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RAILROAD TANK CAR FIRE TEST: TEST NO.6

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FINAL REPORT

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16. Abstract

The Department of Transportation is conducting an extensive research program designed to develop methods to minimize personal injury and damage to property caused by fire from ruptured railroad tank cars filled with hazardous materials. The Ballistic Research Laboratories were requested by the Department of Transportation to conduct a series of field tests with scaled model and standard size railroad tank cars. The test described in this report is one of the scaled model series which had no thermal protective coating, and where the relief valve was turned ninety degrees from the vertical.

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I. INTRODUCTION

The Department of Transportation is conducting an extensive research program designed to develop methods to minimize personal injury and property damage caused by fire from ruptured railroad tank cars filled with hazardous materials. The Ballistic Research Laboratories (BRL) were requested by the Department of Transportation to conduct a series of field tests with scaled model and standard size railroad tank cars.

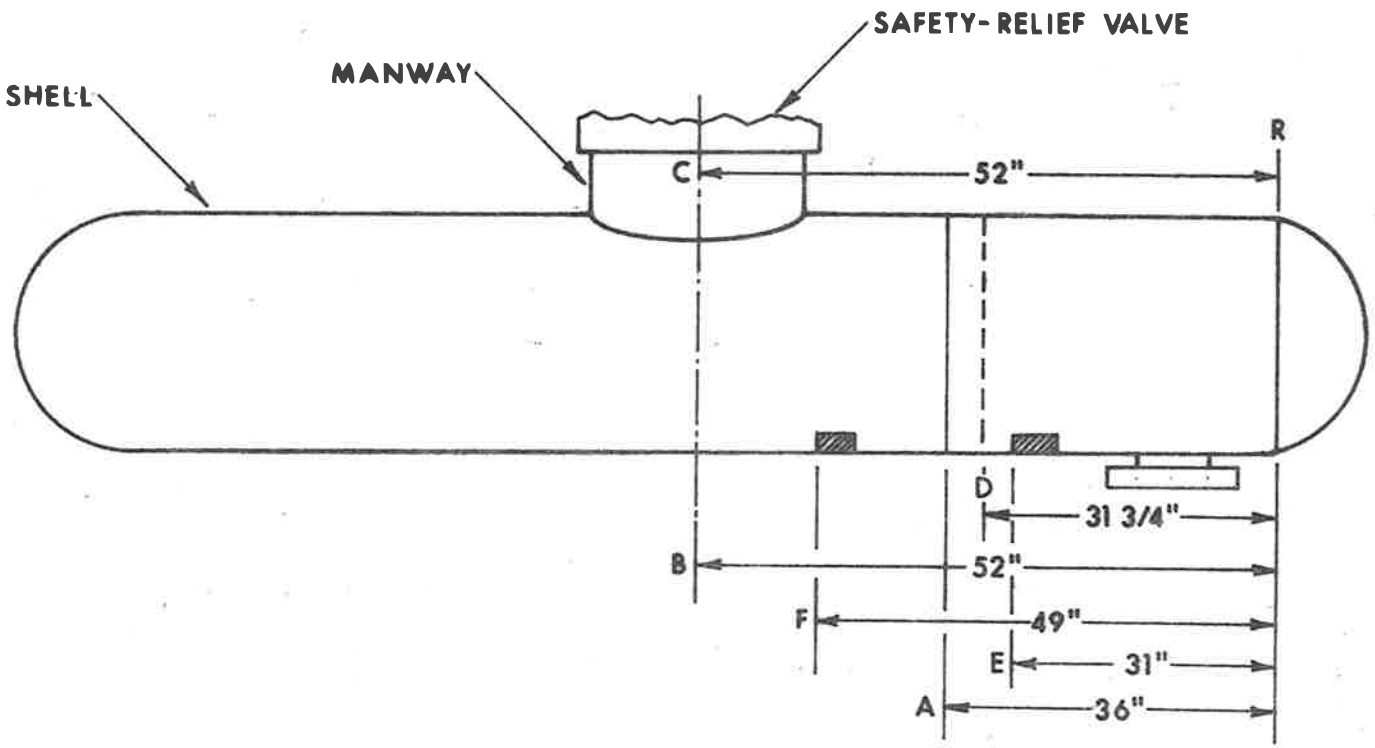
The basic situation under investigation is that of a railroad tank car filled with liquid propane. The tank car is not perforated, but it is engulfed in a large external fire. The intensive heat of the fire is conducted through the tank car's shell and into the propane lading. The burst strength of the tank car shell is significantly reduced by the elevated temperatures and this, in combination with the increase in internal pressure, can rupture the tank car shell, thus creating one of the severe conditions which often results in injuries and extensive property damage.

II. OBJECTIVES

The primary objective of the overall research program sponsored by the Department of Transportation is to develop procedures for preventing or delaying the rupture of pressurized railroad tank cars. The Ballistic Research Laboratories have been assigned the mission of instrumenting and obtaining data from a tank car in a fire environment; and then analyzing these data to investigate and determine the failure modes of a tank car, and to develop a theoretical model of the tank car problem.

In particular, for the one-fifth scale model tests, the rate and mechanism of heat transfer into the lading is being investigated. Secondly, these tests are intended to yield information for the development of appropriate test procedures and instrumentation for use on a full scale tank car test. And thirdly, the operation of the safety relief valve is under investigation.

For the specific test reported herein, the safety relief valve was located 90° to the perpendicular. This simulated the condition of a tank car that has derailed and rolled over on its side, and hence, an objective of this test was to observe the operation of the safety relief valve while it was venting liquid propane, rather than the vapor.



A – INNER WALL THERMOCOUPLE PLANE
B – FIRE TEMPERATURE THERMOCOUPLES
C – MANWAY THERMOCOUPLES
D – GRID THERMOCOUPLE PLANE
E – FRONT FACE OF PRESSURE GAGE #1
F – FRONT FACE OF PRESSURE GAGE #2
R – REFERENCE PLANE

Figure 1 - Test No. 6 - Relative Locations of Thermocouples and Pressure Gages.

III. TEST PROCEDURE

The procedure consisted of simulating real conditions by engulfing a propane filled model of the railroad tank car in an intensive fire and recording data that described important aspects of the test.

The model was mounted on a stand and above a pool of JP-4 jet fuel. The JP-4 jet fuel, which provided the energy source for the exterior fire, was contained in a pit thirty feet by thirty feet and one foot in depth. The height of the tank car model above the surface of the pool was three feet. The test was performed inside an excavation which was fifty feet by fifty feet and twelve feet deep.

The JP-4 jet fuel burned at a rate of about one-third inch per minute. A four inch pipeline fed additional fuel into the pit from a 30,000 gallon storage tank located 570 feet from the excavation. The fuel flow rate was controlled remotely so that a minimum of four inches of fuel remained in the pit during the test.

A one-fifth scaled model tank car with no thermal protective coating was used. Its dimensions were twelve feet (3.658m) in length and two feet (0.6096m) O.D. The steel shell was 0.625 inches (1.588 cm) thick and was not scaled from the full size tank car. The same thickness of steel was used for the model so that the test could simulate the heat flux into a real tank car.

A manway was located at the top of the tank car model, centered lengthwise similar to the standard tank car. The safety relief valve (Midland Model A-3480), one loading valve, a vapor valve, and a gauging device were located in the manway cover. A steel dome was bolted overtop the manway.

The tank car model and the propane lading were provided by the Railway Progress Institute - Association of American Railroads.

IV. INSTRUMENTATION

Since the damage mechanism is the heat transferred from the exterior fire to the lading, measurements of temperature were essential. The model tank car was instrumented with chromel-alumel thermocouples; these were placed on the interior wall of the tank shell (inner wall thermocouples), in the manway (manway thermocouples), and in the lading (grid thermocouples). The inner wall thermocouples were installed by enclosing them in a copper bead and potting them with Saureisen cement. The thermocouples in the lading were dipped in the Saureisen cement and then placed in a grid network. In addition, four thermocouples

were located outside and at a distance of six inches from the tank model. These four thermocouples (fire thermocouples) measured the temperatures of the external fire and they were located at 0°, 90°, 180°, and 270° with respect to the top of the tank car.

The thermocouples were generally positioned in planes which cut perpendicularly through the model. The schematic drawing in Figure 1 shows a side view of the relative locations of the thermocouples. All positions are shown relative to a reference plane indicated by R, and located to the right of the diagram. The numbers shown give distances measured in inches from the reference plane. Figure 2 presents a cross-sectional view of the tank car model and the relative locations of the grid thermocouples. Each thermocouple is numbered for identification (Vidar channel number) and this number is indicated in the appropriate position. The shaded circles in the diagram indicate those thermocouples which were placed inside a radiation shield. Figure 2 also presents a scheme for denoting the location of the inner wall thermocouples and the fire thermocouples. Twelve o'clock (12:00) indicates the vertical direction, and then the other positions are relative to this and are denoted by numbers proceeding clockwise around the circumference.

Two calorimeters were placed in the exterior fire to obtain heat flux values. The "copper kettle" calorimeter bottle furnished by the Railway Progress Institute measured the temperature rise of a specific quantity of water by using a thermocouple. The other calorimeter, called the heat flux calorimeter, measured a temperature difference between two points inside the calorimeter housing.

The safety relief valve is designed to vent when the interior pressure increases beyond a predetermined pressure due to heating. The operation of this valve and its effect on the test were included, and therefore, during the test, the lift of the valve and the interior tank pressure were measured. Figure 1 shows the relative positions of the two CEC Pressure Gauges. Two Linear Differential Transformer Devices were installed to measure the lift of the valve. The data from the two pressure gauges and the two LDT devices were recorded on a Brush Instrument Pen Chart Recorder.

The thermocouples and teflon coated wires from the other instruments were welded to the extension wires which were fed through an underground conduit system leading from the test area to an instrumentation bunker (900 feet from the excavation) which contained all of the recording equipment. The data from the thermocouples (i.e. the emf readings) and the data from the two calorimeters were recorded digitally on a magnetic tape using a Vidar recording system. Tables I, II, and III

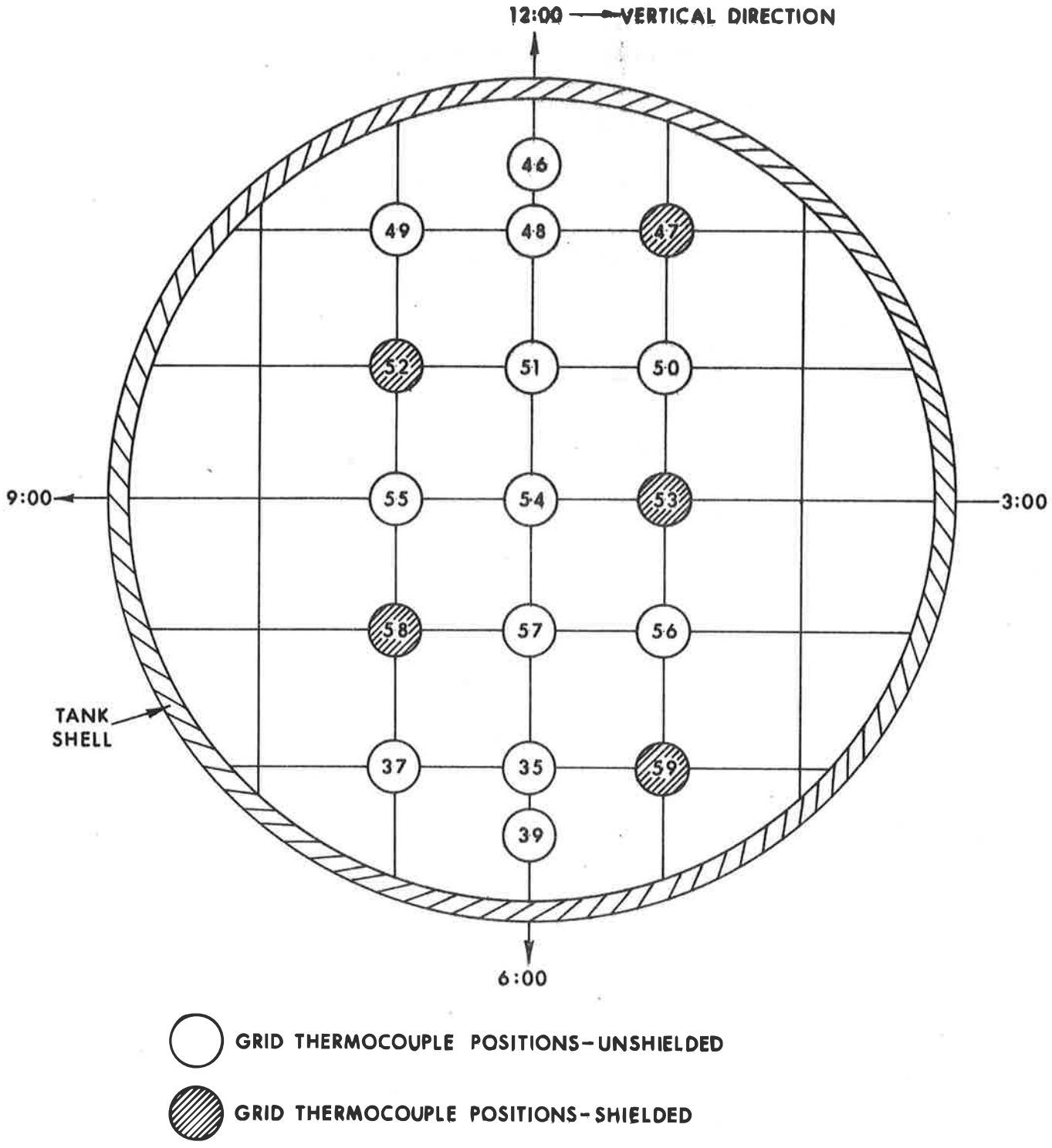


Figure 2 Test No. 6- Relative Positions of Grid Thermocouples.

TABLE I

TEST NO. 6 - INNER WALL THERMOCOUPLES

POSITION	VIDAR CHANNEL NUMBER	POSITION	VIDAR CHANNEL NUMBER
12:00	18	6:00	37
1:00	20	7:00	36
1:30	22	7:30	38
2:00	24	8:00	40
2:30	25	8:30	41
3:00	27	9:00	11
3:30	28	9:30	10
4:00	29	10:00	14
4:30	31	10:30	15
5:00	33	11:00	17

TABLE II

TEST NO. 6 - GRID THERMOCOUPLES

POSITION (Inches from Top)	VIDAR CHANNEL NUMBER	POSITION (Inches from Top)	VIDAR CHANNEL NUMBER
1.0	46	11.2	55
3.15	47	15.2	56
3.15	48	15.2	57
3.15	49	15.2	58
7.15	50	19.2	59
7.15	51	19.2	35
7.15	52	19.2	37
11.2	53	21.45	39
11.2	54		

TABLE III

TEST NO. 6 - THERMOCOUPLES AND HEAT FLUX GAUGES

MANWAY

POSITION	VIDAR CHANNEL NUMBER
1" From Top	42
4" " "	43
7" " "	44
10" " "	45

FIRE

12:00	16
3:00	19
6:00	21
9:00	23

COPPER KETTLE

In Fire	32

HEAT FLUX CALORIMETER

In Fire	26

present the relative positions of the thermocouples and their respective vidar channel numbers.

V. PRETEST PREPARATION

After the tank car was instrumented and the "head end" welded on, it was moved to the pit and positioned on a stand. The manway was directed at the 3:00 position, with the wall on which the manway thermocouples were located in the uppermost position.

To test the operation of the safety relief valve, the model was pressurized with nitrogen. At 270 PSIG the valve opened and based on measurements from both position transducers, it was concluded that the valve opened 0.125" ± 0.010" (.318 cm ± .025 cm). After reducing the pressure to 200 PSIG, a locking bar was placed over the valve. The pressure was increased to 400 PSIG and retained for 24 hours, during which no leakage occurred. The pressure readings on the chart recorder compared well with a calibrated dial gauge located in the nitrogen feed line. The model was then vented to the atmosphere reducing the pressure to 20 PSIG of nitrogen. The 20 PSIG of nitrogen was retained until the propane was loaded into the tank car in order to ensure that no oxygen could enter. 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 three times to ensure that only propane would be in the tank during the test.

The model was loaded with 226 gallons of propane. The temperature of the propane was 41°F (5.0°C) and the internal pressure was 90 PSIG ± 10 PSIG. Vapor pressure of propane as a function of temperature is presented in Figure 3; the propane used in the test had the characteristics represented by the upper solid curve.

On 1 November, 1972, with the atmospheric wind conditions being calm, i.e. approximately 3 knots, the test was conducted. All instrumentation was operating satisfactorily according to pre-test analysis. At approximately 1928 hours the fire was ignited by firing four thermite grenades into the pit. Thermite grenades were used to insure a rapid build-up of the fire. After about sixty seconds, the safety relief valve opened; the sound of the valve venting reminded the test personnel of the sound of a steam engine.

VI. TEST RESULTS

The measurements from the thermocouples were recorded as the test proceeded. The recording process -- the Vidar recording system -- sampled each channel sequentially; the average time between adjacent samplings was 0.2177 seconds. Since 49 channels were used, a particular

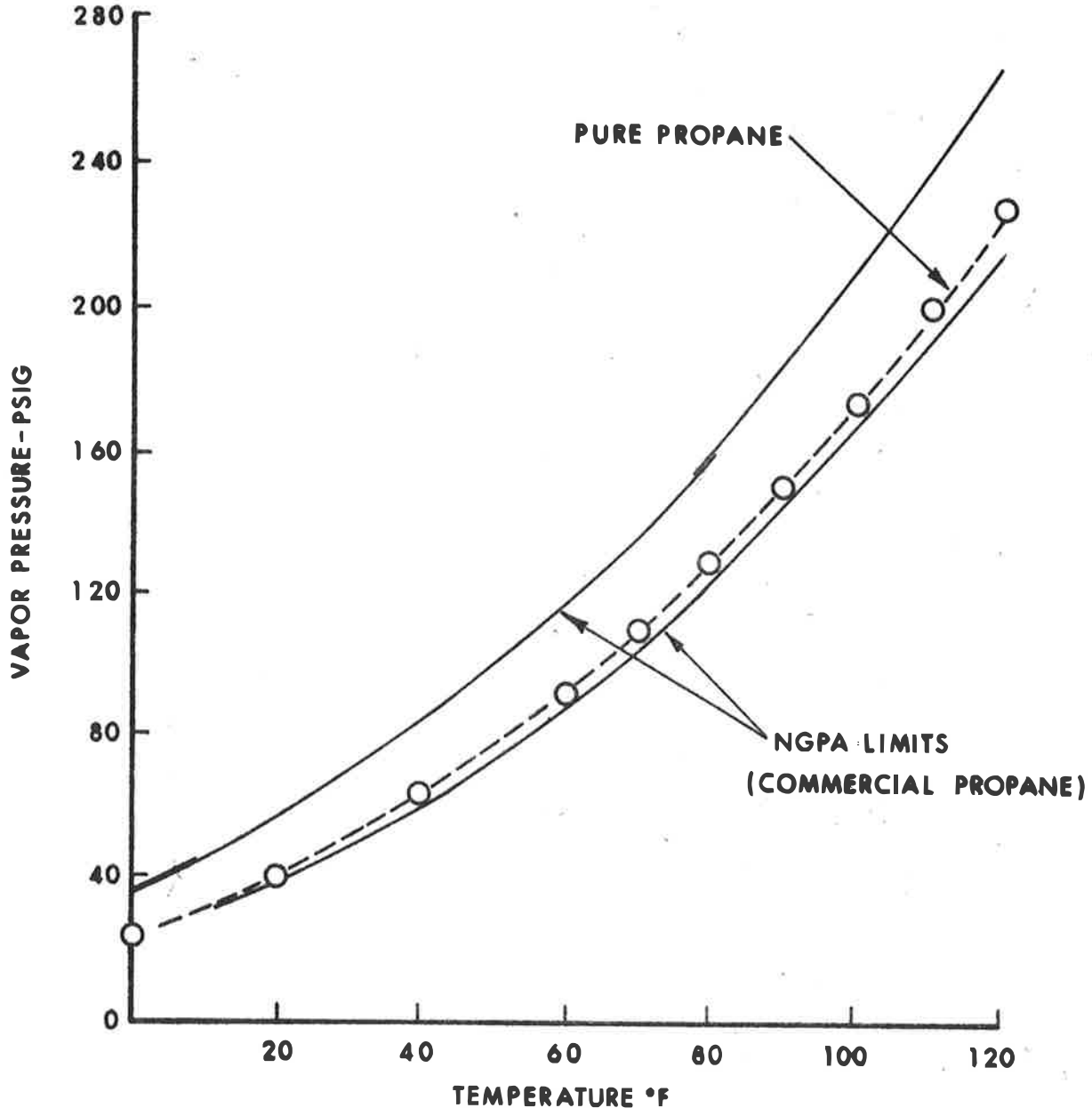


Figure 3 Vapor Pressure of Propane as a Function of Temperature

channel was sampled every 10.667 seconds. Figure 4 is an example of these data after they were converted to temperature and plotted as a function of time at the Ballistic Research Laboratories (BRL). All the pertinent information required to identify the data are included in the figure. Similar plots for all the thermocouples are presented in Appendix A. The actual temperature data for the first eighteen minutes are also presented in Appendix A in tabular form. Channel 10 of the Vidar unit was taken as the reference time, and the last column of each table gives the appropriate adjustment time for each of the other channels. For example, channel 46 records a datum point 7.84 seconds after a datum point was recorded by channel 10; hence, 7.84 seconds must be added to the time given in the column headings to get the actual time channel 46 was sampled.

Table IV gives the temperature data for 87 seconds before the fire was ignited. Upon inspection of these data, no stratification of temperature was apparent inside the tank at the start of the test.

Figure 5 is a scaled drawing of a cross-sectional view of the tank car, showing temperatures in ^{o}F for the grid thermocouples and the inner wall thermocouples at specific times. Again, channel 10 of the Vidar unit was taken for the reference times. Using the adjust times as given in Appendix A, all the other temperatures were adjusted to the reference times by a linear interpolation of the temperature versus time. Diagrams, such as Figure 5, are convenient for comparing temperatures at different positions in the test model at a given time; diagrams of this kind are presented in Appendix B over the entire time period of the test. The time values are measured from the instant of JP-4 fuel ignition. The numbers which are circled indicate those thermocouples which had the special radiation shield. Tables B-I and B-II tabulate the values of temperatures at these specific times in degrees Fahrenheit and degrees Centigrade, respectively.

The fire heat flux values for the first 156 seconds are presented in Table V. The heat flux calorimeter failed after 156 seconds. No useful data were obtained from the copper-kettle calorimeter.

The pressure displacement data and the valve opening data as a function of time were recorded directly as the test progressed. Plots of these data are presented in Appendix C.

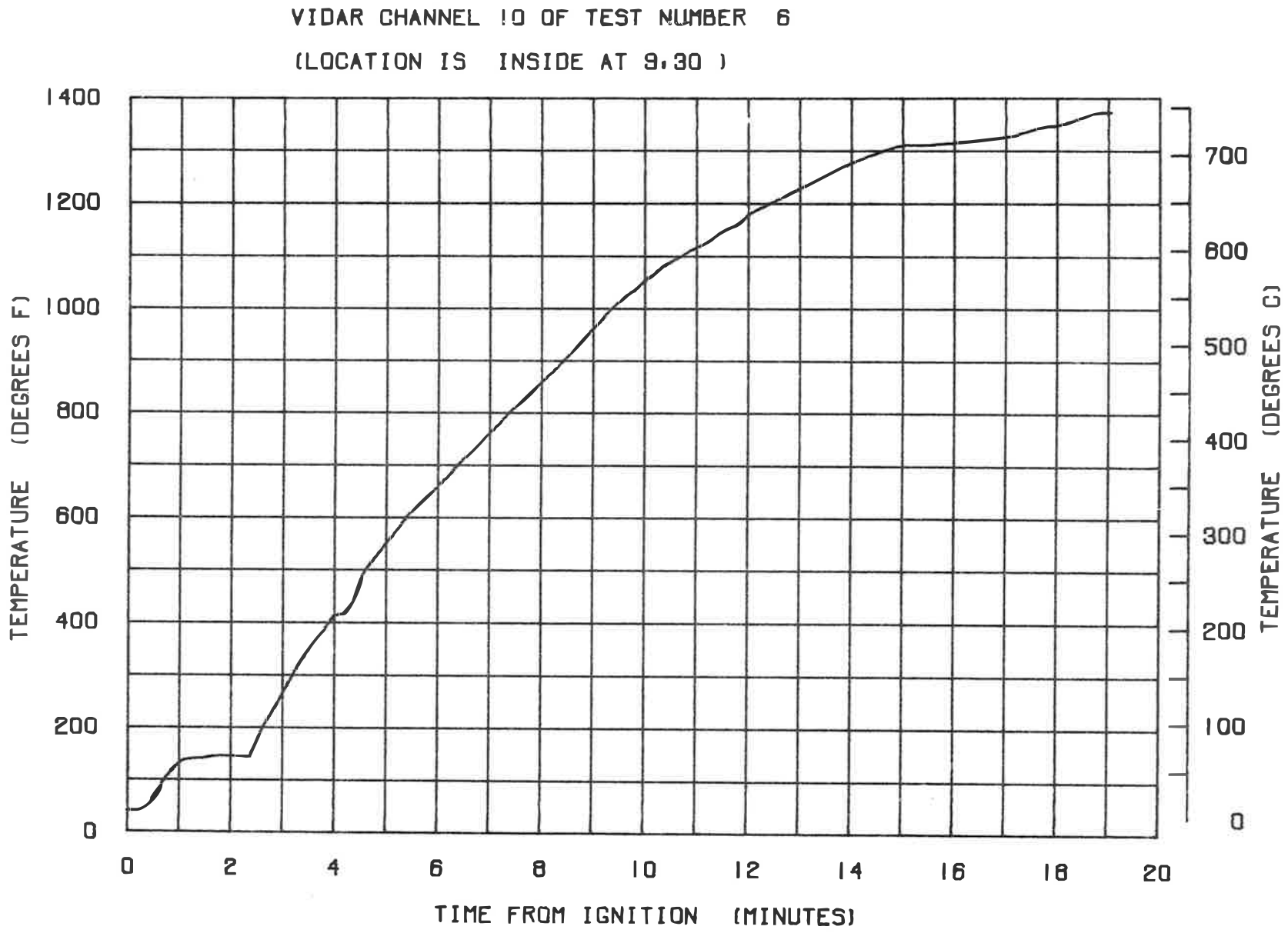


FIGURE 4 THERMOCOUPLE TEMPERATURE VS. TIME

TABLE IV

TEST NO. 6 - TEMPERATURES OF CENTER COLUMN OF GRID

THERMOCOUPLES BEFORE FIRE IGNITION

Time (sec)	Vidar Channel Number						
	46	48	51	54	57	35	39
-87	41.1	41.1	41.1	41.1	41.1	41.1	41.1
-76	41.0	40.7	39.1	39.2	41.5	41.1	41.2
-65	40.9	40.9	40.3	39.7	42.1	41.1	41.1
-54	41.0	41.1	41.6	41.6	45.4	40.8	41.0
-43	41.0	40.6	39.1	39.4	45.0	41.0	41.1
-33	41.0	40.8	39.7	42.1	43.7	40.8	41.1
-22	41.0	40.6	39.5	41.3	41.8	41.1	41.1
-11	41.0	40.6	38.9	40.5	41.6	41.0	41.0
Ignition	41.0	40.7	39.4	42.4	42.2	41.0	41.1

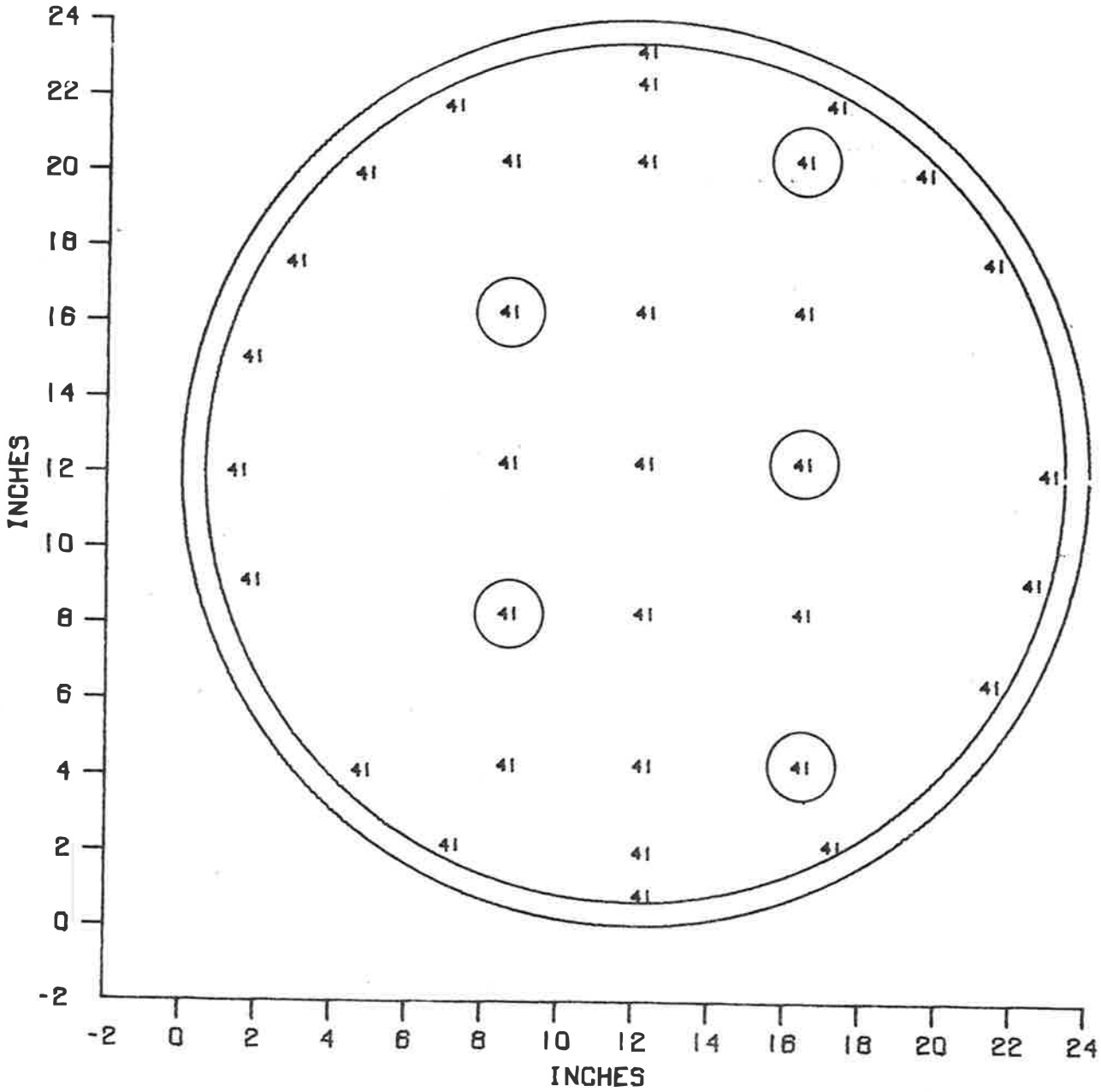


FIGURE 5 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 0 SECONDS FROM IGNITION FOR TEST NR. 6

TABLE V

TEST NO. 6 - HEAT FLUX DATA FROM CALORIMETER FOR FIRE ANALYSIS[1]

CYCLE No.	TIME (Sec)	HEAT FLUX
1	3.5	25,873
2	14.4	48,513
3	25.3	18,595
4	36.1	29,916
5	47.0	42,044
6	57.9	33,958
7	68.8	51,746
8	79.7	38,809
9	90.6	67,108
10	101.5	42,044
11	112.3	40,427
12	123.2	20,213
13	134.1	32,342
14	145.0	39,618
15	155.8	43,661
	Average	38,324

1. No data after 155.8 seconds were obtained due to calorimeter burnout.

VII. DATA ANALYSIS

The overall running time of the test, from ignition until the fire was allowed to die out, was about 20 minutes. The fire build-up was quite rapid, with the temperatures, as recorded by the four fire thermocouples, going from ambient temperatures to 200°F - 300°F (93.3°C - 148.9°C) in 10 seconds, to around 1200°F (648.9°C) in 20 seconds; and reaching the order of 1500°F (815.6°C) 30 seconds after ignition.

Because of the ambiguity of the data, it has not been ascertained as to precisely when the safety relief valve first opened. The pressure versus time data show four pressure variations between 45 and 47 seconds, but the valve displacement data indicate that the valve did not open. (The sensitivity of the linear differential transformer devices was about .001 inches (.0025 cm)). However, both the pressure readings and the valve opening data indicate that the valve definitely opened at 75 seconds after ignition.

To calculate the heat flux into the lading, it is necessary to know how the height of the liquid changed as a function of the time. It is possible to infer the height of the liquid propane by observing the temperatures of the inner wall thermocouples. For example, at the 9:30 position, the inner wall thermocouple (see Figure 4 or Figure A34) has a plateau in the neighborhood of 139°F (59.4°C). This temperature corresponds to saturated conditions for propane at 275 PSIG. The liquid propane is able to cool the wall, not allowing the inner wall temperatures to rise about the boiling temperature of the propane. However, since the propane vapor does not dissipate the heat very effectively, the inner wall temperatures rise rapidly upon being exposed to the vapor. Therefore, following the plateau, the temperature rises quickly, indicating that this portion of the wall is no longer in contact with the liquid.

Figure 6 presents a plot of the ratio of liquid volume to tank volume as a function of the angle to the liquid-vapor interface (refer to Figure D-1 in Appendix D). Using Figure 6, and the data from Table VI on the volume of the modeled tank car and the density of liquid propane at saturated conditions (275 PSIG), the weight of propane below the liquid level can be determined, and these data are presented in Figure 7.

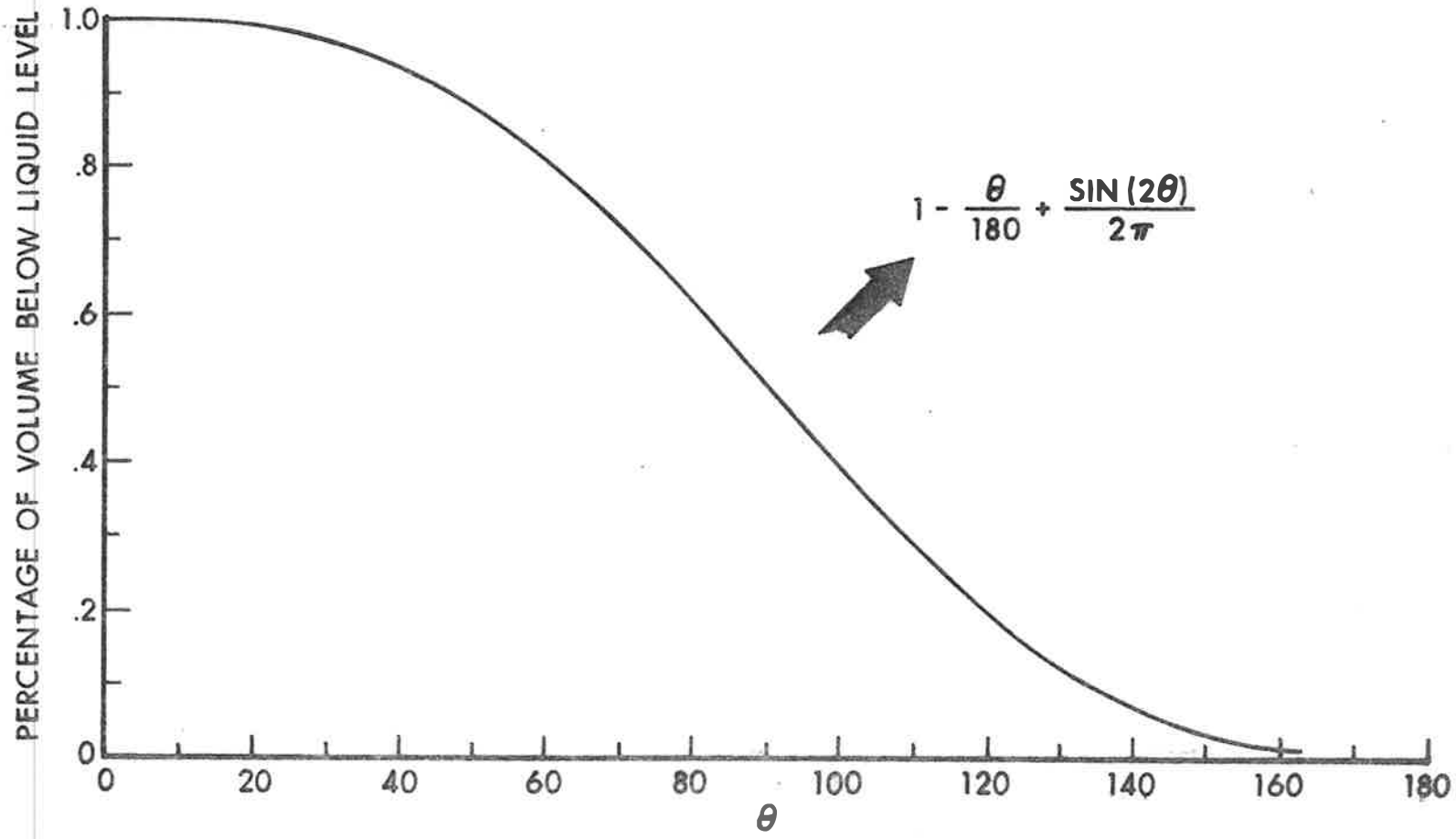


Figure 6. Percentage of Volume of Cylinder Below Liquid Level as a Function of θ.

TABLE VI

TEST NO. 6 - DATA FOR CALCULATIONS

1. Weight density of saturated liquid at $139^{o}F$, 275 PSIG - 27.32 lb/ft^3 (.4376 gm/cm^3)

2. Weight density of saturated vapor at $139^{o}F$, 275 PSIG - 3.0 lb/ft^3 (.0481 gm/cm^3)

3. Heat of vaporization of propane at $139^{o}F$, 275 PSIG - 117 BTU/lb (65 cal/gm)

4. Initial tank temperature $41^{o}F$ ($5.0^{o}C$)

5. Initial pressure reading 90 PSIG $\pm$ 10 PSIG

6. Volume of liquid propane pumped into tank 226 gallons

7. Volume of tank 33.35 ft^3 (.9444 m^3)

8. Inner wall surface area 70.36 ft^2 (6.537 m^2) (neglects area of ends)

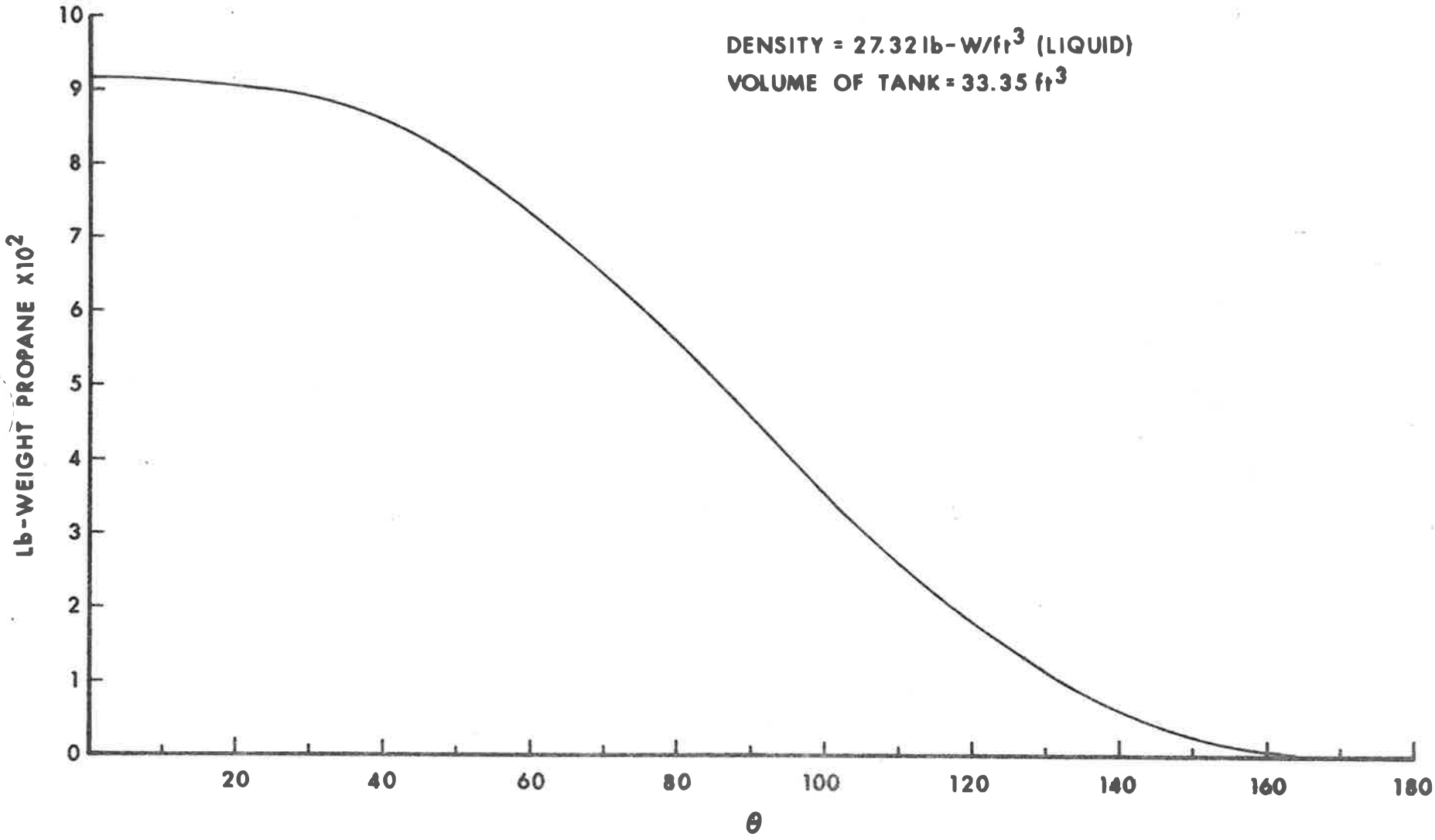


Figure 7 Lb-Weight of Propane Remaining as a Function of θ. For: 139°F (Saturated Conditions), 275 psig

Analysis of the test data allows the determination of the liquid height as a function of time. The height of the liquid, in terms of the angle to the liquid-vapor interface, is obtained from the "break times" of the inner wall thermocouples, i.e., the times at which the wall temperatures break from the 139°F(59.4°C) plateau and begin to rise rapidly. The break times for each of the inner wall thermocouples are listed in Table VII. Using these data, the angle to the liquid level as a function of time is plotted in Figure 8. Utilizing Figures 7 and 8, the weight of liquid propane remaining in the tank versus time is calculated and then plotted in Figure 9.

The heat flux into the propane can be calculated from Figure 9 using the formulation:

$$q = \frac{2Vh_v\rho_\ell}{S(t_2-t_1)} \int_{\theta_1}^{\theta_2} \frac{\sin^2\theta d\theta}{\pi - \theta}$$

where,

q = uniform heat rate per unit area into the lading (heat flux),

V = volume of the tank,

ρ_ℓ = density of the liquid,

h_v = latent heat of vaporization,

S = surface area of the tank

and θ_1, θ_2 = angles to the liquid level at times t_1 and t_2.

The derivation of this formula is given in Appendix D. The integral over θ can be done numerically, and for convenience, the values of the integral evaluated from the origin to an angle θ, for θ varying in 0.1 degree steps from 0° to 180°, are given in Appendix E. The numerical method for evaluating the integral was Simpson's rule with a relative error tolerance of 1.0×10^{-10}.

This formula assumes that the heat flux into the tank is going completely into vaporizing the liquid propane, and that the heat is being transmitted only through the surface area wetted by the liquid. Hence, this formulation can only be applied when all of the liquid propane has been heated to its boiling temperature, i.e., no heat is

TABLE VII

TEST NO. 6 - BREAK TIMES FOR TEMPERATURE PLATEAU FROM INNER WALL THERMOCOUPLES

POSITION	BREAK TIME OF PLATEAU (Min.)		POSITION
12:00	No Plateau		
1:00	1.8	1.5	11:00
1:30	No Plateau	1.65	10:30
2:00	2.05	2.0	10:00
2:30	x	2.4	9:30
3:00	2.55	2.3	9:00
3:30	3.0	2.9	8:30
4:00	3.6	x	8:00
4:30	x	4.25	7:30
5:00	5.0	4.9	7:00
6:00	5.75		

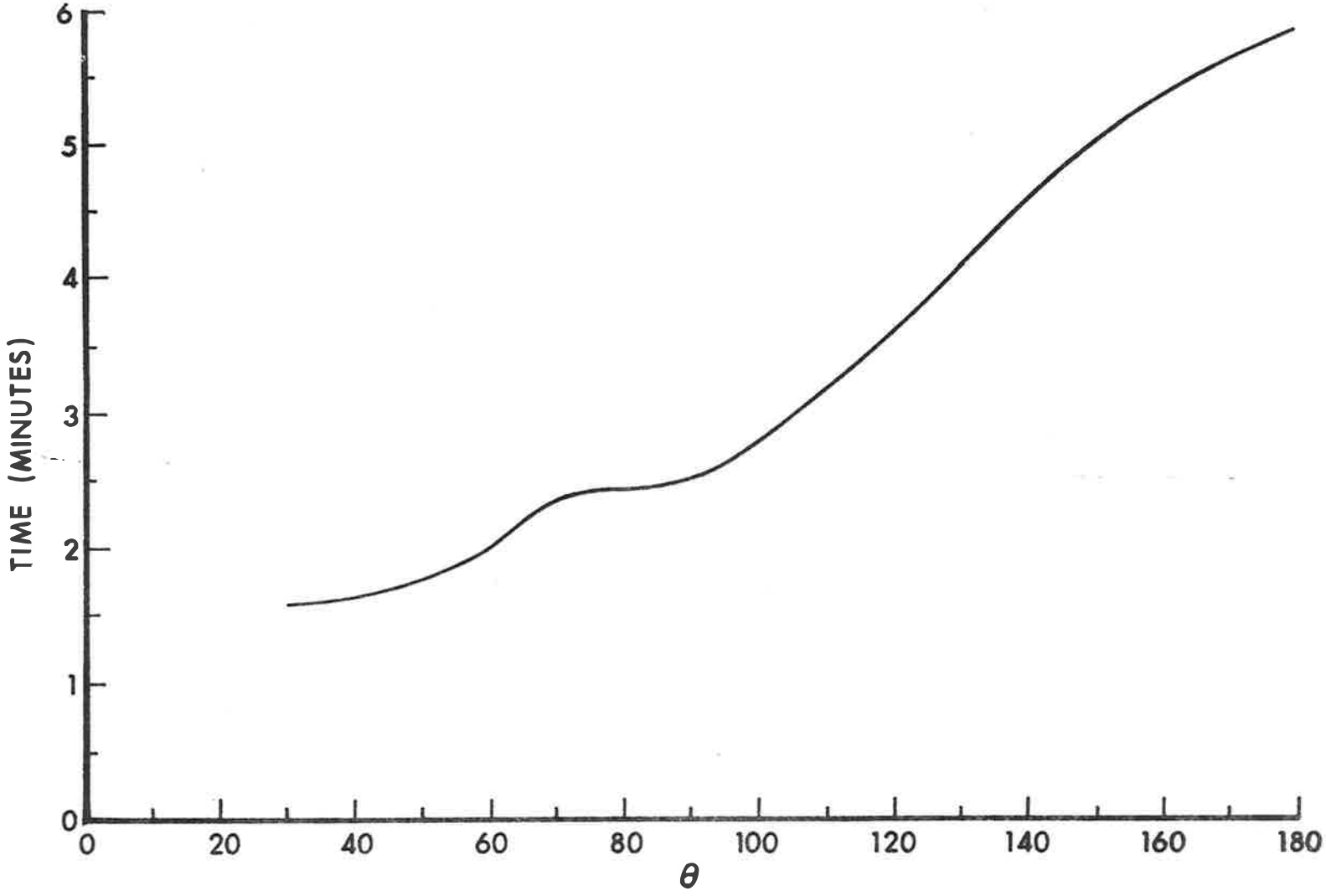


Figure 8. Test No. 6: Liquid Level as a Function of Time (From Inner Wall Thermocouples)

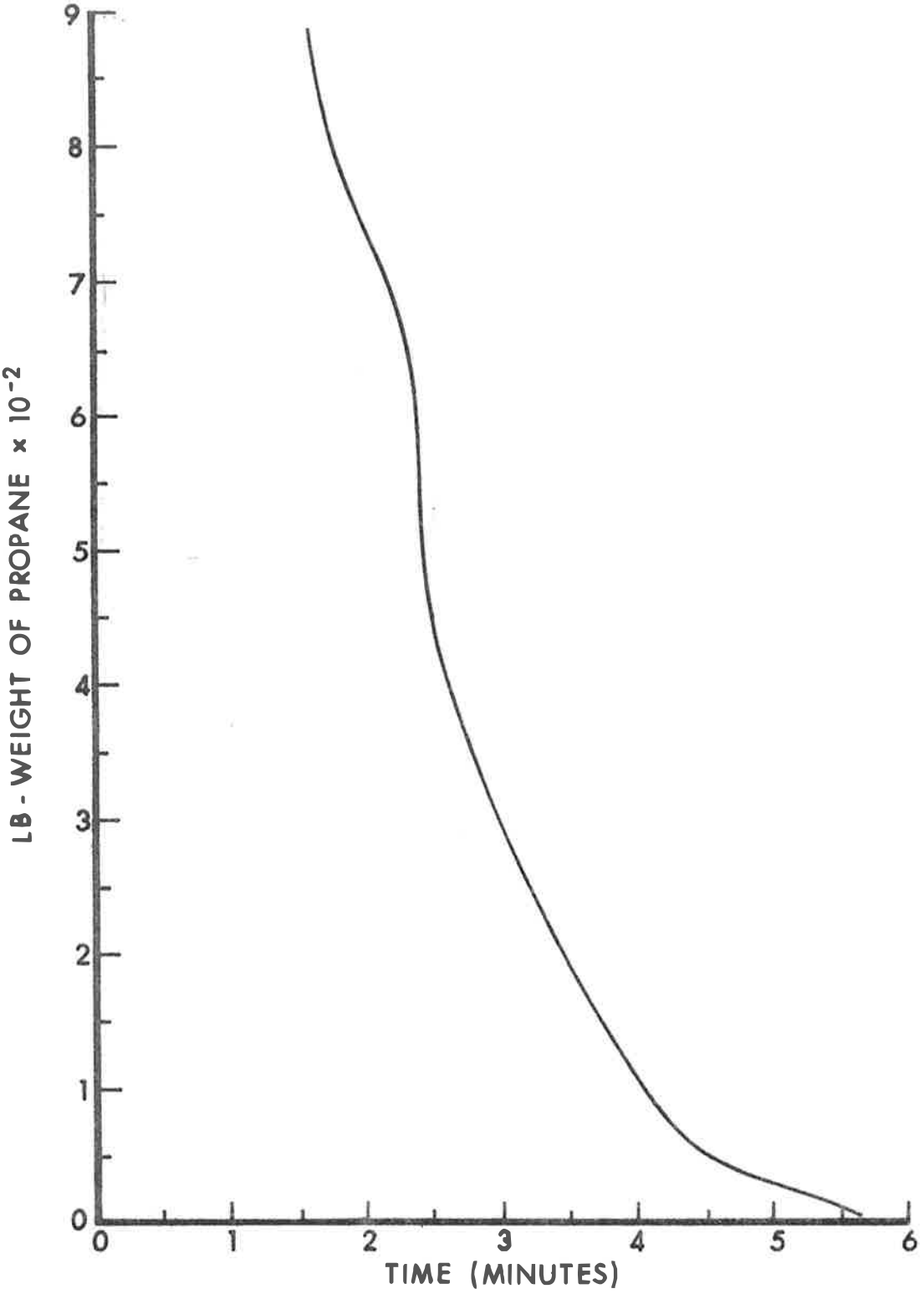


Figure 9. Test No. 6: Lb-Weight of Liquid Propane Remaining in Tank as a Function of Time (Saturated Conditions -.139°F) (From Figures 7 & 8)

being used to raise the temperature of the liquid. Also, the heat going into raising the temperature of the vapor is negligible compared to the heat going into vaporizing liquid. Considering that it requires 117 BTU for every pound of propane vaporized as compared to 1.7 BTU for every pound of vapor raised one degree Fahrenheit, and the great difference in density of the two phases of propane (approximately a factor of nine), this last assumption is valid until the tank is almost empty. This approach of calculating the heat flux into the lading ignores any heating of the liquid from the vapor or heating due to radiation from the walls exposed to vapor, that is, it ignores any heating that takes place at the liquid-vapor interface. This assumption is valid until the wall temperatures become extremely hot. Even when the walls reach 800°F (426.7°C), the radiative heat from the walls is less than 4300 BTU/hr-ft^2, which is very small compared to the heat flux through the wetted surface. For this particular test, the formula cannot be applied until the liquid recedes below the relief valve, since the formulation considers only liquid loss due to vaporization. With this last restraint, the heat flux into the lading has been calculated and the results are given in Table VIII.

It may appear that a conservation law is violated since the average heat flux into the lading was calculated and found to be 44,861 BTU/hr-ft^2 as compared to the average measured heat flux of the fire, 38,324 BTU/hr-ft^2. First, they are more or less equal considering the accuracy of measurement of the two fluxes. In particular, the times used to calculate the heat flux into the lading, i.e., the break times, are only known to within $\pm$ 10.667 seconds due to the recording process of the Vidar system (i.e., a particular channel is only sampled every 10.667 seconds). Also, due to the failure of the heat flux calorimeter at 156 seconds, fire heat flux data were obtained only during the first two and a half minutes of the test, and not during the time span over which the formulation for calculating heat flux to the lading was applied (2.3 - 5.6 minutes). Hence, the fire heat flux data are biased toward the beginning of the fire test. It is evident that because of the resolution in both time and angle to the liquid level, an improved method for determining the liquid level height is needed.

Data describing the operation of the relief valve can be analyzed, and Table IX indicates the valve actions versus time. There were 72 valve actions over the first 5.55 minutes of the test, after which the pressure gauges and LDT devices ceased to function due to the high temperatures in the interior of the tank. The valve was open and venting either liquid or vapor 43.27 seconds of that 5.55 minutes. For a further breakdown of the valve action, approximately the first 42 of the valve actions vented liquid (a total opening time of 23.525 seconds) as compared to about 30 valve actions which vented vapor (a total opening time of 19.745 seconds for vapor). The tank emptied of liquid 5.8

TABLE VIII

HEAT FLUX INTO LADING

θ_1 (degrees)	θ_2 (degrees)	t_1 (minutes)	t_2 (minutes)	$\int_{\theta_1}^{\theta_2} \frac{\sin^2 \theta d\theta}{\pi - \theta}$	q (BTU/hr-ft^2)	Remarks
90	100	2.55	2.75	.1165	105,903	1.
100	110	2.75	3.15	.1242	56,452	
110	120	3.15	3.60	.1261	50,948	
120	130	3.60	4.00	.1217	55,316	
130	140	4.00	4.50	.1109	40,325	
140	150	4.50	4.95	.0938	37,897	
150	160	4.95	5.27	.0712	40,453	
160	170	5.27	5.52	.0446	32,434	
170	180	5.52	5.75	.0151	11,936	2.
				Average	44,832	3.

1. Liquid still escaping through valve: formula not valid.

2. Tank nearly empty: formula not valid.

3. Average does not include the first and last values of the table.

TABLE IX

VALVE ACTIONS

Time Interval (Sec.)	Total Length of Time Valve Stayed Open	Number of Valve Actions
74 - 80	1.025	8
80 - 90	1.41	11
90 - 100	1.65	7
100-110	1.89	5
110-120	2.25	4
120-130	2.425	3
130-140	5.625	1
140-150	3.35	1
150-160	3.90	2
160-170	1.425	1
170-180	2.125	3
180-190	2.125	3
190-200	1.25	2
200-210	1.85	3
210-220	1.15	2
220-230	1.925	3
230-240	1.25	2
240-250	1.175	2
250-260	.625	1
260-270	1.3	2
270-280	.67	1
280-290	.625	1
290-300	.625	1
300-310	.55	1
310-333	1.075	2
	Total: 43.27 seconds	Total: 72

minutes after ignition, or about 4.8 minutes after the valve first opened.

The rate of discharge of liquid versus vapor can be compared for this particular test. With the aid of Figure 9, the rate of flow from the valve can be calculated by:

$$r = \frac{\frac{\Delta M}{\Delta t}}{\frac{\Delta \tau}{\Delta t}} ,$$

where,

r = rate of flow (for either liquid or vapor);

ΔM = change in weight for the time interval Δt;

$\frac{\Delta \tau}{\Delta t}$ = the fraction of time the valve was actually open in the time interval Δt.

The liquid flow rates are given in Table X, along with the time interval for which they were calculated. According to the test data, the valve was only opening about 0.25 inches (0.625 cm) or roughly one-third of the full opening for both the liquid flow and vapor flow. Obviously, the relief valve was considerably more than adequate for venting propane from the one-fifth scale model tank car.

While all numerical calculations were done for saturated conditions of propane at 139°F, 275 PSIG, it is evident that some error has been introduced. The test data shows two abnormalities from saturated conditions. First, the vapor is superheated (i.e., at a temperature greater than saturation temperature). This can readily be seen by looking at the cross-sectional plots in Appendix B. For example, Figure B7 shows that the vapor at the top of the tank is 300°F (148.9°C) above the saturation temperature. For Figure B7, the liquid level is about 8 inches (20.3 cm) from the bottom of the tank (from Figure 8). The vapor just above the liquid surface is much cooler since it has just been vaporized, and thus, has had insufficient time to be heated. This indicates that the vapor near the liquid-vapor interface is being cooled by the vaporization. Hence, the vapor not only is superheated, there is also temperature stratification, within the vapor, the temperature going from approximately 140°F (60.0°C) to over 375°F(190.6°C) in Figure B7. (The purpose of the radiation shields was to insure that the thermocouples were indeed measuring the vapor temperature and not the thermal radiation from the walls. Upon inspection of the data, it is evident that the shielded thermocouples do not differ substantially from

TABLE X

TEST NO. 6 - RATE OF VALVE FLOW

Angle (degrees)	Time (Minutes)	Pound-Weight of Propane	Time Valve Open (sec)	Flow Rate (lbs./sec)
30 - 45	1.5 - 1.65	885-825	1.375	43.6
45 - 60	1.65 - 2.0	825-730	4.415	21.5
60 - 75	2.0 - 2.4	730-600	9.500	13.7
75 - 90	2.4 - 2.55	600-455	3.900	37.2
90 - 105	2.55 - 2.95	455-308	4.950	29.7
105 - 120	2.95 - 3.60	308-177	6.45	20.3
120 - 135	3.6 - 4.25	177-60	4.925	23.8
135 - 180	4.25 - 5.75	60 - 0	5.45	11.0

Valve opened for liquid approx. 0.25 inches.

Valve opened for vapor flow approx. 0.25 inches to 0.30 inches.

the unshielded thermocouples. Hence, it is concluded that the vapor is superheated.)

The second assumption of saturated conditions is that the liquid is thoroughly mixed and is therefore isothermal. This is not the case, for the temperature of the liquid goes from 43°F (6.1°C) at the bottom of the tank to 133°F (56.1°C) at the top of the tank in Figure B4.

An important aspect of a LPG railroad tank car in a fire environment is the determination of whether or not the tank car goes shell full due to the thermal expansion of the liquid. Under shell full conditions, the interior tank pressure is due to the hydraulic forces of an incompressible fluid. Hence, the interior tank pressure under these conditions increases rapidly, and if the relief valve is not capable of discharging liquid at a sufficient rate, rupture of the tank car occurs. Also, when the tank has gone shell full, the entire surface is wetted with liquid. This enables heat to be transported more efficiently to the lading, while at the same time, keeping the tank shell relatively cool. This last factor is important since the tensile strength of the steel shell is temperature dependent.

The shell full phenomenon was not investigated specifically in this test. No specific liquid level instrumentation was included in the test plan. Recent computational data have shown that the shell full condition can occur in rail tank cars, and thus, the test data have been reconsidered to determine if a shell full condition occurred during the fire test.

There are a number of indications that in this test the tank model reached shell full conditions. An analysis of the data in Appendix C shows that between 45 and 47 seconds after ignition, there were four pressure drops, though the LDT devices did not indicate that the valve opened. The conclusion that the liquid expansion caused the valve to open slightly and not be registered by either of the two LDT devices is questionable since the four pressure drops could have been erroneous. However, the pressure rose rapidly from 30 seconds to 45 seconds (120 PSIG to 270 PSIG) and then the pressure levelled off until 75 seconds at which time the relief valve unquestionably opened. If the valve had not opened at 45 seconds, then the pressure could not have increased during a period of approximately a half minute, during which time heat was still being absorbed by the lading. However, if the tank model had gone shell full and nudged open the relief valve, this discrepancy would be resolved.

Additional information concerning the supposition that the tank went shell full can be gleaned from the thermocouple data. If the 226 gallons of liquid propane were loaded at 41°F (5.4°C), then the angle to the liquid level would be 46° at the initiation of the test. Inspection of Figure A19 indicates that the liquid reached the 1:00 position (angle = 30°) as is evident by the plateau. The grid thermocouple located one inch from the top (see Figure A1) and the inner wall thermocouple at the 12:00 position (see Figure A18) show no temperature plateau. However, the one inch grid thermocouple does indicate a short flattening out at approximately the same time the relief valve opened at 75 seconds. Clearly, the plots of the inner wall thermocouple at 12:00 and the grid thermocouple at one inch would not show a plateau if the liquid were still being heated at the time the tank car went shell full.

The rate of increase (i.e., slope) of the temperature of the inner wall thermocouple at 12:00 increased substantially at about the time the valve opened at 75 seconds. If the tank did go shell full, this would imply that the liquid propane was not allowing the thermocouple to heat up rapidly; then the valve opened, liquid poured out, and suddenly the 12:00 thermocouple, exposed to vapor, began to heat up quickly.

VIII. CONCLUSIONS

Calculations of the heat flux into the propane lading indicate that the heat flux is of the order of 40,000 BTU/hr-ft^2 for a tank with no thermal protective coating. However, better resolution in time and the angle to the liquid level are needed.

The propane vapor is superheated, and both the vapor and liquid are temperature stratified, as opposed to the system being isothermal at saturation temperature.

The safety relief valve, which was in the 3:00 position, allowed the propane liquid and vapor to vent at a rate sufficient to preclude internal pressures of greater than 275 PSIG.

There are a number of indications that the tank went shell full causing the relief valve to vent continuously for approximately thirty seconds.

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APPENDIX A: TEMPERATURE VERSUS TIME DATA

TABLE A - I

THERMOCOUPLE TEMPERATURES (DEG. F) FOR TEST NR. 6

CHANNEL NUMBER	LOCATION	TIME (SEC) = .00	10.89	21.77	32.66	43.54	54.43	65.31	76.19	87.08	97.97	TIME ADJUST ADD
46	(GRID AT 1, IN.)	41.1	41.0	42.7	51.2	57.3	69.7	85.8	100.8	130.8	141.4	7.84
47	(GRID AT 3.15 INS.)	41.1	41.0	43.0	50.8	52.3	56.7	71.0	88.7	105.4	127.8	8.02
48	(GRID AT 3.15 INS.)	41.1	40.7	40.9	49.0	51.4	57.6	74.7	95.5	107.3	124.7	8.27
49	(GRID AT 3.15 INS.)	41.1	40.9	41.1	48.2	52.6	63.6	77.5	93.5	108.9	129.8	8.49
50	(GRID AT 7.15 INS.)	41.1	40.0	40.4	45.0	43.8	48.5	59.0	77.7	99.1	109.4	8.71
51	(GRID AT 7.15 INS.)	41.1	40.0	40.2	47.0	49.0	53.7	65.6	83.0	103.3	117.0	8.93
52	(GRID AT 7.15 INS.)	41.1	38.0	38.0	44.1	51.9	50.7	63.3	78.5	104.7	111.9	9.14
53	(GRID AT 11.2 INS.)	41.1	38.7	38.1	40.5	45.1	47.8	58.5	67.5	82.1	94.7	9.36
54	(GRID AT 11.2 INS.)	41.1	39.2	39.9	42.3	47.2	51.1	61.4	72.0	87.7	100.1	9.58
55	(GRID AT 11.2 INS.)	41.1	42.0	41.5	44.9	45.6	49.7	57.9	68.9	86.1	97.3	9.80
56	(GRID AT 15.2 INS.)	41.1	41.7	44.4	40.6	49.4	51.5	61.1	71.0	82.8	90.3	10.01
57	(GRID AT 15.2 INS.)	41.1	43.0	44.9	43.7	49.7	53.6	61.8	71.9	86.0	93.1	10.23
58	(GRID AT 15.2 INS.)	41.1	41.5	40.9	41.4	43.9	47.0	53.0	61.1	71.9	84.3	10.45
59	(GRID AT 19.2 INS.)	41.1	42.1	42.4	42.4	45.0	45.5	50.0	56.9	65.9	74.6	10.67
35	(GRID AT 19.2 INS.)	41.1	41.1	41.0	41.4	41.9	43.1	48.0	52.4	60.4	72.7	5.44
37	(GRID AT 19.2 INS.)	41.1	41.0	40.7	41.4	41.5	43.7	48.8	54.9	61.9	73.3	5.66
39	(GRID AT 21.45 INS.)	41.1	41.0	40.8	40.7	40.3	39.8	39.9	40.4	41.7	45.0	6.31
18	(INSIDE AT 12:00)	41.1	41.0	44.7	61.3	80.7	96.6	111.9	135.5	170.6	215.0	1.74
20	(INSIDE AT 1:00)	41.1	41.0	45.8	61.8	79.1	97.2	116.9	136.2	142.2	143.5	2.18
22	(INSIDE AT 1:30)	41.1	41.0	41.8	45.2	51.1	58.2	69.1	84.3	101.4	120.8	2.61
24	(INSIDE AT 2:00)	41.1	41.1	49.4	71.1	91.4	114.6	133.9	141.4	142.3	142.6	3.05
27	(INSIDE AT 3:00)	41.1	41.1	51.5	81.5	101.3	133.2	138.4	140.3	139.7	140.0	3.70
28	(INSIDE AT 3:30)	41.1	41.2	49.7	73.4	91.9	120.8	134.0	137.6	137.5	138.9	3.92
29	(INSIDE AT 4:00)	41.1	41.5	57.7	83.6	110.4	135.2	140.1	141.0	140.4	141.2	4.14
33	(INSIDE AT 5:00)	41.1	41.7	61.2	86.2	109.9	133.6	141.7	141.7	141.1	140.3	5.01
34	(INSIDE AT 6:00)	41.1	41.4	58.6	76.4	95.0	118.8	130.2	128.9	125.7	125.8	5.22
36	(INSIDE AT 7:00)	41.1	43.1	66.0	84.5	107.7	128.4	134.7	134.2	134.6	134.8	5.66
38	(INSIDE AT 7:30)	41.1	43.7	65.9	87.6	111.2	134.0	142.2	140.3	138.0	138.7	6.10
41	(INSIDE AT 8:30)	41.1	44.0	68.3	87.8	111.3	131.1	135.9	136.6	138.1	139.2	6.75
11	(INSIDE AT 9:00)	41.1	41.1	55.3	81.0	103.8	125.0	133.9	136.1	136.9	138.1	.22
10	(INSIDE AT 9:30)	41.1	41.0	48.2	72.6	102.7	123.5	137.9	140.4	141.6	144.6	.00
14	(INSIDE AT 10:00)	41.1	41.0	51.8	75.8	101.0	121.9	134.1	138.1	140.4	142.7	.87
15	(INSIDE AT 10:30)	41.1	41.1	49.9	72.3	94.4	111.2	128.6	134.7	137.7	140.4	1.09
17	(INSIDE AT 11:00)	41.1	41.1	47.4	68.5	87.3	107.8	123.3	135.8	137.7	177.7	1.52
42	(MANWAY AT 1, IN.)	41.1	41.1	41.5	43.9	48.0	53.1	58.9	65.7	73.9	81.7	6.97
43	(MANWAY AT 4. INS.)	41.1	43.2	63.6	85.4	103.6	123.5	133.5	134.9	136.7	136.8	7.18
44	(MANWAY AT 7. INS.)	41.1	43.8	68.6	93.8	118.3	138.6	140.3	138.6	139.1	140.2	7.40
45	(MANWAY AT 10. INS.)	41.1	43.8	67.0	90.3	114.2	134.0	136.5	136.0	137.7	137.2	7.62
16	(FIRE AT 12:00)	41.1	62.4	907.2	1310.5	847.7	963.0	1162.2	1006.1	1401.5	970.7	1.31
19	(FIRE AT 3:00)	41.1	147.7	1415.1	1591.3	1418.1	1517.1	1650.1	1467.8	1730.2	1427.1	1.96
21	(FIRE AT 6:00)	41.1	229.6	1509.9	1563.6	1551.3	1483.1	1579.0	1575.4	1589.3	1506.6	2.39
23	(FIRE AT 9:00)	41.1	230.8	1291.7	1542.7	1399.1	1393.1	1509.0	1517.6	1532.4	1486.9	2.85

TABLE A - II

THERMOCOUPLE TEMPERATURES (DEG. F) FOR TEST NR, 6

CHANNEL NUMBER	LOCATION	TIME (SEC) = 108.85	119.74	130.62	141.50	152.39	163.27	174.16	185.05	195.93	206.82	TIME ADJUST ADD
46	(GRID AT 1, IN,)	168,0	190.1	208,6	245.3	278,9	307,9	327,3	367.2	396.7	411.4	7.84
47	(GRID AT 3,15 INS.)	130,3	145.5	150,9	160.3	171,2	181,4	203,1	221.7	255.0	263,4	8.05
48	(GRID AT 3,15 INS.)	125,1	134.6	141,8	148.3	164,2	173,5	187.7	203.7	223.3	248,9	8.27
49	(GRID AT 3,15 INS.)	131,1	143.5	155,1	164.6	182,3	195,1	210,2	228.5	258.8	282,9	8.49
50	(GRID AT 7,15 INS.)	115,1	119.4	117,6	118.7	123,5	120,3	126,9	137.4	147.2	155,7	8.71
51	(GRID AT 7,15 INS.)	123,6	128.7	129,8	133.2	140,9	140,4	151,0	163.1	173.4	185,5	8.93
52	(GRID AT 7,15 INS.)	118,1	128.7	125,0	129.0	135,0	135,2	140,6	146.7	156.3	170,9	9.14
53	(GRID AT 11.2 INS.)	102,8	118.6	121,3	125.9	130,0	130,0	130,0	129.3	127.0	130,4	9.36
54	(GRID AT 11.2 INS.)	112,2	128.0	131,3	137.8	140,8	145,8	147.9	148.3	148.0	151.2	9.58
55	(GRID AT 11.2 INS.)	110,5	121.7	122,3	124.6	124,4	129,0	125,4	128.4	126.4	130,5	9.80
56	(GRID AT 15.2 INS.)	103,4	118.0	130,3	131.2	134,4	137,5	133,1	142.5	139.8	144,5	10.01
57	(GRID AT 15,2 INS.)	108,0	122.3	132,2	135.3	135,9	140,2	140,2	149.4	149.0	151,3	10,23
58	(GRID AT 15.2 INS.)	97,8	112.4	121,3	122.3	125,0	124,1	124,0	128.5	128.3	127,4	10.45
59	(GRID AT 19.2 INS.)	86,0	96.5	120,6	123.7	128,7	128,7	130,2	130.9	131.2	132,0	10.67
35	(GRID AT 19,2 INS.)	79,8	90.5	109,4	122.9	124,2	126,3	127,0	128.2	129.7	129,8	5.44
37	(GRID AT 19.2 INS.)	82,8	94.6	108.7	118.3	122,3	124,2	124,9	126.9	126.7	127,2	5.88
39	(GRID AT 21.45 INS.)	50,3	59.4	71,3	86.7	103,6	114,6	117,3	118.4	119.2	119,4	6.31
18	(INSIDE AT 12:00)	253,2	291.1	325,5	366.8	400,2	412,4	426,7	477.4	510.9	542,0	1.74
20	(INSIDE AT 1:00)	151,4	193.8	224,5	257.0	285,2	310,4	332,5	352.2	374.2	393,7	2.13
22	(INSIDE AT 1:30)	135,3	149.9	168,2	187.3	206,6	225,0	247.4	268.8	291.2	313.2	2.61
24	(INSIDE AT 2:00)	142,9	145.3	179,2	234.4	279,2	315,9	346.9	374.1	402.3	419,9	3.05
27	(INSIDE AT 3:00)	138,8	140.6	138,7	139.4	154,3	205,0	249.2	281.9	312.7	342,0	3.70
28	(INSIDE AT 3:30)	138,2	139.4	138,0	141.0	139,2	143,2	145.8	165.4	207.8	246.6	3.92
29	(INSIDE AT 4:00)	141,3	140.8	140,3	142.6	140,0	143,4	143,7	142.5	143.8	145,4	4.14
33	(INSIDE AT 5:00)	139,3	138.2	139,3	141.4	139,2	141,1	143,3	142.3	141.8	144,7	5.01
34	(INSIDE AT 6:00)	125,8	127.7	126,1	131.2	131,2	133,9	134,3	134.0	134.0	135,0	5.22
36	(INSIDE AT 7:00)	135,3	135.1	137,0	138.0	139,2	139,3	139,0	141.6	141.8	141,2	5.66
38	(INSIDE AT 7:30)	140,7	141.9	145,7	142.7	143,3	143,5	143,1	144.3	143.1	145,2	6.10
41	(INSIDE AT 8:30)	140,9	141.0	141,4	141.6	142,4	142,7	158,3	197.4	229.2	259,2	6.79
11	(INSIDE AT 9:00)	139,1	139.6	138,8	136.9	143,0	174,4	206,7	235.2	270.2	296,0	.22
10	(INSIDE AT 9:30)	146,1	145.7	144,8	143.3	186,1	216,2	247,1	280.3	314.2	342,8	.00
14	(INSIDE AT 10:00)	145,0	145.3	169,0	216.7	252,7	277,1	301,5	334.2	364.6	392,4	.87
15	(INSIDE AT 10:30)	155,2	201.4	237,6	279.6	310,5	332,4	356,8	387.8	411.0	424,1	1.09
17	(INSIDE AT 11:00)	218,4	257.0	293,0	333.1	364,9	388,0	409,8	417.4	472.0	507,2	1.52
42	(MANWAY AT 1, IN,)	89,2	97.4	106,7	117.6	124,8	129,9	133,1	136.1	137.7	138,4	6.97
43	(MANWAY AT 4, INS.)	136,9	137.0	138,2	137.0	138,3	138,7	140,2	142.0	141.7	141,8	7.19
44	(MANWAY AT 7, INS.)	139,8	140.1	141,3	140.5	141,6	142,8	144,3	145.0	145.6	146,0	7.40
45	(MANWAY AT 10, INS.)	137,1	137.4	138,4	138.7	141,5	142,0	143,4	143.2	145.9	145,7	7.62
16	(FIRE AT 12:00)	1666,3	1386.5	1617,8	1443.9	1488,2	1581,8	1700,7	1244.5	1772.0	1693,6	1.31
19	(FIRE AT 3:00)	1736,0	1682.2	1645,4	1731.1	1715,7	1674,6	1652,6	1566.7	1688.5	1567,2	1.95
21	(FIRE AT 6:00)	1512,8	1506.3	1549,5	1576.9	1476,7	1526,7	1524,6	1439.3	1539.8	1539,9	2.37
23	(FIRE AT 9:00)	1512,9	1441.4	1516,6	1446.7	1389,5	1436,2	1462,8	1380.8	1473.6	1493,7	2.83

