



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO MECATISS FIRE BARRIERS

FLORIDA POWER CORPORATION

CRYSTAL RIVER UNIT 3

DOCKET NO. 50-302

**I. INTRODUCTION**

By letters dated October 31, 1994, March 6, July 6, 1995, March 30, and October 22, 1996, Florida Power Corporation, the licensee for Crystal River Unit 3 (CR3), submitted information regarding their Mecatiss fire barrier program. This material is part of the licensee's correction action plan for the concerns associated with Thermo-Lag fire barriers as described in Generic Letter (GL) 92-08, "Thermo-Lag 330-1 Fire Barriers." By letter dated April 7, 1995, the staff provided the licensee with a request for additional information (RAI) concerning the Mecatiss fire barrier test program. By letters dated May 17, and July 6, 1995, the licensee responded to the staff request. The licensee also discussed the Mecatiss fire barrier program at public meetings with the staff at U.S. Nuclear Regulatory Commission (NRC) Headquarters on February 28, April 25, and October 19, 1995. The NRC staff visited the Underwriters Laboratories (UL) in Northbrook, Illinois, during the weeks of November 12, November 26, and December 3, 1995, to witness the construction of the fire endurance test assemblies. The staff also witnessed the performance of the fire endurance tests at the UL test facility in Northbrook, Illinois, for Test Deck 2 on November 30, 1995; Test Deck 3 on December 5, 1995; Test Deck 4 on December 7, 1995; Test Deck 5 on November 16, 1995; and Test Deck 6 on July 8, 1996. The staff observations at UL are documented in a trip report dated July 16, 1996. The NRC staff inspected the Mecatiss installation at Crystal River, Unit 3, during June and October 1996. The results of these inspections are documented in NRC Inspection Reports 50-302/96-06 and 50-302/96-15, respectively.

**II. BACKGROUND**

To determine the rating of a fire barrier system, a representative raceway (materials, workmanship, dimensions, orientation, thermal mass, etc.) protected by the fire barrier material is constructed and exposed to the standard time-temperature fire specified in American Society for Testing and Materials (ASTM) E-119, "Fire Tests of Building Construction and Materials." Guidance on the performance of fire endurance tests to satisfy NRC fire

ENCLOSURE

protection requirements is provided in Supplement 1 to GL 86-10, "Fire Endurance Test Acceptance Criteria for Fire Barrier Systems Used to Separate Redundant Safe Shutdown Trains Within the Same Fire Area," dated March 25, 1994. The test methods and acceptance criteria specified in Supplement 1 to GL 86-10 are acceptable to the staff for determining the adequacy of fire barrier systems installed by licensees to meet NRC fire protection requirements. The staff considers the fire endurance qualification test successful if: (1) the maximum average temperature recorded on the raceway does not exceed 250°F above ambient, (2) the maximum single point temperature recorded on the raceway does not exceed 325°F above ambient, and (3) the fire barrier remains intact during the fire exposure and water hose stream tests. By letters dated March 30, and October 22, 1996, the licensee requested the staff to review the fire tests of the Mecatiss fire barrier system performed at the UL test facility in Northbrook, Illinois, for meeting the guidance specified in Supplement 1 to GL 86-10.

### III. EVALUATION

The licensee conducted a series of eight fire endurance tests at the Mecatiss test facility in Morestal, France, and the UL test facility in Northbrook, Illinois. The two tests conducted in Morestal, France, deviated from the guidance specified in Supplement 1 to GL 86-10. These deviations were provided to the licensee in the RAI dated April 7, 1995. The fire tests conducted in Morestal, France, were not used as part of the basis for this safety evaluation of the licensee's Mecatiss fire barrier program, only the fire tests conducted at UL were used. The licensee also conducted flame spread and combustibility tests at UL. A description of each test specimen and a summary of the results for the tests conducted at UL is provided below.

#### Fire Endurance Tests

All of the fire endurance tests were performed without cables in the raceways, as recommended in Supplement 1, to GL 86-10. Therefore, the fire endurance tests bound all potential cable fills. All raceways (conduits, cable trays, wireways, and junction boxes) tested by the licensee were constructed of aluminum. On the basis of the staff observations of the industry sponsored testing of Thermo-Lag fire barriers enclosing both steel and aluminum raceways, (Nuclear Management and Resources Council Test 1-6, Project No. 13890-95676, dated November 11, 1993, and Tennessee Valley Authority Test 6.1.4, Project No. 11210-94943b, dated April 30, 1993) the staff has determined that the fire endurance test results of fire barriers enclosing aluminum raceways can be used to determine the fire endurance of fire barriers enclosing steel raceways of the same dimensions. The staff observations are documented in a trip report dated November 3, 1993, and in Inspection Report 50-390/93-29.

