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U. S. Nuclear Regulatory Commission
Washington, D.C. 20555
Attention: Document Control Desk

Subject: Dresden Nuclear Power Station Units 2 and 3

ComEd's Assessment of Potential Impact of High Pressure Coolant Injection (HPCI) Turbine Exhaust Rupture Disk Opening

<u>NRC Dockets 50-237 and 50-249</u>

References:
(a) W. T. Russell visit to Dresden Nuclear Power station, dated May 1, 1995

(b) NRC SER dated January 17, 1980, for SEP Topic III-5.B

(c) NRC SER dated August 20, 1982, for SEP Topic III-5.B

(d) NRC SER dated June 10, 1981, for EQ

(e) NRC SER dated December 29, 1982, for EQ

(f) NRC SER dated February 12, 1986, for EQ

During the NRC staff visit to Dresden Nuclear Power Station, reference (a), several concerns relating to the potential impact should the High Pressure Coolant Injection (HPCI) turbine exhaust rupture disk open were raised. The purpose of this letter is to provide the results of ComEd's assessments of those concerns and related issues.

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Potential Impact of Rupture Disk Opening

ComEd engineering personnel began reviewing related issues at the Dresden and Quad Cities Stations after the Quad Cities rupture disk event in June, 1993. The reviews have been addressing the potential impact on other important systems, including the swing emergency diesel generator, isolation condenser, core spray, low pressure coolant injection, and the 125 VDC main bus. The results of our reviews indicate that although Dresden HPCI steam exhaust line rupture disk opening due to exhaust overpressure or (premature opening due to disk failure) would disable the HPCI system, the impact of the steam release would be minor. The reviews indicate that HPCI turbine steam exhaust line rupture disk opening would not be a risk significant event for either Dresden unit. Detailed comments on your concerns are provided in Attachment A. A more detailed discussion of the failure modes and effects of the rupture disks is provided in Attachment B.

Adequacy of IPE Treatment of HPCI line break

As part of the Dresden Individual Plant Examination (IPE), a HPCI steam line break was reviewed as a potential initiating event. That review was consistent with industry IPE practice and was supported by prior plant-specific experience. Subsequently, HPCI primary containment isolation valve performance has been improved by the installation of modifications resulting from Generic Letter 89-10 testing and analysis. This provides assurance that the failure-to-function probability of these valves is low and that the failure-to-function rate provided by the IPE is currently appropriate for the HPCI system. Related details are provided in Attachment C.

Adequacy of Existing Design Basis for EQ

A deterministic analysis of a HPCI steam line break was added to Dresden's licensing basis following the NRC's issuance of the "Giambusso letter" in 1972. NRC reviews of that analysis and the Systematic Evaluation Program (SEP) (references (b) and (c)) reaffirmed that the break could be quickly detected and isolated by the redundant and diverse isolation protection which had been provided as part of the original plant design. (With current isolation valve performance, the break would be isolated in less than one (1) minute.) HPCI steam line breaks were later considered in the development of Dresden's program for Environmental Qualification of Electrical Equipment (EQ) in response to IE Bulletin 79-01B. However, the environmental effects of breaks in the HPCI room were assumed to be confined to that space, affecting only the HPCI system. In addition, steam from breaks in the torus compartment was assumed to vent vertically without propagation to other areas of the reactor building, which were classified as mild environments.

Although those assessments of the effects of HPCI steam line breaks were considered adequate at the time for the purpose of establishing the Dresden EQ program (see NRC SER's, references (d), (e), and (f)), the Quad Cities steam exhaust line rupture disc event indicated that previous assumptions regarding the limited extent over which the effects of the breaks would be felt may not have been sufficiently conservative. As a result, ComEd has elected to undertake a reconstitution of the design basis for EQ for HPCI steam line breaks.

The methodology being employed in the reconstitution is summarized as follows (see Flowchart and Schedule, Attachments D and E, respectively). New environmental parameters have been calculated for areas now considered to be affected by the breaks. The functions, systems, and specific electrical components relied upon to achieve safe shutdown for the HPCI line break event are being reconfirmed or identified. For identified components located in areas for which the environment is no longer considered mild, EQ documentation is being obtained or developed. (ComEd already has EQ documentation for certain component types, as a result of their use in other EQ applications.) Consistent with the guidance of Generic Letters 91-18 and 88-07, during the period that qualification is being reestablished, the units will be operating under a "Justification for Continued Operation (JCO)", with the chief technical basis that the safety function can be accomplished by other designated equipment which is qualified, or which is not subject to the harsh environment. Additional detail on the bases of the JCO is provided in Attachment F.

Applicability to Quad Cities

Although the above discussion relates to Dresden Station, ComEd has undertaken a similar effort to reconstitute the design basis for EQ for HPCI steam line breaks for Quad Cities Station. Although the methodology being employed is essentially the same, there are some significant plant differences. For example, the potential pathway for steam to enter the swing diesel room does not exist at Quad Cities; and the systems used to achieve safe shutdown for the HPCI steam line break event are different. The Dresden and Quad Cities efforts are proceeding in parallel and are expected to be completed on about the same schedule.