TABLE A - III

THERMOCOUPLE TEMPERATURES (DEG. F) FOR TEST NR. 6

CHANNEL NUMBER	LOCATION	TIME (SEC) =	217.70	228.58	239.47	250.35	261.24	272.13	283.01	293.89	304.78	315.67	TIME ADJUST ADD
46	(GRID AT 1, IN,)		438.6	467.0	519.0	544.1	546.3	587.6	624.6	646.5	666.4	707.2	7.84
47	(GRID AT 3,15 INS.)		284.6	326.7	354.4	382.1	402.9	409.4	438.5	470.0	497.7	526.5	8.02
48	(GRID AT 3,15 INS.)		264.6	295.5	326.6	352.1	389.0	399.5	426.5	445.7	463.4	486.5	8.27
49	(GRID AT 3,15 INS.)		306.2	337.3	363.3	383.7	413.2	424.9	462.0	481.5	509.3	537.0	8.49
50	(GRID AT 7,15 INS.)		166.2	186.0	197.0	216.7	235.4	255.9	280.3	305.4	326.0	348.4	8.71
51	(GRID AT 7,15 INS.)		198.9	215.6	234.4	256.3	276.9	294.9	317.9	346.6	371.5	400.5	8.93
52	(GRID AT 7,15 INS.)		179.9	195.0	212.5	229.0	251.3	265.6	286.4	317.1	335.3	357.9	9.14
53	(GRID AT 11.2 INS.)		135.6	141.2	151.1	163.3	179.7	187.1	203.0	220.0	232.8	255.8	9.36
54	(GRID AT 11.2 INS.)		156.7	161.7	170.7	182.2	194.4	203.2	217.3	231.7	250.6	268.6	9.58
55	(GRID AT 11.2 INS.)		140.3	145.4	152.1	163.7	176.7	180.1	195.9	209.5	218.9	235.6	9.80
56	(GRID AT 15.2 INS.)		144.3	142.6	148.6	149.6	152.7	162.9	175.5	189.8	196.2	208.0	10.01
57	(GRID AT 15.2 INS.)		152.7	151.7	156.3	156.3	157.6	170.5	181.1	194.0	200.6	214.7	10.23
58	(GRID AT 15.2 INS.)		127.1	127.6	129.6	128.0	127.0	131.4	138.7	149.2	156.6	166.5	10.45
59	(GRID AT 19.2 INS.)		132.0	130.7	132.9	135.0	131.3	135.7	138.5	132.0	132.8	135.0	10.67
35	(GRID AT 19.2 INS.)		130.5	130.5	131.0	132.0	134.0	138.6	134.6	137.9	139.0	137.8	5.44
37	(GRID AT 19.2 INS.)		129.5	128.3	129.9	133.8	133.1	138.3	135.4	135.8	137.7	140.8	5.88
39	(GRID AT 21.45 INS.)		119.4	120.1	120.4	123.0	128.0	130.5	130.1	129.6	131.2	140.1	6.31
18	(INSIDE AT 12:00)		567.6	593.1	616.6	643.6	670.5	698.2	721.1	747.6	768.1	779.4	1.74
20	(INSIDE AT 1:00)		408.5	420.2	456.0	481.6	508.8	534.6	556.5	577.7	594.4	607.4	2.18
22	(INSIDE AT 1:30)		335.3	356.6	377.3	398.0	416.6	422.8	459.0	485.9	508.2	530.4	2.61
24	(INSIDE AT 2:00)		438.6	475.1	501.7	528.4	556.8	585.5	608.9	630.9	646.6	658.3	3.05
27	(INSIDE AT 3:00)		368.8	392.7	406.6	443.2	477.1	506.3	528.5	551.9	569.2	585.0	3.70
28	(INSIDE AT 3:30)		280.7	313.0	341.8	368.1	393.0	416.5	427.6	457.0	481.8	501.1	3.92
29	(INSIDE AT 4:00)		160.7	213.6	257.2	290.2	320.7	346.1	372.0	395.8	414.9	429.6	4.14
33	(INSIDE AT 5:00)		145.0	144.6	145.2	145.7	146.3	148.6	149.0	155.7	189.5	223.4	5.01
34	(INSIDE AT 6:00)		135.0	135.5	136.3	137.3	140.3	143.3	144.5	146.3	149.6	153.7	5.22
36	(INSIDE AT 7:00)		143.3	143.7	145.0	146.0	147.3	150.4	149.9	161.0	200.5	236.6	5.66
38	(INSIDE AT 7:30)		146.2	147.3	149.7	154.6	181.3	219.3	250.1	279.2	308.8	338.2	6.10
41	(INSIDE AT 8:30)		282.0	308.6	334.5	360.2	384.9	403.7	415.4	428.4	451.5	477.5	6.75
11	(INSIDE AT 9:00)		318.4	340.3	368.0	396.6	412.8	443.0	468.8	492.7	514.5	538.2	.22
10	(INSIDE AT 9:30)		366.6	387.2	413.3	416.8	439.7	488.9	514.2	537.9	560.3	582.9	.00
14	(INSIDE AT 10:00)		412.9	423.2	451.2	485.7	518.6	545.5	568.3	592.9	617.9	638.8	.87
15	(INSIDE AT 10:30)		462.8	490.1	521.0	549.9	577.4	604.1	627.1	652.9	677.6	698.7	1.09
17	(INSIDE AT 11:00)		534.6	560.7	589.5	618.9	646.7	675.7	699.9	727.4	752.5	771.0	1.52
42	(MANWAY AT 1, IN,)		138.2	140.8	142.3	144.0	144.3	145.6	143.5	145.4	147.2	149.5	6.97
43	(MANWAY AT 4, INS.)		143.0	144.3	146.3	148.3	149.4	153.3	151.4	151.7	154.7	156.7	7.18
44	(MANWAY AT 7, INS.)		146.8	149.3	150.4	152.1	154.8	159.2	162.8	172.6	202.4	238.8	7.40
45	(MANWAY AT 10, INS.)		145.1	148.3	149.0	151.4	152.8	154.1	157.8	158.8	164.1	201.6	7.62
16	(FIRE AT 12:00)		1484.3	1506.8	1651.7	1544.1	1688.7	907.7	1653.9	1609.0	1482.4	1356.1	1.31
19	(FIRE AT 3:00)		1744.3	1890.6	1562.2	1613.0	1605.5	1472.4	1678.5	1803.0	1747.7	1554.0	1.96
21	(FIRE AT 6:00)		1600.2	1688.4	1495.0	1514.7	1464.3	1610.0	1620.5	1594.5	1612.6	1466.3	2.39
23	(FIRE AT 9:00)		1518.5	1617.6	1439.4	1455.8	1404.7	1507.2	1551.5	1535.2	1567.3	1427.5	2.83

TABLE A - IV

THERMOCOUPLE TEMPERATURES (DEG. F) FOR TEST NR. 6

CHANNEL NUMBER	LOCATION	TIME (SEC) = 326.55	337.43	348.32	359.20	370.09	380.98	391.86	402.74	413.63	424.51	TIME ADJUST ADD
46	(GRID AT 1, INS.)	739.6	746.6	767.2	781.2	799.3	818.5	827.0	839.2	854.3	870.0	7.84
47	(GRID AT 3,15 INS.)	538.7	563.1	587.9	626.5	681.4	713.2	728.2	753.8	772.4	789.5	8.05
48	(GRID AT 3,15 INS.)	517.6	556.5	599.9	633.8	666.0	693.5	719.8	744.5	764.3	783.1	8.27
49	(GRID AT 3,15 INS.)	575.5	602.6	639.5	667.9	697.0	721.5	742.9	767.8	790.1	809.4	8.49
50	(GRID AT 7,15 INS.)	372.0	394.8	434.1	457.4	490.7	500.5	536.0	566.4	595.0	621.2	8.71
51	(GRID AT 7,15 INS.)	430.5	460.6	491.8	527.4	556.4	590.7	617.6	631.6	657.6	687.0	8.93
52	(GRID AT 7,15 INS.)	385.1	415.2	448.9	482.3	510.0	535.8	561.8	573.4	588.1	602.8	9.14
53	(GRID AT 11.2 INS.)	277.6	305.0	338.0	361.8	391.6	420.2	444.7	471.3	495.0	513.7	9.36
54	(GRID AT 11.2 INS.)	289.4	313.2	343.3	363.1	394.1	422.2	448.2	474.8	495.8	511.5	9.58
55	(GRID AT 11.2 INS.)	258.1	288.5	317.8	339.7	363.6	386.4	413.2	437.3	459.2	484.5	9.80
56	(GRID AT 15.2 INS.)	228.1	252.8	276.7	296.8	319.3	346.1	372.0	405.7	430.0	456.6	10.01
57	(GRID AT 15.2 INS.)	233.7	256.0	280.1	302.0	324.8	351.0	375.0	401.7	434.7	460.0	10.23
58	(GRID AT 15.2 INS.)	178.4	197.4	222.0	245.1	264.3	288.2	311.5	332.1	356.8	383.5	10.45
59	(GRID AT 19.2 INS.)	137.6	155.3	172.6	190.5	207.4	225.7	249.1	269.5	290.4	311.5	10.67
35	(GRID AT 19.2 INS.)	145.1	153.4	177.0	199.4	214.8	230.7	255.4	280.7	300.2	324.0	5.44
37	(GRID AT 19.2 INS.)	150.1	159.8	180.4	197.6	213.0	232.8	257.1	280.4	305.7	329.1	5.88
39	(GRID AT 21.45 INS.)	141.4	133.5	138.0	140.6	142.4	143.8	145.0	147.1	151.4	167.0	6.31
18	(INSIDE AT 12:00)	791.5	810.1	826.6	841.0	855.6	863.7	870.6	879.2	891.2	903.5	1.74
20	(INSIDE AT 1:00)	621.7	641.2	658.6	676.2	691.4	703.1	716.5	732.8	749.1	767.6	2.18
22	(INSIDE AT 1:30)	549.7	569.7	588.4	606.4	624.5	640.7	655.7	670.3	685.2	700.7	2.61
24	(INSIDE AT 2:00)	673.3	690.8	707.5	724.3	738.9	748.7	762.0	779.1	796.0	816.3	3.05
27	(INSIDE AT 3:00)	602.1	621.4	640.6	660.9	678.1	692.0	708.7	729.6	746.7	769.8	3.70
28	(INSIDE AT 3:30)	519.5	539.7	561.1	583.7	603.0	619.6	637.6	659.2	680.4	702.6	3.92
29	(INSIDE AT 4:00)	453.8	477.2	500.3	524.7	544.9	563.8	584.3	608.2	629.0	650.4	4.14
33	(INSIDE AT 5:00)	256.9	285.1	313.2	337.6	361.9	384.9	405.9	421.6	441.0	473.1	5.01
34	(INSIDE AT 6:00)	158.1	161.4	184.5	215.4	245.8	274.2	300.4	324.7	346.5	366.7	5.22
36	(INSIDE AT 7:00)	267.2	293.9	318.0	341.5	365.4	391.4	415.6	418.6	439.4	469.8	5.66
38	(INSIDE AT 7:30)	361.4	383.9	405.0	419.3	422.2	438.3	479.7	508.7	532.5	554.6	6.10
41	(INSIDE AT 8:30)	498.4	517.7	536.1	554.1	574.9	595.1	615.4	633.4	654.0	674.3	6.75
11	(INSIDE AT 9:00)	562.0	580.5	598.7	615.5	636.2	656.5	675.4	694.1	713.1	731.0	.22
10	(INSIDE AT 9:30)	606.4	624.7	641.7	657.0	676.2	696.0	714.4	732.3	751.0	768.7	.00
14	(INSIDE AT 10:00)	661.2	680.2	697.6	713.5	734.8	753.3	771.2	789.0	809.8	827.7	.87
15	(INSIDE AT 10:30)	720.3	739.4	758.7	776.8	797.3	814.8	830.9	849.1	867.2	885.0	1.09
17	(INSIDE AT 11:00)	789.6	810.0	828.9	846.0	865.0	878.6	890.4	904.0	920.2	934.2	1.52
42	(MANWAY AT 1, INS.)	150.3	150.6	154.1	156.7	160.9	170.7	201.8	222.4	239.7	260.1	6.97
43	(MANWAY AT 4, INS.)	160.3	198.0	225.1	257.5	287.5	316.5	341.1	365.5	387.7	411.6	7.18
44	(MANWAY AT 7, INS.)	275.1	307.8	338.5	365.7	393.1	416.0	429.4	468.0	493.3	518.8	7.40
45	(MANWAY AT 10, INS.)	238.6	275.1	305.5	333.3	360.6	388.3	412.5	424.1	454.5	485.5	7.62
16	(FIRE AT 12:00)	1362.0	1417.7	1366.4	1282.0	1236.0	1350.6	1298.1	1453.8	1354.5	1470.3	1.31
19	(FIRE AT 3:00)	1473.4	1586.0	1773.1	1227.0	1532.0	1493.2	1747.0	1586.4	1734.0	1748.7	1.96
21	(FIRE AT 6:00)	1554.1	1573.6	1685.7	1482.4	1608.3	1604.1	1718.8	1661.0	1653.9	1744.1	2.39
23	(FIRE AT 9:00)	1503.3	1515.8	1549.4	1476.6	1527.4	1575.9	1601.9	1657.8	1574.8	1718.6	2.83

TABLE A - V

THERMOCOUPLE TEMPERATURES (DEG. F) FOR TEST NR, 6

CHANNEL NUMBER	LOCATION / TIME (SEC) =	435.40	446.29	457.17	468.06	478.94	489.82	500.71	511.60	522.48	533.37	TIME ADJUST ADD
46	(GRID AT 1, IN,)	885,0	900.5	915.3	928.4	939.6	952,6	966.0	979.3	991.5	1001.4	7.84
47	(GRID AT 3,15 INS.)	807,0	825.4	843.0	860.3	877,9	894,3	910.3	924.1	938.2	948.5	8.03
48	(GRID AT 3,15 INS.)	801,1	820.3	840.6	859.2	875,4	890,9	907.2	922.1	935.5	950.0	8.27
49	(GRID AT 3,15 INS.)	824,3	837.2	854.7	868.0	884,3	904,9	922.4	936.2	952.4	968.1	8.49
50	(GRID AT 7,15 INS.)	646,1	670.9	693.0	714.9	736,9	757,6	784.6	800.8	830.6	863.0	8.71
51	(GRID AT 7,15 INS.)	707,0	725.3	747,1	772.4	792,9	819,2	843.6	867.7	886.7	905.4	8.93
52	(GRID AT 7,15 INS.)	636,1	669.2	699,9	730.2	757,0	781,8	806.4	826.3	845.4	864.3	9.14
53	(GRID AT 11.2 INS.)	524,5	527.6	552,6	571.2	607,2	632,7	669.4	699.9	722.2	741.9	9.35
54	(GRID AT 11.2 INS.)	527,7	544.3	570,9	611.6	645,5	672,4	702.9	731.2	757.2	784.1	9.56
55	(GRID AT 11.2 INS.)	505,9	529.2	554,5	579.1	609,2	631,7	654.5	691.3	709.3	733.3	9.80
56	(GRID AT 15.2 INS.)	479,2	499.0	514,2	532.4	539,4	566,8	585.8	607.4	637.1	661.0	10.01
57	(GRID AT 15.2 INS.)	485,8	507.7	532,1	545.2	558,4	578,7	603.1	647.3	677.7	687.6	10.25
58	(GRID AT 15.2 INS.)	408,2	429.3	458,8	486.1	510,4	535,3	560,5	585.7	614.9	637.4	10.45
59	(GRID AT 19.2 INS.)	331,3	352.9	375,0	394.9	416,8	437,3	459.2	462.2	475.9	497.0	10.67
35	(GRID AT 19.2 INS.)	345,1	367.7	391,3	415.7	437,6	462,3	480,4	487.7	508.3	524.4	5.44
37	(GRID AT 19.2 INS.)	351,6	372.7	395,9	417.3	437,7	457,6	479,5	493.0	515.3	529.5	5.85
39	(GRID AT 21.45 INS.)	185,2	207.6	229,9	251.2	267,0	277,1	285.2	295.5	305.6	318.4	6.31
18	(INSIDE AT 12:00)	918,0	932.5	945,0	954.7	965,1	977,4	989.6	1001.9	1016.2	1033.0	1.74
20	(INSIDE AT 1:00)	787,0	806.4	823,1	840.0	858,6	878,8	895.7	912.6	931.5	949.6	2.18
22	(INSIDE AT 1:30)	717,0	732.4	747,8	763.0	777,7	793,6	809.1	824.6	839.5	855.2	2.61
24	(INSIDE AT 2:00)	837,8	859.2	878,0	896.3	915,9	935,6	950.8	965.9	984.5	1002.5	3.05
27	(INSIDE AT 3:00)	792,6	815.0	835,4	855.7	877,6	899,3	915.6	931.9	951.9	971.7	3.70
28	(INSIDE AT 3:30)	724,8	748.3	770,2	791.7	814,7	837,0	855.4	874.1	896.3	918.7	3.92
29	(INSIDE AT 4:00)	674,9	698.4	719,9	741.3	764,6	786,6	804.6	820.7	840.8	862.0	4.14
33	(INSIDE AT 5:00)	499,8	523.7	546,3	567.9	590,2	611,2	629.6	647.6	667.0	686.3	5.01
34	(INSIDE AT 6:00)	387,9	407.2	415,9	435.3	454,5	473,7	490.8	507.3	525.7	539.6	5.22
36	(INSIDE AT 7:00)	497,3	521.1	542,1	563.6	583,5	600,9	621,2	643.2	662.9	682.4	5.66
38	(INSIDE AT 7:30)	576,4	597.3	616,7	638.2	657,9	675,6	695.9	716.7	734.6	752.4	6.10
41	(INSIDE AT 8:30)	693,8	710.6	727,4	747.1	765,8	781,4	799,9	819.6	837.1	855.2	6.75
11	(INSIDE AT 9:00)	750,5	767.5	781,4	798.2	816,1	832,9	848.3	868.4	886.2	903.9	.22
10	(INSIDE AT 9:30)	787,8	805.9	821,0	839.1	857,2	874,3	890.6	910.2	929.4	949.3	.00
14	(INSIDE AT 10:00)	847,6	865.0	882,4	901.2	920,6	937,7	954.4	973.3	991.4	1011.0	.87
15	(INSIDE AT 10:30)	905,5	924.2	940,3	955.4	970,4	984,2	998.6	1013.7	1028.6	1046.6	1.09
17	(INSIDE AT 11:00)	949,9	965.2	979,0	990.7	1003,6	1017,2	1030.2	1041.8	1052.0	1069.9	1.52
42	(MANWAY AT 1, IN,)	278,3	296.5	313,0	328.0	342,3	356,3	369.6	382.0	393.9	405.0	6.97
43	(MANWAY AT 4, INS.)	422,7	451.2	470,2	490.2	510,5	527,3	544.1	560.5	577.1	593.3	7.19
44	(MANWAY AT 7, INS.)	543,4	566.1	587,0	609.6	632,1	651,5	671,0	690.9	710.1	729.1	7.43
45	(MANWAY AT 10, INS.)	511,6	535,6	556,5	577.6	598,7	615,6	634.1	652.6	670.3	689.4	7.62
16	(FIRE AT 12:00)	1506,0	1492,1	1546,4	1514.4	1545,3	1535,2	1534.1	1549.6	1563.2	1563.2	1.31
19	(FIRE AT 3:00)	1633,3	1550,2	1393,0	1657.6	1608,9	1436,8	1405.6	1596.4	1613.8	1544.7	1.96
21	(FIRE AT 6:00)	1678,8	1566,9	1600,4	1633.7	1628,7	1490,3	1460.5	1606.6	1589.0	1574.3	2.39
23	(FIRE AT 9:00)	1573,8	1499,7	1527,6	1609.5	1534,2	1494,7	1485.0	1505.9	1582.2	1551.6	2.83

TABLE A - VI

THERMOCOUPLE TEMPERATURES (DEG. F) FOR TEST NR. 6

CHANNEL NUMBER	LOCATION	TIME (SEC) = 544.25	555.14	566.02	576.91	587.79	598.68	609.56	620.45	631.33	642.22	TIME ADJUST ADD
46	(GRID AT 1, IN.)	1013.4	1016.5	1020.2	1031.4	1041.4	1049.2	1051.7	1056.9	1059.5	1063.0	7.84
47	(GRID AT 3.15 INS.)	955.1	965.6	978.8	989.8	989.9	994.6	997.9	1002.0	1006.2	1010.7	8.05
48	(GRID AT 3,15 INS.)	965.7	977.7	988.2	995.3	1002.1	1011.4	1014.8	1017.1	1023.8	1028.0	8.27
49	(GRID AT 3,15 INS.)	982.8	993.5	1004.1	1012.9	1015.5	1024.1	1026.0	1043.4	1041.3	1044.7	8.49
50	(GRID AT 7,15 INS.)	874.4	876.4	908.5	922.3	923.4	930.6	942.3	950.6	957.3	967.8	8.71
51	(GRID AT 7,15 INS.)	922.1	940.8	944.2	960.0	976.9	988.5	991.8	992.7	998.5	1009.3	8.93
52	(GRID AT 7,15 INS.)	890.2	902.7	918.2	927.3	953.3	961.6	973.7	980.1	981.9	988.5	9.14
53	(GRID AT 11.2 INS.)	757.8	771.9	790.1	819.5	833.6	855.0	860.4	873.9	890.4	896.3	9.36
54	(GRID AT 11.2 INS.)	803.2	821.9	836.9	854.7	879.9	882.7	893.2	919.5	930.5	946.1	9.58
55	(GRID AT 11.2 INS.)	759.9	782.5	805.2	802.3	828.3	840.8	843.9	863.8	879.2	899.6	9.80
56	(GRID AT 15.2 INS.)	690.8	716.9	747.8	765.2	774.1	794.5	815.1	844.6	856.6	869.8	10.01
57	(GRID AT 15.2 INS.)	719.5	748.5	766.1	784.6	805.5	818.8	837.6	864.4	875.4	898.7	10.23
58	(GRID AT 15.2 INS.)	655.4	666.2	708.6	729.4	755.0	759.8	772.2	799.9	815.6	840.7	10.45
59	(GRID AT 19.2 INS.)	522.9	551.4	579.7	611.3	640.5	663.4	688.1	712.6	734.3	756.9	10.67
35	(GRID AT 19.2 INS.)	549.8	578.6	602.6	625.6	651.4	671.2	696.3	713.2	744.4	764.1	5.44
37	(GRID AT 19.2 INS.)	561.2	591.5	618.8	632.4	652.4	680.6	702.1	727.9	745.8	765.2	5.88
39	(GRID AT 21.45 INS.)	330.1	340.9	354.3	366.1	379.0	392.4	406.4	416.8	425.0	433.0	6.31
18	(INSIDE AT 12:00)	1051.0	1058.7	1065.2	1075.3	1080.9	1087.3	1092.4	1095.4	1095.2	1095.0	1.74
20	(INSIDE AT 1:00)	966.5	976.3	989.4	1004.1	1015.6	1024.9	1035.2	1043.4	1052.3	1058.0	2.18
22	(INSIDE AT 1:30)	870.2	885.2	898.7	912.0	923.6	935.3	946.2	956.5	965.7	974.2	2.61
24	(INSIDE AT 2:00)	1019.1	1028.8	1044.0	1058.8	1071.6	1082.2	1092.9	1101.6	1111.4	1116.9	3.05
27	(INSIDE AT 3:00)	989.5	1004.5	1023.3	1042.5	1059.9	1076.0	1092.8	1106.8	1122.3	1132.9	3.70
28	(INSIDE AT 3:30)	939.2	957.2	977.2	997.7	1017.4	1035.2	1052.5	1066.5	1084.0	1096.9	3.92
29	(INSIDE AT 4:00)	881.7	899.1	919.3	941.6	963.8	984.9	1005.2	1024.1	1042.0	1056.3	4.14
33	(INSIDE AT 5:00)	703.3	720.6	738.3	756.9	775.6	793.7	812.1	829.5	846.7	863.4	5.01
34	(INSIDE AT 6:00)	556.6	574.8	593.1	611.9	631.2	650.5	669.8	690.7	710.6	729.9	5.22
36	(INSIDE AT 7:00)	701.2	720.0	739.0	756.3	773.8	791.5	809.9	829.1	848.1	867.4	5.66
38	(INSIDE AT 7:30)	771.1	789.7	807.6	824.8	842.2	860.4	879.2	898.3	917.9	937.6	6.10
41	(INSIDE AT 8:30)	873.8	892.5	908.6	924.8	942.8	960.6	979.8	997.8	1016.6	1035.1	6.75
11	(INSIDE AT 9:00)	921.2	939.2	954.1	969.1	985.0	1003.2	1019.4	1036.5	1050.4	1067.3	.22
10	(INSIDE AT 9:30)	968.2	988.1	1007.0	1022.7	1035.5	1051.6	1064.9	1080.8	1089.9	1100.0	.00
14	(INSIDE AT 10:00)	1029.1	1044.4	1056.6	1068.0	1078.9	1092.5	1104.3	1115.6	1120.8	1127.3	.87
15	(INSIDE AT 10:30)	1063.2	1074.8	1085.3	1095.3	1104.3	1115.1	1125.1	1133.7	1137.9	1142.0	1.09
17	(INSIDE AT 11:00)	1088.8	1097.9	1106.5	1114.4	1120.2	1127.4	1134.2	1138.6	1139.9	1140.3	1.52
42	(MANWAY AT 1, IN.)	410.6	412.2	433.7	448.7	459.7	469.9	480.3	490.6	500.3	509.8	6.97
43	(MANWAY AT 4, INS.)	608.3	622.6	638.2	654.1	667.9	682.4	698.5	712.0	724.7	738.6	7.18
44	(MANWAY AT 7, INS.)	747.1	765.1	784.2	804.7	823.2	843.6	865.1	886.1	905.5	923.1	7.40
45	(MANWAY AT 10, INS.)	707.3	725.0	743.4	762.8	779.4	798.3	818.1	837.1	855.7	876.0	7.62
16	(FIRE AT 12:00)	1564.7	1570.1	1583.3	1571.0	1570.4	1557.7	1588.6	1568.2	1581.3	1565.4	1.31
19	(FIRE AT 3:00)	1535.4	1515.3	1540.0	1534.1	1577.3	1566.0	1465.4	1561.1	1555.4	1575.4	1.96
21	(FIRE AT 6:00)	1539.1	1539.3	1577.3	1571.1	1583.9	1584.7	1525.6	1570.2	1563.0	1589.1	2.39
23	(FIRE AT 9:00)	1532.3	1524.0	1560.1	1559.1	1536.7	1565.7	1548.2	1557.3	1564.2	1574.3	2.85

TABLE A - VII

THERMOCOUPLE TEMPERATURES (DEG. F) FOR TEST NR, 6

CHANNEL NUMBER	LOCATION	TIME (SEC) = 653.10	663.99	674.87	685.75	696.64	707.53	718.41	729.30	740.18	751.07	TIME ADJUST ADD
46	(GRID AT 1, IN.)	1069.7	1077.5	1085.9	1095.4	1102.4	1110.9	1113.2	1127.7	1134.4	1140.0	7.84
47	(GRID AT 3,15 INS.)	1017.5	1026.5	1036.1	1043.9	1050.7	1057.5	1064.8	1071.9	1078.0	1089.1	8.05
48	(GRID AT 3,15 INS.)	1034.7	1044.7	1052.7	1058.4	1065.3	1070.6	1075.7	1087.3	1098.5	1105.9	8.27
49	(GRID AT 3,15 INS.)	1052.1	1061.6	1065.3	1074.0	1084.3	1091.5	1098.9	1110.8	1119.3	1128.0	8.49
50	(GRID AT 7,15 INS.)	978.9	991.5	1005.6	1015.3	1030.1	1041.5	1052.0	1067.0	1091.5	1090.0	8.71
51	(GRID AT 7,15 INS.)	1019.3	1032.3	1045.1	1055.3	1070.0	1077.3	1079.1	1100.3	1125.3	1125.5	8.93
52	(GRID AT 7,15 INS.)	993.2	997.8	1008.8	1038.3	1040.5	1050.5	1057.1	1080.7	1094.9	1095.8	9.14
53	(GRID AT 11.2 INS.)	902.7	901.8	901.1	913.9	920.0	941.6	979.7	1007.9	1030.2	1043.1	9.36
54	(GRID AT 11.2 INS.)	961.4	976.5	994.3	1003.7	1010.9	1029.2	1031.3	1051.4	1057.6	1071.1	9.58
55	(GRID AT 11.2 INS.)	922.4	932.0	944.6	960.0	957.8	990.3	990.4	1009.2	1024.9	1020.1	9.80
56	(GRID AT 15.2 INS.)	893.5	904.2	919.5	938.9	958.4	966.4	972.9	1017.7	1031.9	1028.3	10.01
57	(GRID AT 15.2 INS.)	914.8	922.0	952.1	967.8	984.4	995.5	997.2	1022.3	1037.0	1043.3	10.23
58	(GRID AT 15.2 INS.)	840.5	868.4	886.3	894.4	912.6	940.6	947.0	952.4	971.7	979.6	10.45
59	(GRID AT 19.2 INS.)	782.3	797.6	816.7	832.0	850.0	867.6	862.6	894.6	909.0	910.5	10.67
35	(GRID AT 19.2 INS.)	790.4	810.8	831.4	845.0	873.5	884.8	867.2	897.9	926.9	949.6	5.44
37	(GRID AT 19.2 INS.)	785.4	810.1	828.0	855.7	870.0	886.2	858.0	899.8	932.5	946.0	5.88
39	(GRID AT 21.45 INS.)	446.1	464.5	486.6	501.4	516.0	529.4	524.3	541.3	552.5	568.2	6.31
18	(INSIDE AT 12:00)	1095.4	1101.5	1107.5	1119.6	1124.3	1125.0	1125.8	1133.2	1137.0	1123.6	1.74
20	(INSIDE AT 1:00)	1064.9	1079.2	1090.6	1104.5	1111.3	1114.9	1121.2	1129.2	1133.1	1128.8	2.18
22	(INSIDE AT 1:30)	982.2	990.6	998.4	1007.4	1016.6	1023.7	1032.7	1041.7	1049.3	1055.7	2.61
24	(INSIDE AT 2:00)	1125.5	1139.9	1151.8	1165.9	1173.4	1179.5	1188.5	1195.8	1200.4	1205.3	3.05
27	(INSIDE AT 3:00)	1146.5	1163.8	1179.7	1195.1	1205.2	1215.7	1227.1	1237.7	1246.3	1253.4	3.70
28	(INSIDE AT 3:30)	1112.1	1129.0	1145.2	1161.3	1173.1	1182.7	1190.0	1197.6	1196.3	1188.2	3.92
29	(INSIDE AT 4:00)	1073.7	1090.9	1107.0	1124.8	1139.8	1152.6	1166.5	1167.9	1165.5	1163.6	4.14
33	(INSIDE AT 5:00)	882.7	902.0	920.1	937.5	954.5	973.3	990.5	1003.3	1015.8	1018.1	5.01
34	(INSIDE AT 6:00)	745.7	763.1	779.0	794.6	812.1	828.5	839.7	854.0	867.1	885.1	5.22
36	(INSIDE AT 7:00)	886.2	903.7	916.3	932.7	947.6	964.8	982.5	995.8	1012.3	1028.4	5.66
38	(INSIDE AT 7:30)	957.0	975.8	992.0	1008.6	1027.9	1045.6	1061.7	1078.3	1097.8	1117.7	6.10
41	(INSIDE AT 8:30)	1047.3	1059.3	1073.2	1090.2	1110.5	1130.9	1148.2	1161.3	1174.0	1188.6	6.75
11	(INSIDE AT 9:00)	1083.2	1095.6	1109.7	1123.5	1128.3	1114.5	1091.5	1075.1	1076.5	1089.7	.22
10	(INSIDE AT 9:30)	1111.0	1119.6	1129.2	1142.2	1151.9	1159.5	1175.2	1186.9	1194.8	1203.9	.00
14	(INSIDE AT 10:00)	1135.0	1141.2	1148.5	1159.1	1165.8	1169.2	1160.1	1127.5	1107.4	1062.4	.87
15	(INSIDE AT 10:30)	1146.5	1150.9	1156.8	1166.6	1173.3	1162.8	1149.6	1150.5	1155.4	1160.4	1.09
17	(INSIDE AT 11:00)	1142.5	1146.5	1152.7	1162.5	1166.3	1167.9	1168.9	1170.8	1172.9	1172.4	1.52
42	(MANWAY AT 1, IN.)	518.9	528.4	537.2	546.5	555.1	563.8	577.5	587.0	595.1	601.6	6.97
43	(MANWAY AT 4, INS.)	754.7	768.0	780.7	796.0	813.0	828.5	846.0	860.1	871.5	883.9	7.18
44	(MANWAY AT 7, INS.)	938.4	954.0	971.5	988.6	1005.8	1022.9	1039.3	1056.0	1068.4	1080.8	7.40
45	(MANWAY AT 10, INS.)	893.6	910.3	928.0	944.9	963.0	978.8	997.5	1010.1	1022.8	1035.6	7.62
16	(FIRE AT 12:00)	1583.5	1592.4	1605.7	1584.2	1588.6	1572.2	1588.3	1595.3	1604.5	1600.7	1.31
19	(FIRE AT 3:00)	1521.9	1575.3	1575.8	1517.8	1554.5	1556.6	1535.6	1554.0	1511.7	1497.8	1.96
21	(FIRE AT 6:00)	1558.5	1572.6	1578.8	1551.5	1566.6	1569.9	1556.2	1578.3	1545.8	1539.2	2.39
23	(FIRE AT 9:00)	1567.9	1570.7	1571.5	1548.8	1564.2	1559.2	1560.6	1571.9	1564.2	1554.0	2.83

TABLE A - VIII

THERMOCOUPLE TEMPERATURES (DEG. F) FOR TEST NR, 6

CHANNEL NUMBER	LOCATION	TIME (SEC) =	761.95	772.84	783.72	794.61	805.49	816.38	827.26	838.15	849.03	859.92	TIME ADJUST ADD
46	(GRID AT 1, IN.)		1148.8	1161.3	1162.8	1183.6	1193.5	1206.3	1221.3	1230.8	1245.2	1261.6	7.84
47	(GRID AT 3,15 INS.)		1093.6	1105.7	1112.8	1126.8	1135.8	1149.8	1162.3	1190.6	1202.6	1221.7	8.05
48	(GRID AT 3,15 INS.)		1111.6	1127.6	1131.4	1148.3	1162.5	1176.3	1196.6	1213.8	1229.8	1256.6	8.27
49	(GRID AT 3,15 INS.)		1135.7	1145.5	1150.0	1169.2	1181.5	1194.9	1216.1	1227.3	1243.0	1266.5	8.49
50	(GRID AT 7,15 INS.)		1101.4	1115.1	1119.3	1138.2	1150.7	1164.0	1184.0	1196.2	1210.5	1243.1	8.71
51	(GRID AT 7,15 INS.)		1139.5	1153.6	1155.2	1177.9	1192.0	1202.0	1230.9	1242.0	1260.4	1295.2	8.93
52	(GRID AT 7,15 INS.)		1112.0	1125.6	1132.3	1152.8	1165.9	1180.1	1205.5	1219.5	1237.2	1269.9	9.14
53	(GRID AT 11.2 INS.)		1064.7	1077.6	1086.1	1107.1	1114.5	1127.9	1149.5	1162.3	1186.5	1210.2	9.36
54	(GRID AT 11.2 INS.)		1090.7	1103.4	1113.1	1131.1	1143.6	1160.6	1180.6	1192.2	1216.4	1244.5	9.58
55	(GRID AT 11.2 INS.)		1048.9	1064.1	1068.0	1091.6	1090.9	1127.6	1142.6	1148.4	1179.5	1213.6	9.80
56	(GRID AT 15.2 INS.)		1059.1	1074.5	1080.8	1105.8	1104.8	1131.0	1152.2	1161.3	1176.2	1202.8	10.01
57	(GRID AT 15.2 INS.)		1072.5	1090.2	1097.3	1117.4	1115.2	1141.6	1159.8	1169.1	1197.1	1220.4	10.23
58	(GRID AT 15.2 INS.)		997.2	1014.5	1022.0	1042.4	1052.4	1066.4	1087.4	1100.7	1119.8	1144.4	10.45
59	(GRID AT 19.2 INS.)		918.2	948.8	946.9	961.8	946.8	984.1	1002.8	1011.0	1022.7	1044.2	10.67
35	(GRID AT 19.2 INS.)		931.7	955.1	935.4	974.4	986.5	990.7	1026.6	1001.4	1036.1	1038.6	5.44
37	(GRID AT 19.2 INS.)		941.7	958.9	934.8	984.2	1001.7	1000.5	1023.7	981.2	1049.6	1075.0	5.88
39	(GRID AT 21.45 INS.)		575.4	592.2	595.2	613.1	625.9	631.2	645.5	643.7	664.8	676.3	6.31
18	(INSIDE AT 12:00)		1099.8	1099.0	1101.7	1106.1	1105.5	1106.7	1112.6	1112.3	1121.2	1120.2	1.74
20	(INSIDE AT 1:00)		1119.9	1120.0	1121.9	1126.8	1131.9	1152.7	1172.3	1188.0	1201.5	1209.7	2.18
22	(INSIDE AT 1:30)		1063.5	1071.3	1079.0	1086.8	1094.6	1102.3	1110.9	1119.4	1128.0	1135.8	2.61
24	(INSIDE AT 2:00)		1206.8	1216.9	1228.9	1237.5	1243.4	1250.3	1259.5	1265.5	1270.7	1275.0	3.05
27	(INSIDE AT 3:00)		1258.7	1269.1	1279.9	1289.2	1297.9	1305.5	1315.6	1324.2	1330.3	1334.6	3.70
28	(INSIDE AT 3:30)		1171.7	1148.5	1134.5	1125.8	1124.5	1138.4	1138.9	1144.8	1172.4	1186.5	3.92
29	(INSIDE AT 4:00)		1174.4	1190.7	1203.9	1216.1	1229.9	1244.5	1258.0	1272.6	1284.1	1294.3	4.14
33	(INSIDE AT 5:00)		1020.7	1023.3	1028.3	1033.6	1052.3	1080.5	1108.7	1130.2	1158.5	1180.6	5.01
34	(INSIDE AT 6:00)		906.1	922.1	935.9	952.0	969.5	988.8	1001.8	1020.2	1043.4	1069.4	5.22
36	(INSIDE AT 7:00)		1041.9	1053.6	1064.7	1079.2	1094.8	1104.8	1118.2	1132.7	1145.2	1161.0	5.66
38	(INSIDE AT 7:30)		1134.7	1148.9	1162.8	1177.8	1195.5	1208.1	1222.5	1236.6	1249.2	1263.3	6.10
41	(INSIDE AT 8:30)		1200.6	1212.2	1222.6	1234.8	1247.9	1259.2	1272.4	1283.8	1294.0	1305.9	6.75
11	(INSIDE AT 9:00)		1112.6	1139.8	1173.1	1210.0	1235.4	1263.5	1282.9	1297.6	1311.1	1322.6	.22
10	(INSIDE AT 9:30)		1213.0	1222.1	1230.9	1238.7	1248.8	1257.6	1267.4	1274.8	1283.4	1289.7	.00
14	(INSIDE AT 10:00)		1021.5	982.9	950.0	955.0	960.9	972.9	987.7	974.6	964.5	942.0	.87
15	(INSIDE AT 10:30)		1177.0	1198.4	1221.1	1238.6	1249.0	1256.4	1265.6	1273.8	1279.3	1284.9	1.09
17	(INSIDE AT 11:00)		1166.5	1165.6	1168.7	1175.2	1185.2	1198.5	1209.6	1222.0	1239.2	1247.6	1.52
42	(MANWAY AT 1, IN.)		614.3	619.8	635.4	641.1	650.1	663.5	673.4	697.6	725.0	768.5	6.97
43	(MANWAY AT 4, INS.)		899.1	906.8	922.1	931.4	943.3	958.7	968.2	983.8	999.2	1018.9	7.18
44	(MANWAY AT 7, INS.)		1095.6	1104.4	1115.4	1123.2	1134.7	1146.3	1155.6	1169.5	1183.0	1198.3	7.40
45	(MANWAY AT 10, INS.)		1050.1	1058.2	1072.1	1079.1	1090.5	1103.8	1112.4	1126.0	1139.7	1154.1	7.62
16	(FIRE AT 12:00)		1613.3	1608.8	1603.3	1587.4	1590.0	1600.0	1597.8	1594.7	1590.9	1589.3	1.31
19	(FIRE AT 3:00)		1561.5	1555.0	1558.0	1541.2	1555.6	1569.2	1557.1	1536.2	1546.8	1537.7	1.96
21	(FIRE AT 6:00)		1571.0	1572.9	1572.3	1569.1	1579.8	1584.9	1560.6	1553.9	1553.7	1553.6	2.39
23	(FIRE AT 9:00)		1568.3	1567.9	1568.5	1568.1	1575.1	1575.3	1568.1	1565.1	1568.1	1562.0	2.83

TABLE A - IX

THERMOCOUPLE TEMPERATURES (DEG. F) FOR TEST NR, 6

CHANNEL NUMBER	LOCATION	TIME (SEC) = 870.80	881.69	892.57	903.46	914.34	925.23	936.11	947.00	957.88	968.77	TIME ADJUST ADD
46	(GRID AT 1, IN.)	1261.6	1271.5	1280.0	1279.9	1287.6	1293.3	1297.4	1302.1	1305.4	1310.8	7.84
47	(GRID AT 3,15 INS.)	1231.0	1241.3	1253.1	1258.5	1261.8	1266.5	1272.1	1276.2	1281.7	1287.1	8.03
48	(GRID AT 3,15 INS.)	1253.4	1270.8	1280.7	1281.5	1285.2	1288.1	1293.5	1296.8	1300.4	1307.0	8.27
49	(GRID AT 3,15 INS.)	1262.0	1280.2	1289.2	1288.5	1296.8	1299.5	1296.3	1299.2	1301.7	1309.3	8.49
50	(GRID AT 7,15 INS.)	1243.8	1261.1	1276.0	1278.0	1280.2	1282.5	1288.3	1291.0	1296.2	1301.6	8.71
51	(GRID AT 7,15 INS.)	1290.0	1311.1	1318.1	1315.8	1315.7	1319.5	1322.7	1327.7	1331.9	1338.3	8.93
52	(GRID AT 7,15 INS.)	1267.3	1289.2	1297.5	1298.0	1297.8	1304.0	1306.6	1310.7	1317.6	1322.3	9.14
53	(GRID AT 11.2 INS.)	1221.1	1240.8	1256.3	1266.4	1273.7	1282.6	1288.1	1294.1	1300.9	1307.5	9.36
54	(GRID AT 11.2 INS.)	1250.0	1269.7	1280.8	1288.1	1291.4	1299.6	1304.1	1309.7	1319.0	1323.8	9.58
55	(GRID AT 11.2 INS.)	1212.3	1227.4	1238.4	1241.1	1238.8	1243.9	1249.8	1254.2	1262.8	1267.0	9.80
56	(GRID AT 15.2 INS.)	1206.7	1228.8	1243.6	1246.7	1252.8	1258.4	1264.0	1272.4	1284.8	1287.3	10.01
57	(GRID AT 15.2 INS.)	1220.5	1239.1	1252.0	1262.2	1265.7	1266.6	1271.9	1281.2	1292.6	1297.1	10.23
58	(GRID AT 15.2 INS.)	1149.0	1167.3	1180.4	1190.9	1198.9	1202.3	1209.3	1216.0	1222.1	1228.4	10.45
59	(GRID AT 19.2 INS.)	1057.5	1069.9	1089.1	1086.1	1098.5	1105.4	1110.7	1117.7	1120.7	1127.3	10.67
35	(GRID AT 19.2 INS.)	1026.2	1058.6	1099.7	1072.4	1056.3	1053.5	1057.8	1064.8	1052.3	1054.8	5.44
37	(GRID AT 19.2 INS.)	1062.4	1090.3	1109.4	1100.2	1113.6	1114.9	1113.3	1122.2	1120.5	1130.5	5.88
39	(GRID AT 21.45 INS.)	680.5	693.6	703.2	710.4	717.3	724.7	732.6	740.5	747.8	754.9	6.31
18	(INSIDE AT 12:00)	1133.7	1150.6	1167.8	1184.4	1203.9	1221.8	1235.3	1249.6	1264.9	1278.8	1.74
20	(INSIDE AT 1:00)	1219.1	1225.8	1233.7	1242.3	1250.6	1257.6	1262.3	1269.7	1279.1	1289.1	2.18
22	(INSIDE AT 1:30)	1144.4	1152.5	1162.0	1171.4	1180.6	1189.9	1198.9	1209.5	1220.3	1232.9	2.61
24	(INSIDE AT 2:00)	1280.5	1285.4	1290.5	1298.5	1305.4	1310.9	1314.0	1318.9	1326.3	1331.5	3.05
27	(INSIDE AT 3:00)	1338.3	1339.9	1343.4	1346.7	1348.2	1350.7	1352.0	1358.1	1362.5	1369.7	3.70
28	(INSIDE AT 3:30)	1217.9	1233.6	1249.7	1266.6	1283.4	1296.3	1306.4	1317.1	1329.0	1341.0	3.92
29	(INSIDE AT 4:00)	1301.0	1305.6	1310.1	1315.3	1318.6	1321.4	1321.7	1323.6	1326.7	1330.5	4.14
33	(INSIDE AT 5:00)	1204.9	1223.5	1241.2	1258.9	1273.8	1286.3	1295.7	1305.0	1315.2	1326.1	5.01
34	(INSIDE AT 6:00)	1097.2	1128.8	1150.2	1171.0	1190.0	1211.5	1229.0	1246.5	1262.6	1278.9	5.22
36	(INSIDE AT 7:00)	1174.6	1191.5	1207.6	1222.9	1235.3	1248.4	1260.9	1273.4	1284.4	1294.9	5.66
38	(INSIDE AT 7:30)	1274.8	1287.1	1298.1	1306.3	1311.8	1317.1	1322.0	1325.3	1327.5	1329.4	6.10
41	(INSIDE AT 8:30)	1315.7	1324.2	1329.9	1332.5	1333.2	1333.6	1335.1	1337.5	1340.9	1344.9	6.75
11	(INSIDE AT 9:00)	1328.5	1332.2	1334.7	1336.1	1333.1	1330.7	1330.5	1331.9	1332.6	1333.6	.22
10	(INSIDE AT 9:30)	1296.0	1301.9	1307.8	1310.8	1310.7	1310.3	1312.0	1312.9	1314.6	1316.4	.00
14	(INSIDE AT 10:00)	923.9	942.6	964.1	988.5	1023.3	1064.2	1102.9	1138.2	1169.2	1198.3	.87
15	(INSIDE AT 10:30)	1291.0	1297.1	1303.7	1308.4	1311.4	1316.2	1321.1	1325.7	1328.6	1330.5	1.09
17	(INSIDE AT 11:00)	1259.0	1269.1	1278.6	1287.2	1291.2	1296.4	1300.9	1306.3	1309.5	1314.8	1.52
42	(MANWAY AT 1, IN.)	833.6	896.0	963.8	1024.1	1074.9	1118.7	1157.0	1192.6	1225.9	1256.5	6.97
43	(MANWAY AT 4, INS.)	1043.6	1069.8	1100.6	1131.6	1159.9	1185.0	1208.4	1232.2	1254.5	1275.8	7.18
44	(MANWAY AT 7, INS.)	1216.7	1232.2	1249.0	1265.7	1279.0	1289.4	1298.5	1309.1	1319.5	1330.0	7.40
45	(MANWAY AT 10, INS.)	1172.0	1189.4	1209.1	1229.2	1245.9	1260.3	1273.2	1287.0	1300.3	1313.8	7.62
16	(FIRE AT 12:00)	1608.9	1603.9	1595.3	1591.3	1591.9	1578.2	1591.1	1600.7	1580.2	1599.9	1.31
19	(FIRE AT 3:00)	1561.6	1562.1	1568.6	1565.1	1558.8	1538.8	1570.9	1568.0	1561.0	1569.8	1.96
21	(FIRE AT 6:00)	1558.4	1562.4	1577.9	1570.7	1566.0	1548.5	1572.3	1570.7	1561.1	1568.9	2.39
23	(FIRE AT 9:00)	1568.0	1568.2	1573.9	1566.4	1563.7	1559.0	1567.1	1566.4	1564.9	1571.3	2.85

TABLE A - X

THERMOCOUPLE TEMPERATURES (DEG. F) FOR TEST NR. 6

CHANNEL NUMBER	LOCATION	TIME (SEC) = 979.65	990.54	1001.42	1012.31	1023.19	1034.08	1044.96	1055.84	1066.73	1077.62	TIME ADJUST ADD
46	(GRID AT 1, IN.)	1314.5	1319.1	1324.0	1325.4	1330.1	1334.5	1339.7	1343.0	1347.6	1349.1	7.84
47	(GRID AT 3,15 INS.)	1293.2	1298.5	1304.0	1309.1	1314.3	1319.6	1325.1	1330.3	1335.2	1337.5	8.02
48	(GRID AT 3,15 INS.)	1311.5	1316.0	1319.5	1321.9	1326.5	1331.4	1335.7	1339.5	1344.3	1346.4	8.27
49	(GRID AT 3,15 INS.)	1315.2	1319.2	1321.9	1326.7	1331.0	1335.2	1337.7	1341.3	1344.7	1347.3	8.49
50	(GRID AT 7,15 INS.)	1307.0	1312.5	1317.5	1322.7	1326.1	1330.4	1334.0	1339.1	1343.4	1345.9	8.71
51	(GRID AT 7,15 INS.)	1343.4	1348.8	1352.5	1357.1	1361.5	1365.6	1367.7	1372.0	1375.2	1378.3	8.93
52	(GRID AT 7,15 INS.)	1328.0	1332.3	1337.3	1343.9	1349.6	1350.5	1356.1	1361.2	1362.2	1368.3	9.14
53	(GRID AT 11.2 INS.)	1312.7	1317.5	1323.4	1327.5	1333.3	1338.3	1341.7	1347.3	1352.1	1357.0	9.36
54	(GRID AT 11.2 INS.)	1328.3	1334.9	1338.5	1343.7	1348.6	1353.3	1356.2	1362.9	1366.5	1370.3	9.58
55	(GRID AT 11.2 INS.)	1275.7	1280.7	1284.8	1296.1	1300.3	1303.7	1307.6	1312.7	1315.7	1318.4	9.80
56	(GRID AT 15.2 INS.)	1293.8	1303.6	1312.0	1315.0	1324.7	1325.2	1330.1	1338.0	1344.2	1350.5	10.01
57	(GRID AT 15.2 INS.)	1300.0	1311.1	1315.8	1318.1	1324.1	1327.6	1333.8	1342.8	1340.1	1351.3	10.23
58	(GRID AT 15.2 INS.)	1234.6	1241.4	1244.3	1251.3	1257.0	1261.1	1266.7	1270.9	1274.7	1277.4	10.45
59	(GRID AT 19.2 INS.)	1131.9	1139.0	1144.2	1152.7	1157.9	1169.1	1178.1	1188.2	1195.6	1201.3	10.67
35	(GRID AT 19.2 INS.)	1049.8	1056.5	1055.9	1057.0	1065.3	1063.0	1081.4	1091.8	1084.7	1107.4	5.44
37	(GRID AT 19.2 INS.)	1133.0	1135.2	1141.2	1143.5	1149.2	1154.3	1158.0	1161.2	1165.1	1167.7	5.80
39	(GRID AT 21.45 INS.)	761.9	769.1	777.2	785.3	794.1	801.6	810.5	818.9	828.3	836.2	6.31
18	(INSIDE AT 12:00)	1290.5	1300.0	1306.6	1314.2	1320.1	1326.2	1334.0	1342.7	1347.2	1348.6	1.74
20	(INSIDE AT 1:00)	1299.0	1306.6	1311.5	1319.3	1325.5	1331.7	1338.7	1346.1	1349.9	1352.4	2.18
22	(INSIDE AT 1:30)	1245.5	1258.6	1270.9	1283.8	1296.2	1308.9	1321.5	1334.7	1343.9	1352.3	2.61
24	(INSIDE AT 2:00)	1337.2	1339.4	1339.6	1342.7	1344.3	1346.7	1349.1	1353.8	1355.7	1358.3	3.05
27	(INSIDE AT 3:00)	1378.0	1383.3	1388.1	1393.2	1396.1	1390.1	1400.6	1402.0	1403.3	1404.3	3.70
28	(INSIDE AT 3:30)	1354.1	1367.4	1377.6	1388.0	1394.3	1401.0	1406.6	1410.5	1411.9	1414.9	3.92
29	(INSIDE AT 4:00)	1337.2	1343.1	1349.1	1357.1	1362.3	1368.5	1373.5	1378.5	1381.0	1385.5	4.14
33	(INSIDE AT 5:00)	1336.4	1346.5	1355.5	1365.1	1373.3	1381.4	1388.5	1393.6	1398.8	1403.1	5.01
34	(INSIDE AT 6:00)	1297.4	1311.5	1326.8	1341.2	1353.5	1365.9	1375.7	1384.7	1390.2	1397.9	5.22
36	(INSIDE AT 7:00)	1306.2	1316.3	1326.9	1337.3	1346.8	1356.4	1364.7	1371.5	1377.0	1382.8	5.66
38	(INSIDE AT 7:30)	1331.9	1335.4	1339.9	1345.5	1351.4	1358.2	1364.3	1370.3	1373.4	1380.0	6.10
41	(INSIDE AT 8:30)	1350.4	1355.6	1361.4	1367.2	1372.6	1379.0	1384.4	1388.6	1391.3	1395.4	6.75
11	(INSIDE AT 9:00)	1335.2	1337.3	1337.9	1341.8	1343.1	1349.0	1354.4	1361.0	1364.9	1366.4	.22
10	(INSIDE AT 9:30)	1318.0	1320.6	1321.6	1324.6	1326.8	1331.6	1336.0	1341.7	1346.1	1346.8	.00
14	(INSIDE AT 10:00)	1224.5	1248.0	1267.3	1284.4	1297.6	1310.2	1321.3	1332.3	1340.3	1343.8	.67
15	(INSIDE AT 10:30)	1331.5	1332.6	1334.0	1336.2	1338.8	1342.9	1347.1	1353.3	1357.1	1357.1	1.09
17	(INSIDE AT 11:00)	1317.9	1319.0	1321.4	1325.6	1326.5	1330.1	1333.6	1339.9	1343.8	1345.2	1.52
42	(MANWAY AT 1, IN.)	1285.0	1308.7	1328.6	1345.9	1359.6	1372.3	1381.0	1387.7	1391.9	1397.1	6.97
43	(MANWAY AT 4, INS.)	1295.9	1313.5	1328.7	1341.8	1353.4	1364.0	1372.1	1378.4	1383.2	1387.7	7.19
44	(MANWAY AT 7, INS.)	1340.5	1349.7	1358.1	1366.3	1373.2	1380.5	1387.6	1391.5	1393.0	1397.5	7.40
45	(MANWAY AT 10, INS.)	1326.8	1338.4	1348.7	1357.7	1366.0	1373.3	1380.7	1385.6	1388.8	1393.4	7.62
16	(FIRE AT 12:00)	1585.6	1591.1	1605.2	1596.4	1598.5	1602.0	1603.9	1593.1	1605.8	1618.4	1.31
19	(FIRE AT 3:00)	1558.6	1571.3	1578.0	1573.9	1570.1	1576.6	1583.5	1574.6	1587.1	1592.6	1.90
21	(FIRE AT 6:00)	1558.8	1565.6	1571.5	1567.0	1563.0	1567.4	1571.8	1558.1	1562.0	1570.0	2.37
23	(FIRE AT 9:00)	1567.2	1572.2	1578.3	1572.9	1578.4	1582.4	1586.3	1584.7	1591.5	1594.9	2.83