#### Test Deck 1

Test Deck 1 consisted of three articles. Article 1 was a 3/4-inch diameter conduit protected with the MTS-1 fire barrier system; Article 2 was a 24-inch wide cable tray protected on one half of the length of the article with a 1-hour Thermo-Lag 330 fire barrier upgraded with the MPF-60 fire barrier

system, and on the remaining length with the MTS-1 fire barrier system; and Article 3 was a 3/4-inch diameter conduit protected with a 1-hour Thermo-Lag 330 fire barrier upgraded with the MPF-60 fire barrier system. The fire exposure test was conducted on November 28, 1995, in the column furnace at the UL test facility in Northbrook, Illinois, for a period of 65 minutes and followed the standard time-temperature curve specified in ASTM E-119. At the conclusion of the fire test, the test specimen was subjected to a fog nozzle hose stream test in accordance with the criteria specified in Supplement 1 to GL 86-10. No openings in the barriers were observed following the hose stream test. The maximum recorded single point temperatures above ambient ranged from 156°F on Article 1 to 258°F on Article 3. The maximum recorded average temperatures above ambient ranged from 143°F on Article 1 to 164°F on Article 3. These temperatures are below the maximum allowable single point and average temperatures specified in Supplement 1 to GL 86-10. Based on the information provided by the licensee in Test Report, File NC1973-Project 95NK17030, dated February 5, 1996, all three articles in Test Deck 1 met the acceptance criteria specified in Supplement 1 to GL 86-10, for a fire endurance rating of 1 hour.

#### Test Deck 2

Test Deck 2 consisted of three articles. Article 4 was a 3/4-inch diameter conduit protected with the MTS-3 fire barrier system; Article 5 was a 24-inch wide cable tray protected on one half of the length of the article with a 3-hour Thermo-Lag 330 fire barrier upgraded with the MPF-180 fire barrier system, and on the remaining length with the MTS-3 fire barrier system; and Article 6 was a 3/4-inch diameter conduit protected with a 3-hour Thermo-Lag 330 fire barrier upgraded with the MPF-180 fire barrier system. The fire exposure test was conducted on November 30, 1995, in the column furnace at the UL test facility in Northbrook, Illinois, for a period of 183 minutes and followed the standard time-temperature curve specified in ASTM E-119. At the conclusion of the fire test, the test specimen was subjected to a fog nozzle hose stream test in accordance with the criteria specified in Supplement 1 to GL 86-10. No openings in the barriers were observed following the hose stream test. The maximum recorded single point temperatures above ambient ranged from 150°F on Article 4 to 250°F on Article 6. The maximum recorded average temperatures above ambient ranged from 135°F on Article 4 to 195°F on Article 6. These temperatures are below the maximum allowable single point and average temperatures specified in Supplement 1 to GL 86-10. Based on the information provided by the licensee in Test Report, File NC1973-Project 95NK17030, dated February 6, 1996, all three articles in Test Deck 2 met the acceptance criteria specified in Supplement 1 to GL 86-10, for a fire endurance rating of 3 hours.

#### Test Deck 3

Test Deck 3 consisted of four articles. Article 7 was a 24-inch wide aluminum cable tray protected with the MTS-1 fire barrier system; Article 8 included a 3/4-inch and 4-inch diameter aluminum conduits protected with 1-hour Thermo-Lag 330 fire barriers upgraded with the MPF-60 fire barrier system; Article 9 included two 3/4-inch diameter aluminum conduits protected with a 1-hour Thermo-Lag 330 fire barrier upgraded with the MPF-60 fire barrier

system; and Article 10 was a 24-inch wide aluminum cable tray "tee" with four aluminum conduit stubs ranging in size from 3/4-inch in diameter to 2-inches in diameter protected with a 3-hour Thermo-Lag 330 fire barrier upgraded with the MPF-180 fire barrier system. The fire exposure test was conducted on December 5, 1995, in the floor furnace at the UL test facility in Northbrook, Illinois, for a period of 66 minutes and followed the standard time-temperature curve specified in ASTM E-119. At the conclusion of the fire test, the test specimen was subjected to a solid bore hose stream test in accordance with the criteria specified in Supplement 1 to GL 86-10. No openings in the barriers were observed following the hose stream test. The maximum recorded single point temperatures above ambient ranged from 137 °F on Article 8 to 225°F on Article 9. The maximum recorded average temperatures above ambient ranged from 114°F on Article 8 to 178°F on Article 9. These temperatures are below the maximum allowable single point and average temperatures specified in Supplement 1 to GL 86-10. Based on the information provided by the licensee in Test Report, File NC1973-Project 95NK17030, dated February 7, 1996, all four articles in Test Deck 3 met the acceptance criteria specified in Supplement 1 to GL 86-10, for a fire endurance rating of 1 hour.