Summary Assessment

In summary, although the design basis reconstitution efforts are continuing and could potentially result in minor changes to requirements for EQ, our current appraisal is that for a HPCI line break, the plant would achieve and be maintained in a safe shutdown condition, with vessel inventory assured, through the use of equipment unaffected by the line break and current operating procedures. The probability of this design basis (double ended guillotine) HPCI line break occurring, with the licensing basis assumption of concurrent loss of offsite power, is very low (much less than 1.0 E-07 per year). For the more likely event of a HPCI rupture disk opening, the overall plant response would be much more benign, and plant trip would even be unlikely. The principal effects of this event would be localized to the HPCI room, and little or no impact would be anticipated in other areas of the plant.

Also, during the NRC Staff's visit to Dresden Station, inquires were made as to whether Dresden has ever experienced isolation condenser tube failures and what ongoing actions are taken to ensure continued tube integrity. Attachment G provides additional information on this subject.

Please address questions regarding this letter to Peter Holland, Dresden Station Regulatory Assurance Supervisor, at (815) 942-2920, extension 2714.

Sincerely,

T. P. Joyce

Thomas P. Joyce
Site Vice President
Dresden Station

TPJ/kls

cc: J. B. Martin, Regional Administrator, Region III
W. T. Russell, Director, Office of Nuclear Reactor Reagulations
J. F. Stang, Project Manager, NRR (Units 2/3)
P. B. Erickson, Project Manager, NRR (Unit 1)
M. N. Leach, Senior Resident Inspector, Dresden

List of Attachments

A. HPCI Rupture Disk Issues

B. Failure Modes and Effects of Dresden HPCI Exhaust Line Rupture Disks

C. Dresden IPE Treatment of HPCI Line Break Events

D. Flowchart for Design Basis Reconstitution for EQ for HPCI Steam Line Break

E. Schedule for Design Basis Reconstitution for EQ for HPCI Steam Line Break

F. Dresden HPCI Steam Line Break Environmental Qualification (EQ) Concerns and Summary of Justification for Continued Operation.

G. Information Regarding Isolation Condenser Tube Integrity

ATTACHMENT A

HPCI Rupture Disk Issues

1. **Would the steam release fail the unit 2/3 (swing) emergency diesel generator?**

Two rupture disks, in series, are located in a tee off the High Pressure Coolant Injection (HCPI) steam exhaust line. The rupture disks vent to the HPCI room to provide HPCI turbine protection should steam exhaust line blockage occur. See Fig. A-1 for simplified diagram of the Dresden 2 HPCI system showing the rupture disks. The Dresden 3 and Quad Cities 1 and 2 HPCI systems are similar. Two check valves are located in the steam exhaust line downstream of the rupture disk tee. Failure of either of these check valves, for example, could block steam exhaust line flow.

The room housing the Dresden swing emergency diesel generator (EDG) is located directly above the HPCI rooms. Plugs in the floor of the swing EDG room and manway doors between the swing EDG and HPCI rooms are a possible steam pathway should the HPCI rupture disks open. Because the rupture disks are downstream of the HPCI turbine, a steam release due to open rupture disks would be limited by the steam flow rate through the turbine. In addition, the HPCI turbine stop valves would be available to quickly secure the steam flow. For this reason, it is concluded that a significant amount of steam would not enter the swing EDG room and that this scenario would not result in a significant increase in the failure probability for the swing EDG.

The maximum mass flow rate of steam from open rupture disks would be comparable to that during HPCI testing and does not pose a signficant risk of a reactor scram due to low reactor level. More detail on the failure modes and effects of the rupture disks are given in Attachment B.

2. **Would the steam release fail the Isolation Condenser?**

Small 120 VAC control panels for the Isolation Condenser inboard isolation valves are located in the swing EDG room. The valve motors serviced by these control panels are powered by 480 VAC. These valves are normally open.

The control panels of concern (along with related isolation switches located in the Unit 2 Shutdown Cooling pump room and in the Unit 3 Traversing Incore Probe room) were installed following analysis for 10 CFR 50, Appendix R. That analysis concluded that postulated hot shorts due to a fire in several plant locations could result in spurious Isolation Condenser inboard isolation valve closure. The analysis also showed that faults of control circuitry to ground would not result in spurious closure.

Because of this potential for a fire disabling one or both Isolation Condensers, safe shutdown procedures provide for reopening the inboard isolation valves should spurious closure occur due to hot shorts. In the event of hot shorts associated with the Isolation Condenser control panels in the swing EDG room, the isolation switches in the Unit 2 shutdown cooling pump room and in the Unit 3 Traversing Incore Probe room would restore control to the Main Control Room. Although it was required that the necessary hot shorts be postulated for a fire in the swing EDG room (and the safe shutdown procedures provide a means for coping with the hot shorts), analysis indicates that a steam environment would **not** result in the hot shorts necessary to cause these valves to close spuriously.

In conclusion, even if the steam released from open HPCI rupture disks were to reach the Isolation Condenser control panels in the swing EDG room, operation of the Isolation Condensers would remain unaffected.

