Commonwealth Edison
One First National Plaza, Chicago, Illinois
Address Reply to: Post Office Box 767
Chicago, Illinois 60690

September 20, 1983

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Subject: Byron Generating Station Units 1 and 2
Braidwood Generating Station Units 1 and 2
Fire Protection
NRC Docket Nos. 50-454 and 50-455

Reference (a): August 3, 1983, letter from B. J. Youngblood to D. L. Farrar.

Dear Mr. Denton:

This is to provide additional information regarding fire protection at Byron and Braidwood stations. Attachment A to this letter addresses the NRC concerns which were identified during the July audit at Byron Station and which were subsequently documented in reference (a). Where necessary, revised pages for the Fire Protection Report are provided. These pages will be incorporated into the Fire Protection Report in a future amendment.

Although the July NRC audit included a visit to only Byron Station, most of the concerns identified to relate both Byron and Braidwood stations. Since these plants are for the most part duplicates, our responses to the NRC concerns generally apply to both plants.

It is requested that immediate attention be given to the review of our responses to NRC concerns 8 and 10. These concerns involve possible hardware changes which might not be avaiable in time for the Byron 1 fuel load.

Please address further questions regarding this matter to this office.

B002
1/1

One signed original and fifteen copies of this letter and the attachment are provided for your review. Five copies of the four technical reports referenced in the response to Concern 1 are also provided.

Very truly yours,

B. Rybak for

T. R. Tramm
Nuclear Licensing Administrator

lm

cc: Mr. Robert Barnes

7337N

ATTACHMENT A

Responses to 18 NRC Concerns

Raidsed During the July 12-15, 1983

Byron Fire Protection Audit

7337N

BYRON - 1

RESPONSES TO FIRE PROTECTION SITE AUDIT CONCERNS

Concern No. 2

The following features of the fire protection program were observed to be incomplete:

A) The installation of penetration seals in fire walls and fire rated floor/ceiling assemblies.

B) The provisions of seismic supports for the Hydrogen supply piping routed through the Auxiliary Building.

C) The installation of fire proofing for steel structural elements.

D) The installation of fire hose nozzles, hose houses and hose-house fire fighting equipment.

E) The third repeater for the plant emergency communications network.

F) The O.S. Y-type sectional control valve at the discharge outlet for the fire pumps to avoid the necessity of shutting off one fire pump in order to test the other.

The applicant should verify that these features of the fire protection program will be completed by fuel load.

Response

A) All required penetration seals for fire walls and fire rated floor/ceiling assemblies will be installed by fuel load.

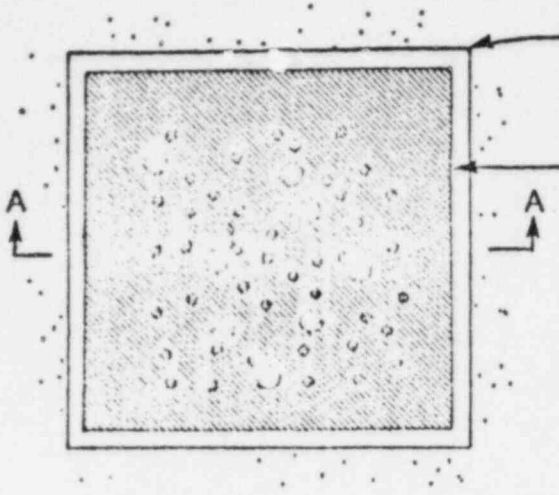
B) It is the applicants practice to seismically support all piping in Category I structures, including Category II piping. A review of the hydrogen piping reveals that it is in fact seismically supported in the auxiliary building.

C) All structural steel elements requiring fire proofing will be coated by fuel load.

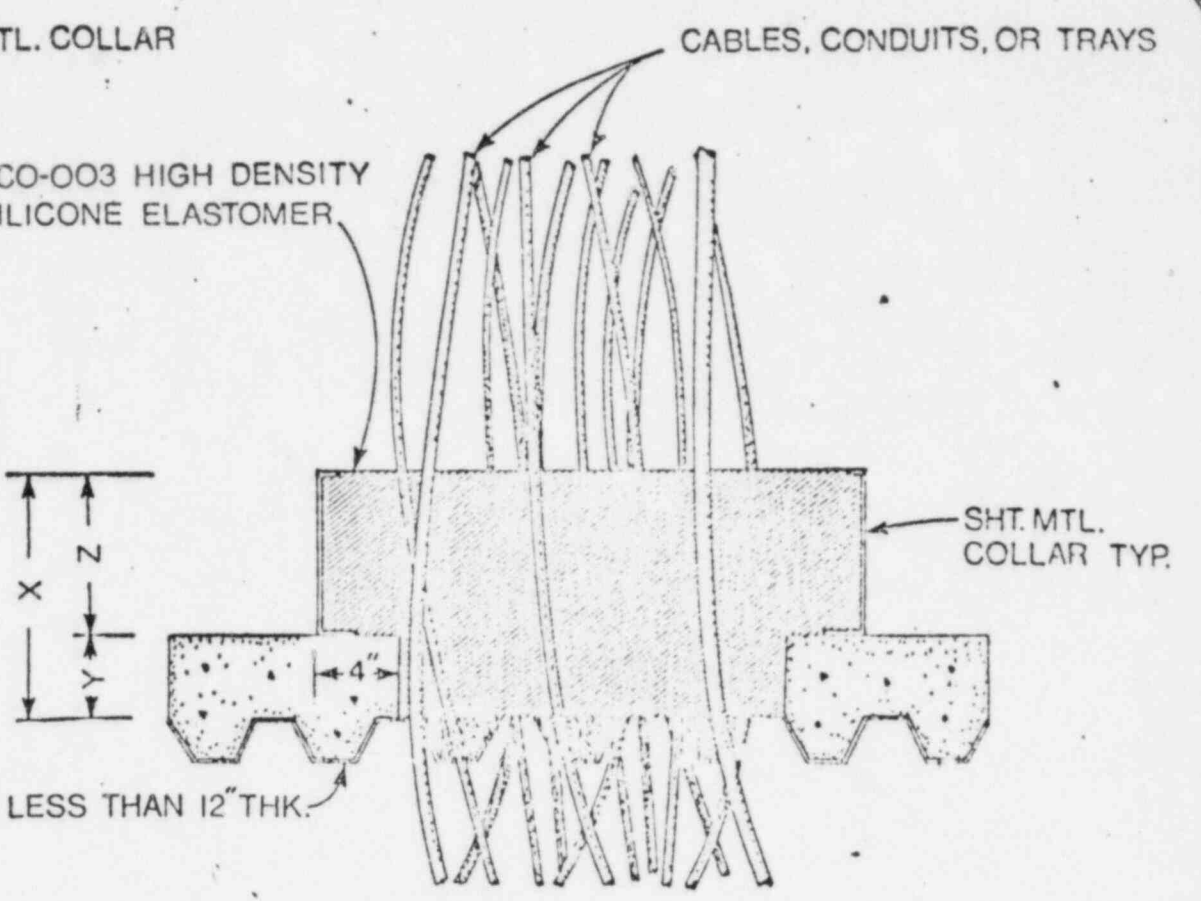
D) All fire hose nozzles, hose houses, and hose house fire fighting equipment will be installed and available for use prior to fuel load.

E) The third radio repeater for the plant communications network has been installed.

F) The control valve in the discharge header of the fire pumps has been installed.



PLAN OR ELEVATION



SECTION A-A

NOTES:

1. X = 12"
   Y = VARIES
   Z = X-Y

TRANSCO. INC.

REVISIONS		
NO.	DATE	BY
1		
2		
3		
4		
5		

BYRON N.P.S., UNITS I AND II
COMMONWEALTH EDISON CO.

TCO-003 HIGH DENSITY SILICONE ELASTOMER FOR THIN FLOORS OR WALLS (LESS THAN 12" THK)

DRAWN BY GJJ	SCALE NA	MATERIAL TCO-003 H.D.E.
CHK'D [illegible]	DATE 8-17-83	DRAWING NO.
TRACED	APP'D [illegible]	BY-E-11

BYRON - 1

RESPONSES TO FIRE PROTECTION SITE AUDIT CONCERNS

Concern No. 3

To comply with Section C.6.a of BTP CMEB 9.5.1, electrical circuits associated with automatic fire suppression systems, including fire detection circuits, are required to be Class "A" supervised such that system activation is possible automatically under a single break or ground fault condition. Information was unavailable during the audit to completely verify this design feature in the plant. With the exception of the redundant fire detection systems in the cable spreading rooms, (where activation of either system initiates fire suppression system discharge), the applicant should verify that all circuits associated with automatic fire suppression systems are Class "A", including those circuits from the local fire alarm panels to the suppression system actuating mechanism.

Response

Contrary to the NRC's documentation of this concern, Section C.6.a of BTP CMEB 9.5.1 does not require Class "A" supervision for all circuits associated with automatic fire suppression systems. Section C.6.a only specifies that "fire detection systems should comply with the requirements of Class "A" systems as defined in NFPA 72D." During the NRC's review of the fire protection program prior to the issuance of SER, CMEB requested CECo to identify what kind of supervision (Class A, B, or none) is provided for fire detection and suppression systems.

CECo's response (dated January 19, 1982) to this request, stated that all fire detection circuits associated with automatic fire suppression systems protecting areas which contain equipment or cables which perform a safety function will be provided with Class A supervision or its equivalent in redundancy and supervision. It was also stated that all remaining fire detection circuits and fire suppression circuits will be Class B supervised. Based on this response, the staff concluded that the fire detection system meets the guidelines of BTP CMEB 9.5.1, Section C.6.a and is therefore acceptable. This conclusion is documented in the Byron SER. Since Section C.6.a of BTP CMEB 9.5.1 refers only to Class A supervision for fire detection circuits, and the Byron SER states that Byron is in compliance with the guidelines outlined in that section. Class A supervision for all circuits associated with automatic fire suppression systems is not required.

BYRON - 1

RESPONSES TO FIRE PROTECTION SITE AUDIT CONCERNS

Concern No. 4

In the August 16, 1982 revision to the Fire Protection Report, the applicant committed to comply with Section C.5.d of BTP CMEB 9.5.1 and with Section C.7.b, with the exception that an automatic fire suppression system will not be installed in "offices" in the control room complex. We observed that the computer related storage area adjacent to the control room is not equipped with an automatic fire suppression system which is not consistent with these commitments.

Response

The estimates of combustible material inventories and the resulting fire loadings for the rooms in question have been revised. As a result, the fire loadings have been substantially reduced. The initial estimates were made over five years ago and were extremely conservative. They reflected the uncertainty at that time regarding the expected use of these rooms. At this time, the expected use of these rooms is much more clearly defined. The new combustible material inventory is consistent with the expected use of the rooms, while still maintaining a degree of conservatism.

The new fire loadings are sufficiently lower than the previous estimated values to preclude the need for an automatic suppression system. Existing manual fire fighting equipment is considered to be adequate for these areas.

The fire protection report will be revised in a future amendment to reflect the new information. (Revised pages to the Fire Protection Report are attached.)

TABLE 2.2-3 (Cont'd)

FIRE AREA/ZONE NUMBER AND NAME	FIRE PROTECTION	FIRE DETECTION	COMBUSTIBLE	FIRE LOAD DESIGN FIRE (Btu/ft^2)
2.1-0 Control room	Note 1	Ionization detection	1000 lb of paper 6400 lb cable insulation	10,900
2.1-1 Record storage room	Note 1	Ionization detection	1000 lb of paper 100 lb of paper transient	42,300
2.1-2 Record st[illegible]ge and toilet room	Note 1	Ionization detection	2,000 lb of paper	87,000
3.1-1 Unit 1 cable tunnel	Automatic total flooding carbon dioxide system	Ionization detection	19,770 lb cable insulation	146,000
3.1-2 Unit 2 cable tunnel	Automatic total flooding carbon dioxide system	Ionization detection	19,770 lb cable insulation	146,000
3.2-0 HVAC duct room	Note 1	Ionization detection	4600 lb cable insulation	39,100
3.2A-1 Unit 1 Nonsegregated bus duct area	Automatic total flooding carbon dioxide system	Ionization detection	45 lb gasketing 36,467 lb cable insulation	64,000
3.2A-2 Unit 2 Nonsegregated bus duct area	Automatic total flooding carbon dioxide system	Ionization detection	45 lb gasketing 36,467 lb cable insulation	64,000
3.2B-1 Lower cable spreading area, Zone B-1	Automatic total flooding carbon dioxide system	Ionization detection	51 lb gaskets 640 lb ducting insulation 16,515 lb cable insulation	27,800
3.2B-2 Lower cable spreading area, Zone B-2	Automatic total flooding carbon dioxide system	Ionization detection	12.5 lb gasketing, 14.4 lb neoprene 16,515 lb cable insulation	26,600
3.2C-1 Lower cable spreading area, Zone C-1	Automatic total flooding carbon dioxide system	Ionization detection	8898 lb cable insulation 50 lb gasketing	25,300
3.2C-2 Lower cable spreading area, Zone C-2	Automatic total flooding carbon dioxide system	Ionization detection	8898 lb cable insulation 50 lb gasketing	25,300
3.2D-1 Lower cable spreading room, Zone D-1	Automatic total flooding carbon dioxide system	Ionization detection	6 lb gasketing 7500 lb cable insulation	96,700
3.2D-2 Lower cable spreading room, Zone D-2	Automatic total flooding carbon dioxide system	Ionization detection	6 lb gasketing 7500 lb cable insulation	142,000
3.2E-1 Division 11 cable riser	Automatic total flooding carbon dioxide system	Ionization detection	3670 lb cable insulation	208,000
3.2E-2 Division 21 cable riser	Automatic total flooding carbon dioxide system	Ionization detection	3670 lb cable insulation	208,000

control room for up to 6 hours during conditions which might otherwise force them to leave.

Any fire in the Control Room would be quickly detected, by ionization detectors or the personnel in the room. The Control Room is continuously manned. Since all combustibles are either contained in cabinets or panels, or present in such small quantities, any postulated fire will be highly localized and would be quickly extinguished using available manual fire fighting equipment.

The analysis of the effect of a fire in this zone cables required for safe shutdown is discussed in Subsection 2.4.2.4.

2.3.2.2 Record Storage Room (Fire Zone 2.1-1)

This area is shown on Figure 2.3-8 (Sheet 1).

Electrical cable trays routed through this zone are shown on Figure 2.3-33.

Fire Barrier Description

The floor slab at elevation 451 feet 0 inch, which is the ceiling of the Lower Cable Spreading Room, is a 9-inch clear cover of structural reinforced concrete over 3-inch fluted steel decking formwork. It is supported by structural steel beams protected with a fire resistant covering and carries a 3-hour fire rating.

All walls are 12-inch hollow concrete masonry units and carry a 3-hour fire rating. They extend up to within 1 inch of the ceiling above. This resulting space is packed with a 1-inch thick blanket of Thermafiber insulation. A 3-hour rated Label "A" fire door leads to the Control Room.

The ceiling slab at elevation 463 feet 5 inches, which is the floor of the Upper Cable Spreading Room, is a 1 1/2-inch clear cover of reinforced concrete over protected 1 1/2-inch fluted steel decking. It is supported by protected structural steel beams and carries a 3-hour fire rating. A 1/2-inch x 1/2-inch x 3/4-inch thick aluminum egg crate suspended ceiling system is provided below the ceiling slab.

Safety-Related Equipment

There is no safety-related or reactor shutdown and cooling equipment in this area.

Protection Criteria and Measures

Combustibles in this room are subject to administrative controls.

Combustible Materials

The floor is covered with 208 ft² of 1/8-inch thick vinyl-asbestos tile. In addition, 55 lineal feet of 4-inch vinyl cove base is provided at the intersection of the walls and the floor.

The following fire hazard characteristics of vinyl-asbestos tile and cove base were obtained from tests in accordance with ASTM Test E-84:

	Vinyl-Asbestos Tile and Cove Base
Flame spread	Less than 75
Fuel contribution	0
Smoke developed	415

This room will contain a desk, two tables, chairs, and file cabinets and/or bookcases. Most of this furniture will be of metal construction. Combustible materials equivalent to 1,000 lbs of paper (8,000 Btu/lb) are estimated to be present. In addition, a transient load of an additional 100 lbs of paper is considered.

Fire Loading

With a floor area of 208 ft², the fire loading is approximately 42,300 Btu/ft².

Extinguishing and Detecting Capabilities

A portable fire extinguisher with a minimum 2A rating is located in the room and a manual hose station can be brought in from the Turbine Building to fight a fire in this area.

Design-Basis Fire

The design-basis fire would result if all of the combustibles in this room burned. The fire loading of 42,300 Btu/ft² is equivalent to a fire of about 1/2 hour severity. The furniture and other materials in this area would be destroyed.

This would not affect the ability to shut down and cool the reactor.

