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ACRS-3088

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS  
MINUTES OF THE ACRS SUBCOMMITTEE ON FIRE PROTECTION  
JANUARY 22, 1998  
ROCKVILLE, MARYLAND

INTRODUCTION

The Advisory Committee on Reactor Safeguards (ACRS) Subcommittee on Fire Protection held a meeting on January 22, 1998, in Room T-2 B3, 11545 Rockville Pike, Rockville, Maryland, with the representatives of the U.S. Nuclear Regulatory Commission (NRC) staff, the Nuclear Energy Institute (NEI), the National Fire Protection Association (NFPA), the Union of Concerned Scientists (UCS), and the Nuclear Information and Resource Service (NIRS). The meeting was held to gather information regarding staff actions taken related to the development of a revised fire protection rule. The entire meeting was open to the public. Mr. Amarjit Singh was the cognizant ACRS staff engineer for this meeting. The meeting was convened at 8:30 a.m. and adjourned at 5:25 p.m.

ATTENDEESACRS Members

D. Powers, Chairman  
G. Apostolakis  
M. Fontana  
T. Kress  
R. Seale

Principal NRC Speakers

G. Holahan, Office of Nuclear Reactor Regulation (NRR)  
T. Marsh, NRR  
E. Connell, NRR  
P. Madden, NRR  
S. West, NRR  
N. Siu, Office of Nuclear Regulatory Research (RES)  
A. Rubin, RES

Industry Representatives

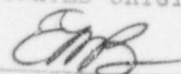
F. Emerson, NEI  
A. O'Neill, NFPA  
D. Lochbaum, UCS  
P. Gunter, NIRS

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No written comments or requests for time to make oral statements were received from members of the public. A complete list of meeting attendees is kept in the ACRS Office File and will be made available upon request. A list of those who registered is available in the ACRS Office. The presentation slides and handouts used during the meeting are attached to the office copy of these minutes.

#### Chairman's Opening Remarks

Dr. Dana A. Powers, Chairman of the Fire Protection Subcommittee, convened the meeting at 8:30 a.m. He stated that the purpose of this meeting was to discuss the staff's action related to the development of a revised fire protection rule.

#### NRC Staff Presentation

##### Opening Remarks - Mr. Ledyard B. Marsh, NRR

Mr. Marsh made the opening remarks and stated that the staff requirements memorandum (SRM) SECY-97-127 dated September 11, 1997 directed the staff to complete three items, which included sending an expedited schedule to the Commission for the rulemaking, briefing the commission on February 6, 1998 on the rulemaking process, and shifting the responsibility of the rulemaking from RES to NRR. The NRR staff has the lead for the rulemaking and is still considering the first two items of the SRM.

##### Fire Protection Rulemaking - Edward A. Connell, NRR

Mr. Connell presented the background and the actions taken by the staff in developing the fire protection rulemaking. SRM of September 11, 1997, directed the staff to take the following approach in developing the risk-informed, performance-based fire protection regulation:

- Finalize the current research and study by the end of 1997 as noted in SECY-97-127, and obtain feedback from the office of the General Counsel (OGC) on the backfit implication.
- Obtain industry feedback regarding interest in a new rule.
- Brief the Commission on all findings, observations, and conclusions including probabilistic risk assessment (PRA) and fire modeling results, fire protection functional inspection results, backfit determinations, industry interaction and comments, and other relevant information.
- Provide the Commission with an expedited schedule for risk-informed, performance-based rulemaking.

- Assess current regulatory requirements so as not to eliminate current requirements that continue to be appropriate during the transition to more risk-informed fire protection requirements.

Since the SRM was issued, there have been new developments in the fire protection rulemaking process. NFPA informed the NRC Chairman that NFPA is developing a performance-based standard for fire protection for light water reactors, which could be used in the staff's rulemaking process. The NFPA standard is to be completed by May 2000, and the NFPA recommended that NRC adopt the new NFPA standard in the fire protection rulemaking. On December 11, 1997, the Commission issued an SRM that directed the staff not to proceed further with the fire protection rulemaking that include the shutdown and fuel storage operation.

The NRC staff proposed three options: (1) develop a new risk-informed, performance-based rule that addresses shutdown as well as normal operation; (2) develop comprehensive guidance for the existing rule; or (3) maintain the status quo.

Mr. Connell concluded that the actions to finalize the options for rulemaking respond to the SRM of September 11, 1997, including the new developments since the SRM. The staff will complete the review of the RES activities in the area of rulemaking and brief the Commission thereon in the near future.

