Appendix B

NPDES Permit

The National Pollutant Discharge Elimination System (NPDES) permit for the Quad Cities Nuclear Power Station is approximately 100 pages long. Appendix B contains a copy of the permit cover page and pages pertinent to discussion in the Applicant's Environmental Report; Operating License Renewal State; Quad Cities Nuclear Power Station Units 1 and 2.

NPDES Permit No IL0005037

Illinois Environmental Protection Agency
Bureau of Water, Division of Water Pollution Control
Permit Section
1021 North Grand Avenue East
Post Office Box 19276
Springfield, Illinois 62794-9276

Iowa Department of Natural Resources
Wastewater Section
Henry A. Wallace Building
900 East Grand Avenue
Des Moines, Iowa 50316

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

Modified (NPDES) Permit

Expiration Date. May 31, 2005

Issue Date May 26, 2000
Effective Date June 1, 2000
Modification Date December 17, 2001

Name and Address of Permittee

Exelon Generation Company, LLC
4300 Winfield Road
Warrenville, Illinois 60555

Facility Name and Address

Quad Cities Generating Station
22710 206th Avenue North
Cordova, Illinois 61242
(Rock Island County)

Discharge Number and Name		Receiving Waters
001/002	Open Cycle Diffusers	Mississippi River
B01	Wastewater Treatment System	Mississippi River
C01	Sanitary Waste Treatment Plant	Mississippi River
A02	Radwaste Treatment System Blowdown	Mississippi River

In compliance with the provisions of the Illinois Environmental Protection Act, Title 35 of Ill. Adm. Code, Subtitle C and/or Subtitle D, Chapter 1, and the Clean Water Act (CWA), the above-named permittee is hereby authorized to discharge at the above location to the above-named receiving stream in accordance with the standard conditions and attachments herein

Permittee is not authorized to discharge after the above expiration date In order to receive authorization to discharge beyond the expiration date, the permittee shall submit the proper application as required by the Illinois Environmental Protection Agency (IEPA) not later than 180 days prior to the expiration date

Thomas G. McSwiggin, P E.
Illinois Environmental Protection Agency
Manager, Permit Section
Division of Water Pollution Control

Wayne C Farrand
Iowa Department of Natural Resources
Supervisor
Wastewater Permit Section
Environmental Protection Division

TGM BAK 99123001.daa

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Modification Date December 17, 2001

NPDES Permit No IL0005037

Effluent Limitations and Monitoring

PARAMETER	LOAD LIMITS lbs/day DAF (DMF) 30 DAY AVERAGE	DAILY MAXIMUM	CONCENTRATION LIMITS mg/l 30 DAY AVERAGE	DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE

1 From the effective date of this permit until the expiration date the effluent of the following discharge(s) shall be monitored and limited at all times as follows:

Outfall(s): 001 and 002 Open Cycle Diffusers

This discharge consists of.

	Approximate Flow
Main Condenser Cooling Water	970 4 MGD
House Service Water	40MGD
Radwaste Treatment System Blowdown*	0 051 MGD
Wastewater Treatment Plant Effluent	0 034 MGD
Sanitary Waste Treatment Plant Effluent	0 008 MGD
House Service Water Strainer Backwash	0 126 MGD
Intake Screen Backwash	0 508 MGD
Units 1 and 2 Oil/Water Separators	Intermittent
Fish Culture Facilities	Intermittent
Crib House Floor Drain Sump**	

PARAMETER	30 DAY AVERAGE	DAILY MAXIMUM	30 DAY AVERAGE	DAILY MAXIMUM	SAMPLE FREQUENCY	SAMPLE TYPE
Flow (MGD)					Daily	24 hr total
pH See Special Condition No. 1					1/Month	Grab
Total Residual Chlorine/Total Residual Oxidant***				0 2	1/Week	Grab
Temperature See Special Condition No. 6					Daily	Continuous Recording

*This sub-waste stream discharges only through Outfall 002, all other sub-waste streams are common to both Outfalls 001 and 002.
**This sub-waste stream is an alternate routing from Outfall 001(b) See Special Condition 18.
***See Special Conditions 3 and 4. The discharge limit of 0 2 mg/l applies when chlorine compounds are used as the sole biocide. See Special Condition 15 for requirements when bromine biocides are used

