

January 12, 2000

MEMORANDUM TO: L. Plisco, Director
Division of Reactor Projects, RII

FROM: Suzanne Black, Deputy Director /RA/
Division of Licensing Project Management, NRR

SUBJECT: RE-EVALUATION OF MANUALLY ACTUATED HALON 1301
FIRE SUPPRESSION SYSTEM FOR NORTH ANNA
EMERGENCY SWITCHGEAR ROOMS (TAC NOS. MA4299
AND MA4300)

The purpose of this memorandum is to transmit the subject re-evaluation as committed in our November 17, 1998, memorandum. We now consider the matter closed.

In a memorandum dated February 19, 1997, Region II requested technical assistance from NRR in determining the acceptability of the manual Halon 1301 fire suppression systems installed in the Emergency Switchgear Rooms (ESGRs) at North Anna, Units 1 and 2. In our response dated November 17, 1998, we transmitted an evaluation which concluded that the level of fire protection is not adequate for the hazard and does not meet the intent of Appendix R. We requested the Plant Systems Branch (SPLB) of the Division of Systems Safety and Analysis to do a backfit analysis, and committed to provide you with the analysis results when they became available.

On the basis of its re-evaluation, the staff concludes that the existing manually-actuated ESGR Halon systems, in combination with the licensee's procedures for discharging the systems in the event of an ESGR fire, are adequate for the expected fire hazards and are, therefore, acceptable. The staff also concludes that the existing manually-actuated Halon systems, in combination with the licensee's procedures for discharging the systems, meet the intent of Section III.G.3 of Appendix R to 10 CFR Part 50. (The staff notes that this conclusion is consonant with the technical requirements of Section III.G.3 of Appendix R, which does not specifically require the installation of automatic fire suppression systems in plant areas with alternative post-fire safe shutdown capability, and with NFPA 12A, which permits the use of manually-actuated Halon systems when acceptable to the authority having jurisdiction, in this case, the NRC.) On the basis of these conclusions, the staff has determined not to pursue a backfit.

Contact: K. Steven West, NRR
301-415-1220

On the basis of its re-evaluation, the staff also concludes that the existing ESGR smoke detection systems may have design and installation deficiencies that could adversely impact the effectiveness of the licensee's procedures for manually actuating an ESGR Halon system and, thereby, the ability of the Halon to extinguish an ESGR fire. Therefore, it is recommended that Region II review the adequacy of the existing ESGR smoke detection systems during a future fire protection inspection at North Anna.

Although our re-evaluation focused on the North Anna Station, we understand that a similar system is installed at the Surry Station. Therefore, we recommend that Region II, in a future inspection, confirm: (1) that the bases for our conclusions regarding North Anna also apply to Surry, particularly with regard to configuration and procedures for actuation of the Halon system, and (2) the adequacy of the relevant ESGR smoke detection systems.

Our detailed re-evaluation is attached. This completes our effort on the subject and TAC Nos. MA4299 and MA4300 are closed.

Docket Nos. 50-338 and 50-339

Attachment: As stated

cc w/att: C. Hehl, RI
G. Grant, RIII
T. Gwynn, RIV

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December 7, 1999

MEMORANDUM TO: Herbert N. Berkow, Director
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

FROM: John N. Hannon, Chief /RA/
Plant Systems Branch
Division of Systems Safety and Analysis
Office of Nuclear Reactor Regulation

SUBJECT: RE-EVALUATION OF MANUALLY ACTUATED HALON 1301 FIRE
SUPPRESSION SYSTEM FOR NORTH ANNA EMERGENCY
SWITCHGEAR ROOMS (TAC NOS. MA4299 and MA4300)

Plant Name: North Anna Power Station, Units 1 and 2
Licensee: Virginia Electric and Power Company
Review Status: Complete