Status of the Pilot Fire Protection Functional Inspections -Mr. Patrick Madden, NRR

Mr. Madden presented the background and the results of the two pilot fire protection functional inspections (FPFIs) conducted at River Bend Station and Susquehanna Steam Electric Station. Mr. Madden stated that the scope of the FPFI program was expanded, in part, due to the degradation of Thermo-Lag. Some of the corrective actions taken are listed below.

- Fire barrier reduction program
- Revised safe shutdown analyses
- Redefined fire area boundaries
- New operator actions and procedures
- Fire events
- Licensee reports of fire protection program deficiencies
- Self-induced station blackout
- Turbine building assessments
- Individual plant examinations of external events (IPEEEs)



The inspection made the following findings at River Bend Station:

Good Points

- Cable re-route modifications which provide positive fire separation between redundant safe-shutdown functions
- Identification of the lack of the required fire barrier protection for service water cable.
- Implementation of a motor-operated valve (MOV) modification, which eliminates the fire-induced spurious actuation and functional operation concerns.

Weaknesses

- Control of combustibles
- Manual fire-fighting capability (fire brigade)
- Fire watches and operability
- Post-fire safe shutdown capability
- Plant safety (fire-induced transient and spurious operation of 16 safety relief valves)

Fire Protection Functional Inspection (FPI) at Susquehanna

The Susquehanna FPI was the second of four pilot FPIs. The following summarizes the inspection findings:

Good Points

- Technical personnel, corporate history, and consistency. Personnel know the plant and its systems.
- Scope and depth of operator training on post-fire safe shutdown operations from outside the control room.
- Emergency lighting, good aiming of lights, which are marked and easily identifiable.
- Pro-active response to the fire performance technical issues associated with Kaowool raceway fire barrier systems, including Thermo-Lag resolution.
- Addressing of associated circuits and fire-induced spurious equipment operations (e.g., a MOV modification eliminating fire-induced spurious actuation and functional operation concerns).

Weaknesses

- Feasibility of certain cold shutdown repairs.
- Potential for water hammer on the high pressure coolant injection, reactor core isolation cooling, core spray system, and the residual heat removal discharge piping.
- IPEEE Fire analysis
- The scope and depth of quality assurance audits
- The use of automatic depressurization system and its capability to meet Appendix R reactor performance parameters.
- Compliance of fire protection plant features with industry fire protection codes and standards.

Mr. Madden stated that the inspection reports for River Bend and Susquehanna are scheduled to be issued by the end of March and April 1998, respectively.

Fire Risk Research Program DEVELOPMENT Status Report - Nathan Siu, RES

Dr. Siu presented the objectives and the status of the fire risk research program development, the process that RES had been using to prioritize issues, and grouped them into topic areas that need to be addressed through this program. The objective of this program was to identify areas in which improvements are needed in fire risk analysis methods and data to provide a better understanding of the risk contribution of fires in nuclear power plants and to support improved decision making regarding nuclear power plant fire protection. Quite a few areas (42) that might require further research were identified, including the following:

- Fire frequency analysis, which includes rated versus unrated cables, the effect of plant operations, compensatory measures, and transient-fueled fires
- Frequency-magnitude relationship for fires
- Single and multi-compartment analysis, including cable tray fires, electrical cabinet fires, large oil fires, hot gas layer development, and flash over
- Smoke generation and transport analysis
- Detection analysis
- Suppression analysis, including automatic and manual suppression effectiveness, effect of compensatory measures, and scenario-specific analysis
- Fire barrier reliability, including penetration seals



- Human reliability analysis, especially the impact of fire on cognitive behavior and the identification and detection of precursors

Dr. Siu stated that these issues will be integrated with previously identified fire protection issues as the agency develops a fire research program. Although there is little argument about the potential importance of fires, the magnitude of the fire risk and the specific measures to efficiently manage this risk are not clear when considering individual plants. This uncertainty is due to uncertainties in the current state of knowledge concerning the initiation, growth, suppression, and impacts on the plant of fire-induced r plant accident scenarios. These latter uncertainties are reflected by the variability in methods and data used by current fire risk assessments (which contribute significantly to variations in predicted fire risk magnitude and profiles) and by the ongoing discussions between the nuclear industry and the NRC regarding the usefulness of current fire risk assessment tools in supporting plant changes and risk-informed, performance-based approaches to fire protection.