3. **Would the steam release fail either unit's 125 VDC main bus?**

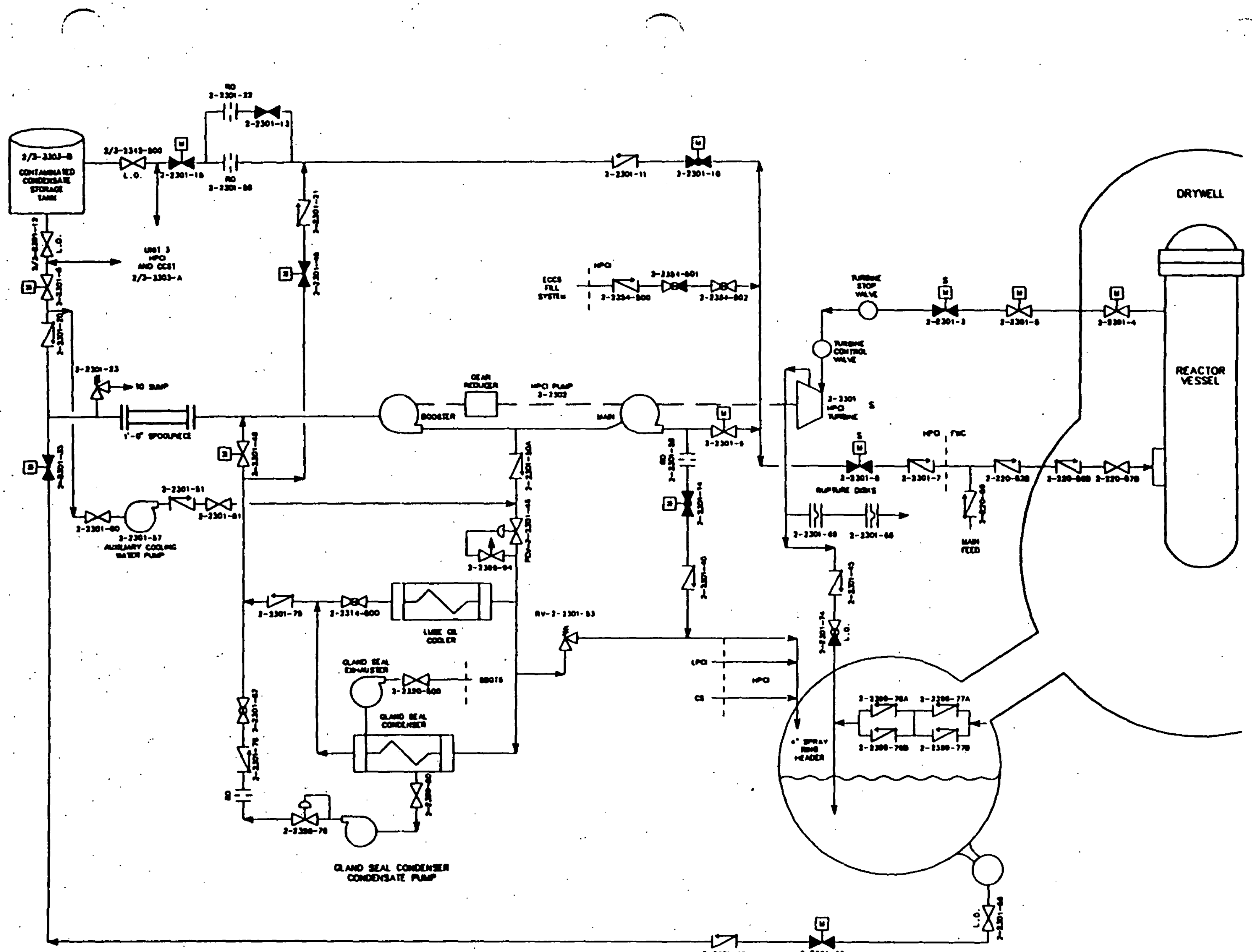
The Dresden PRA models show that the bus has a high importance, and that failure of a unit's 125 VDC main bus would give a large increase in that unit's core damage frequency (CDF). The busses are located on the Mezzanine Level of the Turbine Building, well isolated from any steam release from open HPCI rupture disks. Review of 125 VDC circuits that could be threatened by the steam release and knowledge of the behavior of moisture-induced faults indicates that any faults caused by the steam environment would likely have a high impedance. Furthermore, consideration to date of fuses and breakers for the 125 VDC distribution system has concluded that high impedance 125VDC faults in the HPCI room or swing EDG room would not propagate and cause failure of the main bus.

4. **Does the possibility of HPCI rupture disks opening significantly impact the Dresden PRA results?**

Based on the conclusions above, consideration of the probability of HPCI rupture disks opening, and the discussion in Attachment B, this event does **not** significantly affect the Dresden PRA results. The principal effects of this event would be localized to the HPCI room, and little or no impact is anticipated in other areas of the plant. Due to differences between Dresden and Quad Cities in the location of the rupture disk (discussed in Attachment B), a HPCI rupture disk failure event appears to be less likely at Dresden than at Quad Cities.

Furthermore, Dresden preventive maintenance requirements were strengthened in response to the June 1993 Quad Cities event. The HPCI rupture disks are now replaced every refueling outage and also if the burst pressure is approached but not reached. For example, a HPCI exhaust line stop check valve failed in August 1994 as detailed in Dresden 2 LER 94-021. The failure resulted in an automatic high exhaust pressure HPCI turbine trip at 2500 rpm. (Note that the turbine speed is 4000 rpm at full power conditions on the HPCI turbine.) The HPCI rupture disks were replaced due to reaching a pressure greater than 80% of their burst pressure value.

