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RP

A PRELIMINARY REPORT ON FIRE PROTECTION RESEARCH PROGRAM* FIRE BARRIERS AND SUPPRESSION (September 15, 1978 Test)

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*Further evaluation of these tests is continuing. Additional tests which may affect the conclusions contained herein are underway.

ABSTRACT

A full-scale fire test was conducted at Underwriters Laboratories Inc. on September 15, 1978. The test was to demonstrate the effectiveness of a ceramic fiber blanket and automatic fire suppression system to protect cables in a vertical cable tray configuration that is currently permitted by separation criteria guidelines. An open pool fire fueled by liquid hydrocarbon was used. This was one of a series of tests to demonstrate the response of various cable arrangements and fire protection features in exposure fires.

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FIGURES

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FULL SCALE FIRE TEST NO. 1

Test Procedure

A. DESCRIPTION:

The test assembly was constructed as shown in Figure 1. The various items which comprised the test assembly are described as follows:

1. Corner-Ceiling Assembly - A corner-ceiling assembly approximately 20 x 20 x 15 feet high (6.1 x 6.1 x 4.6 m) was used to simulate a corner-room situation (a conservative approach) as shown on Figure 1. The walls consisted of steel framing with 1/2 inch (1.3 cm) thick Marinite boards forming the interior surface. The suspended ceiling consisted of a steel angle grid system which supported nominal 4 feet x 4 feet x 1/2 inch thick (1.2 x 1.2 x 0.01 m) Marinite panels. The interior surfaces of the walls were painted flat black. Several observation windows were provided.

2. Cable Trays - The five cable trays used in the test configuration were open ladder type and nominally 18 inches (45.7 cm) wide. The side channels were 4 inches (10.2 cm) deep with 3/4 inch (1.9 cm) flanges fabricated from 0.065 inch (1.6 mm) thick galvanized steel. The 0.065 inch thick galvanized steel tray rungs were 1 inch (2.5 cm) wide with 3/4 inch legs, and were welded to the side channels at 9 inch (22.9 cm) intervals.

3. Cable - The three-conductor cable employed in this test had 0.468 inch (1.2 cm) outside diameter and 600 V rating. The conductors were No. 12 AWG stranded copper.

The conductor insulation was 0.027 (0.7 mm) inch thick polyethylene with a polyvinylchloride jacket, a core wrap, and a 0.063 inch (1.6 mm) thick polyvinylchloride cable jacket. This cable was not qualified to IEEE 383-74.

4. Cable Fasteners - Ties formed from No. 16 SWG steel wire were used to group the cables and fasten the cables to the tray rungs. Though not typically used in plant cable systems, these steel wires were chosen to maintain the conservative positioning of the cables in the tray.

5. Fire Pan - A steel pan about 25 square feet (2.3 m^2) in area was formed from cold rolled steel, as shown in Figure 1, and was used as the containment vessel for the liquid fuel.

6. Fire Barrier - The barrier installed about each cable tray consisted of an assembly of ceramic wool blanket pieces as shown in Figure 2. The ceramic wool blanket was 1 inch (2.54 cm) thick and had a density of 7.8 pcf (124.9 kg/m^3). The various blanket pieces were fastened with 3/4 inch (1.9 cm) wide, 0.023 inch (0.6 mm) thick coated steel bands and band clips.

7. Automatic Sprinklers - Upright automatic sprinklers were located as shown in Figure 1. All sprinklers were nominally identical, with standard orifices of 1/2 inch (1.3 cm) diameter and a 165°F (74°C) rating.

8. Automatic Fire Detectors - Two spot-type smoke detectors were installed at the ceiling within the corner as shown in Figure 1. One was an ionization chamber type

and one was a photoelectric type. Neither line-type nor sampling detectors were used in this test.

B. METHOD:

Cable segments in lengths of about 31 feet (9.4 m) were bundled together in groups of eight and fastened together with steel wire ties at about 3 foot (0.9 m) intervals. The cable bundles were installed in each 15 foot (4.6 m) tray with seven bundles forming the back layer against the tray rungs. The cable bundles were folded back at the bottom of the tray to form a front layer of seven bundles. All cable bundles were attached to the top and bottom tray rungs with steel wire ties.

The cable trays were installed in the steel fire pan and located within the corner-ceiling assembly as shown in Figure 1. The trays were installed with the cable ends above the suspended ceiling level. Since the cable bundles were bent at midlength, loops of cable bundles appeared at the base of each cable tray. The distances between the loops and the base of the tray varied from about 3 to 6 inches (7.6 to 15.2 cm).

All cables were energized at low voltage during the test. All conductors with the same color code within each tray were connected in parallel to provide three circuits per tray. During the test, each circuit carried low current (milliamps), and was monitored continuously for shorts between conductors or between conductors and tray.

Each tray was wrapped with a ceramic wool fire barrier as shown in Figure 2. The ceramic wool was installed according to the manufacturer's specifications. The barrier

used an outer layer of 1 inch (2.54 cm) thick wool wrapped around each tray for its entire length from floor to ceiling. Additional pieces covered 1) the entire front surface of the cable bundle along the vertical overlapping joint of the outer layer, 2) the back surface of the cable bundle and tray at horizontal butt joints of the outer layer, 3) the horizontal butt joints of the outer layer, and 4) the ceiling and floor butt joints. The ceramic wool was secured with steel bands located at 12 inch (30.5 cm) intervals along the tray length.

Three open-head sprinklers were located 12 inches below the ceiling and at the positions shown in Figure 1. Each sprinkler was connected to a separate manually operated water supply. Three dummy sprinkler heads without connection to the water supply were suspended near each open head. During the test the three dummy heads were monitored electrically to determine the times at which the fusible links activated. It was intended that only after activation of all three dummy heads at one location would the water system be manually operated. The water system was designed to produce a pressure of 35 psig (2.4×10^5 Pa) at each open head. This sprinkler configuration is acceptable per NFPA guidelines, and the head pressure is representative of the pressure at the first few heads to open in a sprinkler system in a localized fire situation.

Two automatic smoke detectors were located at the ceiling 15 feet (4.6 m) from each wall as shown in Figure 1. Each detector was monitored during the test to determine the

time of actuation. NFPA Nos. 71, 72A, 72B, 72C, and 72D state that the location of smoke detectors should be based upon an engineering survey of the application of this form of protection to the area under consideration.

Temperatures within the cable trays were measured with seven thermocouples located within each tray as shown in Figure 3. Air temperatures between cable trays over the fire pan, and near each open head sprinkler, were measured with stainless-steel-sheathed Type K thermocouples as shown in Figure 4.

The appearance of the test assembly before the fire test is shown in Figure 5.

The test was initiated by pouring two gallons (7.6×10^{-3} m^3) of heptane uniformly into the pan from four separate containers and igniting the heptane by torch ten seconds afterwards. Throughout the test, visual observations were recorded of flame distribution and other developments pertinent to the fire performance of the cable tray assemblies. The test was concluded after all related fire activity had ceased. Photographic coverage included 35 mm slides and 8 mm movies. Video tape recording was used as a backup for the movies.

RESULTS

A. TEST RESULTS:

1. Visual Observations During Test -

Time (Min:Sec)	Description
0:10	Flaming appeared uniform over the entire pan area with a maximum flame height of 4 feet (1.2 m). Appearance of test assembly is shown in Figure 6.
1:30	All flames now issued from the base of ceramic wool on each cable tray. (It appeared the heptane had been soaked up by the wool, and was burning slowly in wick fashion.) Maximum flame height was about 3 feet (0.9 m) except between trays 1 and 3. Maximum flame height between these two trays was 6 feet (1.8 m) Appearance of test assembly is shown in Figure 7.
4:00	Flame height between trays 1 and 3 decreased to 3 feet (0.9 m).
5:00-23:00	Flaming continued but intensity and height gradually diminished.
23:35	A loud report was heard and a burst of flame issued from the base of tray 3. Wool wrapping on tray 3 between 6 and 10 feet (1.8 and 3.0 m) above the floor appeared to have slipped from its fasteners causing openings in the vertical and horizontal joints.

24:00-40:00 Flaming continued to diminish gradually.

40:00 All flaming ceased.