During a routine fire protection inspection at North Anna Power Station, Units 1 and 2, Region II questioned whether or not the manually actuated Halon 1301 fire suppression systems installed in the emergency switchgear rooms (ESGRs) should be automatically actuated. In Task Interface Agreement (TIA) 97-004, dated February 19, 1997, Region II asked us to determine if the manually actuated systems met the technical requirements of Appendix R to 10 CFR Part 50. By memorandum to F.M. Reinhart, Acting Director, Project Directorate II-1, dated April 18, 1997, we provided our response to TIA 97-004. On the basis of our evaluation, we concluded that the manually actuated systems did not meet the intent of Section III.G.3 of Appendix R to 10 CFR Part 50. By memorandum dated November 17, 1998, you sent our response to TIA 97-004 to Region II. Later, by memorandum dated December 7, 1998, you asked us to prepare a backfit analysis.

After we drafted a backfit analysis, Region II provided new information about the licensee's procedures for manually actuating the Halon systems in the event of an ESGR fire. In light of this new information, we re-evaluated the manually actuated Halon system and reconsidered our previous conclusions. On the basis of our re-evaluation, which is attached, we concluded that the existing manually actuated Halon systems, in combination with the licensee's procedures for discharging the systems, are acceptable. Therefore, we recommend that a backfit not be pursued. During our re-evaluation of the Halon system, we noted potential technical deficiencies with the smoke detection systems installed in the ESGRs (see Section 3 of the attachment). Failure of the detection system to promptly detect a ESGR fire could have a

CONTACT: K. Steven West, SPLB/DSSA/NRR
(301) 415-1220

Herbert N. Berkow

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significant impact on the effectiveness of the licensee's procedures for manually discharging the Halon system and on the ability of the Halon to extinguish a fire in the ESGRs. Therefore, we recommend that Region II review the adequacy of the existing ESGR detection systems during a future fire protection inspection at North Anna.

Docket Nos.: 50-338
50-339

Attachment: As stated

cc w/att: R. Emch

Herbert N. Berkow

- 2 -

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Docket Nos.: 50-338
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RE-EVALUATION BY THE
PLANT SYSTEMS BRANCH
OFFICE OF NUCLEAR REACTOR REGULATION
OF THE
MANUALLY ACTUATED HALON 1301 FIRE SUPPRESSION SYSTEMS INSTALLED IN
THE EMERGENCY SWITCHGEAR ROOMS AT
NORTH ANNA POWER STATION, UNITS 1 and 2
DOCKET NOS. 50-338 and 50-339

1. INTRODUCTION

North Anna Power Station, Units 1 and 2 (North Anna), has 2 emergency switchgear rooms (ESGRs), one for each unit. Each ESGR is protected by a smoke detection system and by a *manually actuated* Halon 1301 fire suppression system. During a routine fire protection inspection at North Anna, Region II questioned whether or not the Halon systems should be *automatically actuated* (IFI 50-338, 339/96-13-02). In Task Interface Agreement (TIA) 97-004 (February 19, 1997), Region II asked the Office of Nuclear Reactor Regulation (NRR) to determine if the manually actuated systems meet the technical requirements of Appendix R, "Fire Protection Program For Nuclear Power Facilities Operating Prior to January 1, 1979," to Part 50 of Title 10 of the *Code of Federal Regulations* (10 CFR Part 50). By memorandum from L.B. March, Chief, Plant Systems Branch (SPLB), NRR, to F.M. Reinhart, Acting Director, Project Directorate II-1, NRR, dated April 18, 1997, SPLB provided its technical evaluation of the Halon systems. On the basis of its review of the information provided by Region II, and as documented in its TIA response, SPLB concluded that the manually actuated Halon systems did not meet the intent of Section III.G.3 of Appendix R to 10 CFR Part 50. By memorandum dated November 17, 1998, NRR transmitted the TIA response to Region II.

