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THE EFFECTS OF A FIRE ENVIRONMENT ON A RAIL TANK CAR FILLED WITH LPG

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SEPTEMBER 1974

FINAL REPORT

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16. Abstract

An 127 kiloliter (33,600 gallon) railroad tank car was instrumented and filled with liquified petroleum gas. A large JP-4 fuel pool fire then engulfed the tank car, and measurements of temperature, pressure, etc., were recorded as a function of time. After 24.5 minutes, the car failed catastrophically via stress-rupture. Mass flow rates and a discharge coefficient have been obtained for the relief valve. An analytical expression has been derived and then used to obtain the heat flux to the wetted surface of the tank car. The rupturing of the car is briefly discussed.

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Liquefied Petroleum gases, fire research, tank cars

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I. INTRODUCTION

The Ballistic Research Laboratories (BRL) are conducting a series of field tests with scaled and standard size railroad tank cars at the request of the Federal Railroad Administration/Department of Transportation (FRA/DOT). This effort is part of an extensive research program jointly sponsored by FRA/DOT and Railway Progress Institute - Association of American Railroads (RPI-AAR). The program is designed to develop methods to minimize personal injury and property damage due to the rupture of railroad tank cars filled with flammable materials.

The basic situation under investigation is an unperforated railroad tank car filled with liquid propane and engulfed in a large external fire. The intensive heat of the external fire is conducted through the tank car's shell and into the propane lading. Thus, the lading temperature increases, resulting in an increase in the internal pressure. This higher pressure, in combination with a reduced burst strength of the tank car shell caused by the elevated skin temperatures, can lead to a rupture of the shell and the resulting severe conditions that often result in injuries and extensive property damage.

II. OBJECTIVES

The Federal Railroad Administration desires to develop procedures for ensuring that the railroad tank car will not rupture when subjected to a fire environment, thereby containing the fire and the tank car to the local area. (Often, when rupture does occur, large pieces of the tank car are rocketed a considerable distance.) A less stringent but not as desirable goal is to delay rupture. Delaying rupture allows time for additional lading to escape, allows time to take appropriate measures for minimizing damage to surrounding property, and allows time for evacuating the immediate area. This intermediate goal becomes more desirable as the delay time to rupture becomes long enough to allow the tank to empty its hazardous contents in a controlled manner, i.e., the material escape is controlled by the relief valve as opposed to its being released all at once in a rupture with the consequential explosion.

The Ballistic Research Laboratories' task is to conduct field tests which include instrumenting the experimental tank car and performing appropriate measurements. The data gathered in these tests are then to be analyzed by the BRL for the purpose of determining tank car failure modes, defining a fire environment, and providing empirical information needed in the development of a theoretical model.

This report is concerned with the first controlled experimental test on a full size railroad tank car subjected to a fire environment. Under investigation are the fire environment, the rate and mechanism of heat transfer into the lading, the operation of the safety relief valve in a fire environment, and the torching effect of the relief valve.

In addition, the test provides information useful in the development of appropriate test procedures and instrumentation for application to future full scale tank car tests.

III. THE TANK CAR AND TEST AREA

The procedure consisted of simulating a possible accident environment. Fire engulfment, whether the result of a derailment and puncture, coupler puncture, or a previous rupture, is one of the more severe conditions that a rail tank car can be subjected. For this test, a full size railroad tank car was positioned in a large excavation and filled with liquified petroleum gas (LPG). The energy for the external fire was provided by a pool of JP-4 jet fuel situated beneath the tank car. Data were recorded that described important aspects of the fire test.

The tank car, RAX 201, was especially built for the test; the main differences between RAX 201 and a normal rail tank car of the 33,000 gallon DOT 112A340W non-insulated pressure tank car series, were the inclusion of a second entrance manway to the interior of the tank and two ports through which instrumentation lines could be run. Otherwise, RAX 201 met all applicable requirements of the U.S. Department of Transportation and the Association of American Railroads. RAX 201, except for a few changes to facilitate instrumentation, was a standard tank car for the transportation of liquified petroleum gas, anhydrous ammonia, or vinyl chloride.

The test was performed in the Hazardous Test Area at White Sands Missile Range, New Mexico. The test was planned and conducted by BRL personnel.

A schematic of RAX 201 is presented in Figure 1. The tank car was of the order of 18.3m (60 ft) long and 3.05m (10 ft) in diameter. The steel shell, constructed of TC-128 steel, was 1.59cm (5/8 in) thick. Centered on top of the tank car, enclosed in a protective steel dome, were two liquid filler valves, one vapor valve, one gauging device, a thermometer well, a test tube, and a Midland A-3180-N relief valve. The tank car was provided by the Railway Progress Institute - Association of American Railroads (RPI-AAR).

The tank car was positioned in a large excavation, 45.7m long, 30.5m wide, and 7.92m deep (150 ft by 100 ft by 26 ft); the excavation is designated by the word "Pit" in Figure 2. A fuel dike, which can be seen in Figure 3, was constructed at the center of the excavation, and it measured 24.4m by 9.1m (80 ft by 30 ft). The fuel pit was supplied with JP-4 jet fuel via a 10.2cm (4.0 in) gravity-fed pipeline, from a 113.6 kiloliter (30,000 gallons) storage tank located approximately 183m (600 ft) from the excavation (see Figure 2).

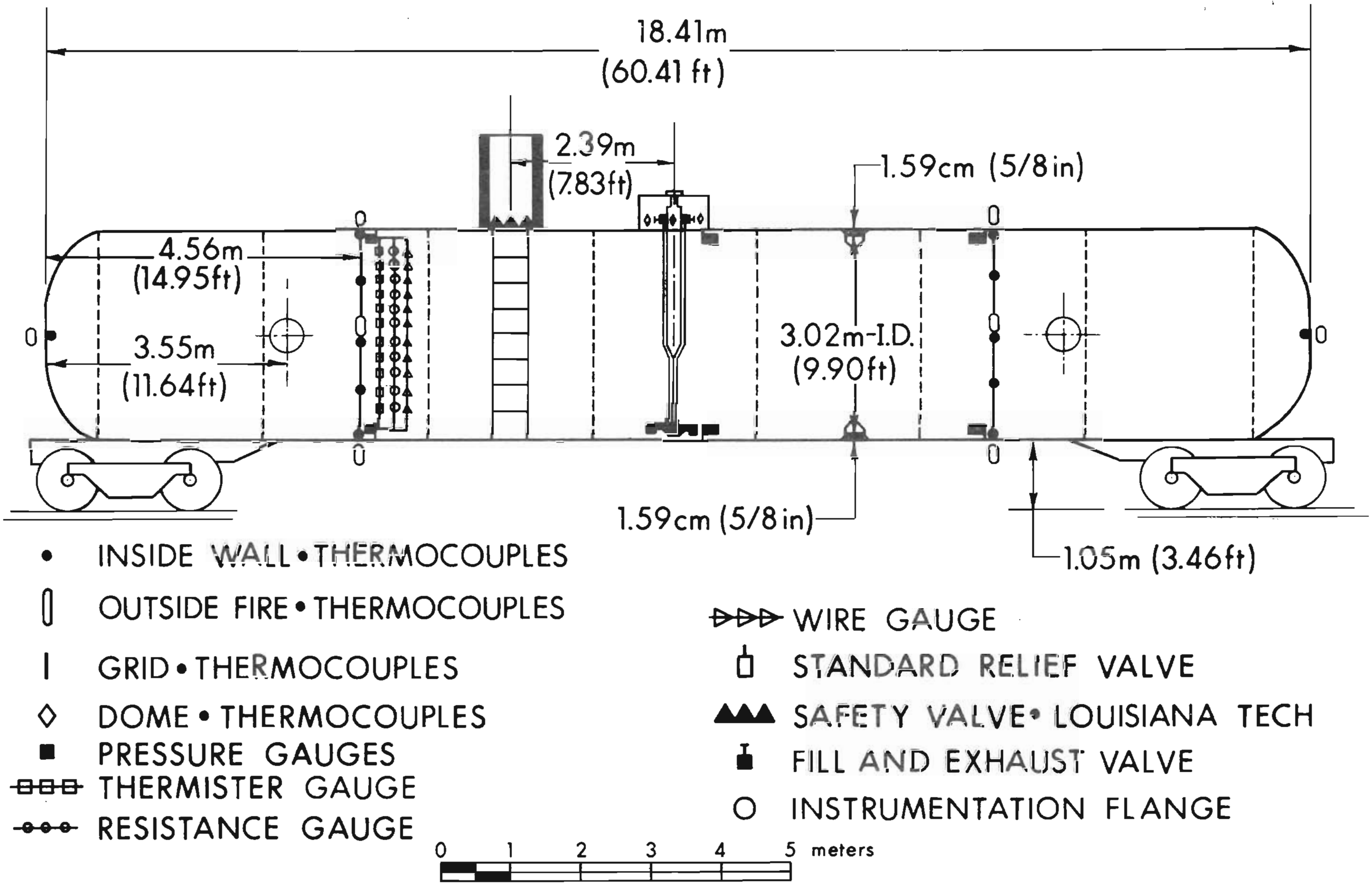

Figure 1 -Test No.8- Instrumentation Layout for RAX 201

Figure 2. Aerial View of the Test Site

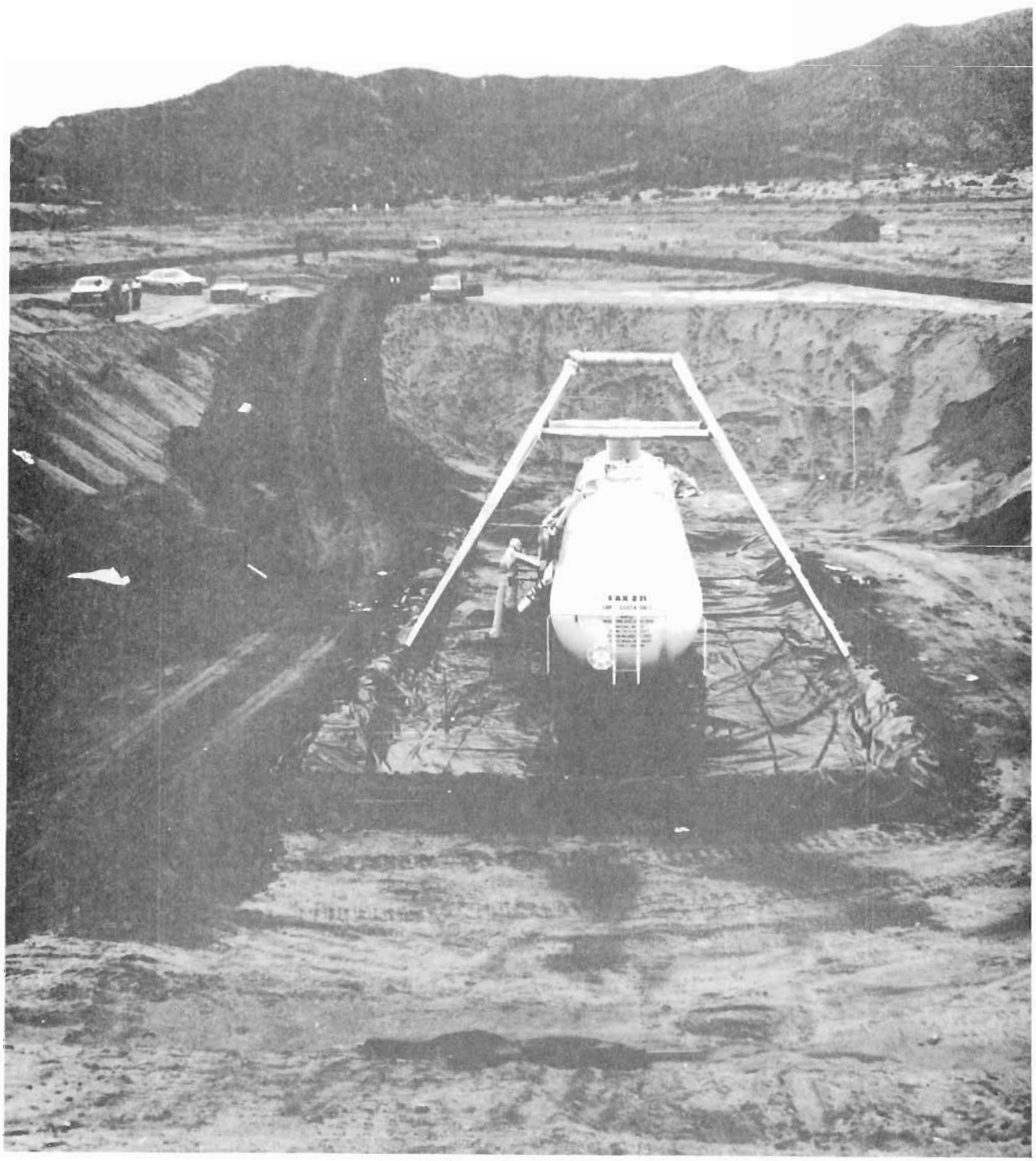

Figure 3. End-On View of the Tank Car Positioned in the Pit

The tank car was filled with LPG; the constituents were:

ethane	1.96%	normal butane	.01%
propane	97.96%	pentanes	.00%.
isobutane	.07%		

The LPG was donated by El Paso Natural Gas, and was delivered to White Sands Missile Range by Desert Air Company of El Paso, Texas. The vapor pressure of propane as a function of temperature and the commercial limits are shown in Figure 4. The vapor pressure, density, heat of vaporization, and specific heat of pure propane are graphed in Figures 5, 6, 7, and 8. All quantitative analyses will make use of these last four figures. (In this report, since the LPG was 97.96% propane, the terms LPG and propane will be used interchangeably.)

The tank car was positioned in the pit in an east-west position, west being the end of the pit containing the entrance ramp which can easily be seen in Figure 3. The east end of the tank car will be denoted as the front end; this is the end facing toward the reader in Figure 3. The west end of the car will be referred to as the rear end of the tank car.

IV. INSTRUMENTATION

Instrumentation consisted of thermocouples, liquid level gauges, pressure gauges, and a radiometer. Also included in the test plan was instrumentation designed and planned by NASA, and an abort safety valve designed by Louisiana Tech University.

A. Thermocouples

The damage mechanism of the tank car is the heat transferred from the exterior fire to the tank shell and to the lading. Chromel-alumel thermocouples were placed on the interior wall of the tank shell (inner wall thermocouples), on the inner wall of the steel dome (dome thermocouples) and in the lading (grid thermocouples). The inner wall thermocouples and the dome thermocouples were installed by enclosing them in a copper bead and potting them with Sauereisen cement. The thermocouples in the lading were placed in a grid network. To aid in defining the fire environment, thermocouples were positioned in the fire (fire thermocouples). Table I, along with the visual aid of Figure 1, gives a resumé of the types, numbers, and relative locations of the various thermocouples. The following paragraphs will explain in more detail the various categories.

The emf data from the thermocouples were recorded by a Vidar recording system. The digital microvolt emf values were stored on magnetic tape as the Vidar recorder sampled each channel sequentially. It took 0.282 seconds to sample each channel; that is, every 42.3 seconds a

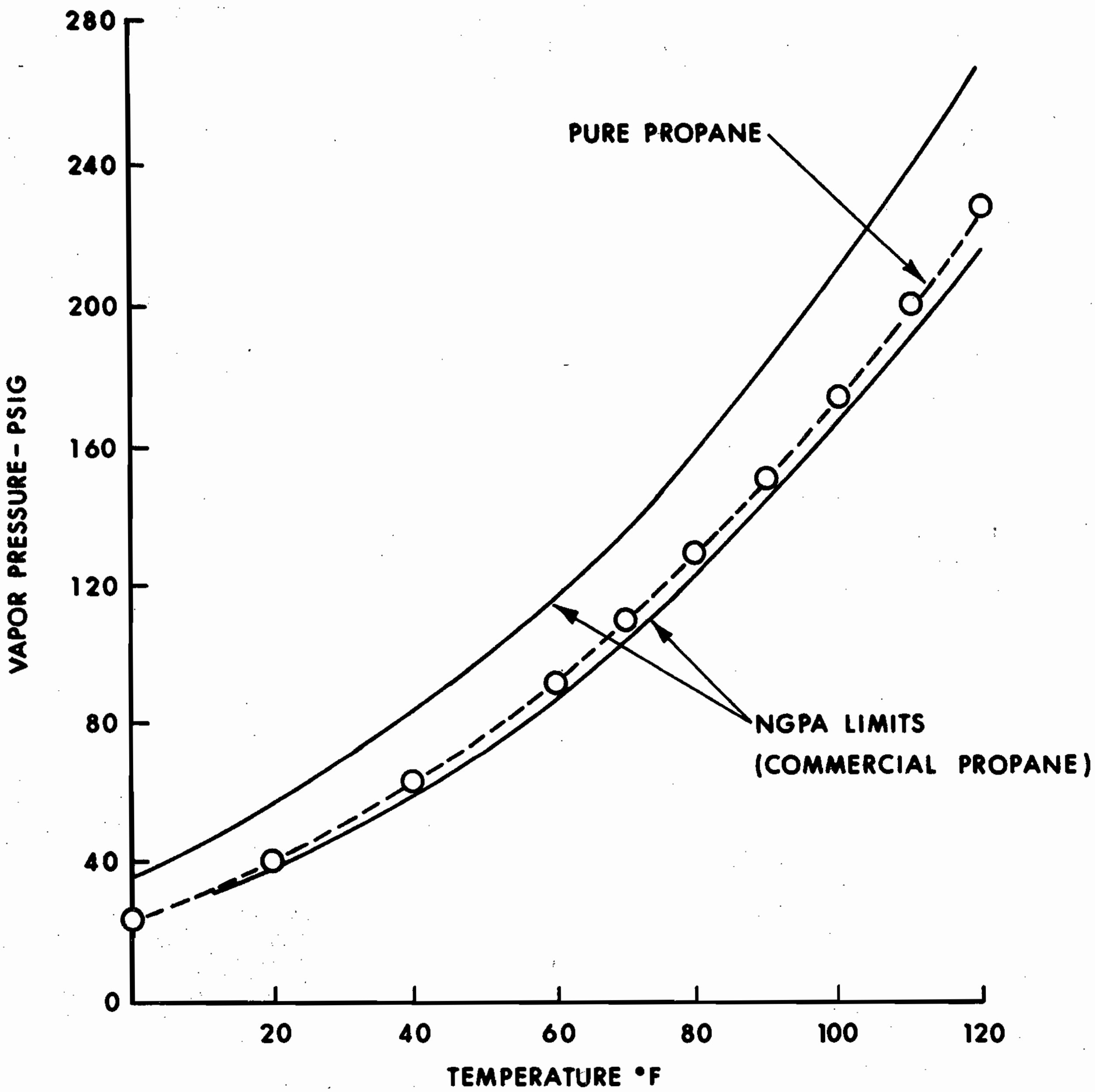

Figure 4-Vapor Pressure of Propane as a Function of Temperature

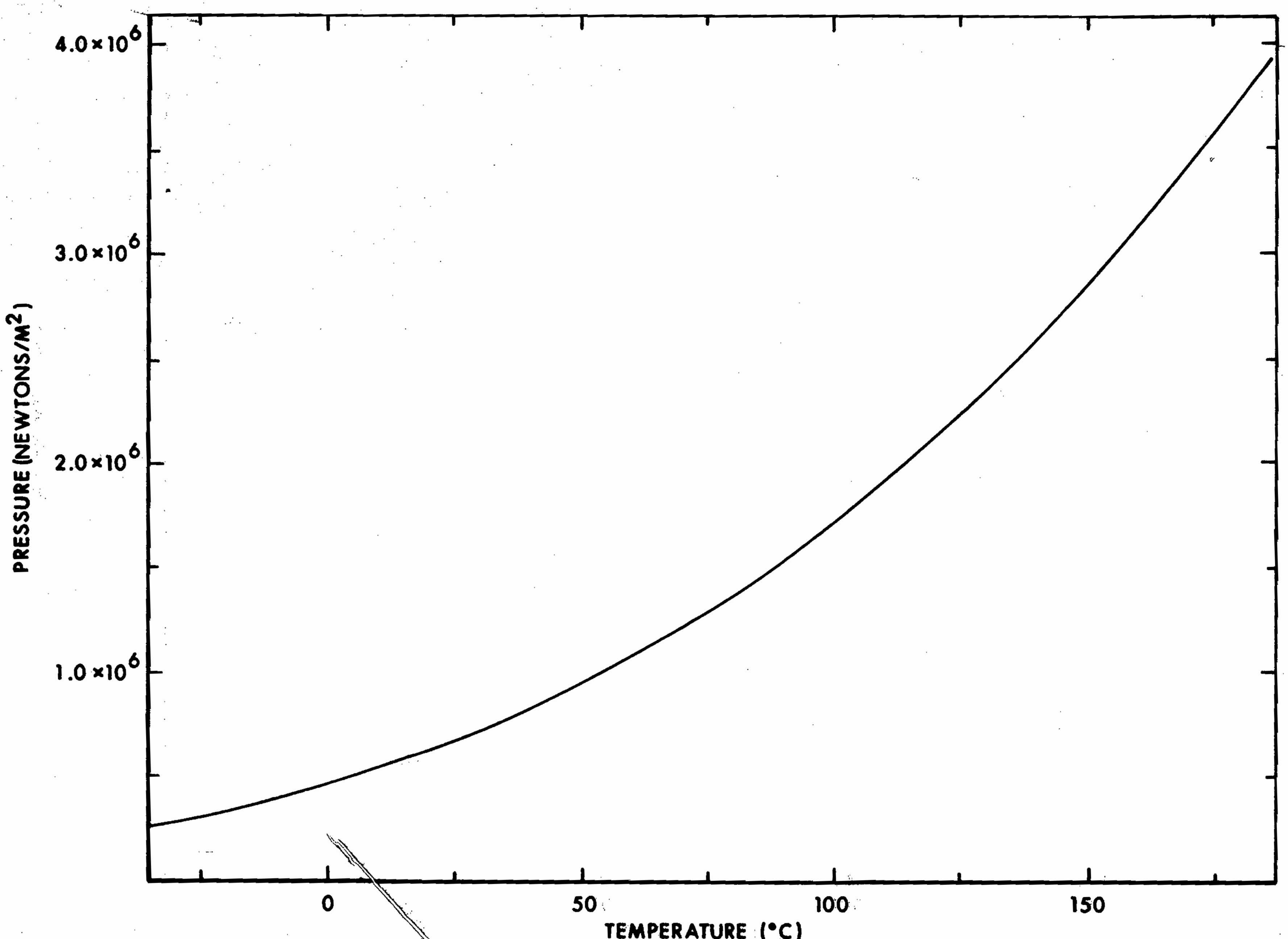

Figure 5 – Vapor Pressure of Propane in Equilibrium with Liquid, vs Temperature

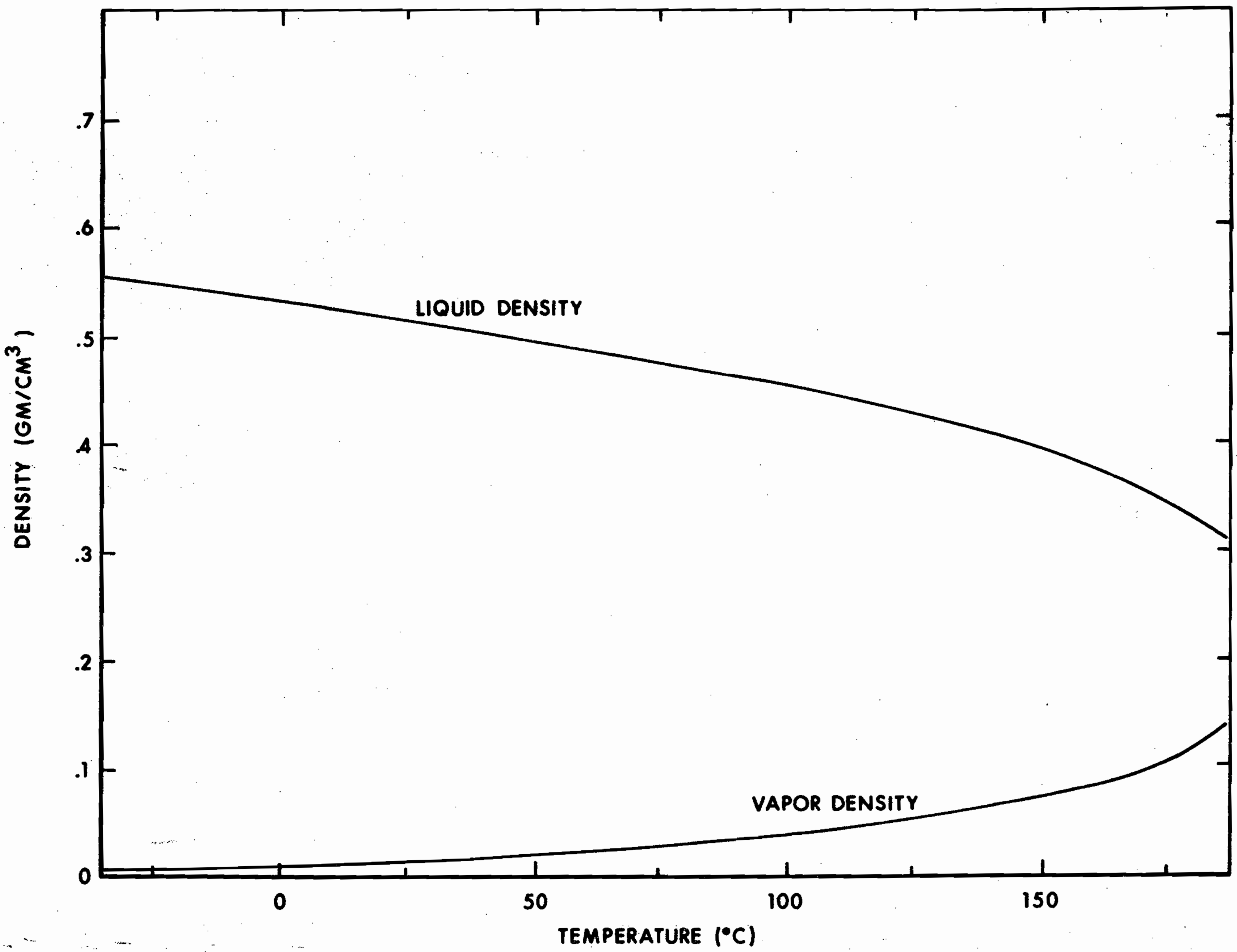

Figure 6-Density of Liquid and Gaseous Propane vs Temperature

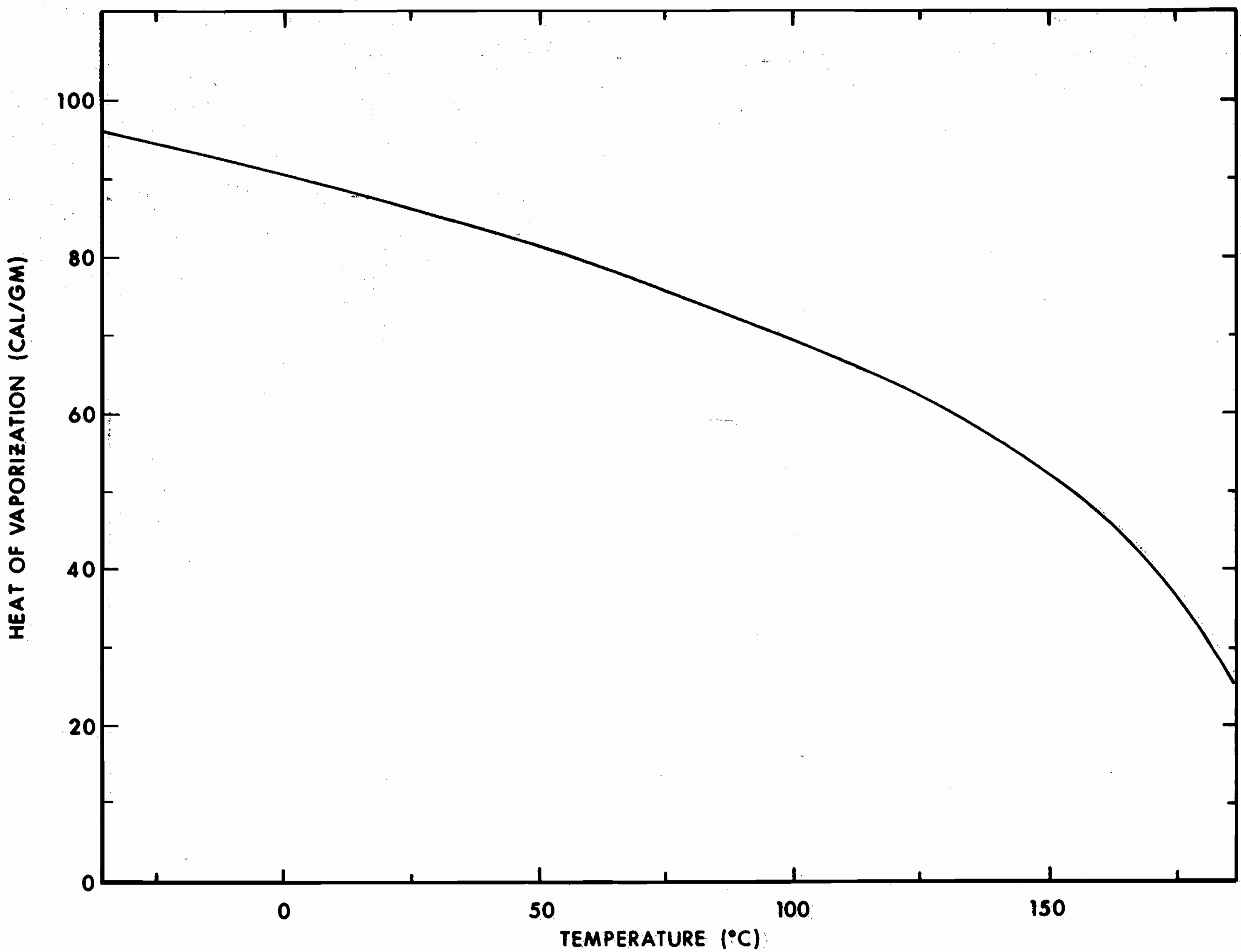

Figure 7–Latent Heat of Vaporization of Propane vs Temperature

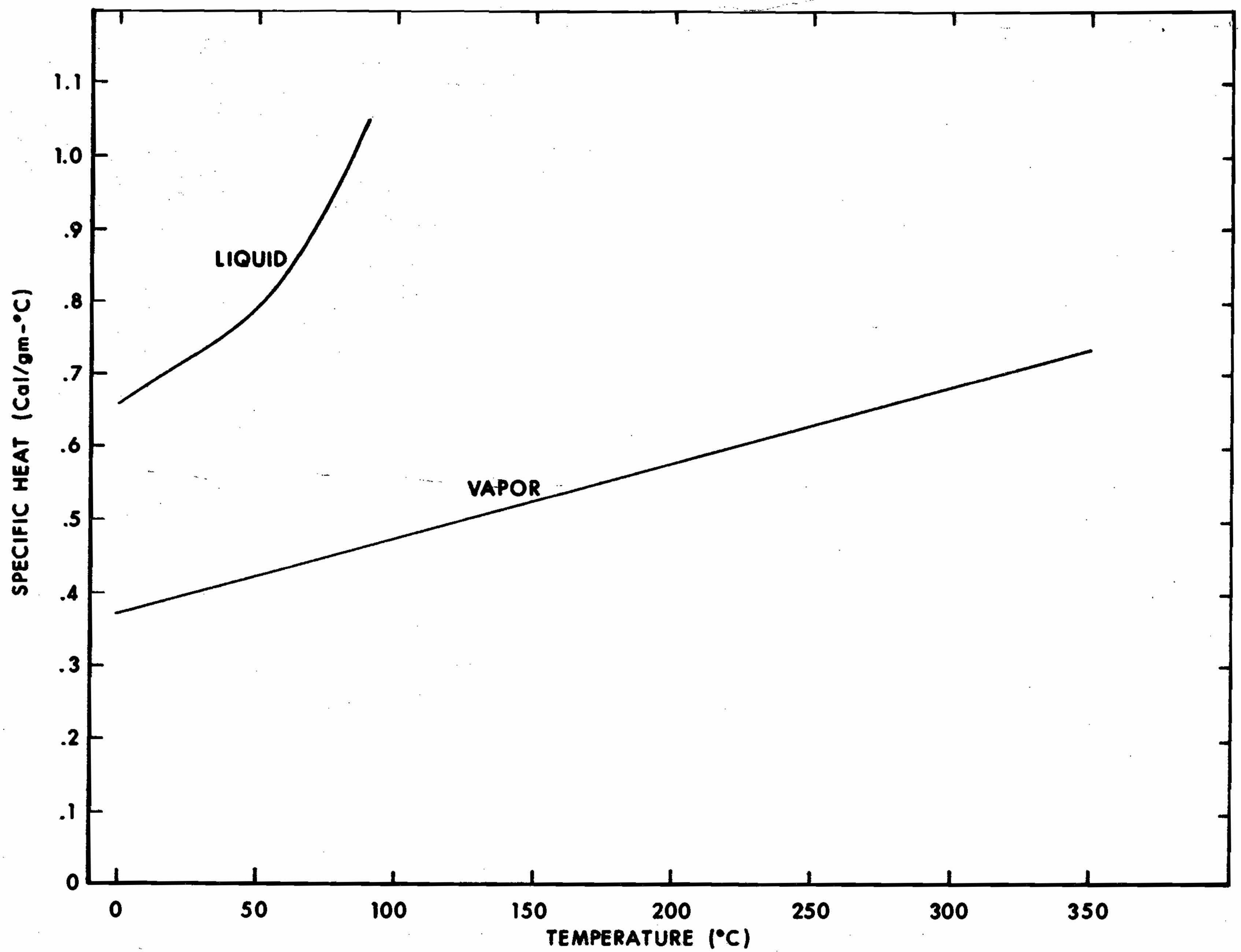

Figure 8- Liquid and Vapor Specific Heats of Propane

Table I. Thermocouple Instrumentation

Type/Description of Thermocouple	Location	Number of Thermocouples
Dome	Protective Dome	4
Inner Wall	Front Grid Plane	24
Inner Wall	Rear Grid Plane	24
Inner Wall	Front Inside End	1
Inner Wall	Rear Inside End	1
Grid	Front Grid Plane	26
Grid	Rear Grid Plane	26
Fire	Front	4
Fire	Rear	4
Fire	Front Outside End	1
Fire	Rear Outside End	1
Possum Hut	Possum Hut	1
Emergency Relief Hatch	La. Tech Valve	1
	Total	118

particular channel was sampled and the data recorded (there were 150 channels on the Vidar unit, though only 118 were connected to thermocouples).

The thermocouples can either be designated by position, or by their Vidar channel number. Tables II, III, and IV tabulates the thermocouples by their respective Vidar channel number and position.

Four thermocouples were attached to the inner wall of the steel protective dome (see Figures 1 and 9). These four dome thermocouples were positioned circumferentially ninety degrees apart approximately half-way between the top and bottom of the dome.

Two planes of inner wall and grid thermocouples were constructed, with each plane located approximately halfway between the center of the tank car and an end (see Figure 1). Thermocouples were placed on the inner wall every fifteen degrees starting from the top of the car. This spacing corresponds to every hour and half-hour position on a clock, and therefore, a way of designating a particular thermocouple is by its clock-time position, e.g., the thermocouple located at 90° clockwise from the vertical is the 3:00 thermocouple.

The grid construction is depicted in Figure 10. The grid was constructed so that the grid thermocouples were positioned on the same levels as the inner wall thermocouples. Figures 11 and 12 are cross-sectional views of the rear and front thermocouple planes respectively. The inner wall and grid thermocouples are shown, as well as their respective Vidar channel numbers.

One thermocouple was placed at each end of the tank. These were attached to the inner wall, and were placed approximately in the center of the elliptical head-end (refer to Figure 1).

Exterior to the tank car, but in the same planes as the grid-inner wall thermocouples, were the fire thermocouples (see Figure 1). Four thermocouples, positioned ninety degrees apart starting from the 12:00 position, were placed in each grid plane. These thermocouples were positioned approximately ten centimeters (four inches) from the tank wall. In addition, a fire thermocouple was placed at the center of each end of the tank approximately twenty-five centimeters (10 inches) from the tank wall.

Finally, one thermocouple was placed in the "water barrel" which enclosed and protected the Louisiana Tech safety valve; and a thermocouple was placed in the "Possum Hut" (a small hut near the edge of the large excavation which provided the physical location for the tie-in of the instrumentation lines from the instrumentation bunker to the lines running from the tank car).

Table II. Inner Wall Thermocouples

	Vidar Channel Number			Vidar Channel Number	
Location	Front Plane	Rear Plane	Location	Front Plane	Rear Plane
12:00	67	1			
12:30	90	2	11:30	68	24
1:00	89	3	11:00	69	23
1:30	88	4	10:30	70	22
2:00	87	5	10:00	71	21
2:30	86	6	9:30	72	20
3:00	85	7	9:00	73	19
3:30	84	8	8:30	74	18
4:00	83	9	8:00	75	17
4:30	82	10	7:30	76	16
5:00	81	11	7:00	77	15
5:30	80	12	6:30	78	14
6:00	79	13			

Center of Front end 117

Center of Rear End 51

Table III. Grid Thermocouples

Location	Vidar Channel Number Front Plane					Location	Vidar Channel Number Rear Plane				
12:30 - 11:30 level			91			12:30 - 11:30 level			25		
1:00 - 11:00 level			92			1:00 - 11:00 level			26		
1:30 - 10:30 level		95	94	93		1:30 - 10:30 level		27	28	29	
2:00 - 10:00 level		98	97	96		2:00 - 10:00 level		30	31	32	
2:30 - 9:30 level		101	100	99		2:30 - 9:30 level		33	34	35	
3:00 - 9:00 level	106	105	104	103	102	3:00 - 9:00 level	36	37	38	39	40
3:30 - 8:30 level		109	108	107		3:30 - 8:30 level		41	42	43	
4:00 - 8:00 level		112		110		4:00 - 8:00 level		44	45	56	
4:30 - 7:30 level		115	114	113		4:30 - 7:30 level		47	48	49	
5:00 - 7:00 level			116			5:00 - 7:00 level			50		

Table IV. Fire Thermocouples and Miscellaneous Thermocouples

FIRE THERMOCOUPLES			MISCELLANEOUS THERMOCOUPLES	
	Vidar Channel Number			Vidar Channel Number
Location	Front Plane	Rear Plane	Location	
12:00	62	53	Emergency Relief Hatch	118
3:00	63	54	Inside Inner Wall of Dome	58, 59, 60, 61
6:00	64	55		
9:00	65	56	Possum Hut	52

Center in Front of Tank	66
Center in Rear of Tank	57

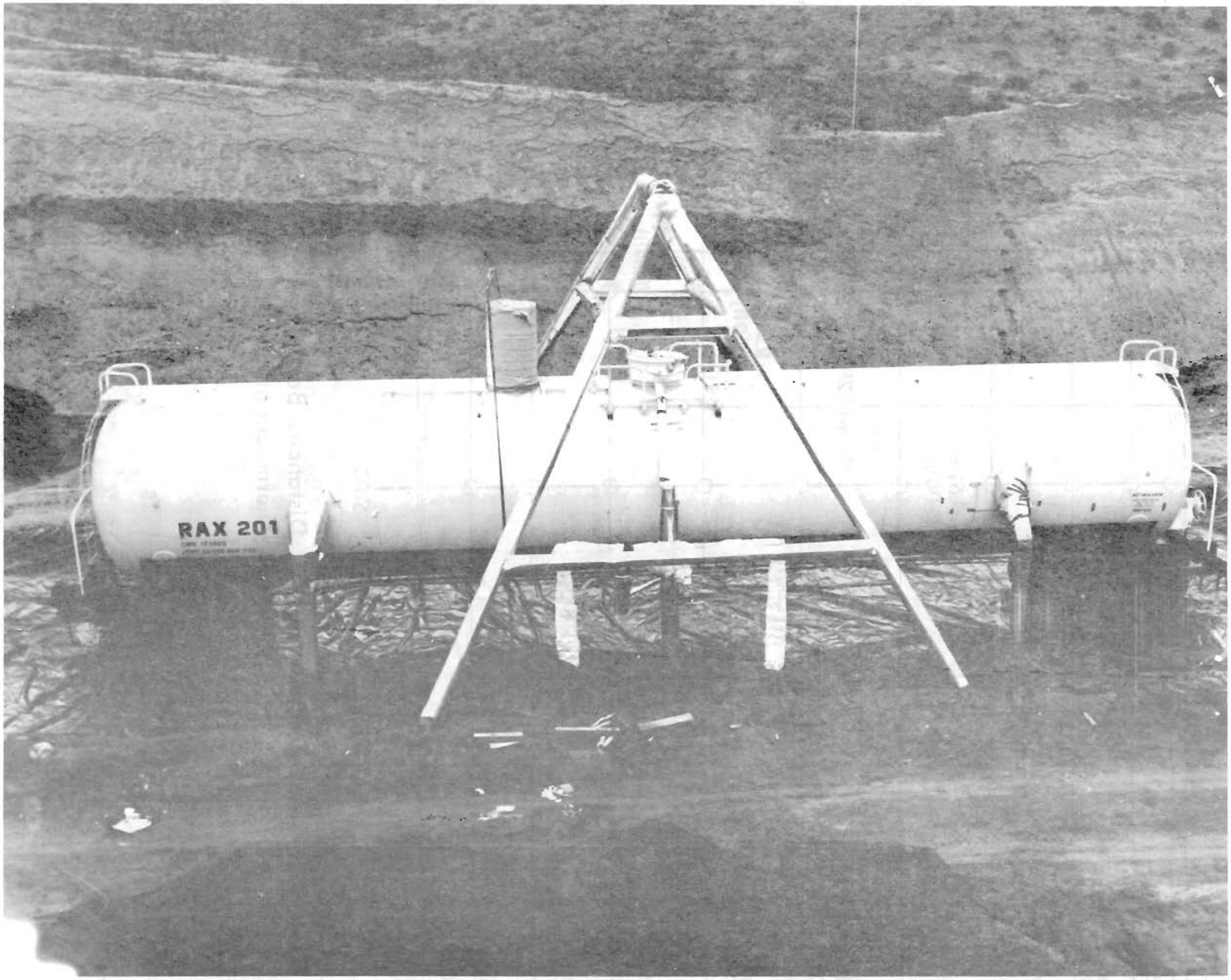

Figure 9. Side View of Tank Car at Test Time

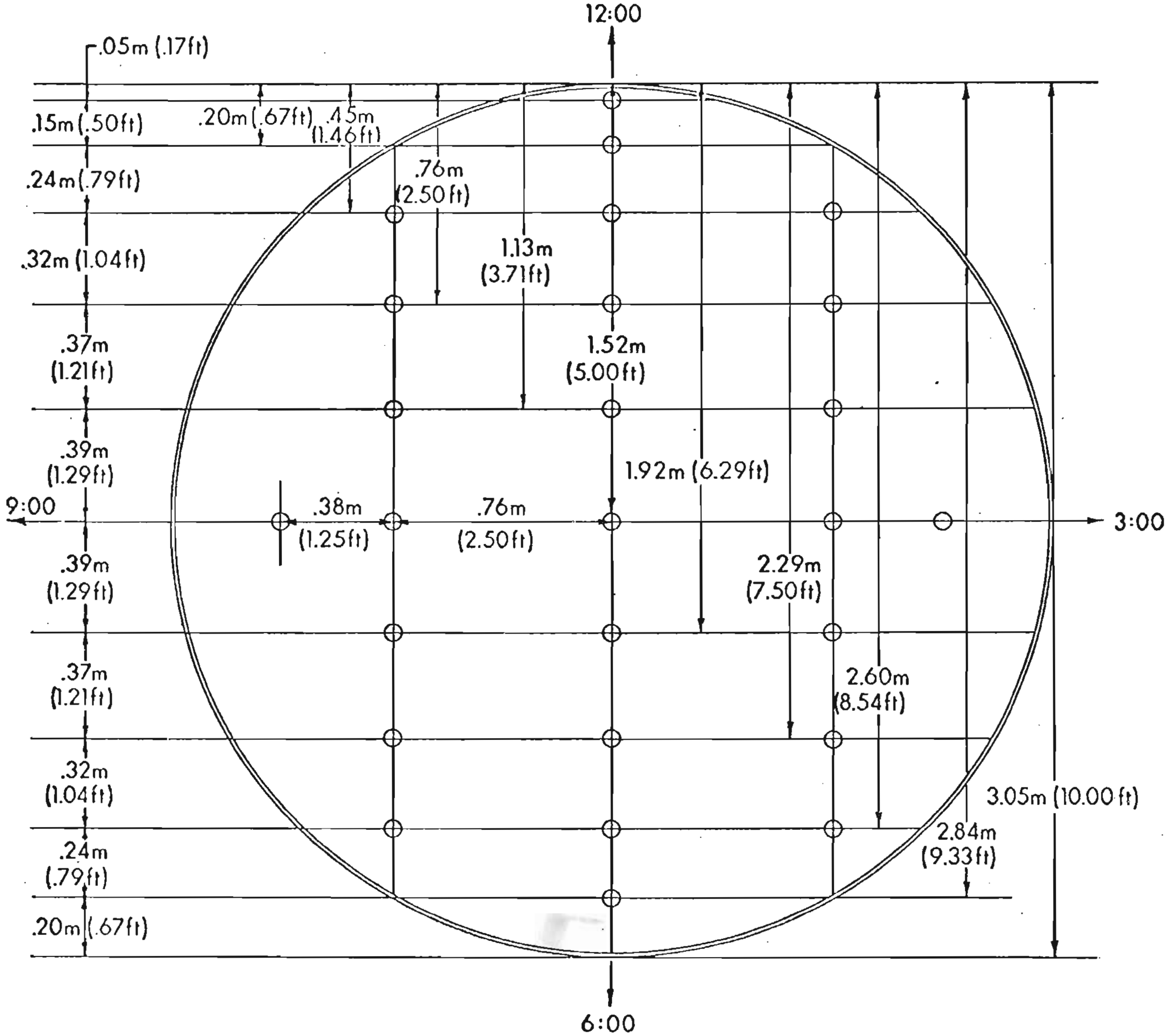

Figure - 10 Distances Between Grid Thermocouples

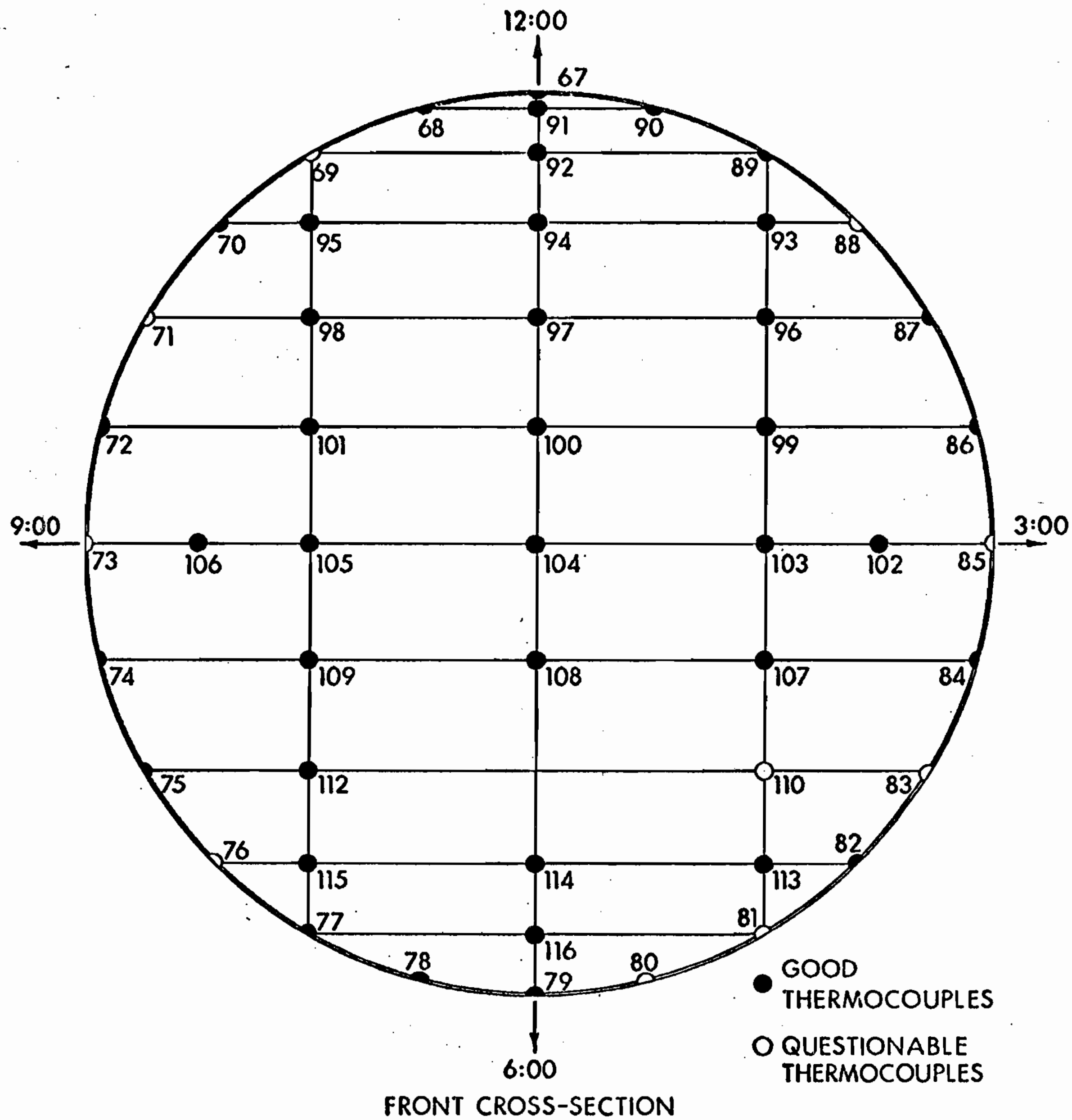

Figure – 11 Cross-Sectional View of Relative Thermocouple Positions and Their Respective Vidar Channel Numbers

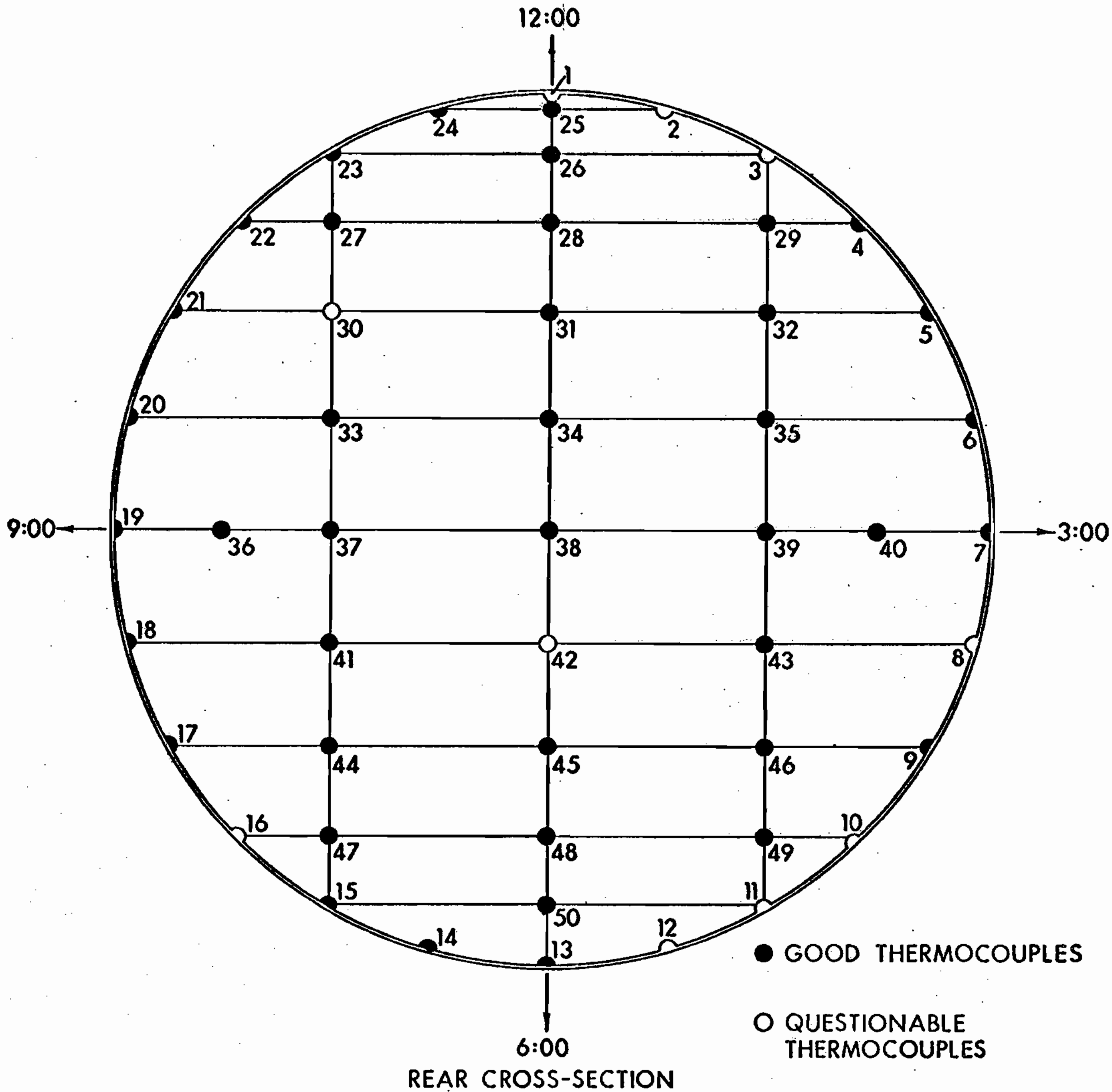

Figure-12 Cross-Sectional View of Relative Thermocouple Positions and Their Respective Vidar Channel Numbers

B. Liquid Level Measurements

During the one-fifth scaled model tank car tests, the need was established for closely monitoring the level of propane in the tank as a function of time. Mr. Thomas Jeter of the BRL developed several different measurement techniques that were utilized on the initial full-scale tank car test. More than one gauge was developed in order to evaluate the usefulness of the different techniques under the thermal stress anticipated, and to provide redundancy.

1. Thermistor Gauge.

A gauge was constructed which consisted of 240 thermistors positioned 1.27 cm (0.5 in) apart on a 3.05m (10.0 ft) linear section. The gauge was then mounted along the vertical diameter of the tank car (see Figure 1). This arrangement permitted the monitoring of the liquid level in 1.27cm (0.5 in) increments over the top 2.74m (9.0 ft) of the tank. The bottom 0.305m (1.0 ft) of the thermistor string was used as a reference. All thermistors were compared continuously with the reference set.

A small excitation current was applied to the thermistors to cause resistive heating. Since the thermal conductivity of liquid propane is much greater than that of gaseous propane, as each thermistor emerged from the liquid into the gas ullage it would resistively heat to a significantly higher temperature. An increase in temperature of a thermistor would result in a large change in the resistance of that thermistor, and hence, a decrease in resistance of the circuit. The resistance of the circuit was recorded against time, and the height of the liquid level would be indicated by the sudden change in a given thermistor resistance.

2. Shorting Wire Gauge.

A taut resistance wire was mounted on the vertical diameter of the tank. On this wire, a stainless steel float containing an electrical wiper contact was mounted. The resistance between the stainless steel ball, floating on top of the liquid, and the bottom end of the wire indicated the liquid level. To account for the change in resistance due to temperature, the measured resistance was compared to a reference resistance located in the liquid propane. This gauge would seem to be less accurate than the thermistor gauge since the level of the ball in the liquid would be a function of internal tank pressure and liquid surface conditions such as surface tension and the surface agitation associated with intense boiling.

3. Hot Wire Gauge.

A single resistance wire was mounted similar to the other two gauges already discussed. This single strand was resistively heated by application of an excitation current. The resistance of the sensor wire was compared to that of an identical wire located near the bottom of the tank. As with the thermistors, that portion of the wire not in the liquid would become resistively heated resulting in a change in resistance which could be correlated with the liquid level. This gauge would be the least accurate measurement of the liquid level because of the influence of temperature gradients in the ullage and surface agitation associated with boiling.

4. Radiation Level Gauge.

While not actually employed in this test since necessary authorization could not be obtained in time to meet the scheduled test date, serious thought and preparation were given to a radiation level gauge. Since most sensors installed inside the tank would eventually experience severe thermal stress and possible error or loss of data due to failure, a technique was devised to employ an isotopic radiation source. The radiation source and detector were to be mounted external to the tank, as depicted in Figure 13.

The isotopic gamma ray source was to be buried in a lead source shield directly below the tank car under 30.5cm (1.0 ft) of soil beneath the JP-4 pool. The gamma rays would then be collimated by a small hole drilled in the lead shield. The detector would be kept cool by a water jacketed container located approximately 30.5cm (1.0 ft) over the tank. The scheme in this case was to measure the attenuation of the gamma radiation from the isotopic source as a function of liquid level in the tank. As attenuation is a function of total mass and not just density, this would have been the only method for directly measuring the amount of propane which had escaped from the tank if shell-full conditions occurred. Laboratory tests utilizing 3.05m (10.0 ft) and 0.61m (2.0 ft) thicknesses of liquid propane indicated that the liquid level could be monitored to within one inch.

C. Pressure Gauges, Valve Lift Measurements, Radiometer, and Other Instrumentation

Six CEC pressure gauges were mounted inside the tank car. Three gauges were mounted along the top of the car, and three gauges were mounted along the bottom of the tank car (refer to Figure 1). Each pressure gauge was mounted on a metal bracket which had been especially welded to the tank shell (and then the area stress-relieved) by the tank car company which manufactured RAX 201. The data from the pressure gauges were recorded digitally on a magnetic tape, and later read back on a FM decoder playback chart recorder.

Two linear differential transformer devices (LDT) were installed to measure the lift of the Midland relief valve. One LDT was mounted in the interior of the tank, and the second LDT was mounted externally. The data from the LDT's were recorded on a Brush Instrument Pen Chart Recorder.

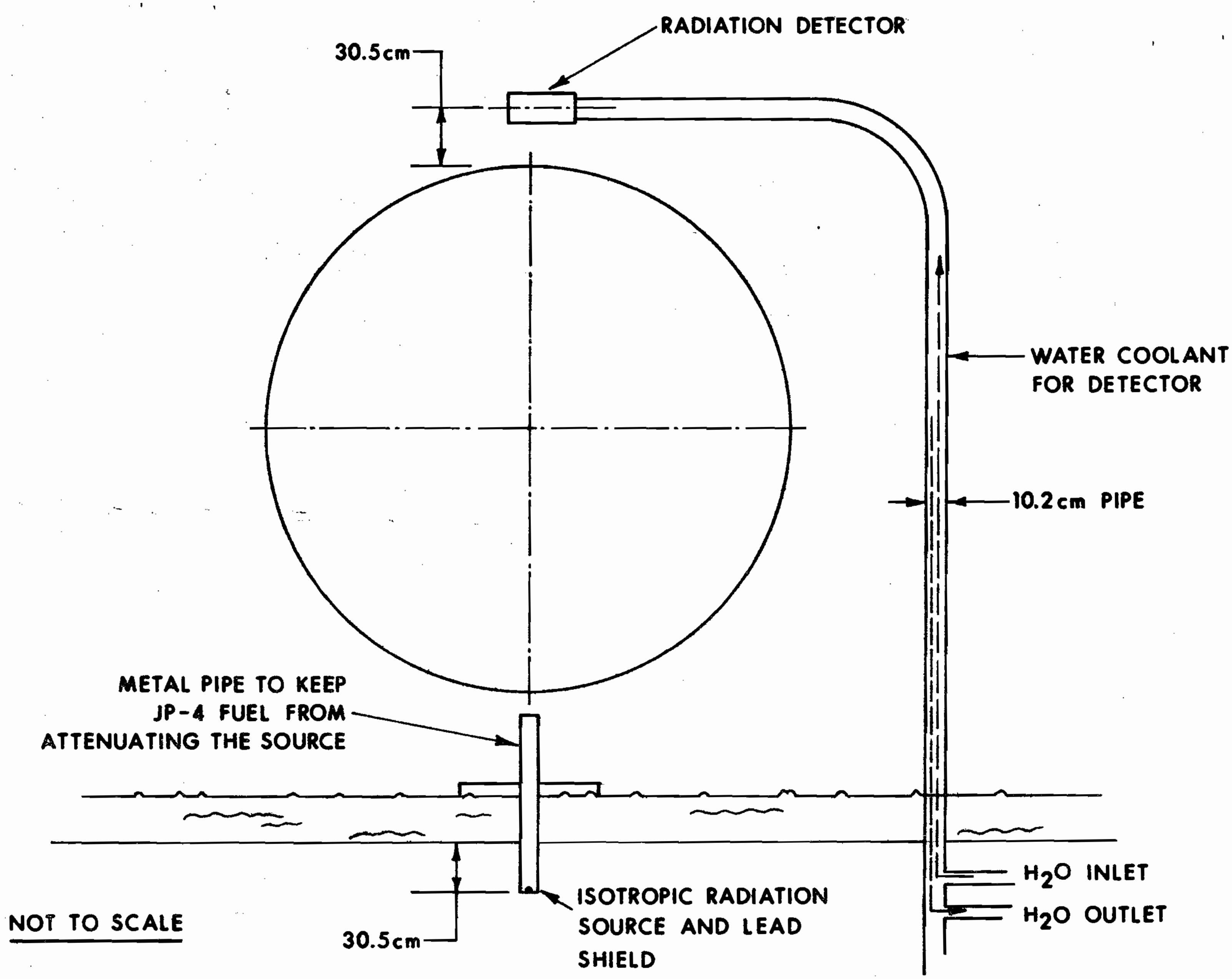

Figure 13-Radiation Detector & Source Location

A radiometer was emplaced on the berm surrounding the large excavation. The radiometer was situated approximately nine meters (thirty feet) from the center of the 45.7m (150 ft) side. The specifications and characteristics of the radiometer are given in Table V. The data from the radiometer were recorded on a Brush Instrument Pen Chart recorder.

Other instrumentation included two x-y plotters which were set-up to monitor two of the thermocouples and the pressure simultaneously. One x-y plotter was wired to monitor thermocouple Number 67 (the front 12:00 thermocouple), while the other plotter was to record the temperature from thermocouple Number 1 (the rear 12:00 thermocouple). The x-y plotters were physically located in the control building, which was situated approximately 914m (1000 yd) from the test pit.

Television coverage was provided for the personnel in the control building. Finally, extensive movie coverage, including high speed camera equipment, was provided.

D. NASA A-Frame and Calorimeters

The National Aeronautical and Space Administration (NASA), in a technology exchange program, planned and designed instrumentation for the measurement of fire heat flux and measurements of some torch parameters. Mr. Joe Mansfield of Ames Research Center headed the NASA effort.

An illustration of the arrangement of the instrumentation is given in Figure 14. The lower calorimeters were approximately 1.2m (4.0 ft) above the surface of the JP-4 fuel and were located halfway between the edge of the fuel pit and the side of the tank car (1.52m (5.0 ft) from the edge of the pool, and 3.05m (10.0 ft) from the center of the pool). The calorimeter support can be seen in Figure 3, and the calorimeters are visible in Figure 4. The calorimeters were directed downwards.

The torch fire and upper pool fire thermocouples and calorimeter were located approximately 7.0m (23 ft) above the JP-4 fuel surface at a location directly above the Midland relief valve of the tank car and supported by the A-frame (refer to Figures 9 and 14). This instrumentation would be subjected to the intense heat and high velocities of the propane torch, and had to be designed accordingly.

E. Louisiana Tech Safety Relief Flange

Louisiana Tech University was contracted by the FRA/DOT to design and construct a remotely-controlled safety relief flange. The flange had to withstand the heat of the fire (no leaks were permitted) and had to be designed to function on command. The safety relief flange was installed so that when actuated, it would preclude rupturing of the tank car. Dr. Mike Wilkinson and Dr. Joe Barnwell of Louisiana Tech University headed this portion of the project.

Table V. Specifications and Characteristics of The Radiometer

Range: 0 - 30 cal/cm^2 sec

View Angle: 5° conical view

Spectral Response: 300 - 50,000 Angstroms

Time constant: (63%) 10 seconds maximum

Accuracy: 1%

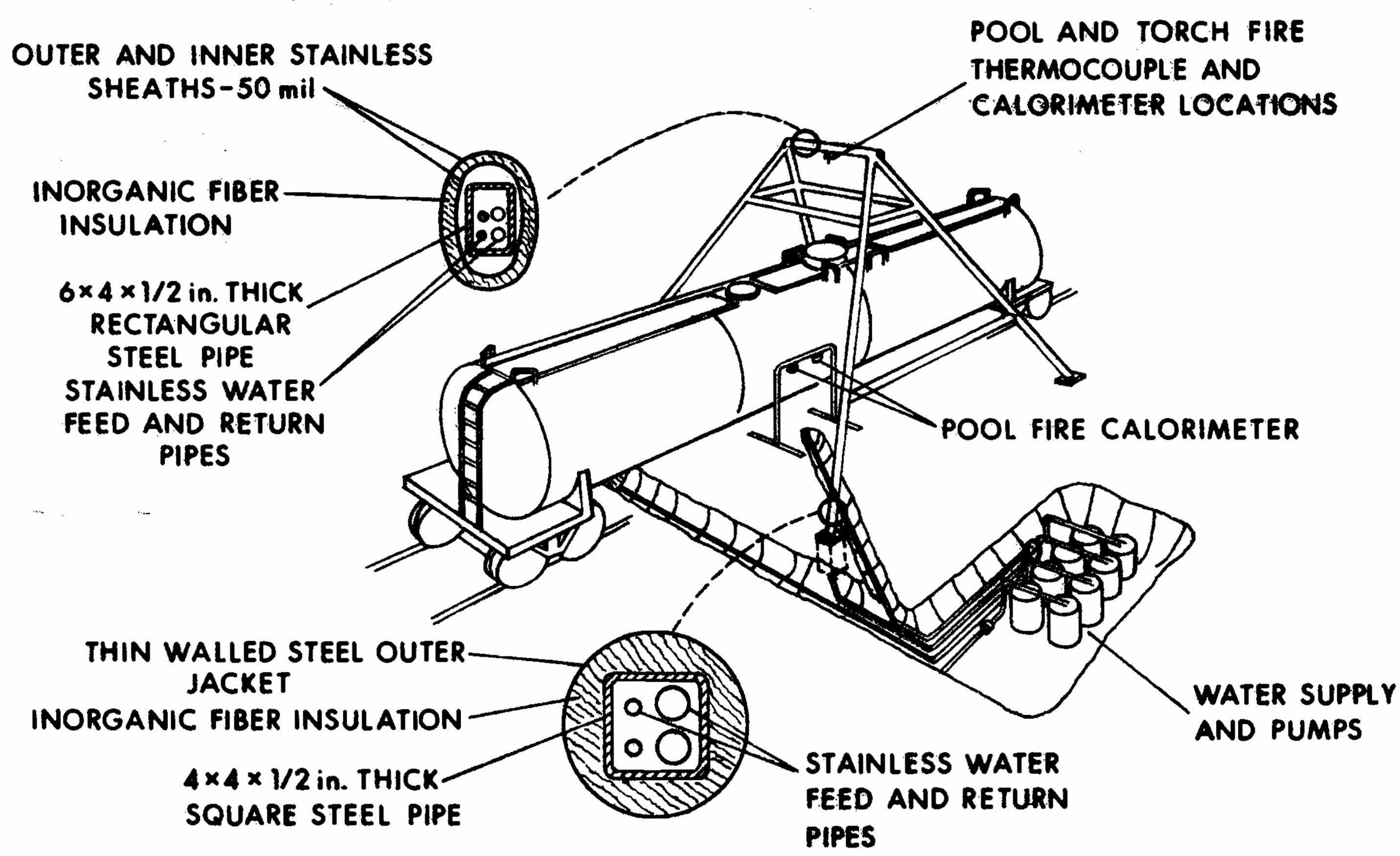

Figure 14-Arrangement of NASA Instrumentation

The cover for the entrance manway was sent to Louisiana Tech where a 25.4cm (10.0 in) diameter hole was cut from the center. The actuating mechanism was constructed, and the entire assembly was sent back to WSMR.

Using a "toilet seat" lid-hole design, a copper gasket, and a pneumatic actuator system, the entire safety relief system was checked out on a one-fifth scale model tank car before installing the assembly on RAX 201. The one-fifth scale model tank car was pressurized to 1.96×10^6 nt/m^2 (270 PSIG). No leaks were observed, and the relief flange actuated according to design. Large, heavy-duty truck shock absorbers were used to prevent the "toilet seat lid" from flapping all the way back and impacting against the side of the tank car.

The Louisiana Tech safety flange and actuator assembly was then installed over the entrance manway. No leaks were observed during nitrogen pressurization of the jumbo tank car, or the subsequent loading of the propane. A large water barrel, wrapped with insulation, was installed over the safety relief assembly (see Figures 1 and 9), and then filled with water. The water barrel and water were used in order to provide the actuating mechanism thermal protection from the fire.

The safety relief flange was connected so it could be operated from the control bunker. From theoretical studies, the criteria for actuating the relief flange were to be if the tank car shell temperature reached 482°C (900°F) of if the internal tank pressure rose to 2.86×10^6 nt/m^2 (400 PSIG). The two x-y plotters were monitored in the control building for these two parameters.

The thermocouples and teflon coated wires from the pressure gauges, liquid level gauges, and the LDT's were welded to extension wires and fed through an underground conduit system. The conduit system led from the immediate test area to the "Possum Hut," where the ice bath reference junction for the thermocouples was located. From the "Possum Hut," the conduit system ran to an instrumentation bunker which contained all the data recording equipment.

V. PRE-TEST PREPARATION AND PROCEDURES

The tank car was positioned in the excavation and instrumented. The Louisiana Tech safety relief flange was emplaced and bolted according to specifications. The car was purged with nitrogen, and then pressurized with nitrogen. At 1.96×10^6 nt/m^2 (270 PSIG) the relief valve opened. The 1.96×10^6 nt/m^2 was confirmed by the gauge on the nitrogen feed line as well as by the pressure gauges mounted inside the tank.

The nitrogen was then vented to the atmosphere until the pressure was reduced to 2.39×10^5 nt/m^2 (20 PSIG) of nitrogen. The 2.39×10^5 nt/m^2 of nitrogen was retained until the propane was loaded into the tank car to ensure that no oxygen would be present in the interior of the car.

Prior to loading the propane, the remaining nitrogen was purged by loading some propane into the tank and venting to the atmosphere. This procedure was repeated two times to ensure that only propane would be inside the tank car. The tank car was then filled according to summer filling specifications. The car was filled 27.9cm (11.0 in) from the top of the car. The temperature of the propane at test time was 21°C (70°F) and the pressure was 9.63×10^5 nt/m^2 (125 PSIG).

On 28 July 1974, with little or no wind blowing, the test was conducted. At approximately 1130 hours, after all personnel had cleared the test area, four thermite grenades were launched simultaneously from each corner of the JP-4 fuel pit into the JP-4 fuel. Thermite grenades were used to insure a rapid build-up of the fire.

VI. TEST RESULTS

A. Temperature Data

The measurements from the thermocouples were recorded as the test proceeded. As discussed before, the emf data from the thermocouples were recorded and stored on magnetic tape as each channel was sampled. The data were converted to temperatures at the BRL with the use of a computer program which incorporated the standard calibration table for chromel-alumel thermocouples. These data are presented in tabular and graphical form in Appendix A.

The tables are divided into five different groupings. The first grouping consists of the thermocouples which made up the rear thermocouple plane (rear inner wall and rear grid thermocouples). The second grouping consists of the thermocouples that made up the front thermocouple plane (front inner wall and front grid thermocouples). The fire and dome thermocouples constitute the third grouping while the last two groupings contained the thermocouples which have questionable or bad data.

The fourth grouping, which has the subheading of "Sign Reversal Occurs During the Test," contains seventeen thermocouples that were attached to the steel wall of the tank car, and one grid thermocouple. One or more sign reversals occurred in the recorded emf values during the test, indicating that the data recorded are not reliable. It is postulated that the reason for these sign reversals was that these thermocouples, when installed in the copper beads, established a resistive contact with the tank shell. It has been shown that a resistive contact with the tank shell results in erroneous readings by the differential voltmeter of the Vidar unit. To get these thermocouples to agree with the other thermocouples at the beginning of the test, various adjustments had to be made without an *a priori* reason (except that different resistances between thermocouples and tank shell would result in different adjustments). Therefore, while trends may be inferred from these thermocouples, great care must be exercised in quoting any of these recorded data.

The final grouping of thermocouples, labeled "The Following Are Not Harmonious," are thermocouples that gave readings completely contrary to all other thermocouples. These thermocouples, except for the one in the water tank that protected the Louisiana Tech safety relief flange, are included only for completeness of all the temperature data.

Tables VI and VII lists the questionable and bad thermocouples. In addition, Figures 11 and 12 denote the questionable thermocouples by open circles as opposed to the blacked-in circles which represent the good thermocouples. Briefly summarizing, 80.5% of the installed thermocouples recorded reliable data while another 15.2% recorded data from which information can be gleaned.

Table VIII is an example of the tabulated data found in Appendix A. The thermocouples are listed by both their channel number and their location. The times given in the heading are the times channel No. 1 was sampled. To get the exact time another channel was sampled, add the value in the TIME ADJUST ADD COLUMN to the time in the column heading. For example, in Table VIII, channel No. 4 read 87.3°F at 85.45 seconds after fire ignition (84.60 sec + 0.85 sec).

Figure 15 is an example of the temperature versus time data also found in Appendix A. The left ordinate gives the temperature in degrees Fahrendheit, and the right ordinate gives the temperature in degrees Centigrade. The sharp drop in temperature at the end of the plot indicates the point at which catastrophic failure of the tank occurred.

Figure 16 is an example of the cross-sectional plots of the rear inner wall-grid thermocouple plane and front inner wall-grid thermocouple plane. A linear interpolation of the temperature with respect to time was performed on the thermocouple data presented in a cross-sectional plot so as to present the temperature data at a common time. These plots, contained in Appendix B, are convenient for quickly comparing the thermocouple data at the specified times.

B. Liquid Level Data

Unfortunately, no useful liquid level data were recorded. Just prior to loading the tank car with LPG, the leads to the thermistor gauge were sheared off when one of the instrumentation glands was tightened (torqued) too far. The adherence to the tight test timetable prevented repair work.

The shorting wire gauge was damaged during the nitrogen pressurization of the tank. The combination of tank pressure, 1.96×10^6 nt/m^2 (270 PSIG), and the extreme turbulence initiated by the popping of the valve during the nitrogen test damaged the spherical ball sufficiently to prevent it from sliding freely on its guidewire.

Table VI. Questionable Thermocouples

Channel Number	Position
1	Rear Inner Wall at 12:00
3	Rear Inner Wall at 1:00
8	Rear Inner Wall at 3:30
10	Rear Inner Wall at 4:30
11	Rear Inner Wall at 5:00
12	Rear Inner Wall at 5:30
16	Rear Inner Wall at 7:30
30	Rear Grid at 2:00 Level - Left
61	Dome - Left
88	Front Inner Wall at 1:30
85	Front Inner Wall at 3:00
83	Front Inner Wall at 4:00
81	Front Inner Wall at 5:00
80	Front Inner Wall at 5:30
76	Front Inner Wall at 7:30
73	Front Inner Wall at 9:00
71	Front Inner Wall at 10:00
69	Front Inner Wall at 11:00

Table VII. Bad Thermocouples

Channel Number	Position
2	Rear Inner Wall at 12:00
42	Rear Grid at 3:30 Level - center
51	Rear end - Inner Wall of Tank
110	Front Grid at 4:00 Level - Right

THERMOCOUPLE TEMPERATURES (DEG. F) FOR TEST NR. 8

CHANNEL NUMBER	LOCATION	TIME (SEC) = -380.70	-338.40	-296.10	-253.80	-211.50	-169.20	-126.90	-84.60	-42.30	TIME ADJUST ARG
4	REAR INNER WALL AT 1:30	67.9	66.6	66.2	69.9	69.6	67.8	66.5	67.5	69.9	0.85
5	REAR INNER WALL AT 2:00	68.8	67.8	68.0	69.9	70.2	68.7	68.1	68.4	71.0	1.13
6	REAR INNER WALL AT 2:30	69.0	69.3	68.6	69.4	69.5	68.9	68.6	68.9	69.5	1.41
7	REAR INNER WALL AT 3:00	69.2	69.7	69.0	69.5	69.5	69.2	69.0	69.1	69.5	1.69
9	REAR INNER WALL AT 4:00	69.5	69.5	69.2	69.9	70.0	70.4	69.4	69.6	69.3	2.26
13	REAR INNER WALL AT 6:00	68.7	69.4	69.9	69.9	70.0	70.3	69.3	69.6	70.0	3.38
14	REAR INNER WALL AT 6:30	70.2	70.1	70.1	69.8	70.6	69.2	69.8	70.4	69.9	3.67
15	REAR INNER WALL AT 7:00	69.1	69.1	69.1	69.3	69.3	69.2	69.9	69.2	69.4	3.95
17	REAR INNER WALL AT 8:00	69.9	69.9	70.5	70.9	70.6	69.9	69.3	69.9	70.6	4.51
18	REAR INNER WALL AT 8:30	70.3	71.1	70.4	70.6	70.6	70.6	70.6	70.5	70.7	4.79
19	REAR INNER WALL AT 9:00	70.3	70.4	70.2	70.9	69.4	70.2	70.4	70.3	70.7	5.08
20	REAR INNER WALL AT 9:30	69.7	69.9	69.9	70.5	69.9	70.6	68.7	70.0	70.0	5.36
21	REAR INNER WALL AT 10:00	69.6	69.8	69.9	69.9	70.0	70.0	70.0	70.6	70.0	5.64
22	REAR INNER WALL AT 10:30	69.5	68.4	69.2	69.9	68.7	69.4	69.4	70.0	69.4	5.92
23	REAR INNER WALL AT 11:00	69.7	69.7	69.8	69.8	69.9	70.0	69.9	70.0	70.0	6.20
24	REAR INNER WALL AT 11:30	69.6	69.6	70.3	69.6	69.8	69.8	69.8	69.9	70.0	6.49
25	REAR GRID AT 12:30 LEVEL CEN	69.6	69.6	70.1	69.6	70.4	69.8	69.8	69.8	70.0	6.77
26	REAR GRID AT 1:00 LEVEL CEN	69.7	69.1	69.1	69.2	69.8	69.2	69.9	69.2	69.3	7.05
27	REAR GRID AT 1:30 LEVEL LFT	69.9	69.9	70.0	69.9	70.0	70.0	70.5	69.9	70.6	7.33
28	REAR GRID AT 1:30 LEVEL CEN	70.0	69.9	70.5	69.8	70.6	69.9	69.9	69.9	70.5	7.61
29	REAR GRID AT 1:30 LEVEL RGT	69.3	69.9	69.2	69.5	69.3	69.3	69.3	69.3	69.4	7.90
31	REAR GRID AT 2:00 LEVEL CEN	70.0	32.1	70.0	70.6	70.0	70.7	70.0	70.0	70.6	8.46
32	REAR GRID AT 2:00 LEVEL RGT	70.1	32.4	70.0	70.0	70.6	70.7	70.0	70.6	70.0	8.74
33	REAR GRID AT 2:30 LEVEL LFT	70.7	31.9	70.0	70.7	70.0	70.1	70.0	70.6	70.0	9.02
34	REAR GRID AT 2:30 LEVEL CEN	70.7	31.8	70.1	69.9	70.0	69.5	70.0	69.4	70.0	9.31
35	REAR GRID AT 2:30 LEVEL RGT	70.0	32.0	70.6	69.9	70.0	70.6	69.9	69.3	70.7	9.59
36	REAR GRID AT 3:00 LEVEL LFT1	70.0	31.6	70.5	70.0	70.7	70.0	70.0	70.6	70.0	9.87
37	REAR GRID AT 3:00 LEVEL LFT2	70.0	30.5	69.2	69.4	70.0	69.3	70.0	69.2	69.3	10.15
38	REAR GRID AT 3:00 LEVEL CEN	69.3	31.0	69.3	69.4	68.8	69.4	69.9	69.3	69.4	10.43
39	REAR GRID AT 3:00 LEVEL RGT2	70.0	32.2	70.5	70.0	70.0	70.0	70.0	70.0	70.7	10.72
40	REAR GRID AT 3:00 LEVEL RGT1	69.4	32.1	69.3	69.4	69.4	69.4	69.4	69.3	69.4	11.00
41	REAR GRID AT 3:30 LEVEL LFT	69.4	70.0	69.3	70.0	69.3	69.4	70.0	69.3	69.4	11.28
43	REAR GRID AT 3:30 LEVEL RGT	70.0	70.1	70.0	70.0	70.0	70.6	70.0	70.7	69.4	11.84
44	REAR GRID AT 4:00 LEVEL LFT	70.2	70.0	70.1	69.5	70.0	70.0	70.0	70.6	70.0	12.13
45	REAR GRID AT 4:00 LEVEL CEN	70.6	70.0	70.1	70.0	70.0	70.0	70.0	70.0	70.0	12.41
46	REAR GRID AT 4:00 LEVEL RGT	70.0	69.9	70.5	70.0	70.0	70.6	70.0	70.0	70.0	12.69
47	REAR GRID AT 4:30 LEVEL LFT	70.1	70.0	70.6	70.0	70.0	70.0	70.0	70.6	70.0	12.97
48	REAR GRID AT 4:30 LEVEL CEN	70.0	69.3	69.3	69.4	70.0	69.3	69.4	69.3	69.4	13.25
49	REAR GRID AT 4:30 LEVEL RGT	69.4	69.3	69.3	69.3	69.3	69.3	70.0	69.3	69.3	13.54
50	REAR GRID AT 5:00 LEVEL CEN	69.9	69.9	70.0	69.9	70.0	70.0	69.9	70.0	70.0	13.82

TABLE VIII SAMPLE OF THERMOCOUPLE DATA VERSUS TIME

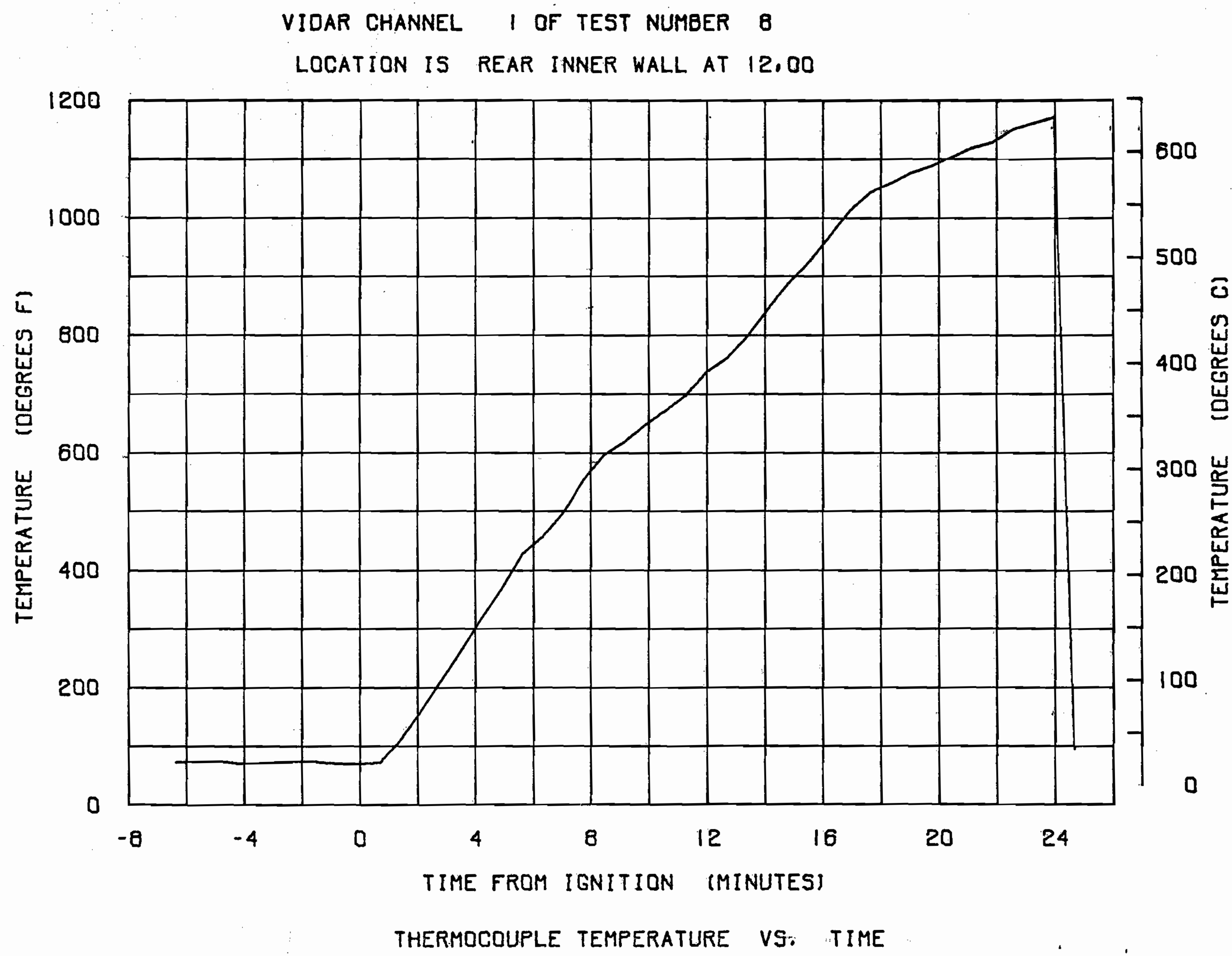

FIGURE 15 SAMPLE PLOT OF TEMPERATURE VERSUS TIME

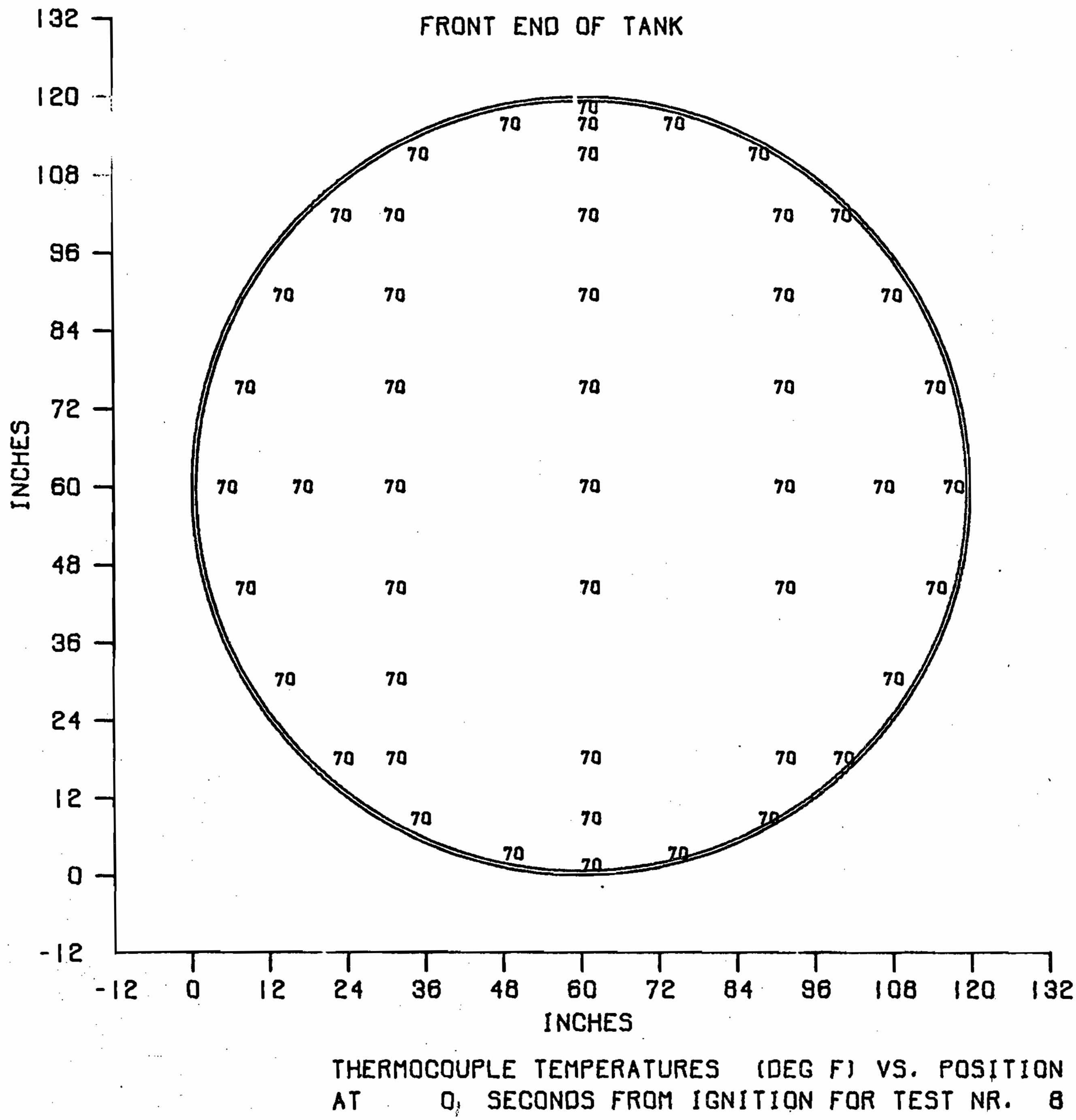

FIGURE 16 SAMPLE OF CROSS-SECTIONAL PLOTS

As anticipated, the violent boiling of the propane precluded any useful data from the hot wire gauge, except to confirm that considerable agitation and splashing occurred inside the tank car.

C. Pressure, Valve Lift, Radiometer, and Other Data

Due to electrical storms in the test area prior to the test, all six pressure gauges became inoperative. However, since the LPG had not been loaded, replacements were found and installed for four of the damaged gauges. Therefore, at test time, two gauges were operative at the top of the tank, and two gauges were operative at the bottom of the tank. The output from all four gauges compared extremely well, with little or no detectable differences. The resultant pressure versus time data are presented in Figure 17. A tabulation of the pressure for every half-minute is presented in Table IX.

The two x-y plotters which were connected in parallel with two thermocouples and two pressure gauges performed extremely well, even though the distance the signal had to travel was quite long - of the order of 914m (1000 yards). Figure 18 was connected to the 12:00 Front Thermocouple, while Figure 19 was connected to the 1:00 Rear Thermocouple.* Note that the ordinate and abscissa scales in Figures 18 and 19 are not linear to compensate for the non-linearity of the amplifiers.

Data for the lift of the valve are graphed in Figure 20. In addition, the exact opening and closing times for the valve are listed in Table X. After approximately eight minutes, the LDT was destroyed by the intense heat of the fire. The second LDT malfunctioned and no output was recorded.

Data from the radiometer, positioned on the berm of the large excavation, are recorded in Figure 21. The millivolt data are converted to heat flux in Section VII, Data Analysis.

D. NASA Data**

The JP-4 pool fire temperature and heat flux averages are presented in Table XI. In addition, Figure 22 presents the time average flux, the flux level distribution, and the time distribution of abrupt changes in flux from the 1.2m (4.0 ft) calorimeters. The time distribution of abrupt changes in the flux is of interest because pool fires are characterized by the migration of "hot" eddies with accompanying fluctuations in flux at a fixed location.

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* *At test time, the 12:00 rear thermocouple was giving erratic readings so the option exercised was to monitor the 1:00 rear thermocouple instead.*

** *All the data presented in this section were analyzed & reported by NASA.*

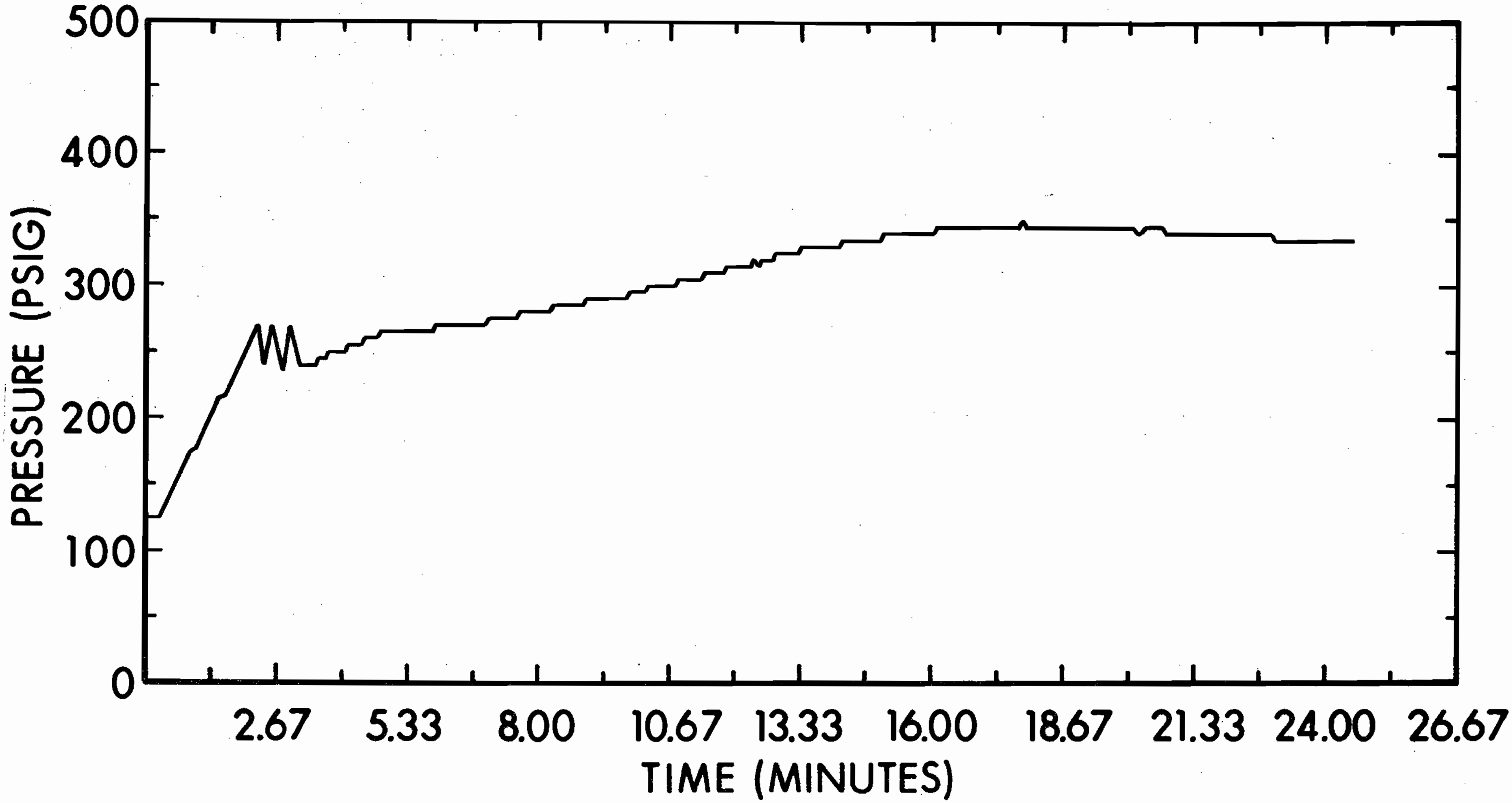

Figure 17 -Pressure vs Time

Table IX. Pressure versus Time

Time	Pressure 10^5 nt/m^2	(PSIG)	Time	Pressure 10^5 nt/m^2	(PSIG)
0.0	9.63	(125)	12.5	22.73	(315)
0.5	10.67	(140)	13.0	23.42	(325)
1.0	13.08	(175)	13.5	23.77	(330)
1.5	15.15	(205)	14.0	23.77	(330)
2.0	17.91	(245)	14.5	24.11	(335)
2.5	18.60	(255)	15.0	24.11	(335)
3.0	18.94	(260)	15.5	24.46	(340)
3.5	17.91	(245)	16.0	24.46	(340)
4.0	18.25	(250)	16.5	24.80	(345)
4.5	18.94	(260)	17.0	24.80	(345)
5.0	19.28	(265)	17.5	24.80	(345)
5.5	19.28	(265)	18.0	24.80	(345)
6.0	19.63	(270)	18.5	24.80	(345)
6.5	19.63	(270)	19.0	24.80	(345)
7.0	19.97	(275)	19.5	24.80	(345)
7.5	19.97	(275)	20.0	24.80	(345)
8.0	20.32	(280)	20.5	24.80	(345)
8.5	20.66	(285)	21.0	24.46	(340)
9.0	21.01	(290)	21.5	24.46	(340)
9.5	21.01	(290)	22.0	24.46	(340)
10.0	21.35	(295)	22.5	24.46	(340)
10.5	21.70	(300)	23.0	24.11	(335)
11.0	22.04	(305)	23.5	24.11	(335)
11.5	22.39	(310)	24.0	24.11	(335)
12.0	22.73	(315)	24.5	24.11	(335)

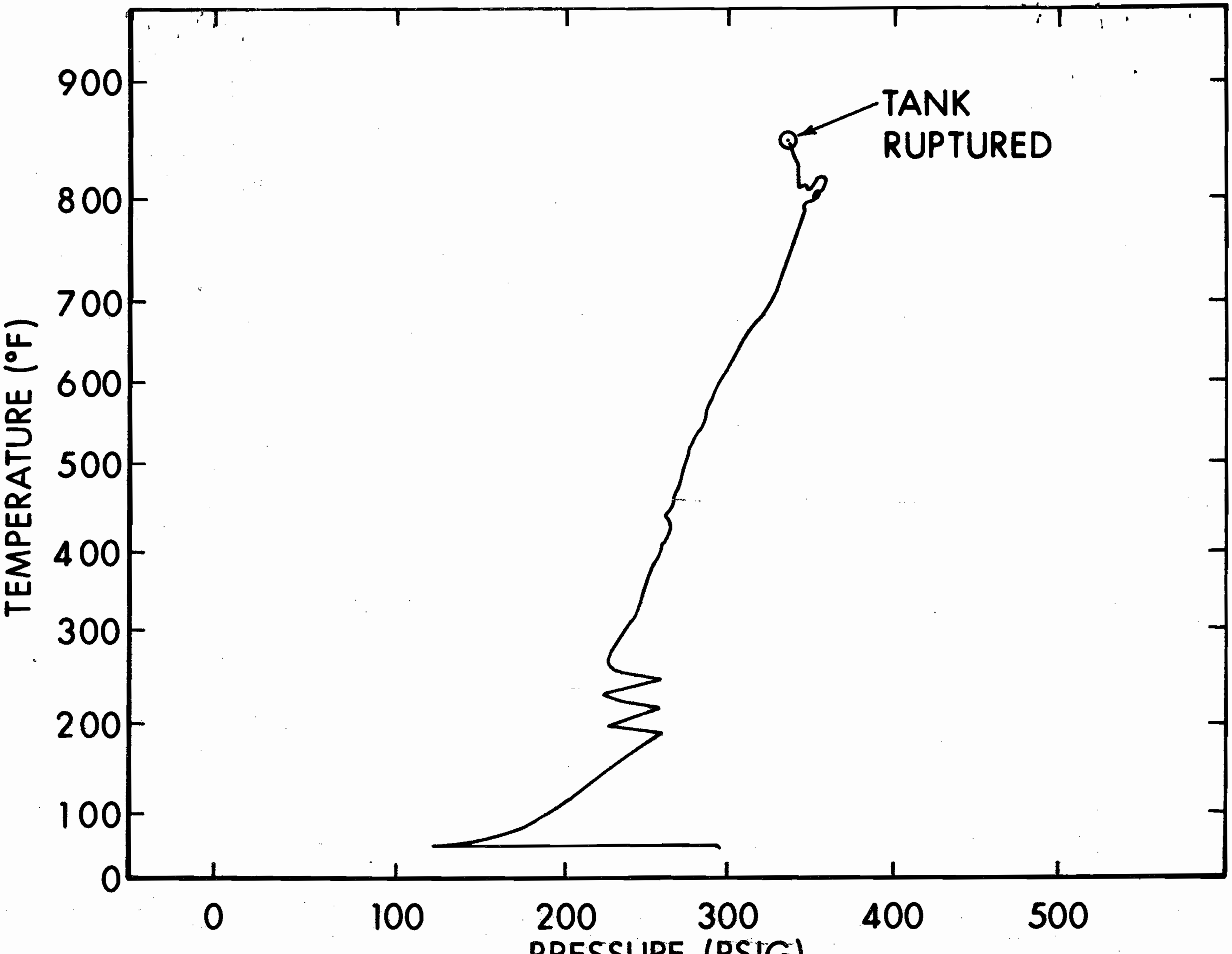

Figure 18-Temperature from 12:00 Front Thermocouple vs Pressure

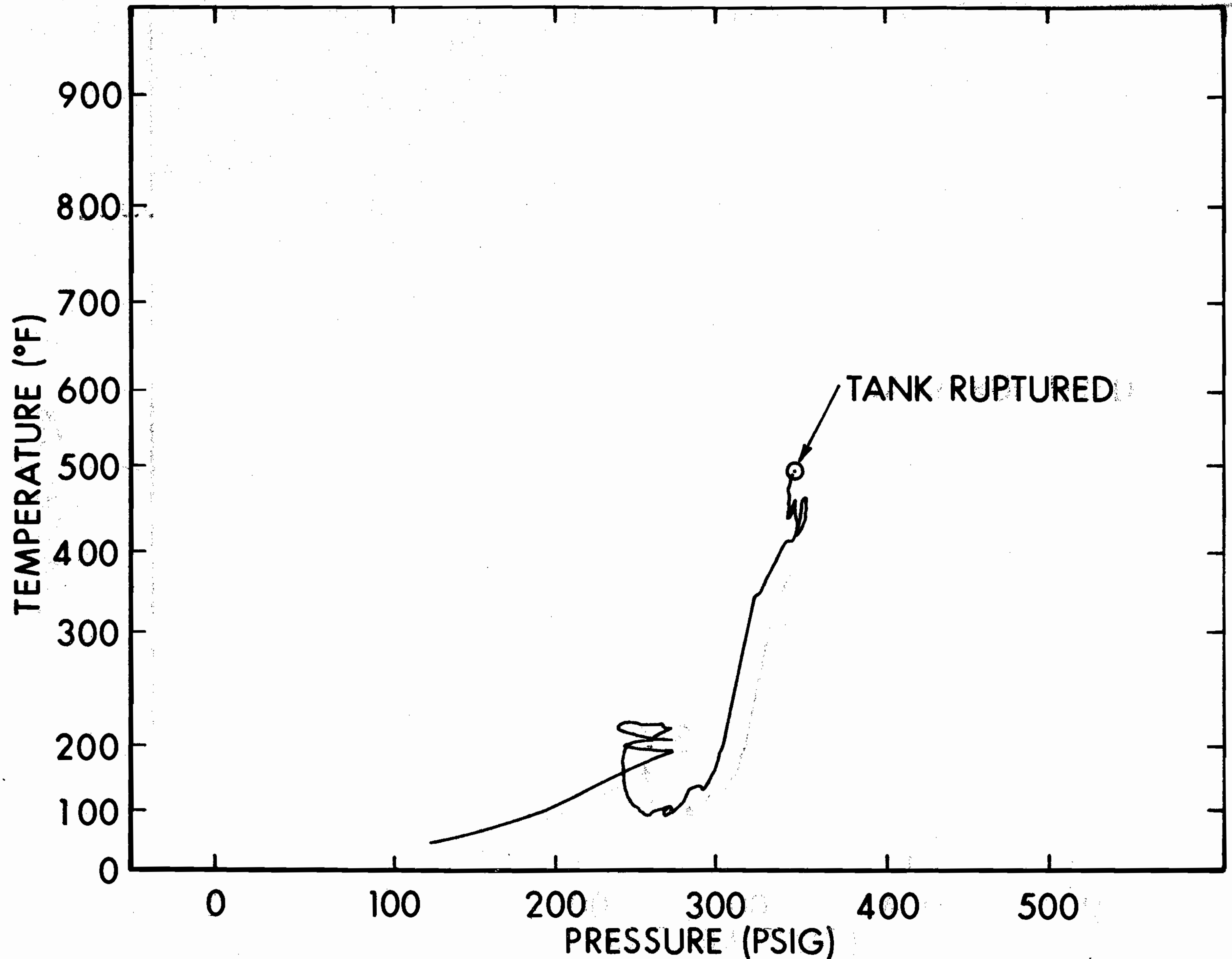

Figure 19-Temperature from 1:00 Rear Thermocouple vs Pressure

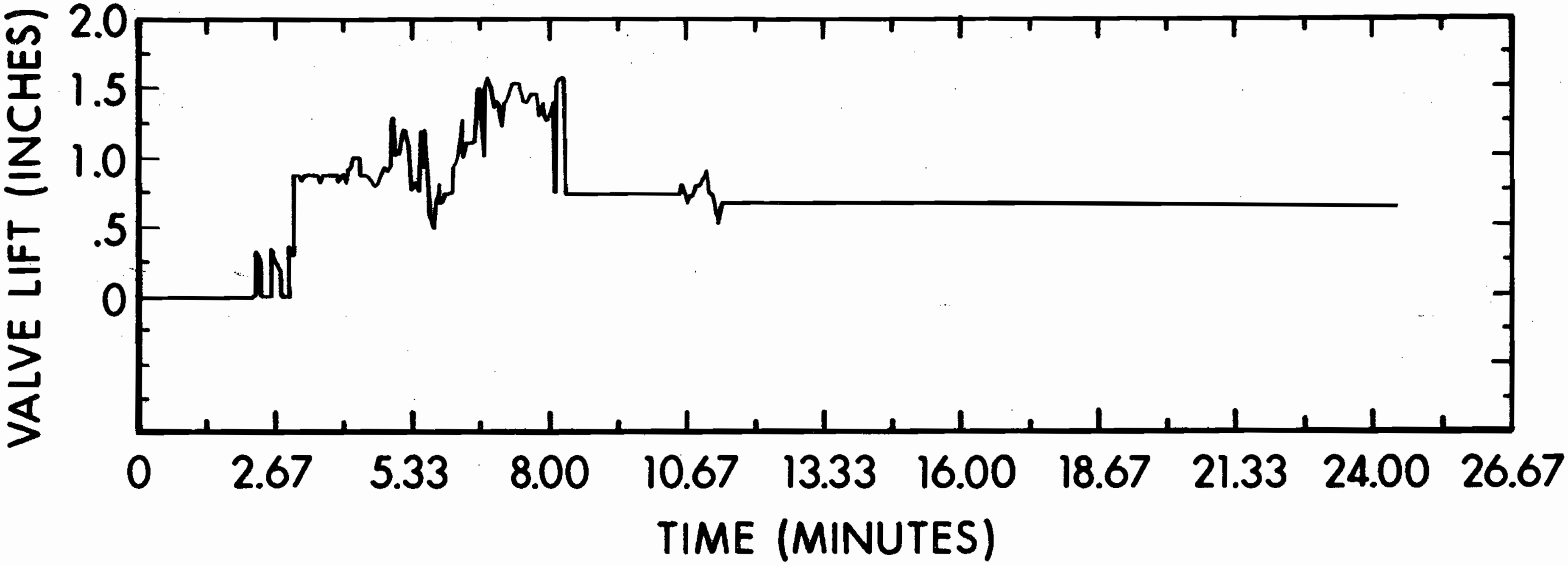

Figure 20-Valve Lift vs Time

Table X. Cycling of The Valve

Time Valve Opened (sec)	(min)	Time Valve Closed (sec)	(min)
132	2.20	140	2.33
156	2.60	164	2.73
176	2.93	Stayed Open	

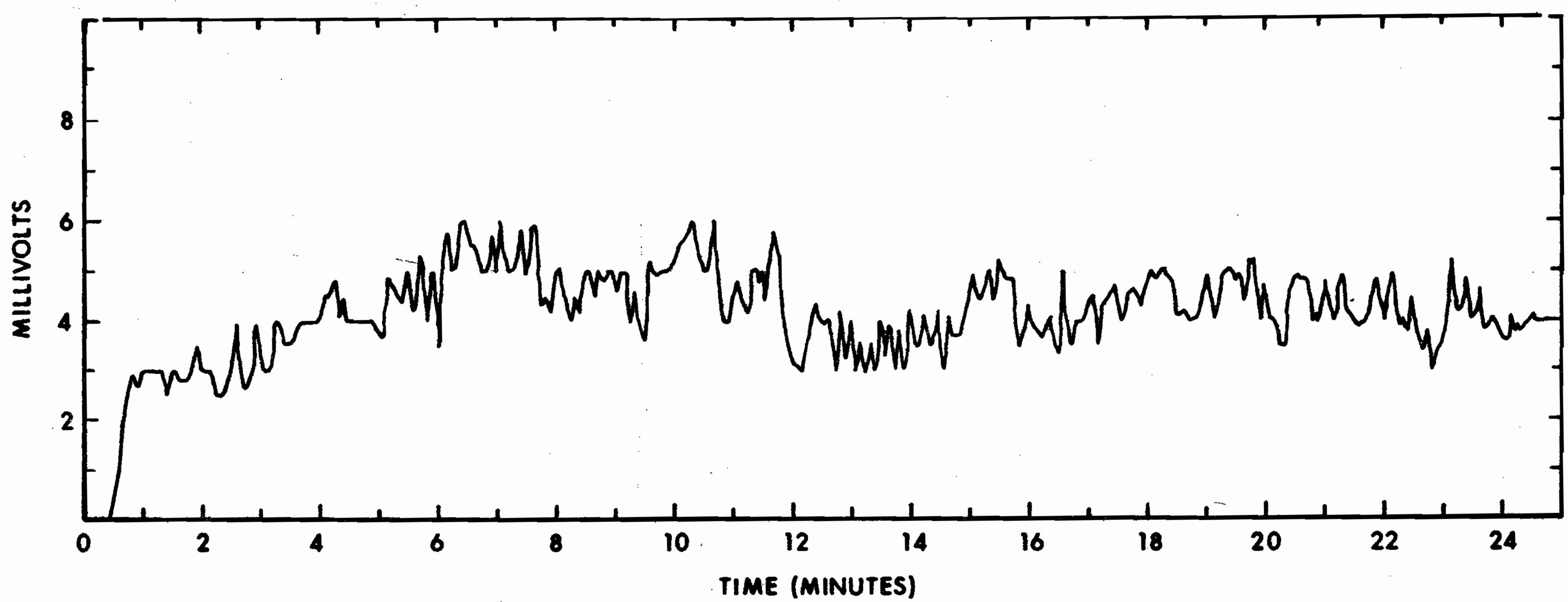

Figure 21-Radiometer Data: Millivolts vs Time

Table XI. Summary of NASA Pool Fire Data

Height of Measurement	Type of Measurement		Value
1.2m (4.0 ft)	HEAT FLUX	Mean	3.30 cal/cm^2-sec (43,920 $BTU/hr\text{-}ft^2$)
		High (90%)*	4.82 cal/cm^2-sec (64,080 $BTU/hr\text{-}ft^2$)
		Low (90%)	2.65 cal/cm^2-sec (35,280 $BTU/hr\text{-}ft^2$)
7.0m (23.0 ft)	HEAT FLUX	Mean	5.20 cal/cm^2-sec (69,120 $BTU/hr\text{-}ft^2$)
		High (90%)	11.11 cal/cm^2-sec (147,600 $BTU/hr\text{-}ft^2$)
		Low (90%)	2.44 cal/cm^2-sec (32,400 $BTU/hr\text{-}ft^2$)
	TEMPERATURE	Mean	1138°C (2080°F)
		High (90%)	1190°C (2175°F)
		Low (90%)	1110°C (2030°F)

*High or Low (90%) indicates that data was respectively, below or above the value given 90% of the time.

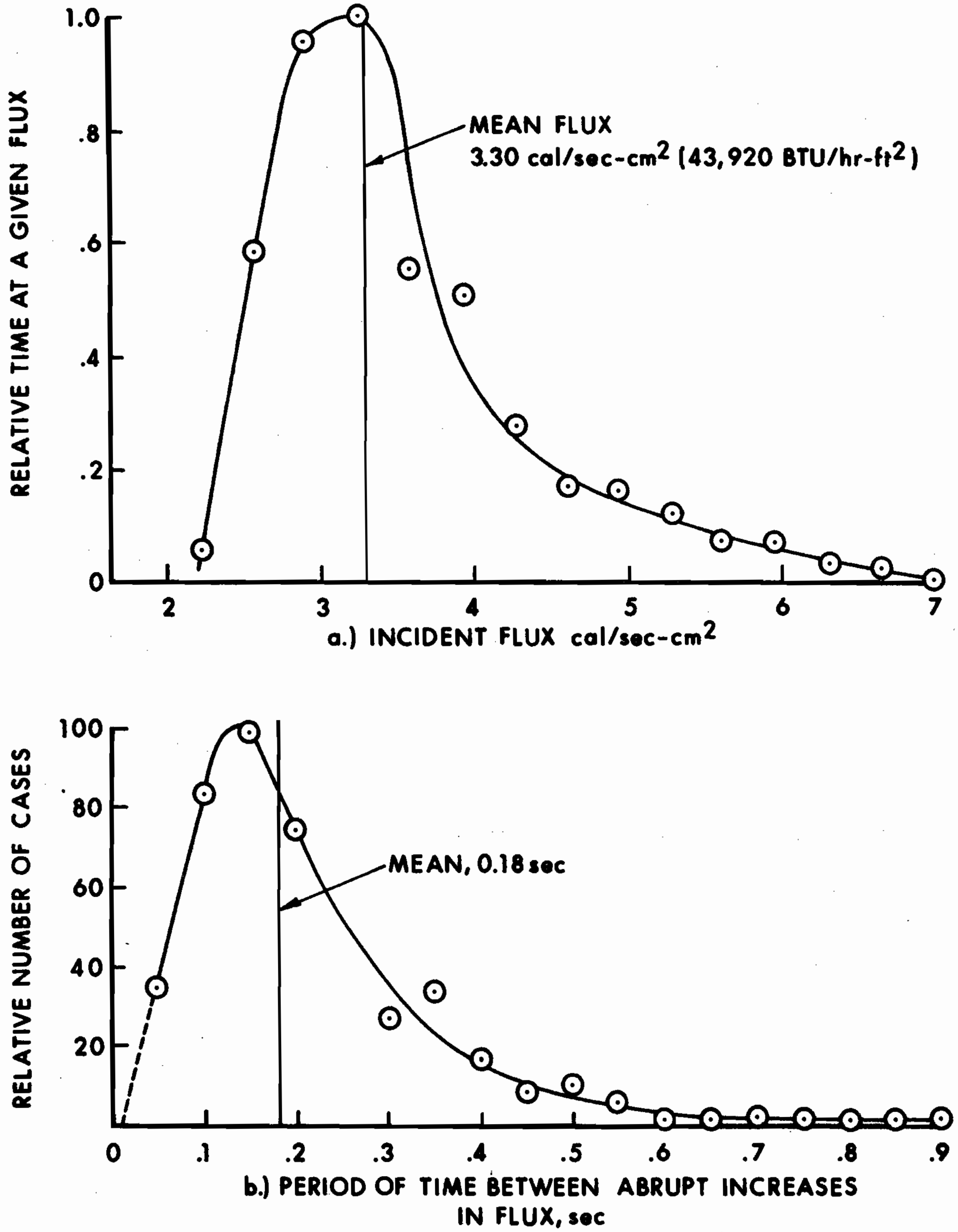

Figure 22-Flux Level Distribution of JP-4 Fuel Fire

The calorimeter which measured the heat flux at the 7.0m (23.0 ft) level saw the influence of the valve cycling. The average heat flux during the propane venting was 9.21 cal/cm^2-sec. (122,400 BTU/hr-ft^2). At the instant the valve opened, the flux decreased sharply to a level below that of the normal pool fire and then rapidly increased to a relatively steady level - the average is based on the steady data. Uncertainties in the temperature and heat flux data are 15 to 16 percent due to the small pen recorder deflections.

The thermocouple positioned above the relief valve provided no information about the torch. The small radius of the thermocouple wire (required for desired time response) couple with the long lengths of wire exposed to the fire (to minimize a particular error) made it difficult to design a thermocouple rugged enough to withstand the shock wave generated by the cycling of the valve. Aggravating the condition was the fact that the exposed wire would be weakened by the elevated temperatures of the pool fire. The conclusion was that the shock wave broke the thermocouple, even though the design allowed for a substantial margin of error. In all likelihood, the wires failed at their junction, their most probable point of weakness.

VII. DATA ANALYSIS

Data collection was terminated 24.5 minutes after ignition of the thermite grenades because of the rupturing of the tank car. More will be said about the tank car rupture further along in this section.

A. The Fire Environment

1. Thermocouple Data.

Time zero was marked by the firing of the thermite grenades. In less than 45 seconds, the temperature of the test environment went from ambient (21°C or 70°F) to temperatures as high as 1090°C (2000°F).

Figures 23 and 24 plot the temperatures with respect to time recorded by the four rear fire and four front fire thermocouples respectively. These two graphs clearly indicate that across the smaller diameter of the fuel pit, the fire was quite uniform. The fire was hottest during the very early phases of the test (the first four minutes), but then the flame intensity decreased. This most likely reflects the change in the fuel-to-air mixture. As the initial oxygen supply was consumed, fire temperatures were relatively high; later, because the excavation slightly impeded the air flow, the oxygen supply was less rich and correspondingly, the fire temperatures declined.

Motion picture coverage of the test indicated that for approximately the first three-quarters of the test, there was little or no wind. The flames and smoke from the JP-4 fuel fire rose vertically. A slight

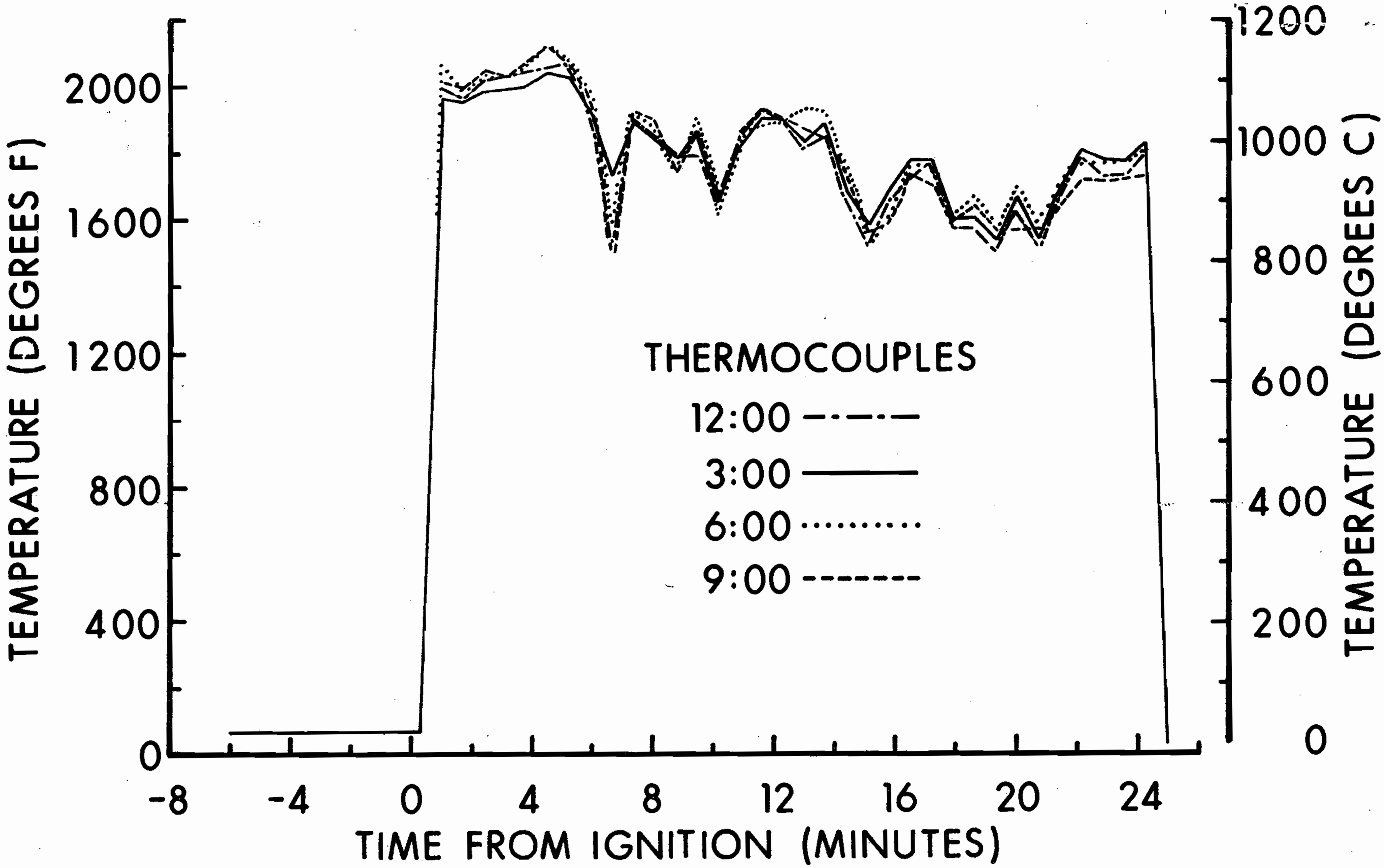

Figure 23- Rear Fire Temperatures vs Time

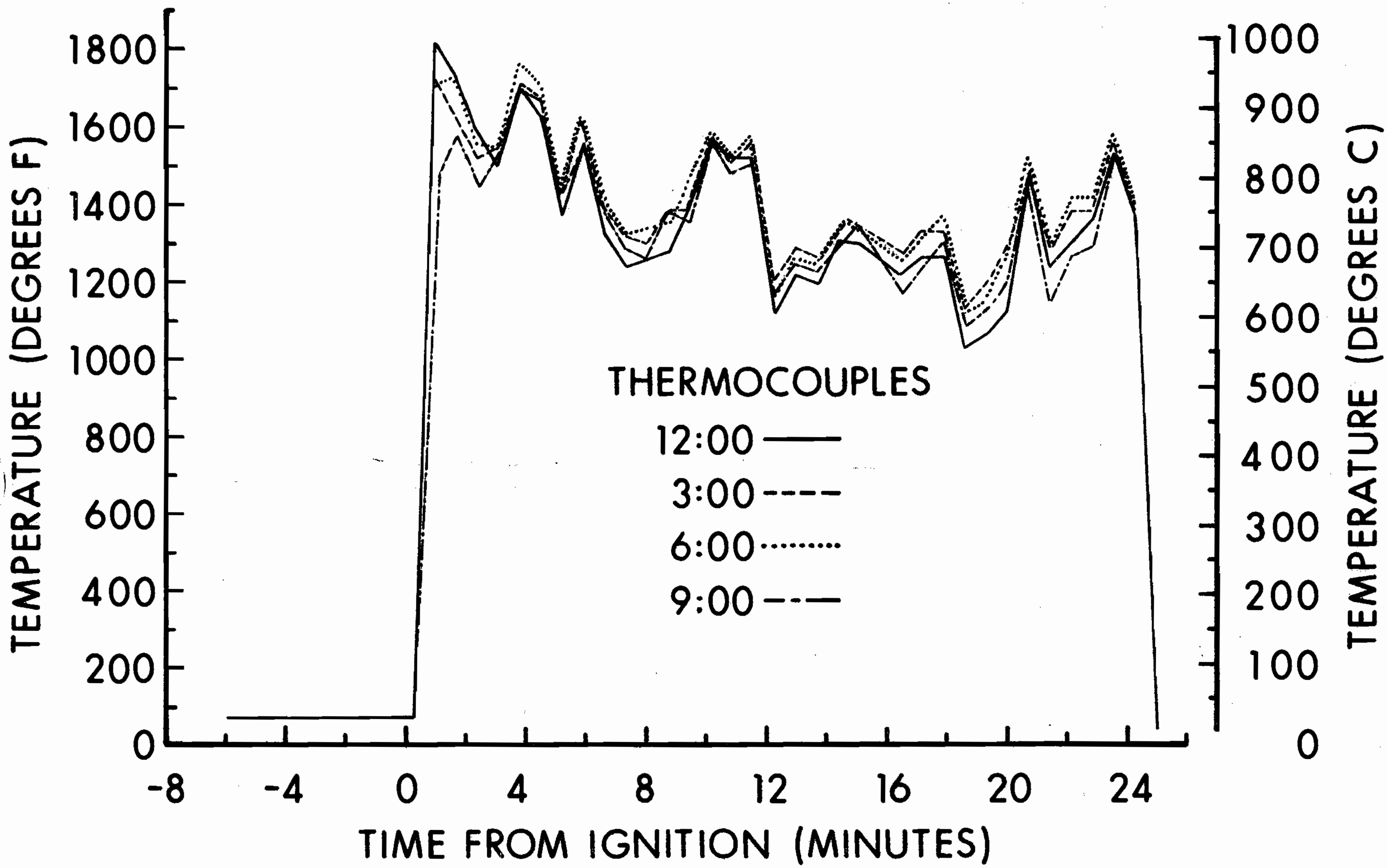

Figure 24-FRONT FIRE TEMPERATURES vs Time

wind arose about three-quarters of the way through the test, blowing from east to west, i.e., the wind blew from front to rear of the tank car. Both Figures 23 and 24 indicate that the slight wind, carrying oxygen into the fire, resulted in an increase of the flame temperatures.