2. Detector Events Record - Detector actuations occurred as follows:

Type	Actuation Time (Min:Sec)
Ionization	0:11
Photoelectric	0:14

3. Sprinkler Events Record - The time at which the fusible links activated are shown in Table 1.

4. Air Temperatures - Temperatures of the air between the cable trays and near the sprinklers are shown in Tables 2 through 6 and Figures 9 and 10.

5. Cable Tray Temperatures - Temperatures within each cable tray are shown in Tables 7 through 11. A summary of maximum cable tray temperatures is shown in Table 14.

6. Circuit Integrity Record - At 3 min 13 sec, a short circuit between conductors 1 and 3 in cable tray 3 was indicated. At 3 min 55 sec, erratic measurements were recorded for the conductors in tray 1 indicating the existence of intermittent short circuits.

B. POSTTEST RESULTS:

1. Posttest Visual Observation - The mineral wool was blackened about the base of each tray and extended upward about 1 foot (0.3 m) on trays 1, 2, and 4. On tray 3, the blackened area extended to about 4 feet (1.2 m)

24:00-40:00 Flaming continued to diminish gradually.

40:00 All flaming ceased.

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1. Posttest Visual Observation - The mineral wool was blackened about the base of each tray and extended upward about 1 foot (0.3 m) on trays 1, 2, and 4. On tray 3, the blackened area extended to about 4 feet (1.2 m)

above the floor. The interior surface of the wool appeared unchanged, except for small areas of light brown near the base in trays 1, 2, 3 and 4, as shown in Figure 11.

In all cable trays except tray 5, thermal damage of cables was observed near the base (3 to 6 inches above the fire pan). A summary of damage is shown in Table 12. Cable damage in tray 3 is shown in Figures 11 and 12. Cable damage in tray 2 is shown in Figure 13.

2. Circuit Integrity Results - The erratic measurements recorded by tray 1 were determined to be the result of inadvertant contact between connectors above the ceiling. Trays 1, 2, 4, and 5 were examined after the test to determine the insulation resistance between conductors and between conductor and trays. All resistances were normal except for that between one conductor and tray 2, which was less than 100,000 ohms (normally greater than 20 mohms). Insulation resistance was measured with a "megger" at 500 V. A short circuit in tray 3 was verified.

3. Sprinkler Operation Test Results - The dummy sprinklers, which did not operate during the test, were subjected to air-oven operation tests in accordance with Standard UL199. Results of these tests are shown in Table 13.

TABLE 1 - Link Activation Time

Location	Sprinkler No.	Link Activation Time (Min:Sec)
1	1A	0:52
1	1B	0:54
1	1C	N
2	2A	N
2	2B	N
2	2C	N
3	3A	N
3	3B	N
3	3C	N

N - Link did not activate during test.

TABLE 2 - Air Temperatures (Sprinklers 1, 2 and 3)(°F)

Time (Min:Sec)	Locations		
	1	2	3
0:00	69.7	70.1	70.0
0:27	234.7	225.0	187.9
0:57	235.4	223.4	§96.8
1:27	186.4	176.7	165.3
1:57	178.0	160.8	153.6
2:27	165.2	148.5	143.4
2:57	-	138.1	-
3:27	158.4	137.0	140.1
3:57	156.2	140.4	133.3
4:27	149.2	130.4	128.3
4:57	142.1	125.3	124.8
5:57	137.4	125.1	119.3
6:57	129.4	120.6	115.9
7.57	123.3	116.8	112.8
8:57	115.1	111.5	108.5
9:57	112.0	109.7	102.2
15:57	96.0	100.7	94.1
19:57	92.9	95.0	90.5
28:44	81.7	83.4	79.9
39:27	77.9	77.6	76.0

TABLE 3

Air Temperatures (°F)

Time (Min:Sec)	T. C. Location					
	1	2	3	4	5	6
Pretest	73.8	73.8	73.8	74.1	74.1	74.1
0:31 - 0:33	215.4	229.8	235.6	162.3	171.7	167.8
1:01 - 1:03	338.9	354.9	369.2	204.5	224.0	220.0
2:01 - 2:03	381.5	389.0	400.4	219.9	245.6	263.5
2:31 - 2:33	353.5	357.1	371.7	202.7	218.8	218.7
3:31 - 3:33	275.0	271.1	292.8	158.6	174.7	171.6
4:01 - 4:03	338.3	319.8	337.7	232.1	255.7	251.9
4:31 - 4:33	323.7	319.2	329.3	257.9	283.3	284.8
5:01 - 5:03	287.9	289.4	319.4	235.0	253.0	254.7
6:01 - 6:03	231.3	230.2	252.5	201.0	220.2	220.0
7:01 - 7:03	209.3	206.7	224.1	203.0	214.3	219.3
8:01 - 8:03	203.8	206.7	226.2	174.9	185.1	187.2
9:01 - 9:03	170.9	177.1	195.2	176.9	190.8	192.5
10:01 - 10:03	170.5	171.5	191.1	163.4	171.0	174.2
12:01 - 12:03	136.3	141.9	155.1	150.1	157.6	157.3
20:01 - 20:03	92.1	92.9	95.8	99.1	100.6	102.6
35:01 - 35:03	81.9	82.3	82.9	82.9	82.5	82.8

TABLE 4

Air Temperatures (°F)

Time (Min:Sec)	T. C. Location					
	7	8	9	10	11	12
Pretest	73.6	73.5	73.6	74.1	74.2	74.1
0:34 - 0:37	1528.6	1329.6	1292.4	474.0	477.6	471.6
1:04 - 1:07	1133.5	1041.3	1022.0	437.5	447.7	460.2
1:34 - 1:37	1605.7	1554.4	1576.8	518.1	533.8	519.1
2:04 - 2:07	1143.0	1112.0	1162.7	489.8	518.1	521.7
2:34 - 2:37	1288.7	1239.3	1283.9	439.6	451.6	460.1
	-	-	-	-	-	-
3:34 - 3:37	989.8	928.3	918.7	344.4	338.9	343.5
4:04 - 4:07	588.3	551.7	552.5	322.9	328.6	325.0
4:34 - 4:37	457.0	430.0	440.7	331.8	334.7	336.3
5:04 - 5:07	394.8	378.0	380.8	299.7	298.8	303.4
6:04 - 6:07	408.2	399.7	407.1	303.7	301.4	309.6
7:04 - 7:07	372.0	354.2	364.1	285.0	290.4	291.1
8:04 - 8:07	269.1	253.9	255.5	242.0	240.7	240.7
9:04 - 9:07	227.7	213.8	218.8	211.7	210.3	209.1
10:04 - 10:07	198.0	184.1	183.9	194.1	186.8	186.4
16:04 - 16:07	136.3	130.9	133.5	141.6	141.8	143.1
20:04 - 20:07	202.1	192.8	199.0	136.7	135.0	138.1
22:04 - 22:07	143.4	137.5	140.2	120.6	120.1	121.6
35:04 - 35:07	94.8	91.6	91.0	91.3	90.1	90.0

TABLE 5

Air Temperatures (°F)

Time (Min:Sec)	T. C. Location					
	13	14	15	16	17	18
Pretest	74.1	73.9	73.9	74.4	74.4	73.8
0:37 - 0:39	579.1	518.4	473.5	182.7	196.7	213.5
1:37 - 1:39	382.8	323.7	278.0	149.9	156.1	182.8
2:07 - 2:09	368.5	300.3	257.2	140.1	148.3	187.9
2:37 - 2:39	260.9	221.0	192.3	129.8	138.3	160.5
3:37 - 3:39	239.2	215.7	201.2	118.8	122.6	118.3
4:07 - 4:09	245.5	212.9	183.5	123.6	125.3	110.2
4:37 - 4:39	205.0	175.8	154.9	122.0	126.1	141.4
5:07 - 5:09	193.0	162.1	141.4	118.9	124.1	141.2
6:07 - 6:09	199.9	184.1	172.1	114.7	118.7	103.8
7:07 - 7:09	206.8	173.8	147.7	117.6	123.6	147.9
8:07 - 8:09	192.7	159.3	139.4	107.1	111.4	123.6
9:07 - 9:09	66.4	140.6	119.7	103.7	104.1	120.5
10:07 - 10:09	154.6	130.4	115.5	105.9	106.5	106.4
16:07 - 16:09	161.4	127.0	108.0	98.4	98.4	103.3
20:07 - 20:09	114.4	105.7	98.4	93.9	95.4	96.1
35:07 - 35:09	84.5	81.9	81.4	82.0	81.9	83.1

