THERMO-LAG

INSTALLED TO TESTED FIRE BARRIER EVALUATION

(GL 86-10 EVALUATION)

Rev. 01 | R1

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I. SUMMARY

The purpose of this GL 86-10 evaluation is to provide technical justification as to why the thermo-lag installed on seven fire dampers and ductwork will provide the necessary passive fire protection at Waterford 3 (W3).

It is important to note, that W3 does not use thermo-lag to protect any cable trays or conduits.

W3 had committed to resolving the thermo-lag issue by December 15, 1994 because Nuclear Energy Institute (NEI) was to have completed their testing prior to this date. At this time, NEI has not yet scheduled Phase III tests which will include assemblies that closely resemble W3 installed configurations.

W3 has used all the resources available from the completed NEI tests and feel confident the information from the NEI tests bounds W3's installed configurations. W3 will continue to follow NEI's test program to completion in order to reinforce this evaluation.

This evaluation was originally completed on 12/13/94. The NRC requested additional information concerning chemical composition testing of thermo-lag installed at each utility. R1

II. BACKGROUND

As a result of the Browns Ferry fire which occurred March 22, 1975, the NRC undertook measures to order the protection of redundant systems required to achieve and maintain safe shutdown in the event of a fire. The NRC issued 10 CFR 50.48 and 10 CFR 50, Appendix R, in 1981 and made them applicable to all nuclear power plants.

Section III. G of Appendix R specifically addresses requirements for the protection of redundant safe shutdown electrical systems for the purpose of ensuring that at least one electrical circuit, capable of achieving and maintaining safe shutdown, remains free of fire damage. Licensees can satisfy the requirements of Section III.G by one of the following methods:

Separate redundant divisions with 3-hour rated fire barriers.

II. BACKGROUND (CONT.)

Separate redundant divisions with 1 hour fire rated barriers and provide automatic suppression and detection.

Provide more than 20 feet of horizontal separation between redundant divisions with no intervening combustibles and provide automatic suppression and detection.

Before licensees could use a fire barrier material to satisfy the requirements of Appendix R, the NRC required that the one and/or three hour ratings be demonstrated by subjecting a specimen to a standard fire exposure test, conducted by a nationally recognized fire testing laboratory.

Fire barrier materials that could be used to protect electrical circuits were still in the developmental stage in 1981 when licensees began submitting fire test reports performed by Thermal Ceramics Inc. for approval. The staff accepted the test reports which were then used throughout the industry to qualify Thermo-Lag. Since the NRC originally accepted Thermo-Lag, increasingly significant allegations associated with Thermo-Lag have surfaced.

In 1989, River Bend Station performed fire endurance tests on site specific Thermo-Lag installations which failed to meet the performance requirements. The NRC established a Special Review Team to evaluate a variety of Thermo-lag issues and make recommendations for their resolution. One conclusion of the Special Review Team was that fire resistance ratings and ampacity derating factors for Thermo-Lag fire barriers are indeterminate. In 1992, Comanche Peak performed fire tests of site specific Thermo-Lag installations which also failed to meet the specified performance requirements. The NRC subsequently indicated that all existing Thermo-Lag fire tests are invalid.

Nuclear Energy Institute (NEI) was tasked to prepare a test program of Thermo-lag to determine what installations were unacceptable along with determining the type of upgrades that may be needed to insure the required fire rating of an installation.

II. BACKGROUND (CONT.)

The NEI test program was set up into phases; two of those phases have been completed. This evaluation will use information from phase two of those tests to document that the installations of Thermo-Lag at Waterford 3 will meet the intent of 10 CFR 50 Appendix R.

III. ASSUMPTIONS

Review of installation records and packages for the seven fire dampers listed within this evaluation found that they did not reference Thermal Science Inc. Technical Note 20684 (Thermo-lag 330 Fire Barrier System Installation Procedures Manual, Power Generating Plant Specification). However, results of destructive examinations indicate that the Thermo-lag was installed on the fire dampers and ductwork in a manner consistent with the guidance provided in the Thermal Science technical note.

Examinations performed under CI/WA 289585/01121648 were limited to three installed configurations. It is assumed that similar thermo-lag configurations were installed in the same manner.

