VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

W. L. STEWART
VICE PRESIDENT
NUCLEAR OPERATIONS

March 21, 1986

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
Attn: Mr. Lester S. Rubenstein, Director
PWR Project Directorate #2
Division of PWR Licensing-A
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Serial No. 86-065
NO/JDH/vlh
Docket Nos. 50-338
50-339
License Nos. NPF-4
NPF-7

Gentlemen:

VIRGINIA ELECTRIC AND POWER COMPANY
NORTH ANNA POWER STATION UNITS NO. 1 AND 2
10CFR50 APPENDIX R REPORT - REVISION 3

Enclosed is Revision 3 to the North Anna 10CFR50 Appendix R Report. Revision 3 consists of revised pages to Volumes I and II (originally submitted May 1984, and revised October 1984 and August 1985). Four engineering evaluations are also submitted for review.

Ten copies of the information are being submitted. At the request of Mr. J. Stang, NRC, two updated copies are being sent directly to Mr. N. Ahmed at the Franklin Research Center. Please update your existing Volumes I and II in accordance with the Table of Changes.

Very truly yours,

JWilson

for W. L. Stewart

Attachments

1. Revised pages to Volumes I and II (10 copies)
2. Engineering Evaluations (10 copies)

A006
1/10 Limited Dist

cc: Dr. J. Nelson Grace
Regional Administrator
NRC Region II

Mr. M. W. Branch
NRC Senior Resident Inspector
North Anna Power Station

Mr. L. B. Engle
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Mr. T. E. Conlon
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Mr. N. Ahmed (2 complete reports updated thru Rev. 3)
Franklin Research Center
20th and Race
Philadelphia, PA 19103

Engineering Evaluations

#2 - Seismic Separation

#4 - Penetration Seals

#7 - Operator Access to Charging Pump Cubicles

#8 - Operator Access to Motor Driven Auxiliary Feedwater (MDAFW) Pump Room

2. EVALUATION OF THE SEISMIC SEPARATION (RATTLESPACE) BETWEEN VARIOUS CONCRETE WALLS NORTH ANNA POWER STATION

Description of Evaluation

Several buildings, most notably the Auxiliary Building, the Cable Vault/Tunnel, Safeguards, Main Steam Valve Houses, and Quench Spray Pump Houses, have common walls that have a rattlespace (to allow for seismic event movement) between the common wall and a perpendicular wall, primarily containment. In some cases, a combustible material was used as a spacer material during the concrete pour. This evaluation will analyze the potential impact of this configuration on the ability of the barrier to prevent fire spread between fire areas.

Area Description

The buildings and fire areas with seismic gaps are listed on Table 2-1. A description of the area in terms of boundaries with seismic gaps, combustibles, etc. is provided on the table.

Fire Protection Systems

The individual fire protection systems in the fire areas with seismic gaps are listed on Table 2-1. Most of the areas in this evaluation have fire detection that annunciates to the Control Room. In general, the areas with larger combustible loadings (over 60 minutes of equivalent fire severity), have fire suppression systems. All areas have manual fire fighting equipment available either within the area or nearby.

Safe Shutdown Equipment

Table 2-1 provides a general listing of the safe shutdown components in each of the fire areas involved. This list is not all-inclusive and primarily gives major components in order to provide an indication of the function of the area. Chapters 3 and 4 in Volume I of the North Anna 10 CFR 50 Appendix R Report provides a detailed description of the components required for safe shutdown and their location.

Evaluation

This evaluation is divided into several sections. The first discusses the configuration of the seismic gaps. The second section provides generic justification for the seismic gaps. The third details previous interaction with NRC concerning the seismic gaps at North Anna. The fourth section is Table 2-1 which provides a review, by fire area, of the seismic gap locations and individual justifications.

1. Seismic Gap Configuration

Seismic gaps, or rattlespaces, are standard in the construction of concrete structures. This is especially true in nuclear power plant due to the number of interconnected concrete structures and the need to minimize the potential effects of a seismic event. The job of the rattlespace is to leave enough space between walls (especially perpendicular walls) to permit movement without buckling during a seismic event. In order to create this space, material strong enough to withstand the concrete pour, but flexible enough to give under seismic pressure, is needed. A standard industry practice is to use styrofoam, as was the practice at North Anna. The width of the seismic gaps are approximately 2 inches.

A number of the seismic gaps at North Anna were reviewed in the field. The current configuration is shown on Figure 2-1 and can be described as follows:

a. There is an angle iron approximately 2½" x 2½" x ¼" thick bolted to one wall to cover the gap.

b. The same type of angle iron is used on the other side of the barrier.

2. Justifications

There are a number of factors that mitigate the potential of fire spread through the seismic gaps. These factors, along with a justification, are provided below:

a. Fire Detection - Most of the areas involved in the evaluation have either heat and/or smoke detectors that annunciate to the Control Room. Detection systems provide early warning of a fire condition to permit prompt station action. This early notification provides extra time for the fire brigade to assemble and attack the fire while it is still in an incipient stage, thereby reducing the potential exposure to the seismic gap.

b. Fire Suppression - In general, fire areas with a combustible loading that results in an equivalent fire severity of over 60 minutes have a fire suppression system. A fire suppression system is designed to extinguish a fire before it can reach flashover or the point where the fire grows beyond the general area of origin. This will reduce any exposure threat to the barrier.

c. Combustibles - In the areas reviewed, the vicinity of seismic gap was free of combustibles on both sides of the barrier. This will reduce the amount of direct flame impingement on the seismic gap on the exposed side of the barrier. This also means that there is little possibility of ignition on the unexposed side, even if the heat did pass through the seismic gap. In addition, the overall level of combustibles in most of the areas when there is no fire suppression where seismic gaps occur is low (an equivalent fire severity of 20 minutes or less). The exception is the Cable Vault/Tunnel which has a suppression system. The type of combustibles in the vicinity of the seismic gap is also an important factor. Although there are few, if any, combustibles in the direct vicinity (up to 5 ft.) of the seismic gap, those that were present were primarily cable insulation. Cable insulation requires a substantial amount of concentrated heat to ignite, and it is unlikely that this would occur via the seismic gaps.

d. Area Configuration - As stated earlier, most of the areas with seismic gaps are on the primary side of the plant. These rooms are large concrete structures with high ceilings that will allow heat to rise and dissipate.

e. Seismic Gap Configuration - There are several factors in the seismic gaps that will prevent the passage of heat and flame through the gap. First, the seismic gaps are provided with the barrier described in the first section of the analysis. This barrier is installed on both sides of the gap. This barrier will prevent the passage of heat and flame for most fires in the area. If the fire is close enough to directly impinge on the barrier, the rubber gasket will fail, but the barrier on the other side shielded by the reinforced concrete wall will prevent passage of heat and flame. The combustible fill within the seismic gap may also actually serve to block the passage of flame if there is insufficient oxygen in the gap to permit total combustion.

   Secondly, as mentioned above, the thickness of the walls are an important consideration. The walls involved are a minimum of 12 in. thick, and some go up to 24 in. This thickness will shield the barrier on the unexposed side and permit the fire gases to cool as they pass through the wall. This will also provide extra time for fire brigade action.

f. Safe Shutdown Equipment - There are no major components of the safe shutdown or alternate shutdown systems within the direct vicinity (5 ft.) of the seismic gap. Of the gaps that were field verified, the closest component to a gap are the RHR power feeds where they enter containment in the electrical penetration area of the Cable Vault and Tunnel (CV/T). These cables were approximately 8 ft. away. The CV/T has detection and suppression.

g. Fire Code Comparison - The passage of limited amounts of gases and even flaming is acceptable for other barrier penetrations. For example, fire door testing as outlined in NFPA-252 paragraphs 6-1.1.1, 6-1.1.2, and 6-1.1.4 permits flaming of up to six (6) inches along the edges of the door.

3. Previous NRC Documentation

During the course of the evaluation, it was determined that this concern had been discussed during the Appendix A evaluation of the late 1970's. NRC Question 16, which is answered in Supplement 3 of the North Anna Fire Protection Systems Review (FPSR) dated October 1, 1978, specifically addresses the use of styrofoam filler in the rattlespace. The Virginia Electric and Power Company response appears to adequately cover the NRC concerns, because no further mention is made of this item in NRC correspondence. The Fire Protection Safety Evaluation Report (SER) issued by the NRC in February of 1979 specifically references the Virginia Electric and Power Company FPSR Supplement 3 as a source document. The SER in Section III-A found that North Anna was in compliance with the guidelines of Appendix A to BTP-9.5-1 in terms of fire barriers and penetration seals. Therefore, it is Virginia Electric and Power Company's position that this has been settled via the Fire Protection SER for Appendix A.

A copy of the applicable section of Supplement 3 of the North Anna FPSR is attached (Attachment II).

4. See Table 2-1 attached at the end of the evaluation.

Conclusions

The seismic gap (rattlespace) configuration will provide adequate separation between adjacent fire areas. The technical bases which justify this conclusion can be summarized as follows:

1. The fire areas (which contain shutdown components) have fire detection systems that alarm in the Control Room on both sides of fire barriers with seismic gaps.
2. The fire areas with the seismic gaps in general have combustible loadings that result in an equivalent fire severity of approximately 20 minutes or less. The notable exception, the Cable Vault and Tunnel, has a fire suppression system.

3. The barrier presently installed over the seismic gaps on both sides of the barrier will provide some degree of separation, especially on the unexposed side.

4. The configuration of the structures involved (primarily heavy concrete with high ceilings and cubicles) will limit exposure to the gaps.

5. There are few combustibles and safe shutdown components within the direct vicinity of the seismic gaps.

6. The passage of limited amounts of heat and even flame is permitted by NFPA codes for such barrier penetrations as fire doors.

7. This configuration has been previously described to the NRC via the Fire Protection System Review submittal. The Fire Protection SER issued by the NRC did not raise further concerns.

TABLE 2-1

Fire Area	Fire Protection Systems	Safe Shutdown Systems	Location of Seismic Gap	Proximity of Safe Shutdown Equipment	Justification
3-1 Unit 1 Cable Vault/ Tunnel (CV/T-1)	Heat and smoke detection total flooding CO_2 system. Manual open and closed head sprinkler systems Equivalent fire severity in excess of 3 hours	Numerous control, instrumentation, and power cables for most safe shutdown components for Unit 1	1. CV/T-1 with Auxiliary Building at containment.	The power feeds for the RHR pumps are routed approximately 10 feet away in the CV/T.	There is detection on both sides of the barrier. The CV/T has a suppression system. The RHR pump power feeds are 10 feet away, and there are few combustibles on the Auxiliary Building side.
			2. CV/T-1 with Auxiliary Building at the Service Building.	Safe shutdown cables near the barrier on the CV/T side.	There is detection on both sides of the barrier. The CV/T has a suppression system. The only safe shutdown cables in the Auxiliary Building exposed by the CV/T are those that are about to enter that CV/T.

TABLE 2-1

(continued)

Fire Area	Fire Protection Systems	Safe Shutdown Systems	Location of Seismic Gap	Proximity of Safe Shutdown Equipment	Justification
3-2 Unit 1 Cable Vault/ Tunnel (CV/T-2)	Heat and smoke detection total flooding CO_2 system. Manual open and closed head sprinkler systems Equivalent fire severity in excess of 3 hours	Numerous control, instrumentation, and power cables for most safe shutdown components for Unit 1	1. CV/T-2 with Auxiliary Building at containment.	The power feeds for the RHR pumps are routed approximately 10 feet away in the CV/T.	There is detection on both sides of the barrier. The CV/t has a suppression system. The RHR pump power feeds are 10 feet away, and there are few combustibles on the Auxiliary Building side.
			2. CV/T-2 with Auxiliary Building at the Service Building.	Safe shutdown cables near the barrier on the CV/T side.	There is detection on both sides of the barrier. The CV/T has a suppression system. The only safe shutdown cables in the Auxiliary Building exposed by the CV/T are those that are about to enter that CV/T.

TABLE 2-1

(continued)

Fire Area	Fire Protection Systems	Safe Shutdown Systems	Location of Seismic Gap	Proximity of Safe Shutdown Equipment	Justification
11 Auxiliary, Fuel and Decontamination Buildings	Smoke detection in most areas. Partial sprinkler system on 244 ft.-6 in. elev. of the Auxiliary Building. Charcoal filters have CO_2 systems. Equivalent fire severity Auxiliary Building overall: approximately 10 minutes. The elevations that have conduit penetration are 10 minutes or less.	Charging system CCW system Auxiliary Monitoring Panel	See 1 and 2 under Cable Vault/Tunnel		Most of the seismic gaps in this fire area communicate to areas within the fire area or to the exterior.