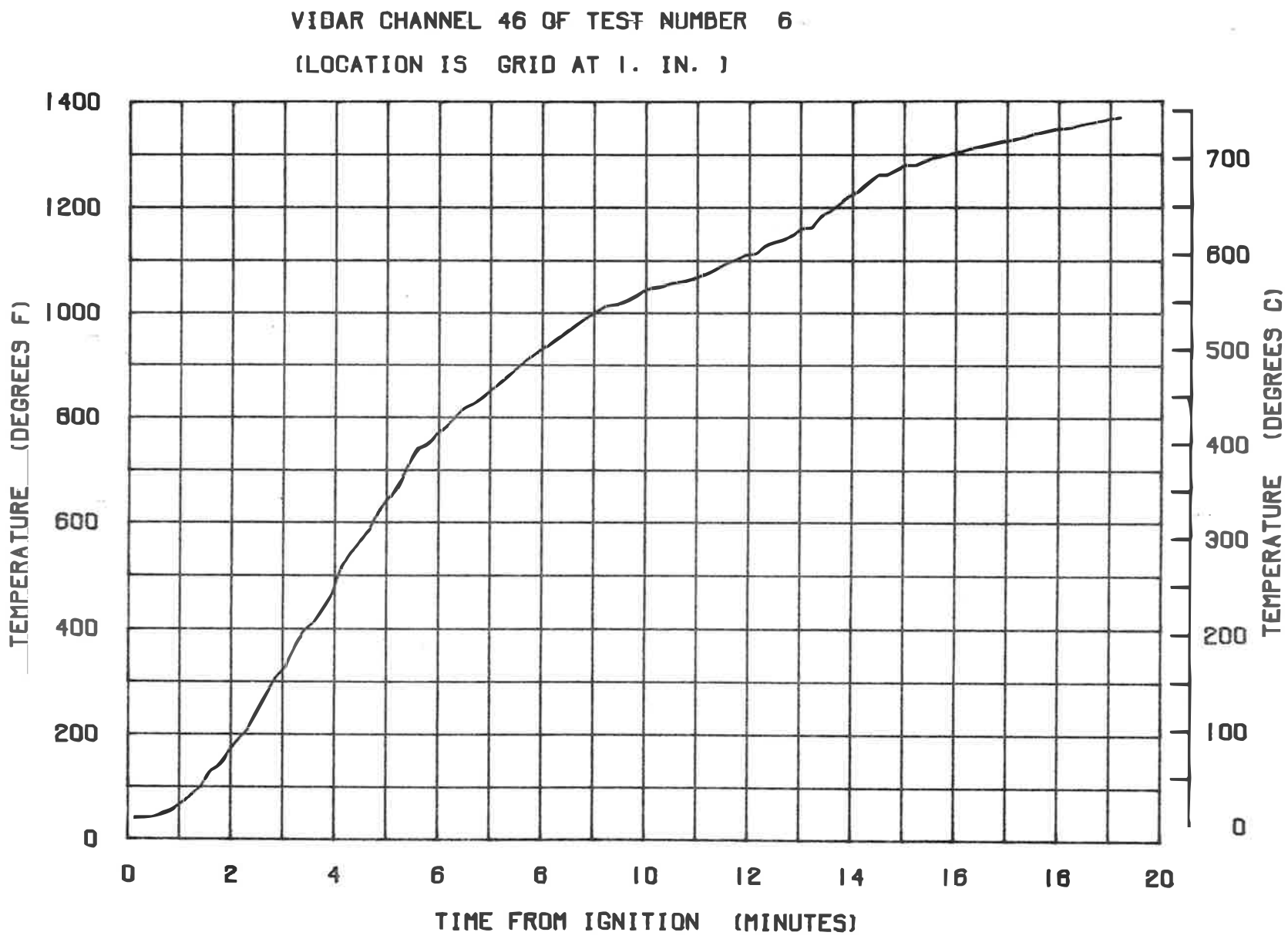

FIGURE A1 THERMOCOUPLE TEMPERATURE VS. TIME

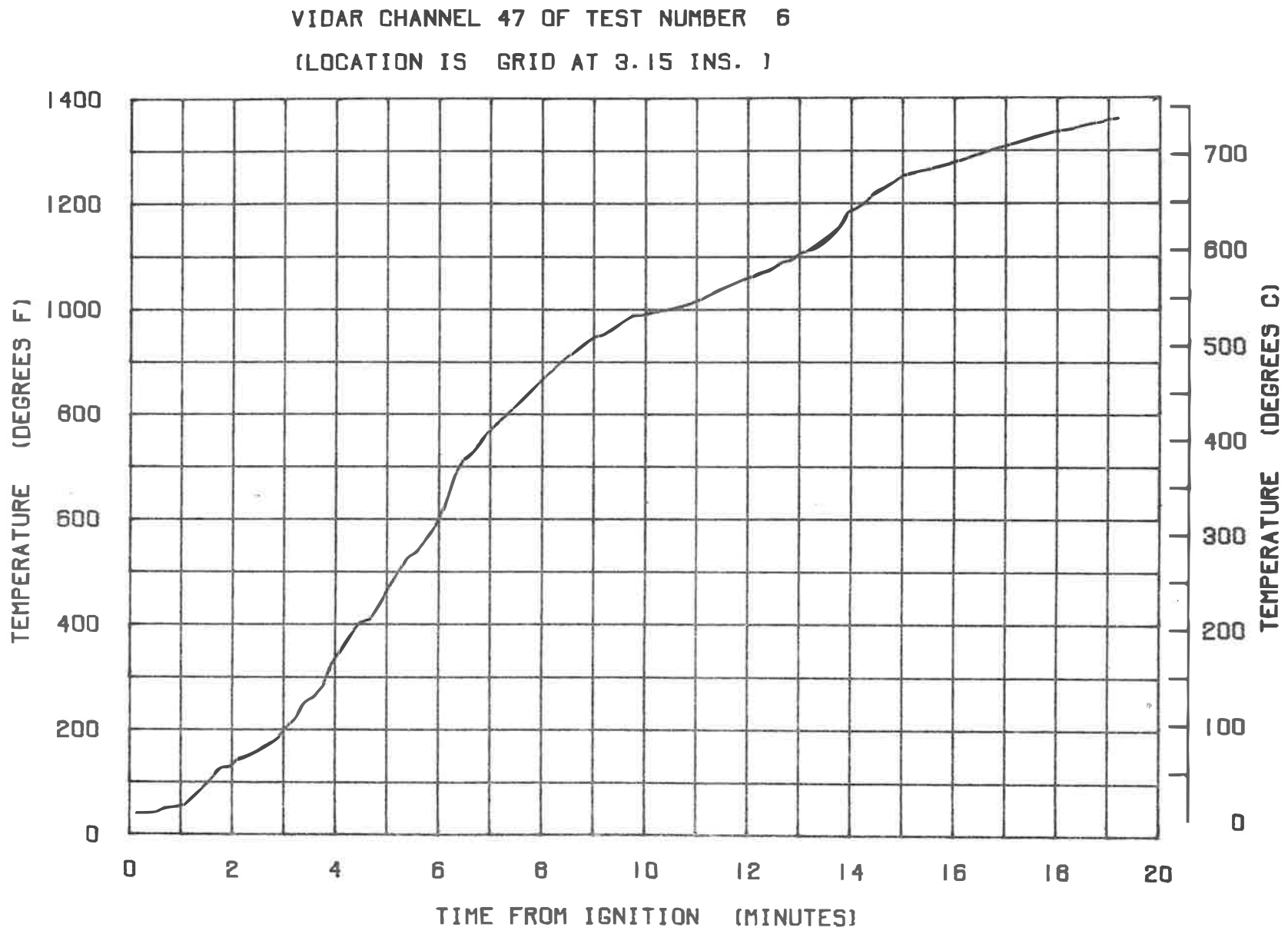

FIGURE A2 THERMOCOUPLE TEMPERATURE VS. TIME

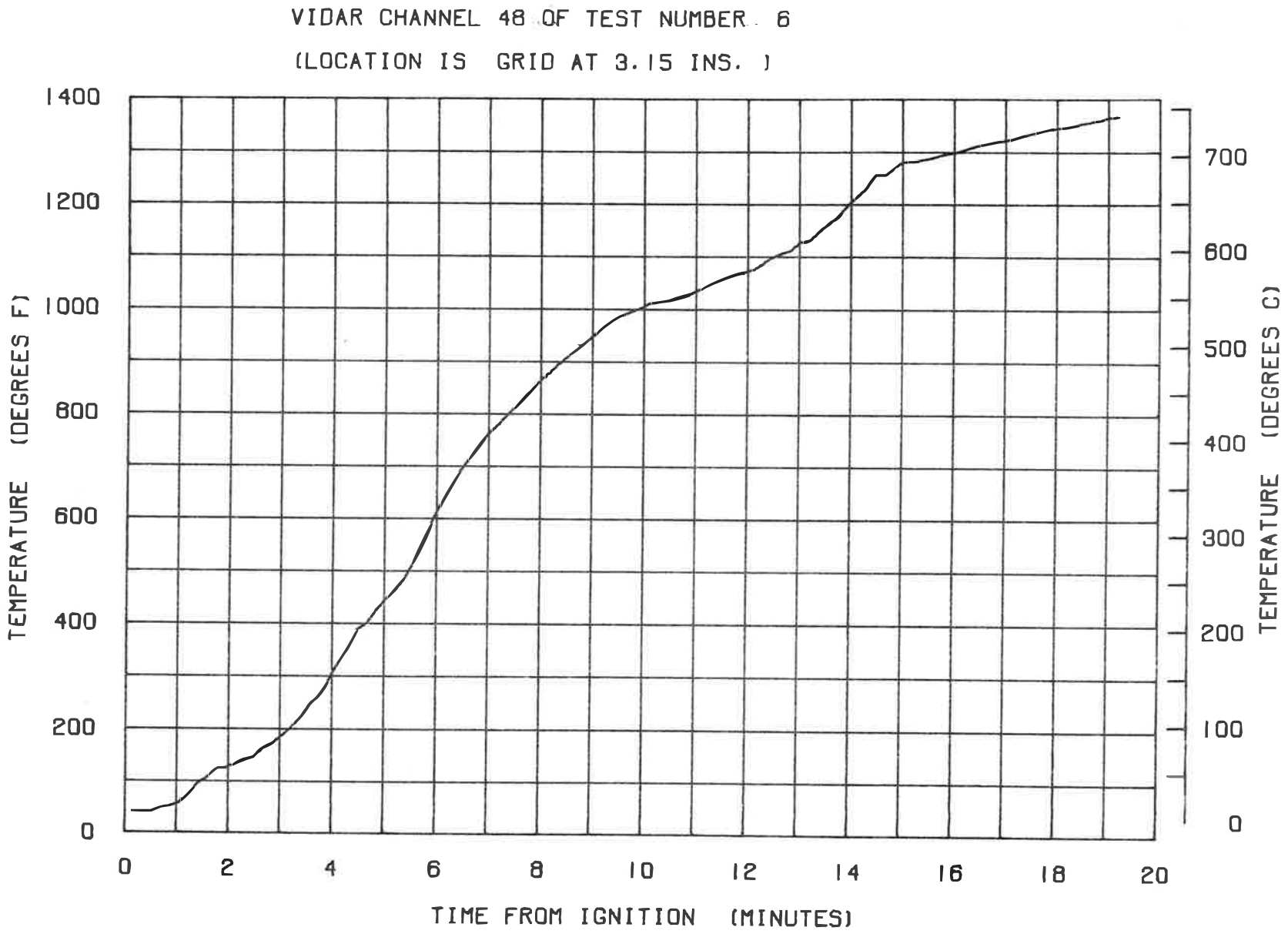

FIGURE A3 THERMOCOUPLE TEMPERATURE VS. TIME

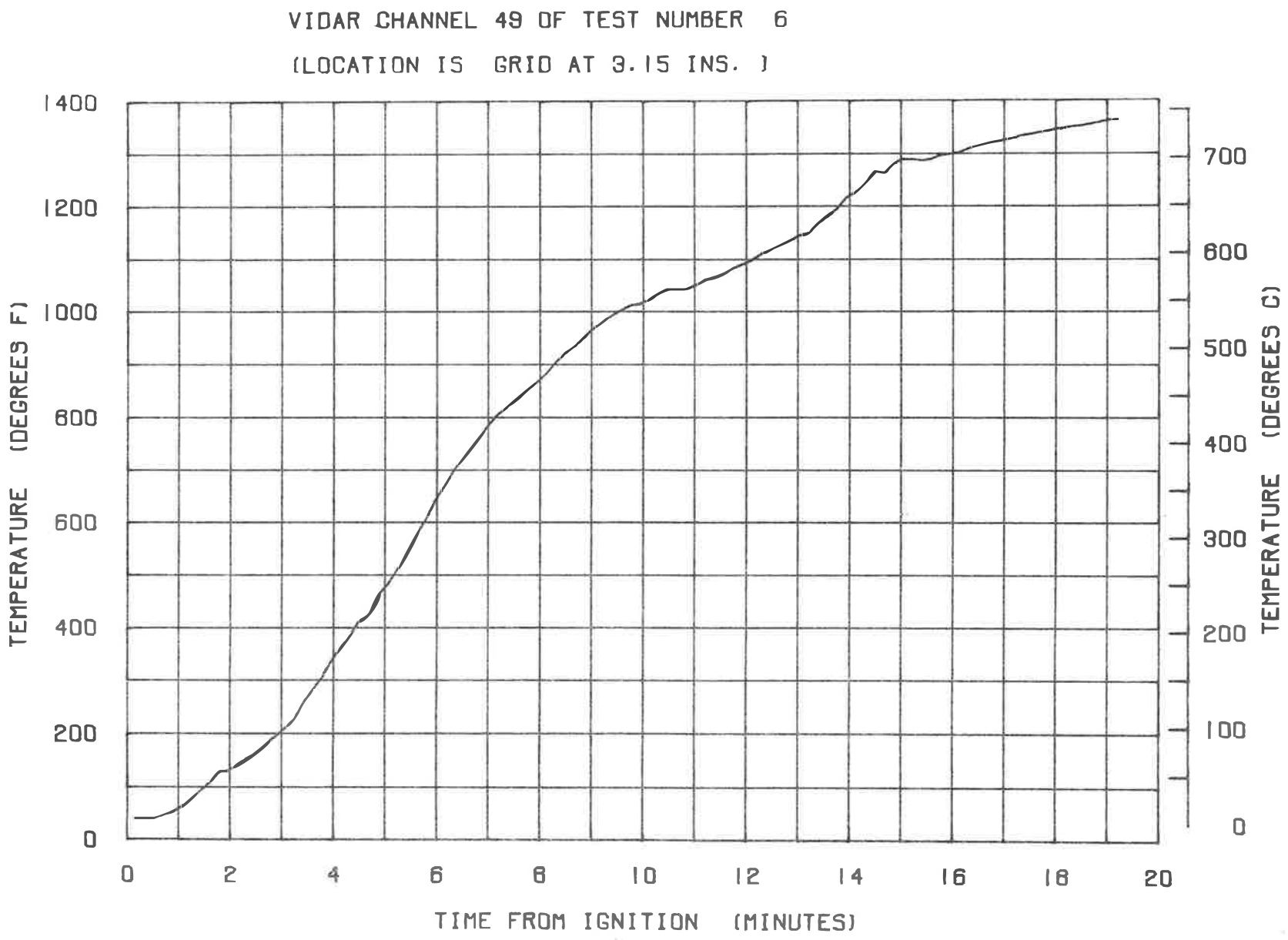

FIGURE A4 THERMOCOUPLE TEMPERATURE VS. TIME

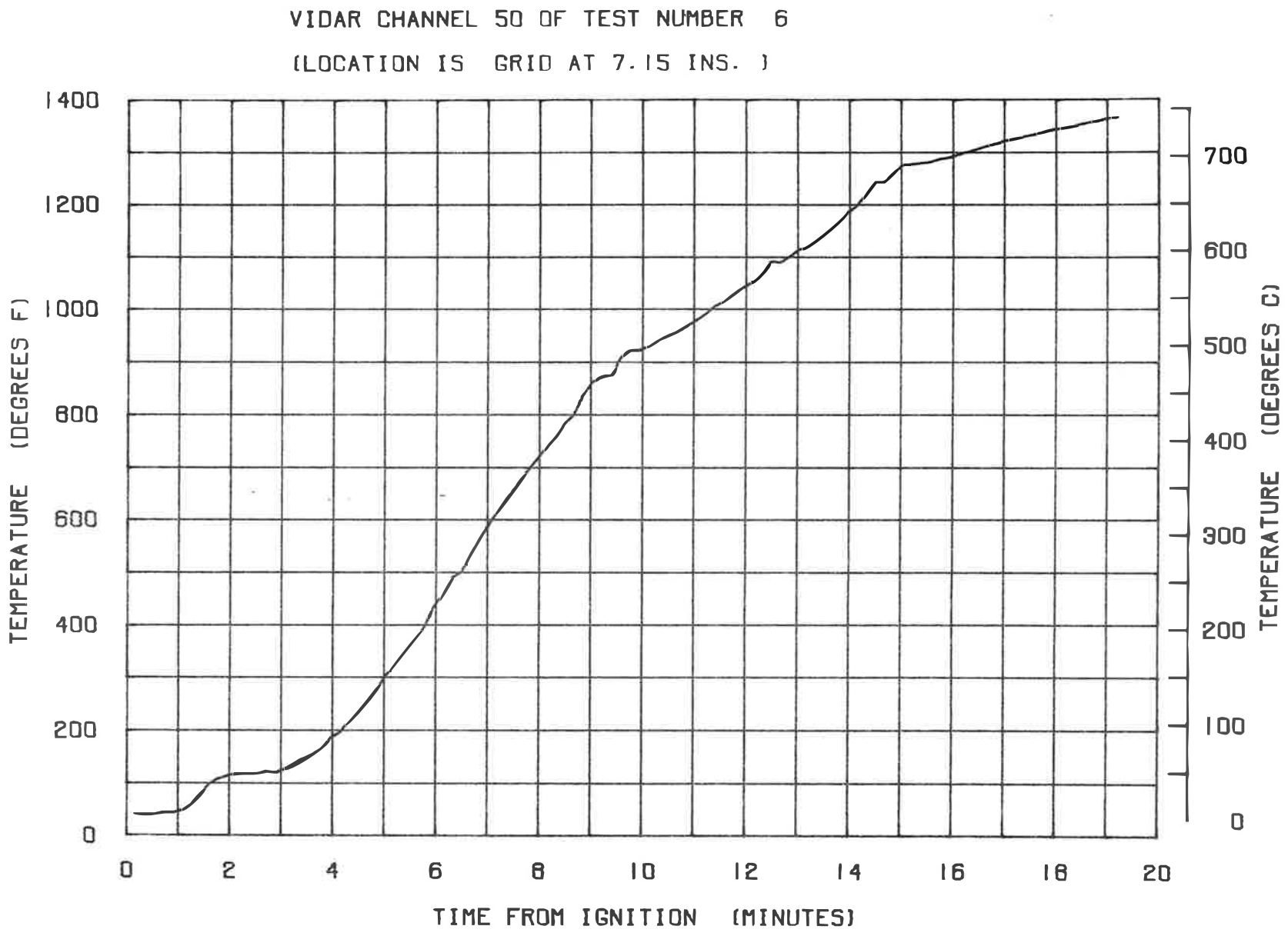

FIGURE A5 THERMOCOUPLE TEMPERATURE VS. TIME

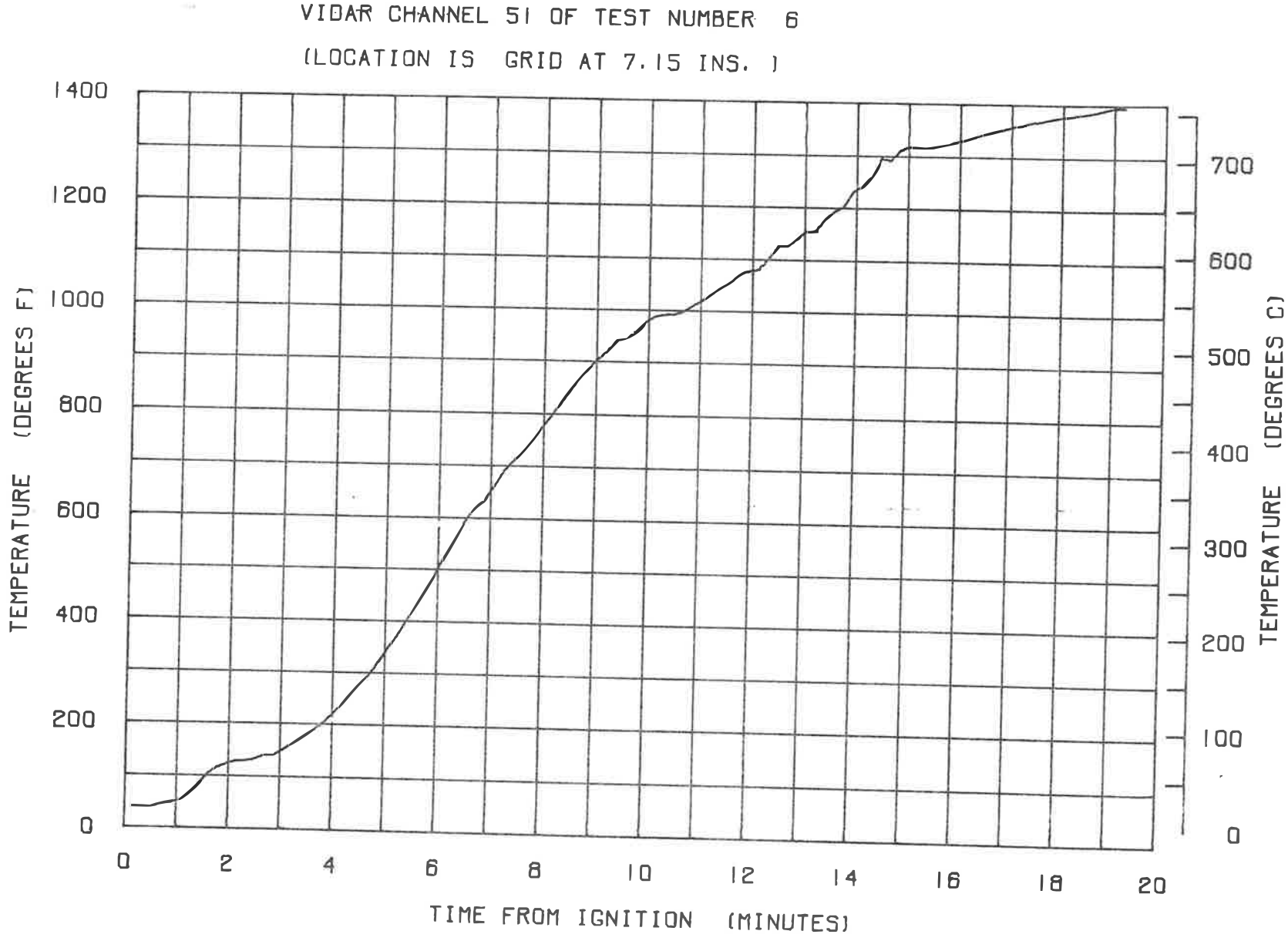

FIGURE A6 THERMOCOUPLE TEMPERATURE VS. TIME

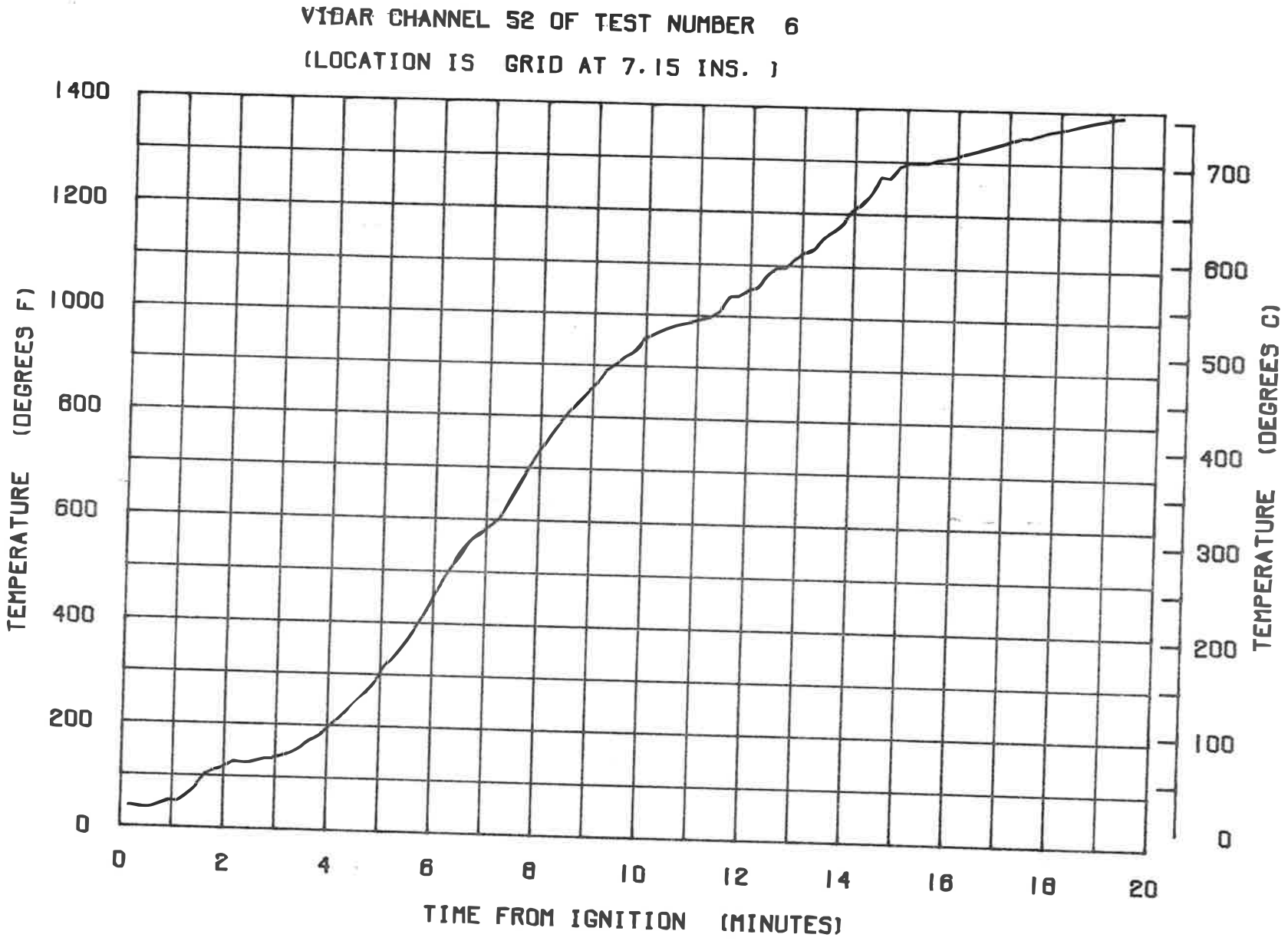

FIGURE A7 THERMOCOUPLE TEMPERATURE VS. TIME

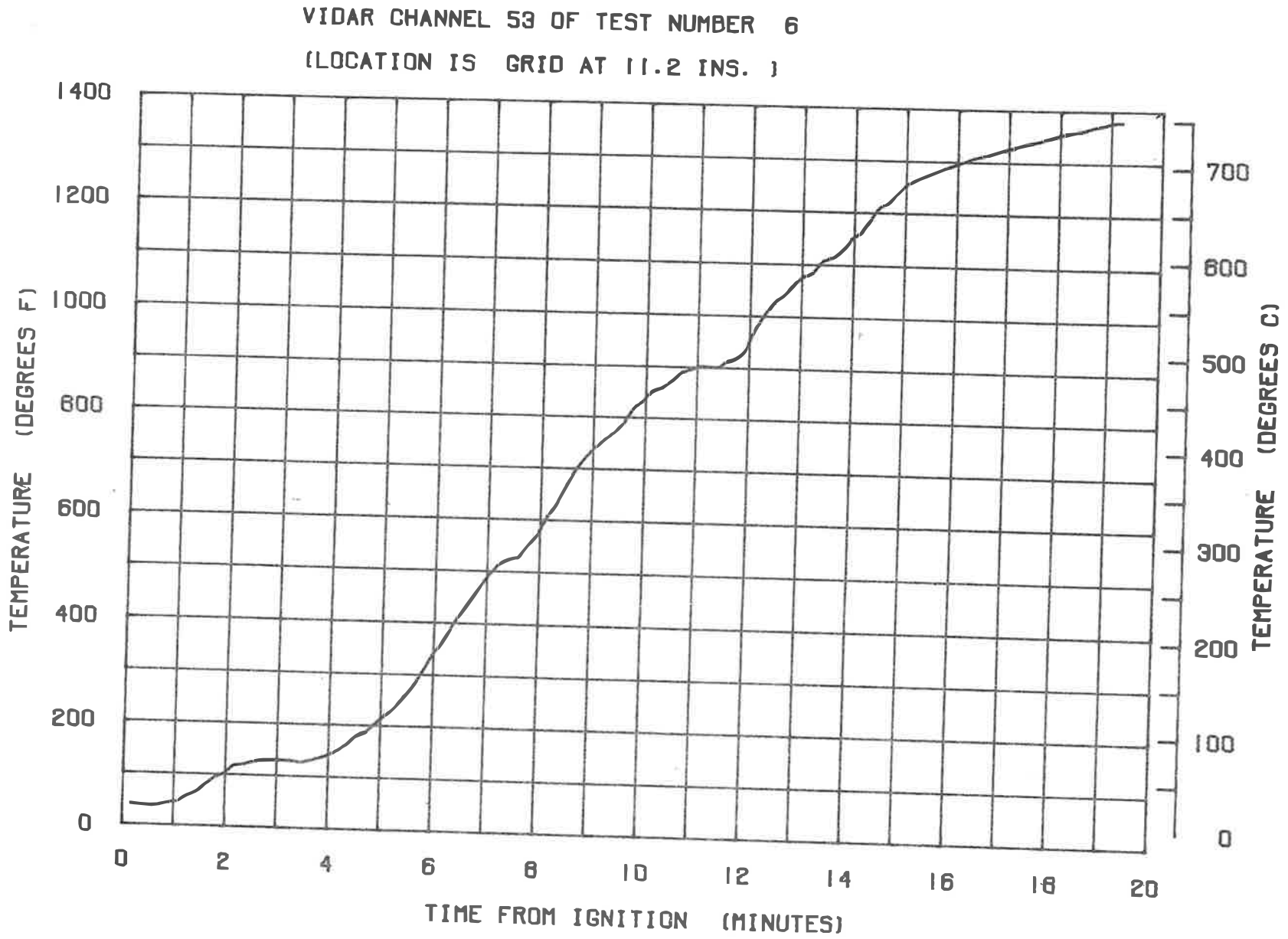

FIGURE A8 THERMOCOUPLE TEMPERATURE VS. TIME

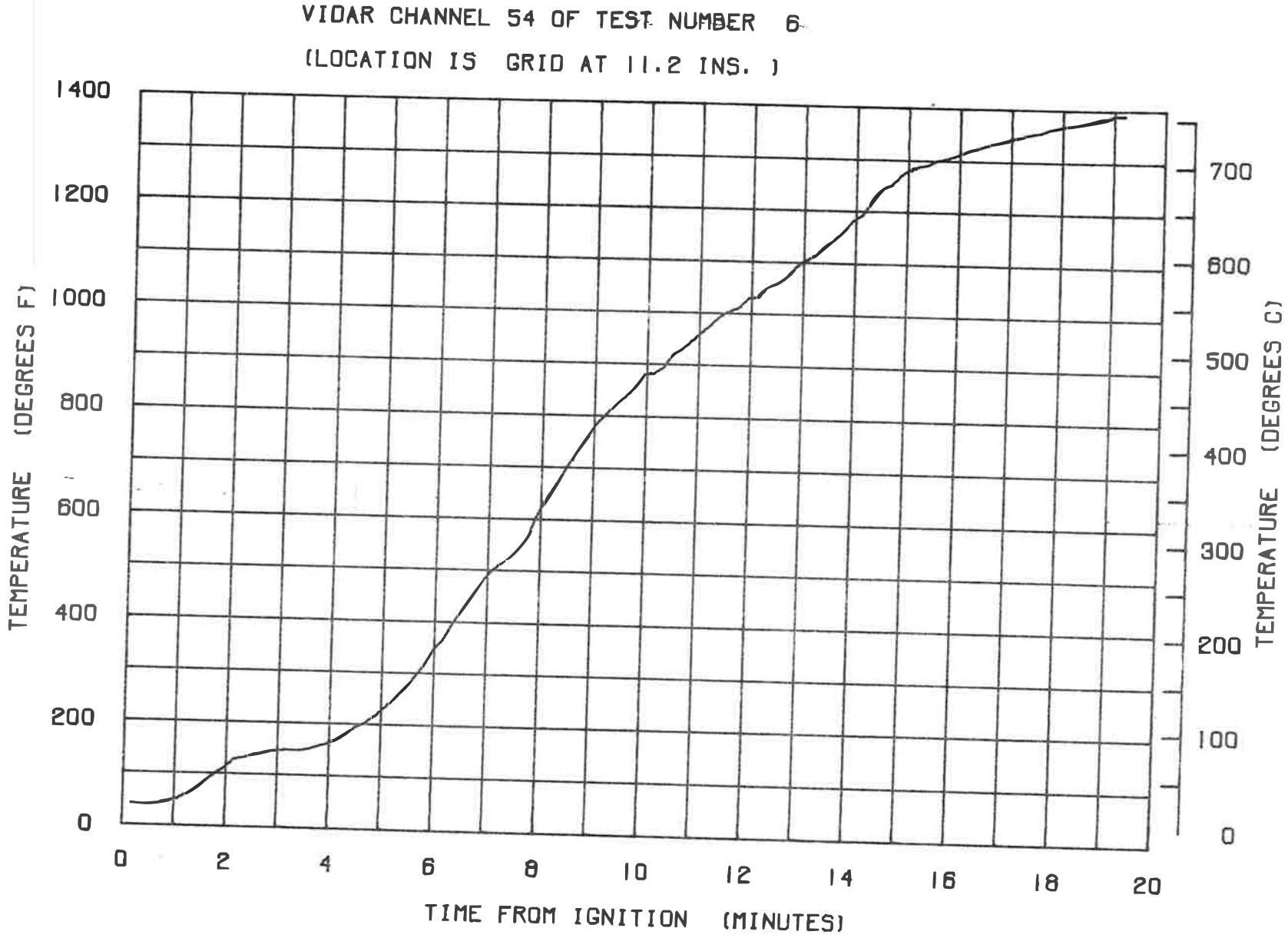

FIGURE A9 THERMOCOUPLE TEMPERATURE VS. TIME

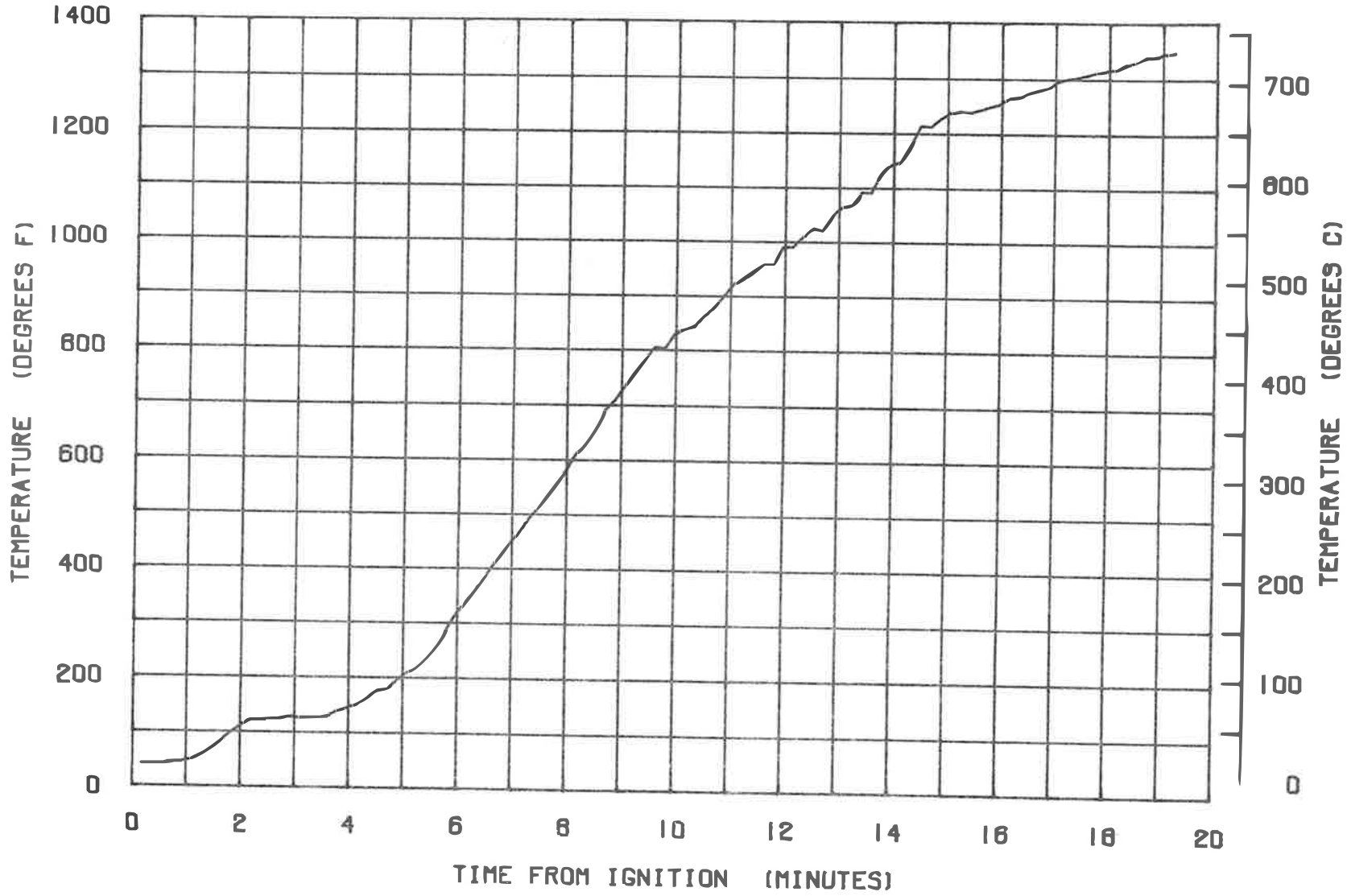

FIGURE A10 THERMOCOUPLE TEMPERATURE VS. TIME

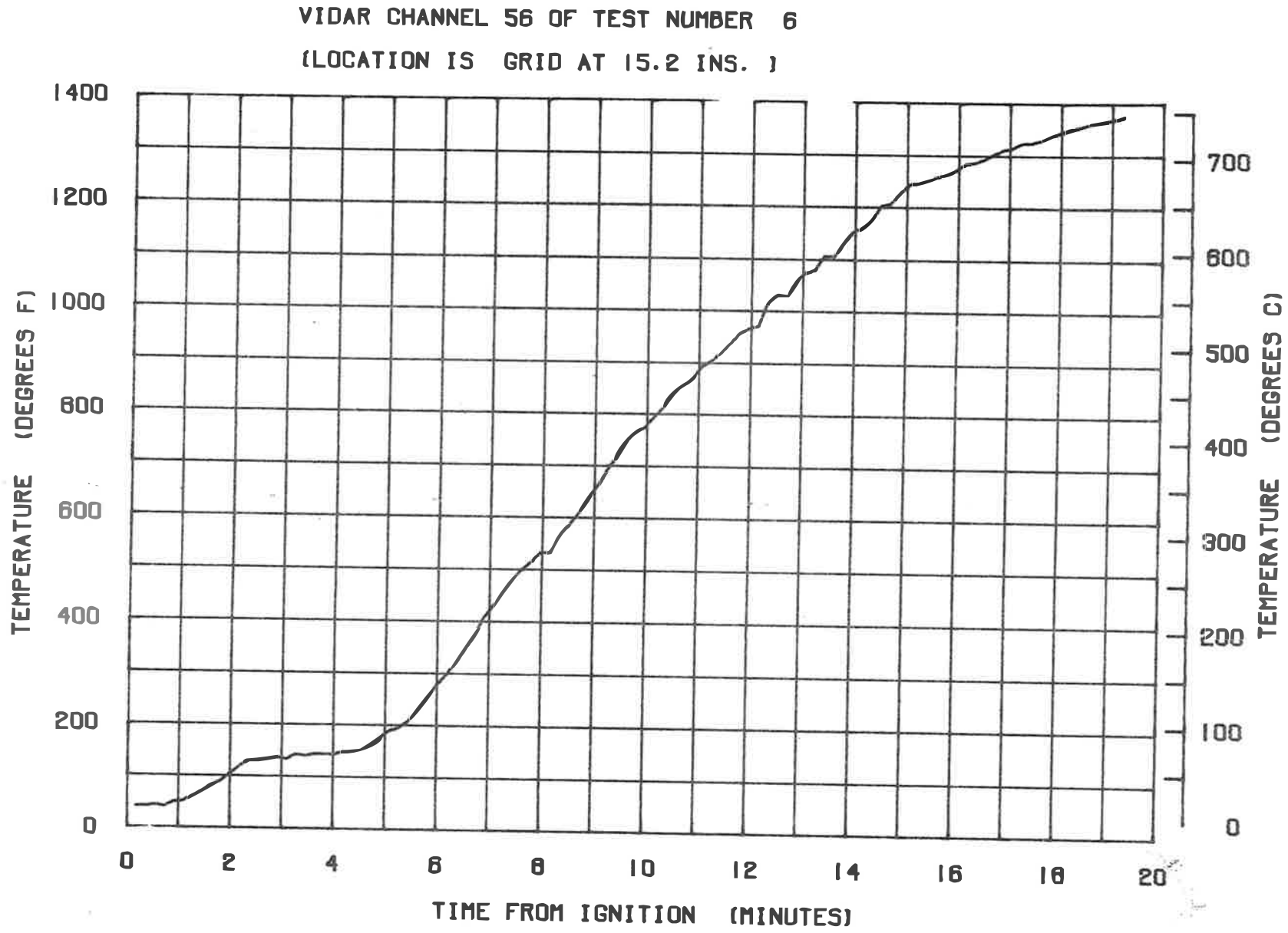

FIGURE A11 THERMOCOUPLE TEMPERATURE VS. TIME

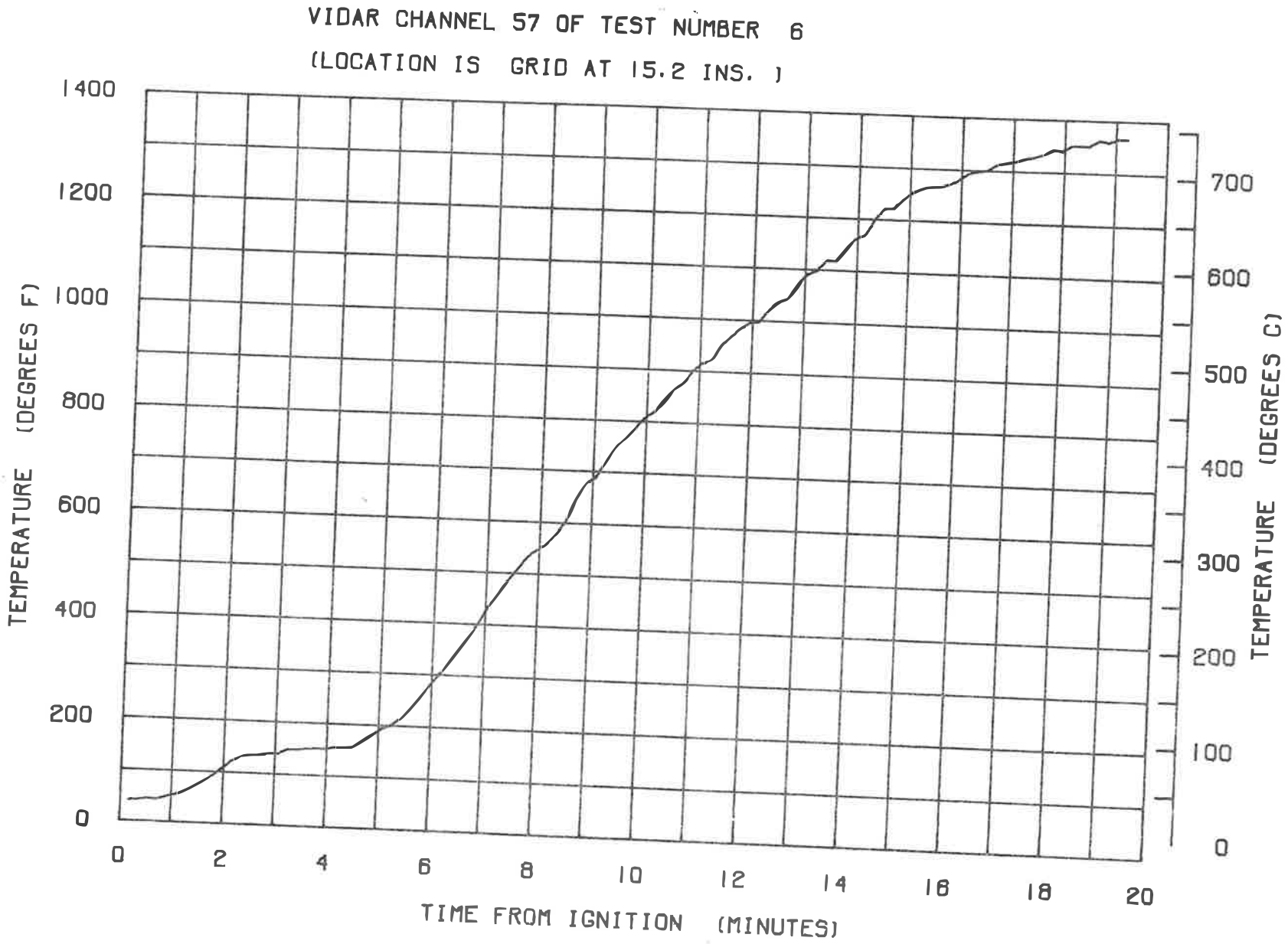

FIGURE A12 THERMOCOUPLE TEMPERATURE VS. TIME

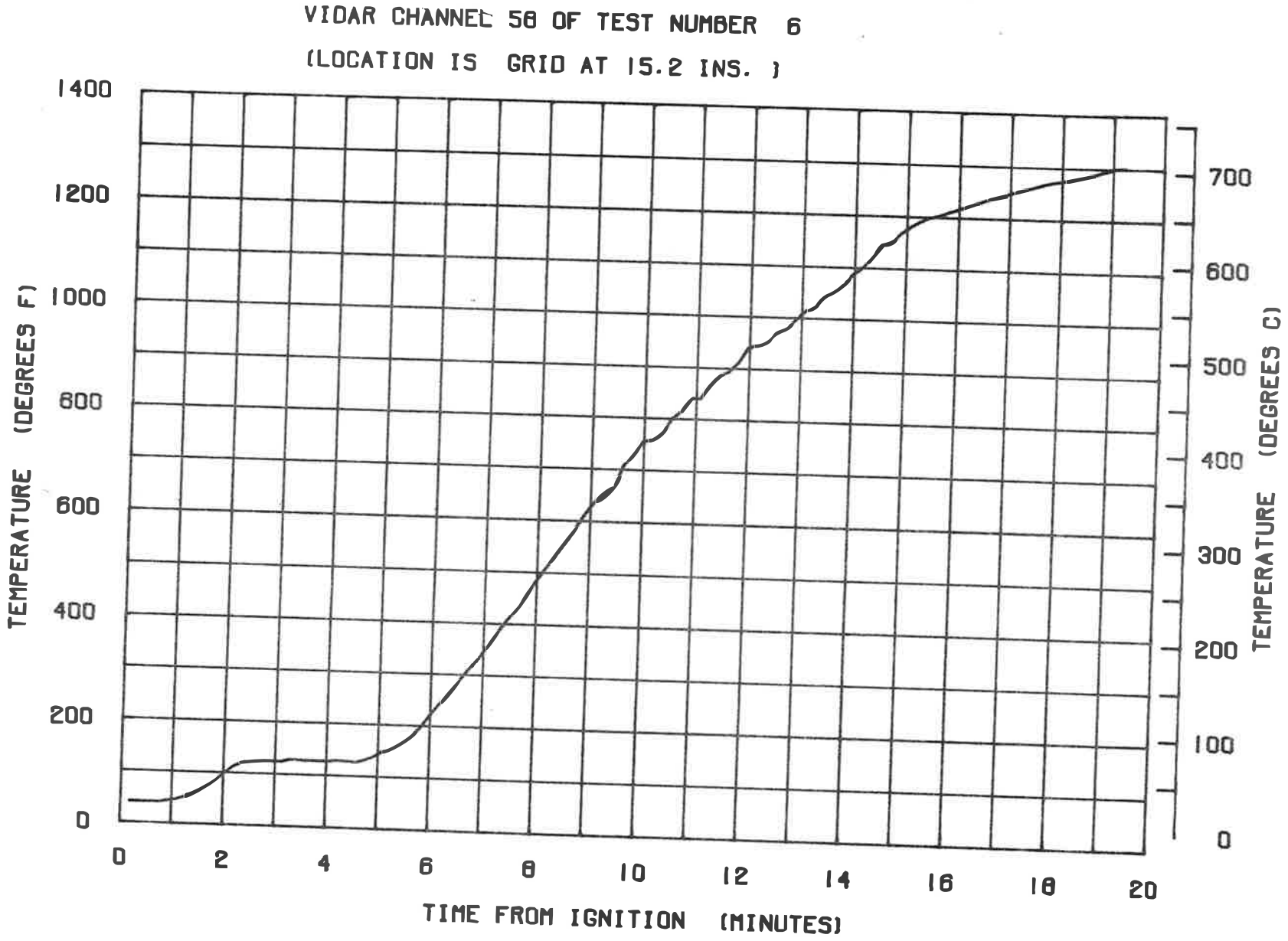

FIGURE A13 THERMOCOUPLE TEMPERATURE VS. TIME

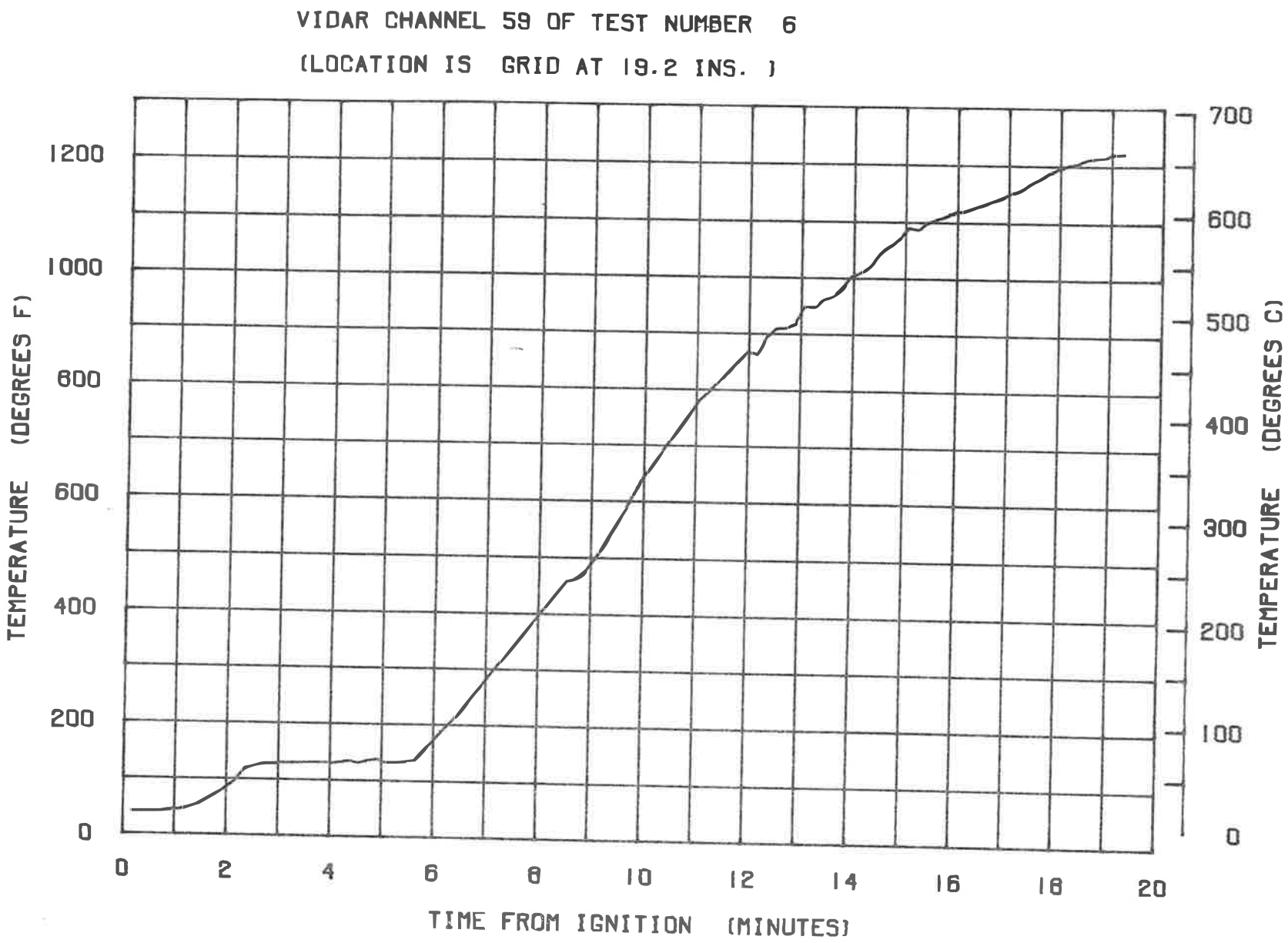

FIGURE A14 THERMOCOUPLE TEMPERATURE VS. TIME

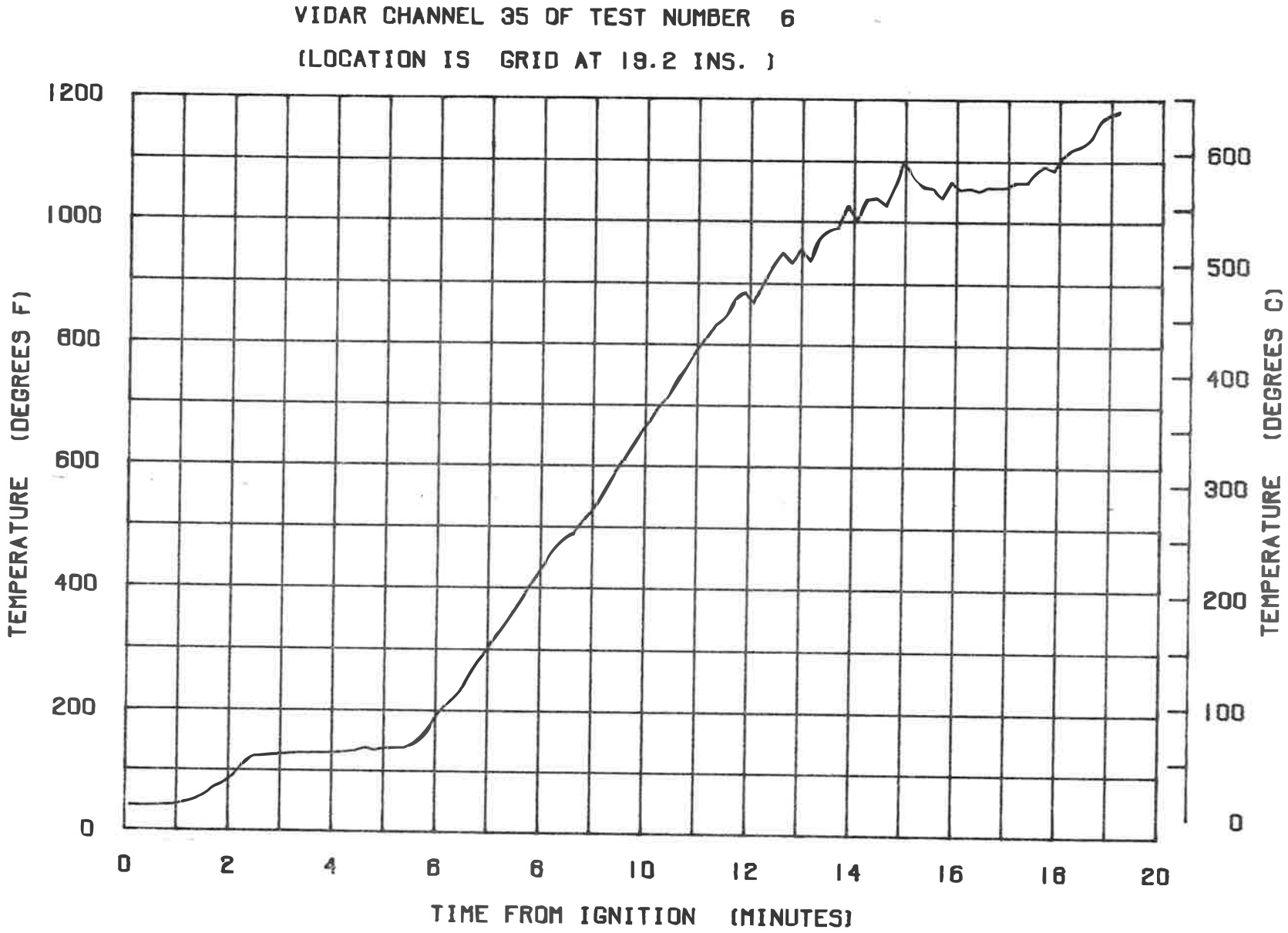

FIGURE A15 THERMOCOUPLE TEMPERATURE VS. TIME

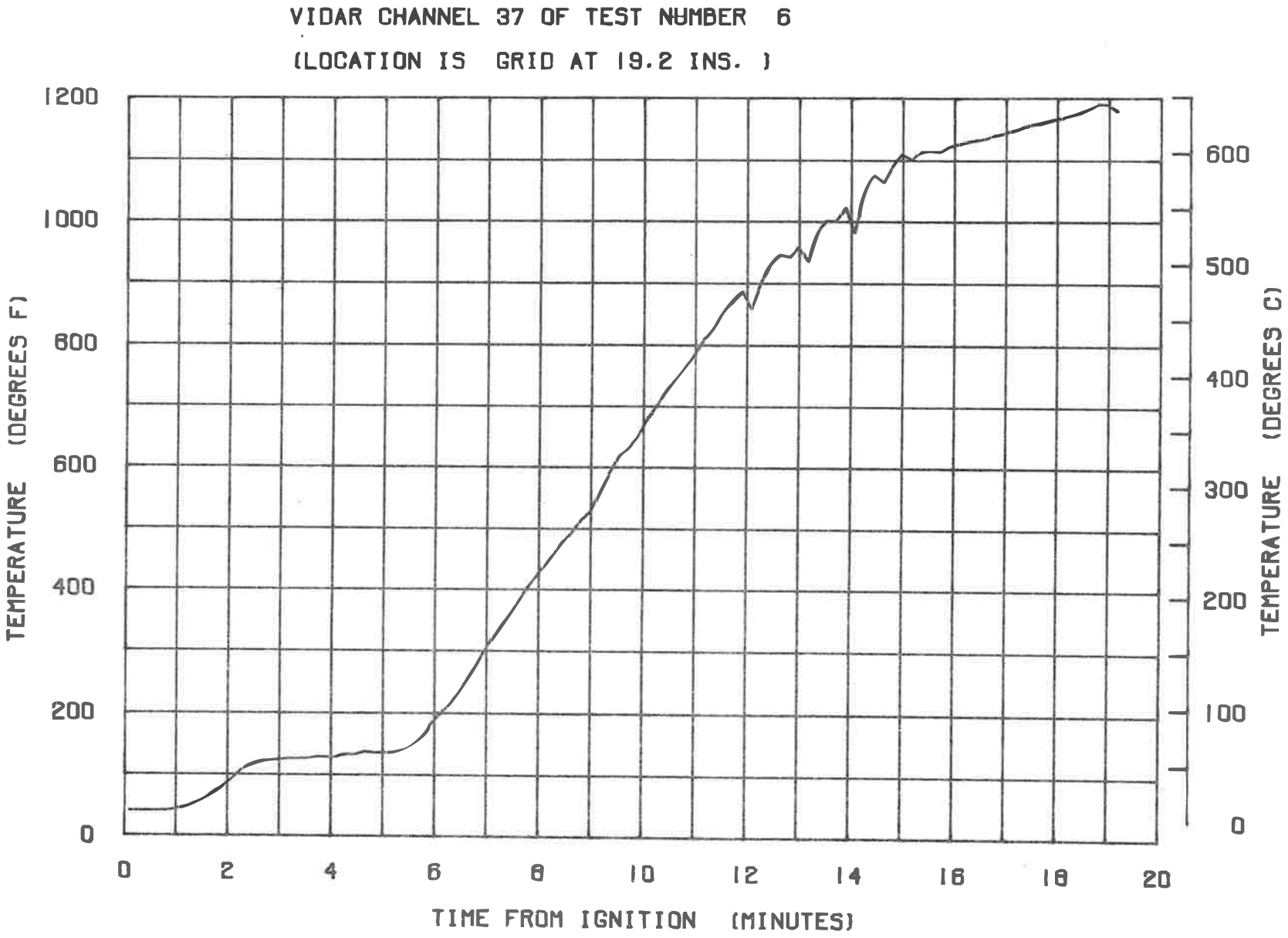

FIGURE A16 THERMOCOUPLE TEMPERATURE VS. TIME

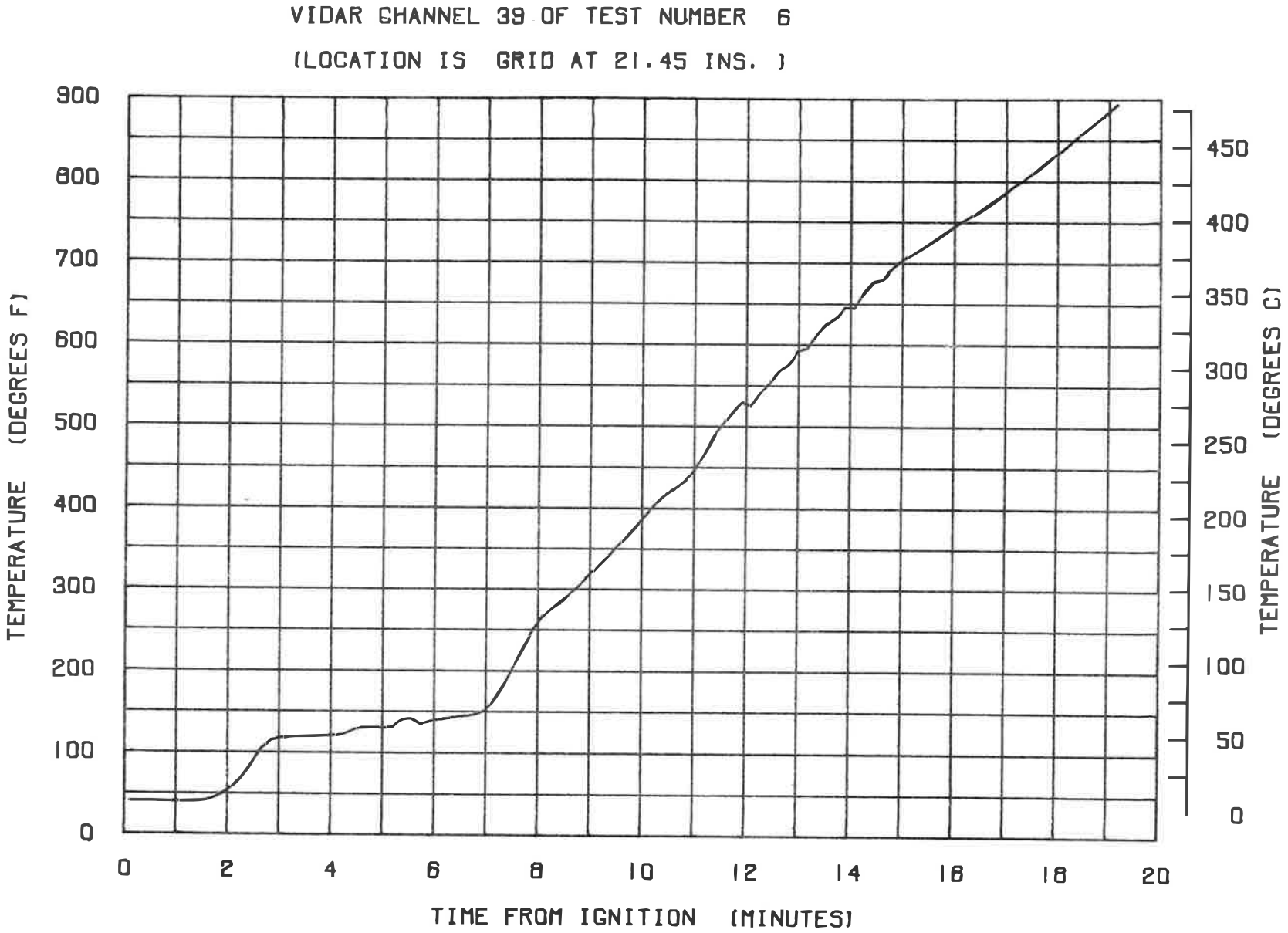

FIGURE A17 THERMOCOUPLE TEMPERATURE VS. TIME

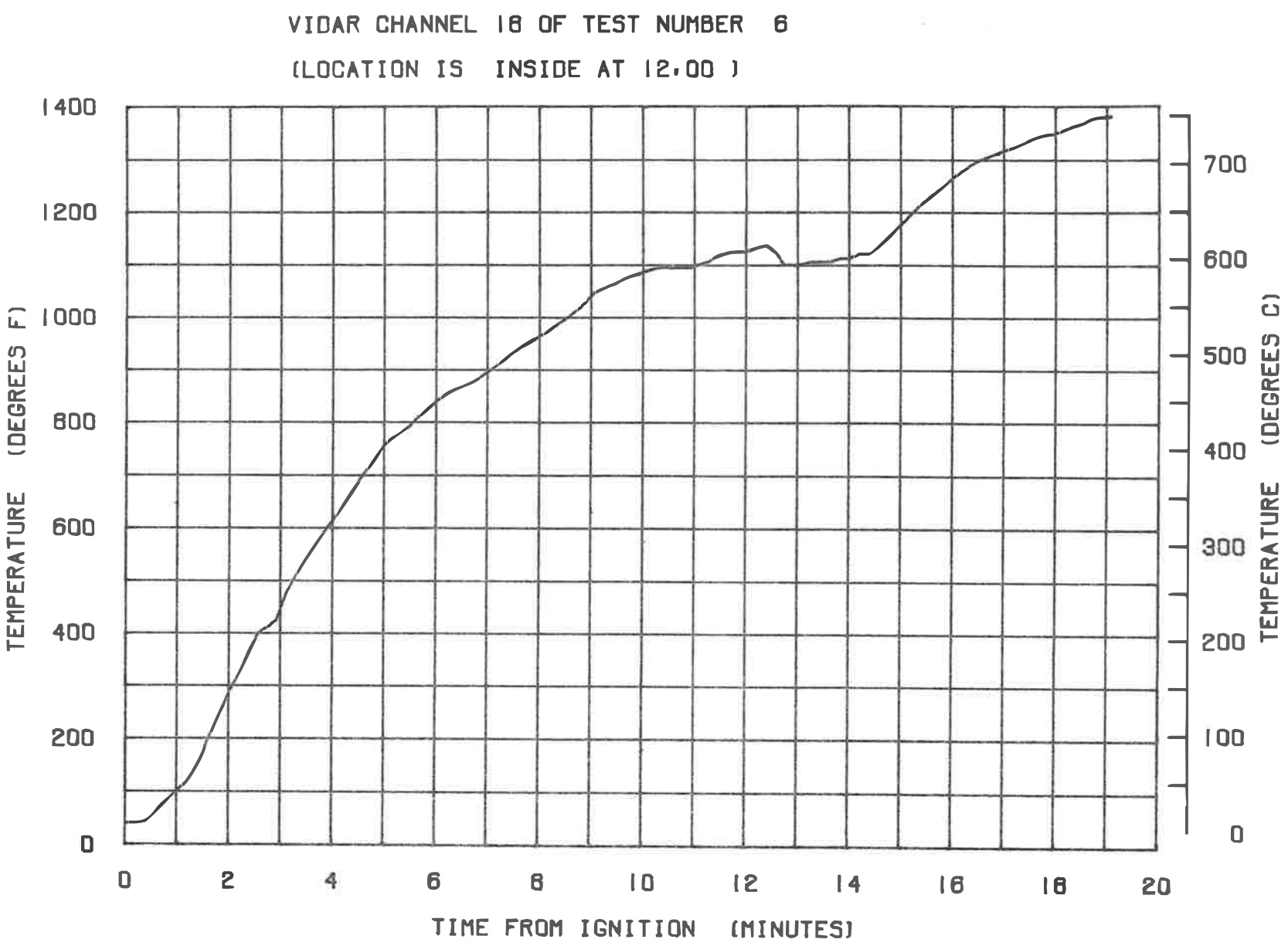

FIGURE A18 THERMOCOUPLE TEMPERATURE VS. TIME

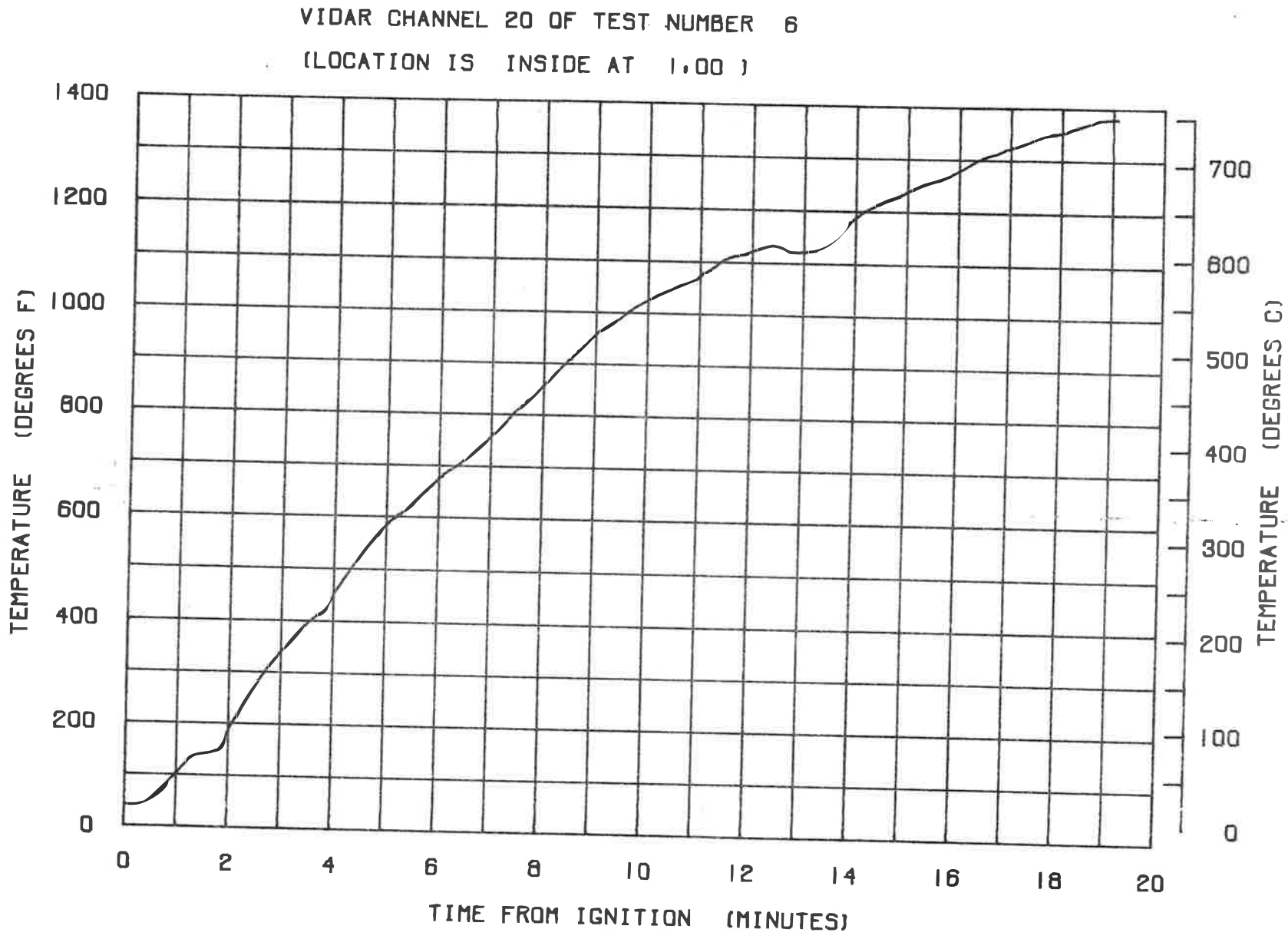

FIGURE A19 THERMOCOUPLE TEMPERATURE VS. TIME

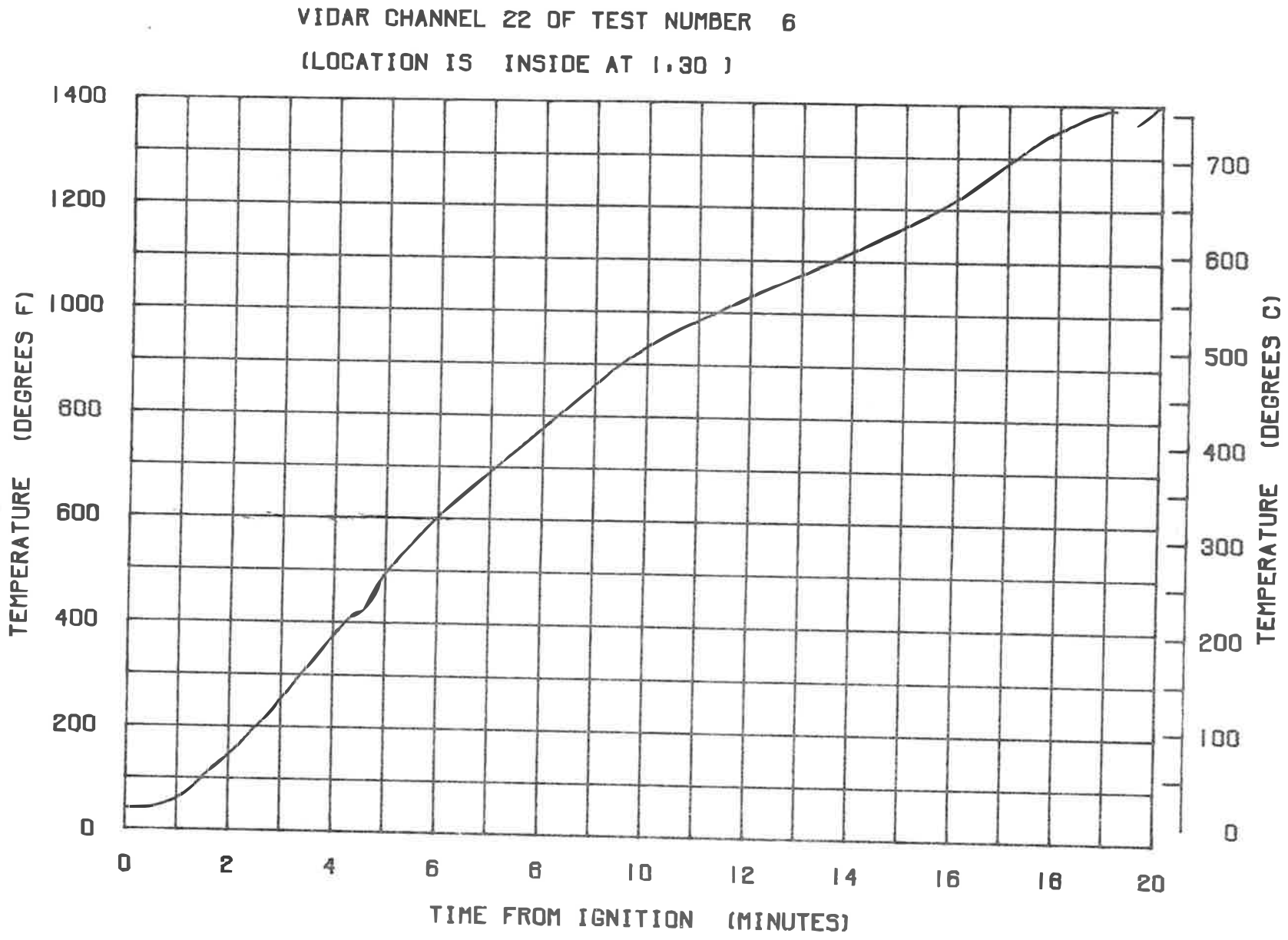

FIGURE A20 THERMOCOUPLE TEMPERATURE VS. TIME

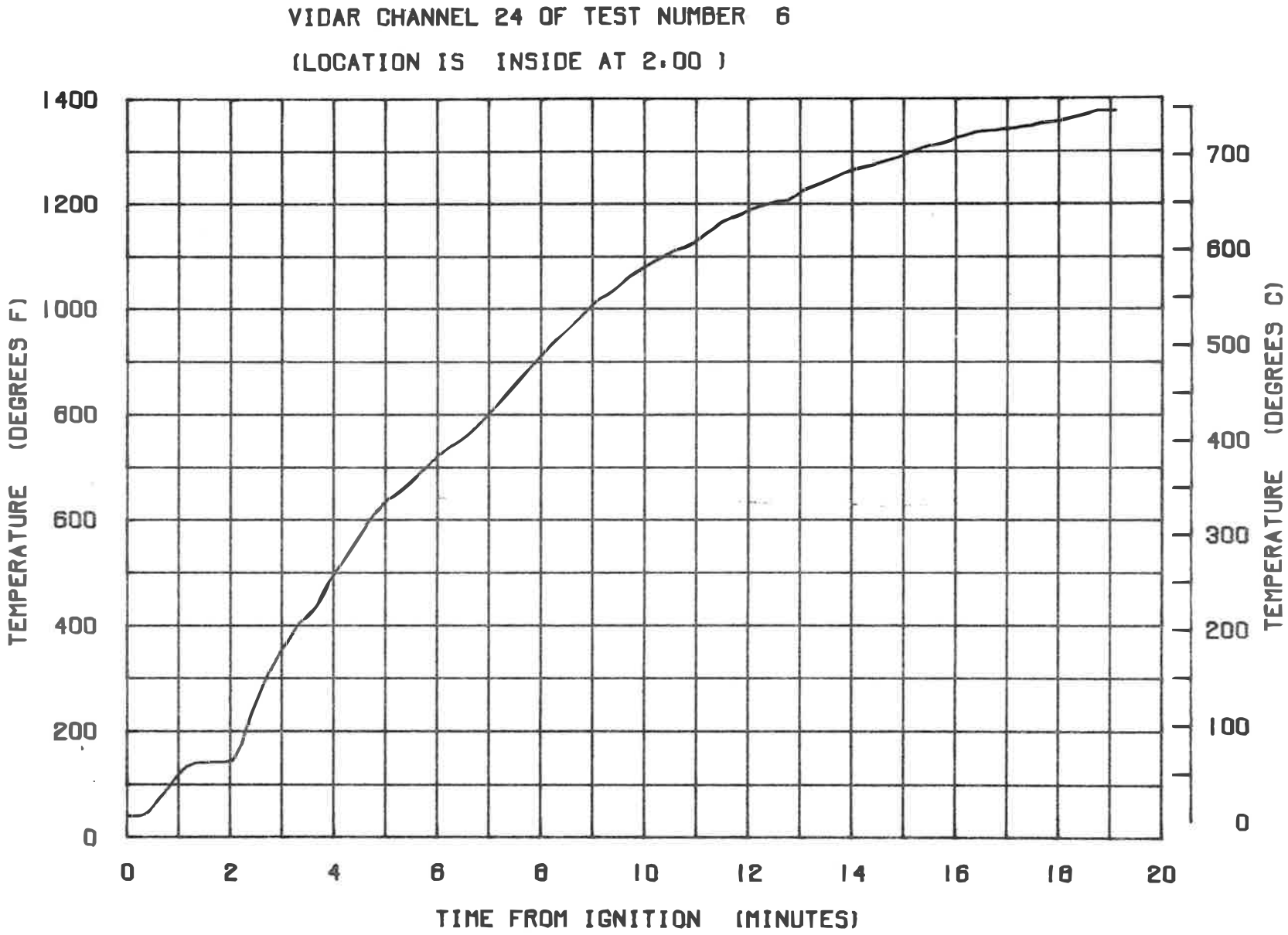

FIGURE A21 THERMOCOUPLE TEMPERATURE VS. TIME

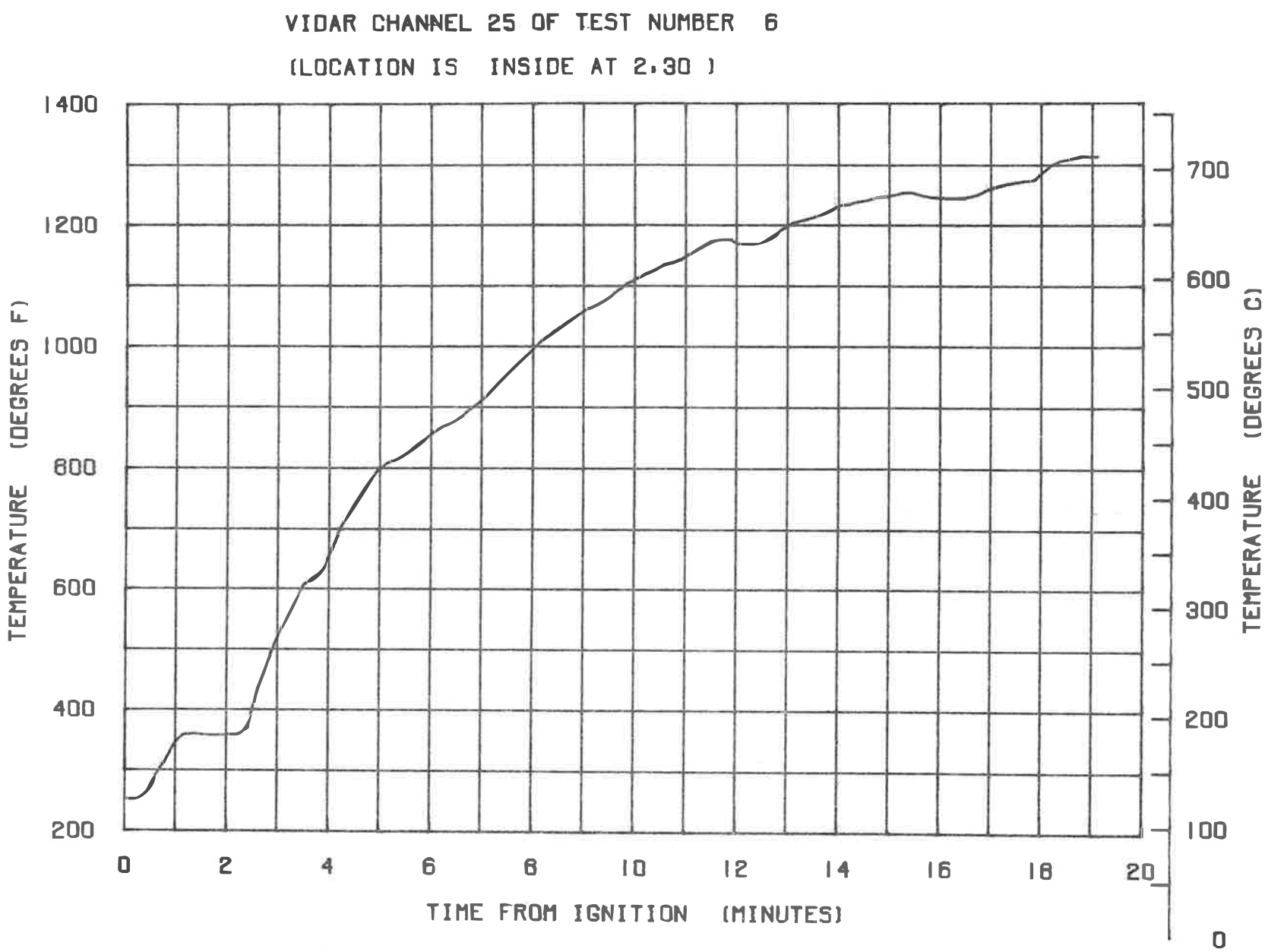

FIGURE A22 THERMOCOUPLE TEMPERATURE VS. TIME

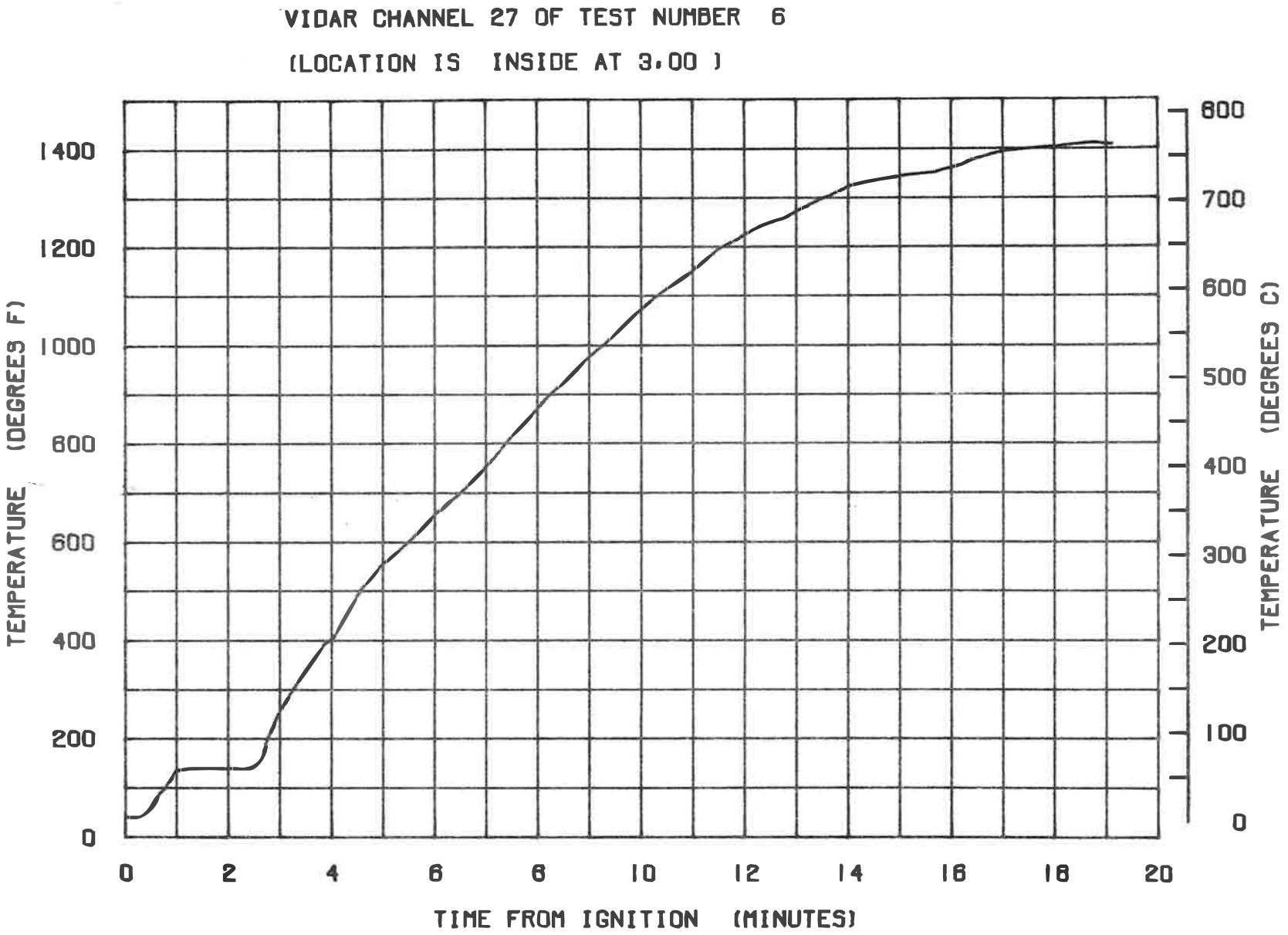

FIGURE A23 THERMOCOUPLE TEMPERATURE VS. TIME

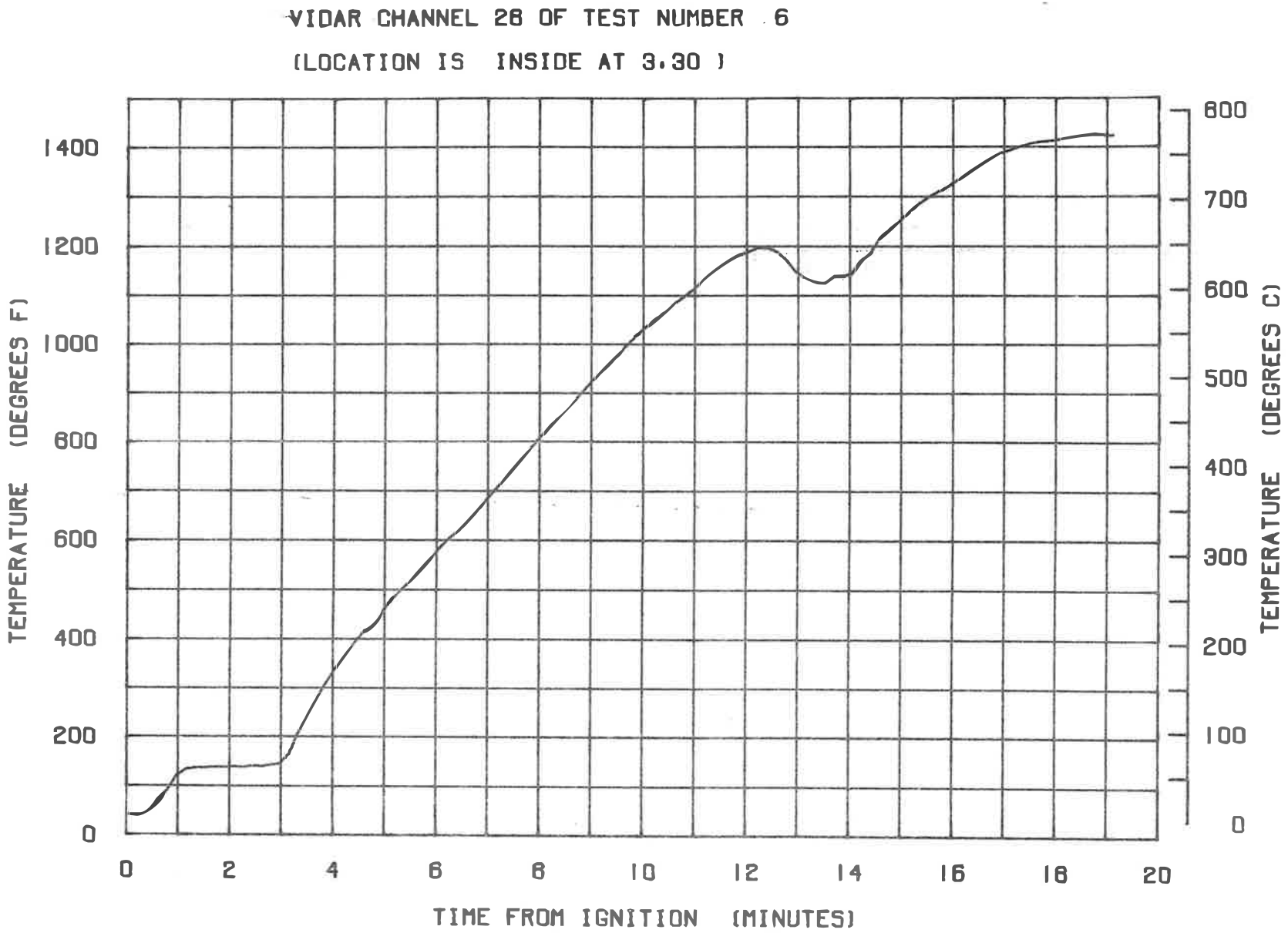

FIGURE A24 THERMOCOUPLE TEMPERATURE VS. TIME

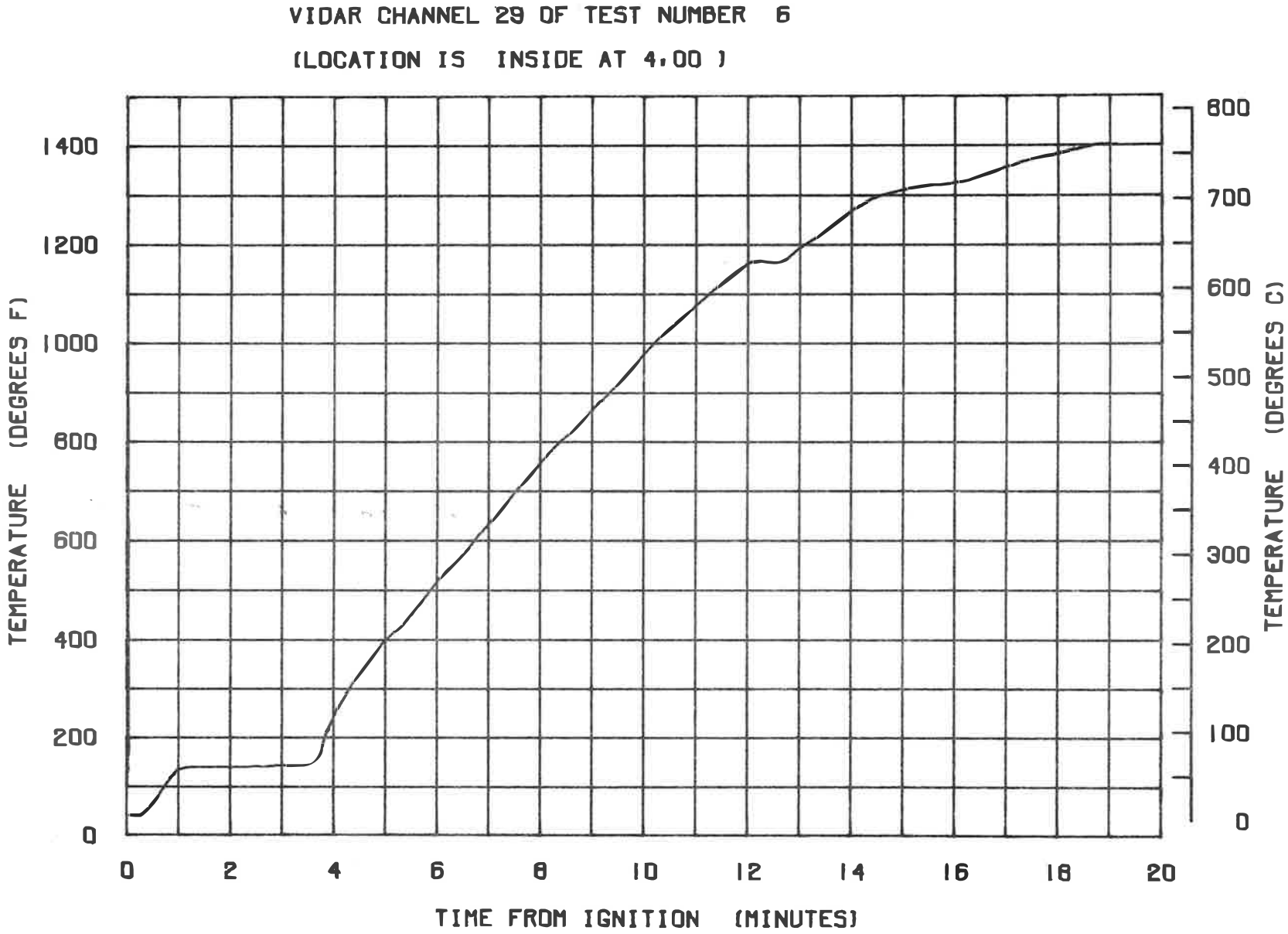

FIGURE A25 THERMOCOUPLE TEMPERATURE VS. TIME

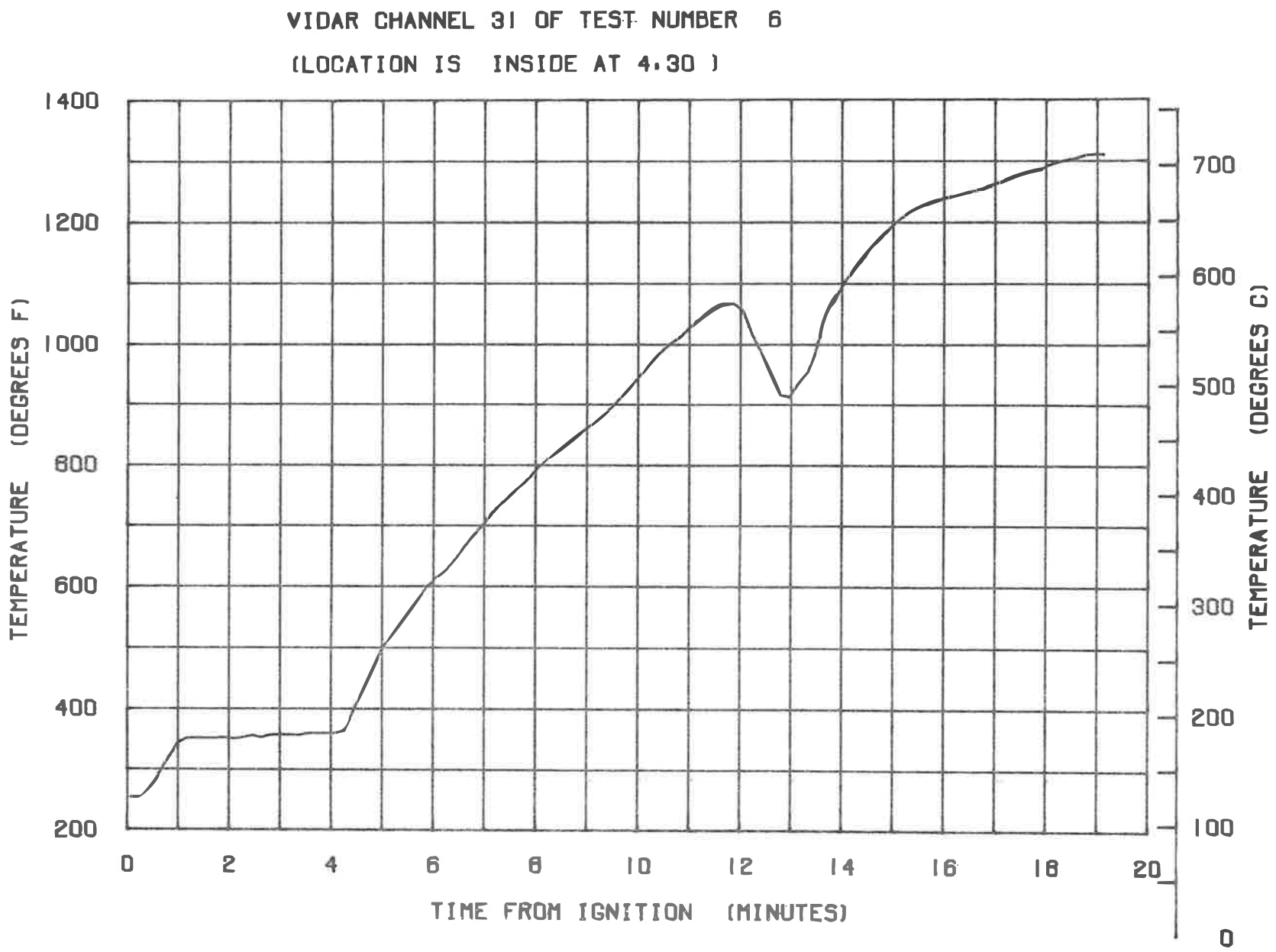

FIGURE A26 THERMOCOUPLE TEMPERATURE VS. TIME

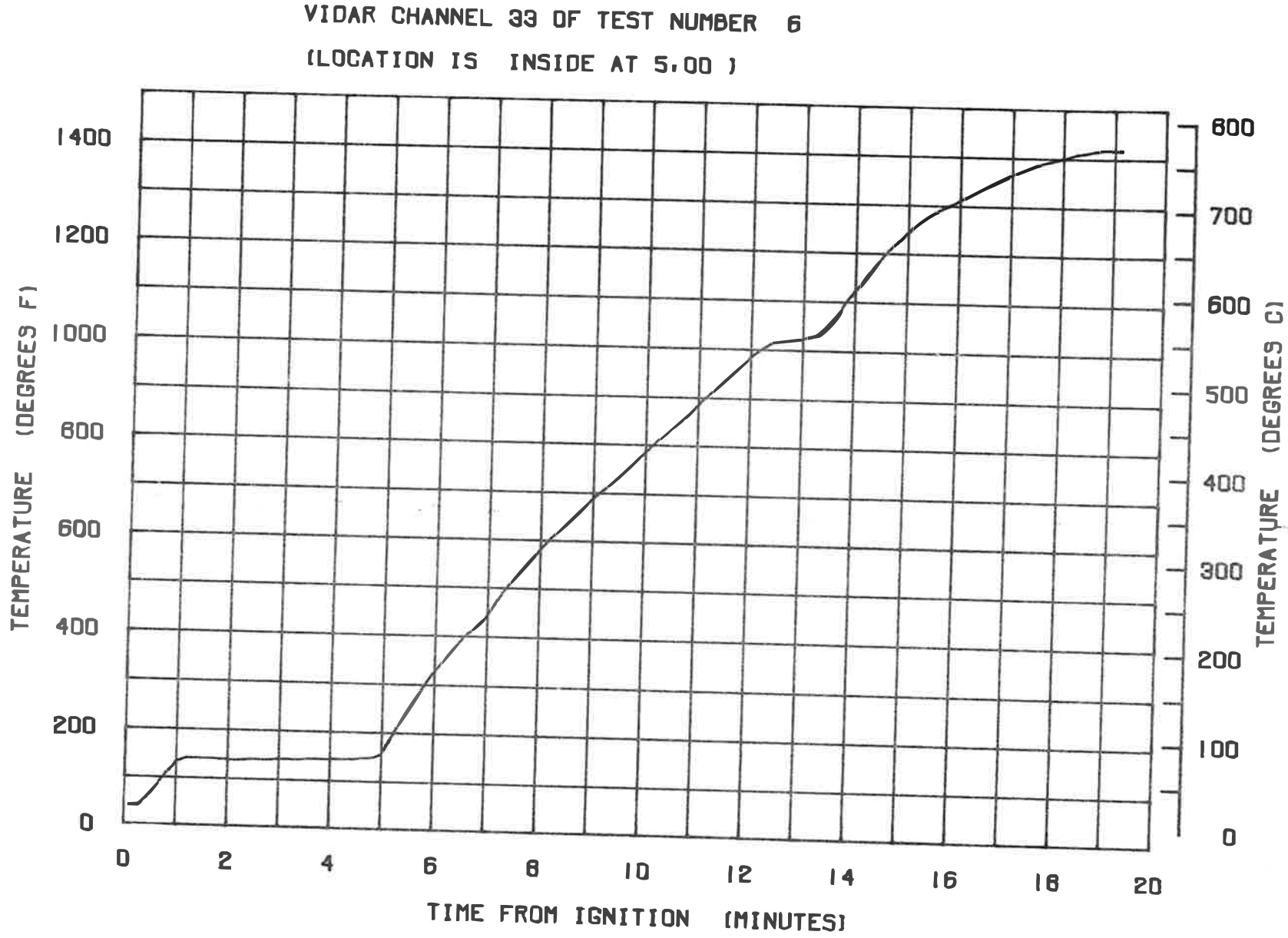

FIGURE A27 THERMOCOUPLE TEMPERATURE VS. TIME

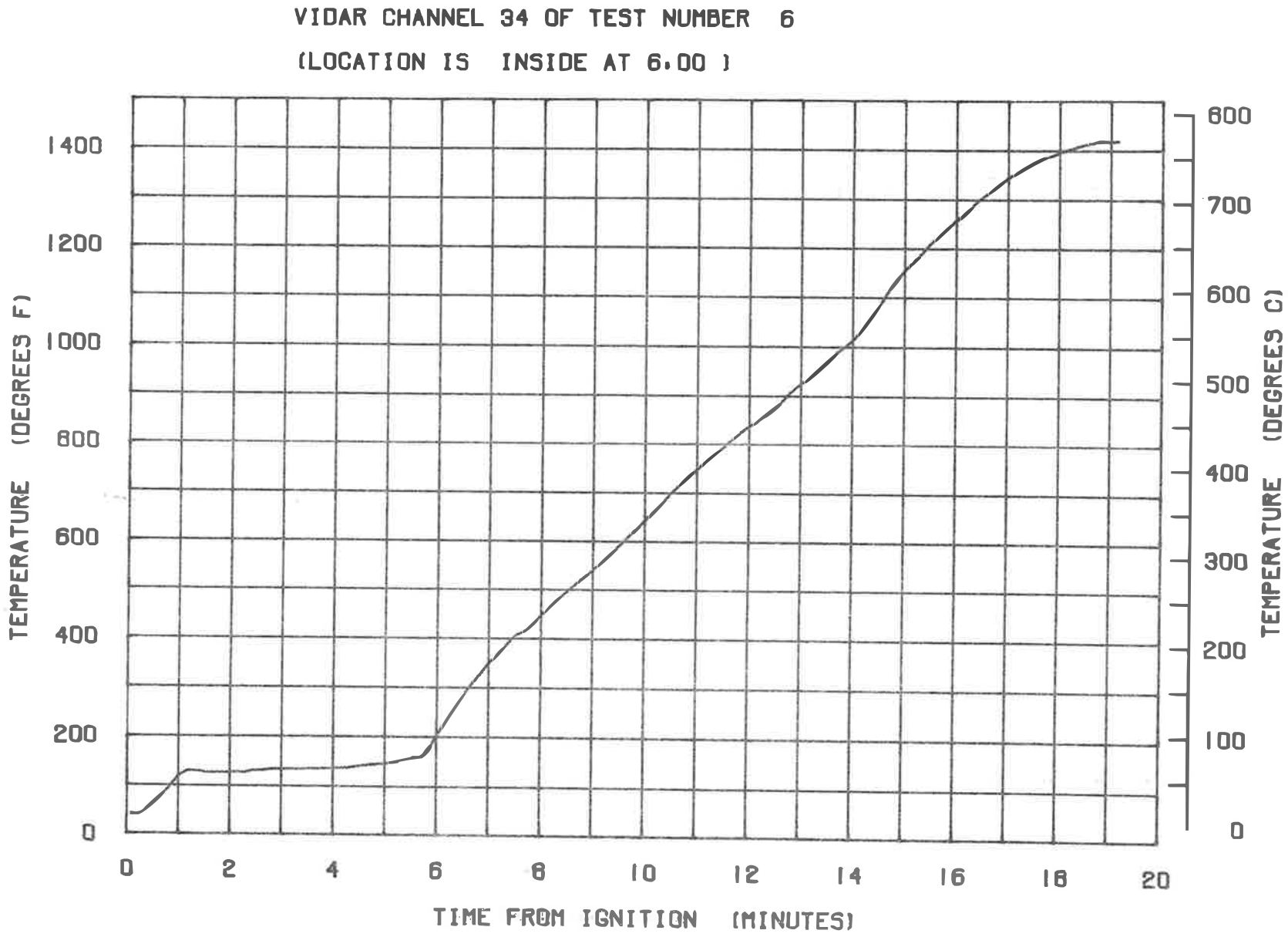

FIGURE A28 THERMOCOUPLE TEMPERATURE VS. TIME

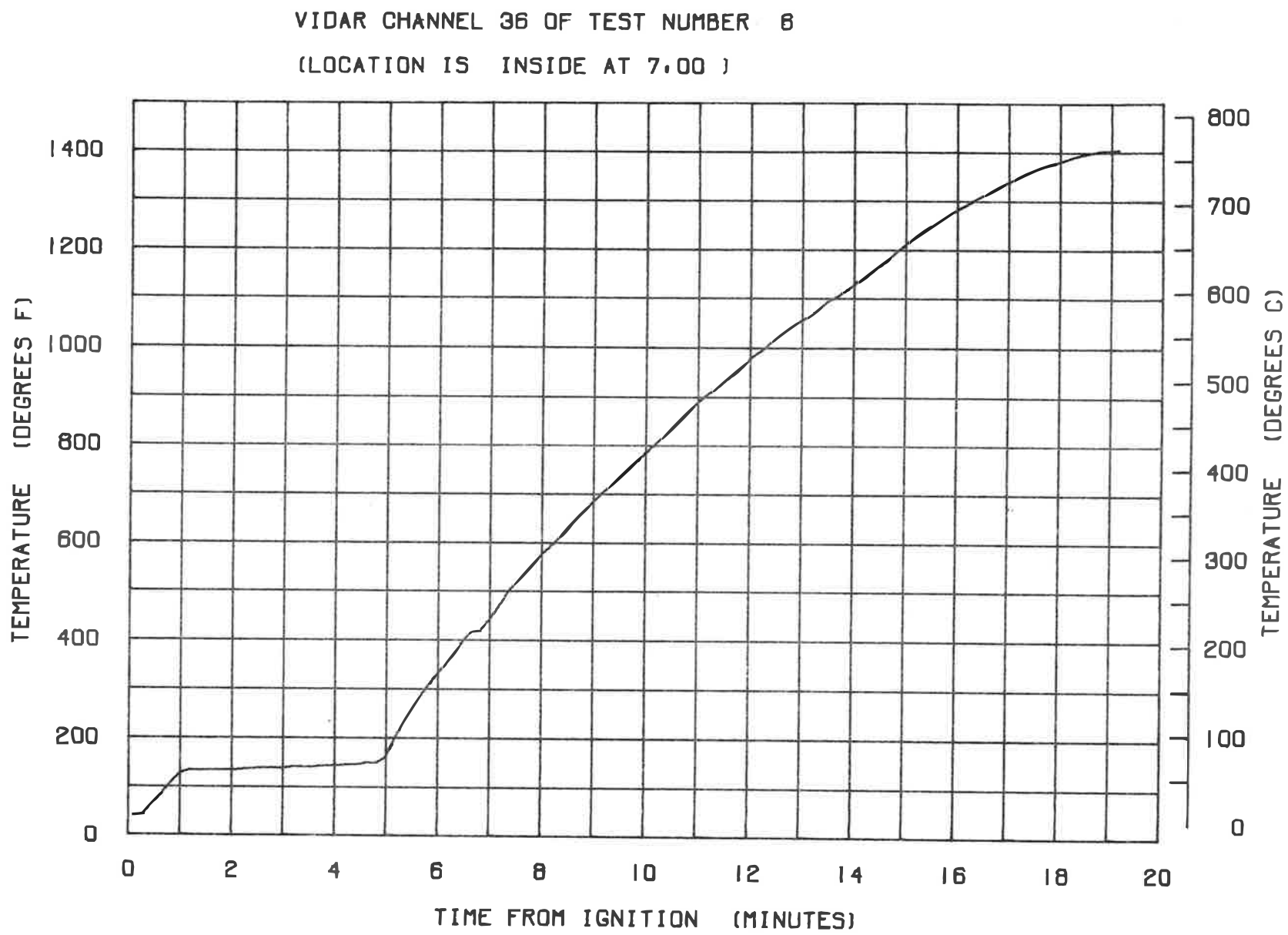

FIGURE A29 THERMOCOUPLE TEMPERATURE VS. TIME

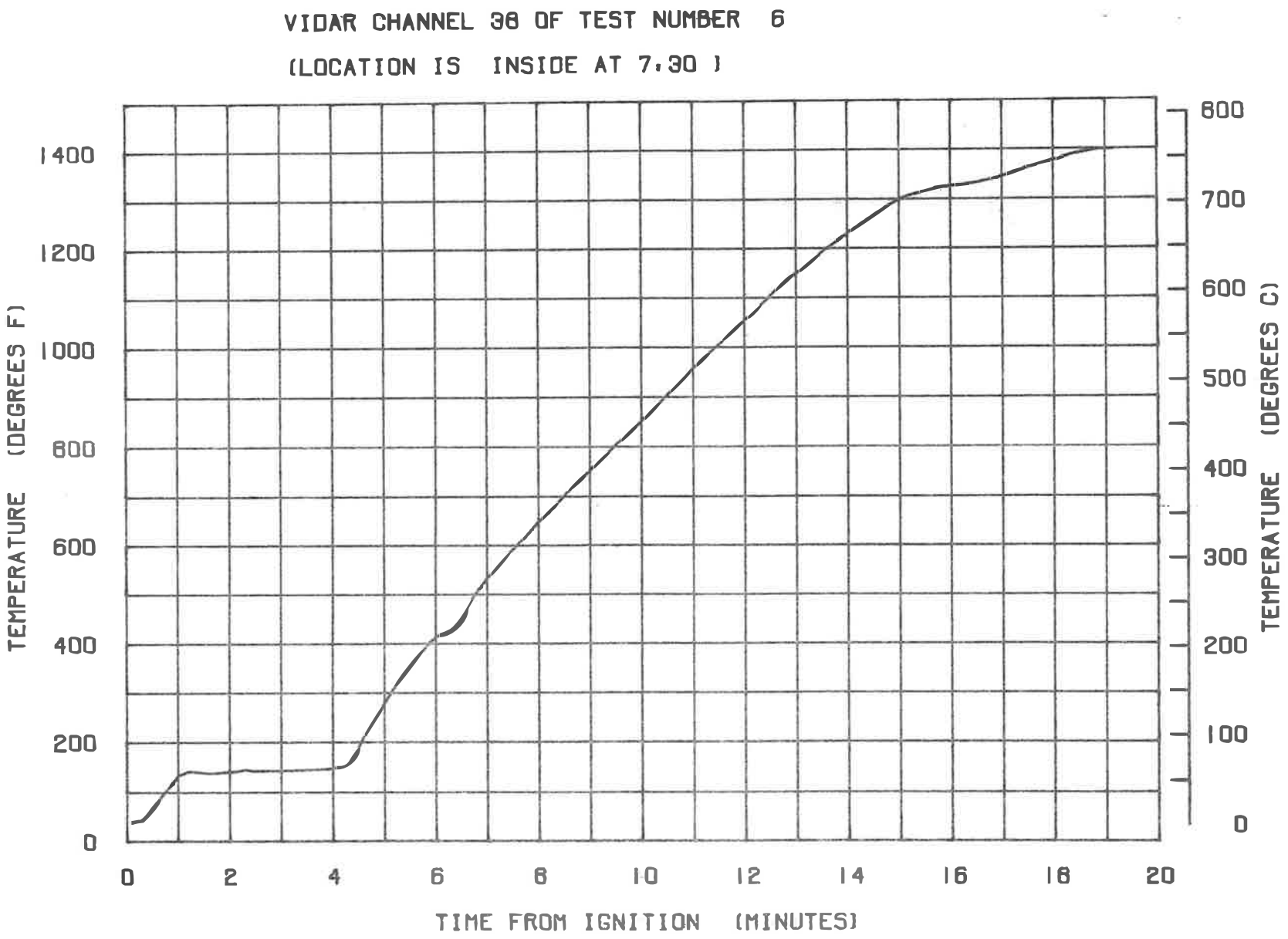

FIGURE A30 THERMOCOUPLE TEMPERATURE VS. TIME

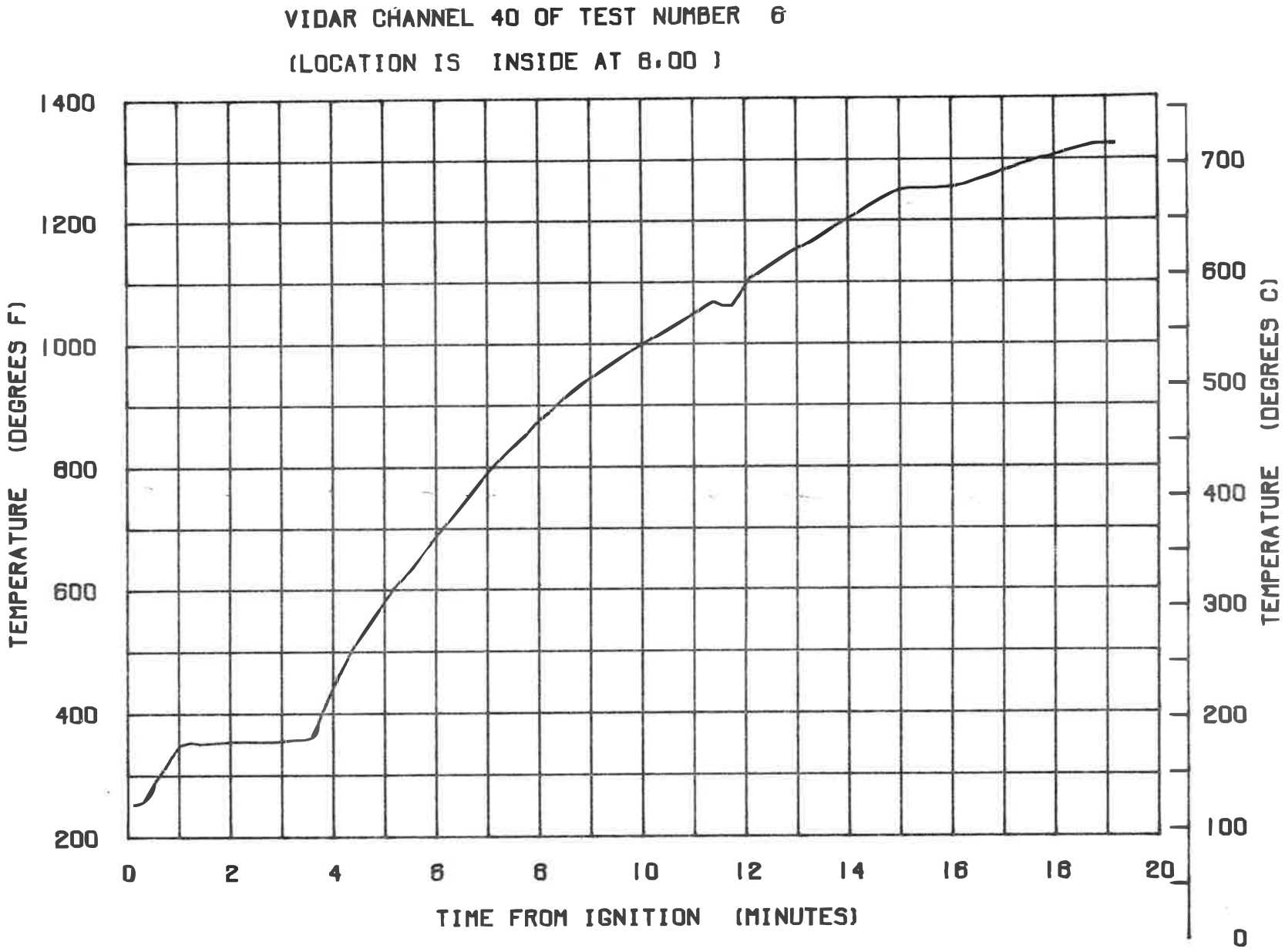

FIGURE A31 THERMOCOUPLE TEMPERATURE VS. TIME

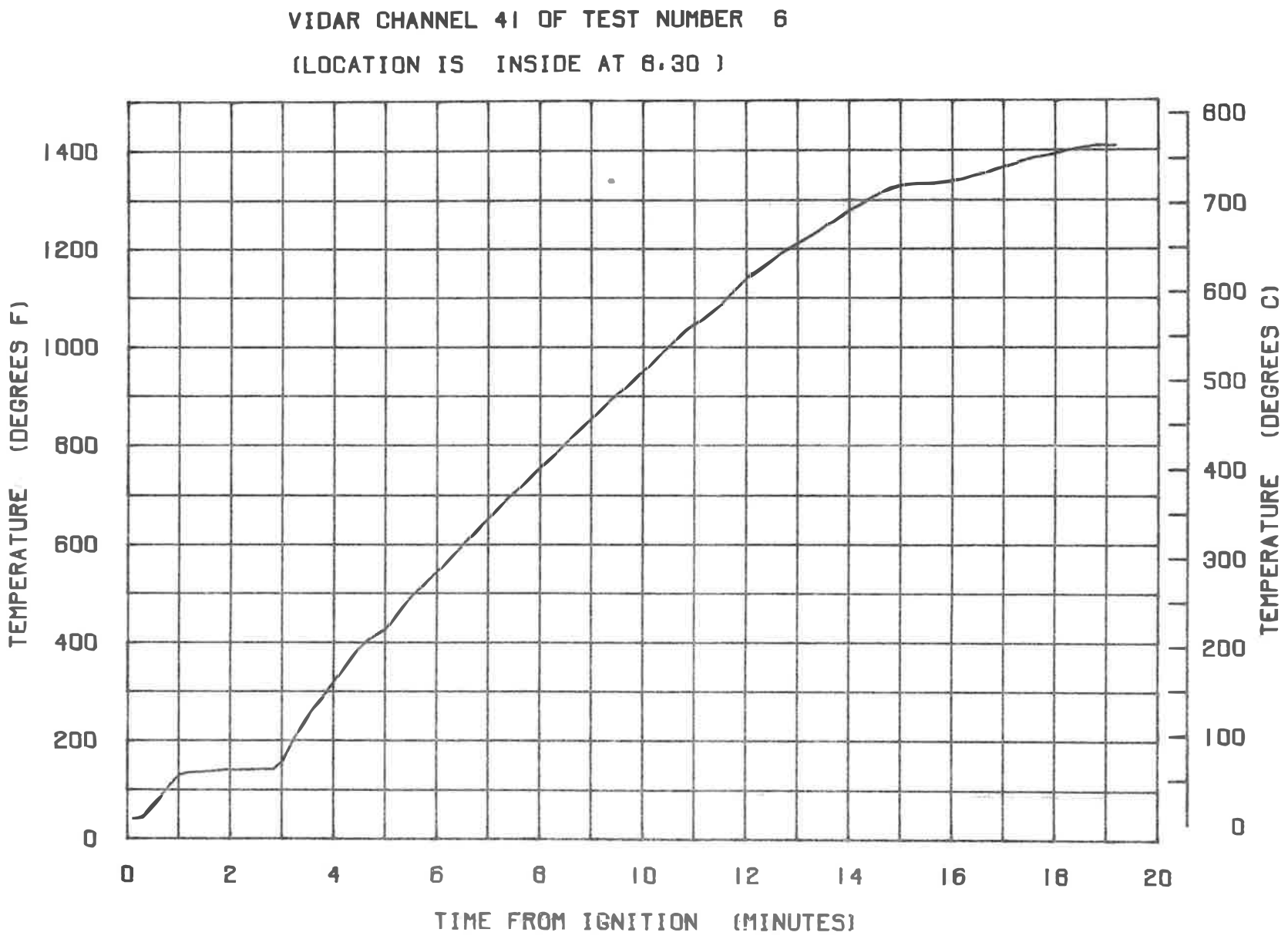

FIGURE A32 THERMOCOUPLE TEMPERATURE VS. TIME

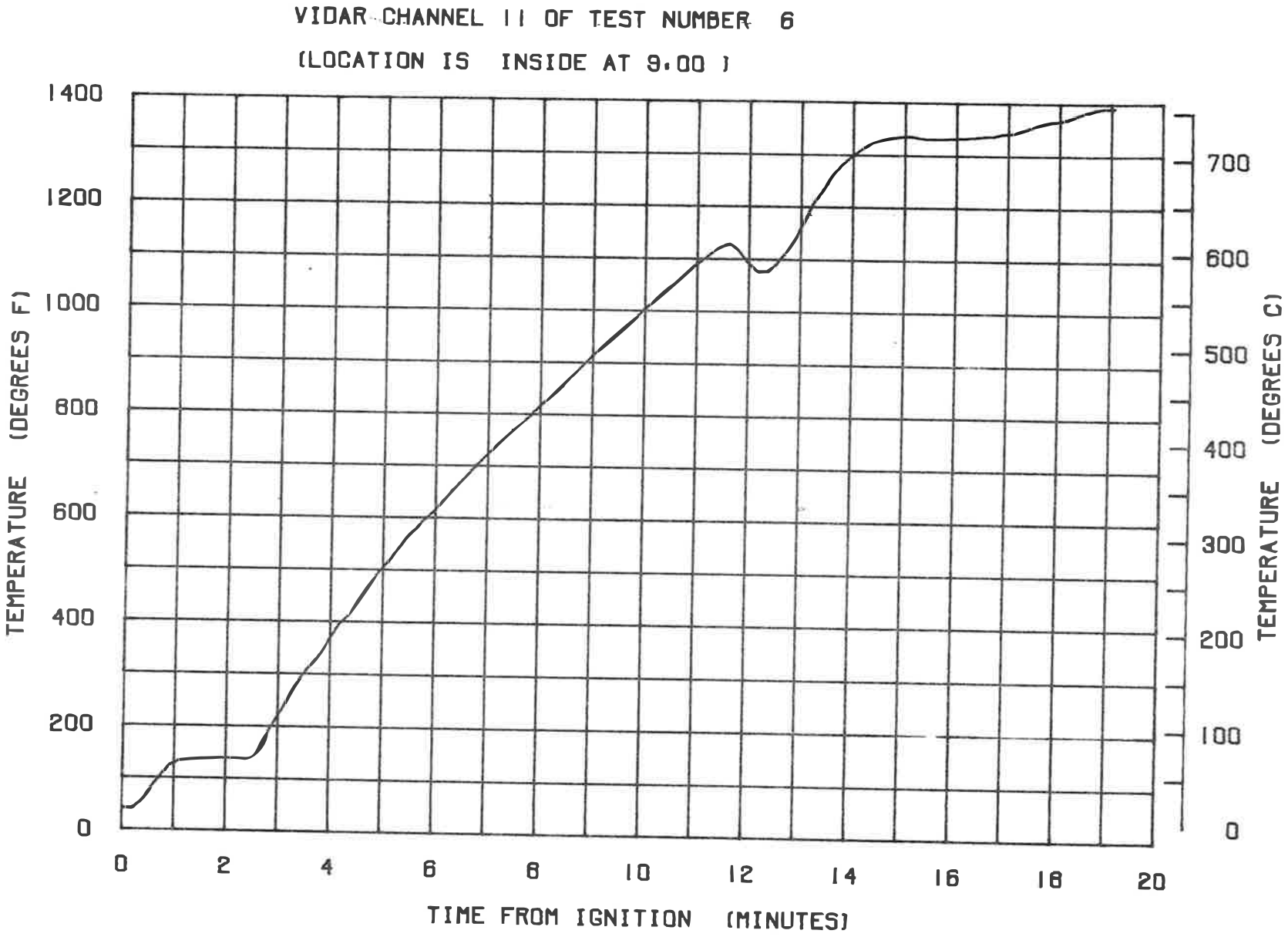

FIGURE A33 THERMOCOUPLE TEMPERATURE VS. TIME

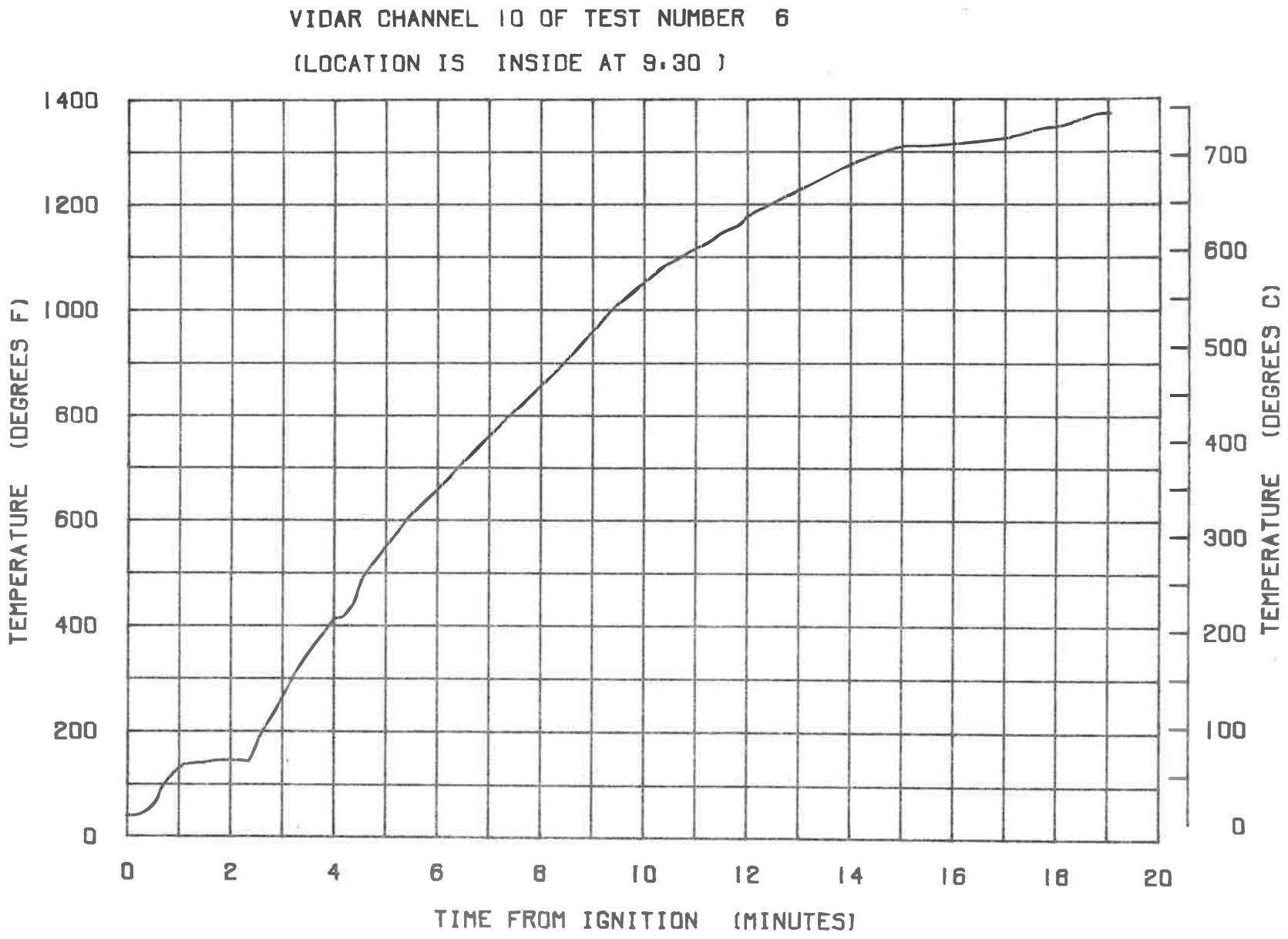

FIGURE A34 THERMOCOUPLE TEMPERATURE VS. TIME

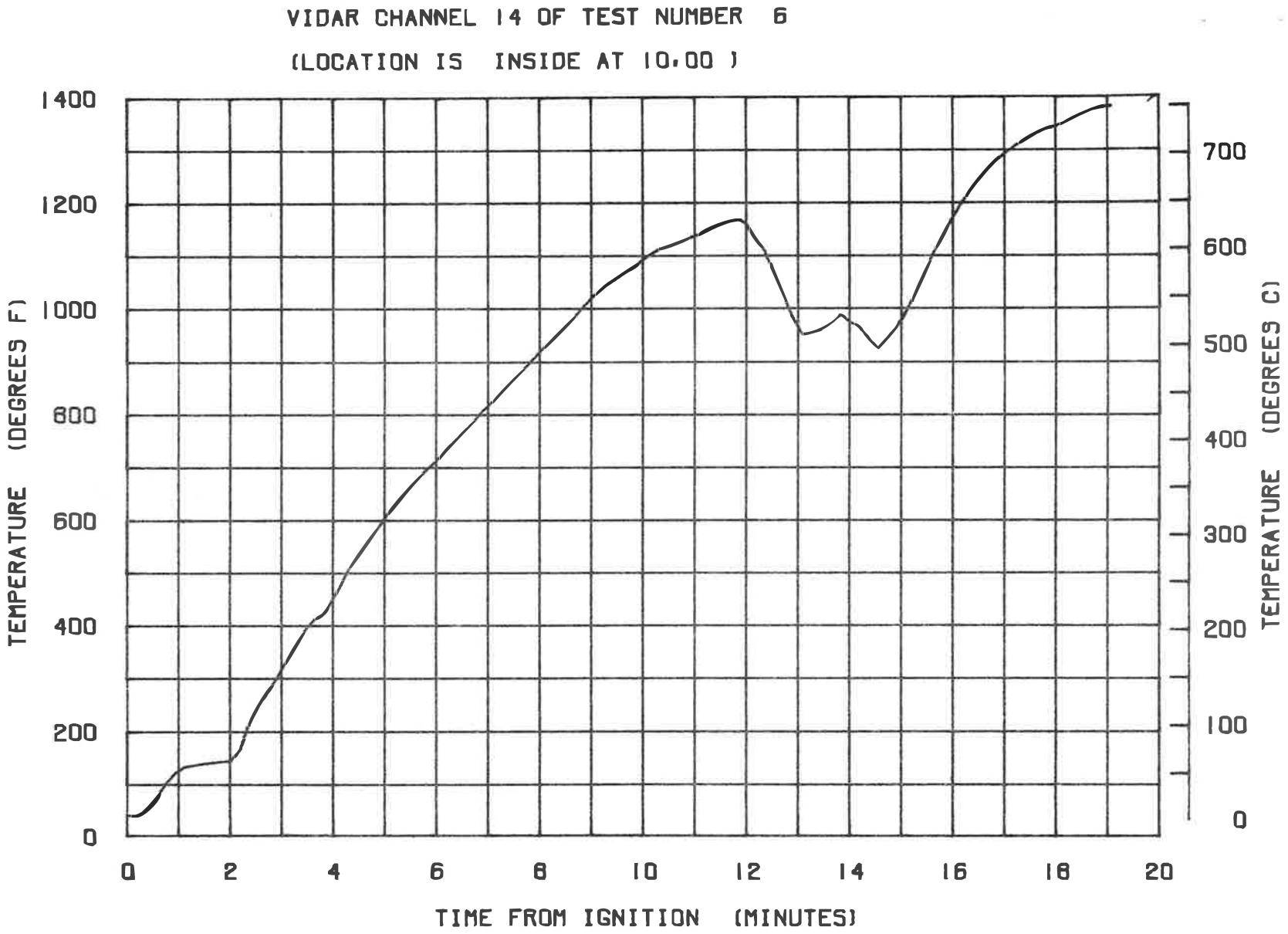

FIGURE A35 THERMOCOUPLE TEMPERATURE VS. TIME

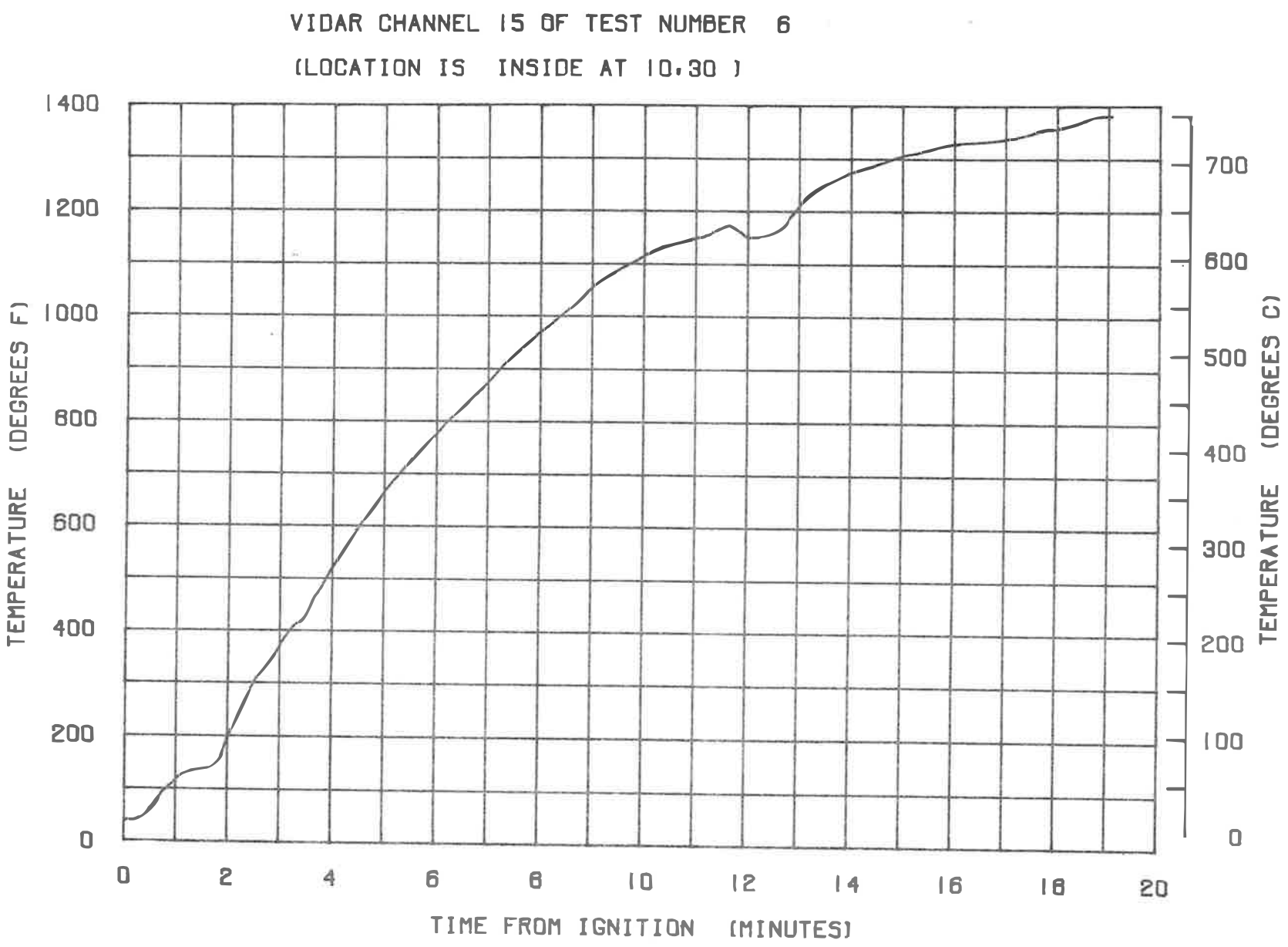

FIGURE A36 THERMOCOUPLE TEMPERATURE VS. TIME

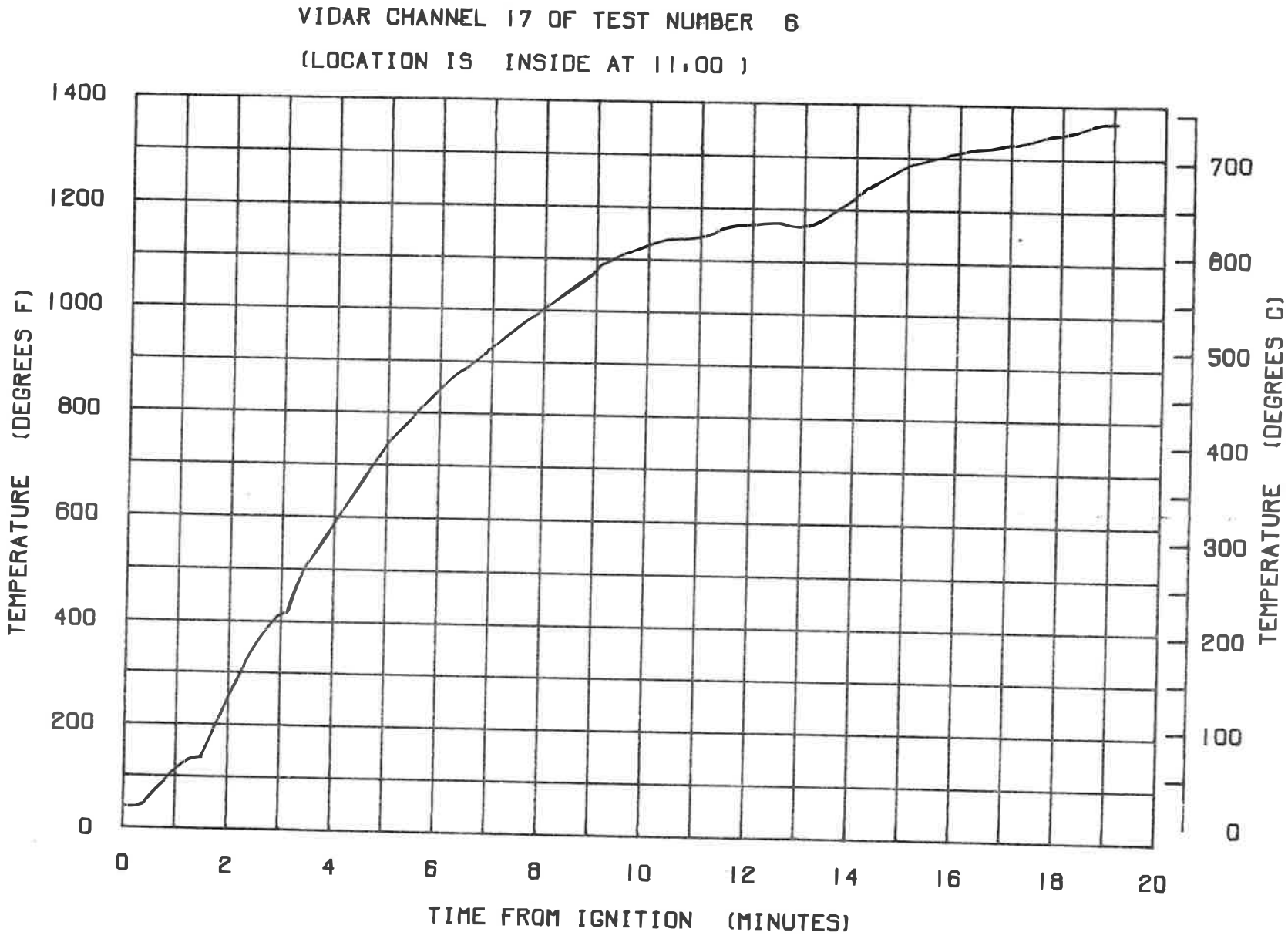

FIGURE A37 THERMOCOUPLE TEMPERATURE VS. TIME

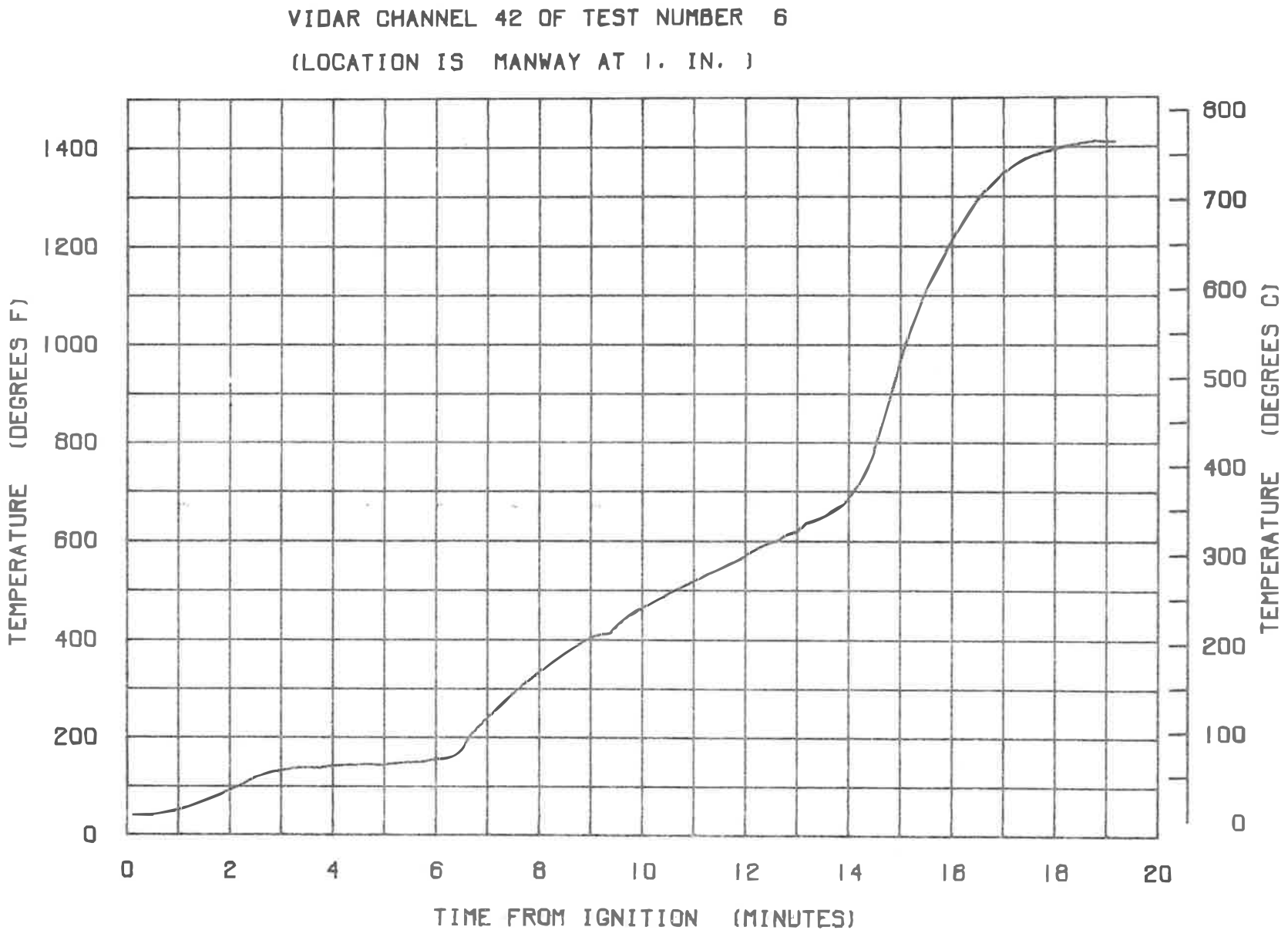

FIGURE A38 THERMOCOUPLE TEMPERATURE VS. TIME

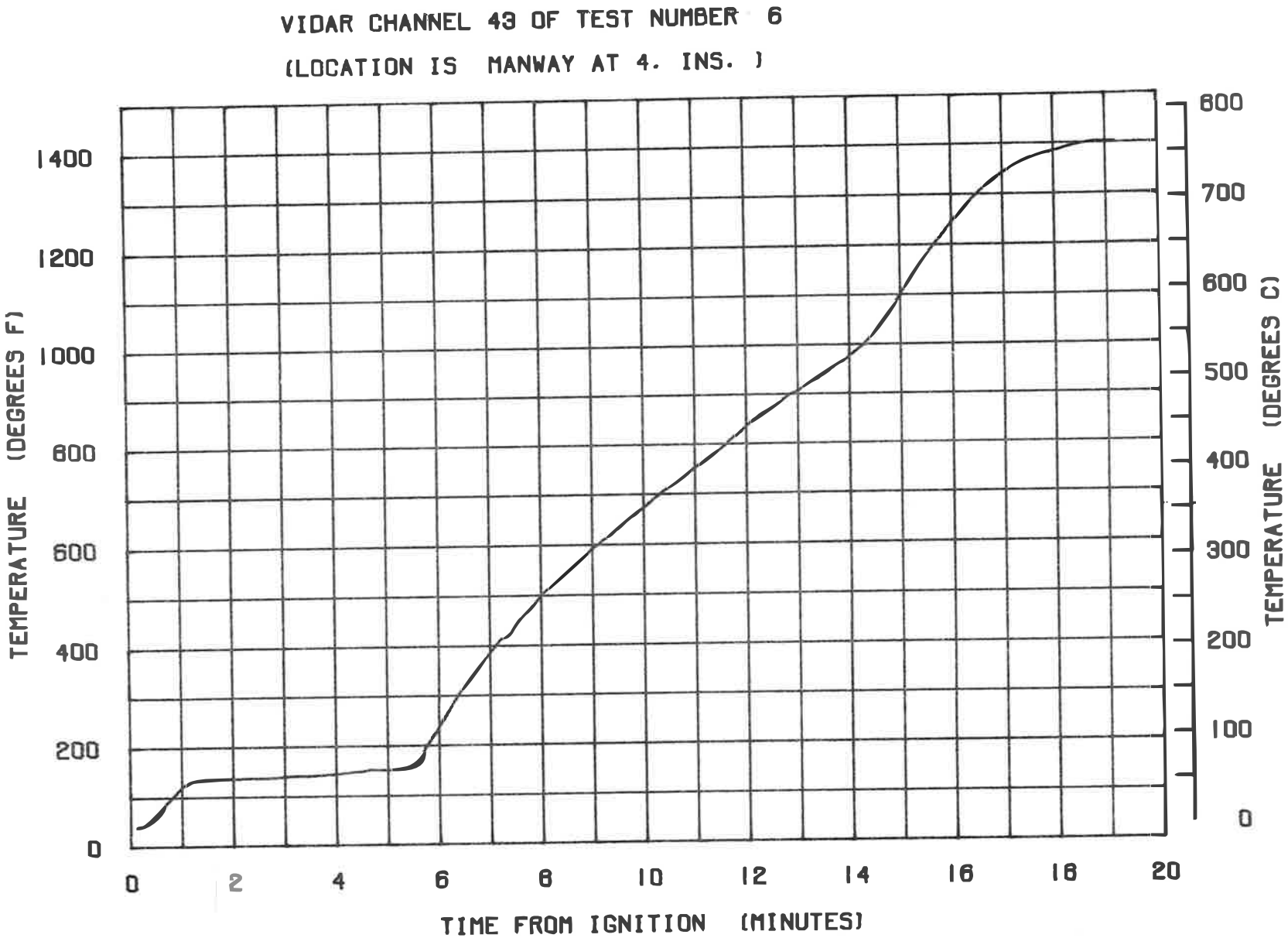

FIGURE A39 THERMOCOUPLE TEMPERATURE VS. TIME

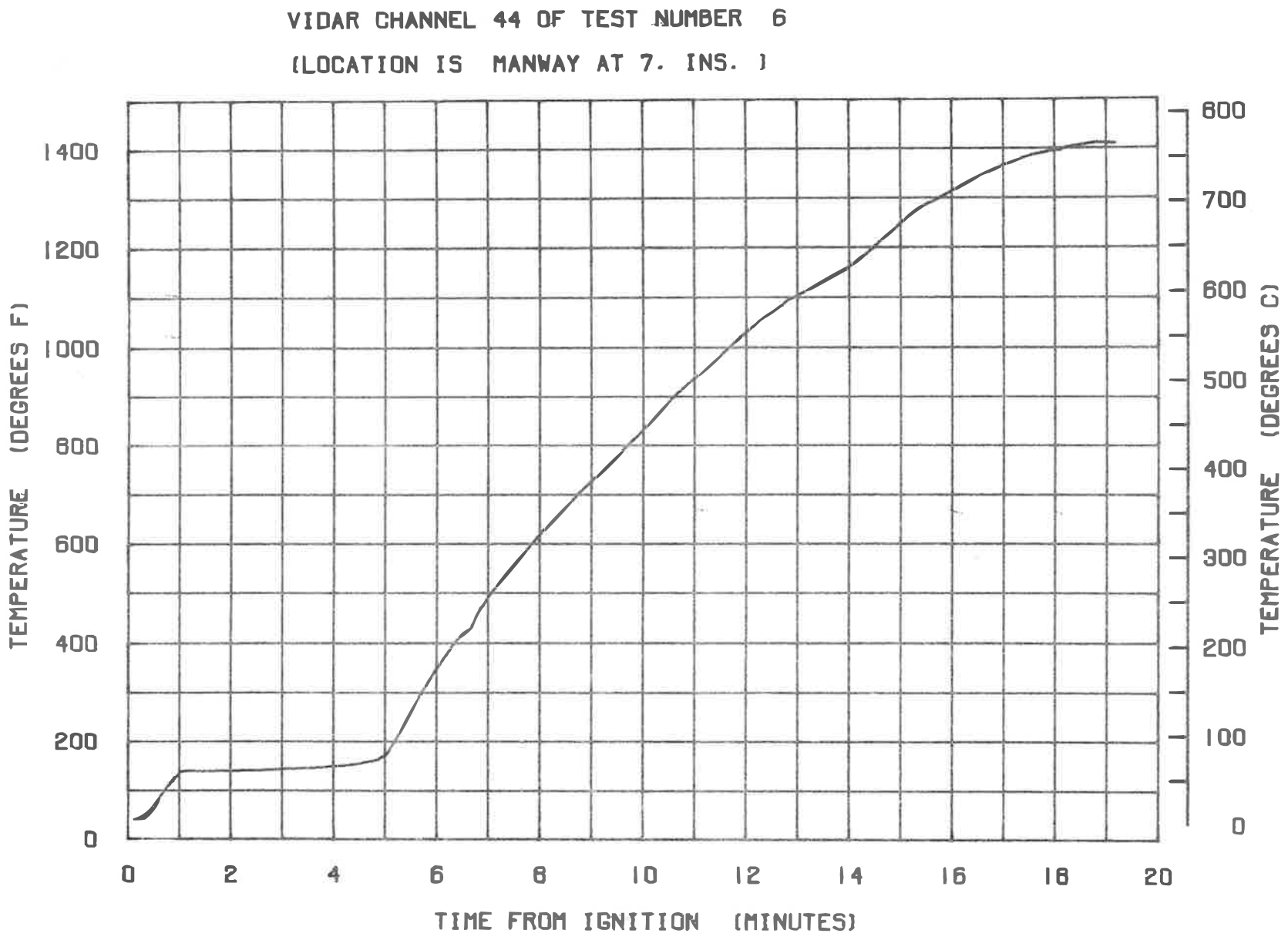

FIGURE A40 THERMOCOUPLE TEMPERATURE VS. TIME

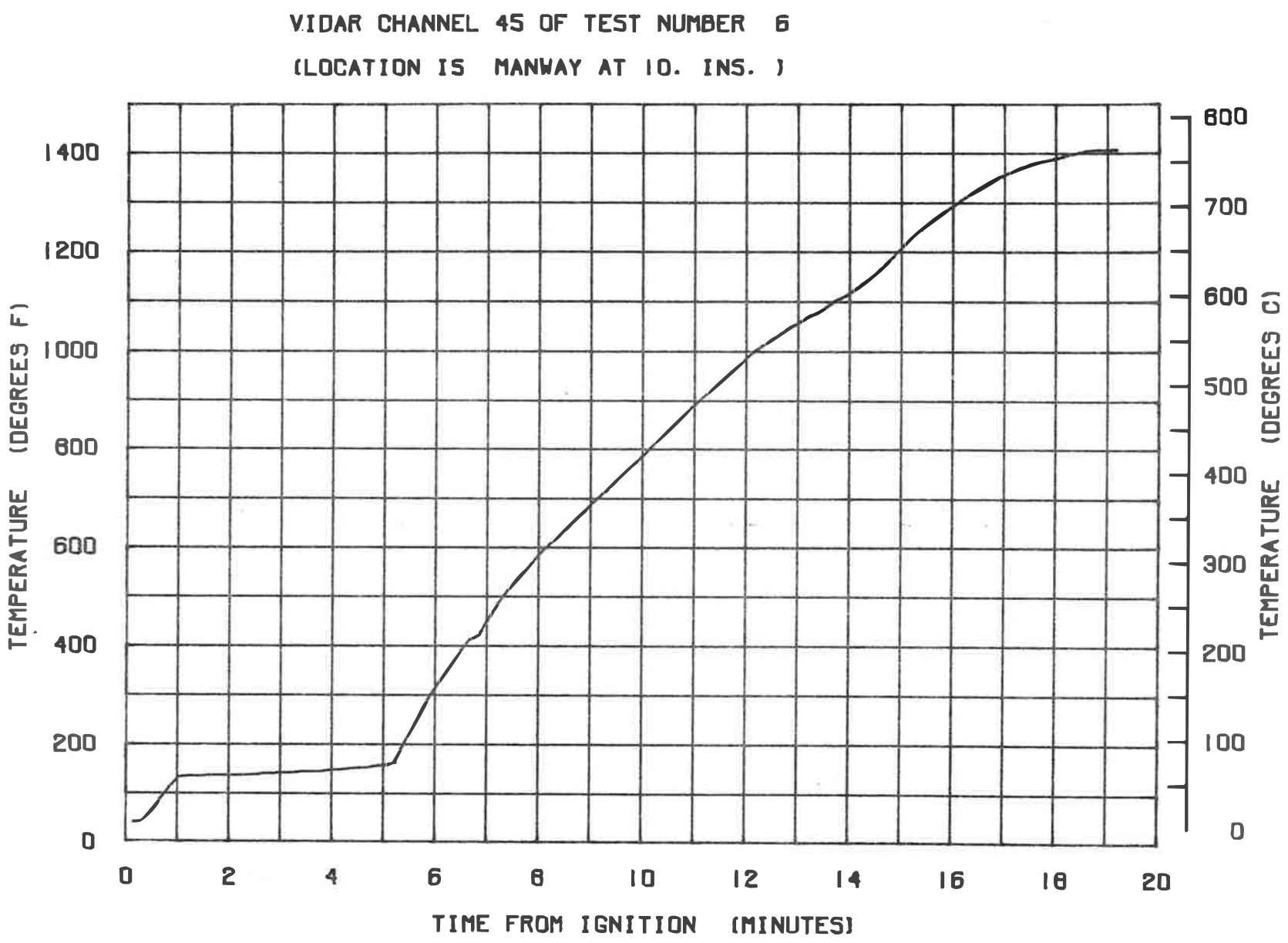

FIGURE A41 THERMOCOUPLE TEMPERATURE VS. TIME

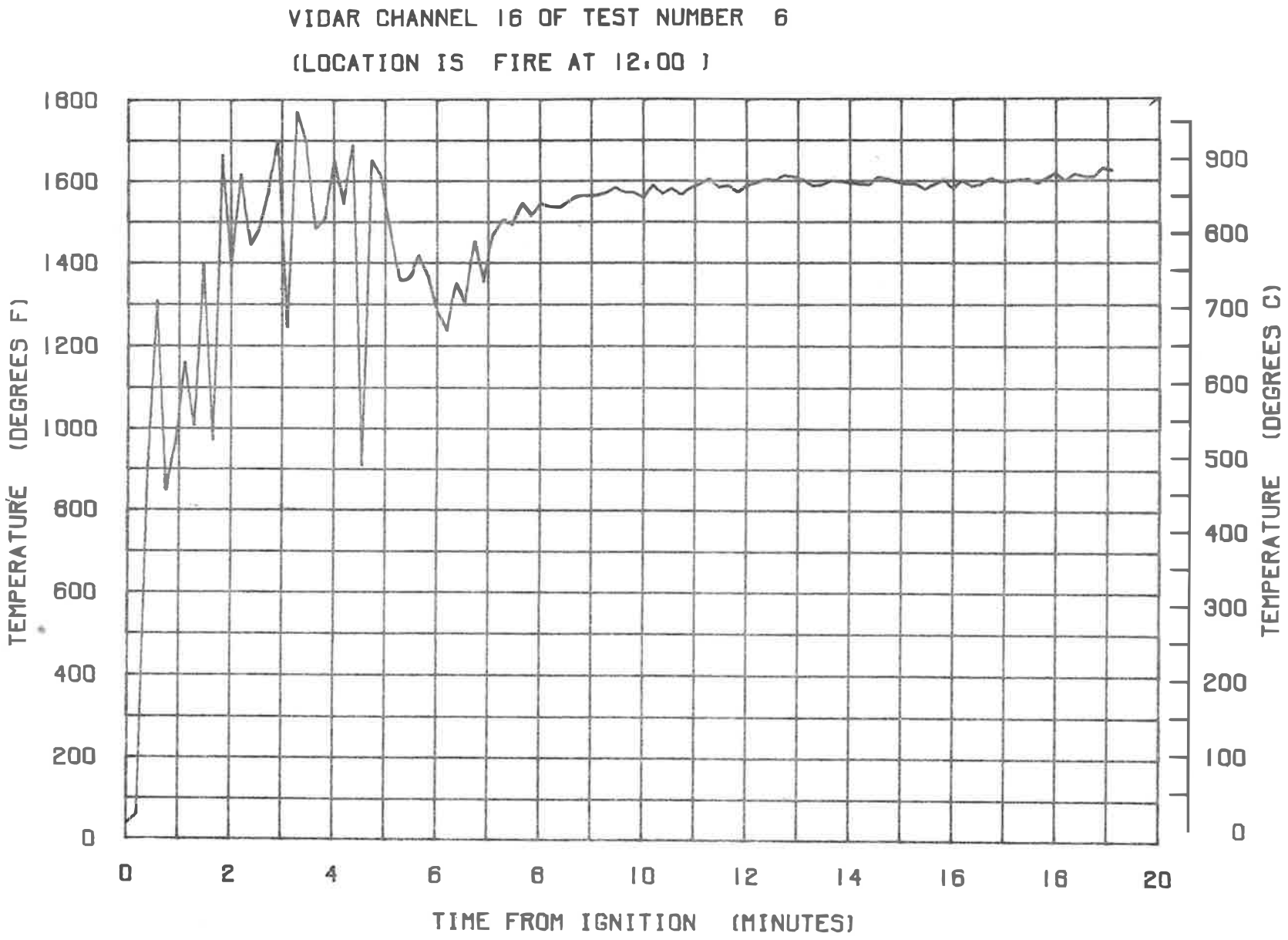

FIGURE A42 THERMOCOUPLE TEMPERATURE VS. TIME

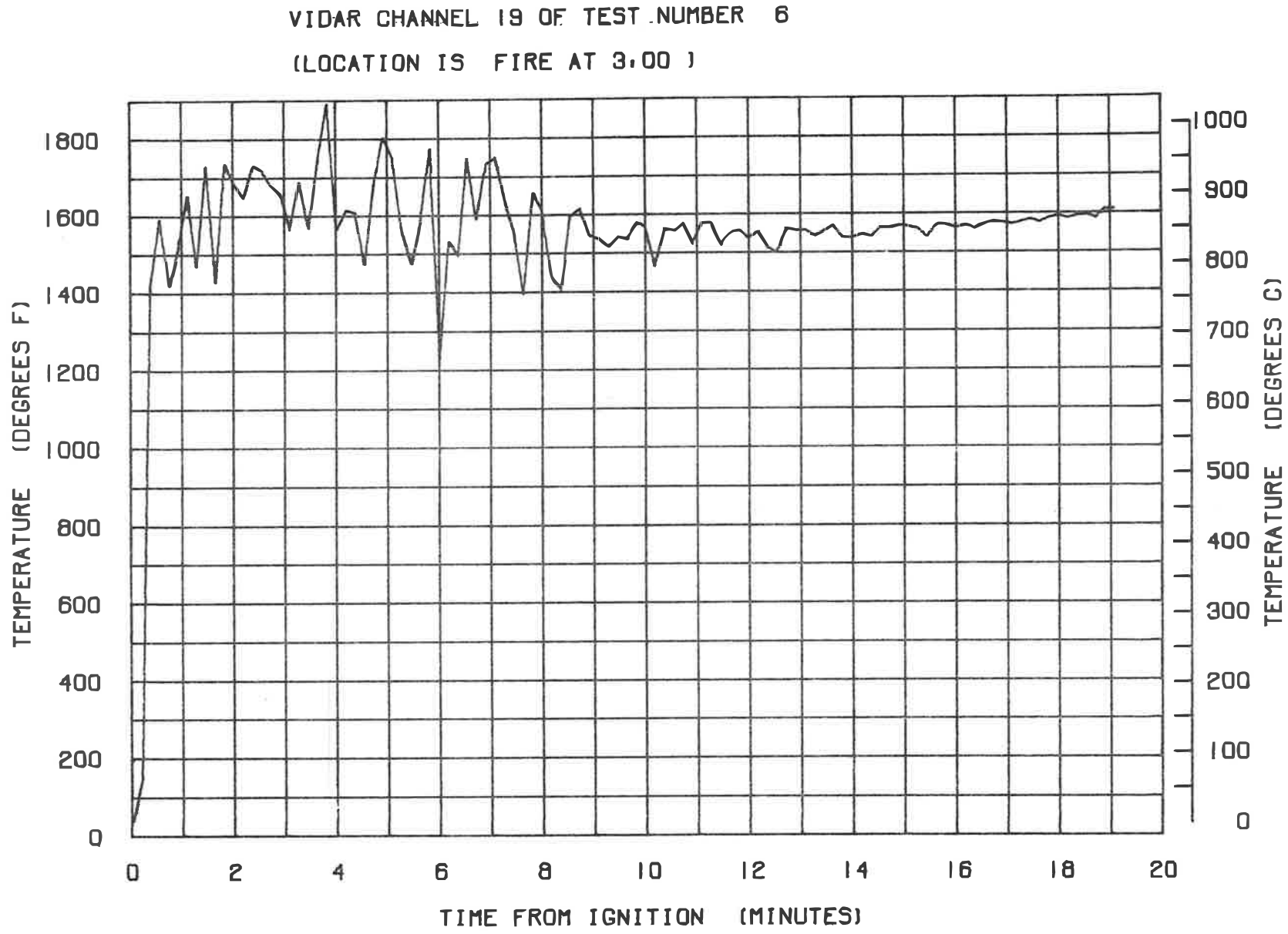

FIGURE A43 THERMOCOUPLE TEMPERATURE VS. TIME

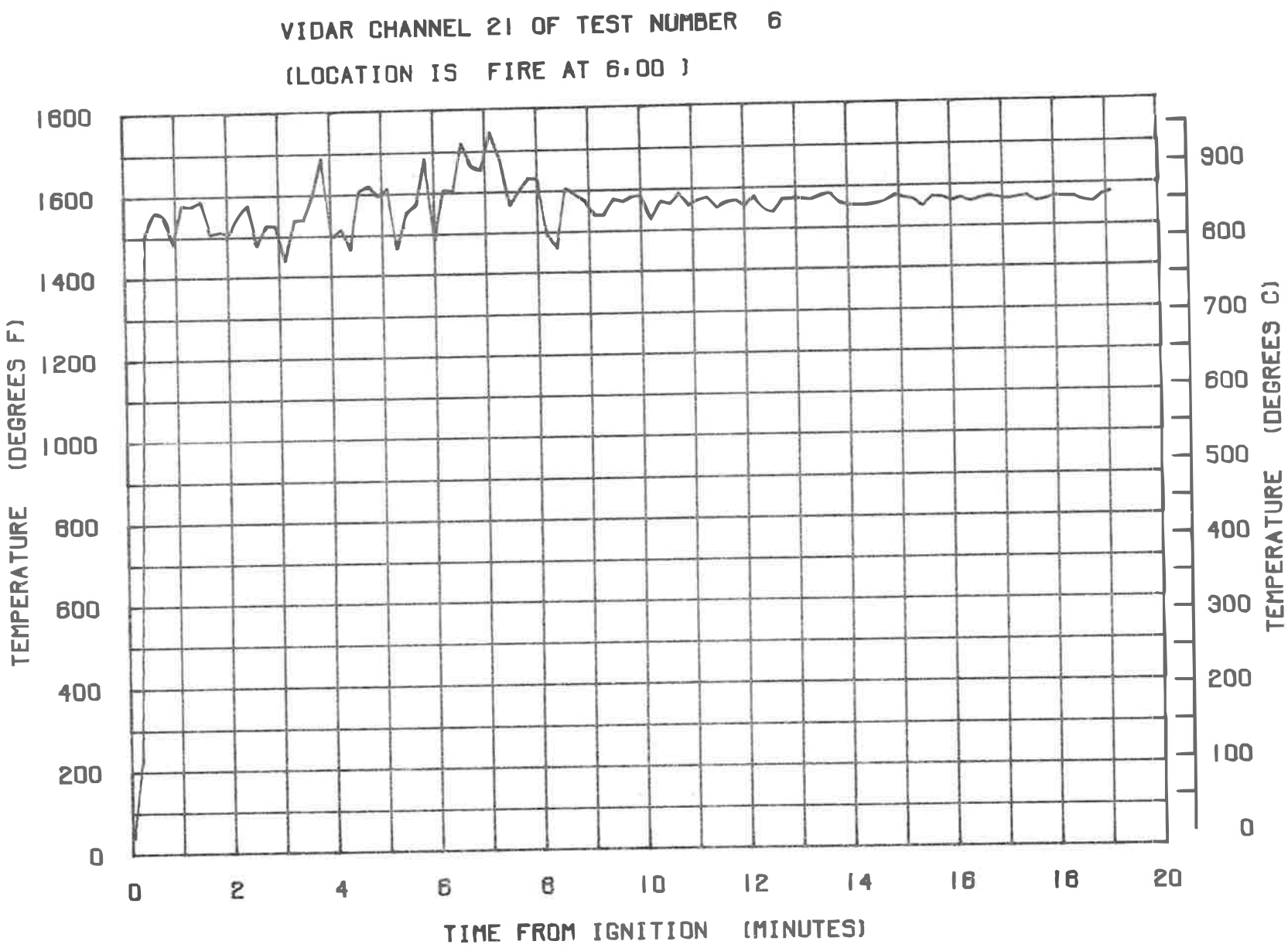

FIGURE A44 THERMOCOUPLE TEMPERATURE VS. TIME

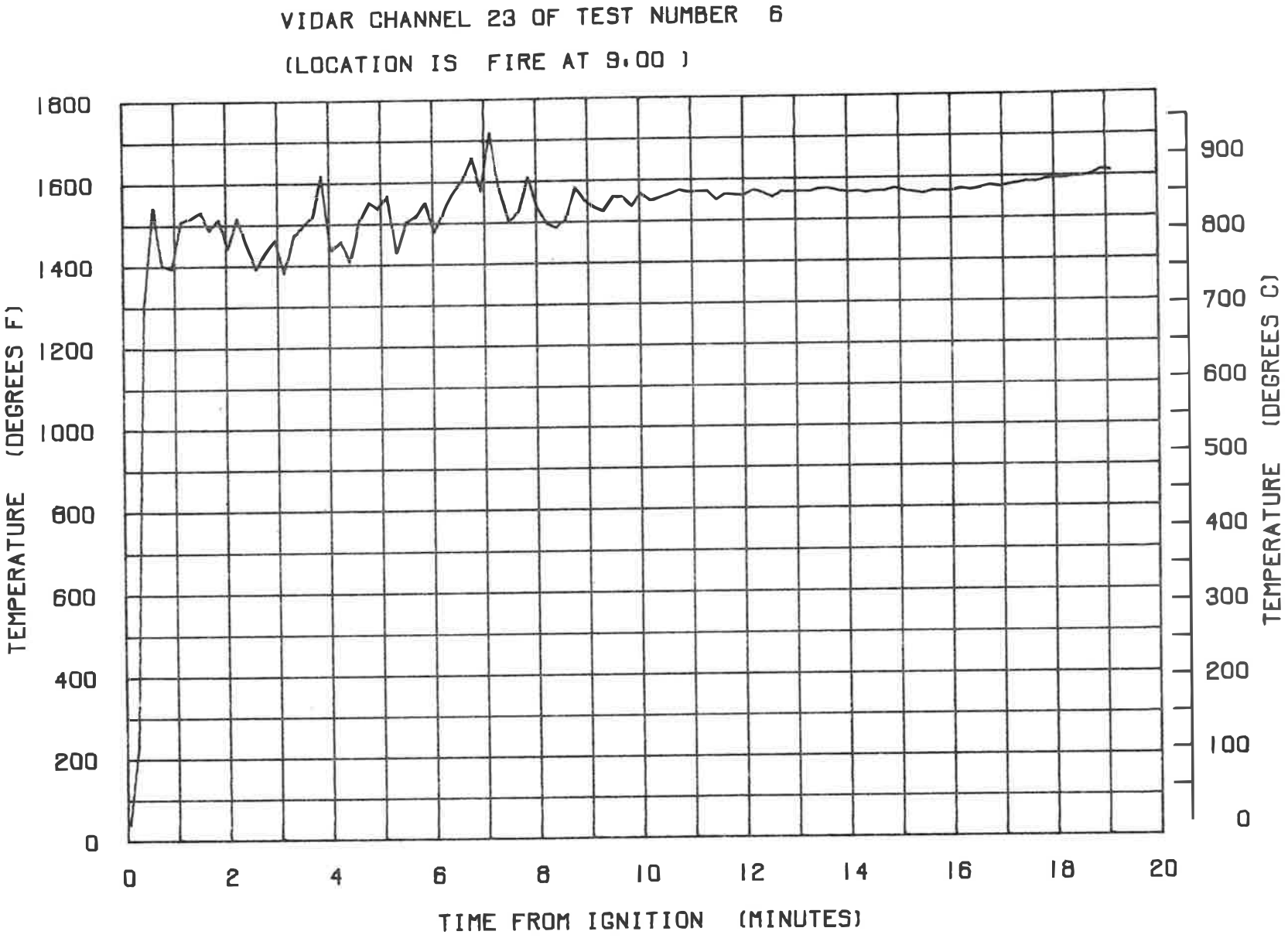

FIGURE A45 THERMOCOUPLE TEMPERATURE VS. TIME

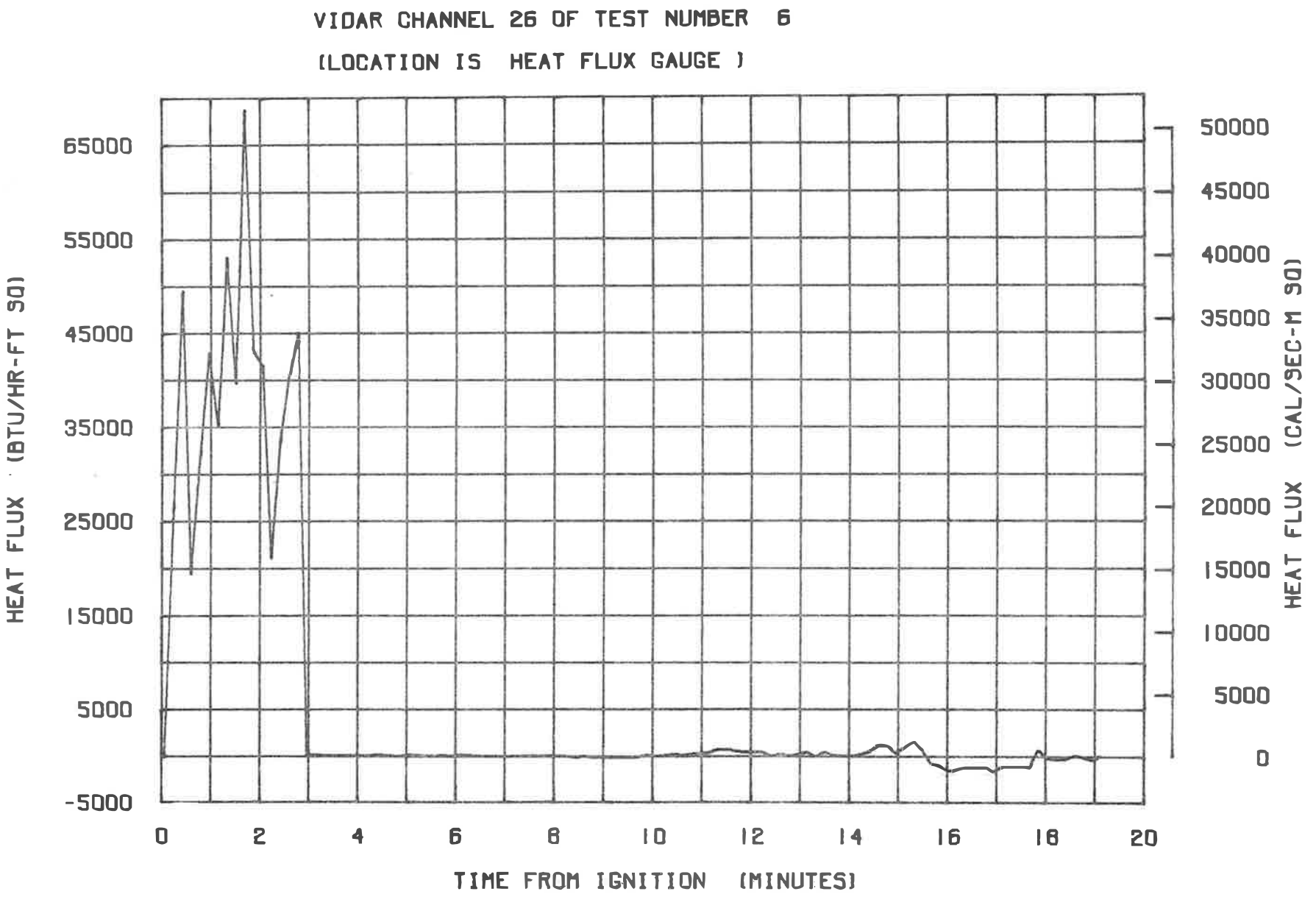

FIGURE A46 HEAT FLUX VS. TIME

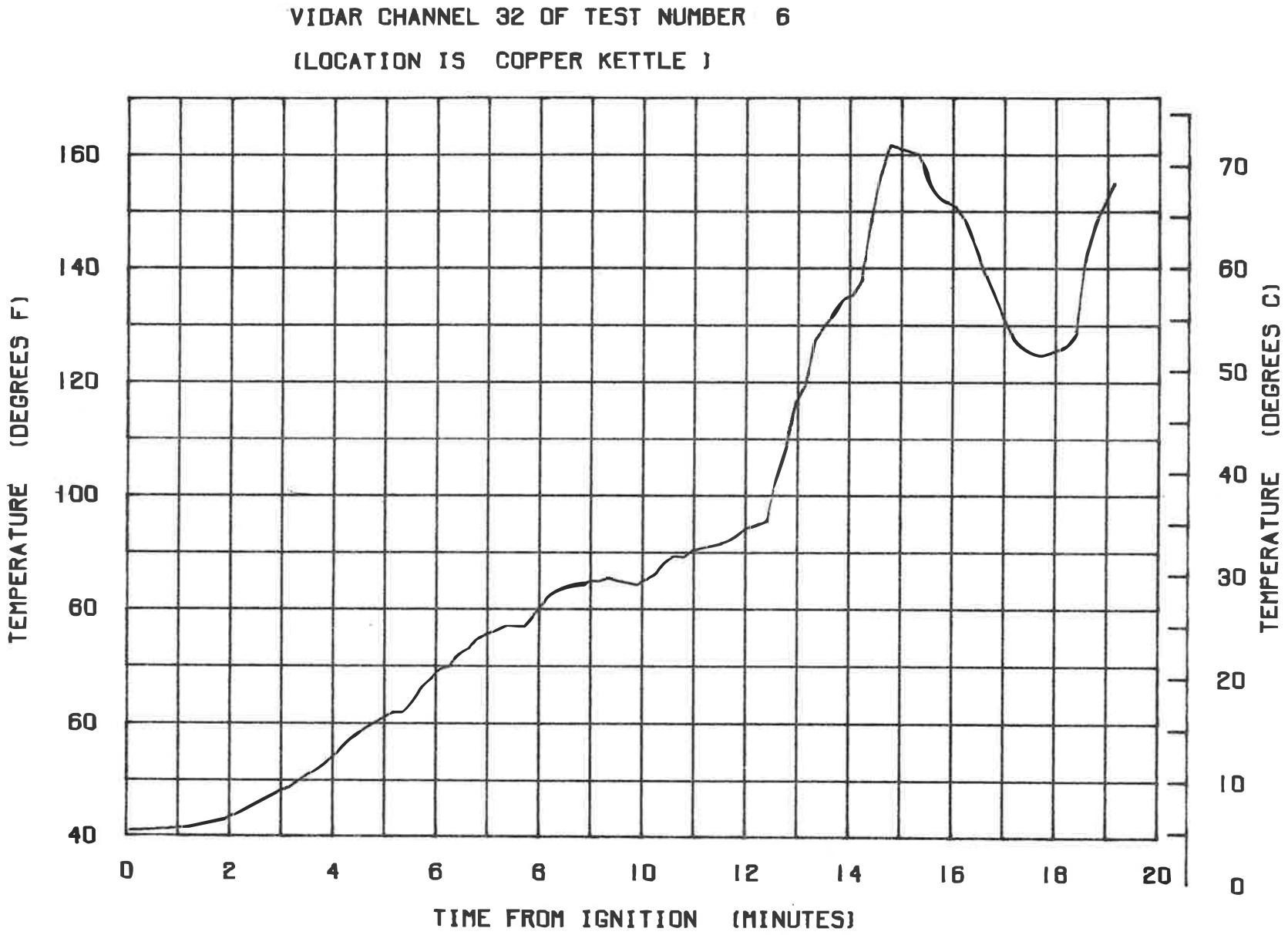

FIGURE A47 COPPER KETTLE CALORIMETER TEMPERATURE VS. TIME

APPENDIX B

CROSS-SECTIONAL PLOTS OF TEMPERATURE AT SPECIFIED TIMES

TABLE B - I

THERMOCOUPLE TEMPERATURES (DEG. F) FOR TEST NR. 6

CHANNEL NUMBER	LOCATION / TIME (SEC) =	0	32	65	97	130	163	195	228	261	293	326	359	391	424	457	489
46	(GRID AT 1, IN.)	41	45	74	133	195	286	375	446	550	630	716	771	820	858	904	943
47	(GRID AT 3,15 INS.)	41	45	60	111	146	173	229	295	387	446	529	597	717	776	829	882
48	(GRID AT 3,15 INS.)	41	42	61	111	136	166	208	271	360	431	493	608	699	768	825	879
49	(GRID AT 3,15 INS.)	41	42	66	113	146	185	235	313	390	466	545	645	726	794	841	888
