VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

October 27, 1994

United States Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D. C. 20555

Serial No. 94-175A
NL&P/CGL R2"
Docket Nos. 50-280
50-281
License Nos. DPR-32
DPR-37

Gentlemen:

**VIRGINIA ELECTRIC AND POWER COMPANY
SURRY POWER STATION UNITS 1 AND 2
SUPPLEMENTAL INFORMATION RELATED TO
APPENDIX R EXEMPTION REQUEST REGARDING
MANUAL HALON SYSTEM IN UNIT 2 ESGR**

In an April 20, 1994 letter (Serial No. 94-175), Virginia Electric and Power Company requested an exemption for Surry Power Station from specific requirements of 10CFR50 Appendix R with regard to the existing manually-actuated halon system in the Unit 2 emergency switchgear room (ESGR). This letter provides supplemental information, which further supports our April 20, 1994 exemption request transmittal, and documents the following conclusions:

- In the event of a fire in the ESGR, the anticipated duration of the fire would not exceed the capability of the one-hour rated fire wrap on the cables/conduit of interest. This conclusion is based on full-scale cabinet fire test data, actual nuclear power plant data regarding switchgear room fires, and fire analysis predictions for Surry risk assessments (performed both by Sandia National Laboratories and by Virginia Power). (Refer to Attachment 1)

- Our original modification plans, associated with the installation of the additional chillers, specified fire wrap in full compliance with Appendix R requirements. However, other circumstances arose that resulted in our pursuit of an alternate approach, which considered precedents related to previously approved exemption requests. (Refer to Attachments 2 and 3)

- Fire drills conducted at Surry support the premise that the proximity of the Control Room and the Unit 2 ESGR facilitates a prompt response time following annunciation of the smoke detection system. (Refer to Attachment 4) The fire drill results, coupled with actual fire data and Surry risk assessment predictions, further support our conclusion that a fire duration of less than one hour is assured.

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In view of these conclusions, we believe an acceptable alternative to the Appendix R requirements has been demonstrated and that the proposed exemption request is technically justified from a fire protection perspective. Therefore, we do not believe the expenditures necessary to achieve verbatim compliance with Appendix R are warranted nor required to assure plant safety. (Refer to Attachment 5)

A technical meeting is planned with the NRC on Friday, November 4, 1994, to discuss the information presented in this letter.

Very truly yours,

James P. O'Hanlon

James P. O'Hanlon
Senior Vice President - Nuclear

Attachments:

1. IPEEE/PRA Fire Analysis Considerations and Related Fire Data
2. History of Design Change and Reason for an Engineering Evaluation or Exemption Request
3. Exemption Request Precedents Related to Fire Detection and Suppression Systems
4. Fire Drill Scenario and Results
5. Cost Estimates Associated with Modifications Related to Cable Routing and Making the Manually-Actuated Halon System Automatic

cc: U. S. Nuclear Regulatory Commission
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Mr. M. W. Branch
NRC Senior Resident Inspector
Surry Power Station

ATTACHMENT 1

IPEEE/PRA FIRE ANALYSIS CONSIDERATIONS AND RELATED FIRE DATA

The following paragraphs present additional information supporting Exemption Request 27 based on full-scale cabinet fire test data, actual nuclear power plant data regarding switchgear room fires, and fire analysis predictions for Surry risk assessments (performed by Sandia National Laboratories and by Virginia Power). This supplemental information supports our conclusion that the anticipated duration of a fire in the ESGR would not exceed the capability of the one-hour rated fire wrap on the MER-5 power cables.

"An Experimental Investigation of Internally Ignited Fires in Nuclear Power Plant Control Cabinets," NUREG/CR-4527

Sandia National Laboratories conducted a series of full-scale cabinet fire tests and documented the tests in "An Experimental Investigation of Internally Ignited Fires in Nuclear Power Plant Control Cabinets," NUREG/CR-4527, Parts 1 and 2, April 1987. The purpose of these cabinet fire tests was to characterize the development and effects of internally ignited cabinet fires as a function of several parameters believed to most influence the burning process. A primary goal of this test program was to test representative and credible configurations and materials. These test results concluded "a cabinet fire can propagate within a single cabinet; however, for the conditions tested it does not appear that the fire poses a threat outside the burning cabinet except the resulting smoke." Three of the tests performed burned "real" fuel (i.e., cable placed inside the cabinets). The heat release rates for these three tests are shown in the figures on page 1-5. As can be seen from these figures, a cabinet fire will build up, reach and stay at a peak for a short while, and then self-extinguish. The maximum duration of these fires was 53 minutes.

