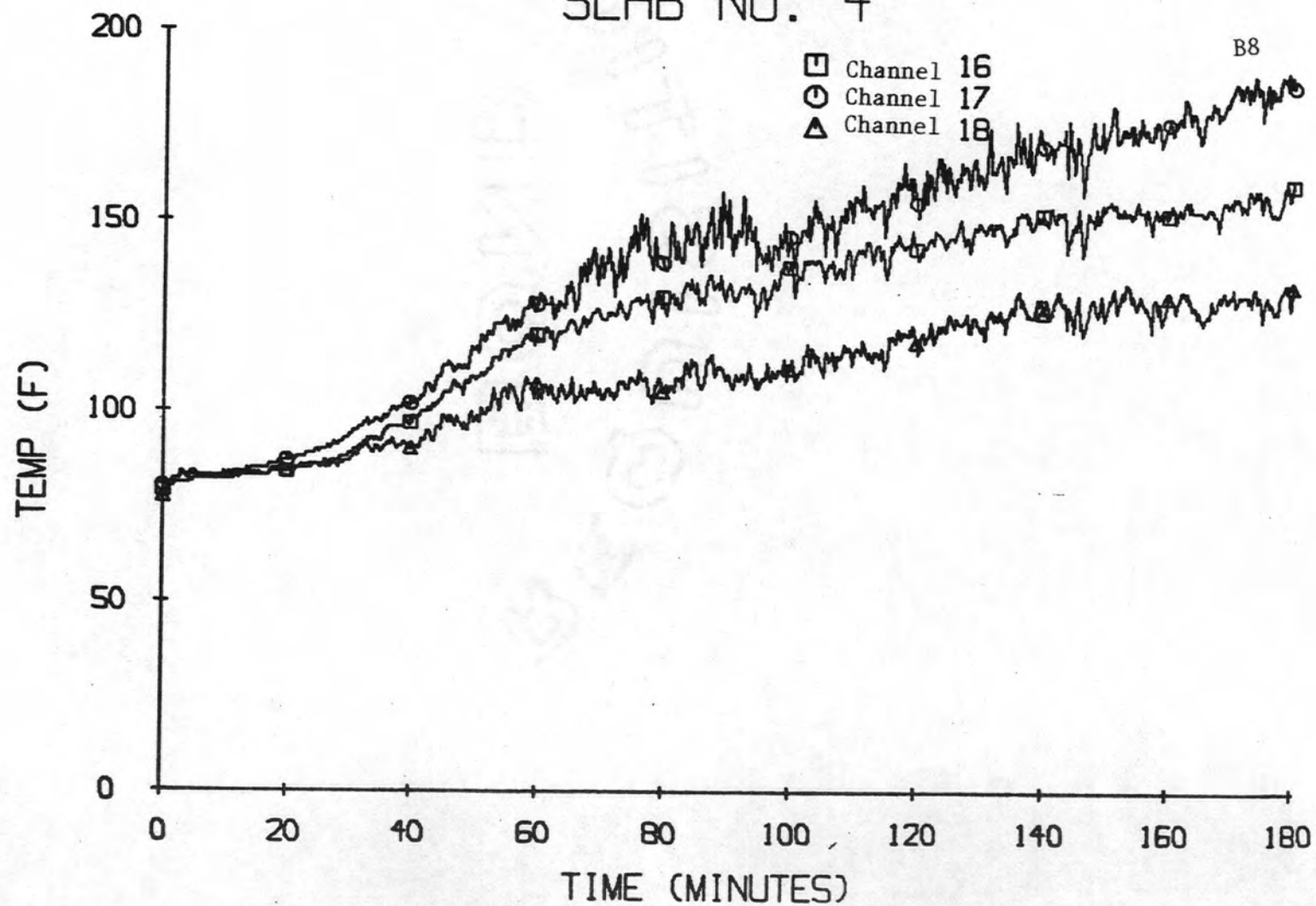
B4



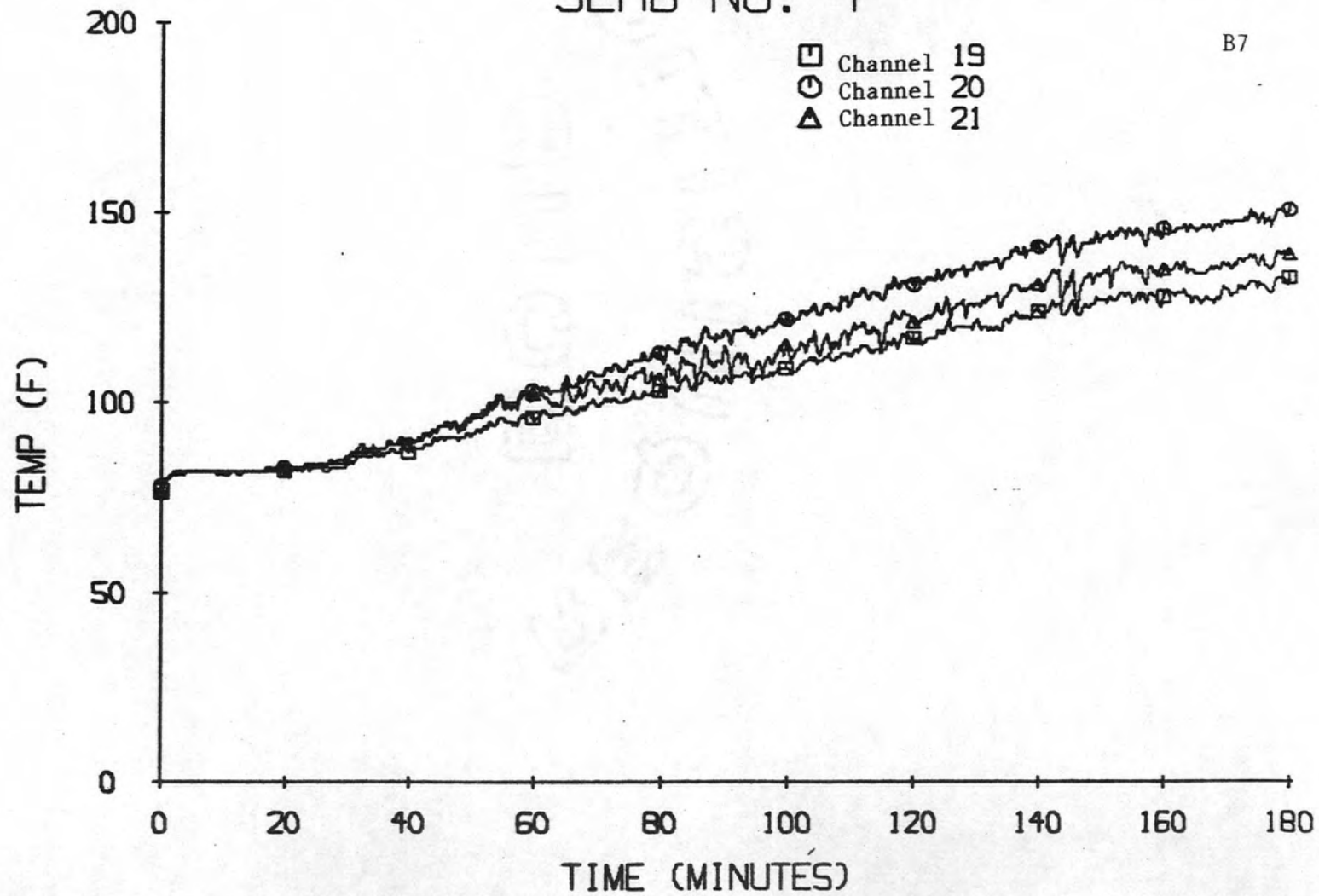
SLAB NO. 4



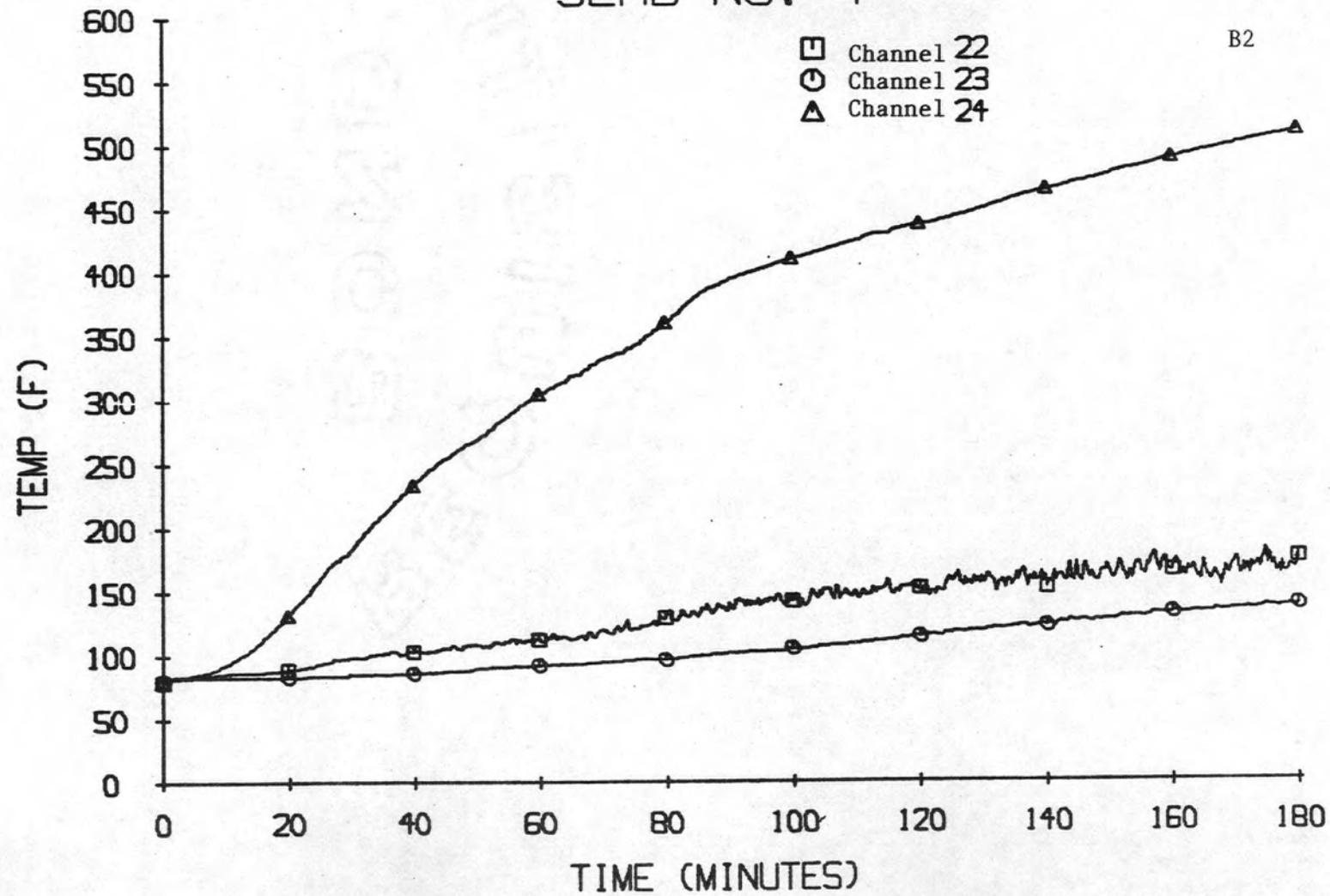
SLAB NO. 4



SLAB NO. 4



SLAB NO.: 4



RATE OF RISE DATA

Rate of Rise Data - Slab 4
5-Minute Intervals

MIN:SEC	CH 1	CH 2	CH 3	CH 4	CH 5	CH 6	CH 7	CH 8	CH 9	CH10	CH11	CH12	CH13	CH14
0:1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:1	10	24	16	4	5	6	2	6	6	5	4	4	3	5
10:1	-2	-5	-3	0	-1	-1	1	-1	0	-1	0	0	0	0
15:1	0	-1	0	0	1	1	0	1	1	1	1	1	1	0
20:1	-1	2	0	0	0	-1	1	0	1	1	2	1	0	1
25:1	1	0	-3	1	0	1	1	1	0	0	2	0	1	0
30:1	0	4	1	2	2	1	2	2	2	2	2	1	1	1
35:1	3	6	2	0	-1	-1	2	1	0	1	2	1	2	1
40:1	-1	1	-2	3	2	2	2	2	2	3	3	2	2	1
45:1	2	7	4	2	1	1	6	3	2	2	5	1	2	1
50:1	3	1	-2	4	2	1	2	1	2	3	4	2	2	2
55:1	2	2	7	2	3	3	7	9	2	4	3	3	4	3
60:1	3	4	-2	3	1	1	4	-2	2	2	5	1	3	1
65:1	1	3	3	3	1	2	4	2	1	4	-4	3	3	1
70:1	1	5	7	-1	1	1	2	4	0	1	5	-1	2	-1
75:1	3	0	-4	5	4	5	4	0	7	2	5	2	3	1
80:1	0	5	9	-6	-4	-1	-3	5	-4	4	-4	2	3	2
85:1	6	2	-2	10	7	4	7	3	5	4	6	1	4	2
90:1	1	-2	-4	5	3	5	6	2	7	1	10	0	2	1
95:1	1	0	3	0	0	0	0	0	-2	2	1	0	1	-1
100:1	1	0	-	2	2	2	4	2	0	2	-1	3	5	2
105:1	2	2	6	-10	-4	-2	0	2	2	3	1	2	3	3
110:1	1	2	-2	14	10	12	11	4	8	2	12	1	4	1
115:1	2	6	4	-9	-1	-3	-3	-1	1	3	-4	2	1	0
120:1	5	-4	0	15	2	1	2	-2	2	4	7	3	6	4
125:1	-5	-14	0	14	8	13	7	6	11	2	15	4	4	5
130:1	7	3	3	-1	1	-12	-5	6	-9	3	-10	3	5	-1
135:1	0	8	3	8	4	5	8	6	7	3	9	0	-7	1
140:1	-1	-12	-5	3	0	4	-3	4	1	1	3	0	8	2
145:1	5	16	7	3	5	10	-3	2	6	4	2	3	4	3
150:1	0	0	-2	4	2	-5	7	1	0	1	4	2	4	-1
155:1	2	-1	3	1	0	2	9	0	1	1	0	2	-1	2
160:1	2	-4	1	1	0	-3	4	4	0	1	0	3	6	1
165:1	2	-5	7	-9	-2	4	7	3	-3	0	2	2	1	0
170:1	1	1	-3	13	6	2	6	2	6	0	5	-3	0	2
175:1	1	8	2	-1	1	3	1	2	1	2	1	3	2	0
180:1	1	9	-2	5	5	4	3	3	1	0	3	3	-2	1
TOTAL	59	73	52	90	66	67	105	83	69	73	101	57	82	46

Rate of Rise - Slab 4
5-Minute Intervals (Cont'd)

MIN:SEC	CH15	CH16	CH17	CH18	CH19	CH20	CH21	CH22	CH23	CH24	CH25	CH26	CH27	CH28
0:1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:1	4	3	3	7	5	4	6	6	3	5	1322	1379	1451	1548
10:1	0	0	0	-1	-1	0	-1	1	0	8	-206	-120	7	156
15:1	0	1	2	0	1	0	1	1	0	16	125	114	111	97
20:1	1	2	2	2	0	1	1	2	0	24	72	68	54	28
25:1	0	1	2	0	1	0	1	5	1	28	80	128	174	244
30:1	2	3	5	2	1	2	2	5	1	22	27	-122	-324	-582
35:1	1	4	3	3	2	3	2	4	0	28	38	29	14	-1
40:1	2	4	6	2	2	2	2	2	2	24	27	119	227	371
45:1	3	8	9	7	3	4	4	1	1	19	24	13	-3	-50
50:1	1	3	4	-1	1	2	3	2	2	15	25	-28	-87	-149
55:1	5	8	8	6	4	3	2	4	1	19	23	55	112	203
60:1	2	2	5	-1	-1	3	3	-2	1	17	8	-32	-104	-212
65:1	2	6	6	3	4	5	3	3	1	14	29	22	10	-4
70:1	2	0	8	-3	0	0	-1	5	1	13	22	96	156	218
75:1	3	5	4	5	2	3	3	2	2	11	5	-37	-76	-120
80:1	2	-2	-8	-3	2	2	-3	14	1	18	16	39	61	87
85:1	2	7	11	6	1	4	6	0	2	21	12	-3	-18	-37
90:1	4	-1	8	-1	3	3	5	2	2	13	22	28	34	39
95:1	0	-5	-14	-3	0	0	-5	4	1	8	1	-3	-7	-12
100:1	5	11	0	7	2	4	4	3	3	8	19	27	33	38
105:1	3	-2	5	-5	2	-	-2	8	2	7	10	29	48	67
110:1	3	3	10	7	1	3	6	-7	1	7	15	6	-5	-15
115:1	3	-5	-3	-2	2	1	-2	8	3	5	11	15	19	22
120:1	6	5	-3	1	2	3	4	-3	3	7	0	-11	-19	-24
125:1	5	6	11	11	3	4	6	8	4	6	-1	18	28	36
130:1	4	3	0	-5	3	3	0	1	1	7	10	15	21	26
135:1	-1	0	5	5	-1	1	3	6	3	8	3	5	6	5
140:1	2	1	3	0	3	2	2	-7	1	6	17	24	29	33
145:1	7	-2	3	2	2	3	2	1	4	7	6	10	12	16
150:1	1	7	1	0	1	1	1	1	0	6	2	4	6	7
155:1	4	-2	-1	1	0	0	0	5	2	6	17	20	23	24
160:1	0	-1	4	3	2	2	2	8	4	6	4	4	2	2
165:1	2	1	-5	-8	-1	-1	-2	-7	0	6	-	-2	-5	-8
170:1	1	1	13	7	2	3	3	8	2	6	5	12	18	24
175:1	-6	2	-3	-4	2	0	-1	-4	2	5	10	13	15	17
180:1	8	1	7	5	0	2	3	-6	0	5	8	11	12	16
	83	78	109	55	55	72	63	84	57	431	1807	1955	2035	2109

Rate of Rise Data - Slab 4
10-Minute Intervals

MIN:SEC	CH 1	CH 2	CH 3	CH 4	CH 5	CH 6	CH 7	CH 8	CH 9	CH10	CH11	CH12	CH13	CH14
0:1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:1	8	19	13	4	4	5	3	5	6	4	4	4	3	5
20:1	-1	1	0	0	1	0	1	1	2	2	3	2	1	1
30:1	1	4	-2	3	2	2	3	3	2	2	4	1	2	1
40:1	2	7	0	3	1	1	4	3	2	4	5	3	4	2
50:1	5	8	2	6	3	2	8	4	4	5	9	3	4	3
60:1	5	6	5	5	4	4	11	7	4	6	8	4	7	4
70:1	2	8	10	2	2	3	6	6	1	5	1	2	5	0
80:1	3	5	5	-1	0	4	1	5	3	6	1	4	6	3
90:1	7	0	-6	16	10	9	13	5	12	5	16	1	6	3
100:1	2	0	3	2	2	2	4	2	-2	4	0	3	6	1
110:1	3	4	4	4	6	10	11	6	10	5	3	3	7	4
120:1	7	2	4	6	1	-2	-1	-3	3	7	3	5	7	4
130:1	2	-11	3	13	9	1	2	12	2	5	5	7	9	4
140:1	-1	-4	-2	11	4	9	5	10	8	4	12	0	1	3
150:1	5	16	5	7	7	5	4	3	6	5	6	5	8	2
160:1	4	-5	4	2	0	-1	13	4	1	2	0	5	5	3
170:1	3	-4	4	4	4	6	13	5	3	0	7	-1	1	2
180:1	2	17	0	4	6	7	4	5	2	2	4	6	0	1
TOTAL	59	73	52	90	66	67	105	83	69	73	101	57	82	46

Rate of Rise Data - Slab 4
10-Minute Intervals (Cont'd)

