One Hour Fire Test of Darmatt KM1 System for Protecting Cable Tray, Conduit, Supports, and Junction Boxes In LaSalle N.P.S. Unit 1 and 2 Diesel Generator Corridors

for

Commonwealth Edison Company
LaSalle County Station, Units 1 and 2

Rev.:	Description:	By:	Date:	Ck.:	Date:	App.:	Date:
0	Draft for Comment	G. Jarosz	2/17/94	NA	NA	NA	NA
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2							

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Attachments:

- Generic Letter (GL) 86-10

SECTION 1.0
SYNOPSIS:

The purpose of this test is to demonstrate the ability of Darmatt KM1 fire barrier system to protect various electrical raceway assemolies for one (1) hour fire resistance in accordance with the performance requirements of GL 86-10 (Final Draft) and the ASTM E-119 time/temperature curve.

The fire test will be conducted at Favordale Laboratories (U.K.) using a prototype specimen which represents a composite of Commonwealth Edison's LaSalle County Station, Units 1 and 2 worst case conditions for where this material/design is intended to be installed. After the conclusion of the one hour fire test, the prototype specimen will be subjected to a hose stream test in accordance with GL 86-10 requirements.

The general configuration of the specimen consists of a single horizontal run of 4" x 30" wide solid back steel cable tray which in plan view resembles a "L" shape. One leg of the "L" will represent a cable tray which runs parallel with the corner of a wall/ceiling (cable tray within 1" of the wall and 12" of the ceiling). In this example, the wall and ceiling form two surfaces of the protective envelop while the remaining two sides will consist of Darmatt KM1. The other leg of the "L" shape will represent the 4" x 30" wide cable tray in a free open space whereas the tray will be protected on all four sides with the Darmatt material. Included with the tray specimen are various hangers, penetrating conduit (both protected and unprotected), and a junction box. The cable trays will be empty with the exception of a bare ground cable.

This configuration (see attached drawings) was chosen since it represents or exceeds the worst case bounding conditions found at LaSalle. These conditions are as follows:

1.) Cable Tray Sizes: The LaSalle trays to be protected consist of both 6" x 30" and 4" x 30" wide solid back steel cable trays. The test will use a 4" x 30" tray section since it represents a smaller heat mass than a 6" tall tray and therefore a more severe condition. Further, 30" wide trays were chosen for the test in order to demonstrate the Darmatt KM1 material's ability to span trays up to and including 30" wide for the duration of a one hour ASTM E-119 fire.

In respect to representative conditions in relation to heat mass, the cable tray test specimens will not contain any cable except for a bare copper ground. One of the objectives of this test is to qualify the smallest possible heat mass for 30" wide raceways (to demonstrate worst case conditions), to bound and qualify larger heat masses (i.e., trays which can contain any number of cables) in the field.

In further regard to heat masses, it should be noted that existing field conditions exhibit raceway and cable assemblies that are completely and/or partially wrapped with TSI's Thermo-Lag material in varying thicknesses (and in some instances, sections of the raceways may be completely bare). It is also the purpose of this test to qualify the use of the Darmatt KM1 material as a "stand-alone

product" without relying on any portion of the test assembly being first covered with the Thermo-Lag product as supplemental protection. The intent here is to qualify actual field conditions where this system will be installed over raceway and cable assemblies that are either completely or partially wrapped with the Thermo-Lag material (as well as raceways without any Thermo-Lag wrap).

Since Thermo-Lag will not be incorporated as a component of the test specimen, the resulting heat mass to be qualified is significantly reduced and therefore is, as a minimum, equal to/more severe condition than cases found at LaSalle where partial/complete Thermo-Lag wraps are already installed. Heat masses to be demonstrated in the test are even further minimized since raceways without Thermo-Lag result in smaller overall specimens (*for example*, if a 30" x 4" tray was hypothetically first covered with 1" of Thermo-Lag, the resulting tray specimen would have a cross-sectional area of 192 square inches [32" x 6"] as opposed to 120 square inches [30" x 4"] for the same size tray without Thermo-Lag). In regard to the reduction in width of the test specimen mentioned herein (actual field trays can be up to 32" [±] when wrapped with Thermo-Lag as opposed to 30" wide tray specimens proposed for this test), the distance between the side rails of the cable tray (the points of the tray that eventually support the Darmatt material and its joints) remains the same (30" whether the tray is or is not first wrapped with Thermo-Lag) and therefore does not impact the test.

In regard to joints in the Darmatt system (where one section of material butts up against an adjoining piece) it has been determined that horizontal joints pose a more severe testing condition than vertical joints for qualification purposes. This thinking follows precedence established for performing fire testing for other applications (i.e., ASTM E-119 and related standards recognize that horizontal test specimen surfaces are a more severe condition to test than vertical surfaces). In this instance, gravity may also tend to work more against horizontal joints (which might tend to sag and pull apart) as opposed to vertical joint (which may benefit from being pulled together by being held slightly in tension). The test will demonstrate (at a minimum) joints in the Darmatt system that are approximately 32" long. Additionally, one long joint (in the Darmatt system) will be tested on a vertical side of the test specimen (size and location to be determined during test fabrication/installation.

