



UNITED STATES
NUCLEAR REGULATORY COMMISSION

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50-302

July 16, 1996

MEMORANDUM TO: K. Steven West, Chief
Fire Protection Section
Plant Systems Branch
Division of Systems Safety and Analysis

FROM: Edward Connell, Senior Fire Protection Engineer
Fire Protection Section
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Patrick Madden, Senior Fire Protection Engineer
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SUBJECT: TRIP TO UNDERWRITERS LABORATORIES (UL) - FLORIDA POWER
CORPORATION MECATISS FIRE BARRIER FIRE ENDURANCE TESTING
PROGRAM (TAC NO. M91772)

In response to NRC concerns about the fire endurance qualification of Thermo-Lag fire barriers at Crystal River, Florida Power Corporation, the licensee, has initiated a program to either replace these fire barriers or upgrade these fire barriers with Mecatiss fire barrier materials. As part of this program the licensee has performed a series of 1 and 3-hour fire endurance test of Mecatiss fire barrier systems at UL, Northbrook, Illinois.

Attached are the trip report which document the construction and fire endurance testing activities witnessed by the Fire Protection Section.

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Docket Nos.: 50-302

Attachments: As stated

DFOL 1/1
1/1 Per
Darin Houser

140035

ATTACHMENT 1
TRIP REPORT

TRIP DATES: November 14-17, 1995
November 29-30, 1995
December 4-8, 1995
July 8, 1996

REVIEWERS: Edward Connell, Senior Fire Protection Engineer
Fire Protection Section
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LOCATION: Underwriters Laboratories, Inc.
Northbrook, Illinois

APPLICANT: Florida Power Corporation (FPC)

SUBJECT: MECATISS FIRE BARRIER SYSTEMS FIRE ENDURANCE TEST PROGRAM

1.0 LICENSEE/CONTRACTOR AND LAB PERSONNEL CONTACTED:

Florida Power Corporation

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Philadelphia Electric Company

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Consultants to FPC

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2.0 DESCRIPTION OF TEST DECK

The following is a general description of the test decks and test specimens reviewed. The drawings highlighting the details of these test decks and test specimens are included in Enclosure 1.

TEST DECK NO. 2

This 3-hour fire endurance test deck was tested in the column furnace and consisted of the following test specimens:

Article 4: A single 3/4-inch diameter rigid aluminum conduit, with a 5 inch radial bend and a LB fitting, containing a single #8 bare copper conductor. This conduit was protected with Mecatiss MTS-3 (stand alone) fire barrier material.

Article 5: A single 4-inch high by 24-inch wide, open ladder, aluminum cable tray, with a 24 inch radial bend and a 90° sharp bend, containing a single #8 bare copper conductor. This cable tray was protected with Thermo-Lag 330 with an overlay of Mecatiss MPF-180 on one vertical tray run, the radial bend and the horizontal tray run, and with Mecatiss MTS-3 (stand alone) for the other vertical tray run.

Article 6: A single 3/4-inch diameter rigid aluminum conduit, with a 5 inch radial bend and a LB fitting, containing a single #8 bare copper conductor. This conduit was protected with Thermo-Lag 330 material with an overlay of Mecatiss MPF-180.

The raceway supports were also protected with Thermo-Lag 330 with a Mecatiss MPF-180 overlay or the Mecatiss MTS-3, over their entire length.

TEST DECK NO. 3

This 1-hour fire endurance test deck was tested in a floor furnace and consisted of the following test specimens:

Test Specimen 1: 4"x 24" wide ladder back aluminum cable tray configured in a U-shape with a 36-inch vertical and 76-inch horizontal run. This test specimen was protected with a 1-hour stand alone Mecatiss fire barrier system (see Section 3.0, below for general description of this fire barrier system);

Test Specimen 2: 4-inch diameter conduit with a 3/4-inch conduit which is routed in close proximity to the 4-inch conduit. The 4-inch conduit is configured in a U-shape with a 36-inch vertical and a 71-inch horizontal run. The 3/4-inch conduit runs parallel to the 4-inch conduit along the horizontal run for 42-1/2 inches and then makes a 30° bend and runs horizontal for approximately 30-inches where it transitions through a lateral bend and runs vertical up and through the test deck. This test specimen is protected with a Thermo-Lag base upgraded with Mecatiss (see Section 3.0);

Test Specimen 3: Two parallel 3/4-inch conduits separated by 18-inches on a common support. Each of these conduits are in a U-shape configuration with 18-inch vertical and a 54-inch horizontal run. Attached to this common

support representing thermal shorts are a 4-inch conduit and a 3/4-inch conduits.

