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U.S. NUCLEAR REGULATORY COMMISSION

June 29, 1981

Docket No. 50-336
A01379

Mr. Darrell G. Eisenhut, Director
Division of Licensing
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

References: (1) D. G. Eisenhut letter to All Operating Plants and Applicants for an Operating License and Holders of Construction Permits, dated October 31, 1980, forwarding NUREG-0737.
(2) W. G. Counsil letter to H. R. Denton, dated December 15, 1979.
(3) W. G. Counsil letter to H. R. Denton, dated December 31, 1979.

Gentlemen:

Millstone Nuclear Power Station, Unit No. 2
Reactor Coolant System Vents

By Reference (1), the NRC Staff forwarded NUREG-0737 which delineated all of the items in the TMI Action Plan, NUREG-0660, which the Commission had approved for implementation at that time. As noted in Item II.B.1 of Reference (1), the Staff requested that Northeast Nuclear Energy Company (NNECO) submit certain information concerning the design and operation of the high point vent system by July 1, 1981. Accordingly, NNECO hereby provides the following information on behalf of Millstone Unit No. 2.

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A description of the design, location, size, and power supply for the high point vent system at Millstone Unit No. 2 is provided in Attachment 1. The high point vents are comprised of one inch (1") piping and valves originating at existing penetrations into the reactor vessel head and pressurizer. Loss-of-coolant accidents initiated by a break in the vent system have been evaluated as discussed in Attachment 1. NNECO has determined that a rupture in either the reactor vessel or pressurizer vent piping would be less limiting than failures of other piping systems previously analyzed. As potential breaks within the reactor coolant system (RCS) vents are bounded by current analyses, no additional analyses are required to demonstrate compliance with 10CFR50.46.

In Reference (2), NNECO documented its intention to submit procedures for operator use of the RCS vent system by July 1, 1981. Procedures are currently being developed in conjunction with the Combustion Engineering Owners Group and will be submitted when they become available. In the absence of any feedback from the Staff regarding the information submitted in Reference (3) and since implementation is not required until July 1, 1982, NNECO concludes that this approach is acceptable.

A discussion of the Millstone Unit No. 2 RCS vent system design with respect to conformance to the design criteria discussed in Reference (1) is provided below.

The reactor vessel and pressurizer vents were designed to utilize existing penetrations within each vessel. The system can pass in excess of the gas volume equivalent to one-half the reactor coolant system volume in one (1) hour. Although the RCS vents are larger than the size corresponding to the definition of LOCA (10CFR50, Appendix A), consequences of ruptures of the vents are bounded by the results of current small break LOCA analyses.

Since the vent lines are sized larger than the size corresponding to the definition of LOCA, the system is equipped with two (2) solenoid operated globe valves in series in each piping train. Each valve has remote-manual control capability from the control room with open and closed position indication. This is discussed further in Attachment 1.

The criteria by which the Millstone Unit No. 2 RCS vent system is designed is discussed in Section 3.0 of Attachment 1. The system is designed in accordance with the criterion described in Reference (1). The design of the venting system minimizes the probability of a vent path failing to close, once opened. This has been accomplished by providing two (2) solenoid operated globe valves in series for each vent train. The power source for each valve train is an independant redundant D.C. emergency bus, energized from separate redundant battery systems. In addition, the valves also receive power from redundant independent A.C. emergency buses. All valves fail closed upon loss of power supply to the actuator.

The discharge sparger for the RCS vent system is located in the vicinity of the containment air coolers where the vented gases will be cooled, mixed with additional containment air, and discharged into the lower elevation of the containment. Uniform mixing of the containment post incident atmosphere is provided by the post incident recirculation (PIR) system. Additional information concerning mixing and cooling of vented gases is provided in Section 2.2 and 3.6 of Attachment 1.

The RCS vent system piping has been analyzed in accordance with ASME, Section III, of the Boiler and Pressure Vessel Code, for the Class 1 portion of the system. The balance of the system has been analyzed pursuant to ANSI B31.1 Power Piping Code. The solenoid vent valves are qualified to IEEE-344-1975. Additional information is provided in Section 3 of Attachment 1.

Provisions for testing of the RCS vent system have been incorporated into the system design. Valve testing and frequency will be conducted consistent with the applicable requirements of ASME, Section XI, Subsection IWV-3420. Channel functional testing of the associated instrumentation and control circuitry will be performed during each refueling outage to confirm that an impact signal to the valve operator initiates valve opening.

