DRY FILM COATING THICKNESSES

OF

THERMO-LAG 330-1 SUBLIMING MATERIAL APPLIED

TO

STEEL HATCH COVERS

FOR

THREE HOUR FIRE RATING

Prepared
by
Wesson and Associates, Inc.
P. O. Box 1082
Norman, Oklahoma 73070

February 15, 1984

DRY FILM COATING THICKNESSES
OF
THERMO-LAG 330-1 SUBLIMING MATERIAL APPLIED
TO
STEEL HATCH COVERS
FOR
THREE HOUR FIRE RATING

I. INTRODUCTION

The purpose of this report is to present the calculated minimum dry film coating thicknesses of THERMO-LAG 330-1 Subliming Material applied to steel hatch covers which are provided in the floors of nuclear power facilities. These hatch covers are used to seal the connecting passageways between two floor levels or between a floor and a vault beneath the floor in these nuclear facilities.

The minimum dry film coating thicknesses have been calculated to provide a three hour fire rating when subjected to the fire condition specified by ASTM E-119 Test Method. In this test procedure, the time-averaged incident heat flux for a three-hour exposure is 42,000 Btu per hour per square foot.

The basis for the determination of the minimum dry film coating thicknesses for the THERMO-LAG 330-1 Subliming Material applied to flat plates is an engineering correlation developed from experimental results from fire tests conducted on the material. The experimental data used in the correlation include the results of fire tests conducted by several independent organizations such as the Underwriter's Laboratory, the U. S. Department of Transportation (Federal Railroad Administration), Mobil Oil Corporation and Wesson and Associates, Inc.

The minimum dry film coating thicknesses have been calculated for hatch covers having thicknesses of 3/16, 3/8 and 1/2 inches, fire exposure from one side only and simultaneous fire exposure on both sides of the hatch cover. The temperature rises used included 250° F for

personnel considerations and 930° F for maintaining the structural integrity of the steel.

II. ENGINEERING CORRELATION FOR FLAT STEEL PLATES

The thermal performance characteristics of fireproofing materials such as THERMO-LAG 330-1 Subliming Material, THERMO-LAG 290 Subliming Material, CHARTEK 59, KOROTHERM and PYROCRETE 102 have been found to correlate as:

$$t = \text{a function of } (T, \Delta T, W, F) \qquad (1)$$

where
- t = fire exposure time, minutes
- T = dry film coating thickness of fireproofing material, inches
- ΔT = temperature rise of the protected metal substrate, $^{\circ}$F
- W = effective heat capacity of protected metal substrate, pounds per square foot of exposed area
- F = total incident heat flux, thousands of Btu per hour per square foot.

Experimental fire test data expressing the fire exposure time as a function of the fireproofing material coating thickness, the temperature rise of the protected metal substrate, the weight of the protected metal substrate and the total incident heat flux have been used to develop empirical engineering correlations for the THERMO-LAG 330-1 Subliming Material applied to various substrates such as flat steel plates, pipes and structural steel members (I-beams). The range of total incident heat fluxes have varied from a low of 10,000 Btu per hour per square foot to a high of about 95,000 Btu per hour per square foot. The coating thicknesses have varied from a low of 0.125 inches to a high of about 1.25 inches.

The engineering correlation expressing the exposure time of a protected steel plate as a function of the coating thickness, temperature rise of the metal substrate, the effective heat capacity of the protected substrate and the total incident heat flux is

$$t = 23.002 \left[(T)(\Delta T)^{0.7}(W)^{0.5}/(F)\right]^{1.3356} \qquad (2)$$

where W is expressed in pounds per square foot of protected flat plate exposed to the incident heat flux. The engineering correlation is presented in Figure 1. As noted on this figure, if the protected substrate is exposed to a fire condition on both sides, the effective heat capacity, W, is based on one-half the thickness of the plate.

III. INCIDENT HEAT FLUXES FROM FIRES

The incident heat fluxes from the ASTM E-119 Test Method and from flammable liquid spill fires are widely used for the determination of the required fireproofing coating thicknesses for various protected steel substrates.

ASTM E-119 Test Method:

The ASTM E-119 Test Method uses a specific time-temperature relationship for testing the fire resistive capabilities of various fireproofing materials. The required time-temperature relationship is presented in Figure 2. As shown the internal air temperature of the the test set-up starts at the prevailing ambient air temperature, reaches a temperature of 1700° F at the end of the first hour of exposure, a temperature of 1850° F at the end of the second hour of exposure and a temperature of of about 1950° F at the end of the third hour of exposure. This specified time-temperature profile does not represent the time-temperature profile for a typical hydrocarbon spill fire wherein the temperature within the flame zone may reach a temperature of about 2200° F or more within a very short period of time (one to three minutes). Thus, the ASTM E-119 Test Method does not truly represent the environment of a flammable hydrocarbon fire.

The time-heat flux relationship corresponding to the time-temperature profile specified by the ASTM E-119 Test Method is presented in Figure 3. As indicated on this figure, the integrated time-averaged incident heat fluxes are 24,500 Btu per hour per square foot for the first hour of exposure, 34,500 Btu per hour per square foot for two hours of exposure

FIGURE 1: CORRELATION OF THE THERMAL PERFORMANCE CHARACTERISTICS OF THERMO-LAG 330-1 SUBLIMING MATERIAL APPLIED TO STEEL PLATES AND PIPES

NOTE: For angles or plate exposed on both sides, use W = weight of metal substrate, lbs/sq.ft of exposed area based on one-half leg or plate thickness