Test Specimen 4: 4"x 24" wide ladder back aluminum cable tray with a horizontal T-section configured in a U-shape with a 36-inch vertical and 60-inch horizontal run. Four 2-foot long aluminum conduits (two 1 inch, one 3/4 inch and one 2 inch diameter conduits), simulating thermal shorts into the fire barrier system, penetrated into the horizontal cable tray T-section.

TEST DECK NO. 4

This test deck contained the same test specimen configurations as test assembly No. 3 above except that the test specimens associated with this assembly were protected for 3-hours.

TEST DECK NO. 5

This 1-hour fire endurance test deck was tested in a wall furnace and consisted of the following test specimens:

Test Specimen 1: a 24 inch x 4 inch aluminum cable tray;

Test Specimen 2: 3/4 inch conduit and junction box configuration;

Test Specimen 3: 3/4 inch conduit; and

Test Specimen 4: 4 inch conduit.

These specimens were mounted flush against the removable concrete block furnace wall and the base fire barrier material protecting these test specimens was Thermo-Lag 330-1 (nominal 5/8 inch thick). The base Thermo-Lag 330-1 fire barrier system was upgraded with Mecatiss system which is described in section 3.0 below.

TEST DECK NO. 6

This 3-hour test conducted in the column furnace had the following 1-hour and 3-hour specimens:

Test Specimen 1: a 6 inch x 4 inch aluminum cable tray protected with 1-hour Thermo-Lag and MPF-60 overlay.

Test Specimen 2: a 6 inch x 4 inch aluminum cable tray protected with MTS-1.

Test Specimen 3: a 6 inch x 4 inch aluminum cable tray protected with 3-hour Thermo-Lag and MPF-180 overlay.

Test Specimen 4: a 6 inch x 4 inch aluminum cable tray protected with MTS-3.

Test Specimen 5: a 6 inch x 6 inch aluminum wireway protected with 1-hour Thermo-Lag and MPF-60 overlay on one half and MTS-1 on the other half.

In addition some 1-hour and 3-hour "thermal shorts" consisting of 3/4-inch diameter aluminum conduit were tested to acquire data to support reduction of the "9-inch" and "18-inch rules" for Thermo-Lag barriers that are upgraded or replaced with Mecatiss. All Thermo-Lag used in this test was fabricated using dry fit butt joints without a trowel grade skim coat. Both tie wires and steel bands were utilized to support the Thermo-Lag panels.

3.0 MECATISS FIRE BARRIER SYSTEM

General Description of Fire Barrier Materials

For the FPC project Mecatiss developed four basic fire barrier systems. The following is a description of the fire barrier materials used construct these systems:

MPF-A Mineral Wool Composite Mat

The MPF-A composite mat is made from refractory alumina-silicate material fibers and refractory material. The MPF-A material is reversible, with both sides being identical.

MPF-B Mineral Wool Composite Mat

The MPF-B composite mat is a refractory alumina-silicate material fibers with glass beads impregnated into the mat. The MPF-B mat is not reversible and is marked on the side which should be exposed to the fire environment.

Refractory Glue Type F Active

The refractory glue type F Active is an air-hardening component and exhibits adhesive characteristics up to 2375 °F.

SILCO Cloth

The SILCO cloth is a nominal 0.02 inch thick woven glass silicone fabric. This material is claimed to be gas and water tight at normal pressures, and chemically inert. In addition, the vendor claims that it can be decontaminated easily.

