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October 9, 1980

Mr. D. M. Crutchfield, Chief
Operating Reactors - Branch 5
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Dresden Station Unit 1
Responses to Request for Additional
Information Concerning HPCI Design
NRC Docket No. 50-10

References (a): D.L. Ziemann letter to C. Reed dated May 12, 1978.
(b): M.S. Turbak letter to D.L. Ziemann dated Aug. 4, 1978.
(c): M.S. Turbak letter to D.L. Ziemann dated Sept. 19, 1978.

Dear Mr. Crutchfield:

Reference (a) transmitted a request for additional information concerning the Dresden Unit #1 HPCI System. Reference (b) transmitted the response to questions, 3a, 5c, 6b, 7, 8a, 8b, 8c, 9, 10, 12, 14, 15, 16 and 17. Reference (c) transmitted responses to the remaining questions. This letter transmitts updated responses to questions 2, 3b1, 3b2, 4a, 4b, 4c, 6a, 6c, 11a, 11b, 11c, 13a, 13c, 13d and 13e.

The format of this response is identical to that used in reference (a) and (b). The information is presented as an update to the Dresden Unit 1 ECCS Design Report.

Please address any questions reguarding this transmittal to this office.

One (1) signed original and thirty-nine (39) copies of this letter and attachment are provided for your review.

Very truly yours,

Robert F. Janecek

Robert F. Janecek
Nuclear Licensing Administrator
Boiling Water Reactors

cc: RIII Inspector - Dresden

JEH/rmr
7168A
Attachment

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DRESDEN UNIT 1

INSTRUCTIONS FOR UPDATING YOUR ECCS DESIGN REPORT

Changes to the report are identified by a vertical line in the right margin of the page. To update your copy, remove and destroy the following pages and figures and insert pages and figures as indicated:

NRC QUESTIONS OF MAY 12, 1978
(D. L. ZIEMANN TO C. REED)

REMOVE	INSERT
Page Q2-1	Page Q2-1
Pages Q3-2 and Q3-3	Pages Q3-2 and Q3-3
Page Q4-1	Page Q4-1 and Q4-2
Pages Q6-1 and Q6-2	Pages Q6-1 and Q6-2
Page Q11-1	Page Q11-1
Pages Q13-1 and Q13-2	Pages Q13-1 and Q13-2

POOR ORIGINAL

QUESTION 2

"The overall design of the D-1 ECC Systems apparently assumes that 'short term' ECCS operation (during which only active single failures are required to be considered) extends until the containment can be reflooded to a level above the active core (elevation 544'). This is not a defendable assumption, since you plan to enter the long term, recirculating cooling mode as soon as the containment is flooded to only the (lower) 505' level, and you would normally maintain that (lower) level unless some failure were to occur which would make it essential to flood containment to the 544' level in order to cool the core. This 'interim' period (post-short-term but pre-containment-flooding above the core) would last on the order of 1 to 1-1/2 days, and it has not been properly analyzed.

For the case of a postulated large recirculation line break such that the core cannot be reflooded, and assuming a single passive failure disables the Core Spray (CS) and the Post Incident (PI) systems shortly after starting the PI system (for example due to failure of certain non-redundant piping common to both systems), describe and quantitatively analyze core cooling for the 'interim' period. We cannot allow credit for any cooling during this period due to feedwater or HPCI flow, unless it can be shown that such flow can be properly distributed (i.e., sprayed) over the entire core."

RESPONSE

"Short term" ECCS operation is the period beginning with ECCS initiation and extending until long-term recirculation begins. There is no "interim" period and we take no credit for filling the sphere above the core, although this could occur as a consequence of running the Post-Incident Pumps and one or more Core Spray Pump in parallel for a bottom break, or running the Core Spray or HPCI system for a Core Spray line break.