"Fire Events Database for U. S. Nuclear Power Plants," NSAC-178L

A comprehensive database of U. S. nuclear plant fire events that have occurred between February 1965 and December 1988 has been compiled and documented in "Fire Events Database for U. S. Nuclear Power Plants," NSAC-178L, Revision 1, January 1993. Of the 753 fires documented in the database, 19 fires occurred in both safety and non-safety switchgear. The report states "Six of the 19 electrical cabinet fires occurred in 4160 volt switchgear, seven in 480 volt motor control centers (MCCs), one in a control panel, and five in either MCCs or switchgear. . . . In all but two fires, manual suppression was used. Automatic gas systems extinguished two of the fires. In one additional fire, an automatic gas system operated, but portable extinguishers also were used. Manual hose stations were not used for fire suppression. The means for suppression were as follows:

- 3 self-extinguishing
- 2 de-energized
- 2 automatic gas systems
- 1 automatic gas system and portable extinguishers
- 5 portable extinguishers
- 6 unknown

Fire duration times ranged from 1 to 50 minutes for 10 of the events. Two durations were 50 minutes and 39 minutes, respectively, while nine fire durations were ten minutes or less. No time period was reported for the others; however, one fire was reported to have been 'quickly extinguished'."

Surry Individual Plant Examination of External Events

The Surry Power Station Individual Plant Examination of External Events (IPEEE), required by Generic Letter 88-20, Supplement 4, has been developed as a draft report and is currently being finalized. The IPEEE analysis includes an assessment of the consequences of a fire in the Unit 1 Emergency Switchgear Room (ESGR), which is being generally applied to support Exemption Request 27. Based on the equipment layout and room configuration, the analysis results for the Unit 1 ESGR are considered to be applicable to the Unit 2 ESGR and are summarized in the following paragraphs.

The ESGR contains numerous pieces of electrical equipment (i.e., electrical cabinets) which are potential fire ignition sources and a considerable quantity of electrical cable which is the only significant combustible material. Using ignition sources and combustibles, the analysis evaluated the postulated fire scenarios that have the capability of damaging vital equipment necessary for safe shutdown. Based on the COMPBRN analysis, fire models were developed for the room in which heat release rates and fire duration times were generated.

As part of the draft Surry IPEEE, a fire originating in an electrical cabinet was postulated for the COMPBRN models and allowed to burn without suppression. The models predicted that the most severe fire would last for 3140 seconds (~52 minutes) generating a total of 6,560,020 kJ of heat. The models predicted that 4 electrical trays located above the cabinet would be involved in this most severe fire event. The models predicted that the maximum hot gas layer temperature at the ceiling would be 652°F (618°K) with a thickness of ~10 feet (~3 meters). Cables are assumed to have an ignition temperature of 932°F (773°K) and a damage temperature of 662°F (623°K). The predicted hot gas layer temperature was below the cable ignition and damage temperatures predicted for the area. Therefore, only those cables and cable trays located either in the fire plume or within a cylinder of an 8 foot radius above the assumed fire point source are expected to be affected by an electrical cabinet fire.

It is physically possible that the MER-5 cables/conduit could be located within an 8 foot radius of a worst case fire. However, separate from the draft Surry IPEEE, it should be noted that the MER-5 cable fire wrap (3M Interam) qualification shows that the cable (cold side) temperature will not exceed 325°F. This result is based on 60-minute fire testing that used the ASTM E-119 time-temperature curve, which reaches 1000°F at 5 minutes, 1300°F at 10 minutes, and a maximum temperature of 1700°F. A cable temperature of less than 325°F is well below the cable damage temperature of 662°F.

To summarize the draft Surry IPEEE report results, a worst case fire in the ESGR is expected to damage only those cables and cable trays that are located either in the fire plume or within an 8 foot radius of the fire plume source. Although the Surry draft IPEEE does not include an MER-5 cable specific case, it predicts that the worst case fire lasts for approximately 52 minutes with no assumed suppression system actuation or suppression activity.