50	(GRID AT 7,15 INS.)	41	41	50	101	119	122	139	170	220	295	353	438	507	598	675	741
51	(GRID AT 7,15 INS.)	41	41	55	105	128	140	164	201	260	325	405	498	595	662	729	797
52	(GRID AT 7,15 INS.)	41	38	52	105	128	135	148	182	232	291	362	454	539	590	674	760
53	(GRID AT 11.2 INS.)	41	38	49	83	110	129	129	136	165	205	258	341	423	497	531	610
54	(GRID AT 11.2 INS.)	41	40	52	89	128	141	148	157	183	219	271	345	425	497	547	648
55	(GRID AT 11.2 INS.)	41	41	50	84	121	124	128	140	165	197	237	320	389	461	531	611
56	(GRID AT 15.2 INS.)	41	44	52	83	119	134	142	144	149	176	209	278	348	432	500	535
57	(GRID AT 15.2 INS.)	41	44	54	83	122	136	149	152	156	181	215	281	352	436	509	559
58	(GRID AT 15.2 INS.)	41	40	47	72	112	125	128	127	127	139	167	222	289	357	430	511
59	(GRID AT 19.2 INS.)	41	42	45	66	98	128	130	131	134	138	135	172	226	290	353	417
35	(GRID AT 19.2 INS.)	41	41	45	66	99	125	128	130	133	136	141	188	243	312	379	449
37	(GRID AT 19.2 INS.)	41	41	46	67	101	123	126	128	133	135	145	188	243	316	383	446
39	(GRID AT 21.45 INS.)	41	40	39	43	64	108	118	119	125	129	140	139	144	157	216	271
18	(INSIDE AT 12:00)	41	58	109	207	319	410	505	588	666	743	789	838	869	901	942	975
20	(INSIDE AT 1:00)	41	58	112	143	218	305	369	417	503	573	618	672	713	763	819	874
22	(INSIDE AT 1:30)	41	44	66	116	163	220	285	351	412	479	545	602	652	696	744	789
24	(INSIDE AT 2:00)	41	65	128	142	169	305	394	464	548	624	669	719	758	810	872	930
27	(INSIDE AT 3:00)	41	71	136	139	139	187	302	384	465	543	596	653	703	762	828	891
28	(INSIDE AT 3:30)	41	64	129	138	138	141	192	301	384	446	512	575	631	694	762	828
29	(INSIDE AT 4:00)	41	73	138	140	140	142	143	193	309	386	444	515	576	642	711	778
33	(INSIDE AT 5:00)	41	74	137	140	138	140	142	144	146	152	241	326	396	458	535	601
34	(INSIDE AT 6:00)	41	67	124	125	126	132	134	135	138	145	156	200	287	357	411	464
36	(INSIDE AT 7:00)	41	74	131	134	136	139	141	143	146	155	251	329	403	453	531	591
38	(INSIDE AT 7:30)	41	75	137	138	143	143	144	146	166	262	348	411	456	542	605	665
41	(INSIDE AT 8:30)	41	75	132	138	141	142	209	292	369	420	485	542	602	661	716	771
11	(INSIDE AT 9:00)	41	80	133	138	138	173	269	339	412	492	561	615	675	730	781	832
10	(INSIDE AT 9:30)	41	72	137	144	144	218	314	387	439	537	606	656	714	768	820	874
14	(INSIDE AT 10:00)	41	73	133	142	167	275	362	422	515	590	659	712	769	826	881	936
15	(INSIDE AT 10:30)	41	70	126	140	233	330	408	487	574	650	718	774	829	883	938	982
17	(INSIDE AT 11:00)	41	65	121	172	287	384	464	557	642	725	786	843	888	932	977	1015
42	(MANWAY AT 1, IN.)	41	42	55	76	100	126	136	139	144	144	149	155	181	247	302	347
43	(MANWAY AT 4, INS.)	41	70	126	136	137	136	141	143	148	151	157	236	324	395	457	516
44	(MANWAY AT 7, INS.)	41	76	139	139	140	141	145	147	152	165	250	347	420	501	572	638
45	(MANWAY AT 10, INS.)	41	73	134	137	137	141	144	146	151	158	212	313	395	463	541	603
16	(FIRE AT 12:00)	41	1262	1138	1022	1590	1570	1708	1504	1671	1614	1361	1292	1304	1456	1539	1536
19	(FIRE AT 3:00)	41	1559	1626	1481	1652	1681	1666	1864	1606	1780	1487	1325	1701	1746	1421	1467
21	(FIRE AT 6:00)	41	1551	1557	1524	1539	1515	1517	1668	1475	1600	1534	1527	1693	1724	1593	1520
23	(FIRE AT 9:00)	41	1477	1478	1498	1497	1424	1449	1591	1418	1539	1483	1495	1595	1681	1520	1504

TABLE B - II

THERMOCOUPLE TEMPERATURES (DEG. C) FOR TEST NR. 6

CHANNEL NUMBER	LOCATION	TIME (SEC) =	0	32	65	97	130	163	195	228	261	293	326	359	391	424	457	489
46	(GRID AT 1, IN.)		4	7	23	56	90	141	190	229	287	332	380	410	437	458	484	506
47	(GRID AT 3,15 INS.)		4	7	15	43	63	78	109	146	197	229	276	313	380	413	442	472
48	(GRID AT 3,15 INS.)		4	5	16	43	57	74	97	132	182	221	256	320	370	408	440	470
49	(GRID AT 3,15 INS.)		4	5	18	45	63	84	112	156	198	241	285	340	385	423	449	475
50	(GRID AT 7,15 INS.)		4	4	9	38	48	50	59	76	104	140	178	225	263	314	357	393
51	(GRID AT 7,15 INS.)		4	4	12	40	53	60	73	93	126	161	207	258	312	350	387	425
52	(GRID AT 7,15 INS.)		4	3	11	40	53	57	64	83	111	143	183	234	281	310	356	404
53	(GRID AT 11.2 INS.)		4	3	9	28	47	53	53	57	73	96	125	171	217	258	277	321
54	(GRID AT 11.2 INS.)		4	4	11	31	53	60	64	69	83	103	132	173	218	258	286	342
55	(GRID AT 11.2 INS.)		4	4	9	28	49	51	53	60	73	91	113	159	198	238	277	321
56	(GRID AT 15.2 INS.)		4	6	11	28	48	56	61	62	64	79	98	136	175	222	260	279
57	(GRID AT 15.2 INS.)		4	6	12	28	50	57	64	66	68	82	101	138	177	224	265	292
58	(GRID AT 15.2 INS.)		4	4	8	22	44	51	53	52	52	59	74	105	142	180	221	266
59	(GRID AT 19.2 INS.)		4	5	7	18	36	53	54	55	56	58	57	77	107	143	178	213
35	(GRID AT 19.2 INS.)		4	4	7	18	37	51	53	54	56	57	60	86	117	155	192	231
37	(GRID AT 19.2 INS.)		4	4	7	19	38	50	52	53	56	57	62	86	117	157	194	229
