LAWRENCE LIVERMORE LABORATORY

Selected Operating Reactor Issues Program II

Reactor Coolant System Vents (NUREG-00737, Item II.B.1.)
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FINAL TECHNICAL EVALUATION REPORT FOR KEWAUNEE

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TECHNICAL EVALUATION REPORT ON REACTOR COOLANT SYSTEM VENTS FOR KEWAUNEE

INTRODUCTION

The requirements for reactor coolant system high point vents are stated in paragraph (c)(3)(iii) of 10 CFR 50.44, "Standards for Combustible Gas Control System in Light Water Cooled Power Reactors," and are further described in Standard Review Plan (SRP) Section 5.4.12, "Reactor Coolant System High Point Vents," and Item II.B.1 of NUREG-0737, "Clarification of TMI Action Plan Requirements." In response to these and previous requirements, the Wisconsin Public Service Corporation has submitted information in References 1 and 2 in support of the vent system at Kewaunee Nuclear Power Plant.

EVALUATION

The function of the high point vent system is to vent noncondensible gases from the high points of the reactor coolant system (RCS) to assure that core cooling during natural circulation will not be inhibited. The Kewaunee reactor coolant gas vent system (RCGVS) provides venting capability from the reactor vessel head and the pressurizer steam space. The noncondensible gases, steam, and/or liquids vented from the reactor vessel head and pressurizer steam space are piped and discharged either to the containment atmosphere (this is the preferred path for post-accident venting) or to the pressurizer relief tank (PRT). The RCGVS is designed to vent a volume in standard cubic feet equal to one half of the reactor coolant volume in one hour. Flow restriction orifices in the RCGVS paths, however, limit the flow from a pipe rupture or from inadvertent actuation of the RCGVS to less than the capability of the reactor coolant makeup system. Hence, the licensee's compliance with 10 CFR 50.46, "Acceptance Criteria for Emergency Core Cooling Systems for Light Water Nuclear Power Reactors," has not been affected by the addition of the RCGVS.

The vent path from the reactor vessel head and the vent path from the pressurizer each contain two independently powered Target Rock solenoid-operated valves in parallel and connect to a common header that discharges either to the containment atmosphere or to the PRT. The lines to the containment atmosphere and the PRT each contain an isolation valve powered from independent safeguard buses. Thus, redundancy has been provided by powering valves in parallel RCGVS paths from different safeguard buses to ensure that RCS venting capability from both the reactor vessel head and the pressurizer is maintained. Valve control switches and positive indications of valve position are provided in the main control room. RCGVS valve seat leakage can be detected by pressure instrumentation located in the common header, with associated alarms in the main control room.

The portion of each RCGVS path up to and including the second normally closed valve farms a part of the reactor coolant pressure boundary and thus must meet reactor coolant pressure boundary requirements. The licensee has stated that this portion of the RCGVS is designated Safety Class 2 (Safety Class 1 upstream of the flow restriction orifices) and Seismic Category 1 in compliance with 10 CFR 50.55a and Regulatory Guides 1.26 and 1.29. The RCGVS is designed for pressures and temperatures corresponding to the RCS design pressure and temperature. In addition, the vent system materials are Type 304 and Type 316 austenitic stainless steel and are compatible with the reactor coolant chemistry and were fobricated, installed, and tested in accordance with the licensee's Operational Quality Assurance Program. The RCGVS is also acceptably separated and protected from missiles and the dynamic effects of postulated piping ruptures. We therefore conclude that the design of the portions of the RCGVS up to and including the second normally closed valve conforms to all reactor coolant pressure boundary requirements, including 10 CFR 50.55a and the applicable portions of General Design Criteria 1, 2, 4, 14, 30, and 31. The licensee has further ascertained that the essential operation of safety-related systems will not be impaired by postulated failures of RCGVS components.