"Analysis of Core Damage Frequency: Surry Power Station, Unit 1 - External Events," NUREG/CR-4550

An earlier analysis of the effects of a fire in the Surry ESGR is documented in the "Analysis of Core Damage Frequency: Surry Power Station, Unit 1 - External Events," NUREG/CR-4550, Volume 3, Revision 1, Part 3, December 1990. The objective of the fire analysis was to estimate the contribution of the fire-induced core damage and plant damage state frequencies. The mean core damage frequency associated with a fire in the ESGR was determined to be 6.09E-6 per year, which is consistent with the results from the draft Surry IPEEE fire analysis.

The report states that "COMPBRN III . . . predicts that it is very difficult to ignite qualified cable insulation unless cables are actually in the flames. For cases where cables are not in the flames (or very close to them), . . . COMPBRN III predicts that they will not be damaged." NUREG/CR-4550 also states that ". . . in several cases the power cables . . . were routed in metal sleeves [in conduit]. In the COMPBRN calculations, these cables were assumed to be incapable of igniting. However, damage was assumed to occur when the surface temperature reached the temperature corresponding to cable failure."

Conclusion

The information presented above supports our conclusion that the manually actuated halon suppression system in conjunction with the one-hour rated fire wrap provided on the MER-5 power cables in the Unit 2 ESGR will provide adequate protection for those cables in the event of a fire. Specifically, the bases for this statement are:

- NUREG/CR-4550 determined a core damage frequency (CDF) associated with a fire in the ESGR of 6.09E-6 per year. The results from the Surry draft IPEEE fire analysis are consistent with this CDF.

- In the event that an ESGR fire occurs, the Surry draft IPEEE fire analysis predicts a worst case fire of 52 minute duration with no suppression.

- Actual full-scale cabinet fire tests demonstrate that a cabinet fire will build up, reach and stay at a peak for a short while, and then self-extinguish. The maximum duration of these cabinet fire tests was 53 minutes.

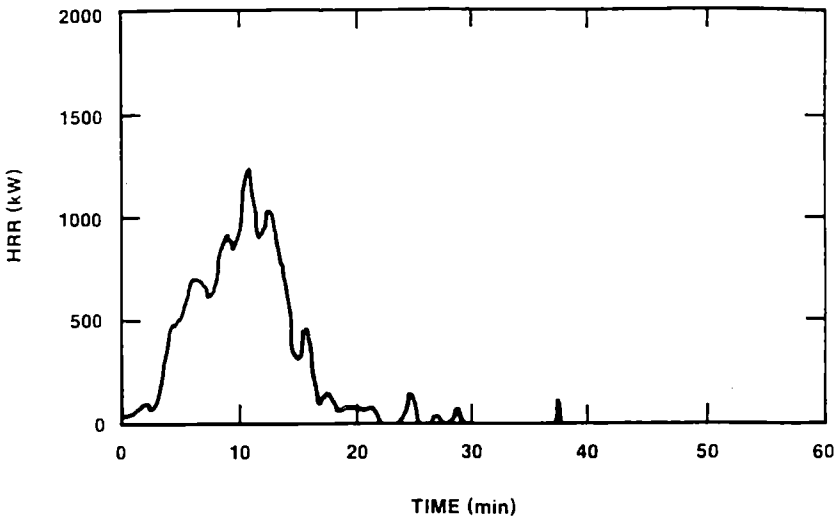
- Actual fire event data for 753 fires in U. S. nuclear power plants from February 1965 to December 1988 demonstrate that only 19 switchgear fires occurred with the longest reported duration time of 50 minutes.

