NRC-01-061

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Kewaunee Nuclear Power Plant
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920-388-2560

Operated by
Nuclear Management Company, LLC

May 17, 2001

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555

Ladies/Gentlemen:

DOCKET 50-305
OPERATING LICENSE DPR-43
KEWAUNEE NUCLEAR POWER PLANT
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION ON URIS 50-305/01-02-02 AND 50-305/01-02-03;

Reference: Letter from J. A. Grobe (NRC) to M. E Reddemann (NMC) dated March 22, 2001.

In the reference, the Nuclear Regulatory Commission (NRC) provided Nuclear Management Company (NMC), LLC with the results of the NRC Triennial Fire Protection Inspection. Included in the report were two issues characterized as unresolved items (URI). As requested, the Attachments to this letter provide NMC's response.

Please note that the date of this response is approximately three weeks later than that which was requested by the referenced letter. Shortly after receiving the NRC's request for the additional information, NMC Licensing staff consulted with Region III management staff and requested an extension to the response time. The Region granted the request for an extension. I would like to thank the NRC for granting the extension.

If you should have any questions with regard to this response, please contact me or a member of my staff for clarification.

Sincerely,

Kyle A Hoops
Manager-Kewaunee Plant

GIH
Attach.

A006

cc: US NRC Senior Resident Inspector
US NRC Region III

ATTACHMENT 1

Letter from K. A. Hoops (NMC)

to

Document Control Desk (NRC)

Dated

May 17, 2001

Response to Request for Additional Information URI 50-305/01-02-02

Requested Information

Provide an evaluation, supported by test data, which demonstrates that the relay room carbon dioxide system can suppress a deep seated fire, i.e., maintain carbon dioxide concentration of at least 50 percent for a sustained period of time. If testing to support such an evaluation has not been performed, provide a plan and a schedule for performing such testing. If the test methodology used or planned is by alternate means (i.e., other than full carbon dioxide discharge testing), provide a justification for the use of the alternative test methodology.

NMC's Response

At the time of this submittal, the carbon dioxide (CO_2) fire suppression system for the Kewaunee relay room can not be explicitly defined as being capable of suppressing a deep seated fire to the degree expected. In order to do so, specific test or analytical data that demonstrates the system's capability to perform would be required. According to the referenced inspection report[1], this would mean data to support a functional test to demonstrate the system has the capability of obtaining and holding a 50% concentration of CO_2 for a minimum of 20 minutes or a suitable analysis to support a deviation would be required. To date Kewaunee has no such data to make such a declaration. However, given the combination of existing test data, records of maintenance history, documented variances from the 50% for 20 minute performance expectation at other facilities, and the potential for a suitable alternative test, Kewaunee engineering staff are confident that the system is capable of suppressing a deep seated fire.

System Evaluation

The following provides a synopsis of how the Kewaunee engineering staff, as a minimum, can conclude that the system as it exists can be relied on to provide fire suppression in the relay room. It also provides additional background information to support a conclusion that, once more definitive performance data is gained, a suitable description of the systems capability can be developed and submitted to the satisfaction of the Commission.

Based on information referred to in the inspection report, the relay room CO_2 system will provide some protection to limit the extent of damage caused by a fire in the relay room. The evidence is provided, in part, by the limited test data from the test performed in 1979. The data along with the knowledge that the discharge time for CO_2 into the room would be longer during a fire, and knowing that improvements have been made to the room's boundaries since the 1979 test, assist in supporting the stated conclusion.

The 1979 test data, shows that minimum required CO_2 concentration, 50%, could be reached and held for five minutes. Two factors that influence an assessment that the system has the capability to hold a 50% concentration for a longer period are; differences between test discharge times and system design, and system boundary improvements since the 1979 test was performed.

The 1979 test was aborted prematurely due to excessive CO_2 leakage from the relay room, most notably into the control room. The CO_2 discharge was aborted at approximately 105 seconds. The timer for the discharge control circuit with a full system test would have resulted in a discharge for at least 120 seconds. Consequently the test did not record what the concentration of the CO_2 would have been with a full discharge interval and did not account for the added discharge time after the minimum CO_2 concentration was reached. Since the hold time is related to the maximum concentration achieved, had the test gone to full duration, the recorded hold time would have been longer. At the time the test was aborted the recorded concentration was slightly in excess of 55% and increasing.

