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 ST. LUCIE 1

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TECHNICAL EVALUATION REPORT
ON REACTOR COOLANT SYSTEM VENTS
FOR ST. LUCIE 1

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 Florida Power & Light Company has submitted information in References 1 and 2 in support of the vent system at St. Lucie Unti 1.

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 St. Lucie 1 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 to either the containment atmosphere or the pressurizer quench tank. The RCGVS is designed to vent one half of the RCS volume of hydrogen in standard cubic feet in one hour. Flow restriction orifices in the RCGVS paths, however, limit mass loss from a vent pipe break or inadvertent actuation of the RCGVS to less than the makeup capacity of a single charging pump. 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 paths from the reactor vessel head and the pressurizer each contain two independently powered solenoid-operated valves in parallel and connect to a common header that discharges either to the containment atmosphere or to the quench tank through one of two isolation valves in parallel that are also powered from diverse power sources. Thus, a degree of redundancy has been provided by powering RCGVS valves from different emergency power supplies, to ensure that RCS venting capability from both the reactor vessel head and the pressurizer is maintained. Valve control switches and valve position indication, activated by reed switch assemblies on the solenoids, are provided in the main control room. RCGVS valve seat leakage is detected by pressure instrumentation with associated alarms in the main control room indicating a leak through one of the primary RCGVS valves. A solenoid valve can then be opened and the leakage discharged to an accumulator and eventually drained to the graduated containment sump to be measured.

The portion of each RCGVS path up to and including the second normally closed valve forms 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 I 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 austenitic stainless steel, are compatible with the reactor coolant chemistry, and were fabricated and tested in accordance with the requirements of Section III of the ASME Boiler and Pressure Vessel Code. 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 other 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 pilot valves in series, and each valve has a separate key locked control switch. Power is removed from the valves during normal reactor operation, with administrative controls for reconnection when venting is required. The valves are powered by emergency power supplies and fail to the closed position in the event of loss of power. The licensee has stated that the controls and displays added to the main control room for the vent system are being considered in a human factors analysis conducted in accordance with NUREG-0737 in order to reduce the potential for operator error. However, recent tests of the RCGVS at St. Lucie 1 have shown that operation of one solenoid-operated valve may cause other solenoid-operated valves in the system to open temporarily. It was recommended in Reference 3 that plants with these solenoid-operated valves evaluate their vent systems and present their conclusions including any design changes necessary to minimize the probability of an inadvertent vent system actuation. We therefore 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 evaluation per Reference 3. However, from the design information submitted by the licensee it is not clear whether RCGVS valve position indication is dependent on control power. Depending on the configuration of valve control and position indication power, removing power from the valves as described above may result in loss of positive valve position indication during normal reactor operation. Until it is ensured that direct position indication is continuously provided, this is a confirmatory item.

We have also examined the locations where the RCGVS discharges to the containment atmosphere directly or through the rupture disk on the pressurizer quench tank. Based on a description provided by the licensee (Reference 2), these locations are in areas 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, these locations are 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 licensee has stated that the potential discharge paths through the leakage detection accumulator to the containment purge ducting and the drains to the reactor cavity sump are intended to be used only during normal plant startup and shutdown, or for periodic drainage.

The licensee has stated that the solenoid-operated valves will be tested for operability during cold shutdown in accordance with subsection IWV of Section XI of the ASME Code.

CONCLUSION

We conclude that the St. Lucie 1 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. We therefore recommend that the St. Lucie 1 RCGVS design be found acceptable with the following two confirmatory items. The solenoid-operated valves in the RCGVS must be evaluated per Reference 3, and the potential problem concerning removal of valve control power and positive position indication must be satisfactorily resolved. It should also 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, R.E. Uhrig (Florida Power & Light Company) to D.G. Eisenhut (NRC), "St. Lucie Unit 1, Docket No. 50-335, Post-TMI Requirements, Reactor Coolant System Vents," dated August 10, 1981.

2. Letter, R.E. Uhrig (Florida Power & Light Company) to R.A. Clark (NRC), "St. Lucie Unit 1, Docket No. 50-335, Post-TMI Requirements, Reactor Coolant Gas Vent System," dated May 7, 1982.