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Temperatures, Pressures and Liquid Levels of Tank Cars Engulfed in Fires

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Volume I, Results of Parametric Analyses

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N O T I C E

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16. Abstract

An analytical procedure has been developed for calculating the effects of fire on a railroad tank car containing a hazardous material. The procedure was developed so that the consequences of using different conductances for the thermal insulation on the tank and different flow capacities of the safety relief valve could be determined. The analysis is used to predict various parameters which characterize the situation such as the time to failure, the amount of product remaining in the tank at the time of failure, the maximum pressure in the tank, the time to reach certain pressure levels, etc. The procedure has been used to analyze Specification 105 railroad tank cars in the pool fire environment (this assumes complete engulfment of the car in the fire). Both the upright and overturned car cases have been considered. In the overturned car case the safety relief valve vents liquid instead of vapor and the fact that the liquid volumetric flow rate is less than that for vapor must be considered. Tank cars containing the following products have been analyzed as part of this study: ethylene oxide, propane, propylene, 1,3-butadiene, vinyl chloride, monomethylamine, and propylene oxide. The results from the analyses can be used to assess the degree to which different combinations of thermal insulation systems and safety relief valves will be successful in preventing or minimizing the consequences of tank car failures. The final report has been prepared in two volumes. This volume, Volume I, presents the results from parametric analyses. Volume II describes the analytical procedure and the computer program which was used to perform the calculations.

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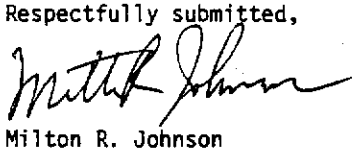
PREFACE

The work described in this report was conducted under Federal Railroad Administration (FRA) Contract No. DTFR53-81-C-00016, Task Order VC-4, entitled "Temperatures, Pressures and Liquid Levels of Tank Cars Engulfed in Fires". The report has been prepared in two volumes. This volume presents results obtained under this project for tank cars loaded with ethylene oxide, propane, propylene, 1,3-butadiene, vinyl chloride, monomethylamine, or propylene oxide. It also includes background concerning the development of the analytical procedure that was used to calculate the phenomena which occur when a tank car is subjected to fire. A detailed description of the computer program, which was used to perform the analyses, is provided in the second volume of the report.

The author wishes to acknowledge the assistance provided by Mr. David Dancer and Mrs. Claire Orth FRA COTRs on this project. The author would also like to acknowledge the informative discussions he has had with Dr. L. A. DeFrate, of E.I. Du Pont De Nemours & Company, who has also developed an analytical model for the computation of fire effects on tank cars.

Respectfully submitted,



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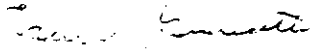


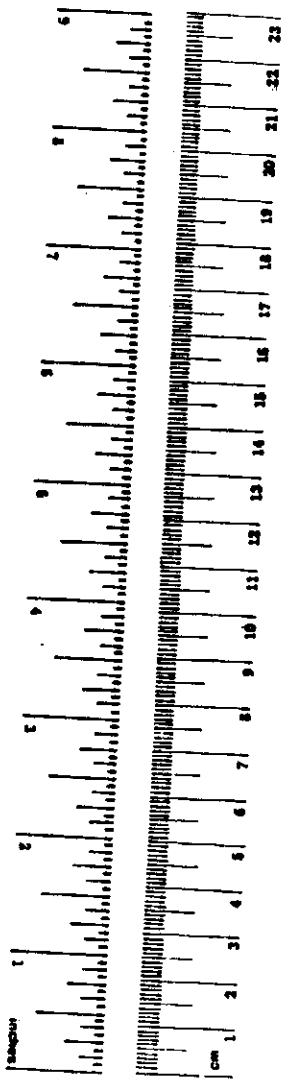
John A. Granath
Director of Research
Special Projects

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

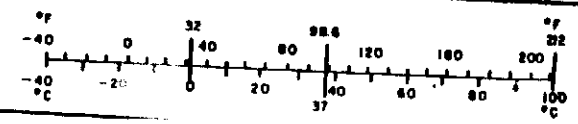
Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

Approximate Conversions from Metric Measures



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1. INTRODUCTION

1.1 OBJECTIVE

This report describes work that has been carried out under Federal Railroad Administration Contract No. DTFR53-81-C-00016, Task Order VC-4, entitled "Temperatures, Pressures and Liquid Levels of Tank Cars Engulfed in Fires".

The objective of this task order was the further development of a procedure for calculating the fire effects on a tank car containing certain hazardous materials and the use of this procedure for determining the vulnerability of cars in the pool fire environment (complete fire engulfment).

1.2 SCOPE

This report includes results from the analysis of upright and overturned DOT specification 105 tank cars subjected to the pool fire environment. Parametric analyses were performed which show the effects of using different thermal shield conductances and safety relief valves flow capacities.

The following products have been considered in these analyses:

ethylene oxide,
propane,
propylene,
1,3-butadiene,
vinyl chloride,
monomethylamine, and
propylene oxide.

The report also discusses the assumptions and background data which were used in the development of the analytical procedure. The procedure applies both to the upright car case, where the valve would normally be venting vapor, and a car that is overturned so that initially the safety relief valve will be releasing liquid product.

2. BACKGROUND

2.1 REGULATORY ACTIONS

The potential for disasters when railroad tank cars containing flammable compressed gases or liquids are involved in accidents has received wide publicity. Fires and explosions from such accidents have caused significant property damage and have resulted in deaths and injuries. Regulations were issued in September 1977 under HM-144 which mandated the use of high temperature thermal insulation, head shield protection, shelf couplers, and adequately sized safety relief valves on DOT Class 112/114 cars which carry these products. Similar regulations issued in January 1981 under HM-174 affected the construction of Class 105 cars which carry flammable gases and ethylene oxide.

On April 14, 1983 a notice of proposed rulemaking (NPRM) was issued under docket number MH-175. It proposed that after December 31, 1986 specification 105 tank cars built before September 1, 1981 with capacities exceeding 18,500 gallons and carrying a flammable gas or ethylene oxide be equipped with high temperature thermal insulation and safety relief valves sized according to the requirements for specification 112 and 114 tank cars.

This report presents data which can be used to assist in the definition of adequately sized safety relief valves in relationship to the properties of the thermal shield used on the tank car. The major factor which must be considered is the increase in the vapor pressure as the car is heated by the fire. The pressure can be controlled by the use of a thermal insulation system which limits the transfer of heat and which retains its effectiveness at high temperatures. The pressure can also be controlled by using an adequately sized safety relief valve.

2.2 PREVIOUS WORK

A report describing the thermal-protection/safety-valve relationships for tank cars subjected to pool fires was prepared and presented to a meeting of the Design Institute for Emergency Relief Systems at the University of Maryland on June 4, 1981 (Ref. 1). The paper dealt with the analysis of DOT Class 112/114 and Class 105 cars which were exposed to the fire environment. A calculational procedure was developed for the analysis of the fire effects on the tank car. The analysis was restricted to cars containing propane which remained upright. Results were included from a parametric analysis of the effects of the conductance of the thermal shield and the flow capacity of the safety relief valve on the rate of increase in pressure within the tank car and the subsequent prediction of the time to failure of the car. The procedure used in this analysis was briefly described in the paper. Under this task order, the work has been extended to include the case of an overturned car, where the tank car safety relief valve initially would be venting liquid product. The work has also been extended to include other commodities.

2.3 RESEARCH AND DEVELOPMENT

Over the last fifteen years several major research efforts have been directed at the study of the problems associated with tank car exposure to accidental fire conditions. In 1970 Cornell Aeronautical Laboratories completed a preliminary investigation (Ref. 2) of the fire hazards associated with railroad tank car transportation. Their work included evaluation of the thermal input to the car, the flow capacity of the safety relief valve for both vapor and liquid discharge, and the specifications used for sizing safety relief valves. From 1973 to 1975 full scale safety relief valve flow tests were conducted at Edwards Air Force Base (Ref. 3). Standard valves used in Class 112 and 114 tank cars were tested to determine their flow capacities for propane, in both the liquid and vapor state, nitrogen, and water. These tests provided evidence of the large variance in relieving capacity between the vapor and liquid states.

In 1975 full scale fire tests were conducted on 112A340W tank cars loaded with propane (Ref. 4). One car was uninsulated, which was the normal condition for cars of this type at the time. The second car had a thin layer of a chemical coating insulation applied to it. The uninsulated car failed after 24.5 minutes with about 40% of the liquid contents remaining at the time of failure. The insulated car failed after 94.5 minutes when it was estimated that 2% of the liquid contents were left in the car. The failure of the uninsulated car produced much more violent effects than the failure of the insulated car because of the large volume of propane in the uninsulated car when it failed.

A facility for simulating fire effects on sample tank car thermal shield systems has also been developed (Ref. 5). Four by four foot samples of the thermal shield systems can be exposed to simulated pool and torch fire effects. The facility has been used for performing acceptance tests under the HM-144 specification. The regulations specify the maximum temperature to which a base plate behind the thermal shield system can be allowed to increase over a 100 minute period for pool fire simulation and over a 30 minute period for torch fire simulation. The use of data from this facility for estimating the conductance of thermal shield systems is discussed later in this report. Values for the effective conductance of thermal shields are required in the analytical procedure for the calculation of fire effects on the tank car.

The phenomena associated with two phase flow through valves, which are similar to those used in railroad tank cars, has been investigated at the University of Maryland (Ref. 6). Recently the AAR Tank Car Committee conducted an extensive review of the requirements for sizing tank car safety relief valves (Ref. 7). Both upright and overturned car cases were considered. Primary emphasis was given to DOT Class 105 cars carrying ethylene oxide or propane.

3. ANALYTICAL PROCEDURE

The calculational procedure, which has been developed under this program to model effects on tank cars, is described in this section. It allows the conditions within the tank to be determined as a function of time for arbitrary characteristics of the thermal insulation system and the flow capacity of the safety relief valve. The assumption is made that the car is fully engulfed by the fire so that the fire is of uniform intensity all over the tank. The calculational procedure begins by assuming that the car has been loaded in accordance with allowable filling density tables so that there is an outage volume which is occupied by the product in the vapor state. Figure 3.1 illustrates the basic phenomena which must be taken into consideration. Four different sets of conditions are recognized. The first deals with the situation where the car is in the upright position venting vapor. Most of the heat is conducted into the car through the wetted area of the tank. The properties of the thermal shield determines the rate of heat transfer into the liquid product. Some heat is also conducted through the thermal shield over the vapor space which increases the temperature of the tank wall. As the temperature rises, some heat is radiated from the wall to the liquid below. The amount of heat radiated depends on both the "view factor" of the surface of the liquid and the temperatures of the wall and liquid. The view factor decreases as the liquid level drops.

The burst strength of the tank is estimated as a function of the wall temperature over the vapor space. When the tank is no longer capable of containing the vapor pressure, failure is assumed causing the sudden release of the remaining product within the car.

The vapor pressure within the tank is a function of the temperature of the liquid product, increasing as its temperature increases. The presence of nitrogen, which is used as a pad of inert gas, must be considered for cars containing ethylene oxide. When the vapor pressure within the the tank exceeds the start-to-discharge pressure of the valve, the valve opens allowing the vapor to exhaust from the car. A slight rise in the pressure above this value causes the valve to move to the fully open position. If the valve flow capacity is adequate, the liquid will tend to remain at a nearly constant temperature as it is vaporized and is exhausted from the tank. If the flow capacity is not large enough, the pressure in the tank will rise allowing the temperature of the liquid to increase and also resulting in a somewhat larger mass flow rate through the valve.

The second set of conditions which must be considered is the overturned car case. The conditions are similar to those of the upright car case except that the car is assumed to be partially rolled over so that when the safety relief valve opens it will vent liquid instead of vapor. The volumetric flow rate for liquid discharge is less than for the vapor case at any given pressure, but the mass flow rate may be larger because of the greater density of the fluid. Liquid flow through the valve is calculated assuming homogeneous isentropic two phase flow (liquid and vapor) and a liquid discharge coefficient of 0.7.

The third set of conditions is the case where the tank car is "shell full" (of liquid) and for all practical purposes there is no vapor space left within the tank. This condition occurs when the car is initially filled with only a small empty volume above the liquid surface. When the car is exposed to the fire, the temperature of the product rises and its specific volume also increases so that eventually all of the tank volume is filled with liquid. DOT requirements, for example, allow some products within Class 105 tank cars to be filled so that the car becomes shell full when the product temperature rises to 105°F. When the car becomes shell full, any further increase in temperature of the product will cause liquid flow through the safety relief valve. There will be some increase of the pressure within the tank to cause this flow. If the capacity of the valve is small and the rate of increase in the specific volume of the liquid is large, very high pressures can be developed. The calculation of the fire effects under these conditions assumes the heat is transferred to the liquid over the entire area of the tank shell. Also, when the vapor pressure of the product exceeds the pressure required to keep the valve open, the fact must be considered that both liquid and vapor can be vented through the valve.

The fourth set of conditions is the case where all the liquid has been vaporized. This condition is also associated with the case where the critical temperature of the product has been exceeded so that the vapor state is the only state in which the product can exist. The temperature of the vapor will increase at a fairly rapid rate because heat is both convected and radiated to the product and because the mass of the product within the tank is relatively small. Under almost all conditions, the safety relief valve is fully capable of relieving any increases in pressure as the vapor becomes hotter. The pressure would be maintained near the valve closing pressure. The tank wall temperature also increases fairly rapidly during this phase because there is no cooling effect from liquid product within the tank.

The calculational procedure assumes that each of the parameters remain constant over a given time step. The parameters are then updated at the end of the time step. An integration time step of 0.1 minutes has been used for the parametric analyses conducted under this study. This time step has been found to be adequate for describing the various phenomena. Typical results showing the computer print-out are presented in Appendix H.

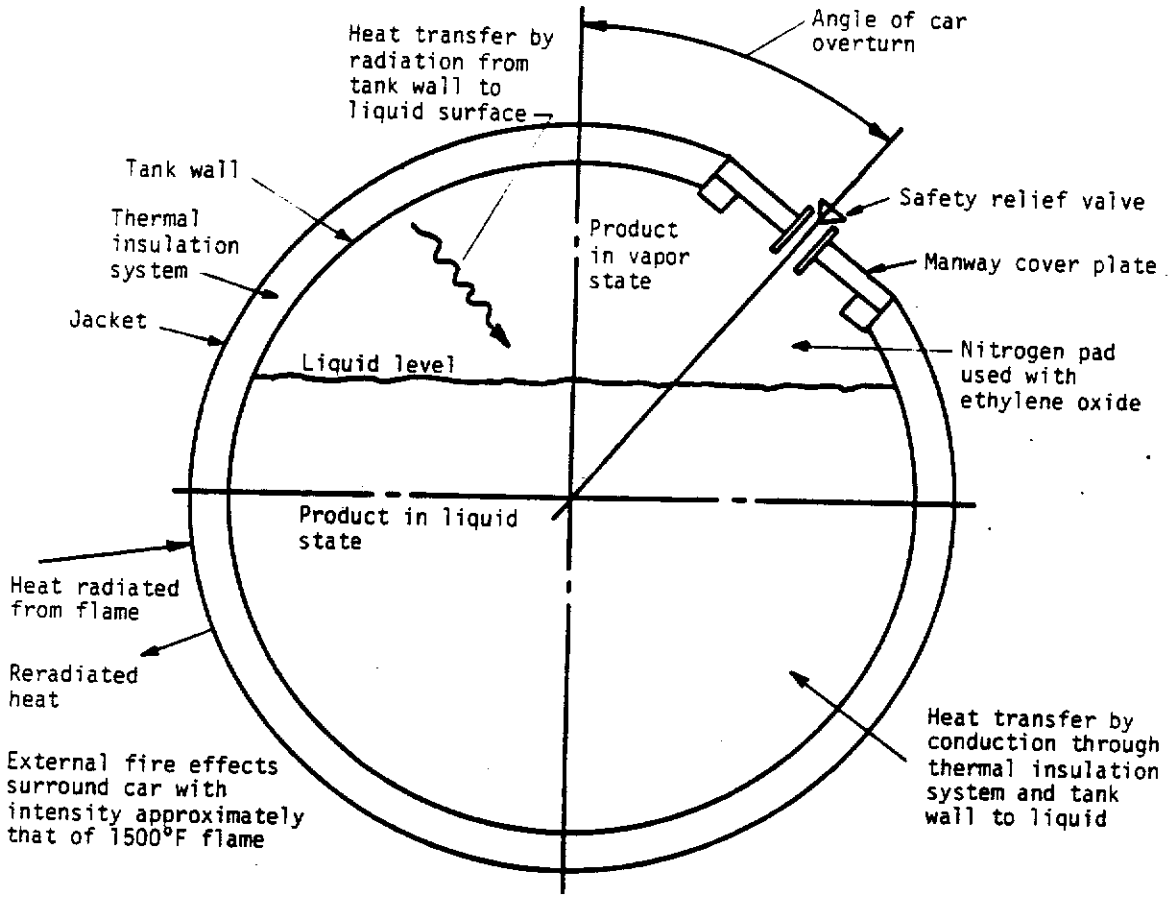

FIGURE 3.1. CONDITIONS CONSIDERED IN THE ANALYSIS OF TANK CARS SUBJECTED TO FIRE

4. PREDICTION OF FULL SCALE FIRE TEST RESULTS

The calculational procedure was used to predict the phenomena associated with the full scale tank car pool fire tests (Ref. 4) and to compare the results with the test data. The results of the tests can be predicted with a high degree of accuracy provided one assumes the average neat flux over the entire surface of the tank was equivalent to complete engulfment in a fire where the flame temperature was approximately 1500°F in the case of the insulated car test and 1530°F in the case of the uninsulated car test. This implies that the average radiant heat flux to a cold base plate would be approximately 25,500 and 27,100 Btu/hr-ft^2, respectively.

The results of these comparisons are summarized in Table 4.1. The prediction of pressure versus time follows the experimental data and the predicted times of failure are within a minute of the actual failure time. Failure in both cases was due to the temperature of the steel in the tank reaching approximately 1200°F at which point it could no longer resist the stresses imposed by the vapor pressure within the car.

If a higher or lower flame temperature were assumed, or if only partial engulfment of the tank car in the fire were assumed, the analytical predictions will not match the test data. These results have been used to establish 1500°F as an estimate of the intensity of the pool fire environment and this estimate has been used in all of the analyses described in this report.

TABLE 4.1 COMPARISON OF FULL SCALE TANK CAR FIRE TEST RESULTS WITH PREDICTIONS (112A340W - 33,700 GAL. CARS)

	Uninsulated Car Test	Insulated Car Test
Initial Temperature (°F)	70	43
Percentage of Car Filled	96	84
Test Results		
Time to Failure (min)	24.5	94.5
Maximum Pressure (psig)	350	310
Estimated Percentage Liquid Remaining at Failure	40	2
Predictions		
Time to Failure (min)	25.2	94.5
Maximum Pressure (psig)	350	281
Percentage Liquid Remaining at Failure	50	0*

*All liquid vaporized at 91 minutes

5. PARAMETRIC ANALYSIS

5.1 ASSUMPTIONS

A series of analyses were made for tank cars exposed to fire to predict the phenomena associated with the use of different safety relief valve flow capacities and properties of the thermal shield. Each of these analyses were made with the assumption that the entire outer surface of the car was exposed to a flame at approximately 1500°F which would give an approximate 25,500 Btu/hr-ft² heat flux to a cold steel plate surface. This condition is based on the estimate of the conditions in the full scale fire tests with the insulated and uninsulated tank cars*.

The analyses have been conducted for both the upright car case, where the safety relief valve is at the top of the car, and the overturned car case, where the safety relief valve is assumed to be oriented at an angle of 120° from the vertical. An overturned angle of 120° has been used in the overturned car cases because accident data (Ref. 8) indicates that in over 97% of the cases where rupture of the tank has occurred because of overheating the angle of overturn was less than 120°. The parametric studies covered all combinations of 7 values for the assumed conductance of the thermal shield and 4 values for the assumed flow capacity of the safety relief valve.

The assumed conductances for the thermal shield were 5.4, 4.0, 3.0, 2.3, 1.8, 1.2 and 0.8 Btu/hr-ft²-°F. These conductances can be related to the expected performance of the thermal insulation system in pool fire simulation test (See Section 6). The assumed safety relief valve flow capacities were different for each commodity.

The results presented in this section are for an assumed constant value of conductance for the thermal shield over the range of conditions considered by each analysis. The significance of this assumption, in view of the fact that most thermal insulation materials have conductivities which are functions of temperature and the fact that the average temperature of the thermal shield changes during the course of the exposure of the car to the fire, is discussed in Appendix I. The assumption is also made that each of the thermal shield systems start out at a conductance of 0.3 Btu/hr-ft² and that there is a linear change to the final value over a 30 minute period. This assumption is based on observations made during pool fire simulation tests of thermal shield systems and is discussed in Section 6. In all cases the initial temperature of the car and its contents are assumed to be 60°F. The relationship between the conductance of a thermal shield system and its expected performance (back plate temperature in 100 minutes) in the pool fire simulation test is also given in Section 6.

5.2 RESULTS FOR CARS CONTAINING ETHYLENE OXIDE

Results from the parametric analyses for tank cars loaded with ethylene oxide are summarized in Tables 5.1 and 5.2. Table 5.1 shows the results for the overturned car case and Table 5.2 for the upright car case. The calculations have been based on a 25,000 gallon capacity car. This is a good estimate of the largest size car which would be used for ethylene oxide service. An initial outage of 3.3% at 60°F is assumed which would result in the car becoming shell full at 105°F. Four different safety relief valve capacities have been assumed, 260, 1100, 3000 and 14,600 SCFM** The 260 SCFM valve is the minimum allowable size which would be calculated by the use of the AAR Tank Car Specifications (Appendix A, Ref. 10) for a Class 105 car of this size. The 1100 SCFM capacity valve is the capacity of the valve that is most commonly used on cars of this type. The 14,600 SCFM valve is the size which would be required if the valve standards of HM-144 were to be applied to a 25,000 gal car containing ethylene oxide. An intermediate size of 3000 SCFM is used in order to provide results between the 1100 and 14,600 SCFM valve sizes.

Most of the information presented in the tables is self-explanatory. It should be noted that there are two modes of failure. One type of failure occurs when high pressures are reached due to the inability of the safety relief valve

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*This assumption on which the heat flux to the product within the car is based differs from that used in the AAR Tank Car Specifications (Ref. 10) and the analyses described in Ref. 7. These references assume that the temperature on the outside of the insulation reaches 1600°F in the fire, but that only a factor of $A^{0.82}$ of the outside of the tank is subjected to the flame. This factor implies that heat from the fire will be transmitted through only 25% of the outside surface of a 2000 ft² tank car. When consideration is given to the 1600°F surface temperature assumption the net heat input to the car would be only 30% of that assumed in this study.

**SCFM: ft³/min of air at standard conditions (1 atm at 60°F)

TABLE 5.1 ETHYLENE OXIDE: 105A300W TANK CAR (25,000 GAL. CAPACITY)
OVERTURNED CAR CASE (VALVE AT 120° ANGLE)
75 PSIG SAFETY RELIEF VALVE START TO DISCHARGE PRESSURE
POOL FIRE ENVIRONMENT

Thermal Shield System Conductance (Btu/hr-ft²-°F)	Relief Valve Flow Capacity (SCFM)	Time to Indicated Pressure (min)			Maximum Pressure		Time for tank wall over vapor space to reach 800°F (min)	Time for liquid level to reach 120° level (min)	Time for all liquid to vaporize (min)	Conditions of Failure		
		100 psig	200 psig	300 psig	Pressure (psig)	Time (min)				Time (min)	Pressure (psig)	Remaining Weight Fraction in Liquid State
5.4 (900)**	260	46	81	108	539	158	52	-	-	158	539	0.77
4.0 (800)	260	67	118	153	583	224	87	-	-	224	583	0.73
3.0 (725)	260	94	161	206	603	303	-	-	-	303	603	0.70
2.3 (650)	260	126	210	265	631	402	-	-	-	402	631	0.65
1.8 (600)	260	162	264	333	650	513	-	-	-	513	650	0.58
1.2 (500)	260	241	386	484	441 (1)	600	*	*	*	*	N	N
0.8 (400)	260	362	561	*	226 (1)	600	*	*	*	*	N	N
5.4 (900)	1100	74	111	136	510	180	51	-	-	180	510	0.51
4.0 (800)	1100	93	140	172	539	233	79	-	-	233	539	0.37
3.0 (725)	1100	118	176	216	556	297	230	-	-	297	556	0.22
2.3 (650)	1100	147	219	268	510	352	331	352	514	*	N	0.00
1.8 (600)	1100	182	269	328	432	392	411	392	586	*	N	0.00
1.2 (500)	1100	261	379	457	328	476	*	476	N	*	N	N
0.8 (400)	1100	377	536	*	250	588	*	588	N	*	N	N
5.4 (900)	3000	78	111	136	408	156	51	156	244	288	62	0.00
4.0 (800)	3000	97	138	167	337	176	77	176	284	352	62	0.00
3.0 (725)	3000	121	172	-	281	200	157	200	340	433	62	0.00
2.3 (650)	3000	150	211	-	239	228	225	228	400	532	62	0.00
1.8 (600)	3000	185	256	*	203	258	287	258	472	*	N	0.00
1.2 (500)	3000	262	*	*	159	324	502	324	*	*	N	N
0.8 (400)	3000	375	*	*	126	416	*	416	*	*	N	N
5.4 (900)	14600	79	-	-	128	88	51	88	190	234	65	0.00
4.0 (800)	14600	98	-	-	110	102	76	102	230	294	67	0.00
3.0 (725)	14600	-	-	-	99	122	116	122	282	372	69	0.00
2.3 (650)	14600	-	-	-	90	142	156	142	342	467	70	0.00
1.8 (600)	14600	-	-	-	84	168	218	168	414	581	70	0.00
1.2 (500)	14600	*	*	*	77	228	448	228	570	*	N	0.00
0.8 (400)	14600	*	*	*	75	74 (2)	*	316	*	*	N	N

- Condition not attained before failure
* Condition not attained within 600 minutes
N Condition cannot be determined from analysis, event would occur after 600 minutes
** Expected temperature which would be reached after 100 minutes in pool fire simulation test of thermal shield system

(1) Pressure still increasing
(2) First time valve opens, valve cycles open and shut, pressure never gets above 75 psig

TABLE 5.2 ETHYLENE OXIDE: 105A300W TANK CAR (25,000 GAL. CAPACITY)
UPRIGHT CAR CASE
75 PSIG SAFETY RELIEF VALVE START TO DISCHARGE PRESSURE
POOL FIRE ENVIRONMENT

Thermal Shield System Conductance (Btu/hr-ft²-°F)	Relief Valve Flow Capacity (SCFM)	Time to Indicated Pressure (min)			Maximum Pressure		Time for tank wall over vapor space to reach 800°F (min)	Time for all liquid to vaporize (min)	Conditions at Failure		
		100 psig	200 psig	300 psig	Pressure (psig)	Time (min)			Time (min)	Pressure (psig)	Remaining Weight Fraction in Liquid State
5.4 (900)**	260	40	65	96	559	147	56	-	147	559	0.79
4.0 (800)	260	59	105	140	585	205	-	-	205	585	0.76
3.0 (725)	260	88	149	191	622	282	-	-	282	622	0.73
2.3 (650)	260	124	198	251	650	401	-	-	401	650	0.69
1.8 (600)	260	164	254	319	663	565	-	-	565	663	0.66
1.2 (500)	260	252	379	512	363 (1)	600	*	*	*	N	N
0.8 (400)	260	378	*	*	193 (1)	600	*	*	*	N	N
5.4 (900)	1100	74	107	140	524	230	56	-	230	524	0.59
4.0 (800)	1100	94	142	199	490	394	160	560	*	N	0.00
3.0 (725)	1100	118	201	308	354	452	414	*	*	N	N
2.3 (650)	1100	157	298	*	267	522	*	*	*	N	N
1.8 (600)	1100	210	512	*	205	597	*	*	*	N	N
1.2 (500)	1100	363	*	*	127 (1)	600	*	*	*	N	N
0.8 (400)	1100	*	*	*	83 (1)	600	*	*	*	N	N
5.4 (900)	3000	86	-	-	194	219	56	444	489	62	0.00
4.0 (800)	3000	120	*	*	144	248	123	560	*	N	0.00
3.0 (725)	3000	194	*	*	107	271	363	*	*	N	N
2.3 (650)	3000	*	*	*	83	262	572	*	*	N	N
1.8 (600)	3000	*	*	*	75 (2)	42	*	*	*	N	N
1.2 (500)	3000	*	*	*	75 (2)	55	*	*	*	N	N
0.8 (400)	3000	*	*	*	75 (2)	74	*	*	*	N	N
5.4 (900)	14600	-	-	-	75 (2)	24	56	442	486	65	0.00
4.0 (800)	14600	*	*	*	75 (2)	27	106	556	*	N	0.00
3.0 (725)	14600	*	*	*	75 (2)	31	343	*	*	N	N
2.3 (650)	14600	*	*	*	75 (2)	36	569	*	*	N	N
1.8 (600)	14600	*	*	*	75 (2)	42	*	*	*	N	N
1.2 (500)	14600	*	*	*	75 (2)	55	*	*	*	N	N
0.8 (400)	14600	*	*	*	75 (2)	74	*	*	*	N	N

- Condition not attained before failure
* Condition not attained within 600 minutes
N Condition cannot be determined from analysis, event would occur after 600 minutes
** Expected temperature which would be reached after 100 minutes in pool fire simulation test of thermal shield system

(1) Pressure still increasing
(2) First time valve opens, valve cycles open and shut, pressure never gets above 75 psig

to pass the liquid product at a sufficient rate (e.g., overturned car cases with 260 SCFM valve and 1.8 - 5.4 conductances and 1100 SCFM valve with 3.0 - 5.4 conductances). The second type of failure occurs after all of the liquid has either been expelled through the valve or vaporized. Then only a small amount of vapor product remains within the tank. The pressure in the tank during this phase is maintained to a range between the start to discharge pressure of the valve and the valve closing pressure (75 to 61 psig). The temperature rises at a fairly rapid rate because there is no cooling effect of the liquid in the tank. Failure is predicted to occur when the burst strength of the tank is diminished to the internal vapor pressure. The tank is approximately 1400°F at this condition. It should be noted that this temperature is above the reported 1060°F violent decomposition temperature for ethylene oxide* so that it is not certain that the failure would be delayed as long as indicated. At some point, when the temperature of the shell gets into the vicinity of 1000°F, the remaining vapor within the tank may decompose explosively causing excessive pressure and failure of the tank.

It is interesting to note that in the overturned car cases an increase in the capacity of the safety relief valve above 1100 SCFM does not have any significant effect in extending the times to reach 100, 200 and 300 psi. The pressure within the car is due both to the vapor pressure of the ethylene oxide and the nitrogen pad pressure. Although the liquid level drops faster in the cars with the larger valves the rate of temperature increase for the liquid stays about the same for an extended period of time. Thus, the rate of increase in the ethylene oxide vapor pressure, which is a function of temperature, is similar for each case. The effect of the nitrogen pad pressure becomes insignificant in a short time because the liquid level is dropping within the car. Hence the rise in the total pressure is similar. The pressure increases faster for the case with the 260 SCFM valve because the outage stays about the same for a long period of time. This maintains the nitrogen pad pressure. The volumetric flow from the valve is approximately balanced by the rate of increase in the specific volume of the liquid, which increases with temperature.

*From Reference 11. The original work was based on small scale laboratory tests which were conducted at one atmosphere pressure with no oxygen present.

The results of these analyses show that the overturned car case is more critical for cars equipped with the 1100, 3000 and 14,600 SCFM valves. This is because it takes longer for the product to be vaporized and exhausted as a gas than for it to be expelled as a liquid. For the cases with the very small valve, 260 SCFM, the upright car case is more critical than the overturned car case. This is due to the effect of the nitrogen pad pressure because it initiates the discharge of the liquid before the tank car becomes shell full. In any event the results show that the use of the 260 SCFM valve results in early failure times with correspondingly large fractions of liquid remaining in the car at the time of failure.

The calculations have been carried out for a maximum of 600 minutes. A condition which is not attained within 600 minutes is indicated by an asterisk in the table. The table also indicates (by the use of a dash) where the condition is not attained before failure.

The maximum pressure for the overturned car case occurs when the liquid reaches the 120°F level. Beyond this point the valve handles only vapor and is able to maintain a flow rate which allows the pressure to decrease within the tank.

Tables 5.1 and 5.2 are for 105A300W cars where the calculation of burst strength of the tank as a function of temperature is based on an assumed initial burst strength of 750 psig, which is the minimum burst strength required in the design of the car. Tables 5.3 and 5.4 give auxiliary information for the failure conditions of Class 105A100W and 105A200W tank cars where the design burst strength is 500 psig. The times to failure given in these tables are less than for the Class 105A300W car cases because the burst strength is reached at an earlier time. The effect is more pronounced for cars that fail at relatively high pressures where there is a substantial fraction of liquid in the car at the time of failure.

Plots of the wall temperature over the vapor space, liquid fraction remaining and pressure versus time for each of the cases given in Tables 5.1 and 5.2 are presented in Appendix A. Selected computer printout data is presented in Appendix H.

5.3 RESULTS FOR CARS CONTAINING PROPANE

Results from the parametric analyses for tank cars loaded with propane are summarized in Tables 5.5, 5.6, and 5.7. Table 5.5 shows results for both the upright and overturned cases for a 33,600 gallon Class 112A340W tank car. Only one set of conditions is presented, namely, a conductance of 4.0 Btu/hr-ft^2-°F and a safety relief valve flow capacity of 27,460 SCFM. These are the values which meet the requirements of HM-144. A thermal shield

TABLE 5.3 ETHYLENE OXIDE: 105A100W AND 105A200W TANK CARS (25,000 GAL. CAPACITY)
OVERTURNED CAR CASE (VALVE AT 120° ANGLE)
75 PSIG SAFETY RELIEF VALVE START TO DISCHARGE PRESSURE
POOL FIRE ENVIRONMENT

Thermal Shield System Conductance (Btu/hr-ft²-°F)	Relief Valve Flow Capacity (SCFM)	Time to Indicated Pressure (min)			Maximum Pressure		Time for tank wall over vapor space to reach 800°F (min)	Time for liquid level to reach 120° level (min)	Time for all liquid to vaporize (min)	Conditions of Failure		
		100 psig	200 psig	300 psig	Pressure (psig)	Time (min)				Time (min)	Pressure (psig)	Remaining Weight Fraction in Liquid State
5.4 (900)**	260	46	81	108	363	123	52	-	-	123	363	0.84
4.0 (800)	260	67	118	153	391	181	87	-	-	181	391	0.79
3.0 (725)	260	94	161	206	405	245	-	-	-	245	405	0.76
2.3 (650)	260	126	210	265	425	324	-	-	-	324	425	0.73
1.8 (600)	260	162	264	333	439	414	-	-	-	414	439	0.68
1.2 (500)	260	241	386	484	441 (1)	600	*	*	*	*	N	N
0.8 (400)	260	362	561	*	226 (1)	600	*	*	*	*	N	N
5.4 (900)	1100	74	111	134	348	147	51	-	-	147	348	0.63
4.0 (800)	1100	93	140	169	375	193	79	-	-	193	375	0.54
3.0 (725)	1100	118	176	214	395	249	230	-	-	249	395	0.43
2.3 (650)	1100	147	219	268	400	310	-	-	-	310	400	0.32
1.8 (600)	1100	182	269	325	408	382	-	-	-	382	408	0.20
1.2 (500)	1100	261	379	453	328	476	*	476	N	*	N	N
0.8 (400)	1100	377	536	*	250	588	*	588	N	*	N	N
5.4 (900)	3000	78	111	136	323	139	51	-	-	139	323	0.32
4.0 (800)	3000	97	138	167	336	176	77	176	-	176	336	0.16
3.0 (725)	3000	121	172	-	281	200	157	200	340	412	62	0.00
2.3 (650)	3000	150	211	-	239	228	225	228	400	504	62	0.00
1.8 (600)	3000	185	256	-	203	258	287	258	472	*	N	0.00
1.2 (500)	3000	262	*	*	159	324	502	324	*	*	N	N
0.8 (400)	3000	375	*	*	126	416	*	416	*	*	N	N
5.4 (900)	14600	79	-	-	128	88	51	88	190	224	59	0.00
4.0 (800)	14600	98	-	-	110	102	76	102	230	279	64	0.00
3.0 (725)	14600	-	-	-	99	122	116	122	282	352	67	0.00
2.3 (650)	14600	-	-	-	90	142	156	142	342	440	68	0.00
1.8 (600)	14600	-	-	-	84	168	218	168	414	548	69	0.00
1.2 (500)	14600	*	*	*	77	228	448	228	570	*	N	0.00
0.8 (400)	14600	*	*	*	75	74 (2)	*	316	*	*	N	N

- Condition not attained before failure
* Condition not attained within 600 minutes
N Condition cannot be determined from analysis, event would occur after 600 minutes
** Expected temperature which would be reached after 100 minutes in pool fire simulation test of thermal shield system

(1) Pressure still increasing
(2) First time valve opens, valve cycles open and shut, pressure never gets above 75 psig

TABLE 5.4 ETHYLENE OXIDE: 105A100W AND 105A200W TANK CARS (25,000 GAL. CAPACITY)
UPRIGHT CAR CASE
75 PSIG SAFETY RELIEF VALVE START TO DISCHARGE PRESSURE
POOL FIRE ENVIRONMENT

Thermal Shield System Conductance (Btu/hr-ft²-°F)	Relief Valve Flow Capacity (SCFM)	Time to Indicated Pressure (min)			Maximum Pressure		Time for tank wall over vapor space to reach 800°F (min)	Time for all liquid to vaporize (min)	Conditions at Failure		
		100 psig	200 psig	300 psig	Pressure (psig)	Time (min)			Time (min)	Pressure (psig)	Remaining Weight Fraction in Liquid State
5.4 (900)**	260	40	65	96	375	114	56	-	114	375	0.85
4.0 (800)	260	59	105	140	393	167	-	-	167	393	0.82
3.0 (725)	260	88	149	191	417	231	-	-	231	417	0.80
2.3 (650)	260	124	198	215	436	305	-	-	305	436	0.78
1.8 (600)	260	164	254	319	451	424	-	-	424	451	0.76
1.2 (500)	260	252	379	512	363 (1)	600	*	*	*	N	N
0.8 (400)	260	378	*	*	193 (1)	600	*	*	*	N	N
5.4 (900)	1100	74	107	140	363	164	56	-	164	363	0.77
4.0 (800)	1100	94	142	199	384	258	160	-	258	384	0.66
3.0 (725)	1100	118	201	308	354	452	414	*	*	N	0.00
2.3 (650)	1100	157	298	*	267	522	*	*	*	N	N
1.8 (600)	1100	210	512	*	205	597	*	*	*	N	N
1.2 (500)	1100	363	*	*	127 (1)	600	*	*	*	N	N
0.8 (400)	1100	*	*	*	83 (1)	600	*	*	*	N	N
5.4 (900)	3000	86	-	-	194	219	56	444	476	62	0.00
4.0 (800)	3000	120	*	*	144	248	123	560	*	N	0.00
3.0 (725)	3000	194	*	*	107	271	363	*	*	N	N
2.3 (650)	3000	*	*	*	83	262	572	*	*	N	N
1.8 (600)	3000	*	*	*	75 (2)	42	*	*	*	N	N
1.2 (500)	3000	*	*	*	75 (2)	55	*	*	*	N	N
0.8 (400)	3000	*	*	*	75 (2)	74	*	*	*	N	N
5.4 (900)	14600	-	-	-	75 (2)	24	56	442	475	62	0.00
4.0 (800)	14600	*	*	*	75 (2)	27	106	556	*	N	0.00
3.0 (725)	14600	*	*	*	75 (2)	31	343	*	*	N	N
2.3 (650)	14600	*	*	*	75 (2)	36	569	*	*	N	N
1.8 (600)	14600	*	*	*	75 (2)	42	*	*	*	N	N
1.2 (500)	14600	*	*	*	75 (2)	55	*	*	*	N	N
0.8 (400)	14600	*	*	*	75 (2)	74	*	*	*	N	N

- Condition not attained before failure
* Condition not attained within 600 minutes
N Condition cannot be determined from analysis, event would occur after 600 minutes
** Expected temperature which would be reached after 100 minutes in pool fire simulation test of thermal shield system

(1) Pressure still increasing
(2) First time valve opens, valve cycles open and shut, pressure never gets above 75 psig

TABLE 5.5. PROPANE: 112A340W TANK CAR (33,600 GAL. CAPACITY)

OVERTURNED AND UPRIGHT CAR CASES

280.5 PSIG SAFETY RELIEF VALVE START TO DISCHARGE PRESSURE POOL FIRE ENVIRONMENT

Thermal Shield System Conductance (Btu/hr-ft²-°F)	Relief Valve Flow Capacity (SCFM)	Time to Reach 340 psig (min)	Maximum Pressure		Time for tank wall over vapor space to reach 800°F (min)	Time for liquid level to reach 120° level (min)	Time for all liquid to vaporize (min)	Conditions at Failure		
			Pressure (psig)	Time (min)				Time (min)	Pressure (psig)	Remaining Weight Fraction in Liquid State
Overturned Car Case (120°)										
4.0 (800)*	27,460	-	312	65	61	65	101	138	231	0.00
Upright Car Case (0°)										
4.0 (800)	27,460	-	281	21 (1)	74	138	177	211	231	0.00

- Condition not attained before failure

(1) First time valve opens, valve cycles open and shut, pressure never gets above 281

* Expected temperature which would be reached after 100 minutes in pool fire simulation test of thermal shield system

TABLE 5.6 PROPANE: 105A300W TANK CAR (33,600 GAL. CAPACITY)
OVERTURNED (VALVE AT 120° ANGLE)
247.5 PSIG SAFETY RELIEF VALVE START TO DISCHARGE
PRESSURE POOL FIRE ENVIRONMENT

Thermal Shield System Conductance (Btu/hr-ft²-°F)	Relief Valve Flow Capacity (SCFM)	Time to Reach 300 psig (min)	Maximum Pressure		Time for tank wall over vapor space to reach 800°F (min)	Time for liquid level to reach 120° level (min)	Time for all liquid to vaporize (min)	Conditions at Failure		
			Pressure (psig)	Time (min)				Time (min)	Pressure (psig)	Remaining Weight Fraction in Liquid State
5.4 (900)	3070	44	581	68	56	-	-	68	581	0.78
4.0 (800)	3070	56	601	90	-	-	-	90	601	0.74
3.0 (725)	3070	76	624	125	-	-	-	125	624	0.68
2.3 (650)	3070	94	601	194	-	196 (1)	196 (1)	202	585	0.00 (1)
1.8 (600)	3070	116	587	245	-	233	238	245	587	0.00
1.2 (500)	3070	166	482	288	370	288	388	534	204	0.00
0.8 (400)	3070	244	401	354	499	354	490	*	N	0.00
5.4 (900)	5000	49	574	74	56	-	-	74	574	0.73
4.0 (800)	5000	62	577	116	84	-	-	116	577	0.42
3.0 (725)	5000	78	573	153	141	151	-	153	573	0.06
2.3 (650)	5000	96	503	172	179	172	234	293	206	0.00
1.8 (600)	5000	118	454	192	221	192	264	350	205	0.00
1.2 (500)	5000	172	376	234	320	234	332	480	204	0.00
0.8 (400)	5000	260	320	290	442	290	430	*	N	0.00
5.4 (900)	12000	53	466	84	52	84	116	132	206	0.00
4.0 (800)	12000	65	410	94	74	94	132	162	205	0.00
3.0 (725)	12000	82	363	106	104	106	154	199	205	0.00
2.3 (650)	12000	105	328	120	135	120	180	244	204	0.00
1.8 (600)	12000	136	300	136	174	136	210	299	204	0.00
1.2 (500)	12000	-	263	172	266	172	274	426	203	0.00
0.8 (400)	12000	*	248	86 (2)	385	222	370	*	N	0.00
5.4 (900)	25800	57	321	64	51	64	94	113	204	0.00
4.0 (800)	25800	-	290	72	63	72	110	141	204	0.00
3.0 (725)	25800	-	265	82	89	82	132	178	204	0.00
2.3 (650)	25800	-	249	96	117	96	156	223	203	0.00
1.8 (600)	25800	-	248	48 (2)	154	110	184	277	203	0.00
1.2 (500)	25800	-	248	64 (2)	245	144	248	402	203	0.00
0.8 (400)	25800	-	248	86 (2)	363	198	342	595	203	0.00

- Condition not attained before failure
* Condition not attained within 600 minutes
N Condition cannot be determined from analysis, event would occur after 600 minutes
** Expected temperature which would be reached after 100 minutes in pool fire simulation test of thermal shield system

(1) Product reaches critical temperature
(2) First time valve opens, valve cycles open and shut, pressure never gets above 248 psig

TABLE 5.7 PROPANE: 105A300W TANK CAR (33,600 GAL. CAPACITY)
UPRIGHT CAR CASE
247.5 PSIG SAFETY RELIEF VALVE START TO DISCHARGE
PRESSURE POOL FIRE ENVIRONMENT

Thermal Shield System Conductance (Btu/hr-ft²-°F)	Relief Valve Flow Capacity (SCFM)	Time to Reach 300 psig (min)	Maximum Pressure		Time for tank wall over vapor space to reach 800°F (min)	Time for liquid level to reach 120° level (min)	Time for all liquid to vaporize (min)	Conditions at Failure		
			Pressure (psig)	Time (min)				Time (min)	Pressure (psig)	Remaining Weight Fraction in Liquid State
5.4 (900)	3070	44	580	68	56	-	-	68	580	0.78
4.0 (800)	3070	56	600	90	-	-	-	90	600	0.74
3.0 (725)	3070	79	619	169	-	-	-	169	619	0.57
2.3 (650)	3070	108	585	246	244	240 (1)	240 (1)	246	585	0.00 (1)
1.8 (600)	3070	144	528	316	321	302	385	462	206	0.00
1.2 (500)	3070	-	295	337	510	448	526	*	N	0.00
0.8 (400)	3070	-	248	86 (2)	*	598	*	*	N	N
5.4 (900)	5000	50	574	74	56	-	-	74	574	0.73
4.0 (800)	5000	70	566	145	96	-	-	145	566	0.29
3.0 (725)	5000	96	483	204	178	196	250	287	207	0.00
2.3 (650)	5000	142	333	210	240	257	304	364	206	0.00
1.8 (600)	5000	-	265	195	320	291	370	455	205	0.00
1.2 (500)	5000	-	248	64 (2)	508	414	524	*	N	0.00
0.8 (400)	5000	-	248	86 (2)	*	598	*	*	N	N
5.4 (900)	12000	-	283	90	54	121	156	171	206	0.00
4.0 (800)	12000	-	248	32 (2)	84	151	194	221	205	0.00
3.0 (725)	12000	-	248	36 (2)	150	190	242	285	205	0.00
2.3 (650)	12000	-	248	42 (2)	228	236	300	363	204	0.00
1.8 (600)	12000	-	248	48 (2)	320	291	368	456	204	0.00
1.2 (500)	12000	-	248	64 (2)	510	415	522	*	N	0.00
0.8 (400)	12000	-	248	86 (2)	*	*	*	*	N	N
5.4 (900)	25800	-	248	27 (2)	53	121	154	172	204	0.00
4.0 (800)	25800	-	248	32 (2)	81	152	192	221	204	0.00
3.0 (725)	25800	-	248	36 (2)	150	191	240	285	204	0.00
2.3 (650)	25800	-	248	42 (2)	223	237	298	363	203	0.00
1.8 (600)	25800	-	248	48 (2)	320	291	366	456	203	0.00
1.2 (500)	25800	-	248	64 (2)	510	416	516	*	N	0.00
0.8 (400)	25800	-	248	86 (2)	*	599	*	*	N	N

- Condition not attained before failure
* Condition not attained within 600 minutes
N Condition cannot be determined from analysis, event would occur after 600 minutes
**Expected temperature which would be reached after 100 minutes in pool fire simulation test of thermal shield system

(1) Product reaches critical temperature
(2) First time valve opens, valve cycles open and shut, pressure never gets above 248 psig

with this conductance is predicted to reach 800°F in the pool fire simulation test and a safety relief valve of this flow capacity satisfies the AAR formula for an uninsulated car. Note that in each case the maximum pressure within the car is less than the test pressure, the expected time of failure is greater than 120 minutes and there is no expected remaining weight fraction of liquid product within the car at the time of failure.

Tables 5.6 and 5.7 present the results for a Class 105A300W tank car loaded with propane. Table 5.6 shows the results for the overturned car and Table 5.7 for the upright car. An initial outage of 5.0% at 60°F is assumed, which meets the requirements given by the CFR for a winter loading of propane in an insulated car. Four different safety relief valve capacities have been assumed, 3070, 5000, 12,000 and 25,800 SCFM. The 3070 SCFM valve was selected because this is the smallest size valve that was included in the recent AAR safety relief valve study. This size valve has been used on Class 105 tank cars used in the shipment of propane. The 25,800 SCFM valve is the size which results when the valve standards of HM-144 (AAR formula for uninsulated car) are applied to a 33,600 gallon car containing propane. The 5000 and 12,000 SCFM valve sizes were selected to provide intermediate results.

The information presented in Tables 5.6 and 5.7 shows results which are similar to those shown in Tables 5.1 and 5.2 for cars loaded with ethylene oxide. The failure pressures are relatively high and significant quantities of liquid product remain at the time of failure for the cases where smaller valve sizes are combined with the higher values of thermal shield conductance. Under other conditions the failure occurs after all of the liquid product within the car has been vaporized and the vapor pressure within the car is essentially at the closing pressure of the safety relief valve.

The results of the analyses show that under most conditions the overturned car case is more critical than the upright car case in the sense that the time to failure is less. With the 3070 and 5000 SCFM valve sizes there are some cases with the higher conductance thermal shield systems where the failure times are the same.

Plots of the wall temperature over the vapor space, liquid fraction remaining and pressure versus time for each of the cases given in Tables 5.6 and 5.7 are presented in Appendix B.

5.4 RESULTS FOR CARS CONTAINING PROPYLENE

Tables 5.8 and 5.9 present the results for a Class 105A400W, 33,600 gallon capacity, tank car loaded with propylene. Table 5.8 shows the results for the overturned car and Table 5.9 for the upright car. An initial outage of 4.7% at 60°F is assumed, which meets the requirements given by the Code of Federal Regulations (CFR), Section 173.314, for a winter loading of propylene in an insulated car. Four different safety relief valve capacities have been assumed, 3070, 5000, 12,000 and 28,600 SCFM. The 3070 SCFM valve was selected because this is the smallest size valve that was included in the AAR safety relief valve study (Ref. 7). The 28,600 SCFM valve is the size which results when the valve standards of HM-144 (AAR formula for uninsulated car) are applied to a 33,600 gallon car containing propylene. The 5000 and 12,000 SCFM valve sizes were selected to provide intermediate results.

The information presented in Tables 5.8 and 5.9 shows results which are similar to those for cars loaded with propane. The failure pressures are relatively high and significant quantities of liquid product remain at the time of failure for the cases where smaller valve sizes are combined with the higher values of thermal shield conductance. Under other conditions the failure occurs after all of the liquid product within the car has been vaporized and the vapor pressure within the car is essentially at the closing pressure of the safety relief valve.

The results of the analyses show that under most conditions the overturned car case is more critical than the upright car case in the sense that the time to failure is less. With the 3070 and 5000 SCFM valve sizes there are some cases with the higher conductance thermal shield systems where the failure times are the same. The critical temperature of propylene, 197.2°F, is predicted to be exceeded before all of the liquid is vaporized in two of the cases for the upright car, the 3070 SCFM valve with the 2.3 conductance thermal shield and the 5000 SCFM valve with the 4.0 conductance thermal shield.

Plots of the wall temperature over the vapor space, liquid fraction remaining and pressure versus time for each of the cases given in Tables 5.8 and 5.9 are presented in Appendix C.

5.5 RESULTS FOR CARS CONTAINING 1,3-BUTADIENE

Tables 5.10 and 5.11 present the results for a Class 105A100W, 33,600 gallon capacity, tank car loaded with 1,3-butadiene. Table 5.10 shows the results for the overturned car and Table 5.11 for the upright car. An initial outage of 5.1% at 60°F is assumed, which meets the requirements given by the CFR (Section 173.314) for a winter loading of butadiene in an insulated car. Four different safety relief valve capacities have been assumed, 1100, 3000, 10,000 and 20,000 SCFM.

TABLE 5.8. PROPYLENE: 105A400W TANK CAR (33,600 GAL. CAPACITY), OVERTURNED (VALVE AT 120° ANGLE), 300 PSIG SAFETY RELIEF VALVE START TO DISCHARGE PRESSURE, POOL FIRE ENVIRONMENT

Thermal Shield System Conductance (BTU/hr-ft²-°F)	Relief Valve Flow Capacity (SCFM)	Time to Reach 400 psig (min)	Maximum Pressure		Time for tank wall over vapor space to reach 800°F (min)	Time for liquid level to reach 120° level (min)	Time for all liquid to vaporize (min)	Conditions at Failure		
			Pressure (psig)	Time (min)				Time (min)	Pressure (psig)	Remaining Weight Fraction in Liquid State
5.4 (900)**	3070	41	783	68	-	-	-	68	783	0.74
4.0 (800)	3070	53	819	88	-	-	-	88	819	0.71
3.0 (725)	3070	70	856	115	-	-	-	115	856	0.69
2.3 (650)	3070	91	868	162	-	-	-	162	868	0.60
1.8 (600)	3070	125	640	241	254	238	241	407	247	0.00
1.2 (500)	3070	184	547	292	398	292	409	N	N	0.00
0.8 (400)	3070	278	465	358	538	538	513	N	N	0.00
5.4 (900)	5000	47	796	72	69	-	-	72	796	0.70
4.0 (800)	5000	60	782	103	-	-	-	103	782	0.61
3.0 (725)	5000	84	634	156	150	153	156	272	250	0.00
2.3 (650)	5000	105	570	176	187	174	245	341	248	0.00
1.8 (600)	5000	132	518	195	237	195	277	411	247	0.00
1.2 (500)	5000	198	441	237	344	237	349	572	247	0.00
0.8 (400)	5000	*	376	294	480	294	454	N	N	0.00
5.4 (900)	12,000	58	531	85	63	85	121	151	248	0.00
4.0 (800)	12,000	73	475	96	86	96	140	187	248	0.00
3.0 (725)	12,000	95	426	108	113	108	163	233	247	0.00
2.3 (650)	12,000	-	385	123	147	123	191	290	247	0.00
1.8 (600)	12,000	-	353	139	191	139	223	359	247	0.00
1.2 (500)	12,000	-	311	174	292	174	295	520	246	0.00
0.8 (400)	12,000	*	300	88(1)	427	227	400	N	N	0.00
5.4 (900)	28,600	-	359	63	60	63	99	132	247	0.00
4.0 (800)	28,600	-	327	71	76	71	118	168	246	0.00
3.0 (725)	28,600	-	303	81	99	82	142	214	247	0.00
2.3 (650)	28,200	-	300	41(1)	131	95	170	271	246	0.00
1.8 (600)	28,600	-	300	48(1)	173	110	202	339	246	0.00
1.2 (500)	28,600	-	300	64(1)	273	147	275	500	246	0.00
0.8 (400)	28,600	*	300	88(1)	411	206	384	N	N	0.00

- Condition not attained before failure
* Condition not attained within 600 minutes
N Condition cannot be determined from analysis, event would occur after 600 minutes
** Expected temperature which would be reached after 100 minutes in pool fire simulation test of thermal shield system
(1) First time valve opens, valve cycles open and shut, pressure never gets above 300 psig

TABLE 5.9. PROPYLENE: 105A400W TANK CAR (33,600 GAL. CAPACITY), UPRIGHT CAR CASE, 300 PSIG SAFETY RELIEF VALVE START TO DISCHARGE PRESSURE, POOL FIRE ENVIRONMENT

Thermal Shield System Conductance (BTU/hr-ft²-°F)	Relief Valve Flow Capacity (SCFM)	Time to Reach 400 psig (min)	Maximum Pressure		Time for tank wall over vapor space to reach 800°F (min)	Time for all liquid to vaporize (min)	Conditions at Failure		
			Pressure (psig)	Time (min)			Time (min)	Pressure (psig)	Remaining Weight Fraction in Liquid State
5.4 (900)**	3070	42	782	68	-	-	68	782	0.74
4.0 (800)	3070	54	819	88	-	-	88	819	0.71
3.0 (725)	3070	71	856	115	-	-	115	856	0.69
2.3 (650)	3070	91	653	214	226	214(2)	262	571	0.00(2)
1.8 (600)	3070	163	620	301	316	389	502	249	0.00
1.2 (500)	3070	*	372	351	528	537	*	N	0.00
0.8 (400)	3070	*	300	89(1)	*	*	*	N	N
5.4 (900)	5000	47	795	72	69	-	72	795	0.70
4.0 (800)	5000	60	653	135	109	135(2)	151	608	0.00(2)
3.0 (725)	5000	108	602	196	182	253	315	250	0.00
2.3 (650)	5000	173	425	220	247	307	403	248	0.00
1.8 (600)	5000	-	327	331	331	378	511	248	0.00
1.2 (500)	5000	*	300	65(1)	530	539	N	N	0.00
0.8 (400)	5000	*	300	89(1)	*	*	N	N	N
5.4 (900)	12,000	-	352	93	65	158	187	248	0.00
4.0 (800)	12,000	-	300	31(1)	97	199	244	248	0.00
3.0 (725)	12,000	-	300	36(1)	157	250	318	247	0.00
2.3 (650)	12,000	-	300	42(1)	238	311	407	247	0.00
1.8 (600)	12,000	-	300	49(1)	332	382	515	247	0.00
1.2 (500)	12,000	*	300	65(1)	532	541	N	N	0.00
0.8 (400)	12,000	*	300	89(1)	*	*	N	N	N
5.4 (900)	28,600	-	300	27(1)	64	161	190	247	0.00
4.0 (800)	28,600	-	300	31(1)	95	201	246	247	0.00
3.0 (725)	28,600	-	300	36(1)	157	251	319	246	0.00
2.3 (650)	28,600	-	300	42(1)	239	312	409	246	0.00
1.8 (600)	28,600	-	300	49(1)	333	382	516	246	0.00
1.2 (500)	28,600	*	300	65(1)	533	542	N	N	0.00
0.8 (400)	28,600	*	300	89(1)	*	*	N	N	N

- Condition not attained before failure
* Condition not attained within 600 minutes
N Condition cannot be determined from analysis, event would occur after 600 minutes
** Expected temperature which would be reached after 100 minutes in pool fire simulation test of thermal shield system
(1) First time valve opens, valve cycles open and shut, pressure never gets above 300 psig
(2) Product reaches critical temperature before all liquid is vaporized

TABLE 5.10. 1,3-BUTADIENE: 105A100W TANK CAR (33,600 GAL. CAPACITY), OVERTURNED (VALVE AT 120° ANGLE), 75 PSIG SAFETY RELIEF VALVE START TO DISCHARGE PRESSURE, POOL FIRE ENVIRONMENT

Thermal Shield System Conductance (BTU/hr-ft²-°F)	Relief Valve Flow Capacity (SCFM)	Time to Reach 100 psig (min)	Maximum Pressure		Time for tank wall over vapor space to reach 800°F (min)	Time for liquid level to reach 120° level (min)	Time for all liquid to vaporize (min)	Conditions at Failure		
			Pressure (psig)	Time (min)				Time (min)	Pressure (psig)	Remaining Weight Fraction in Liquid State
5.4 (900)**	1100	50	375	104	51	-	-	104	375	0.79
4.0 (800)	1100	64	393	137	-	-	-	137	393	0.77
3.0 (725)	1100	81	406	190	-	-	-	190	406	0.69
2.3 (650)	1100	104	422	250	-	-	-	250	422	0.57
1.8 (600)	1100	128	433	320	-	-	-	320	433	0.41
1.2 (500)	1100	183	417	459	551	459	*	N	N	N
0.8 (400)	1100	264	332	569	*	569	*	N	N	N
5.4 (900)	3000	56	350	114	50	-	-	114	350	0.56
4.0 (800)	3000	69	367	150	82	-	-	150	367	0.38
3.0 (725)	3000	86	373	193	167	193	-	193	373	0.15
2.3 (650)	3000	106	322	220	220	220	304	405	61	0.00
1.8 (600)	3000	130	279	247	272	248	350	485	61	0.00
1.2 (500)	3000	185	219	304	402	304	447	N	N	0.00
0.8 (400)	3000	266	172	376	583	376	586	N	N	0.00
5.4 (900)	10,000	58	232	94	49	94	139	174	62	0.00
4.0 (800)	10,000	71	198	106	73	106	164	215	62	0.00
3.0 (725)	10,000	88	170	121	113	121	195	268	62	0.00
2.3 (650)	10,000	108	148	138	146	138	231	332	61	0.00
1.8 (600)	10,000	132	131	157	190	157	273	408	61	0.00
1.2 (500)	10,000	187	109	198	319	198	366	583	61	0.00
0.8 (400)	10,000	*	93	256	496	256	499	N	N	0.00
5.4 (900)	20,000	58	149	74	49	74	123	158	62	0.00
4.0 (800)	20,000	72	130	84	69	84	147	198	61	0.00
3.0 (725)	20,000	89	115	97	96	97	177	250	61	0.00
2.3 (650)	20,000	109	103	112	126	112	213	313	61	0.00
1.8 (600)	20,000	-	94	129	169	129	254	389	61	0.00
1.2 (500)	20,000	-	83	167	299	167	346	564	61	0.00
0.8 (400)	20,000	*	75	142(1)	476	224	479	N	N	0.00

- Condition not attained before failure
* Condition not attained within 600 minutes
N Condition cannot be determined from analysis, event would occur after 600 minutes
** Expected temperature which would be reached after 100 minutes in pool fire simulation test of thermal shield system
(1) First time valve opens, valve cycles open and shut, pressure never gets above 75 psig

TABLE 5.11. 1,3-BUTADIENE: 105A100W TANK CAR (33,600 GAL. CAPACITY), UPRIGHT CAR CASE
75 PSIG SAFETY RELIEF VALVE START TO DISCHARGE PRESSURE, POOL FIRE ENVIRONMENT

Thermal Shield System Conductance (BTU/hr-ft²-°F)	Relief Valve Flow Capacity (SCFM)	Time to Reach 100 psig (min)	Maximum Pressure		Time for tank wall over vapor space to reach 800°F (min)	Time for all liquid to vaporize (min)	Conditions at Failure		
			Pressure (psig)	Time (min)			Time (min)	Pressure (psig)	Remaining Weight Fraction in Liquid State
5.4 (900)**	1100	50	375	104	51	-	104	375	0.79
4.0 (800)	1100	64	393	137	-	-	137	393	0.77
3.0 (725)	1100	81	409	219	-	-	219	409	0.67
2.3 (650)	1100	105	423	321	-	-	321	423	0.51
1.8 (600)	1100	133	413	496	-	-	496	413	0.21
1.2 (500)	1100	206	243(1)	600	*	*	N	N	N
0.8 (400)	1100	340	141(1)	600	*	*	N	N	N
5.4 (900)	3000	58	343	165	52	-	165	343	0.45
4.0 (800)	3000	75	268	226	110	318	366	62	0.00
3.0 (725)	3000	100	186	256	249	390	463	62	0.00
2.3 (650)	3000	138	139	282	356	481	581	62	0.00
1.8 (600)	3000	216	107	299	482	585	N	N	0.00
1.2 (500)	3000	*	75	102(2)	*	*	N	N	N
0.8 (400)	3000	*	75	143(2)	*	*	N	N	N
5.4 (900)	10,000	-	82	91	50	239	274	62	0.00
4.0 (800)	10,000	-	75	43(2)	84	300	350	62	0.00
3.0 (725)	10,000	-	75	52(2)	205	376	449	62	0.00
2.3 (650)	10,000	-	75	62(2)	325	468	568	61	0.00
1.8 (600)	10,000	*	75	74(2)	468	576	N	N	0.00
1.2 (500)	10,000	*	75	102(2)	*	*	N	N	N
0.8 (400)	10,000	*	75	143(2)	*	*	N	N	N
5.4 (900)	20,000	-	75	36(2)	50	239	273	61	0.00
4.0 (800)	20,000	-	75	43(2)	82	300	350	61	0.00
3.0 (725)	20,000	-	75	52(2)	205	376	449	62	0.00
2.3 (650)	20,000	-	75	62(2)	325	468	568	61	0.00
1.8 (600)	20,000	*	75	74(2)	468	575	N	62	0.00
1.2 (500)	20,000	*	75	102(2)	*	*	N	N	N
0.8 (400)	20,000	*	75	143(2)	*	*	N	N	N

- Condition not attained before failure
* Condition not attained within 600 minutes
N Condition cannot be determined from analysis, event would occur after 600 minutes
** Expected temperature which would be reached after 100 minutes in pool fire simulation test of thermal shield system
(1) Pressure still increasing
(2) First time valve opens, valve cycles open and shut, pressure never gets above 75 psig

The 1100 SCFM valve was selected as being representative of the smallest valve size that would be considered for a Class 105A100W tank car. The 20,000 SCFM valve is the size which results when the valve standards of HM-144 (AAR formula for uninsulated car) are applied to a 33,600 gallon car containing butadiene. The 3000 and 10,000 SCFM valve sizes were selected to provide intermediate results.

The information presented in Tables 5.10 and 5.11 shows results which are similar to those shown for cars loaded with propane or propylene. The failure pressures are relatively high and significant quantities of liquid product remain at the time of failure for the cases where smaller valve sizes are combined with the higher values of thermal shield conductance. Under other conditions the failure occurs after all of the liquid product within the car has been vaporized and the vapor pressure within the car is essentially at the closing pressure of the safety relief valve.

The results of the analyses show that under most conditions the overturned car case is more critical than the upright car case in the sense that the time to failure is less. With the 1100 SCFM valve size there are two cases, 5.4 and 4.0 Btu/hr-ft^2-°F conductance thermal shield systems, where the predicted failure times are the same.

Plots of the wall temperature over the vapor space, liquid fraction remaining and pressure versus time for each of the cases given in Tables 5.10 and 5.11 are presented in Appendix D.

5.6 RESULTS FOR CARS CONTAINING VINYL CHLORIDE

Tables 5.12 and 5.13 present the results for a Class 105A200W, 25,000 gallon capacity, tank car loaded with vinyl chloride. Table 5.12 shows the results for the overturned car and Table 5.13 for the upright car. An initial outage of 5.75% at 60°F is assumed which meets the requirements given by the CFR (Section 173.314). Four different safety relief valve capacities have been assumed, 320, 2000, 8000 and 17,500 SCFM. The 320 SCFM valve is the minimum size valve which would be permitted by AAR regulations for an insulated tank car of this size carrying this commodity. The 17,500 SCFM valve is the size which results when the valve standards of HM-144 (AAR formula for uninsulated car) are applied to a 25,000 gallon car containing vinyl chloride. The 2000 and 8000 SCFM valve sizes were selected to provide intermediate results.

The information presented in Tables 5.12 and 5.13 shows results which are similar to those shown for other flammable compressed gases. The failure pressures are relatively high and significant quantities of liquid product remain at the time of failure for the cases where smaller valve sizes are combined with the higher values of thermal shield conductance. All of the 320 SCFM cases fall into this category. These cases show a large increase in pressure when the car becomes shell full because of the small size of the valve opening. A relatively large flow rate is required because of the increase in specific volume of the liquid with temperature. Under other conditions the failure occurs after all of the liquid product within the car has been vaporized and the vapor pressure within the car is essentially at the closing pressure of the safety relief valve.

The results of the analyses show that for the cases where an 8000 or 17,500 SCFM valve are assumed the overturned car case is more critical than the upright car case in the sense that the time to failure is less. With the 320 SCFM valve size the failure times are the same. The cases with the 2000 SCFM valve size show mixed results.

Plots of the wall temperature over the vapor space, liquid fraction remaining and pressure versus time for each of the cases given in Tables 5.12 and 5.13 are presented in Appendix E.

5.7 RESULTS FOR CARS CONTAINING MONOMETHYLAMINE

Tables 5.14 and 5.15 present the results for a Class 105A300W, 33,600 gallon capacity, tank car loaded with monomethylamine. Table 5.14 shows the results for the overturned car and Table 5.15 for the upright car. An initial outage of 7.4% at 60°F is assumed, which meets the requirements given by the CFR (Section 173.314). Four different safety relief valve capacities have been assumed, 1100, 3070, 7000 and 15,800 SCFM. The 1100 SCFM valve was selected as being representative of the smallest valve size that would be considered for a Class 105A300W tank car of this size. The 15,800 SCFM valve is the size which results when the valve standards of HM-144 (AAR formula for uninsulated car) are applied to a 33,600 gallon car containing monomethylamine. The 3070 and 7000 SCFM valve sizes were selected to provide intermediate results.

The information presented in Tables 5.14 and 5.15 shows results which are similar to those shown for other flammable compressed gases. The failure pressures are relatively high and significant quantities of liquid product remain at the time of failure for the cases where smaller valve sizes are combined with the higher values of thermal shield conductance. Under these conditions the failure occurs after all of the liquid product within the car has been vaporized and the vapor pressure within the car is essentially at the closing pressure of the safety relief valve.

TABLE 5.12. VINYL CHLORIDE: 105A200W TANK CAR (25,000 GAL. CAPACITY), OVERTURNED (VALVE AT 120° ANGLE), 150 PSIG SAFETY RELIEF VALVE START TO DISCHARGE PRESSURE, POOL FIRE ENVIRONMENT

Thermal Shield System Conductance (BTU/hr-ft²-°F)	Relief Valve Flow Capacity (SCFM)	Time to Reach 200 psig (min)	Maximum Pressure		Time for tank wall over vapor space to reach 800°F (min)	Time for liquid level to reach 120° level (min)	Time for all liquid to vaporize (min)	Conditions at Failure		
			Pressure (psig)	Time (min)				Time (min)	Pressure (psig)	Remaining Weight Fraction in Liquid State
5.4 (900)**	320	39	425	39	-	-	-	39	425	1.00
4.0 (800)	320	46	433	46	-	-	-	46	433	1.00
3.0 (725)	320	56	427	87	-	-	-	87	427	0.94
2.3 (650)	320	67	442	137	-	-	-	137	442	0.90
1.8 (600)	320	104	455	191	-	-	-	191	455	0.86
1.2 (500)	320	185	471	303	-	-	-	303	471	0.83
0.8 (400)	320	298	481	478	-	-	-	478	481	0.80
5.4 (900)	2000	63	377	86	50	-	-	86	377	0.83
4.0 (800)	2000	80	396	119	107	-	-	119	396	0.79
3.0 (725)	2000	105	405	156	-	-	-	156	404	0.71
2.3 (650)	2000	131	422	203	-	-	-	203	422	0.60
1.8 (600)	2000	162	434	260	-	-	-	260	434	0.46
1.2 (500)	2000	233	428	388	493	388	552	N	N	0.00
0.8 (400)	2000	340	337	490	*	490	*	N	N	N
5.4 (900)	8000	70	338	96	50	-	-	96	338	0.42
4.0 (800)	8000	87	345	126	78	126	190	213	124	0.00
3.0 (725)	8000	109	298	145	130	145	226	262	124	0.00
2.3 (650)	8000	137	261	168	172	168	268	322	123	0.00
1.8 (600)	8000	170	232	192	221	192	316	393	123	0.00
1.2 (500)	8000	-	195	246	366	246	423	555	123	0.00
0.8 (400)	8000	*	169	323	568	323	576	N	N	0.00
5.4 (900)	17,500	72	252	85	50	85	139	152	124	0.00
4.0 (800)	17,500	91	221	99	75	99	167	190	123	0.00
3.0 (725)	17,500	-	197	115	111	115	201	237	123	0.00
2.3 (650)	17,500	-	179	134	145	134	241	296	123	0.00
1.8 (600)	17,500	-	166	157	193	157	288	365	123	0.00
1.2 (500)	17,500	-	150	111(1)	338	207	395	527	123	0.00
0.8 (400)	17,500	*	150	156(1)	539	282	548	N	N	0.00

- Condition not attained before failure
* Condition not attained within 600 minutes
N Condition cannot be determined from analysis, event would occur after 600 minutes
** Expected temperature which would be reached after 100 minutes in pool fire simulation test of thermal shield system
(1) First time valve opens, valve cycles open and shut, pressure never gets above 150 psig

TABLE 5.13. VINYL CHLORIDE: 105A200W TANK CAR (25,000 GAL. CAPACITY), UPRIGHT CAR CASE, 150 PSIG SAFETY RELIEF VALVE START TO DISCHARGE PRESSURE, POOL FIRE ENVIRONMENT

Thermal Shield System Conductance (BTU/hr-ft²-°F)	Relief Valve Flow Capacity (SCFM)	Time to Reach 200 psig (min)	Maximum Pressure		Time for tank wall over vapor space to reach 800°F (min)	Time for all liquid to vaporize (min)	Conditions at Failure		
			Pressure (psig)	Time (min)			Time (min)	Pressure (psig)	Remaining Weight Fraction in Liquid State
5.4 (900)**	320	39	427	39	-	-	39	427 435	1.00
4.0 (800)	320	46	435	47	-	-	47	435	1.00
3.0 (725)	320	56	427	87	-	-	87	427	0.94
2.3 (650)	320	67	442	137	-	-	137	442	0.90
1.8 (600)	320	104	455	192	-	-	192	455	0.86
1.2 (500)	320	186	471	304	-	-	304	471	0.83
0.8 (400)	320	299	481	479	-	-	479	481	0.80
5.4 (900)	2000	63	377	86	51	-	86	377	0.83
4.0 (800)	2000	80	396	113	-	-	113	396	0.82
3.0 (725)	2000	107	408	193	-	-	193	408	0.71
2.3 (650)	2000	147	419	311	-	-	311	419	0.49
1.8 (600)	2000	196	333	429	514	*	N	N	N
1.2 (500)	2000	416	205	501	*	*	N	N	N
0.8 (400)	2000	*	150	157(1)	*	*	N	N	N
5.4 (900)	8000	-	193	126	51	253	266	124	0.00
4.0 (800)	8000	-	153	116	88	318	340	124	0.00
3.0 (725)	8000	-	150	56(1)	210	400	436	124	0.00
2.3 (650)	8000	-	150	67(1)	340	498	552	124	0.00
1.8 (600)	8000	*	150	81(1)	493	*	N	N	N
1.2 (500)	8000	*	150	111(1)	*	*	N	N	N
0.8 (400)	8000	*	150	157(1)	*	*	N	N	N
5.4 (900)	17,500	-	150	39(1)	51	254	267	123	0.00
4.0 (800)	17,500	-	150	46(1)	84	318	341	123	0.00
3.0 (725)	17,500	-	150	56(1)	209	400	437	123	0.00
2.3 (650)	17,500	-	150	67(1)	339	498	552	123	0.00
1.8 (600)	17,500	*	150	81(1)	493	*	N	N	N
1.2 (500)	17,500	*	150	111(1)	*	*	N	N	N
0.8 (400)	17,500	*	150	157(1)	*	*	N	N	N

- **Condition not attained before failure**
- * **Condition not attained within 600 minutes**
- N **Condition cannot be determined from analysis, event would occur after 600 minutes**
- ** **Expected temperature which would be reached after 100 minutes in pool fire simulation test of thermal shield system**
- (1) First time valve opens, valve cycles open and shut, pressure never gets above 150 psig

TABLE 5.14. MONOMETHYLAMINE: 105A300W TANK CAR (33,600 GAL. CAPACITY), OVERTURNED (VALVE AT 120° ANGLE), 225 PSIG SAFETY RELIEF VALVE START TO DISCHARGE PRESSURE, POOL FIRE ENVIRONMENT

Thermal Shield System Conductance (BTU/hr-ft²-°F)	Relief Valve Flow Capacity (SCFM)	Time to Reach 300 psig (min)	Maximum Pressure		Time for tank wall over vapor space to reach 800°F (min)	Time for liquid level to reach 120° level (min)	Time for all liquid to vaporize (min)	Conditions at Failure		
			Pressure (psig)	Time (min)				Time (min)	Pressure (psig)	Remaining Weight Fraction in Liquid State
5.4 (900)**	1100	110	561	160	52	-	-	160	561	0.85
4.0 (800)	1100	143	589	208	-	-	-	208	589	0.85
3.0 (725)	1100	190	613	276	-	-	-	276	613	0.81
2.3 (650)	1100	240	639	361	-	-	-	361	639	0.75
1.8 (600)	1100	299	659	459	-	-	-	459	659	0.68
1.2 (500)	1100	434	533(1)	600	*	*	*	N	N	N
0.8 (400)	1100	*	273(1)	600	*	*	*	N	N	N
5.4 (900)	3070	120	532	163	52	-	-	163	532	0.75
4.0 (800)	3070	152	573	216	136	-	-	216	573	0.64
3.0 (725)	3070	194	589	279	-	-	-	279	589	0.53
2.3 (650)	3070	244	610	359	-	-	-	359	610	0.38
1.8 (600)	3070	304	620	449	-	-	-	449	620	0.21
1.2 (500)	3070	441	508	585	*	585	*	N	N	N
0.8 (400)	3070	*	267(1)	600	*	*	*	N	N	N
5.4 (900)	7000	122	509	162	52	-	-	162	509	0.48
4.0 (800)	7000	155	531	211	131	-	-	211	531	0.29
3.0 (725)	7000	196	503	261	229	261	399	435	186	0.00
2.3 (650)	7000	248	435	305	305	305	479	534	185	0.00
1.8 (600)	7000	309	381	354	386	354	570	N	N	N
1.2 (500)	7000	450	314	463	*	463	*	N	N	N
0.8 (400)	7000	*	256(1)	600	*	*	*	N	N	N
5.4 (900)	15,800	124	409	148	52	148	243	254	186	0.00
4.0 (800)	15,800	158	354	175	127	175	295	317	186	0.00
3.0 (725)	15,800	202	313	208	195	208	360	396	185	0.00
2.3 (650)	15,800	-	283	247	256	247	438	494	185	0.00
1.8 (600)	15,800	*	260	293	337	293	527	N	N	0.00
1.2 (500)	15,800	*	231	397	*	397	*	N	N	N
0.8 (400)	15,800	*	225	326(2)	*	551	*	N	N	N

- Condition not attained before failure
* Condition not attained within 600 minutes
N Condition cannot be determined from analysis, event would occur after 600 minutes
** Expected temperature which would be reached after 100 minutes in pool fire simulation test of thermal shield system
(1) Pressure still increasing
(2) First time valve opens, valve cycles open and shut, pressure never gets above 225 psig

TABLE 5.15. MONOMETHYLAMINE: 105A300W TANK CAR (33,600 GAL. CAPACITY), UPRIGHT CAR CASE, 225 PSIG SAFETY RELIEF VALVE START TO DISCHARGE PRESSURE, POOL FIRE ENVIRONMENT

Thermal Shield System Conductance (BTU/hr-ft²-°F)	Relief Valve Flow Capacity (SCFM)	Time to Reach 300 psig (min)	Maximum Pressure		Time for tank wall over vapor space to reach 800°F (min)	Time for all liquid to vaporize (min)	Conditions at Failure		
			Pressure (psig)	Time (min)			Time (min)	Pressure (psig)	Remaining Weight Fraction in Liquid State
5.4 (900)**	1100	110	561	160	54	-	160	561	0.85
4.0 (800)	1100	143	589	208	-	-	208	589	0.85
3.0 (725)	1100	190	626	298	-	-	298	626	0.83
2.3 (650)	1100	245	647	426	-	-	426	647	0.77
1.8 (600)	1100	320	654(1)	600	*	*	N	N	N
1.2 (500)	1100	509	349(1)	600	*	*	N	N	N
0.8 (400)	1100	*	230(1)	600	*	*	N	N	N
5.4 (900)	3070	128	539	203	54	-	203	539	0.76
4.0 (800)	3070	172	565	336	175	-	336	565	0.53
3.0 (725)	3070	240	429	458	438	*	N	N	N
2.3 (650)	3070	379	318	500	*	*	N	N	N
1.8 (600)	3070	*	250	494	*	*	N	N	N
1.2 (500)	3070	*	225	318(2)	*	*	N	N	N
0.8 (400)	3070	*	225	463(2)	*	*	N	N	N
5.4 (900)	7000	-	288	218	54	461	472	188	0.00
4.0 (800)	7000	*	225	85(2)	149	585	N	N	0.00
3.0 (725)	7000	*	225	106(2)	393	*	N	N	N
2.3 (650)	7000	*	225	131(2)	*	*	N	N	N
1.8 (600)	7000	*	225	160(2)	*	*	N	N	N
1.2 (500)	7000	*	225	228(2)	*	*	N	N	N
0.8 (400)	7000	*	225	328(2)	*	*	N	N	N
5.4 (900)	15,800	-	225	69(2)	54	465	476	186	0.00
4.0 (800)	15,800	*	225	85(2)	144	587	N	N	N
3.0 (725)	15,800	*	225	106(2)	392	*	N	N	N
2.3 (650)	15,800	*	225	131(2)	*	*	N	N	N
1.8 (600)	15,800	*	225	160(2)	*	*	N	N	N
1.2 (500)	15,800	*	225	228(2)	*	*	N	N	N
0.8 (400)	15,800	*	225	328(2)	*	*	N	N	N

- **Condition not attained before failure**
- * **Condition not attained within 600 minutes**
- N **Condition cannot be determined from analysis, event would occur after 600 minutes**
- ** **Expected temperature which would be reached after 100 minutes in pool fire simulation test of thermal shield system**
- (1) Pressure still increasing
- (2) First time valve opens, valve cycles open and shut, pressure never gets above 225 psig

The results of the analyses show that under most conditions the overturned car case is more critical than the upright car case in the sense that the time to failure is less. With the 1100 SCFM valve sizes there are two cases where the failure times are the same.

Plots of the wall temperature over the vapor space, liquid fraction remaining and pressure versus time for each of the cases given in Tables 5.14 and 5.15 are presented in Appendix F.

5.8 RESULTS FOR CARS CONTAINING PROPYLENE OXIDE

Tables 5.16 and 5.17 present the results for a Class 105A300W, 25,000 gallon capacity, tank car loaded with propylene oxide. Table 5.16 shows the results for the overturned car and Table 5.17 for the upright car. An initial outage of 3.58% at 60°F is assumed, which would prevent the car from becoming shell full until the product reached a temperature of 105°F. Because of the low vapor pressure of propylene oxide (6.5 psia at 60°F) a nitrogen padding pressure of 20 psi has been assumed for this case. Four different safety relief valve capacities have been assumed, 330, 1100, 5000 and 16,500 SCFM. The 330 SCFM valve is the minimum size valve which would be permitted by AAR regulations for an insulated tank car of this size carrying a commodity classified as a liquid. The 16,500 SCFM valve is the size which results when the valve standards of HM-144 (AAR formula for uninsulated car) are applied to a 25,000 gallon car containing propylene oxide. The 1100 and 5000 SCFM valve sizes were selected to provide intermediate results.

The information presented in Tables 5.16 and 5.17 shows results which are similar to those shown for the other commodities analyzed in this report. The failure pressures are relatively high and significant quantities of liquid product remain at the time of failure for the cases where smaller valve sizes are combined with the higher values of thermal shield conductance. Under other conditions the failure occurs after all of the liquid product within the car has been vaporized and the vapor pressure within the car is essentially at the closing pressure of the safety relief valve.

The results of the analyses show that for the 1100, 5000 and 16,500 SCFM valve size cases the overturned car case is more critical than the upright car case in the sense that the time to failure is less. With the 330 SCFM valve size cases the opposite is true. The failure times for the upright car cases are slightly less than for the overturned car cases. This results from the effects of the nitrogen pad which causes the release of the product to begin earlier for the overturned car cases.

Plots of the wall temperature over the vapor space, liquid fraction remaining and pressure versus time for each of the cases given in Tables 5.16 and 5.17 are presented in Appendix G. The cycling of the valve during the early stages of the fire exposure due to the presence of the nitrogen pad is shown in many of the plots.

TABLE 5.16. PROPYLENE OXIDE: 105A100W TANK CAR (25,000 GAL. CAPACITY), OVERTURNED (VALVE AT 120° ANGLE)
75 PSIG SAFETY RELIEF VALVE START TO DISCHARGE PRESSURE, POOL FIRE ENVIRONMENT

Thermal Shield System Conductance (BTU/hr-ft²-°F)	Relief Valve Flow Capacity (SCFM)	Time to Reach 100 psig (min)	Maximum Pressure		Time for tank wall over vapor space to reach 800°F (min)	Time for liquid level to reach 120° level (min)	Time for all liquid to vaporize (min)	Conditions at Failure		
			Pressure (psig)	Time (min)				Time (min)	Pressure (psig)	Remaining Weight Fraction in Liquid State
5.4 (900)**	330	113	352	234	48	-	-	234	352	0.74
4.0 (800)	330	150	381	316	80	-	-	316	381	0.71
3.0 (725)	330	195	394	418	-	-	-	418	394	0.67
2.3 (650)	330	250	413	542	-	-	-	542	413	0.61
1.8 (600)	330	314	321(1)	600	*	*	*	N	N	N
1.2 (500)	330	460	168(1)	600	*	*	*	N	N	N
0.8 (400)	330	*	80(1)	600	*	*	*	N	N	N
5.4 (900)	1100	128	338	241	48	-	-	241	338	0.54
4.0 (800)	1100	162	359	313	80	-	-	313	359	0.43
3.0 (725)	1100	206	375	400	306	-	-	400	375	0.30
2.3 (650)	1100	260	384	498	462	-	-	498	384	0.17
1.8 (600)	1100	323	342	578	581	578	*	N	N	N
1.2 (500)	1100	468	175(1)	600	*	*	*	N	N	N
0.8 (400)	1100	*	76(1)	600	*	*	*	N	N	N
5.4 (900)	5000	131	228	186	48	186	252	283	62	0.00
4.0 (800)	5000	165	201	218	80	218	299	346	62	0.00
3.0 (725)	5000	209	172	257	213	257	361	429	61	0.00
2.3 (650)	5000	262	150	303	297	303	434	530	62	0.00
1.8 (600)	5000	324	132	356	377	356	521	N	N	0.00
1.2 (500)	5000	464	110	477	*	477	*	N	N	N
0.8 (400)	5000	*	75	130(2)	*	*	*	N	N	N
5.4 (900)	16,500	131	114	137	48	137	212	244	62	0.00
4.0 (800)	16,500	164	102	165	80	165	261	308	62	0.00
3.0 (725)	16,500	-	93	202	191	202	323	391	61	0.00
2.3 (650)	16,500	-	85	246	253	246	397	493	61	0.00
1.8 (600)	16,500	*	80	298	332	298	484	N	N	0.00
1.2 (500)	16,500	*	75	93(2)	577	417	*	N	N	N
0.8 (400)	16,500	*	75	130(2)	*	594	*	N	N	N

- Condition not attained before failure
* Condition not attained within 600 minutes
N Condition cannot be determined from analysis, event would occur after 600 minutes
** Expected temperature which would be reached after 100 minutes in pool fire simulation test of thermal shield system
(1) Pressure still increasing
(2) First time valve opens, valve cycles open and shut, pressure never gets above 75 psig

TABLE 5.17. PROPYLENE OXIDE: 105A100W TANK CAR (25,000 GAL. CAPACITY), UPRIGHT CAR CASE, 75 PSIG RELIEF VALVE START TO DISCHARGE PRESSURE, POOL FIRE ENVIRONMENT

Thermal Shield System Conductance (BTU/hr-ft²-°F)	Relief Valve Flow Capacity (SCFM)	Time to Reach 100 psig (min)	Maximum Pressure		Time for tank wall over vapor space to reach 800°F (min)	Time for all liquid to vaporize (min)	Conditions at Failure		
			Pressure (psig)	Time (min)			Time (min)	Pressure (psig)	Remaining Weight Fraction in Liquid State
5.4 (900)**	330	107	369	216	51	-	216	369	0.77
4.0 (800)	330	145	398	295	243	-	295	398	0.74
3.0 (725)	330	192	411	392	-	-	392	411	0.72
2.3 (650)	330	247	430	514	-	-	514	430	0.70
1.8 (600)	330	312	296(1)	600	*	*	N	N	N
1.2 (500)	330	465	160(1)	600	*	*	N	N	N
0.8 (400)	330	*	76	170	*	*	N	N	N
5.4 (900)	1100	124	353	266	51	-	266	353	0.69
4.0 (800)	1100	161	376	385	205	-	385	376	0.58
3.0 (725)	1100	208	387	566	497	-	566	387	0.37
2.3 (650)	1100	269	262(1)	600	*	*	N	N	N
1.8 (600)	1100	344	195(1)	600	*	*	N	N	N
1.2 (500)	1100	536	113(1)	600	*	*	N	N	N
0.8 (400)	1100	*	76	170	*	*	N	N	N
5.4 (900)	5000	152	132	252	51	411	442	62	0.00
4.0 (800)	5000	-	85	239	148	505	552	62	0.00
3.0 (725)	5000	*	75	48(2)	343	*	N	N	N
2.3 (650)	5000	*	75	57(2)	547	*	N	N	N
1.8 (600)	5000	*	75	68(2)	*	*	N	N	N
1.2 (500)	5000	*	75	93(2)	*	*	N	N	N
0.8 (400)	5000	*	75	130(2)	*	*	N	N	N
5.4 (900)	16,500	-	75	34(2)	51	397	428	62	0.00
4.0 (800)	16,500	-	75	40(2)	144	501	548	61	0.00
3.0 (725)	16,500	*	75	48(2)	337	*	N	N	N
2.3 (650)	16,500	*	75	57(2)	545	*	N	N	N
1.8 (600)	16,500	*	75	68(2)	*	*	N	N	N
1.2 (500)	16,500	*	75	93(2)	*	*	N	N	N
0.8 (400)	16,500	*	75	130(2)	*	*	N	N	N

- Condition not attained before failure
* Condition not attained within 600 minutes
N Condition cannot be determined from analysis, event would occur after 600 minutes
** Expected temperature which would be reached after 100 minutes in pool fire simulation test of thermal shield system
(1) Pressure still increasing
(2) First time valve opens, valve cycles open and shut, pressure never gets above 75 psig

6. SIMULATION OF FIRE EFFECTS ON SPECIMEN THERMAL SHIELD SYSTEMS

6.1 DESCRIPTION OF TEST FACILITY

A test facility has been developed and used (Ref. 5) to simulate the effects of both pool and torch fires on sample tank car thermal shield systems. Four by four foot test specimens are used where the insulation system is applied to a 5/8 inch thick steel plate. The specimens are mounted vertically in a fixture so that a flame can be directed horizontally at the center of the specimen. The fixture provides a dead air space from 18 to 24 inches deep behind the back of the plate. The sides and rear of this space are insulated so that there will be minimal heat transfer to or from the back of the plate. Nine thermocouples are applied to the back of the plate. A flame is directed at the center of the specimen and the temperature rise in the steel plate indicated by the thermocouples is recorded.

The intensity of the flame is calibrated by using an uninsulated 5/8 inch thick steel plate and noting the time that it takes for the temperature of this plate to reach 800°F. For pool fire simulations this temperature must be reached in 12 to 14 minutes. For the torch fire simulation, the temperature must be reached in 3.5 to 4.5 minutes.

The pool fire simulation test calls for exposure of the specimen to the flame for 100 minutes. The requirements for HM-144 are that the maximum temperature indicated by any of the thermocouples on the back of the plate must not exceed 800°F in the 100 minute test period.

6.2 RESULTS FROM POOL FIRE SIMULATION TESTS

The facility has been used to qualify materials for use under the HM-144 requirements and to develop improved thermal protection systems. It also has been used to evaluate high temperature insulation systems for Class 105 tank cars. Tests have shown that the conventional insulation systems used on Class 105 tank cars break down after about 10 to 30 minutes of exposure to typical fire environments. Minimal protection is subsequently afforded by these systems to the high temperature fire effects. This is demonstrated by a typical test result shown in Figure 6.1. This figure shows the temperature versus time measured on the back of the plate to which the insulation system is applied. Note that the insulation is effective initially in limiting the temperature rise, but that after a period of about 10 minutes a very rapid increase in temperature occurs until an asymptotic value is approached after about 40 minutes. The results show that an 800°F temperature would be reached in about 30 minutes.

A typical result from a test conducted on a Class 105 thermal insulation system where the conventional insulation is augmented by a coating capable of withstanding high temperatures is shown in Figure 6.2. Temperatures measured on the metal plate behind the insulation system are again shown as a function of time. Three distinct regions may be noted. First there is a slow increase in temperature over the first 10 to 30 minutes as the effectiveness of the conventional insulation component as well as the high temperature insulation component provides initial retardation to the heat flow. Secondly, after the performance of the conventional insulation component is degraded by the heat there is a nearly linear increase in temperature with time as the high temperature insulation provides the major retardant to the heat flow. Finally, the temperature approaches an asymptotic value as steady state conditions are reached. In this case, 800°F was the maximum temperature recorded by a thermocouple in 100 minutes.

