NOTICE

Technical Report Documentation Page

1. Report No. DOT/FAA/CT-TN93/7	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle INITIAL EVALUATION OF BURN CHARACTERISTICS OF PHENOLIC FOAM RUNWAY BRAKE ARRESTOR MATERIAL		5. Report Date December 1993
		6. Performing Organization Code
		8. Performing Organization Report No. DOT/FAA/CT-TN93/7
7. Author(s) Dung Do, Joseph Wright and Lawrence Hampton		
9. Performing Organization Name and Address Federal Aviation Administration Technical Center Atlantic City International Airport, NJ 08405		10. Work Unit No. (TRAIS)
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration Technical Center Atlantic City International Airport, NJ 08405		13. Type of Report and Period Covered Technical Note
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

Tests of the burn characteristics of a phenolic foam, under evaluation as a runway brake arrestor material, were conducted by the Fire Safety Branch of the Federal Aviation Administration (FAA) Technical Center.

The purpose of these tests was to assess the fire propagation properties of phenolic foam when exposed to a free burning Jet A fuel fire and to determine the fire control time of phenolic foam immersed in a jet fuel fire when extinguished using 3-percent Aqueous Film Forming Foam (AFFF).

Three pool fire tests were conducted as follows:

In the first and second tests, a 12-foot-square bed of phenolic foam material was placed adjacent to a 35-foot-diameter jet fuel fire. This configuration resulted in ignition and flame propagation across to adjacent foam material, resulting in charring of over 30 percent of the exposed surface of the phenolic foam.

In the third test, the phenolic foam material was immersed in the jet fuel fire to determine ease of extinguishment using conventional AFFF agent. The fire control time was three times longer than when the phenolic foam material was absent. The extinguishing time was an order of magnitude higher than that without the foam.

In addition, the phenolic foam material was evaluated on the basis of FAA fire test requirements for cabin materials. These small-scale tests measured burn length, weight loss, and heat release rates of the foam material in accordance with Federal Aviation Regulation (FAR) 25.853. These results showed the foam material passed the burn test requirements.

17. Key Words Phenolic Foam Materials Jet Fuel Fire Extinguishing Agents Extinguishing Agent Unit	18. Distribution Statement Document is on file at the Technical Center Library, Atlantic City International Airport, New Jersey 08405

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	47	

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EXECUTIVE SUMMARY

This test project was conducted to evaluate the burn resistance of phenolic foam aircraft arrestor bed material to a jet fuel fire and to determine the fire extinguishment time of phenolic foam immersed in a jet fuel fire, using 3-percent Aqueous Film Forming Foam (AFFF) extinguishing agent.

The wind was negligible during these tests, and the fuel fire plume remained near vertical.

The preliminary findings and test results are as follows:

1. The time required to control the pool fire (with the phenolic foam material placed in the fuel fire) was 3 times greater than without phenolic foam material, and the extinguishing time was 10 times greater than without the foam. This increase in time was due to small fires persisting at the rear of the phenolic foam configuration, making it more difficult for the firemen to extinguish the fire.

2. It was found that additional tests and studies would be necessary to properly evaluate the behavior of the phenolic foam under a full range of postcrash conditions. These tests should include:

- Test of phenolic foam material when exposed to wind blown fuel fires.

- Factoring in the effect of phenolic foam breakup that would result from severe aircraft braking action.

- Weathering and aging effects on the fire resistance of phenolic foam.

- Effect of a protective coating on the environmental degradation of the fire resistance capabilities of phenolic foam.

INTRODUCTION

PURPOSE.

The purpose of this test project was to evaluate the burn resistance of phenolic foam material when exposed to a jet fuel fire and to determine the fire extinguishing time of phenolic foam immersed in a jet fuel fire using 3-percent Aqueous Film Forming Foam (AFFF) agent. This project is an initial assessment of the fire safety of phenolic foam material being considered as a runway aircraft arrestor bed in the event of a runway overrun.

BACKGROUND.

In the accident at La Guarda International Airport, New York, on March 22, 1992, a United States Air, Boeing 737-400, failed to takeoff and crashed into the East River. In response to this runway overrun accident, the Airport Technology Branch of the Federal Aviation Administration (FAA) Technical Center initiated a program to evaluate the use of phenolic foam material as an aircraft arrestor bed. The phenolic foam material used in these tests was manufactured by Air Restor Group, Denver, Colorado.

In many cases runway overrun accidents are accompanied by a spilled jet fuel fire. A major concern is whether the phenolic foam arrestor material would contribute to the severity of a postcrash fuel fire. For example, could a jet fuel fire in the outer area propagate flame across the foam bedding, engulfing the aircraft in fire or blocking passenger evacuation? Or, will the presence and involvement of the foam material make it more difficult for rescue and firefighting personnel to control and extinguish a fuel fire? Questions such as these may only be properly addressed by realistic full-scale fire tests.

As a preliminary evaluation of fire resistance, standard FAA small-scale fire tests were conducted on the phenolic foam material. The tests measured burn length, weight loss, and the heat release rate of the foam material by using different test apparatuses, including the Vertical Bunsen Burner, 2-gallon-per-hour Oil Burner, and OSU Heat Release Rate Chamber in accordance with the Federal Aviation Regulations (FAR) 25.853. These results showed that the phenolic foam material passed the burn test requirements. Very little smoke was detected during each test.

Since the material exhibited good fire resistance in the small-scale fire tests, it was then subjected to large-scale pool fire tests at Maxton Airport, North Carolina.

TEST PROCEDURE

There were three pool fire tests conducted on the phenolic foam material.

<u>TEST 1. PHENOLIC FOAM MATERIAL BURN CHARACTERISTICS WHEN EXPOSED HORIZONTALLY TO THE EDGE OF THE POOL FIRE</u>.

The foam arrestor bed consisted of thirty-six 4- by 4-foot pieces of phenolic foam materials, each three inches thick and packed together to simulate a graded arrestor bed (figures 1 and 2). They were packed to form three 4- by 12-foot blocks, one 6 inches thick, one 12 inches thick and the third 18 inches thick to simulate a graded arrestor bed and to expose the maximum foam surface to the fuel fire flame as shown in figures 1 and 2. The 6-inch-thick block was extended 4 inches into a 35-foot-diameter pool fire as shown in figure 3. This pool contained sufficient water to provide a smooth water base upon which to float the Jet A fuel.

The 35-foot diameter pool with 12-inch-deep sides was lined with a submerged water and oil proof plastic material covered with 12 inches of sand to prevent contamination of the surrounding environment. The test pool was isolated from flammable materials such as grass, trees, etc. After each test the Jet A fuel was burned off and the remaining water pumped out of the pool. Fresh water was added for each test sequence.

<u>INSTRUMENTATION</u>.

<u>Computer Systems</u>. The computer systems for this test consisted of a main IBM AT computer and a back up AT&T computer.

These computers were used to acquire, reduce, store, and provide real time graphic display for the heat flux and temperature measurements.

<u>Calorimeter and Thermocouple Locations</u>. Calorimeters used for this test were foil type Gardon gauge heat flux transducers. Temperature was measured using Thermo Electric quick response Chromel/Alumel type K thermocouples. For measuring the heat flux radiation and temperatures, 12 calorimeters and 20 thermocouples were used as shown in figures 4 and 5. Six calorimeters were installed as pairs across the center line on the surface of the phenolic foam at the edge of the pool, 4 feet and 8 feet from the pool fire. The other 6 calorimeters were mounted on a steel tree in pairs, 5 feet off the ground and 8 feet from the pool fire. Four thermocouples were placed as pairs across the center line on the surface of the phenolic foam at the leading edge of the foam block and Jet A fuel level and 4 feet from the pool. Fifteen thermocouples were mounted on a steel tree above the phenolic foam at 5 feet and 10 feet off the ground and 4 feet and 8 feet from the pool. The last thermocouple was placed on the surface of the Jet A fuel and used to determine the time of ignition.

<u>Video Coverage</u>. Five VHS format video cameras placed in circular formation monitored this test. Two cameras were placed opposite from each other on airstairs 15 feet off the ground and 40 feet from the pool. These cameras were employed to monitor the left and right top views of the pool and the phenolic foam blocks. The others, mounted on tripods, were placed 5 feet