TABLE 2-1

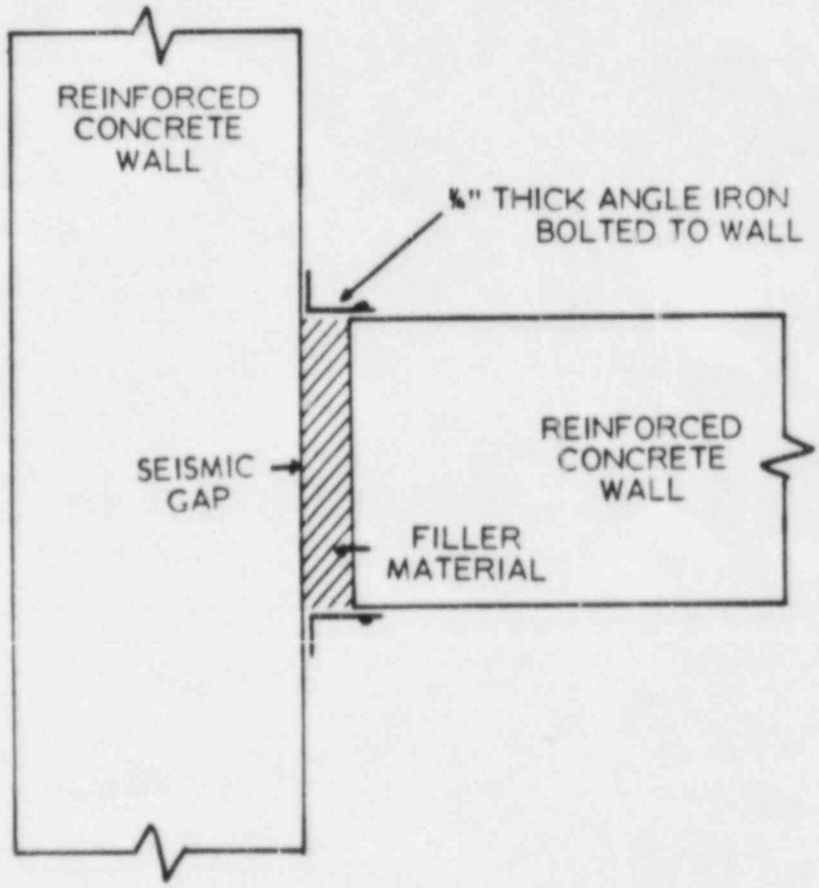
(continued)

Fire Area	Fire Protection Systems	Safe Shutdown Systems	Location of Seismic Gap	Proximity of Safe Shutdown Equipment	Justification
15-1 Unit 1 Quench Spray Pumphouse (QSPH-1) (including Safeguards Building)	Smoke detection Equivalent fire severity 14 minutes	Steam generator Pressure transmitters	QPSH-1 to MSVH-1 at the containment wall	No safe shutdown equipment within 10 feet	Both fire areas have detection, and the equivalent fire severity on both sides of the barrier is 20 minutes or less. There is no safe shutdown equipment in the direct vicinity of the seismic gap.
15-2 Unit 2 Quench Spray Pumphouse (QSPH-2) (including Safeguards Building)	Smoke detection Equivalent fire severity 14 minutes	Steam generator Pressure transmitters	QPSH-2 to MSVH-2 at the containment wall	No safe shutdown equipment within 10 feet	Both fire areas have detection, and the EFS on both sides of the barrier is 20 minutes or less. There is no safe shutdown equipment in the direct vicinity of the seismic gap.
17-1 Unit 1 Main Steam Valve House	Smoke detection Equivalent fire severity Less than 10 minutes	Steam generator PORVs and Safetys	See the Unit 1 Quench Spray Pumphouse		

TABLE 2-1

(continued)

Fire Area	Fire Protection Systems	Safe Shutdown Systems	Location of Seismic Gap	Proximity of Safe Shutdown Equipment	Justification
17-2 Unit 2 Main Steam Valve House	Smoke detection Equivalent fire severity Less than 10 minutes	Steam generator PORVs and Safetys	See the Unit 2 Quench Spray Pump-house		



PLAN VIEW
(NOT TO SCALE)

FIGURE 2-1

VIRGINIA ELECTRIC AND POWER COMPANY
NORTH ANNA POWER STATION

16.

It is our position that the styrofoam material used as a filler between the wall and floor slab be replaced to the extent possible with a noncombustible material such that the fire rating is commensurate with the wall/floor fire resistant rating.

Response

The slab in the auxiliary building is wholly within the auxiliary building fire area and is therefor not a fire rated wall. The filler material has already been added to the inventory of combustables for the auxiliary building.

The slab in the safeguards area is not a partition wall between two fire areas but is a boundary between the safeguards building and the outside. The joint is covered by a structural steel closure angle which covers the filler material.

In addition to the above mentioned items there are walls and slabs listed below wich are fire wall boundaries between separate fire areas. All walls between two fire areas have closure angles covering the joint filler on both sides, slabs have cover angles on the top only. Walls which bound a fire area and the outside have at least one closure angle.

1. Safeguards - Quench Spray common wall at R.C.
2. Quench Spray - Main Steam Valve common wall at R.C.
3. Main Steam Valve - Auxiliary Building common wall at R.C.
4. Main Steam Valve - Cable Tunnel common wall at R.C.
5. Auxiliary Building - Fuel Building common wall at R.C.
6. Fuel Building - Solid Waste below El 271'-6" at R.C.
7. Slab El 274'-2" inside Main Steam Valve house at containment wall
8. Slab El 259'-6" inside cable tunnel at containment wall
9. Cable tunnel walls intersection with north wall of auxiliary building

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III. OTHER ITEMS RELATING TO THE STATION FIRE PROTECTION PROGRAM

A. Fire Barriers and Fire Barrier Penetrations

All floors, walls and ceilings enclosing fire areas are rated at a minimum of three-hour fire ratings. The licensee has provided documentation to substantiate the fire rating of the three-hour penetration seals used in the penetrations for cable trays, conduits and piping. Based on our review, we conclude that the fire barriers and barrier penetrations provided, or to be provided, are in accordance with the guidelines of Appendix A to Branch Technical Position APCSB 9.5-1 and are, therefore, acceptable.

B. Fire Doors and Dampers

We have reviewed the placement of fire doors and dampers to assure proper fire rating has been provided.

The licensee has stated that about 45 percent of all fire rated doors are locked and alarmed with the alarm signal terminating in the control room. All other fire doors are kept in the closed position and are controlled by administrative procedures.

The licensee has provided three-hour ventilation fire dampers for most of the 3-hour wall, ceiling/floor assemblies. Certain locations have 1½-hour fire dampers. These cases were analyzed and found acceptable where the fire load was small and the estimated fire duration was well below the damper rating; otherwise, dampers will be upgraded to three-hour dampers from the existing 1½-hour fire rating. Additionally for Unit 2, the air-handling duct that is routed through the chiller room will be provided with a three-hour fire rated barrier.

Based on our review, we conclude that the fire doors and dampers provided, or to be provided, are in accordance with the guidelines of Appendix A to Branch Technical Position APCSB 9.5-1 and are, therefore, acceptable.

4. EVALUATION OF PENETRATION SEALS
NORTH ANNA POWER STATION

Description of Evaluation

Penetrations in rated fire barriers are protected by silicone foam seals. The penetration seals are installed in three basic configurations. These configurations of penetration seals have been tested and determined to have a 3-hour fire resistance rating. This evaluation describes the documentation of the 3-hour fire resistance rating of the penetration seals. Even though the penetration seal configurations are not listed in the Underwriters Laboratory (U.L.) Building Materials Directory, the seals are acceptable for Appendix R, and no exemption request is necessary.

Evaluation

The following terms are discussed in this evaluation:

1. NRC Criteria
2. Foam and Cerafiber Seal
3. Cable Tray Seal
4. 12-Inch Foam Seal

Each penetration seal configuration is discussed regarding fire resistance test documentation and adequacy of the test.

1. NRC Criteria

   Appendix R, Section III.G, requires safe shutdown cables and equipment to be separated such that one train of safe shutdown components is "free of fire damage." One method for ensuring that one train of safe shutdown components is free of fire damage is to provide separation "by a fire barrier having a 3-hour rating." Penetration seals are part of a fire barrier, so they are also required to have a 3-hour rating. Additional guidance on penetration seals is provided in the NRC's proposed Generic Letter 85-01, Section 8.19.1, which states:

8.19.1 Penetration Designs Not Laboratory Approved

<u>QUESTION</u>

Where penetration designs have been reviewed and approved by NRC but have not been classified by an approval laboratory, will it be necessary to submit an exemption request?

<u>RESPONSE</u>

No.

This guidance states that the following penetration seals are acceptable for Appendix R:

a. those which have been reviewed and approved by the NRC, and

b. those which have been classified by an approved laboratory.

2. <u>Foam and Cerafiber Seal</u>

This penetration seal configuration consists of 10 inches of Dow Corning Q3-6548 Silicone RTV foam, with 1-inch of Johns-Manville Cerafiber or Cerablanket as permanent damming material on each end. The total depth of foam and permanent damming material is a minimum of 12 inches.

Documentation of the seal's fire resistance rating is provided via a report entitled, "Fire Endurance Test of Cable Penetration Fire-Stop Seal Systems Utilizing Dow-Corning Q3-6548 Silicone RTV Sealing

Foam," dated February 15, 1977. As indicated in the test report, a test was conducted in-house by Virginia Electric and Power Company, based on an early draft of standard IEEE-P634.

The testing was not performed to ASTM E-119, nor was it tested by an independent laboratory. However, the testing was based on a similar test procedure, and the acceptance criteria for a 3-hour fire resistance rating was achieved. The test report was then submitted to the NRC and was approved; therefore, based on the proposed Generic Letter 85-01, this penetration seal is acceptable for Appendix R.

The referenced report was submitted to the NRC as an appendix to Supplement 1 dated December 15, 1977 to the "Fire Protection Systems Review" Report. The report was reviewed and approved as indicated by the following statement from the Fire Protection Safety Evaluation Report dated February, 1979:

> "The licensee has provided documentation to substantiate the fire rating of the 3-hour penetration seals used in the penetrations for cable trays, conduits, and piping. Based on our review, we concluded that the fire barriers and barrier penetrations provided, or to be provided, are in accordance with the guidelines of Appendix A to Branch Technical Position APCSB 9.5-1 and are, therefore, acceptable."

2. Cable Tray Seal

This penetration seal configuration consists of the same combination of foam and cerafiber described in Item 2 above, with the addition of a piece of Johns-Manville Marinite XL board permanently attached on each side of the penetration. The board has a cut-out to allow for passage of the tray.

Documentation of the seal's fire resistance rating is provided via the same report, referenced in Item 2 above. This test report was submitted to the NRC and was approved as discussed in Item 2 above; therefore, based on the proposed Generic Letter 85-01, this penetration seal is acceptable for Appendix R.

4. <u>12-Inch Foam Seal</u>

This penetration seal configuration consists of 12 inches of Dow Corning Q3-6548 Silicone RTV foam. Nonpermanent damming materials are used to form the seal. These damming materials are removed upon completion of the penetration sealing process.

Documentation of the seal's fire resistance rating is provided via a report entitled, "Fire and Hose Steam Tests of Cable Tray Seals -Dow Test No. 4," dated October, 1984 (a copy is attached). As indicated in the test report, a full-scale ASTM E-119 fire test was conducted by an independent laboratory, Construction Technology Laboratories, at the request of the manufacturer, Dow Corning U.S.A.

The referenced report is equivalent to one conducted by Underwriters Laboratories (U.L.) for the following reasons:

- o The test was conducted by an independent testing laboratory;
- o A standardized test (ASTM E-119) was used to perform the test;
- o The acceptance criteria for a 3-hour fire resistance rating was achieved.

For these reasons, the test report is acceptable for Appendix R purposes.

<u>Conclusions</u>

The penetration seals used at North Anna Power Station are acceptable for Appendix R. The bases for this conclusion are as follows:

1. The penetration seals have a 3-hour fire resistance rating as required by Appendix R, Section III.G.

2. The foam and cerafiber seal configuration and the cable tray seal configuration were both tested by Virginia Electric and Power Company. The test report was submitted to, and was approved by, the NRC.

3. The 12-inch foam seal configuration was tested in accordance with ASTM E-119 by an independent laboratory. This is equivalent to being classified by an approved laboratory.