39	(GRID AT 21.45 INS.)		4	4	3	6	17	42	47	48	51	53	60	59	62	69	102	132
18	(INSIDE AT 12:00)		4	14	42	97	159	209	262	308	352	395	420	447	465	482	505	523
20	(INSIDE AT 1:00)		4	14	44	61	103	151	187	213	261	300	325	355	378	406	437	467
22	(INSIDE AT 1:30)		4	6	18	46	72	104	140	177	211	248	285	316	344	368	395	420
24	(INSIDE AT 2:00)		4	18	53	61	76	151	201	239	286	328	353	381	403	432	466	498
27	(INSIDE AT 3:00)		4	21	57	59	59	86	149	195	240	283	313	345	372	405	442	477
28	(INSIDE AT 3:30)		4	17	53	58	58	60	88	149	195	229	266	301	332	367	405	442
29	(INSIDE AT 4:00)		4	22	58	60	60	61	61	89	153	196	228	268	302	338	377	414
33	(INSIDE AT 5:00)		4	23	58	60	58	60	61	62	63	66	116	163	202	236	279	316
34	(INSIDE AT 6:00)		4	19	51	51	52	55	56	57	58	62	68	93	141	180	210	239
36	(INSIDE AT 7:00)		4	23	55	56	57	59	60	61	63	66	121	164	206	233	277	310
38	(INSIDE AT 7:30)		4	23	58	58	61	61	62	63	74	127	175	210	235	283	318	351
41	(INSIDE AT 8:30)		4	23	55	58	60	61	98	144	187	215	251	283	316	349	380	410
11	(INSIDE AT 9:00)		4	26	56	58	58	78	131	170	211	255	293	323	357	387	416	444
10	(INSIDE AT 9:30)		4	22	58	62	62	103	156	197	226	280	318	346	378	408	437	467
14	(INSIDE AT 10:00)		4	22	56	61	74	134	183	216	268	310	348	377	409	441	471	502
15	(INSIDE AT 10:30)		4	21	52	60	111	165	208	252	301	343	381	412	442	472	503	527
17	(INSIDE AT 11:00)		4	18	49	77	141	195	239	291	338	383	418	450	475	500	525	546
42	(MANWAY AT 1, IN.)		4	5	12	24	37	52	57	59	62	62	64	68	82	119	149	174
43	(MANWAY AT 4, INS.)		4	21	52	57	58	58	60	61	64	66	69	113	162	201	236	268
44	(MANWAY AT 7, INS.)		4	24	59	59	60	60	62	63	66	75	121	174	215	260	300	336
45	(MANWAY AT 10, INS.)		4	22	56	58	58	60	62	63	66	69	99	156	201	239	282	317
16	(FIRE AT 12:00)		4	683	614	550	865	854	931	817	910	878	738	700	706	791	837	835
19	(FIRE AT 3:00)		4	848	885	805	900	916	907	1017	874	971	808	718	927	952	771	797
21	(FIRE AT 6:00)		4	843	847	828	837	823	825	908	801	871	834	830	922	940	867	826
23	(FIRE AT 9:00)		4	802	803	814	813	773	787	866	770	837	806	812	868	916	826	817

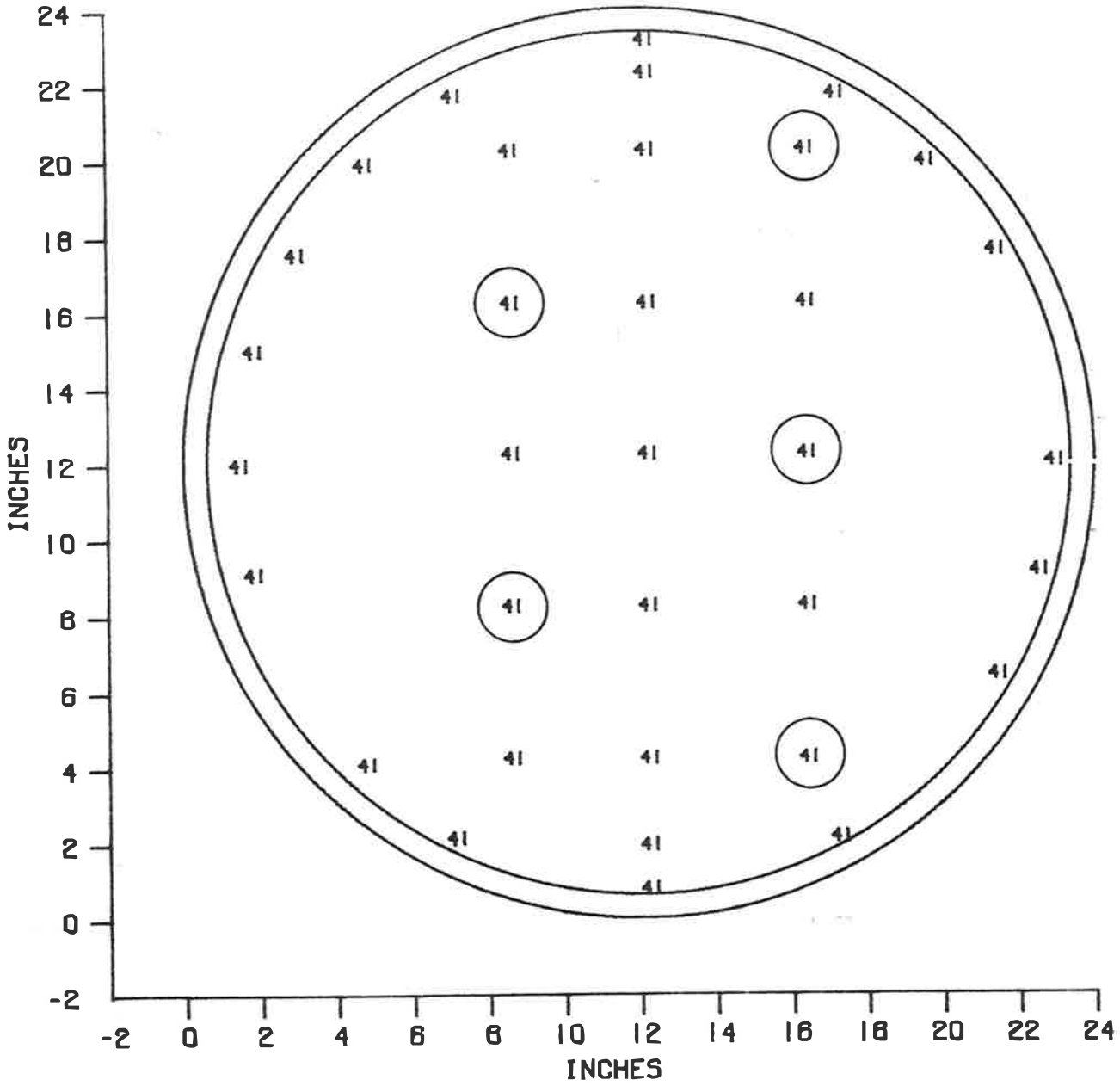

FIGURE B1 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION
AT 0 SECONDS FROM IGNITION FOR TEST NR. 6

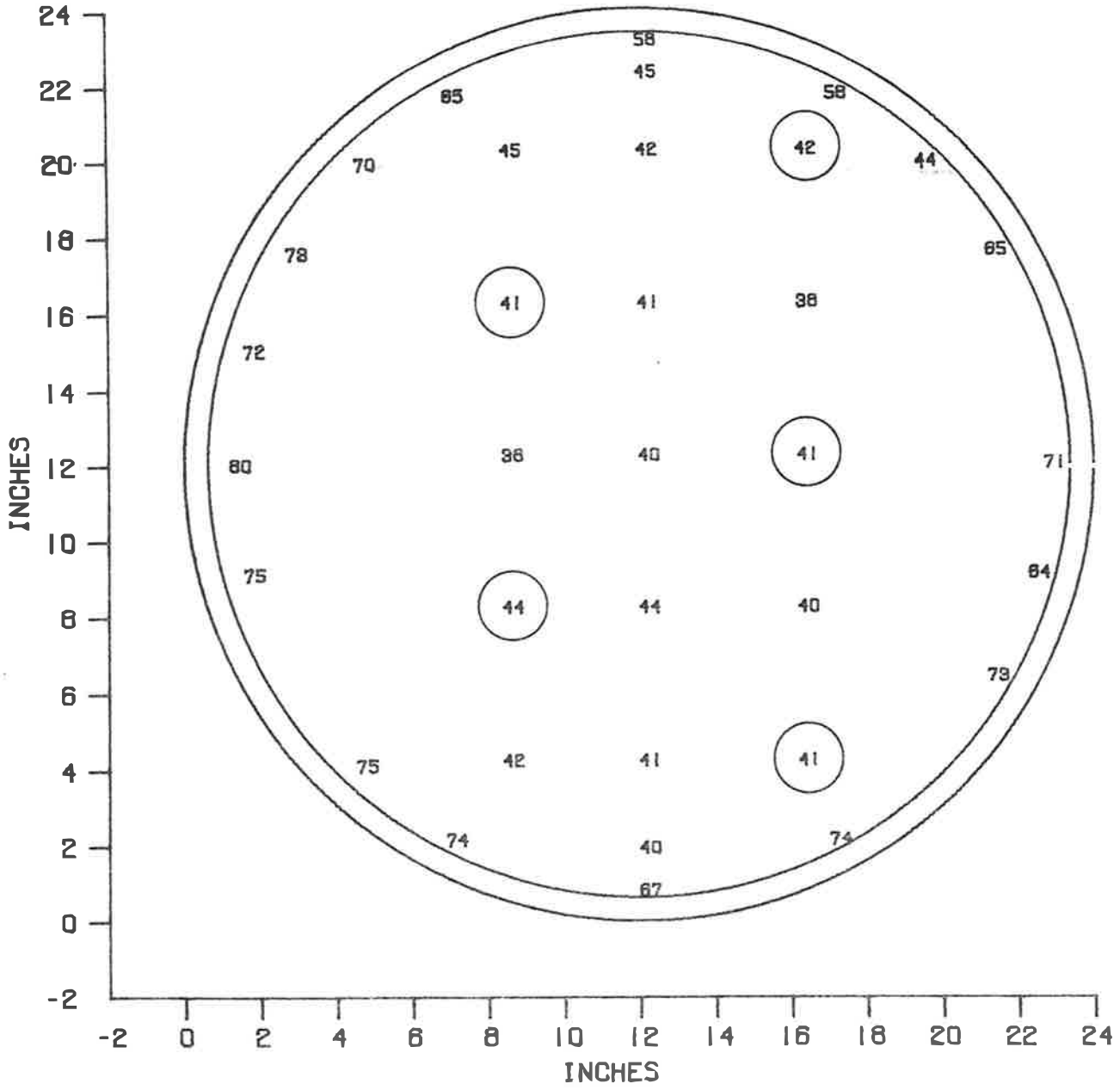

FIGURE B2 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 32 SECONDS FROM IGNITION FOR TEST NR. 6

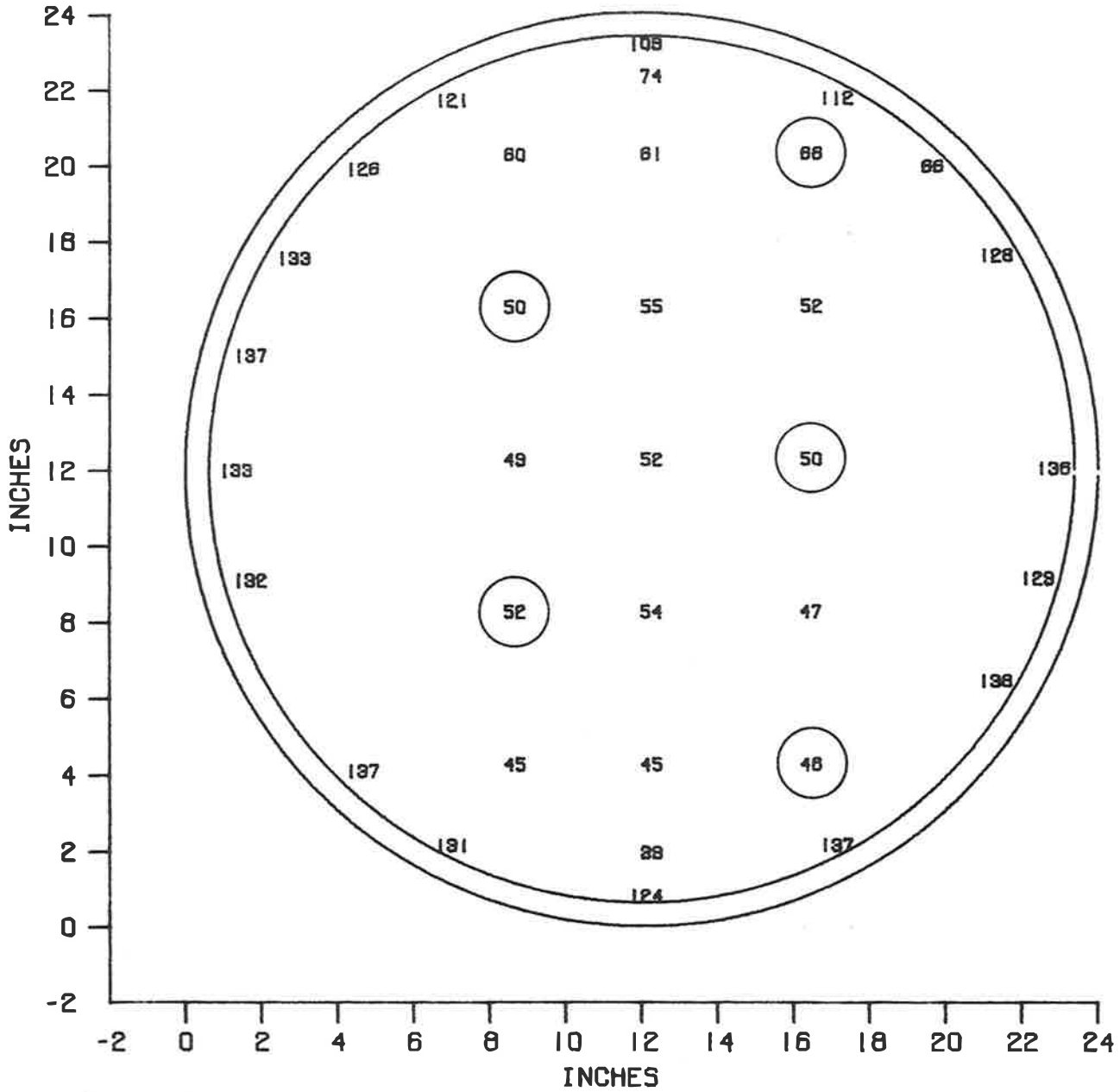

FIGURE B3 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 65 SECONDS FROM IGNITION FOR TEST NR. 6

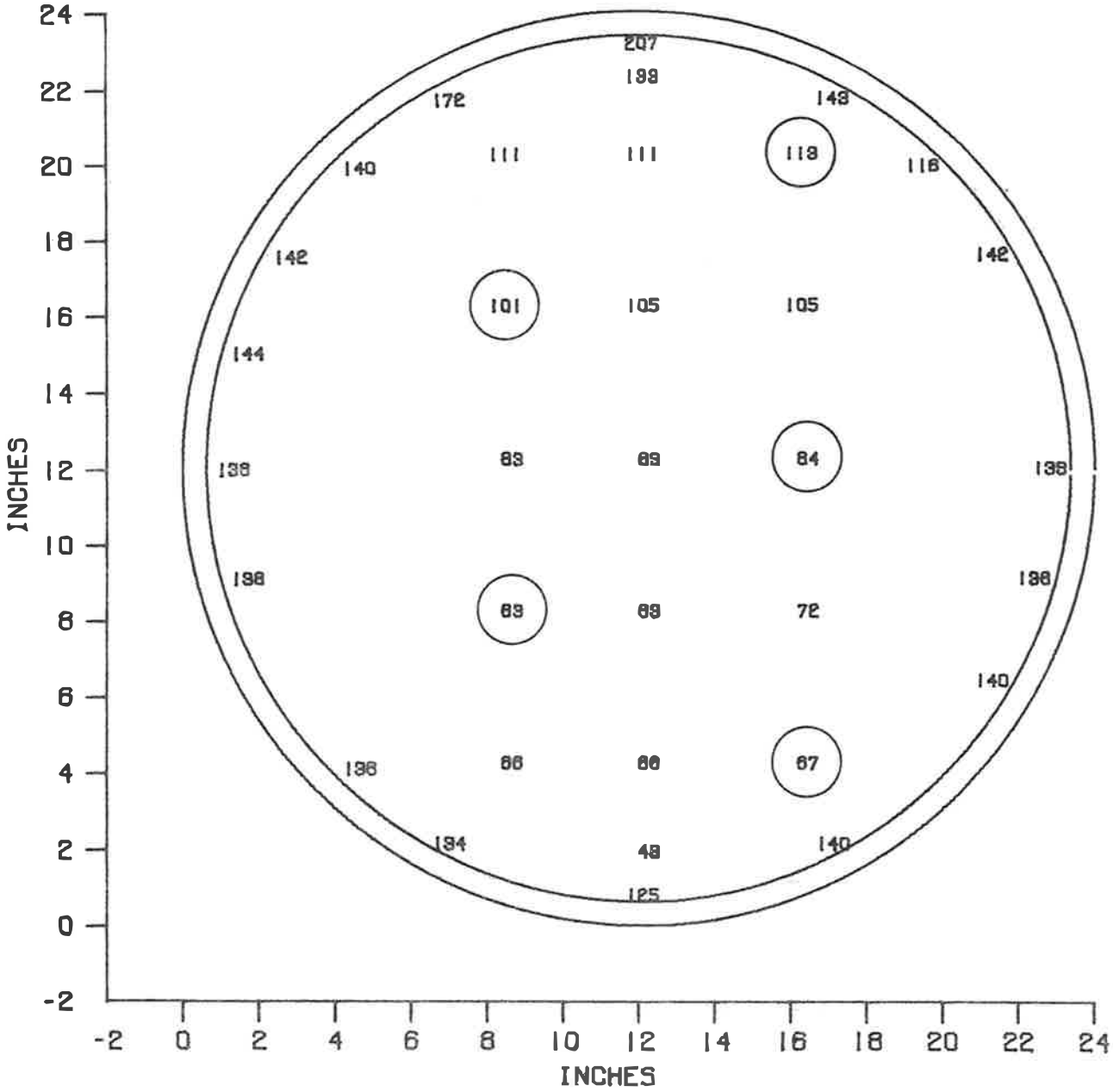

FIGURE B4 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 97 SECONDS FROM IGNITION FOR TEST NR. 6

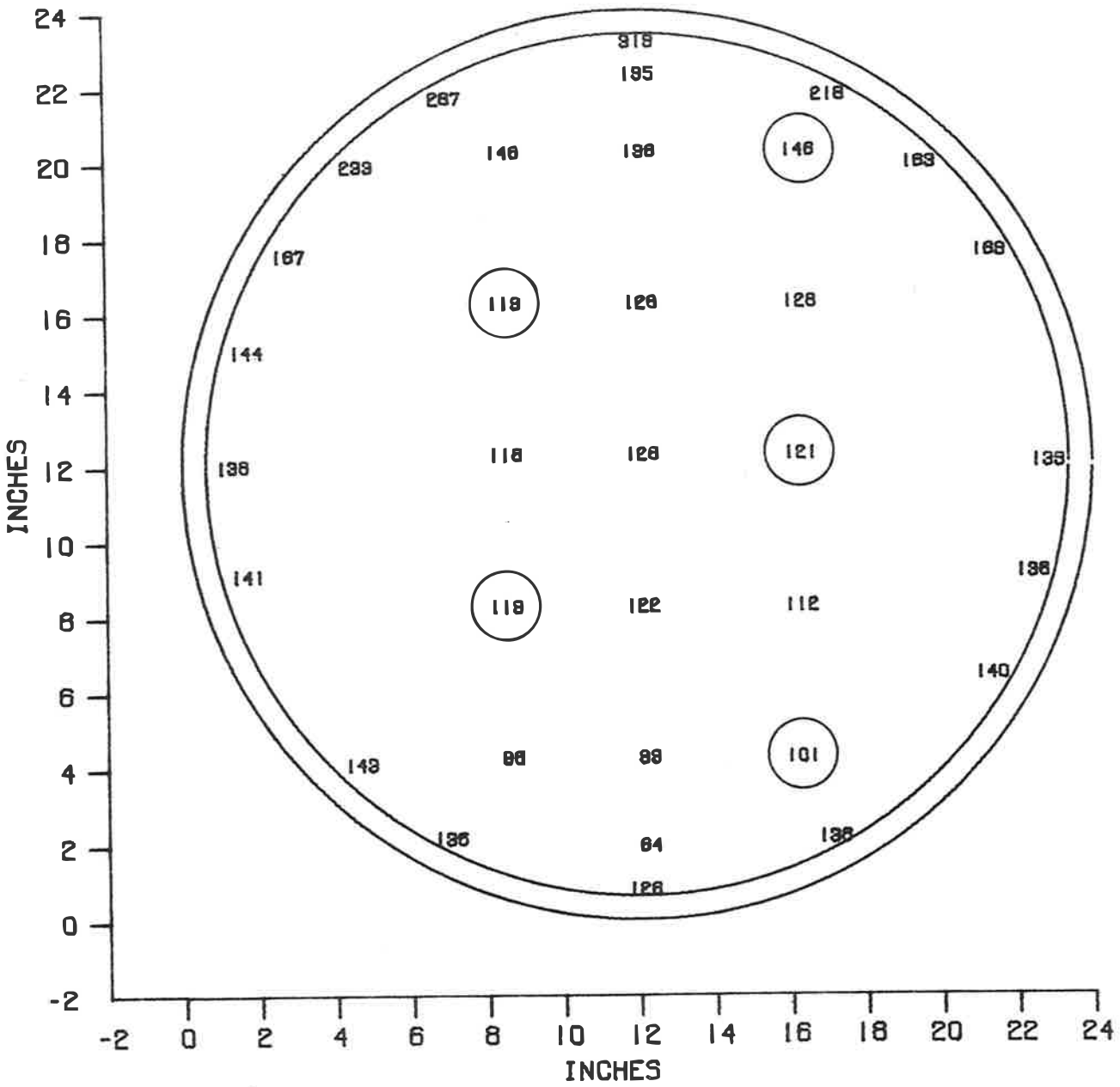

FIGURE B5 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 130 SECONDS FROM IGNITION FOR TEST NR. 6

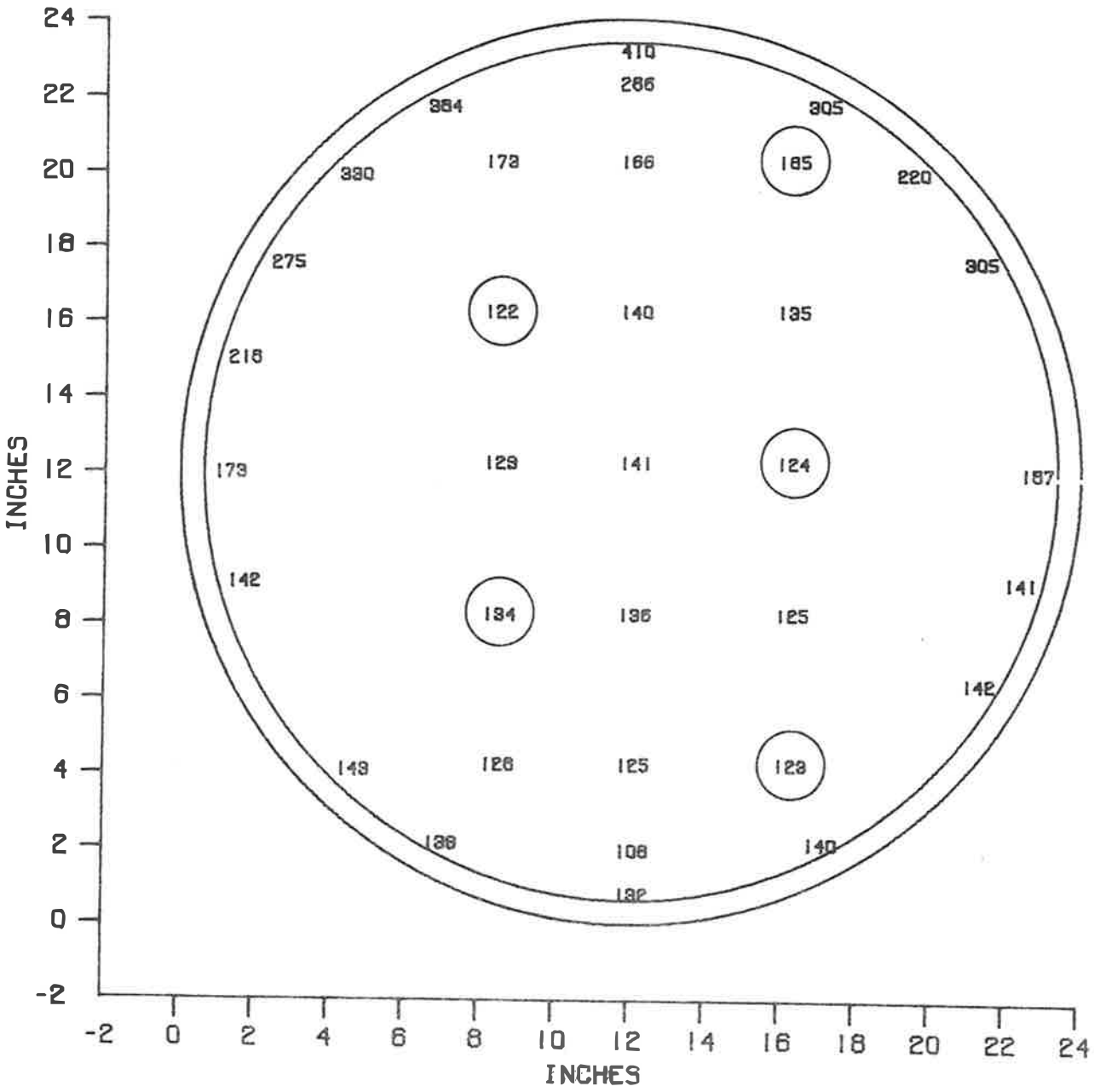

FIGURE B6 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 183 SECONDS FROM IGNITION FOR TEST NR. 6

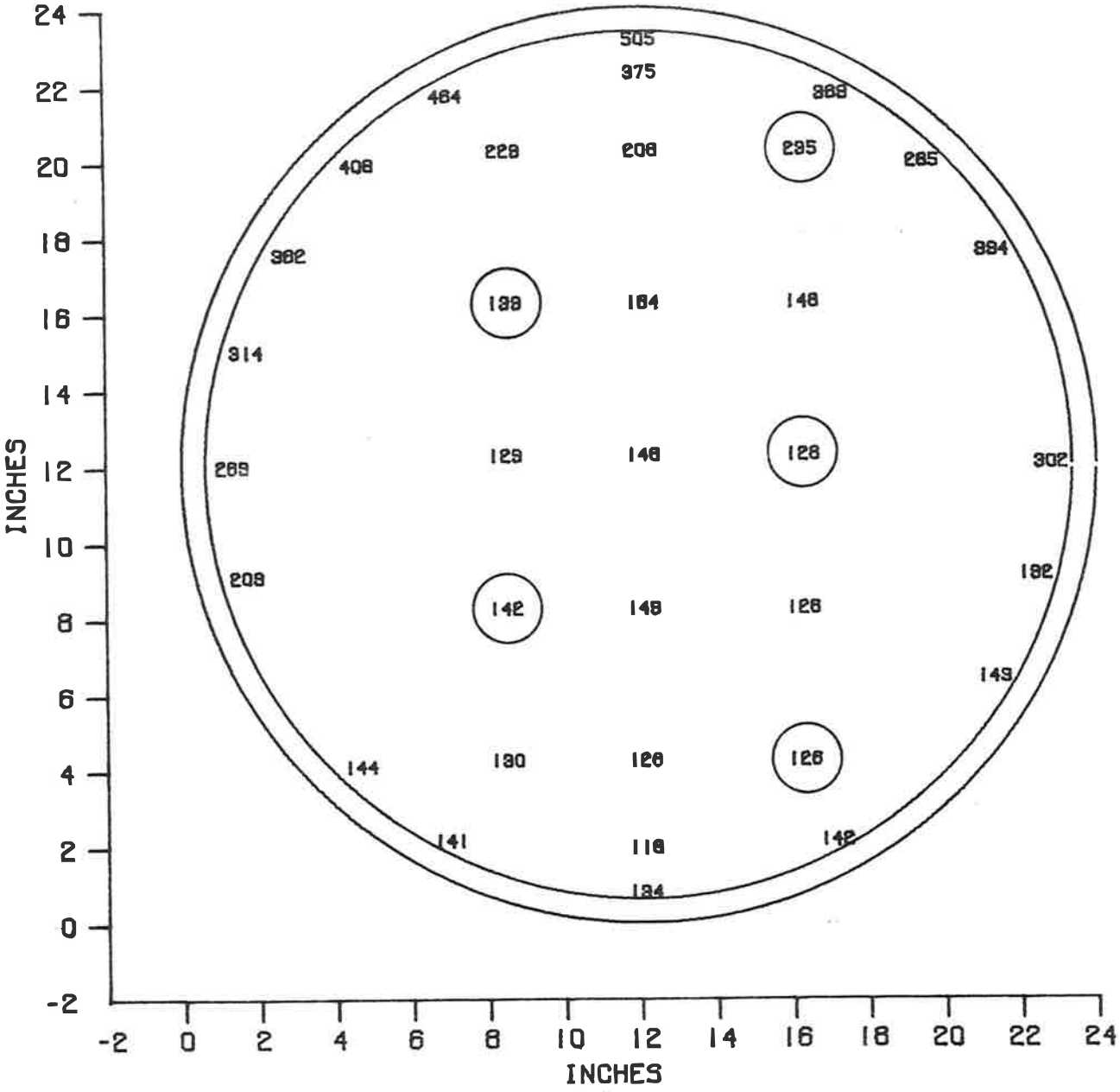

FIGURE B7 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 195 SECONDS FROM IGNITION FOR TEST NR. 6

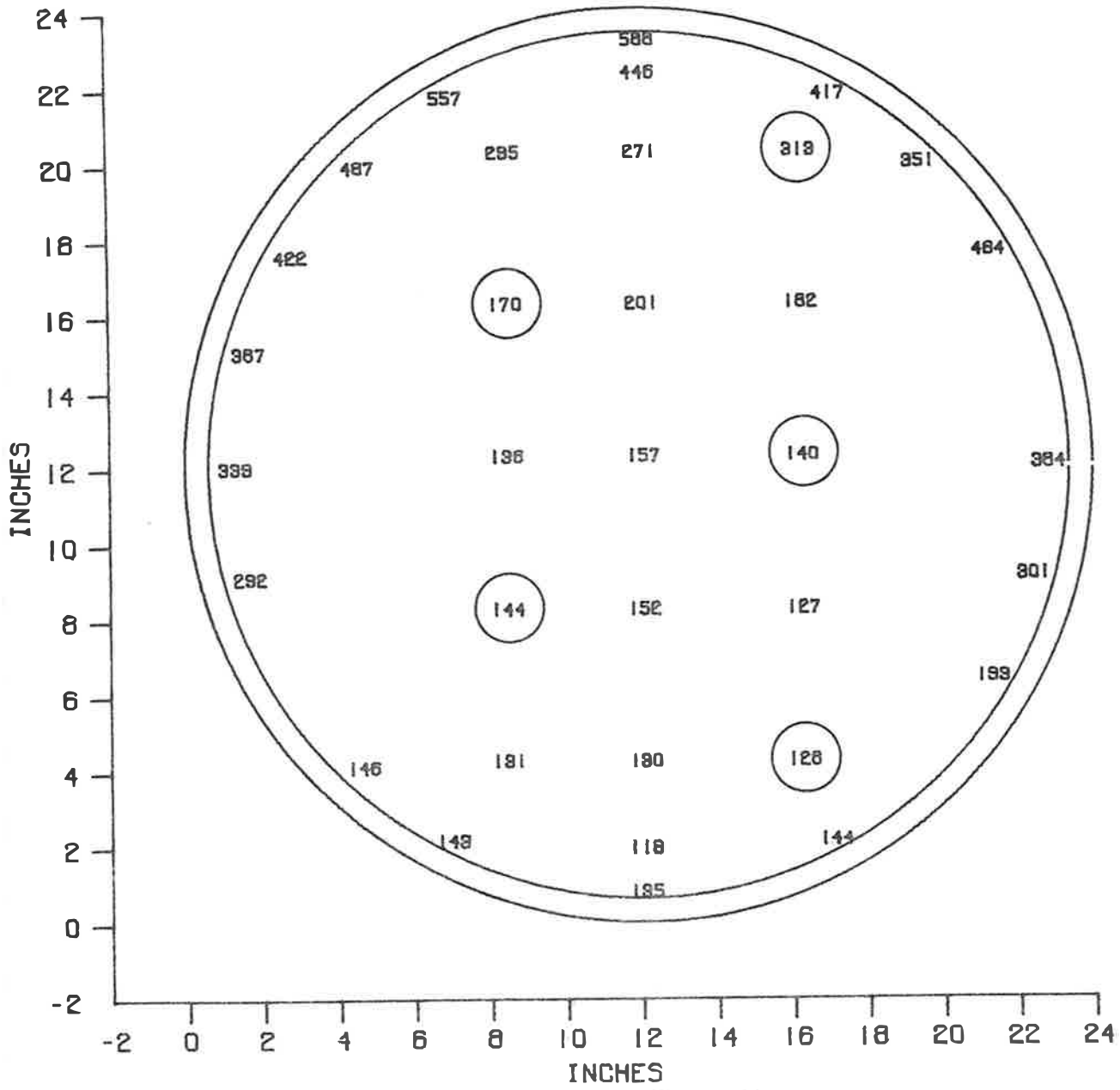

FIGURE B8 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 228 SECONDS FROM IGNITION FOR TEST NR. 6

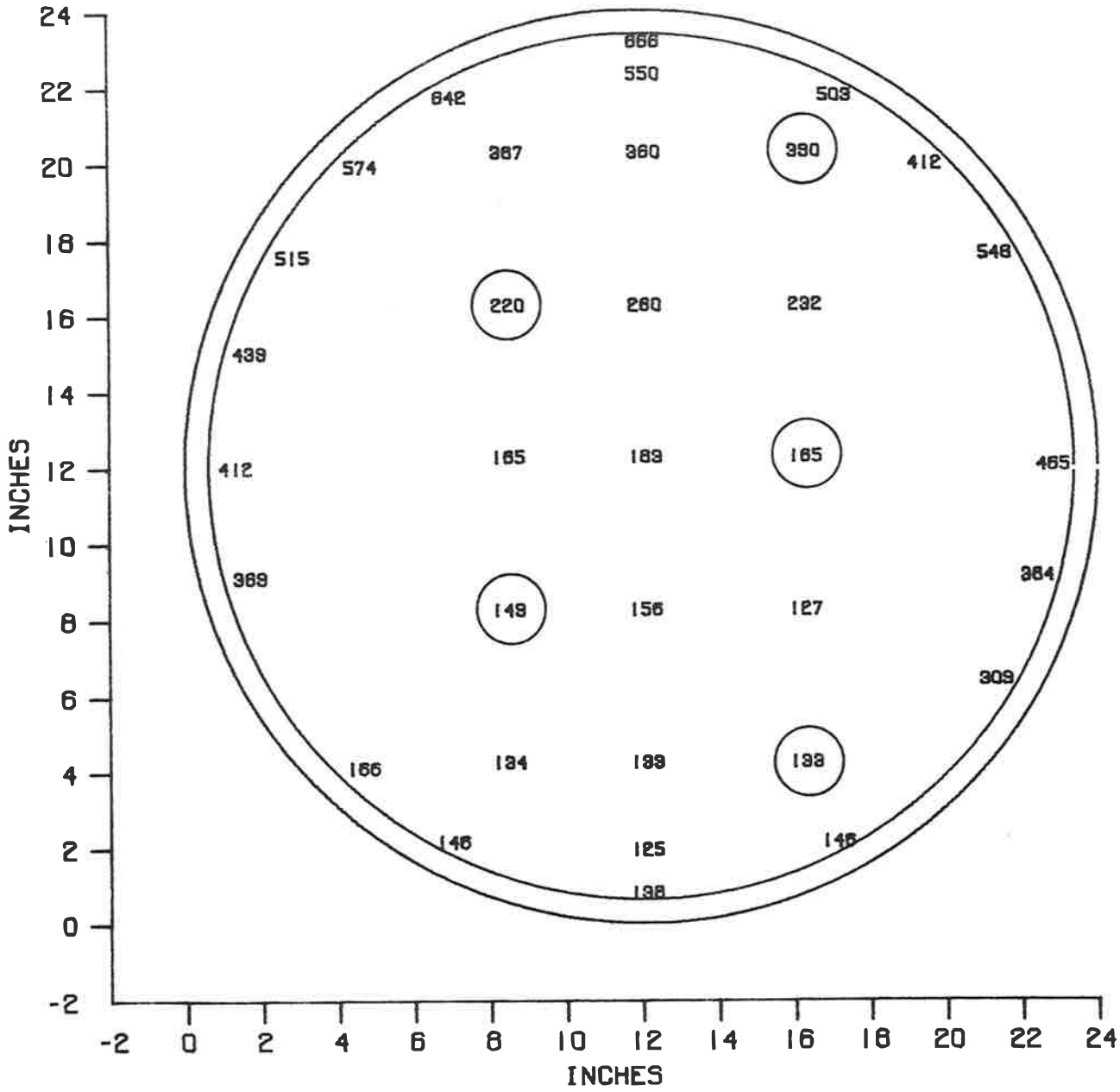

FIGURE B9 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 261 SECONDS FROM IGNITION FOR TEST NR. 6

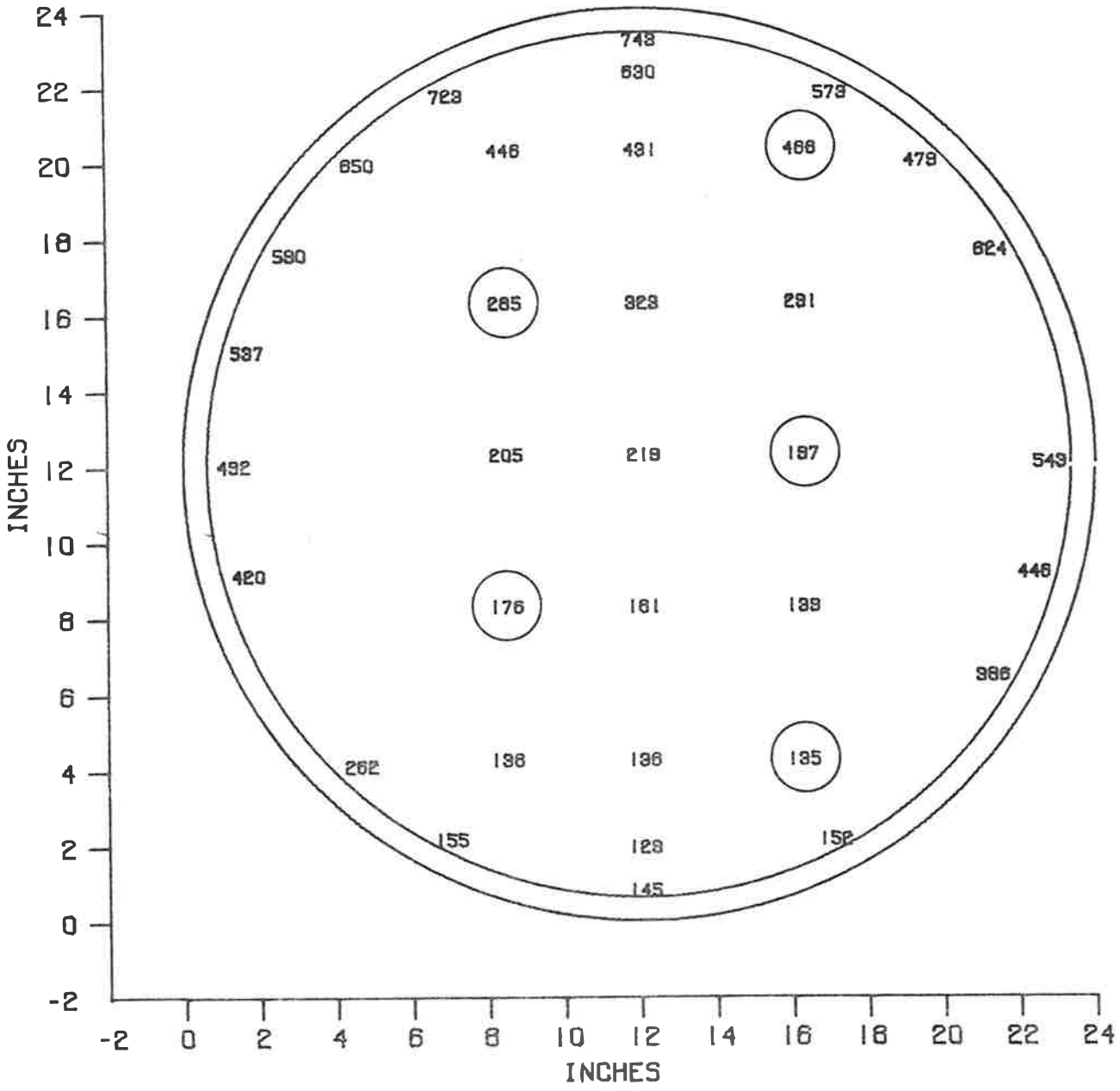

FIGURE B10 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 293 SECONDS FROM IGNITION FOR TEST NR. 6

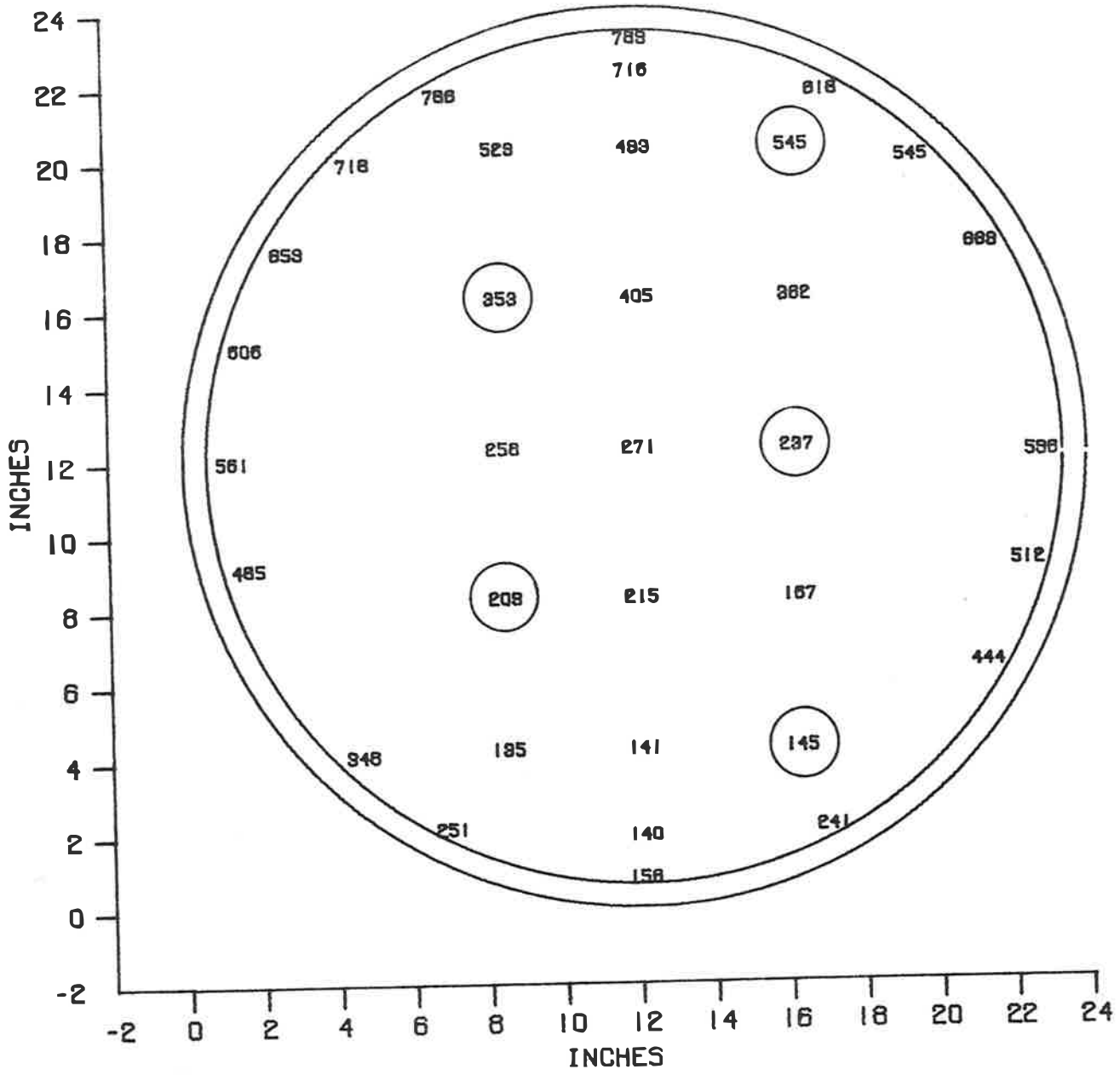

FIGURE B11 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 326 SECONDS FROM IGNITION FOR TEST NR. 6

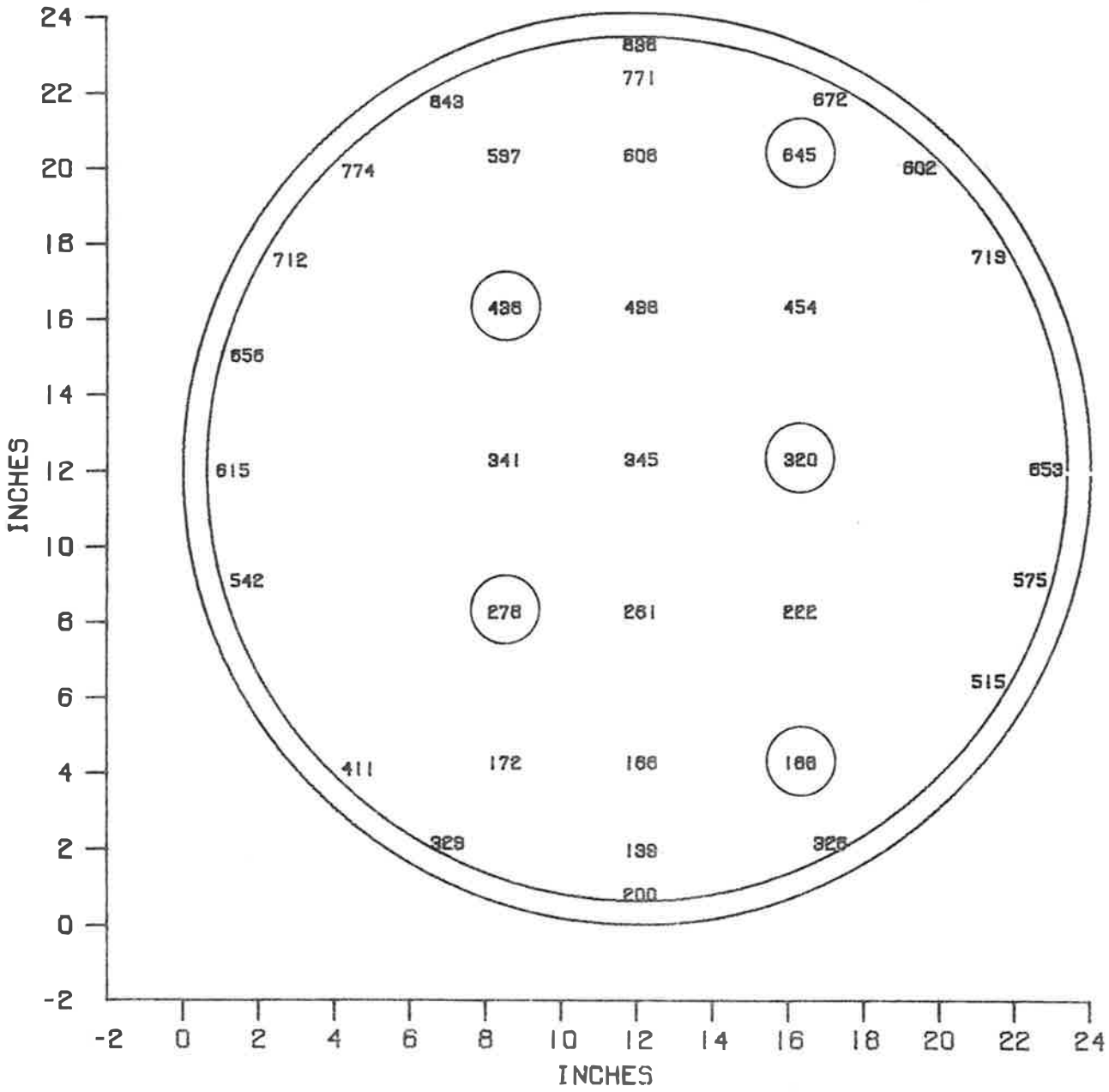

FIGURE B12 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 359 SECONDS FROM IGNITION FOR TEST NR. 6

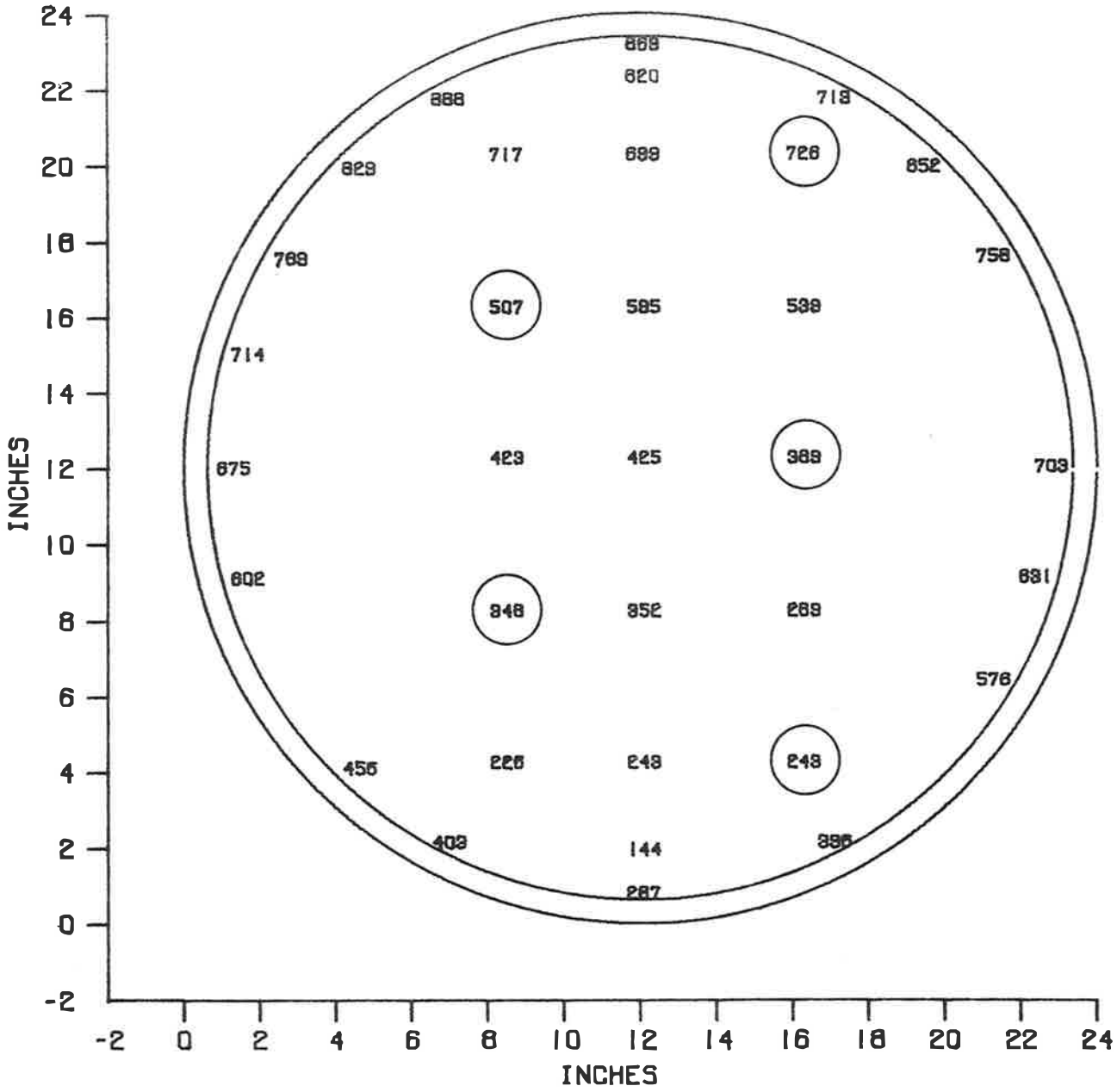

FIGURE B13 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 391 SECONDS FROM IGNITION FOR TEST NR. 6

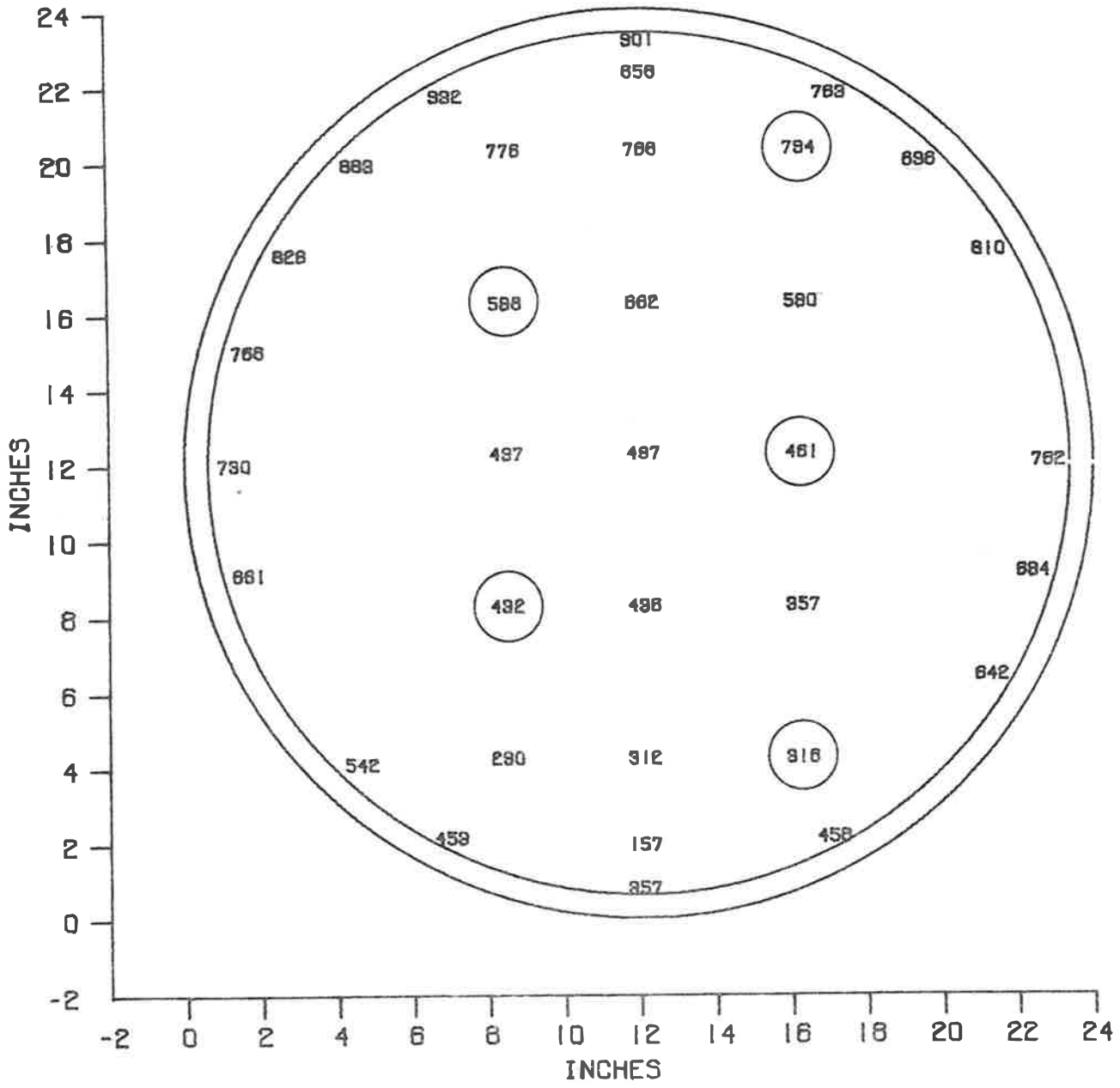

FIGURE B14 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 424 SECONDS FROM IGNITION FOR TEST NR. 6

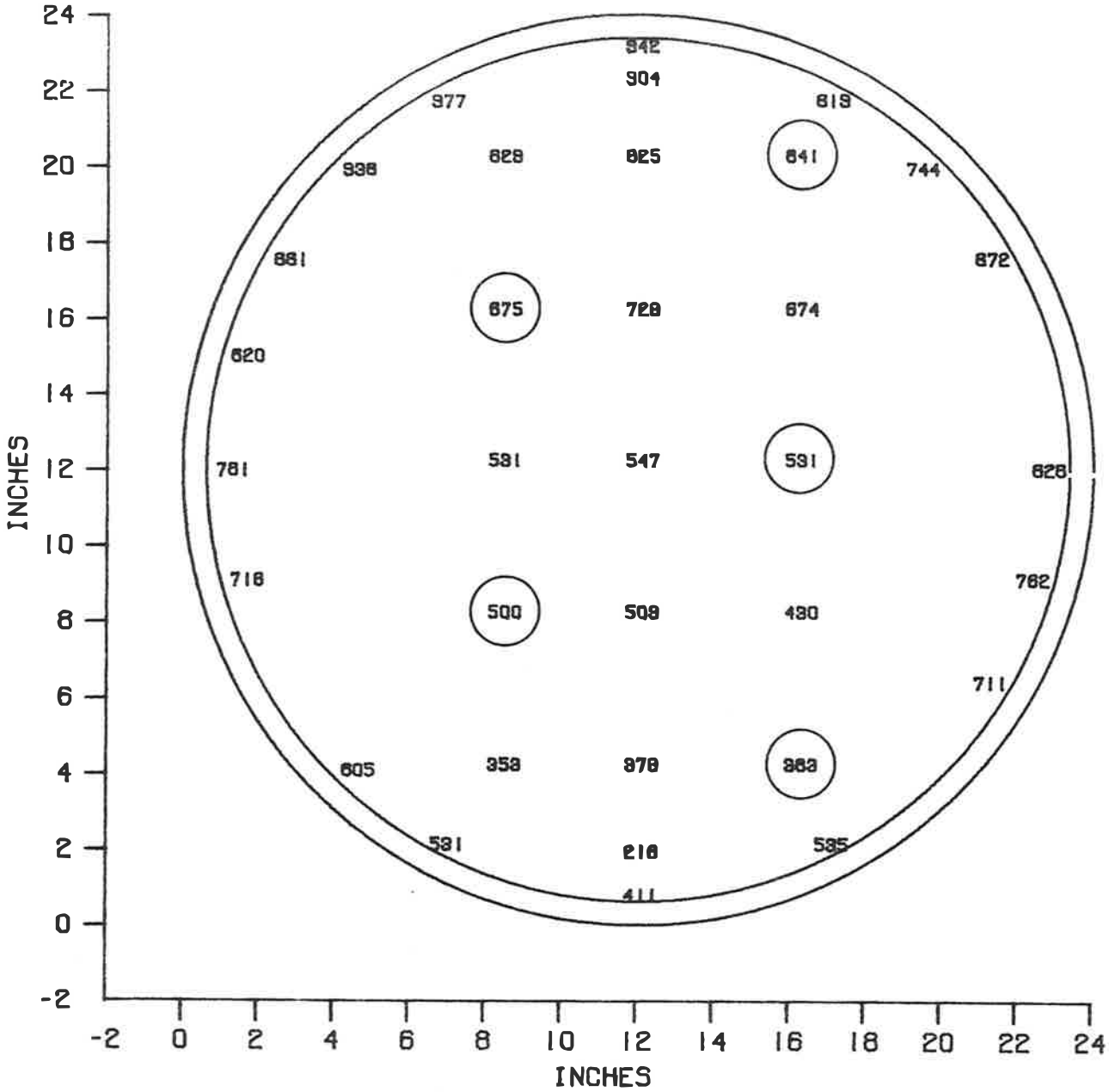

FIGURE B15 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 457 SECONDS FROM IGNITION FOR TEST NR. 6

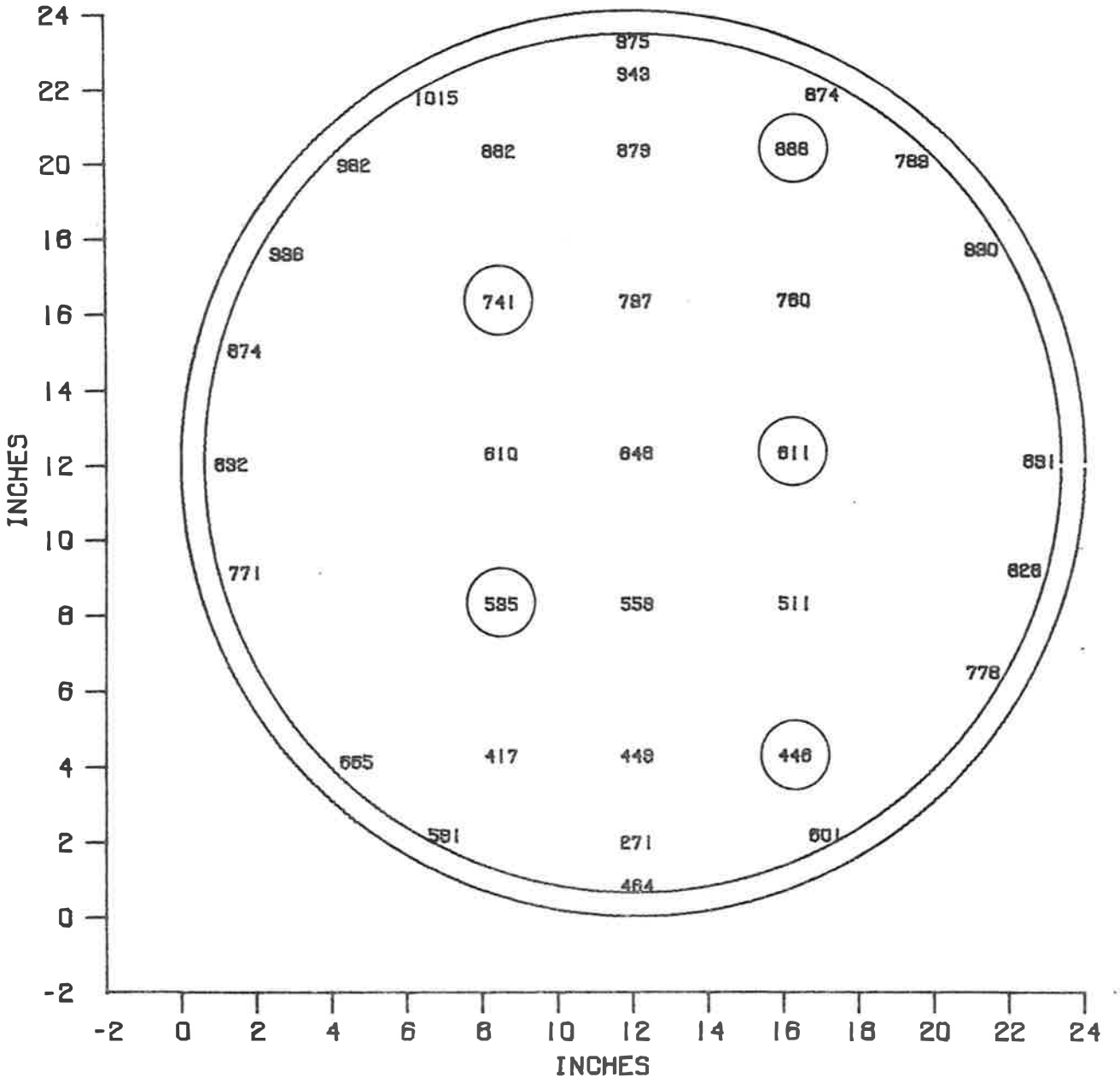

FIGURE B16 THERMOCOUPLE TEMPERATURES (DEG F) VS. POSITION AT 469 SECONDS FROM IGNITION FOR TEST NR. 6

APPENDIX C

PRESSURE AND VALVE DISPLACEMENT DATA VERSUS TIME

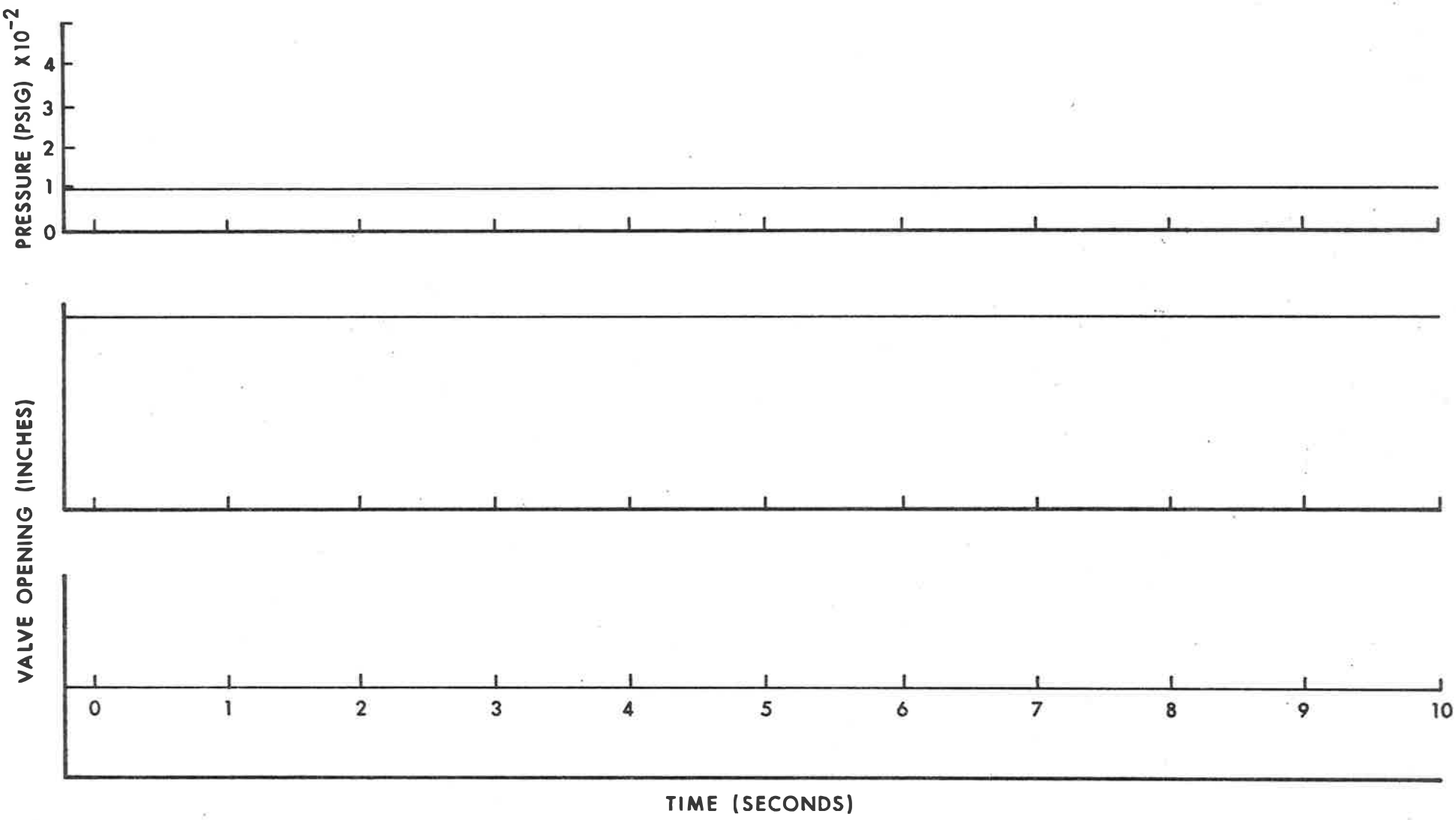

Figure C1 – Test No. 6 : Pressure and Valve Opening as a Function of Time

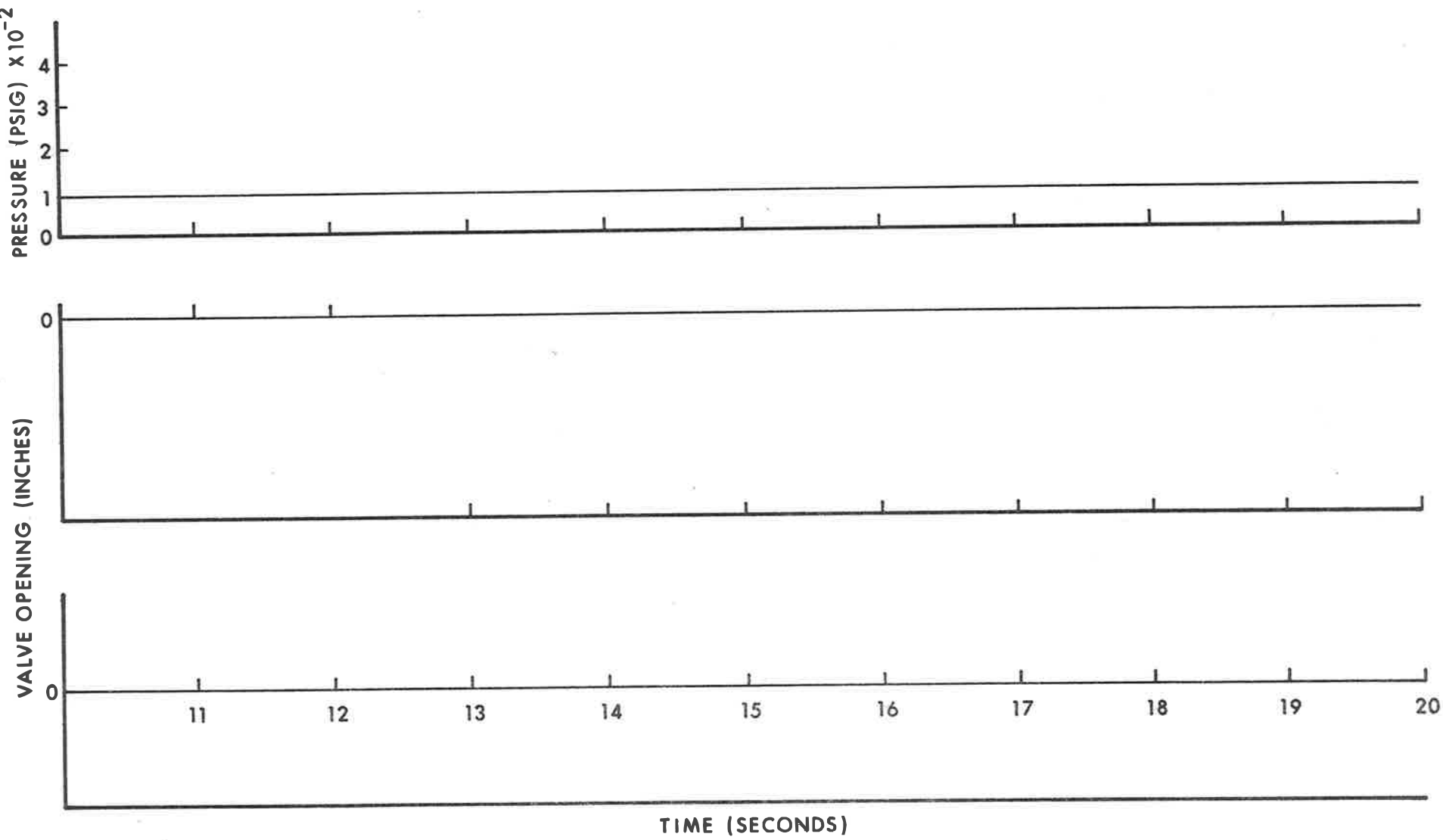

Figure C2– Test No. 6: Pressure and Valve Opening as a Function of Time.