MIN:SEC	CH15	CH16	CH17	CH18	CH19	CH20	CH21	CH22	CH23	CH24	CH25	CH26	CH27	CH28
0:1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:1	4	3	3	6	4	4	5	7	3	13	1116	1259	1458	1704
20:1	1	3	4	2	1	1	2	3	0	40	197	192	165	125
30:1	2	4	7	2	2	2	3	10	2	50	107	6	-150	-338
40:1	3	8	9	5	4	5	4	6	2	52	65	148	241	370
50:1	4	11	13	6	4	6	8	3	3	34	49	-15	-90	-199
60:1	7	10	12	5	3	6	5	2	2	36	30	23	8	-9
70:1	4	6	13	0	4	5	2	8	2	27	51	118	166	214
80:1	5	3	-4	2	4	5	0	16	3	29	21	2	-15	-33
90:1	6	6	19	5	4	8	11	2	4	34	34	25	16	2
100:1	5	6	-14	4	2	4	-1	7	4	16	20	24	26	26
110:1	6	1	15	2	3	3	4	1	3	14	25	35	43	52
120:1	9	0	-6	-1	4	4	2	5	6	12	11	4	0	-2
130:1	9	9	11	6	6	7	6	9	5	13	9	33	49	62
140:1	1	1	8	5	2	3	5	-1	4	14	20	29	35	38
150:1	8	5	4	2	3	4	3	2	4	13	8	14	18	22
160:1	4	-3	3	4	2	2	2	13	6	12	21	24	25	26
170:1	3	2	8	-1	1	2	1	1	2	12	5	10	13	16
180:1	2	3	4	1	2	2	2	-10	2	10	18	24	27	33
TOTAL	83	78	109	55	55	72	63	84	57	431	1807	1955	2035	2109

Rate of Rise Data - Slab 4
20-Minute Intervals

MIN:SEC	CH 1	CH 2	CH 3	CH 4	CH 5	CH 6	CH 7	CH 8	CH 9	CH10	CH11	CH12	CH13	CH14
0:1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20:1	7	20	13	4	5	5	4	6	8	6	7	6	4	6
40:1	3	11	-2	6	3	3	7	6	4	6	9	4	6	3
60:1	10	14	7	11	7	6	19	11	8	11	17	7	11	7
80:1	5	13	15	1	2	7	7	11	4	11	2	6	11	3
100:1	9	0	-3	17	12	11	17	7	10	9	16	4	12	4
120:1	10	6	8	10	7	8	10	3	13	12	16	8	14	8
140:1	1	-15	1	24	13	10	7	22	10	9	17	7	10	7
160:1	9	11	9	9	7	4	17	7	7	7	6	10	13	5
180:1	5	13	4	8	10	13	17	10	5	2	11	5	1	3
TOTAL	59	73	52	90	66	67	105	83	69	73	101	57	82	46

20-Minute Intervals (Cont'd)

MIN:SEC	CH15	CH16	CH17	CH18	CH19	CH20	CH21	CH22	CH23	CH24	CH25	CH26	CH27	CH28
0:1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20:1	5	6	7	8	5	5	7	10	3	53	1313	1451	1623	1829
40:1	5	12	16	7	6	7	7	16	4	102	172	154	91	32
60:1	11	21	25	11	7	12	12	5	5	70	79	8	-82	-208
80:1	9	9	9	2	8	10	2	24	5	56	62	120	151	181
100:1	11	12	5	9	6	11	10	9	8	50	54	49	42	28
120:1	15	1	9	1	7	7	6	6	9	26	36	39	43	50
140:1	10	10	19	11	8	10	11	8	9	27	29	62	84	100
160:1	12	2	7	6	5	6	5	15	10	25	29	38	43	48
180:1	5	5	12	0	3	4	3	-9	4	22	23	34	40	49
TOTAL	83	78	109	55	55	72	63	84	57	431	1807	1955	2035	2109

DATA SYSTEM

DATA SYSTEM

To record thermocouple data from the unexposed side of the test penetrations and the furnace temperature, it was necessary to employ a data system capable of handling fifty channels of data. This system was comprised of a digital temperature recorder, a paper tape recorder-reader, a minicomputer, and a large computer center.

Thermocouples were directly wired to Kaye Instruments, Digital Temperature Recorders. These units supply a data presentation of thermocouple output in degrees Fahrenheit in column format. The Kaye recorders are paralleled to paper tape recorders.

There were two 8-level Facit recorders used during the test to record the actual temperature of the furnace and the unexposed side thermocouples. There were a total of twenty-five (25) channels of temperatures recorded. The first twenty-four (24) channels were used to take actual temperature data off the unexposed side of the slab. Channel 25 was the average inside furnace temperature. For actual placement of thermocouple locations, see Figures IV-1 to IV-8, Appendix IV.

Two forms of data were taken from the recorder. One was a printed copy of listings of temperature and the other is an 8-level punch tape which is used as an input source to the Wang 2200T computer system. The Wang system accepts the 8-level punch tape via a high speed tape recorder, where it is stored on a permanent type diskette as a permanent file. Upon request, the Wang system listed the data tables from a complete listing of time/temperature data stored internally on this disc.

The Wang also has the options to plot all temperature data on a 16-inch Digital Drum Plotter or access the Trinity University Computer System Network. By using the data set (Modern 4800 via telephone communication network) the Wang system communicated with Trinity's IBM 370 computer. The data was further analyzed, plotted, and compared with other known test data. All test results from Trinity University's computer section was sent back to Southwest Research Institute in two modes:

1. Via a data phone set to a Tektronic CRT (Model 4015) for analysis and review of the data and graphs.
2. Via plots and graphs hand carried to SwRI from Trinity.