6.3 INTERPRETATION OF POOL FIRE SIMULATION DATA

Data from the pool fire simulation tests can be used to estimate the effective thermal conductances of tank car thermal shield systems. It must be recognized that the inference of conductance from a test of this type is subject to some uncertainty because it is not an ideal test for the measurement of thermal conductance. The most desirable test procedure would be to hold the temperature on the outer and inner surfaces of the system constant during the test so that the conductance can be established when the system is operating between specific temperature limits. The pool fire simulation test does not meet this requirement because it allows the back plate temperature to rise during the course of the test. Nevertheless, it is possible to calculate an effective conductance of the thermal shield by estimating the heat input to the outside surface and evaluating the effect of the temperature rise in the base plate over the 100 minute test period. The major uncertainty in this calculation is estimating the heat loss from the back side of the base plate to the other surfaces of the dead air space behind the test specimen.

The first step in this analysis is to estimate the heat flux from the uninsulated plate calibration data. Calculations have been made of the heat flux required to cause the temperature

of the base plate to rise from 60°F to 800°F in 13 minutes. (The test procedure requires that 800°F be attained in from 12 to 14 minutes.) The calculation has been made with two different sets of assumptions: first, that there is no heat loss from the back of the plate, and the second that there is a radiant exchange of heat from the back of the plate to the sheet steel that surrounds the dead air cavity and that there is a subsequent small heat loss from this sheet steel through the insulation that is applied to the outside of the test fixture. The first assumption has been found to imply a heat flux of approximately 11,950 Btu/hr-ft² to a cold plate surface. The second assumption implies a heat flux of approximately 13,200 Btu/hr-ft². The heat flux implied by the first assumption probably provides the best estimate because there is not much time to distribute the heat around the inside of the dead air space. The heat flux can be represented as the thermal radiation coming from a 1600°F flame (which is assumed in the definition of the simulation test) where a radiation surface configuration factor (view factor) of 0.48 is applied to represent the fact that the surface of the plate is not completely engulfed by the flame. The corresponding view factor for the second assumption is 0.53.

Calculations have then been made to estimate the effective conductances of thermal shield systems using the above estimates of the flame temperature and radiation surface configuration factors. A surface emissivity factor of 0.8 was assumed. Two different assumptions for heat loss from the back of the plate have also been used in these calculations, namely, no heat loss, and heat loss by radiation to the back and sides of the cavity behind the base plate. It has also been assumed that the conductance of the thermal shield system does not change with time. The effective conductance can be related to the temperature rise in the plate. The assumption of whether or not there is any heat loss from the base plate makes a significant difference in the predicted temperature rise for the base plate of over the 100 minute test period. The results are plotted in Figure 6.3. The curve which includes the effect of heat loss probably most nearly represents the conditions which exist during the test and gives the most conservative estimate of effective conductance. If this curve is used, the following table gives the back plate temperature rises which can be associated with several values of effective conductance.

Effective Conductance (Btu/hr-ft²-°F)	Back Plate Temperature After 100 Minutes
5.4	900
4.0	800
3.0	725
2.3	650
1.8	600
1.2	500
0.8	400

There is an estimated range of ±20% in establishing the conductance associated with a given temperature. That is, an 800°F temperature implies a conductance of 4.0 ±20% (3.2-4.8), and a 650°F temperature implies a conductance of 2.3 ±20% (1.8-2.8). This range is indicated by the shaded region on the figure.

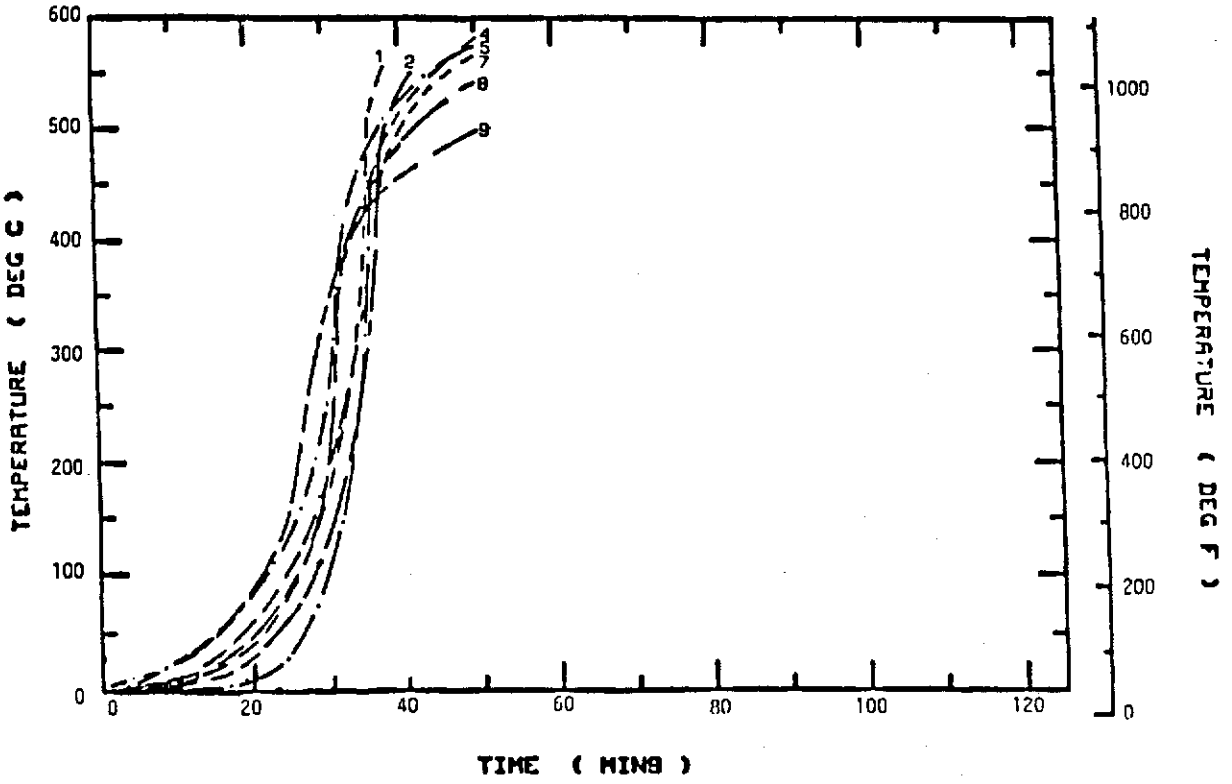

FIGURE 6.1. TYPICAL POOL FIRE SIMULATION TEST RESULT FOR CONVENTIONAL CLASS 105 INSULATION SYSTEM WITHOUT HIGH TEMPERATURE INSULATION COMPONENT

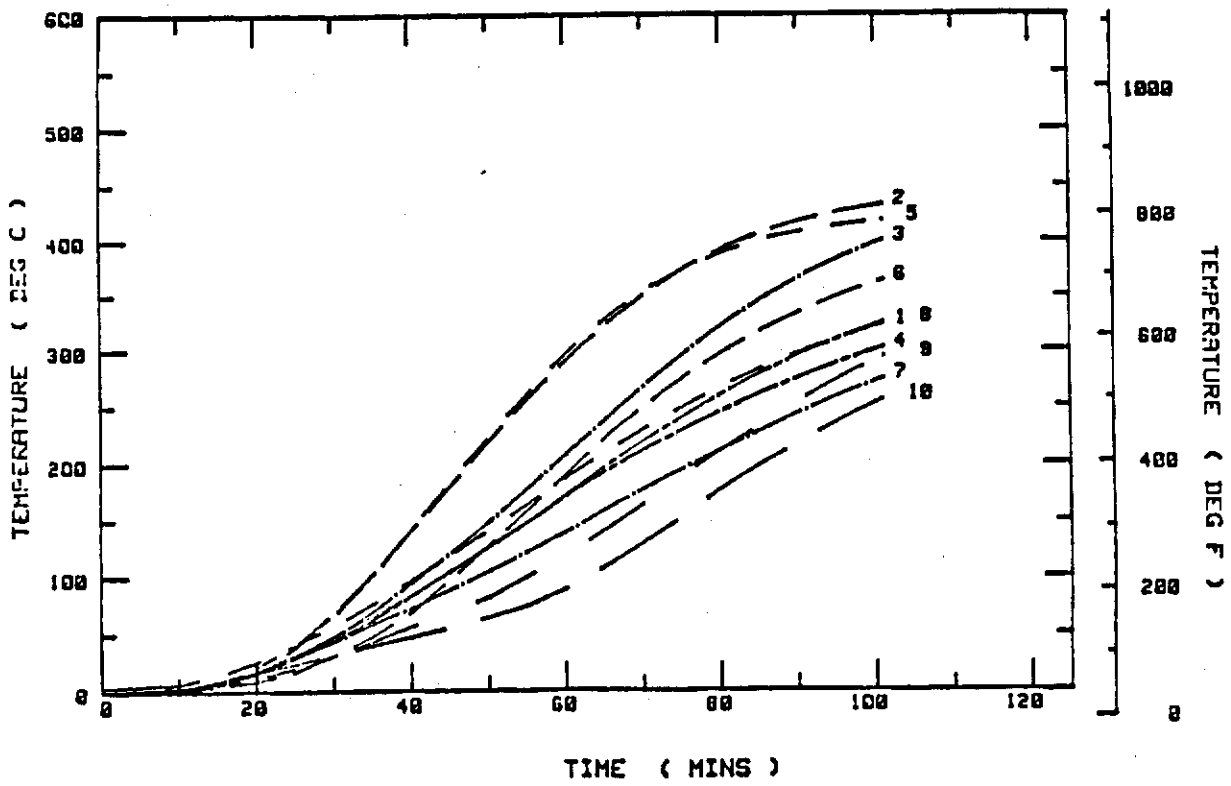

FIGURE 6.2. TYPICAL POOL FIRE SIMULATION TEST RESULT FOR CLASS 105 INSULATION SYSTEM WHICH INCLUDES HIGH TEMPERATURE COMPONENT

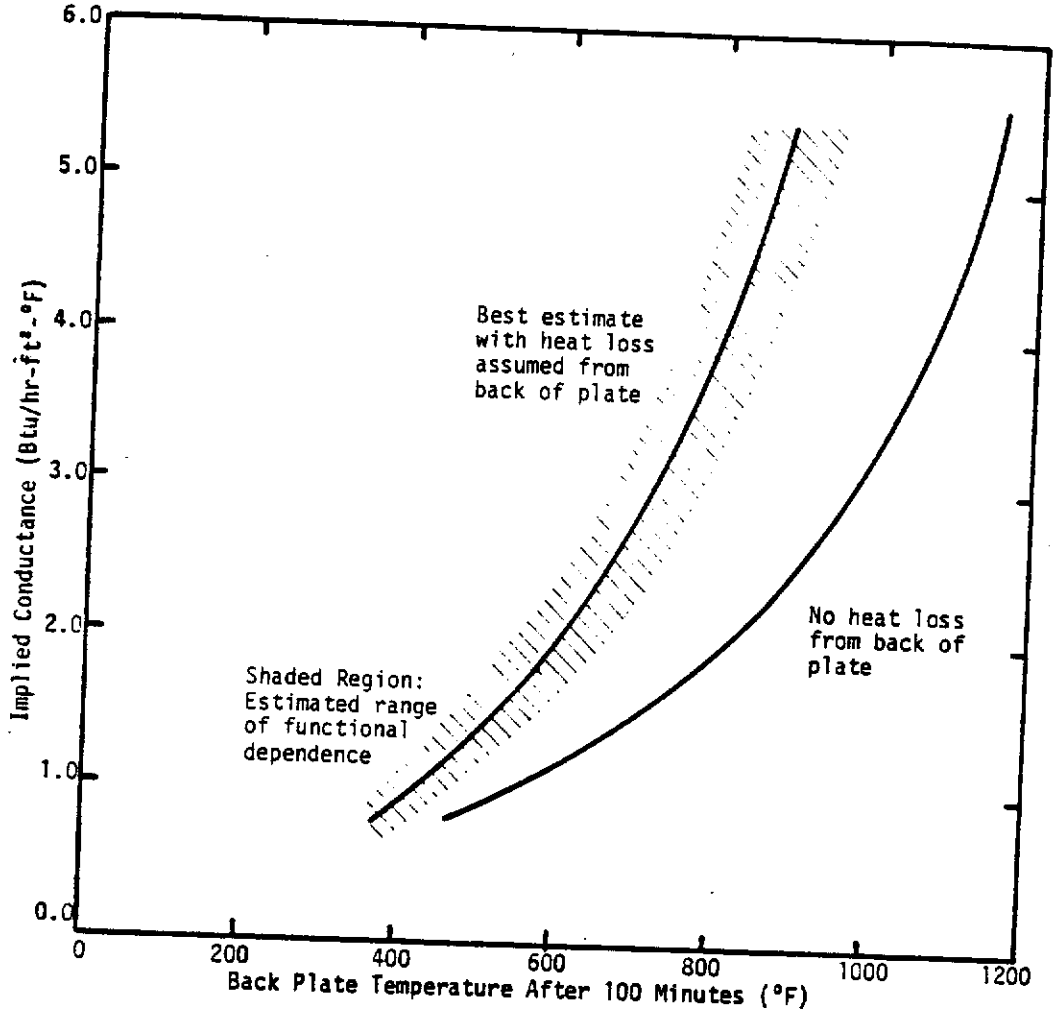

FIGURE 6.3. THERMAL SHIELD CONDUCTANCE IMPLIED FROM TEMPERATURE RISE IN BACK PLATE OVER 100 MINUTE PERIOD OF POOL FIRE SIMULATION TEST (CONSTANT EFFECTIVE CONDUCTANCE ASSUMED)

7. RELATIONSHIP OF RESULTS TO SAFETY CONSIDERATIONS

Tank cars are frequently exposed to the effects of large pool fires when they are involved in accidents. The results from the analyses described in this report can be used to assess the degree to which different combinations of thermal protective systems and safety relief valves will be successful in preventing or minimizing the consequences of tank car failures under these conditions. The results are presented in both tabular and graphical form. The tabulated data summarizes the following information:

1) Differences between upright and overturned car cases.

2) Predicted times to failure of a tank due to the increase in pressure within the tank along with a corresponding reduction in material strength of the tank because of its increase in temperature.

3) The time it takes for the tank test pressure to be reached.

4) The time it takes for the tank to become empty of all liquid product.

5) The time it takes to reach an 800°F temperature level within the tank. This is an important consideration for the thermal protection of products which undergo rapid decomposition at elevated temperatures.

This information allows one to select specific options for protective systems which would satisfy requirements relating to the above factors. The data also can be used to show where trade offs are possible, such as where specific criteria like "no failure before tank empty of liquid" may be satisfied by a large flow capacity of the safety relief valve and a moderate thermal shield capability or by a small valve flow capacity and a high performance thermal shield.

8. REFERENCES

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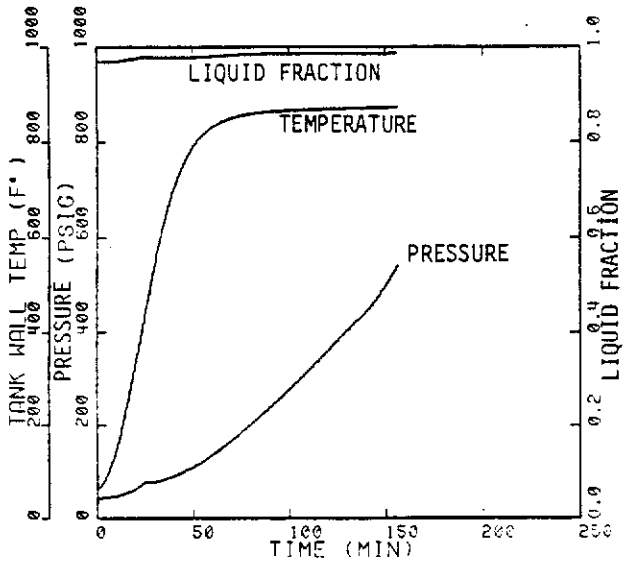
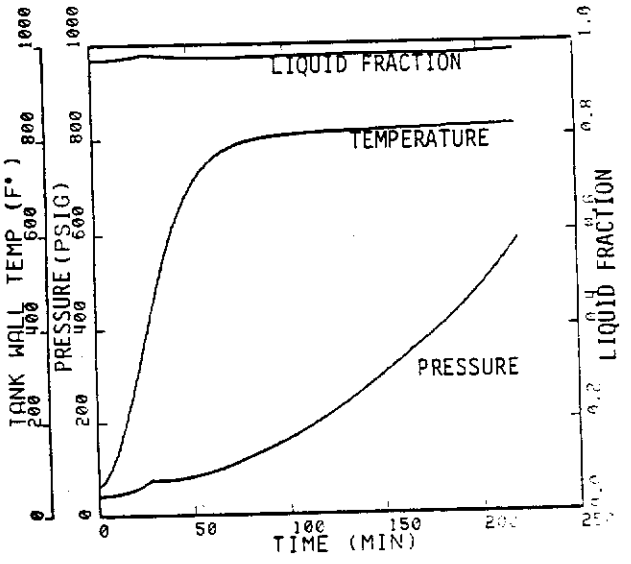
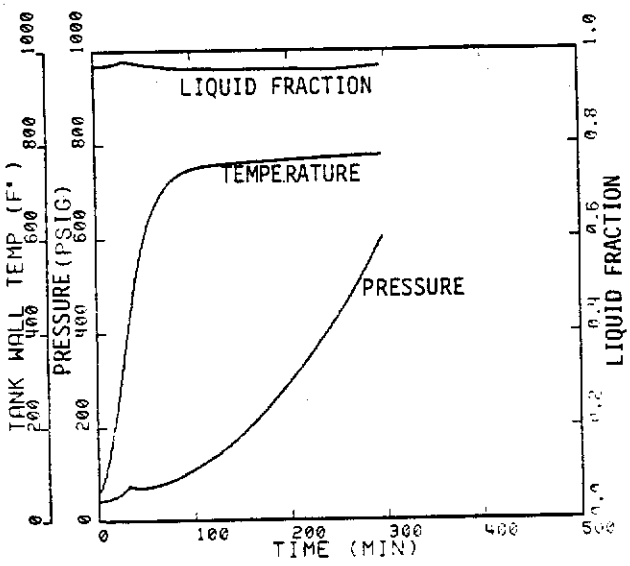
APPENDIX A: ETHYLENE OXIDE PLOTS



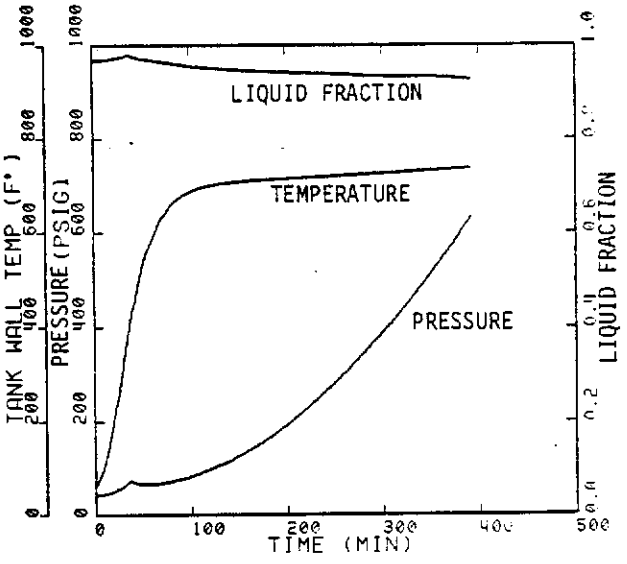
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

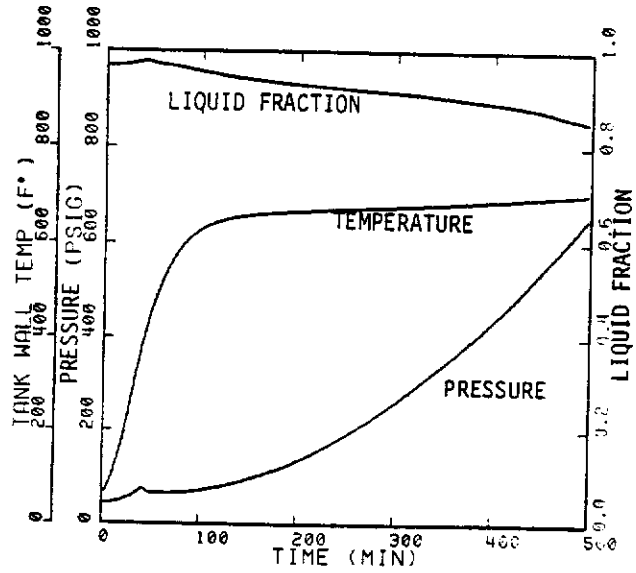


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

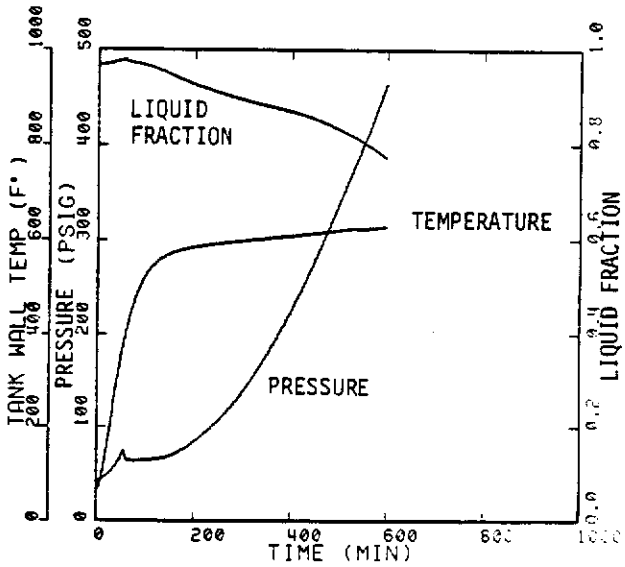


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

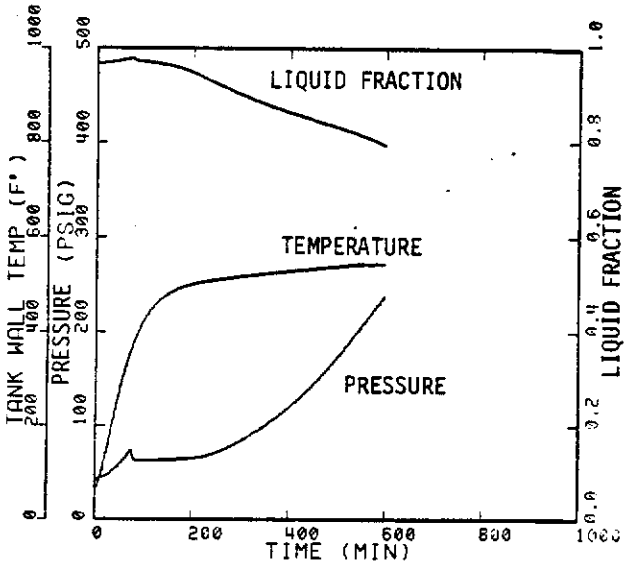
FIGURE A-1. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A300W TANK CAR CONTAINING ETHYLENE OXIDE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 260 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

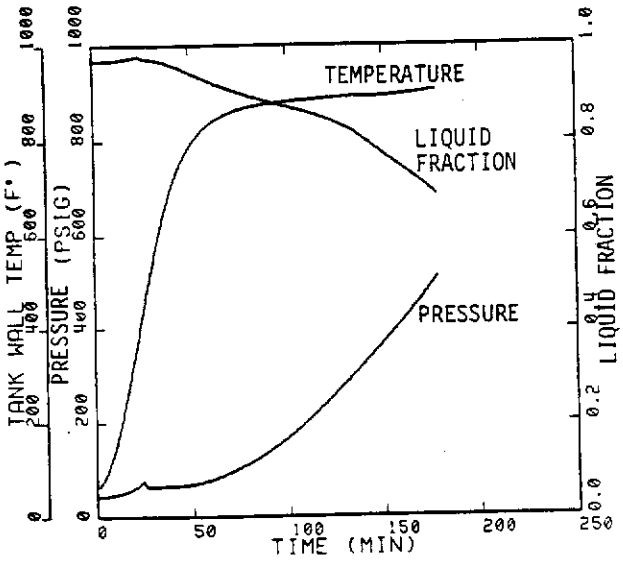


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

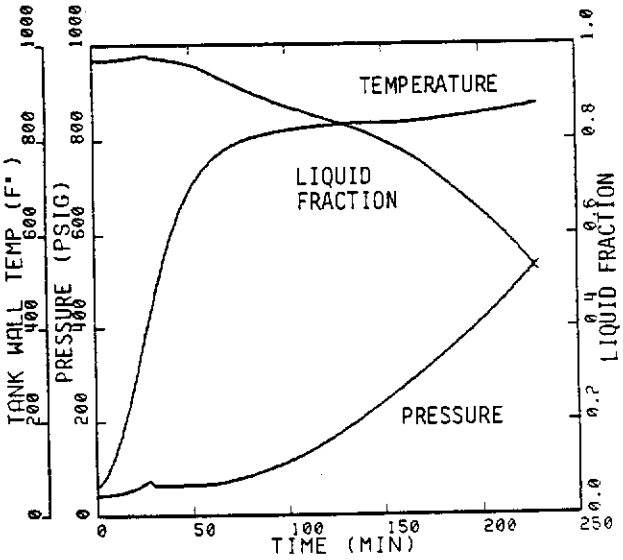


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

FIGURE A-1. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A300W TANK CAR CONTAINING ETHYLENE OXIDE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 260 SCFM



a. THERMAL SHIELD CONDUCTANCE 5.4 BTU/HR-FT²-°F



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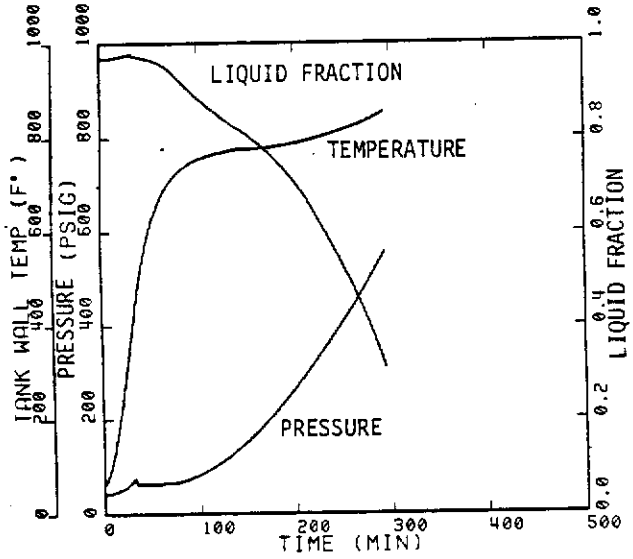

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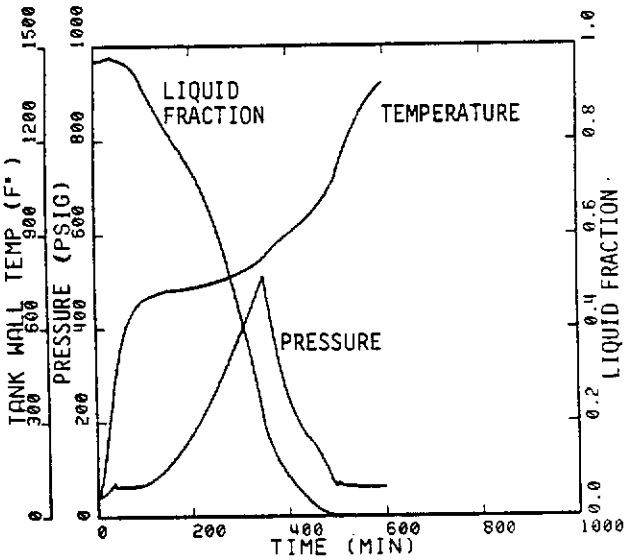
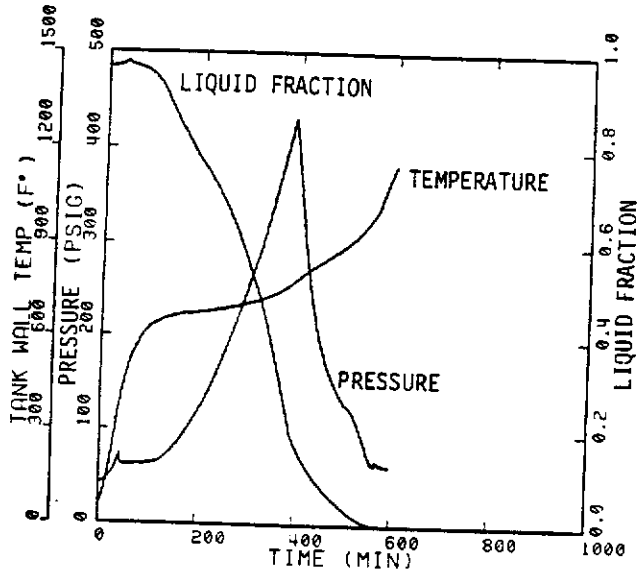
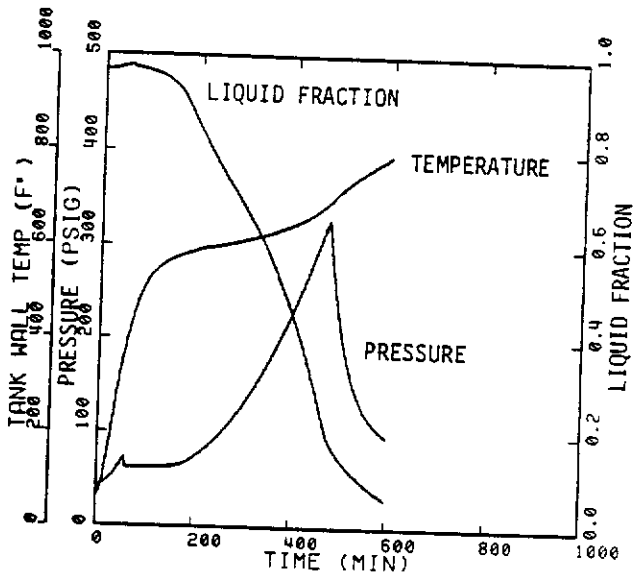


d. THERMAL SHIELD CONDUCTANCE 2.3 BTU/HR-FT²-°F

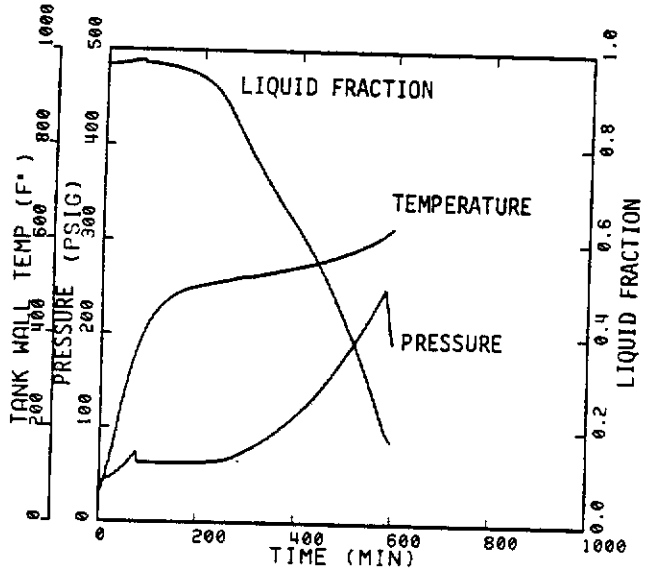
FIGURE A-2. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A300W TANK CAR CONTAINING ETHYLENE OXIDE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 1100 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

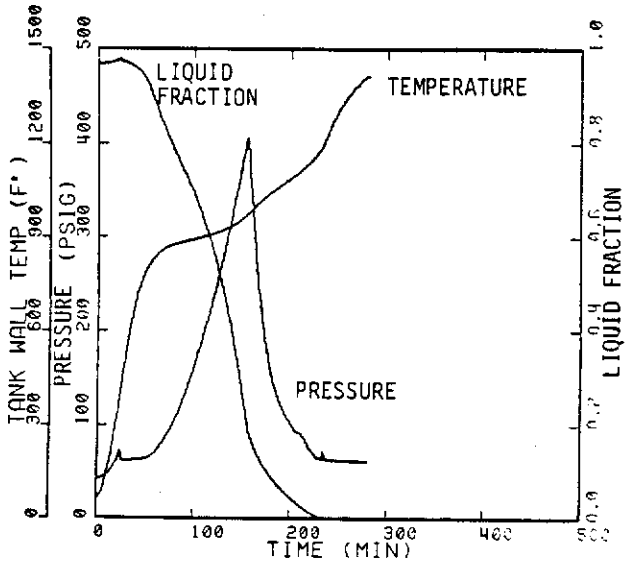


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

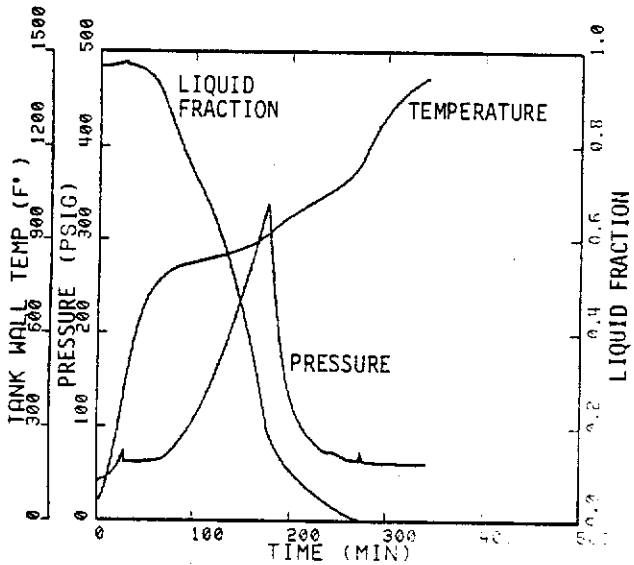


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

FIGURE A-2. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A300W TANK CAR CONTAINING ETHYLENE OXIDE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 1100 SCFM



a. THERMAL SHIELD CONDUCTANCE 5.4 BTU/HR-FT²-°F



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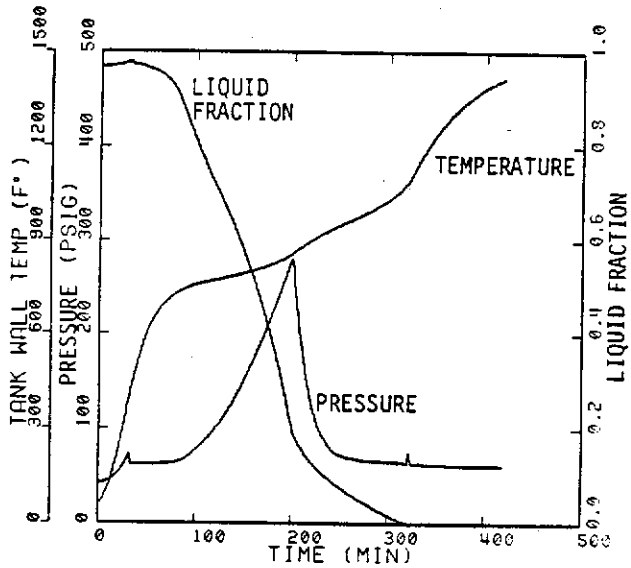

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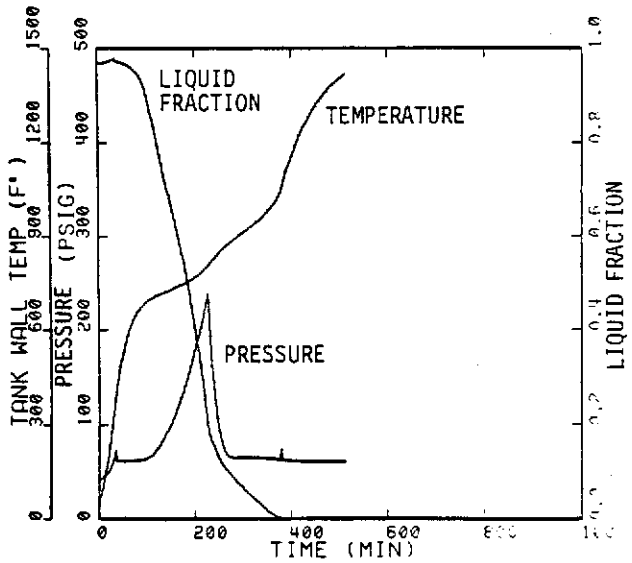
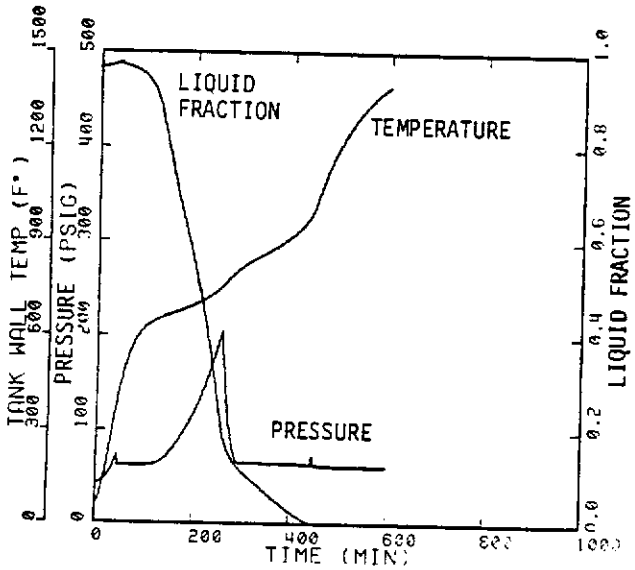
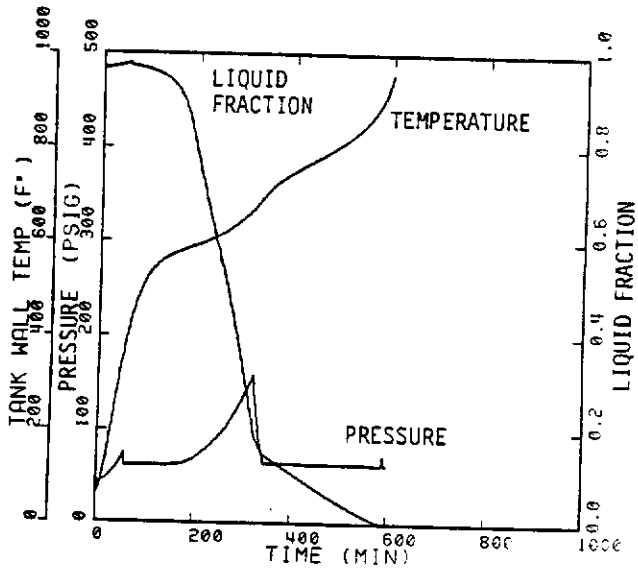


d. THERMAL SHIELD CONDUCTANCE 2.3 BTU/HR-FT²-°F

FIGURE A-3. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A300W TANK CAR CONTAINING ETHYLENE OXIDE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 3000 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F



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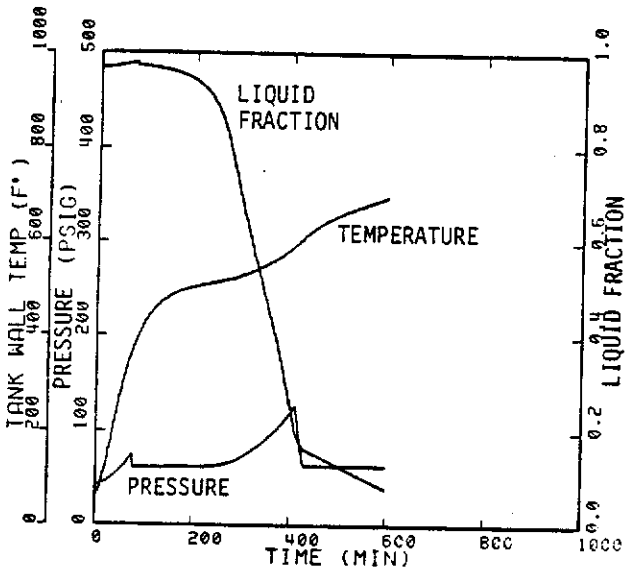
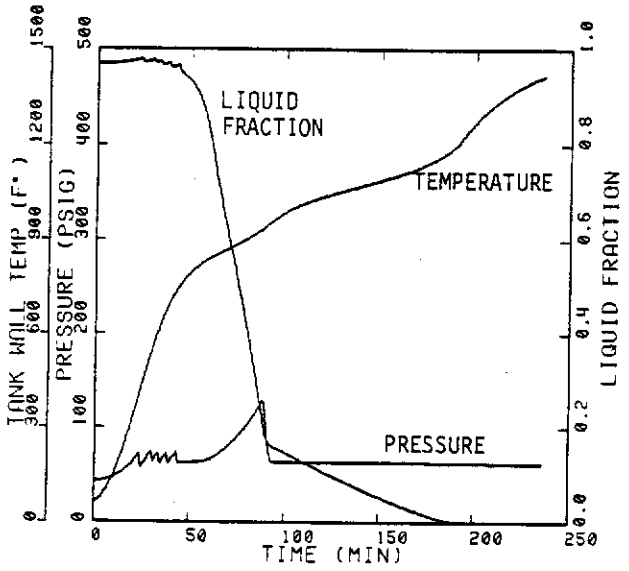
1.2 BTU/HR-FT²-°F

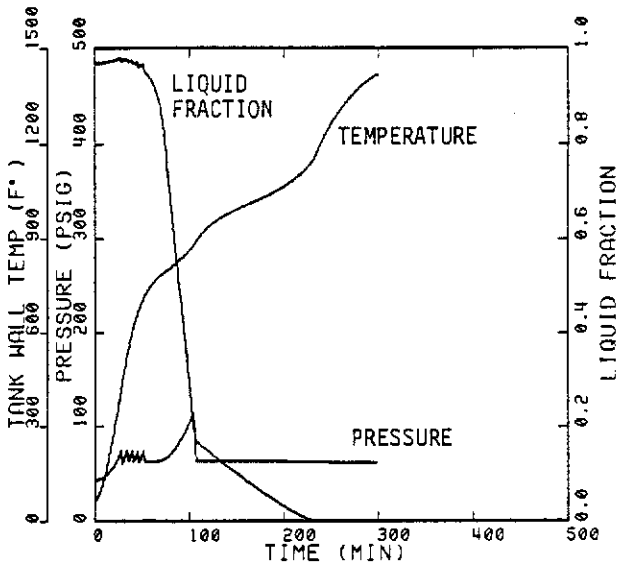


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

FIGURE A-3. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A300W TANK CAR CONTAINING ETHYLENE OXIDE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 3000 SCFM



a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



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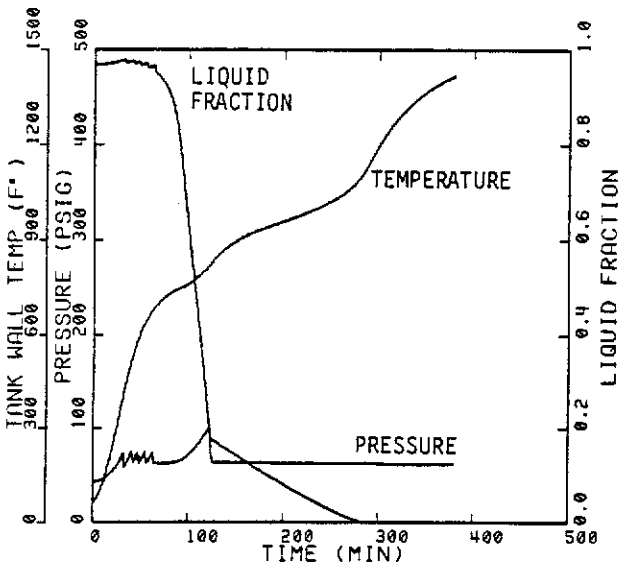
4.0 BTU/HR-FT²-°F



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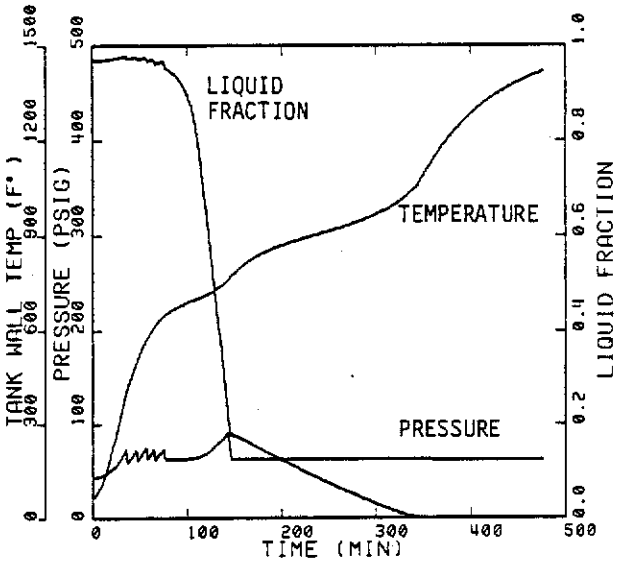
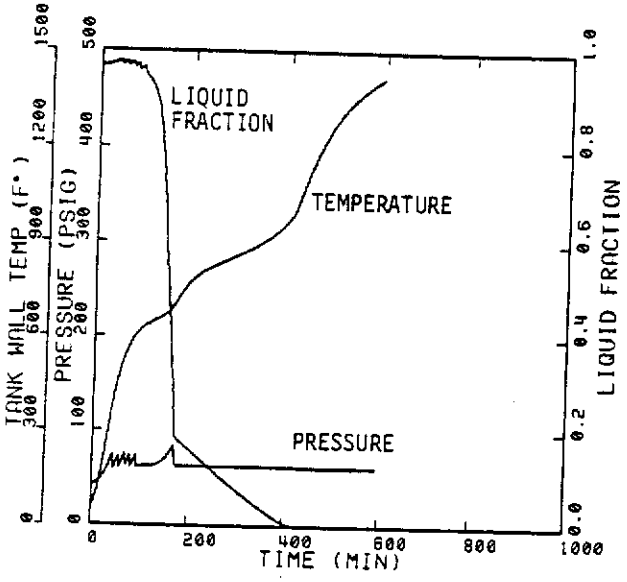
3.0 BTU/HR-FT²-°F

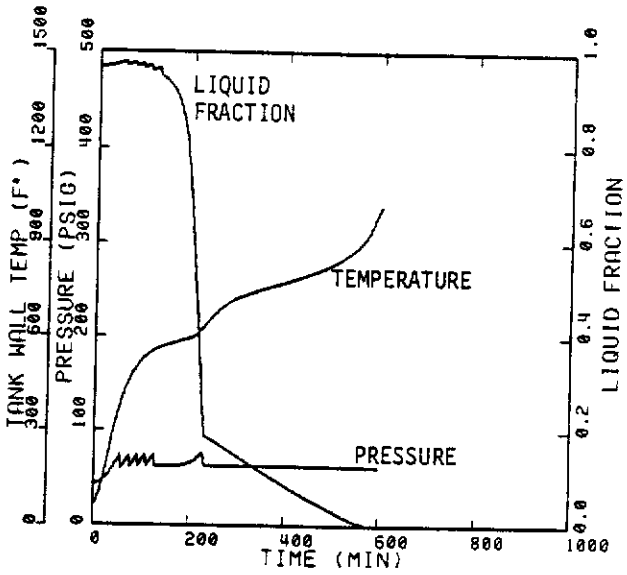


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

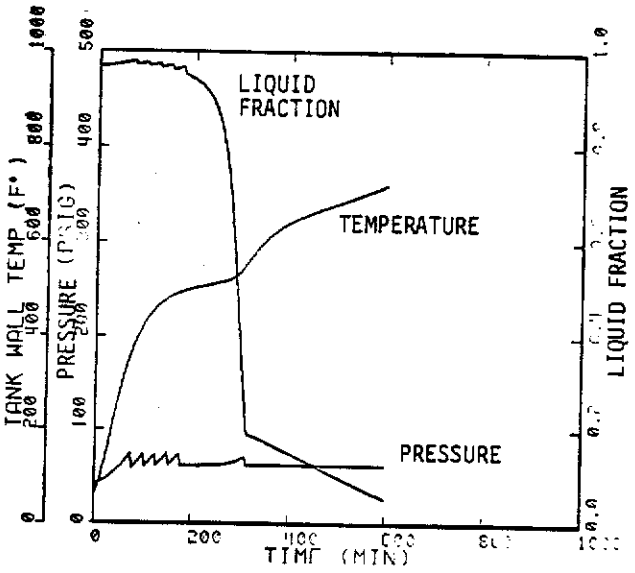
FIGURE A-4. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A300W TANK CAR CONTAINING ETHYLENE OXIDE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 14,600 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

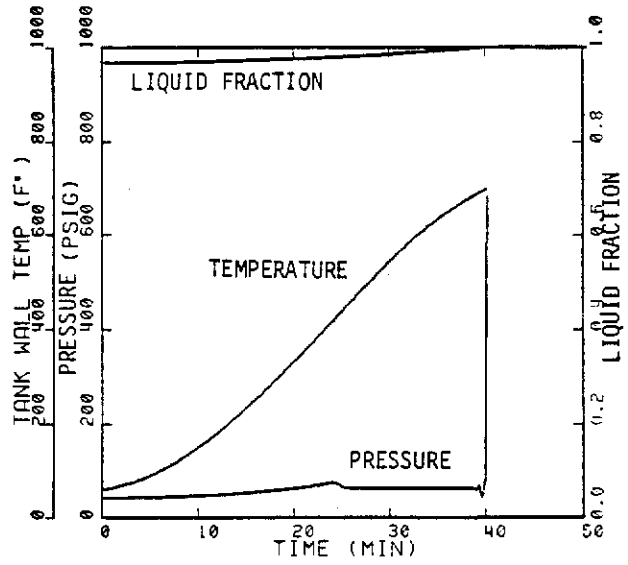


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

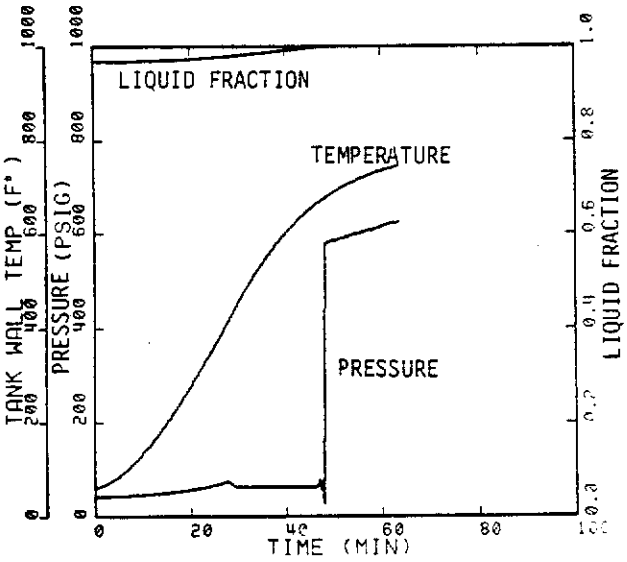


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

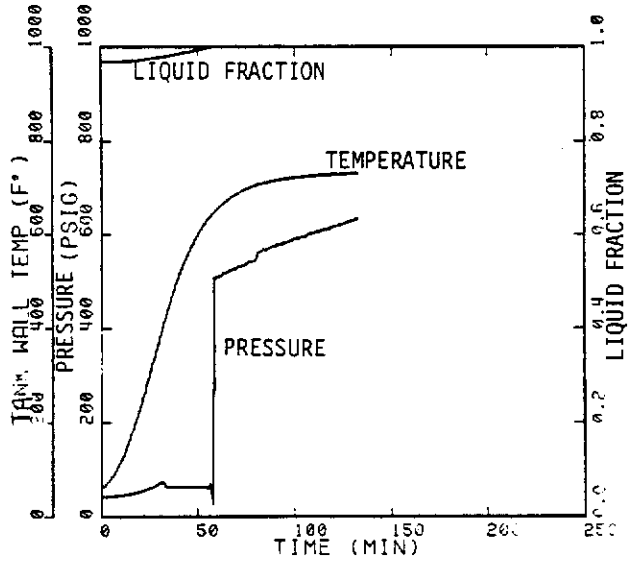
FIGURE A-4. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A300W TANK CAR CONTAINING ETHYLENE OXIDE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 14,600 SCFM



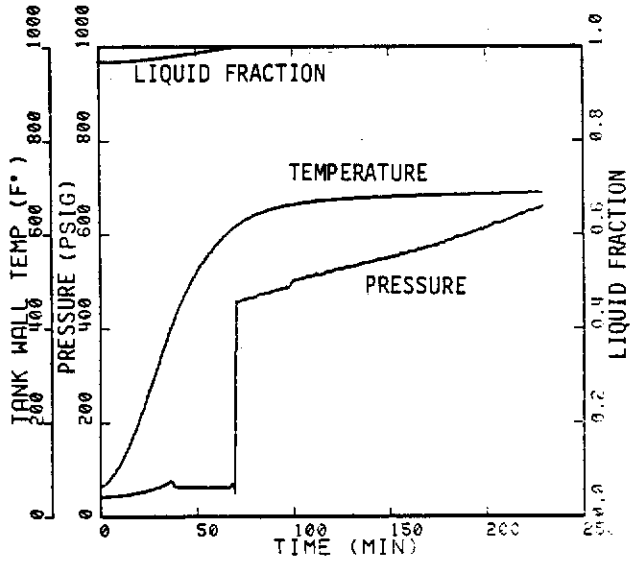
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

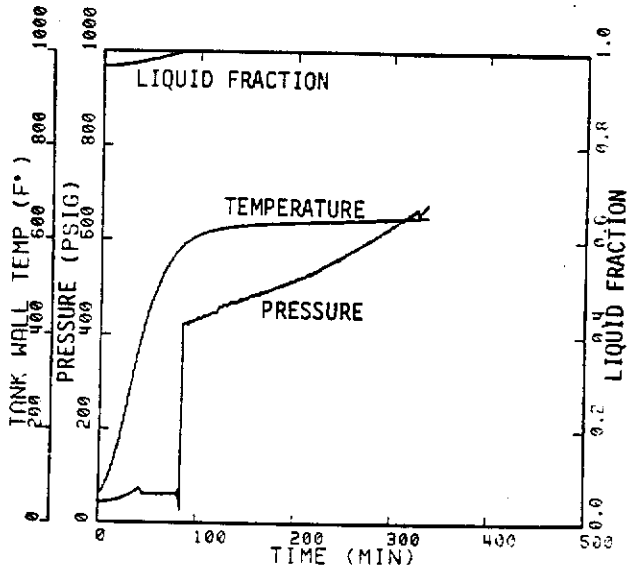


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

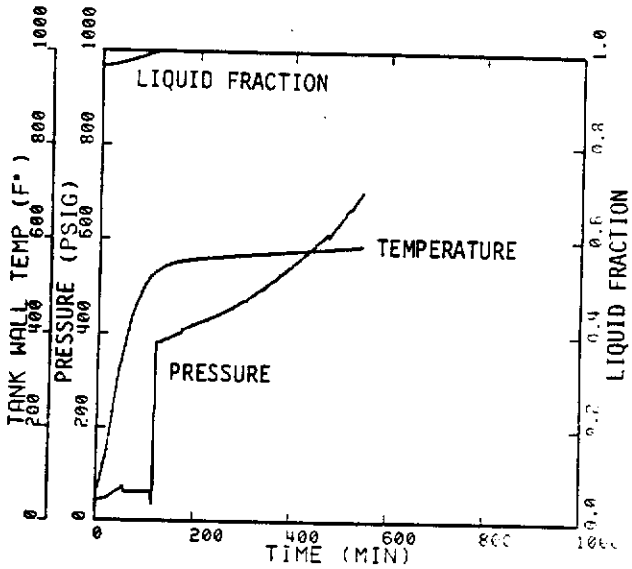


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

FIGURE A-5. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A300W TANK CAR CONTAINING ETHYLENE OXIDE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 260 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F



f. THERMAL SHIELD CONDUCTANCE
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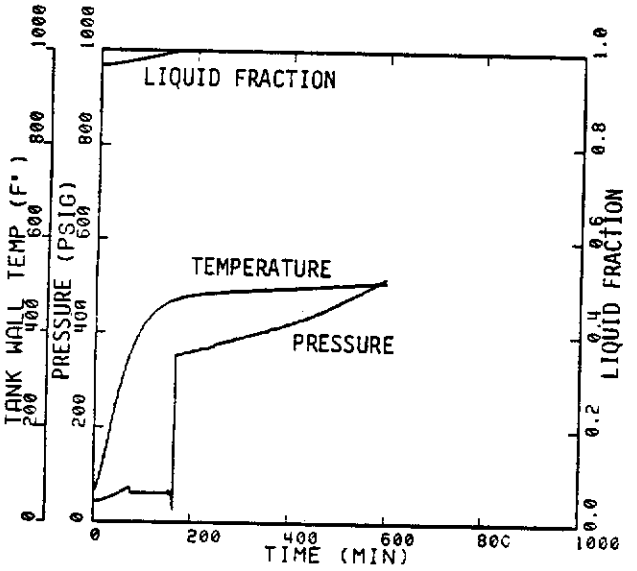
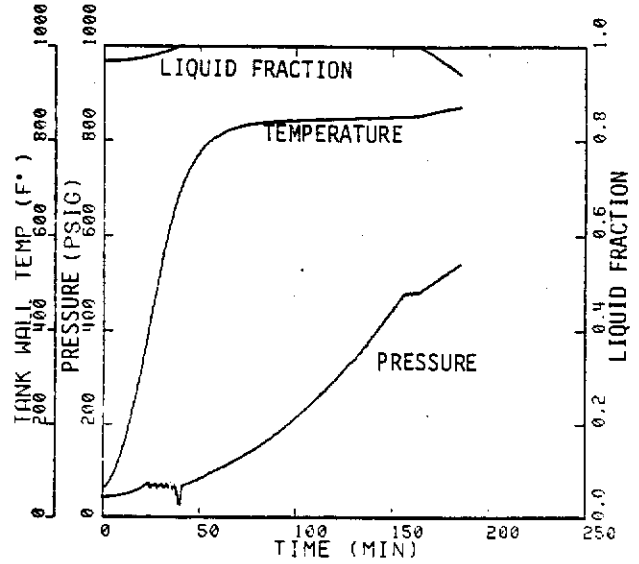
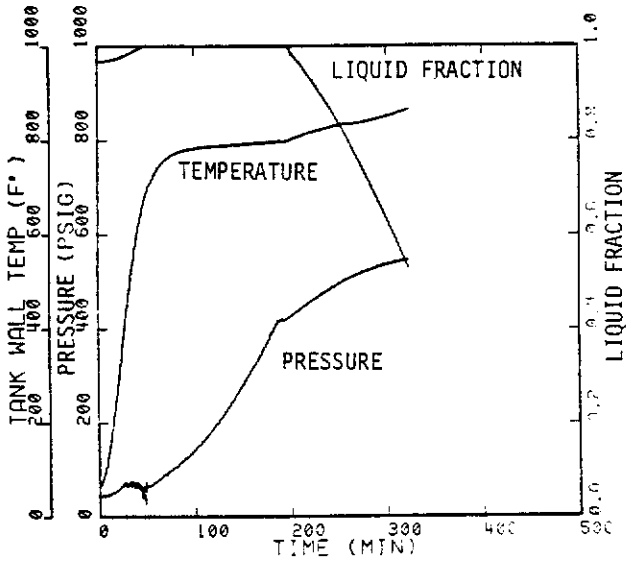


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

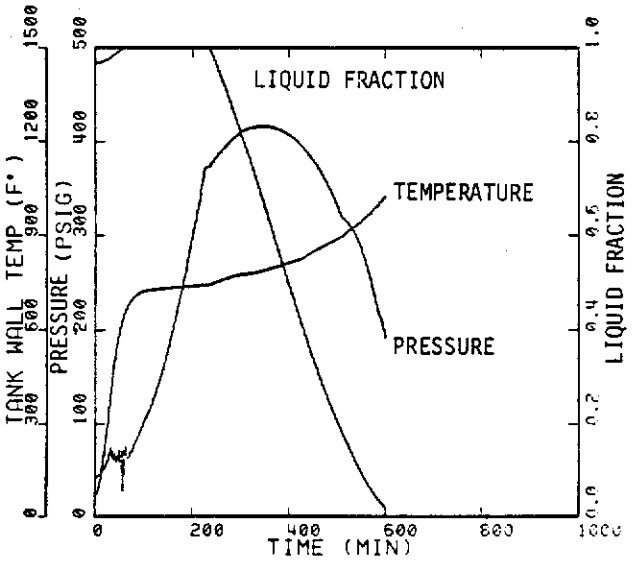
FIGURE A-5. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A300W TANK CAR CONTAINING ETHYLENE OXIDE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 260 SCFM



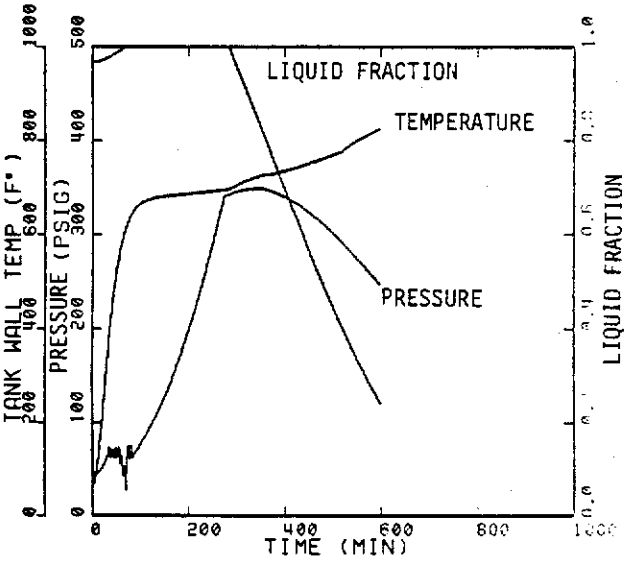
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

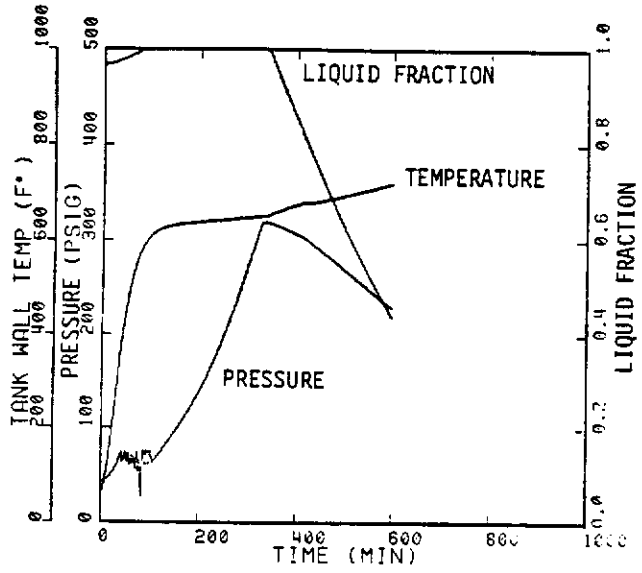


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

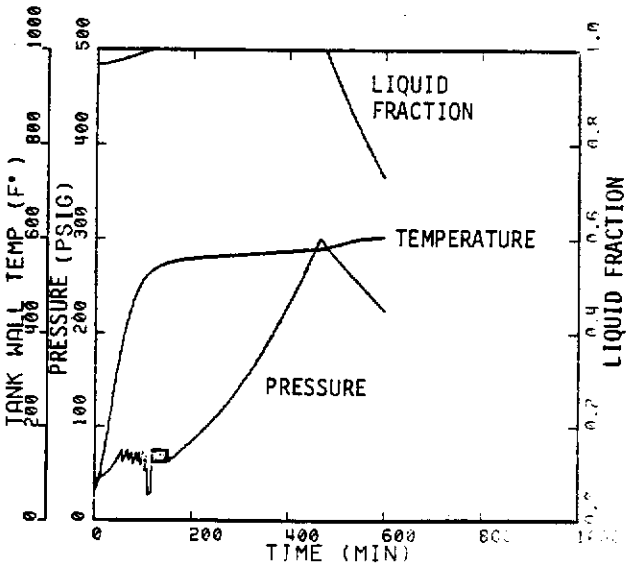


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

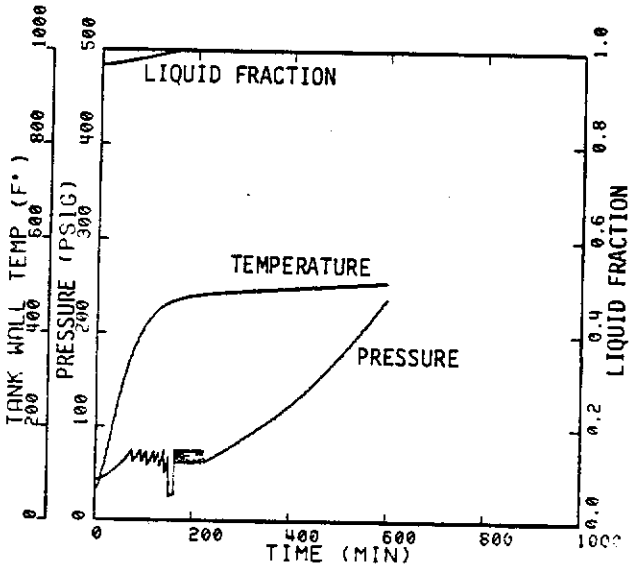
FIGURE A-6. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A300W TANK CAR CONTAINING ETHYLENE OXIDE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 1100 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

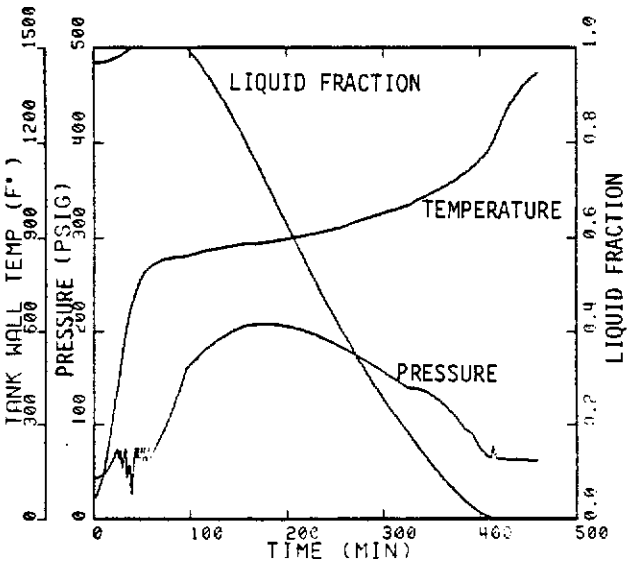


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

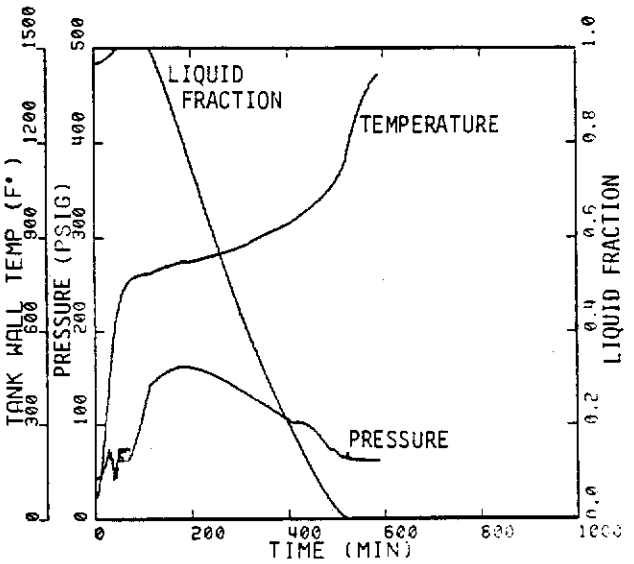


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

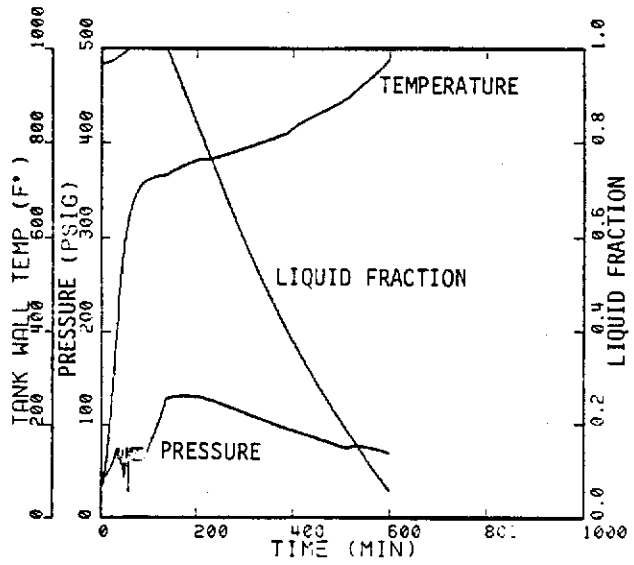
FIGURE A-6. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A300W TANK CAR CONTAINING ETHYLENE OXIDE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 1100 SCFM



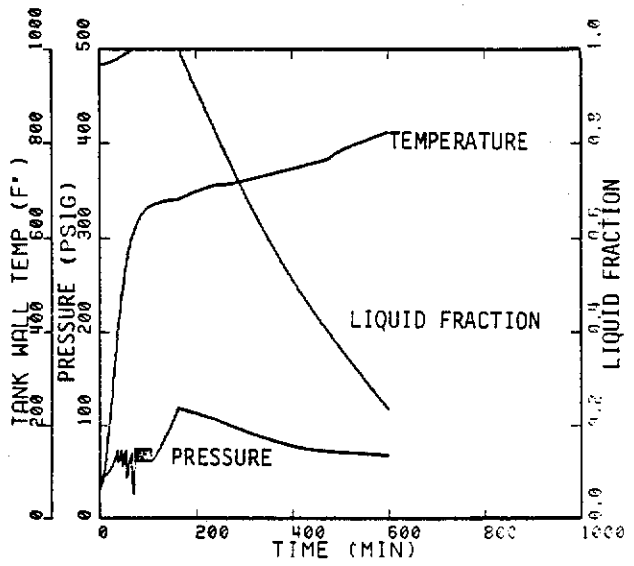
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

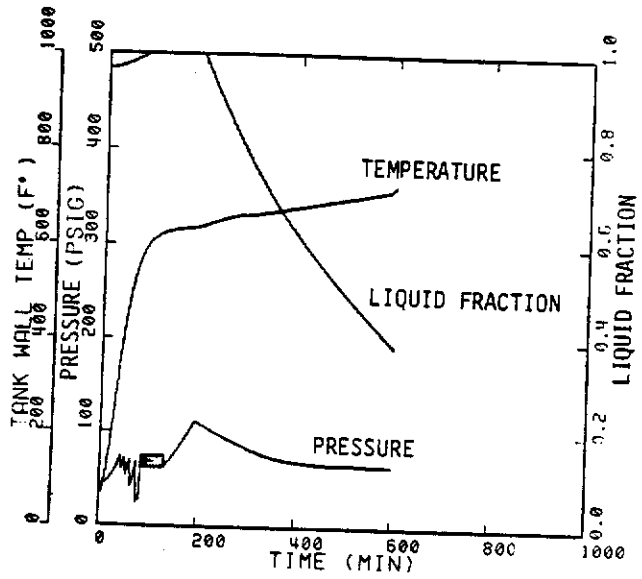


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

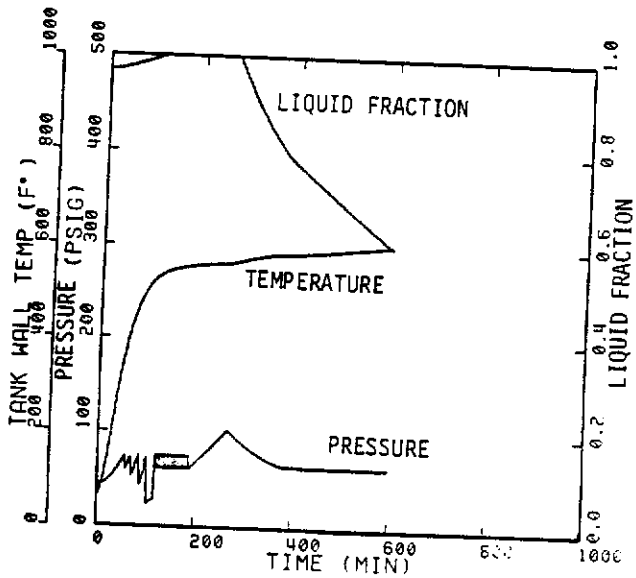


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

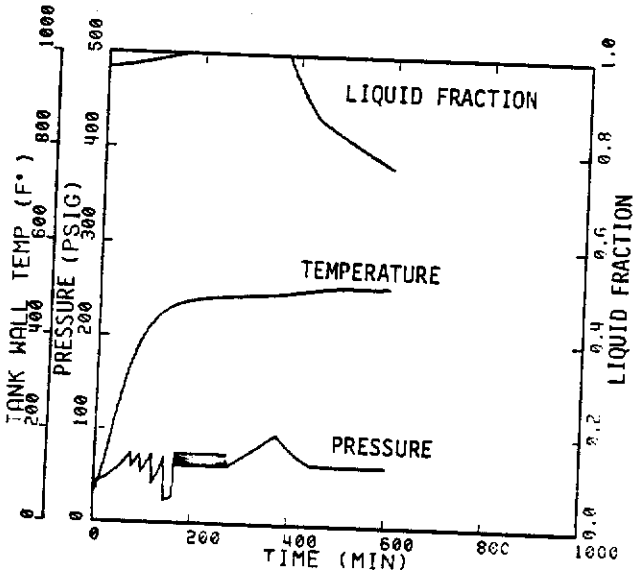
FIGURE A-7. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A300W TANK CAR CONTAINING ETHYLENE OXIDE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 3000 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

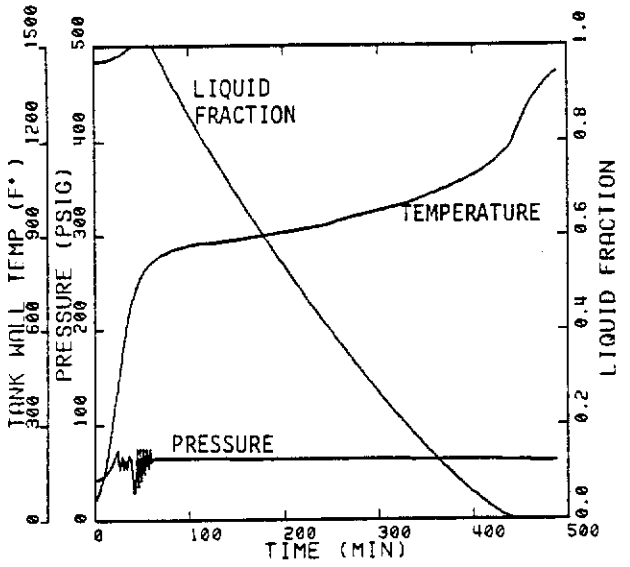


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

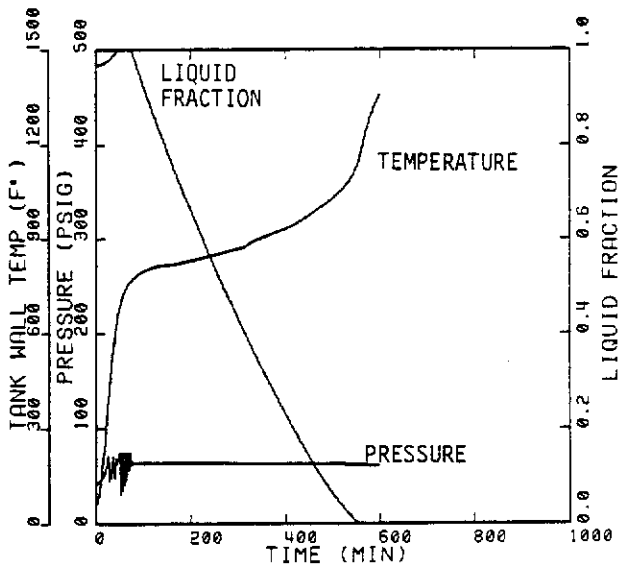


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

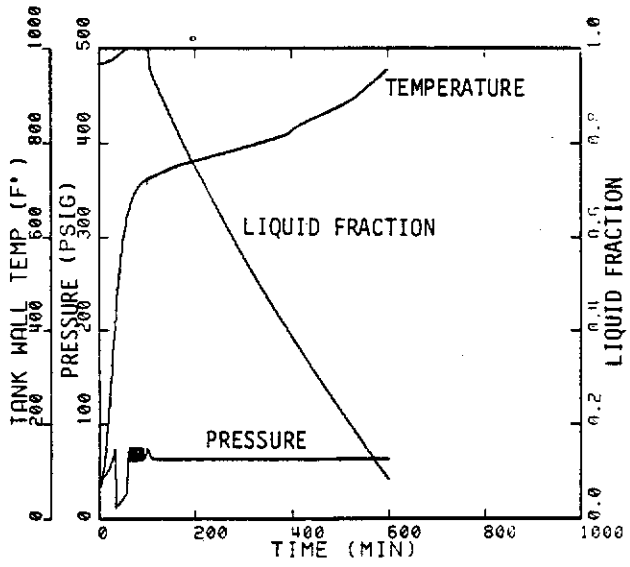
FIGURE A-7. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A300W TANK CAR CONTAINING ETHYLENE OXIDE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 3000 SCFM



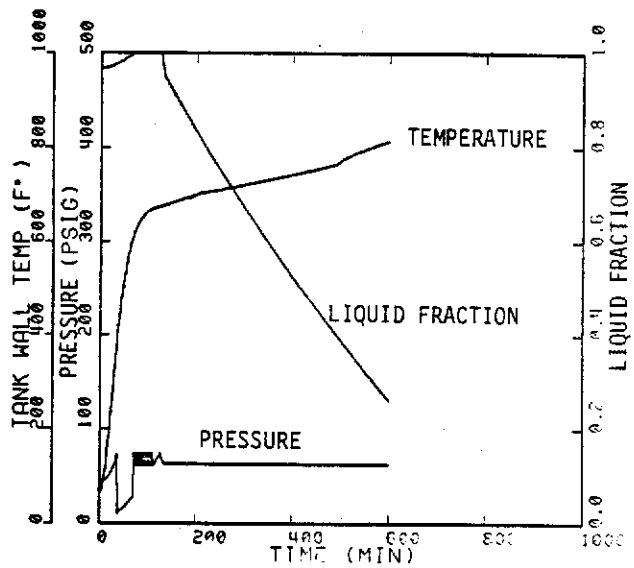
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

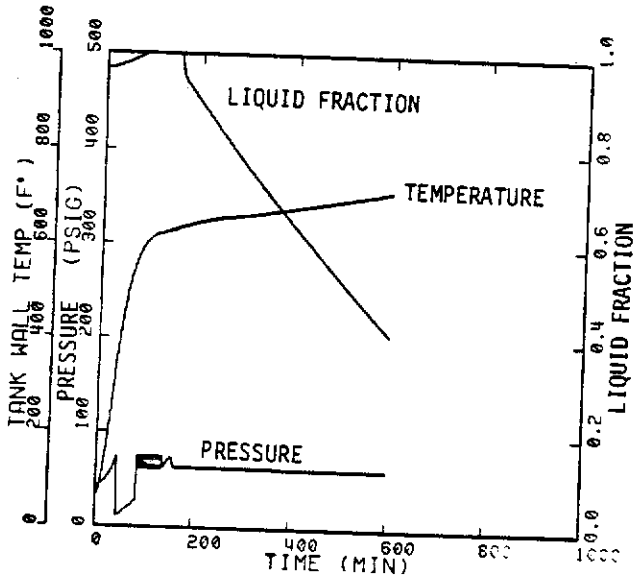


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

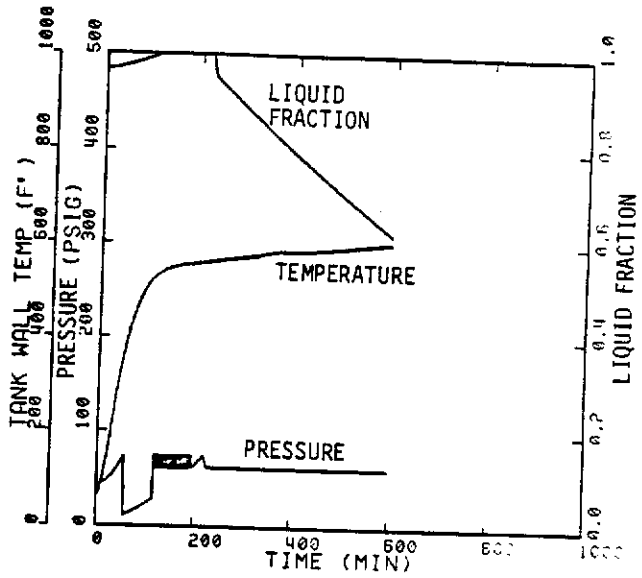


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

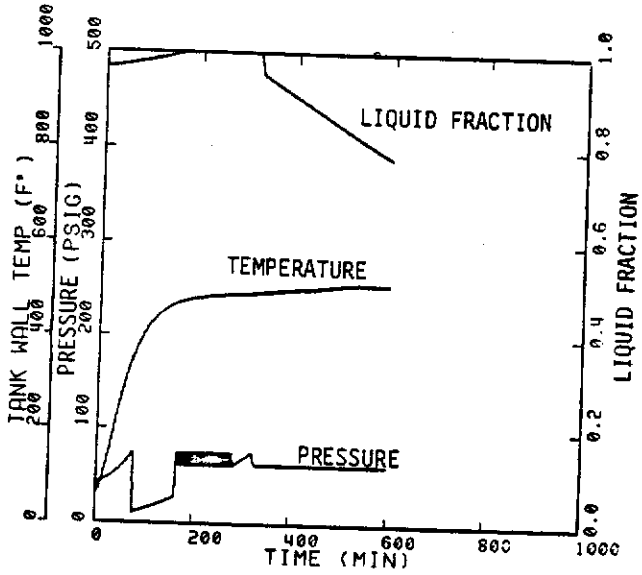
FIGURE A-8. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A300W TANK CAR CONTAINING ETHYLENE OXIDE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 14,600 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F



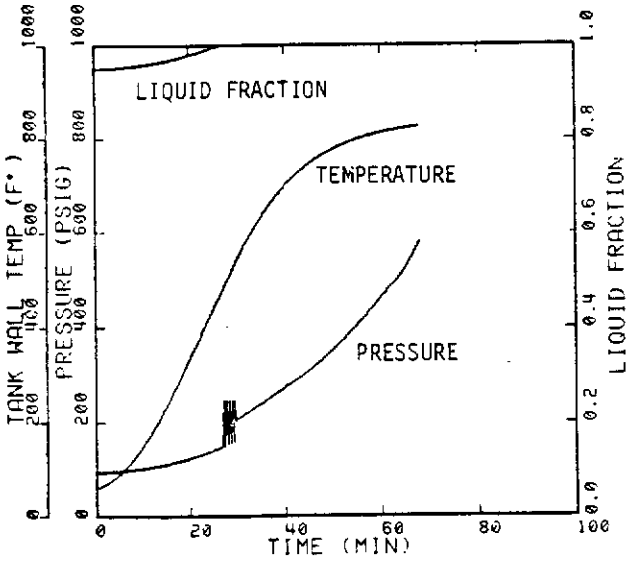
f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F



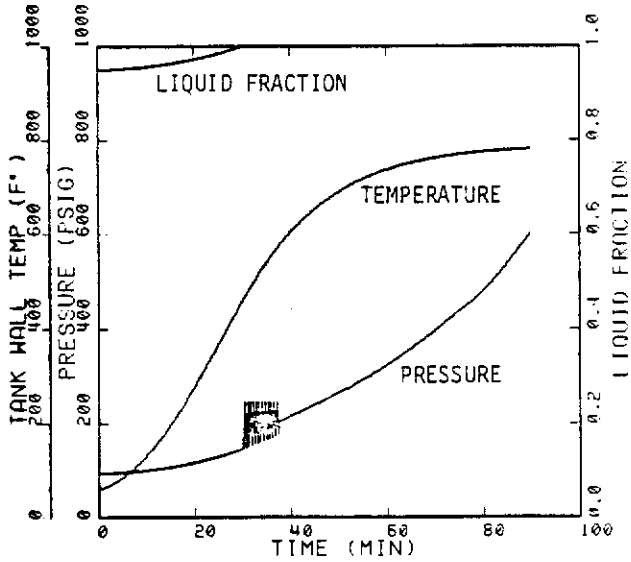
g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

FIGURE A-8. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A300W TANK CAR CONTAINING ETHYLENE OXIDE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 14,600 SCFM

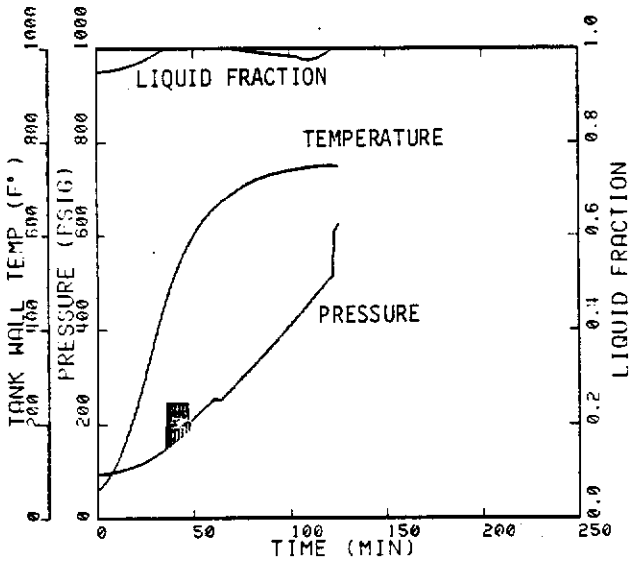
APPENDIX B: PROPANE PLOTS



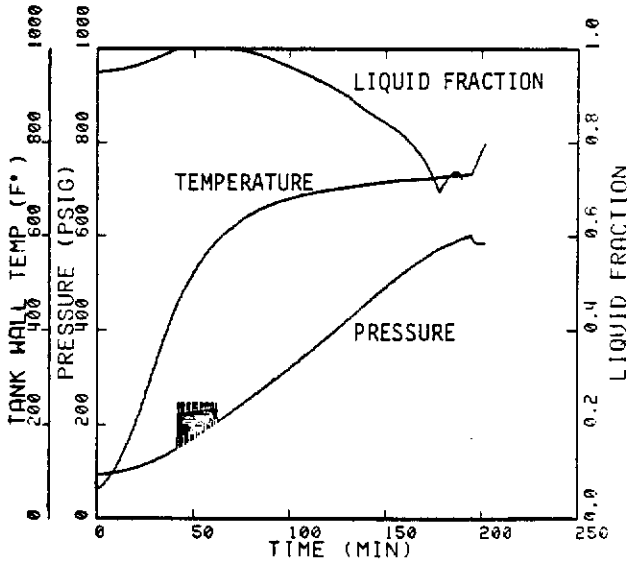
a. THERMAL SHIELD CONDUCTANCE 5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE 4.0 BTU/HR-FT²-°F

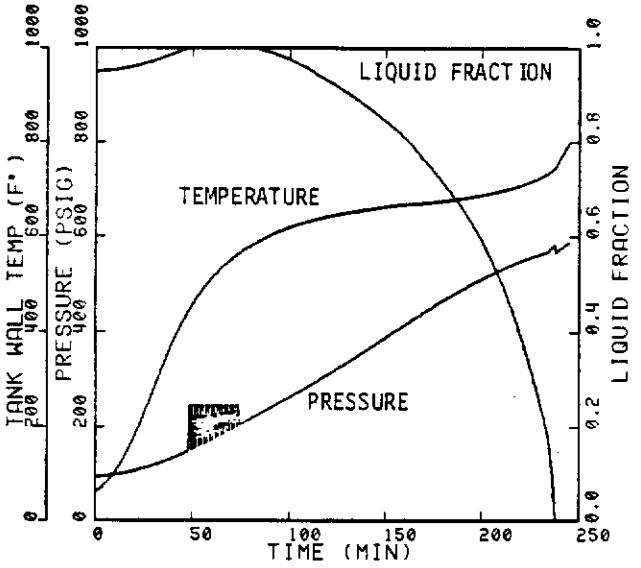


c. THERMAL SHIELD CONDUCTANCE 3.0 BTU/HR-FT²-°F

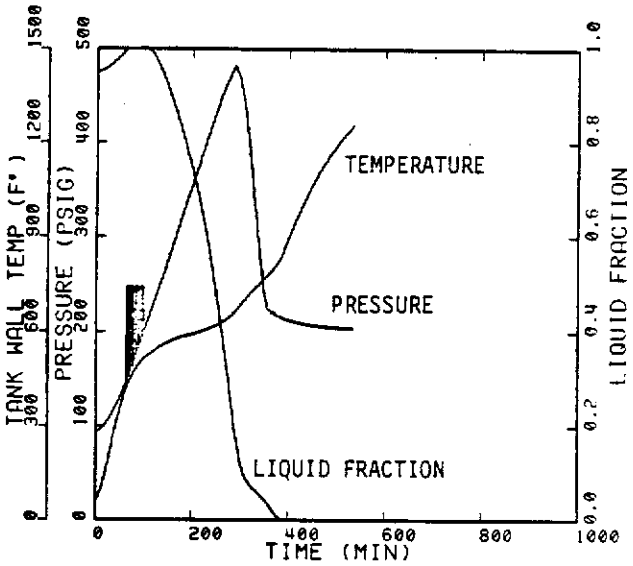


d. THERMAL SHIELD CONDUCTANCE 2.3 BTU/HR-FT²-°F

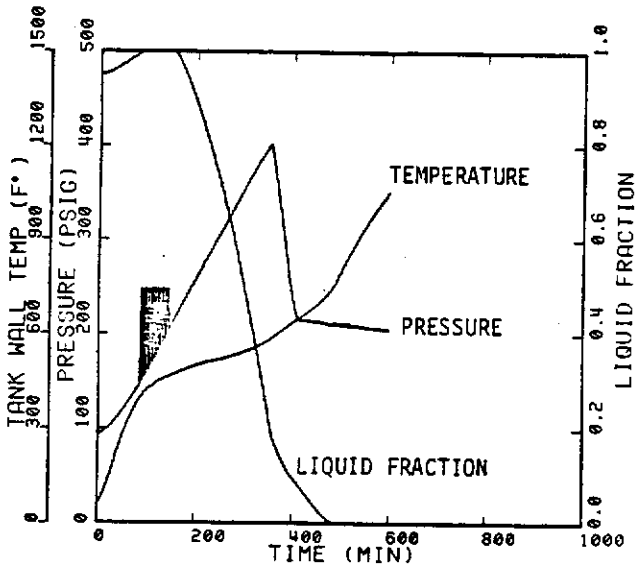
FIGURE B-1. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A300W TANK CAR CONTAINING PROPANE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 3070 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