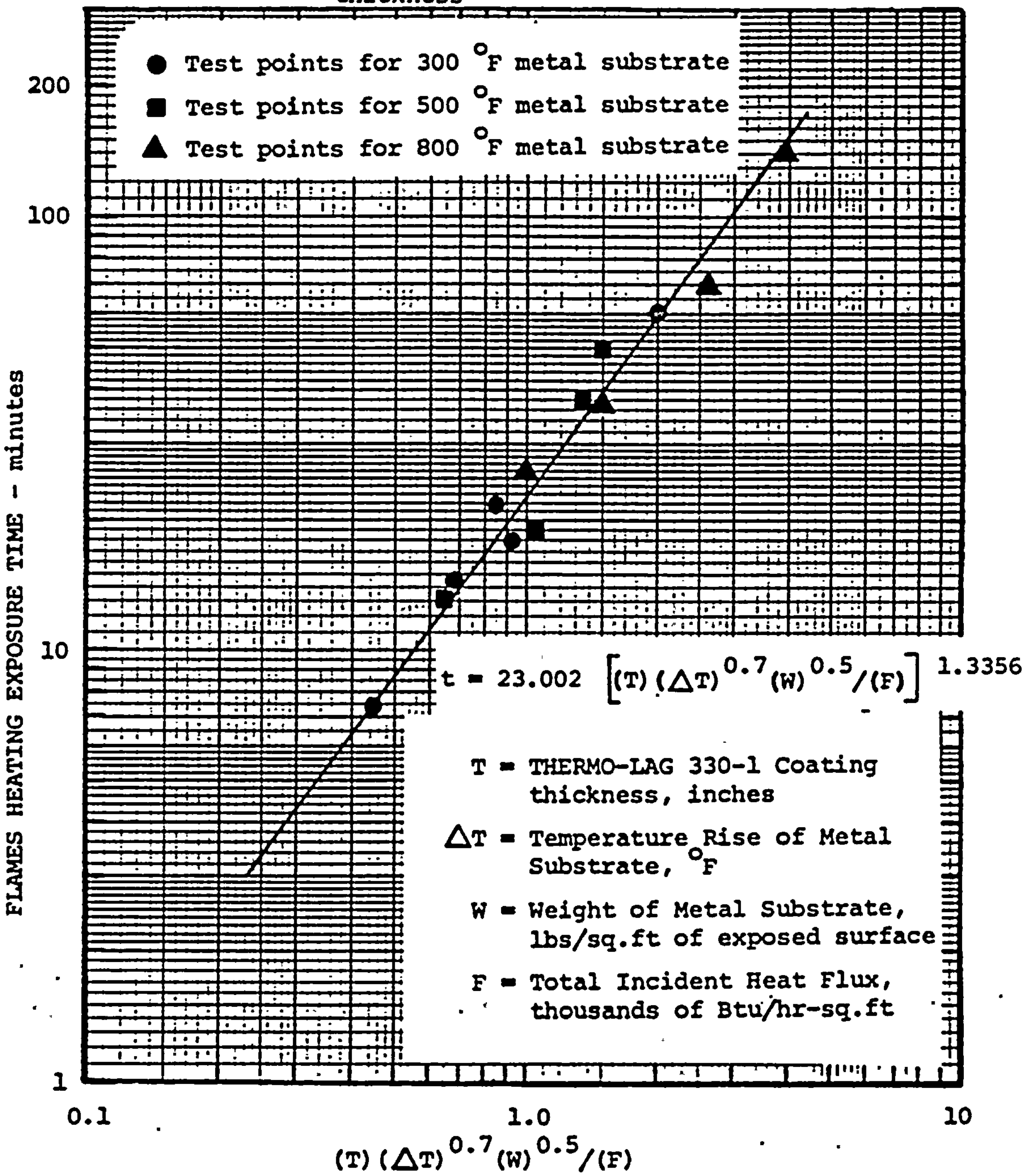


FIGURE 2: ASTM E-119 TEST METHOD TIME-TEMPERATURE PROFILE

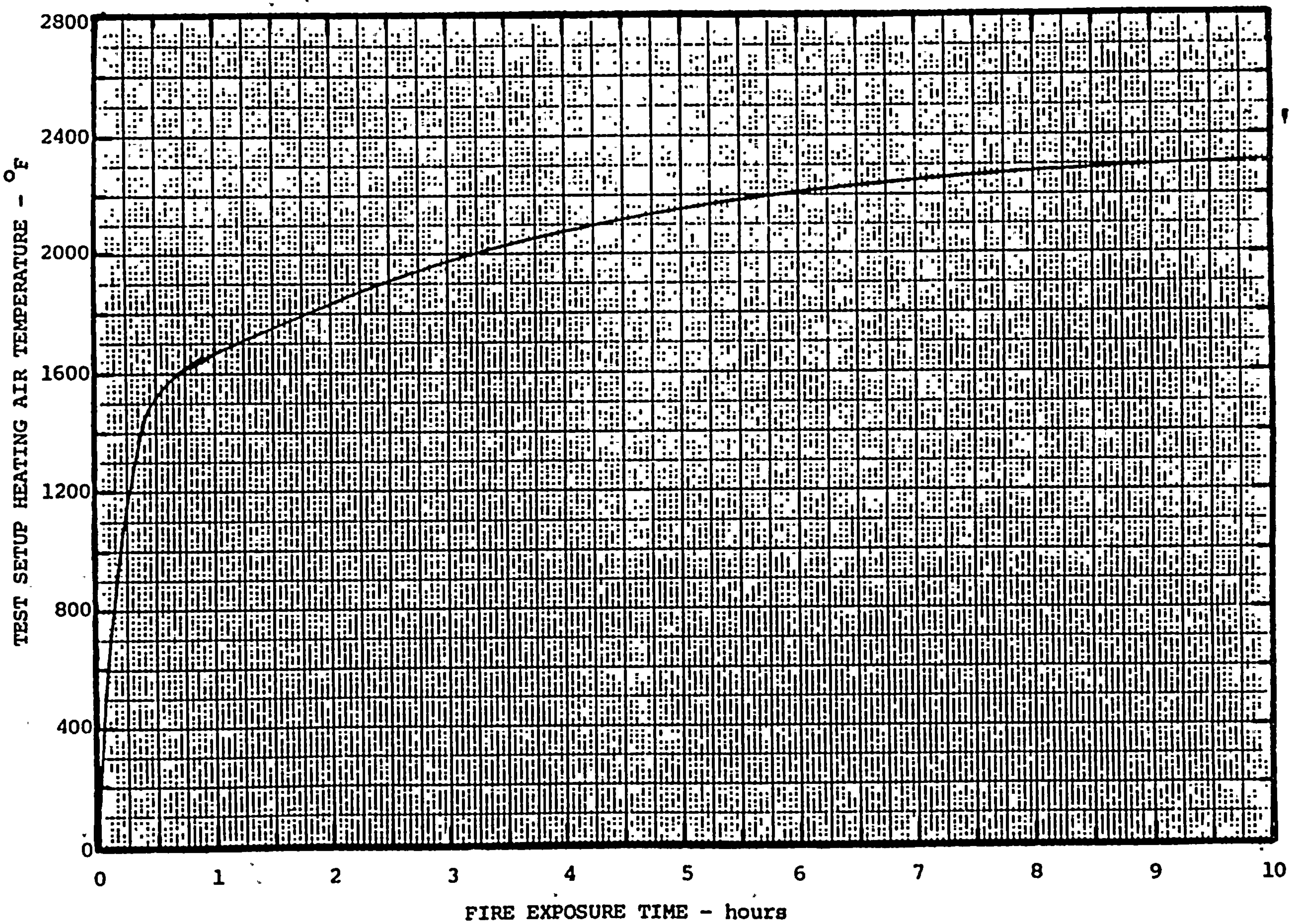
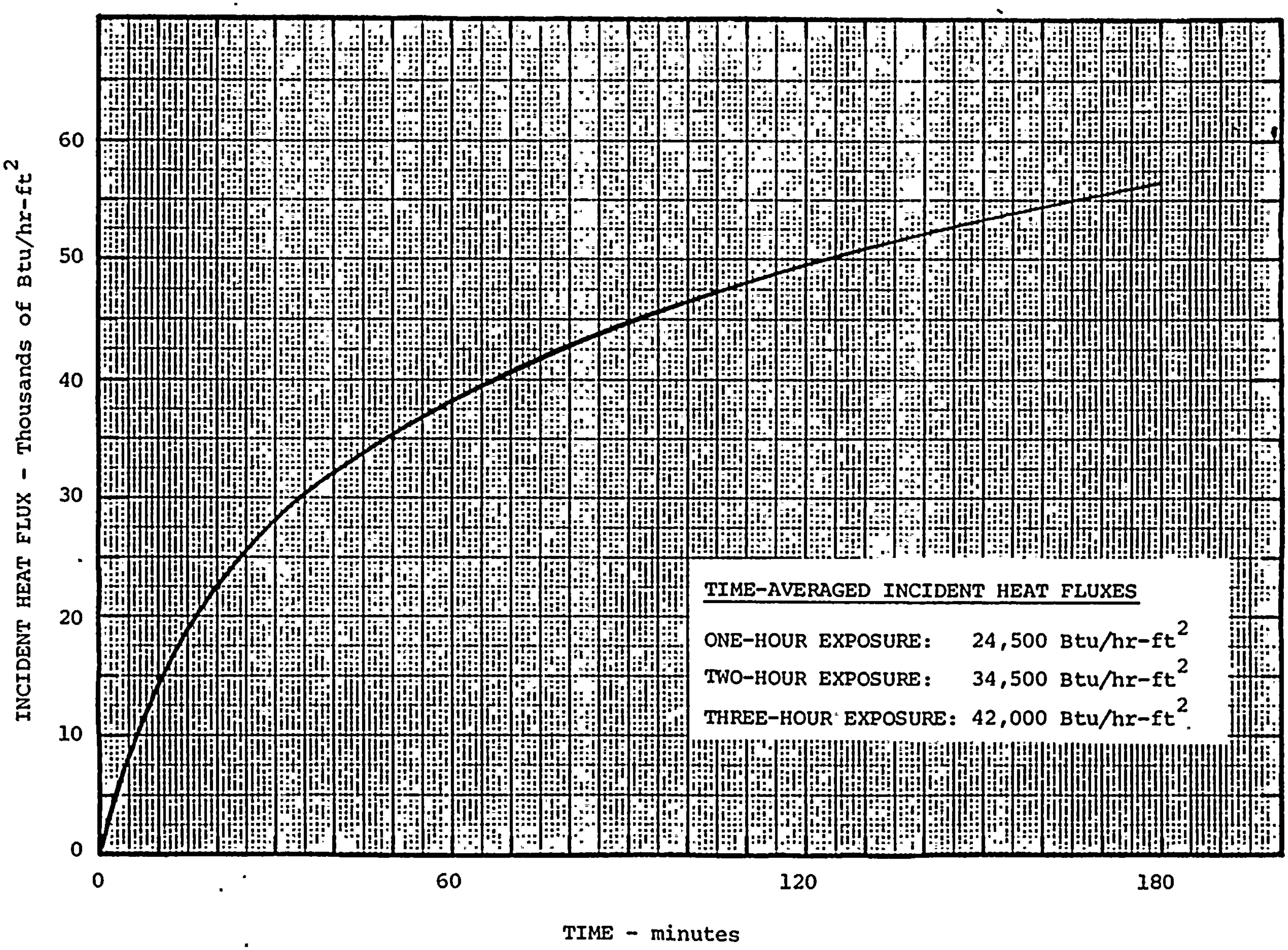


FIGURE 3: INCIDENT HEAT FLUX LEVEL OF FIRE SPECIFIED BY ASTM E-119 TEST METHOD AS A FUNCTION OF FIRE DURATION/EXPOSURE TIME



and 42,000 Btu per hour per square foot for three hours of exposure.

Hydrocarbon Pool Fire Total Heat Fluxes:

It must be emphasized that all liquid hydrocarbon fires do not produce the same total heat effects. As shown by Table 1, different liquid hydrocarbon flames have very different heating effects. For example, a fire involving methanol will only produce a total incident heat flux of about 12,000 Btu per hour per square foot whereas a fire involving LPG could produce a total heat flux of about 40,000 Btu per hour per square foot for a relatively large diameter spill fire (fire diameters in excess of 30 feet).

Since the total incident heat flux appears as a linear term in Equation (2), it is very important to specify or know the type of fire for the determination of the required fireproofing coating thickness.

Incident Heat Flux Used in Determination of Coating Thicknesses:

The three hour fire rating presented herein has been based on the incident heat flux level associated with a three-hour exposure to the fire specified in ASTM E-119 Test Method. The total incident heat flux used to calculate the coating thicknesses was 42,000 Btu per hour per square foot.

IV. REQUIRED THICKNESSES FOR STEEL HATCH COVERS

A complete listing of the calculated coating thicknesses of THERMO-LAG 330-1 Subliming Material applied to steel hatch covers is presented in Table 2. Four cases are presented to cover various aspects of fire exposure and temperature rises of the steel hatch covers. The covers are assumed to be exposed to a fire from one side only and also to a fire from both sides simultaneously. The temperature rises considered were 250° F in consideration of personnel safety and 930° F in consideration of structural integrity of the covers.

It should be pointed out that the dry film coating thicknesses presented in Table 2 do not include a 10 percent aging and weathering allowance

TABLE 1

TYPE OF FUEL	MAXIMUM HEAT TRANSFER FROM FLAMES TO COLD TARGET (BTU/HR - FT.SQ.)		
	RADIANT	CONVECTIVE	TOTAL
Methanol	5,000	7,000	12,000
Acetone	10,000	7,000	17,000
Hexane	22,500	7,000	29,500
Cyclohexane	31,000	7,000	38,000
JP-4: Small Spill Fire	23,700	7,000	30,700
JP-4: Large Spill Fire	31,000	10,000	41,000
Benzol	39,000	7,000	46,000
LPG: Small Spill Fire	25,500	7,000	32,500
LPG: Large Spill Fire	34,500	10,000	45,500
LPG: Impinging Fire	------	------	70,000
LNG: Spill Fire on Land	45,000(Maximum)	10,000	55,000
LNG: Spill Fire on Water	45,000(Maximum)	10,000	55,000
Ethyl Mercaptan	18,800	7,000	25,800
T-Butyl Mercaptan	23,500	7,000	30,500
Ethylene	28,500	7,000	35,500
Buthylene	29,750	7,000	36,750
Butadiene	27,500	7,000	34,500
Carbon Monoxide	4,500	7,000	11,500
Vinyl Chloride	8,500	7,000	15,500

and, therefore, represent the absolute minimum required coating thickness to provide the specifed fire rating. This allowance is based on long term environmental testing programs conducted by Underwriters' Laboratories, U. S. Army Ballistics Research Laboratories and commercial users in the hydrocarbon processing industry. Therefore, to provide an allowance for aging and weathering of the THERMO-LAG 330-1 Subliming Material, the coating thicknesses presented herein should be increased by at least 10 percent.

TABLE 2

MINIMUM DRY FILM THICKNESSES FOR THERMO-LAG 330-1

SUBLIMING MATERIAL APPLIED TO STEEL HATCH COVERS

Basis for Fire Rating: Three-hour exposure to fire condition specified by ASTM E-119 Test Method

Heat Flux = 42,000 Btu/hr-ft^2

Hatch Cover Thickness inches	Exposure* Condition	Dry Film Coating Thickness in Inches** 250° FΔT	930° FΔT
0.1875	single	1.495	0.595
0.375	single	1.055	0.420
0.500	single	0.915	0.365
0.1875	double	2.110	0.840
0.375	double	1.495	0.595
0.500	double	1.295	0.515

* Denotes fire from one side (single) or fire from both sides (double).

** Does not include any allowance for aging and weathering of material.

Submitted to Butane-Propane News: April 1976

THERMAL EFFECTIVENESS OF VARIOUS FIRE RESISTANT COATINGS APPLIED TO STRUCTURAL STEELS EXPOSED TO DIRECT FLAMES CONTACT AND/OR RADIATIVE HEAT FLUXES

H. R. Wesson
Wesson & Associates, Inc.
P. O. Box 1082
Norman, OK 73069

INTRODUCTION

The rapidly growing acceptance of fire resistant coatings for thermal protection of structurals steels, flammable product storage tanks, pressure vessel support structure, among other applications, has placed this unique fireproofing concept in an approved position for extensive usage in the area of "exposure control" for structures that could be exposed to direct flames impingement, free burning plus pressure torching conditions, and/or prolonged periods of high intensity radiative heat fluxes. The inherent reliability and low maintenance costs for this "passive concept" of exposure protection, together with the low performance level of conventional water cooling systems under flame engulfment and/or high pressure impinging or torching type fire conditions, have also given these fireproofing coatings a very high cost-effective, or cost-benefit, characteristic for high heat intensity applications. These type coatings are also finding applications where simultaneous low temperature (cryogenic liquid impinging conditions) and high temperature (flames contact conditions) protection is required for the structural steels in LPG, LNG, and SNG facilities.

The different types of fireproofing coatings that are commonly available, the results of extensive fire testing on these coatings, and engineering correlations of the experimental data that can be used for determination of the required coating thicknesses for a desired period of protection in various heating environments are presented and discussed herein.

GENERAL TYPES OF FIREPROOFING COATINGS

The most commonly accepted fireproofing coating materials include the following:

1. Cement Compounds: Concrete, gunite, and similar concrete base compounds provide good fire exposure protection during both direct flames contact and high intensity flames radiation conditions for extended periods of time. In general, however, the cement compounds are quite heavy, are expensive to install, in some applications are corrosive, and in general exhibit poor mechanical bonding properties between the substrate and the cement compound.

2. Ablative Coatings: These type coatings provide excellent fire exposure protection for structural steels. The fundamental principle is to apply a coating that gradually erodes due to the absorbed energy input from a fire condition. To change the virgin solid coating into a gas composite requires heat input that would otherwise be absorbed by the structure being protected. The temperature rise of the protected structure is retarded in direct proportion to the ablative coating thickness and its thermal properties. The incorporation of ceramic-like intumescents have resulted in a tough microporous char layer which provides additional insulating properties while most of the heat input is required for the physical transformation of the base material. The major disadvantages of these type ablative coatings appear to be the complexity of the application process and the final installed coating costs.

3. Subliming Compounds: The subliming compounds provide a protected substrate temperature based on the temperature of sublimation for each particular compound, the thickness of the coating material, the heat capacity of the substrate, the coating thermal properties, and the degree and time of heat exposure. In general, the subliming compounds form a very tough, esthetic compound that is very tightly bonded (bonding strength of 100 psi and more) to the protected steel surface. Another prime advantage of the subliming compounds is that they are not adversely affected by prolonged exposure to low temperature liquids such as LNG and LPG, as well as simultaneous exposure to such low temperature flammable liquids and resultant flames contact heating effects from liquid spill fires. These advantageous thermal properties have resulted in the use of the subliming compounds at some LNG Facilities for the protection of carbon steel structures, including the actual LNG storage tank, that could be subject to LNG submergence and/or LNG liquid spray impingement as well as direct LNG spill fire flames contact. These coatings must be applied to specified types of prime painted metal surfaces with airless spray equipment during relatively warm and dry atmospheric conditions (above 40 °F and not during rains).