2.3.2.3 Storage and Toilet Room (Fire Zone 2.1-2)

This zone is shown on Figure 2.3-8 (Sheet 3).

Fire Barrier Description

The floor slab at elevation 451 feet 0 inch, which is the ceiling of the Lower Cable Spreading Room, is a 9-inch clear cover of structural reinforced concrete over 3-inch fluted steel decking formwork. It is supported by structural steel beams protected with a fire resistant covering and carries a 3-hour fire rating.

All walls of the storage area are 12-inch thick hollow concrete masonry units and carry a 3-hour fire rating they extend up to within 1 inch of the ceiling above. This resulting space is packed with a 1-inch thick blanket of foil-backed Thermafiber insulation. A 3-hour rated Label "A" fire door leads to the Control Room.

The ceiling slab at elevation 463 feet 5 inches, which is the floor of the Upper Cable Spreading Room, is a 2 1/2-inch clear cover of reinforced concrete over 3 hour protected 1 1/2-inch fluted steel decking. It is supported by unprotected structural steel beams and carries a 3 hour fire rating. An acoustical tile suspended ceiling system is provided below the ceiling slab in the storage area.

Safety-Related Equipment

For details, see Subsection 2.3.2.2.

Protection Criteria

For details, see Subsection 2.3.2.2.

Combustible Materials

This room will be used to store chart paper for control room recorders. It is estimated that 2,000 lbs of paper will be stored here. A transient load is not considered.

The storage area floor is covered with 184 ft² of 1/8-inch thick vinyl-asbestos tile. In addition, 59 lineal feet of 4-inch high vinyl cove base is provided at the intersection of the walls and the floor.

Fire Loading

With a floor area of 184 ft² the fire loading is 87,000 Btu/ft^2.

Extinguishing and Detecting Capabilities

For details, see Subsection 2.3.2.2.

Design-Basis Fire

For details, see Subsection 2.3.2.2, except that with a fire load of 87,000 Btu/ft^2, a 1-hour severity fire could occur.

RESPONSES TO FIRE PROTECTION SITE AUDIT CONCERNS

Concern No. 5

To comply with Section C.6.c of BTP CMEB 9.5.1, interior manual hose stations should be installed so as to be able to reach any location that contains, or could present a fire exposure hazard to safety related equipment with at least one effective hose stream. We observed that because of the present location of manual hose stations, it may not be possible to reach all areas of the computer room and cable riser area on elevation 451 feet. The applicant should conduct a hose stretch test to verify the adequacy of the existing design.

We also observed that because of congested conditions in certain plant areas, such as the cable spreading rooms, it may not be possible to utilize existing manual hose stations because of the inability to fully deploy the woven-jacketed fire hose. In such areas, to comply with Section C.6.c of BTP CMEB 9.5.1, it will be necessary to replace the woven-jacketed hose with a hard rubber type.

Response

The applicant agrees that the computer room and cable riser area on elevation 451'-0" cannot be reached by presently located hose stations. In order to alleviate this concern, hose station no. 16 will be relocated so that it is close enough to these rooms to reach them with an effective hose stream. The Fire Protection Report will be revised in a future amendment to include this change (Revised Fire Protection Report pages are attached).

The applicant also agrees that the use of the woven-jacket fire hose would present difficulties in the upper and lower cable spreading rooms. In these rooms, all of the existing woven-jacket fire hose will be replaced with a hard rubber type fire hose. No Fire Protection Report changes are required by this design change.

reinforced concrete over 1 1/2-inch fluted steel decking. The underside of the decking, and the structural steel members that support this slab are protected with a fire-resistant covering. The slab and the supporting steel members carry a 3-hour fire rating.

Safety-Related Equipment

Cables in this zone are in risers and are ESF Division 11 and contain instrumentation and control cables.

Protection Criteria and Measures

The Cable Spreading Room is separated from other portions of the floor by 3-hour fire walls. Entrance to this limited access area is provided through a Label "A" fire door.

Combustible Materials

There is contained in this riser area cable insulation which has a total weight of 3672 pounds.

Fire Loading

With a floor area of 120 ft^2, the fire loading is 260,100 Btu/ft^2.

Extinguishing and Detecting Capabilities

Several portable CO_2 extinguishers are located in adjacent rooms. This room is also within reach of manual hose station no. 16 in the turbine building.

Design-Basis Fire

The results of a fire in this zone are acceptable since only one ESF division will be lost. Sufficient redundancy exists in the engineered safety features fed from the other ESF division to achieve a reactor shut down and to maintain the reactor in a safe shutdown condition.

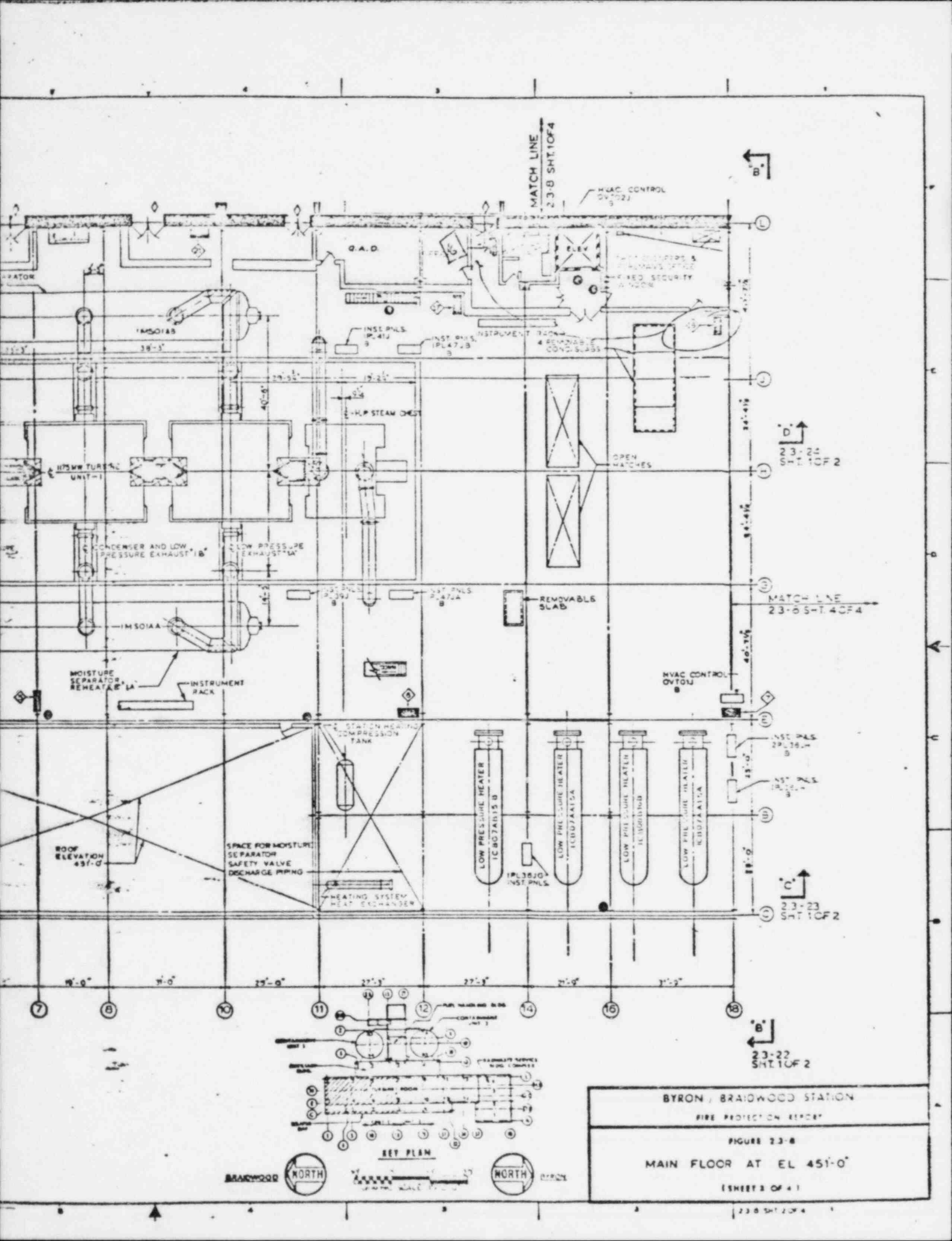
The analysis of the effect of a fire in this zone on cables required for safe shutdown is discussed in Subsection 2.4.2.16.

2.3.3.23 Unit 2 Cable Riser Area (Fire Zone 3.4A-2)

This area is shown on Figure 2.3-8 (Sheet 3).

Electrical cable trays routed through this zone are shown on Figure 2.3-33.

For details, see Subsection 2.3.3.22, except the cabling is ESF Division 12 cables and with a floor area of 150 ft^2, the fire loading is 208,080 Btu/ft^2.



BYRON / BRAIDWOOD STATION

FIRE PROTECTION REPORT

FIGURE 2.3-8

MAIN FLOOR AT EL 451'-0"

(SHEET 3 OF 4)

RESPONSES TO FIRE PROTECTION SITE AUDIT CONCERNS

Concern No. 6

In the August 16, 1982 revision to the Fire Protection Report, the applicant committed to seal fire barrier penetrations with material having a fire resistance rating comparable to the rating of fire walls and floor/ceiling assemblies. Information was unavailable during the audit to verify that bus duct penetrations of fire rated assemblies have been sealed internally with an appropriate fire rated material. The applicant should confirm that such penetrations are sealed to maintain the integrity of the barrier. In addition, we observed that fire dampers were installed in a "ganged" configuration in several large ventilation openings in fire barriers, such as the diesel generator room exhaust vents. This arrangement does not appear to be consistent with the listing of the damper. The applicant should verify that the installation of the dampers in a ganged configuration will achieve a fire rating equivalent to that of the barriers in which they are installed.

Response

The bus ducts (which consist of aluminum conductors and housing with no combustibles inside) are provided with fire and smoke barriers between the bus and the housing at each point where the bus duct penetrates a fire rated assembly.

Ganged fire dampers are multiple parallel fire dampers within a singular fire damper sleeve.

The larger fire dampers at Byron and Braidwood (greater than 48" x 48") are provided by the Ruskin Manufacturing Company. The maximum UL single section fire dampers are either 30" x 30" or 36" x 36". The larger fire dampers are UL listed in the Underwriters Laboratories Building Materials Directory as "Assemblies of Individual Doors". The maximum fire damper assembly is 60" x 60". This size is accomplished by being "Made up from individual doors not exceeding 30 inches in width and 30 inches in height".

The fire damper design for larger sizes at Byron and Braidwood is consistent with UL fire damper listings.

BYRON - 1

RESPONSES TO FIRE PROTECTION SITE AUDIT CONCERNS

Concern No. 7

In the August 16, 1982 revision to the Fire Protection Report, the applicant committed to comply with NFPA Standards 13 and 15 in the design and installation of fixed water extinguishing systems. We observed that manual discharge valves for the water deluge fire suppression systems protecting charcoal filters would be inaccessible during a fire because of their closeness to the filters and the limited access in the area. This condition appears contrary to the commitment.

Response

The applicant takes exception to this concern. The manaul discharge valves in question are for the water deluge system for the charcoal filters. The charcoal filters are enclosed by housing constructed of 1/4-inch steel plate, and are provided with high temperature alarms. The high temperature setpoint is below the ignition point of the charcoal, ensuring that the alarm would be actuated prior to development of a significant fire. The alarm is annunciated in the main control room. An operator would be quickly dispatched to the area to investigate the cause of the high temperature alarm. In all likelihood, the operator would reach the area before a fire could grow to a large enough size to render the area inaccessible. This is especially true when the shielding offered by the steel plate filter housing is considered.

In the unlikely event that the area next to the filter housings was not accessible due to heat radiated from the filter housing, the area could be wetted down and cooled using manual hose stations in the area to allow operator entry for a sufficient period of time to operate the water deluge system manual discharge valve.

In summary, the applicant believes that the high temperature alarms which annunciate in the control room will allow response to any potential fire in the charcoal filters rapidly enough that the area in which the manual discharge valve for the water deluge system is located would still be accessible. A fire severe enough to render the area totally inaccessible within the short period of time during which an operator would respond to the high temperature alarm is not credible.

RESPONSES TO FIRE PROTECTION SITE AUDIT CONCERNS

Concern No. 8

To comply with Section C.5.b of BTP CMEB 9.5.1 and Section III.G of Appendix R, structural steel forming a part of or supporting fire barriers should be protected to provide fire resistance equivalent to that required of the barrier. We observed that in the upper and lower cable penetration areas and in the Auxiliary Building General Floor area, on elevations 346 feet through 426 feet, the structural steel supporting the floors was unprotected. We are concerned that a fire could cause the collapse of such elements and effect components/cables of redundant shutdown divisions located within the same floor elevation or on vertically adjoining elevations. The applicant should provide protection for such structural steel commensurate with the fire exposure and the degree of separation between redundant shutdown divisions (see concern in item 18 below).

We are also concerned that openings in non-fire rated barriers, such as equipment hatches, removable concrete slabs, and unprotected stairway openings in the Auxiliary Building General Floor areas would subject redundant shutdown divisions, which are located on different elevations, to loss from a single fire. The applicant should provide fire protection commensurate with the hazard and in accordance with Section C.5.b of our fire protection guidelines or demonstrate that at least one shutdown division would remain free of damage from a vertically propagating fire.

Response

The applicant has reviewed all plant areas where redundant equipment is separated by non-rated or unprotected barriers. With one exception, the existing design or level of protection is considered to be adequate.

A) Floor at elevation 426'-0" separating the upper and lower cable penetration areas.

The applicant agrees that this floor should be protected from a fire in the lower cable penetration area on elevation 414'-0". Consequently, the structural steel supporting this floor/ceiling assembly will be provided with fire proofing to a 3-hour rating.

Furthermore, all floor penetrations, with the exception of the equipment hatch at column-row 13-15/U-V, are provided with rated fire seals. The equipment hatch will be covered, but the cover will not have a fire rating. This is considered to be acceptable because the combustible materials in these rooms are concentrated in the cable trays, the MCC's and the electrical panels, most of which are not near the equipment hatch. The area near the hatch is open and free

RESPONSES TO FIRE PROTECTION SITE AUDIT CONCERNS

Response (Cont'd)

of combustible materials. Thus, the fire hazard posed to the hatch cover by combustible materials in the room is minimal. For this reason, a non-rated hatch cover is deemed to be acceptable.

B) Elevation 346'-0". The ceiling at elevation 364'-0" is supported by concrete beams and columns. The fire loading in this zone is only 18,100 BTU/ft^2, which is insufficient to cause the structural collapse of a concrete slab supported by concrete beams and columns.

C) Elevation 364'-0". The ceiling at elevation 383'-0" is supported by concrete beams and columns. A pipe tunnel running along column-rows Q-S between the pipe penetration areas is suspended from the ceiling by unprotected structural steel beams and hangers. The fire loading in this zone is 19,700 BTU/ft^2. This is insufficient to cause the structural collapse of either the concrete ceiling slab, which is supported by concrete beams and columns, or the pipe tunnel suspended from the ceiling by unprotected structural steel.

D) Elevation 383'-0". The ceiling at elevation 401'-0" is supported by concrete beams and columns. Two pipe tunnels are suspended from the ceiling by unprotected structural steel. The fire load in this zone is 20,800 BTU/ft^2. This fire load is insufficient to cause the structural collapse of either the concrete ceiling slab supported by concrete beams and columns or the pipe tunnels which are suspended from the ceiling by unprotected structural steel.

E) Elevation 401'-0". The structural steel support columns and main beams which support the ceiling at 426'-0" and the structures above are protected by a fire-resistant covering to a rating of three hours except for the area between column-rows Q to V and 15 to 21. In this area the support steel is unprotected. The fire load for this zone is 30,100 BTU/ft^2. The area with the unprotected support columns contains no significant concentrations of combustibles which present a hazard to the unprotected steel. The low fire loading and lack of identified concentrations of combustible materials results in no credible possibility of structural collapse of either the protected or unprotected steel structures in this zone.

F) Elevation 426'-0". The ceiling of this zone at elevation 439'-0" (cable spreading room floor) and its support steel are three-hour rated. The ceiling at elevation 451'-0" between column-rows Q and V is supported by unprotected steel. However, the main columns and beams which support

RESPONSES TO FIRE PROTECTION SITE AUDIT CONCERNS

Responses (Cont'd)

the control facilities above are covered with a fire resistant material to a three hour rating. The fire load in this zone of 33,400 BTU/ft^2 is considered insufficient to cause a structural collapse of main structural members.

G) In veiw of the low fire loadings throughout the auxiliary building general areas, the presence of open stairways and equipment hatches in the floors at the various elevations is considered to be acceptable. A vertically propagating fire is not considered to be credible because of the lack of concentrations of combustible materials near the floor openings. Thus, the applicant, his consulting engineers, his insurers and his fire protection consultant all agree that fire protection commensurate with the hazards has been provided in the auxiliary building. Additional features are not required.