TABLE 6

Air Temperatures (°F)

Time (Min:Sec)	T. C. Locations					
	19	20	21	22	23	24
Pretest	74.4	73.7				
0:10	134.1	163.2				
0:40	206.1	211.6				
1:10	182.4	171.1				
1:40	164.3	212.2				
2:10	154.1	217.4				
2:40	144.3	170.5				
3:40	123.8	131.3				
4:10	128.6	122.8				
4:40	127.6	160.0				
5:10	129.2	165.8				
6:10	121.4	117.2				
7:10	126.3	162.0				
8:10	114.0	147.3				
9:10	105.7	132.7				
10:10	106.5	118.9				
16:10	99.7	121.8				
20:10	97.5	102.4				
35:10	82.1	83.5				
Pretest			74.4	74.1	73.1	73.1
0:25			333.7	178.5	172.7	167.8
0:55			253.5	160.3	149.3	145.6

TABLE 6 (cont'd)

Air Temperatures (°F)

Time (Min:Sec)	T. C. Locations					
	19	20	21	22	23	24
1:25			224.9	141.1	137.1	133.3
1:55			238.6	136.5	128.7	126.1
2:25			244.0	130.0	123.6	123.3
3:25			204.5	122.3	117.2	113.9
4:25			150.6	114.6	109.8	109.2
5:25			170.4	113.2	108.9	106.8
6:25			166.8	114.7	109.4	106.0
7:25			181.0	117.2	112.2	109.2
8:25			171.5	112.0	107.1	104.4
9:25			155.5	108.1	104.7	105.0
10:25			136.2	103.7	99.3	97.5
15:25			146.7	103.9	101.2	99.5
20:25			103.0	88.7	86.9	86.2
35:25			80.0	76.9	76.5	76.7

TABLE 7

Cable Tray Temperatures (°F)

Tray 1

Time (Min:Sec)	T. C. Locations						
	1	2	3	4	5	6	7
Pretest	74.2	74.1	73.1	73.1	78.7	73.1	73.4
0:42	74.4	73.7	73.4	73.1	82.6	73.1	73.4
1:12	74.3	73.7	73.1	73.1	87.5	73.1	73.4
1:42	74.4	73.8	73.3	73.1	92.0	73.1	73.4
2:12	74.5	73.9	73.5	73.1	96.6	73.2	73.5
2:42	74.6	74.0	73.7	73.2	100.8	73.4	73.5
3:42	74.7	74.3	73.9	74.1	107.8	73.4	73.6
4:12	74.8	74.6	74.1	74.9	110.9	73.4	73.6
5:12	74.9	75.2	74.6	76.3	116.8	73.4	73.6
6:12	75.0	90.8	75.5	76.3	121.4	73.6	73.7
7:12	74.9	79.8	76.3	74.2	123.9	73.6	73.6
8:12	74.9	80.1	77.3	74.7	122.5	73.7	73.6
9:12	74.9	80.8	79.3	75.0	123.9	73.7	73.6
10:12	74.8	81.3	82.1	75.4	124.7	73.7	73.6
20:12	75.2	118.9	118.7	79.5	106.8	75.5	73.7
36:12	76.7	134.5	131.9	89.5	81.5	78.9	74.6
48:38	77.1	130.8	126.9	95.3	73.5	80.5	75.4
60:13	77.3	126.3	121.8	98.2	70.0	81.5	76.1
105:12	77.3	111.9	110.4	99.9	66.8	83.4	77.7

TABLE 8

Cable Tray Temperatures (°F)

Tray 2

Time (Min:Sec)	T. C. Locations						
	1	2	3	4	5	6	7
Pretest	72.2	73.7	73.8	72.7	72.9	76.3	72.8
0:45	72.3	73.8	73.8	72.6	72.9	77.3	72.8
1:15	72.3	73.9	74.0	104.4	79.7	78.2	73.2
1:45	72.3	74.1	74.2	86.3	76.7	79.7	73.5
2:15	72.2	74.4	74.6	82.0	75.7	81.6	73.6
2:45	72.1	74.8	75.0	80.4	75.3	84.1	73.7
3:45	72.1	75.7	75.9	79.3	75.2	90.0	73.8
4:15	72.1	76.3	76.7	79.4	75.4	93.4	73.8
5:15	72.1	78.0	78.5	110.0	89.0	99.2	74.2
6:15	72.1	79.4	80.9	94.2	86.8	105.4	74.4
7:15	72.1	80.7	82.5	90.1	88.9	112.7	74.8
8:15	72.2	80.7	84.3	92.8	94.9	116.8	75.3
9:15	72.3	82.0	86.0	119.8	112.0	117.9	76.3
10:15	72.3	84.8	87.7	101.8	106.7	123.0	76.8
16:15	72.0	99.2	98.6	109.7	121.2	134.0	80.7
20:15	71.3	104.9	102.9	113.0	127.3	133.8	85.0
35:15	70.3	113.9	112.6	115.7	137.4	113.1	100.5
60:16	69.4	115.1	118.5	125.1	137.9	81.6	109.5
105:15	68.2	108.8	116.3	121.7	125.1	55.3	113.2
150:15	68.9	102.8	108.8	115.0	115.5	48.5	112.8

TABLE 9

Cable Tray Temperatures (°F)

Tray 3

Time (Min:Sec)	T. C. Locations						
	1	2	3	4	5	6	7
Pretest	73.9	73.1	73.6	73.5	73.0	73.3	73.5
0:50	73.9	73.4	73.6	73.8	73.8	73.7	75.0
1:20	74.0	73.5	73.8	74.6	74.3	74.3	76.9
1:50	74.1	73.8	74.1	75.1	75.0	75.4	77.3
2:20	74.1	74.1	74.3	75.5	75.3	75.9	79.2
2:50	74.1	74.3	74.5	76.0	75.7	76.3	80.5
3:50	74.2	74.6	74.8	79.2	76.9	77.3	82.4
4:20	74.2	74.7	74.9	83.1	79.7	76.5	84.5
5:20	74.3	74.9	75.0	91.1	91.0	84.1	95.7
6:20	74.4	75.0	75.1	91.0	85.0	80.2	89.4
7:20	74.4	74.9	75.3	91.0	84.6	79.4	89.7
8:20	74.5	75.0	75.5	110.2	94.1	88.6	115.6
9:20	74.8	76.2	75.6	106.2	92.4	85.6	112.6
10:20	74.7	75.5	75.9	105.1	92.6	84.7	115.9
20:20	75.4	76.9	79.1	119.0	102.5	89.8	101.9
35:20	76.3	81.5	81.4	133.1	121.3	107.7	106.0
60:21	76.6	88.1	81.2	141.1	130.4	113.9	107.0
105:20	77.4	94.3	80.9	132.0	132.0	116.8	108.0
150:20	78.8	96.2	82.1	118.2	123.9	118.0	107.8

TABLE 10

Cable Tray Temperatures (°F)

Tray 4

Time (Min:Sec)	T. C. Locations						
	1	2	3	4	5	6	7
Pretest	73.8	73.7	74.2	74.2	73.4	74.0	73.7
2:23	74.4	73.0	74.6	74.9	73.1	73.9	73.9
4:23	74.7	73.7	75.2	78.4	72.9	73.9	74.3
7:23	79.0	75.8	75.3	84.9	71.5	73.9	75.4
20:23	89.1	77.0	75.5	127.1	66.5	74.2	81.3
30:23	96.3	83.8	81.8	130.4	64.8	74.5	83.5
35:23	99.2	83.1	79.7	128.9	62.2	75.1	87.3
40:23	102.4	84.8	80.5	127.9	61.4	75.5	89.0
60:24	111.3	89.7	83.2	129.7	56.0	76.9	93.4
105:23	120.6	96.7	87.5	114.9	42.9	77.9	95.7
150:23	120.7	98.0	89.7	104.5	44.4	79.2	95.4

TABLE 11

Cable Tray Temperatures (°F)

Tray 5

Time (Min:Sec)	T. C. Locations						
	1	2	3	4	5	6	7
Pretest	73.6	73.7					
6:24	73.9	75.2					
14:24	74.2	78.8					
20:24	74.7	83.8					
35:24	76.3	91.3					
60:24	79.0	95.3					

TABLE 12 - Summary of Cable Damage

Tray No.	Description
1	Cable material at bottom of bundle loop melted and charred.
2	Cable material of all cables in contact with bottom tray rung melted.
3	Cable material at bottom of bundle loop and along tray side channels melted and charred. Greatest amount of cable damage occurred in tray 3.
4	Cable material at bottom of bundle loop melted and charred.
5	No cable damage observed.