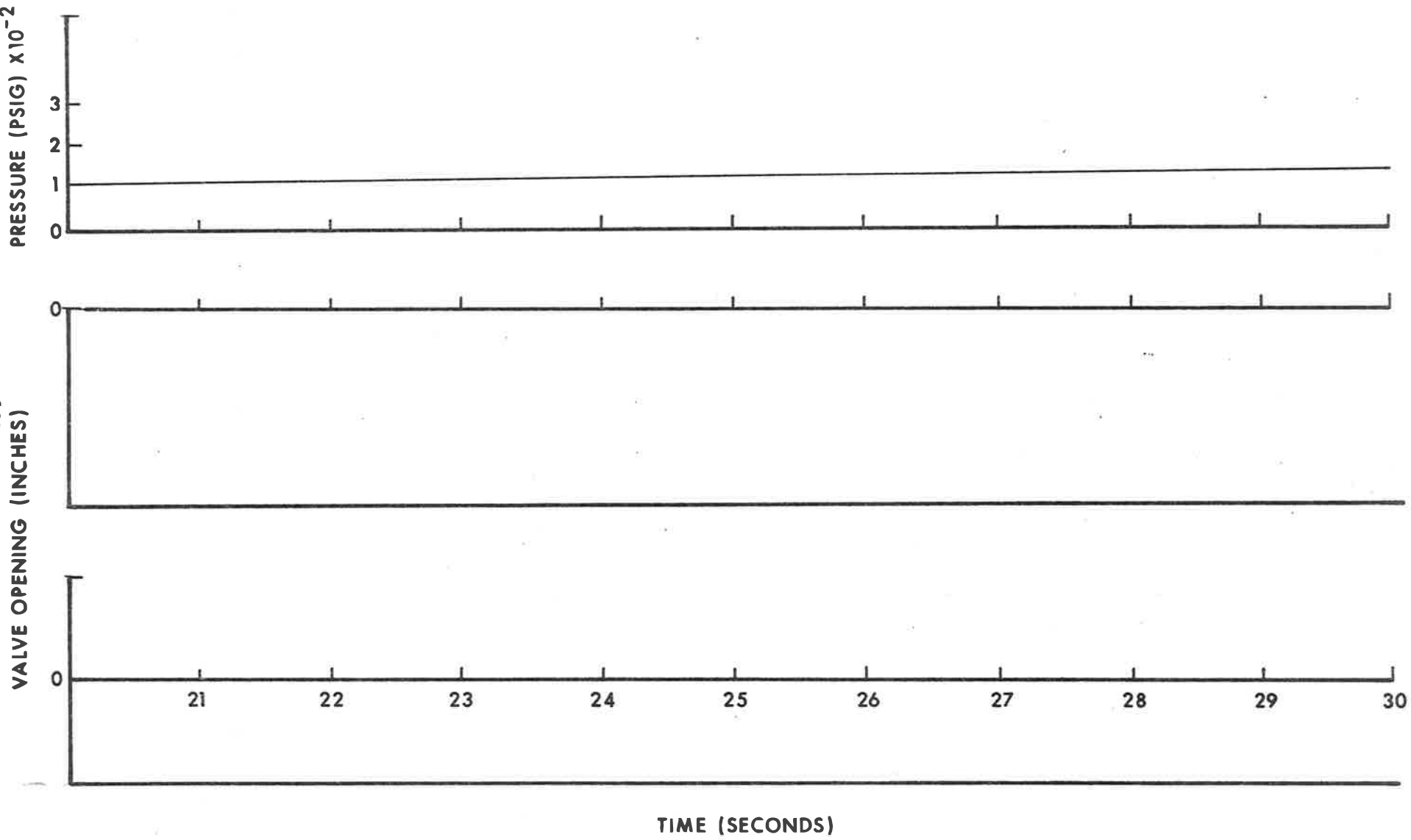

Figure C3-Test No. 6: Pressure and Valve Opening as a Function of Time

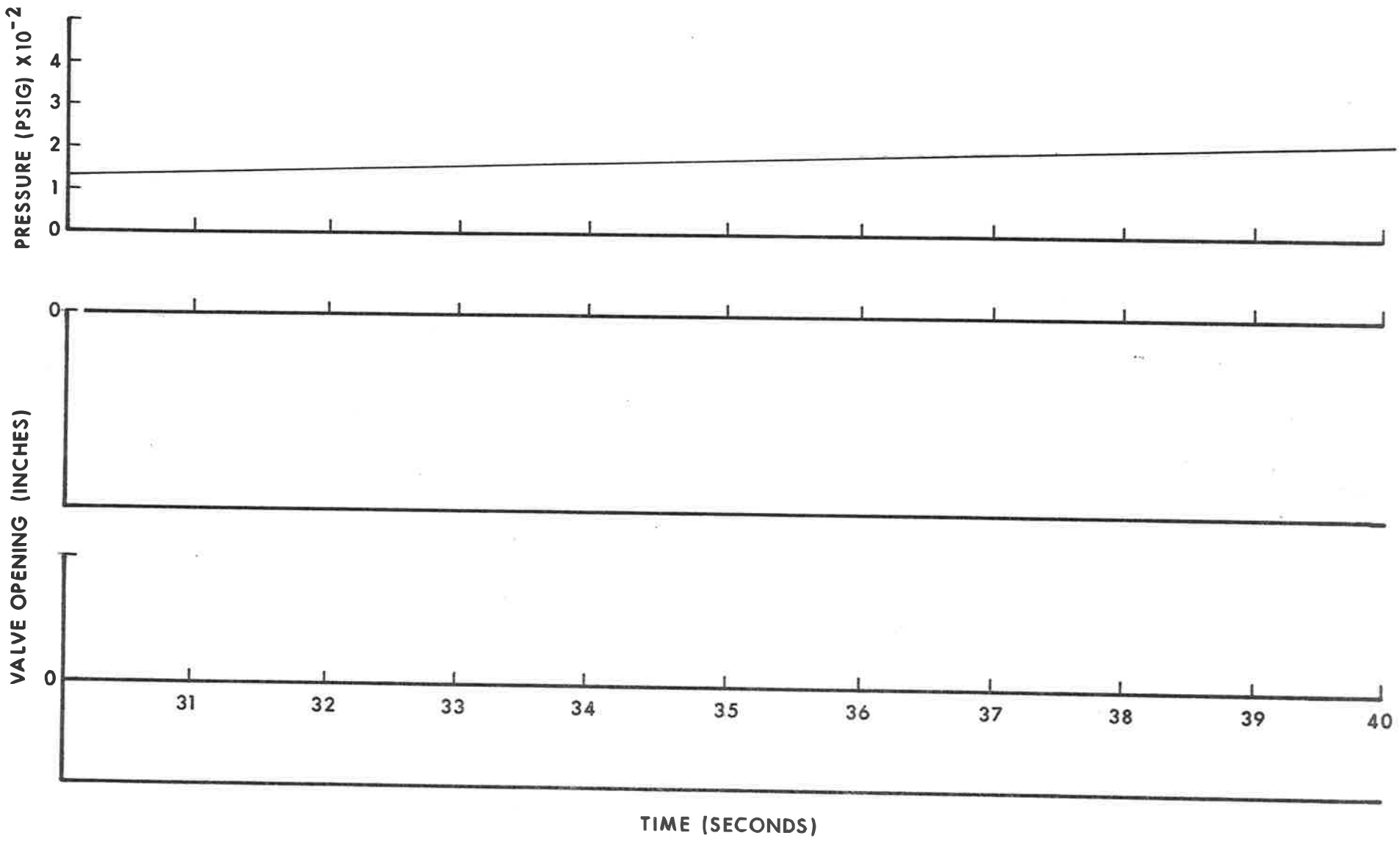

Figure C4- Test No. 6: Pressure and Valve Opening as a Function of Time

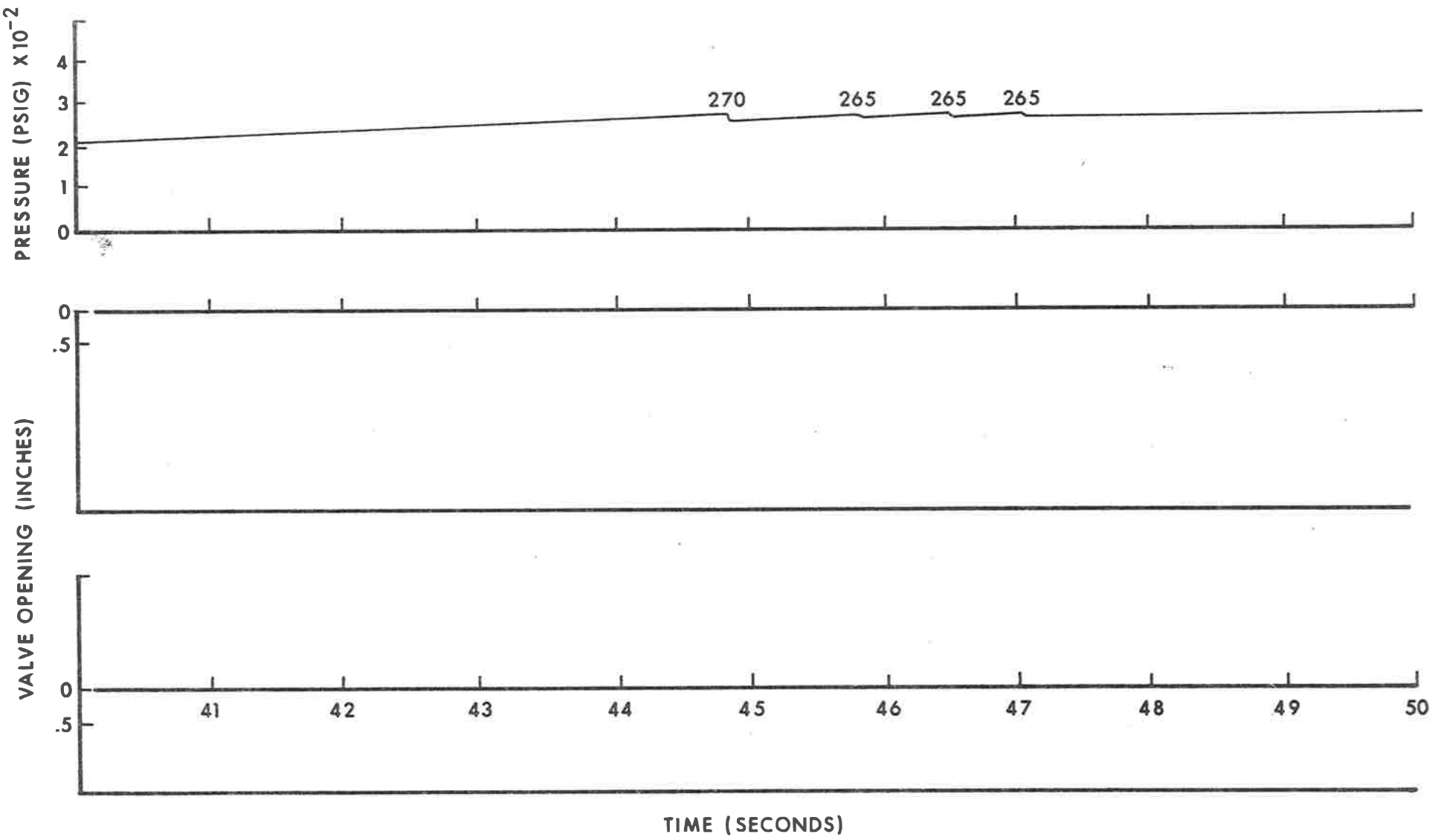

Figure C5- Test No. 6: Pressure and Valve Opening as a Function of Time

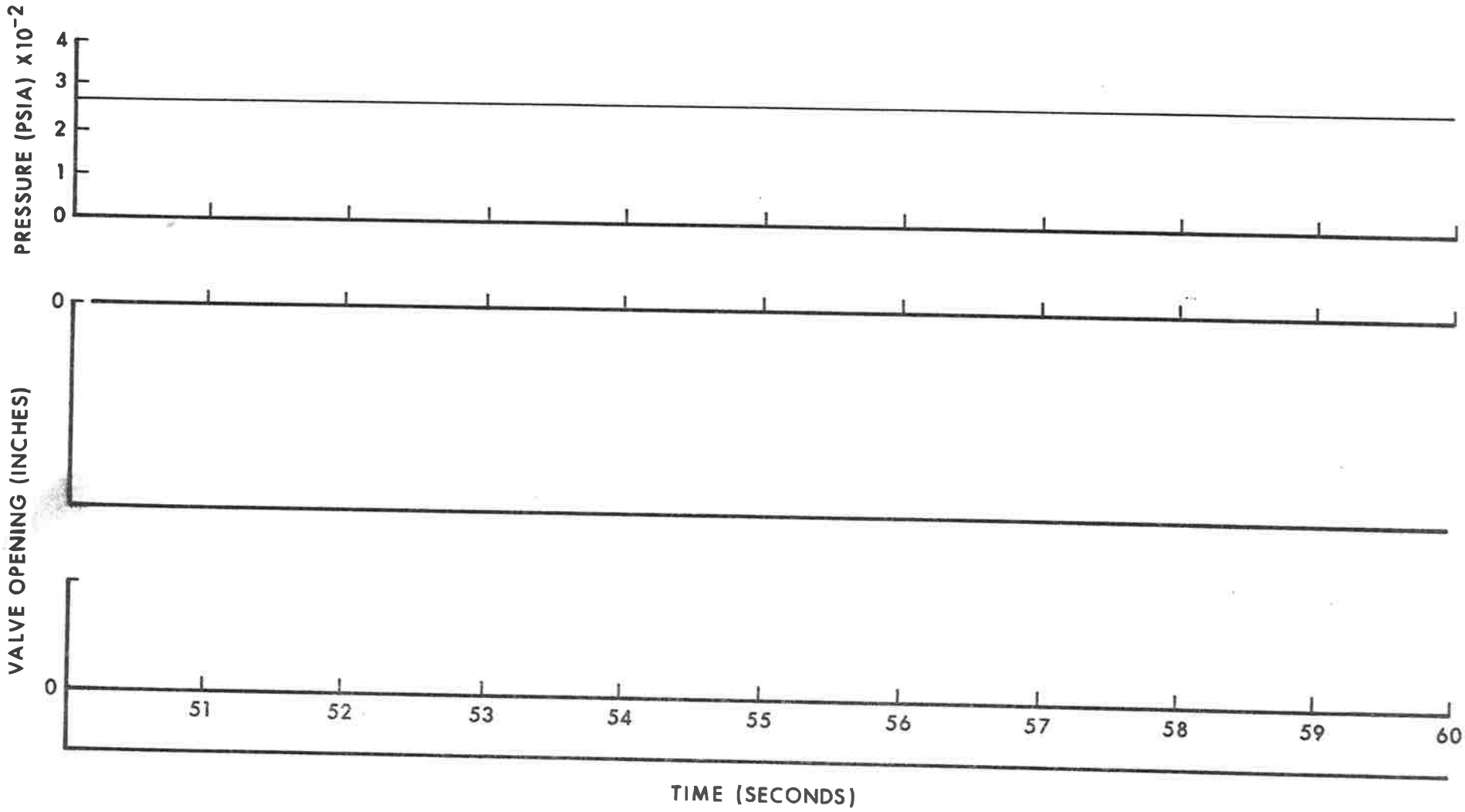

Figure C6-Test No. 6: Pressure and Valve Opening as a Function of Time

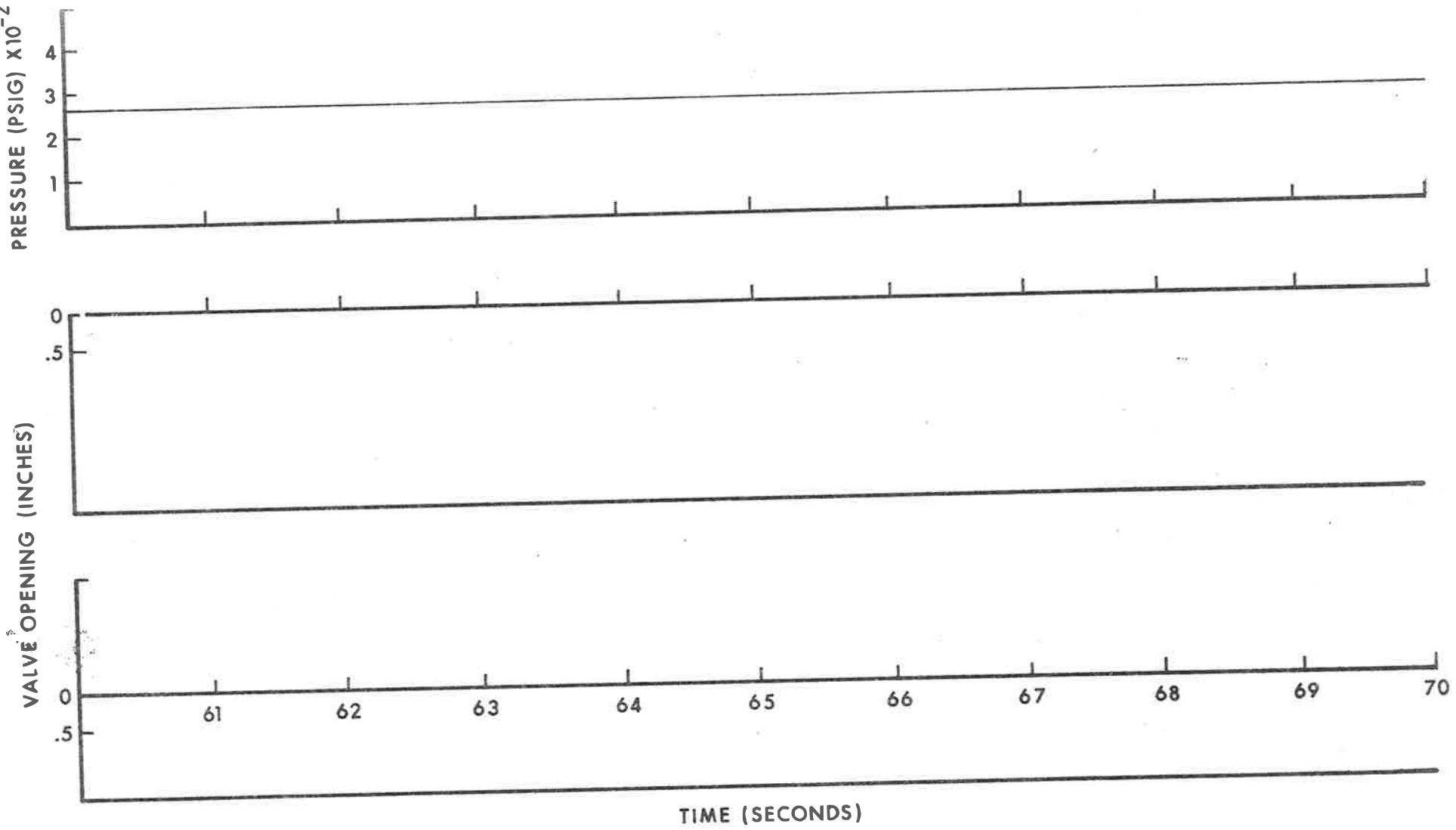

Figure C7-Test No. 6: Pressure and Valve Opening as a Function of Time

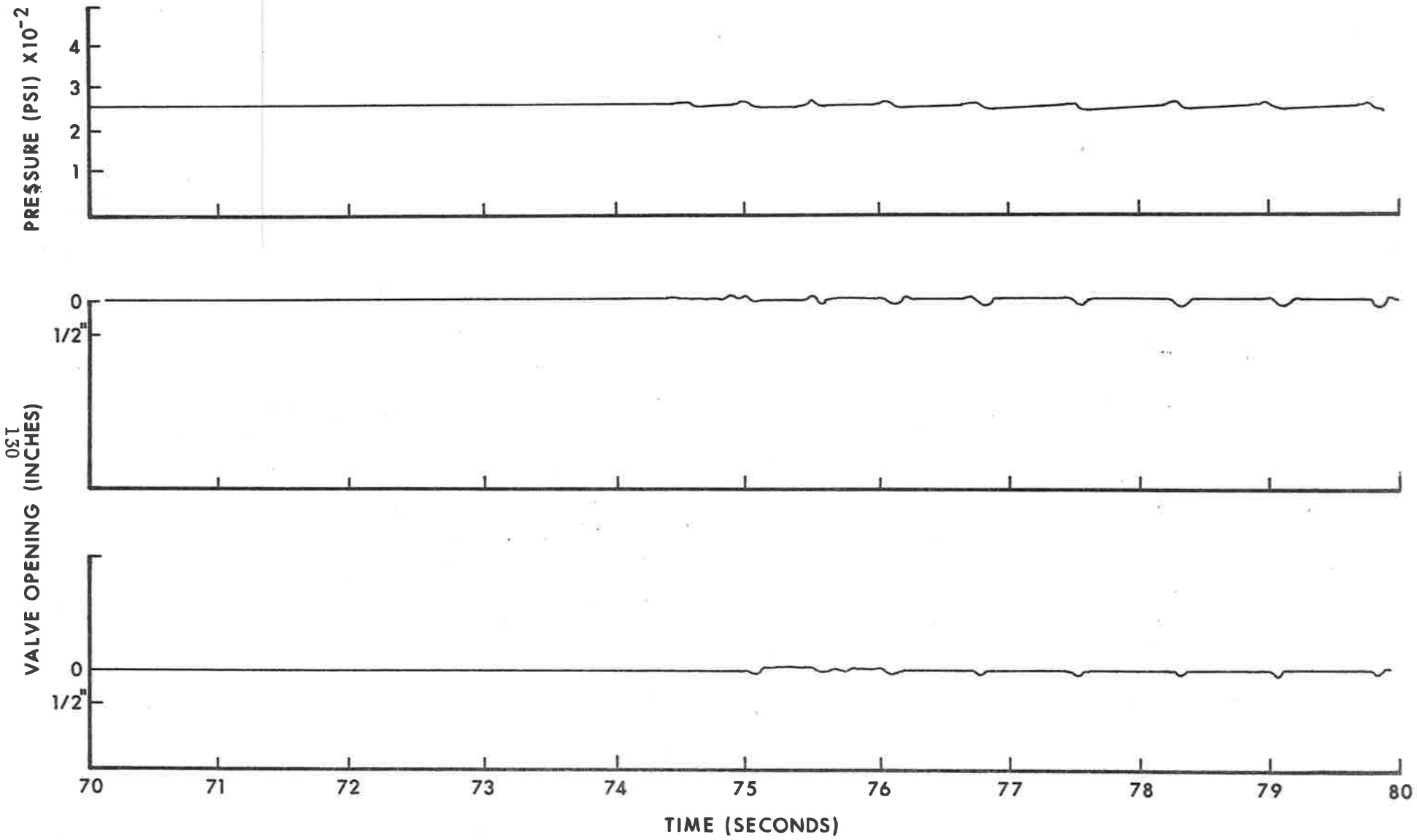

Figure C8–Test No. 6: Pressure and Valve Opening as a Function of Time

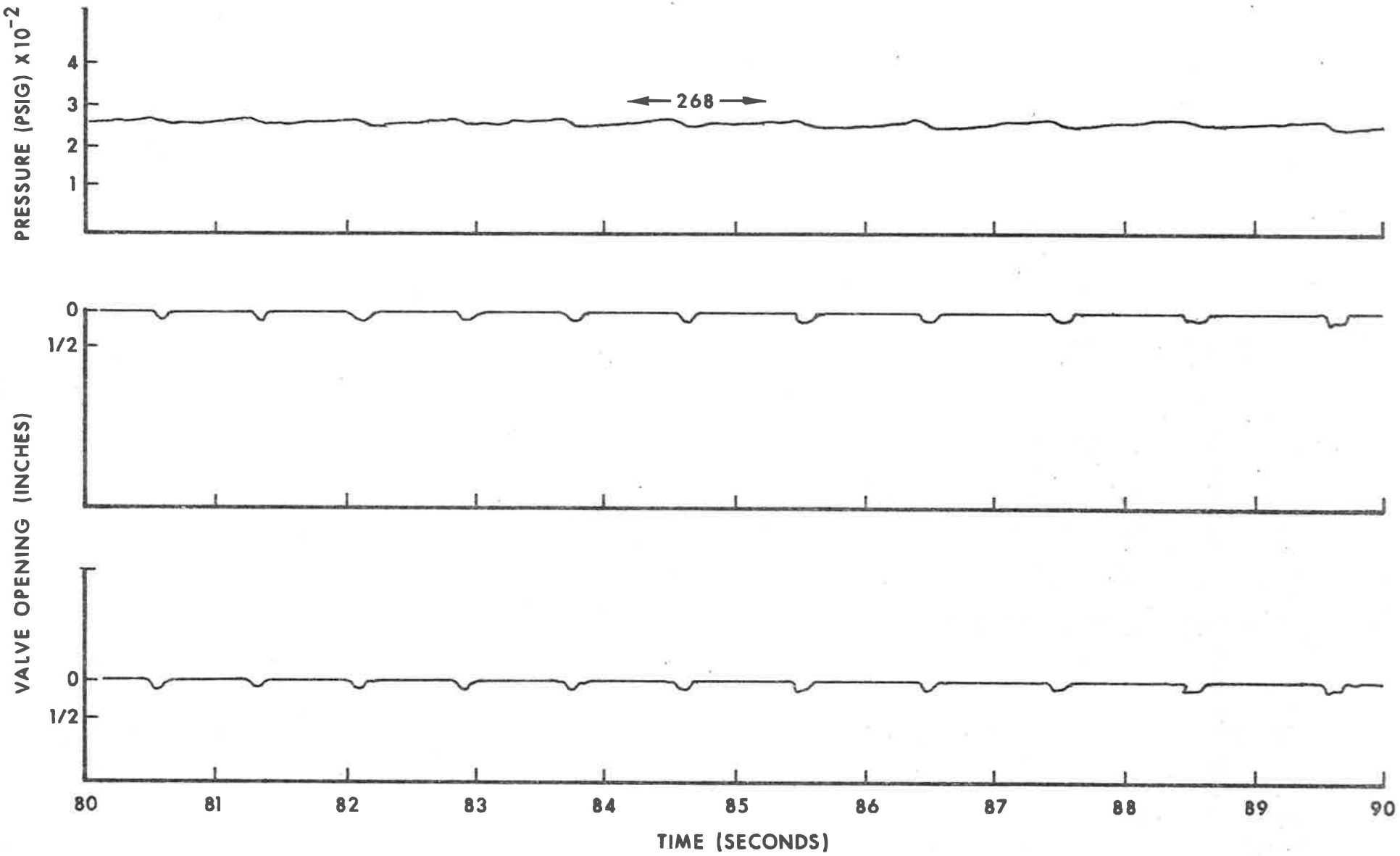

Figure C9-Test No. 6: Pressure and Valve Opening as a Function of Time

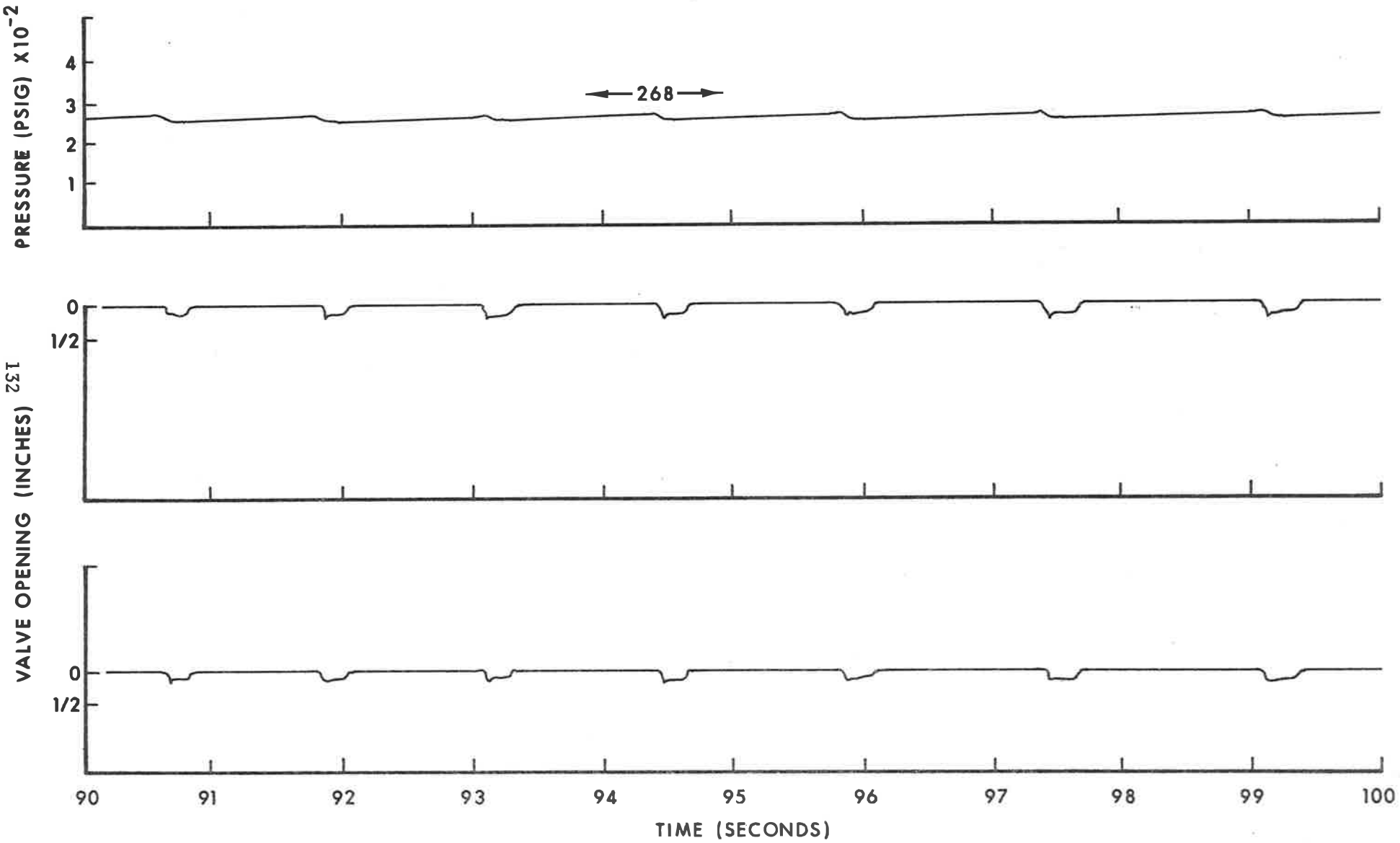

Figure C10-Test No. 6: Pressure and Valve Opening as a Function of Time

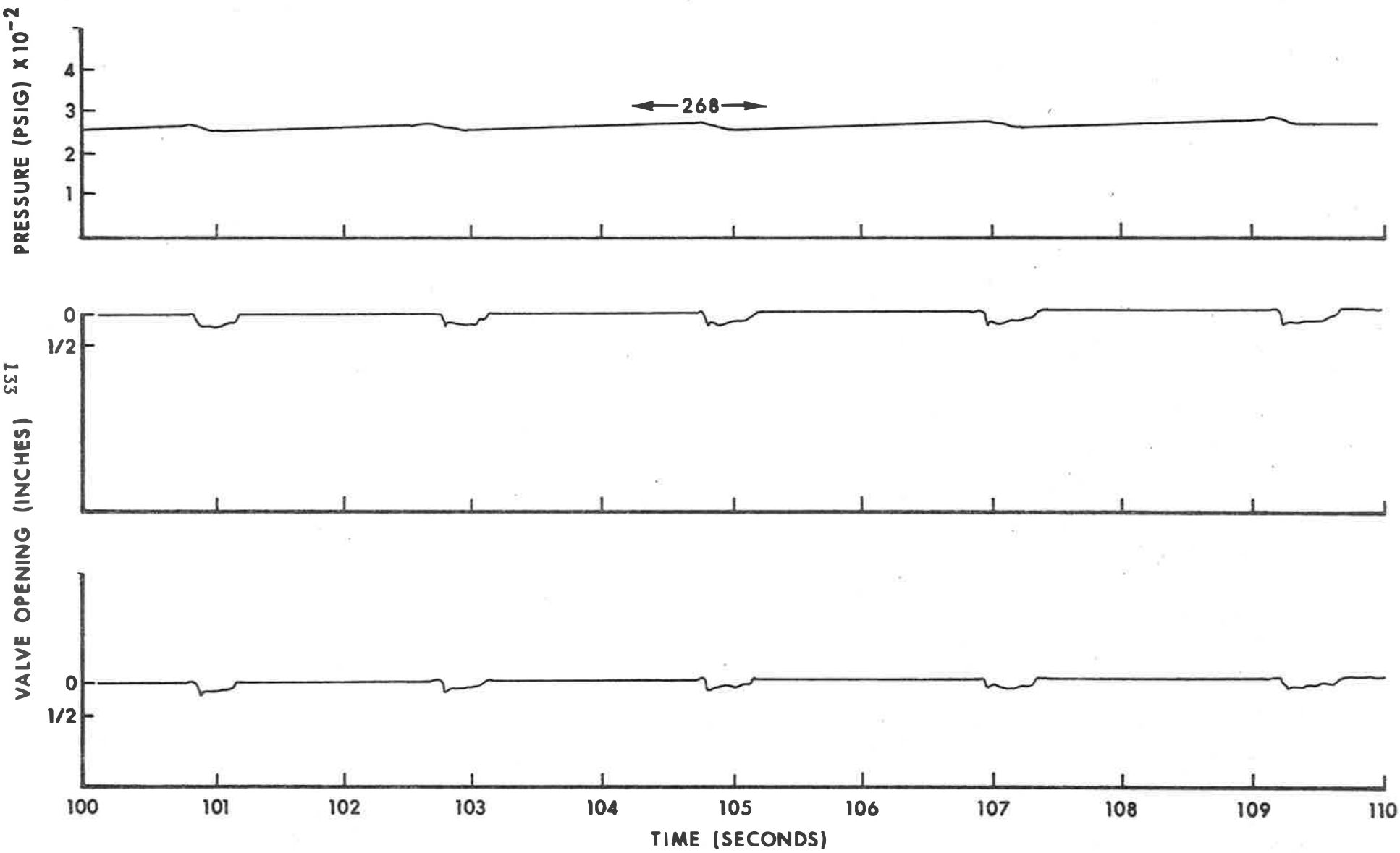

Figure C11- Test No. 6: Pressure and Valve Opening as a Function of Time.

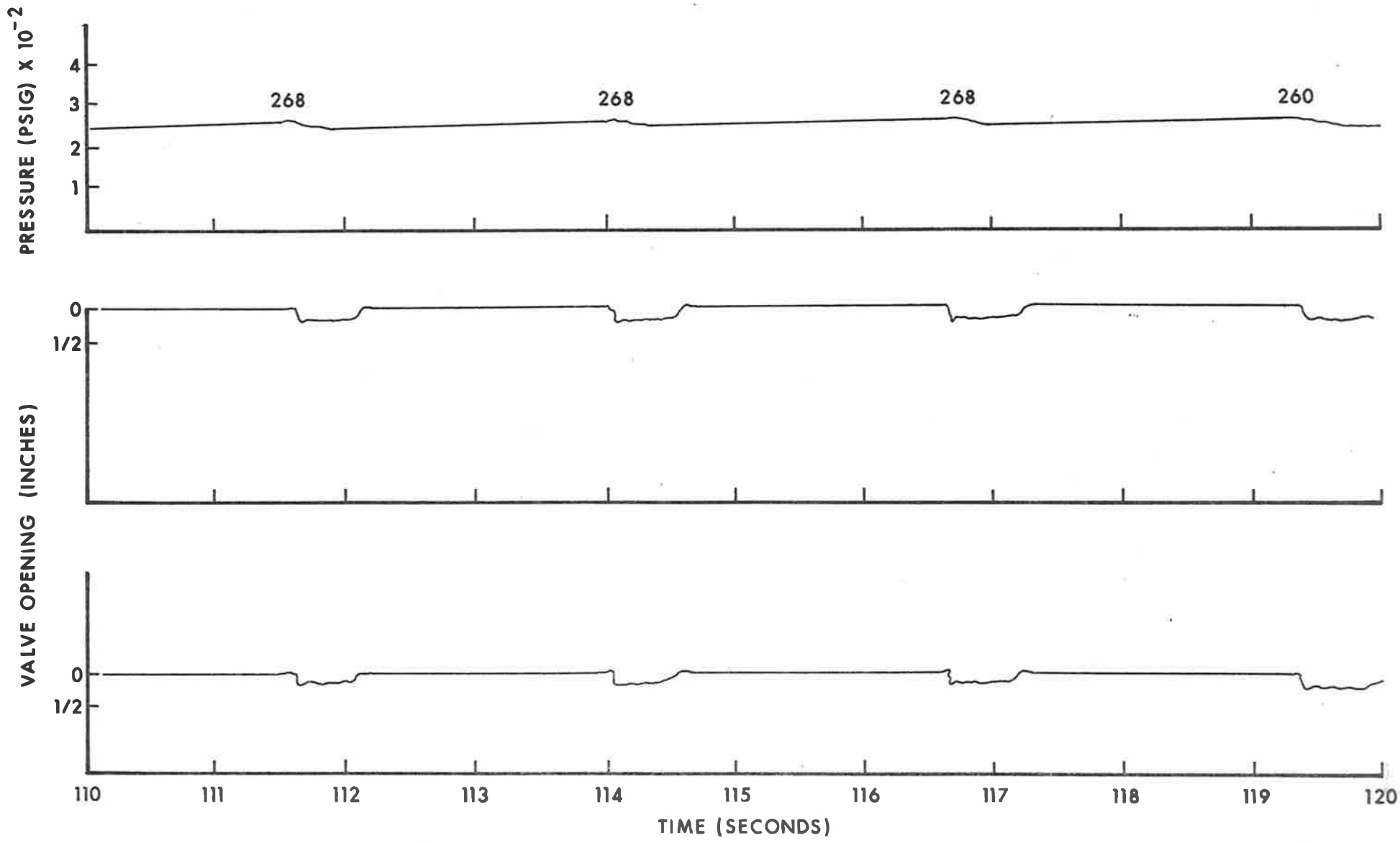

Figure C12- Test No. 6: Pressure and Valve Opening as a Function of Time.

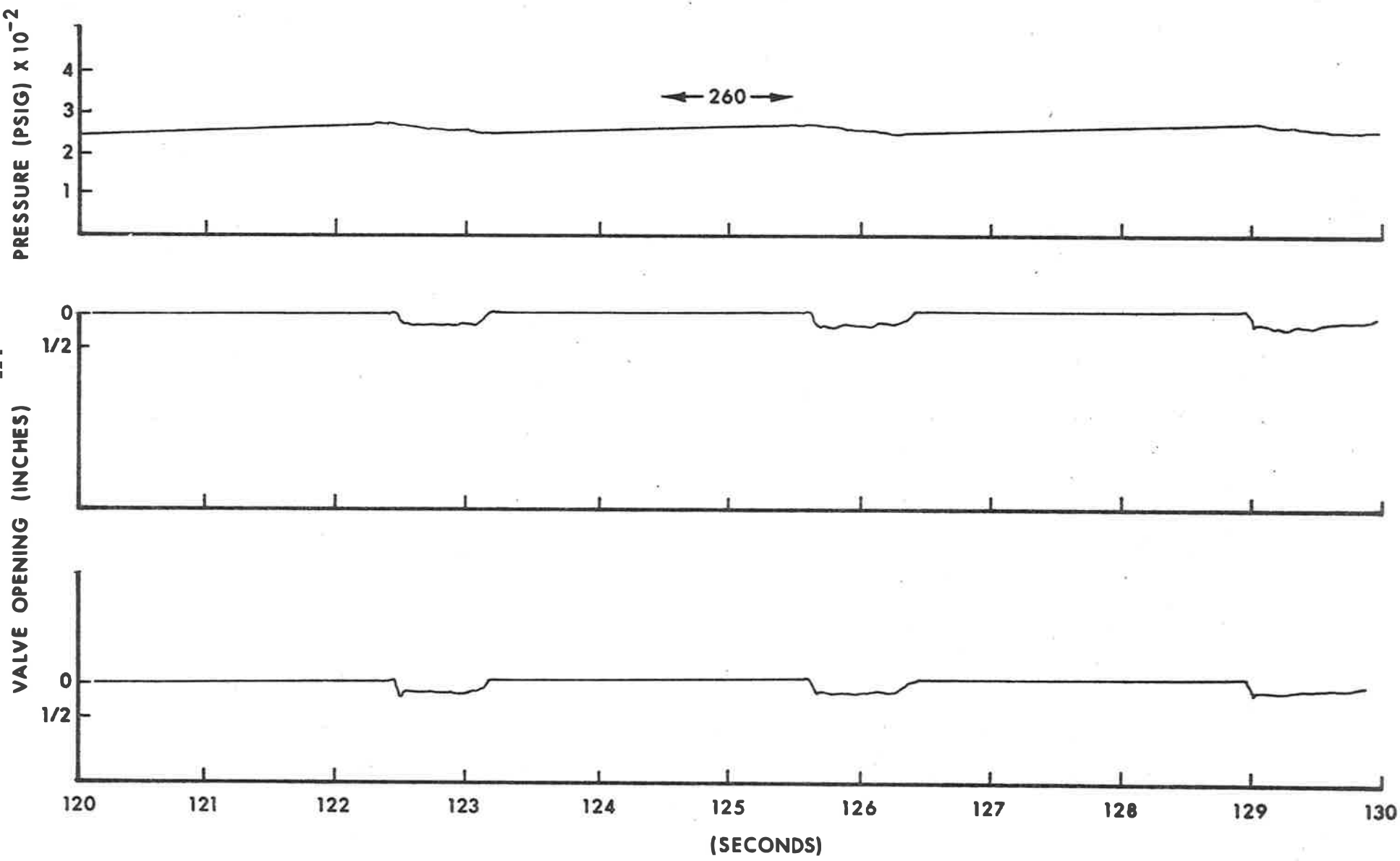

Figure C13- Test No. 6: Pressure and Valve Opening as a Function of Time.

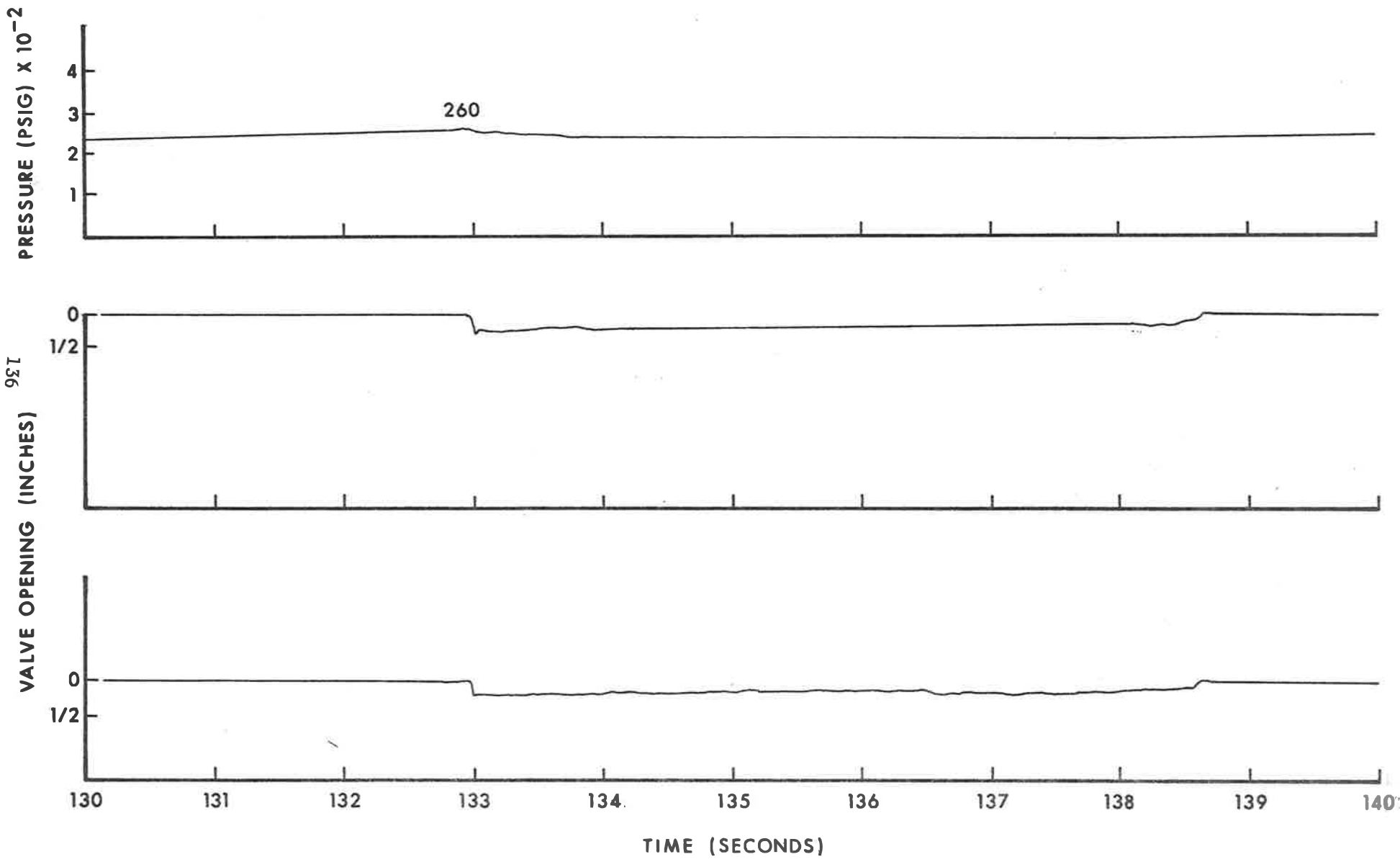

Figure C14– Test No. 6: Pressure and Valve Opening as a Function of Time.

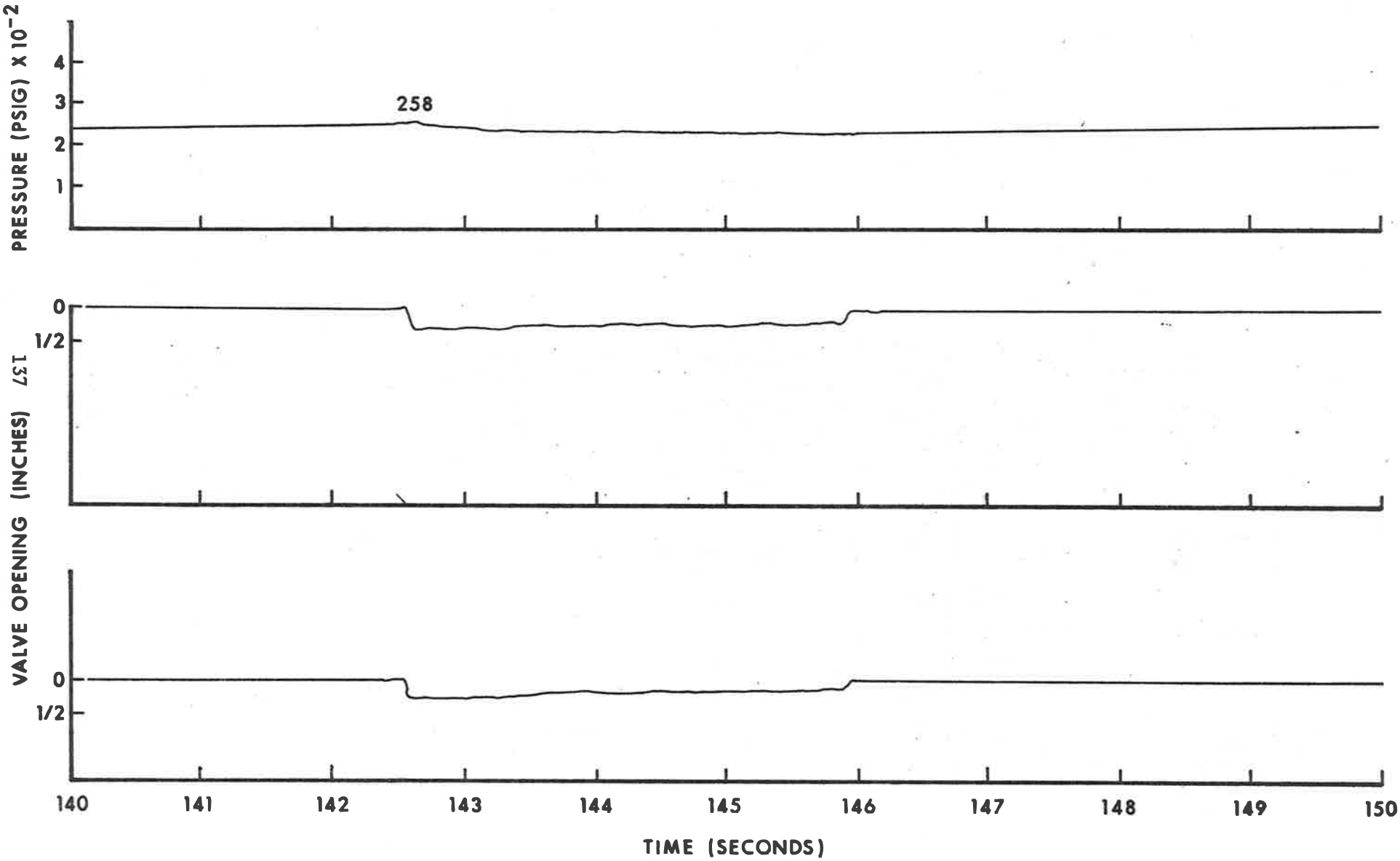

Figure C15– Test No. 6: Pressure and Valve Opening as a Function of Time.

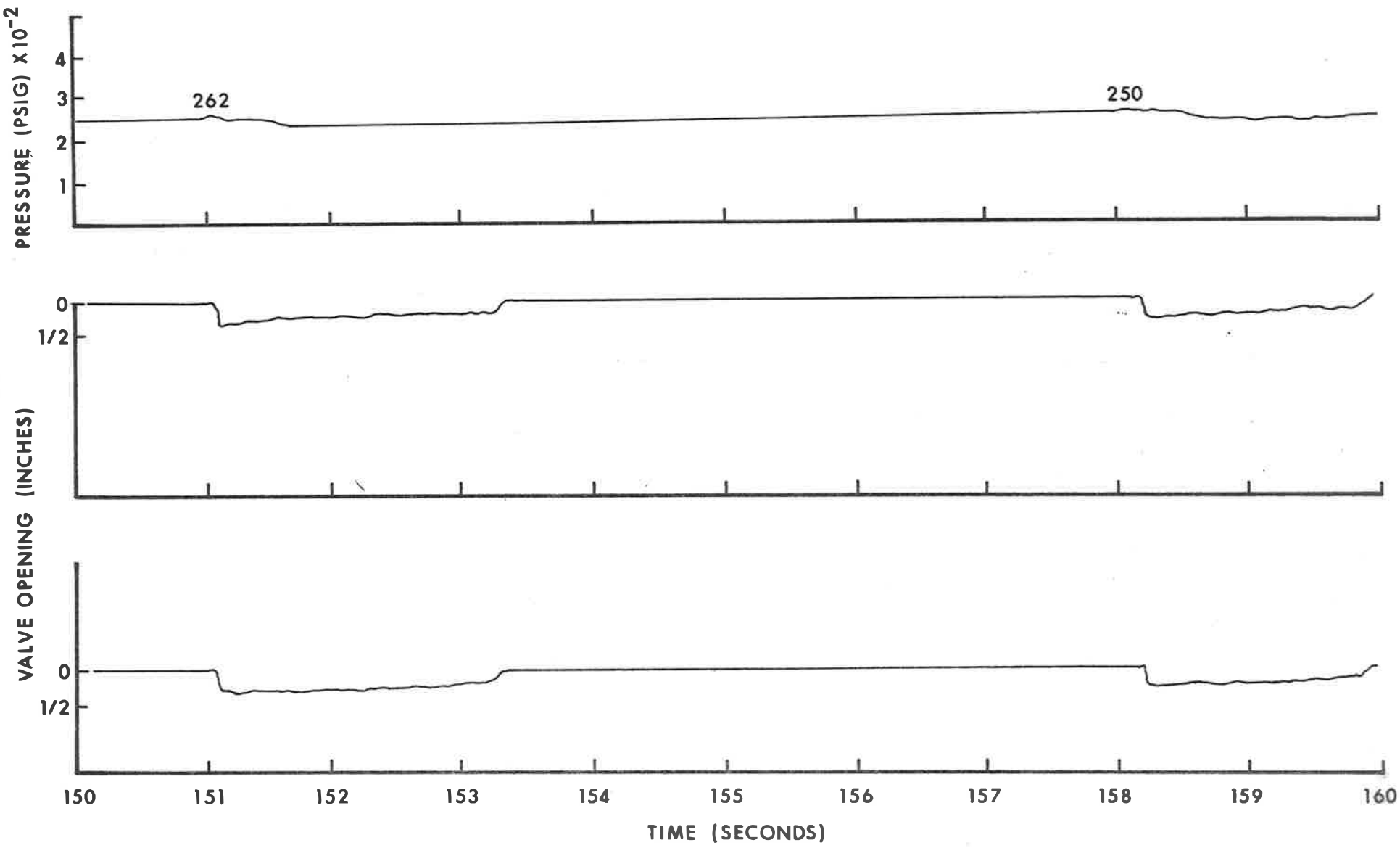

Figure C16– Test No. 6: Pressure and Valve Opening as a Function of Time.

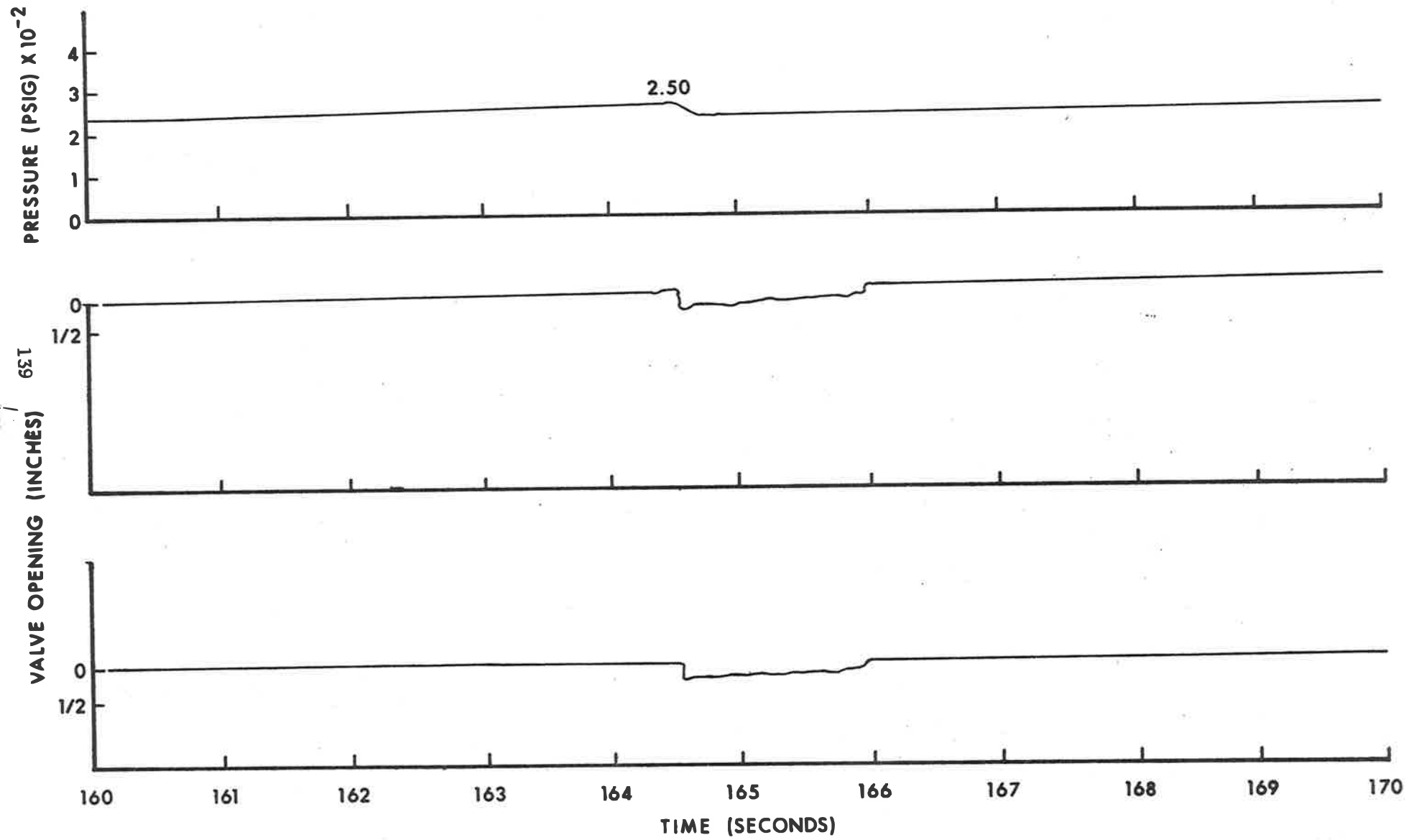

Figure C17– Test No. 6: Pressure and Valve Opening as a Function of Time.

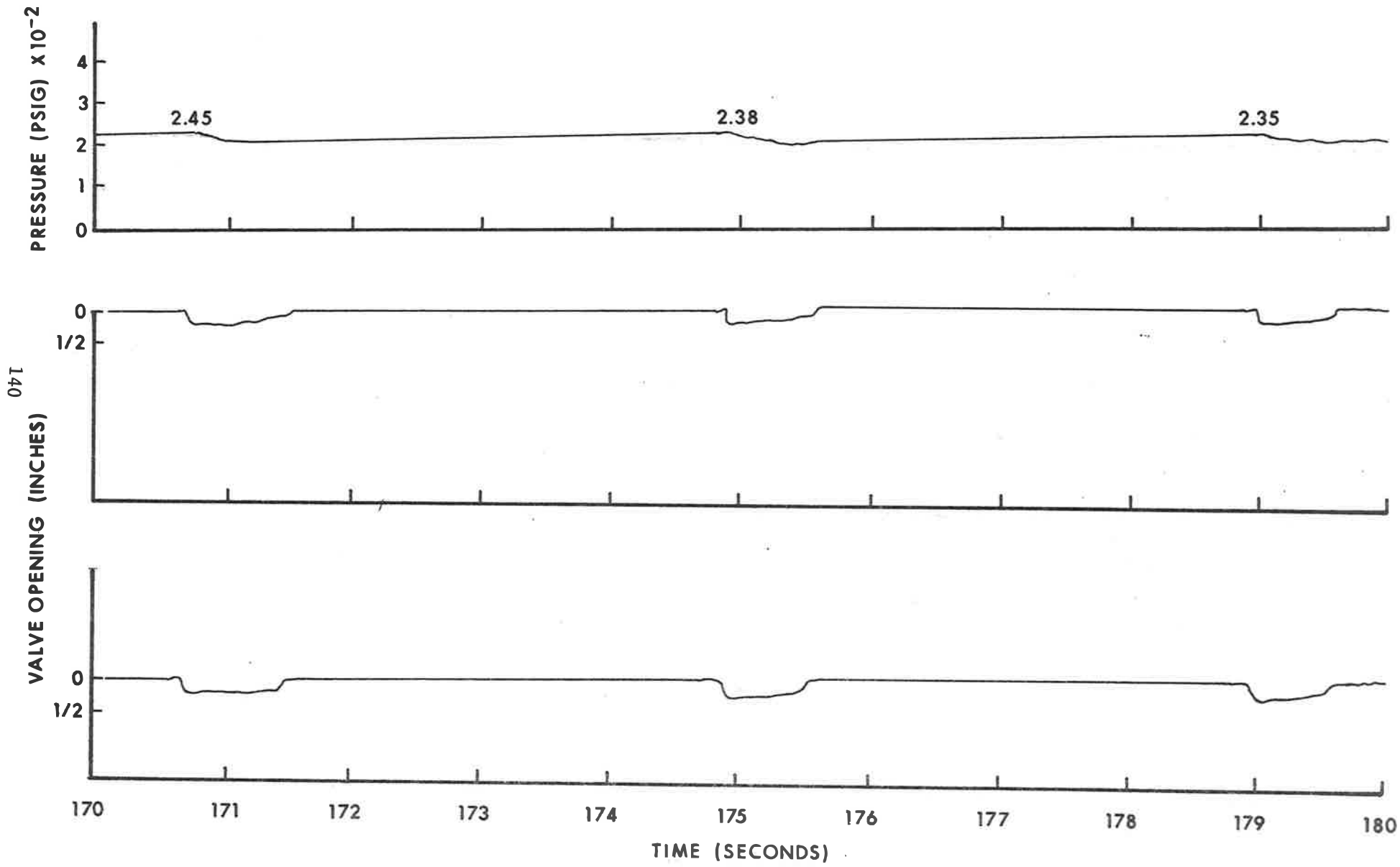

Figure C18– Test No. 6: Pressure and Valve Opening as a Function of Time.

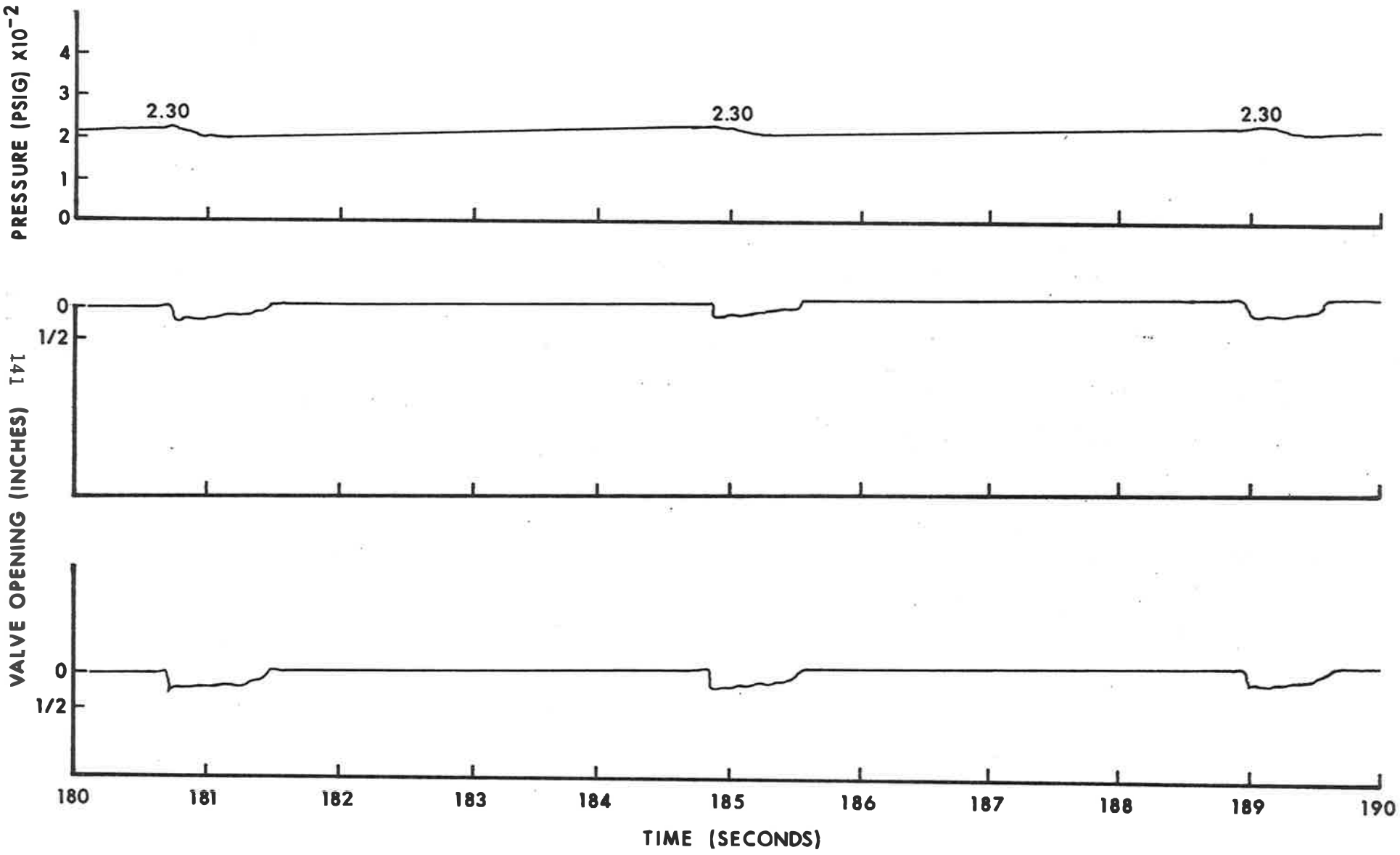

Figure C19–Test No. 6: Pressure and Valve Opening as a Function of Time.