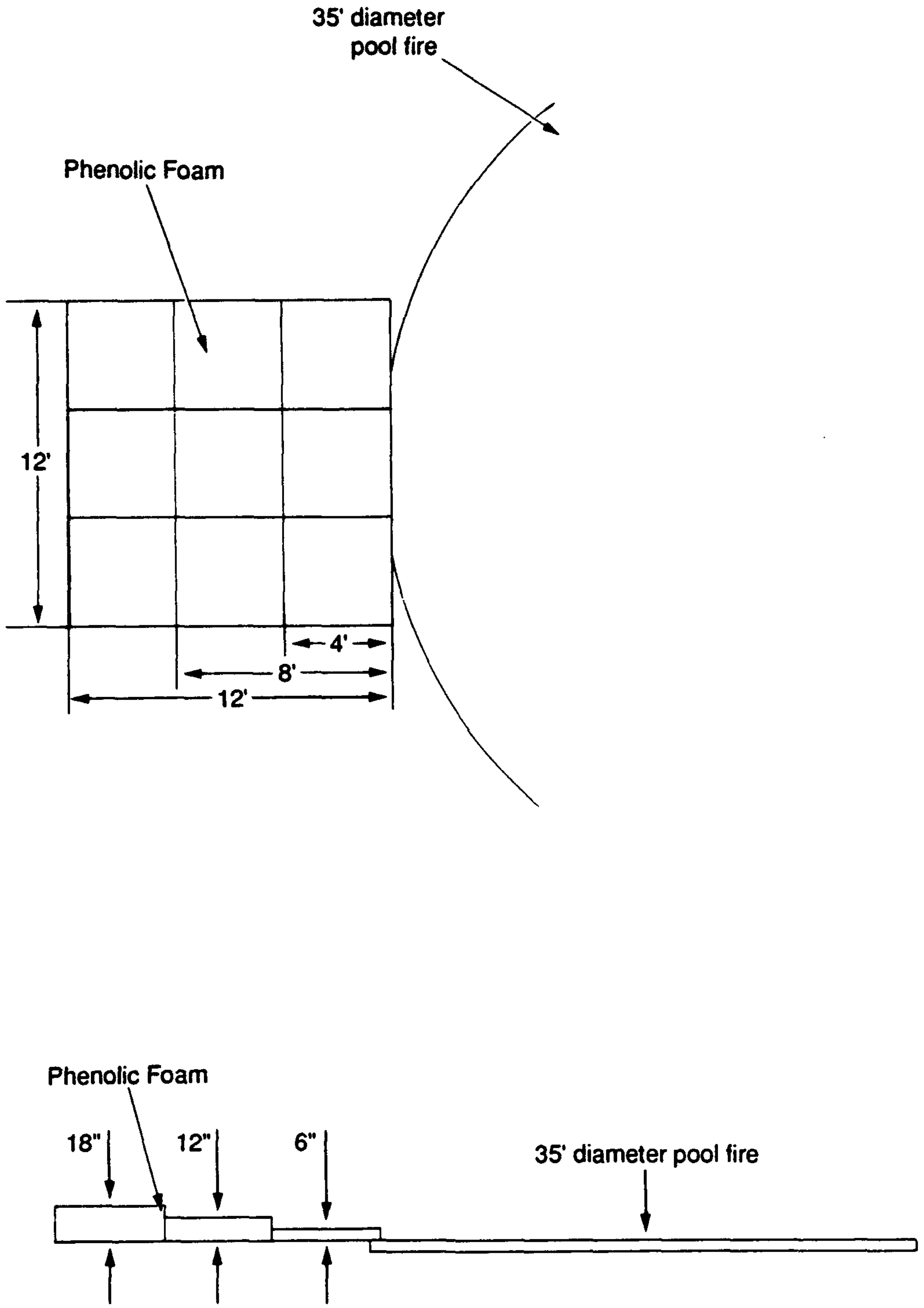

FIGURE 1. THREE BLOCKS OF PHENOLIC FOAM EXPOSED TO THE POOL FIRE

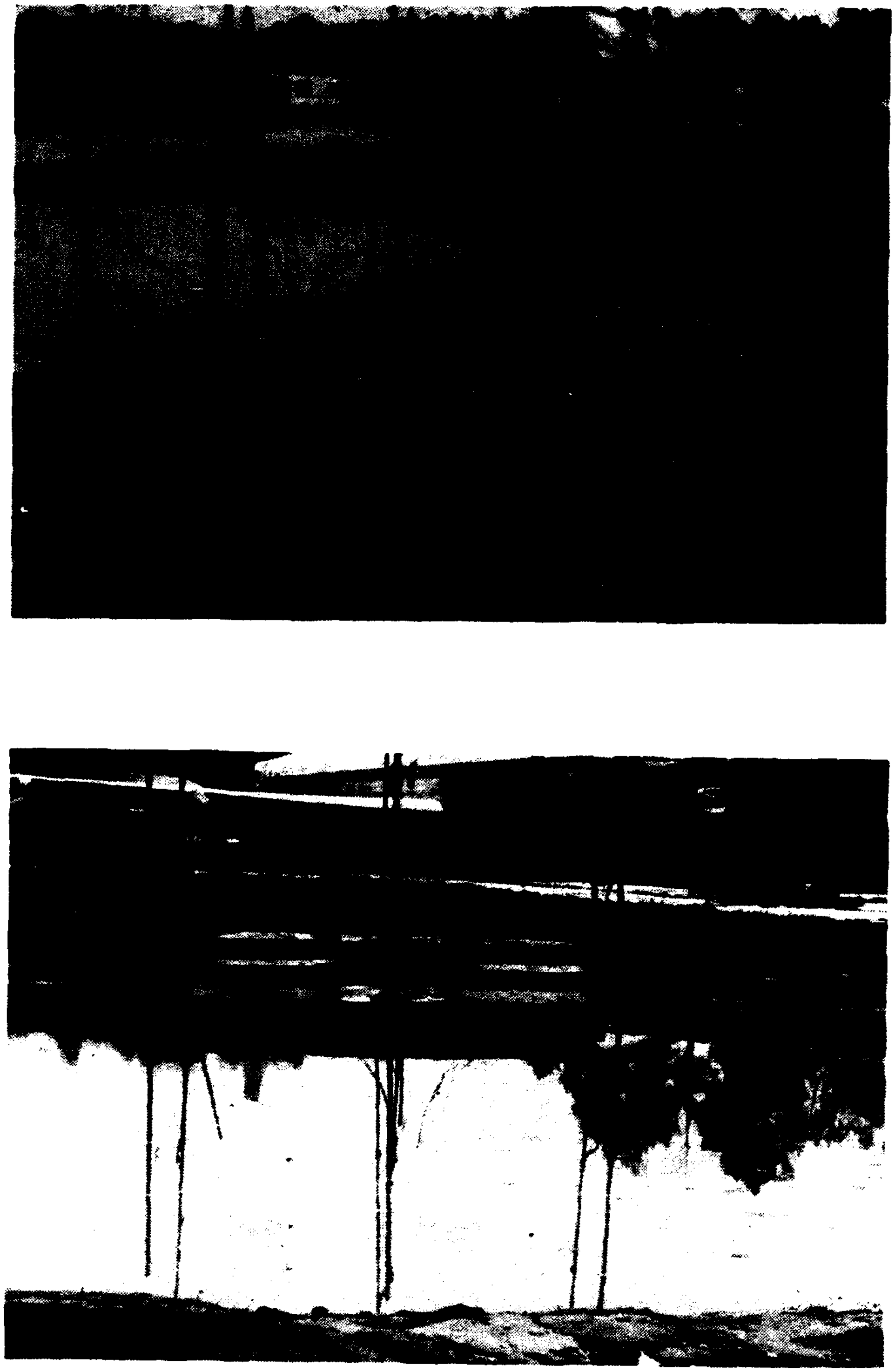

FIGURE 2. PHENOLIC FOAM PLACEMENT (TWO VIEWS)