Figure V-1 shows the entire data system and Figure V-2 shows the minicomputer system used.

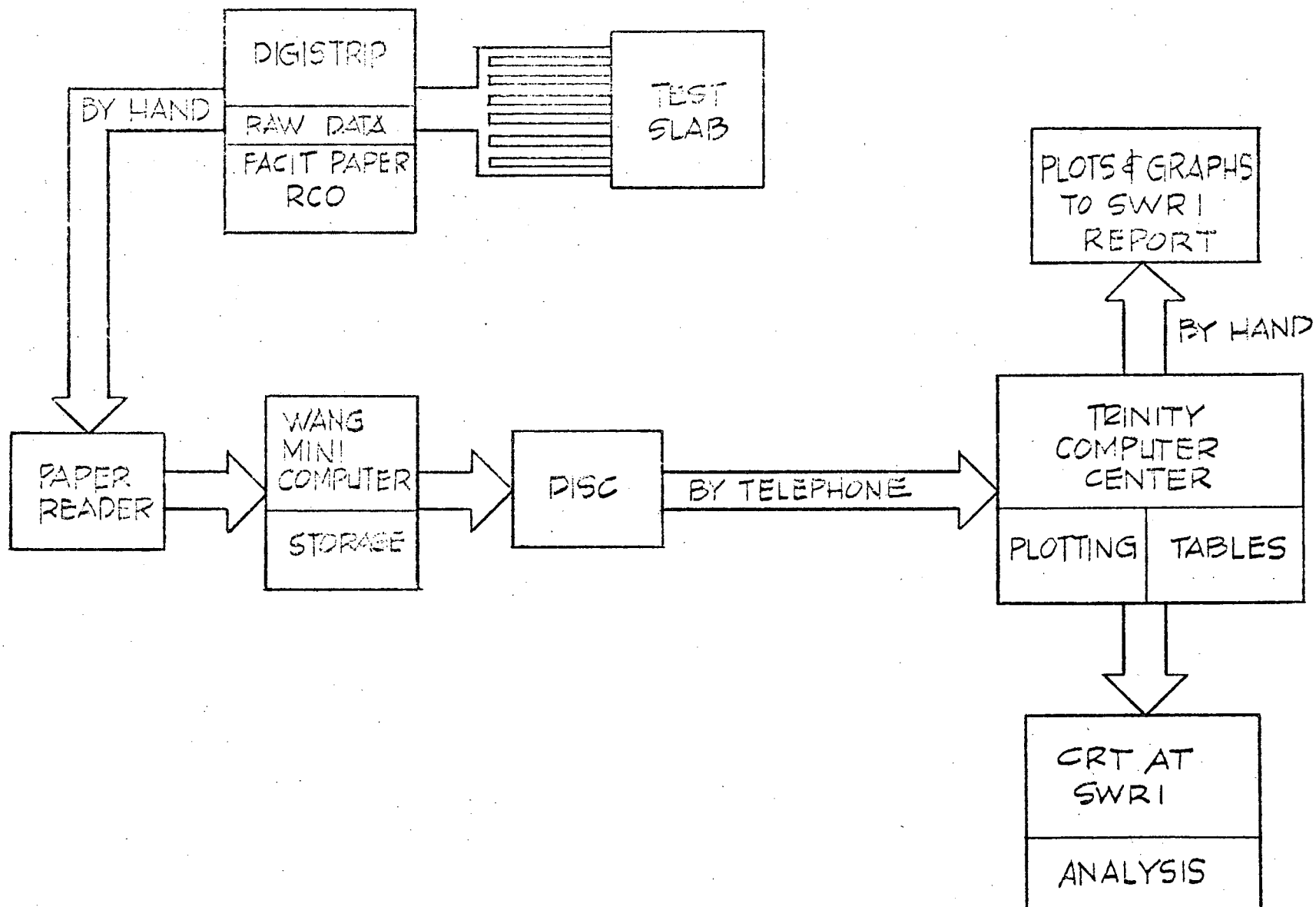
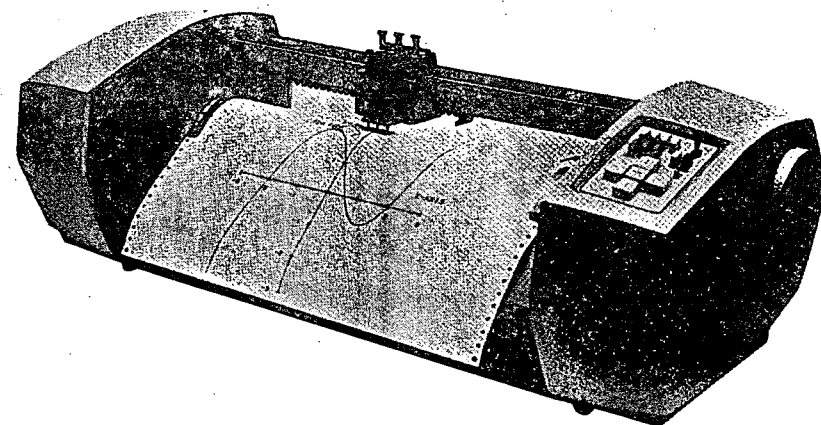
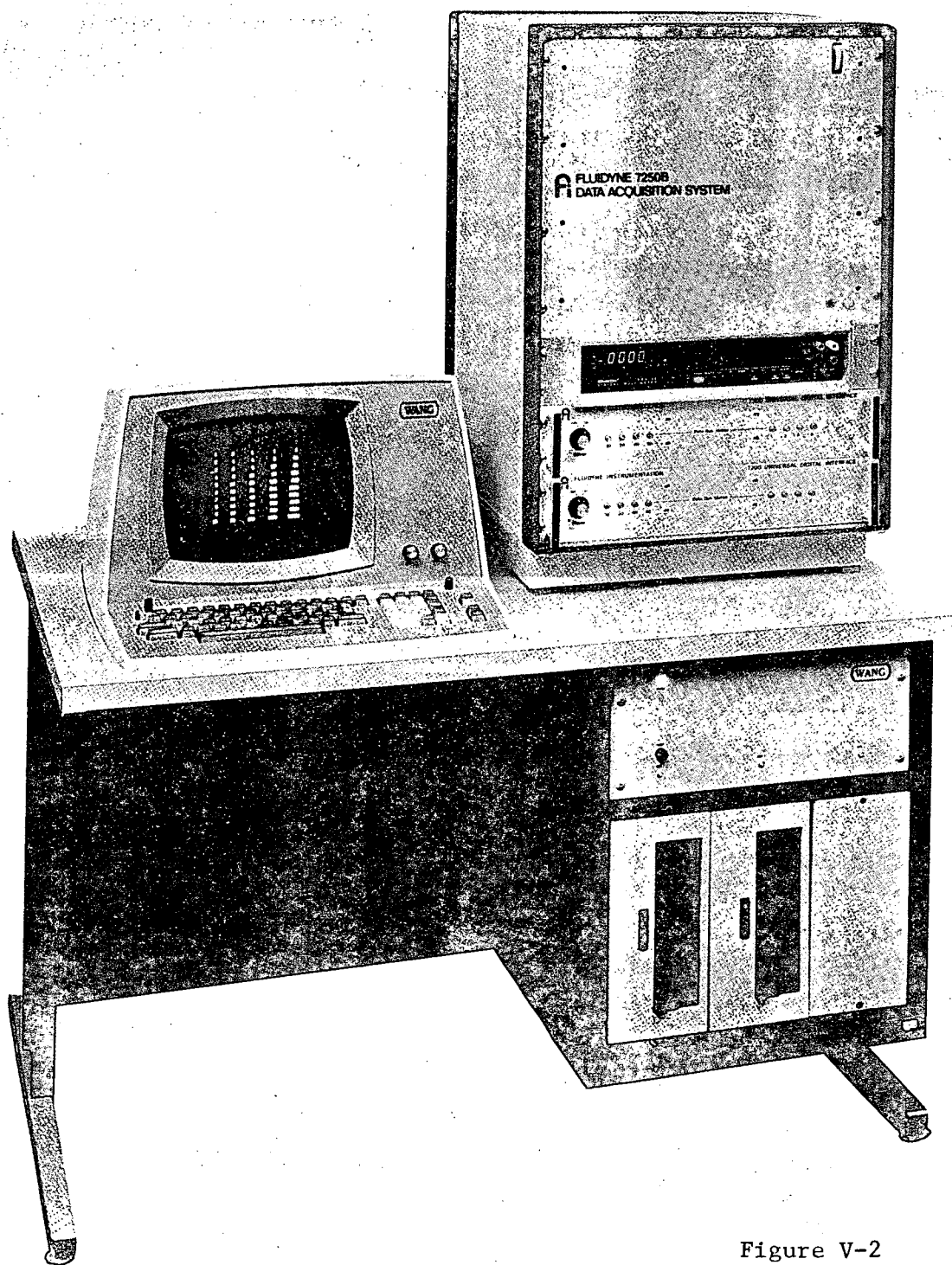


Figure V-1



A complete data acquisition/data processing system is dedicated solely for use by Fire Technology. The system provides the capability to input and read 224 signals per second. The data acquisition system is addressed by a keyboard through a central processing unit. By this means, the channels to be scanned and the rate of scanning may be selected. The input signals are digitized and stored on magnetic disks for subsequent processing. The system output may be in either printed form, using the 112-character impact line printer, or graphic form, using the 16-in. digital drum plotter.

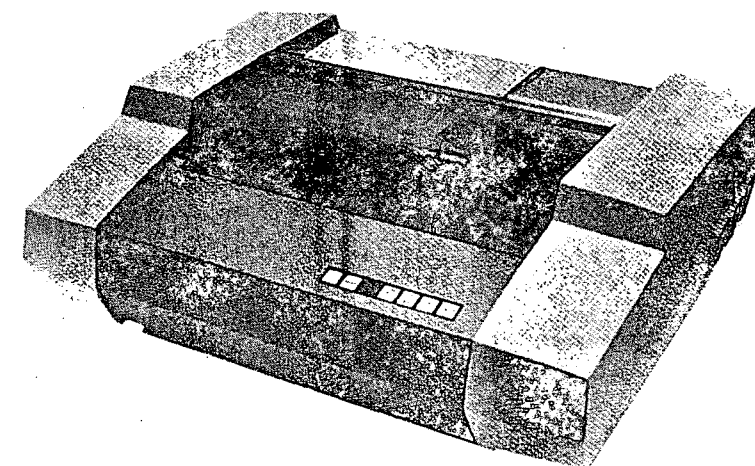


Figure V-2

VACUUM SYSTEM

VACUUM SYSTEM

As requested by individual sponsors, it is possible to impose a differential pressure across the penetrations seals during the fire exposure period of the test. This can be accomplished by either establishing the desired positive pressure inside the furnace or by creating a negative pressure on the unexposed side of the test slab. The positive pressure approach entails restricting the flue discharge of the furnace and overpressuring the intakes of the aspirating burners. Past experience has shown that this creates difficulty in controlling furnace temperature because of the faced burning of cable insulation on the exposed side. To put a negative pressure on the unexposed side involves construction of a large chamber that seals to the cold side of the test slab. This enclosure is then attached to a high volume, high pressure blower as shown in Figure VII-1. Control of the pressure level is obtained by dampers at the intake of the blower or on the enclosure itself.

Because the chamber restricts free access of air on the unexposed side of the furnace, it is possible to obtain higher temperatures on the cold side than normal. However, early tests indicated that these temperature differences were not significant.

Normal test procedures for use of the vacuum enclosure are:

- 1) The test slab with penetrations is placed on the furnace and extension sleeve assembly. The cold side cable ends are sealed with silicone caulk.
- 2) The test slab is sealed to the sleeve.
- 3) Visual inspections of the penetrations are made from the cold side and the inside of the furnace. If necessary seals are corrected.