Page 3 Modification Date. December 17, 2001

NPDES Permit No IL0005037

Effluent Limitations and Monitoring

1. From the effective date of this permit until the expiration date, the effluent of the following discharge(s) shall be monitored and limited at all times as follows:

	LOAD LIMITS lbs/day		CONCENTRATION LIMITS mg/l			
PARAMETER	30 DAY AVG	DAILY MAX.	30 DAY AVG	DAILY MAX.	SAMPLE FREQUENCY	SAMPLE TYPE
	Outfall(s) B01 Wastewater Treatment System****					
	This discharge consists of *****				Approximate Flow (MGD)	
	Crib House Floor Drain Sump				0 033	
	Oil Separator discharges				0 0015	
	Roof and floor drains				Intermittent	
	Portable Demineralizer rinse water				Intermittent	
Flow (MGD)					1/Week	24 hr total
Total Suspended Solids			15	30	1/Week	8 hr Composite
Oil and Grease			15	20	1/Month	Grab
	Outfall(s): C01 Sanitary Waste Treatment Plant (DMF 0 06 MGD)				Approximate Flow 0 008 (MGD)	
Flow (MGD)					2/Month	24 hr total
pH	See Special Condition No. 1				2/Month	Grab
BOD_5	15	30	30	60	2/Month	24 hr Composite
Fecal Coliform	See Special Condition No 9				2/Month	Grab
Total Suspended Solids	15	30	30	60	2/Month	24 hr Composite

****Wastewater Treatment System effluent is routed through an oil/water separator prior to discharge.
*****The listed contributory waste streams all pass through an oil/water separator (Unit ½ oil/water separator) prior to entering the wastewater treatment plant Crib House Floor Drain Sump water may be discharged directly to Outfalls 001/002 open cycle diffuser as an alternate route See Special Condition 18

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Modification Date December 17, 2001

NPDES Permit No IL0005037

Effluent Limitations and Monitoring

PARAMETER	LOAD LIMITS lbs/day 30 DAY AVG.	DAILY MAX.	CONCENTRATION LIMITS mg/l 30 DAY AVG	DAILY MAX.	SAMPLE FREQUENCY	SAMPLE TYPE

1. From the effective date of this permit until the expiration date, the effluent of the following discharge(s) shall be monitored and limited at all times as follows:

Outfall(s): A02 Radwaste Treatment System Blowdown******

This discharge consists of:

Approximate Flow 0 0422 (MGD)

Reactor Water
Contaminated Floor Drains
Equipment Drains
Condensate Demineralizer Filter Backwash
Reactor Cleanup Demineralizer Filter Backwash
Laboratory Wastewater
Sodium Pentaborate Tank Testing Drainage

PARAMETER	LOAD 30 DAY AVG.	LOAD DAILY MAX.	CONC. 30 DAY AVG	CONC. DAILY MAX.	SAMPLE FREQUENCY	SAMPLE TYPE
Flow (MGD)					Daily	24 hr total
Total Suspended Solids			15	30	1/Week When Discharging	Grab
Oil and Grease			15	20	1/Month When Discharging	Grab
Boron	See Special Condition No. 17				1/Discharge Period	Grab

******The permittee shall comply with the Nuclear Regulatory Commission Title 10 (10 CFR 0.735-1) regulations for discharge and monitoring of radioactive wastewater discharges Wastewater is generally batch treated and recycled, therefore the daily average discharge rate from Outfall No. A02 does not reflect influent flow rates.