Silicone Glue Mastic Type 75 A

The type 75 A mastic is a cold application silicone-based mastic used in thin layers for filling, coating, insulating, bonding and joining work. It is used to seal the SILCO fabric and bounds SILCO to itself, concrete, metal, etc.

General Description of Fire barrier Installation

Four basic Mecatiss fire barrier systems were constructed for the FPC project. Two of these systems were upgrades for existing Thermo-Lag fire barrier systems and the other two were stand alone type systems. The following is a general description of these systems:

Mecatiss MPF-60 (1-hour fire rated Thermo-Lag upgrade system)

This fire barrier system is an upgrade for an existing 1-hour Thermo-Lag system. Its fire resistive rating is 1-hour and is constructed by enclosing the Thermo-Lag fire barrier system with 2-layers of SILCO cloth and 1-layer of MPF-A (1 inch thick) mineral wool refractory mat. The inner SILCO cloth, with the bright side against the Thermo-Lag, is secured to the existing Thermo-Lag fire barrier materials with Type 75 A mastic. The inner surface of the SILCO is coated with F Active glue and 1 layer of MPF-A mat is applied. Once the installation of the mat is completed, the outer layer of SILCO cloth is installed. This is accomplished by applying a thin layer of F Active glue to the outer surface of the MPF-A mat and the SILCO cloth with its bright side facing out is installed. The joints and seams are overlapped and they are bonded to each other with Type 75 A mastic.

Mecatiss MPF-180 (3-hour fire rated Thermo-Lag upgrade system)

This system is constructed in the same manner as the MPF-60 system except that this system has two layers of mat. The inner mat layer is MPF-A with a MPF-B outer layer. These mat layers are bounded together and to the SILCO cloth with F-Active glue.

MTS-1, One Hour Mecatiss Fire Barrier System

This system is comprised of two layers of MPF-A mat, covered both inside and outside by a layer of SILCO cloth and uses the same basic construction techniques used to install the MPF-60 system.

MTS-3, Three Hour Mecatiss Fire Barrier System

This system has three layers of MPF-A mat and a layer of MPF-B, covered both inside and outside by a layer of SILCO cloth. The construction techniques used are the same basic techniques used to install the MPF-60 system.

FPC Installation Procedure Review

The following procedures related to the installation of the Mecatiss fire barrier systems were reviewed:

1. Procedure No. 94 MC 0056, "Operation Procedure for the Installation of MPF-60 One Hour Fire Barrier System Over Thermo-Lag 330-1 Material," Revision B, October 20, 1995.

2. Procedure No. 94 MC 0057, "Operation Procedure for the Installation of MPF-180 Three Hour Fire Barrier System Over Thermo-Lag 330-1 Material," Revision B, October 17, 1995.
3. Procedure No. 94 MC 0010, "Operation Procedure for the Installation of MTS-1 One Hour Fire Barrier System," Revision A, October 23, 1995.
4. Procedure No. 94 MC 0011, "Operation Procedure for the Installation of MTS-3 Three Hour Fire Barrier System," Revision A, October 19, 1995.
5. Construction Maintenance Procedure MP-807, (Florida Power Corporation Crystal River Unit 3), "Installation of T.S.I. Fire Barriers," Revision 1, March 27, 1991.

4.0 CONSTRUCTION ACTIVITIES WITNESSED:

NOVEMBER 14-17, 1995 - OBSERVATIONS (P. MADDEN)

The following construction activities were witnessed:

Test Deck No. 2

The installation of the MPF-B mineral wool outer layer and the SILCO outer layer on the MTS-3 fire barrier system, including the application of F-Active glues and the silicone mastic.

Test Deck No. 3

The installation of the tray cover on the 24-inch wide cable tray and the placement and installation of the thermocouples on this cover. The installation of the SILCO inner layer on the 24-inch cable tray and the 24-inch cable tray T-section. The application of inner MPF-A layer on the 24-inch cable tray and T-section.

NOVEMBER 29-30 - OBSERVATIONS (E. CONNELL)

The following construction activities were witnessed:

Test Deck Nos. 3 and 4

The installation of Mecatiss on large diameter conduits and cable trays. Fire barrier assemblies of Mecatiss stand alone and Mecatiss overlay on Thermo-Lag 330 were installed.