The HPCI failure probabilities used in the Dresden PRA were based on Dresden operating experience for 1984 through 1990. No HPCI rupture disk opening events occurred at Dresden during this period. The Dresden PRA model included premature rupture disk opening and used a generic industry failure rate from NUREG/CR-4550; the contribution of premature rupture disk opening to the total HPCI failure probability was insignificant, however. Even if the subsequent rupture disk history of all six ComEd BWR units were included in estimating a rupture disk contribution to the HPCI failure rates, the increase due to rupture disks opening would be a small fraction of the observed Dresden HPCI failure rates already used. Consequently, the resulting increase in Core Damage Frequency calculated for Dresden would also be small. For these reasons, the possibility of HPCI rupture disks opening does not significantly impact the Dresden PRA results.



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M-29, SH 1, REV AU
M-35, SH 1, REV BU
M-51, REV AK

Fig. A-1. Simplified Diagram of Dresden 2 High Pressure Coolant Injection System.

Attachment B

Failure Modes and Effects of Dresden HPCI Exhaust Line Rupture Disks

The purpose of this evaluation is to discuss potential failure modes of the rupture disks on the Dresden 2/3 HPCI exhaust steam lines and the resultant effects on plant systems. This evaluation is motivated by recent questions related to the rupture disk opening event that occurred at Quad Cities on June 6, 1993. The Quad Cities rupture disk opening event was determined to be the result of water intrusion in the turbine casing, leading to a water slug discharge to the exhaust line during a rapid pump start, which caused pressurization of non-condensibles beneath the rupture disks located in a direct path from the turbine exhaust. This caused failure of the rupture disks and release of steam to the room. Isolation occurred rapidly, and the primary damage effects experienced were attributable to a shock wave generated by the rapid release of the non-condensibles trapped and pressurized below the disks.

Failure modes

The Dresden HPCI exhaust line rupture disks are located downstream of the turbine exhaust, and are located in a standpipe that tees off a horizontal section of the exhaust pipe. This configuration does not allow direct water slug impingement on the disks in the event of a water intrusion event. The set pressure for the disks is approximately 140 psig, and the intent is to provide overpressure protection for the exhaust line in the event the exhaust line was isolated via a manual isolation, or due to failure of the check valve in the line. Pressure switches in the line will trip the turbine if the exhaust pressure exceeds 100 psig. Normal operating exhaust line pressure is approximately 25 psig.

Therefore, the principal modes of failure are failure of the check valve, or isolation of the line causing a pressure transient on the line, or material failure of the disks at normal operating pressure. It should be noted that the material failure of the rupture disks is considered unlikely, since two disks are located in series, with a pressure switch alarm to warn of incipient failure of the inboard disk. Given the geometry of the Dresden exhaust lines, a water intrusion event would need to nearly fill the exhaust lines in order to achieve the transient pressure needed to fail the rupture disks.

Effects of Failure on Plant Systems

The effects of HPCI steam exhaust line rupture disks opening on plant systems would be similar to but bounded by a HPCI steam supply line break in the HPCI room. The effects of a HPCI steam supply line break would be direct release of steam at reactor pressures (1005 psig saturated steam) to the room, causing pressure transients capable of moving the blowout plugs in the HPCI room ceiling, and room temperatures of nearly 300F in the HPCI and swing Emergency Diesel Generator (EDG) rooms. The flow would be terminated by isolation valve closure after approximately 60 seconds, and a plant trip is anticipated as a result of the event.

HPCI steam exhaust line rupture disks opening would release steam at considerably lower pressures and higher moisture content. The pressurization effects are considerably less limiting, and would not necessarily lead to the lifting of the blowout plugs in the ceiling. The room temperatures would tend to be considerably lower, with little or no superheating expected due to the high moisture content of the steam. Under many scenarios the duration of the steam release would be less because high exhaust pressure would cause a rapid HPCI turbine trip. The overall plant response would be much more benign and plant trip would be unlikely since the net steam flow from the reactor would not be affected significantly. The principal effects of this event would be localized to the HPCI room and little or no impact is anticipated in other areas of the plant.

ATTACHMENT C

Dresden IPE Treatment of HPCI Steam Line Break Events

Did the treatment of HPCI steam line break initiators presume good performance of the isolation valves?

The Dresden IPE addressed the issue of HPCI steam line break events outside containments using the IPE Methodology developed by the industry. A HPCI steam line rupture was reviewed but was removed from further consideration in the Dresden IPE due to an estimated frequency of 1.2E-08/yr for an unisolated HPCI steam line rupture. This estimate credited one isolation valve and used an isolation valve failure rate of 6.0E-03/demand. This value was provided in the industry IPE Methodology guidelines and was more than three times higher than the Dresden plant-specific MOV fail-to-function rate averaged over all MOVs in the Dresden PRA.