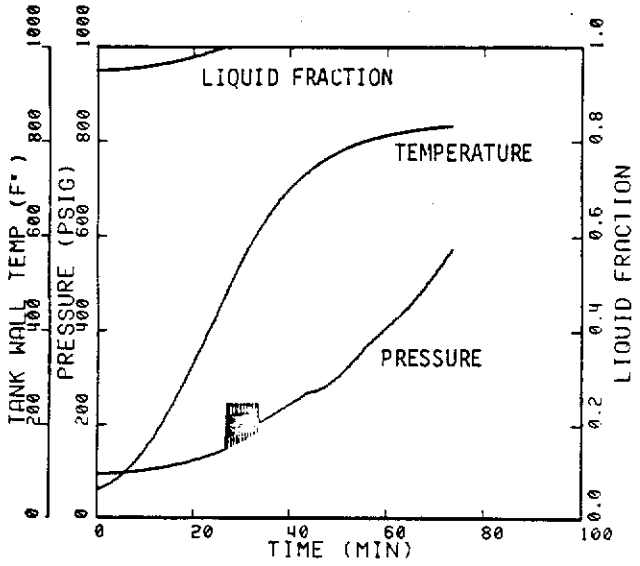


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

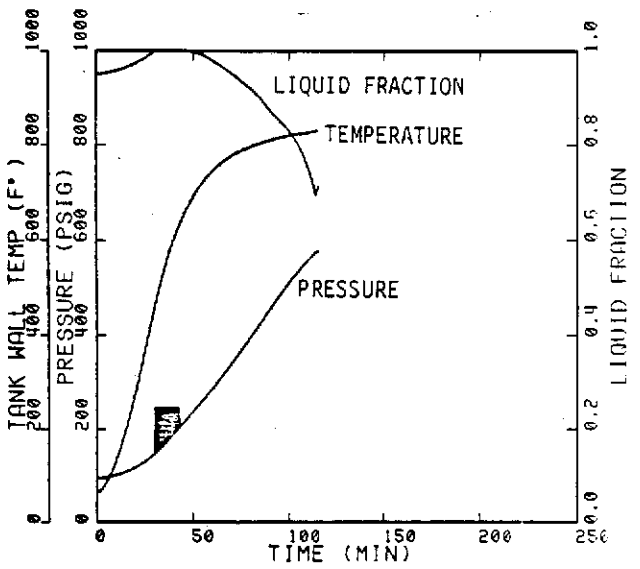


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

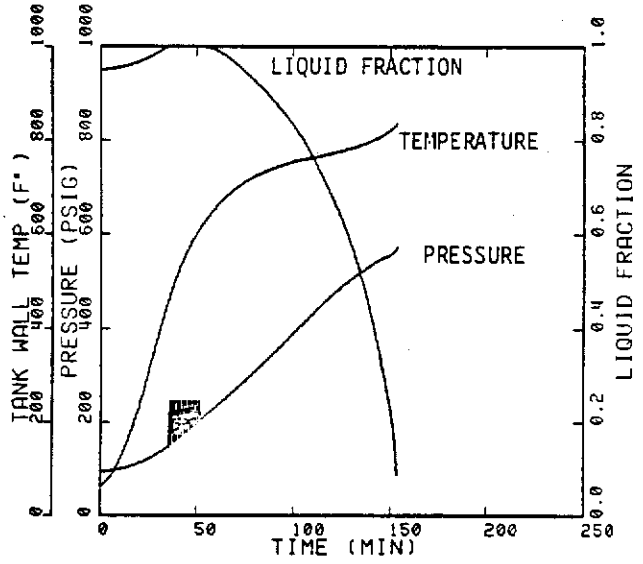
FIGURE B-1. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A300W TANK CAR CONTAINING PROPANE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 3070 SCFM



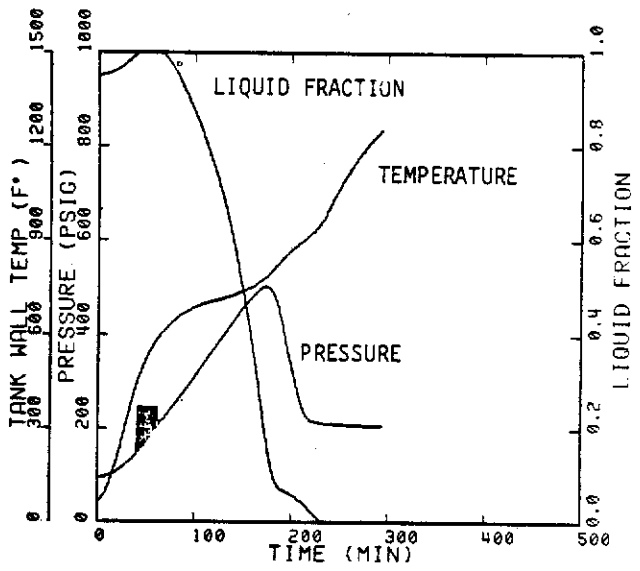
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

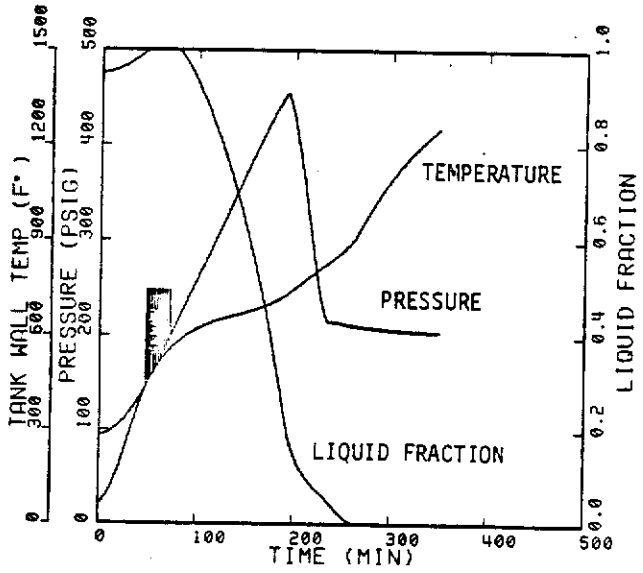


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

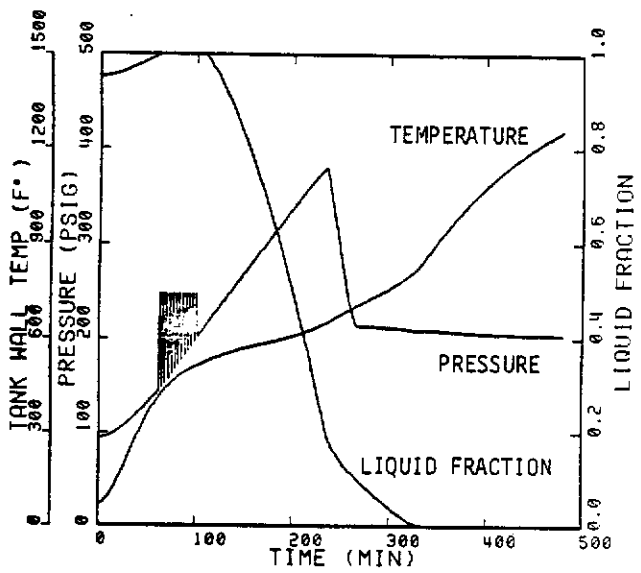


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

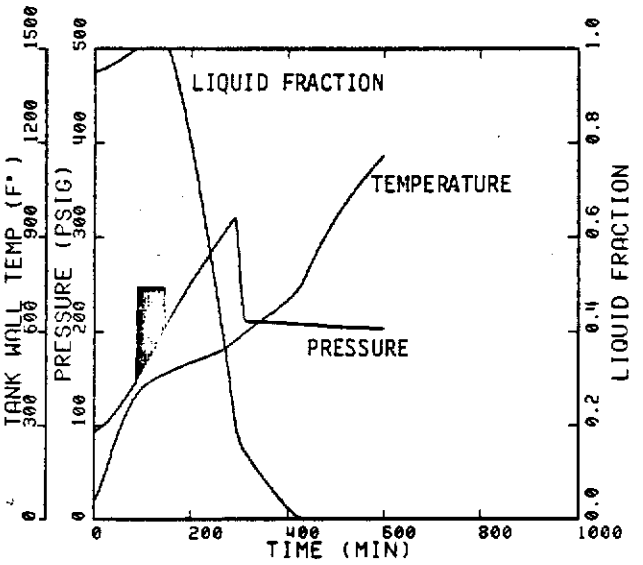
FIGURE B-2. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A300W TANK CAR CONTAINING PROPANE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 5000 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

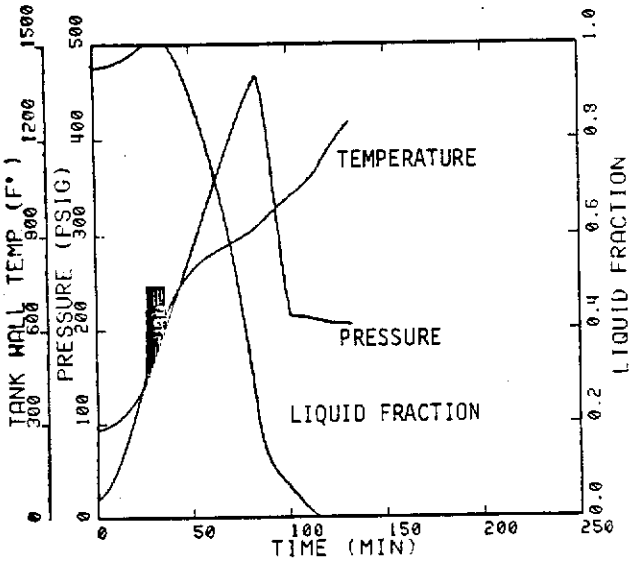


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

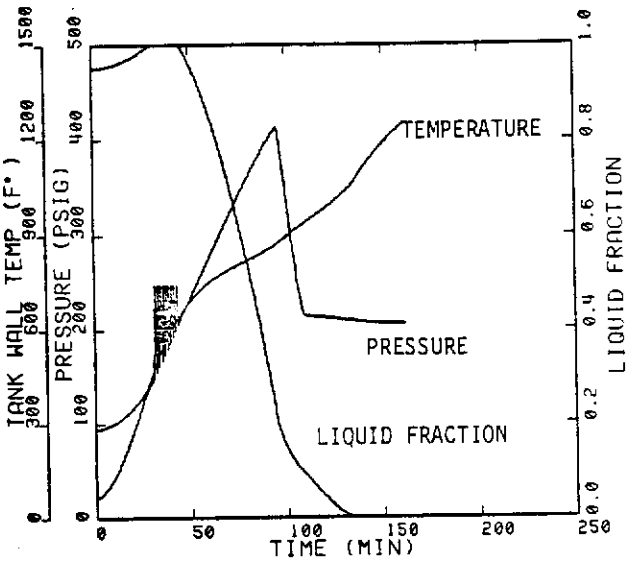


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

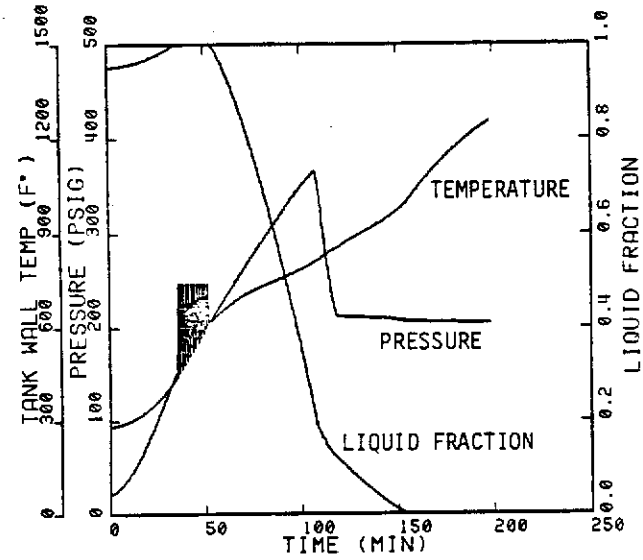
FIGURE B-2. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A300W TANK CAR CONTAINING PROPANE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 5000 SCFM



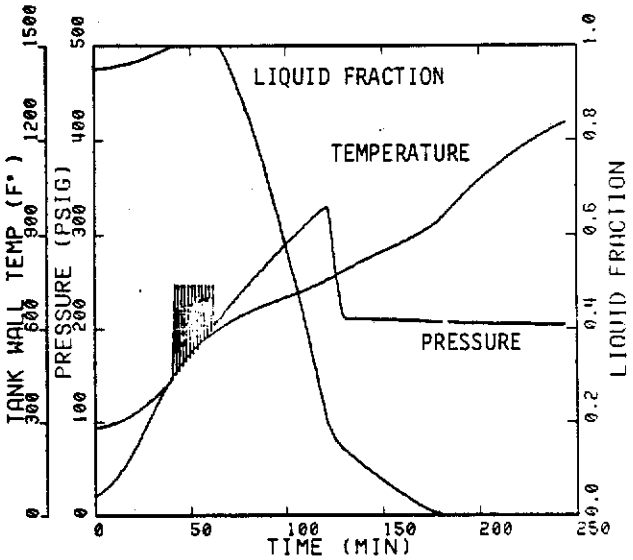
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

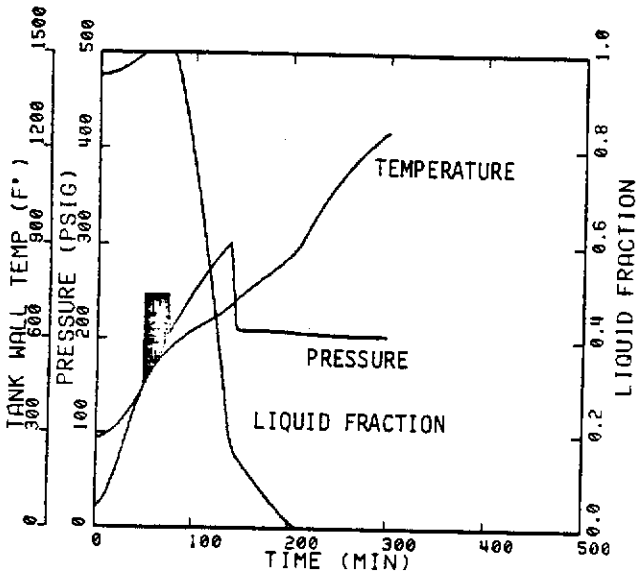


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

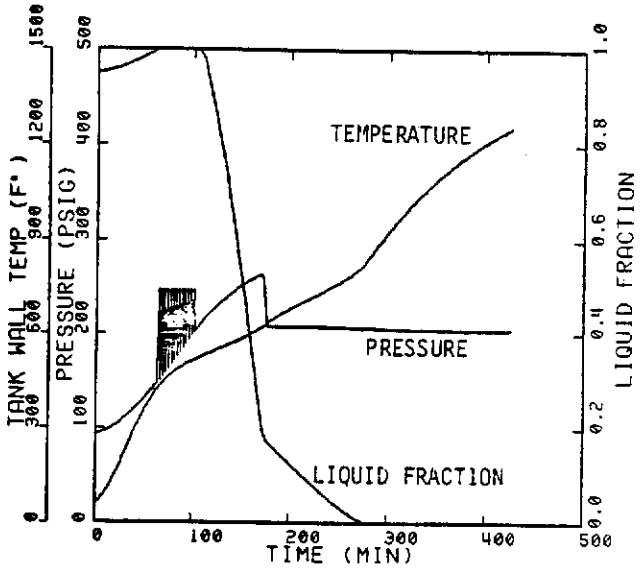


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

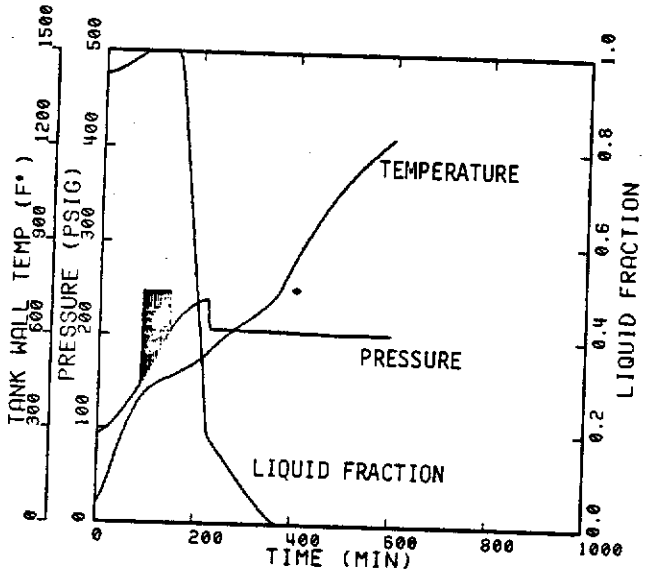
FIGURE B-3. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A300W TANK CAR CONTAINING PROPANE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 12,000 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

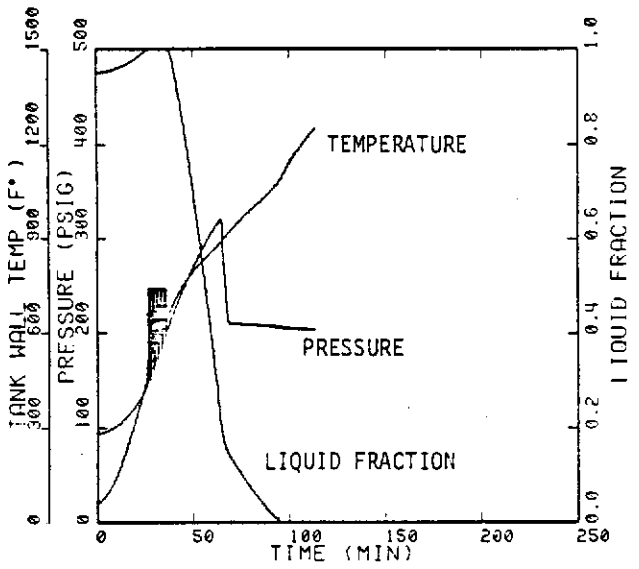


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

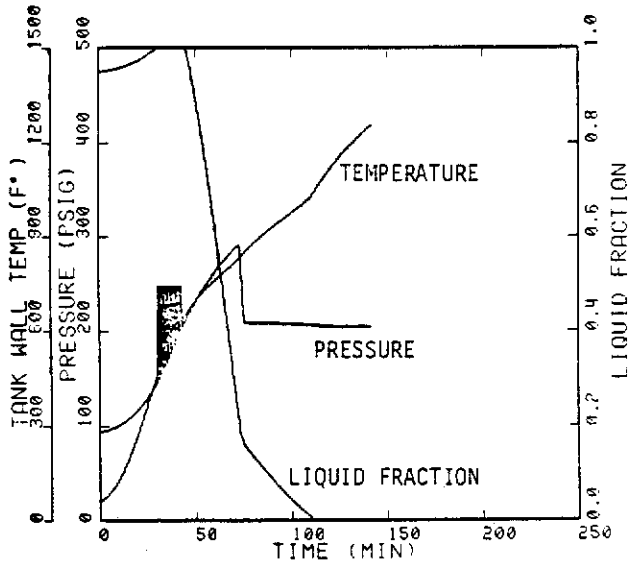


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

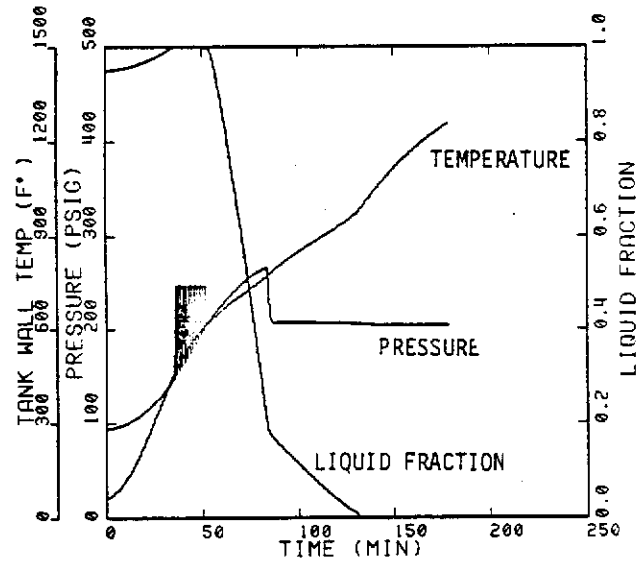
FIGURE B-3. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A300W TANK CAR CONTAINING PROPANE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 12,000 SCFM



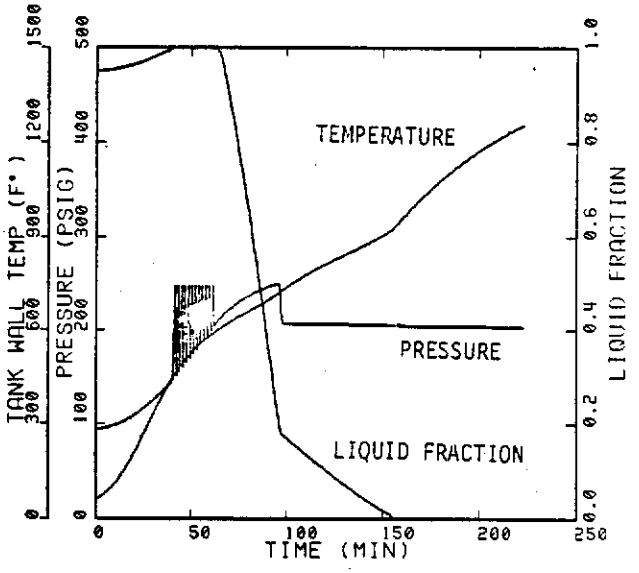
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

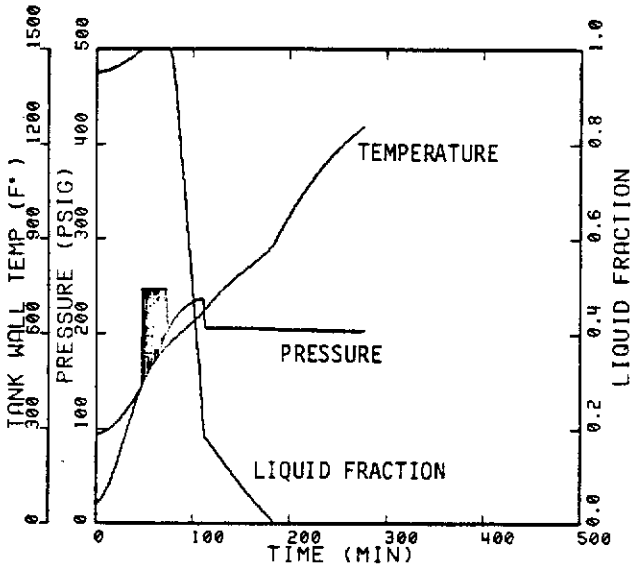


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

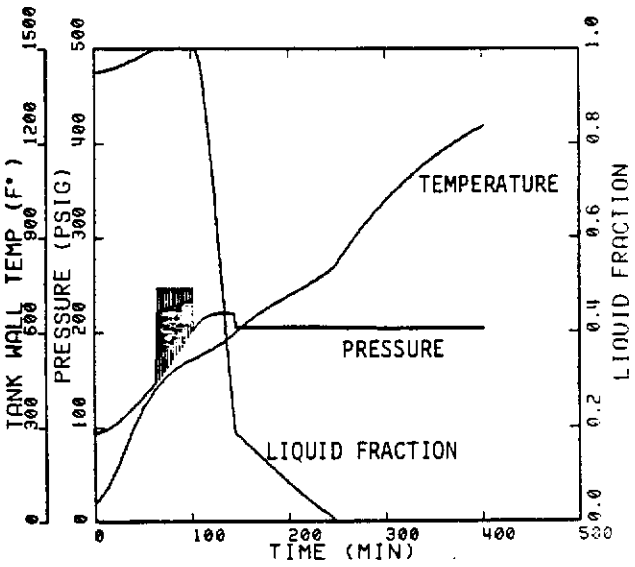


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

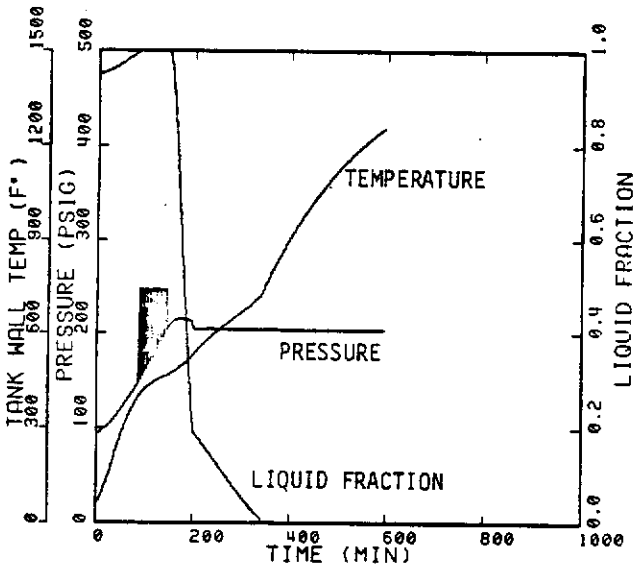
FIGURE B-4. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A300W TANK CAR CONTAINING PROPANE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 25,800 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

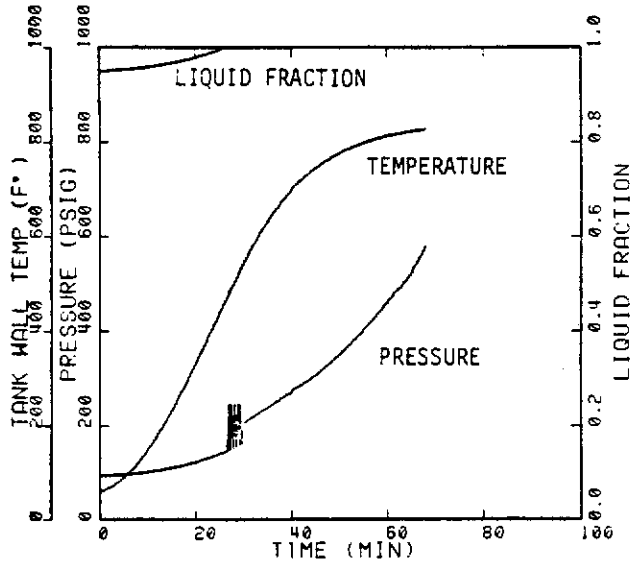


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

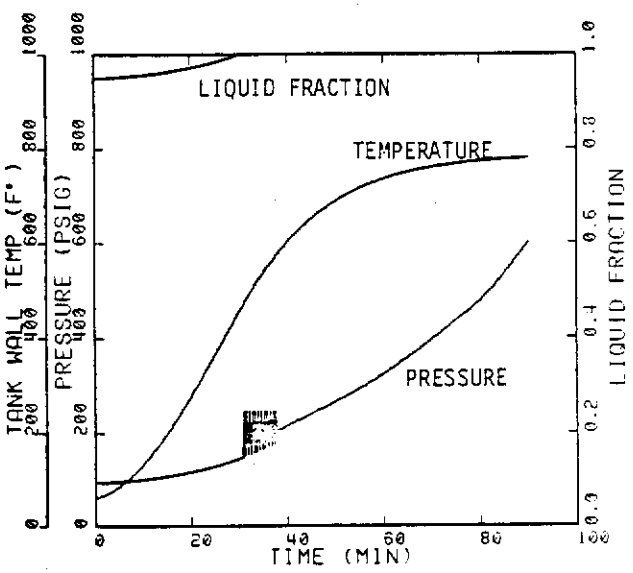


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR/FT²-°F

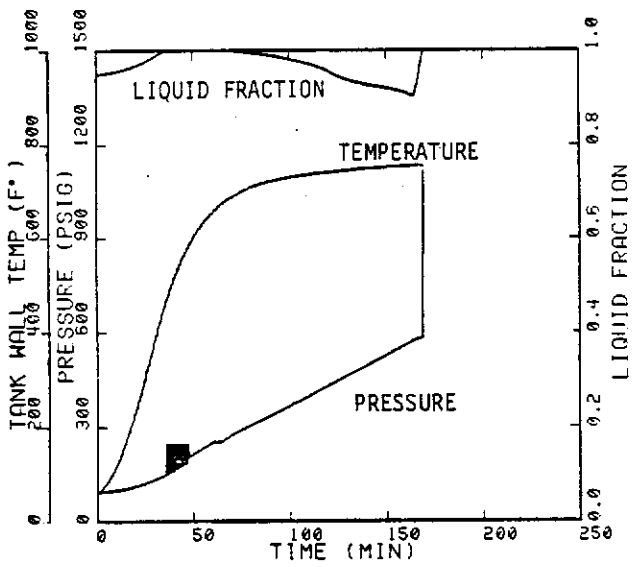
FIGURE B-4. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A300W TANK CAR CONTAINING PROPANE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 25,800 SCFM



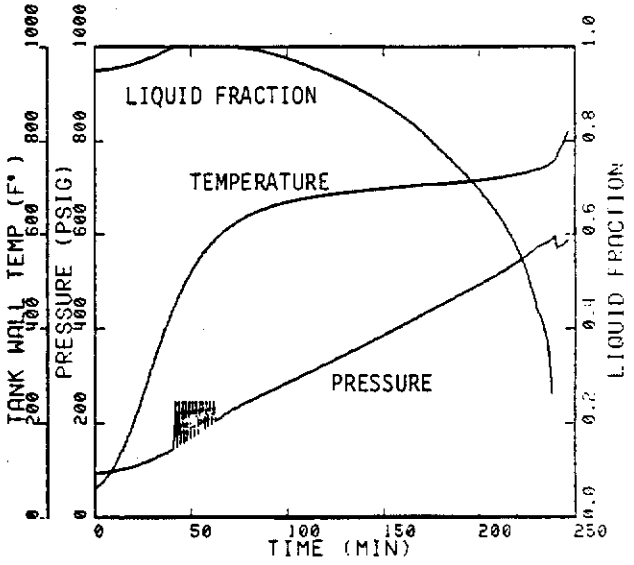
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

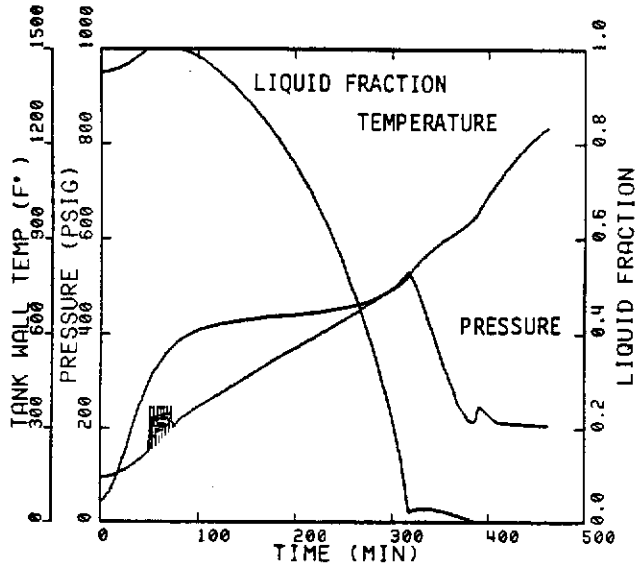


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

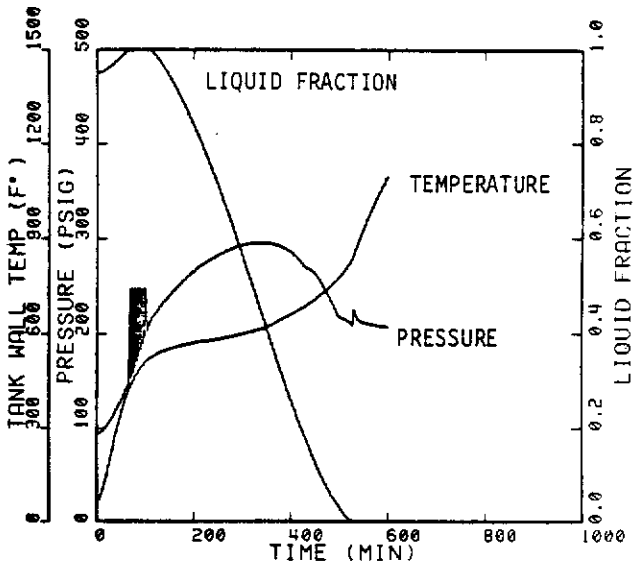


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

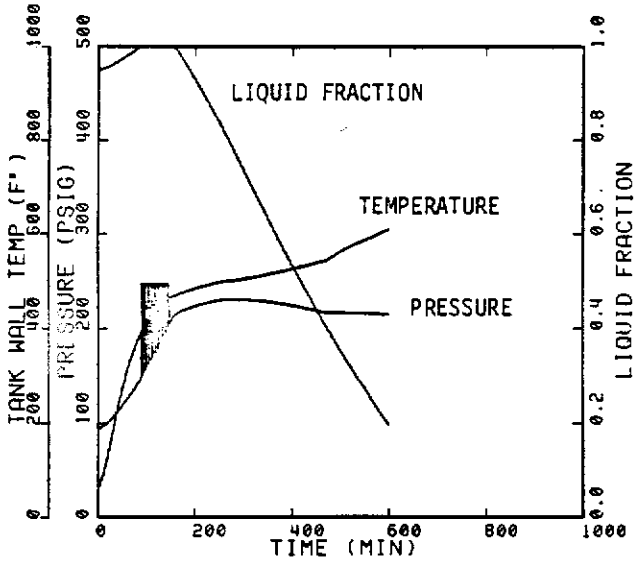
FIGURE B-5. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A300W TANK CAR CONTAINING PROPANE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 3070 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

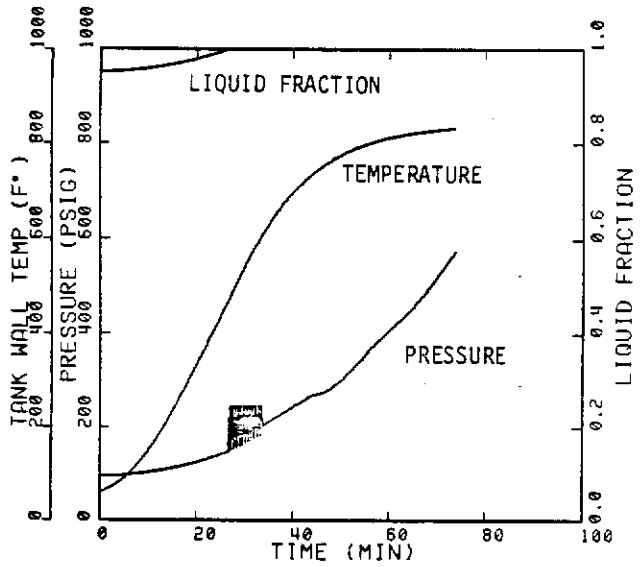


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

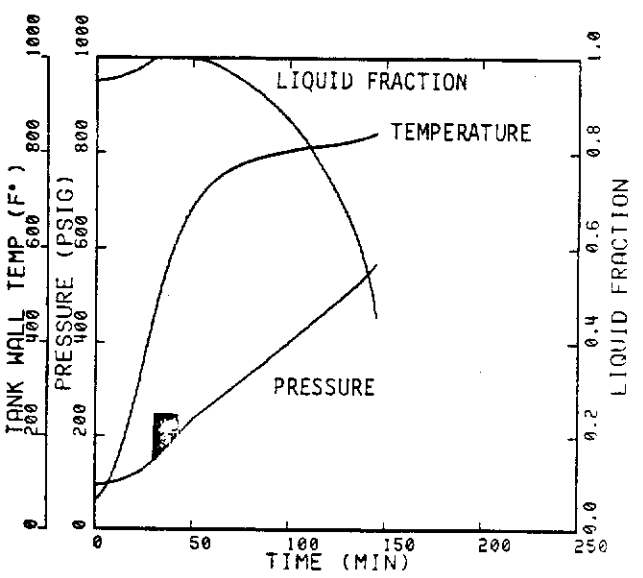


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

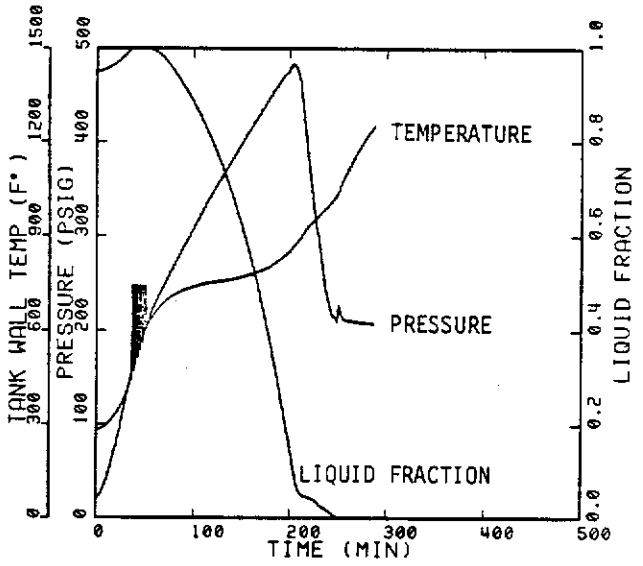
FIGURE B-5. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A300W TANK CAR CONTAINING PROPANE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 3070 SCFM



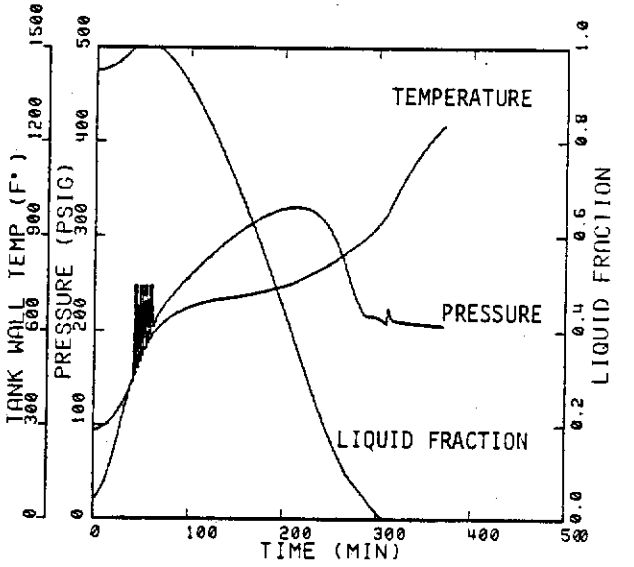
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

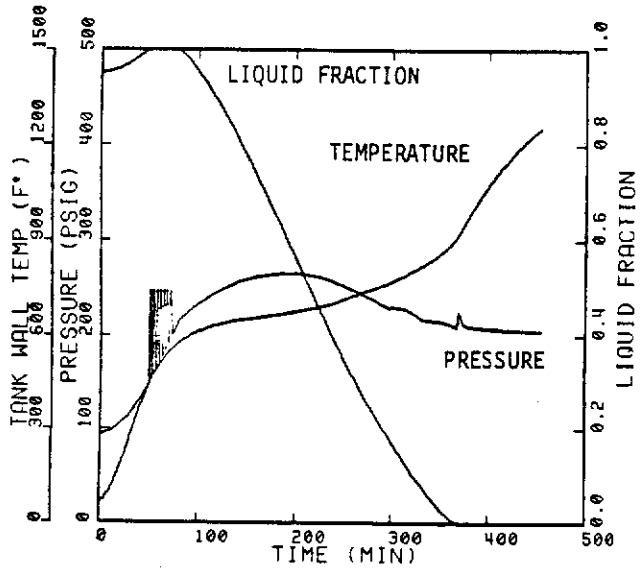


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

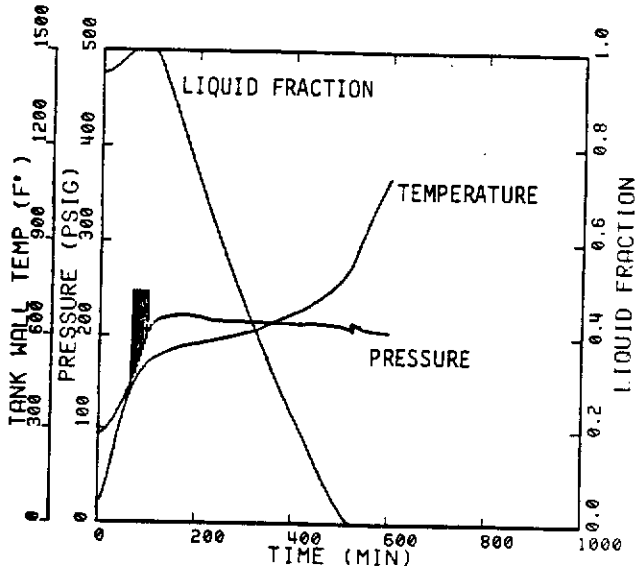


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

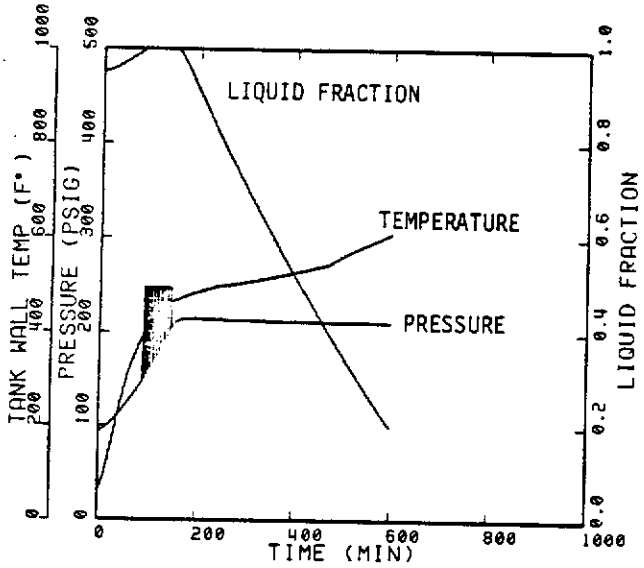
FIGURE B-6. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A300W TANK CAR CONTAINING PROPANE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 5000 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

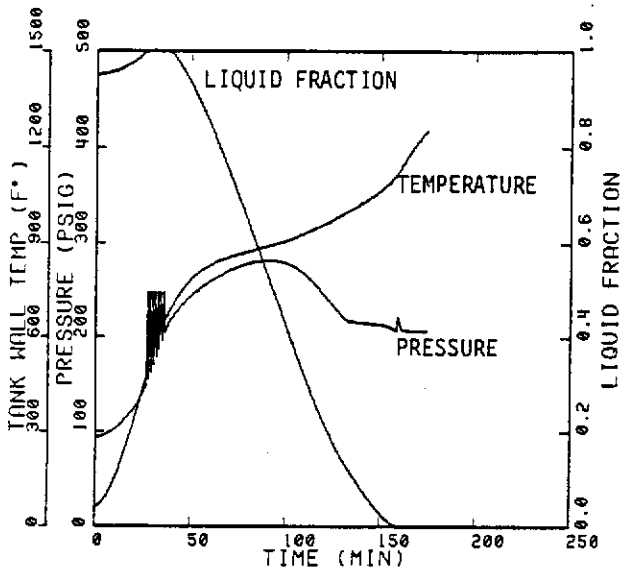


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

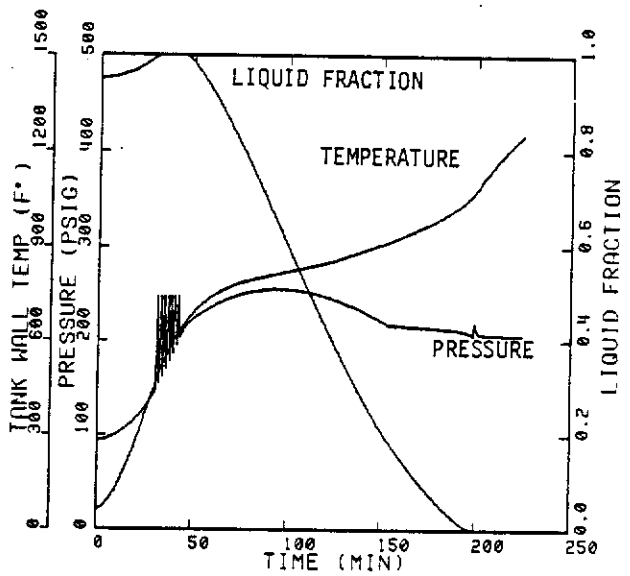


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

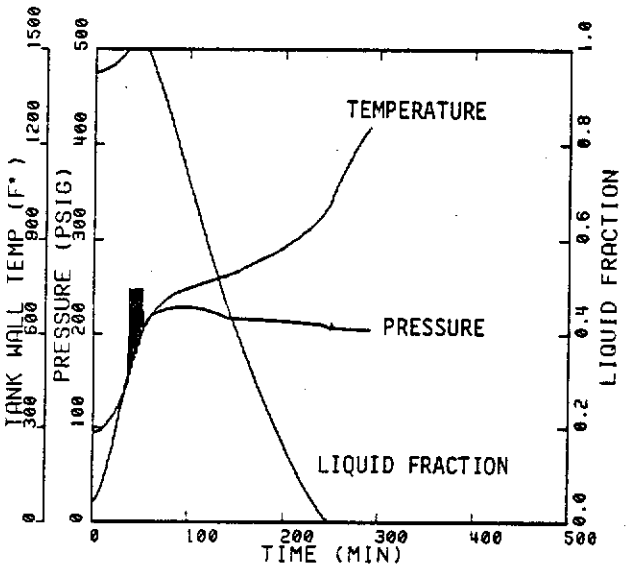
FIGURE B-6. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A300W TANK CAR CONTAINING PROPANE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 5000 SCFM



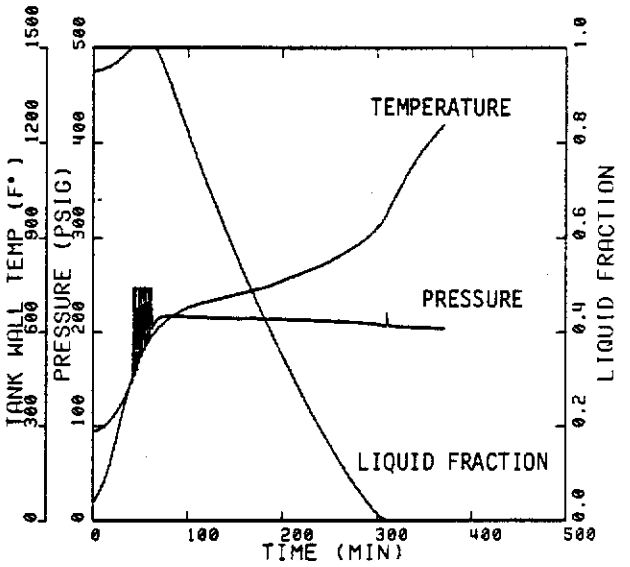
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

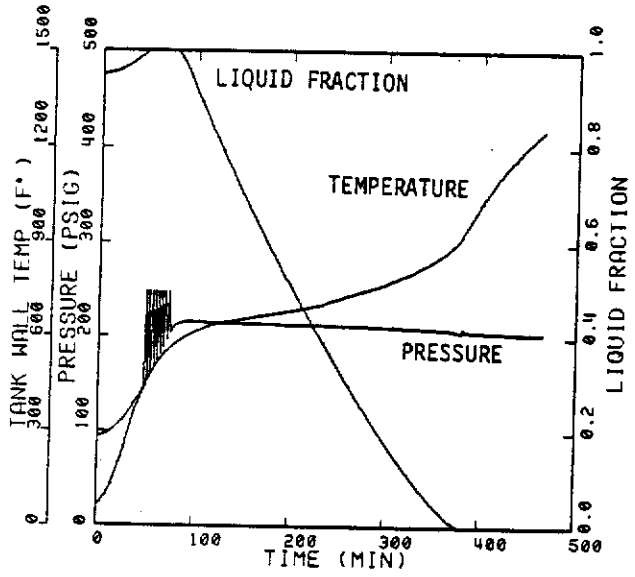


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

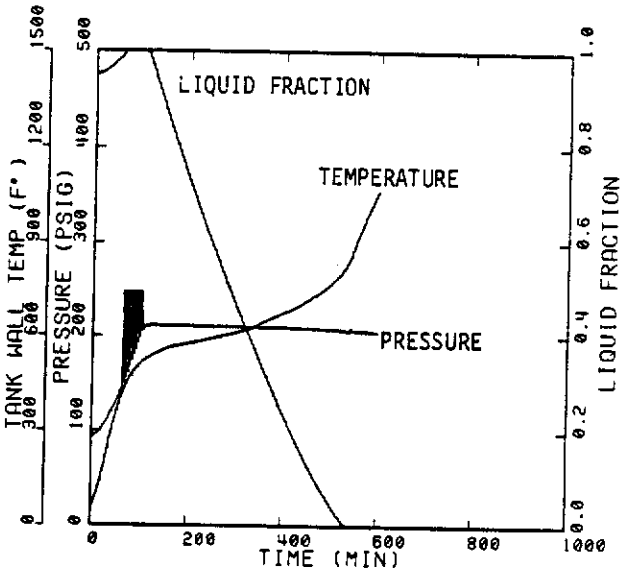


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

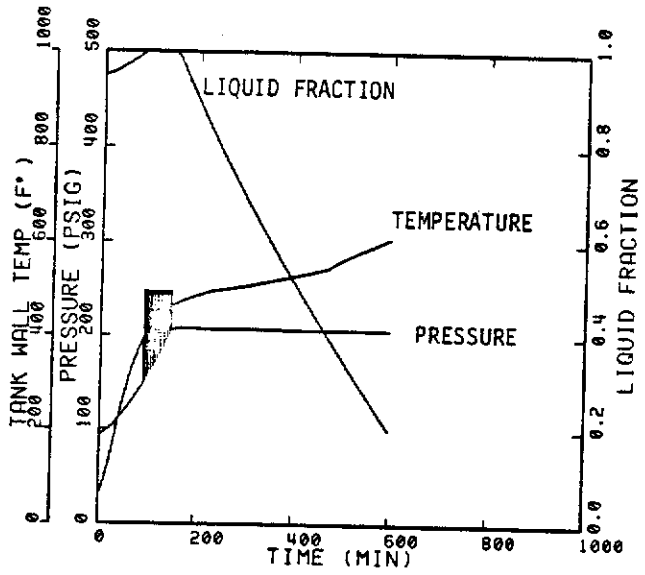
FIGURE B-7. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A300W TANK CAR CONTAINING PROPANE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 12,000 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

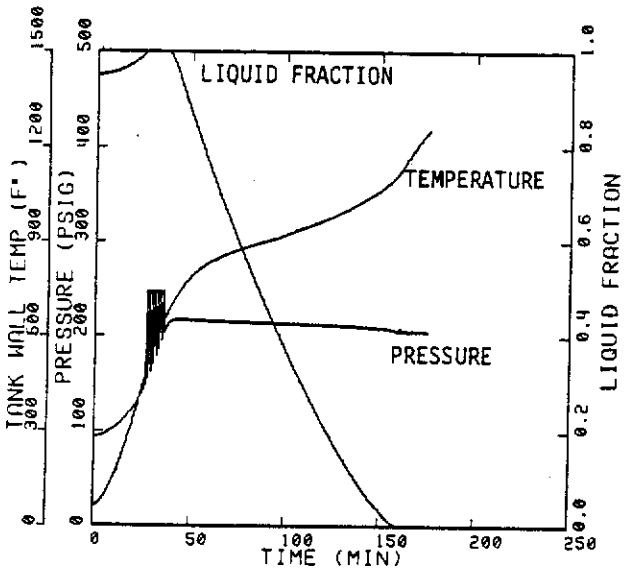


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

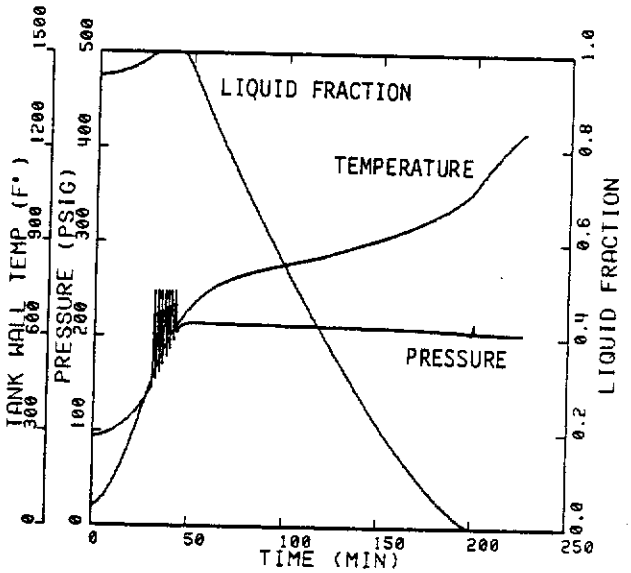


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

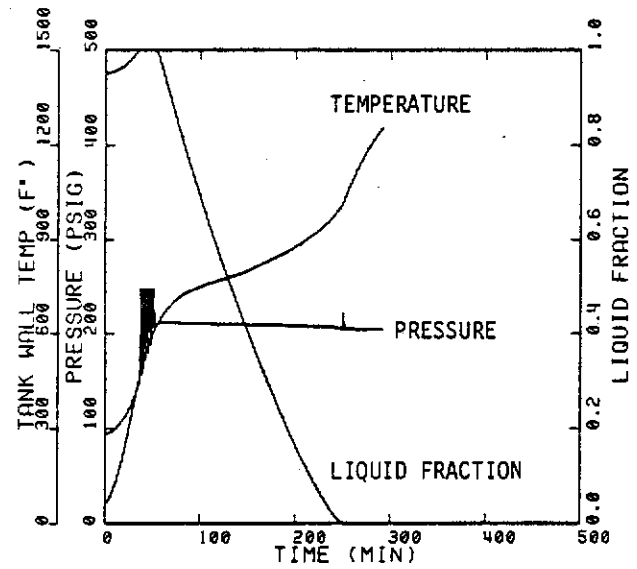
FIGURE B-7. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A300W TANK CAR CONTAINING PROPANE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 12,000 SCFM



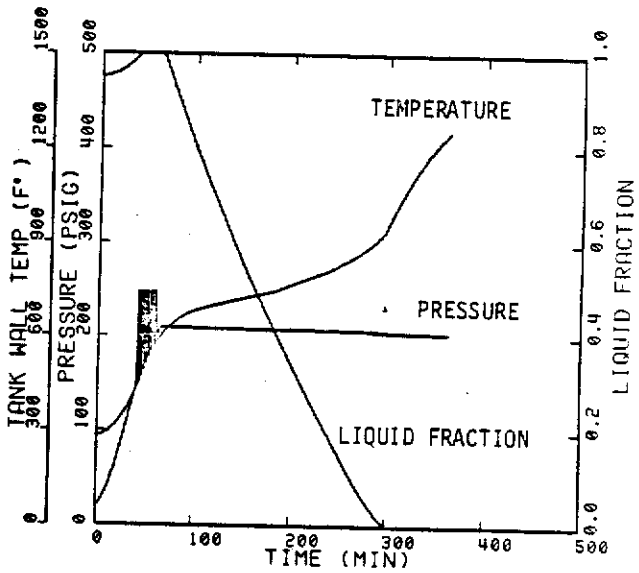
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

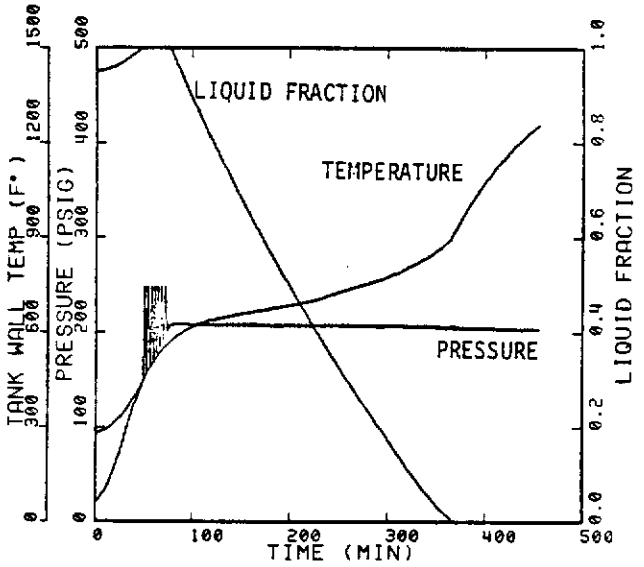


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

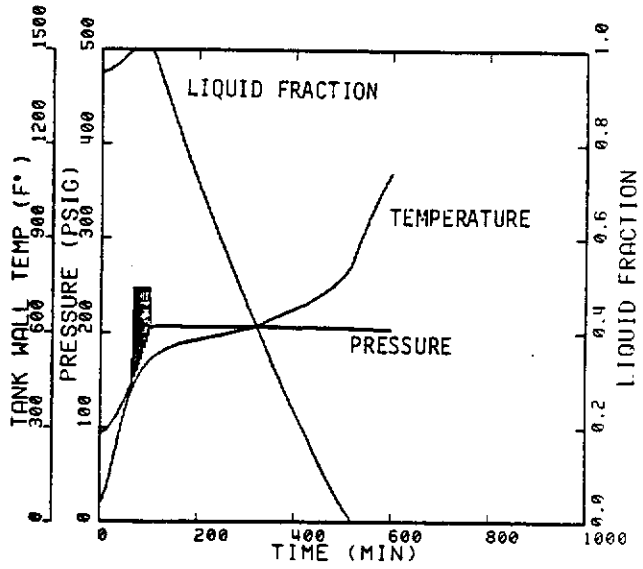


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

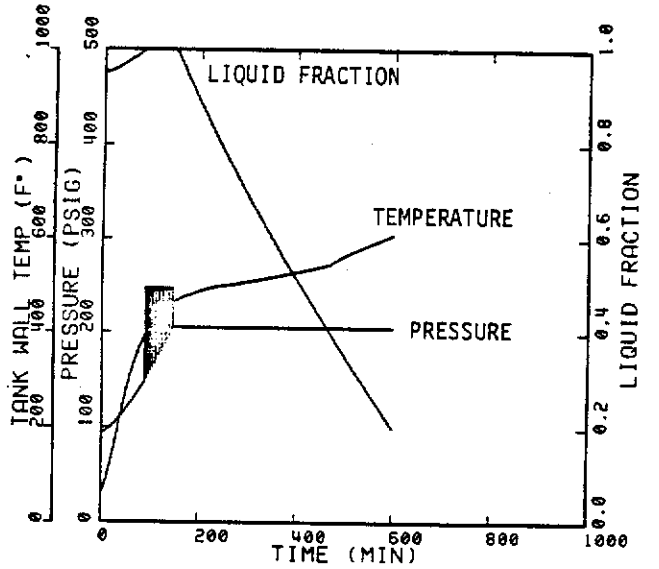
FIGURE B-8. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A300W TANK CAR CONTAINING PROPANE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 25,800 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F



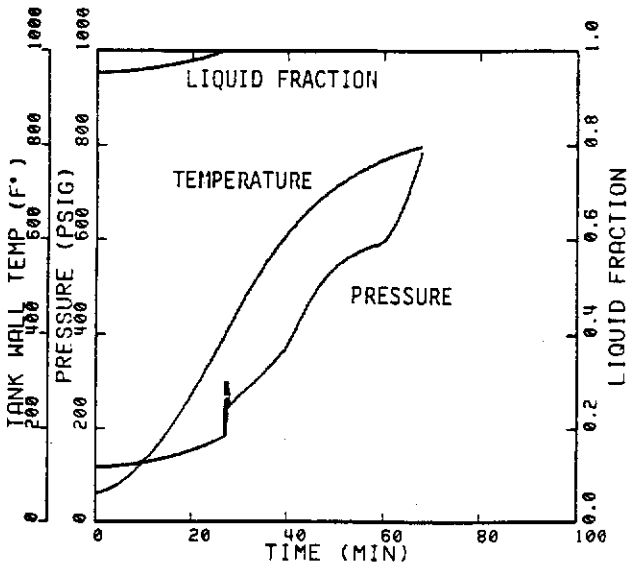
f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F



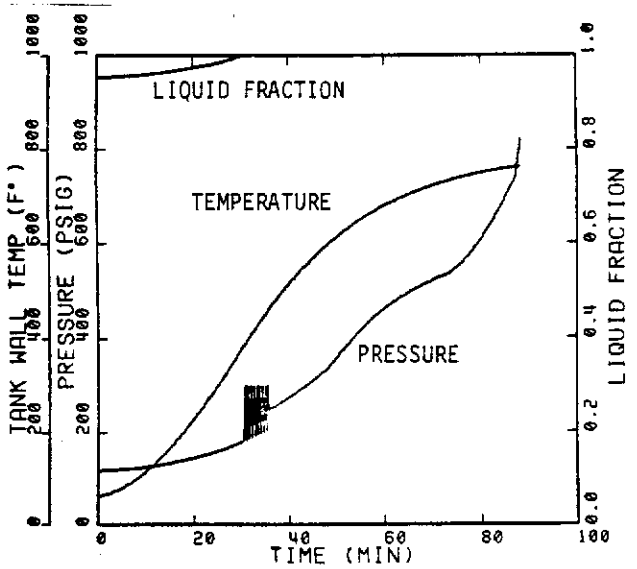
g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

FIGURE B-8. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A300W TANK CAR CONTAINING PROPANE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 25,800 SCFM

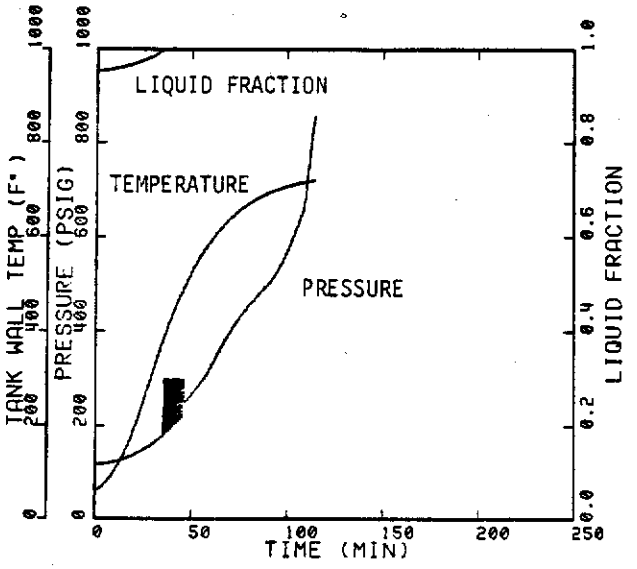
APPENDIX C: PROPYLENE PLOTS



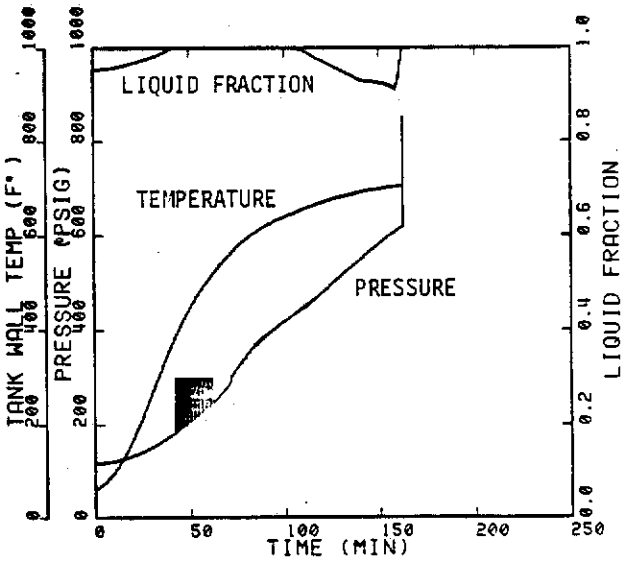
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

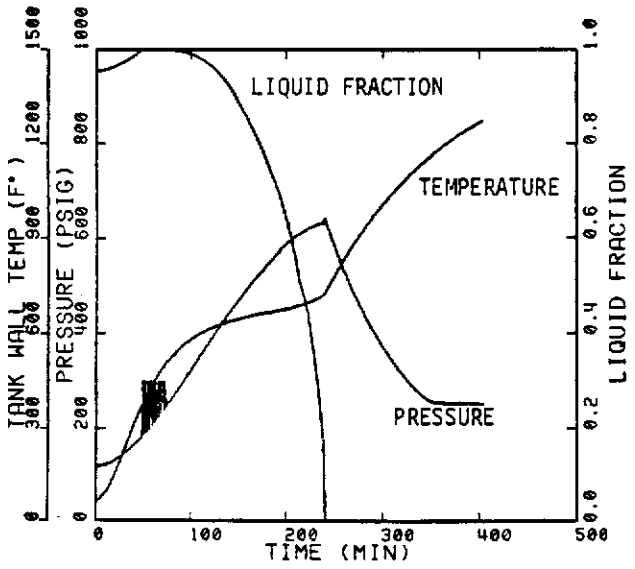


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

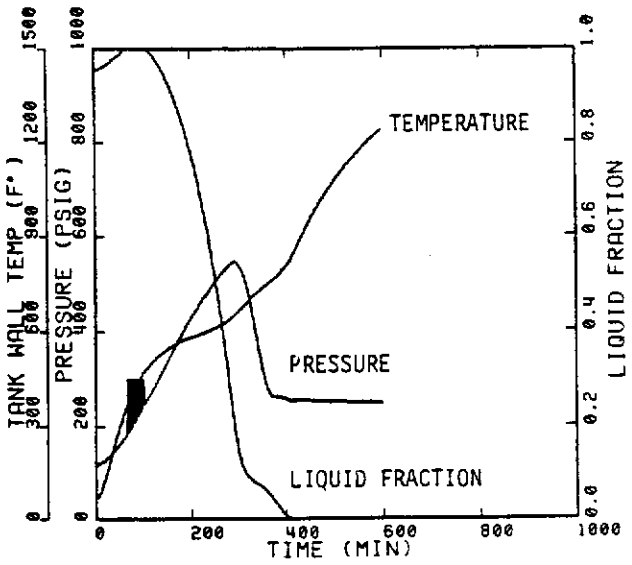


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

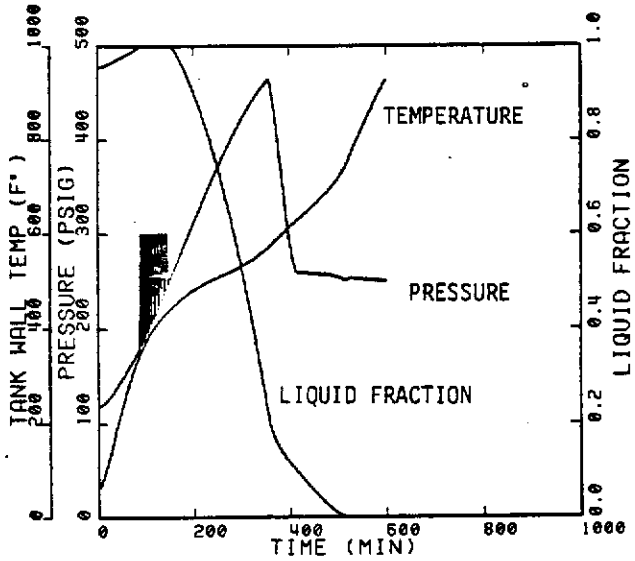
FIGURE C-1. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A400W TANK CAR CONTAINING PROPYLENE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 3070 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

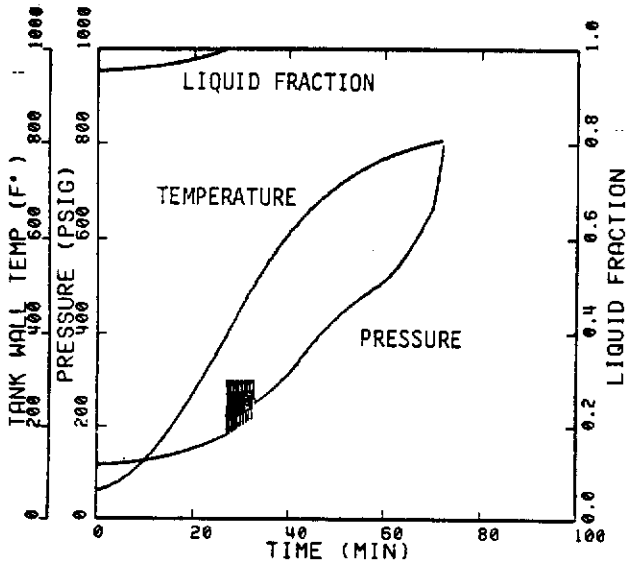


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

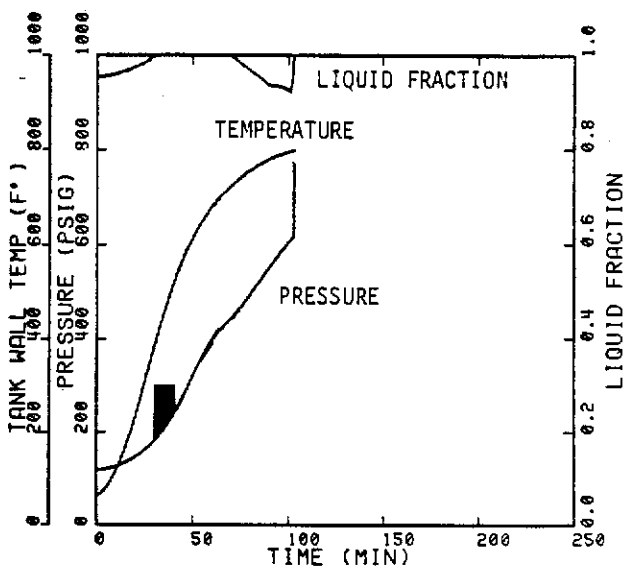


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

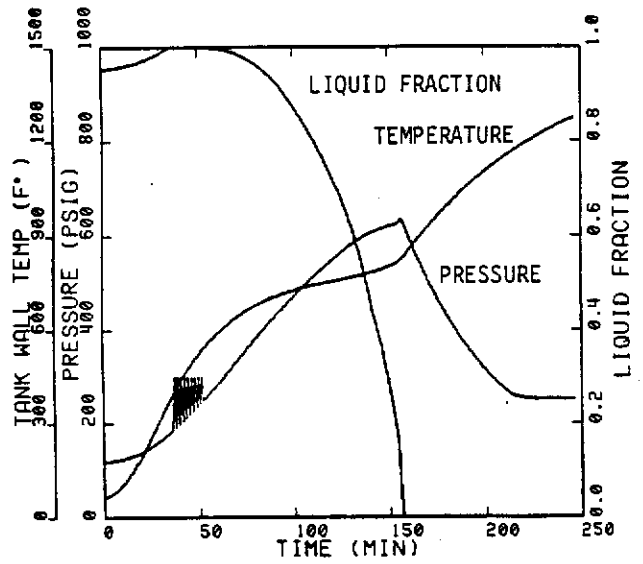
FIGURE C-1. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A400W TANK CAR CONTAINING PROPYLENE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 3070 SCFM



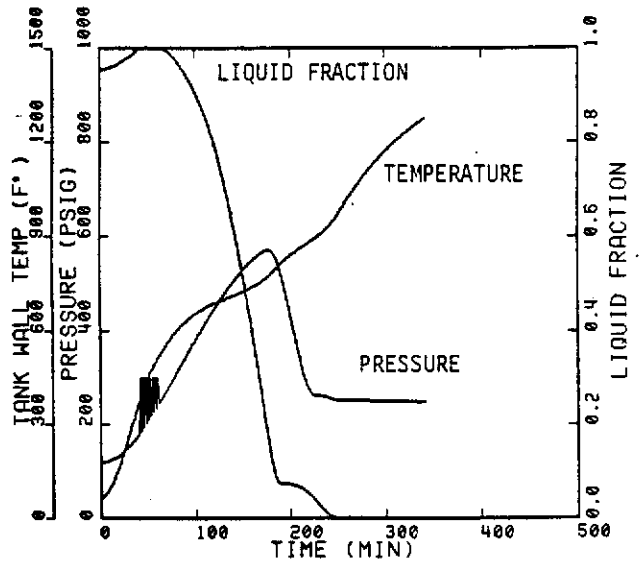
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

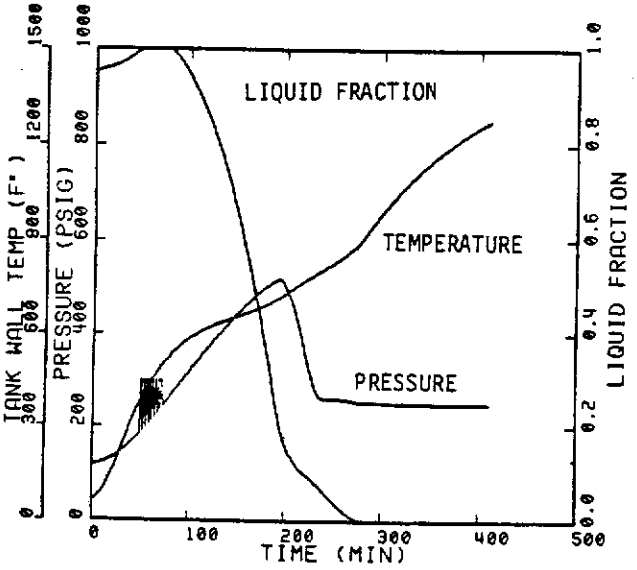


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

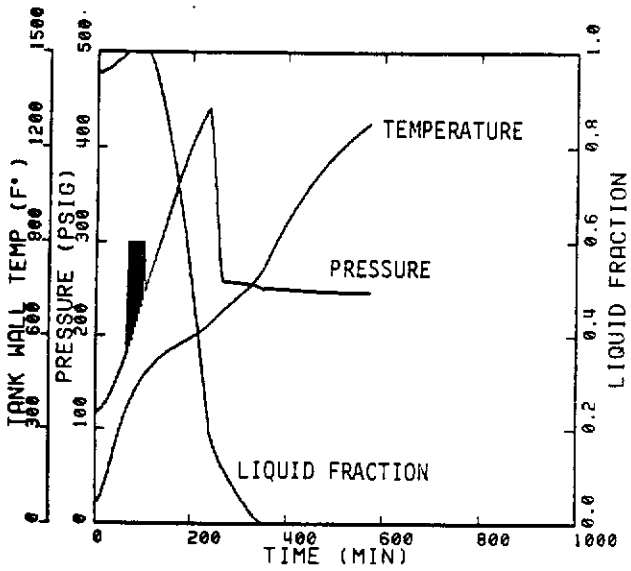


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR/FT²-°F

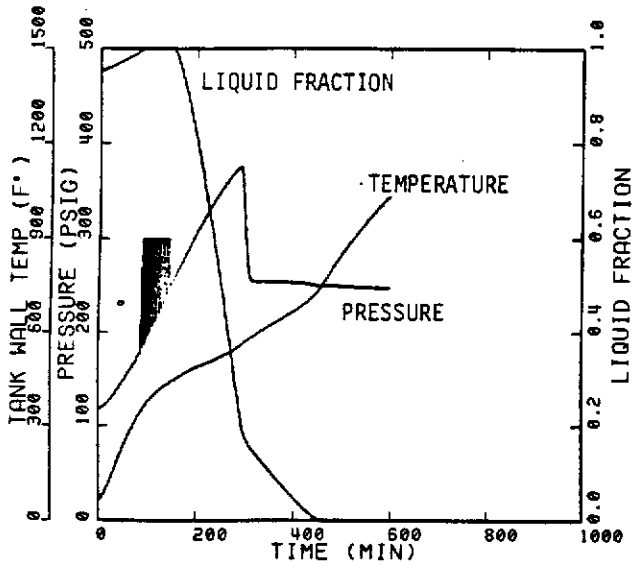
FIGURE C-2. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A400W TANK CAR CONTAINING PROPYLENE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 5000 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

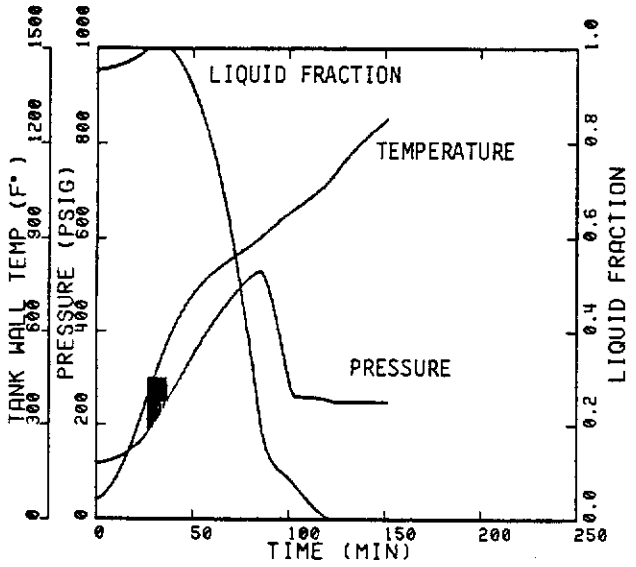


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

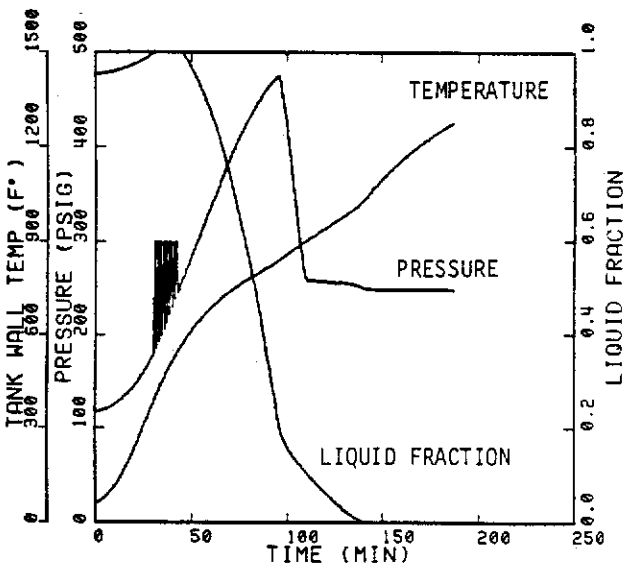


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

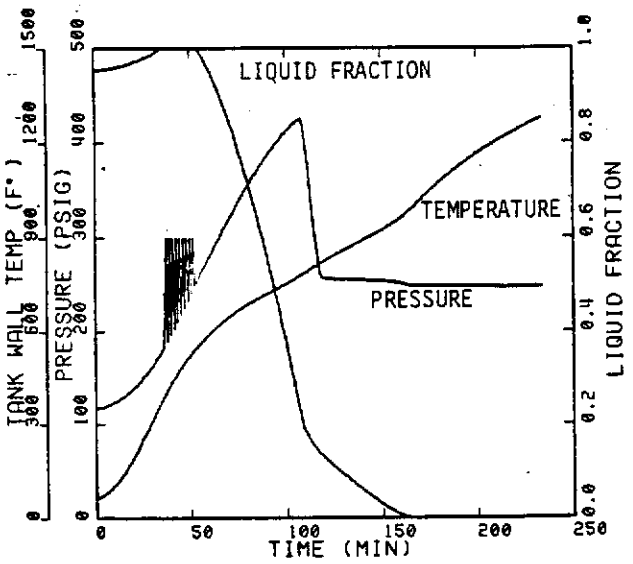
FIGURE C-2. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A400W TANK CAR CONTAINING PROPYLENE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 5000 SCFM



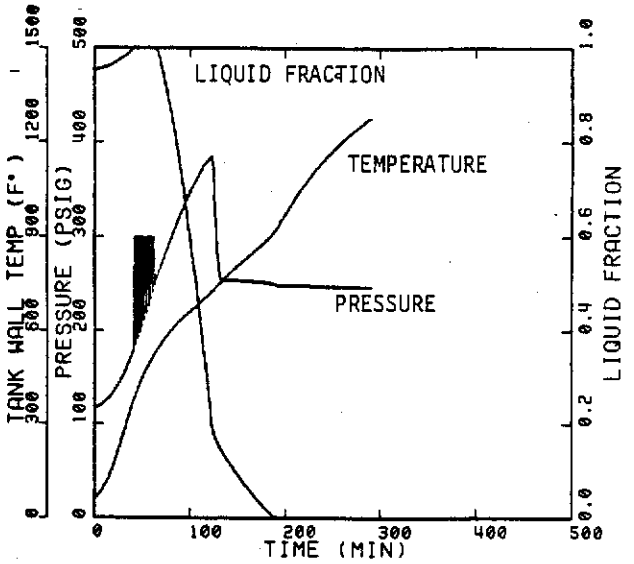
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

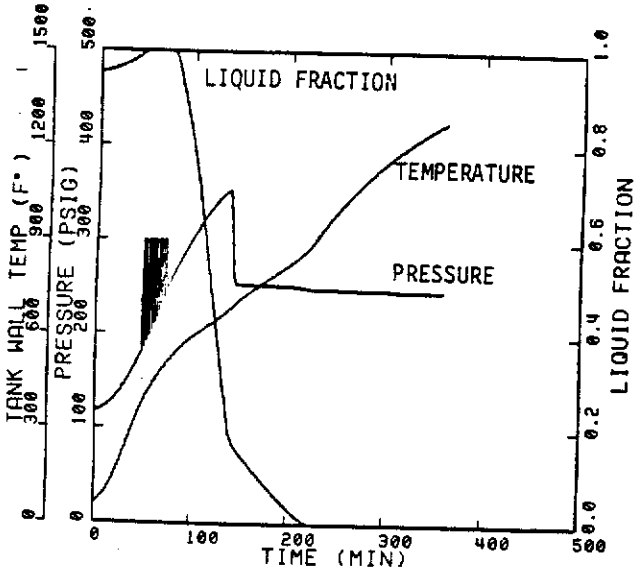


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

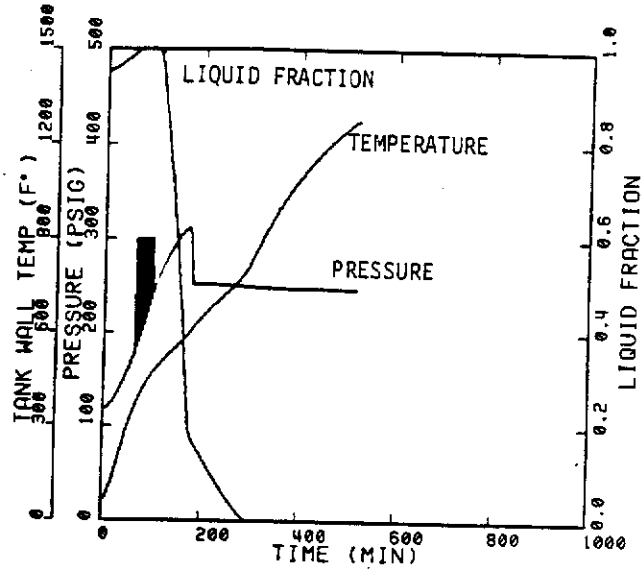


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

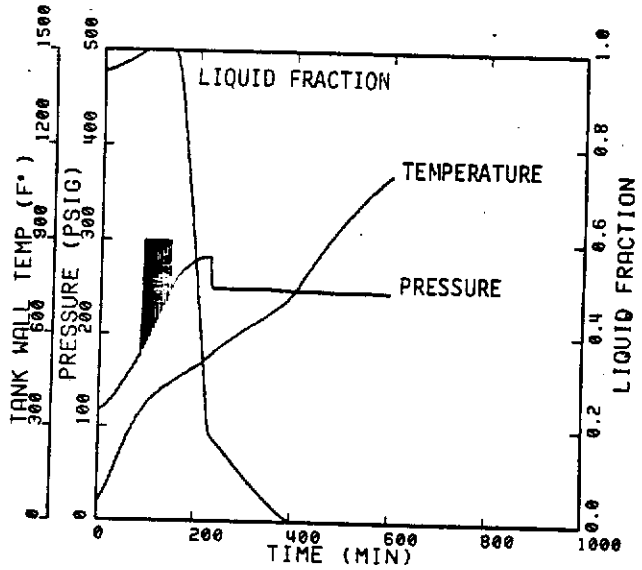
FIGURE C-3. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A400W TANK CAR CONTAINING PROPYLENE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 12,000 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

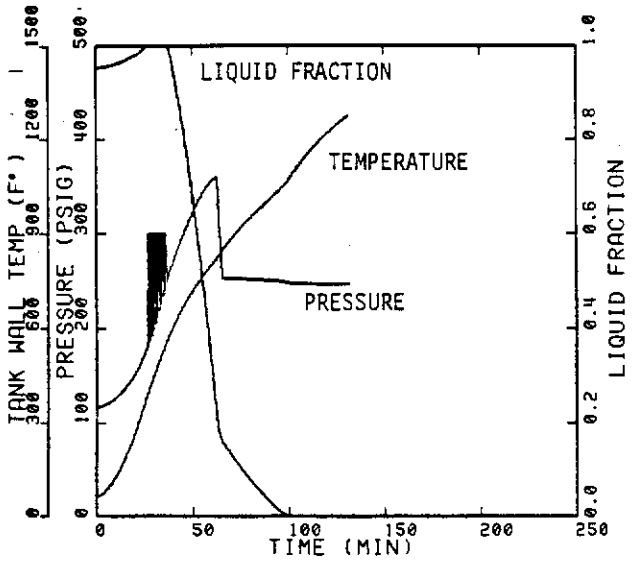


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

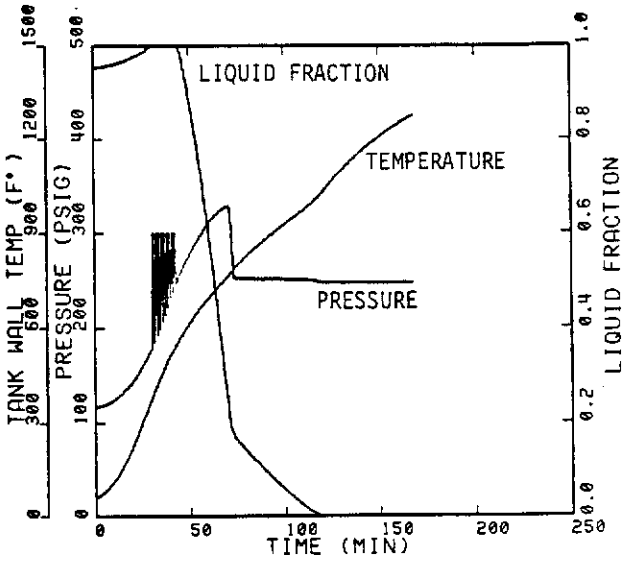


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

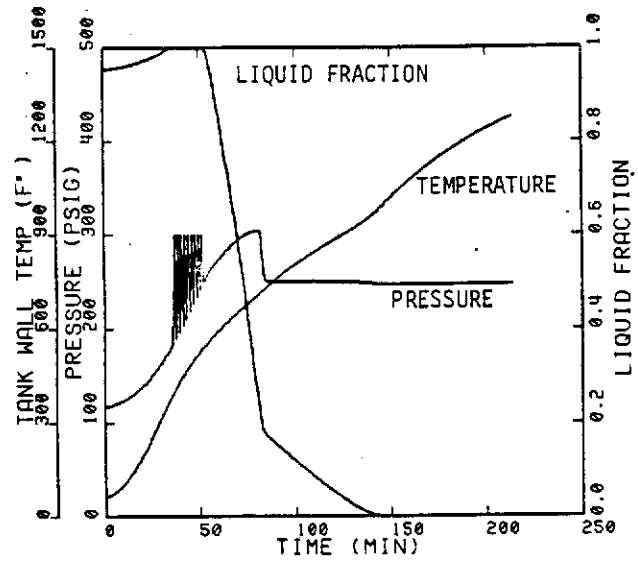
FIGURE C-3. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A400W TANK CAR CONTAINING PROPYLENE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 12,000 SCFM



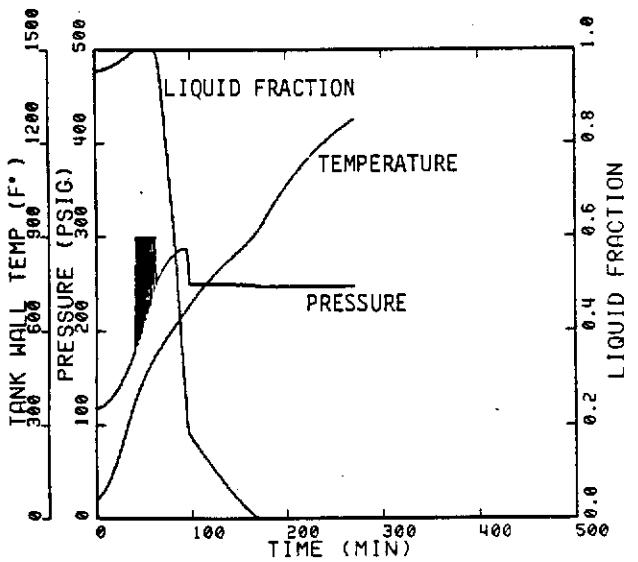
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

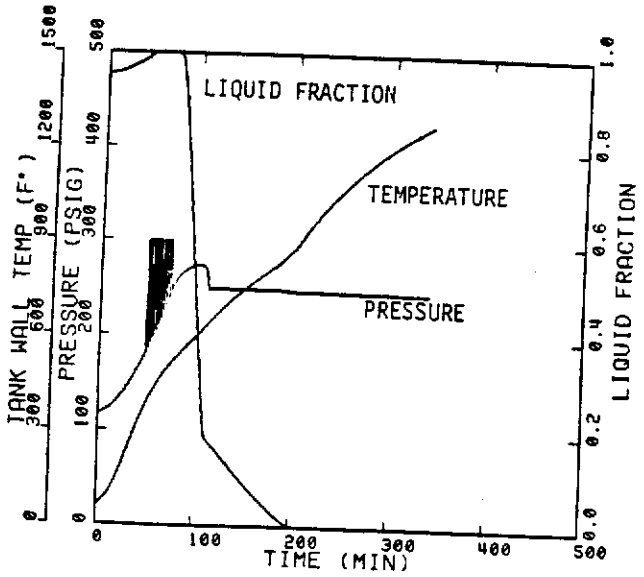


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

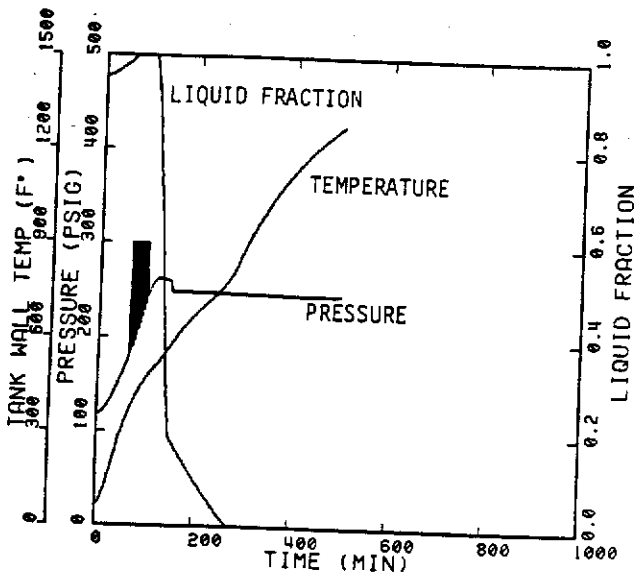


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

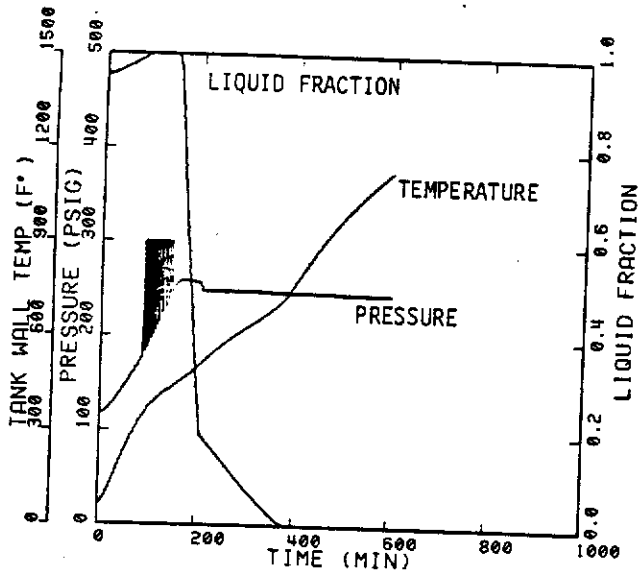
FIGURE C-4. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A400W TANK CAR CONTAINING PROPYLENE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 28,600 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

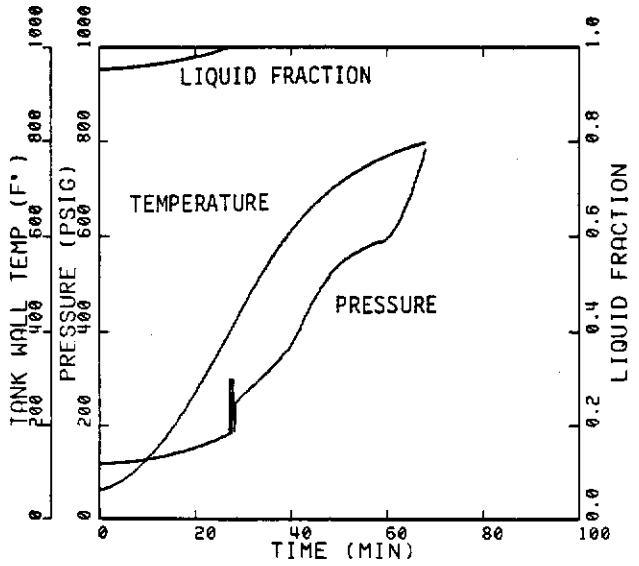


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

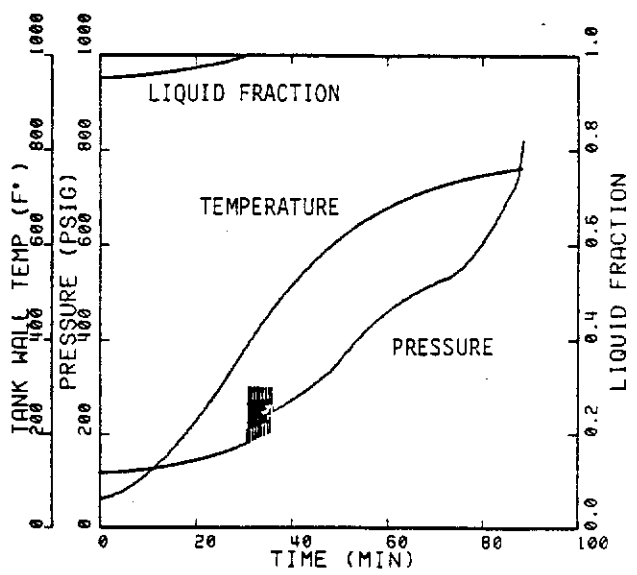


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

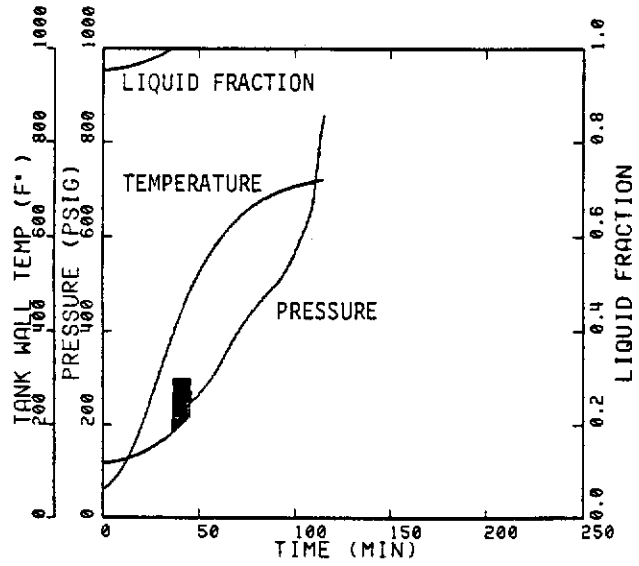
FIGURE C-4. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A400W TANK CAR CONTAINING PROPYLENE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 28,600 SCFM



