Fire Qual Test 14980-98207
Rev. 0

FIRE ENDURANCE TEST OF A WALL ASSEMBLY CLAD WITH THERMO-LAG® 330-1

Project No. 14980-98207

FIRE ENDURANCE TEST TO QUALIFY A WALL DESIGN
AS A 180 MINUTE FIRE RESISTANT ASSEMBLY

May 23, 1995

Prepared For:

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OMEGA POINT LABORATORIES

ABSTRACT

A wall assembly consisting of a 3 in. x 3 in. x 3/8 in. steel angle structural perimeter frame and 3 in. x 3 in. x 1/4 in. steel angle cross framing supporting two layers of (5/8 in. nominal thickness) Thermo-Lag® 330-1 fire protective material (with Thermo-Lag 330-1 Trowel Grade over the steel elements) was tested (with the steel framework towards the fire) in accordance with ASTM E119-88 Fire Tests of Building Construction and Materials for a period of 180 minutes (3h).

The details, procedures and observations reported herein are correct and true within the limits of sound engineering practice. All specimens and test sample assemblies were produced, installed and tested under the surveillance of the testing laboratory's in-house Quality Assurance Program. This report describes the analysis of a distinct assembly and includes descriptions of the test procedure followed, the assembly tested, and all results obtained. All test data are on file and remain available for review by authorized persons.

Cleda Patton for
Constance A. Humphrey
Manager, QA Dept.

8-1-95
Date

Herbert W. Stansberry II,
Fire Test Technologist

8/1/95
Date

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INTRODUCTION[1]

"The performance of walls, columns, floors, and other building members under fire exposure conditions is an item of major importance in securing constructions that are safe, and that are not a menace to neighboring structures nor to the public. Recognition of this is registered in the codes of many authorities, municipal and other. It is important to secure balance of the many units in a single building, and of buildings of like character and use in a community; and also to promote uniformity in requirements of various authorities throughout the country. To do this it is necessary that the fire-resistive properties of materials and assemblies be measured and specified according to a common standard expressed in terms that are applicable alike to a wide variety of materials, situations, and conditions of exposure.

Such a standard is found in the methods that follow. They prescribe a standard exposing fire of controlled extent and severity. Performance is defined as the period of resistance to standard exposure elapsing before the first critical point in behavior is observed. Results are reported in units in which field exposures can be judged and expressed.

The methods may be cited as the "Standard Fire Tests," and the performance or exposure shall be expressed as "2-h," "6-h," "1/2-h," etc.

When a factor of safety exceeding that inherent in the test conditions is desired, a proportional increase should be made in the specified time-classification period.

The ASTM E119 test procedure is identical or very similar to the following standard test methods:

UL 263
UBC 43-1
NFPA 251
ANSI A2.1

1. Scope

1.1 These methods are applicable to assemblies of masonry units and to composite assemblies of structural materials for buildings, including bearing and other walls and partitions, columns, girders, beams, slabs, and composite slab and beam assemblies for floors and roofs. They are also applicable to other

1 American Society for Testing and Materials, 1986 Annual Book of Standards, ASTM E119-88 Standard Methods of FIRE TESTS OF BUILDING CONSTRUCTION AND MATERIALS.

assemblies and structural units that constitute permanent integral parts of a finished building.

1.2 It is the intent that classifications shall register performance during the period of exposure and shall not be construed as having determined suitability for use after fire exposure.

1.3 *This standard should be used to measure and describe the properties of materials, products, or assemblies in response to heat and flame under controlled laboratory conditions and should not be used to describe or appraise the fire hazard or fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test may be used as elements of a fire risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard of a particular end use.*

> Note 1 - A method of fire hazard classification based on rate of flame spread is covered in ASTM Method E84, Test for Surface Burning Characteristics of Building Materials.

1.4 The results of these tests are one factor in assessing fire performance of building construction and assemblies. These methods prescribe a standard fire exposure for comparing the performance of building construction assemblies. Application of these test results to predict the performance of actual building construction requires careful evaluation of test conditions.

2. Significance

2.1 This standard is intended to evaluate the duration for which the types of assemblies noted in 1.1 will contain a fire, or retain their structural integrity or exhibit both properties dependent upon the type of assembly involved during a predetermined test exposure.

2.2 The test exposes a specimen to a *standard* fire *exposure* controlled to achieve specified temperatures throughout a specified time period. In some instance, the *fire exposure* may be followed by the application of a *specified standard* fire hose stream. The exposure, however, may not be representative of all fire conditions which may vary with changes in the amount, nature and distribution of fire loading, ventilation, compartment size and configuration, and heat sink characteristics of the compartment. It does, however, provide a relative measure of fire performance of comparable assemblies under these specified fire exposure conditions. Any variation from the construction or conditions (that is, size, method of assembly, and materials) that are tested may substantially change the performance characteristics of the assembly.

2.3 The test standard provides for the following:

2.3.1 In walls, partitions and floor or roof assemblies:

2.3.1.1 Measurement of the transmission of heat.

2.3.1.2 Measurement of the transmission of hot gases through the assembly, sufficient to ignite cotton waste.

2.3.1.3 For load bearing elements, measurement of the load carrying ability of the *test specimen* during the test exposure.

2.3.2 For individual load bearing assemblies such as beams and columns: Measurement of the load carrying ability under the test exposure with some consideration for the end support conditions (that is, restrained or not restrained).

2.4 The test standard does not provide the following:

2.4.1 Full information as to performance of assemblies constructed with components or lengths other than those tested.

2.4.2 Evaluation of the degree by which the assembly contributes to the fire hazard by generation of smoke, toxic gases, or other products of combustion.

2.4.3 Measurement of the degree of control or limitation of *the passage of* smoke or products of combustion through the assembly.

2.4.4 Simulation of the fire behavior of joints between building elements such as floor-wall or wall-wall, etc., connections.

2.4.5 Measurement of flame spread over surface of tested element.

2.4.6 The effect of fire endurance of conventional openings in the assembly, that is electrical receptacle outlets, plumbing pipe, etc., unless specifically provided for in the construction tested."

OBJECTIVE

The objective of this project was to evaluate a specific Thermo-Lag wall construction for use as a 3-hour fire resistive barrier. The entire program was carried out in accordance with the TEST PLAN; *Fire Endurance Tests of a Wall Assembly Protected With The Thermo-Lag® 330-1 Fire Barrier System, Rev. 2* which may be found in Appendix B of this document. For reasons of clarity and to reduce redundancy, many items discussed in the Test Plan have not been duplicated elsewhere in this document.

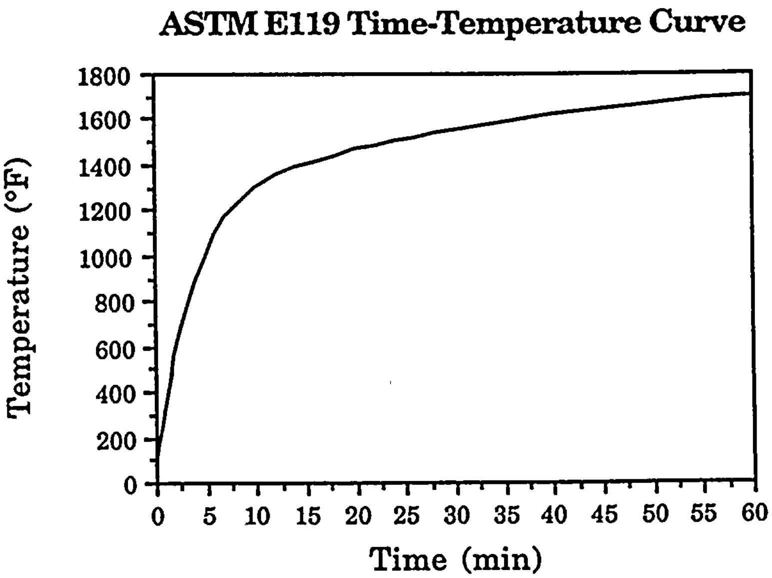
TEST PROCEDURE

FIRE TEST FURNACE

The test furnace is designed to allow the specimen to be uniformly exposed to the specified time-temperature conditions. It is fitted with 39 symmetrically-located natural gas burners designed to allow an even heat flux distribution across the face of a test specimen. Furnace pressures may be maintained at any value from +0.04" W.C. to -0.20" W.C. It must be realized that any full-size vertical fire test furnace will have a pressure difference between the bottom and top of approximately 0.1 in. W.C. after operating temperatures are reached. For this reason, the furnace is operated by controlling the pressure within the furnace (with respect to the laboratory ambient pressure) by regulating the pressure at a specific horizontal plane in the furnace. Many times the furnace pressure will be adjusted so that the "neutral pressure plane" (that where the pressure difference between the furnace interior and the laboratory is zero) is at a desired location: for instance; at the top, at a point 1/3 of the way down from the top, or at the bottom of the specimen. The neutral pressure plane was positioned at the top of the wall assembly in this test.

The temperature within the furnace is determined to be the mathematical average of thermocouples located symmetrically within the furnace and positioned six inches away from the vertical face of the test specimen. The materials used in the construction of these thermocouples are those suggested in the test standard. During the performance of a fire exposure test, the furnace temperatures are recorded at least every 30 seconds and displayed for the furnace operator to allow control along the specified temperature curve.

The fire exposure is controlled to conform with the standard time-temperature curve shown in Figure 1, as determined by the table below:



Time (min)	Temperature (°F)
0	68
5	1000
10	1300
15	1399
20	1462
25	1510
30	1550
35	1584
40	1613
45	1638
50	1661
55	1681
60	1700

Figure 1

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The fire test is controlled according to the standard time/temperature curve, as indicated by the average temperature obtained from the readings of the furnace interior thermocouples symmetrically located across the specimen, 6 in. away. The thermocouples are enclosed in protection tubes of such material and dimensions that the time constant of the thermocouple assembly lies between 5.0 and 7.2 minutes, as required by the E 119 standard. The furnace temperature during a test is controlled such that the area under the time/temperature curve is within 5% of the corresponding area under the standard time/temperature curve for the three hour test period.

The furnace pressure was controlled to be as nearly neutral with respect to the surrounding laboratory atmosphere as possible, measured at the top of the test specimen.

THERMOCOUPLES

Temperatures on the unexposed surface of the wall were measured with Type K, 24 GA, Chromel-Alumel electrically welded thermocouples formed from Chromel and Alumel wires of "special limits of error (±1.1°C)," and covered with Teflon® insulation. These thermocouples have a continuous operating capability of around 600°F. Temperatures of unexposed surfaces are monitored using thermocouples placed under 6 in. x 6 in. x 0.4 in. thick dry, felted pads as described in the standard. Temperature readings are taken at not less than nine points on the surface, at intervals not exceeding 1.0 minute. The temperature on the unexposed surface of a test specimen during the test is taken to be the average value of the qualification thermocouples.

Temperatures on the structural steel members were measured with Type K, Chromel-Alumel, electrically welded thermocouples contained within a 1/16 in. diameter Inconel sheath with sealed, ungrounded tips. These thermocouples were constructed of "special limits of error (±1.1°C)" wire and were purchased as assembled probes and were connected to the data acquisition system with the provided male plugs. All connections within the probes were performed by the thermocouple vender. Thermocouples of this construction, with a diameter of 1/4 in., have a continuous operating capability of around 2100°F.

A drawing showing the exact placement of all thermocouples may be found in Appendix C.

DATA ACQUISITION SYSTEM

The outputs of the test article thermocouples and the furnace probes were monitored by a data acquisition system consisting of a John Fluke Mfg. Co., Model HELIOS 2289A Computer Front End and an Apple Computer Co., Macintosh Classic microcomputer and a 100 input thermocouple jack panel. The Computer Front End is connected to the RS422 Serial Interface Port of the Macintosh. The computer is programmed in Microsoft QuickBASIC to command the HELIOS units to sample the data input lines (from the thermocouple jack panel), receive and convert the data into a digital format, and to manipulate the raw data into usable units for display on screen and paper and for saving to magnetic hard disk.

HOSE STREAM TEST[1]

"10.1 Where required by the conditions of acceptance, subject a duplicate specimen to a fire exposure test for a period equal to one half of that indicated as the resistance period in the fire endurance test, but not for more than 1 h, immediately after which subject the specimen to the impact, erosion, and cooling effects of a hose stream directed first at the middle and then at all parts of the exposed face, changes in direction being made slowly.

10.2 *Exemption* - The hose stream test shall not be required in the case of constructions having a resistance period, indicated in the fire endurance test, of less than 1 h.

10.3 *Optional Program* - The submitter may elect, with the advice and consent of the testing body, to have the hose stream test made on the specimen subjected to the fire endurance test and immediately following the expiration of the fire endurance test.

10.4 *Stream Equipment and Details* - The stream shall be delivered through a $2\frac{1}{2}$-in. (64-mm) hose discharging through a National Standard Play pipe of corresponding size equipped with a $1\frac{1}{8}$-in. (28.5-mm) discharge tip of the standard-taper smooth-bore pattern without shoulder at the orifice. The water pressure and duration of the application shall be as prescribed [in the table below]:

1 American Society for Testing and Materials, 1986 Annual Book of Standards, ASTM E119-88 Standard Methods of FIRE TESTS OF BUILDING CONSTRUCTION AND MATERIALS.

Conditions For Hose Stream Test		
Resistance Period	Water Pressure at Base of Nozzle, psi (kPa)	Duration of Application, min/100 ft^2 (9 m^2) exposed area
8 h and over	45 (310)	6
4 h and over if less than 8 h	45 (310)	5
2 h and over if less than 4 h	30 (207)	2-1/2
1-1/2 h and over if less than 2 h	30 (207)	1-1/2
1 h and over if less than 1-1/2 h	30 (207)	1
Less than 1 h, if desired	30 (207)	1

10.5 *Nozzle Distance* - The nozzle orifice shall be 20 ft (6-m) from the center of the exposed surface of the test specimen if the nozzle is so located that when directed at the center its axis is normal to the surface of the test specimen. If otherwise located, its distance from the center shall be less than 20 ft by an amount equal to 1 ft (305-mm) for each 10 deg of deviation from the normal."

The hose stream test was applied to a previous wall test (OPL Report No. 14980-97261) and therefore was not applied to this test sample. The prior test assembly was considered the "Hose Stream Retest Sample" for this evaluation.

BARRIER INSPECTION

- Following the fire exposure, all barrier materials, joints and seams were visually inspected for burnthrough or openings in the barrier in accordance with the acceptance criteria outlined in the Test Plan.

TEST ASSEMBLY

TEST WALL

Structural Steel Elements

The perimeter framework for the test wall assembly consisted of a matrix of 3 in. x 3 in. x 3/8 in. steel angle. The cross braces and seismic bracing angles within this perimeter were fabricated from 3 in. x 3 in. x 1/4 in. steel angle. Where two angle flanges met back to back, they were welded continuously along their flat sides (the unexposed face of the wall) with nominal 3/16 in. fillet welds. Two sections of the test wall contained 24 in x 24 in. framed openings through which passed 24 in. x 24 in. steel duct sections (formed of 1/4 in. thick steel sections, continuously welded along the edges) perpendicular to the plane of the wall.

To allow for attachment of the Thermo-Lag® Board materials to the wall framework, 5/16 in. diameter holes were drilled through the flanges of the steel angle 12 in. o.c. along each run of angle (3 in. from the beginning of each length of angle, except as noted in the drawings in Appendix A). Bolts (1/4 in. diameter x 2-1/2 in. long) were placed through each hole with the threaded ends protruding on the unexposed face of the wall and the hex heads were tack-welded to the flange of the steel angle. Installed as such, the bolts provided a perimeter fastening means for each Thermo-Lag® panel. Exact locations of the fasteners and steel angle sections are contained in drawing in Appendix A. After assembly and welding, the steel was primed with Thermo-Lag® 351 Primer.

Thermo-Lag® 330-1 Materials

Thermo-Lag® materials were manufactured by Thermal Science, Inc., St. Louis, MO and were supplied by Florida Power & Light and were representative of materials installed in the field. Each one-hour rated Thermo-Lag® 330-1 flat panel is 5/8 in. thick nominal x 48 in. wide x 78 in. long, with stress skin monolithically adhered to the panel on one face. Thermo-Lag® 330-1 trowel grade subliming compound was also supplied to be used with 330-1 panels and for protection of the framework steel. All Thermo-Lag® panels were measured, saw cut and installed onto the respective test assembly by Peak Seals craft personnel. Installations were inspected by Peak Seals quality control inspectors. Details of the Thermo-Lag® installation are illustrated in Appendix A.

Other Materials

Materials used in conjunction with Thermo-Lag® components, or for penetration seals included: Dow Corning Low Density Silicone Elastomer (LDSE) seal material, M-Board (ceramic fiber damming board), wire cloth (ASTM E437, Type 304, stainless steel plain weave, 8x8 square mesh, 0.028 in. diameter wire), 16 GA stainless steel tie wires and staples.

THERMOCOUPLE PLACEMENT

For assessment of the performance of the wall system, only the following thermocouples (#1-14) will be considered:

> 24 gauge, Type K, Chromel-Alumel electrically welded thermocouples (Special Limits of Error: ± 1.1°C, purchased with lot traceability and calibration certifications) with Teflon® insulation were attached at not less than nine points on the unexposed surface of the test wall. Five of these were symmetrically disposed, with one at the approximate center of the specimen (TC #1), and four at the approximate centers of its quarter sections (TC #2-5). None of the thermocouples were located within 12 in. of the edges of the test specimen or over fasteners. All fourteen thermocouples were placed under flexible pads (Ceraform 126, manufactured by Manville Specialty Products,

- 6±1/8 in. x 6±1/8 in. x 0.375±0.05 in. thick, held firmly against the surface and fit closely about the thermocouple. The remaining thermocouples were located near the geometric center of each panel of Thermo-Lag® 330-1 and were covered with similar pads (TC #6-14).

Additional thermocouples (TC #15-16) were installed for information only and designated as engineering thermocouples. The description of placement of these additional engineering thermocouples follows:

Two thermocouples were attached to the unexposed face of the steel angle iron structure and were covered with Thermo-Lag® materials (TC #19-22). All of these thermocouples were installed into appropriately sized holes drilled to the center of each steel section. The thermocouple leads were routed along the angles and secured by welded yokes formed from 1/4 in. x ~3/4 in. x 4 mil thick stainless steel shim stock, placed as necessary. The thermocouples then passed through the fire barrier material, to the unexposed side of the wall assembly.

Additional thermocouples were installed for the assessment of the duct penetration seals. The description of placement of these additional engineering thermocouples follows:

Lower penetration - Two thermocouples were placed on the unexposed face of the Thermo-Lag® material covering the interior of the duct steel, 1" from the penetration seal (TC #17 on left side and TC #18 on top). Two thermocouples were placed on the unexposed face of the duct penetration seal, 1" from the duct walls (TC #19 on right side and TC #18 on bottom). Three thermocouples were placed on the unexposed face of the duct penetration seal, in the field of the seal (TC #21-23). All of these thermocouples were covered with 2 in. x 2 in. pads of the construction noted previously.

Upper penetration - Two thermocouples were placed on the unexposed face of the Thermo-Lag® material covering the interior of the duct steel, 1" from the penetration seal (TC #24 on left side and TC #25 on top). Two thermocouples were placed on the unexposed face of the duct penetration seal, 1" from the duct walls (TC #26 on right side and TC #27 on bottom). Three thermocouples were placed on the unexposed face of the duct penetration seal, in the field of the seal (TC #28-30). All of these thermocouples were covered with 2 in. x 2 in. pads of the construction noted previously.

A drawing showing the exact placement of all thermocouples may be found in Appendix C.

THERMO-LAG® INSTALLATION HIGHLIGHTS

Application Methods

Thermo-Lag® 330-1, 5/8 in. nominal thickness panels were pre-cut to fit steel framing for the wall. Pieces were installed on the framing with two panels back to back, with stress skin facing out on both sides. Panels were fit over 1/4 in. diameter bolts which were welded to the 3 in. x 3 in. x 1/4 in. steel angles. Panels were attached with 1-1/2 in. o.d. and 1/4 in. i.d. washers and 1/4 in. nuts, tightened prior to post-buttering of joints. Following panel installation, Thermo-Lag® 330-1 trowel grade material was installed over bolts and washers and on structural steel on the exposed side of the fire wall. Several layers of Thermo-Lag® 330-1 trowel grade material installation were required to develop the 0.75 in. dry film thickness. For protection of the penetration duct sleeves, a 0.75 in. dry film thickness of Thermo-Lag® 330-1 trowel grade material was applied to the exposed steel on the inside and outside of the duct after the duct penetration seals were installed. An upgrade was applied to the outside of the ducts on the exposed face by adding a 1/8 in. thick layer of Thermo-Lag® 330-1 trowel grade material skim coat over the baseline. A layer of stainless steel wire cloth was applied over this layer and stapled and tie-wired into place. A skim coat (1/16 in. thick) of Thermo-Lag® 330-1 trowel grade material was applied over the stainless steel wire cloth.

Duct Fireseal Installation

As part of the wall test, penetration seals were installed internally in the two duct penetrations. During the installation of the duct penetration seals, the wall assembly test frame was turned with one face parallel with the ground (so that the ducts extended perpendicular to the ground). M-board material was installed into the bottom (exposed side) of each duct (secured by a friction fit with the duct interior by trimming to close tolerances) to serve as damming material for the installation of the pour-in seals. The lower penetration seal installation consisted of a 9 in. thick Low Density Silicone Elastomer seal centered in the duct at the wall location. The upper penetration seal installation consisted of a 4 in. thick Low Density Silicone Elastomer seal centered in the duct at the wall location. For additional details, see VECTRA Technologies' Drawing 0132-00168-D-501, Page 4 of 4 in Appendix A: Construction Drawings.

TEST RESULTS

The completed test specimen was installed against the Laboratory's vertical fire test furnace located on the Laboratory's grounds at 16015 Shady Falls Road, Elmendorf, Texas 78112, on April 11, 1995. The thermocouples were then connected to the data acquisition system and their outputs verified. The test was conducted by Herbert W. Stansberry II, with the following persons present:

Chuck Fisher	-	FP&L
Cal Banning	-	VECTRA
Roger Sims	-	CP&L
Steve Hardy	-	CP&L
Randy Brown	-	Peak Seals
Deggary N. Priest	-	Omega Point Laboratories, Inc.
Kerry Hitchcock	-	Omega Point Laboratories, Inc.
Connie Humphry	-	Omega Point Laboratories, Inc.
Cleda Patton	-	Omega Point Laboratories, Inc.
Richard Beasley	-	Omega Point Laboratories, Inc.

The furnace was fired and the ASTM E119 standard time-temperature curve followed for a period of 180 minutes. The pressure difference between the inside of the furnace (measured by a pressure tap located approximately 1/3 of the way down from the top of the specimen, on the horizontal centerline of the furnace) and the laboratory ambient air, was maintained at -0.03 in. of water column throughout the entire test (placing the neutral pressure plane at the top of the furnace).

TIME (min:sec)	OBSERVATION
0:00	Furnace was fired at 9:10 a.m.
0:54	Discoloration of material along edges of penetrating duct and along edges of the steel angle flanges.
1:59	Ignition of the exposed face of the test wall.
30:00	Cracks forming on exposed face of wall at interfaces between angle flanges and wall panels.
60:00	Material fallen away from edges of penetrating ducts, exposing stress skin.
90:15	Large section of material fallen from steel angle; surface of exposed face is "glass-like."
96:38	Steel angle exposed along diagonal seismic bracing.
101:00	Seam below right of TC #2 opening and allowing a steam leak on the unexposed sample face.

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TIME (min:sec)	OBSERVATION (cont.)
106:12	Steam/smoke leakage across top of unexposed face of wall assembly; smoke leakage from seam to right of TC #7.
119:00	TC #32 moved to 12 in. above TC #2 - no pad was installed over TC #32 and the thermojunction was positioned 1 in. away from the wall surface (as was the junction of TC #31).
131:20	Slight smoke/steam leakage and material separation along perimeter of penetration seals; discoloration of top, right corner of the panel containing TC #7.
136:10	Smoke leakage from lower right corner of the panel containing TC #10.
138:45	Cotton waste applied at the locations of the previously mentioned smoke leaks with no affect.
150:16	Smoke leakage along perimeter of penetration seals in the penetrating ducts.
160:00	Smoke leakage from around bolt directly below TC #6.
176:32	Mounds of material covering bolts near TC #2 falling from unexposed sample surface; surface of upper penetration seal discolored from smoke leakage - cotton waste applied with no affect.
180:00	Furnace extinguished; sample removed from furnace.