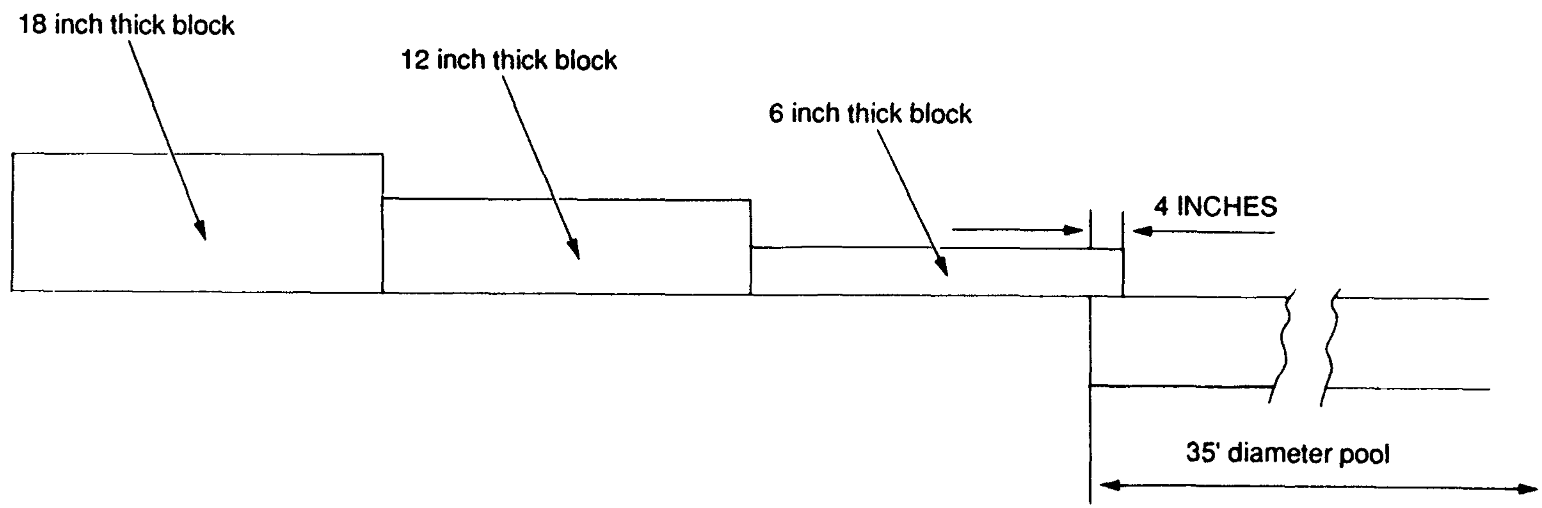

FIGURE 3. THE 6-INCH-THICK FOAM BLOCK EXTENDED 4 INCHES INTO THE POOL

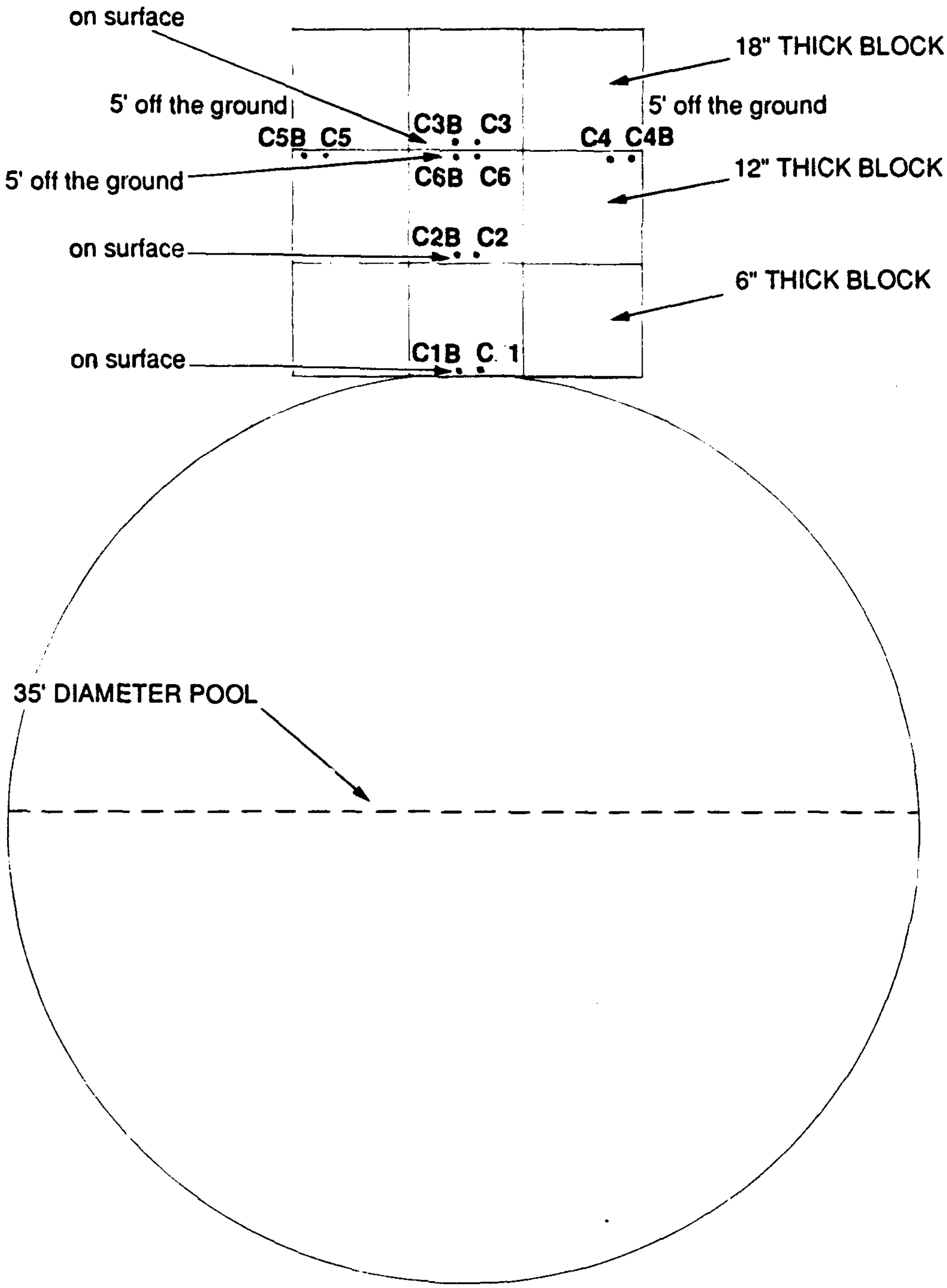

FIGURE 4. CALORIMETER PLACEMENT

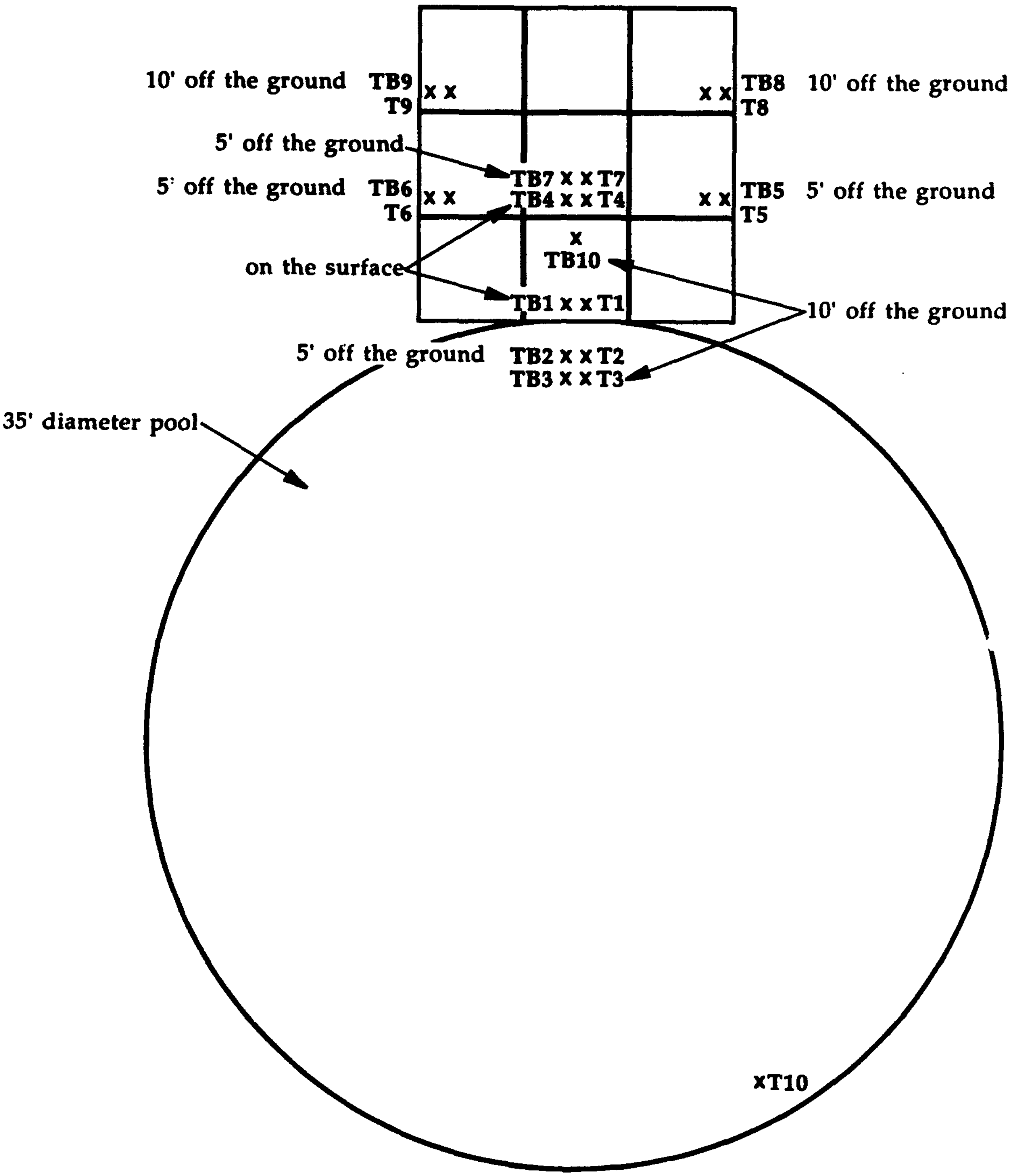

FIGURE 5. THERMOCOUPLE PLACEMENT

from the ground and 50 feet from the fire. These were used to view the side view of the foam blocks and the pool. Still photographs were taken before, during, and after the test.

Wind Equipment. Wind measurement equipment, of the F420c series, was used to measure wind speed and direction during the test. This equipment consisted of a cup rotor anemometer and spread tail wind direction vane with associated speed and direction indicators.

Test Sequence. Four hundred and fifty gallons of Jet A fuel were floated onto the pool for this test. Five gallons of gasoline were poured along the pool edge opposite the phenolic foam blocks to more easily ignite the Jet A fuel using a fire torch.

Test Observation. The observations made during the test are shown in table 1.

TABLE 1. FIRE EVENT TIME TABLE

Time (seconds)	Event
0	Fuel ignition
34	Smoke was initially seen in the area between the 6-inch-thick and 12-inch-thick block sides, 4 feet from the pool. This smoke continued throughout the test (figure 6A). The temperature at this area varied between 150 and 250 degrees Fahrenheit (figure 7).
38	Smoke began to emanate from the confined area between the 12-inch-thick and 18-inch-thick blocks and continued to emanate throughout the test (figure 6A). The temperatures 5 feet from the ground and 8 feet from the pool varied between approximately 100 and 250 degrees Farenheit from this time to the end of the test (figure 8).
43	Fire fully developed and covered the entire pool.
95	Small fires were detected under the area of the center of the leading edge of the 6-inch-thick block (figure 6B).
360	The test was terminated and the Jet A fuel was exhausted.

The wind speed measured during this test was 3 knots and had a negligible effect on the fire flume which remained near vertical for the entire test.

FIGURE 6A. SMOKE COULD BE SEEN IN THE AREA BETWEEN THE 6-INCH-THICK AND 12-INCH-THICK FOAM BLOCKS, AND 12-INCH-THICK AND 18-INCH-THICK FOAM BLOCKS AT 38 SECONDS INTO THE TEST

FIGURE 6B. FIRE DETECTED AT THE LEADING EDGE OF 6-INCH FOAM BLOCK AT 95 SECONDS INTO THE TEST

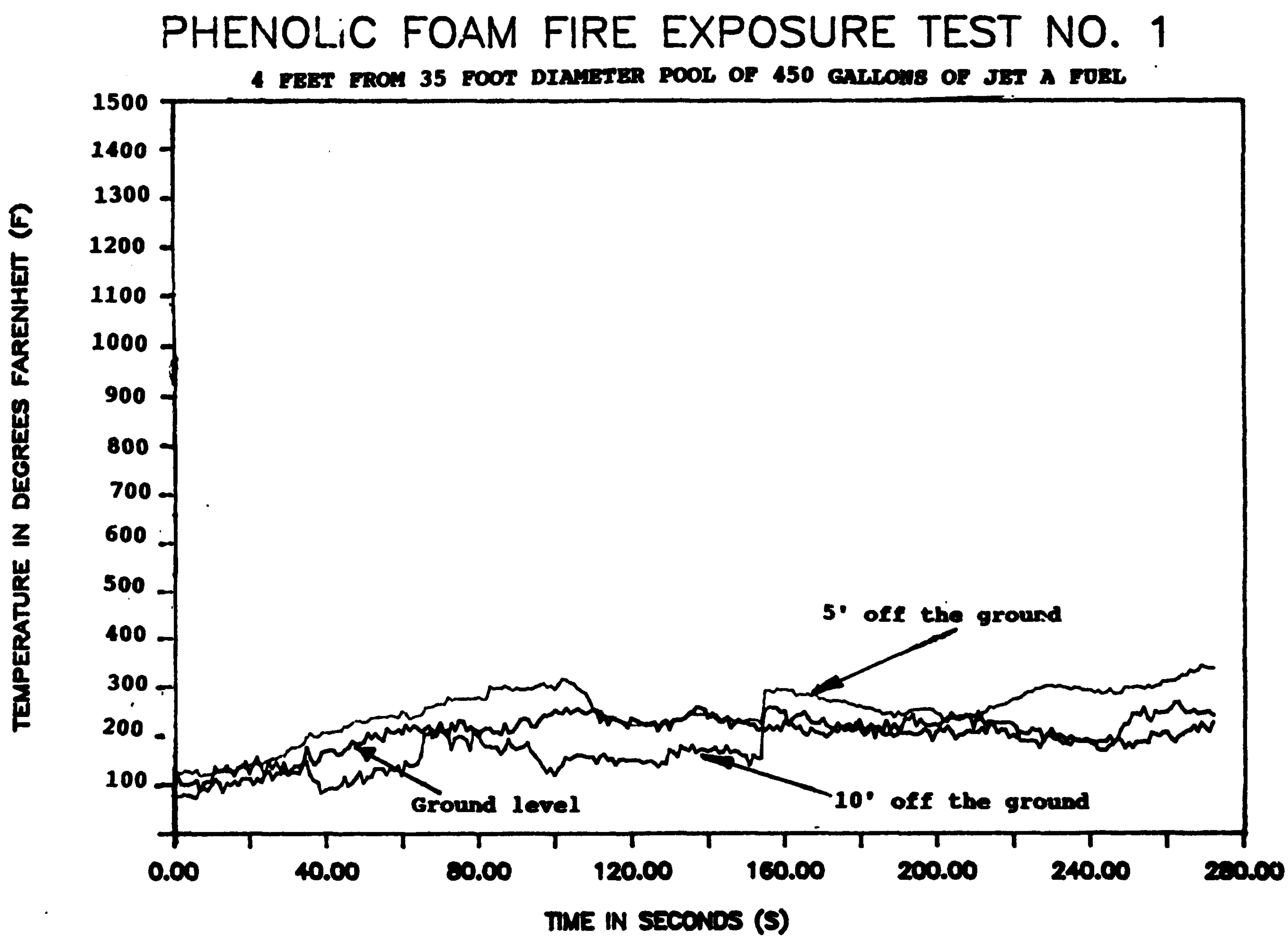

FIGURE 7. TEMPERATURE DATA 4 FEET FROM THE POOL

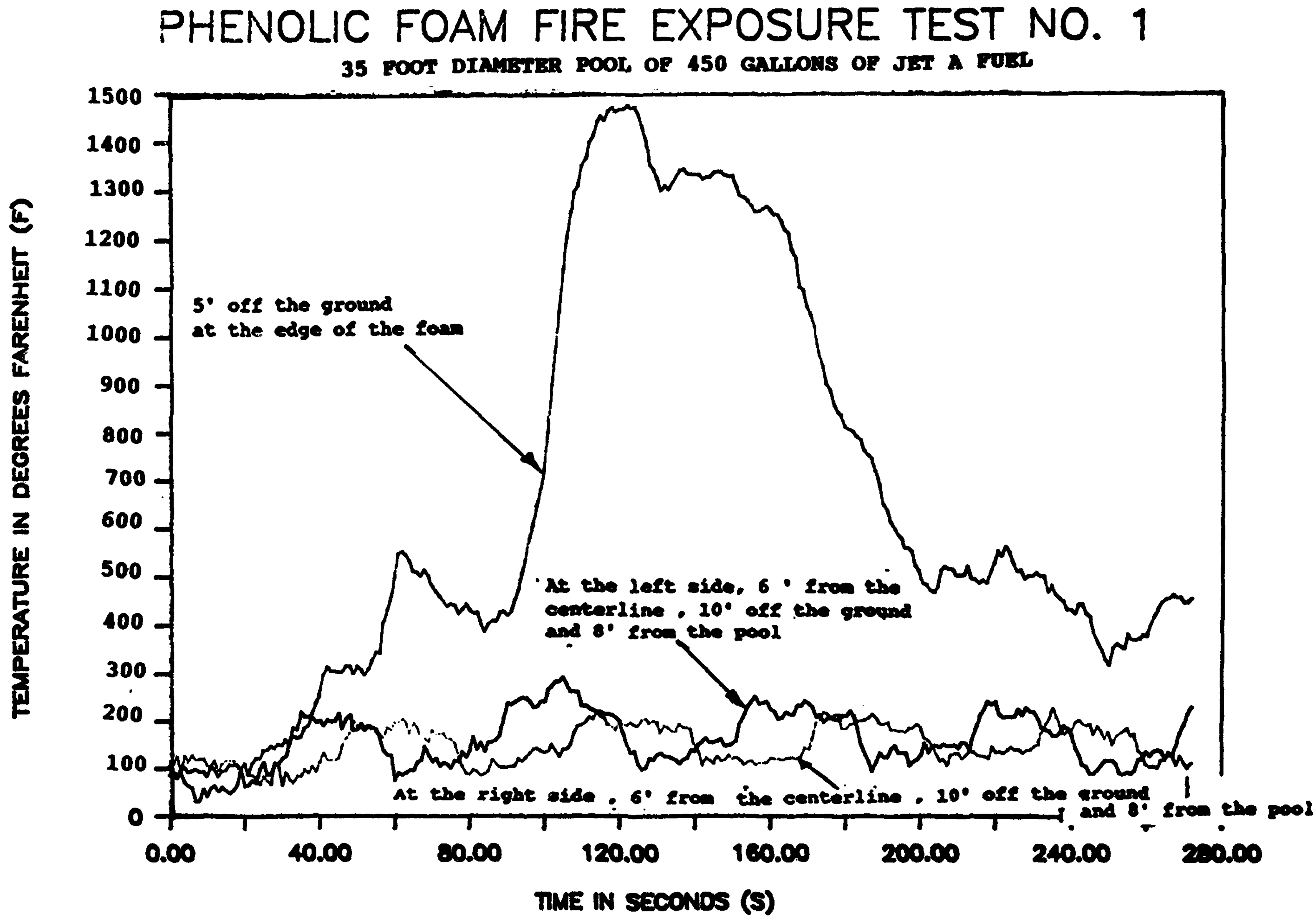

FIGURE 8. TEMPERATURE AT THE EDGE OF THE FOAM AND 8 FEET FROM THE POOL

__Test 1 Results__. Post-test examination of the foam specimens indicated the following damage:

1. Over one-third of the surface of the blocks of foam was charred (figure 9)

2. The surface of the 6-inch-thick block was totally charred and buckled (figure 9).

3. The surface of the 12-inch-thick block located next to the 6-inch-thick block was charred for 2 inches from all leading edges.

4. The surface of the 18-inch-thick block located next to the 12-inch-thick block was charred for 1/2 inch from all leading edges.