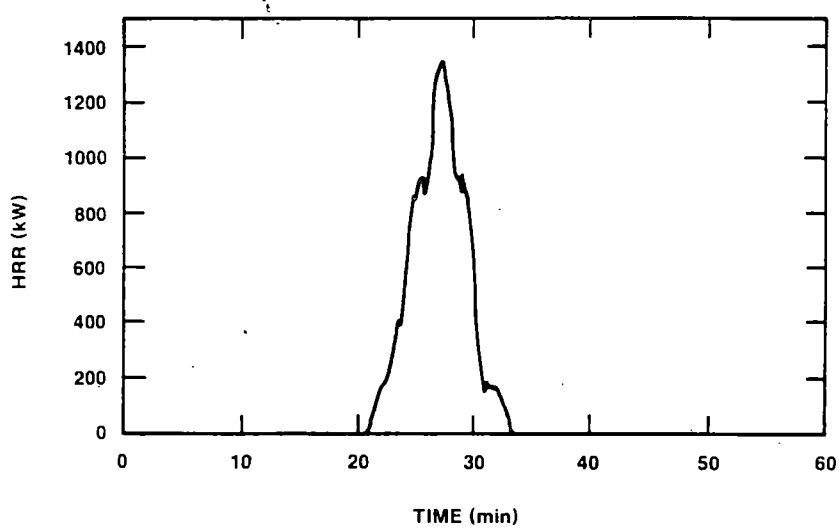
- As stated in Exemption Request 27, the majority of the combustible material in the ESGR is cable insulation. The most likely fire scenario is an electrical cabinet fire with the limited potential for propagation in the cable trays. The limited potential for propagation is supported by the conclusions in NUREG/CR-4550 that cable in conduit is incapable of igniting, as well as the results of the full-scale cabinet fire tests (documented in NUREG/CR-4527) that concluded that it does not appear that an electrical cabinet fire poses a threat outside the burning cabinet except for the

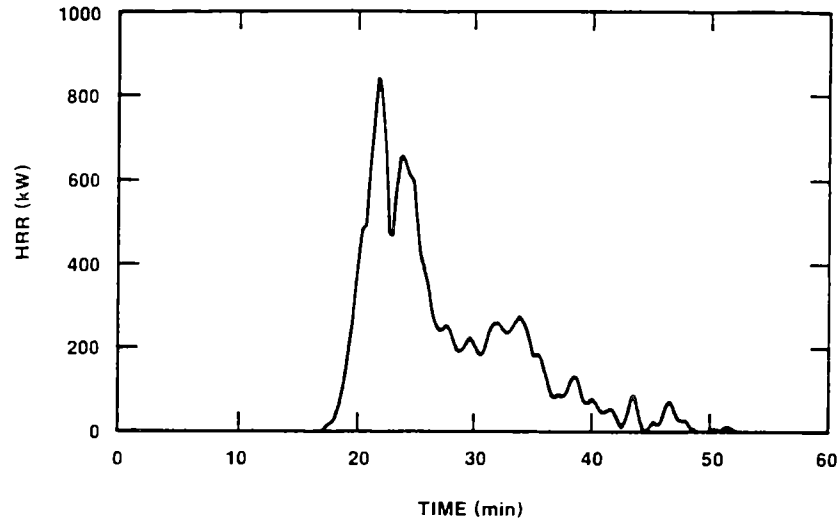
resulting smoke. Although the draft Surry IPEEE fire analysis predicts (for the worst case fire) damage to those cables and cable trays located either in the fire plume or within an 8 foot radius of the fire plume source, this result also supports the limited potential for propagation.

- The qualification of the MER-5 cable fire wrap shows that the cable (cold side) temperature will not exceed 325°F, which is well below the cable damage temperature of 662°F.

In conclusion, in the event of a fire in the ESGR, the anticipated duration of the fire would not exceed the capability of the one-hour rated fire wrap on the MER-5 power cables based upon fire analysis predictions for Surry, full-scale cabinet fire test data, and actual nuclear power plant data from switchgear room fires.







Figures 21, 28, and 35 Excerpted from NUREG/CR-4527, Volume 2

ATTACHMENT 2 -
HISTORY OF DESIGN CHANGE AND REASON FOR AN ENGINEERING EVALUATION OR EXEMPTION REQUEST

This discussion of the Unit 2 ESGR modification history is intended to supplement the discussion previously provided in the Surry Exemption Request 27, transmitted by our April 20, 1994 letter. Specifically, this discussion demonstrates that our original modification plans, associated with the installation of the additional chillers, included using fire wrap that was in compliance with the Appendix R requirements. It must be noted that the modification process was not entered into with the intention to rely upon an engineering evaluation or exemption request as an alternate approach to compliance with the regulation. However, other circumstances arose that resulted in our pursuit of an alternate approach.