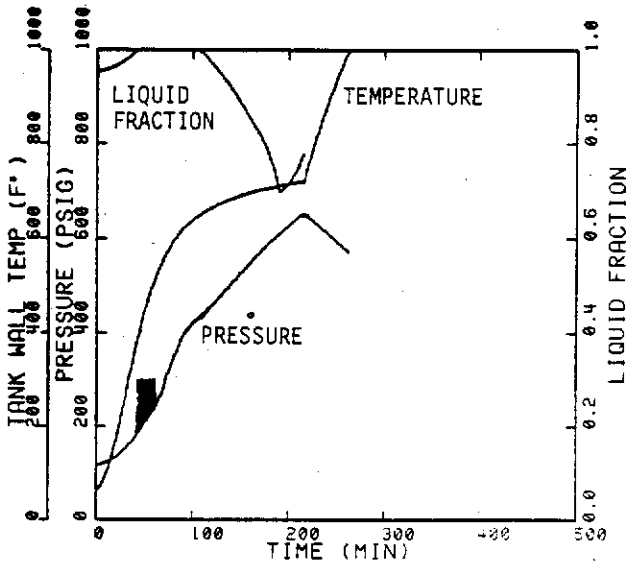
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

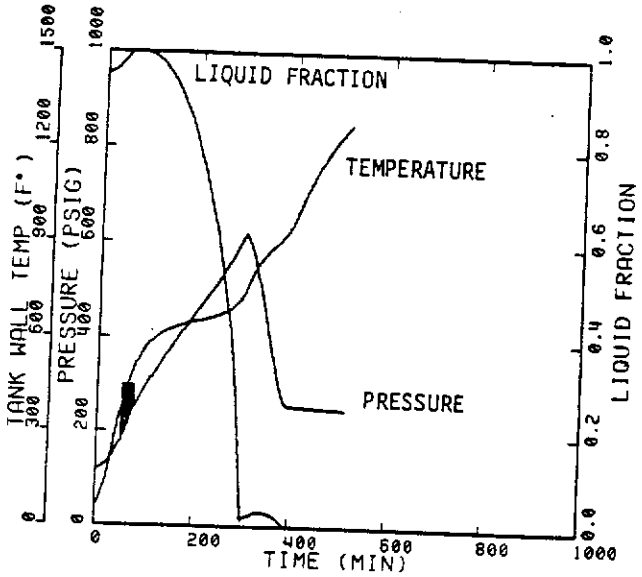


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

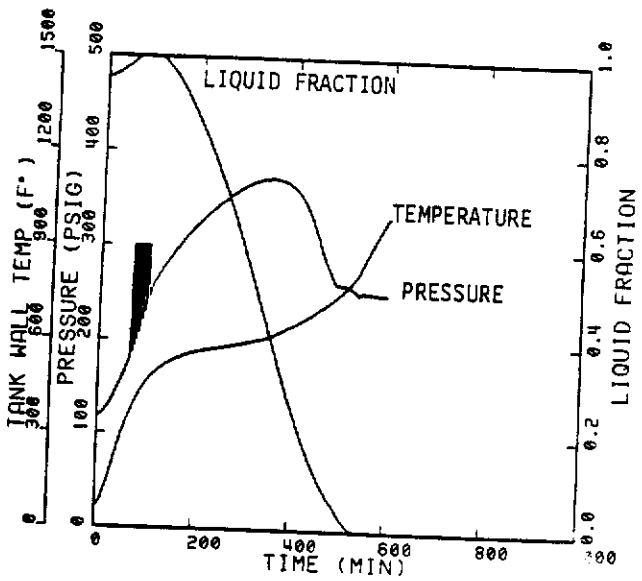


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

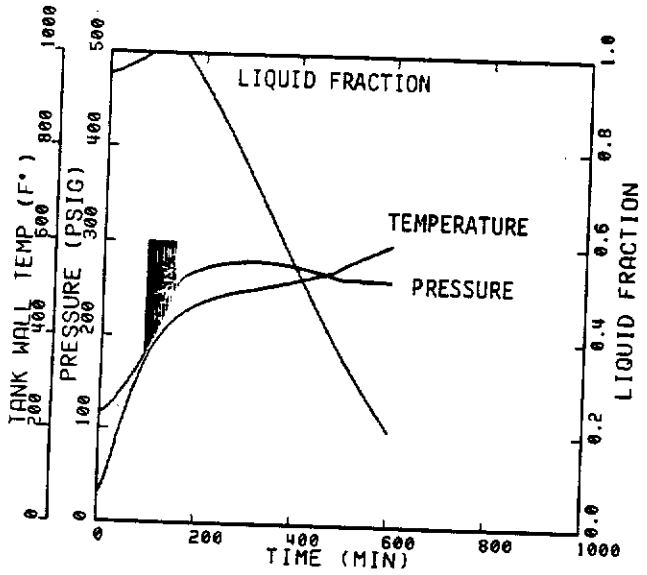
FIGURE C-5. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A400W TANK CAR CONTAINING PROPYLENE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 3070 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

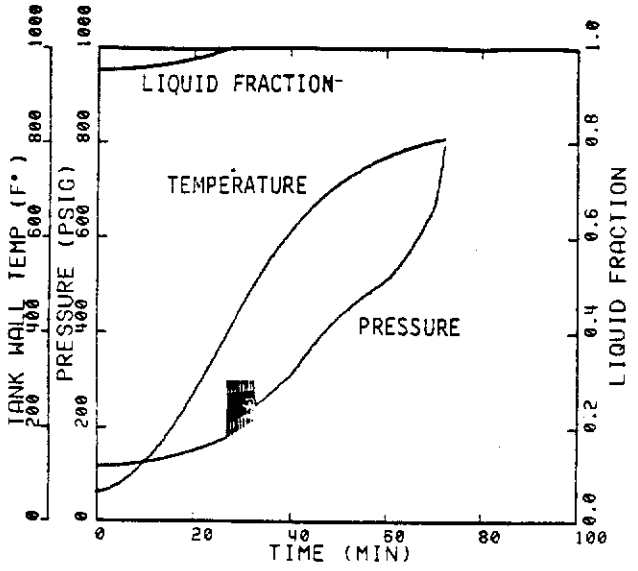


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

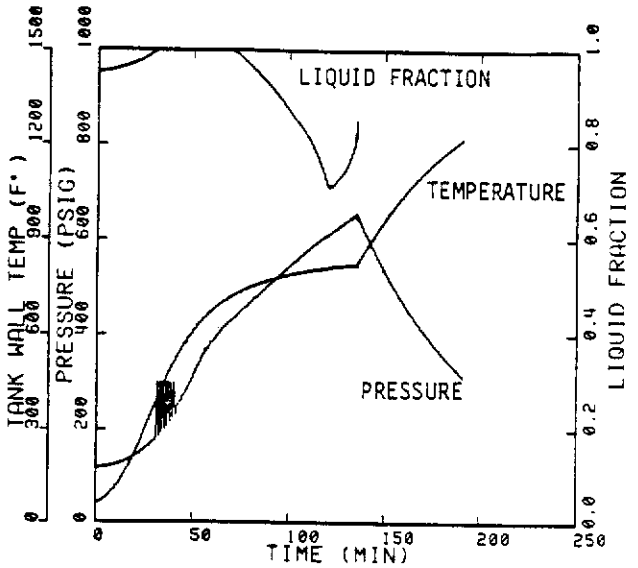


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

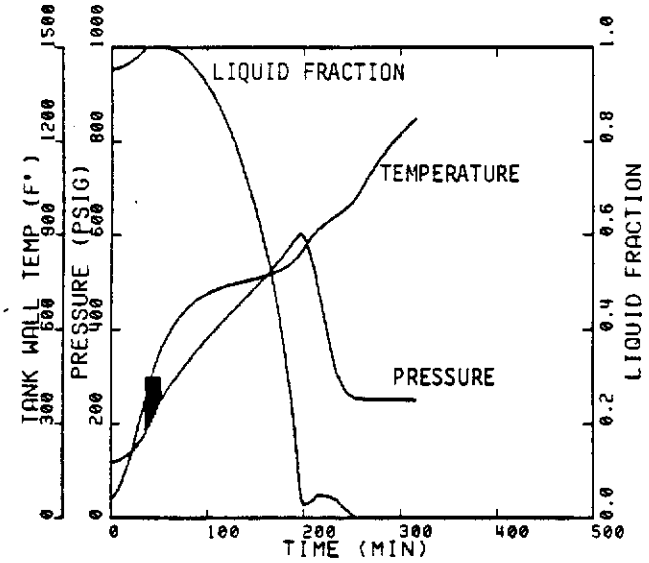
FIGURE C-5. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A400W TANK CAR CONTAINING PROPYLENE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 3070 SCFM



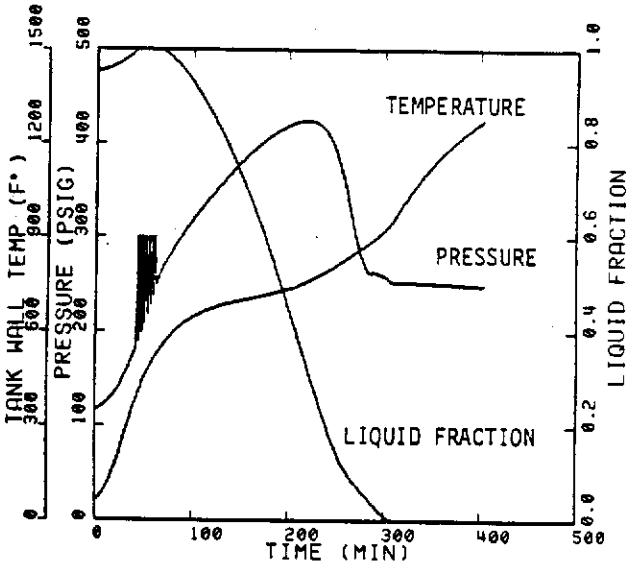
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

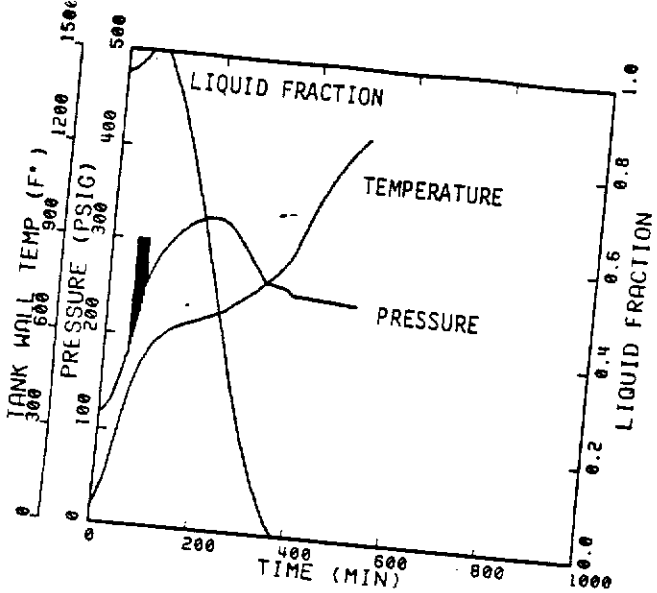


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

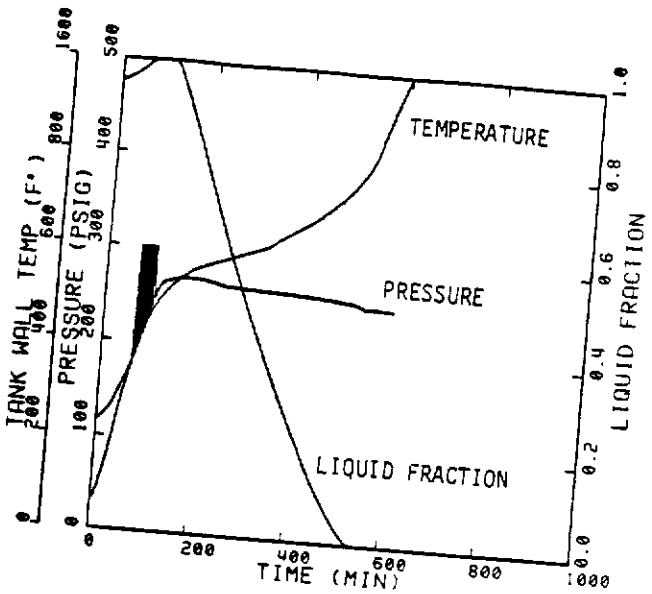


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

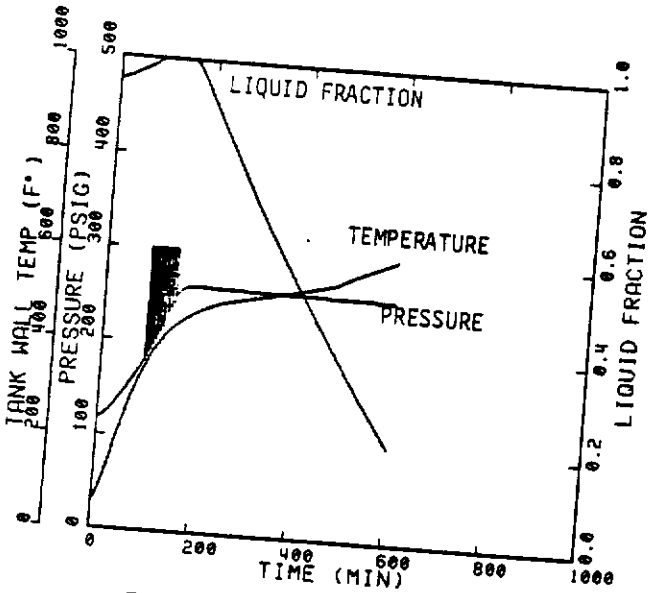
FIGURE C-6. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A400W TANK CAR CONTAINING PROPYLENE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 5000 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

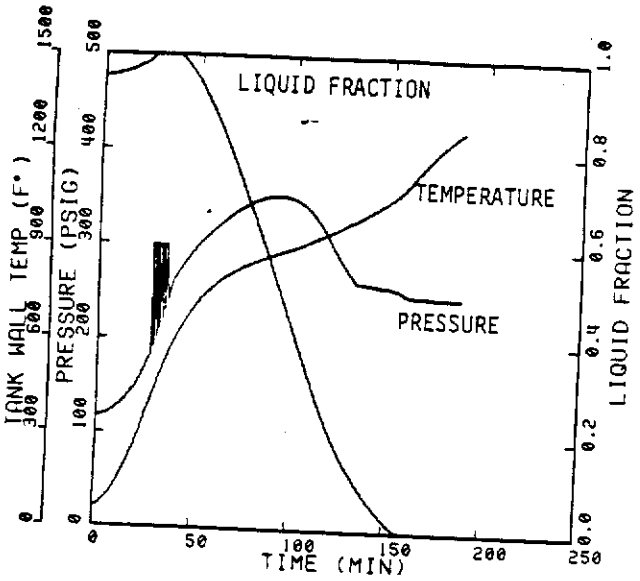


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

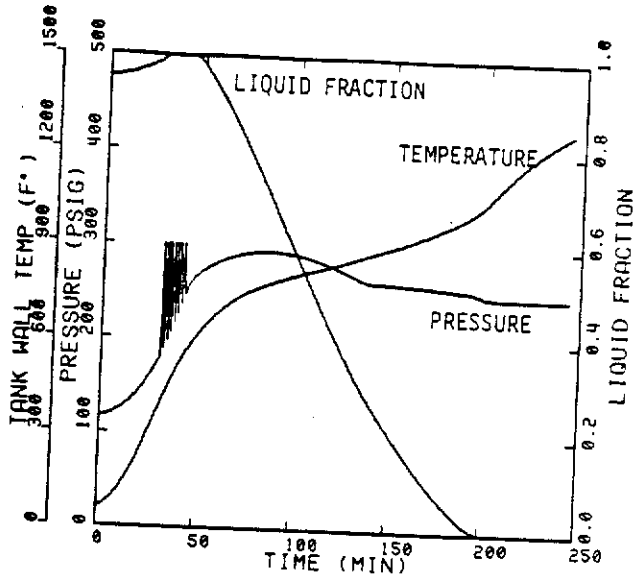


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

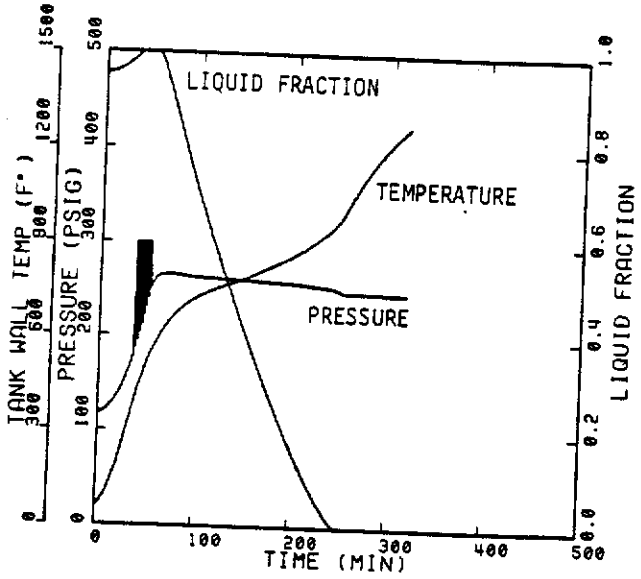
FIGURE C-6. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A400W TANK CAR CONTAINING PROPYLENE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 5000 SCFM



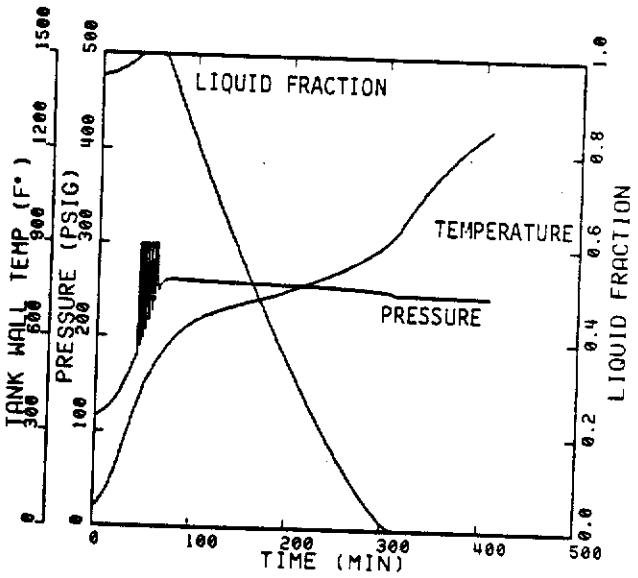
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

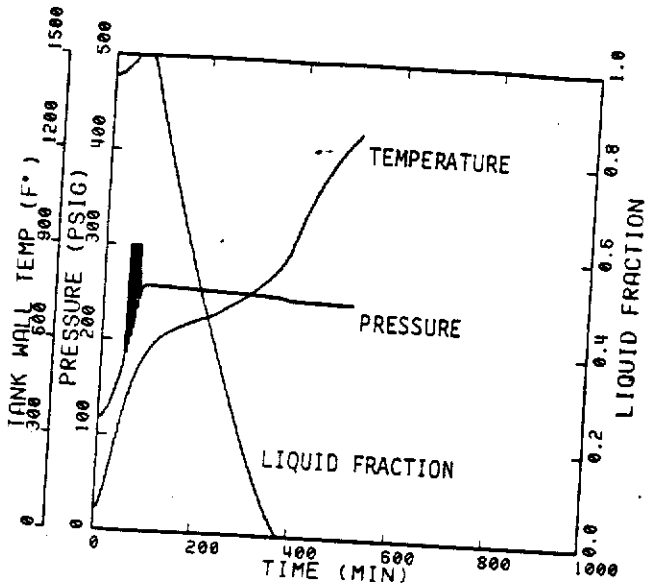


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

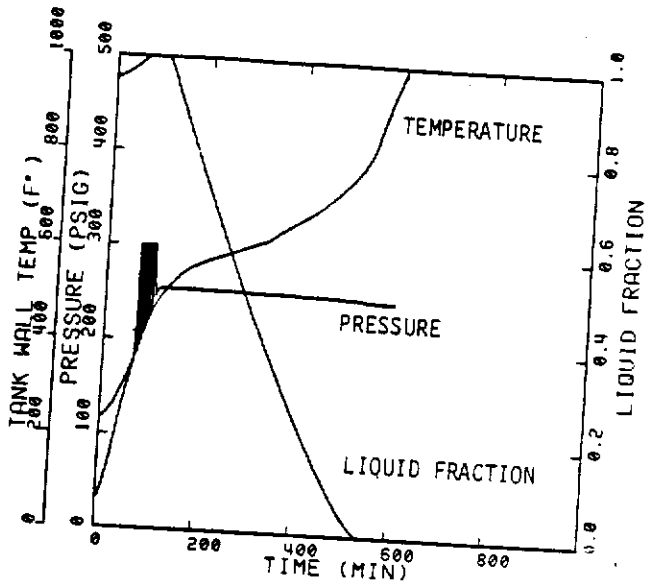


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

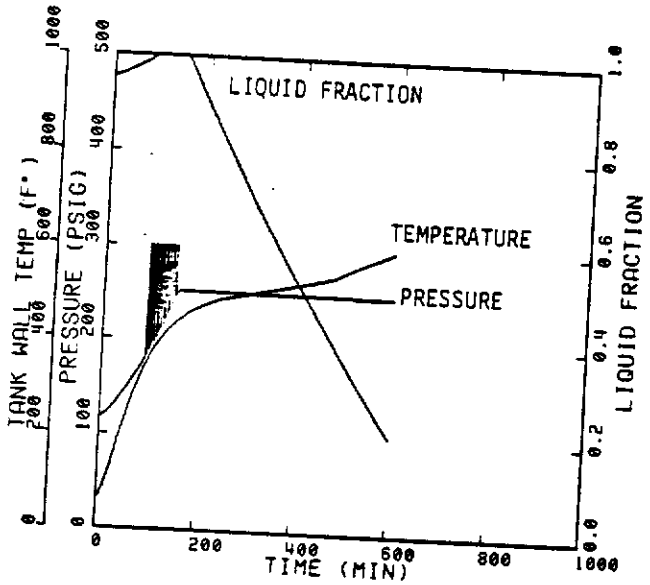
FIGURE C-7. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A400W TANK CAR CONTAINING PROPYLENE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 12,000 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

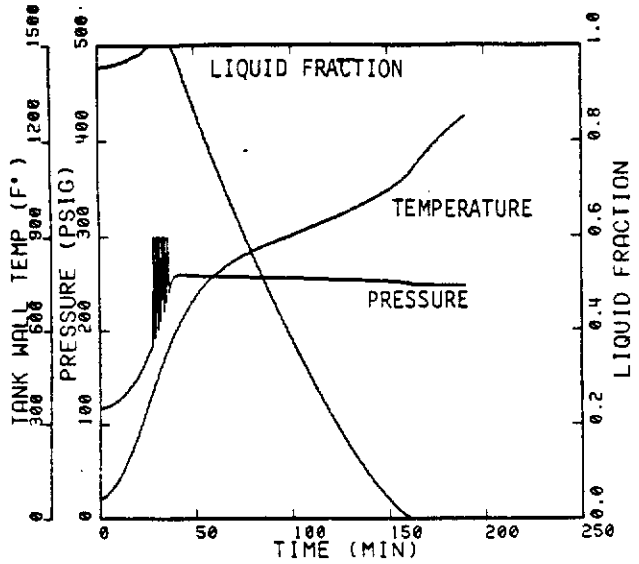


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

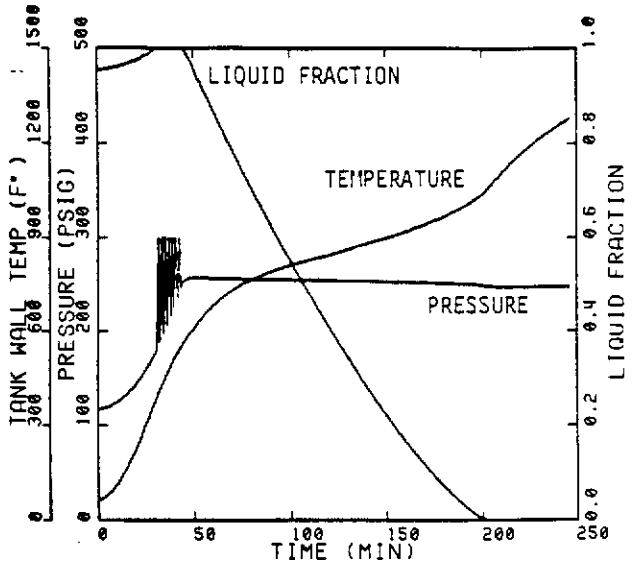


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

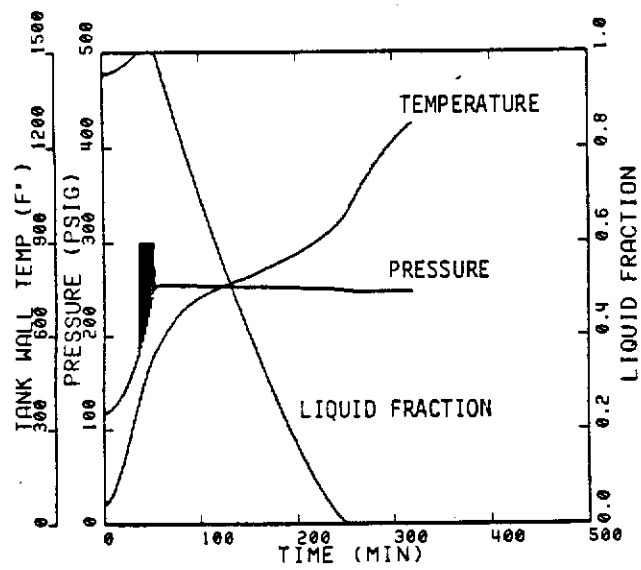
FIGURE C-7. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A400W TANK CAR CONTAINING PROPYLENE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 12,000 SCFM



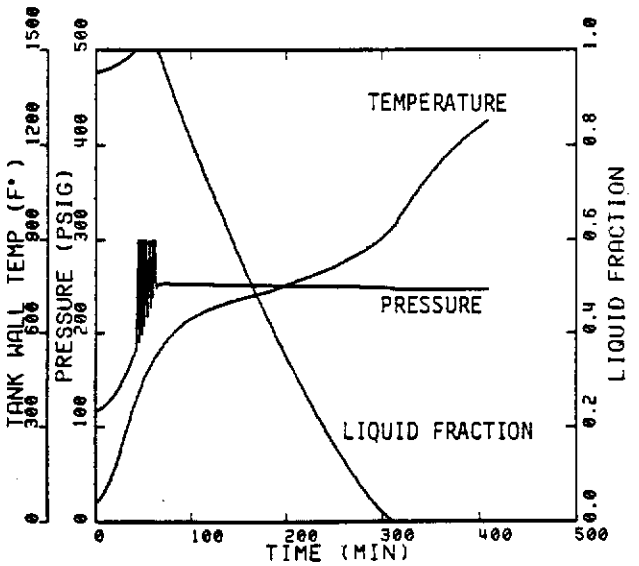
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

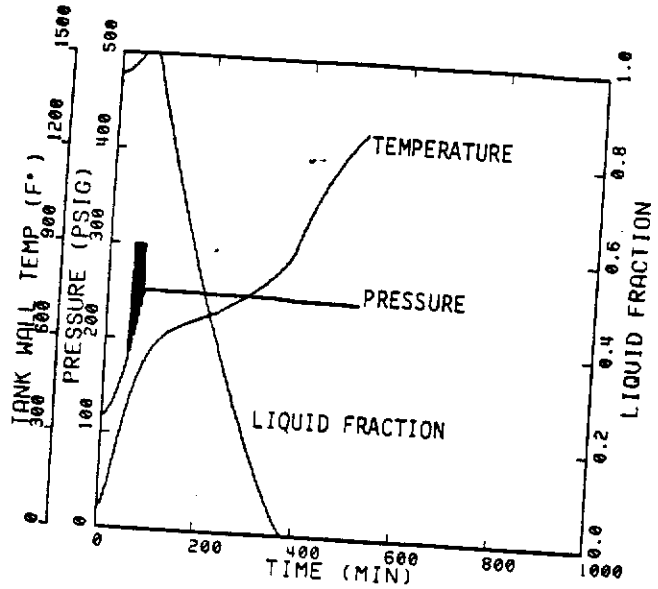


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

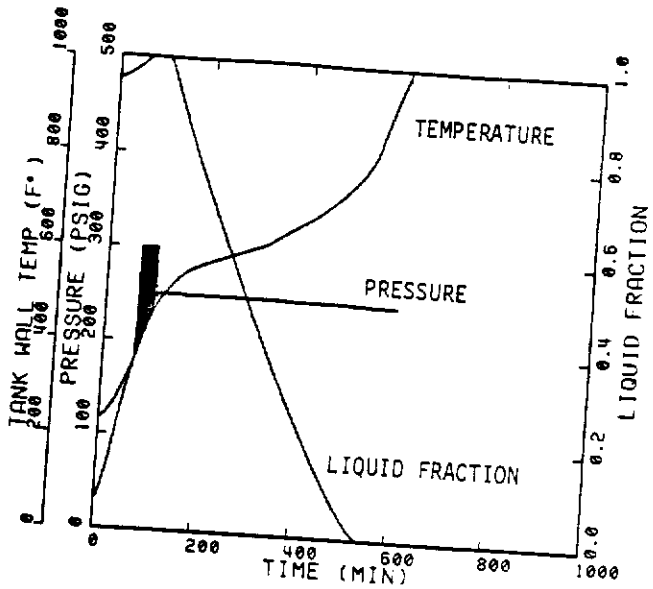


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

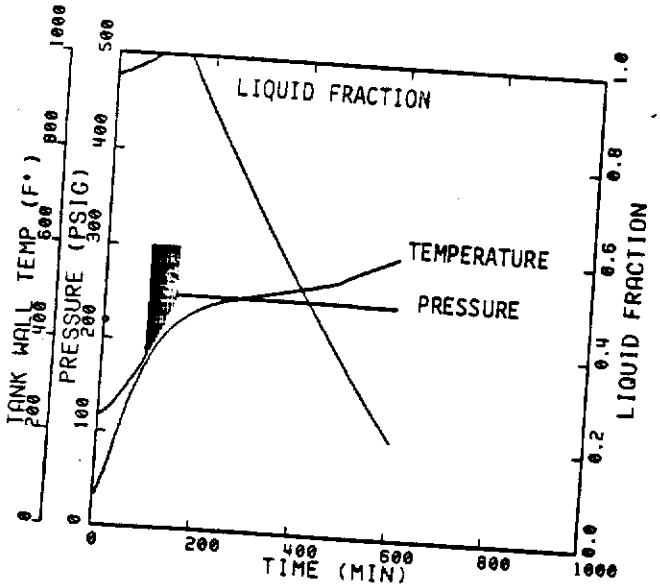
FIGURE C-8. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A400W TANK CAR CONTAINING PROPYLENE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 28,600 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F



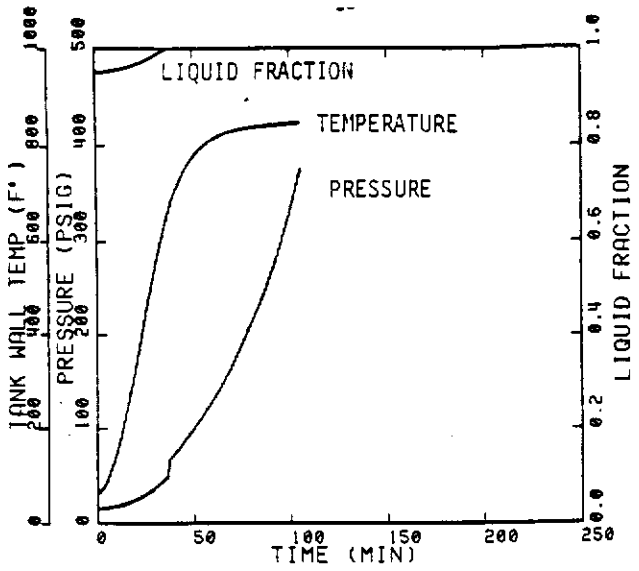
f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F



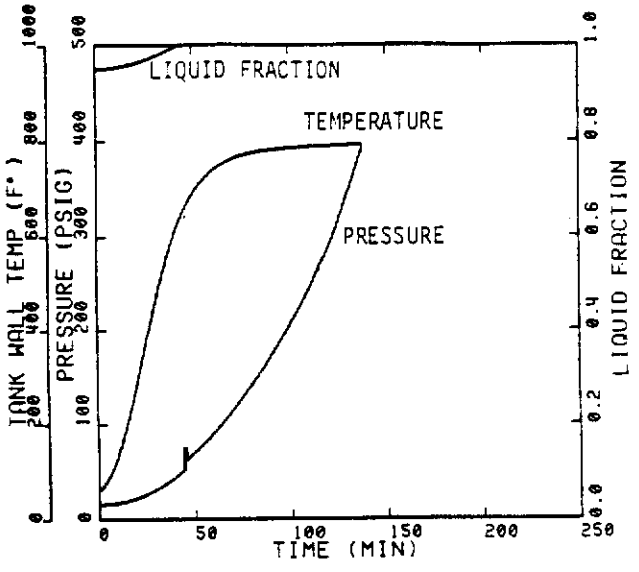
g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

FIGURE C-8. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A400W TANK CAR CONTAINING PROPYLENE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 28,600 SCFM

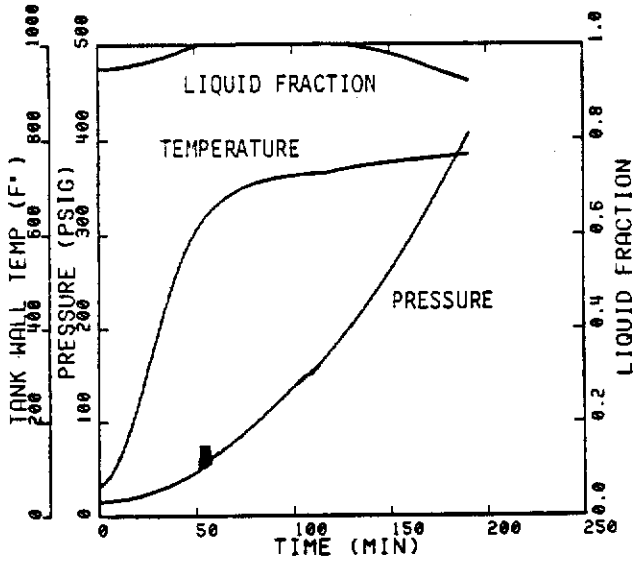
APPENDIX D: 1,3-BUTADIENE PLOTS



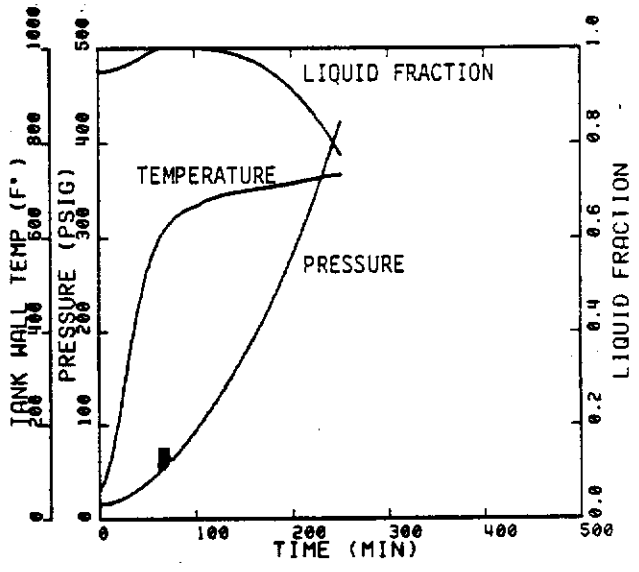
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

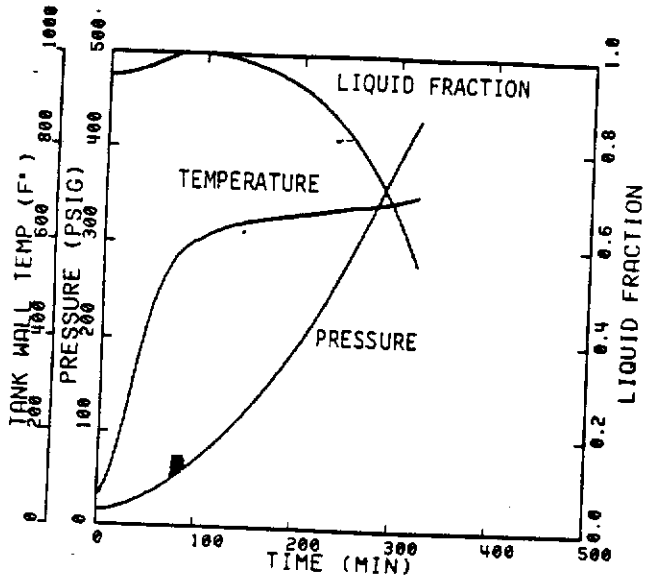


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

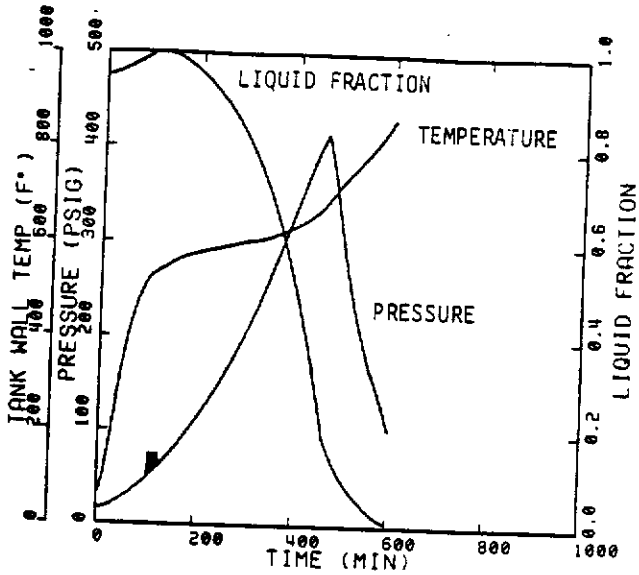


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

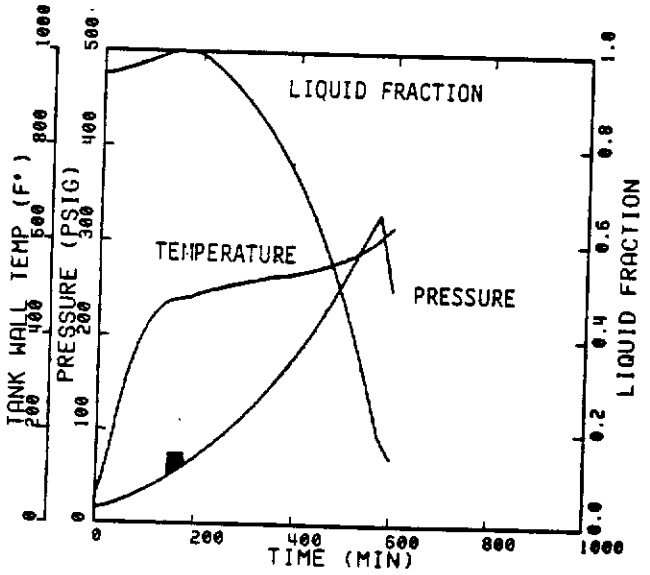
FIGURE D-1. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A100W TANK CAR CONTAINING 1,3-BUTADIENE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 1100 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

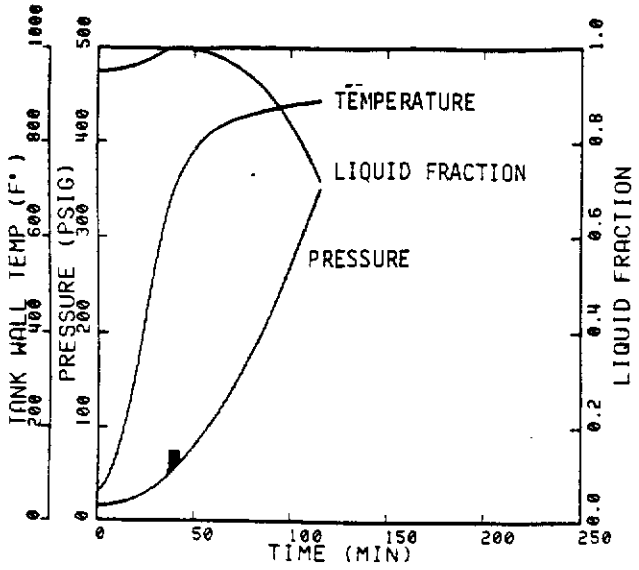


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

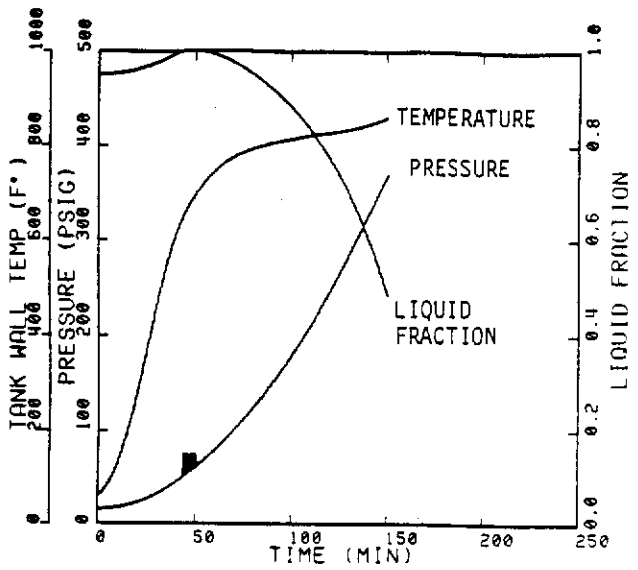


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

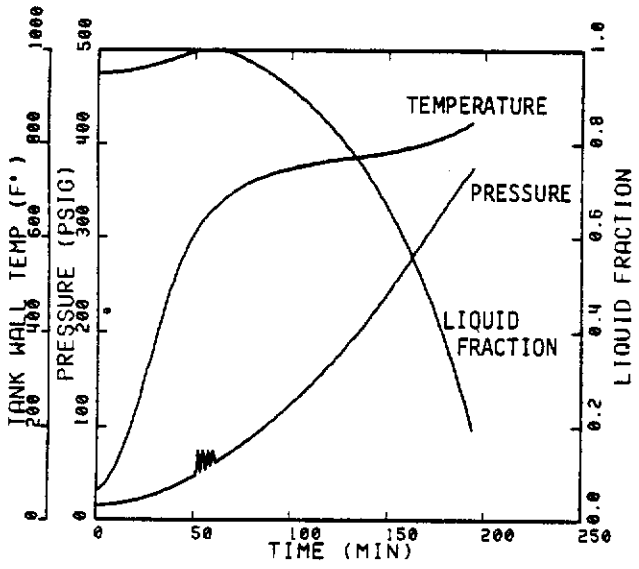
FIGURE D-1. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A100W TANK CAR CONTAINING 1,3-BUTADIENE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 1100 SCFM



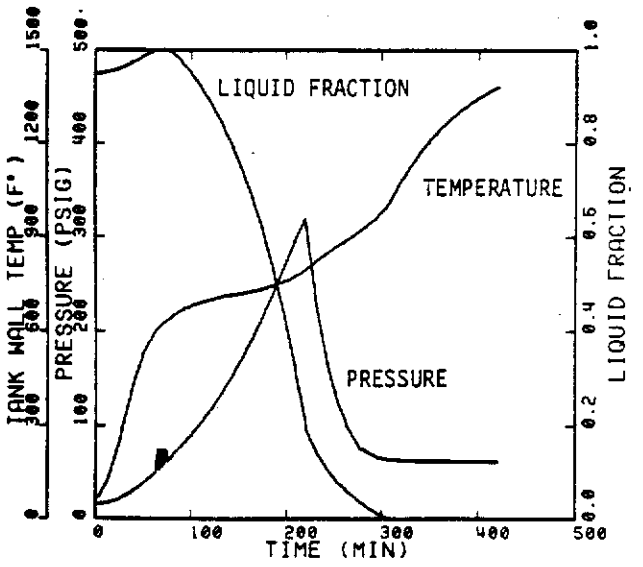
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

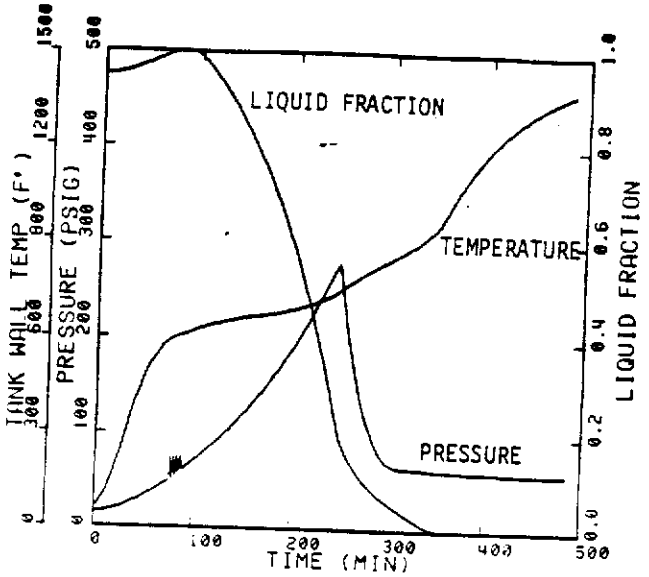


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

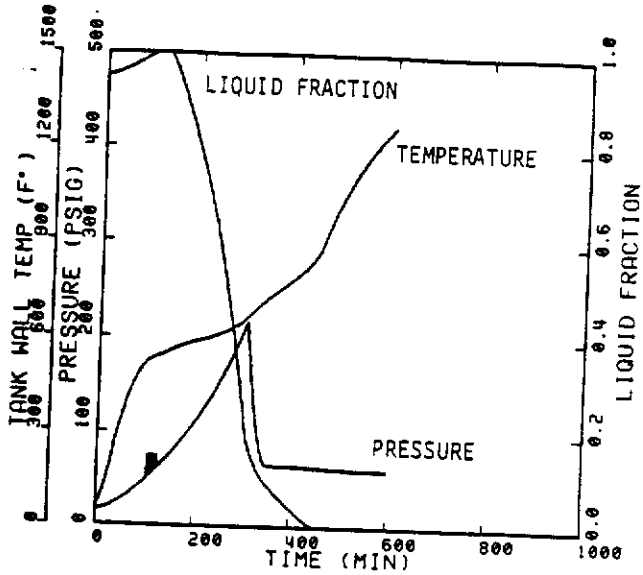


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

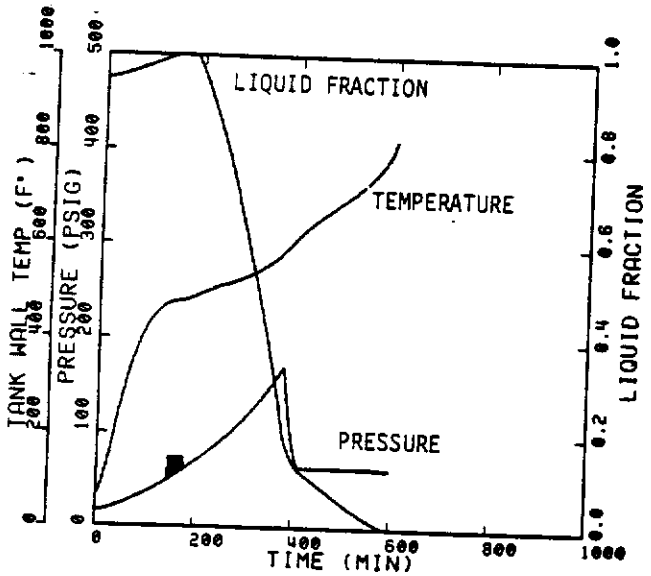
FIGURE D-2. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A100W TANK CAR CONTAINING 1,3-BUTADIENE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 3000 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

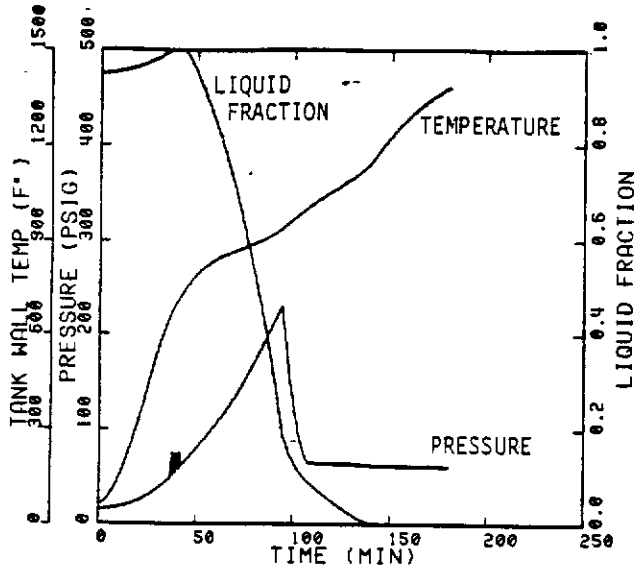


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

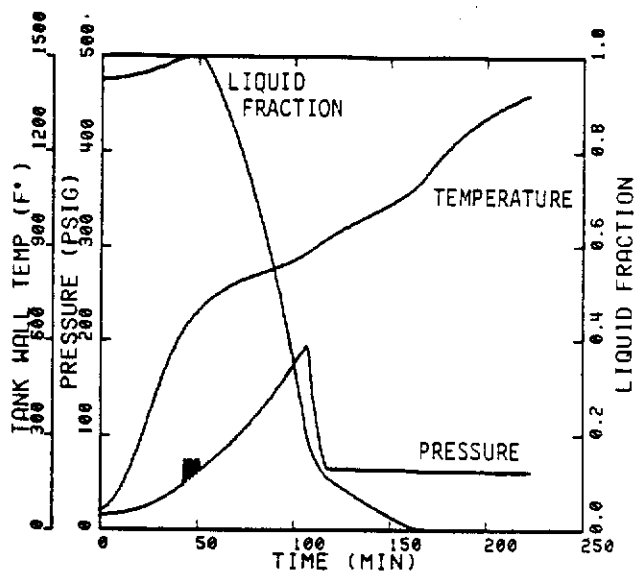


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

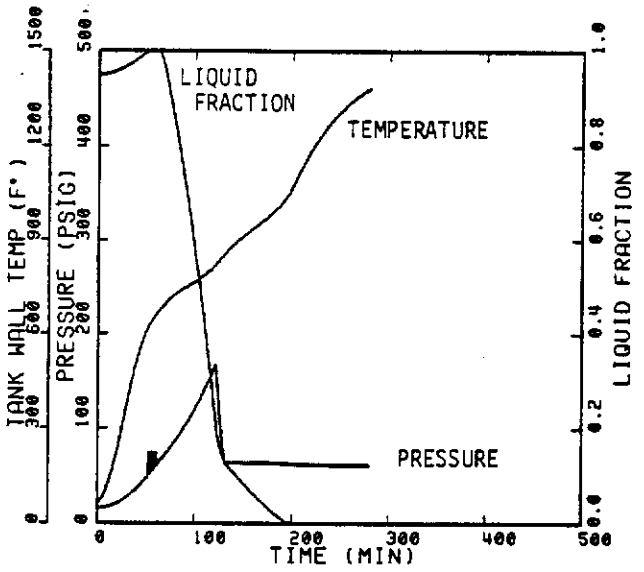
FIGURE D-2. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A100W TANK CAR CONTAINING 1,3-BUTADIENE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 3000 SCFM



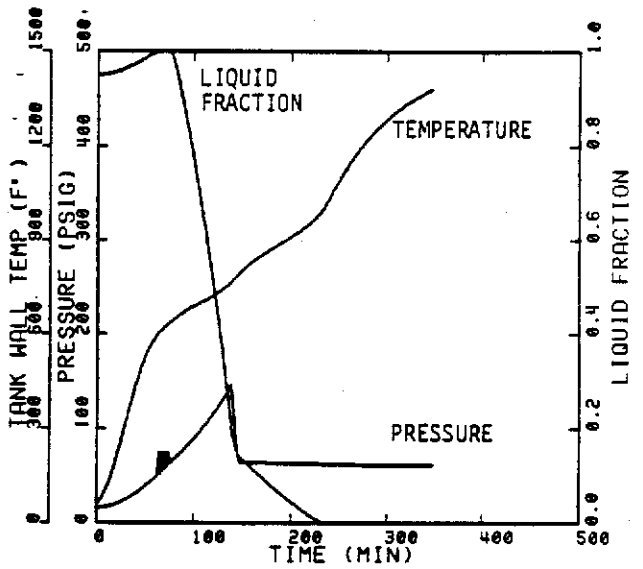
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

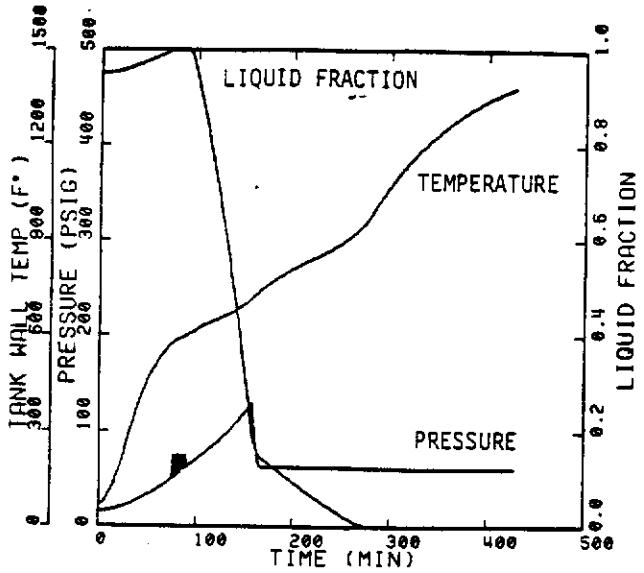


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

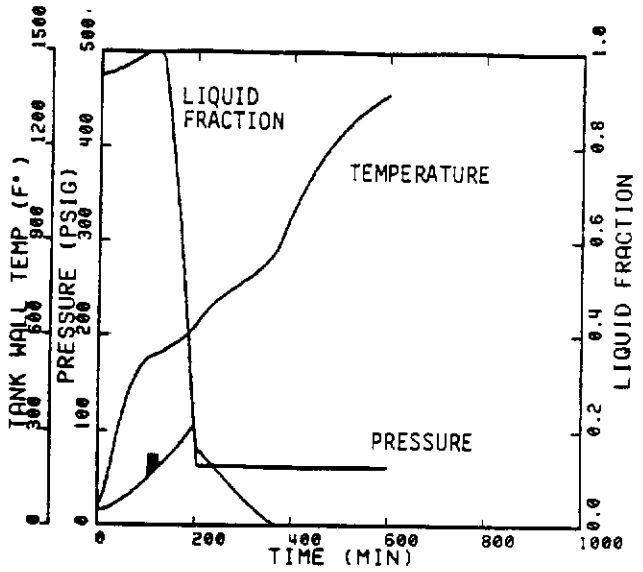


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

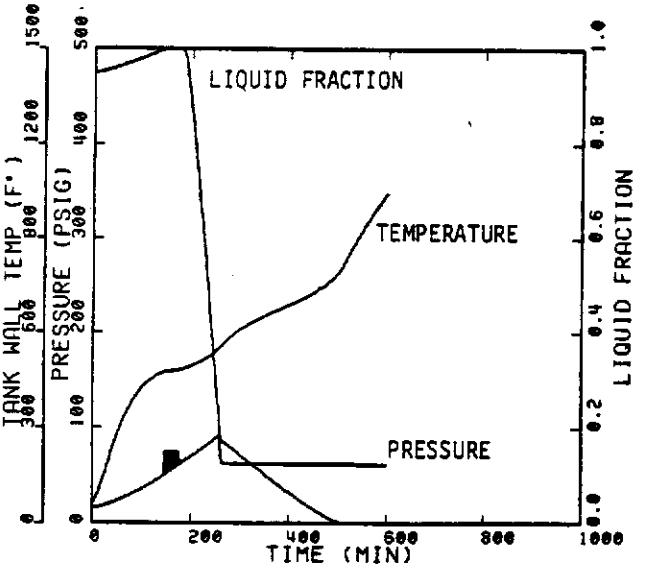
FIGURE D-3. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A100W TANK CAR CONTAINING 1,3-BUTADIENE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 10,000 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

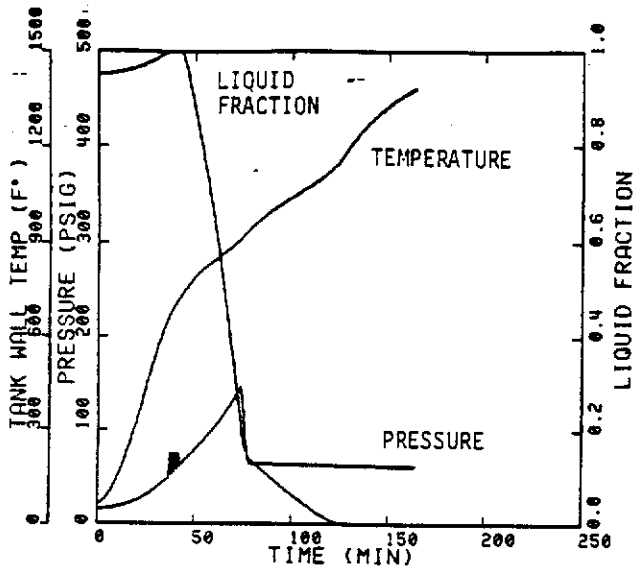


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

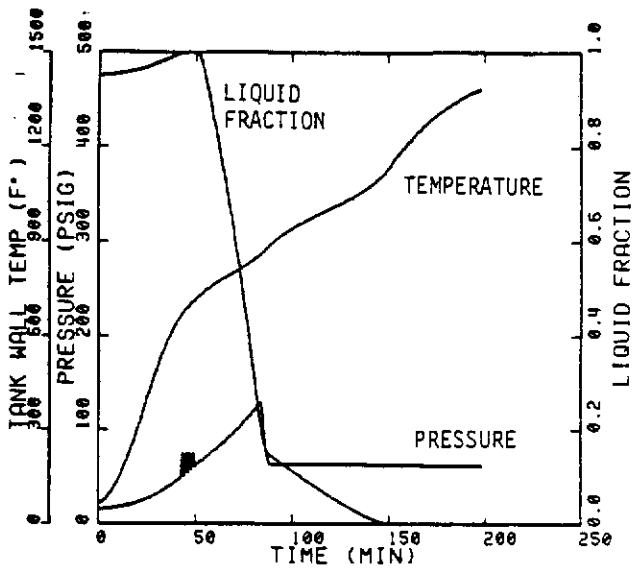


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

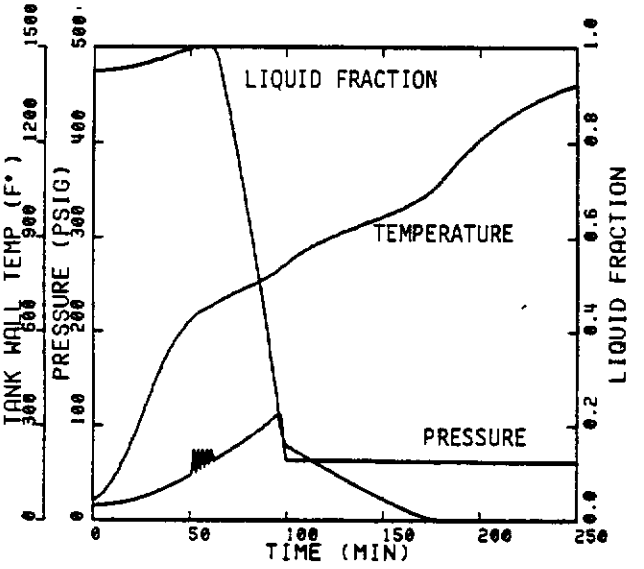
FIGURE D-3. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A100W TANK CAR CONTAINING 1,3-BUTADIENE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 10,000 SCFM



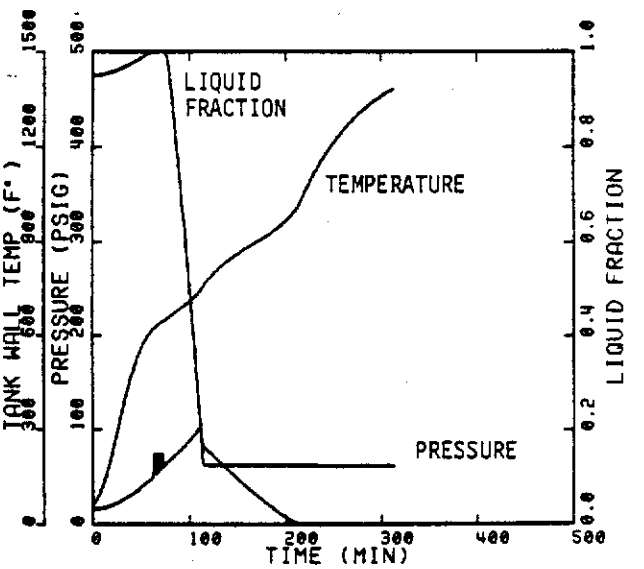
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

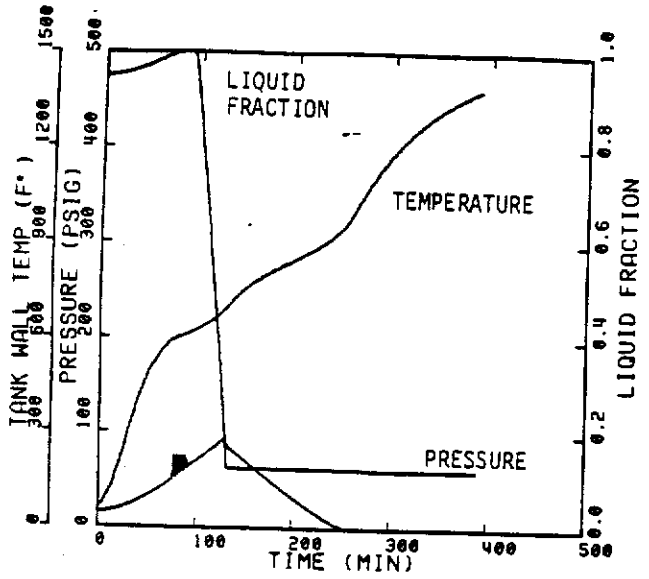


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

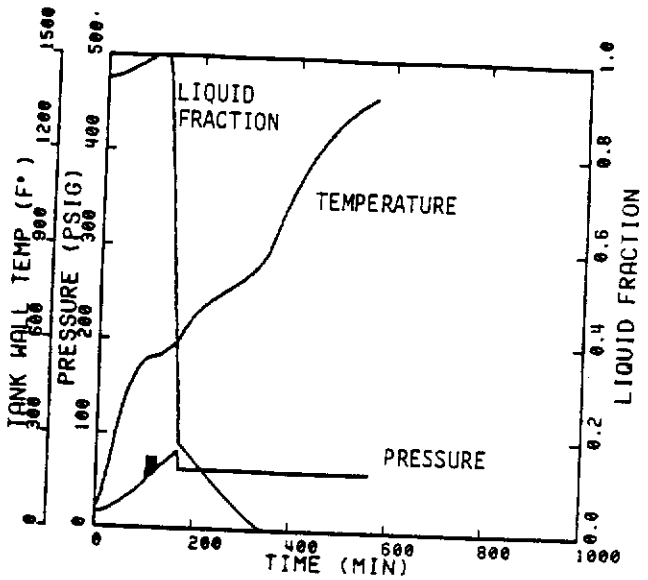


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

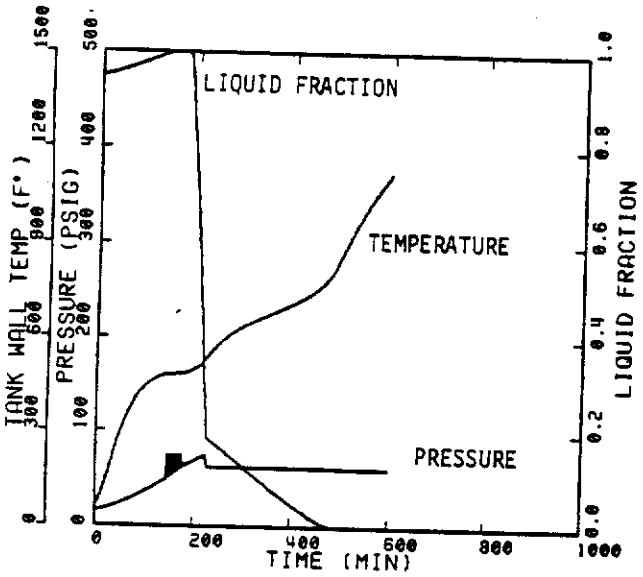
FIGURE D-4. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A100W TANK CAR CONTAINING 1,3-BUTADIENE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 20,000 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

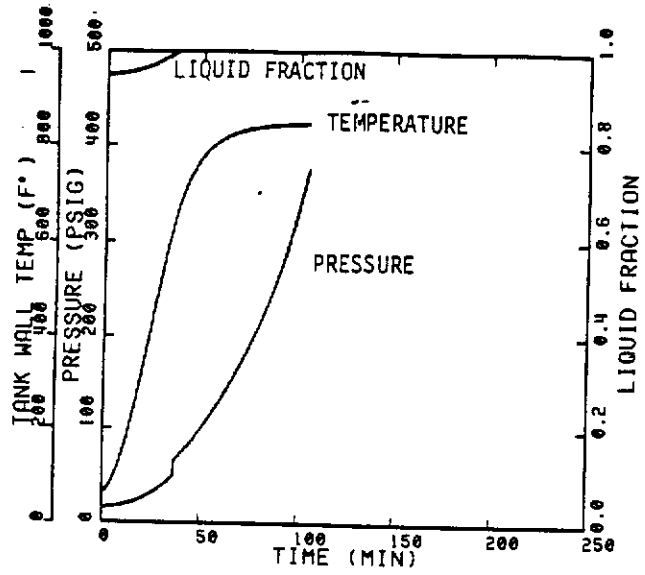


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

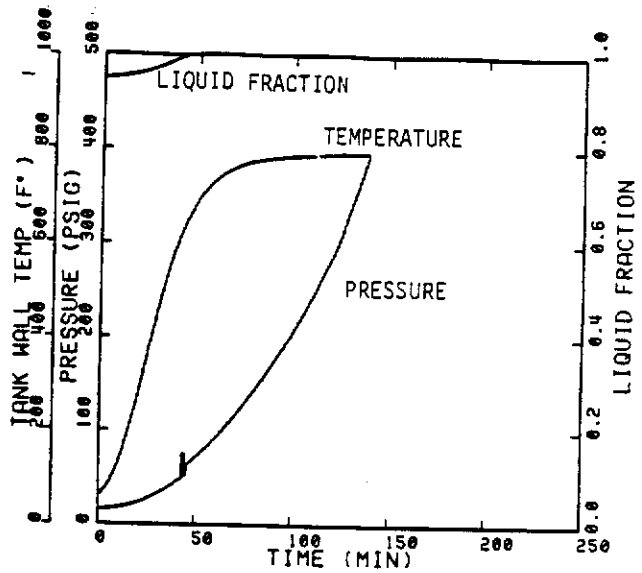


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

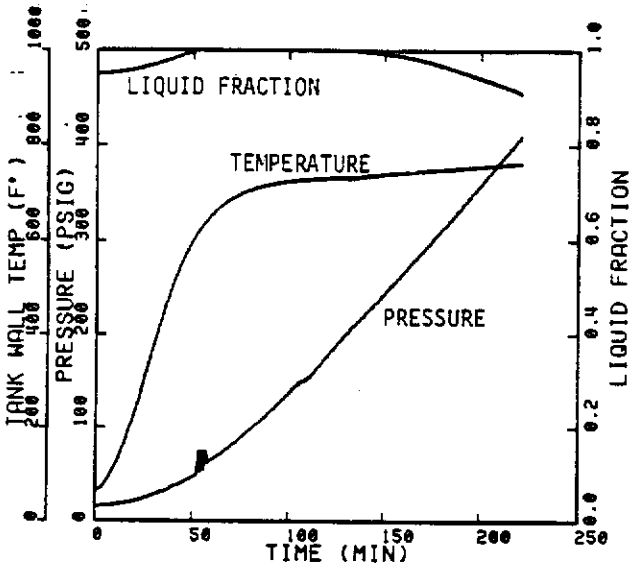
FIGURE D-4. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A100W TANK CAR CONTAINING 1,3-BUTADIENE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 20,000 SCFM



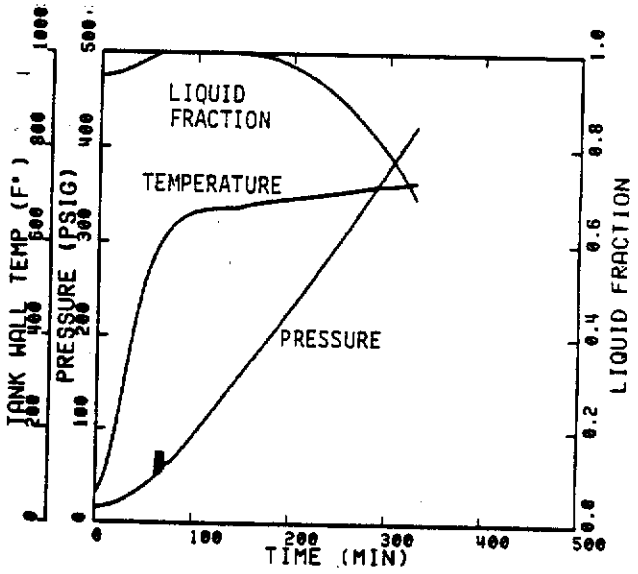
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

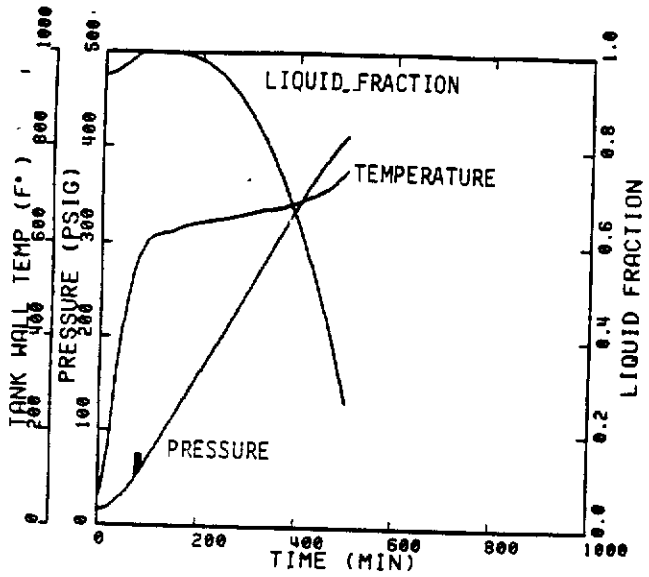


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

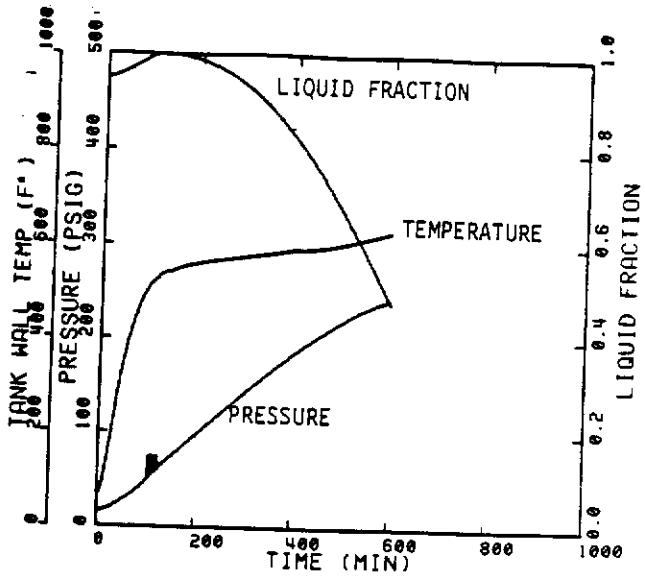


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

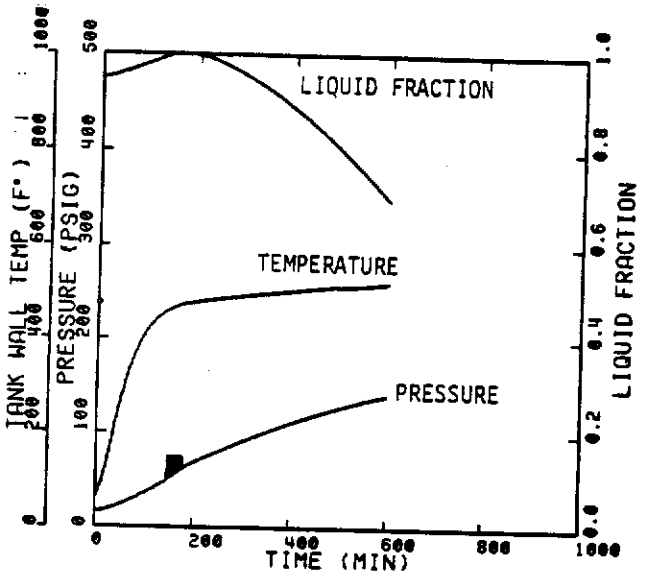
FIGURE D-5. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A100W TANK CAR CONTAINING 1,3-BUTADIENE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 1100 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

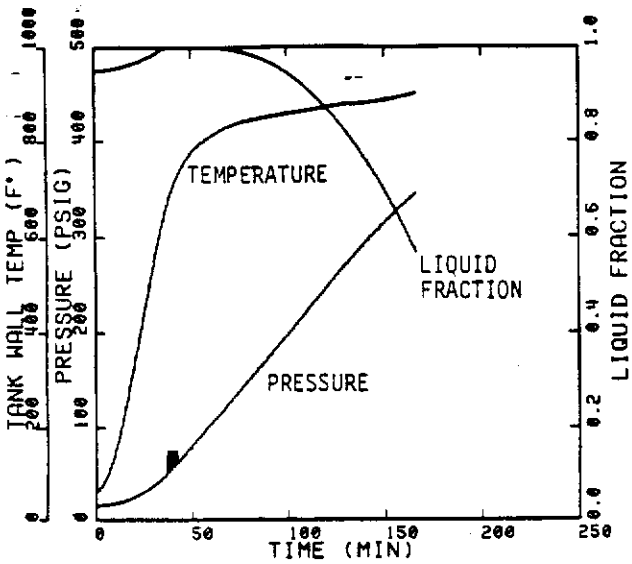


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

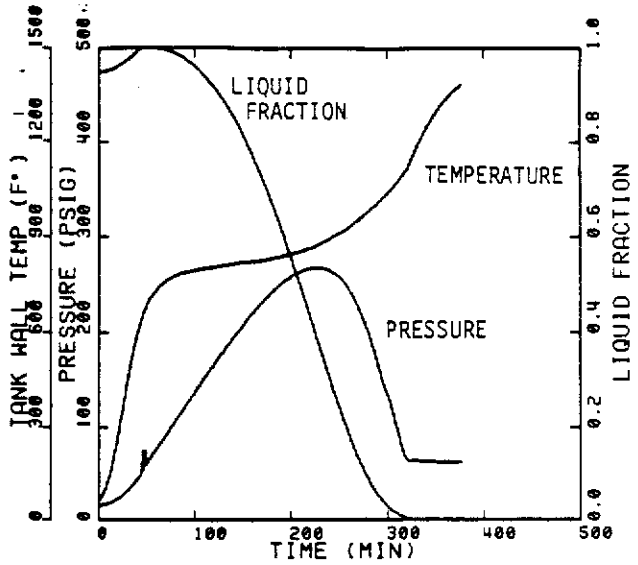


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

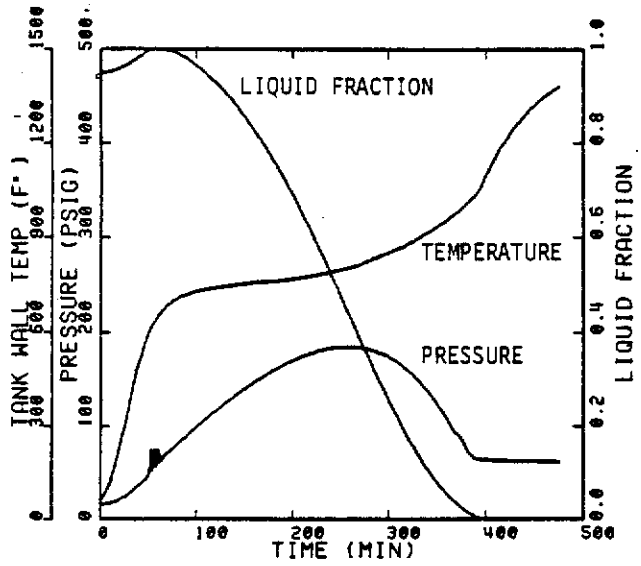
FIGURE D-5. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A100W TANK CAR CONTAINING 1,3-BUTADIENE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 1100 SCFM



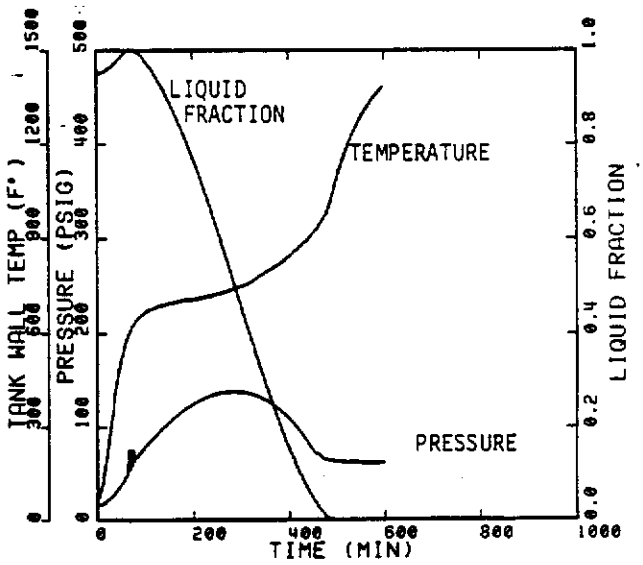
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

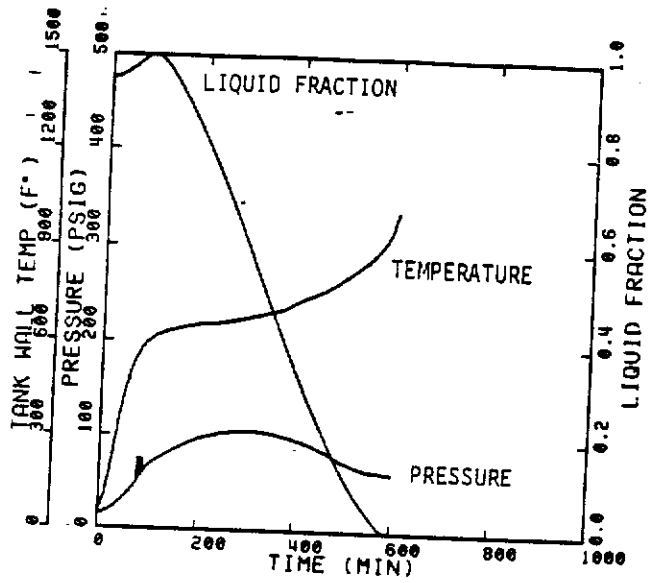


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

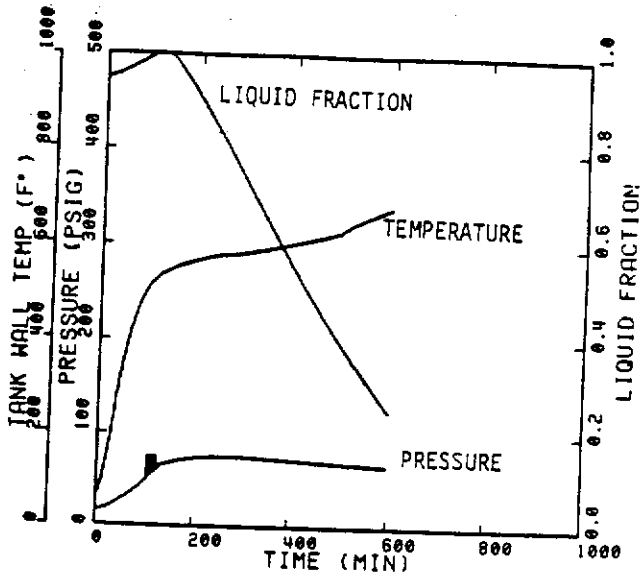


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

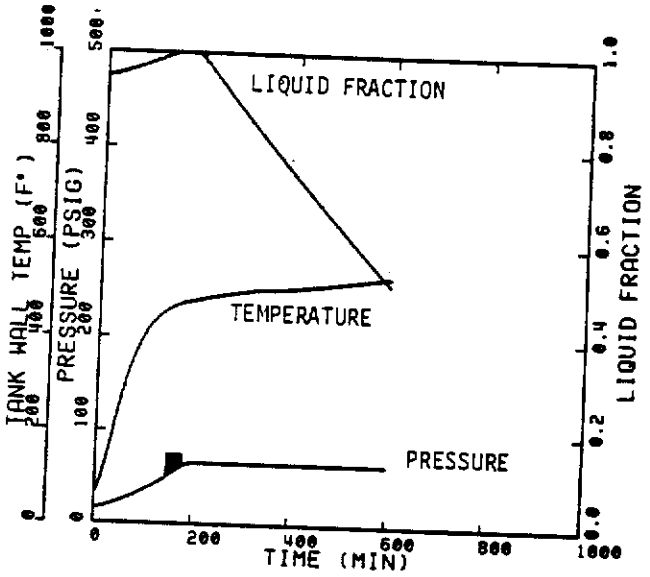
FIGURE D-6. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A100W TANK CAR CONTAINING 1,3-BUTADIENE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 3000 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

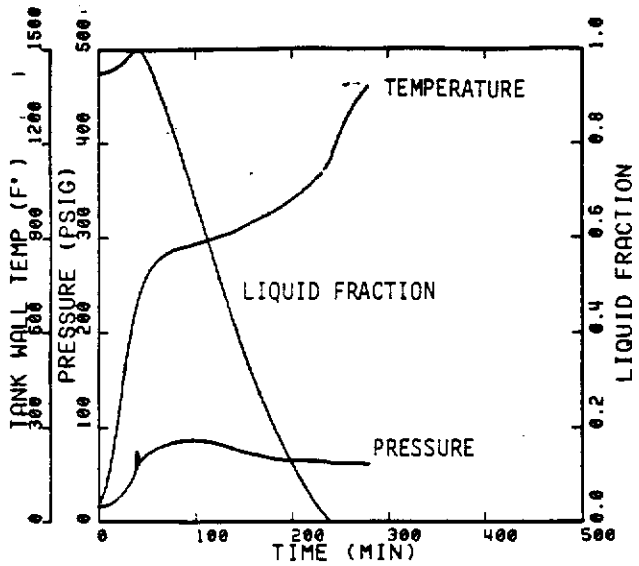


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

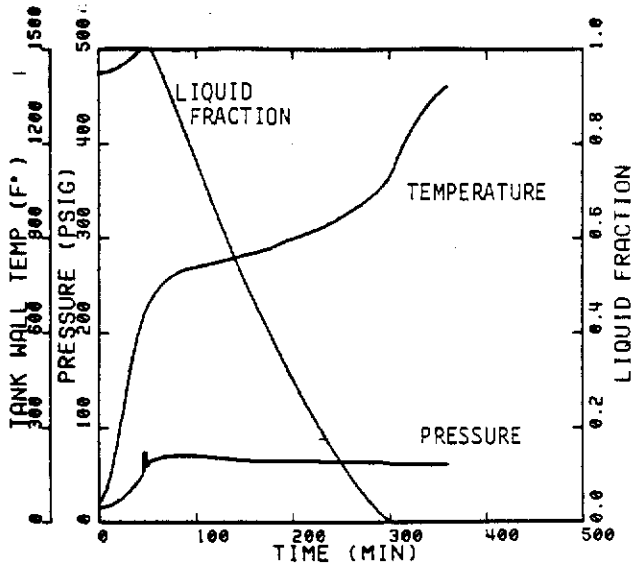


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

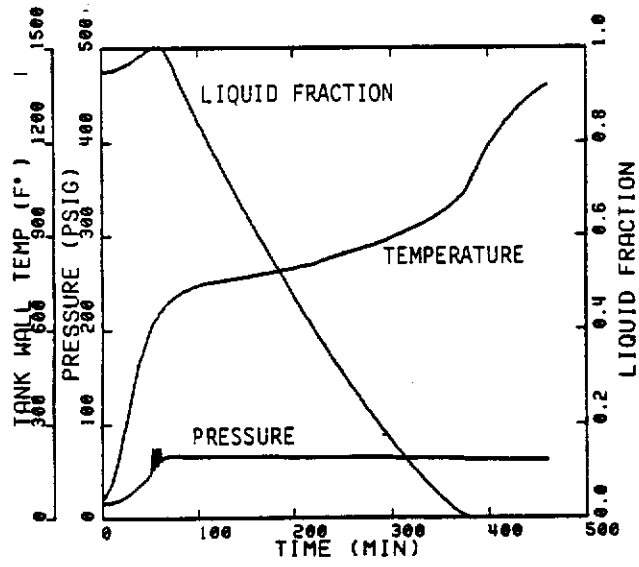
FIGURE D-6. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A100W TANK CAR CONTAINING 1,3-BUTADIENE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 3000 SCFM



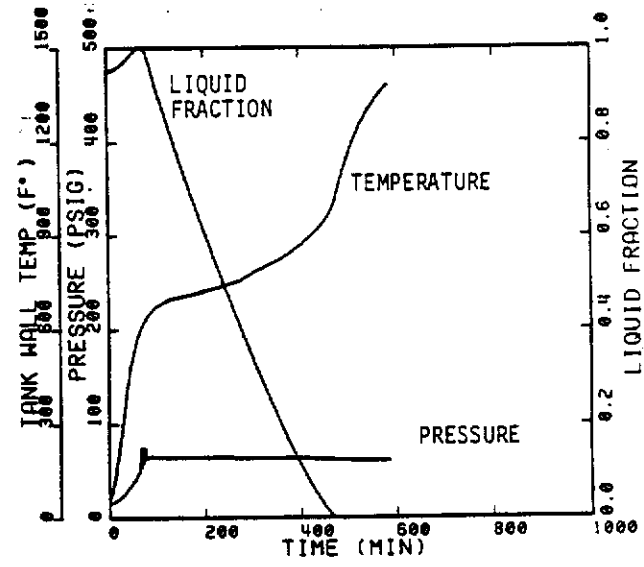
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

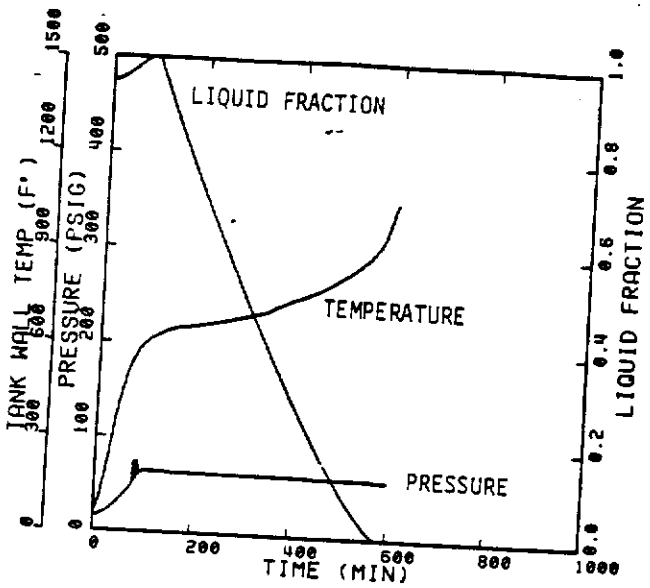


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

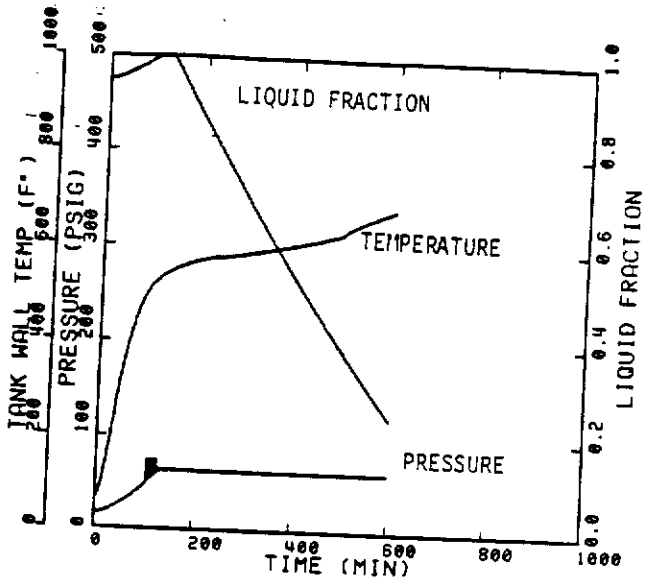


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

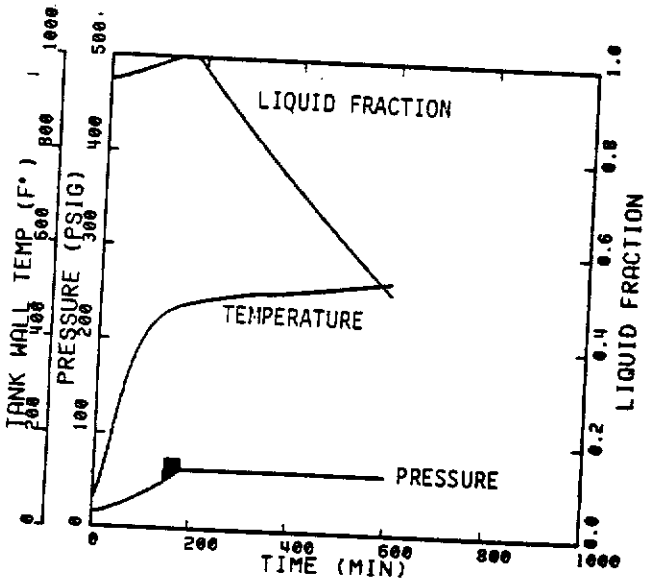
FIGURE D-7. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A100W TANK CAR CONTAINING 1,3-BUTADIENE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 10,000 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

