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FROM: Patrick M. Madden, Senior Fire Protection Engineer
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SUBJECT: TRIP REPORT, NUCLEAR MANAGEMENT AND RESOURCES COUNCIL PHASE II THERMO-LAG FIRE BARRIER TEST PROGRAM, CONSTRUCTION OF TEST ASSEMBLY 2-8, OMEGA POINT LABORATORIES, ELMENDORF, TEXAS

On January 19-20, 1994, I visited Omega Point Laboratories, Elmendorf, Texas, to witness test specimen construction activities associated with Phase II of the Nuclear Management and Resources Council Thermo-Lag fire barrier test program. I witnessed the application of Thermo-Lag fire barrier material to test assembly 2-8. My observations are documented in the enclosed trip report.

Original signed by

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Enclosure:
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OF AD-15-1 (Trip Reports)
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ENCLOSURE

TRIP REPORT

INDUSTRY GROUP: Nuclear Management and Resources Council (NUMARC)

ACTIVITY: NUMARC Phase II Thermo-Lag Fire Barrier Test Program - Construction of Test Assembly 2-8

LOCATION: Omega Point Laboratories, Inc.
Elmendorf, Texas

DATE OF TRIP: January 19-20, 1994

REVIEWER: Patrick M. Madden, Sr. Fire Protection Engineer
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Background

The Nuclear Management and Resources Council (NUMARC) is coordinating the industry program to resolve the technical issues associated with 1 and 3-hour Thermo-Lag fire barrier systems. As part of this program, NUMARC is developing, constructing, and testing various conduit and cable tray test specimens. Currently, NUMARC is performing Phase II of their program which will test representative industry baseline configurations and upgrades to those baseline configurations. During Phase II NUMARC plans to test 11 test assemblies.

Purpose of Trip

On January 19-20, 1994, I visited Omega Point Laboratories, Inc., located in Elmendorf, Texas. The purpose of this trip was to witness the construction of test assembly 2-8 for Phase II of the NUMARC Thermo-Lag fire barrier test program.

During this trip I interfaced with the following industry personnel and contractors: Richard Lohman, Thermal Science Incorporated (TSI); Cal Banning, VECTRA; Michael Jordan, Promatec, Incorporated; and Leo Werner, William Nicar, Donald Bagaby, and Duane Powers of Peak Seals, Incorporated. In addition, I interfaced with the following OPL personnel: Constance Humphrey, Quality Assurance Manager and Vice President, Martin Keathley, QA/QC Inspector, and Kerry Hichcock, Shop Foreman.

Description of Test Assembly 2-8 Configuration and Instrumentation

Test assembly 2-8 consists of four aluminum cable trays (two 6-inch by 4-inch trays and two 24-inch by 4-inch trays) positioned in side-by-side L-shaped configurations (see Attachments 1 and 2 for general arrangement of tray test specimens). The vertical drop of each tray test specimen into the furnace from the top furnace test deck is 36 inches with each specimen making a 90 degree radial bend. At this point each of the tray test specimen makes a 48 inches horizontal run where they exit through the wall of the furnace. Each cable tray had a single layer of cables installed. This single layer of cables represents a 15 percent cable fill. This fill was comprised of one-third instrumentation, one-third control and one-third power cables.

These cable tray test specimens have been instrumented with thermocouples in the following manner:

> The individual cable tray side rails are instrumented with thermocouples attached every 6-inches along the longitudinal center of the exterior surface of the rail;
>
> A bare copper stranded 8 AWG conductor with thermocouples attached to the conductor at 6-inch intervals is routed down the center of the cable tray and is attached to the top of the tray rungs. This copper conductor is located in with the cables;
>
> A second bare copper stranded 8 AWG conductor with thermocouples attached to the conductor at 6-inch intervals is routed down the center of the cable tray, and is attached to the top surface of the cable fill; and,
>
> A third bare copper stranded 8 AWG conductor with thermocouples attached to the conductor at 6-inch intervals is routed down the approximate center of the cable tray and is attached to the bottom of the tray rungs.