5. All leading edges of the 6-inch-thick phenolic foam side were charred and buckled about 2 inches into the foam. Some charred debris had fallen into the pool fire (figure 10).

6. One inch from the leading edges of the 12-inch-thick phenolic foam side facing the 6-inch-thick block was charred and buckled but remained in place.

7. The 18-inch-thick phenolic foam side was charred about 1/4 inch from the leading edges.

8. All three phenolic foam block bottoms were intact except for slight damage to the leading edge bottom of the 6-inch block.

9. The temperature profiles measured at the surface and at 5 and 10 feet above the edge of the pool at the center line of the foam (figure 5) are shown in figure 11. It is evident that except for a period of time extending from 100 sec to 160 thru 200 seconds the pool fire flume was practically vertical. During the above time increment, the elevated temperatures for the 5- and 10-foot thermocouples indicated that the plume was bent in the direction of the foam. Nevertheless, the heat flux at the surface of the foam was relatively low because the wind speed (3 knots) was incapable of bending the plume near the foam (figure 12). The measured heat flux levels were far below the values attainable in the plume (14 to 16 $Btu/ft^2/sec$).

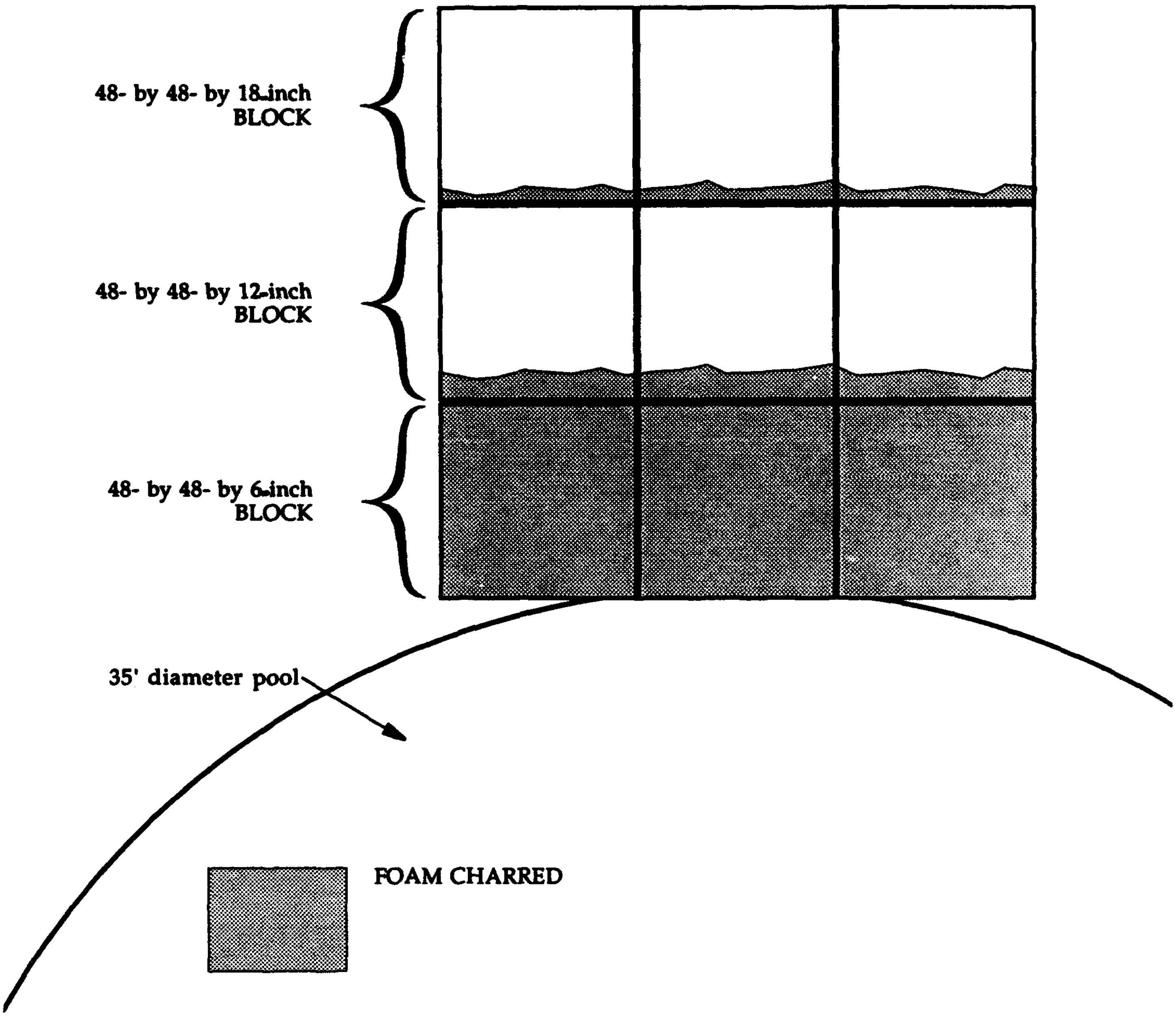

FIGURE 9. PRINCIPAL FIRE DAMAGE--SURFACE OF PHENOLIC FOAM

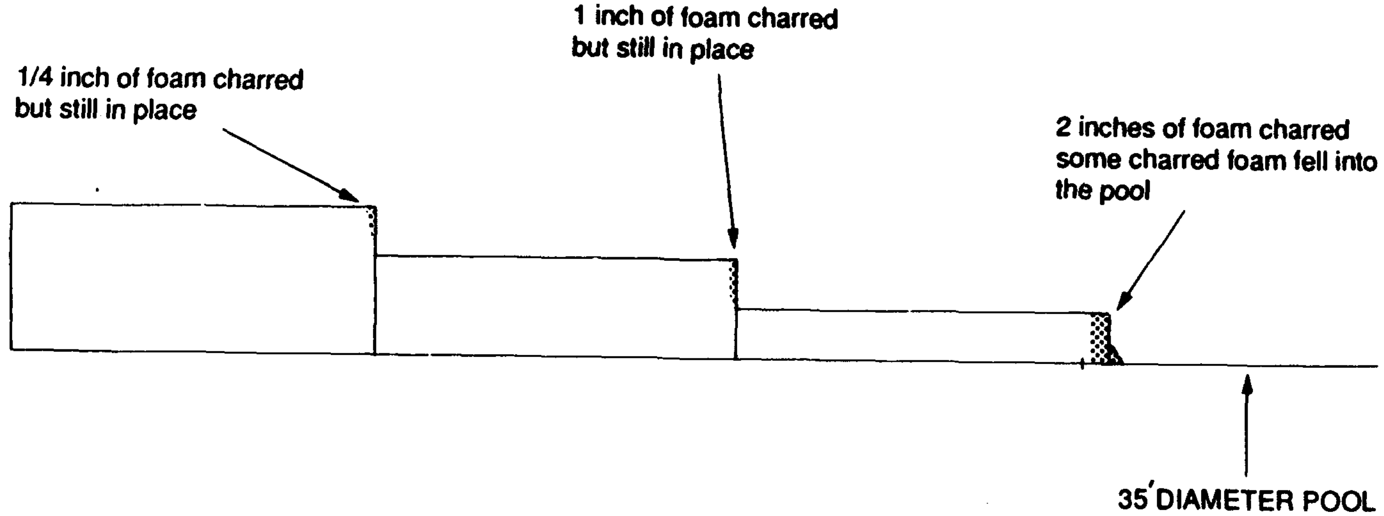

FIGURE 10. SIDE VIEW OF CHARRED SURFACES OF THREE BLOCKS OF FOAM

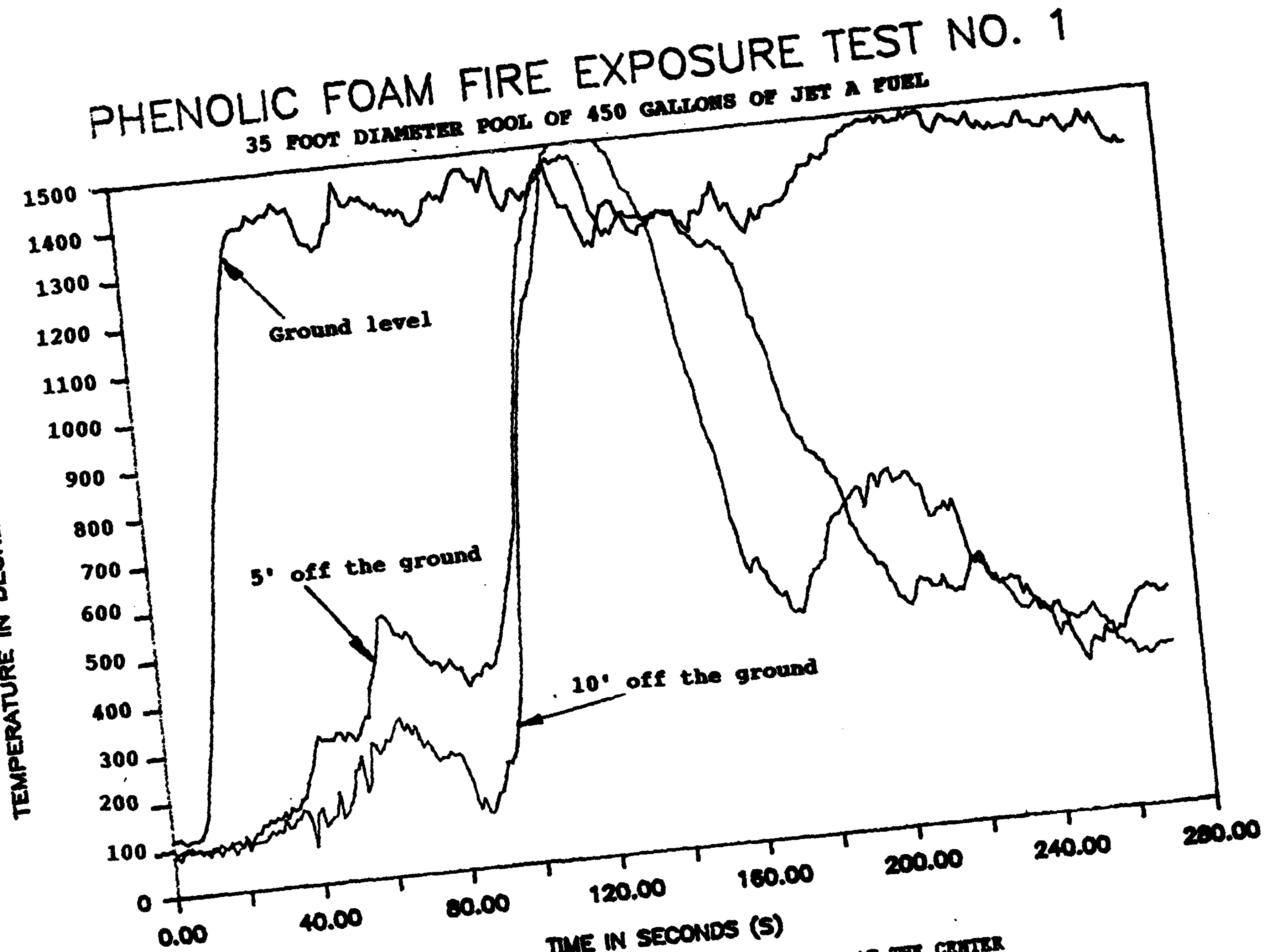

FIGURE 11. TEMPERATURES AT THE EDGE OF THE POOL AT THE CENTER LINE OF THE FOAM