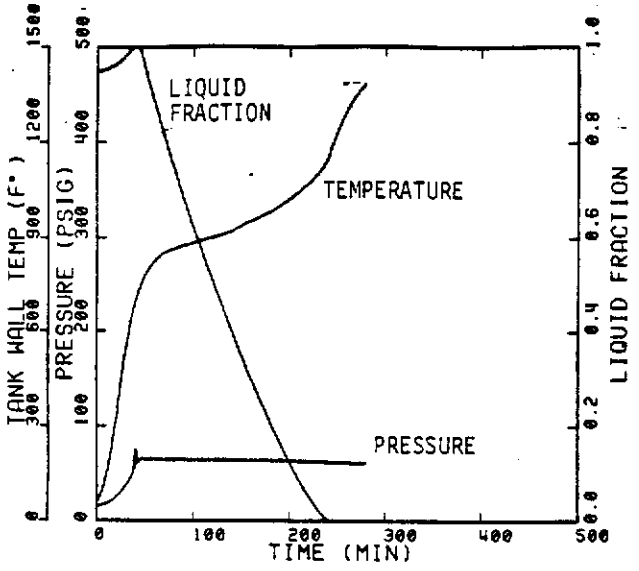


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

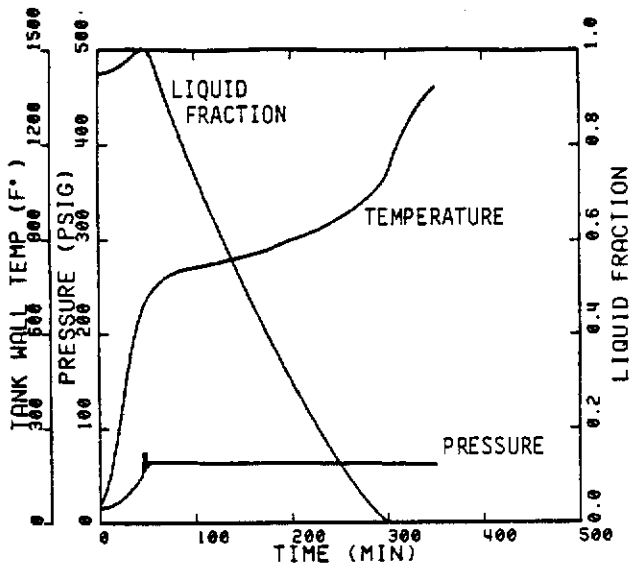


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

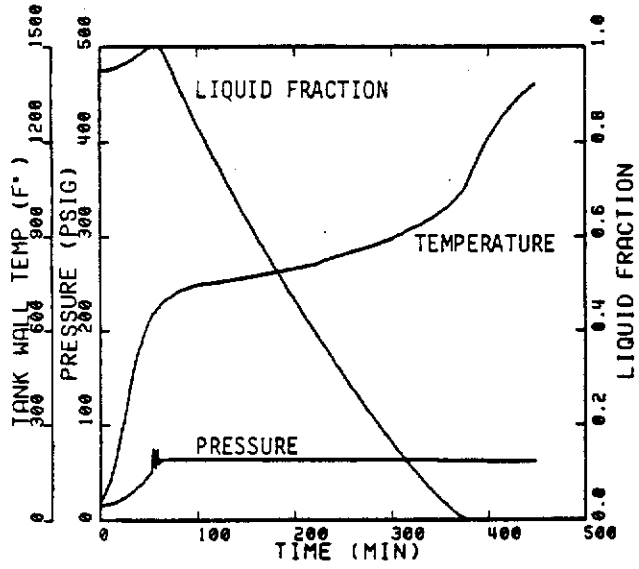
FIGURE D-7. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A100W TANK CAR CONTAINING 1,3-BUTADIENE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 10,000 SCFM



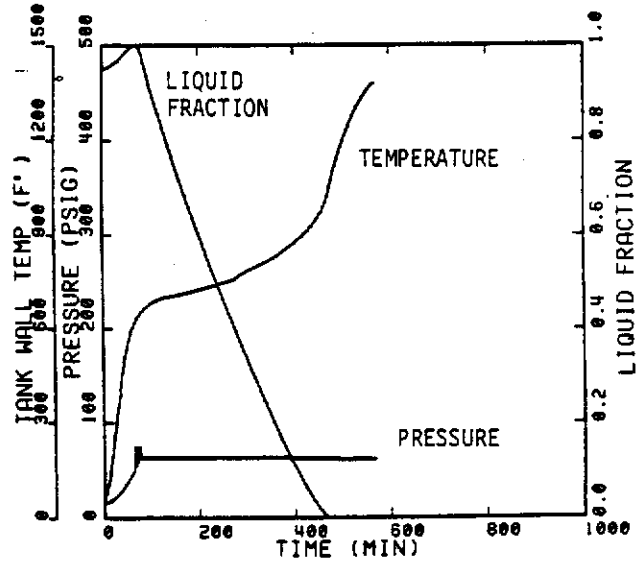
a. THERMAL SHIELD CONDUCTANCE 5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE 4.0 BTU/HR-FT²-°F

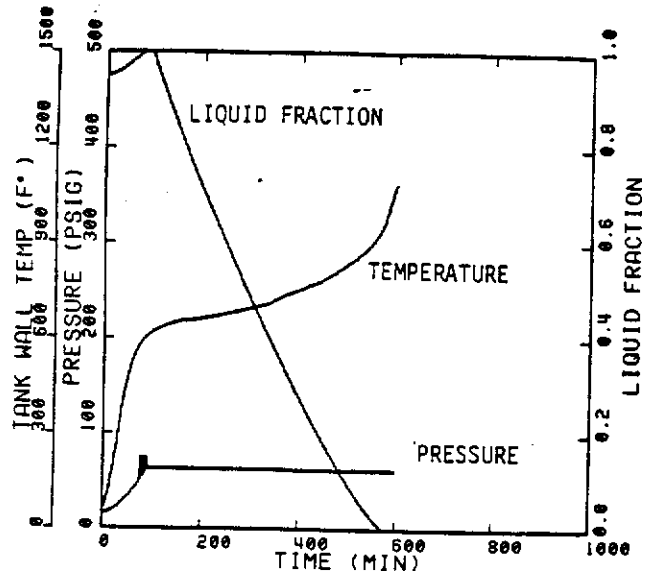


c. THERMAL SHIELD CONDUCTANCE 3.0 BTU/HR-FT²-°F

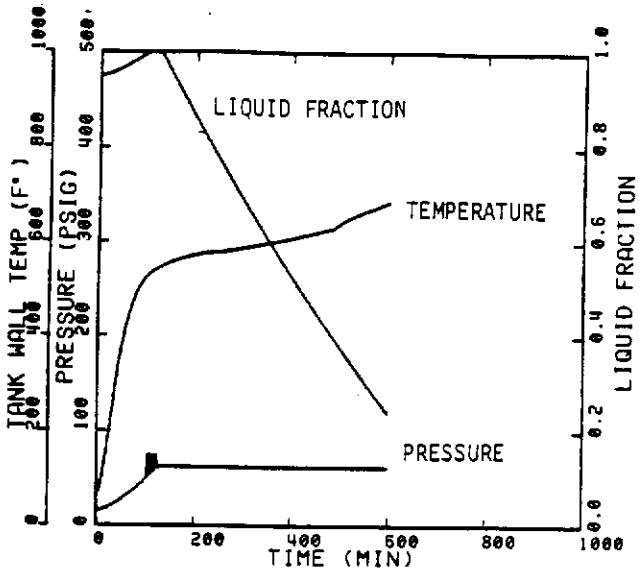


d. THERMAL SHIELD CONDUCTANCE 2.3 BTU/HR-FT²-°F

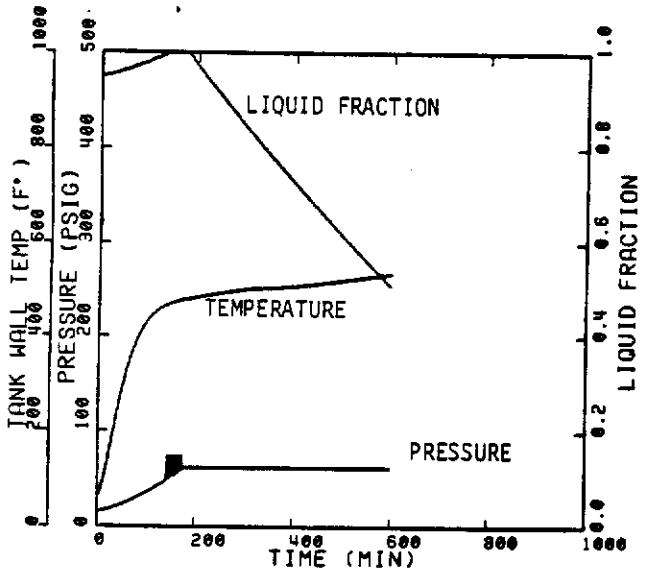
FIGURE D-8. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A100W TANK CAR CONTAINING 1,3-BUTADIENE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 20,000 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F



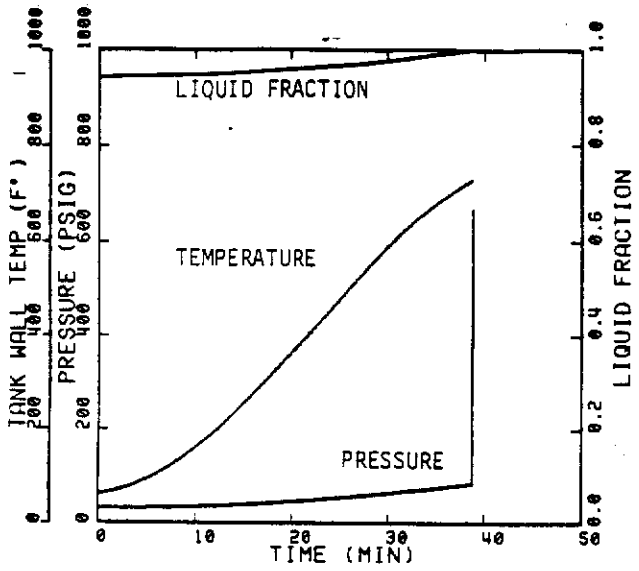
f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F



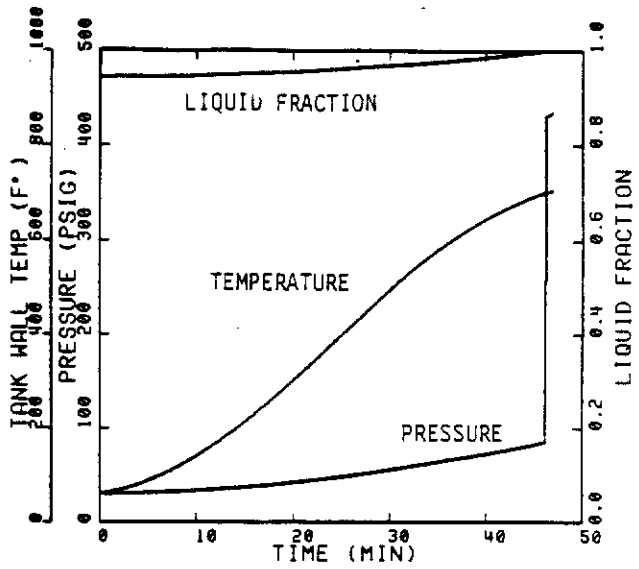
g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

FIGURE D-8. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A100W TANK CAR CONTAINING 1,3-BUTADIENE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 20,000 SCFM

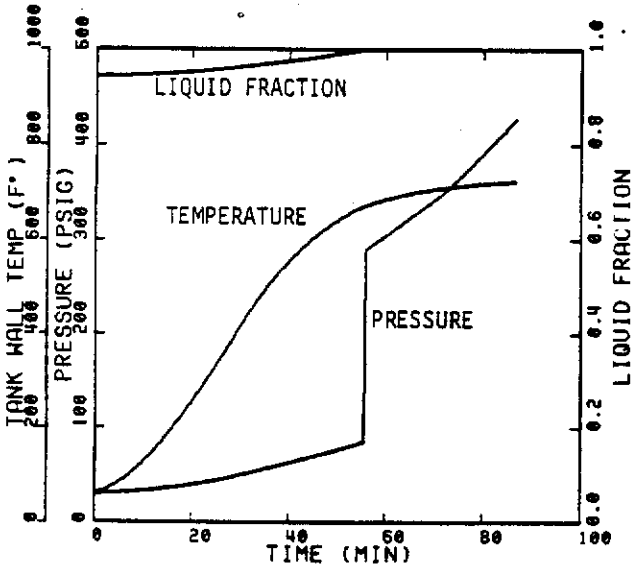
APPENDIX E: VINYL CHLORIDE PLOTS



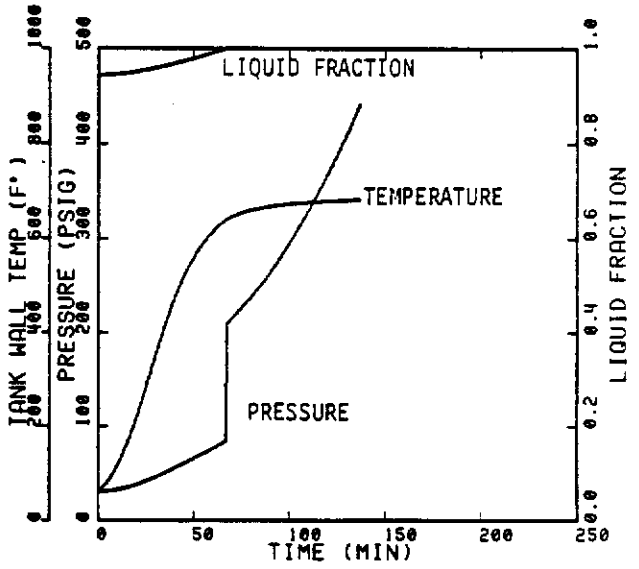
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

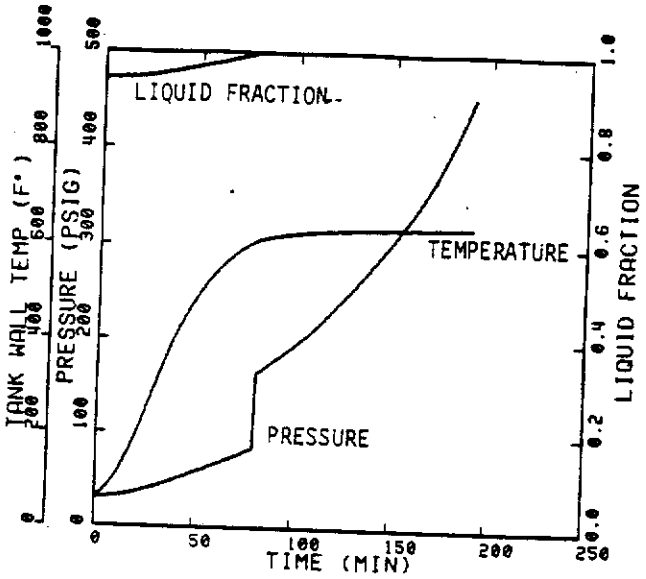


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

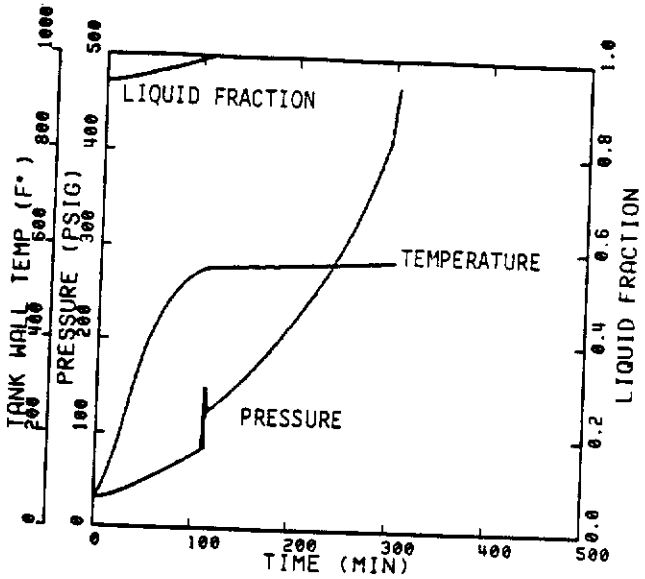


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

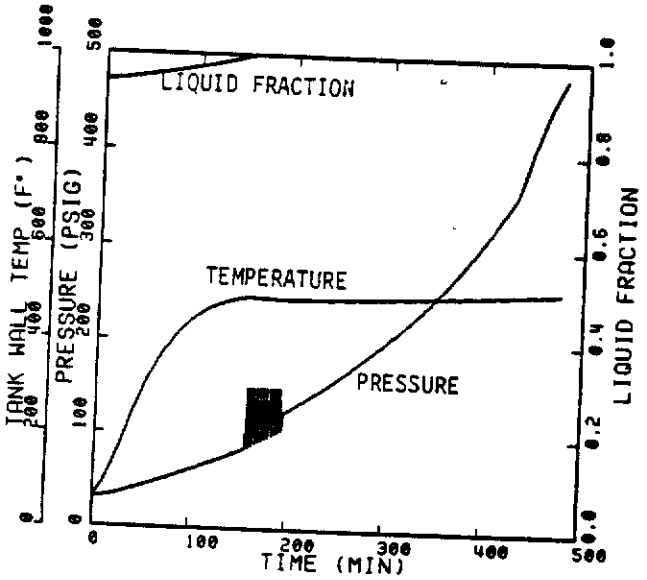
FIGURE E-1. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A200W TANK CAR CONTAINING VINYL CHLORIDE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 320 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

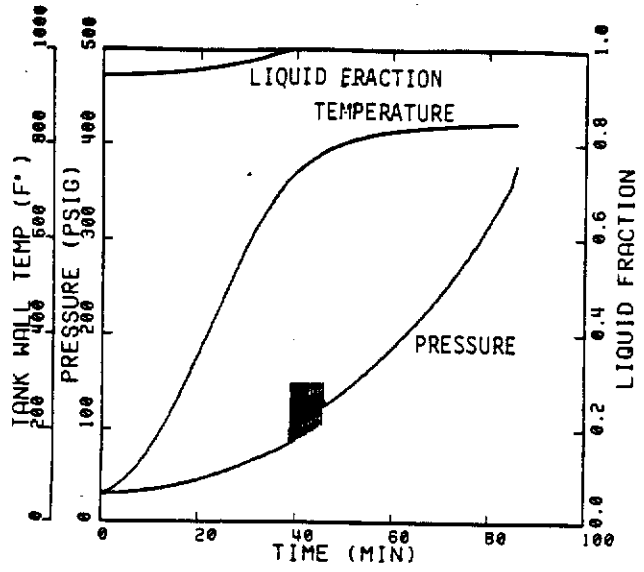


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

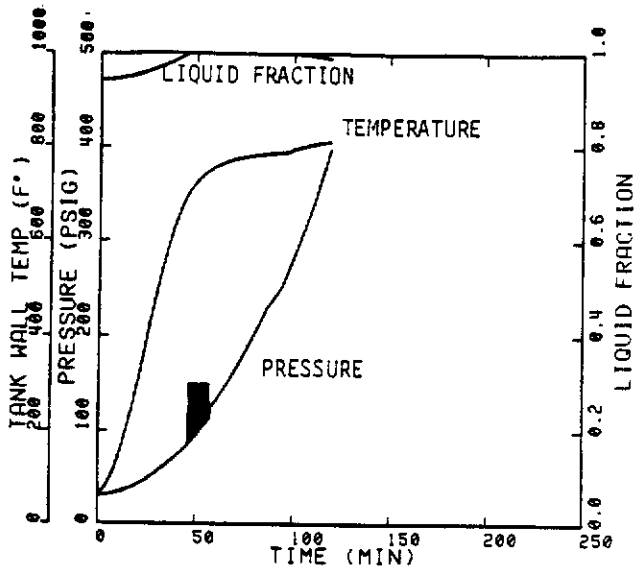


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

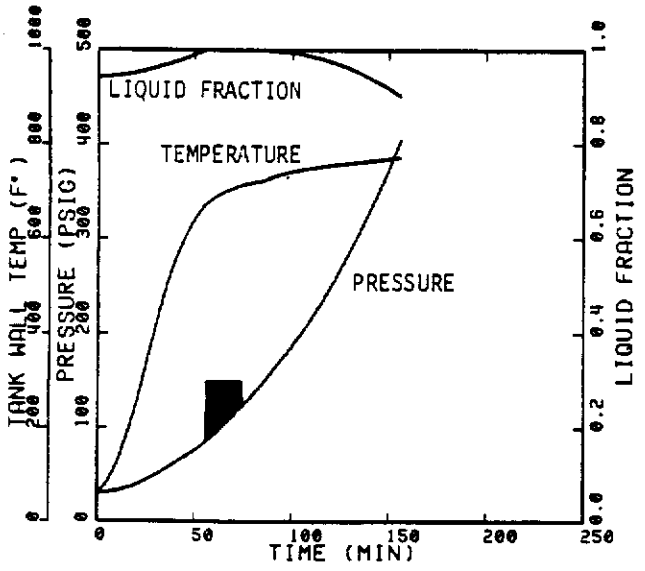
FIGURE E-1. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A200W TANK CAR CONTAINING VINYL CHLORIDE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 320 SCFM



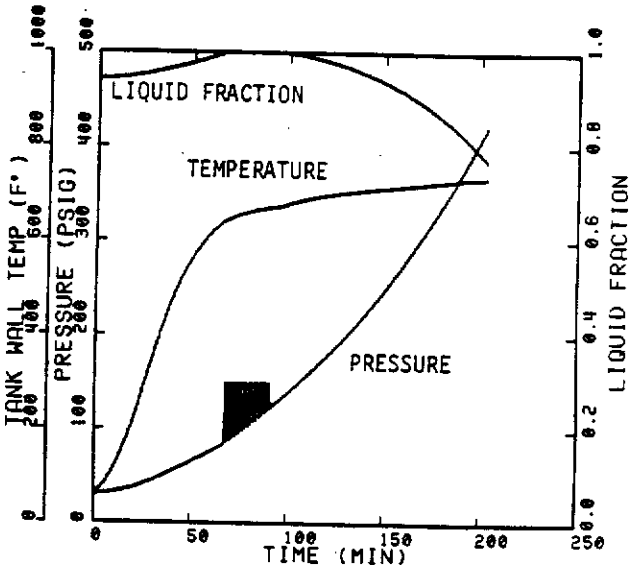
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

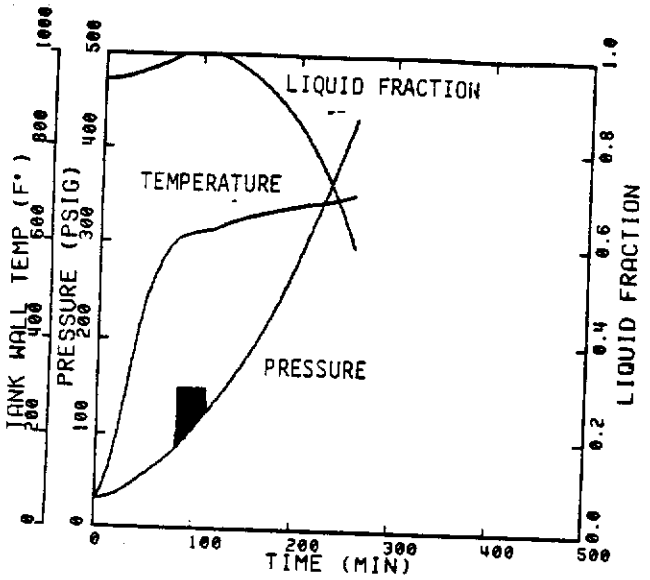


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

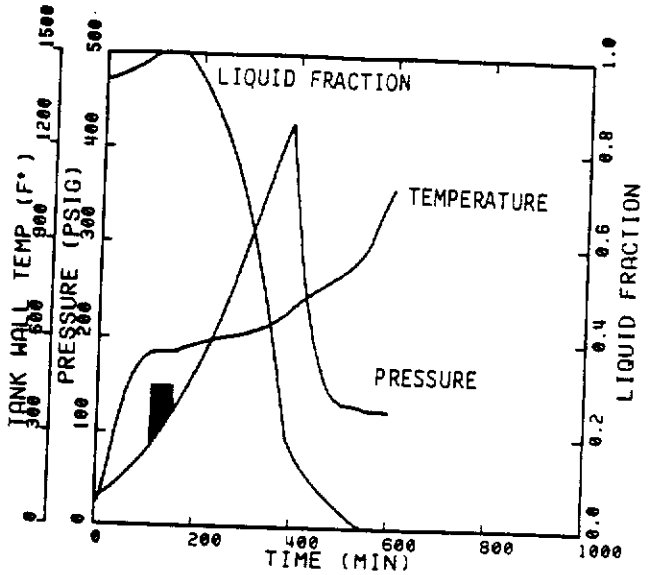


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

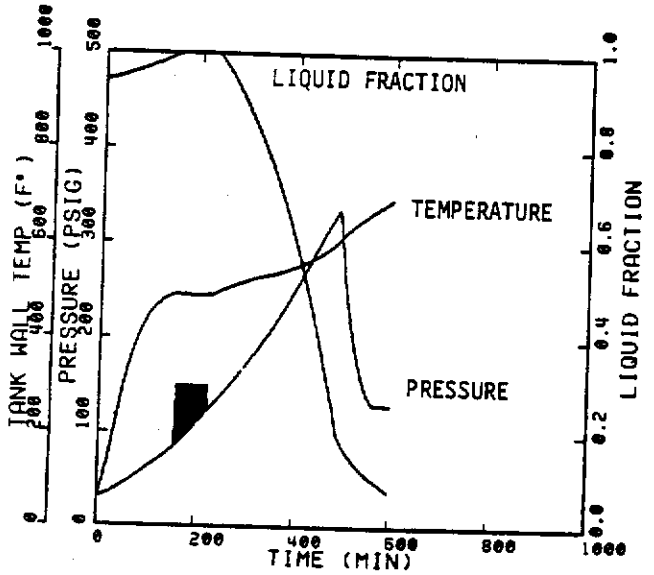
FIGURE E-2. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A200W TANK CAR CONTAINING VINYL CHLORIDE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 2000 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

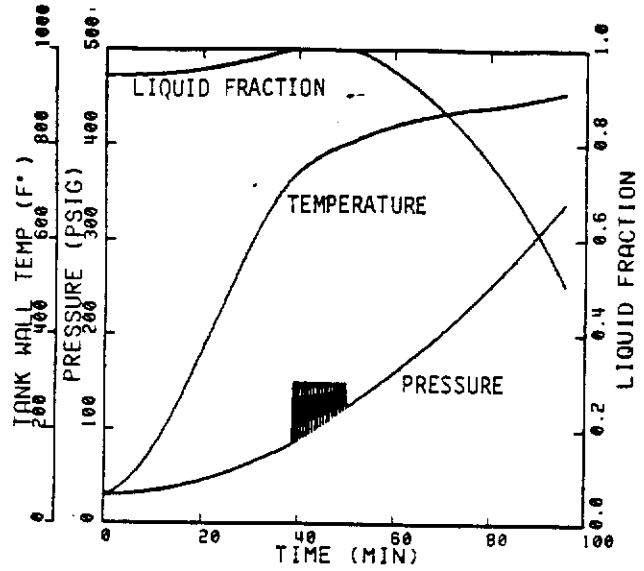


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

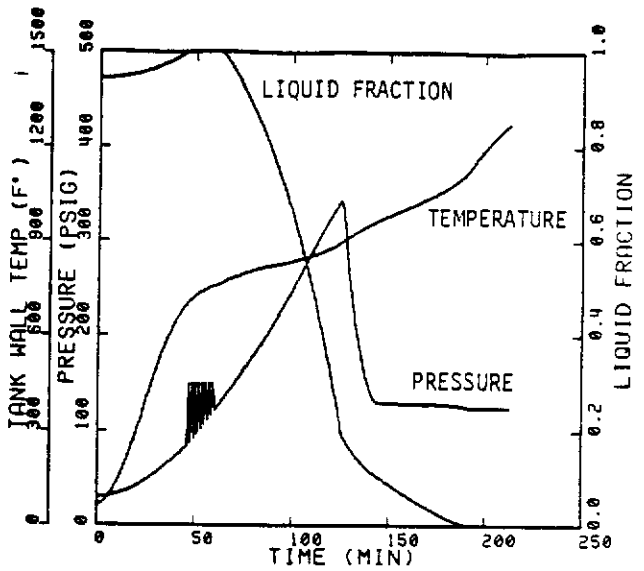


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

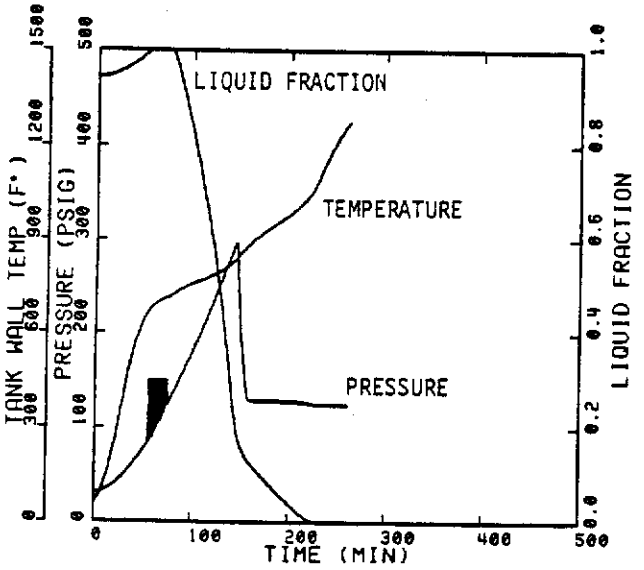
FIGURE E-2. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A200W TANK CAR CONTAINING VINYL CHLORIDE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 2000 SCFM



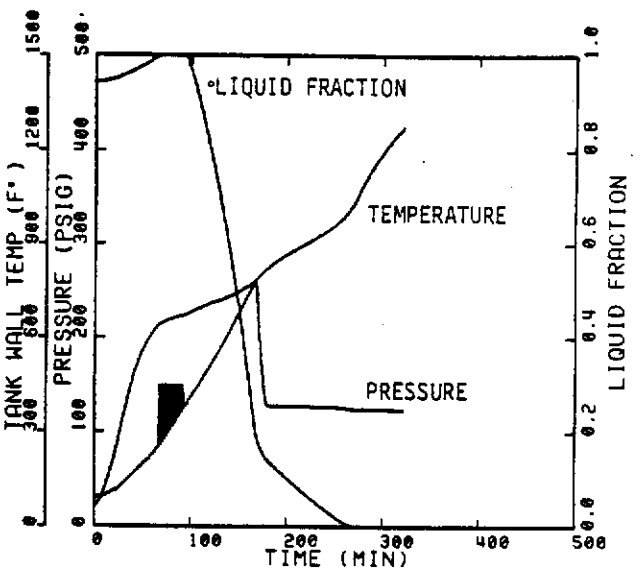
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

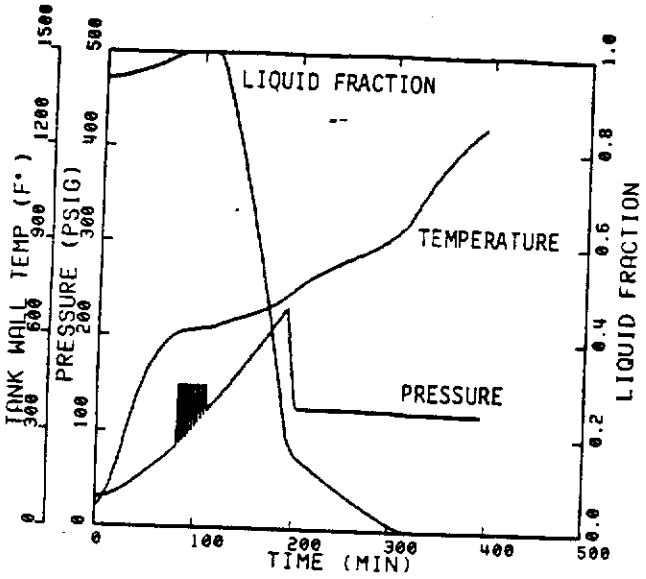


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

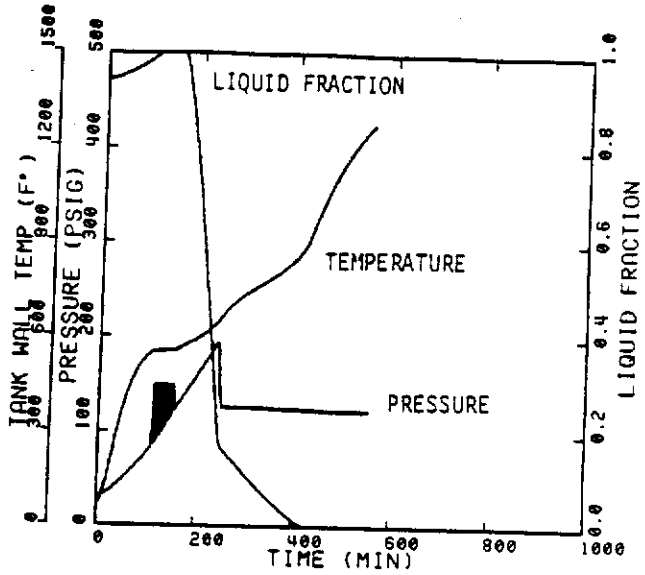


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

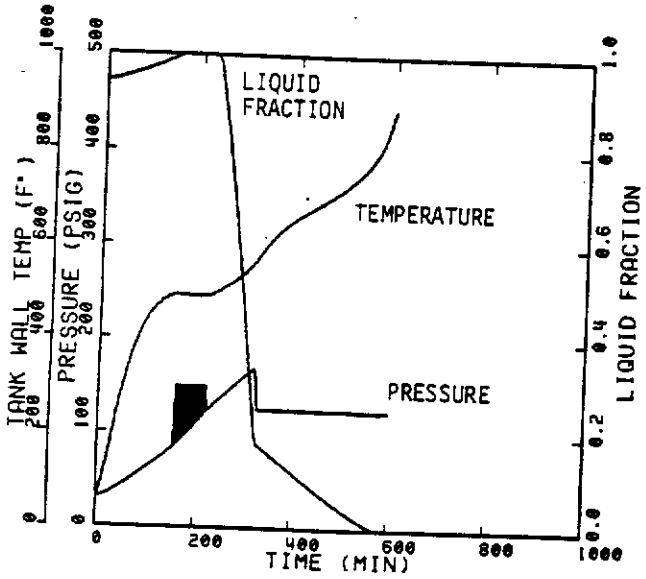
FIGURE E-3. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A200W TANK CAR CONTAINING VINYL CHLORIDE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 8000 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

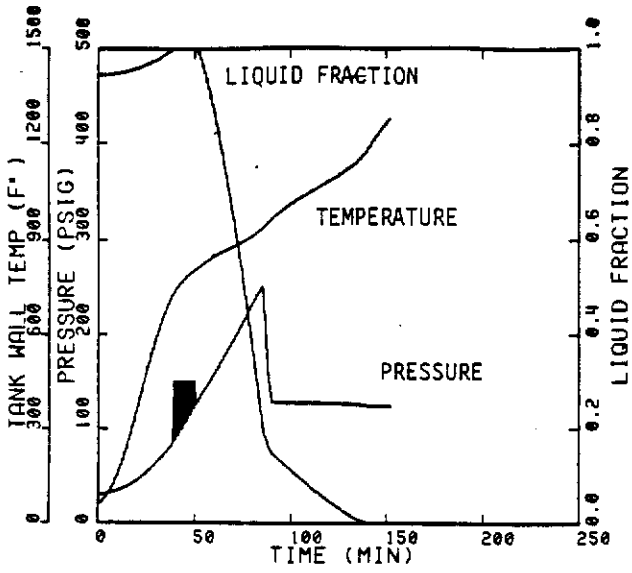


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

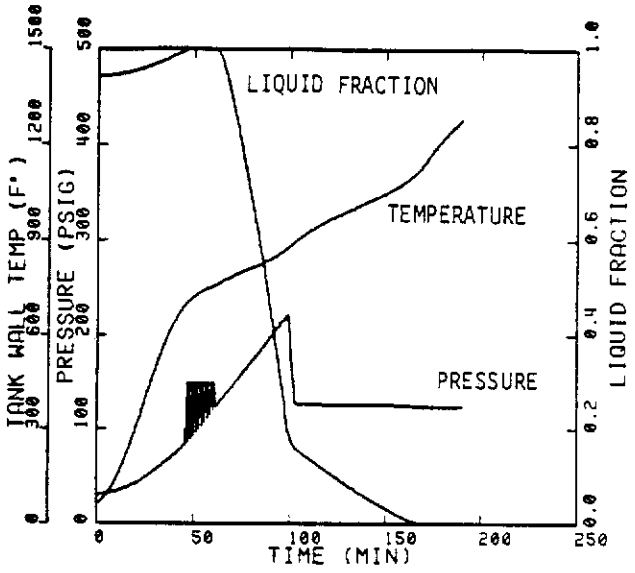


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

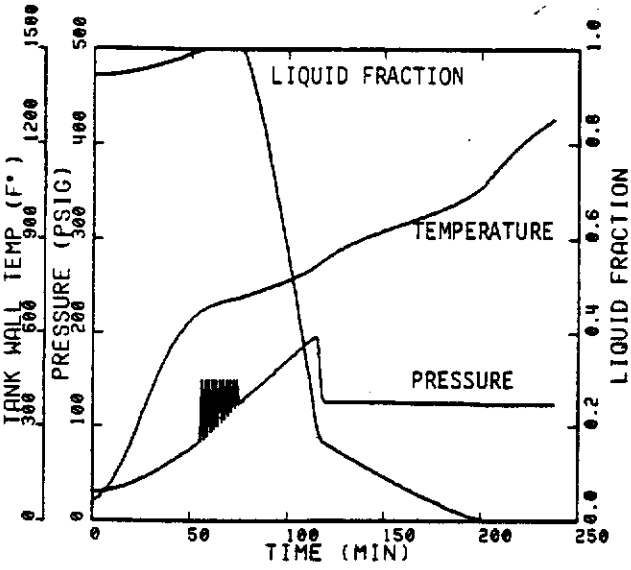
FIGURE E-3. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A200W TANK CAR CONTAINING VINYL CHLORIDE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 8000 SCFM



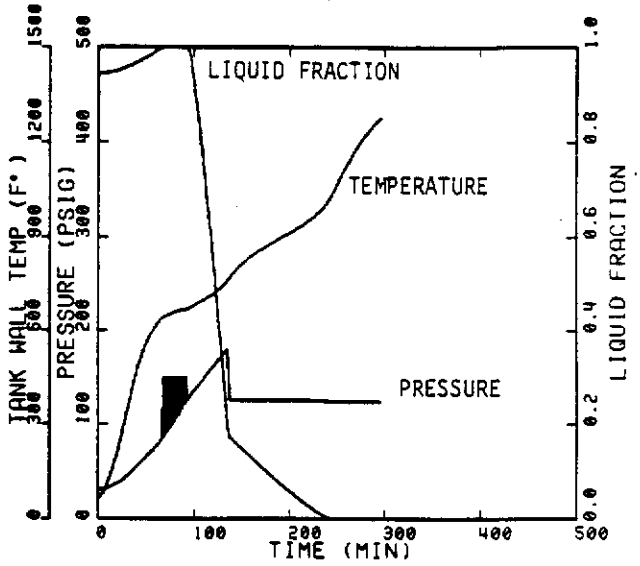
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

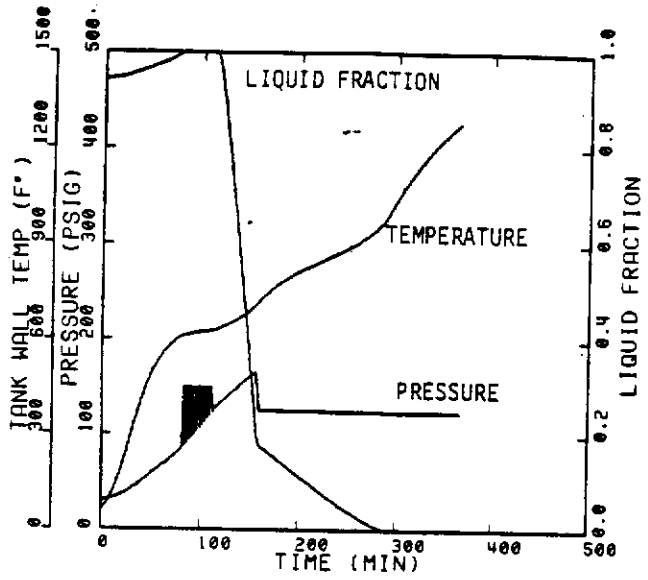


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

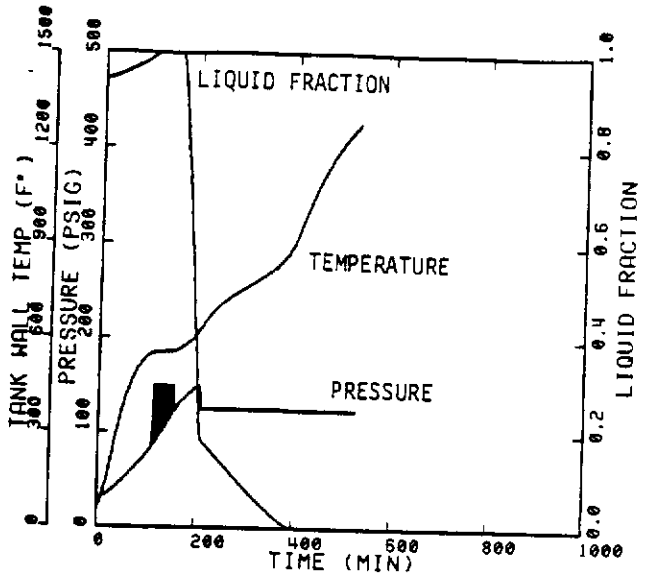


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

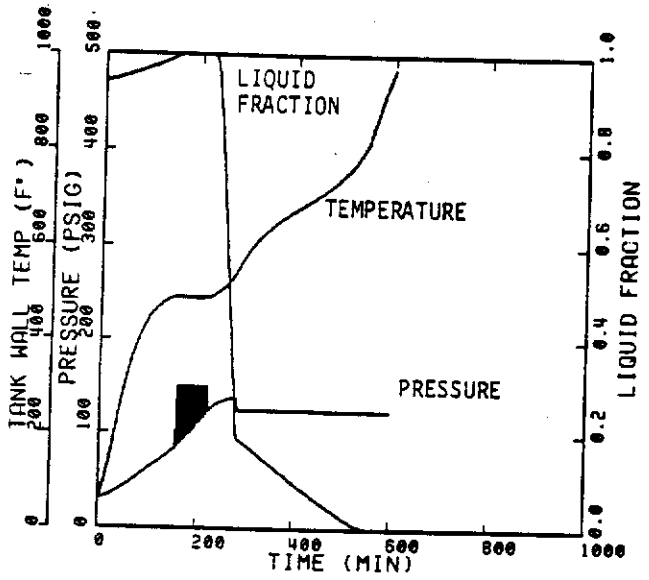
FIGURE E-4. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A200W TANK CAR CONTAINING VINYL CHLORIDE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 17,500 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

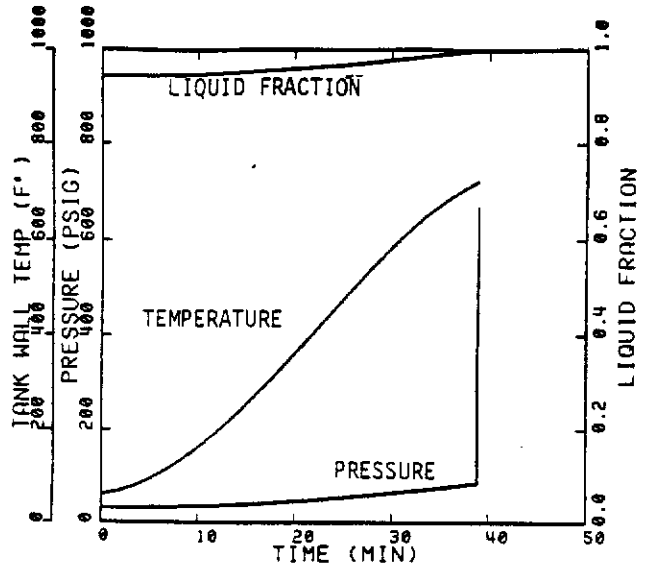


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

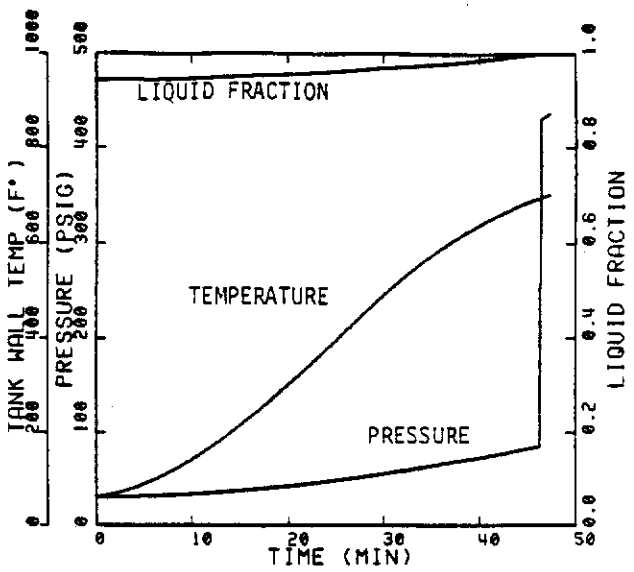


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

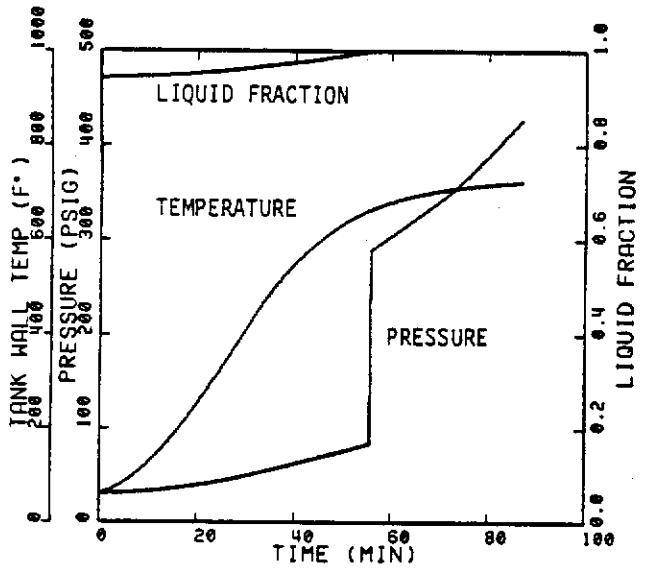
FIGURE E-4. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A200W TANK CAR CONTAINING VINYL CHLORIDE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 17,500 SCFM



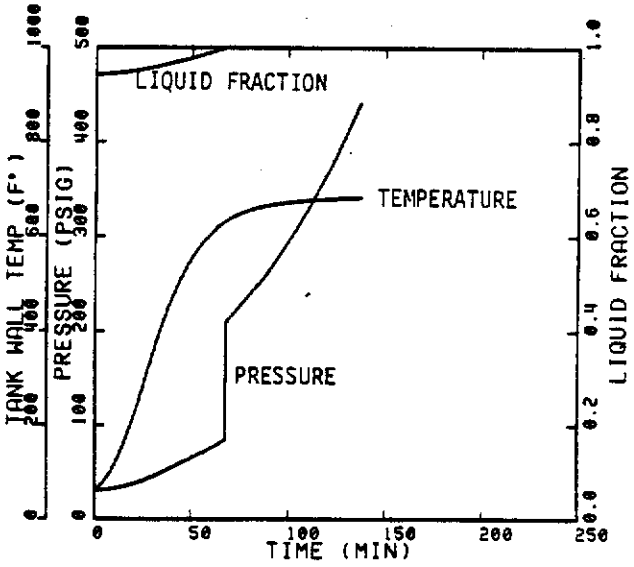
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

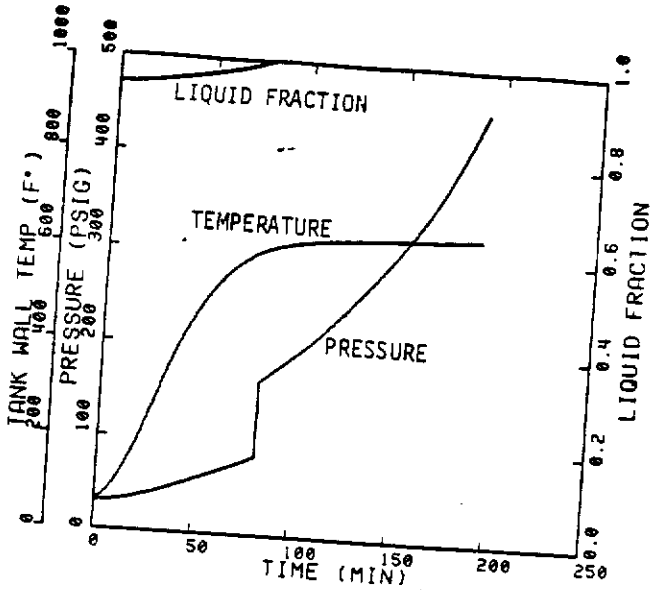


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

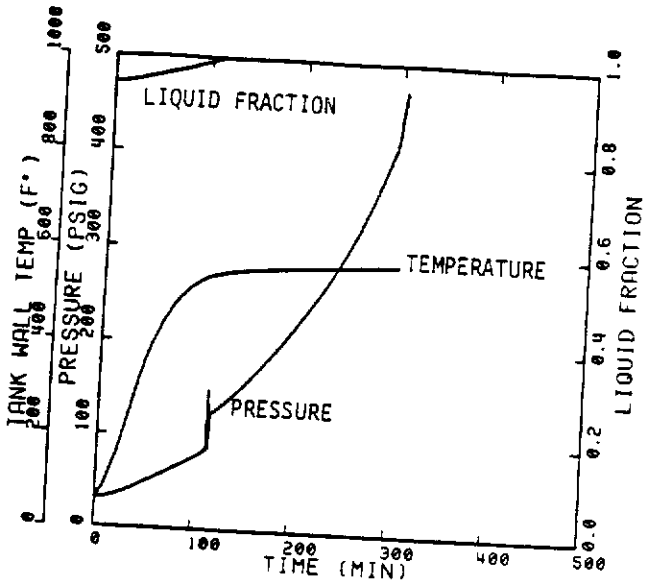


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

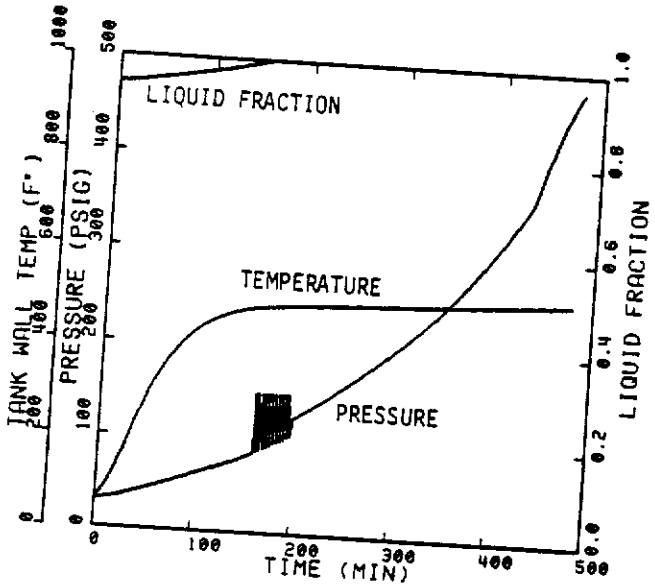
FIGURE E-5. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A200W TANK CAR CONTAINING VINYL CHLORIDE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 320 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

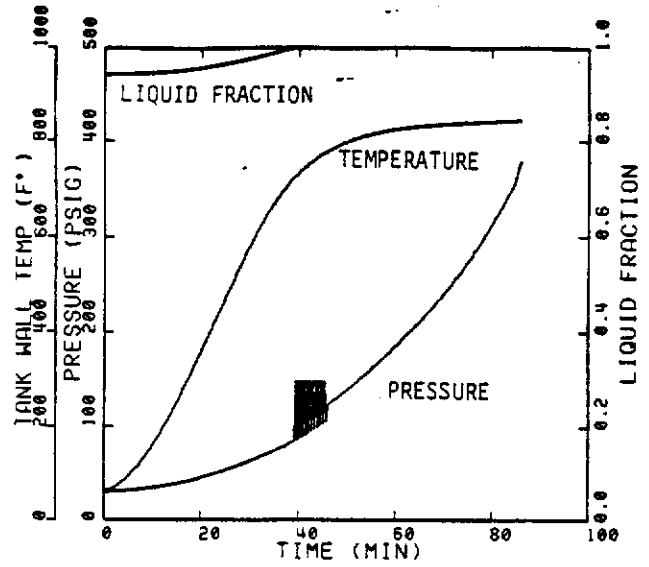


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

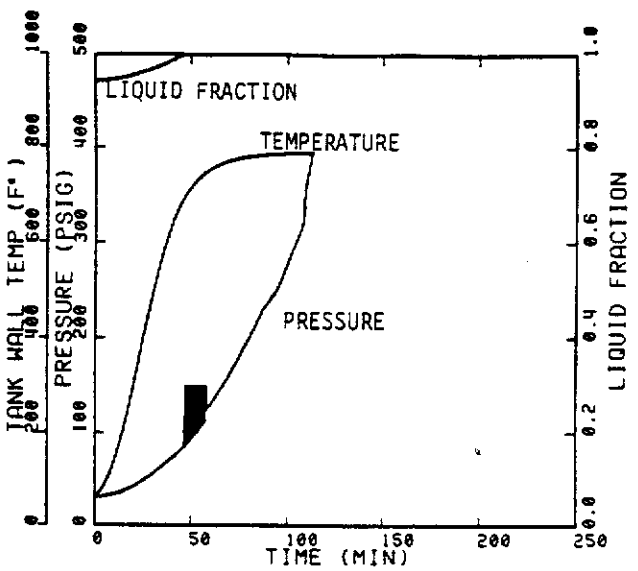


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

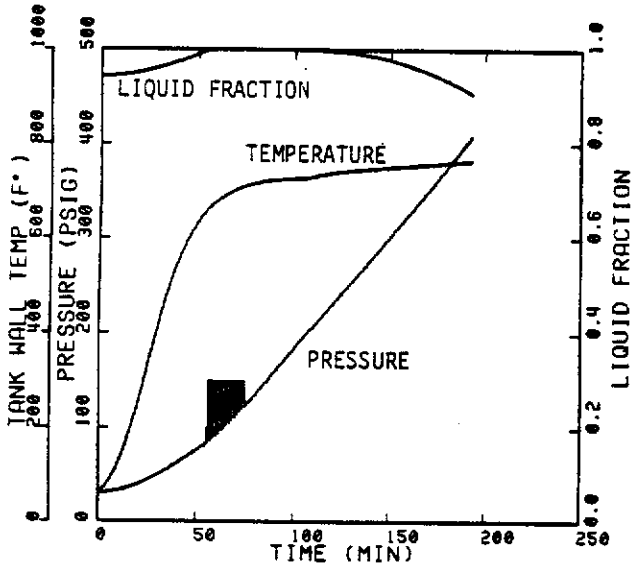
FIGURE E-5. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A200W TANK CAR CONTAINING VINYL CHLORIDE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 320 SCFM



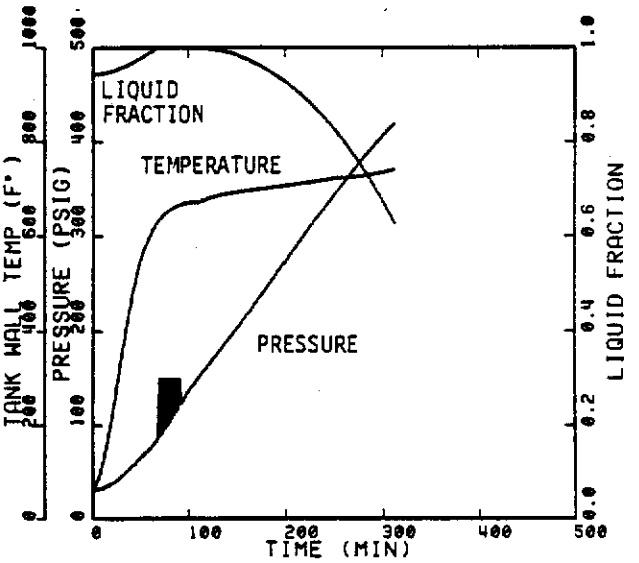
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

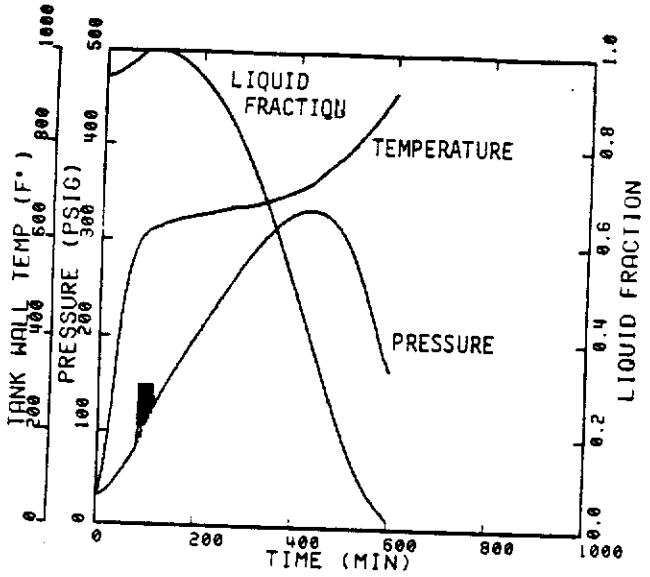


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

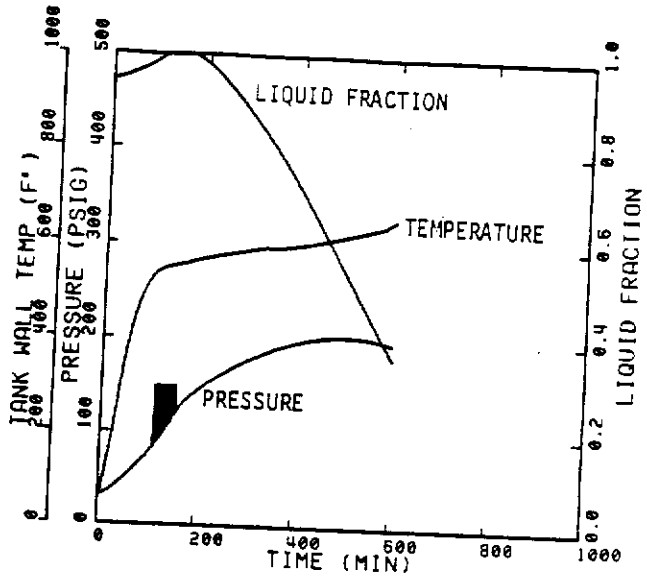


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

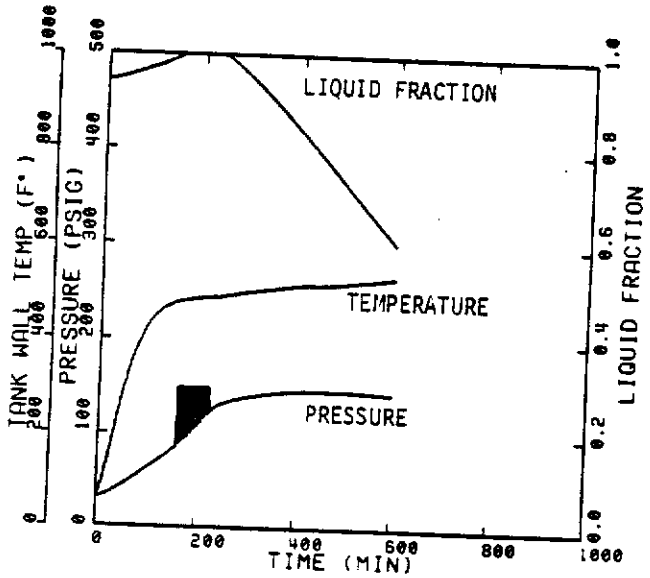
FIGURE E-6. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A200W TANK CAR CONTAINING VINYL CHLORIDE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 2000 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

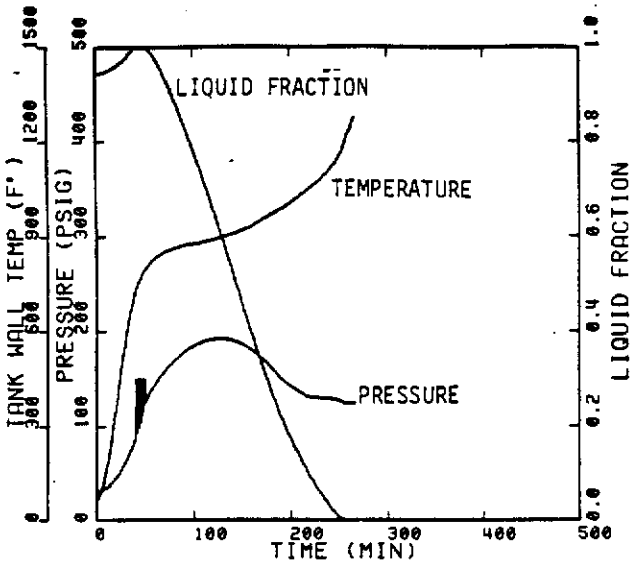


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

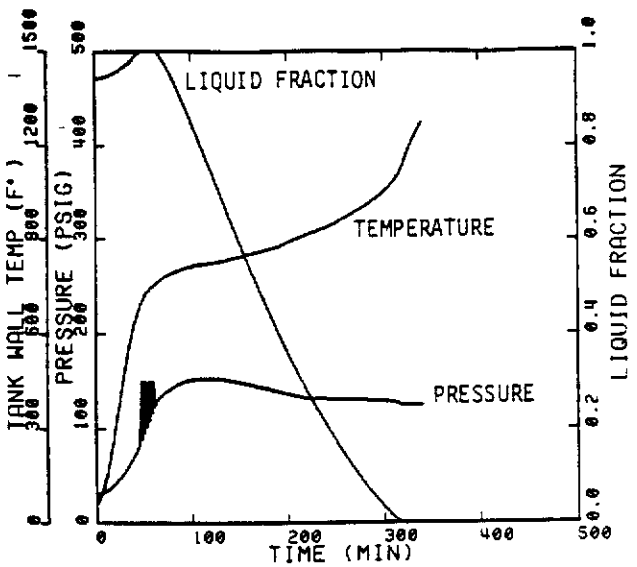


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

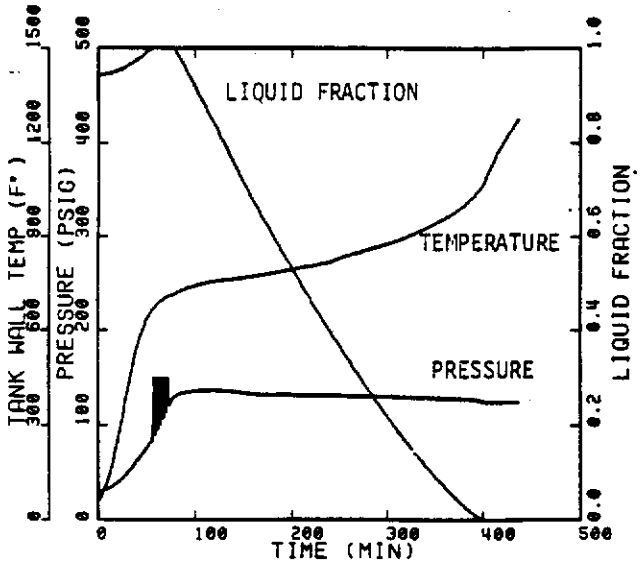
FIGURE E-6. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A200W TANK CAR CONTAINING VINYL CHLORIDE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 2000 SCFM



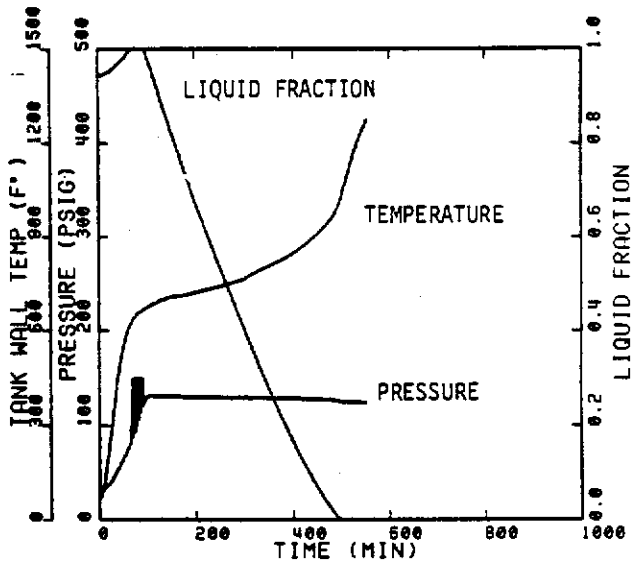
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

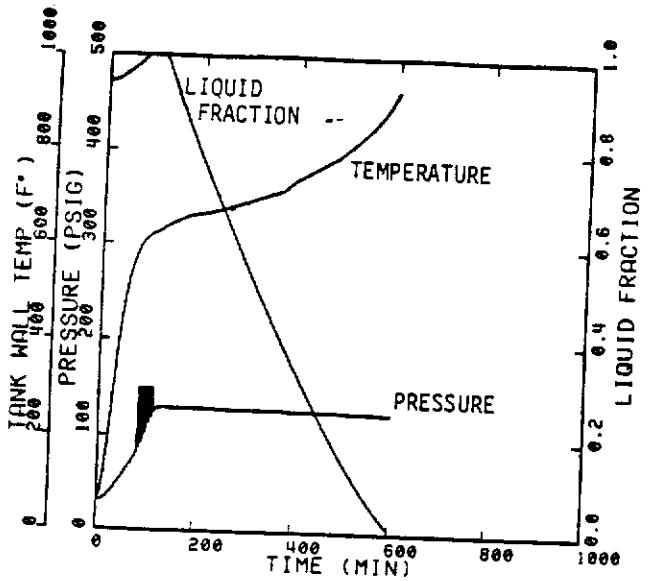


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

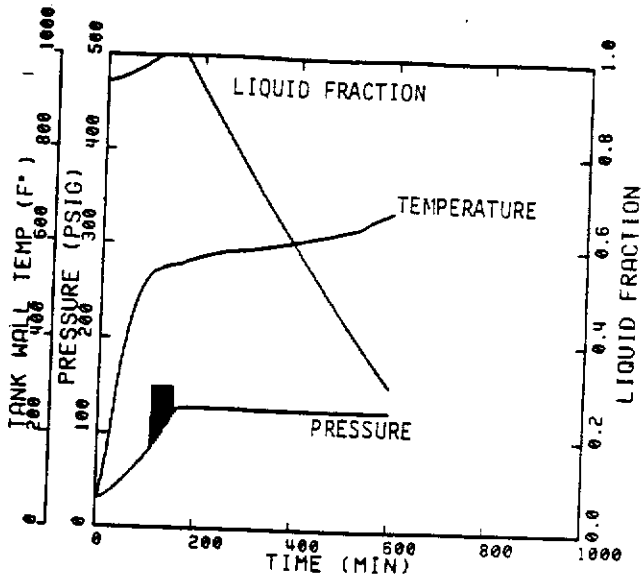


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

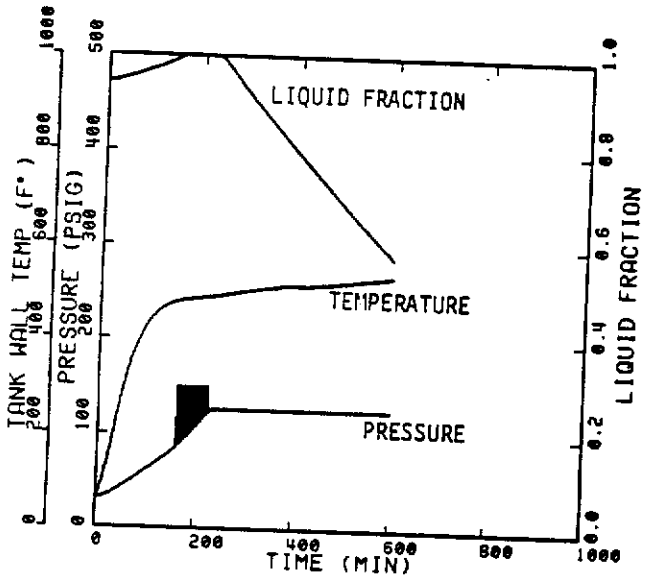
FIGURE E-7. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A200W TANK CAR CONTAINING VINYL CHLORIDE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 8000 SCFM



e. THERMAL SHIELD CONDUCTANCE 1.8 BTU/HR-FT²-°F

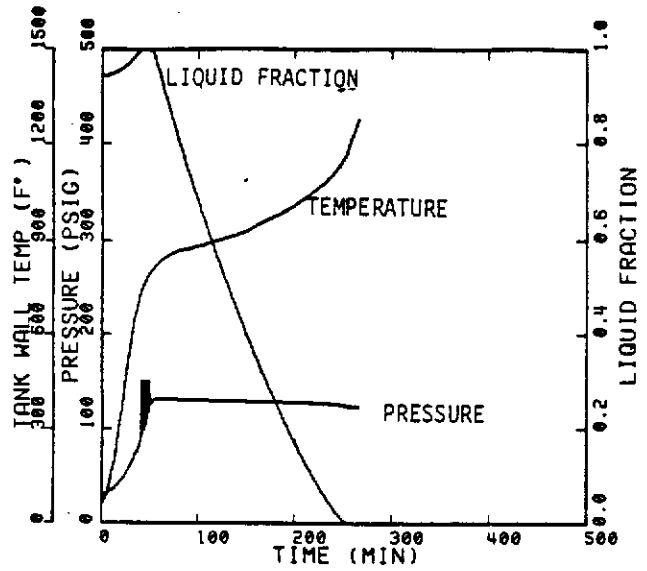


f. THERMAL SHIELD CONDUCTANCE 1.2 BTU/HR-FT²-°F

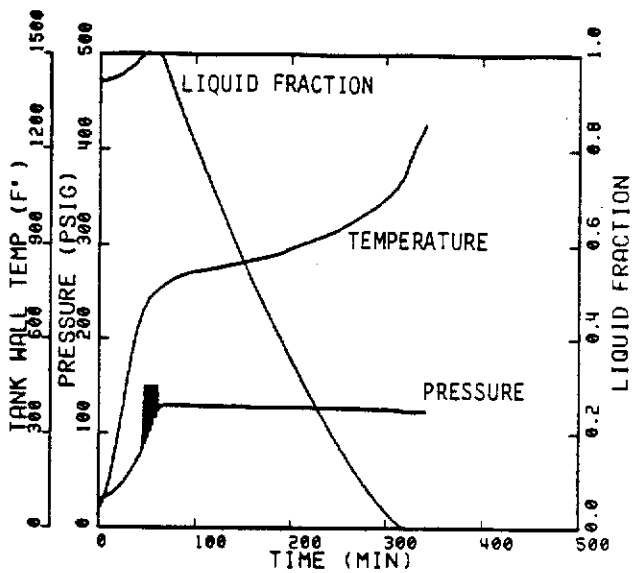


g. THERMAL SHIELD CONDUCTANCE 0.8 BTU/HR-FT²-°F

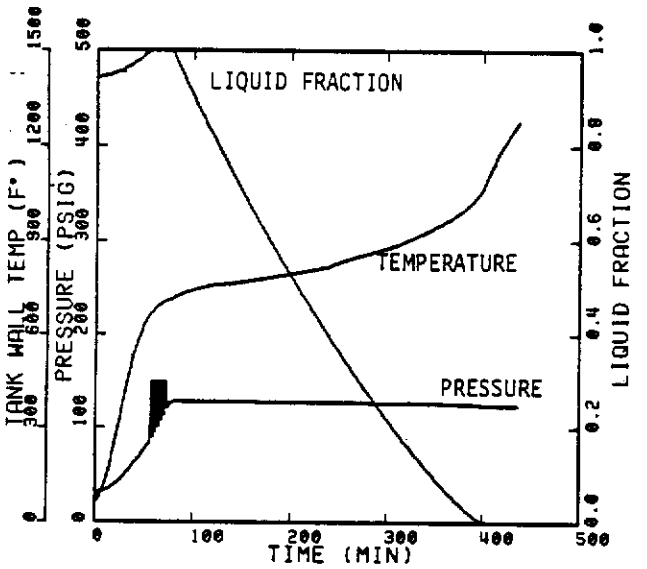
FIGURE E-7. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A200W TANK CAR CONTAINING VINYL CHLORIDE, UPRIGHT CAR CASE; SAFETY RELIEF VALVE FLOW CAPACITY 8000 SCFM



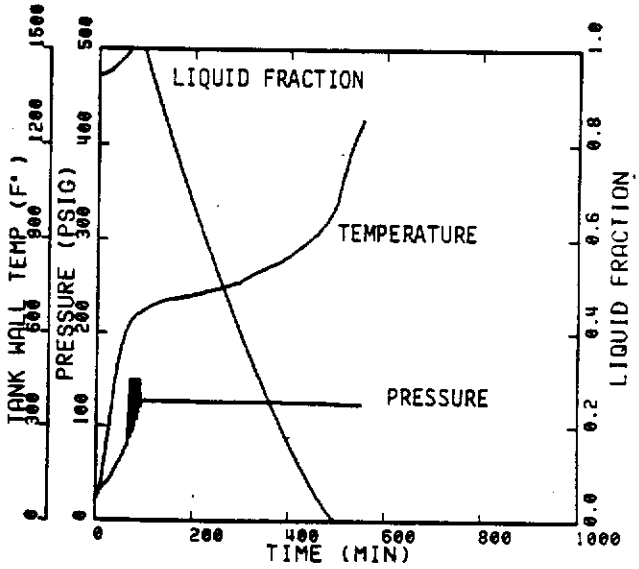
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

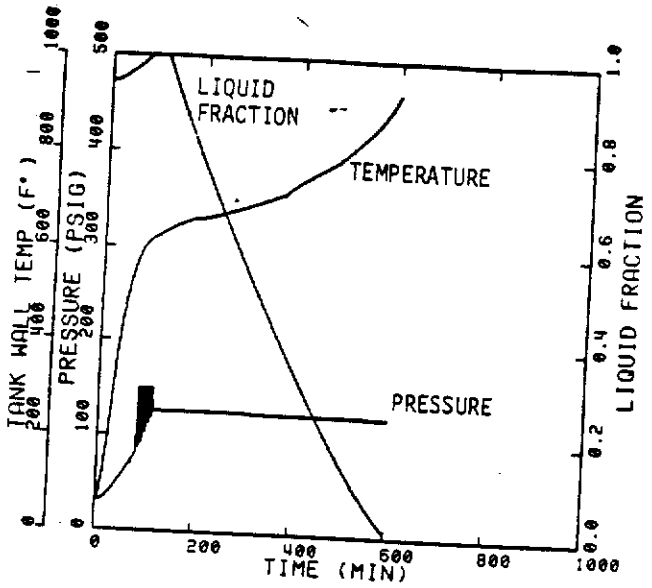


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

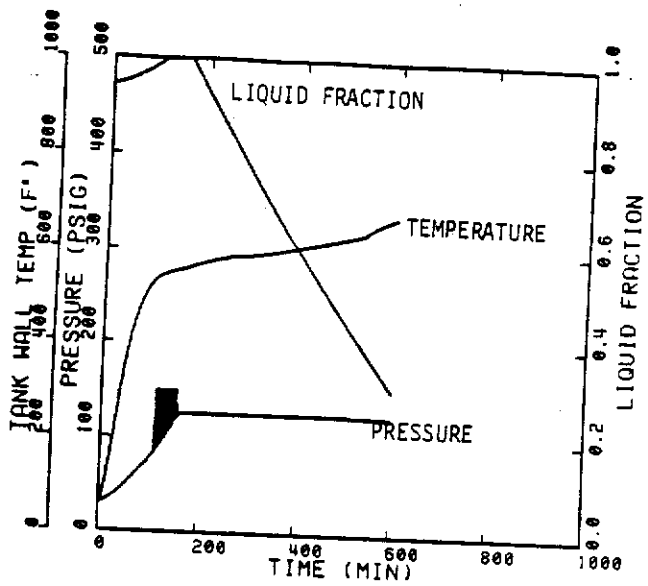


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

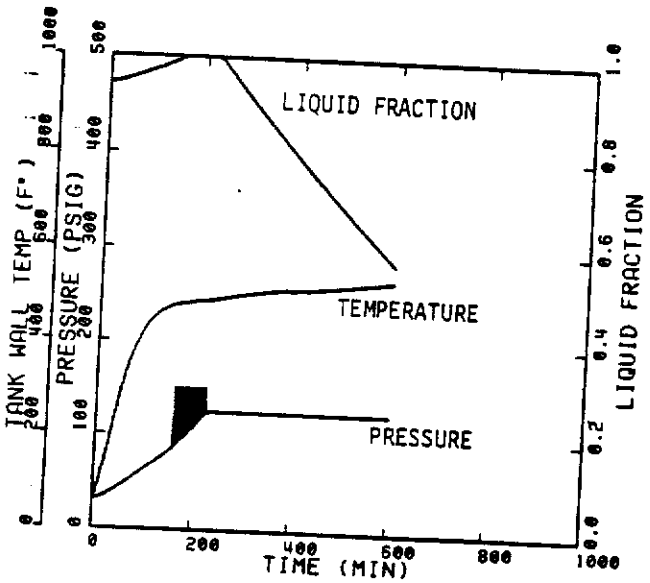
FIGURE E-8. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A200W TANK CAR CONTAINING VINYL CHLORIDE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 17,500 SCFM



e. THERMAL SHIELD CONDUCTANCE 1.8 BTU/HR-FT²-°F



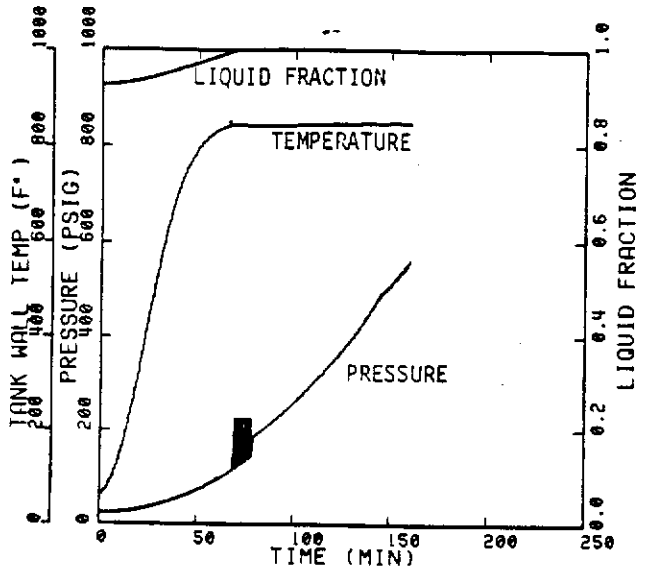
f. THERMAL SHIELD CONDUCTANCE 1.2 BTU/HR-FT²-°F



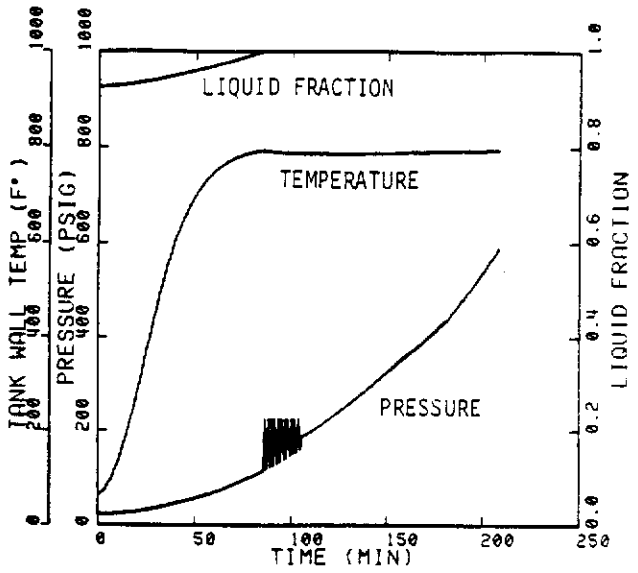
g. THERMAL SHIELD CONDUCTANCE 0.8 BTU/HR-FT²-°F

FIGURE E-8. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A200W TANK CAR CONTAINING VINYL CHLORIDE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 17,500 SCFM

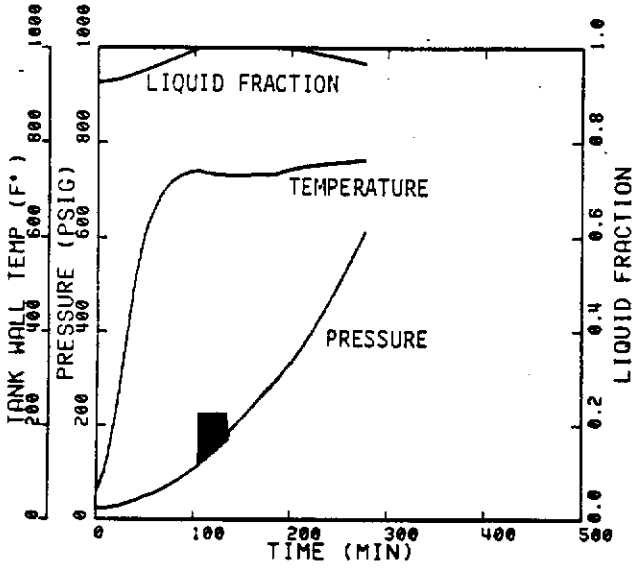
APPENDIX F: MONOMETHYLAMINE PLOTS



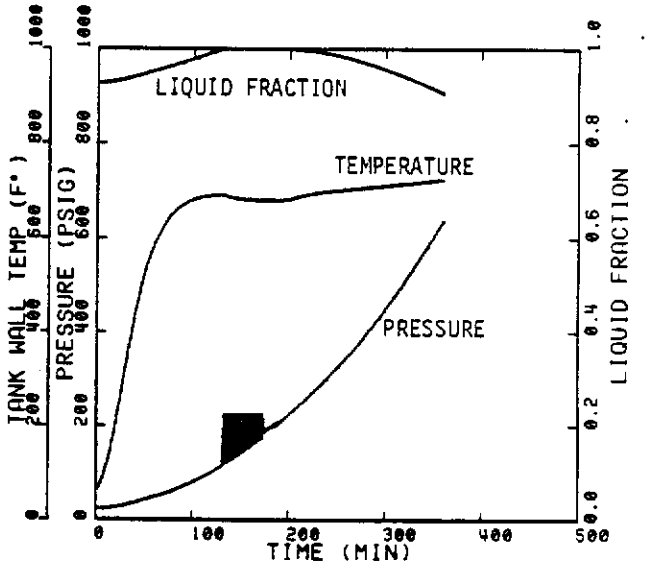
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

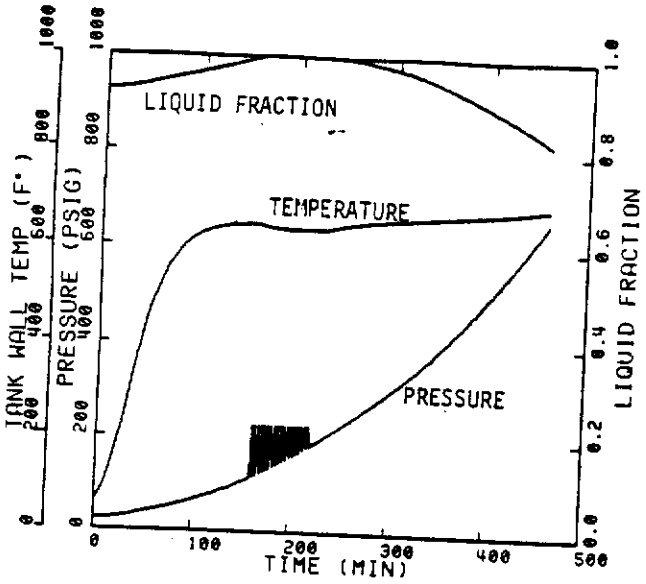


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

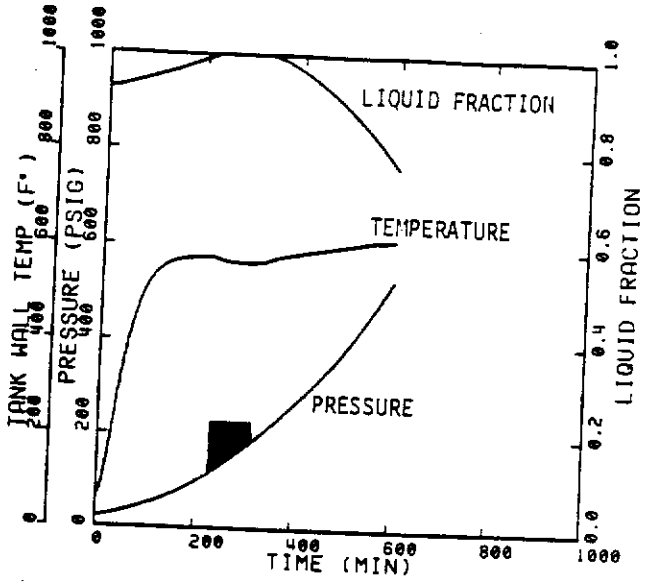


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

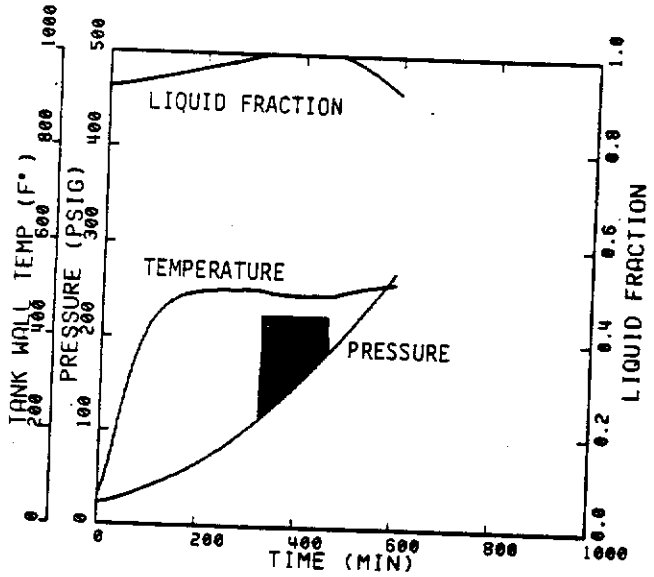
FIGURE F-1. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A300W TANK CAR CONTAINING MONOMETHYLAMINE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 1100 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

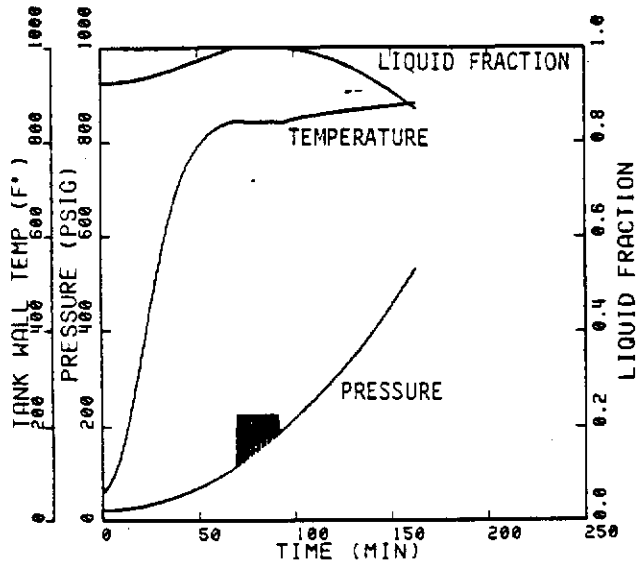


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

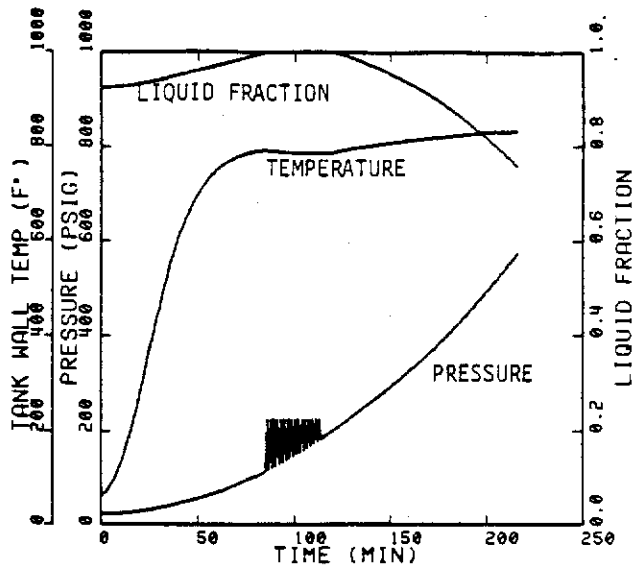


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

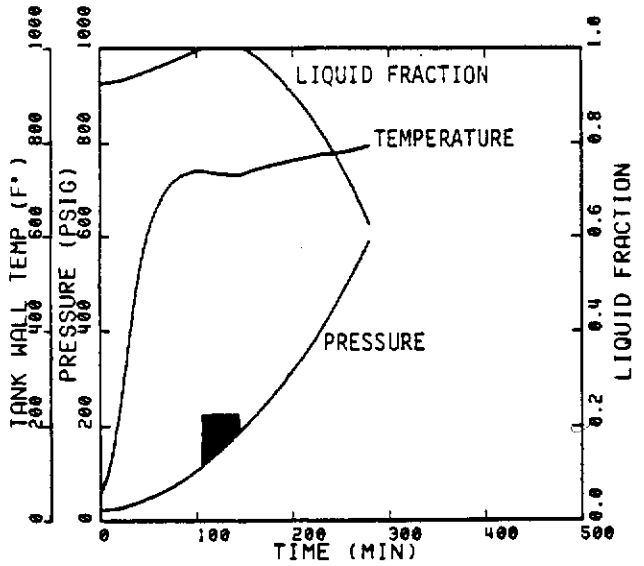
FIGURE F-1. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A300W TANK CAR CONTAINING MONO-METHYLAMINE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 1100 SCFM



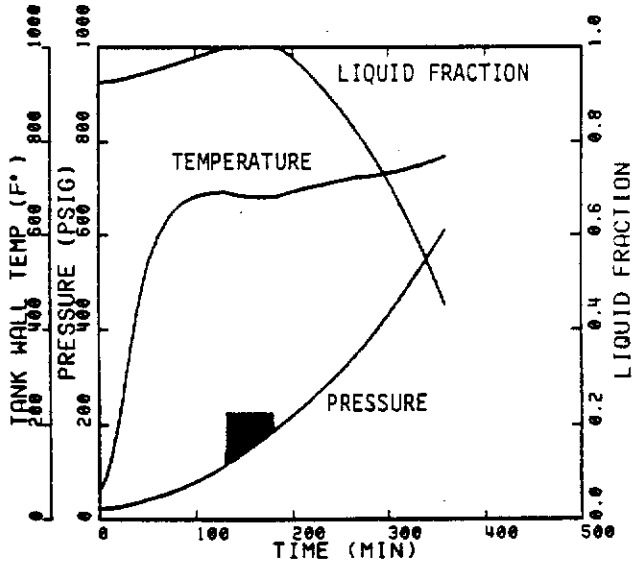
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