Department of Transportation aging and environmental tests give these type coatings a 20-year life when properly cured and the top-coat renewed every five to seven years.

4. Intumescent Mastic Compositions: The most common of these type coatings are a modified vinyl, heavy-bodied mastic containing inorganic fibers in an aromatic solvent blend and a reinforced epoxy, two component, 100 percent solids (no solvent) spray system. In general, these type coatings react by absorbing heat in a chemical reaction which generates a foam-char system on the flames exposed side of the coating. Additional heat input is used to drive the liberated gases through the matrix. The foam-char is also an effective thermal insulator. All of these heat absorbing and/or heat flow retarding mechanisms serve to keep the substrate below its allowable rated maximum operating temperature. The period of substrate protection depends on the coating thickness, the applicable thermal properties, and the period and intensity of heat exposure. The heat capacity of the protected substrate also significantly affects the period of protection for a given coating thickness. Like the subliming compounds, these mastics do not suffer any adverse consequences when subjected to LPG and LNG contact, and are being used for thermal protection of steel structures associated with LNG storage tanks. One disadvantage of these type coatings appears to be the greater thickness required for the same period of protection in a given fire situation. For example, the published results of tests using the ASTM-E-119 Test Method indicate that using a 1000 °F temperature for a 8WF31 beam as a basis for comparison, a ½" thick coating of a typical vinyl-base type intumescent mastic will give a "two-hour" fire rating, a 5/8" thick coating of the epoxy-based intumescent mastic will provide a "two-hour" fire rating, and a ½" thick sublimation compound coating will give a fire rating of "two and one-half" hours. Another disadvantage of some of the intumescents appears to be the propensity of the active ingredients to leach out over prolonged periods of exposure to outdoor environmental conditions. Once such a leaching has occurred, the protection time interval provided by such coatings is significantly reduced over the initial rating period.

As indicated above, the heat capacity of the protected substrate significantly affects the period of protection provided by a given coating thickness. An excellent example of this effect was given by O'Rourke (1) in the 1973 Annual A.I.Ch.E. symposium on the fireproofing of structural steels. For ease of reference, Figure 1 presents this effect for wide flange structural steel beams.

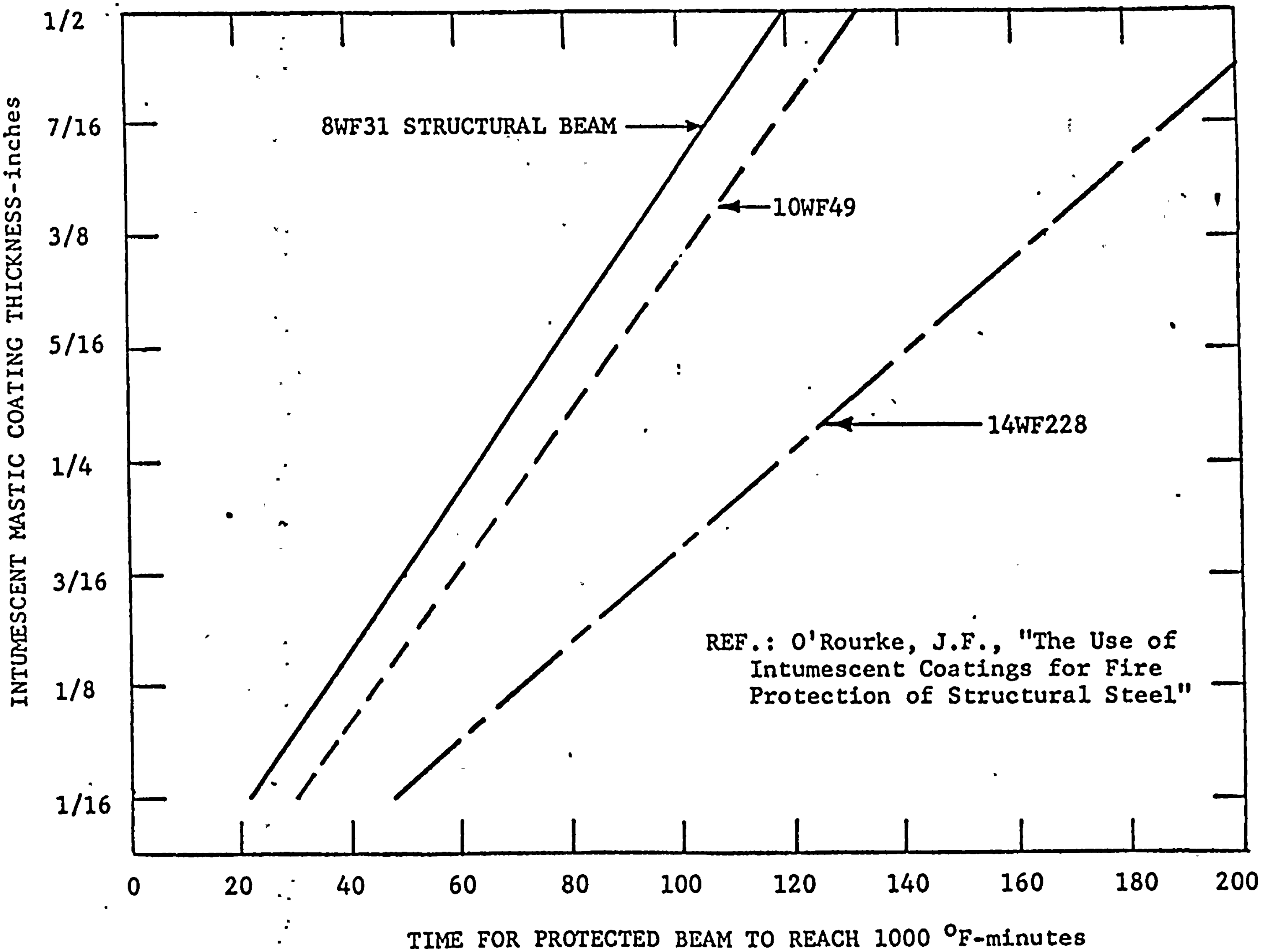


FIGURE 1: EFFECT OF INTUMESCENT MASTIC COATING THICKNESS ON THE EXPOSURE TIME

Unfortunately there are also a number of materials which are frequently MISUSED as fireproofing systems. Materials which are misused for outdoor, fully exposed environmental conditions include:

1. Standard Thermal Insulation Systems: Conventional, so called standard insulation techniques, such as metallic-sheath covered cork, glass-wool, or aggregate systems such as vermiculite, perlite, or calcite provide excellent heat transfer protection for the flowing/stored media. However, such systems are poor fireproofing materials. Normally the thermal insulation systems have very poor bonding properties to the base structure and are usually covered with a thin metallic-sheathing for protection of the thermal insulation from environmental effects. Under direct flame contact, and/or high intensity radiative heat fluxes, these thin metallic coverings will quickly experience large deformations with an attendant loss of thermal protection. Entrapped moisture between the thermal insulation and the steel structure can provide a corrosion problem as well as generating sufficient steam pressure to actually blow large sections of the insulation system off of the protected structure under high heat flux conditions.

2. Refractory Protection Systems: Most refractory materials provide excellent high temperature thermal protection in such applications as kilms, ovens, and high temperature process lines. However, these materials are often misapplied as fireproofing systems for steel structures that could become exposed to flammable liquid spill fires. Most flammable liquids reach their maximum burning intensity within a few seconds and impose very high thermal gradients in the outer regions of the refractory protection systems in a short exposure period. Under large thermal gradients and the resultant high thermal stresses, most refractory materials will crack and/or spill, possibly leaving large structural sections of the basic structure completely unprotected. In general, the refractory materials are designed to be brought up to their normal operating temperature over an extended time interval, as well as being cooled down quite slowly.

3. Intumescent Paint Compounds: These painting compounds, when subjected to flame temperatures, puff up to form an air-filled ash which acts like an insulator material. Unfortunately their ability to intumesce is lost after short periods of exposure to outdoor environmental conditions, usually less than two years. A very serious problem in using the intumescent painting compounds for the fireproofing of exposed structural steels that could be subjected to high velocity

flames impingement is the extreme fragility of the air-filled ash formed by the exposure of the intumescent paint to high temperatures. Experimental data have clearly shown that the gas valocities associated with Class I flammable liquids under direct flame contact conditions are sufficient to completely destroy, or dislodge, the insulating air-filled ash layers.

4. Water of Hydration Plasters: These coatings are simply plaster compositions which undergo chemical and physical changes when exposed to high temperatures to release water vapor. The theory is that the temperatures of the protected structure will be limited to the temperature of hydration process and that the fire energy is absorbed by the hydration process and in the vaporization of the water vapor produced by the various reactions. The materials that have been tested and reported upon in the literature have exhibited a high degree of hydroscopicity and a very limited ability to withstand exposure to outdoor environmental conditions for even short exposure periods, less than one year. The inherent possibility of corrosion due to the water content of these coatings is a serious drawback to the use of these materials for fire protection of steel structures.

DISCUSSION OF EXPERIMENTAL DATA

The principal sources of experimental data on the fire protection capabilities of the various types of fireproofing materials, other than the individual company research and development programs which are not normally available to the general public, are technical papers that have been presented at engineering conferences such as the 1973 Annual Meeting of the A.I.Ch.E. in Philadelphia, PA (1,2), the Fireproofing and Safety Symposium of the Western Research Application Center of Los Angeles, CA, in 1971 (3), independent testing programs such as the Department of Transportation-Federal Railroad Administration LPG torching tests on coated plates and full-scale fire engulfment tests on 33,000 gallon capacity LPG tank cars filled with LPG in 1974-75 (4), and Factory Mutual Research testing reports made available to the author by a sublimation compound type coating manufacturer (5,6,7,8). All of these separate sources of experimental data have been utilized to form as large a data base as is possible for a technical evaluation of the thermal performance characteristics and capabilities of the various fireproofing coatings.

Unfortunately, most, if not all, the available experimental data have been obtained under direct flame contact conditions and/or

under relatively high pressure impinging, or torching, fire conditions, and as such are not directly applicable to those conditions wherein only protection from "radiant heat fluxes" is disired, or required. However, due to the very wide variation of the types of hydrocarbon fuels in the various direct flame contact tests, and the resultant wide variation in coating surface incident heat fluxes (from a low of 12,000 BTU/HR SQ-FT to a high of 67,200 BTU/HR SQ-FT), it has been possible to correlate the experimental data in a form that it can be used for the prediction of the required coating thickness for various types of fire conditions ranging from high pressure flames impingement to only incident radiative heat flux considerations.

Table I presents a listing of the different types of hydrocarbon fuels that have been used in the various reported testing programs and the radiative, convective, and total heat transfer rates reported in the research literature for each type of fuel. A listing of the literature sources for these heat transfer rates is also noted on Table I. As listed in Table I, the radiative heat fluxes range for 5,000 to 39,000 BTU/HR SQ-FT depending on the fuel and fire size, and the convective heat fluxes range from about 7,000 to 11,000 BTU/HR SQ-FT, depending on the fire size.

A tabulation of the experimental data used in the engineering analyses and evaluations reported herein is presented in Table II. As shown, experimental data for a sublimation compound coating, an intumescent mastic coating, a composite system composed of an insulating type concrete with an exterior coating of an intumescent mastic, and an ablative type coating have been utilized as typical examples of the various fireproofing coatings applicable for the protection of outdoor structural steels and LPG storage tanks. The fuels used in the Table II experimental results include methanol, hexane, JP-4 and LPG. The various coating thicknesses ranged from 0.125 inches to 0.750 inches. The structural steel substrates include 5/8 inch plate (LPG storage tank shell material) and 8WF31, 8WF39 and 10WF49 steel beams. The exposure times for the particular steel substretes to reach 300 °F, 500 °F, 800 °F and/or 1000 °F, as applicable, are also given. The sources of the experimental data are also listed on Table II.

