Commonwealth Edison
1400 Opus Place
Downers Grove, Illinois 60515

October 3, 1994

Mr. William T. Russell, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attn: Document Control Desk

Subject: Quad Cities Station Units 1 and 2
Response to NRC Request for Additional Information (RAI)
NRC Docket Nos. 50-254 and 50-265

References:
(1) C.P. Patel to D.L. Farrar letter dated June 9, 1994
(2) J.L. Schrage to W.T. Russell letter dated August 8, 1994
(3) J.L. Schrage to W.T. Russell letter dated September 2, 1994
(4) Teleconference between the NRC (J. Stang, et al) and ComEd (J. Schrage, et al) on September 13, 1994

Mr. Russell,

In Reference (1), the NRC Staff identified additional information which would be required in order to review and approve the Quad Cities Station Individual Plant Evaluation.

ComEd provided the requested information in Reference (2), with the exception of a response to Question 12 regarding internal flooding. In Reference (3), ComEd provided a projected date for the submittal of the response to Question 12 (September 30, 1994). The requested information is provided as Attachment A to this letter.

During the Reference (4) teleconference, ComEd and the NRC staff discussed the need for additional information pertaining to Question 34. The requested information is provided as Attachment B to this letter.

k:/nla/quad cities/093094/1

A001 1/1

If there are any questions, please contact this office.

Very truly yours,

John L. Schrage
Nuclear Licensing Administrator

Attachment A: ***Response to Question 12: Internal Flooding***

Attachment B: ***Supplemental Response to Question 34: ADS Enhancements***

cc: J. Martin, Regional Administrator - Region III
C. Miller, Senior Resident Inspector - Quad Cities Station
R. Pulsifer, Project Manager - NRR
E. Lois, RES/SAIB
Office of Nuclear Facility Safety - IDNS

ATTACHMENT A

Response to Question 12: Internal Flooding

Attachment A

Question 12

12. The submittal screened out internal flooding as a contributor to core damage frequency. Please provide (a) a description of the flood sources considered, (b) the locations of these sources, (c) the equipment failed as a direct result of the floods, and (d) the criteria used for screening out the floods. Also, the DET noted that the electrical switchgear in the turbine building is subject to flooding from overhead water bearing lines, and in fact one of the MCCs had a tarpaulin installed to prevent water from dripping into the switchgear. How did the IPE address flooding-induced failure of electrical switchgear in the turbine building?

Response to Question 12

This response first addresses the issues 12(a) through 12(d) given in the question. For clarity, the response to issue 12(c) follows the response to 12(d). The response to these four issues focuses on the internal flooding analysis that was performed prior to the submittal of the Quad Cities IPE Submittal Report.

The last section of the response addresses the question of failure of electrical switchgear in the turbine building. The response to the question on electrical switchgear also includes a summary of further walkdowns and analyses related to water spray that were performed subsequent to the submittal of the Quad Cities IPE Submittal Report.

(a) Description of the flood sources considered

As discussed in Section 4.4.4 (page 4-171) of the IPE Submittal Report, pipe, tank, and valve ruptures, etc., were considered. The internal flooding analysis considered potential flood sources from many different systems, especially those with pressurized water lines and large volume storage tanks.

Of the many potential sources, several were determined to be insignificant (with respect to the volume of water that would result from component failure) or outside the scope of the internal flooding analysis for other reasons discussed below:

> Pipes which are normally free of liquid, such as drain lines and uncharged (either dry pipe or dry chemical) fire protection lines, were not considered credible water sources.
>
> The analysis did not explicitly address water entering zones via backflow through the drain systems. The drain lines in some zones, such as the Corner Rooms,

contain check valves to alleviate this concern. Other zones, such as the HPCI pump rooms, utilize sumps and sump pumps to remove any accumulated water. These zones would likewise not be expected to experience flooding via drainline backflow.

Fire protection systems were reviewed for their independent contribution to flooding. Fire-induced flooding due to proper operation during a fire event was considered to be within the scope of the external event analysis and thus outside the scope of the internal flooding analysis.

High energy pipe breaks outside containment were addressed in a separate analysis as summarized in Attachment 48-1 in the response to Question 48. Therefore, these high energy lines were considered outside the scope of the internal flooding analysis.

Further assumptions on flooding sources were made in the quantitative analysis of the zones that remained after the screening criteria were applied. These assumptions are listed in the response below for issue 12(c). The significant flooding sources that contributed to the quantitative analysis discussed in the response to 12(c) were the Service Water (SW), RHR Service Water (RHRSW), and Fire Protection (FP) systems.

(b) <u>Locations of these sources</u>

As discussed in Section 1.4.5 (page 1-20) and Section 4.4.4.1 (page 4-171) of the Quad Cities IPE Submittal Report, the fire zones developed for the Quad Cities Safe Shutdown Report (and defined in Quad Cities 1 and 2 Fire Hazards Analysis Report) were used as flooding zones. The fire zones were confirmed to be acceptable as flood zones during the flooding walkdown. Attachment 12-1 lists the flood zones, elevation, and zone identification numbers addressed in the Quad Cities IPE. The location of flood sources, of course, correspond to these zones.

(d) <u>Criteria used for screening out the floods</u>

The screening process used for flooding events is summarized in Section 4.4.4.2 (page 4-174) of the Quad Cities IPE Submittal Report which includes the following conclusion:

"The flooding zones judged to be of possible significance were, therefore, those containing both safe shutdown equipment and equipment whose failure would result in a reactor trip. These zones were investigated during the plant walkdowns. Other flooding zones were eliminated from further analysis as possible contributors to core damage."

Further details on the screening process are provided as follows:

Zones which contained no safe shutdown equipment and zones which were outdoors were considered outside the scope of the internal flooding analysis. Also, the drywells and contents (zones 1.2.1 and 1.2.2 - see Attachment 12-1) were omitted from the flooding analysis because the drywells are designed for the effects of a LOCA event which was considered to bound any other postulated drywell flooding event. Zones where flooding would not result in a plant trip were considered only for their potential propagational effect on adjacent zones.

A flood-induced initiating event was defined in the ComEd analysis as any flood event which results in both a reactor trip (either automatically or manually within two hours) and the failure of a safe-shutdown system. Conditions requiring manual trips after the initial two-hour period were considered to be outside the scope of this analysis.

Each zone was screened to determine those zones which were susceptible to flooding and flooding-induced failures. This screening was achieved by two approaches. The first approach assumed a complete flood of each zone and then removed from further consideration those zones where flooding would not require a reactor trip within two hours. The second approach evaluated the available drainage paths (such as doorways, open hatches, stairways, etc.) to determine whether zone flooding is realistically possible. The remaining zones were then examined in greater depth through qualitative analysis, as discussed in Section 4.4.4.3 (page 4-174) of the Quad Cities IPE Submittal Report. The qualitative analysis considered the impact of zone flooding on equipment within the zone.

Potential flood propagation was also assessed. Barriers (such as watertight doors and curbing) and available drainage were considered. Walls were assumed to remain intact and essentially watertight throughout a flooding event. Likewise, doors were assumed to remain intact and in their normal position. Most of the upper areas of the Turbine and Reactor Buildings are equipped with open stairways and grate-covered floor openings which would permit flow to lower levels. These openings were considered sufficient to drain any credible flood to the lower building elevations. Minor curbing in some areas, except around stairwells, would not significantly affect this drainage capability. Therefore, flooding was generally considered to be a credible event in only the lowest building elevations. The only exception would be those enclosed areas which have both significant water sources and no available drainage pathways, such as rooms sealed with watertight doors.

For the reactor buildings, the corner rooms are the areas containing safe shutdown equipment and located at the lowest elevations. Each unit has four corner rooms.

Two corner rooms per unit (Zones 11.2.1, 11.2.3, 11.3.1, and 11.3.3 - see Attachment 12-1) were found to have only in-room potential flooding sources.

These corner rooms contain the Core Spray and RCIC pumps and were eliminated due to the standby status and relatively small water volumes in components located within the rooms; thus, no further flooding analysis of these rooms was required.

The remaining corner rooms contain the RHR trains (Zones 11.2.2, 11.2.4, 11.3.2, and 11.3.4). Potential flooding of these zones due to in-room sources was eliminated due to the standby status and relatively small water volumes in components located within the rooms. Based on limited flood propagation paths and corner room drain capacity, flooding due to propagation from other zones was judged to be probabilistically insignificant.

Subsequent discussions with Quad Cities personnel clarified that flooding or water spray in the corner rooms would not result in a reactor trip, thus confirming the decision to screen these corner rooms.

The only zones remaining after the screening and analysis discussed above were those at the lowest Turbine Building elevations, i.e., the condensate pump rooms. The quantitative analysis for these rooms is outlined in the response to 12(c) given below.

(c) The equipment failed as a direct result of the floods

Zone 8.2.1.A, the Unit 1 Turbine Building Condensate Pump Room, is located at the lowest elevation in the Unit 1 Turbine Building. Zone 8.2.1.B, the Unit 2 Turbine Building Condensate Pump Room, is essentially identical to Unit 1 Zone 8.2.1.A. Significant piping breaks or component ruptures elsewere in a unit's Turbine Building are generally expected to propagate to the unit's Condensate Pump Room. The existing drains and sumps were assessed to be insufficient to mitigate a significant flood source. Therefore, these zones contributed to the internal plant flooding frequency.

The significant components in these zones consist of the Condensate pumps, Condensate booster pumps, control rod drive pumps, and the pump motors. Should these zones flood, the Condensate pumps are expected to trip, resulting in a loss of feedwater. Since all aspects of a flood in these zones are essentially the same as the Loss of Feedwater transient initiating event, a separate internal flooding initiator was not required. Instead, the internal flooding analysis concluded that the frequency estimated for a flood in these zones could simply be added to the existing Loss of Feedwater initiator as discussed in detail below. Note that the RHR Service Water Pumps are also located at this elevation, but are protected inside watertight compartments adjacent to the condensate pumps. They are, therefore, not subject to failure by flooding of the Condensate Pump Rooms.

To determine a Condensate Pump Room flooding frequency, detailed consideration was given to potential flooding source in the room and potential sources at higher Turbine

Buidling elevations that could propagate to the room. The following assumptions were made in calculating a realistic flooding frequency:

1) Pipes and components greater than two inches were were evaluated as potential flooding sources. Smaller pipes and components were omitted.

2) Any pipe break greater than two inches or other component failure in the Turbine Building areas was initially assumed to flood the condensate pump area. Many lines greater than two inches are incapable of providing sufficient volume to produce a significant flood and were reviewed on a case-by-case basis. Likewise, some closed loop systems have total volumes which are also insufficient to result in a significant flood.

3) Without regard to the piping system postulated to fail or operator action to mitigate the failure, a Condensate pump area flood of sufficient magnitude to trip the Condensate pumps was assumed.

Application of the general assumptions above gave the following results for potential sources of the Condensate Pump Room:

The Acid and Caustic systems were removed from further consideration. Given their small volumes (compared to the volume of water necessary to flood the Condensate pump area), they are not realistic flooding sources.

The Clean Demineralized Water system is a relatively low-volume system. It was therefore removed from further consideration.

The Condensate and Feedwater systems were removed as potential flooding sources for the Condensate pump area. Should components within either system fail, the result is a loss of the system itself. Therefore, the components within these systems were omitted to avoid double counting.

The Diesel Generator Cooling Water (DGCW) system provides cooling water to the diesel generators. Since this system operates only when the diesels are operating, a component failure when the unit is at power will not provide the volume of water necessary to flood the Condensate pump area. Therefore, this system was omitted from further consideration.