2.) **Fire barrier envelope using a ceiling and wall as part of the envelop:** In the case where this configuration occurs in the field, two trays run together (one over the top of another) and will be enclosed in the same Darmatt envelop (and not wrapped individually). Rather than demonstrate the larger heat mass (two trays in the same envelop), only one tray will utilized in the test to qualify this condition.

3.) **Cable Loading:** No cables will be used in the fire test in order to demonstrate the smallest heat mass possible in order to qualify cable trays, conduits, and junction boxes that can have any number of cables.

4.) **Four-sided cable tray fire barrier envelop:** A four-sided Darmatt KM1 envelop installed over a single 4" x 30" wide cable tray will be demonstrated in the test in order to qualify four-sided envelops for both single or multiple cable trays up to and including 30" wide. The single test tray is intended to demonstrate the smallest heat mass to be experienced in actual field installations at LaSalle (LaSalle has cases where both single and multiple trays will be enclosed in the same envelop).

In accordance with the test drawings, one end of this raceway assembly will terminate at a furnace wall. In this case, the tray will not penetrate through the wall. Rather, three (3) 4" diameter cast/core bored round openings through the furnace wall will be positioned immediately above the tray to represent field conditions where cables enter (drop into) the tray from sleeves embedded in an abutting wall. This test feature will be smaller than the actual field condition and hence represents a more severe case in respect to heat mass.

The ground cable used in this tray as well as some of the instrumentation will exit through one of the round test openings. All of these openings will be filled with approximately 6-8" of ceramic fiber and/or blanket for the test.

5.) **Penetrations to the envelops:** In both cases of two and four-side envelop test specimens, penetrations through the envelop fire barriers will be demonstrate. The two-sided envelop will be penetrated by a single cable tray (which uses the four-sided wrap), hangers, and conduit. The four-sided fire barrier wrap will be penetrated by an intervening junction box, conduit, hangers and small I-beam column.

6.) **Conduits:** The test will demonstrate both wrapped (for their entire length) conduits located both in free air as well as against a concrete wall. Also penetrating conduits (to the envelops) will also be used to demonstrate intervening non-vital conduits which are wrapped only a short distance from fire barrier envelop for heat sink purposes. In all cases empty ¾" diameter conduits will be used in order to demonstrate the most severe conduit heat mass in order to qualify all other field conduit conditions. All conduits used in the test will be ¾" diameter rigid steel/IMT conduits.

Additional conduit qualifications for the Darmatt material will be provided (if needed) from other tests already performed by Darchem for this installation

7.) **Free-Air Cable Drop:** A single cable air drop (against a wall) occurs in the field which will be represented in the test by utilizing a small copper ground dropping from a conduit into a cable tray as shown in the attached drawings.

8.) **Junction Box:** An intervening 12" x 12" junction box will be demonstrated in the test. Although this box is not part of the electrical systems to be protected by the intended fire

barrier in the field, it will be totally enclosed in its own envelop during field installation because of its location as an intervening item. Temperature data will be collected for this item during the test as supplemental information which can be used for qualifying junction boxes.

9.) Hangers: Unistrut hangers will be demonstrated in the test. The test hangers will be wrapped with the Darmatt material up to the slab ceiling/wall in order to demonstrate anticipated field installations. Note: like the other raceway items being tested, field hangers are either completely or partially covered with Thermo-Lag (or bare). It is the intent of the test to demonstrate bare hangers as a worst case condition (smallest heat mass) that would later qualify hangers initially covered with Thermo-Lag in the field.

SECTION 2.0
TEST SLAB:

The test will utilize a non-conventional slab/furnace arrangement which consists of a "L"-shaped concrete slab which mates to an insulated steel bulkhead furnace to form a nominal 12' x 7' rectangular box. The concrete slab portion of this arrangement basically forms the ceiling over the "L" shaped cable tray test specimen. In accordance with the attached drawings, two short concrete wall sections will drop from the horizontal slab in order to demonstrate a point of attachment for the two-sided envelop fire barrier as well as an exit penetration for the cable tray/ground cable and instrumentation.

At the option of the test laboratory, the concrete portion of the specimen may consist of commercially available precast slabs provided nominal assurance can be provided that the exposed surface of the concrete will spall in a similar manner as the concrete used in the field. The intent is to use a concrete that will spall when exposed to fire in order to demonstrate a worst case condition at the interface where the Darmatt material is anchored to the concrete wall and ceiling.

The concrete portion of the test assembly will be structurally supported as permanent, non-moving elements. Again, the test is designed so that the furnace will be removed from the test slab/specimen at the conclusion of the fire test as opposed to removing the slab from the furnace.