Since the 1979 test, a number of changes and repairs were made to address problems encountered during the test. All of the changes in one way or another were made to limit leakage from the relay room. Consequently, if leakage was reduced, which was specifically noted by "negligible" leakage into the control room from the system test conducted in 1980, the hold time for the room should also have improved. Although the actual hold time, based on this additional information, can not be quantified, it does provide evidence to indicate that the hold time would be greater than the five minutes recorded by the 1979 test.

The 1973 National Fire Protection Association (NFPA) code of record also did not have a specific acceptance criterion for a hold time. It required that the hold time be significant. It wasn't until the 1980 code that 'significant' was defined as 20 minutes. Therefore, it is possible that even if test data were available from the 1979 test, it still may have been less than 20 minutes.

NRC has issued a safety evaluation report[2] (SER) for alternatives to full discharge testing of CO_2 fire suppression systems. The SER was issued signifying NRC's acceptance of alternative tests related to a Susquehanna Steam Electric Station CO_2 suppression systems. In the SER it was noted that the NRC found a concentration of 50% held for 15 minutes to be an acceptable performance criterion. The SER and the recommendation of the code minimum concentrations signify the fact that a time less than 20 minutes can be an acceptable performance criterion.

A second document[3] involving alternate performance testing was found to have an additional acknowledgement by the NRC of alternate hold times than the 20 minutes specified by the current code. NRC's response to their review of an alternate test methodology at the Vermont Yankee Station specifically acknowledges a hold time of ten minutes being acceptable.

Although the information provided above does not suffice as an adequate accumulation of data to declare the Kewaunee relay room CO_2 system in compliance with code performance requirements, it does indicate that the system will perform to some degree. Furthermore, since there have been documented deviations from the present NFPA code requirements for performance (i.e., 50% for 20 minutes) the data that is available indicates that the Kewaunee system as it exists is closer to compliance than initially believed. It also provides the Kewaunee engineering staff with confidence that once additional test data is gathered and further analysis is completed that the relay room CO_2 fire suppression system will be found to be fully functional.

Test Data to Support the System Capacity

As noted in the referenced NRC inspection report, no test data was available at the time of the inspection to demonstrate that the CO_2 system is capable of suppressing a deep seated fire. To date, complications associated with developing an acceptable door fan test have precluded performing a subsequent test and unacceptable potential safety consequences preclude a CO_2 discharge test. Consequently, no test data has been developed since the inspection has been concluded. Therefore, no additional test data can be provided to quantify the system's performance.

Plan and Schedule for Testing

Further tests of the system were initially planned to be finished shortly after the NRC Triennial Inspection was completed. However, the ventilation system design for the relay room and Kewaunee's licensing basis precluded a test while the plant is on line.

From the data obtained during the last door fan test, it was discovered it would be necessary to shutdown the relay room ventilation system to obtain successful test data. In order to shut down the system, it would be necessary to obtain a License exemption. Kewaunee's Technical Specifications require at least one ventilation fan to be operable at all times to support the design requirements for the control room post accident recirculation (CRPAR) system. Consequently, the relay room ventilation system can not be stopped to support a door fan test during plant operation. Therefore, until an alternative test methodology is discovered, a retest of the relay room can not be performed any earlier than the next plant shutdown where the CRPAR system can be removed from service.

The optimal time for conducting any additional tests and to ensure the least impact on plant staff and plant safety would be during the next scheduled refueling outage. Kewaunee's next outage is scheduled for the fall of this year. The following provides an outline of the activities planned and their schedule to bring this issue to closure:

> **Review Our Options – June through August 1:**
> By August 1st, 2001, with support from Underwriters Laboratories Inc, and Guardian Services Inc, Kewaunee's engineering staff will review the door fan test option as well as other options to resolve the issue of fire suppression in the relay room at Kewaunee. Contractual agreements are being formalized soliciting support from specific industry experts, namely;
>
> > Mr. Tom Wysocki of Guardian Services Inc. CO_2 Systems Expert NFPA Code 12 & 12A author and chairman of code committees, and
> >
> > Mr. Martin Pabich, P.E. & Dr. Pravinray Gandhi Ph.D., P.E. of Underwriters Laboratories Inc.