The Fire Protection (FP) system serves sprinklers and hose stations throughout the facility. A component failure in any of the larger-diameter pipes in this system has the potential of delivering significant volumes of water. Although alarms will alert the operators of a system breach, this system was further analyzed as a potential flood source.

The Heating Steam system serves area heating units throughout the facility. Although a system breach may result in substantial steam (and heat) being introduced to an area, the resulting condensate volume would be insufficient to flood the condensate pump area. Therefore, this system was dropped from further consideration.

The Residual Heat Removal Service Water (RHRSW) system provides cooling to the LPCI heat exchangers. Each of its two loops (per unit) has a dedicated suction line from the crib house and discharges to the service water discharge flume. Although this system is only used when RHR is operating, it was further analyzed as a potential flood source since it interfaces with the SW system.

The Roof Drain system will only have significant water volumes during times of heavy rainfall. Since the system is not pressurized and provides simple gravity flow to the appropriate drainage system, its failure was not considered to be a risk-significant event. The system was thus removed from further consideration.

The Radwaste System transports radwaste from throughout the facility to the Radwaste Facility. Piping in this system is relatively small, is closely monitored and controlled, and is readily isolated by the operators if abnormal flow is detected. Thus, a system breach should not result in significant water volumes being released. The system was removed from further analysis.

The Service Water (SW) system delivers significant water volumes to loads within the Turbine Building. The breach of a major piping segment or component will deliver substantial quantities of water. Therefore, this system received further analysis.

The Turbine Building Component Cooling Water (TBCCW) system is a closed-loop system providing cooling to specific Turbine Building loads. However, given the large floor area which must be flooded before the Condensate pump motors are threatened, this fixed-volume system was not considered a viable threat. Therefore, it was removed from further consideration.

The internal flooding analysis for the Condensate Pump Rooms concluded that the only viable flooding sources were the SW, RHRSW, and FP systems. A review of the walkdown checklists for each Turbine Building zone was performed to obtain the SW, RHRSW, and FP component totals and piping lengths.

All these piping and components are non-primary coolant system (non-PCS) quality. Therefore, a recent study (S.A. Eide et al., "Component External Leakage and Rupture Frequency Estimates," Idaho National Engineering Laboratory, EGG-SSRE-9639, November 1991) was used which gave the following rupture rates:

Piping	1.2E-10/hour-foot
Valves	4.0E-10/hour
Pumps	1.2E-09/hour
Flanges	1.0E-10/hour
Heat Exchangers (shell)	4.0E-10/hour
Tanks	4.0E-10/hour

These rupture rates, the piping and component totals from Turbine Building walkdowns, and an annual exposure time of 8760 hour gave a frequency of 1.3E-02 per year for flooding of a unit's Condensate Pump Room, as given in Section 1.4.5 (page 1-20) and Section 4.4.4.4 (page 4-174) of the Quad Cities IPE Submittal Report.

As discussed in the ComEd response (including Attachments 2(a)-1 and 2(a)-4) to Question 2(a) of the Request for Additional Information) General Transient event group T1 included two types of loss of feedwater events (i.e., NUREG/CR-3862 Initiators 23 and 24). Group T1 is the major component of the General Transient initiating event frequency of 3.87 events per year.

Separate initiating event frequencies for each initiator listed for group T1 were determined for the IPE; summing the results for each gives a subtotal of 2.286 events per year for the group T1 initiators. Adding the flooding frequency of 1.3E-02 per year to group T1 gives a total frequency of 2.299 events per year. Rounding this total frequency to three significant figures gives the value of 2.30E+00 per year for group T1 that was reported in the ComEd response to Question 2(a).

In summary, the General Transient initiating event frequency used in the Quad Cities IPE does account for the internal flooding contribution. Nevertheless, as stated in Section 1.4.5 (page 1-21) and Section 4.4.4.4 (page 4-174) of the Quad Cities IPE Submittal Report, the contribution of internal flooding was probabilistically insignificant.

<u>How did the IPE address flooding-induced failure of electrical switchgear in the turbine building?</u>

Electrical switchgear in the turbine building with a potential to cause a unit trip or to affect safe shutdown equipment is located on the ground floor or higher elevations. Consequently, such switchgear is located in zones that were eliminated from flooding consideration by the screening discussed above.

Failure of electrical switchgear due to water spray was included in the calculation of the General Transient initiating event frequency by inclusion of Unit 2 Event #25 in Attachment 2(a)-3 to Question 2(a) of the Request for Additional Information. In that

event, a significant steam leak on the Turbine Building Mezzanine Floor (due to packing failure for a feedwater regulating valve) resulted in water leakage onto the electrical switchgear for 4 kV busses 21 and 22 located on the Turbine Building Ground Floor. A short across terminal contacts in this switchgear resulted in a turbine trip followed by a reactor scram. A Group I isolation also occurred during this event which is documented in Unit 2 LER #88-005.

The plant walkdowns of flood zones for the IPE not only addressed internal flooding using criteria discussed above in the response to issue 12(d), but also addressed water spray. The general criterion used was that spray sources within 10 feet of safe shutdown equipment (including electrical switchgear supporting safe shutdown equipment) should be identified and its impact evaluated. The susceptibility of safe shutdown equipment to water spray was used as a screening consideration.

During the preparation of the response to this question, however, the earlier review and analysis of water spray was found to have been incomplete. Spray or leaks from the plant heating system had not been included, and, additionally, the analysis of 15 of the zones listed in Attachment 12-1 was incomplete; ComEd regrets this oversight. The additional review and analysis for those 15 zones is summarized in Attachment 12-2 and in the discussion below.

<u>Recent Water Spray Analysis and Assumptions</u>

Further review and analysis of the effects of water spray on electrical switchgear was initiated to complete the IPE analysis. Additional plant walkdowns were performed to support this review. General assumptions used were as follows:

1) The effects of water spray on electrical switchgear were considered in the quantitative analysis. Although walkdown findings identified the potential of a unit trip resulting from the spray of other types of equipment, such trips were judged to fall within the General Transient initiator which, as discussed above, already included a contribution from a water spray event.

2) Because of the low pressure nature of the heating system, steam and condensate return piping and components were screened out from consideration as spray sources if they were not directly over electrical switchgear.

    Note: The concern noted by the DET appears to have resulted from an event in which an open plant heating system drain valve resulted in water dripping through an open floor penetration onto electrical switchgear. Although that event (documented in Unit 1 LER #91-027) did not lead to a unit trip, corrective actions were warranted. One corrective action (completed subsequent to the DET review)

was sealing the fan floor slab piping penetrations above the safety-related 4kV switchgear for busses 13-1, 14-1, 23-1, and 24-1.

3) Water spray from a rupture or leak was assumed to affect only one piece of electrical switchgear. Although cases were observed where a section of piping was within 10 feet of two different sets of electrical switchgear, such piping runs were small. Therefore, the frequency of a leak or rupture causing failure (i.e., de-energization) of two pieces of electrical switchgear was assumed to be probabilistically insignificant and not analyzed further.

Screening Results and Qualitative Analysis

Electrical switchgear (4 kV busses, 480 VAC motor control centers (MCCs), and DC busses) supporting safe shutdown equipment in the Turbine Building, Reactor Building, and Crib House were reviewed with Station Operations and Training personnel. Simulator scenarios were also run involving failure of selected pieces of electrical switchgear. As a result of this review, two pieces of susceptible electrical switchgear (i.e., capable of causing a unit trip and failing safe shutdown equipment upon de-energization) were found for each unit:

1. Failure of 4 kV busses 13 (Unit 1) or 23 (Unit 2) would result in a loss of two of the three circulating water pumps for the affected unit, and station procedures would require a manual scram if a second circulating water pump could not be restored immediately. Failure of these busses would also result in the loss of other equipment besides the two circulating water pumps.

2. Failure of 480 VAC MCCs 18-2 (Unit 1) or 28-2 (Unit 2) would result in loss of all steam tunnel (X-area) coolers for the affected unit. Loss of cooling in this area would eventually result in a Group I isolation and subsequent reactor scram. These MCCs were included in the quantitative analysis based on a conservative assumption that the Group I isolation would occur within two hours of the MCC failure. Failure of these MCCs would also result in the loss of other equipment besides the coolers.

The effects of water spray on these pieces of electrical switchgear were quantified as follows. A failure rate (due to water spray) was calculated for each piece of switchgear based on the geometry of potential spray sources in the vicinity, based on component leakage rates given in the reference cited in the response to 12(c) above, and based on the assumption that water spray on the switchgear would result in its failure, i.e., de-energization. Component *leakage* rates were used because they are appropriate for water spray analysis, while component *rupture* rates were appropriate for the flooding analysis discussed in the response to 12(c). These calculations are summarized in Attachment 12-3.

Quantitative Analysis for Busses 13 and 23

The resulting failure rate calculation for Unit 1 was bounding and therefore was used as the initiating event frequency for a special initiator added to the Quad Cities PRA model. Quantification of this special initiator gave a core damage frequency contribution (CDF) of 5.37E-09 per year. The dominant sequence for this special initiator is as follows:

FREQUENCY	DAMAGE ST	EVENT	VALUE	DESCRIPTION
6.918E-010	TLBS	IFL13	2.650E-003	FLOODING TRANSIENT IE (BUS 13)
		13	1.000E+000	LOSS OF BUS 13 (345KV AVAIL)
		14	2.800E-003	LOSS OF BUS 14 (345KV AVAIL)
		1IA	1.000E+000	UNIT 1 INSTRUMENT AIR FAILS
		PCSA	4.050E-001	POWER CONVERSION SYSTEM UNAVAILABLE
		FW	1.000E+000	FEEDWATER/CONDENSATE FAILS
		RHRHX	1.000E+000	RHR HEAT EXCHANGER FAILS
		SSMP1	2.820E-002	SSMP\CST FAILS; ALL SUPPORTS AVAILABLE
		CRD	1.000E+000	CONTROL ROD DRIVE INJECTION FAILS
		OCST	1.900E-002	OPTR FAILS TO ALIGN TO CCST SOURCE
		LVW	1.000E+000	8-IN WETWELL VENT FAILS
		LVD	1.000E+000	8-IN DRYWELL VENT FAILS

The frequency of this dominant sequence for the Bus 13 special initiator, 6.918E-10 per year, would give it the rank of Sequence #106 when compared with a ranked list of accident sequences from the Base IPE Model quantification. Therefore, addition of this special initiator does not affect the ranked list of the dominant 100 accident sequences given in Table 4.5.3-1 of the Quad Cities IPE Submittal Report.

Quantitative Analysis for MCCs 18-2 and 28-2

The resulting failure rate for Unit 1 was bounding and was therefore used as the initiating event frequency for a special initiator added to the Quad Cities PRA model. Quantification of this special initiator gave a CDF contribution of 4.08E-010 per year. The dominant sequence for this special initiator is as follows:

FREQUENCY	DAMAGE ST	EVENT	VALUE	DESCRIPTION
2.143E-012	TEFE	IFL182	7.130E-004	FLOODING TRANSIENT IE (BUS 18-2)
		1M1	7.344E-005	LOSS OF 125VDC TB MAIN BUS 1A
		1R1	8.375E-005	LOSS OF 125VDC TB RESERVE BUS 1B-1
		FW	1.000E+000	FEEDWATER/CONDENSATE FAILS
		HP1	1.000E+000	HIGH PRESSURE COOLANT INJECTION (SINGLE START) FAILS
		LPA	1.000E+000	RHR PUMP - TRAIN A FAILS
		LPB	1.000E+000	RHR PUMP - TRAIN B FAILS
		RCIC	1.000E+000	REACTOR CORE ISOLATION COOLING FAILS
		SMP1	1.000E+000	SAFE SHUTDOWN MAKEUP PUMP (SUCTION ALIGNED TO CCST) FAILS
		ADS	1.000E+000	AUTOMATIC DEPRESSURIZATION SYSTEM FAILS
		CS	1.000E+000	CORE SPRAY SYSTEM FAILS

The frequency of this dominant sequence for the MCC 18-2 special initiator, 2.143E-012 per year, would give it a rank of over Sequence #2000 when compared with a ranked list of accident sequences from the Base IPE Model quantification. Therefore, addition of this special initiator does not affect the ranked list of the dominant 100 accident sequences given in Table 4.5.3-1 of the Quad Cities IPE Submittal Report.