SECTION 3.0
ITEMS TO BE PROTECTED:

The following is a description of the items to be used as raceway elements for the fire test:

1.) Cable Tray: 4" x 30" solid back steel tray. It the tray is not supplied by LaSalle (as a specific plant item), then trays may be fabricated using 16 ga. sht. metal

side rails and bottom (bottom of tray may be ribbed ½" high 2" apart and may be tack welded to side rails)

2.) Conduit: ¾" rigid steel/IMT. Use steel couplings, connectors and straps.

3.) Junction Box: 12" x 12" x 3" If box not supplied by LaSalle (as a specific plant item), then box may be fabricated from 18 gauge sheet metal with removable lid. Lid will be either held in place with eight #8-32 or ¼-20 screws/nuts approximately 6" apart along perimeter of box. The Darmatt material used for covering this item will be equipped with buckles (for closing) to simulate anticipated field conditions.

4.) Hangers: Hangers will be Unistrut (or comparable) to match smallest size used in LaSalle's Diesel Generator Corridors for the raceways where this system will later be installed.

5.) Anchors: Conduit straps and junction box may be held in place with 1/4" (or 3/16") x 2¼" Tapcon Fasteners (or similar).

Note: Miscellaneous hardware items for connecting and assembling trays, hangers, etc. will be representative of field conditions. An accurate description of specimen fabrication shall be identified in the final test report (as verified by Quality Control [QC]). Hardware substitutions are permitted provided substitute materials (etc.) do not increase the heat mass of the specimen.

SECTION 4.0
FIRE BARRIER MATERIAL INSTALLATION:

The Darmatt KM1 material shall be installed in accordance with the manufacturer's instructions. If complete written instructions are not available at the time of installation, then QC personnel shall document/verify step-by-step methods used for installation.

Materials used for this test shall be purchased, received, and installed in accordance with latest approved revision of Transco Products Inc.'s Quality Assurance Program and applicable procedures.

SECTION 5.0
THERMOCOUPLES:

Thermocouples shall be mounted to the specimen to gather temperature data for the duration of the fire test. At a minimum, temperatures shall be documented at five minute intervals for the first two hours of the test and then at ten minute increments for the remaining hour. Thermocouple placement (quantity and locations) shall be as specified in GL 86-10 as follows:

> "... **Conduits** - The temperature rise on the unexposed surface of a fire barrier system installed on a conduit shall be measured by placing the thermocouples every 152 mm (6 - inches) on the exterior conduit surface, between the conduit and the unexposed surface of the fire barrier material. The thermocouples shall be attached to the exterior conduit surface located opposite of the test deck and closest to the furnace fire source. The internal raceway temperatures shall be measured by a stranded AWG 8 bare copper conductor routed through the entire length of the conduit system with thermocouples installed every 152 mm (6-inches) along the length of the copper conductor. Thermocouples shall also be placed immediately adjacent to all structural members, supports, and barrier penetrations.
>
> **Cable Trays** - The temperature rise on the unexposed surface of a fire barrier system installed on a cable tray shall be measured by placing the thermocouples on the exterior surface of the tray side rails between the cable tray side rail and the fire barrier material.
> Internal raceway temperatures shall be measured by a stranded AWG 8 bare copper conductor routed on the top of the cable tray rungs along the entire length and down the longitudinal center of the cable tray run with thermocouples installed every 152 mm (6-inches) along the length of the copper conductor. Thermocouples shall be placed immediately adjacent to all structural members, supports, and barrier penetrations.
>
> **Junction Boxes (JB)** - The temperature rise on the unexposed surface of a fire barrier system installed on junction boxes shall be measured by placing thermocouples on either the inside or the outside of each JB surface. Each JB surface or face shall have a minimum of one thermocouple, located at its geometric center. In addition, one thermocouple shall be installed for every one square foot of JB surface area. These thermocouples shall be located at the geometric centers of the one square foot areas. At least one thermocouple shall also be placed within 25 mm (1-inch) of each penetration connector/interface.
>
> **Airdrops** - The internal airdrop temperature shall be measured by a stranded AWG 8 bare copper conductor routed inside and along the entire length of the airdrop system with thermocouples installed every 152 mm (6-inches) along the length of the copper conductor. The copper conductor shall be in close proximity with the unexposed surface of the fire barrier material. Thermocouples shall also be placed immediately adjacent to all supports and penetrations. ....."[1]

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[1]: Generic Letter 86-10 Final Draft

All specimen temperatures shall be monitored using 24 gauge Type K Chromel-alumel thermocouples (special limits of error ±1.1°C). Thermojunctions of all specimen thermocouples shall be electrically welded. All thermocouple wire shall be supplied with certifications of purity, accuracy, and calibration.

Furnace atmosphere thermocouples shall be placed 12" below the furnace deck/slab as well as 12" away from representative elements of the test specimen in accordance with ASTM E-119 requirements (as applicable). Additional furnace atmosphere thermocouples may be employed at the laboratories discretion to supplement data acquisition in areas where furnace atmosphere thermocouples can not be mounted to satisfy ASTM E-119 requirements because of the specimen's configuration, et cetera.