ATTACHMENT TO
ENGINEERING EVALUATION 4

Report to

DOW CORNING U.S.A.
Midland, Michigan 48640

FIRE AND HOSE STREAM TESTS OF CABLE TRAY SEALS - DOW TEST NO. 4

by

Michael Gillen

Submitted by

CONSTRU~TION TECHNOLOGY LABORATORIES
A Divis n of Portland Cement Association
5420 Old Orchard Road
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October 1984

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FIRE AND HOSE STREAM TESTS OF PENETRATION SEALS - DOW TEST NO. 4

by

Michael Gillen*

INTRODUCTION

At the request of Dow Corning U.S.A. (DOW) and as authorized by Purchase Order No. 17262-N, Construction Technology Laboratories (CTL) performed a series of five fire and hose stream tests on penetration seal systems. This report describes results of the fourth test in the program, performed on two cable tray penetration seals.

The penetration seal systems consisted of Dow Corning 3-6548 Silicone RTV Foam. The 12-in. thick foam seal systems were cast around two cable tray assemblies installed in a 30x30-in. opening within a 48x48x12-in. concrete slab. The 30x30-in. opening was divided into two 14-1/2x30-in. areas by a 1-in. thick piece of insulation board, as shown in Fig. 1. Slabs were constructed by CTL personnel. Seal systems and cable trays were installed by DOW personnel with construction assistance provided by CTL.

The fire and hose stream tests were performed at the fire research facilities of CTL on October 19, 1984. The slab containing the two cable trays and penetration seals was subjected to a 3-hr fire exposure in accordance with the time temperature

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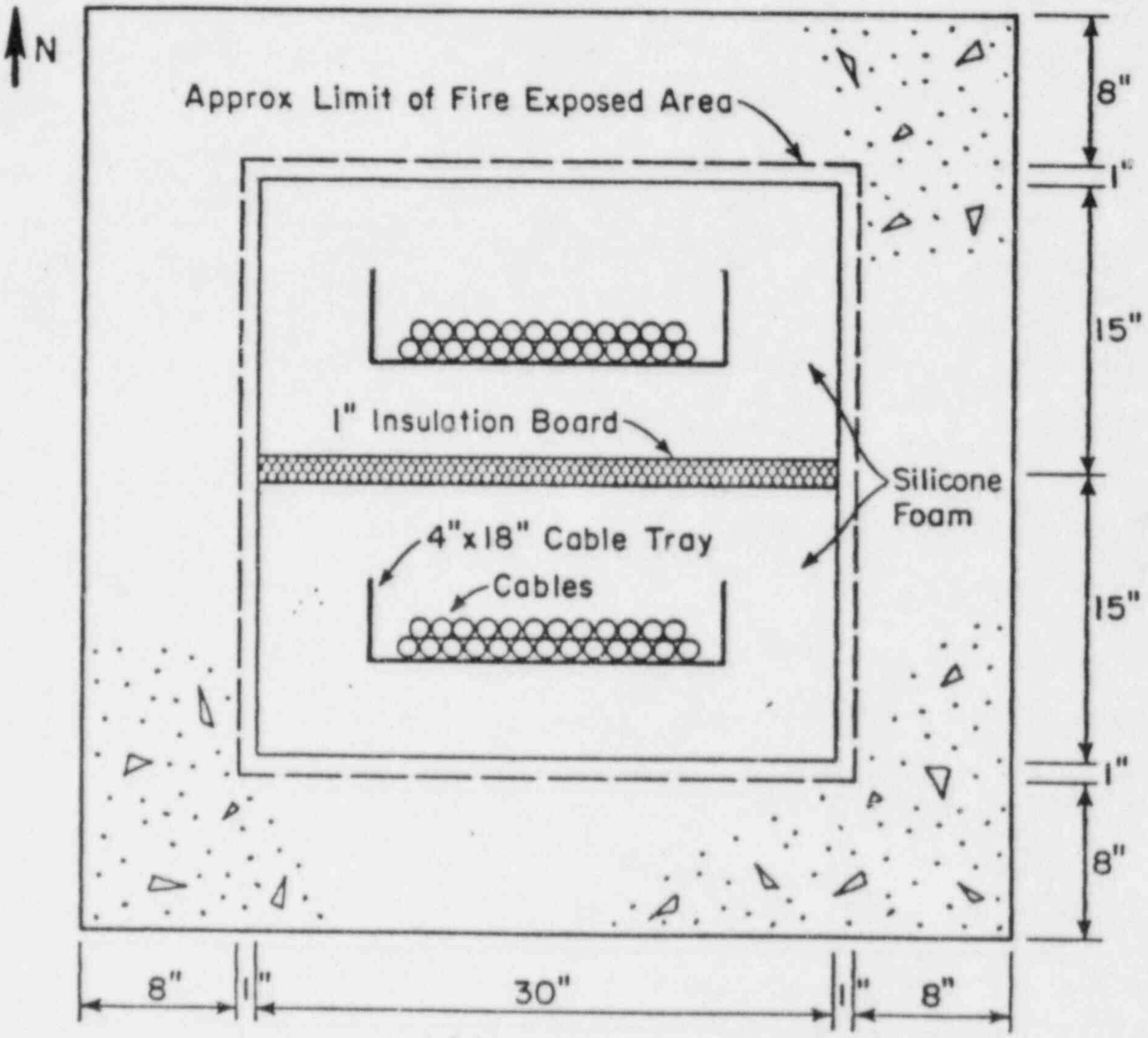

PLAN VIEW

FIG. 1 LAYOUT OF CONCRETE SLAB WITH TWO SILICONE FOAM SEALS AND PENETRATING CABLE TRAY ASSEMBLIES relationship and procedures specified in ASTM Designations: E119[(1)*] and E814.[(2)] Immediately after the fire test, the specimen was removed from the furnace and subjected to two hose stream tests in accordance with provisions of IEEE 634[(3)] and ASTM Designation: E119.

SUMMARY OF RESULTS

The test assembly, consisting of two cable trays and penetration seal systems slab, was subjected to a 3-hr fire test and subsequent hose stream tests. Seals were installed in two 14-1/2x30-in. openings penetrating through the 12-in. thick concrete slab. The openings were separated by a 1-in. thick piece of insulation board. The seals consisted of 12-in. thicknesses of Dow Corning 3-6548 Silicone RTV Foam.

The following are significant test results:

1. No passage of flame occurred through either of the two seal systems during the 3-hr fire test.
2. Limiting end point temperature criterion defined by ASTM Designation: E814 was not exceeded on the unexposed surface of either of the two seal systems during the 3-hr fire test. Limiting end point temperature rise defined by ASTM Designation: E814 was exceeded at several measuring points on cables in both Tray Nos. 1 and 2. Limiting end point temperature criterion defined by IEEE 634 was exceeded at one measuring point on a power cable in Tray No. 1.

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*Numbers in parentheses designate References on Page 18.

3. No water projected beyond the unexposed surface of either of the two penetration seals during the 14 second IEEE 634 hose stream test.

4. No water projected beyond the unexposed surface of the penetration seal containing Tray No. 1 during the 24 second ASTM Designation: E119 hose stream test. Water did project beyond the unexposed surface of the penetration seal containing Tray No. 2 during the ASTM Designation: E119 hose stream test.

TEST ASSEMBLY

A 48x48x12-in. thick concrete slab specimen containing a 30x30-in. square opening was fabricated by CTL personnel. The opening was located in a nominal 32x32-in. area in the central area of the slab. The slab was allowed to cure for approximately one week following casting and subsequently force-dried at elevated temperature to reduce internal moisture content of the concrete.

Seal materials installed in the slab openings were provided by Dow Corning, U.S.A. Seal materials consisted of Dow Corning 3-6548 Silicone RTV Foam.

INSTALLATION PROCEDURES

Installation of cable tray assemblies and seal systems are described in the following sections.

Cable Trays Assemblies

Two cable tray assemblies were installed in the concrete test slab, as shown in Fig. 1. Cable trays were nominal 18-in. wide x 4-in. high 16 ga. galvanized steel ladder-back trays. Trays were Model No. PLMS-SS12-1800-4-12 manufactured by U.S. Gypsum Company. Certification for trays is provided in Appendix A. Trays were cut to 5-ft lengths.

Two types of cables were installed in each cable tray: 600v single conductor MCM350 copper power cable with insulation Type XHHW and 600v AWG10/3C cable with XLP neoprene jacket. Cables were cut into 5-ft lengths prior to installation in the cable trays. Cable fill in each tray consisted of 14 lengths of MCM350 power cable and 40 lengths of AWG10/3C cable. Cables were secured to trays with nylon tie-wraps.

Completed cable tray assemblies were installed so that ends of trays extended 12 in. below the exposed surface of the test slab and 3 ft above the unexposed surface of the test slab. Trays were bolted at two locations to a steel angle framework on the unexposed side of the concrete slab to provide rigid support and minimize tray movement during seal construction and testing.

Seals

Seals were installed in openings in the concrete slab by DOW personnel with construction assistance provided by CTL. The concrete test assembly was placed in a horizontal position and 1-in. thick pieces of ceramic fiber damming board were attached to the unexposed surface of the slab. The ceramic fiber board was M-Board manufactured by Johns-Manville. The damming board was cut to fit tightly around projecting cable tray assemblies. Small gaps between the ceramic fiber board and cables were filled with pieces of CeraFiber ceramic fiber blanket manufactured by Johns-Manville.

The 30x30-in. opening was subdivided into two 14-1/2x30-in. openings using a 12-in. wide x 30-in. long piece of 1-in. thick insulation board. The insulation board was M-Board. The board was installed in the opening as shown in Fig. 1.

Silicone foam materials were mixed and placed both by hand and machine in approximately 1-1/2 to 2-in. lifts to a thickness of 12 in. in each opening. Lot numbers, densities, and snap times of foam materials installed in both penetrations are given

in Appendix A.

After foam had set, damming boards were removed from the exposed side of the slab. The foam in each opening was trimmed flush with the unexposed concrete slab surfaces.

Foam was allowed to cure for approximately 9 days prior to fire testing.

TEST EQUIPMENT & PROCEDURES

The following sections briefly describe equipment and procedures used to conduct fire and hose stream tests of the assembly containing the cable tray penetration seal systems.

Furnace

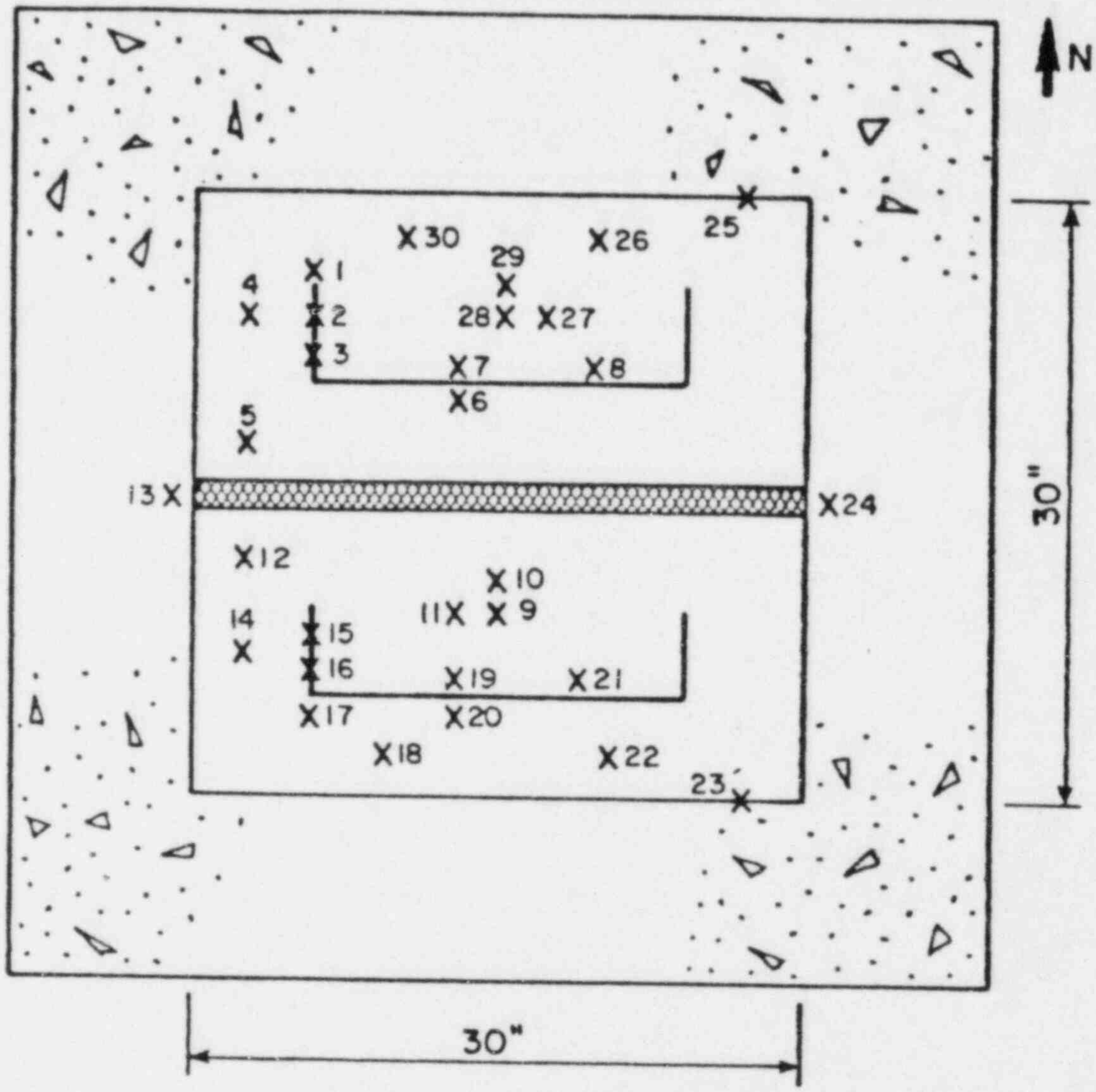
The test assembly containing the two cable tray penetration seal systems was subjected to a 3-hr fire exposure utilizing the small slab furnace at CTL's Fire Research Laboratory. This furnace provides for testing of small-scale specimens in a horizontal position. Approximate area of fire-exposure is 32x32 in., as shown in Fig. 1.