Revised Summary Table

Based on the quantification results discussed above, these two special initiators have an insignificant impact on the total CDF for Quad Cities. Note that Tables 4.6.2-1 (page 4-258) and 6.1-1 (page 6-2) of the IPE Submittal Report, however, included CDF results even for insignificant initiators. For comparison purposes, Attachment 12-4 summarizes CDF for all initiators, including these two special initiators. Addition of these two special initiators results in slight changes in the percent contribution of some of the other initiators, but the total CDF remains 1.20E-06 per year.

In summary, analysis of internal flooding and water spray events has found them to be insignificant contributors to the total CDF for Quad Cities Units 1 and 2. Nevertheless, ComEd regrets the incomplete analysis that had been performed prior to submittal of the Quad Cities IPE Submittal Report.

Attachment 12-1

QUAD CITIES INTERNAL FLOODING ANALYSIS

FLOODING ZONES

ZONES	NOMINAL ELEVATION	ZONE IDENTIFICATION
1.1.1.1	554.5'	Basement Floor (Unit 1 Reactor Building)
1.1.1.2	595'	Ground Floor (Unit 1 Reactor Building)
1.1.1.3	623'	Mezzanine Floor (Unit 1 Reactor Building)
1.1.1.4[1]	647.5'	Main Floor (Unit 1 Reactor Building)
1.1.1.5[1]	666.5'	Reactor Floor (Unit 1 Reactor Building)
1.1.1.5.A[1]	658.8'	Vent Fan Room (Units 1 & 2 Reactor Buildings)
1.1.1.6[1]	690.5'	Refueling Floor (Unit 1 and 2 Reactor Buildings)
1.1.1.6.A[1]	678.8'	Vent Fan Room (Units 1 and 2 Reactor Buildings)
1.1.2.1	554.5'	Basement Floor (Unit 2 Reactor Building)
1.1.2.2	595'	Ground Floor (Unit 2 Reactor Building)
1.1.2.3	623'	Mezzanine Floor (Unit 2 Reactor Building)
1.1.2.4[1]	647'	Main Floor (Unit 2 Reactor Building)
1.1.2.5[1]	666.5'	Reactor Floor (Unit 2 Reactor Building)
1.2.1	554.5', 595', 623', 647.5', 666.5', 690.5'	Primary Containment (Drywell - Unit 1)
1.2.2	554.5', 595', 623', 647.5', 666.5', 690.5'	Primary Containment (Drywell - Unit 2)
2.0	623'	Main Control Room (Service Building)
3.0	609'	Cable Spread Room (Service Building)
4.0	595'	Computer Room (Service Building)
5.0	595'	Safe Shutdown Pump Room (Turbine Building - Unit 2)
6.1.A	615.5'	DC Panel Room (Turbine Building - Unit 1)
6.1.B	615.5'	DC Panel Room (Turbine Building - Unit 1)
6.2.A	615.5'	DC Panel Room (Turbine Building - Unit 2)
6.2.B	615.5'	DC Panel Room (Turbine Building - Unit 2)
6.3	595'	Electrical Equipment Room (Service Building)
7.1	628.5'	Battery Room (Turbine Building - Unit 1)
7.2	628.5'	Battery Room (Turbine Building - Unit 1)
8.1[1]	590'	Clean and Dirty Oil Tank Room (Turbine Building - Unit 1)
8.2.1.A	547', 572.5'	Condensate Pump Room (Turbine Building - Unit 1)
8.2.1.B	547', 572.5'	Condensate Pump Room (Turbine Building - Unit 2)
8.2.1.C[1]	547'	Turbine Foundation (Unit 1)
8.2.1.D[1]	547'	Turbine Foundation (Unit 2)
8.2.2.A	572.5'	Upper Basement (Turbine Building - Unit 2)
8.2.2.B[1]	580'	Radwaste Pipe Tunnel (Turbine Building - Unit 1/2)

ZONES	NOMINAL ELEVATION	ZONE IDENTIFICATION
8.2.3.A	572.5	Upper Basement (Turbine Building - Unit 1)
8.2.3.B[1]	580'	Radwaste Pipe Tunnel (Turbine Building - Unit 1/2)
8.2.4	588'	Unit 1 Cable Tunnel (Turbine Building - Unit 1)
8.2.5	588'	Unit 2 Cable Tunnel (Turbine Building - Unit 1 & 2)
8.2.6.A	595'	Ground Floor (Turbine Building - Unit 1)
8.2.6.B	595'	Ground Floor (Turbine Building - Unit 1)
8.2.6.C	595'	Ground Floor (Turbine Building - Units 1 & 2)
8.2.6.D	595'	Ground Floor (Turbine Building - Unit 2)
8.2.6.E	595'	Ground Floor (Turbine Building - Unit 2)
8.2.7.A	615.5'	Mezzanine Floor (Turbine Building - Unit 1)
8.2.7.B	615.5'	Mezzanine Floor (Turbine Building - Unit 1)
8.2.7.C	615.5'	Mezzanine Floor (Turbine Building - Unit 1/2)
8.2.7.D	615.5'	Mezzanine Floor (Turbine Building - Unit 2)
8.2.7.E	615.5'	Mezzanine Floor (Turbine Building - Unit 2)
8.2.8.A	639'	Switchgear Area (Turbine Building - Unit 1)
8.2.8.B	639'	Switchgear Area (Turbine Building - Unit 1)
8.2.8.C	639'	Switchgear Area (Turbine Building - Unit 2)
8.2.8.D	639'	Switchgear Area (Turbine Building - Unit 2)
8.2.8.E	639'	Turbine Operating Floor (Units 1 & 2)
8.2.10	626.5'	Off-Gas Recombiner Room (Turbine Building)
9.1	595'	Unit 1 DG Room (Turbine Building - Unit 1)
9.2	595'	Unit 2 DG Room (Turbine Building - Unit 2)
9.3	595'	Unit 1/2 DG Room (Reactor Building 1/2)
11.1.1.A	547'	RHRSW Pump 1D Room (Turbine Building 1)
11.1.1.B	547'	RHRSW Pump 1B/1C Room (Turbine Building 1)
11.1.1.C	547'	RHRSW Pump 1A Room (Turbine Building 1)
11.1.2.A	547'	RHRSW Pump 2D Room (Turbine Building 2)
11.1.2.B	547'	RHRSW Pump 2B/2C Room (Turbine Building 2)
11.1.2.C	547'	RHRSW Pump 2A Room (Turbine Building 2)
11.1.3	554'	HPCI Pump Room (Turbine Building 1)
11.1.4	554'	HPCI Pump Room (Turbine Building 2)
11.2.1	554'	Southwest Corner Room (Reactor Building 1)
11.2.2	554'	Southeast Corner Room (Reactor Building 1)
11.2.3	554'	Northwest Corner Room (Reactor Building 1)
11.2.4	554'	Northeast Corner Room (Reactor Building 1)
11.3.1	554'	Southwest Corner Room (Reactor Building 2)
11.3.2	554'	Southeast Corner Room (Reactor Building 2)

ZONES	NOMINAL ELEVATION	ZONE IDENTIFICATION
11.3.3	554'	Northwest Corner Room (Reactor Building 2)
11.3.4	554'	Northeast Corner Room (Reactor Building 2)
11.4.A	559.7'	Basement (Crib House)
11.4.B	595'	Ground Floor (Crib House)
13.1[1]	-	Guardhouse (Outside)
14.1[1]	572.9', 590', 595', 596.9', 608.9', 620.9'	Radwaste Building
14.1.1[1]	626.5', 648.5', 668'	Off-Gas Recombiner Room (Turbine Building - Unit 1)
14.1.2[1]	626.5', 648.5', 668'	Off-Gas Recombiner Room (Turbine Building - Unit 2)
14.3.1[1]	595', 612'	Maximum Recycle Radwaste Building
15.1[1]	-	Security DG Building
16.1[1]	-	HRSS North Building - Unit 2
16.2[1]	-	HRSS South Building - Unit 1
17.1.1[1]	-	Main Power Transformer No. 1 (Outdoor)
17.1.2[1]	-	Auxiliary Power Transformer 11 (Outdoor)
17.1.3[1]	-	Reserve Auxiliary Power Transformer 12 (Outdoor)
17.2.1[1]	-	Main Power Transformer No. 2 (Outdoor)
17.2.2[1]	-	Auxiliary Power Transformer 21 (Outdoor)
17.2.3[1]	-	Reserve Auxiliary Power Transformer 22 (Outdoor)
18.1[1]	-	Technical Support Center (Outdoor)
19.1[1]	595'	Service Building Offices
19.2[1]	609'	Service Building Offices
19.3[1]	623'	Control Room Air Handling Unit Room (Service Building)
20.1[1]	-	Spray Canal Lift Station (Outdoor)
21.1[1]	-	Secondary Alarm Station (Outdoor)
22.1[1]	-	Off-Gas Filter Building (Outdoor)
23.1[1]	-	Central Alarm Station (Service Building Roof)
24.1[1]	-	Heating Boiler Building (Outdoor)

Note:

1. No shutdown equipment is located in this zone or the zone is located outdoors (not within the scope of this internal flooding analysis).

ATTACHMENT 12-2
QUAD CITIES INTERNAL FLOODING ANALYSIS
FLOOD ZONE SCREENING

ZONE	ZONE COMPONENTS	RX TRIP	SPRAY	SSE	SCREEN	WALKDOWN COMMENTS	SCREENED FROM SPRAY	
							SCREEN	COMMENT
1.1.1.2	480V MCC 18/19-5	N	Y	Y	Y	S3 - No Rx Trip	Y	480V MCC 18/19-5 susceptible to spray; RCIC valves in MSIV Room appear ok for short-term - sufficient to align early if MS line break occurs. The only components which may cause a reactor trip are the HCUs, however, the HCUs are not Safe Shutdown Equipment.
	CRD HCUs (89)	Y	Y	N	Y	S1 - Not SSE Equipment, SO 1(2)-0305-117 & 118 valves are not exposed to extensive external spray source piping plus local CRD piping is high schedule seal welded pipe. The electrical components are not EQd but still appear to be partially sealed from spray. Note that these scram valves are normally energized and fail open to scram the individual rod. Operators are instructed to scram the reactor if 3 or more control rods start to drift per QCOA 300-11.		
	CRD HCUS (88)	Y	Y	N	Y	S1 - Not SSE Equipment, SO 1(2)-0305-117 & 118 valves are not exposed to extensive external spray source piping plus local CRD piping is high schedule seal welded pipe. The electrical components are not EQd but still appear to be partially sealed from spray. Note that these scram valves are normally energized and fail open to scram the individual rod. Operators are instructed to scram the reactor if 3 or more control rods start to drift per QCOA 300-11.		
	LI1-263-151A	N	Y		Y	S3 - No Rx Trip		
	LI1-263-151B	N	Y		Y	S3 - No Rx Trip		
	MO1-1001-23A	N	Y		Y	S3 - No Rx Trip		