After removal from the test furnace, the wall surfaces were cooled with a water fog. No hose stream test was performed on this test sample. The condition of the test wall was noted as follows: most of the steel angle on the exposed face was bare, the bottoms of the exposed side of the penetrating ducts were sagging, the stress skin on the exposed face of the sample was mostly consumed on each panel (panel closest to fire was completely consumed), under the remaining stress skin an approximate depth of 1-1/2 in. to 2 in. of char remained.

During the post-test disassembly of the test wall, several cross sectional dissections were made into the panels and seals and the following observations were noted concerning the sample condition:

> Approximately 1/2 in. of uncharred material remained in the unexposed layer of Thermo-Lag® panel directly under TC #5. The surface of this material was discolored.
>
> No uncharred material remained in the unexposed layer of Thermo-Lag® panel directly under TC #7. The surface of this material was blackened. Approximately 3/8 in. of uncharred material remained 12 in. away from the TC and approximately 1/8 in. of material remained in the vicinity of the edge of the pad.

Approximately 1/8 in. of uncharred material remained in the unexposed layer of Thermo-Lag® panel directly under TC #2 and #6. The surface of this material was darkened. Approximately 3/8 in. of uncharred material remained 8 in. away from the TC and approximately 1/4 in. of material remained in the vicinity of the edge of the pad

Upper Duct Penetration Seal (4 in. depth) - the top right corner of the exposed face was consumed and delaminated with 1 in. of solid material remaining. Up to 2 in. of solid material remained in the top left corner. The bottom edge of the seal was "rounded" and charred through to the unexposed face (an approximate height of 1/2 in.). Up to 1/4 in. of powdery char was beneath the ceramic fiber board with 3/8 in. to 1/2 in. of damaged material was found beneath this.
Unexposed side of penetrating duct (Thermo-Lag® applied inside duct lining) - approximately 3/8 in. of uncharred material remaining with several blisters with up to 3/4 in. char between material and steel duct.

Lower Duct Penetration Seal (9 in. depth) - the top right corner of the exposed face was consumed and delaminated with 1 in. of solid material remaining. Up to 2 in. of solid material remained in the top left corner. The bottom edge of the seal was "rounded" and charred (an approximate height of 1/2 in.). Up to 1/4 in. of powdery char was beneath the ceramic fiber board with 3/8 in. to 1/2 in. of damaged material was found beneath this.
Unexposed side of penetrating duct (Thermo-Lag® applied inside duct lining) - approximately 3/8 in. of uncharred material remaining with several blisters with up to 3/4 in. char between material and steel duct.

The significant temperatures for the test wall after 108 minutes of fire exposure are presented in the table below (temperatures on the duct penetration seals are for the end of the 180 minutes fire exposure). Distinctions between sets of similar thermocouples (e.i. wall surface, lower pen. seal, upper pen. seal, structural steel) are made with cell shading.

TC NO.	TEMP AT 108 MIN (°F)	TC NO.	TEMP AT 108 MIN (°F)
1	316	16*	449*
2	360	17	257
3	311	18	258
4	336	19	162
5	287	20	247
6	332	21	81
7	329	22	83
8	318	23	85
9	261	24	233
10	289	25	277
11	284	26	198
12	315	27	527
13	306	28	172
14	284	29	172
15*	546*	30	180
Wall Avg	309		

NOTE: Numbers with asterisks (*) indicate engineering-use-only thermocouples and are not considered in the average or in the performance evaluation of the test wall.

All data may be found in the Appendices attached to this document.

CONCLUSIONS

The test wall successfully withstood the fire endurance test without passage of flame or excessive heat for a three hour period. The barrier system was sufficient to prevent temperature rises on the unexposed face of the wall from exceeding 325°F on individual point for 123 minutes and 250°F on average for 108 minutes. The Upper duct penetration seal (4 in. depth) was sufficient to prevent temperature rises on the unexposed face from exceeding 325°F on individual point for 171 minutes and the lower duct penetration seal (9 in. depth) was sufficient to prevent temperature rises on the unexposed face from exceeding 325°F on individual point for 180 minutes.

ATTACHMENT 2
10 CFR 50.59 SAFETY EVALUATION ON THERMO-LAG ENCLOSURES INSTALLED IN THE CABLE SPREADING ROOMS AND AUXILIARY CONTROL PANEL ROOM

1) ESR No. 95-00620, Attachment D, 10 CFR 50.59 Safety Evaluation (54 pages)

10 CFR 50.59 Safety Evaluation Screen **Page 1 of 2**

ACTIVITY NO. ESR 95-00620 REV. 1

1. DOES THE ACTIVITY REQUIRE A CHANGE TO THE OPERATING LICENSE OR TECHNICAL SPECIFICATION? [ ] YES [X] NO

Basis: SEE PAGE 2 OF 54

Note: If Yes, and the scope of the activity is limited to a Technical Specification/Operating Licensing change, then complete Section #6 of this form, and process per plant procedure. If the scope of the activity is not limited to a Tech. Spec. or OL change, in addition to processing a Tech. Spec. or OL change request, continue the screening process. If No, continue the screening process.

2. IS THE ACTIVITY FULLY BOUNDED BY A PREVIOUSLY PERFORMED 10 CFR 50.59 SAFETY EVALUATION? [ ] YES [X] NO

Evaluation No. N/A

Note: If Yes, attach a copy or provide document number for retrieval capability of the previously performed 10 CFR 50.59 Safety Evaluation and complete Section 6 of this form. If No, continue the screening process.

3. DOES THE ACTIVITY MAKE CHANGES TO THE FACILITY AS DESCRIBED IN THE SAR? [X] YES [ ] NO

Basis: SEE PAGE 2 OF 54

List SAR Items/Sections reviewed: FSAR SECTION 9.5, APP 9.5A, TS 6.5.1.1.1a, 6.8.1.h

4. DOES THE ACTIVITY MAKE CHANGES TO PROCEDURES AS DESCRIBED IN THE SAR? [ ] YES [X] NO

Basis: SEE PAGE 2 OF 54

List SAR Items/Sections reviewed: FSAR SECTION 9.5, APP 9.5A, TS 6.5.1.1.1a, 6.8.1.h

5. DOES THE ACTIVITY INVOLVE A TEST OR EXPERIMENT NOT DESCRIBED IN THE SAR? [ ] YES [X] NO

Basis: SEE PAGE 2 OF 54

List SAR Items/Sections reviewed: FSAR SECTION 9.5, APP 9.5A, TS 6.5.1.1.1a, 6.8.1.h

NOTE: If any question 3 through 5 is answered YES, then mark Section #6 Not Applicable (N/A) and complete Unreviewed Safety Question Determination, otherwise complete Section #6.

6.

	DISCIPLINE	PRINT NAME	SIGNATURE	Date
1st QSR:				Date:
Other QSR:				Date:
Other QSR:	N/A	N/A	N/A	Date:
2nd QSR:				Date:

Attach additional sheets if needed.

(Form AP-011-1-6)

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10 CFR 50.59 Safety Evaluation Screen PAGE 2 of 3

1. This activity involves an evaluation of the Thermo-Lag fire barriers in the Cable Spreading and ACP Rooms to ensure that these barriers will provide adequate separation of redundant divisions or trains of safety-related systems so that both are not subject to damage from a single fire in accordance with the Fire Protection Program as described in FSAR Section 9.5. This activity does not require any changes to Harris Plant procedures or programs as discussed in Technical Specifications 6.5.1.1.1.a and 6.8.1.h and, therefore, the Operating License/Technical Specifications are not affected.

2. The activity is not bounded by a previously performed safety evaluation.

3. This activity involves the evaluation of the Thermo-Lag barriers in Cable Spreading and ACP Rooms to ensure that these barriers will provide adequate separation of redundant divisions or trains of safety-related systems so that both are not subject to damage from a single fire, in accordance with the Fire Protection Program as described in FSAR Section 9.5. The FSAR currently refers to these Thermo-Lag fire barriers as three-hour fire barriers. Fire testing of these barriers performed in accordance with ASTM E-119/NFPA 251, the testing methodology referenced in the FSAR for determining fire barrier ratings, indicates that portions of these barriers cannot achieve a three-hour rating. The various references to these barriers as three-hour barriers will need to be changed to accurately reflect the appropriate capability of these barriers. This evaluation indicates that, even though these barriers cannot achieve a three hour fire rating, they do provide an adequate level of protection of safe shutdown capability in the event of a fire, which is commensurate with hazards in the area.

4. No procedures as described in the FSAR are affected by this activity. Also, no additional procedure changes are required for periodic maintenance or testing of these barriers.

5. The resolution to this evaluation does not introduce any new tests or experiments not described in the FSAR. FSAR Section 9.5.1.2.2 states that fire barrier ratings are based on standard fire tests performed in accordance with ASTM E-119/NFPA 251, "Standard Methods of Fire Tests of Building Construction and Materials". The fire tests performed for qualification of the "wall" and "ceiling" (floor) assemblies references ASTM E-119/NFPA 251 as the basis.

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10CFR50.59 Safety Evaluation

BACKGROUND, PROBLEM IDENTIFICATION AND METHODOLOGY

Background

NRC issued Generic Letter 92-08 to all utilities using Thermo-Lag 330-1 material. This GL identified that testing had demonstrated that the fire resistant capability of the material had been declared indeterminate. The NRC issued additional requests for information associated with GL 92-08 which required that Shearon Harris Nuclear Power Plant (SHNPP) outline Corrective Actions necessary to resolve this issue. SHNPP's response addressed each NRC concern related to the adequacy of Thermo-Lag materials. Numerous NRC issues, as well as other issues identified by CP&L during the course of its review, have already been resolved via separate ESRs. The Safety Evaluation Report, dated November 1983 (Ref. 1.6) issued by the NRC states:

> *"9.5.1 Fire Protection*
>
> *The staff has reviewed the **fire protection program** for conformance with SRP 9.5.1 (NUREG -0800), which contains, in BTP CMEB 9.5.1, the technical requirements of Appendix A to BTP ASB 9.5-1 and Appendix R to 10CFR50."*

Branch Technical Position (BTP) CMEB 9.5.1 (Ref. 1.2) provides the following definition of what constitutes an effective fire protection program:

> *"The purpose of the **fire protection program** is to provide assurance, through a **defense-in-depth** design, that a fire will not prevent the performance of necessary safe plant shutdown functions and will not significantly increase the risk of radioactive releases to the environment in accordance with General Design Criteria 3 and 5."*

BTP CMEB 9.5.1 discusses defense-in-depth as follows:

> *"Nuclear power plants use the concept of defense-in-depth to achieve the required high degree of safety by using echelons of safety systems. This concept is also applicable to the fire safety in nuclear power plants. With*

respect to the fire protection program, the defense-in-depth principle is aimed at achieving an adequate balance in:

a. Preventing fires from starting;

b. Detecting fires quickly, suppressing those fires that occur, putting them out quickly, and limiting their damage; and

c. Designing plant safety systems so that a fire that starts in spite of the fire prevention program and burns for a considerable time in spite of fire protection activities will not prevent essential plant safety functions from being performed.

No one of these echelons can be perfect or complete by itself. Each echelon should meet certain minimum requirements; however, strengthening any one can compensate in some measure for weaknesses, known or unknown, in the others.

The primary objective of the fire protection program is to minimize both the probability and consequences of postulated fires. In spite of steps taken to reduce the probability of fire, fires are expected to occur. Therefore, means are needed to detect and suppress fires with particular emphasis on providing passive and active fire protection of appropriate capability and adequate capacity for the systems necessary to achieve and maintain safe plant shutdown with or without offsite power."

With the issuance of Appendix R and the differences in various license conditions contained in operating licenses, the NRC sought a way to allow facilities to revise the fire protection programs as approved by the NRC without prior approval. Generic Letter 86-10, (Ref. 1.3) Section F, addressed the use of a generic licensing condition and 10CFR50.59 in changing previously approved fire protection programs as follows:

"The Commission believes that the best way to resolve these problems is to incorporate the fire protection program and major commitments, including the fire hazards analysis, by reference into the Final Safety Analysis Report (FSAR) for the facility. In this manner, the fire protection

program, including the systems, the administrative and technical controls, the organization, and other plant features associated with fire protection would be on a consistent status with other plant features described in the FSAR. ***Also, the provisions of 10CFR50.59 would then apply directly for changes the licensee desires to make in the fire protection program that would not adversely affect the ability to achieve and maintain safe shutdown.*** *In this context, the determination of the involvement of an unreviewed safety question defined in ¶50.59(a)(2) would be made based on the "accident....previously evaluated" being the postulated fire in the fire hazards analysis for the fire area affected by the change. The Commission also believes that a standard license condition, requiring licensees to comply with the provisions of the fire protection program as described in the FSAR, should be used to ensure uniform enforcement of fire protection requirements.*

Therefore, the licensee should include, in the FSAR update...the incorporation of the fire protection program that has been approved by the NRC, including the fire hazards analysis and major commitments that form the basis for the fire protection program...Upon completion of this effort...the licensee may apply for an amendment to the operating license which amends any current license conditions regarding fire protection and substitutes the following standard condition:

Fire Protection

(Name of licensee) shall implement and maintain in effect all provisions of the approved fire protection program as described in the Final Safety Analysis Report for the facility (or as described in submittals dated---------) and as approved in the SER dated ---------(and Supplements dated ------) subject to the following provision:

> *The licensee may make changes to the approved fire protection program without prior approval of the Commission only if those changes would not adversely affect the ability to achieve and maintain safe shutdown in the event of a fire.*

The licensee may alter specific features of the approved program provided (a) such changes do not otherwise involve a change in a license condition or technical specification or result in an unreviewed safety question (see 10CFR50.59), and ***(b) such changes do not result in failure to complete the fire protection program as approved by the Commission..*** *As with other changes implemented under 10 CFR 50.59, the licensee shall maintain, in auditable form, a current record of all such changes, including an analysis of the effects of the change on the fire protection program, and shall make such records available to NRC inspectors upon request."*

In accordance with the above philosophy, SHNPP's Plant Operating License (OL), Section 2.F, "Fire Protection Program", states:

"Carolina Power and Light Company shall implement and maintain in effect all provisions of the approved fire protection program as described in the Final Safety Analysis Report for the facility as amended and as approved in the Safety Evaluation Report (SER) dated November 1983 (and supplements 1 through 4), and the Safety Evaluation dated January 12, 1987, subject to the following provision below.

The licensee may make changes to the approved fire protection program without prior approval of the Commission only if those changes would not adversely affect the ability to achieve and maintain safe shutdown in the event of a fire."

Specific Changes to the Facility

The purpose of the ESR is to evaluate the adequacy of the existing Thermo-Lag enclosures located in the Auxiliary Control Panel (ACP) Room and Cable Spreading Rooms (CSR) A & B relative to SHNPP's ability to achieve and maintain safe shutdown in the event of a fire. This will involve revising the rating of the Thermo-Lag barriers in question from 3-hour rated to those which are suitable for the hazard. The evaluation of the barriers constitutes a deviation of the following highlighted guidelines of BTP CMEB 9.5-1:

"5.a(1) Fire barriers with a minimum fire resistance rating of <u>3 hours</u> should be provided to:

a) *Separate safety related systems from any potential fires in nonsafety-related areas that could affect their ability to perform their safety function;*
b) ***Separate redundant divisions or trains of safety-related systems from each other so that both are not subject to damage from a single fire;***
c) *Separate individual units on a multiple-unit site unless the requirements of General Design Criterion 5 are met with respect to fires."*

"7.c <u>Cable Spreading Rooms</u>

A separate cable spreading room should be provided for each redundant division. Cable spreading rooms should not be shared between reactors. Each cable spreading room should be separated from others and from other areas of the plant by barriers with a minimum fire rating of <u>3 hours</u>."

The NRC addressed whether it was acceptable to process deviations from BTP CMEB 9.5-1 in Question 8.21 of GL 86-10:

"8.21 <u>NRC Approval for BTP CMEB 9.5-1 Deviations</u>

<u>QUESTION</u>

Do future deviations from BTP CMEB 9.5-1 guidelines require approval by the NRC? Do such deviations constitute a violation of license conditions?

<u>RESPONSE</u>

Compliance with guidelines in the BTP is only required to the extent that they were incorporated in the approved Fire Protection Program as identified in the license condition. (See Response 8.2)

(Response 8.2 refers back to the Section F dealing with the use of the fire protection licensing condition.)

This is interpreted to mean that a utility whose fire protection program was reviewed and approved against the provisions of BTP CMEB 9.5-1 shall maintain the program in accordance with the license condition, **WHICH ALLOWS CHANGES TO THE PROGRAM (IN ACCORDANCE WITH 50.59 OF 10CFR50) AS LONG AS THE UTILITY CAN DEMONSTRATE THERE IS NO ADVERSE AFFECT ON THE ABILITY TO ACHIEVE AND MAINTAIN SAFE SHUTDOWN.**

As noted in the SHNPP OL, **CP&L may make changes to the fire protection program if those changes do not adversely affect the ability to achieve and maintain safe shutdown in the event of a fire.** Guidance provided in the licensing condition section of GL 86-10 states that these changes must not result in the failure to complete the fire protection program as approved by the commission. This is interpreted to mean the protection of safe shutdown capability through the principles of defense-in-depth, in accordance with the guidance provided in BTP CMEB-9.5.1. In order for the fire barriers to achieve defense-in-depth as defined in BTP CMEB-9.5.1, they must be able to provide the following functions:

1) Limitation of fire damage; and
2) Providing protection to plant safety systems so that a fire that starts in spite of the fire prevention program and burns for a considerable time in spite of fire protection activities will not prevent essential plant safety functions from being performed.

In addition to the above criteria the NRC has provided guidance on the analysis and qualification of fire area boundaries. The barriers in question constitute the fire area boundaries between fire areas 1-A-CSRA, 1-A-CSRB, and 1-A-SWGRB, as opposed to fire barriers to protect redundant safe shutdown circuits within a fire area. This is in accordance with BTP CMEB 9.5.1 which states:

3. *Establishment and Use of Fire Areas*

"Separate fire areas for each division of safety-related systems will reduce the possibility of fire-related damage to redundant safety-related

equipment. Fire areas should be established to separate redundant safety divisions and isolate safety-related systems from fire hazards in non-safety related areas. Particular design attention to the use of separate isolated fire areas for redundant cables will help to avoid loss of redundant safety-related cables..."

The BTP defines "fire area" as follows:

"Fire Area - that portion of a building or plant that is separated from other areas by boundary fire barriers."

As noted in the SER, BTP CMEB 9.5.1 incorporates the technical provisions of Appendix R. GL 86-10, "Interpretations of Appendix R" gives the following guidance related to fire area boundaries:

"4. Fire Area Boundaries

The term "fire area" as used in Appendix R means an area **sufficiently bounded to withstand the hazards associated with the area** *and, as necessary, to protect important equipment within the area from a fire outside the area. In order to meet the regulation, fire area boundaries need not be completely sealed floor-to-ceiling, wall-to-wall boundaries. However, all unsealed openings should be identified and considered the evaluating the effectiveness of the overall barrier. Where fire area boundaries are not wall-to-wall, floor-to-ceiling boundaries with all penetrations sealed to the fire rating of the boundaries, licensees must perform an evaluation to assess the adequacy of fire boundaries in their plants to determine if the boundaries will withstand the hazards associated with the area. This analysis must be conducted by at least a fire protection engineer and, if required, a systems engineer.* **Although not required, licensees may submit their evaluations for staff review and concurrence**... *In any event, these analyses must be retained by the licensees for subsequent NRC audits."*

Section C. of GL 86-10 also states:

"C. Documentation Required to Demonstrate Compliance

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The "Interpretations" document attached to this letter (GL 86-10) *states that, where the licensee chooses not to seek prior NRC review and approval of, for example,* **a fire area boundary** *, an evaluation must be performed by a fire protection engineer (assisted by others as needed) and retained for future NRC audit. Evaluations of this type must be written and organized to facilitate review by a person not involved in the evaluation. Guidelines for what such an evaluation should contain may be found in: (1) Section B of Appendix R and (2) Section C.1.b of Branch Technical Position (BTP) CMEB 9.5-1 Rev. 2 dated July 1981. All calculations supporting the evaluation should be available and all assumptions clearly stated at the outset... "*

This demonstrates that the evaluation of fire area boundaries, evaluated as adequate for the hazard, are not considered by the NRC as requiring prior review and approval.

THIS SAFETY ANALYSIS WILL DEMONSTRATE THAT THE DEFENSE-IN-DEPTH AS DEFINED IN THE FIRE PROTECTION PROGRAM IS MAINTAINED, AND AS SUCH THERE IS NO ADVERSE IMPACT ON THE ABILITY TO ACHIEVE AND MAINTAIN SAFE SHUTDOWN. THIS WILL ENSURE THAT THE CHANGES DO NOT RESULT IN FAILURE TO COMPLETE THE FIRE PROTECTION PROGRAM AS APPROVED BY THE COMMISSION.

Summary of Evaluation Methodology

The evaluation methodology used to determine the adequacy of existing Thermo-Lag configurations in maintaining safe shutdown capability involves a multi-faceted approach consisting of full scale fire testing, multiple analytical approaches, and a review of the existing design features and administrative controls. This resolution strategy ensures that no single approach is relied upon to determine fire barrier effectiveness.

- The Thermo-Lag assembly details were reviewed and these details were utilized to design the test configurations. In addition, field material thickness measurements were taken under ESR 94-00379 to ensure the thickness specified in the fire tests truly bounded the field conditions.

- Fire testing in accordance with ASTM E-119 was conducted of bounding Thermo-Lag configurations. This testing involved three (3) separate fire tests.

  - <u>One hour Thermo-Lag Wall Test</u>

    * The test wall successfully passed this 1 hour fire endurance test
    * The wall system also maintained its integrity when subjected to the post fire hose stream test. This test assembly was considered the "Hose Stream Retest Sample" for later 3 hour "Wall" testing conducted.

  - <u>Three hour Thermo-Lag Ceiling Test</u>

    * This test assembly successfully passed the 3 hour fire endurance test.
    * The tested configuration is representative of the Thermo-Lag tunnel floor assemblies.

  - <u>Three hour Thermo-Lag Wall Test</u>

    * The test wall exceeded the ASTM E-119 average temperature rise criteria at 108 minutes (1 hour and 48 minutes). Although the average temperature rise criteria was exceeded at 108 minutes, this test and data collection was continued for the full 3 hour duration. The collected data over the full 3 hour period was used for input into this evaluation. This establishes "worst" case conditions for the evaluation in that:

      - Inputs assume a fully established fire since ASTM E-119 fire data is used.
      - Tested Thermo-Lag Wall configuration is less fire resistive than the actual configuration installed in the field and is, therefore, conservative.

- The unexposed side temperature data used in the evaluation is that recorded at the 3 hour point of the test. Use of this temperature data affords a more conservative relation of barrier performance to the ASTM testing that was conducted.

- Using the fire test data described above and the differences between the as-tested and as-installed configurations, a calculation (FP-0110) was performed to determine the temperature rise which could be expected if the as-installed configuration were tested. The calculation then determines the temperature rise on a tray side rail surface of a "target" tray located at a limiting distance of 1 inch from the unexposed surface of both the as-tested and the as-installed configurations. Results of this calculation were compared to the maximum allowable average raceway temperature rise acceptance criteria (250° F) stated in GL 86-10, Supplement 1. These calculations demonstrate that the maximum expected temperature rise for the raceway is well below that specified by Generic Letter 86-10, Supplement 1. This is an important consideration since maintenance of safe shutdown capability is dependent on ensuring the safe shutdown cables located on the unexposed side of the installed barriers will remain free of fire damage.

- A calculation (FP-0109) was performed to determine the maximum room heat-up temperatures using bounding cable heat release considerations. First, enclosures with insufficient ventilation openings to support combustion are identified (ACP enclosure and bridge tunnel). Calculations are then made which determine the maximum expected area temperatures based on the ventilation characteristics of each remaining area. The results of these calculations are then compared to the ASTM E119 fire test temperatures to demonstrate that significant margin exists between the calculated maximum room temperatures and the furnace temperatures recorded during the fire test. Finally, the expected fixed suppression response time (sprinklers) was determined for areas provided with fixed suppression based on the conservative cable heat release quantities used for development of the maximum room temperatures. The purpose of calculating sprinkler system response time is to support further evaluation of actual defense in depth features for affected areas. Rapid sprinkler response time to a fully developed

fire will limit the challenge a fire poses to an installed fire barrier by initiating suppression and cooling/quenching of the area.