A comparison of the temperatures from the rear and front fire thermocouples located at the 12:00 position, Figure 25, clearly show that there were considerable non-uniformites in flame fluctuations and temperatures over the length of the fire. The fire environment towards the rear of the tank car was, on the average, 200°C (360°F) hotter than the fire environment near the front of the tank car. Statistically, though, this difference in flame temperatures is at best just a rough number to quote, since the deviations from the average are quite large.

Summarizing, the JP-4 jet fuel fire typified the fire environment of a relatively large hydrocarbon pool fire subject to a slight wind. The fire temperatures were of the order of 650°C to 1090°C (1200°F to 2000°F). The tank car was, to a first approximation, uniformly engulfed by the fire circumferentially, but there existed a temperature gradient in the fire of the order of 200°C (360°F) from the front to the rear of the tank car.

2. <u>NASA Data</u>.

The NASA data indicate that the heat flux was 3.30 cal/sec-cm^2 (43,920 BTU/hr-ft^2) at a height of 1.2m (4.0 ft) above the JP-4 fuel surface, and 5.20 cal/sec-cm^2 (69,120 BTU/hr-ft^2) at a height of 7.0m (23.0 ft) above the fuel surface. It was not noted in the NASA data how long the "A-frame" calorimeter, which was suspended over the relief valve, functioned in the environment of the propane torch. (The calorimeters at the 1.2m level functioned satisfactorily for the entire test). However, the latter heat flux values are suspect.

NASA reports: "The upper level pool fire temperature and heat flux average are given . . . as 2080°F [1130°C] and 19.2 BTU/sec-ft^2 [5.20 cal/sec-cm^2]. It is important to note that these two values are mutually supporting, that is, a soot laden fire at 2080°F temperature will result in a flux of 19.2 BTU/sec-ft^2; thus, two different types of instruments independently (except for a common recorder) indicate a similar environment."[1*]

While the thermocouple data are consistent with Figure 23, it should be noted that the fire temperatures decreased after approximately four minutes. The NASA thermocouple survived only 2.2 minutes (the time at which the Midland valve opened), hence the flame temperatures and fire heat flux are "mutually supporting" for the first two to four minutes only.

**References are listed on page 87.*

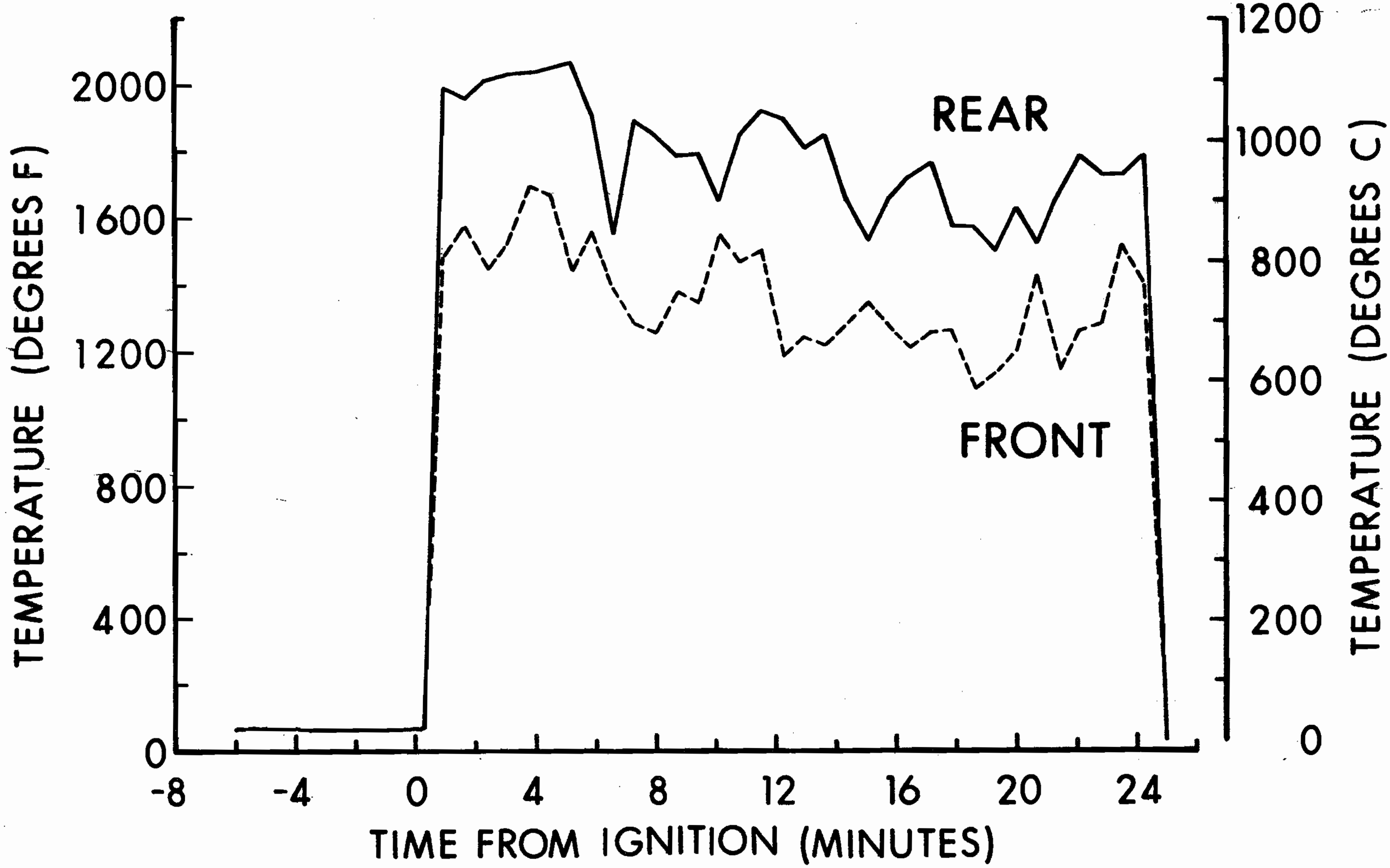

Figure 25-Comparison of the Temperatures Recorded by the Front and Rear 12:00 Fire Thermocouples

The BRL believes that the 5.20 cal/sec-cm^2 (69,120 BTU/hr-ft^2) value obtained from the 7.0m (23.0 ft) calorimeter is typical of the fire heat flux only for the first few minutes of the test. This figure is consistent with the "High 90%" value quoted in Table XI for the 1.2m (4.0 ft) calorimeter. But due to the inability to synchronize the NASA instrumentation with the grenade firings (time = 0.0), it is suspected by the BRL that data were recorded and averaged in the fire heat flux (obtained by the 7.0m calorimeter) when the relief valve was opened. The large variations of the heat flux as recorded by the 7.0m calorimeter would seem to support the validity of this argument, along with the fact that the High 90% value of 11.11 cal/sec-cm^2 (147,600 BTU/hr-ft^2) is not supported by the 1190°C (2175°F) temperature value quoted in Table XI.

12.2 Btu/sec ft²

The heat flux of 3.30 cal/sec-cm^2 (43,920 BTU/hr-ft^2) from the calorimeters positioned 1.2m (4.0 ft) above the JP-4 fuel are believed to be typical of a JP-4 fuel pool fire. This heat flux is compatible with the heat flux obtained in the one-fifth scale model tank car fire tests using JP-4 fuel[2,3].

B. Estimates of the Torch Temperature

Figure 21 records the raw data from the radiometer. A quartic equation was used to fit the radiometer calibration curve for the energy range of interest in order to convert the millivolt output into units of cal/sec-cm^2. The equation which was developed is:

$$q_{rad} = 0.51500R - 1.94167 \times 10^{-2} R^2 + 5.5000 \times 10^{-4} R^3 - 5.8333 \times 10^{-6} R^4, \qquad (1)$$

where q_{rad} = radiative flux measured by the radiometer (cal/sec-cm^2),

R = the output voltage measurement of the calorimeter (millivolts).

The above expression was then used to convert Figure 21 from millivolts to heat flux units, and this graph is presented in Figure 26.

The three valve openings are discernable near the beginning of the data. The radiative flux increases when the valve opens because of the additional radiation from the burning torch. Note that due to the finite time response of the radiometer, the peaks are shifted slightly in time.

The very narrow view angle of the radiometer must be carefully considered in interpreting the radiometer data. The fire should be considered as an infinite sheet of optically thick flame radiating in

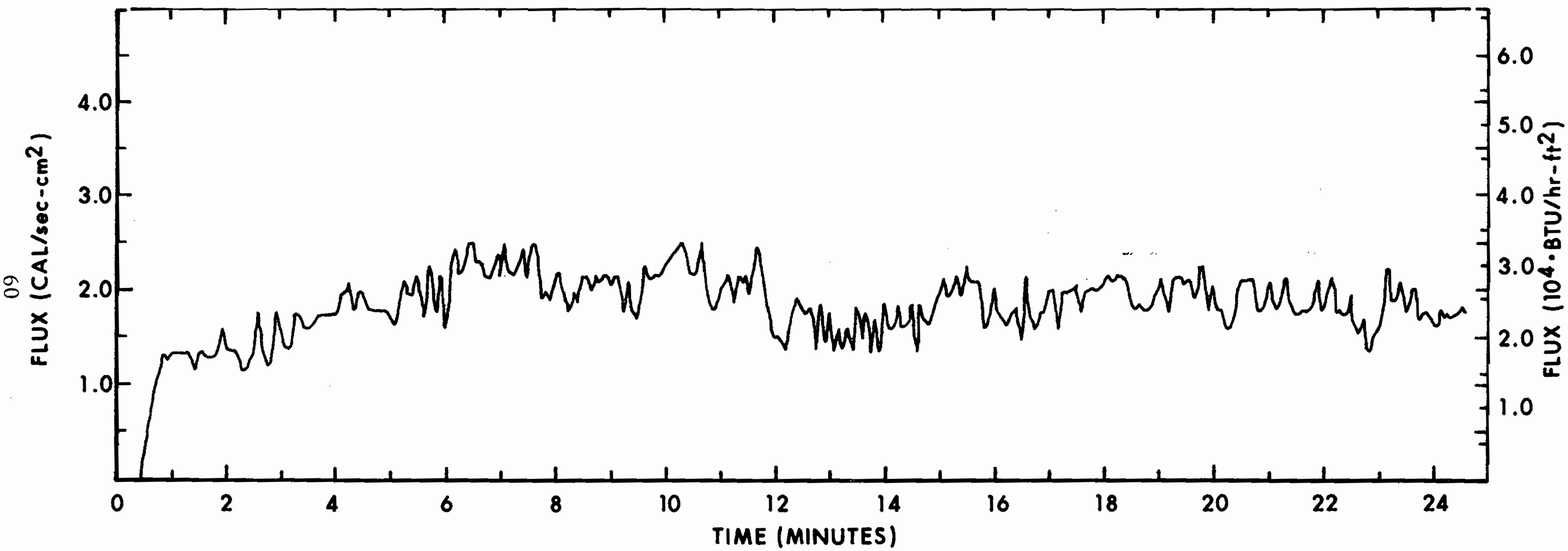

Figure 26-Radiometer Data: Radiative Flux vs Time

both directions. Gauss' Law then implies that the recorded data should be doubled to obtain the radiative component of the fire.

In considering radiation from the torch, it must be determined whether to treat the torch as an infinite cylinder, or an infinite sheet of burning propane. An analysis shows that the radiometer "sees" a circle with a radius of 0.76m (2.5 ft) at a distance of 17.86m (58.6 ft); 17.86m was the approximate distance of the radiometer from the torch. Measurements of the diameter of the torch from the motion picture coverage indicate that the torch was of the order of 4.6m (15 ft) to 6.1m (20 ft) in the vicinity of where the radiometer was sighted. Therefore, in interpreting the radiative data as applied to the propane torch, the recorded data should be multiplied by two, just as in the case of the fire data. That is, to the radiometer, the torch appeared as an inifinte sheet of flame.

The spectral response of the radiometer is 300 to 50,000 Angstroms. The Blackbody Fraction needs to be determined; i.e., the fraction of the total radiant energy to which the radiometer is responsive must be obtained. Table XII tabulates the Blackbody Fraction from 537.8°C (1000°F) to 1482.2°C (2700°F) in 55.6°C (100°F) increments.

Before the relief valve opened, the average radiometric reading, from Figure 26, was 1.35 cal/sec-cm^2 (17,940 BTU/hr-ft^2). Assuming the radiometer saw approximately 81% of the radiative flux, that the flame temperature was 1138°C (2080°F), and treating the fire as an optically thick infinite sheet of flame, the total radiative heat flux was determined to be 3.33 cal/sec-cm^2 (44,296 BTU/hr-ft^2) and the flame emissivity, ε_F, for a JP-4 fuel pool fire to be 0.62.* Therefore, the radiative flux for the fire can be written as:

$$(q_{rad})_F = \varepsilon_F \sigma T_F^4 = 0.62 \sigma T_F^4 \qquad (2)$$

where

$(q_{rad})_F$ = radiative flux of the fire (cal/sec-cm^2),

ε_F = emissity of the JP-4 fuel fire,

σ = Stefan-Boltzmann constant (1.35×10^{-12} cal/sec-cm^2 - (°K)^4),

and T_F = temperature of the fire (°K).

**The temperature is from the NASA data (Table XI).*

TABLE XII

BLACKBODY FRACTIONS

Temperature (°C)	Temperature (°F)	Blackbody Fraction
537.8	1000	0.491
593.3	1100	.538
648.9	1200	.581
704.4	1300	.619
760.0	1400	.654
815.6	1500	.685
871.1	1600	.713
926.7	1700	.738
982.2	1800	.760
1037.8	1900	.780
1093.3	2000	.798
1148.9	2100	.814
1204.4	2200	.829
1260.0	2300	.842
1315.6	2400	.854
1371.1	2500	.865
1426.7	2600	.874
1482.2	2700	.883

Average readings for the radiative flux in three different time increments are given in Table XIII. The fire temperatures listed were obtained by averaging temperatures from the two curves in Figure 25 for the respective time periods. The contribution of the fire to the total radiative flux (fire plus torch) is then given in the table. Then, assuming an emissivity of 0.8 for the propane torch, the radiative flux and the temperature of the torch were determined.*

From Table XIII, it can be concluded that the temperature of the propane torch (which is a pure diffusion flame) is approximately 1100°C (2000°F). This temperature is an effective flame temperature; certainly hotter and cooler regions exist in the flame. Temperatures of the order of 1100°C agree with the experimental investigation performed by Calspan** of the temperatures of burning propane without primary air mixing[4].

C. Mass Flow Rates and Discharge Coefficients of the Relief Valve

The relief valve functioned throughout the test, and was functioning when the car ruptured. The capacity of the valve was not enough to preclude the pressure from rising to over 2.21×10^6 nt/m^2 (306 PSIG), a pressure value which has been quoted as the maximum accumulation pressure for a tank car[5]. The maximum pressure recorded during the fire test was 2.51×10^6 nt/m^2 (350 PSIG), recorded at 17.9 minutes into the test. However, it is evident from Figure 17 that the pressure was subsiding when the car ruptured.

Several quantities of interest can be obtained from the data. The mass flow of propane escaping through the relief valve can be obtained from the change of liquid level.*** Since the mass flow is a function of pressure, time intervals were chosen over which the pressure remained relatively constant. The rate of mass flow is tabulated in Table XIV for eight time intervals. A pressure of 2.31×10^6 nt/m^2 (320 PSIG) and above was chosen for this investigation to ensure that the valve was nearly full or fully opened.

Valve theory predicts that the rate of mass flow can be theoretically calculated from:

$$\dot{M} = C_D \rho A v, \quad (3)$$

where

The emissivity of propane as 0.8 is from verbal conversations with personnel of Systems Scientific Software (S^3), San Diego, California.

***Calspan was formerly Cornell Aeronautical Laboratory.*

****The mechanics of determining the liquid level are discussed in the next section.*

Table XIII. Radiative Fluxes and Temperatures of the Fire and the Propane Torch

Time Interval Minutes	Recorded Flux $cal/sec\text{-}cm^2$ ($BTU/hr\text{-}ft^2$)	T_{Fire} °C (°F)	Fire Flux $cal/sec\text{-}cm^2$ ($BTU/hr\text{-}ft^2$)	Torch Flux $cal/sec\text{-}cm^2$ ($BTU/hr\text{-}ft^2$)	T_{Torch} °C (°F)
5.0 - 11.5	2.15 (28,570)	871 (1600)	1.44 (19,110)	4.10 (54,465)	1120 (2050)
11.5 - 15.0	1.64 (21,790)	816 (1500)	1.18 (15,660)	3.20 (42,567)	1040 (1900)
15.0 - 24.5	1.90 (25,250)	802 (1475)	1.12 (14,880)	3.80 (50,474)	1090 (2000)
Maximum Reading (6.5 Min)	2.50 (33,220)	871 (1600)	1.44 (19,110)	4.85 (64,480)	1180 (2160)

Table XIV. Mass Flow Rates and Discharge Coefficients for the Relief Valve

Time Interval Minutes	Pressure $10^6 nt/m^2$	(PSIG)	Mass Flow Rate (From Liquid Level) kg/sec	(lb_m/sec)	Mass Flow Rate/C_D (Theoretical) kg/sec	(lb_m/sec)	C_D
12.4 - 12.8	2.31	(320)	12.3	(27.1)	36.6	(80.6)	0.34
12.8 - 13.3	2.34	(325)	17.7	(39.1)	37.1	(81.7)	0.48
13.3 - 14.2	2.38	(330)	20.1	(44.4)	37.5	(82.7)	0.54
14.2 - 15.1	2.41	(335)	26.0	(57.4)	38.1	(84.0)	0.68
15.1 - 16.1	2.45	(340)	35.4	(76.0)	38.6	(85.2)	0.92
16.1 - 20.7	2.48	(345)	36.3	(80.0)	39.0	(85.9)	0.93
20.7 - 23.0	2.45	(340)	41.0	(90.3)	38.6	(85.2)	1.06
23.0 - 24.5	2.41	(335)	32.7	(72.0)	38.1	(84.0)	0.86
		$<\dot{M}>=$	33.1	(73.0)		$< C_D > =$	0.86

$\dot{M}$ = rate of mass loss (gm/sec),

C_D = discharge coefficient,

ρ = density of the fluid passing through the relief opening (gm/cm^3),

A = area of the relief opening (cm^2),

and

v = velocity of the fluid passing through the relief opening (cm/sec).

The velocities are obtained from the following expression:

$$v = \left[\frac{2\gamma}{\gamma+1} \frac{P_c}{\rho_c} \right]^{1/2} , \qquad (4)$$

where

γ = ratio of specific heats (for propane, γ = 1.12),

P_c = critical pressure in the relief opening (nt/m^2),

and ρ_c = critical density in the relief opening (gm/cm^3).

The critical pressure and critical density are obtained from the interior tank pressure, P_o and interior fluid density, ρ_o, by the following two expressions:

$$P_c = P_o \left(\frac{2}{\gamma+1} \right)^{\gamma/\gamma-1} , \qquad (5)$$

and

$$\rho_c = \rho_o \left(\frac{P_c}{P_o} \right)^{1/\gamma} . \qquad (6)$$

If the discharge coefficient was known, the theoretical mass flow rate could be calculated using Equations 3 through 6, knowing that the area of the Midland relief valve is 50.6 cm^2 (0.0545 ft^2). The theoretical mass flow rates, divided by the discharge coefficient, are also tabulated in Table XIV for the time intervals of interest. Taking a ratio of column 3 to column 4 in Table XIV then gives the discharge coefficient.

One of the calculated discharge coefficients in Table XIV is greater than 1.0, which is physically impossible. (The discharge coefficient is a quantity less than 1.0 to empirically account for viscosity in fluid flow.) However, this is not a cause for concern as the following discussion will elucidate. The first four discharge coefficients are small relative to the last four numbers given in Table XIV. But inaccuracies in obtaining the correct angles to the liquid level in the time increments of interest causes errors - the smaller the time increments, the larger the errors. Over a long enough total time interval, a small calculated value in one time increment will be balanced by a larger calculated value in another time increment. Therefore, only the time weighted average is significant.

Summarizing, the relief valve functioned throughout the test, but the interior tank pressure rose to 2.51×10^6 nt/m^2 (350 PSIG) before the capacity of the valve precluded a further pressure increase. The mass flow rate of the Midland A-3180-N relief valve, at full open, was found to be 33.1 kg/sec (73.0 lb_m/sec) of propane with a discharge coefficient of 0.86 for the pressure range of 2.31×10^6 nt/m^2 to 2.51×10^6 nt/m^2 (320 PSIG to 350 PSIG).

D. <u>Heat Flux To The Wetted Surface</u>

The heat from the fire is conducted through the steel shell of the tank car into the interior of the car. Almost exclusively, the heat transfer from the inner side of the shell to the contents of the car occurs along the portion of the shell covered by the liquid (i.e., the wetted surface) due to the large difference in the thermal conductivities of gaseous propane versus liquid propane.

The AAR curreltnly uses the following expression to calculate the heat flux to a vessel exposed to fire:

$$\frac{Q}{H} = 34{,}500\ A^{0.82} \qquad (7)$$

where

$\frac{Q}{H}$ = the total heat input to the wetted area in BTU/hr

and

A = wetted area in square feet.

This calculated heat flux value is then used in determining the vapor sizing requirements for tank car relief valves. This formula, in particular, the constant 34,500 and the exponent 0.82, have been questioned and defended in recent studies[6,7].

A correlation of various test data led to a value of 34,500 BTU/hr-ft^2, in Equation 7, to be the heat flux to the outside of the wetted surface of a vessel completely exposed to open flame. (It was assumed that the receiver temperature was low enough to make re-radiation insignificant with respect to the radiating power of the flame). The exponent reflects the so-called "exposure factor" which is a measure of the fraction of the wetted area exposed. (The exposure factor, $E = A^{-0.18}$, is obtained when the heat flux is calculated using Equation 7, instead of the total heat input).

Most of the data used in obtaining Equation 7 were from tests performed on containers of 18.9 kiloliters (5000 gallons) capacity or less[8]. Hence, the data from a fire test on a full-size tank car will be invaluable in future correlations.

The heat flux to the wetted surface can be calculated by:

$$q = -\frac{2\pi h_V \rho_\ell V_\ell}{S(\pi-\theta)(\rho_\ell - \rho_V)} \frac{d\rho_\ell}{dt} + \frac{2Vh_v \rho_\ell \sin^2\theta}{S(\pi-\theta)} \frac{d\theta}{dt} + \frac{c_\ell \rho_\ell V_\ell \pi}{S(\pi-\theta)} \frac{dT_\ell}{dt} \qquad (8)$$

where

q = heat flux to the wetted surface (cal/sec-cm^2),

h_v = latent heat of vaporization (cal/gm),

ρ_ℓ = liquid density (gm/cm^2),

ρ_v = vapor density (gm/cm^3),

V = volume of the tank car (cm^3),

V_ℓ = volume of the tank car filled with liquid (cm^3),

S = surface area of the tank car (cm^2),

c_ℓ = specific heat of the liquid (cal/gm-°C),

θ = angle to the liquid level - θ is the number of degrees between 12:00 and a line drawn from the center of a cross-section of the tank to the point where the liquid surface intersects the circumference, and

t = time (seconds).

Assuming that q is constant over a time interval Δt, the above equation can be integrated to give:

$$q = \langle q_1 \rangle + \langle q_2 \rangle + \langle q_3 \rangle \tag{9}$$

where

$$\langle q_1 \rangle = \frac{2V\bar{h}_v\bar{\rho}_\ell}{S(t_2-t_1)} \int_{\theta_1}^{\theta_2} \frac{\sin^2 \theta d\theta}{\pi-\theta} , \tag{9a}$$

$$\langle q_2 \rangle = \frac{\bar{c}_\ell\bar{\rho}_\ell\bar{V}_\ell\pi}{S(\pi - \bar{\theta})} \frac{(T_2 - T_1)}{(t_2 - t_1)} , \tag{9b}$$

and

$$\langle q_3 \rangle = \frac{-2\pi\bar{h}_v\bar{V}_\ell}{S(\pi-\bar{\theta})(t_2-t_1)} \left[(\rho_\ell)_2 - (\rho_\ell)_1 + \bar{\rho}_v \, \ln \frac{(\rho_\ell-\bar{\rho}_v)_2}{(\rho_\ell-\bar{\rho}_v)_1} \right] . \tag{9c}$$

The bar over a particular quantity indicates that a time averaged value is used to compute that quantity for the time interval $\Delta t = (t_2 - t_1)$. The subscript 1 and 2 denote the value of a quantity at times t_1 and t_2 respectively. The numerical method for evaluating the integral over θ was Simpson's Rule with a relative error tolerence of 1.0×10^{-10}.

Each of the terms in Equation 9 has a physical interpretation. The first term, $\langle q_1 \rangle$, is the amount of heat used to vaporize a quantity of liquid. Vaporization of liquid causes the liquid level, here measured by θ, to change. The second term, $\langle q_2 \rangle$, is the amount of heat absorbed in increasing the temperature of the lading.

The last term, $< q_3 >$, is a correction to the first term. The liquid level can change due to thermal expansion of the lading (as the temperature of the lading increases); thus, more of the lading would have been vaporized than accounted for in just the change of the liquid level. (A specific case which could occur is where the rate of thermal expansion is such that the increase in the volume occupied by the lading is exactly compensated by the amount of lading which has been vaporized. Hence, the angle to the liquid level, θ, would then remain a constant, though liquid has been vaporized).

The liquid level as a function of time is required in order to use Equation 9 to calculate the heat flux to the wetted surface. A fundamental characteristic of the temperature profiles for the inner wall thermocouples provides a procedure for inferring the liquid level. For some specific internal pressure the temperature of the liquid will reach a maximum and begin boiling. This maximum liquid temperature is only a function of the pressure (neglecting impurities). As long as liquid propane is in contact with the inner tank shell wall, the temperature of the wall will remain near this boiling point, even though a high heat flux may exist. Convection is the mechanism of heat transfer from the steel wall to the lading.

Hence, for a constant or nearly constant pressure, an inner wall thermocouple records a constant wall temperature, and a plateau appears in the temperature versus time plot for each thermocouple. For any specified thermocouple, this constant temperature condition will persist until the liquid level recedes below the thermocouple. At this time, due to the inefficient heat transfer characteristics of the vapor, the wall temperature rapidly rises; thus, the plateau on the temperature time plot is terminated.

By recording the time a temperature plateau was terminated for each wall thermocouple, and plotting this datum against the corresponding thermocouple position, a curve of the liquid level as a function of time is generated. Figures 27, 28, 29 and 30 are computer plots of the temperatures recorded by the inner wall thermocouples versus time. The plateaux and plateau break points are easily discernible. Using the break point times of the plateaux obtained from these four figures, and averaging the times for the thermocouples that are positioned on the same level (e.g., the 3:00 and 9:00 front and rear thermocouples), the liquid level as a function of time is obtained and it is plotted in Figure 31.

Several other points have been plotted in Figure 31. The initial angle to the liquid level was determined from the measurement made when the car was loaded with propane. The car was filled 27.9 cm (11.0 in) from the top of the car, and this corresponds to an angle of 35.25° to the liquid level.

TEST NUMBER 8

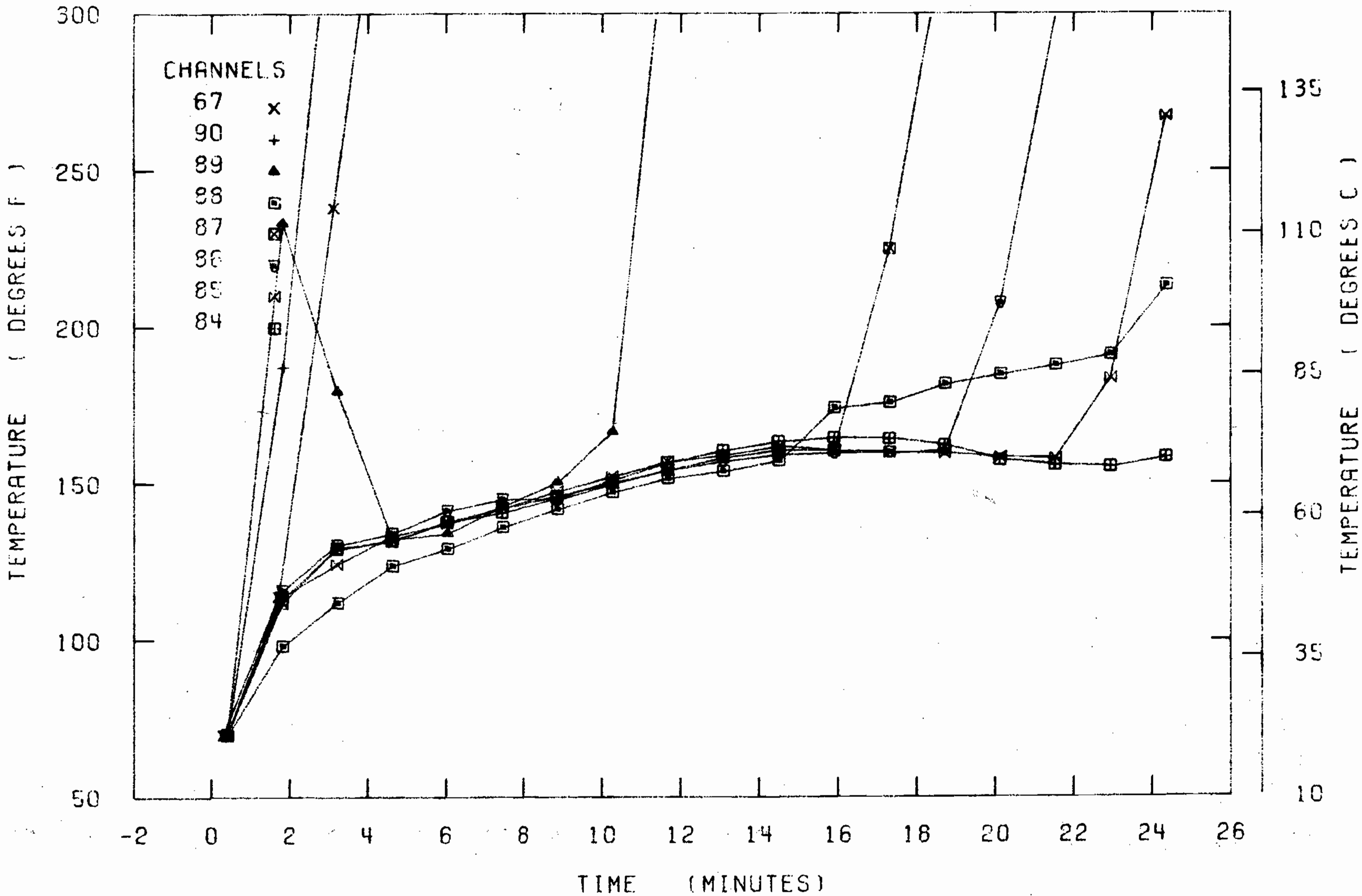

FIGURE 27 TOP RIGHT FRONT WALL THERMOCOUPLES

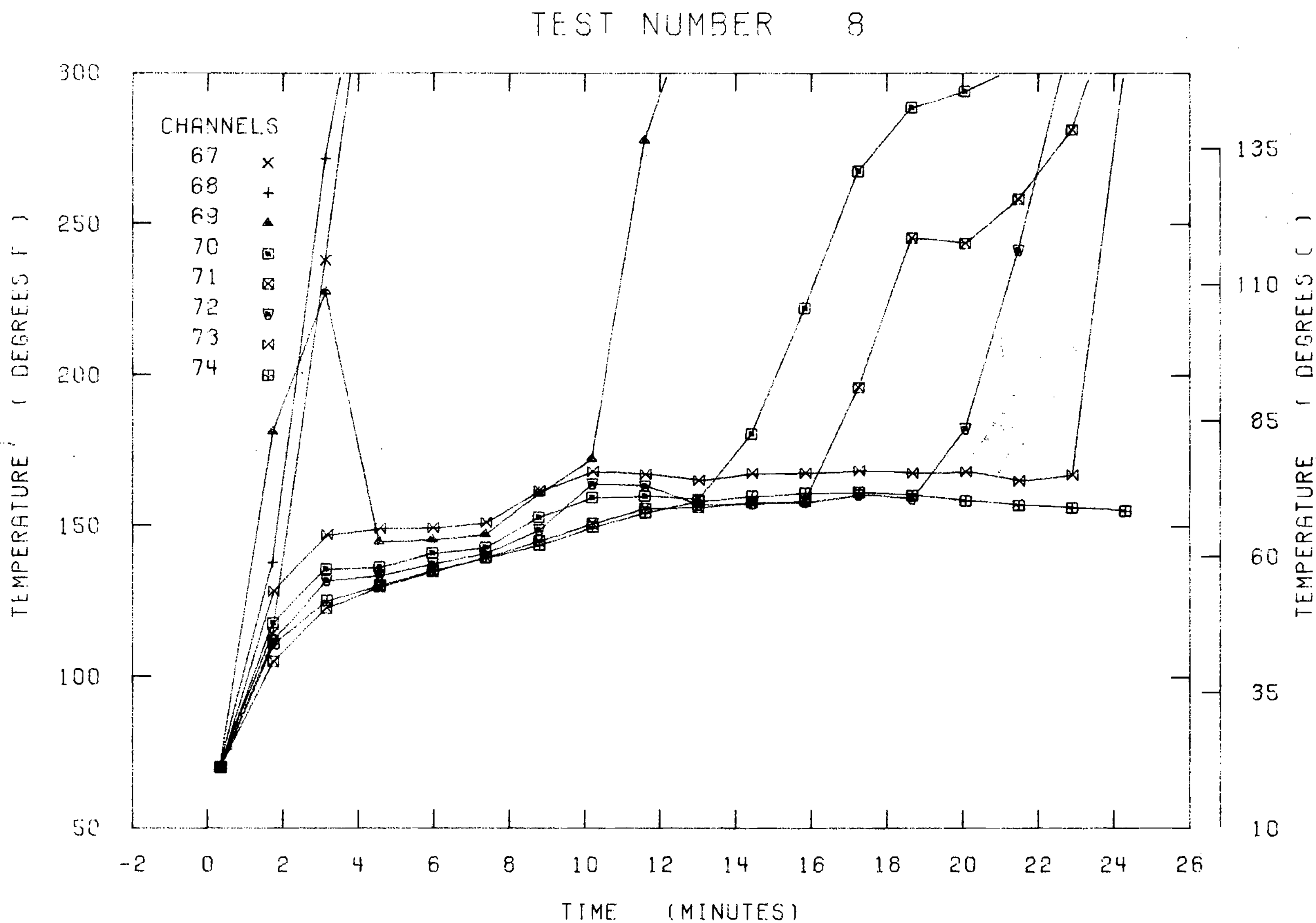

FIGURE 28 TOP LEFT FRONT WALL THERMOCOUPLES

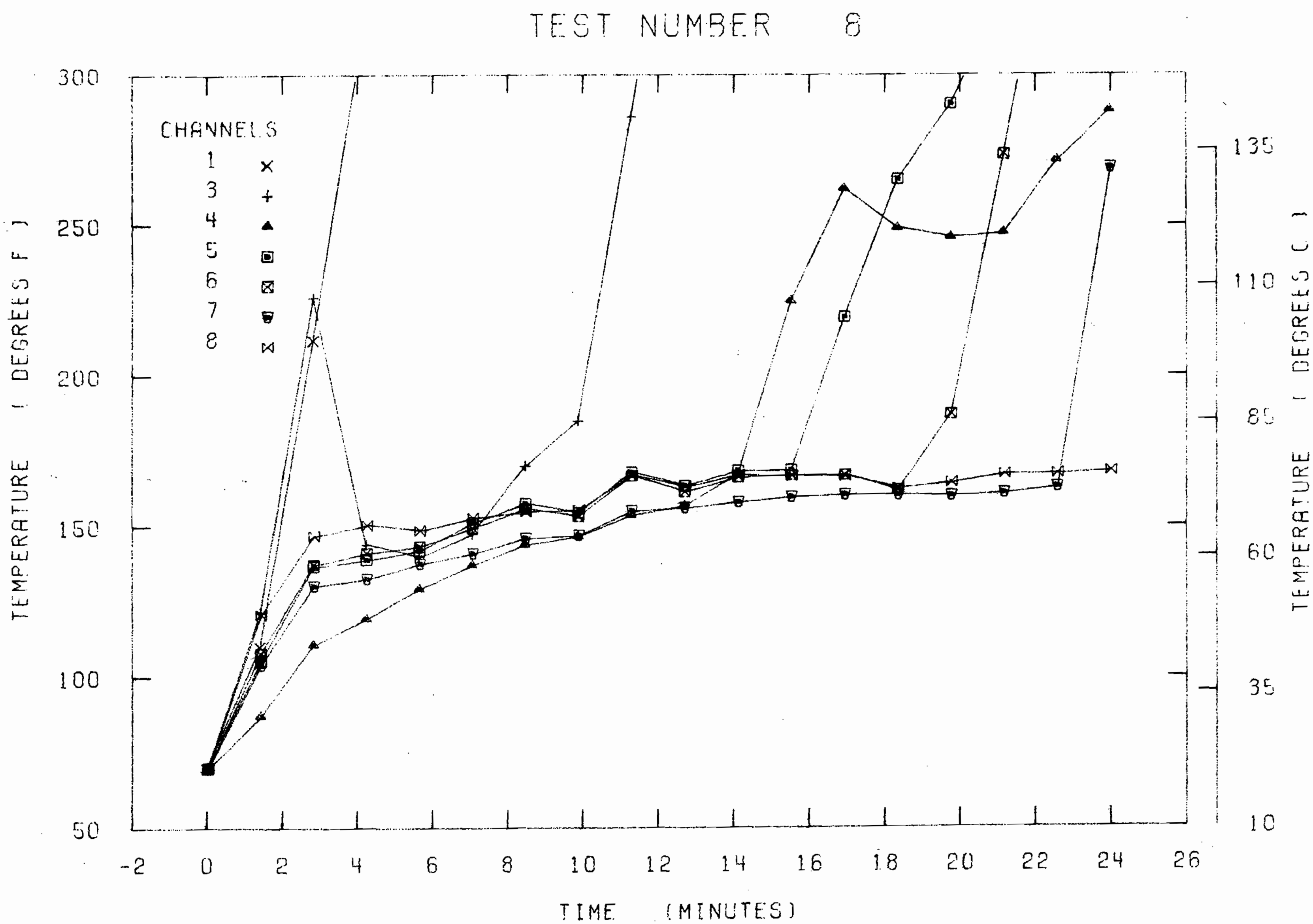

FIGURE 29 TØP RIGHT REAR WALL THERMØCØUPLES

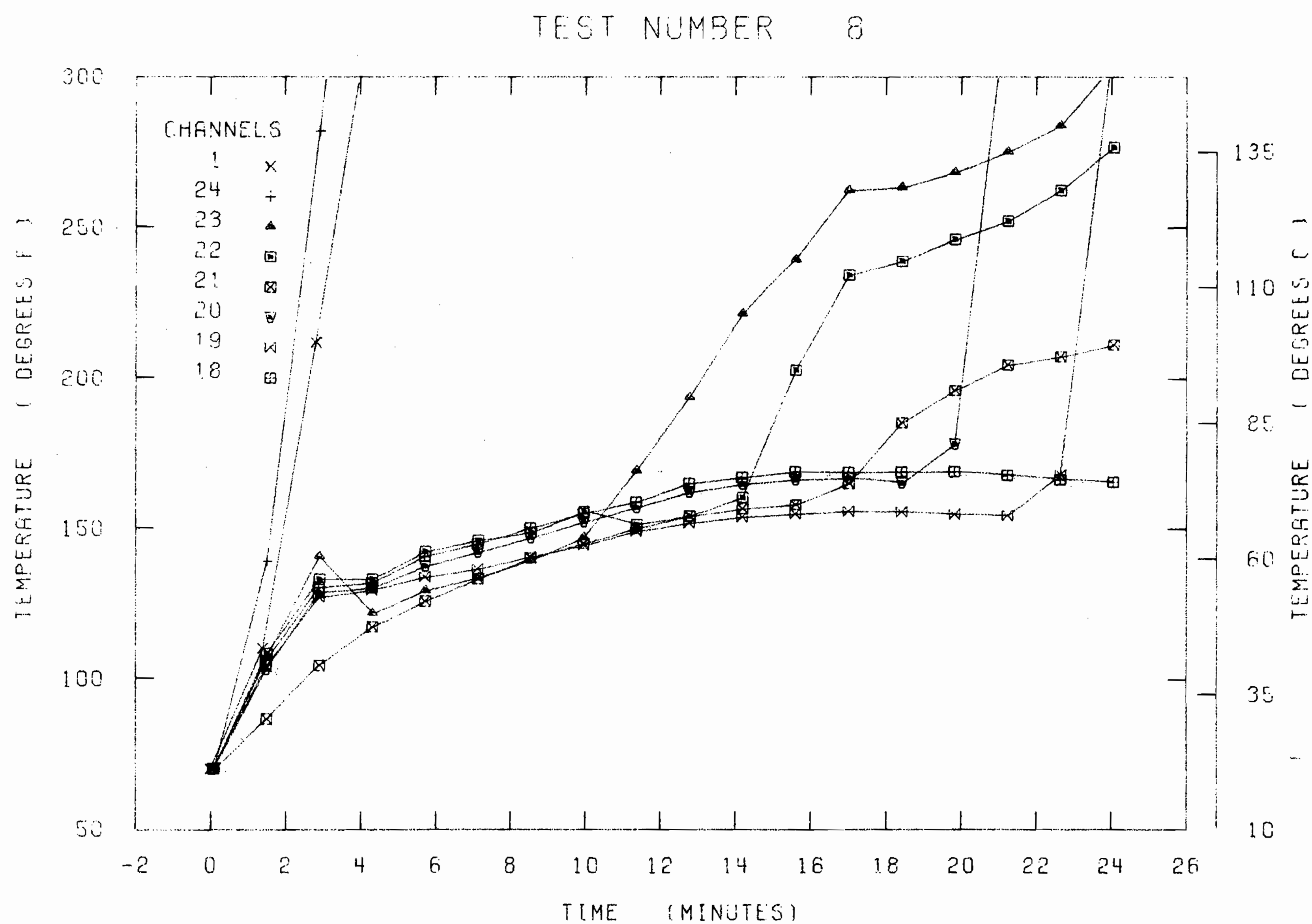

FIGURE 30 TOP LEFT REAR WALL THERMOCOUPLES

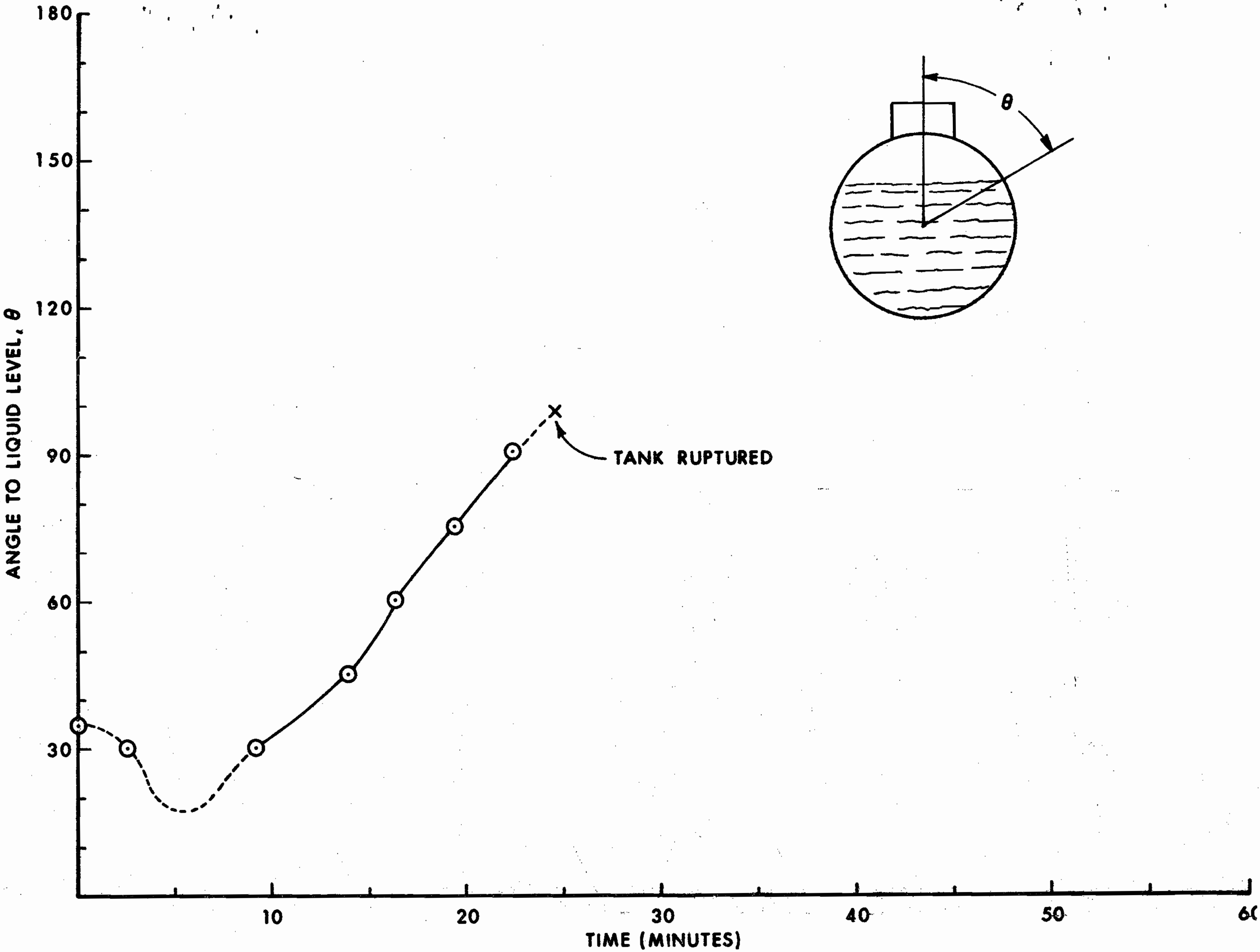

Figure 31-Liquid Level vs Time

Due to thermal expansion, the liquid level rose and covered the 1:00 and 11:00 thermocouples ($\theta = 30°$), evidenced by the sharp decrease in the temperatures recorded by these particular thermocouples. These times can easily be obtained from Figures 27 through 30, then averaged and plotted in Figure 31. The 12:30 and 11:30 thermocouples do not show the sharp temperature drop, indicating that they were not covered by the liquid; however, the temperature-time plots show a tendency for the temperature profile to level off (e.g., see Figure A-21). This decrease in the temperature-time gradient for the 12:30 and 11:30 thermocouples indicate that the liquid level approached but did not reach $\theta = 15°$. In addition, the 12:30 thermocouples on the grid (Figures 32 and 33) show a temperature dip, thus supporting this conclusion. The dotted portion of the graph for small θ in Figure 31 indicates that there exists some uncertainty in interpolating the liquid level as a function of time, but that the general trend of the liquid level has been obtained.

Figures 32 and 33 are computer plots of the temperature profiles recorded by the center pole grid thermocouples (refer to Figures 11 and 12). Figures 32 and 33 record that a temperature gradient existed in the lading for approximately ten minutes. This temperature stratification was caused by the hotter, and hence less dense, propane rising towards the surface, and the cooler, denser propane sinking to the bottom of the tank. Even with the violent agitation which existed in the tank due to boiling, a temperature gradient of approximately 15°C (27°F) persisted in the lading to approximately six minutes. During the next four minutes, the lading gradually became isothermal - a consequence of the efficient mixing caused by boiling.

This process of stratification can be understood by realizing that no boiling of the propane transpires until the relief valve "pops" open. No boiling can occur until the valve opens since the pressure continues to increase. Except for two brief valve openings at 2.20 and 2.60 minutes, the valve was essentially closed for the first three minutes. The propane next to the tank shell was heated during this time period, gradually rising towards the surface and being replaced by the denser, cooler propane. When the relief valve finally stayed open, it took a finite amount of time (of the order of seven minutes), due to the large volume of liquid present, for the agitation and mixing associated with boiling to bring the lading to an isothermal condition. The thermal mixing was additionally slowed by the continued increase in pressure during this time span (see Figure 17). This gradual increase in pressure would tend to diminish the severity of the boiling.

With the above discussions of the physical processes encountered, the heat flux to the wetted surface can be calculated using Equation 9. These calculations were made from 10.3 minutes until the tank car ruptured. It is essential to take time intervals over increments where the pressure is relatively constant, as all the numerical values for specific heat, heat of vaporization, density, etc. are temperature

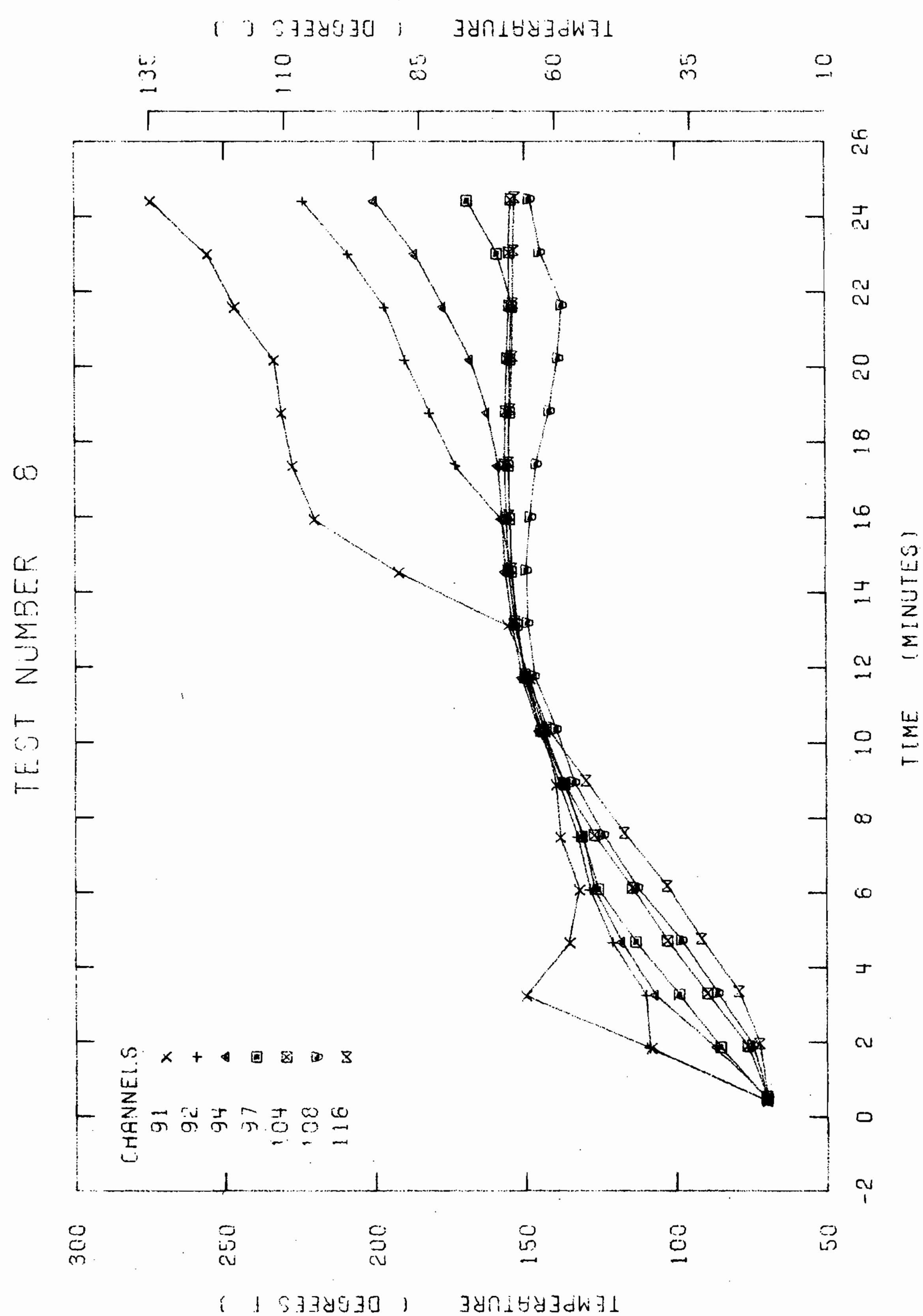

FIGURE 32 SELECTED CENTER FRONT GRID THERMOCOUPLES

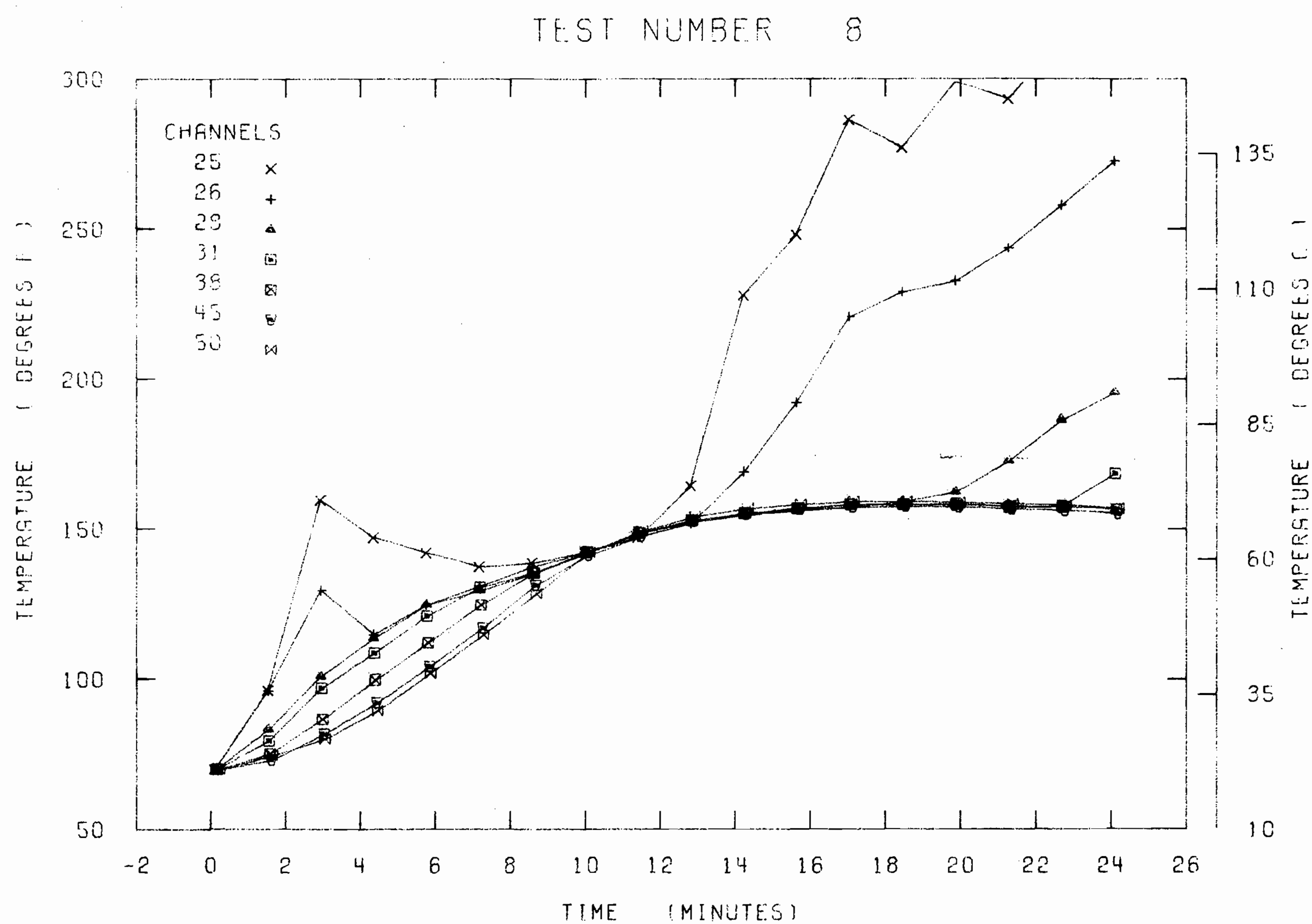

FIGURE 33 SELECTED CENTER-REAR GRID THERMOCOUPLES

dependent - and under saturation or near saturation conditions, temperature dependence implies pressure dependence. Therefore, time intervals were chosen such that the pressure never varied by more than 3.45×10^4 nt/m^2 (5 PSI) from the beginning to the end of a time increment. In addition, no attempt was made to determine the heat flux before 10.3 minutes due to the difficulty of handling the temperature stratification.

Table XV presents the time intervals, the contributions to the heat flux from each term in Equation 9, and the total heat flux over the respective time intervals. The time weighted average of the heat flux was determined to be 2.50 $cal/sec\text{-}cm^2$ (33,230 $BTU/hr\text{-}ft^2$).

E. Rupture of the Tank Car

The two x-y plotters were constantly monitored for the pressure and temperatures by the BRL personnel. The pressure never reached 2.86×10^6 nt/m^2 (400 PSIG), nor did the temperatures recorded by the two thermocouples monitored reach 482°C (900°F), the pressure and temperature values chosen to activate the Louisiana Tech safety flange.

But after 24.5 minutes, catastrophic failure occurred. The sudden release of pressure with the additional energy release of combusting propane broke the tank car into approximately 63 fragments. Including the NASA A-frame and other instrumentation, a total of 127 fragments were found. Many of these fragments were hurled out of the large containment excavation. Figure 34 is an aerial view of the test area after the catastrophic failure, and Figure 35 is a picture of the test pit. A number of the major fragments are visible in the two photographs.

A complete survey including the identification of the fragments was conducted by the BRL. In addition, the ruptured tank car was reassembled on paper and a fragmentation and metallurgical analysis was conducted by Southwest Research Institute (SWRI) for the BRL. The fragmentation and metallurgical analysis of RAX 201 is reported in another BRL report[9]. One comment will be made at this time concerning the rupture, and further information can be obtained from the other BRL report.

Figure 36 plots the temperature profiles recorded by the 12:00 rear and 12:00 front thermocouples. At the time of rupture, a difference of 194°C (350°F) was recorded in the fire temperatures at these respective locations (refer to Figure 25). This gradient in the temperatures of the fire resulted in an 183°C (330°F) difference in the tank car steel at the two thermocouple sites. While the longitudinal thermal gradient of the tank car steel of approximately 0.20°C/cm (11.0°F/ft) is not excessive, the actual temperatures of the two sites are significantly different.

If no other data were available, but knowing that the material strength of the tank car steel decreases with increasing temperatures,

TABLE XV

HEAT FLUX TO THE WETTED SURFACE

Time Interval (Minutes)	$< q_1 >$	$< q_2 >$	$< q_3 >$	q_{Total}*
10.3 - 10.9	0.42 (5593)	1.50 (19,925)	1.35 (17,902)	3.27 (43,420)
10.9 - 11.4	0.41 (5502)	0.60 (8027)	0.54 (7161)	1.56 (20, 690)
11.4 - 11.9	0.60 (8002)	1.22 (16,161)	1.08 (14,328)	2.90 (38,490)
11.9 - 12.4	0.49 (6470)	1.22 (16,238)	1.01 (13,398)	2.72 (36,110)
12.4 - 12.8	0.65 (8600)	0.77 (10,189)	0.84 (11,144)	2.25 (29,930)
12.8 - 13.3	0.94 (12,537)	0.62 (8198)	0.60 (8039)	2.16 (28,770)
13.3 - 14.2	1.09 (14,533)	0.34 (4580)	0.37 (4968)	1.81 (24,080)
14.2 - 15.1	1.46 (19,347)	0.35 (4604)	0.37 (4970)	2.18 (28,920)
15.1 - 16.1	2.06 (27,398)	0.31 (4138)	0.30 (4006)	2.67 (35,540)
16.1 - 20.7	2.42 (32,180)	-0.07 (-865)	-0.06 (-837)	2.29 (30,480)
20.7 - 23.0	3.23 (42,979)	-0.11 (-1525)	-0.12 (-1647)	3.00 (39,810)
23.0 - 24.5	2.85 (37,900)	0.0 (0.0)	0.0 (0.0)	2.85 (37,900)

Time Weighted Average: 2.50 (33,230)

*Units are: $cal/sec\text{-}cm^2$ $(BTU/hr\text{-}ft^2)$

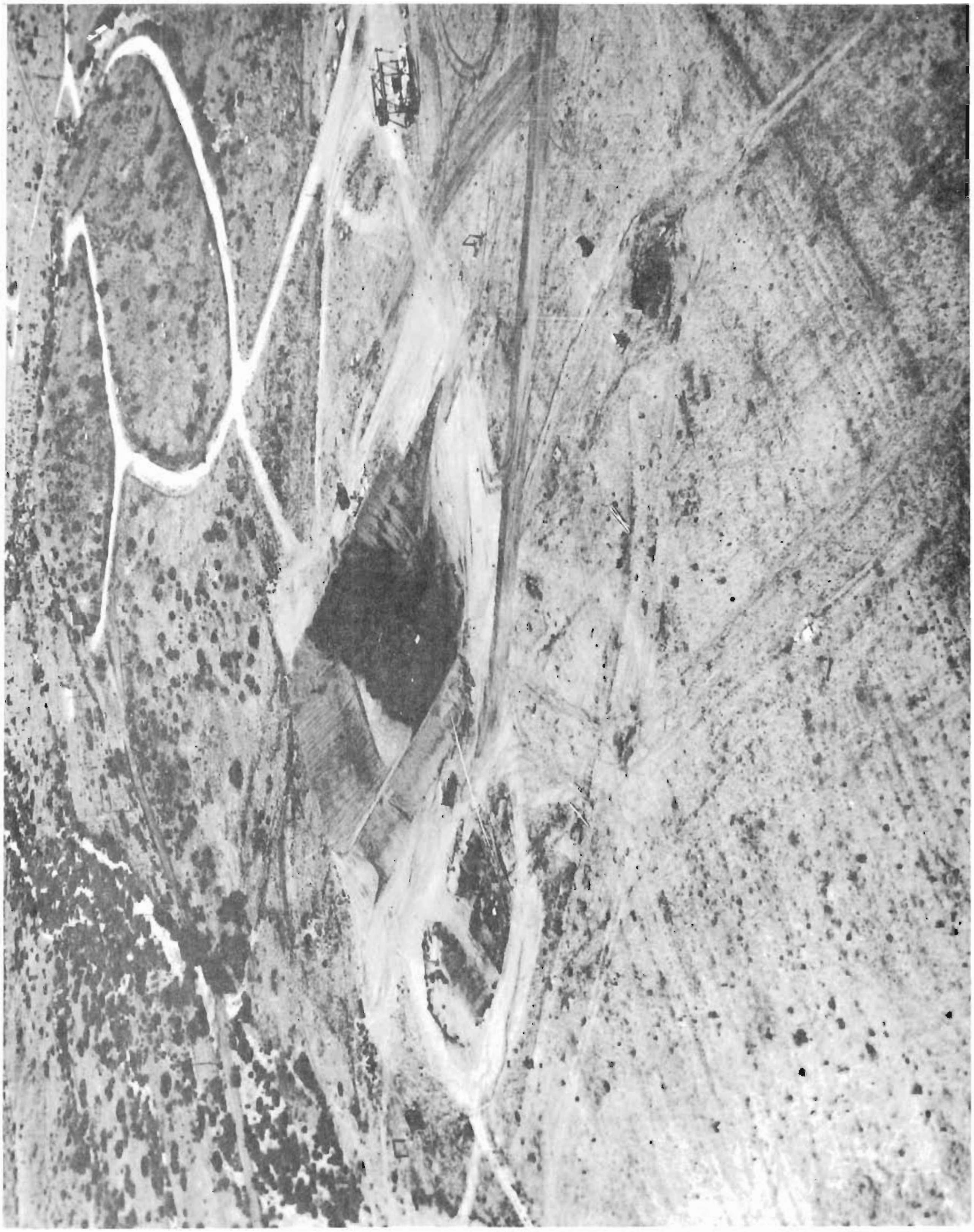

Figure 34. Aerial View of the Test Site After Tank Car Rupture

Figure 35. View of the Test Pit After Tank Car Rupture

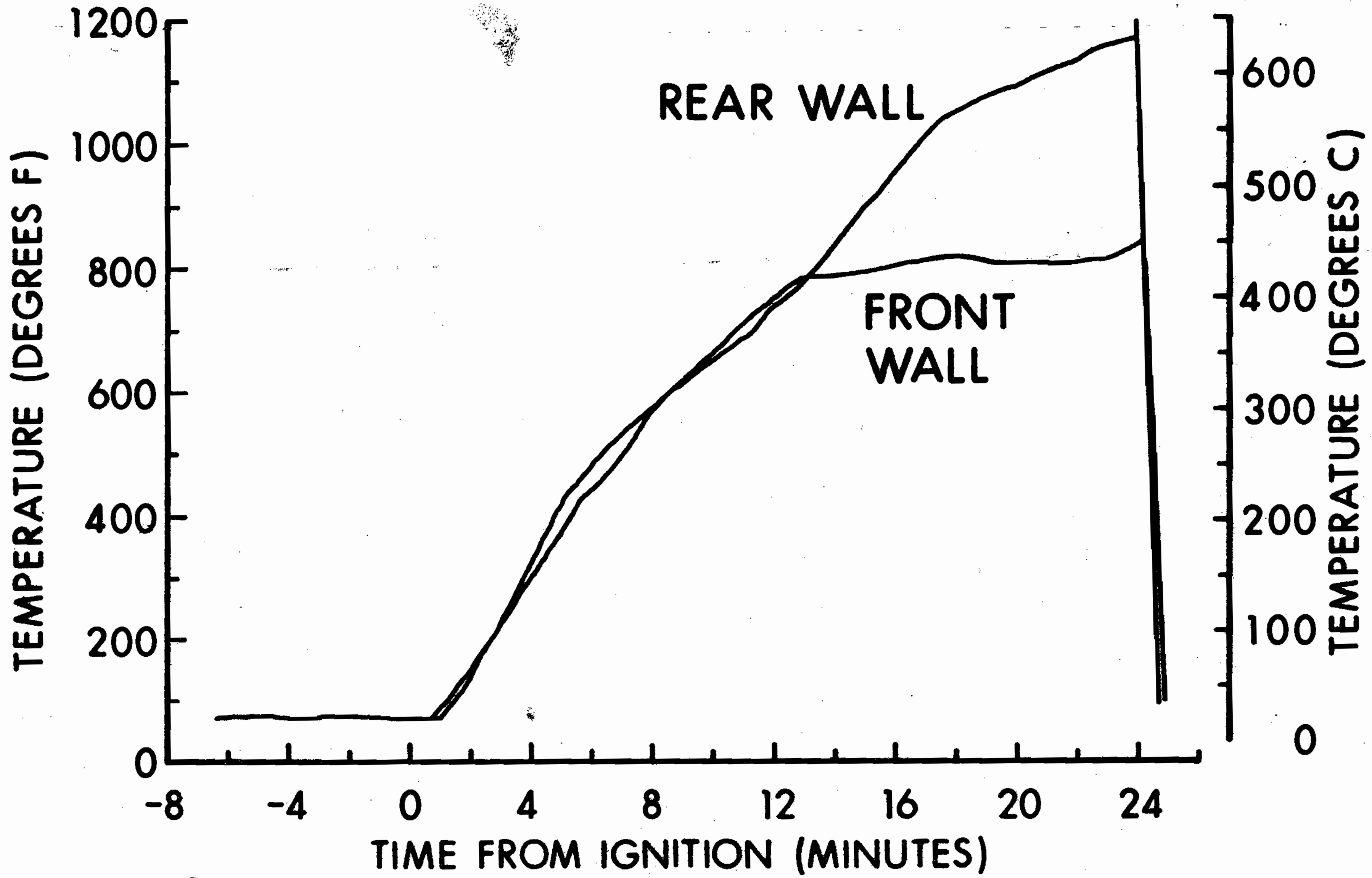

Figure 36–Front and Rear 12:00 Inner Wall Thermocouples: Temperature vs Time

it would be a reasonable supposition to assume that RAX 201 failed toward the rear of the car. The fragmentation and metallurgical analysis indeed confirm this hypothesis. The point of initiation of the failure was concluded to be very close to the position of the 12:00 rear wall thermocouple.

VIII. CONCLUSIONS

A tank car filled with LPG was subjected to the severe fire environment of a large and intense hydrocarbon fire. After 24.5 minutes of being subjected to this environment, the tank car steel had heated to a temperature high enough, in combination with the internal tank pressure, that a catastrophic stress-rupture failure of the tank car resulted. The skin temperature in the region of the initial fracture site was of the order of 650°C (1200°F), and the tank pressure was 2.41×10^6 nt/m^2 (335 PSIG).

The relief valve opened at 1.96×10^6 nt/m^2 (270 PSIG), cycled three times, and remained open after the third "popping" of the valve. The flow capacity of the valve was not adequate to preclude a pressure buildup of 2.51×10^6 nt/m^2 (350 PSIG) in this fire environment. The valve capacity was great enough to prevent a further pressure buildup, and the tank pressure had begun to subside when the car failed. At full open, the Midland A-3180-N relief valve was determined to have a flow capacity of 33.1 kg/sec (73.0 lb_m/sec) of propane with a discharge coefficient of 0.86 at a pressure of the order of 2.45×10^6 nt/m^2 (340 PSIG).

An expression has been derived to obtain the heat flux to the wetted surface. This expression takes into account the change of liquid level due to vaporization, temperature changes of the lading, and changes of the density of the lading. Use of this expression led to a value of 2.50 cal/sec-cm^2 (33,230 BTU/hr-ft^2) for the average heat flux to the wetted surface of a tank car exposed to the severe conditions of a large hydrocarbon pool fire.

As severe as the conditions of fire engulfment are, potentially more hazardous is the impingement of a torch originating either from a punctured area or a relief valve onto another tank car. An estimate of these torch temperatures for propane have been made, yielding temperatures of 1040°C to 1180°C (1900°F to 2160°F). These are effective blackbody temperatures - certainly higher temperatures are to be encountered in certain regions of the torch.

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APPENDIX A

TABULATED TEMPERATURE DATA AND TEMPERATURE - TIME PROFILES

TABLE A I

THERMOCOUPLE TEMPERATURES (DEG. F) FOR TEST NR. 8

CHANNEL NUMBER	LOCATION	TIME (SEC) = -380.70	-338.40	-296.10	-253.80	-211.50	-169.20	-126.90	-84.60	-42.30	TIME ADJUST AND
4	REAR INNER WALL AT 1:30	67.9	66.6	66.2	69.9	69.6	67.8	66.5	67.5	69.9	0.85
5	REAR INNER WALL AT 2:00	68.8	67.8	68.0	69.9	70.2	68.7	68.1	68.4	71.0	1.13
6	REAR INNER WALL AT 2:30	69.0	69.3	68.6	69.4	69.5	68.9	68.6	68.9	69.5	1.41
7	REAR INNER WALL AT 3:00	69.2	69.7	69.0	69.5	69.5	69.2	69.0	69.1	69.5	1.69
9	REAR INNER WALL AT 4:00	69.5	69.5	69.2	69.9	70.0	70.4	69.4	69.6	69.3	2.26
13	REAR INNER WALL AT 6:00	68.7	69.4	69.9	69.9	70.0	70.3	69.3	69.6	70.0	3.38
14	REAR INNER WALL AT 6:30	70.2	70.1	70.1	69.8	70.6	69.2	69.8	70.4	69.9	3.67
15	REAR INNER WALL AT 7:00	69.1	69.1	69.1	69.3	69.3	69.2	69.9	69.2	69.4	3.95
17	REAR INNER WALL AT 8:00	69.9	69.9	70.5	70.9	70.6	69.9	69.3	69.9	70.6	4.51
18	REAR INNER WALL AT 8:30	70.3	71.1	70.4	70.6	70.6	70.6	70.6	70.5	70.7	4.79
19	REAR INNER WALL AT 9:00	70.3	70.4	70.2	70.9	69.4	70.2	70.4	70.3	70.7	5.08
20	REAR INNER WALL AT 9:30	69.7	69.9	69.9	70.5	69.9	70.6	68.7	70.0	70.0	5.36
21	REAR INNER WALL AT 10:00	69.6	69.8	69.9	69.9	70.0	70.0	70.0	70.6	70.0	5.64
22	REAR INNER WALL AT 10:30	69.5	68.4	69.2	69.9	68.7	69.4	69.4	70.0	69.4	5.92
23	REAR INNER WALL AT 11:00	69.7	69.7	69.8	69.8	69.9	70.0	69.9	70.0	70.0	6.20
24	REAR INNER WALL AT 11:30	69.6	69.6	70.3	69.6	69.8	69.8	69.8	69.9	70.0	6.49
25	REAR GRID AT 12:30 LEVEL CEN	69.6	69.6	70.1	69.6	70.4	69.8	69.8	69.8	70.0	6.77
26	REAR GRID AT 1:00 LEVEL CEN	69.7	69.1	69.1	69.2	69.8	69.2	69.9	69.2	69.3	7.05
27	REAR GRID AT 1:30 LEVEL LFT	69.9	69.9	70.0	69.9	70.0	70.0	70.5	69.9	70.6	7.33
28	REAR GRID AT 1:30 LEVEL CEN	70.0	69.9	70.5	69.8	70.6	69.9	69.9	69.9	70.5	7.61
29	REAR GRID AT 1:30 LEVEL RGT	69.3	69.9	69.2	69.5	69.3	69.3	69.3	69.3	69.4	7.90
31	REAR GRID AT 2:00 LEVEL CEN	70.0	32.1	70.0	70.6	70.0	70.7	70.0	70.0	70.6	8.46
32	REAR GRID AT 2:00 LEVEL RGT	70.1	32.4	70.0	70.0	70.6	70.7	70.0	70.6	70.0	8.74
33	REAR GRID AT 2:30 LEVEL LFT	70.7	31.9	70.0	70.7	70.0	70.1	70.0	70.6	70.0	9.02
34	REAR GRID AT 2:30 LEVEL CEN	70.7	31.8	70.1	69.9	70.0	69.5	70.0	69.4	70.0	9.31
35	REAR GRID AT 2:30 LEVEL RGT	70.0	32.0	70.6	69.9	70.0	70.6	69.9	69.3	70.7	9.59
36	REAR GRID AT 3:00 LEVEL LFT1	70.0	31.6	70.5	70.0	70.7	70.0	70.0	70.6	70.0	9.87
37	REAR GRID AT 3:00 LEVEL LFT2	70.0	30.5	69.2	69.4	70.0	69.3	70.0	69.2	69.3	10.15
38	REAR GRID AT 3:00 LEVEL CEN	69.3	31.0	69.3	69.4	68.8	69.4	69.9	69.3	69.4	10.43
39	REAR GRID AT 3:00 LEVEL RGT2	70.0	32.2	70.5	70.0	70.0	70.0	70.0	70.0	70.7	10.72
40	REAR GRID AT 3:00 LEVEL RGT1	69.4	32.1	69.3	69.4	69.4	69.4	69.4	69.3	69.4	11.00
41	REAR GRID AT 3:30 LEVEL LFT	69.4	70.0	69.3	70.0	69.3	69.4	70.0	69.3	69.4	11.28
43	REAR GRID AT 3:30 LEVEL RGT	70.0	70.1	70.0	70.0	70.0	70.6	70.0	70.7	69.4	11.84
44	REAR GRID AT 4:00 LEVEL LFT	70.2	70.0	70.1	69.5	70.0	70.0	70.0	70.6	70.0	12.13
45	REAR GRID AT 4:00 LEVEL CEN	70.6	70.0	70.1	70.0	70.0	70.0	70.0	70.0	70.0	12.41
46	REAR GRID AT 4:00 LEVEL RGT	70.0	69.9	70.5	70.0	70.0	70.6	70.0	70.0	70.0	12.69
47	REAR GRID AT 4:30 LEVEL LFT	70.1	70.0	70.6	70.0	70.0	70.0	70.0	70.6	70.0	12.97
48	REAR GRID AT 4:30 LEVEL CEN	70.0	69.3	69.3	69.4	70.0	69.3	69.4	69.3	69.4	13.25
49	REAR GRID AT 4:30 LEVEL RGT	69.4	69.3	69.3	69.3	69.3	69.3	70.0	69.3	69.3	13.54
50	REAR GRID AT 5:00 LEVEL CEN	69.9	69.9	70.0	69.9	70.0	70.0	69.9	70.0	70.0	13.82

TABLE A II

THERMOCOUPLE TEMPERATURES (DEG. F) FOR TEST NR. 8

CHANNEL NUMBER	LOCATION	TIME (SEC) = 0.00	42.30	84.60	126.90	169.20	211.50	253.80	296.10	338.40	TIME ADJUST ADD
4	REAR INNER WALL AT 1:30	70.0	68.6	87.3	99.8	110.8	113.1	119.5	125.4	129.3	0.85
5	REAR INNER WALL AT 2:00	70.0	73.0	105.3	123.3	136.9	135.0	139.1	145.3	142.1	1.13
6	REAR INNER WALL AT 2:30	70.0	73.3	108.1	127.2	137.5	138.0	141.4	147.6	143.5	1.41
7	REAR INNER WALL AT 3:00	70.0	72.5	104.2	121.9	130.5	129.2	132.9	138.3	137.7	1.69
9	REAR INNER WALL AT 4:00	70.0	79.7	112.7	131.5	142.2	139.7	141.6	145.1	144.1	2.26
13	REAR INNER WALL AT 6:00	70.0	72.3	84.1	95.3	99.1	111.1	113.1	117.5	119.9	3.38
14	REAR INNER WALL AT 6:30	70.0	74.9	108.6	129.4	143.7	145.0	146.1	149.2	152.6	3.67
15	REAR INNER WALL AT 7:00	70.0	69.3	72.5	120.8	135.2	131.9	137.0	140.4	142.9	3.95
17	REAR INNER WALL AT 8:00	70.0	75.8	105.4	123.1	132.4	126.8	131.3	135.3	137.2	4.51
18	REAR INNER WALL AT 8:30	70.0	79.3	105.9	120.5	130.3	129.2	131.9	138.5	140.7	4.79
19	REAR INNER WALL AT 9:00	70.0	75.1	104.0	117.2	127.1	124.9	129.5	133.3	133.8	5.08
20	REAR INNER WALL AT 9:30	70.0	76.8	103.1	119.7	128.7	127.9	130.2	138.5	137.4	5.36
21	REAR INNER WALL AT 10:00	70.0	74.4	86.6	97.1	104.5	109.4	117.2	122.3	125.9	5.64
22	REAR INNER WALL AT 10:30	70.0	78.6	108.3	125.4	133.0	135.2	133.1	144.0	142.3	5.92
23	REAR INNER WALL AT 11:00	70.0	74.8	107.1	139.0	140.7	123.8	121.7	127.4	129.4	6.20
24	REAR INNER WALL AT 11:30	70.0	77.8	139.0	204.3	281.9	363.0	446.5	510.5	563.5	6.49
25	REAR GRID AT 12:30 LEVEL CEN	70.0	72.6	96.4	134.9	159.6	139.2	147.1	136.6	142.0	6.77
26	REAR GRID AT 1:00 LEVEL CEN	70.0	72.8	96.2	117.3	129.6	112.6	114.8	120.5	124.7	7.05
27	REAR GRID AT 1:30 LEVEL LFT	70.0	71.2	80.7	88.0	99.5	107.2	111.4	117.5	122.6	7.33
28	REAR GRID AT 1:30 LEVEL CEN	70.0	71.7	83.2	95.1	101.0	107.5	113.6	119.1	124.7	7.61
29	REAR GRID AT 1:30 LEVEL RGT	70.0	69.8	79.2	90.5	100.1	105.4	112.7	118.0	123.3	7.90
31	REAR GRID AT 2:00 LEVEL CEN	70.0	70.5	79.4	89.1	97.1	103.8	108.7	115.5	121.0	8.46
32	REAR GRID AT 2:00 LEVEL RGT	70.0	70.1	80.5	89.1	97.4	103.2	109.7	116.2	121.2	8.74
33	REAR GRID AT 2:30 LEVEL LFT	70.0	70.1	78.3	85.6	91.3	99.5	106.0	111.7	119.4	9.02
34	REAR GRID AT 2:30 LEVEL CEN	70.0	70.2	78.0	85.3	91.9	98.6	107.0	113.8	119.3	9.31
35	REAR GRID AT 2:30 LEVEL RGT	70.0	70.0	76.3	85.9	92.5	98.6	106.5	111.1	117.5	9.59
36	REAR GRID AT 3:00 LEVEL LFT1	70.0	70.7	75.5	83.3	88.4	95.5	102.4	105.9	114.2	9.87
37	REAR GRID AT 3:00 LEVEL LFT2	70.0	69.4	74.1	83.3	89.1	94.0	101.7	107.2	113.8	10.15
38	REAR GRID AT 3:00 LEVEL CEN	70.0	69.6	75.3	81.1	86.8	93.2	99.7	106.1	112.0	10.43
39	REAR GRID AT 3:00 LEVEL RGT2	70.0	70.7	74.7	81.5	88.1	93.4	99.9	106.5	114.1	10.72
40	REAR GRID AT 3:00 LEVEL RGT1	70.0	69.4	73.9	80.6	86.6	92.5	98.4	105.2	112.7	11.00
41	REAR GRID AT 3:30 LEVEL LFT	70.0	69.5	75.2	75.3	82.6	88.9	95.4	101.0	107.9	11.28
43	REAR GRID AT 3:30 LEVEL RGT	70.0	70.1	73.7	78.9	84.0	89.5	96.6	102.3	107.9	11.84
44	REAR GRID AT 4:00 LEVEL LFT	70.0	70.2	74.3	77.1	82.1	87.8	93.2	99.1	105.3	12.13
45	REAR GRID AT 4:00 LEVEL CEN	70.0	70.1	73.1	76.7	81.7	87.4	92.2	98.1	104.2	12.41
46	REAR GRID AT 4:00 LEVEL RGT	70.0	70.0	72.9	76.9	81.0	87.0	93.2	98.6	104.4	12.69
47	REAR GRID AT 4:30 LEVEL LFT	70.0	70.8	72.9	76.0	79.7	86.0	90.9	97.1	103.2	12.97
48	REAR GRID AT 4:30 LEVEL CEN	70.0	70.2	72.5	75.0	79.2	84.5	90.2	95.6	101.8	13.25
49	REAR GRID AT 4:30 LEVEL RGT	70.0	69.6	71.8	76.8	79.0	85.3	90.2	95.1	101.2	13.54
50	REAR GRID AT 5:00 LEVEL CEN	70.0	70.7	74.7	74.9	80.1	84.6	89.6	95.4	102.0	13.82

TABLE A III

THERMOCOUPLE TEMPERATURES (DEG. F) FOR TEST NR. 8

CHANNEL NUMBER	LOCATION	TIME (SEC) = 380.70	423.00	465.30	507.60	549.90	592.20	634.50	676.80	719.10	TIME ADJUST ADD
4	REAR INNER WALL AT 1:30	134.0	137.3	142.3	143.9	144.9	146.7	150.8	153.7	156.8	0.85
5	REAR INNER WALL AT 2:00	147.5	151.2	157.0	157.6	154.3	154.5	159.9	167.9	171.2	1.13
6	REAR INNER WALL AT 2:30	147.8	149.6	155.1	155.8	152.8	153.3	158.4	166.7	168.8	1.41
7	REAR INNER WALL AT 3:00	139.8	141.1	144.8	146.3	145.0	147.1	149.9	155.1	158.2	1.69
9	REAR INNER WALL AT 4:00	144.3	148.2	150.8	151.9	152.8	155.0	158.3	165.0	167.3	2.26
13	REAR INNER WALL AT 6:00	124.9	132.8	134.1	141.9	143.0	147.3	151.2	153.3	155.7	3.38
14	REAR INNER WALL AT 6:30	153.9	156.9	156.2	158.2	160.1	163.5	166.4	168.1	170.9	3.67
15	REAR INNER WALL AT 7:00	144.3	145.6	147.6	149.3	151.7	154.0	156.7	159.2	160.9	3.95
17	REAR INNER WALL AT 8:00	146.0	145.6	149.6	150.8	154.3	156.3	157.7	157.3	158.9	4.51
18	REAR INNER WALL AT 8:30	144.9	144.9	149.1	150.1	153.0	154.9	157.7	158.8	161.0	4.79
19	REAR INNER WALL AT 9:00	135.0	136.4	138.2	140.6	142.1	144.4	147.1	149.1	150.8	5.08
20	REAR INNER WALL AT 9:30	140.6	142.1	147.0	147.0	149.8	152.2	154.7	157.0	158.1	5.36
21	REAR INNER WALL AT 10:00	129.3	133.2	137.7	140.3	143.6	145.0	147.3	150.0	151.8	5.64
22	REAR INNER WALL AT 10:30	141.7	146.1	151.2	148.7	153.2	155.6	150.0	151.3	152.5	5.92
23	REAR INNER WALL AT 11:00	130.6	133.6	137.0	139.4	142.9	147.0	154.5	169.3	182.0	6.20
24	REAR INNER WALL AT 11:30	577.8	603.8	621.7	634.6	635.4	649.1	651.3	667.9	683.8	6.49
25	REAR GRID AT 12:30 LEVEL CEN	142.1	137.3	136.3	138.7	141.6	142.1	145.3	147.1	149.9	6.77
26	REAR GRID AT 1:00 LEVEL CEN	127.3	131.0	134.7	137.3	140.0	142.1	144.9	147.3	149.7	7.05
27	REAR GRID AT 1:30 LEVEL LFT	125.8	128.8	132.3	134.6	138.7	142.1	145.3	148.2	150.6	7.33
28	REAR GRID AT 1:30 LEVEL CEN	125.8	129.5	133.6	134.9	138.1	141.7	145.7	148.3	150.5	7.61
29	REAR GRID AT 1:30 LEVEL RGT	127.1	128.9	131.7	134.3	137.9	141.2	144.9	148.2	150.4	7.90
31	REAR GRID AT 2:00 LEVEL CEN	127.4	130.6	133.9	135.3	138.7	142.0	145.5	148.9	150.9	8.46
32	REAR GRID AT 2:00 LEVEL RGT	126.6	129.4	133.5	134.8	138.2	141.8	145.4	148.7	151.1	8.74
33	REAR GRID AT 2:30 LEVEL LFT	125.1	128.5	132.5	135.6	139.5	143.0	146.0	149.0	151.1	9.02
34	REAR GRID AT 2:30 LEVEL CEN	124.2	129.2	133.5	135.4	139.0	143.1	145.6	149.1	151.1	9.31
35	REAR GRID AT 2:30 LEVEL RGT	123.4	127.9	133.3	135.5	137.8	141.9	145.1	148.4	150.9	9.59
36	REAR GRID AT 3:00 LEVEL LFT1	118.6	125.0	131.4	135.2	138.9	142.7	145.5	148.3	150.9	9.87
37	REAR GRID AT 3:00 LEVEL LFT2	120.3	123.6	130.7	135.1	138.0	142.9	146.1	148.0	150.5	10.15
38	REAR GRID AT 3:00 LEVEL CEN	119.1	124.7	130.1	135.4	138.3	142.4	145.6	148.6	150.9	10.43
39	REAR GRID AT 3:00 LEVEL RGT2	119.4	126.2	130.6	135.0	138.1	141.9	145.7	148.6	151.3	10.72
40	REAR GRID AT 3:00 LEVEL RGT1	118.3	123.3	130.5	134.3	137.3	140.4	144.6	147.7	150.2	11.00
41	REAR GRID AT 3:30 LEVEL LFT	114.0	120.3	126.1	132.8	137.1	142.0	144.8	148.0	150.5	11.28
43	REAR GRID AT 3:30 LEVEL RGT	114.0	120.4	126.4	133.8	137.3	141.7	145.4	148.4	150.8	11.84
44	REAR GRID AT 4:00 LEVEL LFT	111.5	117.4	124.0	131.5	137.5	141.7	145.6	148.3	151.1	12.13
45	REAR GRID AT 4:00 LEVEL CEN	110.8	116.9	123.3	131.2	136.6	141.2	144.8	147.6	150.5	12.41
46	REAR GRID AT 4:00 LEVEL RGT	111.5	117.2	123.9	131.2	136.7	140.8	145.7	148.3	150.9	12.69
47	REAR GRID AT 4:30 LEVEL LFT	109.2	115.4	122.3	128.9	136.7	141.6	145.6	148.6	151.1	12.97
48	REAR GRID AT 4:30 LEVEL CEN	108.2	114.2	121.0	127.0	135.0	140.5	145.4	147.5	150.6	13.25
49	REAR GRID AT 4:30 LEVEL RGT	108.4	114.9	121.3	128.7	135.3	141.3	145.5	147.3	150.1	13.54
50	REAR GRID AT 5:00 LEVEL CEN	108.3	114.8	122.0	128.4	134.6	142.2	146.9	149.3	152.1	13.82

TABLE A IV

THERMOCOUPLE TEMPERATURES (DEG. F) FOR TEST NR. 8

CHANNEL NUMBER	LOCATION	TIME (SEC) = 761.40	803.70	846.00	888.30	930.60	972.90	1015.20	1057.50	1099.80	TIME ADJUST ADD
4	REAR INNER WALL AT 1:30	156.7	158.4	167.3	205.4	224.8	250.9	261.9	263.0	248.8	0.85
5	REAR INNER WALL AT 2:00	163.3	165.4	168.5	165.8	168.6	178.2	219.5	258.4	265.2	1.13
6	REAR INNER WALL AT 2:30	161.3	163.3	166.2	163.8	166.9	173.1	167.0	164.9	161.7	1.41
7	REAR INNER WALL AT 3:00	156.1	157.1	157.9	158.8	159.6	163.2	160.3	160.4	160.3	1.69
9	REAR INNER WALL AT 4:00	163.4	164.6	167.3	165.8	167.6	172.3	168.3	167.6	164.6	2.26
13	REAR INNER WALL AT 6:00	157.5	159.1	159.9	160.8	161.6	162.2	162.2	162.6	161.8	3.38
14	REAR INNER WALL AT 6:30	172.0	173.5	174.5	174.9	176.3	177.6	176.5	177.1	175.5	3.67
15	REAR INNER WALL AT 7:00	162.5	163.6	164.5	165.3	165.7	166.0	166.3	167.0	166.9	3.95
17	REAR INNER WALL AT 8:00	165.2	161.2	166.0	164.3	168.4	162.8	165.1	170.2	170.2	4.51
18	REAR INNER WALL AT 8:30	165.0	165.7	167.1	168.4	169.0	168.3	168.7	169.8	168.9	4.79
19	REAR INNER WALL AT 9:00	151.9	153.0	153.8	154.5	154.9	155.5	155.7	155.7	155.4	5.08
20	REAR INNER WALL AT 9:30	162.2	163.5	164.8	166.2	166.4	165.8	166.9	167.1	165.3	5.36
21	REAR INNER WALL AT 10:00	154.2	155.5	156.6	157.6	158.0	158.7	165.1	178.6	185.2	5.64
22	REAR INNER WALL AT 10:30	154.3	155.9	160.5	181.8	202.7	220.7	234.3	238.8	238.9	5.92
23	REAR INNER WALL AT 11:00	193.8	202.3	221.5	228.5	239.4	246.3	262.3	260.1	263.2	6.20
24	REAR INNER WALL AT 11:30	690.2	714.5	756.7	797.0	825.2	855.0	884.2	910.8	937.2	6.49
25	REAR GRID AT 12:30 LEVEL CEN	164.4	207.5	227.9	249.1	248.1	262.7	286.2	282.2	276.9	6.77
26	REAR GRID AT 1:00 LEVEL CEN	151.9	154.9	169.2	185.3	192.1	204.7	220.8	229.9	229.1	7.05
27	REAR GRID AT 1:30 LEVEL LFT	152.3	153.6	154.8	155.7	156.4	157.0	157.6	157.5	160.7	7.33
28	REAR GRID AT 1:30 LEVEL CEN	152.2	153.4	154.6	155.4	156.1	156.5	157.1	157.7	159.2	7.61
29	REAR GRID AT 1:30 LEVEL RGT	152.2	153.5	154.6	155.5	156.4	156.7	157.5	157.7	158.6	7.90
31	REAR GRID AT 2:00 LEVEL CEN	152.9	154.2	155.1	156.3	156.7	157.4	158.0	158.1	158.1	8.46
32	REAR GRID AT 2:00 LEVEL RGT	152.9	154.0	155.3	156.1	156.7	157.4	157.8	158.1	157.9	8.74
33	REAR GRID AT 2:30 LEVEL LFT	152.8	154.4	155.4	156.4	156.8	157.6	158.0	158.2	157.8	9.02
34	REAR GRID AT 2:30 LEVEL CEN	152.9	154.3	155.4	156.3	156.7	157.5	158.0	158.1	157.9	9.31
35	REAR GRID AT 2:30 LEVEL RGT	152.8	154.1	155.1	156.3	156.7	157.2	157.9	158.2	158.0	9.59
36	REAR GRID AT 3:00 LEVEL LFT1	152.7	154.2	155.3	156.1	156.7	157.5	157.8	158.0	157.8	9.87
37	REAR GRID AT 3:00 LEVEL LFT2	152.4	153.8	155.0	155.8	156.5	157.2	157.4	157.9	157.6	10.15
38	REAR GRID AT 3:00 LEVEL CEN	152.8	154.5	155.4	156.3	156.9	157.5	158.0	158.2	158.1	10.43
39	REAR GRID AT 3:00 LEVEL RGT2	153.3	154.9	155.6	156.5	157.4	157.7	158.2	158.5	158.2	10.72
40	REAR GRID AT 3:00 LEVEL RGT1	152.2	153.6	154.6	155.4	156.2	156.7	157.0	157.4	157.1	11.00
41	REAR GRID AT 3:30 LEVEL LFT	152.4	153.7	154.8	155.9	156.4	157.1	157.5	157.7	157.7	11.28
43	REAR GRID AT 3:30 LEVEL RGT	152.8	154.1	155.1	156.1	156.7	157.3	157.7	158.0	157.8	11.84
44	REAR GRID AT 4:00 LEVEL LFT	153.1	154.3	155.5	156.6	157.2	158.0	158.3	158.7	158.4	12.13
45	REAR GRID AT 4:00 LEVEL CEN	152.6	153.8	154.9	156.0	156.5	157.0	157.2	157.6	157.4	12.41
46	REAR GRID AT 4:00 LEVEL RGT	152.9	154.2	155.3	156.4	156.7	157.7	157.9	158.2	157.7	12.69
47	REAR GRID AT 4:30 LEVEL LFT	153.1	154.5	155.6	156.7	157.3	157.9	158.3	158.5	158.3	12.97
48	REAR GRID AT 4:30 LEVEL CEN	152.6	154.0	155.3	156.2	157.0	157.5	158.0	158.2	158.0	13.25
49	REAR GRID AT 4:30 LEVEL RGT	152.0	153.1	154.6	155.5	156.1	156.4	157.0	157.5	157.4	13.54
50	REAR GRID AT 5:00 LEVEL CEN	154.2	155.6	156.8	157.5	158.2	158.7	159.1	159.4	159.0	13.82

TABLE A V

THERMOCOUPLE TEMPERATURES (DEG. F) FOR TEST NR. 8

CHANNEL NUMBER	LOCATION	TIME (SEC) = 1142.10	1184.40	1226.70	1269.00	1311.30	1353.60	1395.90	1438.20	1480.50	TIME ADJUST ADD
4	REAR INNER WALL AT 1:30	254.2	245.7	252.2	247.2	256.8	271.3	279.0	288.0	34.1	0.85
5	REAR INNER WALL AT 2:00	288.9	290.4	315.7	327.0	362.0	386.7	387.9	409.0	33.5	1.13
6	REAR INNER WALL AT 2:30	165.4	187.1	237.6	273.5	327.8	369.4	385.5	413.4	32.0	1.41
7	REAR INNER WALL AT 3:00	160.3	159.9	160.4	160.9	163.1	162.8	212.8	269.0	32.1	1.69
9	REAR INNER WALL AT 4:00	166.0	165.2	167.5	169.8	171.0	168.9	166.4	171.4	102.2	2.26
13	REAR INNER WALL AT 6:00	161.9	161.5	161.4	161.2	160.9	160.6	160.6	160.4	35.6	3.38
14	REAR INNER WALL AT 6:30	177.3	176.9	177.8	177.7	178.0	177.1	177.1	177.8	34.5	3.67
15	REAR INNER WALL AT 7:00	167.0	166.7	166.6	166.3	166.0	166.5	166.1	165.7	32.9	3.95
17	REAR INNER WALL AT 8:00	170.4	170.3	168.0	169.8	169.1	167.4	168.0	168.0	32.0	4.51
18	REAR INNER WALL AT 8:30	169.4	169.0	167.3	167.8	167.4	166.2	165.5	165.5	33.6	4.79
19	REAR INNER WALL AT 9:00	155.2	154.5	154.7	154.3	153.8	168.0	249.3	310.7	46.2	5.08
20	REAR INNER WALL AT 9:30	166.3	178.0	261.6	327.3	380.2	429.9	454.4	471.6	32.1	5.36
21	REAR INNER WALL AT 10:00	194.7	196.0	200.3	204.4	204.4	207.2	209.7	211.1	31.5	5.64
22	REAR INNER WALL AT 10:30	241.6	246.1	248.3	252.1	251.2	262.2	267.6	275.6	30.5	5.92
23	REAR INNER WALL AT 11:00	265.0	268.2	272.0	275.1	276.4	283.9	295.4	304.2	31.9	6.20
24	REAR INNER WALL AT 11:30	956.9	972.1	983.3	986.2	997.4	1006.2	1013.0	1043.0	27.8	6.49
25	REAR GRID AT 12:30 LEVEL CEN	293.1	298.9	290.3	293.1	303.7	313.3	316.7	337.8	30.3	6.77
26	REAR GRID AT 1:00 LEVEL CEN	235.0	232.8	241.5	243.7	245.2	257.8	262.6	272.5	32.4	7.05
27	REAR GRID AT 1:30 LEVEL LFT	157.4	160.5	162.6	166.3	176.4	182.1	187.6	191.5	32.4	7.33
28	REAR GRID AT 1:30 LEVEL CEN	159.9	162.2	167.3	172.7	180.7	186.2	190.5	195.5	32.3	7.61
29	REAR GRID AT 1:30 LEVEL RGT	162.2	164.7	169.8	176.1	181.6	186.1	193.7	197.3	30.6	7.90
31	REAR GRID AT 2:00 LEVEL CEN	158.0	158.3	157.4	157.0	156.7	157.6	164.6	168.5	32.1	8.46
32	REAR GRID AT 2:00 LEVEL RGT	157.7	157.7	157.4	157.1	156.7	157.1	163.6	169.3	32.4	8.74
33	REAR GRID AT 2:30 LEVEL LFT	157.9	157.6	157.4	157.0	156.9	156.7	156.3	155.7	31.9	9.02
34	REAR GRID AT 2:30 LEVEL CEN	158.0	157.7	157.7	157.1	157.0	156.6	156.4	155.9	31.8	9.31
35	REAR GRID AT 2:30 LEVEL RGT	158.0	157.7	157.4	157.0	156.8	156.6	156.2	155.9	32.0	9.59
36	REAR GRID AT 3:00 LEVEL LFT1	157.7	157.7	157.5	157.4	157.4	157.0	156.5	156.4	31.6	9.87
37	REAR GRID AT 3:00 LEVEL LFT2	157.4	157.4	157.0	156.7	156.6	156.3	155.8	155.4	30.5	10.15
38	REAR GRID AT 3:00 LEVEL CEN	158.0	157.9	157.6	157.4	157.4	157.1	156.8	156.5	31.0	10.43
39	REAR GRID AT 3:00 LEVEL RGT2	158.2	158.2	157.9	157.7	157.6	157.4	157.1	156.4	32.2	10.72
40	REAR GRID AT 3:00 LEVEL RGT1	157.0	156.8	156.6	156.2	156.2	155.5	155.5	154.7	32.1	11.00
41	REAR GRID AT 3:30 LEVEL LFT	157.6	157.6	157.4	157.2	157.1	157.0	156.9	156.6	32.5	11.28
43	REAR GRID AT 3:30 LEVEL RGT	157.8	157.5	157.5	157.2	157.0	156.9	156.7	156.1	32.4	11.84
44	REAR GRID AT 4:00 LEVEL LFT	158.5	158.2	158.0	157.8	157.6	157.3	156.9	156.3	31.9	12.13
45	REAR GRID AT 4:00 LEVEL CEN	157.3	157.2	156.9	156.5	156.4	156.0	155.4	154.9	32.6	12.41
46	REAR GRID AT 4:00 LEVEL RGT	157.6	157.5	157.4	157.3	157.2	156.8	156.3	155.8	32.4	12.69
47	REAR GRID AT 4:30 LEVEL LFT	158.3	158.0	157.9	157.6	157.4	157.2	156.9	156.4	32.4	12.97
48	REAR GRID AT 4:30 LEVEL CEN	158.0	157.7	157.7	157.4	157.5	157.3	156.9	156.5	31.5	13.25
49	REAR GRID AT 4:30 LEVEL RGT	157.6	157.6	157.6	157.5	157.4	157.4	156.9	156.7	33.8	13.54
50	REAR GRID AT 5:00 LEVEL CEN	158.9	158.6	158.6	158.2	158.0	157.7	157.3	156.6	33.4	13.82

TABLE A VI

THERMOCOUPLE TEMPERATURES (DEG. F) FOR TEST NR. 8

CHANNEL NUMBER	LOCATION	TIME (SEC) = -380.70	-338.40	-296.10	-253.80	-211.50	-169.20	-126.90	-84.60	-42.30	TIME ADJUST ADD
67	FRONT INNER WALL AT 12:00	70.2	69.6	69.7	69.7	69.8	69.8	69.8	70.6	70.0	18.61
90	FRONT INNER WALL AT 12:30	70.0	70.0	69.5	70.4	70.3	69.7	70.3	70.4	70.6	25.10
89	FRONT INNER WALL AT 1:00	70.0	69.5	69.6	69.8	69.7	70.4	69.8	70.6	70.6	24.82
87	FRONT INNER WALL AT 2:00	69.1	69.5	69.7	70.1	69.3	69.1	68.8	69.4	70.1	24.25
86	FRONT INNER WALL AT 2:30	70.4	70.9	70.5	71.4	71.2	70.4	70.9	70.6	71.3	23.97
84	FRONT INNER WALL AT 3:30	69.1	69.0	69.8	69.5	69.4	69.8	69.0	69.3	69.5	23.41
82	FRONT INNER WALL AT 4:30	70.4	69.6	70.0	70.3	70.7	69.7	70.2	70.1	70.9	22.84
79	FRONT INNER WALL AT 6:00	69.0	70.4	69.7	70.6	70.1	69.2	69.6	69.6	70.3	22.00
78	FRONT INNER WALL AT 6:30	70.3	69.3	69.9	71.1	70.0	69.6	69.2	70.7	71.0	21.71
77	FRONT INNER WALL AT 7:00	69.7	69.3	70.0	69.9	70.0	70.2	69.1	70.8	70.5	21.43
75	FRONT INNER WALL AT 8:00	69.4	70.0	69.4	70.1	68.8	69.4	69.4	69.3	70.0	20.87
74	FRONT INNER WALL AT 8:30	69.9	70.6	69.9	70.0	70.7	70.0	70.0	70.0	70.6	20.59
72	FRONT INNER WALL AT 9:30	69.4	69.3	70.0	69.4	70.0	69.4	69.9	69.3	69.4	20.02
70	FRONT INNER WALL AT 10:30	70.7	70.0	70.0	70.0	70.1	70.0	70.0	70.7	70.0	19.46
68	FRONT INNER WALL AT 11:30	70.4	69.7	69.8	69.8	69.9	70.0	69.9	70.0	70.0	18.89
91	FRONT GRID AT 12:30 LEVEL CEN	69.0	69.0	69.7	69.1	69.2	69.2	69.1	69.4	69.3	25.38
92	FRONT GRID AT 1:00 LEVEL CEN	70.4	70.4	71.0	70.5	70.5	71.1	70.4	71.3	70.7	25.66
95	FRONT GRID AT 1:30 LEVEL LFT	69.3	69.2	70.0	69.3	69.3	69.3	69.3	69.3	69.3	26.51
94	FRONT GRID AT 1:30 LEVEL CEN	69.9	70.5	70.0	70.0	70.6	70.0	70.6	70.0	70.0	26.23
93	FRONT GRID AT 1:30 LEVEL RGT	70.8	70.1	70.0	70.1	70.1	70.0	70.0	70.7	70.1	25.94
98	FRONT GRID AT 2:00 LEVEL LFT	69.3	70.0	69.4	70.0	70.0	69.4	69.3	69.3	70.0	27.35
97	FRONT GRID AT 2:00 LEVEL CEN	70.0	70.0	70.0	70.6	70.6	70.0	70.0	70.0	70.6	27.07
96	FRONT GRID AT 2:00 LEVEL RGT	70.0	70.0	70.0	70.0	70.0	70.0	70.1	70.6	70.0	26.79
101	FRONT GRID AT 2:30 LEVEL LFT	70.6	70.6	70.1	70.7	70.0	70.0	70.0	70.7	70.8	28.20
100	FRONT GRID AT 2:30 LEVEL CEN	70.8	70.0	70.0	70.0	70.0	70.6	70.0	70.6	70.0	27.92
99	FRONT GRID AT 2:30 LEVEL RGT	69.4	69.4	69.4	69.4	69.3	70.0	69.3	69.4	69.4	27.64
106	FRONT GRID AT 3:00 LEVEL LT1	69.4	69.3	70.0	69.4	70.0	69.3	69.9	69.4	69.3	29.61
105	FRONT GRID AT 3:00 LEVEL LT2	70.6	70.0	70.0	70.5	70.7	70.0	70.6	69.9	70.6	29.33
104	FRONT GRID AT 3:00 LEVEL CEN	70.7	70.0	70.0	70.0	70.1	70.0	70.0	70.7	70.0	29.05
103	FRONT GRID AT 3:00 LEVEL RT2	69.5	69.3	70.0	69.4	69.4	70.0	69.4	70.0	69.4	28.76
102	FRONT GRID AT 3:00 LEVEL RT1	70.0	70.6	70.6	70.0	70.0	70.0	70.0	70.0	70.0	28.48
109	FRONT GRID AT 3:30 LEVEL LFT	70.1	71.0	70.0	70.6	70.6	70.0	70.5	70.0	70.7	30.46
108	FRONT GRID AT 3:30 LEVEL CEN	70.6	70.0	69.9	70.6	70.6	69.9	70.5	70.0	70.0	30.17
107	FRONT GRID AT 3:30 LEVEL RGT	69.3	69.2	69.9	69.4	69.4	69.9	69.2	69.4	69.4	29.89
112	FRONT GRID AT 4:00 LEVEL LFT	70.7	69.4	70.0	70.8	70.1	70.6	70.0	70.7	70.7	31.30
115	FRONT GRID AT 4:30 LEVEL LFT	70.6	70.0	70.7	70.0	70.0	70.6	70.0	70.6	70.0	32.15
114	FRONT GRID AT 4:30 LEVEL CEN	70.1	69.9	70.6	70.0	70.0	70.6	69.9	70.1	70.0	31.87
113	FRONT GRID AT 4:30 LEVEL RGT	70.6	70.6	70.0	70.0	70.0	70.0	69.9	69.5	70.7	31.58
116	FRONT GRID AT 5:00 LEVEL CEN	70.6	69.9	69.3	70.5	70.6	69.9	70.6	69.3	70.5	32.43

TABLE A VII

THERMOCOUPLE TEMPERATURES (DEG. F) FOR TEST NR. 8

CHANNEL NUMBER	LOCATION	TIME (SEC) = 0.00	42.30	84.60	126.90	169.20	211.50	253.80	296.10	338.40	TIME ADJUST ADD
67	FRONT INNER WALL AT 12:00	70.0	77.7	114.1	176.1	237.9	302.9	368.8	432.9	477.0	18.61
90	FRONT INNER WALL AT 12:30	70.0	100.2	187.4	283.6	359.5	440.8	492.2	535.6	563.4	25.10
89	FRONT INNER WALL AT 1:00	70.0	108.7	233.3	331.4	179.4	135.7	132.5	136.5	134.2	24.82
87	FRONT INNER WALL AT 2:00	70.0	92.8	112.1	130.1	129.7	128.0	131.9	136.8	138.0	24.25
86	FRONT INNER WALL AT 2:30	70.0	94.4	116.1	131.1	130.5	130.1	134.4	142.0	141.6	23.97
84	FRONT INNER WALL AT 3:30	70.0	95.0	113.4	127.2	129.2	128.2	132.2	136.8	138.0	23.41
82	FRONT INNER WALL AT 4:30	70.0	93.7	111.3	129.4	128.9	127.5	131.8	135.0	136.9	22.84
79	FRONT INNER WALL AT 6:00	70.0	68.1	77.5	124.9	127.7	127.0	129.9	134.6	135.4	22.00
78	FRONT INNER WALL AT 6:30	70.0	96.3	115.4	134.0	138.3	142.9	144.2	146.6	150.2	21.71
77	FRONT INNER WALL AT 7:00	70.0	96.5	127.4	144.9	150.9	150.2	151.1	151.5	153.9	21.43
75	FRONT INNER WALL AT 8:00	70.0	93.4	112.6	129.8	128.0	128.3	132.4	135.6	136.2	20.87
74	FRONT INNER WALL AT 8:30	70.0	92.0	110.9	128.3	125.3	126.7	130.4	134.6	135.4	20.59
72	FRONT INNER WALL AT 9:30	70.0	92.7	111.9	130.6	131.9	130.3	133.6	137.4	137.5	20.02
70	FRONT INNER WALL AT 10:30	70.0	90.3	117.8	133.7	135.7	134.3	136.3	142.4	141.0	19.46
68	FRONT INNER WALL AT 11:30	70.0	84.3	137.8	213.4	271.6	324.1	369.1	415.2	431.0	18.89
91	FRONT GRID AT 12:30 LEVEL CEN	70.0	82.1	108.4	152.7	149.9	140.2	135.3	128.5	132.0	25.38
92	FRONT GRID AT 1:00 LEVEL CEN	70.0	87.4	109.0	104.5	110.2	114.9	121.3	125.7	128.7	25.66
95	FRONT GRID AT 1:30 LEVEL LFT	70.0	73.2	87.6	93.6	103.9	107.7	115.8	123.2	126.0	26.51
94	FRONT GRID AT 1:30 LEVEL CEN	70.0	78.8	86.7	99.0	107.1	113.4	118.3	124.1	127.2	26.23
93	FRONT GRID AT 1:30 LEVEL RGT	70.0	72.0	83.9	96.6	105.7	110.5	117.2	122.9	126.4	25.94
98	FRONT GRID AT 2:00 LEVEL LFT	70.0	73.4	87.9	91.5	101.2	107.8	113.3	120.8	124.1	27.35
97	FRONT GRID AT 2:00 LEVEL CEN	70.0	77.8	85.4	93.4	99.2	106.5	113.6	119.4	126.0	27.07
96	FRONT GRID AT 2:00 LEVEL RGT	70.0	72.1	83.9	91.7	98.5	105.3	112.7	119.1	123.6	26.79
101	FRONT GRID AT 2:30 LEVEL LFT	70.0	72.8	81.0	87.7	96.5	100.9	108.3	114.1	120.3	28.20
100	FRONT GRID AT 2:30 LEVEL CEN	70.0	73.8	81.4	87.5	94.2	101.3	107.9	113.6	120.1	27.92
99	FRONT GRID AT 2:30 LEVEL RGT	70.0	75.7	81.7	85.5	93.3	101.0	106.6	113.0	119.1	27.64
106	FRONT GRID AT 3:00 LEVEL LT1	70.0	71.9	77.0	84.7	90.4	95.5	101.7	107.9	114.6	29.61
105	FRONT GRID AT 3:00 LEVEL LT2	70.0	73.1	78.3	83.7	90.0	96.1	103.6	108.6	114.5	29.33
104	FRONT GRID AT 3:00 LEVEL CEN	70.0	74.9	76.5	82.8	89.8	96.2	103.1	108.3	114.7	29.05
103	FRONT GRID AT 3:00 LEVEL RT2	70.0	72.4	77.7	81.9	89.5	95.8	101.2	107.4	114.2	28.76
102	FRONT GRID AT 3:00 LEVEL RT1	70.0	72.3	77.9	82.5	89.3	95.9	102.1	108.5	115.1	28.48
109	FRONT GRID AT 3:30 LEVEL LFT	70.0	70.1	69.9	71.0	71.5	73.0	75.5	82.1	88.6	30.46
108	FRONT GRID AT 3:30 LEVEL CEN	70.0	70.4	74.8	80.4	86.5	92.0	98.4	106.7	113.1	30.17
107	FRONT GRID AT 3:30 LEVEL RGT	70.0	70.3	72.1	78.8	83.5	89.1	96.5	103.2	110.4	29.89
112	FRONT GRID AT 4:00 LEVEL LFT	70.0	70.6	74.7	78.4	83.3	88.5	94.6	100.3	106.8	31.30
115	FRONT GRID AT 4:30 LEVEL LFT	70.0	70.2	72.4	77.3	82.0	87.1	92.6	98.5	105.9	32.15
114	FRONT GRID AT 4:30 LEVEL CEN	70.0	70.5	72.8	76.3	81.3	86.3	92.3	97.5	105.7	31.87
113	FRONT GRID AT 4:30 LEVEL RGT	70.0	71.4	73.0	77.2	81.9	86.1	91.6	97.8	105.6	31.58
116	FRONT GRID AT 5:00 LEVEL CEN	70.0	71.9	72.6	76.3	79.5	85.9	91.9	95.6	103.2	32.43

TABLE A VIII

THERMOCOUPLE TEMPERATURES (DEG. F) FOR TEST NR. 8

CHANNEL NUMBER	LOCATION	TIME (SEC) = 380.70	423.00	465.30	507.60	549.90	592.20	634.50	676.80	719.10	TIME ADJUST ADD
67	FRONT INNER WALL AT 12:00	517.3	551.5	589.0	616.7	643.5	670.3	697.3	735.7	764.9	18.61
90	FRONT INNER WALL AT 12:30	576.2	597.7	628.5	658.3	685.7	704.7	722.0	735.5	742.0	25.10
89	FRONT INNER WALL AT 1:00	138.4	143.0	147.7	150.6	162.8	166.6	208.0	336.7	377.0	24.82
87	FRONT INNER WALL AT 2:00	140.1	142.5	144.3	146.2	147.9	150.4	153.2	154.4	156.9	24.25
86	FRONT INNER WALL AT 2:30	143.5	145.2	146.5	145.1	147.1	150.0	151.8	154.5	156.2	23.97
84	FRONT INNER WALL AT 3:30	139.2	141.0	142.8	145.6	148.2	151.2	153.8	156.8	158.6	23.41
82	FRONT INNER WALL AT 4:30	137.4	140.0	141.4	143.7	145.9	148.5	150.9	152.9	154.3	22.84
79	FRONT INNER WALL AT 6:00	137.7	141.7	143.8	146.3	149.6	152.6	155.8	168.1	162.2	22.00
78	FRONT INNER WALL AT 6:30	153.2	154.5	156.1	160.4	161.7	166.0	167.8	169.8	170.9	21.71
77	FRONT INNER WALL AT 7:00	156.4	158.0	158.9	163.2	163.9	169.5	171.4	171.5	172.0	21.43
75	FRONT INNER WALL AT 8:00	137.3	139.9	139.7	144.0	146.0	149.2	152.1	153.9	155.4	20.87
74	FRONT INNER WALL AT 8:30	136.3	139.4	140.5	143.7	146.0	149.7	152.2	154.5	157.5	20.59
72	FRONT INNER WALL AT 9:30	138.4	140.9	142.5	148.7	150.0	164.0	172.9	163.3	159.3	20.02
70	FRONT INNER WALL AT 10:30	141.3	142.9	143.2	152.8	151.2	159.5	164.8	160.0	158.4	19.46
68	FRONT INNER WALL AT 11:30	448.7	460.8	468.7	478.4	486.5	498.6	533.4	559.5	570.3	18.89
91	FRONT GRID AT 12:30 LEVEL CEN	140.9	138.4	139.3	140.0	141.3	143.6	147.3	148.6	152.7	25.38
92	FRONT GRID AT 1:00 LEVEL CEN	130.5	132.7	135.1	138.7	141.8	145.4	148.3	150.3	152.0	25.66
95	FRONT GRID AT 1:30 LEVEL LFT	127.7	131.3	132.8	134.8	137.7	143.0	145.7	148.6	150.6	26.51
94	FRONT GRID AT 1:30 LEVEL CEN	129.5	130.9	134.3	137.1	141.7	145.7	148.9	151.4	153.5	26.23
93	FRONT GRID AT 1:30 LEVEL RGT	128.3	130.6	132.3	136.6	138.2	143.3	146.6	148.9	150.8	25.94
98	FRONT GRID AT 2:00 LEVEL LFT	128.7	131.5	133.6	136.0	139.6	144.4	147.9	150.6	152.4	27.35
97	FRONT GRID AT 2:00 LEVEL CEN	127.8	131.3	133.9	137.0	140.8	145.0	147.8	150.2	151.8	27.07
96	FRONT GRID AT 2:00 LEVEL RGT	126.0	129.1	132.4	136.4	138.7	143.8	147.2	149.8	151.3	26.79
101	FRONT GRID AT 2:30 LEVEL LFT	125.0	129.8	134.2	136.1	140.0	144.6	148.3	151.3	153.6	28.20
100	FRONT GRID AT 2:30 LEVEL CEN	124.2	128.3	133.1	137.6	139.8	143.9	146.8	150.0	152.0	27.92
99	FRONT GRID AT 2:30 LEVEL RGT	123.3	127.0	131.8	137.3	139.5	143.9	146.8	149.6	151.6	27.64
106	FRONT GRID AT 3:00 LEVEL LT1	121.1	125.6	131.0	134.5	138.2	141.7	145.3	148.8	151.0	29.61
105	FRONT GRID AT 3:00 LEVEL LT2	121.1	126.6	132.2	135.8	140.0	143.0	147.2	150.3	152.5	29.33
104	FRONT GRID AT 3:00 LEVEL CEN	121.4	127.3	131.0	137.5	140.7	144.2	147.2	150.1	152.3	29.05
103	FRONT GRID AT 3:00 LEVEL RT2	121.2	125.7	131.3	135.8	139.8	143.5	147.0	150.2	152.3	28.76
102	FRONT GRID AT 3:00 LEVEL RT1	121.2	125.7	132.5	136.6	140.3	143.7	147.2	149.9	152.4	28.48
109	FRONT GRID AT 3:30 LEVEL LFT	94.7	101.1	108.2	110.6	116.0	120.1	125.7	131.7	138.0	30.46
108	FRONT GRID AT 3:30 LEVEL CEN	120.4	124.4	129.1	133.8	138.5	140.0	144.2	147.3	148.6	30.17
107	FRONT GRID AT 3:30 LEVEL RGT	119.3	126.5	133.8	141.5	147.1	153.2	158.9	164.7	167.8	29.89
112	FRONT GRID AT 4:00 LEVEL LFT	114.1	120.5	127.5	134.0	138.5	141.2	145.3	148.7	151.0	31.30
115	FRONT GRID AT 4:30 LEVEL LFT	113.1	119.6	127.0	134.2	139.4	143.3	146.9	150.9	153.1	32.15
114	FRONT GRID AT 4:30 LEVEL CEN	111.9	119.0	125.4	132.9	139.1	142.3	146.4	150.1	152.6	31.87
113	FRONT GRID AT 4:30 LEVEL RGT	111.6	118.0	125.8	132.4	138.6	142.7	147.3	150.3	152.5	31.58
116	FRONT GRID AT 5:00 LEVEL CEN	110.4	117.3	124.2	130.0	136.0	142.9	146.8	150.2	151.7	32.43