The Core Spray line is a seismically qualified, safety-related line from the Core Spray Pump to the reactor vessel. In the containment sphere, the line is physically routed where it does not come into proximity with other high energy lines or earthquake-generated missiles. Therefore, it is not subject to pipe whip or missile failures. The routing of the Core Spray line is such that a failure of the sphere crane and subsequent fall will not damage the Core Spray line. The Core Spray line contains two closed motor operated injection valves in-series with a check valve between them to protect the Core Spray line from overpressurization. In addition, the system contains injection instrumentation to prevent inadvertent valve opening, and a safety-relief valve set at 300 psig to prevent overpressurization failure. Thus, no mechanism exists for passive failure of the Core Spray line.

We therefore conclude that a passive failure in the Core Spray line is not a credible event. In response A-3 in the October 20, 1976 submittal to the NRC (Abrell to Ziemann), the probability of a passive failure in the Core Spray Line during 30 days post-LOCA, based on WASH-1400, is given as 6.5×10^{-6}. Furthermore, the Appendix K analysis concludes that a large recirculation line break is an acceptable event.

offsite power and that no hidden single failure exists (in these systems, their controls and power supplies, and their essential secondary systems) which could disable more of these systems than your analyses have assumed are vulnerable to a single failure. You must also consider only systems that are environmentally qualified for the post-LOCA environment, particularly those components that would be submerged (below 544' level). Your previous response (#4, 08/31/76 letter to D. Ziemann) only considered levels to 510'. These systems are not normally considered together for accomplishing a safety objective and your review of this item will be of crucial interest particularly if you cannot demonstrate capability of the HPCI to accomplish this function (i.e., if, without having to assume a single failure, the 100 psi interlock, or cavitation damage, will prevent functioning of HPCI in this mode, for examples)."

RESPONSE

a. A break in the Core Spray Line between the vessel and the injection valve station is detected by the Core Spray Break Detection System. The system continuously indicates the pressure difference, if any, that exists between the Core Spray Line and the reactor vessel. If the pressure in the vessel exceeds the pressure in the Core Spray Line by a fixed amount, as set on the trip set point, an alarm sounds in the Control Room.

The detection instrumentation is segregated into two redundant divisions. Each division has two pressure transmitters which must function in order to alarm in the Control Room. This arrangement prevents a single failure that would indicate wrong information to the operator and hence, wrong operator action.

b1. The HPCI system can be used as a quick reflood to the reactor vessel in the event of a Core Spray Line break.

The HPCI system cut-off at 100 psig vessel pressure can be manually overridden by the Control Room operator. Also, all other major components have manual override, so that the entire HPCI system can be operated from the Control Room.

The HPCI system can operate even with the reactor vessel at atmospheric pressure. The net positive suction head required (NPSHR) for the HPCI pumps is always less than the available net positive suction head for any HPCI tank level. Therefore, the HPCI system has a reflood capability for any set of conditions.

Passive failures in the HPCI line are discussed in the response to Question 4C.

b2. No credit is taken for the operation of any other systems except HPCI, Core Spray and Post-Incident.

For short-term cooling, HPCI would be required to function if depressurization is necessary. Otherwise Core Spray provides the cooling water. For a Core Spray Line break, the HPCI system, or Core Spray system, injecting into the vessel through the HPCI lines, and the Post-Incident system, operating through the containment sprays, would be used for long-term cooling.

The HPCI and the Core Spray system are safety-related, redundant, and seismically qualified for operation. The Post-Incident system is available for the long-term cooling of the core and for removal of decay heat.

QUESTION 4

"Questions 2 and 3 above present postulated sequences of events which eventually result in the containment flooded to above the core level, in some cases with HPCI supplying water to the core and/or containment and in other cases where passive failures (or basic design of the system i.e. cavitation and/or the 100 psig HPCI core pressure shut off) have disabled HPCI, and a series of backup 'systems' is supplying water to the core and/or containment. It will eventually be necessary to establish a 'closed cooling' loop, with active or passive (i.e. through the containment sphere wall) cooling in the loop.

a) Quantitatively discuss the systems that can be used to remove water from and to supply water to the containment for this purpose, including how the inventory removed from containment can be routed to the intake of the various systems which are injecting water into the core and/or containment, for each of the scenarios discussed in Questions 2 and 3 above. If tank storage capacities (such as Radwaste) limit total times certain of these 'systems' can be used, state the time limits and specify alternatives available after such capacities are full.