- The evaluation section of this ESR reviews the fire testing methodology and provides justification as to why the as-installed configuration is bounded by the as-tested configuration. It also reviews certain deviations to the testing standards which were necessitated by the unique configurations which are utilized in constructing the Thermo-Lag barriers. Finally, the ESR draws upon the calculation results described above and acknowledges existing fire protection features in each area to demonstrate where defense in depth measures further assure adequacy of the existing Thermo-Lag fire barriers. Fire detection capability and alarms, fire brigade response actions, fixed suppression (i.e., hose stations as well as sprinkler systems), fire resistance of materials (e.g., IEEE 383 cable) and control of transient combustibles in these areas are discussed in detail.

FUNCTIONAL REQUIREMENTS

Fire protection of safe shutdown features is achieved through the "defense-in-depth" philosophy, which provides multiple layers of protection. As discussed in BTP CMEB 9.5-1 (Ref. 1.2), the defense-in-depth principle is aimed at achieving an adequate balance in:

- Preventing fires from starting;
- Detecting fires quickly, suppressing those fires that occur, putting them out quickly, and limiting their damage; and
- Designing plant safety systems so that a fire that starts in spite of the fire prevention program and burns for a considerable time in spite of fire protection activities will not prevent essential plant safety functions from being performed.

It is recognized that no one of these layers of protection can be perfect or complete by itself. however, strengthening any one can compensate in some measure for weaknesses, known or unknown, in the others.

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Based on applicable NRC guidance (Ref. 1.2) and the current SHNPP licensing basis as above, the Thermo-Lag fire barrier enclosures in the Cable Spreading and ACP Rooms are required to be functionally capable of providing a fire resistance rating of three hours. Additionally, structural steel members forming a part of, or supporting these barriers must be protected to provide a three hour fire resistance rating. The basis for such fire ratings is required to be the ASTM E-119 / NFPA 251 test protocol (Ref. 4.1). However, for the inside of Thermo-Lag enclosures, an exception to this requirement was previously identified in the FSAR (section 9.5.1.2.4.3, page 9.5.1-39) , i.e., localized bolted connection areas between cable trays and their support members. In these areas, Thermo-Lag material coverage on structural steel support members was not extended onto adjacent cable tray surfaces to fully attenuate potential (localized) heat transmission from exposed cable tray surfaces to attached support members.

REFERENCES

1. NRC Documents

1.1 NUREG 0800, Standard Review Plan, Section 9.5.1, "Fire Protection, Program," Rev. 3, July 1981.

1.2 Branch Technical Position (BTP) CMEB 9.5-1, "Guidelines For Fire Protection For Nuclear Power Plants," Rev. 2, July 1981.

1.3 Generic Letter 86-10, "Implementation of Fire Protection Requirements," April 24, 1986.

1.4 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," March 25, 1994.

1.5 Generic Letter 92-08, "Thermo-Lag 330-1 Fire Barriers," December 17, 1992.

1.6 NUREG 1038, "Safety Evaluation Report related to the operation of Shearon Harris Nuclear Power Plant", dated November 1983.

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2. Omega Point Laboratories (OPL) Fire Endurance Tests

2.1 OPL Fire Test Report 14980-97261, "Fire Endurance Test to Qualify a Wall Design as a 60 Minute Fire Resistant Assembly," November 7, 1994.

2.2 OPL Fire Test Report 14980-97668, "Fire Endurance Test to Qualify a CP&L Ceiling Design as a 180 Minute Fire Resistant Assembly," May 18, 1995.

2.3 OPL Fire Test Report 14980-98207, "Fire Endurance Test to Qualify a Wall Design as a 180 Minute Fire Resistant Assembly," May 23, 1995.

3. SFPE Handbook of Fire Protection Engineering, 2nd Edition

4. Industry Standards, Studies and Reports

4.1 ASTM E-119-88 / NFPA 251, "Standard Methods of Fire Tests Of Building Construction and Materials"

4.2 Fire Protection Handbook, National Fire Protection Association, 17th Edition

4.3 NFPA 72A-1975, "Standard for Local Protective Signaling Systems"

4.4 NFPA 72D-1977, "Standard for Proprietary Protective Signaling Systems"

4.5 NFPA 72E-1978, "Standard for Automatic Fire Detectors"

4.6 NFPA 14-1976, "Standard for Standpipe and Hose Systems"

4.7 ASTM E814, "Standard Test Method for Fire Tests of Through-Penetration Fire Stops," 1981.

4.8 Manual of Steel Construction, American Institute of Steel Construction, Inc., Seventh Edition.

4.9 B. Bresler, T.Y. Lin and J.B. Scalzi, "Design of Steel Structures," John Wiley & Sons, Second Edition.

4.10 IEEE 383, "Standard for Type Test of Class IE Electric Cables, Field Splices and Connections for Nuclear Power Generating Stations," 1974.

4.11 FMRC, Categorization of Cable Flammability, Intermediate Scale Fire Tests of Cable Tray Installations, "Electric Power Research Institute, EPRI NP-1881, August 1982.

4.12 NUMARC Thermo-Lag 330-1 Combustibility Guidelines, October 12, 1993.

5. <u>Carolina Power & Light Documents</u>

5.1 ESR 94-00379, Revision 1

5.2 DCN 650-697, Revision 6

5.3 DCN 650-724, Revision 2

5.4 DCN 650-742, Revision 2

5.5 DCN 650-789, Revision 1

5.6 ESR 95-00715, Revision 4

5.7 Final Safety Analysis Report, Appendix 9.5A, Fire Protection Hazards Analysis

5.8 Individual Plant Examination of External Events, dated June 30, 1995

5.9 10 CFR 50 Appendix R Safe Shutdown Separation Analysis, Revision 1

5.10 Calculation FP-0110, "Evaluation of Thermo-Lag Fire Barrier Enclosures Within the Cable Spreading and ACP Rooms," Rev.0.

5.11 Calculation FP-0109, "Compartment Heat-Up Analysis for Cable Spreading and ACP Rooms," Rev. 0.

5.12 Procedure FPP-006, "Control of Ignition Sources - Hot Work Permit," Rev. 17

5.13 Procedure AP-302, "Fire Protection Housekeeping and Temporary Storage," Rev. 6.

5.14 Procedure FPP-004, "Transient Combustible Tracking," Rev.7.

5.15 DBD-306, "Fire Protection and Detection System," Rev. 4.

5.16 DBD-137, "Reactor Auxiliary Building HVAC Systems," Rev. 6.

5.17 Fire Pre-Plan PFP/1ACSRA, Rev. 2.

5.18 Fire Pre-Plan PFP/1ACSRB, Rev. 2.

5.19 Fire Pre-Plan PFP/1AACP, Rev. 2

5.20 ESR 97-00562, Rev. 0

5.21 ESR 97-00563, Rev. 0

ANALYSIS

Plant Area Physical Description

Cable Spreading Rooms A and B, and the ACP Room are located on the 286 ft. elevation of the Reactor Auxiliary Building (RAB) and are each located within separate fire areas. As shown by Figure 1, page 47, the ACP Room (Fire Zone 1-A-ACP) is contained within Fire Area 1-A-SWGRB. Cable Spreading Rooms A and B comprise Fire Areas 1-A-CSRA and 1-A-CSRB, respectively. The fire area boundaries consist of one or more of the following:

- Walls, floors, ceilings and structural columns constructed of reinforced concrete with a minimum fire rating of three hours, or;

- Fire barriers constructed of Thermo-Lag materials.

Installed Thermo-Lag Fire Barrier Enclosures

The Thermo-Lag area enclosures in the Cable Spreading and ACP Rooms are comprised of two general configurations. One configuration consists of full height vertical "wall" elements extending full height (17ft) from floor to ceiling in the ACP Room and in CSRA. The other configuration consists of two-sided enclosures (one Thermo-Lag "wall" and one Thermo-Lag "floor"), located in the overhead areas of the respective room. These type configurations include an approximately 5 ft high by 4 ft. wide by 2 ft. long enclosure in the ACP Room, an approximately 5 ft. high by 8 ft. wide by 7 ft. long enclosure in CSRB and two enclosures in CSRA, one approximately 6 ft. high by 4 ft. to 6 ft. wide by 44 ft. long and one 3 ft. to 6 ft. high by 4 ft. wide by 59 ft. long. The concrete walls and ceilings in the room form the remaining sides of these enclosures.

The "walls" and "floors" of these configurations are constructed with one layer of Thermo-Lag panels installed on each side of metal lath and then bolted to a welded steel framing. In addition, the "wall" panels are tie bolted to each other through the metal lath. Trowel grade material is applied over the welded steel frame and the bolts attaching the panels to the frame. The tie bolts holding the panels together have trowel grade material on the outside of the enclosure only. The nuts and washers on the inside of the enclosure are not covered. HVAC ducts, piping, conduit and cable trays passing through the barriers are sealed with penetration seal material. Doors in the enclosures are securely attached to the structure or to the metal framing of the enclosure and are three hour rated doors.

Tested Thermo-Lag Fire Barrier Configurations

CP&L has sponsored three (3) separate full-scale fire endurance tests to evaluate the performance capability of the installed barrier enclosure configurations. Omega Point Laboratories, Inc. (OPL) in San Antonio, Texas performed all these fire tests. OPL is an independent and nationally recognized testing organization, specializing in the conduct of fire endurance testing. All of the fire tests utilized the *standard* time/temperature exposure prescribed by ASTM E119 / NFPA 251. These tests involved Thermo-Lag fire barriers constructed similar to those installed at SHNPP.

The tests involved a one hour test of a vertical "wall" element, a three hour test of a vertical "wall" element and a three hour test of a horizontal "floor" element. The one hour test demonstrated that the vertical "wall" enclosures and vertical portions of two-sided enclosures as installed at SHNPP are capable of providing a minimum of 1 hour of fully rated performance in accordance with ASTM E119 / NFPA 251. The three hour test of the horizontal "floor" element demonstrated that the horizontal "floor" portions of two-sided enclosures as installed at SHNPP are capable of meeting the temperature acceptance criteria of ASTM E-119 / NFPA 251 for a 3 hour duration of exposure. Although some areas of deviation exist between the test methods and acceptance criteria specified by ASTM E-119 / NFPA 251 and the tested Thermo-Lag fire barrier configuration, the discussions in the Review of Test Methods and Results section of this evaluation finds that the results are valid. Therefore, the fire test results can serve as a basis for comparison to installed barrier enclosures. The three hour test of the vertical "wall" element demonstrated that the vertical "wall" enclosures and vertical portions of two-sided enclosures as installed at SHNPP are capable of providing a minimum of 108 minutes (1.8 hours) of fully rated performance in accordance with ASTM E119 / NFPA 251. Moreover, of particular significance, was that the barrier was capable of providing a level of thermal and structural performance such that even following 3 hours of fire exposure, heat and hot gas penetration to the unexposed side of the barrier was not sufficient to ignite cotton waste as required by the testing standards. Additionally, this test demonstrated that the performance of installed Thermo-Lag barriers would not be reduced, or limited by, the presence of through penetrations, which are sealed commensurate with the designs utilized in the test.

Review of Test Methods and Results

This section will compare the test methodology and acceptance criteria prescribed by ASTM E119 / NFPA 251 to that utilized for conduct of the three fire endurance tests. The objective of this comparison is to determine if the methods used to perform these tests and their associated results can serve as a valid technical basis for evaluating the performance capability of installed barrier configurations.

One Hour Wall Test (Ref. 2.1)

This test demonstrated that the vertical "wall" enclosures and vertical portions of Two-sided enclosures as installed at SHNPP are capable of providing a minimum of 1 hour of fully rated performance in accordance with ASTM E119 / NFPA 251 (hereafter termed the "test standard"). The acceptance criteria for "Nonbearing Walls and Partitions" were applicable to this test. The only deviation from test methods outlined by the test standard was for conduct of the hose stream test. Specifically, standard practice of performing the hose stream test would have resulted in subjecting the test assembly to the required 2-1/2 minute hose stream duration immediately following fire exposure. Instead, for this test, the assembly was subjected to hose stream exposures in two parts. The first 1 minute of hose stream application was applied immediately after the test specimen was removed from the test furnace. The final 1-1/2 minute of hose stream application occurred approximately 90 minutes after the first application. No projection of water through the barrier occurred during either portion of the hose stream test. Based on the 1/8 to 3/8 in. thick layer of unreacted Thermo-Lag material remaining on the exposed side of the barrier, application of hose stream test for the full 2-1/2 minutes immediately following fire exposure would not have resulted in passage of water through the barrier. Additionally, the approximate 90 minute lapse between the first and second applications allowed the Thermo-Lag material to absorb water from the initial application and subsequently soften. Therefore, applying the second portion of the hose stream test 90 minutes later may have been a more severe test of the barrier to withstand the impact and erosion effects of the hose stream. Therefore, the ability of the barrier to withstand a hose stream test for a total duration of 2-1/2 minutes satisfied the hose stream acceptance criteria prescribed by ASTM E119 / NFPA 251 for both a 1 and 3 hour fire endurance rating. On this basis the deviation from the test standard is not significant.

Three Hour Wall Test (Ref. 2.3)

This test demonstrated that the vertical "wall" enclosures and vertical portions of two-sided enclosures as installed at SHNPP are capable of providing a minimum

of 108 minutes (1.8 hours) of fully rated performance in accordance with ASTM E119 / NFPA 251. Moreover, of particular significance, the barrier was capable of providing a level of thermal and structural performance such that even following 3 hours of fire exposure, heat and hot gas penetration to the unexposed side of the barrier was not sufficient to ignite cotton waste. Additionally, this test demonstrated that penetrations through installed barriers could be effectively sealed, such that they would not adversely affect the performance of Thermo-Lag barriers. Alternately stated, the performance of installed Thermo-Lag barriers would not be reduced, or limited by, the presence of through penetrations which are sealed commensurate with the designs utilized in the test.

As with the 1 hour test, the acceptance criteria for "Nonbearing Walls and Partitions" were applicable to this test. With the exception of failure to satisfy the unexposed side temperature increase criterion, no areas of deviation from the test standard occurred for conduct of this test. The temperature rise acceptance criteria and test results for the assembly are as follows:

	Average Unexposed Temp Rise	Max Single Temp Rise	Penetration Seal (4" LDSE)
ASTM Acceptance Criteria	250° F	325° F	325° F
Test Results	400° F	684° F	466° F
Time Temp. Criteria Was Exceeded	108 minutes	123 Minutes	171 Minutes

As noted, the barrier successfully prevented the passage of flames or hot gases sufficient to ignite cotton waste.

Three Hour Floor Test (Ref. 2.2)

This test demonstrated that the horizontal "floor" portions of two-sided enclosures as installed at SHNPP are capable of meeting the temperature acceptance criteria of the test standard for a 3 hour duration of fire exposure.

Specifically, the average temperature increase on the unexposed surface of the barrier was only 157°F, compared to 250°F allowed by the standard. The maximum temperature increase recorded by a single thermocouple was 291°F, compared to 325°F allowed by the standard. No hose stream test was required by the test standard, or performed for this barrier assembly. Review of the conduct of this test indicates three issues that conflict with the test methodology and acceptance criteria prescribed by the standard. The issues are as follows:

1. The test specimen was not subjected to fire exposure under a loaded condition representing the maximum load that the assembly would experience in its "as-installed" configuration.

2. The number and position of thermocouples placed on structural steel members were not in accordance with those required by the standard.

3. The conditions for acceptance pertaining to sustaining the applied load throughout the fire exposure duration, and temperatures recorded by structural steel members throughout the fire exposure duration were not explicitly considered.

The first issue stems from a misclassification of the tested barrier assembly. Specifically, as installed at SHNPP, these horizontal elements ostensibly form the "floor" portions of two-sided barrier enclosures located in the Cable Spreading and ACP Room overhead areas. However, the test performed on this barrier apparently treated the barrier as a "ceiling" assembly. When classified as a ceiling, the test standard does not require subjecting the assembly to load under fire exposure conditions. When classified as a floor, the section of the standard entitled "Floor and Roof Assemblies" applies, which states in part:

> "Throughout the fire endurance test, a superimposed load shall be applied to the specimen to simulate a maximum load condition. The maximum load condition shall be as nearly as practicable the maximum load allowed by the limiting condition of design under nationally recognized structural design criteria".

As installed at SHNPP, the structural steel angle members to which the Thermo-

Lag panels forming "floor" elements of two-sided enclosures are attached, carry at least a portion of the load of the bottom cable tray within the enclosure. A load was not applied to the tested barrier assembly to represent this condition. Further, as described below for the third issue, the ability of the barrier assembly to withstand the applied load under fire exposure conditions is a condition for acceptance of the test as defined by the standard.

The second issue pertains to how and where temperatures are measured for acceptance purposes. As described previously, structural steel angle members were used to form the perimeter frame and cross members of the test assembly. The steel angle cross members were spaced 2 ft. 6 in. on center. For this type of construction, the standard states:

> "For specimens using structural members (beams, open-web steel joists) spaced at 4 ft on center or less, the temperature of the steel in these structural members shall be measured by four thermocouples placed on each member. No more than four members shall be so instrumented. Place the thermocouples at significant locations, such as at midspan, over joints in the ceiling, over light fixtures, etc.".

In performing the test, thermocouples were not installed in accordance with this requirement. Specifically three (3) thermocouples were equally spaced across a single support member, located in the approximate center of the barrier assembly. These thermocouples were positioned on the face of the support member oriented away from the test furnace. This meant that the thermocouples were covered by the two layers of Thermo-Lag panels. The surfaces of all support members facing the test furnace were covered with Thermo-Lag trowel grade material to a thickness commensurate with installed configurations (i.e., 0.75 ± 0.06 in.). In performing the test, these three thermocouples were considered "for engineering purposes" and the temperature data obtained by these thermocouples was not considered in the conditions for acceptance. At the conclusion of the test, the temperatures recorded by these thermocouples were 1654°F, 1604°F and 1600°F. Although the specific number and location of thermocouples on support members deviated from that specified by the standard, representative temperature data for the structural supports was nonetheless obtained during the test, thereby satisfying the intent of the standard. The complication with this issue therefore becomes how this

temperature data should be considered within the conditions for acceptance defined by the standard. This is addressed by the third issue.

The third issue involves the conditions of acceptance invoked by the standard for floor and roof assemblies. However, in specifying applicable acceptance criteria, the standard distinguishes between floor or roof assemblies that, in their installed configuration, are "restrained" or "unrestrained" against thermal expansion. The standard defines these conditions as follows:

> "A restrained condition in fire tests...is one in which expansion at the supports of a load-carrying element resulting from the effects of fire is resisted by forces external to the element. An unrestrained condition is one in which the load-carrying element is free to expand and rotate at its supports...For the purposes of this guide, restraint in buildings is defined as follows: Floor and roof assemblies and individual beams in buildings are considered restrained where the surrounding or supporting structure is capable of resisting substantial thermal expansion throughout the range of anticipated elevated temperatures. Construction not complying with this definition is assumed to be free to rotate and expand and therefore is considered as unrestrained".

The installed configurations of two-sided Thermo-Lag enclosures are secured to the surrounding concrete structure on at least two sides and therefore would be restrained from thermal expansion on those sides. Additionally, the welded connections between support members and bolted connections of support members to the concrete structure will provide substantial rotational restraint upon exposure to elevated temperatures. <u>On this basis the two-sided barrier enclosures would be predominately restrained from thermal expansion.</u> However, if the installed two-sided barrier enclosures are conservatively considered to be only partially restrained, interpretation of the test standard would lead to at least considering the conditions of acceptance for unrestrained floor assemblies, which are more severe than for restrained assemblies. The conditions of acceptance specified by the standard for restrained and unrestrained assemblies are as follows:

- For both "restrained' and "unrestrained" assemblies, the specimen shall have sustained the applied load during the classification period without developing unexposed surface conditions that will ignite cotton waste.

- For both "restrained" and "unrestrained" assemblies, transmission of heat through the specimen during the classification period shall not have been such as to raise the average temperature on its unexposed surface more than 250°F above its initial temperature.

- For "restrained" assemblies using steel structural members (e.g. beams, open-web steel joists) spaced 4 ft or less on center, the average temperature recorded by all joist or beam thermocouples shall not have exceeded 1100°F for a period of 1 1/2 hours.

- For "unrestrained" assemblies using steel members (e.g., beams, open-web joists) spaced 4 ft or less on center, the average temperature recorded by all joist or beam thermocouples shall not exceed 1100°F during the classification period.

The following will assess these conditions of acceptance as they pertain to the tested barrier assembly.

<u>Imposition of Maximum Load</u>

Although the fire barrier assembly was tested without a superimposed load to simulate its maximum loaded condition, the test results are valid. This is based on the following:

- The tested barrier did not exhibit structural failure or collapse during the 3 hour duration of ASTM E119 fire exposure. The maximum temperature increase developed on the unexposed side of the barrier was only 291°F over the initial temperature, and the barrier prevented the ignition of cotton waste applied just prior to termination of the test.

- As a test standard for generic building construction and materials, the requirement for imposition of maximum loaded conditions for fire endurance qualification is intended for structural load bearing building floor and roof systems. This is due to that fact that the loaded conditions of floor and roof assemblies within buildings can change over time due to changes in occupancy, repositioning of machinery and equipment, etc. The nature of the installed Thermo-Lag fire barrier enclosures represents a unique case that is not explicitly contemplated by the standard. Specifically, the barrier support members do not carry building structure loads, and the loads imposed on the barrier supports by attached Thermo-Lag panels, cable trays, etc. will not undergo significant change over the life of the plant.

- For the limiting case installed configuration where the bottom support members of an enclosure carry a portion of the load of a cable tray, the resulting loads are not significant in relation to the extent of the overall support system. Specifically, the bottom cross brace angle members are typically spaced at 18 to 28 in. intervals, which are less than the 30 in. cross brace member spacing for the tested configuration. Unlike the tested configuration, on one end, the installed cross brace members are welded to other structural steel members that are attached to concrete walls via anchor bolts or welded to embedded steel plates. On the other end, the installed cross brace members are welded to vertically oriented structural steel members which are secured to the concrete ceiling structure.

- The adequacy of physical attachment of the Thermo-Lag panels to respective support members via nuts, bolts and washers has been demonstrated by fire test, and such means of connection will not be affected by minor loads imposed on the support members.

Therefore, the fact that the barrier assembly was not tested under loaded conditions does not adversely affect the fire endurance qualification basis of the barrier assembly.

Heat Transmission

As described above, this condition of acceptance was satisfied by the tested configuration. The average temperature increase on the unexposed side of the barrier assembly was less than 250°F.

Temperature Increase of Steel Support Members for Restrained Assemblies

As described above, the number and specific placement of thermocouples on

the steel cross brace angle members was not in accordance with the standard. However, representative support member temperatures were nonetheless obtained during the test via the three thermocouples positioned on a single centrally located support member. Therefore, the intent of the standard was satisfied. Moreover, the temperatures on this support member, as recorded at the 1 1/2 hour mark during the fire test, were less than the 1100°F (maximum) temperature required by the standard for restrained assemblies. Specifically, the temperatures recorded by these thermocouples were 611°F, 946°F and 895°F.

Temperature Increase of Steel Support Members for Unrestrained Assemblies

For floor and roof assemblies classified as unrestrained, the standard requires that the temperature of steel support members not exceed 1100°F for the entire duration of the fire test (i.e., 3 hours). The temperatures recorded by the three thermocouples installed on the structural member at the 3 hour mark during the test were 1654°F, 1652°F and 1600°F. The 1100°F maximum temperature invoked by the standard is based on the fact that at room temperature, the design working stress of structural steel is approximately 60%. In contrast, at 1100°F the yield stress (and Modulus of elasticity) decreases to a value approximately equal to the originally allocated design working stress of 60%. Since the reduced yield stress value is approximately equal to the original design working stress (60%), steel is considered fire resistive at temperatures up to 1100°F without the need for fireproofing material (Ref. 4.8).