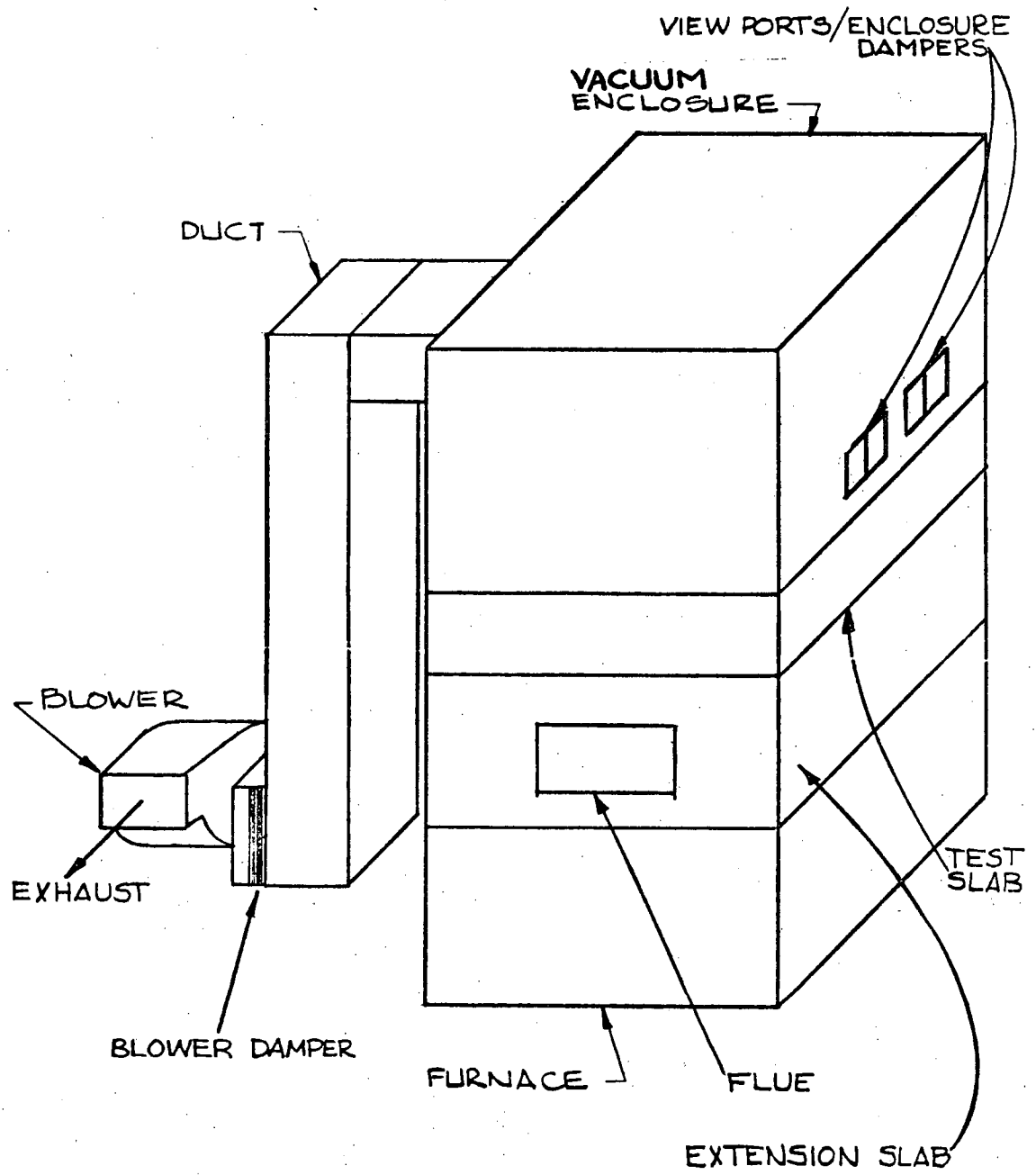
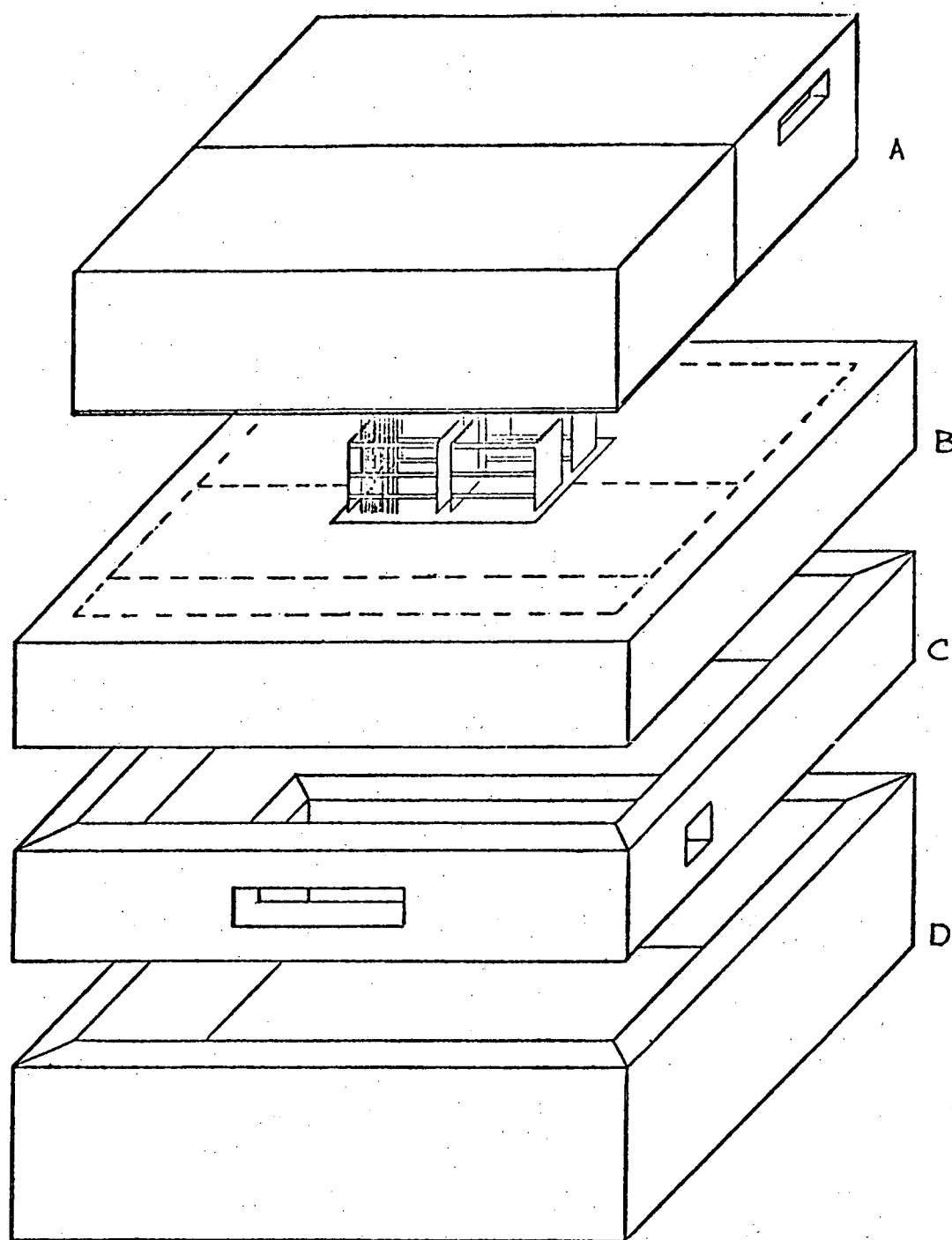


Figure VI-1. Vacuum System

- 4) The vacuum enclosure is mated to the test slab by a three inch angle seal surface. The seal is made by a large bead of standard air conditioning duct putty.
- 5) The enclosure and slab are fastened together using C-Clamps.
- 6) The blower and duct assembly are attached and sealed to the vacuum enclosure.
- 7) The blower is started and the selected vacuum is established.
- 8) Inspection of the penetration seals is accomplished from the inside of the furnace with the vacuum on.
- 9) Once all seals have been verified, the vacuum system is allowed to establish steady state for five minutes prior to the start of the fire exposure period.

As shown above, this procedure allows for a number of inspections of the seal prior to the test. Vacuum readings are taken in two zones of the chamber as space allows and are monitored continuously by vacuum gauges or manometers using a water medium during the test.



- A.) VACUUM ENCLOSURE
- B.) TEST SLAB (TYPICAL)
- C.) FURNACE EXTENSION SLEEVE
- D.) FURNACE

Figure VI-2. Exploded View of Test Assembly

SLAB #4 (B1-B8)

TIME		FURNACE TEMPERATURE		REMARKS	PRESSURE	
Actual	Hr:Mins	Actual	Required		$\Delta P.L.$	$\Delta P.R.$
7:20	-5	79°F				
7:25	0	79°F		Smoke from inside	1.2	1.3
7:30	5	1445°F	1000°F	OK	1.1	1.3
7:35	10	1243°F	1300°F	OK	1.2	1.3
7:40	15	1370°F	1399°F	OK	1.1	1.3
7:45	20	1440°F	1462°F	Smoke clearing	1.1	1.3
7:50	25	1519°F	1510°F	OK	1.1	1.3
7:55	30	1545°F	1550°F	OK	1.1	1.3
8:00	35	1583°F	1584°F	OK	1.1	1.3
8:05	40	1610°F	1613°F	OK	1.1	1.3
8:10	45	1632°F	1638°F	OK	1.0	1.3
8:15	50	1655°F	1661°F	OK	1.0	1.2
8:20	55	1680°F	1681°F	OK	1.0	1.2
8:25	1:00	1692°F	1700°F	OK	0.95	1.15
8:30	1:05	1717°F	1718°F	OK	0.95	1.15
8:35	1:10	1739°F	1735°F	OK	0.95	1.15
8:40	1:15	1743°F	1750°F	OK	0.95	1.15
8:45	1:20	1759°F	1765°F	OK	0.90	1.15
8:50	1:25	1769°F	1779°F	Adjustment of $\Delta P.L.$	1.0	1.3
8:55	1:30	1790°F	1792°F	OK	1.0	1.3
9:00	1:35	1800°F	1804°F	OK	1.0	1.2
9:05	1:40	1811°F	1815°F	OK	1.0	1.2
9:10	1:45	1822°F	1826°F	OK	1.0	1.2
9:15	1:50	1836°F	1835°F	OK	1.0	1.2
9:20	1:55	1845°F	1843°F	OK	1.0	1.2
9:25	2:00	1846°F	1850°F	OK	1.0	1.2
9:30	2:05	1848°F	1856°F	OK	1.0	1.2
9:35	2:10	1859°F	1862°F	OK	0.95	1.15
9:40	2:15	1862°F	1868°F	OK	0.95	1.15
9:45	2:20	1876°F	1875°F	OK	0.95	1.15
9:50	2:25	1880°F	1881°F	OK	0.95	1.15
9:55	2:30	1884°F	1888°F	OK	0.95	1.10
10:00	2:35	1895°F	1894°F	OK	0.95	1.10
10:05	2:40	1900°F	1900°F	OK	0.95	1.10
10:10	2:45	1908°F	1906°F	OK	0.95	1.10
10:15	2:50	1912°F	1912°F	OK	0.95	1.10
10:20	2:55	1906°F	1918°F	OK	0.95	1.10
10:25	3:00	1940°F	1925°F	OK	0.95	1.10

CABLE PENETRATION FIRE STOP QUALIFICATION TEST
(P634/D4)

10/06/77

Copy to Stds Board.

Rec'd Milwaukee Wisconsin

11/14/77

CABLE PENETRATION FIRE STOP
QUALIFICATION TEST
P634/D4
SEPTEMBER 28, 1977

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Prepared by Task Force 12-40 of Insulated Conductors Committee
of IEEE.

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10/07/77

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CABLE PENETRATION FIRE STOP
QUALIFICATION TEST

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FOREWORD

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Page 1FOREWORD

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Purpose of Standard

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This standard provides qualification test procedures for type testing cable penetration fire stops when mounted in rated fire barriers.

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Statement of Problem

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In the course of construction of all types of buildings, cables in raceways penetrate barriers such as walls, floors, or floor-ceiling assemblies of that building. If these barriers are rated as fire resistive barriers, the penetrations should be as resistant to fire as required of the barriers. Thus, in order to test the penetration and rate it, the penetration should be mounted in a rated wall, floor, or floor ceiling assembly as it would be used in practice and the combination exposed to the same standard fire as used for the wall, floor, or floor ceiling assembly.

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Standard Fire in E119

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The standard fire is defined by a time-temperature relationship which must be produced by the test furnace. The seven defined points on this curve are given as follows:

1,000 F (538 C)	at 5 min	58
1,300 F (704 C)	at 10 min	59
1,550 F (843 C)	at 30 min	60
1,700 F (927 C)	at 1 hr	61
1,850 F (1,010 C)	at 2 hr	62
2,000 F (1,093 C)	at 4 hr	63
2,300 F (1,260 C)	at 8 hr or more	64

A more detailed description is given in ANSI/ASTM E119 Appendix A1 which lists intervening points and tabulates the integrated area under the time-temperature curve as a function of time.

The same standard fire is used on the cable penetration fire test.