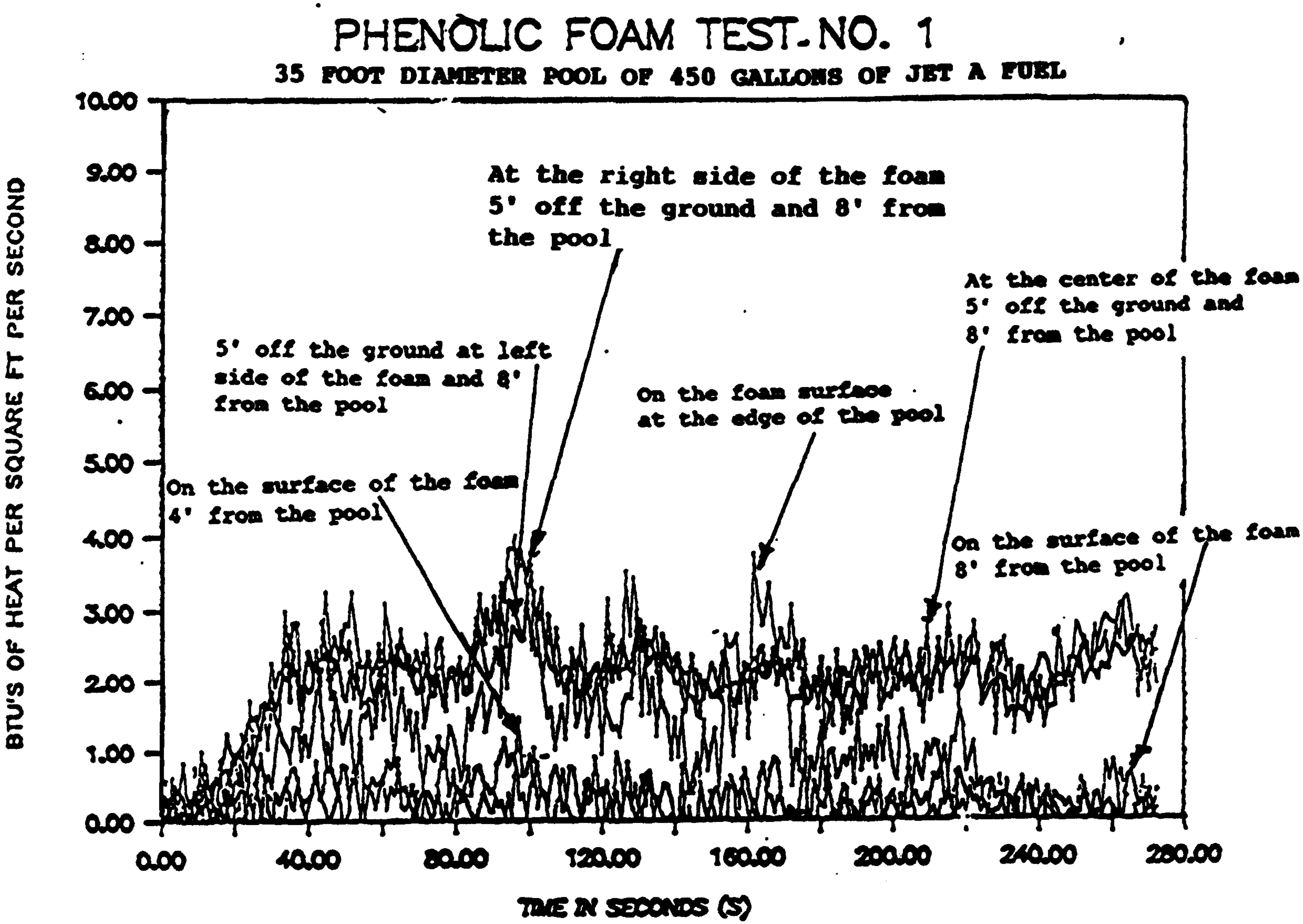

FIGURE 12. HEAT FLUX PROFILES ON AND ABOVE THE FOAM

TEST 2. PHENOLIC FOAM MATERIAL BURN CHARATERISTICS WHEN EXPOSED HORIZONTALLY TO THE POOL FIRE.

The second test configuration was similiar to the first test. This test was repeated because the wind in the first test was insufficient to cause the fire plume to impinge against or bend closer to the phenolic foam blocks. Two 48-inch diameter fans and one 24-inch diameter fan were placed opposite the foam blocks in an attempt to direct the flames toward the foam (figure 13).

Fourteen 36- by 4- by 3-inch foam fragments were mounted vertically around the circumference of the pool (figure 14).

One 48- by 48- by 6-inch block was placed in the center of the pool. Placement of the additional specimen was done to assess potential combustibility of the foam material (figure 14).

INSTRUMENTATION.

The computer systems, calorimeter, thermocouple locations, and video coverage were identical to the first test.

Test Sequence. Pool fire test 2 was similiar to test 1, except the quantity of Jet A fuel in the pool was reduced to 300 gallons. The fans used in this test were incapable of directing the fire plume against the foam blocks. The test was begun by using a fire torch to ignite half the pool circumference opposite the foam block location.

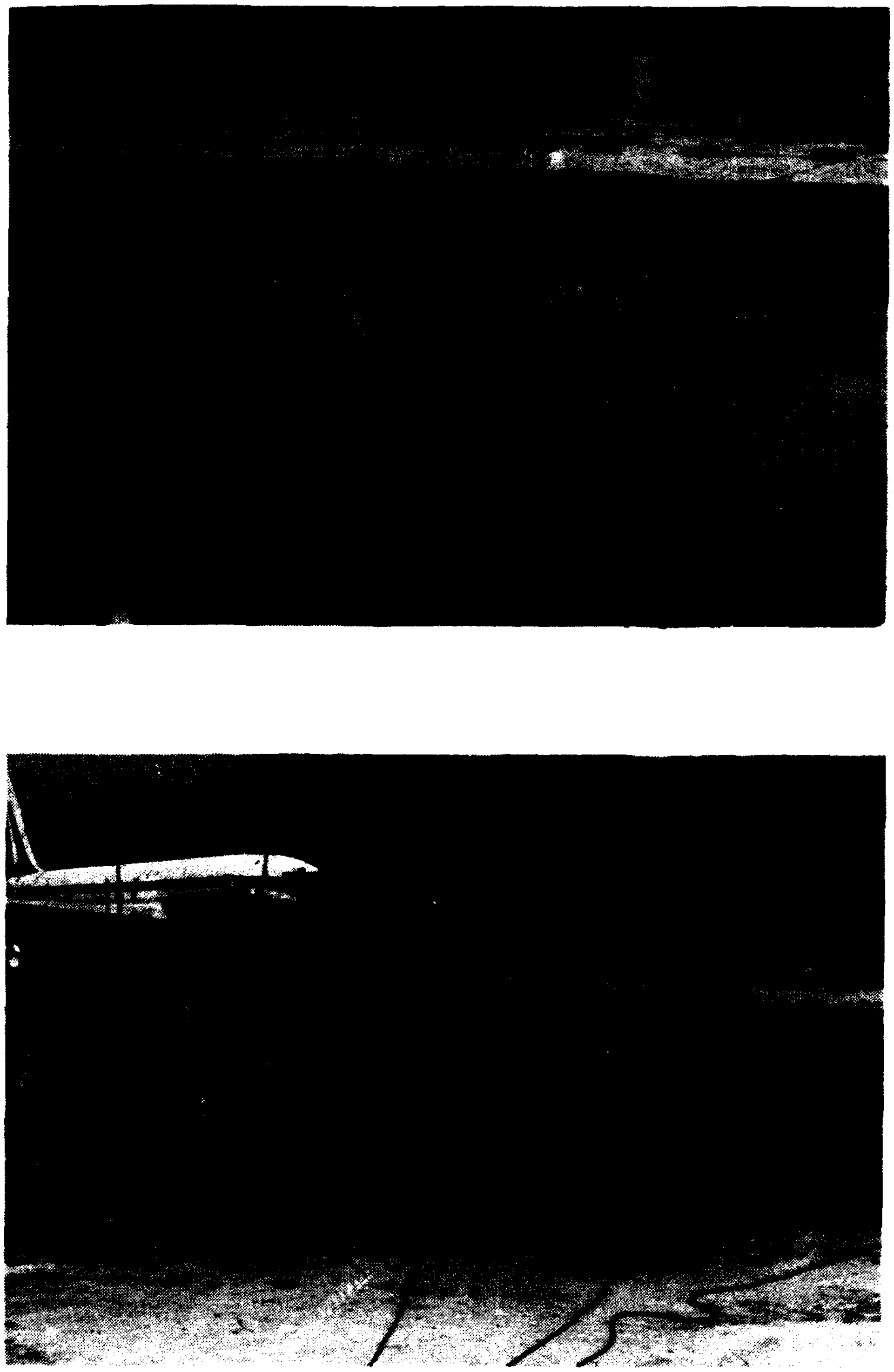

FIGURE 13. THREE FANS OPPOSITE THE FOAM BLOCKS

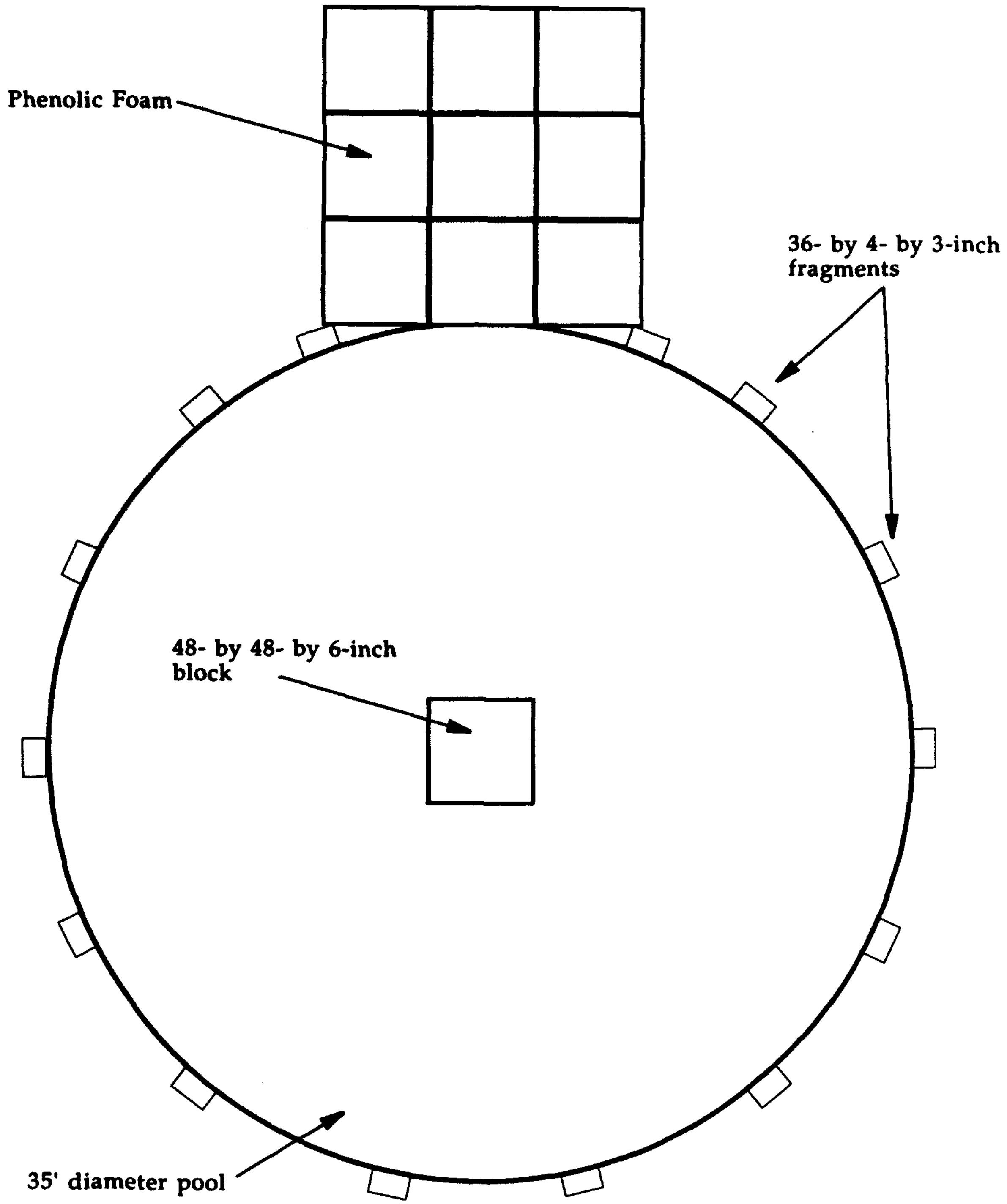

FIGURE 14. FOURTEEN 36- BY 4- BY 3-INCH FOAM FRAGMENTS AND A 48- BY 48- BY 6-INCH FOAM BLOCK WERE ADDED TO TEST 2

Test Observation. The observations during the test are shown in table 2.