The steel framework for support of the installed Thermo-Lag enclosures is based on combined bending (due to dead weight and seismic considerations) and axial loading (due to seismic). The dead load includes the weight of the support members themselves, the weight of Thermo-Lag materials, the weight of the expanded metal lath and the weight contributed by cable tray loading. As analyzed by Reference 5.10, the seismic loads are based on 2.5g vertical and 0.88g horizontal acceleration. The member with the highest stress has a stress interaction of 0.781 (i.e., 22% margin) based on the allowable stresses of F_a (axial compressive) =12.1 ksi and F_b (bending) =18.5 ksi. The stress interaction for dead weight only is conservatively 0.22 (i.e., 0.781/(1+2.5)), yielding a 78% margin. Since F_a and F_b are functions of F_y (yield stress), and since F_y decreases with increasing temperature, it is obvious that the design margin of the limiting case support member will decrease with increasing temperature. The stresses on the steel members supporting the installed Thermo-Lag barrier enclosures range from 3 ksi for lightly loaded members, to 4 ksi for the heaviest loaded member (Ref. 5.10). The tensile strength of ASTM A-36 steel at 1400°F is between 7-15 ksi (Ref. 4.9). At temperatures in the range of 1600°F, it is between 5-12 ksi with a very slow drop beyond that. Therefore, based on actual load conditions, it is reasonable to expect that the installed barrier support members are capable of withstanding temperatures in the range measured during the full 3 hour fire test duration.

Finally, the 1100°F temperature limit prescribed by the standard is intended for structural load bearing members supporting floor and roof assemblies. The unique nature of the installed Thermo-Lag fire barrier enclosures represents a special case application (i.e., non-structural load bearing) that is not explicitly contemplated by the standard. Therefore, the fact that the temperatures recorded on the structural support member during the fire test, exceed the 1100°F limit specified by the standard does not adversely affect the fire endurance qualification basis of the barrier assembly.

<u>Span Support During Testing</u>

During the test it was noted that the assembly started to undergo deflection on an unsupported side of the assembly. This portion of the assembly was at the interface between the CP&L test configuration and an adjacent configuration being tested simultaneously for another utility. This configuration led to an unsupported span of 12 feet. As a result, the assembly had to be supported during the test through the use of a chain fall. This is not considered to adversely impact the application of the test results, since the assembly in the field is structurally supported one side through attachment to a concrete wall, and on the other side through attachment to structural steel which is supported from the floor and/or the ceiling. As a result, the spans in the field do not approach that encountered in the test. In addition, supplementary bracing is supplied in the field which further adds strength to the assembly.

<u>Conclusions</u>

Although some areas of deviation exist between the test methods and acceptance criteria specified by the test standard and the tested Thermo-Lag fire barrier configurations, the results are valid. Therefore, the fire test results can serve as a basis for comparison to installed barrier enclosures.

Comparison of Tested and Installed Barrier Configurations

A comparison of the construction attributes of the as-installed barriers to the as-tested barriers indicated that there are no significant differences between tested and installed Thermo-Lag fire barriers that could result in installed barrier enclosures providing a level of protection less than that demonstrated during fire endurance testing.

The following are the differences between the installed and tested vertical "wall" elements:

- The Thermo-Lag material thickness of tested assemblies is less than that for installed configurations so the tested bounds the installed.

- The tested assemblies did not utilize the ¼ in. thick layer of metal lath between the two layers of Thermo-Lag 330-1 panels, whereas installed configurations are constructed with the metal lath. There is minimal thermal benefit from the lath, but it does provide additional rigidity to the barrier assembly which will help keep the Thermo-Lag panels in place.

- The tested assemblies did not utilize ¼ in. tie bolts (including nuts and fender washers) between the two Thermo-Lag panel layers, whereas installed configurations are constructed with tie bolts. The bolts are covered with Thermo-Lag trowel grade material on the outside surfaces of the enclosures, but the nuts and washers on the inside surfaces of the enclosures are not covered with trowel grade material. The tie bolts will provide increased rigidity and stability for the installed Thermo-Lag enclosure. The effect of not covering the bolts with Thermo-Lag on the inside of the enclosures was evaluated in Reference 5.10 and found not to adversely affect the thermal performance of the barriers.

- The largest Thermo-Lag panel size utilized for installed vertical "wall" elements is approximately 34 in. by 67 in. The largest panel size used to construct the tested assemblies was 45 in. by 75 in. Therefore, the maximum panel size tested bounds the maximum installed panel size.

- The size of the steel duct penetration utilized in the tested configuration was 24 in. by 24 in. While this size is larger than most through sleeves that penetrate installed barrier enclosures, sleeves with dimensions up to 4ft. 6 in. exist for installed enclosures. The larger penetrations reduce the free area and unsupported spans of installed seal configurations and unsupported spans of installed seal configurations. Additionally, the tested duct penetration achieves a higher rating (171 minutes) than the rating of the tested barrier (108 minutes). Therefore, there is sufficient assurance that sleeves of larger sizes will not adversely affect the performance of installed barrier enclosures.

- The design of the structural steel supporting framework for the tested "wall" configurations was based on the structural framework supporting the installed barrier enclosures (Ref. 5.2 through 5.5). Additionally, the same methods for attachment of the Thermo-Lag panels to the framework were utilized for the tested configurations as was used to construct the installed enclosures. Therefore, the structural integrity of installed enclosures would be expected to be maintained under fire condition, commensurate with the configurations tested.

- To conduct the test, the wall was positioned such that the side with the steel angle support members covered with Thermo-Lag trowel grade material was exposed to the test furnace environment . This was conservative since on this side the Thermo-Lag coverage was significantly less than on the side away from the furnace.

The following are the differences between the installed and tested horizontal "floor" elements:

- The Thermo-Lag material thickness of tested assemblies is less than that for installed configurations so the tested bounds the installed.

- The largest Thermo-Lag panel size utilized for installed horizontal "floor" elements is approximately 25 in. by 66 in. The largest panel size used to construct the tested assemblies was 30 in. by 69 in. Therefore, the maximum panel size tested bounds the maximum installed panel size.

- The design of the structural steel supporting framework for the tested "floor" configuration was based on the structural framework supporting the installed barrier enclosures (Ref. 5.2 through 5.5). Additionally, the same methods for attachment of the Thermo-Lag panels to the framework were utilized for the tested configuration as was used to construct the installed enclosures. Therefore, the structural integrity of installed enclosures would be expected to be maintained under fire condition, commensurate with the configuration tested.

- To conduct the test, the "floor" was positioned such that the side with the steel angle support members covered with Thermo-Lag trowel grade material was exposed to the test furnace environment . This was conservative since on this side the Thermo-Lag coverage was significantly less than on the side away from the furnace.

Fire Hazards Analysis for Cable Spreading Rooms A and B

Fire Protection Features

Physical separation of redundant electrical Safe Shutdown Trains A and B within CSRA and CSRB is achieved by three hour rated reinforced concrete walls, or Thermo-Lag fire barrier enclosures. Automatic fire detection system capability is provided throughout all areas of CSRA and CSRB, including within the Thermo-Lag fire barrier enclosures. The fire detection system provides local notification of fire alarm, trouble and fire suppression system actuation conditions, and also provides notification of these conditions to the Main Fire Detection Information Center (MFDIC). Ionization type fire detectors are provided for incipient stage alarm and notification, and rate compensated thermal detectors are also provided throughout all areas, including within Thermo-Lag enclosures, to initiate the flow of water into the pre-action sprinkler system. Additionally, manual pull stations are provided at egress routes and other key locations in the rooms, for fire alarm system activation. Finally, a local graphic display annunciator panel is provided inside CSRB, which gives the fire zone layout of the ionization type fire detectors installed in the Cable Spreading Rooms, including ionization detectors located within the Thermo-Lag fire barrier enclosures. This graphic display panel facilitates plant fire brigade response to a fire condition by operating on a "first-out" alarm annunciation basis, whereby illumination of an indicator lamp represents the initially activated detector. A Field evaluation of fire detection and suppression system coverage in the areas was performed by ESR 97-00563 (Ref. 5.21). As a result of this field evaluation, relocation of one ionization type fire detector in CSRB was required to achieve compliance with NFPA 72E (Ref. 4.5) for specified distance of fire detector placement from walls. This ionization type fire detector was relocated via ESR 97-00562 (Ref. 5.20).

An automatic pre-action sprinkler system is installed within CSRA and CSRB. Sprinkler system coverage is not provided within the Thermo-Lag enclosures. The sprinkler system is electrically supervised with alarm notification provided for control valve position, supervisory air pressure, and waterflow conditions. An electrical signal from rate compensated thermal detectors located throughout the rooms, including areas within the Thermo-Lag fire barrier enclosures, will automatically trip the sprinkler system deluge valve if temperatures approach 135°F to 140°F. The deluge valve controlling waterflow into the sprinkler system distribution piping can also be tripped manually, via pull stations located throughout the protected area, and at the valve location (286-Fw-41 Exit in the Demin. Resin Fill Area). Individual sprinkler heads will fuse open to enable water discharge, if temperatures reach the 212°F rating point of the sprinklers. This type of sprinkler system is designed to minimize the potential for inadvertent actuation, since trip of the deluge valve and operation of one or more sprinkler heads are required to enable water discharge. Manual fire suppression capability is provided throughout the rooms by Hose Stations 286-C-39 and 286-Fw-42, and portable fire extinguishers (CO_2 and pressurized water) that are readily accessible for use by fire brigade members. The effects of fire suppression system activation and manual fire-fighting actions in these rooms have been considered. Specifically, accumulation of water is minimized by provision of a floor drainage system. Floor water surcharge is estimated to be insignificant, since excess water can overflow to adjacent areas, with runoff directed to the storm drainage system.

Separate ventilation systems are provided for CSRA and CSRB. The normal ventilation mode for both areas is recirculated type. Ionization type smoke detectors are provided in the return air ductwork for the rooms. These detectors will sense incipient-stage products of combustion, actuate an alarm in the

Control Room and automatically shut down the supply fans for the respective room, thereby preventing circulation of smoke (Ref. 5.15, 5.16). The ventilation system can also be switched to once-through (purge) operation to prevent propagation of smoke via the ductwork to unaffected areas. The change from normal ventilation to smoke purge is manually initiated by the control room operator (Ref. 5.16). Therefore, smoke, heat and products of combustion can be effectively removed from all areas, including the Thermo-Lag enclosures, except for the "bridge" enclosure within CSRB (see Figure 1 on page 47), which is a relatively small enclosure (approximately 7 ft x 8 ft x 5 ft), and is non-ventilated.

Analysis of Hazards for CSRA and CSRB

Except for the specific quantities of combustible materials, such as exposed electrical cabling and Thermo-Lag fire barrier materials, the hazards in CSRA and CSRB are essentially the same. Therefore, the following hazards analysis is applicable for both rooms. As described in FSAR Section 8.3.1.2.14, the cable spreading areas do not contain high energy equipment such as switchgear, transformers above 480v or rotating equipment, and are not used for storage of flammable materials. As such, the hazards in the rooms consist primarily of exposed electrical cable insulation for cables routed in cable trays.

Class IE electrical cables and connector assemblies have been qualified in accordance with IEEE Standard 383 (Ref. 4.10). The cables in these areas are for low voltage power, control and instrumentation applications. The potential for self-ignition of these cables is considered minimal due to their relatively low voltage levels, and that they are primarily used for intermittent duty (i.e., not continuously energized). The low voltage power and control cables are constructed of ethylene-propylene rubber (EPR) type or cross-linked polyethylene (XPE) insulation with flame resistant jacketing. Instrumentation cables are constructed of EPR or XPE insulation with hypalon jackets, or ETFE fluoropolymer insulation and jacket. Non-Class IE cables are routed in separate raceways from Class IE cables with a separation distance of 1 ft for trays separated horizontally, 3 ft for trays separated vertically, or alternate separation criteria per FSAR Table 8.3.1-10 is provided. Cable splices in cable trays are prohibited, and cable fill in trays is maintained below the side rails unless specifically evaluated and addressed on a case-by-case basis.

The combustible loading in the rooms is considered high, when determined by simply compiling the heat of combustion values for exposed in-situ combustibles and evenly distributing the total Btu content over the floor area of the respective room. However, this approach for assessing the hazards in the areas is misleading in that the methodology assumes that all of the energy released during a fire is evenly distributed throughout the floor area, ignoring the effect of having a concentrated fire impacting the barrier. A more appropriate assessment of the hazards in the rooms is obtained by considering the potential energy which can be transferred to a representative section of the barrier based on a conservative heat release rate for the actual combustibles in the area. This determines the expected amount of thermal energy the material will be exposed to. This approach is also conservative because an actual fire involving IEEE 383 cabling would be slow to develop.

To mitigate the potential for cable fires, adequate means for circuit protection are provided. As part of the Safe Shutdown Separation Analysis (Ref. 5.9), the methods for circuit protection for safe shutdown essential circuits and associated circuits were reviewed and determined to be acceptable and properly coordinated. Additionally, for purposes of this ESR evaluation, the fuse/breaker schemes for a random selection of 55 cables routed in non-safety related cable trays in CSRA, CSRB and the ACP Room were reviewed. The results of this review were that all cables were either 1) protected by fuses or breakers, 2) associated with circuits that did not contain devices (i.e., amplifiers or power supplies) that could potentially fault and cause high energy arcing, sparking or overheating, or 3) were low level instrumentation or annunciator circuits.

The IPEEE performed for SHNPP (Ref. 5.8) calculated the overall core damage frequency from fires originating in these rooms to be 5.6E-8 per year. The IPEEE states, "Review of the ignition source data sheet indicates that there are no significant ignition sources (i.e., ignition sources with capability of generating significant heat) located in these fire areas (Analysis File 2Y57.F/05)." Finally, procedures are established to administratively control potential ignition sources (e.g., hot work permits), housekeeping and temporary storage, and transient combustibles (Ref. 5.12 through 5.14) for these rooms. There are no radioactive sources in these areas.

Postulated Fire Scenarios in CSRA and CSRB

Based on the hazards in.these areas, the most credible scenario involves a cable tray fire on one side of the Thermo-Lag fire barrier enclosures. To assess the resulting room temperatures from such a fire, Calculation FP-0109 (Ref. 5.11) was prepared. One purpose in performing this calculation was to derive conservative room temperatures resulting from a cable tray fire, that could be compared to the standard ASTM E119 temperature exposure profile used during the fire tests performed to evaluate the performance of the Thermo-Lag fire barrier enclosures. If conservatively derived room temperatures under postulated fire conditions are significantly lower than those of the ASTM E119 test exposure, a margin of safety beyond that demonstrated by the Thermo-Lag barriers under test conditions can be realized. Another purpose for performing the calculation was to determine the approximate time required for the sprinkler system in CSRA and CSRB to activate based on the most credible fire scenario of a postulated fire developing in these areas (i.e., outside of the Thermo-Lag enclosures). The methodology used to perform this calculation is embodied in Section 10 (Chapter 11) of the NFPA Handbook (Ref. 4.2) and Section 3 (Chapter 6) of the SFPE Handbook (Ref. 3). These mathematical formulas are based on correlations of experimental fire data that developed reasonable predictions of approximate peak room temperatures based on postulated cable tray fire scenarios. The mathematical correlations are state of the art approximations and have been used for design and litigation applications in general industry.

The results of the calculation demonstrated that approximate potential temperatures reached during a postulated fire in CSRA, CSRB and the Thermo-Lag "tunnel" enclosure in CSRA would be significantly lower than the ASTM E119 exposure temperatures used for fire endurance tests of the Thermo-Lag barriers. Additionally, the results of the calculation correlate with the data obtained by the FMRC/EPRI testing (Ref. 4.11), which demonstrated that the peak temperatures developed in the flame region immediately above the surface of a burning cable tray array were in the vicinity of 1500°F. Therefore, based on the very conservative postulated fire scenario used in the calculation, the installed Thermo-Lag fire barrier enclosures would be expected to provide a level of protection beyond the 108 minute duration of fully rated performance capability demonstrated during the vertical "wall" test (Ref. 2.3). Additionally, based on the peak room temperatures determined by the calculation, a fire of sufficient intensity to challenge the load bearing capability of structural steel members supporting the Thermo-Lag enclosures in these rooms is not credible. Moreover, water discharge from the fixed suppression system and/or hose streams would prevent development of temperatures required to challenge the integrity of the steel support members. Specifically, for the cable fire scenario used to derive the peak room temperatures, a fire developing within CSRA or CSRB (outside of the Thermo-Lag barrier enclosures) was calculated to result in activation of the automatic sprinkler system in approximately 60 seconds.

In performing Calculation FP-0109, the temperatures resulting from a fire in the Thermo-Lag "bridge" enclosure in CSRB, were not calculated. This enclosure is relatively small in comparison to the CSRA "tunnel" enclosure and unlike the "tunnel" enclosure, has no forced ventilation or other unsealed openings. Therefore, a postulated fire within the "bridge" enclosure would not have sufficient oxygen to develop into a flaming fire, which could produce temperatures anywhere near those of the standard ASTM E119 exposure used for conduct of the Thermo-Lag barrier fire tests.

To further evaluate the level of protection afforded by the Thermo-Lag fire barrier enclosures, Calculation FP-0110 (Ref. 5.10) was performed. This calculation used the temperature data obtained during the 3 hour fire test of the vertical "wall" barrier (Ref. 2.3), in conjunction with heat transfer analysis techniques to assess the ability of the barrier to maintain acceptable temperatures on raceways located on the unexposed side. Specifically, the objective of Calculation FP-0110 was to determine the temperature increase that would be anticipated on side rail surfaces of a "target" cable tray located at a lateral distance of 1 in. from the unexposed side of a vertical Thermo-Lag fire barrier, when subjected to a temperature of 1925°F. The 1925°F temperature represents the maximum temperature developed during a standard 3 hour ASTM E119 exposure test and is therefore conservative. Evaluating the temperature increase on a cable tray located 1 in. from the unexposed side of the barrier is also conservative, since in no instance are installed cable trays located closer than 1 in. to barrier surfaces. Additionally, the nuts and washers located on the "inside" surfaces of installed wall enclosures are not covered with Thermo-Lag trowel grade material. To address this issue, the calculation conservatively assumes that the postulated fire occurs "outside" the enclosure, and the "target" cable tray ("inside" the enclosure) is situated adjacent to the exposed nuts and washers.

In performing Calculation FP-0110, two barrier configurations were evaluated. One configuration was the specific vertical "wall" section tested. However, some differences exist between the wall barrier tested and those actually installed. These differences include greater installed Thermo-Lag material thickness, presence of 1/4" thick metal lath between the two layers of Thermo-Lag panels, and the exposed nuts and washers on installed enclosure "inside" surfaces. Therefore, using temperature data obtained from the fire test, the calculation also evaluated the performance of the as-installed wall barrier configuration.

Although the unexposed average surface temperature of the tested wall section exceeded the 250°F increase prescribed by ASTM E119, the actual function of the installed barriers is to preclude a fire on one side of the barrier from damaging redundant trains of electrical cabling required for safe shutdown (predominately routed in cable trays), located on the unexposed side of the barrier. The acceptance criteria for fire barrier systems installed directly on raceway commodities, such as cable trays, specified by Supplement 1 to GL 86-10 (Ref. 1.4), limits the average temperature increase on protected raceway surfaces to 250°F.

The cable tray side rail temperature increase was calculated using the average temperature recorded on the unexposed side of the tested wall section at 180 minutes (458°F). The resultant cable tray side rail temperature increase was determined to be 187°F. This increase is below the 250°F average temperature increase acceptance criteria allowed for by Supplement 1 to GL 86-10.

As an added measure of confidence, the cable tray side rail temperature increase was also calculated for the actual installed barrier configuration using the 458°F unexposed surface temperature recorded during the test. The resultant cable tray side rail surface temperature increase was 106°F. This suggests that even more margin exists relative to the GL 86-10 Supplement 1 average temperature increase acceptance criteria for actual as-installed vertical "wall" barrier configurations.

It is clear that the temperature increase on installed cable trays, located at a limiting-case distance of 1 in. from unexposed vertical barrier surfaces, will be significantly less than that allowed by the GL 86-10 Supplement 1 raceway surface temperature increase acceptance criteria. Therefore, installed Thermo-Lag wall fire barrier enclosures will provide adequate protection to cable trays situated nearby.

Fire Event in CSRA and CSRB

In the event of a fire in these rooms, activation of one or more of the ionization detectors installed throughout the areas will occur and provide early warning to the Control Room. An operator will then be dispatched to the appropriate room to investigate the nature of the alarm. Should the operator detect evidence of a fire condition (i.e., flame, smoke or other products of combustion), the Control Room will be notified to dispatch the site fire brigade. A fire releasing sufficient products of combustion to activate one or more ionization type fire detectors within the Cable Spreading Rooms would also be expected to activate ionization detectors provided in the return air ductwork for the affected room. This will also transmit an alarm to the Control Room, and automatically trip the supply air fan(s) for the room. Should an alarm signal be initiated via activation of a thermal type fire detector, the fire brigade will be dispatched immediately. However, since a fire in these rooms would be anticipated to be a slowly developing fire, activation of a thermal detector prior to an ionization type detector is unlikely. In the event that the fire undergoes significant growth, and based on the most credible scenario, the fire originates outside of the Thermo-Lag enclosures, the installed automatic suppression system would actuate to suppress or control the fire until the fire brigade's arrival. Portable fire extinguishers and hose stations are readily accessible outside the affected room for fire brigade use. Additionally, as part of this ESR, applicable fire pre-plan procedures (Ref. 5.17, 5.18) were revised to direct fire brigade members to watch for indications of charring or other visible fire-induced degradation of the Thermo-Lag enclosures within the rooms. Therefore, should visible degradation of a Thermo-Lag enclosure be detected, the fire brigade training requires that hose streams be directed at the enclosures to cool them. The extent of damage within, and beyond the affected room will be limited by controlled removal of heat, smoke and products of combustion by switching the applicable ventilation system to purge mode. A fire of insufficient heat release to activate the suppression system would not compromise the Thermo-Lag fire barrier enclosures prior to extinguishment, based on the severe conditions under which the barriers have been tested. In summary, the Thermo-

Lag fire barrier enclosures are capable of maintaining adequate physical separation for redundant trains of safe shutdown cabling based on the following:

- Cable trays containing safe shutdown cables are not in actual contact with vertical barrier surfaces. As demonstrated by analysis (Ref. 5.10), without a direct conductive path, acceptable temperatures will be maintained on surfaces of cable trays containing safe shutdown cables for a 3 hour duration.

- The barriers were not breached during conduct of the fire endurance tests. This assures that cables required for safe shutdown located on the unexposed sides of the enclosures will not be subjected to the effects of a fire originating on exposed sides of barrier enclosures.

Therefore, based on the fire prevention program in place, the nature of the hazards in the areas and the fire protection defense in depth features provided, it is concluded that the Thermo-Lag fire barrier enclosures within CSRA and CSRB are adequate to ensure the ability to achieve and maintain fire safe shutdown is not adversely impacted.

Auxiliary Control Panel (ACP) Room

Fire Protection Features

Physical separation of redundant electrical Safe Shutdown Trains A and B within the ACP Room is achieved by a Thermo-Lag fire barrier enclosure. A concrete wall and a normally closed "A" rated double door assembly provide physical separation for the ACP Room from adjacent Switchgear Room B. However, through wall openings for cable trays, are located above the door assembly and in other locations in the wall, which result in the ACP being partially exposed to the adjacent switchgear room. Collectively, these rooms constitute Fire Area 1-A-SWGRB. Automatic fire detection system capability via ionization type fire detectors is provided throughout Fire Area 1-A-SWGRB, including the ACP Room and the Thermo-Lag enclosure within the ACP Room. Although fire detection capability was not previously provided within the Thermo-Lag enclosure located in the ACP Room, ESR 97-00563 (Ref. 5.21) was issued

which determined that ionization type detection was needed in the enclosure and ESR 97-00562 (Ref. 5.20) was issued to add ionization type fire detection inside this enclosure. Additionally, manual pull stations are provided at egress routes and other key locations in the area, for fire alarm system activation.