Fundamental Difference Between a Fire Test on a Barrier Alone and a Penetration/Barrier Combination

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The fire resistive barrier described above has a relatively low thermal conductivity so that it can maintain a 1,300-1,600 F temperature difference between the face exposed to fire and the opposite face. A cable penetration has a metallic electrical conductor which has a very high thermal conductance. It may have many large copper conductors and steel trays or conduits or metal parts of the penetration, all of which pass through the barrier. On the cool side of the barrier, these metal parts are necessarily at a higher temperature than the wall adjacent to the penetration. The stop material filling the interstices between cables or between cables and the barrier should give comparable thermal conductance to the barrier itself, in addition to resisting the fire.

Thus the higher temperature rise of the metallic parts of the penetration presents a new and different problem and may make it impossible to use the same pass-fail criteria as for the barriers. An obvious failure occurs when sufficient heat is transmitted so that the insulation of the cable on the cold side bursts into flame. This is discussed further in Section 2.3.

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Maximum Allowable Cable Penetration Fire Stop Face Temperature

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If one examines the temperatures across the unexposed face of the cable penetration fire stop near the end of a three-hour test, the temperatures will vary widely depending on the distance from a cable or a raceway. The temperature of the unexposed face of the cable penetration fire stop material at a point away from the cable or the raceway will also depend on the thermal conductivity of the cable penetration fire stop material. The maximum temperature on that face is the important one. If this temperature is at the interface between the cable jacket and the cable penetration fire stop material, and this temperature rises to the self-ignition temperature of the cable jacket or the stop material, a fire may result.

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Thus, the test procedure finds the maximum temperature on the unexposed cable penetration fire stop face and compares it with a maximum allowable temperature. The maximum allowable temperature is defined as one at which the insulation systems expected to be used should not ignite.

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The maximum allowable temperature is arrived at by an examination of the known ignition temperatures of insulating materials. Ignition temperature is measured by a procedure in ASTM D1929-68 (ANSI K65.111-1971) "Standard Methods of Test for the Ignition Properties of Plastics." This is described as a hot-air ignition furnace. The values obtained represent the lowest ambient air temperature that will cause ignition of the material under the conditions of test. Measured properties are "flash-ignition temperature" where an igniting source is present (small gas flame) and "self-ignition temperature," where ignition occurs spontaneously.

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For ignition, there must be adequate temperature; the combustible gases released from the hot insulation must be mixed with the correct proportion of air.

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The required temperature to cause ignition would be much higher than the ASTM value because the hot gases released are swept away by air drafts, and a higher temperature is needed to produce a higher rate of release of gases so that an ignitable gas/air ratio can be attained. Thus, there is a good factor of safety in the assigned maximum allowable temperature.

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Typical values of the ignition temperatures as determined in ASTM D1929-68 (ANSI D1929-68) are given below in deg F:

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<u>Material</u>	<u>Flash-Ignition</u>	<u>Self-Ignition</u>	
Cotton	446-511	490	140
Newspaper	445	445	141
Pine shavings	406-507	500	142
Wool	401	---	143
Polyethylene	645	660	156
Polyvinyl chloride	735	850	157
Polytetrafluoroethylene	---	986	158
Polyvinyl chloride-acetate	608-644	815-1,035	159
Polystyrene	635-680	910-925	160
Nylon 66	750-790	788-806	161

The maximum allowable temperature selected for a cable penetration fire stop should be based on the self-ignition temperature of the outer cable covering the fire stop materials, or materials in contact with the cable penetration fire stop, whichever has the lower self-ignition temperature. For cable penetration fire stops the self-ignition temperatures of the outer cable covering and fire stop materials are generally above 700 F.

The maximum allowable temperature is the actual measured temperature on the unexposed side and not temperature rise. This is because the ignition of a given material occurs at a specific temperature F.

What This Standard Does Not Do, and Problems Yet to Be Covered

Pressure Seals

A penetration fire stop and the fire barrier itself should, in some locations, function as a seal to maintain any existing pressure difference and should not pass through hot gases or smoke. It should maintain that ability for the duration of the rating test. While this problem is recognized, the present standard does not address it, nor does the E119 test. This should be a future task.

If it is desired by the user of this standard, he can specify an added test, outside the scope of this standard and supplementing the information it provides, which would require a check of the ability of the penetration to maintain a differential pressure before, during, and after the fire test. There has been no standard method yet proposed and accepted for checking this seal during a fire test.

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<u>Ampacity Derating Due to Penetration Stops</u>	200
<u>It is recognized that the thermal insulating characteristics of a penetration fire stop may have an effect on the ampacity of the cables passing through the penetration. Design of the fire stop should address this effect. However, ampacity considerations are not a part of the qualification test and, consequently, are not within the scope of this standard.</u>	202 203 206 207
<u>Adequacy of Test Furnace</u>	209
<u>Furnaces used in these rating tests are sometimes operated at lower than atmospheric pressure, and thus hot gases or smoke would not tend to leak outward but cold air would tend to flow inward toward the fire. This test may not represent a typical situation in a real fire and should be the subject of future investigations.</u>	212 213 215 216 217
<u>Test Limitation and Cautions</u>	220
<u>Just as in the case of the fire barrier in ANSI/ASTM E119 76, this test is run with a specific standard fire. This fire may or may not be as severe as fires actually experienced and hence may not predict the performance of the cable penetration fire stop barrier combination in actual service. It is the judgment of those experienced in the field that relative performance is accurately portrayed and the relative values may be used as a basis for engineering judgment in a particular design situation.</u>	222 225 226 227 228
<u>The test, as already pointed out, gives no information on the necessity, if any, for ampacity derating of cables within the cable penetration, nor does it give any indication of the capability of the stop to maintain a pressure differential between the opposing faces of the barrier before, during, or after a fire test.</u>	230 232 233
<u>Furthermore, the user must consider the higher temperature of those components emerging from the face of the barrier not exposed to fire, e.g., the conductors and metallic elements, such as the tray, conduit, or structural parts of the penetration. These higher temperatures must be considered by the designer who will perform a hazards analysis and will take steps necessary to counter these hazards if any are found.</u>	235 236 237 238

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Electric Penetration Assemblies in Containment Structures 241

Electric penetration assemblies in containment structures are 243
not covered in this document. For guidance in this area, 246
refer to IEEE Standard 317.

Seismic, Radiation, Aging, and LOCA 250

Although it is recognized that seismic, radiation, aging, and 252
LOCA conditions may be required to be considered and 253
evaluated for nuclear power plants, these effects are not
within the scope of this standard. For guidance in these 255
areas, refer to IEEE-344-1975 and IEEE 323-1974.

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<u>CABLE PENETRATION FIRE STOP QUALIFICATION TEST</u>	258
<u>1.0 SCOPE</u>	261
This standard provides direction for establishing type tests for qualifying the performance of cable penetration fire stops when mounted in rated fire barriers.	263 264
<u>2.0 PURPOSE</u>	268
The purpose of this standard is to establish type tests to assure that cable penetration fire stops meet the required fire rating.	270 271
<u>2.1 General</u>	275
The requirements presented include the principles and procedures for testing. These test requirements, when met, will confirm the adequacy of the cable penetration fire stop design under fire conditions tested.	277 278 279
<u>2.2 Applicability</u>	282
Cable penetration fire stops that meet the requirements outlined herein are intended for use in power-generating stations including nuclear-generating stations, as well as other applicable commercial and industrial installations. Among the categories of cables covered, but not limited to, are those used for power, control, and instrumentation services.	284 285 287 288
<u>2.3 Method of Approach</u>	291
When a cable penetration is used in a rated fire-resistive barrier, the fire stop should remain intact and prevent the spread of fire and restrict the passage of hot gases through that barrier for the required rated time. A fire barrier meeting the requirements of E119 must limit the flow of heat or gases through from the fire side as indicated by a relatively cool surface, one whose temperature will not ignite gases, cotton waste, or NFPA Class A materials which require a temperature of approximately 400 F (in E119 this is expressed as 250 F above ambient). With a fire stop, however, there are always metallic conductors and perhaps structural portions of the penetration which present good thermal conduction paths through the fire stop and whose temperatures at the point of exit may exceed markedly the approximately 400 F expected of the unpenetrated wall. The temperature can be such that the insulation	293 294 296 297 298 299 300 301 302 303

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and jacket on the cable may ignite, indicating a failure of the stop. These higher temperatures of the metallic through-portions of the penetration must be considered and evaluated by the user/designer.

3.0 DEFINITIONS

These definitions establish the meanings of words in the context of their use in this standard:

3.1 Unexposed Side

The side of a fire-rated wall, floor-ceiling assembly, or floor which is opposite to the fire side. Also referred to as cold side.

3.2 Fire Resistive Barrier

A wall, floor, or floor-ceiling assembly erected to prevent the spread of fire. (To be effective, fire barriers must have sufficient fire resistance to withstand the effects of the most severe fire that may be expected to occur in the area adjacent to the fire barrier and must provide a complete barrier to the spread of fire.)

3.3 Fire Resistive Barrier Rating

This is expressed in time (hours and minutes) and indicates that the wall, floor, or floor-ceiling assembly can withstand, without failure, exposure to a standard fire for that period of time. The test fire procedure and acceptance criteria are defined in ANSI/ASTM E119-1976.

3.4 Fire Rating

The term applied to cable penetration fire stops to indicate the endurance in time (hours and minutes) to the standard time-temperature curve in ANSI/ASTM E119-76, while satisfying the acceptance criteria specified in this standard.

3.5 Cable Penetration Fire Stop

Material, devices, or an assembly of parts providing cable penetrations through fire-rated walls, floors, or floor ceiling assemblies, and maintaining their required fire rating.

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<u>3.6</u>	<u>Cable Penetration</u>	352
	An assembly or group of assemblies for electrical conductors to enter and continue through a fire-rated structural wall, floor, or floor-ceiling assembly.	354 355
<u>3.7</u>	<u>Raceway</u>	356
	Any channel that is designed and used expressly for supporting or enclosing wires, cable, or bus bars. Raceways consist primarily of, but are not restricted to, cable trays and conduits.	360 361
<u>3.8</u>	<u>Module</u>	364
	An opening in a fire resistive barrier so located and spaced from adjacent modules (openings) that its respective cable penetration fire stop's performance will not affect the performance of cable penetration fire stops in any adjacent module. A module may take on any shape to permit the passage of cables from one or any number of raceways.	366 367 368 369
<u>4.0</u>	<u>TEST DESCRIPTION</u>	372
<u>4.1</u>	<u>General</u>	374
	This section describes the methods for testing cable penetration fire stops around cables penetrating a fire resistive barrier.	376 377
<u>4.1.1</u>	<u>Applicability</u>	380
	These methods shall be applicable to assemblies or groups of cables and materials or components which comprise the fire stop that will be installed in a fire resistive barrier wall, floor, or floor-ceiling assembly. It is not the intent of this standard to test the wall, floor, floor-ceiling assembly or other structural members of the fire resistive barrier. Therefore, no simulated structural loading is required.	382 383 384 385 386 387
<u>4.1.2</u>	<u>Penetration Fire Stop Components - Excluding Cable</u>	390 392
	Individual components of the fire stop system shall have a flame spread rating of 25 or less in accordance with ASTM E84. Components to	394 395 396

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which ASTM E84 test is not applicable shall be tested in accordance with ASTM D2863 and shall have a minimum limiting oxygen index of 25. 398

4.1.3 Method of Testing 401

Qualification shall be by type testing of an actual full-sized cable penetration fire stop or module indicative of installed conditions. 403
404

4.1.4 Test Experience 407

Cable penetration fire stops and/or modules that have successfully functioned under test can be considered qualified for equal or less severe fire rating. Testing in the floor/ceiling position qualifies the cable penetration fire stops for either floor or wall penetration provided the cable penetration fire stop under test is constructed symmetrically so as to provide equal resistance to fire from either side. For unsymmetrical design, refer to 4.3.5. 409
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4.2 Test Specimens 418

4.2.1 General 420

The type tests specified shall be for power, control, and instrumentation (including signal and communications) cables. The cable penetration fire stops shall be installed in modules or openings through fire-rated barriers, which may be lined with metallic components. Cables may penetrate these openings either directly without a raceway or within a metallic raceway depending on the intended installed configuration. 422
423
425
426
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4.2.2 Cable Selection and Raceway Fill 437

The selection of the sizes, construction, and materials of the cables and cable penetration opening fill to be used in the test shall be representative of the cables used in the fire stop under actual installed conditions. 439
440

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The cable sizes and cable penetration fire stop fill listed in Table I may be used. If these sizes, constructions, or fills are not indicative of the actual installed conditions, more suitable selections shall be used. It is not the intent that different construction types, i.e., instrumentation and medium voltage power cable, be installed in the same test cable penetration unless this is indicative of actual conditions.

In order to assess the design of cable penetration fire stops by type testing, similar designs with maximum and minimum, or zero, percent cable fills shall be tested.

When large modules in the fire resistive barrier are used to permit several cable systems to pass through, intermediate percent fills as well as minimum and maximum should be tested in the openings. If these designs are successfully tested, then all designs within these extremities of fill also are qualified. For further guidance, refer to Appendix 3.