TABLE A IX

THERMOCOUPLE TEMPFRATUPES (DEG. F) FOR TEST NR. 8

CHANNEL NUMBER	LOCATION	TIME (SEC) = 761.40	803.70	846.00	888.30	930.60	972.90	1015.20	1057.50	1099.80	TIME ADJUST ADD
67	FRONT INNER WALL AT 12:00	782.9	788.9	795.3	797.4	800.2	806.4	812.4	814.4	811.2	18.61
90	FRONT INNER WALL AT 12:30	731.4	727.7	736.0	750.9	771.4	785.8	795.3	801.2	807.2	25.10
89	FRONT INNER WALL AT 1:00	428.5	464.5	485.6	497.9	511.0	519.2	525.2	524.6	528.1	24.82
87	FRONT INNER WALL AT 2:00	158.4	159.9	160.7	160.3	160.8	166.8	225.0	281.8	325.4	24.25
86	FRONT INNER WALL AT 2:30	157.3	158.1	159.2	159.3	159.8	159.8	160.0	159.9	160.6	23.97
84	FRONT INNER WALL AT 3:30	160.6	162.4	163.5	163.9	164.7	164.1	164.4	163.8	162.2	23.41
82	FRONT INNER WALL AT 4:30	155.4	156.7	157.1	157.5	157.5	157.7	158.4	158.3	157.0	22.84
79	FRONT INNER WALL AT 6:00	164.1	177.8	167.9	168.8	170.5	181.3	170.6	184.9	172.7	22.00
78	FRONT INNER WALL AT 6:30	171.7	171.6	172.3	174.2	174.8	174.7	174.8	174.8	174.9	21.71
77	FRONT INNER WALL AT 7:00	173.2	172.8	173.3	175.4	176.3	176.4	176.5	176.1	177.1	21.43
75	FRONT INNER WALL AT 8:00	156.6	157.2	158.1	158.8	158.8	159.1	159.3	158.8	158.4	20.87
74	FRONT INNER WALL AT 8:30	158.4	158.8	159.9	160.7	161.0	161.0	161.2	160.5	160.1	20.59
72	FRONT INNER WALL AT 9:30	156.8	156.6	157.4	157.8	157.8	159.8	160.3	158.7	159.0	20.02
70	FRONT INNER WALL AT 10:30	158.7	160.2	180.4	200.5	222.0	247.4	267.3	275.3	288.6	19.46
68	FRONT INNER WALL AT 11:30	565.6	554.9	552.3	547.0	546.3	548.4	552.3	548.1	542.7	18.89
91	FRONT GRID AT 12:30 LEVEL CEN	155.9	167.5	192.1	211.2	220.4	221.6	227.6	227.5	231.3	25.38
92	FRONT GRID AT 1:00 LEVEL CEN	153.0	153.7	154.8	155.3	158.0	166.2	173.2	178.3	181.9	25.66
95	FRONT GRID AT 1:30 LEVEL LFT	151.7	152.7	153.6	154.0	154.4	154.8	155.1	155.3	157.3	26.51
94	FRONT GRID AT 1:30 LEVEL CEN	154.5	155.8	156.8	157.3	157.8	158.0	159.1	159.5	162.6	26.23
93	FRONT GRID AT 1:30 LEVEL RGT	151.9	152.9	153.7	154.4	154.5	154.9	155.3	155.4	155.5	25.94
98	FRONT GRID AT 2:00 LEVEL LFT	153.8	154.8	156.0	156.7	157.3	157.4	157.8	158.0	158.1	27.35
97	FRONT GRID AT 2:00 LEVEL CEN	152.8	153.8	154.7	155.1	155.3	155.5	155.5	155.4	155.1	27.07
96	FRONT GRID AT 2:00 LEVEL RGT	152.2	153.1	154.1	154.5	154.9	155.0	155.1	154.8	154.6	26.79
101	FRONT GRID AT 2:30 LEVEL LFT	155.1	156.4	157.8	158.6	159.2	159.9	160.1	160.0	159.9	28.20
100	FRONT GRID AT 2:30 LEVEL CEN	153.5	154.8	155.8	156.6	157.0	157.6	157.8	157.6	157.5	27.92
99	FRONT GRID AT 2:30 LEVEL RGT	152.9	153.9	154.9	155.3	155.5	155.7	155.7	155.4	155.4	27.64
106	FRONT GRID AT 3:00 LEVEL LT1	152.2	153.5	154.5	154.8	155.4	155.6	156.1	156.0	155.8	29.61
105	FRONT GRID AT 3:00 LEVEL LT2	154.0	155.3	156.4	157.0	157.5	158.0	158.2	158.1	157.8	29.33
104	FRONT GRID AT 3:00 LEVEL CEN	153.7	154.9	155.7	156.3	156.5	156.5	156.8	156.4	156.4	29.05
103	FRONT GRID AT 3:00 LEVEL RT2	153.4	154.7	155.6	156.3	156.8	157.0	157.3	157.2	157.0	28.76
102	FRONT GRID AT 3:00 LEVEL RT1	153.7	154.8	155.8	156.3	156.6	156.7	156.8	156.6	156.4	28.48
109	FRONT GRID AT 3:30 LEVEL LFT	142.0	144.0	146.9	150.3	156.4	159.3	160.9	161.8	162.0	30.46
108	FRONT GRID AT 3:30 LEVEL CEN	149.4	149.3	149.7	148.9	148.2	147.1	146.2	144.3	141.8	30.17
107	FRONT GRID AT 3:30 LEVEL RGT	169.8	171.7	170.8	174.1	175.2	176.2	176.1	176.7	177.5	29.89
112	FRONT GRID AT 4:00 LEVEL LFT	152.3	153.7	154.5	154.9	155.3	155.8	156.1	155.9	155.7	31.30
115	FRONT GRID AT 4:30 LEVEL LFT	154.8	155.8	156.9	157.3	157.5	157.9	158.0	157.6	157.1	32.15
114	FRONT GRID AT 4:30 LEVEL CEN	154.1	155.1	156.6	156.9	157.0	157.8	158.0	157.4	157.1	31.87
113	FRONT GRID AT 4:30 LEVEL RGT	153.8	153.2	154.2	156.1	155.0	155.9	156.9	156.9	156.6	31.58
116	FRONT GRID AT 5:00 LEVEL CEN	153.4	154.1	154.6	154.8	155.4	155.5	155.5	155.3	154.8	32.43

TABLE A X

THERMOCOUPLE TEMPERATURES (DEG. F) FOR TEST NR. 8

CHANNEL NUMBER	LOCATION	TIME (SEC) = 1142.10	1184.40	1226.70	1269.00	1311.30	1353.60	1395.90	1438.20	1480.50	TIME ADJUST ADD
67	FRONT INNER WALL AT 12:00	803.7	802.1	803.0	802.9	806.5	811.9	823.9	849.0	29.6	18.81
90	FRONT INNER WALL AT 12:30	804.0	820.4	833.2	845.9	857.5	867.7	881.4	909.4	28.7	25.10
89	FRONT INNER WALL AT 1:00	534.6	536.6	538.3	541.3	546.4	552.4	575.9	606.0	29.1	24.82
87	FRONT INNER WALL AT 2:00	354.9	375.5	386.1	405.2	408.4	407.9	418.9	437.6	33.1	24.25
86	FRONT INNER WALL AT 2:30	162.7	207.7	258.7	299.0	325.6	344.1	363.4	380.6	31.9	23.97
84	FRONT INNER WALL AT 3:30	159.7	157.5	156.5	155.8	155.6	155.3	156.6	158.3	31.7	23.41
82	FRONT INNER WALL AT 4:30	157.1	156.8	156.5	155.8	155.8	156.6	155.5	156.3	33.6	22.84
79	FRONT INNER WALL AT 6:00	182.1	191.9	193.3	167.6	167.9	165.5	172.0	169.2	32.0	22.00
78	FRONT INNER WALL AT 6:30	173.0	173.3	173.1	171.6	171.4	171.	172.2	172.8	39.3	21.71
77	FRONT INNER WALL AT 7:00	174.9	176.1	175.0	174.7	175.0	175.[illegible]	177.7	178.7	34.5	21.43
75	FRONT INNER WALL AT 8:00	157.7	157.3	156.2	155.9	155.6	157.1	158.7	159.5	31.9	20.87
74	FRONT INNER WALL AT 8:30	159.0	158.3	157.5	156.9	156.5	156.0	155.6	155.0	29.9	20.59
72	FRONT INNER WALL AT 9:30	157.9	182.2	215.4	241.3	273.4	313.5	359.7	426.4	32.7	20.02
70	FRONT INNER WALL AT 10:30	287.6	294.0	299.0	302.1	311.1	326.0	355.9	404.1	32.1	19.46
68	FRONT INNER WALL AT 11:30	532.5	530.5	529.4	528.2	529.5	538.3	556.3	583.1	30.6	18.89
91	FRONT GRID AT 12:30 LEVEL CEN	234.3	233.6	235.2	246.6	248.0	255.6	261.0	274.5	30.6	25.38
92	FRONT GRID AT 1:00 LEVEL CEN	185.2	190.0	196.1	196.8	202.7	208.8	213.5	223.8	33.9	25.66
95	FRONT GRID AT 1:30 LEVEL LFT	154.9	158.2	161.8	164.1	170.7	174.1	180.2	185.5	31.8	26.51
94	FRONT GRID AT 1:30 LEVEL CEN	166.0	168.1	170.8	177.1	181.3	186.5	193.6	199.8	31.6	26.23
93	FRONT GRID AT 1:30 LEVEL RGT	157.9	161.5	166.6	169.2	174.6	179.6	185.2	191.0	33.1	25.94
98	FRONT GRID AT 2:00 LEVEL LFT	157.4	157.2	156.5	156.8	155.7	157.4	163.5	168.9	30.3	27.35
97	FRONT GRID AT 2:00 LEVEL CEN	154.9	154.8	154.5	154.2	155.1	159.3	165.4	169.2	32.6	27.07
96	FRONT GRID AT 2:00 LEVEL RGT	154.5	154.8	154.5	155.1	155.4	159.3	[illegible]64.1	168.2	33.1	26.79
101	FRONT GRID AT 2:30 LEVEL LFT	159.6	159.2	158.7	158.3	158.0	157.7	[illegible]57.1	156.5	32.0	28.20
100	FRONT GRID AT 2:30 LEVEL CEN	157.0	156.7	156.2	155.9	155.6	155.2	[illegible]54.8	154.8	32.4	27.92
99	FRONT GRID AT 2:30 LEVEL RGT	155.1	155.0	154.8	154.6	154.5	154.5	[illegible]4.1	154.3	35.4	27.64
106	FRONT GRID AT 3:00 LEVEL LT1	155.6	155.5	155.4	155.2	155.1	155.0	[illegible]4.5	154.3	32.2	29.61
105	FRONT GRID AT 3:00 LEVEL LT2	157.5	157.1	156.6	156.2	155.8	155.5	[illegible]5.2	154.7	32.2	29.33
104	FRONT GRID AT 3:00 LEVEL CEN	155.9	155.9	155.4	155.1	155.0	155.1	[illegible].1	154.5	33.5	29.05
103	FRONT GRID AT 3:00 LEVEL RT2	156.6	156.5	156.0	155.7	155.4	155.2	[illegible].9	154.6	31.2	28.76
102	FRONT GRID AT 3:00 LEVEL RT1	156.0	155.7	155.3	155.1	154.8	154.8	[illegible]	155.2	32.5	28.48
109	FRONT GRID AT 3:30 LEVEL LFT	164.1	162.6	162.0	159.3	154.3	151.7	[illegible]	154.9	40.6	30.46
108	FRONT GRID AT 3:30 LEVEL CEN	140.5	138.8	138.8	137.6	141.1	145.0	[illegible]	140.3	41.6	30.17
107	FRONT GRID AT 3:30 LEVEL RGT	177.1	176.7	176.1	170.1	163.2	159.6	[illegible]	156.1	41.8	29.89
112	FRONT GRID AT 4:00 LEVEL LFT	155.4	155.3	155.0	154.9	155.1	155.1	[illegible]	154.5	32.9	31.30
115	FRONT GRID AT 4:30 LEVEL LFT	156.7	156.3	155.7	155.2	155.0	154.9	154[illegible]	154.2	32.0	32.15
114	FRONT GRID AT 4:30 LEVEL CEN	156.5	156.0	155.5	155.1	154.8	154.8	[illegible]	153.6	34.2	31.87
113	FRONT GRID AT 4:30 LEVEL RGT	156.2	155.4	155.3	154.5	154.8	155.1	[illegible]	154.6	33.9	31.58
116	FRONT GRID AT 5:00 LEVEL CEN	154.5	154.1	153.9	153.8	153.6	153.6	[illegible]	153.1	36.1	32.43

TABLE A XI

THERMOCOUPLE TEMPERATURES (DEG. F) FOR TEST NR. 8

CHANNEL NUMBER	LOCATION	TIME (SEC) = -380.70	-338.40	-296.10	-253.80	-211.50	-169.20	-126.90	-84.60	-42.30	TIME ADJUST ADD
117	FRONT INNER TANK END CENTER	69.7	69.7	69.8	69.7	70.4	69.7	70.4	69.7	69.8	32.71
53	REAR FIRE AT 12:00	72.9	72.0	70.5	71.7	68.4	69.2	66.9	68.7	72.5	14.66
54	REAR FIRE AT 3:00	67.9	67.8	67.8	68.0	67.5	67.0	67.1	68.9	69.0	14.95
55	REAR FIRE AT 6:00	69.7	70.5	69.8	70.1	70.7	69.3	69.1	70.1	70.9	15.23
56	REAR FIRE AT 9:00	71.3	69.4	69.7	69.9	68.3	67.0	66.7	69.6	70.9	15.51
62	FRONT FIRE AT 12:00	72.3	70.0	71.8	69.3	68.9	70.1	70.7	69.4	71.1	17.20
63	FRONT FIRE AT 3:00	69.6	70.5	69.3	69.1	70.8	69.9	71.1	70.3	69.9	17.48
64	FRONT FIRE AT 6:00	68.7	70.3	69.4	70.7	69.6	68.7	68.5	69.5	70.3	17.77
65	FRONT FIRE AT 9:00	71.2	70.4	71.7	69.7	68.7	69.6	69.2	70.3	70.4	18.05
57	REAR OUTSIDE TANK END	72.1	72.1	72.6	71.7	72.6	73.3	71.5	70.7	71.9	15.79
66	FRONT OUTSIDE TANK END	69.7	70.7	69.1	68.3	66.9	67.9	67.2	69.1	69.2	18.33
58	DOME - FRONT	69.6	69.7	70.3	69.8	69.9	70.4	69.8	70.5	70.0	16.07
59	DOME - RIGHT	69.7	69.7	69.8	69.9	70.5	69.7	69.8	70.5	70.6	16.36
60	DOME - REAR	69.6	69.0	69.1	69.9	69.9	69.1	69.6	69.2	69.5	16.64
52	POSSUM HUT	72.0	73.4	73.5	69.9	70.0	72.4	73.9	71.6	68.7	14.38

TABLE A XII

THERMOCOUPLE TEMPERATURES (DEG. F) FOR TEST NR. 8

CHANNEL NUMBER	LOCATION TIME (SEC) =	0.00	42.30	84.60	126.90	169.20	211.50	253.80	296.10	338.40	TIME ADJUST ADD
117	FRONT INNER TANK END CENTER	70.0	108.7	127.3	149.9	150.7	152.2	154.2	152.8	146.5	32.71
53	REAR FIRE AT 12:00	70.0	1993.8	1960.4	2016.6	2034.3	2036.3	2048.0	2067.7	1904.8	14.66
54	REAR FIRE AT 3:00	70.0	1960.1	1947.0	1980.7	1986.2	1998.9	2036.7	2022.2	1917.5	14.95
55	REAR FIRE AT 6:00	70.0	2072.6	1988.0	2036.4	2026.9	2075.2	2119.8	2058.3	1970.1	15.23
56	REAR FIRE AT 9:00	70.0	2011.1	1990.7	2048.4	2020.1	2080.8	2113.1	2063.4	1971.8	15.51
62	FRONT FIRE AT 12:00	70.0	1479.0	1576.0	1450.4	1518.9	1699.6	1662.5	1436.7	1556.0	17.20
63	FRONT FIRE AT 3:00	70.0	1725.3	1633.9	1522.0	1553.9	1715.2	1680.0	1420.3	1609.2	17.48
64	FRONT FIRE AT 6:00	70.0	1715.0	1730.2	1556.6	1549.4	1770.9	1705.7	1423.9	1624.6	17.77
65	FRONT FIRE AT 9:00	70.0	1822.6	1728.1	1579.5	1495.2	1703.4	1624.5	1368.2	1558.1	18.05
57	REAR OUTSIDE TANK END	70.0	1977.8	2025.0	2014.9	1991.2	2050.9	2083.2	2046.7	1943.0	15.79
66	FRONT OUTSIDE TANK END	70.0	1838.9	1728.6	1391.5	1690.2	1708.5	1758.1	1599.6	1428.8	18.33
58	DOME - FRONT	70.0	86.9	197.4	278.6	467.8	536.8	725.7	932.7	851.3	16.07
59	DOME - RIGHT	70.0	78.4	132.1	215.2	327.3	425.8	555.7	652.6	1090.5	16.36
60	DOME - REAR	70.0	85.8	189.0	279.9	388.0	485.5	548.2	622.1	707.0	16.64
52	POSSUM HUT	70.0	72.2	73.9	71.8	68.5	70.9	74.1	73.8	72.4	14.38

TABLE A XIII

THERMOCOUPLE TEMPERATURES (DEG. F) FOR TEST NR. 8

CHANNEL NUMBER	LOCATION	TIME (SEC) = 380.70	423.00	465.30	507.60	549.90	592.20	634.50	676.80	719.10	TIME ADJUST ADD
117	FRONT INNER TANK END CENTER	143.7	146.5	148.9	149.9	151.5	154.4	157.4	165.7	160.8	32.71
53	REAR FIRE AT 12:00	1547.1	1895.7	1851.0	1788.6	1795.2	1645.9	1851.2	1923.3	1899.0	14.66
54	REAR FIRE AT 3:00	1727.0	1886.1	1841.4	1780.4	1864.4	1651.5	1821.3	1901.0	1898.1	14.95
55	REAR FIRE AT 6:00	1608.6	1922.0	1869.5	1732.9	1917.2	1609.7	1842.6	1881.7	1891.2	15.23
56	REAR FIRE AT 9:00	1494.0	1921.1	1890.1	1735.8	1870.7	1647.6	1871.0	1931.3	1893.6	15.51
62	FRONT FIRE AT 12:00	1381.7	1284.0	1255.5	1381.5	1350.6	1554.0	1470.3	1505.8	1186.4	17.20
63	FRONT FIRE AT 3:00	1388.7	1315.6	1296.6	1385.3	1383.9	1578.4	1506.6	1555.7	1207.6	17.48
64	FRONT FIRE AT 6:00	1400.2	1315.1	1340.3	1346.4	1486.8	1587.6	1525.6	1579.1	1171.7	17.77
65	FRONT FIRE AT 9:00	1322.4	1236.5	1254.9	1277.3	1398.0	1570.7	1520.5	1521.1	1119.9	18.05
57	REAR OUTSIDE TANK END	1784.5	1906.5	1898.6	1822.1	1912.3	1761.8	1853.9	1931.7	1915.4	15.79
66	FRONT OUTSIDE TANK END	1221.9	1070.8	1045.3	1271.6	1154.8	1584.6	1819.7	1651.6	1077.4	18.33
58	DOME - FRONT	849.9	918.1	944.0	1128.4	1299.8	1395.9	1501.3	1479.9	1833.9	16.07
59	DOME - RIGHT	1160.8	1172.5	1259.4	1364.6	1446.9	1481.6	1568.0	1796.5	1767.7	16.36
60	DOME - REAR	832.2	930.3	1043.9	1332.5	1459.2	1509.6	1605.6	1706.6	1825.9	16.64
52	POSSUM HUT	72.1	73.8	74.0	75.8	77.9	81.0	85.0	89.0	92.5	14.38

TABLE A XIV

THERMOCOUPLE TEMPERATURES (DEG. F) FOR TEST NR. 8

CHANNEL NUMBER	LOCATION TIME (SEC) =	761.40	803.70	846.00	888.30	930.60	972.90	1015.20	1057.50	1099.80	TIME ADJUST ADD
117	FRONT INNER TANK END CENTER	161.6	160.8	161.5	163.7	159.9	160.0	160.7	163.9	161.9	32.71
53	REAR FIRE AT 12:00	1809.5	1850.0	1650.2	1530.8	1660.0	1727.1	1768.8	1572.1	1574.5	14.66
54	REAR FIRE AT 3:00	1833.4	1892.8	1681.6	1582.2	1688.5	1777.2	1776.6	1595.4	1604.2	14.95
55	REAR FIRE AT 6:00	1930.7	1924.1	1748.7	1508.3	1611.3	1778.9	1737.4	1604.3	1672.9	15.23
56	REAR FIRE AT 9:00	1864.7	1842.9	1737.5	1551.0	1598.8	1733.1	1701.7	1599.8	1638.4	15.51
62	FRONT FIRE AT 12:00	1243.9	1221.3	1284.7	1347.2	1260.2	1215.4	1263.3	1266.9	1086.3	17.20
63	FRONT FIRE AT 3:00	1288.2	1261.1	1327.4	1354.0	1305.6	1278.9	1332.0	1331.1	1129.0	17.48
64	FRONT FIRE AT 6:00	1258.4	1251.3	1341.7	1354.7	1307.5	1255.7	1322.0	1375.8	1112.5	17.77
65	FRONT FIRE AT 9:00	1221.2	1196.8	1307.9	1300.8	1258.1	1170.5	1244.8	1308.4	1027.5	18.05
57	REAR OUTSIDE TANK END	1862.9	1856.9	1776.4	1661.4	1721.6	1791.9	1782.9	1645.8	1634.0	15.79
66	FRONT OUTSIDE TANK END	1166.1	1181.2	1089.6	1226.6	1116.3	1183.3	1110.0	1193.7	1107.1	18.33
58	DOME - FRONT	1723.4	1606.1	1531.1	1485.3	1430.3	1366.0	1338.0	1326.3	1290.8	16.07
59	DOME - RIGHT	1650.3	1539.9	1469.9	1430.0	1372.7	1312.2	1295.6	1280.5	1239.3	16.36
60	DOME - REAR	1712.5	1603.1	1532.3	1487.4	1434.7	1376.3	1349.7	1335.8	1302.0	16.64
52	POSSUM HUT	94.7	96.6	99.0	101.6	104.0	106.1	107.9	110.7	116.3	14.38

TABLE A XV

THERMOCOUPLE TEMPERATURES (DEG. F) FOR TEST NR. 8

CHANNEL NUMBER	LOCATION	TIME (SEC) = 1142.10	1184.40	1226.70	1269.00	1311.30	1353.60	1395.90	1438.20	1480.50	TIME ADJUST AND
117	FRONT INNER TANK END CENTER	164.0	161.2	179.6	214.2	230.7	261.2	255.6	274.4	31.5	32.71
53	REAR FIRE AT 12:00	1503.1	1633.6	1517.7	1669.4	1784.1	1730.6	1732.4	1790.6	28.4	14.66
54	REAR FIRE AT 3:00	1534.3	1667.0	1536.3	1696.7	1805.1	1774.3	1768.7	1828.1	30.6	14.95
55	REAR FIRE AT 6:00	1565.6	1692.0	1583.7	1693.7	1765.1	1765.4	1775.3	1793.1	34.5	15.23
56	REAR FIRE AT 9:00	1565.2	1572.4	1570.9	1650.4	1715.3	1712.8	1720.4	1734.0	32.2	15.51
62	FRONT FIRE AT 12:00	1121.1	1203.8	1434.1	1146.7	1262.9	1284.0	1519.5	1401.9	31.7	17.20
63	FRONT FIRE AT 3:00	1192.6	1293.5	1485.9	1281.4	1379.3	1381.9	1564.7	1397.8	32.2	17.48
64	FRONT FIRE AT 6:00	1151.9	1268.3	1520.1	1293.6	1423.8	1413.9	1585.9	1404.9	35.5	17.77
65	FRONT FIRE AT 9:00	1064.4	1128.2	1481.4	1235.3	1297.8	1357.9	1533.2	1371.9	31.7	18.05
57	REAR OUTSIDE TANK END	1551.1	1687.4	1567.0	1691.6	1774.9	1804.2	1775.5	1829.5	34.4	15.79
66	FRONT OUTSIDE TANK END	1222.6	1214.4	1299.2	1138.0	1170.7	1167.7	1565.3	1450.0	30.9	18.33
58	DOME - FRONT	1242.4	1198.2	1166.8	1146.8	1150.5	1178.2	1263.3	1436.1	30.6	16.07
59	DOME - RIGHT	1188.7	1143.3	1114.5	1103.5	1105.0	1131.1	1245.7	1428.2	30.6	16.36
60	DOME - REAR	1255.6	1214.1	1184.9	1165.0	1158.8	1183.5	1267.7	1428.3	29.3	16.64
52	POSSUM HUT	120.3	123.8	125.8	128.7	131.1	134.1	136.8	140.7	40.3	14.38

TABLE A XVI

QUESTIONABLE DATA

THERMOCOUPLE TEMPERATURES (DEG. F) FOR TEST NR. 8

CHANNEL NUMBER	LOCATION	TIME (SEC) = -380.70	-338.40	-296.10	-253.80	-211.50	-169.20	-126.90	-84.60	-42.30	TIME ADJUST AND
	SIGN REVERSAL OCCURS DURING TEST										
1	REAR INNER WALL AT 12:00	73.3	75.0	75.6	70.5	71.1	73.7	75.1	72.9	70.0	0.00
3	REAR INNER WALL AT 1:00	71.9	73.4	73.4	70.6	69.7	72.4	73.8	72.7	70.7	0.56
8	REAR INNER WALL AT 3:30	71.8	73.1	72.8	70.8	69.9	71.4	73.4	71.7	70.2	1.97
10	REAR INNER WALL AT 4:30	70.6	71.2	70.5	69.0	69.4	70.0	69.9	70.2	68.6	2.54
11	REAR INNER WALL AT 5:00	1014.3	654.1	185.3	-1276.5	-470.9	-223.2	-149.3	-136.9	25.2	2.82
12	REAR INNER WALL AT 5:30	111.3	111.3	111.3	111.3	70.8	71.1	70.5	70.2	70.0	3.10
16	REAR INNER WALL AT 7:30	70.2	70.2	70.2	70.0	70.0	70.0	69.5	70.1	69.3	4.23
30	REAR GRID AT 2:00 LEVEL LFT	70.0	69.4	70.1	69.4	70.0	70.0	69.4	70.1	70.0	8.18
61	DOME - LEFT	71.0	71.1	70.7	70.0	69.7	70.8	71.2	69.5	69.1	16.92
88	FRONT INNER WALL AT 1:30	71.8	70.9	70.4	70.1	69.6	70.5	70.0	70.2	70.0	24.53
85	FRONT INNER WALL AT 3:00	72.4	71.6	70.5	70.8	71.0	71.0	71.3	70.7	70.5	23.69
83	FRONT INNER WALL AT 4:00	71.7	70.9	70.4	70.0	70.3	69.9	70.6	69.3	69.8	23.12
81	FRONT INNER WALL AT 5:00	72.3	71.0	71.7	70.0	70.3	71.1	70.6	70.5	69.8	22.56
80	FRONT INNER WALL AT 5:30	73.0	71.6	70.5	69.9	70.4	70.9	71.1	69.9	69.6	22.28
76	FRONT INNER WALL AT 7:30	71.0	70.7	70.3	69.7	69.7	71.4	71.0	69.8	69.0	21.15
73	FRONT INNER WALL AT 9:00	70.9	71.2	71.0	70.9	70.9	70.8	70.2	70.7	70.8	20.30
71	FRONT INNER WALL AT 10:00	71.0	70.5	70.3	70.3	70.3	69.5	70.3	70.0	70.0	19.74
69	FRONT INNER WALL AT 11:00	70.9	70.6	70.9	70.1	70.2	70.9	70.8	70.8	70.0	19.18
	THE FOLLOWING ARE NOT HARMONIOUS										
2	REAR INNER WALL AT 12:30	73.3	74.9	75.1	70.0	69.9	73.6	74.1	72.1	68.6	0.28
42	REAR GRID AT 3:30 LEVEL CEN	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	11.56
51	REAR INNER TANK END CENTER	70.6	71.6	71.6	70.3	70.0	70.9	71.7	71.2	70.0	14.10
110	FRONT GRID AT 4:00 LEVEL RGT	68.7	69.3	69.7	69.2	69.1	69.3	69.1	69.3	69.3	30.74
118	EMERGENCY RELIEF HATCH	69.9	69.1	69.4	69.5	69.4	70.0	69.3	70.0	69.4	31.02

TABLE A XVII

QUESTIONABLE DATA

THERMOCOUPLE TEMPERATURES (DEG. F) FOR TEST NR. 8

SIGN REVERSAL OCCURS DURING TEST

CHANNEL NUMBER	LOCATION	TIME (SEC) = 0.00	42.30	84.60	126.90	169.20	211.50	253.80	296.10	338.40	TIME ADJUST ADD
1	REAR INNER WALL AT 12:00	70.0	73.2	110.1	159.2	211.8	263.0	318.6	370.0	428.2	0.00
3	REAR INNER WALL AT 1:00	70.0	74.8	121.5	179.3	226.1	195.7	144.0	145.3	139.9	0.56
8	REAR INNER WALL AT 3:30	70.0	80.1	120.8	138.4	147.1	146.7	150.6	154.6	148.7	1.97
10	REAR INNER WALL AT 4:30	70.0	75.9	119.4	137.5	147.6	147.1	148.6	150.7	150.6	2.54
11	REAR INNER WALL AT 5:00	70.0	165.2	311.7	500.3	882.8	1294.5	1571.3	1573.4	1576.0	2.82
12	REAR INNER WALL AT 5:30	70.0	77.7	125.6	145.6	159.1	160.9	162.6	163.9	166.3	3.10
16	REAR INNER WALL AT 7:30	70.0	66.0	59.3	255.9	498.7	841.7	1027.8	1142.9	1233.6	4.23
30	REAR GRID AT 2:00 LEVEL LFT	70.0	70.2	81.0	87.9	98.2	105.2	108.4	118.3	122.6	8.18
61	DOME - LEFT	70.0	34.6	180.1	234.1	478.5	996.9	1061.0	873.8	533.2	16.92
88	FRONT INNER WALL AT 1:30	70.0	84.5	98.4	107.8	112.2	118.1	123.9	127.6	129.4	24.53
85	FRONT INNER WALL AT 3:00	70.0	95.1	114.4	125.0	124.3	126.1	133.6	137.1	137.5	23.69
83	FRONT INNER WALL AT 4:00	70.0	111.6	125.7	141.7	149.4	149.0	150.8	163.7	163.7	23.12
81	FRONT INNER WALL AT 5:00	70.0	102.3	128.8	150.7	152.8	154.3	152.9	160.2	163.8	22.56
80	FRONT INNER WALL AT 5:30	70.0	103.8	135.6	157.0	162.5	165.9	161.7	163.7	169.0	22.28
76	FRONT INNER WALL AT 7:30	70.0	88.8	104.7	113.6	112.4	115.2	121.0	122.9	125.4	21.15
73	FRONT INNER WALL AT 9:00	70.0	95.6	128.3	144.4	147.0	145.5	149.2	148.6	149.4	20.30
71	FRONT INNER WALL AT 10:00	70.0	84.4	105.0	119.7	122.8	124.7	129.9	133.8	134.9	19.74
69	FRONT INNER WALL AT 11:00	70.0	95.6	181.1	275.1	227.5	152.2	144.6	149.1	145.4	19.18

THE FOLLOWING ARE NOT HARMONIOUS

CHANNEL NUMBER	LOCATION	0.00	42.30	84.60	126.90	169.20	211.50	253.80	296.10	338.40	TIME ADJUST ADD
2	REAR INNER WALL AT 12:30	70.0	72.6	74.9	75.3	74.7	79.1	77.7	90.9	98.1	0.28
42	REAR GRID AT 3:30 LEVEL CEN	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	11.56
51	REAR INNER TANK END CENTER	70.0	70.6	71.5	70.9	70.0	70.1	71.3	71.9	71.4	14.10
110	FRONT GRID AT 4:00 LEVEL RGT	70.0	70.4	73.0	96.1	118.1	140.2	168.7	176.8	177.5	30.74
118	EMERGENCY RELIEF HATCH	70.0	69.6	71.0	61.7	60.7	67.3	70.9	88.0	107.8	31.02

TABLE A XVIII

QUESTIONABLE DATA

THERMOCOUPLE TEMPERATURES (DEG. F) FOR TEST NR. 8

CHANNEL NUMBER	LOCATION	TIME (SEC) = 380.70	423.00	465.30	507.60	549.90	592.20	634.50	676.80	719.10	TIME ADJUST ADD
	SIGN REVERSAL OCCURS DURING TEST										
1	REAR INNER WALL AT 12:00	458.2	498.4	554.0	596.5	618.8	646.6	671.4	697.7	738.0	0.00
3	REAR INNER WALL AT 1:00	145.7	147.4	160.9	170.1	167.8	184.9	221.1	286.1	353.4	0.56
8	REAR INNER WALL AT 3:30	149.2	152.8	154.3	154.9	154.3	155.5	159.3	166.9	169.0	1.97
10	REAR INNER WALL AT 4:30	149.0	151.2	153.2	154.0	155.8	158.2	160.9	164.8	167.7	2.54
11	REAR INNER WALL AT 5:00	1575.1	1578.8	1580.1	1581.4	1582.8	1585.8	1588.4	1591.5	1594.6	2.82
12	REAR INNER WALL AT 5:30	165.4	169.3	169.7	169.4	171.0	174.4	177.1	178.8	182.2	3.10
16	REAR INNER WALL AT 7:30	1298.1	1334.4	1358.4	1370.3	1329.7	1272.4	1212.7	1181.8	1253.4	4.23
30	REAR GRID AT 2:00 LEVEL LFT	125.9	126.9	131.2	132.5	135.8	138.4	139.7	140.2	139.0	8.18
61	DOME - LEFT	-295.4	364.9	-13.8	1226.4	1343.7	1394.0	-1713.2	1199.8	1745.1	16.92
88	FRONT INNER WALL AT 1:30	133.1	136.3	137.6	142.1	143.6	147.4	151.2	151.8	152.7	24.53
85	FRONT INNER WALL AT 3:00	140.3	142.3	144.8	147.7	148.6	152.5	157.0	157.1	158.8	23.69
83	FRONT INNER WALL AT 4:00	162.1	165.4	166.1	171.4	170.4	175.3	180.6	182.1	176.8	23.12
81	FRONT INNER WALL AT 5:00	170.3	168.3	169.6	173.5	171.7	173.4	179.9	178.3	178.8	22.56
80	FRONT INNER WALL AT 5:30	177.7	176.9	177.2	183.9	181.4	185.0	190.2	189.8	188.0	22.28
76	FRONT INNER WALL AT 7:30	130.6	134.7	137.0	142.8	144.5	148.4	148.6	153.2	154.8	21.15
73	FRONT INNER WALL AT 9:00	147.3	151.1	147.9	161.8	159.4	168.1	170.7	167.0	166.5	20.30
71	FRONT INNER WALL AT 10:00	136.6	139.7	141.2	145.0	147.1	150.9	155.1	155.8	155.8	19.74
69	FRONT INNER WALL AT 11:00	145.5	147.0	146.6	160.6	160.4	172.2	205.9	277.6	314.3	19.18
	THE FOLLOWING ARE NOT HARMONIOUS										
2	REAR INNER WALL AT 12:30	106.7	115.5	121.6	128.7	126.2	120.8	123.6	127.5	130.5	0.28
42	REAR GRID AT 3:30 LEVEL CEN	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	11.56
51	REAR INNER TANK END CENTER	71.5	72.0	72.4	73.1	74.1	75.3	77.1	79.1	81.3	14.10
110	FRONT GRID AT 4:00 LEVEL RGT	201.8	224.4	244.7	266.3	290.7	312.3	334.6	349.3	364.9	30.74
118	EMERGENCY RELIEF HATCH	120.2	131.7	141.2	149.4	157.7	166.1	176.3	186.9	196.7	31.02

TABLE A XIX

QUESTIONABLE DATA

THERMOCOUPLE TEMPERATURES (DEG. F) FOR TEST NR. 8

CHANNEL NUMBER	LOCATION	TIME (SEC) = 761.40	803.70	846.00	888.30	930.60	972.90	1015.20	1057.50	1099.80	TIME ADJUST ADD
	SIGN REVERSAL OCCURS DURING TEST										
1	REAR INNER WALL AT 12:00	761.2	798.1	844.1	887.3	923.6	966.9	1010.7	1043.2	1059.1	0.00
3	REAR INNER WALL AT 1:00	474.6	432.0	448.0	462.1	467.2	493.0	512.2	508.4	492.4	0.56
8	REAR INNER WALL AT 3:30	162.9	164.4	167.0	165.4	166.6	171.4	166.6	165.3	162.4	1.97
10	REAR INNER WALL AT 4:30	166.4	166.6	168.9	167.4	168.3	170.7	169.0	169.2	166.0	2.54
11	REAR INNER WALL AT 5:00	1593.9	1595.4	1597.5	1596.7	1598.1	1600.0	1599.2	1599.0	1596.1	2.82
12	REAR INNER WALL AT 5:30	179.6	179.2	180.7	178.7	177.7	178.7	174.0	169.3	159.7	3.10
16	REAR INNER WALL AT 7:30	1317.1	1403.4	1558.5	1678.9	1811.0	1983.8	2126.6	2260.0	2038.7	4.23
30	REAR GRID AT 2:00 LEVEL LFT	137.4	134.6	131.6	127.3	123.5	119.1	114.4	109.1	103.0	8.18
61	DOME - LEFT	1569.3	1522.3	1404.5	1397.3	1257.6	1279.9	1256.4	1218.6	1080.7	16.92
88	FRONT INNER WALL AT 1:30	154.1	155.1	157.4	153.8	174.3	178.5	176.0	179.5	181.9	24.53
85	FRONT INNER WALL AT 3:00	159.0	160.7	161.9	161.9	160.4	161.3	159.9	160.0	159.6	23.69
83	FRONT INNER WALL AT 4:00	177.1	177.8	177.7	179.9	178.9	177.1	178.3	176.6	175.3	23.12
81	FRONT INNER WALL AT 5:00	179.2	180.5	180.8	182.7	183.1	180.7	181.8	183.8	181.4	22.56
80	FRONT INNER WALL AT 5:30	192.7	192.6	192.6	195.6	196.8	196.6	197.6	199.5	199.9	22.28
76	FRONT INNER WALL AT 7:30	156.6	156.6	157.4	158.1	158.4	158.2	158.0	157.9	157.5	21.15
73	FRONT INNER WALL AT 9:00	165.1	165.2	167.4	166.5	167.6	167.8	168.3	167.9	167.4	20.30
71	FRONT INNER WALL AT 10:00	156.2	157.7	157.8	157.8	158.3	159.9	195.9	213.8	245.4	19.74
69	FRONT INNER WALL AT 11:00	328.1	330.8	333.6	332.5	336.0	345.3	353.9	354.3	357.8	19.18
	THE FOLLOWING ARE NOT HARMONIOUS										
2	REAR INNER WALL AT 12:30	133.6	135.5	138.0	139.0	140.7	141.3	142.6	143.6	147.0	0.28
42	REAR GRID AT 3:30 LEVEL CEN	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	11.56
51	REAR INNER TANK END CENTER	83.2	84.9	87.0	88.9	90.9	93.1	95.1	97.3	100.9	14.10
110	FRONT GRID AT 4:00 LEVEL RGT	390.1	409.3	425.1	439.2	458.5	477.8	502.1	517.6	540.4	30.74
118	EMERGENCY RELIEF HATCH	203.1	206.7	208.7	217.2	220.0	216.7	215.9	216.6	214.0	31.02

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TABLE A XX

QUESTIONABLE DATA

THERMOCOUPLE TEMPERATURES (DEG. F) FOR TEST NR. 8

CHANNEL NUMBER	LOCATION	TIME (SEC) = 1142.10	1184.40	1226.70	1269.00	1311.30	1353.60	1395.90	1438.20	1480.50	TIME ADJUST ADD
	SIGN REVERSAL OCCURS DURING TEST										
1	REAR INNER WALL AT 12:00	1076.3	1088.3	1103.8	1119.7	1129.2	1150.8	1161.7	1171.5	92.4	0.00
3	REAR INNER WALL AT 1:00	487.1	475.2	476.6	470.0	487.5	505.8	498.3	502.7	18.6	0.56
8	REAR INNER WALL AT 3:30	165.5	164.4	167.2	167.2	169.0	167.3	163.7	168.1	96.2	1.97
10	REAR INNER WALL AT 4:30	168.1	166.9	169.8	169.6	169.9	168.9	167.4	168.7	82.0	2.54
11	REAR INNER WALL AT 5:00	1597.9	1597.0	1599.1	1599.1	1599.9	1599.6	1598.4	1599.5	1462.4	2.82
12	REAR INNER WALL AT 5:30	158.8	151.4	150.3	143.6	139.2	128.3	120.8	114.8	111.3	3.10
16	REAR INNER WALL AT 7:30	1735.7	1557.8	1379.7	1185.3	936.0	625.9	344.4	52.8	107.1	4.23
30	REAR GRID AT 2:00 LEVEL LFT	96.5	90.5	83.3	76.6	68.3	62.0	60.2	56.7	109.7	8.18
61	DOME - LEFT	1151.2	1062.1	1045.7	1016.3	999.7	1028.4	1177.7	1344.7	123.2	16.92
88	FRONT INNER WALL AT 1:30	184.7	185.0	187.4	187.9	190.6	191.2	204.3	213.3	191.7	24.53
85	FRONT INNER WALL AT 3:00	159.4	158.4	158.7	158.0	157.3	183.6	232.9	267.2	163.6	23.69
83	FRONT INNER WALL AT 4:00	177.6	173.3	175.1	172.1	172.6	169.6	174.6	172.3	162.6	23.12
81	FRONT INNER WALL AT 5:00	182.4	181.1	182.0	178.2	179.6	177.1	178.1	176.7	140.6	22.56
80	FRONT INNER WALL AT 5:30	199.3	199.6	201.3	196.2	197.8	193.8	198.0	197.0	188.6	22.28
76	FRONT INNER WALL AT 7:30	156.9	156.6	156.3	156.5	155.7	155.4	156.1	155.0	118.6	21.15
73	FRONT INNER WALL AT 9:00	163.5	168.0	164.8	165.0	164.9	167.0	204.7	304.5	148.9	20.30
71	FRONT INNER WALL AT 10:00	234.2	243.6	253.2	258.2	266.8	281.2	302.3	334.0	141.8	19.74
69	FRONT INNER WALL AT 11:00	355.4	362.6	367.3	371.3	380.7	391.2	429.2	461.3	136.3	19.18
	THE FOLLOWING ARE NOT HARMONIOUS										
2	REAR INNER WALL AT 12:30	147.9	148.3	149.2	148.4	150.6	149.7	155.1	165.6	-76014.9	0.28
42	REAR GRID AT 3:30 LEVEL CEN	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	11.56
51	REAR INNER TANK END CENTER	104.2	106.7	109.2	111.7	114.1	116.6	119.0	121.8	40.0	14.10
110	FRONT GRID AT 4:00 LEVEL RGT	573.8	601.3	641.2	643.9	660.6	683.1	707.6	731.2	41.6	30.74
118	EMERGENCY RELIEF HATCH	212.6	207.5	199.7	200.7	179.6	162.2	151.9	145.4	40.9	31.02

VIDAR CHANNEL 1 OF TEST NUMBER 8

LOCATION IS REAR INNER WALL AT 12.00

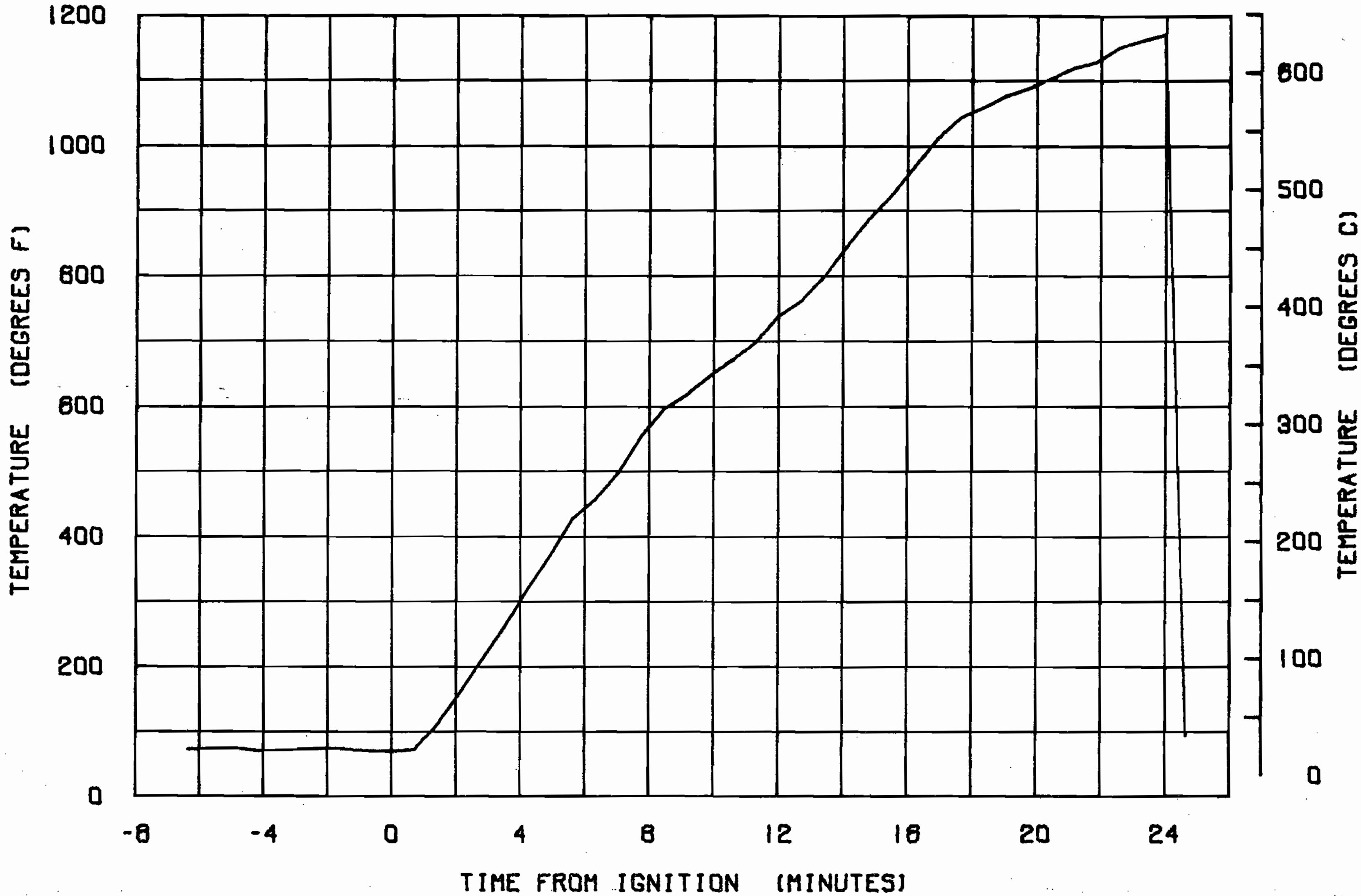

FIGURE A 1 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 3 OF TEST NUMBER 8

LOCATION IS REAR INNER WALL AT 1:00

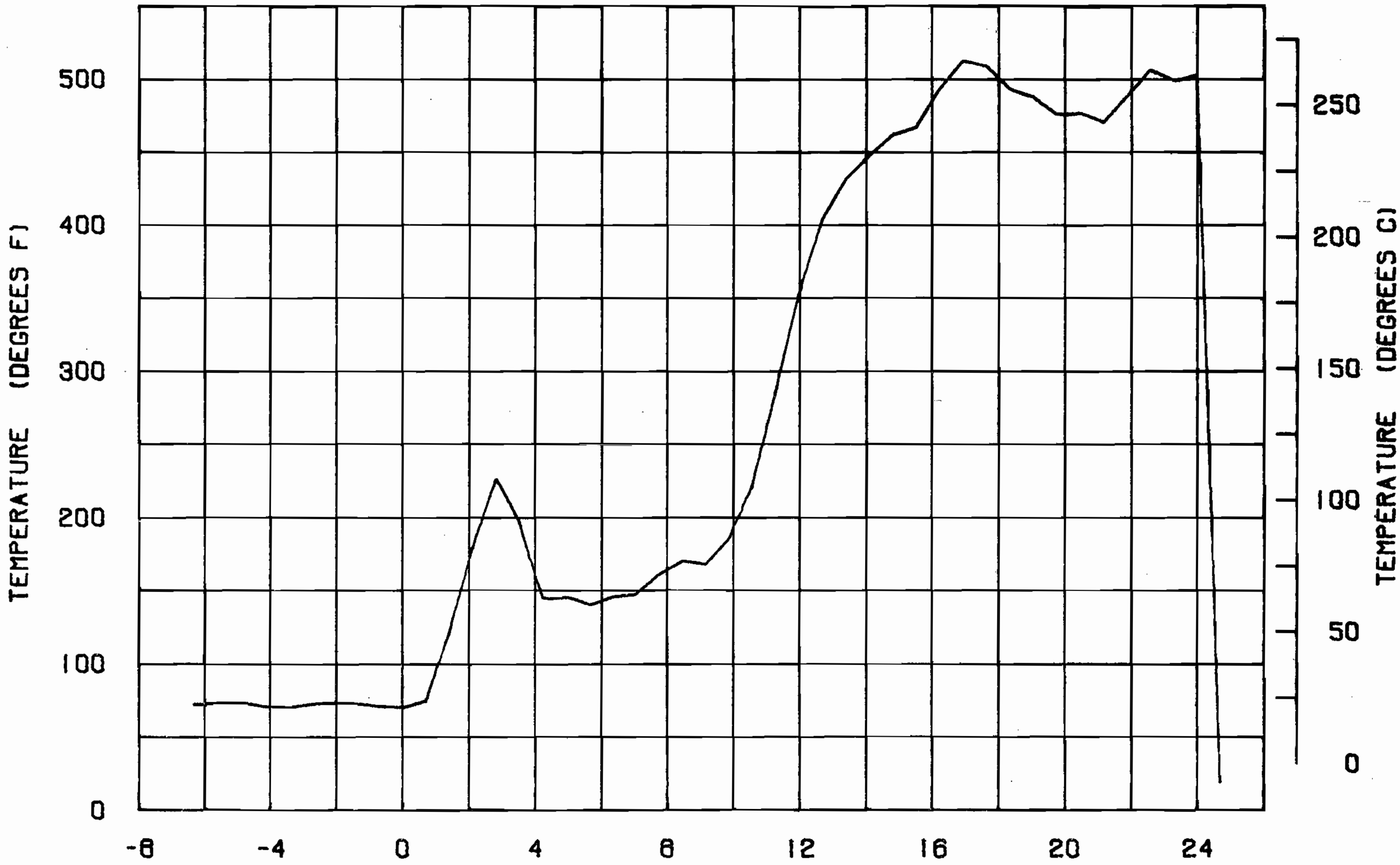

FIGURE A 2 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 4 OF TEST NUMBER 8

LOCATION IS REAR INNER WALL AT 1.30

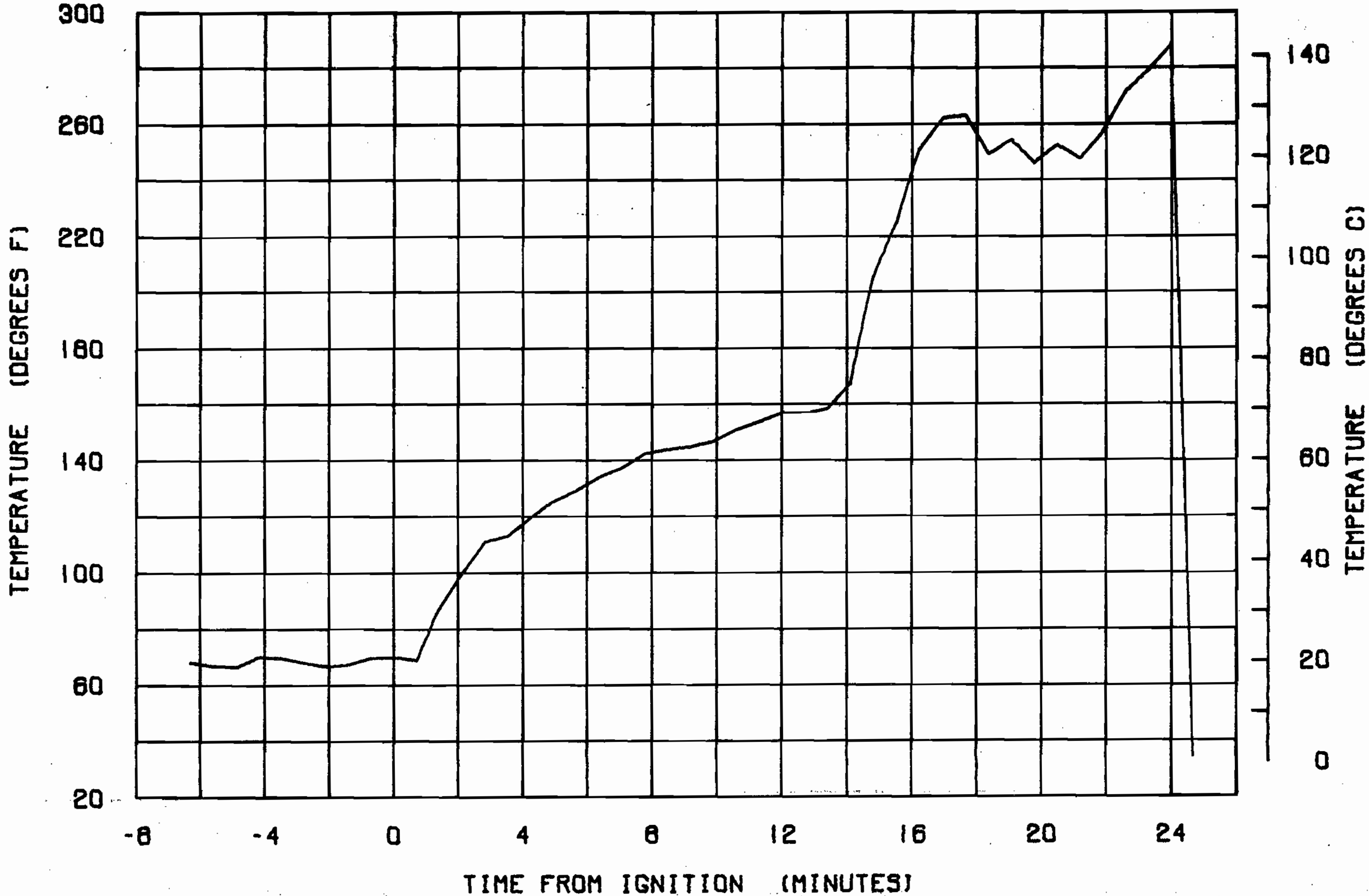

FIGURE A 3 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 5 OF TEST NUMBER 8

LOCATION IS REAR INNER WALL AT 2.00

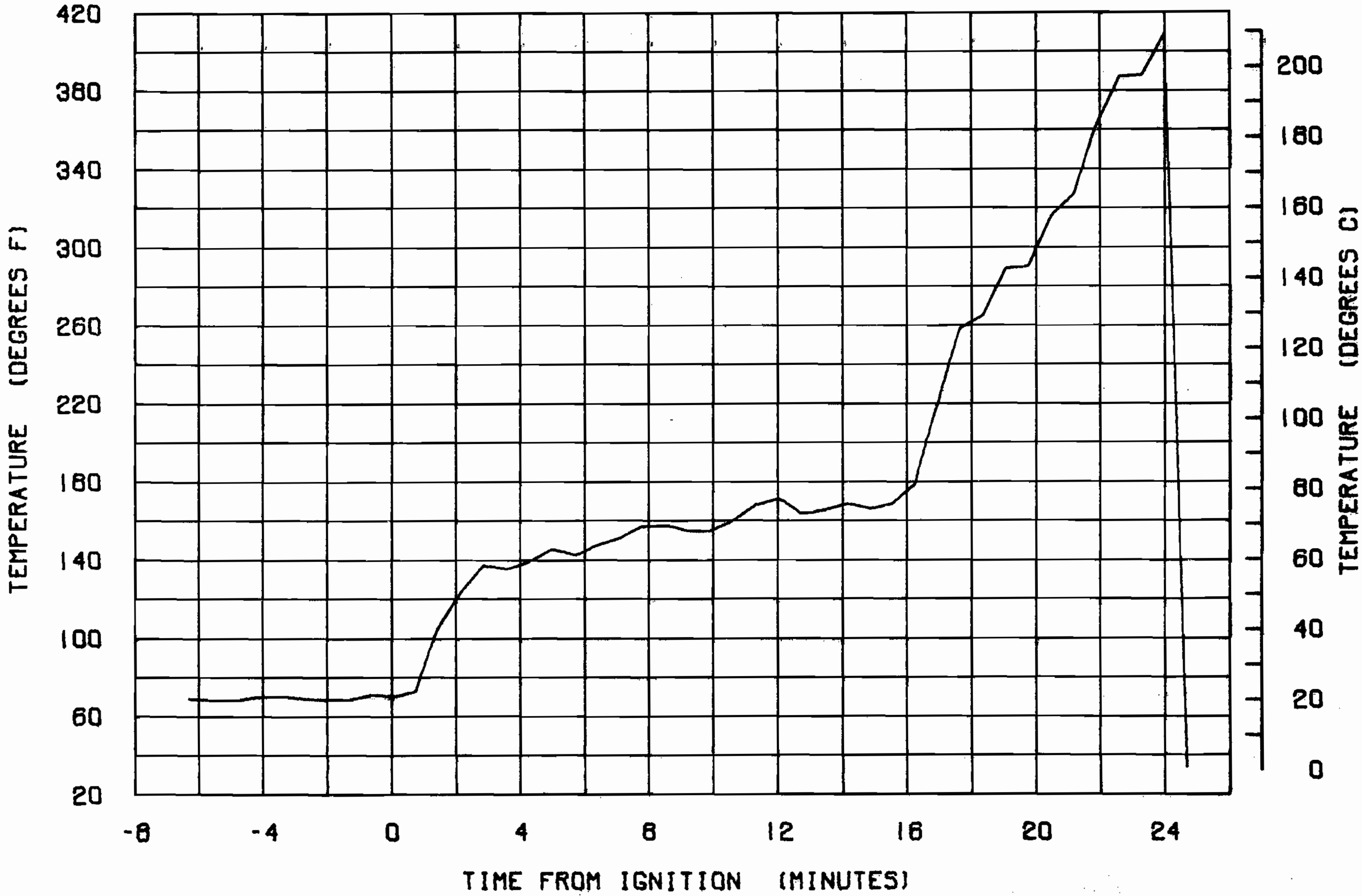

FIGURE A 4 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 6 OF TEST NUMBER 8

LOCATION IS REAR INNER WALL AT 2.30

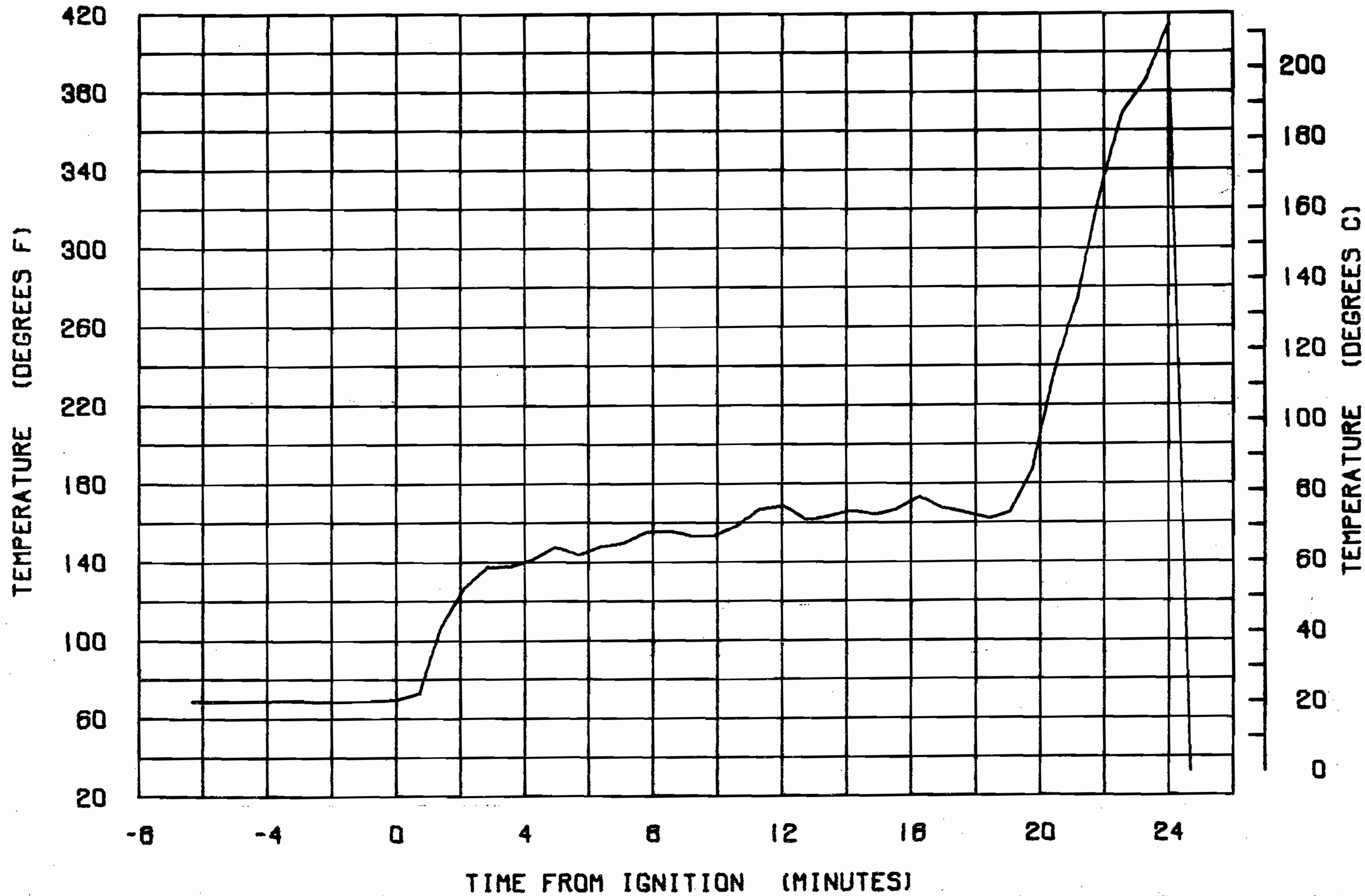

FIGURE A 5 THERMOCOUPLE TEMPERATURE VS. TIME

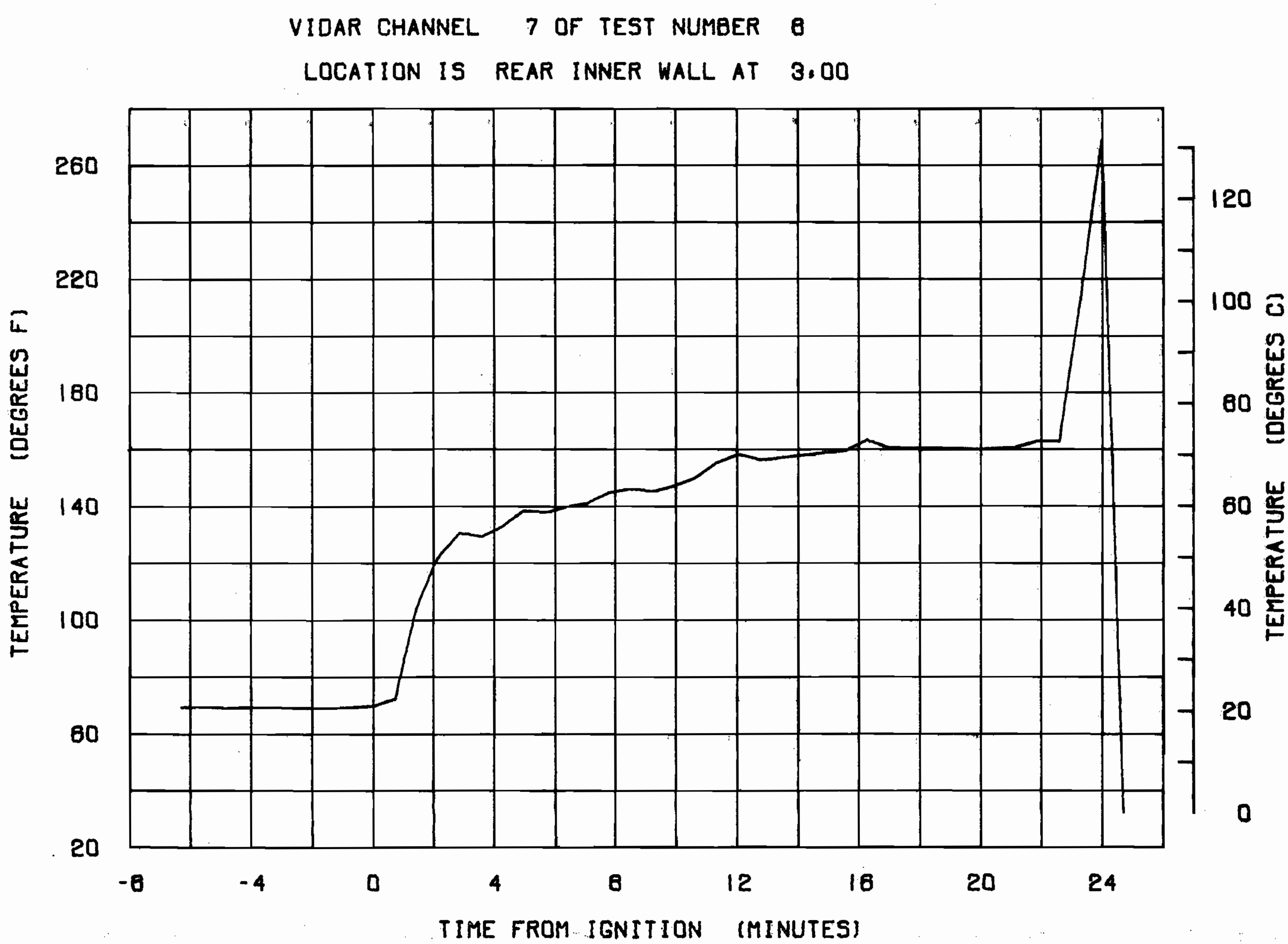

FIGURE A 6 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 8 OF TEST NUMBER 8

LOCATION IS REAR INNER WALL AT 3.30

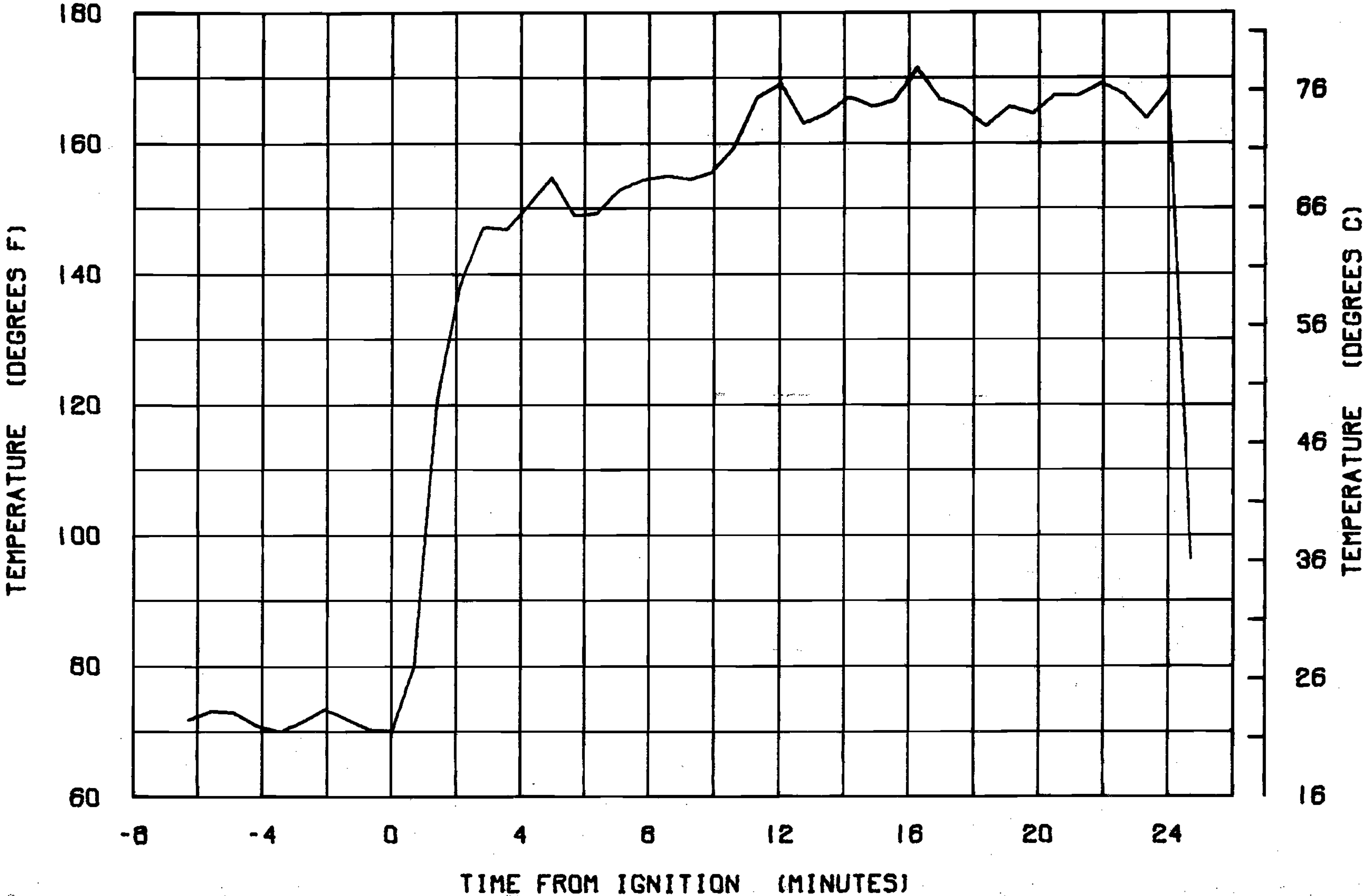

FIGURE A 7 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 9 OF TEST NUMBER 8

LOCATION IS REAR INNER WALL AT 4:00

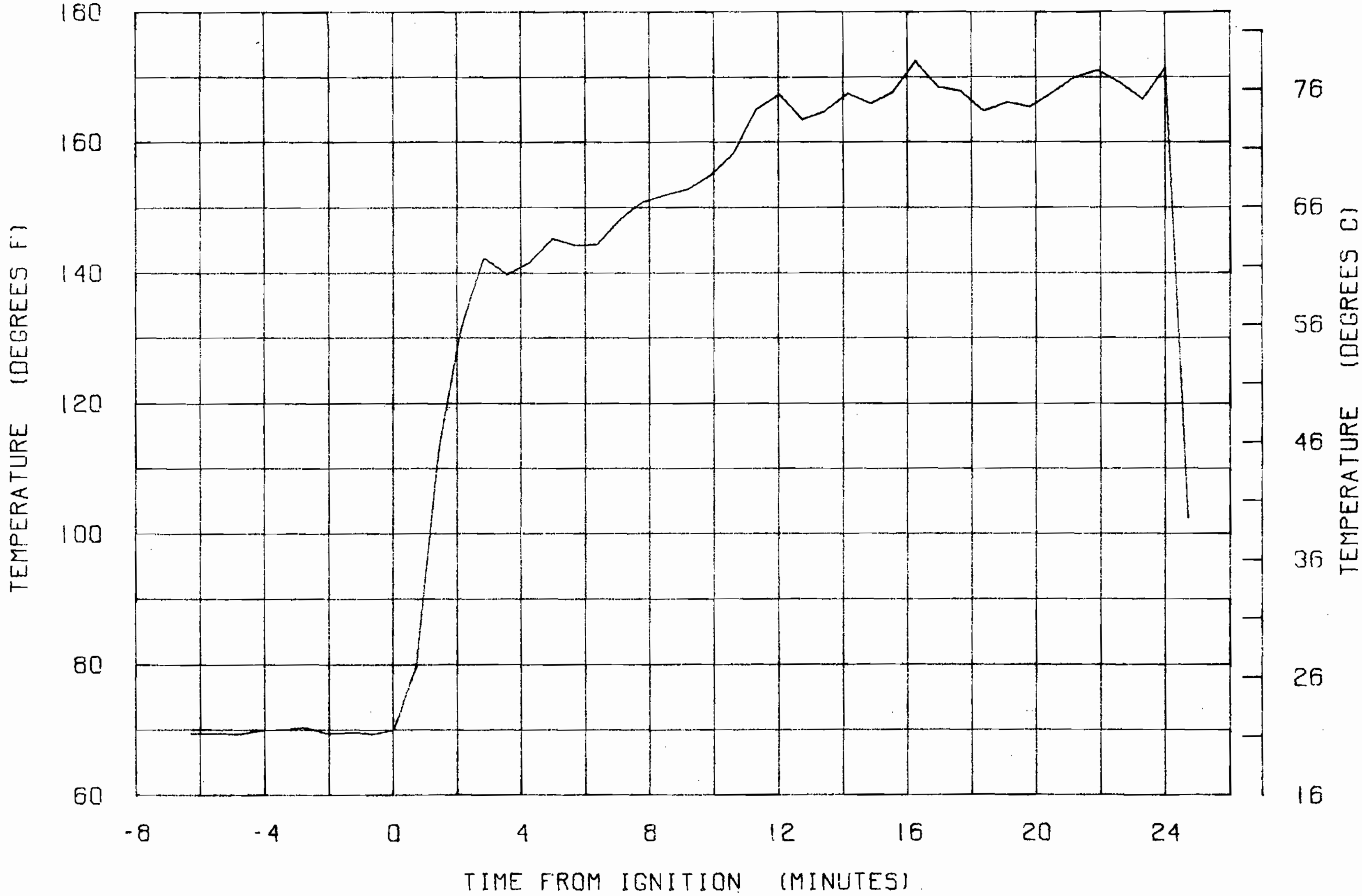

FIGURE A 8 THERMOCOUPLE TEMPERATURE – VS. TIME

VIDAR CHANNEL 10 OF TEST NUMBER 8

LOCATION IS REAR INNER WALL AT 4:30

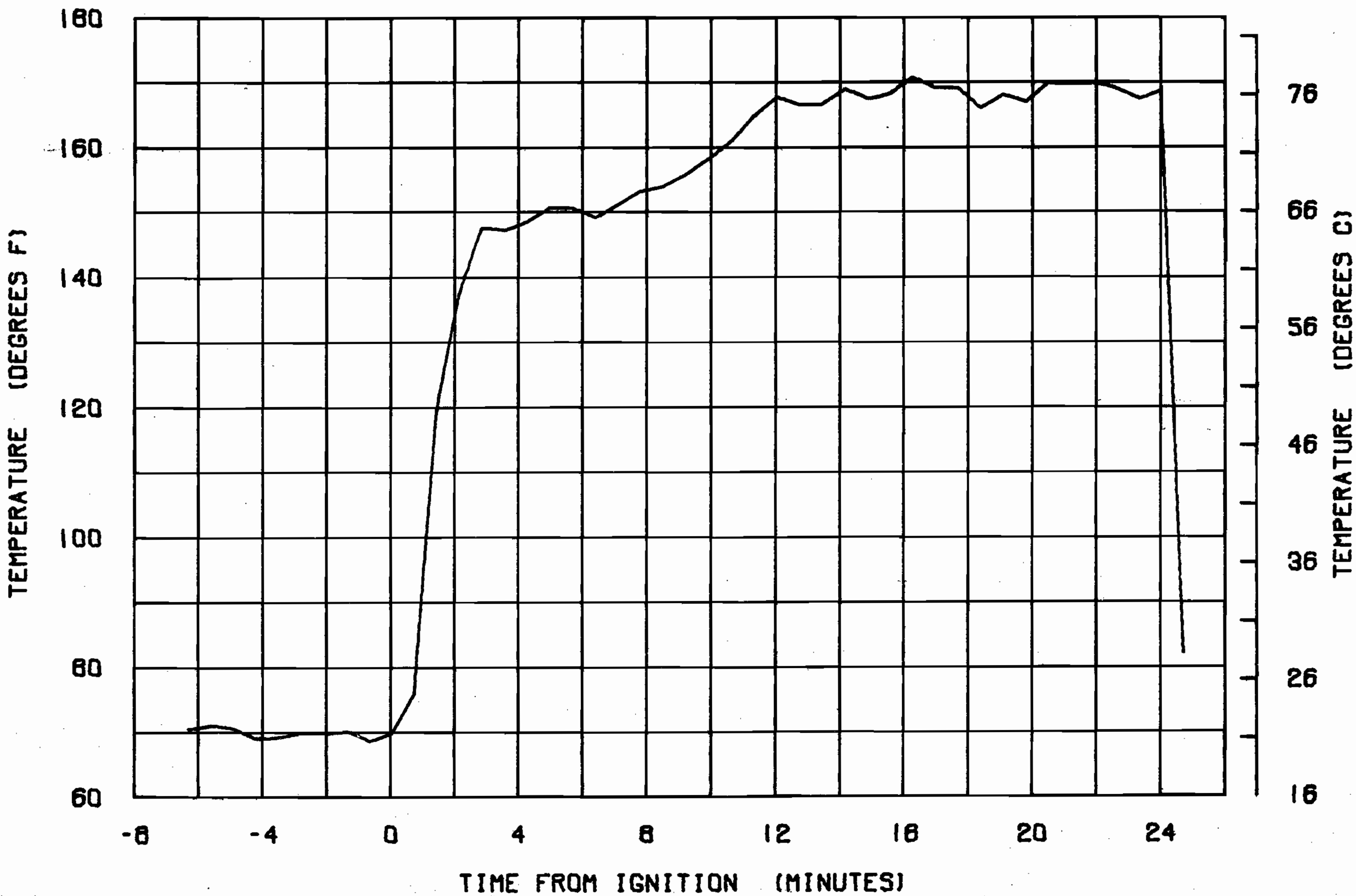

FIGURE A 9 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 12 OF TEST NUMBER 8

LOCATION IS REAR INNER WALL AT 5:30

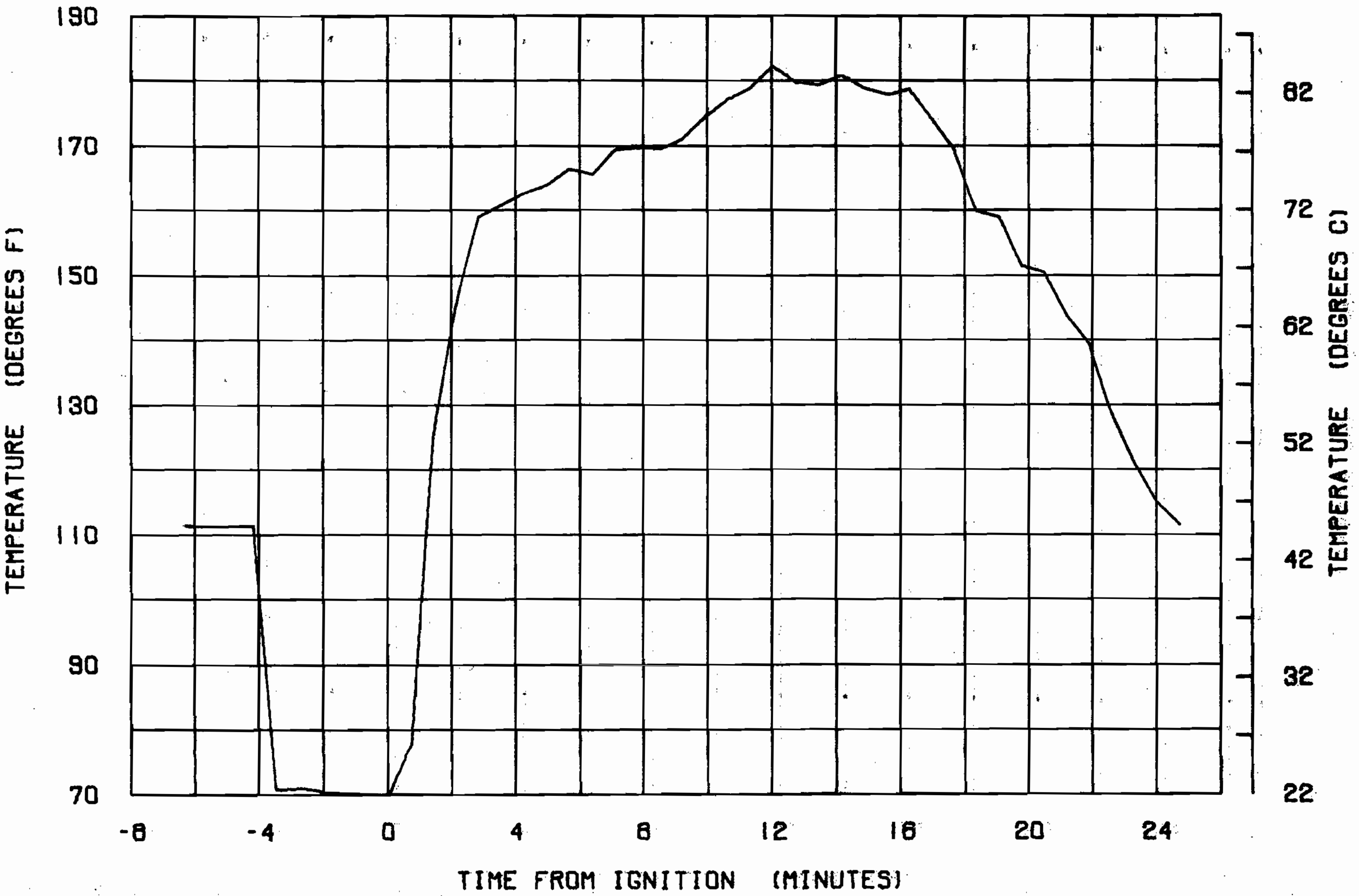

FIGURE A 10 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 13 OF TEST NUMBER 8

LOCATION IS REAR INNER WALL AT 6.00

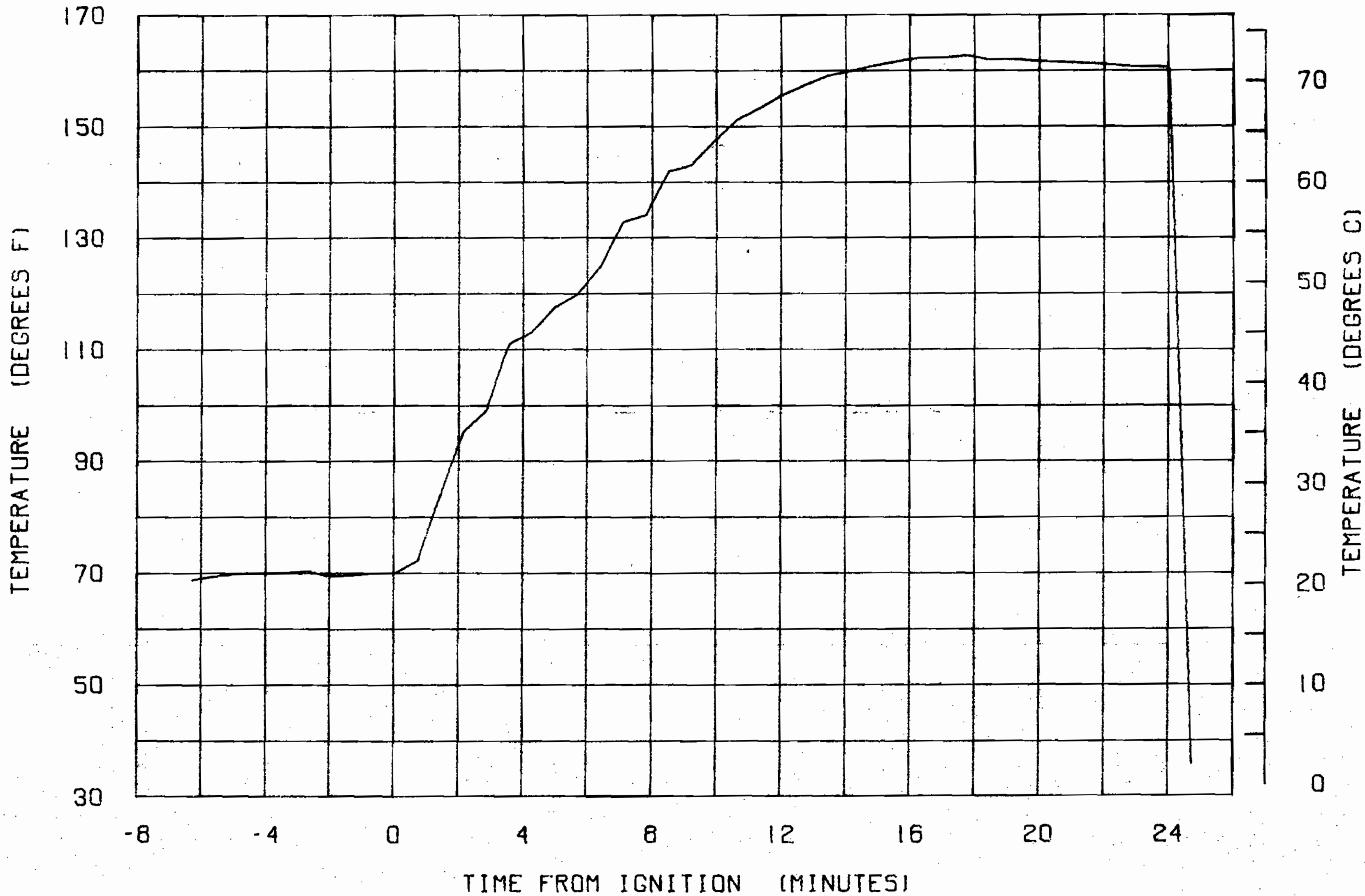

FIGURE **A 11** THERMOCOUPLE TEMPERATURE VS. TIME

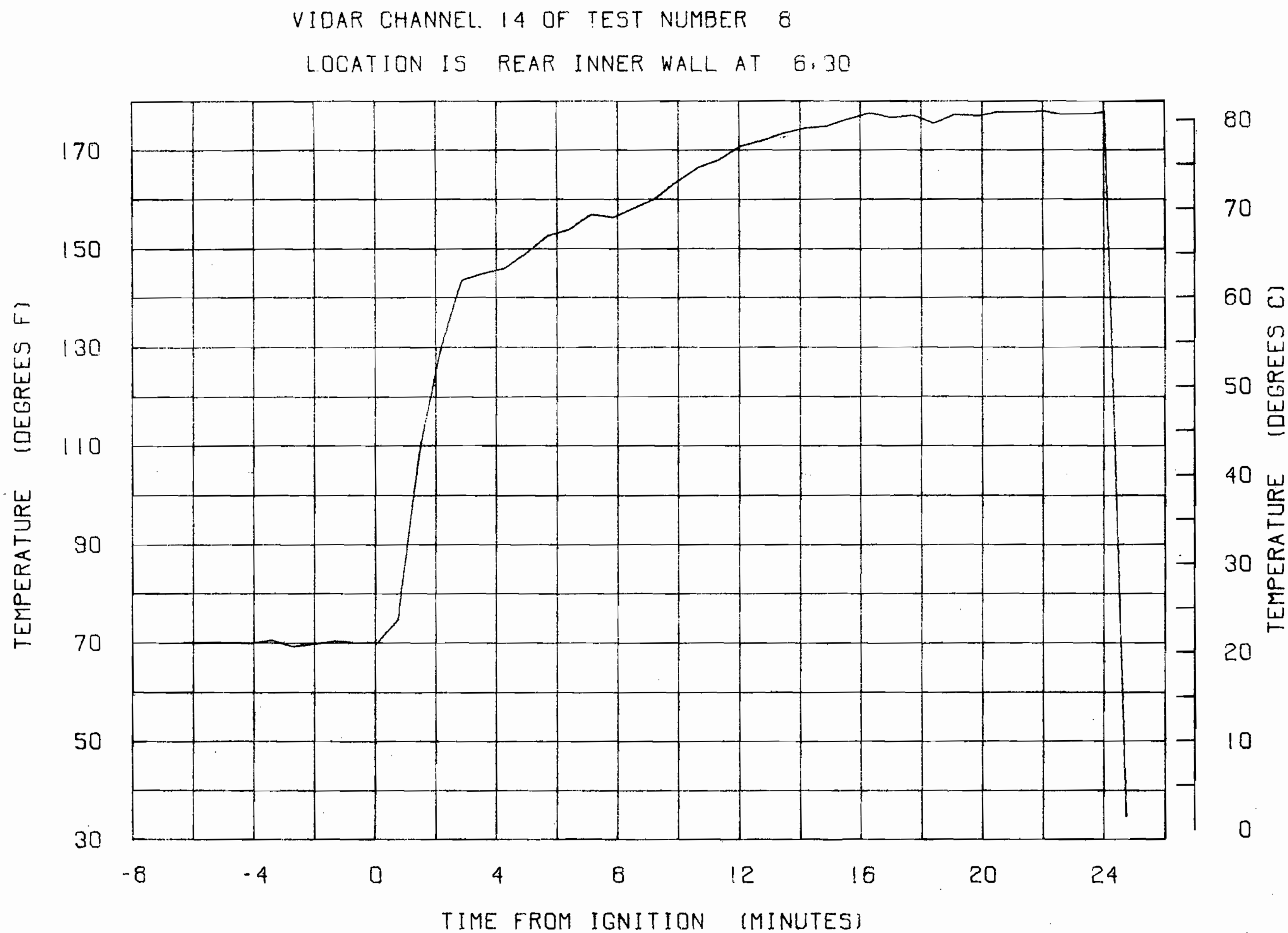

FIGURE A 12 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 15 OF TEST NUMBER 8

LOCATION IS REAR INNER WALL AT 7:00

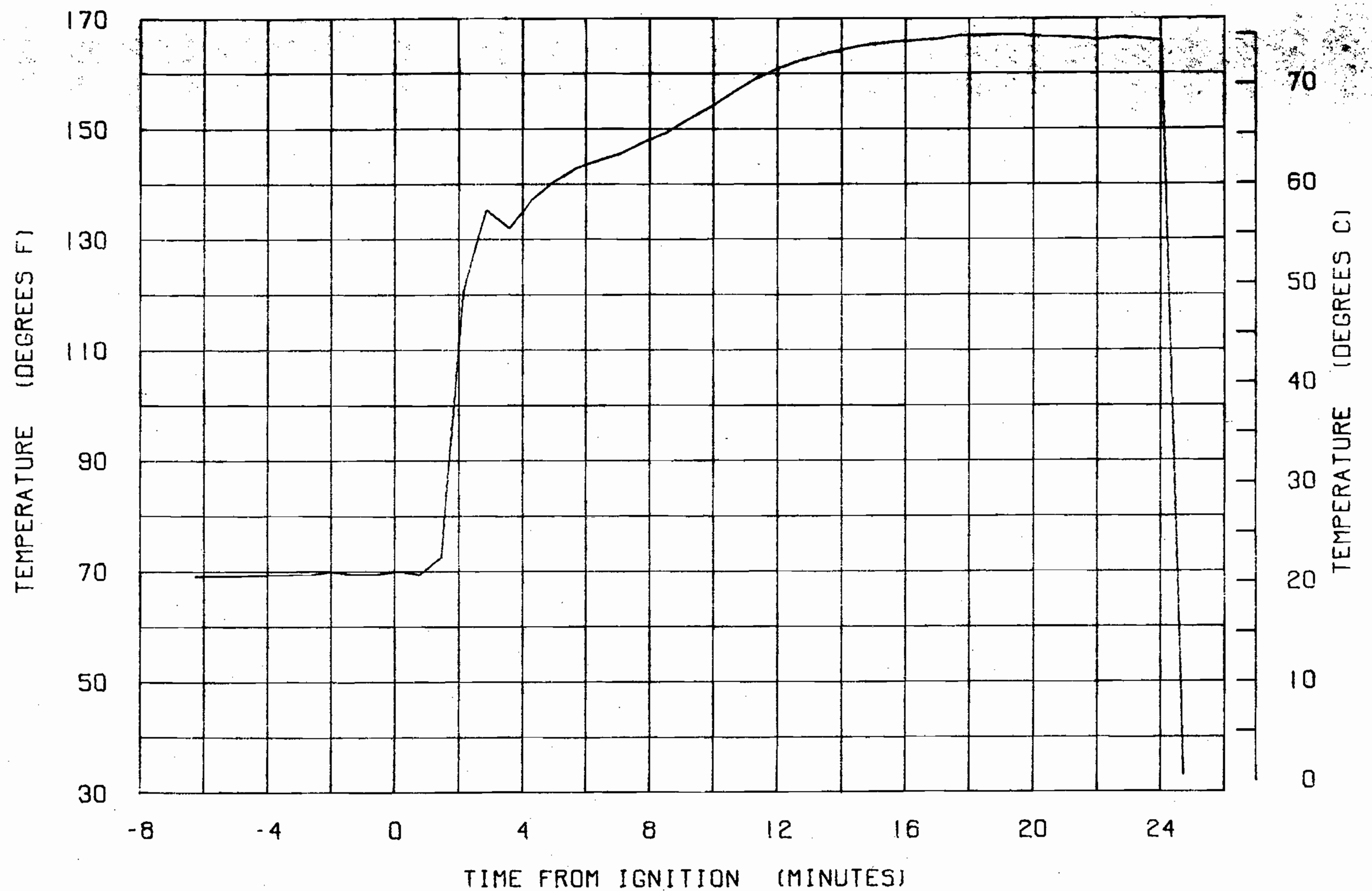

FIGURE A 13 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 17 OF TEST NUMBER 8

LOCATION IS REAR INNER WALL AT 6:00

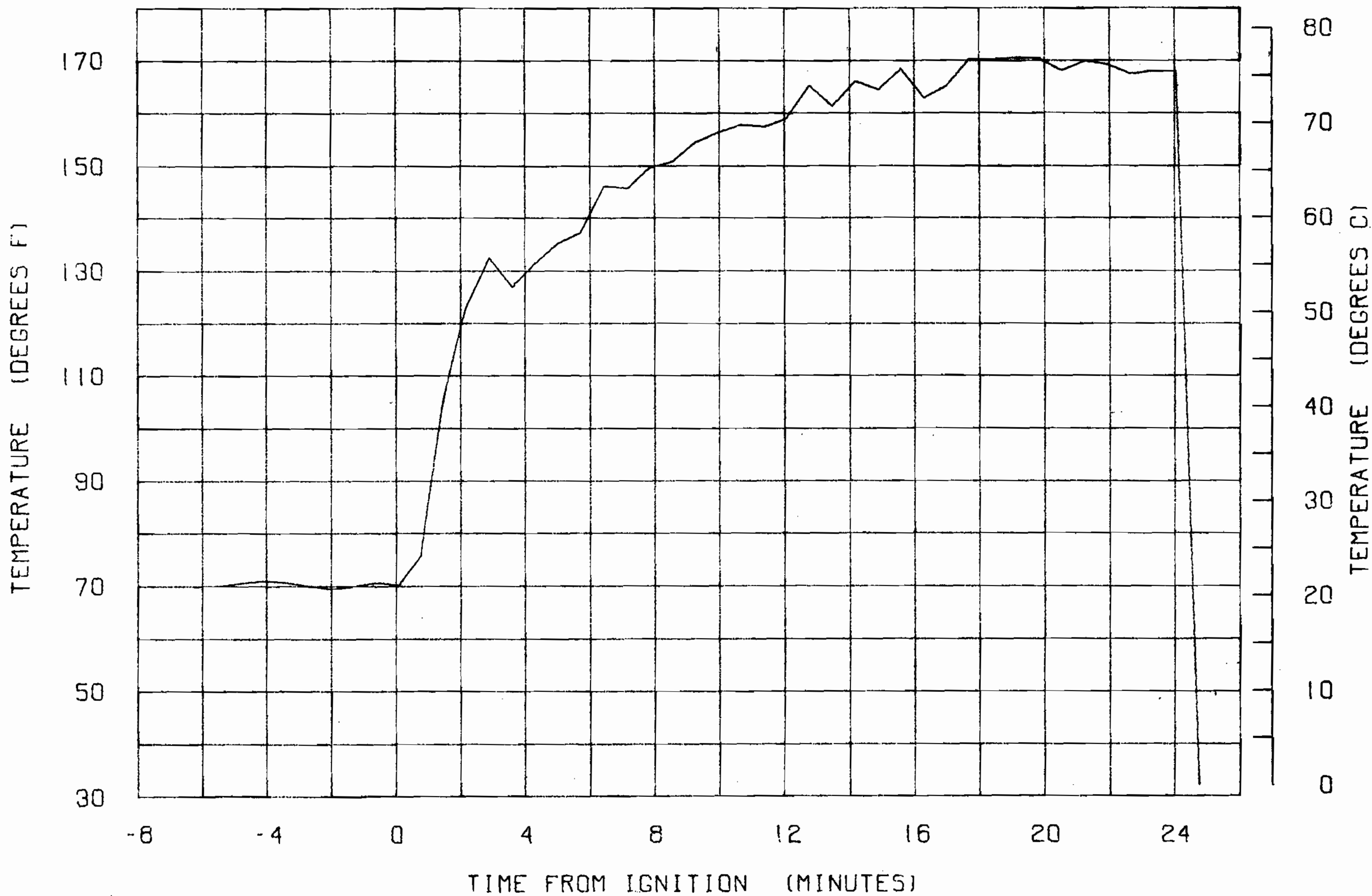

FIGURE A 14 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 18 OF TEST NUMBER 8

LOCATION IS REAR INNER WALL AT 8:30

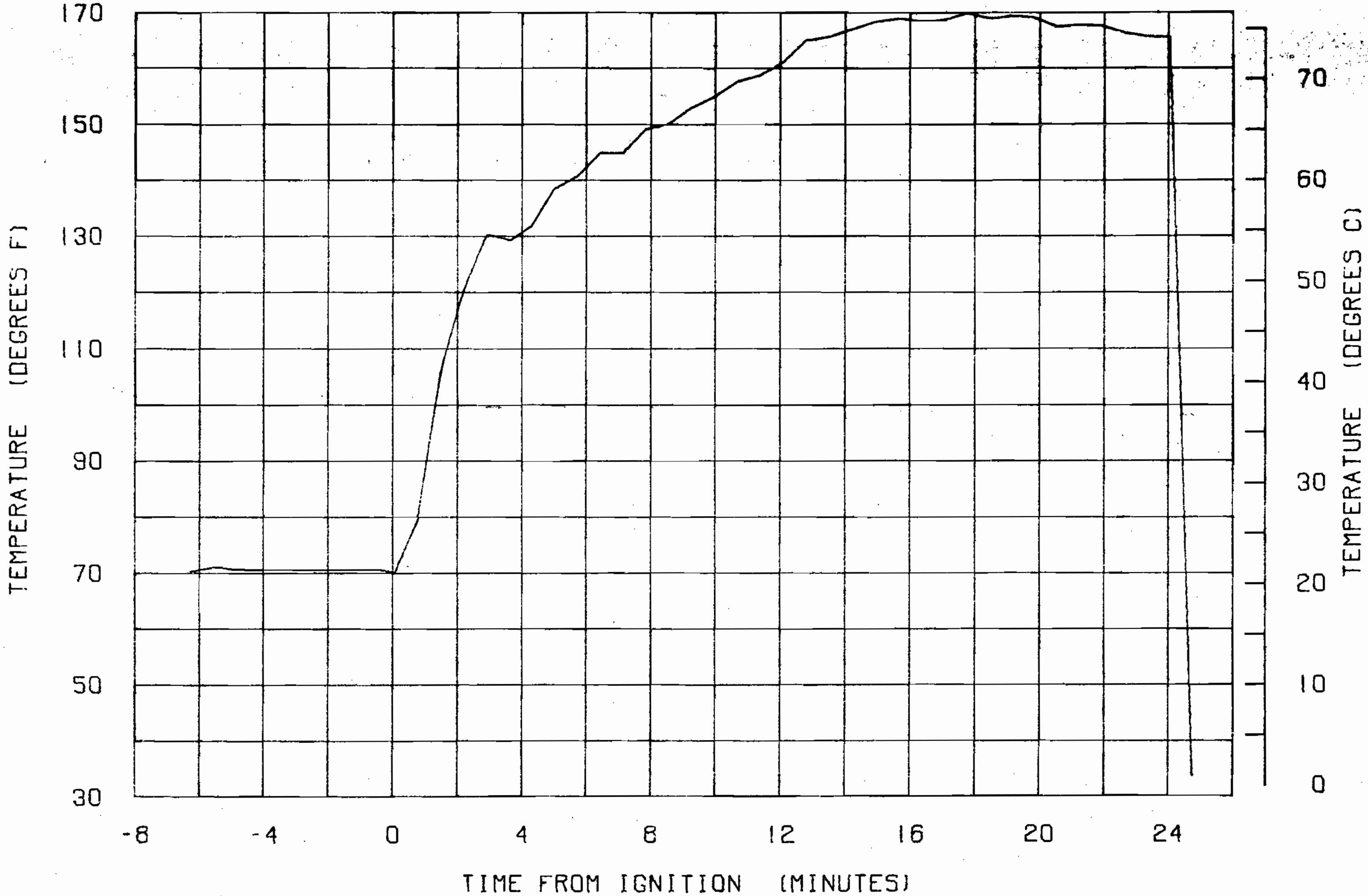

FIGURE A 15 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 19 OF TEST NUMBER 8

LOCATION IS REAR INNER WALL AT 9:00

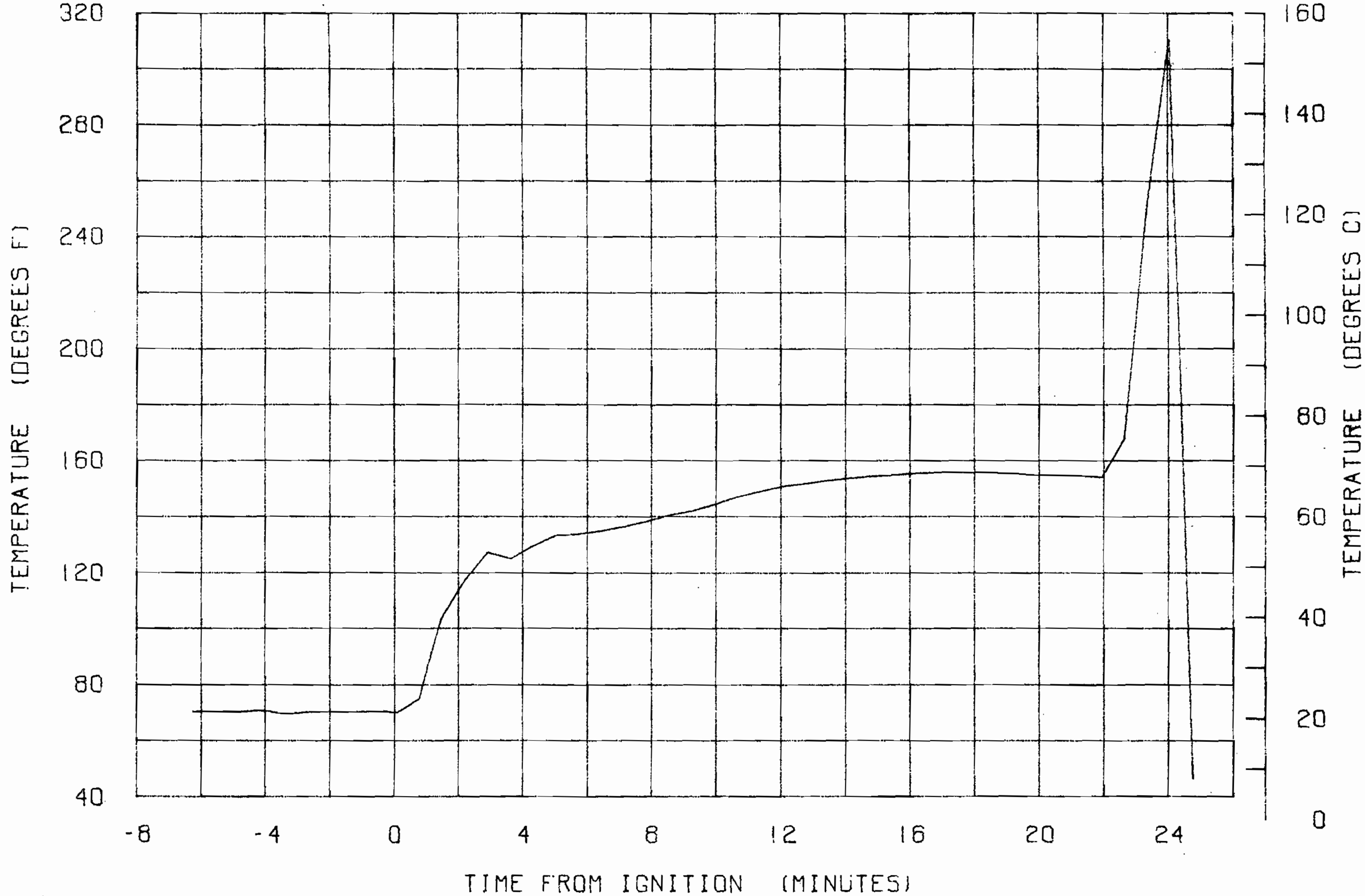

FIGURE **A 16** THERMOCOUPLE TEMPERATURE VS. TIME

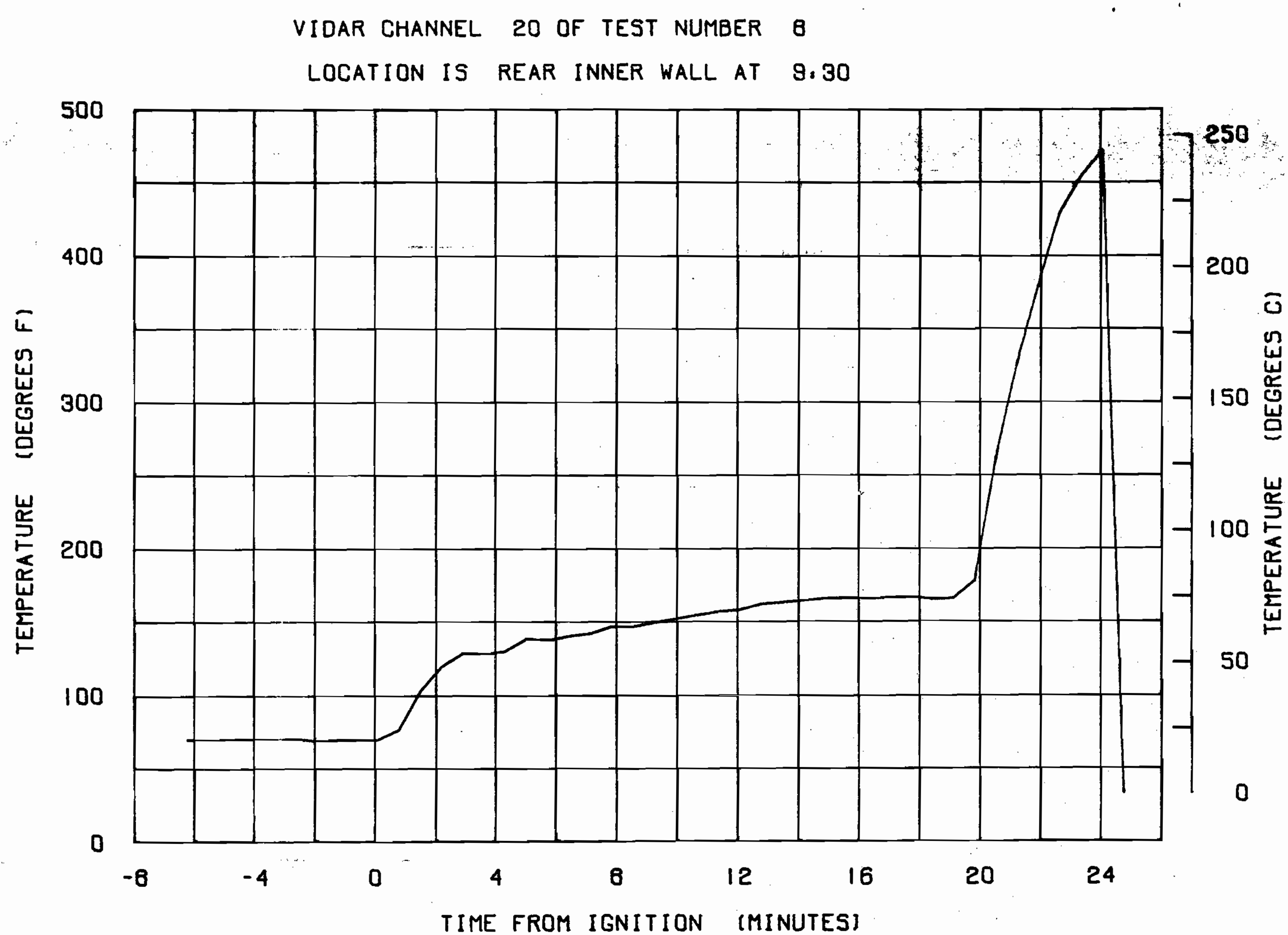

FIGURE A 17 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 21 OF TEST NUMBER 8

LOCATION IS REAR INNER WALL AT 10:00

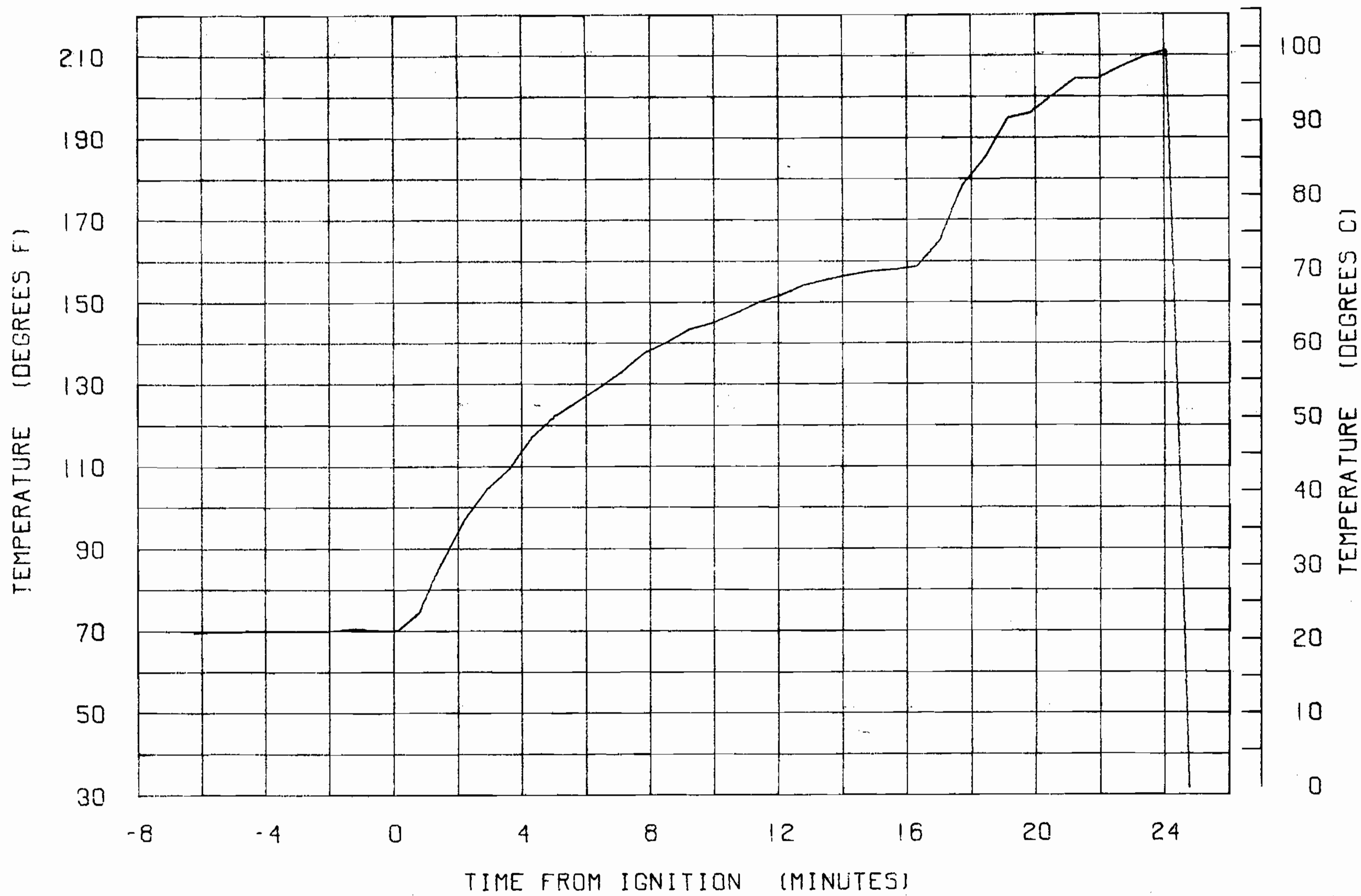

FIGURE A 18 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 22 OF TEST NUMBER 8

LOCATION IS REAR INNER WALL AT 10:30

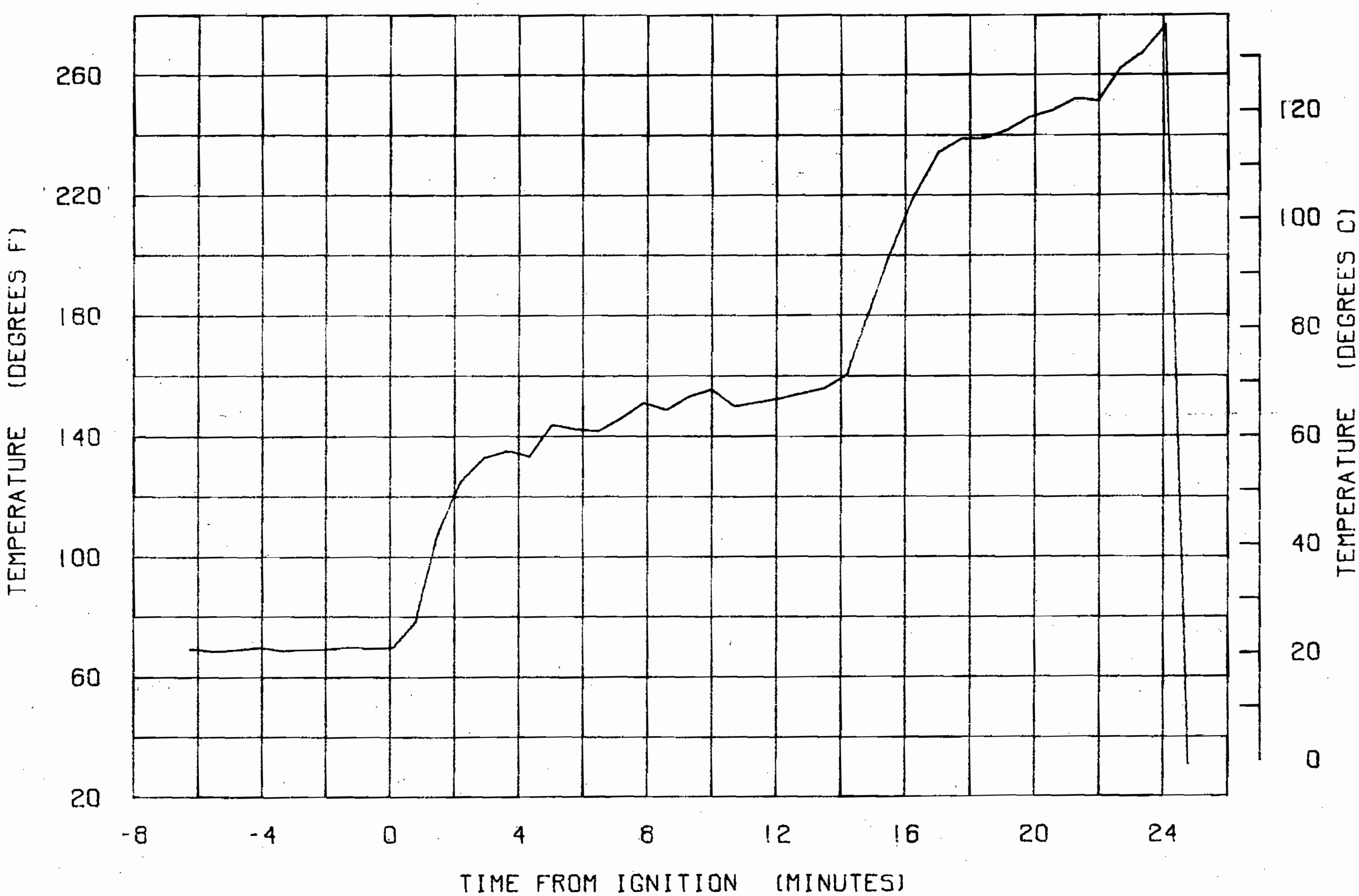

FIGURE **A 19** THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 23 OF TEST NUMBER 8

LOCATION IS REAR INNER WALL AT 11:00

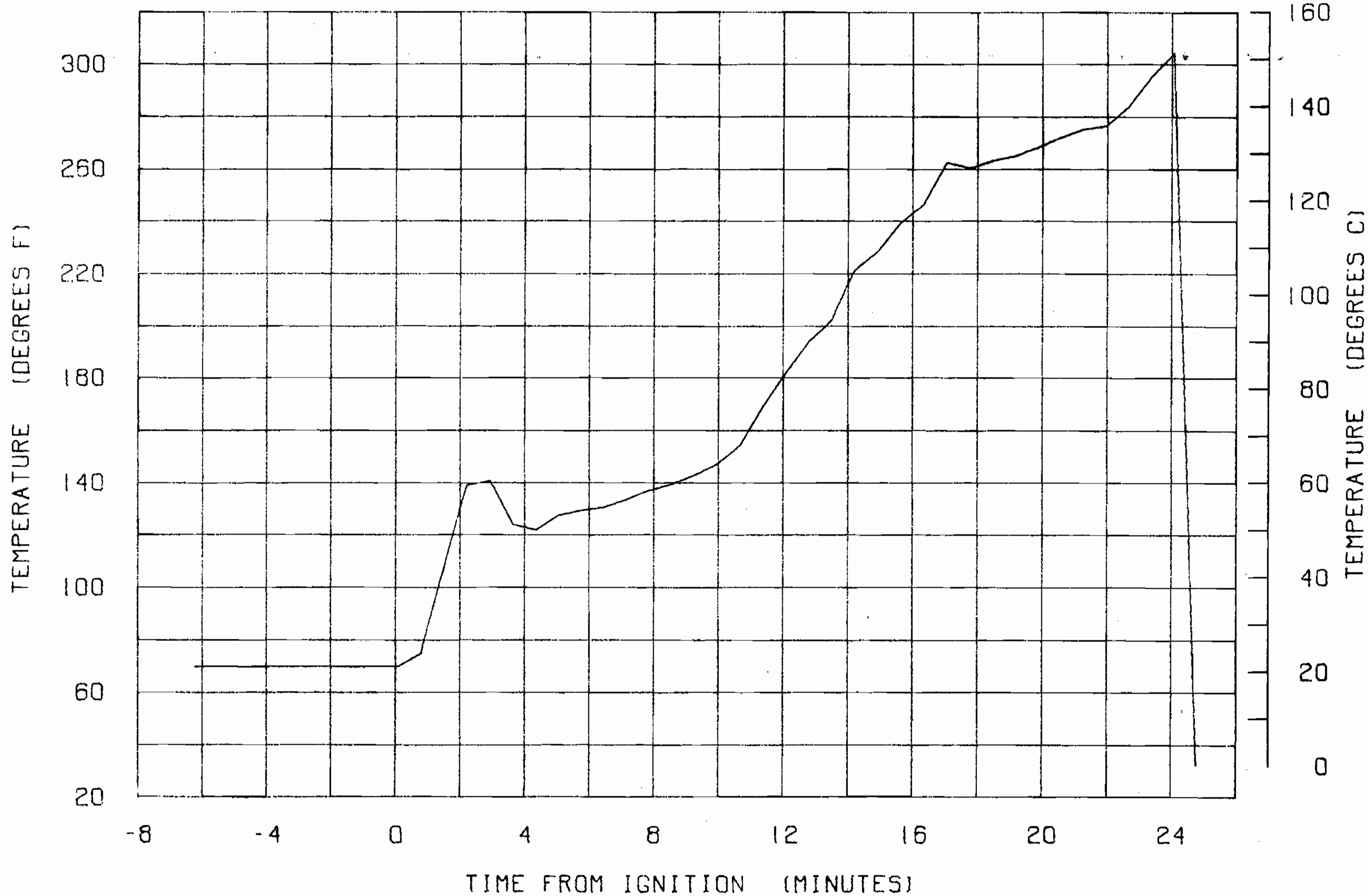

FIGURE A 20 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 24 OF TEST NUMBER 8