Fixed fire suppression system equipment provided for the ACP Room is located in Fire Area 1-A-CSRB and consists of Hose Station 286-C-39, which is supplied by a dedicated Class II standpipe system, designed and installed in accordance with NFPA 14 (Ref. 4.6). Waterflow through the riser supplying the hose station activates an alarm at local fire detection panel LFDCP4 which is also annunciated at the MFDIC and in the Control Room. The hose station is equipped with 100 ft of 1-1/2 in. diameter fire hose, that can easily reach all portions of the ACP Room and the Thermo-Lag fire barrier enclosure within the room. Should this hose station be out of service, coverage can readily be provided by Hose Station 286-E-38, located in adjacent Fire Area 1-A-5-HVB. Portable CO_2 fire extinguishers are provided inside and immediately outside of the ACP Room. Automatic sprinkler system coverage is not provided to preclude spurious actuation of such a system from damaging the ACP. Water that may accumulate during manual fire fighting operations can migrate to adjacent areas equipped with floor drains.

The ventilation system for Fire Area 1-A-SWGRB normally operates in a part recirculation mode. Under accident conditions the position of damper assemblies changes such that the system can operate in the full recirculation mode (Ref. 5.16). Ionization type smoke detectors are provided in the return air ductwork for the Switchgear and ACP Rooms. These detectors will sense incipient-stage products of combustion, actuate an alarm in the Control Room and automatically shut down the supply fans, thereby preventing circulation of smoke (Ref. 5.15, 5.16). The ventilation system can also be switched to once-through (purge) operation to prevent propagation of smoke via the ductwork to unaffected areas. The change from normal ventilation to smoke purge is manually initiated by the control room operator (Ref. 5.16). Therefore, smoke, heat and products of combustion can be effectively removed from all areas, except the Thermo-Lag enclosure within the ACP Room, which is non-ventilated.

Analysis of Hazards or ACP Room

Switchgear Room B contains 6.9 kV and 480V emergency switchgear, DC panels, Transfer Panel B, exhaust fans, battery chargers, and associated wiring in conduit and cable trays. In-situ combustibles located in Switchgear Room B include normally expected amounts of cable insulation associated with cabling routed in trays, and limited amounts of cable insulation within enclosed electrical equipment. Therefore, the hazards in the Switchgear Room consist of energized electrical equipment and exposed IEEE 383 qualified cabling. The ACP Room is physically located approximately 25 ft from the nearest 480V switchgear enclosure, around a 90° corner formed by the stairwell enclosure in the Switchgear Room. Therefore, although unsealed wall openings are present, the ACP Room is physically separated from direct exposure to energized switchgear hazards. The ACP Room contains the Auxiliary Control Panel and the Thermo-Lag fire barrier enclosure. On this basis, in-situ combustibles and hazards in the ACP Room are limited to normally expected amounts of IEEE 383 qualified cabling routed in trays, limited amounts of cable insulation within the ACP and the Thermo-Lag materials forming the fire barrier enclosure. Transient materials are limited and controlled in Fire Area 1-A-SWGRB by administrative control procedures (Ref. 5.13).

The combustible loading in Switchgear Room B is considered moderate, when the heat of combustion values of combustibles within the room are viewed in relation to the floor area, which is in excess of 5,000 sq. ft. However, the combustible loading in the ACP Room is considered high when the heat of combustion values for exposed in-situ combustibles in the room are distributed over the small floor area of the room (approximately 300 sq. ft). However, this approach for assessing the hazards in the ACP Room is misleading in that the methodology assumes that an equal area under the standard time-temperature fire exposure curve equates to equivalent fire performance, and that the combustible load is the only important factor in determining the intensity of a postulated fire. A more realistic and accurate assessment of the hazards is obtained by considering the potential heat release rate for combustibles in the room, in lieu of the total heat of combustion. This approach is also conservative because an actual fire involving IEEE 383 cabling would be slow to develop.

As with CSRA and CSRB, most cables within the ACP Room are for low voltage power, control and instrumentation applications. The potential for self-ignition of these cables is considered minimal due to their relatively low voltage levels, and that they are primarily used for intermittent duty (i.e., not continuously energized). However, as part of this ESR, a review was performed to determine if circuits associated with the ACP panel could serve as a credible ignition source for a postulated fire. This review evaluated 126 cables associated with operation of the ACP panel. The results of the review were that the cables were either 1) protected by fuses or breakers, 2) associated with circuits that did not contain devices (i.e., amplifiers or power supplies) that could potentially fault and cause high energy arcing, sparking or overheating, 3) were associated with low level instrumentation circuits, or 4) were associated with annunciator circuits that are not normally energized.

The IPEEE performed for SHNPP (Ref. 5.8) calculated the overall core damage frequency from fires originating in the Fire Area 1-A-SWGRB to be 4.0E-6 per year. The IPEEE also states, "Significant fire ignition sources for this area include electrical cabinets, transformers, and battery chargers." Fires originating in electrical cabinets were evaluated as part of the IPEEE, and it was determined that the Auxiliary Control Panel was not a contributor to the loss of B division of power.

Finally, procedures are established to administratively control potential ignition sources (e.g., hot work permits), housekeeping and temporary storage, and transient combustibles (Ref. 5.12 through 5.14), and there are no radioactive sources in this fire area.

Postulated Fire Scenarios in the ACP Room

Based on the hazards in these areas, the most credible scenario involves a cable tray fire on one side of the Thermo-Lag fire barrier enclosure in the room. Consistent with the approach used to assess fire scenarios in CSRA and CSRB, Calculation FP-0109 (Ref. 5.11) derived conservative peak temperatures resulting from a cable tray fire in the ACP Room, that can be compared to the standard ASTM E119 temperature exposure profile used during fire endurance tests of the Thermo-Lag barriers. The same assumptions and inputs as used for the postulated fire scenario in CSRA and CSRB apply to the ACP Room calculation.

The results of the calculation demonstrated that approximate potential temperatures reached during a postulated fire in the ACP Room would be significantly lower than the ASTM E119 exposure temperatures used for fire endurance tests of the Thermo-Lag barriers. Additionally, the results of the calculation correlate with the data obtained by the FMRC/EPRI testing (Ref. 4.11), which demonstrated that the peak temperatures developed in the flame region immediately above the surface of a burning cable tray array were in the vicinity of 1500°F. Therefore, based on the very conservative postulated fire scenario used in the calculation, the installed Thermo-Lag fire barrier enclosure would be expected to provide a level of protection beyond the 108 minute duration of fully rated performance capability demonstrated during the vertical "wall" test (Ref. 2.3). Additionally, based on the peak room temperatures determined by the calculation, a fire of sufficient intensity to challenge the load bearing capability of structural steel members supporting the Thermo-Lag enclosure in the ACP Room is not credible. Moreover, water discharge from hose streams would prevent development of temperatures required to challenge the integrity of the steel support members.

In performing Calculation FP-0109, the temperatures resulting from a fire in the Thermo-Lag enclosure in the ACP were not determined. This enclosure is relatively small in comparison to the CSRA "tunnel" enclosure and unlike the "tunnel" enclosure, has no forced ventilation or other unsealed openings. Therefore, a postulated fire within the Thermo-Lag enclosure in the ACP Room would not have sufficient oxygen to develop into a flaming fire, which could produce temperatures anywhere near those of the standard ASTM E119 exposure used for conduct of the Thermo-Lag barrier fire tests.

Additionally, the results of Calculation FP-0110 (Ref. 5.10) are applicable for assessment of the ability of the barrier in the ACP Room to maintain acceptable temperatures on raceways located on the unexposed side. The analysis determined that the resulting average temperature increase on the side rail surface of the "target' cable tray would be 106°F. This calculated increase in average temperature is less than the 250°F limit for average temperature increase on the surfaces of protected raceways as specified by Supplement 1 to GL 86-10 (Ref.1.4). Therefore, although the average temperature increase on the unexposed side of the tested barrier exceeded 250°F at approximately 108 minutes, this evaluation demonstrates that the performance of the barrier was sufficient to have maintained acceptable temperatures on adjacent raceway surfaces for a 3 hour duration.

Fire Event in the ACP Room

In the event of a fire in Switchgear Room B or the ACP Room, activation of one or more of the ionization detectors installed throughout the fire area will occur and provide early warning to the Control Room. An operator will then be dispatched to the appropriate room to investigate the nature of the alarm. Should the operator detect evidence of a fire condition (i.e., flame, smoke or other products of combustion), the Control Room will be notified to dispatch the site fire brigade. A fire releasing sufficient products of combustion to activate one or more ionization type fire detectors within Fire Area 1-A-SWGRB, would also be expected to activate ionization fire detectors provided in the return air ductwork for the area. This will also transmit an alarm to the Control Room, and automatically trip the supply air fan(s) for the area. A fire in Switchgear Room B or the ACP Room would be anticipated to be a slowly developing fire. However, in the event that the fire undergoes significant growth, the installed Thermo-Lag fire barrier enclosure will be capable of maintaining adequate physical separation for redundant trains of safe shutdown cabling until the fire brigade's arrival. This is based on the severe conditions under which the barriers were tested, in which the barriers were capable of providing fully rated performance in accordance with ASTM E119 for a duration of 108 minutes (1.8 hours). Additionally, Calculation FP-0109 (Ref. 5.11) conservatively demonstrated that peak temperatures resulting from a cable tray fire in the ACP Room will be significantly less than those experienced during the fire tests. Upon arrival of the fire brigade, portable fire extinguishers and hose stations are readily accessible for use throughout the area. Additionally, as part of this ESR, the applicable fire pre-plan procedure for this fire area (Ref. 5.19) was revised to direct fire brigade members to watch for indications of charring or other visible fire-induced degradation of the Thermo-Lag enclosure within the ACP Room. Therefore, should visible degradation of the Thermo-Lag enclosure be detected, the fire brigade training requires that hose streams be directed at the enclosure to cool it. For the most credible scenario of a fire originating outside of the Thermo-Lag enclosure, the extent of damage within, and beyond the affected room will be limited by controlled removal of heat, smoke and products of combustion by switching the ventilation system to purge mode. In summary, the Thermo-Lag barrier enclosure in the ACP Room is capable of maintaining adequate physical separation for redundant trains of safe shutdown cabling based on the following:

- Cable trays containing safe shutdown cables are not in actual contact with vertical barrier surfaces. As demonstrated by analysis (Ref. 5.10), without a direct conductive path, acceptable temperatures will be maintained on surfaces of cable trays containing safe shutdown cables for a 3 hour duration.

- The barriers were not breached during conduct of the fire endurance tests. This assures that cables required for safe shutdown located on the unexposed sides of the enclosures will not be subjected to the effects of a fire originating on exposed sides of barrier enclosures.

Therefore, based on implementation of ESR 97-00562 to install ionization type fire detection capability inside the Thermo-Lag fire barrier enclosure within the ACP Room, the fire prevention program in place, the nature of the hazards in the areas and the fire protection defense in depth features provided, it is concluded that the Thermo-Lag fire barrier enclosure within the ACP Room is adequate to ensure the ability to achieve and maintain fire safe shutdown is not adversely impacted.

CONCLUSION

The protection provided by the Thermo-Lag fire barrier enclosures within the Cable Spreading and ACP Rooms will ensure the plant's ability to achieve and maintain safe shutdown conditions under postulated fire scenarios. The FSAR shall be changed to revise the rating of the barriers from a 3 hour barrier to one which is adequate for the hazard.

The existing Thermo-Lag fire barrier enclosures installed in the Cable Spreading and ACP Rooms do not explicitly meet the current functional and licensing basis requirements. However, based on fire endurance test results, as supplemented by evaluation and/or analysis performed by qualified fire protection engineers as described (or summarized) herein, the installed Thermo-Lag fire barrier enclosures are adequate to ensure the plant's ability to achieve and maintain safe shutdown conditions under postulated fire scenarios. Moreover, the previously described enhancements to the fire detection system capability in CSRB and the ACP Room, field verification of overall fire suppression and detection system coverage adequacy and upgrade modifications to penetrations in the Thermo-Lag barrier enclosures (performed via ESRs 97-00562, 97-00563 and 95-00715 respectively), provide further assurance that adequate levels of fire protection are provided. Based on completion of these ESR activities, the fire prevention program in place, the nature of the hazards in the areas and the fire protection defense in depth features provided, it is concluded that the Thermo-Lag fire barrier enclosures within the Cable Spreading and ACP Rooms are adequate to ensure the plant's ability to achieve and maintain safe shutdown conditions under postulated fire scenarios. Therefore, an adequate technical basis exists for modifying the current licensing basis requirement for the subject Thermo-Lag fire barrier enclosures. Specifically, explicit reference to these barrier enclosures as being capable of providing a three (3) hour fire endurance rating in accordance with ASTM E119 / NFPA 251, should be modified to state that the barriers are capable of providing an adequate level of protection that is commensurate with the hazards in the respective areas.

The protection provided by the Thermo-Lag fire barrier enclosures within the Cable Spreading and ACP Rooms will ensure the plant's ability to achieve and maintain safe shutdown conditions under postulated fire scenarios. The FSAR shall be changed to revise the rating of the barriers from a 3 hour barrier to one which is adequate for the hazard.

CP&L 10CFR50.59 Guideline
ATTACHMENT 1
10CFR50.59 Safety Evaluation

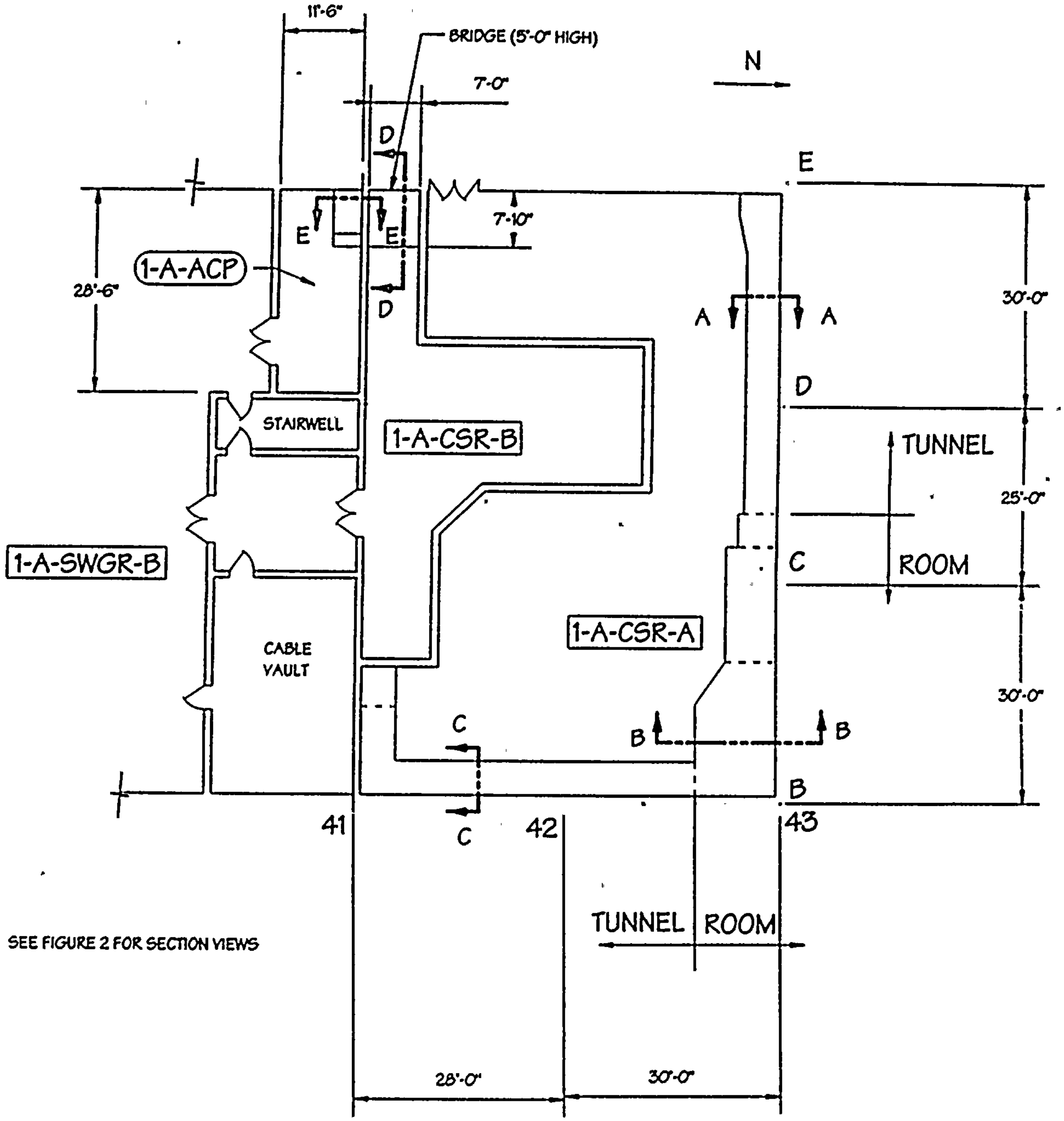

FIGURE 1

CP&L 10CFR50.59 Guideline
ATTACHMENT 1
10CFR50.59 Safety Evaluation

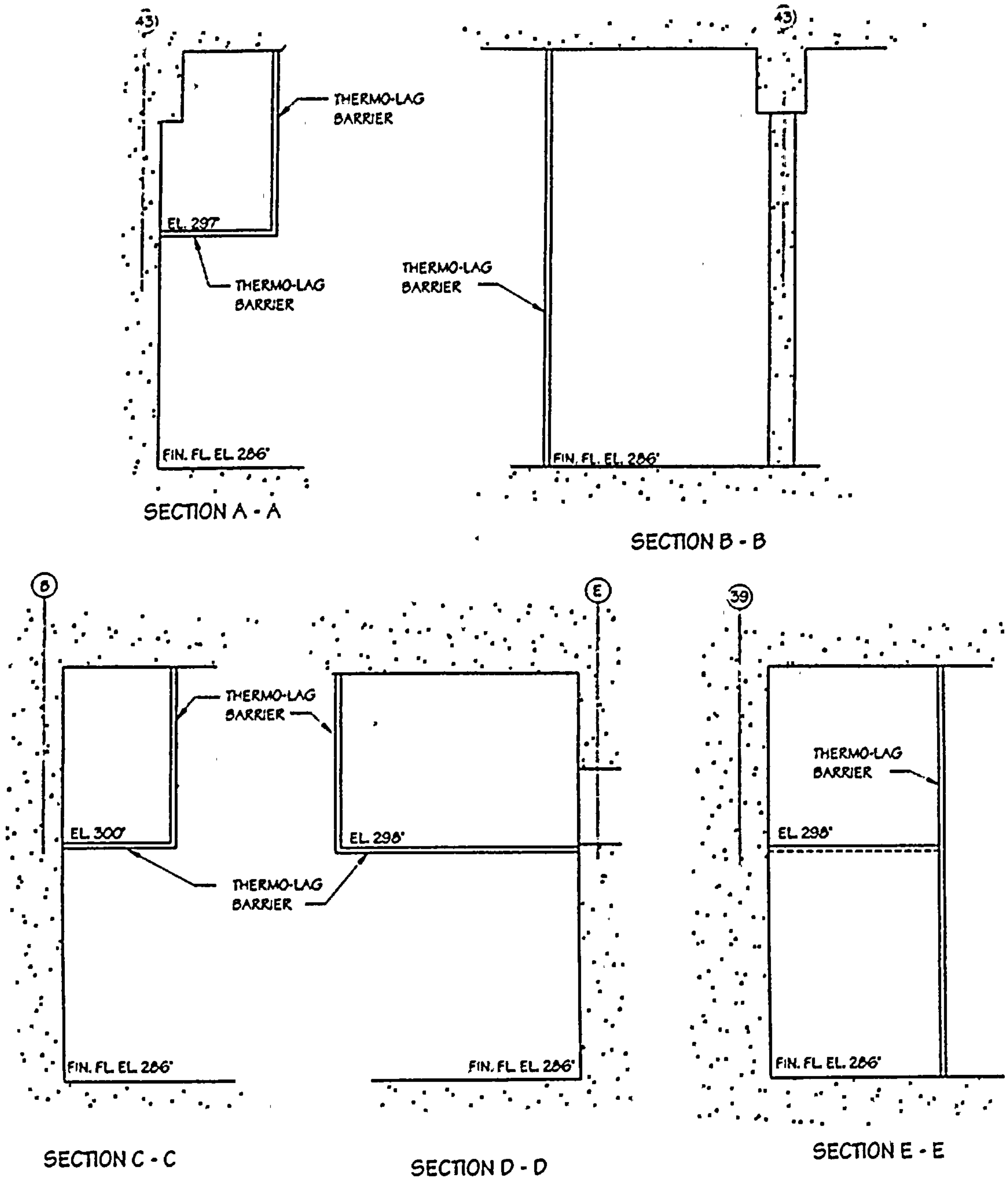

FIGURE 2

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10 CFR 50.59 Safety Evaluation
Unreviewed Safety Question Determination Form Page 1 of 6

1. **May The Probability Of Occurrence Of An Accident Previously Evaluated In The SAR Be Increased?**
   [ ] YES [X] NO

   Basis: SEE PAGE 53 OF 54

2. **May The Consequences Of An Accident Previously Evaluated In The SAR Be Increased?**
   [ ] YES [X] NO

   Basis: SEE PAGE 53 OF 54

3. **May The Possibility Of An Accident Of A Different Type Than Any Previously Evaluated In The SAR Be Created?**
   [ ] YES [X] NO

   Basis: SEE PAGE 53 OF 54

4. **May The Probability Of Occurrence Of A Malfunction Of Equipment Important To Safety Previously Evaluated In The SAR Be Increased?**
   [ ] YES [X] NO

   Basis: SEE PAGE 54 OF 54

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Unreviewed Safety Question Determination Form Page 2 of 6

5. **May The Consequences Of A Malfunction Of Equipment Important To Safety Previously Evaluated In The SAR Be Increased?**

[ ] YES [X] NO

Basis: SEE PAGE 54 OF 54

6. **May The Possibility Of A Malfunction Of Equipment Important To Safety Of A Different Type Than Any Previously Evaluated In The SAR Be Created?**

[ ] YES [X] NO

Basis: SEE PAGE 54 OF 54

7. **Is The Margin Of Safety As Defined In The Bases Of Any Technical Specification Reduced? Note: The basis may be discussed in the SAR.**

[ ] YES [X] NO

Basis: SEE PAGE 54 OF 54

Safety Evaluation Serial: 97-255
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ATTACHMENT 1
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Unreviewed Safety Question Determination Form Page 3 of 6

If the answer to any of the questions in this evaluation is yes, then a potential Unreviewed Safety Question exists for the activity as proposed. Mark question 8 yes and sign this form.

8. IS THERE A POTENTIAL USQ INVOLVED? [ ] YES* [X] NO

***If YES, PNSC review is required.**

REFERENCES: FSAR SECTION 9.5, APPENDIX 9.5A
TS 6.5.1.1.1a AND 6.8.1.h SEE PAGE 14 OF 54
FOR ADDITIONAL REFERENCES

REVIEWERS:	Discipline	Print Name	Signature	Date
1st QSR:	ELEC. / I&C	BARRY L. PULLEN	Barry L Pullen	8/18/97
Other QSR:	Admin Controls	J.H. Eads	J H Eads	8/18/97
Other QSR:	Elec/I&C	Mike D. Moore	Mike D Moore	8/18/97
2ND QSR:	MECH.	ROGER SIMS	[illegible]	8/18/97

R NOTE: If all of the questions are answered "No,", the first reviewer shall complete a 10 CFR 50.59 Safety Evaluation Transmittal (Attachment 3 of this procedure) and transmit a copy of the completed Unreviewed Safety Question Determination to the Nuclear Assessment Section (per TS 6.5.3.9) and to Licensing/Regulatory Programs.

Attach additional sheet for other QSRs if needed.