As was discussed earlier, the procedures for operator use of the RCS vent system are currently under development. Until such time as these procedures are available, it would be inappropriate to expend significant efforts in the area of human-factors engineering. These considerations will be evaluated upon the availability of the procedures for operator use of the RCS vent system.

The RCS high point vent system described herein is currently under internal review by NNECO. Implementation of the system described herein as well as potential modifications to the existing design is contingent upon the outcome of this review.

Based upon telephone discussions with the Staff, it is our current understanding that the NRC is preparing model Technical Specifications for this system. NNECO intends to propose Technical Specifications for this system subsequent to receipt of the model Technical Specifications.

This information supersedes that docketed by Reference (3).

We trust you find this information responsive to the Reference (1) requests.

Very truly yours,

NORTHEAST NUCLEAR ENERGY COMPANY

W. G. Counsil

W. G. Counsil
Senior Vice President

Docket No. 50-336

Attachment 1

Millstone Nuclear Power Station, Unit No. 2

Reactor Coolant System

High Point Vent

July, 1981

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MILLSTONE UNIT NO. 2
REACTOR COOLANT SYSTEM VENTING

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MILLSTONE UNIT NO. 2
REACTOR COOLANT SYSTEM VENTING

LIST OF ATTACHMENTS

A. Reactor Coolant System - Piping and Instrument Diagram (Drawing No. 25203-26014)

B. Diagrammatic Piping Plan - Reactor and Pressurizer Vent System (Drawing No. SK-JPD-79228)

C. One-Inch DC Solenoid Valve (Drawing No. 25203-29400)

D. Head Vent Solenoid Operated Valve (Drawing No. 25203-32007, Sheet 41) - Typical

E. Bechtel Electrical Separation Criteria (Drawing No. 25203-33001, Sheets 1-8)

F. Front View Panel Arrangement - CVCS and Reactor Coolant System (Drawing No. 25203-29097, Sheet 36)

G. Hanger Location Isometric for Remote Operated Reactor Vessel Head and Pressurizer Vent (Drawing No. 25203-22200, Sheets 60231, 60239, 60243, and 60250).

H. RCS Head Vent and Pressurizer Vent Temperatures - Loop Diagram (Drawing No. 25203-28500, Sheet 30()

MILLSTONE UNIT NO. 2
REACTOR COOLANT SYSTEM VENTING

1.0 INTRODUCTION

10 CFR Part 50.46 requires that after any calculated successful initial operation of the emergency core cooling system (ECCS), the calculated core temperature shall be maintained at an acceptably low value and decay heat shall be removed for the extended period of time required by the long-lived radioactivity remaining in the core. Additionally, Criterion 35 of 10 CFR 50, Appendix A, requires that a system to provide abundant emergency core cooling shall be provided. The system safety function shall be to transfer heat from the reactor core following any loss of reactor coolant at a rate such that: (1) fuel and clad damage that could interfere with continued effective core cooling is prevented; and (2) metal-water reaction is limited to negligible amounts.

During the Three Mile Island #1 accident, a condition of low water level in the reactor vessel and inadequate core cooling existed and was not rectified for a long period of time. The resultant high core temperatures produced a metal-water reaction with the subsequent production of significant amounts of hydrogen. The collection of noncondensible gases impaired natural circulation cooling capability. Additionally, the collection of noncondensible gases limited reactor coolant pump operational capability because of voids in the coolant system caused by the gases. Even when reactor coolant pump operation was possible, the installed plant venting system was capable of removing the noncondensible gases only through an extremely slow process.

The reactor coolant system (RCS) venting system described herein provides the capability for removing noncondensible gases collected in the system in order to allow for satisfactory long-term core cooling.

The two important safety functions enhanced by this venting capability are core cooling and containment integrity. For events within the present design basis for nuclear power plants, the capability to vent noncondensible gases will provide additional assurance that the requirements of 10 CFR 50.44 will be met. For events beyond the design basis, this venting capability will substantially increase the ability to deal with large quantities of noncondensible gas.

The reactor coolant system venting system installed at Millstone Unit No. 2 will meet the NRC position and PWR vent design considerations addressed in References 1 through 3, as specified herein. The vent system utilizes two (2) separate vent manifolds, one located on the reactor vessel head and one located on the top of the pressurizer. Each of these manifolds consists of separate/redundant safety grade, seismically qualified piping trains with vent and block valves as illustrated in Attachment A, "Reactor Coolant System Piping and Instrumentation Diagram".

