TOLEDO EDISON

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Docket No. 50-346
License No. NPF-3
Serial No. 804
April 13, 1982

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Director of Nuclear Reactor Regulation
Attention: Mr. John F. Stolz
Operating Reactors Branch No. 4
Division of Licensing
United States Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Stolz:

This is in reference to your letter dated February 10, 1982 (Log No. 905) relating to the request for additional information on reactor coolant system high point vents (Item II.B.1 NUREG-0737). Attached is the Toledo Edison response to the NRC request as applicable to the Davis-Besse Nuclear Power Station Unit 1.

Toledo Edison had planned to install the high point hot leg and pressurizer vents during the current refueling outage. On March 23, 1982 (Serial No. 795), we identified that installation of the pressurizer vent line would be delayed until the 1983 refueling outage. Excessive outage demands related to other post-TMI modifications have delayed completion of both the hot leg and the pressurizer vent activities until the next scheduled (Refueling III-fall 1983) outage after the current refueling. This is consistent with the recent revision to Title 10 of the code of Federal Regulations, Section 50.44(c)(3)iii which modified the required implementation date to the first scheduled outage beginning after July 1, 1982.

Very truly yours,

R P Crouse /

RPC:SCJ

Attachments

cc: DB-1 NRC Resident Inspector

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ATTACHMENT 1 TO TOLEDO EDISON RESPONSE
TO NRC REQUEST FOR ADDITIONAL INFORMATION
ON REACTOR COOLANT SYSTEM HIGH POINT VENTS

1. Submit operating guidelines for reactor operator use of the reactor coolant system (RCS) high point vent system. Also provide a copy of "Small Break Operating Guidelines for Davis-Besse 1," 69-1106003-01 (or latest revision), Babcock and Wilcox. The operating guidelines should include:

   a. Guidelines to determine when the operator should and should not manually initiate venting, and information and instrumentation required for this determination (reference NUREG-0737, Item II.B.I, Clarification A.(2)). The guidelines to determine whether or not to vent should cover a variety of reactor coolant system conditions (e.g., pressures and temperatures). The effect of the containment hydrogen concentration on the decision to vent or to continue venting should also be addressed considering the balance between the need for increased core cooling and decreased containment integrity due to elevated hydrogen levels.

   b. Methods for determining the size and location of a noncondensible gas bubble (reference Position (2) and Clarification A.(2)).

   c. Guidelines for operator use of the vents, including information and instrumentation available to the operator for initiating or terminating vent usage (reference Position (2)).

   d. Required operator actions in the event of inadvertent opening, or failure to close after opening, of the vents including a description of the provisions and instrumentation necessary to detect and correct fault conditions (reference Position (2) and Clarification A.(2)).

Response

The operating guidelines for the use of reactor coolant system high point vents are included in Attachment 2 - Supplement to Davis-Besse Unit 1 Small Break Operating Guidelines (Document No. 77-1130302-00 as revised by Toledo Edison, April 1982). Note that these guidelines refer to the use of the hot leg and the pressurizer vents. Following NRC approval of the attached guidelines and installation of the vents these guidelines will be incorporated into Davis-Besse operating/emergency procedures.

The Small Break Operating Guidelines for Davis-Besse 1 (Document No. 69-1106003-00) were submitted to the NRC through Serial No. 566 dated December 27, 1979, portions of which are now superseded. For your reference, Attachments 3 and 4 herewith include a copy of the latest revision of the Davis-Besse Emergency Procedure, EP1202.06 (Loss of Reactor Coolant and Reactor Coolant Pressure, Revision 19) and AB1203.06 (Inadequate Core Cooling Guidelines, Revision 4) respectively.

2. Demonstrate that the RCS high point vent system (including the pressurizer vent) flow restriction orifices are smaller than the size corresponding to the definition of a loss-of-coolant accident (10 CFR Part 50, Appendix A) by providing the pertinent design parameters of the reactor coolant makeup system and a calculation of the maximum rate of loss of reactor coolant through the RCS high point vent orifices. For those new portions of the RCS high point vent system that are within the LOCA definition (i.e., upstream of the flow restriction orifices), verify that previous analysis or a new analysis has been performed to demonstrate compliance with 10 CFR 50.46 (reference NUREG-0737, Item 11.B.1, Clarification A.(7)). Justify why the flow restriction orifices are not placed upstream of the RCS high point vent valves to limit the amount of new piping that is within the LOCA definition (reference Clarification A.(4)).