The installation and location of each uniquely identified thermocouple (for both the specimen and furnace) shall be mapped and verified (measured) by Quality Control. Verification may be performed as hand written notes and shall become part of the permanent records of the test. Also, all thermocouple certifications shall also become a permanent record of the test.

Note: In accordance with GL 86-10 requirements, "for the thermocouples installed on conduits, cable tray side rails, and bare copper conductors, a ±13 mm (±½ inch) installation tolerance is acceptable". Hence, this tolerance shall be considered acceptable for use in this test. The tolerance is considered to be from the point of individual thermocouple placement and not compounded from one thermocouple to the next (i.e., all thermocouples can not be 6½" from each other but rather must be ±½" from the measured 6" [minimum] mark on the item being monitored).

SECTION 6.0
FIRE TEST:

The fire test shall be conducted in accordance with the ASTM E-119 time/temperature curve (and temperature tolerance) for one (1) hour. As a minimum, temperature data provided by both furnace and specimen thermocouples shall be monitored and documented in 5 minute intervals. The laboratory shall verify and document the furnace draft (pressure) experienced during the test.
The laboratory shall also document visual specimen performance (i.e., smoke, et cetera) and occurrences for the duration of the test.

SECTION 7.0
HOSE STREAM TEST:

After the conclusion of the one (1) hour fire test, the specimen shall be subjected to a minimum of one of the following hose stream tests (as identified in GL 86-10):

(a.) "The stream applied at random to all exposed surfaces of the test specimen through a 6.4 cm (2½-inch) national standard playpipe with a 2.9 cm (1⅛-inch) orifice at a pressure of 207 kPa (30 psi) at a distance of 6.1 meters (20 feet) from the specimen, (Duration of the hose stream application - 1 minute for a 1-hour barrier and 2½ minutes for a 3-hour barrier); or"[2]

(b.) "The stream applied at random to all exposed surfaces of the test specimen through a 3.8 cm (1½-inch) fog nozzle set at a discharge angle of 30 degrees with a nozzle pressure of 517 kPa (75 psi) and a minimum discharge of 284 lpm (75 gpm) with the tip of the nozzle at a maximum of 1.5 meters (5 feet) from the test specimen. (Duration of the hose stream application - 5 minutes for both 1-hour and 3-hour barriers); or"[2]

(c.) "The stream applied at random to all exposed surfaces of the test specimen through 3.8 cm (1½-inch) fog nozzle set at a discharge angle of 15 degrees with a nozzle pressure of 517 kPa (75 psi) and a minimum discharge of 284 lpm (75 gpm) with the tip of the nozzle at a maximum of 3 meters (10 feet) from the test specimen. (Duration of the hose stream application - 5 minutes for both 1-hour and 3-hour barriers.)"[2]

The order of preference for conducting one, or more of the above hose stream tests is (by item letter) is "c", "b", and then "a". QC shall verify and document quantitative data/compliance with requirements (i.e., type of hose stream, distance, time, et cetera) employed in each hose stream test.

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[2]: Generic Letter 86-10 Final Draft

SECTION 8.0
TEST REPORT:

The laboratory performing the test shall provide a written report which accurately describes the following minimum elements of the test:

1.) Verification of specimen (trays conduits, hangers, junction box, slab, et cetera) materials and dimensions used;

2.) Verification of fire barrier envelop materials, dimensions, and installation techniques (procedures) used;

3.) Verification of furnace construction/dimensions and locations of burner, thermocouples, et cetera;

4.) Verification of specimen thermocouple locations (along with copies of thermocouple material certifications);

5.) Verification of standards used for conducting fire test along with record of both furnace atmosphere and specimen temperature data acquired during test;

6.) Record of furnace pressure during fire test;

7.) Record of visual occurrences/observations of fire and hose stream tests;