2.0 LONG TERM SOLUTIONS FOR RCS VENTING

The long term means of assuring adequate natural circulation in the reactor vessel consists of a combination of hardware and procedural modifications which provide for reactor coolant system venting capability. Modifications include the installation of two (2) vent manifolds, located on the reactor vessel head and the top of the pressurizer which discharge to a common sparger in the containment in the vicinity of the A and B containment air recirculation units (see Attachment B). Each manifold arrangement consists of redundant piping trains comprised of two (2) solenoid operated globe valves (Attachment C) in series which provide reactor coolant system pressure boundary integrity. The first valve provides the block valve function, while the second valve functions as the vent valve. Each valve has remote-manual control capability from the control room with open and closed position indication (Attachment D). Power is removed from the valves during normal plant operation to preclude inadvertent operation of these valves. Procedural and administrative controls for operation of this system will be submitted when they become available as discussed in the forwarding letter.

The reactor vessel head vent is capable of venting noncondensible gas from the reactor vessel hot legs (to the elevation of the top of the outlet nozzle) and cold legs based on original design considerations. Specifically, the relative elevations of piping to components is such that all portions of each hot leg can be vented through the reactor vessel head. Specifically, there is capability for flow from the inlet plenum through the alignment keyways to the vessel head region (Subsection 3.5.2.3.1 of Amendment 14 of Reference 4). Consequently, no additional venting capability is required for hot or cold leg piping.

2.1 Loss of Coolant Accident Analyses

The Millstone Unit No. 2 reactor coolant system venting system consists of a 0.612" ID (.002 ft^2) pressurizer vent and a 0.612" ID (.002 ft^2) reactor vessel head vent. NNECO has determined that a rupture of either of these two reactor coolant system penetrations would not constitute a more limiting loss of coolant accident (LOCA) than currently analyzed. The justification is provided by the docketed Cycle 3 small break LOCA analysis (Reference 5) and the Combustion Engineering generic small break LOCA report (Reference 6), and License Amendment 6, dated October 6, 1980.

2.1.1 Reactor Vessel Head Vent

In the case of the vessel head vent, a rupture at this location would cause a LOCA scenerio similar to that produced by a hot leg break. Typically, hot leg breaks produce peak clad temperature (PCT) transients less severe than that of equivalent sized cold leg breaks, provided that the reactor coolant pumps are tripped soon after the SIAS is generated. As stated in Reference 6, this concept is generally true even if the reactor coolant pumps are tripped up to several minutes after the initiation of the SIAS. Since the plant emergency procedures require an immediate reactor coolant pump trip after an SIAS, a 0.612" ID (.002 ft^2) hot leg break is judged to be less severe than a similar size cold leg break. For Millstone Unit No. 2, Cycle 3, the limiting cold leg break has been determined to be the 0.1 ft^2, resulting in a 1971^oF peak clad temperature. The smallest break analyzed (.02 ft^2) produced peak clad temperatures less than 600^oF, and no core uncovery. A very small break, 0.30" ID (.0005 ft^2) was analyzed in Section 3.8 of Reference 6, again yielding no core uncovery. Thus, since cold leg breaks larger and smaller than the 0.612" ID (.002 ft^2) size under consideration do not uncover the core, and since hot leg breaks would be less limiting than cold leg breaks (considering the present reactor coolant pump criteria), the proposed head vent penetration would not cause a loss of coolant accident more severe than that presently analyzed and approved.

2.1.2 Pressurizer Vent

With regard to the proposed .612" ID (.002 ft^2) pressurizer vent, a rupture at this location would cause an accident similar to, but less severe in terms of time to core uncovery, than the opening of a PORV (.0075 ft^2). The inadvertent opening of a PORV incident is analyzed in Sections 3.8.3.4 and 3.11.3.4 of Reference 6. Since a vent rupture would cause a smaller mass flow out the break than the analyzed case, time to core uncovery would be substantially greater than the 4,000 second (1.1 hours) quoted in Reference 6. Within this time interval the operator is expected to initiate feedwater to the steam generators and commence a plant cooldown and depressurization. The Millstone Unit No. 2 emergency core cooling system flow rate, however, would be greater than that assumed in Reference 6 since at least one positive displacement charging pump would be operating.

2.2 Combustible Gas Concentrations in Containment

The post-incident hydrogen control system (Section 6.6 of Reference 4) includes independent, fully redundant, subsystems to mix, monitor, and reduce the hydrogen concentration in the containment. The post-incident hydrogen generation analysis is described in Section 14.8 of Reference 4.