DATA ANALYSES: STRUCTURAL STEEL BEAMS

In order to generalize the available direct flames contact and impinging fire test data and develop a generalized engineering data correlation that can be used for any type of fire heating condition, the Table II experimental data have to be expressed as

TABLE I

SUMMARY OF TOTAL CONTACT HEAT FLUXES FOR VARIOUS TYPE HYDROCARBON FLAMES

TYPE OF FUEL	MAXIMUM HEAT TRANSFER TO A COLD TARGET (BTU/HR SQ-FT) RADIANT	CONVECTIVE	TOTAL
Methanol	5,000	7,000	12,000
Acetone	10,000	7,000	17,000
Hexane	22,500	7,000	29,500
Cyclohexane	31,000	7,000	38,000
JP-4: Small Fires	23,700	7,000	30,700
JP-4: Large Fires	31,000	10,000	41,000
Benzol	39,000	7,000	46,000
LPG: Impinging Type Fires	------	------	64,850 Avg[6]
LPG: Small spills	25,500	7,000	32,500

REFERENCES:

1. Atallah, S. and Allen, D.S., "Safe Separation Distances from Liquid Fuel Fires", Fire Technology, 1, 47 (1971).
2. Law, M., "Structural Fire Protection in the Process Industry", Building, 86-90 (18 July 1969).
3. Neill, D.T., Welker, J.M., and Sliepcevich, C.M., "Direct Contact Heat Transfer from Buoyant Diffusion Flames", J. Fire & Flammability, 1, 289 (1970).
4. Rasbash, D.J., Rogowski, Z.E., and Stark, G.W.V.,"Properties of Fires and Liquids", Fuel, 35, (1956).
5. Bader, B.E., "Heat Transfer in Liquid Hydrocarbon Fuel Fires", Proceedings, International Symposium for Packaging and Transportation of Radioactive Materials, Sandia Corporation and U.S. Atomic Energy Commission, SC-RR-65-98, Albuquerque, NM (12-15 January 1965).
6. Anderson, C., Townsend, W., Markland, R., and Zook, J., "Comparison of Various Thermal Systems for the Protection of Rail Cars Tested at the FRA/BRL Torching Facility", BRL Interim Memorandum Report No. 459 (December 1975), Funded under Federal Railroad Administration, DCN AR 30026/Req. 731231

TABLE II

SUMMARY OF EXPERIMENTAL DATA ON THERMAL PROTECTION SYSTEM EXPOSED TO DIRECT FLAMES CONTACT

MATERIAL	TYPE OF FUEL	TYPE OF SUBSTRATE	COATING THICKNESS (in)	INCIDENT HEAT FLUX (BTU/HR SQ-FT)	INCHES OF COATING PER THOUDANDS OF BTU/HR SQ-FT	TIME FOR SUBSTRATE TO REACH SPECIFIED TEMPERATURE-Minutes 300 °F	500 °F	800 °F	1,000 °F
SUBLIMITATION COMPOUND	Methanol	8WF39 Beam	0.150	12,000	0.0125	48			
"	Hexane	8WF39 Beam	0.150	29,500	0.0051	15			
"	Hexane	8WF39 Beam	0.250	29,500	0.0085				117
"	Hexane	10WF49 Beam	0.150	29,500	0.0051	13.5	34		
"	Methanol	10WF49 Beam	0.150	12,000	0.0125	48	105		
"	Hexane	10WF49 Beam	0.217	29,500	0.0074				128
"	Hexane	10WF49 Beam	0.200	29,500	0.0068				120
"	LPG Press.	5/8" Plate	0.125	64,850	0.00193	7.5	14.5	25.5	
"	LPG Press.	5/8" Plate	0.187	64,850	0.0029	14	24	48	
"	LPG Press.	5/8" Plate	0.250	64,650	0.0038	22	38.5	64	
"	JP-4	5/8" Plate	0.125	32,500	0.0038	17.4	33	60	
"	JP-4	5/8" Plate	0.250	32,500	0.0077	49.2	70.6	141.2	
INTUMESCENT MASTIC	Hexane	8WF31 Beam	0.125	30,700	0.0041				35
"	Hexane	8WF31 Beam	0.250	30,700	0.0081				64
"	Hexane	8WF31 Beam	0.500	30,700	0.0162				120
"	Hexane	10WF49 Beam	0.125	30,700	0.0041				45
"	Hexane	10WF49 Beam	0.250	30,700	0.0081				73
"	Hexane	10WF49 Beam	0.500	30,700	0.0162				132
COMPOSITE SYSTEM: CON-	Hexane	8WF31 Beam	0.250	30,700	0.0081				50
CRETE + 1/8" INTUMESCENT	Hexane	8WF31 Beam	0.500	30,700	0.0162				85
MASTIC TOP COATING	Hexane	8WF31 Beam	0.750	30,700	0.0244				125
ABLATIVE COATING	LPG Pool Fire	5/8" Plate	0.125	32,500	0.00385	12	19	42	
"	LPG Pool Fire	5/8" Plate	0.250	32,500	0.00760	27	41	95	

REFERENCES:

1. Anderson, C., Townsend, W., Markland, R., and Zook, J., "Comparison of Various Thermal Systems for the Protection of Rail Cars Tested at the FRA/BRL Torching Facility", BRL Interim Memorandum Report No. 459 (December 1975), Funded Under the Federal Railroad Administration, DCN AR 30026/Req. 731231
2. Concerning Fire Protective Coatings, A Summary of a Symposium Presented at the A.I.Ch.E. Meeting in Philadelphia, PA (November 1973).
3. Feldman, R., "Fire Retardancy and Heat Transfer Transmission Control Using Applied Materials", Presented to the Fireproofing and Safety Symposium, Western Research Application Center, Los Angeles, CA (May 1971).
4. O'Rourke, J.F., "The Use of Intumescent Coatings for Fire Protection of Structural Steel", Presented at the Annual Meeting of the A.I.Ch.E., Philadelphia, PA (November 1973).
5. TSI, INC., Technical Note No. 75120, "Thermo-Lag Subliming System for Extended Fire Resistance of LPG Storage Tanks", January 1975.

the exposure time required to reach a preselected temperature level as a function of the coating thickness, incident heat flux and substrate heat capacity for each particular type of coating and metallic substrate. Figure 2 presents a correlation of the Figure data for an intumescent coating applied to a variety of structural beams sizes. As shown, the time required for structural steel beams to reach the design limiting temperature of 1000 °F can be expressed as a function of

$(T)(W)^{0.5}/(F)$, where:

T = Fireproofing coating thickness in inches
W = Weight of the structural steel beams in lbs/ft
F = Total incident heat flux in thousands of BTU/hr sq-ft

The Figure 2 correlations have considered a fireproofing coating thickness range of 0.125 inches to 0.500 inches, structural beam sizes from 8WF31 to 14WF228, and a total incident heat flux of 29,500 BTU/hr sq-ft as being applicable to the ASTM-E-119 flames exposure test method.

The different data correlations shown for the intumescent mastic coatings and the sublimation compound coatings adequately illustrate the very significant effect of the coating thermal properties on a generalized engineering correlation. If, or when, sufficient data on the "energy absorption rates" of the various type coatings become available, it should be possible to express the individual data correlations as a single generalized correlation of the type:

$$t = \text{a function of } (T^a, \Delta T^b, F^c, W^d, E^e)$$

where,
t = Flames exposure time
T = Fireproofing coating thickness
ΔT = Temperature rise of structural beam substrate
F = Total incident heat flux
W = Weight of beam per linear foot exposed to flames heating
E = Coating energy absorption rate.

DATA ANALYSES: LPG STORAGE TANKS

Due to the large scale engulfment fire tests and plate torching tests conducted by the Department of Transportation-Federal Railroad Administration on full scale 33,000 gallon capacity LPG railcars filled with LPG product, and the possible application of these data for fireproofing of other type flammable product storage tanks, particular attention has been given to the Table II experi-

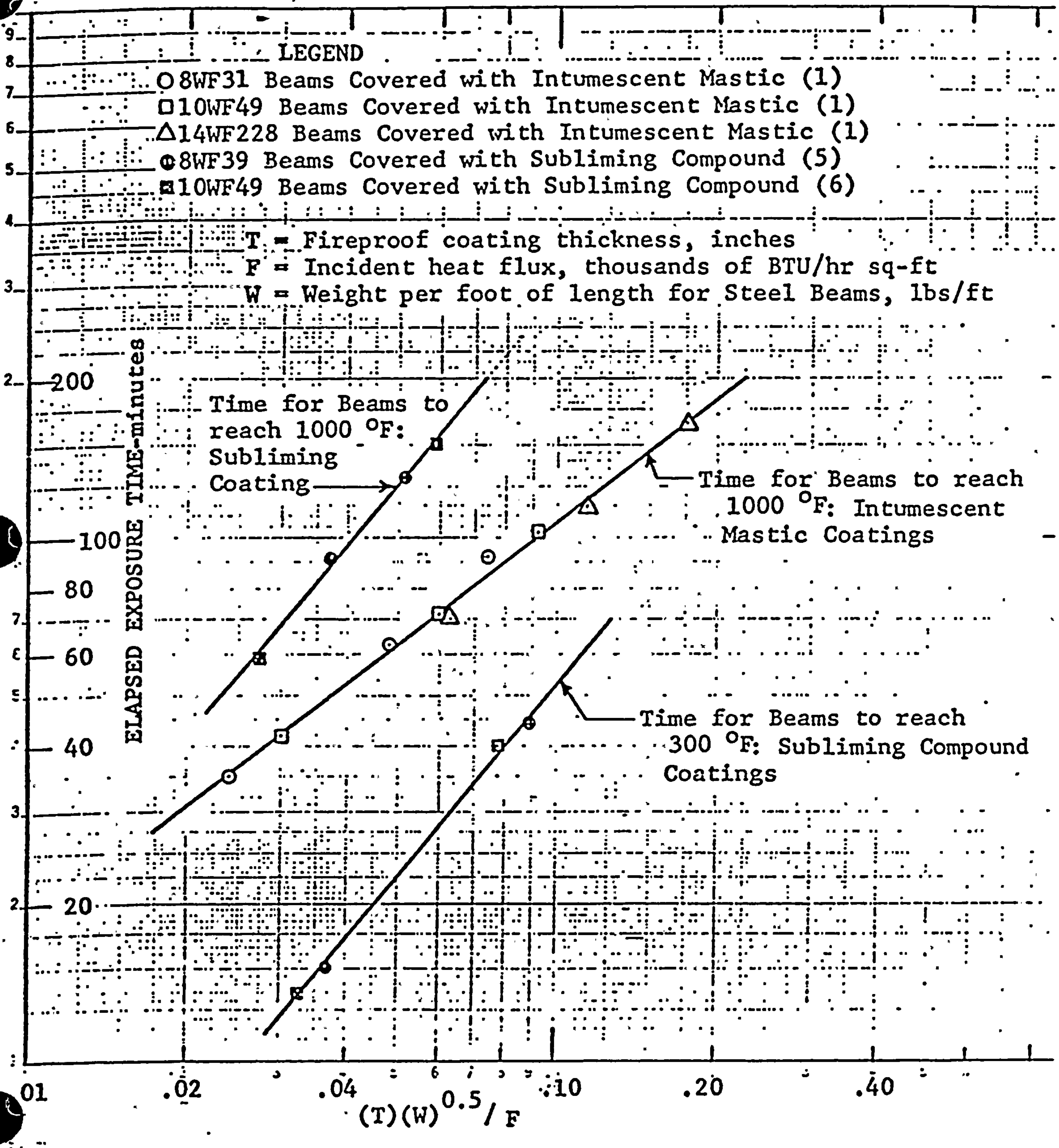


FIGURE 2: CORRELATION OF THE THERMAL CHARACTERISTICS OF DIFFERENT TYPE FIREPROOF COATING FOR STRUCTURAL STEEL BEAMS

mental data relating to this DOT/FRA testing program (4). However, before presenting the results of the data analyses of the DOT/FRA LPG railcar test programs, it may be of interest to note a few of the characteristics associated with LPG storage tank fire hazards.