It is anticipated that this part of the effort will point Kewaunee's engineering staff in the direction of the most appropriate option to close the issue. Although at this point it appears that a door fan test will likely be the optimal success path, we are not discarding the possibility of the experts proposing alternate testing methods or even the possibility of installing a different style of suppression system.

Develop Alternate Test or Conceptual Design - August 1 through September 1:
By September 1st, 2001, we anticipate having determined and developed procedures for the optimal test method or replacement option should a replacement be required. This should allow some pre-staging for testing and/or modifications before the planned outage scheduled to begin the third week of September.

Conduct Test or Initiate Modifications – September through October 31st:
If it is determined that the door fan test will be the success path, testing will be completed by October 1st. Between the beginning of the outage and the end of October, it is expected that any tests and/or modifications resulting from information gathered from the tests, and subsequent tests will be completed. Included in this time frame is the performance of any analyses to support system performance and development of any plans to address additional concerns that may surface. From October 1st through to November, we anticipate that test data will be incorporated into a model that will demonstrate system performance and a report will be developed to present to management staff for review.

Complete System Upgrades and Analyses Review – November 1st through Startup:
Any system upgrades necessary to bring the CO_2 system and/or the relay room up to code performance requirements are expected to be completed before plant startup. This includes any management or regulatory reviews, should they be required, to assure a system that complies to requirements. Should we find that these actions can not be completed within these time constraints we will inform the NRC.

Install Alternative Fire Suppression System – September through November:
This item is listed only if, for whatever reason, alternative testing is determined not to be an available option.

In summary our plans to bringing the issue of the relay room fire suppression system to closure is all testing, analyses and/or modifications are expected to be completed prior to startup from the fall refueling outage. We will keep NRC informed of any changes to this schedule that result in exceeding our proposed completion date.

Alternate Test Method Justification

It appears that the test option that will be chosen to develop system performance data will be an alternative to full CO_2 discharge testing. The potential consequences of a full discharge test while the plant is on-line are an unacceptable risk. The potential consequences for equipment damage while the plant is shutdown, should a full discharge test be performed, is also undesirable. Although the risks have not been quantified in any fashion, a qualitative assessment seems justified. The risk of equipment failure due to rapid temperature changes on plant protective equipment in the relay room as well as the potential personnel safety challenge due to toxic levels of CO_2, are the driving factors.

Kewaunee plant staff are continuing to work with industry experts to develop an alternative test methodology suitable to Kewaunee's plant design, design basis and operating license. It appears, at least at this point, that a model supported by the door fan test and validated by laboratory testing is the most likely success path available as an alternative test method. Kewaunee staff does not, nor does the NMC, alone have the expertise to develop a justification to support this alternative as an adequate replacement to a full discharge test. Kewaunee staff continues to pursue fire protection industry-expert support in resolving the issue.

However, there is industry experience and documentation to support alternative methods as an acceptable option to the full discharge test. Referring again to the NRC letter[3] to Vermont Yankee Nuclear Power Station, their alternative test method was the door fan test. Specifically noted in the letter was, "The staff reviewed the acceptance criteria developed for the enclosure integrity testing performed by the licensee based on the enclosure integrity procedure of Appendix B to NFPA 12A-1989 and Section 2-6.2.1 of NFPA 12-1985."

Although the specific test methodology and the comparison analyses for the Kewaunee system have not been developed, it appears there is an option to full discharge testing. We are confident that once the methodology is defined, we can provide a justification to support full operational capability of the CO_2 system in the relay room.

References

1. Letter from J. A. Grobe (NRC) to M. E Reddemann (NMC) dated March 22, 2001.

2. NRC SER, "SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION PLANT SYSTEMS BRANCH EVAULATION OF ALTERNATIVES TO FULL DISCHARGE TESTING OF CARBON DIOXIDE FIRE SUPPRESSION SYSTEMS SUSQUEHANNA STEAM ELECTRIC STATION, UNITS 1 AND 2 DOCKET NOS. 50-387 AND 50-388.")