Safety Evaluation Serial: 97-255

CP&L 10 CFR 50.59 Guideline
ATTACHMENT 1
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10 CFR 50.59 Safety Evaluation
PNSC Unreviewed Safety Question Determination Form Page 4 of 6

Activity Identification ____________ Rev. ____________

DETERMINATION:

BASIS:

N/A

ACTION TAKEN:

PNSC Chairman: ____________ Date: ____________

1. The probability of occurrence of an accident previously evaluated in the FSAR is not increased. This activity evaluates the Thermo-Lag fire barriers in the Cable Spreading and ACP Rooms to ensure that these barriers will provide adequate separation of redundant divisions or trains of safety-related systems so that both are not subject to damage from a single fire in accordance with the Fire Protection Program as described in FSAR Section 9.5. This ESR evaluates the fire resistance of the Thermo-Lag enclosures to establish that the change from a fully rated 3 hour barrier to one suitable for the hazards is acceptable. Since this change is limited to the Thermo-Lag barrier fire rating and does not involve any changes, additions or deletions of field installed components, equipment or combustibles, this change does not impact the probability of occurrence of a fire previously evaluated. However, the probability of breaching this barrier and affecting two redundant trains of safe shutdown cables must be reviewed due to the change in the barrier rating. This evaluation demonstrates that, even though portions of the Thermo-Lag barriers are not capable of achieving a full three hour rating in accordance with ASTM E-119 / NFPA 251, the Thermo-Lag barriers are capable of providing an adequate level of protection to ensure that, in the event of a fire on one side, redundant safe shutdown cables located on the unexposed side of the barriers will remain free of fire damage. Therefore, the probability of a fire breaching the Thermo-Lag barriers has not increased.

2. The consequences of an accident previously evaluated in the FSAR is not increased. The FSAR has evaluated the potential for loss of redundant safe shutdown systems due to fire. The ESR evaluation demonstrates that when taking into consideration the actual and anticipated (future) fire hazards in the area of these enclosures, the differences between the installed versus tested configurations and the defense-in-depth features provided, the performance capability of the barriers is sufficient to prevent the loss of redundant safe shutdown components. This is, therefore consistent with the scenario currently evaluated by the FSAR.

3. This ESR does not create the possibility of a different type of accident than previously evaluated in the FSAR. The Thermo-Lag enclosures are still fire barriers so there is no change in the type of accident being evaluated. This ESR demonstrates that these fire barriers in the Cable Spreading and ACP Rooms can perform their intended function as indicated in the FSAR.

4. The probability of a malfunction of equipment important to safety previously evaluated in the FSAR is not increased. This ESR evaluation demonstrates that the installed barriers are capable of providing an adequate level of protection to ensure that, in the event of a fire on one side, redundant safe shutdown cables located on the unexposed side of the barriers will remain free of fire damage. Therefore, the probability of malfunction of the barriers as previously evaluated in the FSAR has not increased.

5. The consequences of a malfunction of equipment important to safety previously evaluated in the FSAR has not been increased. This ESR evaluation demonstrates that when taking into consideration the actual and anticipated (future) hazards in the area of these enclosures, the differences between the installed versus tested configurations and the defense-in-depth features provided, the performance capability of the barriers is sufficient to prevent the loss of redundant safe shutdown equipment or increase the consequences of an evaluated malfunction.

6. This ESR does not create the possibility of a malfunction of equipment important to safety of a different type that any previously evaluated in the FSAR. The Thermo-Lag enclosures are still fire barriers so there is no change in the type of malfunction. This evaluation considers the potential for thermal and non-thermal damage of fire including products of combustion and smoke. The evaluation demonstrates that the installed barriers are capable of providing an adequate level of protection to ensure that in the event of a fire on one side, redundant safe shutdown cables located on the unexposed side of the barriers will remain free of fire damage. Therefore, the possibility of barrier malfunction of a different type to that previously evaluated in the FSAR is not created.

7. The margin of safety as defined in the bases of any Technical Specification is not reduced. The ESR evaluation demonstrates that the installed configurations, portions of which are not capable of achieving a full three hour rating in accordance with ASTM E 119/NFPA 251, are none the less capable of providing an adequate level of protection to ensure that in the event of a fire on one side, redundant safe shutdown cables located on the unexposed side of the barriers will remain free of fire damage. Therefore, the margin of safety for these barriers has not been reduced.

9710100123

ENCLOSURE 1

LICENSEE ACTIONS NEEDED ON

CATEGORY I AUXILIARY RESERVOIR DAM

SHEARON HARRIS NUCLEAR POWER PLANT

DOCKET NO. 50-400

Based on the audit conducted on January 24, 1995, the following actions should be taken by Carolina Power and Light Company, if not already addressed and corrected, to ensure the continued safety of the Auxiliary Reservoir Dam consistent with the Federal Guidelines for Dam Safety (1979) and the Dam Safety Program Act defined in the Water Resources Act of 1996. A written response is requested within 180 days of the date of this letter to provide information on the current status of these items and to describe the schedule for any future actions, except as noted.

1. During the audit it was noted that vegetation has been allowed to establish itself on the crest roadway and in the riprap. All vegetation should be removed from these areas and the areas should be maintained free of the vegetation to preclude root entry into the impervious core which, after the end of life of the individual plant, will leave entry paths of precipitation, etc. into the core. Subsequent freeze-thaw cycles can then began to degrade the as-built integrity of the impervious core. This process repeated numerous times over the years can lead to an increasing depth of the degradation of the core as a progressive attack. The vegetal growth may also attract certain animals that will burrow into the dam elements. Such animal activity can also lead to degrading conditions at a dam. In addition, vegetal growth on the dam surfaces can mask subtle changes that may be occurring in the geometry of the dam surfaces and prevent adequate visual inspections and evaluations from being conducted.

2. The audit revealed that trees and brush have become established along the downstream abutment groin and along the toe of the dam that is not permanently submerged in the Main Reservoir. Additionally, the erosion process along the abutment groin has initiated, with some erosion channels up to 16 to 18 inches or more in depth, and the process continues to be active. The erosion process along a portion of the toe of the dam has been made more pronounced because the natural ground slopes toward the toe of the dam. This results in surface runoff being channeled toward the toe which in several areas has resulted in erosion of materials from under the riprap at the toe. Areas were observed where the riprap appears to have settled as the underlying materials were eroded. These areas should be cleared of trees and brush, and regrading should be accomplished so that surface runoff is not directed toward the toe. It is suggested that a toe ditch be installed to adequately direct the runoff away from the toe of the dam. All areas of regrading and those existing without adequate cover should be protected to prevent erosion.

3. During the audit it was noted that there was an area of spalled concrete on the right (west) spillway wall at the construction joint above the spillway crest. It also appeared that the area was part of a larger area that had been repaired previously. This spalled concrete should be repaired. Protection of the newly repaired area as well as the old repair area with a high quality concrete sealer/waterproofing may help in stabilizing the repaired area by retarding water entry into the concrete, thus reducing the weathering effects on the repair area.

4. A review of the periodic data collected and analyzed by Carolina Power and Light Company personnel indicated that piezometer ADP-21A is included in the monitored instrumentation as defined in Engineering Periodic Test, EPT-811, "SHNPP Dam/Dike/Retaining Wall Monitoring Procedure," dated 7/22/91, with Rev.

2, 1/22/93. The as-built drawings do not reflect the existence of ADP-21A. The as-built drawings should be revised to accurately update the actual installation and should include information on the piezometer location, diameter, depth, depth to seal and the depth range of the slotted pipe section.

5. Records that were reviewed during the audit included data from the piezometers and survey monument movements that had been put into graphical form. It was noted that data plots were made for each year reflecting the quarterly data. In order to clearly reflect the historical data and to identify trends or anomalies, at least 4 or 5 years of data should be included on the plots and the scaling should be such as to readily highlight the changes. It is also suggested that the vertical movement/settlement of the survey monuments be plotted separately from the horizontal movement/deflection of the survey monuments and that an amplified scaling of the values be used. The data should be reflected on the plots at the same frequency the data are recorded from the field and not held until several new sets of data are available. Consider incorporating these suggestions into the existing procedures.

Enclosure 2

NATDAM INVENTORY OF DAMS
INVENTORY DATA

SHEARON HARRIS AUXILIARY DAM
NC-WAKE COUNTY

DAM INFORMATION
NATIONAL INVENTORY FIELDS

1.	DAM NAME	SHEARON HARRIS AUXILIARY DAM
2.	OTHER DAM NAMES	CAT I EMERGENCY COOLING WATER
3.	FEDERAL AGENCY ID	NRCNC2
4.	NATIONAL ID	NC83102
5.	LATITUDE DEG	35
6.	LATITUDE MIN	37
7.	LATITUDE SEC	44
8.	LONGITUDE DEG	78
9.	LONGITUDE MIN	58
10.	LONGITUDE SEC	13
11.	SECTION,TOWNSHIP,RANGE	
12.	COUNTY	WAKE
13.	RIVER OR STREAM	TOM JACK
14.	NEAREST CITY-TOWN	CARY
15.	DISTANCE CITY-TOWN(MILE)	12
16.	OWNER NAME	CAROLINA POWER & Light CO.
17.	OWNER TYPE	U
18.	NONFED DAM ON FED PROP	NO
19.	DAM TYPE	ER
20.	PURPOSE	O-CAT I EMERGENCY COOLING WATER
21.	YEAR COMPLETED	1979
22.	DAM LENGTH (FT)	3900
23.	DAM HEIGHT (FT)	50
24.	STRUCTURAL HEIGHT (FT)	
25.	HYDRAULIC HEIGHT (FT)	
26.	MAXIMUM DISCHARGE (CU FT)	5030
27.	MAXIMUM STORAGE (ACRE FT)	7200
28.	NORMAL STORAGE (ACRE FT)	5000
29.	SURFACE AREA (ACRES)	403
30.	DRAINAGE AREA (SQ MILES)	2.43
31.	DOWNSTREAM HAZARD	LOW
32.	EMERGENCY ACTION PLAN	NR
33.	PHASE I INSPECTION	NO
34.	INSPECTION DATE	1/24/95

DAM NAME: SHEARON HARRIS AUXILIARY DAM
COUNTY: WAKE
NATIONAL ID: NC83102

DAM INFORMATION
NATIONAL INVENTORY FIELDS

35.	SPILLWAY TYPE..............	UNCONTROLLED
36.	SPILLWAY WIDTH (FT).........	170
37.	VOLUME OF DAM (CU YARDS)...	
38.	NUMBER OF LOCKS.............	0
39.	LENGTH OF LOCKS.............	0
40.	WIDTH OF LOCKS (FT).........	0
41.	FED AGENCY INV FUNDING.....	NO
42.	FED AGENCY INV DESIGN......	NO
43.	FED AGENCY INV CONSTRUCTION	NO
44.	FED AGENCY INV REGULATORY..	YES
45.	FED AGENCY INV INSPECTION..	YES
46.	FED AGENCY INV OPERATION...	NO
47.	FED AGENCY INV OWNER.......	NO
48.	FED AGENCY INV OTHER.......	NO
49.	FEDERAL REGULATORY AGENCY..	USNRC

OWNER INFORMATION

1.	OWNER NAME..................	CAROLINA POWER & LIGHT COMPANY
2.	OWNER TYPE..................	ELECTRIC UTILITY
3.	CONTACT NAME................	
4.	CONTACT TITLE...............	
5.	CONTACT SALUTATION..........	
6.	ADDRESS1....................	P.O. BOX 165-MAIL CODE: ZONE 1; NEW HILL, NC 27562-0165
7.	ADDRESS2....................	
8.	ADDRESS3....................	
9.	CITY........................	
10.	STATE.......................	
11.	ZIP.........................	
12.	PHONE.......................	
13.	FAX.........................	
14.	EMERGENCY CONTACT NAME......	
15.	EMERGENCY CONTACT PHONE.....	
16.	OWNER NOTE..................	
17.	DATE........................	

DAM NAME: SHEARON HARRIS AUXILIARY DAM
COUNTY: NC-WAKE
NATIONAL ID: NC83102

INSPECTION INFORMATION
============================

1. GENERAL CONDITION............ Inspection on 1/24/95 by NRC/FERC noted areas where vegetation must be removed, erosion in the groin and the toe regions from surface flow to be corrected, regrading for improveddrainage to be completed. The general condition of the dam was very good. The owner has probably completed another inspection in 1995 by an independent consultant on the five year cycle.

DAM NOTE
==

1. RESEARCH COMPLETE (Y/N).....
2. NOTE: Awaiting additional information from the owner.

ENCLOSURE 3

3.3 THE NATDAM FIELD DEFINITION: FIVE PARTS

There are forty-nine fields included in the program for the update of the National Inventory of Dams. The definition for each field consists of five parts:

- A *field number* indicating the order in which the data is to appear in the NATDAM database management file.
- The *field label*, indicating the standard name used for each field item. For example, **Latitude Deg.**
- The *field type*, including alphanumeric, number, or date.
- The *field size* indicating either a designated size or a variable size with a designated range, which will be supported in the National Inventory of Dams. Fields transmitted with a field size larger than that indicated in the definition, will be truncated and data lost when the file is added to the national inventory.
- A *description of the field*, standardizing the information transmitted for individual data items.

As indicated in the previous discussion of the NATDAM file structure, some flexibility has been provided in field sizes and in the date format. In addition, for a few fields, alternative data entries are supported. If an alternative data entry is provided, it will be designated within the field item definition. The alternative data entries will be converted to the standard form by FEMA prior to incorporation into the National Inventory of Dams.

3.4 LIST OF FIELD DEFINITIONS

The NATDAM forty-nine field definitions[4] are as follows. The expression included within parenthesis is used to indicate the type and size of the field. For example, the phrase, "Dam Name (Alphanumeric, 65 var)" designates an alphanumeric field and a variable field size, with a designated range of 1 to 65.

FIELD DEFINITIONS

(1) **Dam Name** (Alphanumeric, 65 var)

Enter the official name of the dam. Do not abbreviate unless the abbreviation is a part of the official name. For dams that do not have an official name, use the popular name.

(2) **Other Dam Names** (Alphanumeric, 65 var)

Enter the reservoir name, followed by (res). Also, if there are names other than the official name of the dam in common use, enter the names in this space. Separate the names using a semi-colon. Leave blank if not applicable.

(3) **Federal Agency ID** (Alphanumeric, 15 var)

Enter the official agency identification number for the dam.

[4] Note. Field definition items #1-34 are similar to the first 34 field items included in the <u>ASDSO National Inventory Of Dams Methodology, State Agency Manual (1989)</u>. Additional items were added to the <u>Federal Agency Manual</u> as a result of the ICODS Subcommittee Meeting November, 1989.

(4) **National ID** (Alphanumeric, 7)

Enter the official national identification number for the dam. ***This is a required field, and must have an entry for each dam included in the National Inventory of Dams.***

The National ID is the Corps Identification No. assigned to each dam that was used on the 1981 National Inventory of Dams.

For those dams that were not included on the 1981 National Inventory Of dams, an identification number will need to be generated. Each federal agency will be assigned a range of numbers that may be used to generate new National ID numbers. The same range will be assigned to an agency for each state even though that agency may have no dams in that state.

The first two characters of the identity will be the appropriate state two letter abbreviation, based on the location of the dam. The last five (5) characters of the identity will be a unique number in the agency's assigned range. See *Figure 3-2, 1981 National Inventory of Dams, Corps Identification Numbers By State*, for an example listing by state of National ID's used in the 1981 inventory.

Please contact the National Inventory Coordinator for the range of numbers assigned to your agency for the generation of National ID numbers.

In some cases, it is anticipated that federal agencies will be assigning numbers to dams already added to the database by another agency. As such cases are identified, you will be notified and asked to adjust the National ID number as needed.

(5) **Latitude Deg** (Number, 2)

(6) **Latitude Min** (Number, 4 var)

(7) **Latitude Sec** (Number, 2)

Latitude may be entered in one of two ways. The standard field entry gives latitude in degrees, minutes and seconds. An alternative field entry is provided for the convenience of those agencies who track latitude in degrees, minutes and tenths of a minute. If the alternative form is used, FEMA will convert it to the standard form prior to inclusion in the national inventory.

Latitude Standard Entry: Enter latitude in degrees, minutes and seconds, using the three designated fields. For example, if the dam is located at latitude 38 deg., 52 min., 30 sec., enter:

Latitude Deg: 38
Latitude Min: 52
Latitude Sec: 30

Latitude Alternative Entry: Enter the latitude in degrees minutes and tenths of a minute by entering: the *degrees* value in Latitude Deg; and the *minutes and tenths of a minute* value in Latitude Min. Transmit the Latitude Sec field as a blank field. For example, if the dam is located at Latitude 38 deg., 52.5 min., enter:

Latitude Deg: 38
Latitude Min: 52.5
Latitude Sec:

(8) **Longitude Deg** (Number, 3)

(9) **Longitude Min** (Number, 4 var)

(10) **Longitude Sec** (Number, 2)

Longitude many be entered in one of two ways. If the alternative form is used, FEMA will convert it to the standard form prior to inclusion in the national inventory.

Longitude Standard Entry: Enter longitude in degrees, minutes and seconds, using the three designated fields. For example, if the dam is located at longitude 82 deg., 36 min., 0 sec., enter:

Longitude Deg: 82
Longitude Min: 36
Longitude Sec: 0

Longitude Alternative Entry: Enter the longitude in degrees minutes and tenths of a minute by entering: the *degrees* value in Longitude Deg; and the *minutes and tenths of a minute* value in Longitude Min. Transmit the Longitude Sec field as a blank field. For example, if the dam is located at Longitude 82 deg., 36.0 min., enter:

Longitude Deg: 82
Longitude Min: 36.0
Longitude Sec:

(11) **Section, Township, Range Location** (Alphanumeric, 30 var)

This is an optional field. If your agency tracks the dam location by Section, Township, and Range, please enter the information. Enter the information in any form that is understandable and that clearly designates the individual values. For example, *S.21, T.3N, R.69W.* If the meridian location is needed to locate the dam within the agency, include it in the field. For example, S.21, T.3N, R.68W of the Sixth Principal Meridian.

(12) **County** (Alphanumeric, 30 var)

Enter the name of the county in which the dam is located.

(13) **River or Stream** (Alphanumeric, 30 var)

The River or Stream designation may be entered in one of two ways. An alternative field entry is provided which is consistent with the "tributary and offstream" designations used in the 1981 National Inventory of Dams. If the alternative form is used, FEMA will convert it to the standard form prior to inclusion in the national inventory.

River or Stream Standard Entry: Enter the official name of the river or stream on which the dam is built. If the stream is unnamed, identify it as a tributary to a named river, *e.g., Snake-TR*. If the dam is located offstream, enter the name of the river or stream plus "-OS", *e.g., Snake-OS*.

River or Stream Alternative Entry: Enter the official name of the river or stream on which the dam is built. If the stream is unnamed, identify it as a tributary to a named river, *e.g., TR-Snake*. If the dam is located offstream, enter the name of the river or stream plus the word, "OFFSTREAM," *e.g., Snake OFFSTREAM*.

(14) **Nearest City-Town** (Alphanumeric, 30 var)

Enter the name of the nearest downstream city, town, or village that is most likely to be affected by floods resulting from the failure of the dam.

(15) **Distance Nearest City-Town (Miles) (Number, 3 var)**

Enter the distance from the dam to the nearest downstream affected City-Town-Village, to the nearest mile.

(16) **Owner Name** (Alphanumeric, 50 var)

Enter the name of the owner of the dam.

(17) **Owner Type** (Alphanumeric, 1)

Enter the *code* to indicate the type of owner,

F for Federal;
S for State;
L for Local Government;
U for Public Utility; or
P for Private.

(18) **NonFed Dam On Fed Prop** (Alphanumeric, 1)

Enter the *code* indicating whether this dam is a non-federal dam located on federal property,

Y for Yes; or
N for No.

(19) **Dam Type** (Alphanumeric, 6 var)

Enter one or more of the following *codes* to indicate the type of dam,

RE for Earth;
ER for Rockfill;
PG for Gravity;
CB for Buttress;
VA for Arch;
MV for Multi-Arch;
CN for Concrete;
MS for Masonry;

ST for Stone;

TC for Timber Crib; and/or

OT for Other.

For example, the entry *CNCB* would indicate a concrete buttress dam type.

(20) **Purposes** (Alphanumeric, 8 var)

Enter ***one or more of the following codes*** to indicate the purposes for which the reservoir is used:

I for Irrigation;

H for Hydroelectric;

C for Flood Control And Storm Water Management;

N for Navigation;

S for Water Supply;

R for Recreation;

P for Fire Protection, Stock, Or Small Farm Pond;

F for Fish And Wildlife Pond;

D for Debris Control;

T for Tailings; and/or

O for Other.

why isn't "cooling" listed

The order should indicate the ***relative decreasing importance*** of the purpose. For example, *SCR* would indicate the primary purposes, *Water Supply* and *Flood Control And Storm Water Management*, followed by *Recreation*.

(21) **Year Completed** (Number, 4)

Enter the year when the original main dam structure was completed.

(22) **Dam Length (Feet)** (Number, 7 var)

Enter, in feet, the length of the dam, which is defined as: the length along the top of the dam. This also includes the spillway, powerplant, navigation lock, fish pass, etc., where these

form part of the length of the dam. If detached from the dam these structures should not be included.

Items 23-25: **Dam Height, Hydraulic Height, Structural Height**

Enter a corresponding value for the height field(s) that most closely correspond to the "Height of the Dam" definition used by the agency. If the agency database contains values for more than one type of height, enter the value for each corresponding height field.

The height field(s) that do not presently correspond to agency data, may be left blank. This information should be added as it becomes available for new dams.

(23) **Dam Height (Feet)** (Number, 6 var)

Enter, in feet, the height of the dam, which is defined as: the vertical distance between the lowest point on the crest of the dam and the lowest point in the original streambed.

(24) **Structural Height (Feet)** (Number, 6 var)

Enter, in feet, the structural height of the dam, which is defined as: the vertical distance from the lowest point of the excavated foundation to the top of the dam.

(25) **Hydraulic Height (Feet)** (Number, 6 var)

Enter, in feet, the hydraulic height of the dam, which is defined as: the vertical difference between the maximum design water level and the lowest point in the original streambed.

(26) **Maximum Discharge** (Cu Ft/Sec) (Number, 7 var)

Enter the number of cubic feet per second (cu ft/sec) which the spillway is capable of discharging when the reservoir is at its maximum designed water surface elevation.

(27) **Maximum Storage (Acre-Feet)** (Number, 10 var)

Enter, in acre-feet, the maximum storage, which is defined as: the total storage space in a reservoir below the maximum attainable water surface elevation, including any surcharge storage.

(28) **Normal Storage (Acre-Feet)** (Number, 10 var)

Enter, in acre-feet, the normal storage, which is defined as: the total storage space in a reservoir below the normal retention level, including dead and inactive storage and excluding any flood control or surcharge storage.

(29) **Surface Area (Acres)** (Number, 8 var)

Enter, in acres, the surface area of the impoundment at its normal retention level.

(30) **Drainage Area (Square Miles)** (Number, 10 var)

Enter, in square miles, the drainage area of the dam, which is defined as: the area that drains to a particular point (in this case, the dam) on a river or stream.

(31) **Downstream Hazard** (Alphanumeric, 1)

Enter the *code* to indicate the potential hazard to the downstream area resulting from failure or mis-operation of the dam or facilities,

L for Low,
S for Significant, or
H for High.

(32) **Emergency Action Plan (Y/N/NR)** (Alphanumeric, 2)

Enter the *code*, indicating whether this dam has an Emergency Action Plan (EAP) which is defined as: a plan of action to be taken to reduce the potential for property damage and loss of life in an area affected by a dam failure or large flood. Leave blank if unknown. Enter the code:

Y for Yes;
N for No; or
NR for Not Required. Enter the code NR if an EAP is not required for this dam under the agency requirements.

(33) **Phase I Inspection (Y/N)** (Alphanumeric, 1)

Enter the *code* indicating whether this dam was inspected in the Phase I Inspection Program, National Program of Inspection of Non-Federal Dams (P.L. 92-367). Leave blank if unknown. Enter the code:

Y for Yes;
N for No.

(34) **Last Inspection Date** (Date, 11 var)

Enter the date when the most recent inspection of the dam was performed. Enter the date, in one of the following formats:

- o In the form 31JUN87. The month abbreviations supported by the FEMA database are: JAN, FEB, MAR, APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV, DEC.

- o mm/dd/yy (06/31/87);

- o mm/dd/yyyy (06/31/1987); and

- yyyymmdd (19870631), the form used by Dbase III files.

If only the *inspection year* is known, indicate the inspection date as the first day of the year. For example, inspections performed during the year 1988 would be entered in the form 01JAN88.

If only the *inspection month and year* are known, indicate the inspection date as the first day of the month. For example, inspections conducted in March, 1988 would be entered in the form 01MAR88.