TABLE 2. FIRE EVENT TIME TABLE

Time (seconds)	Event
0	Fuel ignition
42	Smoke emanated from the area between the 6-inch-thick foam and the pool edge (figure 15A).
75	Fire covered only half the pool opposite the foam blocks because the wind blew the fuel vapors away from the block side (figure 15B).
105	Smoke could be seen in the confined area between the sides of the 6-inch-thick and 12-inch-thick blocks.
133	Fire was fully developed and covered the entire pool.
144	Fourteen 36- by 4- by 3-inch foam fragments located around the circumference of the pool were observed to be involved by the fire (figure 16).
201	Fire could be seen in the area along the sides between the 6-inch-thick and 12-inch-thick blocks. This fire continued for 50 seconds.
210	Fire was detected at the area between the 12-inch-thick and 18-inch-thick block sides. The fire stopped at 278 seconds into the test.
230	Fire again could be seen at the area along the sides between the right and the center of the 6-inch-thick blocks. The fire stopped at 269 seconds into the test.
320	The test was terminated and the Jet A fuel was exhausted.

FIGURE 15A. SMOKE FROM THE 6-INCH-THICK FOAM LEADING EDGE AT 42 SECONDS INTO THE TEST

FIGURE 15B. FIRE COVERED HALF THE POOL AT 75 SECONDS INTO THE TEST

FIGURE 16. FOAM FRAGEMENTS WERE INVOLVED IN THE FIRE AT 144 SECONDS INTO THE TEST

Test 2 Results. Post-test examination of the foam specimens indicated the following damage:

1. Over 50 percent of the surface of the blocks of foam was charred (figure 17).

2. The surface of the 6-inch-thick phenolic foam block was totally charred and buckled (figure 17).

3. The surface of the 12-inch-thick and 18-inch-thick phenolic foam blocks were charred as shown in figure 17.

4. All leading edges of 6-inch-thick foam side were charred about 2 inches into the foam, and some charred debris had fallen into the pool fire (figure 18).

5. Approximately 1 inch from the leading edges of the 12-inch-thick foam side was charred and buckled but still intact.

6. The 18-inch-thick foam side was charred for approximately 1/4 inch from the leading edges.

7. Seven 36- by 4- by 3-inch foam blocks at the left side of the pool were charred on the area facing the fire for approximately an inch into the foam. The other seven 36- by 4- by 3-inch blocks were totally charred and had fallen down.

8. The 48- by 48- by 6-inch block placed in the center of the pool was charred 1-inch deep on top as well as all sides (figure 19).

9. The temperature and heat flux profiles are shown in figures 20 and 21. The temperatures reflect the unusually long time before the pool fire became fully developed. This delay and the reduced burning time of the pool fire did not present a significant thermal threat to the foam material. The heat flux readings were comparable to test 1.