b) Identify all systems involved in each postulated 'closed loop' and conduct a review to insure that no hidden single failure exists (in the systems, their controls and power supplies and their essential secondary systems) that could disable more equipment than the analyses assume could be disabled due to a single failure. This must include consideration of environmental qualification of equipment, including components that might be required to operate while submerged (i.e. below 544' level).

c) The analyses in b) above must consider the possibility of core repressurization in the case of a small break and long term HPCI failure. That is, credit must be assumed for operation of the emergency condenser contrary to response A8 in your July 26, 1976 letter (or alternate means of steam removal or condensation) or credit must be assumed for ability to inject water into the core at 1210 psig (the lowest set Safety Valve pressure) that equals the boiloff rate."

RESPONSE

a. For long-term cooling, the systems involved would be the Post-Incident system and the Core Spray system through the Core Spray grid over the core. The residual heat is removed by the Post-Incident heat exchangers. In the event of a LOCA caused by the Core Spray Line break, the HPCI system can intermittently reflood the vessel to keep the core covered.

Alternatively, the Core Spray can reflood the vessel through the HPCI line crosstie. The residual heat is removed from the containment by using the Post-Incident system and directing the flow through the containment spray system to condense the steam that is generated in the reactor vessel.

b. All systems involved in either long-term cooling mode as defined in Response 4a are available for use. The HPCI and Core Spray systems are redundant, seismically qualified and safety-related. The Post-Incident system is redundant to the extent that only one Post-Incident pump is required to remove decay heat from the containment beginning three hours after the LOCA when the decay heat rate reaches 15×10^6 BTU/hr.

If it is necessary to flood the containment to the 545' elevation, the only components which could be affected by flooding are the HPCI injection valves and the HPCI vessel level instrumentation. The valves could be isolated by tripping the breaker on the motor control center in the HPCI building. The breaker could then be racked out and padlocked to prevent re-energization.

The HPCI system would then inject using the containment isolation valves 1-6129 A&B for injection. Containment integrity is maintained by check valves 1-6107 A&B.

c. The HPCI system is not subject to passive failures, since the mechanisms for passive failure in the non-redundant portion of the HPCI line do not exist. The HPCI line is underground by 5-1/2 feet, and those portions in the containment and HPCI building are not near any equipment which could generate missiles, and are not subject to pipe whip. The design pressure of the HPCI line is greater than either the shut-off head of the HPCI pumps or the safety valve set point on the primary cooling system. Therefore, overpressurization is not a problem. The HPCI line is fully seismically qualified.

QUESTION 6

"You have provided spray cone angle results for a single core spray system nozzle at various flows (i.e. at various nozzle ΔP's, Fig. 6.3-12), and you have provided calculated results for the core-wide spray distribution at the rated flow of 2150 gpm (Fig. 6.3-10). However, the following additional information is needed to allow the full spray cooling credit taken in various portions of your short and long term ECCS analyses:

a) Indicate the spray distribution that was assumed within each individual nozzles spray cone (Fig. 6.3-12) when the overall core distribution (Fig. 6.3-10) was calculated. Provide data to justify the distribution assumed within the individual nozzles spray cone.

b) Clarify the total core spray flow that is expected during long term core cooling. The report (p. 6.3-8) states 1600 gpm but Table 6.3-5 indicates rated flow rates for each of the two PI pumps and for each of the two PI heat exchangers at only 600 gpm, i.e. 1200 gpm total.

c) Considering a) and b) above, justify the spray cooling credit (i.e. the spray distribution and the resulting spray cooling heat transfer coefficient) taken in your long term spray cooling analyses in the time period before containment is flooded to a level above the active core."