An examination of the fire risk analysis process has been performed to systematically identify the areas in which additional research is needed. This examination considers the treatment of fire initiation, fire scenario induced equipment damage, and plant response to the loss of equipment. The results of this examination have been supplemented with input from a variety of sources, including the NRC's Fire Protection Task Action Plan and insights gained from the staff's review of IPEEE submittals.

The issues and topic areas have been given an initial prioritization, feedback has been obtained by the RES staff, and the differences in prioritization are being resolved. Dr. Siu stated that the next step is to complete prioritization of topic areas, which will include any regrouping of issues, and to develop and document a research plan for management's review and approval.

#### Preliminary Fire Perspectives from the IPEEE Program - Alan Rubin, RES

Mr. Rubin presented the overview of the preliminary fire perspective from the IPEEE program and focused only on the fire area. Mr. Rubin covered three major topics: (1) the review process for the IPEEE; (2) the status of the IPEEE program; and (3) the schedule for milestones in this program. Mr. Rubin provided the general background on the program itself in which the licensees were requested to perform an IPEEE in response to Generic Letter (GL) 88-20, Supplement 4, dated June 28, 1991. The following objectives were considered in performing the IPEEE:

- To develop an appreciation of severe accident behavior.
- To understand the most likely severe accident sequences that could occur at the plant.
- To gain a qualitative understanding of the overall likelihood of core damage and fission product release.

- If necessary, to reduce the overall likelihood of core damage and fission product releases by modifying, when appropriate, hardware and procedures that would help prevent or mitigate severe accidents.
- To ensure the IPEEE submittals were complete, focusing on whether the licensee met the intent of the GL 88-20.

The preliminary IPEEE perspectives in the fire area indicated that the IPEEE program generally was successful in meeting the intent of GL 88-20. The staff identified the following significant points during the preliminary review of the IPEEE submittals:

- The comparison of quantitative core damage frequency (CDF) between plants was not straightforward because it varies in the methods used for analyses, input, and modeling assumptions by analysts, and in the level of detail provided in the analyses.
- The CDF contribution from fire events can, in some cases, approach (or even exceed) that from internal events.
- The range of reported fire CDF is less than  $1 \text{ E-}09$  to  $5 \text{ E-}03$  per reactor year.
- Only one licensee for (Quad Cities) identified fire "Vulnerability" from turbine building oil and electrical fires.
- About 50 percent of the licensees have implemented or proposed plant improvements, such as hardware changes, relocation of cables out of the fire area, upgrading of fire barriers, and improvement of fire suppression systems, and, additionally, improvement of the fire response procedures and modification of the procedures to control transient combustibles and active fire barriers.

The vulnerability at Quad Cities was identified by the licensee from the postulated fires in the turbine building and from electrical fires, including the lack of separation of certain cables in the turbine building, reliance on alternate unit equipment, and complicated procedures for recovery actions, which led to high CDF. The licensee implemented an interim shutdown method by using an independent backup power supply for both units. The CDF was reduced to  $7 \text{ E-}04$  per year. The licensee evaluated long-term measures to further reduce the CDF by adding two independent pumps for reactor makeup powered by the station blackout diesel generator.

#### Status and Schedule

Mr. Rubin stated that a total of 74 IPEEE submittals are expected, but to date, 69 submittals have been received and 57 are in various stages of review. The staff is scheduled to complete all reviews and to issue plant-specific safety evaluation reports (SERs) by June 1999. To date, one SER for Diablo Canyon was issued.



Mr. Rubin concluded that, overall, the IPEEE program is generally successful in meeting the intent of GL 88-20 and more specific and detailed reviews may be needed to apply information from IPEEEs to support risk-informed, performance-based regulation.

Presentation by the Nuclear Energy Institute (NEI) - Fred Emerson, NEI

Mr. Emerson presented the industry positions and the results of the NEI survey of the Chief Nuclear Officers regarding the development of new rule. Mr. Emerson stated that the general consensus among the industry is that the industry does not want the new fire protection regulation. Industry representatives expressed the following opinions:

- They had no interest in an expanded rule (new requirements).
- Further development of risk-informed performance-based regulations should support changes in the existing regulations and the need to emplace a framework for the development of risk and modeling tools and performance-based standards. The new rule will add more confusion to the existing fire protection regulation.
- NRC and the industry are concerned about the maturity of risk-informed and performance-based methods that could lead to considerable uncertainty about their application in a new rule.
- Many utilities would like increased use of risk and modeling tools to address regulatory or balance-of-plant issues.
- Changes to rule or supporting guidance must allow adequate time for completion of pilot functional inspections and the review of IPEEEs. The process for developing NFPA Standard 805 should continue and insights should be used appropriately.
- A high CDF from fire events at one plant is not indicative of a flawed rule, and there is no indication from the IPEEE results to date that there are generic issues demanding a new rule.
- Adverse effects will result from eliminating currently approved exemptions without due consideration and rebaselining existing programs to new requirements without demonstrated safety improvements.