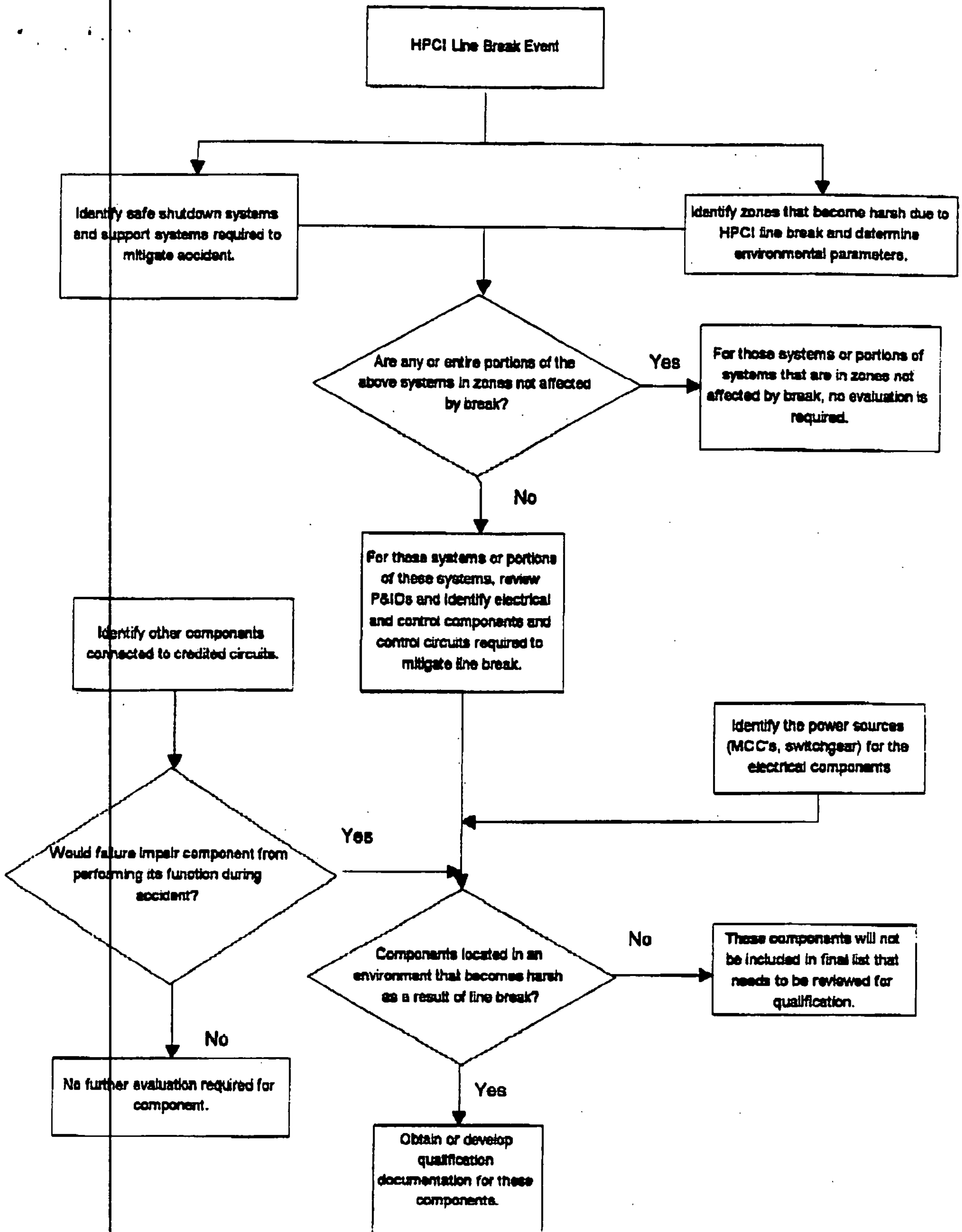
Subsequent MOV testing and analysis in response to Generic Letter 89-10 found that the Unit 3 inboard and outboard HPCI steam line isolation valves could possibly not close due to valve guide damage during blowdown should a steam line rupture occur. This finding was documented in Dresden 3 LER 94-006. The analysis concluded, however, that a steam line leak would not cause valve guide damage, and that the isolation valves would be able to perform their design function under steam leak conditions. Modifications correcting this problem had already been performed on the Dresden 2 HPCI isolation valves. Modifications to Dresden 3 HPCI isolation valves were performed after the LER submittal.

The purpose of the IPE was to search for vulnerabilities, not to predict failures of individual components. Use of the IPE Methodology was appropriate for the purpose of selecting initiating events. The Generic Letter 89-10 concerns were known at the time of the preparation of the Dresden IPE, and station efforts to address those concerns were already underway. (The resulting modifications occurred during the Dresden 2 and 3 refueling outages following the issuance of the Dresden IPE submittal report.) Therefore, assuming higher isolation valve failure rates and analyzing a HPCI steam line break would not have given new insight regarding this potential (at that time of the IPE) vulnerability, already identified and being addressed.

In hindsight, Generic Letter 89-10 testing and analysis results could be used to determine a higher unisolated HPCI steam line break frequency. This approach would not give insight regarding the current safety of the plant, however, because subsequent improvements of isolation valves as a result of the Generic Letter 89-10 testing gives reasonable assurance today that the failure-to-function probability for these HPCI isolation valves is low and that the failure-to-function rate provided by the IPE Methodology is currently appropriate for the HPCI systems.

In summary, review and removal of the HPCI steam line break initiator from detailed consideration in the IPE used a valve failure rate from the industry IPE Methodology that was more than three times higher than the historic Dresden failure rate. Therefore, the Dresden IPE presumed poorer isolation valve performance than that indicated by Dresden operating history. Furthermore, based on recent modifications to the HPCI isolation valves, the performance assumed for the IPE is appropriate for the current condition of the HPCI isolation valves.