Description of Fire Barrier Design

The four cable trays used in this test assembly are designated as TI-B-24AX, TI-B-6AX, TI-B-24BX, and TI-B-6BX. A 1-hour Thermo-Lag fire barrier design (nominal 1/2-inch thick Thermo-Lag 330-1 panels) will be installed using two different installation methods. The four piece method will be used on trays TI-B24-AX and TI-B-6BX. The score and fold method will be used on trays TI-B-24BX and TI-B-6BX. The 24-inch-wide cable tray using the four piece method will not be prebanded. The Thermo-Lag V-rib orientation for the top and bottom panels, for both the 6 and 24-inch wide cable tray, will be parallel to the cable tray side rails. The rib orientation for the Thermo-Lag fire barrier material being installed on the cable tray side rails using the score and fold method is in the same direction as the run of the tray. For example if the tray side rail is running horizontal the rib would be horizontal. Where the four piece method is going to be used, the V-rib orientation on the side rails of those trays is vertical on the horizontal and horizontal on the vertical tray runs. The stainless steel bands are to be spaced 3 inches on each side of a butt joint and at 12 inch (maximum) intervals on the horizontal and vertical tray runs. All baseline fire barrier joints and seams will be post-buttered with trowel grade Thermo-Lag material. The construction of all radial bend tray sections will use the four piece mitered method.

The baseline fire barriers will be upgraded by applying additional stress skin and trowel grade Thermo-Lag to the joints and seams. On the 24-inch wide cable tray, the U-shape stress skin pieces will be installed on the longitudinal seams. These U-shapes will have a 3-inch (minimum) overlap onto the top and bottom and will be held in place with 1/2-inch staples. The two stress skin U-shapes (one installed on each cable tray side rail) will be secured to one another with wire ties. These wire ties will extend across the top and bottom Thermo-Lag fire barrier panels at 6-inch intervals, except at the area of the butt joints where the wire ties will be spaced a maximum of 2-inches from the joint. For the butt joints, a circumferential stress skin wrap is going to be installed after the U-shaped upgrades are completed. This stress skin wrap will be approximately 8-inches wide and will cover the baseline stainless steel bands on either side of the butt joint. The circumferential stress skin ends will be overlapped and held together with tie wire loops and secured to the baseline fire barrier assembly with 1/2-staples.

In addition, at the end of the horizontal section of tray TI-B-24AX, the fire barrier will be terminated inside the furnace and a Thermo-Lag fire stop constructed at the fire barrier termination point (see attachment 3). The Thermo-Lag fire barrier assembly on the horizontal tray run, will end approximately 6 inches away from the furnace wall. At this point the aluminum cable tray will be exposed directly to the furnace. The fire stop will be constructed from 4-inch wide by 1/2-inch (nominal) thick panels. The ribs of these panels will be flattened with a hammer and cut to length to conform to the inside dimensions of the cable tray above the cable fill. The panels and the cables will be pre-buttered with trowel grade Thermo-Lag material and the panels will be laid horizontally and stacked to fill the void space from the top of the cables to the underside of the Thermo-Lag top fire barrier enclosure top panel.

The 6-inch wide cable trays will not have butt joint upgrades. The upgrade for the 6-inch tray configuration will consist of two stress skin U-shapes. Prior to applying the stress skin upgrades, the interfacing baseline fire barrier surfaces will have a skim coat of Thermo-Lag trowel grade applied. These shapes, when applied to the longitudinal seams, overlap one another near the center of the top and the bottom of the baseline fire barrier enclosure. This stress skin upgrade will have a minimum 1 inch overlap. The overlap of the two stress skin U-shape upgrades will be secured to one another with stainless steel tie wire on 6-inch spacing.

<u>Test Assembly 2-8 Construction Activities Witnessed</u>

On January 19, 1994, the internal fire barrier enclosure silicone elastomer seals were installed in the cable trays where the cable tray fire barrier enclosure exits the furnace at the through penetration. No apparent problems were noted with the seals installed in the horizontal tray segments. However, the dam construction for the seals in vertical tray segment allowed elastomer to leak down into the vertical tray segments and the radial bends of the 6-inch trays. This residual elastomer material coated cables, bare copper conductors, and thermocouple leads, specifically in the radial bends. On January 20, 1994, I identified this condition to the QA/QC inspector. The majority of the excess elastomer, which had solidified, was removed from the affected tray segments. Once this work was completed, I reinspected the area of concern. In my judgement the remaining residual elastomer should not effect the ability of the thermocouples to perform their function during the fire test.