The fire Protection Report will be revised in a future amendment to indicate correctly the protection provided for the floor/ceiling assembly at elevation 426'-0" between the upper and lower cable penetration areas. (Revised FPR pages are attached.)

Extinguishing and Detecting Capabilities

Portable fire extinguishers are available in this room and adjacent zone. Two manual hose stations are positioned within reach of the room.

Ionization detectors are provided, which annunciate and alarm in the Control Room.

Design-Basis Fire

With a fire loading of 13,000 Btu/ft², the design-basis fire is less than 1/2 hour in severity. If a fire should occur in this room the ventiltion system may be damaged. The loss of the room would not prevent a safe shutdown of the reactor.

The analysis of the effect of a fire in this zone on cables required for safe shutdown is discussed in Subsection 2.4.2.47.

2.3.11.42 Unit 2 Containment Chillers Room (Fire Zone 11.5-2)

This zone is shown on Figure 2.3-12 (Sheet 3) and in elevation on Figures 2.3-21 (Sheet 2) and 2.3-26 (Sheet 2).

Electrical cable trays routed through this zone are shown on Figure 2.3-36.

For details, see Subsection 2.3.11.41 except:

a. Two 4-inch diameter drains are provided in the HVAC filter room and four in the reactor containment chiller pump room 2.

b. There is about 25 pounds of gasketing present.

c. There are 18 HEPA filters and 18 prefilter modules used.

d. With a floor area of 3030 ft², the fire loading becomes 7200 Btu/ft².

2.3.11.43 Division 11 Cable Penetration Area (Fire Zone 11.5A-1)

This zone is shown on Figure 2.3-11.

Fire Barrier Description

The floor at elevation 414 feet 0 inch, which is the ceiling of the Reactor Containment Chiller Pump Room, is a 5-inch to 33-inch clear cover of structural reinforced concrete over 3-inch fluted steel decking formwork. It contains a nonrated penetration, and a large opening for equipment removal, is supported by unprotected steel beams and columns, and carries no fire rating. Six 4-inch diameter floor drains are provided. The perimeter

walls of this zone are minimum 36-inch thick structural reinforced concrete. These walls carry a 3-hour fire rating except for the walls common to this zone, and to the Auxiliary Building ground floor, which are of 3-hour rated construction, but contain several nonrated penetrations and thus do not carry a fire rating. A stairway up to elevation 426 feet 0 inch is included in this zone and is enclosed by 12-inch thick hollow concrete masonry unit walls which carry a 3-hour fire rating. A door of Label "A" construction leads to this stairway.

The ceiling at elevation 426 feet 0 inch is a 6-inch to 15-inch clear cover of structural reinforced concrete on 3-inch fluted steel decking formwork. It is supported by steel beams and columns which are protected to a 3-hour rating with a fire-resistant covering. Floor penetrations, with the exception of the equipment hatch at column-row 13-15/U-V, are provided with 3-hour rated fire seals. The equipment hatch is covered by a nonrated hatch cover. Due to the nonrated hatch cover, the ceiling carries no fire rating.

Safety-Related Equipment

The safety-related equipment in this zone is:

a. portions of the Auxiliary Building Ventilation System,

b. Motor Control Centers-131X2 and 131X4 (ESF Division 11), and

c. cable and cable trays associated with ESF Division 11.

Protection Criteria and Measures

Only Division 11 components are in this fire zone.

Combustible Materials

An estimated 35 pounds of gasketing is used in the ventilation ductwork.

An estimated 28,845 pounds of cable insulation is in this zone.

Fire Loading

With a floor area of 4,150 ft^2, the fire loading is 59,100 Btu/ft^2.

Extinguishing and Detecting Capabilities

Two manual hose stations are in this zone. Portable fire extinguishers are also available.

Ionization detectors are provided which annunciate and alarm in the Control Room.

Combustible Materials

About 500 pounds of clothing may be stored here.

The recirculation pumps hold 2 gallons of lubricating oil.

The ductwork uses an estimated 824 pounds of gasketing and 4500 pounds of ductwork insulation.

There is an estimated 69,670 pounds of cable insulation used.

About 1000 pounds of paper is assumed to be kept in this area.

A transient load equivalent to one 55-gallon drum of oil is considered for this zone.

Fire Loading

With a floor area of 19,910 ft^2, the fire loading is 33,400 Btu/ft^2.

Extinguishing and Detecting Capabilities

Five manual hose stations are located within this zone. Portable fire extinguishers are also available.

Ionization detectors are provided which annunciate and alarm in the Control Room.

Design-Basis Fire

The design-basis fire would occur if all the combustibles in the zone burned. In this event the boron injection recirculation pumps could be damaged. These pumps are provided to circulate the concetrated boric acid through the safety injection system in order to maintain a uniform temperature and boron concentration in the system. These pumps are not required for safe shutdown since they are stopped upon initiation of the safety injection system to prevent pump damage.

The analysis of the effect of a fire in this zone on cables required for safe shutdown is discussed in Subsection 2.4.2.49.

2.3.11.46 Division 12 Cable Penetration Area (Fire Zone 11.6-1)

This zone is shown on Figure 2.3-10 (Sheet 1) and in elevation on Figure 2.3-26 (Sheet 1).

Electrical cable trays routed through this zone are shown on Figure 2.3-35.

Fire Barrier Description

The floor at elevation 426 feet 0 inch, which is the ceiling of the Cable Penetration Area, Division 11, is a 5-inch to 15-inch clear cover of structural reinforced concrete on 3-inch fluted steel decking formwork. It is supported by steel beams and columns protected to a 3-hour rating by a fire-resistant covering. The equipment hatch located at column-row 13-15/U-V is covered by a nonrated hatch cover. All other floor penetrations are sealed by 3-hour rated fire seals. Because of the nonrated hatch cover, this floor carries no fire rating. Five 4-inch diameter floor drains are provided.

The perimeter walls of this zone are minimum 8-inch thick solid concrete masonry units or 36-inch thick structural reinforced concrete. These walls carry a 3-hour fire rating except for the walls common to this zone and to the Auxiliary Building Mezzanine Floor. These walls are of 3-hour rated construction but contain one or more nonrated penetrations and thus do not carry a fire rating. A stairway is provided in this zone which is enclosed in a 3-hour rated masonry barrier from elevation 426 feet 0 inch down to elevation 414 feet 0 inch, and which is open up to elevation 439 feet 0 inch. Masonry walls extend up to within 1 inch of the ceiling and and this remaining space is packed with a 1-inch thick blanket of Thermafiber insulation. Label "A" fire doors are provided for access to the Fuel Handling Building. The ceiling at elevation 451 feet 0 inch is a 5-inch clear cover of structural reinforced concrete over 3-inch fluted steel decking formwork, is supported by unprotected steel beams and columns, and does not carry a fire rating.

Safety-Related Equipment

MCC 132X2 (ESF Div. 12), MCC 132X4(ESF Div. 12), and ESF Division 12 cables are present in this zone.

Protection Criteria and Measures

This zone is separated from the other ESF division by a 2-hour rated fire barrier.

Combustible Materials

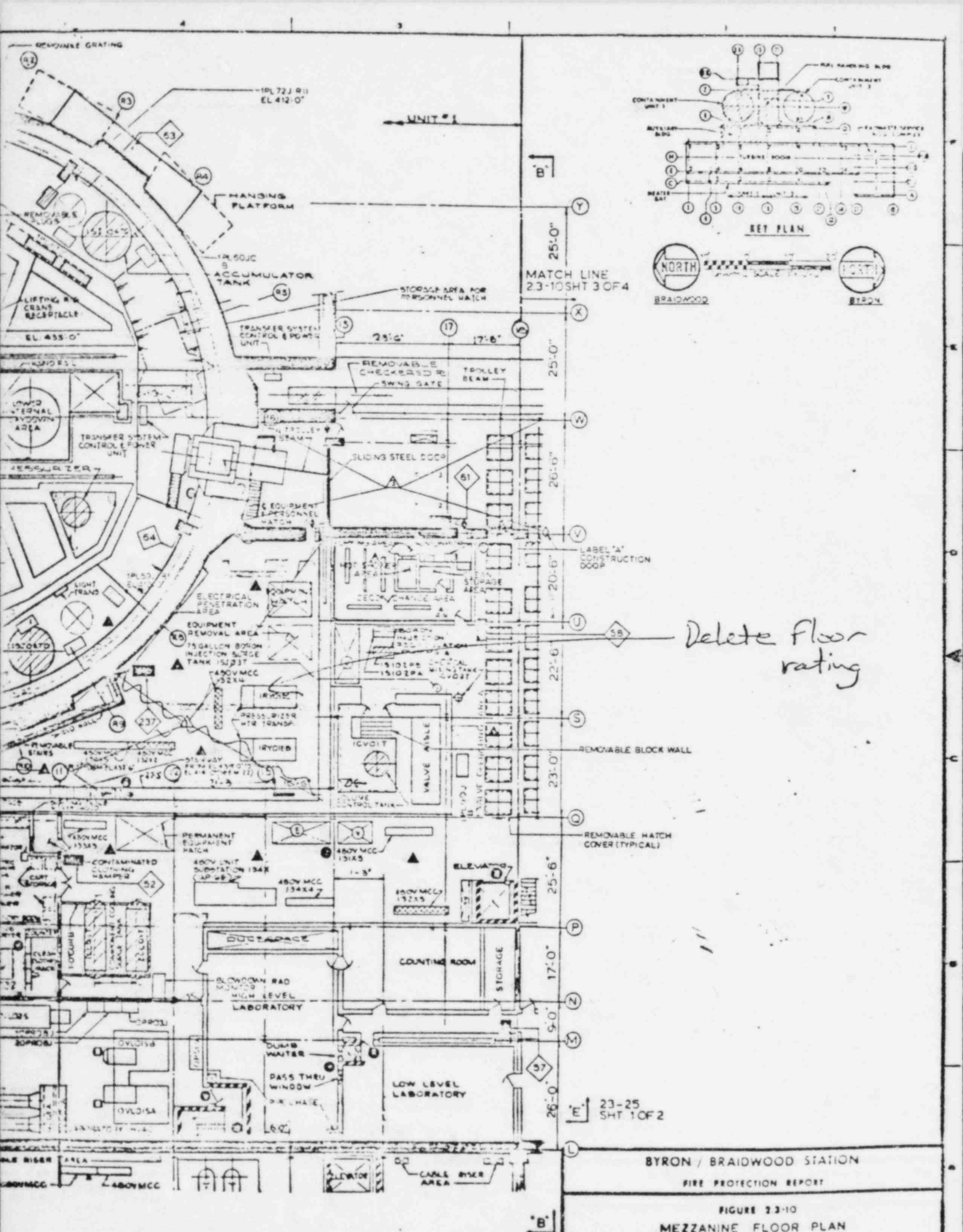
The ventilation ductwork uses an estimated 50 pounds of gasketing.

There is an estimated 17,482 pounds of cable insulation in this zone.

A transient load is not considered as this is a controlled access area.

Fire Loading

With a floor area of 4100 ft^2, the fire loading is 36,300 Btu/ft^2.



BYRON / BRAIDWOOD STATION

FIRE PROTECTION REPORT

FIGURE 2.3-10

MEZZANINE FLOOR PLAN
EL. 426'-0"

BYRON - 1

RESPONSES TO FIRE PROTECTION SITE AUDIT CONCERNS

Concern No. 9

We observed several discrepancies in the description of fire protection features in the applicant's Fire Protection Report from what was observed in the plant. Such discrepancies include the description of fire proofing for structural steel, the extent of fire detection in safety related plant areas, the nature of fire doors and the lack of a fire hazard's analysis and fire protection for the "Med-Chem" area on elevation 401 feet.

Response

The Fire Protection Report will be revised in a future amendment to correct the omission and discrepancies listed. (Revised FPR pages are attached.)

TABLE 2.2 (Cont'd)

FIRE AREA/ZONE NUMBER AND NAME	FIGURE NUMBER	SAFETY-RELATED EQUIPMENT	RADIOACTIVE EQUIPMENT
11.4C-0 Radwaste and remote shutdown control room	2.3-13, 2 of 2 2.3-25, 2 of 2	remote shutdown panels: div 11, div 12, div 21, div 22	None
11.4C-1 Letdown heat exchanger 1A room	2.3-13, 1 of 2 2.3-22, 2 of 2	Letdown heat exchanger	Letdown heat exchanger
11.4C-2 Letdown heat exchanger 2A room	2.3-13, 2 of 2	Letdown heat exchanger	Letdown heat exchanger
11.4D-1 Letdown heat exchanger room 1B room	2.3-13, 1 of 2 2.3-22, 2 of 2	Letdown heat exchanger	Letdown heat exchanger
11.4D-2 Letdown heat exchanger 2B room	2.3-13, 2 of 2	Letdown heat exchanger	Letdown heat exchanger
11.5-0 Auxiliary building, elevation 401 ft-0 in.	2.3-12, 1 of 4 2.3-12, 3 of 4 2.3-22, 2 of 2 2.3-25, 1 of 2 2.3-25, 2 of 2 2.3-26, 1 of 2 2.3-26, 2 of 2	Auxiliary building ventilation system; boron thermal regenerative demineralizers; cation bed and mixed bed demineralizers; recycle evaporator feed demineralizers; condensate demineralizer, boric acid tank and transfer pumps; boric acid filters, H_2 recombiners and panels	Boron thermal regenerative heat exchanger
11.5-1 Unit 1 containment refrigeration equipment room	2.3-12, 1 of 4 2.3-26, 1 of 2	None	None
11.5-2 Unit 2 containment refrigeration equipment room	2.3-12, 3 of 4 2.3-21, 2 of 2 2.3-26, 1 of 2	None	None
11.5A-0 Radiological Instrument Calibration Room	2.3-12, 1 of 4	Division 11 and 12 cabling	None
11.5A-1 Division 11 containment electrical penetrations area, elevation 414 ft-0 in.	2.3-11	Auxiliary building ventilation system; division 11 ESF cabling and panels	None
11.5A-2 Division 21 containment electrical penetrations area, elevation 414 ft-0 in.	2.3-11	Auxiliary building ventilation system; division 21 ESF cabling and panels	None
11.6-0 Auxiliary building elevation 426 ft-0 in.	2.3-10, 1 of 4 2.3-10, 3 of 4 2.3-22, 2 of 2 2.3-25, 1 of 2 2.3-25, 2 of 2 2.3-26, 1 of 2 2.3-26, 2 of 2	Auxiliary building ventilation system; component cooling surge tanks; boron injection recirculation pumps and surge tanks, cable and panels; divisions 11, 12, 21 and 22 and volume control tanks	None
11.6-1 Division 12 electrical penetrations area	2.3-10, 1 of 4 2.3-26, 1 of 2	Division 12 cabling MCC 12X3, MCC 12X4	None
11.6-2 Division 22 electrical penetrations area	2.3-10, 3 of 4 2.3-21, 2 of 2 2.3-22, 2 of 2	Division 22 cabling MCC 22X3, MCC 22X4	None
11.6A-0 Laboratory HVAC equipment room	2.3-10, 1 of 4 2.3-25, 1 of 2	Division 11 and 12 cabling	None

TABLE 2.2-3 (Cont'd)

FIRE AREA/ZONE NUMBER AND NAME	FIRE PROTECTION	FIRE DETECTION	COMBUSTIBLE	FIRE LOAD DESIGN FIRE (Btu/ft^2)
11.5-2 Unit 2 containment chillers room	Note 1	Ionization detection	874 lb cable insulation, 18 HEPA filters, 18 prefilters, 25 lb gasketing, 32 gal lube oil, 55 gal drum oil transient load	7,200
11.5A-0 Radiological Instrument Calibration Room	Note 1	None	1000 lb plastic, 250 lb rubber, 60 lb rope, 10 lb cotton	19,200
11.5A-1 Division 11 Cable penetration area	Note 1	Ionization detection	35 lb gasketing 28,845 lb cable insulation	59,100
11.5A-2 Division 21 Cable penetration area	Note 1	Ionization detection	35 lb gasketing 28,845 lb cable insulation	59,100
11.6-0 Auxiliary building elevation 426 feet-0 inch	Note 1	Ionization detection	69,670 lb cable insulation, 824 lb gasketing, 4500 lb ductwork insulation, 2 gal lube oil, 500 lb clothing, 55 gal oil drum transient load, 1000 lb paper	33,400
11.6-1 Division 12 electrical penetration area	Note 1	Ionization detection	50 lb gasketing, 17,482 lb cable insulation	36,300
11.6-2 Division 22 electrical penetration area	Note 1	Ionization detection	50 lb gasketing, 17,482 lb cable insulation	36,300
11.6A-0 Laboratory HVAC equipment room	Note 1	None	6 lb lube oil, 47 HEPA filters, 18 prefilters, 560 lb silencers, 97 lb gasketing, 2525 lb ducting insulation 3445 lb cable insulation	29,600
11.7-0 HEPA filter rooms	Manual charcoal deluge system	Thermostats Ionization detection	1241 prefilters, 1148 HEPA filters, 31,122 lb charcoal, 435 lb lube oil	35,200
11.7-1 Unit 1 purge room	Manual charcoal deluge system	Thermostats	240 lb charcoal, 40 lb lube oil, 46 lb gasketing, 88 prefilters, 88 HEPA filters	2,300
11.7-2 Unit 2 purge room	Manual charcoal deluge system	Thermostats	240 lb charcoal, 40 lb lube oil, 46 lb gasketing, 88 prefilters, 88 HEPA filters	2,300

2.3.11.42A Radiological Instrument Calibration Room (Fire Zone 11.5A-0)

This zone is shown on Figure 2.3-12 (sheet 1).