Attachment D
Design Basis Reconstitution for EQ for HPCI Line Break



ATTACHMENT E

Schedule for Design Basis Reconstitution for EQ for HPCI Steam Line Break

Task	Expected Completion Date
1) Prepare Justification for Continued Operation (JCO)	Completed
2) Determine environmental parameters for areas now considered affected.	Completed
3) Reconfirm/identify function and systems relied upon for safe shutdown.	Completed
4) Reconfirm/identify electrical equipment necessary for item (3)	07/31/95
5) Identify equipment in item (4) located in areas now considered affected.	08/15/95
6) Perform walkdown to verify nameplate data for equipment in item (4).	09/30/95
7) Obtain/review EQ documentation for equipment in item (4) which may not ave been previously included in EQ program.	10/31/95
8) Develop plans and schedules for preparing EQ documentation for any equipment in item (5) not covered in item (7).	11/30/95
9) Prepare updates for licensing and design basis documentation (UFSAR, etc.).	06/30/96
10) Submit UFSAR updates	12/31/97

Attachment F

Dresden HPCI Steam Line Break Environmental Qualification (EQ) Concerns and Summary of Justification for Continued Operation

Description of Issue

Previous EQ zone maps consider the LPCI/Core Spray corner rooms as mild environments for the HPCI line break in the torus area. The location of the HPCI steam line break would be classified as a harsh environment for this event. The swing EDG room was considered to be a mild environment and was not included as an EQ zone. Previous EQ analyses considered the torus area as the worst location for a HPCI steam line break and did not consider the effects of a line break in the HPCI room on other EQ zones.

It is now apparent that the corner rooms or swing EDG room would in fact experience a short duration steam environment as a result of line break scenarios in the torus area or in the HPCI room. It is not clear that the equipment in the corner rooms or swing EDG rooms would fail as a result of this event. The short duration of the blowdown would limit the equipment heatup, and the principal effect of concern is condensation on electrical equipment. However, until environmental qualification can be established, the operability of the corner room and swing EDG room equipment during this event is in question.

HPCI Line Break Scenario

This scenario is the double-ended failure of the HPCI steam line (10") in the torus area or HPCI room. This failure would release approximately 600 lb/s of reactor steam. Isolation of the HPCI steam line will occur as a result of a high flow trip in approximately 1 minute. The reactor is expected to trip within several seconds on high level as a result of the 22% step load increase caused by the line break. Licensing requirements lead to the assumption of simultaneous loss of offsite power (LOOP) on the affected unit. Therefore, the main condenser (normal heat sink) would be lost. Following isolation of the broken HPCI steam line, the reactor would repressurize and transfer decay heat to the suppression pool via the relief valves.

Coping with HPCI Line Break

The principal concerns following this event are to control vessel inventory, maintaining level above the top of active fuel (TAF), and to establish a long term heat sink for the core decay heat. Vessel level can be restored and controlled by limiting the cooldown rate and adding water via either Control Rod Drive (CRD) pump of the affected unit or via the CRD cross tie to either CRD pump of the opposite unit. Multiple power supplies exist for the CRD pumps of both units. Completion of installation of the Station Blackout alternate AC sources and the Division I cross tie to the opposite unit will provide additional power supplies to further assure level control of the vessel during a LOOP on the affected unit.

Restoration of the heat sink is the principal difficulty that would arise as a result of this event. The Isolation Condenser system would be the path of choice, allowing the plant to be brought to a stable hot shutdown condition. Slow depressurization of the vessel to the entry point for the Shutdown Cooling System would allow bringing the plant to a stable cold shutdown condition. In the event that Isolation Condenser operation is lost, the suppression pool can absorb decay heat for approximately 4 hours with some vessel depressurization required to stay within the Heat Capacity Temperature Limit (HCTL) curves. Access to the corner rooms for restorative maintenance activities would be achievable shortly after the break isolation. It is considered likely that a LPCI pump would be able to be started (in the suppression pool cooling mode) within four hours of the event. Although offsite power is assumed to be lost, it is highly likely that power would be restored shortly after the event, and this would allow use of the main condenser as a heat sink, as well as a range of bleed/feed and alternate injection methods if needed.

Probability of Break, Plant Trip, LOOP

The probability of a double guillotine break of steam line piping failure is very low. The HPCI steam line piping to the HPCI turbine is made of A106, Grade B, carbon steel. The nominal operating pressure and temperature of 1000 psi, 550 F to the HPCI turbine is lower than the maximum allowable pressure. Additionally, since the material is ductile with relatively high fracture toughness, a slowly opening break is the most likely, and the plant control system would be able to balance the steam flow changes, reducing the likelihood of plant trip.

It is also noted that the HPCI steam piping is ASME Section XI Class 1 and 2, and is included in the ISI program. This provides further assurance that any conditions leading to a break will be detected prior to the break.

Although such event combinations are typically postulated as part of licensing bases analyses, insights from recent probabilistic risk assessments (PRAs) have shown that the frequency of a concurrent LOOP and HPCI steam line break is much less than 1 E-7/yr and is not a credible event. This further supports the expectation that a LOOP will not be likely in this event.

Conclusions

Based on the discussion provided above, it can be concluded that the probability of a design basis HPCI line break in the torus area or HPCI room and the postulated simultaneous LOOP is very low. If the event actually were to occur, the plant could achieve and be maintained in a safe shutdown condition, with vessel inventory assured, through the use of equipment unaffected by the line break and current station procedures. It is considered appropriate to review the bases of equipment qualification for this event and develop upgrades as needed. However, the small impact on safety margins justifies continued operation of the plant during the performance of these evaluations.