Refer to attached Notes - Component (SWGR & MCC) Screening Criteria Assumptions

ATTACHMENT 12-2
QUAD CITIES INTERNAL FLOODING ANALYSIS
FLOOD ZONE SCREENING

ZONE	ZONE COMPONENTS	RX TRIP	SPRAY	SSE	SCREEN	WALKDOWN COMMENTS	SCREENED FROM SPRAY	
							SCREEN	COMMENT
	MO1-1001-26A	N	Y		Y	S3 - No Rx Trip		
	AO1-203-2A	N				S3 - No Rx Trip - Refer to Assumption 1		
	AO1-203-2B	N				S3 - No Rx Trip - Refer to Assumption 1		
	AO1-203-2C	N				S3 - No Rx Trip - Refer to Assumption 1		
	AO1-203-2D	N				S3 - No Rx Trip - Refer to Assumption 1		
	MO1-1301-17	N	N		Y	S3 - No Rx Trip - Refer to Assumption 1		
	MO1-1301-49	N			Y	S3 - No Rx Trip - Refer to Assumption 1		
1.1.1.3	480V MCC 18-1A	N	Y	Y	Y	S3 - No Rx Trip	Y	Several MCCs susceptible to spray. No Reactor Trip / No Spray Source.
	480V MCC 18-1A1	N	N	Y	Y	S3 - No Rx Trip S4 - No Spray Source		
	480V MCC 18-1B	N	Y	Y	Y	S3 - No Rx Trip		
	480V MCC 18-3	N	Y		Y	S3 - No Rx Trip		
	480V MCC 19-1	N	Y	Y	Y	S3 - No Rx Trip		
	480V MCC 19-1-1	N	Y		Y	S3 - No Rx Trip		
	480V MCC 19-3	N	Y		Y	S3 - No Rx Trip		
	480V MCC 19-4	N	Y		Y	S3 - No Rx Trip		
	480V MCC 19-6	N	Y		Y	S3 - No Rx Trip		
	125VDC RB PNL #1	N	Y	Y	Y	S3 - No Rx Trip		
	250VDC MCC #1A	N	N	Y	Y	S3 - No Rx Trip S4 - No Spray Source		
	250VDC MCC #1B	N	Y	Y	Y	S3 - No Rx Trip		
	LIS1-263-59A	N	Y		Y	S3 - No Rx Trip		

Refer to attached Notes - Component (SWGR & MCC) Screening Criteria Assumptions

ATTACHMENT 12-2
QUAD CITIES INTERNAL FLOODING ANALYSIS
FLOOD ZONE SCREENING

ZONE	ZONE COMPONENTS	RX TRIP	SPRAY	SSE	SCREEN	WALKDOWN COMMENTS	SCREENED FROM SPRAY	
							SCREEN	COMMENT
	LIS1-263-59B	N	Y		Y	S3 – No Rx Trip		
	LIS1-263-72A	N	Y		Y	S3 – No Rx Trip		
	LIS1-263-72B	N	Y		Y	S3 – No Rx Trip		
	LIS1-263-72C	N	Y		Y	S3 – No Rx Trip		
	LIS1-263-72D	N	Y		Y	S3 – No Rx Trip		
	PI1-263-60A	N	Y		Y	S3 – No Rx Trip		
	PI1-263-60B	N	Y		Y	S3 – No Rx Trip		
	MO1-1001-23B	N	Y		Y	S3 – No Rx Trip		
	MO1-1001-26B	N	Y		Y	S3 – No Rx Trip		
	MO1-1402-25A	N	Y		Y	S3 – No Rx Trip		
	MO1-1402-25B	N	Y		Y	S3 – No Rx Trip		
1.1.2.2	480V MCC 28/29-5	N	Y	Y	Y	S3 – No Rx Trip	Y	480V MCC 28/29-5 susceptible to spray; RCIC valves in MSIV Room ok for short-term – sufficient to align early if MS line break occurs. The only components which may cause a reactor trip are the HCUs, however, the HCUs are not Safe Shutdown Equipment.
	CRD HCUs (89)	Y	Y	N	Y	S1 – Not SSE Equipment, SO 1(2)-0305-117 & 118 valves are not exposed to extensive external spray source piping plus local CRD piping is high schedule seal welded pipe. The electrical components are not EQd but still appear to be partially sealed from spray. Note that these scram valves are normally energized and fail open to scram the individual rod. Operators are instructed to scram the reactor if 3 or more control rods start to drift per QCOA 300-11.		

Refer to attached Notes – Component (SWGR & MCC) Screening Criteria Assumptions

ATTACHMENT 12-2
QUAD CITIES INTERNAL FLOODING ANALYSIS
FLOOD ZONE SCREENING

ZONE	ZONE COMPONENTS	RX TRIP	SPRAY	SSE	SCREEN	WALKDOWN COMMENTS	SCREENED FROM SPRAY	
							SCREEN	COMMENT
	CRD HCUs (88)	Y	Y	N	Y	S1 - Not SSE Equipment, SO 1(2)-0305-117 & 118 valves are not exposed to extensive external spray source piping plus local CRD piping is high schedule seal welded pipe. The electrical components are not EQd but still appear to be partially sealed from spray. Note that these scram valves are normally energized and fail open to scram the individual rod. Operators are instructed to scram the reactor if 3 or more control rods start to drift per QCOA 300-11.		
	PI2-263-151A	N	Y		Y	S3 - No Rx Trip		
	PI2-263-151B	N	Y		Y	S3 - No Rx Trip		
	MO2-1001-23A	N	N		Y	S3 - No Rx Trip S4 - No Spray Source		
	MO2-1001-26A	N	N		Y	S3 - No Rx Trip S4 - No Spray Source		
	AO-2-203-2A	N			Y	S3 - No Rx Trip - Refer to Assumption 1		
	AO-2-203-2B	N			Y	S3 - No Rx Trip - Refer to Assumption 1		
	AO-2-203-2C	N			Y	S3 - No Rx Trip - Refer to Assumption 1		
	AO-2-203-2D	N			Y	S3 - No Rx Trip - Refer to Assumption 1		
	MO2-1301-17	N	N		Y	S3 - No Rx Trip - Refer to Assumption 1		
	MO2-1301-49	N			Y	S3 - No Rx Trip - Refer to Assumption 1		

Refer to attached Notes - Component (SWGR & MCC) Screening Criteria Assumptions

ATTACHMENT 12-2
QUAD CITIES INTERNAL FLOODING ANALYSIS
FLOOD ZONE SCREENING

ZONE	ZONE COMPONENTS	RX TRIP	SPRAY	SSE	SCREEN	WALKDOWN COMMENTS	SCREENED FROM SPRAY	
							SCREEN	COMMENT
1.1.2.3	480V MCC 28-1A	N	Y	Y	Y	S3 - No Rx Trip	Y	Several MCCs susceptible to spray. No Reactor Trip / No Spray Source.
	480V MCC 28-1A1	N	Y	Y	Y	S3 - No Rx Trip		
	480V MCC 28-1B	N	Y	Y	Y	S3 - No Rx Trip		
	480V MCC 28-3	N	Y		Y	S3 - No Rx Trip		
	480V MCC 29-1	N	Y	Y	Y	S3 - No Rx Trip		
	480V MCC 29-1-1	N	Y		Y	S3 - No Rx Trip		
	480V MCC 29-3	N	Y		Y	S3 - No Rx Trip		
	480V MCC 29-4	N	Y		Y	S3 - No Rx Trip		
	480V MCC 29-6	N	Y		Y	S3 - No Rx Trip		
	125VDC RB PNL #2	N	Y	Y	Y	S3 - No Rx Trip		
	250VDC MCC #2A	N	Y	Y	Y	S3 - No Rx Trip		
	250VDC MCC #2B	N	N	Y	Y	S3 - No Rx Trip S4 - No Spray Source		
	LIS2-263-59A	N	Y		Y	S3 - No Rx Trip		
	LIS2-263-59B	N	Y		Y	S3 - No Rx Trip		
	LIS2-263-72A	N	Y		Y	S3 - No Rx Trip		
	LIS2-263-72B	N	Y		Y	S3 - No Rx Trip		
	LIS2-263-72C	N	Y		Y	S3 - No Rx Trip		
	LIS2-263-72D	N	Y		Y	S3 - No Rx Trip		
	PI2-263-60A	N	Y		Y	S3 - No Rx Trip		
	PI2-263-60B	N	Y		Y	S3 - No Rx Trip		
	MO2-1001-23B	N	Y		Y	S3 - No Rx Trip		

Refer to attached Notes - Component (SWGR & MCC) Screening Criteria Assumptions

ATTACHMENT 12-2
QUAD CITIES INTERNAL FLOODING ANALYSIS
FLOOD ZONE SCREENING

ZONE	ZONE COMPONENTS	RX TRIP	SPRAY	SSE	SCREEN	WALKDOWN COMMENTS	SCREENED FROM SPRAY	
							SCREEN	COMMENT
	MO2-1001-26B	N	Y		Y	S3 - No Rx Trip		
	MO2-1402-25A	N	Y		Y	S3 - No Rx Trip		
	MO2-1402-25B	N	Y		Y	S3 - No Rx Trip		
8.2.6.A	4160V SWGR 11	N	Y		Y	S3 - No Rx Trip - See U2 LER 88-005	Y	Components susceptible. FW pumps included in Transient IE. No Reactor Trip / No Spray Source.
	4160V SWGR 12	N	Y		Y	S3 - No Rx Trip - See U2 LER 88-005		
	LI1/2-3341-77A	N	Y		Y	S3 - No Rx Trip		
	LI1/2-3341-77B	N	Y		Y	S3 - No Rx Trip		
	MO1-1001-47	N			Y	S3 - No Rx Trip - Refer to Assumption 1		
	FI 1-3941-26	N	Y		Y	S3 - No Rx Trip		
	1-3201A	Y	Y		Y	S5 - Included in Transient IE		
	1-3201B	Y	Y		Y	S5 - Included in Transient IE		
	1-3201C	Y	Y		Y	S5 - Included in Transient IE		
8.2.7.A	4160V SWGR 13	Y	Y	Y	N	T3 - Rx Trip per QCOA 4400-4 - Loss of 2 Circ Water Pmps	N	Switchgear susceptible. See T3 for Loss of 2 Circ Water Pmps. See T3 for Loss of MSIV Room Coolers Trip.
	4160V SWGR 14	N	Y	Y	Y	S3 - No Rx Trip		
	480V MCC 15-2	N	Y		Y	S3 - No Rx Trip		
	480V MCC 18-2	Y	Y	Y	N	T3 - Loss of MSIV Room Coolers - Refer to Assumption 6.G		
	480V MCC 19-2	N	Y	Y	Y	S3 - No Rx Trip		