DECEMBER 4-8, 1995 - OBSERVATIONS (P. MADDEN)

The following construction activities were witnessed:

The installation of a MTS-3 hour fire barrier system with thermal activated vents on a 24-inch wide cable tray ampacity derating test specimen.

5.0 FIRE ENDURANCE AND HOSE STREAM TESTING

Supplement 1 to Generic Letter 86-10, "Fire Endurance test Acceptance Criteria for Fire Barrier Systems Used to Separate Redundant Safe Shutdown Trains Within the Same Fire Area," was used to judge the thermal performance of the following test assemblies:

TEST DECK NO. 2

DATE OF TEST: November 30, 1995

TEST DURATION: 3-hour (ASTM E119 - standard time-temperature curve)

NRC REVIEWER: E. Connell

TEST PROCEDURE: Florida Power Corporation Thermo-Lag and Mecatiss Fire Barrier Endurance Test Procedure, Three Hour Fire Endurance Test of Articles, Column Floor Furnace Test, November 13, 1995

HOSE STREAM TEST: Fog (30° pattern, 75 gpm @ 75 psi); Duration of hose stream application is one minutes and was applied within 10 minutes after the fire endurance test.

INITIAL TEMPERATURE CONDITIONS: 67 °F

THERMAL ACCEPTANCE CRITERIA: Maximum average temperature - 317 °F
Maximum single hot spot - 392 °F

TEST OBSERVATIONS: Minor burning of the Silicone Mastic throughout the test. SILCO outer fabric seams and joints opened 10-15 minutes into the fire test as Silicone Mastic was consumed by the fire.

RESULTS:

TEST DECK NO. 2	MECATISS 3-HOUR FIRE BARRIER SYSTEMS (FPC PROJECT)			
	maximum temperatures (°F) noted during the test			
SPECIMENS TESTED	north side rail	south side rail	conduit surface	bare #8 copper conductor
24 inch aluminum cable tray w/ Thermo-Lag & MPF-180 & MTS-3	229	229		227
3/4 inch conduit w/ Thermo-Lag & MPF-180			318	282
3/4 inch conduit w/ MTS-3			213	213

POST-FIRE TEST SPECIMEN EXAMINATION:

Post-fire examination of the test assembly was performed on December 1, 1995. The following summarizes the reviewer's observations made during the examination process:

Sections of the outer SILCO fabric covering and the outer layer of the MPF mineral wool mat was dislodged by hose stream test.

No burnthrough or breach conditions through the fire barrier test specimens were noted during the post-fire and hose stream test examination.

TEST DECK NO. 3

DATE OF TEST: December 5, 1995

TEST DURATION: 1-hour (ASTM E119 - standard time-temperature curve)

NRC REVIEWER: P. Madden

TEST PROCEDURE: Florida Power Corporation Thermo-Lag and Mecatiss Fire Barrier Endurance Test Procedure, One Hour Fire Endurance Test of Articles, Floor Furnace Test, November 13, 1995

HOSE STREAM TEST: Standard 1-1/8 inch smooth bore nozzle (nozzle pressure 30 psi with the nozzle tip set back 20-feet from the test assembly); Duration of hose stream application is one minutes and was applied within 10 minutes under the fire endurance test.

INITIAL TEMPERATURE CONDITIONS: 72° F

THERMAL ACCEPTANCE CRITERIA: Maximum average temperature - 322 °F
Maximum single hot spot - 392 °F

TESTS OBSERVATIONS:

Exposed Thermo-Lag fire barrier material ignited 3 minutes into the fire test.

Minor burning of the Silicone Mastic throughout the test. SILCO outer fabric seams and joints opened 10-15 minutes into the fire test as Silicone Mastic was consumed by the fire.

At 18 minutes, the exposed aluminum on the conduits simulating thermal hot shorts into the cable tray T-section started to melt and drip.