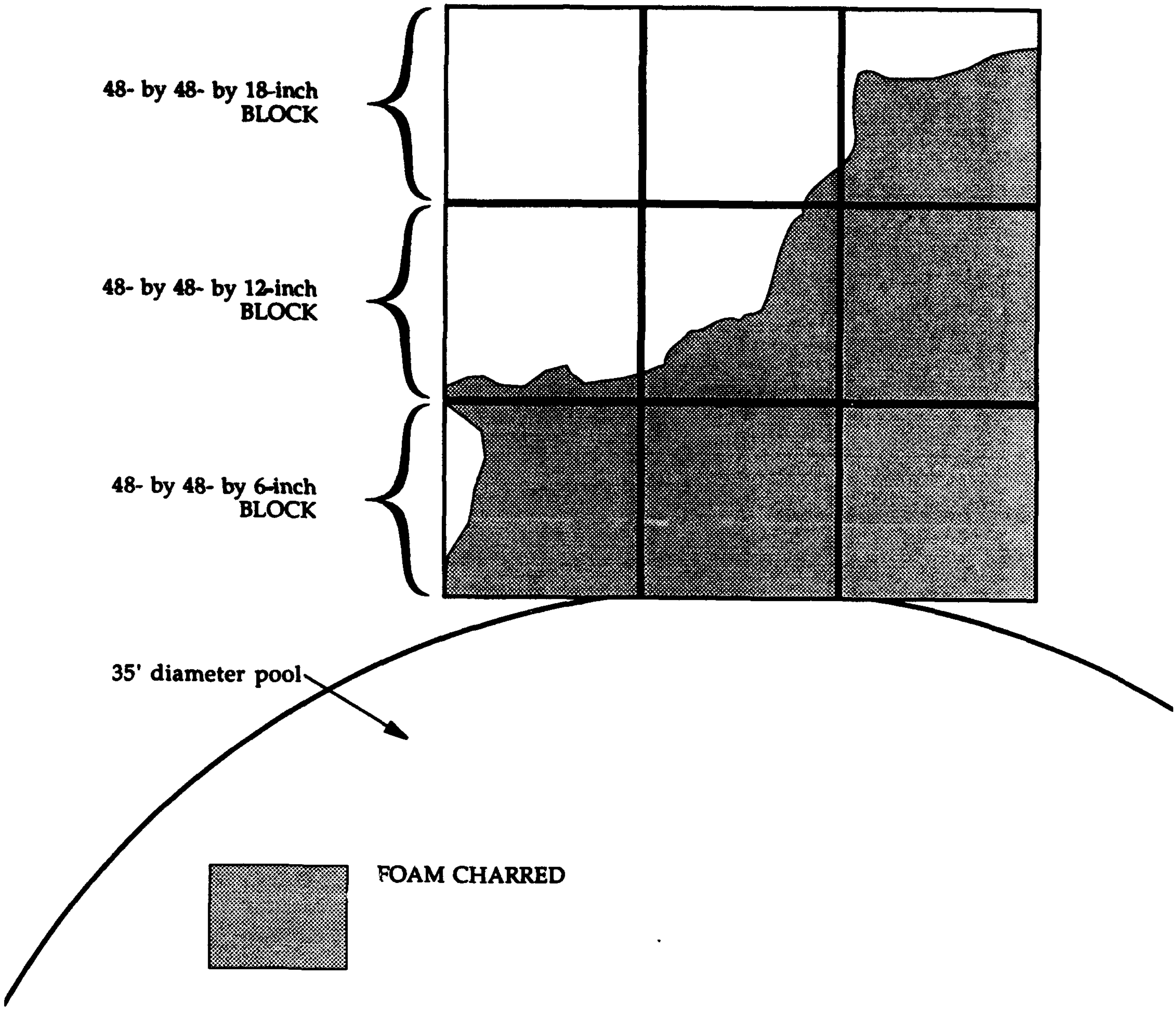

FIGURE 17. PRINCIPAL FIRE DAMAGE SURFACE OF PHENOLIC FOAM

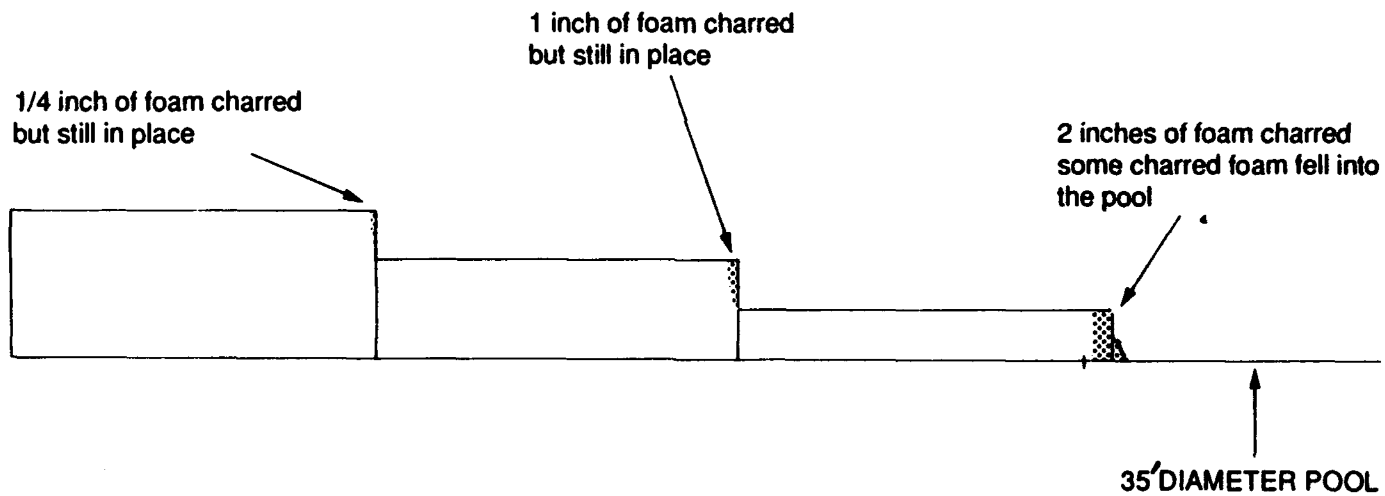

FIGURE 18. SIDE VIEW OF CHARRED SURFACES OF THREE DIFFERENT THICKNESSES OF FOAM

FIGURE 19. SECTION OF THE 48- BY 48- BY 6-INCH BLOCK OF FOAM CHARRED ON ITS SURFACE

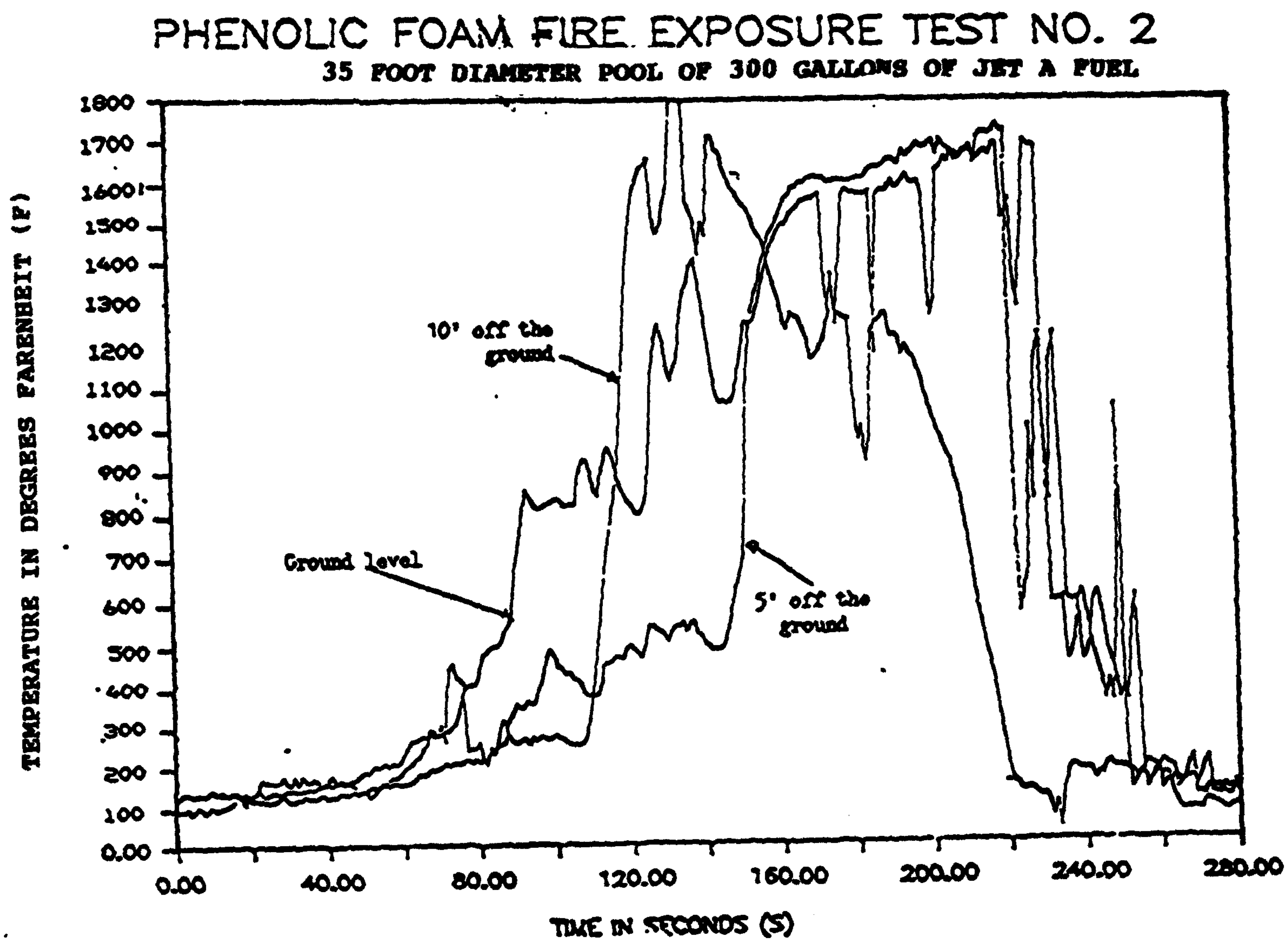

FIGURE 20. TEMPERATURES AT THE EDGE OF THE POOL AT THE CENTER LINE OF THE FOAM

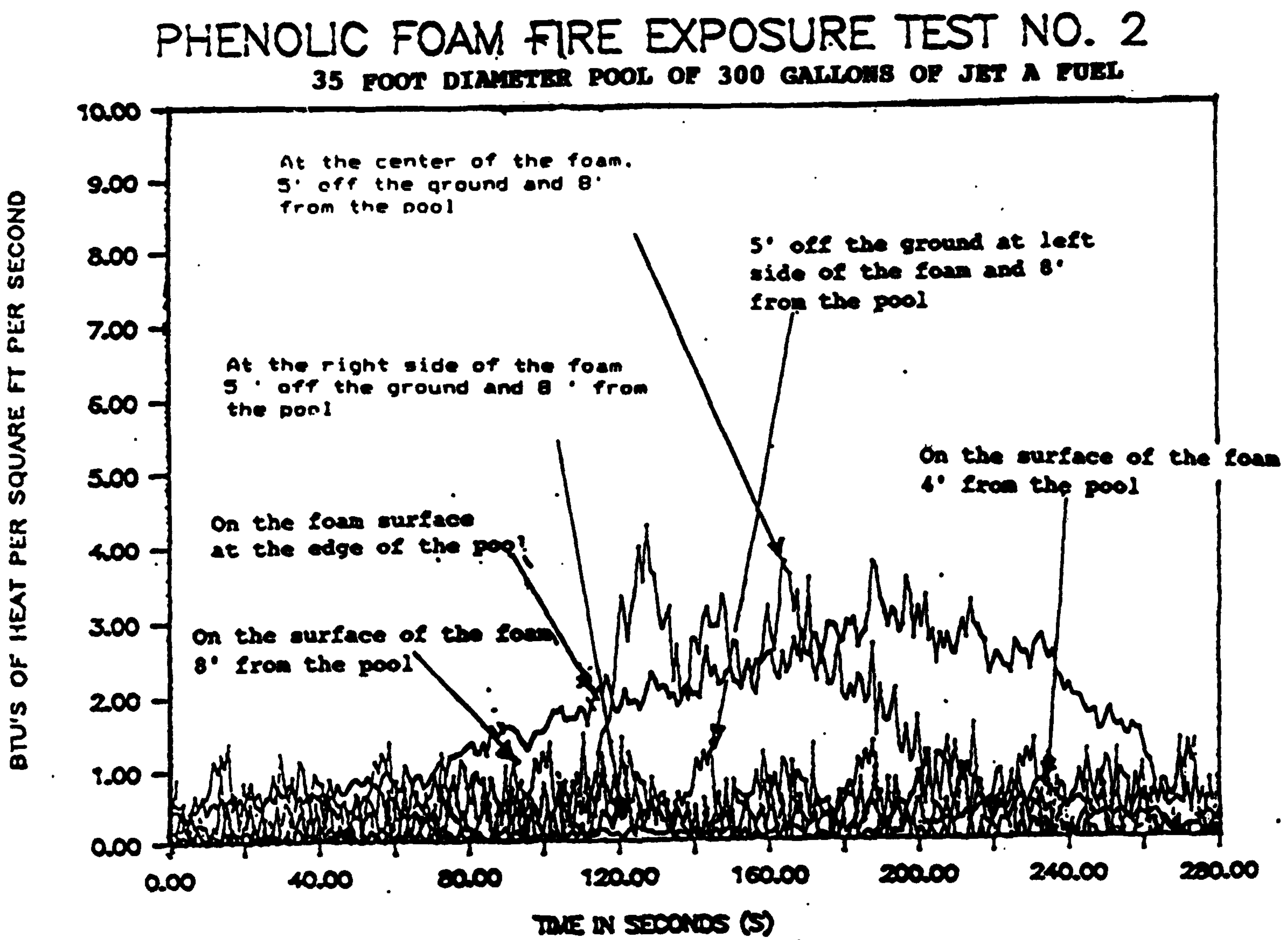

FIGURE 21. HEAT FLUX DATA ON AND ABOVE THE FOAM

TEST 3. PHENOLIC FOAM FIRE EXTINGUISHING TEST PROCEDURE.

A total of twenty-two 48- by 48- by 6-inch phenolic foam blocks were placed in a 35-foot-diameter pool fire. These foam blocks were floated on the Jet A fuel surface. The foam blocks covered an area of 352 square feet and occupied approximately one-third of the pool area surface of 962 square feet. One hundred gallons of Jet A fuel were placed into the pool and 125 gallons splashed on all the foam blocks (figure 22).

The extinguishing agent used to suppress the foam fire was a 3 percent AFFF agent, Mil Specification MILL-F-24385C.

The Fire Boss Twin Agent AFFF/Dry Powder Extinguishing Unit (TAU) provided the extinguishing agent for this test. This unit consisted of two metal spheres. One sphere contained 200 gallons of AFFF agent and the second contained 450 pounds of Potassium Bicarbonate (Purple K) Dry Chemical Powder.

The AFFF extinguishing agent only was employed to combat the fire at a rate of 60 gallons per minute. The fire was fought from the upwind side. A solid stream of extiguishing agent was discharged into the base of the fire and sprayed back and forth across the pool.

The fire control and fire extinguishing times were determined by analysis of video tape. The fire control time is when 90 percent of the surface of the pool was covered by foam. The fire extinguishing time was when all flames were extinguished.

INSTRUMENTATION.

Computer Systems. The main IBM and back up AT&T computer systems were the same as for the previous tests .

Calorimeter Locations. Six calorimeters were placed in pairs; one pair was 5 feet off the ground and 10 feet from the pool. The other two pair were 14 feet from the pool and 10 feet off the ground, as shown in figure 23. The calorimeters monitored the heat flux radiation emitted by the flames during the extinguishing process.

Video Coverage. Five video cameras were located at the same positions used in the first test.

Test Sequence. To start the test, the pool was ignited by using a fire torch along the half of the pool not containing foam blocks. The fire took 40 seconds to cover the entire pool. At 69 seconds into the test, the fire extinguishing agent (3-percent AFF) was discharged into the fire. It took 31 seconds to control the fire (figure 24B). Small fires ignited behind and under the foam blocks and caused the fireman to take more time than usual to supress the fire. By 202 seconds the test was terminated as the fires were determined to be extinguished.