Furnace atmosphere temperatures were monitored by three Type K, Chromel-Alumel, protected thermocouples located 12 in. below the exposed face of the test assembly. The fire exposure was controlled according to the time-temperature relationship prescribed by ASTM Designation: E119, and is tabulated in Appendix B.

Furnace atmosphere pressure was maintained close to ambient laboratory air pressure or slightly negative (-0.02 to -0.08 inches of water). For this test, the average draft was -0.08 inches of water.

Specimen Instrumentation

A total of 30 thermocouples were used for measuring temperatures on the unexposed side of the test specimen at locations shown in Fig. 2. Six thermocouples were used for measuring temperatures of electrical cables and cable trays at a distance of 1-in. above the unexposed surface of the test assembly during the fire test. Twenty-two thermocouples were used to measure temperatures on seal surfaces, concrete/seal interfaces, cable/seal and tray/seal interfaces, and concrete surfaces on the unexposed side of the test assembly. Two



X- Thermocouple Locations

FIG. 2 UNEXPOSED SURFACE AND INTERFACE THERMOCOUPLE LOCATIONS thermocouples were used to measure foam temperatures at a depth of 2 in. below the unexposed surface of the seals. A list of thermocouple locations is provided in Appendix B.

Data Acquisition

Furnace atmosphere and specimen thermocouple temperatures were monitored at 5-minute intervals throughout the 3-hr fire test. The automated data acquisition system consisted of a Hewlett-Packard HP3455A digital voltmeter and a series of HP3495A data scanners. The data acquisition system controller was an HP9845T desktop computer.

Hose Stream Tests

Two hose stream tests were conducted after fire testing of the test assembly. Hose stream test procedures were those described in the IEEE 634 and ASTM Designation: E119 Test Standards. Equipment and procedures for these tests are as follows:

IEEE 634 - A 75 psi hose stream was delivered through a 1-1/2 in. diameter hose equipped with a fog nozzle set at a discharge angle of 30° from a distance of 10 ft. The spray was delivered over an exposed area of 36x36 in. for a duration of 14 seconds.

ASTM E119- A 30 psi solid stream was delivered through a 2-1/2 in. diameter hose equipped with a National Standard Playpipe with a 1-1/8 in. diameter discharge tip from a distance of 20 ft. The stream was delivered over an exposed area of 48x48 in. for a duration of 24 seconds.

TEST RESULTS

The test assembly containing the two cable tray penetration seal systems was subjected to a 3-hr fire exposure at the fire research facilities of CTL on October 19, 1984.

A listing of furnace atmosphere temperature measurements and variations from the standard are given in Appendix B. Variation of the measured furnace temperatures from the standard was approximately 0.03%, based on comparison of total area under the time-temperature curves. This was well within the 5.00% variation permitted by the Test Standard.(1) Average furnace draft pressure was -0.08 inches of water.

A listing of measured unexposed concrete, interfaces, cable, and seal temperatures is also given in Appendix B. The maximum allowable temperature rise of 325°F+ ambient as defined by ASTM Designation: E814(2) was not exceeded on the unexposed surface of either penetration seal during the 3-hr fire test. Limiting end point temperature rise defined by ASTM Designtaion: E814 was exceeded at several measuring points on cables in both seals. Limiting end point temperture criterion defined by IEEE 634 was exceeded at one measuring point on a power cable in Tray No. 1.

No passage of flame occurred through either penetration seal during the 3-hr fire test.

After the 3-hr fire exposure, the test assembly was removed from the furnace, as shown in Fig. 3, and subjected to the IEEE 634 and ASTM Designation: E119 hose stream tests. Views of exposed and unexposed surfaces of test assembly before hose stream testing are shown in Figs. 4 and 5. Views of hose stream tests are shown in Figs. 6 and 7.

No water projected beyond the unexposed surface of either of the two penetration seal during the IEEE 634 hose stream test. No water projected beyond the unexposed surface of the penetration seal containing Tray No. 1 during the ASTM Designation: E119 hose stream test. Water did project beyond the unexposed surface of the penetration seal containing Tray No. 2 during the ASTM Designation: E119 hose stream test. Views of exposed and unexposed surfaces of the test assembly after hose stream testing are shown in Figs. 8 and 9.

Following the hose stream tests, measurements were made of the thickness of remaining silicone seal material from each opening, as shown in Fig. 10. Remaining thicknesses of unburned materials are listed in Table 1.

TABLE 1 - THICKNESS OF UNBURNED SILICONE FOAM

Measurement Location*	Thickness, inches	
	Tray No. 1	Tray No. 2
West end of seal	6	5
West leg of tray	3-3/4	3-3/4
Mid-point of seal	4	3-3/4
East leg of tray	3-1/2	2-3/4
East end of seal	5	5

*See Fig. 1 for orientation.