The air conditioning system for the Control Room Complex (CR) and Emergency Switchgear Room (ESGR) requires two chillers to be operational for Appendix R safe shutdown conditions. Initially, alternative Appendix R shutdown capability for this system was provided by a mechanical cross-connect to the non-safety related central system chillers located in Mechanical Equipment Room Number 1 (MER-1). This capability was independent of the Unit 2 ESGR. In this configuration, the applicable Appendix R requirement was Section III.G.3, with which we were in compliance. The Unit 2 ESGR is provided with fire detection (i.e., smoke detectors) and a manually-actuated halon fire suppression system.

The CR/ESGR ventilation system was determined to be only marginally adequate for the current heat loads, and therefore the system was modified to provide five 50% safety related chillers. Design Change Package (DCP) 90-08 installed two additional chillers in a new fire area, Mechanical Equipment Room Number 5 (MER-5). However, the power feeds for all five chillers are routed through the Unit 2 ESGR. Related to the addition of the MER-5 chillers, Appendix R Section III.G.2 became the applicable requirement to ensure that the circuits of one of the redundant trains is free of potential fire damage by providing separation by either a rated fire barrier or distance. Because the ESGR is provided with a manually-actuated halon fire suppression system, DCP 90-08 originally specified a 3-hour rated Thermo-Lag fire wrap for the MER-5 power feeds in order to achieve compliance with the Appendix R requirements. After construction activities had been initiated, the generic concerns related to the operability of Thermo-Lag were raised. Therefore, the DCP was revised in 1993 to specify a 3-hour rated 3M Interam fire wrap (which is thicker than the Thermo-Lag wrap originally specified). During installation of the modification, many interferences around the conduits were identified which could not be resolved due to the increased thickness of the 3M fire wrap. A discussion of the alternatives considered at that time is included on pages 27-9 through 27-11 of Exemption Request 27. It was concluded that the only reasonable option was to install the one-hour rated fire wrap and to prepare an engineering evaluation. An engineering evaluation was prepared based on the precedents discussed in Attachment 3, and the one-hour rated fire wrap was installed. Subsequently, it was determined through discussions with the NRC staff in February 1994 that an exemption request was necessary. Therefore, Exemption Request 27 was transmitted on April 20, 1994.

ATTACHMENT 3 -
EXEMPTION REQUEST PRECEDENTS RELATED TO FIRE DETECTION AND SUPPRESSION SYSTEMS

As noted in Attachment 2, an engineering evaluation had been prepared to address the circumstances that are the subject of Exemption Request 27 and this transmittal. Subsequently, it was determined through discussions with the NRC staff that an exemption request was necessary. The following discussion presents the exemption request precedents that formed that basis on which the engineering evaluation was prepared. These precedents also support the alternate approach discussed in Exemption Request 27 and this transmittal.

The Appendix R requirements of interest in this discussion for fire detection and suppression systems can be summarized as follows:

APPENDIX R SECTION	DETECTION	SUPPRESSION
III.G.2.b	Full area	Automatic, full area
III.G.2.c	Full area	Automatic, full area
III.G.3	Full area	Fixed, full area

Prior to the issuance of Generic Letter (GL) 86-10, we had developed and submitted exemption requests for those areas at Surry with less than full area coverage by the fire detection and/or suppression systems. On February 25, 1988, the NRC issued a safety evaluation (SE) for these requests. As part of the NRC's SE, in the cases summarized below, the NRC concluded that our analyses and justification were acceptable and provided an adequate level of fire protection. Furthermore, the NRC evaluation indicated that these cases were in conformance with the guidance issued in GL 86-10 and no exemption was necessary for these conditions.

