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August 23, 1982

5211-82-180

Office of Nuclear Reactor Regulation
Attn: J. F. Stolz, Chief
Operating Reactors Branch No. 4
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Sir:

Three Mile Island Nuclear Station, Unit 1 (TMI-1)
Operating License No. DPR-50
Docket No. 50-289
RCS Vents (NUREG 0737 II.B.1)

Enclosed please find our supplemental response to your request for additional information dated March 16, 1982. Also enclosed are two copies of drawings.

IE-222-22-001 Sheet 1, Rev. 1 - Reactor Coolant System Vent to Containment, Piping Plan
IE-222-22-001 Sheet 2, Rev. 1 - Reactor Coolant System Vent to Containment, Piping Sections & Details.
B-000-53-001 Sheets 10, 11, 12, 8 - Reactor Coolant System Vent to Containment, Valve List
B-000-52-001 Sheets 13, 14, 15 7 - Reactor Coolant System Vent to Containment, Line List

Sincerely,

H D Hukill

H. D. Hukill
Director, TMI-1

HDH:LWH:CJS:vjf
Enclosures
cc: R. C. Haynes

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Drawings To: Reg File - 1
BC-3

Item 1

In addition to the Babcock & Wilcox "Operating Guidelines for High Point Vents During Small Break Transients" referenced in your response to NUREG 0737 Item II.V.1, and the information provided in your "Division II System Description" (SDD-222A Rev. 0), provide additional information regarding the following:

a. Criteria or pertinent information concerning a decision to terminate venting based on containment hydrogren concentration limits or pressurizer level limits.

b. Methodolgy describing the determination for the location and size of a noncondensible gas bubble in the reactor coolant system (reference NUREG 0737 Item II.B.1 Position (2) and Clarification A. (2).)

c. Operating guidelines for venting of the pressurizer in order to maintain system pressure and volume control (reference NUREG 0737 Item II.B.1 Clarification C.(3)).

Response 1a:

There are presently no criteria for termination of venting based on hydrogen concentration limit in the containment building. Analyses performed in accordance with 10CFR50.46b(3) and Reg. Guide 1.7 show that the reactor building hydrogen concentration (including hydrogen from all sources including metal water reaction) is only three percent after 12 days following a postulated accident. Since a hydrogen recombiner has been installed at TMI-1 there is currently no concern at TMI-1 regarding use of the RCS High point Vent System to vent hydrogen to the containment atmosphere.

Response 1b:

The determination of whether a bubble in the primary system is mainly composed of noncondensible gas or of steam is not of particular significance. Either type of bubble can hinder the reestablishment of or interrupt natural circulation cooling if the bubble becomes too large. However, the composition of the bubble can be inferred from the type of transient which occurs. If the transient progresses to an inadequate core cooling (ICC) situation, then noncondensible gases will probably be contained in the bubble. For plant transients in which a bubble develops in the RCS and plant parameters indicate the core is being cooled, the bubble will primarily be composed of steam.

The determination of the location and size of a bubble can be made by monitoring plant process parameters, mainly primary and secondary system temperatures and pressures, during the transient. If a bubble develops in the hot leg of such a size as to interrupt generator heat removal, the operator is directed to bump the pumps and/or use the high point vents (HPV) to reestablish natural circulation. Loss of the steam generator (SG) heat sink is noted by the difference in temperature between the cold leg RTD and the steam generator saturation temperature. In addition, the steam generator pressure will decrease and, for small breaks wherein the steam generators play an active role, the primary side pressure will increase. The decoupling can be further confirmed by depressurizing the steam generator and noting no accompanying change in the primary system.

Following the removal of the bubble in the hot leg and the establishment of natural circulation, the operator is expected to be able to recognize a reactor vessel head bubble by monitoring pressurizer spray effects on pressurizer level. Methods for removal of a bubble in the reactor vessel head are provided in Section 3.2 and 3.3 of the High Point Vent Generic Operating Guidelines (Reference 1), which will be used in the development of the applicable operating procedures.

Response 1c:

The use of the PORV in conjunction with HPI for depressurization and volume control for transients wherein the steam generator heat sink is not available is being incorporated into ATOG. The ATOG guidance will be used in the development of the applicable operating procedures.

Item 2

Section 7.4.3.1.1 of your "Division II System Design Description" (SDD-222A Rev. 0) and Section 3.1 of the Babcock and Wilcox "Operating Guidelines for High Point Vents During Small Break Transients" referenced in your submittal both state that the operator will open the hot leg high point vents when the refill phase of the accident commences. In practice, the operator has no means to determine whether steam or saturated water is present in the hot legs, and will probably not notice a difference between natural circulation and steam condensing heat transfer modes. A transition from one heat transfer mode to another may be obscured by temporary operation of the pressure vessel internal vent valves between the cold and hot legs. Discuss in detail how timely venting can be assured and present the necessary diagnostic and operational steps in explicit guidelines form.