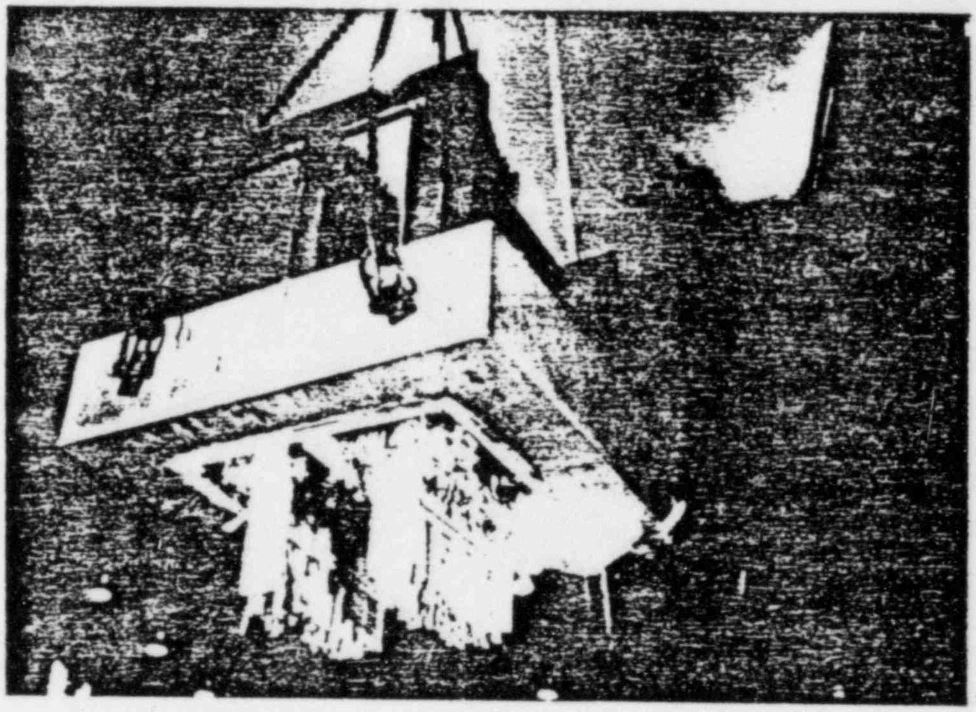


Fig. 3 Specimen Removed from Furnace After Fire Testing

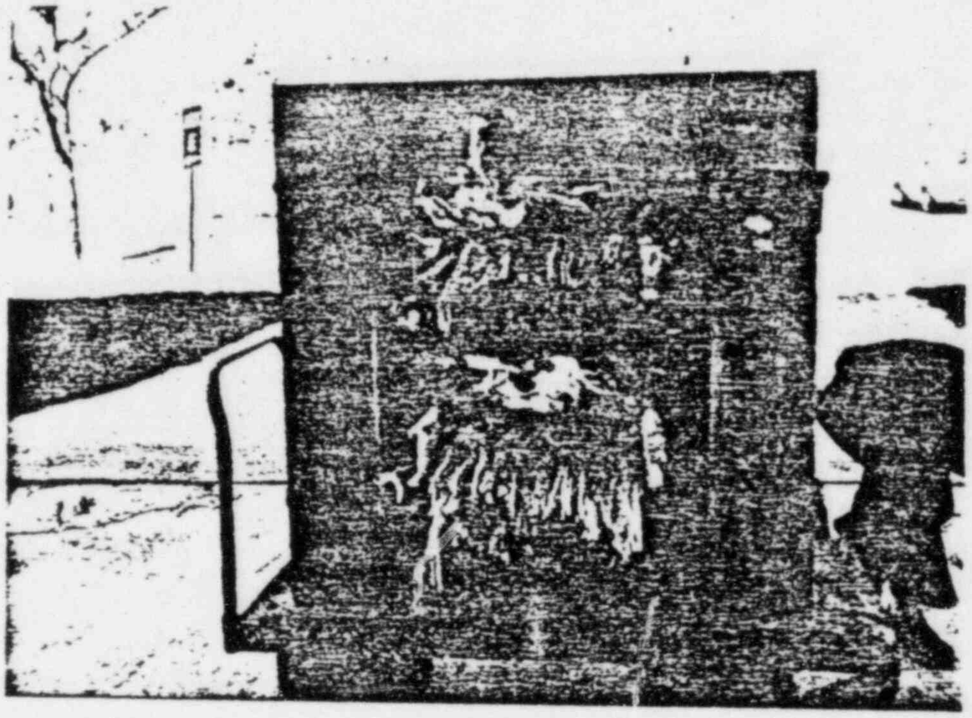


Fig. 4 Exposed Surface of Test Assembly Prior to Hose Stream Testing

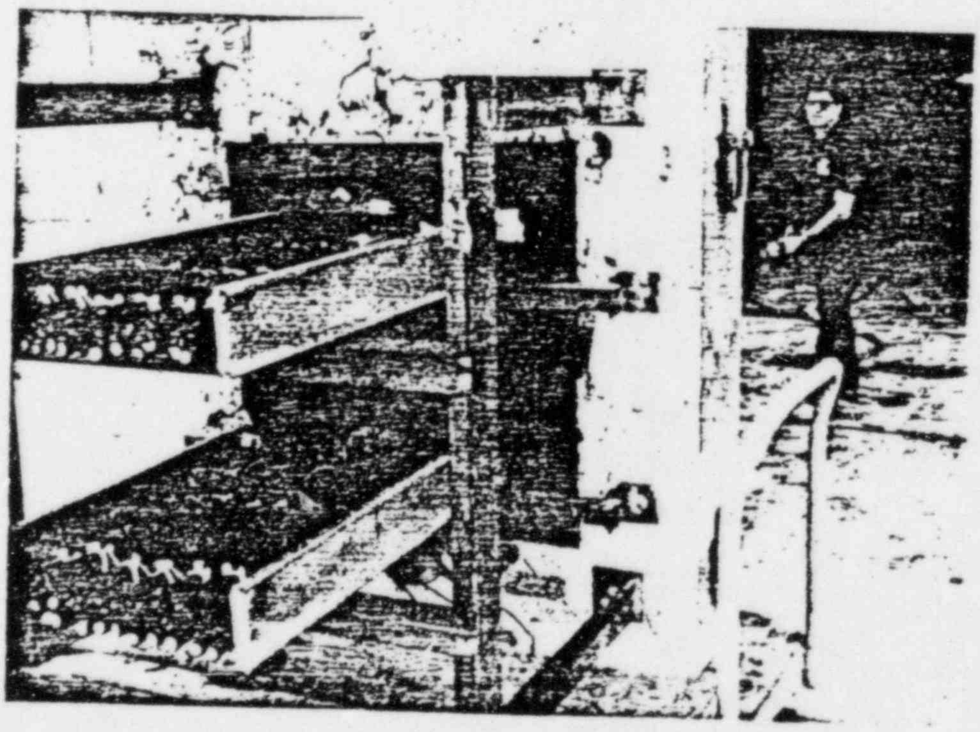


Fig. 5 Unexposed Surface of Test Assembly Prior to Hose Stream Testing

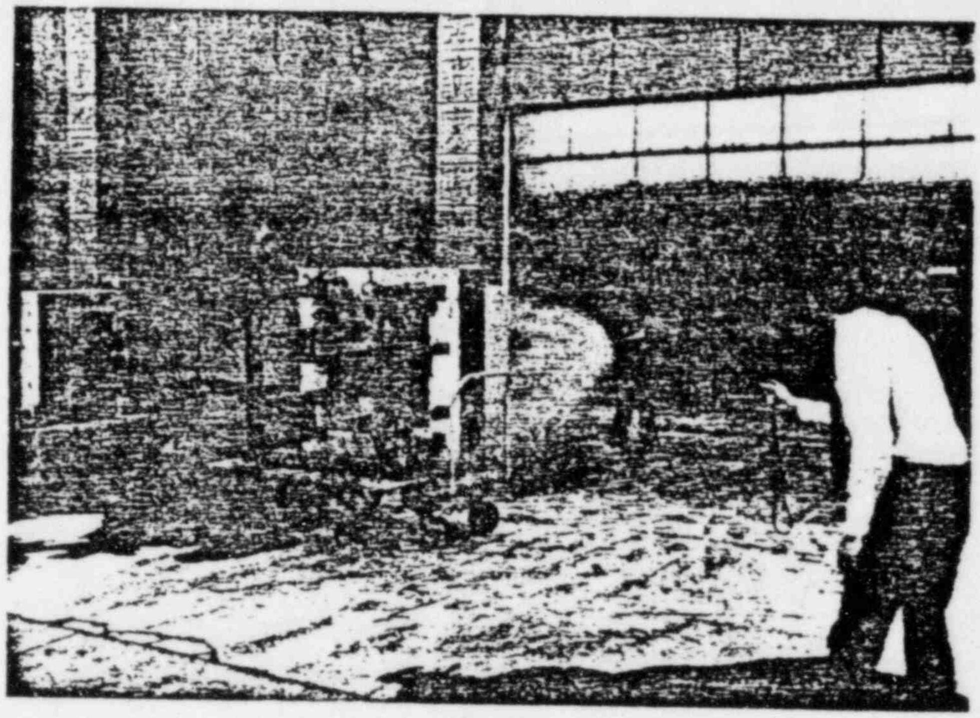


Fig. 6 IEEE 634 Hose Stream Test

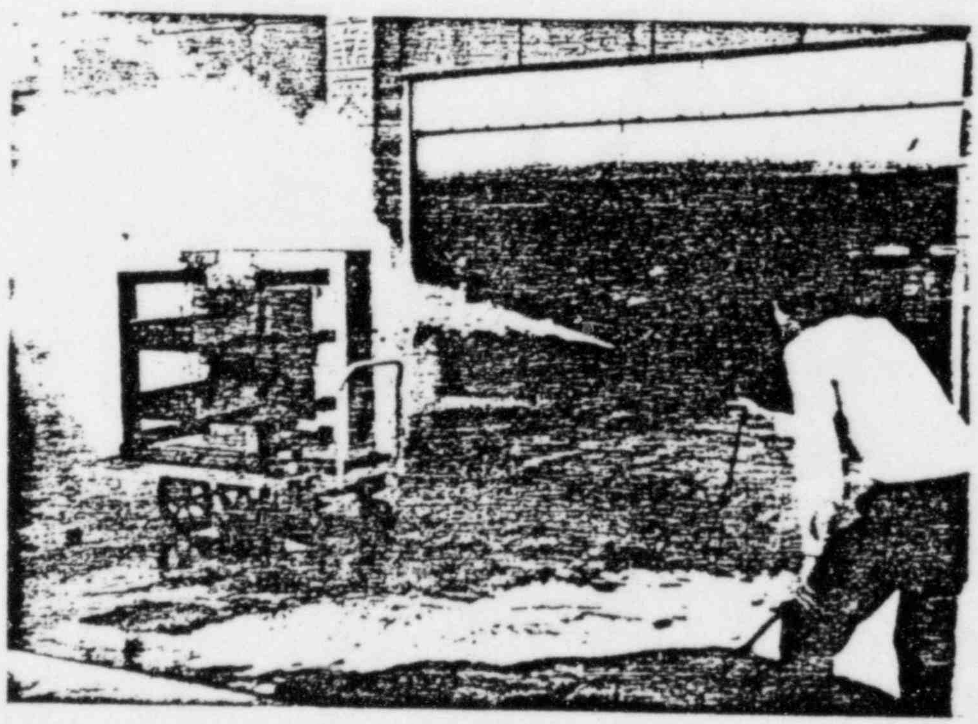


Fig. 7 ASTM E119 Hose Stream Test

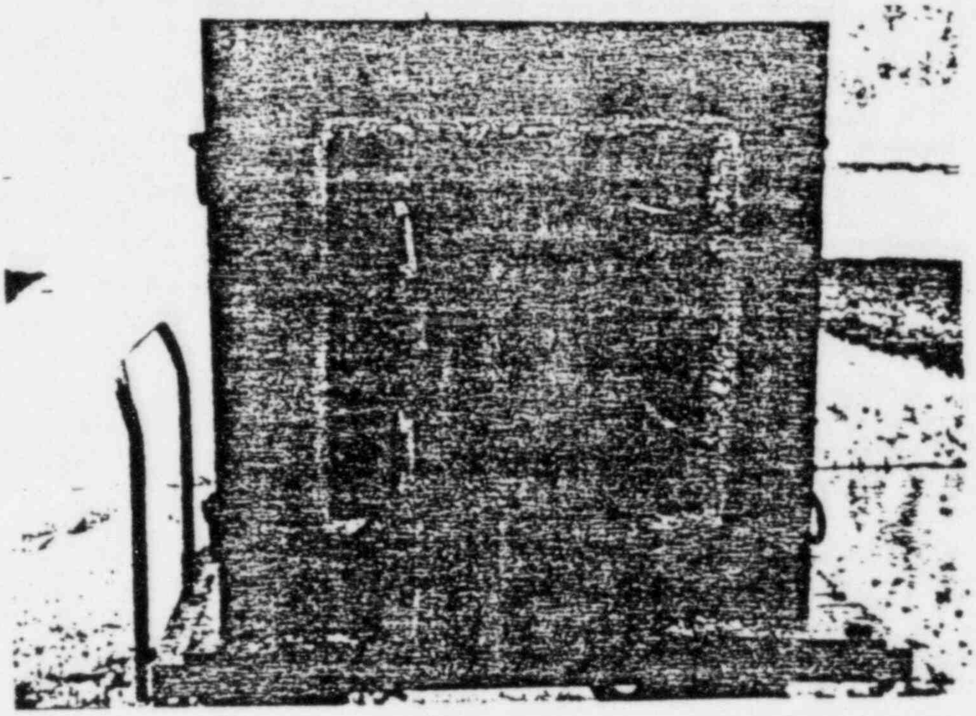


Fig. 8 Exposed Surface of Test Assembly After Hose Stream Testing

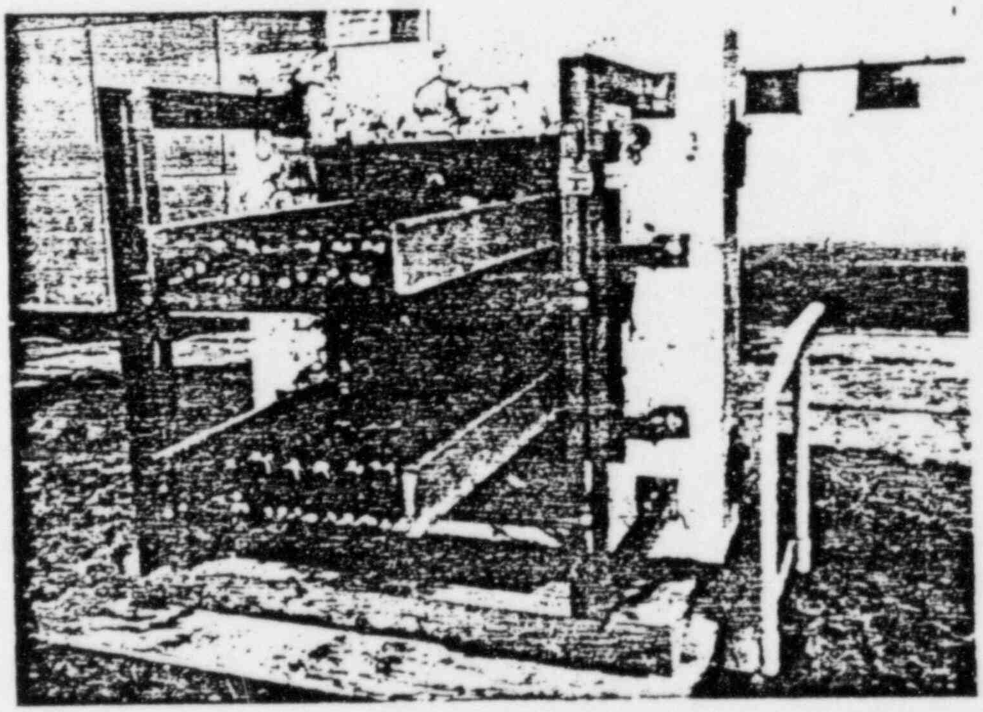
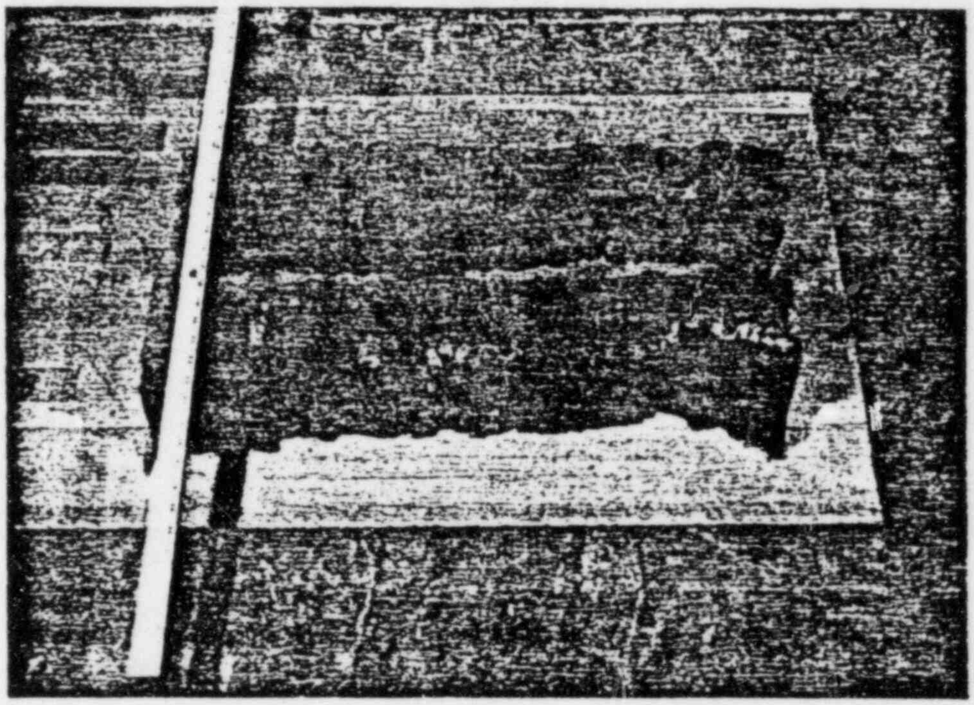
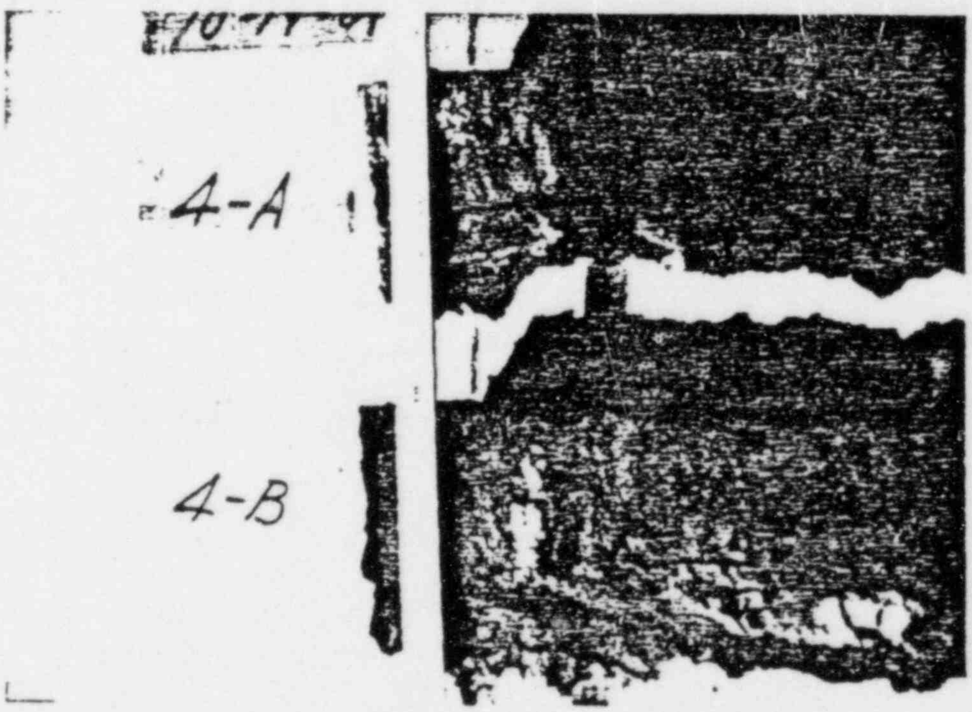