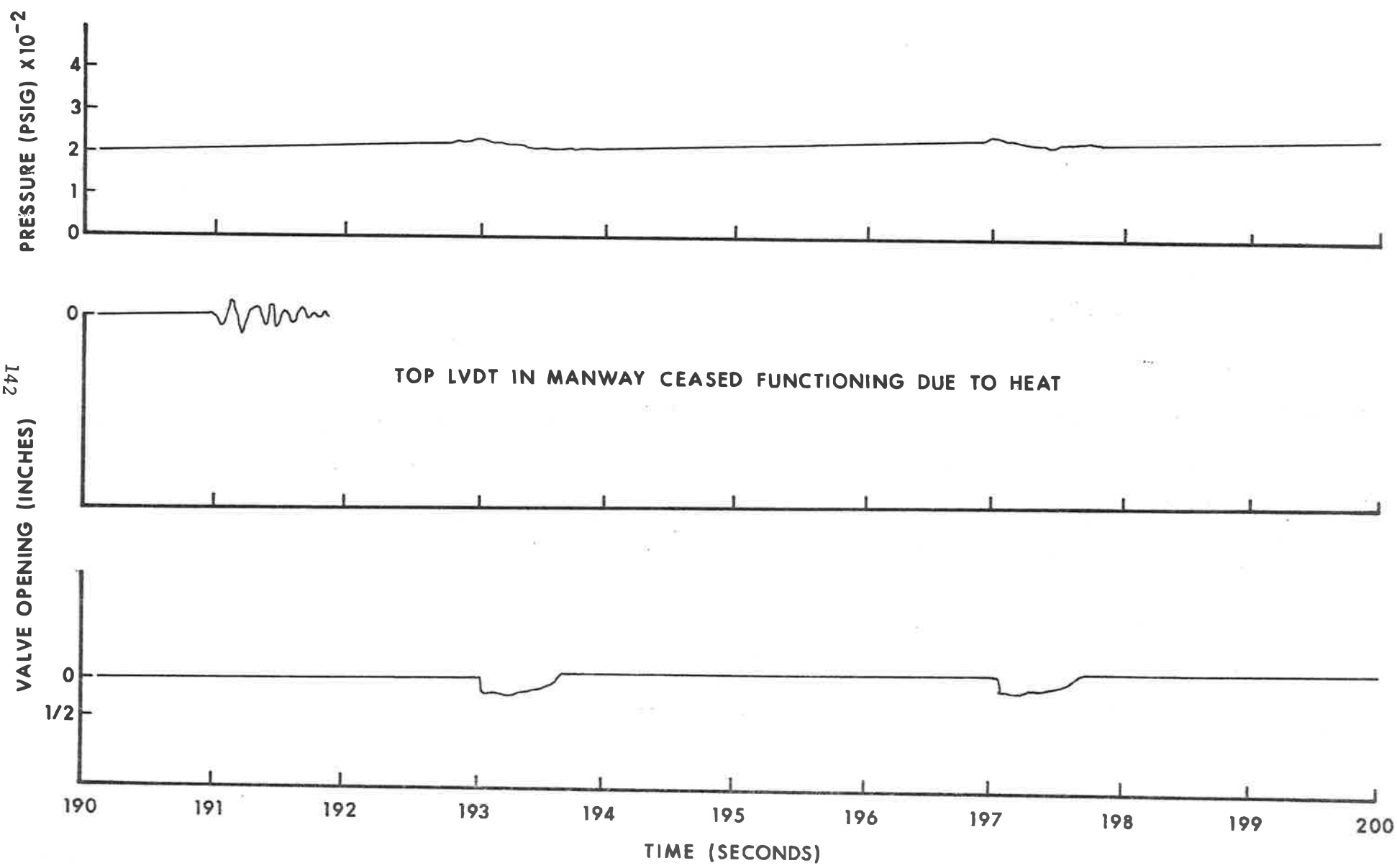

Figure C20– Test No. 6: Pressure and Valve Opening as a Function of Time.

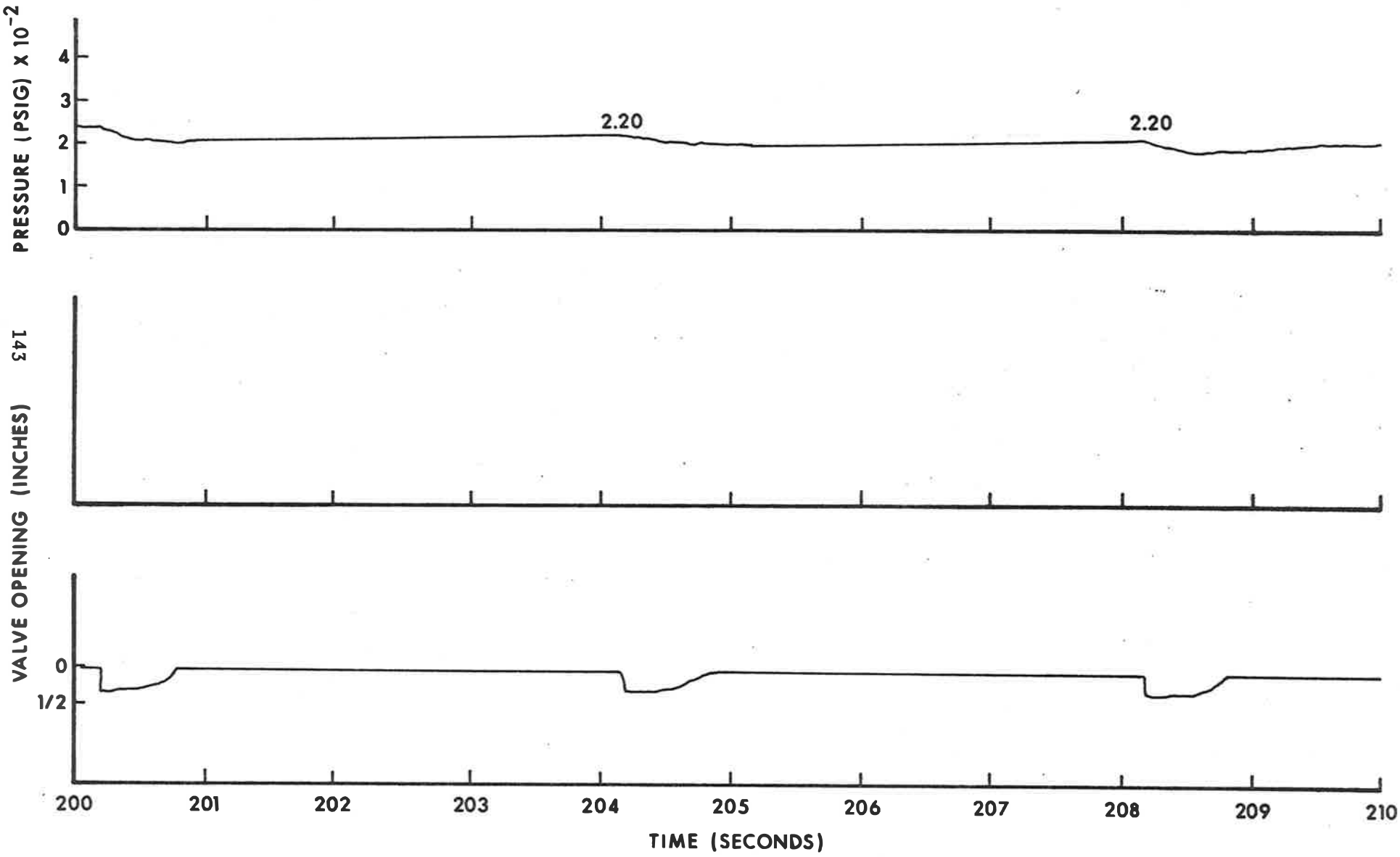

Figure C21- Test No. 6: Pressure and Valve Opening as a Function of Time.

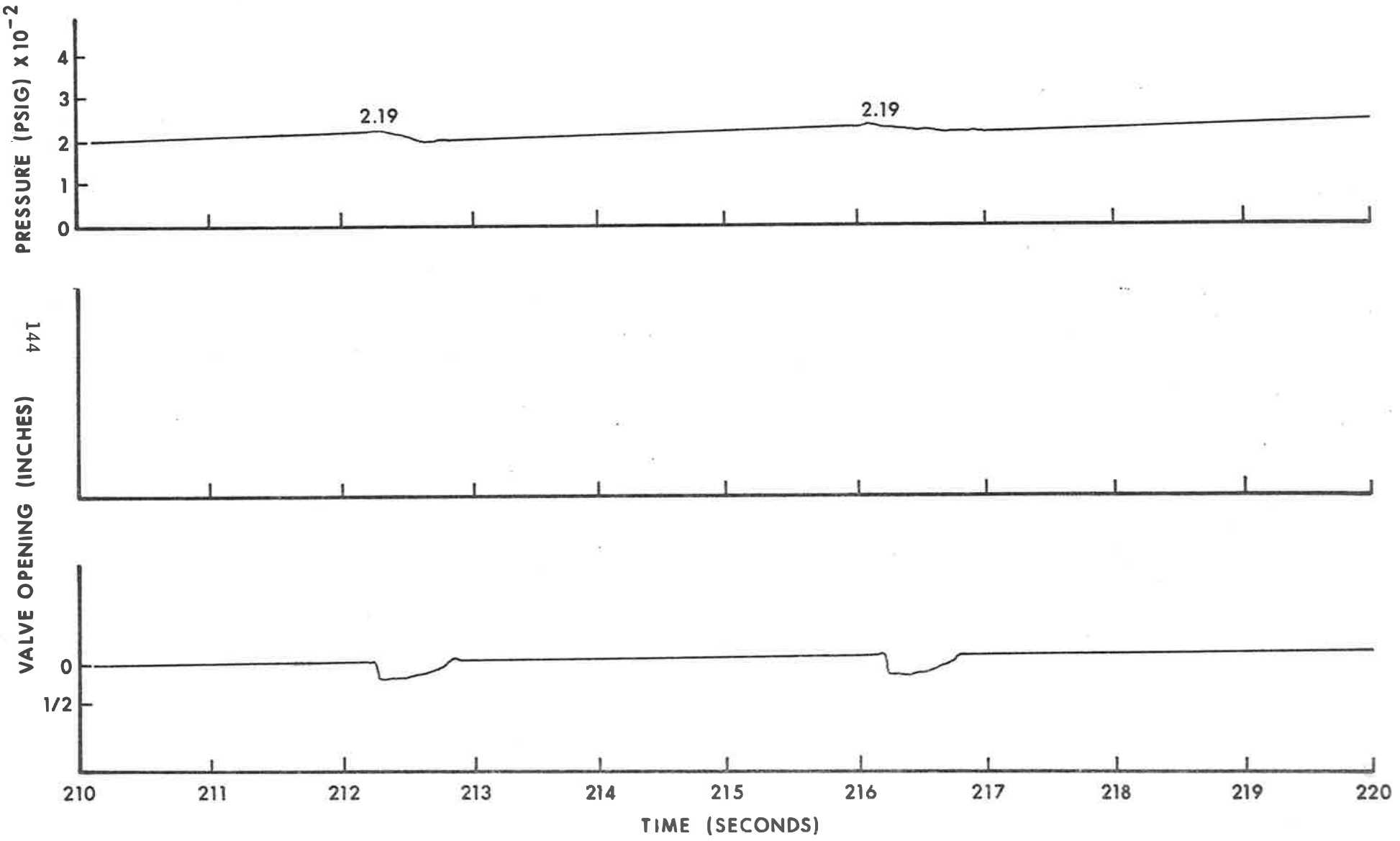

Figure C22-Test No. 6: Pressure and Valve Opening as a Function of Time.

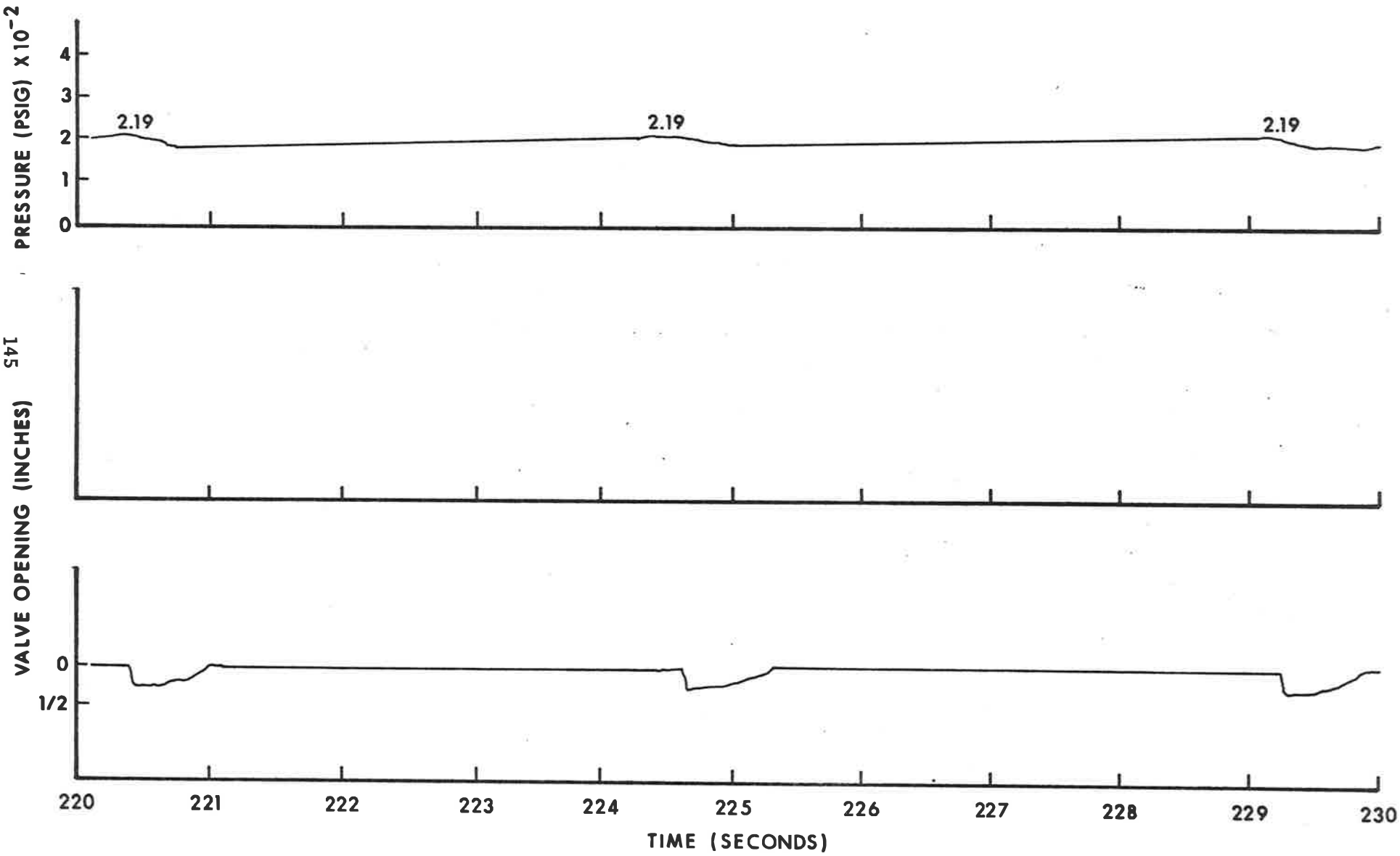

Figure C23– Test No. 6: Pressure and Valve Opening as a Function of Time.

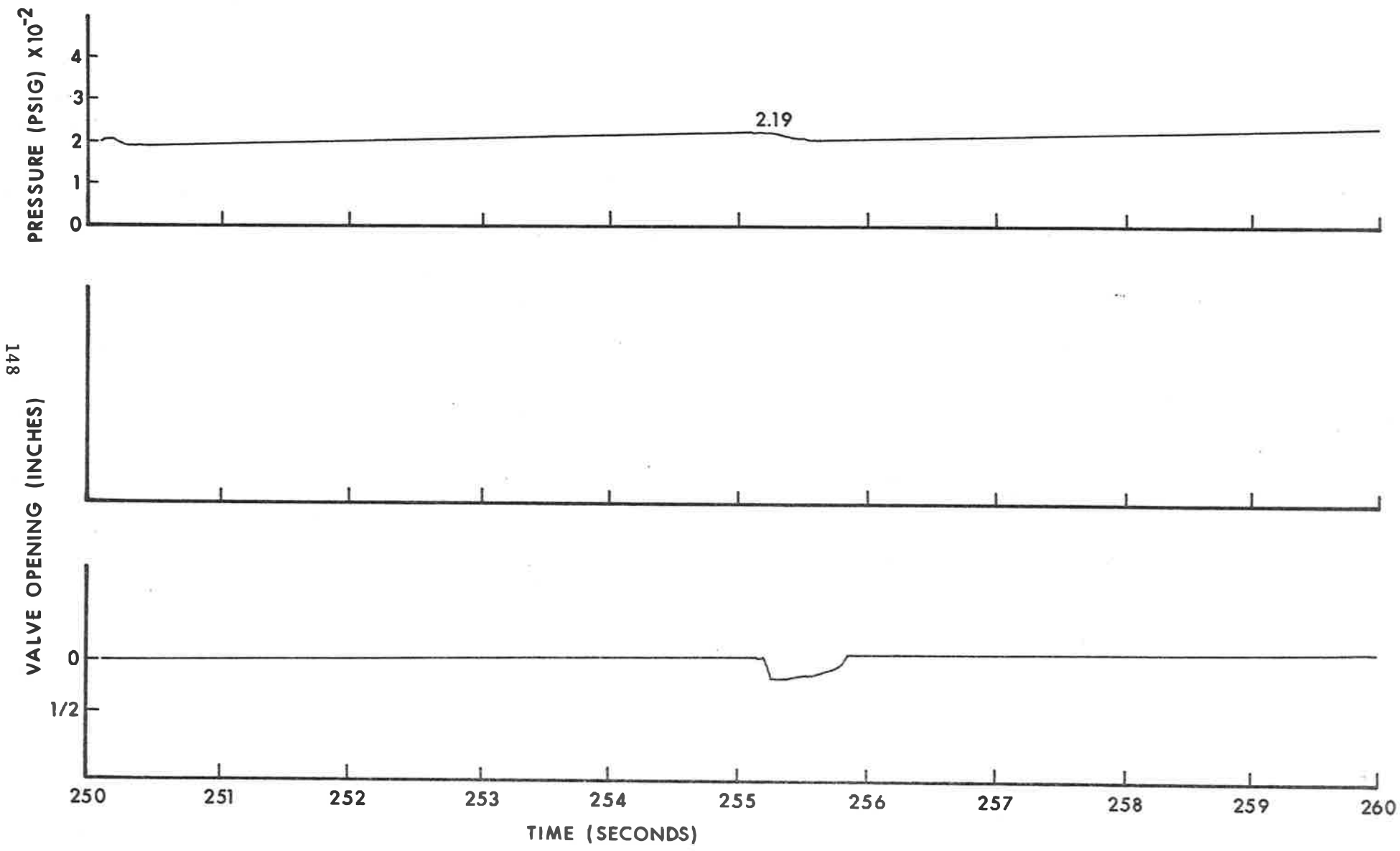

Figure C26- Test No. 6: Pressure and Valve Opening as a Function of Time.

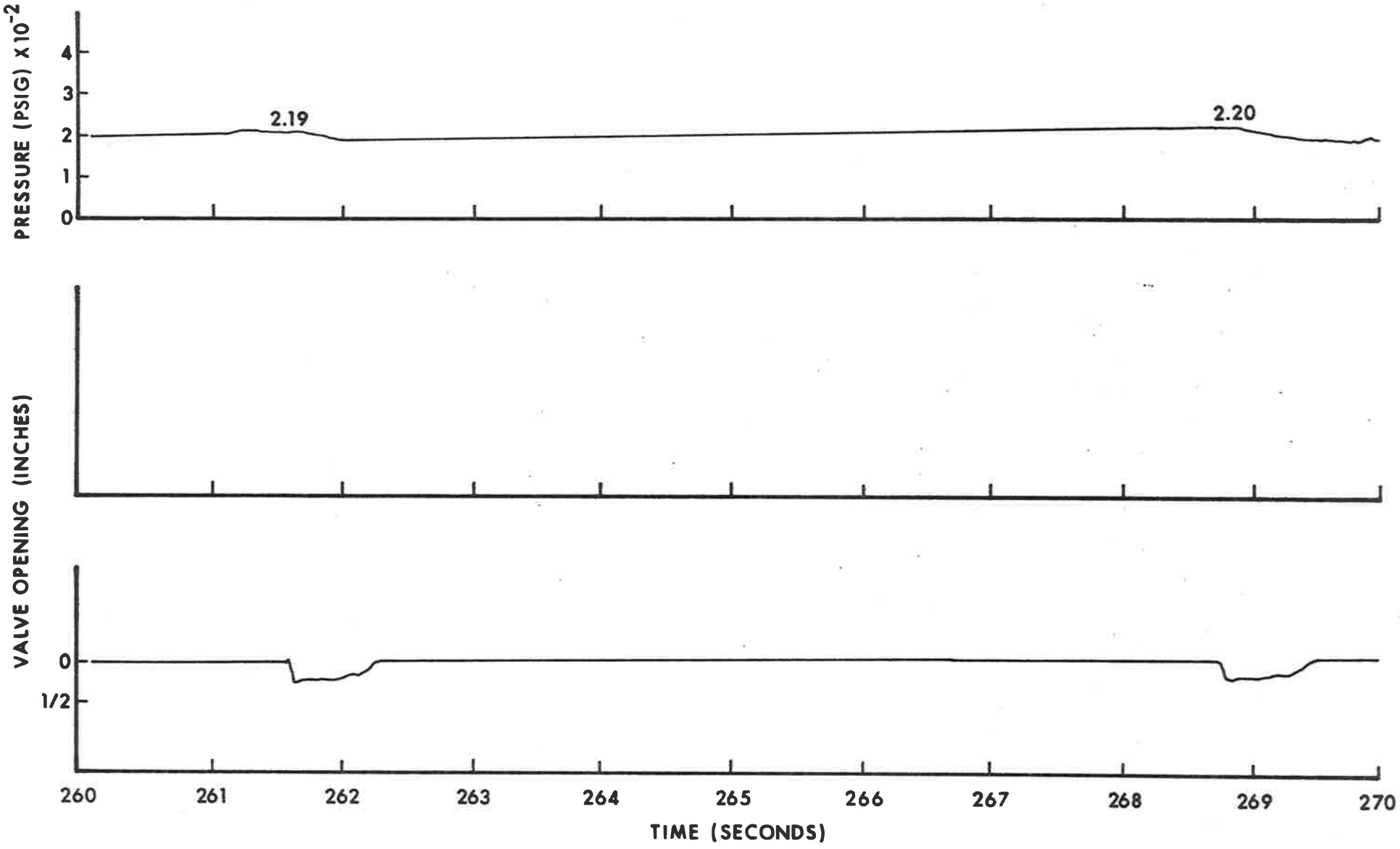

Figure C27- Test No. 6: Pressure and Valve Opening as a Function of Time.

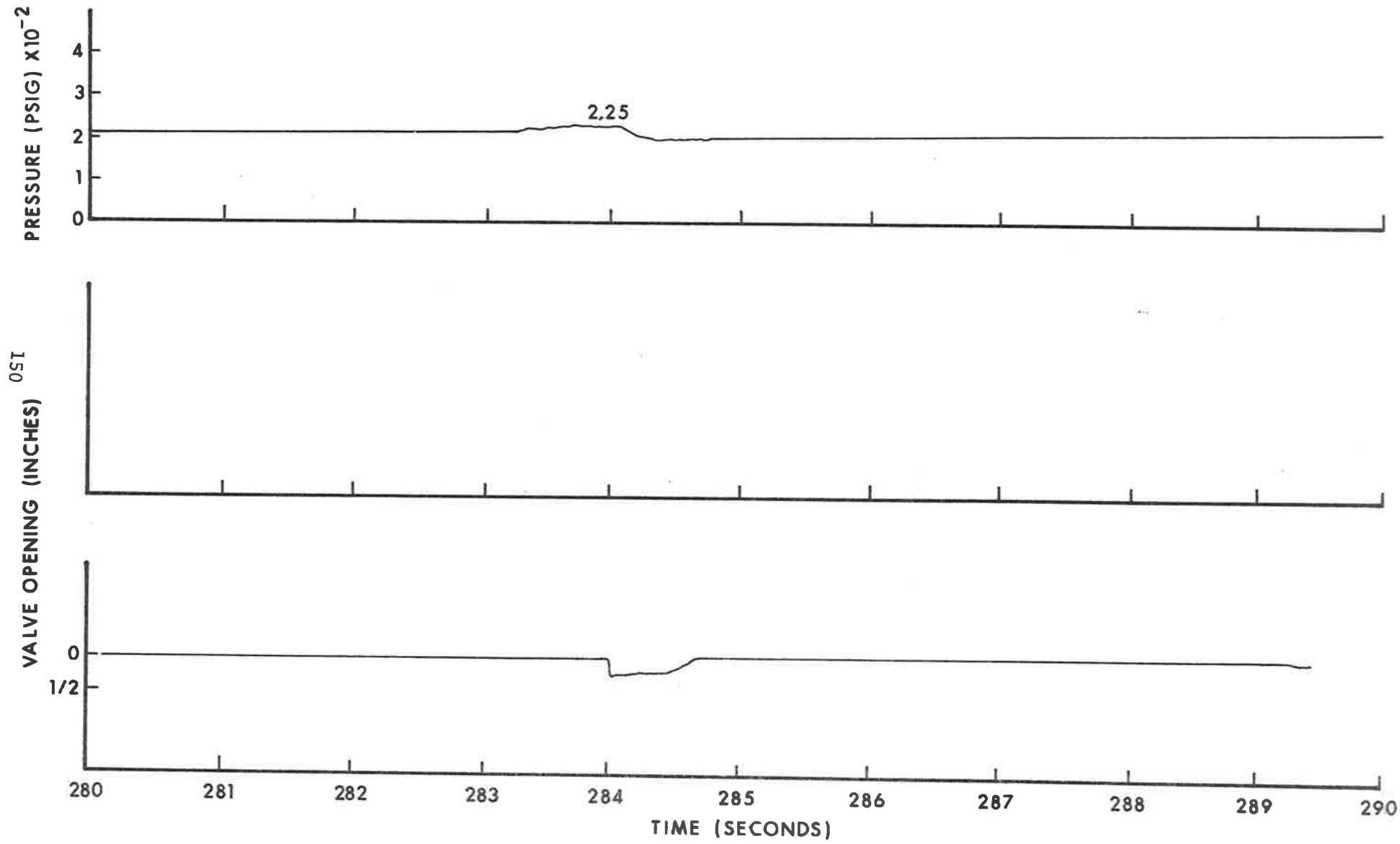

Figure C28– Test No. 6: Pressure and Valve Opening as a Function of Time.

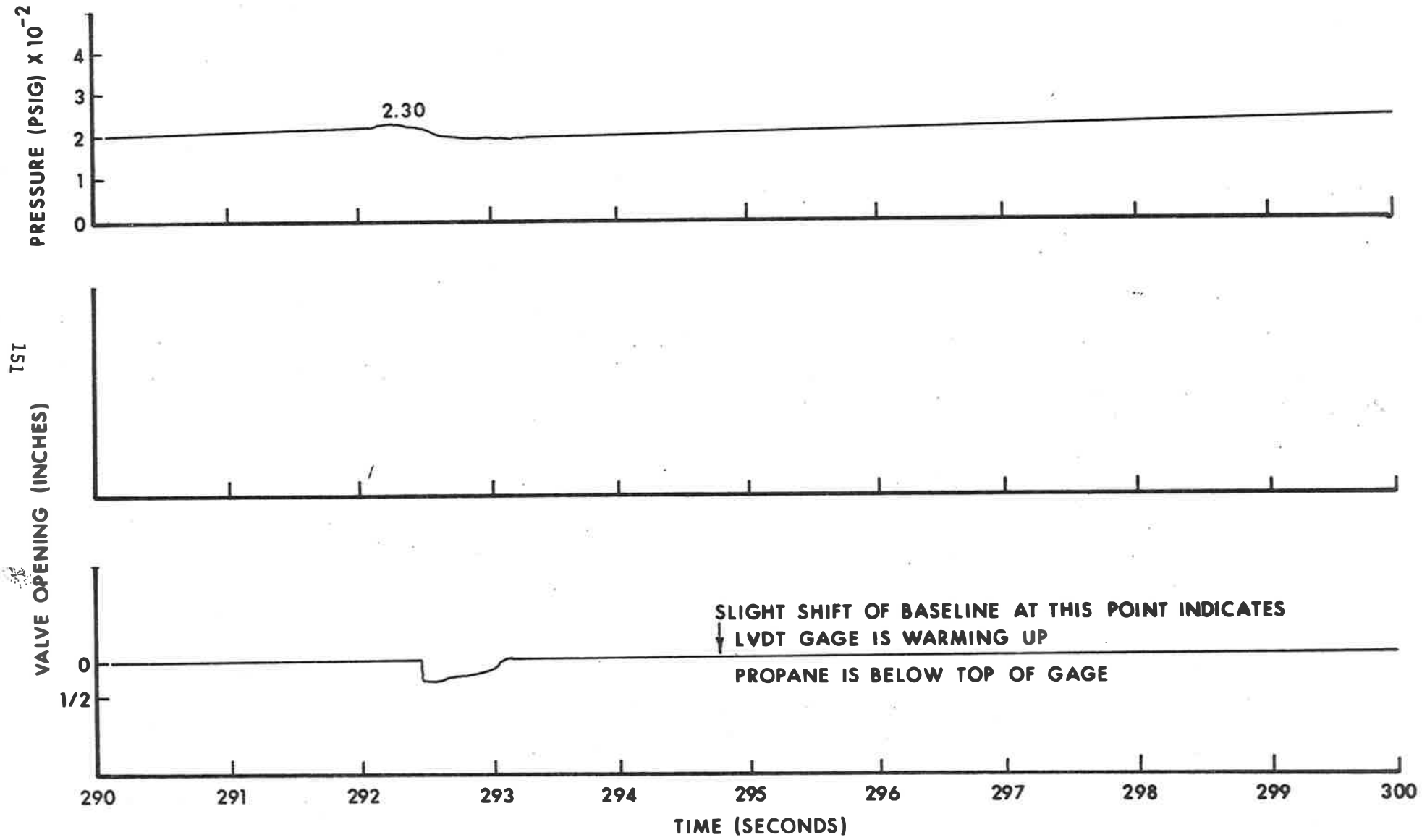

Figure C29–Test No. 6: Pressure and Valve Opening as a Function of Time.

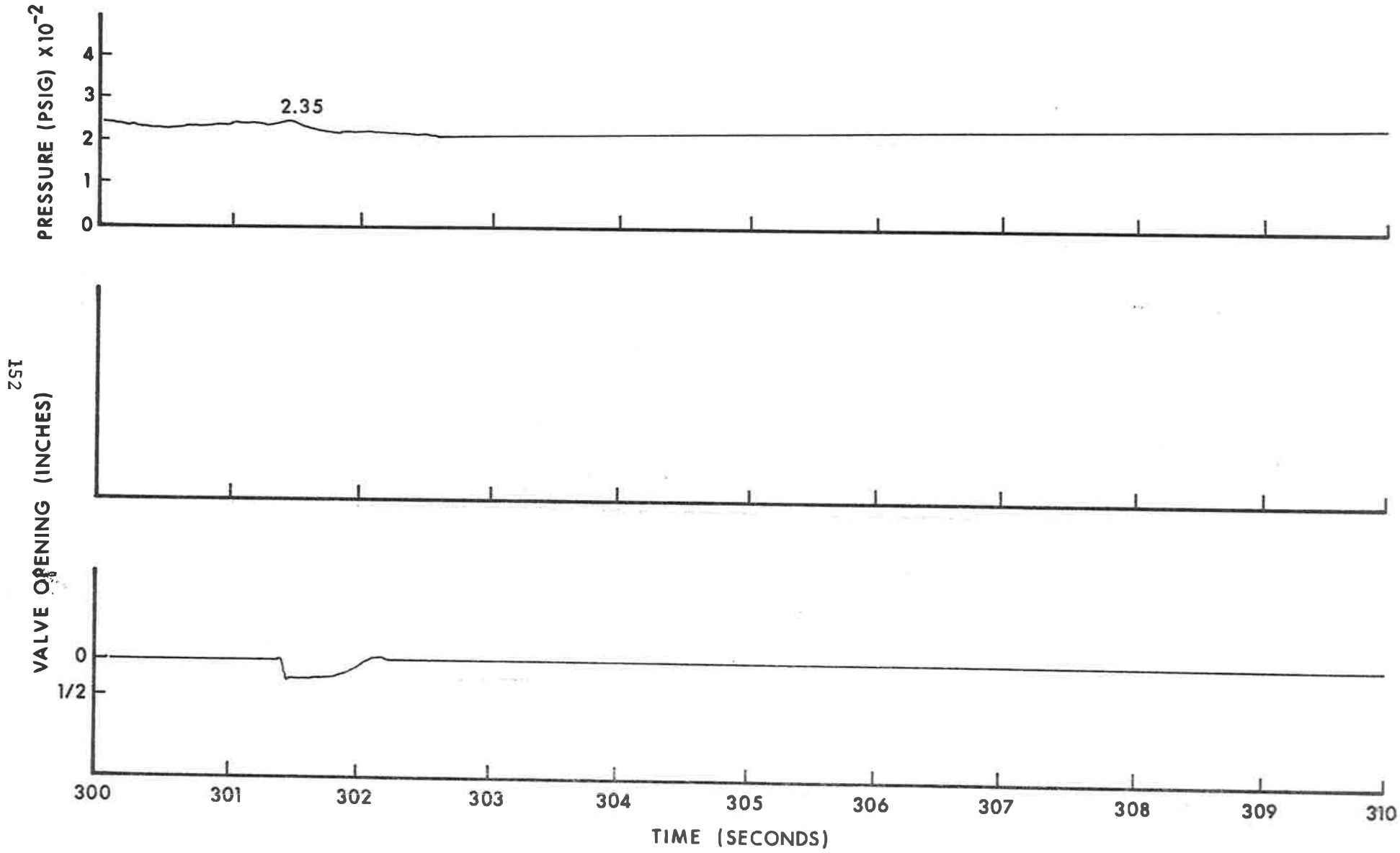

Figure C30- Test No. 6: Pressure and Valve Opening as a Function of Time.

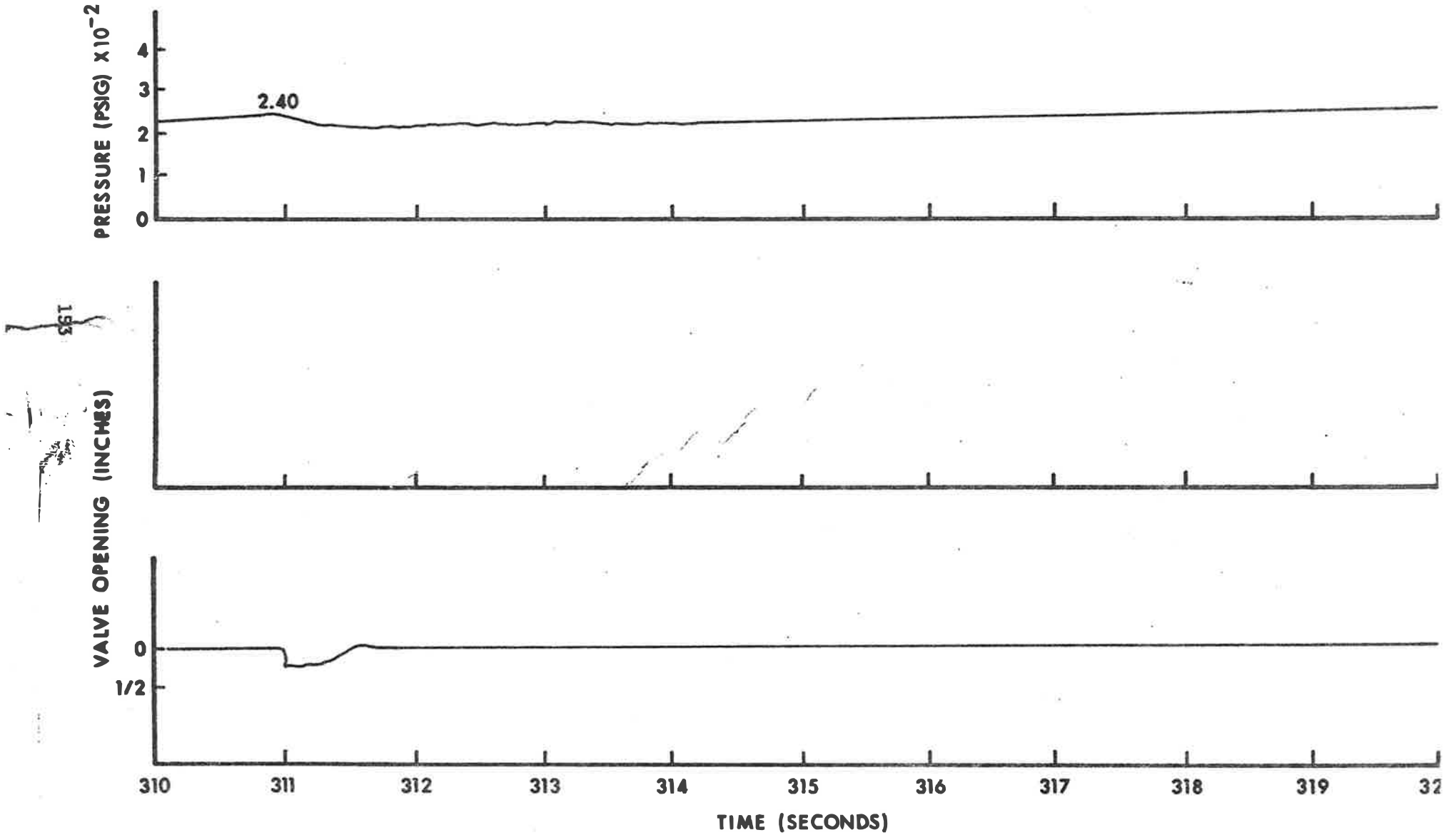

Figure C31- Test No. 6: Pressure and Valve Opening as a Function of Time.

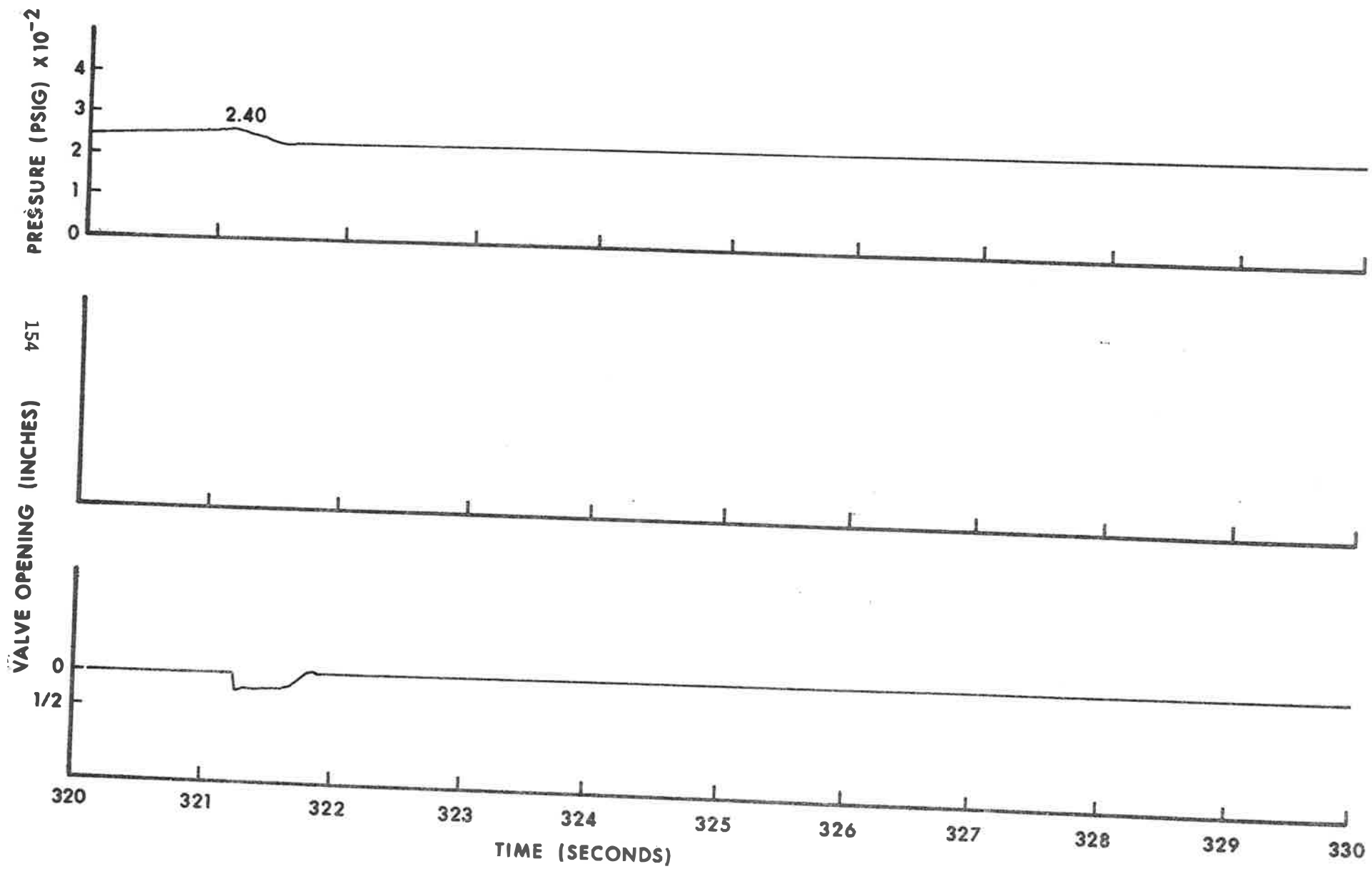

Figure C32- Test No. 6: Pressure and Valve Opening as a Function of Time.

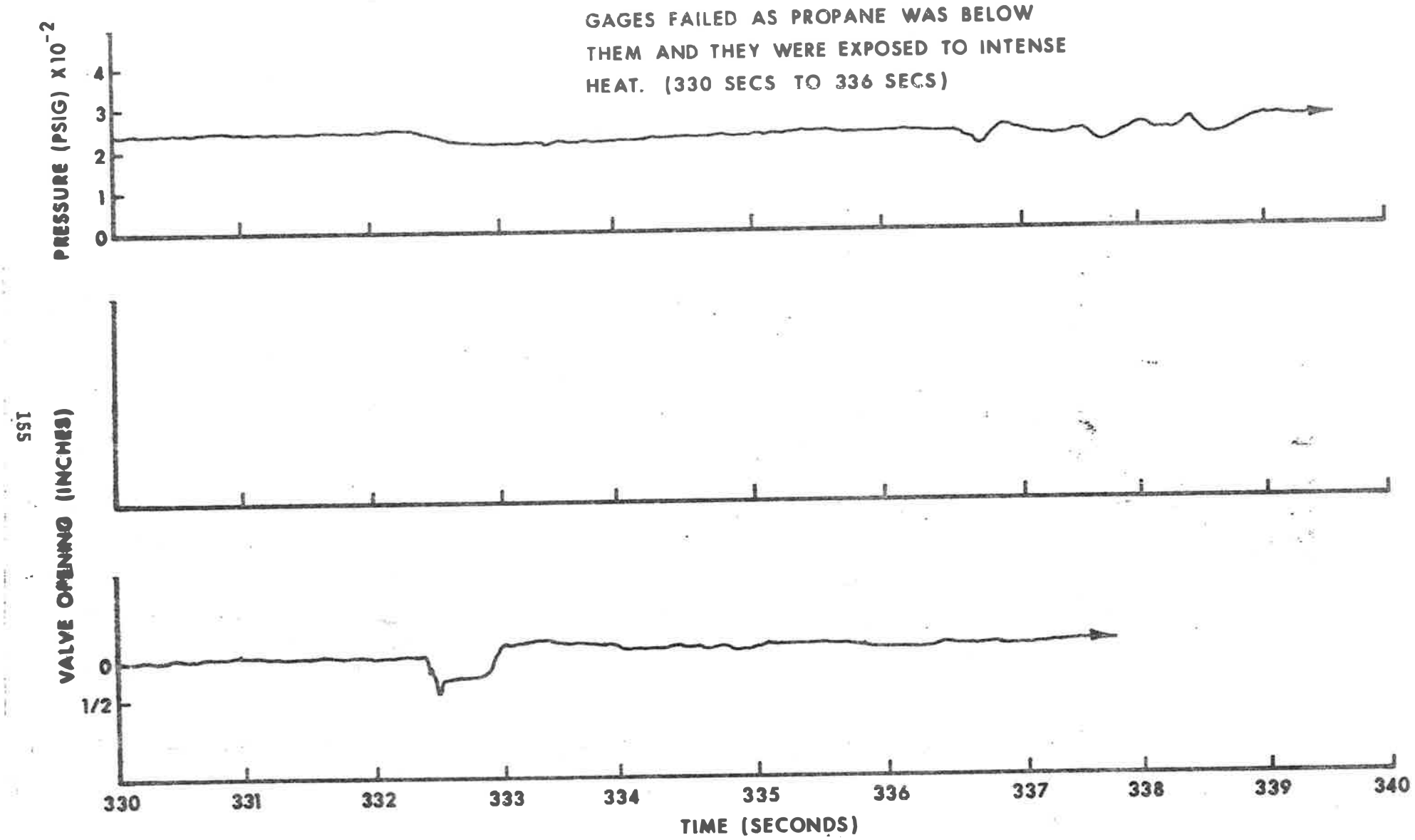

Figure C33- Test No. 6: Pressure and Valve Opening as a Function of Time.

APPENDIX D

DERIVATION OF FORMULA FOR HEAT FLUX INTO LADING

APPENDIX D: HEAT FLUX INTO THE LADING*

The mass of the lading in the tank is given by

$$M = V_\ell \rho_\ell + V_v \rho_v \ , \qquad \text{(D-1)}$$

where:

M = mass,

V_ℓ = volume occupied by the liquid,

ρ_ℓ = average density of the liquid,

V_v = volume occupied by the vapor,

ρ_v = average density of the vapor.

The volume of liquid and vapor are given respectively by

$$V_\ell = V \left[1 - \frac{\theta - \sin\theta \cos\theta}{\pi} \right] , \qquad \text{(D-2)}$$

and

$$V_v = V \left[\theta - \sin\theta \cos\theta \right] , \qquad \text{(D-3)}$$

where V is the tank volume and θ is the angle to the liquid level. (See Figure D-1).

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*This derivation follows one given by Leo Manda, RPI-AAR, in report #RA-11-2-14, RPI-AAR Tank Car Safety Research.

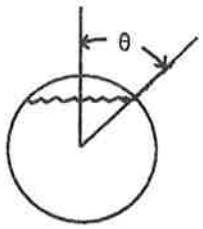

FIGURE D-1

Thus, equation (D-1) becomes, upon replacing V_ℓ and V_v in equation (D-1) by their respective expressions in equations (D-2) and (D-3),

$$M = V\rho_\ell + \frac{V}{\pi} (\rho_v - \rho_\ell) \left[\theta - \sin\theta \cos\theta\right] \quad \text{(D-4)}$$

Taking the time derivative of equation (D-4), and assuming that the average densities of the two phases do not change with time, or that the change is negligible, gives the following expression:

$$\frac{dM}{dt} = \frac{2V}{\pi} (\rho_v - \rho_\ell) \sin^2\theta \frac{d\theta}{dt} \quad . \quad \text{(D-5)}$$

Defining the following quantities:

Q = total heat rate into the lading,

q = uniform heat rate per unit area into the lading (heat flux),

and

S_W = area of the wetted surface,

we can write

$$Q = qS_W = qS\left(\frac{S_W}{S}\right) = qS\left(\frac{\pi-\theta}{\pi}\right) \quad . \quad \text{(D-6)}$$

The vapor efflux rate, $\frac{dm_v}{dt}$, can be determined if it is assumed that all the heat going into the lading goes into vaporizing the liquid, and that this amount of liquid vaporized must escape from the tank if the pressure is not to increase. If all the heat going into the lading is used for vaporization of the liquid vaporized times the heat of vaporization gives the total heat into the lading,

$$Q = h_v \rho_\ell \frac{dV_\ell}{dt} \quad , \tag{D-7}$$

where h_v is the heat of vaporization. The total volume is given by

$$V = V_\ell + V_v \quad , \tag{D-8}$$

and hence,

$$\frac{dV_\ell}{dt} = - \frac{dV_v}{dt} \quad . \tag{D-9}$$

Differentiating equation (D-1) with respect to time, and again assuming that the density change with time is zero or negligible, and making use of equation (D-8), the vapor efflux rate is:

$$\frac{dm_v}{dt} = - \frac{dM}{dt} = (\rho_\ell - \rho_v) \frac{dV_\ell}{dt} \quad . \tag{D-10}$$

Solving for $\frac{dV_\ell}{dt}$ in equation (D-7) and inserting the resulting expression into equation (D-10) gives,

$$- \frac{dM}{dt} = \frac{\rho_\ell - \rho_v}{\rho_\ell h_v} Q. \tag{D-11}$$

Now, upon equating equation (D-5) and (D-11), and using equation (D-6) to substitute for Q in equation (D-11), we have:

$$\frac{2V}{\pi}(\rho_v - \rho_\ell)\sin^2\theta\ \frac{d\theta}{dt} = -\frac{(\rho_\ell - \rho_v)}{\rho_\ell h_v} qS\ \frac{(\pi-\theta)}{\pi}. \quad \text{(D-12)}$$

Therefore, solving for q results in,

$$q = \frac{2Vh_v\rho_\ell}{S}\ \frac{\sin^2\theta}{\pi-\theta}\ \frac{d\theta}{dt}. \quad \text{(D-13)}$$

Assuming q is constant over a time interval Δt, equation (D-13) can be integrated to get the average heat flux going into the lading,

$$q = \frac{2Vh_v\rho_\ell}{S(t_2-t_1)} \int_{\theta_1}^{\theta_2} \frac{\sin^2\theta}{\pi-\theta}\, d\theta, \quad \text{(D-14)}$$

where θ_1 is the angle to the liquid level at time t_1 and θ_2 is the angle to the liquid level at time t_2.

APPENDIX E

EVALUATION OF INTEGRAL

$$\int_0^{\theta} \frac{\sin^2 \theta d\theta}{\pi - \theta}$$

FOR VARIOUS VALUES OF THETA

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
0.10	0.00175	9.70165E-07	5.64340E-10
0.20	0.00349	3.88280E-06	4.51660E-09
0.30	0.00524	8.74113E-06	1.52498E-08
0.40	0.00698	1.55483E-05	3.61627E-08
0.50	0.00873	2.43076E-05	7.06593E-08
0.60	0.01047	3.50220E-05	1.22150E-07
0.70	0.01222	4.76948E-05	1.94048E-07
0.80	0.01396	6.23291E-05	2.89777E-07
0.90	0.01571	7.89279E-05	4.12761E-07
1.00	0.01745	9.74944E-05	5.66432E-07
1.10	0.01920	1.18032E-04	7.54227E-07
1.20	0.02094	1.40543E-04	9.79588E-07
1.30	0.02269	1.65031E-04	1.24596E-06
1.40	0.02443	1.91498E-04	1.55681E-06
1.50	0.02618	2.19949E-04	1.91557E-06
1.60	0.02793	2.50386E-04	2.32573E-06
1.70	0.02967	2.82811E-04	2.79074E-06
1.80	0.03142	3.17228E-04	3.31408E-06
1.90	0.03316	3.53640E-04	3.89923E-06
2.00	0.03491	3.92049E-04	4.54968E-06
2.10	0.03665	4.32459E-04	5.26891E-06
2.20	0.03840	4.74873E-04	6.06041E-06
2.30	0.04014	5.19292E-04	6.92769E-06
2.40	0.04189	5.65721E-04	7.87425E-06
2.50	0.04363	6.14162E-04	8.90360E-06
2.60	0.04538	6.64616E-04	1.00192E-05
2.70	0.04712	7.17091E-04	1.12247E-05
2.80	0.04887	7.71585E-04	1.25235E-05
2.90	0.05061	8.28101E-04	1.39192E-05
3.00	0.05236	8.86644E-04	1.54153E-05
3.10	0.05411	9.47215E-04	1.70154E-05
3.20	0.05585	1.00982E-03	1.87229E-05
3.30	0.05760	1.07445E-03	2.05415E-05
3.40	0.05934	1.14113E-03	2.24747E-05
3.50	0.06109	1.20984E-03	2.45260E-05
3.60	0.06283	1.28060E-03	2.66990E-05
3.70	0.06458	1.35339E-03	2.89973E-05
3.80	0.06632	1.42824E-03	3.14244E-05
3.90	0.06807	1.50514E-03	3.39840E-05

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
4.00	0.06981	1.58409E-03	3.66795E-05
4.10	0.07156	1.66509E-03	3.95147E-05
4.20	0.07330	1.74815E-03	4.24930E-05
4.30	0.07505	1.83327E-03	4.56180E-05
4.40	0.07679	1.92045E-03	4.88935E-05
4.50	0.07854	2.00970E-03	5.23229E-05
4.60	0.08029	2.10102E-03	5.59099E-05
4.70	0.08203	2.19440E-03	5.96580E-05
4.80	0.08378	2.28986E-03	6.35710E-05
4.90	0.08552	2.38739E-03	6.76523E-05
5.00	0.08727	2.48700E-03	7.19058E-05
5.10	0.08901	2.58869E-03	7.63348E-05
5.20	0.09076	2.69246E-03	8.09432E-05
5.30	0.09250	2.79832E-03	8.57345E-05
5.40	0.09425	2.90626E-03	9.07124E-05
5.50	0.09599	3.01629E-03	9.58804E-05
5.60	0.09774	3.12841E-03	1.01242E-04
5.70	0.09948	3.24262E-03	1.06802E-04
5.80	0.10123	3.35893E-03	1.12562E-04
5.90	0.10297	3.47734E-03	1.18528E-04
6.00	0.10472	3.59784E-03	1.24702E-04
6.10	0.10646	3.72045E-03	1.31088E-04
6.20	0.10821	3.84516E-03	1.37690E-04
6.30	0.10996	3.97198E-03	1.44511E-04
6.40	0.11170	4.10091E-03	1.51556E-04
6.50	0.11345	4.23195E-03	1.58827E-04
6.60	0.11519	4.36510E-03	1.66329E-04
6.70	0.11694	4.50036E-03	1.74066E-04
6.80	0.11868	4.63775E-03	1.82040E-04
6.90	0.12043	4.77725E-03	1.90256E-04
7.00	0.12217	4.91887E-03	1.98717E-04
7.10	0.12392	5.06261E-03	2.07427E-04
7.20	0.12566	5.20848E-03	2.16390E-04
7.30	0.12741	5.35648E-03	2.25609E-04
7.40	0.12915	5.50660E-03	2.35089E-04
7.50	0.13090	5.65885E-03	2.44832E-04
7.60	0.13264	5.81324E-03	2.54843E-04
7.70	0.13439	5.96976E-03	2.65125E-04
7.80	0.13614	6.12842E-03	2.75683E-04
7.90	0.13788	6.28921E-03	2.86519E-04

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
8.00	0.13963	6.45215E-03	2.97638E-04
8.10	0.14137	6.61723E-03	3.09042E-04
8.20	0.14312	6.78445E-03	3.20737E-04
8.30	0.14486	6.95381E-03	3.32726E-04
8.40	0.14661	7.12532E-03	3.45012E-04
8.50	0.14835	7.29898E-03	3.57599E-04
8.60	0.15010	7.47479E-03	3.70491E-04
8.70	0.15184	7.65276E-03	3.83692E-04
8.80	0.15359	7.83287E-03	3.97206E-04
8.90	0.15533	8.01514E-03	4.11035E-04
9.00	0.15708	8.19957E-03	4.25185E-04
9.10	0.15882	8.38616E-03	4.39658E-04
9.20	0.16057	8.57490E-03	4.54459E-04
9.30	0.16232	8.76581E-03	4.69592E-04
9.40	0.16406	8.95888E-03	4.85059E-04
9.50	0.16581	9.15411E-03	5.00865E-04
9.60	0.16755	9.35152E-03	5.17014E-04
9.70	0.16930	9.55108E-03	5.33510E-04
9.80	0.17104	9.75282E-03	5.50355E-04
9.90	0.17279	9.95673E-03	5.67555E-04
10.00	0.17453	1.01628E-02	5.85112E-04
10.10	0.17628	1.03711E-02	6.03031E-04
10.20	0.17802	1.05815E-02	6.21315E-04
10.30	0.17977	1.07941E-02	6.39968E-04
10.40	0.18151	1.10089E-02	6.58995E-04
10.50	0.18326	1.12258E-02	6.78398E-04
10.60	0.18500	1.14450E-02	6.98181E-04
10.70	0.18675	1.16663E-02	7.18350E-04
10.80	0.18850	1.18898E-02	7.38906E-04
10.90	0.19024	1.21155E-02	7.59854E-04
11.00	0.19199	1.23434E-02	7.81198E-04
11.10	0.19373	1.25734E-02	8.02942E-04
11.20	0.19548	1.28057E-02	8.25089E-04
11.30	0.19722	1.30401E-02	8.47643E-04
11.40	0.19897	1.32767E-02	8.70608E-04
11.50	0.20071	1.35155E-02	8.93989E-04
11.60	0.20246	1.37565E-02	9.17788E-04
11.70	0.20420	1.39997E-02	9.42009E-04
11.80	0.20595	1.42451E-02	9.66657E-04
11.90	0.20769	1.44927E-02	9.91735E-04

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
12.00	0.20944	1.47425E-02	1.01725E-03
12.10	0.21118	1.49945E-02	1.04320E-03
12.20	0.21293	1.52486E-02	1.06959E-03
12.30	0.21468	1.55050E-02	1.09643E-03
12.40	0.21642	1.57636E-02	1.12371E-03
12.50	0.21817	1.60244E-02	1.15145E-03
12.60	0.21991	1.62873E-02	1.17965E-03
12.70	0.22166	1.65525E-02	1.20831E-03
12.80	0.22340	1.68199E-02	1.23743E-03
12.90	0.22515	1.70895E-02	1.26702E-03
13.00	0.22689	1.73613E-02	1.29709E-03
13.10	0.22864	1.76353E-02	1.32763E-03
13.20	0.23038	1.79115E-02	1.35865E-03
13.30	0.23213	1.81899E-02	1.39015E-03
13.40	0.23387	1.84705E-02	1.42214E-03
13.50	0.23562	1.87533E-02	1.45463E-03
13.60	0.23736	1.90384E-02	1.48760E-03
13.70	0.23911	1.93256E-02	1.52108E-03
13.80	0.24086	1.96151E-02	1.55506E-03
13.90	0.24260	1.99067E-02	1.58955E-03
14.00	0.24435	2.02006E-02	1.62455E-03
14.10	0.24609	2.04967E-02	1.66007E-03
14.20	0.24784	2.07950E-02	1.69610E-03
14.30	0.24958	2.10955E-02	1.73266E-03
14.40	0.25133	2.13982E-02	1.76974E-03
14.50	0.25307	2.17032E-02	1.80735E-03
14.60	0.25482	2.20103E-02	1.84550E-03
14.70	0.25656	2.23197E-02	1.88418E-03
14.80	0.25831	2.26313E-02	1.92341E-03
14.90	0.26005	2.29451E-02	1.96318E-03
15.00	0.26180	2.32611E-02	2.00351E-03
15.10	0.26354	2.35794E-02	2.04438E-03
15.20	0.26529	2.38998E-02	2.08581E-03
15.30	0.26704	2.42225E-02	2.12781E-03
15.40	0.26878	2.45474E-02	2.17037E-03
15.50	0.27053	2.48745E-02	2.21350E-03
15.60	0.27227	2.52038E-02	2.25720E-03
15.70	0.27402	2.55353E-02	2.30148E-03
15.80	0.27576	2.58691E-02	2.34633E-03
15.90	0.27751	2.62051E-02	2.39178E-03

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
16.00	0.27925	2.65433E-02	2.43781E-03
16.10	0.28100	2.68837E-02	2.48443E-03
16.20	0.28274	2.72263E-02	2.53165E-03
16.30	0.28449	2.75712E-02	2.57947E-03
16.40	0.28623	2.79183E-02	2.62789E-03
16.50	0.28798	2.82675E-02	2.67693E-03
16.60	0.28972	2.86191E-02	2.72657E-03
16.70	0.29147	2.89728E-02	2.77683E-03
16.80	0.29322	2.93287E-02	2.82770E-03
16.90	0.29496	2.96869E-02	2.87920E-03
17.00	0.29671	3.00473E-02	2.93133E-03
17.10	0.29845	3.04099E-02	2.98409E-03
17.20	0.30020	3.07747E-02	3.03748E-03
17.30	0.30194	3.11418E-02	3.09152E-03
17.40	0.30369	3.15110E-02	3.14619E-03
17.50	0.30543	3.18825E-02	3.20151E-03
17.60	0.30718	3.22562E-02	3.25748E-03
17.70	0.30892	3.26321E-02	3.31411E-03
17.80	0.31067	3.30103E-02	3.37139E-03
17.90	0.31241	3.33906E-02	3.42934E-03
18.00	0.31416	3.37732E-02	3.48795E-03
18.10	0.31590	3.41580E-02	3.54723E-03
18.20	0.31765	3.45450E-02	3.60718E-03
18.30	0.31939	3.49342E-02	3.66781E-03
18.40	0.32114	3.53256E-02	3.72913E-03
18.50	0.32289	3.57193E-02	3.79112E-03
18.60	0.32463	3.61151E-02	3.85381E-03
18.70	0.32638	3.65132E-02	3.91719E-03
18.80	0.32812	3.69135E-02	3.98127E-03
18.90	0.32987	3.73160E-02	4.04605E-03
19.00	0.33161	3.77207E-02	4.11153E-03
19.10	0.33336	3.81277E-02	4.17772E-03
19.20	0.33510	3.85368E-02	4.24462E-03
19.30	0.33685	3.89482E-02	4.31224E-03
19.40	0.33859	3.93617E-02	4.38057E-03
19.50	0.34034	3.97775E-02	4.44964E-03
19.60	0.34208	4.01955E-02	4.51943E-03
19.70	0.34383	4.06157E-02	4.58995E-03
19.80	0.34557	4.10381E-02	4.66120E-03
19.90	0.34732	4.14627E-02	4.73320E-03

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
20.00	0.34907	4.18895E-02	4.80594E-03
20.10	0.35081	4.23186E-02	4.87942E-03
20.20	0.35256	4.27498E-02	4.95366E-03
20.30	0.35430	4.31832E-02	5.02865E-03
20.40	0.35605	4.36189E-02	5.10440E-03
20.50	0.35779	4.40567E-02	5.18091E-03
20.60	0.35954	4.44968E-02	5.25818E-03
20.70	0.36128	4.49390E-02	5.33623E-03
20.80	0.36303	4.53835E-02	5.41505E-03
20.90	0.36477	4.58301E-02	5.49465E-03
21.00	0.36652	4.62790E-02	5.57503E-03
21.10	0.36826	4.67300E-02	5.65620E-03
21.20	0.37001	4.71832E-02	5.73815E-03
21.30	0.37175	4.76387E-02	5.82090E-03
21.40	0.37350	4.80963E-02	5.90444E-03
21.50	0.37525	4.85561E-02	5.98879E-03
21.60	0.37699	4.90181E-02	6.07393E-03
21.70	0.37874	4.94823E-02	6.15989E-03
21.80	0.38048	4.99487E-02	6.24666E-03
21.90	0.38223	5.04173E-02	6.33425E-03
22.00	0.38397	5.08881E-02	6.42265E-03
22.10	0.38572	5.13610E-02	6.51188E-03
22.20	0.38746	5.18362E-02	6.60194E-03
22.30	0.38921	5.23135E-02	6.69282E-03
22.40	0.39095	5.27930E-02	6.78455E-03
22.50	0.39270	5.32747E-02	6.87711E-03
22.60	0.39444	5.37586E-02	6.97051E-03
22.70	0.39619	5.42446E-02	7.06476E-03
22.80	0.39793	5.47329E-02	7.15986E-03
22.90	0.39968	5.52233E-02	7.25582E-03
23.00	0.40143	5.57158E-02	7.35263E-03
23.10	0.40317	5.62106E-02	7.45030E-03
23.20	0.40492	5.67075E-02	7.54884E-03
23.30	0.40666	5.72066E-02	7.64825E-03
23.40	0.40841	5.77079E-02	7.74853E-03
23.50	0.41015	5.82113E-02	7.84969E-03
23.60	0.41190	5.87169E-02	7.95173E-03
23.70	0.41364	5.92247E-02	8.05465E-03
23.80	0.41539	5.97346E-02	8.15846E-03
23.90	0.41713	6.02467E-02	8.26317E-03

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
24.00	0.41888	6.07609E-02	8.36877E-03
24.10	0.42062	6.12773E-02	8.47526E-03
24.20	0.42237	6.17959E-02	8.58266E-03
24.30	0.42411	6.23166E-02	8.69097E-03
24.40	0.42586	6.28395E-02	8.80019E-03
24.50	0.42761	6.33645E-02	8.91032E-03
24.60	0.42935	6.38916E-02	9.02138E-03
24.70	0.43110	6.44210E-02	9.13335E-03
24.80	0.43284	6.49524E-02	9.24625E-03
24.90	0.43459	6.54860E-02	9.36008E-03
25.00	0.43633	6.60218E-02	9.47484E-03
25.10	0.43808	6.65597E-02	9.59054E-03
25.20	0.43982	6.70997E-02	9.70718E-03
25.30	0.44157	6.76418E-02	9.82476E-03
25.40	0.44331	6.81861E-02	9.94329E-03
25.50	0.44506	6.87326E-02	1.00628E-02
25.60	0.44680	6.92811E-02	1.01832E-02
25.70	0.44855	6.98318E-02	1.03046E-02
25.80	0.45029	7.03846E-02	1.04270E-02
25.90	0.45204	7.09396E-02	1.05503E-02
26.00	0.45379	7.14966E-02	1.06746E-02
26.10	0.45553	7.20558E-02	1.07999E-02
26.20	0.45728	7.26171E-02	1.09261E-02
26.30	0.45902	7.31805E-02	1.10534E-02
26.40	0.46077	7.37460E-02	1.11816E-02
26.50	0.46251	7.43137E-02	1.13108E-02
26.60	0.46426	7.48834E-02	1.14410E-02
26.70	0.46600	7.54553E-02	1.15722E-02
26.80	0.46775	7.60293E-02	1.17044E-02
26.90	0.46949	7.66053E-02	1.18376E-02
27.00	0.47124	7.71835E-02	1.19718E-02
27.10	0.47298	7.77638E-02	1.21070E-02
27.20	0.47473	7.83461E-02	1.22432E-02
27.30	0.47647	7.89306E-02	1.23805E-02
27.40	0.47822	7.95171E-02	1.25187E-02
27.50	0.47997	8.01057E-02	1.26580E-02
27.60	0.48171	8.06965E-02	1.27984E-02
27.70	0.48346	8.12893E-02	1.29397E-02
27.80	0.48520	8.18842E-02	1.30821E-02
27.90	0.48695	8.24811E-02	1.32256E-02

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
36.00	0.62832	1.37467E-01	2.86219E-02
36.10	0.63006	1.38223E-01	2.88624E-02
36.20	0.63181	1.38982E-01	2.91043E-02
36.30	0.63355	1.39742E-01	2.93476E-02
36.40	0.63530	1.40505E-01	2.95921E-02
36.50	0.63704	1.41269E-01	2.98380E-02
36.60	0.63879	1.42034E-01	3.00853E-02
36.70	0.64054	1.42802E-01	3.03338E-02
36.80	0.64228	1.43571E-01	3.05837E-02
36.90	0.64403	1.44342E-01	3.08350E-02
37.00	0.64577	1.45115E-01	3.10876E-02
37.10	0.64752	1.45890E-01	3.13415E-02
37.20	0.64926	1.46666E-01	3.15968E-02
37.30	0.65101	1.47444E-01	3.18535E-02
37.40	0.65275	1.48224E-01	3.21115E-02
37.50	0.65450	1.49005E-01	3.23709E-02
37.60	0.65624	1.49789E-01	3.26316E-02
37.70	0.65799	1.50574E-01	3.28938E-02
37.80	0.65973	1.51360E-01	3.31572E-02
37.90	0.66148	1.52149E-01	3.34221E-02
38.00	0.66322	1.52939E-01	3.36883E-02
38.10	0.66497	1.53731E-01	3.39560E-02
38.20	0.66672	1.54524E-01	3.42250E-02
38.30	0.66846	1.55320E-01	3.44954E-02
38.40	0.67021	1.56117E-01	3.47671E-02
38.50	0.67195	1.56915E-01	3.50403E-02
38.60	0.67370	1.57716E-01	3.53149E-02
38.70	0.67544	1.58518E-01	3.55908E-02
38.80	0.67719	1.59321E-01	3.58682E-02
38.90	0.67893	1.60127E-01	3.61470E-02
39.00	0.68068	1.60934E-01	3.64271E-02
39.10	0.68242	1.61742E-01	3.67087E-02
39.20	0.68417	1.62553E-01	3.69917E-02
39.30	0.68591	1.63365E-01	3.72762E-02
39.40	0.68766	1.64178E-01	3.75620E-02
39.50	0.68940	1.64994E-01	3.78492E-02
39.60	0.69115	1.65811E-01	3.81379E-02
39.70	0.69290	1.66629E-01	3.84280E-02
39.80	0.69464	1.67449E-01	3.87196E-02
39.90	0.69639	1.68271E-01	3.90125E-02

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
40.00	0.69813	1.69094E-01	3.93069E-02
40.10	0.69988	1.69919E-01	3.96028E-02
40.20	0.70162	1.70746E-01	3.99001E-02
40.30	0.70337	1.71574E-01	4.01988E-02
40.40	0.70511	1.72404E-01	4.04990E-02
40.50	0.70686	1.73236E-01	4.08006E-02
40.60	0.70860	1.74069E-01	4.11037E-02
40.70	0.71035	1.74903E-01	4.14082E-02
40.80	0.71209	1.75739E-01	4.17142E-02
40.90	0.71384	1.76577E-01	4.20217E-02
41.00	0.71558	1.77416E-01	4.23306E-02
41.10	0.71733	1.78257E-01	4.26410E-02
41.20	0.71908	1.79099E-01	4.29528E-02
41.30	0.72082	1.79943E-01	4.32661E-02
41.40	0.72257	1.80789E-01	4.35809E-02
41.50	0.72431	1.81636E-01	4.38972E-02
41.60	0.72606	1.82484E-01	4.42150E-02
41.70	0.72780	1.83335E-01	4.45342E-02
41.80	0.72955	1.84186E-01	4.48549E-02
41.90	0.73129	1.85039E-01	4.51771E-02
42.00	0.73304	1.85894E-01	4.55008E-02
42.10	0.73478	1.86750E-01	4.58260E-02
42.20	0.73653	1.87608E-01	4.61527E-02
42.30	0.73827	1.88467E-01	4.64809E-02
42.40	0.74002	1.89327E-01	4.68106E-02
42.50	0.74176	1.90189E-01	4.71418E-02
42.60	0.74351	1.91053E-01	4.74745E-02
42.70	0.74525	1.91918E-01	4.78087E-02
42.80	0.74700	1.92785E-01	4.81444E-02
42.90	0.74875	1.93652E-01	4.84816E-02
43.00	0.75049	1.94522E-01	4.88204E-02
43.10	0.75224	1.95393E-01	4.91606E-02
43.20	0.75398	1.96265E-01	4.95024E-02
43.30	0.75573	1.97139E-01	4.98457E-02
43.40	0.75747	1.98014E-01	5.01906E-02
43.50	0.75922	1.98891E-01	5.05369E-02
43.60	0.76096	1.99769E-01	5.08848E-02
43.70	0.76271	2.00648E-01	5.12343E-02
43.80	0.76445	2.01529E-01	5.15852E-02
43.90	0.76620	2.02411E-01	5.19377E-02

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
44.00	0.76794	2.03295E-01	5.22918E-02
44.10	0.76969	2.04180E-01	5.26474E-02
44.20	0.77143	2.05066E-01	5.30045E-02
44.30	0.77318	2.05954E-01	5.33632E-02
44.40	0.77493	2.06843E-01	5.37234E-02
44.50	0.77667	2.07734E-01	5.40852E-02
44.60	0.77842	2.08625E-01	5.44485E-02
44.70	0.78016	2.09519E-01	5.48134E-02
44.80	0.78191	2.10413E-01	5.51799E-02
44.90	0.78365	2.11309E-01	5.55479E-02
45.00	0.78540	2.12206E-01	5.59175E-02
45.10	0.78714	2.13105E-01	5.62887E-02
45.20	0.78889	2.14005E-01	5.66614E-02
45.30	0.79063	2.14906E-01	5.70357E-02
45.40	0.79238	2.15809E-01	5.74115E-02
45.50	0.79412	2.16713E-01	5.77890E-02
45.60	0.79587	2.17618E-01	5.81680E-02
45.70	0.79761	2.18524E-01	5.85486E-02
45.80	0.79936	2.19432E-01	5.89308E-02
45.90	0.80111	2.20341E-01	5.93146E-02
46.00	0.80285	2.21251E-01	5.96999E-02
46.10	0.80460	2.22163E-01	6.00869E-02
46.20	0.80634	2.23076E-01	6.04754E-02
46.30	0.80809	2.23990E-01	6.08656E-02
46.40	0.80983	2.24905E-01	6.12573E-02
46.50	0.81158	2.25822E-01	6.16506E-02
46.60	0.81332	2.26739E-01	6.20456E-02
46.70	0.81507	2.27659E-01	6.24421E-02
46.80	0.81681	2.28579E-01	6.28403E-02
46.90	0.81856	2.29500E-01	6.32400E-02
47.00	0.82030	2.30423E-01	6.36414E-02
47.10	0.82205	2.31347E-01	6.40443E-02
47.20	0.82379	2.32272E-01	6.44489E-02
47.30	0.82554	2.33198E-01	6.48551E-02
47.40	0.82729	2.34126E-01	6.52629E-02
47.50	0.82903	2.35054E-01	6.56724E-02
47.60	0.83078	2.35984E-01	6.60834E-02
47.70	0.83252	2.36915E-01	6.64961E-02
47.80	0.83427	2.37847E-01	6.69104E-02
47.90	0.83601	2.38781E-01	6.73264E-02

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
48.00	0.83776	2.39715E-01	6.77439E-02
48.10	0.83950	2.40651E-01	6.81631E-02
48.20	0.84125	2.41587E-01	6.85839E-02
48.30	0.84299	2.42525E-01	6.90064E-02
48.40	0.84474	2.43464E-01	6.94305E-02
48.50	0.84648	2.44404E-01	6.98563E-02
48.60	0.84823	2.45346E-01	7.02837E-02
48.70	0.84997	2.46288E-01	7.07127E-02
48.80	0.85172	2.47231E-01	7.11434E-02
48.90	0.85347	2.48176E-01	7.15757E-02
49.00	0.85521	2.49121E-01	7.20097E-02
49.10	0.85696	2.50068E-01	7.24453E-02
49.20	0.85870	2.51016E-01	7.28826E-02
49.30	0.86045	2.51964E-01	7.33215E-02
49.40	0.86219	2.52914E-01	7.37621E-02
49.50	0.86394	2.53865E-01	7.42043E-02
49.60	0.86568	2.54817E-01	7.46482E-02
49.70	0.86743	2.55770E-01	7.50938E-02
49.80	0.86917	2.56724E-01	7.55410E-02
49.90	0.87092	2.57679E-01	7.59899E-02
50.00	0.87266	2.58635E-01	7.64405E-02
50.10	0.87441	2.59592E-01	7.68927E-02
50.20	0.87615	2.60550E-01	7.73467E-02
50.30	0.87790	2.61509E-01	7.78022E-02
50.40	0.87965	2.62469E-01	7.82595E-02
50.50	0.88139	2.63430E-01	7.87184E-02
50.60	0.88314	2.64392E-01	7.91790E-02
50.70	0.88488	2.65355E-01	7.96413E-02
50.80	0.88663	2.66318E-01	8.01053E-02
50.90	0.88837	2.67283E-01	8.05710E-02
51.00	0.89012	2.68249E-01	8.10383E-02
51.10	0.89186	2.69216E-01	8.15073E-02
51.20	0.89361	2.70183E-01	8.19780E-02
51.30	0.89535	2.71152E-01	8.24504E-02
51.40	0.89710	2.72121E-01	8.29245E-02
51.50	0.89884	2.73091E-01	8.34003E-02
51.60	0.90059	2.74063E-01	8.38778E-02
51.70	0.90233	2.75035E-01	8.43570E-02
51.80	0.90408	2.76008E-01	8.48378E-02
51.90	0.90583	2.76982E-01	8.53204E-02