Response

A loss-of-coolant accident is defined as a hypothetical accident that would result from a loss of reactor coolant at a rate in excess of the capability of the reactor coolant makeup system, from breaks in pipes in the reactor coolant pressure boundary up to and including a break equivalent in size to a double ended rupture of the largest pipe in the reactor coolant system.

The excess capacity of the reactor coolant makeup system during normal operation is 45 gallons per minute (GPM) at 2500 psig and 200°F. The venting path of the RCS high point vents is through 1" pipe, 2 control valves and the flow restriction orifice.

For conservatism in the calculation of the maximum flow through the restriction orifices the pressure drop across the valves and piping was neglected. Also, the downstream pressure of the restriction orifices was taken to be absolute zero instead of containment atmosphere pressure. Credit is not taken for the fact that the volume of water provided by the makeup system expands once discharged into the RCS. Consequently, the flow restriction orifices are sized for a flow rate of 45 GPM at 2500 psig and 670°F (3.5 lb./sec.). The makeup water is supplied at a minimum of 45 GPM at 2500 psig and 200° (6.03 lb./sec.).

The design parameters used in this analysis for the hot leg vents and the results are as follows:

Upstream pressure of restriction orifice

lbs/in^2	=	2,500
lbs/ft^2	=	360,000

Downstream pressure of restriction orifice

lbs/in^2	=	0
lbs/ft^2	=	0

Maximum temperature, °F	=	670

Makeup flow, normal

Gallons per minute	=	45
lbs/sec	=	6.03

Formulas used

$$W_1 = CYA_2 \left[\frac{2g_c \quad (P_1 - P_2) \quad p_1}{1 - B^4} \right]^{\frac{1}{2}}$$

W_1 = flow rate through restriction orifice, lbs/sec

C = coefficient of discharge of restriction orifice, dimensionless

A_2 = cross sectional area of restriction orifice bore, ft^2

g_c = dimensional constant, $\frac{lb_m \cdot ft}{lb_f \cdot sec^2}$

P_1 = pressure upstream of restriction orifice, lb_f/ft^2

P_2 = pressure downstream of restriction orifice, lb_f/ft^2

p_1 = density of fluid upstream of restriction orifice, lb/ft^3

Y = expansion factor of steam, dimensionless

B = beta ratio, ratio of restriction orifice bore to internal pipe diameter, dimensionless

$W_2 = V_s A p_2$

W_2 = flow rate of hydrogen, ft^3/sec

V_s = maximum velocity, ft/sec

A = orifice area, ft^2

p_2 = density of hydrogen, lb/ft^3

$R_e = \left[\frac{D \ V \ p_1}{\mu}\right]$ orifice

R_e = Reynolds number, dimensionless (needed for calculating C)

D = diameter of restriction orifice bore, ft

v = velocity of fluid upstream of restriction orifice

μ = absolute dynamic viscosity, centipoise

RESULTS

Beta ratio required, B = 0.2364
In 1 inch schedule 160 pipe, the required flow restriction orifice bore is 0.1927 inches.

The pressurizer vent is sized so as to relieve 3.3 lb./sec. of steam as outlined in response to item 9 below. This is within the capability of one make up pump and therefore inadvertent opening of this vent path during normal operation will not result in a LOCA.

REFERENCES

1. 'Fundamentals of Classical Thermodynamics' 2nd Ed., by Gordon J. Van Wyler and Richard E. Sonntag; John Wiley and Sons.

2. 'Chemical Engineers Handbook' 5th Ed., by Robert H. Perry and Cecil H. Chilton; McGraw-Hill.

The flow restriction orifices are placed so that maximum protection from flashing and cavitation is afforded to the RCS high point vent valves.

Also, Clarification A.(4) requires double valve isolation for new or existing vent lines whose smallest orifice size is larger than the LOCA definition. The flow restriction orifices are sized smaller than the LOCA definition. In addition, the vent on the pressurizer is designed such that the inadvertent opening of both valves could not cause the RCS to depressurize when all pressurizer heaters are energized. This along with double valve isolation for each vent is above and beyond the requirements of NUREG 0737, Item II.B.1, Clarification A.(4). The new piping for the RCS high point vents is the minimal amount required to have the hot leg vents exhaust to the containment atmosphere and the pressurizer vent exhaust to the pressurizer quench tank (see Toledo Edison letter, Serial No. 795 dated March 22, 1982 for details of the pressurizer vent routing). Since the design of the RCS high point vent system allows for adequate protection provided by the isolation valves and the routings of the vent system are short, placing the restriction orifices upstream of the isolation valves would not have limited the amount of new pipe within the LOCA definition substantially.