Refer to attached Notes - Component (SWGR & MCC) Screening Criteria Assumptions

ATTACHMENT 12-2
QUAD CITIES INTERNAL FLOODING ANALYSIS
FLOOD ZONE SCREENING

ZONE	ZONE COMPONENTS	RX TRIP	SPRAY	SSE	SCREEN	WALKDOWN COMMENTS	SCREENED FROM SPRAY	
							SCREEN	COMMENT
8.2.7.E	4160V SWGR 23	Y	Y	Y	N	T3 – Rx Trip per QCOA 4400-4 – Loss of 2 Circ Water Pmps	N	Switchgear susceptible. See T3 for Loss of 2 Circ Water Pmps. See T3 for Loss of MSIV Room Coolers Trip.
	4160V SWGR 24	N	Y	Y	Y	S3 – No Rx Trip		
	480V MCC 28-2	Y	Y	Y	N	T3 – Loss of MSIV Room Coolers – Refer to Assumption 6.G		
	480V MCC 29-2	N	Y	Y	Y	S3 – No Rx Trip		
8.2.8.B	4160V SWGR 13-1	N	Y	Y	Y	S3 – No Rx Trip	Y	Switchgear susceptible. No Reactor Trip / No Spray Source.
	480V MCC 18	Y	N	Y	Y	S4 – No Spray Source		
	480V MCC 19	N	Y	Y	Y	S3 – No Rx Trip		
	1A-202-51	N	N		Y	S3 – No Rx Trip S4 – No Spray Source		
8.2.8.C	4160V SWGR 24-1	N	Y	Y	Y	S3 – No Rx Trip	Y	Switchgear susceptible. No Reactor Trip / No Spray Source.
	480V MCC 28	Y	N	Y	Y	S4 – No Spray Source		
	480V MCC 29	N	Y	Y	Y	S3 – No Rx Trip		
8.2.8.D	4160V SWGR 23-1	N	Y	Y	Y	S3 – No Rx Trip	Y	Switchgear susceptible. No Reactor Trip.
11.2.1	1B-1401	N	Y		Y	S3 – No Rx Trip	Y	Pump susceptible. No Reactor Trip / No Spray Source.
	1-3999-96	N	N/A		Y	S3 – No Rx Trip – Manual Valve		
	1-5748B	N	N		Y	S3 – No Rx Trip S4 – No Spray Source		
11.2.3	1A-1401	N	Y		Y	S3 – No Rx Trip	Y	Pumps susceptible. No Reactor Trip / No Spray Source.
	1-1304	N	Y		Y	S3 – No Rx Trip		
	1-5748A	N	Y		Y	S3 – No Rx Trip		

Refer to attached Notes – Component (SWGR & MCC) Screening Criteria Assumptions

ATTACHMENT 12-2
QUAD CITIES INTERNAL FLOODING ANALYSIS
FLOOD ZONE SCREENING

ZONE	ZONE COMPONENTS	RX TRIP	SPRAY	SSE	SCREEN	WALKDOWN COMMENTS	SCREENED FROM SPRAY	
							SCREEN	COMMENT
	PI1-1360-5	N	N/A		Y	S3 – No Rx Trip – Local Instrument		
	FI1-1360-30	N	N/A		Y	S3 – No Rx Trip – Local Instrument		
	SI1-1360-31	N	Y		Y	S3 – No Rx Trip		
	MO1-1301-22	N	Y		Y	S3 – No Rx Trip S4 – No Spray Source		
	MO1-1301-26	N	Y		Y	S3 – No Rx Trip		
	MO1-1301-48	N	Y		Y	S3 – No Rx Trip		
	MO1-1301-53	N	Y		Y	S3 – No Rx Trip		
	MO1-1301-60	N	Y		Y	S3 – No Rx Trip		
	MO1-1301-61	N	Y		Y	S3 – No Rx Trip		
	MO1-1301-62	N	Y		Y	S3 – No Rx Trip		
	1-1302	N	Y		Y	S3 – No Rx Trip		
	1-1303	N	Y		Y	S3 – No Rx Trip		
	1-1305	N	Y		Y	S3 – No Rx Trip		
	1-1306	N	N/A		Y	S3 – No Rx Trip – Barometric Cond		
	LI1-1360-28	N	N/A		Y	S3 – No Rx Trip – Local Instrument		
	LI1-1360-29	N	N/A		Y	S3 – No Rx Trip – Local Instrument		
	PI1-1360-12	N	N/A		Y	S3 – No Rx Trip – Local Instrument		
	1/2-1099-1	N	N/A		Y	S3 – No Rx Trip – Manual Valve		
	1-3999-93	N	N/A		Y	S3 – No Rx Trip – Manual Valve		
11.3.1	2B-1401	N	Y		Y	S3 – No Rx Trip	Y	Pumps susceptible. No Reactor Trip.

Refer to attached Notes – Component (SWGR & MCC) Screening Criteria Assumptions

ATTACHMENT 12-2
QUAD CITIES INTERNAL FLOODING ANALYSIS
FLOOD ZONE SCREENING

ZONE	ZONE COMPONENTS	RX TRIP	SPRAY	SSE	SCREEN	WALKDOWN COMMENTS	SCREENED FROM SPRAY	
							SCREEN	COMMENT
	2-5748B	N	Y		Y	S3 – No Rx Trip		
	FI2-1360-30	N	N/A		Y	S3 – No Rx Trip – Local Instrument		
	PI2-1360-5	N	N/A		Y	S3 – No Rx Trip – Local Instrument		
	SI2-1360-31	N	Y		Y	S3 – No Rx Trip		
	MO2-1301-22	N	Y		Y	S3 – No Rx Trip		
	MO2-1301-26	N	Y		Y	S3 – No Rx Trip		
	MO2-1301-48	N	Y		Y	S3 – No Rx Trip		
	MO2-1301-53	N	Y		Y	S3 – No Rx Trip		
	MO2-1301-60	N	Y		Y	S3 – No Rx Trip		
	MO2-1301-61	N	Y		Y	S3 – No Rx Trip		
	MO2-1301-62	N	Y		Y	S3 – No Rx Trip		
	2-1302	N	Y		Y	S3 – No Rx Trip		
	2-1303	N	Y		Y	S3 – No Rx Trip		
	2-1304	N	Y		Y	S3 – No Rx Trip		
	2-1305	N	Y		Y	S3 – No Rx Trip –		
	2-1306	N	N/A		Y	S3 – No Rx Trip – Barometric Cond		
	LI2-1360-28	N	N/A		Y	S3 – No Rx Trip – Local Instrument		
	LI2-1360-29	N	N/A		Y	S3 – No Rx Trip – Local Instrument		
	PI2-1360-12	N	N/A		Y	S3 – No Rx Trip – Local Instrument		
	1/2-1099-1B	N	N/A		Y	S3 – No Rx Trip – Manual Valve		
	2-3999-93	N	N/A		Y	S3 – No Rx Trip – Manual Valve		

Refer to attached Notes – Component (SWGR & MCC) Screening Criteria Assumptions

ATTACHMENT 12-2
QUAD CITIES INTERNAL FLOODING ANALYSIS
FLOOD ZONE SCREENING

ZONE	ZONE COMPONENTS	RX TRIP	SPRAY	SSE	SCREEN	WALKDOWN COMMENTS	SCREENED FROM SPRAY	
							SCREEN	COMMENT
11.3.3	2A-1401	N	Y		Y	S3 - No Rx Trip	Y	Pump susceptible. No Reactor Trip.
	2-3999-96	N	N/A		Y	S3 - No Rx Trip - Manual Valve		
	2-5748A	N	N		Y	S3 - No Rx Trip		
11.4.B	480V MCC 16-2	N	Y		Y	S3 - No Rx Trip	Y	Spraying water could affect Circ Water pumps, MCCs, and SW pumps. No Reactor Trip / No Spray Source.
	480V MCC 26-2	N	Y		Y	S3 - No Rx Trip		
	1A-4401	N	Y		Y	S3 - No Rx Trip		
	1B-4401	N	Y		Y	S3 - No Rx Trip		
	1C-4401	N	Y		Y	S3 - No Rx Trip		
	2A-4401	N	N		Y	S3 - No Rx Trip S4 - No Spray Source		
	2B-4401	N	Y		Y	S3 - No Rx Trip		
	2C-4401	N	Y		Y	S3 - No Rx Trip		
	1/2A-4101	N	Y		Y	S3 - No Rx Trip		
	1/2B-4101	N	Y		Y	S3 - No Rx Trip		
	PI1/2-4141-2B	N	N		Y	S3 - No Rx Trip S4 - No Spray Source		
	MO1/2-4101A	N	Y		Y	S3 - No Rx Trip		
	MO1/2-4101B	N	Y		Y	S3 - No Rx Trip		
	1A-3901	N	Y		Y	S3 - No Rx Trip		
	1B-3901	N	Y		Y	S3 - No Rx Trip		
	1/2-3901	N	Y		Y	S3 - No Rx Trip		
	2A-3901	N	Y		Y	S3 - No Rx Trip		

Refer to attached Notes - Component (SWGR & MCC) Screening Criteria Assumptions

ATTACHMENT 12-2
QUAD CITIES INTERNAL FLOODING ANALYSIS
FLOOD ZONE SCREENING

ZONE	ZONE COMPONENTS	RX TRIP	SPRAY	SSE	SCREEN	WALKDOWN COMMENTS	SCREENED FROM SPRAY	
							SCREEN	COMMENT
	2B-3901	N	Y		Y	S3 - No Rx Trip		
	PI1/2-4141-2A	N	Y		Y	S3 - No Rx Trip		

Refer to attached Notes - Component (SWGR & MCC) Screening Criteria Assumptions

NOTES FOR ATTACHMENT 12-2: COMPONENT (SWGR & MCC) SCREENING CRITERIA ASSUMPTIONS

1. Internal Flooding Plant Walkdown Checklists shall be used to identify components susceptible to failure due to spray. This assumption was used to determine the entry for "Spray" Column in Attachment 12-2 above. Additional walkdowns were performed for the 15 zones to verify that the original walkdown checklist data was correct. The exceptions for additional walkdowns are as follows:

   - Spray information from the original Quad Cities Walkdown Master Checklists for Zones 11.3.1 and 11.3.3 (Unit 2 Core Spray & RCIC Corner Rooms) was used in Attachment 12-2. This decision was made after comparing the additional walkdown checklist data with the original walkdown checklist data for Unit 1.

   - Spray information from the original Quad Cities Walkdown Master Checklists for the Unit 1 and 2 High Pressure Heater Bays and MSIV Rooms (Zones 1.1.1.2.A, 1.1.2.2.A and 8.2.6.A) was used in Attachment 12-2. Units 1 and 2 were at power at the time of the additional walkdowns making these areas inaccessible. The components in these areas include AO1(2)-203-2A through AO1(2)-203-2D, MO1(2)-1301-17, MO1(2)-1301-49, and MO1-1001-47.

   NOTE

   Assumptions 2 and 3 are addressed in the Commonwealth Edison IPE/Accident Management Program, Internal Flooding Evaluation Methodology Guideline, Revision 0, November 1989, and shall be used in this analysis.

2. SSE FAILURE BUT NO REACTOR TRIP - The flooding events that may only fail safe shutdown systems but do not cause a reactor trip (automatic trip or manual shutdown < 2 hours) are excluded from the analysis because these events are not flood-induced initiators. Rather, these events may lead to a technical specification violation (and subsequent shutdown) which is not addressed in the internal flooding analysis. The events which do not result in an immediate manual shutdown will be identified and documented for future reference in the PRA.

3. REACTOR TRIP BUT NO SSE FAILURE - If flooding in an area causes a reactor trip but does not fail a safe shutdown system, the internal flooding frequency (i.e., the frequency of the events in that area which initiate the flood) for that area is estimated and compared to the initiating event frequency for the same initiating event from the internal events analysis. If the estimated frequency for the flooding event is 25 percent or less that the frequency of the initiating event from the internal events analysis, then that event is excluded from the internal flooding analysis. If it is greater than 25 percent, the estimated frequency of that event is further analyzed taking into account detection, isolation, drainage, and mitigation, and re-evaluated using the new refined frequency. Note that the screening value of 25 percent or less may be adjusted after reviewing the results obtained from the initial screening.

4. The following Screening Criteria was used in the Quad Cities Nuclear Power Station Units 1 and 2 Internal Flooding Analysis Notebook, October 1993, Revision 0.

   S1 NO SAFE SHUTDOWN EQUIPMENT IN ZONE - Zones which did not contain Safe Shutdown Equipment were outside the scope of this analysis and were removed from further consideration.