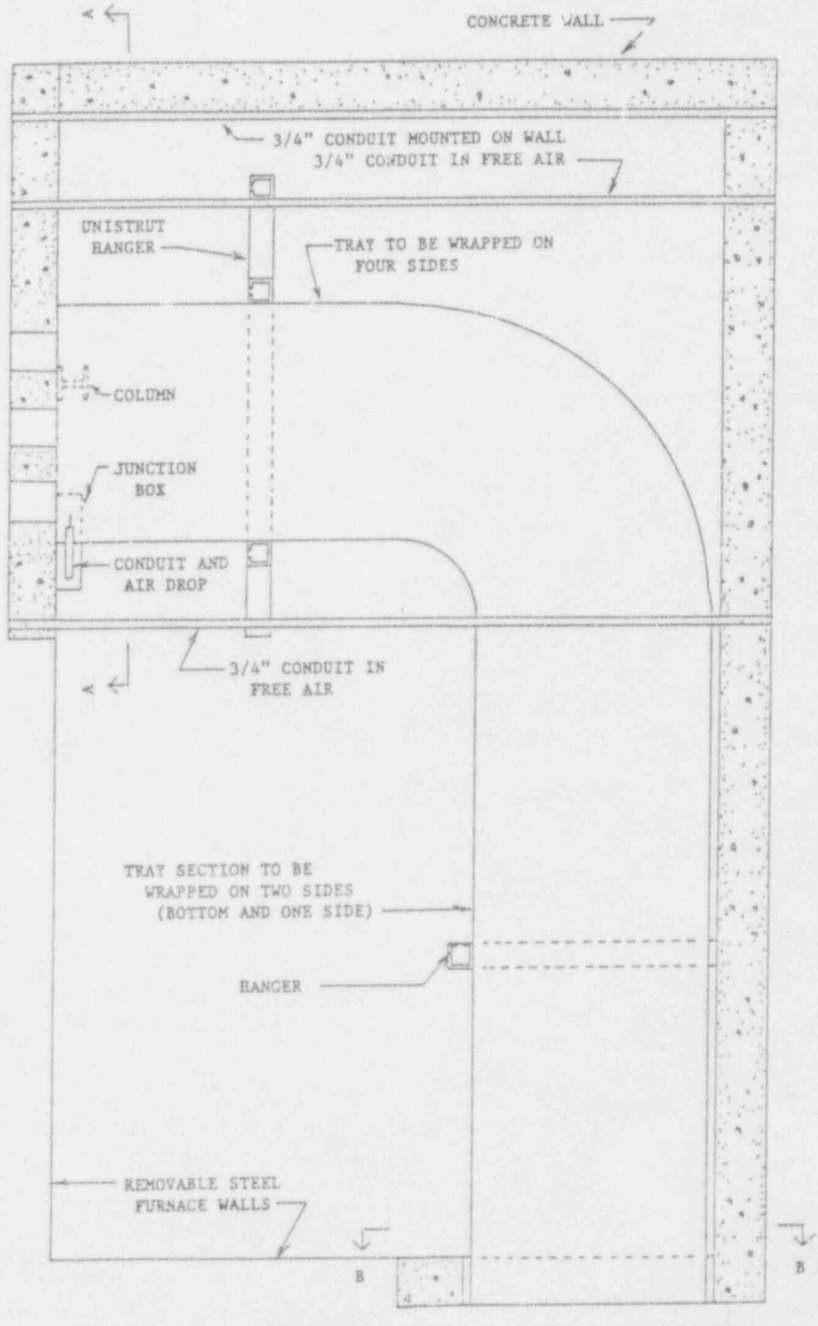
8.) Record of hose stream test(s);

9.) Photographic records of specimen before fire barrier envelop installation, after fire barrier installation, and post fire/hose stream tests;

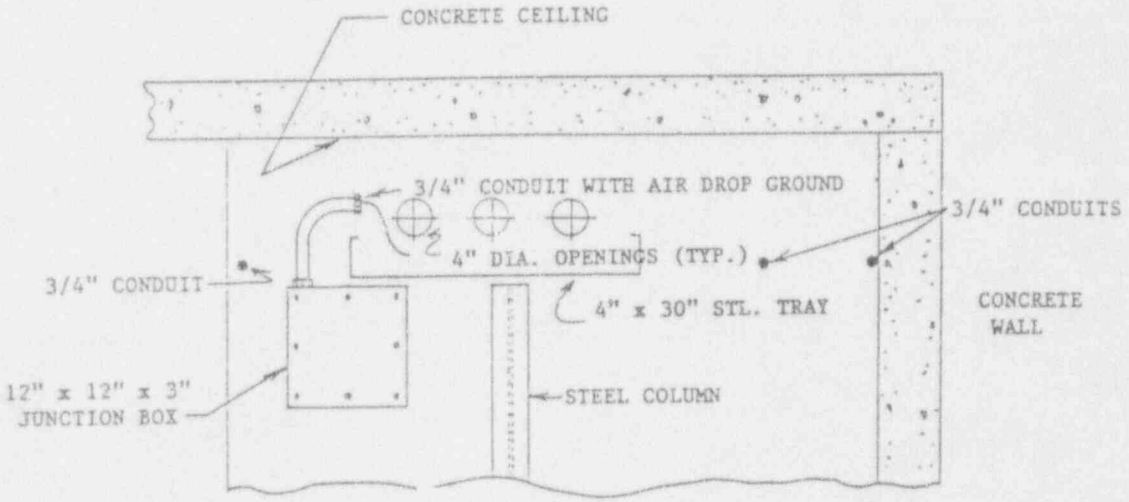
10.) Post test observations including measurements of material loss/degradation, et cetera;