Page 5 Modification Date. December 17, 2001

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Special Conditions

SPECIAL CONDITION 1. The pH shall be in the range 6 0 to 9 0

SPECIAL CONDITION 2 Samples taken in compliance with the effluent monitoring requirements shall be taken at a point representative of the discharge, but prior to entry into the receiving stream

SPECIAL CONDITION 3 A minimum of three grab samples shall be taken at approximately five minute intervals in the discharge bay at the diffuser pipes during the respective sodium bromide and/or chlorine injection period of a generating unit allowing for lag time between the initiation of injection and the point of sampling before the first grab sample is taken. The individual values and average (mean) values for each set of samples shall be reported including the Unit sampled, the times samples were collected, the time and duration of the sodium bromide and/or chlorine dosing period plus the rate and amount (lbs.) of sodium bromide and/or chlorine applied. For purposes of reporting, the daily discharge shall be the average of all non-zero values measured in a day and the monthly average shall be the average of all daily discharges.

For the purpose of determining compliance, the highest single instantaneous TRC/TRO concentration measured on any day will be regarded as the daily maximum concentration Total residual oxidant concentration shall be measured and reported in terms of total residual chlorine.

SPECIAL CONDITION 4. Neither total residual chlorine nor total residual oxidant may be discharged from any unit's main condenser for more than two hours in any one day. Not more than one of the unit's main condensers may discharge total residual chlorine or total residual oxidant at any one time unless the permittee can demonstrate to the Agency that doing so will not violate water quality limitations of the State Simultaneous chlorination of the generating units will require a modification of the permit. The Agency will public notice the permit modification.

SPECIAL CONDITION 5 Nothing in this permit affects or abrogates the responsibilities or commitments of the Permittee herein as set forth in the agreement entered into by the Permittee in the consolidated cases of Izaak Walton League of America, et. al. v Schlesinger, No 2208-71 and People of the State of Illinois, et. al v United States Atomic Energy Commission, No. 2208-71 (U S District Court, District of Columbia).

SPECIAL CONDITION 6 Discharge of wastewater from this facility must not alone or in combination with other sources cause the receiving stream to violate the following thermal limitations at the edge of the mixing zone:

A. Maximum temperature rise above natural temperature must not exceed 5°F.

B. Water temperature at representative locations in the main river shall not exceed the maximum limits in the following table during more than one (1) percent of the hours in the 12-month period ending with any month Moreover, at no time shall the water temperature at such locations exceed the maximum limits in the following table by more than 3°F. (Main river temperatures are temperatures of those portions of the river essentially similar to and following the same thermal regime as the temperatures of the main flow of the river)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec
°F	45	45	57	68	78	85	86	86	85	75	65	52

C. The area of diffusion of an effluent in the receiving water is a mixing zone, and that mixing zone shall not extend

i) over more than 25 percent of the cross sectional area or volume of flow in the Mississippi River,

ii) more than 26 acres of the Mississippi River

Page 6 Modification Date: December 17, 2001

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Special Conditions

The following data shall be collected and recorded

1. Weekly determination of the river flow rate (daily when the river flows fall below 23,000 cfs)
2. Daily determination of the ambient river temperature (at or upstream of station intakes)
3. Daily recording of station discharge rate.
4. Daily continuous recording of the temperature of the station discharge
5. Daily determination of station load.
6. As deemed necessary according to the above data, daily determination of the cross-sectional average temperature at the 500 foot downstream cross-section in the river.

Compliance with the thermal limitations of Special Condition 6 shall be demonstrated as follows:

1. When river flow is 21,000 cfs or greater and the ambient river temperature is 5° F or more lower than the monthly limiting temperatures, the temperature monitoring curve[1] establishes that the permittee is in compliance for all power generation levels.
2. When the river flow is less than 21,000 cfs and/or the ambient river temperature is within 5° F of the monthly limiting temperatures, the permittee shall demonstrate compliance using either:
   a Plant load, river flow, ambient river temperature, and the temperature monitoring curve, or
   b Field measurement[2] of the river cross-sectional average temperature taken 500 feet downstream of the diffusers

In the event that compliance monitoring shows that the permittee has exceeded the monthly limiting temperature, the number of hours of such exceedance shall be reported on the permittee's Discharge Monitoring Report.

[1]The temperature monitoring curve identified asFigure 2 in the December 2000 "Revised Temperature Monitoring Curve for Quad Cities Nuclear Generating Station".

