April 27, 2005

MEMORANDUM TO: John Hannon, Chief
Plant Systems Branch
Division of Systems Safety and Analysis
Office of Nuclear Reactor Regulation

FROM: David C. Lew, Chief ***/RA/***
Probabilistic Risk Analysis Branch
Division of Risk Analysis Applications
Office of Nuclear Regulatory Research

SUBJECT: PRELIMINARY PASS/FAIL TEST RESULTS FOR MT 3-HOUR RATED ELECTRICAL RACEWAY FIRE BARRIER SYSTEMS

The purpose of this memorandum is to communicate the preliminary pass/fail test results for the MT 3-hour fire rated, Electrical Raceway Fire Barrier System (ERFBS). The testing was conducted on April 25, 2005, at Omega Point Laboratories (OPL), San Antonio, Texas. The principal focus of this testing was basic electrical raceway configurations protected with typical MT 3-hour fire rated ERFBS. The MT ERFBS was manufactured and installed by Promatec using materials and installation techniques common to those configurations installed in the nuclear industry. The conduct of the testing and acceptance criteria were in accordance with NRC guidance as documented in Generic Letter 86-10, Supplement 1, "Fire Endurance Test Acceptance Criteria for Fire Barrier Systems used to Separate Redundant Safe-Shutdown Trains within the Same Fire Area."

Attachment 1 provides the preliminary pass/fail test results for the MT 3-hour fire rated ERFBS. A total of ten configurations were tested in the full scale fire endurance test; all configurations failed to meet the NRC acceptance criteria. After our review of the final documentation and the detailed test data we will transmit the final report to you by separate correspondence.

If you have any questions, please contact Mark Salley (x2840) or Roy Woods (x6622) of my staff.

Attachment: As Stated

April 27, 2005

MEMORANDUM TO: John Hannon, Chief
Plant Systems Branch
Division of Systems Safety and Analysis
Office of Nuclear Reactor Regulation

FROM: David C. Lew, Chief ***/RA/***
Probabilistic Risk Analysis Branch
Division of Risk Analysis Applications
Office of Nuclear Regulatory Research

SUBJECT: PRELIMINARY PASS/FAIL TEST RESULTS FOR MT 3-HOUR RATED ELECTRICAL RACEWAY FIRE BARRIER SYSTEMS

The purpose of this memorandum is to communicate the preliminary pass/fail test results for the MT 3-hour fire rated, Electrical Raceway Fire Barrier System (ERFBS). The testing was conducted on April 25, 2005, at Omega Point Laboratories (OPL), San Antonio, Texas. The principal focus of this testing was basic electrical raceway configurations protected with typical MT 3-hour fire rated ERFBS. The MT ERFBS was manufactured and installed by Promatec using materials and installation techniques common to those configurations installed in the nuclear industry. The conduct of the testing and acceptance criteria were in accordance with NRC guidance as documented in Generic Letter 86-10, Supplement 1, "Fire Endurance Test Acceptance Criteria for Fire Barrier Systems used to Separate Redundant Safe-Shutdown Trains within the Same Fire Area."

Attachment 1 provides the preliminary pass/fail test results for the MT 3-hour fire rated ERFBS. A total of ten configurations were tested in the full scale fire endurance test; all configurations failed to meet the NRC acceptance criteria. After our review of the final documentation and the detailed test data we will transmit the final report to you by separate correspondence.

If you have any questions, please contact Mark Salley (x2840) or Roy Woods (x6622) of my staff.