Fire Barrier Description

The floor at elevation 401 feet 0 inch is a 33-inch clear cover of structural reinforced concrete over a 3-inch fluted steel decking formwork. It is supported by unprotected steel beams which carries no fire rating. Two 4-inch diameter floor drains are provided in this area.

The walls common to this zone and to the containment chiller pump room are 2'-11 5/8" thick solid concrete masonry which contains non-rated penetrations. Masonry walls extend up to within 1-inch of the structural slab above and the remaining space is packed with a 1-inch thick blanket of the thermafiber insulation. The wall common to this zone and to the containment building buttress enclosure is 24-inch thick structural reinforced concrete and carries a 3-hour fire rating. The wall common to this zone and to the auxiliary building along colum row 'Q' is 36-inch thick structural reinforced concrete and contains a non-rated metal personnel door.

The ceiling slab at elevation 414 feet 0 inch is a 33-inch clear cover of structural reinforced concrete over a 3-inch fluted steel decking formwork. This slab contains two floor openings (1'-3" x 1'-3" & 1'-11" x 2'-5") and is supported by unprotected steel beams and columns which carries no fire rating.

Safety-Related Equipment

Safety-related cables run in conduit are routed through this zone. No safety-related euqipment is located in this room.

Protection Criteria and Measures

This room is separated from other plant areas by barriers of substantial construction.

Combustible Materials

Material stored in this room consists of radiation protection clothing and materials. The maximum estimated inventory is 1000 pounds of plastics, 250 pounds of rubber, 60 pounds of rope and 10 pounds of cotton. An additional transient load is not considered.

Fire Loading

With a floor area of 1100 ft^2, the fire loading is 19,200 BTU/ft^2.

Extinguishing and Detecting Capability

Automatic detection is not provided for this room.

Two manual hose stations are within 50 feet of this room. Portable extinguishers are available.

Design-Basis Fire

With a fire loading of 19,200 BTU/ft^2, the design-basis fire is of less than 1/2 hour severity. It would not affect safe shutdown of the reactor.

the general area which could result from actuation of a deluge system. As shown in Figures 2.3-7 and 2.3-9, hose stations are located in each compartment of the upper and lower cable spreading areas. Hose stations are located adjacent to each doorway so that water availability will be guaranteed even if severe smoke conditions exist.

In summary, the Byron/Braidwood cable spreading area fire protection system design ensures that a fire will not compromise plant safety. Use of automatic Halon or CO_2 systems instead of water deluge reduces the probability of a plant shutdown or equipment damage in the event of s spurious actuation. In the unlikely event that water is required, the area is well supplied with manual hose stations.

Refer to the following subsections for a detailed discussion of each fire zone.

2.3.3.1 Unit 1 Electrical Cable Tunnel (Fire Zone 3.1-1)

This zone is shown on Figure 2.3-12 (Sheet 1) and in elevation on Figure 2.3-25 (Sheet 1).

Electrical cable trays routed through this zone are shown on Figure 2.3-36.

Fire Barrier Description

The floor slab at elevation 415 feet-0 inch consists of a 5-inch to 21-inch clear cover of structural reinforced concrete over 3-inch fluted steel decking formwork, which is supported by protected structural steel beams and hangers which carry a 3-hour rating. Three walls of the tunnel are structural reinforced concrete varying in thickness from 12 inches to 36 inches. These carry a 3-hour fire rating. The fourth wall is 12-inch thick hollow concrete masonry units, extends up to within 1 inch of the ceiling or steel beam, and carries a 3-hour fire rating. The space at the top of the wall is packed with a 1-inch thick blanket of Thermafiber insulation.

The ceiling at elevation 426 feet-0 inch, which is the floor of an ESF switchgear room, consists of a 5-inch clear cover of structural reinforced concrete with a 3-inch concrete topping over 3-inch fluted steel decking formwork. It is supported by steel beams protected with a fire-resistant covering and carries a 3-hour fire rating.

Access to the room is by hatches from elevation 426 feet-0 inch that are enclosed within a 3-hour rated barrier.

Four 4-inch diameter floor drains (90 gpm capacity each) are provided.

RESPONSES TO FIRE PROTECTION SITE AUDIT CONCERNS

Concern No. 10

In our Safety Evaluation Report, we stated that an oil collection system for each reactor coolant pump was required in accordance with Section C.7.a of BTP CMEB 9.5.1. Based on observations of conditions in containment as they pertain to the fire hazard posed by the reactor coolant pumps, our conclusion regarding the need for an RCP oil collection system remains unchanged.

Response

Subsequent to our initial submittal on an oil collection system for RCP motors, we have reexamined the individual components of the oil system on the RCP motors and re-evaluated all potential ignition sources in the containment surrounding the motors.

The reactor coolant pump motors have a lubrication system which contains only a few external components which could leak. If the lower motor bearing leaks, oil could leak onto the upper seal housing of the pump, which would be hot. To prevent this, an oil collection pan has been fitted below the motor to prevent leakage onto the pump.

The oil lift pump is the only portion of the lubrication system which is pressurized above about 15 psig. The oil lift system is pressurized only for about three minutes when the pump is started, greatly reducing the probability of a significant oil leak. The oil cooler is the only other major external component of the lubrication system. The cooler is never pressurized to a high level.

In order to have an oil fire inside containment, a heat source is required to ignite the oil. All hot piping in the containment is well insulated with metal reflective insulation. The insulation joints are covered. As a result, oil will not be able to reach the hot pipe surface. Ignition from electric sources is not probable. Components which could cause sparks, such as switches or motors with brushes, are sealed. The only known hot surfaces would be pipe support components very near to the pipe. The pump orientation is such that the oil lift system and oil cooler are not above the reactor coolant piping or any other hot system. Oil dripping from the lift pump or cooler will not fall onto a hot system support and as a result no fire hazard exists. Oil falling on the floor will flow into the floor drain system and be disposed of.

RESPONSES TO FIRE PROTECTION SITE AUDIT CONCERNS

Response (Cont'd)

The applicant feels that the only significant fire hazard associated with the reactor coolant pumps has been addressed with the drip pan under the lower motor bearing. Other portions of the lubrication system have been shown not to be potential fire hazards.

We continue to maintain our position that an oil collection system, other than the drip pan under the lower motor bearing, is not needed and will not increase the safety of the plant.

RESPONSES TO FIRE PROTECTION SITE AUDIT CONCERNS

Concern No. 11

In the August 16, 1982 revision to the Fire Protection Report, the applicant committed to comply with NFPA Standard No. 20 regarding the installation of fire pumps. We observed that an unlisted controller has been installed for the electric motor driven fire pump which is not consistent with that commitment.

Response

Due to the location of the motor driven fire pump (in the River Screen House), it was necessary to drive the pump with a 4000V motor. Since Underwriters Laboratories (UL) labels are not supplied on motors or starters rated over 600V, it was not possible to meet the specific committment in NFPA Standard No. 20 requiring that the controller for the electric motor driven fire pump must be UL listed. However in an effort to meet the intent of the NFPA standard, it was required that the 4KV motor and controller should utilize components with approved documented reliability equal to UL or Factory Mutual labeled controllers. All fire pumps and controllers are subjected to a final field acceptance test. Based on these requirements M&M Protection Consultants have determined that the fire pumps and controllers are acceptable.

RESPONSES TO FIRE PROTECTION SITE AUDIT CONCERNS

Concern No. 12

In the August 16, 1982 revision to the Fire Protection Report, the applicant committed to comply with Section C.5.d(1), "Control of Combustibles" of BTP CMEB 9.5.1. In the diesel generator rooms and at the Auxiliary Fuel Pump Room, we observed that curbs were not provided at doorways into these areas and therefore, a potential existed for a diesel fuel fire to propagate through the doorway into adjoining areas. The applicant should provide curbs at these doorways to be consistent with their commitment.

Response

The applicant does not believe that curbs are required in either the diesel generator rooms or the auxiliary feedwater pump room as explained below:

A) It is the applicant's position that curbs are not required for the diesel-generator rooms at Byron. The fuel oil supply and returning piping is embedded in the floor for much of its length. It is exposed for short lengths at the engine mounted diesel fuel oil pump and at the day tank. This means the piping is embedded in the high traffic areas of the room, reducing the possibility of accidental breakage of the pipe. Furthermore, the day tank enclosure itself is provided with and integral curb which will contain a spill of the 500 gallons of fuel oil in the day tank.

   In the unlikely event of a pipe break in one of the fuel oil lines, five four-inch diameter floor drains are provided (90 gpm capacity each) which will prevent any accumulation of fuel oil on the floor. The 500 gallon fuel oil day tank could not drain fast enough to cause a problem.

   Due to the small volume of the day tank, the relatively large room area of over 2,300 ft^2, and the number and capacity of floor drains provided, the applicant considers the accumulation of enough fuel oil on the floor to leak under the door to be an incredible event.

   The applicant concludes that the existing design and arrangement provides adequate protection against breakage of fuel oil piping and accumulation of fuel oil.

B) It is the applicant's position that curbs are not required for the diesel driven auxiliary feedwater pump rooms at Byron. A four-inch diameter leak detection sump floor drain (90 gpm capacity) is provided in each of these rooms.

Response (Cont'd)

In the unlikely event of a pipe break in the diesel fuel oil lines, an alarm would be generated by the leak detection floor drain sump. The auxiliary building leak detection sump alarms and indication are located on the liquid radwaste panel in the radwaste control room on elevation 383'-0". A simultaneous control room alarm is generated on the main control board annunciator panel. Thus, leakage would generate a "Liquid Radwaste Panel Trouble" alarm in the MCR. Upon arriving at the liquid radwaste panel, the operator would see a specific window on this panel's annunciator which would inform him of the precise location of the leak detection sump high level alarm (in this case the diesel-driven AFW pump cubicle).

Because this room is provided with a leak detection sump and control room indication of leakage, and because the 90 gpm capacity of the drain is sufficient to prevent accumulation of fuel oil in the room, the applicant believes that the existing design and arrangement provides adequate protection against the break of a diesel fuel oil pipe and accumulation of fuel oil on the floor, and thus curbs are not warranted for these rooms.

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RESPONSES TO FIRE PROTECTION SITE AUDIT CONCERNS

Concern No. 13

In the Fire Protection Report, the applicant committed to comply with NFPA Stnadard No. 13 in the design of automatic sprinkler systems. We observed that the ceiling level sprinklers over the lube oil drain tank were obstructed, which is contrary to that commitment.

Response

The applicant agrees with the staff concern. Additional sprinkler protection will be provided to the lube oil drain tanks on El. 364'-0" in the Turbine Building. The work will be completed by fuel load.

BYRON - 1

RESPONSES TO FIRE PROTECTION SITE AUDIT CONCERNS

Concern No. 14

To comply with Section C.5.g(1) of BTP CMEB 9.5.1, fixed self-contained lighting consisting of flourescent or sealed beam units with individual 8-hour minimum battery power supplies should be provided in all plant areas that need to be manned for safe shutdown and all routes to these areas. We observed that the Essential Safety Features Switchgear Room has not been provided with 8-hour battery powered emergency lighting as required. All other areas of the plant that are accessed for safe shutdown have been provided with emergency lighting off of individual battery units or the station batteries. The use of station batteries represents a deviation from our fire protection guidelines. To be considered acceptable, the applicant would have to demonstrate that a fire in an area containing emergency lighting off of the station batteries would not affect battery powered emergency lighting in all other plant areas.

Response

An excellent description of the lighting systems provided for the Byron/Braidwood stations is provided in Subsection 9.5.3 of the FSAR.

Regarding the ESF switchgear rooms, the applicant agrees that these rooms should have been provided with 8-hour battery powered emergency lights. A design change to add such lighting to both ESF switchgear rooms has been initiated. This change will be completed and the new lighting installed prior to fuel load.

All of the AC and DC lighting circuits are provided with protective devices (circuit breakers) to prevent a circuit failure in one circuit from affecting either other circuits or the lighting power supply.

RESPONSES TO FIRE PROTECTION SITE AUDIT CONCERNS

Concern No. 15

The August 16, 1982 revision to the Fire Protection Report identifies equipment located within the Control Room Refrigeration Equipment Rooms being necessary for safe shutdown. We observed that components and cables from both shutdown division are vulnerable to damage from a fire in this room and therefore do not meet the guidelines of Section C.5.b of BTP CMEB 9.5.1.

Response

The FPR will be revised in a future amendment to correctly indicate that this equipment is not essential to the safe shutdown of the unit. Note that this equipment is not included on the lists of equipment required for safe shutdown in Section 2.4 of the FPR. (Revised Fire Protection Report pages are attached.)

Combustible Materials

The ventilation ductwork uses 123 pounds of gasketing. The refrigeration units have 260 pounds of lubricating oil associated with them.

Fire Loading

With a floor area of 1400 ft^2, the fire loading is 4400 Btu/ft^2.

Extinguishing and Detection Capabilities

One manual hose station is in this room. Portable fire extinguishers are also available.

Ionization detectors are provided which annunciate and alarm in the Control Room.

Design-Basis Fire

A partition separates the two redundant refrigeration trains, however, it is not a fire barrier. In the event of a fire, the galvanized ductwork, ductwork accessories, dampers, refrigeration equipment, and pumps may be damaged. However, this equipment is not required for safe shutdown of the plant.

2.3.11.31 Unit 1 Auxiliary Feedwater Diesel-Driven Pump Room (Fire Zone 11.4A-1)

This zone is shown on Figure 2.3-13 (Sheet 1) and in elevation on Figures 2.3-22 (Sheet 2) and 2.3-25 (Sheet 1).

Fire Barrier Description

The floor at elevation 383 feet 0 inch is an 18-inch thick structural reinforced concrete slab and carries a 3-hour fire rating. One 4-inch diameter leak detection sump drain is provided.

The perimeter walls of this zone are 12-inch thick hollow concrete masonry units or 42-inch thick structural reinforced concrete and carry a 3-hour fire rating. Masonry walls extend up to within 1 inch of the ceiling above, and this remaining space is packed with a 1-inch thick blanket of Thermafiber insulation. All doors in these perimeter walls are Label "A" fire doors.

The ceiling of this fire zone, at elevation 401 feet 0 inch, is a 24-inch thick structural reinforced concrete slab supported by concrete beams and columns and carries a 3-hour fire rating.

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RESPONSES TO FIRE PROTECTION SITE AUDIT CONCERNS

Concern No. 16

Labeled fire doors were not provided at the Auxiliary Fuel Pump Room and at the doorway in the fire wall at Column L-11 on elevation 401 feet, as committed to in the Fire Protection Report.

Response

Fire doors for the auxiliary feedwater pump room on elevation 383'-0" are Label "A" fire doors as currently indicated in the Fire Protection Report. A review of vendor shop drawings indicates that this is the case. The label in the field may have been inadvertently painted over or removed.

The fire doors at column-row L-11 on elevation 401'-0" are "doors of label construction" and not UL labeled doors as indicated in the Fire Protection Report. As described in agreement No. 4 of the fire protection site audit report, these doors provide an equivalent level of safety to labeled fire doors, and their use is therefore acceptable. The Fire Protection Report will be revised to correctly indicate the nature of these doors (revised Fire Protection Report pages are attached).

For further details, see Subsection 2.3.11.36 except that:

a. There is 9.6 pounds of gasket material.

b. With a floor area of 170 ft², the fire loading is negligible.

c. The fire loading is minimal and the design-basis fire is minimal and will not affect the ability to shut down the reactor.

2.3.11.39 Letdown Heat Exchanger 2B Room (Fire Zone 11.4D-2)

This zone is shown on Figure 2.3-13.

For details, see Subsection 2.3.11.38.

2.3.11.40 Auxiliary Building Elevation 401 feet 0 inch (Fire Zone 11.5-0)

This zone is shown on Figure 2.3-12 (Sheets 1 and 3) and in elevation on Figures 2.3-25 and 2.3-26.

Electrical cable trays routed through this zone are shown on Figure 2.3-36.