11.) Certification of the report by the agency performing test; and,

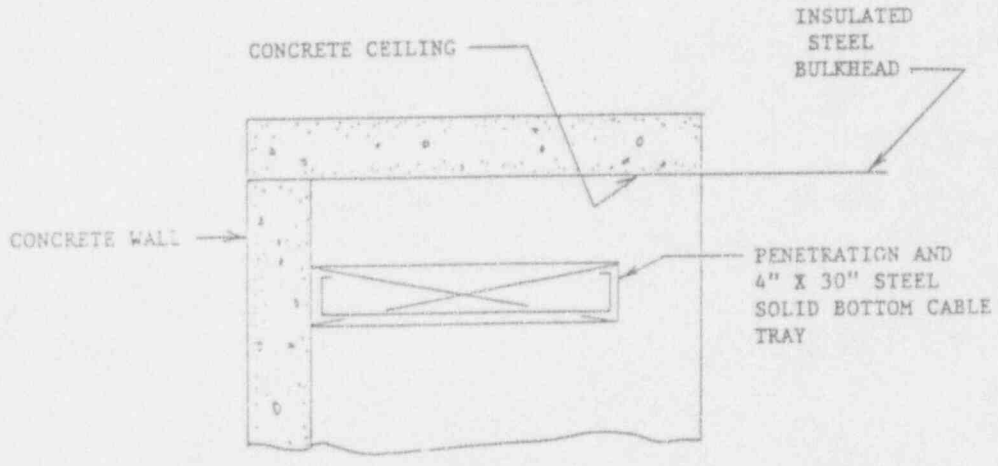
12.) QC records and notes from installation and test as an appendix to the report.



PLAN VIEW OF TEST SPECIMEN AND FURNACE



SECTION "A"-"A"

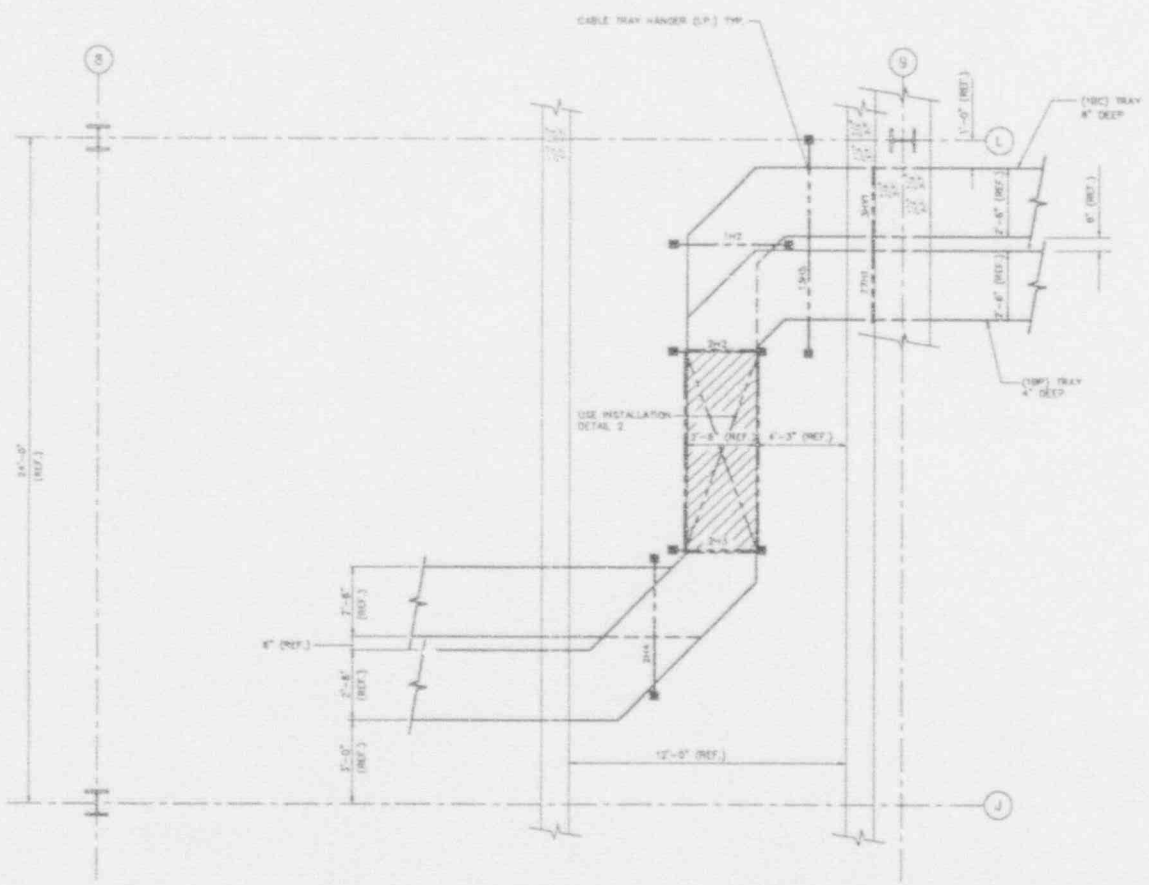


SECTION "B"-"B"

DETAILS OF TEST SPECIMEN

Attachment 2

Conceptual Design Drawings for
Thermo-Lag Configurations

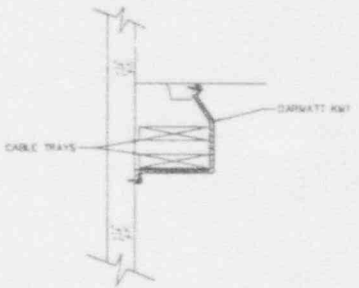


PLAN EL. 710'-6"

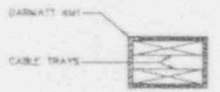
NOTE:
USE INSTALLATION DETAIL 2 WHERE INDICATED.
USE STANDARD INSTALLATION DETAIL FOR ALL OTHER TRAYS.