Reference: J.W. Dingler letter to B. Pikelny dated 7/26/94 with attachment providing safety evaluation of HPCI Steam Line Break event for Dresden Station.

ATTACHMENT G

Information Regarding Isolation Condenser Tube Integrity

Aside from Dresden Units 2 and 3, only three other U.S. Nuclear plants have an Isolation Condenser system: Oyster Creek, Millstone Unit 1, and Nine Mile Point Unit 1. Each of these plants were contacted in an effort to determine if tube degradation had ever been encountered and what on-going actions are taken to ensure continued tube integrity. The following is a synopsis of the information obtained:

1. Only one instance of Isolation Condenser tube degradation has ever been observed at a U.S. BWR. This instance occurred at Millstone Unit 1 following an automatic shutdown from full power in 1976. During this incident a small amount of radioactive steam and water was discharged from the Isolation Condenser vent as the result of a tube failure. Subsequent visual inspection of the tube bundle revealed a tube with a 1 inch hole in the tube wall at the "U" bend. Eddy current testing of the remaining tubes indicated that approximately 30% of the tubes had crack indications. This incident prompted the NRC to issue IEB 76-01, "Isolation Condenser Tube Failure," which required licensees to submit plans to ensure continued integrity of their Isolation Condenser tubes. According to the Millstone Unit 1 Isolation Condenser System Engineer, the mechanism of the cracking was determined to be stress corrosion cracking and the tube bundles were subsequently replaced with Inconel tube bundles. The root cause of the cracking was attributed to a major saltwater intrusion that had occurred at the plant in 1972. For a period of several years after the intrusion, Millstone experienced tube failures in many of their heat exchangers.

   The root cause determined by Millstone Unit 1 in 1976 is consistent with the information known regarding Intergranular Stress Corrosion Cracking (IGSCC) of susceptible type 304 stainless steel materials today. In the essentially pure and highly oxygenated BWR environment, type 304 stainless steel materials are considered to be susceptible to IGSCC only when: 1) the material is under a sufficient stress field, and 2) the material has been sensitized in some fashion, and 3) the material experiences prolonged exposure to temperatures exceeding 200F.

   Although the cracking experienced at Millstone Unit 1 is not surprising given the significance of the saltwater intrusion that occurred there, IGSCC would not be expected to occur in the type 304 stainless steel Isolation Condenser tubes exposed to the typical BWR environment. These tubes see no steam flow and are surrounded by the shell side clean demineralized water during normal plant operations. Under these conditions the tube temperature is maintained below 200F. As stated above, type 304 stainless steel is not considered to be susceptible to IGSCC in the typical BWR environment at these temperatures. The only time this tubing is exposed to temperatures greater than 200F is during the very infrequent times that the Isolation Condenser System is actually operating, and reactor steam is passing through the tubes and being condensed by the shell side demineralized water surrounding the tubes.

The excellent service history of these Isolation Condenser tubes at all U.S. plants (when exposed to the typical BWR environment) is consistent with that which should be expected based on the infrequent exposure of the tubing to elevated temperatures.

2. All Isolation Condenser plants periodically (e.g., monthly) take samples of the shell side water to analyze for increased radiological activity. Any unexplained increases would be attributed to a tube leak. Note: This action is in response to IEB 76-01.

3. All Isolation Condenser plants perform a Maximum Heat Removal Capability Test every five years. Any Isolation Condenser tube leakage would be detected by the radiation sensing elements in the shell side vent piping.

4. All Isolation Condenser plants perform some type of periodic pressure testing of the tubes per the ASME Code, Section XI. These tests are either performed each period (3 1/3 years) per Class 2 requirements or at the end of each refuel outage per Class 1 requirements. At Dresden Station the Isolation Condenser tubing is tested each refuel outage by monitoring the level in the shell side of the Isolation Condenser during performance of the Reactor Vessel System Pressure Test, at which time the Isolation Condenser tube side is filled with water and pressurized to a minimum of 1000 psig. Any rise in the shell side level experienced during the tube side pressurization would be attributed to tube leakage. Note: This action is in response to IEB 76-01.

5. In addition to the above testing performed at all Isolation Condenser plants, Dresden Station also performs an inspection of the Isolation Condenser internals each outage with the Isolation Condenser drained.

6. No Isolation Condenser plant currently performs periodic Eddy Current Testing to monitor for tube degradation. Access to the Isolation Condenser tubes is restricted by a welded cover plate beneath the bolted head that would have to be ground off to make the tube bundle accessible for Eddy Current Testing. Due to the excellent service history of Isolation Condenser tubes (when exposed to the typical BWR environment) throughout the industry, the extensive periodic monitoring currently being performed, and the ability to isolate the tube bundles should leakage be detected, the significant burden that would be associated with periodic Eddy Current Testing is not deemed warranted at this time.

In addition to the periodic monitoring of the Isolation Condenser tubes for degradation, the system piping also undergoes extensive augmented ultrasonic examinations on an on-going basis per the requirements of Generic Letter 88-01, "NRC Position on IGSCC in BWR Austenitic Stainless Steel Piping." This Generic Letter requires an augmented ultrasonic examination program for all weldments in BWR piping made of austenitic stainless steel that is NPS four inches or larger and contains reactor coolant at a temperature above 200F during power operation. The frequency at which these examinations must be performed is dependent upon the actual piping materials and any IGSCC mitigation methods that may have been employed to reduce the susceptibility of the materials.