3. The following items apply to the portions of the RCS high point vent system that form a part of the reactor coolant pressure boundary, up to and including the second normally closed valve (reference NUREG-0737, Item II.B.1, Clarification A.(7)):

   a. Verify that the piping, valves, components, and supports are classified Seismic Category I and Safety Class I.

   b. Provide the design temperature and pressure of the piping, valves, and components.

   c. Describe the instrumentation that has been provided to detect and measure RCS high point vent system isolation valve seat leakage (reference Appendix A to 10 CFR Part 50, General Design Criterion 30).

   d. Describe the materials of construction, and verify that they are compatible with the reactor coolant chemistry and will be fabricated and tested in accordance with SRP Section 5.2.3, "Reactor Coolant Pressure Boundary Materials."

   e. Although you have stated that the vent system valves are protected against damage from missiles, demonstrate that internal missiles and the dynamic effects associated with the postulated rupture of piping will not prevent the essential operation of the RCS high point vent system (i.e., at least one vent path remains functional) (reference Appendix A to 10 CFR Part 50, General Design Criterion 4).

Response

a. All piping, valves, components and supports of the RCS high point vent system up to and including the second normally closed valve are classified as ASME Section III, Nuclear Class I and are Seismic Category I.

b. The design pressure and temperature of the piping, valves and components for the RCS high point vent system are as follows:

pressurizer vent	2500 psig at 670°F
hot leg vents	2500 psig at 650°F

c. Instrumentation is not provided in the design of the RCS high point vents because of the low seat leakage attained by the isolation valve design. Double isolation further precludes the leakage of the RCS high point vents to such an infinitesimal amount far below the flow monitoring capabilities of existing flow detection technology. Additionally, the isolation valves have positive open/close indication in the control room, and RCS pressure, pressurizer level and pressure indications to show RCS status while venting.

d. The materials of construction for the piping and components are as follows:

pipe, ASME SA-376 Type 316 stainless steel

fittings, ASME SA-182 F316 stainless steel

valves, ASME SA-182 F316, SA-240 type 316, SA-479 type 316 stainless steel

restriction orifice, ASME SA-479 type 316 stainless steel.

All these materials are compatible with the reactor coolant chemistry. The fabrication and installation specifications meet the requirements of SRP Section 5.2.3 and NRC Regulatory Guide 1.44.

e. The routing of the vent system precludes any damage to it from missiles and postulated pipe breaks as discussed in Davis-Besse Unit #1, FSAR Volume 2, Sections 3.5 and 3.6.

4. Verify that the following RCS high point system failures have been analyzed and found not to prevent the essential operation of safety-related systems required for safe shutdown or mitigation of the consequences of a design basis accident:

a. Seismic failure of RCS high point vent system components that are not designed to withstand the safe shutdown earthquake.

b. Postulated missiles generated by failure of RCS high point vent system components.

c. Fluid sprays from RCS high point vent system component failures. Sprays from normally unpressurized portions of the RCS high point vent system that are Seismic Category I and Safety Class 1, 2, or 3 and have instrumentation for detection of leakage from isolation valves need not be considered.

Response

a. The isolation valves, flow restriction orifices, pipes and supports in the RCS high point vent system are designed to withstand the safe shutdown earthquake (SSE); therefore, no analysis is required.

b. Postulated missiles of the RCS high point vent system consist of the valve stems of the isolation valves. The primary source of energy associated with the RCS high point vents is contained fluid energy. The generation mechanism associated with these potential missiles is postulated by assuming that the seal and fillet welds of the valve stem fails. A material flaw or some other defect may permit this failure to occur and in turn allow the transfer of contained fluid energy into the kinetic energy of the missile generated.

   Adequate overpressurization protection of the RCS is provided by the safety relief valves directly connected to the RCS pressure boundary. Additional margin against the generation of these potential missiles is provided by the standards established by the ASME to which these components must adhere and the various tests and periodic in-service inspections the components are subject to. Therefore, it is highly unlikely that missiles would be generated preventing the essential operation of safety related systems required for safe shutdown or mitigation of the consequences of a design basis accident.

c. The pipe routing for the RCS high point vents was chosen to minimize the unlikely event of fluid spray damage to essential safety-related systems required for safe shutdown or mitigation of the consequences of a design basis accident. The pressurizer vent exhausts to the pressurizer quench tank and the hot leg vents are directed towards the steam generator shield walls. For fluid sprays from pipe rupture up to the first isolation valve, the analysis revealed no damage to essential safety-related systems.