4.2.3

Cable Penetration Fire Stop Opening Dimensions and Type

The opening dimensions and type of cable penetration fire stops to be tested shall be representative of the type to be used. In order to facilitate the selection of test specimens where several variations of the same type penetration are used, the sizes and type of cable penetration fire stop openings listed in Table II may be used as a basis for selection.

If these sizes or types are not indicative of the actual installed condition, more suitable selections shall be used.

In order to assess the design of the cable penetration fire stop by type testing, the largest module and/or opening shall be tested and the cable selected in accordance with 4.2.2.

If the largest cross-sectional module design is successfully tested, then all designs of

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the same type and size module or smaller 476
modules are also qualified. Likewise, arrays 477
of openings or modules which are successfully
tested shall qualify similar arrays with the 478
same or larger spacing.

The user of cable penetration fire stops and 480
modules qualified by themselves shall 481
demonstrate that the influence of adjacent 481
cable penetration fire stops and/or modules 483
does not compromise their qualification. For
further guidance, refer to Appendix 3.

4.3 Fire Test Facility and Procedure 486

4.3.1 Test Room 488

The fire test shall be conducted in a suitable 490
room or area as defined in ANSI/ASTM E119-76, 491
paragraph 10.1.

4.3.2 System Test 494

The cable penetration fire stop shall be 496
tested as a complete system. The raceway 497
mounting and anchoring to the fire stop
assembly, the cable arrangement, including 499
attachment to raceway and the raceway fill, 500
shall be representative of the actual
installed conditions.

4.3.3 Cable Installation 503

The cable within the penetration shall 505
protrude 3 ft to 5 ft on the unexposed side
and the ends capped. The cable on the side to 506
which the flame is to be applied shall
protrude a minimum of 1 ft. Vertical cables 507
in floor penetration tests shall be supported
on the unexposed side to simulate continuous
cables in an actual installation. 508

4.3.4 Raceway Installation 511

If the penetration under test is to simulate 513
an actual penetration in which the raceway
passes through the fire barrier, the test 514
raceway shall protrude 3 ft to 5 ft on the
unexposed side and a minimum of 1 ft on the
exposed side.

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<u>4.3.5</u>	<u>Orientation</u>	517
	Testing in the floor/ceiling position	519
	qualifies the cable penetration fire stop for	520
	either a floor or wall penetration. Cable	522
	penetration fire stops that are symmetrical	
	with respect to design and location in the	
	wall/floor need only be fire tested on one	523
	side. Cable penetration fire stop designs	524
	which are unsymmetrical in design or location	
	may require testing on both sides for	525
	qualification. For example of unsymmetrical	526
	designs and location, refer to Appendix 3.	
<u>4.3.6</u>	<u>Time-Temperature Curve</u>	529
	The test penetration module shall be subjected	531
	to the standard time-temperature curve in	
	ANSI/ASTM E119-1976 (reproduced in Appendix 1)	532
	for the time necessary to obtain the required	
	fire rating.	
<u>4.3.7</u>	<u>Exposed Side Test Instrumentation</u>	535
	The temperature fixed by the curve shall be	537
	deemed to be the average temperature obtained	
	from the readings of not less than three	538
	thermocouples symmetrically disposed and	
	distributed to show the temperature for each	540
	cable penetration fire stop. Additional	541
	thermocouples shall be used, as necessary, for	
	larger test specimens. The thermocouples	542
	shall be enclosed in sealed porcelain tubes	
	3/4 in. (19 mm) in outside diameter and	543
	1/8 in. (3 mm) in wall thickness, or, as an	
	alternative in the case of base metal	
	thermocouples, enclosed in sealed, standard-	544
	weight, 1/2 in. (13 mm), black wrought steel	
	or black wrought iron pipe. The exposed	545
	length of the pyrometer tube and thermocouple	
	in the flame area shall be not less than	
	12 in. (305 mm). Other types of protecting	546
	tubes or pyrometers may be used that, under	
	test conditions, give the same indications as	547
	the above standard. For cable penetrations	548
	through floors or floor/ceiling assemblies,	
	the junction of the thermocouples shall be	
	placed 12 in. away from the exposed face of	549
	the test penetration at the beginning of the	
	test and, during the test, shall not touch the	550

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sample as a result of its deflection. In the case of cable penetration through walls, the thermocouples shall be placed 6 in. (152 mm) away from the exposed face of the test penetration at the beginning of the test and shall not touch the test penetration during the test, in the event of deflection.

4.3.8 Exposed Side Temperature Reading Intervals

The temperatures shall be read at intervals not exceeding 5 min during the first 2 hr, and thereafter the intervals may be increased to not more than 10 min.

4.3.9 Flame Source Accuracy

The accuracy of the flame source control shall be such that the area under the time-temperature curve, obtained by averaging the results from the pyrometer readings, is within the following tolerances, or exceeds the corresponding area under the standard time-temperature curve in Appendix A1.

<u>Fire Test</u>		574
<u>Duration</u>	<u>Tolerance</u>	572
1 hr or less	10%	577
Over 1 hr to 2 hr	7.5%	575
Over 2 hr	5%	576

4.3.10 Unexposed Side Temperature

Temperatures on the penetration cold side surfaces shall be measured with thermocouples. A minimum of three thermocouples shall be located on the surface of each fire stop under test. The maximum temperature on the face of the cable penetration fire stop shall be measured. As a minimum, temperature shall be measured at the cable jacket/cable penetration fire stop interface, the interface between the fire stop, and through metallic components, other than the insulated cable conductor, and on the surface of the fire stop material.

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- 4.3.11 Unexposed Side Temperature Reading Intervals 592
- Temperature readings shall be taken at 594
 intervals not exceeding 15 min until a reading 595
 exceeding 212 F (100 C) has been obtained at
 any one point. Thereafter, the readings may 597
 be taken more frequently at the discretion of
 the tester, but the intervals need not be less 598
 than 5 min.
- 4.3.12 Hose Stream Test 600
- A hose stream test shall be conducted 602
 immediately following the end of the fire
 endurance test and removal, if necessary, of 603
 the test slab.
- For power-generating stations including 606
 nuclear-generating stations, a 1 1/2 in. hose 607
 discharging through a nozzle approved, for use 608
 on fires in electrical equipment producing a
 long-range-narrow-angle (30-90 deg set at
 30 deg included angle) high velocity spray 609
 only shall be used. The hose stream shall be 610
 applied to the exposed side. The water 611
 pressure shall be 75 psig, calculated, at the
 base of the nozzle and minimum flow of 75 gpm
 with a duration of application of 2 1/2 min
 per 100 sq ft of test slab. The nozzle 613
 distance shall be 10 ft from the center of the
 exposed surface of the test specimen.
- For other applicable industrial and commercial 615
 establishments, the hose stream shall be
 applied to the exposed surface for a period 616
 calculated on a basis of 2 1/2 min per
 100 sq ft of test slab. The stream shall be 617
 delivered through a 2 1/2 in. national
 standard playpipe equipped with 1 1/8 in. tip, 618
 nozzle pressure of 30 psig calculated, located
 20 ft from the exposed face.

5.0 EVALUATION OF TEST RESULTS 621

Cable penetration fire stops which allow cables or fire stop 623
 materials on the unexposed side to ignite, or allow
 thermocouples on the unexposed side to exceed the temperature 624
 limits specified, or any visible flame on the unexposed side, 626
 within the specified fire rating time, or the hose stream to
 cause through-openings, fail the test.

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5.1 Acceptance 629

The test can be considered acceptable and the cable penetration fire stop suitable for use in accordance with the fire rating, provided the following is met: 631 632

5.1.1 The cable penetration fire stop shall have withstood the fire endurance test as specified without passage of flame or gases hot enough to ignite the cable or other fire stop material on the unexposed side for a period equal to the required fire rating. 635 636 638

5.1.2 Transmission of heat through the cable penetration fire stop shall not raise the temperature on its unexposed surface above the self-ignition temperature as determined in ASTM D1929-68/ANSI K65.111-1971 of the outer cable covering, the cable penetration fire stop material, or material in contact with the cable penetration fire stop, when measured in accordance with 4.3.10 and 4.3.11. For power generating station, the maximum temperature is 700 F. 640 641 642 643 645

5.1.3 The fire stop shall have withstood the hose stream test without the hose stream causing an opening through the test specimen. 648 649

6.0 DOCUMENTATION OF TESTING 653

Following the procedures outlined in this standard, provide data necessary to document satisfactory compliance. Type test data derived from tests shall be organized to present the results in an orderly manner so as to be easily understood and located. 655 658 659

Specifically, the following data shall be recorded: 662

a. Manufacturer of cable 664

b. Manufacturer's designation for cable and generic name of materials used 667 668

c. Temperature, current, and voltage rating of cable 672

d. Physical dimensions including conductor size insulation and jacket thickness 674 675

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e.	Miscellaneous construction details including type of raceway, <u>etc.</u>	677 678
f.	Manufacturer of fire stop materials or devices	680
g.	Manufacturer of fire stop designation and generic name of materials and/or <u>devices</u>	682 683
h.	Environmental conditions, such as air ambient, air <u>currents</u>	685 686
i.	Details of hose stream test	688
j.	Complete description of materials surrounding the fire stop, <u>including</u> test results of 4.1.2	690 691
k.	The temperature and time readings taken	693
	<u>The test equipment shall be described in detail, supplemented with record of fuel supply, photographs, dimensioned drawings, and written specifications with not less data than that necessary to reproduce accurately the same test.</u>	695 696 697
	<u>The results, pass or fail, shall be recorded and supplemented with photographs and a statement of the conclusions <u>drawn</u> made by those conducting the test.</u>	699 700
	<u>Engineering data and references to other publications which were used to make the test and select the equipment shall <u>be</u> included in the documentation.</u>	702 703
	<u>Installation methods shall be described including any Quality Assurance data applicable to the specific <u>materials</u> and installation methods used.</u>	705 706

7.0 REFERENCES

	<u>The following documents were used as references in preparing this guide and may <u>be</u> useful in interpretation of its meaning:</u>	709 711 712
<u>ANSI/ASTM E-119-76</u>	Standard Methods of Fire Tests of Building Construction and Materials	715 716
<u>ASTM E84-76</u>	Standard Method of Test for Surface Burning Characteristics of Building <u>Materials</u>	719 720 721

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<u>ASTM</u> D2863-76	Standard Method for Measuring of	724
	Test for Flammability of Plastics	725
	Using Oxygen Index Method	726
<u>IEEE</u> -317-1976	Standard for Electric Penetration	730
	Assemblies in Containment Structure	731
	for Nuclear Generating Stations	
<u>ASTM</u> D1929-68/	Standard Methods of Test for the	733
<u>ANSI</u> K65.111-1971	Ignition Properties of Plastics	735

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TABLE I

SUGGESTED REPRESENTATIVE CABLES
 AND CABLE PENETRATION FIRE STOP OPENING FILL FOR TYPE TESTS

<u>Cable Fire Stop Penetration Type Cable</u>	<u>Size Cable and Construction</u>	<u>Fraction of Total* Fill for Each Penetration Type</u>	
			10
			12
			13
			16
			17
			18
			20
Medium voltage power (2-15 kv)	3/C No. 6 AWG	1/3	21
	3/C No. 2/0	1/3	22
	3/C No. 4/0	1/3	
			24
Low voltage power	3/C No. 6 AWG	1/3	25
	3/C No. 2/0	1/3	26
	3/C No. 4/0	1/3	
			28
Control and Instrumentation	7/C No. 12	1/2	29
	1 pr No. 16 AWG shielded	1/2	30

- * Total fill is the total quantity of cable to be installed in the test penetration. For example, this could be 40 percent of the cross-sectional area of the raceway penetration or raceway.