#### Test Deck 4

Test Deck 4 consisted of four articles. Article 11 was a 24-inch wide aluminum cable tray protected with the MTS-3 fire barrier system; Article 12 included a 3/4-inch and 4-inch diameter aluminum conduits protected with 3-hour Thermo-Lag 330 fire barriers upgraded with the MPF-180 fire barrier system; Article 13 included two 3/4-inch diameter aluminum conduits protected with a 3-hour Thermo-Lag 330 fire barrier upgraded with the MPF-180 fire barrier system; and Article 14 was a 24-inch wide aluminum cable tray "tee" with four aluminum conduit stubs ranging in size from 3/4-inch in diameter to 2-inches in diameter protected with a 3-hour Thermo-Lag 330 fire barrier upgraded with the MPF-180 fire barrier system. The fire exposure test was conducted on December 7, 1995, in the floor furnace at the UL test facility in Northbrook, Illinois, for a period of 184 minutes and followed the standard time-temperature curve specified in ASTM E-119. At the conclusion of the fire test the test specimen was subjected to a solid bore hose stream test in accordance with the criteria specified in Supplement 1 to GL 86-10. No openings in the barriers were observed following the hose stream test. The maximum recorded single point temperatures above ambient ranged from 156 °F on Article 12 to 317°F on Article 14. The maximum recorded average temperatures above ambient ranged from 136°F on Article 12 to 189°F on Article 13. These temperatures are below the maximum allowable single point and average temperatures specified in Supplement 1 to GL 86-10. Based on the information provided by the licensee in Test Report, File NC1973-Project 95NK17030, dated February 8, 1996, all four articles in Test Deck 4 met the acceptance criteria specified in Supplement 1 to GL 86-10, for a fire endurance rating of 3 hours.

#### Test Deck 5

Test Deck 5 consisted of three articles. Article 15 was a 24-inch wide aluminum cable tray protected with 1-hour Thermo-Lag 330 fire barriers upgraded with the MPF-60 fire barrier system; Article 16 included a 3/4-inch diameter aluminum conduit and a 12-inch wide by 14-inch high by 6-inch deep



aluminum junction box protected with 1-hour Thermo-Lag 330 fire barriers upgraded with the MPF-60 fire barrier system; and Article 17 included 3/4-inch and 4-inch diameter aluminum conduits protected with 1-hour Thermo-Lag 330 fire barriers upgraded with the MPF-60 fire barrier system and 3/4-inch and 4-inch diameter aluminum conduits protected with the MTS-1 fire barrier system. The fire exposure test was conducted on November 16, 1995, in the wall furnace at the UL test facility in Northbrook, Illinois, for a period of 66 minutes and followed the standard time-temperature curve specified in ASTM E-119. At the conclusion of the fire test the test specimen was subjected to a solid bore hose stream test in accordance with the criteria specified in Supplement 1 to GL 86-10. No openings in the barriers were observed following the hose stream test. The maximum recorded single point temperatures above ambient ranged from 123°F on Article 15 to 167°F on Articles 16 and 17. The maximum recorded average temperatures above ambient ranged from 77°F on Article 15 to 159°F on Article 17. These temperatures are below the maximum allowable single point and average temperatures specified in Supplement 1 to GL 86-10. Based on the information provided by the licensee in Test Report, File NC1973-Project 95NK17030, dated February 9, 1996, all three articles in Test Deck 5 met the acceptance criteria specified in Supplement 1 to GL 86-10, for a fire endurance rating of 1 hour.