TABLE 13 - Results of Air-Oven Tests of Dummy Sprinklers

Sprinkler No.	Operation Time (Min:Sec)	Temp (°F/°C)
1C	2:50	250/121
2A	3:40	272/133
2B	3:10	260/127
2C	3:38	265/129
3A	3:10	260/127
3B	3:36	265/129
3C	3:12	262/128

TABLE 14 - Summary of Cable Tray Temperatures

MAXIMUM TEMPERATURES

WITHIN CABLE TRAY

TRAY No.	T. C. Location	Temperature (°F/°C)	Time (Min:Sec)
1	2	133/56	40:00
2	6	135/57	18:00
3	4	141/61	60:00
4	4	130/55	25:00
5	6	99/37	78:00

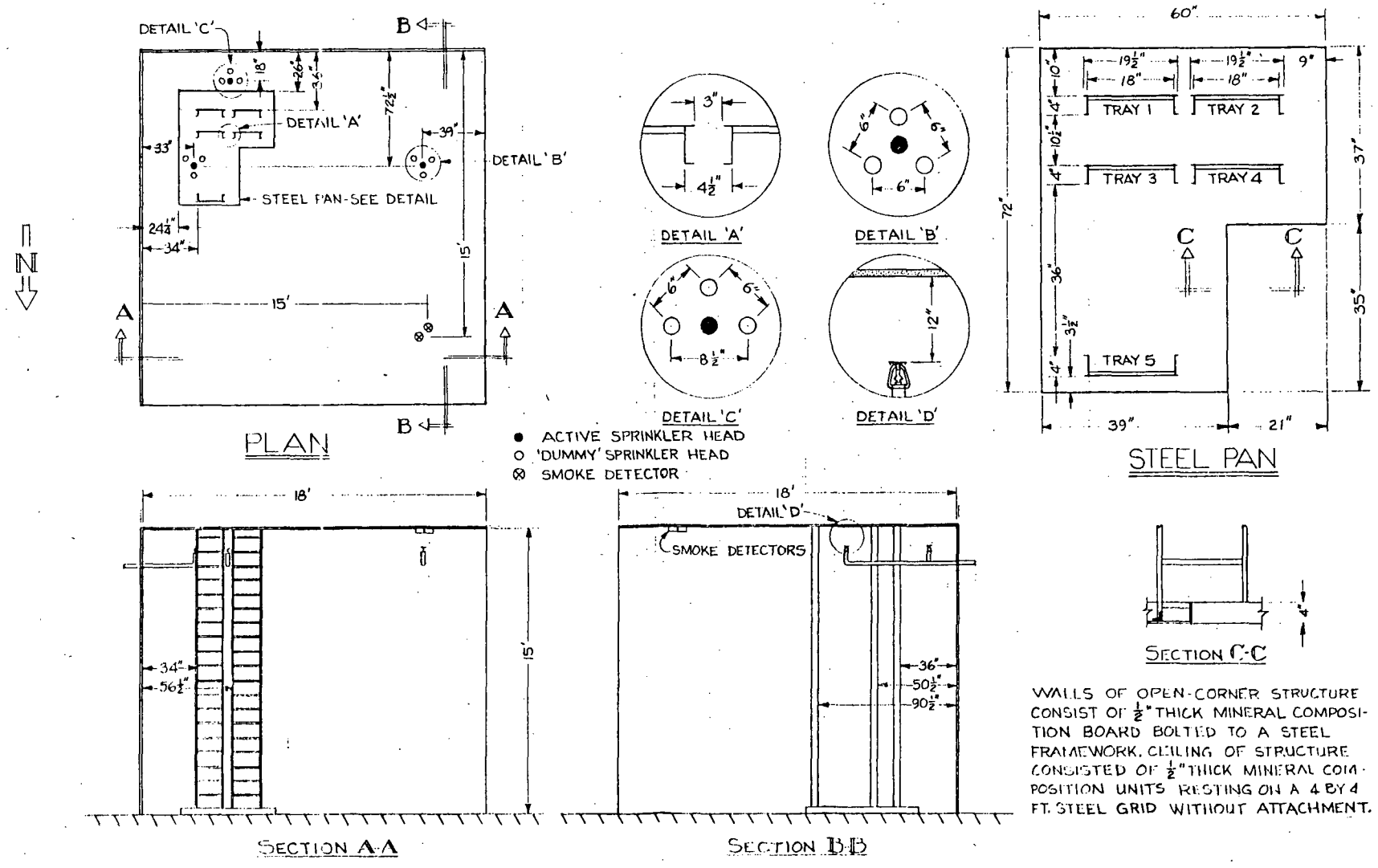


Figure 1. Test Assembly

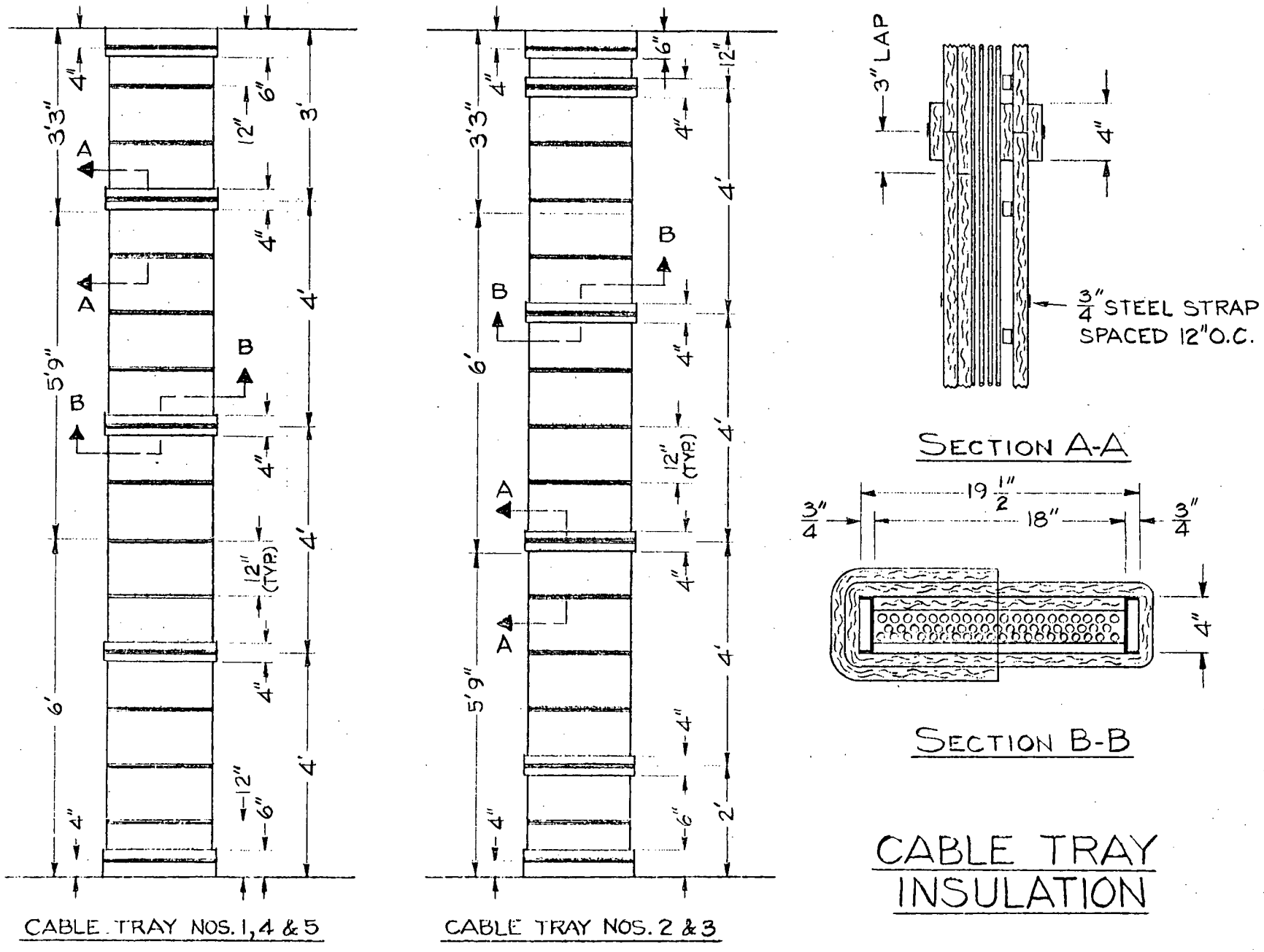
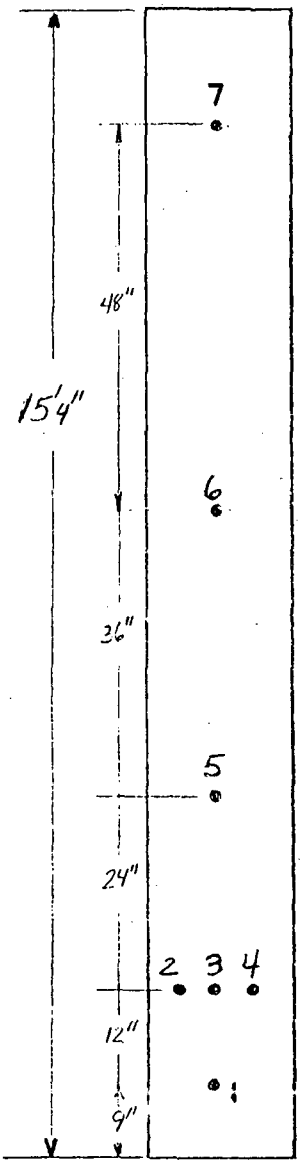