Response:

The RCS Vents are used only for inadequate core cooling situations. The SDD and the ATOG guidelines have been revised to indicate RCS Vent use only during ICC events.

Item 3

Section 3.3 of the Babcock and Wilcox "Operating Guidelines for High Points Vents During Small Break Transients" referenced in your submittal prescribes operator actions to depressurize the reactor coolant system with a bubble in the reactor vessel head. Although we assume normally this guidance applies only to plants without reactor vessel head vents, it may also apply to Three Mile Island I for the following two reasons. First, the reactor vessel head vent at Three Mile Island I is not redundant and thus might be disabled by a single failure. Second, since your reactor vessel head vent is not at the highest point of the vessel, a small noncondensible gas bubble could remain even after venting the reactor vessel head. Therefore, since the prescribed operator actions to depressurize the reactor coolant system with a bubble in the reactor vessel head could apply to Three Mile Island I, we require that you respond to the following NRC concern.

Section 3.3 of the Babcock and Wilcox guidelines states that once natural circulation is established and temperatures in the hot and cold legs are between 50°F and 100°F subcooled, the operator is to depressurize the plant with the pressurizer high point vent or PORV at a rate not greater than indicated by Curve I of Figure 2. This maximum allowable depressurization rate is based on assuring that the rate of expanding gas from the vessel head into the hot legs is less than the relieving capability of the hot leg high point vent in order to preclude a net accumulation of gas at the top of the hot legs and interruption of natural circulation. The staff disagrees with this method of depressurization with a bubble in the reactor vessel head for the following reason:

The maximum allowable depressurization rate provided by Curve I of Figure 2 of the Babcock and Wilcox (B&W) guidelines appears to be based on computer analyses. B&W and their customers have yet to satisfactorily demonstrate to the staff the adequacy of the analysis models to properly predict the transport of steam and other gases in the vessel and primary coolant loops under transient and accident conditions, including post-LOCA. As such, we believe the uncertainties in the depressurization rates shown in Figure 2 to be unquantified, and the consequences of incorrect depressurization significant.

We, therefore, request that you identify a method of depressurizing the primary system with the assumption of a bubble in the reactor vessel head which does not rely on computer calculated curves and does not involve a risk of interruption of natural circulation.

Response:

Since the RCS Vents are used only for inadequate core cooling situations, no further response to this item is provided.

However, we must make the following comments on your reasoning for why this concern applies to TMI-1.

a. The reactor vessel head vent for TMI-1 is not redundant, and thus, might be disabled by a single failure. Please note, however, that redundancy was not required by NUREG 0737, and indeed, a redundant vent path for the reactor vessel head vent would have increased the probability of a spurious vent actuation. NUREG 0737 requires that our design minimize the potential for accidental actuation. For these two reasons, (no requirement for redundancy and minimization of accidental vent actuation) the TMI-1 reactor vessel head vent was designed with a single vent path.

b. The TMI-1 reactor vessel head vent is not at the highest point in the vessel and a small non-condensible gas bubble would remain even after venting the reactor vessel head. The TMI-1 reactor vessel head is vented by way of a core barrel thermocouple penetration which terminates at a point 6 inches below the inside surface of the head near the periphery of the vessel. Our calculations indicate that following venting of the head up to this penetration, approximately 16 per cent of the head volume would still remain as gas. Therefore, it would be necessary for the RCS pressure to drop by a factor of 6 before this gas volume would pose a threat to natural circulation. At this point venting could be repeated.

Item 4

During conditions of inadequate core cooling, the operator is instructed to open the high point vents. Another instruction is to start the reactor coolant pumps (RCPS). If the pumps are started, can a slug of water impact the reactor vessel head or hot leg piping at the high point vent location? If so, is the vent system designed to withstand the dynamic loads associated with these water slugs? If not, what precautionary measures are provided or will be provided to preclude pump start with the vents open?

Response:

The hot leg high point vent piping and the reactor vessel head vent piping have been designed to withstand transient shock loading due to rapid opening of the valves with subcooled liquid upstream of the valves. The vents will survive the water slug transient postulated.

Item 5

Recently a number of plants with B&W designed NSSS's have experienced bubble formation in the hot leg piping while in the shutdown cooling mode. This has been caused by the flashing of stagnant hot water in the hot legs during depressurizing operations by the operator (the hot water was possible due to outsurges from the pressurizer).

What instructions are provided to the operator regarding the use of the vents to remove trapped steam under these conditions? In particular, should the vents be used or not? Consider that the containment may not be isolated and personnel may be in containment. If vent operation under these conditions must be avoided, what provisions have been made to preclude vent operation?