LOCATION IS REAR INNER WALL AT 11:30

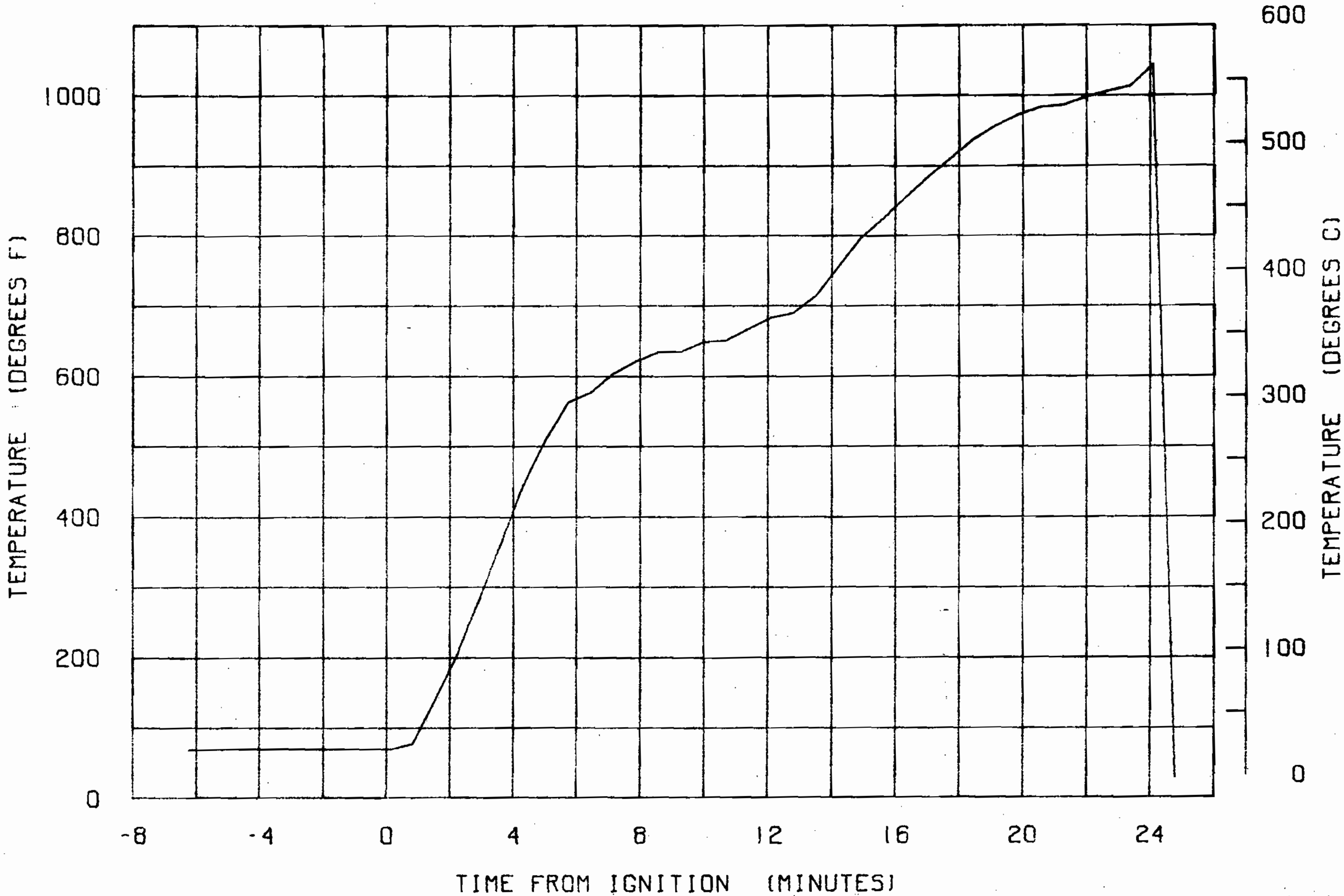

FIGURE A 21 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 25 OF TEST NUMBER 8

LOCATION IS REAR GRID AT 12:30 LEVEL CEN

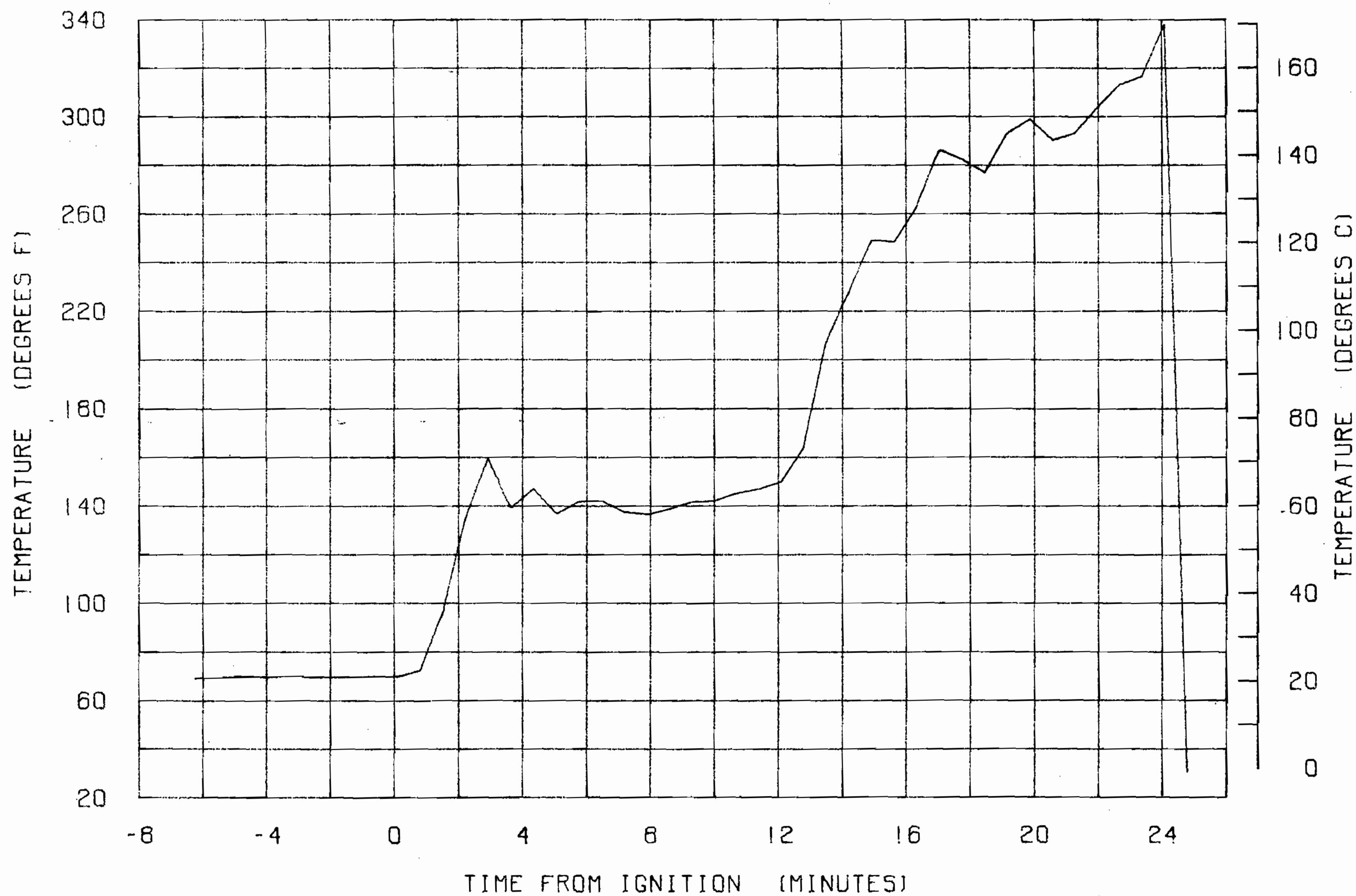

FIGURE A 22 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 26 OF TEST NUMBER 8

LOCATION IS REAR GRID AT 1.00 LEVEL CEN

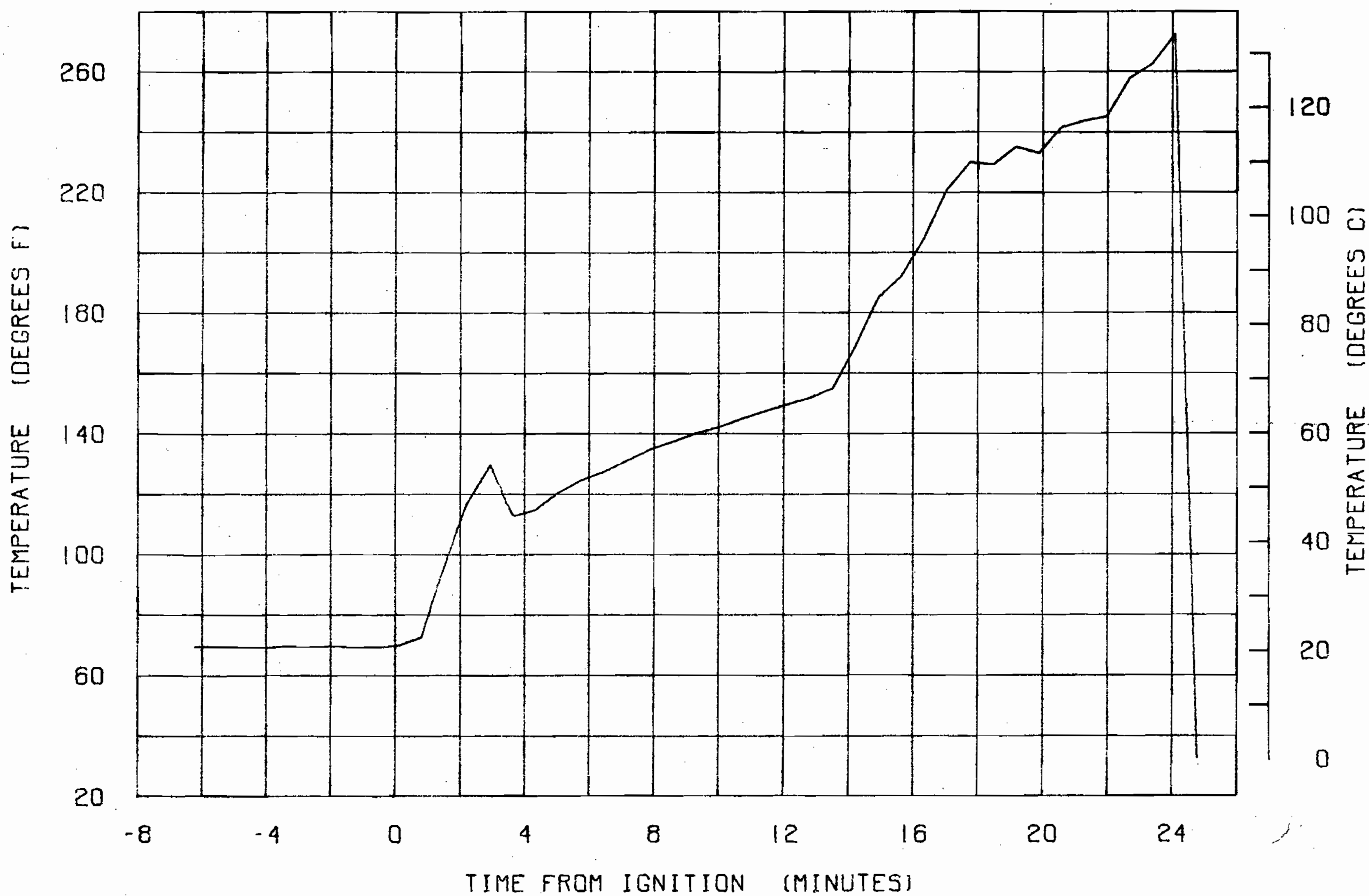

FIGURE A 23 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 27 OF TEST NUMBER 8

LOCATION IS REAR GRID AT 1.30 LEVEL LFT

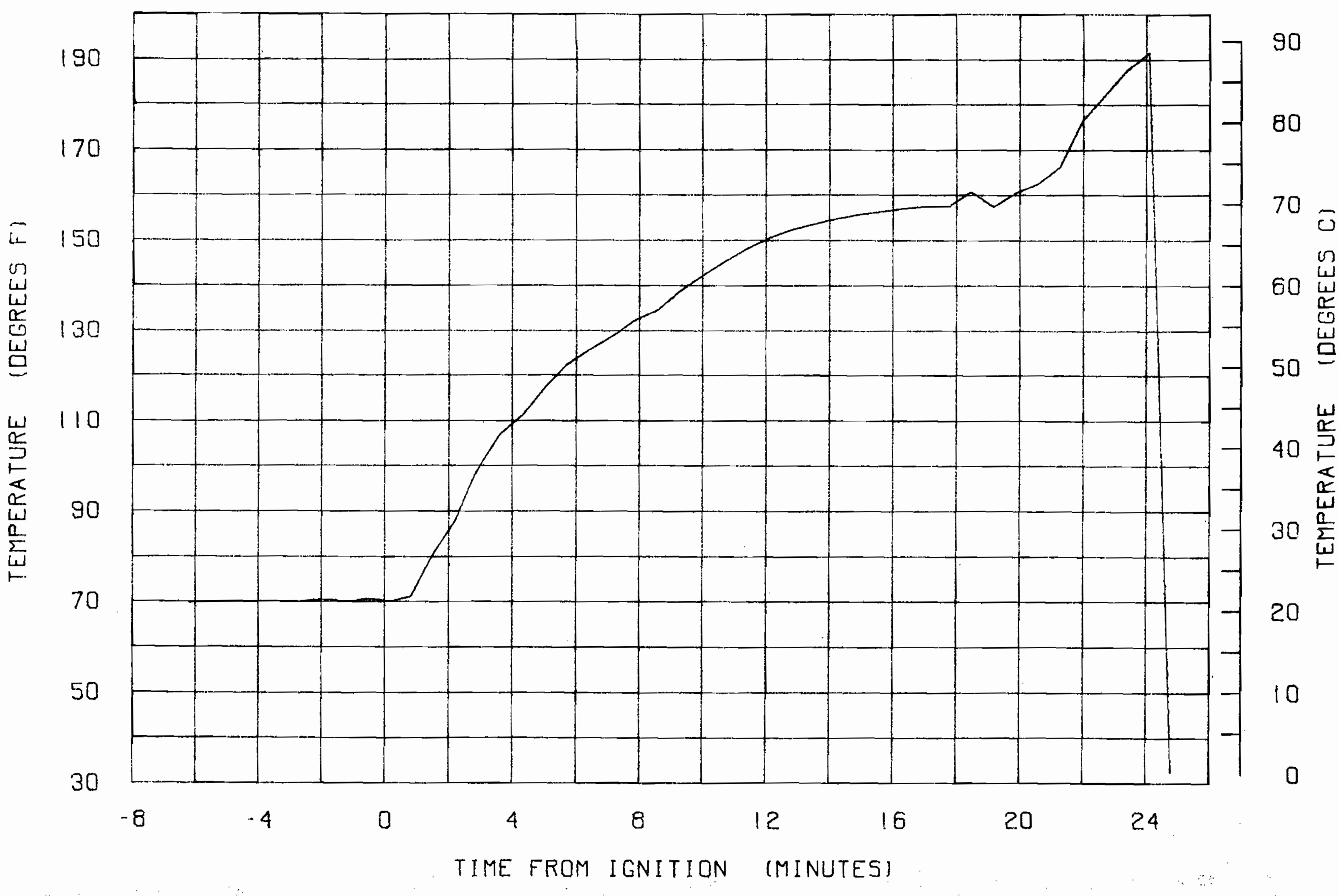

FIGURE A 24 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 28 OF TEST NUMBER 8

LOCATION IS REAR GRID AT 1:30 LEVEL CEN

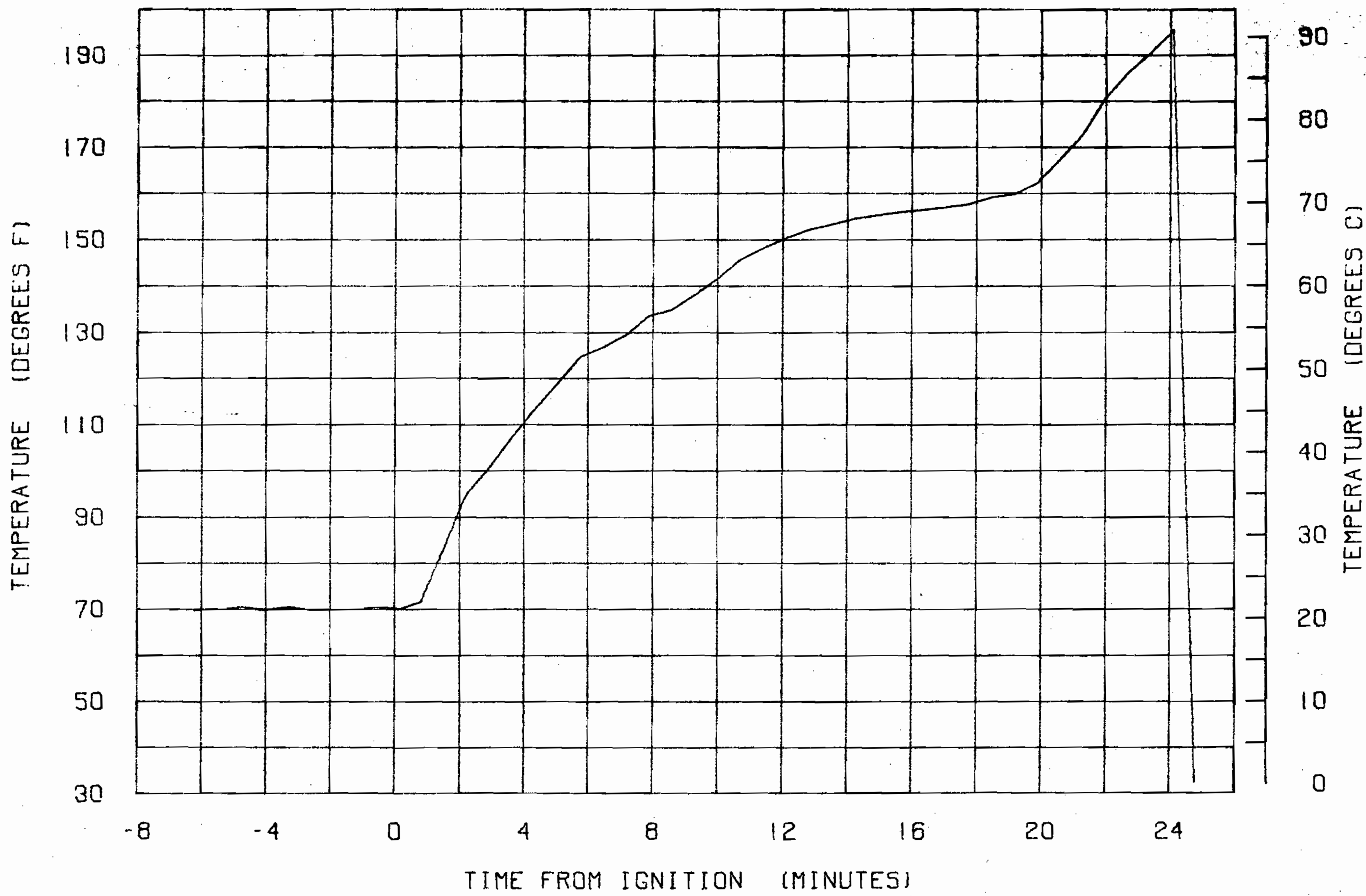

FIGURE A 25 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 29 OF TEST NUMBER 8

LOCATION IS REAR GRID AT 1,30 LEVEL RGT

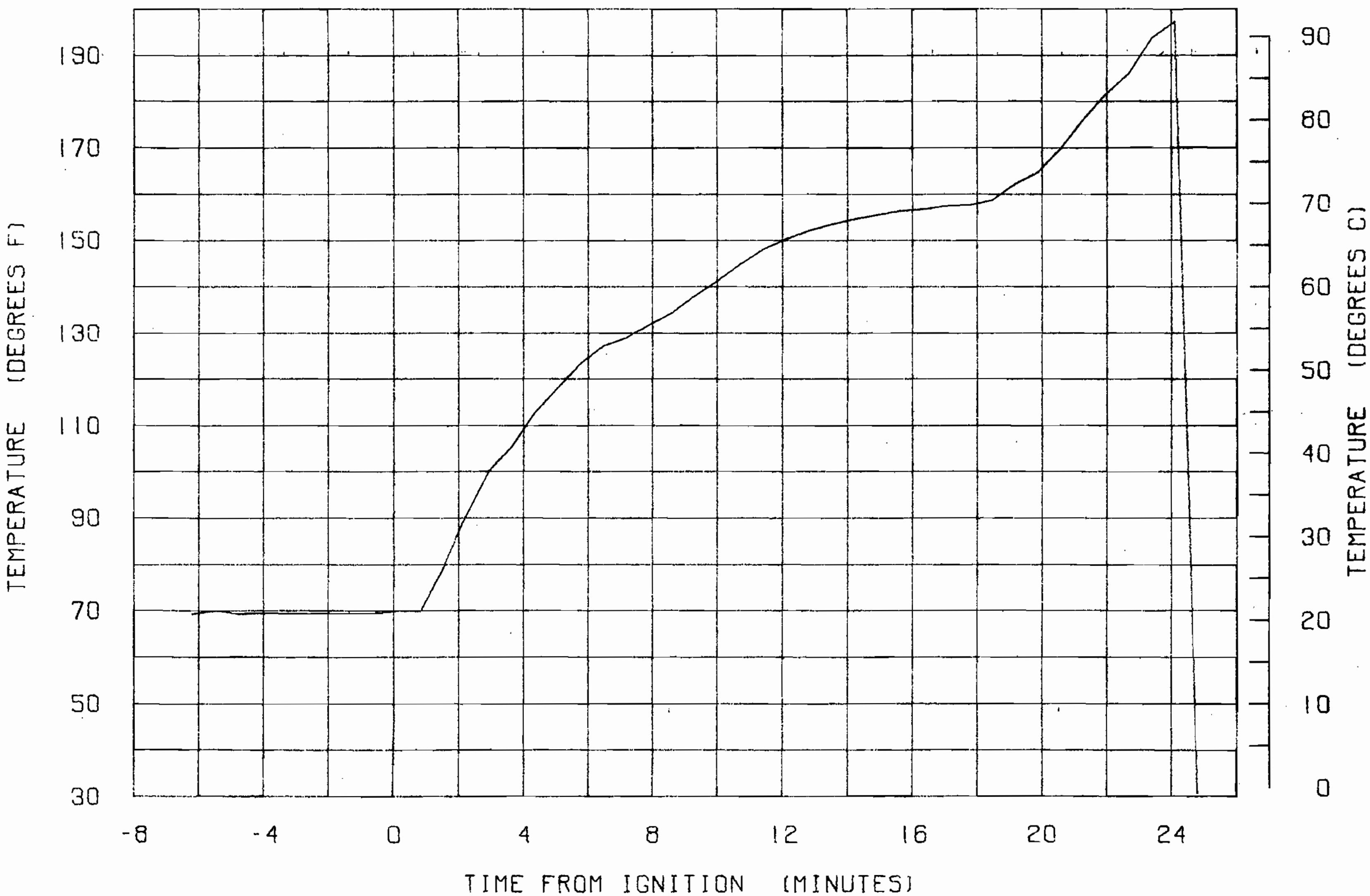

FIGURE A 26 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 30 OF TEST NUMBER 8

LOCATION IS REAR GRID AT 2.00 LEVEL LFT

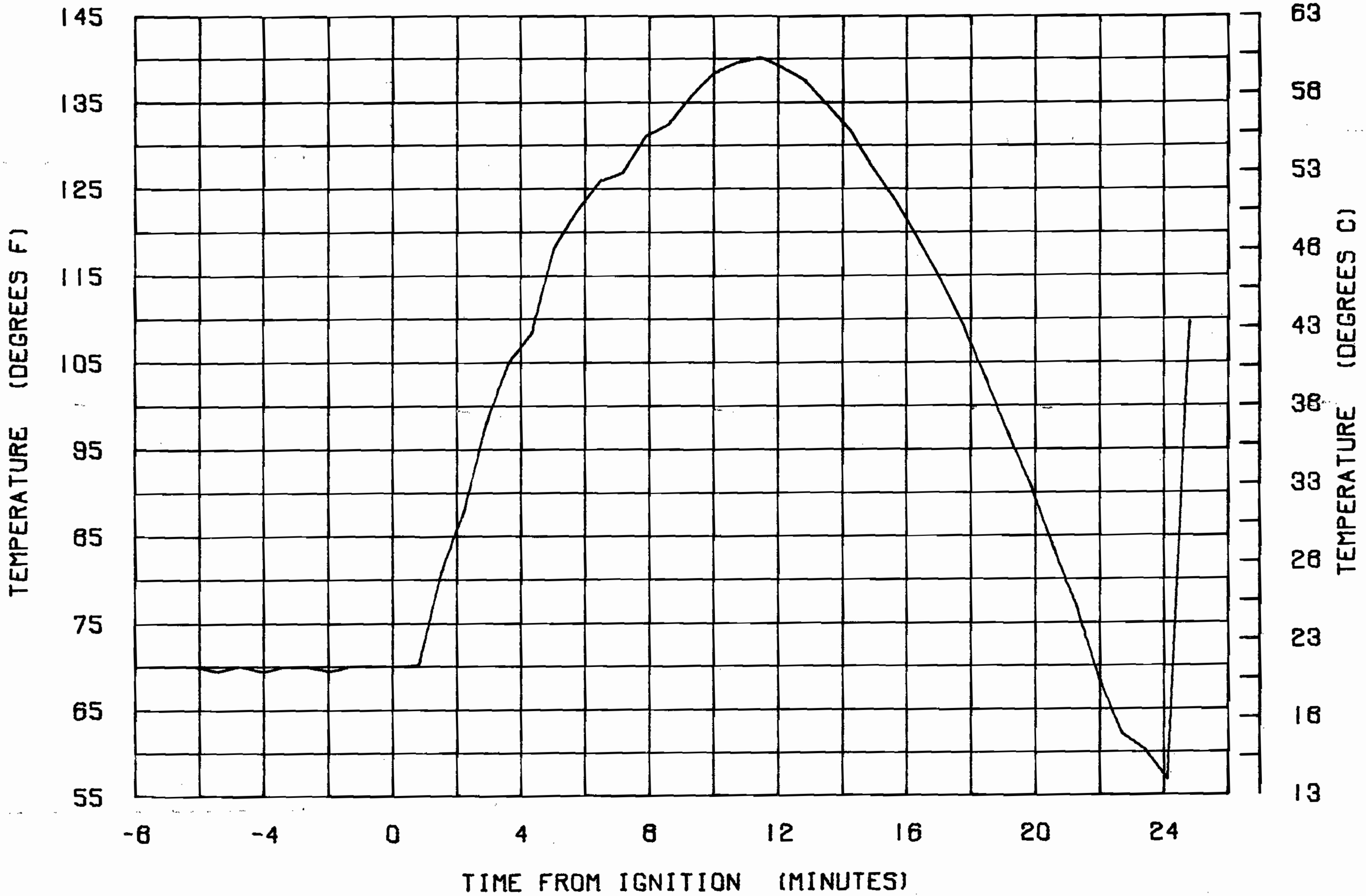

FIGURE A 27 THERMOCOUPLE TEMPERATURE VS. TIME

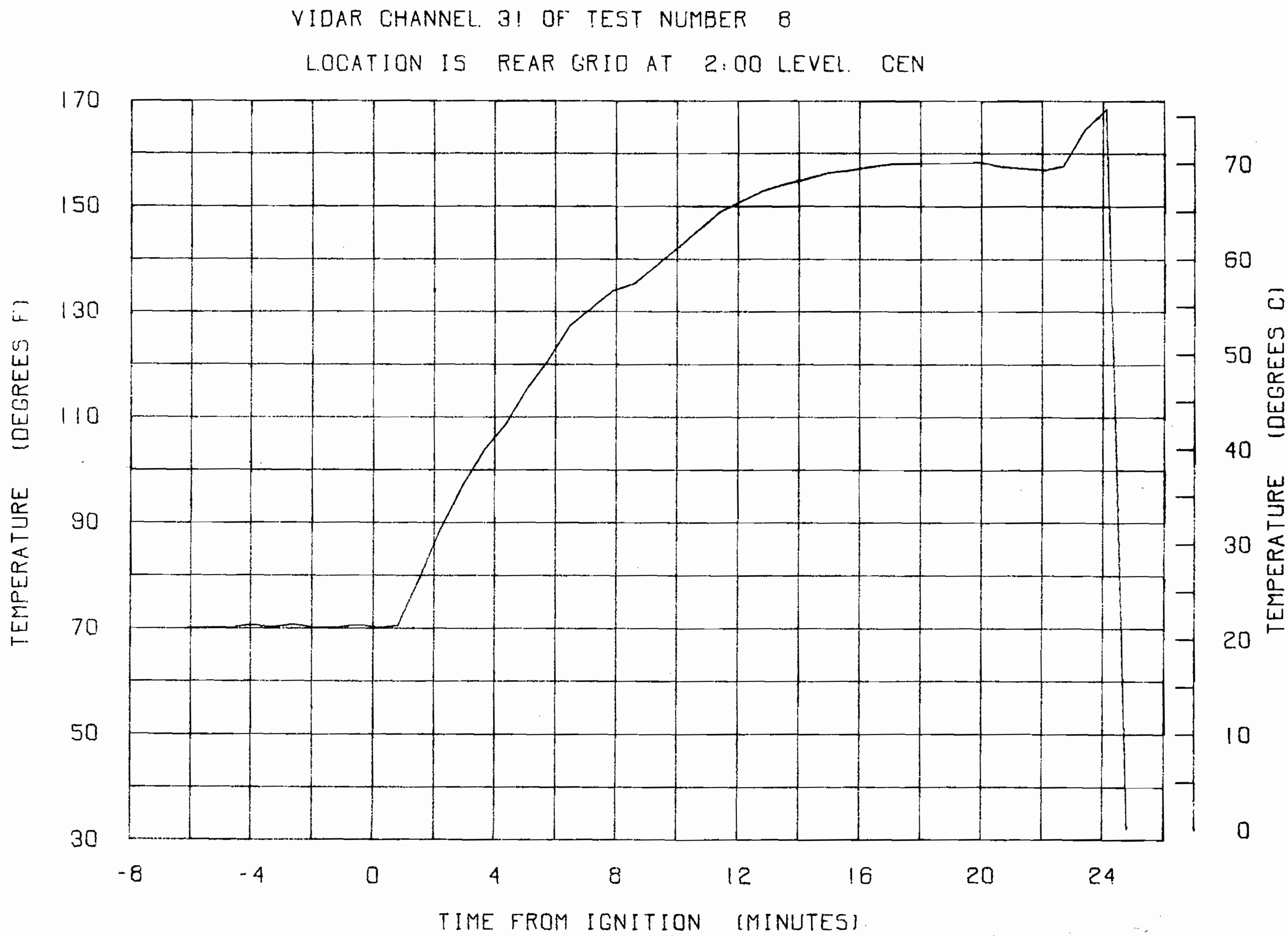

FIGURE A 28 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 32 OF TEST NUMBER 8

LOCATION IS REAR GRID AT 2:00 LEVEL RGT

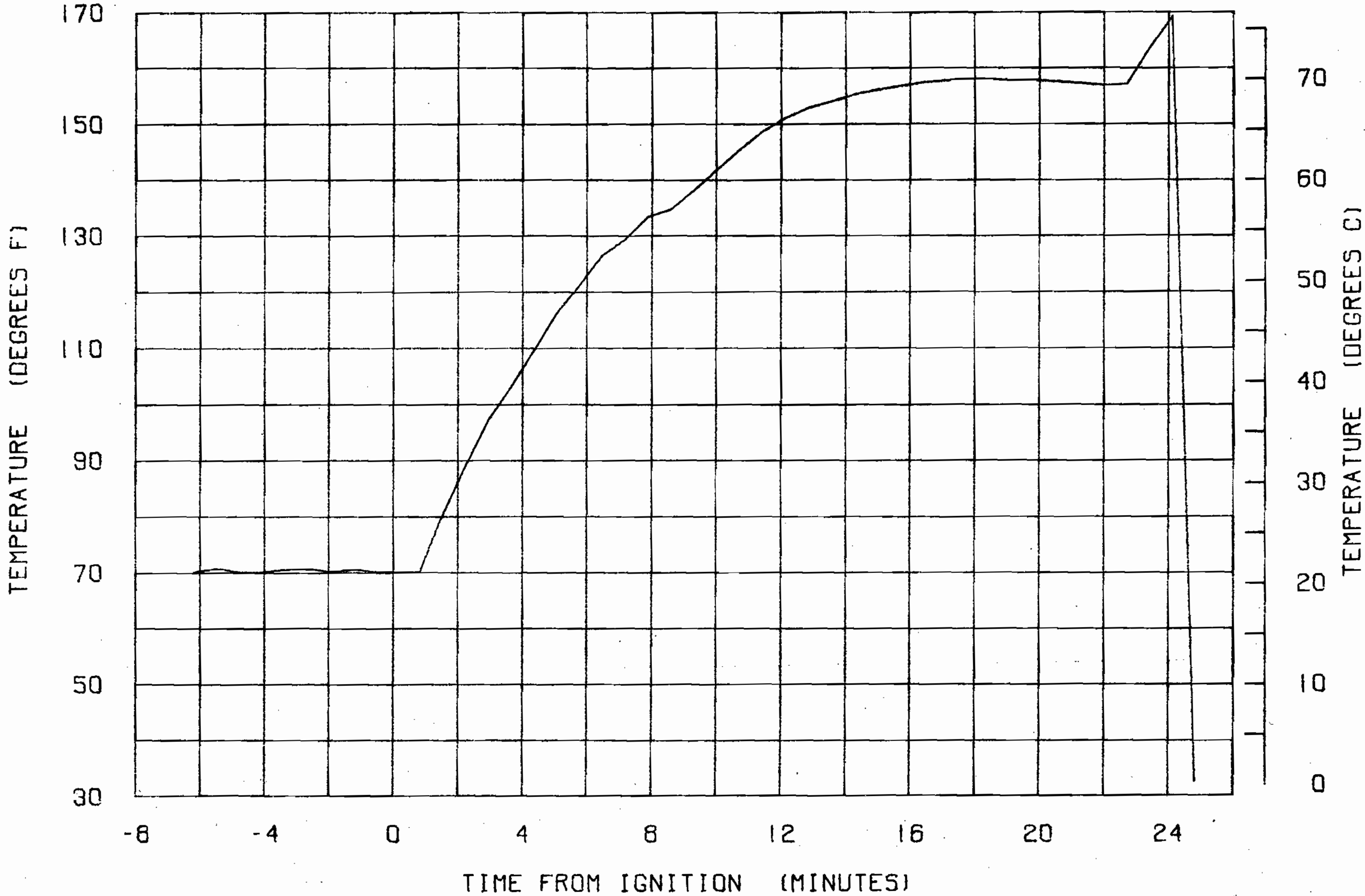

FIGURE A 29 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 33 OF TEST NUMBER 8

LOCATION IS REAR GRID AT 2:30 LEVEL LFT

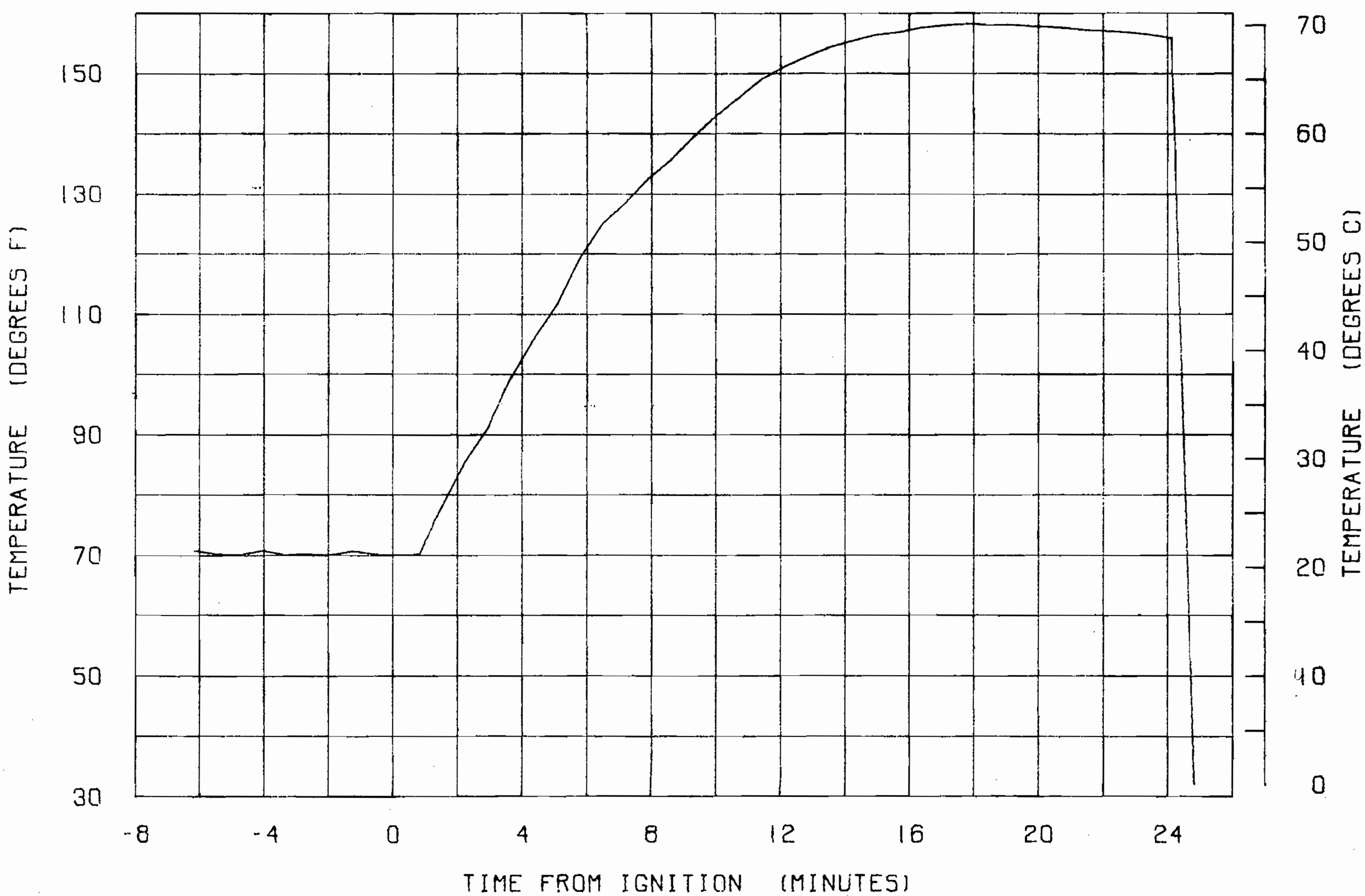

FIGURE A 30 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 34 OF TEST NUMBER 8

LOCATION IS REAR GRID AT 2.30 LEVEL CEN

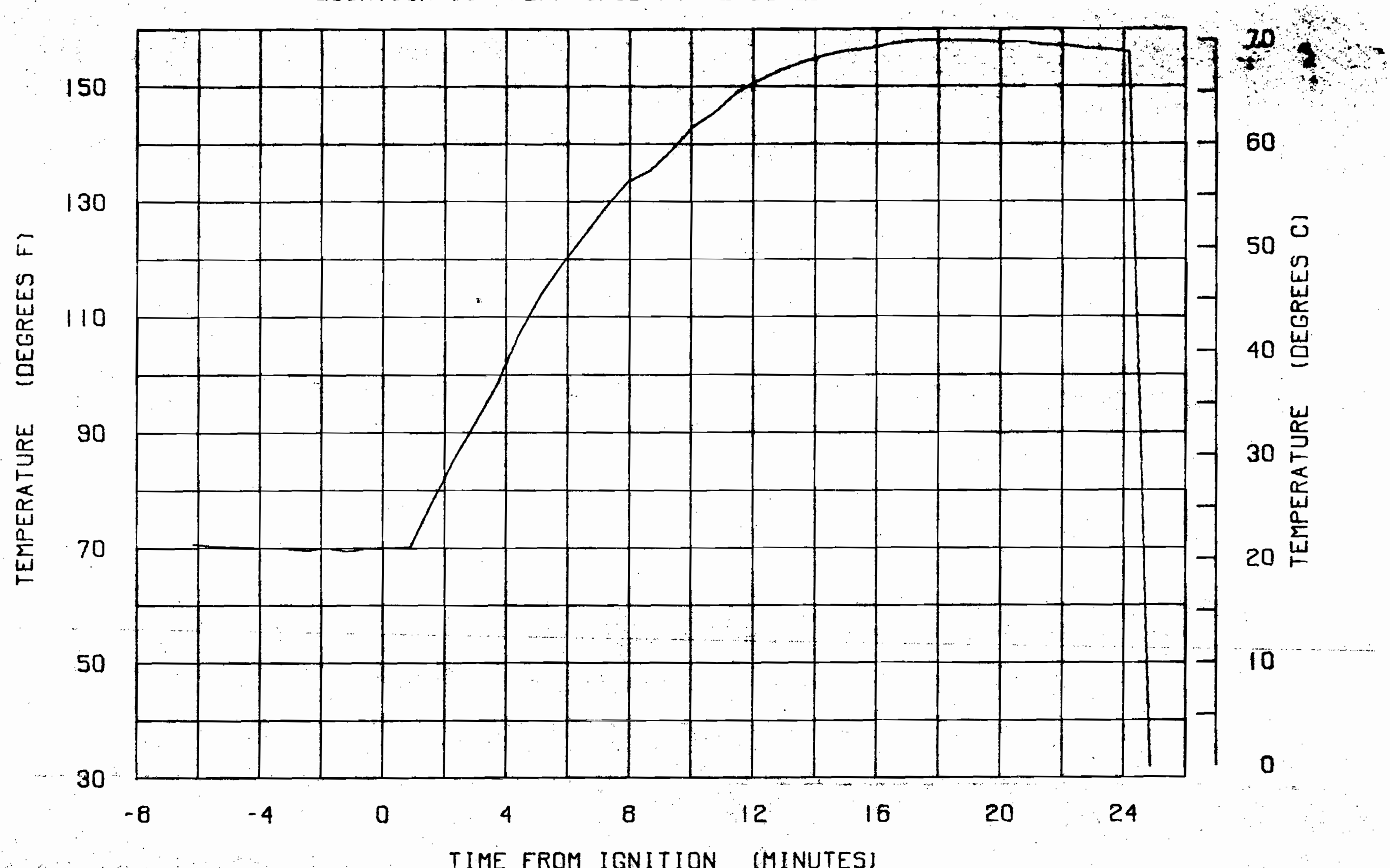

FIGURE A 31 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 35 OF TEST NUMBER 8

LOCATION IS REAR GRID AT 2.30 LEVEL RGT

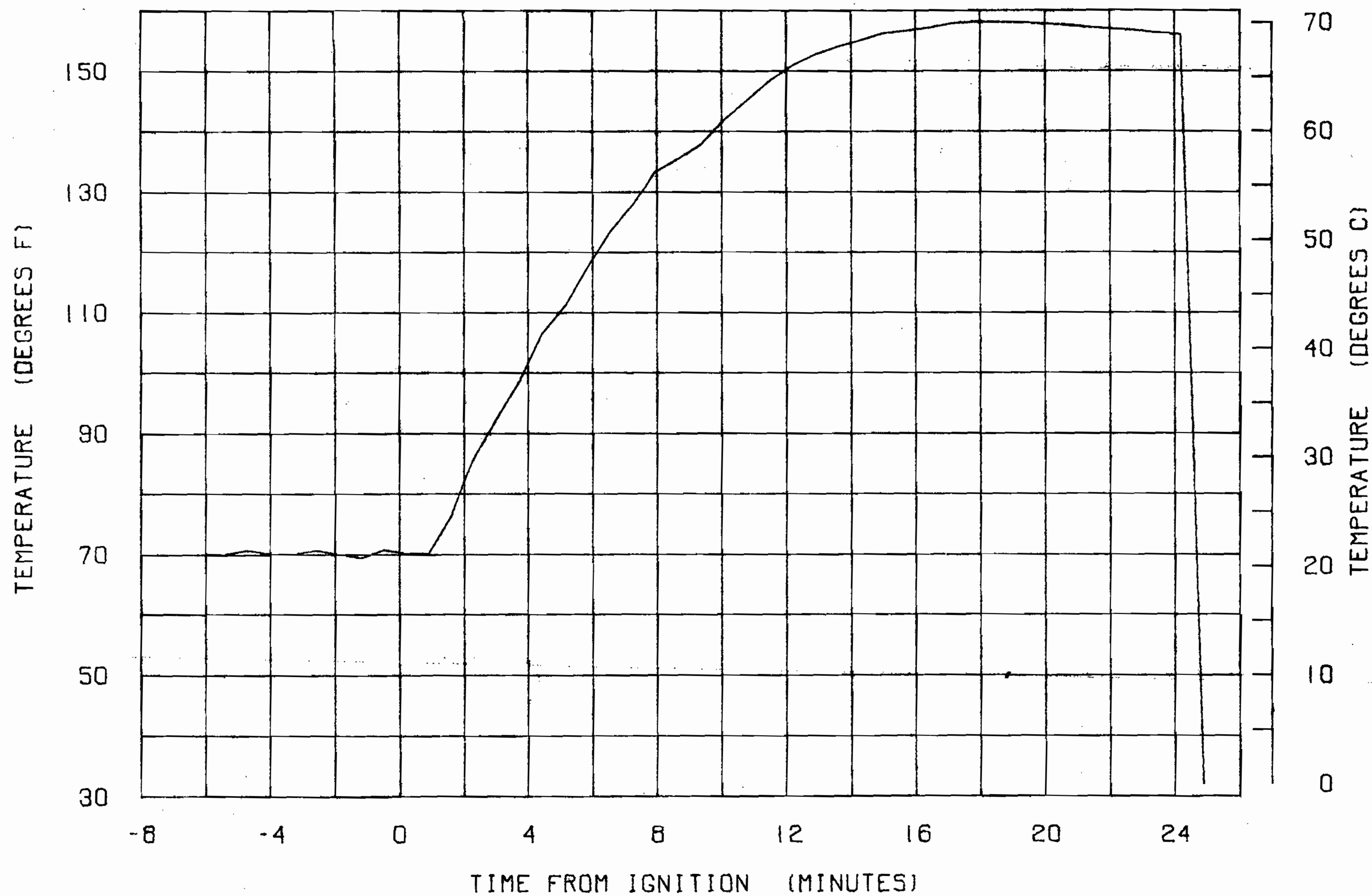

FIGURE A 32 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 36 OF TEST NUMBER 8

LOCATION IS REAR GRID AT 3:00 LEVEL LFTI

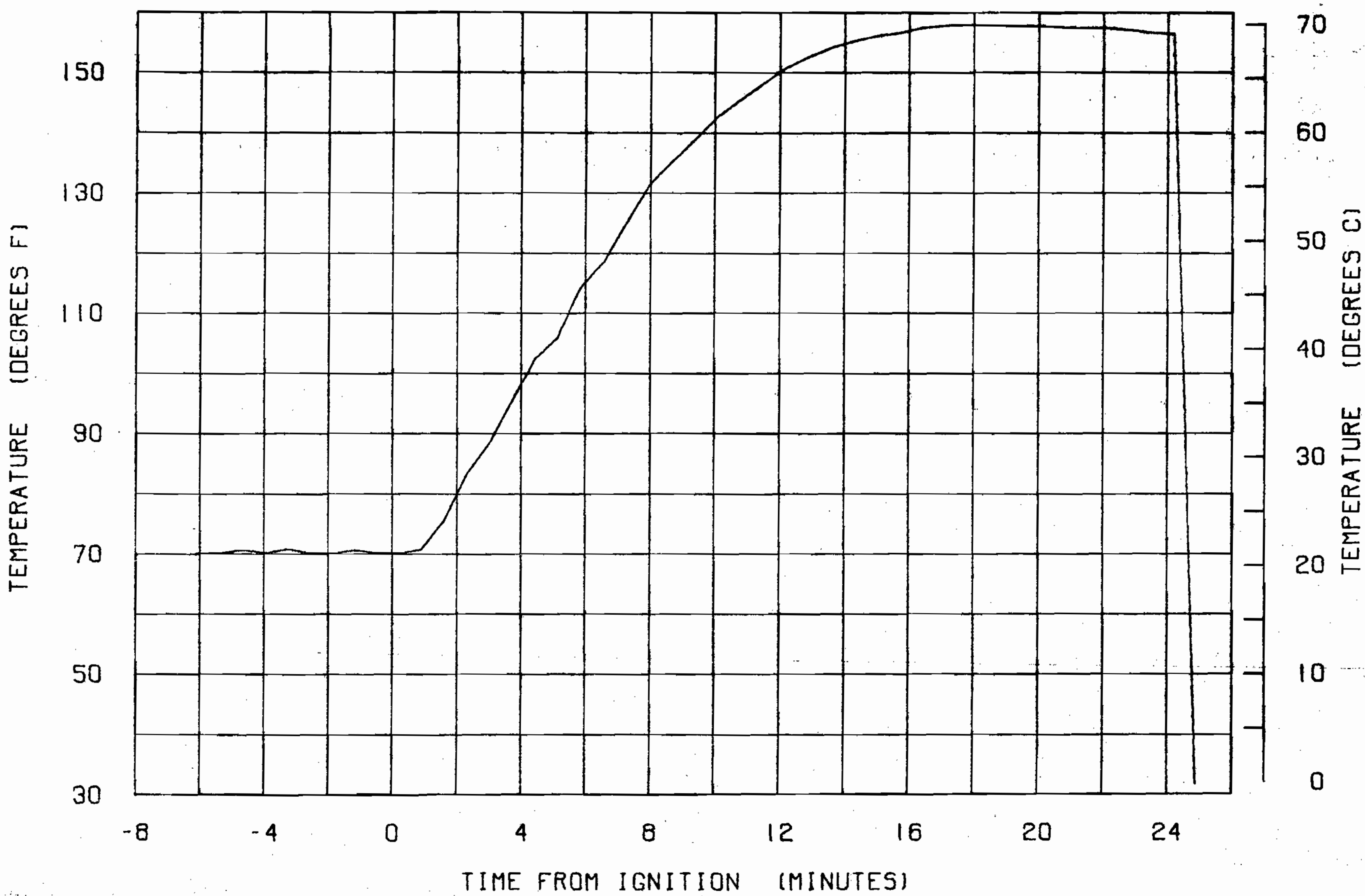

FIGURE **A 33** THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 37 OF TEST NUMBER 8

LOCATION IS REAR GRID AT 3.00 LEVEL LFT2

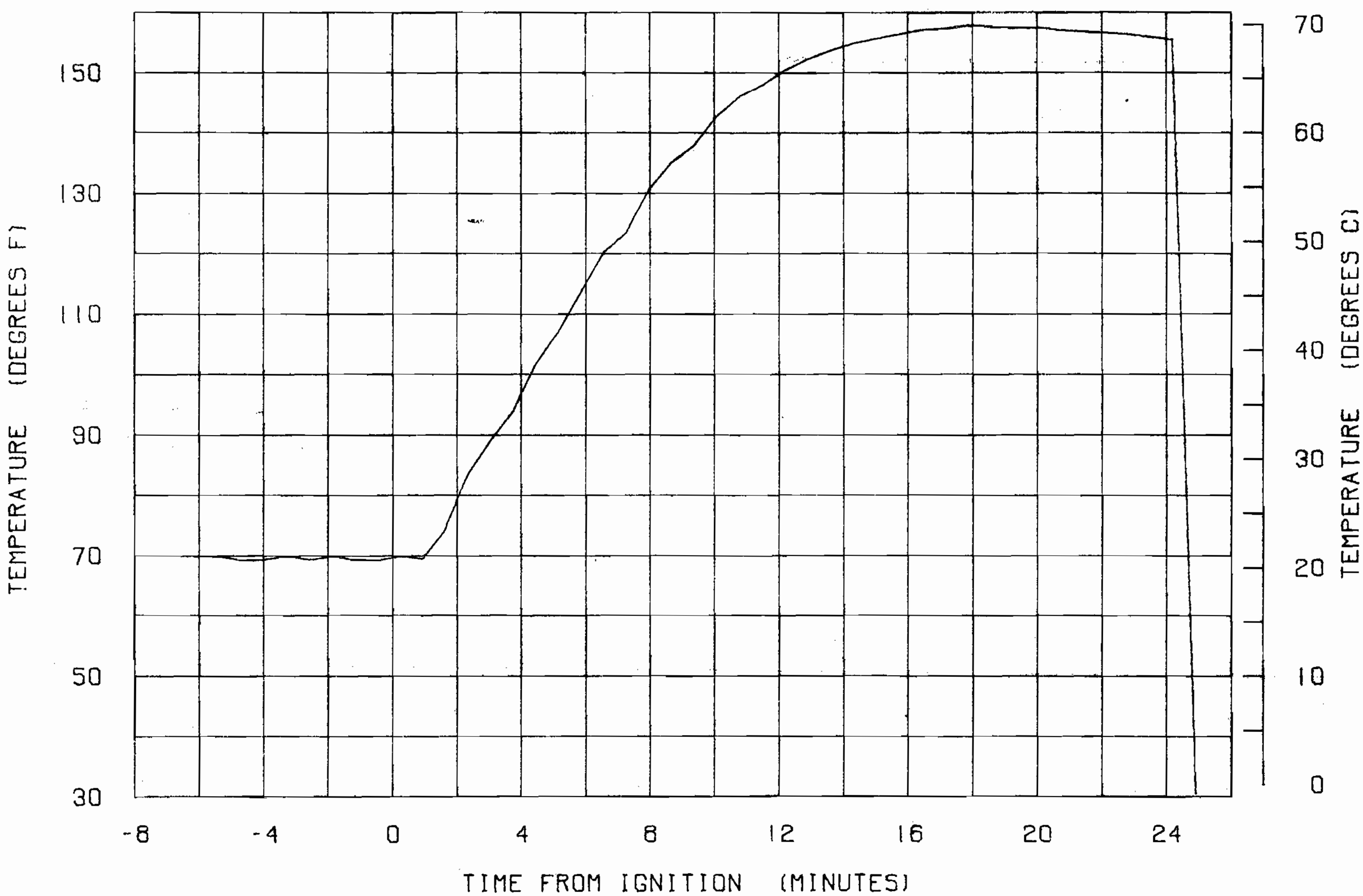

FIGURE A 34 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 38 OF TEST NUMBER 8

LOCATION IS REAR GRID AT 3.00 LEVEL CEN

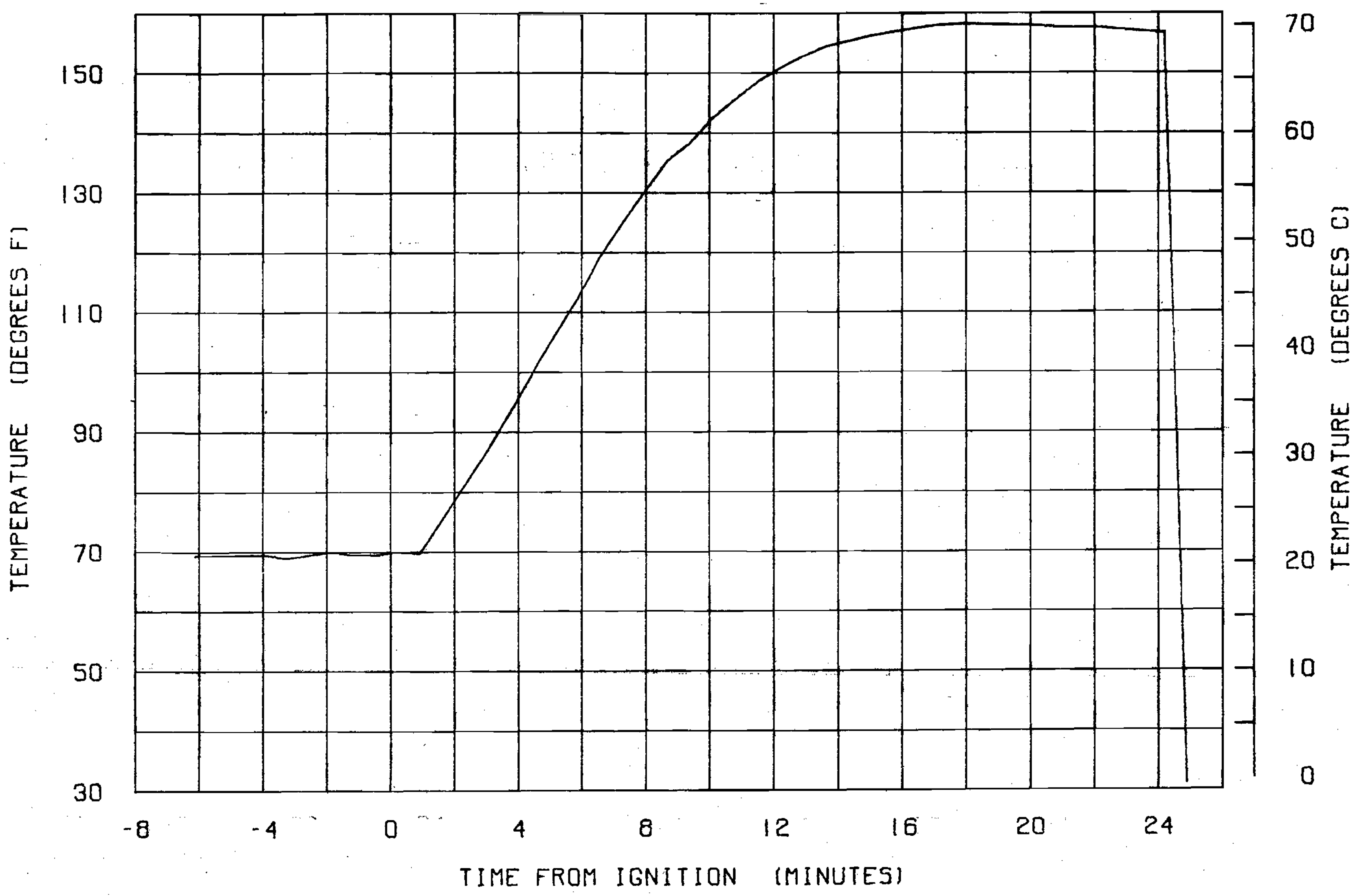

FIGURE A 35 THERMOCOUPLE TEMPERATURE VS. TIME

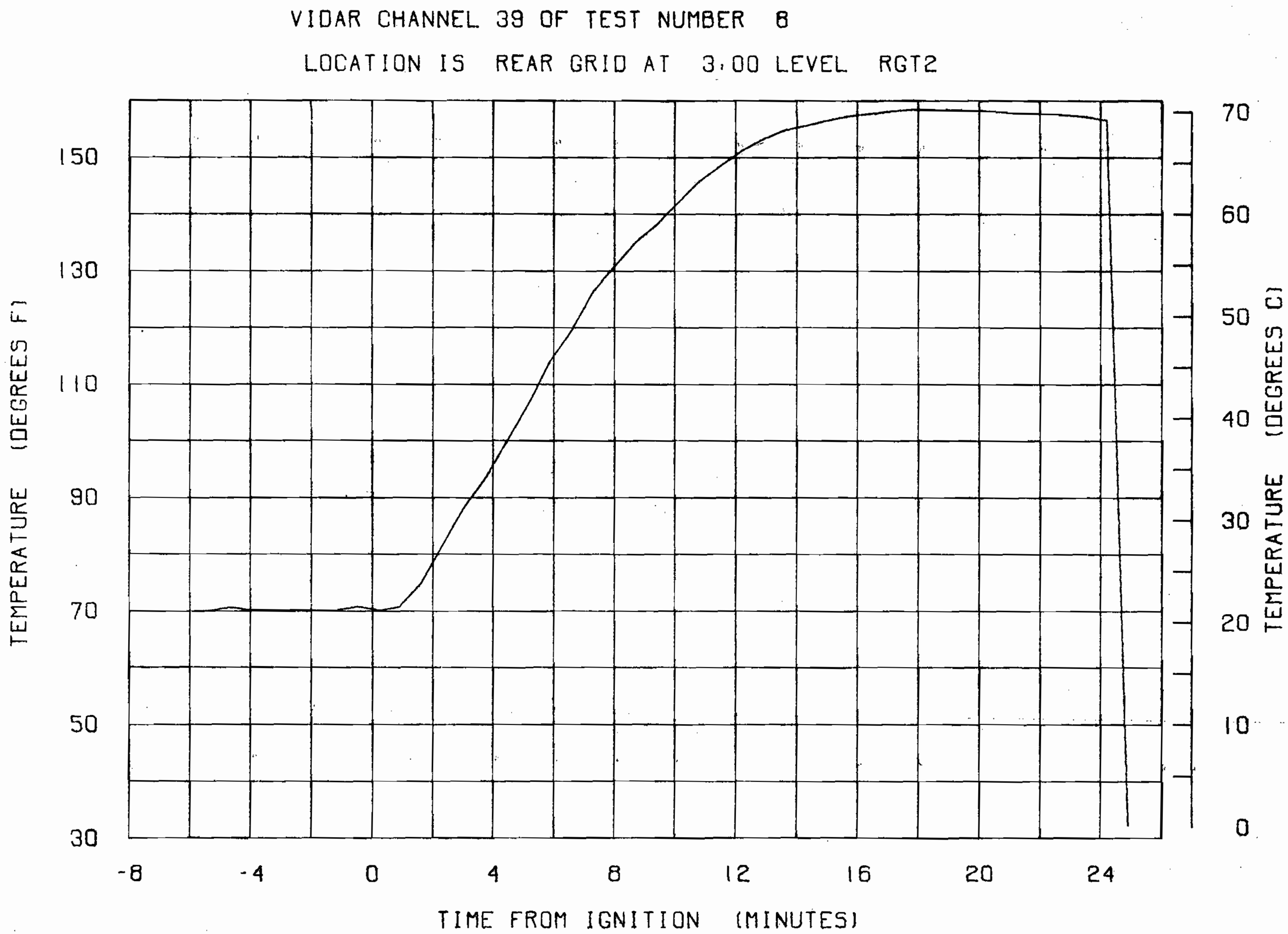

FIGURE A 36 THERMOCOUPLE TEMPERATURE VS. TIME

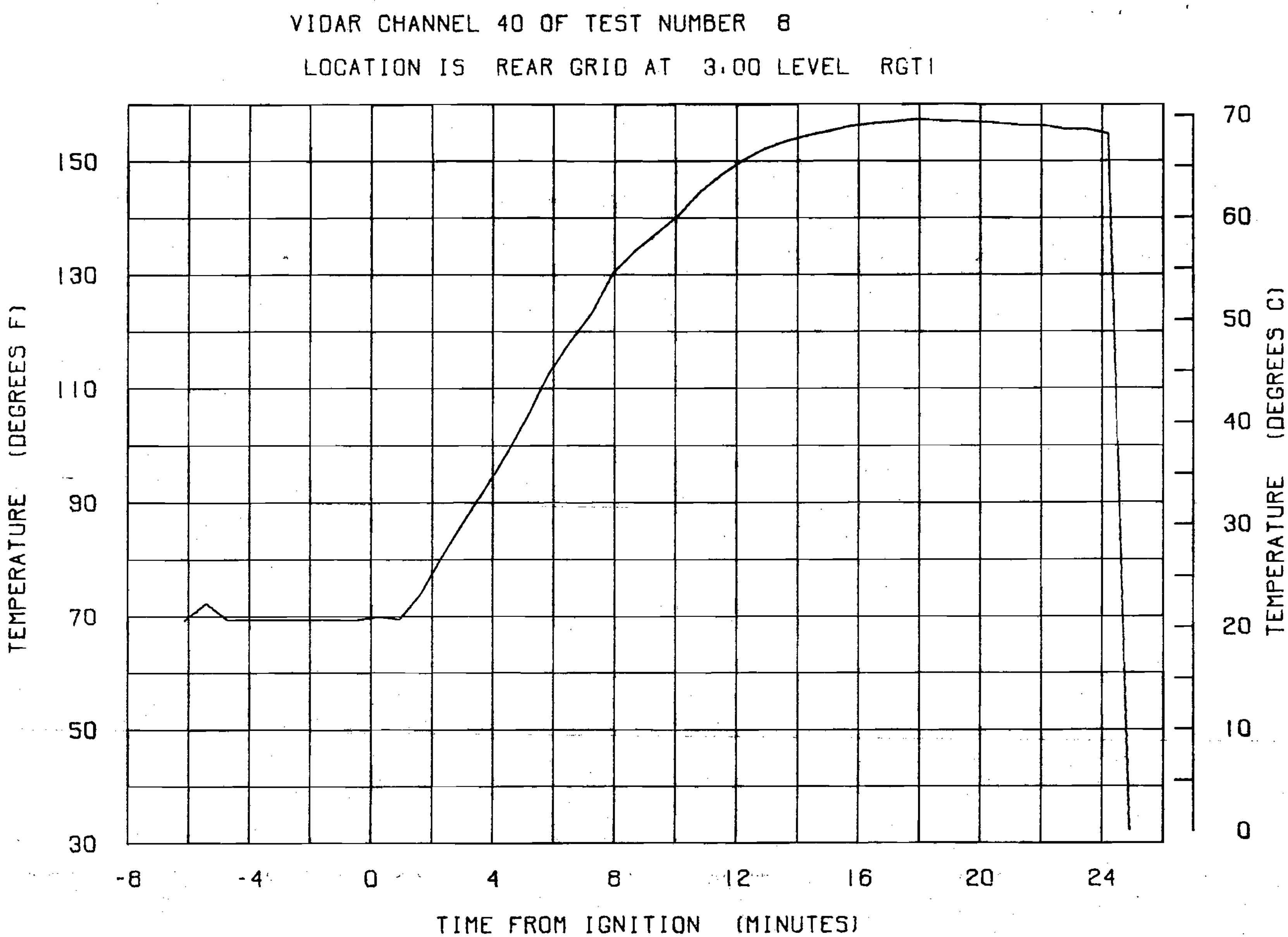

FIGURE A 37 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 41 OF TEST NUMBER 8

LOCATION IS REAR GRID AT 3,30 LEVEL LFT

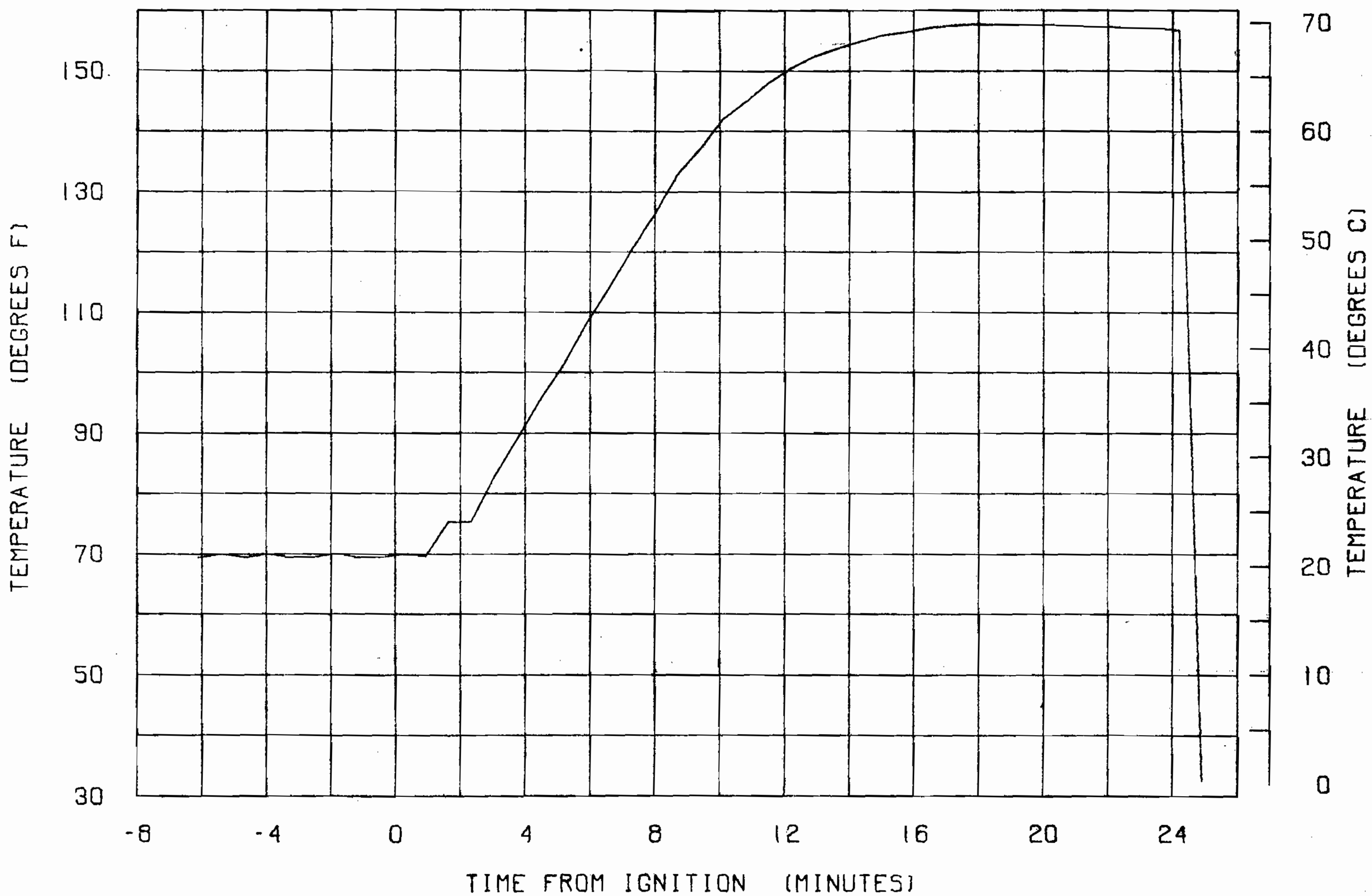

FIGURE A 38 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 43 OF TEST NUMBER 8

LOCATION IS REAR GRID AT 3.30 LEVEL RGT

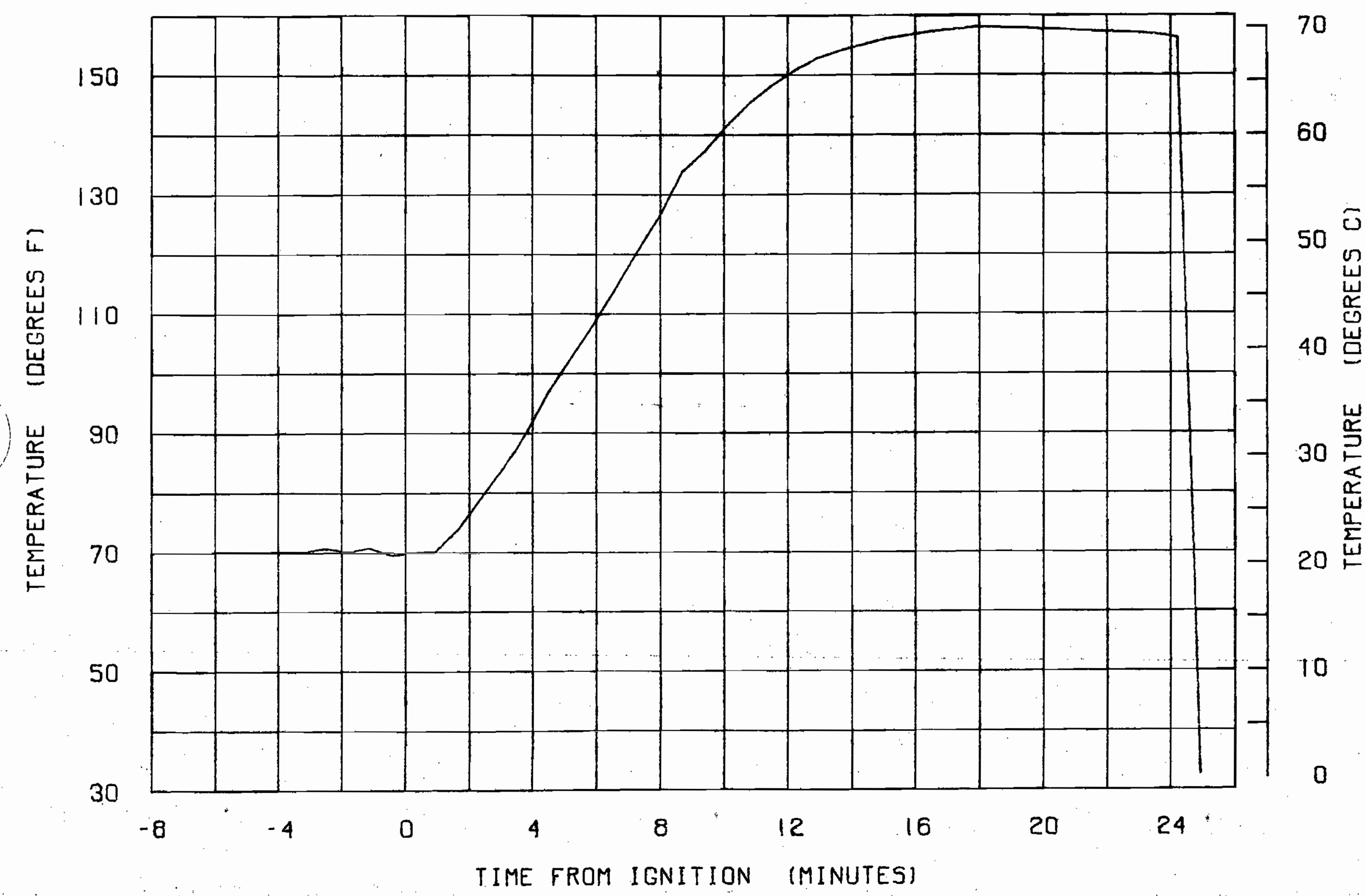

FIGURE A 39 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 44 OF TEST NUMBER 8

LOCATION IS REAR GRID AT 4.00 LEVEL LFT

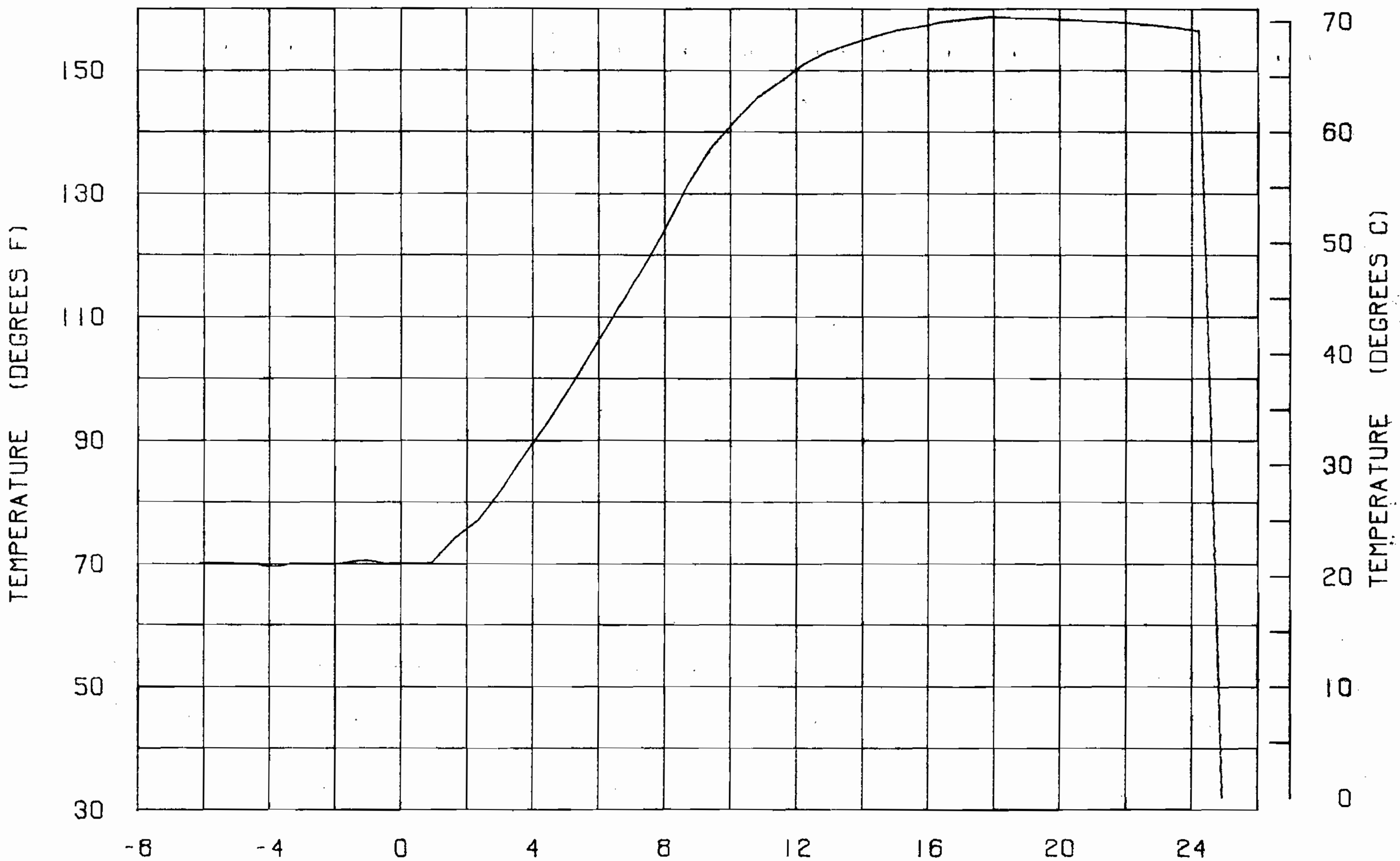

FIGURE A 40 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 45 OF TEST NUMBER 8

LOCATION IS REAR GRID AT 4.00 LEVEL CEN

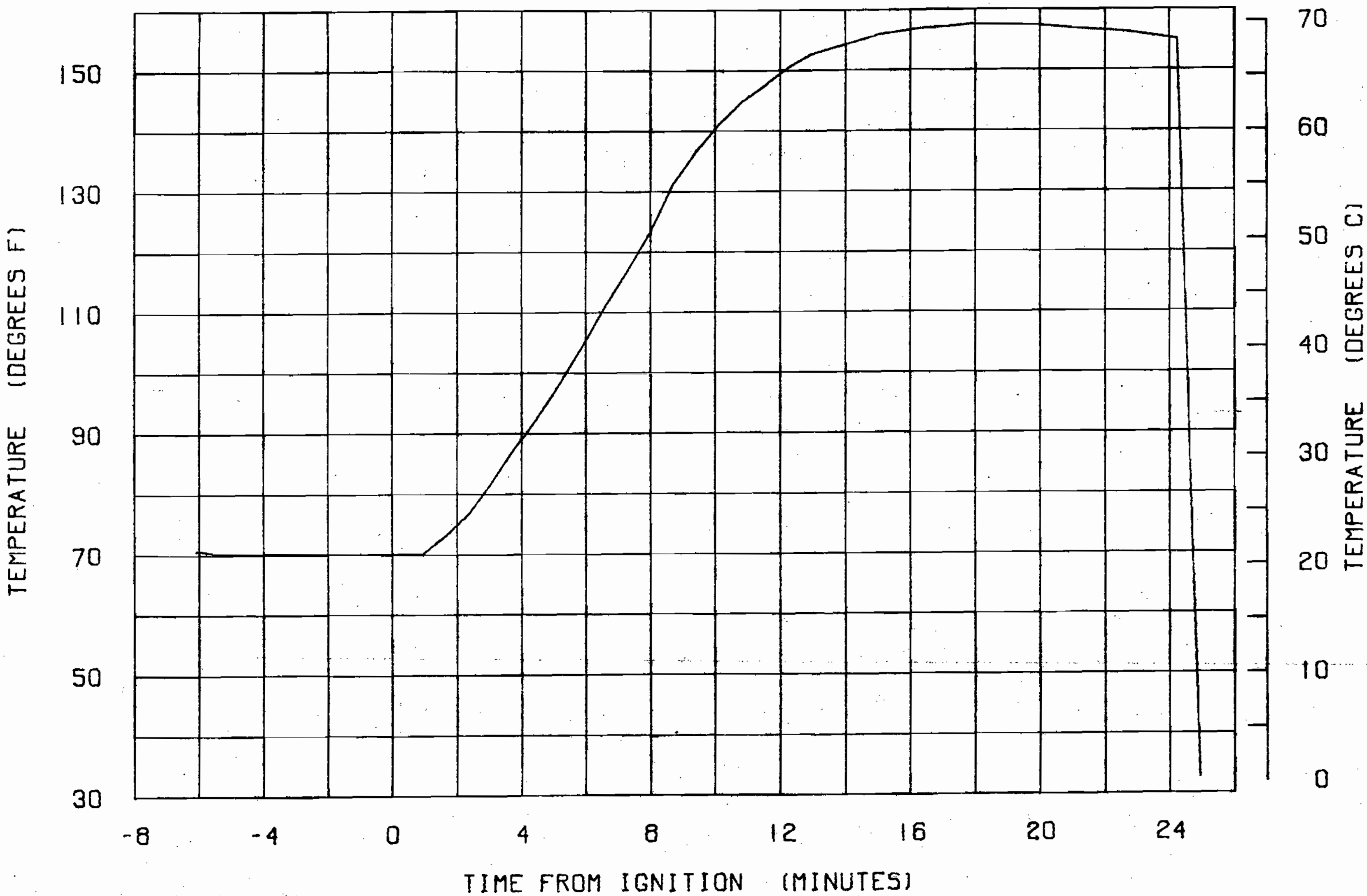

FIGURE A 41 THERMOCOUPLE TEMPERATURE VS. TIME

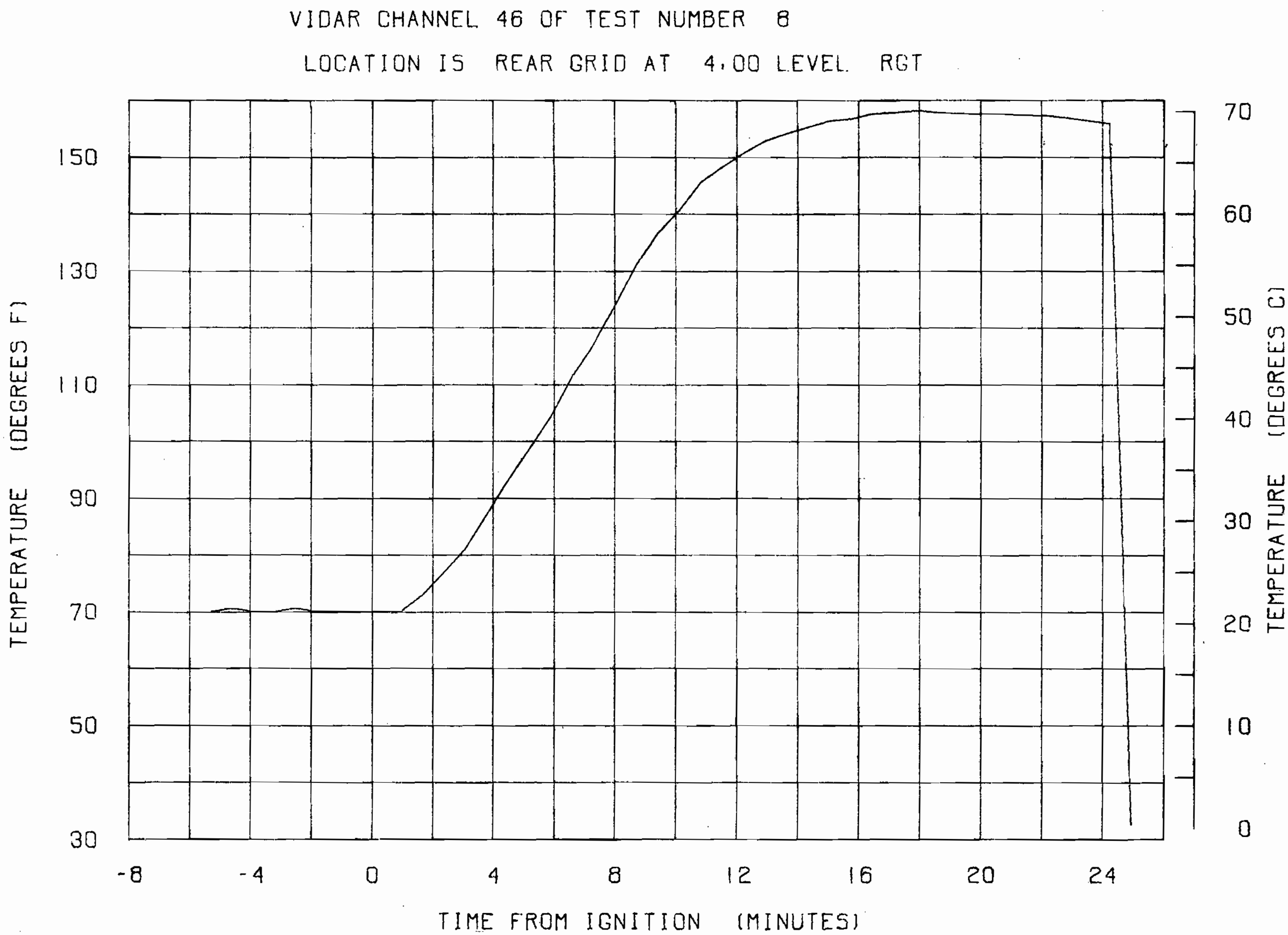

FIGURE A 42 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 47 OF TEST NUMBER 8

LOCATION IS REAR GRID AT 4:30 LEVEL LFT

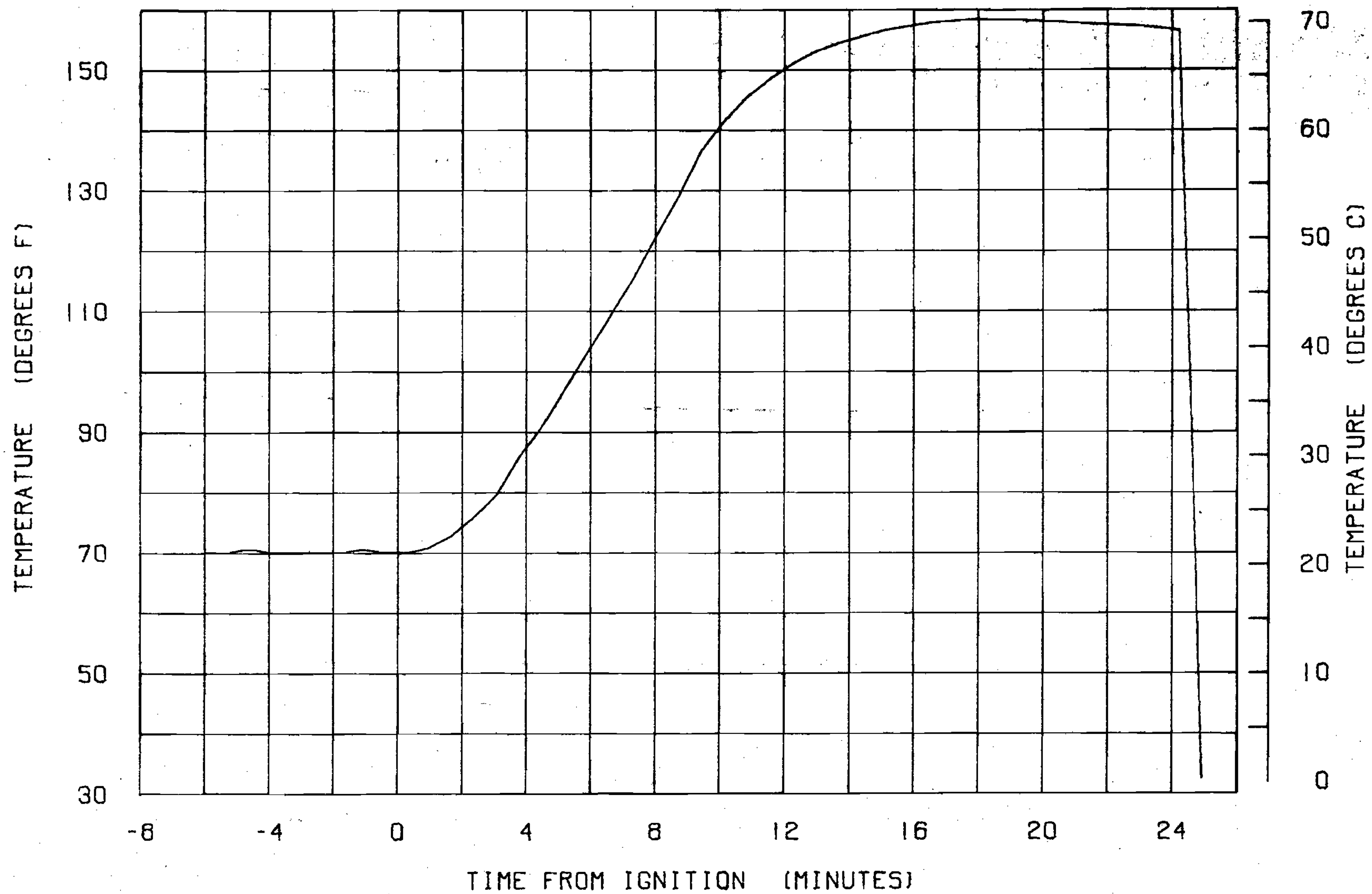

FIGURE A 43 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 48 OF TEST NUMBER 8

LOCATION IS REAR GRID AT 4.30 LEVEL CEN

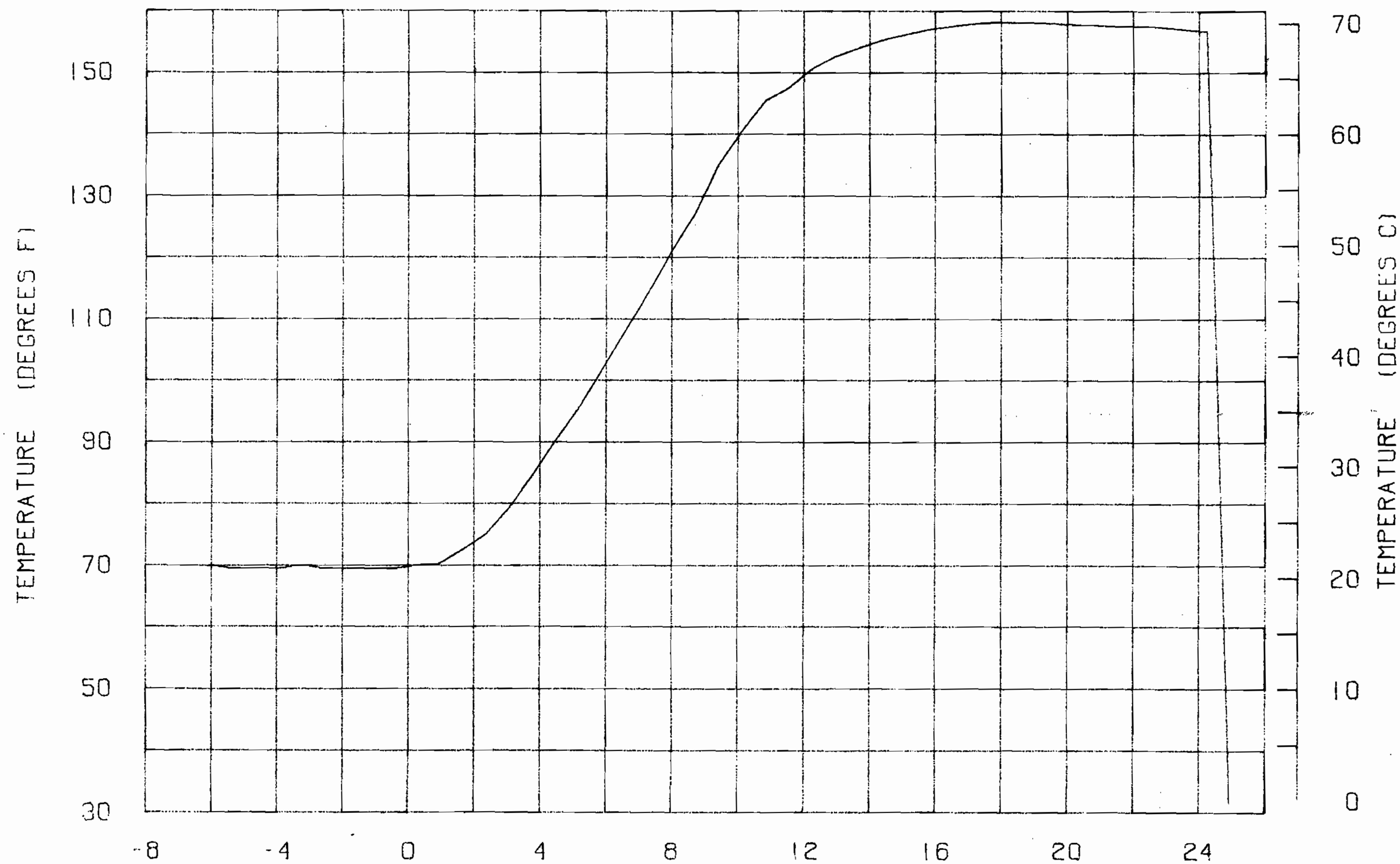

FIGURE **A 44** THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 49 OF TEST NUMBER 8

LOCATION IS REAR GRID AT 4,30 LEVEL RGT

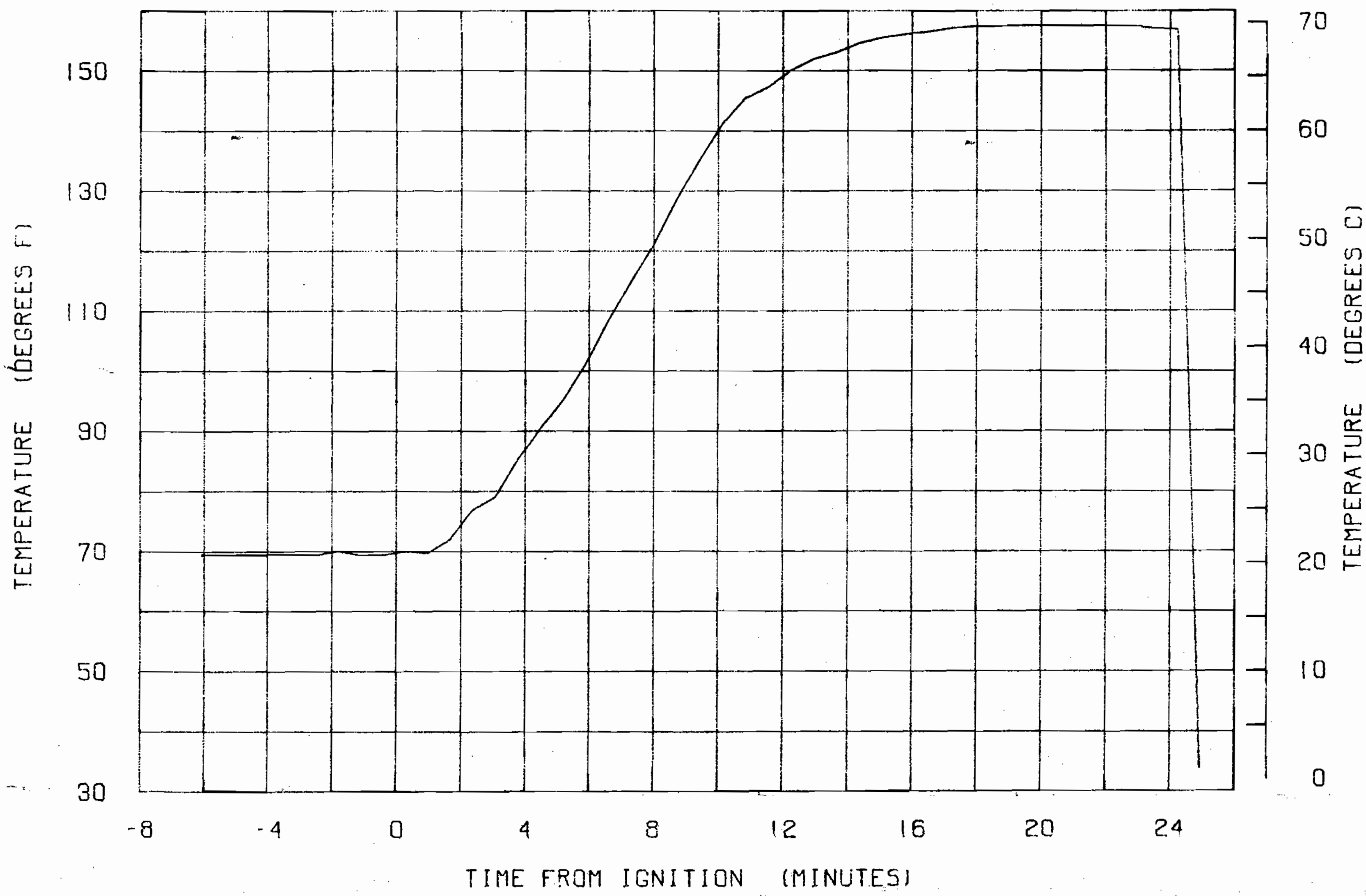

FIGURE **A 45** THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 50 OF TEST NUMBER 8

LOCATION IS REAR GRID AT 5.00 LEVEL CEN

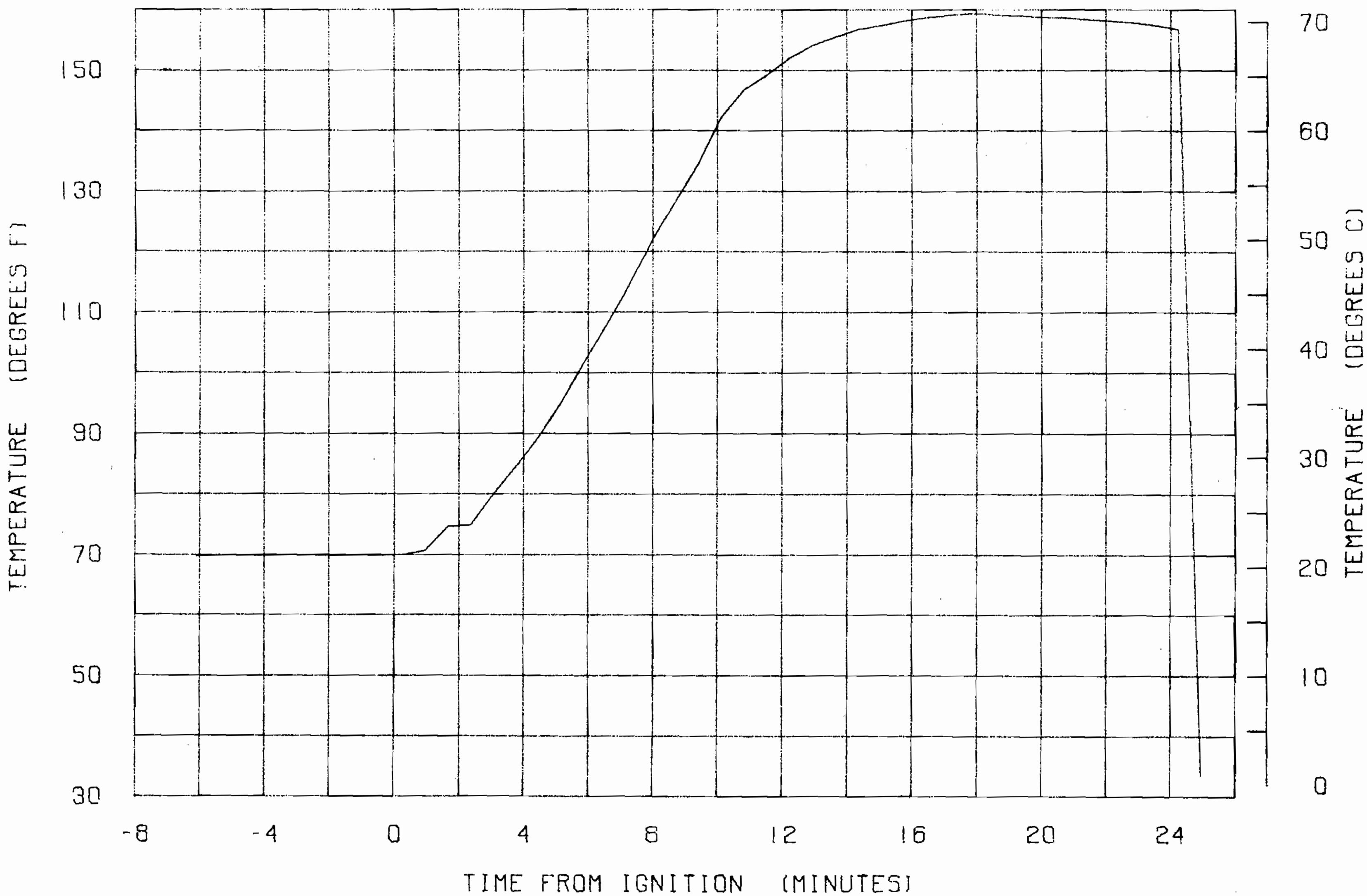

FIGURE **A 46** THERMOCOUPLE TEMPERATURE VS. TIME

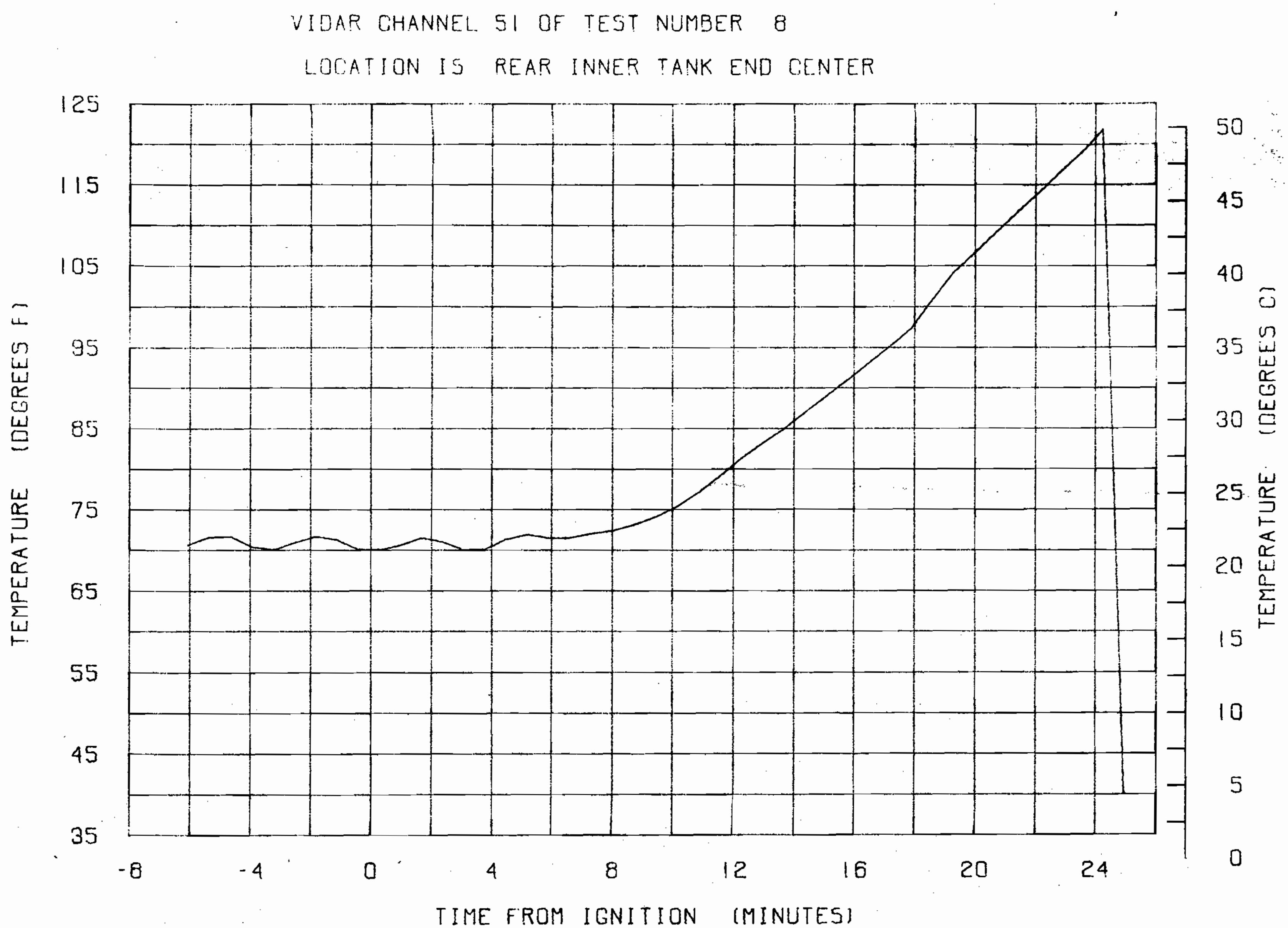

FIGURE **A 47** THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 52 OF TEST NUMBER 6

LOCATION IS POSSUM HUT

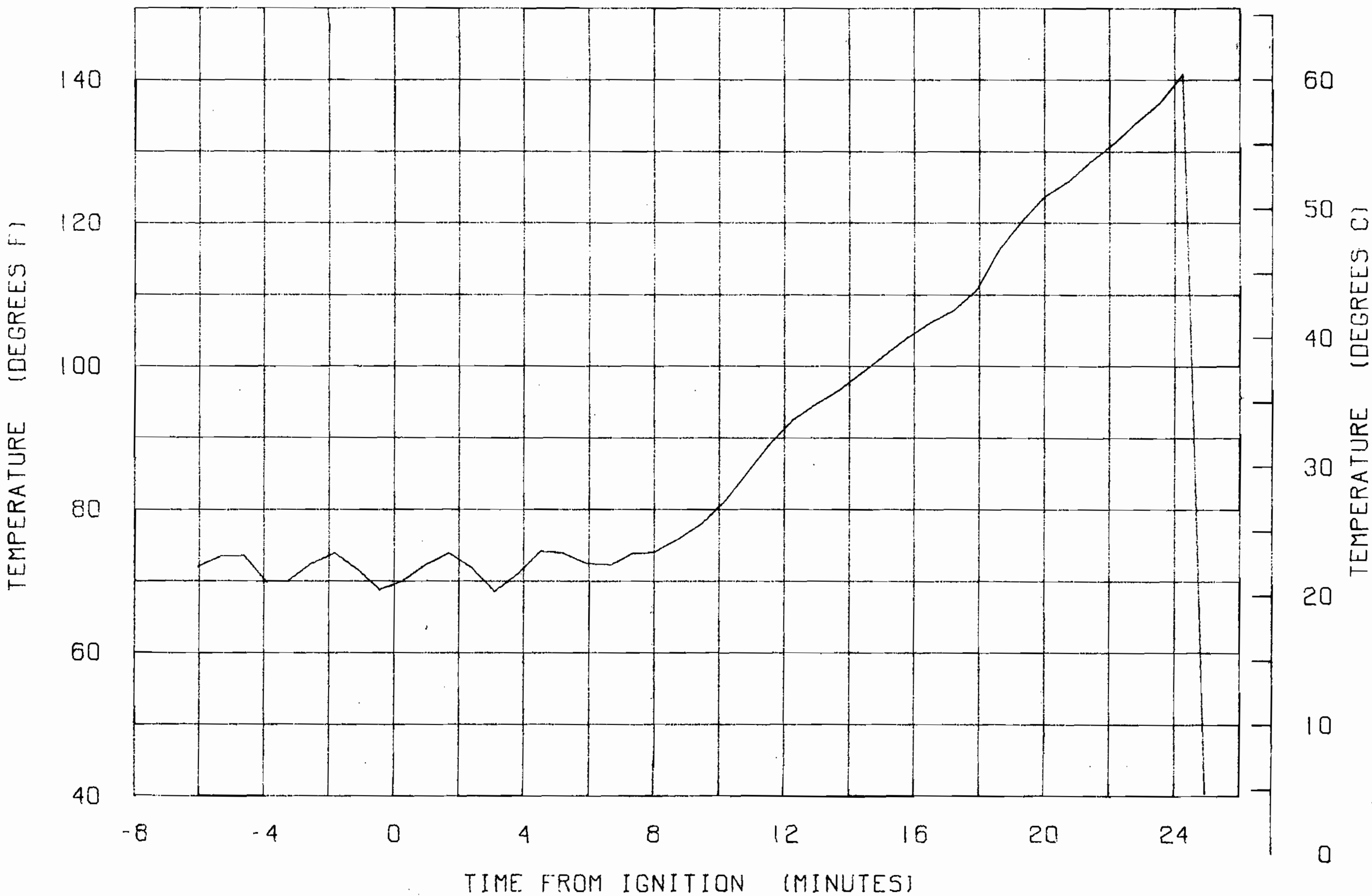

FIGURE **A 48** THERMOCOUPLE TEMPERATURE VS. TIME

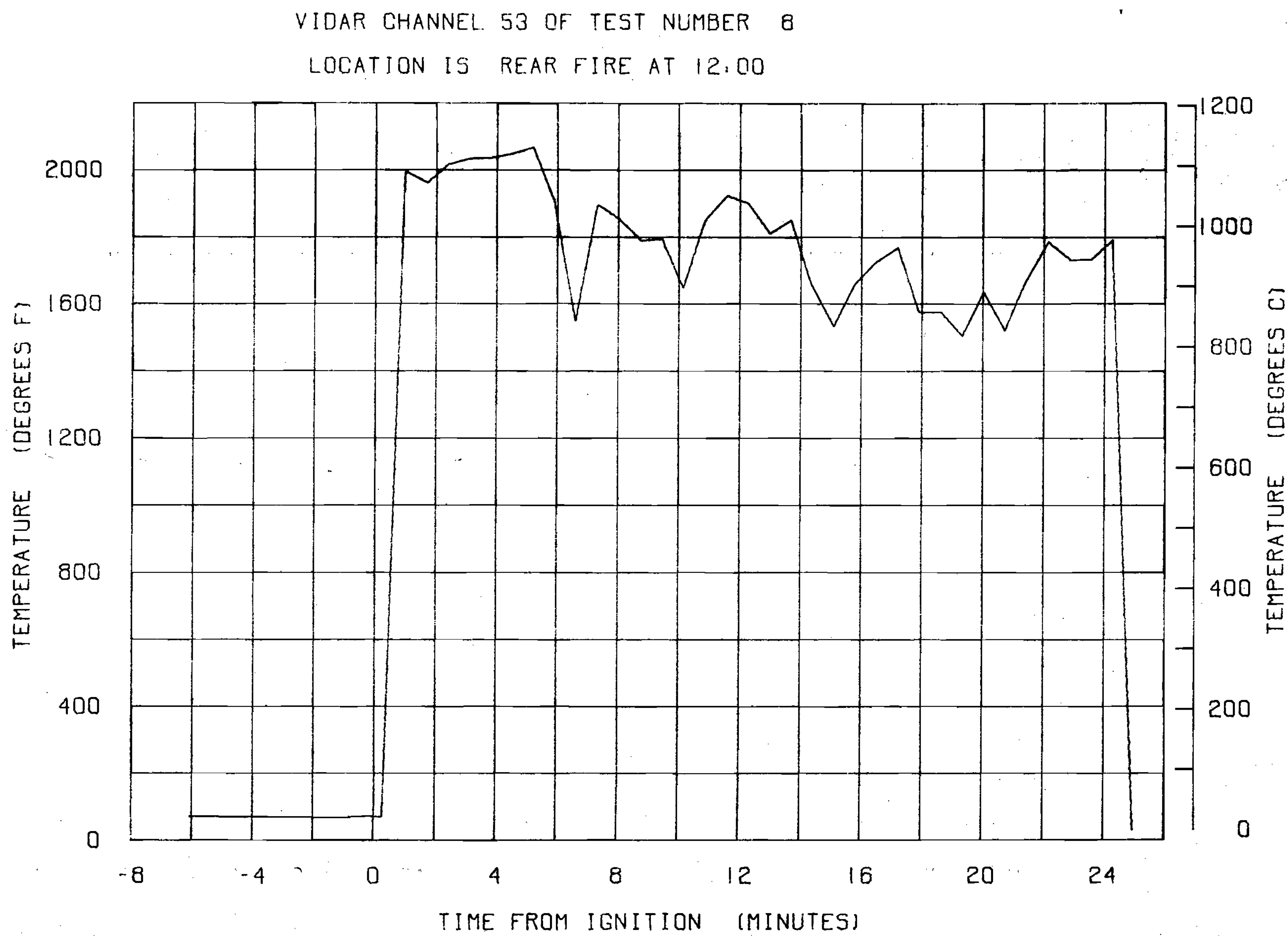

FIGURE A 49 THERMOCOUPLE TEMPERATURE VS. TIME

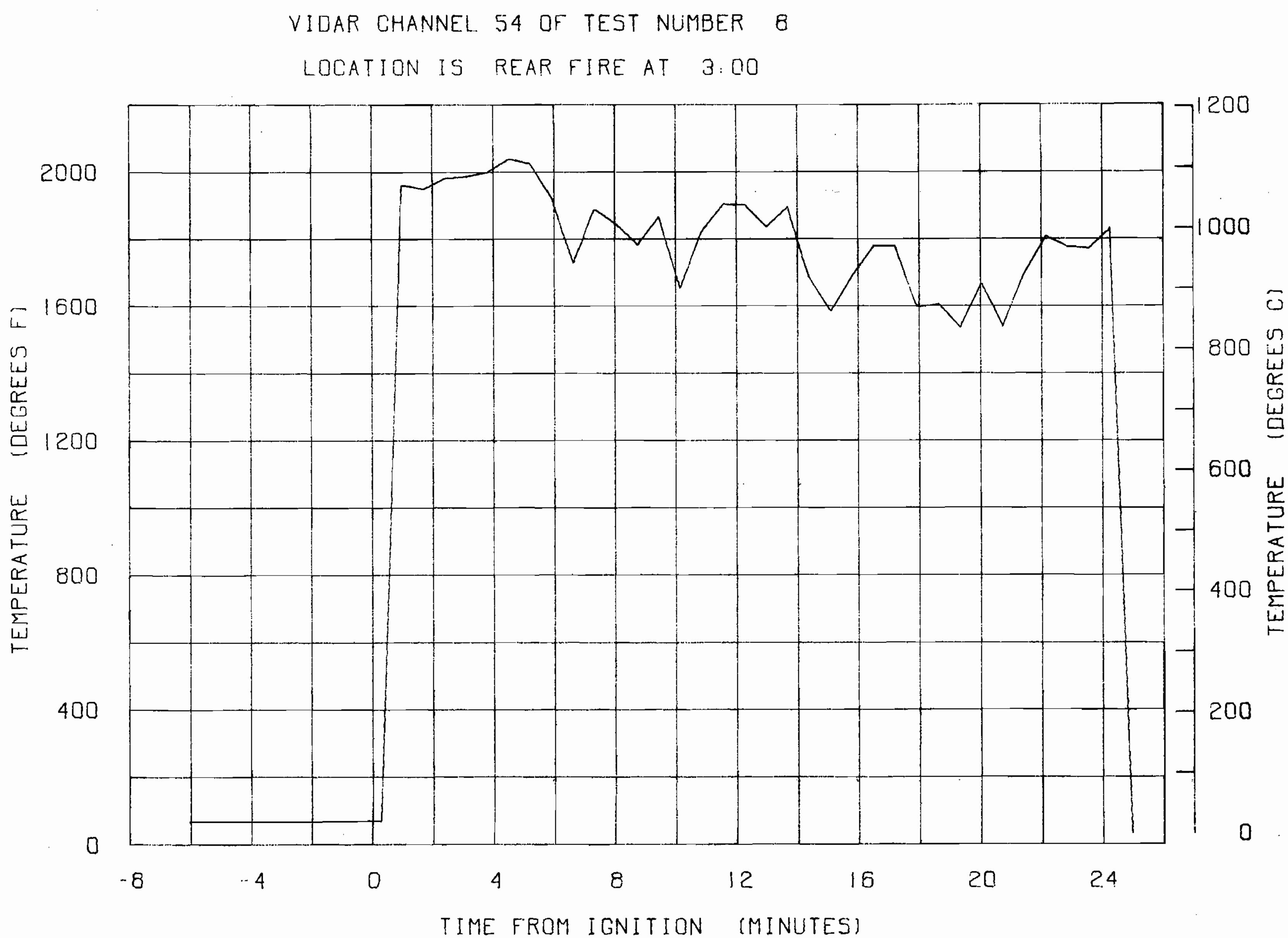

FIGURE A 50 THERMOCOUPLE TEMPERATURE VS. TIME

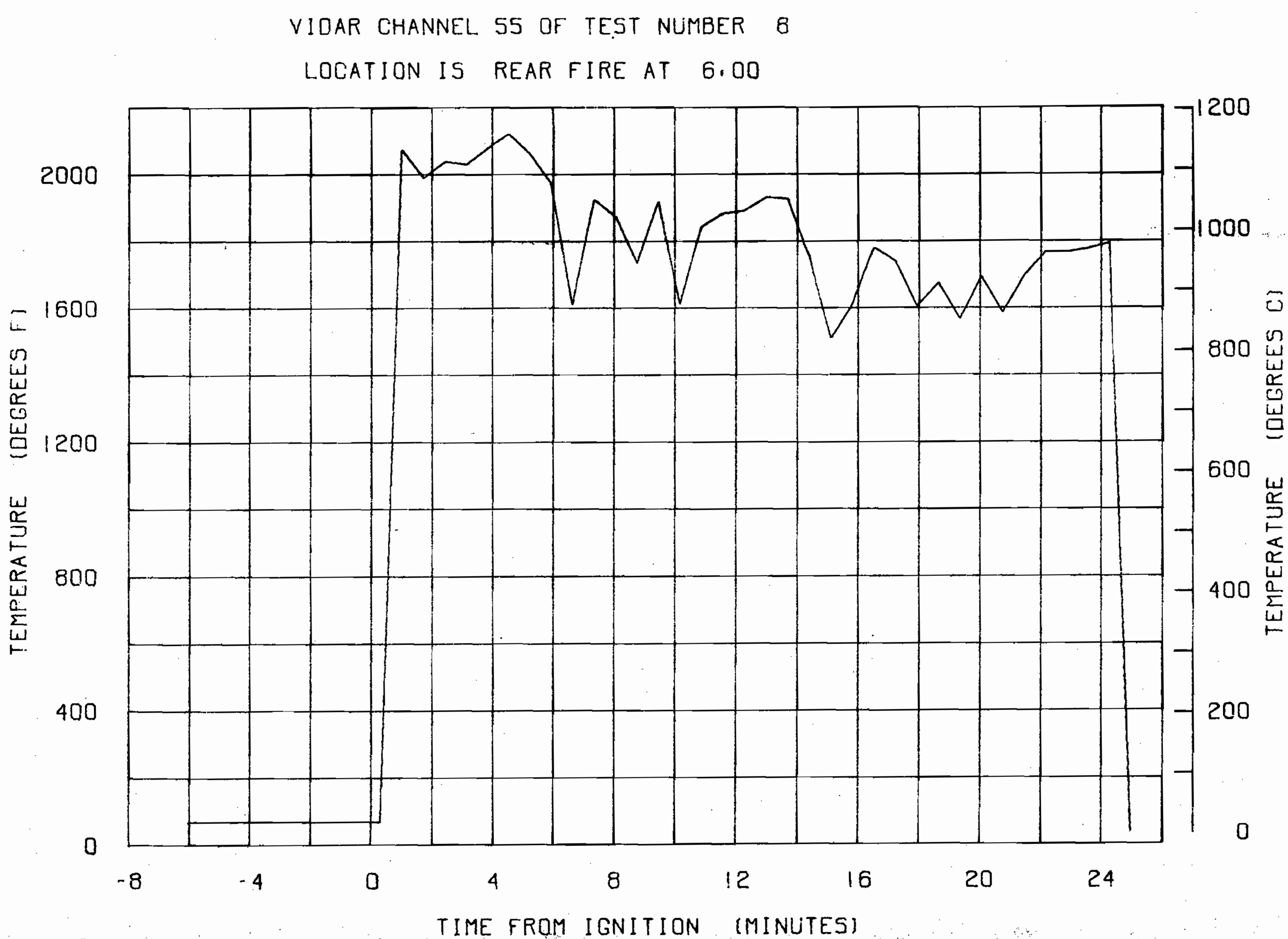

FIGURE **A 51** THERMOCOUPLE TEMPERATURE VS. TIME

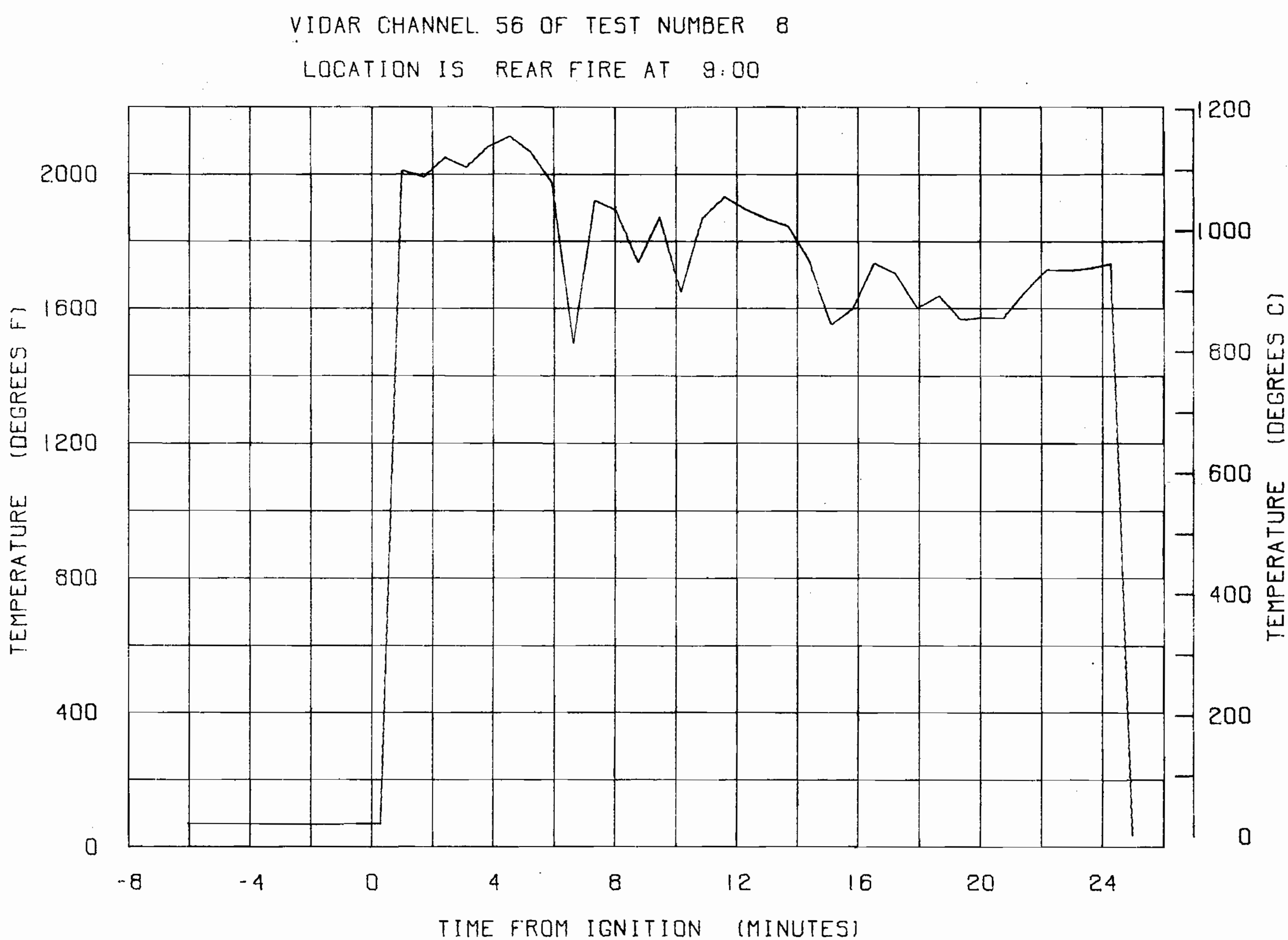

FIGURE A 52 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 57 OF TEST NUMBER 8