Fig. 9 Unexposed Surface of Test Assembly After Hose Stream Testing



(a)



(b)

Fig. 10 Unburned Silicone Foam Material from Penetration Seals

A = Tray No. 2
B = Tray No. 1

LABORATORY RESPONSIBILITY

The Construction Technology Laboratories is a Division of the Portland Cement Association and was not involved in the design of the Penetration Seal System. Personnel of the Construction Technology Laboratories make no judgment of the suitability of the materials or seal systems for particular end point uses. Acceptance of the test results for guidance for field installation is the prerogative of the authority having jurisdiction.

CONCLUDING REMARKS

This report described fire and hose stream tests conducted on two silicone penetration seal systems. Significant test results are presented in the section entitled SUMMARY OF RESULTS at the beginning of this report.

REFERENCES

1. ASTM Designation: E119, "Standard Methods of Fire Tests of Building Construction and Materials," American Society for Testing and Materials, Philadelphia, PA, 1983.

2. ASTM Designation: E814, "Standard Method of Fire Tests of Through-Penetration Fire Stops," American Society for Testing and Materials, Philadelphia, PA, 1983.

3. Standard IEEE 634-1978, "IEEE Standard Cable Penetration Fire-Stop Qualification Test," The Institute of Electrical and Electronic Engineers, Inc., New York, NY.

7. EVALUATION OF OPERATOR ACCESS TO THE CHARGING PUMP CUBICLES NORTH ANNA POWER STATION

Description of Evaluation

The purpose of this evaluation is to show that station operators will be able to access charging pump cubicles 1C and 2A within 30 minutes of a fire-induced failure of all three of one unit's charging pumps, in order to manually open the isolation valves in the charging pump discharge cross-connection.

Background

There are six charging pumps arranged side by side in individual cubicles on the 244'-6" elevation of the Auxiliary Building. The three on the east end are for Unit 1, and the remaining three are for Unit 2. At least one operable charging pump per unit is required for safe shutdown. In order to assure the availability of at least two charging pumps, Virginia Electric and Power Company has done the following:

1. A discharge header cross-connect pipe has been installed between the Unit 1 charging pumps and Unit 2 charging pumps. This cross-connect header is normally closed, and isolation valves in cubicles 1C and 2A must be manually opened when the cross-connect is needed. This discharge cross-connection between the two units' charging pumps is in accordance with the Fire Protection Safety Evaluation Report issued by the NRC in February of 1979.

2. The power cable routing for the charging pumps were reviewed as part of the Appendix R (to 10 CFR 50) re-analysis to determine the adequacy of the separation of these power cables. It was found that the separation meets the criteria of Appendix R Section III.G.2(b) based on the following:

   a. Separation of the Unit 1 charging pumps cabling from the Unit 2 charging pumps cabling with no intervening combustible by approximately 22'.

b. An exemption request (No. 1) was submitted for the use of partial area detection and suppression. However, detection and automatic sprinkler protection are provided for the area where the cables are located.

3. The individual charging pump cubicles have been separated from one another by fire rated barriers. An Exemption Request, (No.7), has been submitted for the north walls separating the charging pump cubicles and the 244'-6" elevation of the Auxiliary Building.

4. A fire originating in cubicles 1C or 2A and exposing other charging pumps or cable is not considered credible because the charging pump cubicles are almost totally enclosed.

Therefore, the "worst case" fire that can be postulated is one that will disable the power cables of all three charging pumps of one unit. To restore charging to the affected unit, the charging discharge header cross-connect must be manually opened via valves in cubicles 1C and 2A. Charging to the affected unit needs to be restored within approximately 30 minutes after its loss to minimize potential reactor coolant pump seal degradation.

In order to access the manual valves in cubicles 1C and 2A, an operator must enter the fire area (fire area 11 which includes the Auxiliary, Fuel, and Decontamination Buildings), potentially on the same elevation where the fire occurred that disabled the one unit's charging pumps.

The 259'-6" elevation of the Auxiliary Building can be divided into fire zones based on the separation of the Unit 1 and 2 charging pump power cabling. A fire zone is a smaller division of a fire area as defined by Generic Letter 85-01, Section 3.1.1. Therefore, it can be shown that an operator can access both cubicles by a route in a different fire zone than the one in which the fire originated.

Area Description

Fire area 11 consists of the Auxiliary, Fuel, and Decontamination Buildings. For the purposes of this evaluation, only the Auxiliary Building will be considered because of the lack of primary safe shutdown components and a low fuel loading in the other two buildings. The Auxiliary Building is a four-story structure consisting of the 244'-6", 259'-6", 274'-0", and 291'-10" elevations. The CCW and charging pumps are located on the 244'-6" elevation, with the CCW pumps in the main open floor area of this elevation, and each charging pump in a separate cubicle accessed from the 259'-6" elevation. The power feeds for these pumps rise up to the 259'-6" elevation and travel in a northerly direction prior to entering each units Cable Vault and Tunnel.

The main access point into the Auxiliary Building is through its north wall on the 274'-0" elevation via a 3-hour rated fire door from the Service Building. Access is also provided from each unit's Cable Vault and Tunnel at elevation 259'-6".

Evaluation

In order to show that an operator can access charging pump cubicles 1C and 2A within 30 minutes after the loss of one unit's charging capability, the following items must be analyzed:

1. The division of the 259'-6" elevation of the Auxiliary Building into two fire zones based on the separation of redundant cable.

2. The access routes to the charging pump cubicles in terms of emergency lighting, distance, potential obstructions, operator familiarity and the need for protective equipment.

3. Type, size and duration of a fire to be expected to expose the access routes and cubicles.

4. Station resources, both passive and active, that will impact the fire and the ability of the operator to access the cubicles. This includes fire protection systems, the station fire brigade, and administrative controls.

This evaluation is based on the assumption that a fire would disable the power cables of all three charging pumps of a single unit. This is a conservative approach since, as explained in the remainder of this evaluation, there is detection and suppression along the power cables routing and a limited amount of combustibles in the area.

1. Fire Zone Divisions

The charging pumps are located on elevation 244'-6" of the Auxiliary Building. The cubicle walls around each pump extend up to the floor of the next elevation (259'-6"). The charging pump cubicles are accessed through hatches on the 259'-6" elevation. The power cables for the charging pumps also exit the cubicles on the 259'-6" elevation. As shown on Figure 1, they achieve an initial 22' separation and remain separated by an excess of 20' through the point where they exit the Auxiliary Building into their respective units Cable Vault/Tunnel. By virtue of this separation, using the guidance of Generic Letter 85-01, Section 3.1.1, fire zones can be developed for elevation 259'-6". These fire zones are located as follows:

a. Zone 11-1, the east side of elev. 259'-6" from the center of the 20' separation to the east wall (see Figure 1).

b. Zone 11-2 the west side of elevation 259'-6" from the center of the 20' separation to the west wall (see Figure 1).

Due to the separation and the presence of detection and suppression, based on the Appendix R criteria, the fire will be confined to the zone of origin. However, since no rated barrier is involved, heat and smoke may be present in the unaffected zone.

The charging pump cubicles, although not a separate fire zone or fire area will not be involved in a fire in either zones 11-1 or 11-2. The cubicles have three (3) hour rated walls and the floor is on grade. The only openings are at the ceiling of the cubicle which is at the floor of elevation 259'-6" and a fire traveling down and involving the cubicles is not considered credible.

2. Access Routes

The normal access path to the charging pumps 1C and 2A is as follows:

a. Control Room to the Health Physics area of the Service Building (elevation 271'-6").

b. Health Physics area to the Auxiliary Building at elevation 274'-0", and then to the enclosed stairwell along the east wall next to the elevator.

c. Down the stairwell to the 259'-6" elevation.

d. Exit the stairwell to charging pump cubicles 1C and 2A located approximately 50 and 60 feet away, respectively.

e. The normal exit path would retrace these steps.

Travel through the 274' elevation of the Auxiliary Building can be virtually eliminated if the outside personnel door to the Auxiliary Building is used. It is approximately 10' along the east wall between the outside personnel door and the enclosed stairwell door.

This path is within fire zone 11-1. Therefore, this access path to cubicles 1C and 2A can be used for a fire affecting the Unit 2 charging pumps.

Emergency lighting for been installed along the path. In addition, this is the normal access route so the operators are familiar with this path. There are no major obstructions from the stairs to the cubicles. The stairwell is enclosed which will provide the operator protection while descending from elevation 274' to 259'-6" and when leaving the area.

The access route to cubicles 1C and 2A for a fire that disables the Unit 1 charging pumps (zone 11-1) is as follows:

a. Control Room to the electrical penetration area of the Unit 2 Cable Vault/Tunnel at elevation 259'-6". This is done via the Turbine Building and the Emergency Switchgear room.

b. Go through the door in the southeast corner of the electrical penetration area directly into the 259'-6" elevation of the Auxiliary Building.

c. Turn north and proceed to cubicles 1C and 2A.

This route affords protection in an area separated by a 3-hour rated barrier until actually entering the 259'-6" elevation. Emergency lighting is available along this route. It is approximately 100' from the Cable Vault/Tunnel door to the cubicle hatches, and there are no major obstructions in this path.

In both cases, the operator should be prepared to encounter some smoke and heat conditions. Self-contained breathing apparatus (SCBA) should be carried to the point of entry into the 259'-6" elevation of the Auxiliary Building. The SCBA can be obtained in the Control Room or in the H.P. area. As a safety precaution, the operator should wear the SCBA from the protected area to the charging pump hatch. The hatch is wide enough to permit wearing an SCBA while descending into the cubicle. Operators are trained in the use of SCBA's. Radio communication between the operator and the Control Room or Fire Brigade Leader can be used to get information on the conditions in the Auxiliary Building. As noted above the two cubicles to be entered will not be involved in the fire, so the operator will be protected while performing his actions.

The operator will be in a position to access the cubicle within 15 minutes.

3. Auxiliary Building Fires

The Auxiliary Building is a non-combustible structure (primarily concrete, especially on the lower elevations). The combustible loading in the Auxiliary Building is documented in the 1985 Combustible Loading Analysis. The combustible loading in the two elevations that expose the access paths and the charging pump power cables (244'-6" and 259'-6") is low (less than 20,000 BTU/sq. ft.), and the standard duration is 10 minutes or less.

It is important to consider the types of combustible and the contributions they will make in a postulated fire. The following combustibles are taken from those listed in the 1985 Combustible Loading Analysis for the Auxiliary Building.

a. Cable Insulation - Cable insulation makes up approximately 60% of the combustible loading on the lower two elevations. The cable in the Auxiliary Building is virtually all IEEE-383 rated. Cable insulation normally requires a substantial fire for ignition and to provide sufficient heat input to sustain combustion.

