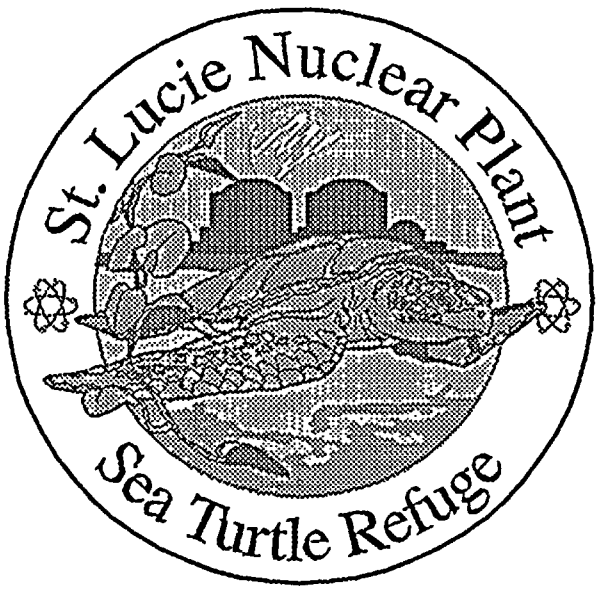
St. Lucie Unit 2

Thermo-Lag 330-1 Fire Barrier Summary Report



Florida Power & Light Company
St. Lucie Plant
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Table of Contents

1.0 BACKGROUND

The NRC began a review of Thermo-Lag 330-1 fire barrier system fire endurance and ampacity derating test reports, installation procedures, and as-built configurations after receiving reports from Gulf States Utilities (GSU) about failed qualification fire tests and installation problems. This review resulted in the issuance of the following NRC documents: Bulletin 92-01 & Supplement 1, *Failure of Thermo-Lag 330-1 fire Barrier Systems;* Generic Letter 92-08, *Thermo-Lag 330-1 Fire Barriers*; Information Notice (IN) 91-47, *Failure of Thermo-Lag Fire Barrier Material to Pass Fire Endurance Test*; IN 91-79 & Supplement 1, *Deficiencies in the Procedures for Installing Thermo-Lag Fire Barrier Material*; IN 92-46, *Thermo-Lag Fire Barrier Material Special Review Team Final Report Findings*; IN 92-55, *Current Fire Endurance Test Results For Thermo-Lag Fire Barrier Material*; IN 92-82, *Results of Thermo-Lag 330-1 Combustibility Testing*; IN 94-22, *Fire Endurance and Ampacity Derating Test Results for 3 Hour Fire Rated Thermo-Lag 330-1 Fire Barriers*; IN 94-86 & Supplement 1, *Legal Actions Against Thermal Science, Inc., Manufacturer of Thermo-Lag*; IN 95-27, *NRC Review of Nuclear Energy Institute's Thermo-Lag 330-1 Combustibility Evaluation Methodology Plant Screening* Guide; and IN 95-49 & Supplement 1, *Seismic Adequacy of Thermo-Lag Panels*. The purpose of these documents was to provide notification of Thermo-Lag fire barrier material testing and installation related problems. In addition, Generic Letter 92-08 requested additional information from licensees to verify that Thermo-Lag 330-1 fire barrier systems manufactured by Thermal Science Incorporated, St. Louis, Missouri comply with NRC requirements.

The initial St. Lucie Plant response to Generic Letter 92-08 was submitted by FPL letter L-93-96 on April 16, 1993. The submittal was supplemented in response to NRC requests for additional information (RAI) dated December 20, 1993; August 9, 1994; December 28, 1994; October 9, 1995; and November 6, 1996; by FPL letter L-94-33 dated February 11, 1994. Additional supplements were submitted by FPL letters, L-94-104 dated April 29, 1994; L-94-275 dated November 4, 1994; L-95-101 dated March 28, 1995; L-95-286 dated October 27, 1995; L-96-28 dated February 12, 1996; L-96-211 dated August 27, 1996; L-96-335 dated December 19, 1996; and L-96-19 dated March 17, 1997.