5. Describe the design features or administrative procedures, such as key locked closed valves, alarms, or removal of power during operation, that will be employed to prevent inadvertent actuation of the RCS high point vents. Also, since the pressurizer high point vent valves are powered by the same power supply, verify that the vent valves fail closed on loss of power, or provide a reliability analysis consisting of a failure mode and effects analysis (FMEA) or equivalent qualitative analysis that shows that no single active component failure could result in failure to close after intentional opening of the pressurizer high point vent path (reference NUREG-0737, Item II.B.1, Clarifications A.(7) and (8)).

Response

Each hot leg vent valve circuit is designed as a fail close circuit. During normal plant operation the valves are de-energized with no power at the solenoid coil. Removal or loss of power during the operation of these valves will cause the valves to close. In addition, each of the two valves in series at each vent point are controlled by separate Class 1E power sources, with the cables for each circuit being routed separately. Any single failure in a circuit would not affect the other circuit.

The separation assures that a fire would not cause inadvertent opening of a vent path, or failure of a vent path if needed. The electrical design assures that a single failure, including interruption of a power supply or hot shorts, will neither prevent the ability to vent through at least one high point vent nor cause the inadvertent opening of any high point vent.

The pressurizer vent valves are powered from Class 1E, Channel 2 power supplies through completely separate motor control centers. During normal plant operation these valves are deenergized. Removal or loss of power will cause these valves to close. The cables for each circuit are routed separately.

6. Demonstrate, using engineering drawings (including isometrics) and design descriptions as appropriate, that the normal RCS high point vent paths to the containment atmosphere discharge into areas:

   a. That provide good mixing with containment air to prevent the accumulation or pocketing of high concentrations of hydrogen, and

   b. In which any nearby structures, systems, and components essential to safe shutdown of the reactor or mitigation of a design basis accident are capable of withstanding the effects of the anticipated mixtures of steam, liquid, and noncondensible gas discharging from the RCS high point vent system (reference NUREG-0737, Item II.B.1, Clarification A.(9)).

Response

a. The hot leg high point vents discharge inside the steam generator compartments, where the mixture of noncondensible gases will rise due to natural circulation to the top of the compartments at elevation 653'-0" and into the containment atmosphere where the containment air coolers will provide mixing and disperse any remaining concentration.

The pressurizer vent will discharge into the pressurizer quench tank where it will mix in the 250 cubic feet vapor space of the tank till the pressure in the tank reaches approximately 85 psig. At this point the noncondensible gases from the pressurizer vent will flow to the containment atmosphere from elevation 585 feet by natural circulation.

b. Both hot leg high point vents discharge close to a 1" nitrogen line (Figures 2 and 3). The nearby structures, systems and components are capable of withstanding the effects of the anticipated mixtures of steam, liquid and noncondensible gases which would be discharged from the RCS high point vent system.

The pressurizer high point vent will discharge to the pressurizer quench tank. All vent paths have been analyzed and designed so as not to preclude the essential operation of safety-related systems required for safe shutdown or mitigation of the consequences of a design basis event.

7. Verify that operability testing of the RCS high point vent system valves will be performed in accordance with Subsection IWV of Section XI of the ASME code for Category B valves (reference NUREG-0737, Item II.B.1, Clarification A.(11)).

Response

Through a separate letter, Toledo Edison is proposing Technical Specification surveillance requirements for the RCS high point vents (see Serial No. 803 dated April 1, 1982). Thereupon, the surveillance requirements of Davis-Besse Technical Specification 4.0.5 will be applied to the RCS hot leg vents except that the surveillance will be performed once per 18 months during the cold shutdown or refueling mode.

8. Verify that all displays (including alarms) and controls, added to the control room as a result of the TMI Action Plan requirement for reactor coolant system vents, have been or will be considered in the human factors analysis required by NUREG-0737, Item I.D.1, "Control Room Design Reviews."

Response

Toledo Edison will consider the addition of all displays (including alarms) and controls, added to the control room as a result of the TMI Action Plan Requirement for reactor coolant system high point vents, in the human factors analysis required by NUREG-0737, Item I.D.1.

9. State the venting capacity of the RCS high point vent system, and the design criteria which were used in the selection of the vent system size (reference NUREG-0737, Item II.B.I, Clarification A.(3)).

Response

The venting capacities of the RCS high point vent system are as follows:

	Hot Leg, Loop 1	Hot Leg, Loop 2	Pressurizer
reactor coolant (GPM)	45	45	Not Applicable
steam (lb/sec)	1.2	1.2	3.3
H_2 (cu. ft/sec)	3	3	5.3

For assumptions used in the selection of vent system size see response to Item 2 above.

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