Fire Barrier Description

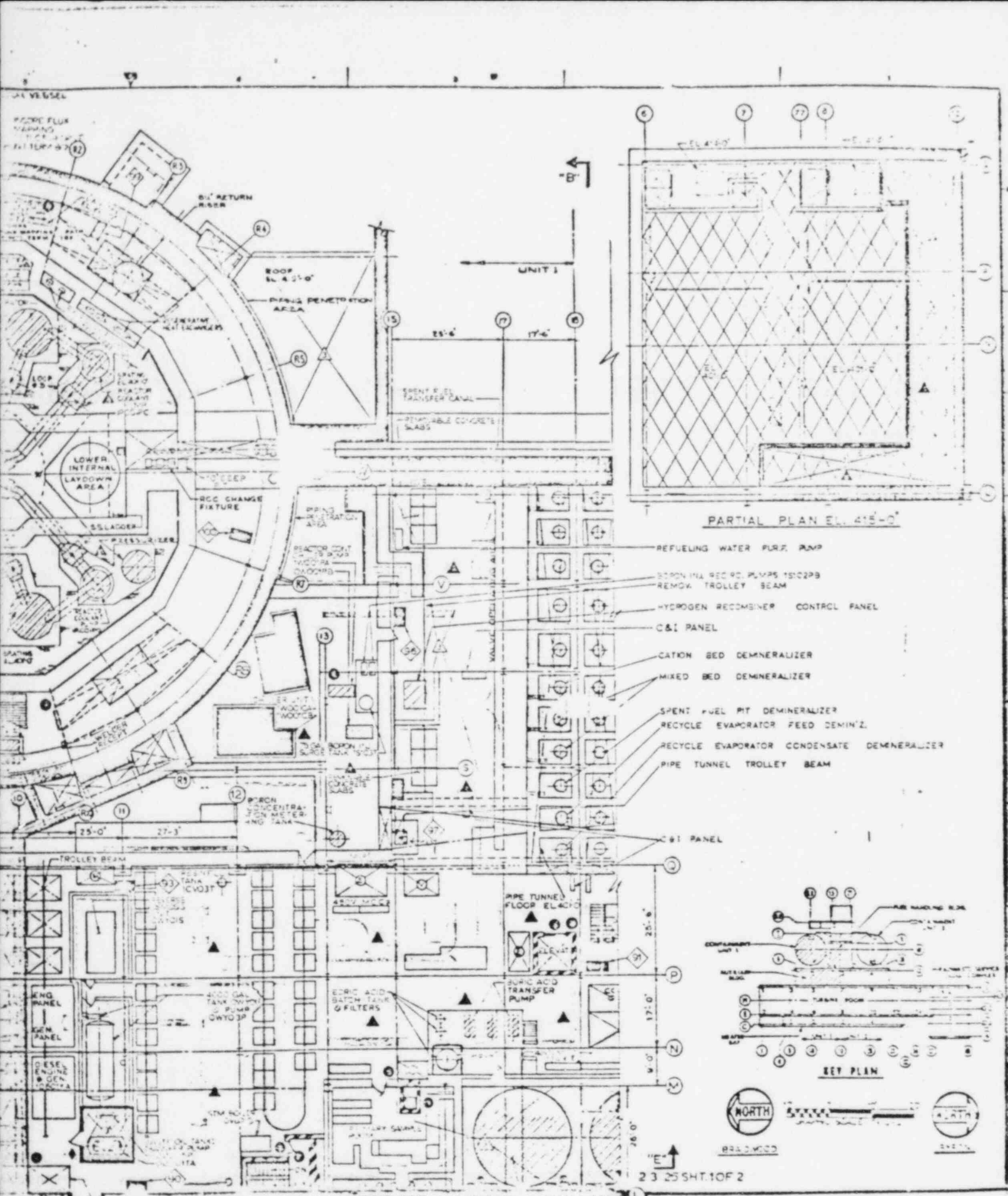
The floor at elevation 401 feet 0 inch is a 12-inch to 48-inch structural reinforced concrete slab supported by concrete beams and columns. The portion of the floor over the RHR heat exchanger rooms carry a 3-hour fire rating. The remainder of the floor contains a number of openings for equipment removal, for an open stairway, and therefore, carries no fire rating. Several 4-inch diameter floor drains are provided.

The perimeter walls of this zone are minimum 12-inch thick solid concrete masonry units or 30-inch thick structural reinforced concrete. The wall common to this zone and the Turbine Building ground floor and the Diesel-Generator Rooms carry a 3-hour fire rating. Fire doors in these walls are either Label "A" doors or "doors of label A construction."

Three stairways and an elevator hoistway included in this zone are enclosed by 12-inch thick hollow concrete masonry unit walls, which contain Label "B" fire doors and carry a 2-hour fire rating.

All masonry walls extend up to within 1 inch of the ceiling above, and the remaining space is packed with a 1-inch thick blanket of Thermafiber insulation.

The ceiling slab at elevation 426 feet 0 inch is 36-inch thick structural reinforced concrete or a 5-inch to 41-inch clear cover of structural reinforced concrete over 3-inch fluted steel



BYRON, BRAIDWOOD STATION

FIRE PROTECTION REPORT

FIGURE 2.3-12

GRADE FLOOR EL. 401'-0"

(SHEET 1 OF 4)

RESPONSES TO FIRE PROTECTION SITE AUDIT CONCERNS

Concern No. 17

We observed that, because of the absence of an automatic fire suppression system and the lack of a fire wall between redundant divisions, both RHR pumps and related cabling are vulnerable to a fire located in the containment spray pump area. To satisfy the guidelines in Section C.5.b of BTP CMEB 9.5.1, the unprotected openings in the wall separating the Division 11 RHR pump room from the containment spray pump area should be protected to prevent the passage of smoke and heat.

Response

It is the applicant's position that the residual heat removal pump rooms are already adequately separated, and that upgrading one or both of the intervening pump cubicle walls to a rated fire barrier is not warranted. The reasons for this are as follows:

The division 11 RHR pump cubicle is separated from the division 12 RHR pump cubicle by over 70 feet. The intervening rooms contain the division 11 and 12 containment spray pumps. The combustible loading in these rooms is conservatively estimated to be 10,300 BTU/ft^2 (division 11 CS pump room) and 36,200 BTU/ft^2 (division 12 CS pump room). The majority of this material consists of cable insulation and jacket materials. Because these are controlled access areas, no transient combustibles are assumed. All of these rooms are provided with ionization type fire detection. These combustible loadings are quite small, and the materials constitute a low fire hazard. Any fire which could occur in these CS pump rooms would not be of sufficient severity to propagate to the adjoining RHR pump rooms. The RHR pump cubicle walls, and door, while not fire rated, are of substantial construction, and could withstand a fire of the severity which might occur here without structural failure.

In addition, the RHR pumps are not required for normal plant operation nor to maintain the plant in hot standby. They are only used to bring the plant to cold shutdown. Thus, as allowed by Appendix R, credit can be taken for making repairs in the 72 hour interval prior to the time when the pumps are required. Thus, any cables which may have suffered fire damage due to a fire in the CS pump cubicles could be replaced or repaired during this time.

For these reasons, the applicant believes that upgrading the RHR pump cubicle walls to fire rated barriers is not required.

BYRON - 1

RESPONSES TO FIRE PROTECTION SITE AUDIT CONCERNS

Concern No. 18

We observed that, because of the absence of automatic fire suppression systems, area-wide smoke detection systems and/or physical separation between redundant divisions, both trains of shutdown related cabling and components are vulnerable to damage from a single fire in the following plant areas:

- Non segregated bus duct area
- Aux. electrical equipment room
- Aux. building general area, Elevation 346 feet
- Aux. building general area, Elevation 364 feet
- Aux. building general area, Elevation 401 feet
- Aux. building general area, Elevation 426 feet
- Containment

The fire protection for these areas is not in accordance with the guidelines in BTP CMEB 9.5.1 or Section III.G of Appendix R. Outside containment, the applicant should completely protect one shutdown division with a one-hour fire rated barrier wherever redundant divisions are located within 20 feet of one another or located more than 20 feet apart but the inervening space contains combustible material. In addition, complete area-wide fire detection and automatic fire suppression are required. Inside containment, the fire protection guidelines of Section C.7.a of BTP CMEB 9.5.1 apply. To facilitate our evaluation of any deviation from our guidelines and to evaluate the adequacy of the applicant's response to Item 8 (above), the applicant should provide color coded drawings showing the relative location of redundant shutdown related cables for all fire areas.

NOTE Because no safe shutdown analysis was provided for Unit 2, our evaluation applies only to Unit 1.

Response

In order to facilitate the staff's continuing evaluation of fire protection features in the plant areas listed above, a set of color-coded drawings showing redundant safe shutdown cable pairs for these areas will be completed and provided to the staff for their use, as requested by this concern. These drawings are expected to be available by September 30, 1983.

RESPONSES TO FIRE PROTECTION SITE AUDIT CONCERNS

Response (Cont'd)

A response to each area listed above follows:

A) Non-segregated bus duct area (Fire Zone 3.2A-1) -- As described in Subsection 2.4.2.7 of the Fire Protection Report, all redundant safe shutdown cable pairs are separated by at least 20 feet. In addition, this area has area wide fire detection and a total flooding CO_2 suppression system. It is the applicant's position that the existing design for this area is adequate, and additional features are not required.

B) Auxiliary Electric Equipment Room (Fire Zone 5.5-1) -- The applicant is in the process of designing a new panel to provide the operators with vital safe shutdown parameters independent of this zone. The new panel is redundant to equipment in this room, thus a fire in this room will not prevent safe shutdown of the unit. Details regarding the new panel and the instrumentation to be provided on it are included in the revised response to FSAR question 10.57, and in revised Subsection 2.4.2.21 of the Fire Protection Report. Advance transmittals of these sections (which will be included in future amendments to the respective documents) were sent to the NRC on June 17, 1983 via a letter from Mr. T. R. Tramm (CECo) to Mr. H. R. Denton (NRC).

C) Auxiliary Building General Area, Elevation 346'-0" (Fire Zone 11.2-0) -- As described in Subsection 2.4.2.33 of the Fire Protection Report, the applicant believes that the existing arrangement for this area is adequate.

D) Auxiliary Building General Area, Elevation 364'-0" (Fire Zone 11.3-0) -- As described in Subsection 2.4.2.37 of the Fire Protection Report, the applicant believes that the existing arrangement for this area is adequate.

E) Auxiliary Building General Area, Elevation 401'-0" (Fire Zone 11.5-0) -- As described in Subsection 2.4.2.46 of the Fire Protection Report, the applicant believes that the existing arrangement for this area is adequate.

F) Auxiliary Building General Area, Elevation 426'-0" (Fire Zone 11.6-0) -- Upon completion of the modification described in Subsection 2.4.2.49 of the Fire Protection Report, the arrangement in this area will be adequate.

G) Containment (Fire Zones 1.1-1, 1.2-1 and 1.3-1) -- As described in Subsections 2.4.2.1-3 of the Fire Protection Report, the applicant believes that the existing arrangement in these areas is adequate.

RESPONSES TO FIRE PROTECTION SITE AUDIT CONCERNS

Response (Cont'd)

In summary, the applicants position regarding the adequacy of the existing design for these areas remains unchanged. All of the areas listed outside of containment already have complete area-wide detection. Except for the non-segregated bus duct area, which is provided with an automatic total flooding CO_2 suppression systems, no automatic area-wide suppression systems are provided, nor are they justified due to the low combustible loading and the widely dispersed nature of the identified combustible materials. Redundant safe shutdown divisions are already separated by 20 feet or more in all cases. This provides adequate separation. The additional installation of a one hour rated barrier around one safe shutdown division is not justified on the basis that the only identified combustible materials between the redundant cables consists of cable insulation and jacketing materials. Due to the fire resistant construction of cables used at Byron/Braidwood, propagation of a fire in one cable tray to nearby cable trays of the opposite division will not occur. Thus, the applicant concludes that changes to the existing arrangement are not warranted.

BYRON - 1

RESPONSES TO FIRE PROTECTION SITE AUDIT CONCERNS

Concern No. 1

In the August 16, 1982 revision to the Fire Protection Report, the applicant committed to seal fire barrier penetrations with material having a fire resistance rating comparable to the ratings of fire walls and floor/ceiling assemblies. This necessitates that sealant material be installed to an appropriate depth consistant with its UL listing. We observed that RTV silicon sealant material was installed in the plant in thicknesses greater than the depth of the concrete floor slab. This configuration does not appear to be consistent with the listing of the material. We are concerned that this sealant material will not be able to withstand anticipated fire exposures. The applicant should verify that penetration seals featuring silicon foam, as installed in the plant, are equivalent to the structural assembly.

Response

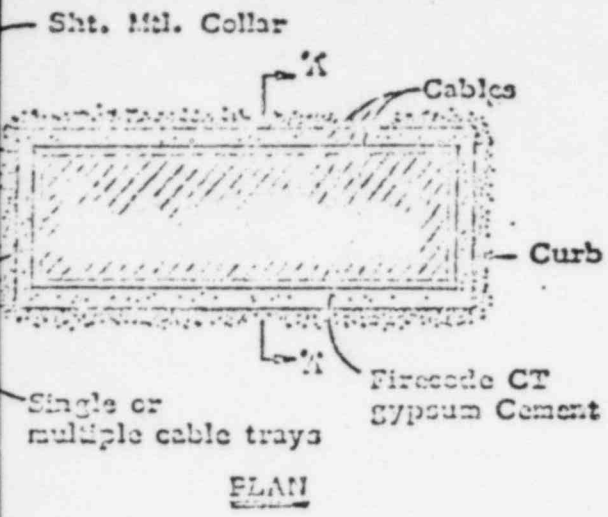
The sealant fire test reports for the different fire stop materials used in "electrical" openings in walls, floors, or ceilings address the amount of fire stop material required in order to meet the required fire ratings of these fire barriers. This information is transmitted to the installation contractor via drawings which give specific installation requirements for each opening requiring a fire stop. For openings where the thickness of the fire barrier is less than required thickness of the fire stop material, a detail has been shown on the installation drawings specifying how the required thickness is to be attained. The type of detail used for attaining a thickness of fire stop greater than the floor thickness is shown on drawing B1-E-0-5A (copy attached). The fire stop sealant test reports also address the installation of plugs in installed fire stops. For this testing an installed fire stop was drilled to make an opening and then resealed with the same fire stop material. The installation was subsequently exposed to fire tests.

The applicable test reports for the fire stop materials used in "electrical" openings in floors, walls, and ceilings at Byron/ Braidwood are listed below. These test reports are currently under review to verify that the fire stops meet all applicable requirements.

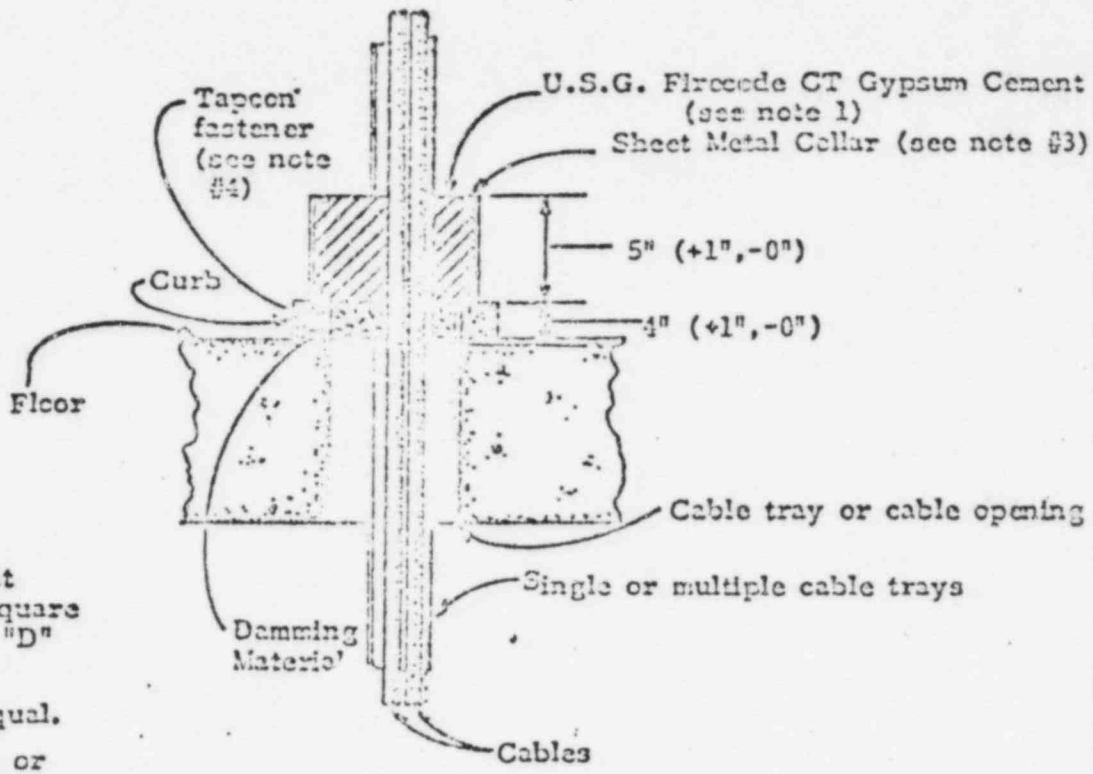
1. CT Gypsum - Transco Test Report TR-109

2. High Density Silicone - Transco Test Reports TR-110+TR-121

3. Medium Density Silicone - Transco Test Report TR-111



PLAN



SECTION 'A-A'

DETAIL "D1"

NOTES:

1.) Use U.S.G. Firecode CT Gypsum Cement as shown for types 1, 1/5, or 5 floor square or rectangular openings (or see details "D" or "D2").