By memorandum dated December 7, 1998, the Division Reactor Projects, NRR, requested that SPLB prepare a backfit analysis based on "adequate protection" or "safety enhancement" for the manually actuated Halon fire suppression system. After the staff drafted a backfit analysis, Region II obtained new information from Virginia Electric Power Company (the licensee) about its procedures for manually discharging a Halon system in the event of an ESGR fire (see NRC Inspection Report Nos.: 50-338, 339/99-01). In light of this new information, SPLB re-evaluated the manually actuated Halon systems and reconsidered the conclusions it had previously provided in response to TIA 97-004.

NRR staff discussed this issue with the licensee during a telephone conference on April 22, 1999.

This re-evaluation supplants the requested backfit analysis. However, while gathering information for a backfit analysis, the staff developed preliminary information about the fire risk associated with the ESGRs and about the costs to convert the manually actuated Halon systems to automatically actuated systems. Although this information was not used to develop the conclusions stated in Section 4 of this re-evaluation, it is appended for information.

2. BACKGROUND

In its final safety analysis report (FSAR) for North Anna, the licensee stated that an alternative post-fire safe shutdown capability (as opposed to protecting a redundant train of post-fire safe shutdown equipment) is provided for fires in the ESGRs. Section III.G.3 of Appendix R to 10 CFR Part 50, specifies that a fire detection system and a fixed fire suppression system shall be installed in plant areas where alternative shutdown capability is provided. In contrast to the technical requirements of Section III.G.2 of Appendix R, which specify that *automatic* fire suppression systems be used to protect redundant post-fire safe shutdown equipment, Section III.G.3 of Appendix R does not specifically require that installed fire suppression systems be automatic. Each of the 2 ESGRs at North Anna is protected by a smoke detection system and by a *manually actuated* Halon 1301 fire suppression system.

National Fire Protection Association (NFPA) Standard 12A, "Standard on Halon Fire Extinguishing Systems," is the industry consensus standard that is used to design, install, test, and maintain Halon 1301 fire suppression systems. The 1980 edition of NFPA 12A specifies that Halon systems be provided with automatic detection and automatic actuation. The NFPA standard has an exception that permits manual actuation if it is acceptable to the authority having jurisdiction. (For the purposes of this evaluation, the authority having jurisdiction is the U.S. Nuclear Regulatory Commission.)

Position E.4 of Appendix A to Branch Technical Position APCS 9.5-1, "Guidelines for Fire Protection for Nuclear Power Plants Docketed Prior to July 1, 1976," specifies that Halon systems should comply with NFPA 12A. This position also specifies that particular consideration should be given to: (a) the minimum required Halon concentration and soak time, (b) the toxicity of Halon, and (c) the toxicity and corrosive characteristics of the thermal decomposition products of Halon. Staff guidance provided in Generic Letter (GL) 86-10, "Implementation of Fire Protection Requirements" (April 24, 1986), Enclosure 2, Section 3.8.1, states that fire protection features required by Section III.G of Appendix R, should comply with the applicable NFPA standard. Furthermore, Section 8.9 of GL 86-10 states that licensees should identify and justify deviations from the applicable NFPA standards in the FSAR or the fire hazard analysis.

The licensee's FSAR states that the ESGRs have automatic smoke detection systems and that the Halon 1301 systems provided for the ESGRs are manually actuated. During the review it conducted in response to TIA 97-004, the staff did not find documentation of any prior NRC review of the manually actuated Halon systems at North Anna. As a result of an inspection at North Anna, conducted from February 8-12, 1999, the Region II inspector noted that the licensee had not performed the justification, described in GL 86-10, Section 8.9, for the deviation from NFPA 12A. During a conference call on April 22, 1999, the licensee declined a request by the staff to submit its justification for the manual Halon system. The licensee stated that it would include its justification in the next scheduled update of the FSAR required under 10 CFR 50.71.

3. EVALUATION

NFPA 12A specifies that Halon 1301 systems be provided with automatic detection and automatic actuation to ensure early application of Halon during the incipient stage of the fire. Early application provides for proper extinguishment. It also helps limit the formation of such hazardous decomposition products as hydrogen fluoride and hydrogen bromide, which occurs

at temperatures above 480 °C. These decomposition products are toxic to personnel and can damage electronic components.