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TABLE II

SUGGESTED REPRESENTATIVE
 PENETRATION OPENING DIMENSIONS

Cable Fire			16
Stop Penetration			17
<u>Type - Structural</u>	<u>Cross-Sectional</u> <u>Dimensions</u>	<u>Slab</u> <u>Thickness</u>	18
Round - No metal sleeve; cables pass through without raceway	6" diameter	12" or 6"	20 21 22
Round - No metal sleeve; cables pass through in metal raceway	6" diameter	12" or 6"	24 25 26
Round - Metal sleeve; cables pass through without raceway	6" diameter	12" or 6"	28 29 30
Round - Metal sleeve; cables pass through in raceway	6" diameter	12" or 6"	32 33 34
Rectangular - No metal sleeve; cables pass through without raceway	8" x 42" or 48"	12" or 6"	36 37 38
Rectangular - No metal sleeve; cables pass through in metal raceway	8" x 42" or 48"	12" or 6"	40 41 42
Rectangular - Metal sleeve; cables pass through without raceway	8" x 42" or 48"	12" or 6"	44 45 46
Rectangular - Metal sleeve; cables pass through in raceway	8" x 42" or 48"	12" or 6"	48 49 50

APPENDIX 1

A1. STANDARD TIME-TEMPERATURE CURVE FOR CONTROL OF FIRE TESTS

Time h:min	Temperature, deg F	Area Above 68 F Base		Temperature, deg C	Area Above 20 C Base	
		deg F-min	deg F-h		deg C-min	deg C-h
0:00	68	00	0	20	00	0
0:05	1 000	2 330	39	538	1 290	22
0:10	1 300	7 740	129	704	4 300	72
0:15	1 399	14 150	236	760	7 860	131
0:20	1 462	20 970	350	795	11 650	194
0:25	1 510	28 050	468	821	15 590	260
0:30	1 550	35 360	589	843	19 650	328
0:35	1 584	42 860	714	862	23 810	397
0:40	1 613	50 510	842	878	28 060	468
0:45	1 638	58 300	971	892	32 390	540
0:50	1 661	66 200	1 103	905	36 780	613
0:55	1 681	74 220	1 237	916	41 230	687
1:00	1 700	82 330	1 372	927	45 740	762
1:05	1 718	90 540	1 509	937	50 300	838
1:10	1 735	98 830	1 647	946	54 910	915
1:15	1 750	107 200	1 787	955	59 560	993
1:20	1 765	115 650	1 928	963	64 250	1 071
1:25	1 779	124 180	2 070	971	68 990	1 150
1:30	1 792	132 760	2 213	978	73 760	1 229
1:35	1 804	141 420	2 357	985	78 560	1 309
1:40	1 815	150 120	2 502	991	83 400	1 390
1:45	1 826	158 890	2 648	996	88 280	1 471
1:50	1 835	167 700	2 795	1 001	93 170	1 553
1:55	1 843	176 550	2 942	1 006	98 080	1 635
2:00	1 850	185 440	3 091	1 010	103 020	1 717
2:10	1 862	203 330	3 369	1 017	112 500	1 802
2:20	1 875	221 330	3 689	1 024	122 960	2 049
2:30	1 888	239 470	3 991	1 031	133 040	2 217
2:40	1 900	257 720	4 295	1 038	143 180	2 386
2:50	1 912	276 110	4 602	1 045	153 390	2 556
3:00	1 925	294 610	4 910	1 052	163 670	2 728
3:10	1 938	313 250	5 221	1 059	174 030	2 900
3:20	1 950	332 000	5 533	1 066	184 450	3 074
3:30	1 962	350 890	5 848	1 072	194 940	3 249
3:40	1 975	369 890	6 165	1 079	205 500	3 425
3:50	1 988	389 030	6 484	1 086	216 130	3 602
4:00	2 000	408 280	6 805	1 093	226 820	3 780
4:10	2 012	427 670	7 128	1 100	237 590	3 960
4:20	2 025	447 180	7 453	1 107	248 430	4 140
4:30	2 038	466 810	7 780	1 114	259 340	4 322
4:40	2 050	486 560	8 110	1 121	270 310	4 505
4:50	2 062	506 450	8 441	1 128	281 360	4 689
5:00	2 075	526 450	8 774	1 135	292 470	4 874
5:10	2 088	546 580	9 110	1 142	303 660	5 061
5:20	2 100	566 840	9 447	1 149	314 910	5 248
5:30	2 112	587 220	9 787	1 156	326 240	5 437
5:40	2 125	607 730	10 129	1 163	337 630	5 627
5:50	2 138	628 360	10 473	1 170	349 090	5 818
6:00	2 150	649 120	10 819	1 177	360 620	6 010
6:10	2 162	670 000	11 167	1 184	372 230	6 204
6:20	2 175	691 010	11 517	1 191	383 900	6 398
6:30	2 188	712 140	11 869	1 198	395 640	6 594

APPENDIX 2CABLE PENETRATION TYPE TESTS

A-2.1 TYPICAL CROSS SECTIONS

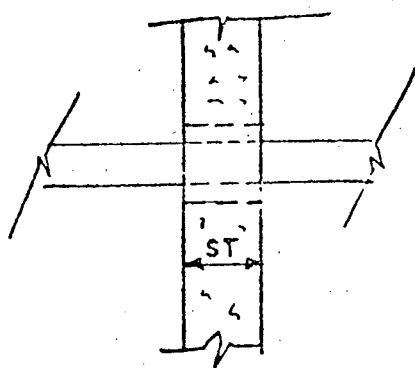


FIG A2.1-1

RACEWAY PASSES
THROUGH FIRE
RESISTIVE BARRIER

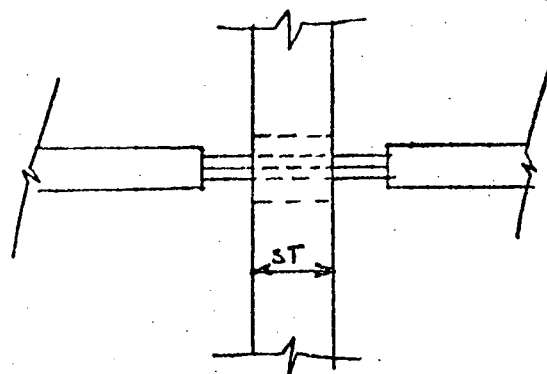


FIG A2.1-2

RACEWAY DOES NOT
PASS THROUGH FIRE
RESISTIVE BARRIER

A-2.2 EXAMPLE OF SINGLE TYPE TEST

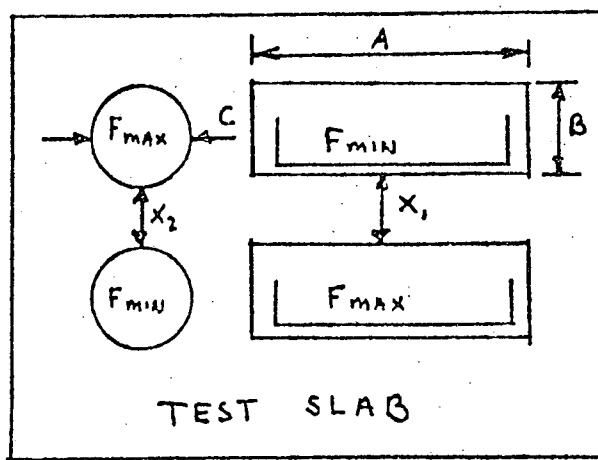


FIG A2.2
FOUR INDIVIDUAL MODULES EACH
WITH ONE OPENING

A-2.3 MULTI-OPENING, SINGLE MODULE TYPE TEST-EXAMPLE

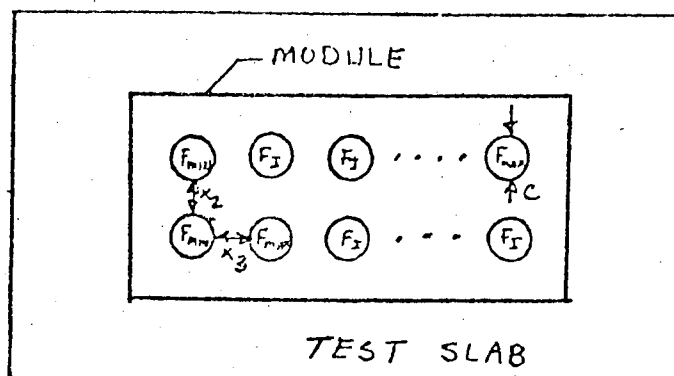


FIG. A2.3-1

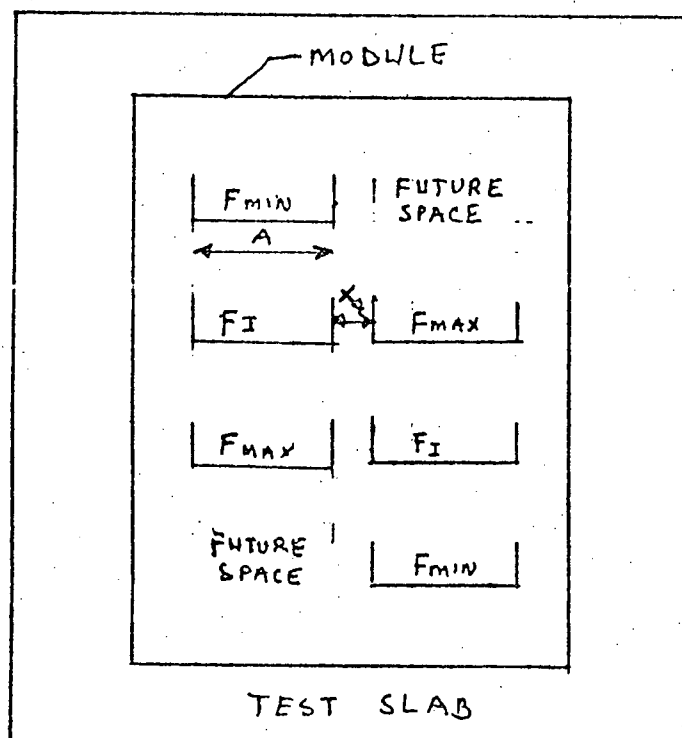


FIG. A2.3-2

NOTE: IF TEST FACILITY WILL PERMIT, BOTH MULTI-OPENING, SINGLE MODULES SHOWN ABOVE COULD BE TESTED SIMULTANEOUSLY.

ST SLAB THICKNESS. IF MIN SLAB THICKNESS IS QUALIFIED
ALL LARGER THICKNESSES OF SIMILAR DESIGN ARE ALSO
QUALIFIED

A, B, C LARGEST DIMENSIONS OF OPENING TO BE
QUALIFIED. IF LARGEST A, B, C DIMENSION IS
QUALIFIED, ALL SMALLER A, B, C'S OF SIMILAR
DESIGN ARE ALSO QUALIFIED

X_1, X_2, X_3 MINIMUM SEPARATION TO BE QUALIFIED. IF X_1, X_2, X_3
IS QUALIFIED ALL LARGER X_1, X_2, X_3 ARE ALSO QUALIFIED