On January 20, 1994, during my inspection of the silicone elastomer seal installed in the vertical tray section at the horizontal penetration in the furnace deck, I noticed a open 1/4-inch outside diameter (OD) copper tube extending through the elastomer seal. This copper tube links the atmosphere inside the fire barrier enclosure to that outside the enclosure. The intent of this tube is to relieve pressure which may form inside the enclosure as result of air temperature increases within the enclosure during the fire test. It is my speculation that NUMARC is concerned that the pressure buildup inside these enclosures during the fire test may be sufficient enough to cause an early joint or seam failure. In addition, this vent could be considered a heat vent out of the enclosure and could have an effect on lowering the internal temperature of the fire barrier system. In my opinion, this vent does not present a big concern with respect to either internal temperature. From a internal temperature perspective, the fire barrier unexposed surface temperature is being sufficiently monitored by the side rail thermocouples and the thermocouple instrumented bare copper conductor routed on the bottom of the cable tray rungs. The 1/4-inch OD vent is not large enough to create air currents within the enclosure sufficient enough to affect the temperatures at the thermocouples. With respect to internal pressure, in reality, in-plant raceway fire barrier internal fire stops installed are generally designed to be air tight. In-plant barriers, if constructed properly, are also air tight. The NUMARC test configurations are not being tested in this manner. According to Mr. Banning, Project Engineer for the Phase II NUMARC program, these vents were used in the Texas Utilities conduit and tray tests. He stated that the small-diameter tubes were installed to vent internal air pressure increases due to the test fire exposure.

In speculation, it is my opinion that the vent is not installed just for venting internal pressure buildup. The internal pressure increase resulting from a 250 °F internal temperature rise should not affect the integrity of the barrier system. The vent keeps the internal pressure of the fire barrier assembly at atmospheric. With the furnace's neutral pressure plane at the test specimen mid-point, the bottom half of the test specimen is at negative pressure. If a failure in a seam or a joint were to occur, the gas flow would be from the area of positive pressure to the area of negative pressure. Under these conditions, if no vent were present, pressure equilibrium and temperature would be reached very quickly. With a vent present, equilibrium would not be reached and a positive to negative gas flow would be established. This established positive to negative gas flow out through a small barrier opening could possibly cause some localized cooling effect thus, causing a delay in the indication of a failure. In my opinion, this is not significant in the event of a early or catastrophic barrier failure.

On January 20, 1994, I witnessed the construction of the baseline application of a Thermo-Lag 1-hour fire system to a 24 and 6-inch wide cable tray using the score and fold application method. During the application of the Thermo-Lag on the 24-inch tray, several internal shims had to be used to achieve the proper alignment of the panels. Generally, these shims were used on the side rails to true the top alignment of the side rail panel. Misalignment was caused by the V-rib acting as a pivot point since its orientation was parallel and in contact with the side rail. In addition some shims were used to align the bottom panel butt joints. In inspecting the relationship of the side rail thermocouples to the unexposed surface of the fire barrier material, it was noted on the 24-inch wide tray that there was approximately a 1/4-inch air gap and approximately a 1/2-inch air gap existed between the bottom Thermo-Lag panel and the thermocouples located below the tray rungs. The air gap distance between the unexposed surface of the fire barrier bottom panel and the thermocouples in the cable tray was approximately 1-1/2 inches. On the 24-inch tray, the top Thermo-Lag panel was constructed from GPU Nuclear stock (shipped from TSI to GPU January 28, 1991). The remaining Thermo-Lag material used on this 24-inch tray is from TSI stock which was shipped to Omega Point on December 10, 1993.

During the construction of the fire barrier on the 6-inch wide tray the thermocouple relationship to the fire barrier material unexposed surface was evaluated. It was noted that there was approximately a 1/4-inch air gap between the cable tray side rail and the fire barrier material and approximately a 1/4-inch air gap between the bottom Thermo-Lag panel and the thermocouples located below the tray rungs. The fire barrier on the 6-inch tray was constructed from TSI stock except for the inside top on the vertical tray run which was fabricated from Iowa Electric stock (shipped from TSI to Iowa Electric February 26, 1985).

In reviewing the routing of the instrumented bare copper conductors and their terminations on the four tray assemblies, it was noted that these conductors terminated outside the barrier on the other side of the upper furnace test deck penetration seals. For the lower furnace penetration seals through the furnace wall three tray configurations (one 24-inch and two 6-inch trays) were terminated in this fashion. This method of termination may cause minor conductive heat losses and lower thermocouple temperature readings for those thermocouples attached to these bare copper conductors directly adjacent to the penetrations on the inside of the fire barrier enclosure. In addition, it was noted that for the 24-inch wide tray that had the fire barrier terminated on the horizontal run within the furnace, the bare copper conductors were terminated within the fire barrier system. Mr. Banning explained that if the copper conductors were routed through the furnace that the internal temperatures may be affected and read higher. In my opinion, the current routing of the bare copper conductors through the penetration seals will not have an effect on the determining the temperature conditions in the critical areas of the test specimen therefore, the current configuration is sufficient and the data collected by the thermocouples adjacent to this seal will not have an affect on the overall results of the test.

During the week of January 24, 1994, the baseline Thermo-Lag fire barrier, using the four piece method, will be applied to the other 24 and 6-inch wide trays, the Thermo-Lag fire stop will be constructed, and the upgrades will be installed.