[2] When conditions such as ice formation render the Mississippi River inaccessible to marine activity, the Permittee may demonstrate compliance with the thermal limitations of Special Condition 6 by using the most recent field measurement data collected at a river flow equal to or less than the flow for which field measurement data cannot be collected. The most recent field measurement data shall be normalized to the power production level for the day when the river was inaccessible.

SPECIAL CONDITION 7. There shall be no discharge of polychlorinated biphenyl compounds from any discharge.

SPECIAL CONDITION 8. There shall be no discharge of complexed metal bearing wastestreams and associated rinses from chemical metal cleaning, unless this permit has been modified to include the new discharge.

SPECIAL CONDITION 9 The daily maximum fecal coliform count examined twice per month shall not exceed 400 per 100 ml

SPECIAL CONDITION 10. Commonwealth Edison Company's demonstration for the Quad Cities Nuclear Power Station in accordance with Section 316(a) and 316(b) of the Clean Water Act was approved by IEPA by letter dated July 28, 1981 and by the Iowa Department of Environmental Quality (IDEQ) by letter dated May 18, 1981. Based on these conclusions the following actions by the permittee are required:

A The permittee shall monitor fish impingement once per week, year round Each year's data shall be tabulated and compared to historical fish impingement data for the same period with the results submitted to IEPA Permit Section and Compliance Assurance Section by July 28, each year.

B The permittee shall monitor water temperatures as described in Special Condition 6.

SPECIAL CONDITION 11. A permittee who wishes to establish the affirmative defense of upset as defined in 40 CFR 122 41(n) shall demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence that: An upset occurred and that the permittee can identify the cause(s) of the upset; the permitted facility was at the time being properly operated; the permittee submitted notice of the upset as required in standard condition 12 of this permit; and the permittee complied with any remedial measures required in standard condition 4 of this permit.

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NPDES Permit No IL0005037

Special Conditions

SPECIAL CONDITION 12. Discharge is allowed from the Unit 1 oil/water separator and the Unit 2 oil/water separator in accordance with the Spill Prevention Control and Countermeasure Plan (SPCC) If an applicable effluent standard or water quality related effluent limitation is promulgated under Section 301 and 302 of the Clean Water Act (CWA) and that effluent or water quality standard or limitation is more stringent than any effluent or water quality limitations in this permit, or controls a pollutant not limited in this NPDES Permit, the Agency shall revise or modify the permit in accordance with the promulgated standard and shall notify the permittee

SPECIAL CONDITION 13 The permittee shall record monitoring results on Discharge Monitoring Report Forms using one such form for each discharge each month

SPECIAL CONDITION 14 The completed Discharge Monitoring Report forms shall be mailed and received by the IEPA no later than the 28th day of the following month, unless otherwise specified by the permitting authority Discharge Monitoring Reports shall be mailed to the IEPA at the following address:

Illinois Environmental Protection Agency
Division of Water Pollution Control
1021 North Grand Avenue East
Springfield, Illinois 62706
Attention: Compliance Assurance Section

SPECIAL CONDITION 15 A discharge limit of 0 05 mg/l (instantaneous maximum) shall be achieved for total residual oxidant when bromine biocides are used for condenser biofouling control, in accordance with Special Condition 3.

SPECIAL CONDITION 16. The Agency has determined that the effluent limitations in this permit constitute BAT/BCT for storm water which is treated in the existing treatment facilities for purposes of this permit reissuance, and no pollution prevention plan will be required for such storm water. In addition to the chemical specific monitoring required elsewhere in this permit, the permittee shall conduct an annual inspection of the facility site to identify areas contributing to a storm water discharge associated with industrial activity, and determine whether any facility modifications have occurred which result in previously-treated storm water discharges no longer receiving treatment. If any such discharges are identified the permittee shall request a modification of this permit within 30 days after the inspection Records of the annual inspection shall be retained by the permittee for the term of this permit and be made available to the Agency on request.