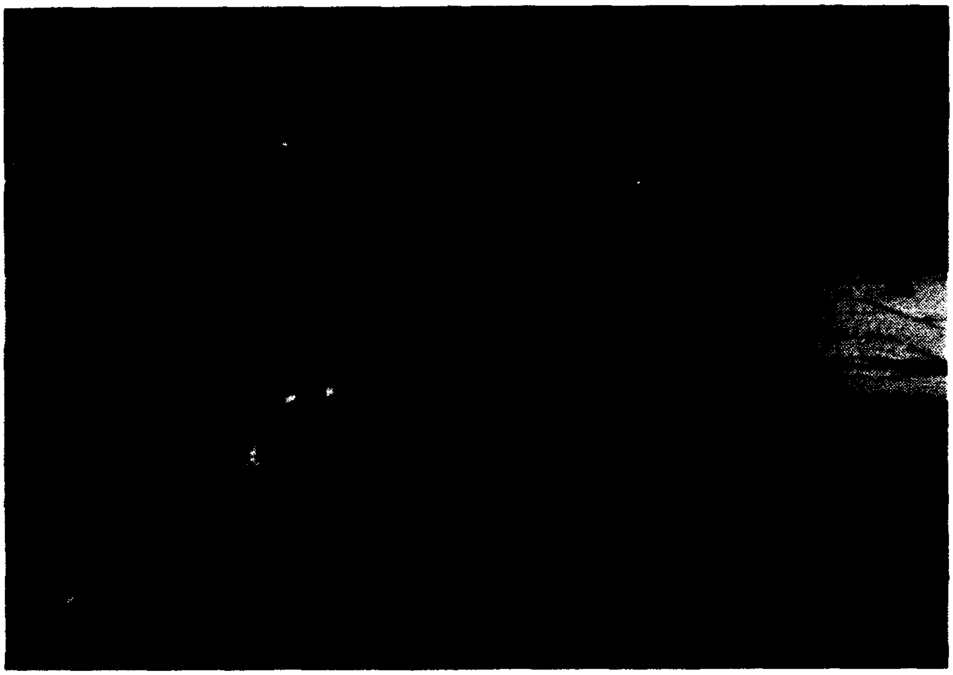

FIGURE 22.   PHENOLIC FOAM BLOCKS IN THE POOL

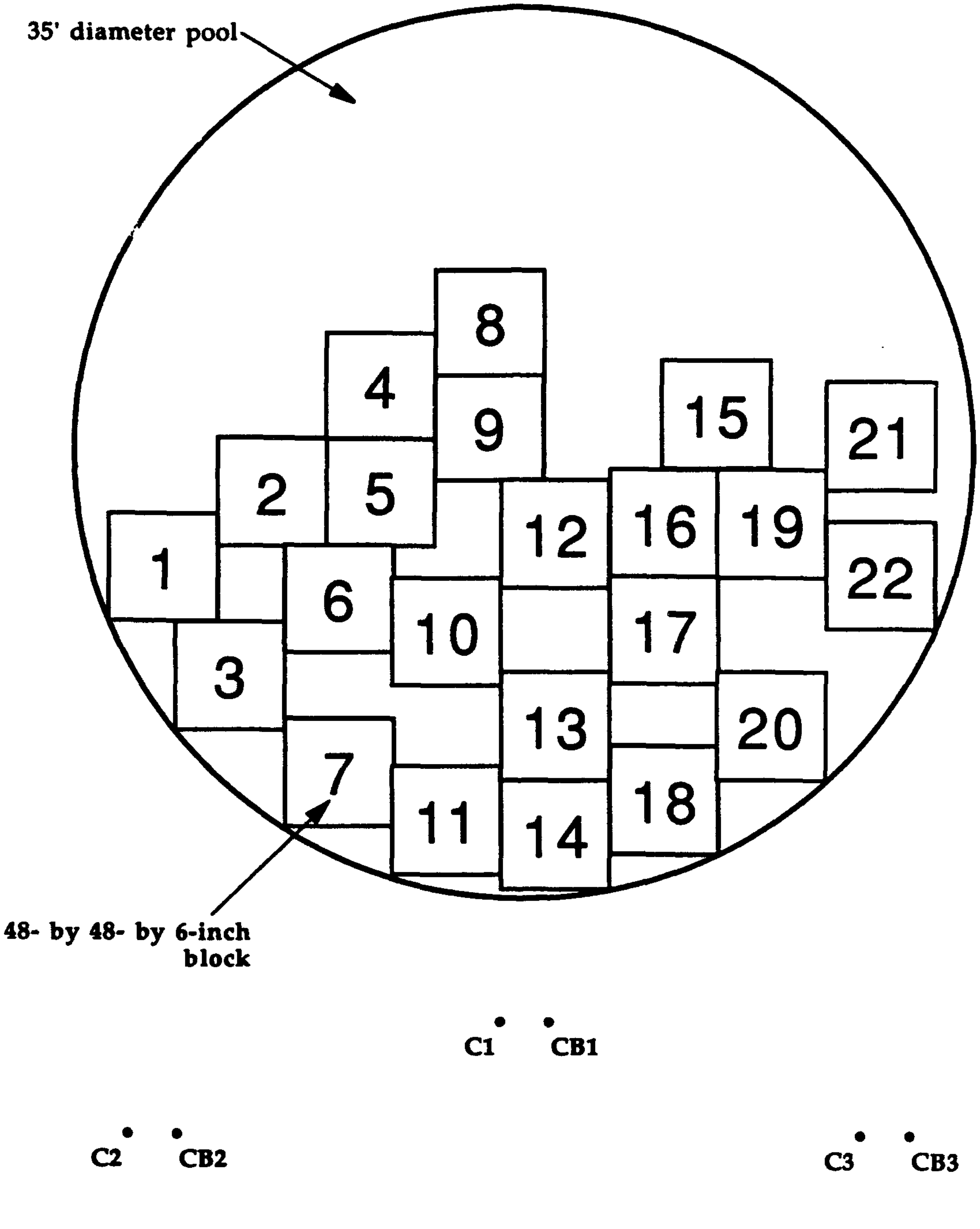

FIGURE 23. CALORIMETERS 10 FEET AND 14 FEET FROM THE POOL

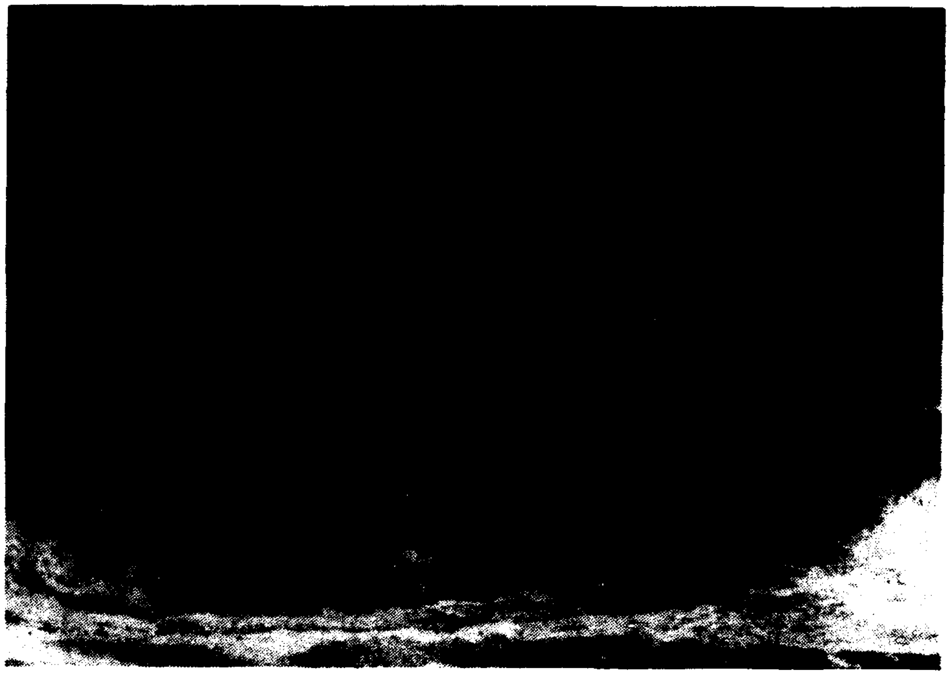

FIGURE 24A. AT START OF EXTINGUISHING

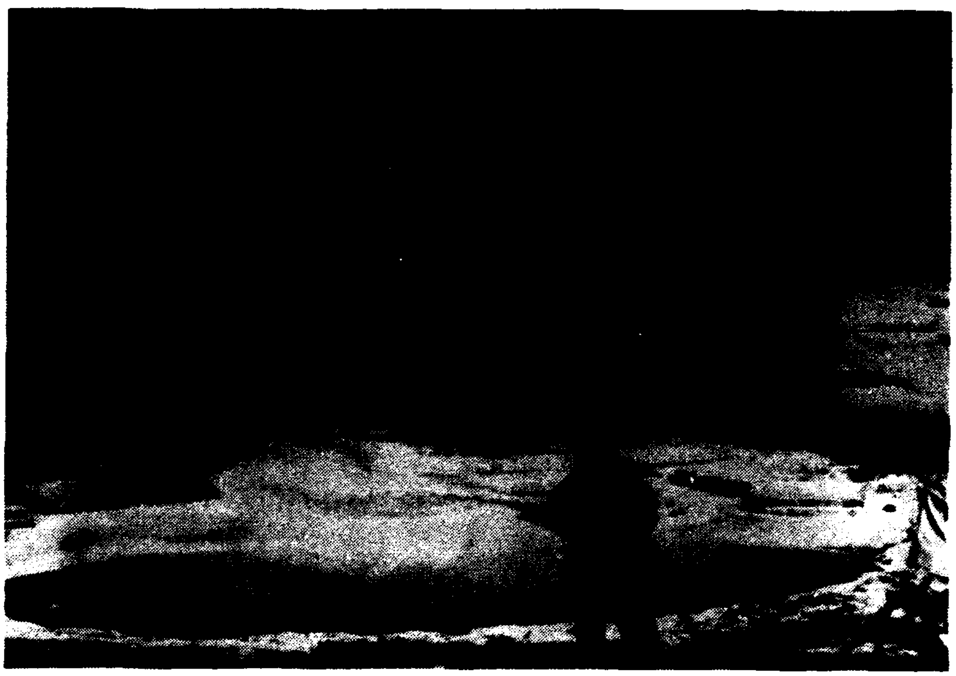

FIGURE 24B. FIRE UNDER CONTROL

After the test, a small fire was detected in one of the foam blocks and it was removed from the pool for examination. It was determined that this small fire was still vaporizing and burning Jet A fuel that was absorbed in the block. This block was chopped into the small pieces, allowing the oxygen from the surrounding air to feed the fire. The fire grew in intensity until charring prevented the block from burning further.

Test 3 Results. Fire control time for this type of fire was 3 times longer than in previous pool fire tests without the foam blocks (see table 3). The extinguishing time with foam blocks was significantly longer than without. The top and sides of the foam blocks were charred about 1-inch deep. The bottoms were undamaged because there wasn't any access for air to penetrate and cause fire. Breaking a foam block into smaller pieces intensified the fire by exposing more block surface areas to the surrounding air.

TABLE 3. AGENT TEST RESULTS

Agent	Solution Conc %	Fire Area Ft^2	Solution Rate GPM	Control Time (Seconds)	Extinguishing Time (Seconds)	Application Density GPM/Ft^2	Sources In Pool
AFFF	3	962	60	31	133	0.052	Jet A Fuel and Phenolic Foam
AFFF	3	962	60	9	12	0.052	Jet A Fuel Only
AFFF	3	962	60	11	No Fire Extinguishing Time Performed for This Test	0.052	Jet A Fuel Only

MAJOR FINDINGS

1. The phenolic foam brake arrestor material chars when exposed to heat or flame.

2. The char forming properties of the foam material resisted burning and flame propagation under heating conditions experienced during the relatively quiescent pool fire tests.

3. The heating conditions experienced by the foam samples were significantly smaller than the maximum heating rates attainable in a wind driven pool fire.

4. Breaking of the phenolic foam material into fragments, as will occur in an accident, will increase its burning rate.

5. Involvement of the phenolic foam material in a Jet A fuel fire causes the fire to be more difficult to control and extinguish.

APPENDIX A

VERTICAL BUNSEN BURNER TEST

The vertical Bunsen Burner test was used to determine the burn length of the phenolic foam material in accordance with FAR 25.853.

Two different phenolic foam materals were tested as follows:

- The first phenolic foam material had no white cotton linen bonded on its surface.

- The second phenolic foam material had white cotton linen bonded on its surface.

VERTICAL BURN LENGTH TEST RESULTS.

(a) Three 13- by 3- by 1/2-inch samples of the first phenolic foam material were tested vertically and their burn lengths were as follows:

(1) 2.88 inches

(2) 2.50 inches

(3) 2.75 inches

The average burn length was 2.70 inches.

(b) Three 13- by 3- by 1/2-inch samples of the second phenolic foam material were tested and the burn lengths were as follows:

(1) 2.00 inches

(2) 2.25 inches

(3) 2.00 inches

The average burn length was 2.08 inches.

CONCLUSION

Both phenolic foam test samples were self extinguishing. The burn lengths were well within the maximum 8 inches allowed. Moreover, very little smoke was detected during the testing of both materials.

APPENDIX B

OIL BURNER TEST

PURPOSE.

The purpose of this test method was to evaluate the burn resistance and weight loss characteristic of phenolic foam material when exposed to an oil burner open flame.

The test was conducted in accordance with Federal Aviation Regulation (FAR) Part 25 Admendment 25-59 for aircraft seat cushions.

PHENOLIC FOAM TEST SPECIMENS.

The phenolic foam test specimen set consists of one back cushion specimen and one bottom cushion specimen as follows:

(a) Back Cushion Specimen - The back cushion specimen was in the vertical orientation. This phenolic foam back cushion was 25 +0-1/8 inches high, 18 +0-1/8 inches wide, and 2 +0-1/8 inches wide.

(b) Bottom Cushion Specimen - The bottom cushion specimen was in the horizontal orientation. This bottom cushion was 20 +0-1/8 inches by 18 +0-1/8 inches by 4 +0-1/8 inches and placed 4 1/8 inches in front of the burner cone as shown in figure 1.

APPARATUS.

The test burner used for this oil burner test was a modified gun type such as Park Model D P L 3400, Lennox Model OB -32. This test burner consisted of a nozzle, a burner cone, fuel, and a fuel pressure regulator.

BURNER CALIBRATION TESTS.

The burner was calibrated to measure the heat flux and temperatures 4 inches from the burner cone.

As required, the flame produced a calorimeter reading of 10.5 Btu/ft^2/sec, and the temperature of each thermocouple was approximately 1900 ^{o}F.

BURN LENGTH MEASUREMENTS.

The four principal burn lengths were measured along the top side of the horizontal seat cushion, bottomside of the horizontal seat cushion, frontside of the vertical seat cushion, and the backside of the vertical seat cushion.

TEST REQUIREMENTS.

In order to pass the oil burner test, the test specimen set should meet the following requirements:

1. No burn length should exceed 17 inches on at least 2/3 of the total number of speciment sets tested.

2. The average percentage weight loss should not exceed 10 percent.

3. The weight loss of at least 2/3 of the total number of specimen sets tested should not exceed 10 percent.

OIL BURNER TEST RESULTS FOR PHENOLIC FOAM SEAT CUSHIONS.

The three test specimen sets weights were as follows:

1. 4.38 lbs.

2. 3.80 lbs.

3. 4.12 lbs.

The results of the three phenolic foam cushion tests in the following table contain information of the test specimen set post-test weights and the burn lengths.

Test	Bottom Cushion Specimen		Back Cushion Specimen		Post Test
	Topside	Bottomside	Frontside	Backside	Weight
1.	3.00 in	6.00 in	6.00 in	0.00 in	4.12 lbs
2.	2 1/4 in	10 3/8 in	6 1/4 in	0.00 in	3.64 lbs
3.	3 1/4 in	5 1/2 in	6.00 in	0.00 in	3.96 lbs

The weight losses of the first, second, and third test specimen sets were 5.9, 4.2, and 3.8 percent, respectively.

CONCLUSION

The phenolic foam test specimens passed the oil burner test. Each burn length was well within the 17 inches maximum allowed and the weight losses were below the allowable 10 percent.

APPENDIX C

HEAT RELEASE RATE TEST FOR PHENOLIC FOAM MATERIAL

SCOPE.

This test was used to determine heat release rates of the phenolic foam material. The test requirements are specified in Federal Aviation Regulation (FAR) 25.853 (a-1) through Amendment 25-66.

TEST SPECIMEN.

Specimen Size: The size for phenolic foam specimen was 6.00 inches by 6.00 inches in lateral dimensions. Specimen thickness was 1 inch.

Specimen Number: Three phenolic foam specimens were prepared and tested.

REQUIREMENTS.

- The average maximum heat release rate during the 5-minute test should not exceed 65 kW/m^2

- The average total heat released during the first 2 minutes should not exceed 65 $kW\text{-}min/m^2$

HEAT RELEASE RATE RESULTS.

Three samples of phenolic foam material were tested and their heat release peaks during the 5-minute test were as the follows:

	Heat Release Peak	Heat Release Total
1.	32.04 kW/m^2	40.36 $\frac{kW\text{-}min}{m^2}$
2.	36.44 kW/m^2	43.32 $\frac{kW\text{-}min}{m^2}$
3.	31.83 kW/m^2	47.58 $\frac{kW\text{-}min}{m^2}$
Avg =	33.43 kW/m^2	43.75 $\frac{kW\text{-}min}{m^2}$

CONCLUSION

The phenolic foam specimens passed the heat release test. The total and peak heat release rates were well within the pass-fail criteria.