3. NRC letter from NRC to Vermont Yankee Nuclear Power Corporation, dated November 29, 1990, "ALTERNATIVE TESTING METHOD FOR CABLE VAULT CO_2 FIRE SUPPRESSION SYSTEM FOR VERMONT YANKEE NUCLEAR POWER STATION (TAC NO. 75502") circa 1992)

ATTACHMENT 2

Letter from K. A. Hoops (NMC)

to

Document Control Desk (NRC)

Dated

May 17, 2001

Response to Request for Additional Information URI 50-305/01-02-03

Requested Information

Provide an evaluation which demonstrates that the existing placement of heat detectors in the Diesel Generator B Room will provide acceptable detection response. If the risk assessment of the heat detection function for the Diesel Generator B Room presented in the Individual Plant Examination for External Events is not considered accurate, provide an updated risk assessment of the heat detection function. Such an updated assessment should discuss and quantify how failure of the heat detection function can contribute towards core damage.

NMC Response

This evaluation shows that the location of heat detectors used to actuate the systems, while not in literal compliance with NFPA 72E code criteria, will detect the type of fire that requires automatic actuation of the suppression systems and meets the intent of the code. Two types of detectors are provided in the diesel rooms, infrared flame detectors mounted at ceiling level and heat detectors mounted below ceiling level. Each is described separately below.

Infrared Detectors

The ceiling-level infrared detectors are provided to detect fires and provide an alarm to the Control Room. The infrared detectors will detect a small fire that occurs in transient materials, in a cable tray as a result of a cable failure, or as a result of a small leak of oil from the diesel generator. Such a small fire could occur both prior to and during operation of the diesel generator.

Detection of the small fire would result in dispatching an Operator to investigate the source of the alarm. The Operator would, if necessary based on the size of the fire, manually initiate the CO_2 suppression system. Detection of the small fire would also result in response by the fire brigade, and the fire would be manually extinguished using hose stations or extinguishers, depending on the size of the fire. The fire brigade also has the option of manually initiating the CO_2 suppression system, if necessary based on the fire size.

The infrared heat detectors will also detect a larger fire resulting from catastrophic failure of the diesel generator when it is operating. This would also result in dispatch of an Operator and response by the fire brigade as described above. The infrared detectors are installed according to code requirements and will perform their intended function.

Heat Detectors

Six heat detectors are installed in the diesel generator room to actuate the CO_2 suppression system. Per Section 1422 of NFPA 12, automatic detection shall be by any listed or approved method that is capable of detecting a fire. Per Section 3-4.1 of NFPA 72E, spot-type heat detectors shall be located on the ceiling.

The installed heat detectors are Detect-A-Fire heat detectors, Fenwal Model Number 27121-0, with a temperature setting of 160°F and a listed spacing of 25 feet. The heat detectors are not installed in compliance with Section 3-4.1 of NFPA 72E. Five of the six heat detectors in the Diesel Generator Room are mounted about 6-1/2 feet below the ceiling, and the sixth is about 10-1/2 feet below the ceiling. Five of the heat detectors are located within the curbed area used to contain potential oil spills from the diesel. The sixth is just outside the curbed area directly opposite the oil cooler end of the diesel engine.

Section 3-5.1 of NFPA 72E indicates that the distance between heat detectors shall not exceed their listed spacing, and that all points on the ceiling shall have a detector within 0.7 times the listed spacing. Based on the listed spacing of the installed heat detectors, at most, 4 detectors would be required to provide the required coverage per Section 3-5.1. The six heat detectors are at a reduced spacing in comparison to the listed spacing, and result in a 50% increase in detector density over that required by the code.

The reduced spacing takes into account the guidance contained in Appendix B of NFPA 72E. Appendix B, "Spacing and Sensitivity," is, according to the code, not part of the code but is provided for information purposes only. The principals of Section B-1.7 for reduction in spacing are applicable to the spacing of heat detectors in the diesel generator room.