STANDARD INSTALLATION DETAIL

(EXCEPT WHERE NOTED)



INSTALLATION DETAIL 1

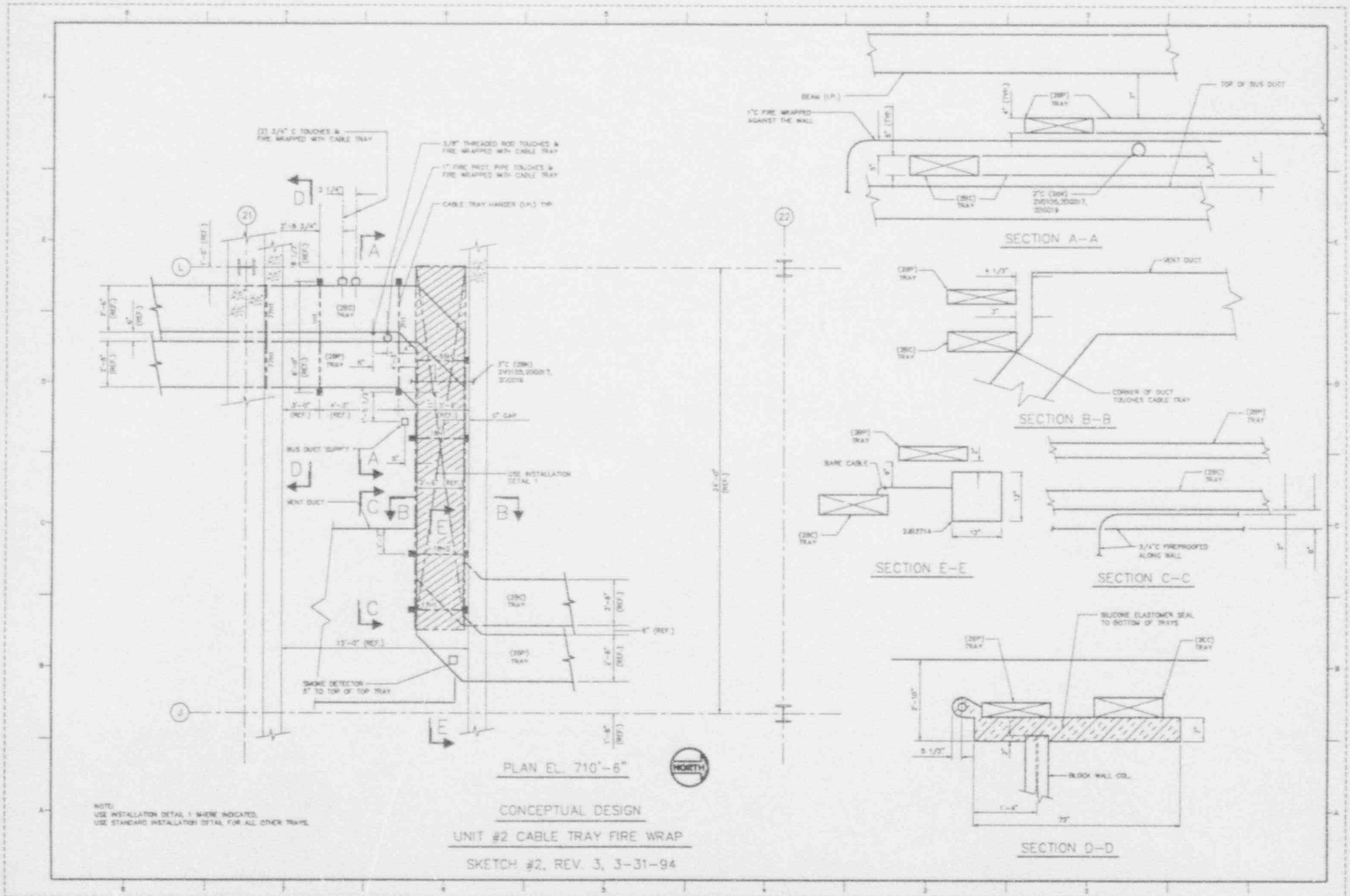


INSTALLATION DETAIL 2

CONCEPTUAL DESIGN

UNIT #1 CABLE TRAY FIRE WRAP

SKETCH #1, REV. 3, 3-31-94



NOTE:
USE INSTALLATION DETAIL 1 WHERE INDICATED.
USE STANDARD INSTALLATION DETAIL FOR ALL OTHER TRAYS.