   The cabling is located primarily on the 259'-6" elevation at the ceiling level. Therefore, the heat and smoke generated by a cable insulation fire would be above the level the operator must travel to the cubicles.

b. Lube Oil - The charging pumps and CCW pumps both contain lube oil. The majority of the lube oil is contained in the charging pumps (30 gallons per pump). Since each charging pump is in an individual cubicle (but is considered part of elevation 244'-6" when calculating combustible loading), that portion of the lube oil is not a factor. Lube oil for the CCW pumps is not under pressure and is in a lesser quantity (12 gallons each) than in the charging pumps. Transient lube oil is only brought in during an oil change for a specific pump .

c. Class A Combustibles - Step-off pads and protective clothing along with maintenance supplies are the primary Class A combustible in the Auxiliary Building. The amount listed in the referenced analysis is during an outage when the transient combustible loading is at its peak.

d. Other Combustibles - There are several other combustibles (i.e., grease and hydrogen) in quantities so small (see the 1985 Combustible Loading Analysis), as to not make them an individual factor.

The configuration of the Auxiliary Building will also help reduce the heat exposure to the operator. The Auxiliary Building has several open shafts and high ceilings that will allow heat and smoke to rise to the upper elevations away from the paths that the operator must take to reach the cubicles. There are numerous thick concrete shielding floors and walls. Although these walls may not be specifically fire rated, they are effective barriers to fire spread and will provide protection for the operators as well as the fire brigade. There are several openings to the exterior of the Auxiliary Building on upper elevations where smoke can be exhausted.

4. Station Resources

a. Detection and Suppression

There is a detection system in the Auxiliary Building (although it does not provide full area coverage, see Exemption Request 1). The detectors are concentrated on the 244'-6" and 259'-6" elevations where the charging and CCW pumps and associated cabling are located. These detectors, ionization type smoke detectors, annunciate in the Control Room. Detection will provide an early warning of a fire, normally while it is still in an incipient stage that can be handled with a fire extinguisher. There is normally personnel in the Auxiliary Building. Operators and Health Physics (H.P.) technicians as well as Security personnel make periodic rounds of the Auxiliary Building. Personnel in the Auxiliary Building will be able to detect a fire or confirm a detection alarm very quickly. This will enable the personnel in the Auxiliary Building (if trained), or the fire brigade, additional time to assemble and extinguish a fire in the first critical moments of the fire.

There is an automatic wet pipe sprinkler system on portions of the 244'-6" and 259'-6" elevations of the Auxiliary Building (see Figures 7-1 and 7-2). The primary goal of this sprinkler system is to protect the CCW pumps and the associated cabling of the charging and CCW pumps. In addition, the sprinkler system will provide the following benefits in terms of operator access to the charging pump cubicles:

(1) Prevent flashover - Flashover is defined as the point where all combustibles in the room reach their ignition temperature and is recognized as the threshold between a readily controllable fire and rapid growth fire. Preventing flashover will almost assure operator access to the elevation.

(2) Reduce the fire's output of heat and smoke which improves visibility and accessibility of the area.

(3) Reduce and control the size of the fire.

The sprinkler system has a flow alarm that provides annunciation in the Control Room.

Hose stations and portable fire extinguishers are provided throughout the Auxiliary Building.

b. Fire Brigade

North Anna Power Station has a fire brigade that meets the criteria of Branch Technical Position APCSB 9.5-1 Section B-4 (August, 1976). The brigade has a minimum of five members including a trained brigade leader who, along with two of the other brigade members, are plant operators. In addition to the assigned brigade members, North Anna has additional brigade members who may be available to fight fires.

The fire brigade is fully equipped with SCBA's, radios, fire fighting equipment, and detailed pre-fire plans.

The response time of the fire brigade obviously varies with the location of the fire. Response time is recorded as a critique item during fire drills. Experience has shown the response time to the Auxiliary Building to be less than 10 minutes. This time includes the arrival, in turnout gear, of a full compliment of brigade members. Due to the low level of combustible and the detection and suppression systems, the fire brigade should be able to quickly control a fire.

Therefore, within 30 minutes the fire brigade will be able to assemble, attack, and control or completely extinguish a fire.

The fire brigade will be in radio contact with the Control Room and most likely the operator who will access the cubicle. The fire brigade will be able to provide any assistance the operator needs in accessing the cubicle. This may include information on the fire location, quantities of heat and smoke, suggested paths, or even hose stream protection of the path. Although credit cannot be taken under Appendix R, one of the operators on the fire brigade via instruction from the Control Room could access the cubicles and operate the valves. This would not jeopardize the fire fighting activities since the time required to perform the operator action is less than 5 minutes.

c. Administrative Controls

North Anna has a number of station policies and procedures that provide for fire prevention. The ones with the greatest impact are:

(1) North Anna Fire Protection Program

(a) Flame and Welding permit and procedure system

(b) Limits on storage and use of flammable and combustible liquids

(c) Limits on storage and use of transient combustibles

(2) Housekeeping Policy

(3) Q.A. Inspections

While these procedures do not assure that fires will be prevented, they will reduce the likelihood and the potential effects should a fire occur.

Conclusion

An operator will be able to access charging pump cubicles 1C and 2A within 30 minutes of the loss of charging for one unit due to a fire in the Auxiliary Building. The bases for this conclusion are as follows:

1. Access pathways to the two cubicles are available for a fire disabling either unit's charging pumps.

2. Both access routes have emergency lighting, protected stairways, and direct paths to the cubicles.

3. The operators are familiar with both routes and will be able to communicate with the fire brigade on conditions in the Auxiliary Building.

4. Breathing apparatus is available to the operator.

5. The combustible loading in the Auxiliary Building is low, especially on the two lower elevations where the standard duration of a fire has been calculated to be 10 minutes or less.

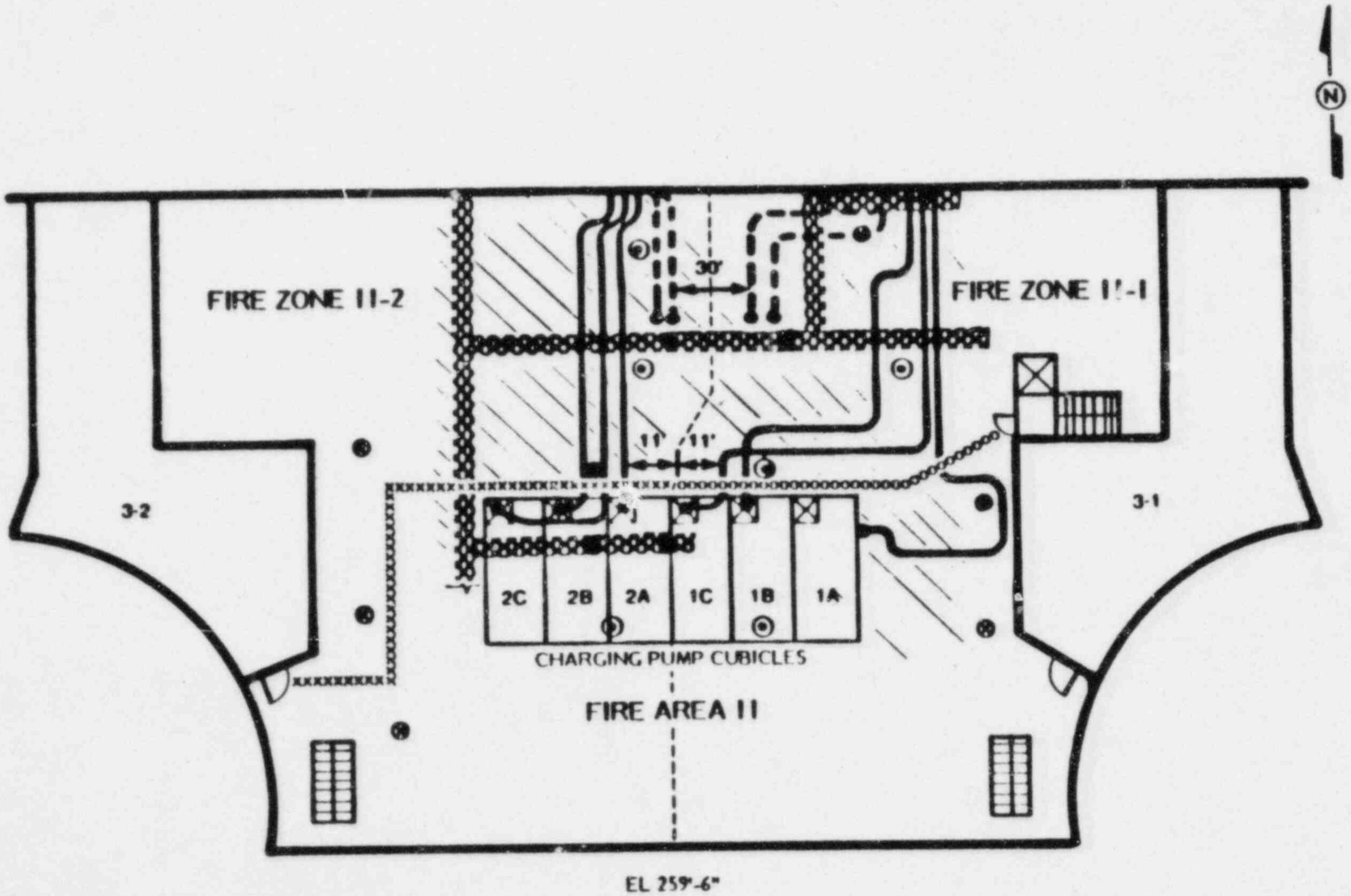
6. The configuration of the combustibles and the construction of the Auxiliary Building will reduce exposure to the pathways.

7. Ionization smoke detectors are installed on the 244'-6" and 259'-6" elevations of the Auxiliary Building, in the vicinity of the charging and CCW pumps and power cables. The detection annunciates in the Control Room.

8. An automatic sprinkler system is installed on the same two elevations in the vicinity of the power cables for the charging pumps and CCW pumps, as well as along most of the access routes.

9. The station fire brigade will assemble, and control or extinguish a fire in the vicinity of the access paths within 30 minutes and will be able to provide any protection needed for the operator.

Therefore, an operator will be able to restore charging to one unit from the other unit via the charging pump discharge cross-connect header to allow safe shutdown of the plant.



AUTOMATIC SUPPRESSION

INTERVENING CABLE TRAYS

CHARGNG PUMP POWER FEED

CCW PUMP POWER FEEDS

SMOKE DETECTORS

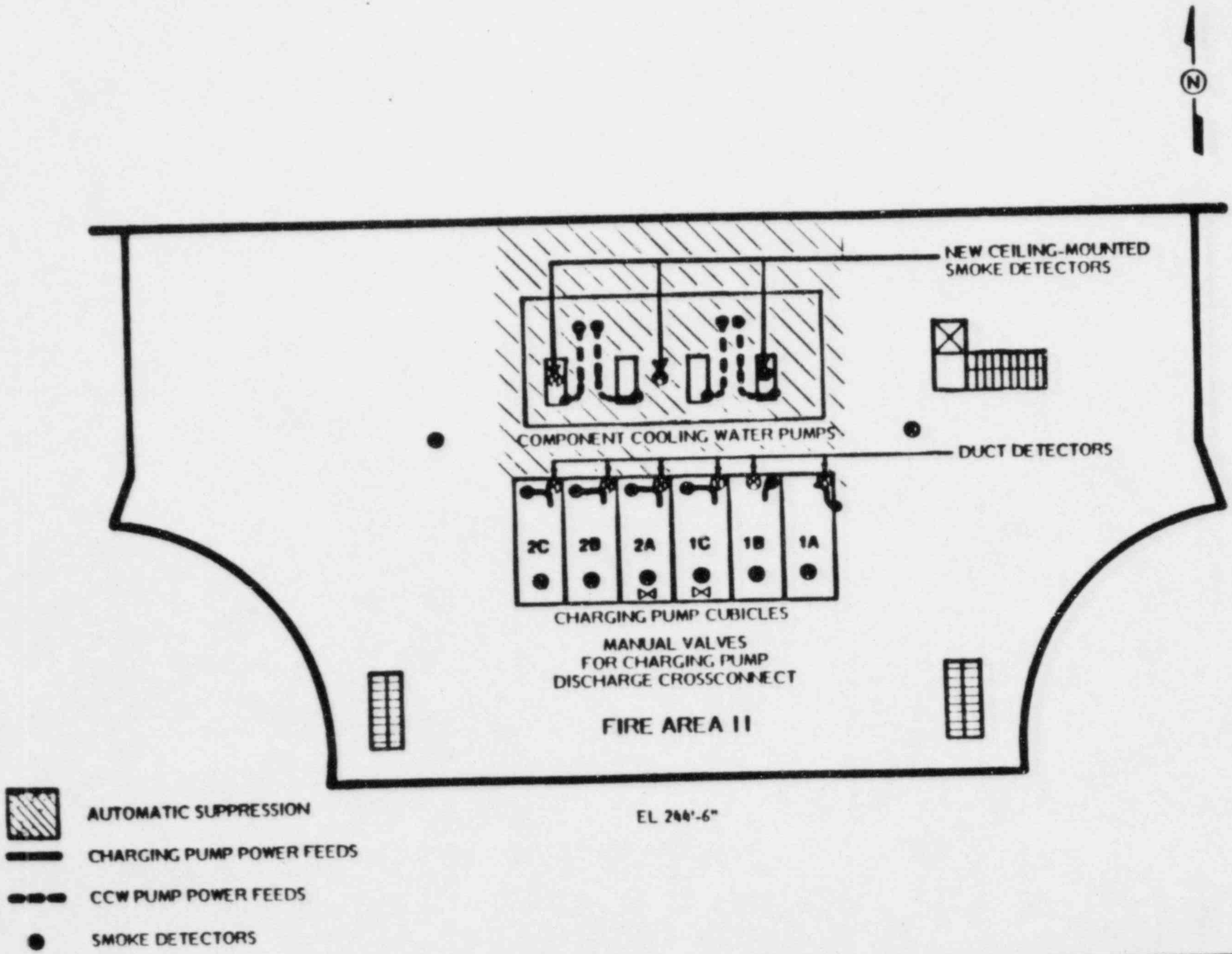
FIRESTOPS

ooooo ACCESS ROUTE FOR FIRE IN FIRE ZONE 11-2

xxxxx ACCESS ROUTE FOR FIRE IN FIRE ZONE 11-1

------ DIVISION LINE BETWEEN FIRE ZONES 11-1 & 11-2

VIRGINIA ELECTRIC & POWER COMPANY NORTH ANNA POWER STATION UNITS 1 & 2	AUXILIARY BUILDING ELEVATION 259'-6"	FIGURE NO. 7-1