The uniform mixing of the containment post-incident atmosphere is provided by the post-incident recirculation (PIR) system. This post-incident recirculation system is provided inside the containment to mix any hydrogen accumulated in the upper portion of the containment with the rest of the containment atmosphere.

Two full capacity, completely redundant, hydrogen concentration monitoring systems are provided outside the containment for periodic or continuous analysis of hydrogen concentration in the containment atmosphere. Each hydrogen monitoring system draws containment gases through a small diameter sample line which limits the flow rate and reduces sample transient time. The sample is conditioned by heating or cooling for optimum response and admitted to the analyzer. From the analyzer the sample is returned to the system from which it was drawn. High containment hydrogen concentration is alarmed in the control room.

The active means for reducing the hydrogen concentration in the containment following a postulated incident are provided by hydrogen recombination subsystems and hydrogen purge subsystems. The hydrogen recombiners are located within the containment and consist of two completely independent, full capacity thermal-type recombiner units. The recombiner unit reduces the concentration of hydrogen in containment following a postulated incident by recombination of hydrogen and oxygen.

The alternate method for hydrogen reduction in the containment following an incident is through the hydrogen purge subsystem. This subsystem consists of pipe headers with inlets in the highest portion of the containment which pass through two separate containment penetrations to connections in the enclosure building filtration system (EBFS). The hydrogen purge operation is provided as backup to the hydrogen recombiners.

Additional discussions relating to the operating modes and procedures necessary to deal with significant amounts of hydrogen gas that may be generated during an incident is discussed in Reference 7.

3.0 DESIGN CRITERIA

The proposed reactor coolant system venting system is in accordance with the design criteria stated in References 2 and 3. The applicability of the design criteria to the venting system for Millstone Unit No. 2 is discussed in detail below.

3.1 Operator Action

The reactor coolant system venting system has been designed as a remote manual system requiring two actions by the control room operator to initiate the system: (1) closing of breakers to supply power to the valves; and (2) control of the switches to open and close the block and vent valves, as necessary.

3.2 Single Failure

Consistent with the requirements of References 2 and 3, the system is safety grade and, as a minimum, has the same qualifications as the reactor protection system. Where feasibile, later criteria and qualifications have been applied. In particular, the solenoid vent and block valves are designed to ASME, Section III, Class 1, requirements and qualified to IEEE 323-1974 (References 8 and 9). The design basis for the reactor coolant system venting system is such that single failures are considered in addition to the event that results in the need to vent. The additional single failures that have been assumed for the system applies to the actuating mechanisms for the solenoid vent valves.

A loss of venting capability is minimized by providing two (2) full capacity vent trains for each vessel (i.e., reactor and pressurizer) and by providing independent power supplies to each of the vent trains. Failure to terminate the venting operation, once initiated, has been reduced to the greatest extent possible by including two (2) series isolation valves for each venting train and by requiring all solenoid valves to fail close upon the loss of the power supply to the actuator.

3.3 Capacity/Sizing

The venting system has been sized to assure adequate discharge capacity as defined in References 2 and 3. The system is comprised of one inch (1") piping and valves originating at existing vessel penetrations and piping of three-quarter inch (3/4") size. The block and vent valves each have a minimum C_v of two (Attachment C). A conservative bounding calculation verifies that the system can pass in excess of the gas volume of one-half the reactor coolant system (approximately 5,400 ft^3/90 scfm) in one (1) hour.

3.4 Seismic Design and IEEE-279 Criteria

The design criteria for the piping, solenoid valves, and the associated control hardware is based on the existing applicable plant criteria and the following considerations.

3.4.1 Single Failure Criterion

The single failure criterion has been met as discussed in Section 3.2.

3.4.2 IEEE-279 Criteria

This criterion has been implemented within the limitations of the original plant design and construction philosophy. The control and indication circuits for each valve train are independent of each other as required by this criterion and Bechtel electrical separation criteria (Attachment E). Control of each valve for each valve train is of a remote manual nature from the main control board. Open and closed position indications are provided for each valve on the main control board (Attachment F). The power source for each valve train will be an independent redundant 125 volt DC emergency bus. These buses are energized from separate redundant battery systems and also receive power from redundant independent 480 volt AC emergency buses.