Response:

GPUN has no plans to use these vents under this particular situation described above. Procedures and emergency actions are available to recover from this situation without resorting to using the hotleg vent piping. Our particular design vents the hotlegs directly to the containment building atmosphere and we would plan to use these only during inadequate core cooling events as described in the ATOG Guidelines which were submitted to you on April 1, 1982.

Item 6.

On page 18 of the Division II System Design Description, it states that when the RCPs are not available following a small break LOCA for removing trapped gases from the reactor coolant system high points, the hot leg vents can be utilized. Moreover, the first sentence in section 7.4.3.1.1 (page 18) states that operator action will be required to open the vents during small break transients. It is our understanding that neither the RCPS nor the high point vents are considered to be part of the engineered safety features (ESFs) and are not required to be operable following a LOCA. Previous ECCS analyses submitted on license applications for plants with B&W NSSS's were not performed beyond the start of primary system inventory recovery and it was assumed that single phase natural circulation would be reestablished without the aid of either the RCPs or the high point vents.

Please state whether or not operation of the RCPs and/or the high point vents are necessary in order to reestablish single phase natural circulation following a small break LOCA. If they are required, justify why they are not considered part of the engineered safety features, and required to meet the design requirements of ESFs. If they are not required, provide the supporting analyses for small break LOCAs which demonstrate that single phase natural circulation will be reestablished following recovery from a small break LOCA. Discuss how steam trapped in the reactor coolant system high points (vessel head and hot leg "candy canes") will be condensed or removed and not inhibit natural circulation or long-term cooling of the core, per the requirements of 10CFR50.46(b)(5).

When considering the need of the high point vents take into account also the possibility of an early break isolation which takes place during the period between interruption of natural circulation and start of steam condensing heat transfer.

<u>Response</u>:

The long term cooling requirement of 10CFR50.46(b)(5) does not specify the reestablishment of single phase natural circulation as a design objective. Rather, it states that the ... "core temperatures shall be maintained at an acceptable low value and decay heat shall be removed for the extended period of time required by the long-lived radioactivity remaining in the core". The long term cooling of the core, as required by 10CFR50.46(b)(5), is provided by assuring that the core remains covered by a two-phase mixture. To assure this capability in the long term, the high pressure injection has been designed to take suction from the reactor building sump, thereby assuring an indefinite supply of coolant. The SBLOCA evaluations demonstrate that the ECC systems satisfy this requirement. It has never been assumed that single phase natural circulation would be reestablished following design basis SBLOCAs.

Operation of the RC pumps and/or the high point vents is believed necessary in order to reestablish the preferred mode of cooling by single phase natural circulation during certain small breaks. The range of break sizes, for which the reestablishment of single phase natural circulation would aid in bringing the plant to cold shutdown, is bounded on the small side by the largest break size for which natural circulation would not be lost (Approximately 0.005 ft.) and on the largest side the smallest break size for which the RCS pressure spontaneously depressurizes to the LPI setpoint (approximately 0.05 ft.) where natural circulation is not important. For breaks which are isolated during the period between the interruption of natural circulation and start of steam condensing heat transfer, the RC pumps and/or vents may be used to reestablish single phase natural circulation. However, if the steam bubble in the hot leg U-bend is small, it may be possible to reestablish natural circulation by pressurizing the system with the HPI. Alternatively, the plant would evolve to a high pressure and displace sufficient inventory through the PORV or code safety valves to establish boiler-condensor heat removal.

Although the RC pumps and high point vents could be utilized for the establishment of single phase natural circulation, the long term cooling requirement of 10 CFR 50.46(b)(5) is met without utilizing the RC pumps or the high point vents. The SBLOCA transients have been analyzed beyond the point at which the primary system pressure is controlled; by the break; at pressures below the SG secondary pressure; or by the steam generator, in a boiler condenser mode of cooling. The results indicate that the core temperature excursion is terminated and the ECC injection exceeds the core boiloff. Since the core decay heat continues to decrease thereafter, the ECC systems assure that adequate makeup to keep the core covered is provided if primary system pressure can be controlled. Pressure control is provided by the break, for the larger SBLOCAs, and by use of the steam generator for the smaller breaks. Since the condensing surface in the SG is located at an elevation above the top of the core, primary system pressure will be controlled at a value which assures that the HPI will keep the core covered for the long term. Additionally, since the HPI and LPI system can be operated from the containment sump, following the emptying of the BWST, long term ECC injection is assured.