LOCATION IS REAR OUTSIDE TANK END

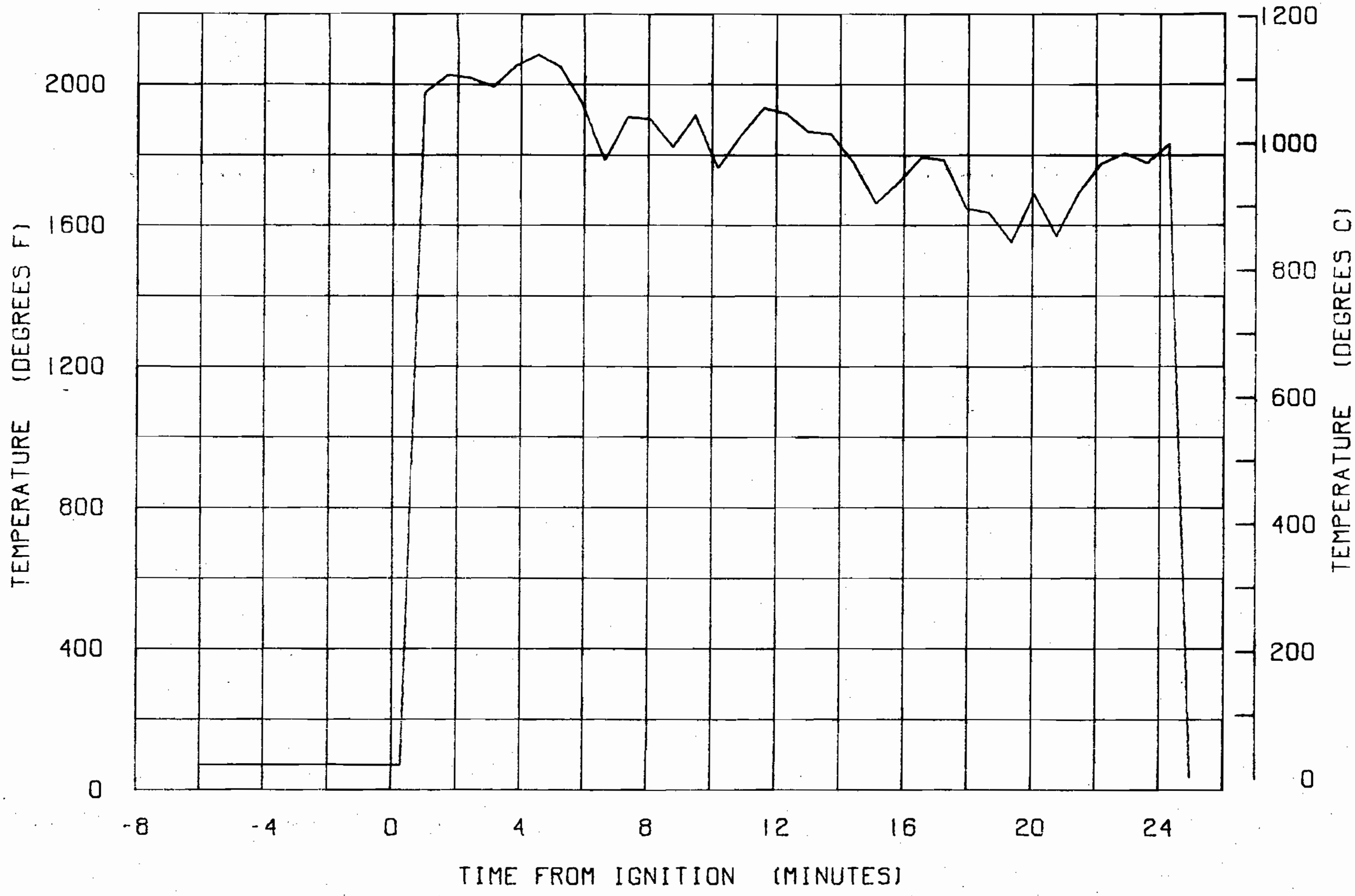

FIGURE A 53 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 58 OF TEST NUMBER 8

LOCATION IS DOME - FRONT

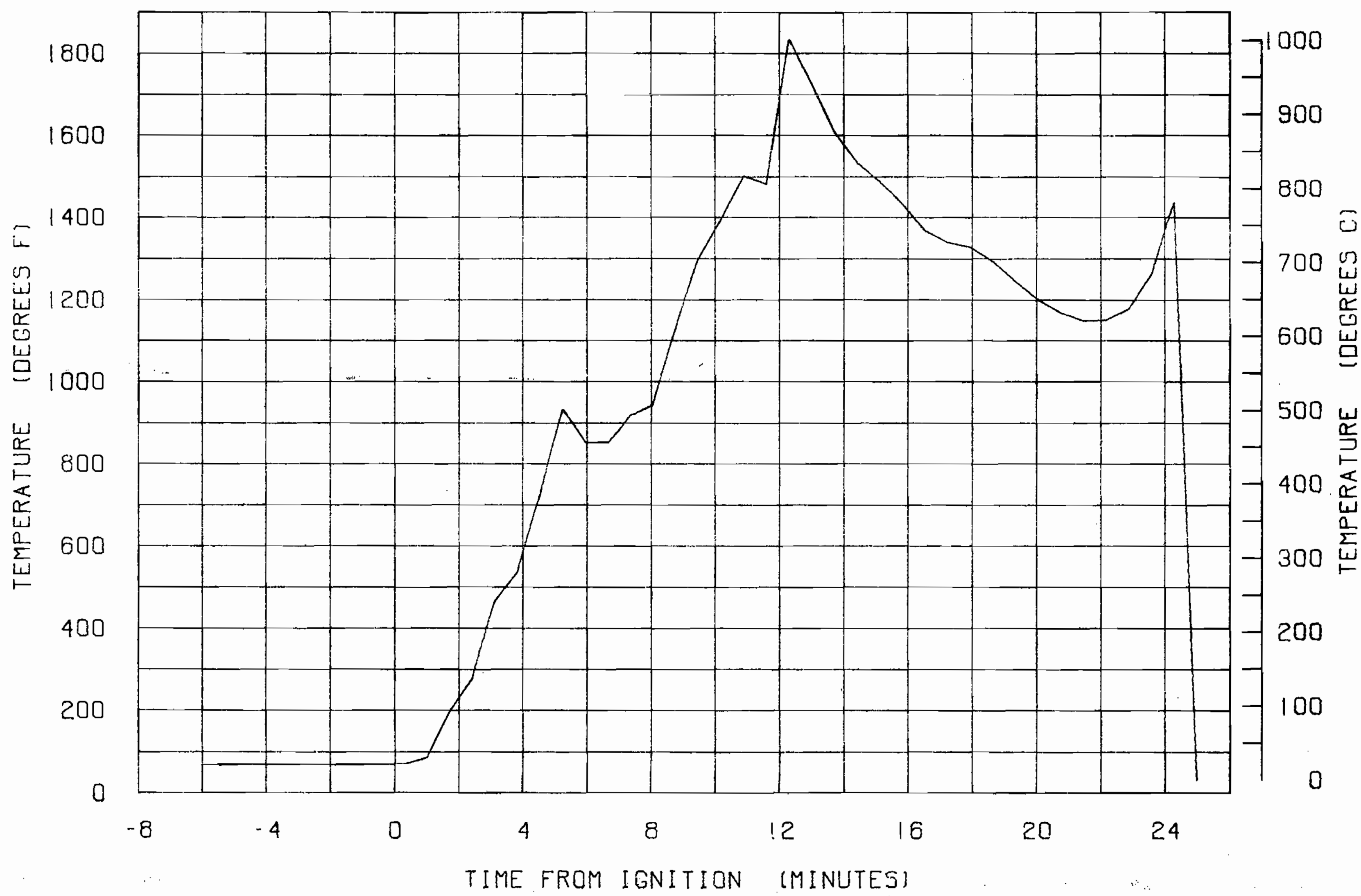

FIGURE **A 54** THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 59 OF TEST NUMBER 8

LOCATION IS DOME - RIGHT

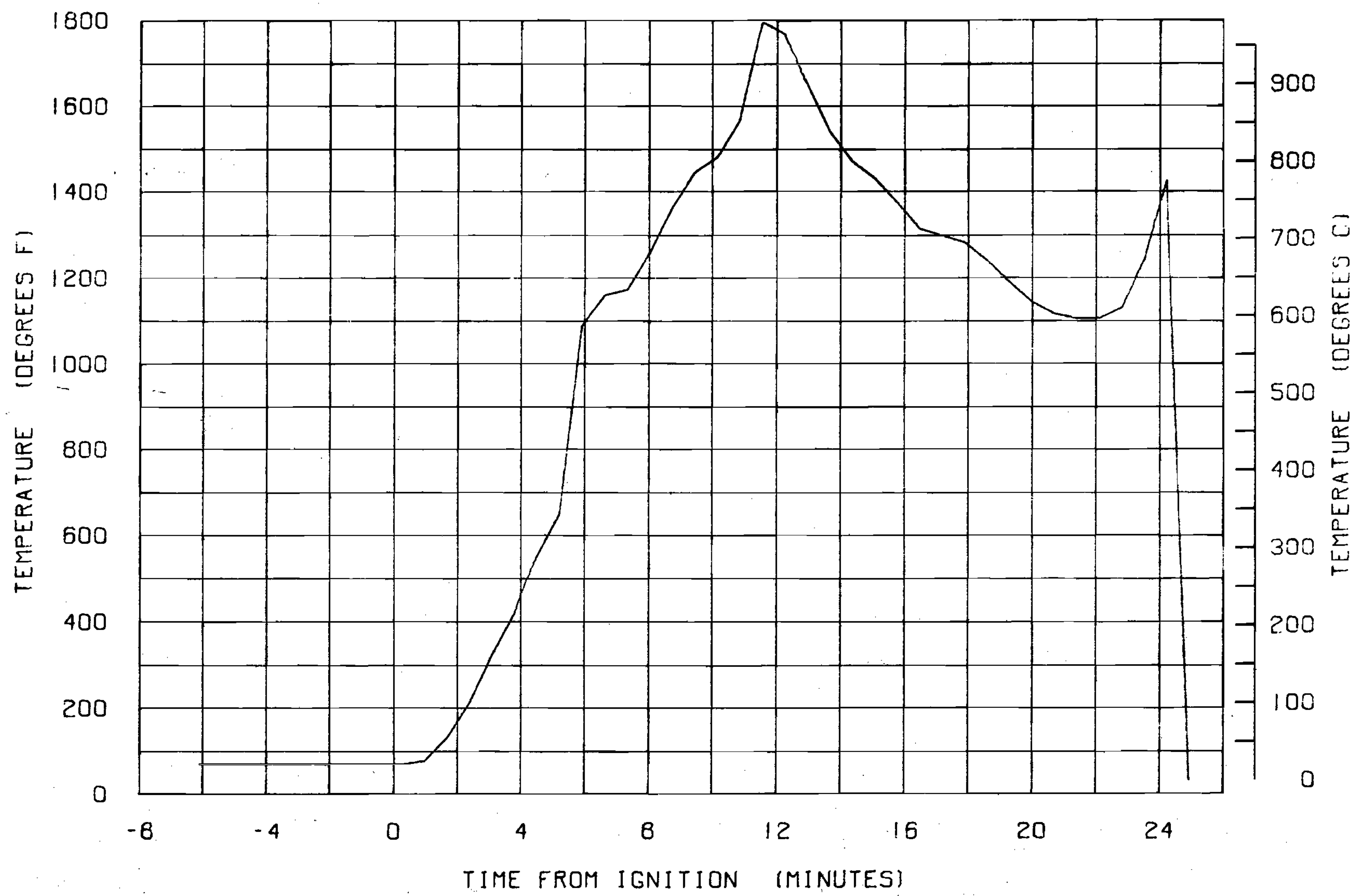

FIGURE A 55 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 60 OF TEST NUMBER 8

LOCATION IS DOME - REAR

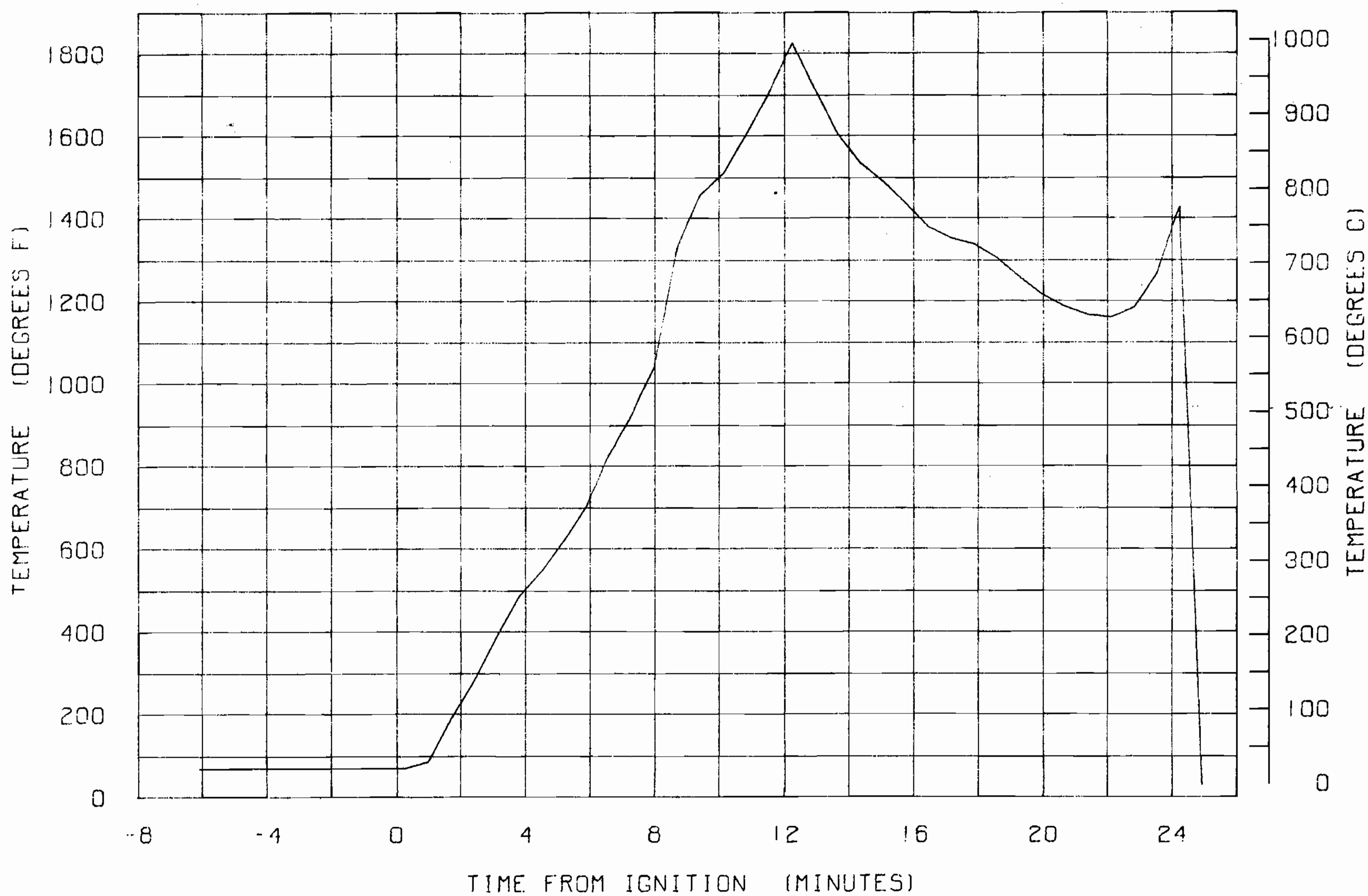

FIGURE A 56 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 62 OF TEST NUMBER 8

LOCATION IS FRONT FIRE AT 12:00

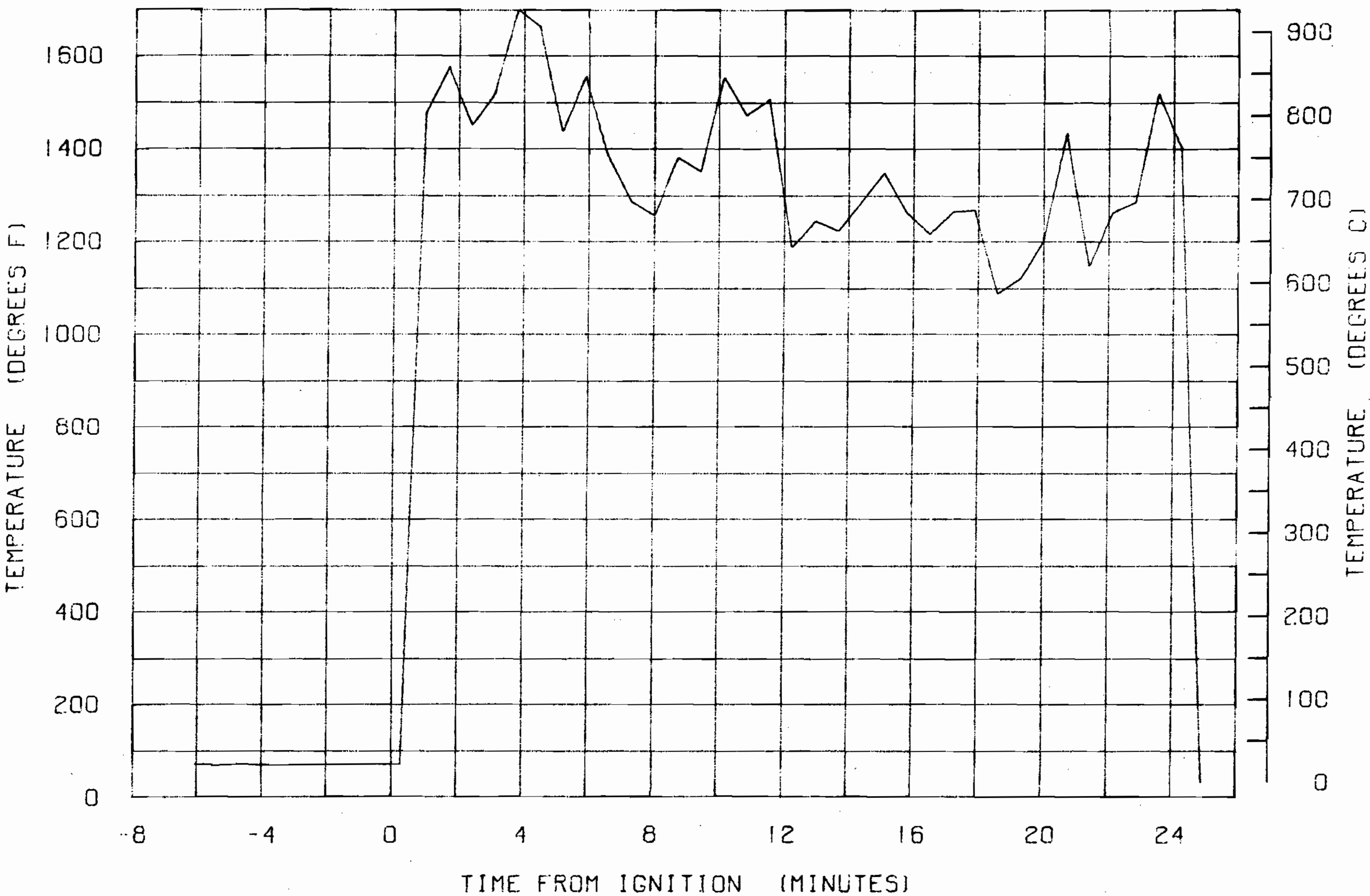

FIGURE A 57 THERMOCOUPLE TEMPERATURE VS. TIME

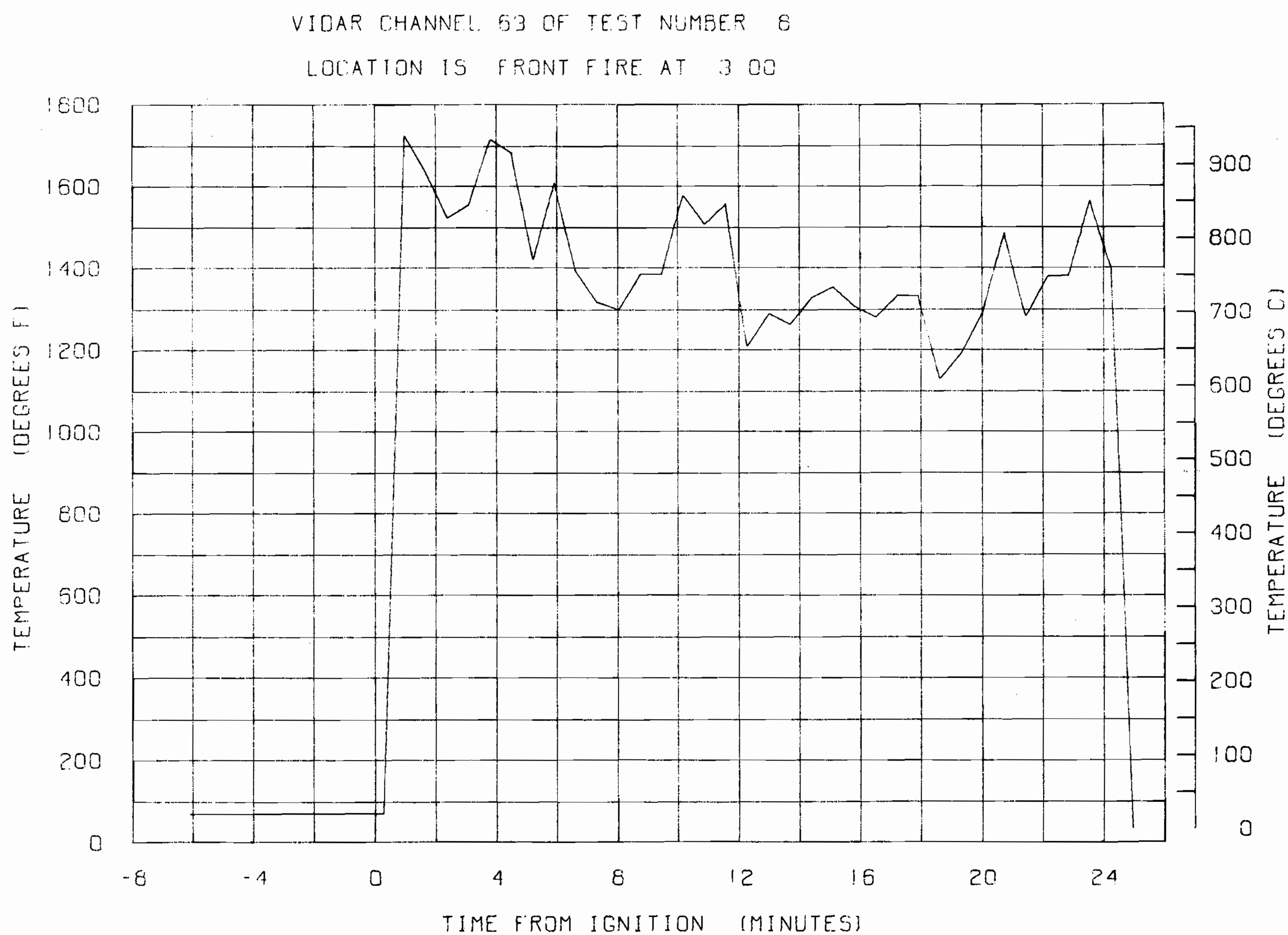

FIGURE A 58 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 64 OF TEST NUMBER 8

LOCATION IS FRONT FIRE AT 6:00

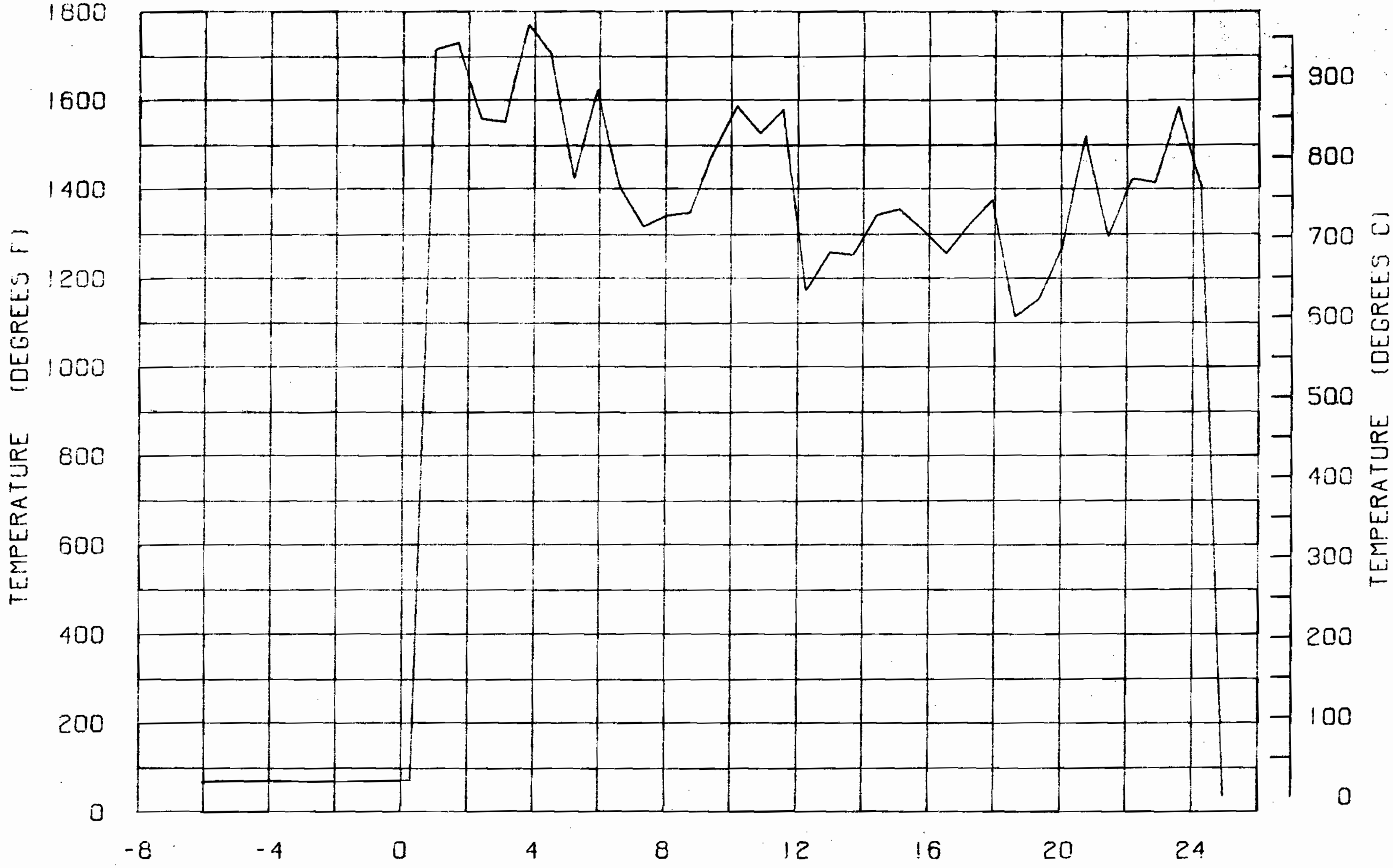

FIGURE A 59 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 65 OF TEST NUMBER 8

LOCATION IS FRONT FIRE AT 9:00

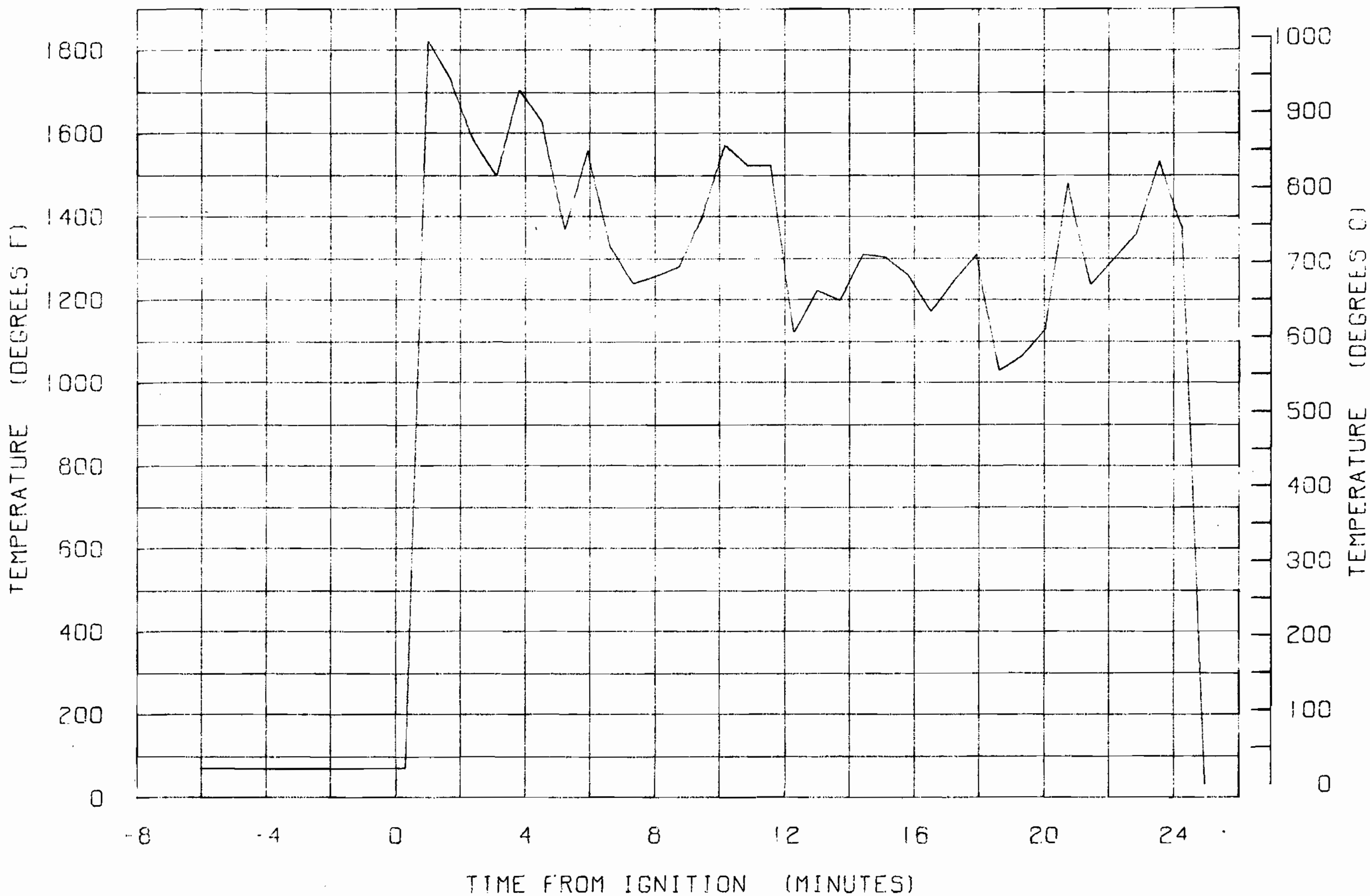

FIGURE **A 60** THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 56 OF TEST NUMBER 8

LOCATION IS FRONT OUTSIDE TANK END

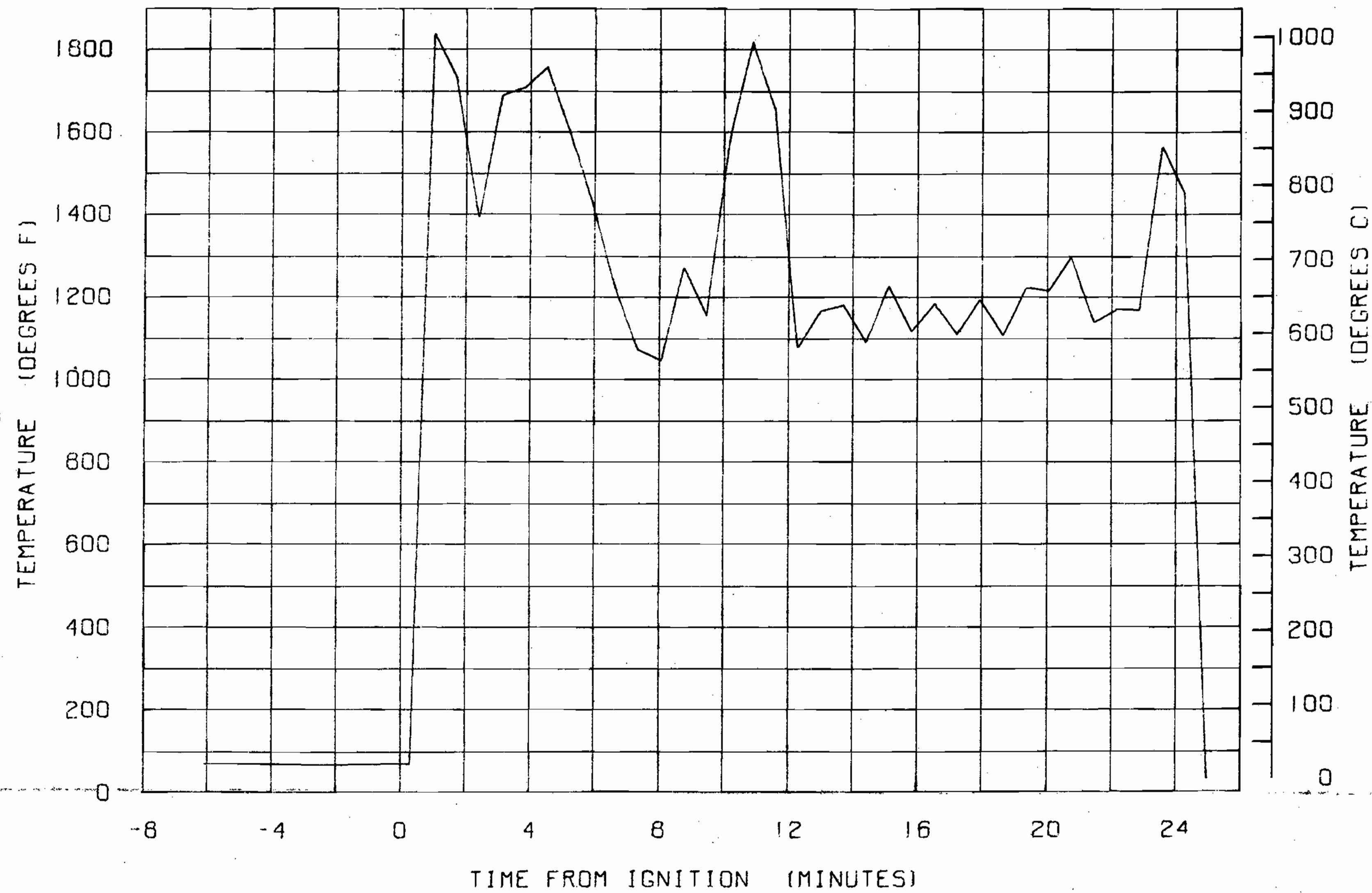

FIGURE **A 61** THERMOCOUPLE TEMPERATURE VS. TIME

FIGURE **A 62** THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 66 OF TEST NUMBER 8

LOCATION IS FRONT INNER WALL AT 11:30

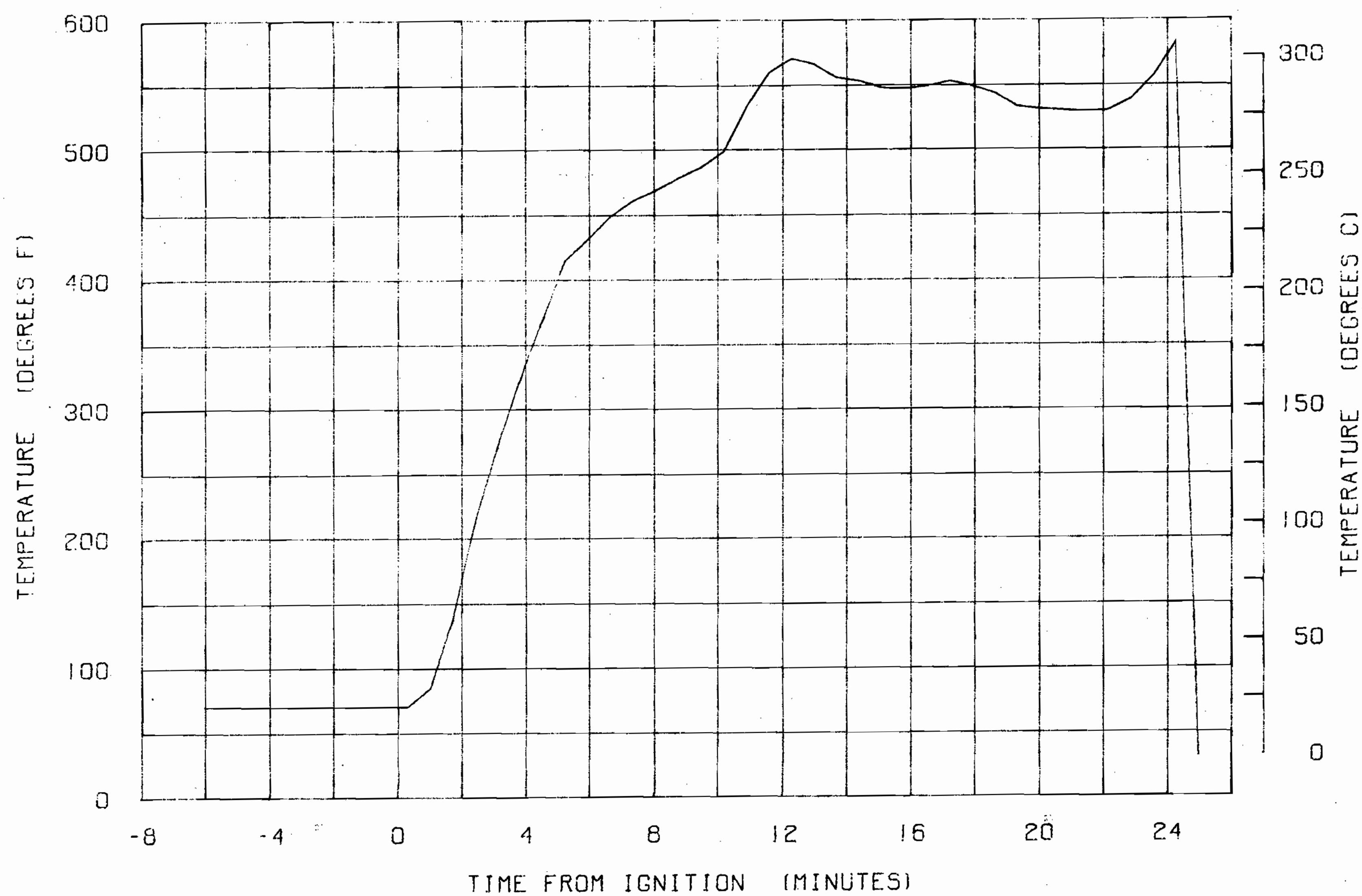

FIGURE **A-63** THERMOCOUPLE TEMPERATURE VS. TIME

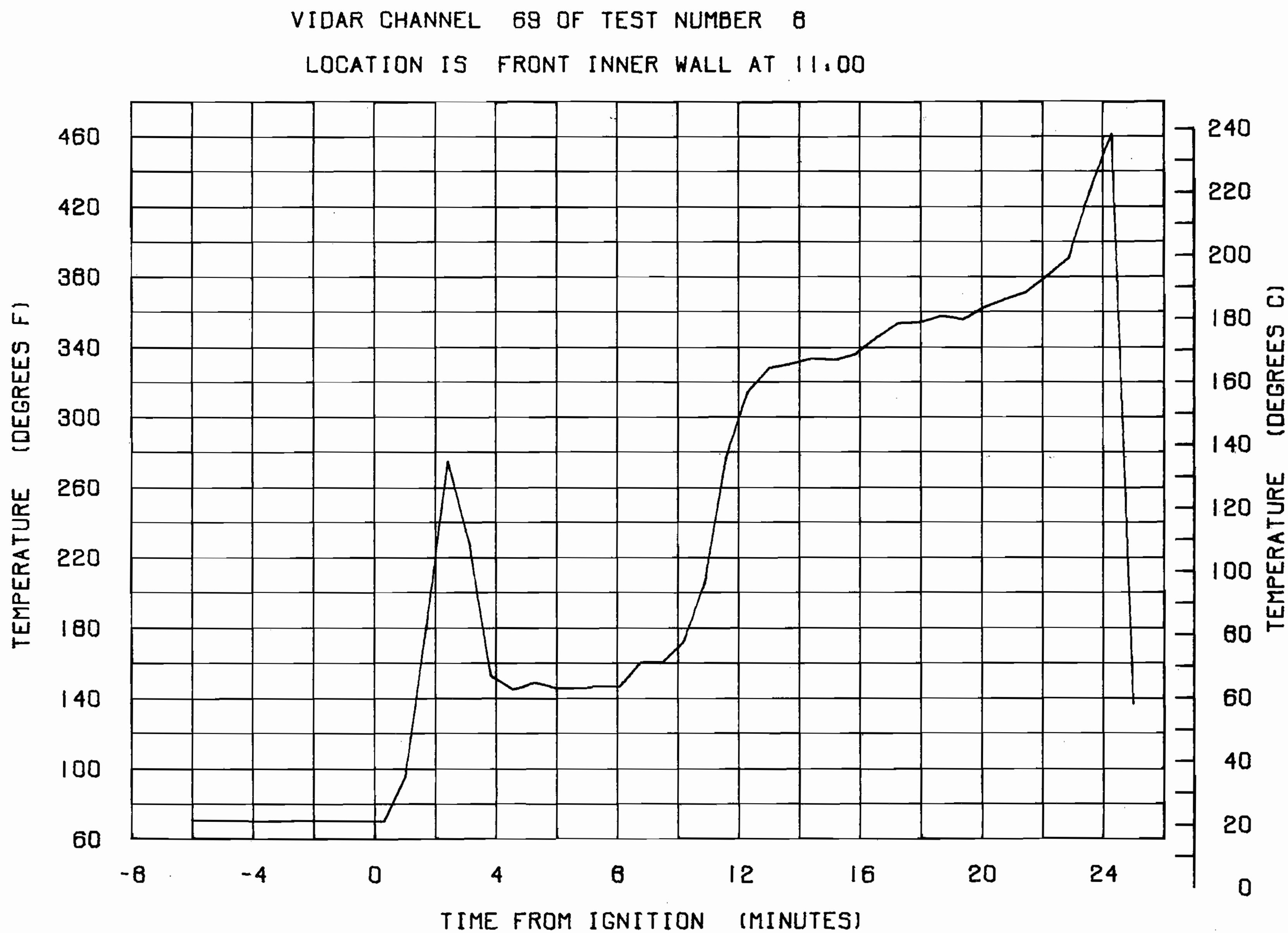

FIGURE A 64 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 70 OF TEST NUMBER 8

LOCATION IS FRONT INNER WALL AT 10:30

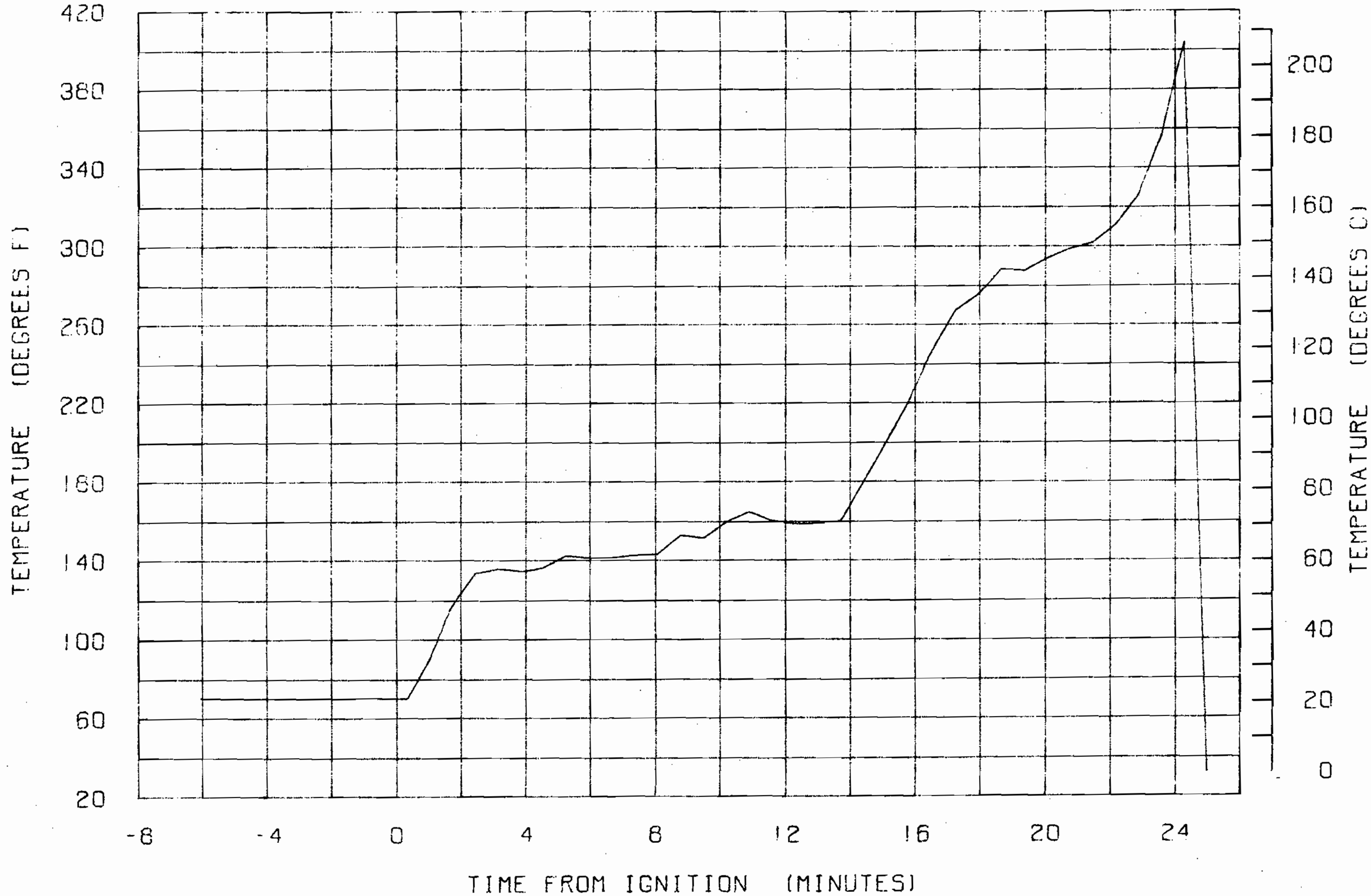

FIGURE A-65 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 71 OF TEST NUMBER 8

LOCATION IS FRONT INNER WALL AT 10:00

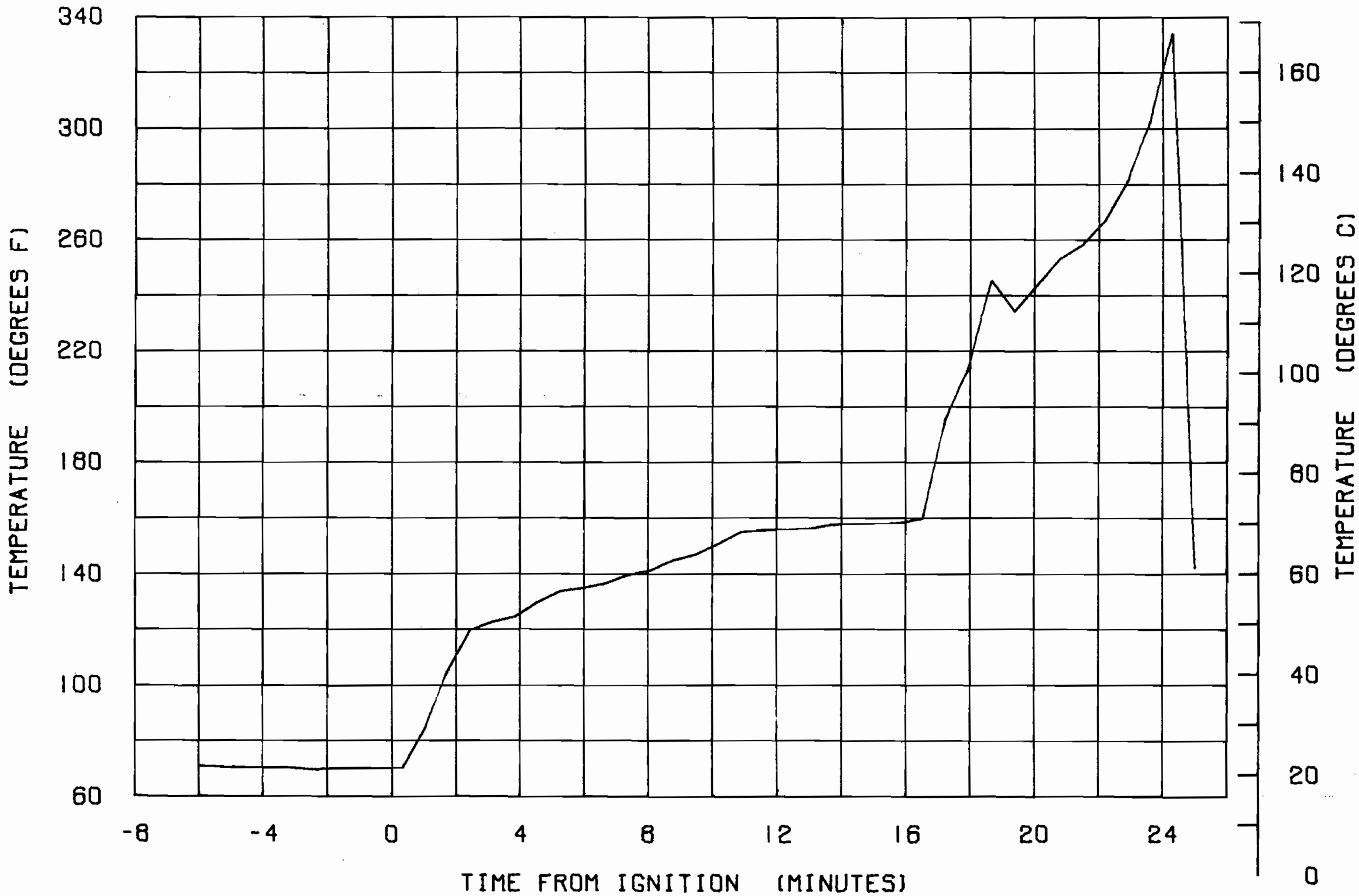

FIGURE A 66 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 72 OF TEST NUMBER 8

LOCATION IS FRONT INNER WALL AT 9:30

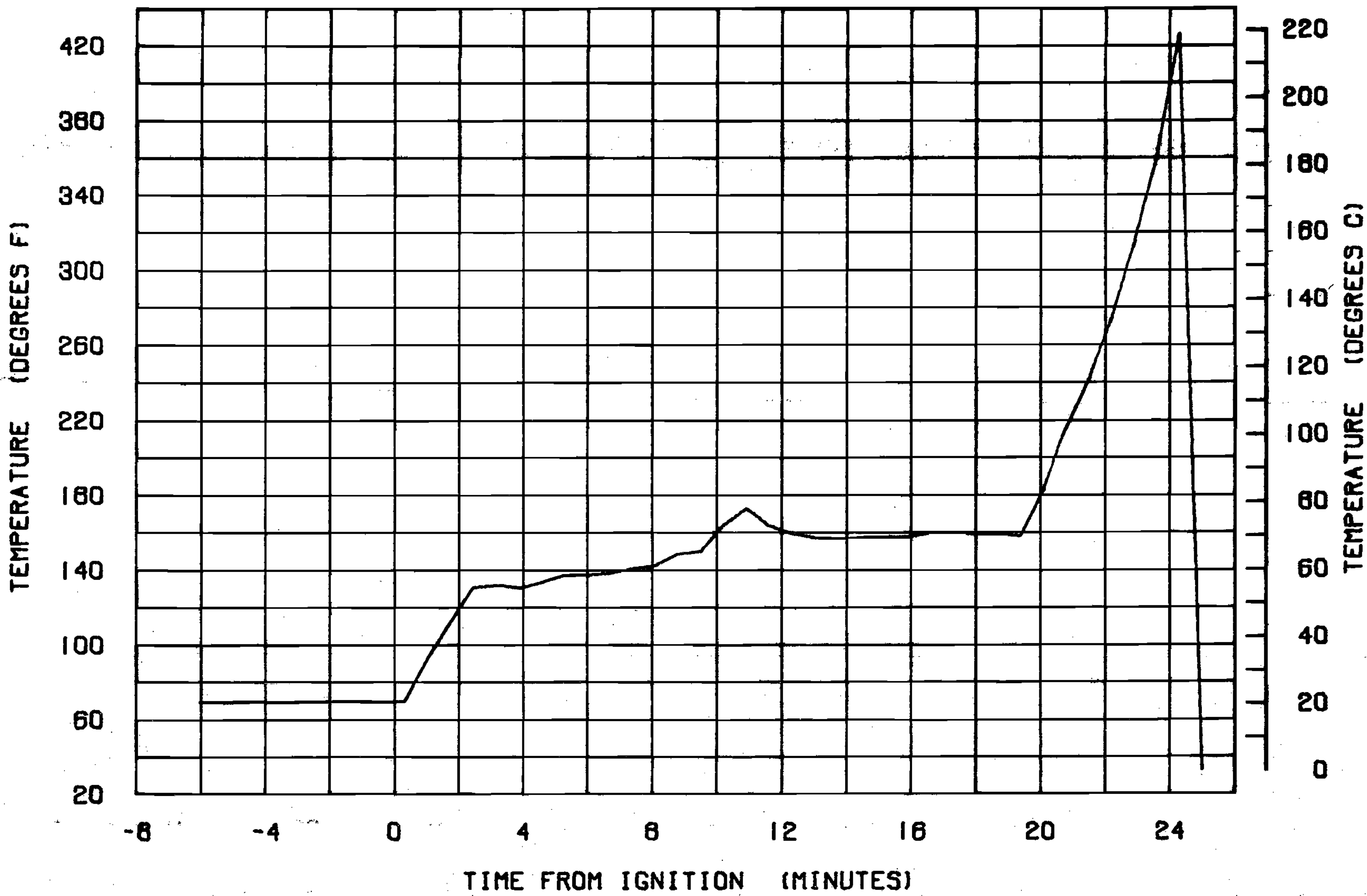

FIGURE A 67 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 73 OF TEST NUMBER 8

LOCATION IS FRONT INNER WALL AT 9:00

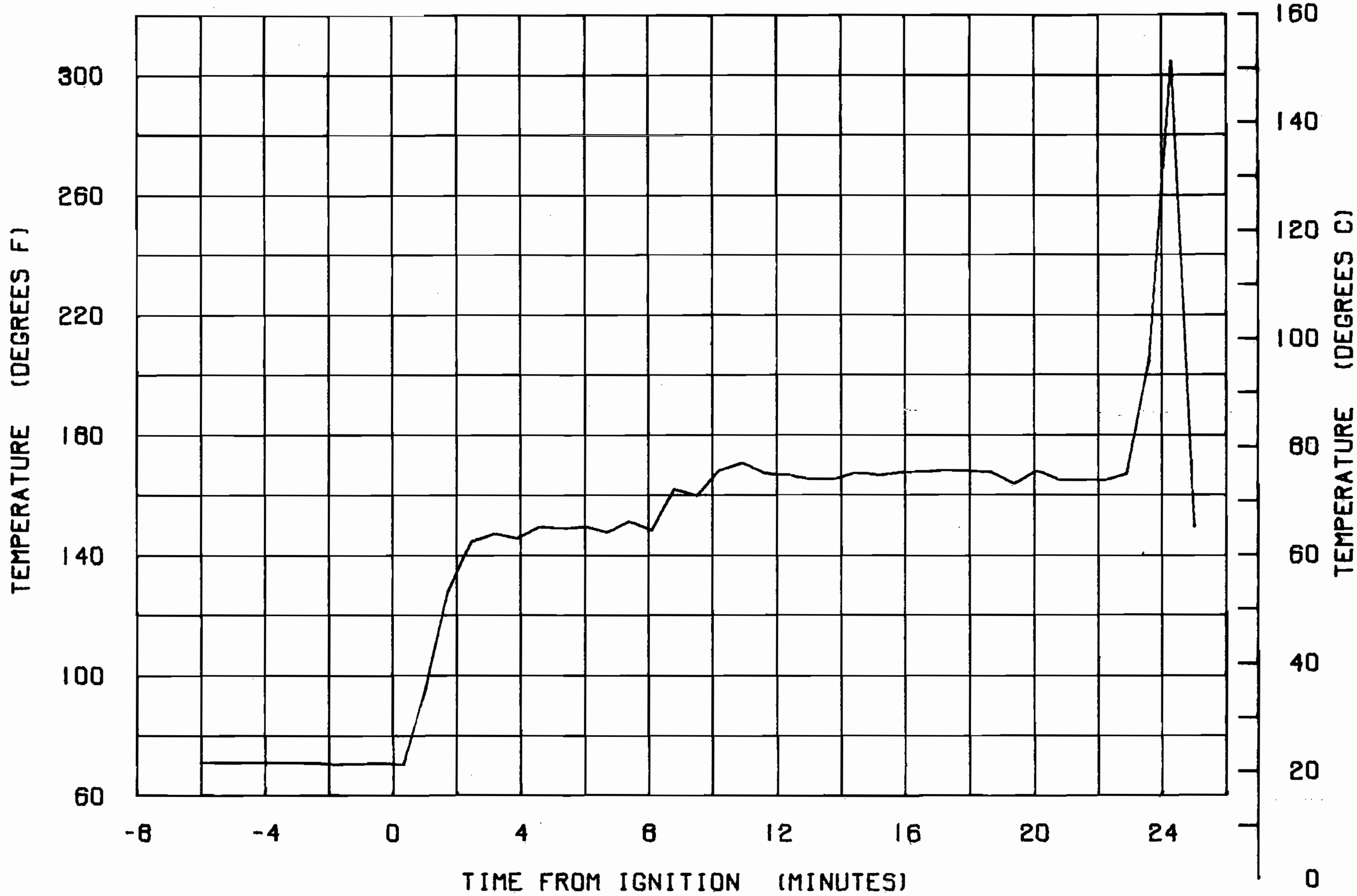

FIGURE A 68 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 74 OF TEST NUMBER 8

LOCATION IS FRONT INNER WALL AT 8:30

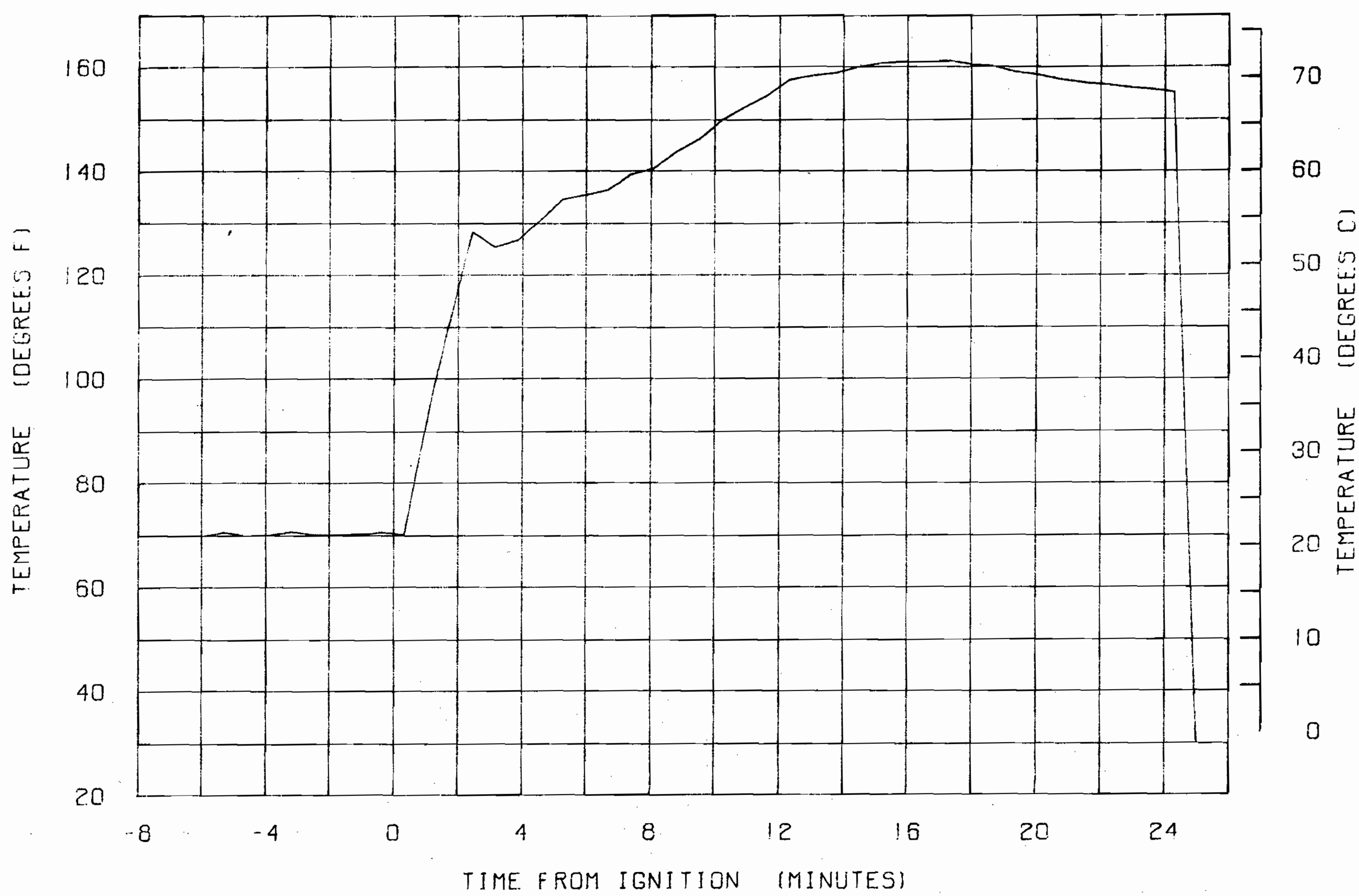

FIGURE A 69 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 75 OF TEST NUMBER 8

LOCATION IS FRONT INNER WALL AT 8:00

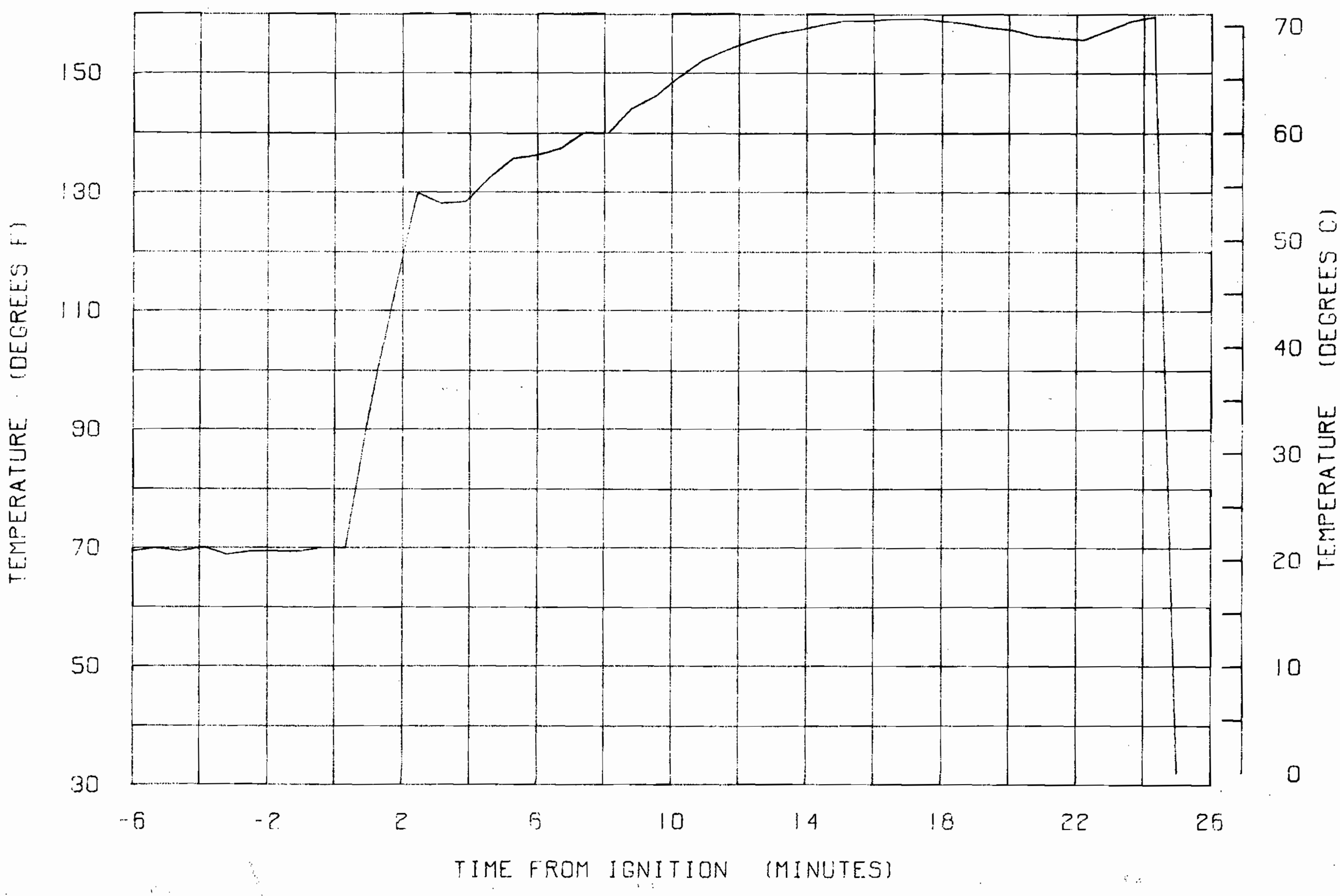

FIGURE **A 70** THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 76 OF TEST NUMBER 8

LOCATION IS FRONT INNER WALL AT 7:30

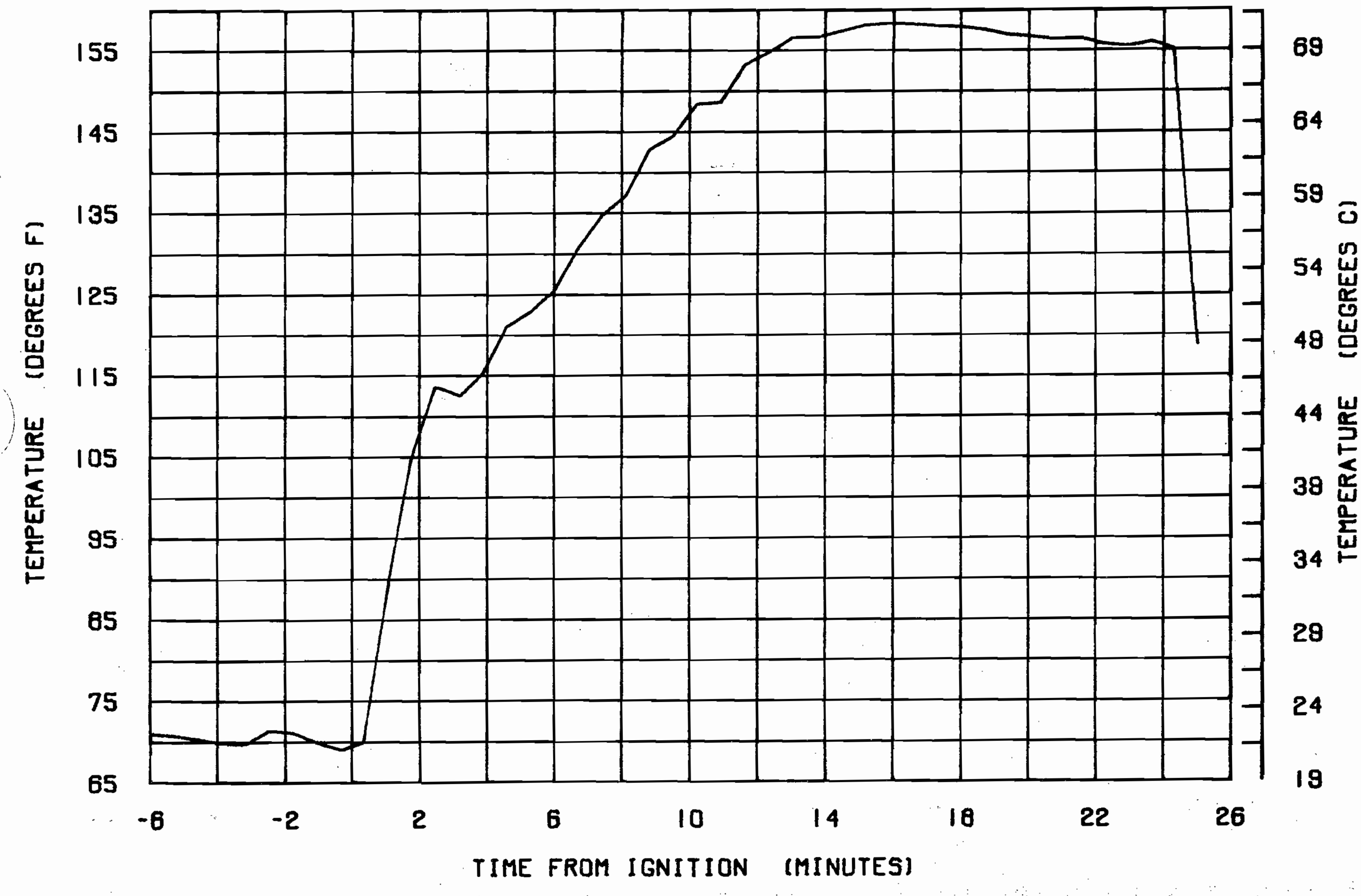

FIGURE A 71 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 77 OF TEST NUMBER 8

LOCATION IS FRONT INNER WALL AT 7:00

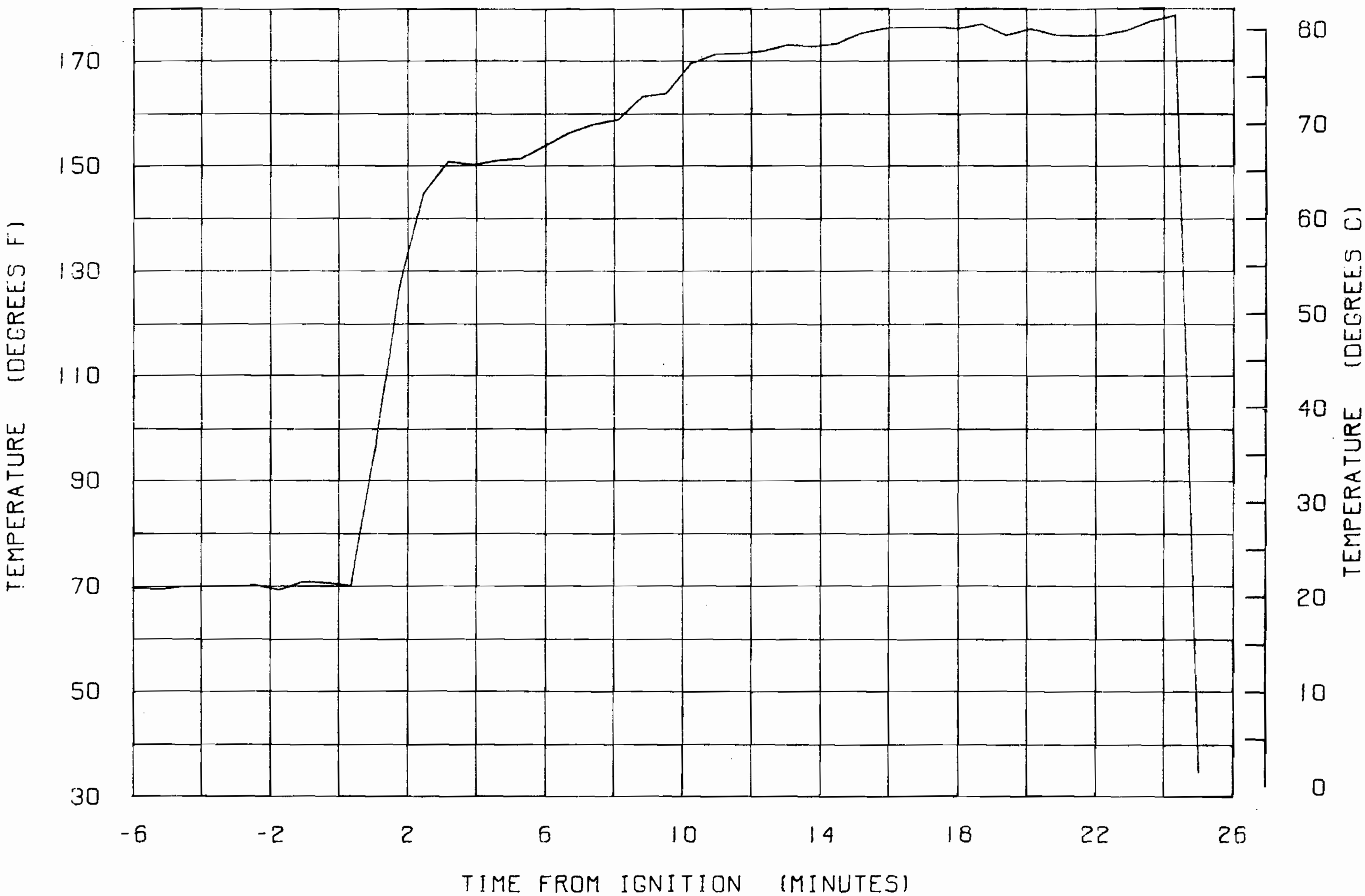

FIGURE A 72 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 78 OF TEST NUMBER 8

LOCATION IS FRONT INNER WALL AT 6:30

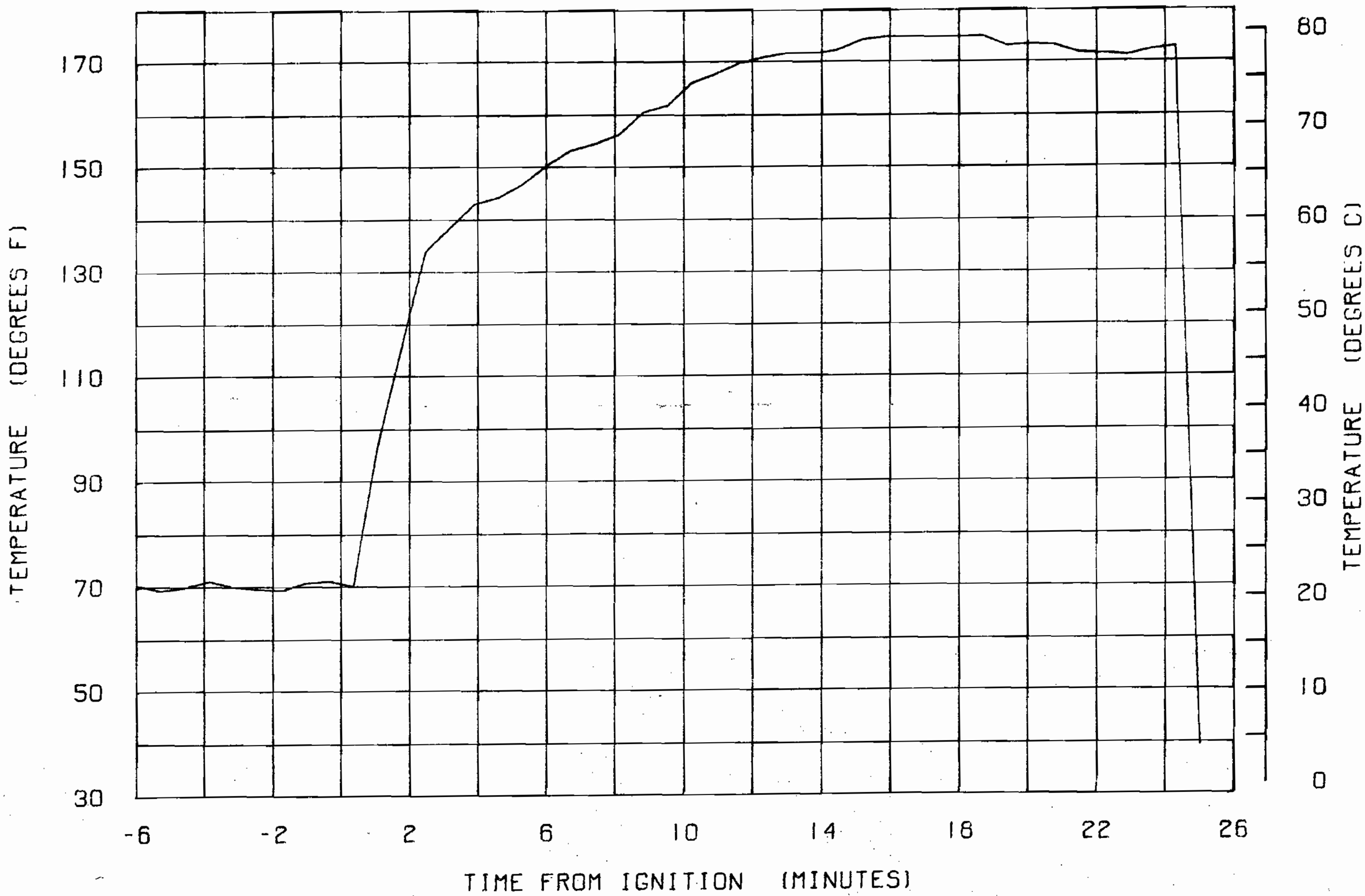

FIGURE A 73 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 79 OF TEST NUMBER 6

LOCATION IS FRONT INNER WALL AT 6:00

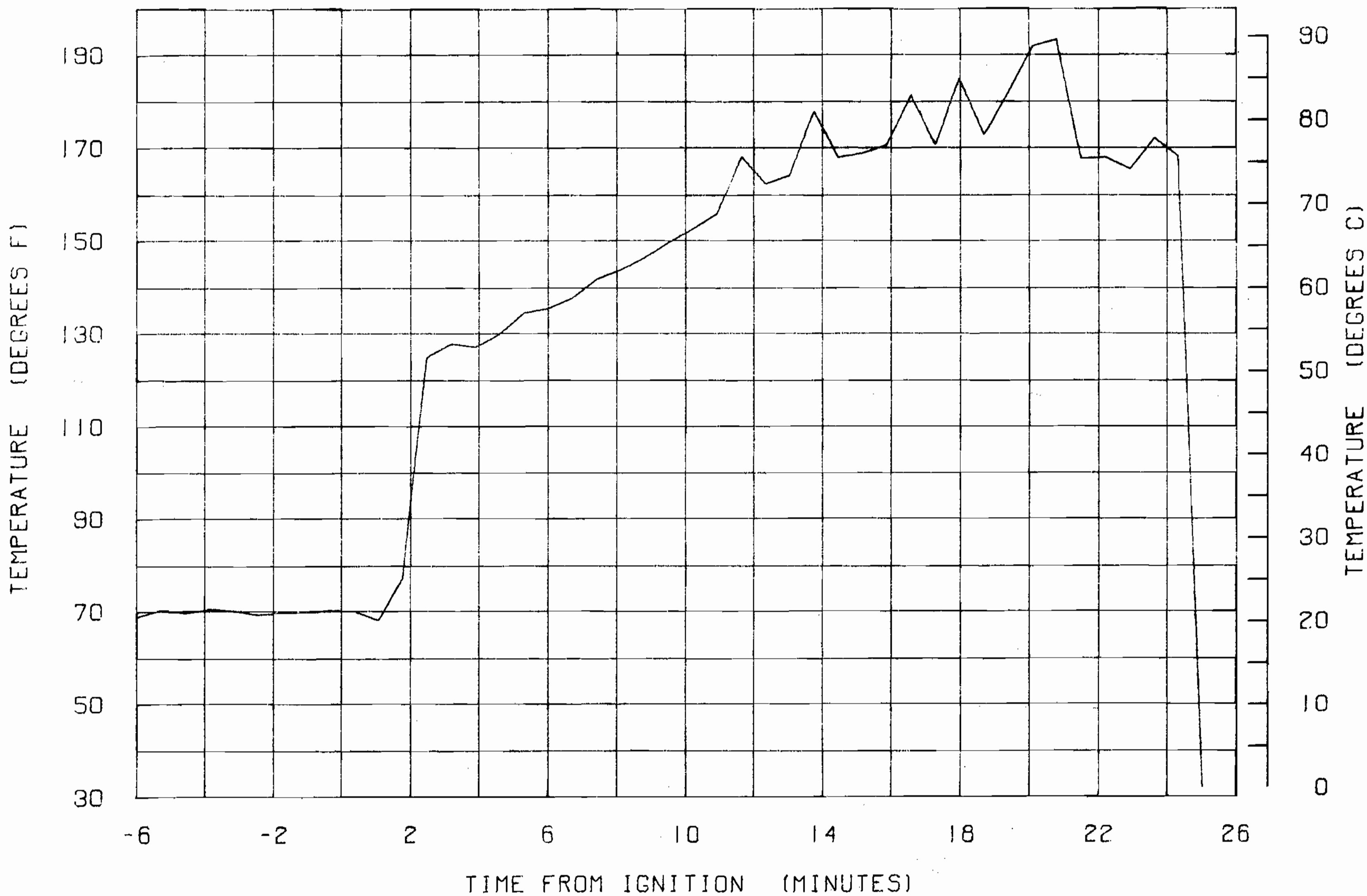

FIGURE A 74 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 80 OF TEST NUMBER 8

LOCATION IS FRONT INNER WALL AT 5.30

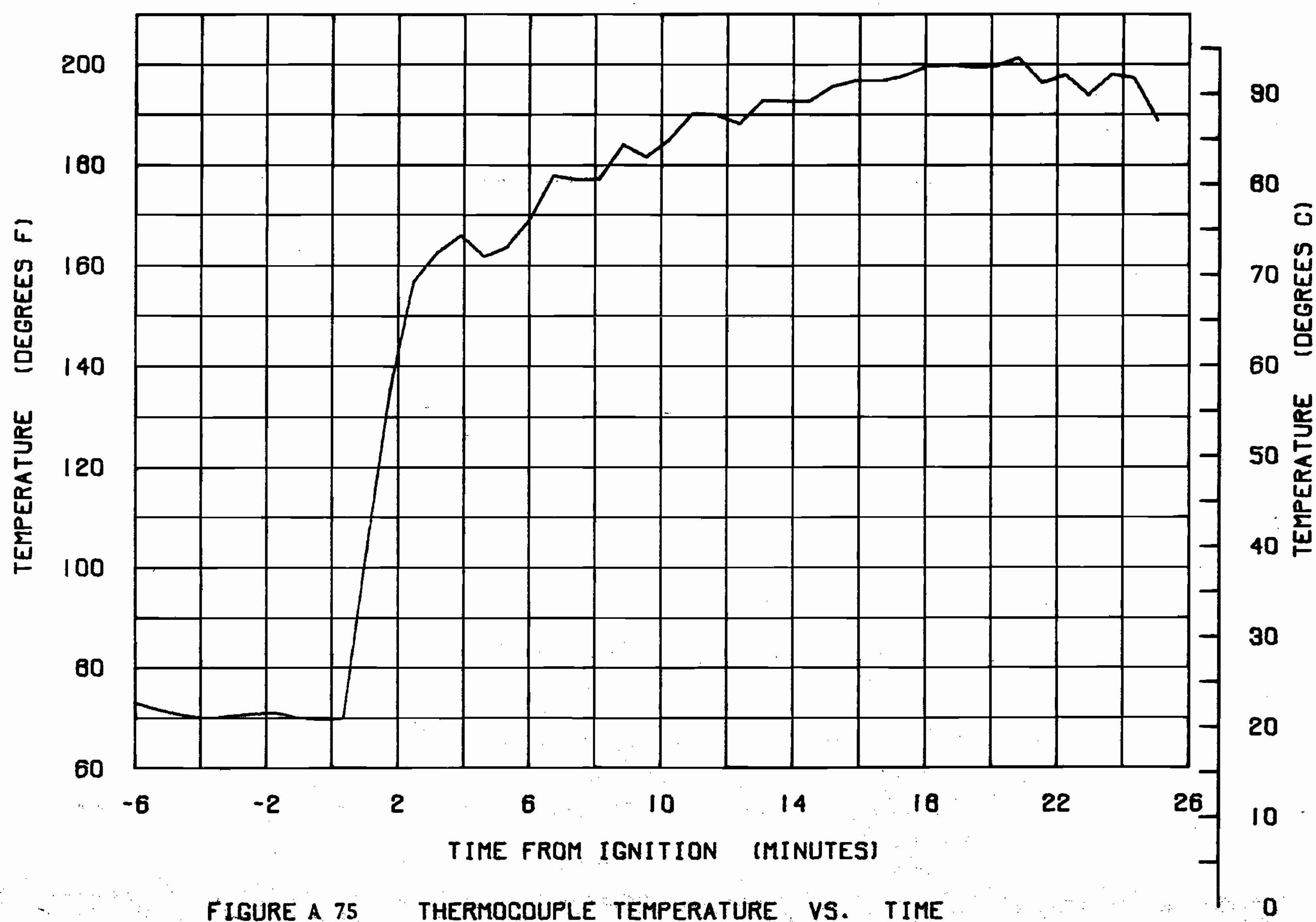

FIGURE A 75 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 81 OF TEST NUMBER 8

LOCATION IS FRONT INNER WALL AT 5.00

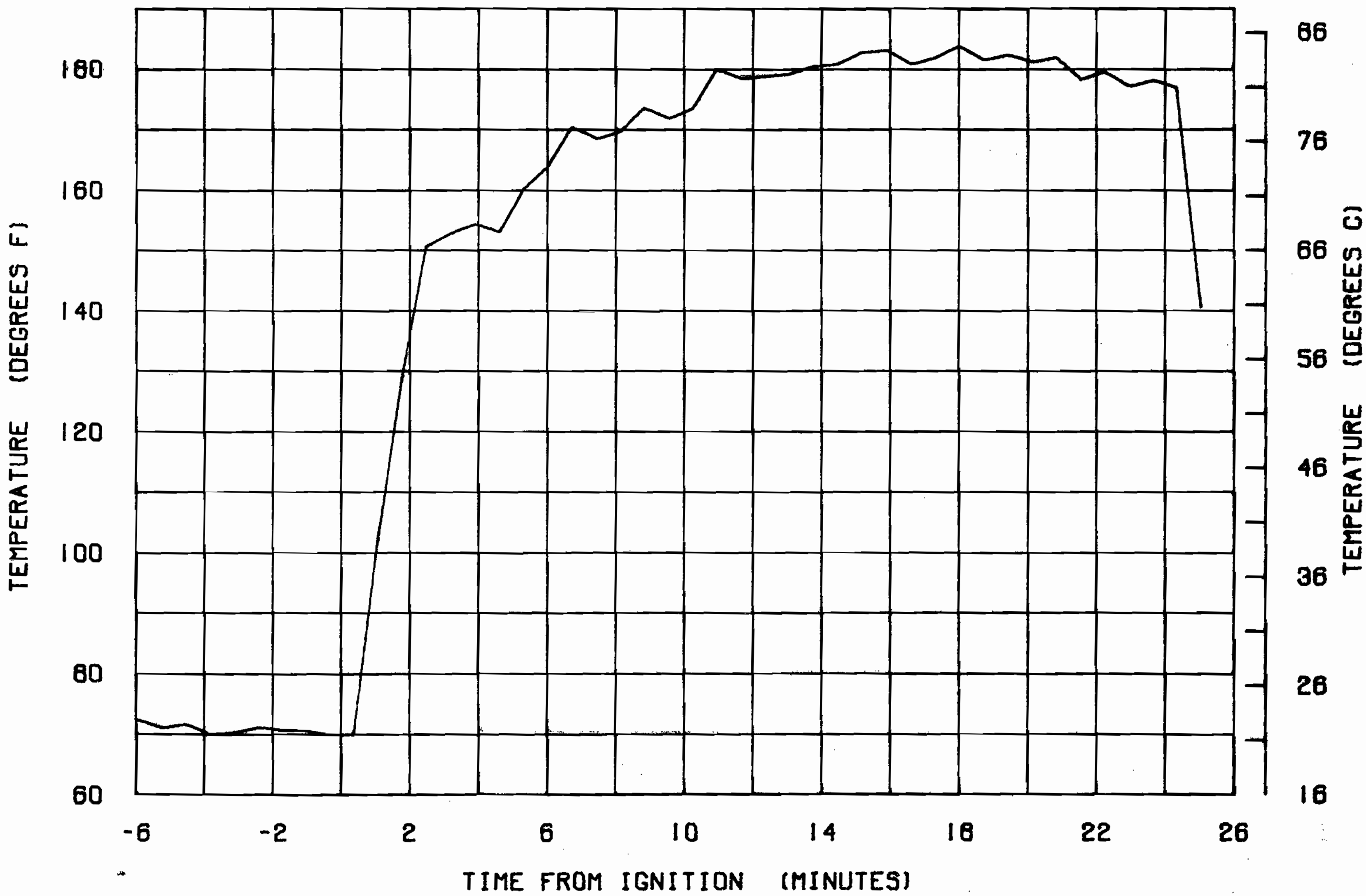

FIGURE A 76 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 82 OF TEST NUMBER 8

LOCATION IS FRONT INNER WALL AT 4:30

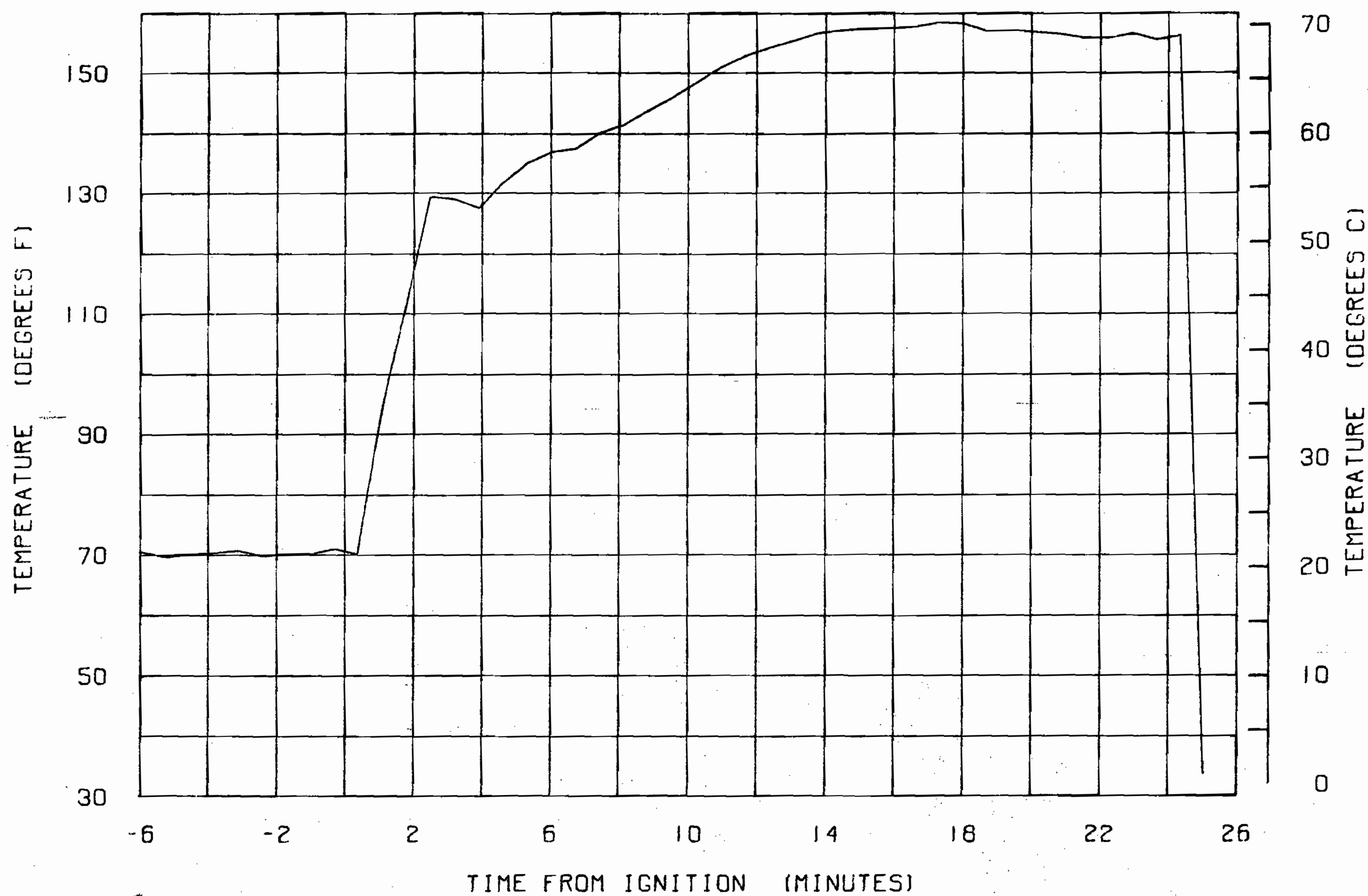

FIGURE **A 77** THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 83 OF TEST NUMBER 8

LOCATION IS FRONT INNER WALL AT 4:00

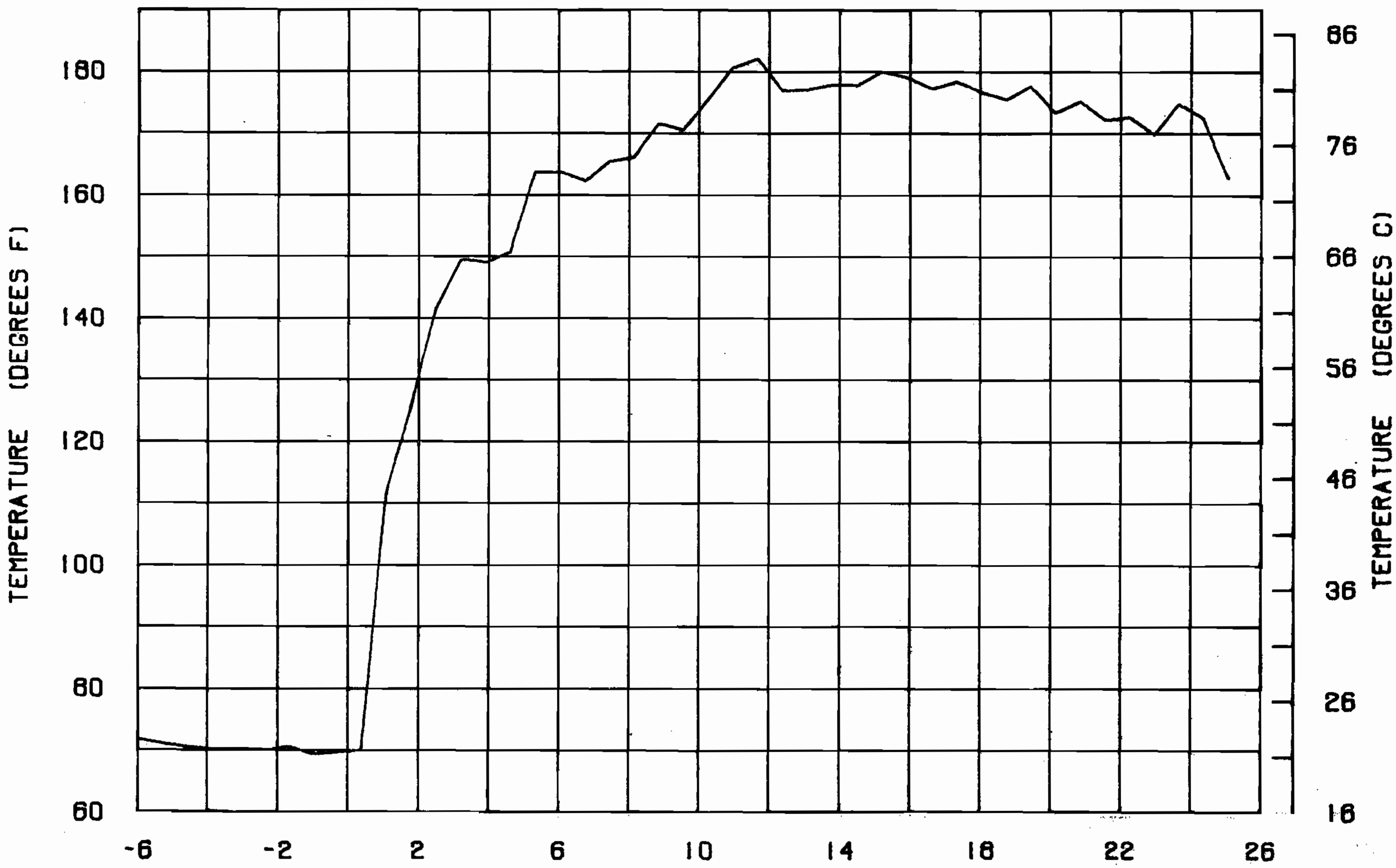

FIGURE A 78 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 84 OF TEST NUMBER 8

LOCATION IS FRONT INNER WALL AT 3:30

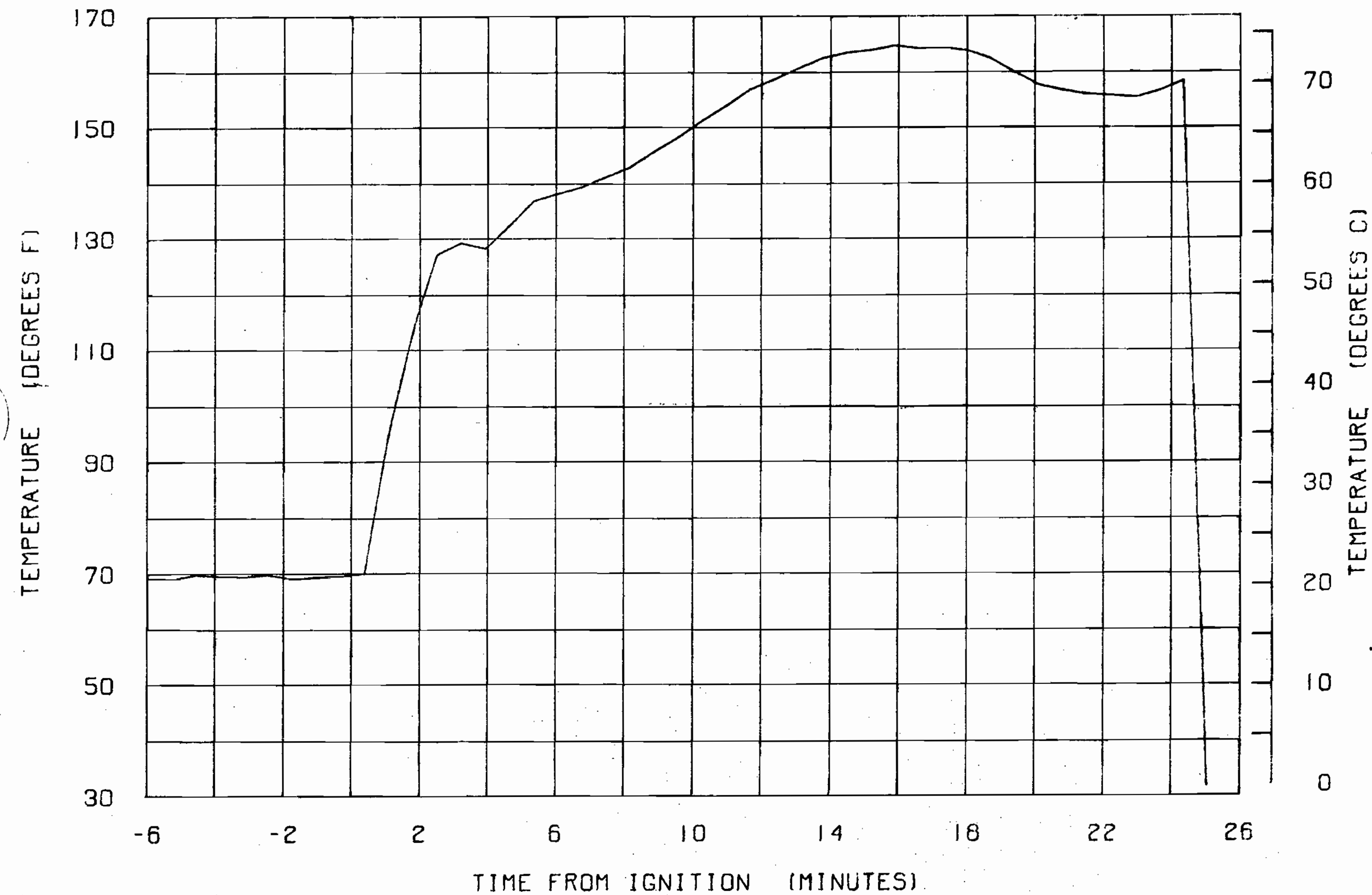

FIGURE A 79 THERMOCOUPLE TEMPERATURE VS. TIME

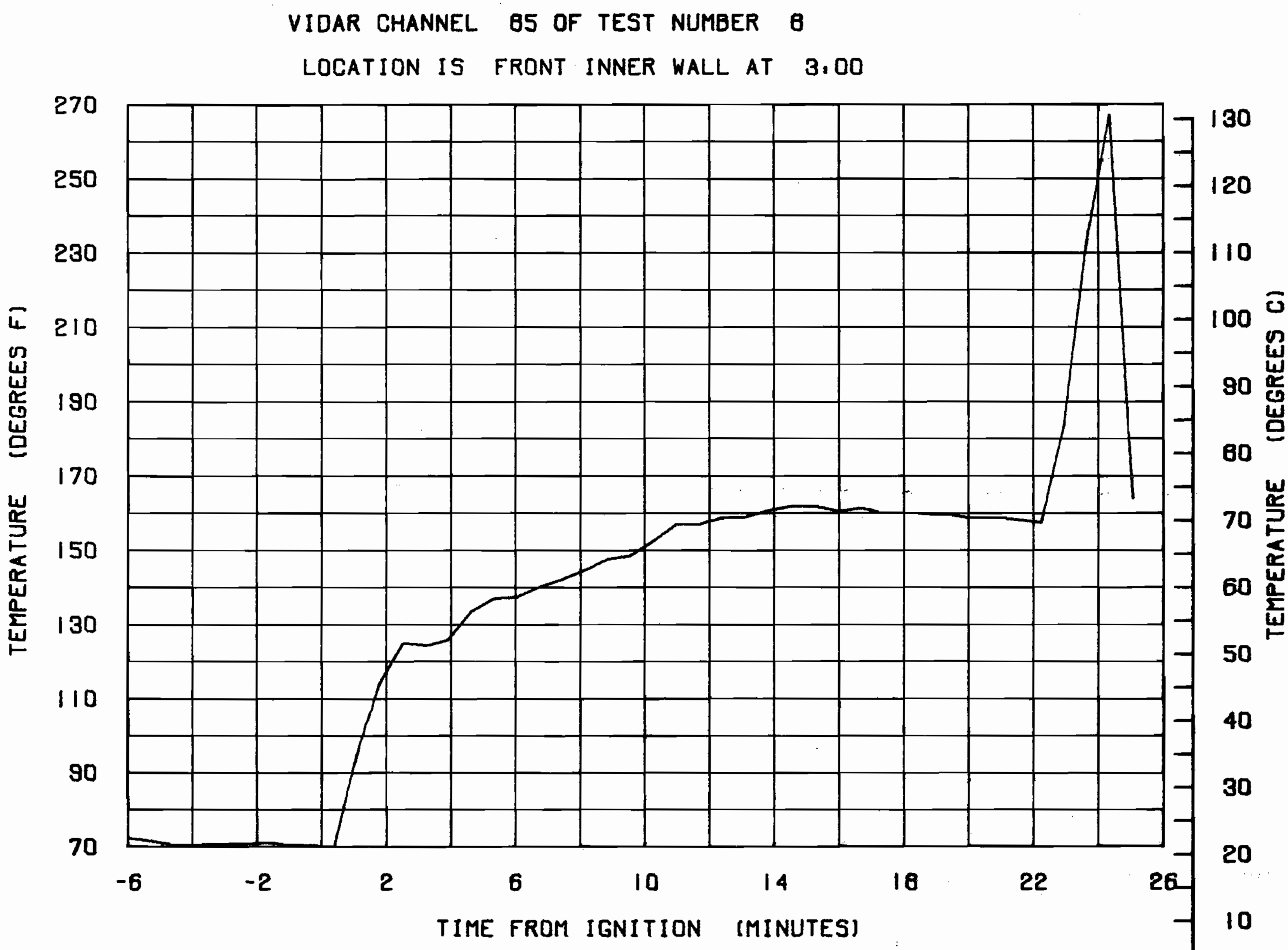

FIGURE A 80 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 66 OF TEST NUMBER 8

LOCATION IS FRONT INNER WALL AT 2:30

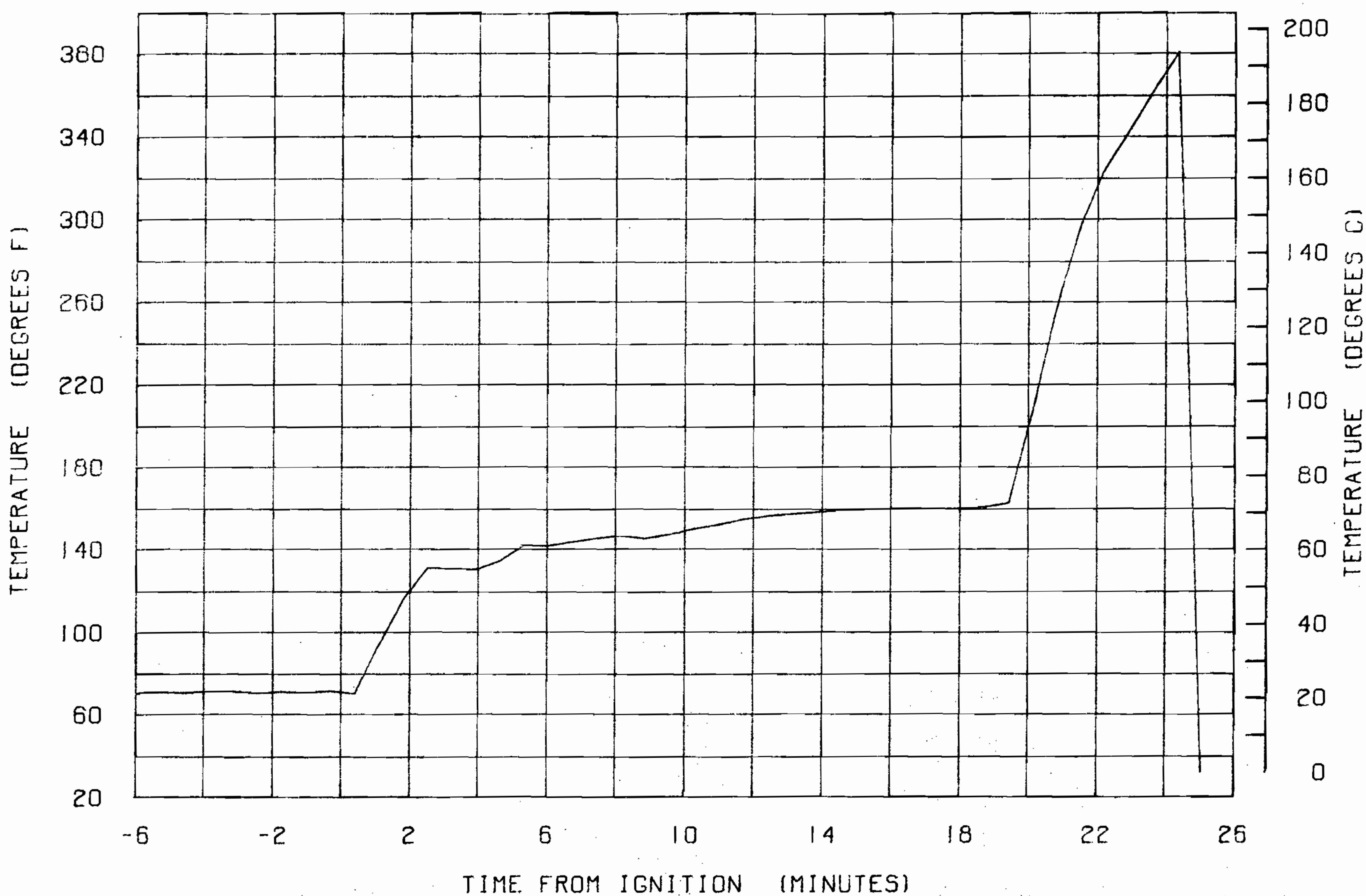

FIGURE A 81 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 67 OF TEST NUMBER 6

LOCATION IS FRONT INNER WALL AT 2:00

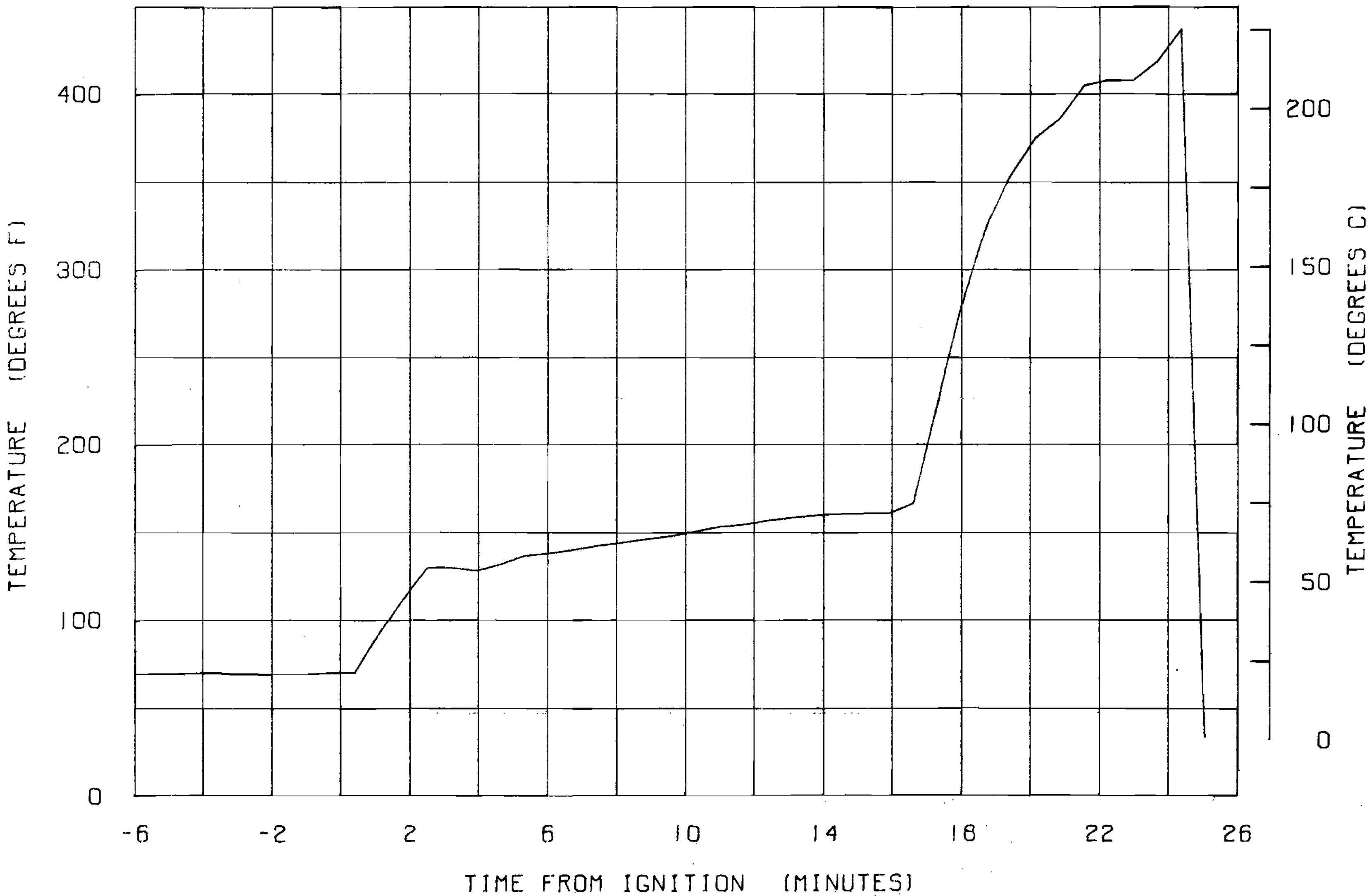

FIGURE A 82 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 88 OF TEST NUMBER 8

LOCATION IS FRONT INNER WALL AT 1.30

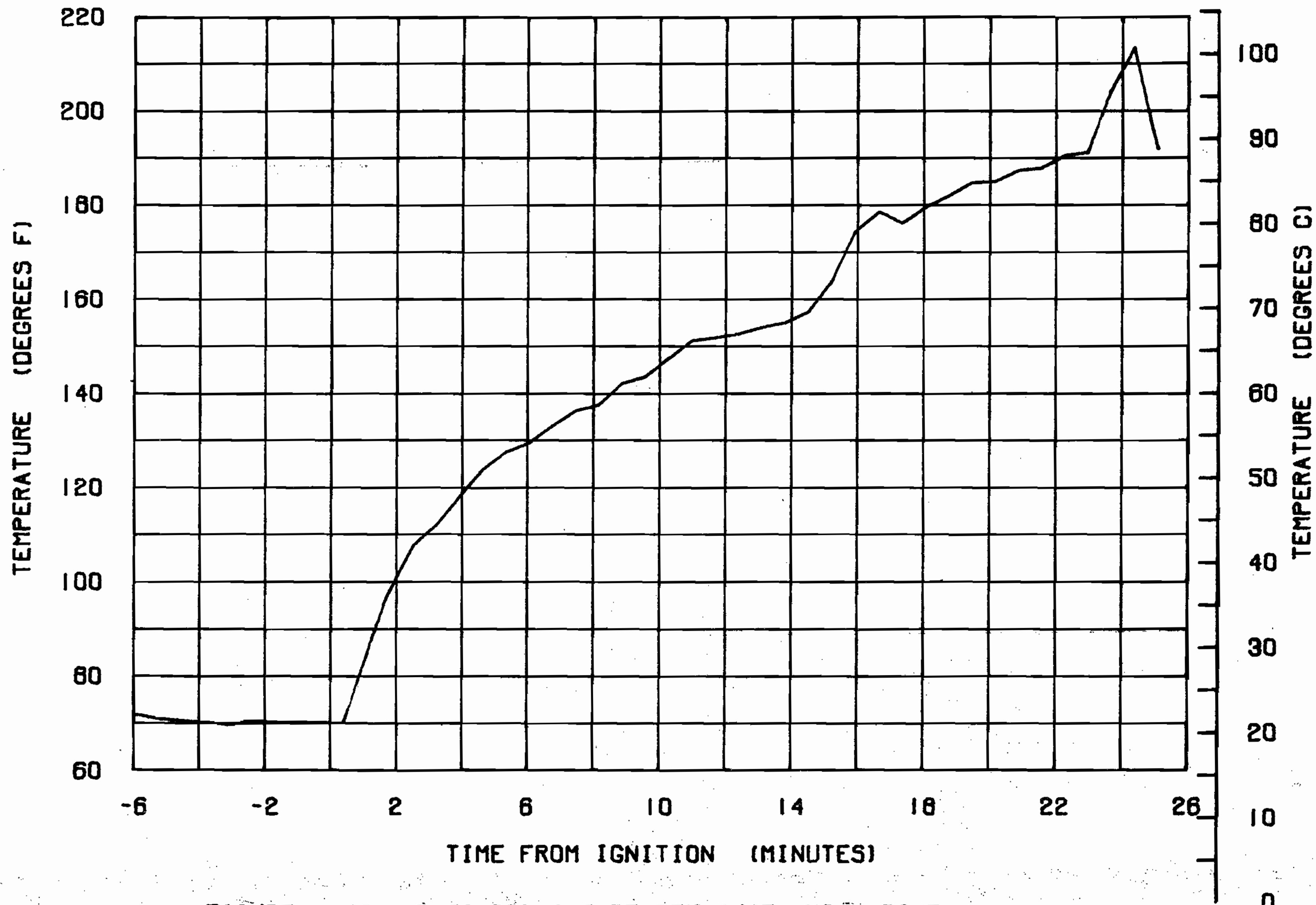

FIGURE A 83 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 83 OF TEST NUMBER 8

LOCATION IS FRONT INNER WALL AT 1:00

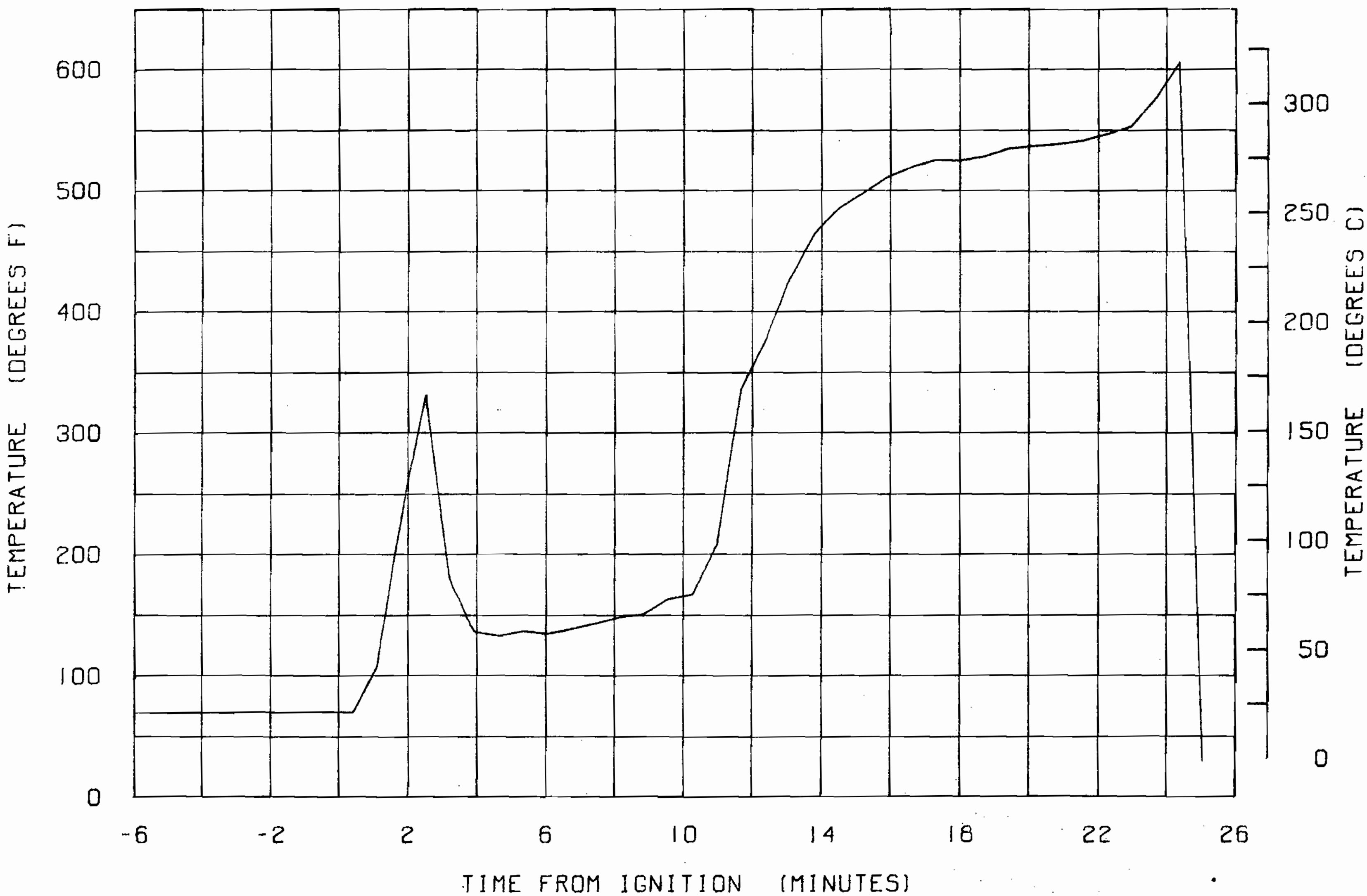

FIGURE A 84 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 90 OF TEST NUMBER 8