RESULTS:

TEST DECK NO. 3	MECATISS 1-HOUR FIRE BARRIER SYSTEMS (FPC PROJECT): maximum temperatures (°F) noted during the test				
	east side rail	west side rail	tray cover	conduit surface	thermal short interface
24" aluminum cable tray	210	211	214	4" - 206 3/4" - 262 296	
4-inch diameter conduit with a 3/4-inch conduit routed in close proximity to the 4-inch conduit					
Two parallel 3/4-inch conduits separated by 18-inches on a common support					
4"x 24" wide ladder back aluminum cable tray with a horizontal T-section	214	237			277

POST-FIRE TEST SPECIMEN EXAMINATION:

Post-fire examination of the test assembly was performed on December 6, 1995. The following summarizes the reviewer's observations made during the examination process:

The exposed aluminum conduits simulating thermal hot shorts into the cable tray T-section melted/consumed by the fire exposure.

Sections of the outer SILCO fabric covering and the outer layer of the MPF-A mineral wool mat was dislodged by hose stream test.

No burnthrough or breach conditions through the fire barrier test specimens were noted during the post-fire and hose stream test examination.

TEST DECK NO. 4

DATE OF TEST: December 7, 1995

TEST DURATION: 3-hour (ASTM E119 - standard time-temperature curve)

NRC REVIEWER: P. Madden

TEST PROCEDURE: Florida Power Corporation Thermo-Lag and Mecatiss Fire Barrier Endurance Test Procedure, Three Hour Fire Endurance Test of Articles, Wall Furnace Test, November 13, 1995

HOSE STREAM TEST: Standard 1-1/8 inch smooth bore nozzle (nozzle pressure 30 psi with the nozzle tip set back 20-feet from the test assembly); Duration of hose stream application is one minutes and was applied within 10 minutes after the fire endurance test.

INITIAL TEMPERATURE CONDITIONS: 70 ° F

THEMAL ACCEPTANCE CRITERIA: Maximum average temperature - 320 °F
 Maximum single hot spot - 390 °F

TEST OBSERVATIONS:

Exposed Thermo-Lag fire barrier material ignited 3 minutes into the fire test.

Minor burning of the Silicone Mastic throughout the test. SILCO outer fabric seams and joints opened 10-15 minutes into the fire test as Silicone Mastic was consumed by the fire.

At 21 minutes, the exposed aluminum on the conduits simulating thermal hot shorts into the cable tray T-section started to melt and drip.

At 1 hour and 40 minutes, the 3-hour Thermo-Lag fire barrier systems protecting the thermal shorts appears to be fully activated and at 2 hours and 20 minutes they were completely consumed.

RESULTS:

TEST DECK NO. 4	MECATISS 3-HOUR FIRE BARRIER SYSTEMS (FPC PROJECT)				
	maximum temperatures (°F) noted during the test				
SPECIMENS TESTED	east side rail	west side rail	tray cover	conduit surface	thermal short interface
24" aluminum cable tray	212	212	215		
4-inch diameter conduit with a 3/4-inch conduit routed in close proximity to the 4-inch conduit				4" - 224 3/4" - 336	
Two parallel 3/4-inch conduits separated by 18-inches on a common support				305	
4" x 24" wide ladder back aluminum cable tray with a horizontal T-section	234	251			386

POST-FIRE TEST SPECIMEN EXAMINATION

Post-fire examination of the test assembly was performed on December 8, 1995. The following summarizes the reviewer's observations made during the examination process:

The exposed aluminum conduits simulating thermal hot shorts into the cable tray T-section melted/consumed by the fire exposure. This included the 3-hour Thermo-Lag fire barrier system that protected them.

Sections of the outer SILCO fabric covering and the outer layer of the MPF mineral wool mat was dislodged by hose stream test.

No burnthrough or breach conditions through the fire barrier test specimens were noted during the post-fire and hose stream test examination.

TEST DECK NO. 5

DATE OF TEST: November 16, 1995

TEST DURATION: 1-hour (ASTM E119 - standard time-temperature curve)

NRC REVIEWER: P. Madden

TEST PROCEDURE: Florida Power Corporation Thermo-Lag and Mecatiss Fire Barrier Endurance Test Procedure, Three Hour Fire Endurance Test of Articles, Wall Furnace Test, November 13, 1995

HOSE STREAM TEST: Standard 1-1/8 inch smooth bore nozzle (nozzle pressure 30 psi with the nozzle tip set back 20-feet from the test assembly); Duration of hose stream application is one minutes and was applied within 10 minutes after the fire endurance test.