In order to quantify the combustibility hazard presented by Thermo-Lag, each fire area containing thermo-lag has been included into the combustible loading of that fire area. The heat of combustion used for thermo-lag is 7000Btu/lbs. This heat content value is from the NEI Combustibility evaluation guide. The value for the heat of combustion of thermo-lag as stated in the NEI Letter (Alex Marion) (IN95-27 Attachment 1) the NRC states that based on their own combustibility test, the NRC staff concluded that thermo-lag has the combustible characteristics similiar to fire retardent plywood. The combustion of white pine is 19.2MJ/Kg (Ref. NFPA handbook 16th Edition Table 5-11C). This is consistent with the value of 16.3 MJ/Kg used for thermo-lag. R1

IV. REFERENCES

a. 10 CFR Appendix R
b. FSAR Section 9.5
c. Waterford 3 Associated Circuits Analysis
d. LDRS (Commitment Management)
e. FSAR Amendments (Pre-Startup)
f. NRC Bulletin No. 92-01
g. NRC Bulletin No. 92-01 Supplement 1
h. NRC Information Notice 91-47
i. NRC Information Notice 91-79
j. NRC Information Notice 91-79 Supplement 1
k. NRC Information Notice 92-46
l. NRC Information Notice 92-55
m. NRC Information Notice 92-82
n. NRC Information Notice 94-34
o NRC Information Notice 95-27 R1
p NRC Information Notice 95-32
q. NRC Generic Letter 92-08
r. Grand Jury Subpoena dated Feb. 1, 1993
s. CI/WA 278842/01097171
t. CI/WA 289585/01121648
u. CI/WA 259011/01028139
v. CI 281257
w. CR94-739
x. CMS A-20258
y. Fire Impairment 93-313
z. Policy Issue-SECY-94-127
aa. UL Standard 555-Fire Dampers

bb. W3 Drawings R1

B-316 S5A	G-252-S20	G-858-S01	G-869-S02
G-252-S07	G-252-S23	G-859-S02	
G-252-S10G	G-252-S27	G-863-S01	
G-252-S15	G-322-S10	G-864-S01	

cc. W3 Combustible Load Calculations R1

EC-F-91-004-CLC for RAB 2
EC-F-91-015-CLC for RAB 15
EC-F-91-017-CLC for RAB 16
EC-F-91-025-CLC for RAB 23

IV. REFERENCES (CONT.)

EC-F-91-028-CLC for RAB 25
EC-F-91-031-CLC for RAB 31
EC-F-91-032-CLC for RAB 32

dd. ME-003-006 R1
ee. ME-003-009
ff. DCN-NY-HV-323
gg. DCN-NY-HV-257R1
hh. DCN-NY-HV-272R1
ii. NOCP-300
jj. FP-001-015
kk. NFPA Fire Protection Handbook Sixteenth Edition
ll. Fire Research for Steel HVAC Systems-NFPA Journal, Nov.1984 pg. 46
mm. Nuclear Management & Resources Council "Thermo-lag 330-1 Combustibility Evaluation Methodology, October 1993 R1
nn. NEI Letter dated August 3, 1995 (Thermo-Lag Fire Barrier - Update
oo. NEI Letter dated August 31, 1995 (Thermo-Lag Fire Barrier - Chemical Testing R1
pp. Pyrolysis Gas Chromatography Analysis of 3 Thermo-Lag Fire Barrier Samples (Nucon P.O. NWC0035) RTYPE A9.02

V. DESCRIPTION

Physical Location of Assembly

In areas where fire dampers are located outside the 3 hour barrier, Thermo-lag has been used to enclose the HVAC duct and fire damper from the fire barrier to the fire damper. This fireproofing is a result of requirements from Branch Technical Position APCSB 9.5-1 Appendix A. These locations are as follows:

1.RAB +21 Elev.-Diesel Generator Room B, FD-76 (3 hr.)
Fire Area RAB 15

2.RAB +21 Elev.-Diesel Generator Room A, FD-77 (3 hr)
Fire Area RAB 16

3.RAB -4 Elev.- Boric Acid Concentrator Room A, FD-177 (3 hr.)
Fire Area RAB 31

V. DESCRIPTION (cont'd)

4.RAB -4 Elev.- Boric Acid Concentrator Room B, FD-178 (3 hr.)
Fire Area RAB 31

5.RAB -4 Elev.- Boric Acid Concentrator Room C, FD-179 (3 hr.)
Fire Area RAB 31

6.Wing Area +21 Elev.-FD-3HV-B217B (3hr.)
Fire Area RAB 25

7.Wing Area -4 Elev. -FD-3HV-B218A (3hr.)
Fire Area RAB 32

VI. LEVEL OF PROTECTION

The assemblies installed at W3 are solely on ductwork and fire dampers. The amount of thermo-lag installed to protect a length of ductwork is ≤ 5'-0". Due to the minimal amount of protected ductwork, a very localized plume would have to develop. Furthermore, temperatures could exceed the 250°F plus ambient on the unexposed side, but not affect the system because their are no cables within the assembly.