Figure 2. Insulation Assembly



• T/C Location

Top Surface of Cable
Front Cable Tray

Figure 3. Cable Tray Thermocouple Locations

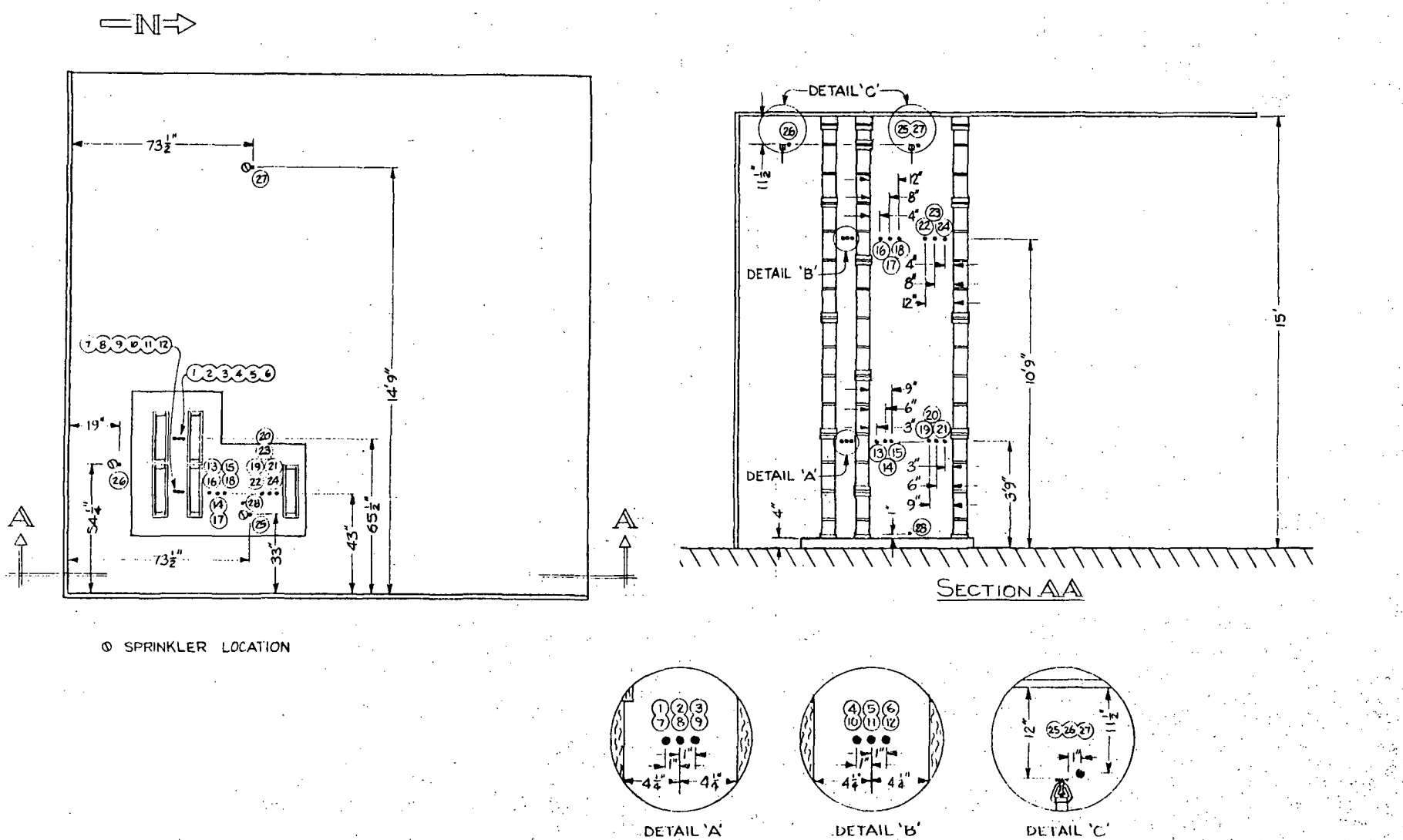


Figure 4. Air Thermocouple Locations