#### Test Deck 6

Test Deck 6 consisted of five articles. Article 18 was a 6-inch wide aluminum cable tray protected with a 1-hour Thermo-Lag 330 fire barrier upgraded with the MPF-60 fire barrier system; Article 19 was a 6-inch wide aluminum cable tray protected with the MTS-1 fire barrier system; Article 20 was a 6-inch wide cable tray protected with a 3-hour Thermo-Lag 330 fire barrier upgraded with the MPF-180 fire barrier system; Article 21 was a 6-inch wide aluminum cable tray protected with the MTS-3 fire barrier system; and Article 22 was a 6-inch wide by 6-inch high aluminum wireway protected on one half of the length of the article with a 1-hour Thermo-Lag 330 fire barrier upgraded with the MPF-60 fire barrier system, and on the remaining length with the MTS-1 fire barrier system. The fire exposure test was conducted on July 8, 1996, in the column furnace at the UL test facility in Northbrook, Illinois, for a period of 192 minutes and followed the standard time-temperature curve specified in ASTM E-119. Based on the hose stream test performance of the Mecatiss fire barriers in Test Decks 1 through 5. The licensee elected not to perform a hose stream test on Test Deck 6, due to the combination of 1-hour and 3-hour barrier systems in the same test deck. The Mecatiss fire barrier system has demonstrated its ability to withstand both a solid bore and fog nozzle hose stream test with no failures in the 17 articles previously tested. Therefore, the non-performance of the hose stream test for Test Deck 6 is acceptable. Article 18 exceeded the maximum allowable average temperature at 93 minutes, Article 19 exceeded the maximum allowable single point temperature at 102 minutes, Article 20 exceeded the maximum allowable single point temperature at 115 minutes, Article 21 did not exceed either the maximum allowable average or single point temperature during the fire exposure, and Article 22 exceeded the maximum allowable average temperature at 110 minutes. Based on the information provided by the licensee in Test Report, File NC1973-Project 95NK17030, dated August 19, 1996, Articles 18, 19, 20, and 22 met the acceptance criteria specified in Supplement 1 to GL 86-10, for a fire

endurance rating of 1 hour. Article 21 met the acceptance criteria specified in Supplement 1 to GL 86-10 for a fire endurance rating of 3 hours.

#### Flame Spread and Combustibility Tests

The flame spread tests were conducted in accordance with the criteria specified in ASTM E-84, "Standard Test Method for Surface Burning Characteristics of Building Materials." The staff accepted the use of the ASTM E-84 test for the determination of the flame spread index in Branch Technical Position (BTP) CMEB 9.5-1, "Guidelines for Fire Protection for Nuclear Power Plants," dated July 1981. The tests were performed on November 2, 1995, in the Steiner Tunnel at the UL test facility in Northbrook, Illinois, for a duration of 10 minutes. Test No. 1 consisted of Mecatiss Type MPF-A mineral wool insulation secured to three inorganic reinforced cement boards each 2 feet wide and 8 feet long with Mecatiss Type F Active refractory glue. The mineral wool insulation was covered by a layer of Mecatiss Silco woven glass fabric secured to the cement boards with Mecatiss Type 75 A silicone sealant. Test No. 2 consisted of Mecatiss Type MPF-B mineral wool insulation secured to three inorganic reinforced cement boards each 2 feet wide and 8 feet long with Mecatiss Type F Active refractory glue. The mineral wool insulation was covered by a layer of Mecatiss Silco woven glass fabric secured to the cement boards with Mecatiss Type 75 A silicone sealant. These two test configurations are representative of the Mecatiss fire barrier system for determining the flame spread index of this system. The flame spread index reported by UL for Test No.1 was 41.4 with a smoke developed index of 78.2. Test No. 1 ignited 26 seconds into the test. The flame spread index reported by UL for Test No. 2 was 39.1 with a smoke developed index of 86.8. Test No. 2 ignited 23 seconds into the test. Based on the information provided by the licensee in Test Report, File NC1973-Project 95NK17030, dated December 7, 1995, the Mecatiss fire barrier system has a flame spread index less than 50 in accordance with the criteria specified in BTP CMEB 9.5-1.

In BTP CMEB 9.5-1, noncombustible material is defined as:

- a. A material which in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat.
- b. Material having a structural base of noncombustible material, as defined in a., above, with a surfacing not over 1/8-inch thick that has a flame spread rating not higher than 50 when measured using ASTM E-84.

The combustibility tests were conducted in accordance with the criteria specified in ASTM E-136, "Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C." ASTM E-136 was accepted by the staff in Supplement 1 to GL 86-10, as an acceptable method for determining the combustibility of a fire barrier material. A total of nine tests were conducted on November 8, 9 and 21, 1995, at the UL test facility in Northbrook, Illinois. Tests 1, 2 and 3 consisted of two layers of Mecatiss Type MPF-A mineral wool insulation laminated together with Mecatiss Type F Active refractory glue approximately 1 1/2-inches square and 2-inches thick. One side of the insulation was covered with Mecatiss Silco woven glass fabric