The thermo-lag could become red hot, but if no flame through occurs, this configuration would be successful in preventing flame propagation to an adjacent area (UL Standard 555). In addition, the continuous backing of the ductwork along with the air space inside the duct will reduce the effects of conductive heat transfer into the protective envelopes as well as reduce the rate that the barrier material softens during fire exposure. The ductwork also offers a greater resistance to the thermo-lag material from sagging. R1

To fail these configurations, first the fire would need to fail the thermo-lag, then it must breach a metal enclosure and traverse a short distance (≤ 5')containing no combustibles, then exit the enclosure and still be hot enough to cause ignition. The expected fire severity curve for a low fire load as represented by the fire areas containing thermo-lag (less than 100,000 Btu/sq.ft.-NFPA Handbook Sixteenth Edition Section 7 Chapter 9),indicates that room temperatures would not reach 1700° F within the first 50 minutes of a fire. Temperatures considered for the stress limitations of steel is the actual temperature of the steel and

VI. LEVEL OF PROTECTION (CONT.)

not the ambient temperature within the room. The ability of steel to transfer heat from a localized source in conjunction with the ability of the air space inside the duct to dissipate heat would prolong the time it would take for the steel to reach a critical temperature of 1100 F. Due to this reasoning, it can be concluded that the ductwork will provide an additional 60 minutes of fire rating to the minimum 86 minute thermo-lag fire rating determined in Attachment A. Therefore the overall rating of the thermo-lag protected assembly is a minimum 146 minutes.

FD-3-HV-B217B and FD-3-HV-B218A are located on the same ductwork that penetrates a 3 hour barrier. Thermo-lag enclosing each duct and damper is located on each side of the 3 hour barrier. Fire propagation to either side of the barrier would be a tortuous path. First, the fire would need to fail the thermo-lag, then it must breach a metal enclosure and traverse 6 to 10 ft. containing no combustibles, then breach another metal enclosure and additional thermo-lag on the opposite side of the barrier.

Following this difficult path required for fire propagation, the fire would have to exit the enclosure and still be hot enough to cause ignition. It is concluded that the combination of these two dampers located on opposite sides of the same 3 hour barrier, can be considered a 3 hour configuration.

For dampers FD-177, 178 and 179 the thermo-lag enclosure would not experience a high degree of impact from the plume generated by thermal thrust because of their location (directly above a doorway, therefore negligible combustibles). It is concluded that the location of these thermo-lag installations along with the determined minimum fire rating that these barriers can be considered a 3 hr. barrier.

For dampers FD-76 and FD-77 an additional 60 minutes is added to their duration because of the 10 gauge metal which completely encapsulates the thermo-lag. It is concluded that the combination of the 10 gauge metal and the determined minimum fire rating, that these barriers can be considered a 3 hr. barrier.

VII. FIRE HAZARDS ANALYSIS

A. Propagation of Flame through the Thermo-lag Barrier

The btu/sq.ft. and fire severity indicated in this section includes the thermo-lag installed in the fire area.

Fire Area RAB 15 to Fire Area RAB 2

FD-76 separates the Diesel Generator Room B (RAB 15) from the H & V Mechanical Room (RAB 2).

A fire originating in the H & V Mechanical Room does not pose a legitimate threat to the Diesel Generator Room B because of the fire damper. This is due primarily to the low fire severity of 43 minutes (57,143 Btu/sq.ft.).

Also, the fire damper and ductwork enclosed with the thermo-lag provides the level of protection cited in Section VI and Attachment A.

A fire originating in the Diesel Generator Room B does not pose a legitimate threat to the H & V Room because of the fire damper. This is due primarily to the moderate fire severity of 92 minutes (122,299 Btu/sq.ft.) and level of protection cited in Section VI and Attachment A.