SPECIAL CONDITION 17 The permittee shall monitor for boron during periods when Sodium Pentaborate is discharged as a result of tank testing and connection drainage from components in the radwaste treatment system. The effluent boron concentration in the subject discharge shall not cause the receiving stream to exceed the water quality standards in Section 302 of 35 Ill Adm Code, Chapter 1, Subtitle C. This permit may be modified to include effluent limitations or requirements which are consistent with applicable laws, regulations, or judicial orders The Agency will public notice the permit modification

SPECIAL CONDITION 18. Crib House Floor Drain Sump shall only be routed to the Outfall 001/002 Open Cycle Diffusers during periods when increased pump seal cooling water leakage is significant enough so as to overload the wastewater treatment plant Alternate routing of this discharge shall not take place in lieu of proper maintenance and operation of the circulating pumps

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ATTACHMENT H

Standard Conditions

Definitions

Act means the Illinois Environmental Protection Act, Ch. 111 1/2 Ill Rev Stat., Sec 1001-1052 as Amended.

Agency means the Illinois Environmental Protection Agency

Board means the Illinois Pollution Control Board.

Clean Water Act (formerly referred to as the Federal Water Pollution Control Act) means Pub. L. 92-500, as amended. 33 U.S.C. 1251 et seq.

NPDES (National Pollutant Discharge Elimination System) means the national program for issuing, modifying, revoking and reissuing, terminating monitoring and enforcing permits and imposing and enforcing pretreatment requirements, under Sections 307, 402, 318 and 405 of the Clean Water Act.

USEPA means the United States Environmental Protection Agency.

Daily Discharge means the discharge of a pollutant measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. For pollutants with limitations expressed in units of mass, the "daily discharge" is calculated as the total mass of the pollutant discharged over the day. For pollutants with limitations expressed in other units of measurements, the "daily discharge" is calculated as the average measurement of the pollutant over the day.

Maximum Daily Discharge Limitation (daily maximum) means the highest allowable daily discharge.

Average Monthly Discharge Limitation (30 day average) means the highest allowable average of daily discharges over a calendar month, calculated as the sum of all daily discharges measured during a calendar month divided by the number of daily discharges measured during that month.

Average Weekly Discharge Limitation (7 day average) means the highest allowable average of daily discharges over a calendar week, calculated as the sum of all daily discharges measured during a calendar week divided by the number of daily discharges measured during that week.

Best Management Practices (BMPs) means schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the State. BMPs also include treatment requirements, operating procedures, and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

Aliquot means a sample of specified volume used to make up a total composite sample.

Grab Sample means an individual sample of at least 100 milliliters collected at a randomly-selected time over a period not exceeding 15 minutes.

24 Hour Composite Sample means a combination of at least 8 sample aliquots of at least 100 milliliters, collected at periodic intervals during the operating hours of a facility over a 24-hour period.

8 Hour Composite Sample means a combination of at least 3 sample aliquots of at least 100 milliliters, collected at periodic intervals during the operating hours of a facility over an 8-hour period.

Flow Proportional Composite Sample means a combination of sample aliquots of at least 100 milliliters collected at periodic intervals such that either the time interval between each aliquot or the volume of each aliquot is proportional to either the stream flow at the time of sampling or the total stream flow since the collection of the previous aliquot.

(1) **Duty to comply.** The permittee must comply with all conditions of this permit. Any permit noncompliance constitutes a violation of the Act and is grounds for enforcement action, permit termination, revocation and reissuance, modification, or for denial of a permit renewal application. The permittee shall comply with effluent standards or prohibitions established under Section 307(a) of the Clean Water Act for toxic pollutants within the time provided in the regulations that establish these standards or prohibitions, even if the permit has not yet been modified to incorporate the requirement.

(2) **Duty to reapply.** If the permittee wishes to continue an activity regulated by this permit after the expiration date of this permit, the permittee must apply for and obtain a new permit. If the permittee submits a proper application as required by the Agency no later than 180 days prior to the expiration date, this permit shall continue in full force and effect until the final Agency decision on the application has been made.

(3) **Need to halt or reduce activity not a defense.** It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

(4) **Duty to mitigate.** The permittee shall take all reasonable steps to minimize or prevent any discharge in violation of this permit which has a reasonable likelihood of adversely affecting human health or the environment.