Mr. Emerson stated that the industry will participate actively in any changes to the rule or supporting guidance to the existing rule. The industry will work with the NRC staff on an alternative to rulemaking, but it needs to agree on realistic goals, objectives, methods for using risk-informed performance-based regulations.

National Fire Protection Association (NFPA) - Anthony R. O'Neill

Mr. O'Neill presented an overview of the organization of the NFPA and stated that NFPA has been in existence since 1896. The NFPA has developed standards in the areas of electrical



installation, building fire protection and life safety, fire protection systems and equipment, and chemicals and hazardous materials and has participated in the development of other codes and standards by various professional organizations. The NFPA codes and standards have been developed at three levels: Federal, State, and Local. The NFPA standards have been adopted and used by various agencies of the Federal Government, and the States, building code organizations and the insurance industries, and individuals such as architects, engineers, and designers. NFPA has various technical committees that are involved in developing codes and standards. The NFPA 805 committee for nuclear facilities has the primary responsibility for documents on the safeguarding of life and property from fire in which radiation or other effects of nuclear energy might be a factor. The NFPA standard committee is formed of engineering specialists from the various engineering firms, nuclear utilities, the Federal Government and nuclear insurers. The NFPA 805 committee has proposed a new performance-based standard for light water reactor electric generating plants. The NFPA 805 committee plans to complete task group assignments by February 15, 1998, and to issue a draft of the performance-based standard by mid-September 1998 for public comment. The NFPA 805 committee believes that the committee has a sound action plan for addressing performance-based fire protection for nuclear power plants which is being implemented by a balanced committee of experts who are organized under the umbrella of an accredited national standards process.

Presentation on Penetration Seals by Nuclear Information and Resource Service (NIRS) and the Union of Concerned Scientists (UCS) - Paul Gunter and David Lochbaum

Messrs. Gunter and Lochbaum expressed the following concerns with the NRC staff's current approach to the fire protection rulemaking:

- UCS and NIRS stated that the NRC staff should be pursuing the development of a "one hazard/one rule" approach to the fire protection for all power reactors, as opposed to the agency's current approach in which licensees are allowed to choose from a variety of regulations and guidance documents containing many different standards that can range over many commitments to meet fire safety goals.
- UCS and NIRS registered a concern that in formulating its proposed rule change the NRC staff has not demonstrated a complete and adequate understanding of the formulation of the current regulation especially in regard to the development of the "noncombustibility" standard for barrier penetration seals that the NRC staff currently recommends be eliminated from 10 CFR Part 50, Appendix R, Section III M, and all other associated guidance documents.
- The regulations for penetration seals are plant-specific, scattered among numerous licensing documents, and undermined by literally hundreds of exemptions, thus making conformance and enforcement virtually impossible.
- Penetration seals are difficult to install and test and testing reduces their chances for integrity. Experience indicates that many plants have had extensive problems with penetration seals which are subject to more severe challenges from a fire than fire-rated doors and walls.

- The NRC staff's review also has identified a current practice that can affect the qualification status of installed seals. Plant modifications are being made that require running new cable and conduits through existing penetration seals. These modifications are generally being made without an associated technical review that would ensure that the resulting penetration seal design configuration or design parameters are consistent with those validated by initial qualification tests. What assurance does NRC have that modified penetration seals remain bound by qualification tests?

Messrs. Gunter and Lochbaum concluded that licensing requirements for penetration seals are extremely complicated, thus making both compliance and enforcement very difficult. If NRC pursues rulemaking, a unified rule applicable to all operating plants should be adopted without wholesale exemptions. Until NRC completes rulemaking, existing regulations must be rigorously enforced. Finally, the use of silicone foam in penetration seals may constitute an unreviewed safety question as a result of hydrogen generation.