The NRC had three principle areas of concern: (1) the fire endurance capability of Thermo-Lag 330-1 barriers, (2) the ampacity derating of cables enclosed in Thermo-Lag 330-1 barriers, and (3) the evaluation and application of the results of tests conducted to determine the fire endurance rating and the ampacity derating factors of Thermo-Lag 330-1 barriers.

Florida Power & Light Company (FPL) letter L-92-273, dated September 28, 1992, committed to compensatory measures (roving fire watch and verification of fire detector operability) until the Thermo-Lag issues were resolved. Additionally, in the response to Generic Letter 92-08, dated April 16, 1993, FPL indicated that specific plant resolution of the Thermo-Lag concerns would be deferred until after completion of a NUMARC (i.e., Nuclear Energy Institute (NEI))

coordinated testing program. The testing of upgraded Thermo-Lag barrier configurations was completed and Revision 2 to the NEI Applications Guide was issued in February 1996. The design of the required Unit 2 Thermo-lag upgrades commenced in September 1996 and implementation of modifications was completed on December 31, 1997.

2.0 LICENSING AND DESIGN BASIS REQUIREMENTS

In letter L-97-19 dated March 17, 1997, FPL committed to complete all modifications required to resolve St. Lucie Unit 2 Thermo-Lag related issues by the end of the calendar year 1997. In addition, a commitment was made to complete the closeout documentation and to submit a final summary report by June 30, 1998.

3.0 ORIGINAL THERMO-LAG APPLICATIONS

Thermo-Lag 330-1 has been used at St. Lucie Unit 2 to achieve compliance with 10 CFR 50, Appendix R requirements for the separation of redundant safe shutdown components and circuits. The original application of Thermo-Lag consisted of 1-hour and 3-hour fire barrier conduit protection, 3-hour fire area boundary walls and ceilings, and containment radiant energy shields. The 1-hour and 3-hour protection installations for conduit consisted of one-half inch (minimum) thickness and one-inch (minimum) thickness of Thermo-Lag 330-1 preformed sections tie-wired or banded to the conduit, respectively. The 3-hour fire rated walls and ceilings consisted of two "back to back" one-half inch thick (minimum) Thermo-Lag 330-1 prefabricated panels mounted to a steel framework or a one inch thick prefabricated panel mounted to a steel framework. The radiant energy shields consisted of two types; wall barriers constructed of one inch thick Thermo-Lag 330-1 panels and conduit barriers constructed of one half inch thick preshaped sections.

4.0 UPGRADED THERMO-LAG APPLICATIONS

The upgraded Thermo-Lag installations at St. Lucie constitute 1-hour and 3-hour fire rated conduit barrier installations and fire rated walls and ceilings. Containment Thermo-Lag radiant energy shields were replaced with radiant energy shields of stainless steel sheet metal construction. Upgrades to the Thermo-Lag conduit barriers were performed to meet the critical attributes of the NEI Application Guide based upon acceptable qualification testing in accordance with the requirements of Generic Letter 86-10, Supplement 1. The engineering specification was revised to provide the design criteria and installation guidance necessary to assure that Thermo-Lag fire barrier system upgrades were performed with the proper control over the materials and installation process. These upgrades were performed under the site quality assurance program utilizing the plant modification process.

In general, the modifications for Thermo-Lag conduit fire barriers included the following:

1) Verification of a properly installed base layer. In instances where the existing Thermo-Lag 330-1 barrier was improperly installed, repair or replacement of the base layer was performed.
2) Upgrades for the 1-hour barriers included the reinforcement of seams and joints through the addition of stress skin and tie wires, and the addition of a one-quarter inch (minimum) thickness Thermo-Lag 330-1 overlays for conduits smaller than three inches in diameter.

3) Upgrades for 3-hour barriers required the reinforcement of the baseline material at conduit and support interfaces with the use of wire mesh or stress skin. In addition, the upgrades included the application of layers of one-quarter inch (minimum) thickness Thermo-Lag 770-1 Mat over the existing base layer. The number of layers required was dependent upon the size of the conduit and the percentage of cable fill. Finally, the upgrades included the application of a Thermo-Lag 770-1 trowel grade finish coat.