   S2 ZONES LOCATED IN CONTAINMENT - Zones 1.2.1 and 1.2.2 are removed from further consideration because "These zones (within the containment) are designed for the effects of a LOCA event, which is considered to bound any other postulated flooding event."

S3 NO REACTOR TRIP OCCURS – "If a reactor trip will not occur, even if the entire zone is flooded, then the zone may be removed from further consideration."

S4 NO FLOOD SOURCES OR SPRAY SOURCES – If neither flooding sources nor spraying sources are present in the zone, it may be removed from further consideration.

S5 FLOOD SOURCES AND/OR SPRAY SOURCES NOT A CONCERN – "If neither flooding nor spraying is a concern for the zone, it may be removed from further consideration." Note that if a zone has flood sources but flooding has been determined not to be a concern then the zone will be "screened" from further analysis. In addition, if a zone has spray sources but spraying has been determined not to be a concern then the zone will be "screened" from further analysis. The zone will only be screened from further analysis if both flooding and spraying are screened as indicated in Table 2 of the subject Notebook.

5. SAFE SHUTDOWN EQUIPMENT (SSE) – Safe shutdown equipment is listed in QCAP 1500-2, Revision 0, Administrative Requirements for Inoperable Safe Shutdown Equipment. Note that this assumption was used to determine entry for "SSE" Column in Attachment 12-2 above.

6. REACTOR TRIP / REACTOR SHUTDOWN (< 2 HRS) – Reactor Trip (Automatic) and Reactor Shutdown (< 2 hrs). Note that this assumption was used to determine entry for "RX Trip" Column in Attachment 12-2 above.

A. Reactor Trip / Shutdown < 2 hrs due to failed switchgear / motor control centers was determined from the following sources:

1) Operating Procedures (QCOA, QOA, QOS, QGA, etc.)
2) Controlled copy of Operating Electrical Loads Notebook
3) Electrical Drawings
4) Quad Cities Station SRO/RO License Training Lesson Plans
5) Quad Cities IPE Notebooks.
6) "Loss of Bus Power" scenarios on Training Simulator.
7) Discussions with Station Operating Department and License Training Department personnel.
8) LER# 91-027, Load Reduction (Unit Shutdown) from Heating Steam Leak on Bus 14-1 due to a Heating Steam Drain Valve Vibrating Open.

B. The Unit was assumed to be at full power at time of switchgear / motor control center failure.

C. The Unit standby systems / components were assumed available at time of switchgear / motor control center failure.

D. The following information relating to Reactor Trip / Shutdown < 2 hrs due to failed switchgear / motor control centers was provided by the Quad Cities Operating Department and License Training Department:

LOSS OF SWGR/MCC	AUTO TRIP/MAN TRIP (<2hrs)
TB 125VDC MAIN BUS 1A	NO REACTOR TRIP
TB 125VDC MAIN BUS 1A-1	NO REACTOR TRIP
TB 125VDC RES BUS 1B	NO REACTOR TRIP
TB 125VDC RES BUS 1B-1	NO REACTOR TRIP
TB 250VDC MAIN BUS MCC 1	NO REACTOR TRIP
TB 125VDC MAIN BUS 2A	NO REACTOR TRIP
TB 125VDC MAIN BUS [illegible]-1	NO REACTOR TRIP
TB 125VDC RES BU[illegible]	NO REACTOR TRIP
TB 125VDC RES BUS 2B-1	NO REACTOR TRIP
TB 250VDC MAIN BUS MCC 2	NO REACTOR TRIP
4160V SWGR 11	NO REACTOR TRIP - Refer to U2 LER 88-005
4160V SWGR 12	NO REACTOR TRIP - Refer to U2 LER 88-005
4160V SWGR 13	*MAN REACTOR TRIP - per QCOA 4400-4
4160V SWGR 13-1	NO REACTOR TRIP
4160V SWGR 14	NO REACTOR TRIP
4160V SWGR 14-1	NO REACTOR TRIP - Refer to U1 LER 91-027
480V SWGR 18	*AUTO REACTOR TRIP - Refer to Assumptions 6.F & 6.G
480V MCC 18-1A	NO REACTOR TRIP - Refer to Assumption 6.F
480V MCC 18-1B	NO REACTOR TRIP - Refer to Assumption 6.F
480V MCC 18-2	*AUTO REACTOR TRIP - Refer to Assumption 6.G
480V SWGR 19	NO REACTOR TRIP - Refer to Assumption 6.F
480V MCC 19-2	NO REACTOR TRIP
480V MCC 19-3	NO REACTOR TRIP - Refer to Assumption 6.F
480V MCC 19-4	NO REACTOR TRIP - Refer to Assumption 6.F
480V MCC 19-6	NO REACTOR TRIP - Refer to Assumption 6.F
480V MCC 15-2	NO REACTOR TRIP
4160V SWGR 21	NO REACTOR TRIP - Refer to U2 LER 88-005
4160V SWGR 22	NO REACTOR TRIP - Refer to U2 LER 88-005
4160V SWGR 23	*MAN REACTOR TRIP - per QCOA 4400-4
4160V SWGR 23-1	NO REACTOR TRIP
4160V SWGR 24	NO REACTOR TRIP
4160V SWGR 24-1	NO REACTOR TRIP - Refer to U1 LER 91-027
480V SWGR 28	*AUTO REACTOR TRIP - Refer to Assumptions 6.F & 6.G
480V MCC 28-1A	NO REACTOR TRIP - Refer to Assumption 6.F

480V MCC 28-1B	NO REACTOR TRIP - Refer to Assumption 6.F
480V MCC 28-2	*AUTO REACTOR TRIP - Refer to Assumption 6.G
480V SWGR 29	NO REACTOR TRIP - Refer to Assumptions 6.F
480V MCC 29-2	NO REACTOR TRIP
480V MCC 29-3	NO REACTOR TRIP - Refer to Assumption 6.F
480V MCC 29-4	NO REACTOR TRIP - Refer to Assumption 6.F
480V MCC 29-6	NO REACTOR TRIP - Refer to Assumption 6.F
480V MCC 25-2	NO REACTOR TRIP

E. The following scenarios were performed on the Quad Cities Simulator. Note that the Simulator scenario results were used only to support the results of this engineering evaluation and were not used as the primary source or substitution for this engineering evaluation.

<u>LOSS OF SWGR/MCC</u>	<u>AUTO TRIP/MAN TRIP (<2hrs)</u>
MCC 14	NO REACTOR TRIP
MCC 15-2	NO REACTOR TRIP
MCC 18 (includes 18-1A, 18-1B, 18-2, 18-3)	NO REACTOR TRIP - Refer to Assumptions 6.F & 6.G below
MCC 19 (includes 19-1, 19-1-1, 19-2, 19-3, 19-4, 19-6)	NO REACTOR TRIP - Refer to Assumption 6.F below
MCC 18/19-5	NO REACTOR TRIP
ALL 125VDC (includes 125VDC Bus 1, 1A, 1A-1, 1A-2, 1B, 1B-1, 1B-2, RB PNL 1, BAT 1)	NO REACTOR TRIP
ALL 250VDC (includes 250VDC MCC 1, 1A, 1B, BAT 1)	NO REACTOR TRIP

F. The Containment Cooling Fans receive power from MCC 18 (28) and MCC 19 (29).

MCC 18-1A (MCC 28-1A) - DW CLG Fan 1A (2A)
MCC 18-1B (MCC 28-1A) - DW CLG Fan 1B (2B), 1F (2F)
MCC 19-3 (MCC 29-3) - DW CLG Fan 1E (2E)
MCC 19-4 (MCC 29-4 - DW CLG Fan 1D (2D)
MCC 19-6 (MCC 29-6) - DW CLG Fan 1C (2C), 1G (2G)

Normally, six of the seven Containment Cooling Fans are running during unit operation. The standby fan may be started after loss of MCC 18-1A (MCC 28-1A), MCC 19-3 (MCC 29-3), or MCC 19-4 (MCC 29-4) with no impact on plant operation. However, the loss of MCC 18 (MCC 28), MCC 19 (MCC 29), MCC 18-1B (MCC 28-1B), or MCC 19-6 (MCC 29-6) will reduce the number of operating fans below the required six operating fans which will result in an increase in containment temperature.

Containment pressure and temperature may be controlled by commencing a unit shutdown, implementing the containment venting procedure (pressure control) and implementing the de-inerting procedure (temperature control). Therefore, it is assumed that the operators will not initiate a manual reactor trip within 2 hours after the loss of MCC 18 (MCC 28), MCC 19 (MCC 29), MCC 18-1B (MCC 28-1B), or MCC 19-6 (29-6).

G. The MSIV Room Cooling Fans receive power from MCC 18-2 (28-2). Loss of SWGR 18 (SWGR 28) or MCC 18-2 (MCC 28-2) could result in MSIV Room temperature reaching the Group 1 MSIV isolation high temperature setpoint of 185 DEG F, and reactor trip within 2 hours (note that the actual setpoint is 185 DEG F and the Technical Specification setpoint is equal to or less than 200 DEG f). Therefore, it is assumed that automatic reactor trip occurs upon loss of SWGR 18 (SWGR 28) or MCC 18-2 (MCC 28-2) until MSIV Room Cooler design data is obtained or thermal study is performed.

ATTACHMENT 12-3
4160V SWGR 13
ZONE 8.2.7.A

SYSTEM	COMPONENT	FAC	No. COMPs	FREQ/HR-COMP	FREQ/HR	UC-HRS/YR	UC-ANNUAL FREQ	C-HRS/YR	C-ANNUAL FREQ
Fire Prot	8" pipe	.5	42'	3.0E-9/h-ft	6.30E-8/h	8760 h/y	5.52E-4/y	6855 h/y	4.32E-4/y
	6" pipe	.5	17'	3.0E-9/h-ft	2.55E-8/h	8760 h/y	2.23E-4/y	6855 h/v	1.75E-4/y
	2" pipe		19'	3.0E-9/h-ft	5.70E-8/h	8760 h/y	4.99E-4/y	6855 h/y	3.91E-4/y
	3/4" pipe		19'	3.0E-9/h-ft	5.70E-8/h	8760 h/y	4.99E-4/y	6855 h/y	3.91E-4/y
	8" valve		1	1.0E-8/h-c	1.00E-8/h	8760 h/y	8.76E-5/y	6855 h/y	6.86E-5/y
	8" flange		2	1.0E-8/h-c	2.00E-8/h	8760 h/y	1.75E-4/y	6855 h/y	1.37E-4/y
	2" valve		1	1.0E-8/h-c	1.00E-8/h	8760 h/y	8.76E-5/y	6855 h/y	6.86E-5/y
	3/4" valve		1	1.0E-8/h-c	1.00E-8/h	8760 h/y	8.76E-5/y	6855 h/y	6.86E-5/y
Clean Dem	1" pipe		4'	3.0E-9/h-ft	1.20E-8/h	8760 h/y	1.05E-4/y	6855 h/y	8.23E-5/y
	3/4" pipe		17'	3.0E-9/h-ft	5.10E-8/h	8760 h/y	4.47E-4/y	6855 h/y	3.50E-4/y
	1" valve		1	1.0E-8/h-c	1.00E-8/h	8760 h/y	8.76E-5/y	6855 h/y	6.86E-5/y
Heat Stm	2" lagged pipe		27'	3.0E-9/h-ft	8.10E-8/h	8760 h/y	7.10E-4/y	5110 h/y	4.14E-4/y
						TOTAL	3.56E-3/y		2.65E-3/y