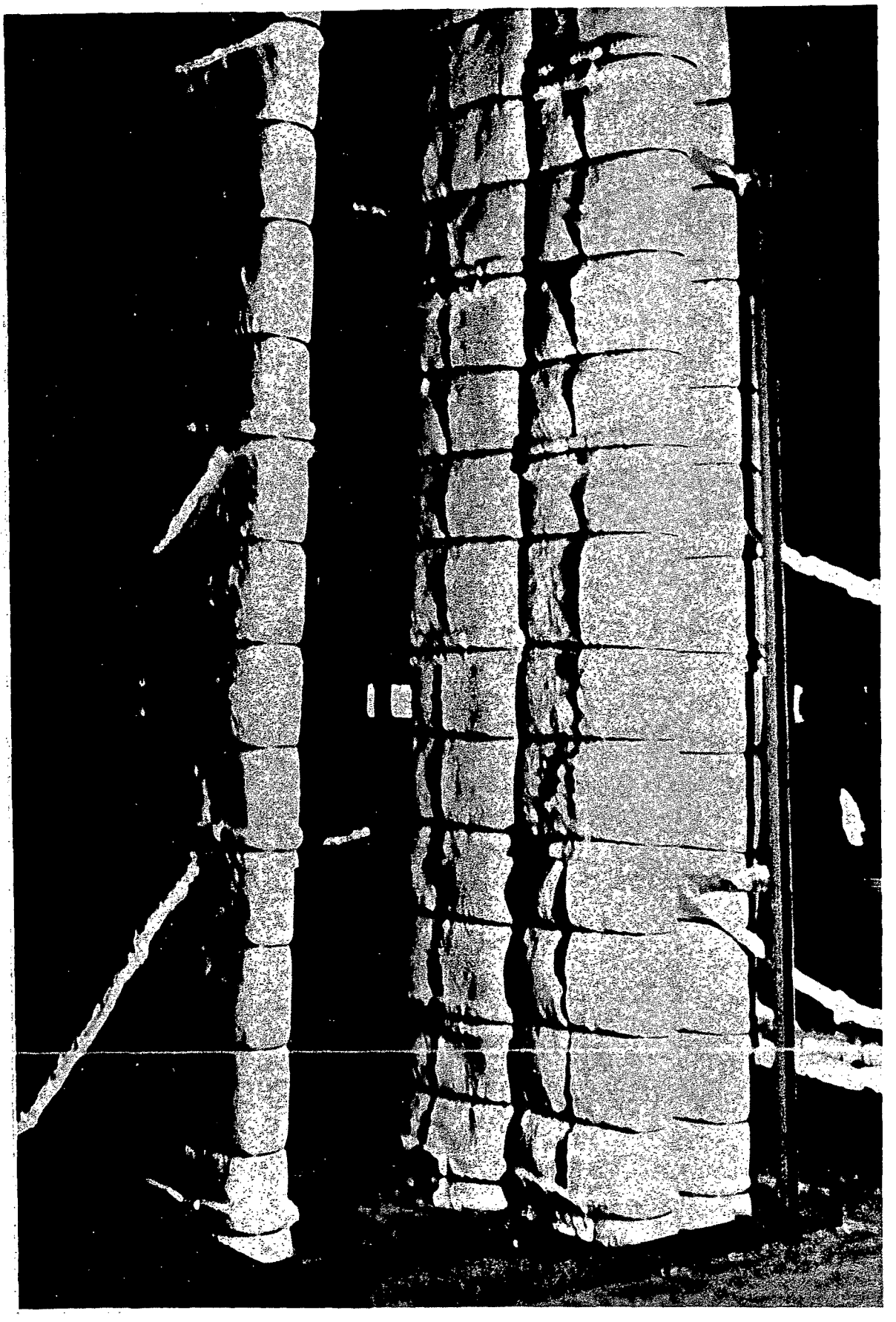


Figure 5. Test Assembly Prior to Test

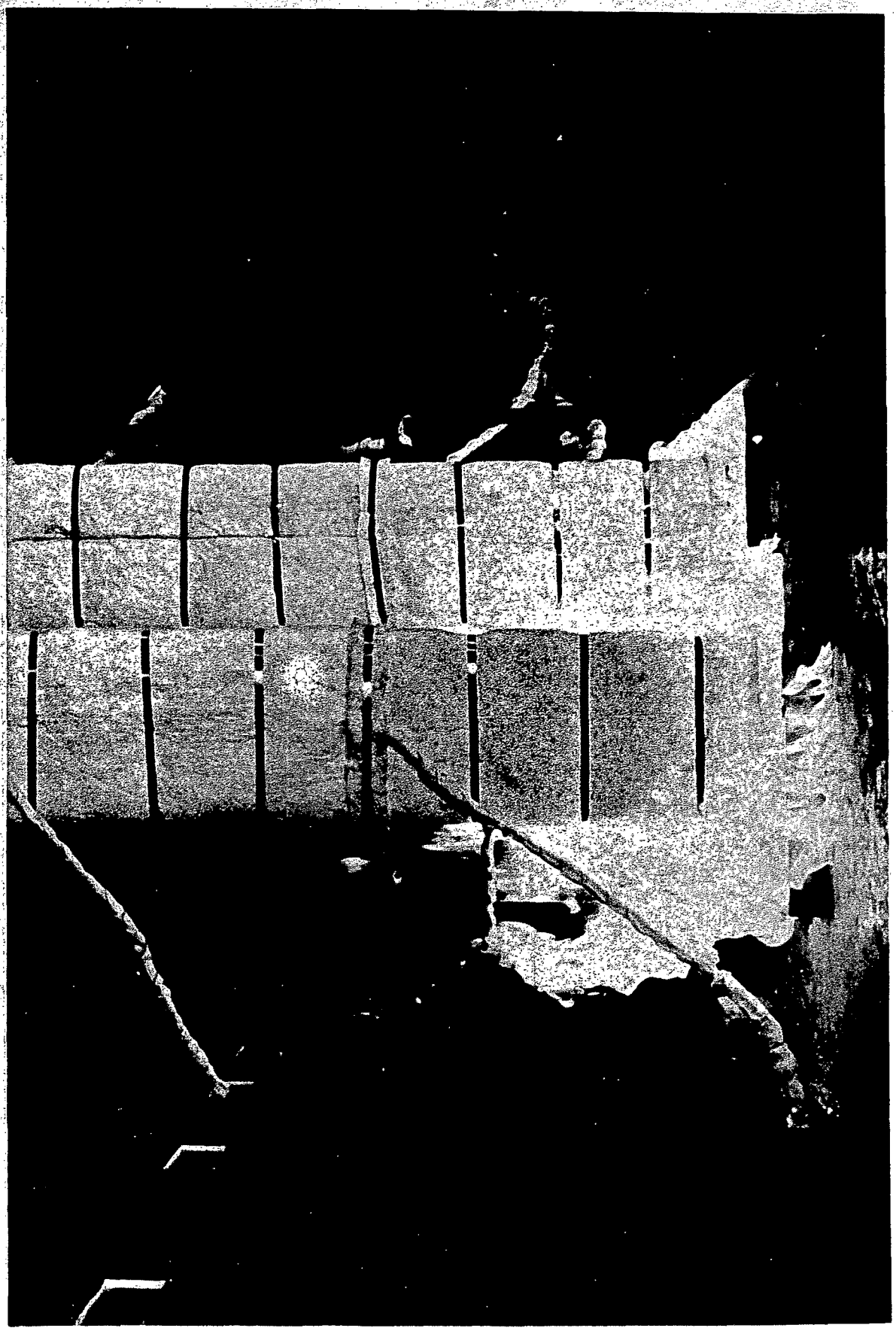


Figure 6. Test Assembly at Ten Seconds

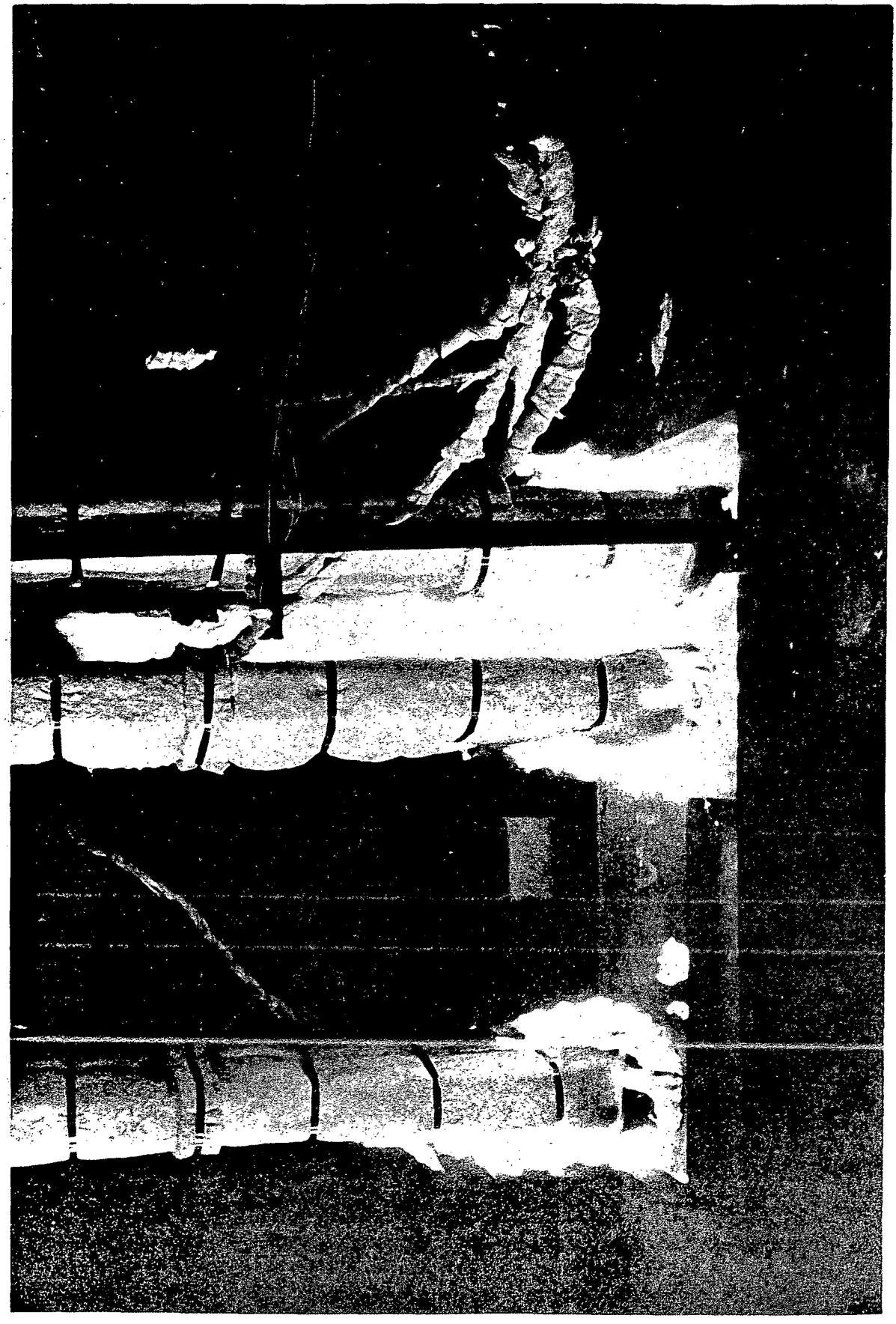