In general, the modifications associated with the Thermo-Lag fire area wall/ceiling upgrades included the following:

1) Inspection of the existing configuration to verify critical attributes, identification of unsupported seams/joints, and other installation deficiencies.

2) Reinforcement of Thermo-Lag panels at unsupported seams/joints, penetrations, and intervening items.

3) Additional reinforcement of horizontal Thermo-Lag panels.

5.0 THERMO-LAG REDUCTION EFFORTS

Thermo-Lag reduction efforts included engineering analyses to eliminate the reliance on Thermo-Lag as a fire barrier as much as practical. The following methodology was used:

1) Analysis evaluated the need for Thermo-Lag protection of each essential circuit based upon its function and the availability of redundant circuits.

2) The requirement for protection was eliminated where equipment redundancy existed in another fire area or a redundant circuit was protected in the same fire area.

   Note: The essential equipment list was not changed, nor were manual actions added as part of this effort.

3) The preferred method of protection of essential circuits was to reroute the circuits through a separate fire area and utilization of the existing fire rated walls/ceilings to provide separation. Where feasible, the essential circuit was rerouted.

4) An analysis of equipment cooling requirements was performed to evaluate the necessity for protection of HVAC circuits in specific fire areas. Where not required, the Thermo-Lag protection of the HVAC circuits was either eliminated or abandoned in place.

   Note: The HVAC equipment associated with these circuits supplied cooling for other fire areas and did not provide for ventilation or smoke removal capability of the fire area in which the circuit was protected.

5) Thermo-Lag inside the reactor containment building was replaced with or encapsulated in stainless steel sheet metal. This Thermo-Lag was originally used as a radiant energy shield.

6.0 SUMMARY OF MODIFICATIONS

Provided below is a summary table listing approximate quantities (linear feet or square feet) of the final Thermo-Lag barrier material utilized at St. Lucie Unit 2 and a brief description of the plant change/modifications (PC/M) implemented to resolve Thermo-Lag related issues.

Final Thermo-Lag Quantities

Barrier Type	1-Hr	3-Hr	3-Hr (1)
Trays	None	None	N/A
Conduits	1100 ft.	10 ft.	N/A
Walls, Floors, Ceilings	N/A	N/A	1700 ft^2
Radiant Energy Shields	None	None	None

Notes: (1) 3-hour fire rating as described in PC/M 96-149

Design Modification Packages

PC/M 96-143 - Conduit Reroutes For Thermo-Lag Reduction Train A DC Equipment Room

1) Relocated conduits protected with Thermo-Lag 330-1 fire barrier systems entering or leaving the Train "A" DC equipment/inverter room, fire zone D-34* and revised the safe

shutdown analysis to reflect updated information for conduits previously protected for safe shutdown capabilities. The conduits rerouted by this package contained cables for the 480 volt power feed to battery charger 2A from motor control center (MCC) 2A5, low voltage DC power from bus 2A to RTGB-205 and RTGB-206, low voltage 120 volt AC power from Instrument bus 2MA-1 to isolation cabinet MA/SA for power distribution to RTGB-201, RTGB-202, RTGB-203, RTGB-205, and RTGB-206.

2) Rerouted power cables associated with the PORV V-1474 and V-1475 to the containment electrical penetrations in dedicated conduits to provide for the protection of the PORVs from spurious actuation in lieu of protection of the PORV block valves. This provided for a design consistent with the high-low pressure interface requirements of the FSAR.

PC/M 96-163 - Replacement of Radiant Energy Shields

1) Replaced the one-inch thick Thermo-Lag wall panels utilized as a radiant energy barrier between redundant circuits required for safe shutdown inside the containment building. Thermo-Lag wall panels were replaced with 16 gauge stainless steel sheet metal. The sheet metal was secured by bolting to the existing structural members that supported the Thermo-Lag wall materials.

2) Installed a 24 gauge stainless steel sheet metal over preshaped sections of Thermo-Lag covered conduits. This sheet metal was installed by banding and pop riveting to achieve a snug fit.