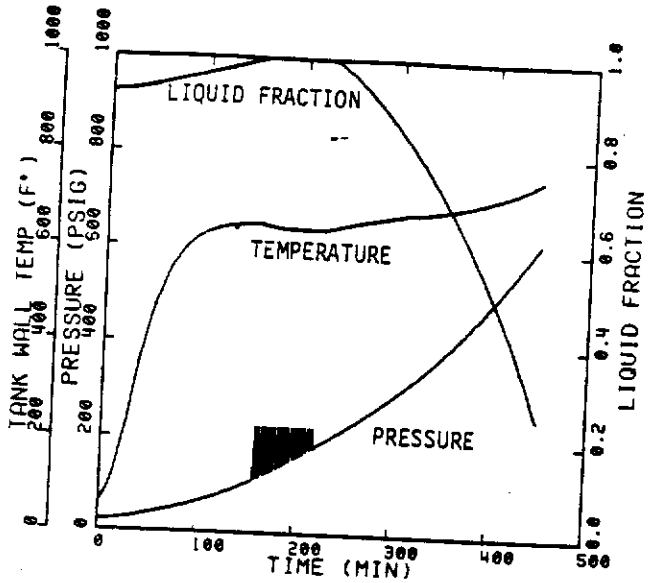


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

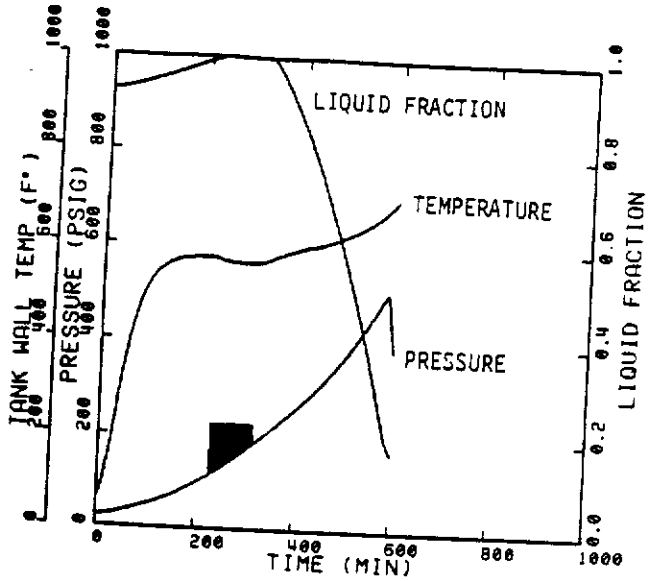


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

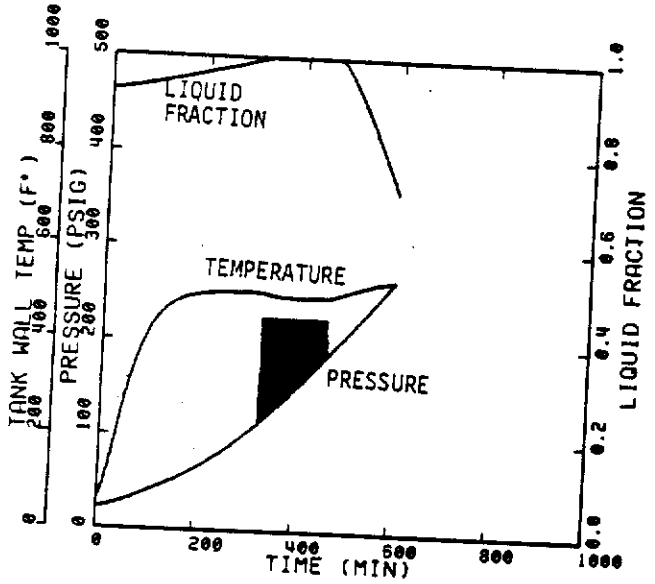
FIGURE F-2. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A300W TANK CAR CONTAINING MONO-METHYLAMINE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 3070 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

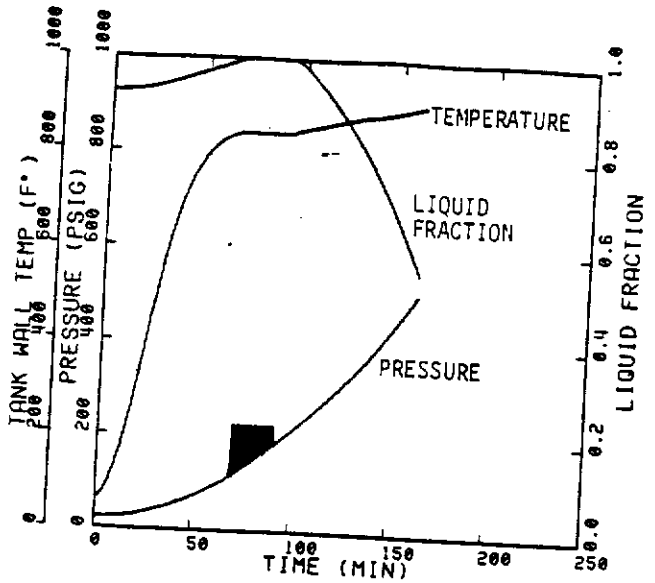


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

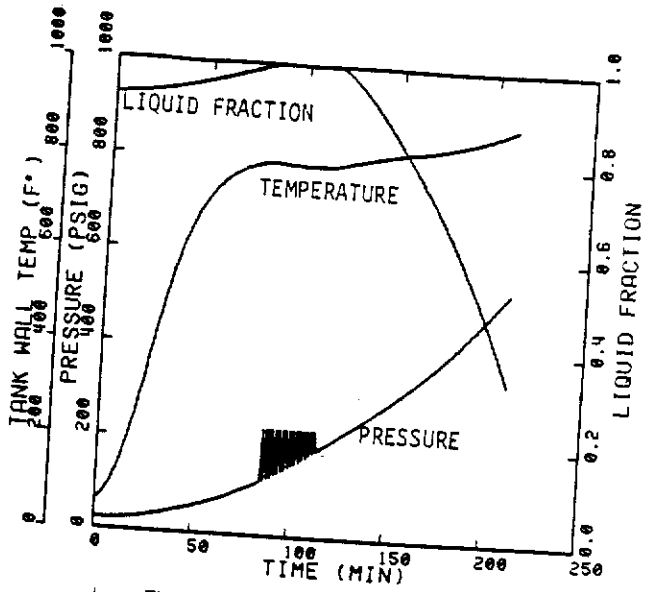


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

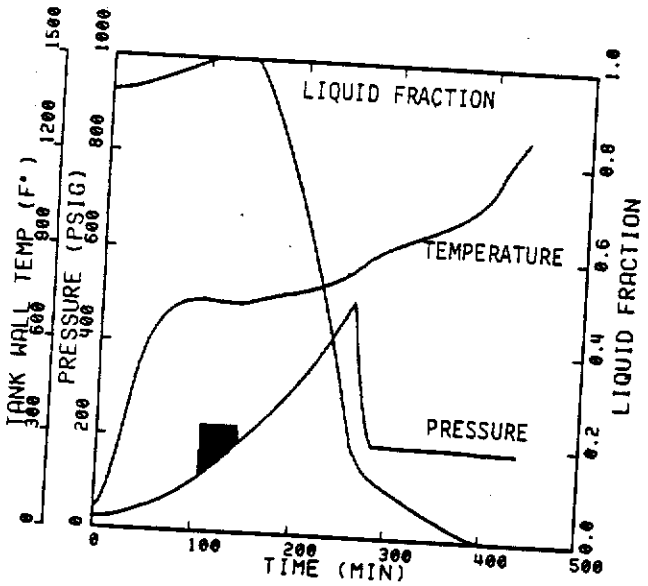
FIGURE F-2. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A300W TANK CAR CONTAINING MONO-METHYLAMINE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 3070 SCFM



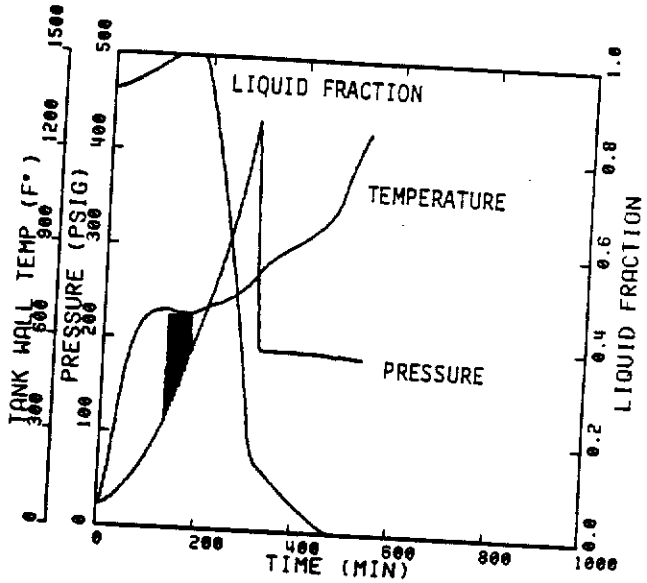
a. THERMAL SHIELD CONDUCTANCE 5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE 4.0 BTU/HR-FT²-°F

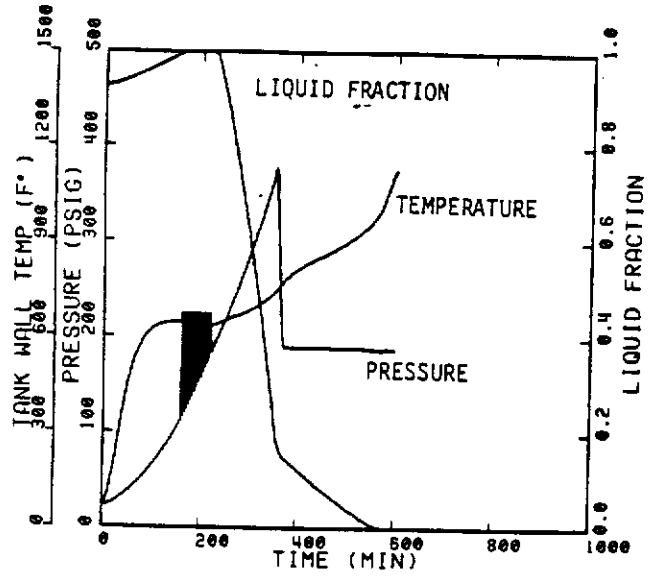


c. THERMAL SHIELD CONDUCTANCE 3.0 BTU/HR-FT²-°F

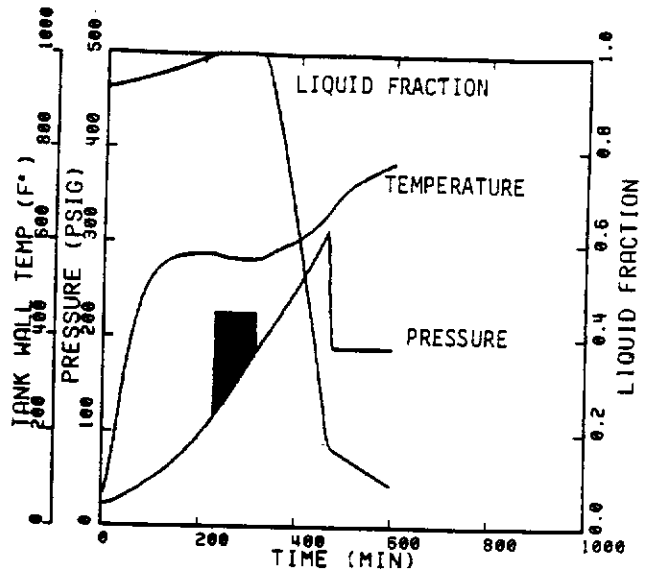


d. THERMAL SHIELD CONDUCTANCE 2.3 BTU/HR-FT²-°F

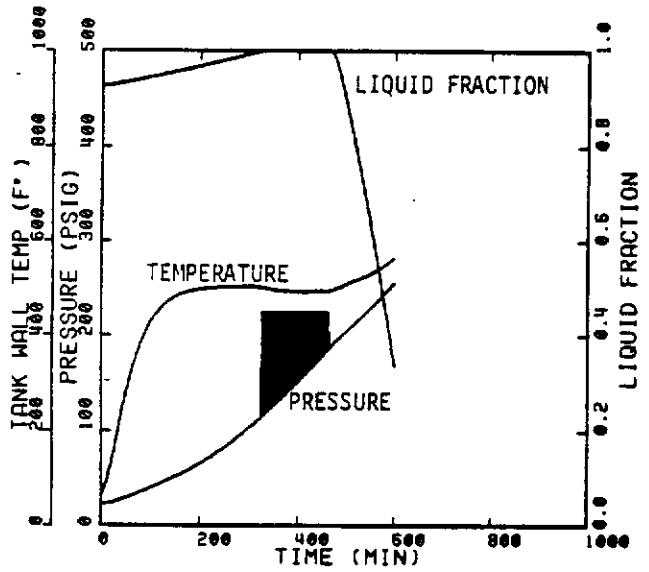
FIGURE F-3. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A300W TANK CAR CONTAINING MONO-METHYLAMINE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 7000 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

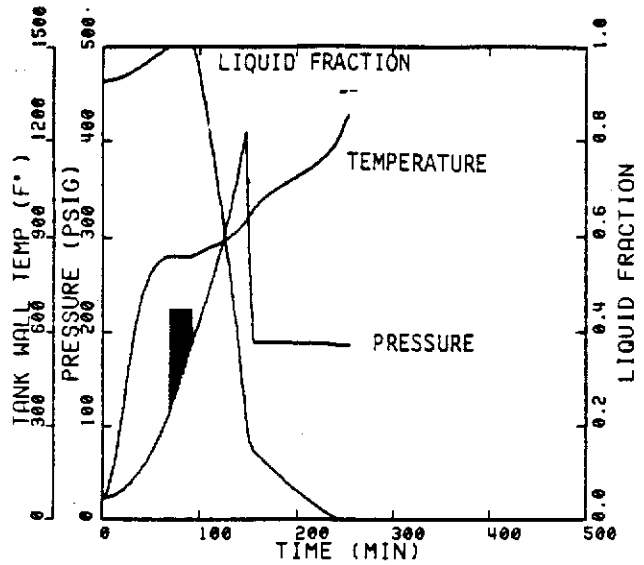


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

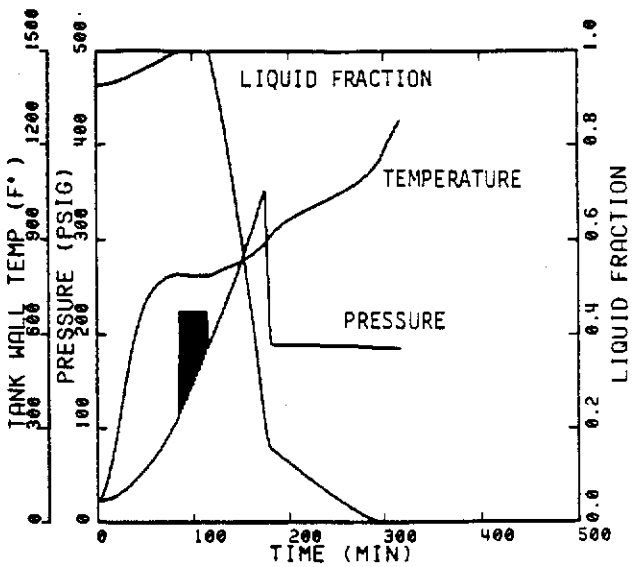


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

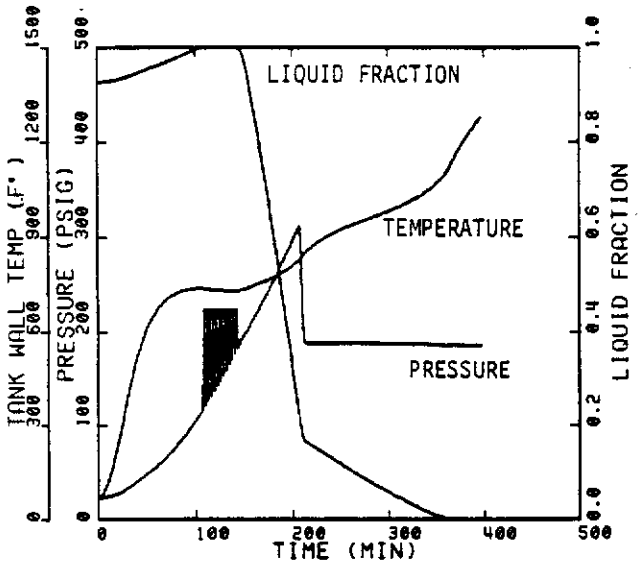
FIGURE F-3. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A300W TANK CAR CONTAINING MONO-METHYLAMINE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 7000 SCFM



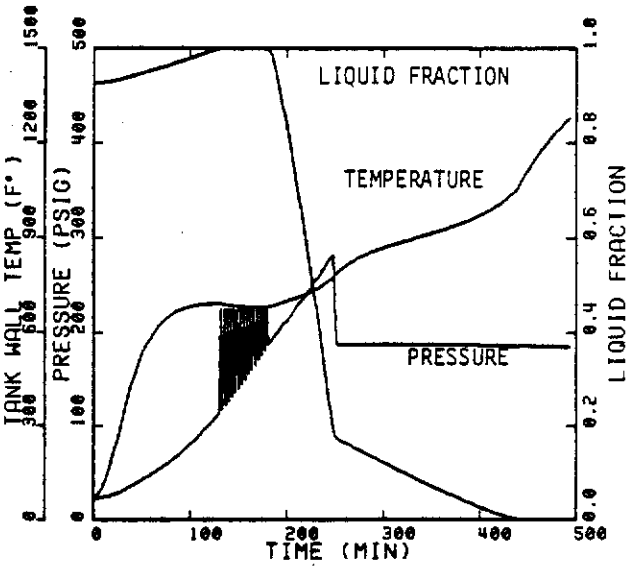
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

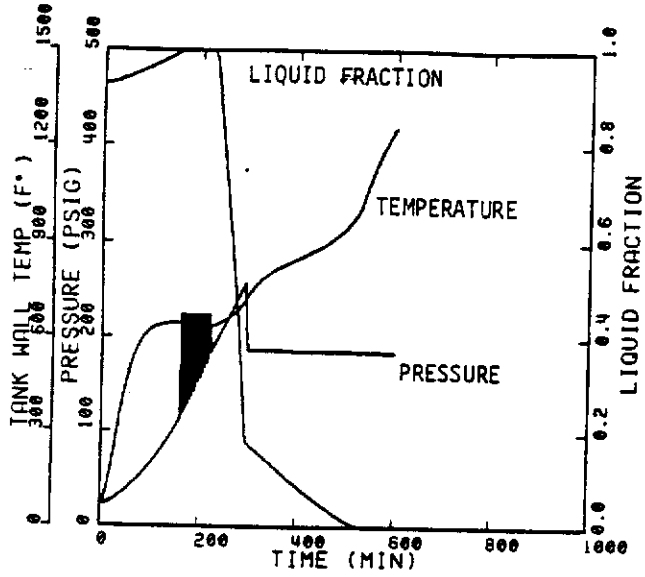


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

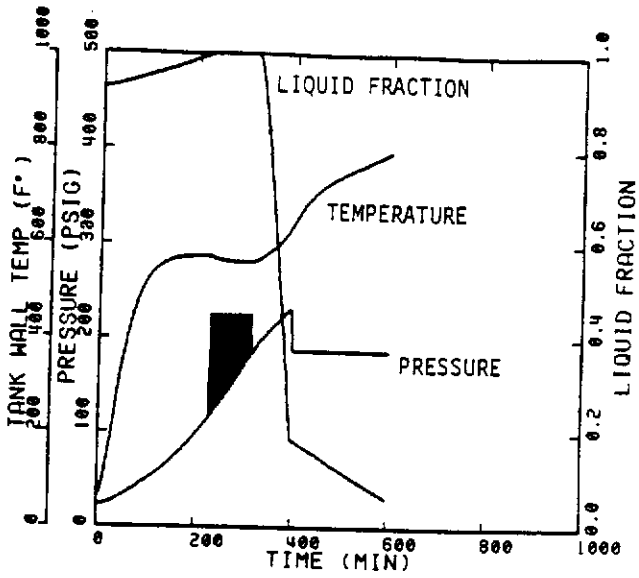


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

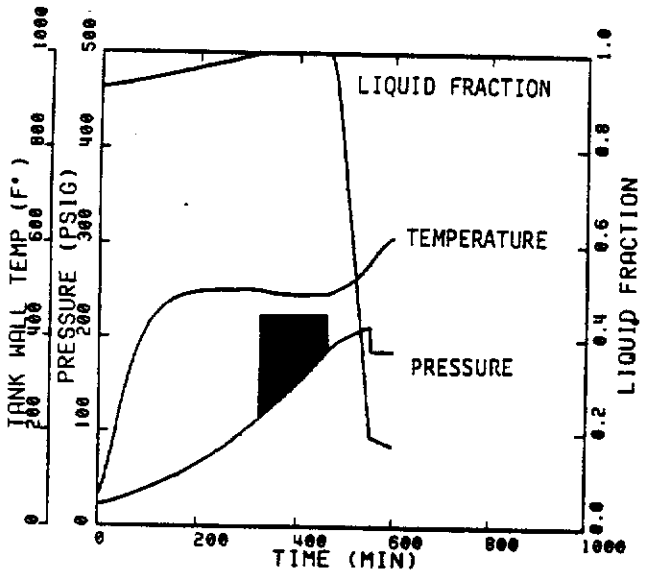
FIGURE F-4. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A300W TANK CAR CONTAINING MONO-METHYLAMINE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 15,800 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

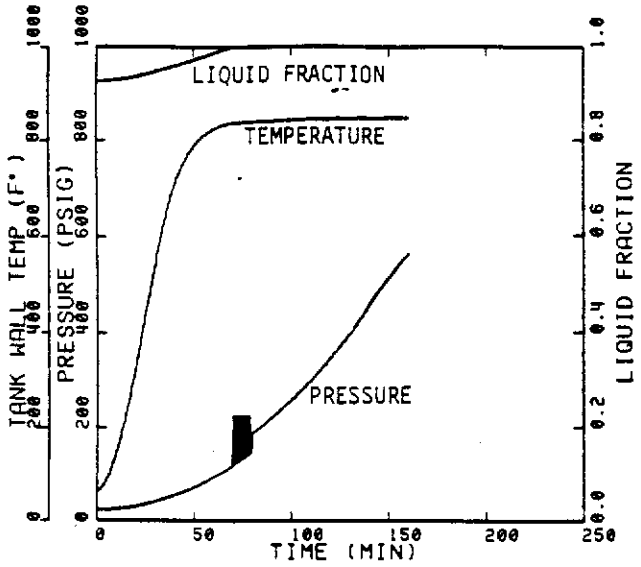


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

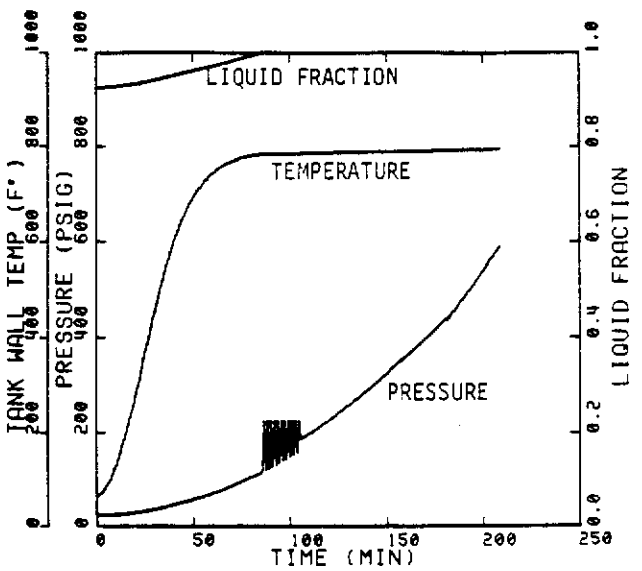


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

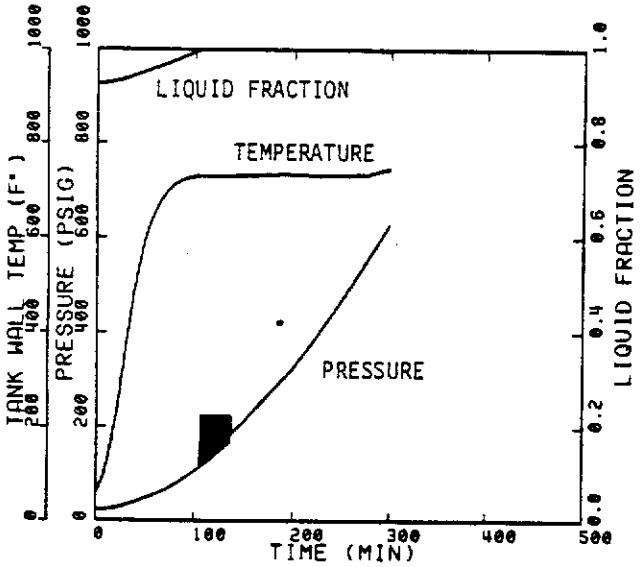
FIGURE F-4. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A300W TANK CAR CONTAINING MONO-METHYLAMINE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 15,800 SCFM



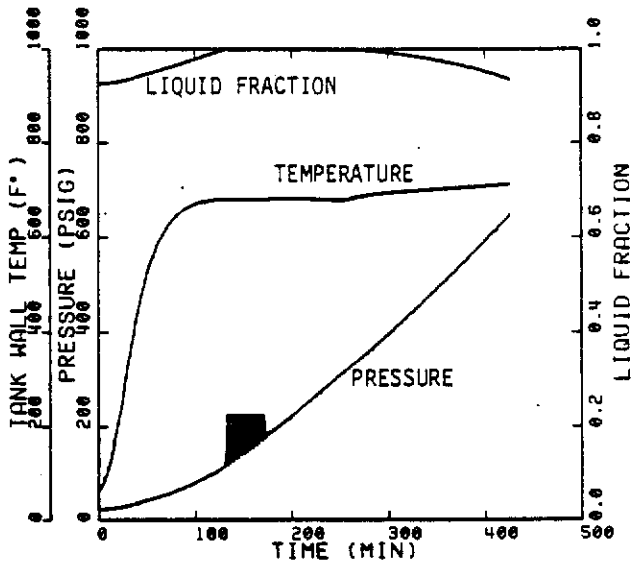
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

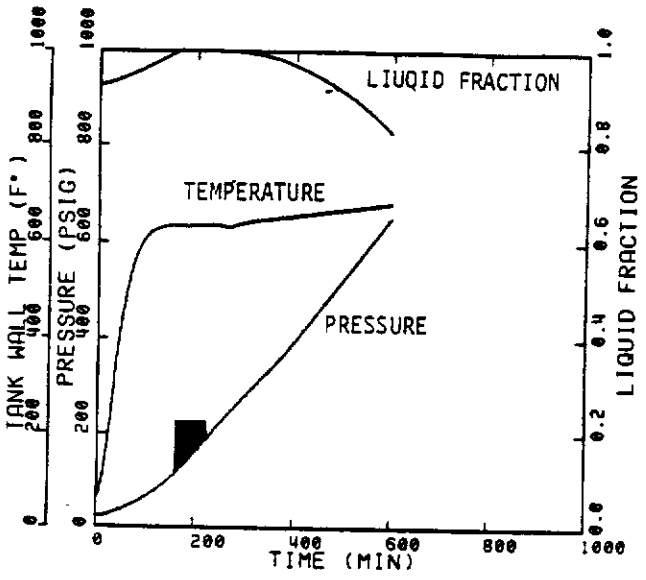


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

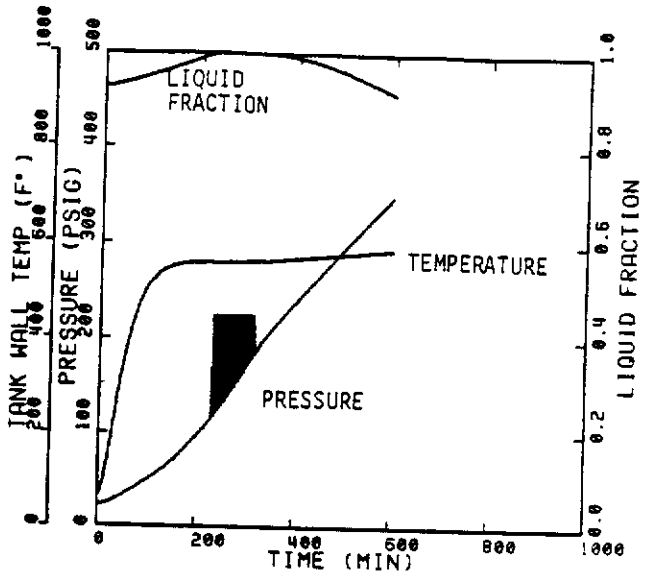


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

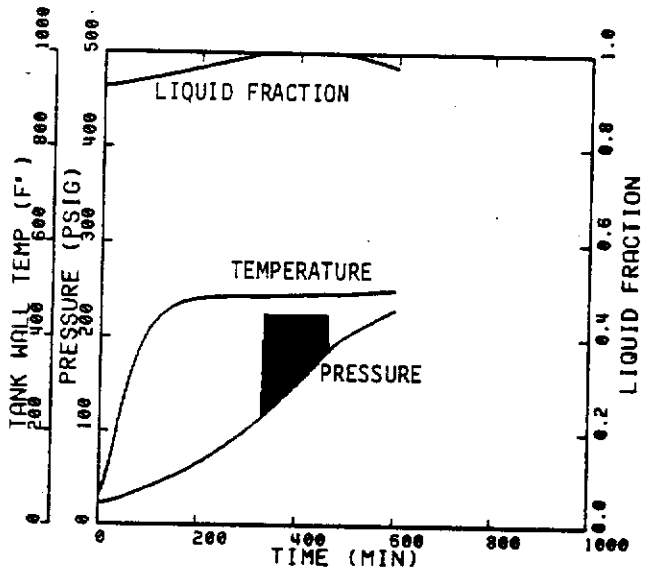
FIGURE F-5. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A300W TANK CAR CONTAINING MONO-METHYLAMINE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 1100 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

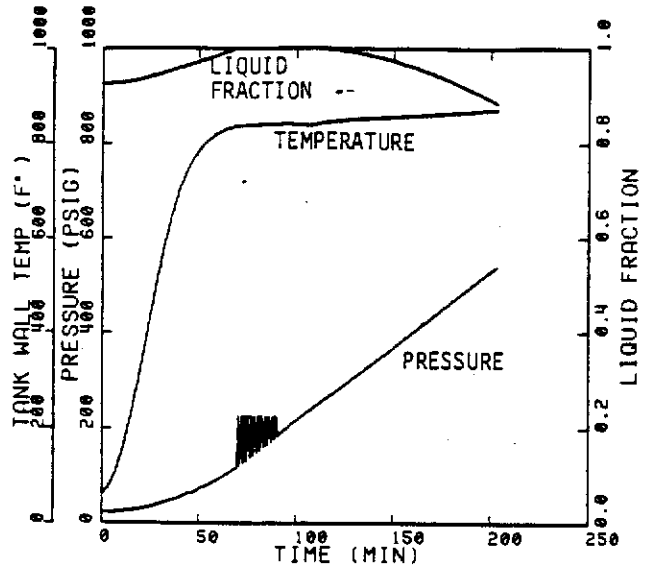


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

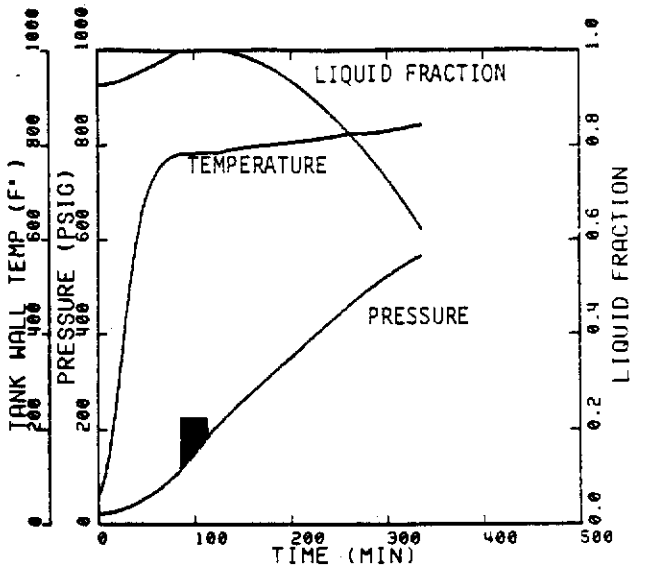


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

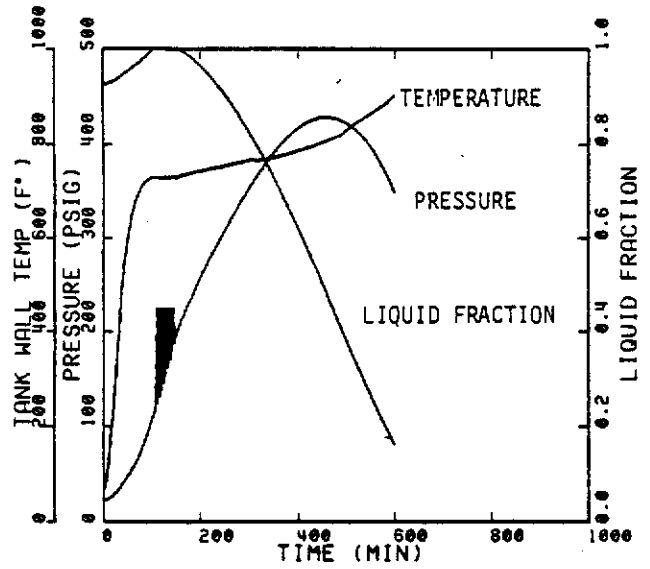
FIGURE F-5. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A300W TANK CAR CONTAINING MONO-METHYLAMINE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 1100 SCFM



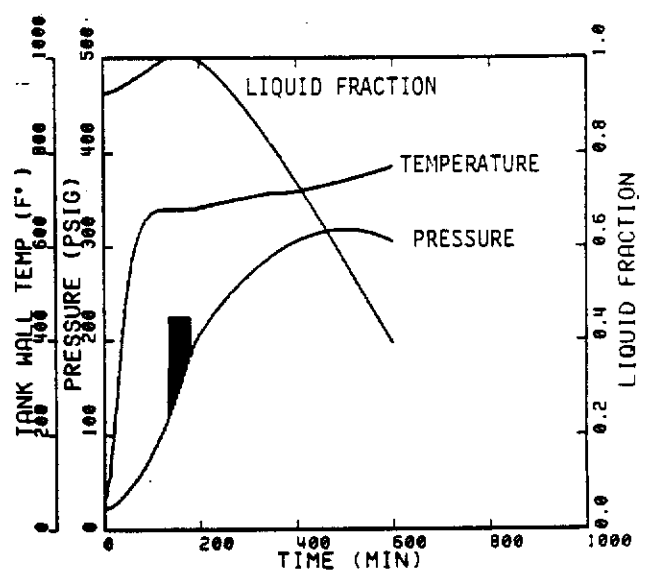
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

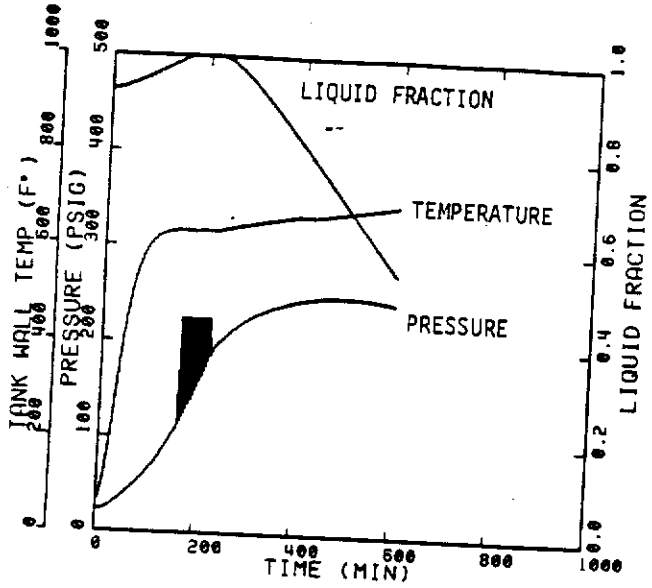


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

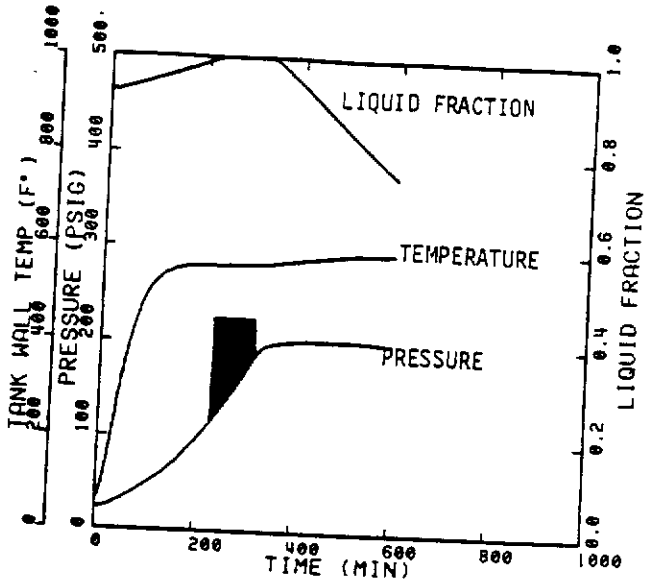


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

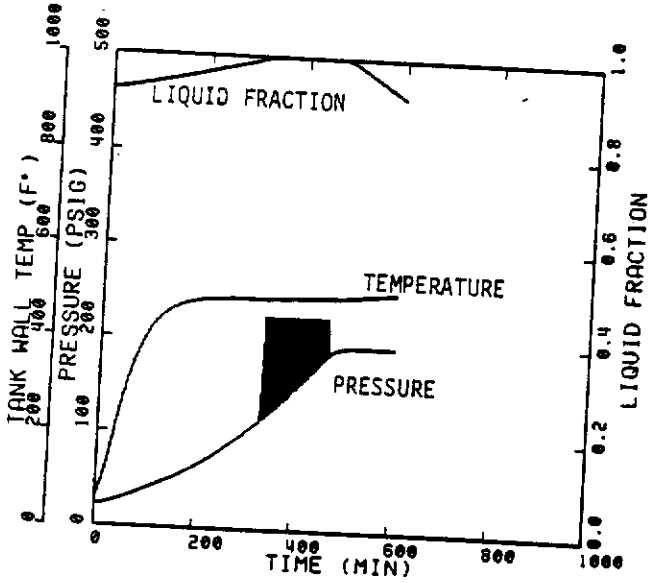
FIGURE F-6. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A300W TANK CAR CONTAINING MONO-METHYLAMINE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 3070 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

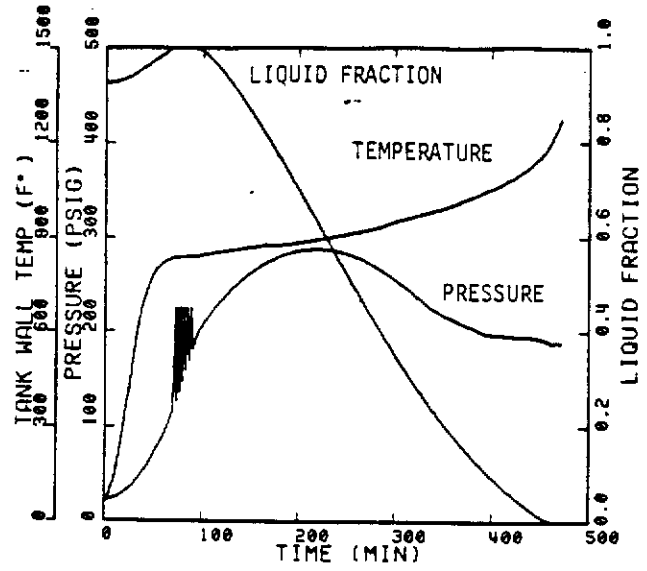


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

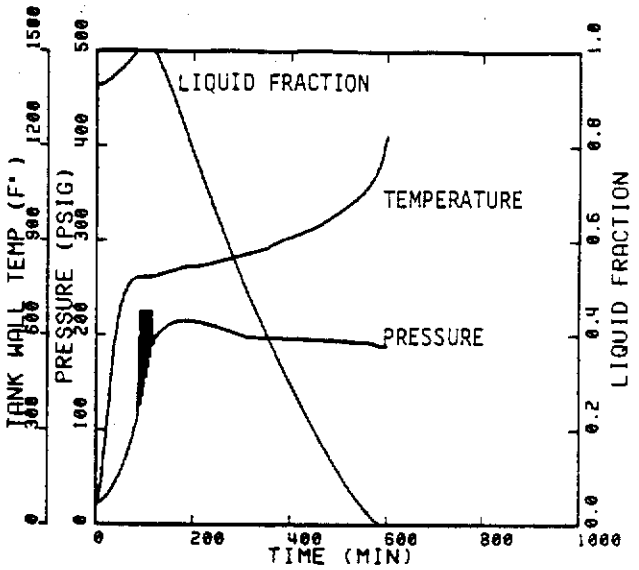


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

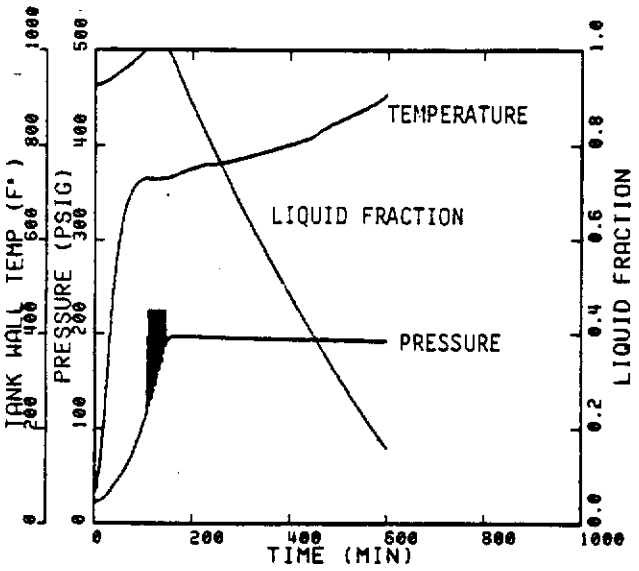
FIGURE F-6. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A300W TANK CAR CONTAINING MONO-METHYLAMINE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 3070 SCFM



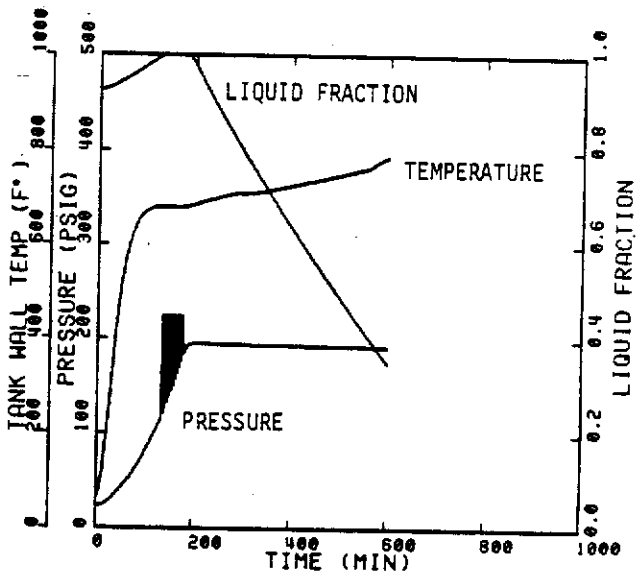
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

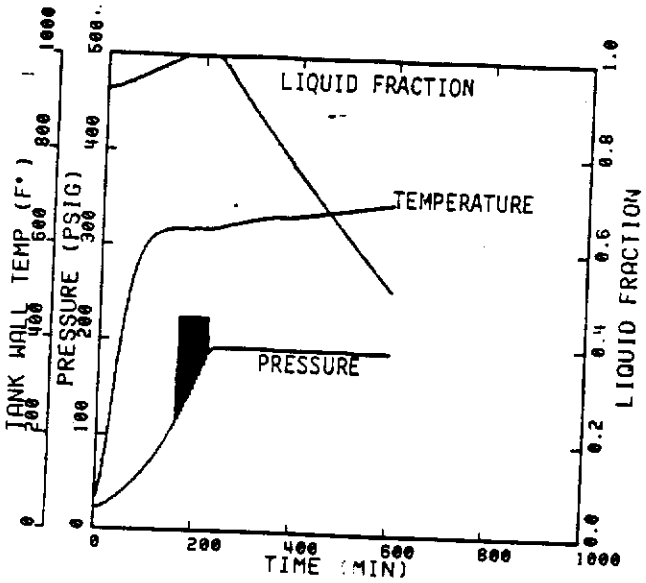


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

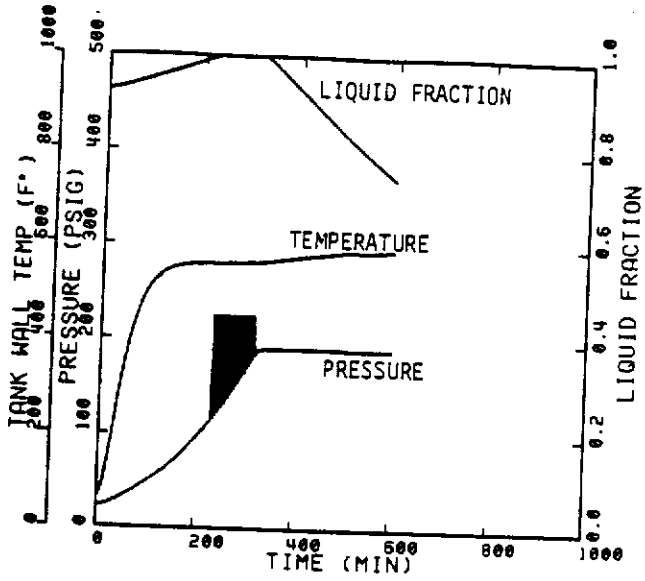


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

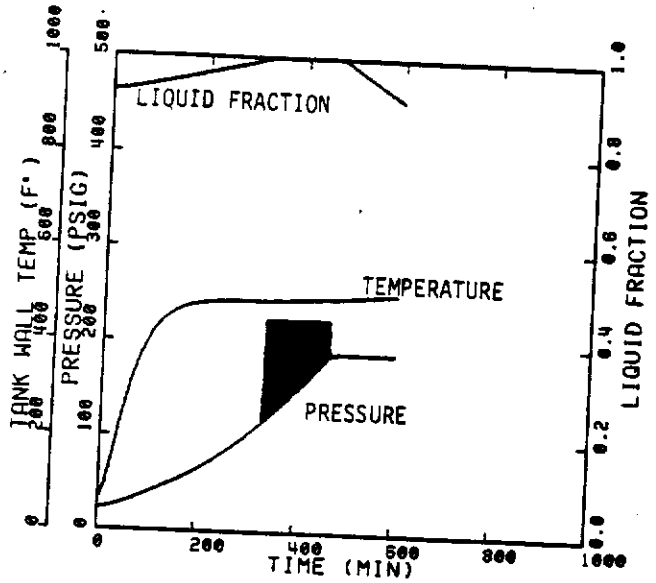
FIGURE F-7. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A300W TANK CAR CONTAINING MONO-METHYLAMINE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 7000 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

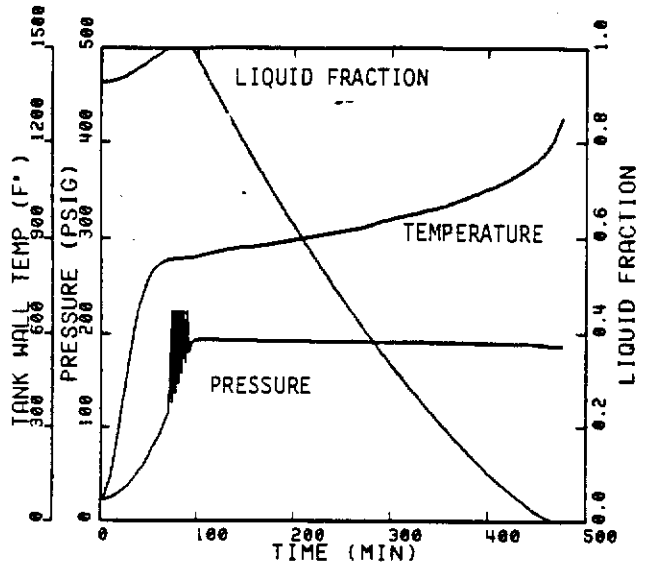


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

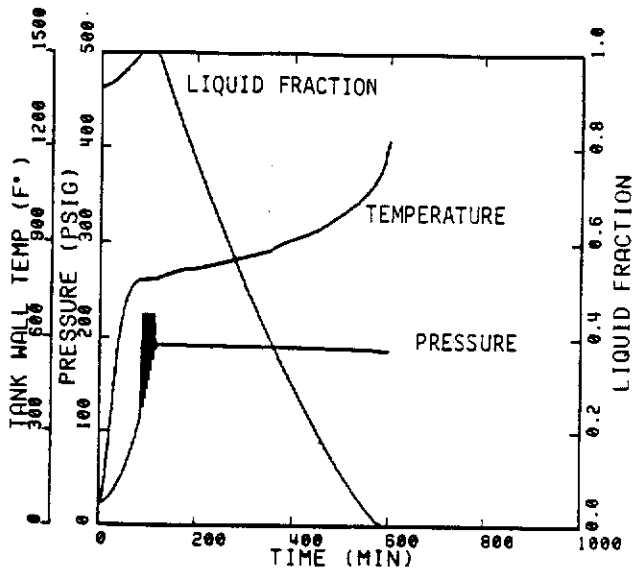


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

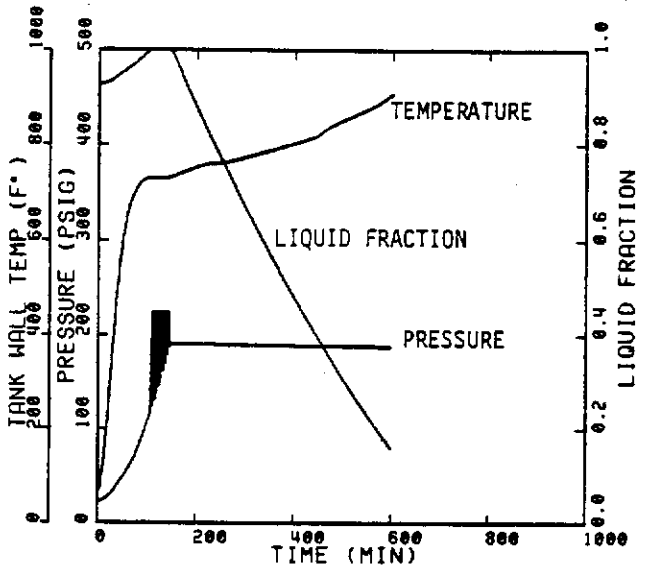
FIGURE F-7. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION TIME; 33,600 GAL. 105A300W TANK CAR CONTAINING MONO-METHYLAMINE, UPRIGHT CAR ASE, SAFETY RELIEF VALVE FLOW CAPACITY 7000 SCFM



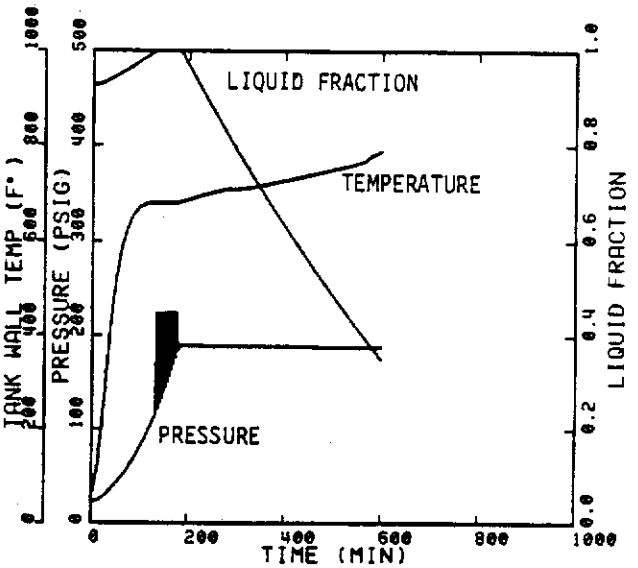
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

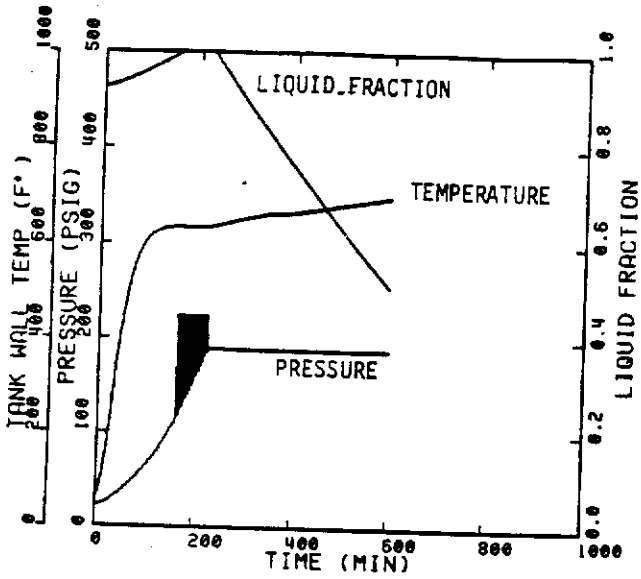


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

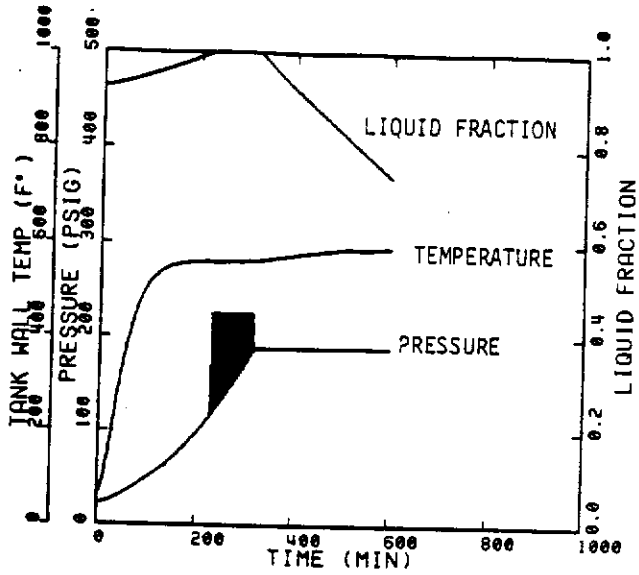


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

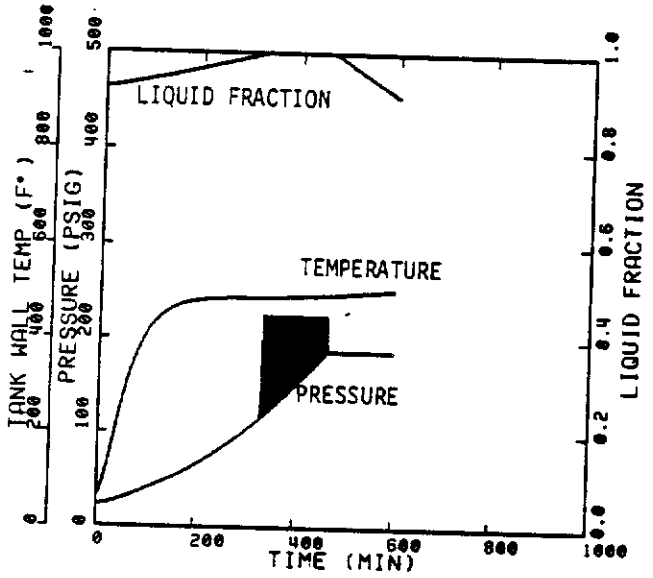
FIGURE F-8. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A300W TANK CAR CONTAINING MONO-METHYLAMINE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 15,800 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F



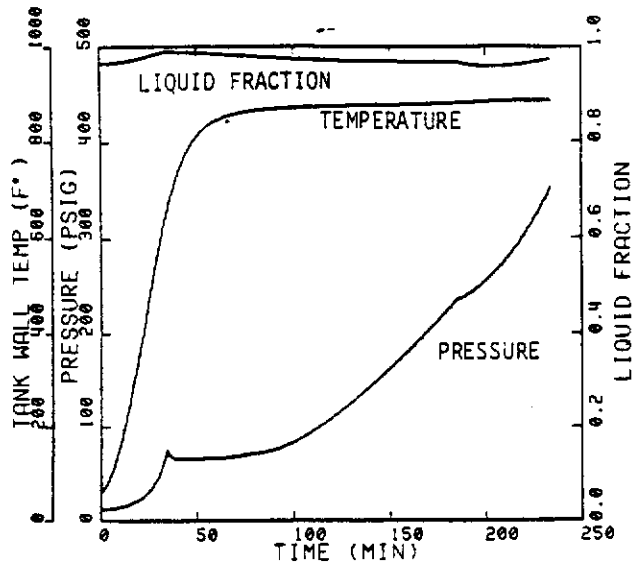
f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT-°F



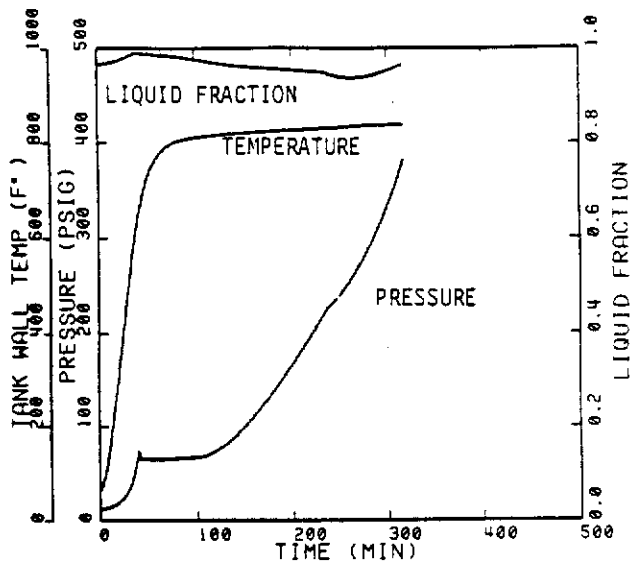
g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

FIGURE F-8. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 33,600 GAL. 105A300W TANK CAR CONTAINING MONO-METHYLAMINE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 15,800 SCFM

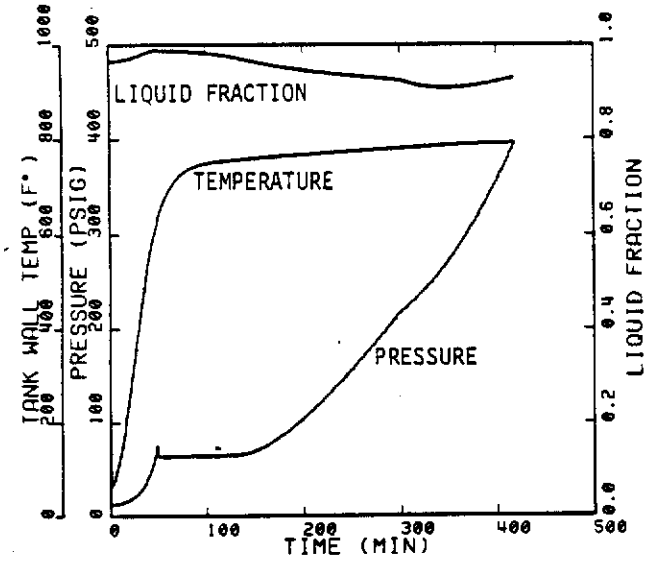
APPENDIX G: PROPYLENE OXIDE PLOTS



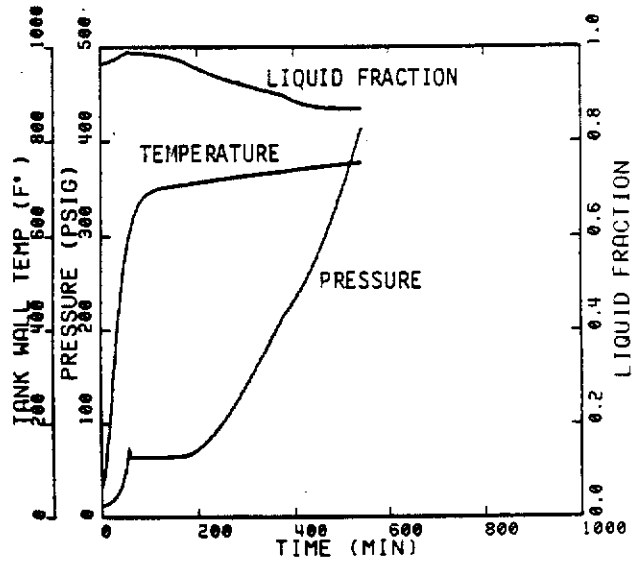
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

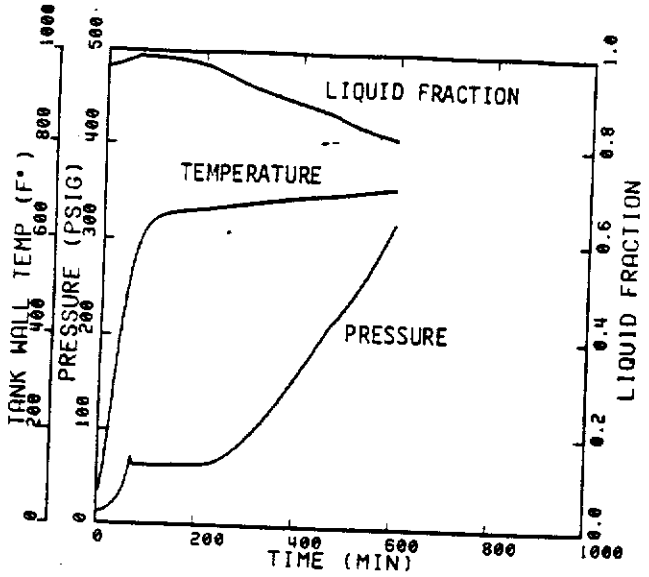


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

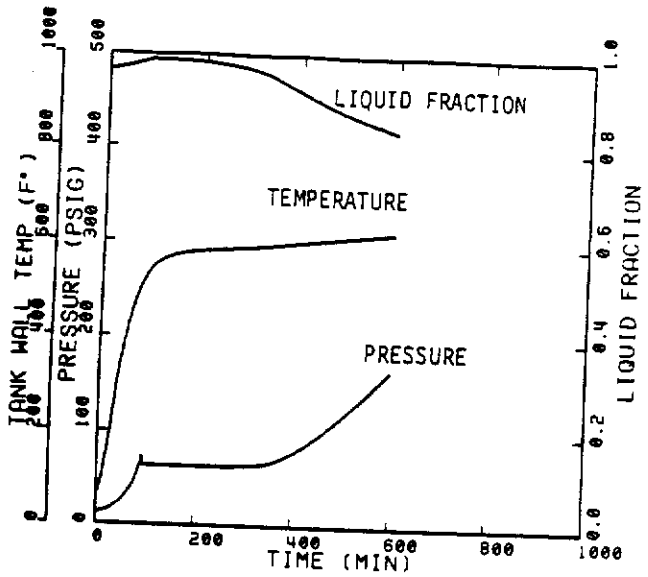


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

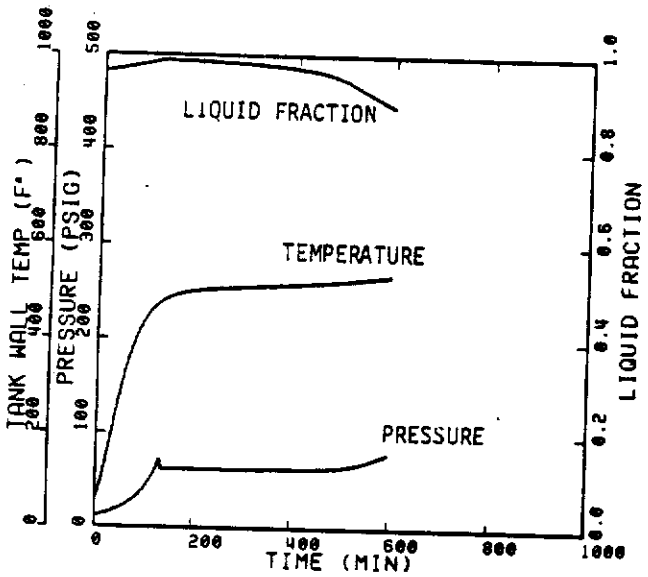
FIGURE G-1. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A100W TANK CAR CONTAINING PROPYLENE OXIDE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 330 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

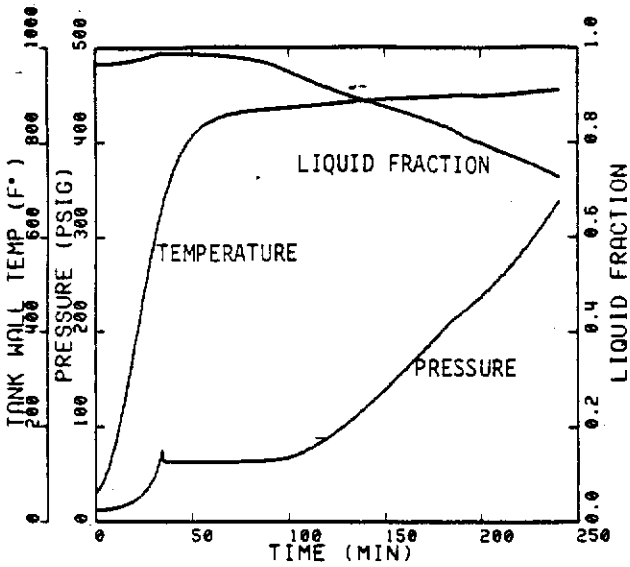


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

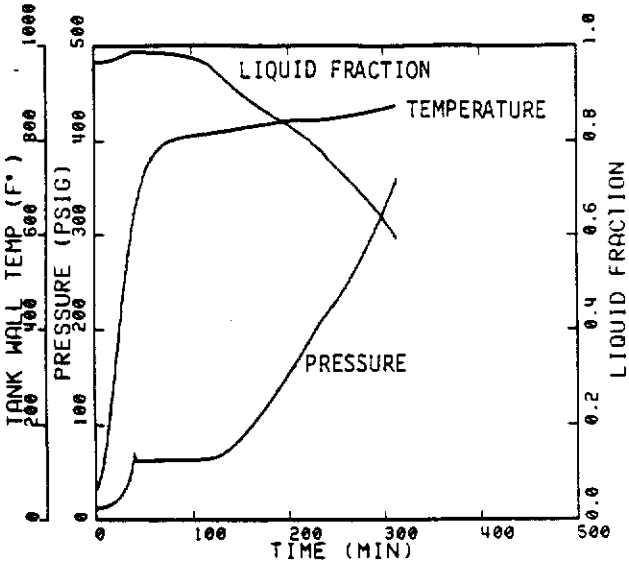


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

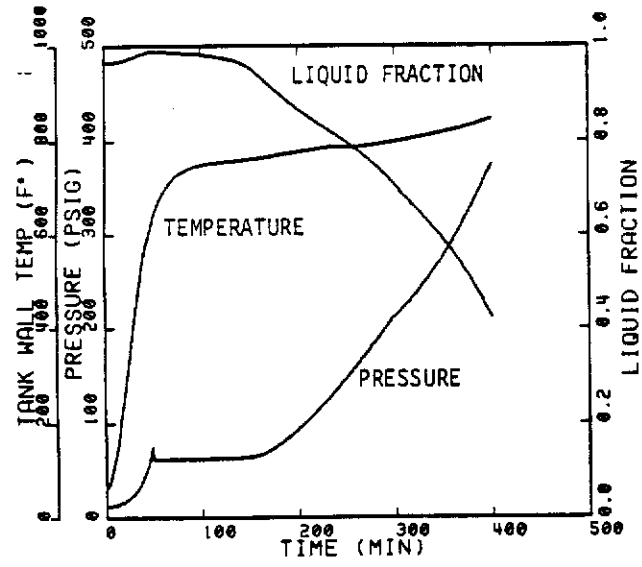
FIGURE G-1. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A100W TANK CAR CONTAINING PROPYLENE OXIDE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 330 SCFM



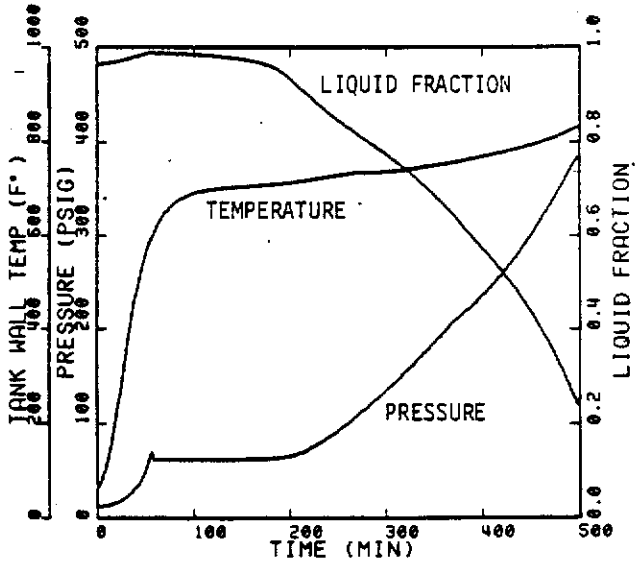
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

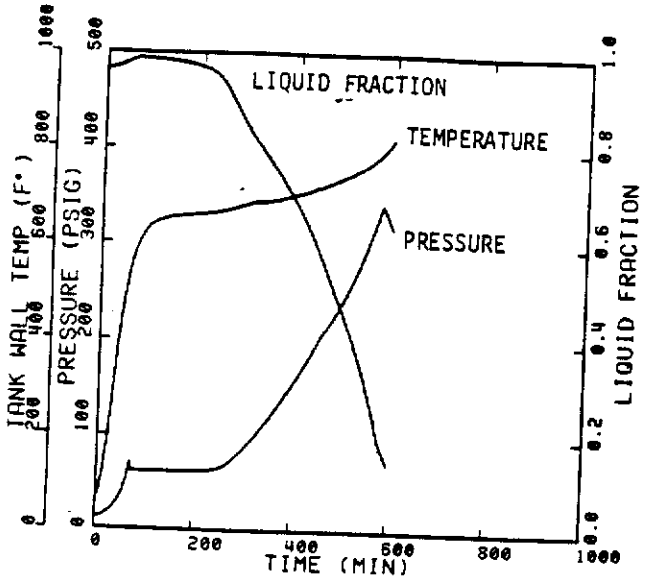


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

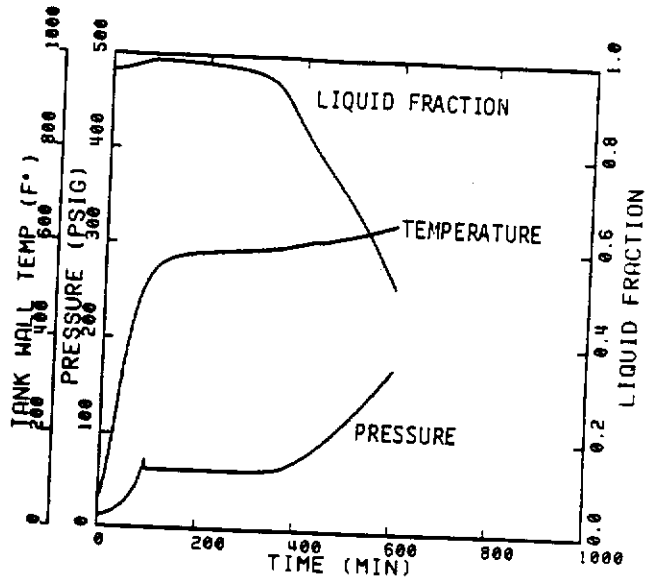


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

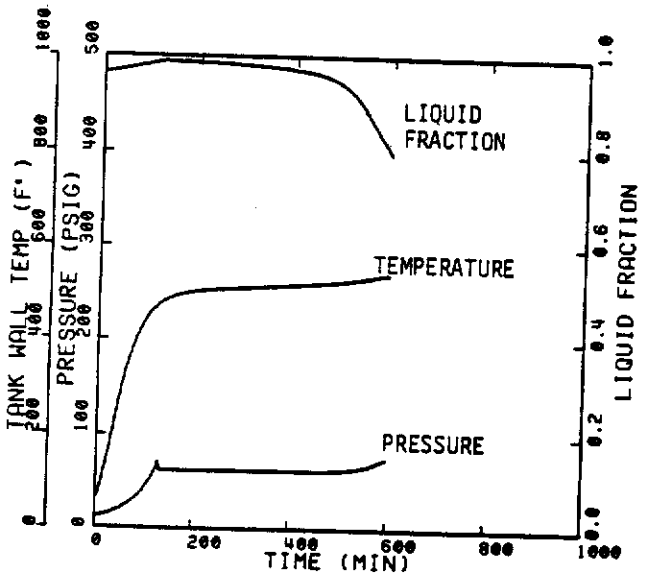
FIGURE G-2. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A100W TANK CAR CONTAINING PROPYLENE OXIDE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 1100 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

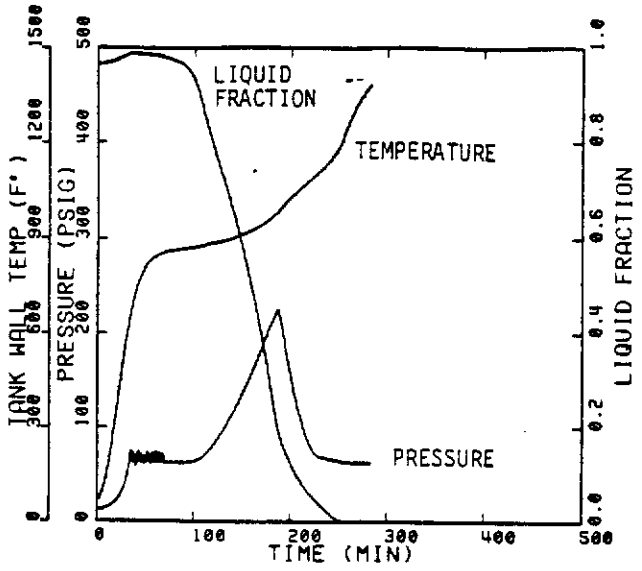


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

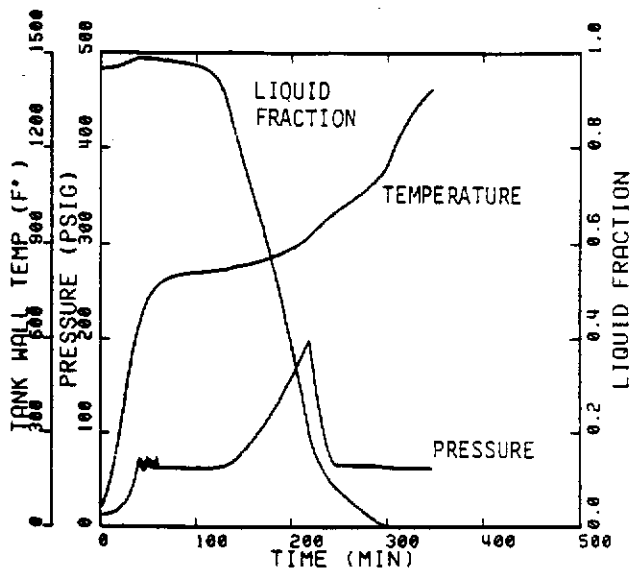


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

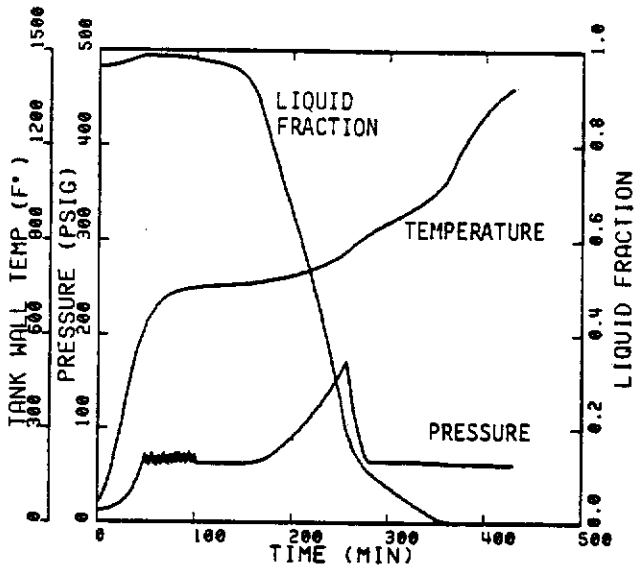
FIGURE G-2. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A100W TANK CAR CONTAINING PROPYLENE OXIDE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 1100 SCFM



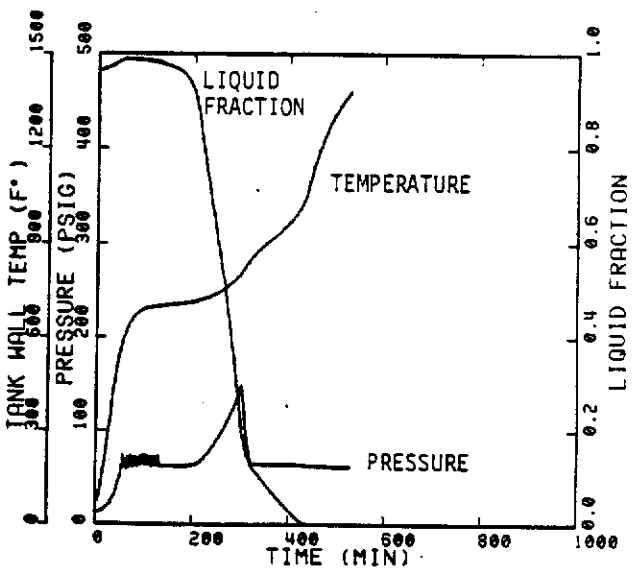
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

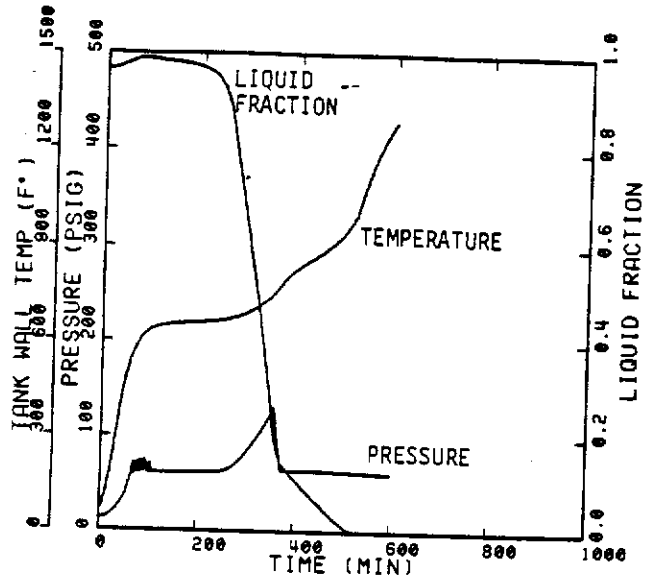


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

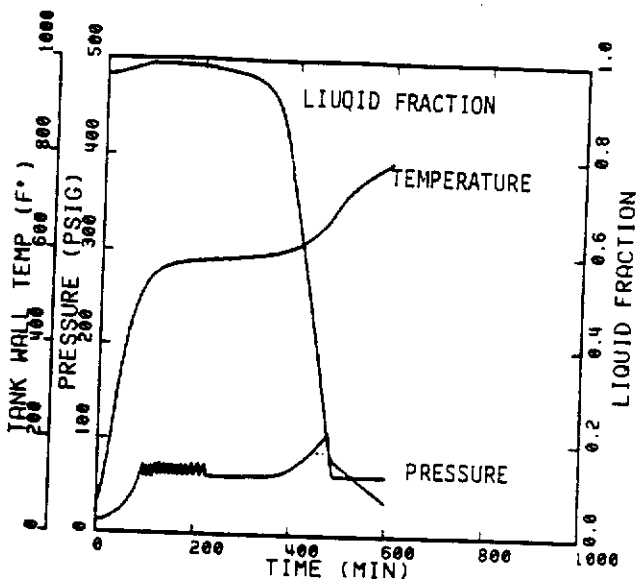


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

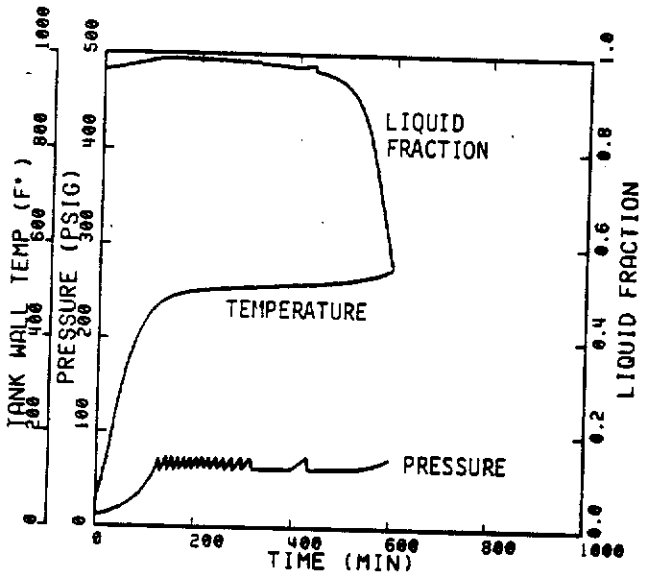
FIGURE G-3. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A100W TANK CAR CONTAINING PROPYLENE OXIDE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 5000 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

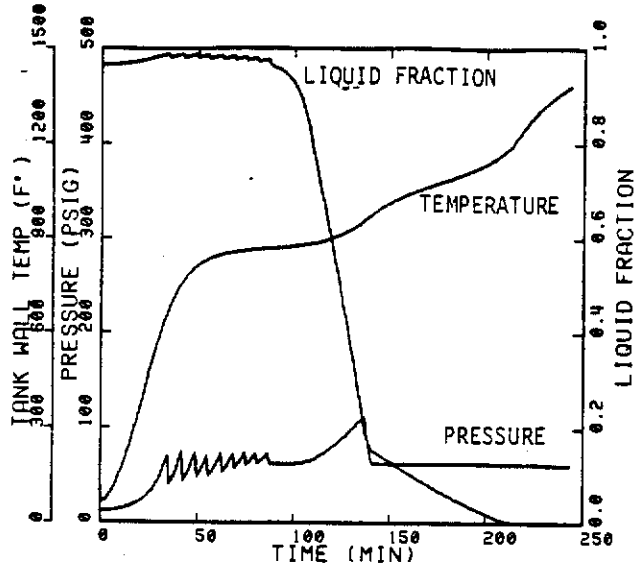


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

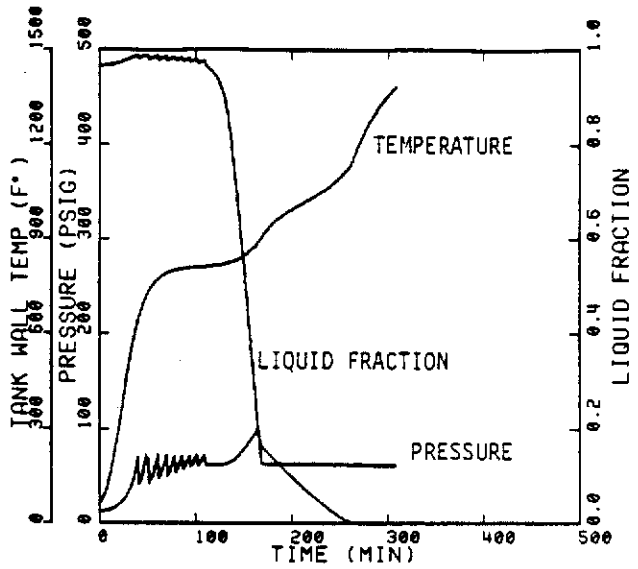


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

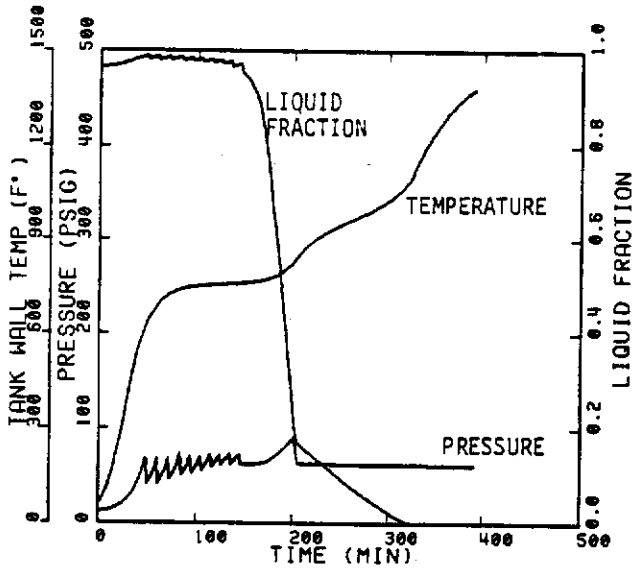
FIGURE G-3. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A100W TANK CAR CONTAINING PROPYLENE OXIDE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 5000 SCFM



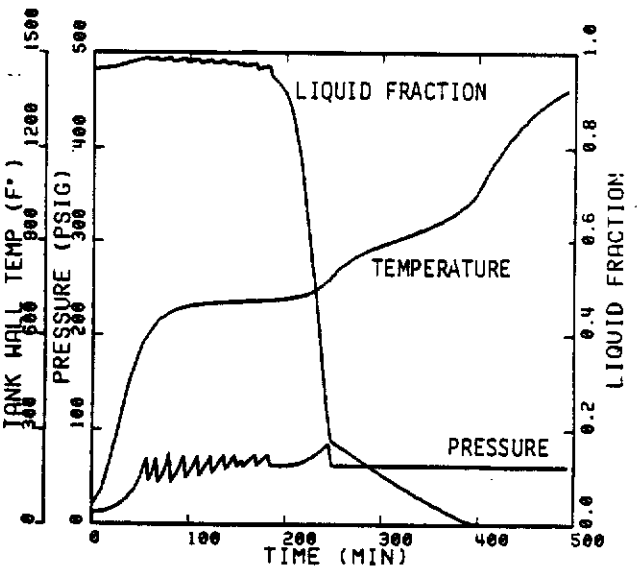
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

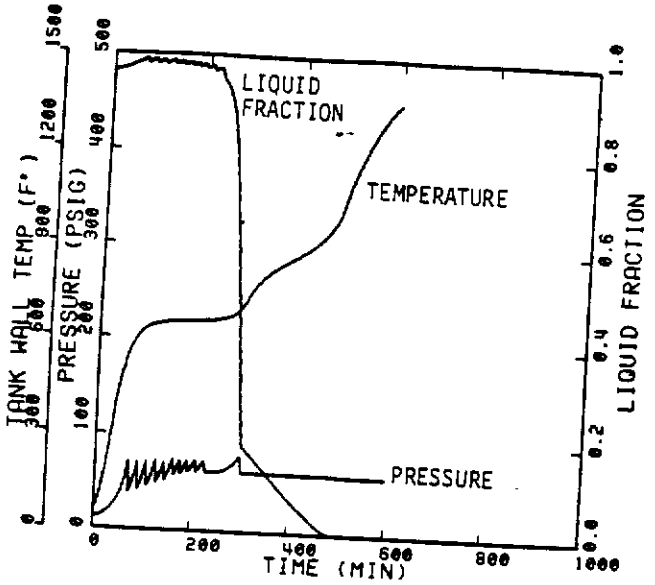


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

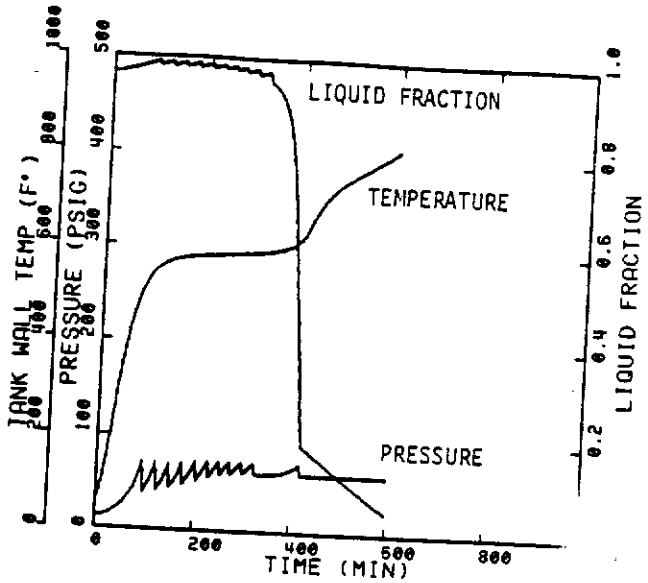


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

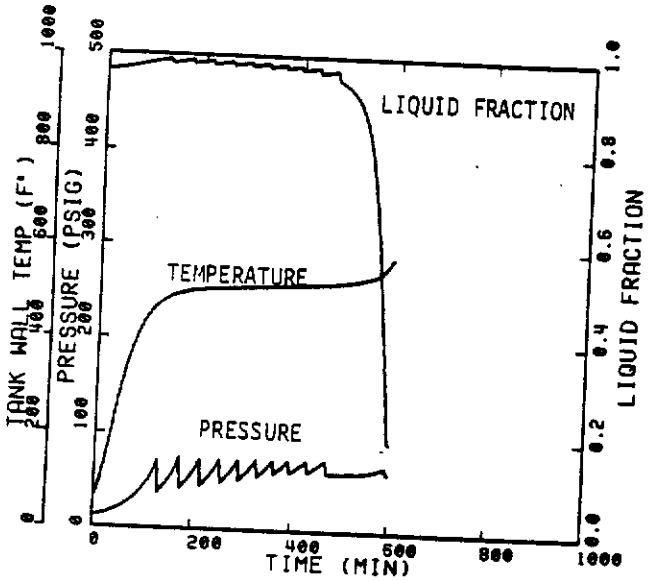
FIGURE G-4. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A100W TANK CAR CONTAINING PROPYLENE OXIDE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 16,500 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

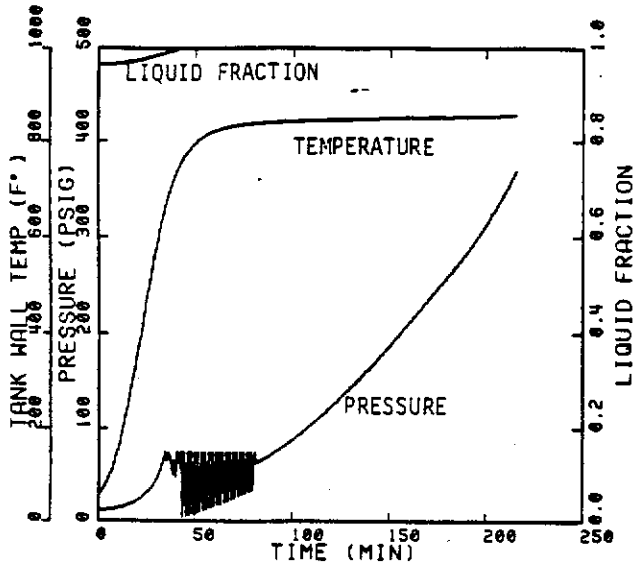


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

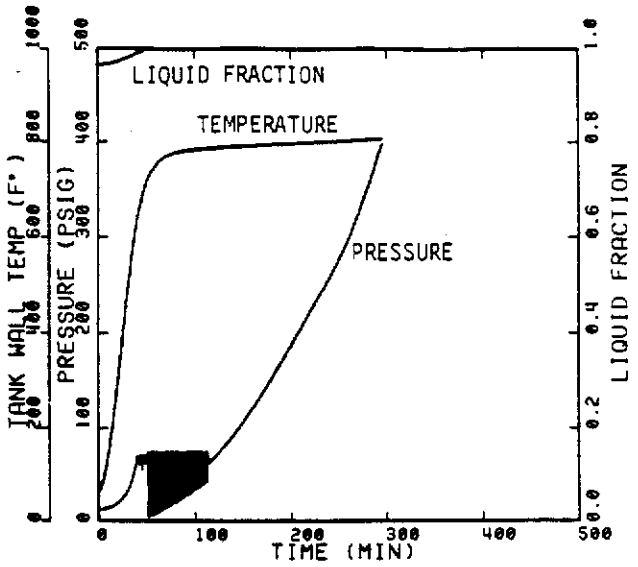


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT-°F

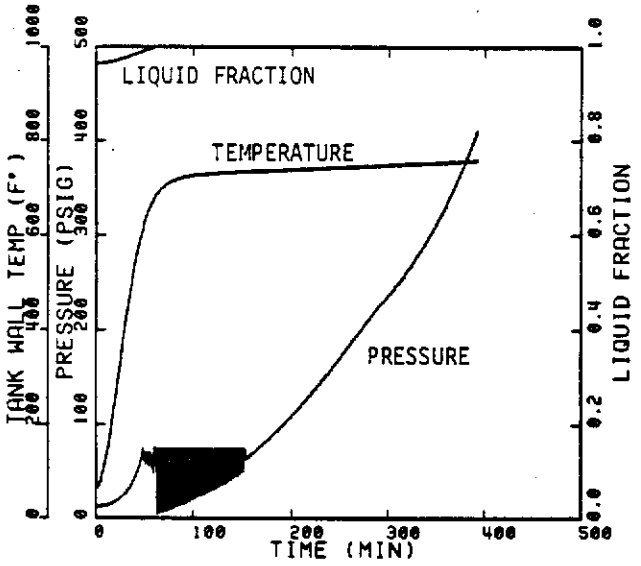
FIGURE G-4. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A100W TANK CAR CONTAINING PROPYLENE OXIDE, OVERTURNED (120°) CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 16,500 SCFM