VIRGINIA ELECTRIC & POWER COMPANY NORTH ANNA POWER STATION UNITS 1 & 2	AUXILIARY BUILDING ELEVATION 244'-6"	FIGURE NO. 7-2

8. EVALUATION OF OPERATOR ACCESS TO THE MOTOR DRIVEN AUXILIARY FEEDWATER PUMP ROOM NORTH ANNA POWER STATION

Description of Evaluation

The purpose of this evaluation is to show that station operators will be able to access the Motor Driven Auxiliary Feedwater (MDAFW) Pump Room within 30 minutes of a fire-induced failure of both MDAFW pumps in order to manually operate valves to realign the turbine driven auxiliary feedwater pump. This evaluation applies to North Anna Power Station Units 1 and 2.

Background

Each unit at North Anna is equipped with three auxiliary feedwater pumps. Two of these pumps are motor driven, and the third pump is turbine driven. The motor driven pumps are in a separate enclosure from the turbine driven pump, and there is a three (3) hour rated fire barrier between the enclosures in accordance with 10 CFR 50, Appendix R, Section III.G.2(a). An Exemption Request (no. 5) from Section III.G.3. has been submitted for the lack of fixed fire suppression in the motor driven AFW pump rooms. This exemption regards the condensate storage tank level transmitters and does not impact this evaluation.

A fire in the MDAFW pump room could disable both motor driven pumps and require the use of the turbine driven pump to provide auxiliary feedwater. The turbine driven AFW pump is normally aligned to feed one steam generator. Virginia and Electric Power Company's current analysis has determined that this will provide adequate heat removed for approximately 30 minutes. After 30 minutes, auxiliary feedwater must be realigned for adequate heat removal. In order to realign the auxiliary feedwater flow from the turbine driven AFW pump, valves must be manually operated in the MDAFW pump room. In addition, air or motor operated valves may have to be manually aligned if spurious signals, caused by the fire, affected the valves normal position. These air and motor operated valves are also located in the MDAFW pump room. Therefore, entry into the MDAFW pump room within approximately 30 minutes after the loss of the motor driven AFW pumps is required.

Area Description

Fire areas 14B-1 and 14B-2 contain the motor driven auxiliary feedwater pumps for Units 1 and 2, respectively, of North Anna Power Station. Each fire area is located in a separate structure which is distinct from all other plant structures and is dedicated solely to the auxiliary feedwater system. Fire areas 14B-1 and 14B-2 are bounded to the north by Fire areas 14A-1 and 14A-2, which are the turbine-driven AFW pump fire areas, and to the south by the 110,000 gallon condensate storage tanks.

The walls and roof of fire areas 14B-1 and 14B-2 are constructed of 24" thick reinforced concrete. All penetrations in the north wall are sealed to a 3-hour fire rating with Dow Corning silicone RTV foam. Access to fire areas 14B-1 and 14B-2 is through unrated hollow metal exterior doors in the east and west walls for Unit 1 and Unit 2, respectively.

Evaluation

In order to show that an operator can access the motor driven AFW pump rooms within 30 minutes after the loss of the motor driven AFW pumps, the following must be analyzed:

a. The type, size, and duration of a fire expected in the motor driven AFW pump room.

b. Station resources, both passive and active, that will impact the fire and the ability of the operator to access the pump room. This includes fire protection systems, the station fire brigade, and administrative controls.

c. Operator access to the motor driven AFW pump room and to the valves.

This evaluation is based on the assumption that a fire would disable both motor driven pumps concurrent with the loss of off-site power. This is a conservative "worst case" approach since, as explained in the remainder of this evaluation, there are a number of factors (low level of combustibles, smoke detection, enclosed lube oil system, etc.) that will limit a fire in the room.

1. MDAFW Pump Room Fire

The motor driven AFW pump rooms are small (approximately 750 sq. ft.) concrete rooms that are part of a structure that also houses the turbine driven AFW pump. There is a 3-hour rated barrier between the motor and turbine driven AFW pump rooms. The structural components are non-combustible. The combustible loading in the motor driven AFW pump room is given in the 1985 Combustible Loading Analysis. Lubricating oil is the only listed combustible and the amount results in approximately 10 minutes of equivalent fire severity.

The lubrication oil in the room is a high flashpoint oil (in excess of 200°F). The 1985 Combustible Loading Analysis states that there is 12 gallons of lube oil in each pump. The additional 12 gallons is considered to be the transient lube oil in the room, while the oil from one MDAFW pump is being changed. Therefore, normally there will be only 24 gallons of lube oil in the room.

Since lube oil is the only combustible noted by the Combustible Loading Analysis in the MDAFW pump rooms, it should be considered in any fire scenario for the rooms. Lube oil has a high flashpoint and is considered a Class III B combustible liquid (flashpoint in excess of 200°F). The exact flashpoint will vary somewhat with each manufacturer's oil, but it will be in the Class III B range. In order to ignite, lube oil must be pre-heated or atomized and sprayed onto a heat source. If the pump is not in operation, it is very unlikely that either of these conditions will occur. Even welding sparks falling into a cold lube oil spill normally do not create sufficient heat to ignite the oil. In addition, the lube oil system for the pump is non-pressurized and is in an enclosed system. Therefore, it must be postulated that the pump is running or has recently been running, and the lube oil system fails before ignition of the oil can occur. The room has metal grating at the floor elevation over a trench that extends down approximately 24". Oil will pool in the trench away from heat sources.

Although hardly credible, as shown above, for the purpose of the evaluation it is assumed that the lube oil will ignite and include the oil from both pumps. As shown in the referenced Combustible Loading Analysis, even if all the combustibles in the room were involved, the equivalent fire severity is less than 10 minutes under ideal combustion conditions.

2. Station Resources

a. Fire Protection Systems

There is a smoke detection system in the MDAFW pump room which alarms in the Control Room. Smoke detectors are designed to detect a fire in its incipient stages before there is heat and smoke build-up that could damage equipment or prevent entry. Since the smoke detectors annunicate directly to the Control Room prompt action can be taken, including notification of the fire brigade and starting corrective action. Fire extinguishers are located at the entrance to the MDAFW pump rooms and yard hydrants with hose houses are located nearby.

b. Fire Brigade

North Anna Power Station has a plant fire brigade that meets the criteria of Branch Technical Position APCSB 9.5-1, Section B-4 (August, 1976). The brigade has a minimum of five trained members including a brigade leader (who receives additional training) who, along with two other brigade members, are plant operators. This level of manning is provided for all shifts. In addition to the assigned brigade members, North Anna has additional brigade members that may be available to fight fires.

The fire brigade is fully equipped with all necessary fire fighting equipment as well as detailed pre-fire plans, including one for the MDAFW pump rooms.

The response time of the fire brigade will obviously vary according to several factors, such as: location, time of day, plant status, etc. However, experience has shown (via the fire brigade drill critique sheets which records response time) that response time to the motor driven AFW pump rooms is less than 10 minutes. This time includes the arrival, in full turnout gear, of a full complement of brigade members.

Due to the low level of combustibles in the room, the brigade will be able to quickly control the fire. Lube oil, like most Class III B combustible liquids, can be extinguished with fog streams. A fog nozzle will be especially effective on a fire in this room because it is "tight" enough to allow the resulting steam to assist in suppressing the fire by oxygen displacement. Fire extinguishment should be accomplished within 5 to 10 minutes after the arrival of the fire brigade. Therefore, the total elapsed time from the fire brigade notification to extinguishment should be approximately 20 minutes in the worst case conditions.

The fire brigade is in radio contact with the Control Room and possibly the operator who will be entering the pump room to align the valves. The brigade will be able to assist the operator if needed. This assistance may include information on fire and smoke conditions. Although credit cannot be taken under Appendix R, one of the operators on the fire brigade via instructions from the Control Room, could enter the pump room and operate the valves.

c. Administrative Controls

North Anna has a number of station policies and procedures that provide for fire prevention. The ones with the greatest impact are:

(1) North Anna Fire Protection Program

(a) Flame and Welding permit and procedure system

(b) Limits on storage and use of flammable and combustible liquids

(c) Limits on storage and use of transient combustibles

(2) Houskeeping Policy

(3) Q.A. Inspections

While these procedures do not assure that no fire will occur, they will reduce the likelihood and the potential effects should a fire occur.

3. Operator Access

In order to access the motor driven AFW pump room, the operator will take the normal route from the Control Room. Emergency lighting is provided either by 8 hour battery powered lights or by the station security lighting system, which is powered by the security diesel generator.

The MDAFW rooms are small so the path from the door to the valves are direct. Emergency lighting is provided throughout the room, and in the event of its failure, the portable lighting the fire brigade brought to the area can be used. The operator can use self-contained breathing apparatus (SCBA) if conditions require. SCBA's are available in the Control Room, or one brought to the area by the fire brigade can be used. Operators are trained in the use of SCBA's.

It will take less than 30 minutes for an operator to receive instructions from the Control Room, travel to the MDAFW pump room, enter the room, and operate the valves.

Conclusions

An operator will be able to access the motor driven auxiliary feedwater pump room within 30 minutes in order to manually operate valves . The bases for this conclusion are as follows:

1. The combustible loading in the room is very low and has an equivalent fire severity of less than 10 minutes.

2. It is very unlikely that a fire could occur in the MDAFW pump room since lube oil (a Class III B combustible liquid) is the primary combustible, and the lube oil is not pressurized and is in an enclosed system.

3. The room has a smoke detection system annunciating to the Control Room.

4. Portable fire extinguishers and yard hydrants with hose houses are located nearby.

5. The station has a fully equipped and trained fire brigade capable of assembling and responding to a fire within 10 minutes.

6. The type of combustibles and room configuration are such that extinguishment should be accomplished within 10 minutes of the fire attack.

7. The fire brigade will be able to provide assistance to the operator if necessary.

8. SCBA's are available for use by the operators if needed for entering the room. Operators are trained in the use of SCBA's.

TABLE OF CHANGES

Please remove and insert the pages and tables listed below in your copy of the North Anna 10 CFR 50 Appendix R Report, Volumes I and II:

VOLUME I

1. Insert entire volume (Table of Contents, Executive Summary, Chapters 1-5 and Appendixes A and B).

VOLUME II

Table of Contents

1. Remove the Table of Contents. Insert new Table of Contents.

Chapter 6

1. Remove Chapter 6. Insert new Chapter 6 (Pages I-1 through III-6).

Chapter 7

1. Remove Preface to Exemptions. Insert new Preface to Exemptions.

2. With the exception of Summary Evaluation Tables, photographs, and figures, remove the text from the following exemption requests and insert new text:

   1, 2, 3, 4, 5, 7, 14, 15, 17, 19, 20

   21, 22, 23, 24, 25, 26, 27, 28, 31, 32

3. Remove Exemption Requests 6, 8, 10, and 11. Insert new Pages 6-1, 8-1, 10-1, and 11-1.

4. Remove text and table for Exemption Request 16 and replace with new text and table.

5. Insert new Exemption Requests 33, 34, and 35.