ATTACHMENT 12-3
480V MCC 18-2
ZONE 8.2.7.A

SYSTEM	COMPONENT	FAC	No. COMPs	FREQ/HR-COMP	FREQ/HR	UC-HRS/YR	UC-ANNUAL FREQ	C-HRS/YR	C-ANNUAL FREQ
Fire Prot	STATOR & H2 SEAL OIL DELUGE STATION								
	4" pipe	.5	25'	3.0E-9/h-ft	3.8E-08/h	8760 h/y	3.33E-4/y	6855 h/y	2.60E-4/y
	4" valve flange	.5	1	1.0E-8/h-c	5.0E-9/h	8760 h/y	4.38E-5/y	6855 h/y	3.43E-5/y
	4" valve		1	1.0E-8/h-c	1.0E-8/h	8760 h/y	8.76E-5/y	6855 h/y	6.86E-5/y
	4" del valve flange	.5	1	1.0E-8/h-c	5.0E-9/h	8760 h/y	4.38E-5/y	6855 h/y	3.43E-5/y
	4" del valve		1	1.0E-8/h-c	1.0E-8/h	8760 h/y	8.76E-5/y	6855 h/y	6.86E-5/y
	3/8" pipe		1'	3.0E-9/h-ft	3.0E-9/h	8760 h/y	2.63E-5/y	6855 h/y	2.06E-5/y
	3/8" valve		2	1.0E-8/h-c	2.0E-8/h	8760 h/y	1.75E-4/y	6855 h/y	1.37E-4/y
	1/2" valve		1	1.0E-8/h-c	1.0E-8/h	8760 h/y	8.76E-5/y	6855 h/y	6.86E-5/y
	1/2" pipe		1'	3.0E-9/h-ft	3.0E-9/h	8760 h/y	2.63E-5/y	6855 h/y	2.06E-5/y
						TOTAL	9.11E-4/y		7.13E-4/y

ATTACHMENT 12-3 4160V SWGR 23 ZONE 8.2.7.E									
SYSTEM	COMPONENT	FAC	No. COMPs	FREQ/HR-COMP	FREQ/HR	UC-HRS/YR	UC-ANNUAL FREQ	C-HRS/YR	C-ANNUAL FREQ
Fire Prot	8" pipe	.5	45'	3.0E-9/h-ft	6.75E-8/h	8760 h/y	5.91E-4/y	6943 h/y	4.69E-4/y
						TOTAL	5.91E-4/y		4.69E-4/y

ATTACHMENT 12-3
480V MCC 28-2
ZONE 8.2.7.E

SYSTEM	COMPONENT	FAC	No. COMPs	FREQ/HR-COMP	FREQ/HR	UC-HRS/YR	UC-ANNUAL FREQ	C-HRS/YR	C-ANNUAL FREQ
Fire Prot	STATOR WTR CLG & H2 SEAL OIL UNIT DELUGE STATION								
	4" pipe	.5	20'	3.0E-9/h-ft	3.0E-8/h	8760 h/y	2.63E-4/y	6943 h/y	2.08E-4/y
	4" valve flange	.5	2	1.0E-8/h-c	1.0E-8/h	8760 h/y	8.76E-5/y	6943 h/y	6.94E-5/y
	4" valve	.5	1	1.0E-8/h-c	5.0E-9/h	8760 h/y	4.38E-5/y	6943 h/y	3.47E-5/y
	4" deluge valve	.5	1	1.0E-8/h-c	5.0E-9/h	8760 h/y	4.38E-5/y	6943 h/y	3.47E-5/y
	1/2" valve		1	1.0E-8/h-c	1.0E-8/h	8760 h/y	8.76E-5/y	6943 h/y	6.94E-5/y
	1/2" pipe		2'	3.0E-9/h-ft	6.0E-9/h	8760 h/y	5.26E-5/y	6943 h/y	4.17E-5/y
	3/8" valve		2	1.0E-8/h-c	2.0E-8/h	8760 h/y	1.75E-4/y	6943 h/y	1.39E-4/y
	3/8" pipe	.5	1'	3.0E-9/h-ft	1.5E-9/h	8760 h/y	1.31E-5/y	6943 h/y	1.04E-5/y
						TOTAL	7.67E-4/y		6.07E-4/y

NOTES FOR ATTACHMENT 12-3: COMPONENT (SWGR & MCC) LEAKAGE FAILURE ASSUMPTIONS

1. It is conservatively assumed that if water came in contact with any electrical equipment (i.e., switchgear / motor control centers) that was not covered and/or sealed to protect them from water intrusion, water spraying or splashing onto them would cause the switchgear / motor control centers to fail in the de-energized condition for an extended period of time. Refer to Unit 1 LER 91-005.

2. If the electrical equipment (i.e., switchgear / motor control centers) was located either directly below or within a ten foot radius and in the line-of-sight of a water spray source, then it was analyzed with respect to failure modes as a result of spraying or splashing. Where there existed such factors as higher system pressure, elevated sources, and intervening components which redirected the flow, engineering judgment was used to appropriately adjust this initial area. Piping which impacted two or more switchgear / motor control centers was documented in the Walkdown Checklists. However, multiple switchgear / motor control center failure due to "insignificant" piping lengths which could impact two or more switchgear / motor control centers was not included in this analysis.

3. In this analysis only pipe joints (flanges, valves, etc.) and tanks were considered as sources of spraying or splashing.

4. Water intrusion into switchgear / motor control centers via bus ducts, cable pans, and conduits other than from spray sources identified during the walkdown was not included in this analysis. Refer to Unit 2 LER 88-005.

5. Water spray sources due to Seismic events, High Energy Line Break events and normal initiation of the Fire Protection System were beyond the scope of this analysis.

6. Non-pressurized piping systems (drain, return, etc.) which infrequently transferred water and were located directly over "open" switchgear / motor control centers were excluded from this analysis.

   A. Turbine Drain, Roof Drain and uncharged/dry pipe fire protection piping which were located directly over "open" switchgear / motor control centers were not included in this analysis.

7. Non-pressurized piping systems (drain, return, etc.) which frequently transferred water and were located directly over "open" switchgear / motor control centers were included in this analysis.

   A. Service Water return piping located directly over "open" switchgear / motor control centers was included in this analysis.

8. It is assumed that piping systems which were lagged and had metal jackets limited leakage to jacket seams and ends.

   A. The Heating Steam System piping and components (steam or condensate return pipe) and Service Water system piping and components which were located directly over "open" switchgear / motor control centers were included in this analysis.

9. Average Annual Hours Used in this Analysis

A. Unit 1 and Unit 2 Average Hours Per Year (Not in Shutdown)

The average annual hours (not in shutdown) for Unit 1 and Unit 2 were used in this analysis. The cold shutdown hours were calculated to be 13,342.6 hours for Unit 1 and 12,726.1 hours for Unit 2. For the period from January 1, 1985, through December 31, 1991, the total calendar time was determined to be 61,344 hours per unit. Thus, Unit 1 and Unit 2 were not in cold shutdown for 48,001.4 hours and 48,617.9 hours, respectively. Refer to the Quad Cities Station Data Collection and Analysis Notebook for additional information.

1) Unit 1 Hours = (48,001.4 / 61,344) X 8760 h/y = 6855 h/y

2) Unit 2 Hours = (48,617.9 / 61,344) x 8760 h/y = 6943 h/y

B. Station Heating Steam System Average Hours Per Year (in operation)

The average time in operation for the Station Heating Steam System was determined to be approximately six months - "Startup system in November and shutdown system in April" per Quad Cities personnel. This analysis conservatively assumed seven months per year. Therefore, the average annual hours (in operation) for the Heating Steam Systems was (7/12) X 8760 h/y = 5110 h/y.

10. No operator or maintenance errors were included in this analysis.

11. The leakage mean frequencies listed below were used in this leakage analysis. Refer to Table ES-1, EGG-SSRE-9639, Component External Leakage and Rupture Frequency Estimates, November 1991, for additional information.

· Piping (including elbows)	3.0E-9/h-ft
· Valve	1.0E-8/h
· Pump	3.0E-8/h
· Flange (union, strainer)	1.0E-8/h
· Heat Exchanger	
Tube	1.0E-7/h
Shell	1.0E-8/h
· Tank	1.0E-8/h

NOTES

- External leakage and rupture referred to events in which the coolant within the component escaped to the outside environment. Events which involved coolant leakage past a closed valve disk were not found in this report. Such events

were termed internal leakages.

- External rupture was defined as a leakage greater than 50 gpm or a complete severance of a pipe.

- External leakages ranged from 50 gpm to a lower limit (not well defined) above which an LER was submitted.

- External leakages or ruptures in welded or threaded connections between piping and components were associated with the component. However, flanges were covered separately.

- E[illegible] events were combined into the piping data.

12. Pipe lengths were normally measured with a tape measure. However, vertical pipe lengths greater than 6' off the floor were estimated (Rad Protection requirement). Pipe lengths in congested areas which required climbing greater than 6' off the floor or pipe lengths located in unsurveyed areas were also estimated (Rad Protection requirement).

13. Component leakage reduction factors (FAC) based upon physical orientation were estimated for those switchgear /motor control centers which were not screened for spray (i.e., Safe Shutdown Equipment AND Sprayed AND Reactor Trip). Leakage source components which were physically oriented in the plant such that water spray could only come in contact with the switchgear / motor control center in 180 DEG out of 360 DEG, had the component(s) leakage failure rate reduced by 0.5. Note that conservative Engineering Judgement was applied when determining leakage reduction factors (FAC). Use of the component leakage reduction factors was indicated in the Attachments for the individual switchgear / motor control centers. Currently, leakage failure frequencies for BUS 13, BUS 23, MCC 18-2, and MCC 28-2 have been estimated with reduction factors (FAC).

Attachment 12-4

CORE DAMAGE FREQUENCY BY INITIATING EVENT

INITIATING EVENT	INITIATING EVENT FREQUENCY (/YR)	CORE DAMAGE FREQUENCY (/YR)	PERCENT CONTRIBUTION
Dual Unit LOSP[1]	1.61E-02	6.74E-07	56.0
Single Unit LOSP	3.20E-02	1.92E-07	15.9
Medium LOCA[2]	8.00E-04	1.72E-07	14.3
ATWS[3]	1.16E-04	7.61E-08	6.3
General Transient	3.87	4.69E-08	3.9
Large LOCA	3.00E-04	2.48E-08	2.1
Small LOCA	3.00E-03	1.14E-08	0.9
Spray of Bus 13	2.65E-03	5.37E-09	0.4
IORV[4]	1.06E-01	8.71E-10	< 0.1
ISLOCA[5]	1.20E-07	6.30E-10	< 0.1
Spray of MCC 18-2	7.13E-04	4.08E-10	< 0.1
TOTAL		1.20E-06	100

Notes:

1. LOSP = Loss of Offsite Power
2. LOCA = Loss of Coolant Accident
3. ATWS = Anticipated Transient Without Scram
4. IORV = Inadvertent Open Relief Valve
5. ISLOCA = Interfacing System LOCA

ATTACHMENT B

Supplemental Response to Question 34: ADS Enhancements

Attachment B

QUESTION 34

34. There is no discussion of any consideration of enhancing the reactor pressure vessel (RPV) depressurization system reliability, as per the CPI recommendations. Provide a discussion of the potential benefits of enhanced RPV depressurization capability and whether such enhancements will be made at Quad Cities.

CLARIFICATION

The original response to this question addressed the issue of the reliability of the Electromatic Relief Valves (ERVs) that are used in the Automatic Depressurization System (ADS). In a subsequent discussion of this question with the NRC, it was agreed that a supplemental response would address the consideration of enhancing the reliability of the support systems providing the "motive force" for the ADS valves under station blackout (SBO) conditions.