2.) Use U.S.G. Thermafiber or approved equal.

3.) Use sheet metal collars attached to curb or floor (or end of collar to wall) as conditions require.

4.) Use Tapcon fasteners (or approved equal) as required to attach collar to floor or wall. Anchors shall not be embedded more than 1" deep into the surrounding concrete.

REVISIONS			Byron N.P.S., Unit I and II Commonwealth Edison Company		
NO.	DATE	BY	Detail "D1" Firecode CT Gypsum Cement Seal with collar for floor penetrations		
1			Drawn BY	Scale NS	Material Firecode CT Gyp.
2			Check BY	Date 10/15/82	Drawing No.
3			Issued BY	Approved	BY-E-03A
4					
5					

TRANSCO

TRANSCO FIRE TEST REPORT TR-109

FIRE AND HOSE STREAM TESTS OF TCO-001 CEMENT

By: G.J.Jarosz

Date: 4-7-83

A) Synopsis:

This report describes a three hour fire and subsequent hose stream floor test of Transco #TCO-001/U.S. Gypsum Firecode CT Gypsum Cement used in a large electrical opening. The fire test was performed in accordance with the ASTM E-119 time/temperature curve for three hours and provisions for testing penetration seals set forth in the IEEE 634-78, ANI, NML, and ASTM E-814 (for a "F" rating) test standards. This penetration seal was tested along with 26 other openings in a large 17'-9" x 13'-10-1/2" concrete slab on March 9, 1983, at Portland Cement Association's Fire Research Laboratory (Skokie, Illinois).

The opening measured 109-1/2" x 32" x 12" deep and had two substrate surfaces which consisted of 1/4" thick steel plate while the remaining two substrate surfaces were cast concrete. Three cable trays and two conduits penetrated the opening. Two of the trays (one ladder and one solid back) and one conduit were filled with PVC jacketed cable. The third tray and other conduit were filled with Hypalon jacketed cable. The two trays with PVC jacketed material were located 1/16"-1/8" from the substrates at each end of the penetration in order to show the sealing material's ability to seal narrow spaces. The third tray was located 17-3/8" from one end of the penetration.

The opening was filled with 5" of Transco #TCO-001/U.S. Gypsum Firecode CT Gypsum Cement. Four inches of #TCO-009/U.S. Gypsum Thermafiber damming material was used to dam inside of the cable trays and conduits (only). No damming material was used for the areas outside of the trays and conduits.

Transco #TCO-001 cement is a water based, 20-35 lbs./cu.ft. material. It is normally mixed with an accelerator to produce a rigid material which can be easily altered. The materials used for this test were mixed with varying amounts of water and accelerator (and in some batches no accelerator was used) in order to demonstrate the material's installtion versatility. During installation, the material's consistency ranged from a stiff material which had to be troweled in place to a soupy liquid which flowed and self-leveled.

It should be noted that a small hairline crack developed at the center of the seal's surface (this crack was not visible from beneath the slab).

The single surface crack was the result of a slight amount of linear shrinkage of the material (this is a normally occurring characteristic of this material). It should also be noted that the seal had been walked upon on several occasions prior to the actual fire test. Although no damage was visible, standing on the seal is not recommended since it is a very thin, unsupported material.

Besides qualifying the seal to the test standards mentioned, several other objectives were established in this test. These are:

1. The materials ability to seal both narrow and wide areas without support;
2. The material's ability to provide the desired fire protective qualities even if surface cracks occur and when the material is installed using a variety of water and accelerator to dry material ratios;
3. The use of material to seal both solid and ladder back cable trays;
4. The use of the material when installed next to either steel or concrete substrates;
5. The use of a damming board divider (used in several sections) to separate larger field openings into sections which are equal to or smaller than the penetration tested;
6. The ability of the sealing material to be removed for additional cable installation; and,
7. That a symmetrical 5" thick seal can withstand the 3 hour fire and 2 hose separate stream tests.

B.) Test Slab:

The test slab measured 17'-9" x 13'-10-1/2" x 12" thick. Twenty-seven openings which ranged from 1-1/2" diameter to 109-1/2" x 32" in size penetrated the test slab. The penetra-

tions were arranged in the slab so that 18" wide (min.) concrete columns separated each row of penetrations. These columns were placed in the direction which would allow for the least amount of deflection from heat during the fire test.

The slab's steel reinforcement design and actual slab fabrication were completed by Portland Cement Association's personnel. After the slab was cast, the concrete was allowed to cure for several days after which the slab was subjected to additional heat curing on a furnace.

The slab's superstructure and specimen fabrication and seal installation was performed by Transco employees. The slab's superstructure consisted of steel angle braces mounted to the slab which supported the pipes, cable trays, cables, etc., for the test.

C.) Specimen Configuration:

The test penetration measured 109-1/2" x 32" x 12" deep. Two sides of the penetration were lined with 1/4" thick steel plate (set at a right angle in the plan view of the penetration). The remaining two substrate surfaces were cast concrete.

The opening was penetrated by three cable trays and two conduits. Each cable tray was mounted so that it extended 36" above the slab's unexposed surface and 12" below its exposed

surface. The conduit sleeves were 12" long and mounted flush inside of the penetration.

The cable trays and conduits were filled with cable based on loadings which exceeded 100% fills. The loadings were calculated so that a 100% fill was equivalent to 40% of the actual sectional areas of the cable trays or conduits. Some of the loadings were increased so that 100% visual loadings were also chieved. Cable loadings were as follows:

1.) 24" x 6" solid back cable tray filled with Hypalon jacketed cable:

7	4 pr.	#20	0.4185	2.9295
5	1 pr.	#16	0.1046	0.523
5	8 pr.	#16	0.6792	3.396
9	12 pr.	#16	0.916	8.2448
10	2/C	#14	0.1839	1.8398
3	3/C	#14	0.2058	0.6176
3	3/C	#14	0.2715	0.81464
8	7/C	#14	0.3717	2.9741
4	9/C	#14	0.4938	1.96
4	12/C	#14	0.7013	2.8052
4	7/C	#10	0.5242	2.0969
2	9/C	#10	0.7697	1.5395
3	2/C	#10	0.2846	0.8538
1	3/C,	500MCM	5.2563	5.2563
5	3/C,	1/0	1.6695	8.3475

Total loading = 44.1986 sq. in.
(115.10% fill of tray)

*one 12/C #14 cable was added to this tray as part of the repair to this seal.

2.) 4" diameter conduit filled with Hypalon jacketed cable:

2	12 pr. #20	0.9160	1.832
2	12 pr. #14	0.7013	1.4026
1	3/C, 4/0	2.6822	2.6822

100% fill Total loading = 5.9168 sq. in.
(117.7% fill of conduit)

3.) 30" x 4" ladder back cable tray filled with PVC jacketed cable:

134	2/C #14	0.1372	18.3848
35	12/C #14	0.5329	18.6190
26	1/C, 500MCM	0.7013	18.2359

Total loading = 55.2397 sq. in.
(115% fill of tray)

*three 2/C #14 cables were added to this tray as part of the repair to this seal.

4.) 30" x 4" solid back cable tray filled with PVC jacketed cable:

134	2/C #14	0.1372	18.3348
35	12C #14	0.5329	18.6190
26	1/C #14	0.7013	18.2359

Total loading = 55.2397 sq. in.
(115% fill of tray)

5.) 6" diameter conduit filled with PVC jacketed cable:

30	2/C	#14	0.1372	4.1160
8	12/C	#14	0.5329	4.2632
7	1/C,	500MCM	0.7013	4.9091

Total loading = 13.2883 sq. in.
(117.4% fill of conduit)

All cables used in the test extended 36" above the slab's unexposed surface and 12" below its exposed surface. Cables were held to the trays with both compression clamps and metal plates located approximately 12" from the top of each tray. In addition, a threaded rod was used across the bottom of each tray to prevent the cables from being pulled forward during the seal installation. This was done to simulate field conditions where continuous cables make it impossible in some cases to move the cables apart for seal installation.

The conduits were welded directly to the steel substrate. This was performed to show the sealing material's ability to fill a space which gets increasingly smaller (following the curvature of the conduit to where it is welded to the substrate). The cables used in these conduits were held to a bar which was located approximately 30" above the slab.

The top ends of all cables used inside of cable trays were covered with silicone adhesive while conduit cable ends were taped. This was completed in accordance with IEEE-634-78 requirements.

D.) Seal Installation:

The opening around the cable trays and conduits was first formed with plywood and supported from the floor below (any other smooth, removable form can be used in field installations or an approved noncombustible material can be used if damming is to remain as a permanent part of the installation). Four inches of #TCO-009 damming material was then installed between the cables to hold the liquid #TCO-001 cement material in place until set (and remained in place as part of the permanent seal between the cables only).

The #TCO-001 cement was then installed 5" deep over the forming materials. The cement material was mixed both in a dispensing machine and by hand in plastic buckets to demonstrate both conditions. Varying amounts of water were used in both cases to produce a material consistency which ranged from a flowable, soupy liquid to a thick material which had to be placed by trowel.

Varying amounts of liquid and dry accelerator were also used from batch to batch (and in some cases, no accelerator was used). This wide range of installation techniques was used to demonstrate the material's fire protective properties when batches as described are installed and when set percentages of water and accelerator to dry material might be altered by the installer to suit field conditions.

After the cement had been placed, its surface was trowelled smooth. An additional light coating of #TCO-001 cement (approximately 1/4" thick) was sprayed onto all PVC jacketed cable to a height of 12" above the already installed 5" thick seal. The Hypalon jacketed cables were not sprayed with any additional material.

After the materials had hardened, a wooden rod was used to bore a small hole through the cement in front of the cable tray holding the Hypalon jacketed cables while a second hole was made in front of the ladder back tray filled with PVC jacketed cable. One 12/C #14 Hypalon cable was then added to the Hypalon cable tray and three 12/C #14 PVC cables were added to the ladder back tray through the holes. The spaces around the cables were then filled with additional cement and damming material to simulate field conditions where a finished seal might be altered for the addition of cables.

It should be noted that prior to the installation for the cement material, a section of 1" thick Johns-Manville Ceraboard (8lb. density) was set perpendicularly in front of the solid back cable tray filled with PVC jacketed cable. This section of board material consisted of three separate sections of the board which were butted up against each other across the width of the penetration. The section of board was as high as the cement seal surrounding it. This board was installed to demonstrate field conditions where penetrations larger than the penetration qualified in this test can be divided using the board material into sections the same size or smaller to meet the size limitations of this test.

E.) Thermocouples:

Thermocouples were mounted to the test specimen to gather temperature data throughout the test at five minute intervals for the first two hours and at ten minute intervals for the remaining hour (in accordance with IEEE 634-78). Temperatures were recorded for the seal surface (in eight different locations), concrete and steel substrate/seal interfaces, at tray/seal and conduit/seal interfaces, on seal surfaces of conduits, and at cable/seal interfaces. In each cable tray and conduit, thermocoupes were mounted to typical instrument, control, and power type cables. Where the cables were covered with a sprayed coating (in the cable trays and conduit which were filled with PVC jacketed cable), the thermo couples were attached directly to the cables at the surrounding seal surface (beneath the coating).

All seal surface thermocouples were embedded approximately 1/4-1/2" deep into the seal's surface. Where thermocouples were used to measure cable, substrate, tray, or conduit temperatures, the thermocouples were also embedded 1/4-1/2" deep into the interface surfaces. The thermocouples used in this test along with final temperature readings at the conclusion of the test are as follows (temperature data for the entire test can be found in Section H of this report):

T/C#	Print#	Description	Final Temperature (°F)	
9	9c	Seal surface	137	
10	10c	Seal surface	150	
11	11c	Seal surface	141	
12	12c	Steel substrate/ seal interface	423	
13	13c	Concrete substrate/ seal interface	193	
14	14c	Instrument cable	416	Cable tray filled with Hypalon jacketed cable
15	15c	Control cable	441	
16	16c	Power cable	464	
17	17c	Cable tray	326	
18	18c	Seal surface	471	Conduit filled with Hypalon jacketed cable
19	19c	Instrument cable	424	
20	20c	Control cable	391	
21	21c	Power cable	326	
22	22c	Seal/conduit interface	471	
23	53a	Instrument cable	368.9	Ladder back tray filled with PVC jacketed cable
24	54a	Control cable	426.9	
25	55a	Power cable	809.2	
26	56a	Cable tra	201.5	
27	27c	Instrument cable	271	Solid back tray filled with PVC jacketed cable
28	28c	Control cable	364	

T/C#	Print#	Description	Final Temperature (°F)	
29	29c	Power cable	627	
30	30c	Cable tray	188	
31	31c	Instrument cable	391	
32	52a	Control cable	546.3	Conduit filled with PVC jacketed cable
33	49a	Power cable	578.6	
34	50a	Seal surface	213.7	
35	51a	Seal/conduit interface	704.3	
163	163c	Seal surface	141	
164	164c	Seal surface	390	
165	165c	Seal surface	325	
166	166c	Seal surface	470	
167	167c	Seal surface	423	
209	98b	Repair surface	165.3	Hypalon jacketed cable
210	99b	Repair cable	370.4	
211	100b	Repair surface	150.2	PVC jacketed cable
212	90b	Repair cable	178.9	

F.) Furnace:

The furnace used for this test measures approximately 14' x 18' at its support points. It is approximately 7' tall making it possible to work on the specimen's exposed surface and view it prior to the fire test. The furnace atmosphere is controlled by six self-igniting burners which burn natural gas and operate in unison. The burners are automatically controlled by a computer located inside of the control room. As the furnace atmosphere temperatures are monitored in the control room, manual adjustments can be made to account for varying amounts of fuel contri-bution throughout the test.

The furnace atmosphere temperatures are monitored by 16 thermocouples located 12" below the test slab. These temperatures are individually printed on a continuous chart and also averaged on a computer print-out.

The furnace draft is manually operated and averaged approximately -.08" of water pressure throughout the test. Since manual adjustments are made to the burners in order to follow the ASTM E-119 time/temperature curve, brief periods of positive pressure are introduced inside of the furnace. This is evidenced by visible puffs of smoke generated through any openings in the test specimen (i.e., through a fire damper, unsealed pipe insulation, etc.).

G.) Test Record:

The fire test was conducted for three hours in accordance with the ASTM E-119 time/temperature curve. Throughout the test, an even blanket of flame covered the plan area of the furnace. All combustible materials located on the exposed surface of the slab quickly ignited and continued to char throughout the test. During the first 2 hours of the test, very little smoke was generated from the cables used in this specimen. Water began to evaporate through the hairline crack (noted prior to the test) at the center of the seal. This was evidenced by moisture highlighting the crack.

During the test, the west side of the penetration's substrate (concrete with the 1/4" thick steel plate liner) was level. This portion of the slab was supported by the edge of the furnace and remained level. Although no deflection of the slab was noted here, slab expansion did occur as evidenced by 1/16"-1/8" wide cracks at the corners of the slab.

The opposite side of the penetration (cast concrete with no steel liner) was not supported by the edge of the furnace and as a result was exposed to more heat than the concrete substrate with the steel liner. This lack of support and exposure to greater heat caused the concrete to expand and visibly deflect downward into the furnace.

The downward deflection of the concrete resulted in a combined shear/twisting action on penetration seal during the fire test. The most severe downward deflection of the concrete occurred near the damming board divider. During the fire test it was observed that the seal twisted and sloped here to follow the slab's deflection. At this point of the severest slab deflection, several small cracks and a small bulge occurred on the seal surface. This was a result of strain release of the twisted seal. During the fire test, higher surface temperatuers were obtained in this area. After the fire test, it was noted that some of the seal's exposed surface had fallen from this area also. Outside of the area of the seal affected by the deflection of the slab, seal surface temperatures remained relatively cool and no loss of material was observed after the conclusion of the test.

Within the last hour of the test, the PVC jacketed cables began to swell near the seal surface causing cracking in their coatings. This swelling was not observed on the Hypalon jacketed cables. A light density smoke generated from the PVC cables for the duration of the test.

Two hose stream tests were conducted on the concrete slab and penetration seal. Water did not penetrate any portion of the seal during either test.