LOCATION IS FRONT INNER WALL AT 12:30

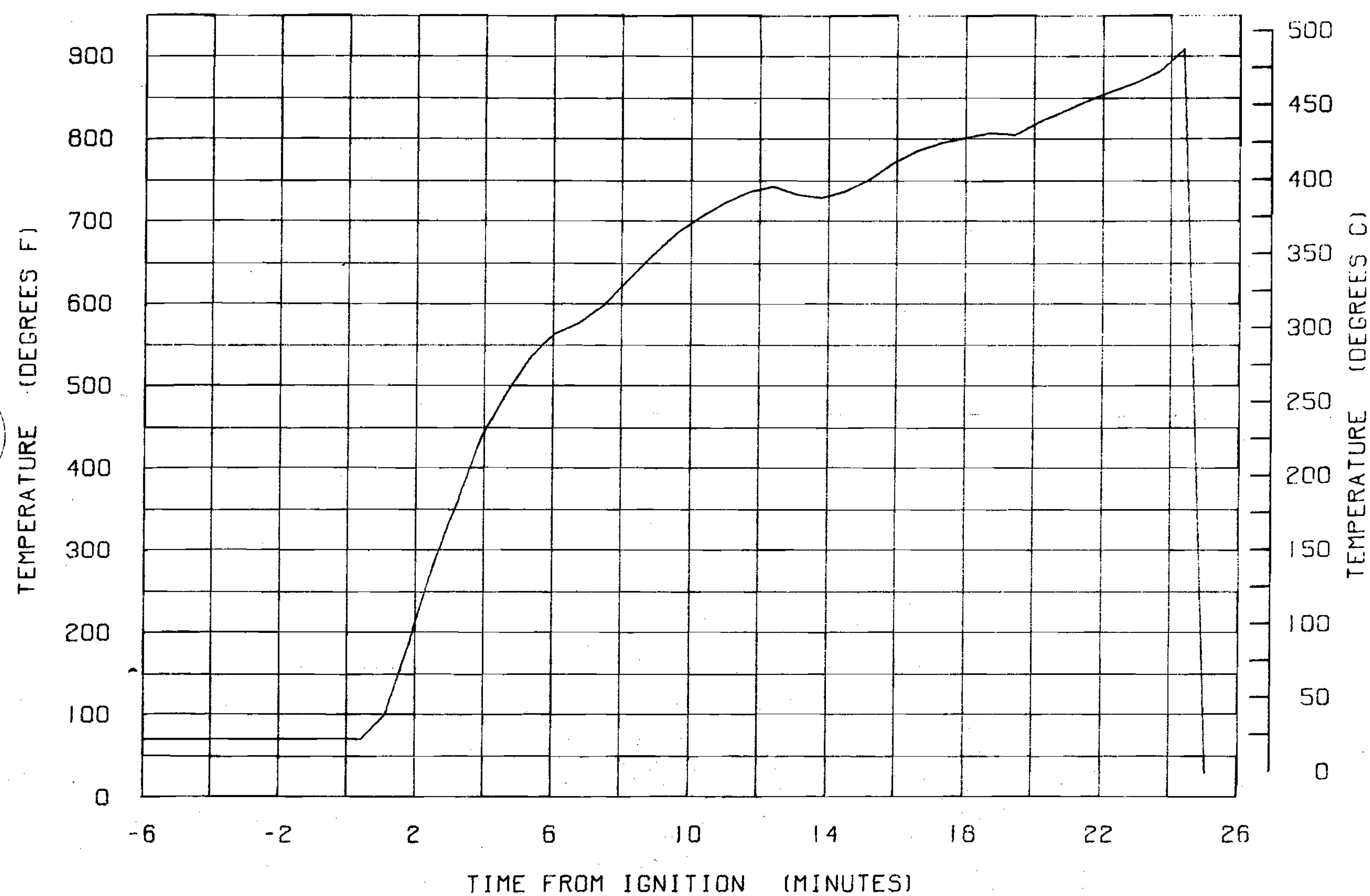

FIGURE A 85 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 91 OF TEST NUMBER 8

LOCATION IS FRONT GRID AT 12:30 LEVEL CEN

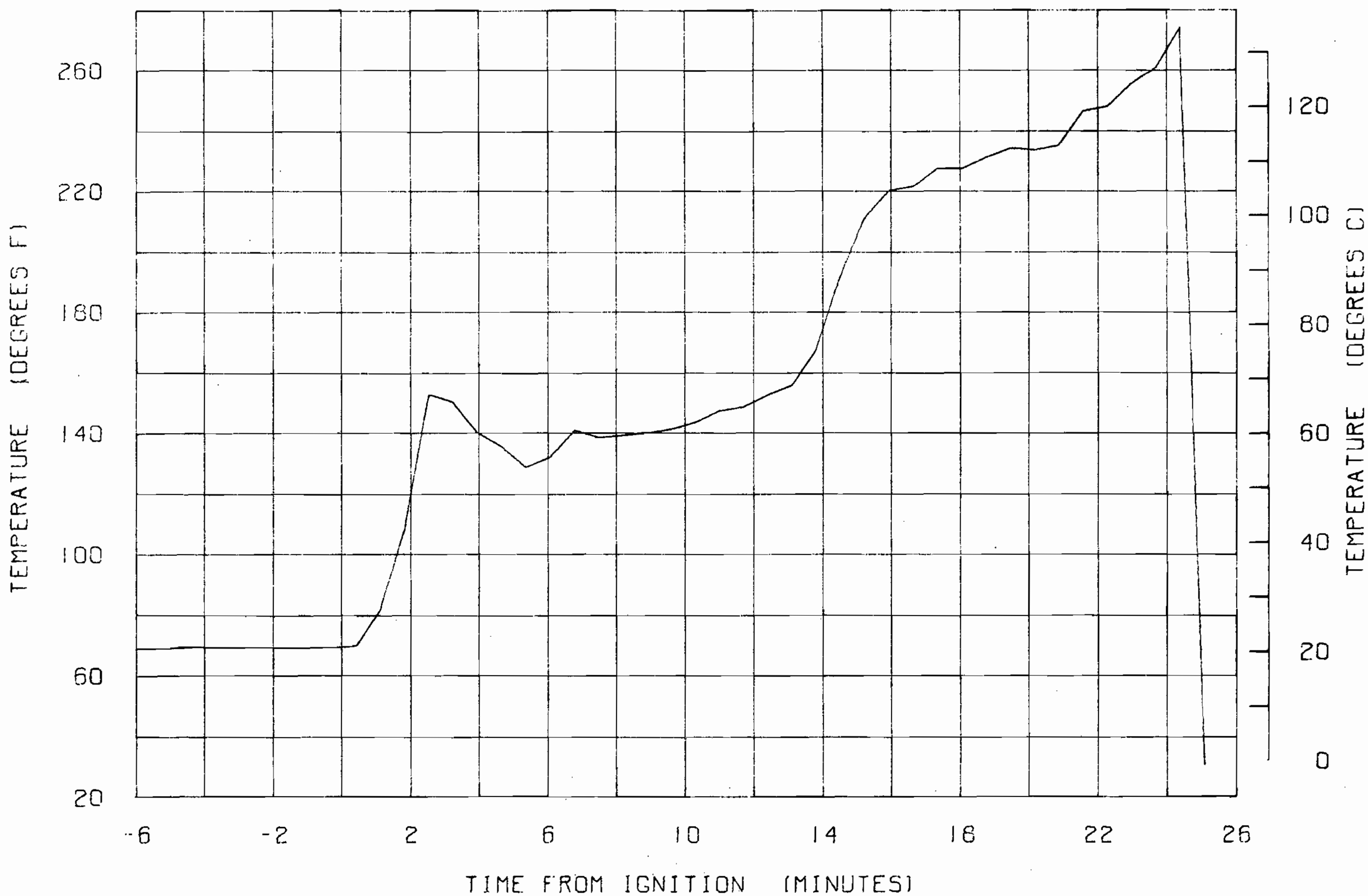

FIGURE **A 86** THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 92 OF TEST NUMBER 8

LOCATION IS FRONT GRID AT 1:00 LEVEL CEN

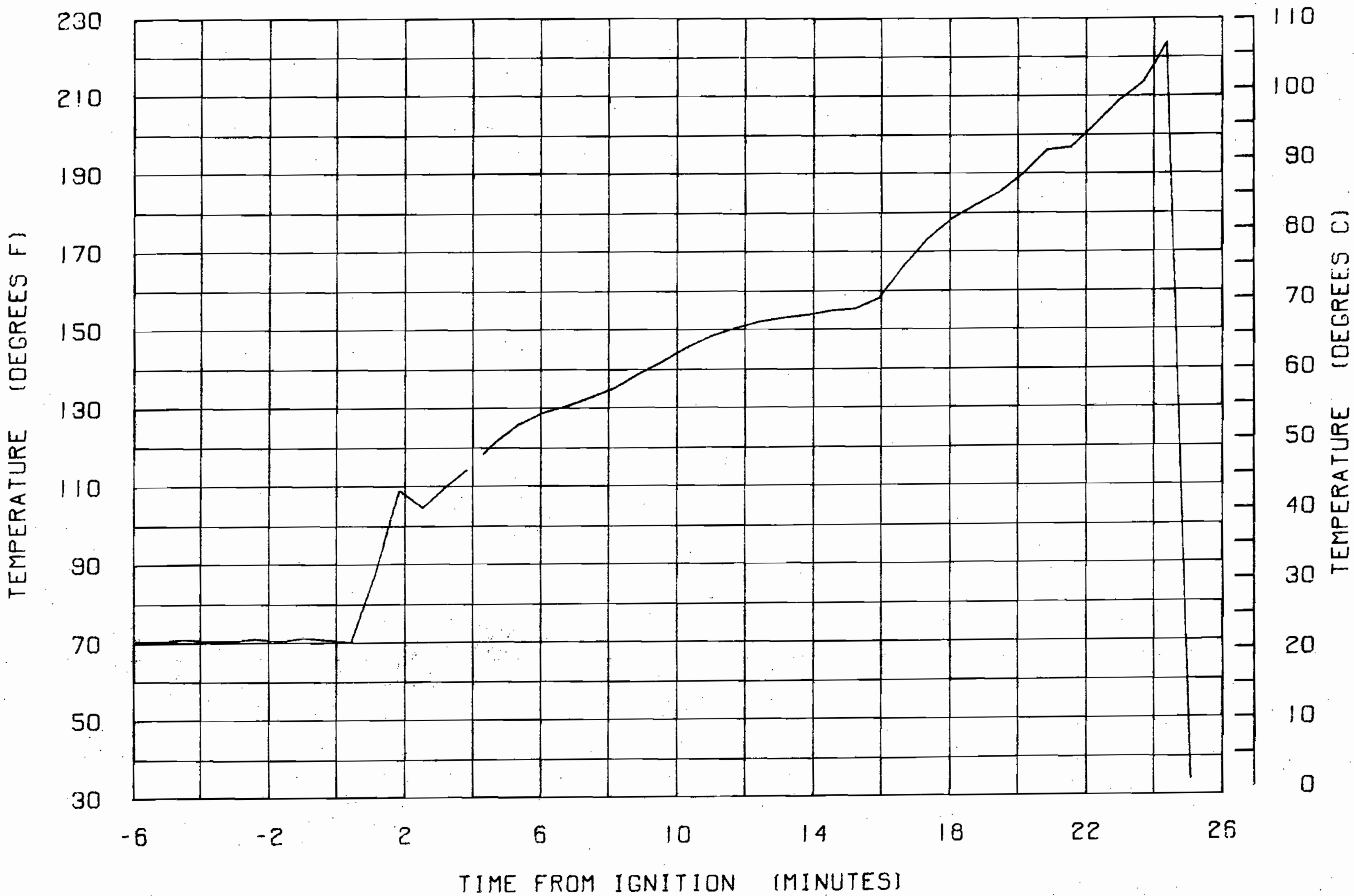

FIGURE A 87 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 93 OF TEST NUMBER 8

LOCATION IS FRONT GRID AT 1:30 LEVEL RGT

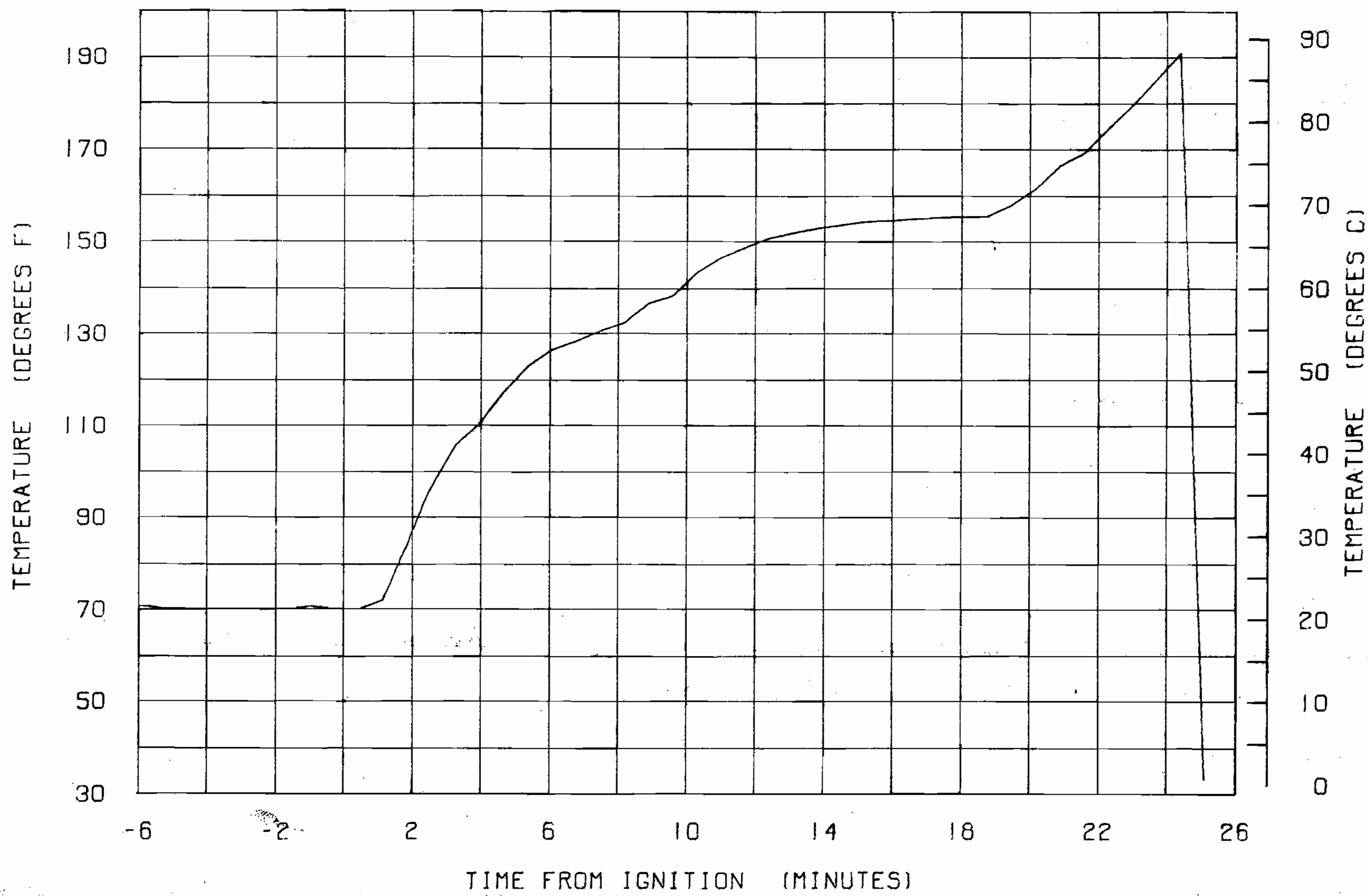

FIGURE **A 88** THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 94 OF TEST NUMBER 8

LOCATION IS FRONT GRID AT 1.30 LEVEL CEN

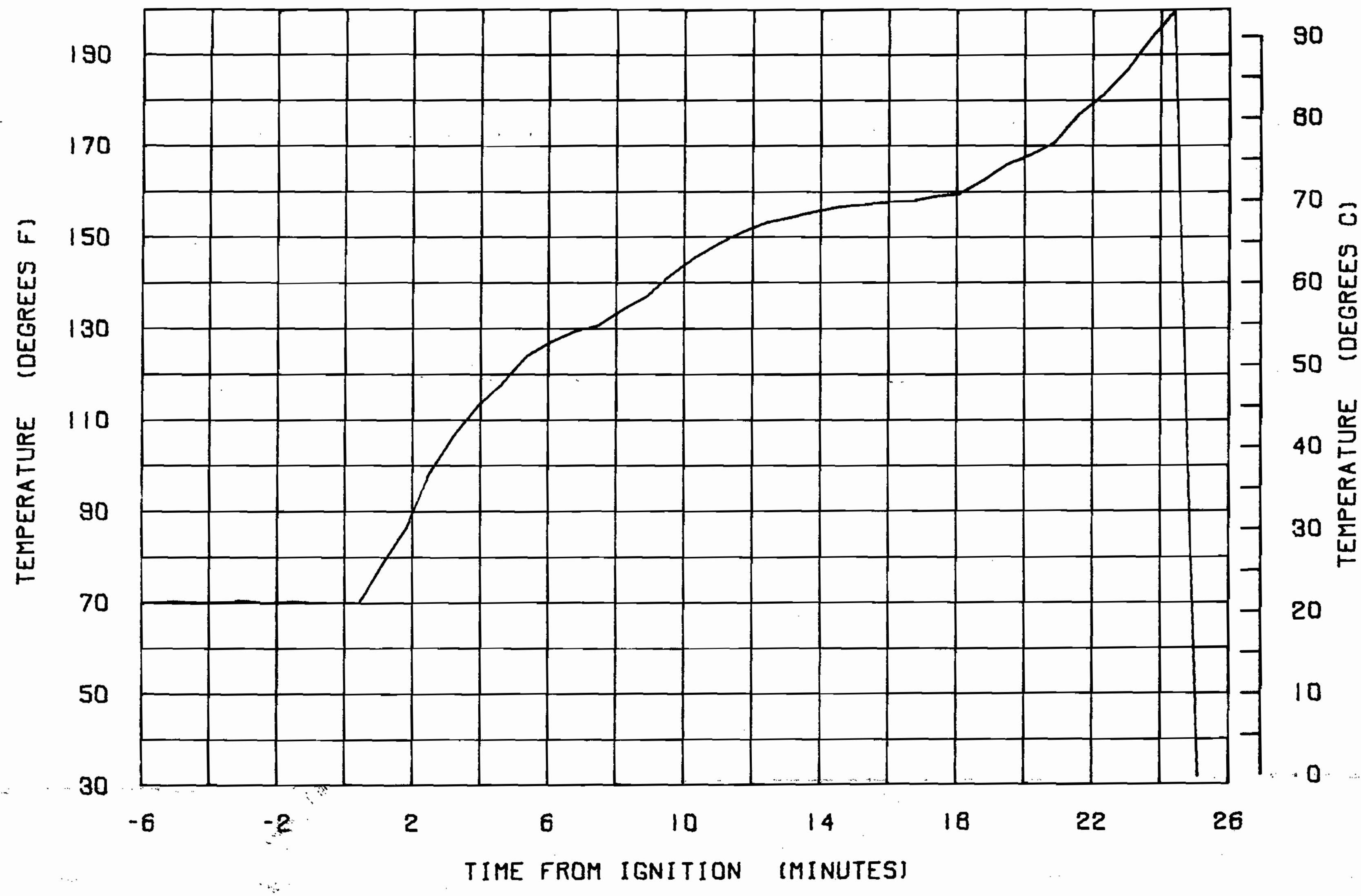

FIGURE A 89 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 95 OF TEST NUMBER 8

LOCATION IS FRONT GRID AT 1:30 LEVEL LFT

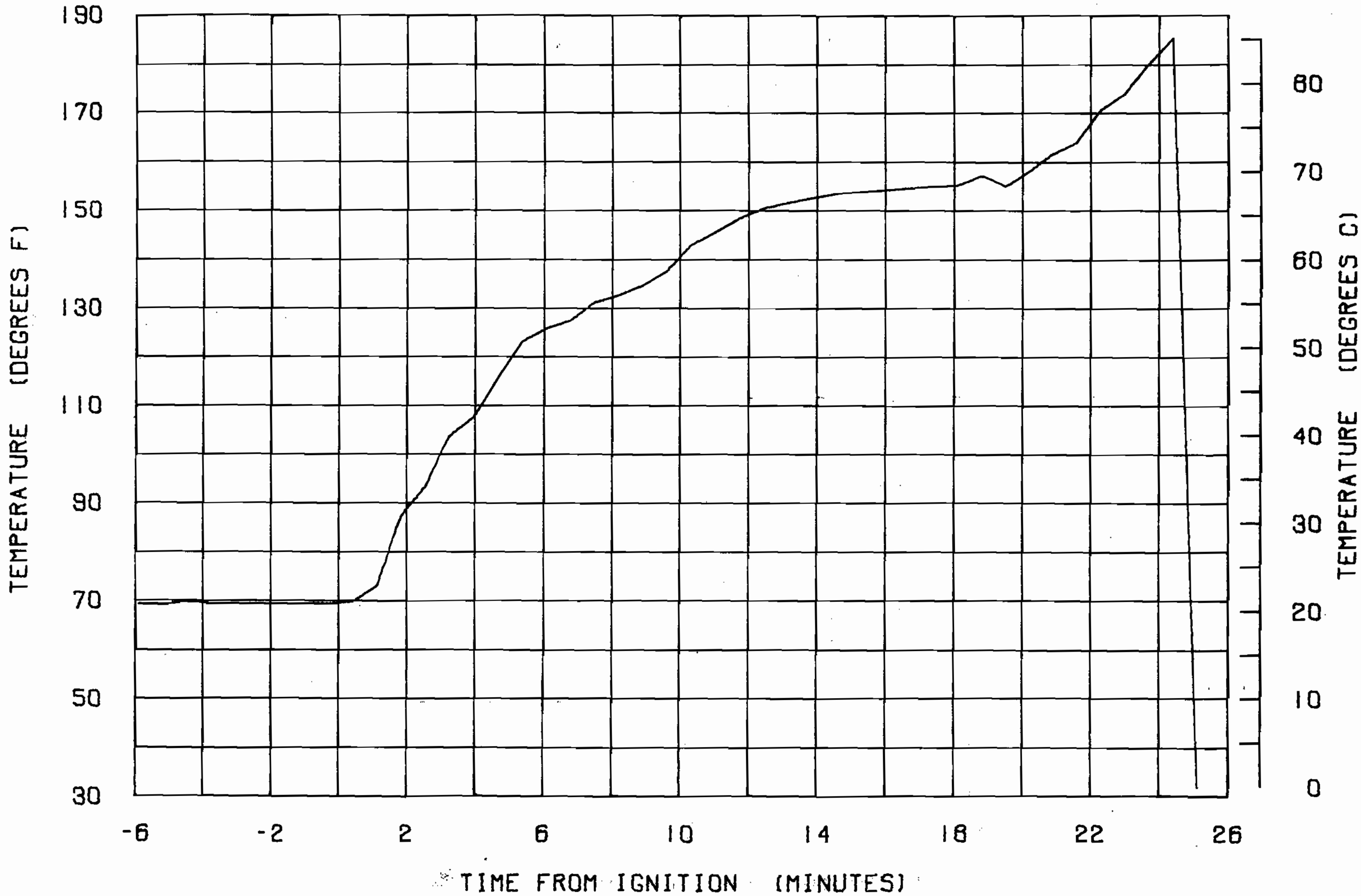

FIGURE A 90 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 96 OF TEST NUMBER 8

LOCATION IS FRONT GRID AT 2:00 LEVEL RGT

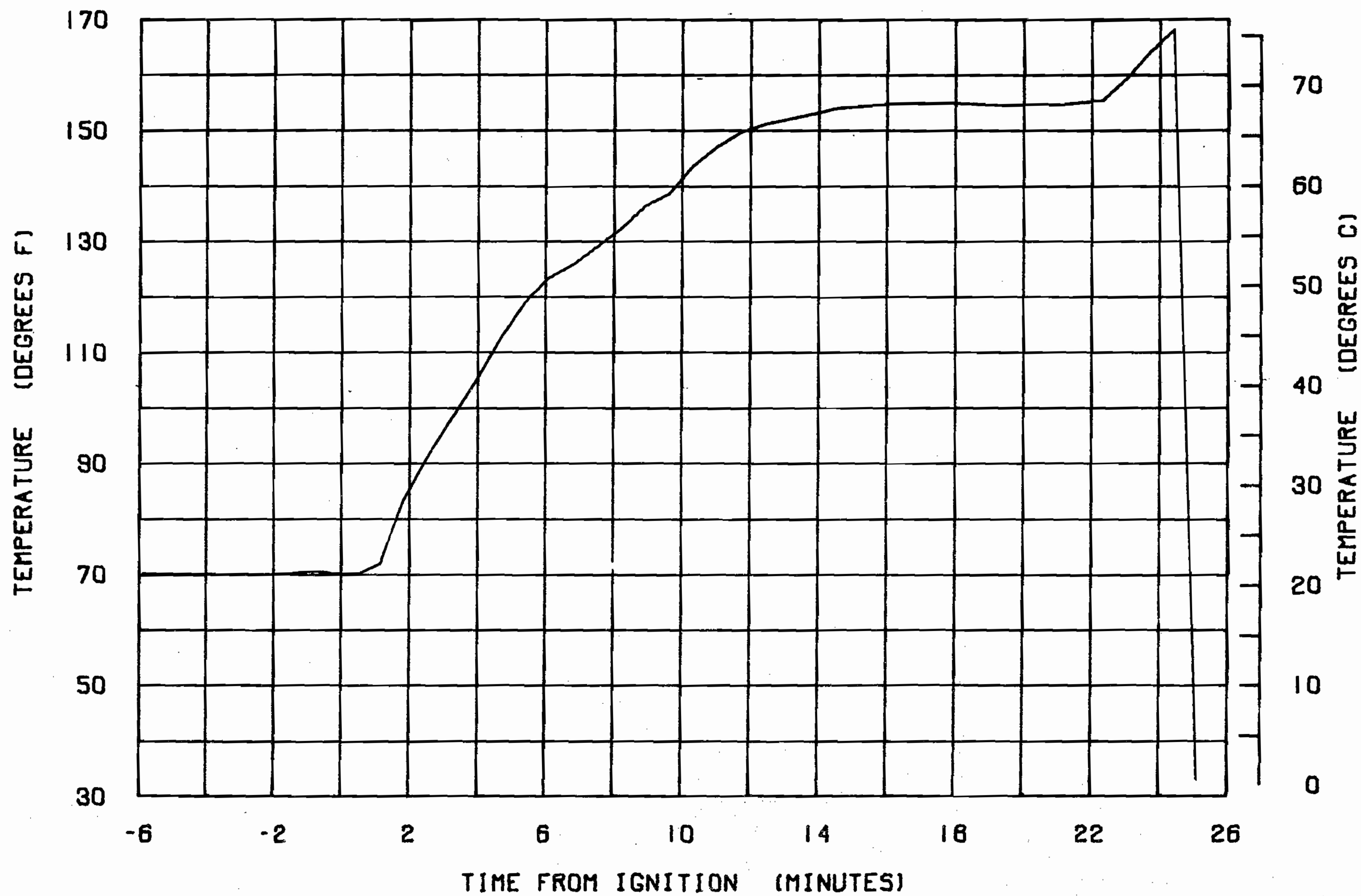

FIGURE A 91 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 97 OF TEST NUMBER 8

LOCATION IS FRONT GRID AT 2:00 LEVEL CEN

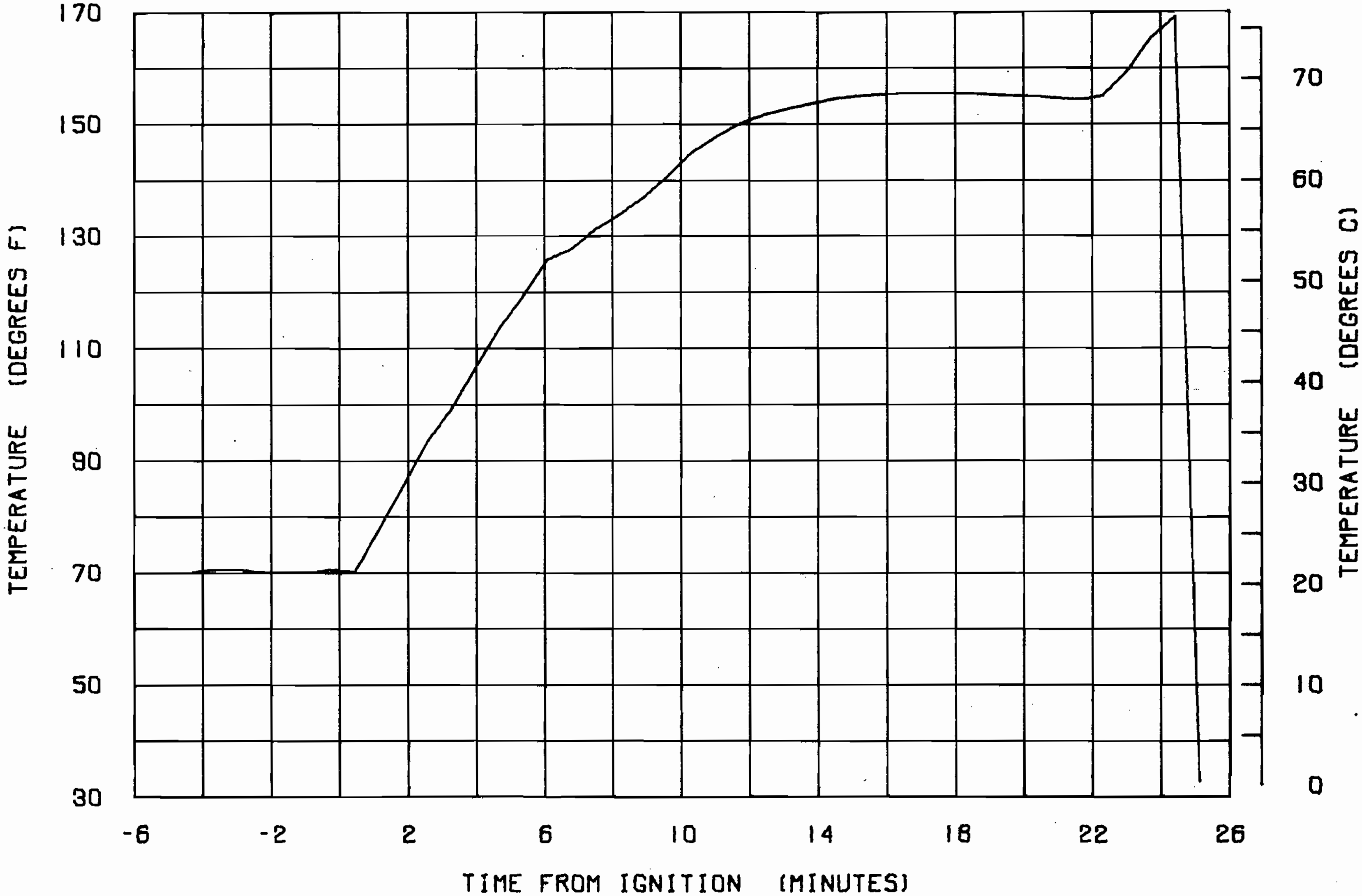

FIGURE A 92 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 98 OF TEST NUMBER 8

LOCATION IS FRONT GRID AT 2:00 LEVEL LFT

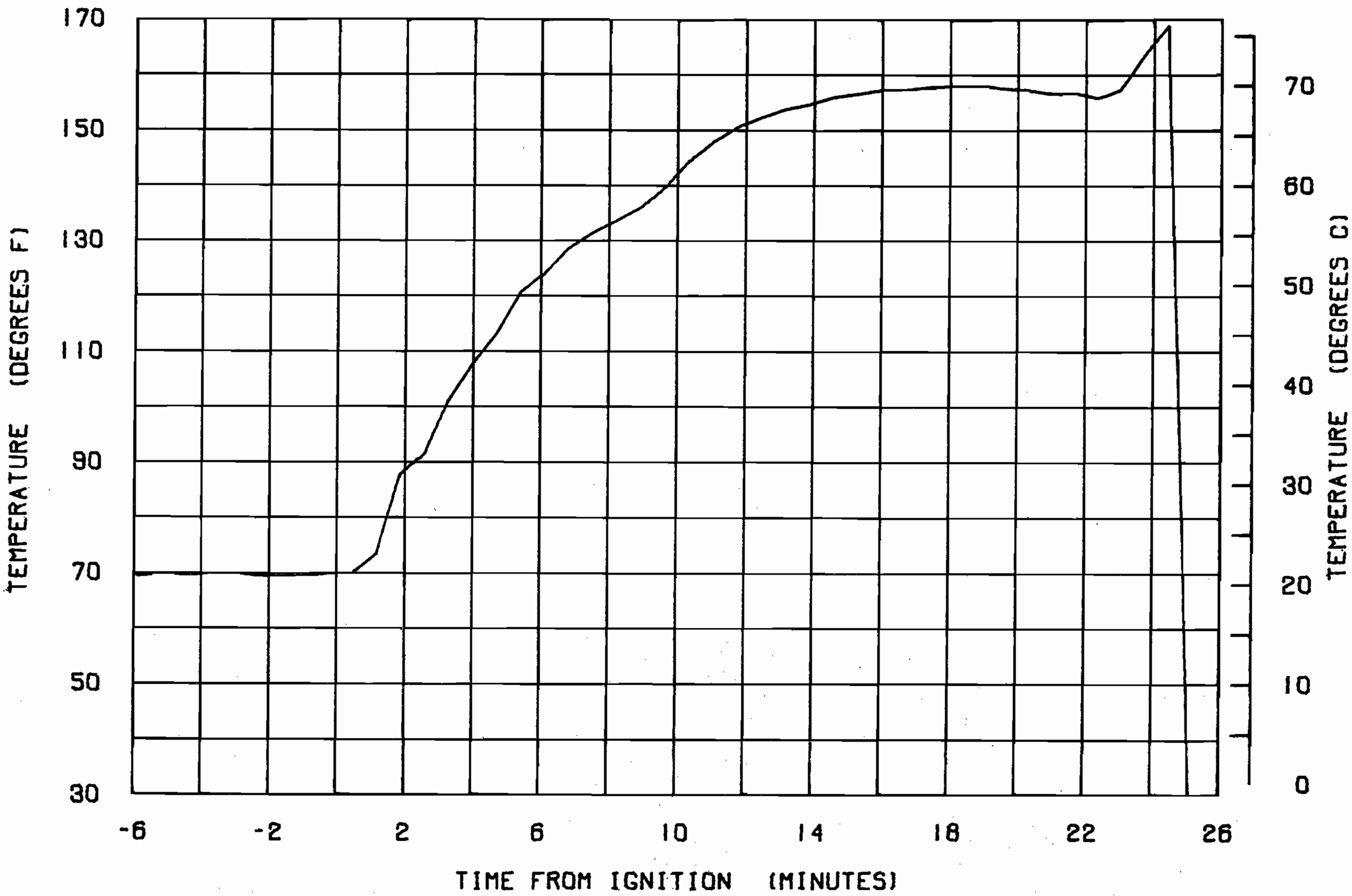

FIGURE A 93 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 99 OF TEST NUMBER 8

LOCATION IS FRONT GRID AT 2.30 LEVEL RGT

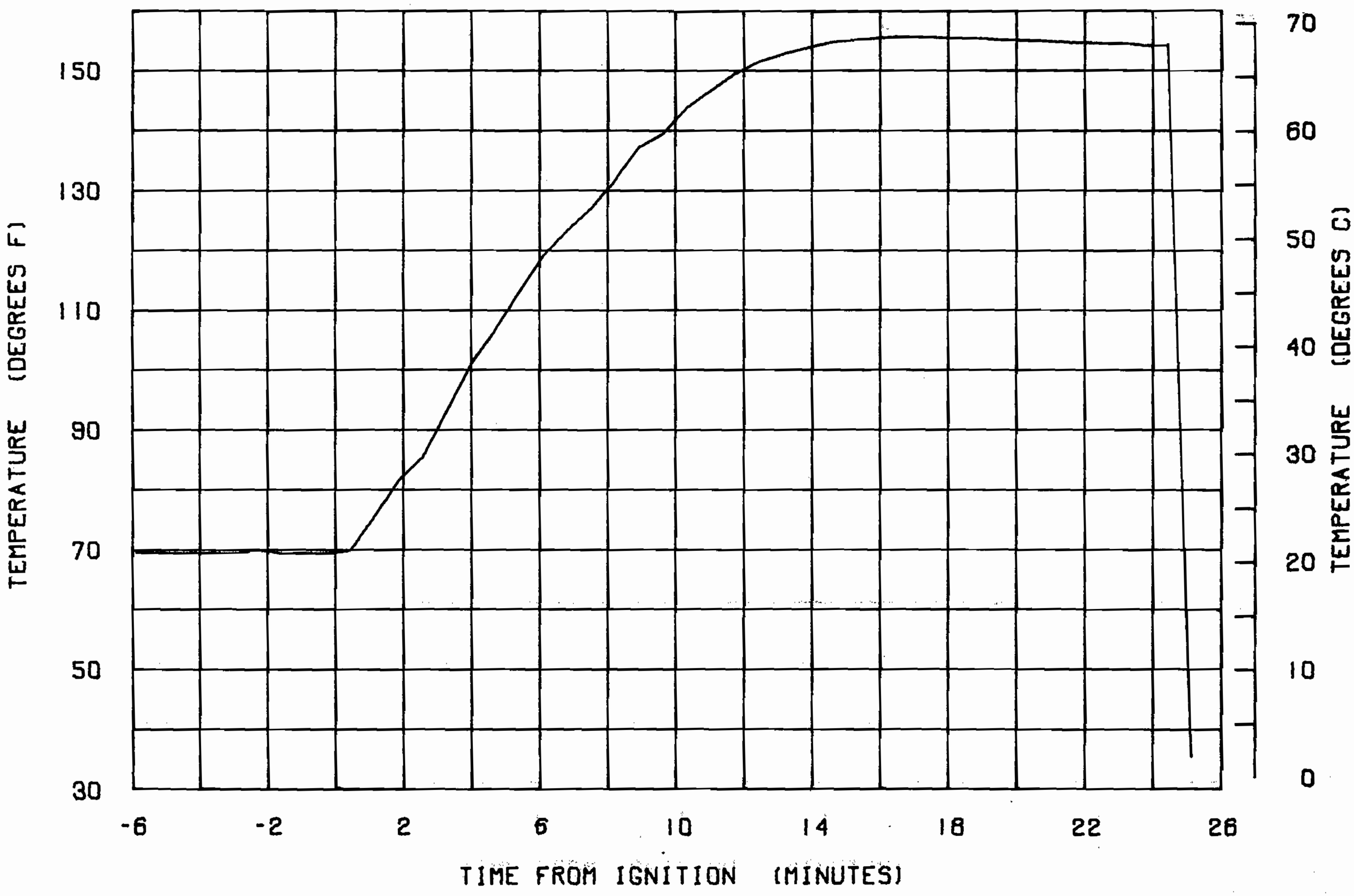

FIGURE A 94 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 100 OF TEST NUMBER 8

LOCATION IS FRONT GRID AT 2:30 LEVEL CEN

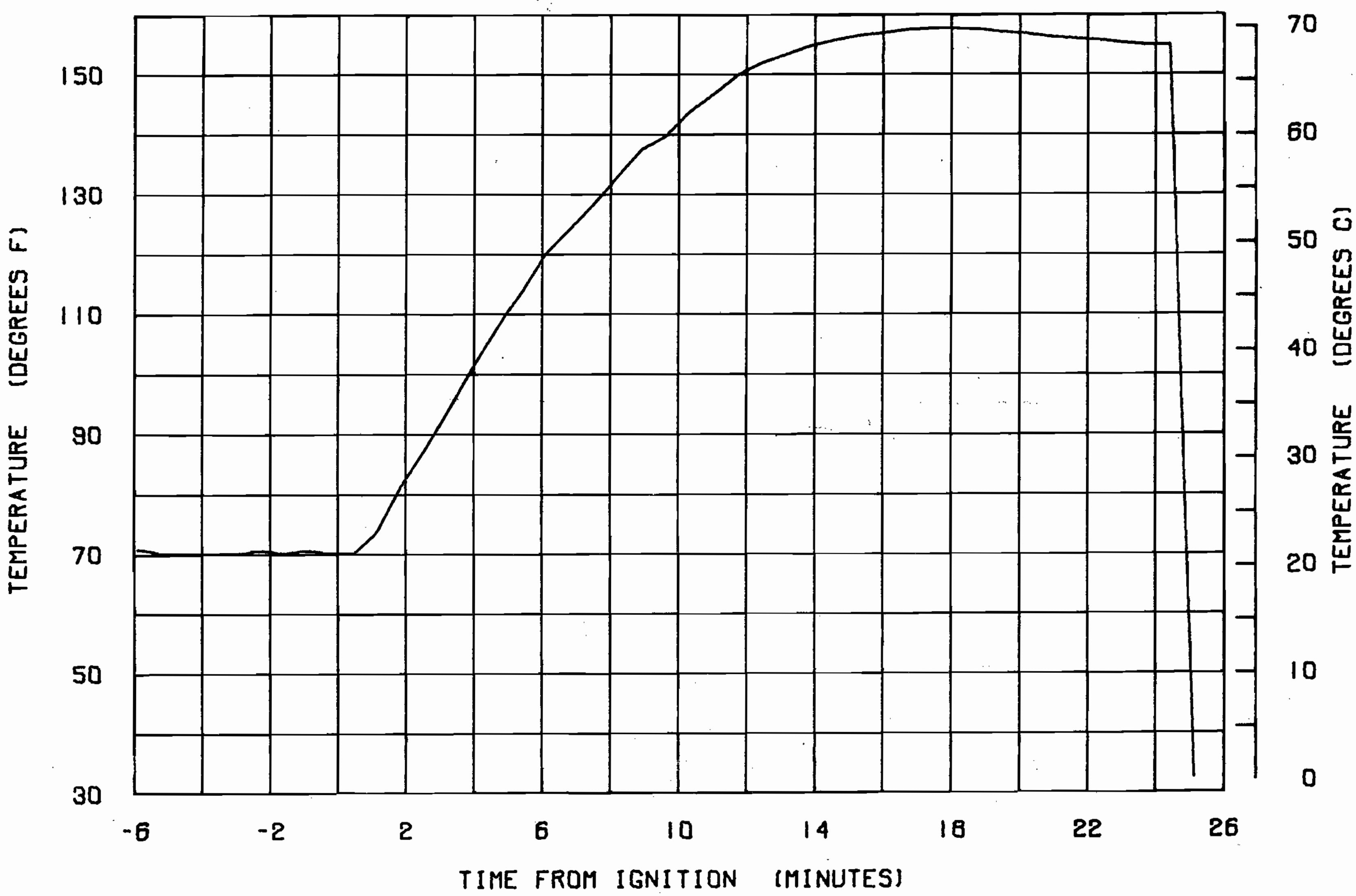

FIGURE A 95 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 101 OF TEST NUMBER 8

LOCATION IS FRONT GRID AT 2:30 LEVEL LFT

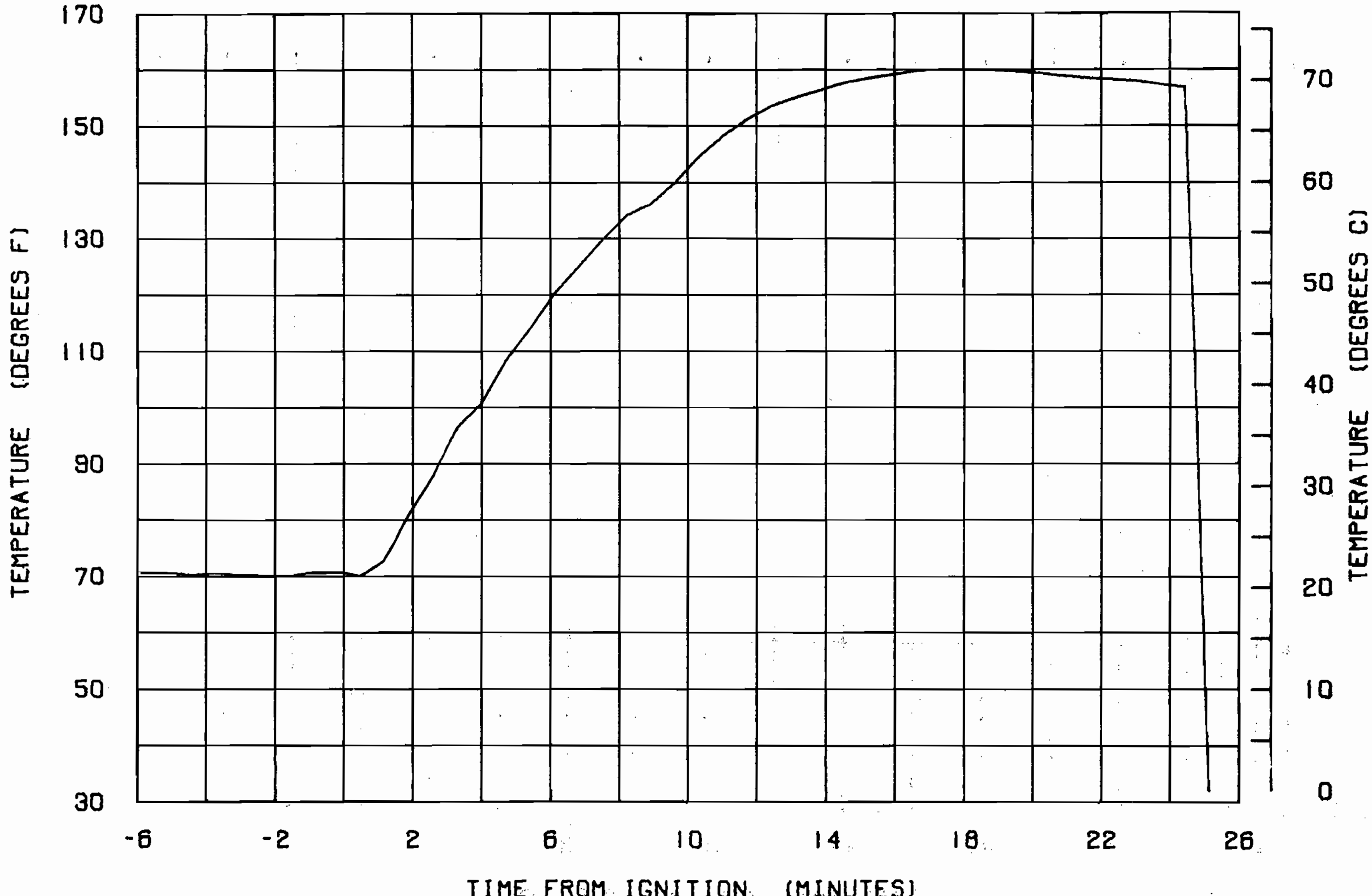

FIGURE A 96 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 102 OF TEST NUMBER 8

LOCATION IS FRONT GRID AT 3:00 LEVEL RTI

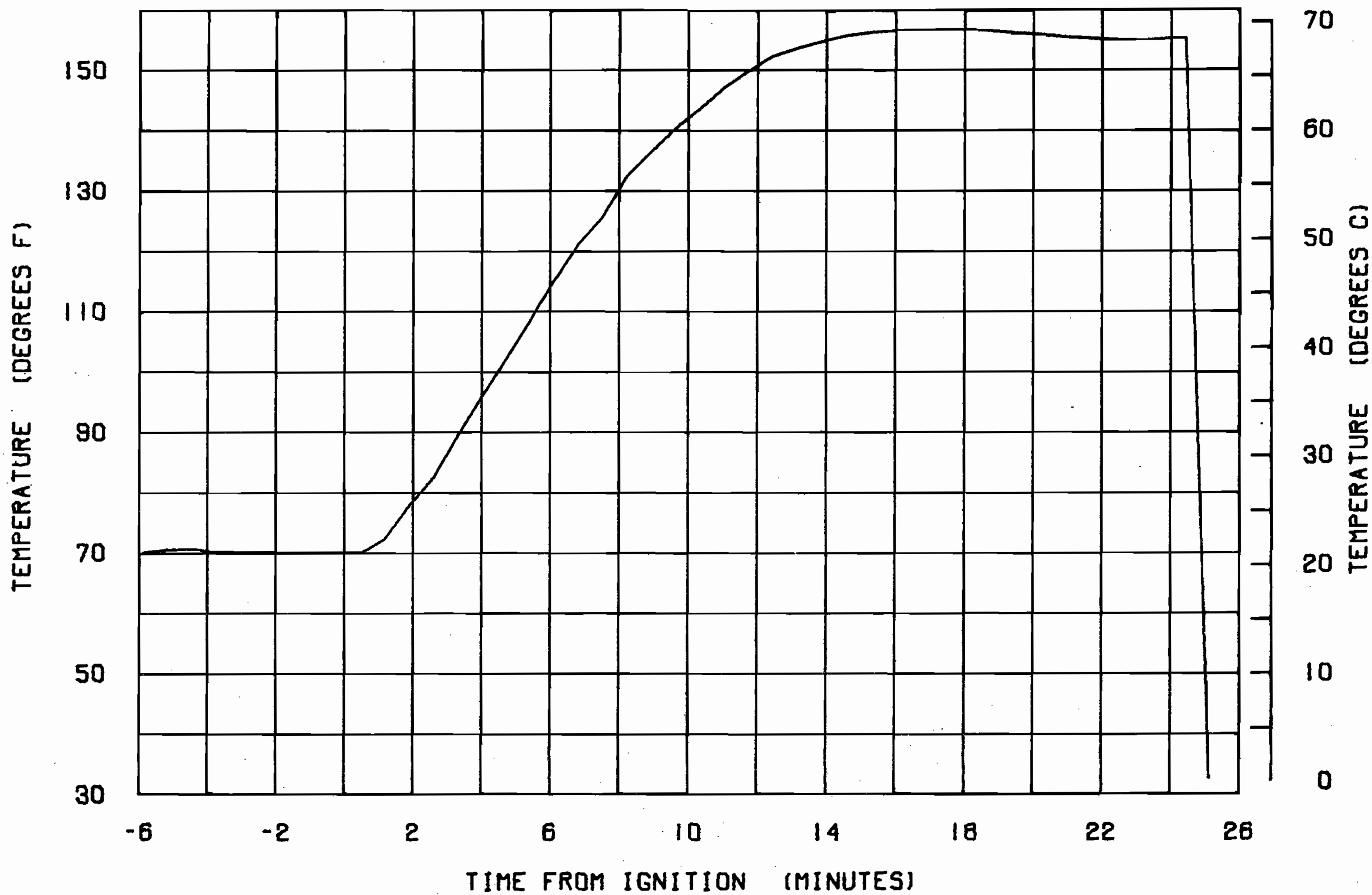

FIGURE A 97 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 103 OF TEST NUMBER 8

LOCATION IS FRONT GRID AT 3.00 LEVEL RT2

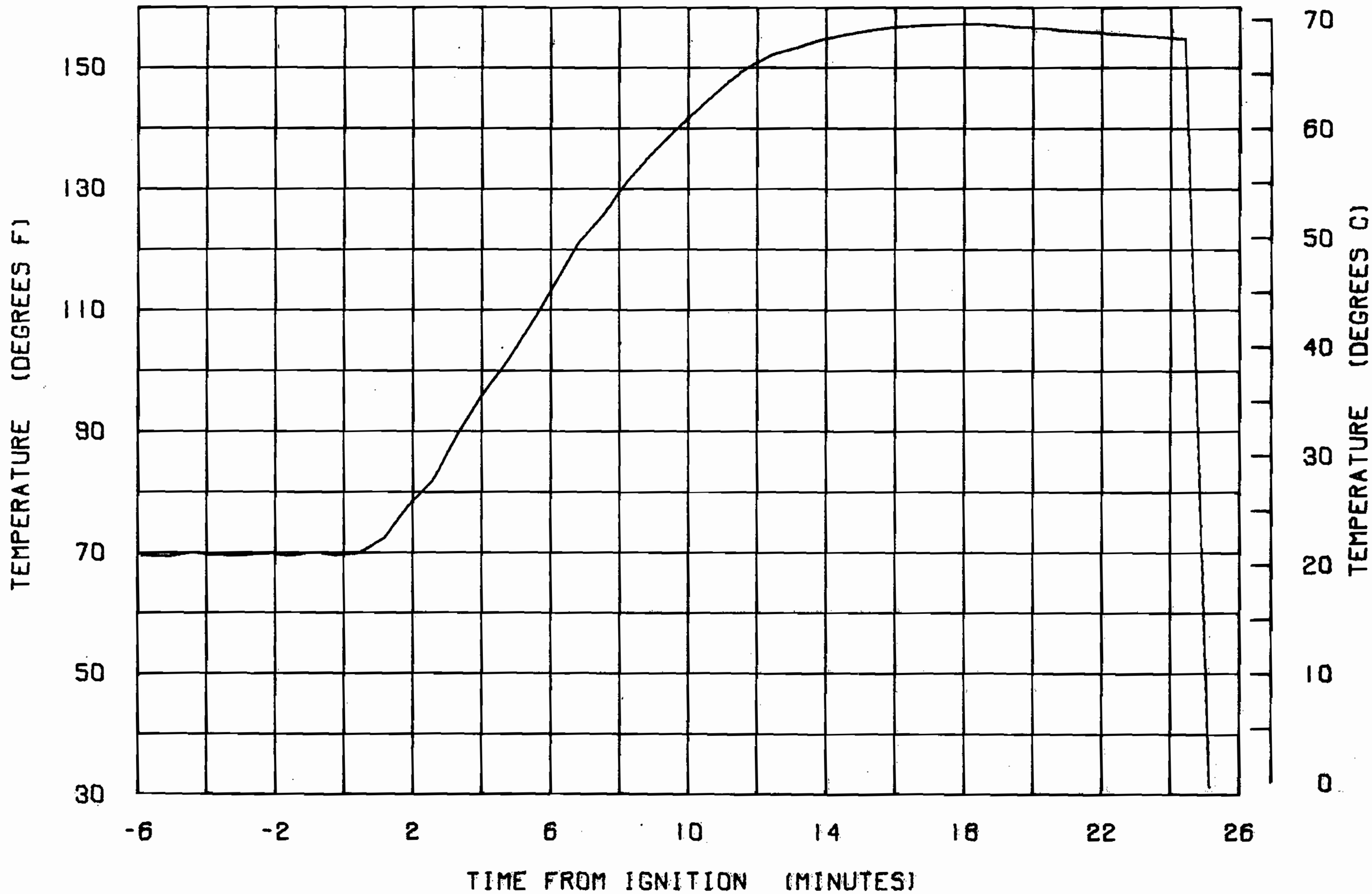

FIGURE A 98 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 104 OF TEST NUMBER 8

LOCATION IS FRONT GRID AT 3.00 LEVEL CEN

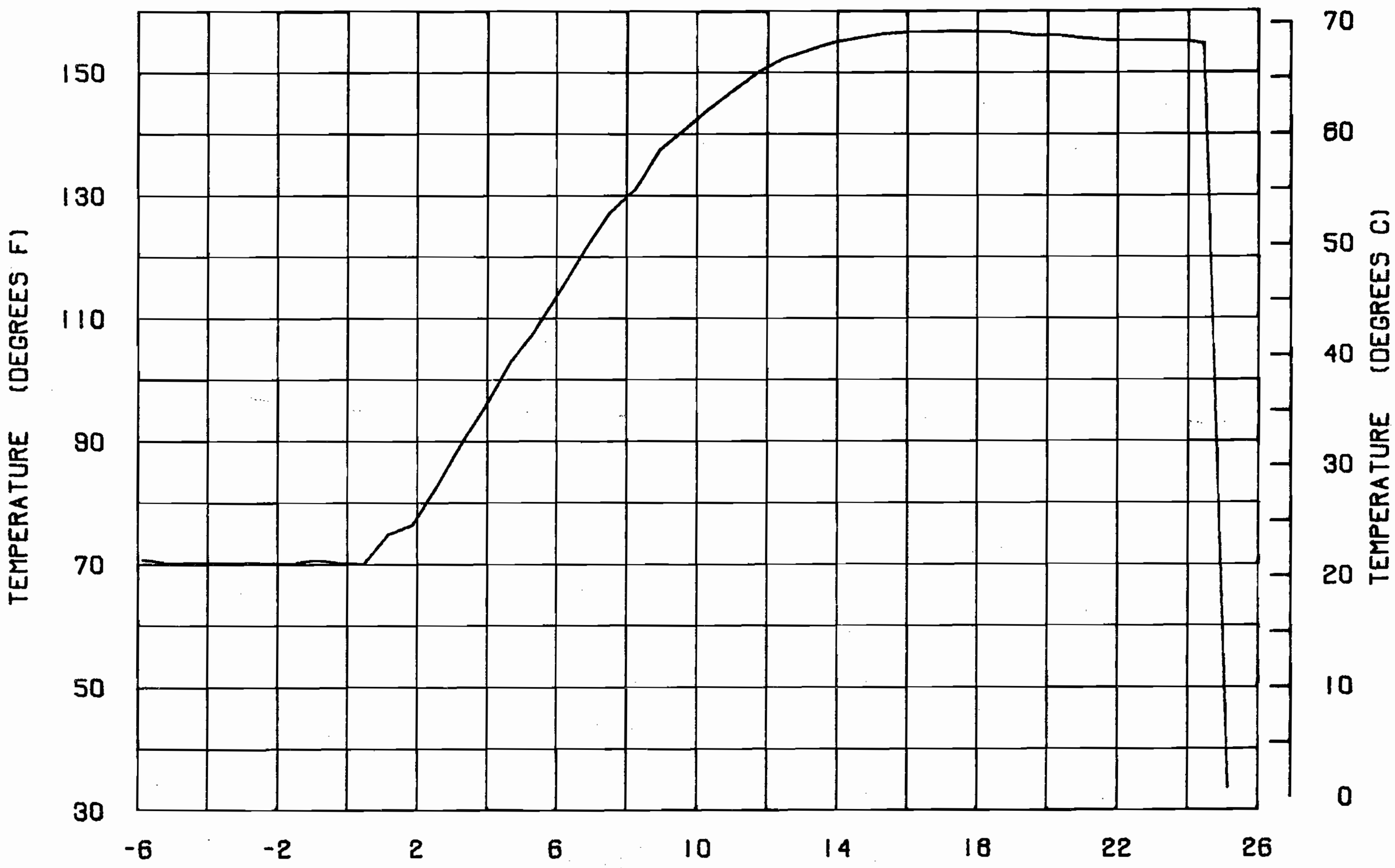

FIGURE A 99 THERMOCOUPLE TEMPERATURE VS. TIME

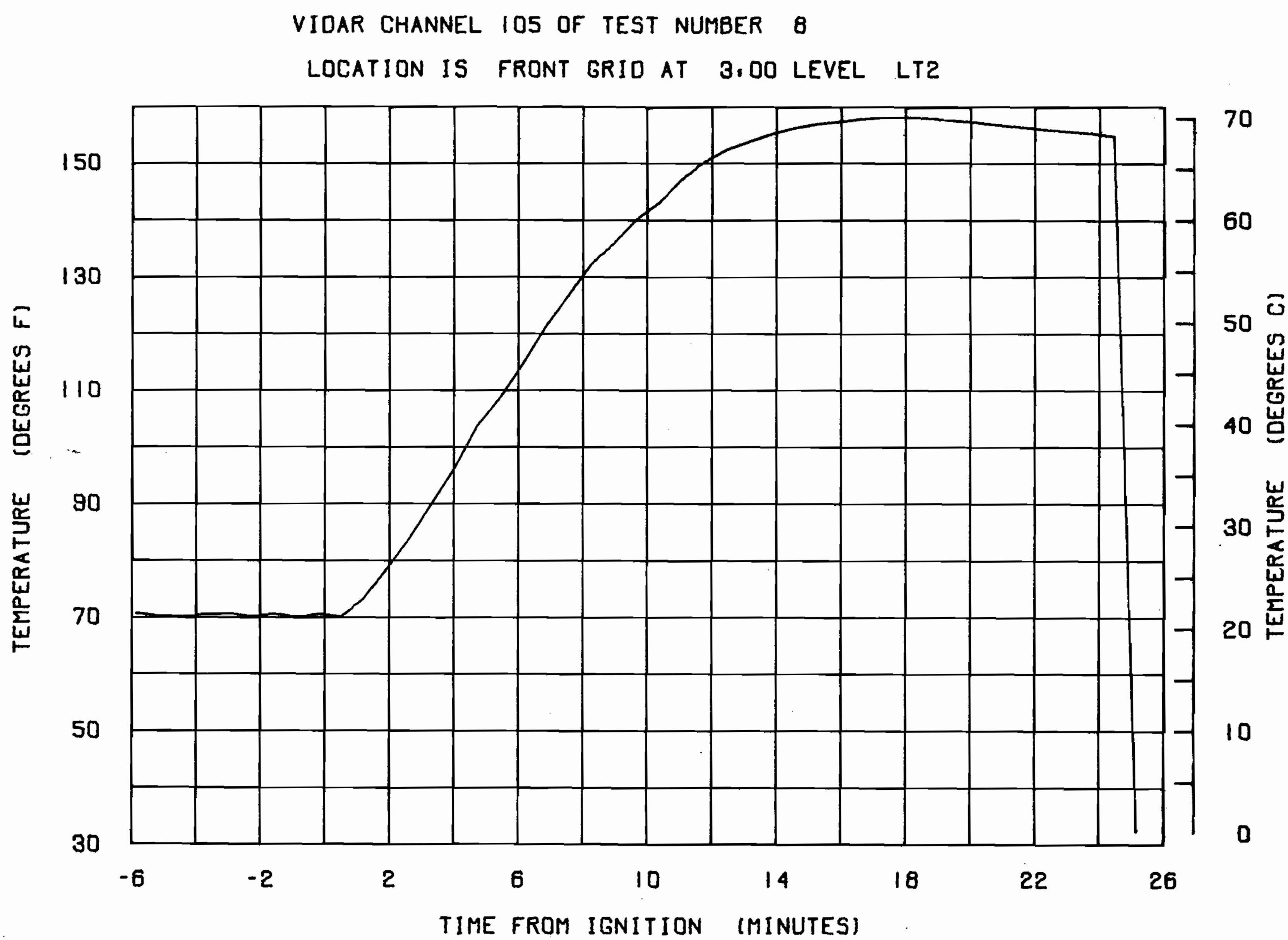

FIGURE A 100 THERMOCOUPLE TEMPERATURE VS. TIME

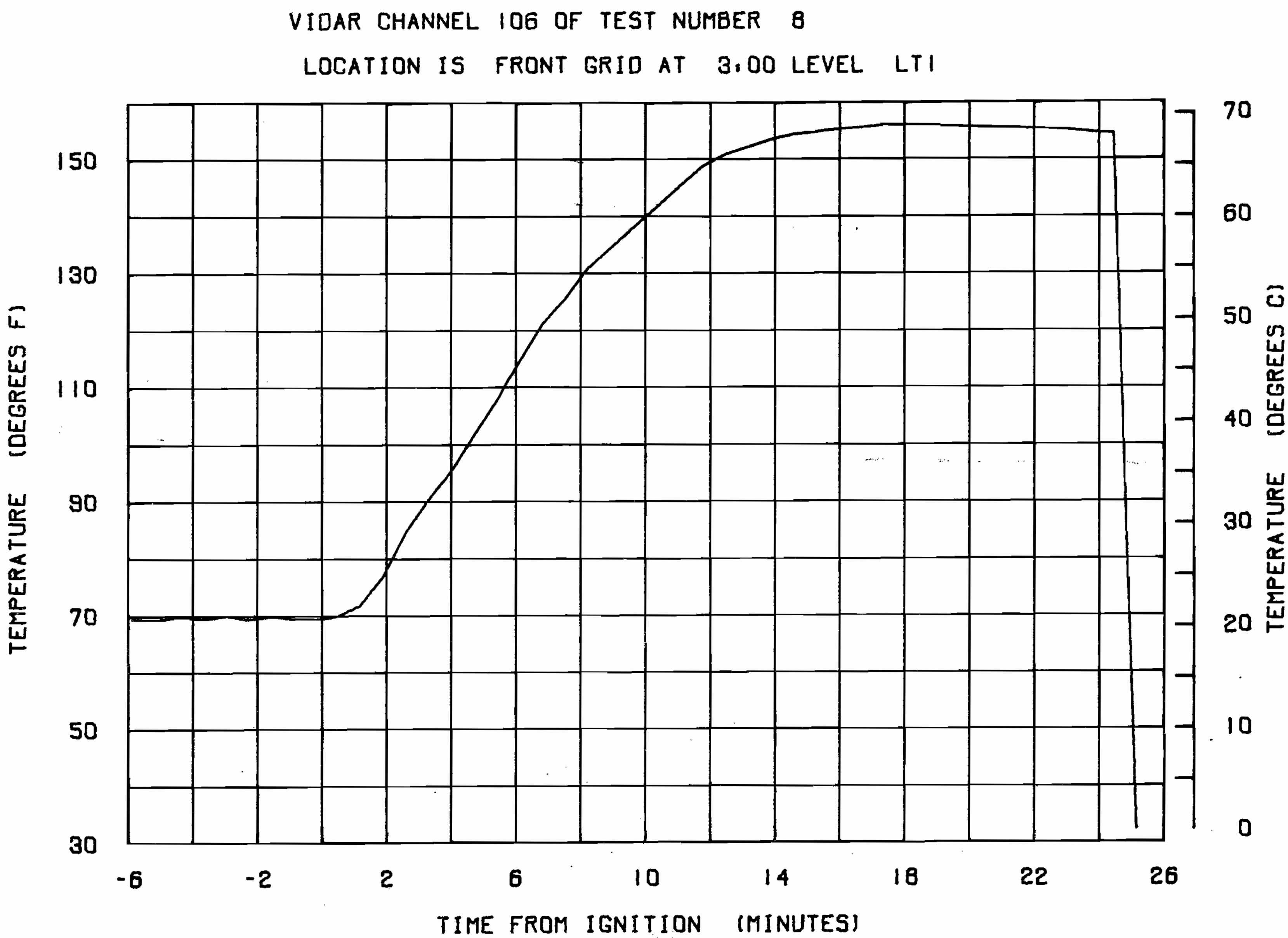

FIGURE A 101 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 107 OF TEST NUMBER 8

LOCATION IS FRONT GRID AT 3:30 LEVEL RGT

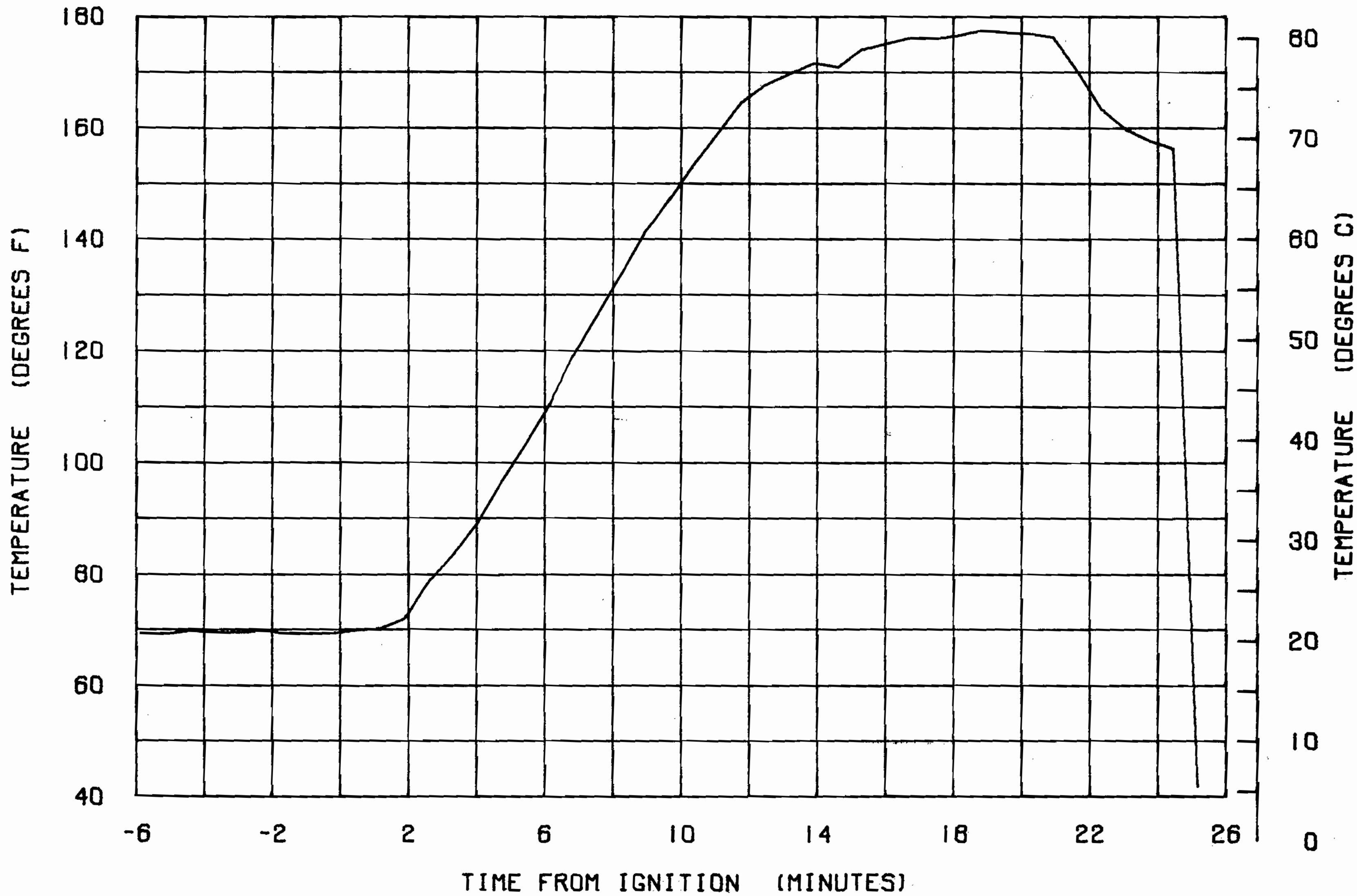

FIGURE A 102 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 108 OF TEST NUMBER 8

LOCATION IS FRONT GRID AT 3:30 LEVEL CEN

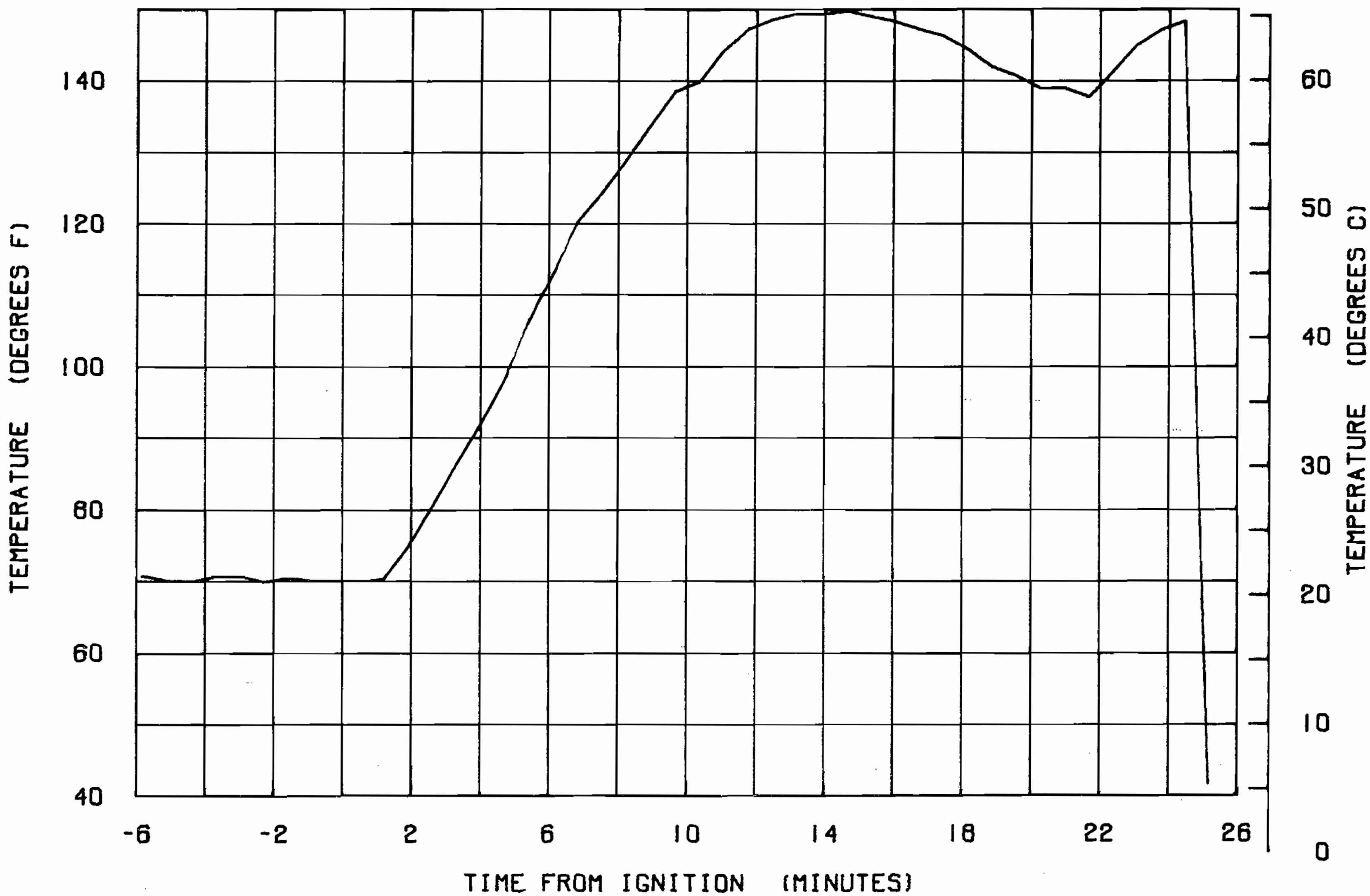

FIGURE A 103 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 109 OF TEST NUMBER 8

LOCATION IS FRONT GRID AT 3,30 LEVEL LFT

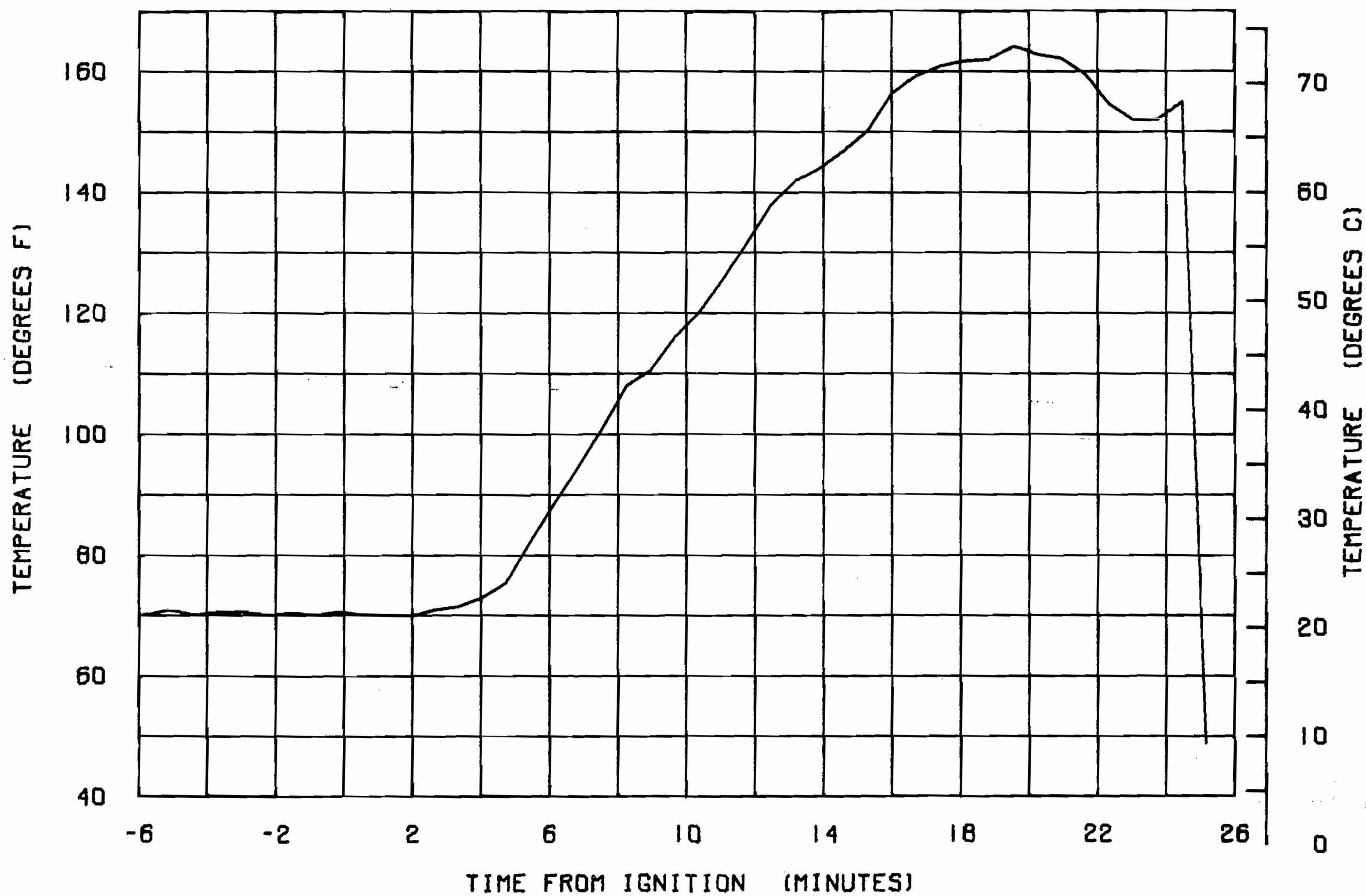

FIGURE A 104 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 112 OF TEST NUMBER 8

LOCATION IS FRONT GRID AT 4.00 LEVEL LFT

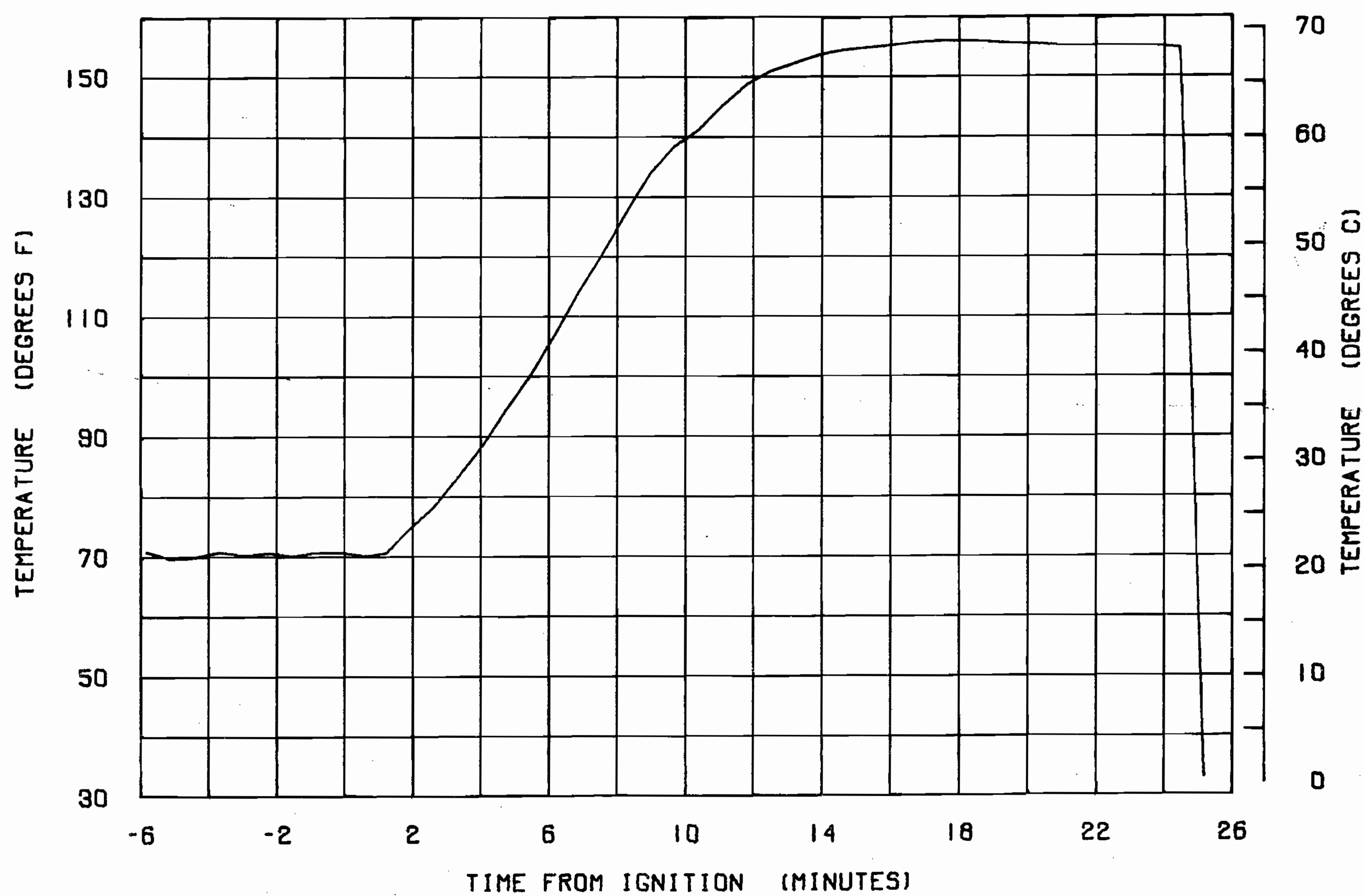

FIGURE A 105 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 113 OF TEST NUMBER 8

LOCATION IS FRONT GRID AT 4,30 RGT

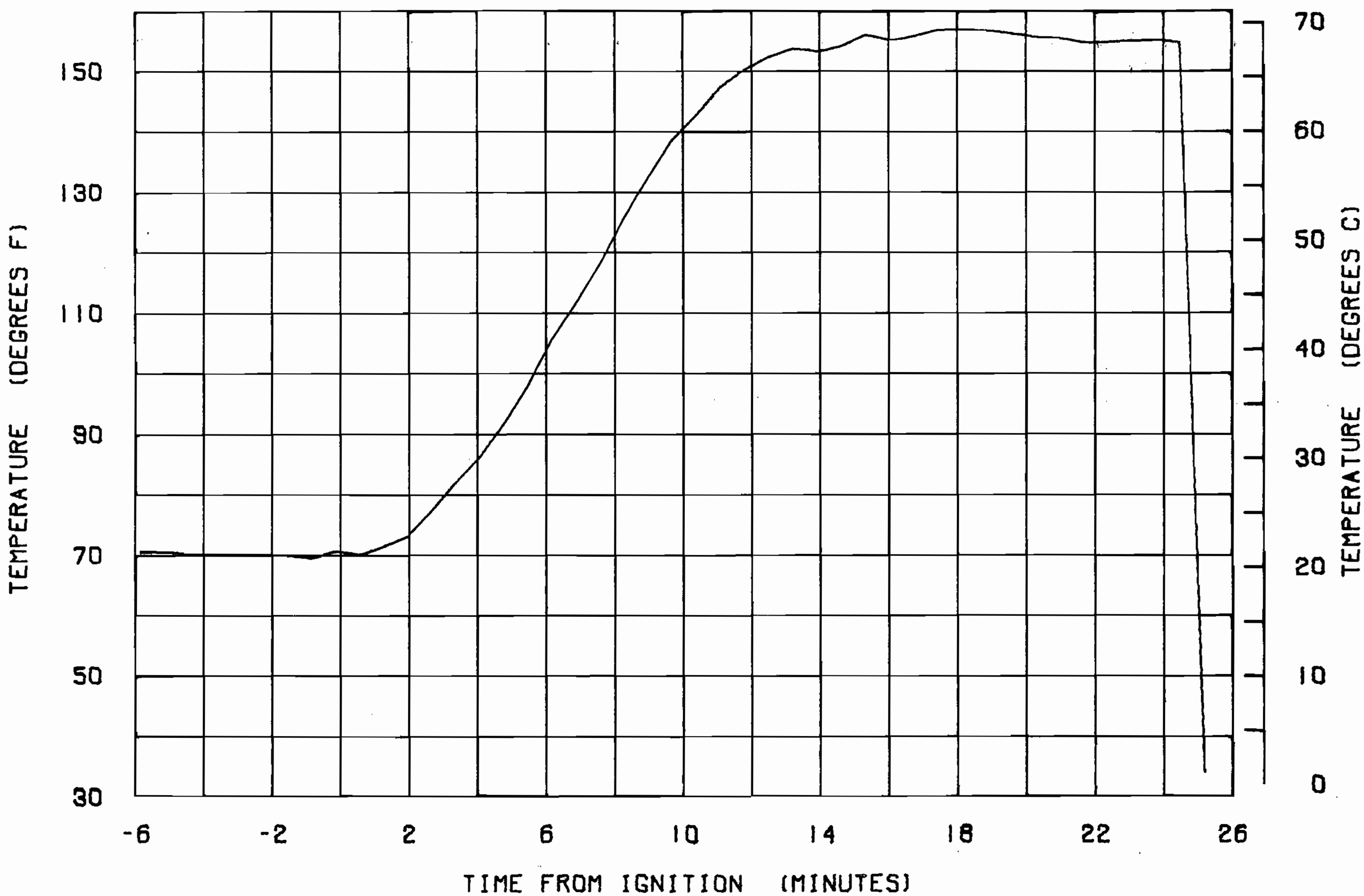

FIGURE A 106 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 114 OF TEST NUMBER 8

LOCATION IS FRONT GRID AT 4.30 LEVEL CEN

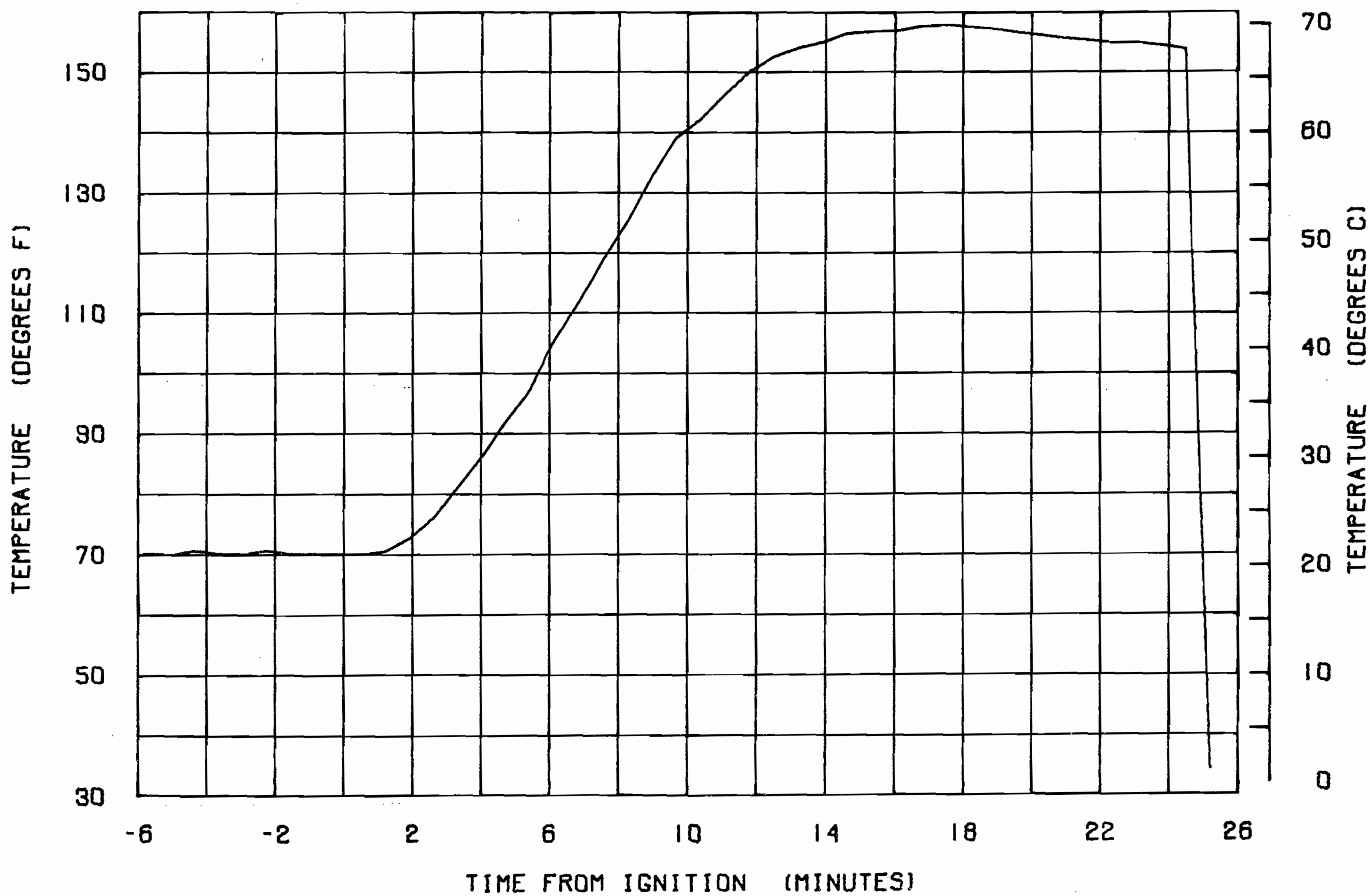

FIGURE A 107 THERMOCOUPLE TEMPERATURE VS. TIME

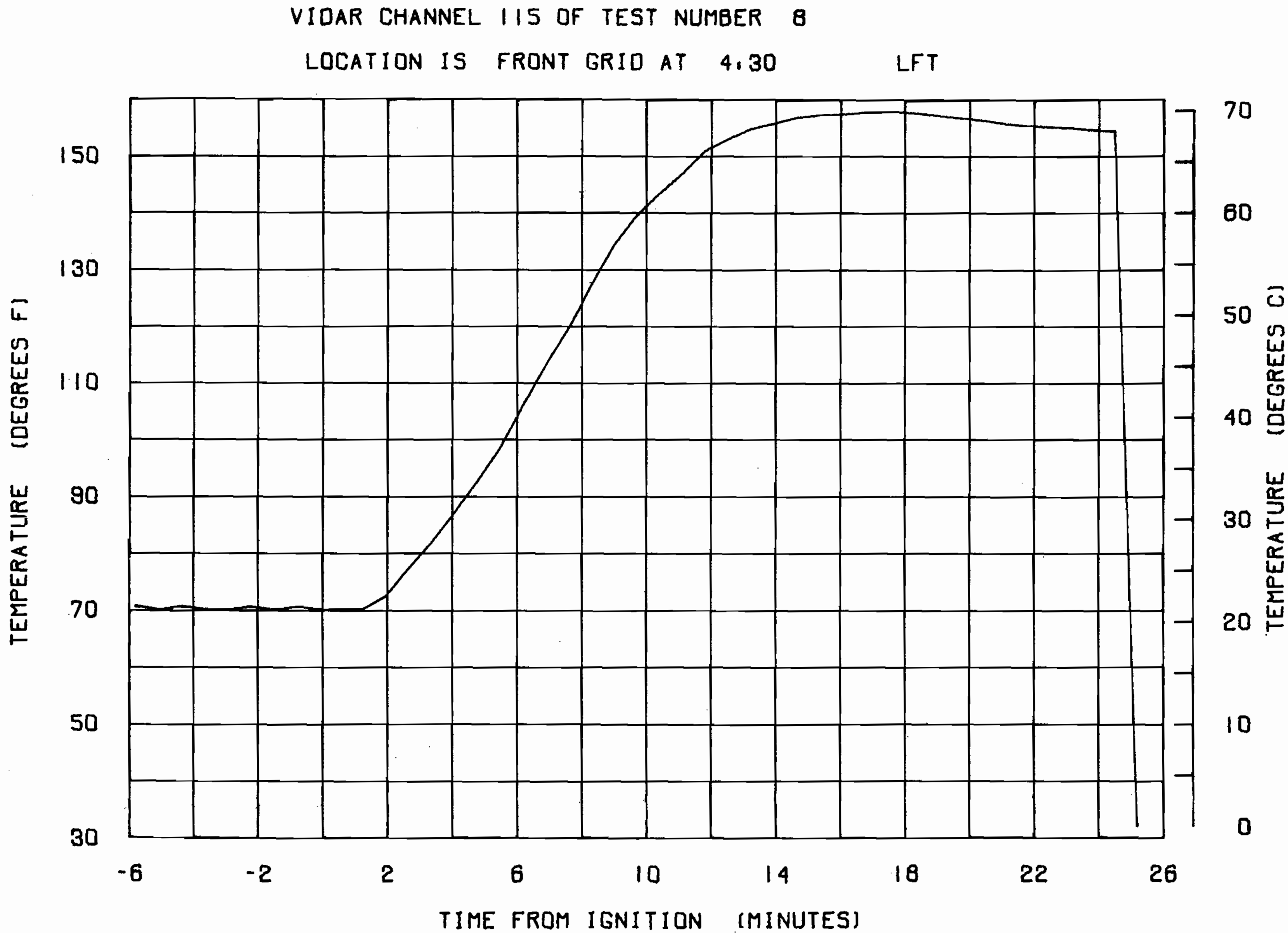

FIGURE A 108 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 1-16 OF TEST NUMBER 8

LOCATION IS FRONT GRID AT 5.00 LEVEL CEN

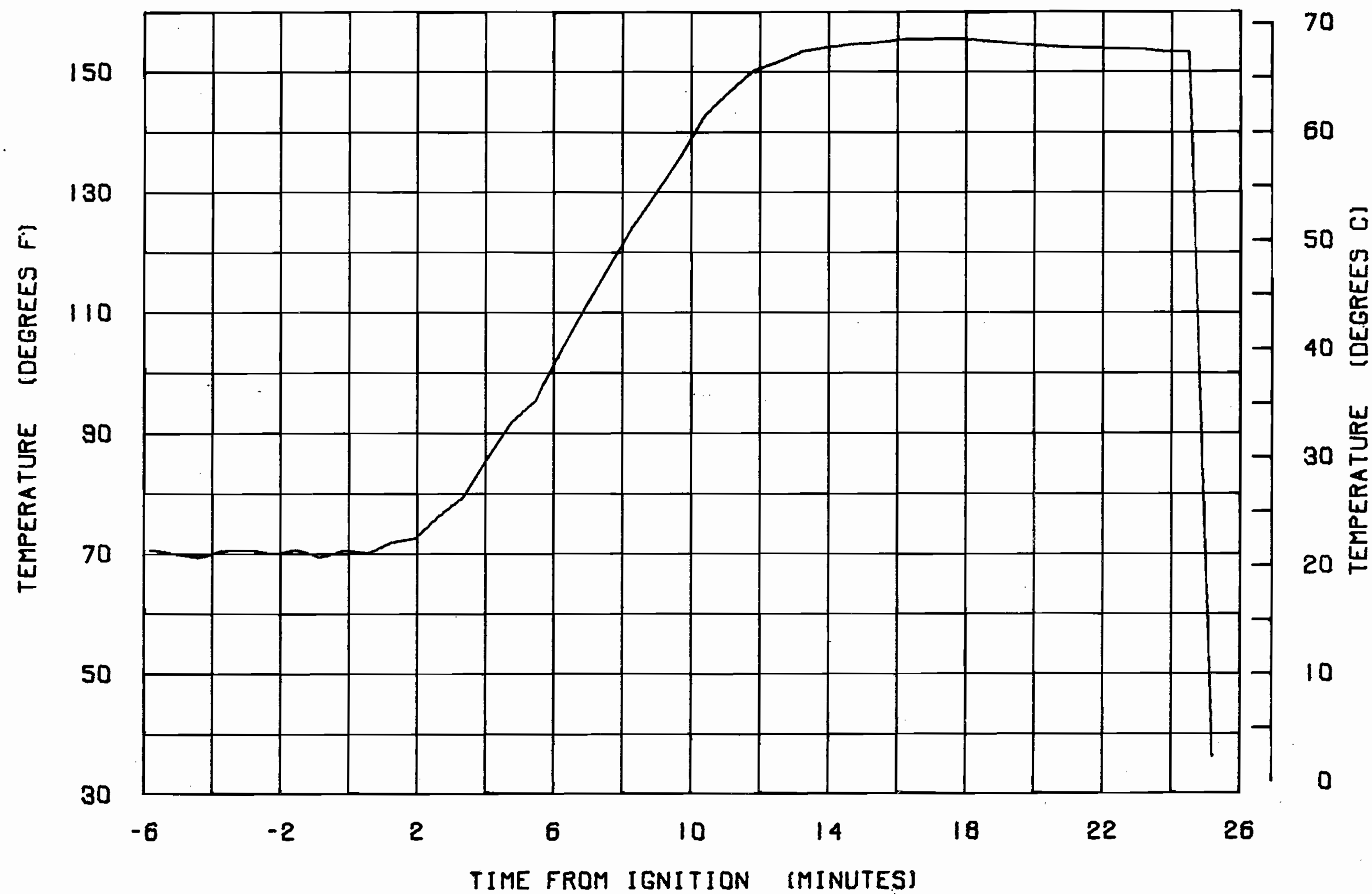

FIGURE A 109 THERMOCOUPLE TEMPERATURE VS. TIME

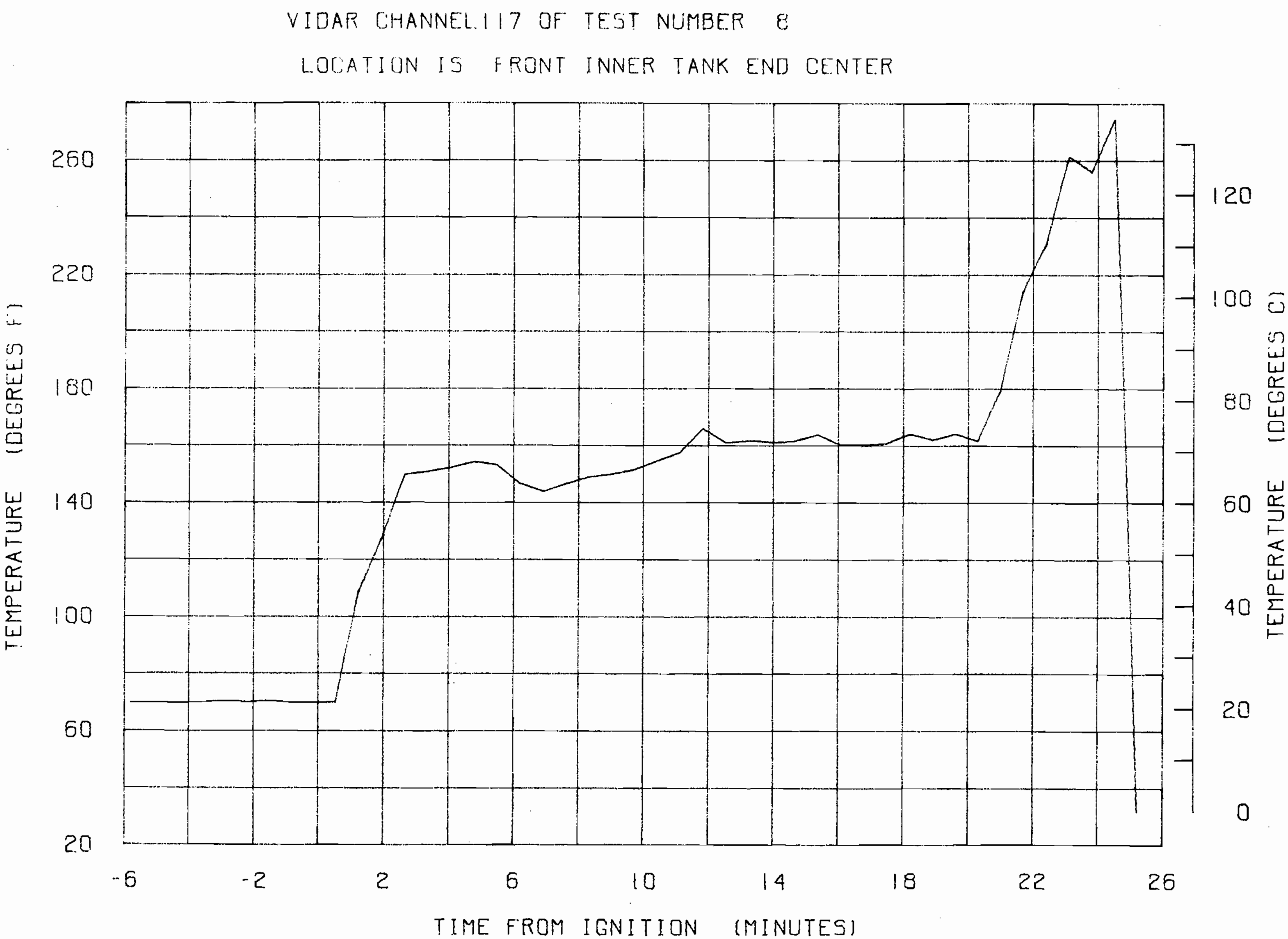

FIGURE A 110 THERMOCOUPLE TEMPERATURE VS. TIME

VIDAR CHANNEL 11B OF TEST NUMBER 8

LOCATION IS EMERGENCY RELIEF HATCH

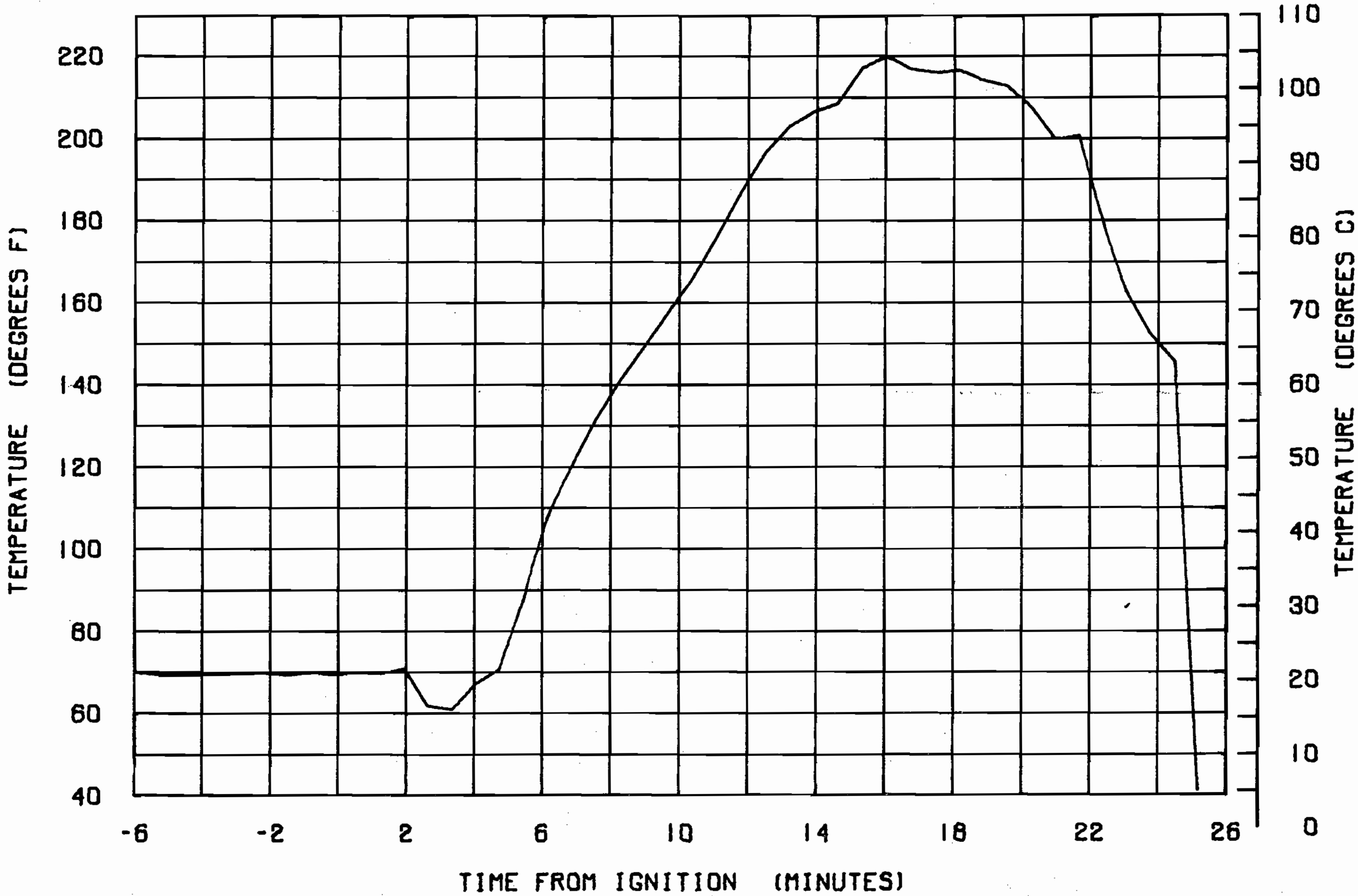

FIGURE A 111 THERMOCOUPLE TEMPERATURE VS. TIME

APPENDIX B

CROSS-SECTIONAL PLOTS

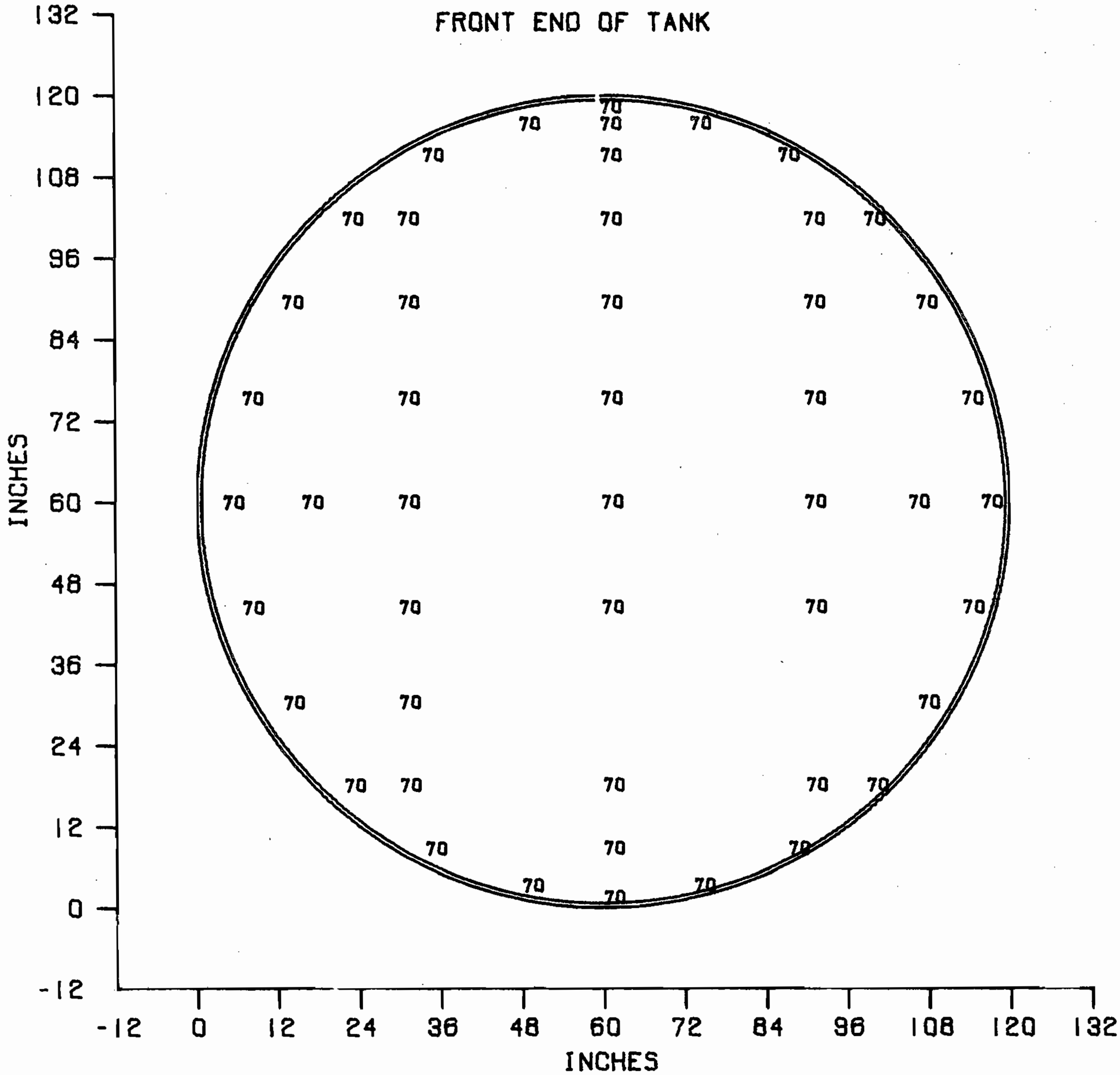

FIGURE B 1 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 0 SECONDS FROM IGNITION FOR TEST NR, 8

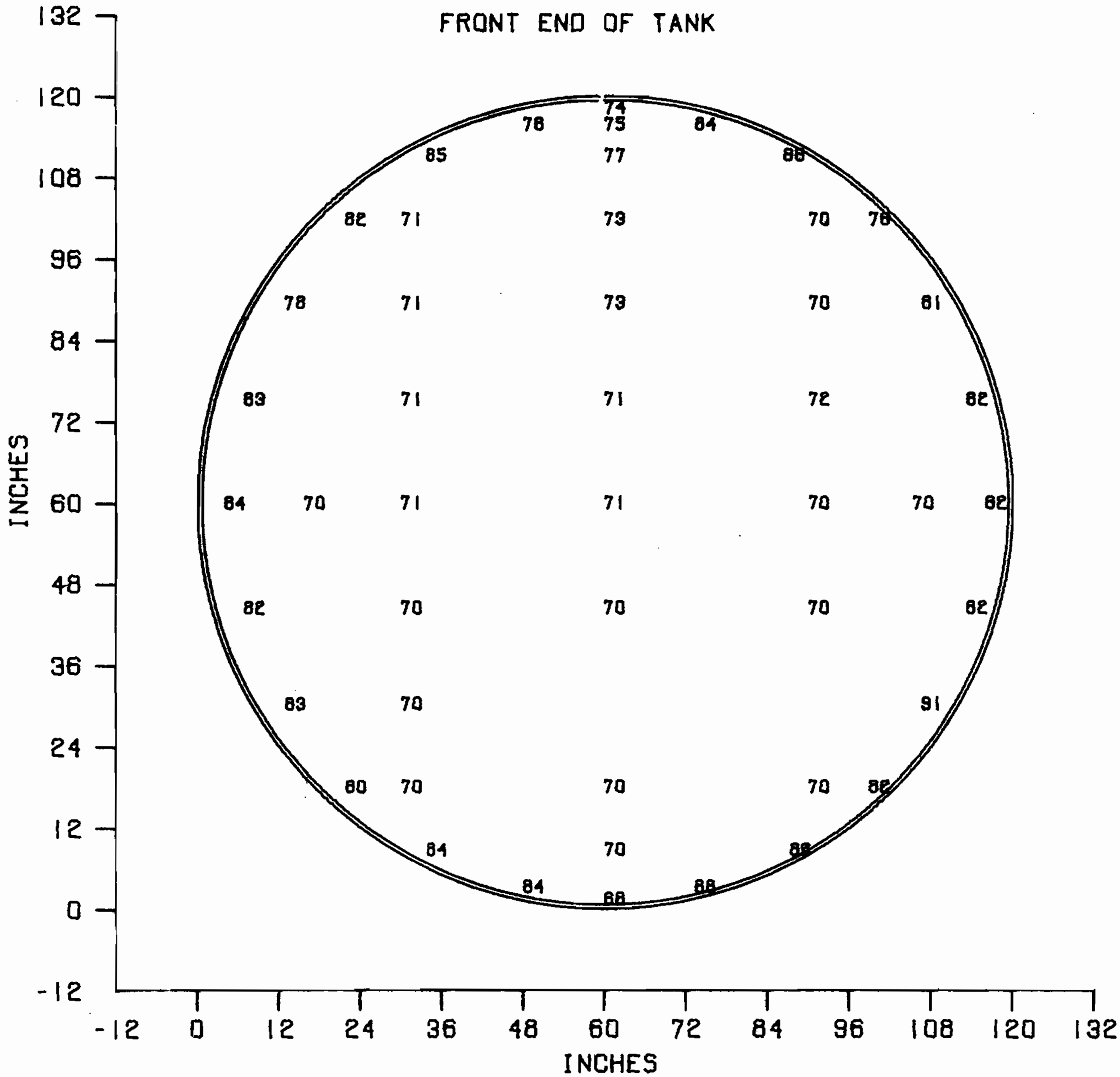

FIGURE B 2 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 42 SECONDS FROM IGNITION FOR TEST NR. 8

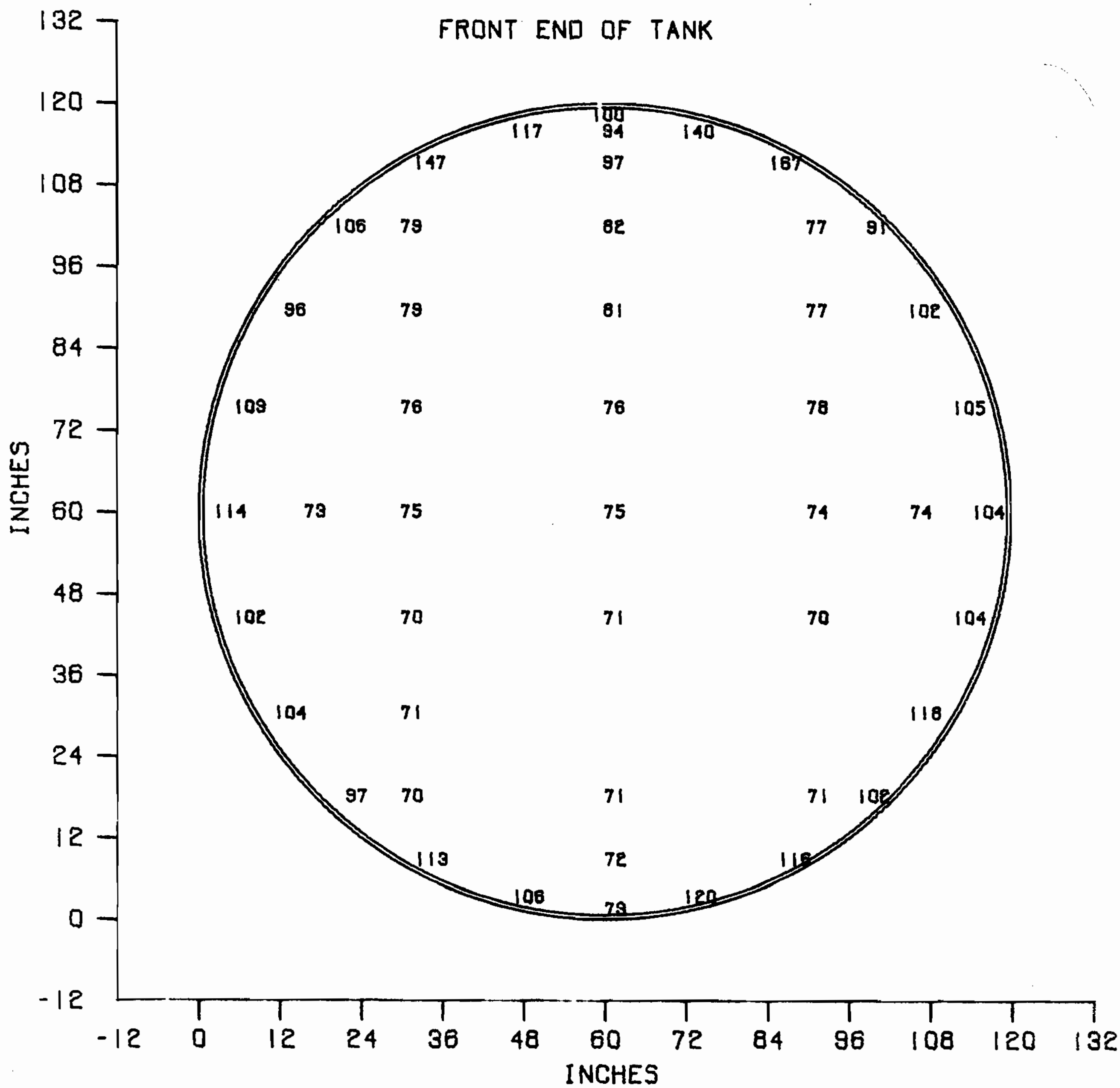

FIGURE B 3 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 84 SECONDS FROM IGNITION FOR TEST NR. 8

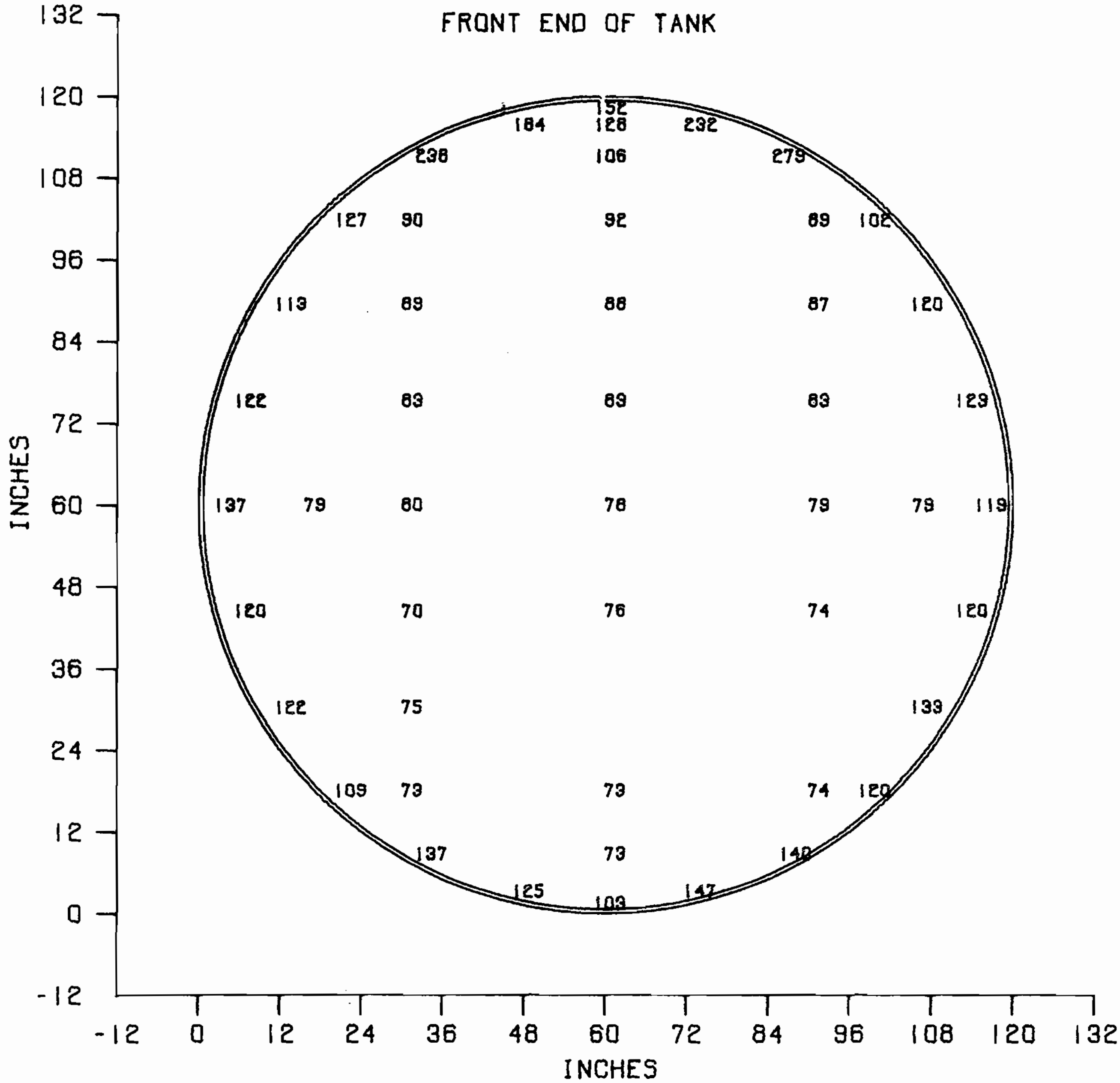

FIGURE B 4 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 126 SECONDS FROM IGNITION FOR TEST NR. 8