Figure 7. Test Assembly at Ninety Seconds

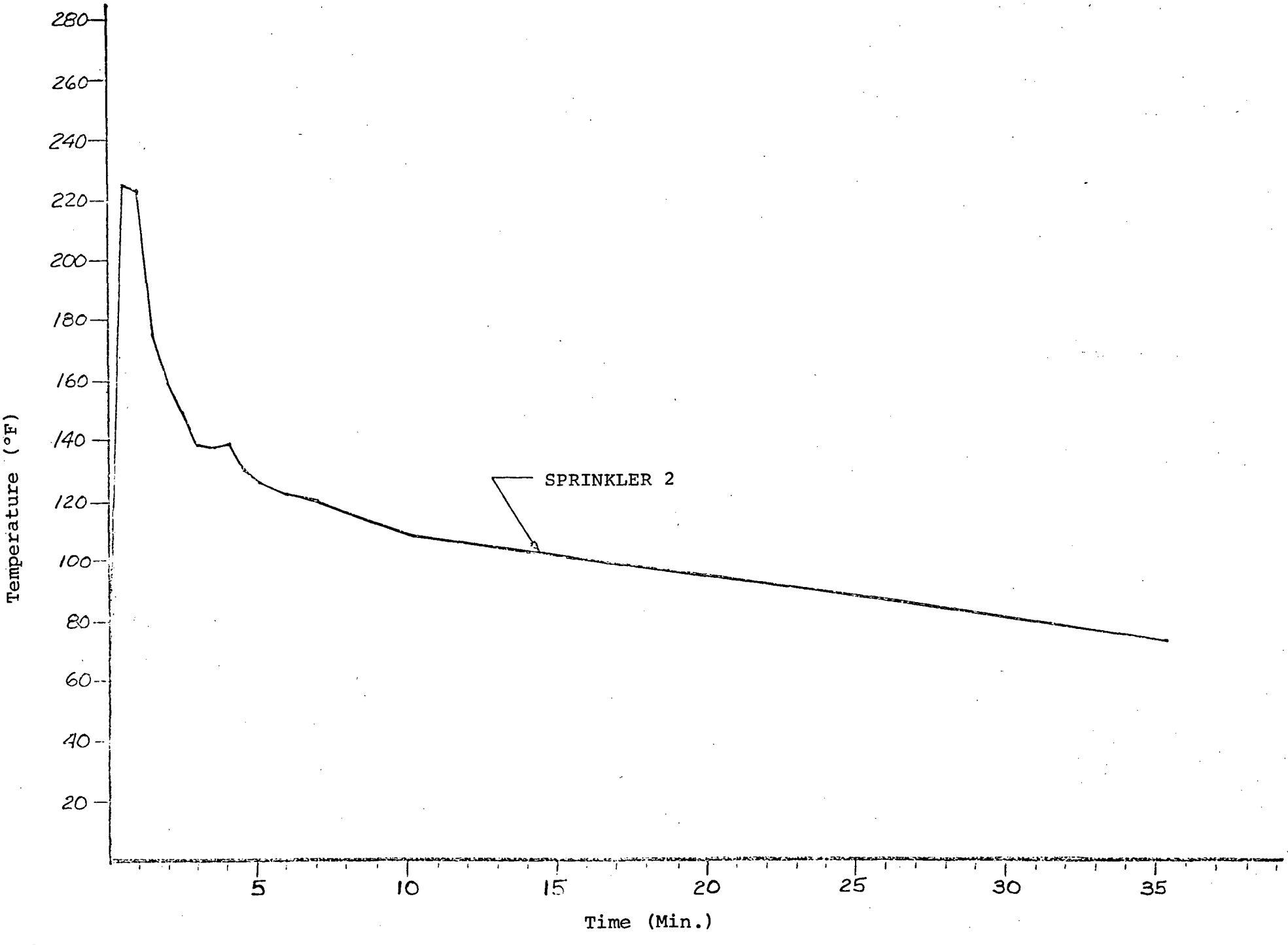


Figure 8. Air Temperature Versus Time (Sprinkler 2)

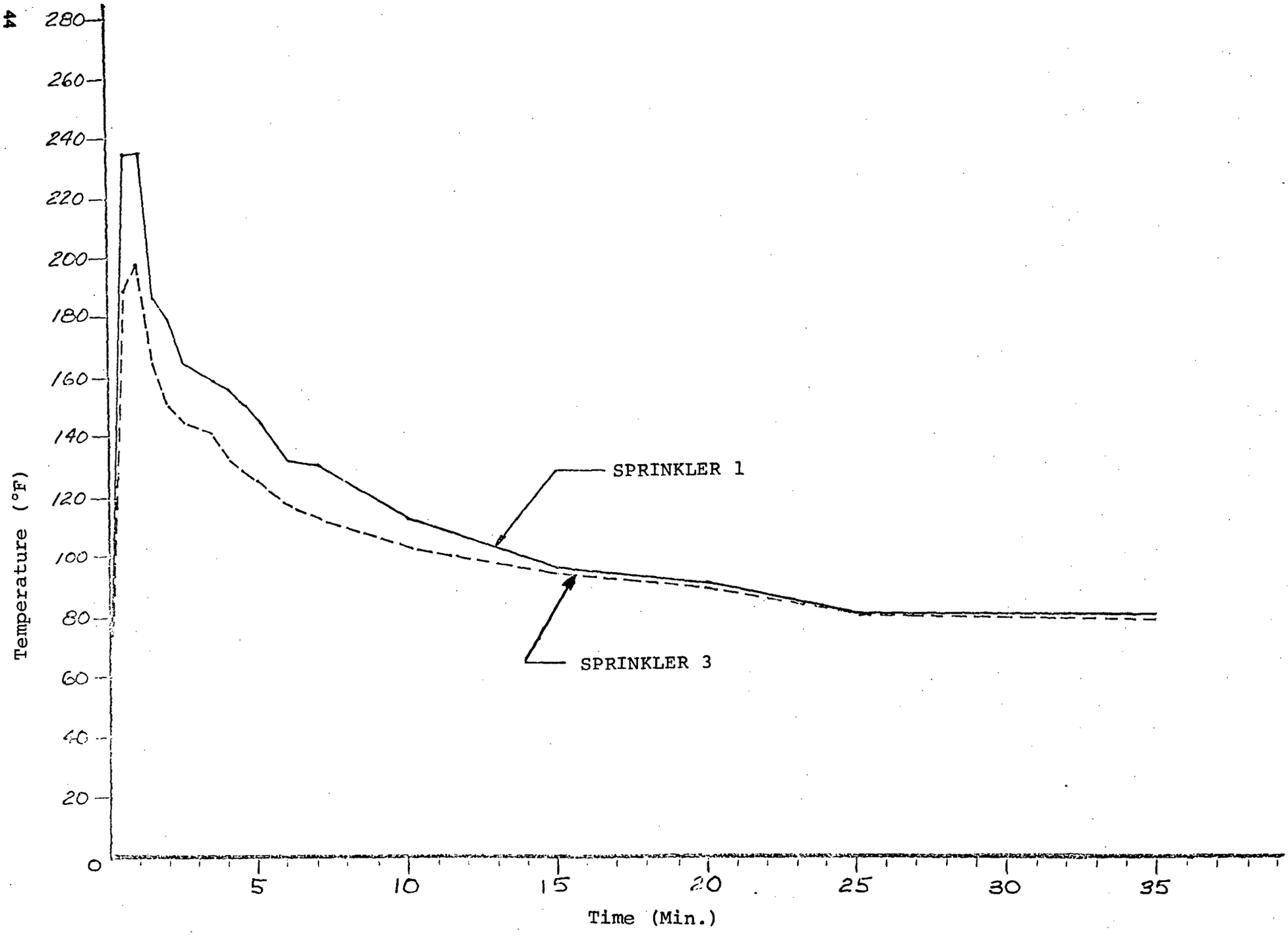


Figure 9. Air Temperature Versus Time (Sprinklers 1 & 3)