Attachment: As Stated

E:\Filenet\ML051170311.wpd

DISTRIBUTION: DRAA r/f, PRAB r/f, CAder, DLew, MSalley, HWoods, CPaperiello, JCraig, JDyer, DSSA r/f, SPLB r/f, SBlack, JHannon, SWeerakkody, DFrumkin, WBorchardt

OAR in ADAMS? (Y or N) Y ADAMS ACCESSION NO. ML051170311 TEMPLATE NO. RES-006
Publicly Available? (Y or N) Y DATE OF RELEASE TO PUBLIC Immediate SENSITIVE? N
To receive a copy of this document, indicate in the box: "C" = Copy without enclosures **"E"** = Copy with enclosures **"N"** = No copy
* See Previous Concurrences

OFFICE	*DRAA	*PRAB	*PRAB	*PRAB	*PRAB	*SISP Review	*SISP Review
NAME	EMiller	JDreisbach	HWoods	MSalley	DLew	JDreisbach	DLew
DATE	4/27/05	4/27/05	4/27/05	4 /27/05	4/27/05	4/27/05	4/27/05

Attachment 1

Preliminary Pass/Fail Report for MT 3 Hour Fire Rated ERFBS Testing

Purpose of the Testing

The purpose of this testing was to perform confirmatory fire endurance testing on typical MT 3-hour fire rated Electrical Raceway Fire Barrier Systems (ERFBS). The testing was conducted on April 25, 2005, at Omega Point Laboratories (OPL), San Antonio, Texas. The MT ERFBS was manufactured and installed by Promatec using materials and installation techniques common to those configurations installed in the nuclear industry. The testing protocol and acceptance criteria used for this testing were in accordance with NRC guidance as documented in Generic Letter 86-10, Supplement 1, "Fire Endurance Test Acceptance Criteria for Fire Barrier Systems used to Separate Redundant Safe-Shutdown Trains within the Same Fire Area."

Scope of the Testing

The scope of the testing was to perform confirmatory testing on conduits, junction boxes, air drops and structural supports protected with MT 3-hour fire rated ERFBS. The test consisted of 1, 2-1/2, and 4-inch conduits empty and with significant cable fill, one junction box, one cable air drop, and two structural steel supports. All MT ERFBS were directly attached to the raceways. Electrical cable ampacity de-rating and ERFBS seismic position retention testing was beyond the scope of this testing.

Preliminary Test Results & Observations

The preliminary results for the test are provided in the table that follows. In addition to the tabular results, key observations are provided in the following discussions.

1. ERFBS Construction:

   MT for use with conduits is constructed with four discrete layers. The first layer, closest to the conduit, is 1 inch of Kaowool blanket wrapped in a fiberglass fabric. The second layer is a 2 mil sheet of stainless steel. The third layer is a hydrate packet. This packet is made by stitching together packets of aluminum trihydrate in a fiberglass coated fabric. The fourth and outermost layer is 1-1/2 inch Kaowool blanket wrapped in Siltemp. The configuration is slightly different for air drops and structural supports. Air drops use a 3 inch blanket of Kaowool as the inner layer. Structural supports do not have the hydrating packet layer or the stainless steel sheet.

2. Outer Layer Shrinkage:

   The MT fire barrier uses an outer layer of Kaowool that is covered with high temperature Siltemp fabric. During the fire testing, this outer layer experienced a phenomenon of thermal shrinkage and change of color from tan to white. This shrinkage led to the mats contracting and opening gaps, which exposed the inner layers of the hydrate packets and the stainless steel sheet. This outer layer of MT is essentially the same construction as the 1 hour Hemyc ERFBS. The outer layer of MT exhibits similar behavior to the 1 hour Hemyc ERFBS.

3. Hydrate Packet failure:

When the outer layer of Kaowool and Siltemp shrank during the test, the hydrate packets were exposed at the barrier joints to furnace temperatures. The hydrate packets experienced structural failure after approximately 120 minutes into the test.

4. Thermocouple insulation jackets:

Thermocouples were mechanically attached to the outer surfaces of the conduits at 6 inch intervals. The thermocouple wires had insulating jackets to prevent the wires from contacting other metal surfaces and creating new thermal junctions. However, post-test observations indicated that the insulation jackets were consumed during the test. Consequently, the outer thermocouple data should be treated with caution.