RESPONSE

a. The General Electric Company (GE) is currently performing an evaluation of the Dresden-1 core spray distribution through the grid system. A report for submittal to the NRC should be available in the early part of October 1980.

b. The original purpose of the Post Incident (PI) pumps was for use with the Containment Spray System. For the Containment Spray System, the design point for the pumps was 600 gpm at a 320 foot head. When the Post Incident pumps were tied into the Core Spray System, a new flow rate was calculated based upon the pressure requirements of the system. At this point, the PI Pump flow rate is 800 gpm at 240 foot head, and the 1600 gpm came from this number. Table 6.3-5 reflects the 600 gpm at the 320 foot head design point. The difference in head requirements comes from the pumps not having to pump water to the top of the sphere for the containment spray, and from the decrease in friction pressure drop in the larger Core Spray Line.

c. The General Electric Company is performing a technical analysis of long term cooling with the new Core Spray grid system. This analysis should be available for submittal in October 1980.

QUESTION 11

"The non-redundant, low pressure piping in the CS system is one of the most vital (and vulnerable) portions of the D-1 ECCS. Accordingly, describe in detail design features, controls, interlockas, built in testing features, surveillance and administrative measures that will keep the CS piping from being exposed to pressures above the CS design pressure. Your answer should include both day-to-day routine operation (no LOCA) and the post-LOCA condition. In the latter case, failure or leakage of one check valve could cause system overpressurization if the MO valves are opened while core pressure is still above CS design pressure. This could result in failure of the CS due to pipe break, with a non-refloodable bottom break as the initiating event (i.e., one of the worst situations, where you can't flood quickly and you can't spray)."

RESPONSE

The low-pressure Core Spray piping is protected against high reactor pressure by three in-series valves (two injection valves and one check valve). The injection valves will open only when all three of the following conditions exist:

A. LOCA signal (low steam drum level and/or high sphere pressure);

B. Low Reactor Water Level; and

C. Reactor Vessel pressure less than Core Spray system pressure.

Since three separate spurious signals would be required to open the valves, overpressurization of the Core Spray Line from this mode is not a credible event. Also, leakage past three in-series closed valves is extremely likely. Lastly, the core spray line has a 300 psig pressure relief valve on the line which would operate if the other valves failed.

QUESTION 13

"With regard to your assumption of credit for closure of isolation valves for the downcomer break (allows credit for reflooding the vessel by isolating the break from the vessel):

a) How quickly does the valve close? Did LOCA analyses assume blowdown through the full break area before the valve is closed?

b) Can all portions of all of the downcomers be isolated from the pressure vessel by closure of these valves? Either analyze or justify not analyzing a break between the isolation valve and the pressure vessel.

c) Can a single failure disable ability to isolate any portion of any downcomer from the vessel?

d) Can the isolation valve function in the post-LOCA environment, including the possibility they may be submerged when required to close?

e) Provide an estimate of the consequences of a worst core downcomer and a worst core riser break (peak cladding temperature)."

RESPONSE

a. The valves have a closure time of less than 1-1/2 minutes. The new Appendix K analysis assumes full blowdown through the break area, with no credit taken for valve closure.

b. As defined, the downcomer lines are those lines that return water from the bottom of the steam drum to the suction side of the recirculation pumps. From the pumps through the secondary steam generators to the vessel, these lines are called the recirculation lines (refer to Figure Q13-1). On each of the four recirculation lines there is a 25-foot section of piping which cannot be isolated from the vessel. It is in these sections that postulated bottom breaks could occur. These breaks are analyzed in the new Appendix K analysis and found to be acceptable.

c. The motor-operated valves on the recirculation lines (MO-110, -111, -113, -114, -115, -116, -117, -118, -138, -139, -141, -142, -143, -144, -148, and -149) that isolate the recirculation pumps and the secondary steam generators are subject to loss of offsite power. The new Appendix K analysis shows that even with no credit taken for valve closures, the HPCI system can deliver the flow to the vessel required to depressurize the primary system.

d. If it is possible to operate one of these MO valves in order to isolate a break, switching of emergency power could be accomplished and the valve closed. This would be done during the short term. Should the containment flood up to these valves, the power to the valve could be removed by tripping the breaker to the bus which powers the valve. Therefore, no method of opening the valve would exist.

e. Consequences of these breaks are discussed in the new Appendix K analysis. Riser and downcomer breaks are shown to be non-limiting.