It is important to realize that past fire experience shows that water cooling of LPG tanks is not totally effective for the protection of such tanks when the tanks are exposed to full engulfment and/or torching fire conditions, especially when the impinging fire is on the LPG tank vapor space. It is equally important to realize that the newly developed "passive fireproofing" cannot delay LPG tank BLEVE (Boiling Liquid Expanding Vapor Explosion) for an indefinite time period. Economic considerations, as well as design and system applications considerations, dictate that practical time exposure limits must be established for these "passive", or fireproofing, protection systems. These exposure limits are influenced by the following considerations:

1. The "credible" amount of fuel available to be burned.
2. A "credible" rate of fuel release if a spill fire is involved.
3. Type of fire condition(s) to be considered. For example, if the downwind distance of flammable vapor-air mixture is to be limited, then the LPG spill surface area must be controlled. This may require impounding of the spilled LPG at the LPG tank area, or close by, with a resultant possibility of spill fire flames impingement, or high intensity radiant heat fluxes, directly upon the LPG tank.
4. The availability and/or response time for emergency counter-actions such as manual shut-off of flow control valves, time for setting up remote cooling water monitors, time for local Fire Departments to respond, etc.

The failure of an LPG tank exposed to a fire situation is directly related to the tank's steel structural strength characteristics as a function of tank shell temperature. In general, the strength of LPG tank steel materials increases as the steel temperature increases to a temperature range of from 600 to 800 ^{o}F. Somewhere in the range of 650 to 850 ^{o}F, depending on the particular steel being considered, the strength starts to decrease. At a steel temperature of about 1000 ^{o}F, the burst strength of an LPG tank will be reduced to about 300 psig internal tank pressure. At about 1100 ^{o}F, the burst strength can be as low as 200 psig. Thus, prolonged exposure to fire heating conditions can reduce the burst pressure capabilities of an LPG tank from the normal range of about 1000 to 1250 psig at ambient temperature conditions to 200 psig, or lower, during a fire situation. Then, depending on the exposure time, the steel temperature, the relief valve setting and capacities, and the amount of LPG in the tank, a BLEVE condition could result.

The energy stored in an LPG tank, or any pressure vessel for that matter, due to internal pressurization is proportional to the volume available for product vapors and the amount of energy available for release per unit time. A generally accepted method for calculation of the net amount of energy available is to equate the relief valve set pressure to a calculated equivalent of TNT per cubic foot of tank volume. This can be done using the relationship:

$$F = \text{Lbs of TNT} = 0.00135\ V \left[\frac{P_r}{P_a}\right] \ln\left[\frac{P_r}{P_a}\right]$$

where, V = Volume of LPG tank, cubic feet
P_r = LPG tank pressure relief valve set point, psia
P_a = Ambient pressure, psia.

The value thus derived for a particular tank's TNT equivalent is useful in estimating the over-pressures resulting from a BLEVE condition.

The damage potential of a TNT explosion as a function of the separation distance from the explosion source point can be estimated from the maximum overpressure at the point of interest. Assuming a cylindrical charge of TNT, the maximum overpressure can be estimated from the relationship,

$$Pm = Po \left[\left[\frac{11.34}{Z}\right] - \left[\frac{185.9}{Z^2}\right] + \left[\frac{19210}{Z^3}\right]\right]$$

where, P_m = maximum overpressure, psi
P_o = Ambient pressure, psia
$Z = 3.967\ R/(W)^{0.333}$
R = Distance from explosion source, feet
W = TNT equivalent weight, lbs.

The assumption of a cylindrical charge of TNT in Equation 2 gives a conservative value for the overpressures as compared to those for a rectangular charge of TNT. However, the normal configuration of an LPG storage tank dictates the use of the cylindrical shape charge. The variation of maximum overpressure with distance for several TNT equivalent weights has been generated from the Equation 2 and these results are presented in Figure 3. A cross-plot of Figure 3 is presented in Figure 4 and is somewhat more convenient to use for the estimation of the damage potential due to an LPG tank BLEVE. For reference purposes, the maximum overpressure from a 250 psig LPG tank BLEVE condition is indicated

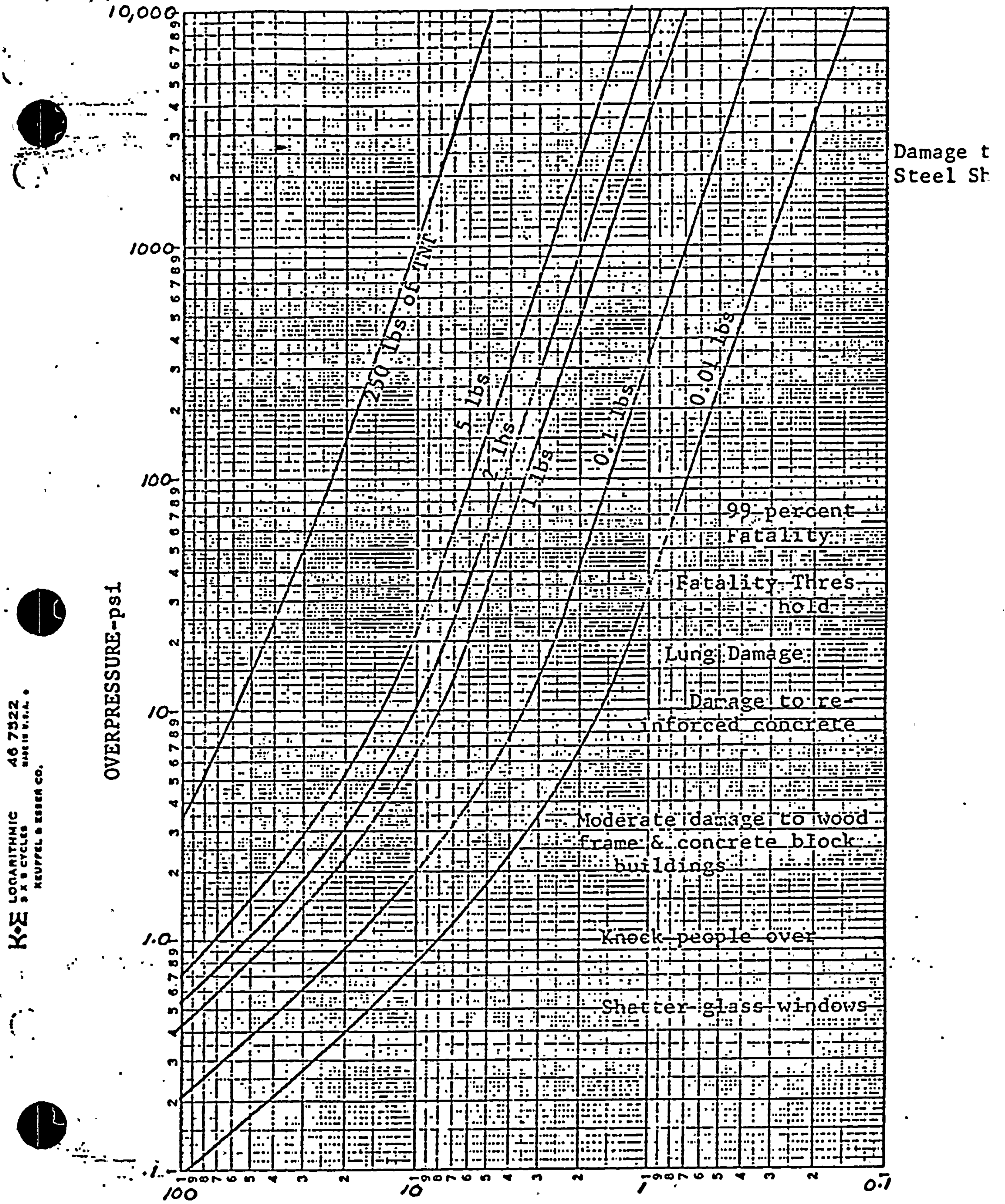


FIGURE 3: DAMAGE POTENTIALS FROM TNT EXPLOSIONS

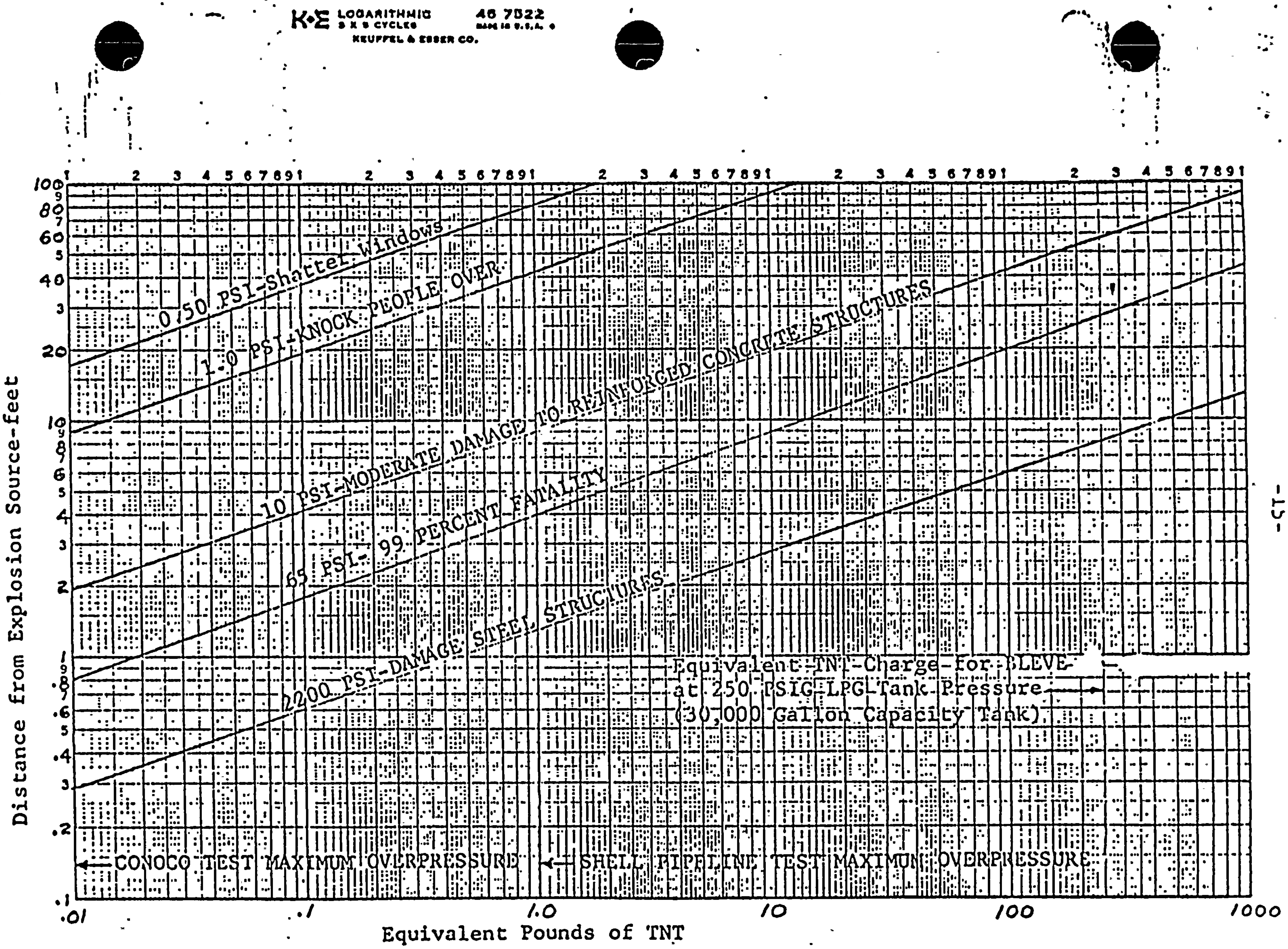


FIGURE 4: DAMAGE POTENTIALS FOR TNT EXPLOSIONS

on Figure 4. It should be noted that the Figure 4 damage potentials do not account for "projectile" damage that might result from an LPG tank BLEVE condition.

There are numerous examples in the literature of the consequences of LPG tank fires and BLEVE conditions. However, the most common and frequent cause of major tank failures appears to be from safety relief flare fires burning for prolonged periods of time above the tank's vapor space and/or impingement on the vapor space of adjacent tankage. A review of the literature, available test reports and published articles indicate the following facts:

1. Most engulfment fires exhaust the tank contents within one hour of fire exposure.

2. Thermal coatings that are approved by nationally recognized and independent testing and/or fire rating agencies are available for fire rating under direct flames contact conditions for in excess of a two-hour exposure period.