Fire Area RAB 16 to Fire Area RAB 2

FD-77 separates the Diesel Generator Room A (RAB 16) from the H & V Mechanical Room (RAB 2).

A fire originating in the H & V Mechanical Room does not pose a legitimate threat to the Diesel Generator Room A because of the fire damper. This is due primarily to the low fire severity of 43 minutes (57,143 Btu/sq.ft.).

Also, the fire damper and ductwork enclosed with thermo-lag provides the level of protection cited in Section VI and Attachment A.

VII. FIRE HAZARDS ANALYSIS (CONT.)

A fire originating in the Diesel Generator Room A does not pose a legitimate threat to the H & V Room because of the fire damper. This is due primarily to the moderate fire severity of 85 minutes (113,374 Btu/sq.ft.) and level of protection cited in Section VI and Attachment A.

Fire Area RAB 31 to Fire Area RAB 23

FD-177 separates the Vestibule/Corridor of RAB 31 from the Boric Acid Concentrator Room A (RAB 23).

A fire originating in the Vestibule/Corridor does not pose a legitimate threat to the Boric Acid Concentrator Room A because of the fire damper.

This is due primarily to the low fire severity of 53 minutes (69,625 Btu/sq.ft.). Also, the fire damper and ductwork enclosed with thermo-lag provides the level of protection cited in Section VI and Attachment A.

A fire originating in the Boric Acid Concentrator Room A does not pose a legitimate threat to the Vestibule/Corridor because of the fire damper. This is due primarily to the low fire severity of 36 minutes (47,280 Btu/sq.ft.). Also, the fire damper and ductwork enclosed with thermo-lag provides the level of protection cited in Section VI and Attachment A.

Fire Area RAB 31 to Fire Area RAB 23

FD-178 separates the Vestibule/Corridor of RAB 31 from the Boric Acid Concentrator Room B (RAB 23).

A fire originating in the Vestibule/Corridor does not pose a legitimate threat to the Boric Acid Concentrator Room B because of the fire damper. This is due primarily to the low fire severity of 53 minutes (69,625 Btu/sq.ft.). Also, the fire damper and ductwork enclosed with thermo-lag provides the level of protection cited in Section VI and Attachment A.

VII. FIRE HAZARDS ANALYSIS (CONT.)

A fire originating in the Boric Acid Concentrator Room B does not pose a legitimate threat to the Vestibule/Corridor because of the fire damper. This is due primarily to the low fire severity of 36 minutes (47,280 Btu/sq.ft.). Also, the fire damper and ductwork enclosed with thermo-lag provides the level of protection cited in Section VI and Attachment A.

Fire Area RAB 31 to Fire Area RAB 23

FD-179 separates the Vestibule/Corridor of RAB 31 from the Waste Concentrator Room (RAB 23).

A fire originating in the Vestibule/Corridor does not pose a legitimate threat to the Waste Concentrator Room because of the fire damper. This is due primarily to the low fire severity of 53 minutes (69,625 Btu/sq.ft.).

Also, the fire damper and ductwork enclosed with thermo-lag provides the level of protection cited in Section VI and Attachment A.

A fire originating in the Waste Concentrator Room does not pose a legitimate threat to the Vestibule/Corridor because of the fire damper. This is due primarily to the low fire severity of 36 minutes (47,280 Btu/sq.ft.). Also, the fire damper and ductwork enclosed with thermo-lag provides the level of protection cited in Section VI and Attachment A.

Fire Area RAB 25 to Fire Area RAB 32

FD-3HV-B217B separates the +21 Wing Area-Equipment Access Area (RAB 25) from the -4 Wing Area-Pipe Penetrations and Auxiliary Component Cooling Water Pumps (RAB 32).

VII. FIRE HAZARDS ANALYSIS (CONT.)

A fire originating in the +21 Wing Area-Equipment Access Area does not pose a legitimate threat to the -4 Wing Area-Pipe Penetrations and Auxiliary Component Cooling Water Pumps because of the fire damper. This is due primarily to the low fire severity of 48 minutes (63,886 Btu/sq.ft.). Also, the fire damper and the ductwork enclosed with thermo-lag provides the level of protection cited in Section VI and Attachment A.