We have reviewed the licensee's RCGVS design to assure an acceptably low probability exists for inadvertent or irreversible actuation of the vent system. Each vent path has two solenoid-operated valves in series, and each valve control switch is normally sealed in the closed position. Parallel valves are powered by independent safeguard buses and fail to the closed position in the event of loss of power. Positive indication of valve position and an annunciator indicating opening of the RVHVS are also provided in the

main control room. Furthermore, the licensee has stated that the controls and indicators added to the main control room for the vent system were designed using good engineering practice and are consistent with the design of other system controls in the main control room. However, the licensee has failed to verify that the vent system displays and controls have been acceptably analyzed from a human factors viewpoint, with due consideration to their design, location, prioritization, and integration into emergency procedures and operator training, and this is an open item. In addition, the Kewaunee RCGVS design includes Target Rock solenoid-operated valves which may be susceptible to common mode failure because operation of one valve may cause other valves in the system to open temporarily (see Reference 3). The licensee will be required to evaluate this problem and present their conclusions including any design changes necessary to minimize the probability of inadvertent vent system actuation. Therefore, with the exception of the open item concerning the verification that a human factors analysis has been or will be conducted that considers displays and controls added to the main control room for the RCGVS, we find that no single active component failure or human error should result in inadvertent opening or irreversible operation (i.e., failure to close after intentional opening) of the RCGVS, contingent on a satisfactory resolution of the problem with Target Rock solenoid-operated valves.

We have also examined the location where the RCGVS discharges directly to the containment atmosphere. Based on a description provided by the licensee, this location is in an area that will provide good mixing with the containment atmosphere to prevent the accumulation or pocketing of high concentrations of hydrogen in compliance with 10 CFR 50.44, "Standards for Combustible Gas Control System in Light Water Cooled Power Reactors." Additionally, this location is such that the operation of safety-related systems would not be adversely affected by the discharge of the anticipated mixtures of steam, liquids, and noncondensible gases.

The RCGVS is designed for operability testing in accordance with Subsection IWV of Section XI of the ASME Code for Category B valves. The licensee has stated that the solenoid operated valves are included in the valve timing ISI procedure performed during refueling mode.

CONCLUSION

We conclude that the Kewaunee RCGVS design is sufficient to effectively vent noncondensible gases from the reactor coolant system without leading to an unacceptable increase in the probability of a LOCA or a challenge to containment integrity, meets the design requirements of NUREG-0737 Item II.B.1, and conforms to the requirements of paragraph (c)(3)(iii) of 10 CFR 50.44, with one exception. This exception concerns the verification that an acceptable human factors analysis has been or will be performed to demonstrate that the potential for operator error has not been increased by the addition of RCGVS displays and controls in the main control room. We therefore recommend following resolution of this open item that the Kewaunee RCGVS design be found acceptable with the following confirmatory item. The Target Rock solenoid-operated valve problem noted above must be satisfactorily resolved. In addition, it should be noted that the following items were excluded from the scope of our review: seismic and environmental qualification of the RCGVS, RCGVS operating guidelines and procedures, and required modifications to the plant technical specifications and in-service inspection program for the RCGVS.

REFERENCES

1. Letter, E.R. Mathews (Wisconsin Public Service Corporation) to D.G. Eisenhut (NRC), "Docket 50-305, Operating License DPR-43, Kewaunee Nuclear Power Plant, TMI Action Plan Requirements: NUREG 0737," dated July 1, 1981.

2. Letter, E.R. Mathews (Wisconsin Public Service Corporation) to S.A. Varga (NRC), "Kewaunee Nuclear Power Plant, Operating License DPR-43, Docket 50-305, Reactor Coolant Gas Vent System (RCGVS), NUREG 0737 Item II.B.1," dated May 21, 1982.

3. NRC Memorandum, T.P. Speis (Division of Systems Integration) to T.M. Novak (Division of Licensing), "Unintentional Lifting of Solenoid Operated Pilot Valves in RCS Vent System," dated March 9, 1982.