CONCEPTUAL DESIGN

UNIT #2 CABLE TRAY FIRE WRAP

SKETCH #2, REV. 3, 3-31-94

Attachment 3

National Measurement Accreditation Service
(NAMAS)
for
Faverdale Laboratory

NAMAS

National Measurement
Accreditation Service

National Testing Laboratory Accreditation Scheme

ACCREDITATION CERTIFICATE

Accreditation number

0666

This is to certify that

Darchem Development Laboratory
Faverdale Industrial Estate
Darlington
Co. Durham
DL3 0PX

is accredited by the National Measurement Accreditation Service to undertake testing as detailed in the NAMAS Schedule bearing the above accreditation number. From time to time this Schedule may be revised.

This Accreditation shall remain in force until further notice subject to continuing compliance with the general conditions applicable to Accredited Laboratories and any special conditions as may be prescribed.

NATLAS
NATIONAL TESTING
LABORATORY
ACCREDITATION
SCHEME

Head NAMAS J. Summerfield
on behalf of Secretary of State for Trade and Industry

Date 27 October 1988

MF123 (N)

NAMAS (National Measurement Accreditation Service) has been formed by the amalgamation of SCS (British Calibration Service) and NATLAS (National Testing Laboratory Accreditation Scheme) and is a service of the National Physical Laboratory.

NATIONAL MEASUREMENT ACCREDITATION SERVICE

TESTING LABORATORY
No. 0666

SCHEDULE

Address of permanent laboratory	Category 0 Permanent Laboratory Testing performed on permanent laboratory premises
Faverdale Technology Centre Ltd Faverdale Industrial Estate Darlington Co Durham DL3 0PX	Laboratory Contact: Mr C T M Hall
Telephone : Darlington (0325) 301220	Issue No: 9 Date: 12 February 1993

Materials/Products Tested	Types of Test/Properties Measured Range of Measurement	Standard Specifications Equipment/Techniques Used
	Fire Tests	
AEROSPACE EQUIPMENT	Fire resistance	BS3G100:Part 2:Sect 3: Sub Sect 3.13:1973(1983)
HYDRAULIC EQUIPMENT and FITTINGS PIPES and PIPELINE COMPONENTS CONSTRUCTION PRODUCTS STRUCTURAL COMPONENTS and FIXINGS OFFSHORE STRUCTURES INSULATING MATERIALS, THERMAL	Fire resistance	Documented In-House Method based on cellulosic curve (BS 476 Part 8:1972: Fig 1 and BS 476:Part 20:1987 Fig 2) Documented In-House Method based on hydrocarbon curve (BRE 1985:BR65)
BUILDING MATERIALS and STRUCTURES	Non-combustibility Heat emission	BS 476:Part 4:1970 (1984) BS 476:Part 11:1982 (1988)
BEAMS	Fire resistance	BS 476:Part 20:1987 BS 476:Part 21:1987:Section 5 Fire Test Study Group Resolutions 47 and 70
COLUMNS	Fire resistance	BS 476:Part 20:1987 BS 476:Part 21:1987:Section 6 Fire Test Study Group Resolutions 47 and 70 Documented In-House Method based on Mobil hydrocarbon curve

NATIONAL MEASUREMENT ACCREDITATION SERVICE

TESTING LABORATORY No. 0656

Category 0 : Permanent Laboratory

Issue No: 9

Date: 12 February 1993

SCHEDULE

Materials/Products Tested	Types of Test/Properties Measured Range of Measurement	Standard Specifications Equipment/Techniques Used
	Fire Tests (cont'd)	
WALLS and PARTITIONS	Fire resistance	BS 476:Part 20:1987 BS 476:Part 22:1987 Fire Test Study Group Resolutions 68 and 70 Documented In-House Method based on Mobil hydrocarbon curve
COMPOSITES for UPHOLSTERED SEATING	Ignitability	BS 5852:Part 2:1982: Crib sources 4, 5, 6 and 7 BS 5852:1990:Crib sources 4, 5, 6 and 7
ARMOURED CABLES for ELECTRICITY SUPPLY	Smoke Emission	BS 6724:1986:App.F BS 6853:1987:App.B
	Health and Hygiene	
AIRBORNE ASBESTOS FIBRES and DUSTS	Fibre counting	Membrane Filter Methods in accordance with Health and Safety Executive MDHS 39/3, June 1990 Documented In-House Methods
ASBESTOS ASBESTOS PRODUCTS including: INSULATING MATERIALS. SPRAYED COATINGS. BOARDS. CEMENTS. FLOOR COVERINGS. FRICTION MATERIALS. GASKETS. PLASTICS. RUBBERS. SURFACE FINISHES	Identification	Documented In-House Methods using stereo-microscopy, polarised light optical microscopy and dispersion staining

END