3. A good medium response time for a City Fire Department and set-up for application of cooling water for LPG storage tanks is about 15 to 20 minutes.

4. The medium time to BLEVE for an unprotected tank is about 14 minutes (somewhat less than the medium response time for the City Fire Department).

5. Safety relief valve fires can be extinguished by cooling of the tank contents to below that pressure level at which the safety relief valve will open.

6. None of the conventional standard insulation systems now available will withstand all design requirements and keep the LPG tank vapor space temperature below 120 °F temperature is about that for 250/225 psig relief valve setting.

7. Excess flow valves cannot be depended upon alone to stop the flow of fuel due to possible restrictions in the supply lines and leak rates well below that necessary for excess flow valve operation.

8. A "passive" thermal protection system (a system that does not require the actuation of protective equipment or manpower response) is just as important a tank design feature as the safety relief valve.

9. A "passive" thermal coating that affords at least one-hour of protection should be applied to all LPG tankage to allow firemen to initiate application of supplemental cooling water.

10. Automatic fire, or heat actuated, valves are commercially available and are highly reliable. Such valves should be installed in all liquid transfer lines and should be of the full internal type.

As a result of the large number of LPG tank fires and/or BLEVE's that have occurred and are still occurring in this country, and perhaps due in part to some identification of the types of fires that cause such incidents, the DOT/FRA sponsored a research and full scale fire testing program on full size, and filled, 33,000 gallon capacity LPG railroad tank cars. This testing included environmental tests, one-fifth scale preliminary fire tests, full scale spill fire engulfment tests on 33,000 gallon tank cars, and high pressure flame impinging (torching) fire tests on sample size LPG tank material plates protected with most, if not all available, thermal protection systems. Some of the protection systems failed during environmental tests, others failed during the one-fifth scale tests, and others successfully completed all the required tests. Since the high pressure LPG impinging fire tests resulted in the most severe, but realistic and possible, fire heating rates (up to 67,200 BTU/hr sq-ft incident heat fluxes), coating erosion conditions, and coating thermal stress rates and levels, the remainder of this paper will be devoted to the general analysis of the two highest performance level systems resulting from the DOT/FRA (4) experimental testing programs, an ablative type coating and a sublimation compound coating.

From the former analyses discussed for structural steel beams, it appeared that the data obtained from the sample plate torching tests should correlate in the form of,

$$t = \text{a function of } (T^a, F^b, \Delta T^c, W^d)$$

where, t = Plate exposure time, minutes
T = Thermal coating thickness, inches
ΔT = Steel plate substrate temperature rise, ^oF
F = Total incident heat flux, thousands of BTU/hr sq-ft
W = Steel plate weight per unit area exposed to flames heating, lbs/sq-ft
a,b,c,d = Correlating coefficients.

Figure 5 presents the correlating results for the ablative coating and the sublimation compound coating experimental results obtained from the DOT/FRA torching tests on 5/8" thick steel plate samples

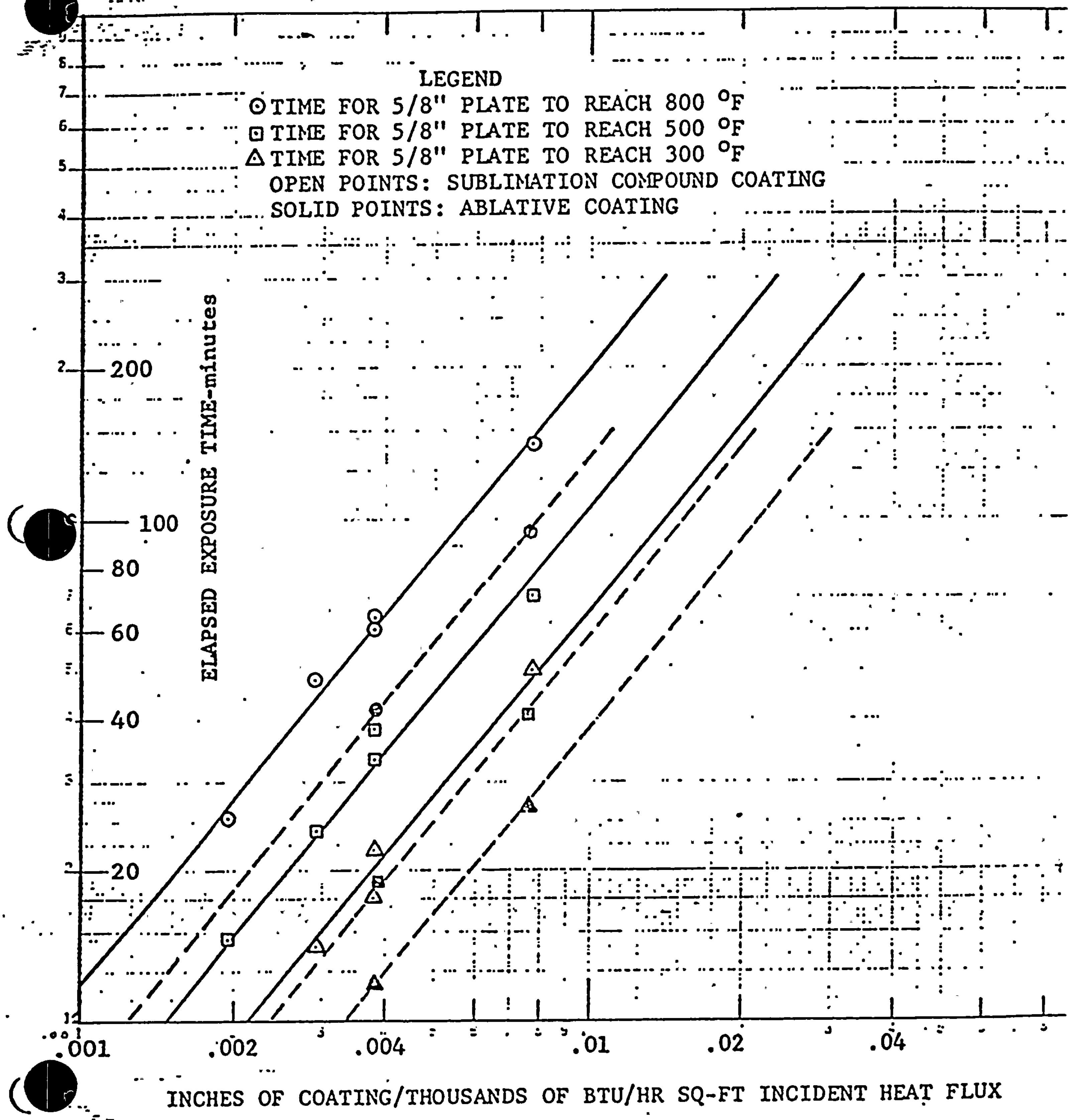


FIGURE 5 : CORRELATION OF DOT/FRA LPG TORCHING TESTS RESULTS ON 5/8" THICK LPG TANK PLATE MATERIAL

Logarithmic, 2 x 2 Cycles

in the form of plate exposure time expressed as a function of the coating thickness divided by the total incident heat flux with the metal plate substrate temperatures of 300, 500, and 800 °F as a correlating parameter. The five test points shown in Table II for the sublimation compound type coating resulted in an excellent linear correlation for the Figure 5 log-log type of presentation. The two experimental test points (at each of the three noted plate temperatures) for the ablative type coating shown in Table II and the relative locations with respect to the sublimation compound coating correlations for each temperature, indicate a linear correlation for the ablative type coating that has the same slope as that of the sublimation compound type coating. You might recall that this characteristic was not true for a comparison of the sublimation compound coating and the intumescent mastic coatings for steel structural beams, wherein the slopes were quite different.

A close examination of the Figure 5 data correlations indicates two important features; one, the parallelism of the linear lines shown for the 300, 500, and 800 °F plate temperatures indicated that it should be possible to collapse the three lines to a single line correlation incorporating plate temperature rise as a general correlating parameter and, two, the sublimation compound coating, taking a given plate temperature rise at a given period of exposure, has a higher thermal performance capability than does the ablative coating, using the required coating thickness as a measure of the coating thermal performance capabilities. For example, for a two-hour exposure at an incident heat flux of 30,000 BTU/hr sq-ft (this heat flux could come from any type of fire situation: direct flames contact, flames impingement under pressure, or only radiative heat loads) and a limiting plate substrate temperature of 800 °F, the sublimation compound coating requires only 66% of the thickness required by the ablative coating (0.180 inches versus 0.273 inches).

If we make an assumption similar to that utilized for the Figure 2 general correlation for structural steel beams wherein it is assumed that the metal substrate heat capacity can be correlated as the beam weight per linear foot, it should be possible to obtain a completely generalized correlation for the sublimation compound coating when applied to metal plate substrates. As is shown by Figure 6, such a correlation is possible, and correlates all the Table II test data for 5/8" thick steel plate quite well. As shown, the exposure time can be expressed as a general function of the sublimation compound coating thickness times the substrate temperature rise to an exponent of 0.70 times the metal plate substrate weight in lbs per sq-ft of exposed surface area to an 0.50 exponent divided by the total incident heat flux in thousands of BTU/hr sq-ft. Thus, the Figure 6

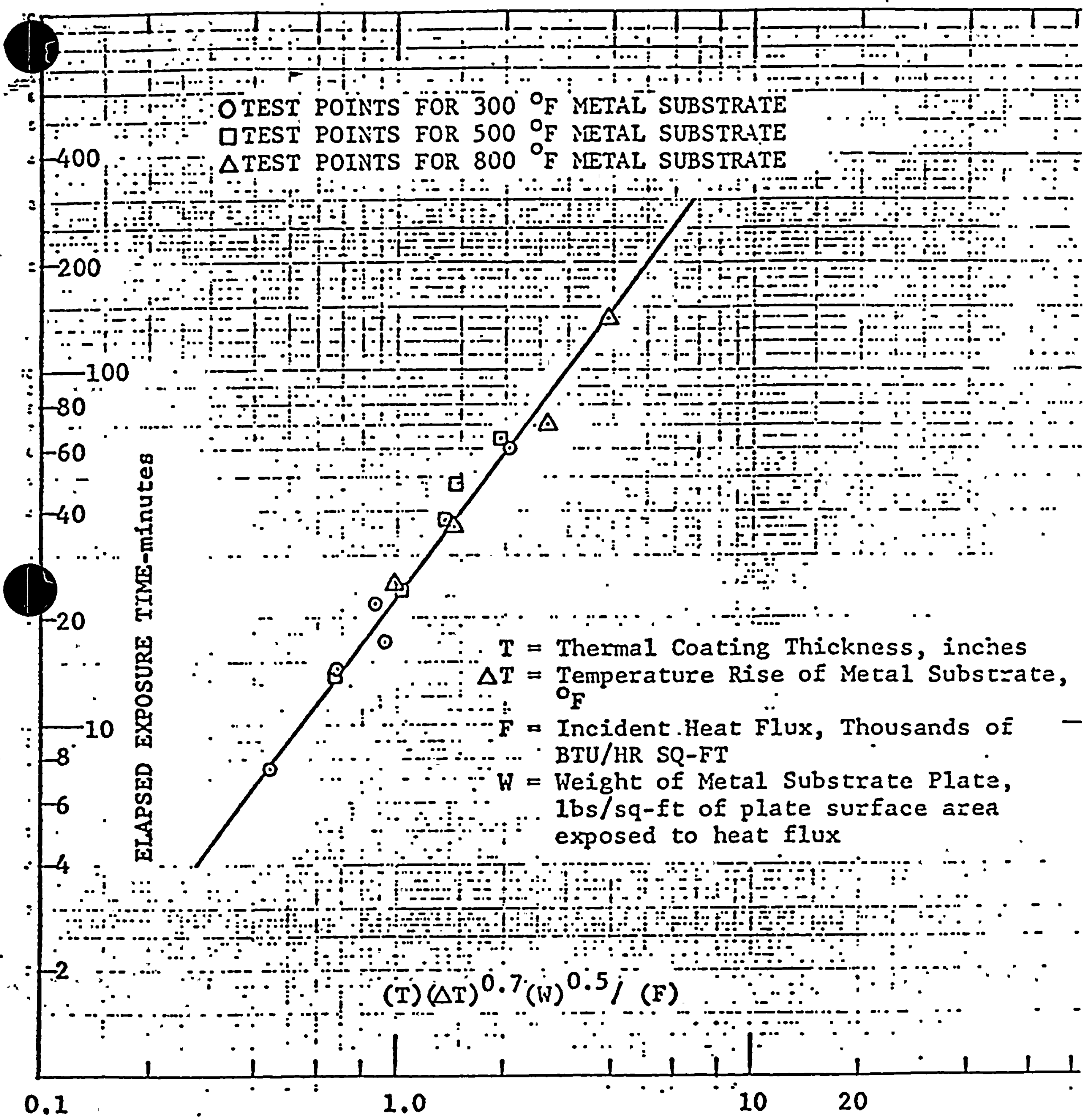


FIGURE 6 : GENERALIZED CORRELATION FOR THE THERMAL EFFECTIVENESS OF THE SUBLIMITATION COMPOUND COATING APPLIED TO A SUBSTRATE OF CARBON STEEL PLATE

correlation can be used for engineering design purposes for the determination of the required sublimation compound coating thickness for any given fire situation, given metal plate substrate thickness, and specified allowable substrate temperature.