F_{max} MAXIMUM PERCENT CABLE FILL TO BE QUALIFIED

F_{min} MINIMUM PERCENT CABLE FILL USED. IF DESIGN IS
TO BE QUALIFIED FOR SPARES, THEN $F_{min} = 0$ PERCENT

F_1 INTERMEDIATE PERCENT CABLE FILL, USUALLY TAKEN AS
 $(F_{max} + F_{min})/2$

A-2.4 EXAMPLE OF MODULES WITH NON-SYMMETRICAL FIRE STOPS

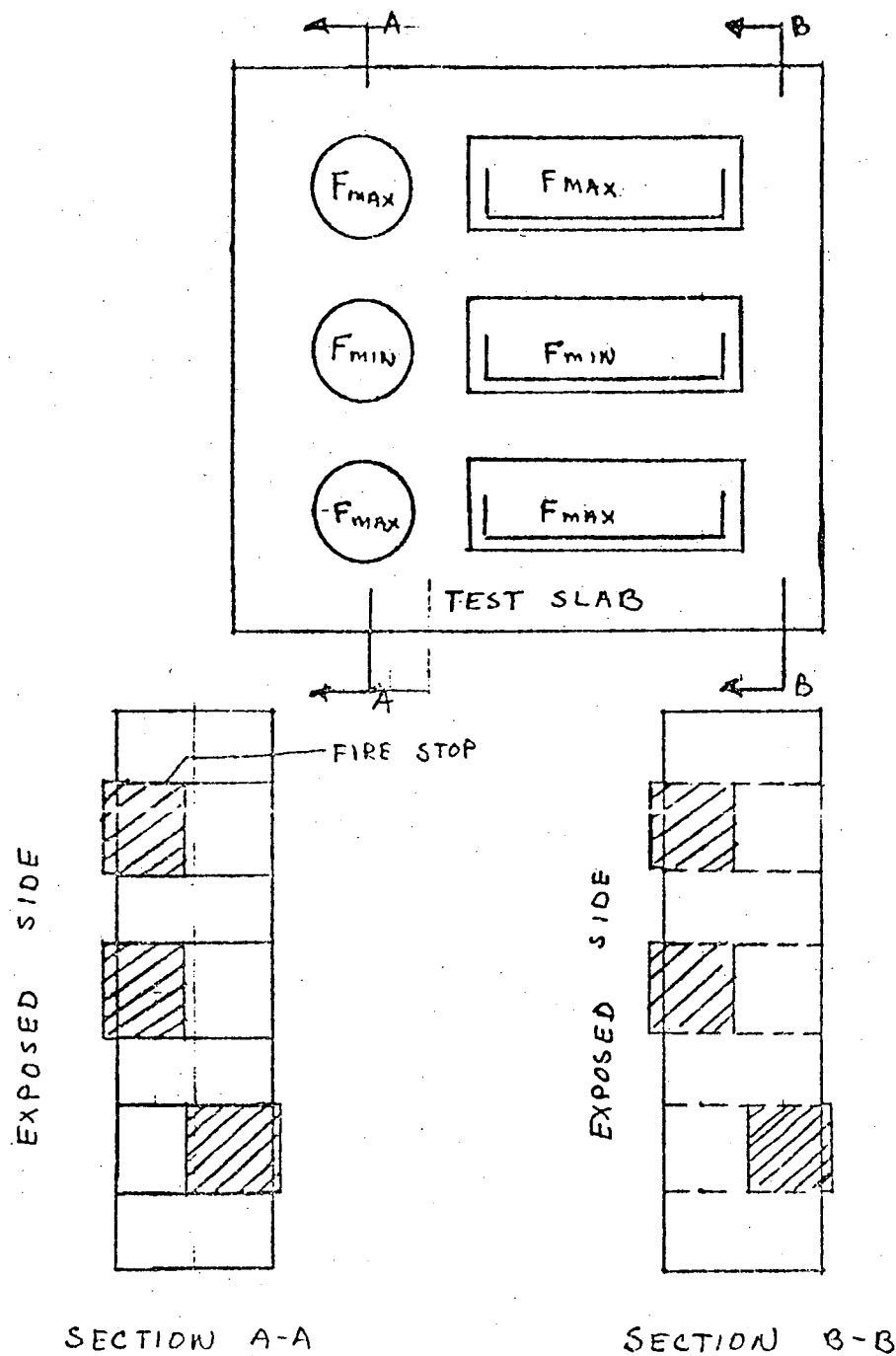


FIG A2.4-1

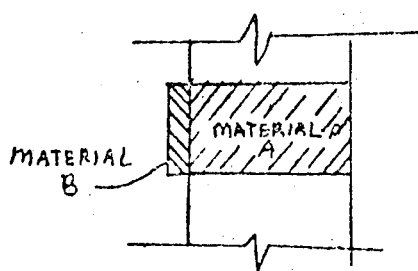


FIG A2.4-2

PROCEDURE FOR MOISTURE REMOVAL
FROM MONOKOTE®

PROCEDURE FOR MOISTURE REMOVAL FROM MONOKOTE[®]

After application of Monokote[®] in four-inch layers in penetrations B9, B10, B11, B12 and B13 (see Figure VIII-1), the test slab was maintained at an elevated temperature (100° to 150°F) to cure (remove excess moisture) the Monokote[®] for final seal assembly. After some two months, the moisture levels were still in excess of 30% as measured by a Weston Moisture Meter Model No. 8009 Type No. 1 Serial No. 6432. Calls to W. R. Grace, who manufactures the materials resulted in no assistance in the moisture retention problems. Furthermore, discussions of possible treatments to apply to the already installed Monokote[®] were met with some disinterest.

After a discussion of the problem with Duke Power personnel, SWRI proposed a procedure to effect a rapid cure of the Monokote[®]. The procedure was to thoroughly flush the material with anhydrous methyl alcohol and then to elevate the building temperature up to 130° to 150°F. Anhydrous methyl alcohol has an affinity to absorb water and also is easily vaporized.

To verify the procedure, a sample of Monokote[®] was prepared and poured into a one-half gallon can. After twelve hours, the section was removed and placed on a sieve screen for treatment with alcohol. This was accomplished by pouring the liquid over the top surface and allowing total penetration of the liquid. The section was then placed on a drying plate and weighed. The prepared specimen was placed in a laboratory oven at 150°F and allowed to bake for 24 hours. When weighed, the sample had encountered significant weight loss with no effect to its structure. The sample was placed in the oven again and after 48 hours, it was weighed. The weighing results and the moisture meter readings concurred that the specimen had reached about 8% moisture. The preliminary test was deemed successful and

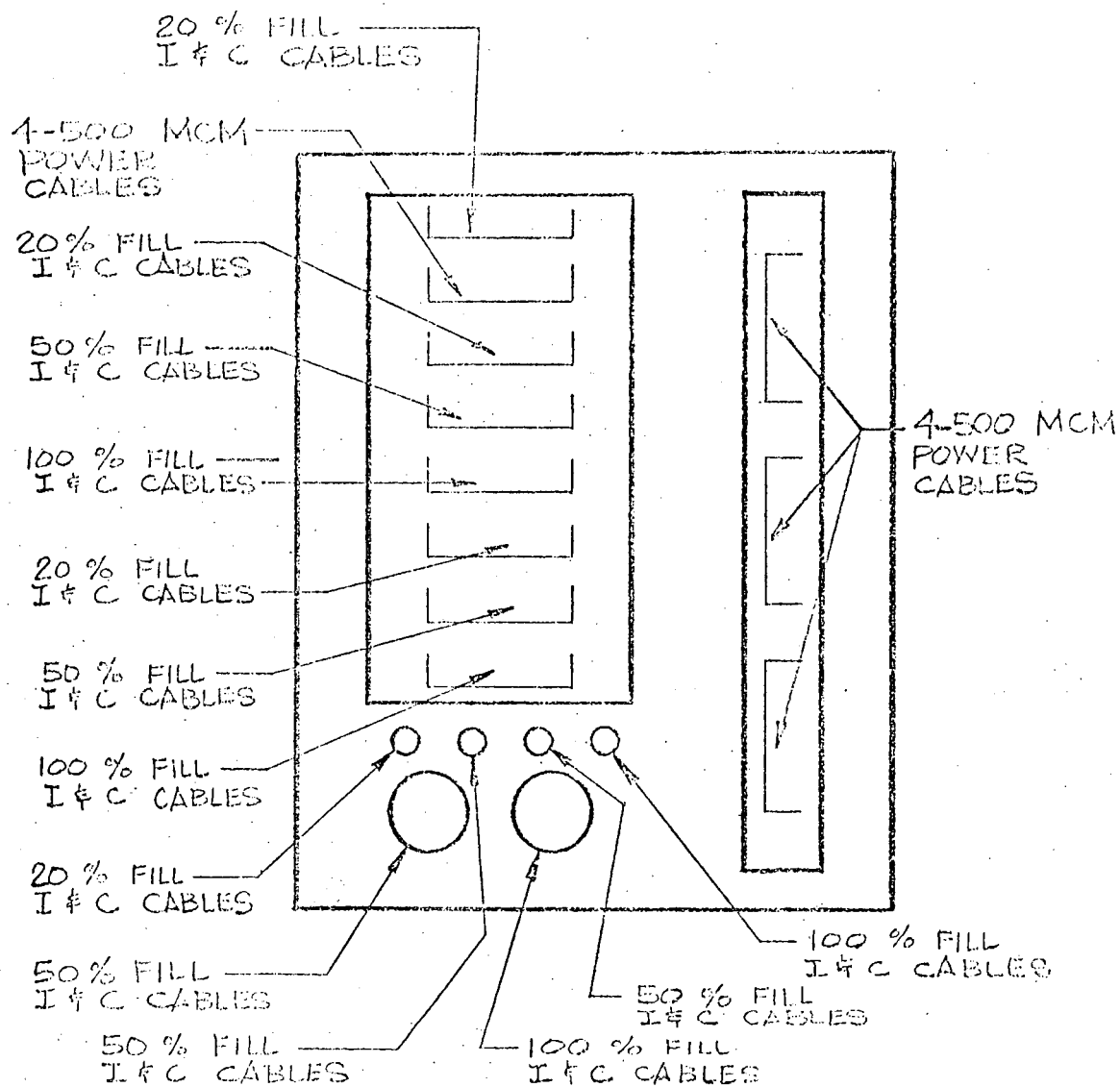


Figure VIII-1. Test Slab Layout

treatment of the test penetrations was planned.

The slab enclosure building was vacated except for the test slabs containing Monokote[®]. A fifty-five gallon drum of anhydrous methyl alcohol (99.9% ABSOLUTE) was placed outside of the building and a hand-pump was attached. Leading from the pump to the test slab was a new 5/8-inch garden hose. The building was opened on two sides. One side was for personnel access and fresh air intake and the other was for exhaust air and had a large-volume fan (4 x 4 ft) to induce a draft which would dilute escaping vapors. Also located outside both openings were fire extinguishers.

The personnel involved with application of the alcohol wore self-contained breathing apparatuses. One of the individuals was from SwRI and was responsible for application of the alcohol and the other was from Chemtrol Corporation and was responsible for quality control for the operation. Directing the application was the project manager while stationed outside the building were one man operating the pump and two (2) men on fire extinguishers. The application took about 20 minutes. Photographs of the operation are included in Appendix II.

After application, the building was closed and the temperature elevated to 130°F using electric heaters. The building and the test slabs were under constant surveillance for the next six hours. Periodic moisture checks were made. After 24 hours it was apparent that the treatment was successful. After 48 hours the moisture level was 8% and the building was opened and vented for final penetration assembly.

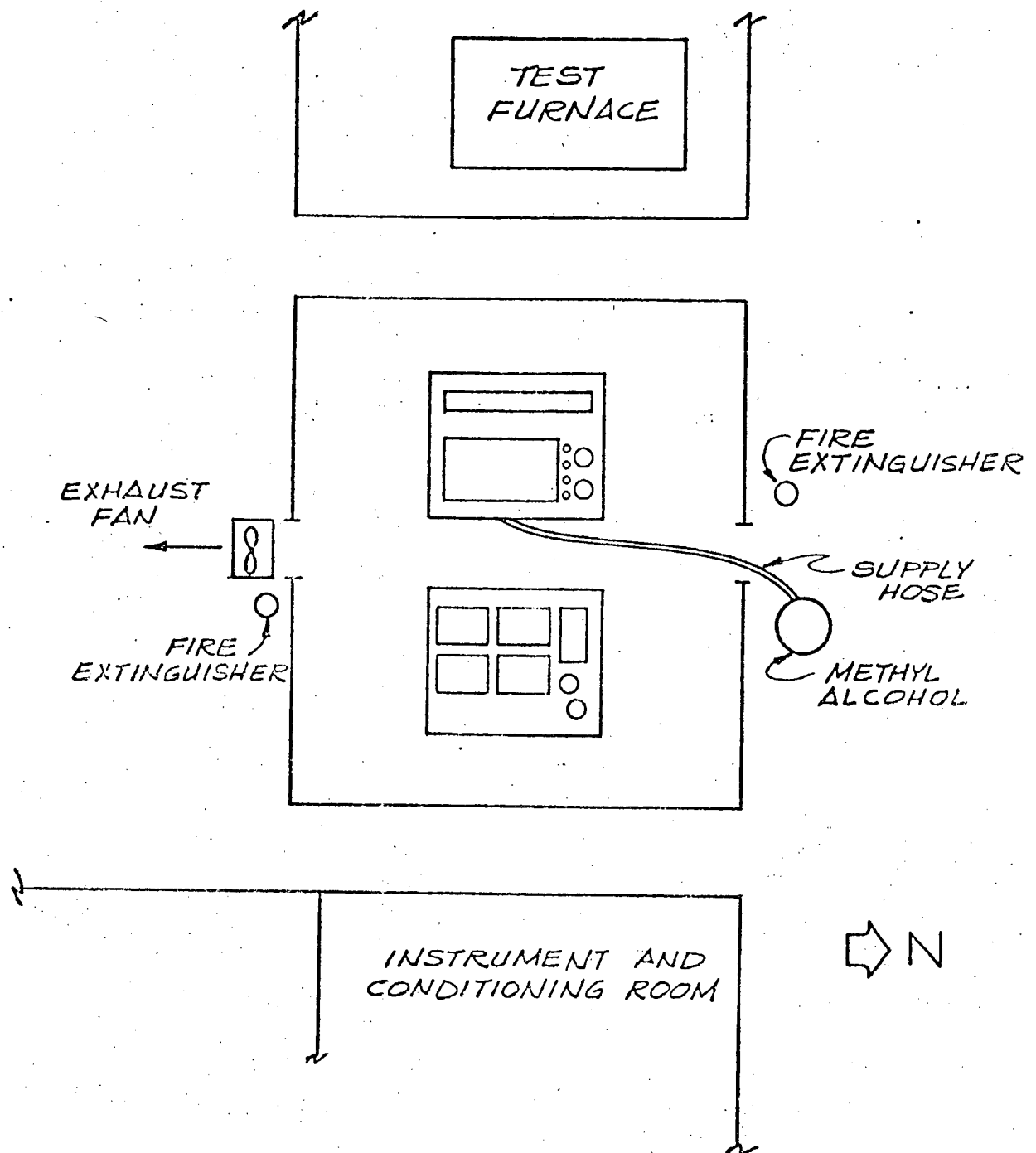


Figure VIII-2. Floor Plan Slab Enclosure Bldg.