SE SECTION	EXEMPTION NUMBER	PLANT LOCATION	APP. R SECTION	DETECTION/ SUPPRESSION
2.0	1	Aux. Bldg. (Charging & CCW)	III.G.3	Partial/None
4.0	4	Main Steam Valve House	III.G.3	Partial/None
7.0	18	Aux. Bldg. (Ventilation Equip.)	III.G.2.b	Partial/Partial, manual
10.0	3	Turbine Bldg.	III.G.2.b	None/Full, automatic
11.0	5	MER-3	III.G.3	Full/None

One case will be outlined in summary. For Surry Exemption 18, in the ventilation

equipment area of the auxiliary building (Fire Area 17), the power and control cables of redundant fans are separated by more than 20 feet of horizontal distance and are routed in conduit. In addition to the separation requirement, Appendix R, Section III.G.2.b requires full area detection and automatic, full area suppression. The exemption request noted that fire detectors are located on each elevation of the auxiliary building near cable trays and in each charging pump cubicle (i.e., partial rather than full area coverage). The exemption request also indicates that portable extinguishers and hose stations are provided for fire-fighting purposes. The primary combustibles in this area are the charcoal filters. Two of the filters are protected by a manual carbon dioxide fire suppression system that can be actuated either locally, near the filters, or remotely, from the control room. The third filter is protected by a water-spray deluge system. Therefore, the suppression systems provide partial area coverage and are manually actuated. Applying Appendix R, Section III.G.2.b without consideration of the clarification given in GL 86-10, it would be concluded that an exemption was necessary in this case. However, based on the combustible loading and the detection/suppression systems, the NRC's SE concluded that the installation of area-wide automatic detection and suppression systems would not significantly increase the level of fire protection for this area. In addition, the SE stated that "The lack of area-wide fire detection and suppression is a condition encompassed by the revised interpretations of Appendix R contained in GL 86-10. According to these interpretations, no exemption for this condition is necessary."

As can be seen by comparing these two tables, the February 25, 1988 SE deemed as acceptable several circumstances where equivalence to the Appendix R requirements was demonstrated by our analyses and justification, which considered the specific configurations, combustible loadings, and the detection/suppression systems.

The information in Exemption Request 27 relative to detection and suppression systems can be summarized as follows:

EXEMPTION REQUEST	PLANT LOCATION	APP. R SECTION	DETECTION	SUPPRESSION
27	Unit 2 ESGR	III.G.2.c	Full area	Full area, manual

Exemption Request 27 concludes that the fire protection features of the ESGR will provide a level of protection equivalent to that of an automatic fire suppression system and that conversion of the manual halon system to an automatic system would not increase the level of fire protection safety for the Unit 2 ESGR.

The NRC's 1988 SE indicated that engineering evaluations would have been sufficient in cases where there is no suppression system. In this case (Exemption Request 27), having a manual (versus automatic) system is more conservative than having no system. Review of the other factors involved in this case (e.g., fire wrap configuration, combustible loadings, fire detection systems, and fire brigade response) indicate that the level of hazard is similar or less severe than the previously evaluated and approved configurations. Therefore, the logical conclusion drawn for this case is that the alternate approach discussed in Exemption Request 27 and supplemented in this transmittal is acceptable and consistent with past NRC approved precedents.

ATTACHMENT 4 -
FIRE DRILL SCENARIO AND RESULTS

Subsequent to our April 20, 1994 transmittal, we conducted fire drills at Surry to support the premise in our exemption request that the proximity of the Control Room and the Unit 2 ESGR will provide for a very short response time following annunciation of the smoke detection system. A conference call was held with the NRC on September 8, 1994 to discuss these drills and present the drill results. This attachment presents the drill scenario and the drill results.

Drill Scenario

A construction crew was grouting fire barriers in the overhead between the Unit 2 Emergency Switchgear Room (ESGR) and the Control Room. The process involves the use of portable lighting, cleaning equipment, such as rags, along with grout barrels and tools. A drop light (portable lighting) was placed on top of a cable tray to illuminate the ceiling area. While preparing a surface for grouting, the worker smelled an odor like rubber burning. The worker turned toward the light and noticed smoke and what was thought to be small flames. The worker took a cleaning rag and slapped at the "FIRE." The rag snagged on something in the area and fell across the light bulb. The rag ignited, the worker panicked and climbed from the cable trays to the floor. The worker retrieved a fire extinguisher from across the room and started back to the trays. The smoke and flames were too heavy to enter the area, and the worker called the Control Room on the Gai-tronics to report the fire.