A fire originating in the -4 Wing Area-Pipe Penetrations and Auxiliary Component Cooling Water Pumps does not pose a legitimate threat to the +21 Wing Area-Equipment Access Area because of the fire damper. This is due primarily to the low fire severity of 14 minutes (17,349 Btu/sq.ft.). Also, the fire damper and ductwork enclosed with thermo-lag provides the level of protection cited in Section VI and Attachment A. | R1

Fire Area RAB 32 to Fire Area RAB 25

FD-3HV-B218A separates the -4 Wing Area-Pipe Penetrations and Auxiliary Component Cooling Water Pumps (RAB 32) from the +21 Wing Area-Equipment Access Area (RAB 25).

A fire originating in the +21 Wing Area-Equipment Access Area does not pose a legitimate threat to the -4 Wing Area-Pipe Penetrations and Auxiliary Component Cooling Water Pumps because of the fire damper. This is due primarily to the low fire severity of 48 minutes (63,886 Btu/sq.ft.). Also, the fire damper and ductwork enclosed with thermo-lag provides the level of protection cited in Section VI and Attachment A.

A fire originating in the -4 Wing Area-Pipe Penetrations and Auxiliary Component Cooling Water Pumps does not pose a legitimate threat to the +21 Wing Area-Equipment Access Area because of the fire damper. This is due primarily to the low fire severity 14 minutes (17,349 Btu/sq.ft.). Also, the fire damper and ductwork enclosed with thermo-lag provides the level of protection cited in Section VI and Attachment A. | R1

VIII. DEGREE OF PROTECTION PROVIDED BY EXISTING INSTALLATION

A. Similarities/Differences Between Tested Configurations and Installed Assemblies

See Attachment A "NEI Installed to Tested Fire Barrier Evaluation Forms" for each fire damper being evaluated.

IX. CONCLUSIONS

Through this evaluation, it has been concluded that the thermo-lag enclosing fire dampers and ductwork will provide a minimum fire rating of 3 hours. This far exceeds the fire loading of the areas involved.

This evaluation concludes that the installed thermo-lag provides sufficient protection to insure that at least one train of safe shutdown equipment will remain free of fire damage.

X. PHOTOGRAPHS

Photographs taken during the destructive examination of the thermo-lag are attached to this evaluation.

XI. ATTACHMENTS

A. NEI "Installed to Tested Fire Barrier Evaluations" for:

Fire Damper-76
Fire Damper-77
Fire Damper-177
Fire Damper-178
Fire Damper-179
Fire Damper-3HV-B217B
Fire Damper-3HV-B218A

B. Combustibility Values for Thermo-lag | R1

ATTACHMENT B

COMBUSTIBILITY VALUES FOR THERMO-LAG

FIRE DAMPER	TOTAL THERMO-LAG PER FIRE DAMPER cubic ft.	WEIGHT OF THERMO-LAG lbs./cu.ft.	TOTAL WEIGHT OF THERMO-LAG PER FIRE DAMPER lbs.	COMBUSTIBILITY VALUE btu/lb.	TOTAL BTU PER FIRE DAMPER btu
FD-76	5.8	126	731	7,000	5,117,000
FD-77	5.8	126	731	7,000	5,117,000
FD-177	1.08	126	137	7,000	959,000
FD-178	0.66	126	83	7,000	581,000
FD-179	1.29	126	163	7,000	1,141,000
FD-3HV-217B	4.14	126	522	7,000	3,654,000
FD-3HV-218A	4.95	126	624	7,000	4,368,000

ATTACHMENT B (CONT.)

FIRE SEVERITY FOR FIRE AREAS CONTAINING THERMO-LAG

FIRE DAMPER AND FIRE AREA	BTU'S PER FIRE AREA btu	TOTAL BTU'S PER FIRE DAMPER btu	TOTAL BTU'S PER FIRE AREA btu	FIRE AREA sq. ft.	FIRE AREA btu/sq.ft.	FIRE SEVERITY PER FIRE AREA min.
FD-76 RAB15	238,013,679	5,117,000	243,130,679	1,988	122,299	92
FD-77 RAB16	221,631,900	5,117,000	226,748,900	2,000	113,374	85
FD-177 RAB31		959,000				
FD-178 RAB31		581,000				
FD-179 RAB31		1,141,000				
TOTAL RAB31	762,993,281	2,681,000	765,674,281	10,997	69,625	53
FD-3HV-217B RAB25	157,658,290	3,654,000	161,312,290	2,525	63,886	48
FD-3HV-218A RAB32	268,273,506	4,368,000	272,641,506	15,715	17,349	13