(35) **Spillway Type** (Alphanumeric, 1 var)

Enter the one letter code that describes the type of spillway:

C for Controlled
U for Uncontrolled
N for None

(36) **Spillway Width (Feet)** (Numeric, 4 var)

Enter the width of the spillway, to the nearest foot, available for discharge when the reservoir is at its maximum designed water surface elevation.

(37) **Volume Of Dam (Cubic Yards)** (Numeric, 12 var)

Enter the total number of cubic yards occupied by the materials used in the dam structure. Include portions of powerhouse, locks and spillways, only if they are an integral part of the dam and required for structural stability.

(38) **Number Of Locks** (Numeric, 1)

Enter the number of existing navigation locks for the project. Maximum of 4.

(39) **Length of Locks (Feet)** (Numeric, 4)

Enter to the nearest foot the length of the primary navigation lock.

(40) **Width of Locks (Feet)** (Numeric, 3)

Enter to the nearest foot the width of the primary navigation lock.

Items 41-48: Federal Agency Involvement Fields

Eight fields, #41-#48 are provided to indicate federal agency involvement in a dam. **At least one of the federal involvement fields must be designated as "Y", in order for the dam to be included in the National Inventory of Dams.**

In fields #41 - #48, indicate agency involvement with respect to a dam, by entering the code:
Y for Yes; or
N for No.

(41) **Fed Agency Inv Funding (Y/N)** (Alphanumeric, 1)

(42) **Fed Agency Inv Design (Y/N)** (Alphanumeric, 1)

(43) **Fed Agency Inv Construction (Y/N)** (Alphanumeric, 1)

(44) **Fed Agency Inv Regulatory (Y/N)** (Alphanumeric, 1)

(45) **Fed Agency Inv Inspection (Y/N)** (Alphanumeric, 1)

(46) **Fed Agency Inv Operation (Y/N)** (Alphanumeric, 1)

(47) **Fed Agency Inv Owner (Y/N)** (Alphanumeric, 1)

(48) **Fed Agency Inv Other (Y/N)** (Alphanumeric, 1)

(49) **Federal Agency Code** (Alphanumeric, 9)

Enter the Federal Agency Code for each dam. **This is a required field, and must have an entry for each dam included in the National Inventory of Dams.**

ENCLOSURE 4

OPERATION INSPECTION REPORT
for
THE NUCLEAR REGULATORY COMMISSION

Inspection by

THE FEDERAL ENERGY REGULATORY COMMISSION
Atlanta Regional Office

Date of inspection January 24, 1995

Dam (name) Auxiliary Reservoir Dam

Location Harris Nuclear Station (Facility) Wake (County) North Carolina (State)

NRC Licensed Project Shearon Harris Nuclear Station

Licensee Carolina Power and Light Company (CP&L)

Features of the Dam and Impoundment Inspected Embankment, Spillway, and Reservoir

Inspected by Robert L. Bryant

Accompanied by Messrs. R. E. Shewmaker and Raman Pichumani (NRC-HQ); Joe Lenahan (NRC-RII); Bob Marler and Charles Smart (CP&L)

Weather Clear, temperatures in the mid 30s (0-4°C)

Summary

Based on a review of project design documents, maintenance and instrumentation records, discussions with NRC representatives and Carolina Power and Light Company (CP&L) employees, and observations made during the inspection, no conditions were found that should be considered an immediate threat to the safety and permanence of the project structures. However, observations made during the field inspection revealed problems relating to undesirable vegetation, erosion and poor downstream drainage. These conditions could lead to significant long-term safety problems if not corrected in due course of time. A complete list of recommendations is included in the text of the report.

Submitted JUN 30 1995

JIL & DEH

Robert L. Bryant, P.E.

Project Description

The Shearon Harris Nuclear Power Plant Auxiliary Reservoir Dam was constructed to provide an adequate source of emergency cooling water for the plant's reactor. The site is located on Tom Jack Creek approximately 16 miles (mi) {26 kilometers (km)} southwest of Raleigh, North Carolina. Effluent from the dam's spillway discharges into the plant's main reservoir which is impounded by the main dam located downstream on Buckhorn Creek. Buckhorn Creek is a tributary of the Cape Fear River. Normal surface water elevation in the auxiliary reservoir is 252 feet (ft) {76.8 meters(m)}. Normal surface water elevation in the main reservoir is approximately 220 ft (67.3 m). The downstream toe of the Auxiliary dam is submerged in the waters of the main reservoir. The Auxiliary reservoir was constructed by building a dam across the flood plain of Tom Jack Creek, creating a lake of approximately 0.63 square miles (mi^2) {1.6 square kilometers (km^2)} at the base of a 2.43 mi^2 (6.3 km^2) watershed (drainage area). The principal structure consists of a random rockfill dam with an impervious core. The core is protected on each side by transition filters. A cutoff trench was excavated into the rock (siltstone) below the core. A grout curtain was injected into the foundation rock along the centerline of the dam. The rockfill was obtained from excavation of the spillway channel and local borrow areas and is primarily a clay shale. This clay shale weathers when exposed to the elements, but remains relatively unaffected when protected. Upstream and downstream slopes are protected by riprap in the areas potentially affected by wave action and by larger stones from the random rockfill in those areas not affected by wave action. A gravel surface road is located along the crest of the dam. The road ends at either side of the spillway. There is no bridge across the spillway. Harris Nuclear Station is operated by CP&L. Figure 1 is a plan view of the dam and major features. Figure 2 provides cross section views of the spillway and dam.

TABLE 1

Pertinent Data

Reservoir	
Drainage area	2.43 mi^2 (6.3 km^2)
Normal water surface elevation	252.0 ft (76.8 m)
Surface area @ el. 252.0 ft. (76.8 m)	0.63 mi^2. (1.6 km^2)
Volume @ el. 252.0 ft. (76.8 m)	5,000 acre-ft (6.17×10^6 m^3)
Maximum storm surcharge	6.0 ft (1.8 m)
Dam	
Type	Random rockfill with impervious core, designed for normal and seismic loadings.
Upstream slope	2.5H:1V
Downstream slope	2.5H:1V
Crest elevation	260.0 ft (79.2 m)
Maximum height	50 ft (15.2 m)
Length at crest	3900 ft (1188 m)
Width at crest	20 ft (6.1 m)
Slope protection	Riprap on upstream and downstream slopes
Spillway	Uncontrolled, reinforced concrete over in-situ rock
Length	170 ft (51.8 m)
Crest elevation	252 ft (76.8 m)
Downstream slope	3.33H:1V
NATDAM Number	NC 83102
Hazard Potential	Low

NOTE: All elevations are mean sea level.

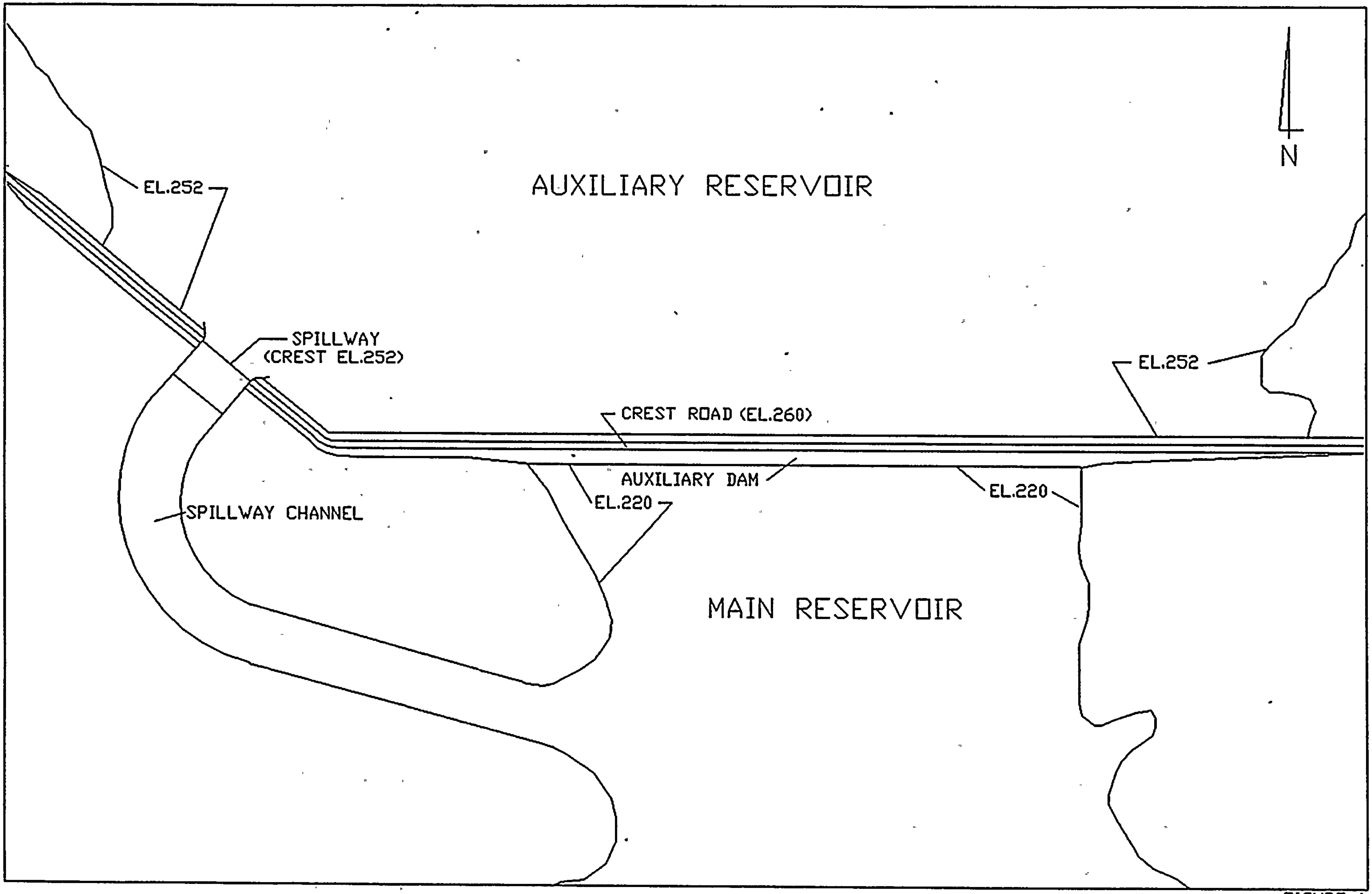
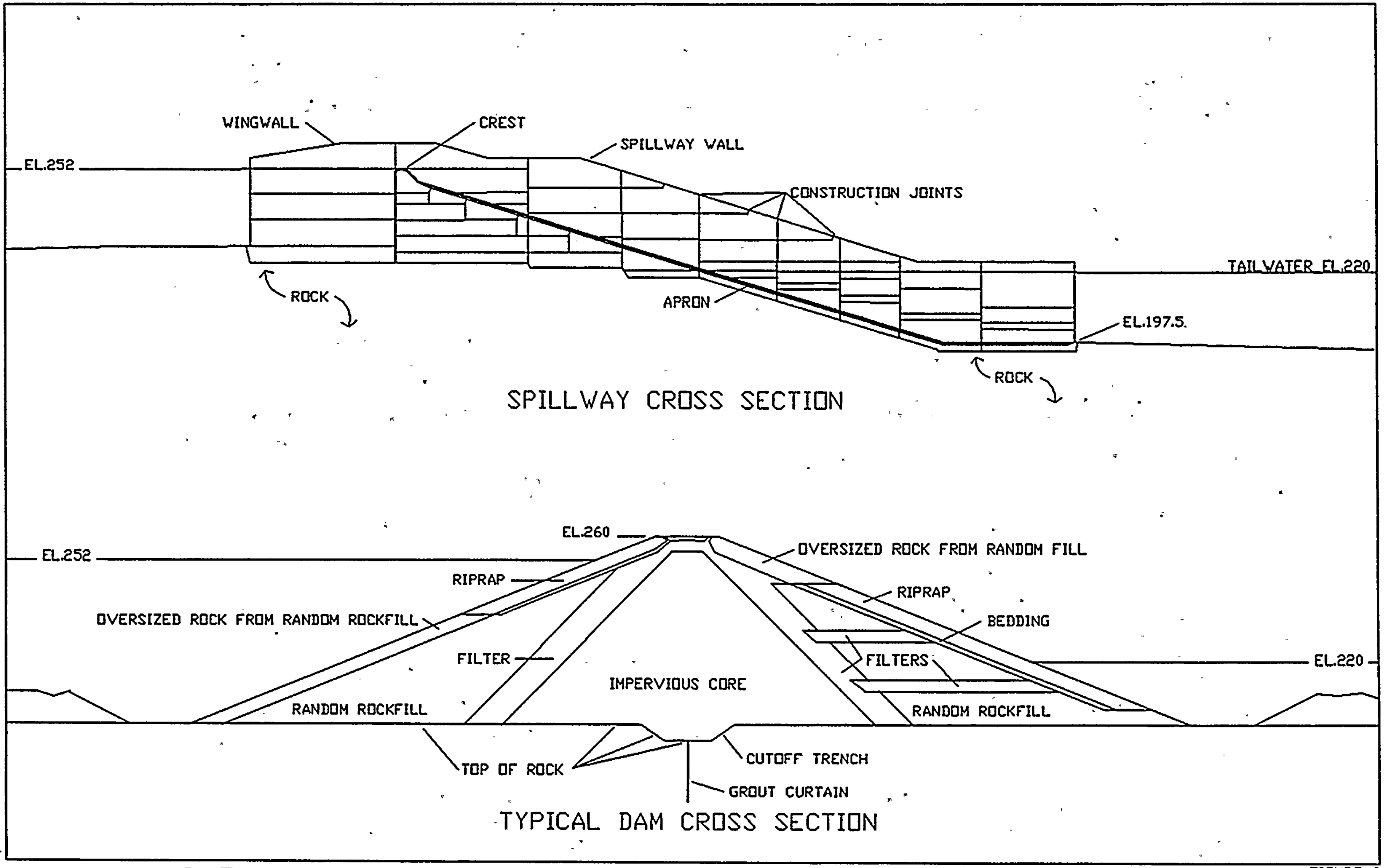


FIGURE 1

SHEARON HARRIS AUXILIARY DAM SITE PLAN



SHEARON HARRIS AUXILIARY DAM AND SPILLWAY CROSS SECTIONS

FIGURE 2

A. Safety of the Project.

1. Dams, Dikes, and Appurtenant Structures. The inspection team walked the crest and downstream toe of the Auxiliary dam, the abutments and accessible areas of the spillway. No conditions were observed that should be considered an immediate threat to the safety and permanence of the project structures.

a. Auxiliary Reservoir Dam. The upstream slope of the Auxiliary dam is protected by riprap (Photographs 1 - 3). No indications of movement of the upstream slope such as sliding, sloughing, or subsidence were observed.

The crest and roadway along the top of the dam appeared to be in good condition, with no indication of cracking, sliding, or subsidence (Photograph 2).

The downstream slope appeared to be in good condition (Photographs 10 & 11). The slope is protected by riprap at the lower levels where the slope meets the main reservoir water level (tailwater) and by large stone from the random rockfill on the upper slope. Some indications of movement and/or subsidence of the riprap were observed near the juncture of the abutments and the toe of the downstream slope (Photographs 8 & 9). These areas appear to be the result of erosion along the toe of the dam. The erosion appears to have been caused by poor drainage that channels runoff from the abutment to the toe of the Auxiliary dam (Photographs 8 & 9).

b. Spillway. The spillway is a reinforced concrete uncontrolled overflow type structure located near the right (west) abutment (Photographs 16 - 21). Reinforced concrete abutment walls extend into the reservoir and along the downstream slope into the outlet channel. Overflow passes through the spillway structure, down

an outlet channel and into the main reservoir. A buoy supported boat barrier is located upstream of the spillway wingwalls (Photograph 16). The spillway, abutment walls, and outlet channel appeared to be stable and in good condition.

c. __Abutments__. The search for possible seepage areas along the intersection of the downstream toe and both abutments was adversely affected by standing water due to erosion and poor drainage (Photographs 11 - 14) and by overgrown vegetation (Photographs 8, 9 - 12, & 17) in the areas downstream of the Auxiliary dam toe. Areas downstream of the toe along both abutments were found to be wet, probably from the recent snow melt. Overgrown vegetation along the toe of the dam and the abutments needs to be removed and both abutments reworked (regraded and protected) to improve drainage. Once the drainage is improved, eliminating standing surface water, the areas can be inspected for indications of seepage.

d. __Reservoir__. Portions of the reservoir shoreline were inspected from the dam and abutments. No indications of active shoreline erosion or accumulations of floating trash or debris were observed.

2. __Instrumentation__. Project instrumentation includes surface monuments and piezometers. Monuments are located along the crest of the dam to monitor horizontal and vertical movement. Photograph 4 shows a typical location of a survey reference point and piezometers with protective barriers. Piezometers are located along the crest of the dam and downstream of the toe. The piezometers located along the crest measure pore pressures at or near the interface of the impervious core and foundation. Readings from these piezometers will likely represent the water levels in the foundation or core, whichever is

higher. Accurate measurement of the Auxiliary dam embankment (core) phreatic surface will require installation of additional piezometers with screens (or slotted pipe) installed completely in the core and adequately isolated from the foundation. Monuments are surveyed and the results are recorded quarterly. An anomalous reading appeared in the monument deflection measurements made in 1985. Readings indicated higher than normal downstream deflection at monument AM-5. Subsequent readings have been consistent with previous data and compatible with readings made for other monuments. Possible explanations for the anomaly include survey error and/or damaged (disturbed) monument. CP&L will continue to monitor this monument closely. Piezometer readings are also made and recorded quarterly. No other anomalies or changing trends were revealed by field observations or instrumentation data reviews made during the inspection.

3. Hazard Potential Classification. Since the Auxiliary dam is located on the headwaters of the main dam reservoir, failure of the Auxiliary dam would result in an increase of approximately 1.5 ft (0.46 m) in the level of the main reservoir. The increase is not considered significant enough to upgrade the hazard classification. The Auxiliary dam is therefore classified as a "Low" hazard dam. No conditions were observed during this inspection that would warrant a change of classification.

4. Consultant's Safety Inspection Report. Prior to 1990 (1981-1986), annual consultant's inspections were made by EBASCO. The first (and most recent) five-year independent consultant's inspection was made by Law Engineering Testing Company on December 18, 1990. The consultants found the project to be in good condition. No problems affecting the safety of the project were observed. The report noted

the need for removal of vegetation from the riprap, some erosion of the west (right) abutment, some hairline cracks in the spillway walls and apron, and two areas of spalled concrete on the spillway walls. The next five-year independent consultant's inspection is scheduled for 1995.

5. Licensee's Inspection Program. The following table summarizes the licensee's inspection program:

Inspection	Frequency	Performed By	Last Inspection
Visual	Quarterly	CP&L-HESS	01/04/95
Piezometers	Quarterly	CP&L-HESS	01/04/95
Monuments	Quarterly	CP&L-HESS	12/19/94
Operation/Safety	5-Year	Consultant	12/18/90

HESS - Harris Engineering Support Section

The inspection schedule appears to be appropriate for the project size and complexity.

B. Operation and Maintenance. The project appeared to be efficiently operated and adequately maintained, with the exception of some drainage and erosion problems which will be discussed below. The reservoir level was approximately 252 feet (77.0 m), at the spillway crest. Tailwater elevation (surface elevation of the main reservoir) was approximately 220 ft (67.3 m).

1. Dams, Dikes, and Appurtenant Structures. The upstream riprap appeared to be in good condition. The riprap appeared to be relatively free of vegetative growth. Downstream slopes are protected by riprap near the waterline (main reservoir) and by large rock (segregated from the random rockfill) on the upper portion of the slope. There was evidence of some dormant vegetative growth in the riprap near the waterline.

The abutment areas immediately downstream of the dam were heavily overgrown with trees and brush; there were several areas of erosion, and areas of standing water. The natural ground slopes toward the toe of the dam, channelling runoff toward the toe, and resulting in erosion of materials from under the riprap at the toe. Several areas were observed where the riprap appears to have settled following erosion of underlying materials.

2. Spillway Gates and Standby Power. The project has no spillway gates. The spillway is an uncontrolled, reinforced concrete structure. The flow passes over the spillway into an outlet channel. The outlet channel directs water into the main reservoir. The right (west) spillway wall had a small area of spalled concrete at the construction joint above the crest. This spalled area appeared to be a small portion of a previously repaired area.

3. Power Plants. There is no hydro plant at this site. The pond is used to provide emergency cooling water for the nuclear power plant.

4. Reservoir. Areas of the reservoir observed during this inspection appear to be clean and free of debris. No indications of erosion were observed. Operation and maintenance of the reservoir appear to be in accordance with good engineering practice.

5. Records. Design/construction/as-built drawings and operation records are maintained by CP&L at the site. Summary design/construction records are also maintained at the NRC-HQ offices in Washington, D. C.

6. Emergency Action Plan. Since the auxiliary pond dam is classified as a "Low" hazard dam, no emergency action plan is required.

C. Environmental, Public Use, and Safety. No environmental,

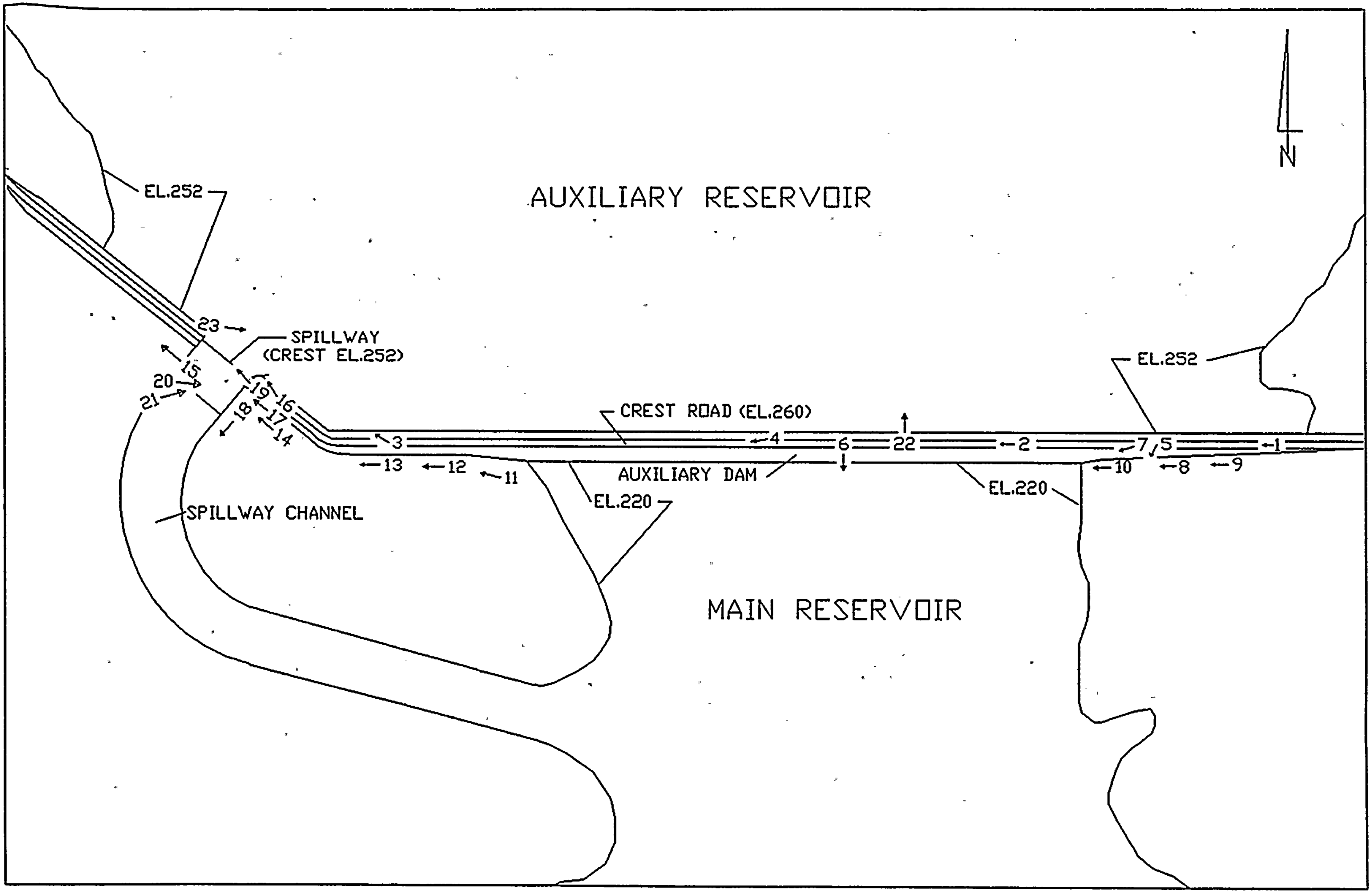
public use, or safety problems were noted during the inspection. The dam and reservoir are closed to the public. The area is fenced and access road gates are locked. A boat barrier supported by buoys is located upstream of the spillway (Photograph 16). Existing public safety devices appear adequate and are properly maintained. No additional actions to protect life and property were required as a result of the inspection.