Halon 1301 is not effective on deep-seated fires at agent concentrations less than 10 percent (ref. NFPA 12A-1980, and *Society of Fire Protection Engineers Handbook of Fire Protection Engineering*, First Edition). A deep-seated fire is defined by NFPA as a fire involving solid materials that would not be extinguish with a 5 percent concentration of Halon 1301 within 10 minutes of application. The factors that affect whether or not a fire will become deep-seated include: (1) the properties of the combustible material, (2) the length of time the material burns prior to agent application, (3) the configuration of the fuel, and (4) the ratio of the surface burning area to the enclosure volume. Low area/volume ratios require higher agent concentrations and longer soak times than high ratios.

The licensee's description of the Halon systems, dated October 27, 1983, states that the systems are designed in accordance with NFPA 12A, that the design concentration of the systems installed in the ESGRs is 6 percent, and that the concentration can range from no less than 5 percent to no greater than 10 percent. On the basis of its review of the information provided by the licensee in its submittal of October 27, 1983, the staff found that the combustibles located in the ESGRs consist primarily of cabling, electrical control panels, and switchgear. A fire involving these materials could result in a deep-seated fire if the actuation of the Halon system is delayed.

The licensee's procedures for an alarm of the smoke detection system in an ESGR (1-AR-D-C8 (for Unit 1) and 2-AR-D-C8 (for Unit 2), both Revision 1, dated February 3, 1999) specify that an operator be immediately sent to the ESGR to determine if a fire exists. If there is a fire in the ESGR, the operator can manually discharge the Halon system from a control station located near the ESGR. If the operator that is sent to investigate the smoke detection alarm does not report back to the control room within "approximately" 5 minutes, a control room operator will make an announcement over the plant public address system and discharge the Halon system for the affected ESGR is actuated from the fire protection control panel located in the main control room. Following the discharge signal from the control room, a 60 second time delay is initiated prior to actual discharge of the Halon into the fire-affected ESGR. These procedures were reviewed by Region II during the February 1999, inspection. Based on this inspection Region II closed Inspection Followup Item 50-338, 339/96-13-02, which was the basis for TIA 97-004.

This information about the licensee's procedures for actuating the Halon system was not available when the staff originally evaluated the system (memorandum of November 17, 1998, from NRR to Region II). Assuming that the smoke detection system is effective (see below), the procedures, as verified by Region II, provide reasonable assurance that the licensee will actuate the Halon system in the event of a fire in the ESGR in a timely manner. Therefore, there is reasonable assurance that the Halon discharge will be effective against the expected fire hazards before the fire becomes deep-seated. In addition, because the procedures require an operator to visit the ESGR to investigate any fire alarms received from the ESGR, there is reasonable assurance that if the operator discovers a fire, he or she could give to the fire brigade exact information about the nature and location of the fire. This provides added assurance that the licensee could cope with ESGR fires.

During the re-evaluation of the Halon system documented herein, the staff noted that the automatic smoke detection system installed in the ESGRs does not meet the design criteria specified in NFPA 72E-1983, "Automatic Fire Detectors." Specifically, contrary to the design criteria specified in NFPA 72E, all beam pockets are not provided with smoke detectors. In its engineering evaluation, dated July 1990, the licensee concluded that the existing detection system configuration is acceptable and that the deviations from the NFPA standard would not result in a "substantial delay" in the actuation of the Halon system. The licensee's evaluation is a qualitative assessment based primarily on engineering judgement. The evaluation does not define "substantial delay" and does not include empirical data to support the licensee's conclusions. For the reasons discussed above, the effectiveness of the manually actuated Halon system is dependent on prompt fire detection followed by timely discharge of the system. The lack of smoke detectors in each beam pocket could result in delayed fire detection which could result in delayed actuation of the Halon system, thereby adversely impacting the ability of the Halon to extinguish an ESGR fire.