INITIAL TEMPERATURE CONDITIONS: 72° F

THERMAL ACCEPTANCE CRITERIA: Maximum average temperature - 322 °F
Maximum single hot spot - 392 °F

TEST OBSERVATIONS:

Exposed Thermo-Lag fire barrier material ignited 3 minutes into the fire test.

Minor burning of the Silicone Mastic throughout the test. SILCO outer fabric seams and joints opened 10-15 minutes into the fire test as Silicone Mastic was consumed by the fire.

RESULTS:

TEST DECK NO. 5	MECATISS 1-HOUR FIRE BARRIER SYSTEMS (FPC PROJECT) maximum temperatures (°F) noted during the test			
	north side rail	south side rail	junction box surface	conduit surface
24 inch aluminum cable tray	195	197		
3/4 inch conduit and junction box configuration			210	244
3/4 inch conduit				239
4 inch conduit				205

POST-FIRE TEST SPECIMEN EXAMINATION

Post-fire examination of the test assembly was performed on November 17, 1995. The following summarizes the reviewer's observations made during the examination process:

Sections of the outer SILCO fabric covering and the outer layer of the MPF mineral wool mat was dislodged by hose stream test.

No burnthrough or breach conditions through the fire barrier test specimens were noted during the post-fire and hose stream test examination.

TEST DECK NO. 6

DATE OF TEST: July 8, 1996

TEST DURATION: 3-hour (ASTM E119 - standard time-temperature curve)

NRC REVIEWER: E. Connell

TEST PROCEDURE: Florida Power Corporation Thermo-Lag and Mecatiss Fire Barrier Endurance Test Procedure, Three Hour Fire Endurance Test of Articles, Column Furnace Test, July 1996

HOSE STREAM TEST: Not performed with NRC staff concurrence based on hose stream test performance of previous test assemblies.

INITIAL TEMPERATURE CONDITIONS: 81° F

THERMAL ACCEPTANCE CRITERIA: Maximum average temperature - 331 °F
Maximum single hot spot - 406 °F

TEST OBSERVATIONS:

Minor burning of the Silicone Mastic throughout the test. SILCO outer fabric seams and joints opened 10-15 minutes into the fire test as Silicone Mastic was consumed by the fire.

RESULTS:

TEST DECK NO. 6	MECATISS MTS-1, MTS-3, MPF-80 & MPF-180 FIRE BARRIER SYSTEMS maximum temperatures (°F) noted during the test			
	East side rail	West side rail	Top bare #8 conductor	Side bare #8 conductor
6 inch aluminum cable tray MTS-1	221	222	228	228
6 inch aluminum cable tray MPF-80	243	230	233	210
6 inch aluminum cable tray MTS-3	288	236	237	216
4 inch aluminum wireway MTS-1 and MPF-80	213/210	214/229	206/208	210/209

The 6-inch cable tray protected with MPF-180 Thermo-Lag overlay exceeded the maximum allowable temperature on the #8 bare copper conductor at 115 minutes.

6.0 CONCLUSION

These test assemblies, with the exception of the 6 inch cable tray protected with 3-hour Thermo-Lag and MPF-180 overlay, successfully met, with margin, the thermal performance acceptance criteria of Supplement 1 to Generic Letter 86-10, "Fire Endurance test Acceptance Criteria for Fire Barrier Systems Used to Separate Redundant Safe Shutdown Trains Within the Same Fire Area." In addition, some of these assemblies immediately following the fire endurance test were subjected to a hose stream test using a solid stream. Both the Mecatiss MPF-180/Thermo-Lag 330-1 system combination and the Mecatiss MTS-3 stand alone system met the hose stream test acceptance criteria by not allowing a projection of water to penetrate the barrier system. During the post-fire and hose stream test examination no breaches or openings in these barrier test specimens were identified.