The parallelism of the Figure 5 correlations for the sublimation compound coating and the ablative coating also suggests that a parameter expressing the "energy absorption rate" of the two type coating could be used to make the Figure 6 generalized correlation applicable for both type coating. However, this has not been done as yet due to a lack of knowledge on the exact energy absorption characteristics of the two coatings, but can be done once this characteristic is defined.

To illustrate the potential usage for the Figure 6 data correlation, let us assume that we wish to thermally protect the roof of a particular product storage tank from the thermal radiation due of an adjoining tank fire situation for a period of one-hour. Typical numbers applicable to such a situation would be as follows:

1. Incident radiant heat flux: 12,500 BTU/hr sq-ft
2. Roof thickness: 0.250 inches of carbon steel plate (10.2 lbs/sq-ft)
3. Design allowable roof temperature: 350 °F (70°F ambient)
4. Protect with sublimation compound coating.

From Figure 6 at 60-minutes Elapsed Exposure Time, we read a figure of 2.0. Thus,

$$2.0 = (T)\ (\Delta T)^{0.7} (W)^{0.5} / \ (F)$$

or

$$T = 2.0\ (12.5)/(280)^{0.7}\ (10.2)^{0.5}$$

$$T = 0.152 \text{ inches of sublimation compound coating.}$$

Based on the preceeding discussions and engineering data correlations, it can be concluded that LPG tankage can be thermally protected with a "passive" fireproofing coating system that exhibits the following performance capabilities:

1. The passive thermal coating must keep the LPG tank steel temperature to below 800 °F for a period of two-hours when the tank is not more than 80% full of liquid product, and the tank is exposed to direct flames impingement from a spill fire below the LPG tank having the following characteristics:

   a. Incident heat flux of from 40,000 to 50,000 BTU/hr sq-ft

b. Flame velocity on the order of 100 ft/sec
c. Distance from spill surface to LPG tank bottom is 3-ft or less.

2. The thermal protective coating should be durable in the intended exposed environmental service conditions for a period of 20 years, with the top coat renewal being at least five to seven years. During this service period it should not dust, flake, chip, crack, or spall off during normal service conditions.

3. During fire conditions, the residual coating should not spall from the thermal shock due to supplemental water stream cooling.

4. The thermal coating materials should be non-toxic and entirely non-flammable.

5. The material should not contain any asbestos.

6. The material should not be corrosive to structural steels.

7. The materials should be resistant to chemical spills and fumes from those chemicals normally associated with petroleum and petrochemical processing and storage plants.

8. The materials should be applicable with airless spray equipment and the coating should cure within a maximum time period of three days, at 75 °F and 50% relative humidity.

9. The material should have a bonding strength of not less than 100 psi.

10. When used for protection of low temperature flammable liquid storage or transfer lines (such as LPG or LNG), submergence and/or liquid spray contact with the stored product should not result in any adverse consequences on the fireproofing capabilities of the coating. Further, the coating should be able to withstand simultaneous exposure to the low temperature liquids and direct flames contact conditions without loss of protective capabilities.

CONCLUSIONS

Based upon the experimental data, data analyses, and discussions presented herein, it can be concluded that:

1. It is possible to generalize the experimental data obtained from specific rating tests on specified structural substrates with specified coating thicknesses exposed to direct flame

contact fire conditions into generalized engineering correlations for each type of steel substrate and coating which express the protection time as a direct function of the coating thickness, substrate temperature rise, substrate heat capacity, and total incident heat fluxes. These engineering correlations can then be used for the determination of the required type of coating thickness for a given substrate, given substrate design temperature and given substrate heat capacity under any type of fire heating condition (flame contact, impinging flames, and/or flames radiation).

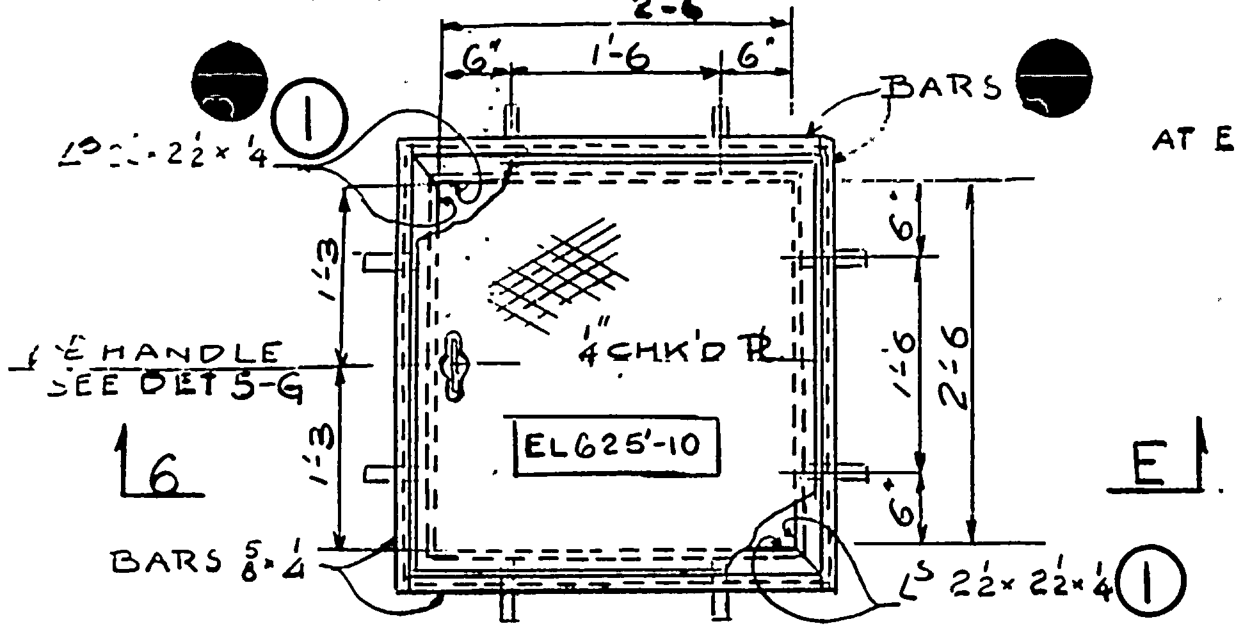
2. Based on the experimental data presented in this paper, and now available in the research literature, the sublimation compound type coating gives a superior fireproofing performance, as measured by the thickness of coating required with all other applicable parameters held constant, than any other fireproofing coating analyzed in this paper.

REFERENCES

1. O'Rourke, J.F., "The Use of Intumescent Coatings for Fire Protection of Structural Steel", Presented at the 1973 Annual Meeting of the A.I.Ch.E. in Philadelphia, PA (November 14, 1973).
2. Kayser, J.N., "Tests of Fireproofing Materials for Structural Steel for Refineries and Chemical Plants", Presented at the 1973 Annual Meeting of the A.I.Ch.E. in Philadelphia, PA (November 14, 1973).
3. Feldman, R., "Fire Retardancy and Heat Transmission Control Using Applied Materials", Presented to the Fireproofing and Safety Symposium, Western Research Application Center, Low Angeles, CA (May 27, 1971).
4. Ballistic Research Laboratories, Aberdeen Proving Ground, MD (Anderson, C., Townsend, W., Markland, R., and Zook, J.), "Comparison of Various Thermal Systems for the Protection of Railcars Tested at the FRA/BRL Torching Facility", Interim Report No. 459 to the Department of Transportation, Federal Railroad Administration, Washington, DC (December 1975).
5. Factory Mutual Research, "Fire Endurance Test on Steel Columns Protected with Thermo-Lag 330-1 Coating", Report to TSI, Inc., St. Louis, MO (November 6, 1972).
6. Factory Mutual Research, "ASTM E119 Fire Endurance Test (Modified) Structural Steel Column Protected by Thermo-Lag 330-1 Coating-Design CT-36", Report to TSI, Inc., St. Louis, MO (April 1974).
7. Factory Mutual Research, "Exploratory Fire Endurance Fire Test on Structural Steel Column with Thermo-Lag 330-1 Coating". Report to TSI, Inc., St. Louis, MO (November 30, 1973).
8. Factory Mutual Research, "Exploratory Fire Endurance Test on Structural Steel Column with Thermo-Lag 330-1 Coating", Report to TSI, Inc., St. Louis, MO (November 30, 1973).

ATTACHMENT 3

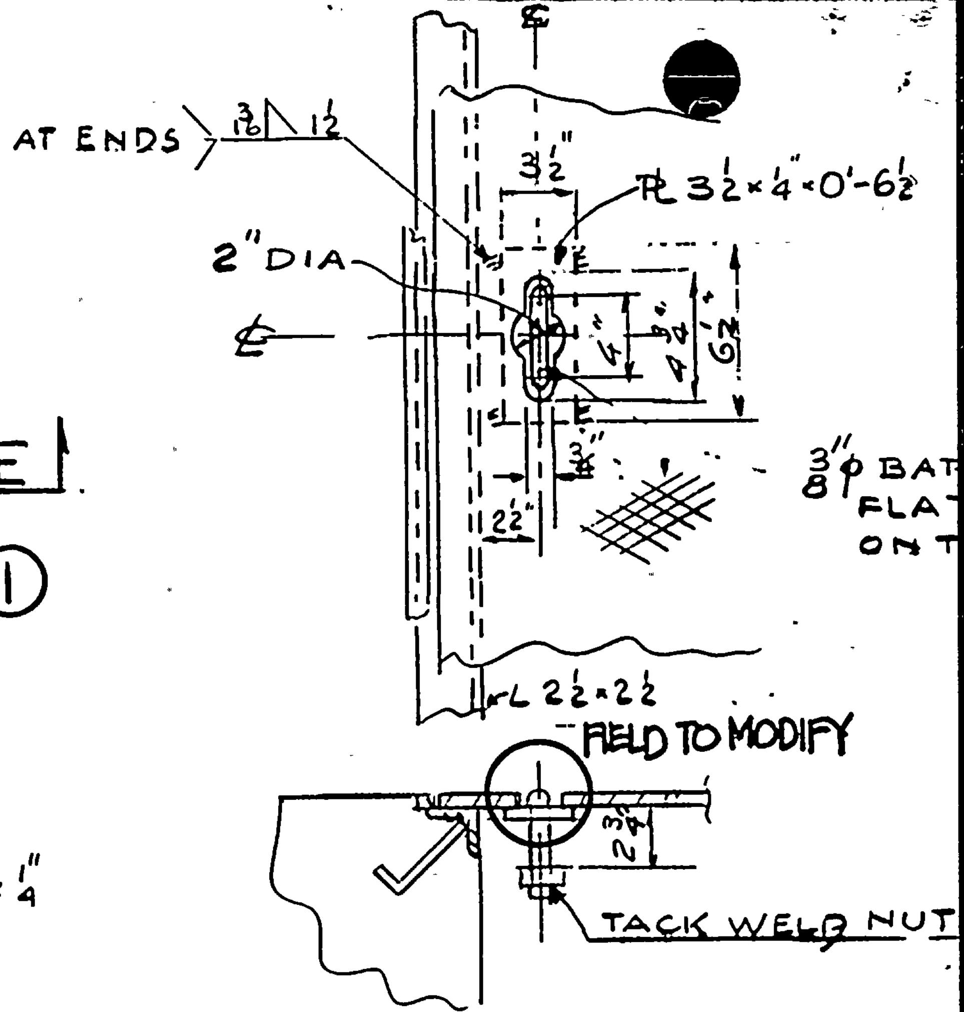
ITEM 3 - MOVABLE PARTS AND UNPROTECTED AREAS.