4. CONCLUSIONS AND RECOMMENDATIONS

On the basis of its re-evaluation, the staff concludes that the existing manually actuated ESGR Halon systems, in combination with the licensee's procedures for discharging the systems in the event of an ESGR fire, are adequate for the expected fire hazards and are, therefore, acceptable. The staff also concludes that the existing manually actuated Halon systems, in combination with the licensee's procedures for discharging the systems, meet the intent of Section III.G.3 of Appendix R to 10 CFR Part 50. (The staff notes that this conclusion is consonant with the technical requirements of Section III.G.3 of Appendix R, which does not specifically require the installation of automatic fire suppression systems in plant areas with alternative post-fire safe shutdown capability, and with NFPA 12A, which permits the use of manually actuated Halon systems when acceptable to the authority having jurisdiction, in this case, the NRC.) On the basis of these conclusions, the staff recommends that a backfit not be pursued.

On the basis of its re-evaluation, the staff also concludes that the existing ESGR smoke detection systems may have design and installation deficiencies that could adversely impact the effectiveness of the licensee's procedures for manually actuating an ESGR Halon system and, thereby, the ability of the Halon to extinguish an ESGR fire. Therefore, SPLB recommends that Region II review the adequacy of the existing ESGR smoke detection systems during a future fire protection inspection at North Anna.

Principal Contributor: K. Steven West, NRR

FIRE RISK AND COST INFORMATION ASSOCIATED WITH THE
MANUALLY ACTUATED HALON 1301 FIRE SUPPRESSION SYSTEMS INSTALLED IN
THE EMERGENCY SWITCHGEAR ROOMS AT
NORTH ANNA POWER STATION UNITS 1 and 2

1. FIRE RISK

To address the risk significance of relying on a manually actuated Halon fire suppression system in comparison to an automatic system, the staff reviewed the fire risk assessment submitted by the licensee on June 28, 1994, in response to Generic Letter 88-20, Supplement 4, "Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities." The ESGRs contain circuits and equipment for auxiliary feedwater, main feedwater, air conditioning, DC equipment, charging pumps, pressurizer power operated relief valves (PORVs), and other plant systems. In its IPEEE submittal, the licensee concluded that the North Anna Unit 1 ESGR has a core damage frequency (CDF) of $3.28\text{E-}6$ per reactor year, which represents 84 percent of the total Unit 1 fire CDF. This fire area, based on the licensee's assessment, is the dominant contributor to fire risk at North Anna. The licensee notes in its submittal that operator actions (removing control circuit fuses from the 4160 volt breaker cubicles), are required to recover feedwater following a fire in this area. The licensee did not credit the manual Halon system in its fire risk assessment. Using industry data on automatic suppression system reliability for an automatic Halon system, provided in the "Fire-Induced Vulnerability Evaluation (FIVE)," EPRI TR-100370, April 1992, published by the Electric Power Research Institute, the unavailability of a system is $5.0\text{E-}02$ per reactor year. Using the licensee's reported CDF for this area of $3.28\text{E-}06$ per reactor year, the modification of the Halon system to automatic would result in a decrease of the CDF in this area to $1.64\text{E-}07$, or a 95 percent reduction in the CDF. This equates to about an 82 percent reduction in the total reported fire CDF.

2. COST

In 1995, the licensee estimated that it would cost \$360,000 to convert the manually actuated Halon system in the Unit 2 ESGR at Surry Power Station, using the existing detection system, to an automatically-actuated system. The licensee did not provide its cost breakdown for staff review. However, to provide a rough estimate of the potential costs to modify the existing Halon systems at North Anna, the staff prepared an estimate for the installation of a new gaseous fire suppression system based on the data provided in the 1995 Edition of "Means Square Foot Costs." Using a cost of \$3.45 per cubic (cu.) foot (ft) for a complete alternative gaseous system, including detection, and the total volume of the two North Anna ESGRs (Unit 1 = 127,700 cu. ft and Unit 2 = 119,300 cu. ft), the staff estimates that the cost to replace the existing Halon and detection systems would be about \$852,000.