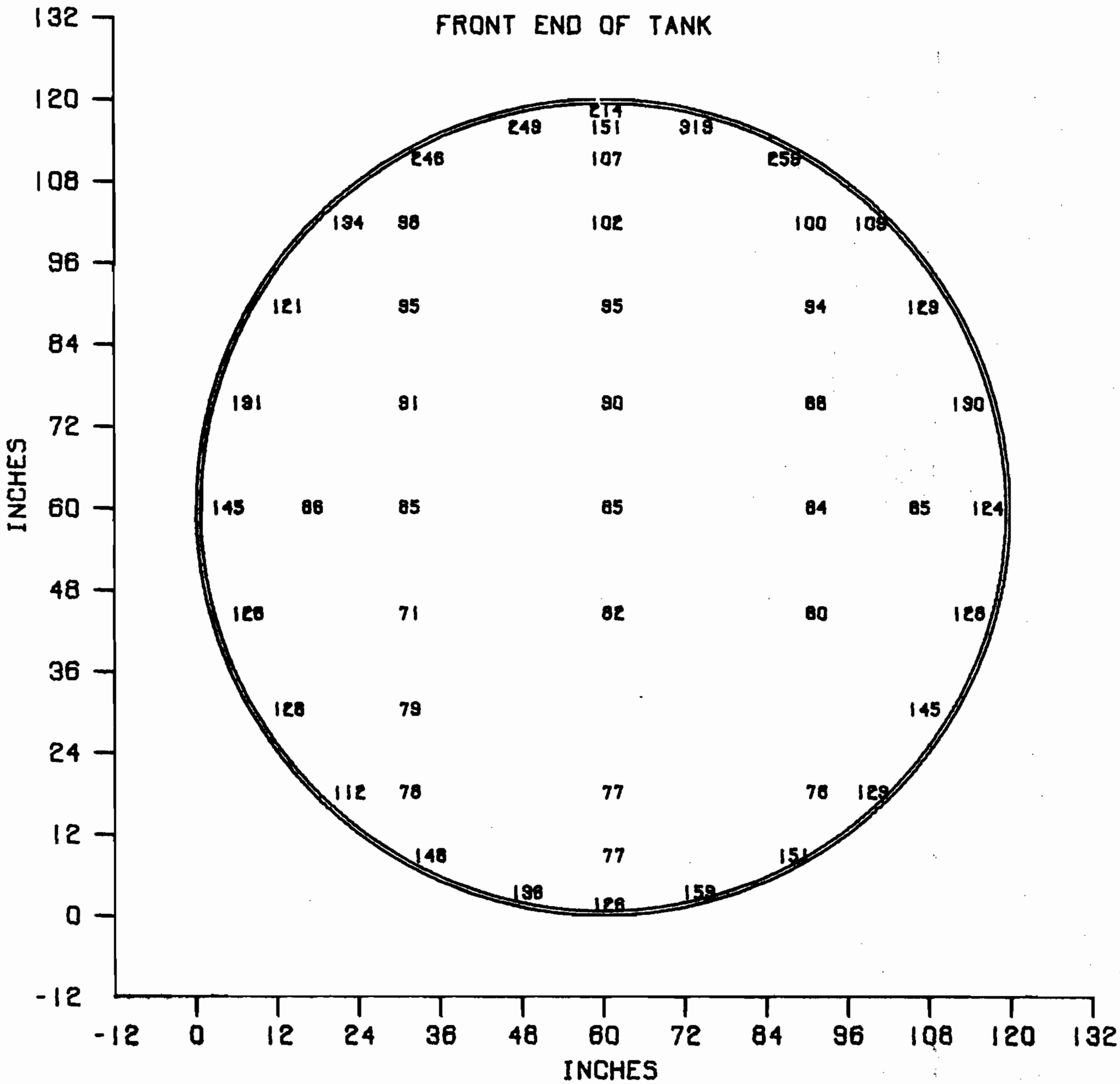

FIGURE B 5 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 169 SECONDS FROM IGNITION FOR TEST NR. 8

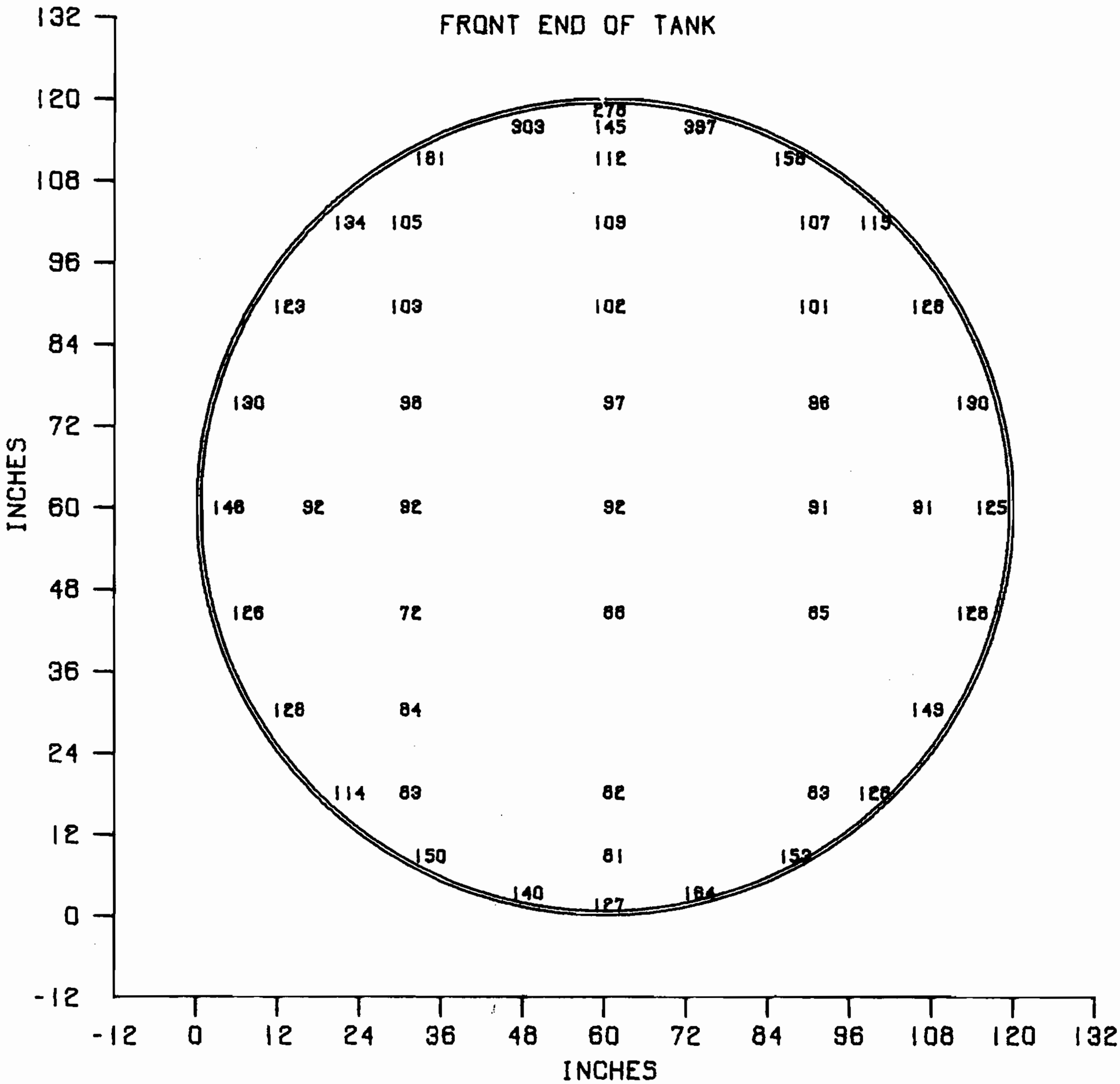

FIGURE B 6 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 211 SECONDS FROM IGNITION FOR TEST NR. 8

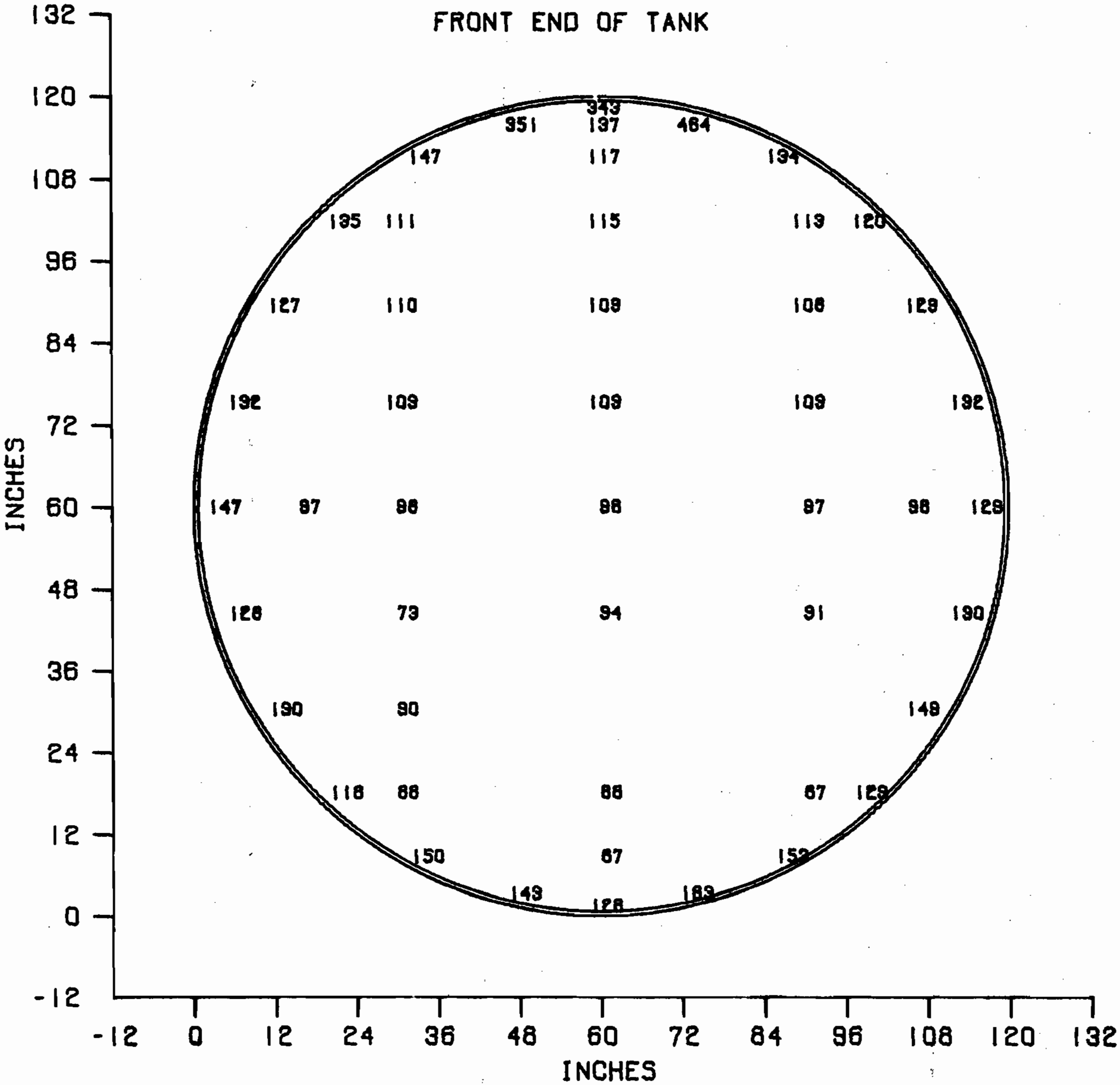

FIGURE B 7 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 253 SECONDS FROM IGNITION FOR TEST NR. 8

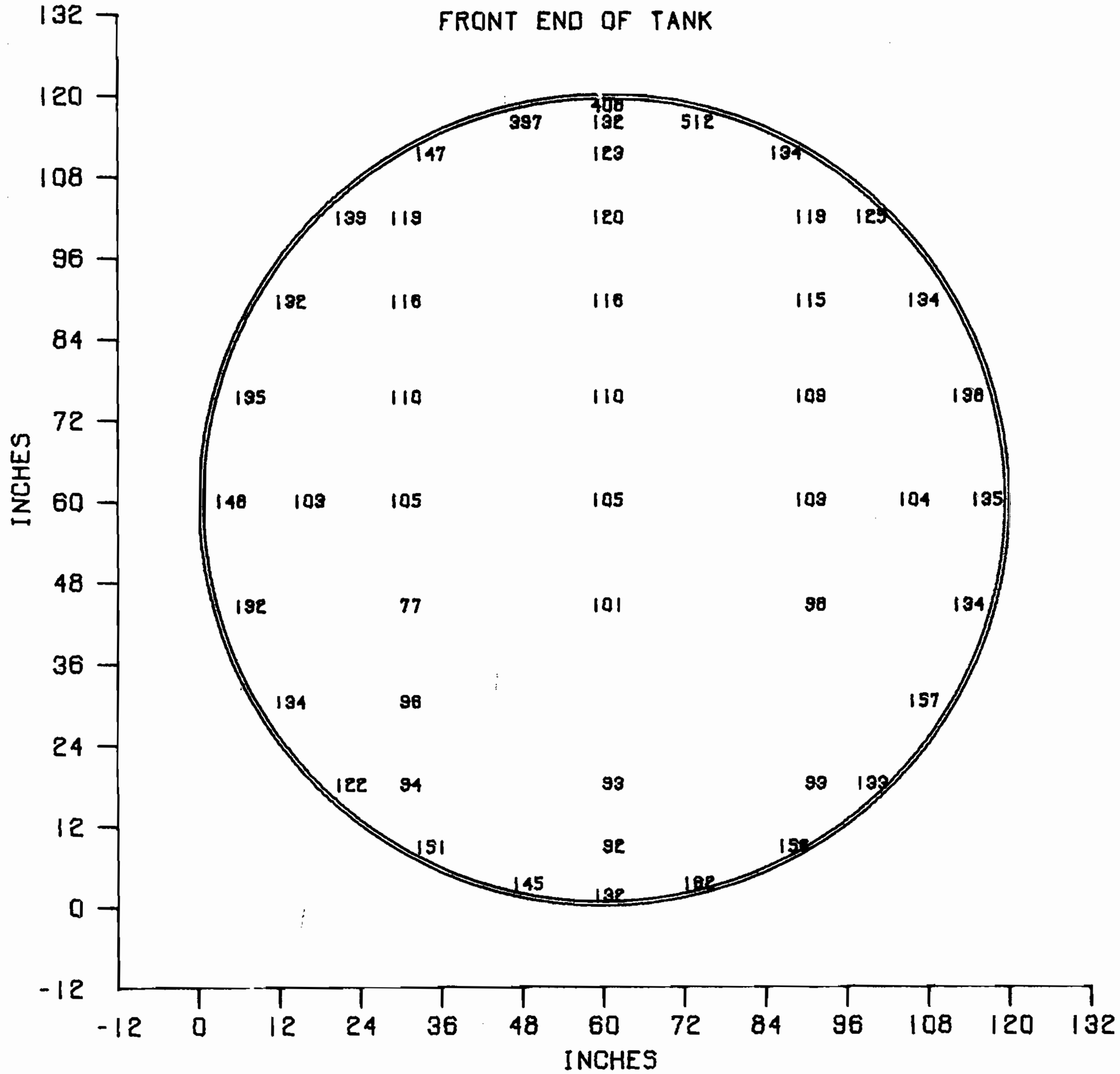

FIGURE B 8 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 296 SECONDS FROM IGNITION FOR TEST NR. 8

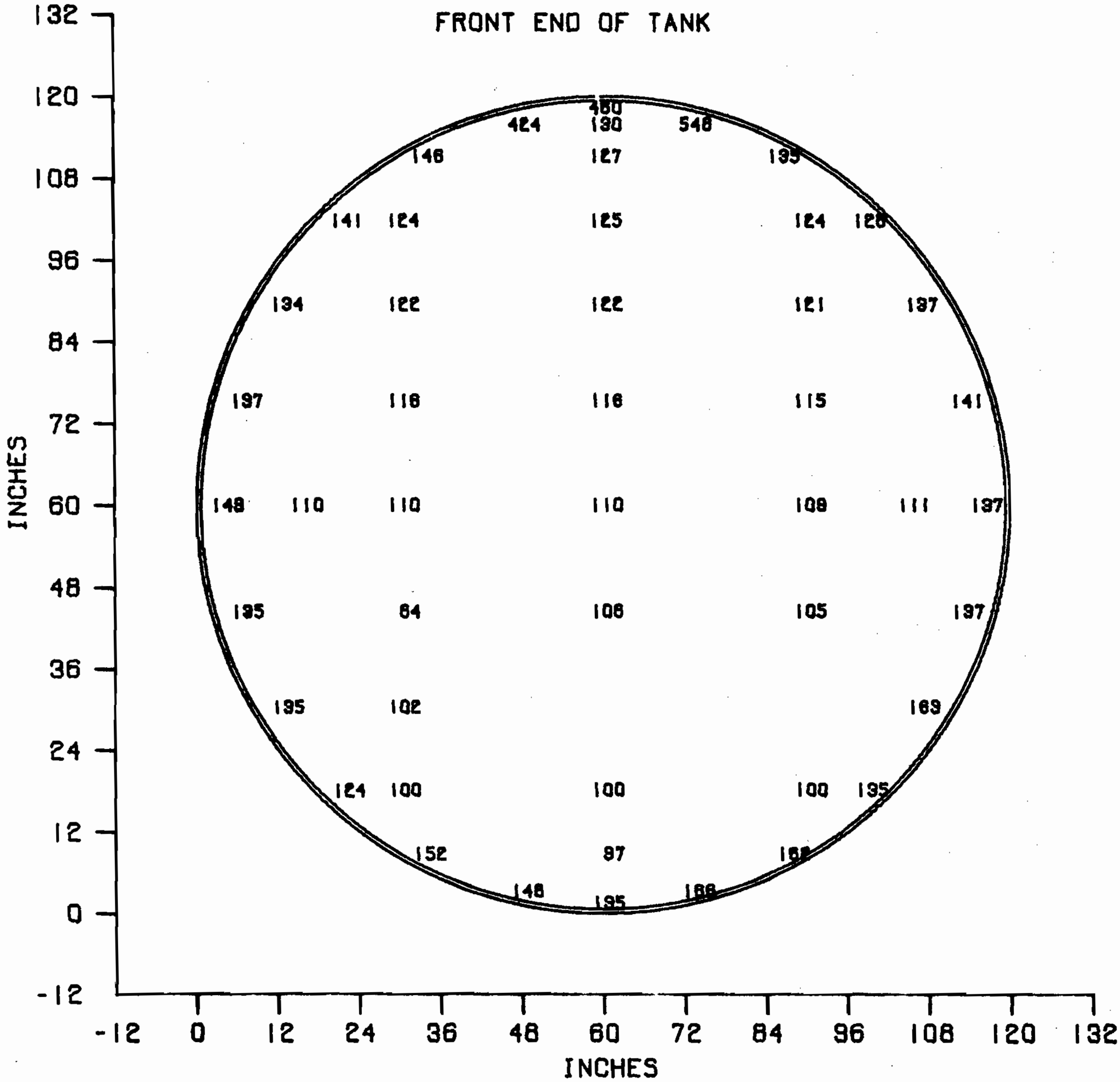

FIGURE B 9 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 338 SECONDS FROM IGNITION FOR TEST NR. 8

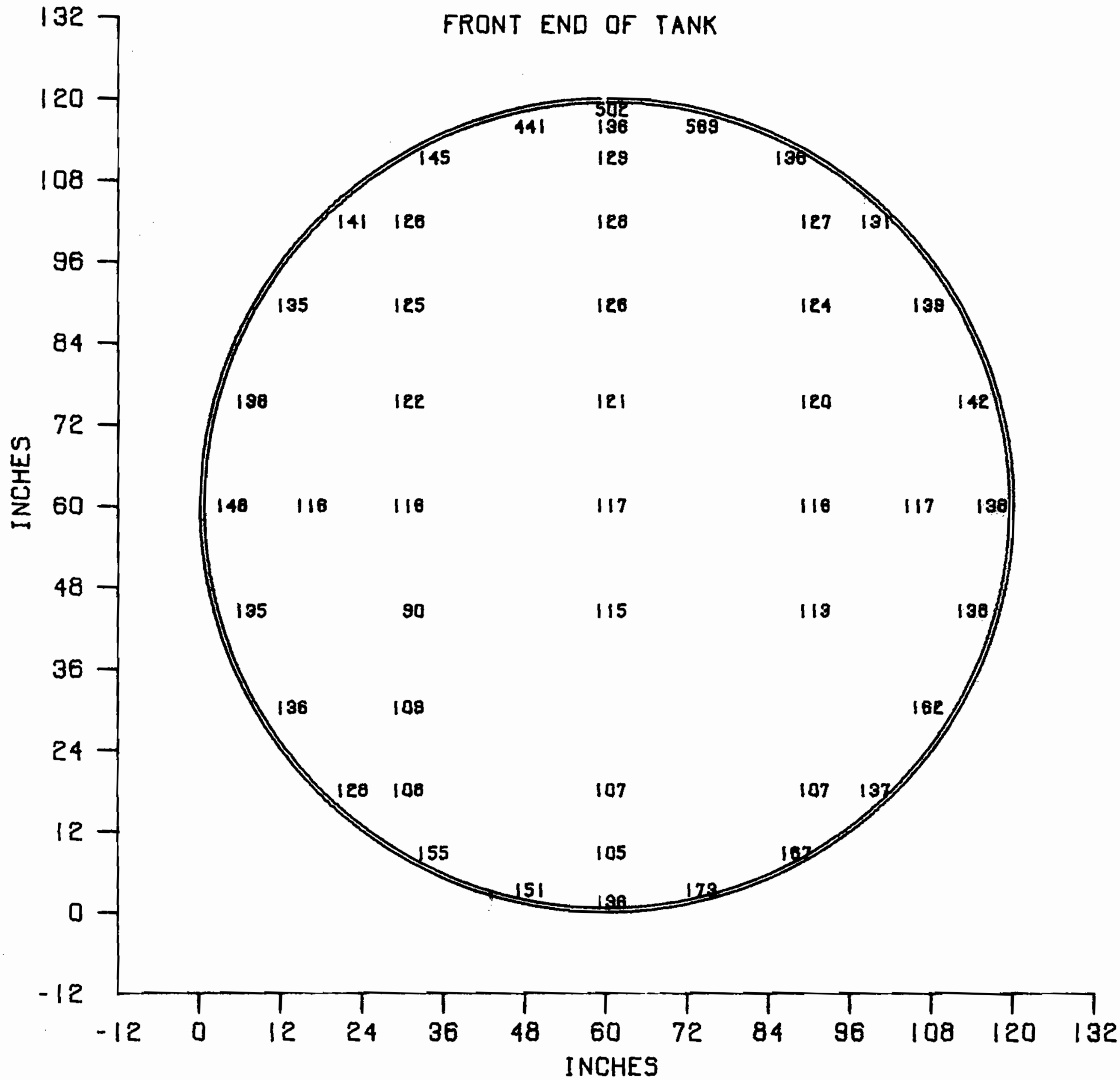

FIGURE B 10 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 380 SECONDS FROM IGNITION FOR TEST NR. 8

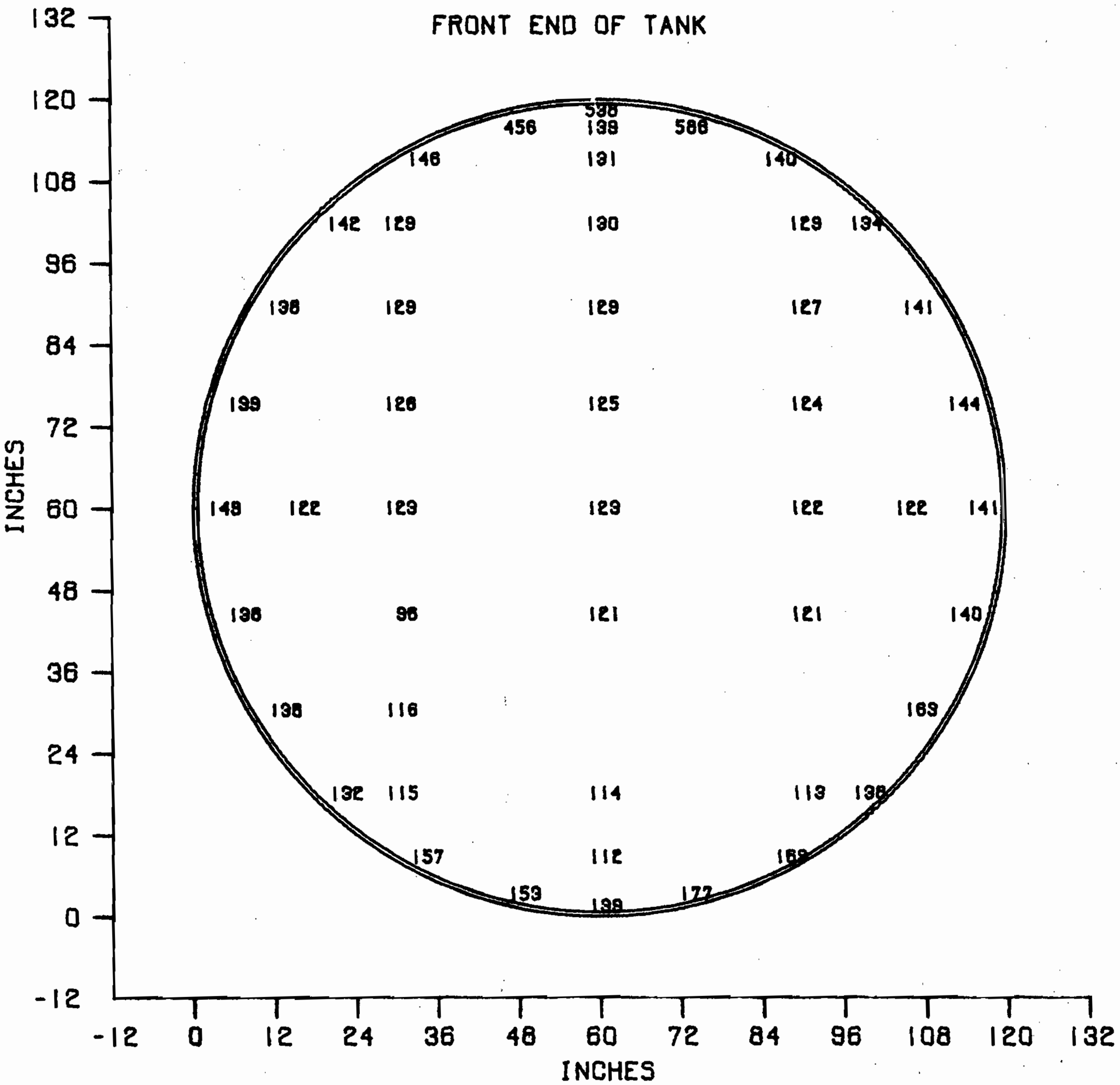

FIGURE B 11 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 423 SECONDS FROM IGNITION FOR TEST NR. 8

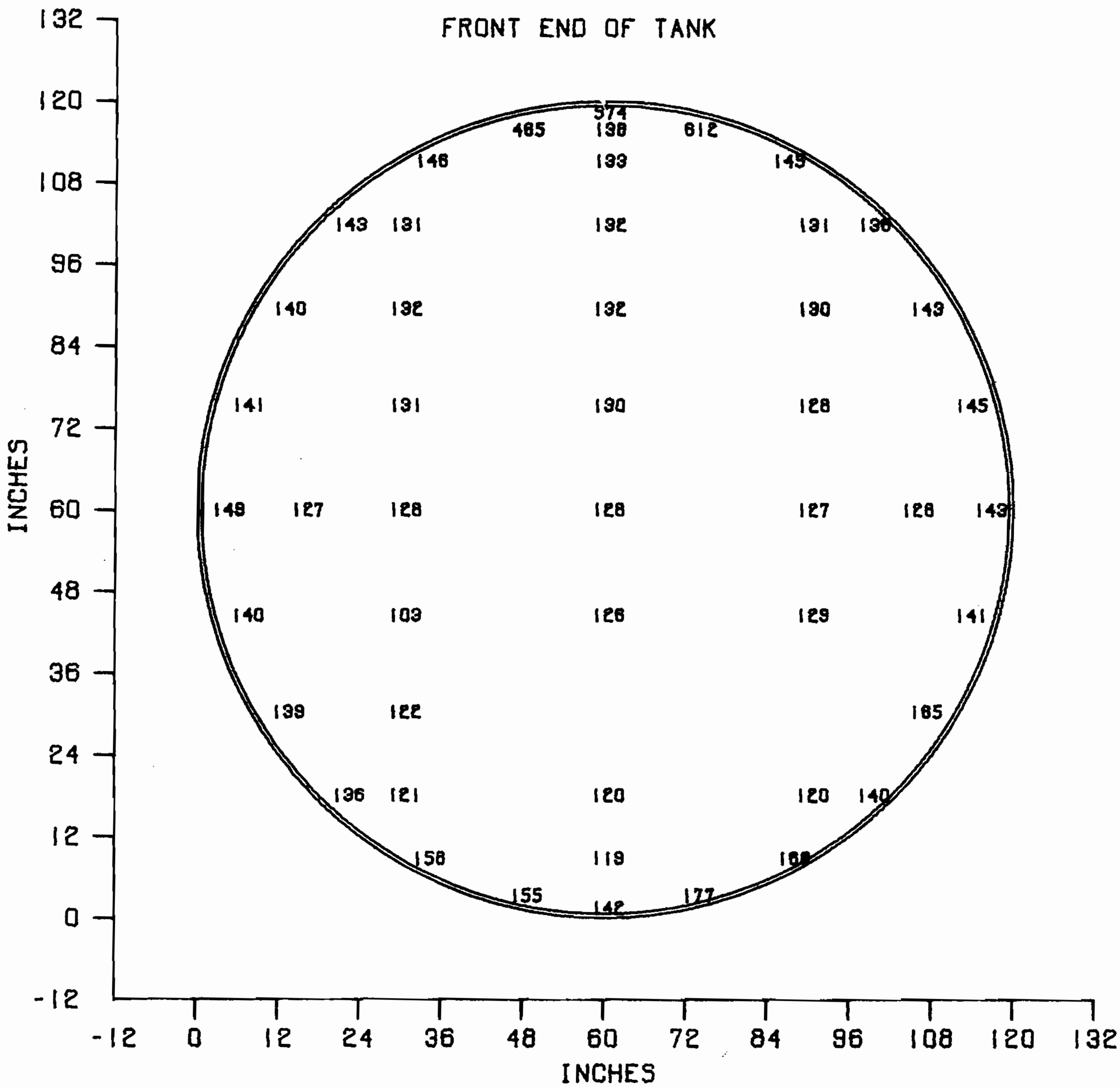

FIGURE B 12 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 465 SECONDS FROM IGNITION FOR TEST NR. 8

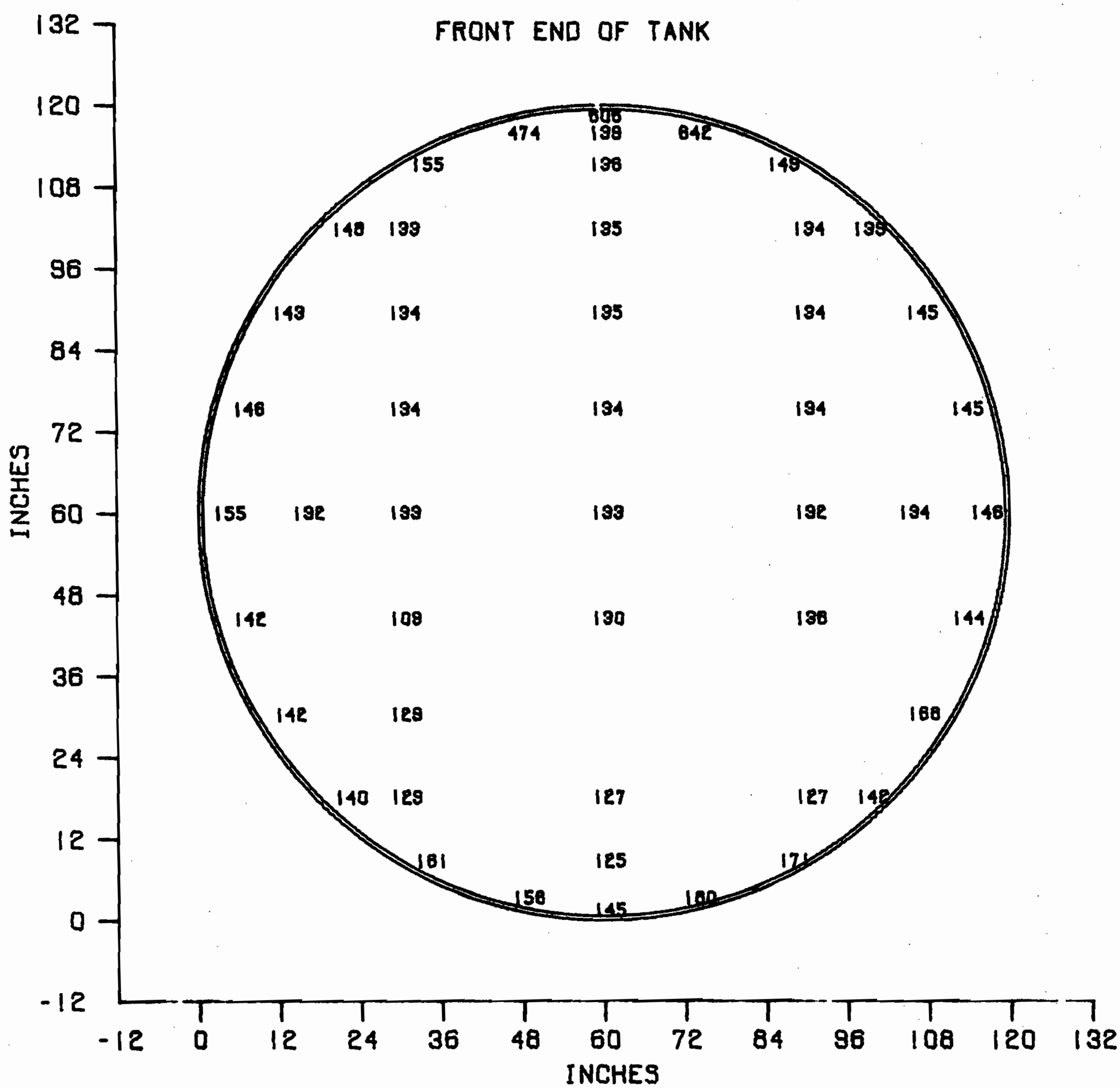

FIGURE B 13 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 507 SECONDS FROM IGNITION FOR TEST NR. 8

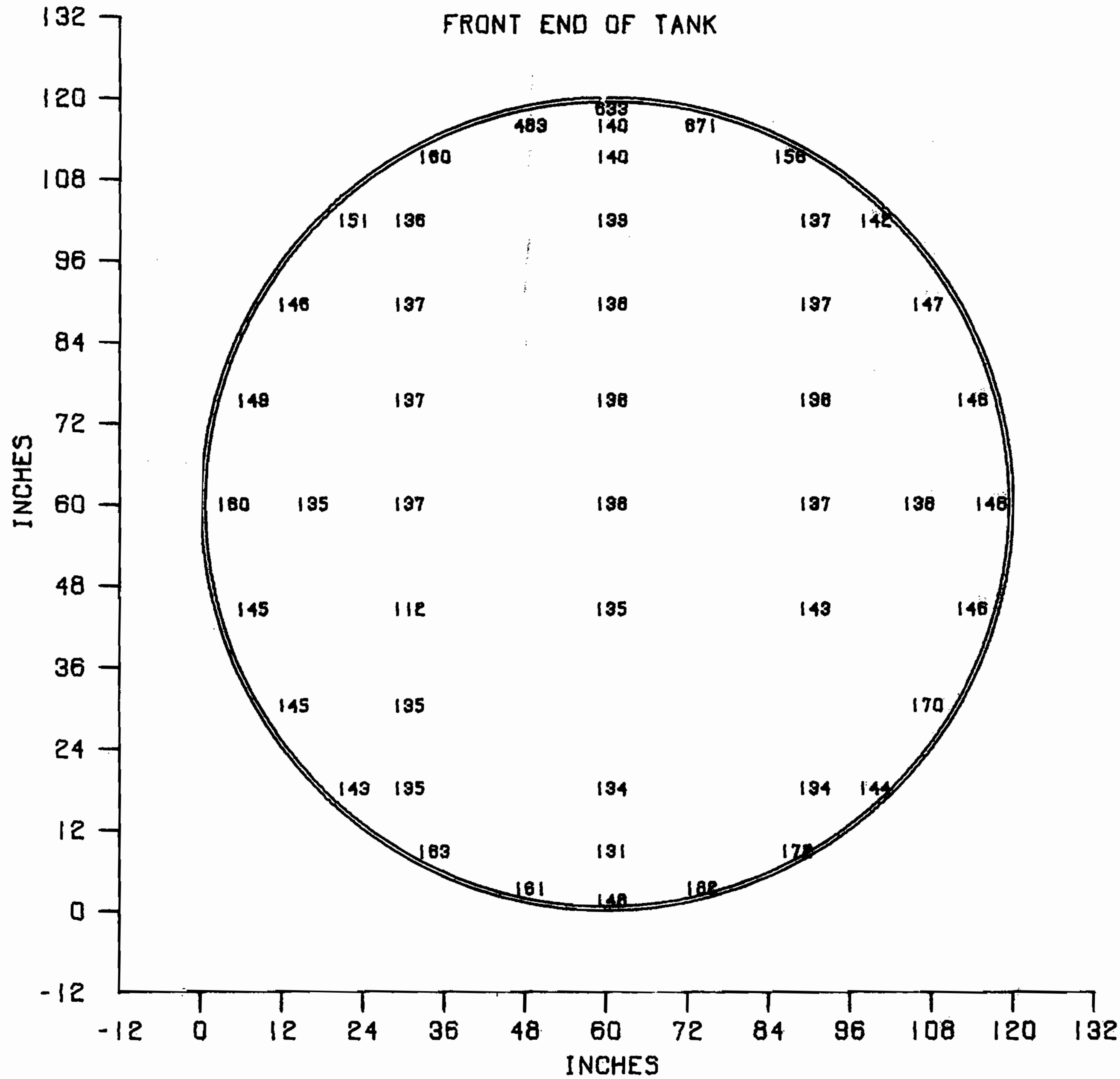

FIGURE B 14 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 549 SECONDS FROM IGNITION FOR TEST NR. 8

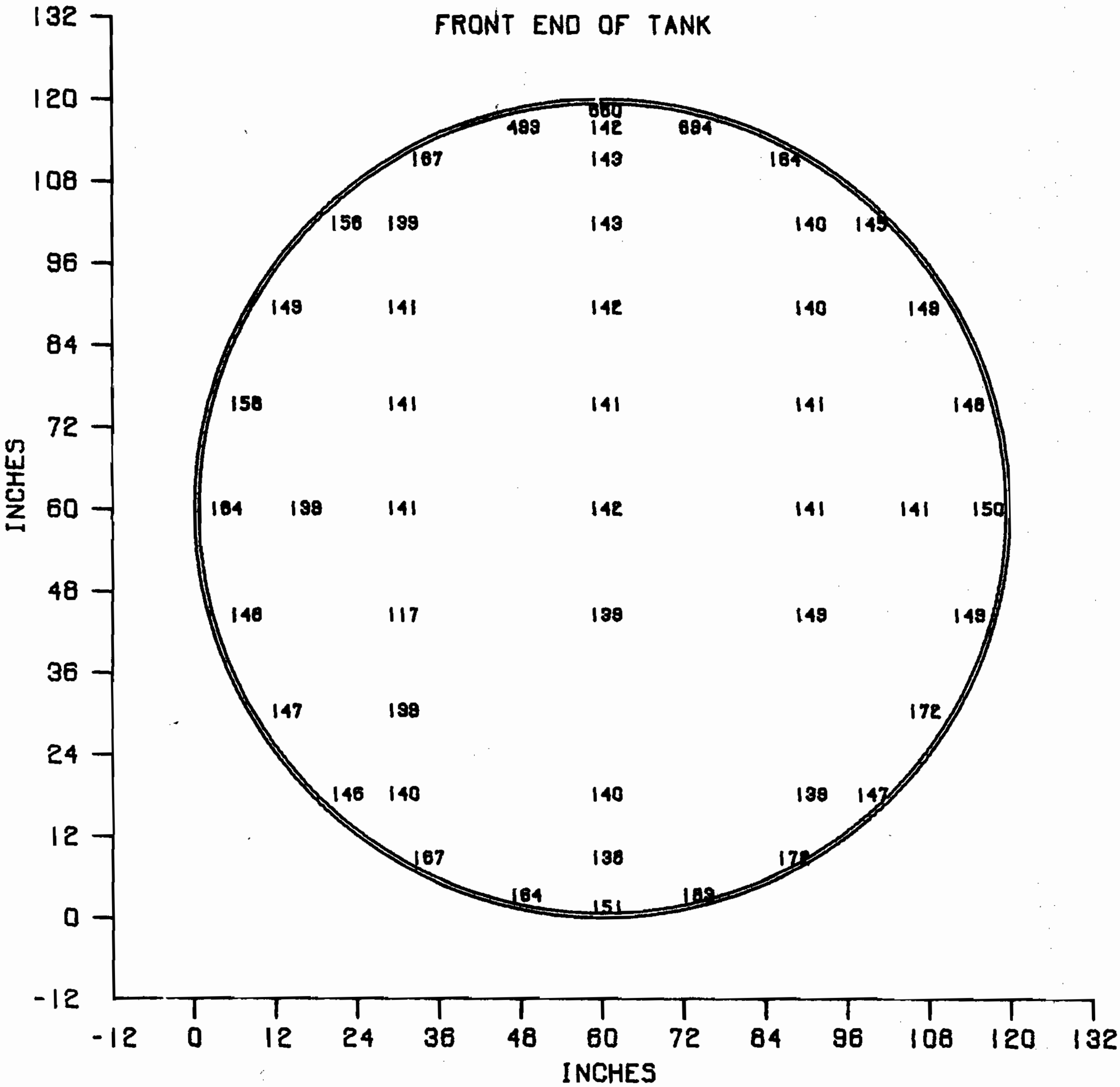

FIGURE B 15 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 592 SECONDS FROM IGNITION FOR TEST NR. 8

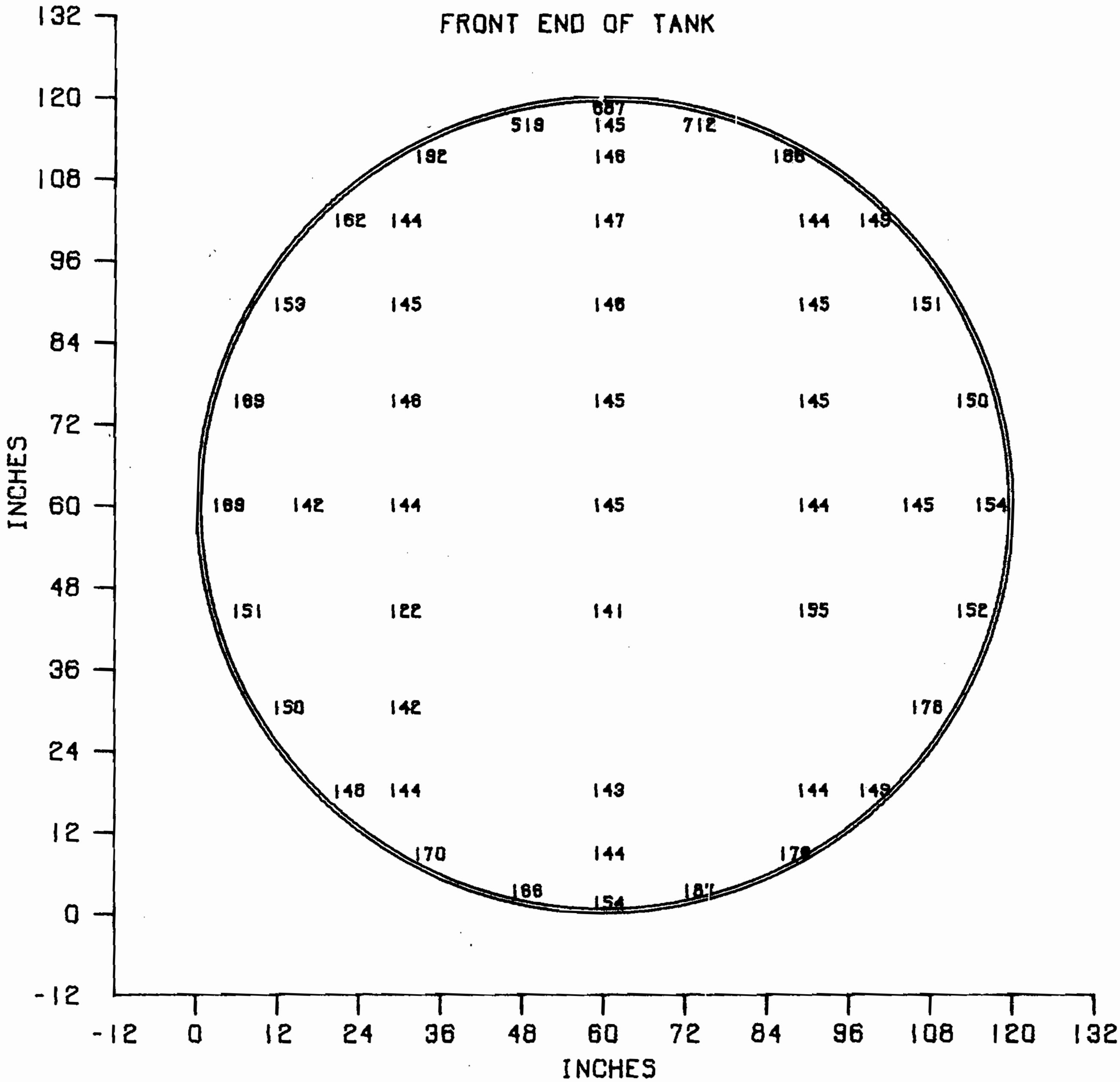

FIGURE B 16 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 634 SECONDS FROM IGNITION FOR TEST NR. 8

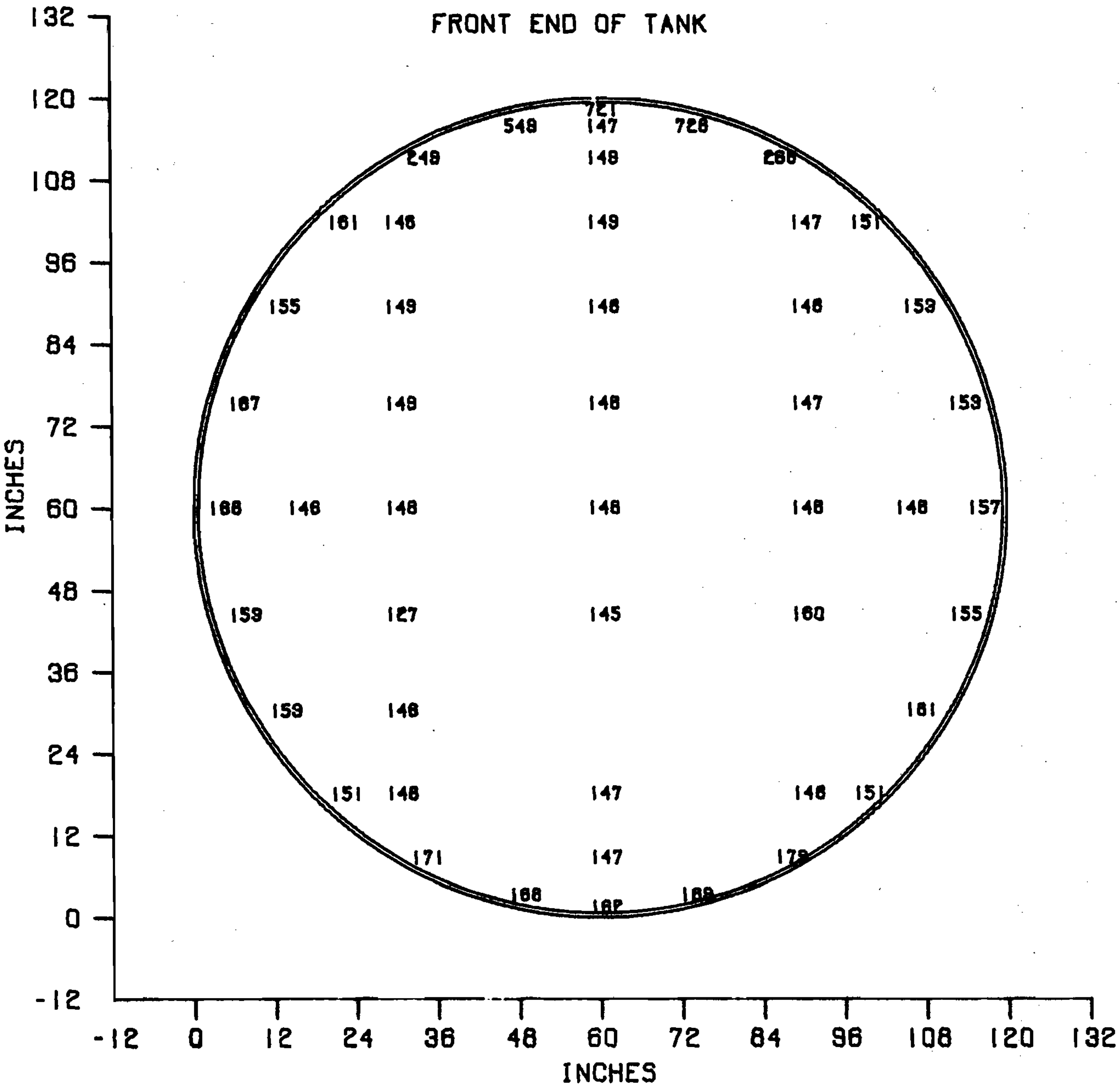

FIGURE B 17 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 676 SECONDS FROM IGNITION FOR TEST NR. 8

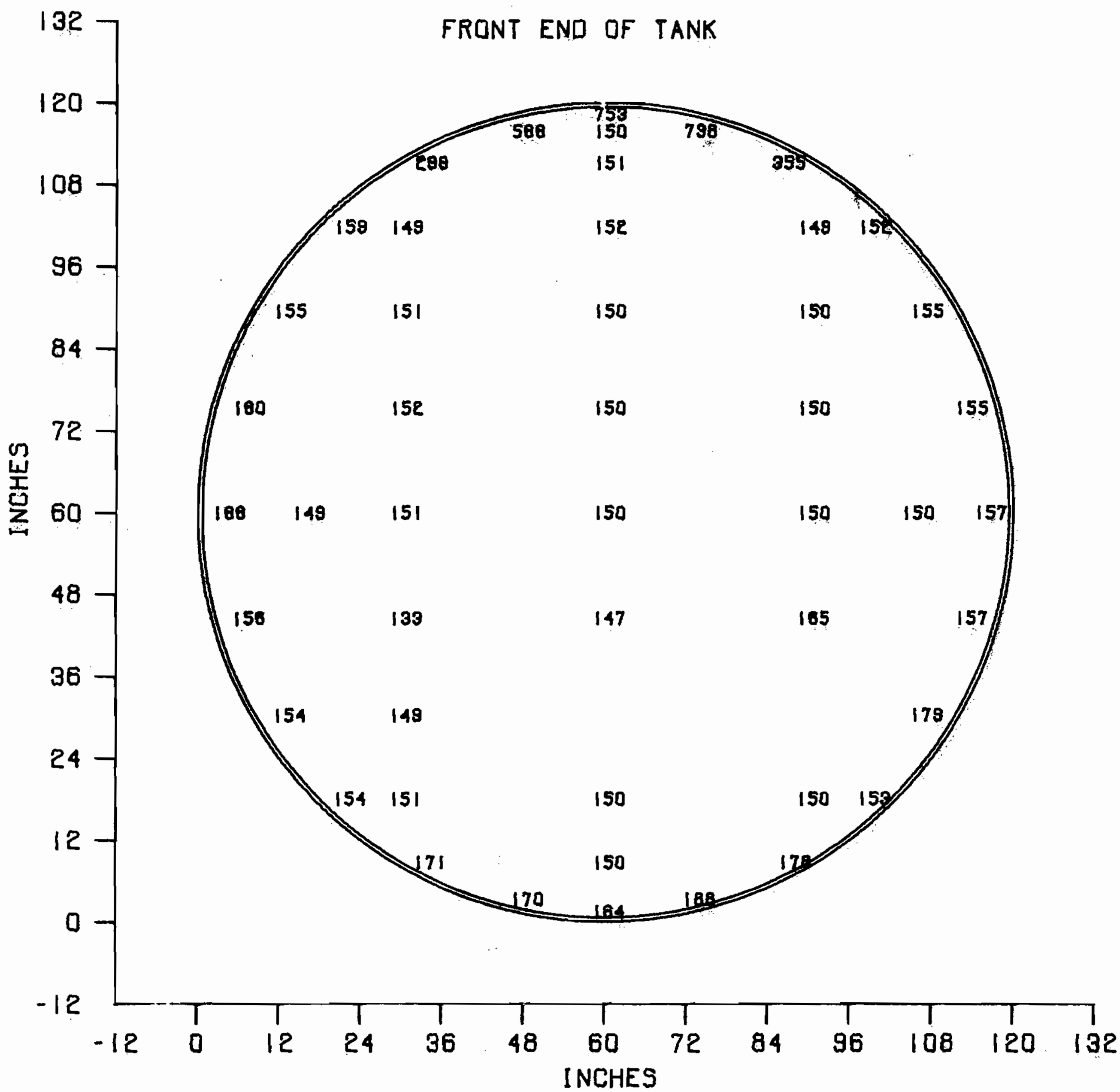

FIGURE B 18 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 719 SECONDS FROM IGNITION FOR TEST NR. 8

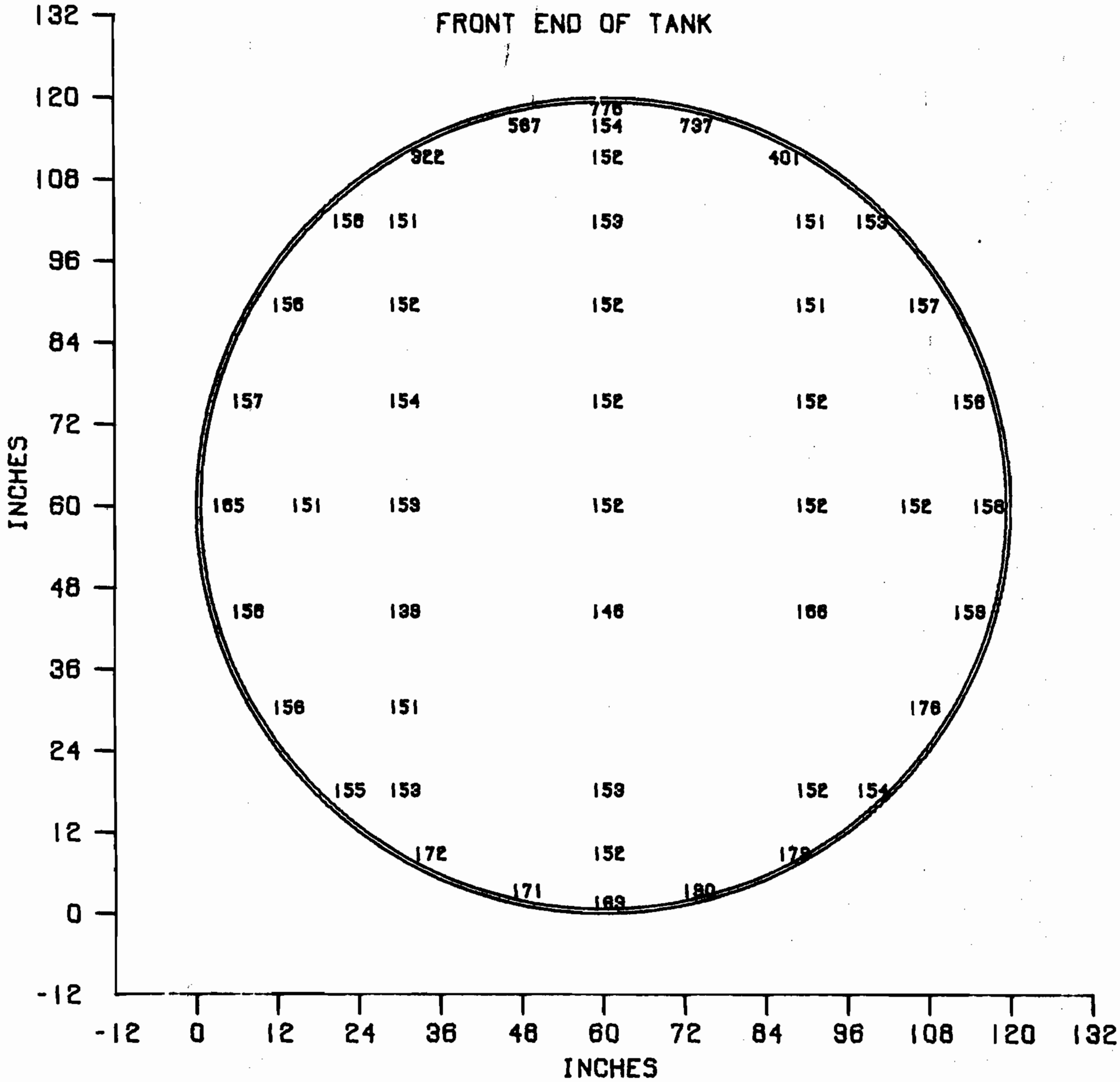

FIGURE B 19 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 761 SECONDS FROM IGNITION FOR TEST NR. 8

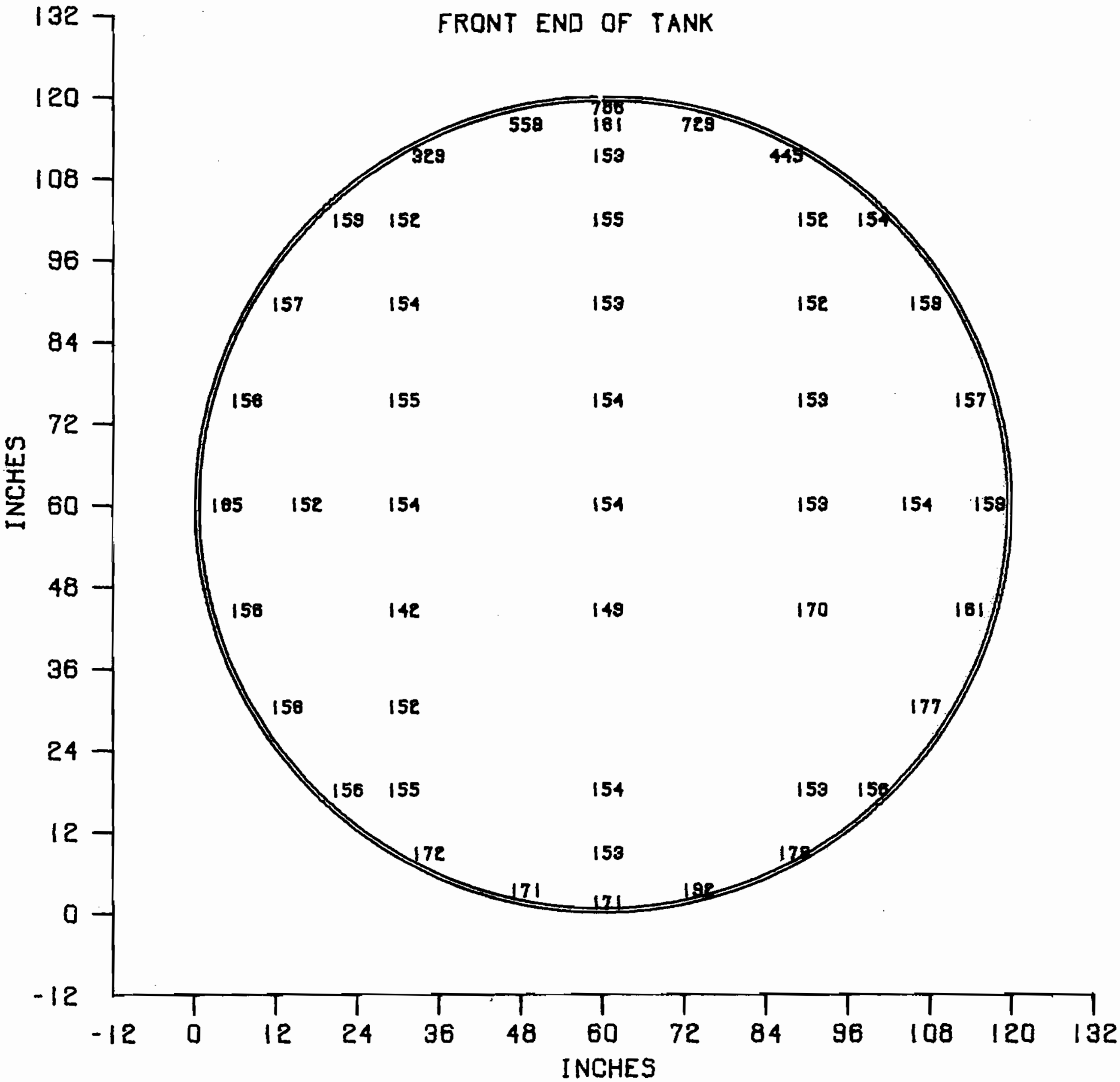

FIGURE B 20 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 803 SECONDS FROM IGNITION FOR TEST NR. 8

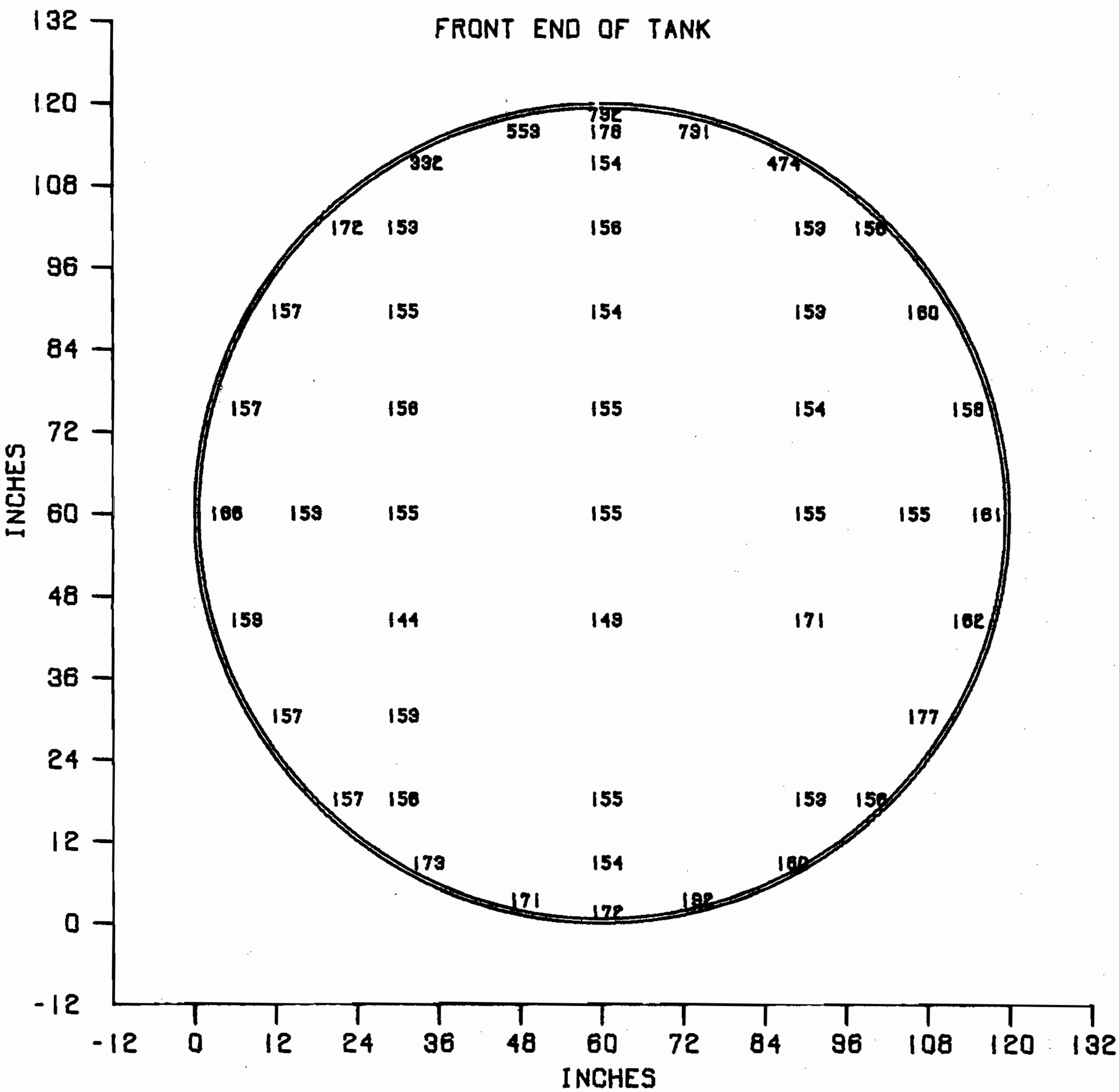

FIGURE B 21 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 846 SECONDS FROM IGNITION FOR TEST NR. 8

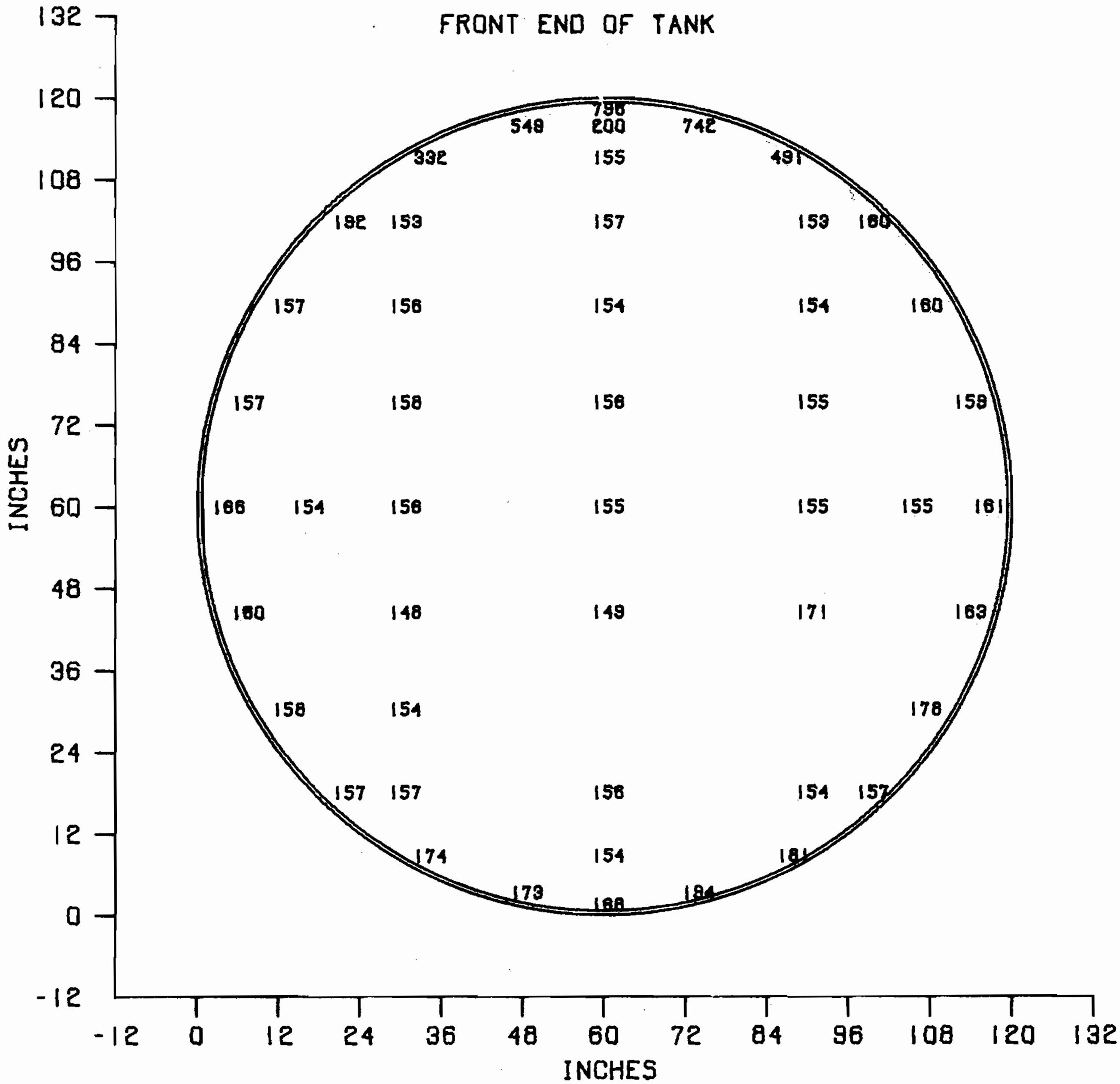

FIGURE B 22 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 888 SECONDS FROM IGNITION FOR TEST NR. 8

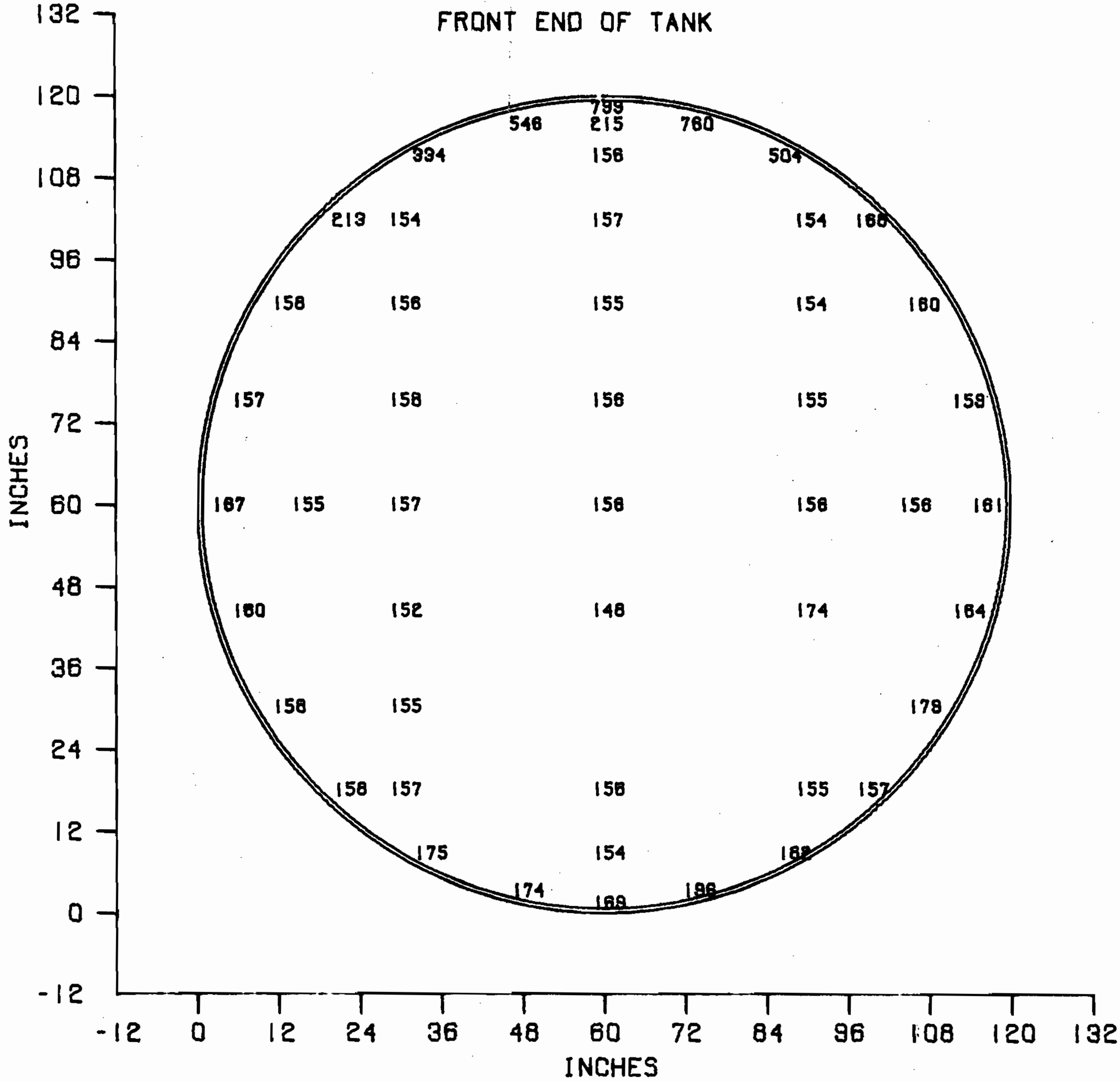

FIGURE B 23 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 930 SECONDS FROM IGNITION FOR TEST NR. 8

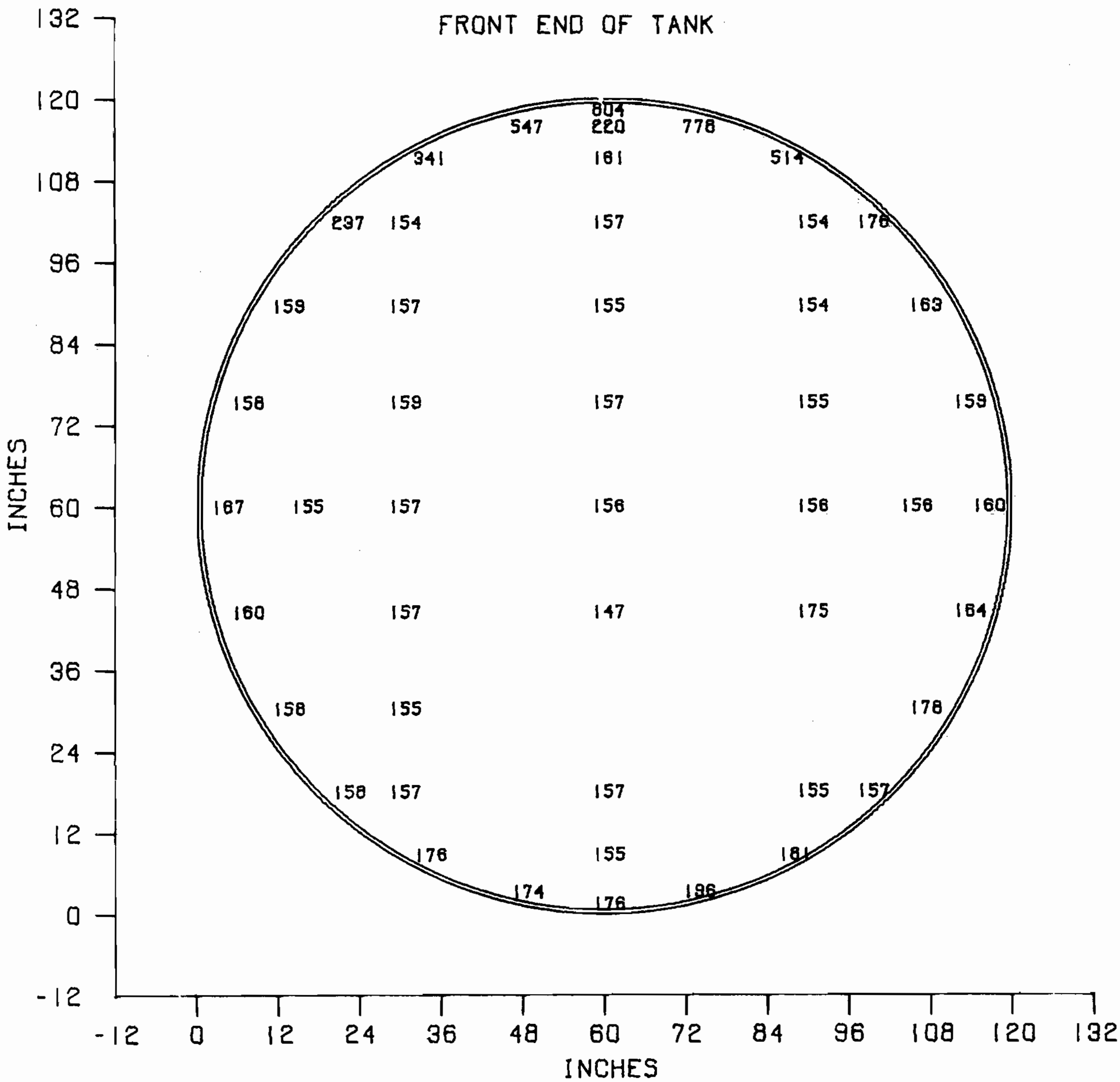

FIGURE B 24 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 972 SECONDS FROM IGNITION FOR TEST NR. 8

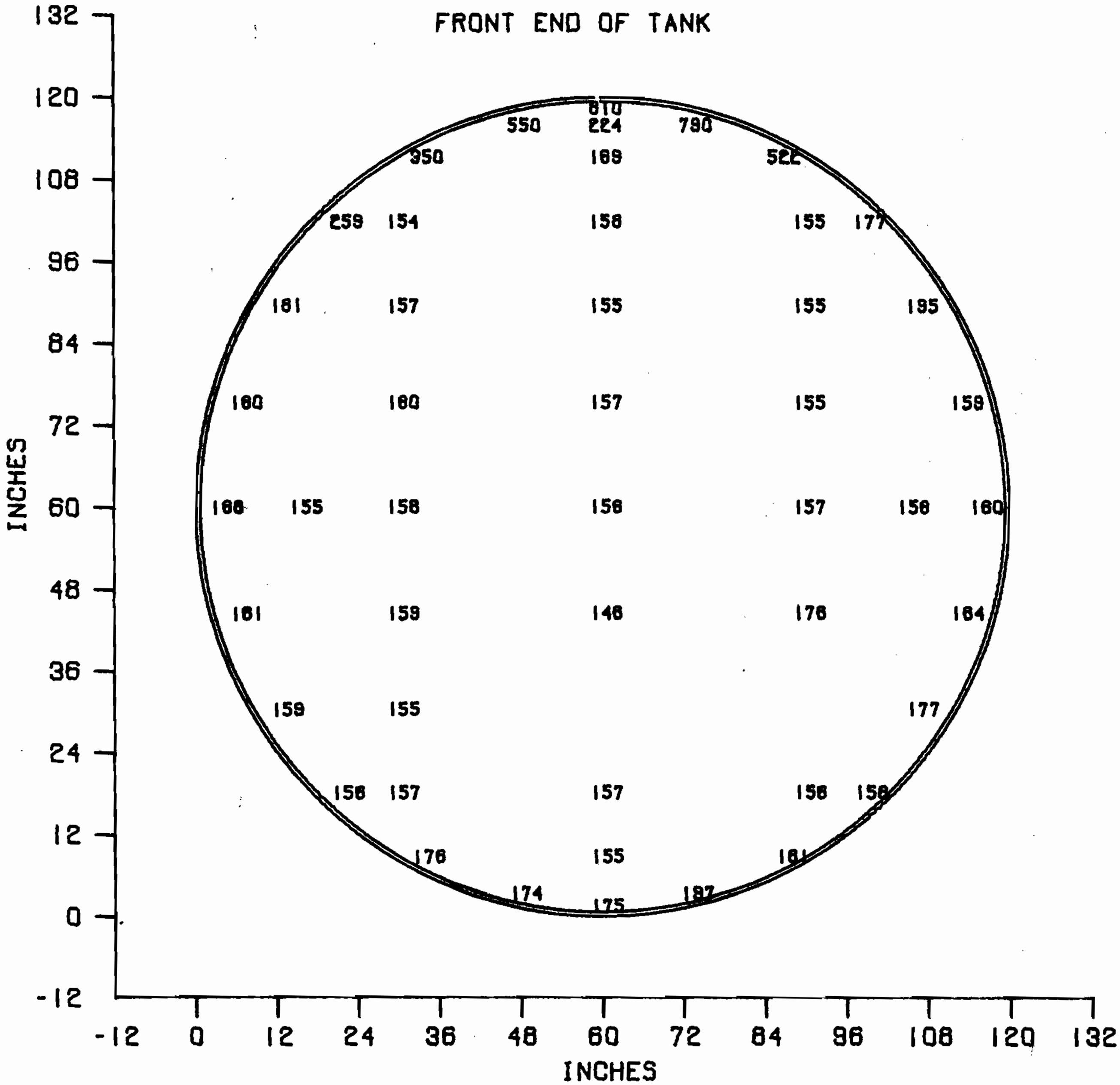

FIGURE B 25 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 1015 SECONDS FROM IGNITION FOR TEST NR. 8

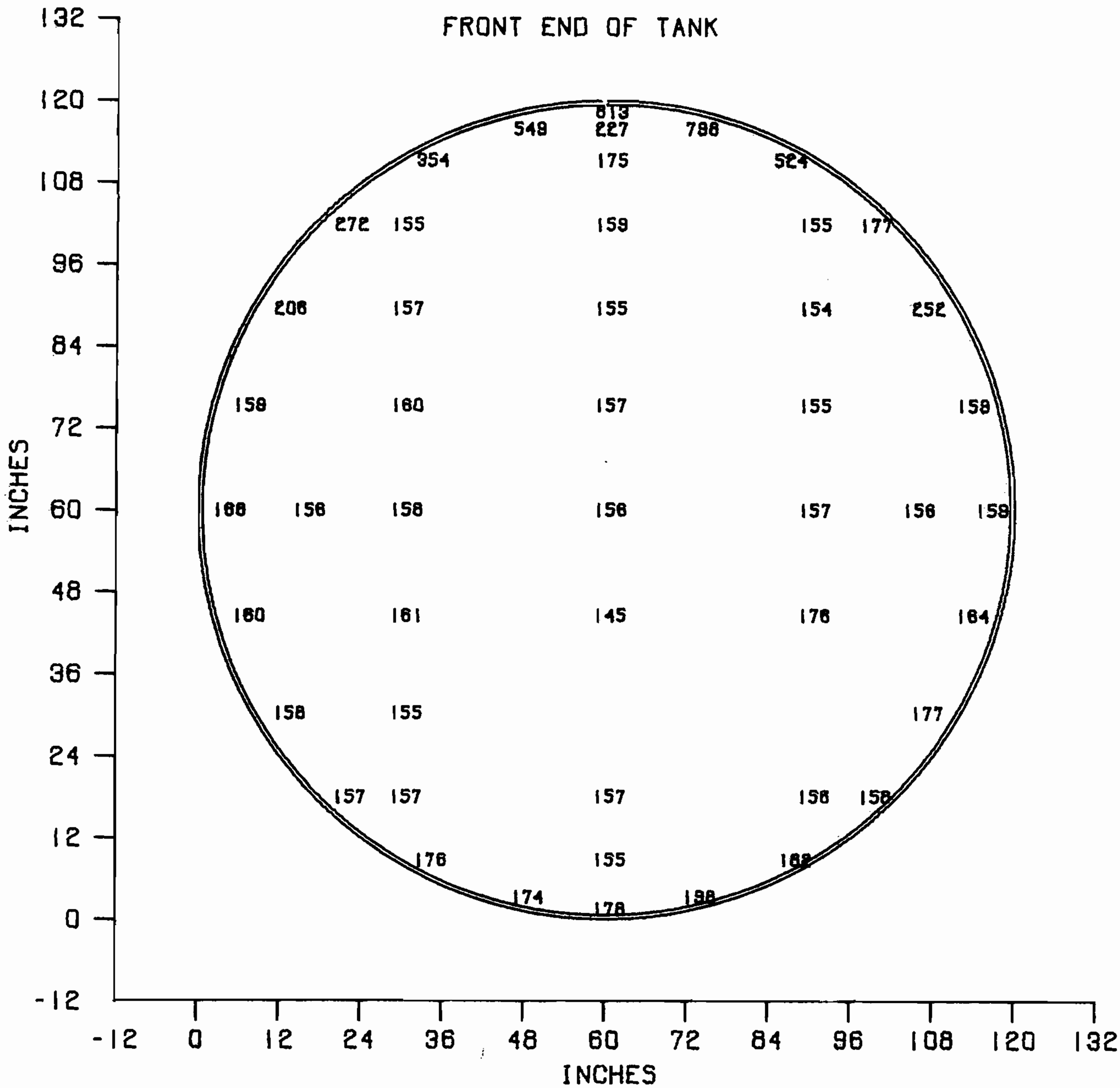

FIGURE B 26 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 1057 SECONDS FROM IGNITION FOR TEST NR. 8

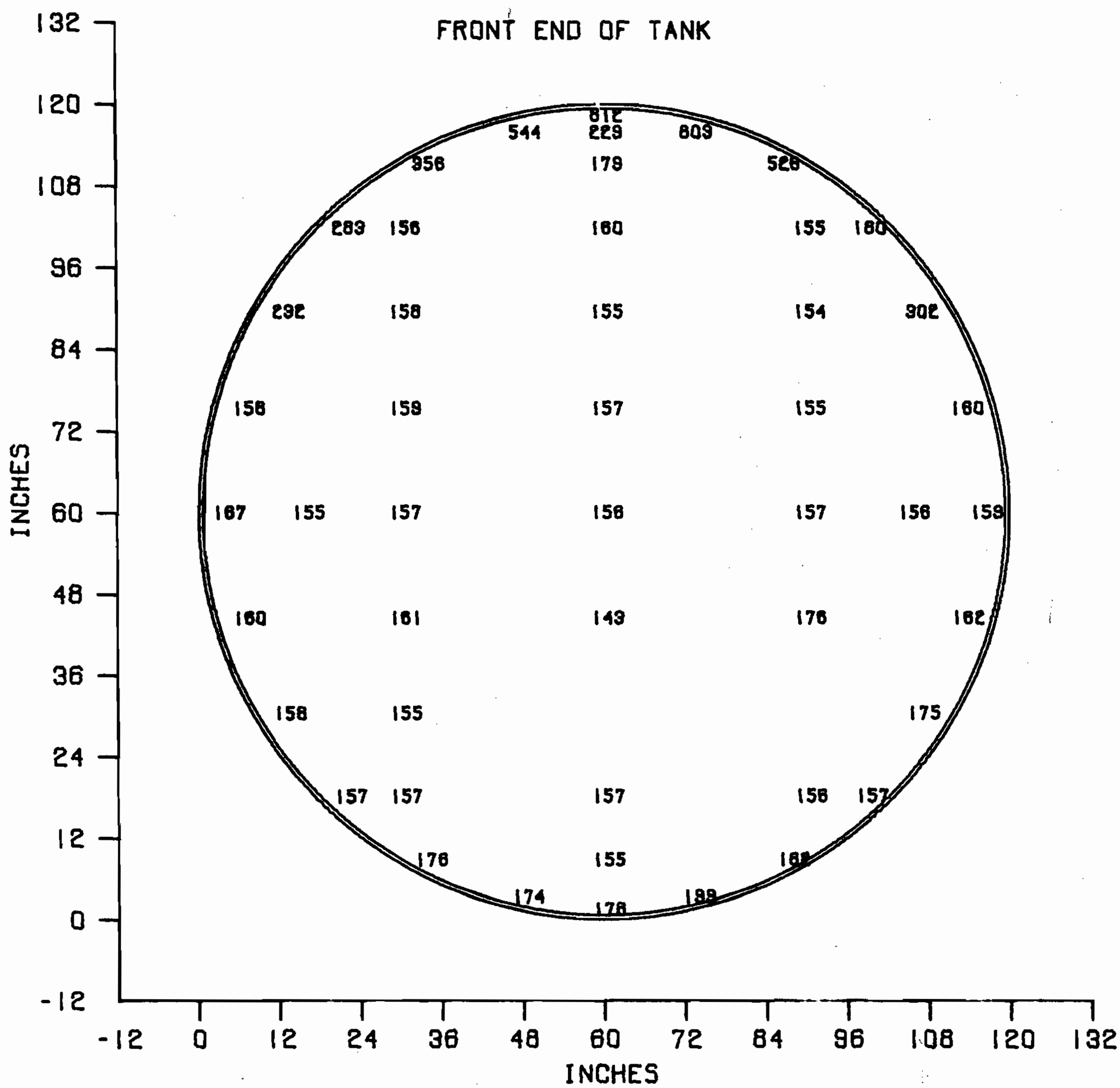

FIGURE B 27 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 1099 SECONDS FROM IGNITION FOR TEST NR. 8

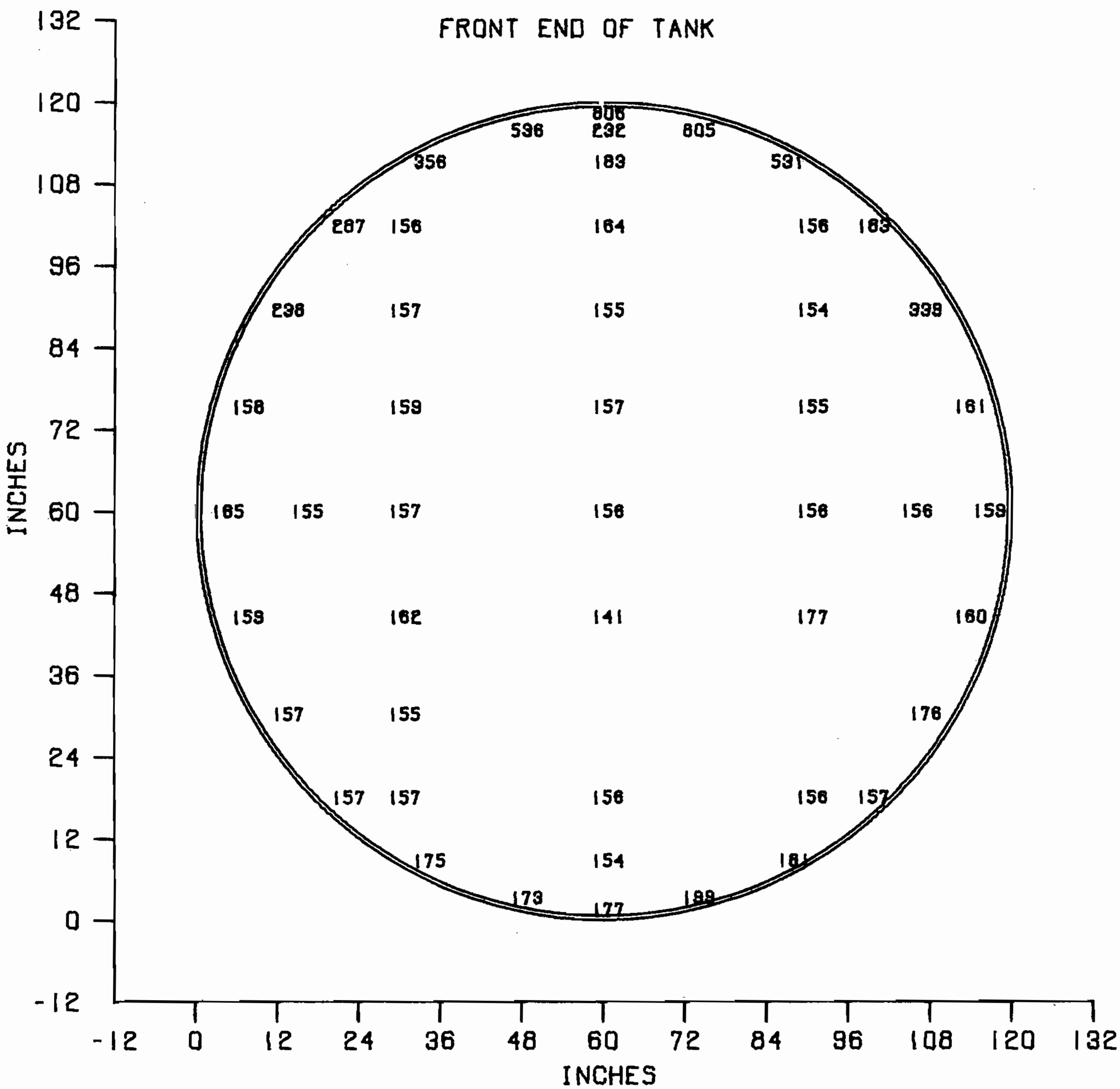

FIGURE B 28 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 1142 SECONDS FROM IGNITION FOR TEST NR. 8

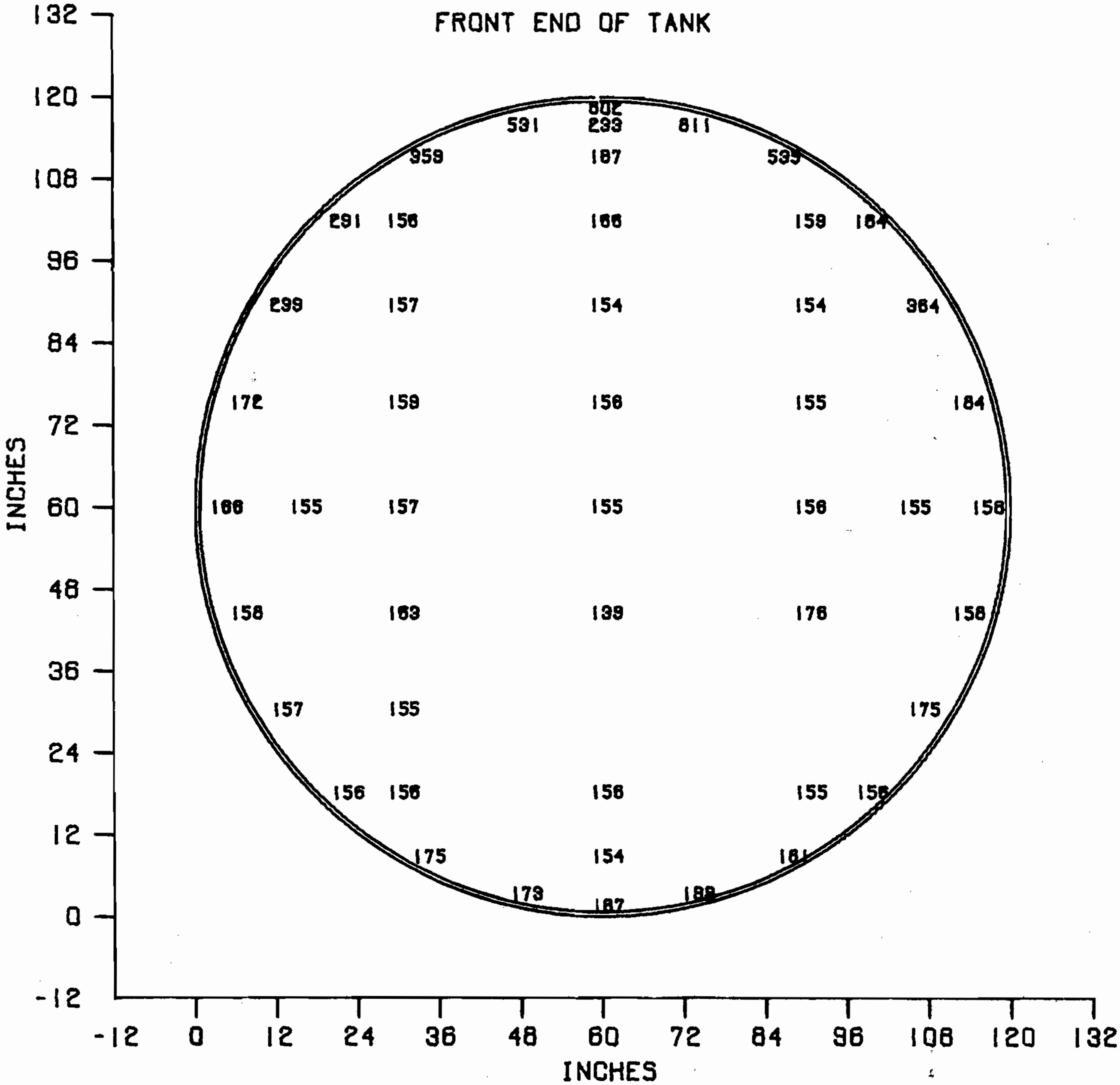

FIGURE B 29 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 1184 SECONDS FROM IGNITION FOR TEST NR. 8

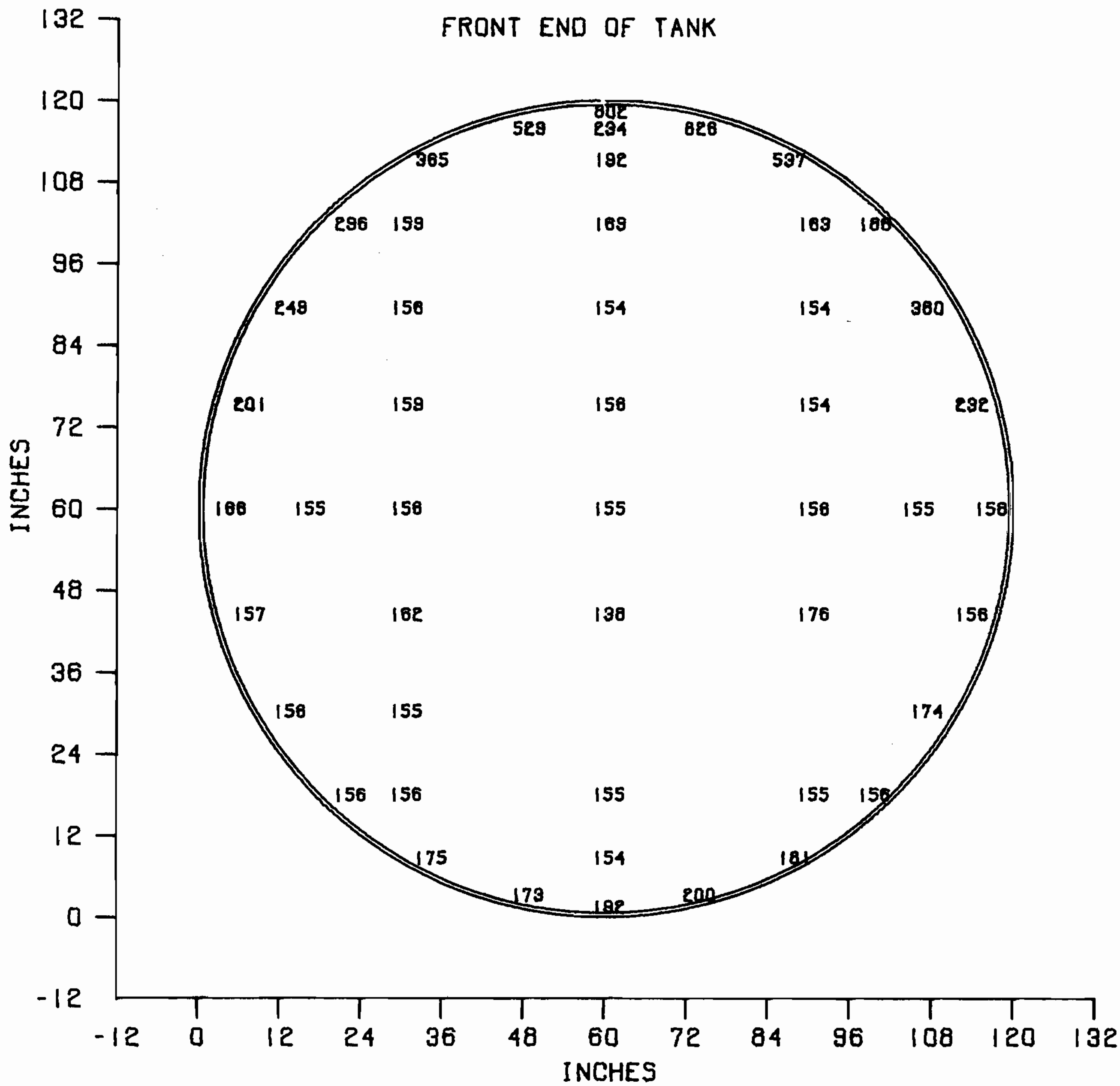

FIGURE B 30 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 1226 SECONDS FROM IGNITION FOR TEST NR. 8

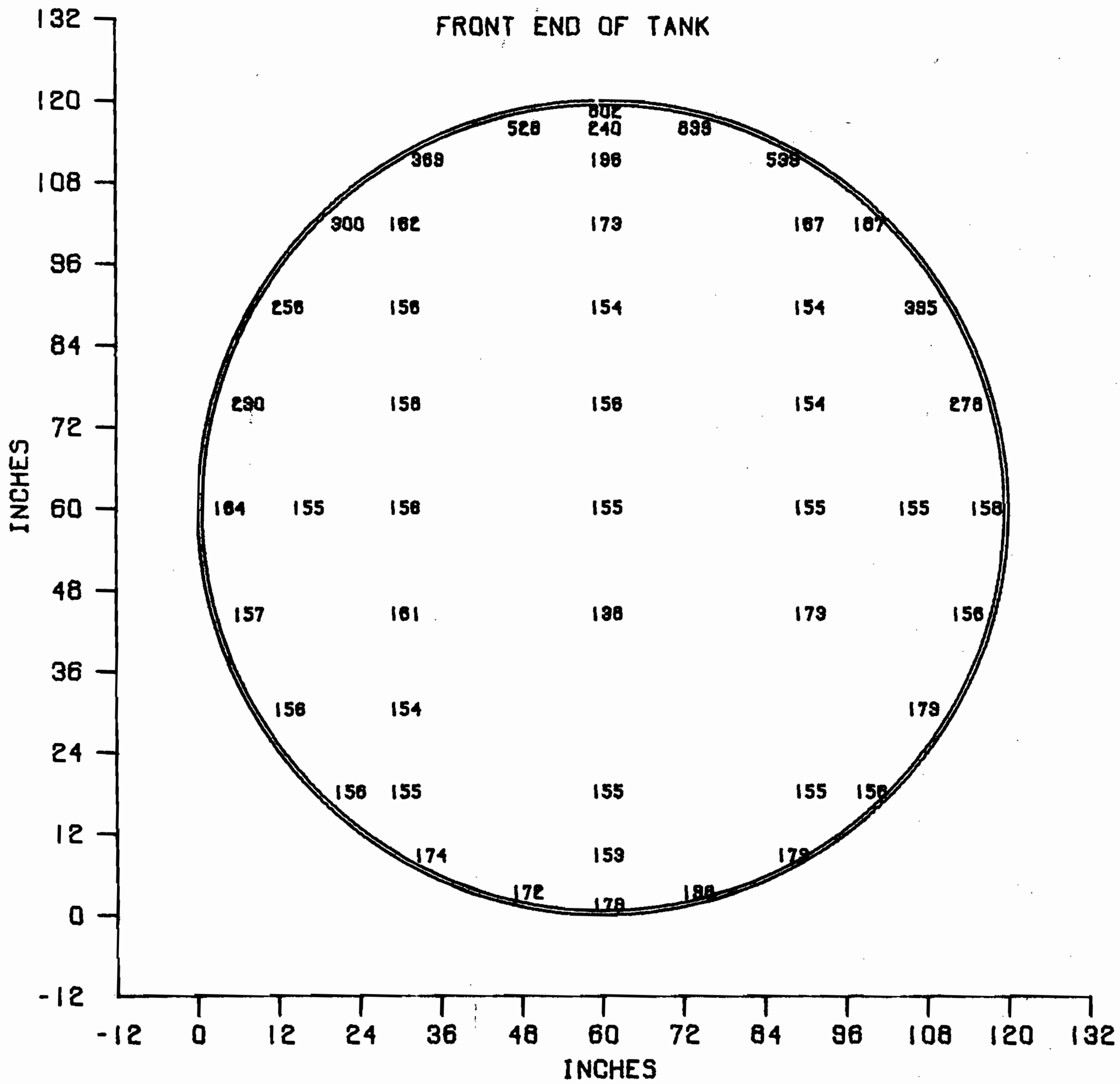

FIGURE B 31 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 1269 SECONDS FROM IGNITION FOR TEST NR. 8

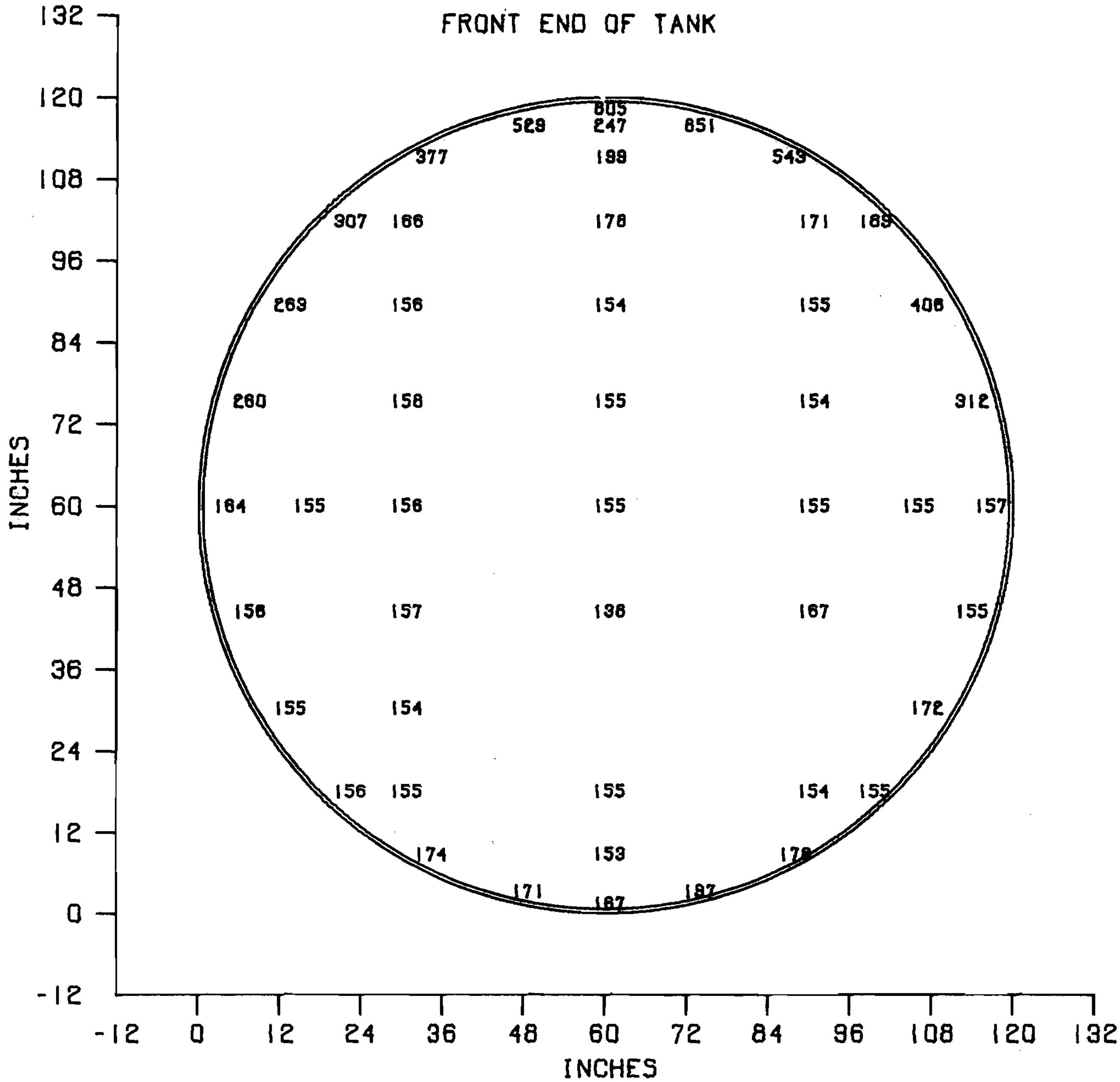

FIGURE B 32 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 1311 SECONDS FROM IGNITION FOR TEST NR. 8

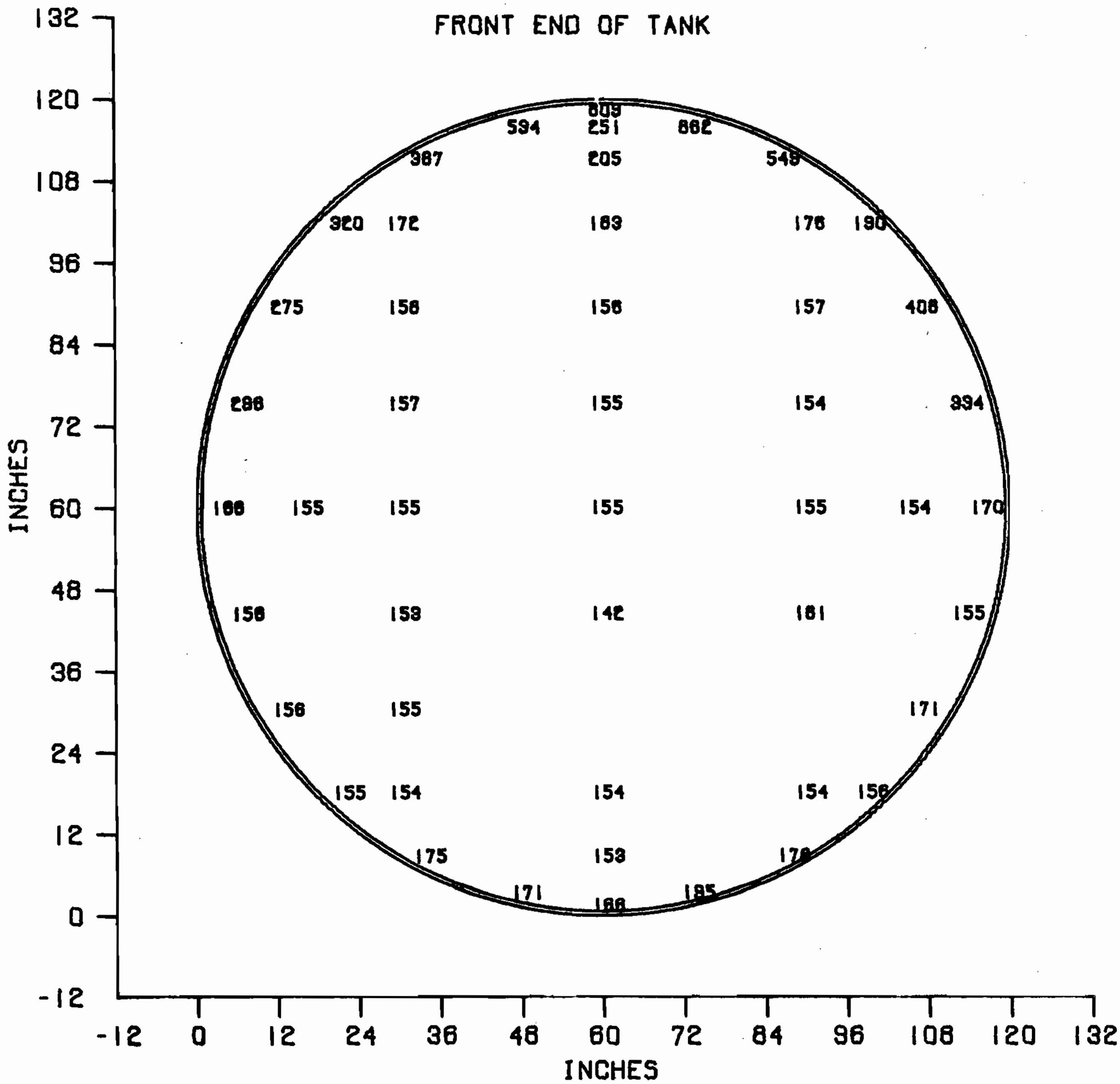

FIGURE B 33 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 1353 SECONDS FROM IGNITION FOR TEST NR. 8

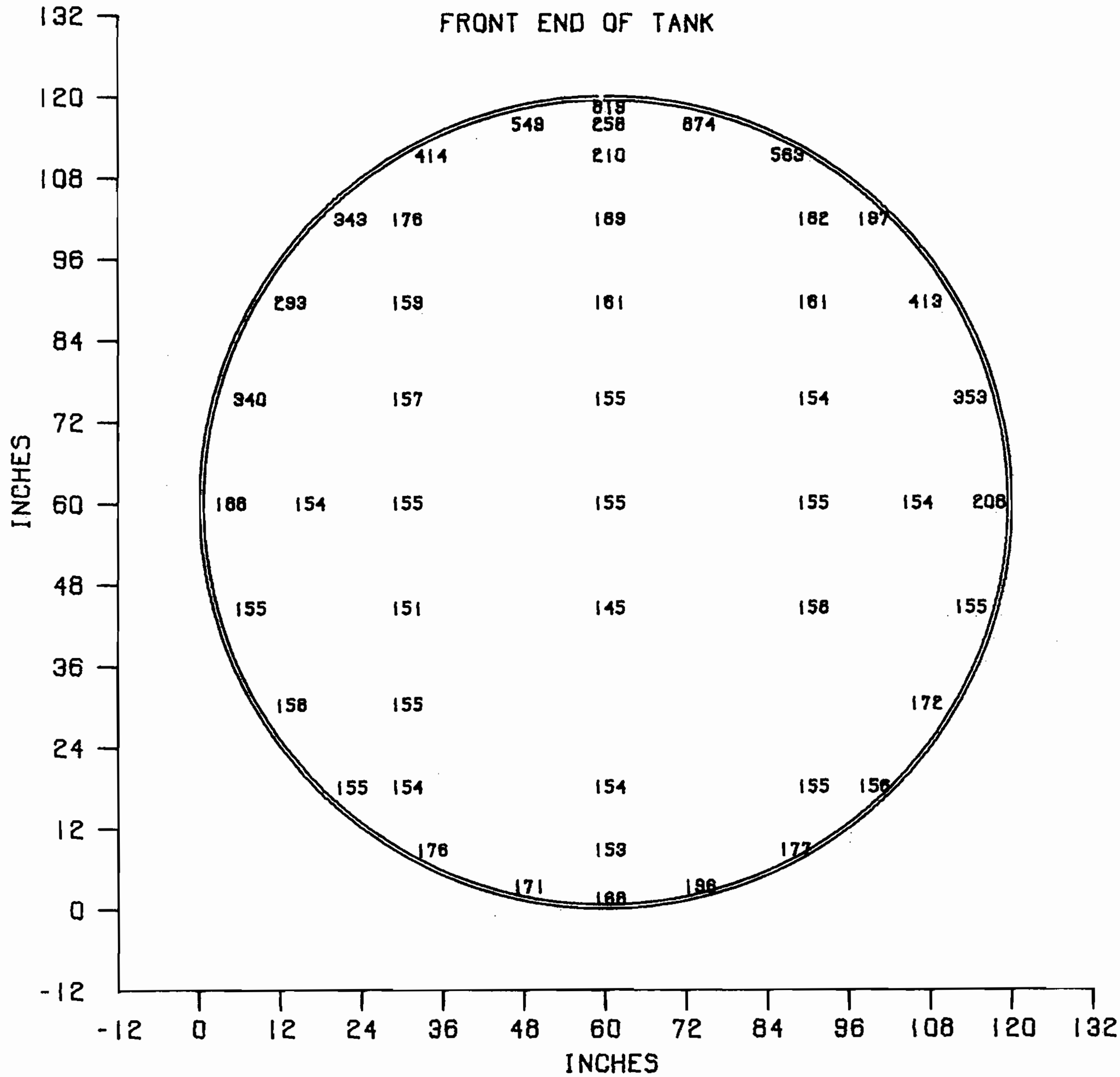

FIGURE B 34 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 1395 SECONDS FROM IGNITION FOR TEST NR. 8

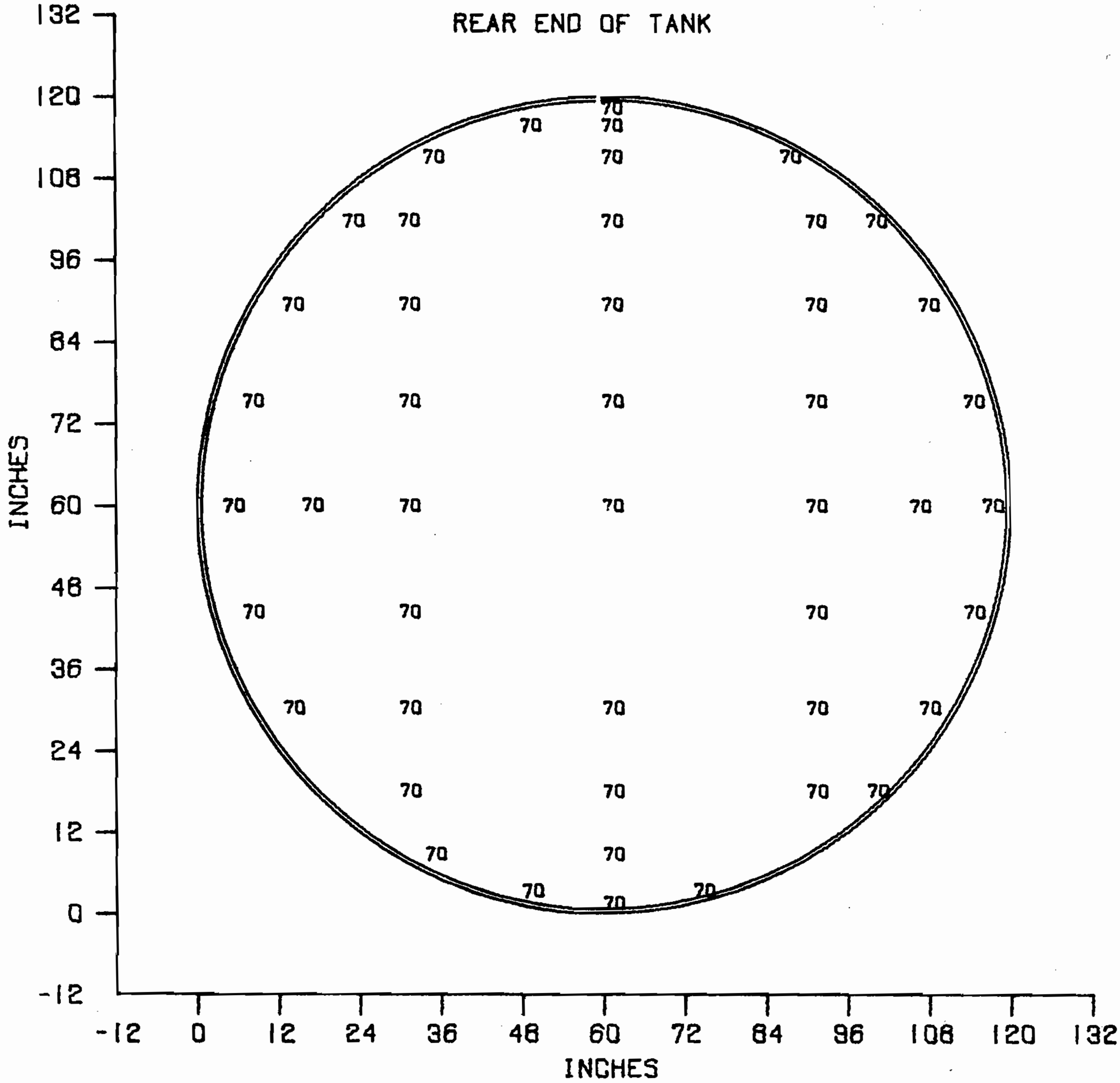

FIGURE B 35 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 0 SECONDS FROM IGNITION FOR TEST NR. 8

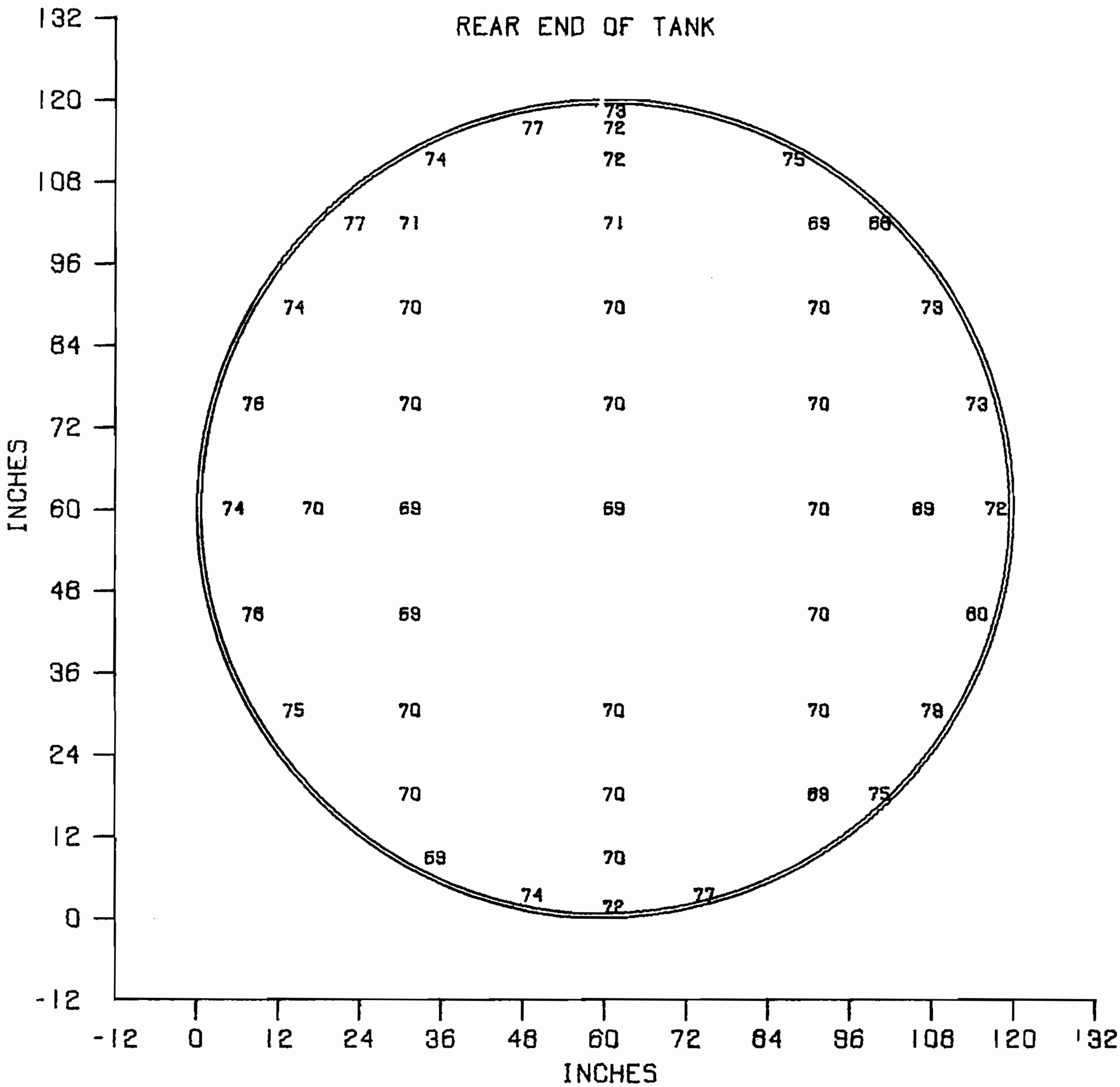

FIGURE B 36 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 42 SECONDS FROM IGNITION FOR TEST NR. 8