The first hose stream test consisted of spraying the exposed surface of the 17'-9" x 13'-10-1/2" slab with water delivered from a 1-1/2" hose equipped with a fog nozzle set at a discharge angle of 15° at 75 p.s.i. from 10' for 6 minutes and 18 seconds. The second hose stream test was identical to the first except that the nozzle was set at a discharge angle of 30°.

H.) Temperature Data:

The following sheets identify both furnace atmosphere and unexposed surface temperatures obtained through the fire test.

TRANSCO (CP5056) - 03/09/83

FURNACE ATMOSPHERE TEMPERATURE (DEG. F)

TEST TIME, Hr:Min	FURNACE TEMP. F	ASTM E119 TEMP. F	VARIATION FROM ASTM TEMP. F
0:00	196	68	128
0:05	995	1000	-5
0:10	1271	1300	-29
0:15	1503	1399	104
0:20	1527	1462	65
0:25	1547	1510	37
0:30	1557	1550	7
0:35	1608	1584	24
0:40	1626	1613	13
0:45	1638	1638	0
0:50	1655	1661	-6
0:55	1704	1681	23
1:00	1714	1700	14
1:05	1724	1718	6
1:10	1729	1735	-6
1:15	1748	1750	-2
1:20	1771	1765	6
1:25	1776	1779	-3
1:30	1779	1792	-13
1:35	1818	1804	14
1:40	1823	1815	8
1:45	1830	1826	4
1:50	1836	1835	1
1:55	1844	1843	1
2:00	1854	1850	4
2:10	1873	1862	11
2:20	1880	1875	5
2:30	1880	1888	-8
2:40	1895	1900	-5
2:50	1916	1912	4
3:00	1930	1925	5

TRANSCO (CP5056) - 03/09/83

UNEXPOSED SURFACE THERMOCOUPLE TEMPERATURES (DEG F)

TEST TIME, Hr:Min	T/C NO.					
	9	10	11	12	13	14
0:00	75	75	76	76	76	76
0:05	72	72	74	75	73	74
0:10	73	73	74	83	73	77
0:15	73	74	74	97	74	90
0:20	74	74	74	113	74	109
0:25	75	75	75	136	75	135
0:30	76	77	76	153	78	168
0:35	78	79	78	164	82	192
0:40	80	81	82	176	87	203
0:45	83	84	92	188	93	208
0:50	87	88	105	198	99	211
0:55	92	93	121	207	105	214
1:00	99	99	135	220	112	217
1:05	106	108	146	235	119	222
1:10	112	115	151	249	126	229
1:15	118	123	153	263	133	236
1:20	122	130	153	283	139	238
1:25	127	136	152	300	144	251
1:30	129	139	152	314	150	251
1:35	129	141	149	325	154	272
1:40	129	142	146	337	157	279
1:45	130	142	145	346	160	287
1:50	129	143	144	353	163	293
1:55	129	143	144	359	166	308
2:00	130	144	143	367	169	321
2:10	132	145	143	378	175	334
2:20	132	145	142	389	180	347
2:30	132	147	142	399	184	367
2:40	135	149	142	408	187	386
2:50	135	149	141	415	189	402
3:00	137	150	141	423	193	416

UNEXPOSED SURFACE THERMOCOUPLE TEMPERATURES (DEG F)

TEST TIME, Hr:Min	T/C NO.					
	15	16	17	18	19	20
0:00	76	75	75	77	76	75
0:05	75	73	75	78	76	73
0:10	82	73	82	92	83	77
0:15	105	75	94	114	97	86
0:20	130	78	106	136	113	98
0:25	160	84	120	162	136	114
0:30	181	92	144	182	153	141
0:35	206	102	156	194	164	154
0:40	226	114	162	206	176	159
0:45	241	128	167	219	188	166
0:50	251	143	179	233	198	171
0:55	261	160	192	248	208	176
1:00	271	176	204	265	220	183
1:05	282	186	216	284	235	198
1:10	290	191	232	298	249	211
1:15	298	197	244	315	263	222
1:20	306	204	253	336	283	236
1:25	314	212	264	356	300	248
1:30	321	220	272	372	315	260
1:35	328	225	278	383	326	271
1:40	336	230	280	393	338	280
1:45	344	235	283	402	346	289
1:50	350	241	287	409	354	298
1:55	356	248	293	415	360	307
2:00	363	254	292	421	367	315
2:10	378	269	295	433	379	334
2:20	395	291	307	442	389	348
2:30	407	320	321	451	399	359
2:40	420	352	314	458	408	370
2:50	429	397	316	464	415	382
3:00	441	464	326	471	424	391

TRANSCO (CHECOS) - 03/09/83
UNEXPOSED SURFACE THERMOCOUPLE TEMPERATURES (DEG.F)

TEST TIME, HR:MIN	T/C NO						
	21	22	23	24	25	26	27
0:00	75	76	70.1	71.8	73.8	71.5	75
0:0	75	78	70.4	72.4	78.4	72.3	73
0:10	82	91	71.5	75.4	95.4	95.4	74
0:15	94	114	74.0	82.3	123.3	73.5	78
0;20	105	136	78.7	94.2	165.5	76.4	83
0:25	119	162	86.2	110.2	210.3	80.7	90
0:30	144	182	97.2	128.1	241.5	86.7	98
0:35	156	194	115.1	147.9	270.4	93.9	108
0:40	161	206	159.1	173.4	307.9	102.4	123
0:45	167	218	192.0	199 2	335.4	112.9	142
0:50	179	233	197.8	206.3	353.1	126.1	149
0:55	192	248	198.1	210.2	365.2	133.9	153
1:00	203	265	197.0	215.4	379.9	141.9	156
1:05	216	284	195.7	221.0	379.1	146.8	158
1:10	231	298	194.9	227.7	415.8	153.7	160
1:15	243	315	193.9	233.6	436.0	157.4	163
1:20	253	336	193.7	241.5	463.5	159.7	167
1:25	264	355	193.9	248.6	485.7	162.3	171
1:30	272	371	194.2	257.0	501.2	164.1	176
1:35	278	383	195.1	264.5	516.4	167.2	179
1:40	280	393	199.6	270.5	536.1	166.1	184
1:45	283	402	204.8	277.3	560.9	166.1	190
1:50	287	409	209.9	284.6	584.3	167.7	196
1:55	292	414	215.4	292.5	607.2	168.3	200
2:00	292	421	220.4	298.1	632.1	169.9	206
2:10	295	433	229.3	312.0	680.2	172.9	215
2:20	307	442	236.8	325.6	692.8	177.9	225
2:30	321	450	266.9	340.5	712.5	183.8	231
2:40	314	458	309.3	364.1	737.8	190.3	243
2:50	316	463	339.5	393.0	784.6	195.6	250
3:00	326	471	368.9	426.9	809.2	201.5	271

TRANSCO (CR5056) - 03/09/83
UNEXPOSED SURFACE THERMOCOUPLE TEMPERATURES (DEG F)

TEST TIME, HR:MIN	T/C No.							
	28	29	30	31	32	33	34	35
0:00	75	75	69	75	72.1	71.5	71.6	73.2
0:05	74	74	67	73	72.6	71.8	72.2	77.1
0:10	78	80	68	77	75.1	74.4	74.8	94.6
0:15	85	90	71	86	82.6	80.8	82.1	124.8
0:20	94	103	74	98	96.8	92.3	97.1	163.0
0:25	107	120	78	114	120.9	111.5	119.0	217.1
0:30	122	140	83	141	180.3	144.9	171.1	236.1
0:35	139	165	89	154	299.8	170.3	190.8	250.1
0:40	154	198	95	159	210.8	179.0	194.1	259.8
0:45	164	220	101	166	210.6	179.4	195.5	272.8
0:50	171	238	111	171	208.9	179.6	195.6	291.2
0:55	178	248	122	176	206.9	183.8	198.1	311.9
1:00	184	257	131	183	205.7	190.7	213.3	333.7
1:05	191	268	137	198	214.9	200.5	224.1	355.2
1:10	196	281	142	211	244.7	209.8	229.9	380.8
1:15	200	294	145	222	273.9	218.8	223.0	407.1
1:20	206	305	147	235	231.5	227.4	213.8	435.8
1:25	212	316	150	248	264.0	227.7	214.2	458.3
1:30	217	325	152	260	303.0	225.9	214.2	481.1
1:35	220	335	153	271	308.3	226.9	214.3	504.0
1:40	223	347	154	279	291.3	224.3	181.2	522.1
1:45	232	374	156	289	285.4	236.5	175.7	539.6
1:50	243	411	158	297	295.1	254.4	176.2	555.1
1:55	154	430	160	306	304.2	274.4	179.6	572.7
2:00	269	448	162	315	323.3	294.9	181.4	509.0
2:10	286	482	167	333	361.6	348.0	187.1	620.9
2:20	299	517	169	347	387.2	406.3	192.9	640.5
2:30	308	538	173	358	401.1	424.8	195.6	653.2
2:40	327	566	178	369	438.9	475.3	200.9	667.0
2:50	343	594	182	382	507.2	552.9	207.3	690.6
3:00	364	627	188	391	546.3	578.6	213.7	704.3

TRANSCO (CR5056) - 03/09/83
UNEXPOSED SURFACE THERMOCOUPLE TEMPERATURES (DEG F)

TEST TIME HR:MIN	T/C NO				
	163	164	165	166	167
0:00	77	75	75	76	76
0:05	74	73	75	78	75
0:10	74	77	82	91	83
0:15	74	86	93	114	97
0:20	75	97	105	136	113
0:25	76	114	119	162	136
0:30	79	141	144	182	153
0:35	86	153	155	194	164
0:40	97	159	161	205	176
0:45	109	166	166	218	188
0:50	122	171	179	232	198
0:55	132	176	192	248	207
1:00	138	183	203	264	220
1:05	142	198	215	283	234
1:10	145	211	231	298	249
1:15	146	222	243	315	263
1:20	147	235	252	336	283
1:25	147	248	264	355	300
1:30	148	260	271	371	314
1:35	147	270	277	382	325
1:40	145	279	280	392	337
1:45	143	289	282	401	346
1:50	142	297	286	408	353
1:55	143	306	292	414	359
2:00	142	314	291	420	366
2:10	142	333	294	432	378
2:20	142	347	306	441	389
2:30	143	358	321	450	398
2:40	142	369	313	457	408
2:50	141	382	315	463	414
3:00	141	390	325	470	423

TRANSCO (CR5056) - 03/09/83
UNEXPOSED SURFACE THERMOCOUPLE TEMPERATURES (DEG F)

TEST TIME	T/C NO			
HR:MIN	209	210	211	212
0:00	72.6	73.1	70.4	70.9
0:05	72.9	75.4	70.7	74.4
0:10	73.8	82.2	72.1	79.3
0:15	75.7	93.4	73.9	83.8
0:20	79.0	109.6	76.5	89.0
0:25	83.7	129.9	79.2	93.8
0:30	89.8	152.0	82.3	99.0
0:35	97.6	172.5	85.6	104.6
0:40	107.4	192.2	90.4	113.7
0:45	117.6	208.9	103.1	135.5
0:50	128.2	223.8	124.9	161.8
0:55	138.6	236.1	141.7	175.0
1:00	143.9	244.4	151.4	180.5
1:05	147.2	253.4	156.8	183.0
1:10	149.5	261.5	159.3	183.2
1:15	152.0	269.9	160.9	182.8
1:20	153.9	277.9	159.3	181.9
1:25	153.5	284.8	157.8	179.6
1:30	156.0	291.7	156.1	177.5
1:35	153.5	294.5	154.6	175.1
1:40	155.0	300.1	153.5	173.8
1:45	156.7	304.6	152.4	172.7
1:50	157.2	310.3	150.3	170.5
1:55	157.6	315.1	149.8	169.2
2:00	158.6	320.3	148.9	168.7
2:10	161.0	328.8	149.0	169.1
2:20	162.0	338.4	149.0	171.4
2:30	162.5	347.2	148.2	170.6
2:40	162.7	353.9	148.4	172.5
2:50	164.1	362.2	149.2	174.8
3:00	165.3	370.4	150.2	178.9

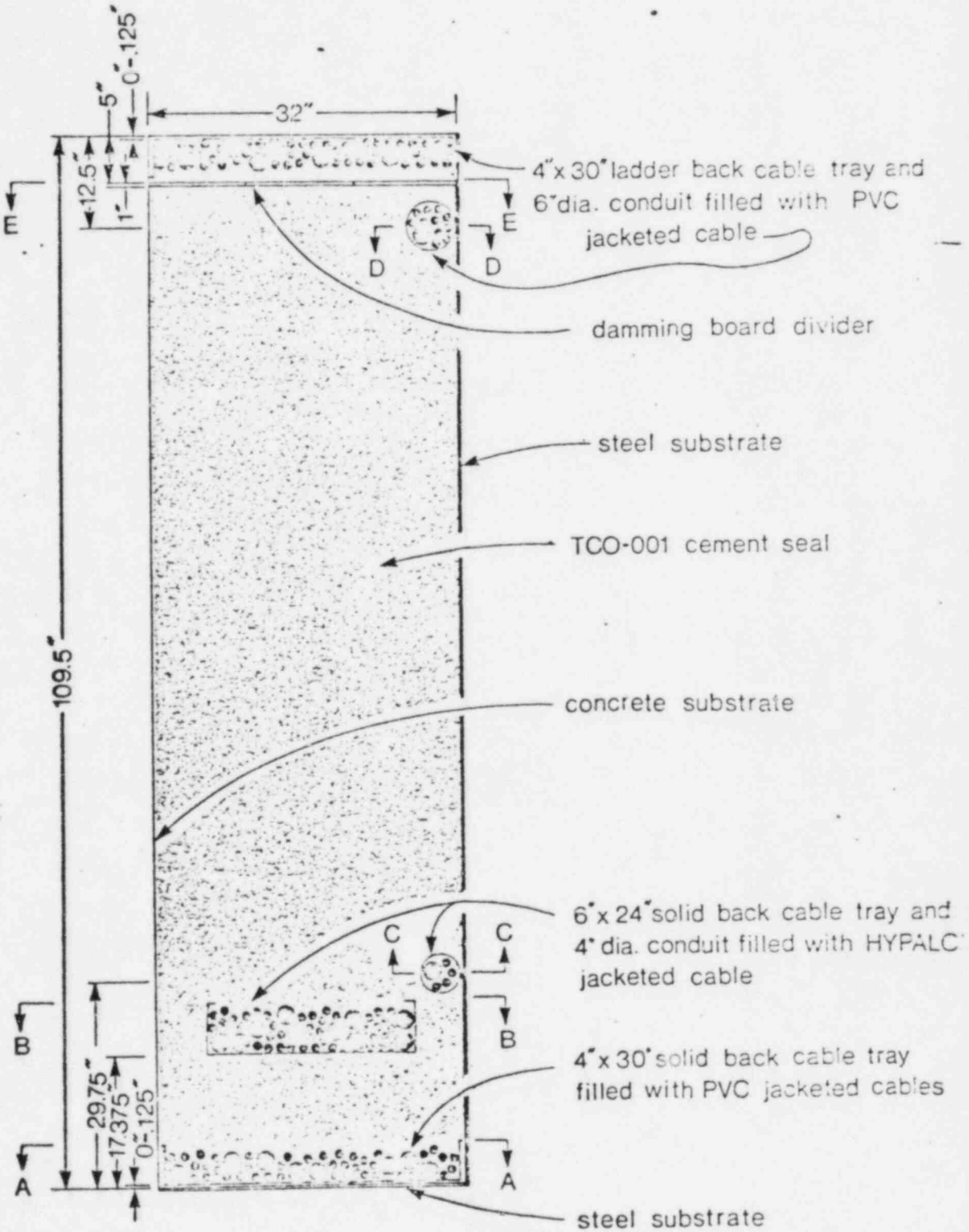
I.) Post Test Observations:

After the hose stream tests were concluded, the exposed surface of the seal was available for viewing. It was noted that most of the sealing material was intact. Several cracks appeared across the bottom of the seal which were caused by the intense heat of the fire test.