Evaluation of Detector Locations

Locating the detectors at the ceiling is required by the code. Given the tendency for heat to rise in an enclosure, locating heat detectors at the ceiling would typically result in the earliest detection of postulated fires. However, operation of the diesel generator results in about 60,000 cfm of air to be introduced into the room from the exterior. This is equivalent to about one air change per minute in the room.

It is apparent that the design and location of the heat detectors took into account the conditions of the diesel generator room when determining the number and location of detectors. The code of record contained limited guidance on how to deal with high air velocity spaces, with Appendix B indicating that reductions in spacing should be considered. The design of the system increased the density of detectors by 50% over what was required by the code. The design of the system also lowered the elevation of detectors in the room to account for the high airflow introduced at the upper elevations. As such, it appears the detectors were located in order to meet the intent of the code requirements, given the lack of design guidance available for detector locations in high air velocity spaces.

Heat Release Rate to Actuate Detectors

The average air temperature in the room would only have to rise to about 200°F to actuate the heat detectors (which are rated at 160°F) and actuate the CO_2 suppression system. There would be a great deal of mixing in the room with 60,000 cfm ventilation flow. The fire size necessary to increase the room temperature can be calculated by taking the air flow rate times the air density times the heat capacity of the air, along with the appropriate conversion factors, as follows:

> 60,000 cfm x 0.02832 m^3/ft^3 x 0.998 kg/m^3 x 1.009 kW-sec/kg °K x 1/60 min/sec = 28.5 kW/°K or 15.8 kW/°F.

In order to heat the room to 200°F, it would require 15.8 kW/°F times 200°F, which equals 3160kW of energy to be imparted into the room, assuming that the outside air is at 0°F. The detection system is designed to detect a diesel lube or fuel oil spill or spray fire. The heat release from such a fire is 2044 kW/m^2 for a pool fire or 2110kW/gpm for a spray fire. The detection system will detect a pool fire as small as 3160kW divided by 2044kW/m^2, which has an area of 1.55m^2, or 16ft^2. The detection system will also detect a spray fire as small as 3160kW divided by 2110kW/gpm, or 1.5gpm. Larger pool or spray fires will also be detected by the detection system. This does not assume any radiative losses from the flame, however 0°F is a conservative outside temperature. Therefore, heat detectors located 6-1/2 to 10-1/2 feet below the ceiling would actuate as a result of a pool or spray fire and actuate the CO_2 suppression system.

The heat detectors are also located above the area of postulated pool oil fires. The pool oil fire would be evenly distributed within the room, and the heat detectors would be in the plume of the fire. The flames from the pool oil fire may also directly impinge on the heat detectors. Direct plume and/or flame impingement will also result in actuation of the heat detectors. As such, the detectors would operate due to direct plume impingement and the CO_2 suppression system would actuate.

System Operability

As indicated in Kewaunee's original Fire Protection Program Analysis (FPPA) submittal, the primary hazard of concern in the diesel generator room is lube oil in the diesel. In addition, a diesel fuel oil fire could also occur given a pressurized or unpressurized leak in the fuel oil system. According to the NFPA 12-1973 definition of fire types that may be extinguished using a total flooding CO_2 system, a diesel fuel or lube oil fire hazard qualifies as a surface type fire. There are several design criteria which must be considered in the design of a total flooding system application for a surface type fire (i.e., CO_2 concentration, rate of discharge, volume factor, and soak time).

- The minimum design CO_2 concentration identified for extinguishment of a diesel fuel or lube oil fire is 34%.
- The extinguishing system must be sized such that this minimum concentration is achieved within one minute of the initial CO_2 discharge to satisfy the rate of discharge requirements.