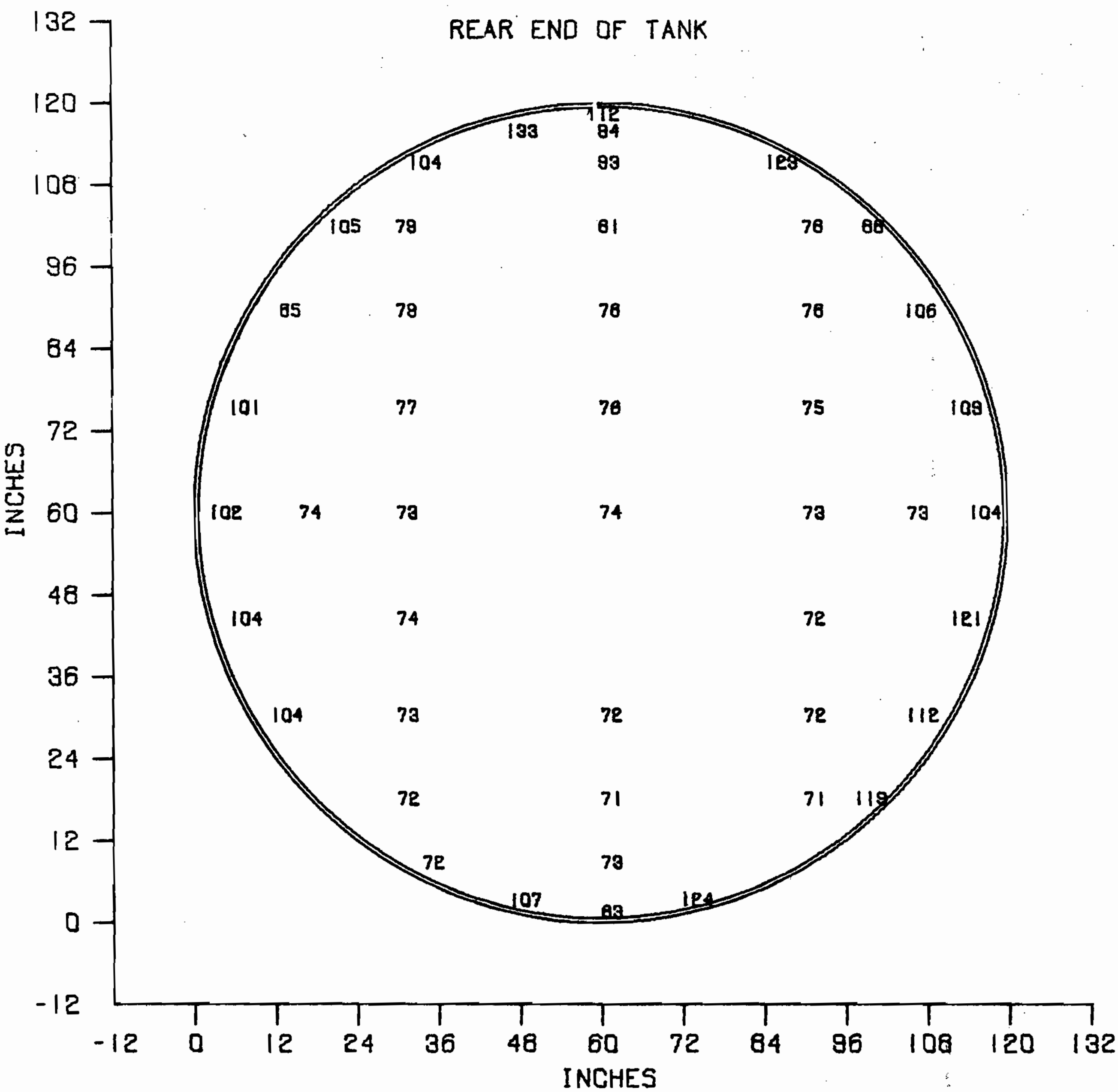

FIGURE B 37 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 84 SECONDS FROM IGNITION FOR TEST NR. 8

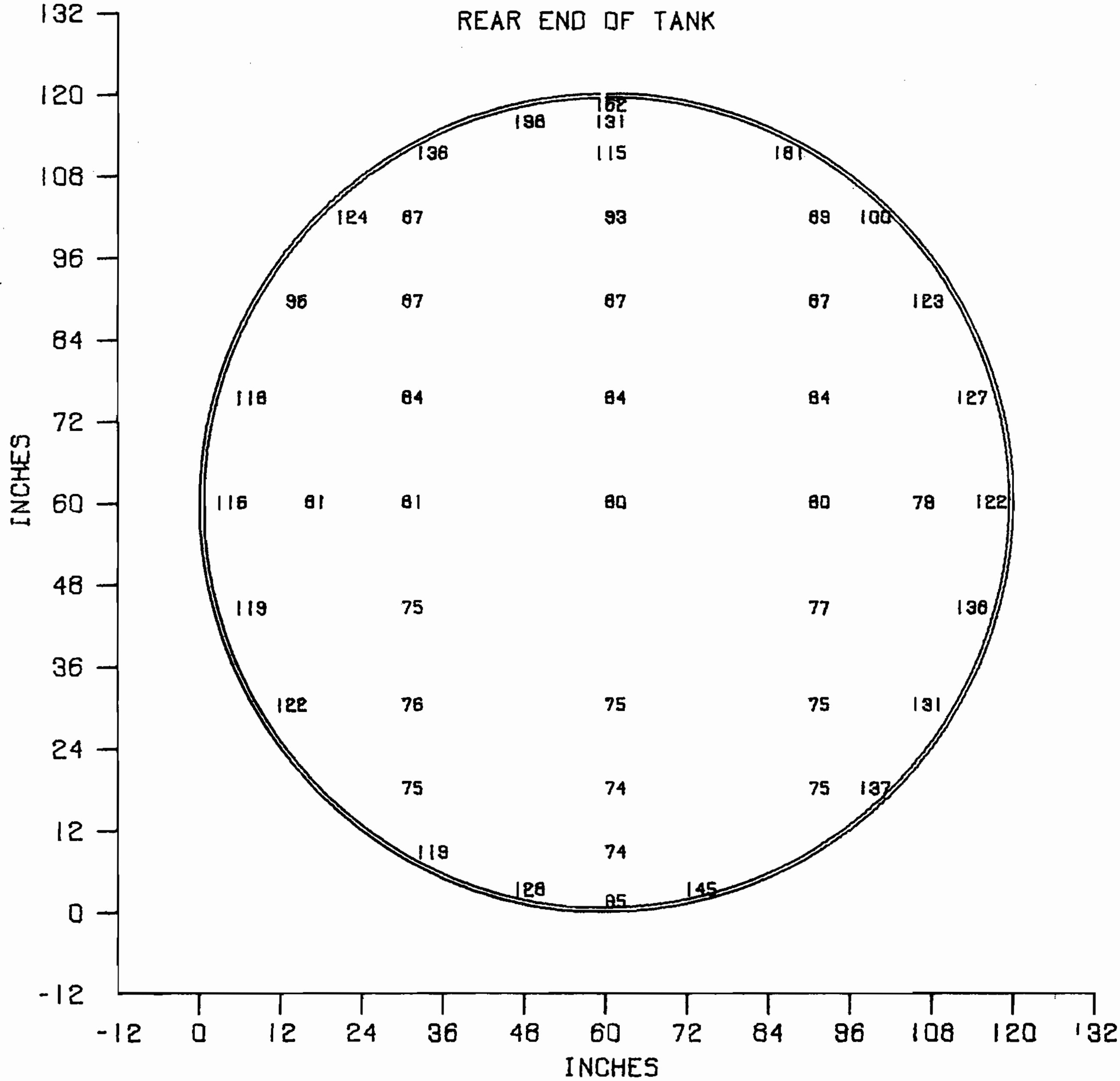

FIGURE B 38 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 126 SECONDS FROM IGNITION FOR TEST NR. 8

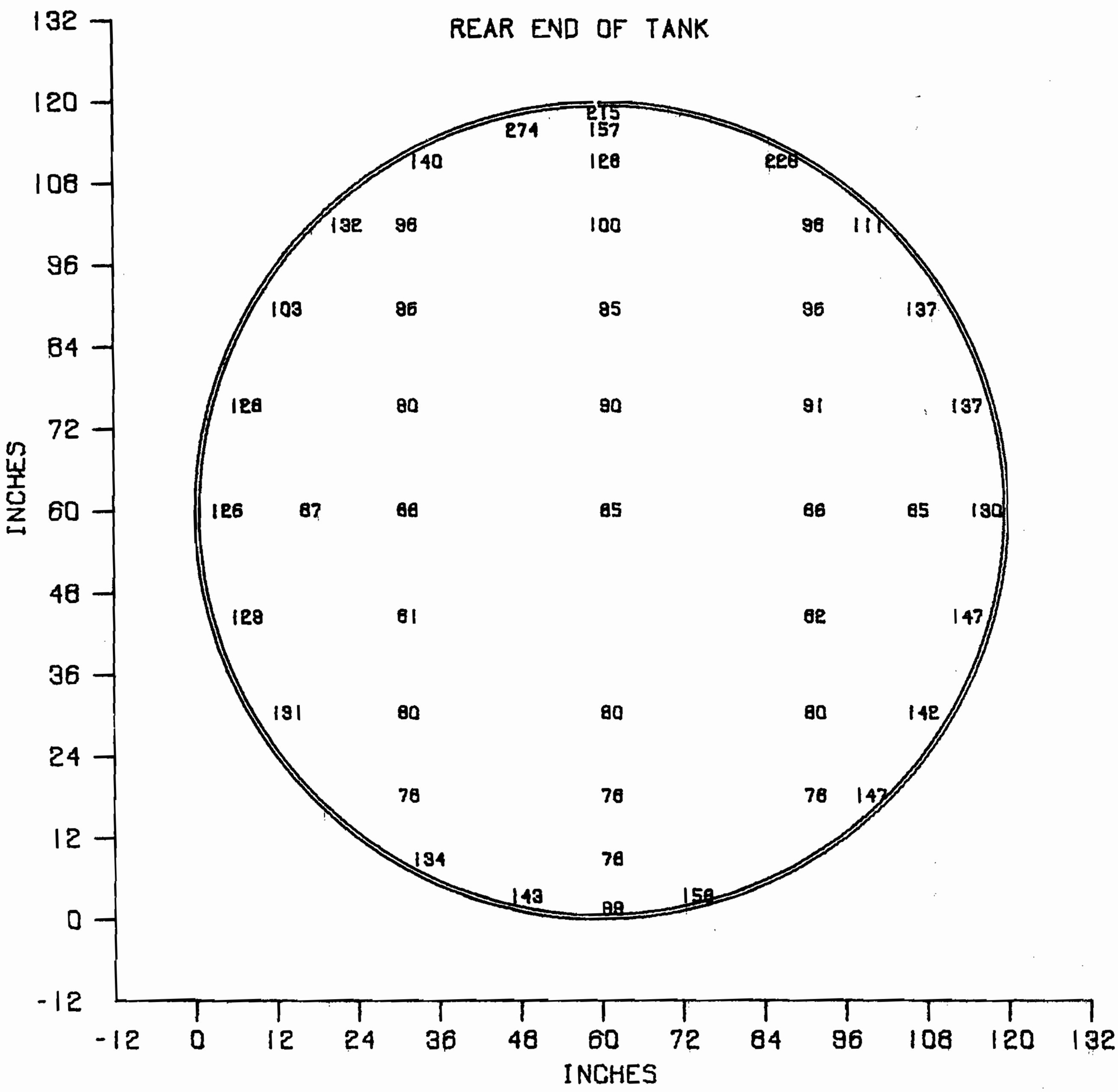

FIGURE B 39 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 169 SECONDS FROM IGNITION FOR TEST NR. 8

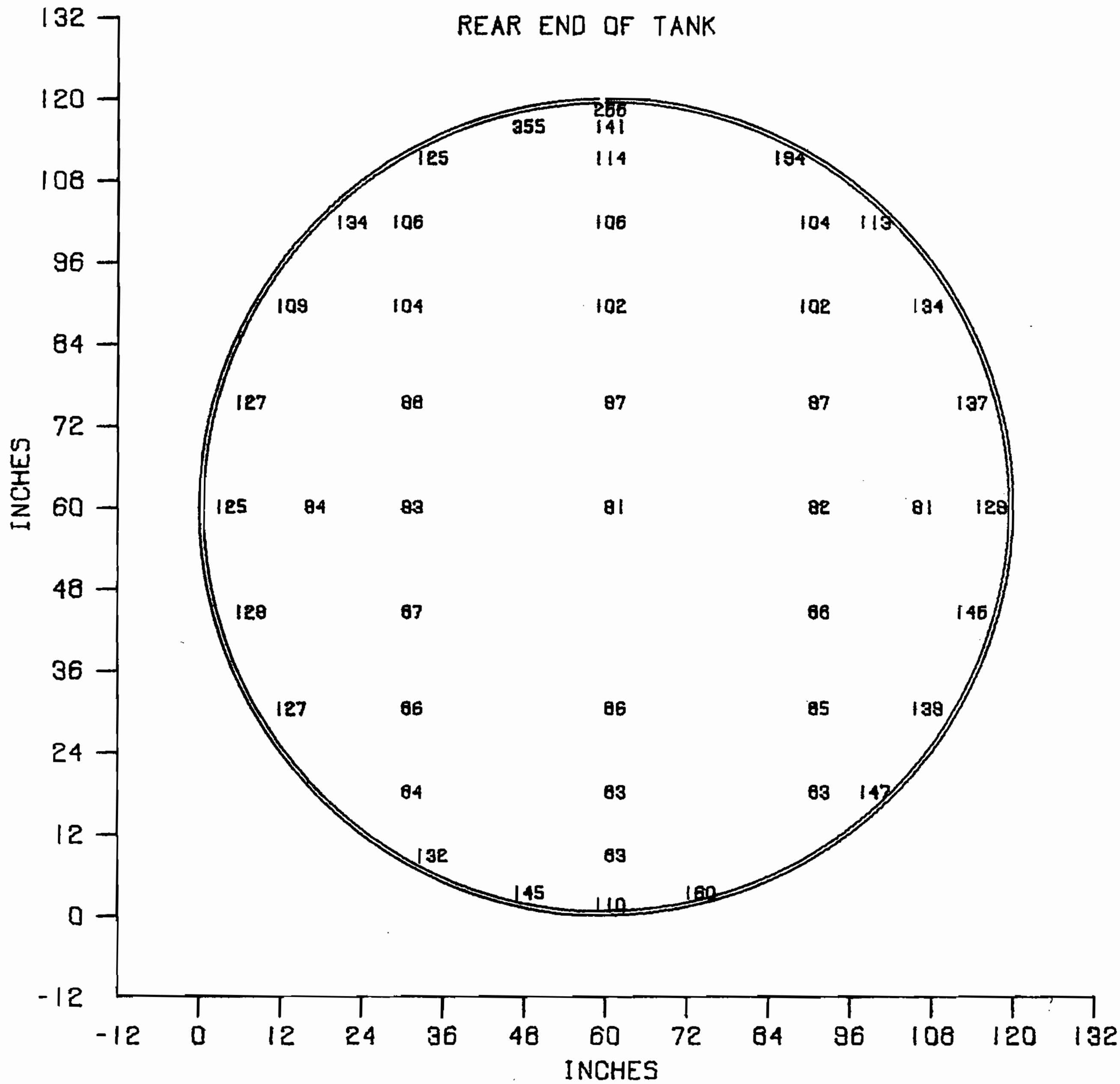

FIGURE B 40 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 211 SECONDS FROM IGNITION FOR TEST NR. 8

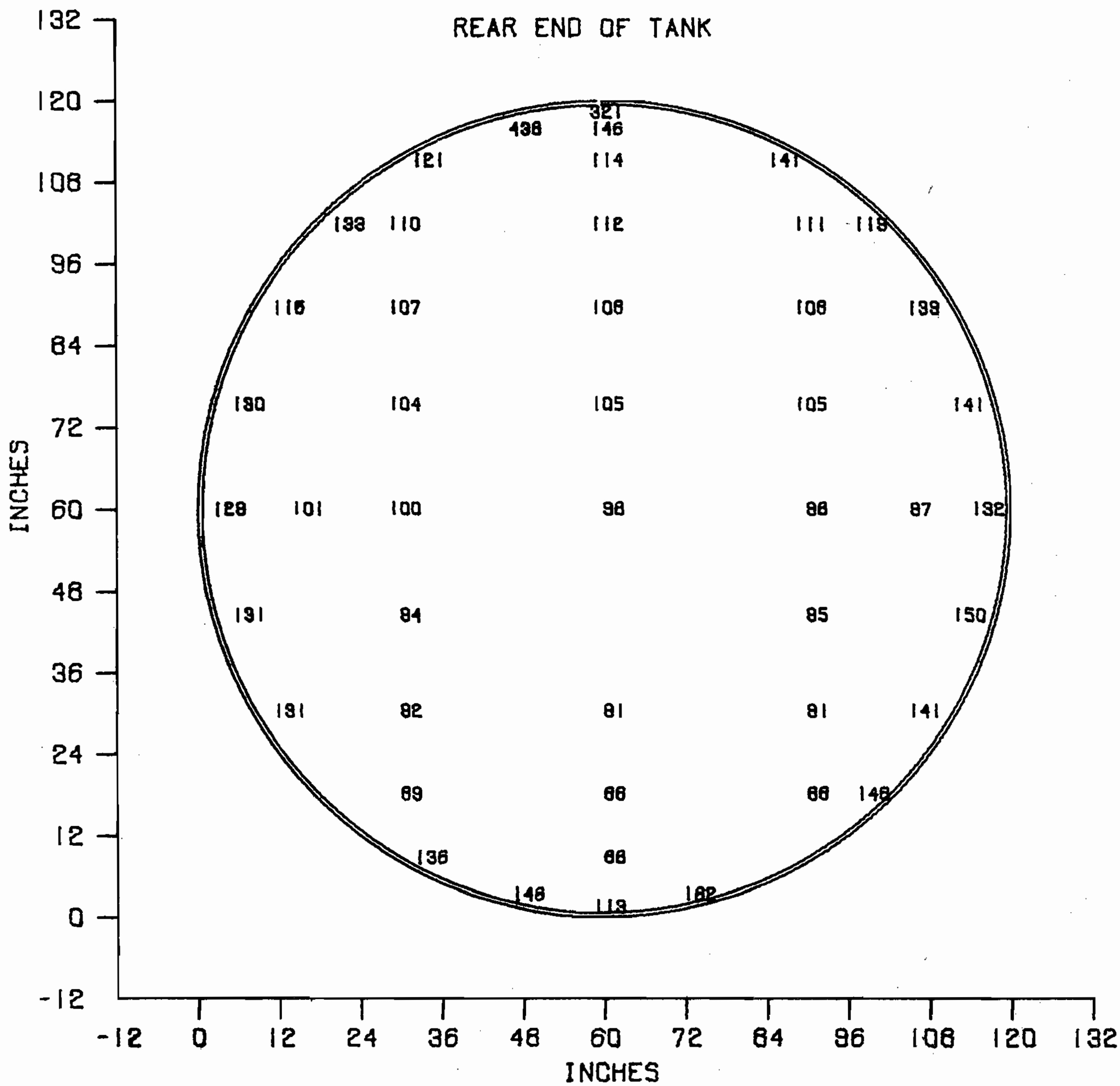

FIGURE B 41 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 253 SECONDS FROM IGNITION FOR TEST NR. 8

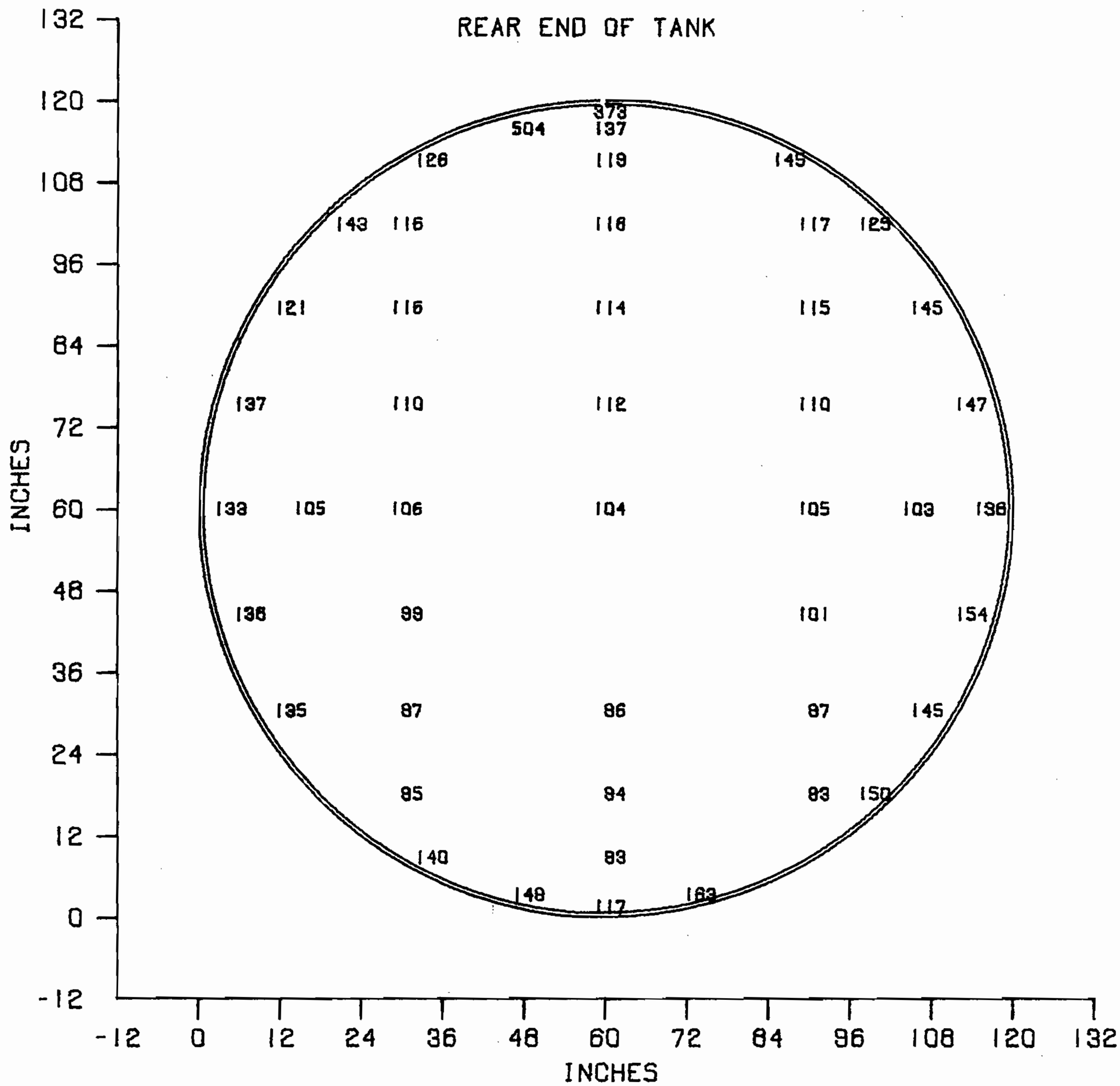

FIGURE B 42 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 296 SECONDS FROM IGNITION FOR TEST NR. 8

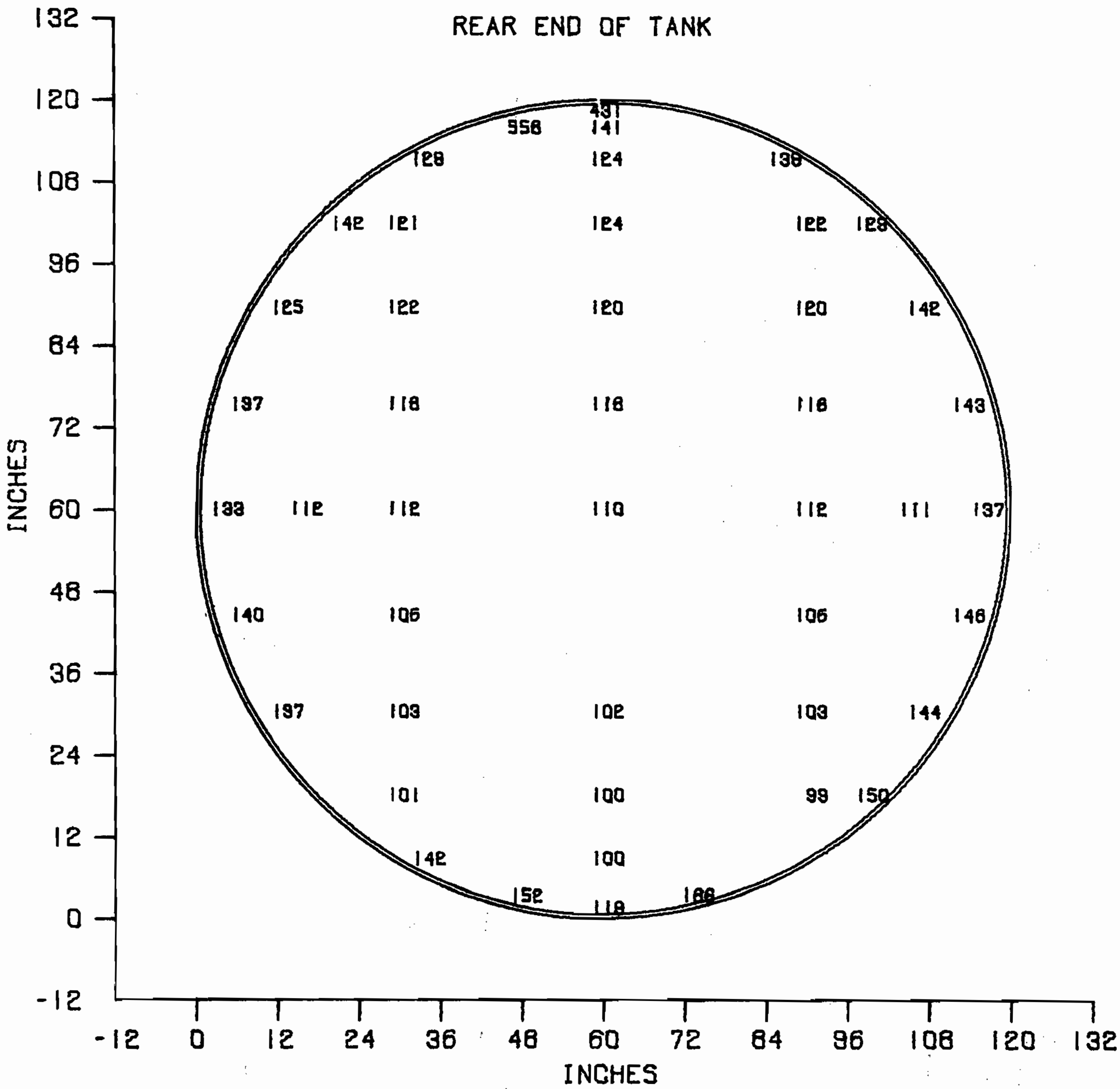

FIGURE B 43 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION
AT 336 SECONDS FROM IGNITION FOR TEST NR. 6

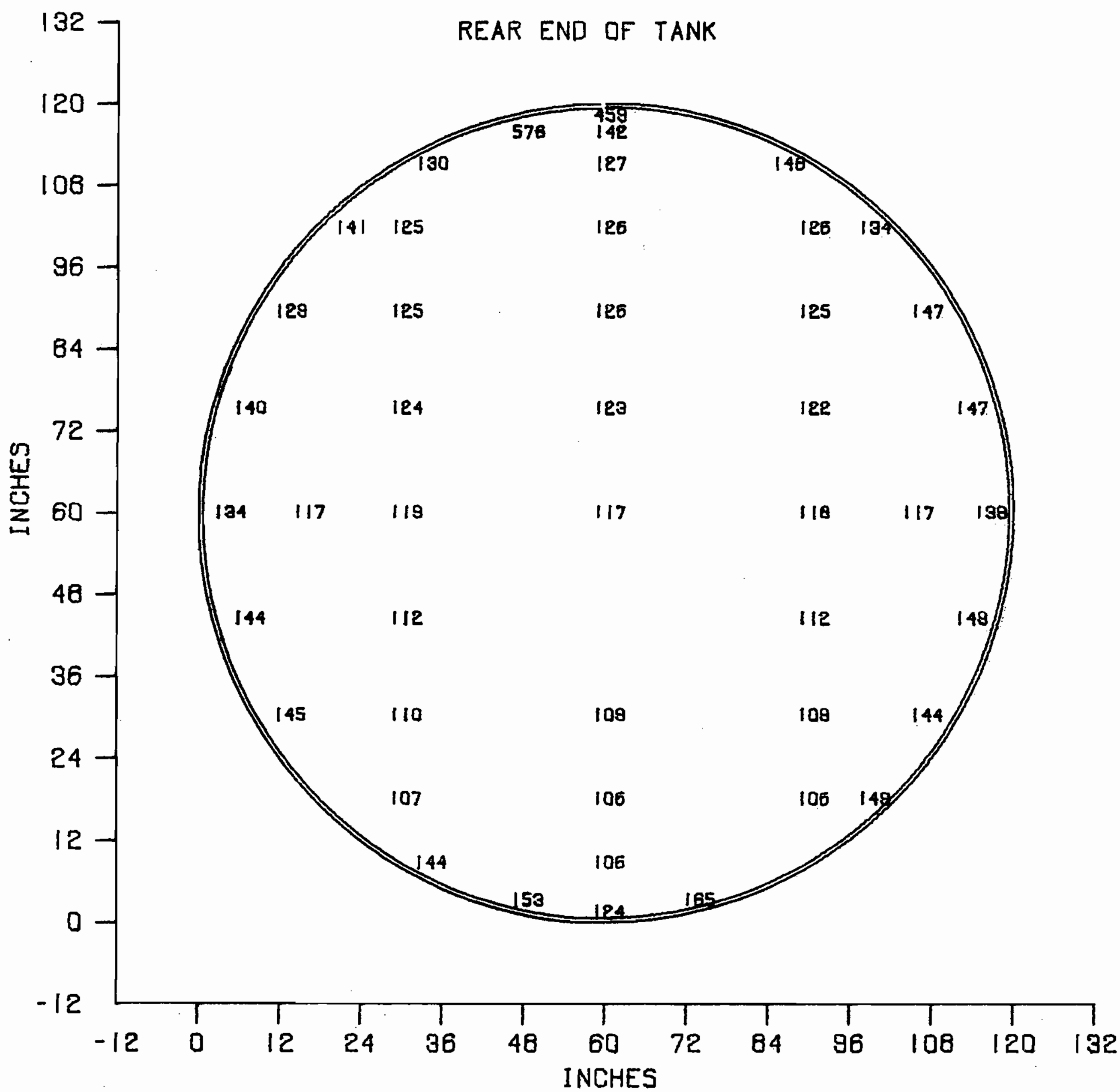

FIGURE B 44 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 380 SECONDS FROM IGNITION FOR TEST NR. 8

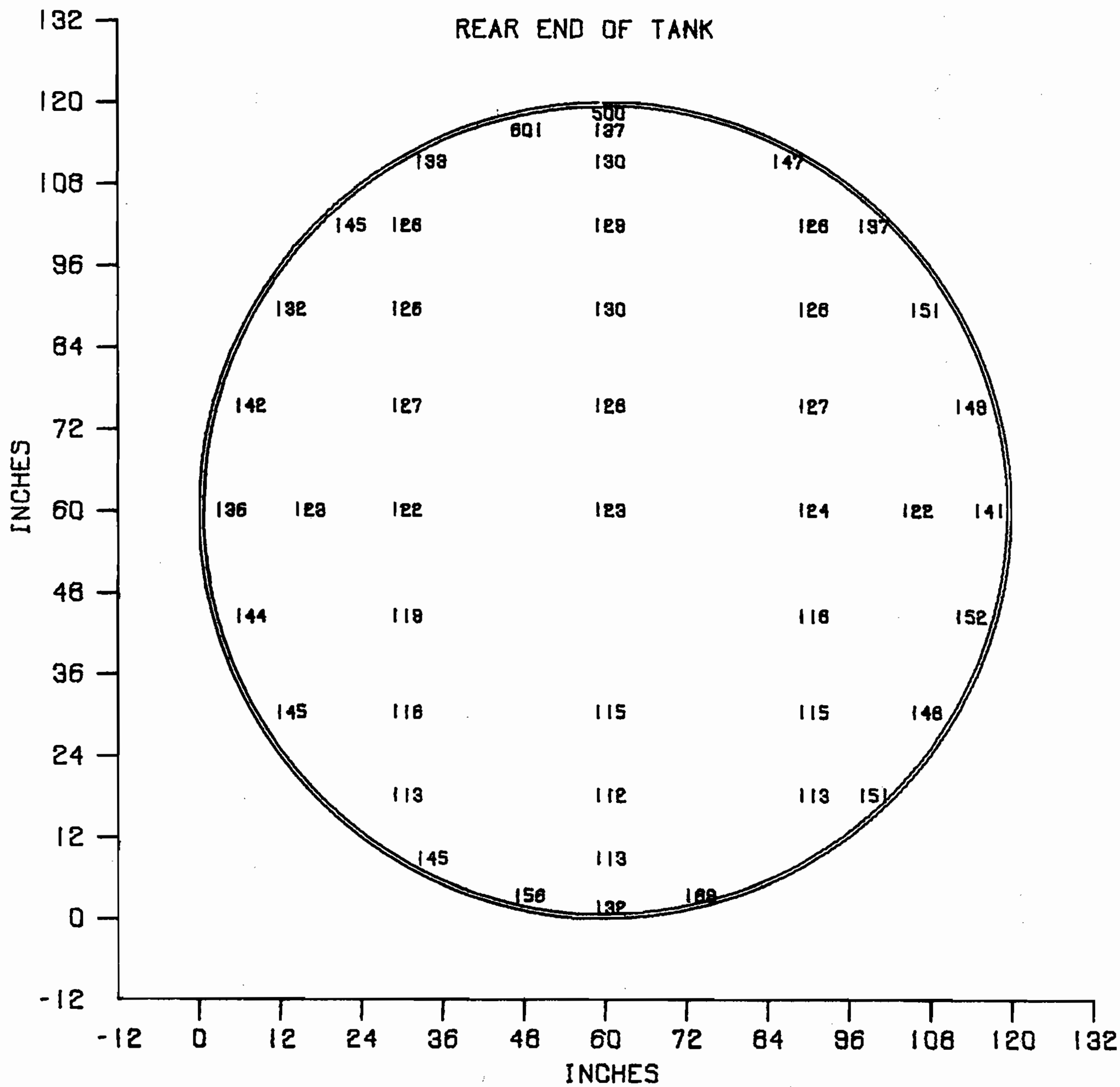

FIGURE B 45 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 423 SECONDS FROM IGNITION FOR TEST NR. 6

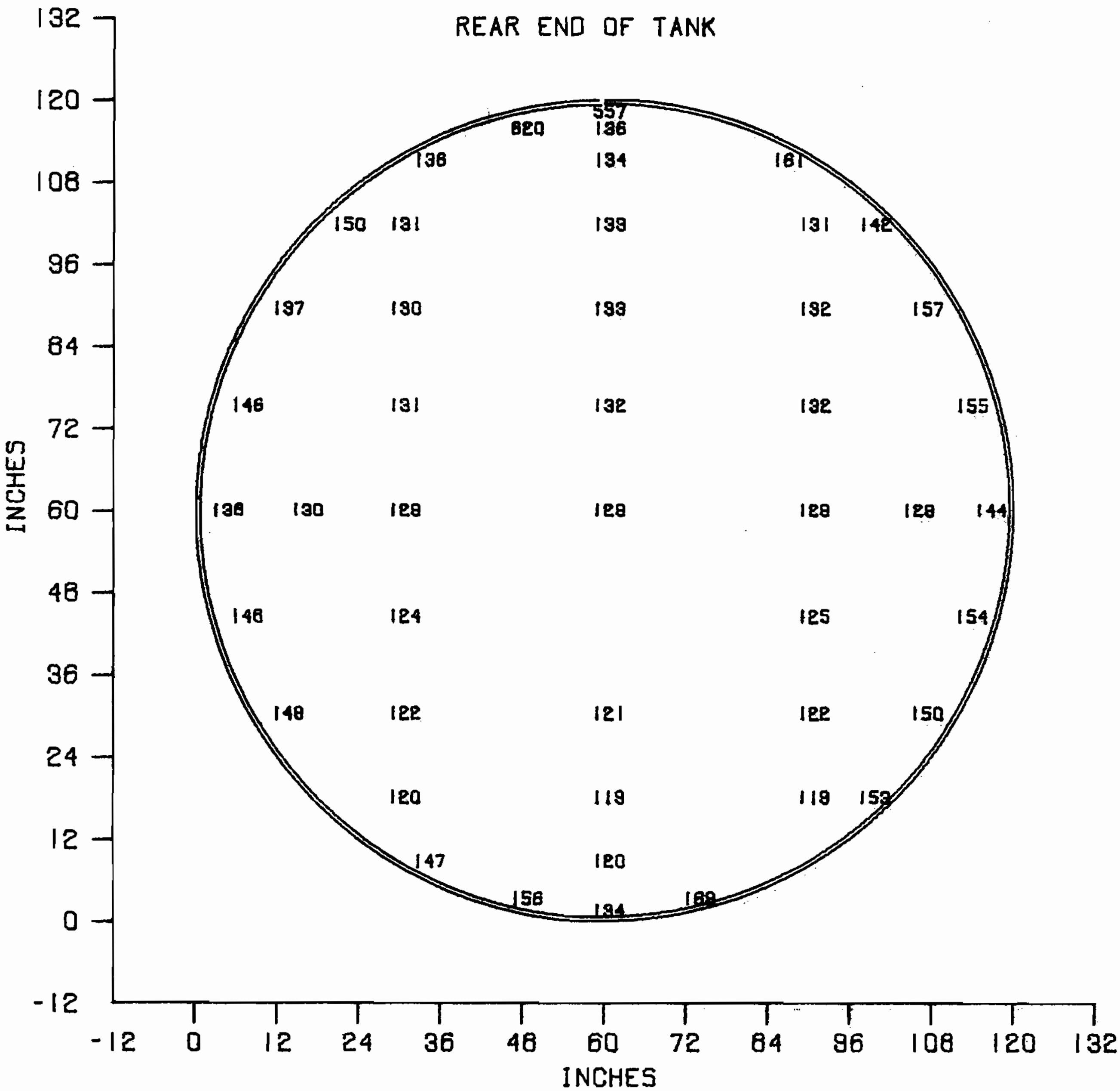

FIGURE B 46 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 465 SECONDS FROM IGNITION FOR TEST NR. 8

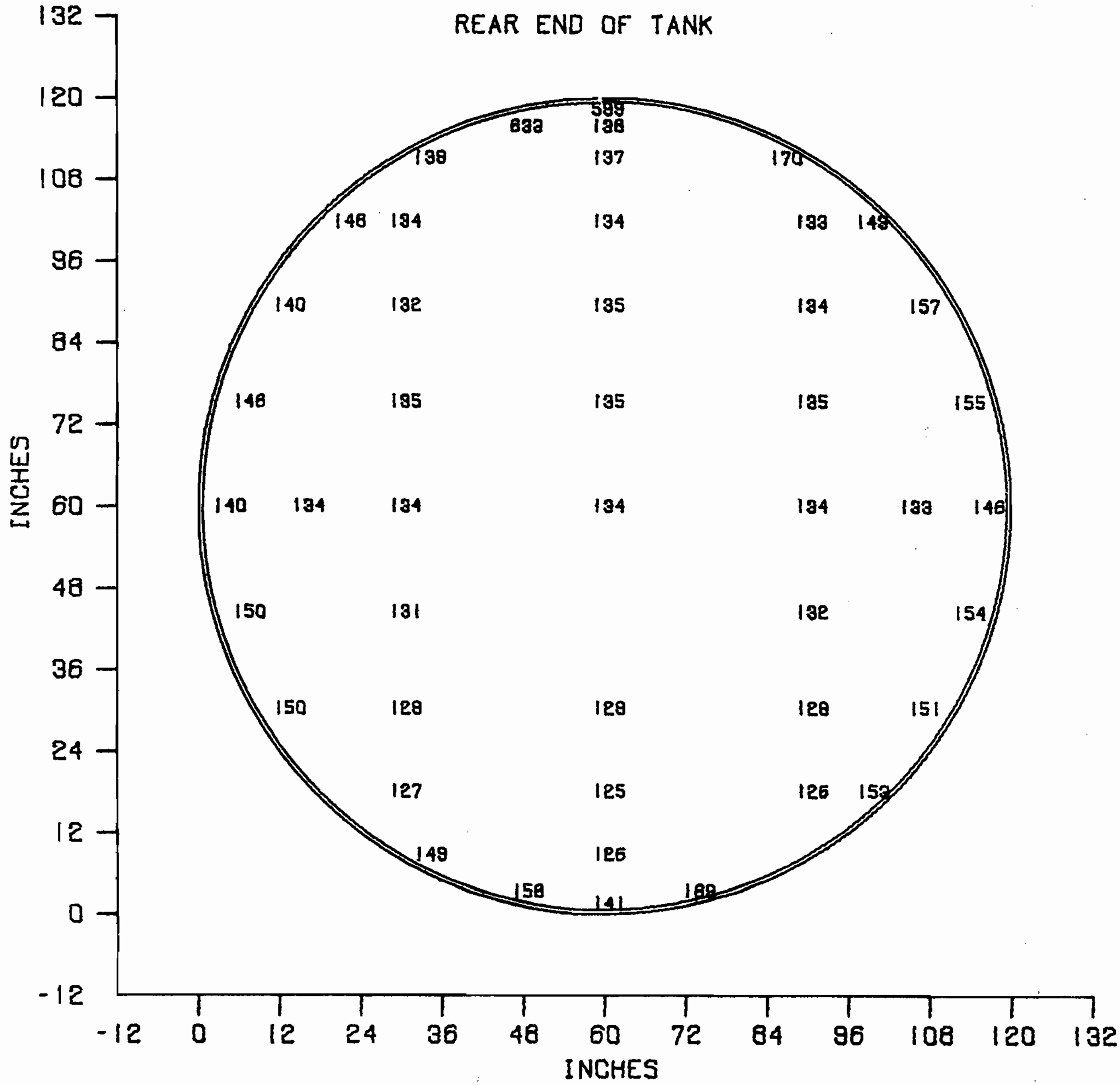

FIGURE B 47 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 507 SECONDS FROM IGNITION FOR TEST NR. 8

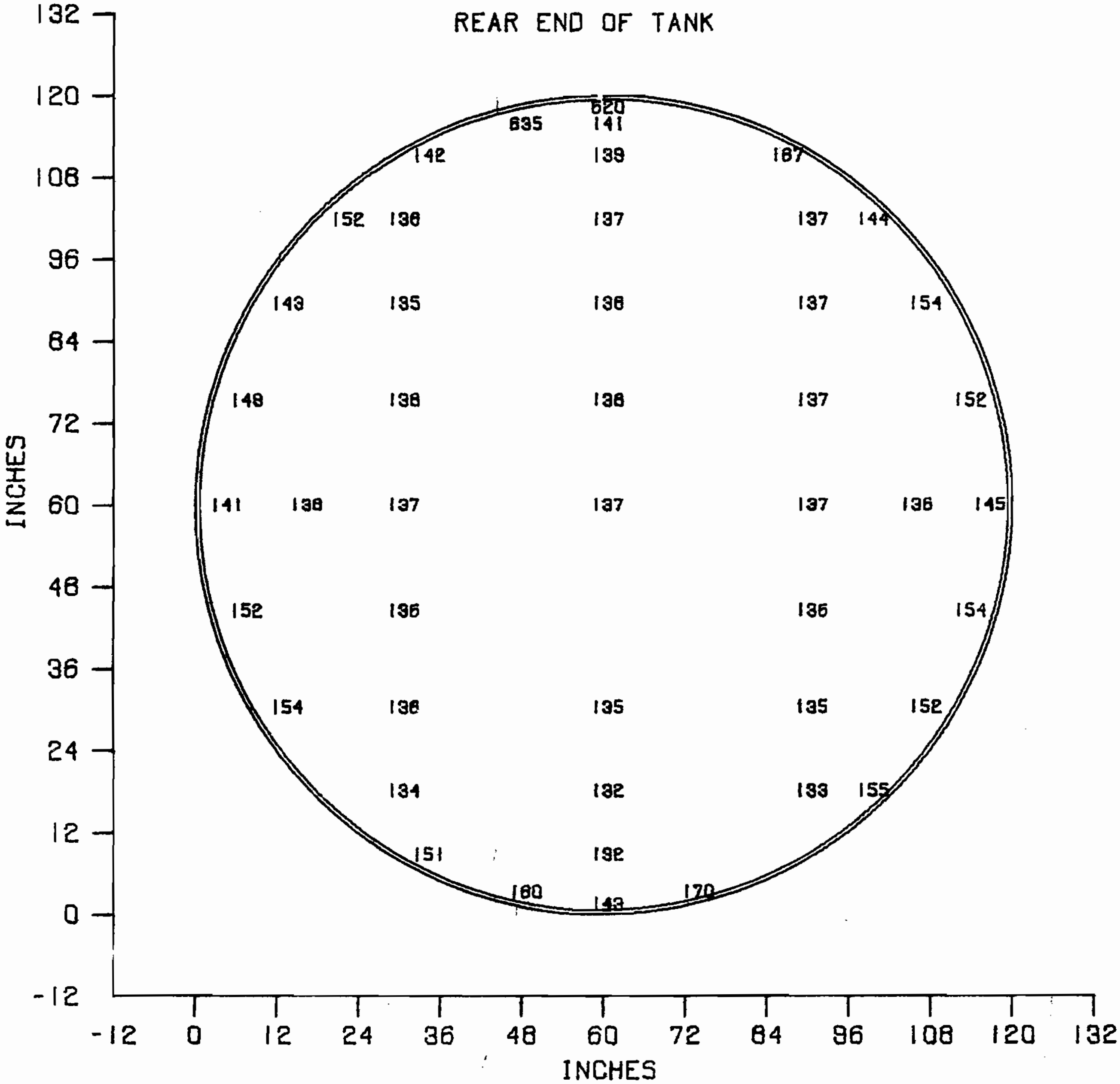

FIGURE B 48 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION
AT 549 SECONDS FROM IGNITION FOR TEST NR. 8

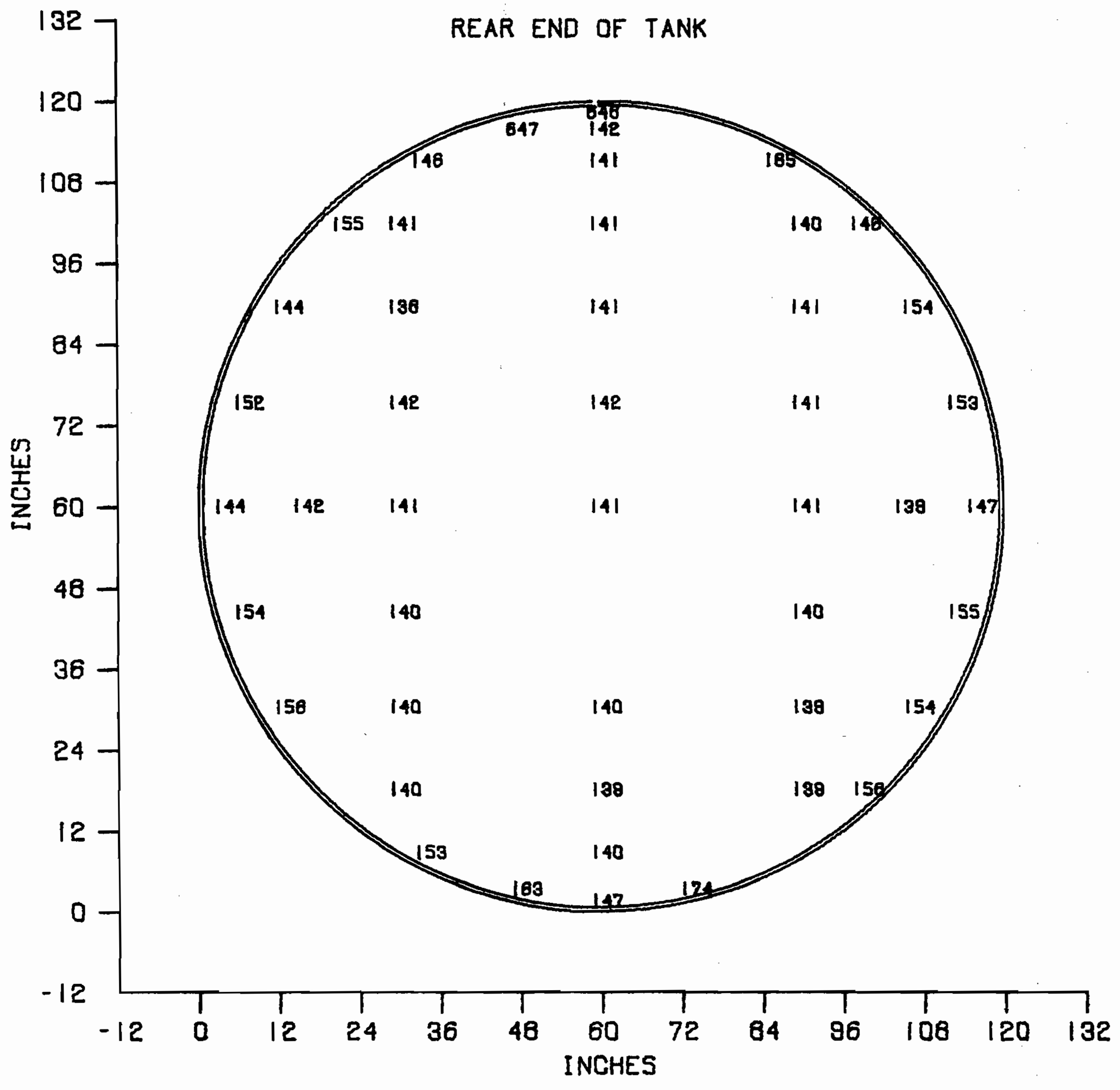

FIGURE B 49 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 592 SECONDS FROM IGNITION FOR TEST NR. 8

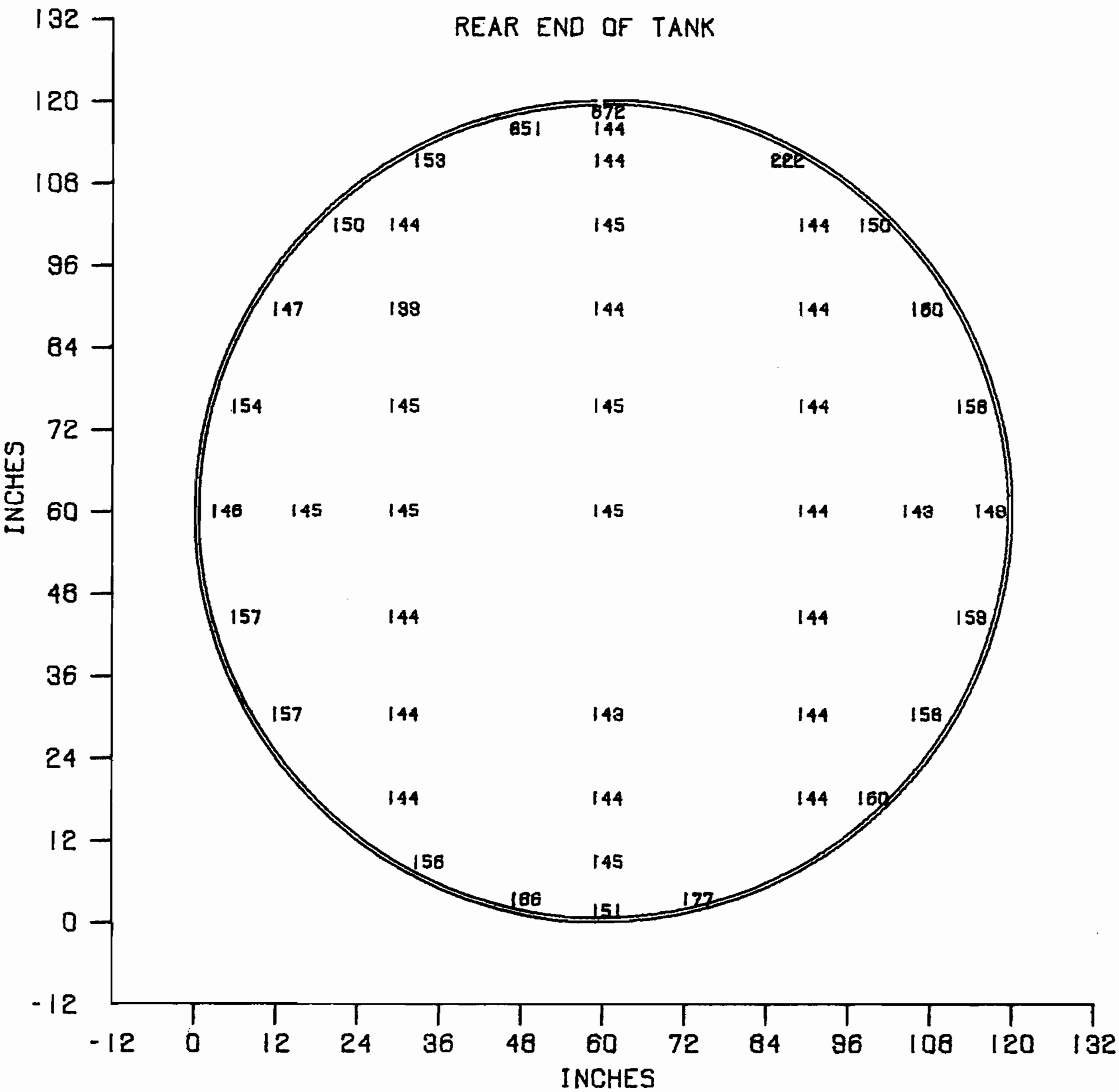

FIGURE B 50 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 634 SECONDS FROM IGNITION FOR TEST NR. 8

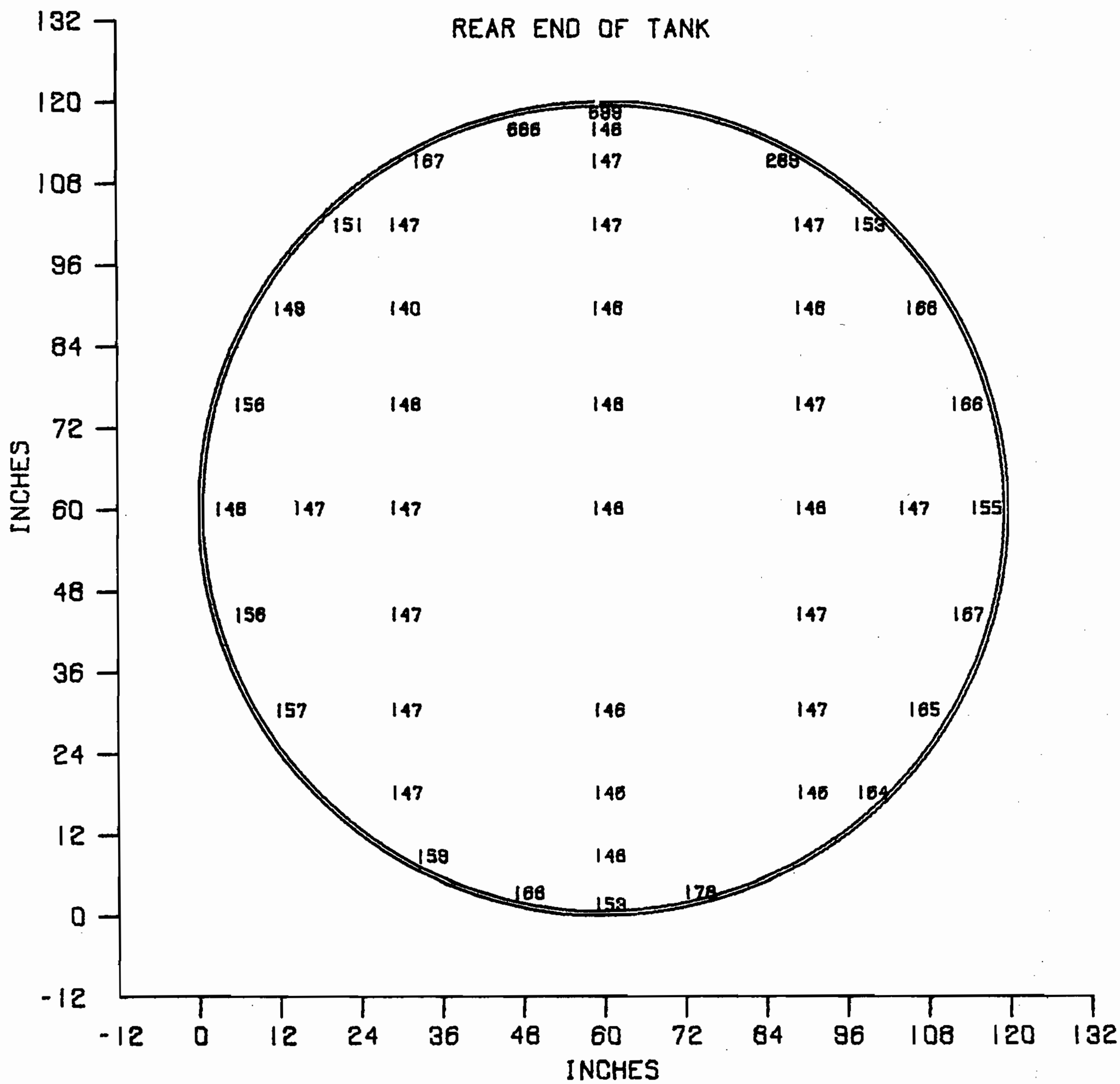

FIGURE B 51 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 676 SECONDS FROM IGNITION FOR TEST NR. 8

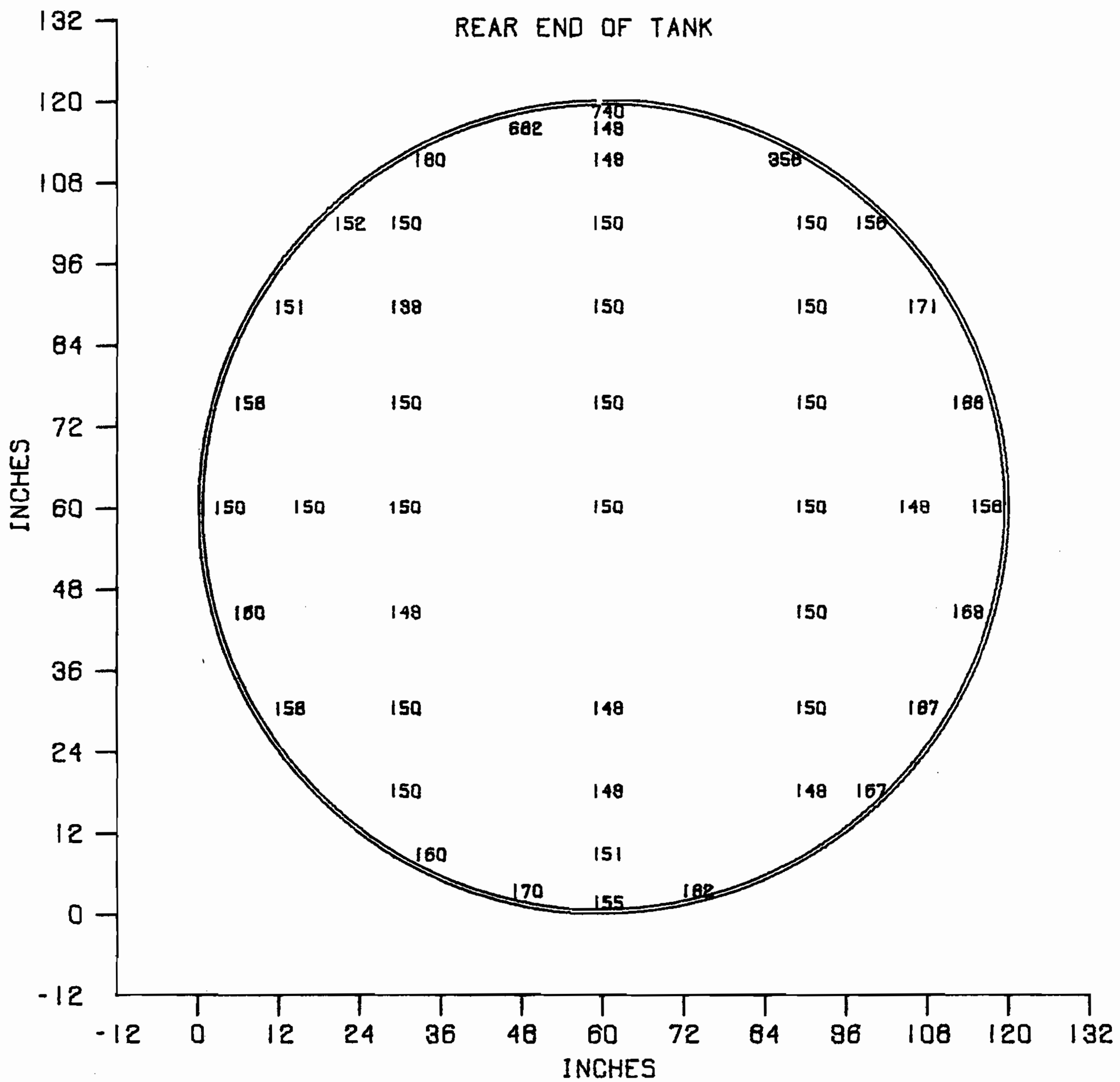

FIGURE B 52 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 719 SECONDS FROM IGNITION FOR TEST NR. 8

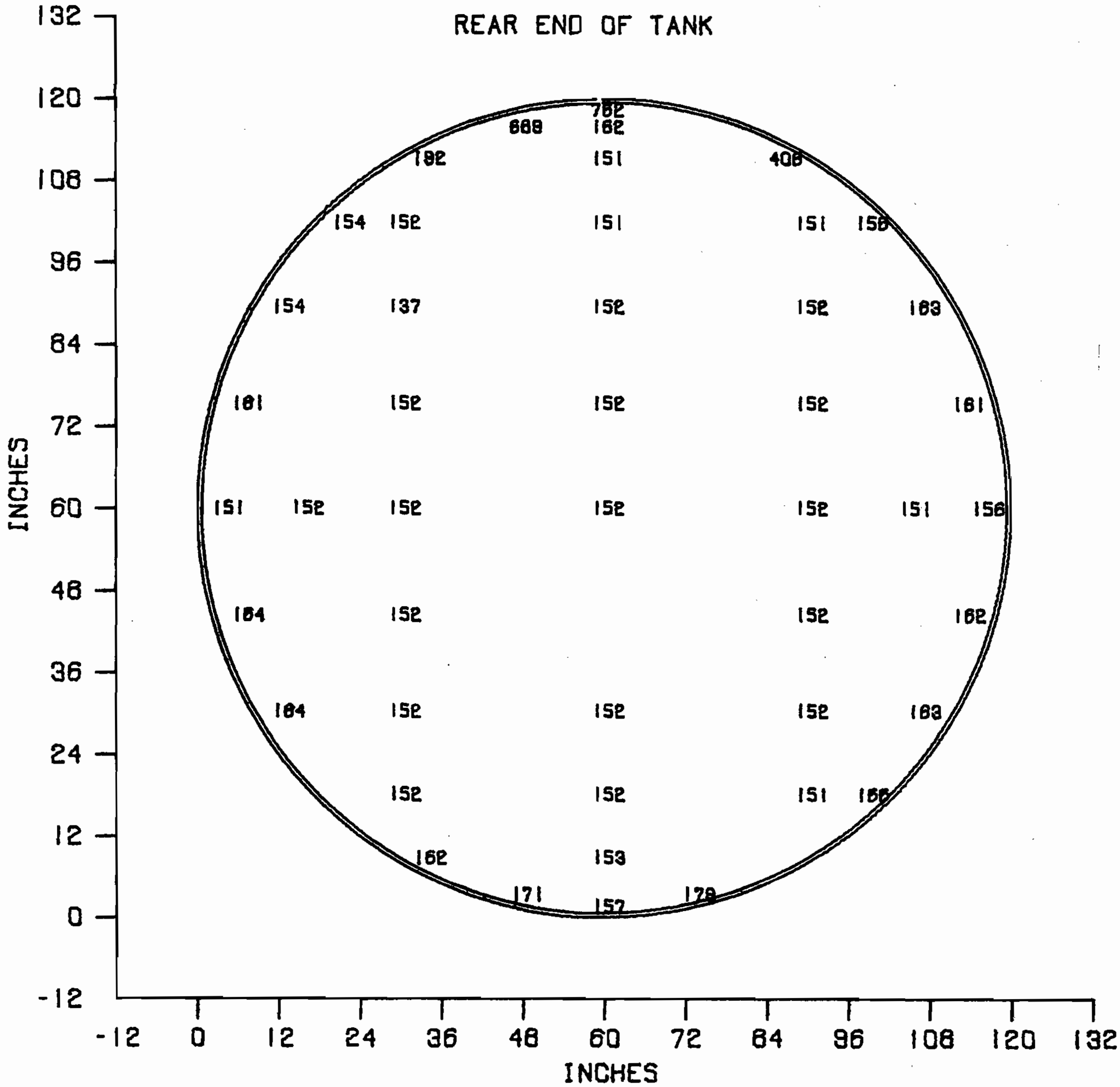

FIGURE B 53 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 761 SECONDS FROM IGNITION FOR TEST NR. 8

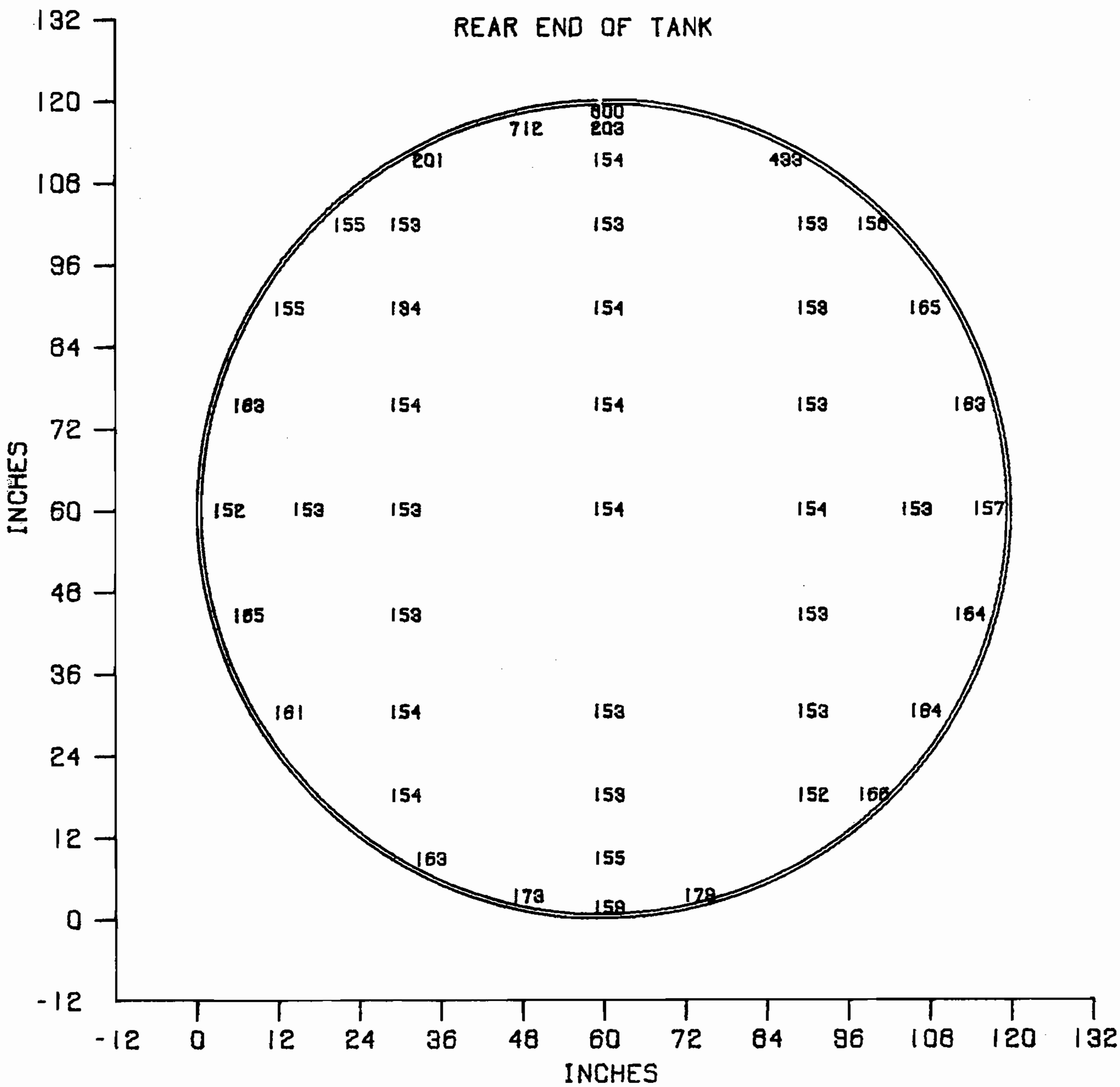

FIGURE B 54 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 803 SECONDS FROM IGNITION FOR TEST NR. 8

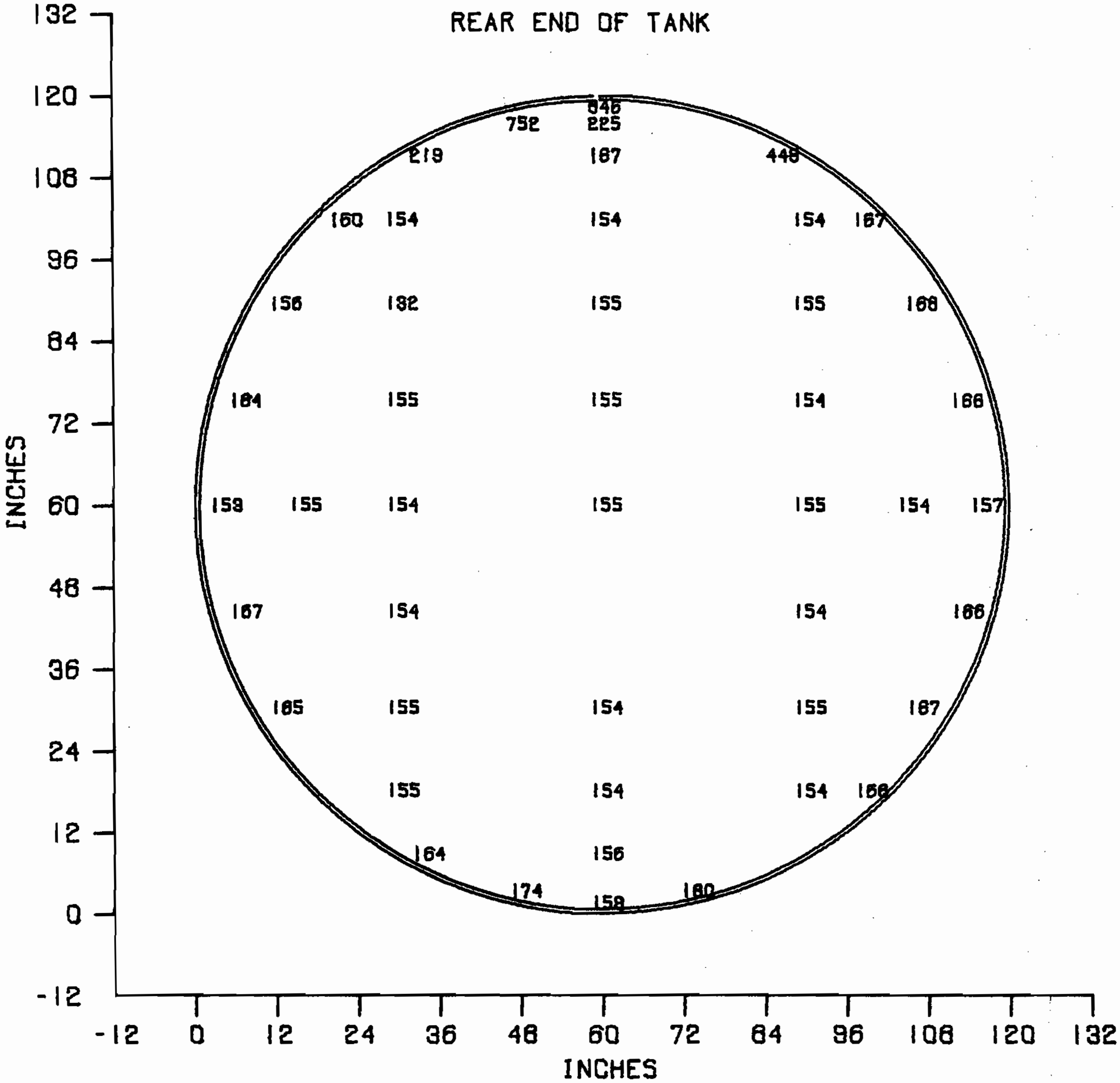

FIGURE B 55 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 846 SECONDS FROM IGNITION FOR TEST NR. 8

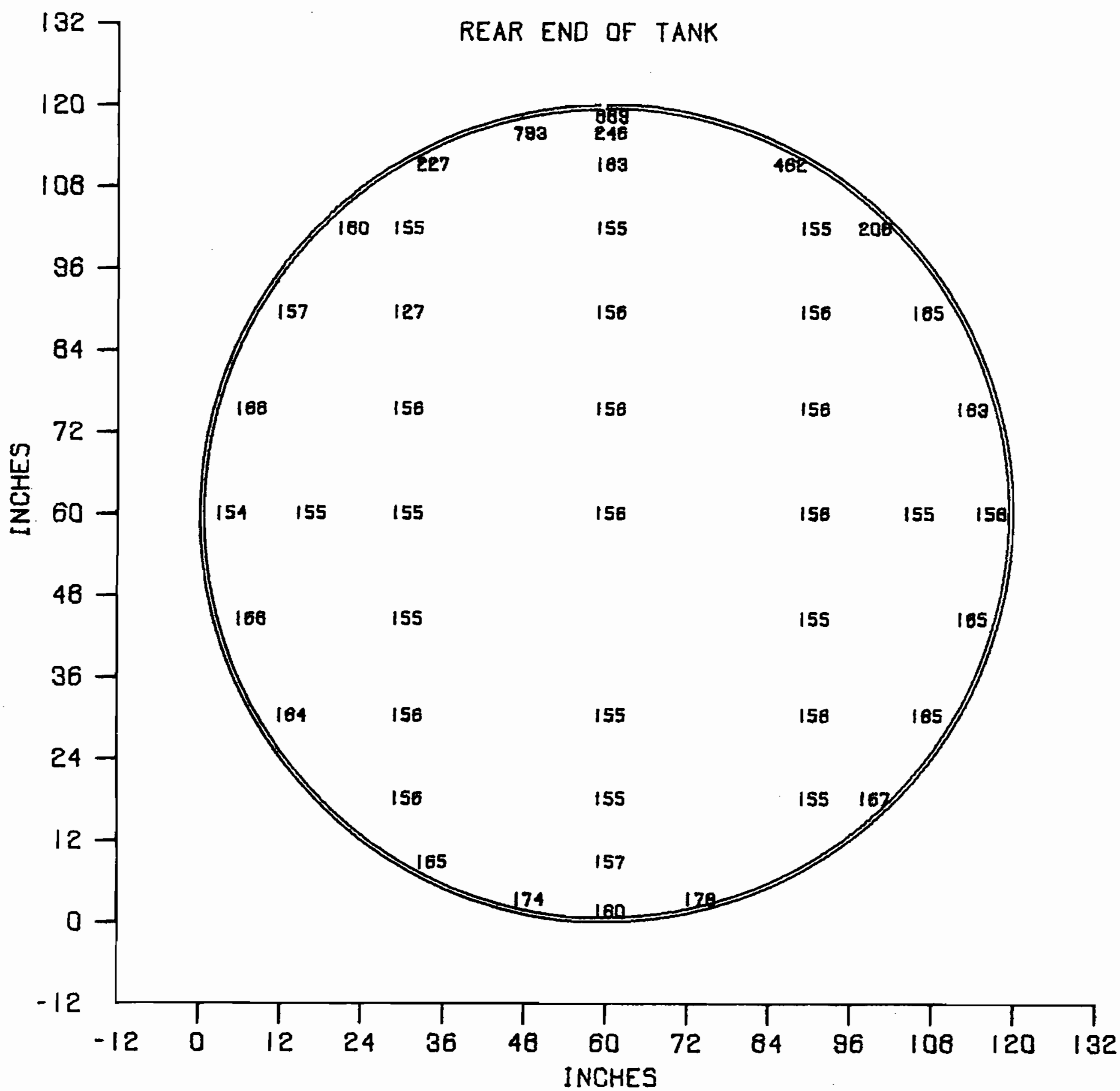

FIGURE B 56 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION
AT 888 SECONDS FROM IGNITION FOR TEST NR. 8

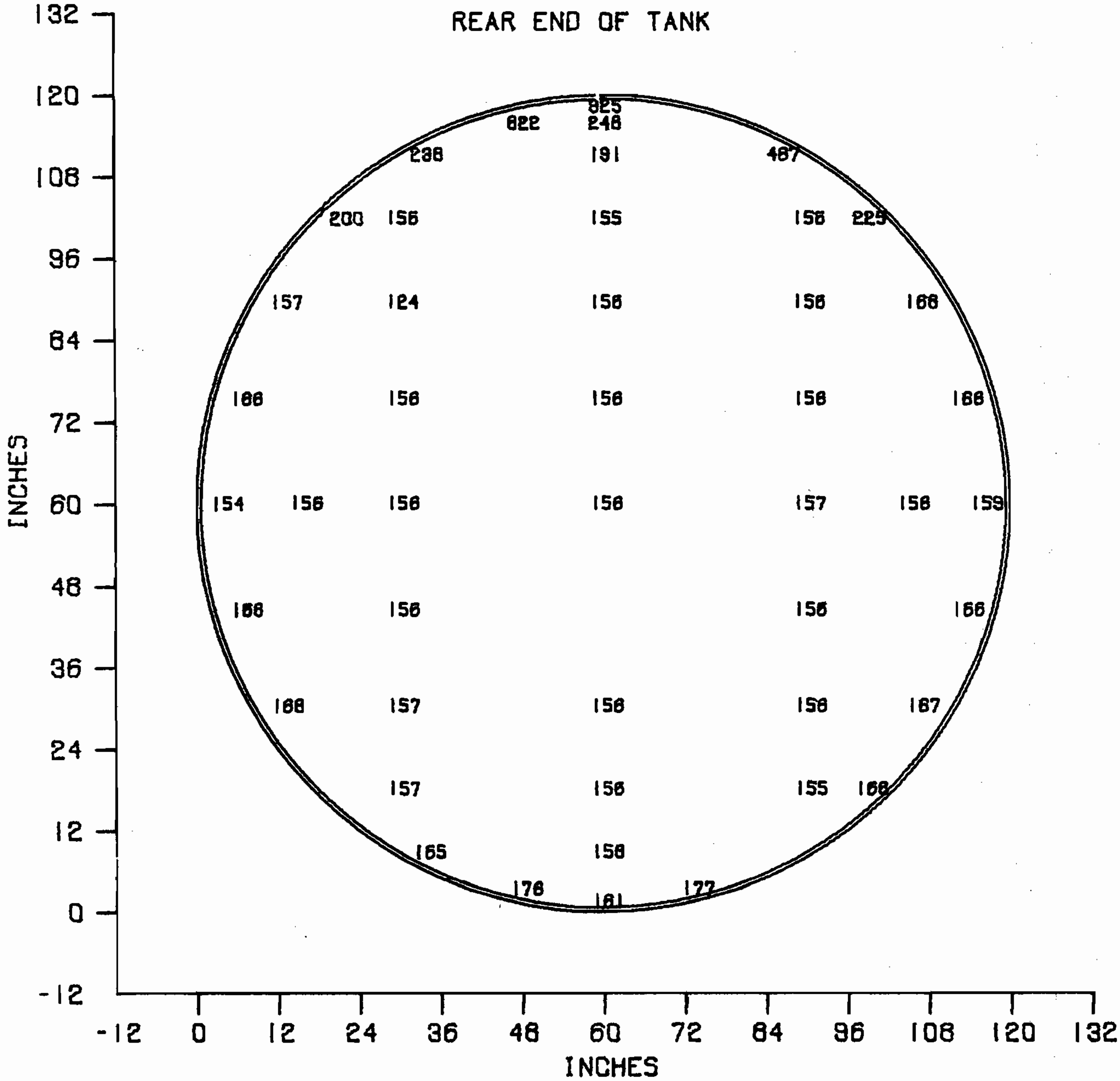

FIGURE B 57 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 930 SECONDS FROM IGNITION FOR TEST NR. 6

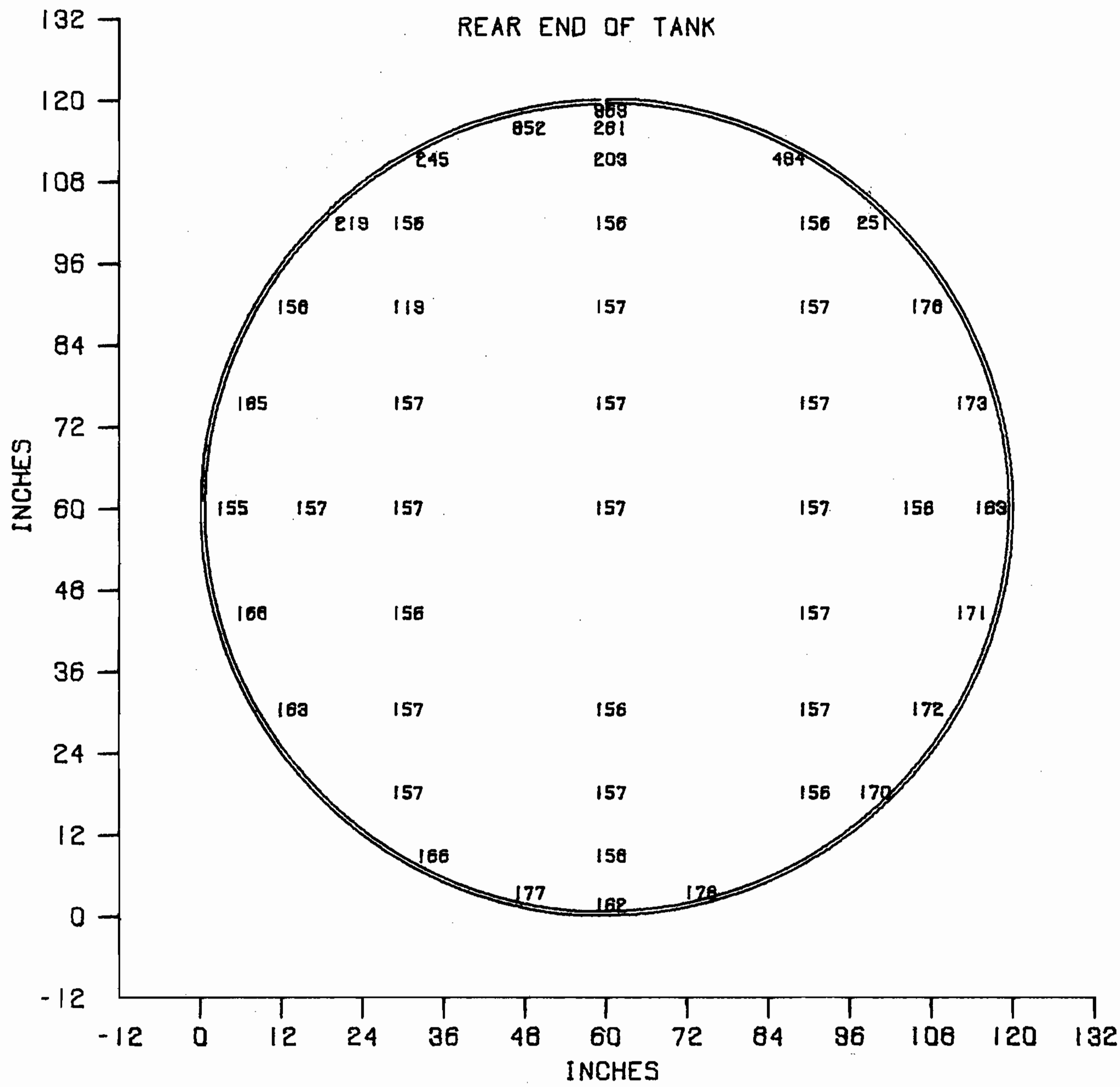

FIGURE B 58 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 972 SECONDS FROM IGNITION FOR TEST NR. 8

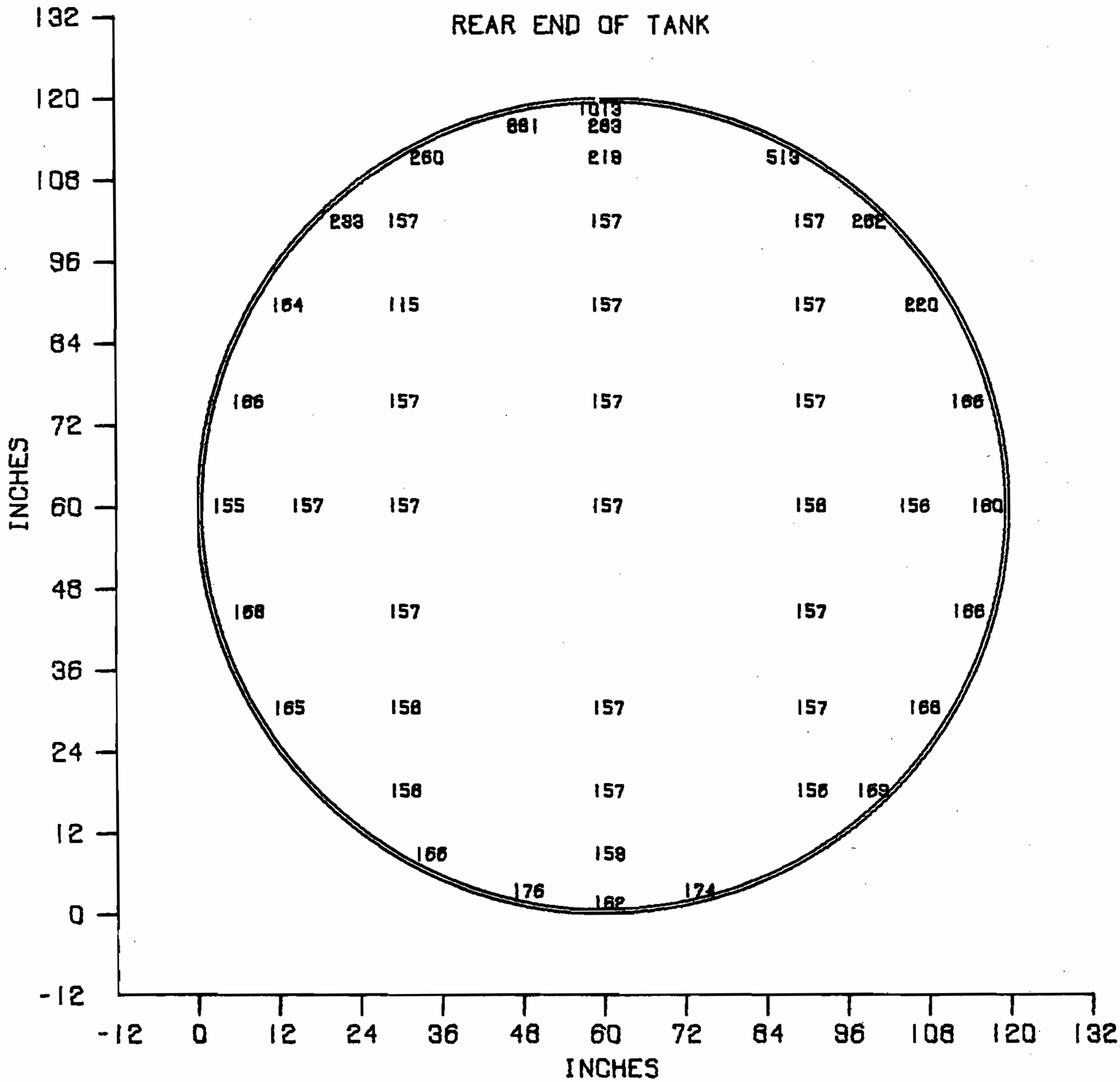

FIGURE 59 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 1015 SECONDS FROM IGNITION FOR TEST NR. 8

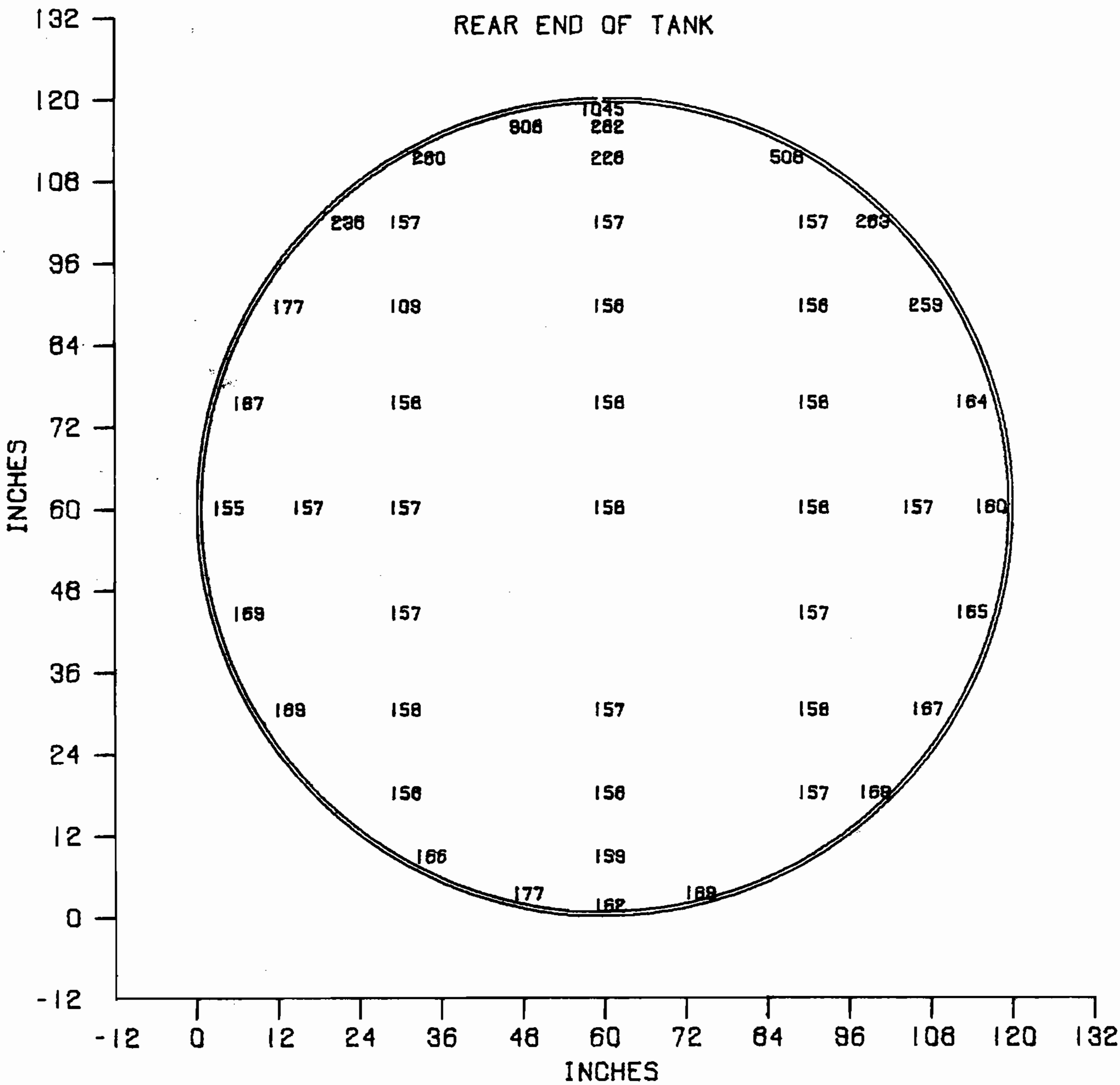

FIGURE B 60 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 1057 SECONDS FROM IGNITION FOR TEST NR. 8

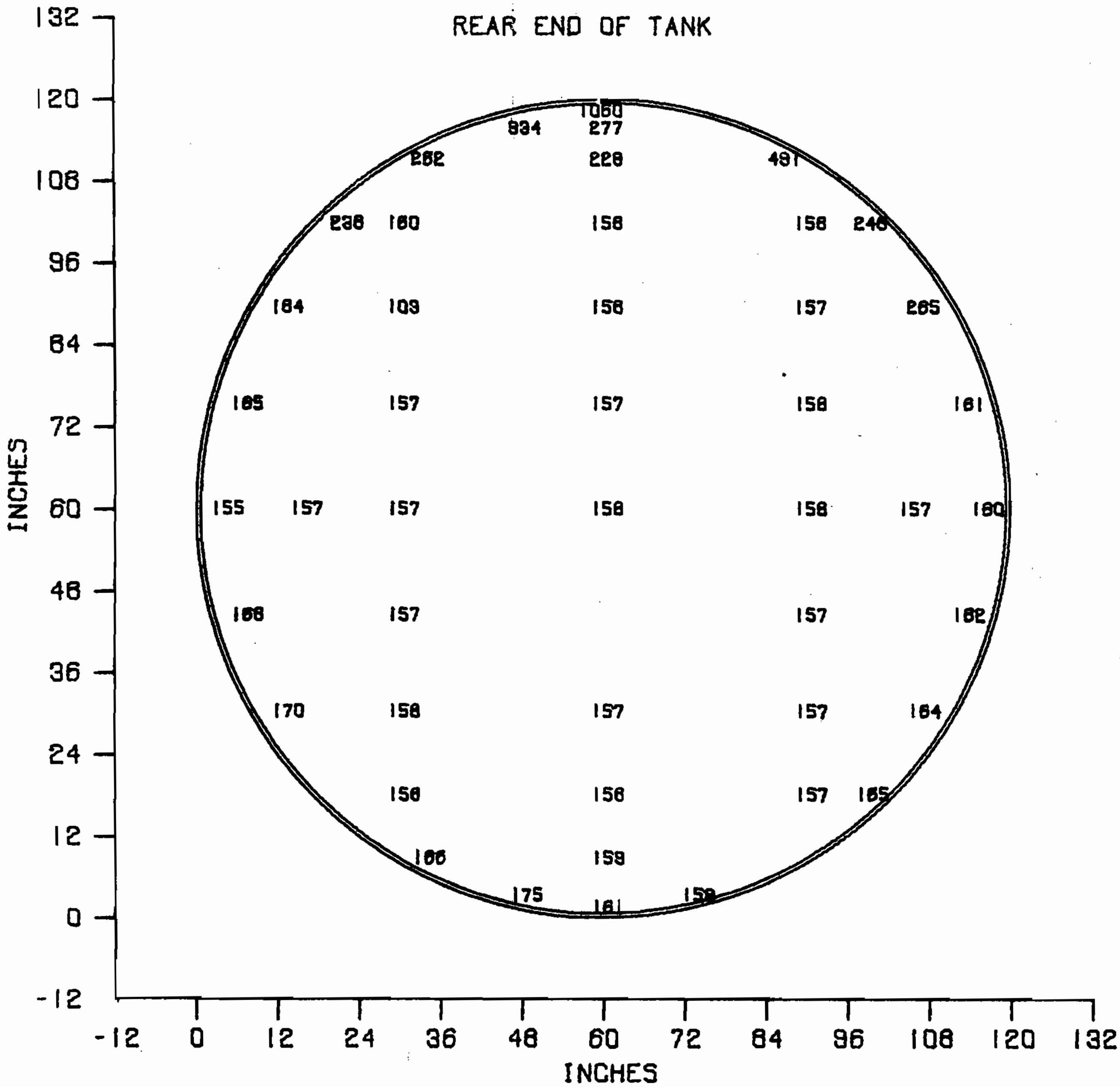

FIGURE B 61 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 1099 SECONDS FROM IGNITION FOR TEST NR. 8

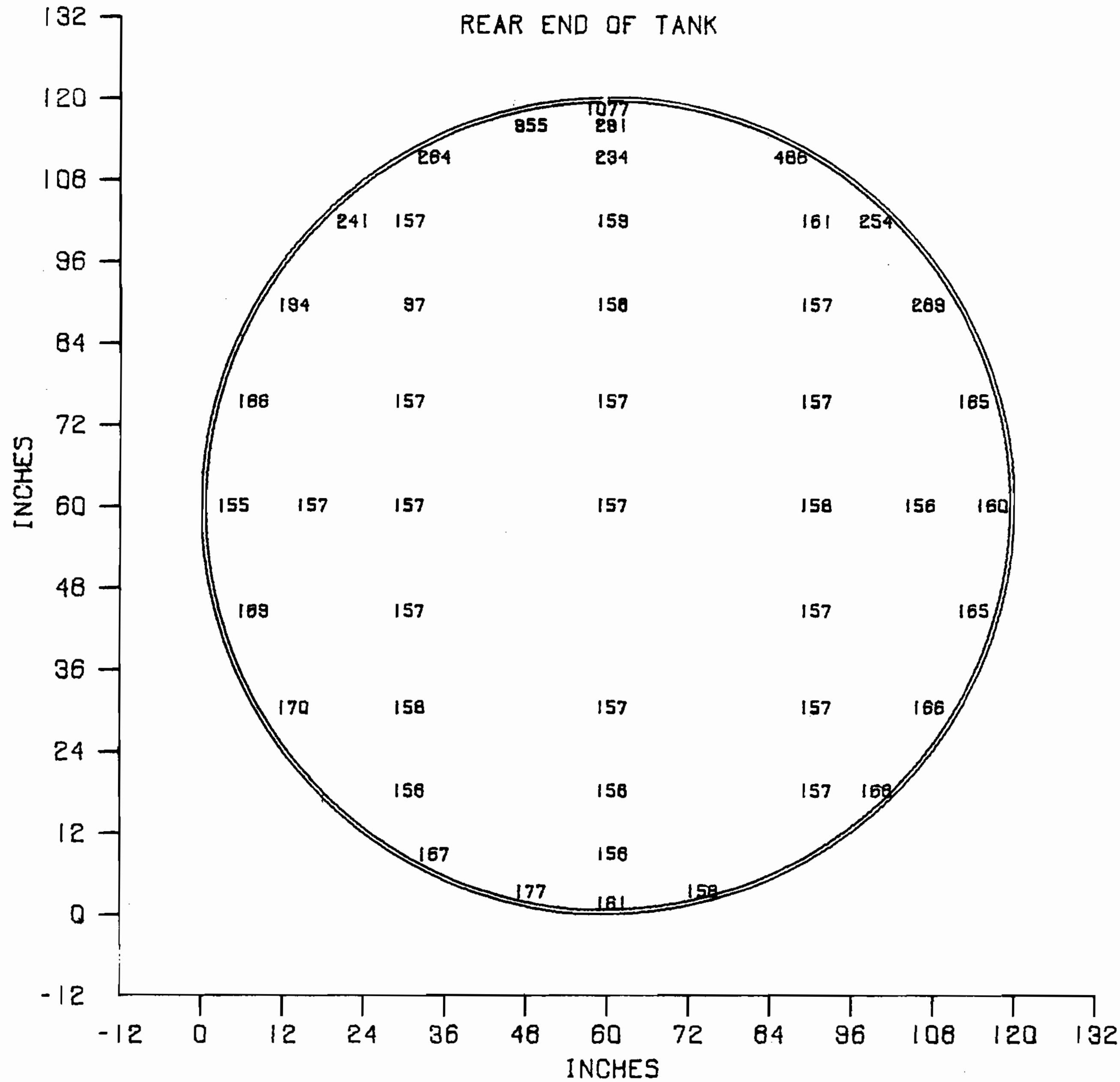

FIGURE B 62 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 1142 SECONDS FROM IGNITION FOR TEST NR. 8

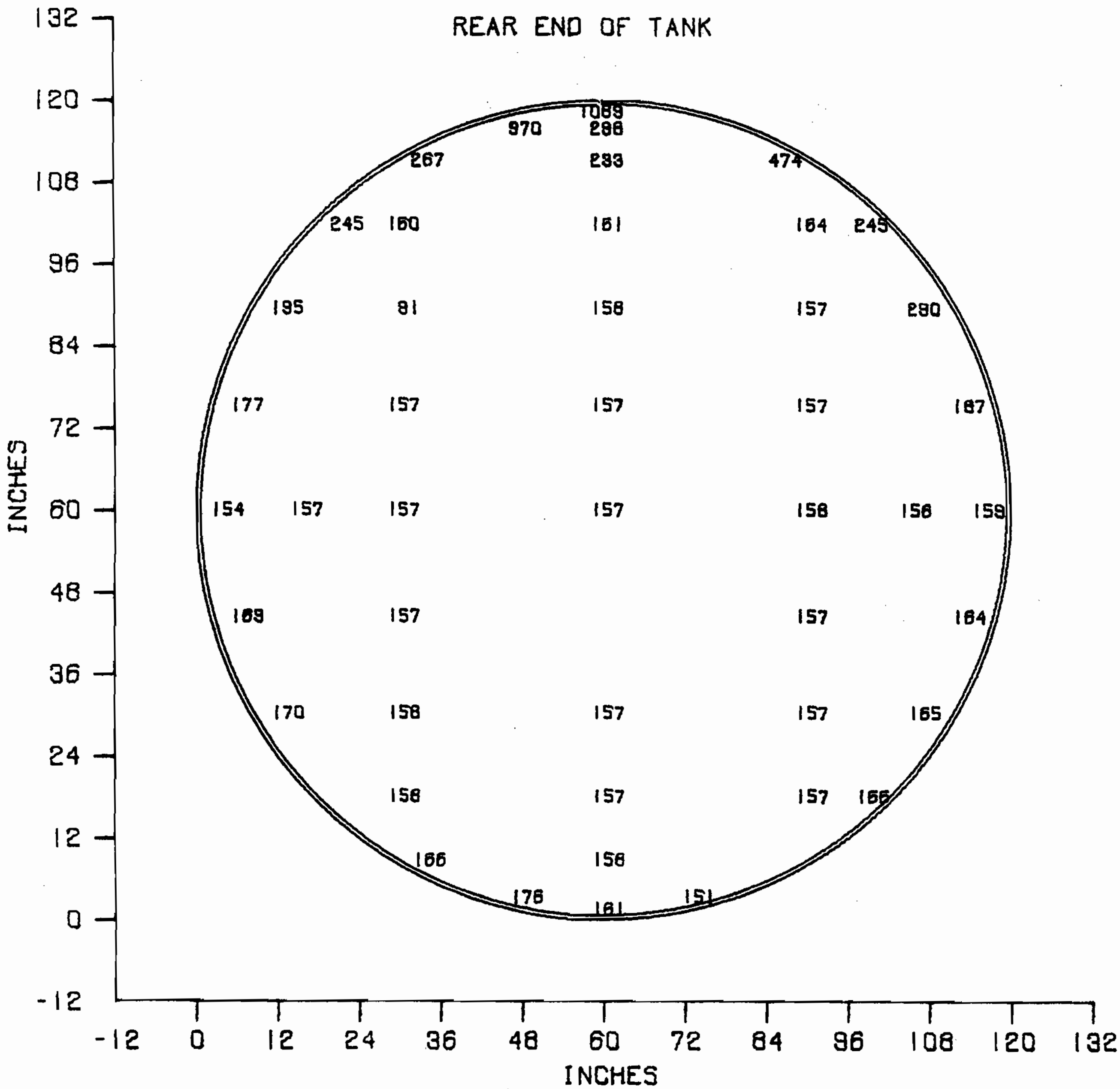

FIGURE B 63 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 1164 SECONDS FROM IGNITION FOR TEST NR. 8

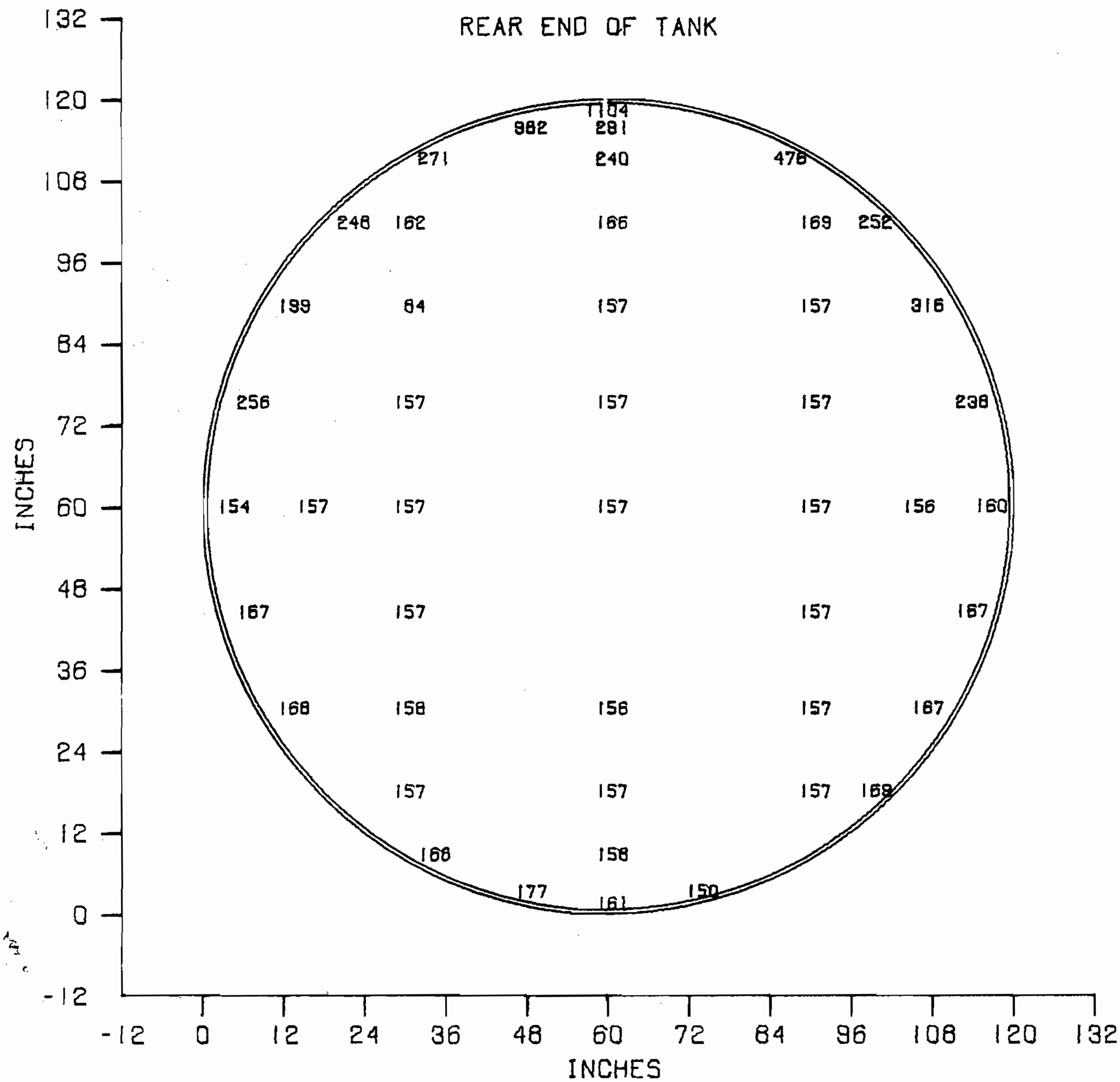

FIGURE B 64 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 1226 SECONDS FROM IGNITION FOR TEST NR. 8

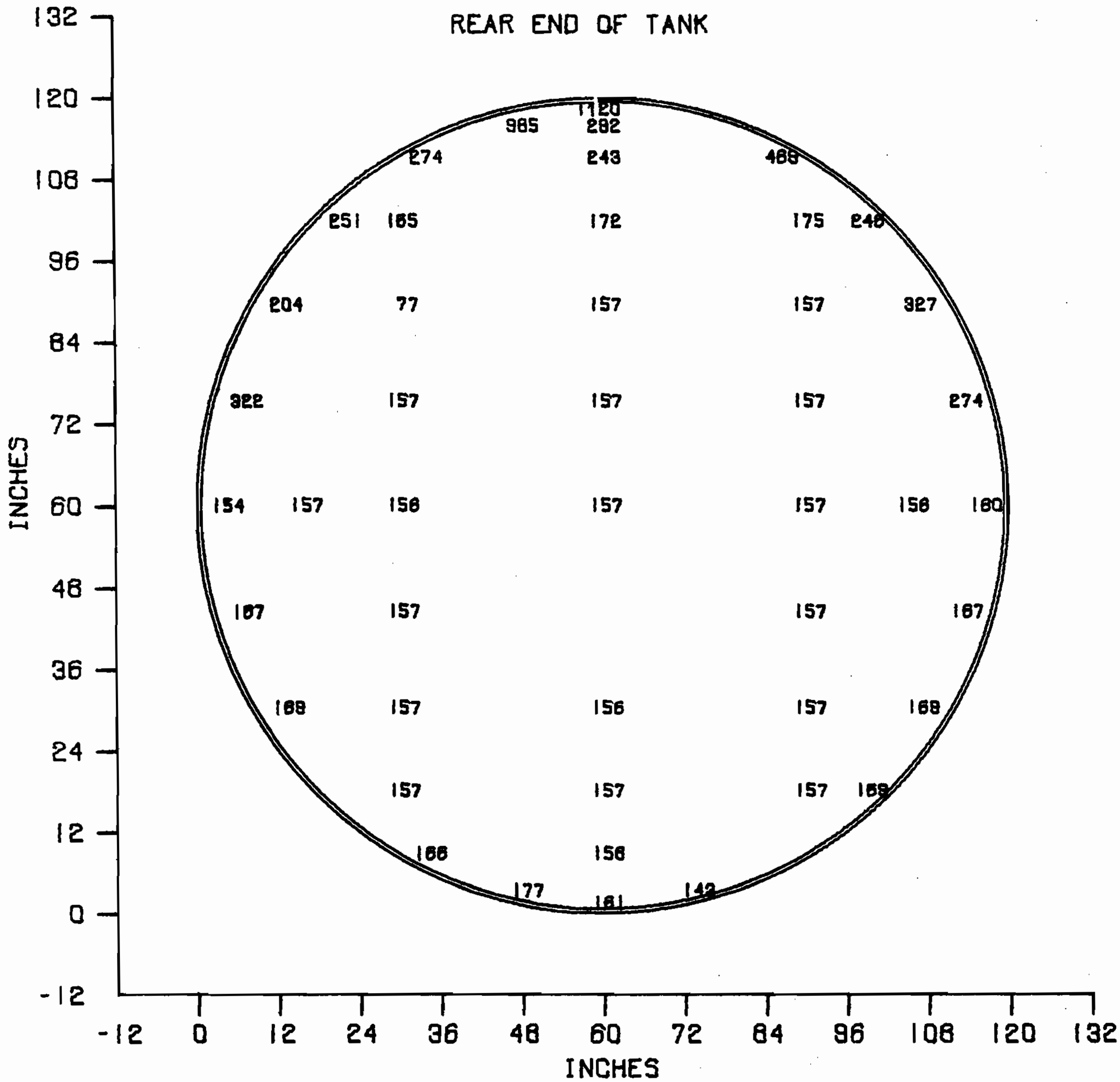

FIGURE B 65 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 1269 SECONDS FROM IGNITION FOR TEST NR. 8

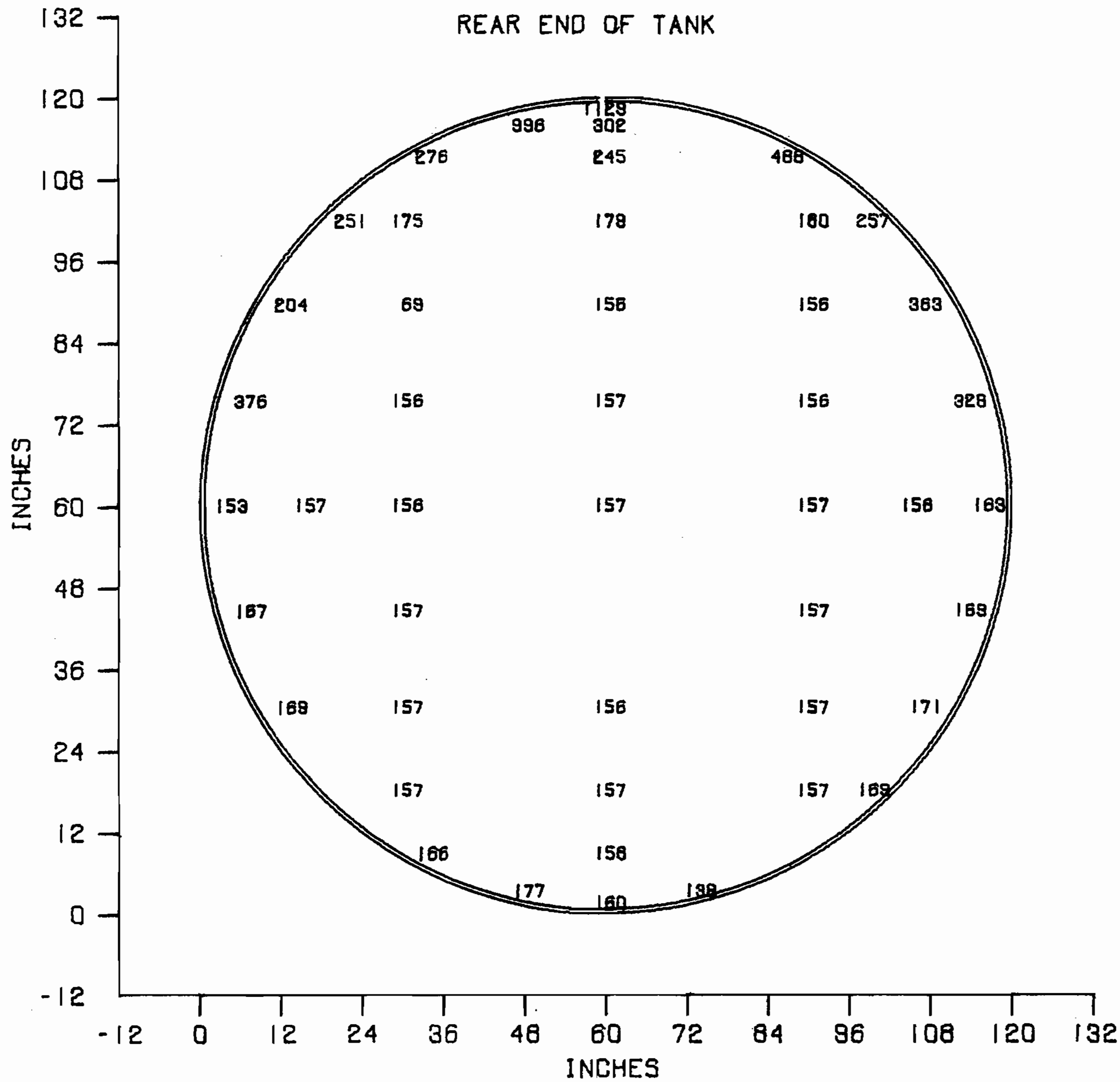

FIGURE B 66 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 1311 SECONDS FROM IGNITION FOR TEST NR. 8

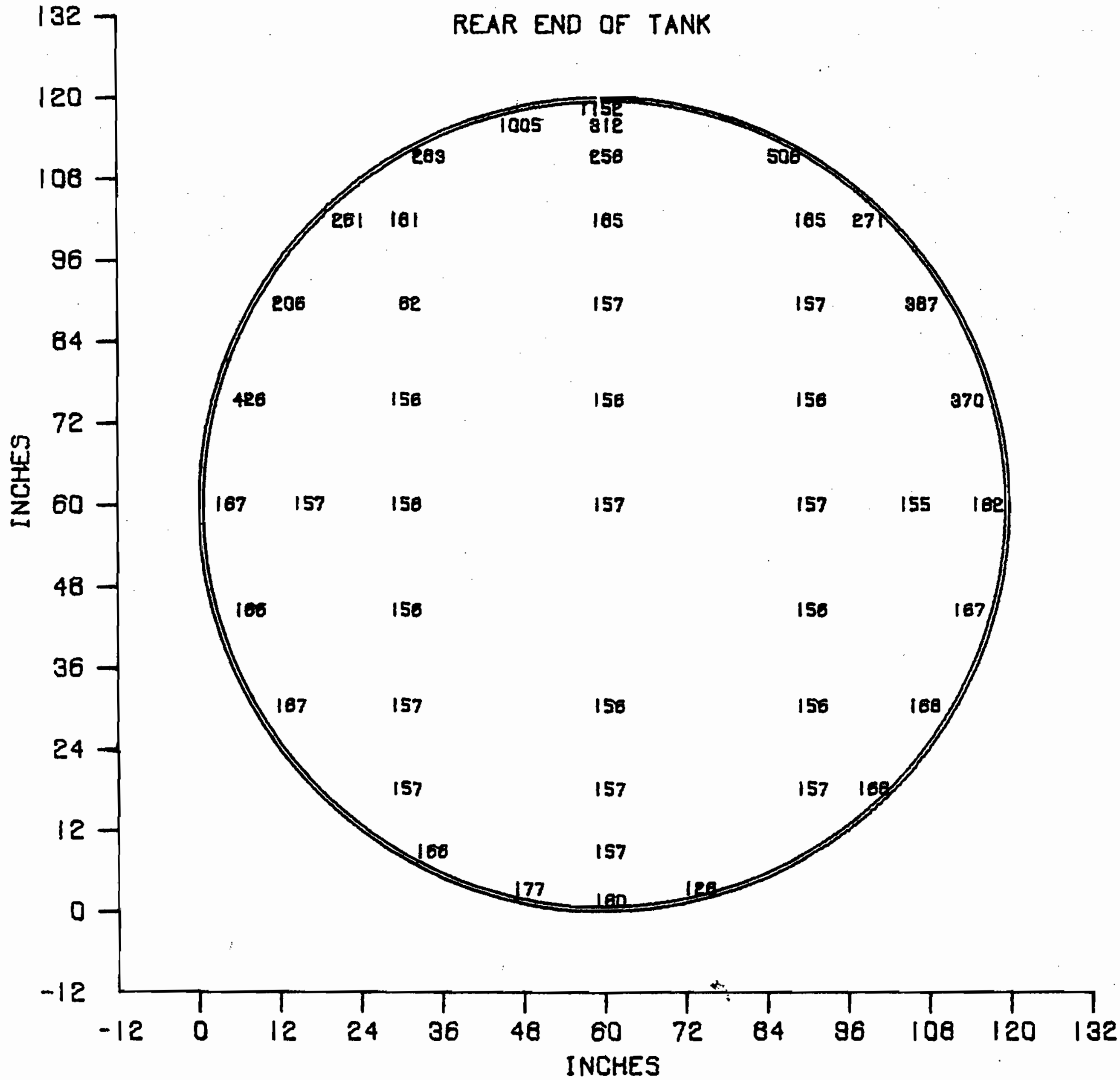

FIGURE B 67 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 1353 SECONDS FROM IGNITION FOR TEST NR. 8

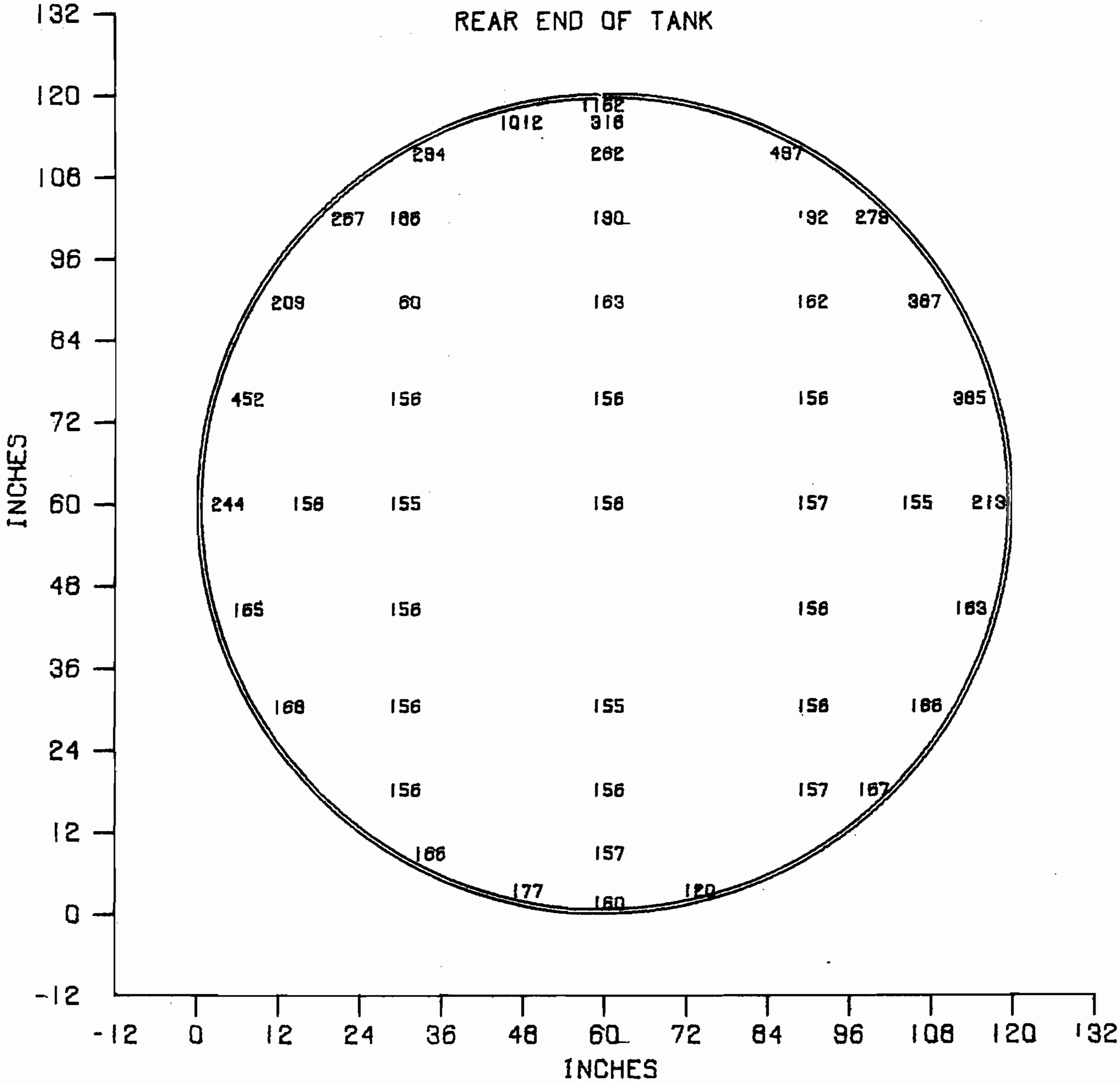

FIGURE B 68 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 1395 SECONDS FROM IGNITION FOR TEST NR. 8