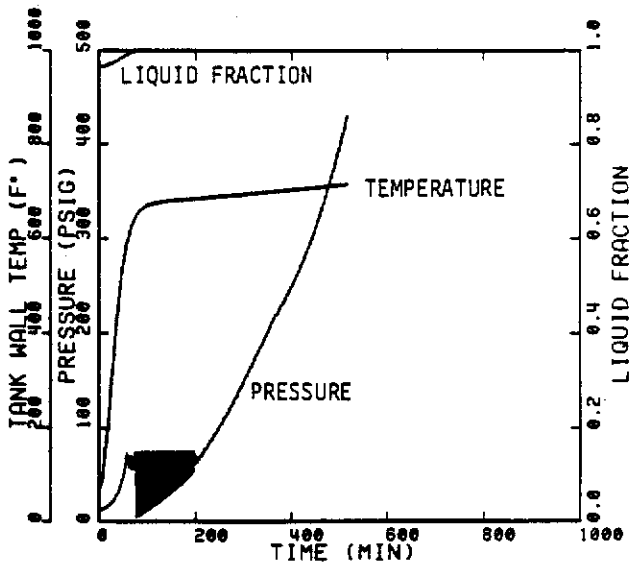
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

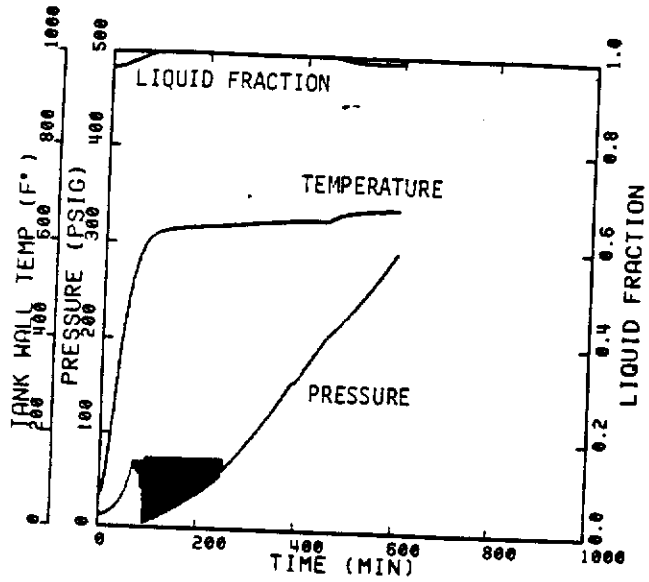


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

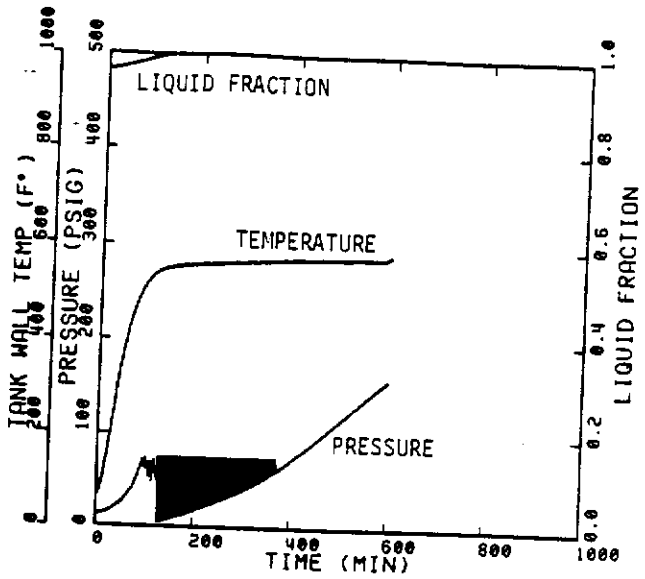


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

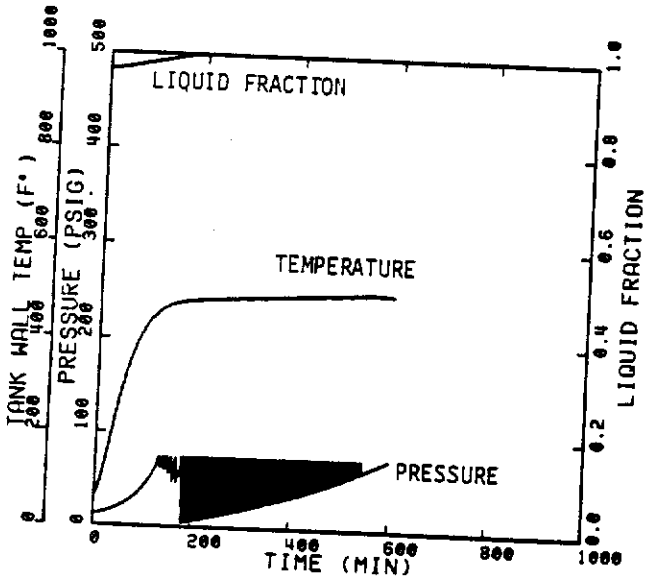
FIGURE G-5. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A100W TANK CAR CONTAINING PROPYLENE OXIDE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 330 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

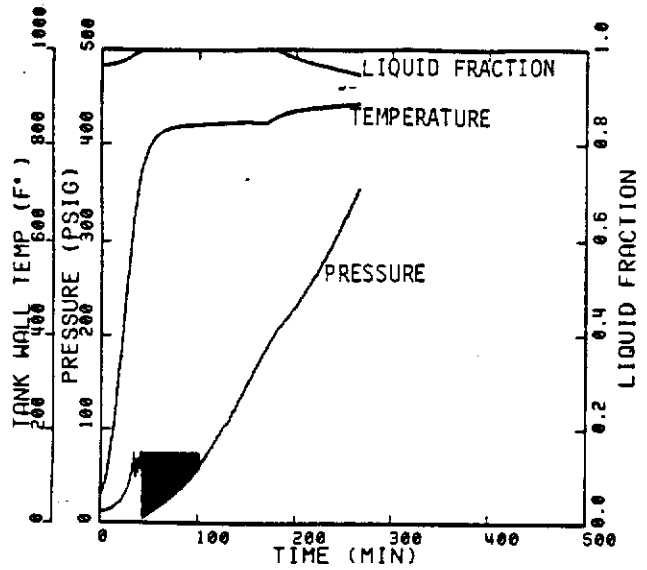


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

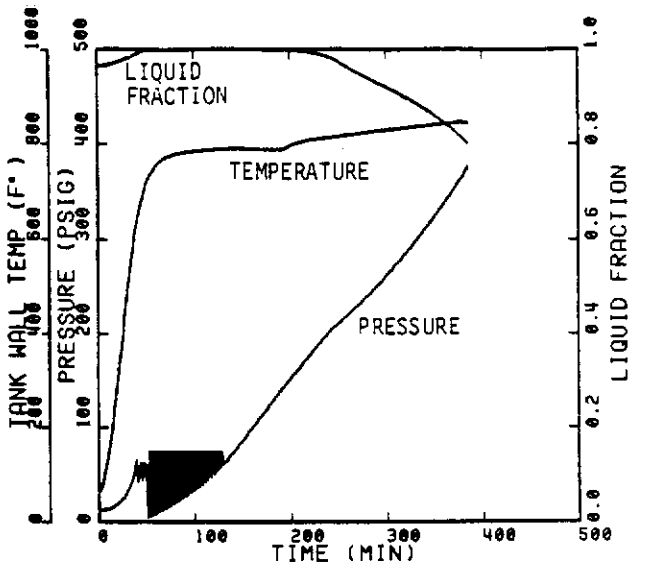


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

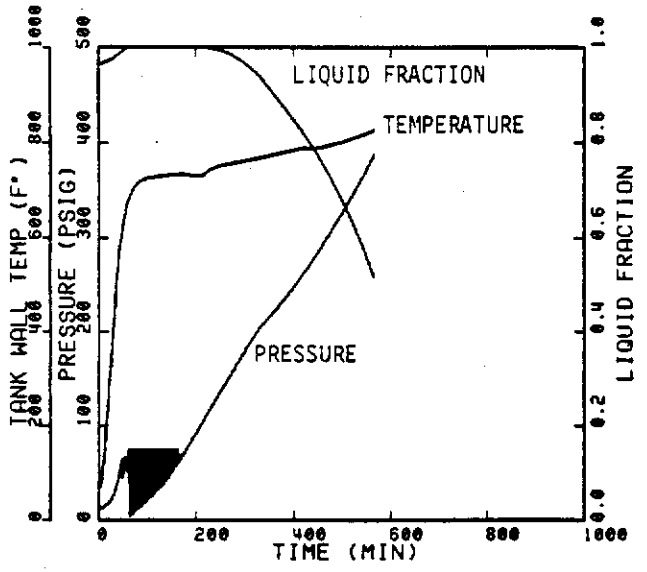
FIGURE G-5. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A100W TANK CAR CONTAINING PROPYLENE OXIDE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 330 SCFM



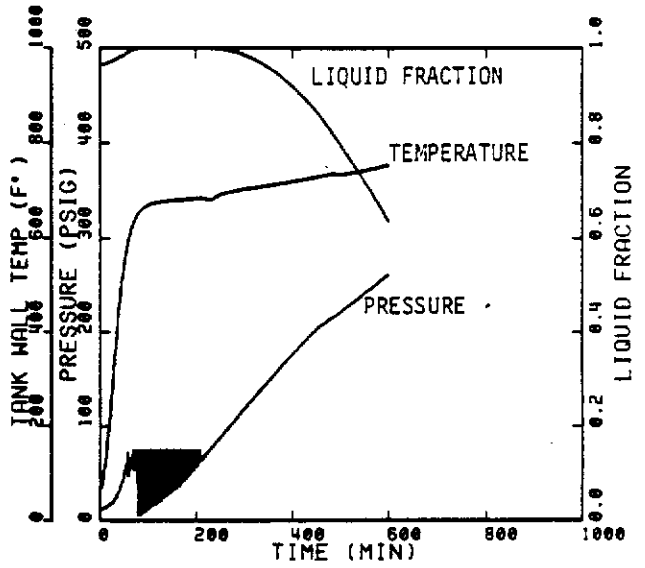
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

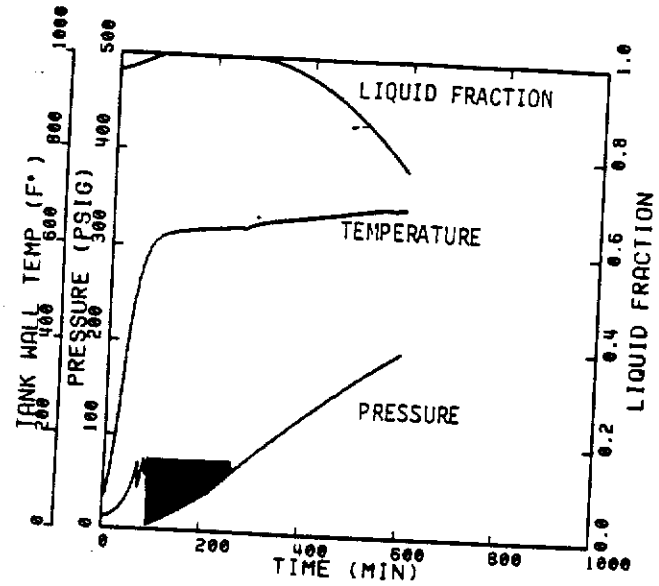


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

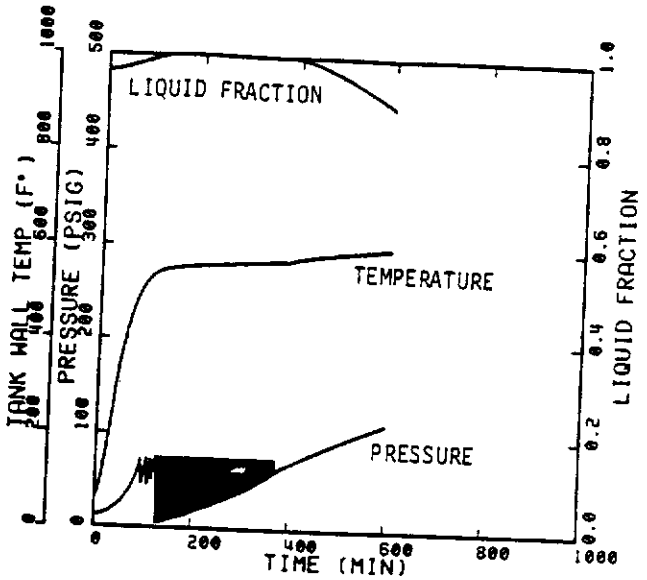


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

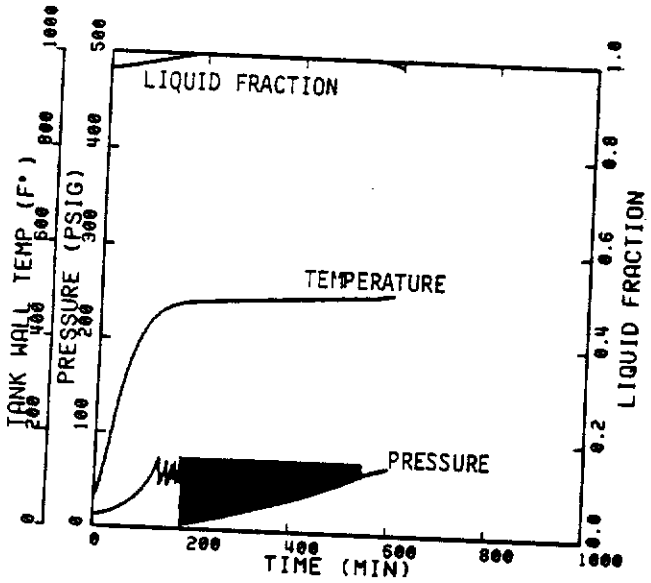
FIGURE G-6. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A100W TANK CAR CONTAINING PROPYLENE OXIDE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 1100 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

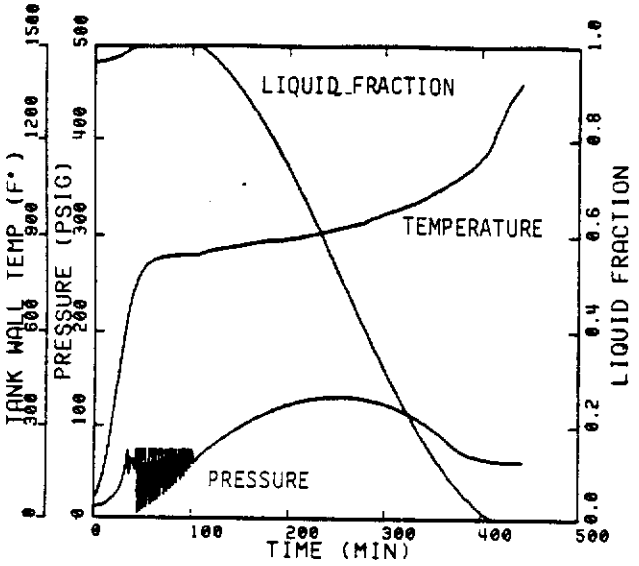


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

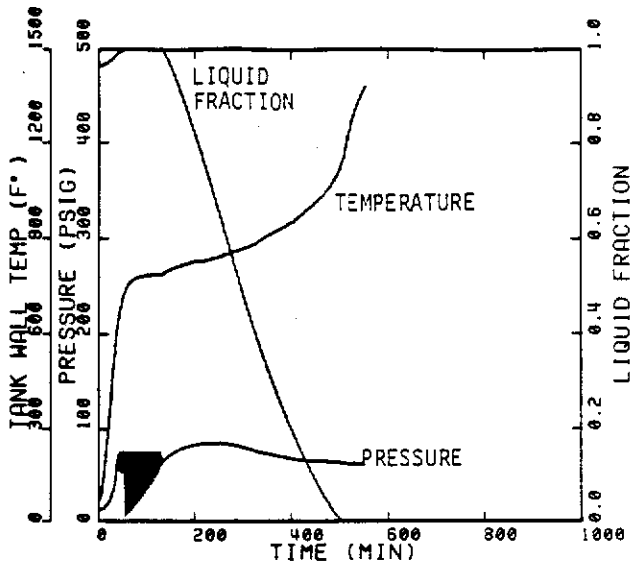


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

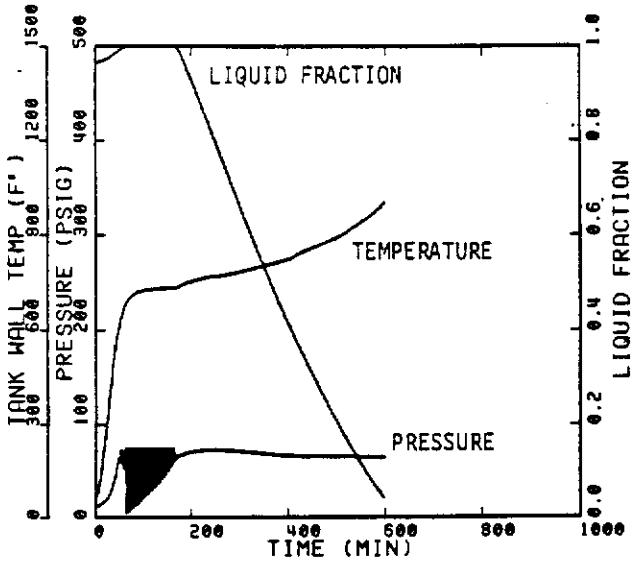
FIGURE G-6. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A100W TANK CAR CONTAINING PROPYLENE OXIDE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 1100 SCFM



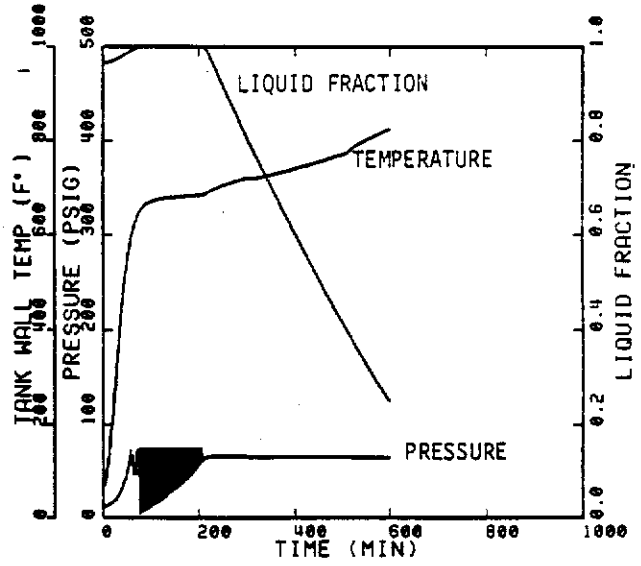
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

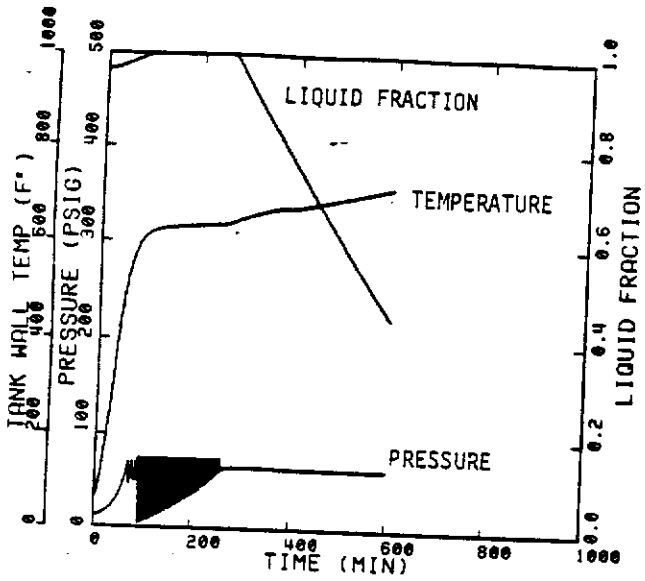


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

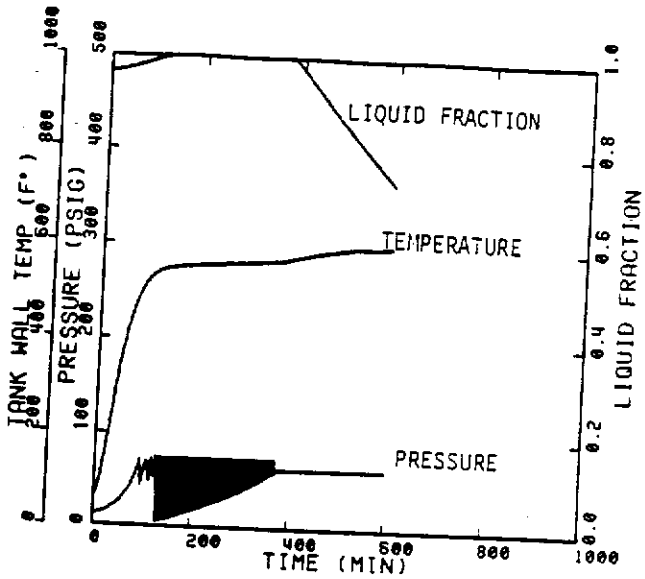


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

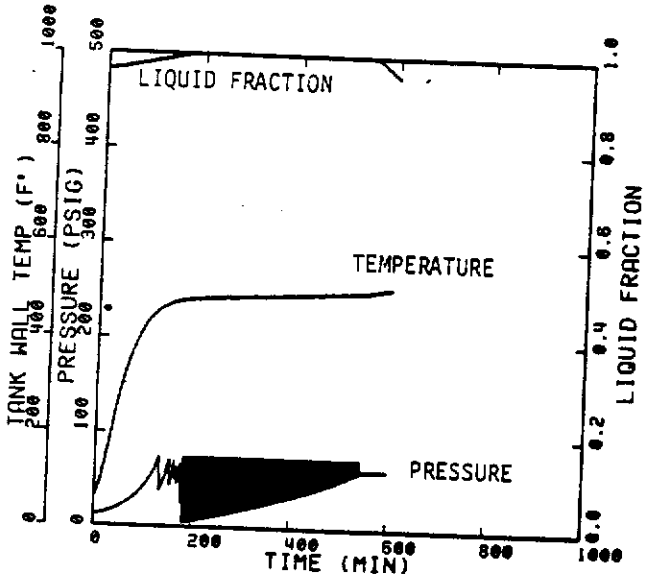
FIGURE G-7. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A100W TANK CAR CONTAINING PROPYLENE OXIDE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 5000 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F

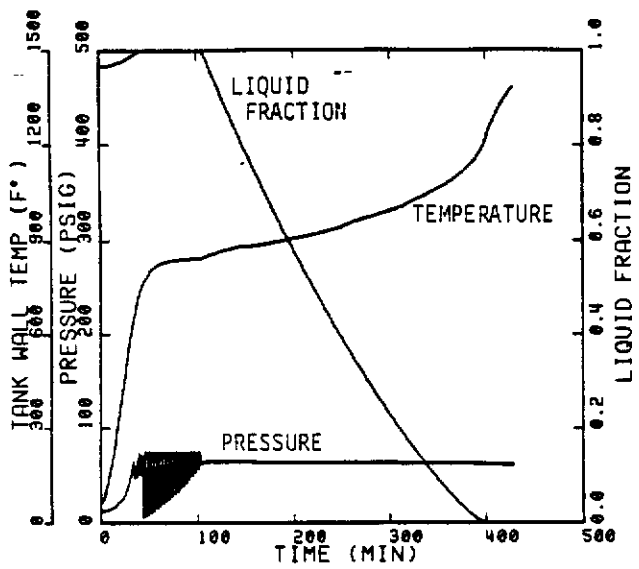


f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F

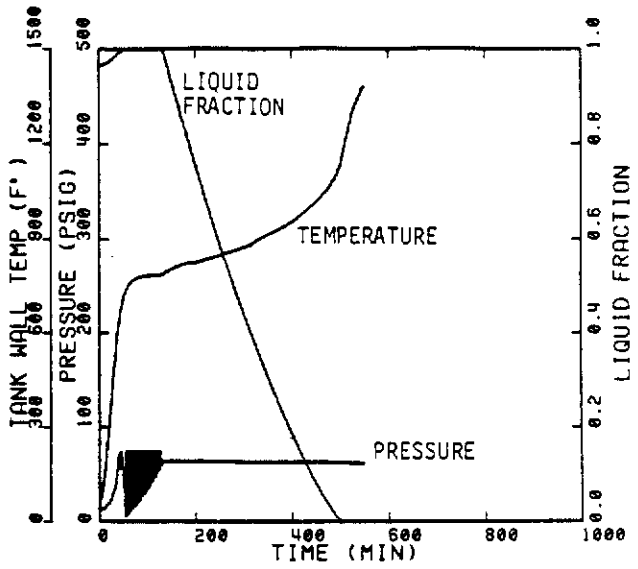


g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

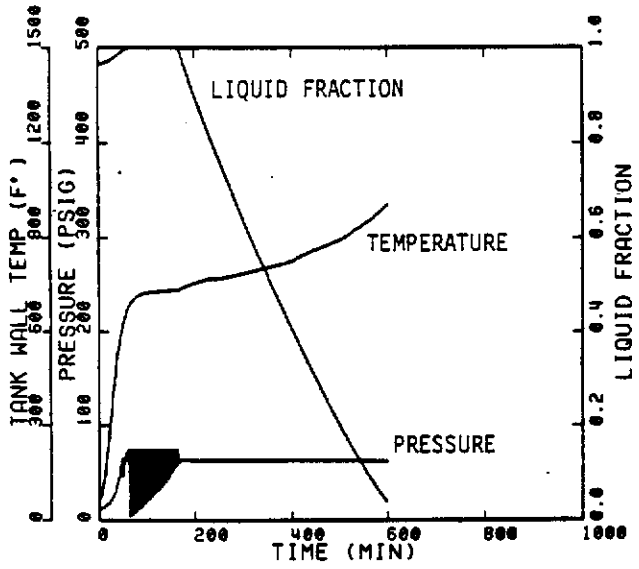
FIGURE G-7. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A100W TANK CAR CONTAINING PROPYLENE OXIDE, [illegible]RIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 5000 SCFM



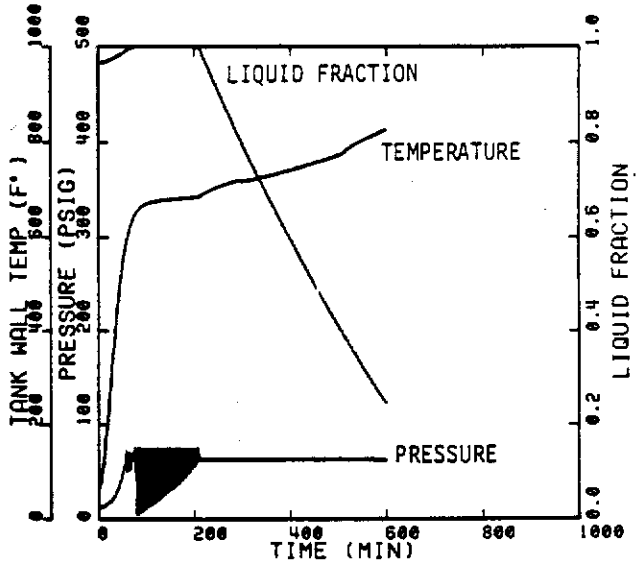
a. THERMAL SHIELD CONDUCTANCE
5.4 BTU/HR-FT²-°F



b. THERMAL SHIELD CONDUCTANCE
4.0 BTU/HR-FT²-°F

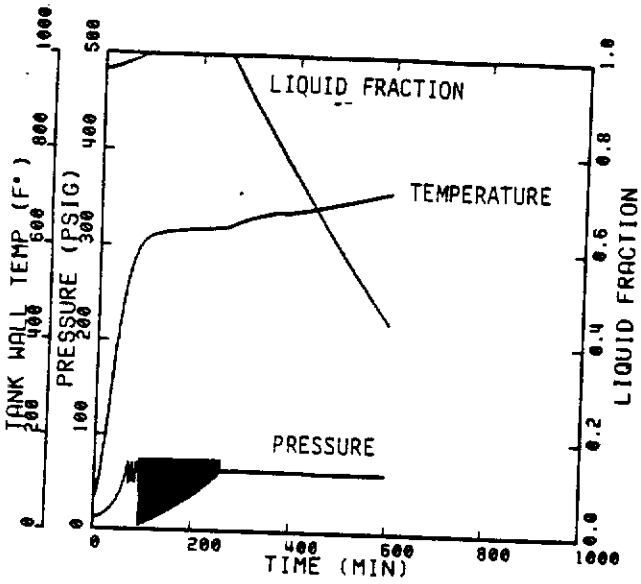


c. THERMAL SHIELD CONDUCTANCE
3.0 BTU/HR-FT²-°F

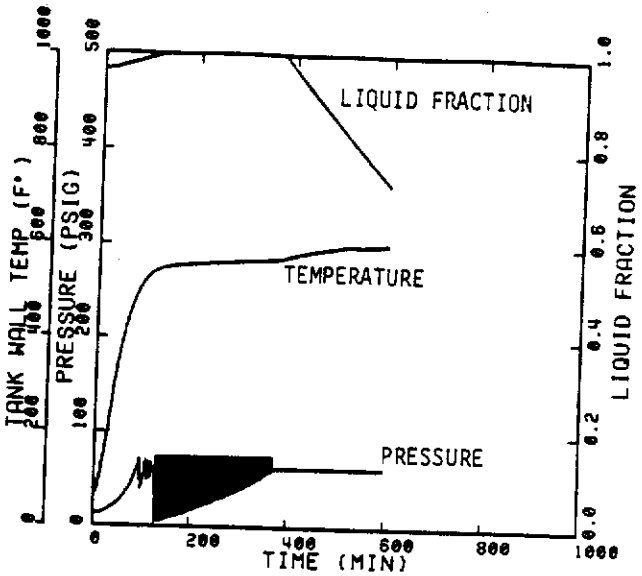


d. THERMAL SHIELD CONDUCTANCE
2.3 BTU/HR-FT²-°F

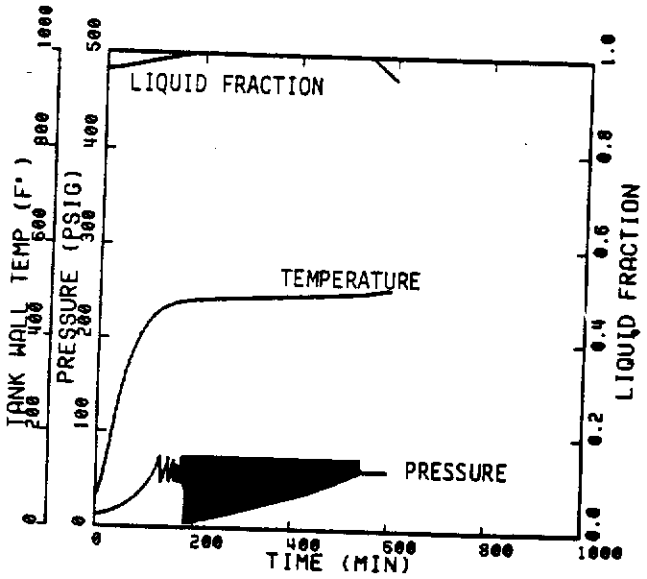
FIGURE G-8. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A100W TANK CAR CONTAINING PROPYLENE OXIDE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 16,500 SCFM



e. THERMAL SHIELD CONDUCTANCE
1.8 BTU/HR-FT²-°F



f. THERMAL SHIELD CONDUCTANCE
1.2 BTU/HR-FT²-°F



g. THERMAL SHIELD CONDUCTANCE
0.8 BTU/HR-FT²-°F

FIGURE G-8. PRESSURE, TANK WALL TEMPERATURE OVER VAPOR SPACE AND FRACTION OF TANK VOLUME FILLED WITH LIQUID AS FUNCTION OF TIME; 25,000 GAL. 105A100W TANK CAR CONTAINING PROPYLENE OXIDE, UPRIGHT CAR CASE, SAFETY RELIEF VALVE FLOW CAPACITY 16,500 SCFM

APPENDIX H: SELECTED DATA FROM PARAMETRIC ANALYSES

Selected computer printout data from the parametric analyses are presented in this Appendix. Data is included from the overturned ethylene oxide car cases. The following cases are included:

1100 SCFM valve - 5.4, 4.0, 3.0, 1.8 and 1.2 Btu/hr-ft²-°F conductances;

14,600 SCFM valve - 4.0 Btu/hr-ft²-°F conductance

The output data includes the following parameters:

Input Conditions

SVPR	Safety valve flow rating pressure (psia)
INIT	Initial Temperature (°F)
COND	Input Conductance (Btu/ft²-hr-°F)
SCFM	Valve Flow Capacity (SCFM)
TEMP	Flame Temperature (°F)
SIZE	Car Capacity (gallons)
TILT	Angle of Safety Relief Valve from Vertical (degrees)
WEIGHT	Initial weight of product (lbs)

Parameters Given as Function of Time

TIME	Time (minutes)
PSIG	Pressure within Tank (psig)
TTNK	Temperature of Product (°F)
TWAL	Temperature of Outside Surface of Tank in Wetted Region (°F)
FRAC	Fraction of Tank Volume Occupied by Liquid
FMAT	Fraction of Original Product Weight Remaining
TVAP	Temperature of Tank over Vapor Space (°F)
WOUT	Mass Flow Rate Through Safety Valve (lbs/min)
PBRS	Burst Strength of Tank (psig)
PNIT	Partial Pressure of Nitrogen Padding Gas (psi)
KIDN	Identification No. used in Program
THETA	Angle of Liquid Surface from Horizontal (radians)
PICR	Excess Fluid Pressure for Shell Full Liquid Flow Through Valve (psig)
CNDLQ	Effective Conductance of Thermal Shield in Wetted Region (Btu/hr-ft²-°F)
CNDVP	Effective Conductance of Thermal Shield in Vapor Region (Btu/hr-ft²-°F)
FRACLQ	Fraction of Original Product Weight in Liquid State

ETHLYENE OXIDE CAR

SVPR	INTT	COND	SCFM	TEMP	SIZE	TILT	WEIGHT
99.7#	60.0#	5.4#	1100.	1500.##	25###.	12#.	178703.

TIME	PSIG	TTNK	TWAL	FRAC	FMAT	TVAP	WOUT	PBRS	PNIT	KIDN	THETA	PICR	CNDLO	CNDVP	FRACLQ
2.##	42.54	6#.	1478.	.967	1.###	68.	#.	750.	4#.3	2	1.#23	.#	.64	.64	1.###
4.##	43.19	61.	1466.	.968	1.###	81.	#.	750.	4#.7	2	1.#25	.#	.98	.98	1.###
6.##	44.13	62.	1454.	.968	1.###	1##.	#.	750.	41.4	2	1.#28	.#	1.32	1.32	1.###
8.##	45.39	63.	1442.	.969	1.###	123.	#.	75#.	42.2	2	1.#31	.#	1.66	1.66	1.###
10.##	46.99	64.	1431.	.969	1.###	15#.	#.	75#.	43.4	2	1.#36	.#	2.##	2.##	1.###
12.##	48.99	65.	1419.	.97#	1.###	181.	#.	75#.	44.8	2	1.#41	.#	2.34	2.34	1.###
14.##	51.44	67.	1407.	.971	1.###	216.	#.	749.	46.5	2	1.#47	.#	2.68	2.68	1.###
16.##	54.44	69.	1396.	.972	1.###	253.	#.	748.	48.7	2	1.#55	.#	3.#2	3.#2	1.###
18.##	58.1#	71.	1384.	.974	1.###	293.	#.	747.	51.4	2	1.#64	.#	3.36	3.36	1.###
2#.##	62.6#	73.	1373.	.975	1.###	334.	#.	745.	54.8	2	1.#74	.#	3.7#	3.7#	1.###
22.##	68.1#	76.	1361.	.977	1.###	377.	#.	742.	59.2	2	1.#86	.#	4.#4	4.#4	1.###
24.##	75.23	79.	1350.	.979	1.###	42#.	#.	737.	64.8	2	1.1##	.#	4.38	4.38	1.###
26.##	63.26	82.	1339.	.973	.992	464.	343.	731.	51.3	2	1.#61	.#	4.72	4.72	.992
28.##	63.19	85.	1327.	.972	.989	507.	31#.	723.	49.4	2	1.#53	.#	5.#6	5.#6	.989
3#.##	63.42	88.	1316.	.971	.985	549.	344.	713.	47.7	2	1.#46	.#	5.4#	5.4#	.985
32.##	63.6#	91.	1316.	.969	.981	588.	369.	702.	45.7	2	1.#37	.#	5.4#	5.4#	.981
34.##	63.78	95.	1317.	.968	.977	623.	392.	689.	43.7	2	1.#27	.#	5.4#	5.4#	.977
36.##	63.99	98.	1317.	.966	.972	654.	417.	676.	41.6	2	1.#17	.#	5.4#	5.4#	.972
38.##	64.24	1#1.	1318.	.964	.967	682.	446.	662.	39.4	2	1.##5	.#	5.4#	5.4#	.967
4#.##	64.53	1#5.	1318.	.961	.962	707.	478.	649.	37.2	2	.992	.#	5.4#	5.4#	.962
42.##	64.88	1#8.	1319.	.959	.957	729.	515.	636.	34.9	2	.979	.#	5.4#	5.4#	.956
44.##	65.29	111.	1319.	.956	.951	748.	557.	623.	32.6	2	.963	.#	5.4#	5.4#	.950
46.##	65.78	114.	1320.	.952	.944	765.	607.	612.	3#.3	2	.946	.#	5.4#	5.4#	.944
48.##	66.46	118.	1320.	.948	.937	779.	62#.	601.	28.1	2	.928	.#	5.4#	5.4#	.937
5#.##	67.62	121.	1321.	.944	.93#	792.	609.	591.	26.2	2	.911	.#	5.4#	5.4#	.93#
52.##	69.15	124.	1322.	.94#	.923	8#3.	603.	6##.	24.7	2	.895	.#	5.4#	5.4#	.923
54.##	7#.98	128.	1322.	.936	.917	813.	682.	592.	23.3	2	.8##	.#	5.4#	5.4#	.916
56.##	73.#7	131.	1323.	.932	.91#	822.	6#3.	584.	22.2	2	.865	.#	5.4#	5.4#	.909
58.##	75.41	134.	1323.	.929	.9#3	829.	6#7.	578.	21.1	2	.852	.#	5.4#	5.4#	.902
6#.##	77.91	137.	1324.	.925	.896	835.	6#8.	572.	2#.2	2	.838	.#	5.4#	5.4#	.896
62.##	8#.62	14#.	1324.	.921	.89#	841.	594.	567.	19.4	2	.826	.#	5.4#	5.4#	.889
64.##	83.51	144.	1325.	.918	.883	846.	582.	563.	18.6	2	.814	.#	5.4#	5.4#	.882
66.##	86.58	147.	1325.	.914	.877	85#.	571.	559.	1#.#	2	.8#3	.#	5.4#	5.4#	.876
68.##	89.79	15#.	1325.	.911	.87#	854.	561.	556.	17.4	2	.792	.#	5.4#	5.4#	.869
7#.##	93.15	153.	1326.	.9#8	.864	857.	551.	553.	16.9	2	.783	.#	5.4#	5.4#	.863
72.##	96.63	156.	1326.	.9#5	.858	86#.	543.	55#.	16.5	2	.773	.#	5.4#	5.4#	.857
74.##	1##.23	159.	1327.	.9#2	.852	863.	535.	548.	16.1	2	.764	.#	5.4#	5.4#	.851
76.##	1#4.#6	163.	1327.	.899	.846	865.	527.	546.	15.7	2	.756	.#	5.4#	5.4#	.844
78.##	1#7.97	166.	1328.	.896	.84#	867.	52#.	544.	15.3	2	.747	.#	5.4#	5.4#	.839
8#.##	112.1#	169.	1328.	.894	.834	869.	514.	542.	15.#	2	.739	.#	5.4#	5.4#	.833
82.##	116.46	172.	1329.	.891	.829	871.	5#8.	541.	14.7	2	.732	.#	5.4#	5.4#	.827
84.##	121.#3	175.	1329.	.888	.823	872.	5#2.	539.	14.4	2	.724	.#	5.4#	5.4#	.821
86.##	125.8#	178.	1330.	.886	.817	874.	496.	538.	14.2	2	.717	.#	5.4#	5.4#	.815
88.##	13#.78	181.	1330.	.883	.812	875.	491.	537.	13.9	2	.71#	.#	5.4#	5.4#	.81#
9#.##	135.96	184.	1330.	.881	.8#6	876.	486.	536.	13.7	2	.7#3	.#	5.4#	5.4#	.8#1
92.##	141.32	1#7.	1331.	.878	.8#1	877.	481.	535.	13.5	2	.696	.#	5.4#	5.4#	.796
94.##	146.8#	19#.	1331.	.876	.796	878.	476.	534.	13.3	2	.69#	.#	5.4#	5.4#	.793
96.##	152.61	193.	1332.	.873	.79#	879.	472.	533.	13.1	2	.6#4	.#	5.4#	5.4#	.788
98.##	158.53	196.	1332.	.871	.785	8#0.	468.	531.	12.9	2	.678	.#	5.4#	5.4#	.782
1##.##	164.62	199.	1333.	.869	.78#	8#1.	464.	532.	12.7	2	.672	.#	5.4#	5.4#	.777
1#2.##	17#.8#	2#2.	1333.	.866	.775	8#2.	46#.	531.	12.6	2	.666	.#	5.4#	5.4#	.771
1#4.##	177.3#	2#5.	1333.	.864	.77#	8#3.	456.	531.	12.4	2	.66#	.#	5.4#	5.4#	.766
1#6.##	183.89	2#7.	1334.	.862	.764	8#3.	452.	53#.	12.3	2	.654	.#	5.4#	5.4#	.761
1	19#.63	21#.	1314.	.86#	.759	8#4.	452.	529.	12.1	2	.64#	.#	5.4#	5.4#	.756
1	1 .51	213.	1335.	.857	.754	8#5.	455.	529.	12.#	2	.643	.#	5.4#	5.4#	.75#

112.00	204.54	216.	1335.	.855	.749	885.	459.	528.	11.8	2	.637	.0	5.40	5.40	.745
114.00	211.70	219.	1335.	.852	.744	886.	464.	527.	11.7	2	.631	.0	5.40	5.40	.740
116.00	218.99	222.	1336.	.850	.739	887.	469.	527.	11.5	2	.625	.0	5.40	5.40	.734
118.00	226.41	224.	1336.	.847	.734	887.	475.	526.	11.4	2	.619	.0	5.40	5.40	.729
120.00	233.95	227.	1337.	.844	.728	888.	482.	526.	11.2	2	.612	.0	5.40	5.40	.723
122.00	241.62	230.	1337.	.841	.723	889.	488.	525.	11.0	2	.605	.0	5.40	5.40	.717
124.00	249.40	233.	1337.	.838	.717	889.	495.	525.	10.9	2	.598	.0	5.40	5.40	.711
126.00	257.30	235.	1338.	.835	.712	890.	502.	524.	10.7	2	.590	.0	5.40	5.40	.705
128.00	265.31	238.	1338.	.832	.706	891.	509.	524.	10.5	2	.583	.0	5.40	5.40	.699
130.00	273.43	241.	1339.	.828	.700	891.	516.	523.	10.3	2	.575	.0	5.40	5.40	.693
132.00	281.65	243.	1339.	.824	.694	892.	524.	522.	10.2	2	.566	.0	5.40	5.40	.687
134.00	289.98	246.	1339.	.820	.688	893.	531.	522.	10.0	2	.558	.0	5.40	5.40	.681
136.00	298.41	249.	1340.	.816	.682	893.	539.	521.	9.8	2	.549	.0	5.40	5.40	.674
138.00	306.94	251.	1340.	.812	.676	893.	546.	522.	9.6	2	.540	.0	5.40	5.40	.668
140.00	315.55	254.	1341.	.807	.670	892.	553.	522.	9.4	2	.530	.0	5.40	5.40	.661
142.00	324.25	256.	1341.	.802	.664	892.	560.	522.	9.2	2	.520	.0	5.40	5.40	.655
144.00	333.06	259.	1341.	.797	.658	892.	567.	522.	9.0	2	.509	.0	5.40	5.40	.648
146.00	341.96	261.	1342.	.792	.651	892.	574.	522.	8.8	2	.499	.0	5.40	5.40	.641
148.00	350.95	264.	1342.	.787	.645	892.	581.	522.	8.6	2	.489	.0	5.40	5.40	.634
150.00	360.01	266.	1342.	.782	.638	893.	587.	522.	8.5	2	.478	.0	5.40	5.40	.627
152.00	369.14	269.	1343.	.777	.632	893.	594.	521.	8.3	2	.468	.0	5.40	5.40	.619
154.00	378.36	271.	1343.	.771	.625	894.	601.	521.	8.1	2	.457	.0	5.40	5.40	.612
156.00	387.60	274.	1343.	.766	.618	894.	607.	520.	7.9	2	.446	.0	5.40	5.40	.605
158.00	397.10	276.	1344.	.760	.611	895.	614.	520.	7.8	2	.435	.0	5.40	5.40	.597
160.00	406.61	279.	1344.	.754	.604	896.	621.	519.	7.6	2	.424	.0	5.40	5.40	.589
162.00	415.87	281.	1344.	.748	.597	896.	626.	518.	7.5	2	.413	.0	5.40	5.40	.582
164.00	425.82	283.	1345.	.742	.590	897.	634.	518.	7.3	2	.401	.0	5.40	5.40	.574
166.00	435.91	286.	1345.	.735	.583	898.	641.	517.	7.2	2	.389	.0	5.40	5.40	.566
168.00	446.15	288.	1345.	.729	.576	899.	649.	516.	7.0	2	.377	.0	5.40	5.40	.558
170.00	456.54	290.	1346.	.722	.569	900.	656.	515.	6.8	2	.364	.0	5.40	5.40	.549
172.00	467.09	293.	1346.	.715	.562	901.	664.	514.	6.7	2	.352	.0	5.40	5.40	.541
174.00	477.79	295.	1346.	.708	.554	902.	663.	513.	6.6	2	.340	.0	5.40	5.40	.533
176.00	488.59	297.	1347.	.700	.547	903.	677.	512.	6.4	2	.326	.0	5.40	5.40	.524
178.00	499.50	300.	1347.	.692	.539	904.	690.	511.	6.3	2	.312	.0	5.40	5.40	.515
180.00	510.53	302.	1347.	.684	.531	906.	699.	510.	6.1	2	.298	.0	5.40	5.40	.506

ETHLYENE OXIDE CAR

SVPR	INTT	COND	BCFM	TEMF	SIZE	TILT	WEIGHT
99.78	60.00	4.00	1100.	1500.00	25000.	120.	178703.

TIME	PSIG	TTNK	TWAL	FRAC	FMAT	TVAP	WOUT	PENS	PNIT	KIDN	THETA	PICR	CNDLQ	CNDVP	FRACLQ
2.00	42.50	60.	1481.	.967	1.000	67.	0.	750.	40.2	2	1.023	.0	.55	.55	1.000
4.00	43.04	61.	1472.	.967	1.000	78.	0.	750.	40.6	2	1.025	.0	.79	.79	1.000
6.00	43.79	61.	1464.	.968	1.000	93.	0.	750.	41.1	2	1.027	.0	1.04	1.04	1.000
8.00	44.76	62.	1455.	.968	1.000	111.	0.	750.	41.8	2	1.030	.0	1.29	1.29	1.000
10.00	45.97	63.	1447.	.969	1.000	133.	0.	750.	42.6	2	1.033	.0	1.53	1.53	1.000
12.00	47.46	64.	1438.	.970	1.000	157.	0.	750.	43.7	2	1.037	.0	1.78	1.78	1.000
14.00	49.24	66.	1430.	.970	1.000	184.	0.	750.	44.9	2	1.042	.0	2.03	2.03	1.000
16.00	51.37	67.	1421.	.971	1.000	214.	0.	749.	46.5	2	1.047	.0	2.27	2.27	1.000
18.00	53.90	69.	1413.	.972	1.000	246.	0.	749.	48.3	2	1.054	.0	2.52	2.52	1.000
20.00	56.91	70.	1405.	.973	1.000	279.	0.	748.	50.5	2	1.061	.0	2.77	2.77	1.000
22.00	60.49	72.	1396.	.975	1.000	314.	0.	746.	53.2	2	1.069	.0	3.01	3.01	1.000
24.20	64.79	75.	1388.	.976	1.000	350.	0.	744.	56.5	2	1.079	.0	3.26	3.26	1.000
26.00	70.00	77.	1380.	.978	1.000	387.	0.	741.	60.6	2	1.090	.0	3.51	3.51	1.000
28.00	76.30	79.	1371.	.977	.998	423.	1024.	737.	60.7	2	1.093	.0	3.75	3.75	.998
30.00	82.91	82.	1363.	.973	.992	460.	267.	732.	58.9	2	1.059	.0	4.00	4.00	.992
32.00	82.90	84.	1363.	.972	.989	495.	256.	726.	49.4	2	1.053	.0	4.00	4.00	.989
34.00	82.98	87.	1364.	.971	.986	527.	267.	719.	47.9	2	1.047	.0	4.00	4.00	.986
36.00	83.07	89.	1364.	.970	.983	557.	279.	711.	46.4	2	1.040	.0	4.00	4.00	.983
38.00	83.18	92.	1364.	.969	.980	584.	293.	703.	44.9	2	1.033	.0	4.00	4.00	.980
40.00	83.30	95.	1364.	.967	.976	608.	307.	694.	43.3	2	1.025	.0	4.00	4.00	.976
42.00	83.43	97.	1365.	.966	.973	631.	323.	686.	41.6	2	1.017	.0	4.00	4.00	.973
44.00	83.58	100.	1365.	.964	.969	651.	341.	677.	39.9	2	1.008	.0	4.00	4.00	.969
46.00	83.75	102.	1365.	.963	.965	669.	361.	669.	38.2	2	.999	.0	4.00	4.00	.965
48.00	83.95	105.	1366.	.961	.961	685.	382.	661.	36.4	2	.988	.0	4.00	4.00	.961
50.00	84.18	107.	1366.	.958	.957	700.	407.	653.	34.6	2	.976	.0	4.00	4.00	.956
52.00	84.44	110.	1366.	.956	.952	713.	434.	645.	32.8	2	.964	.0	4.00	4.00	.952
54.00	84.75	113.	1366.	.953	.947	725.	465.	638.	30.9	2	.951	.0	4.00	4.00	.947
56.00	85.11	115.	1367.	.950	.941	735.	501.	632.	29.1	2	.936	.0	4.00	4.00	.941
58.00	85.53	118.	1367.	.946	.936	745.	540.	626.	27.3	2	.920	.0	4.00	4.00	.935
60.00	86.02	120.	1367.	.942	.929	753.	585.	620.	25.4	2	.904	.0	4.00	4.00	.929
62.00	86.75	123.	1367.	.938	.923	760.	572.	615.	23.8	2	.806	.0	4.00	4.00	.922
64.00	87.79	125.	1368.	.934	.917	767.	563.	610.	22.4	2	.870	.0	4.00	4.00	.916
66.00	89.07	128.	1368.	.930	.910	773.	558.	605.	21.2	2	.856	.0	4.00	4.00	.910
68.00	90.55	130.	1368.	.926	.904	778.	555.	601.	20.2	2	.841	.0	4.00	4.00	.903
70.00	92.22	133.	1369.	.922	.898	783.	554.	598.	19.2	2	.828	.0	4.00	4.00	.897
72.00	94.04	135.	1369.	.918	.892	787.	556.	594.	18.4	2	.814	.0	4.00	4.00	.891
74.00	95.97	138.	1369.	.914	.885	791.	558.	591.	17.6	2	.801	.0	4.00	4.00	.884
76.00	98.02	140.	1369.	.910	.879	795.	556.	588.	16.9	2	.789	.0	4.00	4.00	.878
78.00	100.19	143.	1370.	.906	.873	798.	545.	586.	16.3	2	.777	.0	4.00	4.00	.872
80.00	102.48	145.	1370.	.902	.867	801.	534.	582.	15.8	2	.765	.0	4.00	4.00	.866
82.00	104.88	148.	1370.	.899	.861	803.	525.	580.	15.3	2	.755	.0	4.00	4.00	.860
84.00	107.38	150.	1370.	.895	.855	806.	516.	578.	14.8	2	.744	.0	4.00	4.00	.854
86.00	109.97	153.	1371.	.892	.849	808.	508.	576.	14.4	2	.734	.0	4.00	4.00	.848
88.00	112.64	155.	1371.	.888	.844	810.	501.	574.	14.0	2	.725	.0	4.00	4.00	.842
90.00	115.39	158.	1371.	.885	.838	812.	494.	573.	13.7	2	.716	.0	4.00	4.00	.837
92.00	118.22	160.	1371.	.882	.833	813.	487.	571.	13.3	2	.707	.0	4.00	4.00	.831
94.00	121.14	162.	1372.	.879	.827	815.	481.	570.	13.0	2	.698	.0	4.00	4.00	.826
96.00	124.14	165.	1372.	.876	.822	816.	475.	569.	12.8	2	.690	.0	4.00	4.00	.820
98.00	127.22	167.	1372.	.873	.817	818.	470.	568.	12.5	2	.682	.0	4.00	4.00	.815
100.00	130.38	170.	1372.	.870	.811	819.	464.	567.	12.3	2	.674	.0	4.00	4.00	.809
102.00	133.62	172.	1373.	.867	.806	820.	459.	566.	12.0	2	.667	.0	4.00	4.00	.804
104.00	136.93	174.	1373.	.864	.801	821.	454.	565.	11.8	2	.659	.0	4.00	4.00	.799
106.00	140.32	177.	1373.	.861	.796	822.	450.	564.	11.6	2	.652	.0	4.00	4.00	.794
108.00	143.78	179.	1373.	.858	.791	823.	445.	563.	11.4	2	.645	.0	4.00	4.00	.788
110.00	147.32	182.	1374.	.855	.786	824.	441.	562.	11.3	2	.638	.0	4.00	4.00	.783

112.00	133.27	184.	1374.	.852	.781	825.	437.	581.	11.1	2	.631	.0	4.00	4.00	.778
114.00	137.46	186.	1374.	.850	.776	826.	433.	580.	10.9	2	.625	.0	4.00	4.00	.773
116.00	141.77	189.	1374.	.847	.772	827.	429.	580.	10.8	2	.618	.0	4.00	4.00	.768
118.00	146.20	191.	1375.	.844	.767	827.	426.	579.	10.6	2	.612	.0	4.00	4.00	.763
120.00	150.74	193.	1375.	.842	.762	828.	422.	578.	10.5	2	.606	.0	4.00	4.00	.758
122.00	155.39	196.	1375.	.839	.757	829.	419.	578.	10.3	2	.600	.0	4.00	4.00	.754
124.00	160.15	198.	1375.	.836	.753	830.	415.	577.	10.2	2	.594	.0	4.00	4.00	.749
126.00	165.02	200.	1376.	.834	.748	830.	414.	576.	10.1	2	.588	.0	4.00	4.00	.744
128.00	169.98	202.	1376.	.831	.743	831.	416.	576.	10.0	2	.582	.0	4.00	4.00	.739
130.00	175.05	205.	1376.	.828	.739	832.	418.	575.	9.8	2	.576	.0	4.00	4.00	.734
132.00	180.21	207.	1376.	.826	.734	832.	422.	575.	9.7	2	.569	.0	4.00	4.00	.729
134.00	185.46	209.	1377.	.823	.729	833.	426.	574.	9.6	2	.563	.0	4.00	4.00	.724
136.00	190.80	211.	1377.	.820	.724	834.	430.	573.	9.5	2	.557	.0	4.00	4.00	.719
138.00	196.24	214.	1377.	.817	.720	834.	435.	573.	9.3	2	.550	.0	4.00	4.00	.714
140.00	201.75	216.	1377.	.814	.715	834.	440.	573.	9.2	2	.544	.0	4.00	4.00	.709
142.00	207.35	218.	1378.	.811	.710	833.	445.	574.	9.1	2	.537	.0	4.00	4.00	.704
144.00	213.04	220.	1378.	.807	.705	833.	451.	574.	9.0	2	.530	.0	4.00	4.00	.699
146.00	218.80	222.	1378.	.804	.700	833.	456.	574.	8.8	2	.523	.0	4.00	4.00	.693
148.00	224.64	225.	1378.	.800	.694	833.	462.	574.	8.7	2	.515	.0	4.00	4.00	.688
150.00	230.55	227.	1378.	.797	.689	833.	468.	574.	8.6	2	.508	.0	4.00	4.00	.682
152.00	236.55	229.	1379.	.793	.684	833.	473.	574.	8.4	2	.500	.0	4.00	4.00	.677
154.00	242.62	231.	1379.	.789	.679	834.	479.	574.	8.3	2	.492	.0	4.00	4.00	.671
156.00	248.76	233.	1379.	.785	.673	834.	485.	573.	8.2	2	.484	.0	4.00	4.00	.665
158.00	254.98	235.	1379.	.781	.668	834.	491.	573.	8.1	2	.476	.0	4.00	4.00	.660
160.00	261.27	237.	1380.	.776	.662	835.	497.	573.	7.9	2	.467	.0	4.00	4.00	.654
162.00	267.63	240.	1380.	.772	.657	835.	503.	572.	7.8	2	.459	.0	4.00	4.00	.648
164.00	274.05	242.	1380.	.767	.651	836.	510.	572.	7.7	2	.450	.0	4.00	4.00	.642
166.00	280.55	244.	1380.	.763	.645	836.	516.	571.	7.5	2	.440	.0	4.00	4.00	.635
168.00	287.12	246.	1380.	.758	.639	837.	522.	571.	7.4	2	.431	.0	4.00	4.00	.629
170.00	293.75	248.	1381.	.753	.633	837.	528.	570.	7.3	2	.422	.0	4.00	4.00	.623
172.00	300.45	250.	1381.	.748	.628	838.	534.	570.	7.1	2	.412	.0	4.00	4.00	.616
174.00	307.20	252.	1381.	.742	.622	839.	540.	569.	7.0	2	.402	.0	4.00	4.00	.610
176.00	314.03	254.	1381.	.737	.615	840.	546.	568.	6.9	2	.391	.0	4.00	4.00	.603
178.00	320.92	256.	1381.	.731	.609	840.	552.	567.	6.8	2	.381	.0	4.00	4.00	.597
180.00	327.87	258.	1382.	.725	.603	841.	558.	567.	6.6	2	.370	.0	4.00	4.00	.590
182.00	334.89	260.	1382.	.719	.597	842.	564.	566.	6.5	2	.360	.0	4.00	4.00	.583
184.00	341.98	262.	1382.	.713	.590	843.	569.	565.	6.4	2	.349	.0	4.00	4.00	.576
186.00	349.13	264.	1382.	.707	.584	844.	575.	564.	6.3	2	.338	.0	4.00	4.00	.569
188.00	356.32	266.	1382.	.700	.578	845.	580.	564.	6.2	2	.327	.0	4.00	4.00	.562
190.00	363.56	268.	1383.	.694	.571	846.	586.	563.	6.0	2	.316	.0	4.00	4.00	.554
192.00	370.86	270.	1383.	.688	.564	847.	591.	562.	5.9	2	.304	.0	4.00	4.00	.547
194.00	378.23	272.	1383.	.681	.558	848.	596.	561.	5.8	2	.293	.0	4.00	4.00	.540
196.00	385.66	274.	1383.	.674	.551	849.	602.	560.	5.7	2	.281	.0	4.00	4.00	.532
198.00	393.16	276.	1384.	.667	.544	850.	607.	559.	5.6	2	.270	.0	4.00	4.00	.525
200.00	400.73	278.	1384.	.660	.537	851.	613.	558.	5.5	2	.258	.0	4.00	4.00	.517
202.00	408.36	280.	1384.	.653	.531	852.	618.	557.	5.4	2	.246	.0	4.00	4.00	.509
204.00	415.75	281.	1384.	.645	.524	853.	623.	556.	5.3	2	.233	.0	4.00	4.00	.501
206.00	423.69	283.	1384.	.638	.517	854.	629.	555.	5.2	2	.220	.0	4.00	4.00	.493
208.00	431.74	285.	1384.	.630	.510	856.	635.	554.	5.1	2	.208	.0	4.00	4.00	.485
210.00	439.87	287.	1385.	.622	.502	857.	641.	553.	5.0	2	.195	.0	4.00	4.00	.477
212.00	448.10	289.	1385.	.614	.495	858.	647.	552.	4.9	2	.181	.0	4.00	4.00	.469
214.00	456.42	291.	1385.	.605	.488	859.	653.	551.	4.8	2	.168	.0	4.00	4.00	.460
216.00	464.84	293.	1385.	.597	.481	861.	658.	550.	4.7	2	.154	.0	4.00	4.00	.452
218.00	473.30	295.	1385.	.588	.473	862.	664.	549.	4.7	2	.140	.0	4.00	4.00	.443
220.00	481.97	296.	1386.	.579	.466	863.	669.	547.	4.6	2	.126	.0	4.00	4.00	.435
222.00	490.62	298.	1386.	.570	.459	865.	675.	546.	4.5	2	.111	.0	4.00	4.00	.426
224.00	499.34	300.	1386.	.560	.451	866.	680.	545.	4.4	2	.096	.0	4.00	4.00	.417
226.00	508.12	302.	1386.	.550	.443	868.	685.	543.	4.3	2	.080	.0	4.00	4.00	.407
228.00	516.96	304.	1386.	.540	.435	869.	702.	542.	4.2	2	.064	.0	4.00	4.00	.398
230.00	525.87	306.	1387.	.530	.427	871.	709.	541.	4.1	2	.047	.0	4.00	4.00	.388
232.00	534.84	307.	1387.	.519	.419	873.	715.	539.	4.0	2	.030	.0	4.00	4.00	.379
232.90	538.50	308.	1387.	.514	.416	873.	718.	539.	4.0	2	.023	.0	4.00	4.00	.374

ETHLYENE OXIDE CAR

SVPR	INTT	COND	SCFM	TEMP	SIZE	TILT	WEIGHT
99.70	60.00	3.00	1100.	1500.00	25000.	120.	178703.

TIME	PSIG	TTNK	TWAL	FRAC	FMAT	TVAP	VOUT	PBRS	PNIT	KIDN	THETA	PICR	CNDLO	CNDVP	FRACLQ
2.00	42.47	60.	1483.	.967	1.000	67.	0.	750.	40.2	2	1.023	.0	.48	.48	1.000
4.00	42.93	61.	1477.	.967	1.000	76.	0.	750.	40.5	2	1.024	.0	.66	.66	1.000
6.00	43.54	61.	1471.	.968	1.000	88.	0.	750.	41.0	2	1.026	.0	.84	.84	1.000
8.00	44.31	62.	1465.	.968	1.000	103.	0.	750.	41.5	2	1.028	.0	1.02	1.02	1.000
10.00	45.26	63.	1458.	.969	1.000	120.	0.	750.	42.1	2	1.031	.0	1.20	1.20	1.000
12.00	46.39	64.	1452.	.969	1.000	140.	0.	750.	42.9	2	1.034	.0	1.38	1.38	1.000
14.00	47.72	65.	1446.	.970	1.000	161.	0.	750.	43.9	2	1.038	.0	1.56	1.56	1.000
16.00	49.29	66.	1440.	.970	1.000	185.	0.	750.	45.0	2	1.042	.0	1.74	1.74	1.000
18.00	51.11	67.	1434.	.971	1.000	210.	0.	749.	46.3	2	1.047	.0	1.92	1.92	1.000
20.00	53.23	68.	1427.	.972	1.000	237.	0.	749.	47.8	2	1.052	.0	2.10	2.10	1.000
22.00	55.68	70.	1421.	.973	1.000	265.	0.	748.	49.6	2	1.058	.0	2.28	2.28	1.000
24.00	58.54	71.	1415.	.974	1.000	294.	0.	747.	51.7	2	1.065	.0	2.46	2.46	1.000
26.00	61.87	73.	1409.	.975	1.000	324.	0.	746.	54.3	2	1.072	.0	2.64	2.64	1.000
28.00	65.77	75.	1403.	.976	1.000	355.	0.	744.	57.3	2	1.081	.0	2.82	2.82	1.000
30.00	70.39	77.	1397.	.978	1.000	386.	0.	741.	60.9	2	1.091	.0	3.00	3.00	1.000
32.00	73.79	79.	1397.	.978	.999	416.	1089.	738.	63.3	2	1.101	.0	3.00	3.00	.999
34.00	62.67	81.	1397.	.973	.993	444.	226.	734.	51.1	2	1.060	.0	3.00	3.00	.992
36.00	62.56	83.	1397.	.972	.990	471.	195.	730.	49.8	2	1.055	.0	3.00	3.00	.990
38.00	62.61	85.	1398.	.972	.988	496.	202.	726.	48.7	2	1.051	.0	3.00	3.00	.988
40.00	62.66	87.	1398.	.971	.986	518.	209.	721.	47.6	2	1.045	.0	3.00	3.00	.986
42.00	62.72	89.	1398.	.970	.983	540.	217.	716.	46.4	2	1.040	.0	3.00	3.00	.983
44.00	62.79	91.	1398.	.969	.981	559.	225.	710.	45.2	2	1.035	.0	3.00	3.00	.981
46.00	62.85	93.	1398.	.968	.978	577.	234.	705.	43.9	2	1.028	.0	3.00	3.00	.978
48.00	62.93	95.	1398.	.967	.976	594.	243.	700.	42.7	2	1.023	.0	3.00	3.00	.975
50.00	63.01	97.	1399.	.966	.973	609.	253.	694.	41.4	2	1.016	.0	3.00	3.00	.973
52.00	63.11	99.	1399.	.965	.970	623.	264.	689.	40.0	2	1.009	.0	3.00	3.00	.970
54.00	63.21	101.	1399.	.963	.967	636.	276.	684.	38.7	2	1.001	.0	3.00	3.00	.967
56.00	63.33	103.	1399.	.962	.964	648.	289.	679.	37.3	2	.993	.0	3.00	3.00	.964
58.00	63.46	105.	1399.	.960	.960	659.	304.	674.	35.9	2	.984	.0	3.00	3.00	.960
60.00	63.61	107.	1399.	.958	.957	668.	320.	669.	34.4	2	.976	.0	3.00	3.00	.957
62.00	63.77	109.	1399.	.956	.953	677.	337.	665.	33.0	2	.966	.0	3.00	3.00	.953
64.00	63.96	111.	1400.	.954	.949	685.	357.	661.	31.5	2	.956	.0	3.00	3.00	.949
66.00	64.17	113.	1400.	.952	.945	692.	378.	657.	30.1	2	.944	.0	3.00	3.00	.945
68.00	64.42	115.	1400.	.949	.941	699.	402.	653.	28.6	2	.932	.0	3.00	3.00	.941
70.00	64.70	117.	1400.	.946	.936	705.	429.	650.	27.1	2	.920	.0	3.00	3.00	.936
72.00	65.02	119.	1400.	.943	.931	710.	458.	647.	25.7	2	.906	.0	3.00	3.00	.931
74.00	65.39	121.	1400.	.939	.926	715.	491.	644.	24.2	2	.892	.0	3.00	3.00	.925
76.00	65.81	123.	1401.	.935	.920	720.	528.	641.	22.8	2	.876	.0	3.00	3.00	.920
78.00	66.32	125.	1401.	.931	.914	724.	569.	639.	21.4	2	.860	.0	3.00	3.00	.914
80.00	67.04	127.	1401.	.926	.908	728.	529.	636.	20.3	2	.844	.0	3.00	3.00	.908
82.00	67.96	129.	1401.	.922	.902	731.	522.	634.	19.2	2	.829	.0	3.00	3.00	.902
84.00	69.03	131.	1401.	.918	.897	735.	517.	632.	18.3	2	.816	.0	3.00	3.00	.896
86.00	70.25	133.	1401.	.914	.891	738.	514.	630.	17.5	2	.802	.0	3.00	3.00	.890
88.00	71.57	134.	1401.	.910	.885	740.	513.	628.	16.8	2	.789	.0	3.00	3.00	.884
90.00	72.99	136.	1402.	.906	.879	743.	512.	627.	16.1	2	.777	.0	3.00	3.00	.878
92.00	74.49	138.	1402.	.902	.874	745.	513.	625.	15.5	2	.764	.0	3.00	3.00	.872
94.00	76.07	140.	1402.	.898	.868	747.	514.	624.	15.0	2	.752	.0	3.00	3.00	.867
96.00	77.72	142.	1402.	.894	.862	750.	513.	622.	14.4	2	.741	.0	3.00	3.00	.861
98.00	79.45	144.	1402.	.890	.856	751.	503.	621.	14.0	2	.730	.0	3.00	3.00	.855
100.00	81.26	146.	1402.	.886	.851	753.	495.	620.	13.5	2	.719	.0	3.00	3.00	.849
102.00	83.14	148.	1402.	.882	.845	755.	487.	619.	13.1	2	.708	.0	3.00	3.00	.844
104.00	85.08	150.	1403.	.879	.840	756.	480.	617.	12.8	2	.698	.0	3.00	3.00	.838
106.00	87.08	152.	1403.	.875	.835	758.	473.	616.	12.4	2	.688	.0	3.00	3.00	.833
108.00	89.14	154.	1403.	.872	.829	759.	466.	615.	12.1	2	.679	.0	3.00	3.00	.828
110.00	91.25	156.	1403.	.868	.824	761.	460.	614.	11.8	2	.670	.0	3.00	3.00	.822

112.00	93.42	158.	1403.	.865	.819	762.	455.	614.	11.6	2	.661	.0	3.00	3.00	.817
114.00	95.63	160.	1403.	.861	.814	763.	449.	613.	11.3	2	.653	.0	3.00	3.00	.812
116.00	99.00	161.	1404.	.858	.809	764.	444.	612.	11.1	2	.644	.0	3.00	3.00	.807
118.00	100.31	163.	1404.	.855	.804	765.	439.	611.	10.9	2	.636	.0	3.00	3.00	.802
120.00	102.72	165.	1404.	.851	.799	766.	434.	610.	10.7	2	.628	.0	3.00	3.00	.797
122.00	105.21	167.	1404.	.848	.794	767.	430.	610.	10.5	2	.621	.0	3.00	3.00	.792
124.00	107.79	169.	1404.	.845	.789	768.	425.	609.	10.3	2	.613	.0	3.00	3.00	.787
126.00	110.45	171.	1404.	.842	.785	769.	421.	608.	10.1	2	.606	.0	3.00	3.00	.782
128.00	113.20	173.	1404.	.839	.780	770.	417.	608.	10.0	2	.599	.0	3.00	3.00	.777
130.00	116.03	175.	1405.	.836	.775	771.	414.	607.	9.8	2	.592	.0	3.00	3.00	.772
132.00	118.95	177.	1405.	.832	.771	772.	410.	606.	9.6	2	.585	.0	3.00	3.00	.768
134.00	121.94	178.	1405.	.829	.766	772.	406.	606.	9.5	2	.578	.0	3.00	3.00	.763
136.00	125.01	180.	1405.	.826	.762	773.	403.	605.	9.4	2	.571	.0	3.00	3.00	.758
138.00	128.17	182.	1405.	.824	.757	774.	400.	605.	9.2	2	.565	.0	3.00	3.00	.754
140.00	131.40	184.	1405.	.821	.753	775.	396.	604.	9.1	2	.558	.0	3.00	3.00	.749
142.00	134.70	186.	1405.	.818	.748	775.	393.	604.	9.0	2	.552	.0	3.00	3.00	.745
144.00	138.08	188.	1406.	.815	.744	775.	390.	604.	8.9	2	.546	.0	3.00	3.00	.740
146.00	141.53	189.	1406.	.812	.740	775.	387.	604.	8.8	2	.540	.0	3.00	3.00	.736
148.00	145.05	191.	1406.	.809	.735	775.	385.	604.	8.7	2	.533	.0	3.00	3.00	.731
150.00	148.64	193.	1406.	.806	.731	775.	385.	604.	8.6	2	.527	.0	3.00	3.00	.727
152.00	152.30	195.	1406.	.803	.727	775.	386.	604.	8.5	2	.521	.0	3.00	3.00	.722
154.00	156.02	197.	1406.	.800	.722	775.	388.	604.	8.3	2	.515	.0	3.00	3.00	.718
156.00	159.80	199.	1406.	.797	.718	775.	391.	604.	8.2	2	.509	.0	3.00	3.00	.713
158.00	163.65	200.	1407.	.794	.713	775.	394.	604.	8.1	2	.503	.0	3.00	3.00	.708
160.00	167.56	202.	1407.	.791	.709	776.	397.	603.	8.0	2	.496	.0	3.00	3.00	.704
162.00	171.53	204.	1407.	.788	.705	776.	401.	603.	8.0	2	.490	.0	3.00	3.00	.699
164.00	175.56	206.	1407.	.785	.700	776.	405.	603.	7.9	2	.484	.0	3.00	3.00	.694
166.00	179.64	208.	1407.	.781	.695	777.	409.	603.	7.8	2	.477	.0	3.00	3.00	.690
168.00	183.79	209.	1407.	.778	.691	777.	413.	602.	7.7	2	.470	.0	3.00	3.00	.685
170.00	187.99	211.	1407.	.775	.686	778.	417.	602.	7.6	2	.463	.0	3.00	3.00	.680
172.00	192.26	213.	1407.	.771	.682	778.	422.	602.	7.5	2	.456	.0	3.00	3.00	.675
174.00	196.58	215.	1408.	.767	.677	778.	426.	601.	7.4	2	.449	.0	3.00	3.00	.670
176.00	200.95	216.	1408.	.764	.672	779.	431.	601.	7.3	2	.442	.0	3.00	3.00	.665
178.00	205.38	218.	1408.	.760	.667	779.	435.	600.	7.2	2	.435	.0	3.00	3.00	.660
180.00	209.86	220.	1408.	.756	.662	780.	440.	600.	7.1	2	.427	.0	3.00	3.00	.655
182.00	214.40	222.	1408.	.752	.657	781.	445.	600.	7.0	2	.420	.0	3.00	3.00	.649
184.00	219.00	223.	1408.	.748	.652	781.	449.	599.	6.9	2	.412	.0	3.00	3.00	.644
186.00	223.64	225.	1408.	.744	.647	782.	454.	599.	6.8	2	.404	.0	3.00	3.00	.639
188.00	228.34	227.	1409.	.739	.642	782.	459.	598.	6.7	2	.396	.0	3.00	3.00	.633
190.00	233.09	228.	1409.	.735	.637	783.	464.	598.	6.6	2	.388	.0	3.00	3.00	.628
192.00	237.90	230.	1409.	.730	.632	784.	469.	597.	6.5	2	.380	.0	3.00	3.00	.622
194.00	242.75	232.	1409.	.726	.626	784.	474.	597.	6.4	2	.372	.0	3.00	3.00	.617
196.00	247.65	234.	1409.	.721	.621	785.	479.	596.	6.3	2	.363	.0	3.00	3.00	.611
198.00	252.61	235.	1409.	.716	.616	786.	484.	595.	6.2	2	.354	.0	3.00	3.00	.605
200.00	257.61	237.	1409.	.711	.610	787.	489.	595.	6.1	2	.346	.0	3.00	3.00	.599
202.00	262.66	239.	1409.	.706	.605	787.	494.	594.	6.0	2	.336	.0	3.00	3.00	.593
204.00	267.76	240.	1410.	.701	.599	788.	499.	594.	5.9	2	.328	.0	3.00	3.00	.587
206.00	272.91	242.	1410.	.696	.594	789.	504.	593.	5.9	2	.318	.0	3.00	3.00	.581
208.00	278.11	244.	1410.	.690	.588	790.	509.	592.	5.8	2	.309	.0	3.00	3.00	.575
210.00	283.35	245.	1410.	.685	.582	791.	514.	592.	5.7	2	.299	.0	3.00	3.00	.569
212.00	288.64	247.	1410.	.679	.576	792.	519.	591.	5.6	2	.290	.0	3.00	3.00	.563
214.00	293.98	248.	1410.	.673	.571	792.	525.	590.	5.5	2	.280	.0	3.00	3.00	.556
216.00	299.36	250.	1410.	.667	.565	793.	530.	590.	5.4	2	.270	.0	3.00	3.00	.550
218.00	304.78	252.	1410.	.661	.559	794.	535.	589.	5.3	2	.259	.0	3.00	3.00	.543
220.00	310.25	253.	1411.	.655	.553	795.	540.	588.	5.2	2	.248	.0	3.00	3.00	.537
222.00	315.76	255.	1411.	.648	.547	796.	544.	587.	5.2	2	.238	.0	3.00	3.00	.530
224.00	321.33	257.	1411.	.642	.540	797.	549.	587.	5.1	2	.227	.0	3.00	3.00	.523
226.00	326.93	258.	1411.	.635	.534	798.	554.	586.	5.0	2	.216	.0	3.00	3.00	.517
228.00	332.59	260.	1411.	.628	.528	799.	559.	585.	4.9	2	.205	.0	3.00	3.00	.510
	338.28	261.	1411.	.622	.522	800.	563.	603.	4.8	2	.194	.0	3.00	3.00	.503

232.00	344.03	263.	1411.	.615	.515	801.	568.	682.	4.8	2	.183	.0	3.00	3.00	.496
234.00	349.82	265.	1411.	.608	.509	802.	573.	681.	4.7	2	.171	.0	3.00	3.00	.489
236.00	355.63	266.	1412.	.601	.503	803.	577.	680.	4.6	2	.160	.0	3.00	3.00	.481
238.00	361.47	268.	1412.	.593	.496	805.	582.	599.	4.5	2	.148	.0	3.00	3.00	.474
240.00	367.32	269.	1412.	.586	.490	806.	586.	598.	4.5	2	.136	.0	3.00	3.00	.467
242.00	373.31	271.	1412.	.578	.483	807.	590.	597.	4.4	2	.124	.0	3.00	3.00	.459
244.00	379.38	273.	1412.	.571	.476	808.	595.	596.	4.3	2	.112	.0	3.00	3.00	.452
246.00	385.34	274.	1412.	.563	.470	809.	599.	595.	4.3	2	.100	.0	3.00	3.00	.444
248.00	391.42	276.	1412.	.555	.463	811.	604.	594.	4.2	2	.088	.0	3.00	3.00	.437
250.00	397.56	277.	1412.	.547	.456	812.	608.	593.	4.1	2	.075	.0	3.00	3.00	.429
252.00	403.74	279.	1413.	.539	.449	813.	613.	592.	4.1	2	.062	.0	3.00	3.00	.421
254.00	409.56	280.	1413.	.531	.442	814.	617.	590.	4.0	2	.049	.0	3.00	3.00	.413
256.00	415.94	282.	1413.	.522	.435	816.	621.	589.	3.9	2	.035	.0	3.00	3.00	.405
258.00	422.39	283.	1413.	.513	.428	817.	626.	588.	3.9	2	.022	.0	3.00	3.00	.397
260.00	428.91	285.	1413.	.505	.421	819.	631.	587.	3.8	2	.008	.0	3.00	3.00	.389
262.00	435.48	286.	1413.	.496	.414	820.	636.	585.	3.8	2	-.006	.0	3.00	3.00	.381
264.00	442.11	288.	1413.	.486	.407	822.	641.	584.	3.7	2	-.021	.0	3.00	3.00	.372
266.00	448.80	289.	1413.	.477	.400	823.	646.	583.	3.6	2	-.035	.0	3.00	3.00	.364
268.00	455.54	291.	1413.	.467	.393	825.	651.	581.	3.6	2	-.050	.0	3.00	3.00	.355
270.00	462.34	292.	1414.	.458	.385	826.	656.	580.	3.5	2	-.066	.0	3.00	3.00	.347
272.00	469.25	294.	1414.	.448	.378	828.	661.	579.	3.5	2	-.081	.0	3.00	3.00	.338
274.00	476.18	296.	1414.	.438	.371	830.	664.	577.	3.4	2	-.097	.0	3.00	3.00	.330
276.00	483.14	297.	1414.	.428	.364	831.	665.	576.	3.4	2	-.113	.0	3.00	3.00	.321
278.00	490.13	298.	1414.	.417	.356	833.	674.	574.	3.3	2	-.130	.0	3.00	3.00	.312
280.00	497.14	300.	1414.	.406	.349	835.	682.	572.	3.3	2	-.147	.0	3.00	3.00	.302
282.00	504.17	301.	1414.	.395	.341	837.	690.	571.	3.2	2	-.165	.0	3.00	3.00	.293
284.00	511.24	303.	1414.	.384	.333	839.	696.	569.	3.1	2	-.183	.0	3.00	3.00	.284
286.00	518.32	304.	1414.	.372	.325	841.	702.	567.	3.1	2	-.202	.0	3.00	3.00	.274
288.00	525.42	306.	1415.	.360	.317	843.	707.	565.	3.0	2	-.222	.0	3.00	3.00	.264
290.00	532.54	307.	1415.	.348	.309	845.	712.	563.	3.0	2	-.242	.0	3.00	3.00	.254
292.00	539.66	308.	1415.	.336	.301	847.	718.	561.	2.9	2	-.263	.0	3.00	3.00	.244
294.00	546.79	310.	1415.	.323	.293	850.	723.	559.	2.9	2	-.284	.0	3.00	3.00	.234
296.00	553.91	311.	1415.	.310	.285	852.	728.	557.	2.8	2	-.307	.0	3.00	3.00	.224
296.20	556.75	312.	1415.	.305	.282	853.	730.	556.	2.8	2	-.316	.0	3.00	3.00	.220

ETHLYENE OXIDE CAR

SVPR	INTT	COND	SCFM	TEMF	SIZE	TILT	WEIGHT	THICK
99.70	63.00	1.80	1100.	1500.00	25000.	120.	178703.	1.000

TIME	PSIG	TTHK	TVAL	FRAC	FMAT	TVAP	WOUT	PSRS	PHIT	KIDN	THETA	PICR	CNDLQ	CNDVP	FRACLQ
2.00	12.44	60.	1486.	.967	1.000	66.	0.	750.	40.2	2	1.023	.0	.40	.40	1.000
4.00	42.80	61.	1483.	.967	1.000	73.	0.	750.	40.4	2	1.024	.0	.50	.50	1.000
6.00	43.25	61.	1479.	.968	1.000	82.	0.	750.	40.7	2	1.025	.0	.60	.60	1.000
8.00	43.78	61.	1476.	.968	1.000	93.	0.	750.	41.1	2	1.027	.0	.70	.70	1.000
10.00	44.41	62.	1472.	.968	1.000	105.	0.	750.	41.6	2	1.028	.0	.80	.80	1.000
12.00	45.14	63.	1469.	.968	1.000	118.	0.	750.	42.1	2	1.031	.0	.90	.90	1.000
14.00	45.97	63.	1465.	.969	1.000	132.	0.	750.	42.6	2	1.033	.0	1.00	1.00	1.000
16.00	46.92	64.	1462.	.969	1.000	148.	0.	750.	43.3	2	1.036	.0	1.10	1.10	1.000
18.00	47.98	65.	1458.	.970	1.000	164.	0.	750.	44.1	2	1.039	.0	1.20	1.20	1.000
20.00	49.19	66.	1455.	.970	1.000	182.	0.	750.	44.9	2	1.042	.0	1.30	1.30	1.000
22.00	50.53	67.	1452.	.971	1.000	201.	0.	749.	45.9	2	1.045	.0	1.40	1.40	1.000
24.00	52.04	68.	1448.	.971	1.000	220.	0.	749.	47.0	2	1.049	.0	1.50	1.50	1.000
26.00	53.73	69.	1445.	.972	1.000	241.	0.	749.	48.2	2	1.053	.0	1.60	1.60	1.000
28.00	55.63	70.	1441.	.973	1.000	262.	0.	748.	49.6	2	1.058	.0	1.70	1.70	1.000
30.00	57.75	71.	1438.	.974	1.000	283.	0.	747.	51.2	2	1.063	.0	1.80	1.80	1.000
32.00	60.06	72.	1438.	.974	1.000	305.	0.	747.	52.9	2	1.068	.0	1.80	1.80	1.000
34.00	62.54	73.	1438.	.975	1.000	325.	0.	745.	54.8	2	1.074	.0	1.80	1.80	1.000
36.00	65.19	75.	1438.	.976	1.000	345.	0.	744.	56.8	2	1.080	.0	1.80	1.80	1.000
38.00	68.05	76.	1438.	.977	1.000	363.	0.	743.	59.1	2	1.086	.0	1.80	1.80	1.000
40.00	71.12	77.	1438.	.978	1.000	381.	0.	741.	61.5	2	1.092	.0	1.80	1.80	1.000
42.00	74.45	78.	1438.	.979	1.000	398.	0.	740.	64.2	2	1.099	.0	1.80	1.80	1.000
44.00	62.70	80.	1438.	.974	.994	415.	255.	738.	51.8	2	1.063	.0	1.80	1.80	.994
46.00	62.15	81.	1438.	.973	.992	430.	121.	736.	50.5	2	1.058	.0	1.80	1.80	.992
48.00	62.16	82.	1438.	.972	.991	445.	122.	734.	49.8	2	1.055	.0	1.80	1.80	.991
50.00	62.18	83.	1439.	.972	.989	459.	124.	732.	49.1	2	1.052	.0	1.80	1.80	.989
52.00	62.20	85.	1439.	.971	.988	472.	127.	730.	48.4	2	1.049	.0	1.80	1.80	.988
54.00	62.22	86.	1439.	.971	.987	484.	130.	728.	47.7	2	1.046	.0	1.80	1.80	.987
56.00	62.25	87.	1439.	.970	.985	496.	133.	726.	47.0	2	1.043	.0	1.80	1.80	.985
58.00	62.27	88.	1439.	.970	.984	507.	137.	723.	46.2	2	1.040	.0	1.80	1.80	.984
60.00	62.29	90.	1439.	.969	.982	517.	140.	721.	45.5	2	1.036	.0	1.80	1.80	.982
62.00	62.32	91.	1439.	.969	.981	527.	143.	719.	44.7	2	1.032	.0	1.80	1.80	.981
64.00	62.35	92.	1439.	.968	.979	536.	147.	717.	43.9	2	1.028	.0	1.80	1.80	.979
66.00	62.38	93.	1439.	.967	.977	544.	151.	714.	43.1	2	1.024	.0	1.80	1.80	.977
68.00	62.41	95.	1439.	.967	.975	552.	155.	712.	42.3	2	1.020	.0	1.80	1.80	.975
70.00	62.45	96.	1439.	.966	.974	560.	159.	710.	41.4	2	1.016	.0	1.80	1.80	.974
72.00	62.49	97.	1439.	.965	.972	567.	164.	708.	40.6	2	1.012	.0	1.80	1.80	.972
74.00	62.53	99.	1439.	.964	.970	573.	168.	706.	39.7	2	1.007	.0	1.80	1.80	.970
76.00	62.57	100.	1439.	.963	.968	579.	173.	704.	38.9	2	1.003	.0	1.80	1.80	.968
78.00	62.62	101.	1439.	.962	.966	585.	179.	703.	38.0	2	.997	.0	1.80	1.80	.966
80.00	62.67	102.	1439.	.962	.964	590.	184.	701.	37.1	2	.992	.0	1.80	1.80	.964
82.00	62.72	104.	1439.	.960	.962	595.	190.	699.	36.2	2	.987	.0	1.80	1.80	.962
84.00	62.78	105.	1439.	.959	.960	600.	197.	698.	35.3	2	.981	.0	1.80	1.80	.960
86.00	62.84	106.	1440.	.958	.958	604.	204.	696.	34.3	2	.975	.0	1.80	1.80	.957
88.00	62.91	107.	1440.	.957	.955	608.	211.	695.	33.4	2	.969	.0	1.80	1.80	.955
90.00	62.99	109.	1440.	.956	.953	612.	219.	693.	32.5	2	.963	.0	1.80	1.80	.953
92.00	63.07	110.	1440.	.954	.950	615.	228.	692.	31.5	2	.956	.0	1.80	1.80	.950
94.00	63.16	111.	1440.	.953	.948	619.	237.	691.	30.6	2	.948	.0	1.80	1.80	.947
96.00	63.26	112.	1440.	.951	.945	622.	247.	690.	29.6	2	.941	.0	1.80	1.80	.945
98.00	63.37	114.	1440.	.949	.942	624.	258.	688.	28.7	2	.933	.0	1.80	1.80	.942
100.00	63.49	115.	1440.	.947	.939	627.	270.	687.	27.7	2	.925	.0	1.80	1.80	.939
102.00	63.62	116.	1440.	.945	.936	630.	282.	686.	26.7	2	.916	.0	1.80	1.80	.936
104.00	63.76	117.	1440.	.943	.933	632.	296.	685.	25.8	2	.908	.0	1.80	1.80	.933
106.00	63.93	119.	1440.	.941	.930	634.	311.	685.	24.8	2	.898	.0	1.80	1.80	.932
108.00	64.10	120.	1440.	.938	.926	636.	327.	684.	23.9	2	.888	.0	1.80	1.80	.929
110.00	64.30	121.	1440.	.936	.922	638.	344.	683.	22.9	2	.877	.0	1.80	1.80	.922