secured with Mecatiss Type F refractory glue. A small bead of Mecatiss Type 75 A silicone sealant was placed on top of the Silco fabric. Tests 4, 5 and 6 consisted of one layer of Type MPF-A mineral wool insulation laminated to one layer of Type MPF-B mineral wool insulation with Type F Active glue. The MPF-B mineral wool insulation was covered with Mecatiss Silco woven glass fabric secured with Mecatiss Type F refractory glue. A small bead of Mecatiss Type 75 A silicone sealant was placed on top of the Silco fabric. Tests 7 and 8 consisted of two layers of Type MPF-A insulation laminated together with Type F glue. One side of the insulation was covered with Silco fabric secured with Type F glue. A bead of silicone sealant was not provided for these two tests. Test 9 consisted of two layers of Type MPF-A insulation laminated together with Type F glue. The Silco cloth and silicone sealant were not used in this test. Tests 1, 2 and 3 are representative of the MTS-1 fire barrier system and Tests 4, 5 and 6 are representative of the MPF-180 fire barrier system without the Thermo-Lag underlayment. (As documented in Information Notice 92-82, "Results of Thermo-Lag 330-1 Combustibility Testing," Thermo-Lag has been determined by the NRC staff to be a combustible material.) Tests 7 and 8 are representative of the MTS-1 fire barrier system without the silicone sealant. Test 9 is representative of the structural base of the Mecatiss fire barrier system.

The criteria for passing the ASTM E-136 test for classifying a material as noncombustible are that 3 of the 4 test specimens must meet the following conditions: (1) the increase in the recorded temperatures of internal and external thermocouples may not exceed 30 °C, (2) there is no flaming from the test specimen after the first 30 seconds of the test, and (3) if the weight loss of the specimen exceeds 50 percent, then the increase in the recorded temperatures of the internal and external thermocouples may not exceed the furnace temperature at the beginning of the test and the specimen may not flame.

All nine test specimens met the maximum internal and external temperature acceptance criteria, as the highest recorded increase in external temperature of 7 °C was achieved by Test 3. No increases in internal temperatures were recorded for any of the tests. Sample flaming in excess of the first 30 seconds was observed on all test specimens with the exception of Test 9. The duration of the flaming ranged from 80 seconds for Test 1 to 121 seconds for Test 8. No flaming was reported for Test 9. All nine specimens met the weight loss acceptance criteria of less than 50 percent. The measured weight loss ranged from about 17 percent for Test 9 to about 23 percent for Test 1. Based on the information provided by the licensee in Test Report, File NC1973-Project 95NK17030, dated December 8, 1995, the mineral wool base of the Mecatiss fire barrier system meets the acceptance criteria specified in ASTM E-136 to be classified as a noncombustible material. The Silco coated fabric, which is nominally 0.019-inches thick, is combustible based on the ASTM E-136 test results. In addition, as documented above, the Mecatiss system has a flame spread rating less than 50. Therefore, the Mecatiss fire barrier system meets BTP CMEB 9.5-1 Criterion b., listed above, and is classified as noncombustible.

#### IV. CONCLUSION

On the basis of its review of the licensee's submittals, including the fire endurance test reports prepared by UL, the staff has concluded that the Mecatiss fire barrier system, when designed and installed in accordance with the techniques utilized for the test specimens, meets the acceptance criteria specified in Supplement 1 to GL 86-10 and is, therefore, acceptable for fire barrier systems relied upon by the licensee to meet NRC fire protection requirements for the following raceway types and sizes:

(1) MTS-1 fire barriers - 1-hour fire rated protection for conduits 3/4-inch in diameter to 4-inches in diameter, 6-inch by 6-inch wireways, and cable trays 6-inches wide to 24-inches wide.

(2) MTS-3 fire barriers - 3-hour fire rated protection for conduits 3/4-inch in diameter, and cable trays 6-inches wide to 24-inches wide.

(3) MPF-60/1-hour Thermo-Lag 330 fire barriers - 1 hour rated protection for conduits 3/4-inch in diameter to 4-inches in diameter, 6-inch by 6-inch wireways, junction boxes 12-inches by 14-inches by 6-inches deep, and cable trays 6-inches wide to 24-inches wide.

(4) MPF-180/3-hour Thermo-Lag 330 fire barriers - 3 hour rated protection for conduits 3/4-inch in diameter to 4-inches in diameter, and cable trays 24-inches wide.

Based on the results reported by UL and submitted by the licensee for the ASTM E-84 and E-136 tests of the Mecatiss fire barrier system, the Mecatiss fire barrier system is classified as noncombustible in accordance with the criteria specified in BTP CMEB 9.5-1.