#### NRC Staff Presentation on Penetration Seals - Steven West, NRR

Mr. West presented a brief background and the work which staff has performed on penetration seals over the years. In 1985, the NRC staff had become aware of the possibility that some licensees may not have been complying with NRC requirements and guidance for fire penetration seals. In response to these concerns, in 1987 and 1988, the NRC staff had assessed aspects of fire barrier penetration seals. The staff had reviewed such relevant data as licensee event reports, inspection findings, and fire test reports, interviewed industry staff, inspected licensees and vendors and reviewed a sample population of as built fire barrier penetration seal installations and substantiating documentation. Although it did not find widespread problems or safety-significant generic issues, the staff addressed the potential problems in a series of information notices.

Since 1992, the potential problems have again been reported. In response, from 1993-96, the staff conducted a second comprehensive generic technical assessment of fire barrier penetration seals. The principal purpose of the second assessment was to address potential problems of safety significance or with generic implications, and to determine if NRC regulatory requirements, review guidance and inspection procedures for penetration seal are adequate. The staff found several minor weaknesses with some of plant-specific penetration seal programs that it reviewed. However, these weaknesses did not result in problems with the penetration seals installed in the plants. In 1994, as part of the research program the staff had Sandia National Laboratories performed a study on aging of fire barriers including fire penetration seals. In 1995, AEOD did a review of penetration seals and wrote a letter report which concluded that general condition of penetration seal program in industry is satisfactory.

In June 1996, the staff issues a NUREG -1552, " Fire Barrier Penetration Seals in Nuclear Power Plants." On the basis of the totality of the information it found and assessed including other documents, the staff concluded that it did not find plant-specific problems of safety significance or concerns with generic implications.



In 1997, to today, the staff is performing a third comprehensive generic assessment on this issue. The third assessment includes the response to Representative Markey's questions regarding the issue of penetration seals. The staff has enhanced core inspection module guidance for the penetration seals. The staff is scheduled to issue Supplement 1 to NUREG-1552 which will include the recent inspection findings. The staff's conclusion in NUREG 1552 has not changed.

#### SUBCOMMITTEE RECOMMENDATIONS:

The subcommittee Chairman recommended that he will present the subcommittee report during the 449th ACRS meeting.

#### CONCLUSIONS

The subcommittee decided to follow-up the discussions on fire protection rulemaking when staff has issued the commission paper.

#### BACKGROUND MATERIAL PROVIDED TO THE SUBCOMMITTEE:

- Memorandum to L. Joseph Callan, Executive Director for Operations from John C. Hoyle, Secretary, Subject: Staff Requirements-SECY-97-127-Development of a Risk-Informed, Performance-Based Regulation for Fire Protection at Nuclear Power Plants, dated September 11, 1997
- SECY-97-127, dated June 19, 1997, Subject: Development of a Risk-Informed, Performance-Based Regulation for the Fire Protection at Nuclear Power Plants
- Letter to Mr. L. Joseph Callan, Executive Director for Operations, from Ralph E. Beedle, NEI, concerning the proposed NRC staff performance-based rulemaking for fire protection, dated August 20, 1997
- Letter to Dr. Robert L. Seale, Chairman, ACRS, from Mr. Richard P. Bielen, Chief Systems and Applications Engineer, NFPA, dated November 7, 1997
- Letter to George D. Miller, President and Chief Executive Officer, NFPA, from Samuel J. Collins, Director, NRR, response to the November 7, 1997 letter
- Letter to Mr. Amarjit Singh, ACRS, from Mr. Paul Gunter, Director, Reactor Watchdog Project, Nuclear Information Service, dated October 22, 1997 concerning the proposed NRC staff performance-based rulemaking for fire protection, dated October 27, 1997
- NRC Information Notice 97-70: Potential Problems with fire barrier penetration seals, dated September 19, 1997



January 22, 1998

- NRC Inspection Manual, Inspection Procedure 64704, dated September 8, 1997
- Letter to Mr. L. Joseph Callan, Executive Director for Operations, from Ralph E. Beedle, NEI, dated December 11, 1997
- SECY-97-278 Subject: Plans to issue Confirmatory Orders concerning schedules for corrective actions regarding licensee use of Thermo-Lag 330-1 Fire Barriers, dated December 3, 1997

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Note: Additional details of this meeting can be obtained from a transcript of this meeting available in the NRC Public Document Room, 2120 L Street, N.W. Washington, D.C. 20006, (202) 634-3274, or can be purchased from Ann Riley & Associates, LTD., Court Reporters and Transcribers, 1250 I Street, N.W. Suite 300, Washington, D.C. 20005, (202) 842-0034.