Drill Results

Five drills were conducted using this scenario between June 28, 1994 and July 5, 1994. The purpose of the drills was to determine the response times and the time required to make the decision to activate the halon system. Three drills were conducted on day shift, one on swing shift, and one on midnight shift. The start times of the drills were:

- June 28, 1994 - 8:43
- June 29, 1994 - 16:38
- June 30, 1994 - 12:40
- July 5, 1994 - 5:17
- July 5, 1994 - 8:32

The results of the drills are summarized as follows:

- Maximum response time from start of drill to the scene (i.e., Unit 2 ESGR) - 4 minutes [Maximum response time for each drill: 4, 2, 3, 3, 2 minutes]

- Average response time from start of drill to the scene - 2.8 minutes

- Maximum time from start of drill to dump halon in Unit 2 ESGR - 14 minutes [Maximum time to dump for each drill: 14, 4, 10, 11, 8 minutes] As discussed during the conference call, the difference in the maximum times to dump was driven by the decision making process used in responding (i.e., the 14 minute time included search of the ESGR prior to halon dump versus the 4 minute time included an immediate halon dump).

- Average time from start of drill to dump halon - 9.4 minutes

- Minimum number of responders - 5 [Minimum number of responders for each drill: 5, 9, 6, 6, 8]

These drill results support the premise in our exemption request that the proximity of the Control Room and the Unit 2 ESGR will provide for a very short response time following annunciation of the smoke detection system. These drill results, coupled with actual fire data and Surry risk assessment predictions, further support our conclusion that a fire duration of less than one hour is assured.

ATTACHMENT 5 -
COST ESTIMATES ASSOCIATED WITH MODIFICATIONS RELATED TO CABLE REROUTING AND MAKING THE MANUALLY-ACTUATED HALON SYSTEM AUTOMATIC

A discussion of the alternatives considered to resolve the issue related to the MER-5 power feeds is included on pages 27-9 through 27-11 of Exemption Request 27. The alternatives considered included two modifications - rerouting the conduits for the MER-5 power feeds and making the manually-actuated halon system automatic. The following paragraphs quantify the cost estimates associated with these modifications. It should be noted that either of these modifications, or other modifications of similar or greater cost, would be required to achieve verbatim compliance with Appendix R.

Based on the preceding discussions documenting the fire protection adequacy of the alternate approach and the anticipated duration of an ESGR fire, we have concluded that the costs associated with these modifications are not warranted and are not commensurate with the benefit gained by verbatim compliance to the Appendix R requirements in this case.

Rerouting of the Conduits for the MER-5 Power Feeds

In Exemption Request 27, it was determined that rerouting of the conduits was not feasible since the ESGR is a very congested area and space limitations preclude the clearances necessary for either the required physical separation or a three-hour rated fire wrap. However, for the purposes of this discussion, it was assumed that rerouting of the conduits is feasible.

A cost estimate of approximately $760,000 is associated with replacement of the MER-5 chiller power cables and rerouting of the conduits that will provide dimensional clearance to allow installation of 3-hour rated fire wrap material manufactured by 3M.

Making the Manually-Actuated Halon System Automatic

In Exemption Request 27, it was determined that making the manually-actuated halon system automatic was unacceptable due to the costs associated with modifications for an automatic system and due to the issue of spurious actuation considering the current environmental concerns with halon. For the purposes of quantifying the costs associated with an automatic halon system, it was assumed that a new zone of line-type heat detection would be added throughout the Unit 2 ESGR. The existing halon control panel would be modified to actuate the suppression system upon receiving signals from both the heat detection control panel and the smoke detection control panel. Such a modification would cost approximately $360,000.

A significant concern associated with an automatic system is the issue of spurious actuation. Spurious actuation of a halon system is of concern primarily due to the current environmental issues (i.e., ozone depletion due to halon release to the atmosphere).

There is also an economic concern associated with the replacement cost for halon following system actuation. It is estimated that the cost to replace the halon gas in the ESGR suppression system following an actuation is approximately $100,000.00. As halon becomes less available because it is no longer manufactured, this replacement cost will likely increase. Although this cost will be incurred whether an actuation is spurious or actual, an automatic system increases the possibility of a spurious actuation.

As indicated in Exemption Request 27, the option of changing the manually-actuated halon system to an automatic system using an environmentally-benign gas was also considered. This option was rejected due to the costs associated with modification of the system and due to the fact that alternative technology is not yet well established.