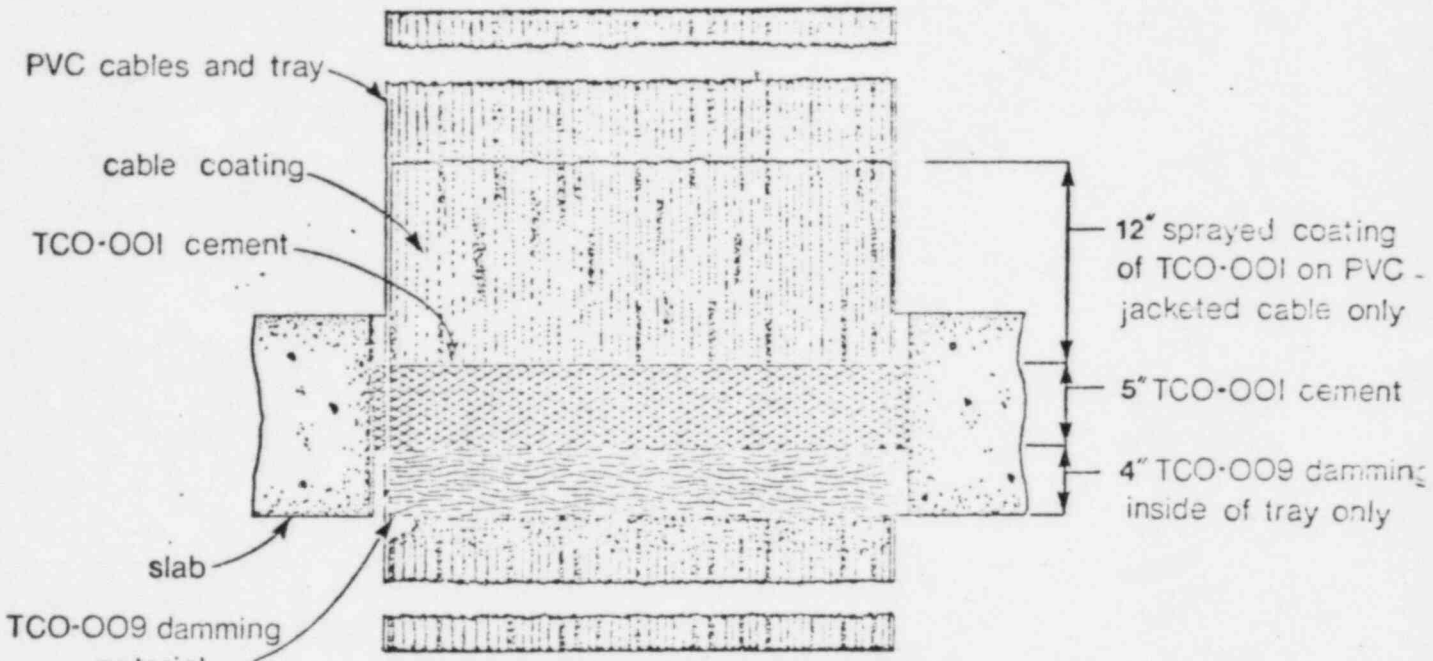
Material had fallen from the seal's exposed surface near the damming board divider. Approximately 2 to 2-1/2" of material had fallen from the seal which was affected by the greatest amount of surrounding slab deflection. It was in this area where higher seal surface temperatures were experienced during the fire test.

The seal's unexposed surface remained completely intact throughout the fire and hose stream tests. The only visible change noted was the swelling on the PVC materials and several small cracks in the area of the slab deflection.

As the seal was removed for slab destruction it was observed that the PVC jacketed cables completely charred through the seal. The Hypalon jacketed cables charred approximately 1-2" into the seal's exposed surface.

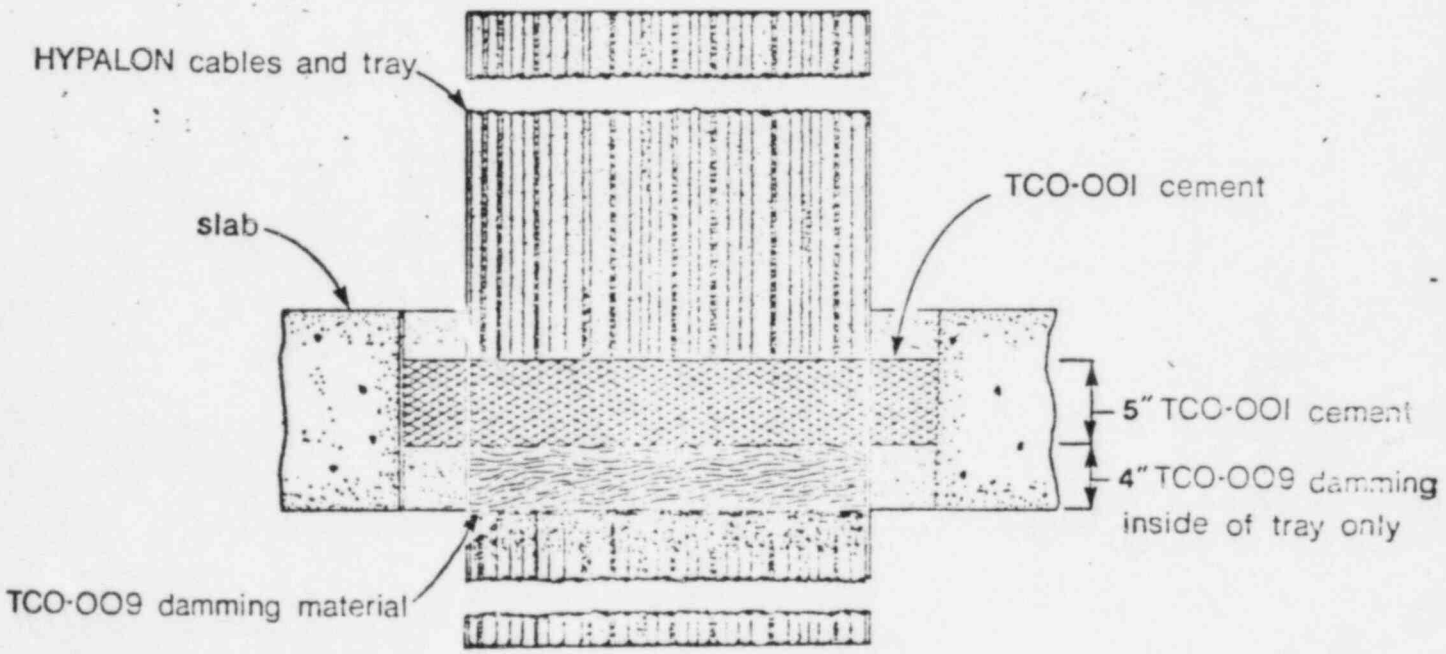

5"
0"-.125"
32"
12.5"
1"
E
E
D
D
4"x30" ladder back cable tray and
6" dia. conduit filled with PVC
jacketed cable
damming board divider
steel substrate
TCO-001 cement seal
109.5"
concrete substrate
6"x24" solid back cable tray and
4" dia. conduit filled with HYPALC
jacketed cable
C
C
B
B
29.75"
17.375"
0"-.125"
4"x30" solid back cable tray
filled with PVC jacketed cables
A
A
steel substrate

PLAN VIEW



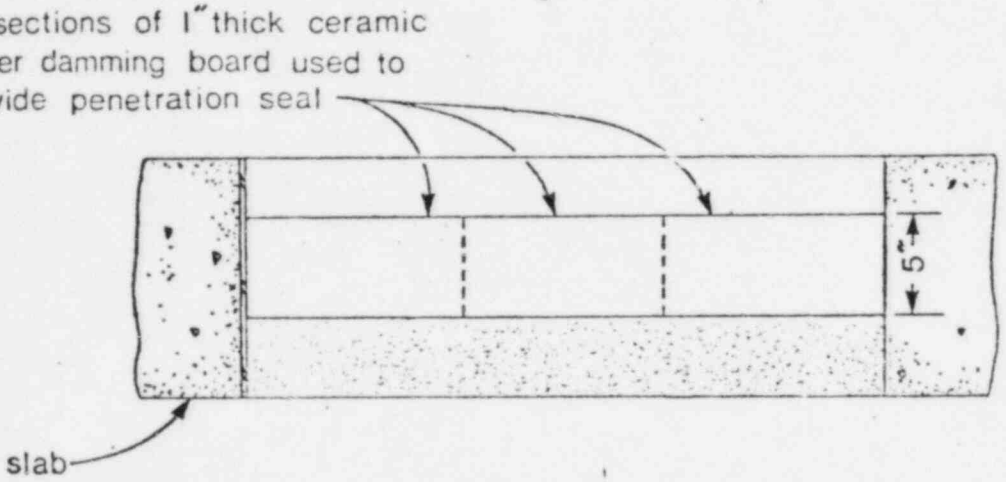
SECTION A-A

TRAY WITH PVC JACKETED CABLES

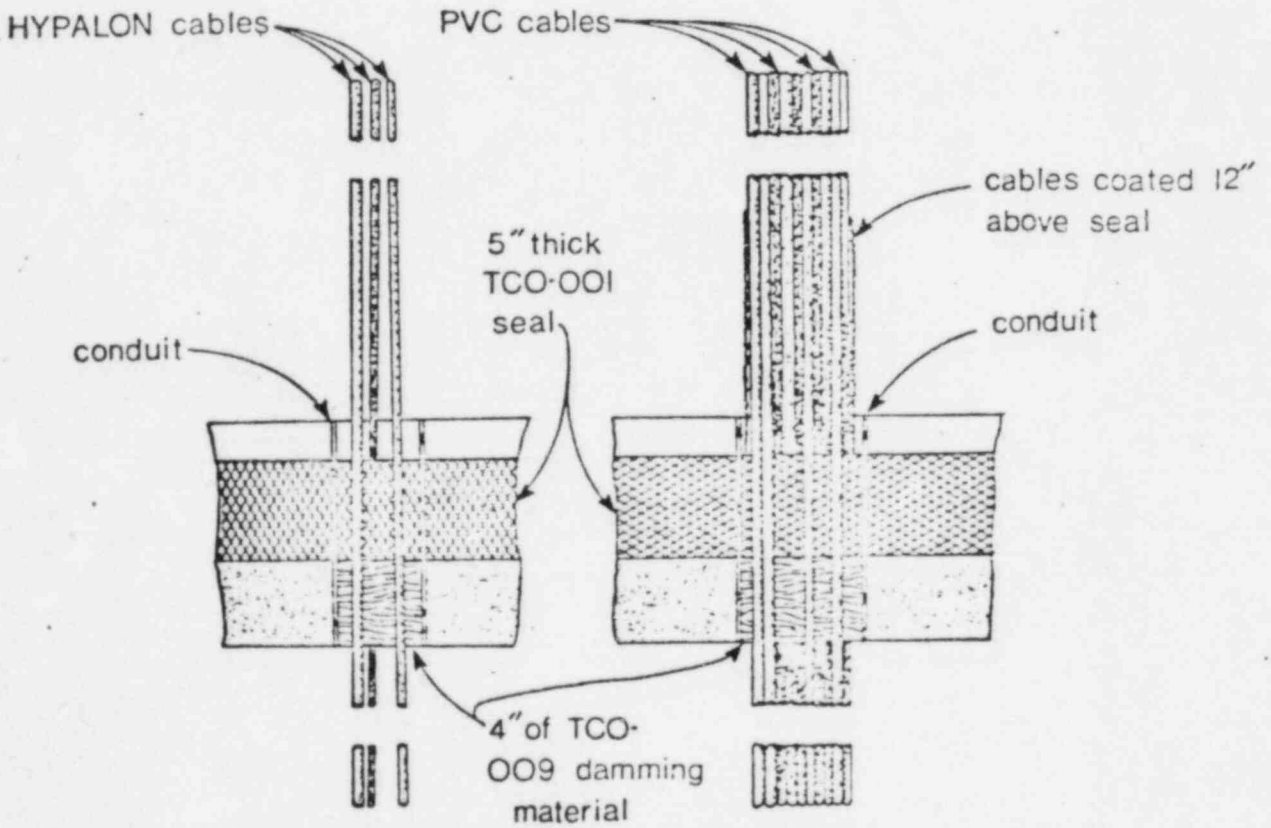


SECTION B-B

TRAY WITH HYPALON JACKETED CABLES

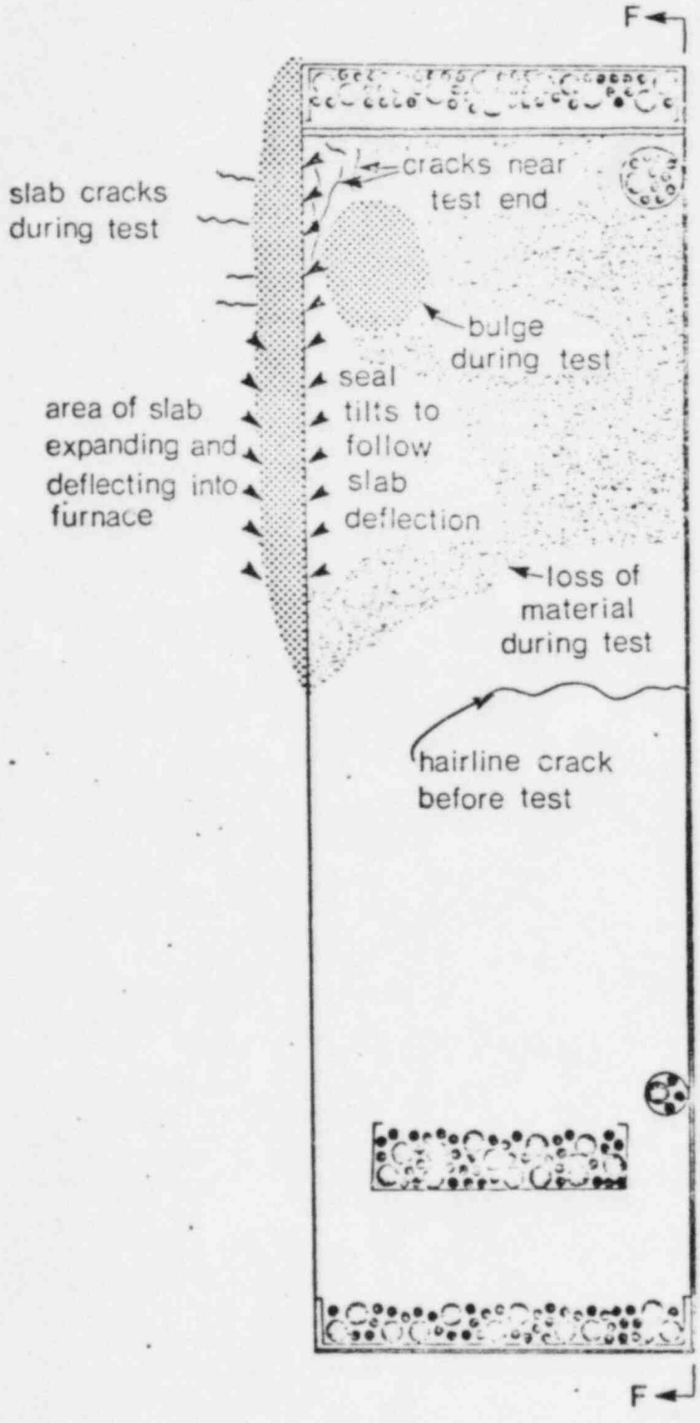


SECTION E-E
DAMMING BOARD DIVIDER

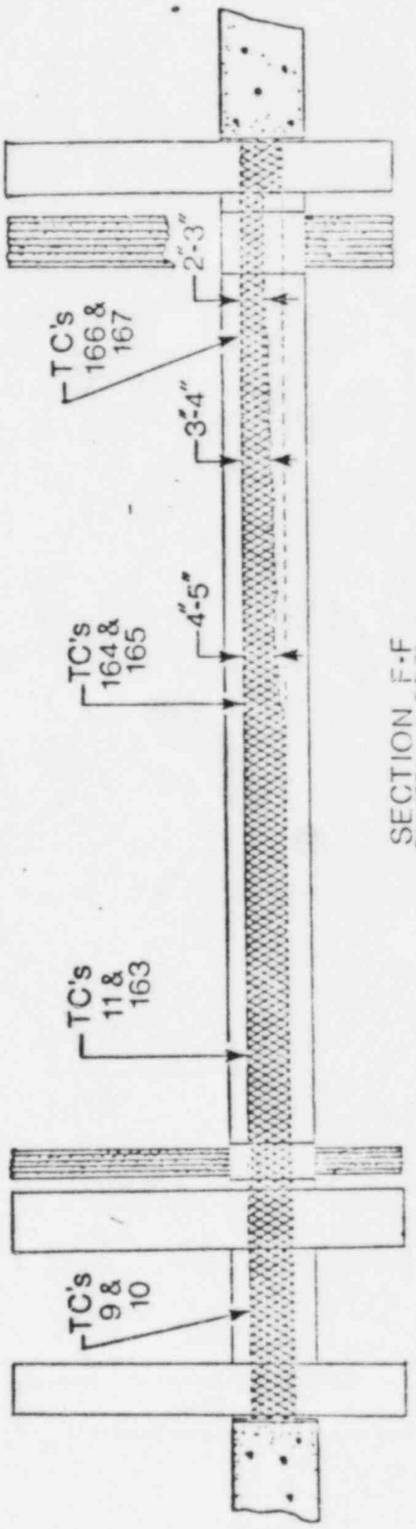


SECTION C-C
HYPALON CABLE CONDUIT

SECTION D-D
PVC CABLE CONDUIT



PLAN VIEW
TEST RECORD



SECTION F-F
THERMOCOUPLE ARRANGEMENT AND POST-TEST OBSERVATIONS