3.4.3 Seismic Criteria

The piping for the reactor coolant system venting system has been analyzed for hydrotest, deadweight, thermal, and seismic, loads (Attachment G). The criteria used for the piping analysis was ASME, Section III, of the Boiler and Pressure Vessel Code, for the Class 1 portion of the system; and ANSI B31.1 Power Piping Code for the balance of the piping as shown in Attachment A. The solenoid valves are qualified to IEEE-344-1975 (Reference 10). The electrical and control circuitry installation for the solenoid valves is consistent with the requirements of References 2 and 3, and the original plant design philosophy.

3.5 Common Mode Failures

Common mode failures such as loss of power, and seismic events, have been considered in the design of the reactor coolant system venting system. Specifically, these common mode failures have been considered to the extent that the single failure or failures initiating the event which results in the need to vent the system will not disable the effectiveness and operability of the reactor coolant system venting system.

The hardware modifications described herein meet the intent of the design criteria, and in no way is the existing plant design degraded. As previously noted, the system is redundant in design at the reactor vessel head and at the pressurizer. Consequently, the system exceeds the PWR vent design considerations of References 2 and 3 with respect to redundancy. Additionally, power is supplied by two separate 125 volt DC buses which assume a high degree of reliability in the unlikely event a DC bus is lost.

3.6 Mixing and Cooling of Vented Gases

Uniform mixing of the containment post incident atmosphere is provided by the post incident recirculation system. This system takes suction from the highest points in the containment and discharges at an elevation between the inlets to containment air recirculation and cooling units which dilute this mixture with additional containment air and discharges it into the lower elevation of containment. Since the discharge sparger of the reactor coolant system venting system will be located in the vicinity of the "A" and "B" containment air coolers (Attachment E), the vent gases will be adequately cooled and mixed via the post incident recirculation system.

A detailed description of this system is provided in Section 6.6 of Reference 4.

3.7 Leakage Detection

Thermocouples installed on the downstream side of each solenoid valve train (see Attachment A) are utilized to monitor leakage past the system solenoid valves. Under normal operating conditions, the thermocouples will measure the ambient temperature in the piping downstream of each solenoid valve train. The output of each thermocouple is continuously recorded by the plant computer (Attachment H).

Any leakage through the system valves will cause an increased temperature in the downstream piping which will be detected by the thermocouple. At a predetermined setpoint the alarm typewriter will be actuated, identifying a high temperature reading on the appropriate thermocouple. Once a high temperature alarm is received, further actions will be governed by the Technical Specifications for reactor coolant system leakage.

3.8 Testability

Adequate testing of system operability is considered to be the confirmation that an input signal to the solenoid operator initiates valve opening. In conjunction with this, a channel functional test of the associated instrumentation and control hardware will be conducted during each refueling outage to confirm operability.

Valve testing and frequency will be conducted consistent with the applicable requirements of ASME, Section XI, Subsection IWV-3420. In this regard, test connections for the required tests have been included in the system design.

The design basis for the system includes provisions for electrical functionality tests and pressure boundary verification as required by the appropriate codes and standards. These are considered to be the extent of testing required. No consideration was given to system operability tests at power in the design basis.

JPDonohue/caw
April 28, 1981 /June 26, 1981
Attachments/References

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THE CONNECTICUT LIGHT AND POWER COMPANY
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MILLSTONE UNIT NO. 2
REACTOR COOLANT SYSTEM VENTING

REFERENCES

1. NRC Letter to All Operating Nuclear Power Plants from Harold R. Denton, dated October 30, 1979; subject: Discussion of Lessons Learned Short Term Requirements.

2. TMI-2 Lessons Learned Task Force Status Report and Short Term Recommendations, NUREG 0578, July 1979.

3. Clarification of TMI Action Plan Requirements, NUREG 0737, October 1980.

4. Final Safety Analysis Report (FSAR), Millstone Nuclear Power Station, Unit No. 2.

5. Millstone Unit No. 2 Cycle 3 LOCA Analysis, dated March 22, 1979.

6. CEN 114-P, "Review of Small Break Transients in CE NSSS's", dated July 1979.

7. NNECO Reponse to NRC I&E Bulletin 79-06B to Mr. Boyce Grier of the Office of Inspection and Enforcement, King of Prussia, Pennsylvania, dated April 24, 1979.

8. QR 52600-5940-2, Valcor Engineering Test Report, "Qualification Test Report on SNUPPS Solenoid Valves".

9. QR 5402-1, Valcor Engineering Test Report, "Qualification Test Report for Litton Connector and Assembly".

10. MR 526-6402-3A-1, Valcor Engineering Analysis, "Stress Analysis Report on Valve Solenoid One Inch DC Position Indication", Nuclear Service, N.C.