D. Findings and Followup Actions. The inspection team observed no conditions that might adversely affect the immediate safety of the project, however several conditions were observed that could lead to safety problems if left uncorrected. A meeting was held at the site on the morning of January 25, 1995 and the following observations and recommendations that FERC will make to NRC were discussed with NRC and CP&L representatives:

- A review of excerpts from the Final Safety Analysis Report (FSAR) 90-18 revealed that the Probable Maximum Precipitation (PMP) for the Auxiliary dam drainage basin was based on outdated information. The FSAR noted that the PMP was 36.32 inches (in) {92.2 centimeters (cm)} based on a 36 hour storm duration. A review of the National Weather Service Hydrometeorological Report 52 revealed that the current chart for the all-season PMP for 24 hours and a 10 mi^2 (25.9 km^2) storm is approximately 41 in (104 cm) for the project site.
- Computerized instrumentation data plots for piezometers should include 4 to 5 years (or more) of historical data and should be scaled to readily identify trends and anomalies. Separate plots should be provided for monument deflection and settlement data. Horizontal and vertical (deflection and

settlement) movement data should be amplified to show trends. Data should be added to the plots on the same frequency as they are collected.

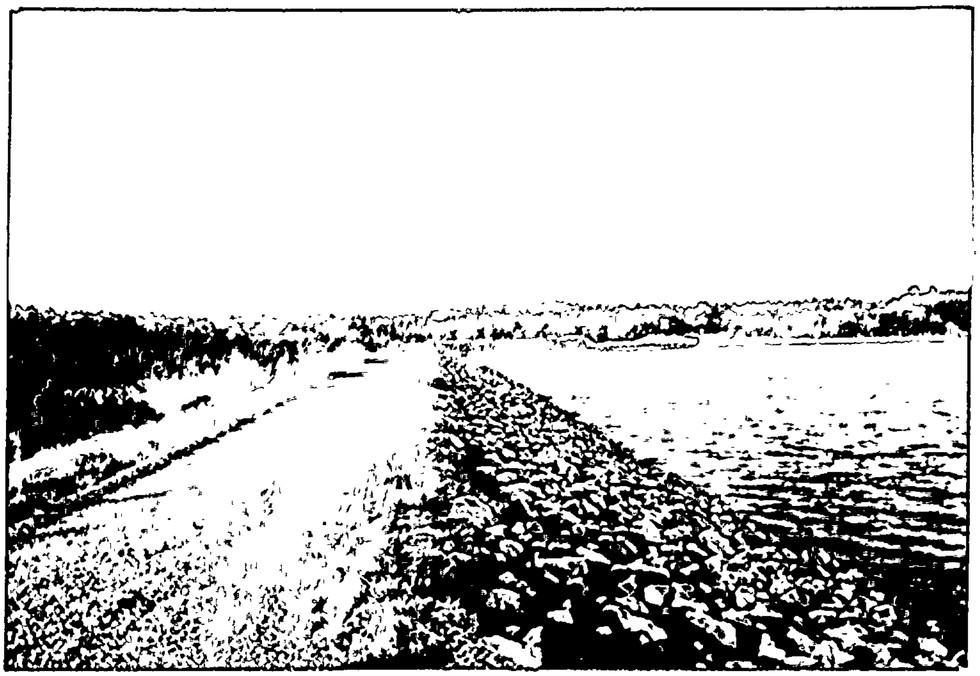
- The piezometers located in the impervious core portion of the embankment all have tips based at or near the foundation/core interface. Readings taken from these piezometers will most likely represent the higher of the water levels from the foundation or the core. If it should become necessary to accurately measure the phreatic surface of the impervious core, additional piezometers should be installed in the core and isolated from the foundation.
- As-built drawings should be updated to accurately depict the location, depth, depth to seal, and slotted pipe depth range for piezometer 21A.
- Remove all vegetation from the riprap and crest road.
- Repair spalled concrete area at right (west) spillway abutment wall construction joint above the spillway crest.
- The abutments along the toe of the dam should be cleared of trees and brush, graded to drain, and protected from erosion. A toe ditch should be installed to channel runoff away from the toe of the dam.



SHEARON HARRIS AUXILIARY DAM PHOTOGRAPH LOCATION PLAN

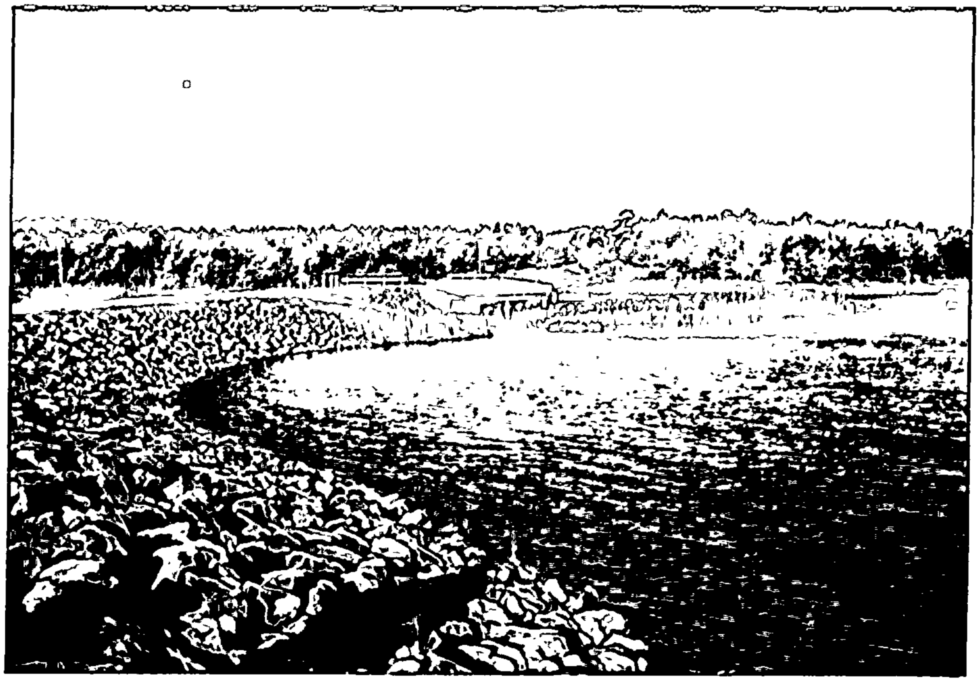
Photograph No. 1 01/24/95

Upstream slope of dam as seen from near the left abutment. Note undesirable vegetation along the crest of the dam.



Photograph No. 2 01/24/95

Crest and upstream slope of the central portion of the dam.



Photograph No. 3 01/24/95

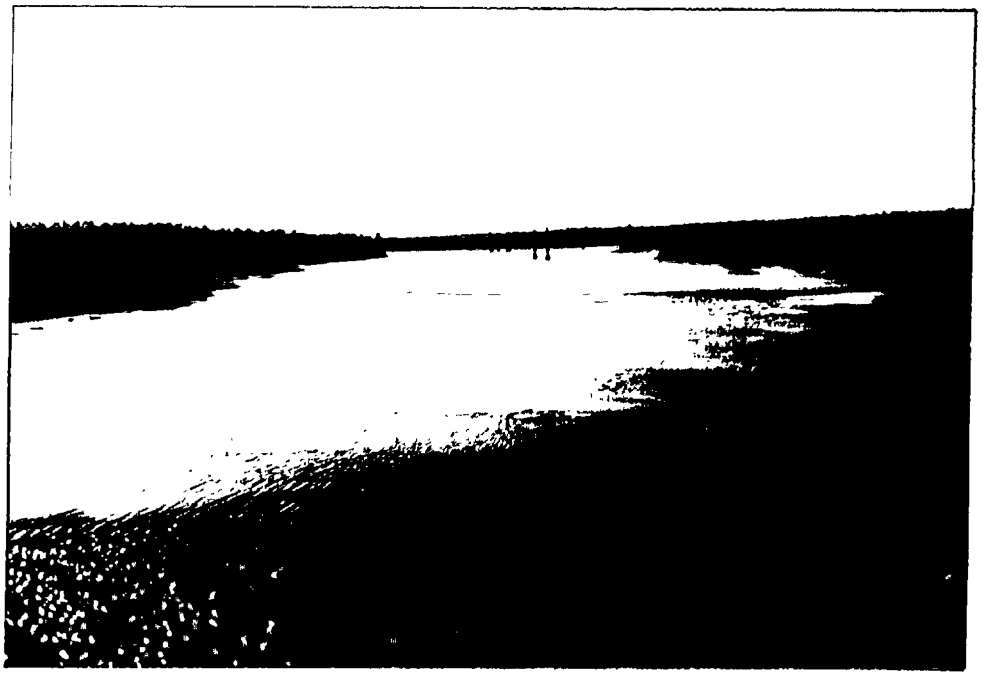
Upstream slope showing the spillway and the right (west) abutment.

Photograph No. 4 01/24/95

Crest road, piezometers 5 & 12, monument AM9. Note undesirable vegetation.

Photograph No. 5 01/24/95

View downstream (main reservoir) from near left abutment.



Photograph No. 6 01/24/95

Downstream view from near the center of the dam.

Photograph No. 7 01/24/95

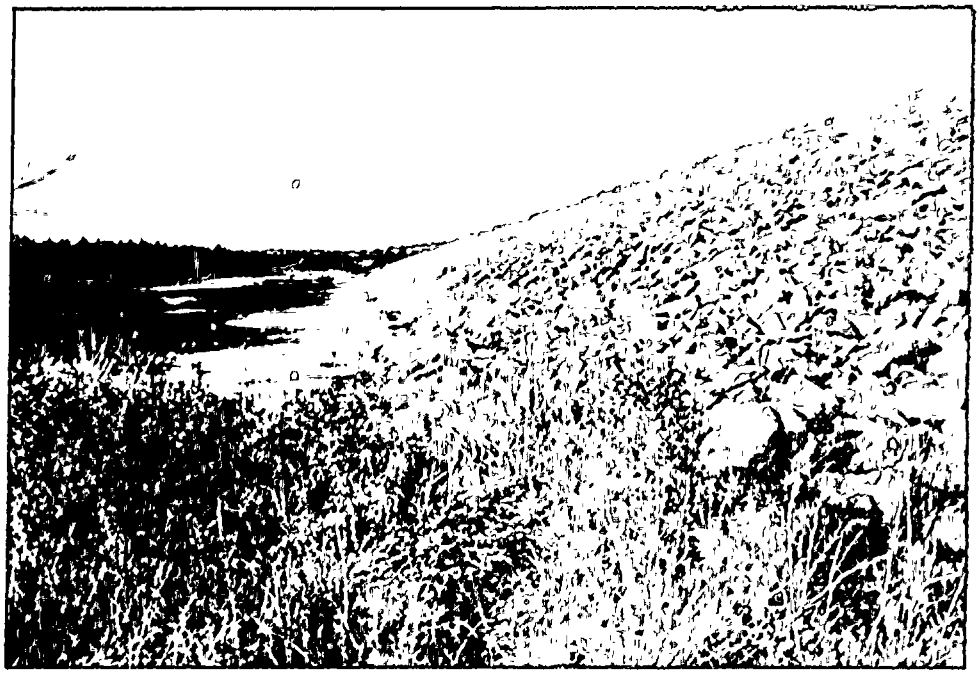
Downstream slope as seen from near the left abutment.

Photograph No. 8 01/24/95

Toe of dam and left abutment. Note low area between toe and natural ground.

Photograph No. 9 01/24/95

Eroded area under toe at left abutment. Note higher elevation of natural ground.



Photograph No. 10 01/24/95

Downstream slope and tailwater (main reservoir).

Photograph No. 11 01/24/95

Downstream slope at right abutment.

Photograph No. 12 01/24/95

Downstream slope at right abutment. Note undesirable vegetation.

Photograph No. 13 01/24/95

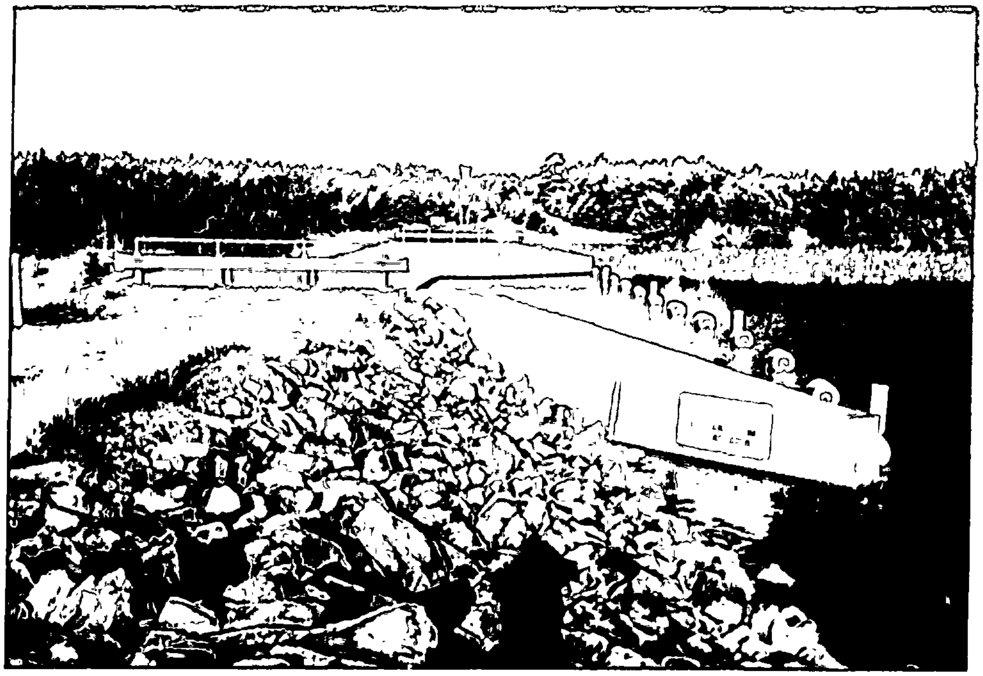
Erosion of right abutment.

Photograph No. 14 01/24/95

Erosion of right abutment near spillway.

Photograph No. 15 01/24/95

Riprap placed on abutment east of spillway. Note undesirable vegetation, no bedding material.

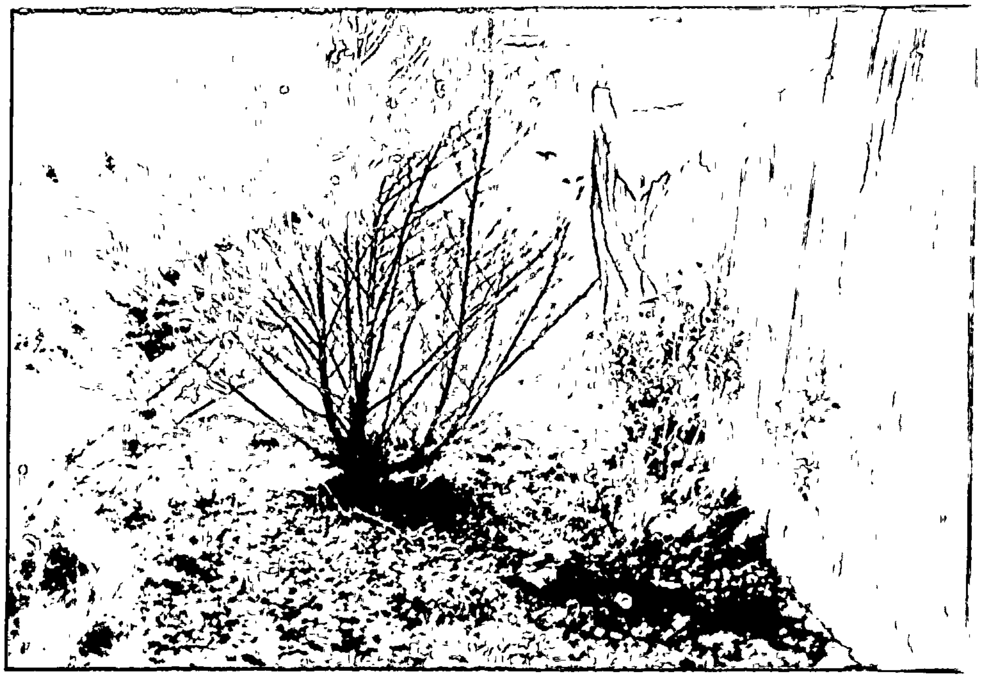


Photograph No. 16 01/24/95

View of spillway looking toward right abutment.

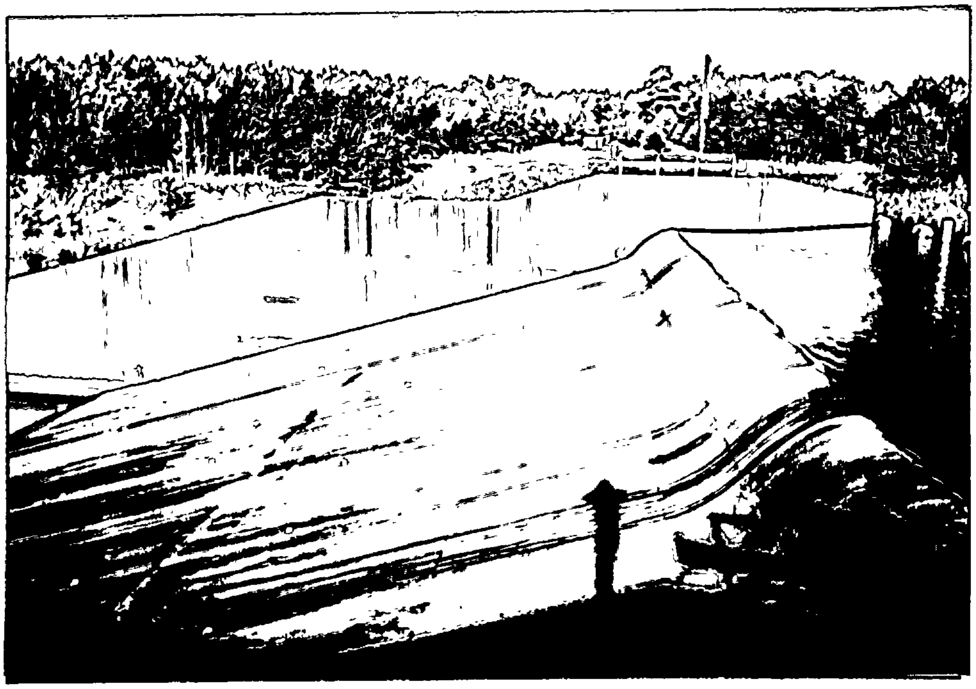
Photograph No. 17 01/24/95

View of spillway wall looking toward right abutment. Note undesirable vegetation.



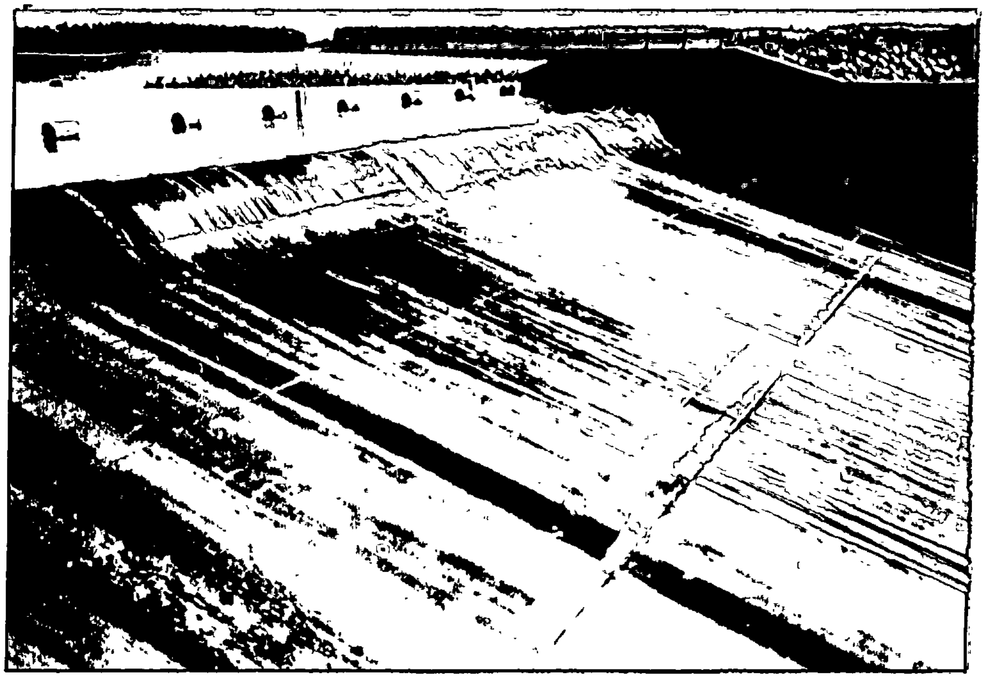
Photograph No. 18 01/24/95

View of left spillway abutment wall looking toward outlet channel. Note tree.



Photograph No. 19 01/24/95

View of spillway from left abutment wall.



Photograph No. 20 01/24/95

View of spillway from right abutment wall.

Photograph No. 21 01/24/95

View of spillway from right abutment wall.

Photograph No. 22 01/24/95

View of reservoir as seen from near the center of the dam.

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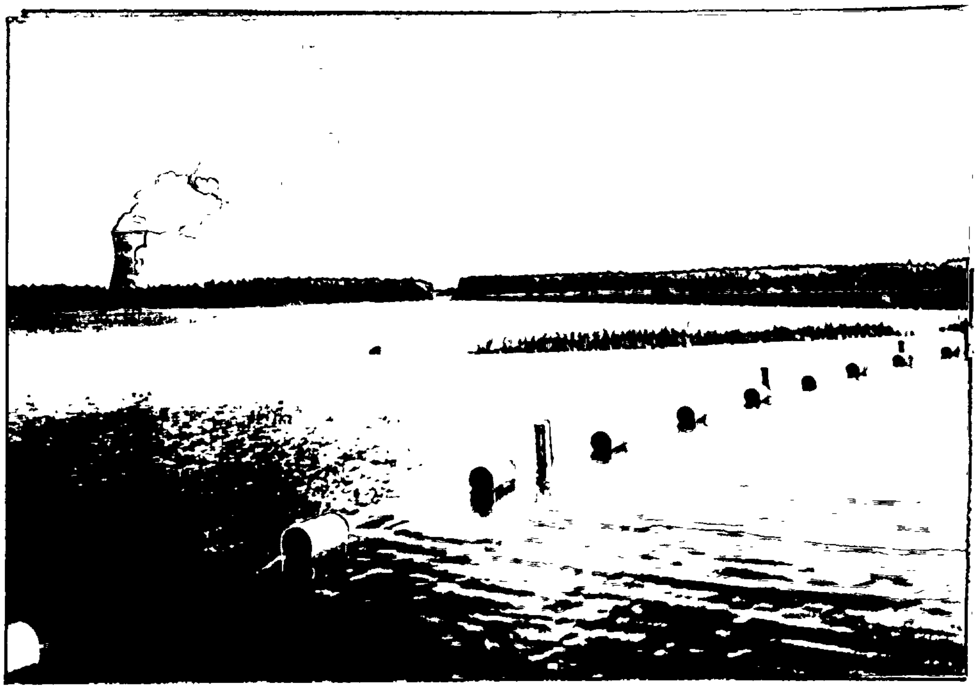

Photograph No. 23 01/24/95

View of reservoir as seen from the spillway right abutment wall.

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