5. Discoloration of bare #8 conductors inside condolet:

Three different conduit sizes were used in this test. Both “empty” and “loaded” configurations were tested for each conduit size. The loaded configurations consisted of bare #8 conducts routed inside the conduits to account for approximately 30% cross-sectional fill. In order to view the condition of the bare #8 conductors inside the conduits, the 90 degree condolets were disassembled. The bare #8 conductors inside both the 1 inch and 4 inch loaded conduits sustained significant discoloration. This discoloration is a result of the oxidation of the bare copper wires at high temperatures.

6. Stainless steel wire tie failure:

All the joints on the exterior of the MT were tied together using stainless steel wire ties looped around hooks attached to the Siltemp fabric. The hooks were attached to the Siltemp using darts. This tie method and the shrinkage of the outer layer of Siltemp resulted in some tearing of the fabric. The shrinkage of the Siltemp and the heating of the stainless steel also broke some of the wire ties, allowing the Siltemp to continue to shrink.

Table 1

Conduit, Cable Air Drop, Supports & Junction Box
MT 3 Hour Fire Rated Test Results

Raceway	Time to $\Delta T_{ave} \geq$ 250°F (min.)	Time to Single Point ΔT > 325°F (min.)	Max. Temp. Bare #8[1] @ 3 hour (°F)	Joint Failure/ Structural Failure[2] Yes/No	Pass Hose Stream Yes/No	Final Grade[3] Rating (Minutes)
4" Conduit (3A) (Empty)	121	110	961	YES	YES	110
4" Conduit (3B) 14.58 lb./lin.ft. Cable Fill	143	113	374	YES	YES	113
2 ½ " Conduit (3C) (Empty)	119	103	1119	YES	YES	103
2 ½ " Conduit (3D) 5.68 lb./lin.ft. Cable Fill	126	112	577	YES	YES	112
1" Conduit (3E) (Empty)	98	87	1314	YES	YES	87
1" Conduit (3F) 0.95 lb./lin.ft. Cable Fill	108	96	1084	YES	YES	96
Junction Box (3I) 18" x 24" x 8"	122	134	NA	YES	YES	122
Unistrut Support[4] (3G)	NA	58	NA	YES	YES	58
Bare Copper Wire Air Drop (3J)	169	159	607	YES	YES	159
2" Tube Steel Support[4] (3G)	NA	56	NA	YES	YES	56

Table 1 (continued)

Conduit , Supports & Junction Box
MT 3 Hour Fire Rated Test Results

Notes:

1. The temperatures recorded on the Bare #8 should be viewed with extreme caution for at least two reasons. First, to insure the integrity of the thermocouple's jacket and insulation during installation, the instrumented Bare # 8 was located in the center of the cable bundle rather than on the outside bottom where it would have scavenged the most heat. The second reason was the joint failure in the two outer layers experienced during the testing. This will produce local hot spots on the interior of the raceway that may or may not have been picked-up by the Bare #8.

2. All MT ERFBS experienced some thermal shrinkage of the outer Siltemp covering and the hydrate packet layer down to the stainless steel foil. This led to some vertical and all horizontal joints opening and exposing the stainless steel layer to the furnace temperature at varying points during the test. This was not burn-through as Siltemp, Kaowool, the hydrate packets, and the stainless steel are non-combustible.

3. The final rating is based on the first temperature rise criteria point to be exceeded. Note that all raceways except the junction box failed on the single point criteria ($\Delta T > 325^{o}F$), which further indicates the joint failure.

4. Failure of the structural supports was determined to be when the time the Single Point temperature rise (ΔT) exceeded $325^{o}F$ at a distance 18-inches into the MT protected structural steel. Eighteen inches is the manufacturer recommended coverage for structural supports to prevent hot thermal shorts from entering into the ERFBS. Also note that the structural support fire barrier system does not include hydrate packets or stainless steel foil.