As seen from the foregoing discussion, long term cooling of the core for a SBLOCA is maintained without the need to establish single phase natural circulation. Thus, the RC pumps and the high point vents are not required to be part of the engineered safety features. It is our belief that the use of available plant equipment, whether or not it is "safety grade", which aids the operator in managing the plant during a transient or accident should be identified in the operator guidelines. Thus, the operator guidelines does contain instructions for utilizing the RC pumps and the high point vents for the purpose of returning the plan to single phase natural circulation.

Item 7

The following items apply to the portions of the reactor coolant system (RCS) 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 materials of construction will be fabricated and tested in accordance with SRP Section 5.2.3, "Reactor Coolant Pressure Boundary Materials".

b. Verify that the Nuclear Class N-1 and N-2 designations of the piping, valve, components, and support are equivalent to Safety Classes 1 and 2, respectively (i.e., ASME Boiler and Pressure Vessel Code, Section III, Classes 1 and 2).

Response 7a:

Portions of the RCS highpoint vent system rely on existing TMI-1 piping. This piping was originally designed to ANSI B 31.10 with quality assurance, examination and inspection requirements to USA B 31.7 and the Special Requirements of the Commonwealth of Pennsylvania.

For new portions of the system, materials are being purchased to ASME Section III for the hot legs, pressurizer and Reactor Coolant Drain tank vents, with design in accordance with ANSI B31.1.0 (Original Plant Piping Design Code). Fabrication and examination shall be in accordance, as a minimum with, USAS B. 31.7. Installation erection and testing shall be in accordance with ASME Code Section XI and Special Requirements of the Commonwealth of Pennsylvania. The Reactor Vessel Head Vent, since it does not interface with any existing piping, is being designed in accordance with the ASME Section III.

Response 7b:

Piping Classification N1, N2, and N3 correspond to calssifications used in USA Standard B 31.7 as noted in MI-1 FSAR, para. 1.3.2.11, "Piping".

Item 8

Section 7.1.5 of the Division II System Design Description for RCS vents states that the physical arrangement of the RCS vents is shown on GPUSC drawing number IE-222-22-001, Sheets 1 and 2, yet this drawing was not included in the submittal. Provide this drawing and any others necessary to demonstrate that the RCS vent paths to the containment atmosphere discharge into areas in which any nearby structures, systems, and components essential to safe reactor shutdown or mitigation of the consequences of a design basis accident are capable of withstanding the effects of the anticipated mixtures of steam, liquid, and non-condensibles discharging from the vent system.

Response:

The GPUN drawings which show the physical arrangement of the RCS high point vent at the hot leg, pressurizer, reactor coolant drain tank (drawing 222-11-001 sheets 1 & 2 Rev. 1 are attached). The B&W drawings which show the reactor vessel head vent are not yet released for construction. These drawings will be transmitted to you when appropriate signatures have been obtained.

Item 9

Verify that motor-operated valve RC-V28 is provided with positive position indication in the control room and is powered from an emergency bus (reference NUREG 0737 Item II.B.1 clarification A(5) and (8)).

Response:

The pressurizer motor operated vent valve RC-V-28 is provided with positive indication in the control room and is powered from an emergency bus.

Item 10

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.I, "Control Room Design Reviews".

Response:

The RCS highpoint vent system displays including alarms and controls that have been added to the control room as part of the TMI-1 action plan requirements for RCS vents have been considered in human factors analysis as required by NUREG 0737, Item I.D.I,"Control Room Design Review". (Ref. January 21, 1981 L1L 019 - GPU Design Review Report.)

Item 11

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

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

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

c. Dynamic effects associated with the postulated rupture of hot leg high point vent piping greater than one-inch nominal size.

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

Response 11a:

All RCS vent system paths at TMI-1 are designed to Seismic Category I requirements and, thus, are designed to withstand the Safe Shutdown Earthquake.

Response 11b:

The TMI-1 RCS highpoint vent system consists of small bore piping (one inch and smaller). The heaviest single active component in the system, for the hotlegs vents and the reactor vessel head vent, are the solenoid operated vent valves. These valves weigh 32 pounds, each, total weight. A credible missile generated by this active component would be the valve operator coming off the valve and falling down into the D-ring. This mass, less than 32 pounds is not considered a threat to the integrity and functional ability of systems required for safe shutdown.

Response 11c:

The RCS hotleg highpoint vent piping for TMI-1 consists of one inch, three quarter inch, and one-half inch pipe size. Therefore, this particular concern does not apply.

Response 11d:

Because of the location of the RCS highpoint vent piping (above the D-ring, outside the D-ring, and in the reactor vessel cavity) failure of pressurized portions of the system (maximum opening one inch schedule 160 pipe) are not considered to be a credible concern due to the smallness of the piping involved, lack of targets of concern in these particular areas, and the fact that components which lie beneath this piping (e.g., down inside the D-ring) are designed for containment spray conditions.