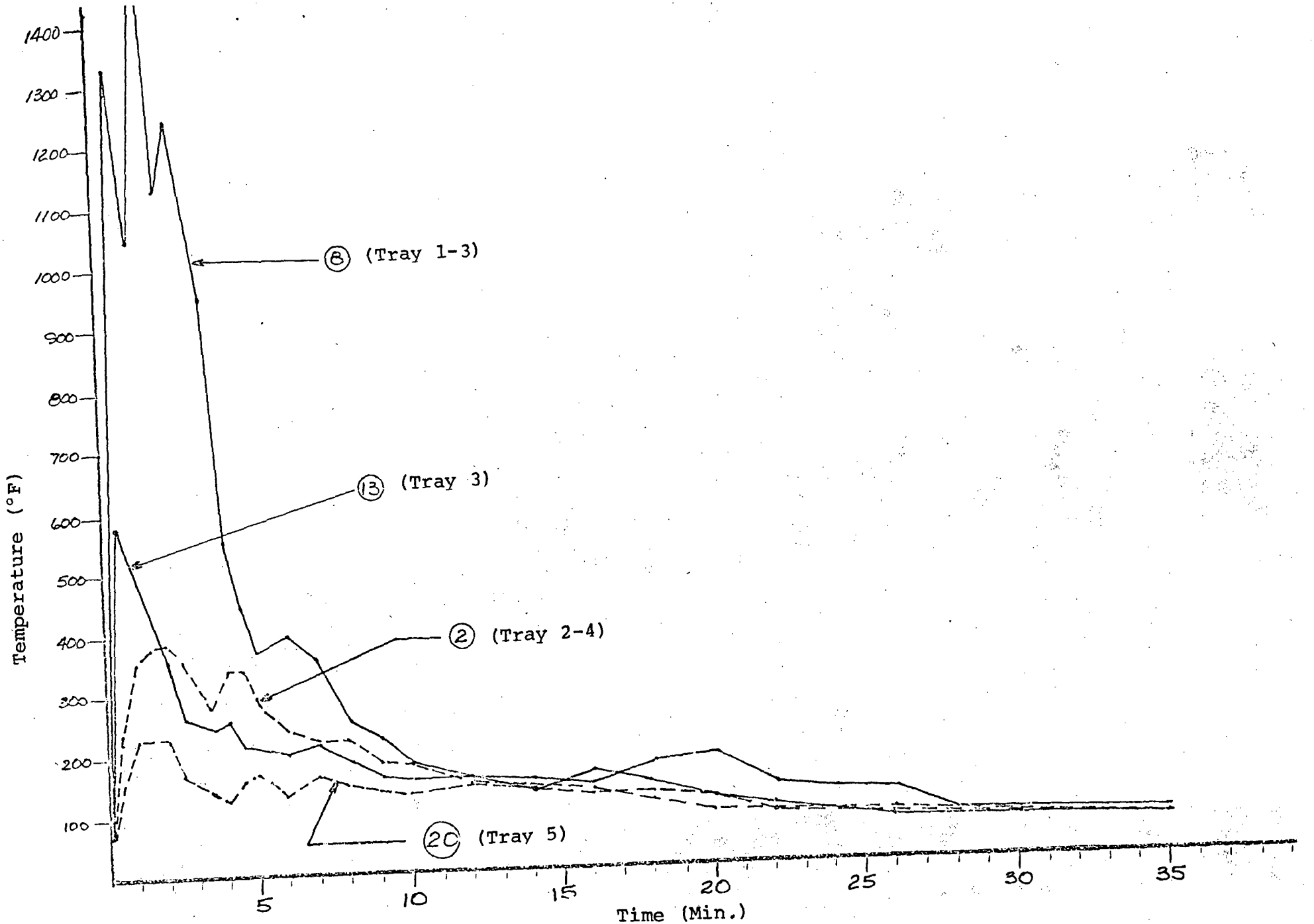


Figure 10. Air Temperature Versus Time

Figure 11. Tray 3 After Test

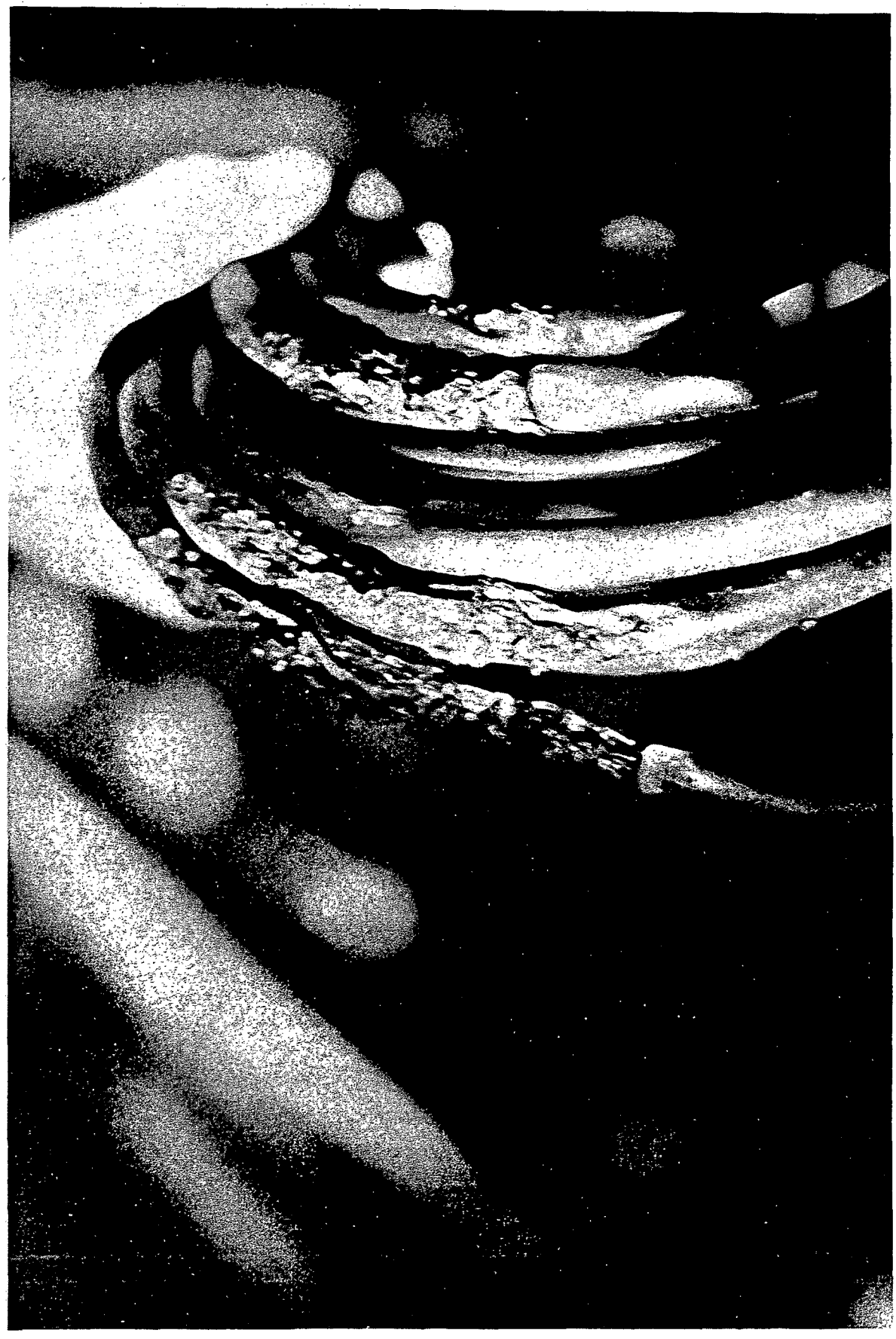


Figure 12. Tray 3 After Test

Figure 13. Tray 2 After Test

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