PC/M 96-150 - Thermo-Lag Conduit Fire Barrier Upgrades

This design package provided for the upgrade of approximately 1100 linear feet of Thermo-Lag protected conduits to the requirements of Engineering Specification MN-3.21, *Installation and Inspection Guidelines for Thermo-Lag Fire Barrier Material.* This specification identifies the general requirements for installing 1-hour and 3-hour Thermo-Lag fire barriers, as well as, approved methods for upgrading existing Thermo-Lag fire barriers to qualified 1-hour and 3-hour fire resistant barriers. The technical requirements of this specification are based upon the acceptable fire testing and analysis performed under the Nuclear Energy Institute, *NEI Application Guide For Evaluation of Thermo-Lag 330-1 Fire Barrier Systems.*

PC/M 96-149 - Thermo-Lag Wall Modifications

This design package implemented upgrades to the existing Thermo-Lag 330-1 walls to permit their use as 3-hour fire rated barriers. The Thermo-Lag walls were originally designed as 3-hour fire rated barriers; however, subsequent fire endurance testing demonstrated that the ASTM E119 temperature criteria was exceeded at 1-hour and 48 minutes. The fire testing did demonstrate that

the other test criteria for a 3-hour rated barrier were met. Specifically, no ignition of cotton waste for the full test duration, no visible flame for the full test duration, and a successful hose stream test. Additionally, thermocouples located at approximately 1 inch from the wall on the cold side did not exceed 130 degrees Fahrenheit. Acceptability of these walls as fire area boundaries was documented in a fire hazards analysis, using the criteria outlined in Generic Letter 86-10 and demonstrated that the upgraded walls are equivalent 3-hour fire barriers for the barrier configuration and safe shutdown circuit orientation associated with the field conditions. Included in this evaluation was confirmation that no redundant essential circuits are in proximity of the wall so as to be impacted by the elevated cold side temperatures. The modifications implemented by this PC/M generally include reinforcement of the Thermo-Lag panels at the seams, additional bolting/attachment of the Thermo-Lag panels to the structural frames, and Thermo-Lag upgrades to the penetrations in the walls. A total of approximately 1700 square feet of Thermo-Lag walls were upgraded.

7.0 OTHER RELATED THERMO-LAG ISSUES

Combustibility

Combustible loading calculations were performed for the final Thermo-Lag quantities installed in each fire area/zone. A fire hazards analysis was then performed to document the acceptability of this increased combustible loading for each affected fire area, and a 10 CFR 50.59 safety evaluation including an FSAR change package was issued.

In order to comply with 10 CFR 50, Appendix R, Section III.G.2.f which requires radiant energy shields to be constructed of non-combustible material, the Thermo-Lag panels used as radiant energy shields inside containment were replaced with panels constructed of stainless steel sheet metal. Additionally, the Thermo-Lag originally utilized as a radiant energy shield for conduit was encapsulated in sheet metal, which now functions as the radiant energy shield.

St. Lucie does not use Thermo-Lag to achieve 20 ft. separation of redundant circuits, nor is Thermo-Lag an intervening combustible in any area where Appendix R, Section III.G.2(b) is taken credit for in design.

Seismic Qualification

Thermo-Lag does not perform a safety related function; however, since the material is installed on safety related equipment and in areas containing safety related equipment, it must be capable of maintaining gross structural integrity such that it does not adversely interact with safety related systems during a design basis seismic event (i.e., seismic II/I consideration). St. Lucie has taken into consideration this design requirement in the implementation of Thermo-Lag modifications,

and has also reviewed the data provided by IN 95-49 and 95-49 Supplement 1. In conclusion, the St. Lucie Unit 2 Thermo-Lag installations have been determined to meet applicable seismic design requirements.

Ampacity

The effect of Thermo-Lag 330-1 and 770-1 fire barrier material on cable ampacity has been evaluated. Adequate design margin has been demonstrated to exist by calculation and utilization of the recent Florida Power Corporation (FPC) derating test data for Crystal River 3.

The Thermo-Lag ampacity derating methodology issues are still under review by the NRC. St. Lucie Plant is currently in the process of preparing a response to the most recent NRC RAI dated April 23, 1998.