112.00	64.52	122.	1440.	.933	.918	640.	363.	682.	22.0	2	.866	.0	1.80	1.80	.918
114.00	61.76	124.	1440.	.930	.914	642.	383.	681.	21.0	2	.855	.0	1.80	1.80	.913
116.00	65.02	125.	1440.	.926	.910	643.	405.	681.	20.1	2	.843	.0	1.80	1.80	.909
118.00	65.32	126.	1440.	.923	.905	645.	428.	680.	19.2	2	.830	.0	1.80	1.80	.904
120.00	65.64	127.	1440.	.919	.900	646.	453.	679.	18.3	2	.816	.0	1.80	1.80	.899
122.00	65.99	128.	1441.	.914	.895	648.	480.	679.	17.4	2	.803	.0	1.80	1.80	.894
124.00	66.42	130.	1441.	.910	.889	649.	474.	678.	16.6	2	.788	.0	1.80	1.80	.889
126.00	66.95	131.	1441.	.906	.884	650.	467.	678.	15.9	2	.776	.0	1.80	1.80	.883
128.00	67.58	132.	1441.	.902	.879	652.	462.	677.	15.3	2	.763	.0	1.80	1.80	.878
130.00	68.27	133.	1441.	.897	.874	653.	457.	676.	14.7	2	.751	.0	1.80	1.80	.873
132.00	69.04	135.	1441.	.893	.869	654.	454.	676.	14.2	2	.739	.0	1.80	1.80	.868
134.00	69.85	136.	1441.	.889	.864	655.	451.	675.	13.7	2	.727	.0	1.80	1.80	.863
136.00	70.72	137.	1441.	.885	.859	656.	449.	675.	13.2	2	.716	.0	1.80	1.80	.857
138.00	71.64	138.	1441.	.881	.854	657.	447.	674.	12.8	2	.705	.0	1.80	1.80	.852
140.00	72.60	139.	1441.	.877	.849	658.	446.	674.	12.4	2	.694	.0	1.80	1.80	.847
142.00	73.60	141.	1441.	.873	.844	660.	445.	673.	12.0	2	.684	.0	1.80	1.80	.842
144.00	74.63	142.	1441.	.869	.839	661.	445.	673.	11.7	2	.673	.0	1.80	1.80	.837
146.00	75.70	143.	1441.	.865	.834	661.	445.	672.	11.4	2	.663	.0	1.80	1.80	.832
148.00	76.80	144.	1441.	.861	.829	662.	445.	672.	11.1	2	.653	.0	1.80	1.80	.827
150.00	77.93	146.	1441.	.857	.824	663.	442.	672.	10.8	2	.643	.0	1.80	1.80	.822
152.00	79.09	147.	1441.	.853	.819	664.	436.	671.	10.5	2	.633	.0	1.80	1.80	.817
154.00	80.29	148.	1441.	.849	.814	665.	430.	671.	10.2	2	.624	.0	1.80	1.80	.812
156.00	81.52	149.	1441.	.846	.809	666.	425.	670.	10.0	2	.615	.0	1.80	1.80	.807
158.00	82.77	150.	1442.	.842	.804	667.	420.	670.	9.8	2	.606	.0	1.80	1.80	.802
160.00	84.06	152.	1442.	.838	.800	668.	415.	669.	9.6	2	.597	.0	1.80	1.80	.798
162.00	85.37	153.	1442.	.834	.795	669.	411.	669.	9.4	2	.589	.0	1.80	1.80	.793
164.00	86.70	154.	1442.	.831	.791	669.	406.	669.	9.2	2	.581	.0	1.80	1.80	.788
166.00	88.06	155.	1442.	.827	.786	670.	402.	668.	9.0	2	.572	.0	1.80	1.80	.784
168.00	89.45	157.	1442.	.823	.782	671.	398.	668.	8.9	2	.565	.0	1.80	1.80	.779
170.00	90.85	158.	1442.	.820	.777	672.	394.	668.	8.7	2	.557	.0	1.80	1.80	.775
172.00	92.28	159.	1442.	.816	.773	672.	390.	667.	8.6	2	.549	.0	1.80	1.80	.770
174.00	93.86	160.	1442.	.813	.768	672.	387.	667.	8.4	2	.542	.0	1.80	1.80	.766
176.00	95.31	162.	1442.	.810	.764	673.	384.	667.	8.3	2	.535	.0	1.80	1.80	.761
178.00	96.80	163.	1442.	.806	.760	673.	380.	667.	8.2	2	.527	.0	1.80	1.80	.757
180.00	98.33	164.	1442.	.803	.756	673.	377.	667.	8.0	2	.520	.0	1.80	1.80	.753
182.00	99.90	165.	1442.	.799	.751	673.	374.	667.	7.9	2	.513	.0	1.80	1.80	.748
184.00	101.50	166.	1442.	.796	.747	673.	371.	667.	7.8	2	.507	.0	1.80	1.80	.744
186.00	103.15	168.	1442.	.793	.743	674.	368.	667.	7.7	2	.500	.0	1.80	1.80	.740
188.00	104.83	169.	1442.	.790	.739	674.	365.	666.	7.6	2	.493	.0	1.80	1.80	.736
190.00	106.54	170.	1442.	.786	.735	674.	363.	666.	7.5	2	.487	.0	1.80	1.80	.731
192.00	108.30	171.	1442.	.783	.731	675.	360.	666.	7.4	2	.480	.0	1.80	1.80	.727
194.00	110.09	172.	1443.	.780	.727	675.	357.	666.	7.3	2	.474	.0	1.80	1.80	.723
196.00	111.92	174.	1443.	.777	.723	675.	355.	666.	7.2	2	.468	.0	1.80	1.80	.719
198.00	113.78	175.	1443.	.774	.719	676.	352.	666.	7.1	2	.461	.0	1.80	1.80	.715
200.00	115.67	176.	1443.	.770	.715	676.	350.	665.	7.0	2	.455	.0	1.80	1.80	.711
202.00	117.61	177.	1443.	.767	.711	677.	348.	665.	7.0	2	.449	.0	1.80	1.80	.707
204.00	119.57	179.	1443.	.764	.707	677.	345.	665.	6.9	2	.443	.0	1.80	1.80	.703
206.00	121.58	180.	1443.	.761	.703	677.	343.	665.	6.8	2	.437	.0	1.80	1.80	.699
208.00	123.61	181.	1443.	.758	.699	678.	342.	664.	6.7	2	.431	.0	1.80	1.80	.695
210.00	125.68	182.	1443.	.755	.696	678.	341.	664.	6.7	2	.426	.0	1.80	1.80	.691
212.00	127.79	183.	1443.	.752	.692	679.	341.	664.	6.6	2	.420	.0	1.80	1.80	.687
214.00	129.92	185.	1443.	.749	.688	679.	342.	664.	6.5	2	.414	.0	1.80	1.80	.683
216.00	132.09	186.	1443.	.746	.684	680.	344.	663.	6.4	2	.408	.0	1.80	1.80	.679
218.00	134.29	187.	1443.	.742	.680	680.	345.	663.	6.4	2	.402	.0	1.80	1.80	.675
220.00	136.52	188.	1443.	.739	.676	681.	347.	663.	6.3	2	.396	.0	1.80	1.80	.671
222.00	138.78	189.	1443.	.736	.672	681.	349.	663.	6.2	2	.390	.0	1.80	1.80	.667
224.00	141.07	191.	1443.	.733	.669	682.	352.	662.	6.2	2	.384	.0	1.80	1.80	.663
226.00	143.40	192.	1443.	.729	.665	682.	355.	662.	6.1	2	.378	.0	1.80	1.80	.659
228.00	145.75	193.	1443.	.726	.661	683.	357.	662.	6.1	2	.372	.0	1.80	1.80	.655
230.00	148.13	194.	1444.	.723	.657	683.	360.	662.	6.0	2	.366	.0	1.80	1.80	.650

232.00	150.54	195.	1444.	.719	.653	684.	364.	661.	5.9	2	.360	.0	1.80	1.80	.646
234.00	152.98	197.	1444.	.716	.648	685.	367.	661.	5.9	2	.353	.0	1.80	1.80	.642
236.00	155.46	198.	1444.	.712	.644	685.	370.	661.	5.8	2	.347	.0	1.80	1.80	.638
238.00	157.96	199.	1444.	.708	.640	686.	373.	660.	5.7	2	.340	.0	1.80	1.80	.633
240.00	160.49	200.	1444.	.705	.636	686.	376.	660.	5.7	2	.334	.0	1.80	1.80	.629
242.00	163.05	201.	1444.	.701	.632	687.	379.	660.	5.6	2	.327	.0	1.80	1.80	.624
244.00	165.64	202.	1444.	.697	.627	688.	382.	660.	5.6	2	.321	.0	1.80	1.80	.620
246.00	168.26	204.	1444.	.693	.623	688.	385.	659.	5.5	2	.314	.0	1.80	1.80	.615
248.00	170.91	205.	1444.	.689	.619	689.	388.	659.	5.4	2	.307	.0	1.80	1.80	.611
250.00	173.59	206.	1444.	.685	.614	689.	391.	659.	5.4	2	.300	.0	1.80	1.80	.606
252.00	176.29	207.	1444.	.681	.610	690.	394.	658.	5.3	2	.294	.0	1.80	1.80	.602
254.00	179.03	208.	1444.	.677	.606	691.	397.	658.	5.3	2	.286	.0	1.80	1.80	.597
256.00	181.80	210.	1444.	.673	.601	691.	400.	658.	5.2	2	.279	.0	1.80	1.80	.592
258.00	184.59	211.	1444.	.669	.597	692.	404.	657.	5.1	2	.272	.0	1.80	1.80	.588
260.00	187.41	212.	1444.	.665	.592	693.	407.	657.	5.1	2	.265	.0	1.80	1.80	.583
262.00	190.27	213.	1444.	.660	.588	693.	410.	656.	5.0	2	.258	.0	1.80	1.80	.578
264.00	193.15	214.	1444.	.656	.583	694.	414.	656.	5.0	2	.250	.0	1.80	1.80	.573
266.00	196.05	215.	1444.	.651	.578	695.	417.	656.	4.9	2	.243	.0	1.80	1.80	.568
268.00	198.99	217.	1445.	.647	.574	695.	420.	655.	4.9	2	.235	.0	1.80	1.80	.563
270.00	201.96	218.	1445.	.642	.569	696.	424.	655.	4.8	2	.228	.0	1.80	1.80	.558
272.00	204.95	219.	1445.	.638	.564	697.	427.	655.	4.8	2	.220	.0	1.80	1.80	.553
274.00	207.97	220.	1445.	.633	.559	697.	430.	651.	4.7	2	.212	.0	1.80	1.80	.548
276.00	211.02	221.	1445.	.628	.554	698.	434.	654.	4.6	2	.204	.0	1.80	1.80	.543
278.00	214.10	222.	1445.	.623	.550	699.	437.	653.	4.6	2	.196	.0	1.80	1.80	.538
280.00	217.20	223.	1445.	.618	.545	700.	441.	653.	4.5	2	.188	.0	1.80	1.80	.532
282.00	220.34	225.	1445.	.613	.540	700.	444.	652.	4.5	2	.180	.0	1.80	1.80	.527
284.00	223.50	226.	1445.	.608	.535	701.	447.	652.	4.4	2	.172	.0	1.80	1.80	.522
286.00	226.69	227.	1445.	.603	.530	702.	451.	652.	4.4	2	.164	.0	1.80	1.80	.516
288.00	229.90	228.	1445.	.598	.525	703.	454.	651.	4.3	2	.155	.0	1.80	1.80	.511
290.00	233.15	229.	1445.	.592	.520	704.	458.	651.	4.3	2	.147	.0	1.80	1.80	.505
292.00	236.42	230.	1445.	.587	.514	705.	461.	650.	4.2	2	.138	.0	1.80	1.80	.500
294.00	239.72	232.	1445.	.581	.509	705.	465.	650.	4.2	2	.129	.0	1.80	1.80	.494
296.00	243.04	233.	1445.	.576	.504	706.	469.	649.	4.1	2	.120	.0	1.80	1.80	.489
298.00	246.39	234.	1445.	.570	.499	707.	472.	649.	4.1	2	.111	.0	1.80	1.80	.483
300.00	249.77	235.	1445.	.565	.493	708.	476.	648.	4.1	2	.102	.0	1.80	1.80	.477
302.00	253.18	236.	1445.	.559	.488	709.	479.	648.	4.0	2	.093	.0	1.80	1.80	.471
304.00	256.61	237.	1445.	.553	.483	710.	483.	647.	4.0	2	.084	.0	1.80	1.80	.466
306.00	260.07	238.	1445.	.547	.477	711.	486.	647.	3.9	2	.074	.0	1.80	1.80	.460
308.00	263.56	240.	1446.	.541	.472	712.	490.	646.	3.9	2	.065	.0	1.80	1.80	.454
310.00	267.07	241.	1446.	.535	.466	713.	494.	646.	3.8	2	.055	.0	1.80	1.80	.448
312.00	270.61	242.	1446.	.529	.461	714.	497.	645.	3.8	2	.045	.0	1.80	1.80	.442
314.00	274.17	243.	1446.	.522	.455	715.	501.	644.	3.7	2	.035	.0	1.80	1.80	.436
316.00	277.76	244.	1446.	.516	.449	716.	504.	644.	3.7	2	.026	.0	1.80	1.80	.430
318.00	281.38	245.	1446.	.509	.444	717.	508.	643.	3.6	2	.015	.0	1.80	1.80	.423
320.00	285.03	246.	1446.	.503	.438	718.	512.	643.	3.6	2	.005	.0	1.80	1.80	.417
322.00	288.70	247.	1446.	.496	.432	719.	515.	642.	3.6	2	-.006	.0	1.80	1.80	.411
324.00	292.39	249.	1446.	.489	.427	720.	519.	641.	3.5	2	-.016	.0	1.80	1.80	.404
326.00	296.11	250.	1446.	.482	.421	721.	523.	641.	3.5	2	-.027	.0	1.80	1.80	.398
328.00	299.86	251.	1446.	.475	.415	722.	526.	640.	3.4	2	-.038	.0	1.80	1.80	.391
330.00	303.63	252.	1446.	.468	.409	723.	530.	639.	3.4	2	-.049	.0	1.80	1.80	.385
332.00	307.43	253.	1446.	.461	.403	724.	533.	639.	3.4	2	-.060	.0	1.80	1.80	.378
334.00	311.26	254.	1446.	.454	.397	726.	537.	638.	3.3	2	-.072	.0	1.80	1.80	.372
336.00	315.11	255.	1446.	.447	.391	727.	540.	637.	3.3	2	-.084	.0	1.80	1.80	.365
338.00	318.99	256.	1446.	.439	.385	728.	544.	636.	3.2	2	-.095	.0	1.80	1.80	.358
340.00	322.89	258.	1446.	.432	.379	729.	547.	635.	3.2	2	-.107	.0	1.80	1.80	.351
342.00	326.82	259.	1446.	.424	.373	731.	551.	635.	3.2	2	-.120	.0	1.80	1.80	.344
344.00	330.77	260.	1446.	.416	.366	732.	554.	634.	3.1	2	-.132	.0	1.80	1.80	.338
346.00	334.76	261.	1447.	.408	.360	733.	557.	633.	3.1	2	-.144	.0	1.80	1.80	.331
348.00	338.76	262.	1447.	.401	.354	735.	561.	632.	3.1	2	-.157	.0	1.80	1.80	.324
350.00	342.80	263.	1447.	.393	.348	736.	564.	631.	3.0	2	-.170	.0	1.80	1.80	.316

352.00	346.86
354.00	350.93
356.00	355.02
358.00	359.14
360.00	363.28
362.00	367.44
364.00	371.64
366.00	375.85
368.00	380.10
370.00	384.36
372.00	388.65
374.00	392.97
376.00	397.30
378.00	401.66
380.00	406.03
382.00	410.01
384.00	414.43
386.00	418.86
388.00	423.30
390.00	427.74
392.00	432.18
394.00	427.28
396.00	413.37
398.00	400.43
400.00	387.52
402.00	374.91
404.00	362.62
406.00	350.68
408.00	339.07
410.00	327.80
412.00	316.93
414.00	306.46
416.00	296.39
418.00	286.74
420.00	277.50
422.00	268.67
424.00	260.23
426.00	252.18
428.00	244.50
430.00	237.19
432.00	230.23
434.00	223.61
436.00	217.32
438.00	211.35
440.00	205.69
442.00	200.29
444.00	195.10
446.00	190.34
448.00	185.74
450.00	181.38
452.00	177.25
454.00	173.33
456.00	169.60
458.00	166.07
460.00	162.72
462.00	159.54
464.00	156.51
466.00	153.63
468.00	150.89
470.00	148.28

264.	1447.	.384	.341	737.	567.	630.
265.	1447.	.376	.335	739.	571.	629.
266.	1447.	.368	.329	740.	574.	628.
268.	1447.	.360	.322	742.	577.	627.
269.	1447.	.351	.316	743.	580.	626.
270.	1447.	.343	.309	745.	583.	625.
271.	1447.	.334	.303	747.	587.	624.
272.	1447.	.325	.296	748.	590.	623.
273.	1447.	.316	.289	750.	593.	622.
274.	1447.	.307	.283	752.	596.	621.
275.	1447.	.298	.276	754.	600.	619.
276.	1447.	.289	.269	756.	603.	618.
278.	1447.	.280	.263	757.	606.	617.
279.	1447.	.270	.256	759.	609.	615
280.	1447.	.261	.249	761.	612.	614
281.	1447.	.251	.242	764.	615.	612.
282.	1447.	.241	.235	766.	618.	611.
283.	1447.	.231	.228	768.	622.	609.
284.	1448.	.221	.221	770.	625.	607.
285.	1448.	.211	.214	773.	628.	606.
286.	1448.	.200	.207	775.	632.	604.
285.	1418.	.192	.201	778.	424.	602.
282.	1447.	.187	.197	781.	412.	600.
279.	1417.	.182	.192	783.	401.	597.
275.	1447.	.177	.188	786.	389.	595.
272.	1147.	.172	.183	789.	378.	593.
269.	1447.	.167	.179	791.	367.	591.
266.	1447.	.163	.175	794.	356.	589.
263.	1447.	.159	.171	797.	346.	587.
260.	1446.	.155	.167	799.	336.	585.
257.	1416.	.151	.164	802.	326.	601.
254.	1146.	.147	.160	804.	316.	599.
251.	1416.	.114	.157	807.	307.	597.
248.	1416.	.140	.153	809.	298.	595.
245.	1446.	.137	.150	811.	289.	593.
242.	1416.	.134	.147	814.	281.	591.
240.	1146.	.131	.144	816.	273.	589.
237.	1445.	.128	.141	818.	266.	587.
235.	1415.	.125	.138	820.	259.	585.
232.	1415.	.122	.135	822.	252.	583.
230.	1445.	.119	.132	824.	245.	582.
227.	1415.	.116	.129	826.	239.	580.
225.	1415.	.114	.127	828.	233.	578.
223.	1415.	.111	.124	830.	227.	576.
221.	1445.	.108	.122	832.	222.	575.
219.	1415.	.106	.119	834.	217.	573.
217.	1415.	.104	.117	836.	212.	571.
215.	1144.	.101	.114	838.	208.	570.
213.	1414.	.099	.112	840.	203.	568.
211.	1114.	.097	.110	842.	199.	566.
210.	1114.	.094	.108	844.	195.	565.
208.	1114.	.092	.105	845.	191.	563.
207.	1441.	.090	.103	847.	188.	562.
205.	1114.	.088	.101	849.	184.	560.
204.	1444.	.086	.099	851.	181.	558.
202.	1414.	.084	.097	853.	178.	557.
201.	1144.	.082	.095	851.	175.	555.
200.	1444.	.080	.093	856.	172.	554.
198.	1111.	.078	.091	858.	170.	552.
197.	1114.	.076	.090	860.	167.	551.

3.0	2	-.183	.0	1.80	1.80	.309
3.0	2	-.196	.0	1.80	1.80	.302
2.9	2	-.210	.0	1.80	1.80	.295
2.9	2	-.224	.0	1.80	1.80	.288
2.9	2	-.237	.0	1.80	1.80	.280
2.8	2	-.252	.0	1.80	1.80	.273
2.8	2	-.266	.0	1.80	1.80	.265
2.8	2	-.281	.0	1.80	1.80	.258
2.7	2	-.296	.0	1.80	1.80	.250
2.7	2	-.312	.0	1.80	1.80	.242
2.7	2	-.328	.0	1.80	1.80	.235
2.6	2	-.344	.0	1.80	1.80	.227
2.6	2	-.360	.0	1.80	1.80	.219
2.6	2	-.377	.0	1.80	1.80	.211
2.5	2	-.395	.0	1.80	1.80	.203
2.5	2	-.413	.0	1.80	1.80	.195
2.5	2	-.432	.0	1.80	1.80	.187
2.5	2	-.451	.0	1.80	1.80	.179
2.4	2	-.471	.0	1.80	1.80	.171
2.4	2	-.491	.0	1.80	1.80	.162
2.4	2	-.512	.0	1.80	1.80	.154
2.1	1	-.529	.0	1.80	1.80	.148
1.7	1	-.541	.0	1.80	1.80	.145
1.4	1	-.552	.0	1.80	1.80	.142
1.1	1	-.563	.0	1.80	1.80	.139
.9	1	-.574	.0	1.80	1.80	.136
.7	1	-.584	.0	1.80	1.80	.133
.6	1	-.594	.0	1.80	1.80	.131
.5	1	-.604	.0	1.80	1.80	.128
.4	1	-.613	.0	1.80	1.80	.126
.3	1	-.622	.0	1.80	1.80	.123
.3	1	-.631	.0	1.80	1.80	.121
.2	1	-.640	.0	1.80	1.80	.118
.2	1	-.648	.0	1.80	1.80	.116
.1	1	-.656	.0	1.80	1.80	.114
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.1	1	-.680	.0	1.80	1.80	.108
.1	1	-.688	.0	1.80	1.80	.105
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.0	1	-.703	.0	1.80	1.80	.101
.0	1	-.711	.0	1.80	1.80	.099
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.0	1	-.725	.0	1.80	1.80	.096
.0	1	-.732	.0	1.80	1.80	.094
.0	1	-.740	.0	1.80	1.80	.092
.0	1	-.746	.0	1.80	1.80	.090
.0	1	-.753	.0	1.80	1.80	.088
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.0	1	-.767	.0	1.80	1.80	.085
.0	1	-.774	.0	1.80	1.80	.083
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.0	1	-.794	.0	1.80	1.80	.078
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.0	1	-.814	.0	1.80	1.80	.073
.0	1	-.821	.0	1.80	1.80	.071
.0	1	-.823	.0	1.80	1.80	.070
.0	1	-.834	.0	1.80	1.80	.068

472.00	145.79	196.	1444.	.074	.088	862.	165.	549.
474.00	143.42	195.	1444.	.072	.086	863.	162.	547.
476.00	141.15	194.	1443.	.070	.084	865.	160.	546.
478.00	138.98	193.	1443.	.069	.082	867.	158.	544.
480.00	136.90	192.	1443.	.067	.080	869.	156.	543.
482.00	134.90	191.	1443.	.065	.079	871.	154.	541.
484.00	132.98	190.	1443.	.063	.077	872.	152.	539.
486.00	131.13	189.	1443.	.062	.075	874.	151.	538.
488.00	129.35	188.	1443.	.060	.074	876.	149.	536.
490.00	127.62	187.	1443.	.058	.072	878.	147.	535.
492.00	125.95	186.	1443.	.056	.070	880.	145.	533.
494.00	124.33	185.	1443.	.055	.069	882.	144.	531.
496.00	122.75	184.	1443.	.053	.067	884.	142.	530.
498.00	121.21	183.	1443.	.052	.066	885.	141.	528.
500.00	119.71	183.	1443.	.050	.064	887.	139.	526.
502.00	118.24	182.	1443.	.048	.062	889.	138.	525.
504.00	116.79	181.	1443.	.047	.061	891.	137.	523.
506.00	115.37	180.	1443.	.045	.059	893.	135.	521.
508.00	113.96	179.	1443.	.044	.058	895.	134.	519.
510.00	112.57	178.	1443.	.042	.056	897.	132.	518.
512.00	111.19	178.	1443.	.041	.055	899.	131.	516.
514.00	109.82	177.	1443.	.039	.053	901.	130.	514.
516.00	108.46	176.	1443.	.038	.052	904.	128.	512.
518.00	107.52	175.	1443.	.036	.051	906.	127.	510.
520.00	107.46	175.	1443.	.035	.049	908.	127.	508.
522.66	107.22	175.	1443.	.033	.018	910.	127.	506.
524.00	106.80	175.	1443.	.032	.016	912.	127.	504.
526.00	106.23	175.	1443.	.030	.045	915.	126.	502.
528.00	105.58	174.	1443.	.029	.043	917.	125.	500.
530.00	104.63	174.	1443.	.027	.042	920.	125.	498.
532.00	103.63	173.	1443.	.026	.041	922.	124.	496.
534.00	102.50	172.	1443.	.025	.039	925.	123.	494.
536.00	101.26	171.	1442.	.023	.038	927.	121.	491.
538.00	99.92	171.	1442.	.022	.037	930.	120.	489.
540.00	98.48	170.	1442.	.021	.035	933.	119.	487.
542.00	96.94	169.	1442.	.020	.034	935.	117.	484.
544.00	95.31	168.	1442.	.018	.033	938.	116.	482.
546.00	93.60	166.	1442.	.017	.031	941.	114.	479.
548.00	91.82	165.	1442.	.016	.030	944.	112.	477.
550.00	89.99	164.	1442.	.015	.029	947.	110.	474.
552.00	88.08	162.	1442.	.014	.028	950.	108.	471.
554.00	86.12	161.	1442.	.013	.026	953.	107.	468.
556.00	83.96	159.	1442.	.012	.025	957.	104.	466.
558.00	81.87	158.	1442.	.011	.024	960.	102.	463.
560.00	79.71	156.	1442.	.010	.023	963.	100.	460.
562.00	77.49	154.	1442.	.009	.022	967.	98.	457.
564.00	75.49	153.	1442.	.008	.021	970.	94.	453.
566.00	74.00	151.	1442.	.008	.020	974.	91.	450.
568.00	72.65	150.	1442.	.007	.019	978.	88.	447.
570.00	71.30	149.	1441.	.006	.018	982.	85.	443.
572.00	69.88	148.	1441.	.005	.017	986.	82.	440.
574.00	68.40	147.	1441.	.004	.016	990.	79.	436.
576.00	66.81	145.	1441.	.004	.015	995.	75.	432.
578.00	65.72	144.	1441.	.003	.014	999.	69.	428.
580.00	65.45	144.	1441.	.002	.014	1001.	61.	421.
582.00	65.14	144.	1441.	.002	.013	1010.	59.	419.
584.00	64.54	143.	1441.	.001	.012	1015.	52.	414.
586.00	64.15	143.	1441.	.000	.012	1022.	43.	409.
588.00	63.34	142.	1441.	.000	.011	1029.	32.	402.
590.00	63.33	185.	1443.	.000	.011	1038.	0.	395.
592.00	75.85	238.	1445.	.000	.011	1047.	89.	387.
594.00	76.73	285.	1447.	.000	.010	1056.	81.	379.
596.00	71.48	341.	1150.	.000	.009	1064.	71.	371.
598.00	69.13	341.	1152.	.000	.009	1073.	68.	363.
600.00	66.70	456.	1151.	.000	.008	1081.	62.	356.

.0	1	-.841	.0	1.80	1.80	.067		
.0	1	-.848	.0	1.80	1.80	.065		
.0	1	-.854	.0	1.80	1.80	.063		
.0	1	-.860	.0	1.80	1.80	.062		
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.0	1	-.943	.0	1.80	1.80	.044		
.0	1	-.950	.0	1.80	1.80	.043		
.0	1	-.957	.0	1.80	1.80	.042		
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.0	1	-.994	.0	1.80	1.80	.035		
.0	1	-1.002	.0	1.80	1.80	.033		
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.0	1	-1.046	.0	1.80	1.80	.027		
.0	1	-1.056	.0	1.80	1.80	.025		
.0	1	-1.065	.0	1.80	1.80	.024		
.0	1	-1.074	.0	1.80	1.80	.023		
.0	1	-1.083	.0	1.80	1.80	.022		
.0	1	-1.093	.0	1.80	1.80	.021		
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.0	1	-1.112	.0	1.80	1.80	.018		
.0	1	-1.122	.0	1.80	1.80	.017		
.0	1	-1.132	.0	1.80	1.80	.016		
.0	1	-1.141	.0	1.80	1.80	.015		
.0	1	-1.152	.0	1.80	1.80	.014		
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.0	1	-1.173	.0	1.80	1.80	.012		
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.0	1	-1.215	.0	1.80	1.80	.009		
.0	1	-1.226	.0	1.80	1.80	.008		
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.0	1	-1.265	.0	1.80	1.80	.006		
.0	1	-1.281	.0	1.80	1.80	.005		
.0	1	-1.297	.0	1.80	1.80	.004		
.0	1	-1.309	.0	1.80	1.80	.004		
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.0	1	-1.373	.0	1.80	1.80	.001		
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.0	1	-1.429	.0	1.80	1.80	.000		
.0	1	-1.489	.0	1.80	1.80	.000		
.0	4	-1.571	.0	1.80	1.80	.000		
.0	4	-1.571	.0	1.80	1.80	.000		
.0	4	-1.571	.0	1.80	1.80	.000		
.0	4	-1.571	.0	1.80	1.80	.000		
.0	4	-1.571	.0	1.80	1.80	.000		

ETHLYENE OXIDE CAR

SVPR	INTT	COND	SCFM	TEMP	SIZE	TILT	WEIGHT	THICK
99.70	60.00	1.20	1100.	1500.00	25000.	120.	178703.	1.000

TIME	PSIG	TTNK	TVAL	FRAC	FMAT	TVAP	WOUT	PBRS	POUT	KIDN	THETA	PICR	CNDLQ	CNDVP	FRACLQ
2.00	42.42	60.	1487.	.967	1.000	66.	0.	750.	40.2	2	1.023	.0	.36	.36	1.000
4.00	42.74	61.	1485.	.967	1.000	72.	0.	750.	40.4	2	1.024	.0	.42	.42	1.000
6.00	43.10	61.	1483.	.967	1.000	79.	0.	750.	40.6	2	1.025	.0	.48	.48	1.000
8.00	43.52	61.	1481.	.968	1.000	88.	0.	750.	40.9	2	1.026	.0	.54	.54	1.000
10.00	43.99	62.	1479.	.968	1.000	97.	0.	750.	41.3	2	1.027	.0	.60	.60	1.000
12.00	44.52	62.	1477.	.968	1.000	106.	0.	750.	41.6	2	1.029	.0	.66	.66	1.000
14.00	45.12	63.	1475.	.968	1.000	117.	0.	750.	42.0	2	1.031	.0	.72	.72	1.000
16.00	45.78	63.	1473.	.969	1.000	128.	0.	750.	42.5	2	1.032	.0	.78	.78	1.000
18.00	46.50	64.	1471.	.969	1.000	140.	0.	750.	43.0	2	1.035	.0	.84	.84	1.000
20.00	47.30	64.	1469.	.969	1.000	153.	0.	750.	43.6	2	1.036	.0	.90	.90	1.000
22.00	48.18	65.	1467.	.970	1.000	167.	0.	750.	44.2	2	1.039	.0	.96	.96	1.000
24.00	49.14	66.	1465.	.970	1.000	181.	0.	750.	44.9	2	1.042	.0	1.02	1.02	1.000
26.00	50.19	66.	1463.	.971	1.000	195.	0.	749.	45.6	2	1.044	.0	1.08	1.08	1.000
28.00	51.34	67.	1461.	.971	1.000	210.	0.	749.	46.5	2	1.047	.0	1.14	1.14	1.000
30.00	52.60	68.	1459.	.972	1.000	225.	0.	749.	47.4	2	1.051	.0	1.20	1.20	1.000
32.00	53.94	69.	1459.	.972	1.000	241.	0.	749.	48.3	2	1.054	.0	1.20	1.20	1.000
34.00	55.33	70.	1459.	.973	1.000	256.	0.	749.	49.4	2	1.057	.0	1.20	1.20	1.000
36.00	56.78	70.	1459.	.973	1.000	270.	0.	748.	50.4	2	1.061	.0	1.20	1.20	1.000
38.00	58.30	71.	1459.	.974	1.000	284.	0.	747.	51.6	2	1.064	.0	1.20	1.20	1.000
40.00	59.89	72.	1459.	.974	1.000	298.	0.	747.	52.8	2	1.068	.0	1.20	1.20	1.000
42.00	61.55	73.	1459.	.975	1.000	311.	0.	746.	54.0	2	1.072	.0	1.20	1.20	1.000
44.00	63.29	74.	1459.	.976	1.000	324.	0.	746.	55.4	2	1.076	.0	1.20	1.20	1.000
46.00	65.11	75.	1459.	.976	1.000	336.	0.	745.	56.8	2	1.080	.0	1.20	1.20	1.000
48.00	67.03	76.	1459.	.977	1.000	348.	0.	744.	58.3	2	1.084	.0	1.20	1.20	1.000
50.00	69.05	76.	1459.	.977	1.000	359.	0.	743.	59.8	2	1.088	.0	1.20	1.20	1.000
52.00	71.18	77.	1459.	.978	1.000	370.	0.	742.	61.5	2	1.092	.0	1.20	1.20	1.000
54.00	73.43	78.	1459.	.978	1.000	380.	0.	742.	63.3	2	1.097	.0	1.20	1.20	1.000
56.00	68.07	79.	1459.	.976	.997	390.	951.	741.	57.5	2	1.084	.0	1.20	1.20	1.000
58.00	61.99	80.	1459.	.973	.993	400.	94.	740.	51.0	2	1.060	.0	1.20	1.20	.997
60.00	61.94	81.	1459.	.973	.992	409.	81.	739.	50.5	2	1.058	.0	1.20	1.20	.993
62.00	61.95	81.	1459.	.973	.992	418.	82.	738.	50.0	2	1.056	.0	1.20	1.20	.992
64.00	61.95	82.	1459.	.972	.991	427.	84.	737.	49.5	2	1.054	.0	1.20	1.20	.991
66.00	61.96	83.	1459.	.972	.990	435.	85.	736.	49.1	2	1.052	.0	1.20	1.20	.990
68.00	61.97	84.	1459.	.972	.989	442.	86.	734.	48.6	2	1.050	.0	1.20	1.20	.990
70.00	61.98	85.	1459.	.971	.988	450.	88.	733.	48.1	2	1.048	.0	1.20	1.20	.989
72.00	62.00	86.	1459.	.971	.987	457.	89.	732.	47.6	2	1.046	.0	1.20	1.20	.988
74.00	62.01	87.	1459.	.971	.986	463.	91.	731.	47.1	2	1.043	.0	1.20	1.20	.987
76.00	62.02	88.	1459.	.970	.985	470.	93.	730.	46.6	2	1.041	.0	1.20	1.20	.986
78.00	62.03	88.	1159.	.970	.984	476.	94.	729.	46.0	2	1.039	.0	1.20	1.20	.985
80.00	62.04	89.	1459.	.969	.983	482.	95.	728.	45.5	2	1.036	.0	1.20	1.20	.983
82.00	62.06	90.	1459.	.969	.981	487.	97.	727.	45.0	2	1.034	.0	1.20	1.20	.982
84.00	62.07	91.	1459.	.969	.980	492.	99.	726.	44.4	2	1.031	.0	1.20	1.20	.981
86.00	62.08	92.	1459.	.968	.979	497.	101.	725.	43.9	2	1.029	.0	1.20	1.20	.980
88.00	62.10	93.	1459.	.968	.978	502.	102.	724.	43.3	2	1.026	.0	1.20	1.20	.979
90.00	62.11	94.	1459.	.967	.977	506.	104.	723.	42.8	2	1.023	.0	1.20	1.20	.978
92.00	62.13	94.	1159.	.967	.976	510.	107.	723.	42.2	2	1.020	.0	1.20	1.20	.977
94.00	62.14	95.	1159.	.966	.975	514.	108.	722.	41.6	2	1.017	.0	1.20	1.20	.976
96.00	62.16	96.	1459.	.966	.973	518.	111.	721.	41.1	2	1.015	.0	1.20	1.20	.974
98.00	62.18	97.	1459.	.965	.972	522.	113.	720.	40.5	2	1.011	.0	1.20	1.20	.973
100.00	62.20	98.	1159.	.964	.971	525.	115.	719.	39.9	2	1.008	.0	1.20	1.20	.972
102.00	62.22	99.	1459.	.964	.969	528.	117.	718.	39.3	2	1.005	.0	1.20	1.20	.971
104.00	62.24	100.	1459.	.963	.968	531.	120.	718.	38.7	2	1.002	.0	1.20	1.20	.969
106.00	62.27	100.	1460.	.963	.967	534.	123.	717.	38.1	2	.998	.0	1.20	1.20	.968
108.00	62.29	101.	1460.	.962	.965	537.	125.	716.	37.4	2	.995	.0	1.20	1.20	.967
110.00	62.31	102.	1460.	.961	.964	539.	128.	716.	36.8	2	.991	.0	1.20	1.20	.965
												.0	1.20	1.20	.964

112.00	62.34	103.	1460.	.961	.963	542.	131.	715.	36.2	2	.987	.0	1.20	1.20	.962
114.00	62.37	104.	1460.	.960	.961	544.	134.	715.	35.6	2	.983	.0	1.20	1.20	.961
116.00	62.40	105.	1460.	.959	.960	546.	137.	714.	34.9	2	.979	.0	1.20	1.20	.959
118.00	62.43	106.	1460.	.958	.958	548.	141.	713.	34.3	2	.975	.0	1.20	1.20	.958
120.00	62.46	107.	1460.	.957	.956	550.	145.	713.	33.6	2	.971	.0	1.20	1.20	.956
122.00	62.50	107.	1460.	.956	.955	552.	148.	712.	33.0	2	.966	.0	1.20	1.20	.954
124.00	62.54	108.	1460.	.955	.953	554.	152.	712.	32.3	2	.961	.0	1.20	1.20	.953
126.00	62.58	109.	1460.	.954	.951	555.	157.	711.	31.7	2	.956	.0	1.20	1.20	.951
128.00	62.62	110.	1460.	.953	.950	557.	161.	711.	31.0	2	.952	.0	1.20	1.20	.949
130.00	62.67	111.	1460.	.952	.948	558.	166.	711.	30.3	2	.947	.0	1.20	1.20	.947
132.00	62.72	112.	1460.	.951	.946	560.	171.	710.	29.7	2	.941	.0	1.20	1.20	.945
134.00	62.77	113.	1460.	.950	.944	561.	176.	710.	29.0	2	.936	.0	1.20	1.20	.943
136.00	62.83	113.	1460.	.949	.942	563.	182.	709.	28.3	2	.931	.0	1.20	1.20	.941
138.00	62.89	114.	1460.	.947	.940	564.	188.	709.	27.6	2	.924	.0	1.20	1.20	.939
140.00	62.95	115.	1460.	.946	.938	565.	195.	709.	27.0	2	.919	.0	1.20	1.20	.937
142.00	63.02	116.	1460.	.944	.935	566.	201.	708.	26.3	2	.912	.0	1.20	1.20	.935
144.00	63.10	117.	1460.	.943	.933	567.	209.	708.	25.6	2	.906	.0	1.20	1.20	.933
146.00	63.18	118.	1460.	.941	.931	568.	216.	708.	24.9	2	.899	.0	1.20	1.20	.930
148.00	63.27	118.	1460.	.939	.928	569.	225.	708.	24.2	2	.892	.0	1.20	1.20	.928
150.00	63.37	119.	1460.	.938	.926	570.	233.	707.	23.5	2	.884	.0	1.20	1.20	.925
152.00	63.47	120.	1460.	.936	.923	571.	243.	707.	22.9	2	.877	.0	1.20	1.20	.922
154.00	63.59	121.	1460.	.934	.920	572.	253.	707.	22.2	2	.869	.0	1.20	1.20	.920
156.00	63.71	122.	1460.	.931	.917	573.	263.	706.	21.5	2	.861	.0	1.20	1.20	.917
158.00	63.84	123.	1460.	.929	.914	574.	275.	706.	20.9	2	.853	.0	1.20	1.20	.914
160.00	63.98	124.	1460.	.927	.911	574.	286.	706.	20.2	2	.844	.0	1.20	1.20	.911
162.00	64.14	124.	1460.	.924	.908	575.	299.	706.	19.5	2	.835	.0	1.20	1.20	.907
164.00	64.30	125.	1460.	.921	.904	576.	312.	705.	18.9	2	.826	.0	1.20	1.20	.904
166.00	64.48	126.	1460.	.918	.901	577.	327.	705.	18.2	2	.816	.0	1.20	1.20	.900
168.00	64.68	127.	1460.	.915	.897	577.	342.	705.	17.6	2	.806	.0	1.20	1.20	.896
170.00	64.89	128.	1460.	.912	.893	578.	357.	705.	17.0	2	.795	.0	1.20	1.20	.892
172.00	65.11	129.	1460.	.909	.889	579.	374.	705.	16.4	2	.784	.0	1.20	1.20	.888
174.00	65.36	129.	1460.	.905	.885	580.	391.	704.	15.7	2	.773	.0	1.20	1.20	.884
176.00	65.62	130.	1460.	.901	.880	580.	410.	704.	15.2	2	.761	.0	1.20	1.20	.879
178.00	65.90	131.	1460.	.897	.876	581.	430.	704.	14.6	2	.750	.0	1.20	1.20	.875
180.00	66.21	132.	1460.	.893	.871	582.	433.	704.	14.0	2	.737	.0	1.20	1.20	.870
182.00	66.58	133.	1460.	.889	.866	582.	428.	703.	13.5	2	.725	.0	1.20	1.20	.865
184.00	66.99	134.	1460.	.885	.861	583.	423.	703.	13.1	2	.714	.0	1.20	1.20	.860
186.00	67.45	135.	1461.	.881	.856	584.	418.	703.	12.6	2	.703	.0	1.20	1.20	.855
188.00	67.95	135.	1461.	.876	.852	584.	415.	703.	12.2	2	.692	.0	1.20	1.20	.851
190.00	68.49	136.	1461.	.873	.847	585.	412.	703.	11.9	2	.682	.0	1.20	1.20	.846
192.00	69.06	137.	1461.	.869	.843	586.	409.	702.	11.5	2	.672	.0	1.20	1.20	.841
194.00	69.65	138.	1461.	.865	.838	586.	407.	702.	11.2	2	.661	.0	1.20	1.20	.837
196.00	70.28	139.	1461.	.861	.833	587.	405.	702.	10.9	2	.652	.0	1.20	1.20	.832
198.00	70.93	140.	1461.	.857	.829	588.	403.	702.	10.6	2	.642	.0	1.20	1.20	.827
200.00	71.60	140.	1461.	.853	.824	588.	402.	701.	10.4	2	.632	.0	1.20	1.20	.823
202.00	72.29	141.	1461.	.849	.820	589.	400.	701.	10.1	2	.623	.0	1.20	1.20	.818
204.00	73.01	142.	1461.	.845	.815	590.	399.	701.	9.9	2	.614	.0	1.20	1.20	.814
206.00	73.74	143.	1461.	.841	.811	590.	399.	701.	9.6	2	.605	.0	1.20	1.20	.809
208.00	74.49	144.	1461.	.837	.807	591.	398.	701.	9.4	2	.596	.0	1.20	1.20	.805
210.00	75.26	145.	1461.	.833	.802	592.	398.	700.	9.2	2	.587	.0	1.20	1.20	.800
212.00	76.05	145.	1461.	.830	.798	592.	397.	700.	9.0	2	.578	.0	1.20	1.20	.796
214.00	76.85	146.	1461.	.826	.793	593.	397.	700.	8.8	2	.570	.0	1.20	1.20	.791
216.00	77.67	147.	1461.	.822	.789	593.	395.	700.	8.6	2	.561	.0	1.20	1.20	.787
218.00	78.50	148.	1461.	.818	.784	593.	391.	699.	8.5	2	.553	.0	1.20	1.20	.782
220.00	79.35	149.	1461.	.814	.780	595.	387.	699.	8.3	2	.544	.0	1.20	1.20	.779
222.00	80.22	150.	1461.	.810	.776	595.	381.	699.	8.2	2	.536	.0	1.20	1.20	.773
224.00	81.10	151.	1461.	.807	.771	595.	380.	699.	8.0	2	.528	.0	1.20	1.20	.769
226.00	82.00	151.	1461.	.803	.767	595.	376.	699.	7.9	2	.521	.0	1.20	1.20	.765
228.00	82.91	152.	1461.	.799	.763	595.	373.	699.	7.7	2	.513	.0	1.20	1.20	.760
230.00	83.84	153.	1461.	.796	.759	596.	370.	699.	7.6	2	.506	.0	1.20	1.20	.756

232.00	84.77	154.	1461.	.792	.755	596.	367.	699.	7.5	2	.498	.0	1.20	1.20	.752
234.00	85.72	155.	1461.	.789	.751	596.	364.	699.	7.4	2	.491	.0	1.20	1.20	.748
236.00	86.69	156.	1461.	.785	.747	597.	361.	699.	7.3	2	.484	.0	1.20	1.20	.744
238.00	87.66	157.	1461.	.781	.742	597.	358.	699.	7.2	2	.477	.0	1.20	1.20	.740
240.00	88.65	157.	1461.	.778	.738	597.	355.	698.	7.1	2	.470	.0	1.20	1.20	.735
242.00	89.64	158.	1461.	.775	.735	598.	352.	698.	7.0	2	.463	.0	1.20	1.20	.731
244.00	90.65	159.	1461.	.771	.731	598.	350.	698.	6.9	2	.456	.0	1.20	1.20	.727
246.00	91.67	160.	1461.	.768	.727	598.	347.	698.	6.8	2	.450	.0	1.20	1.20	.723
248.00	92.83	161.	1461.	.764	.723	599.	345.	698.	6.7	2	.444	.0	1.20	1.20	.719
250.00	93.87	162.	1461.	.761	.719	599.	342.	698.	6.6	2	.437	.0	1.20	1.20	.715
252.00	94.92	163.	1461.	.758	.715	600.	340.	698.	6.5	2	.431	.0	1.20	1.20	.712
254.00	96.00	163.	1461.	.754	.711	600.	338.	698.	6.4	2	.424	.0	1.20	1.20	.708
256.00	97.09	164.	1461.	.751	.708	600.	336.	697.	6.4	2	.418	.0	1.20	1.20	.704
258.00	98.21	165.	1461.	.748	.704	601.	333.	697.	6.3	2	.412	.0	1.20	1.20	.700
260.00	99.34	166.	1461.	.745	.700	601.	331.	697.	6.2	2	.406	.0	1.20	1.20	.696
262.00	100.50	167.	1461.	.741	.696	602.	329.	697.	6.2	2	.400	.0	1.20	1.20	.692
264.00	101.67	168.	1462.	.738	.693	602.	327.	697.	6.1	2	.394	.0	1.20	1.20	.689
266.00	102.87	169.	1462.	.735	.689	603.	325.	697.	6.0	2	.388	.0	1.20	1.20	.685
268.00	104.08	169.	1462.	.732	.685	603.	323.	696.	6.0	2	.382	.0	1.20	1.20	.681
270.00	105.32	170.	1462.	.728	.682	604.	322.	696.	5.9	2	.376	.0	1.20	1.20	.677
272.00	106.57	171.	1462.	.725	.678	604.	320.	696.	5.8	2	.371	.0	1.20	1.20	.674
274.00	107.84	172.	1462.	.722	.675	605.	318.	696.	5.8	2	.365	.0	1.20	1.20	.670
276.00	109.14	173.	1462.	.719	.671	605.	316.	696.	5.7	2	.360	.0	1.20	1.20	.666
278.00	110.45	174.	1462.	.716	.668	606.	315.	696.	5.7	2	.354	.0	1.20	1.20	.663
280.00	111.78	175.	1462.	.713	.664	606.	314.	695.	5.6	2	.348	.0	1.20	1.20	.659
282.00	113.13	175.	1462.	.710	.661	607.	314.	695.	5.6	2	.343	.0	1.20	1.20	.655
284.00	114.50	176.	1462.	.707	.657	607.	315.	695.	5.5	2	.337	.0	1.20	1.20	.652
286.00	115.88	177.	1462.	.703	.653	608.	315.	695.	5.5	2	.332	.0	1.20	1.20	.648
288.00	117.29	178.	1462.	.700	.650	608.	316.	695.	5.4	2	.326	.0	1.20	1.20	.645
290.00	118.71	179.	1462.	.697	.646	609.	317.	694.	5.4	2	.321	.0	1.20	1.20	.641
292.00	120.15	180.	1462.	.694	.643	609.	318.	694.	5.3	2	.315	.0	1.20	1.20	.637
294.00	121.60	181.	1462.	.691	.639	610.	320.	694.	5.3	2	.310	.0	1.20	1.20	.633
296.00	123.08	182.	1462.	.687	.636	610.	321.	694.	5.2	2	.304	.0	1.20	1.20	.630
298.00	124.57	182.	1462.	.684	.632	611.	323.	694.	5.2	2	.298	.0	1.20	1.20	.626
300.00	126.08	183.	1462.	.681	.628	611.	324.	694.	5.1	2	.293	.0	1.20	1.20	.622
302.00	127.61	184.	1462.	.678	.625	612.	326.	693.	5.1	2	.287	.0	1.20	1.20	.618
304.00	129.16	185.	1462.	.674	.621	612.	328.	693.	5.0	2	.281	.0	1.20	1.20	.615
306.00	130.72	186.	1462.	.671	.617	613.	330.	693.	5.0	2	.275	.0	1.20	1.20	.611
308.00	132.30	187.	1462.	.667	.614	613.	332.	693.	4.9	2	.270	.0	1.20	1.20	.607
310.00	133.90	188.	1462.	.664	.610	614.	333.	692.	4.9	2	.264	.0	1.20	1.20	.603
312.00	135.51	188.	1462.	.660	.606	614.	335.	692.	4.8	2	.258	.0	1.20	1.20	.599
314.00	137.14	189.	1462.	.657	.603	615.	337.	692.	4.8	2	.252	.0	1.20	1.20	.595
316.00	138.79	190.	1462.	.653	.599	615.	339.	692.	4.8	2	.246	.0	1.20	1.20	.591
318.00	140.16	191.	1462.	.650	.595	616.	342.	692.	4.7	2	.240	.0	1.20	1.20	.587
320.00	142.15	192.	1462.	.646	.591	617.	344.	691.	4.7	2	.234	.0	1.20	1.20	.583
322.00	143.85	193.	1462.	.642	.587	617.	347.	691.	4.6	2	.228	.0	1.20	1.20	.579
324.00	145.57	194.	1462.	.639	.583	618.	349.	691.	4.6	2	.222	.0	1.20	1.20	.575
326.00	147.30	194.	1462.	.635	.579	618.	351.	691.	4.5	2	.216	.0	1.20	1.20	.571
328.00	149.06	195.	1462.	.631	.575	619.	354.	691.	4.5	2	.209	.0	1.20	1.20	.567
330.00	150.83	196.	1462.	.627	.571	620.	357.	690.	4.5	2	.203	.0	1.20	1.20	.563
332.00	152.62	197.	1462.	.623	.567	620.	359.	690.	4.4	2	.196	.0	1.20	1.20	.559
334.00	154.42	198.	1462.	.619	.563	621.	362.	690.	4.4	2	.190	.0	1.20	1.20	.554
336.00	156.25	199.	1462.	.615	.559	621.	364.	690.	4.3	2	.184	.0	1.20	1.20	.550
338.00	158.09	200.	1462.	.611	.555	622.	367.	689.	4.3	2	.177	.0	1.20	1.20	.546
340.00	159.95	200.	1462.	.607	.551	623.	369.	689.	4.3	2	.170	.0	1.20	1.20	.542
342.00	161.82	201.	1463.	.603	.547	623.	371.	689.	4.2	2	.164	.0	1.20	1.20	.537
344.00	163.72	202.	1463.	.599	.543	624.	374.	689.	4.2	2	.157	.0	1.20	1.20	.533
346.00	165.63	203.	1463.	.595	.539	624.	376.	688.	4.2	2	.150	.0	1.20	1.20	.528
348.00	167.56	204.	1463.	.591	.534	625.	379.	688.	4.1	2	.144	.0	1.20	1.20	.524
350.00	169.50	205.	1463.	.586	.530	626.	381.	688.	4.1	2	.137	.0	1.20	1.20	.520

352.00	171.47	206.	1463.	.502	.526	626.	383.	608.	4.0	2	.130	.0	1.20	1.20	.515
354.00	173.45	207.	1463.	.577	.522	627.	386.	607.	4.0	2	.123	.0	1.20	1.20	.510
356.00	175.45	207.	1463.	.573	.517	628.	388.	607.	4.0	2	.116	.0	1.20	1.20	.506
358.00	177.47	208.	1463.	.569	.513	629.	391.	607.	3.9	2	.108	.0	1.20	1.20	.501
360.00	179.51	209.	1463.	.564	.508	629.	393.	607.	3.9	2	.101	.0	1.20	1.20	.497
362.00	181.56	210.	1463.	.559	.504	630.	396.	606.	3.9	2	.094	.0	1.20	1.20	.492
364.00	183.63	211.	1463.	.555	.500	631.	398.	606.	3.8	2	.087	.0	1.20	1.20	.487
366.00	185.72	212.	1463.	.550	.495	631.	401.	606.	3.8	2	.079	.0	1.20	1.20	.483
368.00	187.83	213.	1463.	.545	.491	632.	403.	605.	3.8	2	.072	.0	1.20	1.20	.478
370.00	189.96	213.	1463.	.511	.486	633.	406.	605.	3.7	2	.064	.0	1.20	1.20	.473
372.00	192.10	214.	1463.	.536	.481	634.	408.	605.	3.7	2	.057	.0	1.20	1.20	.468
374.00	194.26	215.	1463.	.531	.477	634.	411.	604.	3.7	2	.049	.0	1.20	1.20	.463
376.00	196.44	216.	1463.	.526	.472	635.	414.	604.	3.6	2	.041	.0	1.20	1.20	.458
378.00	198.64	217.	1463.	.521	.468	636.	416.	604.	3.6	2	.034	.0	1.20	1.20	.453
380.00	200.85	218.	1463.	.516	.463	637.	419.	603.	3.6	2	.026	.0	1.20	1.20	.448
382.00	203.09	219.	1463.	.511	.458	637.	421.	603.	3.5	2	.018	.0	1.20	1.20	.443
384.00	205.34	219.	1463.	.506	.453	638.	424.	603.	3.5	2	.010	.0	1.20	1.20	.438
386.00	207.62	220.	1463.	.501	.449	639.	427.	602.	3.5	2	.002	.0	1.20	1.20	.433
388.00	209.90	221.	1463.	.495	.444	640.	429.	602.	3.4	2	-.007	.0	1.20	1.20	.428
390.00	212.21	222.	1463.	.490	.439	641.	432.	602.	3.4	2	-.015	.0	1.20	1.20	.423
392.00	214.54	223.	1463.	.485	.434	642.	434.	601.	3.4	2	-.024	.0	1.20	1.20	.418
394.00	216.88	224.	1463.	.479	.429	642.	437.	601.	3.3	2	-.032	.0	1.20	1.20	.413
396.00	219.24	225.	1463.	.474	.424	643.	440.	601.	3.3	2	-.041	.0	1.20	1.20	.407
398.00	221.62	226.	1463.	.468	.420	644.	442.	600.	3.3	2	-.049	.0	1.20	1.20	.402
400.00	224.01	226.	1463.	.463	.415	645.	445.	600.	3.2	2	-.058	.0	1.20	1.20	.397
402.00	226.43	227.	1463.	.457	.410	646.	448.	679.	3.2	2	-.067	.0	1.20	1.20	.391
404.00	228.86	228.	1463.	.451	.405	647.	451.	679.	3.2	2	-.076	.0	1.20	1.20	.386
406.00	231.31	229.	1463.	.446	.399	648.	453.	679.	3.2	2	-.085	.0	1.20	1.20	.380
408.00	233.78	230.	1463.	.440	.394	649.	456.	678.	3.1	2	-.094	.0	1.20	1.20	.375
410.00	236.27	231.	1463.	.434	.389	650.	459.	678.	3.1	2	-.104	.0	1.20	1.20	.369
412.00	238.78	232.	1463.	.428	.384	651.	461.	677.	3.1	2	-.113	.0	1.20	1.20	.364
414.00	241.30	232.	1463.	.422	.379	652.	464.	677.	3.0	2	-.123	.0	1.20	1.20	.358
416.00	243.85	233.	1463.	.416	.374	653.	467.	676.	3.0	2	-.132	.0	1.20	1.20	.353
418.00	246.41	234.	1463.	.410	.368	654.	470.	676.	3.0	2	-.142	.0	1.20	1.20	.347
420.00	248.99	235.	1464.	.404	.363	655.	472.	676.	3.0	2	-.152	.0	1.20	1.20	.341
422.00	251.58	236.	1464.	.397	.358	656.	475.	675.	2.9	2	-.162	.0	1.20	1.20	.335
424.00	254.20	237.	1464.	.391	.353	657.	478.	675.	2.9	2	-.172	.0	1.20	1.20	.330
426.00	256.83	238.	1464.	.385	.347	658.	481.	674.	2.9	2	-.183	.0	1.20	1.20	.324
428.00	259.49	239.	1464.	.378	.342	659.	484.	674.	2.9	2	-.193	.0	1.20	1.20	.318
430.00	262.16	239.	1464.	.372	.336	660.	486.	673.	2.8	2	-.204	.0	1.20	1.20	.312
432.00	264.84	240.	1464.	.365	.331	661.	489.	672.	2.8	2	-.215	.0	1.20	1.20	.306
434.00	267.55	241.	1464.	.358	.325	663.	492.	672.	2.8	2	-.226	.0	1.20	1.20	.300
436.00	270.27	242.	1464.	.352	.320	664.	495.	671.	2.7	2	-.237	.0	1.20	1.20	.294
438.00	273.01	243.	1464.	.345	.314	665.	498.	671.	2.7	2	-.248	.0	1.20	1.20	.288
440.00	275.77	244.	1464.	.338	.309	666.	500.	670.	2.7	2	-.260	.0	1.20	1.20	.282
442.00	278.54	245.	1464.	.331	.303	668.	503.	670.	2.7	2	-.272	.0	1.20	1.20	.275
444.00	281.33	245.	1464.	.324	.297	669.	506.	669.	2.6	2	-.283	.0	1.20	1.20	.269
446.00	284.14	246.	1464.	.317	.292	670.	509.	668.	2.6	2	-.296	.0	1.20	1.20	.263
448.00	286.96	247.	1464.	.310	.286	672.	512.	668.	2.6	2	-.308	.0	1.20	1.20	.257
450.00	289.80	248.	1464.	.302	.280	673.	515.	667.	2.6	2	-.320	.0	1.20	1.20	.250
452.00	292.65	249.	1464.	.295	.275	674.	518.	666.	2.6	2	-.333	.0	1.20	1.20	.244
454.00	295.52	250.	1464.	.288	.269	676.	520.	666.	2.5	2	-.346	.0	1.20	1.20	.237
456.00	298.41	251.	1464.	.280	.263	677.	523.	665.	2.5	2	-.360	.0	1.20	1.20	.231
458.00	301.31	252.	1464.	.273	.257	679.	526.	664.	2.5	2	-.373	.0	1.20	1.20	.224
460.00	304.23	252.	1464.	.265	.251	680.	529.	663.	2.5	2	-.387	.0	1.20	1.20	.218
462.00	307.14	253.	1464.	.257	.245	682.	531.	662.	2.4	2	-.401	.0	1.20	1.20	.211
464.00	310.08	254.	1464.	.250	.239	684.	534.	662.	2.4	2	-.416	.0	1.20	1.20	.204
466.00	313.03	255.	1464.	.242	.233	685.	537.	661.	2.4	2	-.431	.0	1.20	1.20	.198
468.00	316.00	256.	1464.	.234	.227	687.	540.	660.	2.4	2	-.446	.0	1.20	1.20	.191
470.00	318.97	257.	1464.	.226	.221	689.	542.	659.	2.4	2	-.461	.0	1.20	1.20	.184

472.00	321.95	258.	1464.	.218	.215	691.	545.	650.	2.3	2	-.477	.0	1.20	1.20	.177
474.00	324.94	258.	1464.	.210	.209	692.	548.	657.	2.3	2	-.494	.0	1.20	1.20	.170
476.00	327.94	259.	1464.	.201	.203	694.	550.	656.	2.3	2	-.510	.0	1.20	1.20	.164
478.00	327.19	259.	1464.	.194	.197	696.	333.	655.	2.2	1	-.526	.0	1.20	1.20	.158
480.00	315.47	256.	1464.	.190	.194	698.	323.	654.	1.7	1	-.534	.0	1.20	1.20	.155
482.00	304.22	253.	1464.	.186	.190	701.	313.	652.	1.4	1	-.543	.0	1.20	1.20	.153
484.00	293.41	250.	1464.	.183	.187	703.	303.	651.	1.2	1	-.551	.0	1.20	1.20	.151
486.00	283.06	247.	1464.	.179	.183	705.	294.	650.	.9	1	-.559	.0	1.20	1.20	.148
488.00	273.13	244.	1464.	.175	.180	706.	285.	649.	.8	1	-.566	.0	1.20	1.20	.146
490.00	263.63	241.	1464.	.172	.177	708.	276.	648.	.6	1	-.574	.0	1.20	1.20	.141
492.00	254.54	238.	1464.	.169	.174	710.	268.	647.	.5	1	-.581	.0	1.20	1.20	.142
494.00	245.85	235.	1464.	.166	.171	712.	260.	646.	.4	1	-.588	.0	1.20	1.20	.140
496.00	237.55	232.	1463.	.163	.168	714.	252.	645.	.3	1	-.595	.0	1.20	1.20	.138
498.00	229.64	229.	1463.	.160	.165	716.	245.	643.	.3	1	-.602	.0	1.20	1.20	.136
500.00	222.09	227.	1463.	.157	.163	718.	237.	642.	.2	1	-.609	.0	1.20	1.20	.134
502.00	214.89	224.	1463.	.154	.160	720.	231.	641.	.2	1	-.615	.0	1.20	1.20	.132
504.00	208.04	222.	1463.	.151	.157	722.	224.	640.	.2	1	-.622	.0	1.20	1.20	.131
506.00	201.51	219.	1463.	.149	.155	723.	218.	639.	.1	1	-.628	.0	1.20	1.20	.129
508.00	195.30	217.	1463.	.146	.153	725.	212.	638.	.1	1	-.634	.0	1.20	1.20	.127
510.00	189.40	215.	1463.	.144	.150	727.	207.	637.	.1	1	-.640	.0	1.20	1.20	.125
512.00	183.78	212.	1463.	.141	.148	729.	201.	636.	.1	1	-.646	.0	1.20	1.20	.124
514.00	178.45	210.	1463.	.139	.146	730.	196.	635.	.1	1	-.652	.0	1.20	1.20	.122
516.00	173.38	208.	1463.	.137	.143	732.	191.	634.	.1	1	-.657	.0	1.20	1.20	.121
518.00	168.56	206.	1463.	.134	.141	733.	187.	633.	.0	1	-.663	.0	1.20	1.20	.119
520.00	163.99	204.	1463.	.132	.139	735.	182.	632.	.0	1	-.668	.0	1.20	1.20	.117
522.00	159.65	202.	1463.	.130	.137	736.	178.	631.	.0	1	-.674	.0	1.20	1.20	.116
524.00	155.53	200.	1462.	.128	.135	738.	174.	630.	.0	1	-.679	.0	1.20	1.20	.114
526.00	151.62	199.	1462.	.126	.133	739.	170.	629.	.0	1	-.684	.0	1.20	1.20	.113
528.00	147.90	197.	1462.	.124	.132	741.	167.	628.	.0	1	-.690	.0	1.20	1.20	.111
530.00	144.38	195.	1462.	.122	.130	742.	163.	627.	.0	1	-.695	.0	1.20	1.20	.110
532.00	141.03	194.	1462.	.120	.128	743.	160.	626.	.0	1	-.700	.0	1.20	1.20	.108
534.00	137.85	192.	1462.	.118	.126	745.	157.	625.	.0	1	-.705	.0	1.20	1.20	.107
536.00	134.84	191.	1462.	.117	.124	746.	154.	624.	.0	1	-.710	.0	1.20	1.20	.106
538.00	131.97	189.	1462.	.115	.123	748.	151.	624.	.0	1	-.715	.0	1.20	1.20	.104
540.00	129.25	188.	1462.	.113	.121	749.	149.	623.	.0	1	-.720	.0	1.20	1.20	.103
542.00	126.66	186.	1462.	.111	.119	750.	146.	622.	.0	1	-.724	.0	1.20	1.20	.101
544.00	124.20	185.	1462.	.110	.118	751.	144.	621.	.0	1	-.729	.0	1.20	1.20	.100
546.00	121.87	184.	1462.	.108	.116	753.	142.	620.	.0	1	-.734	.0	1.20	1.20	.099
548.00	119.64	182.	1462.	.106	.115	754.	139.	619.	.0	1	-.738	.0	1.20	1.20	.097
550.00	117.53	181.	1462.	.105	.113	755.	137.	618.	.0	1	-.743	.0	1.20	1.20	.096
552.00	115.52	180.	1462.	.103	.111	757.	135.	617.	.0	1	-.748	.0	1.20	1.20	.095
554.00	113.60	179.	1462.	.102	.110	758.	133.	616.	.0	1	-.752	.0	1.20	1.20	.093
556.00	111.77	178.	1462.	.100	.108	759.	132.	616.	.0	1	-.757	.0	1.20	1.20	.092
558.00	110.03	177.	1462.	.099	.107	760.	130.	615.	.0	1	-.761	.0	1.20	1.20	.091
560.00	108.37	176.	1462.	.097	.106	762.	128.	614.	.0	1	-.766	.0	1.20	1.20	.090
562.00	106.79	175.	1462.	.096	.104	763.	127.	613.	.0	1	-.770	.0	1.20	1.20	.088
564.00	105.28	174.	1462.	.094	.103	764.	125.	612.	.0	1	-.775	.0	1.20	1.20	.087
566.00	103.84	173.	1462.	.093	.101	765.	124.	611.	.0	1	-.780	.0	1.20	1.20	.086
568.00	102.45	172.	1462.	.091	.100	766.	122.	610.	.0	1	-.784	.0	1.20	1.20	.085
570.00	101.13	171.	1462.	.090	.099	768.	121.	609.	.0	1	-.788	.0	1.20	1.20	.084
572.00	99.87	171.	1462.	.088	.097	769.	120.	609.	.0	1	-.793	.0	1.20	1.20	.083
574.00	98.66	170.	1462.	.087	.096	770.	119.	608.	.0	1	-.797	.0	1.20	1.20	.081
576.00	97.50	169.	1462.	.086	.095	771.	118.	607.	.0	1	-.801	.0	1.20	1.20	.080
578.00	96.38	168.	1462.	.084	.093	772.	116.	606.	.0	1	-.806	.0	1.20	1.20	.079
580.00	95.31	168.	1462.	.083	.092	773.	115.	605.	.0	1	-.811	.0	1.20	1.20	.078
582.00	94.28	167.	1461.	.082	.091	775.	114.	604.	.0	1	-.815	.0	1.20	1.20	.077
584.00	93.30	166.	1461.	.080	.089	776.	113.	603.	.0	1	-.820	.0	1.20	1.20	.075
586.00	92.34	165.	1461.	.079	.088	777.	112.	602.	.0	1	-.824	.0	1.20	1.20	.074
588.00	91.43	165.	1461.	.078	.087	778.	112.	601.	.0	1	-.828	.0	1.20	1.20	.073
590.00	90.54	164.	1461.	.076	.086	779.	111.	601.	.0	1	-.832	.0	1.20	1.20	.072
592.00	89.68	163.	1461.	.075	.084	781.	110.	600.	.0	1	-.837	.0	1.20	1.20	.071
594.00	88.86	163.	1461.	.074	.083	782.	109.	599.	.0	1	-.841	.0	1.20	1.20	.069
596.00	88.06	162.	1461.	.073	.082	783.	108.	598.	.0	1	-.846	.0	1.20	1.20	.068
598.00	87.28	162.	1461.	.071	.081	784.	107.	597.	.0	1	-.851	.0	1.20	1.20	.067
600.00	86.53	161.	1461.	.070	.080	785.	107.	596.	.0	1	-.855	.0	1.20	1.20	.066

ETHLYENE OXIDE CAR

SVPR	INTT	COND	SCFM	TEMP	SIZE	TILT	WEIGHT
99.70	60.00	4.00	14600.	1500.00	25000.	120.	178703.

TIME	PSIG	TTNK	TVAL	FRAC	FMAT	TVAP	WOUT	PBRS	PHIT	KIDN	THETA	PICR	CNDLO	CNDVP	FRACLO
2.00	42.50	60.	1481.	.967	1.000	67.	0.	750.	40.2	2	1.023	.0	.55	.55	1.000
4.00	43.04	61.	1472.	.967	1.000	78.	0.	750.	40.6	2	1.025	.0	.79	.79	1.000
6.00	43.79	61.	1464.	.968	1.000	93.	0.	750.	41.1	2	1.027	.0	1.04	1.04	1.000
8.00	44.76	62.	1455.	.968	1.000	111.	0.	750.	41.8	2	1.030	.0	1.29	1.29	1.000
10.00	45.97	63.	1447.	.969	1.000	133.	0.	750.	42.6	2	1.033	.0	1.53	1.53	1.000
12.00	47.46	64.	1438.	.970	1.000	157.	0.	750.	43.7	2	1.037	.0	1.78	1.78	1.000
14.00	49.24	66.	1430.	.970	1.000	184.	0.	750.	44.9	2	1.042	.0	2.03	2.03	1.000
16.00	51.37	67.	1421.	.971	1.000	214.	0.	749.	46.5	2	1.047	.0	2.27	2.27	1.000
18.00	53.90	69.	1413.	.972	1.000	246.	0.	749.	48.3	2	1.054	.0	2.52	2.52	1.000
20.00	56.91	70.	1405.	.973	1.000	279.	0.	748.	50.5	2	1.061	.0	2.77	2.77	1.000
22.00	60.49	72.	1396.	.975	1.000	314.	0.	746.	53.2	2	1.069	.0	3.01	3.01	1.000
24.00	64.79	75.	1388.	.976	1.000	350.	0.	744.	56.5	2	1.079	.0	3.26	3.26	1.000
26.00	70.00	77.	1388.	.978	1.000	387.	0.	741.	60.6	2	1.090	.0	3.51	3.51	1.000
28.00	58.15	79.	1371.	.971	.992	423.	0.	737.	47.5	2	1.047	.0	3.75	3.75	.992
30.00	62.98	82.	1363.	.973	.992	460.	0.	732.	50.9	2	1.059	.0	4.00	4.00	.992
32.00	68.46	84.	1363.	.975	.992	495.	0.	726.	55.0	2	1.071	.0	4.00	4.00	.992
34.00	74.90	87.	1364.	.977	.992	527.	0.	719.	59.9	2	1.084	.0	4.00	4.00	.992
36.00	63.95	89.	1364.	.971	.984	557.	0.	711.	47.3	2	1.043	.0	4.00	4.00	.983
38.00	69.34	92.	1364.	.973	.984	584.	0.	703.	51.0	2	1.055	.0	4.00	4.00	.983
40.00	74.33	95.	1364.	.974	.983	608.	973.	695.	54.3	2	1.069	.0	4.00	4.00	.983
42.00	65.21	97.	1365.	.967	.974	631.	0.	686.	43.4	2	1.024	.0	4.00	4.00	.974
44.00	70.33	100.	1365.	.970	.974	651.	0.	677.	46.6	2	1.036	.0	4.00	4.00	.974
46.00	60.94	102.	1365.	.968	.962	669.	8185.	669.	35.3	2	1.006	.0	4.00	4.00	.962
48.00	65.12	105.	1366.	.962	.962	685.	0.	661.	37.5	2	.993	.0	4.00	4.00	.962
50.00	69.69	107.	1366.	.964	.962	700.	0.	653.	40.1	2	1.005	.0	4.00	4.00	.962
52.00	74.73	110.	1366.	.966	.962	713.	0.	645.	43.0	2	1.018	.0	4.00	4.00	.962
54.00	61.01	113.	1366.	.948	.942	724.	565.	638.	28.0	2	.920	.0	4.00	4.00	.942
56.00	61.07	115.	1367.	.944	.935	735.	636.	632.	25.8	2	.909	.0	4.00	4.00	.935
58.00	61.94	118.	1367.	.938	.928	745.	726.	626.	23.7	2	.888	.0	4.00	4.00	.927
60.00	62.84	120.	1367.	.931	.919	753.	843.	620.	21.5	2	.862	.0	4.00	4.00	.918
62.00	62.17	123.	1367.	.923	.909	761.	997.	614.	19.2	2	.833	.0	4.00	4.00	.908
64.00	62.36	125.	1368.	.913	.896	768.	1203.	609.	17.0	2	.799	.0	4.00	4.00	.895
66.00	62.64	128.	1368.	.900	.881	774.	1477.	605.	14.9	2	.759	.0	4.00	4.00	.880
68.00	63.03	130.	1368.	.883	.863	780.	1841.	600.	12.8	2	.711	.0	4.00	4.00	.862
70.00	63.58	133.	1369.	.861	.839	785.	2314.	596.	10.8	2	.655	.0	4.00	4.00	.838
72.00	64.37	135.	1369.	.833	.810	791.	2891.	592.	9.0	2	.589	.0	4.00	4.00	.808
74.00	65.39	137.	1369.	.797	.774	795.	3566.	588.	7.5	2	.512	.0	4.00	4.00	.772
76.00	66.72	140.	1369.	.754	.731	799.	3846.	585.	6.2	2	.428	.0	4.00	4.00	.728
78.00	68.56	142.	1370.	.712	.689	804.	3654.	600.	5.3	2	.351	.0	4.00	4.00	.686
80.00	70.75	145.	1370.	.672	.649	808.	3535.	596.	4.7	2	.281	.0	4.00	4.00	.645
82.00	73.22	147.	1370.	.633	.610	813.	3460.	591.	4.2	2	.215	.0	4.00	4.00	.606
84.00	75.91	150.	1370.	.594	.571	818.	3415.	587.	3.8	2	.151	.0	4.00	4.00	.566
86.00	78.80	152.	1371.	.555	.534	823.	3332.	583.	3.5	2	.090	.0	4.00	4.00	.528
88.00	81.90	155.	1371.	.517	.497	828.	3285.	578.	3.2	2	.030	.0	4.00	4.00	.490
90.00	85.19	158.	1371.	.479	.460	834.	3293.	573.	3.0	2	-.030	.0	4.00	4.00	.453
92.00	88.78	161.	1371.	.441	.423	839.	3343.	569.	2.8	2	-.090	.0	4.00	4.00	.415
94.00	92.45	164.	1372.	.401	.385	845.	3388.	563.	2.6	2	-.153	.0	4.00	4.00	.376
96.00	96.42	167.	1372.	.361	.347	851.	3459.	558.	2.5	2	-.219	.0	4.00	4.00	.337
98.00	100.73	170.	1372.	.319	.308	858.	3523.	552.	2.3	2	-.289	.0	4.00	4.00	.297
100.00	105.36	173.	1373.	.276	.268	864.	3627.	546.	2.2	2	-.364	.0	4.00	4.00	.256
102.00	110.34	176.	1373.	.231	.227	872.	3737.	540.	2.1	2	-.448	.0	4.00	4.00	.213
104.00	103.77	172.	1373.	.189	.189	880.	1657.	533.	1.2	1	-.536	.0	4.00	4.00	.175
106.00	68.19	146.	1370.	.171	.174	889.	1064.	525.	.1	1	-.575	.0	4.00	4.00	.164
108.00	62.81	142.	1370.	.165	.169	898.	274.	517.	.0	1	-.589	.0	4.00	4.00	.159
110.00	62.82	142.	1370.	.162	.166	906.	274.	510.	.0	1	-.596	.0	4.00	4.00	.156

112.00	62.82	142.	1370.	.159	.162	913.	274.	504.	.0	1	-.604	.0	4.00	4.00	.153
114.00	62.82	142.	1370.	.156	.159	920.	275.	498.	.0	1	-.611	.0	4.00	4.00	.150
116.00	62.82	142.	1370.	.153	.156	926.	275.	492.	.0	1	-.618	.0	4.00	4.00	.147
118.00	62.82	142.	1370.	.149	.153	932.	275.	487.	.0	1	-.626	.0	4.00	4.00	.144
120.00	62.82	142.	1370.	.146	.150	938.	274.	482.	.0	1	-.634	.0	4.00	4.00	.141
122.00	62.82	142.	1370.	.143	.147	943.	274.	477.	.0	1	-.642	.0	4.00	4.00	.138
124.00	62.81	142.	1370.	.140	.144	948.	274.	473.	.0	1	-.650	.0	4.00	4.00	.135
126.00	62.81	142.	1370.	.136	.141	952.	273.	469.	.0	1	-.658	.0	4.00	4.00	.131
128.00	62.81	142.	1370.	.133	.138	957.	272.	465.	.0	1	-.666	.0	4.00	4.00	.128
130.00	62.80	142.	1370.	.130	.135	961.	271.	462.	.0	1	-.674	.0	4.00	4.00	.125
132.00	62.80	142.	1370.	.127	.132	965.	270.	458.	.0	1	-.682	.0	4.00	4.00	.122
134.00	62.79	142.	1370.	.124	.129	968.	269.	455.	.0	1	-.691	.0	4.00	4.00	.119
136.00	62.79	142.	1370.	.121	.126	972.	268.	452.	.0	1	-.699	.0	4.00	4.00	.116
138.00	62.78	142.	1370.	.117	.123	975.	267.	449.	.0	1	-.708	.0	4.00	4.00	.113
140.00	62.78	142.	1370.	.114	.120	979.	266.	446.	.0	1	-.716	.0	4.00	4.00	.110
142.00	62.77	142.	1370.	.111	.117	982.	264.	443.	.0	1	-.725	.0	4.00	4.00	.107
144.00	62.76	142.	1370.	.108	.114	985.	263.	441.	.0	1	-.733	.0	4.00	4.00	.104
146.00	62.76	142.	1370.	.105	.111	988.	261.	438.	.0	1	-.742	.0	4.00	4.00	.101
148.00	62.75	142.	1370.	.102	.108	991.	260.	436.	.0	1	-.752	.0	4.00	4.00	.098
150.00	62.74	142.	1370.	.099	.105	994.	258.	433.	.0	1	-.760	.0	4.00	4.00	.095
152.00	62.73	142.	1370.	.096	.102	996.	257.	431.	.0	1	-.769	.0	4.00	4.00	.092
154.00	62.73	142.	1370.	.093	.099	999.	255.	428.	.0	1	-.779	.0	4.00	4.00	.089
156.00	62.72	142.	1370.	.090	.097	1002.	253.	426.	.0	1	-.788	.0	4.00	4.00	.087
158.00	62.71	142.	1370.	.087	.094	1005.	251.	423.	.0	1	-.797	.0	4.00	4.00	.084
160.00	62.70	142.	1370.	.084	.091	1007.	249.	421.	.0	1	-.807	.0	4.00	4.00	.081
162.00	62.69	142.	1370.	.081	.088	1010.	247.	419.	.0	1	-.817	.0	4.00	4.00	.078
164.00	62.68	142.	1370.	.078	.085	1013.	245.	416.	.0	1	-.827	.0	4.00	4.00	.075
166.00	62.67	142.	1370.	.075	.083	1015.	243.	414.	.0	1	-.836	.0	4.00	4.00	.073
168.00	62.66	142.	1370.	.072	.080	1018.	241.	412.	.0	1	-.847	.0	4.00	4.00	.070
170.00	62.65	142.	1370.	.070	.077	1021.	239.	409.	.0	1	-.857	.0	4.00	4.00	.067
172.00	62.64	142.	1369.	.067	.075	1024.	236.	407.	.0	1	-.867	.0	4.00	4.00	.064
174.00	62.63	142.	1369.	.064	.072	1026.	234.	404.	.0	1	-.878	.0	4.00	4.00	.062
176.00	62.62	142.	1369.	.061	.069	1029.	232.	402.	.0	1	-.888	.0	4.00	4.00	.059
178.00	62.60	142.	1369.	.059	.067	1032.	229.	399.	.0	1	-.899	.0	4.00	4.00	.056
180.00	62.59	142.	1369.	.056	.064	1035.	227.	397.	.0	1	-.910	.0	4.00	4.00	.054
182.00	62.58	142.	1369.	.053	.062	1038.	224.	394.	.0	1	-.921	.0	4.00	4.00	.051
184.00	62.56	142.	1369.	.051	.059	1041.	221.	392.	.0	1	-.933	.0	4.00	4.00	.049
186.00	62.55	142.	1369.	.048	.057	1044.	218.	389.	.0	1	-.944	.0	4.00	4.00	.046
188.00	62.54	142.	1369.	.046	.054	1047.	216.	386.	.0	1	-.956	.0	4.00	4.00	.044
190.00	62.52	142.	1369.	.043	.052	1050.	212.	384.	.0	1	-.968	.0	4.00	4.00	.041
192.00	62.51	142.	1369.	.041	.050	1053.	210.	381.	.0	1	-.981	.0	4.00	4.00	.039
194.00	62.49	142.	1369.	.038	.047	1057.	206.	378.	.0	1	-.993	.0	4.00	4.00	.037
196.00	62.56	142.	1369.	.036	.045	1060.	221.	375.	.0	1	-1.007	.0	4.00	4.00	.034
198.00	62.55	142.	1369.	.033	.043	1063.	217.	372.	.0	1	-1.021	.0	4.00	4.00	.032
200.00	62.53	142.	1369.	.031	.040	1067.	213.	369.	.0	1	-1.036	.0	4.00	4.00	.029
202.00	62.51	142.	1369.	.028	.038	1071.	209.	365.	.0	1	-1.052	.0	4.00	4.00	.027
204.00	62.49	142.	1369.	.026	.035	1075.	204.	362.	.0	1	-1.067	.0	4.00	4.00	.025
206.00	62.46	142.	1369.	.023	.033	1079.	200.	358.	.0	1	-1.084	.0	4.00	4.00	.022
208.00	62.44	141.	1369.	.021	.031	1083.	194.	355.	.0	1	-1.101	.0	4.00	4.00	.020
210.00	62.41	141.	1369.	.019	.029	1088.	189.	351.	.0	1	-1.119	.0	4.00	4.00	.018
212.00	62.38	141.	1369.	.016	.027	1092.	183.	347.	.0	1	-1.137	.0	4.00	4.00	.016
214.00	62.35	141.	1369.	.014	.025	1097.	177.	342.	.0	1	-1.157	.0	4.00	4.00	.014
216.00	62.33	141.	1369.	.012	.023	1102.	171.	338.	.0	1	-1.178	.0	4.00	4.00	.012
218.00	62.28	141.	1369.	.010	.021	1108.	164.	333.	.0	1	-1.201	.0	4.00	4.00	.010
220.00	62.24	141.	1369.	.009	.019	1113.	156.	328.	.0	1	-1.225	.0	4.00	4.00	.008
222.00	62.23	141.	1369.	.007	.017	1120.	146.	323.	.0	1	-1.249	.0	4.00	4.00	.006
224.00	62.15	141.	1369.	.005	.016	1126.	136.	317.	.0	1	-1.281	.0	4.00	4.00	.005
226.00	62.05	141.	1369.	.004	.014	1133.	127.	310.	.0	1	-1.313	.0	4.00	4.00	.003
228.00	62.19	141.	1369.	.002	.013	1141.	103.	304.	.0	1	-1.349	.0	4.00	4.00	.002
230.00	59.84	172.	1372.	.000	.010	1153.	0.	293.	.0	4	-1.571	.0	4.00	4.00	.000

232.00	68.18	242.	1380.	.000	.010	1167.	0.	281.	.0	4	-1.571	.0	4.00	4.00	.000
234.00	75.22	303.	1387.	.000	.009	1181.	1110.	268.	.0	4	-1.571	.0	4.00	4.00	.000
236.00	63.21	369.	1393.	.000	.008	1194.	0.	257.	.0	4	-1.571	.0	4.00	4.00	.000
238.00	70.18	413.	1400.	.000	.008	1207.	0.	246.	.0	4	-1.571	.0	4.00	4.00	.000
240.00	57.39	491.	1405.	.000	.006	1219.	161.	235.	.0	4	-1.571	.0	4.00	4.00	.000
242.00	62.34	572.	1413.	.000	.006	1231.	0.	225.	.0	4	-1.571	.0	4.00	4.00	.000
244.00	67.85	645.	1420.	.000	.006	1242.	0.	215.	.0	4	-1.571	.0	4.00	4.00	.000
246.00	72.85	711.	1427.	.000	.006	1252.	0.	206.	.0	4	-1.571	.0	4.00	4.00	.000
248.00	56.03	749.	1430.	.000	.005	1263.	0.	197.	.0	4	-1.571	.0	4.00	4.00	.000
250.00	60.27	821.	1437.	.000	.005	1272.	0.	188.	.0	4	-1.571	.0	4.00	4.00	.000
252.00	64.81	884.	1443.	.000	.005	1282.	0.	180.	.0	4	-1.571	.0	4.00	4.00	.000
254.00	67.30	940.	1449.	.000	.005	1291.	0.	172.	.0	4	-1.571	.0	4.00	4.00	.000
256.00	70.21	989.	1453.	.000	.005	1300.	0.	165.	.0	4	-1.571	.0	4.00	4.00	.000
258.00	72.70	1033.	1458.	.000	.005	1308.	0.	157.	.0	4	-1.571	.0	4.00	4.00	.000
260.00	75.06	1071.	1461.	.000	.005	1316.	0.	150.	.0	4	-1.571	.0	4.00	4.00	.000
262.00	54.00	1079.	1462.	.000	.004	1323.	0.	144.	.0	4	-1.571	.0	4.00	4.00	.000
264.00	56.07	1123.	1466.	.000	.004	1331.	0.	137.	.0	4	-1.571	.0	4.00	4.00	.000
266.00	57.76	1161.	1469.	.000	.004	1338.	0.	131.	.0	4	-1.571	.0	4.00	4.00	.000
268.00	59.21	1193.	1472.	.000	.004	1344.	0.	125.	.0	4	-1.571	.0	4.00	4.00	.000
270.00	60.45	1220.	1475.	.000	.004	1351.	0.	120.	.0	4	-1.571	.0	4.00	4.00	.000
272.00	61.52	1244.	1477.	.000	.004	1357.	0.	114.	.0	4	-1.571	.0	4.00	4.00	.000
274.00	62.44	1265.	1479.	.000	.004	1363.	0.	109.	.0	4	-1.571	.0	4.00	4.00	.000
276.00	63.25	1283.	1481.	.000	.004	1369.	0.	104.	.0	4	-1.571	.0	4.00	4.00	.000
278.00	63.96	1299.	1482.	.000	.004	1374.	0.	99.	.0	4	-1.571	.0	4.00	4.00	.000
280.00	64.59	1312.	1483.	.000	.004	1379.	0.	95.	.0	4	-1.571	.0	4.00	4.00	.000
282.00	65.14	1325.	1484.	.000	.004	1384.	0.	90.	.0	4	-1.571	.0	4.00	4.00	.000
284.00	65.64	1336.	1485.	.000	.004	1389.	0.	86.	.0	4	-1.571	.0	4.00	4.00	.000
286.00	66.08	1346.	1486.	.000	.004	1394.	0.	82.	.0	4	-1.571	.0	4.00	4.00	.000
288.00	66.48	1355.	1487.	.000	.004	1398.	0.	78.	.0	4	-1.571	.0	4.00	4.00	.000
290.00	66.84	1363.	1488.	.000	.004	1402.	0.	75.	.0	4	-1.571	.0	4.00	4.00	.000
292.00	67.18	1370.	1488.	.000	.004	1406.	0.	71.	.0	4	-1.571	.0	4.00	4.00	.000
294.00	67.48	1377.	1489.	.000	.004	1410.	0.	68.	.0	4	-1.571	.0	4.00	4.00	.000
294.10	67.50	1377.	1489.	.000	.004	1410.	0.	67.	.0	4	-1.571	.0	4.00	4.00	.000

APPENDIX I: EFFECT OF TEMPERATURE DEPENDENT THERMAL CONDUCTIVITY

The thermal conductivity of most high temperature insulation materials is a function of temperature, with the conductivity increasing with increasing temperature. This dependence can be quite significant resulting in a tenfold increase in conductivity over the temperature range from 60 to 1600°F.

The parametric analyses described in Section 5 were made with the assumption of constant conductance. This does not imply that conductivity is not a function of temperature, but only that the value of conductance does not change over the course of the analysis. For the tank car problem, where the temperature of the car changes with time, the assumption of temperature dependent conductivity implies some change in conductance over the course of the analysis.

One reason that constant conductance was assumed for the parametric analyses was that some materials, which have been used for thermal shield systems, have met the requirements of HM-144, but they have never been tested to determine their conductivities as a function of temperature. Also, if the assumption of temperature dependent conductivity were made the results would be specialized to a material having that particular functional dependence on temperature. Using the assumption of constant conductance allowed the calculation of data which had more general application. It was thought best to perform the analyses with an assumed constant overall effective conductance and then make a separate study to determine what the influence of this assumption is on the results.

One would expect that the inclusion of temperature dependent conductivity in the analysis of the tank car in the fire would have the following consequences. The portion of the thermal shield adjacent to the wetted area of the tank would have a relatively constant thermal conductance because the average temperature of the insulation would change only a small amount. The effective conductance would be expected to be less than that given by the pool fire simulation test. On the other hand, the thermal conductance of the shield adjacent to the vapor space would show a marked increase with time because as the inner wall temperature rises the average temperature through the thermal shield is increasing.

The influence of temperature dependent conductivity on the prediction of effects when a tank car is engulfed in a fire was examined in the following manner. First, the consequences on a pool fire simulation test were determined. Several thermal systems were selected which were predicted to give specific temperature results on this type of test. These were then applied to tank cars and full scale pool fire effects analyzed.

The significance of using a thermal shield system with temperature dependent conductivity in the pool fire simulation test is that the effective conductance of the thermal shield would tend to rise with time because the average temperature of the system would be increasing. The effects were examined by assuming a temperature dependent conductivity for a thermal shield system which was based on data (not from DOT pool fire simulation test) for a high temperature material which undergoes a large change in conductivity with a change in temperature. Calculations were made for different thicknesses of the thermal insulation material so that one could then identify the temperature rise of the base plate with a given thickness of insulation.

To determine the effect of this property on a tank car in a fire, analyses were conducted with different thicknesses of thermal insulation. These analyses were performed by recalculating the thermal conductance of the insulation system each time step. This procedure took into account the different temperatures on the front and back of the insulation. Two different thermal conductances were calculated, one for the material over the vapor space and the other for the material adjacent to the liquid region.

The results were compared with constant conductance cases where the predictions of the temperature resulting from exposure of the insulation systems to the pool fire simulation tests were the same. The results of these comparisons were somewhat surprising because there were no significant differences. Several effects interact to produce these results. First of all, the thermal shield over the vapor space tends to become more conductive as the temperature of the tank wall increases causing an even more rapid increase in temperature and corresponding decrease in strength. A more surprising fact is that the effective conductance in the wetted area is greater than that indicated by the pool fire simulation test. One would expect that because the temperature of the tank, which is adjacent to the liquid, is being held at a relatively low value, that the thermal conductance of this region would be lower than that provided by the pool fire simulation test. However, the heat flux associated with the pool fire simulation test, which is governed by the way the flame is adjusted in the uninsulated plate calibration test, is less than that encountered in the full scale fire. Thus, the temperature on the flame side of the insulation is not as hot in the pool fire simulation test as it is in the fire environment, and therefore, the thermal conductance of the insulation system in the pool fire simulation test is less than that in the full scale fire.

The conclusion from these analyses is that it does not make much difference in the prediction of fire effects on tank cars if the assumption is made that the thermal shield has a constant conductance or if the assumption is made that the conductivity of the insulation system changes with temperature. Approximately the same minimum pressures are predicted for equivalent thermal shield systems and the times to failure are comparable. The results indicate that either approach can be used to develop background information on which safety considerations can be evaluated.

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232.00	68.18	242.	1380.	.000	.010	1167.	0.	281.	.0	4	-1.571	.0	4.00	4.00	.000
234.07	75.22	303.	1387.	.000	.009	1181.	1110.	268.	.0	4	-1.571	.0	4.00	4.00	.000
236.00	63.21	369.	1393.	.000	.008	1194.	0.	257.	.0	4	-1.571	.0	4.00	4.00	.001
238.00	70.18	413.	1400.	.000	.008	1207.	0.	246.	.0	4	-1.571	.0	4.00	4.00	.003
240.00	57.39	491.	1405.	.000	.006	1219.	161.	235.	.0	4	-1.571	.0	4.00	4.00	.003
242.00	62.34	572.	1413.	.000	.006	1231.	0.	225.	.0	4	-1.571	.0	4.00	4.00	.000
244.00	67.85	645.	1420.	.000	.006	1242.	0.	215.	.0	4	-1.571	.0	4.00	4.00	.000
246.00	72.85	711.	1427.	.000	.006	1252.	0.	206.	.0	4	-1.571	.0	4.00	4.00	.000
248.00	56.03	719.	1430.	.000	.005	1263.	0.	197.	.0	4	-1.571	.0	4.00	4.00	.000
250.00	60.27	821.	1437.	.000	.005	1272.	0.	188.	.0	4	-1.571	.0	4.00	4.00	.000
252.00	64.81	884.	1443.	.000	.005	1282.	0.	180.	.0	4	-1.571	.0	4.00	4.00	.000
254.00	67.30	940.	1449.	.000	.005	1291.	0.	172.	.0	4	-1.571	.0	4.00	4.00	.000
256.00	70.21	909.	1453.	.000	.005	1300.	0.	165.	.0	4	-1.571	.0	4.00	4.00	.000
258.00	72.78	1033.	1458.	.000	.005	1308.	0.	157.	.0	4	-1.571	.0	4.00	4.00	.000
260.00	75.06	1071.	1461.	.000	.005	1316.	0.	150.	.0	4	-1.571	.0	4.00	4.00	.000
262.00	54.08	1079.	1462.	.000	.004	1323.	0.	144.	.0	4	-1.571	.0	4.00	4.00	.000
264.00	56.07	1123.	1466.	.000	.004	1331.	0.	137.	.0	4	-1.571	.0	4.00	4.00	.000
266.00	57.76	1161.	1469.	.000	.004	1338.	0.	131.	.0	4	-1.571	.0	4.00	4.00	.000
268.00	59.21	1193.	1472.	.000	.004	1344.	0.	125.	.0	4	-1.571	.0	4.00	4.00	.000
270.00	60.45	1220.	1475.	.000	.004	1351.	0.	120.	.0	4	-1.571	.0	4.00	4.00	.000
272.00	61.52	1244.	1477.	.000	.004	1357.	0.	114.	.0	4	-1.571	.0	4.00	4.00	.000
274.00	62.44	1265.	1479.	.000	.004	1363.	0.	109.	.0	4	-1.571	.0	4.00	4.00	.000
276.00	63.25	1283.	1481.	.000	.004	1369.	0.	104.	.0	4	-1.571	.0	4.00	4.00	.000
278.00	63.96	1299.	1482.	.000	.004	1374.	0.	99.	.0	4	-1.571	.0	4.00	4.00	.000
280.00	64.59	1312.	1483.	.000	.004	1379.	0.	95.	.0	4	-1.571	.0	4.00	4.00	.000
282.00	65.14	1325.	1484.	.000	.004	1384.	0.	90.	.0	4	-1.571	.0	4.00	4.00	.000
284.00	65.64	1336.	1485.	.000	.004	1389.	0.	86.	.0	4	-1.571	.0	4.00	4.00	.000
286.00	66.08	1346.	1486.	.000	.004	1394.	0.	82.	.0	4	-1.571	.0	4.00	4.00	.000
288.00	66.48	1355.	1487.	.000	.004	1398.	0.	78.	.0	4	-1.571	.0	4.00	4.00	.000
290.00	66.84	1363.	1488.	.000	.004	1402.	0.	75.	.0	4	-1.571	.0	4.00	4.00	.000
292.00	67.18	1370.	1488.	.000	.004	1406.	0.	71.	.0	4	-1.571	.0	4.00	4.00	.000
294.00	67.48	1377.	1489.	.000	.004	1410.	0.	68.	.0	4	-1.571	.0	4.00	4.00	.000
294.10	67.50	1377.	1489.	.000	.004	1410.	0.	67.	.0	4	-1.571	.0	4.00	4.00	.000

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