- For systems required to satisfy the 34% concentration, a volume factor is invoked that identifies the minimum amount of CO_2 that must be injected into the room. The required volume factors for the KNPP diesel generator rooms have been met since the 16.5 and 20.6 ft^3 per lb. CO_2 discharged into the 1A and 1B room achieved the minimum required concentration levels during the tests conducted in 1973.
- The code states that under normal conditions surface fires are usually extinguished during the discharge period and that except for unusual conditions, it is not necessary to provide extra carbon dioxide to maintain the concentration. Consequently, a soak time, at a predetermined CO_2 concentration is not considered necessary or required.
- While a small fire in the diesel room may not actuate the heat detectors located between 6-1/2 to 10-1/2 feet below the ceiling, the infrared flame detectors will actuate and the fire brigade will respond to the scene. If the fire were too big for the brigade to handle, the brigade could manually trip the CO_2 suppression system.
- Larger oil fires will most likely occur during diesel operation, when 60,000 cfm of air is introduced in the room. An air exchange rate of about 1 air change per minute will result in an even distribution of air temperature in the room. Heat detectors at the ceiling and heat detectors located between 6-1/2 to 10-1/2 feet below the ceiling would be immersed in the same temperature air, even during the early stages of a large pool oil fire.
- The heat detectors are rated at 160°F; a large pool oil fire involving approximately 300 gallons of oil would release upwards of 40 million BTUs of energy into the room. This amount of energy would raise the average air temperature in the room to well in excess of the 160°F necessary to actuate the detectors and trip the CO_2 suppression system in the room.
- The number of heat detectors in the diesel generator rooms (6) exceeds the required number of detectors (4) based on the listed spacing of the detectors. The reduction in spacing and increased number of detectors meets the guidance of Appendix B of NFPA 72E.

Based on the information provided above and the CO_2 acceptance testing, along with the design of the installed detection system to detect postulated fires and trip the CO_2 suppression system, it is reasonable to conclude that these systems will perform their intended function. Therefore, these systems are considered adequate to protect the hazard posed and, as documented in the FPPA, these systems satisfy the relevant fire suppression requirements of Appendix A to Standard Review Plan, BTP APCSB 9.5-1.

Conclusion

The CO_2 suppression systems protecting the diesel generator room are considered operable in their current configuration. NFPA 72E requires that heat detectors be located at the ceiling. The installed heat detectors are located between 6-1/2 to 10-1/2 feet below the ceiling. The results of the preceding evaluation document that the installed detectors will actuate under the postulated fire conditions where automatic actuation of the CO_2 suppression system is required.

Albeit the configuration of the system is functional, it does deviate from the code requirements. Deviation from the code is acceptable. However, in order to do so, a justification is typically developed and documented, which provides the basis for deviation, similar to that which is provided above. Kewaunee had not, in the past, provided such a justification for the deviation that supports the system as it is installed. It is our intent to formalize our basis for the installed configuration and include it in the KNPP FPPA.

Risk Assessment

As noted, Kewaunee's risk assessment of the heat detection system function for the diesel room is not accurate as presented in the Individual Plant Examination for External Events (IPEEE). The issue is that the inaccuracy results in an overstatement of the importance of a fire in the diesel room. Efforts are in process to improve the fire probabilistic risk assessment (PRA). However, these efforts are part of a greater industry effort to improve fire protection PRA issues as a whole. Kewaunee is currently planning to participate in the EPRI Fire PRA Guide (EFPG) revision project. This project will result in better risk assessment modeling for fire related events.

Nevertheless, the current fire PRA was reviewed against the current EFPG for obvious conservatisms. Applying severity factors (0.4 for diesel generators, 0.08 for ventilation systems) results in a fire initiating frequency of 4.64×10^{-3}/year. Multiplying that value by the unavailability of detection and suppression (4% from FIVE) yields 1.86×10^{-4}/year. The core damage frequency (CDF) due to a fire in B Diesel Generator Room is 1.2×10^{-5}/year with automatic detection and suppression credited and 3.0×10^{-4}/year without it. The resultant increase in CDF would be 2.9×10^{-4}/year if the detection function were indeed failed. Since the above assessment shows that the detectors are indeed functional there is no risk increase due to the current configuration.

References

1. NFPA 12-1973, Carbon Dioxide Extinguishing Systems
2. NFPA 72E-1974, Automatic Fire Detectors
3. Amendment No. 23 to Facility Operating License DPR-43, dated December 12, 1978 (Appendix A SER)