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
52.00	0.90757	2.77956E-01	8.58047E-02
52.10	0.90932	2.78932E-01	8.62907E-02
52.20	0.91106	2.79909E-01	8.67784E-02
52.30	0.91281	2.80886E-01	8.72677E-02
52.40	0.91455	2.81864E-01	8.77588E-02
52.50	0.91630	2.82843E-01	8.82516E-02
52.60	0.91804	2.83823E-01	8.87461E-02
52.70	0.91979	2.84804E-01	8.92424E-02
52.80	0.92153	2.85785E-01	8.97403E-02
52.90	0.92328	2.86767E-01	9.02399E-02
53.00	0.92502	2.87750E-01	9.07413E-02
53.10	0.92677	2.88734E-01	9.12444E-02
53.20	0.92851	2.89719E-01	9.17492E-02
53.30	0.93026	2.90704E-01	9.22557E-02
53.40	0.93201	2.91691E-01	9.27639E-02
53.50	0.93375	2.92678E-01	9.32739E-02
53.60	0.93550	2.93665E-01	9.37856E-02
53.70	0.93724	2.94654E-01	9.42990E-02
53.80	0.93899	2.95643E-01	9.48141E-02
53.90	0.94073	2.96633E-01	9.53309E-02
54.00	0.94248	2.97624E-01	9.58495E-02
54.10	0.94422	2.98615E-01	9.63699E-02
54.20	0.94597	2.99607E-01	9.68919E-02
54.30	0.94771	3.00600E-01	9.74157E-02
54.40	0.94946	3.01593E-01	9.79412E-02
54.50	0.95120	3.02587E-01	9.84684E-02
54.60	0.95295	3.03582E-01	9.89974E-02
54.70	0.95469	3.04578E-01	9.95281E-02
54.80	0.95644	3.05574E-01	1.00061E-01
54.90	0.95818	3.06571E-01	1.00595E-01
55.00	0.95993	3.07568E-01	1.01131E-01
55.10	0.96168	3.08566E-01	1.01668E-01
55.20	0.96342	3.09565E-01	1.02208E-01
55.30	0.96517	3.10565E-01	1.02749E-01
55.40	0.96691	3.11565E-01	1.03292E-01
55.50	0.96866	3.12565E-01	1.03837E-01
55.60	0.97040	3.13566E-01	1.04383E-01
55.70	0.97215	3.14568E-01	1.04931E-01
55.80	0.97389	3.15571E-01	1.05481E-01
55.90	0.97564	3.16574E-01	1.06033E-01

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
56.00	0.97738	3.17577E-01	1.06586E-01
56.10	0.97913	3.18581E-01	1.07141E-01
56.20	0.98087	3.19586E-01	1.07698E-01
56.30	0.98262	3.20591E-01	1.08257E-01
56.40	0.98436	3.21597E-01	1.08817E-01
56.50	0.98611	3.22603E-01	1.09379E-01
56.60	0.98786	3.23610E-01	1.09943E-01
56.70	0.98960	3.24617E-01	1.10509E-01
56.80	0.99135	3.25625E-01	1.11076E-01
56.90	0.99309	3.26634E-01	1.11646E-01
57.00	0.99484	3.27642E-01	1.12217E-01
57.10	0.99658	3.28652E-01	1.12789E-01
57.20	0.99833	3.29662E-01	1.13364E-01
57.30	1.00007	3.30672E-01	1.13940E-01
57.40	1.00182	3.31683E-01	1.14518E-01
57.50	1.00356	3.32694E-01	1.15098E-01
57.60	1.00531	3.33706E-01	1.15679E-01
57.70	1.00705	3.34718E-01	1.16263E-01
57.80	1.00880	3.35730E-01	1.16848E-01
57.90	1.01054	3.36743E-01	1.17435E-01
58.00	1.01229	3.37756E-01	1.18023E-01
58.10	1.01404	3.38770E-01	1.18614E-01
58.20	1.01578	3.39784E-01	1.19206E-01
58.30	1.01753	3.40799E-01	1.19800E-01
58.40	1.01927	3.41814E-01	1.20395E-01
58.50	1.02102	3.42829E-01	1.20993E-01
58.60	1.02276	3.43845E-01	1.21592E-01
58.70	1.02451	3.44861E-01	1.22193E-01
58.80	1.02625	3.45877E-01	1.22796E-01
58.90	1.02800	3.46894E-01	1.23400E-01
59.00	1.02974	3.47911E-01	1.24007E-01
59.10	1.03149	3.48929E-01	1.24615E-01
59.20	1.03323	3.49946E-01	1.25225E-01
59.30	1.03498	3.50964E-01	1.25836E-01
59.40	1.03672	3.51983E-01	1.26450E-01
59.50	1.03847	3.53001E-01	1.27065E-01
59.60	1.04022	3.54020E-01	1.27682E-01
59.70	1.04196	3.55039E-01	1.28301E-01
59.80	1.04371	3.56059E-01	1.28921E-01
59.90	1.04545	3.57079E-01	1.29544E-01

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
60.00	1.04720	3.58099E-01	1.30168E-01
60.10	1.04894	3.59119E-01	1.30794E-01
60.20	1.05069	3.60139E-01	1.31421E-01
60.30	1.05243	3.61160E-01	1.32051E-01
60.40	1.05418	3.62181E-01	1.32682E-01
60.50	1.05592	3.63202E-01	1.33315E-01
60.60	1.05767	3.64223E-01	1.33950E-01
60.70	1.05941	3.65245E-01	1.34586E-01
60.80	1.06116	3.66267E-01	1.35225E-01
60.90	1.06290	3.67288E-01	1.35865E-01
61.00	1.06465	3.68311E-01	1.36507E-01
61.10	1.06640	3.69333E-01	1.37151E-01
61.20	1.06814	3.70355E-01	1.37796E-01
61.30	1.06989	3.71378E-01	1.38443E-01
61.40	1.07163	3.72400E-01	1.39092E-01
61.50	1.07338	3.73423E-01	1.39743E-01
61.60	1.07512	3.74446E-01	1.40396E-01
61.70	1.07687	3.75469E-01	1.41050E-01
61.80	1.07861	3.76492E-01	1.41707E-01
61.90	1.08036	3.77515E-01	1.42365E-01
62.00	1.08210	3.78539E-01	1.43024E-01
62.10	1.08385	3.79562E-01	1.43686E-01
62.20	1.08559	3.80586E-01	1.44349E-01
62.30	1.08734	3.81609E-01	1.45014E-01
62.40	1.08908	3.82633E-01	1.45681E-01
62.50	1.09083	3.83657E-01	1.46350E-01
62.60	1.09258	3.84680E-01	1.47021E-01
62.70	1.09432	3.85704E-01	1.47693E-01
62.80	1.09607	3.86728E-01	1.48367E-01
62.90	1.09781	3.87751E-01	1.49043E-01
63.00	1.09956	3.88775E-01	1.49720E-01
63.10	1.10130	3.89799E-01	1.50400E-01
63.20	1.10305	3.90823E-01	1.51081E-01
63.30	1.10479	3.91846E-01	1.51764E-01
63.40	1.10654	3.92870E-01	1.52449E-01
63.50	1.10828	3.93894E-01	1.53135E-01
63.60	1.11003	3.94917E-01	1.53824E-01
63.70	1.11177	3.95941E-01	1.54514E-01
63.80	1.11352	3.96964E-01	1.55206E-01
63.90	1.11526	3.97988E-01	1.55900E-01

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
64.00	1.11701	3.99011E-01	1.56595E-01
64.10	1.11876	4.00034E-01	1.57292E-01
64.20	1.12050	4.01058E-01	1.57992E-01
64.30	1.12225	4.02081E-01	1.58692E-01
64.40	1.12399	4.03103E-01	1.59395E-01
64.50	1.12574	4.04126E-01	1.60099E-01
64.60	1.12748	4.05149E-01	1.60806E-01
64.70	1.12923	4.06172E-01	1.61514E-01
64.80	1.13097	4.07194E-01	1.62224E-01
64.90	1.13272	4.08216E-01	1.62935E-01
65.00	1.13446	4.09238E-01	1.63648E-01
65.10	1.13621	4.10260E-01	1.64364E-01
65.20	1.13795	4.11282E-01	1.65081E-01
65.30	1.13970	4.12303E-01	1.65799E-01
65.40	1.14144	4.13325E-01	1.66520E-01
65.50	1.14319	4.14346E-01	1.67242E-01
65.60	1.14494	4.15367E-01	1.67966E-01
65.70	1.14668	4.16387E-01	1.68692E-01
65.80	1.14843	4.17408E-01	1.69420E-01
65.90	1.15017	4.18428E-01	1.70149E-01
66.00	1.15192	4.19448E-01	1.70880E-01
66.10	1.15366	4.20468E-01	1.71613E-01
66.20	1.15541	4.21487E-01	1.72348E-01
66.30	1.15715	4.22506E-01	1.73084E-01
66.40	1.15890	4.23525E-01	1.73823E-01
66.50	1.16064	4.24544E-01	1.74563E-01
66.60	1.16239	4.25562E-01	1.75305E-01
66.70	1.16413	4.26580E-01	1.76048E-01
66.80	1.16588	4.27597E-01	1.76794E-01
66.90	1.16762	4.28615E-01	1.77541E-01
67.00	1.16937	4.29632E-01	1.78290E-01
67.10	1.17111	4.30648E-01	1.79041E-01
67.20	1.17286	4.31665E-01	1.79793E-01
67.30	1.17461	4.32681E-01	1.80547E-01
67.40	1.17635	4.33696E-01	1.81303E-01
67.50	1.17810	4.34711E-01	1.82061E-01
67.60	1.17984	4.35726E-01	1.82821E-01
67.70	1.18159	4.36740E-01	1.83582E-01
67.80	1.18333	4.37754E-01	1.84345E-01
67.90	1.18508	4.38768E-01	1.85110E-01

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
68.00	1.18682	4.39781E-01	1.85877E-01
68.10	1.18857	4.40794E-01	1.86645E-01
68.20	1.19031	4.41806E-01	1.87416E-01
68.30	1.19206	4.42818E-01	1.88188E-01
68.40	1.19380	4.43829E-01	1.88961E-01
68.50	1.19555	4.44840E-01	1.89737E-01
68.60	1.19729	4.45850E-01	1.90514E-01
68.70	1.19904	4.46860E-01	1.91293E-01
68.80	1.20079	4.47869E-01	1.92074E-01
68.90	1.20253	4.48878E-01	1.92856E-01
69.00	1.20428	4.49887E-01	1.93641E-01
69.10	1.20602	4.50895E-01	1.94427E-01
69.20	1.20777	4.51902E-01	1.95215E-01
69.30	1.20951	4.52909E-01	1.96004E-01
69.40	1.21126	4.53915E-01	1.96796E-01
69.50	1.21300	4.54921E-01	1.97589E-01
69.60	1.21475	4.55926E-01	1.98384E-01
69.70	1.21649	4.56930E-01	1.99180E-01
69.80	1.21824	4.57934E-01	1.99979E-01
69.90	1.21998	4.58938E-01	2.00779E-01
70.00	1.22173	4.59940E-01	2.01581E-01
70.10	1.22347	4.60943E-01	2.02384E-01
70.20	1.22522	4.61944E-01	2.03190E-01
70.30	1.22697	4.62945E-01	2.03997E-01
70.40	1.22871	4.63945E-01	2.04806E-01
70.50	1.23046	4.64945E-01	2.05616E-01
70.60	1.23220	4.65944E-01	2.06429E-01
70.70	1.23395	4.66942E-01	2.07243E-01
70.80	1.23569	4.67940E-01	2.08058E-01
70.90	1.23744	4.68937E-01	2.08876E-01
71.00	1.23918	4.69933E-01	2.09695E-01
71.10	1.24093	4.70929E-01	2.10516E-01
71.20	1.24267	4.71924E-01	2.11339E-01
71.30	1.24442	4.72918E-01	2.12164E-01
71.40	1.24616	4.73912E-01	2.12990E-01
71.50	1.24791	4.74904E-01	2.13818E-01
71.60	1.24965	4.75896E-01	2.14648E-01
71.70	1.25140	4.76888E-01	2.15479E-01
71.80	1.25315	4.77878E-01	2.16312E-01
71.90	1.25489	4.78866E-01	2.17147E-01

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
72.00	1.25664	4.79867E-01	2.17984E-01
72.10	1.25838	4.80845E-01	2.18822E-01
72.20	1.26013	4.81832E-01	2.19662E-01
72.30	1.26187	4.82819E-01	2.20504E-01
72.40	1.26362	4.83805E-01	2.21348E-01
72.50	1.26536	4.84790E-01	2.22193E-01
72.60	1.26711	4.85774E-01	2.23040E-01
72.70	1.26885	4.86757E-01	2.23889E-01
72.80	1.27060	4.87739E-01	2.24739E-01
72.90	1.27234	4.88721E-01	2.25591E-01
73.00	1.27409	4.89702E-01	2.26445E-01
73.10	1.27583	4.90681E-01	2.27301E-01
73.20	1.27758	4.91660E-01	2.28158E-01
73.30	1.27933	4.92639E-01	2.29017E-01
73.40	1.28107	4.93616E-01	2.29877E-01
73.50	1.28282	4.94592E-01	2.30740E-01
73.60	1.28456	4.95567E-01	2.31604E-01
73.70	1.28631	4.96542E-01	2.32470E-01
73.80	1.28805	4.97515E-01	2.33337E-01
73.90	1.28980	4.98488E-01	2.34206E-01
74.00	1.29154	4.99459E-01	2.35077E-01
74.10	1.29329	5.00430E-01	2.35950E-01
74.20	1.29503	5.01400E-01	2.36824E-01
74.30	1.29678	5.02368E-01	2.37700E-01
74.40	1.29852	5.03336E-01	2.38578E-01
74.50	1.30027	5.04303E-01	2.39457E-01
74.60	1.30201	5.05268E-01	2.40338E-01
74.70	1.30376	5.06233E-01	2.41221E-01
74.80	1.30551	5.07197E-01	2.42105E-01
74.90	1.30725	5.08159E-01	2.42991E-01
75.00	1.30900	5.09121E-01	2.43879E-01
75.10	1.31074	5.10082E-01	2.44768E-01
75.20	1.31249	5.11041E-01	2.45659E-01
75.30	1.31423	5.11999E-01	2.46552E-01
75.40	1.31598	5.12957E-01	2.47447E-01
75.50	1.31772	5.13913E-01	2.48343E-01
75.60	1.31947	5.14868E-01	2.49241E-01
75.70	1.32121	5.15822E-01	2.50140E-01
75.80	1.32296	5.16775E-01	2.51041E-01
75.90	1.32470	5.17727E-01	2.51944E-01

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
76.00	1.32645	5.18678E-01	2.52848E-01
76.10	1.32819	5.19627E-01	2.53754E-01
76.20	1.32994	5.20576E-01	2.54662E-01
76.30	1.33169	5.21523E-01	2.55572E-01
76.40	1.33343	5.22469E-01	2.56483E-01
76.50	1.33518	5.23414E-01	2.57395E-01
76.60	1.33692	5.24358E-01	2.58310E-01
76.70	1.33867	5.25300E-01	2.59226E-01
76.80	1.34041	5.26242E-01	2.60143E-01
76.90	1.34216	5.27182E-01	2.61063E-01
77.00	1.34390	5.28121E-01	2.61983E-01
77.10	1.34565	5.29059E-01	2.62906E-01
77.20	1.34739	5.29995E-01	2.63830E-01
77.30	1.34914	5.30930E-01	2.64756E-01
77.40	1.35088	5.31864E-01	2.65684E-01
77.50	1.35263	5.32797E-01	2.66613E-01
77.60	1.35437	5.33729E-01	2.67543E-01
77.70	1.35612	5.34659E-01	2.68476E-01
77.80	1.35787	5.35588E-01	2.69410E-01
77.90	1.35961	5.36515E-01	2.70345E-01
78.00	1.36136	5.37442E-01	2.71282E-01
78.10	1.36310	5.38367E-01	2.72221E-01
78.20	1.36485	5.39290E-01	2.73162E-01
78.30	1.36659	5.40213E-01	2.74104E-01
78.40	1.36834	5.41134E-01	2.75047E-01
78.50	1.37008	5.42054E-01	2.75993E-01
78.60	1.37183	5.42972E-01	2.76940E-01
78.70	1.37357	5.43889E-01	2.77888E-01
78.80	1.37532	5.44804E-01	2.78838E-01
78.90	1.37706	5.45719E-01	2.79790E-01
79.00	1.37881	5.46631E-01	2.80743E-01
79.10	1.38055	5.47543E-01	2.81698E-01
79.20	1.38230	5.48453E-01	2.82654E-01
79.30	1.38404	5.49361E-01	2.83612E-01
79.40	1.38579	5.50269E-01	2.84572E-01
79.50	1.38754	5.51174E-01	2.85533E-01
79.60	1.38928	5.52079E-01	2.86496E-01
79.70	1.39103	5.52981E-01	2.87460E-01
79.80	1.39277	5.53883E-01	2.88426E-01
79.90	1.39452	5.54783E-01	2.89394E-01

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
80.00	1.39626	5.55681E-01	2.90363E-01
80.10	1.39801	5.56578E-01	2.91333E-01
80.20	1.39975	5.57474E-01	2.92305E-01
80.30	1.40150	5.58368E-01	2.93279E-01
80.40	1.40324	5.59260E-01	2.94255E-01
80.50	1.40499	5.60151E-01	2.95231E-01
80.60	1.40673	5.61040E-01	2.96210E-01
80.70	1.40848	5.61928E-01	2.97190E-01
80.80	1.41022	5.62815E-01	2.98171E-01
80.90	1.41197	5.63699E-01	2.99154E-01
81.00	1.41372	5.64583E-01	3.00139E-01
81.10	1.41546	5.65464E-01	3.01125E-01
81.20	1.41721	5.66344E-01	3.02113E-01
81.30	1.41895	5.67223E-01	3.03102E-01
81.40	1.42070	5.68100E-01	3.04093E-01
81.50	1.42244	5.68975E-01	3.05085E-01
81.60	1.42419	5.69849E-01	3.06079E-01
81.70	1.42593	5.70721E-01	3.07074E-01
81.80	1.42768	5.71591E-01	3.08071E-01
81.90	1.42942	5.72460E-01	3.09069E-01
82.00	1.43117	5.73327E-01	3.10069E-01
82.10	1.43291	5.74192E-01	3.11071E-01
82.20	1.43466	5.75056E-01	3.12074E-01
82.30	1.43640	5.75918E-01	3.13078E-01
82.40	1.43815	5.76779E-01	3.14084E-01
82.50	1.43990	5.77637E-01	3.15091E-01
82.60	1.44164	5.78495E-01	3.16100E-01
82.70	1.44339	5.79350E-01	3.17111E-01
82.80	1.44513	5.80204E-01	3.18123E-01
82.90	1.44688	5.81055E-01	3.19136E-01
83.00	1.44862	5.81906E-01	3.20151E-01
83.10	1.45037	5.82754E-01	3.21167E-01
83.20	1.45211	5.83601E-01	3.22185E-01
83.30	1.45386	5.84446E-01	3.23204E-01
83.40	1.45560	5.85289E-01	3.24225E-01
83.50	1.45735	5.86130E-01	3.25247E-01
83.60	1.45909	5.86970E-01	3.26271E-01
83.70	1.46084	5.87808E-01	3.27296E-01
83.80	1.46258	5.88644E-01	3.28323E-01
83.90	1.46433	5.89478E-01	3.29351E-01

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
84.00	1.46608	5.90310E-01	3.30381E-01
84.10	1.46782	5.91141E-01	3.31412E-01
84.20	1.46957	5.91970E-01	3.32444E-01
84.30	1.47131	5.92796E-01	3.33476E-01
84.40	1.47306	5.93622E-01	3.34513E-01
84.50	1.47480	5.94445E-01	3.35550E-01
84.60	1.47655	5.95266E-01	3.36588E-01
84.70	1.47829	5.96085E-01	3.37628E-01
84.80	1.48004	5.96903E-01	3.38669E-01
84.90	1.48178	5.97719E-01	3.39712E-01
85.00	1.48353	5.98533E-01	3.40756E-01
85.10	1.48527	5.99344E-01	3.41801E-01
85.20	1.48702	6.00154E-01	3.42848E-01
85.30	1.48876	6.00962E-01	3.43896E-01
85.40	1.49051	6.01768E-01	3.44945E-01
85.50	1.49226	6.02573E-01	3.45996E-01
85.60	1.49400	6.03375E-01	3.47049E-01
85.70	1.49575	6.04175E-01	3.48103E-01
85.80	1.49749	6.04973E-01	3.49158E-01
85.90	1.49924	6.05770E-01	3.50214E-01
86.00	1.50098	6.06564E-01	3.51272E-01
86.10	1.50273	6.07356E-01	3.52332E-01
86.20	1.50447	6.08147E-01	3.53392E-01
86.30	1.50622	6.08935E-01	3.54454E-01
86.40	1.50796	6.09721E-01	3.55518E-01
86.50	1.50971	6.10506E-01	3.56583E-01
86.60	1.51145	6.11288E-01	3.57649E-01
86.70	1.51320	6.12068E-01	3.58717E-01
86.80	1.51494	6.12846E-01	3.59786E-01
86.90	1.51669	6.13623E-01	3.60856E-01
87.00	1.51844	6.14397E-01	3.61927E-01
87.10	1.52018	6.15169E-01	3.63000E-01
87.20	1.52193	6.15939E-01	3.64075E-01
87.30	1.52367	6.16706E-01	3.65150E-01
87.40	1.52542	6.17472E-01	3.66228E-01
87.50	1.52716	6.18236E-01	3.67306E-01
87.60	1.52891	6.18997E-01	3.68386E-01
87.70	1.53065	6.19757E-01	3.69467E-01
87.80	1.53240	6.20514E-01	3.70549E-01
87.90	1.53414	6.21269E-01	3.71633E-01

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
88.00	1.53589	6.22022E-01	3.72718E-01
88.10	1.53763	6.22773E-01	3.73804E-01
88.20	1.53938	6.23522E-01	3.74891E-01
88.30	1.54112	6.24268E-01	3.75980E-01
88.40	1.54287	6.25013E-01	3.77071E-01
88.50	1.54462	6.25755E-01	3.78162E-01
88.60	1.54636	6.26495E-01	3.79255E-01
88.70	1.54811	6.27233E-01	3.80349E-01
88.80	1.54985	6.27968E-01	3.81444E-01
88.90	1.55160	6.28702E-01	3.82541E-01
89.00	1.55334	6.29433E-01	3.83639E-01
89.10	1.55509	6.30162E-01	3.84738E-01
89.20	1.55683	6.30888E-01	3.85839E-01
89.30	1.55858	6.31613E-01	3.86940E-01
89.40	1.56032	6.32335E-01	3.88043E-01
89.50	1.56207	6.33055E-01	3.89148E-01
89.60	1.56381	6.33773E-01	3.90253E-01
89.70	1.56556	6.34488E-01	3.91360E-01
89.80	1.56730	6.35201E-01	3.92468E-01
89.90	1.56905	6.35912E-01	3.93577E-01
90.00	1.57080	6.36620E-01	3.94688E-01
90.10	1.57254	6.37327E-01	3.95799E-01
90.20	1.57429	6.38030E-01	3.96912E-01
90.30	1.57603	6.38732E-01	3.98026E-01
90.40	1.57778	6.39431E-01	3.99142E-01
90.50	1.57952	6.40128E-01	4.00258E-01
90.60	1.58127	6.40823E-01	4.01376E-01
90.70	1.58301	6.41515E-01	4.02495E-01
90.80	1.58476	6.42205E-01	4.03616E-01
90.90	1.58650	6.42892E-01	4.04737E-01
91.00	1.58825	6.43577E-01	4.05860E-01
91.10	1.58999	6.44260E-01	4.06984E-01
91.20	1.59174	6.44940E-01	4.08109E-01
91.30	1.59348	6.45618E-01	4.09235E-01
91.40	1.59523	6.46294E-01	4.10362E-01
91.50	1.59697	6.46967E-01	4.11491E-01
91.60	1.59872	6.47638E-01	4.12621E-01
91.70	1.60047	6.48306E-01	4.13752E-01
91.80	1.60221	6.48972E-01	4.14884E-01
91.90	1.60396	6.49635E-01	4.16017E-01

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
92.00	1.60570	6.50296E-01	4.17151E-01
92.10	1.60745	6.50954E-01	4.18287E-01
92.20	1.60919	6.51610E-01	4.19424E-01
92.30	1.61094	6.52264E-01	4.20561E-01
92.40	1.61268	6.52915E-01	4.21700E-01
92.50	1.61443	6.53564E-01	4.22840E-01
92.60	1.61617	6.54210E-01	4.23982E-01
92.70	1.61792	6.54853E-01	4.25124E-01
92.80	1.61966	6.55494E-01	4.26268E-01
92.90	1.62141	6.56133E-01	4.27412E-01
93.00	1.62315	6.56769E-01	4.28558E-01
93.10	1.62490	6.57402E-01	4.29705E-01
93.20	1.62665	6.58033E-01	4.30853E-01
93.30	1.62839	6.58662E-01	4.32002E-01
93.40	1.63014	6.59288E-01	4.33152E-01
93.50	1.63188	6.59911E-01	4.34303E-01
93.60	1.63363	6.60532E-01	4.35455E-01
93.70	1.63537	6.61150E-01	4.36609E-01
93.80	1.63712	6.61765E-01	4.37763E-01
93.90	1.63886	6.62378E-01	4.38919E-01
94.00	1.64061	6.62989E-01	4.40075E-01
94.10	1.64235	6.63597E-01	4.41233E-01
94.20	1.64410	6.64202E-01	4.42392E-01
94.30	1.64584	6.64804E-01	4.43551E-01
94.40	1.64759	6.65404E-01	4.44712E-01
94.50	1.64933	6.66002E-01	4.45874E-01
94.60	1.65108	6.66596E-01	4.47037E-01
94.70	1.65283	6.67188E-01	4.48201E-01
94.80	1.65457	6.67778E-01	4.49366E-01
94.90	1.65632	6.68364E-01	4.50532E-01
95.00	1.65806	6.68948E-01	4.51699E-01
95.10	1.65981	6.69530E-01	4.52867E-01
95.20	1.66155	6.70108E-01	4.54036E-01
95.30	1.66330	6.70684E-01	4.55206E-01
95.40	1.66504	6.71258E-01	4.56377E-01
95.50	1.66679	6.71828E-01	4.57549E-01
95.60	1.66853	6.72396E-01	4.58722E-01
95.70	1.67028	6.72961E-01	4.59896E-01
95.80	1.67202	6.73524E-01	4.61071E-01
95.90	1.67377	6.74084E-01	4.62247E-01

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
96.00	1.67551	6.74641E-01	4.63424E-01
96.10	1.67726	6.75195E-01	4.64602E-01
96.20	1.67901	6.75746E-01	4.65781E-01
96.30	1.68075	6.76295E-01	4.66961E-01
96.40	1.68250	6.76841E-01	4.68142E-01
96.50	1.68424	6.77384E-01	4.69324E-01
96.60	1.68599	6.77925E-01	4.70507E-01
96.70	1.68773	6.78463E-01	4.71690E-01
96.80	1.68948	6.78997E-01	4.72875E-01
96.90	1.69122	6.79530E-01	4.74060E-01
97.00	1.69297	6.80059E-01	4.75247E-01
97.10	1.69471	6.80585E-01	4.76434E-01
97.20	1.69646	6.81109E-01	4.77623E-01
97.30	1.69820	6.81630E-01	4.78812E-01
97.40	1.69995	6.82148E-01	4.80002E-01
97.50	1.70169	6.82663E-01	4.81193E-01
97.60	1.70344	6.83175E-01	4.82385E-01
97.70	1.70519	6.83685E-01	4.83578E-01
97.80	1.70693	6.84191E-01	4.84771E-01
97.90	1.70868	6.84695E-01	4.85966E-01
98.00	1.71042	6.85196E-01	4.87161E-01
98.10	1.71217	6.85694E-01	4.88358E-01
98.20	1.71391	6.86189E-01	4.89555E-01
98.30	1.71566	6.86682E-01	4.90753E-01
98.40	1.71740	6.87171E-01	4.91952E-01
98.50	1.71915	6.87657E-01	4.93152E-01
98.60	1.72089	6.88141E-01	4.94352E-01
98.70	1.72264	6.88622E-01	4.95554E-01
98.80	1.72438	6.89099E-01	4.96756E-01
98.90	1.72613	6.89574E-01	4.97959E-01
99.00	1.72787	6.90046E-01	4.99163E-01
99.10	1.72962	6.90515E-01	5.00368E-01
99.20	1.73137	6.90981E-01	5.01573E-01
99.30	1.73311	6.91444E-01	5.02780E-01
99.40	1.73486	6.91904E-01	5.03987E-01
99.50	1.73660	6.92361E-01	5.05195E-01
99.60	1.73835	6.92815E-01	5.06404E-01
99.70	1.74009	6.93267E-01	5.07613E-01
99.80	1.74184	6.93715E-01	5.08824E-01
99.90	1.74358	6.94160E-01	5.10035E-01

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
100.00	1.74533	6.94602E-01	5.11247E-01
100.10	1.74707	6.95041E-01	5.12459E-01
100.20	1.74882	6.95478E-01	5.13673E-01
100.30	1.75056	6.95911E-01	5.14887E-01
100.40	1.75231	6.96341E-01	5.16102E-01
100.50	1.75405	6.96768E-01	5.17318E-01
100.60	1.75580	6.97192E-01	5.18534E-01
100.70	1.75755	6.97614E-01	5.19751E-01
100.80	1.75929	6.98032E-01	5.20969E-01
100.90	1.76104	6.98447E-01	5.22188E-01
101.00	1.76278	6.98859E-01	5.23407E-01
101.10	1.76453	6.99268E-01	5.24628E-01
101.20	1.76627	6.99673E-01	5.25848E-01
101.30	1.76802	7.00076E-01	5.27070E-01
101.40	1.76976	7.00476E-01	5.28292E-01
101.50	1.77151	7.00873E-01	5.29515E-01
101.60	1.77325	7.01266E-01	5.30739E-01
101.70	1.77500	7.01656E-01	5.31963E-01
101.80	1.77674	7.02044E-01	5.33188E-01
101.90	1.77849	7.02428E-01	5.34413E-01
102.00	1.78023	7.02809E-01	5.35640E-01
102.10	1.78198	7.03187E-01	5.36867E-01
102.20	1.78372	7.03562E-01	5.38094E-01
102.30	1.78547	7.03934E-01	5.39323E-01
102.40	1.78722	7.04303E-01	5.40551E-01
102.50	1.78896	7.04668E-01	5.41781E-01
102.60	1.79071	7.05030E-01	5.43011E-01
102.70	1.79245	7.05390E-01	5.44242E-01
102.80	1.79420	7.05746E-01	5.45474E-01
102.90	1.79594	7.06099E-01	5.46706E-01
103.00	1.79769	7.06448E-01	5.47938E-01
103.10	1.79943	7.06795E-01	5.49172E-01
103.20	1.80118	7.07138E-01	5.50405E-01
103.30	1.80292	7.07479E-01	5.51640E-01
103.40	1.80467	7.07816E-01	5.52875E-01
103.50	1.80641	7.08149E-01	5.54111E-01
103.60	1.80816	7.08480E-01	5.55347E-01
103.70	1.80990	7.08808E-01	5.56584E-01
103.80	1.81165	7.09132E-01	5.57821E-01
103.90	1.81340	7.09453E-01	5.59059E-01

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
104.00	1.81514	7.09771E-01	5.60298E-01
104.10	1.81689	7.10085E-01	5.61537E-01
104.20	1.81863	7.10396E-01	5.62776E-01
104.30	1.82038	7.10705E-01	5.64016E-01
104.40	1.82212	7.11009E-01	5.65257E-01
104.50	1.82387	7.11311E-01	5.66498E-01
104.60	1.82561	7.11609E-01	5.67740E-01
104.70	1.82736	7.11905E-01	5.68982E-01
104.80	1.82910	7.12196E-01	5.70225E-01
104.90	1.83085	7.12485E-01	5.71468E-01
105.00	1.83259	7.12770E-01	5.72712E-01
105.10	1.83434	7.13052E-01	5.73956E-01
105.20	1.83608	7.13331E-01	5.75201E-01
105.30	1.83783	7.13607E-01	5.76446E-01
105.40	1.83958	7.13879E-01	5.77692E-01
105.50	1.84132	7.14148E-01	5.78938E-01
105.60	1.84307	7.14413E-01	5.80185E-01
105.70	1.84481	7.14676E-01	5.81432E-01
105.80	1.84656	7.14935E-01	5.82680E-01
105.90	1.84830	7.15190E-01	5.83928E-01
106.00	1.85005	7.15443E-01	5.85176E-01
106.10	1.85179	7.15692E-01	5.86425E-01
106.20	1.85354	7.15938E-01	5.87674E-01
106.30	1.85528	7.16180E-01	5.88924E-01
106.40	1.85703	7.16419E-01	5.90174E-01
106.50	1.85877	7.16655E-01	5.91425E-01
106.60	1.86052	7.16887E-01	5.92676E-01
106.70	1.86226	7.17116E-01	5.93927E-01
106.80	1.86401	7.17342E-01	5.95179E-01
106.90	1.86576	7.17564E-01	5.96431E-01
107.00	1.86750	7.17783E-01	5.97684E-01
107.10	1.86925	7.17999E-01	5.98937E-01
107.20	1.87099	7.18211E-01	6.00190E-01
107.30	1.87274	7.18420E-01	6.01444E-01
107.40	1.87448	7.18625E-01	6.02698E-01
107.50	1.87623	7.18827E-01	6.03952E-01
107.60	1.87797	7.19026E-01	6.05207E-01
107.70	1.87972	7.19221E-01	6.06462E-01
107.80	1.88146	7.19413E-01	6.07718E-01
107.90	1.88321	7.19601E-01	6.08973E-01

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
108.00	1.88495	7.19786E-01	6.10229E-01
108.10	1.88670	7.19968E-01	6.11486E-01
108.20	1.88844	7.20146E-01	6.12743E-01
108.30	1.89019	7.20321E-01	6.14000E-01
108.40	1.89194	7.20492E-01	6.15257E-01
108.50	1.89368	7.20660E-01	6.16515E-01
108.60	1.89543	7.20825E-01	6.17773E-01
108.70	1.89717	7.20986E-01	6.19031E-01
108.80	1.89892	7.21143E-01	6.20289E-01
108.90	1.90066	7.21298E-01	6.21548E-01
109.00	1.90241	7.21448E-01	6.22807E-01
109.10	1.90415	7.21596E-01	6.24066E-01
109.20	1.90590	7.21739E-01	6.25326E-01
109.30	1.90764	7.21880E-01	6.26586E-01
109.40	1.90939	7.22017E-01	6.27846E-01
109.50	1.91113	7.22150E-01	6.29106E-01
109.60	1.91288	7.22280E-01	6.30366E-01
109.70	1.91462	7.22407E-01	6.31627E-01
109.80	1.91637	7.22529E-01	6.32888E-01
109.90	1.91812	7.22649E-01	6.34149E-01
110.00	1.91986	7.22765E-01	6.35411E-01
110.10	1.92161	7.22877E-01	6.36672E-01
110.20	1.92335	7.22987E-01	6.37934E-01
110.30	1.92510	7.23092E-01	6.39196E-01
110.40	1.92684	7.23194E-01	6.40458E-01
110.50	1.92859	7.23293E-01	6.41720E-01
110.60	1.93033	7.23388E-01	6.42983E-01
110.70	1.93208	7.23479E-01	6.44245E-01
110.80	1.93382	7.23567E-01	6.45508E-01
110.90	1.93557	7.23651E-01	6.46771E-01
111.00	1.93731	7.23732E-01	6.48034E-01
111.10	1.93906	7.23810E-01	6.49297E-01
111.20	1.94080	7.23883E-01	6.50561E-01
111.30	1.94255	7.23954E-01	6.51824E-01
111.40	1.94430	7.24021E-01	6.53088E-01
111.50	1.94604	7.24084E-01	6.54352E-01
111.60	1.94779	7.24143E-01	6.55615E-01
111.70	1.94953	7.24200E-01	6.56879E-01
111.80	1.95128	7.24252E-01	6.58143E-01
111.90	1.95302	7.24301E-01	6.59407E-01

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
112.00	1.95477	7.24347E-01	6.60672E-01
112.10	1.95651	7.24388E-01	6.61936E-01
112.20	1.95826	7.24427E-01	6.63200E-01
112.30	1.96000	7.24461E-01	6.64465E-01
112.40	1.96175	7.24493E-01	6.65729E-01
112.50	1.96349	7.24520E-01	6.66994E-01
112.60	1.96524	7.24544E-01	6.68258E-01
112.70	1.96698	7.24565E-01	6.69523E-01
112.80	1.96873	7.24582E-01	6.70787E-01
112.90	1.97048	7.24595E-01	6.72052E-01
113.00	1.97222	7.24604E-01	6.73317E-01
113.10	1.97397	7.24610E-01	6.74581E-01
113.20	1.97571	7.24613E-01	6.75846E-01
113.30	1.97746	7.24612E-01	6.77111E-01
113.40	1.97920	7.24607E-01	6.78375E-01
113.50	1.98095	7.24599E-01	6.79640E-01
113.60	1.98269	7.24587E-01	6.80905E-01
113.70	1.98444	7.24571E-01	6.82169E-01
113.80	1.98616	7.24552E-01	6.83434E-01
113.90	1.98793	7.24529E-01	6.84698E-01
114.00	1.98967	7.24503E-01	6.85963E-01
114.10	1.99142	7.24473E-01	6.87227E-01
114.20	1.99316	7.24439E-01	6.88492E-01
114.30	1.99491	7.24402E-01	6.89756E-01
114.40	1.99665	7.24361E-01	6.91020E-01
114.50	1.99840	7.24316E-01	6.92285E-01
114.60	2.00015	7.24266E-01	6.93549E-01
114.70	2.00189	7.24216E-01	6.94813E-01
114.80	2.00364	7.24161E-01	6.96077E-01
114.90	2.00538	7.24101E-01	6.97341E-01
115.00	2.00713	7.24039E-01	6.98604E-01
115.10	2.00887	7.23972E-01	6.99868E-01
115.20	2.01062	7.23902E-01	7.01132E-01
115.30	2.01236	7.23828E-01	7.02395E-01
115.40	2.01411	7.23751E-01	7.03658E-01
115.50	2.01585	7.23670E-01	7.04921E-01
115.60	2.01760	7.23585E-01	7.06184E-01
115.70	2.01934	7.23497E-01	7.07447E-01
115.80	2.02109	7.23405E-01	7.08710E-01
115.90	2.02283	7.23309E-01	7.09972E-01

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
116.00	2.02458	7.23210E-01	7.11235E-01
116.10	2.02633	7.23106E-01	7.12497E-01
116.20	2.02807	7.23000E-01	7.13759E-01
116.30	2.02982	7.22889E-01	7.15020E-01
116.40	2.03156	7.22775E-01	7.16282E-01
116.50	2.03331	7.22657E-01	7.17543E-01
116.60	2.03505	7.22536E-01	7.18805E-01
116.70	2.03680	7.22411E-01	7.20065E-01
116.80	2.03854	7.22282E-01	7.21326E-01
116.90	2.04029	7.22149E-01	7.22587E-01
117.00	2.04203	7.22013E-01	7.23847E-01
117.10	2.04378	7.21873E-01	7.25107E-01
117.20	2.04552	7.21729E-01	7.26367E-01
117.30	2.04727	7.21582E-01	7.27626E-01
117.40	2.04901	7.21431E-01	7.28886E-01
117.50	2.05076	7.21276E-01	7.30145E-01
117.60	2.05251	7.21118E-01	7.31403E-01
117.70	2.05425	7.20956E-01	7.32662E-01
117.80	2.05600	7.20790E-01	7.33920E-01
117.90	2.05774	7.20620E-01	7.35178E-01
118.00	2.05949	7.20447E-01	7.36435E-01
118.10	2.06123	7.20270E-01	7.37693E-01
118.20	2.06298	7.20089E-01	7.38950E-01
118.30	2.06472	7.19905E-01	7.40206E-01
118.40	2.06647	7.19717E-01	7.41463E-01
118.50	2.06821	7.19525E-01	7.42718E-01
118.60	2.06996	7.19329E-01	7.43974E-01
118.70	2.07170	7.19130E-01	7.45229E-01
118.80	2.07345	7.18927E-01	7.46484E-01
118.90	2.07519	7.18720E-01	7.47739E-01
119.00	2.07694	7.18510E-01	7.48993E-01
119.10	2.07869	7.18295E-01	7.50247E-01
119.20	2.08043	7.18077E-01	7.51500E-01
119.30	2.08218	7.17856E-01	7.52754E-01
119.40	2.08392	7.17630E-01	7.54006E-01
119.50	2.08567	7.17401E-01	7.55259E-01
119.60	2.08741	7.17168E-01	7.56510E-01
119.70	2.08916	7.16932E-01	7.57762E-01
119.80	2.09090	7.16691E-01	7.59013E-01
119.90	2.09265	7.16447E-01	7.60264E-01

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
120.00	2.09439	7.16199E-01	7.61514E-01
120.10	2.09614	7.15948E-01	7.62764E-01
120.20	2.09788	7.15692E-01	7.64013E-01
120.30	2.09963	7.15433E-01	7.65262E-01
120.40	2.10137	7.15171E-01	7.66510E-01
120.50	2.10312	7.14904E-01	7.67758E-01
120.60	2.10487	7.14634E-01	7.69006E-01
120.70	2.10661	7.14360E-01	7.70253E-01
120.80	2.10836	7.14082E-01	7.71499E-01
120.90	2.11010	7.13800E-01	7.72745E-01
121.00	2.11185	7.13515E-01	7.73991E-01
121.10	2.11359	7.13226E-01	7.75236E-01
121.20	2.11534	7.12933E-01	7.76481E-01
121.30	2.11708	7.12637E-01	7.77725E-01
121.40	2.11883	7.12336E-01	7.78968E-01
121.50	2.12057	7.12032E-01	7.80211E-01
121.60	2.12232	7.11724E-01	7.81454E-01
121.70	2.12406	7.11413E-01	7.82696E-01
121.80	2.12581	7.11098E-01	7.83937E-01
121.90	2.12755	7.10778E-01	7.85178E-01
122.00	2.12930	7.10456E-01	7.86418E-01
122.10	2.13105	7.10129E-01	7.87658E-01
122.20	2.13279	7.09799E-01	7.88897E-01
122.30	2.13454	7.09465E-01	7.90135E-01
122.40	2.13628	7.09127E-01	7.91373E-01
122.50	2.13803	7.08785E-01	7.92611E-01
122.60	2.13977	7.08440E-01	7.93847E-01
122.70	2.14152	7.08090E-01	7.95084E-01
122.80	2.14326	7.07738E-01	7.96319E-01
122.90	2.14501	7.07381E-01	7.97554E-01
123.00	2.14675	7.07020E-01	7.98788E-01
123.10	2.14850	7.06656E-01	8.00022E-01
123.20	2.15024	7.06288E-01	8.01255E-01
123.30	2.15199	7.05917E-01	8.02487E-01
123.40	2.15373	7.05541E-01	8.03719E-01
123.50	2.15548	7.05162E-01	8.04950E-01
123.60	2.15723	7.04779E-01	8.06181E-01
123.70	2.15897	7.04392E-01	8.07410E-01
123.80	2.16072	7.04001E-01	8.08639E-01
123.90	2.16246	7.03607E-01	8.09868E-01

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
124.00	2.16421	7.03209E-01	8.11096E-01
124.10	2.16595	7.02807E-01	8.12322E-01
124.20	2.16770	7.02402E-01	8.13549E-01
124.30	2.16944	7.01992E-01	8.14774E-01
124.40	2.17119	7.01579E-01	8.15999E-01
124.50	2.17293	7.01162E-01	8.17223E-01
124.60	2.17468	7.00742E-01	8.18447E-01
124.70	2.17642	7.00317E-01	8.19669E-01
124.80	2.17817	6.99889E-01	8.20891E-01
124.90	2.17991	6.99457E-01	8.22112E-01
125.00	2.18166	6.99021E-01	8.23333E-01
125.10	2.18341	6.98582E-01	8.24552E-01
125.20	2.18515	6.98139E-01	8.25771E-01
125.30	2.18690	6.97692E-01	8.26989E-01
125.40	2.18864	6.97241E-01	8.28207E-01
125.50	2.19039	6.96786E-01	8.29423E-01
125.60	2.19213	6.96328E-01	8.30639E-01
125.70	2.19388	6.95866E-01	8.31854E-01
125.80	2.19562	6.95400E-01	8.33068E-01
125.90	2.19737	6.94931E-01	8.34281E-01
126.00	2.19911	6.94458E-01	8.35494E-01
126.10	2.20086	6.93980E-01	8.36705E-01
126.20	2.20260	6.93500E-01	8.37916E-01
126.30	2.20435	6.93015E-01	8.39126E-01
126.40	2.20609	6.92527E-01	8.40335E-01
126.50	2.20784	6.92035E-01	8.41544E-01
126.60	2.20958	6.91539E-01	8.42751E-01
126.70	2.21133	6.91039E-01	8.43957E-01
126.80	2.21308	6.90536E-01	8.45163E-01
126.90	2.21482	6.90029E-01	8.46368E-01
127.00	2.21657	6.89518E-01	8.47572E-01
127.10	2.21831	6.89003E-01	8.48775E-01
127.20	2.22006	6.88485E-01	8.49977E-01
127.30	2.22180	6.87963E-01	8.51178E-01
127.40	2.22355	6.87437E-01	8.52378E-01
127.50	2.22529	6.86907E-01	8.53578E-01
127.60	2.22704	6.86374E-01	8.54776E-01
127.70	2.22878	6.85837E-01	8.55973E-01
127.80	2.23053	6.85296E-01	8.57170E-01
127.90	2.23227	6.84752E-01	8.58366E-01

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
128.00	2.23402	6.84203E-01	8.59560E-01
128.10	2.23576	6.83651E-01	8.60754E-01
128.20	2.23751	6.83096E-01	8.61947E-01
128.30	2.23926	6.82536E-01	8.63138E-01
128.40	2.24100	6.81973E-01	8.64329E-01
128.50	2.24275	6.81406E-01	8.65519E-01
128.60	2.24449	6.80835E-01	8.66708E-01
128.70	2.24624	6.80261E-01	8.67895E-01
128.80	2.24798	6.79682E-01	8.69082E-01
128.90	2.24973	6.79100E-01	8.70268E-01
129.00	2.25147	6.78515E-01	8.71453E-01
129.10	2.25322	6.77925E-01	8.72636E-01
129.20	2.25496	6.77332E-01	8.73819E-01
129.30	2.25671	6.76736E-01	8.75001E-01
129.40	2.25845	6.76135E-01	8.76181E-01
129.50	2.26020	6.75531E-01	8.77361E-01
129.60	2.26194	6.74923E-01	8.78539E-01
129.70	2.26369	6.74311E-01	8.79717E-01
129.80	2.26544	6.73696E-01	8.80893E-01
129.90	2.26718	6.73076E-01	8.82069E-01
130.00	2.26893	6.72454E-01	8.83243E-01
130.10	2.27067	6.71827E-01	8.84416E-01
130.20	2.27242	6.71197E-01	8.85588E-01
130.30	2.27416	6.70563E-01	8.86759E-01
130.40	2.27591	6.69925E-01	8.87929E-01
130.50	2.27765	6.69284E-01	8.89097E-01
130.60	2.27940	6.68639E-01	8.90265E-01
130.70	2.28114	6.67990E-01	8.91431E-01
130.80	2.28289	6.67337E-01	8.92596E-01
130.90	2.28463	6.66681E-01	8.93761E-01
131.00	2.28638	6.66021E-01	8.94924E-01
131.10	2.28812	6.65358E-01	8.96085E-01
131.20	2.28987	6.64690E-01	8.97246E-01
131.30	2.29162	6.64019E-01	8.98406E-01
131.40	2.29336	6.63345E-01	8.99564E-01
131.50	2.29511	6.62667E-01	9.00721E-01
131.60	2.29685	6.61985E-01	9.01877E-01
131.70	2.29860	6.61299E-01	9.03032E-01
131.80	2.30034	6.60609E-01	9.04186E-01
131.90	2.30209	6.59916E-01	9.05338E-01

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
132.00	2.30383	6.59220E-01	9.06489E-01
132.10	2.30558	6.58519E-01	9.07639E-01
132.20	2.30732	6.57815E-01	9.08788E-01
132.30	2.30907	6.57108E-01	9.09935E-01
132.40	2.31081	6.56396E-01	9.11081E-01
132.50	2.31256	6.55681E-01	9.12226E-01
132.60	2.31430	6.54962E-01	9.13370E-01
132.70	2.31605	6.54240E-01	9.14513E-01
132.80	2.31780	6.53514E-01	9.15654E-01
132.90	2.31954	6.52784E-01	9.16794E-01
133.00	2.32129	6.52051E-01	9.17933E-01
133.10	2.32303	6.51314E-01	9.19070E-01
133.20	2.32478	6.50574E-01	9.20206E-01
133.30	2.32652	6.49829E-01	9.21341E-01
133.40	2.32827	6.49081E-01	9.22474E-01
133.50	2.33001	6.48330E-01	9.23607E-01
133.60	2.33176	6.47575E-01	9.24738E-01
133.70	2.33350	6.46816E-01	9.25867E-01
133.80	2.33525	6.46054E-01	9.26995E-01
133.90	2.33699	6.45288E-01	9.28122E-01
134.00	2.33874	6.44518E-01	9.29248E-01
134.10	2.34048	6.43745E-01	9.30372E-01
134.20	2.34223	6.42968E-01	9.31495E-01
134.30	2.34398	6.42187E-01	9.32616E-01
134.40	2.34572	6.41403E-01	9.33737E-01
134.50	2.34747	6.40615E-01	9.34855E-01
134.60	2.34921	6.39824E-01	9.35973E-01
134.70	2.35096	6.39029E-01	9.37089E-01
134.80	2.35270	6.38231E-01	9.38203E-01
134.90	2.35445	6.37429E-01	9.39317E-01
135.00	2.35619	6.36623E-01	9.40428E-01
135.10	2.35794	6.35814E-01	9.41539E-01
135.20	2.35968	6.35001E-01	9.42648E-01
135.30	2.36143	6.34184E-01	9.43755E-01
135.40	2.36317	6.33364E-01	9.44862E-01
135.50	2.36492	6.32541E-01	9.45966E-01
135.60	2.36666	6.31713E-01	9.47069E-01
135.70	2.36841	6.30883E-01	9.48171E-01
135.80	2.37016	6.30048E-01	9.49272E-01
135.90	2.37190	6.29210E-01	9.50371E-01

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
136.00	2.37365	6.28369E-01	9.51468E-01
136.10	2.37539	6.27524E-01	9.52564E-01
136.20	2.37714	6.26675E-01	9.53658E-01
136.30	2.37888	6.25823E-01	9.54752E-01
136.40	2.38063	6.24968E-01	9.55843E-01
136.50	2.38237	6.24108E-01	9.56933E-01
136.60	2.38412	6.23246E-01	9.58022E-01
136.70	2.38586	6.22379E-01	9.59109E-01
136.80	2.38761	6.21510E-01	9.60194E-01
136.90	2.38935	6.20636E-01	9.61278E-01
137.00	2.39110	6.19759E-01	9.62361E-01
137.10	2.39284	6.18879E-01	9.63441E-01
137.20	2.39459	6.17995E-01	9.64521E-01
137.30	2.39634	6.17108E-01	9.65599E-01
137.40	2.39808	6.16217E-01	9.66675E-01
137.50	2.39983	6.15322E-01	9.67750E-01
137.60	2.40157	6.14424E-01	9.68823E-01
137.70	2.40332	6.13523E-01	9.69894E-01
137.80	2.40506	6.12618E-01	9.70964E-01
137.90	2.40681	6.11710E-01	9.72033E-01
138.00	2.40855	6.10798E-01	9.73100E-01
138.10	2.41030	6.09882E-01	9.74165E-01
138.20	2.41204	6.08964E-01	9.75229E-01
138.30	2.41379	6.08041E-01	9.76291E-01
138.40	2.41553	6.07115E-01	9.77351E-01
138.50	2.41728	6.06186E-01	9.78410E-01
138.60	2.41902	6.05253E-01	9.79467E-01
138.70	2.42077	6.04317E-01	9.80523E-01
138.80	2.42251	6.03378E-01	9.81576E-01
138.90	2.42426	6.02435E-01	9.82629E-01
139.00	2.42601	6.01488E-01	9.83679E-01
139.10	2.42775	6.00538E-01	9.84728E-01
139.20	2.42950	5.99585E-01	9.85776E-01
139.30	2.43124	5.98628E-01	9.86821E-01
139.40	2.43299	5.97668E-01	9.87865E-01
139.50	2.43473	5.96704E-01	9.88907E-01
139.60	2.43648	5.95737E-01	9.89948E-01
139.70	2.43822	5.94766E-01	9.90987E-01
139.80	2.43997	5.93792E-01	9.92024E-01
139.90	2.44171	5.92815E-01	9.93060E-01

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
140.00	2.44346	5.91834E-01	9.94094E-01
140.10	2.44520	5.90850E-01	9.95126E-01
140.20	2.44695	5.89863E-01	9.96156E-01
140.30	2.44869	5.88872E-01	9.97185E-01
140.40	2.45044	5.87877E-01	9.98212E-01
140.50	2.45219	5.86880E-01	9.99237E-01
140.60	2.45393	5.85879E-01	1.000 6E 00
140.70	2.45568	5.84874E-01	1.00128E 00
140.80	2.45742	5.83867E-01	1.00230E 00
140.90	2.45917	5.82855E-01	1.00332E 00
141.00	2.46091	5.81841E-01	1.00434E 00
141.10	2.46266	5.80823E-01	1.00535E 00
141.20	2.46440	5.79802E-01	1.00636E 00
141.30	2.46615	5.78777E-01	1.00737E 00
141.40	2.46789	5.77749E-01	1.00838E 00
141.50	2.46964	5.76718E-01	1.00939E 00
141.60	2.47138	5.75684E-01	1.01040E 00
141.70	2.47313	5.74646E-01	1.01140E 00
141.80	2.47487	5.73605E-01	1.01240E 00
141.90	2.47662	5.72560E-01	1.01340E 00
142.00	2.47837	5.71512E-01	1.01440E 00
142.10	2.48011	5.70461E-01	1.01540E 00
142.20	2.48186	5.69407E-01	1.01639E 00
142.30	2.48360	5.68349E-01	1.01739E 00
142.40	2.48535	5.67288E-01	1.01838E 00
142.50	2.48709	5.66224E-01	1.01937E 00
142.60	2.48884	5.65157E-01	1.02035E 00
142.70	2.49058	5.64086E-01	1.02134E 00
142.80	2.49233	5.63012E-01	1.02232E 00
142.90	2.49407	5.61934E-01	1.02330E 00
143.00	2.49582	5.60854E-01	1.02428E 00
143.10	2.49756	5.59770E-01	1.02526E 00
143.20	2.49931	5.58683E-01	1.02624E 00
143.30	2.50105	5.57593E-01	1.02721E 00
143.40	2.50280	5.56499E-01	1.02818E 00
143.50	2.50455	5.55402E-01	1.02915E 00
143.60	2.50629	5.54303E-01	1.030 2E 00
143.70	2.50804	5.53199E-01	1.03109E 00
143.80	2.50978	5.52093E-01	1.03205E 00
143.90	2.51153	5.50983E-01	1.03302E 00

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
144.00	2.51327	5.49870E-01	1.03398E 00
144.10	2.51502	5.48754E-01	1.03494E 00
144.20	2.51676	5.47635E-01	1.03589E 00
144.30	2.51851	5.46513E-01	1.03685E 00
144.40	2.52025	5.45387E-01	1.03780E 00
144.50	2.52200	5.44259E-01	1.03875E 00
144.60	2.52374	5.43127E-01	1.03970E 00
144.70	2.52549	5.41992E-01	1.04065E 00
144.80	2.52723	5.40853E-01	1.04159E 00
144.90	2.52898	5.39712E-01	1.04254E 00
145.00	2.53073	5.38568E-01	1.04348E 00
145.10	2.53247	5.37420E-01	1.04442E 00
145.20	2.53422	5.36269E-01	1.04535E 00
145.30	2.53596	5.35115E-01	1.04629E 00
145.40	2.53771	5.33958E-01	1.04722E 00
145.50	2.53945	5.32798E-01	1.04815E 00
145.60	2.54120	5.31635E-01	1.04908E 00
145.70	2.54294	5.30469E-01	1.05001E 00
145.80	2.54469	5.29299E-01	1.05093E 00
145.90	2.54643	5.28127E-01	1.05185E 00
146.00	2.54818	5.26951E-01	1.05277E 00
146.10	2.54992	5.25772E-01	1.05369E 00
146.20	2.55167	5.24590E-01	1.05461E 00
146.30	2.55341	5.23406E-01	1.05552E 00
146.40	2.55516	5.22218E-01	1.056 4E 00
146.50	2.55691	5.21027E-01	1.05735E 00
146.60	2.55865	5.19833E-01	1.05826E 00
146.70	2.56040	5.18636E-01	1.05916E 00
146.80	2.56214	5.17436E-01	1.06007E 00
146.90	2.56389	5.16233E-01	1.06097E 00
147.00	2.56563	5.15026E-01	1.06187E 00
147.10	2.56738	5.13817E-01	1.06277E 00
147.20	2.56912	5.12605E-01	1.06366E 00
147.30	2.57087	5.11390E-01	1.06456E 00
147.40	2.57261	5.10172E-01	1.065 5E 00
147.50	2.57436	5.08951E-01	1.06634E 00
147.60	2.57610	5.07726E-01	1.06722E 00
147.70	2.57785	5.06499E-01	1.06811E 00
147.80	2.57959	5.05269E-01	1.06899E 00
147.90	2.58134	5.04036E-01	1.069 7E 00

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
148.00	2.58309	5.02800E-01	1.07075E 00
148.10	2.58483	5.01561E-01	1.07163E 00
148.20	2.58658	5.00319E-01	1.07250E 00
148.30	2.58832	4.99075E-01	1.07337E 00
148.40	2.59007	4.97827E-01	1.07424E 00
148.50	2.59181	4.96576E-01	1.07511E 00
148.60	2.59356	4.95322E-01	1.07598E 00
148.70	2.59530	4.94066E-01	1.07684E 00
148.80	2.59705	4.92806E-01	1.07770E 00
148.90	2.59879	4.91544E-01	1.07856E 00
149.00	2.60054	4.90279E-01	1.07942E 00
149.10	2.60228	4.89011E-01	1.08027E 00
149.20	2.60403	4.87740E-01	1.08112E 00
149.30	2.60577	4.86466E-01	1.08197E 00
149.40	2.60752	4.85189E-01	1.08282E 00
149.50	2.60927	4.83910E-01	1.08367E 00
149.60	2.61101	4.82627E-01	1.08451E 00
149.70	2.61276	4.81342E-01	1.08535E 00
149.80	2.61450	4.80054E-01	1.08619E 00
149.90	2.61625	4.78763E-01	1.08703E 00
150.00	2.61799	4.77469E-01	1.08786E 00
150.10	2.61974	4.76172E-01	1.08870E 00
150.20	2.62148	4.74873E-01	1.08953E 00
150.30	2.62323	4.73571E-01	1.09035E 00
150.40	2.62497	4.72266E-01	1.09118E 00
150.50	2.62672	4.70958E-01	1.09200E 00
150.60	2.62846	4.69647E-01	1.09282E 00
150.70	2.63021	4.68334E-01	1.09364E 00
150.80	2.63195	4.67018E-01	1.09446E 00
150.90	2.63370	4.65699E-01	1.09527E 00
151.00	2.63544	4.64377E-01	1.09608E 00
151.10	2.63719	4.63053E-01	1.09689E 00
151.20	2.63894	4.61726E-01	1.09770E 00
151.30	2.64068	4.60396E-01	1.09850E 00
151.40	2.64243	4.59063E-01	1.09931E 00
151.50	2.64417	4.57728E-01	1.100 1E 00
151.60	2.64592	4.56390E-01	1.10090E 00
151.70	2.64766	4.55049E-01	1.10170E 00
151.80	2.64941	4.53706E-01	1.10249E 00
151.90	2.65115	4.52360E-01	1.10328E 00

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
152.00	2.65290	4.51011E-01	1.10407E 00
152.10	2.65464	4.49660E-01	1.10486E 00
152.20	2.65639	4.48306E-01	1.10564E 00
152.30	2.65813	4.46949E-01	1.106 2E 00
152.40	2.65988	4.45589E-01	1.10720E 00
152.50	2.66162	4.44227E-01	1.10798E 00
152.60	2.66337	4.42863E-01	1.10875E 00
152.70	2.66512	4.41495E-01	1.10952E 00
152.80	2.66686	4.40125E-01	1.11029E 00
152.90	2.66861	4.38753E-01	1.11106E 00
153.00	2.67035	4.37378E-01	1.11182E 00
153.10	2.67210	4.36000E-01	1.11259E 00
153.20	2.67384	4.34620E-01	1.11335E 00
153.30	2.67559	4.33237E-01	1.11410E 00
153.40	2.67733	4.31851E-01	1.11486E 00
153.50	2.67908	4.30463E-01	1.11561E 00
153.60	2.68082	4.29072E-01	1.11636E 00
153.70	2.68257	4.27679E-01	1.11711E 00
153.80	2.68431	4.26284E-01	1.11785E 00
153.90	2.68606	4.24885E-01	1.11860E 00
154.00	2.68780	4.23485E-01	1.11934E 00
154.10	2.68955	4.22081E-01	1.12008E 00
154.20	2.69130	4.20675E-01	1.12081E 00
154.30	2.69304	4.19267E-01	1.12154E 00
154.40	2.69479	4.17856E-01	1.12227E 00
154.50	2.69653	4.16443E-01	1.12300E 00
154.60	2.69828	4.15027E-01	1.12373E 00
154.70	2.70002	4.13609E-01	1.12445E 00
154.80	2.70177	4.12188E-01	1.12517E 00
154.90	2.70351	4.10765E-01	1.12589E 00
155.00	2.70526	4.09340E-01	1.12661E 00
155.10	2.70700	4.07912E-01	1.12732E 00
155.20	2.70875	4.06481E-01	1.12803E 00
155.30	2.71049	4.05048E-01	1.12874E 00
155.40	2.71224	4.03613E-01	1.12944E 00
155.50	2.71398	4.02175E-01	1.13015E 00
155.60	2.71573	4.00735E-01	1.13085E 00
155.70	2.71748	3.99292E-01	1.13155E 00
155.80	2.71922	3.97848E-01	1.13224E 00
155.90	2.72097	3.96400E-01	1.13293E 00

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
156.00	2.72271	3.94951E-01	1.13362E 00
156.10	2.72446	3.93499E-01	1.13431E 00
156.20	2.72620	3.92044E-01	1.13500E 00
156.30	2.72795	3.90588E-01	1.13568E 00
156.40	2.72969	3.89129E-01	1.13636E 00
156.50	2.73144	3.87667E-01	1.13704E 00
156.60	2.73318	3.86204E-01	1.13771E 00
156.70	2.73493	3.84738E-01	1.13839E 00
156.80	2.73667	3.83269E-01	1.13906E 00
156.90	2.73842	3.81799E-01	1.13973E 00
157.00	2.74016	3.80326E-01	1.14039E 00
157.10	2.74191	3.78851E-01	1.14105E 00
157.20	2.74366	3.77373E-01	1.14171E 00
157.30	2.74540	3.75894E-01	1.14237E 00
157.40	2.74715	3.74412E-01	1.14302E 00
157.50	2.74889	3.72928E-01	1.14368E 00
157.60	2.75064	3.71441E-01	1.14433E 00
157.70	2.75238	3.69953E-01	1.14497E 00
157.80	2.75413	3.68462E-01	1.14562E 00
157.90	2.75587	3.66969E-01	1.14626E 00
158.00	2.75762	3.65474E-01	1.14690E 00
158.10	2.75936	3.63976E-01	1.14754E 00
158.20	2.76111	3.62477E-01	1.14817E 00
158.30	2.76285	3.60975E-01	1.14880E 00
158.40	2.76460	3.59471E-01	1.14943E 00
158.50	2.76634	3.57965E-01	1.15006E 00
158.60	2.76809	3.56457E-01	1.15068E 00
158.70	2.76984	3.54946E-01	1.15130E 00
158.80	2.77158	3.53434E-01	1.15192E 00
158.90	2.77333	3.51919E-01	1.15253E 00
159.00	2.77507	3.50403E-01	1.15315E 00
159.10	2.77682	3.48884E-01	1.15376E 00
159.20	2.77856	3.47363E-01	1.15436E 00
159.30	2.78031	3.45840E-01	1.15497E 00
159.40	2.78205	3.44315E-01	1.15557E 00
159.50	2.78380	3.42788E-01	1.15617E 00
159.60	2.78554	3.41258E-01	1.15677E 00
159.70	2.78729	3.39727E-01	1.15736E 00
159.80	2.78903	3.38194E-01	1.15795E 00
159.90	2.79078	3.36659E-01	1.15854E 00

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
160.00	2.79252	3.35121E-01	1.15913E 00
160.10	2.79427	3.33582E-01	1.15971E 00
160.20	2.79602	3.32041E-01	1.16029E 00
160.30	2.79776	3.30497E-01	1.16087E 00
160.40	2.79951	3.28952E-01	1.16145E 00
160.50	2.80125	3.27405E-01	1.16202E 00
160.60	2.80300	3.25855E-01	1.16259E 00
160.70	2.80474	3.24304E-01	1.16316E 00
160.80	2.80649	3.22751E-01	1.16372E 00
160.90	2.80823	3.21196E-01	1.16428E 00
161.00	2.80998	3.19639E-01	1.16484E 00
161.10	2.81172	3.18080E-01	1.16540E 00
161.20	2.81347	3.16519E-01	1.16595E 00
161.30	2.81521	3.14956E-01	1.16650E 00
161.40	2.81696	3.13391E-01	1.16705E 00
161.50	2.81870	3.11825E-01	1.16760E 00
161.60	2.82045	3.10256E-01	1.16814E 00
161.70	2.82220	3.08686E-01	1.16868E 00
161.80	2.82394	3.07114E-01	1.16922E 00
161.90	2.82569	3.05540E-01	1.16975E 00
162.00	2.82743	3.03964E-01	1.17029E 00
162.10	2.82918	3.02386E-01	1.17081E 00
162.20	2.83092	3.00806E-01	1.17134E 00
162.30	2.83267	2.99225E-01	1.17186E 00
162.40	2.83441	2.97642E-01	1.17239E 00
162.50	2.83616	2.96057E-01	1.17290E 00
162.60	2.83790	2.94470E-01	1.17342E 00
162.70	2.83965	2.92882E-01	1.17393E 00
162.80	2.84139	2.91291E-01	1.17444E 00
162.90	2.84314	2.89699E-01	1.17495E 00
163.00	2.84488	2.88106E-01	1.17545E 00
163.10	2.84663	2.86510E-01	1.17595E 00
163.20	2.84837	2.84913E-01	1.17645E 00
163.30	2.85012	2.83314E-01	1.17695E 00
163.40	2.85187	2.81713E-01	1.17744E 00
163.50	2.85361	2.80111E-01	1.17793E 00
163.60	2.85536	2.78507E-01	1.17842E 00
163.70	2.85710	2.76901E-01	1.17890E 00
163.80	2.85885	2.75293E-01	1.17939E 00
163.90	2.86059	2.73684E-01	1.17987E 00

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
164.00	2.86234	2.72074E-01	1.18034E 00
164.10	2.86408	2.70461E-01	1.18081E 00
164.20	2.86583	2.68847E-01	1.18129E 00
164.30	2.86757	2.67232E-01	1.18175E 00
164.40	2.86932	2.65614E-01	1.18222E 00
164.50	2.87106	2.63996E-01	1.18268E 00
164.60	2.87281	2.62375E-01	1.18314E 00
164.70	2.87455	2.60753E-01	1.18360E 00
164.80	2.87630	2.59129E-01	1.18405E 00
164.90	2.87805	2.57504E-01	1.18450E 00
165.00	2.87979	2.55877E-01	1.18495E 00
165.10	2.88154	2.54249E-01	1.18539E 00
165.20	2.88328	2.52619E-01	1.18584E 00
165.30	2.88503	2.50988E-01	1.18628E 00
165.40	2.88677	2.49355E-01	1.18671E 00
165.50	2.88852	2.47721E-01	1.18715E 00
165.60	2.89026	2.46085E-01	1.18758E 00
165.70	2.89201	2.44448E-01	1.18801E 00
165.80	2.89375	2.42809E-01	1.18843E 00
165.90	2.89550	2.41168E-01	1.18885E 00
166.00	2.89724	2.39527E-01	1.18927E 00
166.10	2.89899	2.37883E-01	1.18969E 00
166.20	2.90073	2.36239E-01	1.190 0E 00
166.30	2.90248	2.34593E-01	1.19051E 00
166.40	2.90423	2.32945E-01	1.19092E 00
166.50	2.90597	2.31296E-01	1.19133E 00
166.60	2.90772	2.29646E-01	1.19173E 00
166.70	2.90946	2.27994E-01	1.19213E 00
166.80	2.91121	2.26341E-01	1.19252E 00
166.90	2.91295	2.24687E-01	1.19292E 00
167.00	2.91470	2.23031E-01	1.19331E 00
167.10	2.91644	2.21374E-01	1.193 0E 00
167.20	2.91819	2.19715E-01	1.19408E 00
167.30	2.91993	2.18055E-01	1.19446E 00
167.40	2.92168	2.16394E-01	1.19484E 00
167.50	2.92342	2.14732E-01	1.19522E 00
167.60	2.92517	2.13068E-01	1.19559E 00
167.70	2.92691	2.11403E-01	1.19596E 00
167.80	2.92866	2.09737E-01	1.19633E 00
167.90	2.93041	2.08069E-01	1.19669E 00

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
168.00	2.93215	2.06400E-01	1.19706E 00
168.10	2.93390	2.04730E-01	1.19742E 00
168.20	2.93564	2.03058E-01	1.19777E 00
168.30	2.93739	2.01386E-01	1.19812E 00
168.40	2.93913	1.99712E-01	1.19847E 00
168.50	2.94088	1.98037E-01	1.19882E 00
168.60	2.94262	1.96361E-01	1.19917E 00
168.70	2.94437	1.94683E-01	1.19951E 00
168.80	2.94611	1.93005E-01	1.19985E 00
168.90	2.94786	1.91325E-01	1.200 8E 00
169.00	2.94960	1.89644E-01	1.20051E 00
169.10	2.95135	1.87962E-01	1.200 4E 00
169.20	2.95309	1.86279E-01	1.20117E 00
169.30	2.95484	1.84594E-01	1.20149E 00
169.40	2.95659	1.82909E-01	1.20181E 00
169.50	2.95833	1.81222E-01	1.20213E 00
169.60	2.96008	1.79535E-01	1.20245E 00
169.70	2.96182	1.77846E-01	1.20276E 00
169.80	2.96357	1.76156E-01	1.20307E 00
169.90	2.96531	1.74465E-01	1.20337E 00
170.00	2.96706	1.72773E-01	1.20368E 00
170.10	2.96880	1.71080E-01	1.20398E 00
170.20	2.97055	1.69386E-01	1.20427E 00
170.30	2.97229	1.67691E-01	1.20457E 00
170.40	2.97404	1.65995E-01	1.20486E 00
170.50	2.97578	1.64297E-01	1.20515E 00
170.60	2.97753	1.62599E-01	1.20543E 00
170.70	2.97927	1.60900E-01	1.20571E 00
170.80	2.98102	1.59200E-01	1.20599E 00
170.90	2.98277	1.57499E-01	1.20627E 00
171.00	2.98451	1.55797E-01	1.20654E 00
171.10	2.98626	1.54094E-01	1.20681E 00
171.20	2.98800	1.52390E-01	1.20708E 00
171.30	2.98975	1.50685E-01	1.20735E 00
171.40	2.99149	1.48980E-01	1.20761E 00
171.50	2.99324	1.47273E-01	1.20787E 00
171.60	2.99498	1.45565E-01	1.20812E 00
171.70	2.99673	1.43857E-01	1.20837E 00
171.80	2.99847	1.42148E-01	1.20862E 00
171.90	3.00022	1.40437E-01	1.20887E 00

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
172.00	3.00196	1.38726E-01	1.20911E 00
172.10	3.00371	1.37015E-01	1.20935E 00
172.20	3.00545	1.35302E-01	1.20959E 00
172.30	3.00720	1.33588E-01	1.20983E 00
172.40	3.00895	1.31874E-01	1.21006E 00
172.50	3.01069	1.30159E-01	1.21029E 00
172.60	3.01244	1.28443E-01	1.21051E 00
172.70	3.01418	1.26726E-01	1.21074E 00
172.80	3.01593	1.25009E-01	1.21095E 00
172.90	3.01767	1.23291E-01	1.21117E 00
173.00	3.01942	1.21572E-01	1.21139E 00
173.10	3.02116	1.19852E-01	1.21160E 00
173.20	3.02291	1.18131E-01	1.21180E 00
173.30	3.02465	1.16410E-01	1.21201E 00
173.40	3.02640	1.14688E-01	1.21221E 00
173.50	3.02814	1.12966E-01	1.21241E 00
173.60	3.02989	1.11242E-01	1.21260E 00
173.70	3.03163	1.09518E-01	1.21280E 00
173.80	3.03338	1.07794E-01	1.21299E 00
173.90	3.03513	1.06069E-01	1.21317E 00
174.00	3.03687	1.04343E-01	1.21336E 00
174.10	3.03862	1.02616E-01	1.21354E 00
174.20	3.04036	1.00889E-01	1.21372E 00
174.30	3.04211	9.91612E-02	1.21389E 00
174.40	3.04385	9.74328E-02	1.21406E 00
174.50	3.04560	9.57038E-02	1.21423E 00
174.60	3.04734	9.39743E-02	1.21440E 00
174.70	3.04909	9.22441E-02	1.21456E 00
174.80	3.05083	9.05134E-02	1.21472E 00
174.90	3.05258	8.87822E-02	1.21487E 00
175.00	3.05432	8.70504E-02	1.21503E 00
175.10	3.05607	8.53180E-02	1.21518E 00
175.20	3.05781	8.35852E-02	1.21532E 00
175.30	3.05956	8.18519E-02	1.21547E 00
175.40	3.06130	8.01180E-02	1.21561E 00
175.50	3.06305	7.83837E-02	1.21575E 00
175.60	3.06480	7.66489E-02	1.21588E 00
175.70	3.06654	7.49136E-02	1.21602E 00
175.80	3.06829	7.31779E-02	1.21615E 00
175.90	3.07003	7.14417E-02	1.21627E 00

ANGLE DEGREES	RADIANS	FUNCTIONAL VALUE	INTEGRAL FROM ORIGIN
176.00	3.07178	6.97051E-02	1.21640E 00
176.10	3.07352	6.79680E-02	1.21652E 00
176.20	3.07527	6.62306E-02	1.21663E 00
176.30	3.07701	6.44927E-02	1.21675E 00
176.40	3.07876	6.27545E-02	1.21686E 00
176.50	3.08050	6.10158E-02	1.21697E 00
176.60	3.08225	5.92768E-02	1.21707E 00
176.70	3.08399	5.75375E-02	1.21717E 00
176.80	3.08574	5.57977E-02	1.21727E 00
176.90	3.08748	5.40577E-02	1.21737E 00
177.00	3.08923	5.23173E-02	1.21746E 00
177.10	3.09098	5.05766E-02	1.21755E 00
177.20	3.09272	4.88356E-02	1.21764E 00
177.30	3.09447	4.70943E-02	1.21772E 00
177.40	3.09621	4.53527E-02	1.21780E 00
177.50	3.09796	4.36108E-02	1.21788E 00
177.60	3.09970	4.18687E-02	1.21795E 00
177.70	3.10145	4.01263E-02	1.21802E 00
177.80	3.10319	3.83836E-02	1.21809E 00
177.90	3.10494	3.66408E-02	1.21816E 00
178.00	3.10668	3.48977E-02	1.21822E 00
178.10	3.10843	3.31544E-02	1.21828E 00
178.20	3.11017	3.14109E-02	1.21834E 00
178.30	3.11192	2.96672E-02	1.21839E 00
178.40	3.11366	2.79233E-02	1.21844E 00
178.50	3.11541	2.61792E-02	1.21849E 00
178.60	3.11716	2.44350E-02	1.21853E 00
178.70	3.11890	2.26907E-02	1.21857E 00
178.80	3.12065	2.09462E-02	1.21861E 00
178.90	3.12239	1.92016E-02	1.21865E 00
179.00	3.12414	1.74568E-02	1.21868E 00
179.10	3.12588	1.57120E-02	1.21871E 00
179.20	3.12763	1.39670E-02	1.21873E 00
179.30	3.12937	1.22220E-02	1.21876E 00
179.40	3.13112	1.04769E-02	1.21878E 00
179.50	3.13286	8.73173E-03	1.21879E 00
179.60	3.13461	6.98651E-03	1.21881E 00
179.70	3.13635	5.24124E-03	1.21882E 00
179.80	3.13810	3.49595E-03	1.21882E 00
179.90	3.13984	1.75064E-03	1.21883E 00