The Isolation Condenser system piping that falls under the scope of Generic Letter 88-01 is as follows (see Fig. G-1 provided for reference):

- The steam supply piping from the RPV to Isolation Condenser Steam inlet nozzle.

- The condensate return piping from the outboard containment isolation valve to the tie in with the Shutdown Cooling system piping.

Note: The condensate return piping from the Isolation Condenser condensate return outlet nozzle to the outboard containment isolation valve contains reactor coolant at temperatures <u>less</u> than 200F during power operation and as such, does not fall under the scope of Generic Letter 88-01.

The Isolation Condenser system piping welds have undergone extensive, periodic ultrasonic examination by EPRI qualified examiners since issuance of Generic letter 88-01. These examinations have not identified any cracking to date in the system piping welds.

In addition to the on-going ultrasonic examination program, several actions have also been taken to reduce the IGSCC susceptibility of the Isolation Condenser System piping at Dresden Station. These actions include the following:

- All accessible (accessible to the Mechanical Stress Improvement Fixture) Isolation Condenser system welds considered to be highly susceptible to IGSCC have been stress improved.

- Corrosion resistant inlays have been applied to the wetted surfaces of inaccessible welds located on the inside of containment penetrations.

- The Unit 3 condensate return piping from the outboard containment isolation valve to the tie in with the Shutdown Cooling system piping has been replace with IGSCC resistant material.

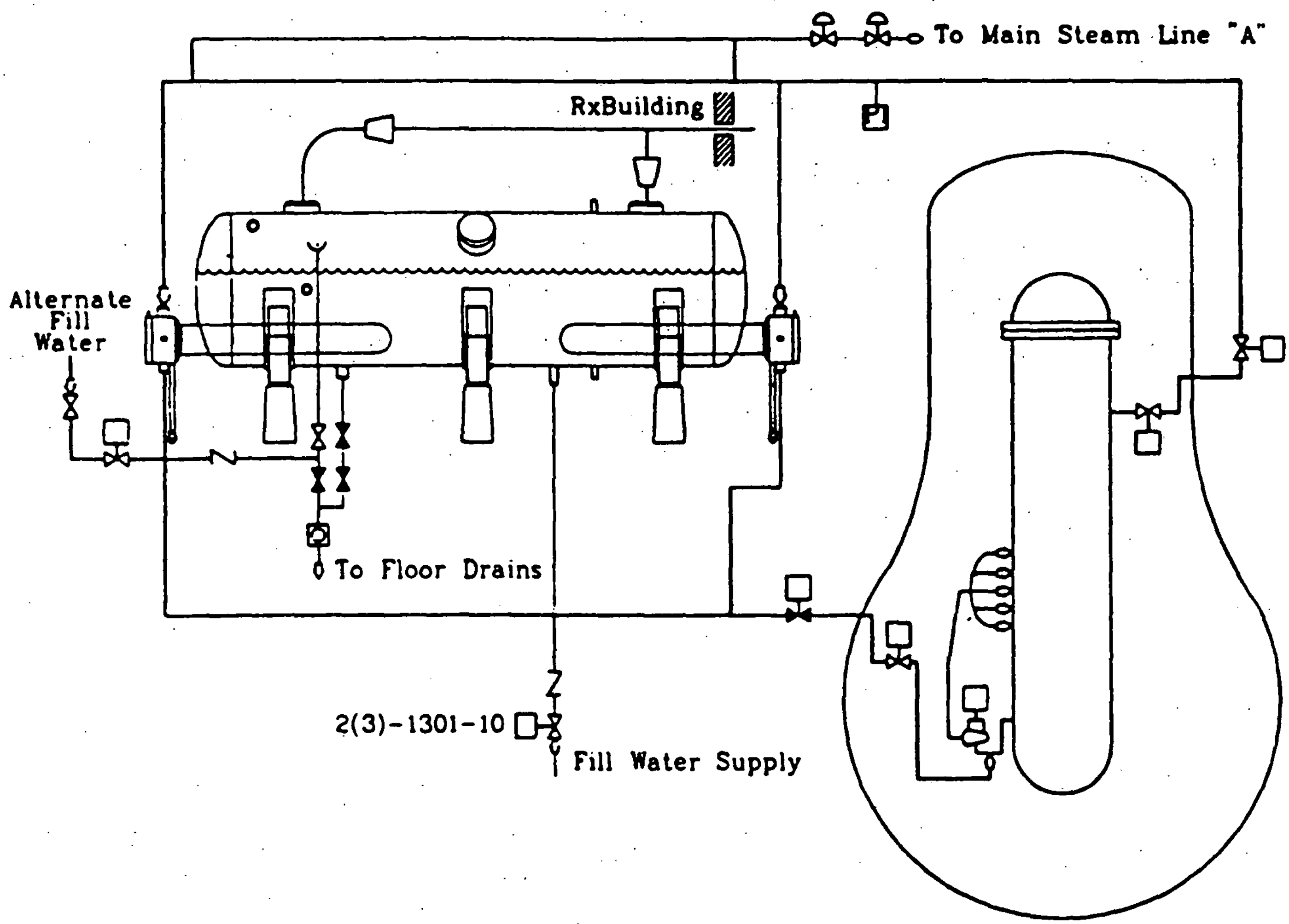


FIG. G-1 ISOLATION CONDENSER SYSTEM SIMPLIFIED SCHEMATIC