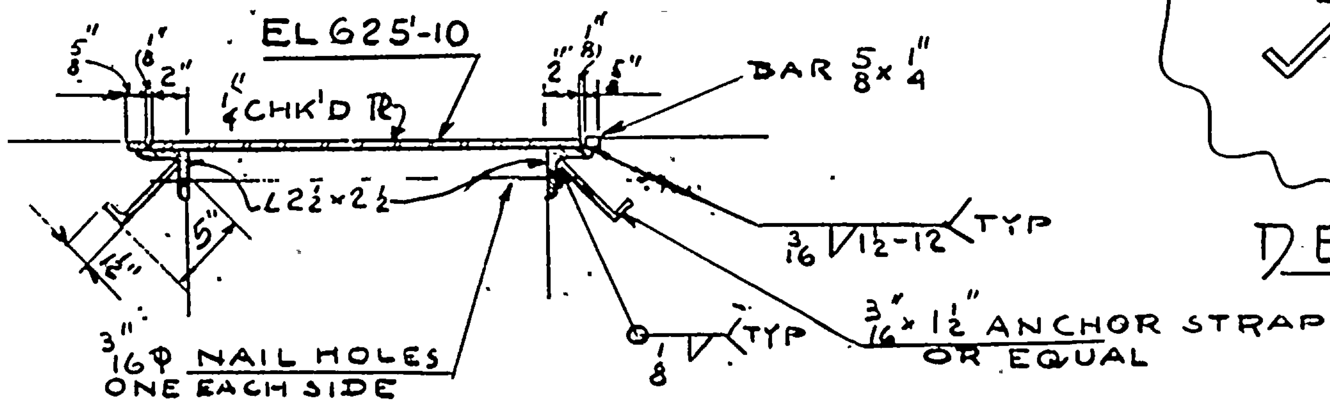
FRAME MK F10-TWO REQ'D

REF. DWG 12-3434; 12-3436

¾" = 1'-0"



DETAIL 5-G



SECTION 6-E

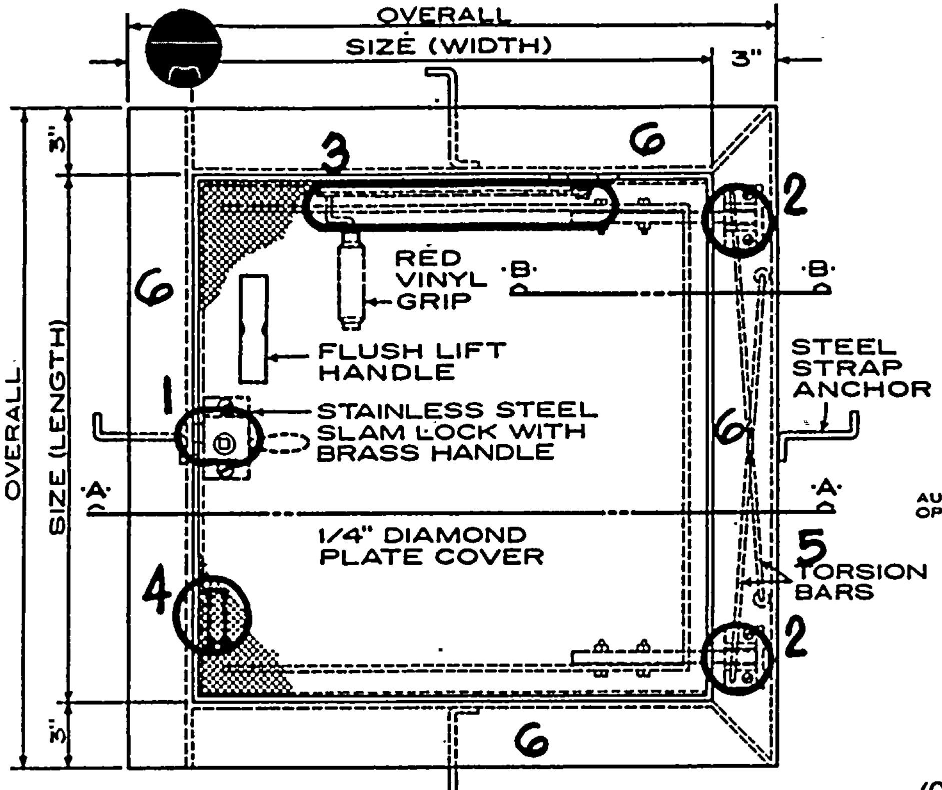
UNPROTECTED FLOOR HATCH AREA

1. FRAME

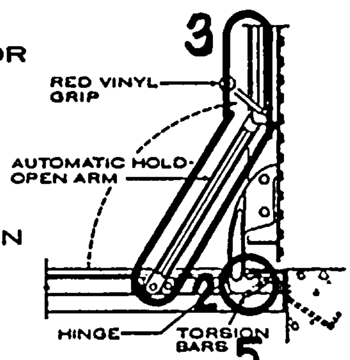
FLOOR HATCH

FIRE ZONE 41 - UNIT 1

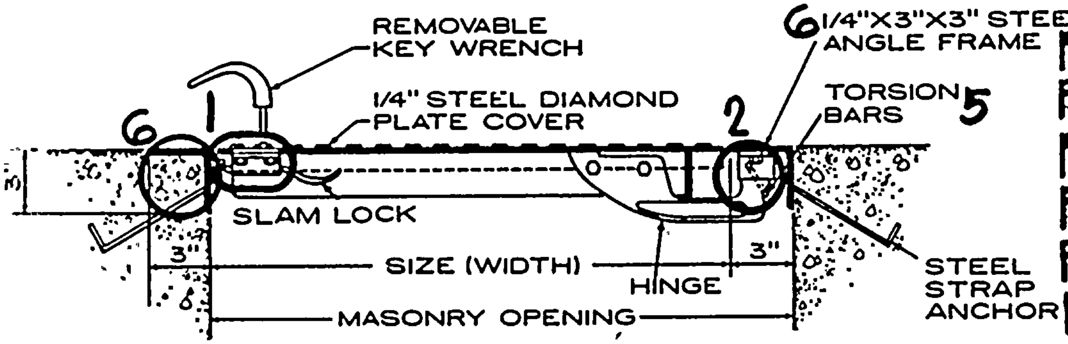
FIRE ZONE 45 - UNIT 2



PLAN VIEW



SECTION B-B
(Cover in Open Position)



F.Z. 40B UNIT-1
F.Z. 47B UNIT-2
F.Z. 43 UNIT-1
F.Z. 52 UNIT-2
F.Z. 53 UNIT-1
F.Z. 58 UNIT-2

SECTION A-A

UNPROTECTED FLOOR HATCH AREAS
1. LATCH
2. HINGES
3. HOLD OPEN ARM
4. ELEC. ALARM
6. FRAME

This drawing is the property of The Bilco Company and incorporates specifications and patented designs in which The Bilco Company has proprietary rights and, accordingly, is not to be reproduced without the express written consent of The Bilco Company.

Type Q FLOOR DOOR

SINGLE LEAF STEEL DIAMOND PATTERN PLATE

Reinforced for 150 lbs. per square foot live load.

General Contractor, Please Note:
Be careful not to rack or twist frame when setting unit. Block up and shim the frame if necessary to be sure door rests evenly on frame all around.

Factory Finish: Steel — red oxide primer
Hardware — cadmium plated steel

Bilco
Manufacturers of Doors for Special Services
THE BILCO COMPANY
New Haven, Connecticut 06505

QUANTITY	TYPE	SIZE WIDTH LENGTH
	Q-1	2'-0" x 2'-0"
	Q-2	2'-6" x 2'-6"
	Q-3	2'-6" x 3'-0"
	Q-4	3'-0" x 3'-0"

ARCH'T. OR ENG'R. ____
PURCHASE ORDER ____ DATE ____
PROJECT ____
GEN'L. CONTRACTOR ____
PURCHASER ____
BILCO REPRESENTATIVE ____
DWG. NO. ____ DATE ____

ITEM 4 - ALTERNATIVES

AMERICAN ELECTRIC POWER SERVICE CORPORATION

DATE: May 15, 1984

SUBJECT: D. C. Cook Nuclear Plant
Fire Rated Floor Hatches
RFC's 01-2676 and 02-2692

FROM: V. Del Favero

TO: F. S. Van Pelt, Jr.

In response to Item 4, "Provide any alternatives to the insulation or compensatory measures that may be available", of the NRC letter to Mr. Dolan dated April 4, 1984, the following measures were considered:

1. Provide a vertical fire rated enclosure above the hatch. This is not possible due to the limited space and close proximity of electrical cabinets which require access for maintenance and operation.

2. Laying a fire rated blanket above door. This impedes the operation of the hatch, and creates a personnel safety problem.

3. Provide a vertical fire rated enclosure below hatch. This is not possible due to many interferences with cables, conduit, troughs, and cabinets.

4. Add a horizontal fire rated panel below hatch. There is an interference with the access ladder and a personnel safety problem of access to the hatch.

5. Replace hatch with a fire rated hatch. No prefabricated fire rated floor hatch is available. We have contacted The Bilco Company about design and testing of a fire rated floor hatch. (See attached communications)

V. Del Favero

VDF:b

cc:: S. Fox
W. RIGG

AMERICAN ELECTRIC POWER *Service Corporation*

AEP

1 Riverside Plaza *(614) 223-1000*
P.O. Box 16631
Columbus, Ohio 43216-6631

March 13, 1984

Robert Lyons, President
The Bilco Company
P O Box 1203
New Haven, Connecticut 06505

RE: D. C. Cook Nuclear Plant
DC-D-4260 A

Dear Mr. Lyons:

In a recent telephone conversation you may recall our request that The Bilco Company submit a quotation for furnishing a 2'-6" x 3'-0" floor hatch bearing an Underwriters "A" label.

It is understood that you do not manufacture a U.L. rated floor hatch, however, as AEP anticipates the likelihood that retro-fitting of several Bilco installations in the subject plant may be required, we need to make allowance for such a contingency.

If this request is agreeable to you may we suggest that your quotation also include the cost of one submission to U.L. for testing and labeling and a separate price for each successive U.L. application as may be necessary.

At a future date, if AEP becomes committed to the replacement of hatches as referred to above, the program will probably be industry wide and these rated hatches will be in demand.

As a long standing purchaser of many of your products, we hope that you will be able to furnish us with the desired pricing data. If you require any further information, please don't hesitate to contact us.

Your early response will be greatly appreciated.

Very truly yours,

Alfred C Macksoud

A. C. Macksoud
Chief Architect

ACM:b

THE BILCO COMPANY
P.O. BOX 1203
NEW HAVEN, CT 06505

March 21, 1984

Mr. A. C. Macksoud
Chief Architect
American Electric Power Service Corporation
1 Riverside Plaza
P. O. Box 16631
Columbus, Ohio 43216-6631

RE: D. C. Cook Nuclear Plant
DC-D-4260A

Dear Mr. Macksoud:

Thank you for your letter of March 13, 1984 concerning your requirements for a floor door to carry an Underwriters "A" label.

We have contacted both Underwriters Laboratories and Factory Mutual Engineering Division with requests for costs to fire test one of our single leaf J-3 doors, size 2'6" x 3'0", and also one of our J-4 doors, size 5'0" x 5'0", in double leaf design.

Just as soon as I receive some information from them I hope I will be better able to answer your letter and I will be in touch with you at that time.

Yours truly,

THE BILCO COMPANY

R. Lyons

Robert J. Lyons

RJL:wfg

RECEIVED
MAR 23 1984
Architectural Section