SUPPLEMENTAL RESPONSE TO QUESTION 34

Reliability of Motive Force for ADS Valves

As shown in Table 4.1.4-1 of the Quad Cities IPE Submittal Report, opening 1 valve is the ADS success criterion for RPV depressurization for the SBO initiator with all high pressure injection sources failed. Footnote 1 of this table states that operator action is also required. As discussed on pages 4-76 and 4-77 of the IPE Submittal Report, five relief valves (1 Target Rock safety-relief valve and 4 ERVs) can be opened as part of the ADS.

The motive force for opening the Target Rock safety-relief valve is provided by the drywell pneumatic system. As discussed on page 4-76 of the IPE Submittal Report, an accumulator and check valve arrangement serves as a backup to the drywell pneumatic system. 125 VDC is required to reposition a solenoid valve to apply motive force to the Target Rock safety-relief valve. As discussed on page 4-76 of the IPE Submittal Report, the motive force for opening the ERVs is 125 VDC.

The potential benefit of enhancing the drywell pneumatic system and Target Rock accumulator and check valve arrangement is minimal because the 4 ERVs would still be available to perform the ADS function. This was confirmed using a computer model of the Quad Cities PRA to quantify the potential benefits for the ADS function by setting the failure probability for the accumulator and check valve to zero in the ADS fault tree. The resulting decrease in the calculated CDF was less than 0.01%.

In contrast, loss of 125 VDC would prevent operation of the ADS valves. (Note: The 125 VDC feed for the ADS valves is designed so that an automatic transfer to the alternate 125 VDC supply will occur upon loss of the normal 125 VDC supply. For the normal configuration of the 125 VDC system, the alternate 125 VDC supply is fed by the opposite unit's 125 VDC battery and battery chargers.) The remaining discussion will address the potential benefits of enhancing the 125 VDC supply for the ADS valves.

The potential benefit of enhancing the 125 VDC system to increase the reliability of RPV depressurization is minimal because the 125 VDC system has a high reliability; therefore, failure of ADS has a minimal contribution to core damage frequency (CDF). To quantify the potential benefits for the ADS function, a bounding analysis was performed using a computer model of the Quad Cities PRA; the 125 VDC failure rates were set to zero in the ADS fault tree. The resulting decrease in the calculated CDF was approximately 0.02%.

In summary, the potential benefits of increasing the reliability of the RPV depressurization function of ADS by increasing the reliability of the motive force of the ADS valves are minimal

<u>Benefits of Increasing the Reliability of the 125 VDC System for Other Reasons</u>

Nevertheless, the Quad Cities IPE did consider enhancement of the 125 VDC system because increasing the lifetime of the 125 VDC supply during an SBO would allow longer operation of turbine-driven high pressure injection pumps (HPCI or RCIC) and would give a longer amount of time to recover AC power. In the Quad Cities PRA, no credit was given for recovery of failed emergency diesel generators, but credit was given for the possibility of recovering offsite power. Based on the 4-hour battery lifetime and thermal hydraulic calculations, a 6-hour mission time was used for recovering offsite power, giving an estimated probability of failing to recover offsite power of 5.088E-02. The site-specific calculation of this failure probability is based on the methodology given in NUREG-1032 and is outlined in the ComEd response to Question 1(b) of the NRC request for additional information on the Quad Cities IPE Submittal Report. (Previous responses to that NRC request were included with the J. L. Schrage letter to W.T. Russell dated August 8, 1994.)

An increased lifetime of the 125 VDC supply would result in a longer mission time for recovery of offsite power and, consequently, a lower failure probability for recovery of offsite power. For example, the site-specific calculation discussed above gives 2.115E-02 as the estimated probability of failing to recover offsite power within 16 hours at Quad Cities. As a bounding estimate of the potential benefit of increasing the lifetime of the 125 VDC supply, the failure to recover offsite power probability was set to zero in the computer model of the Quad Cities PRA; the resulting decrease in the calculated CDF was approximately 43%.

Because of this potential benefit of increasing the mission time for recovery of offsite power, several possible enhancements of the 125 VDC system were considered during the insights review of the Quad Cities IPE. As listed in the "Maintain Support Systems" row of Table 1 of Attachment 42-1 of the ComEd response to Question 42(a) of the NRC request for additional information on the Quad Cities IPE Submittal Report, these enhancements include the following:

Insight	Subject
QC-87/IP	Procedure for 125 VDC Batteries for Extended SBO Events
QC-117/IP	Use of Additional DC Battery Banks
QC-119/AM	Provide Portable Generator for DC Power

Attachment 34-1 gives additional detail on these insights.

Details of a related insight, QC-130/IP, are given on page 4-299 of the Quad Cities IPE Submittal Report. Insight QC-130/IP recommends manual operation of RCIC to allow for continued injection after depletion of the batteries, thus reducing CDF by as much as 42%. Implementation of the recommendations in insight QC-130/IP, however, would by itself obtain much of the potential benefit of enhancing the 125 VDC system as recommended by insights QC-87/IP, QC-117/IP, and QC-119/AM.

Insight QC-130/IP is being actively evaluated by the Quad Cities Systems Engineering Department, but a decision has not yet been made on its implementation. The other insights discussed above will also be evaluated, but decisions on their implementation may, to some extent, be dependent on the eventual decision on Insight QC-130/IP.

Attachment 34-1

PROC FOR 125VDC BATTRS FOR EXTNDED SBO EVNTS	Log Number: QC-87/IP

ANALYST: Buell Bob F.
ANALYST: Trainer Jack E.
SYS: DC COMP: Batteries FUNCT: 125VDC Power
ACC. PHASE: Prior to Core Damage
EXPECTED RESULT: Improved Plnt Procdrs for SBO Cond
SOURCE: DRESDEN INSIGHTS DATABASE (DR-69/IP)
EOP/AOP: QOA 6100-4

OBSERVATIONS:
Procedure QOA 6100-4, Station Blackout, does not provide guidance to the plant operators for SBO events that extend beyond four hours (design life of the station batteries) for reactor vessel makeup and decay heat removal. The Station Blackout procedure does not consider an SBO event going beyond four hours since it is anticipated that AC powe. 'll be restored before the batteries are depleted; therefore, no further actions are speci ed to extend operation of the station batteries.

SEQUENCE/CONDITIONS:
Station Blackout Conditions beyond four hours in duration.

INSIGHT/STRATEGY:
QOA 6100-4 should be r--ised to provide guidance to the operators for actions which should be taken prior to depletion of the station batteries at four hours. This should include further load shedding based upon priority of loads.

CONSTRAINTS:
None

TIGER TEAM:				
IMPLEMENTATION CATEGORY				
Hardware	Test & Maint	X Procedures	Training	Information
A.M. Strategy	A.M. Tools	A.M. Organization	A.M. Information	A.M. Training
NATURE OF BENEFIT:	X Major	Minor	None	
Clarification	X Utiliz. of Capab.	Improve Efficiency	Risk Reduction	Acc. Prev.
Acc. Mitigation	Tech Spec. Relax.	Lic.Basis Simplif.	Reduce Maint.	Operat. Sim.
Other(Specify):				
NATURE OF IMPACT:	Major	X Minor	None	
Licensing Basis	Lic. Agreements	Tech Specs	Plant Hardware	Operat.Compl.
Admin. Controls	Staff Knowledge	Staffing Req'mnts	X Plant Procedures	Gen.Procedure
Other(Specify):				
RECOMMENDATIONS:	No Further Action		X Candidate for Distillation	

Attachment 34-1 (continued)

USE OF ADDITIONAL DC BATTERY BANKS

Log Number: QC-117/IP

ANALYST:
ANALYST: Trainer Jack E.
SYS: DC
ACC. PHASE: Prior to Core Damage
COMP: Batteries
FUNCT: Reserve 125VDC Power
EXPECTED RESULT: Significant Reduction in CDF
SOURCE: DRESDEN INSIGHTS DATABASE (DR-94/AM)
EOP/AOP:

OBSERVATIONS:
A redundant, 125V battery is installed at each unit. These batteries are not permanently connected, and are intended for use during maintenance on the normal 125V batteries only. Appropriate procedures involving these batteries could significantly enhance safety system operation during loss of DC power and SBO events.

SEQUENCE/CONDITIONS:
This insight is applicable to sequences involving a plant transient and subsequent loss of 125VDC at one unit, or during SBO conditions.

INSIGHT/STRATEGY:
Quad Cities technical staff engineering should develop the appropriate procedures to address use of the connection between the safety related 125VDC battery system and the maintenance batteries for reserve DC power under extended SBO plant conditions.

CONSTRAINTS:
The licensing basis for use of these battery systems would have to be established.

TIGER TEAM:

IMPLEMENTATION CATEGORY				
Hardware	Test & Maint	X Procedures	Training	Information
A.M. Strategy	A.M. Tools	A.M. Organization	A.M. Information	A.M. Training

NATURE OF BENEFIT:	X Major	Minor	None	
Clarification	X Utiliz. of Capab.	Improve Efficiency	X Risk Reduction	Acc. Prev.
Acc. Mitigation	Tech Spec. Relax.	Lic.Basis Simplif.	Reduce Maint.	Operat. Sim.
Other(Specify):				

NATURE OF IMPACT:	Major	X Minor	None	
Licensing Basis	Lic. Agreements	Tech Specs	Plant Hardware	Operat.Compl.
Admin. Controls	X Staff Knowledge	Staffing Req'mnts	X Plant Procedures	Gen.Procedure
Other(Specify):				

RECOMMENDATIONS: No Further Action X Candidate for Distillation

Attachment 34-1 (continued)

PROVIDE PORTABLE GENERATOR FOR DC POWER	Log Number: QC-119/AM

ANALYST:
ANALYST: Trainer Jack E.
SYS: DC COMP: Portable Generator FUNCT: Reserve DC Power
ACC. PHASE: Pre/Post Core Damage
EXPECTED RESULT: Extend time to recover power
SOURCE: DRESDEN INSIGHTS DATABASE (DR-116/AM)
EOP/AOP: QOA 6100-4

OBSERVATIONS:
One of the NRC's preventative strategies requires making use of portable battery chargers to recharge the 125VDC batteries. Use of a portable charger would be especially beneficial for extended SBO conditions, since the charger could be used to keep the ADS valves open and allow injection with the diesel-driven fire protection water pumps (see related insight QC 88/IP). Time to recover offsite power would be extended.

SEQUENCE/CONDITIONS:
This insight is applicable to station blackout sequences.

INSIGHT/STRATEGY:
The Quad Cities station should provide a portable generator for each unit capable of supplying rectified DC power to recharge the batteries or supply pre-selected DC bus loads directly in the event of loss of DC power at one or both units. Connections to the 125VDC battery bus should be pre-staged and proceduralized in QOA 6100-4 (Station Blackout) to expedite this connection if required.

CONSTRAINTS:
None

TIGER TEAM:				
IMPLEMENTATION CATEGORY				
X Hardware	Test & Maint	Procedures	Training	Information
X A.M. Strategy	A.M. Tools	A.M. Organization	A.M. Information	A.M. Training
NATURE OF BENEFIT: X Major		Minor	None	
Clarification	Utiliz. of Capab.	Improve Efficiency	X Risk Reduction	Acc. Prev.
Acc. Mitigation	Tech Spec. Relax.	Lic.Basis Simplif.	Reduce Maint.	Operat. Sim.
Other(Specify):				
NATURE OF IMPACT: X Major		Minor	None	
Licensing Basis	Lic. Agreements	Tech Specs	X Plant Hardware	Operat.Compl.
Admin. Controls	Staff Knowledge	Staffing Req'mnts	Plant Procedures	Gen.Procedure
Other(Specify):				
RECOMMENDATIONS:	No Further Action		X Candidate for Distillation	