(5) **Proper operation and maintenance.** The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to achieve compliance with the conditions of this permit. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training, and adequate laboratory and process controls, including appropriate quality assurance procedures. This provision requires the operation of back-up, or auxiliary facilities, or similar systems only when necessary to achieve compliance with the conditions of the permit.

(6) **Permit actions.** This permit may be modified, revoked and reissued, or terminated for cause by the Agency pursuant to 40 CFR 122.62. The filing of a request by the permittee for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance, does not stay any permit condition.

(7) **Property rights.** This permit does not convey any property rights of any sort, or any exclusive privilege.

(8) **Duty to provide information.** The permittee shall furnish to the Agency within a reasonable time, any information which the Agency may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit, or to determine compliance with the permit. The permittee shall also furnish to the Agency, upon request, copies of records required to be kept by this permit.

(9) **Inspection and entry.** The permittee shall allow an authorized representative of the Agency, upon the presentation of credentials and other documents as may be required by law to

   (a) Enter upon the permittee's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this permit,

   (b) Have access to and copy at reasonable times, any records that must be kept under the conditions of this permit,

   (c) Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit, and

   (d) Sample or monitor at reasonable times, for the purpose of assuring permit compliance, or as otherwise authorized by the Act, any substances or parameters at any location.

(10) **Monitoring and records.**

   (a) Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity

   (b) The permittee shall retain records of all monitoring information, including all calibration and maintenance records, and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit, for a period of at least 3 years from the date of this permit, measurement, report or application. This period may be extended by request of the Agency at any time.

   (c) Records of monitoring information shall include

      (1) The date, exact place, and time of sampling or measurements;

      (2) The individual(s) who performed the sampling or measurements

      (3) The date(s) analyses were performed,

      (4) The individual(s) who performed the analyses,

      (5) The analytical techniques or methods used and

      (6) The results of such analyses.

   (d) Monitoring must be conducted according to test procedures approved under 40 CFR Part 136, unless other test procedures have been specified in this permit. Where no test procedure under 40 CFR Part 136 has been approved, the permittee must submit to the Agency a test method for approval. The permittee shall calibrate and perform maintenance procedures on all monitoring and analytical instrumentation at intervals to ensure accuracy of measurements.

(11) **Signatory requirement.** All applications, reports or information submitted to the Agency shall be signed and certified.

   (a) Application. All permit applications shall be signed as follows

      (1) For a corporation: by a principal executive officer of at least the level of vice president or a person or position having overall responsibility for environmental matters for the corporation;

      (2) For a partnership or sole proprietorship, by a general partner or the proprietor respectively, or

      (3) For a municipality, State, Federal, or other public agency: by either a principal executive officer or ranking elected official.

   (b) Reports. All reports required by permits, or other information requested by the Agency shall be signed by a person described in paragraph (a) or by a duly authorized representative of that person. A person is a duly authorized representative only if:

      (1) The authorization is made in writing by a person described in paragraph (a), and

      (2) The authorization specifies either an individual or a position responsible for the overall operation of the facility from which the discharge originates, such as a plant manager, superintendent or person of equivalent responsibility, and

      (3) The written authorization is submitted to the Agency

PRINTED ON RECYCLED PAPER

Appendix C

Special-Status Species Correspondence

Table of Contents

Exelon. Nuclear

Exelon Generation
4300 Winfield Road
Warrenville IL 60555

www.exeloncorp.com

RS-01-294

January 11, 2001

Mr. Keith Dohrmann
Department of Natural Resources
Divisions of Parks, Recreation & Preserves
Wallace State Office Building
502 East 9th
Des Moines, IA 50319-0034

Subject Quad Cities Nuclear Power Station, Units 1 and 2 License Renewal: Request For Information On Listed Species And Important Habitats

Exelon Generation Company (EGC), LLC (formerly Commonwealth Edison Company) is currently preparing an application to the U.S Nuclear Regulatory Commission (NRC) to renew the operating license for Quad Cities Nuclear Power Station (QCNPS) Units 1 and 2. The current operating licenses for Unit 1 and 2 expire in 2012. The renewal term would be for an additional 20 years beyond the original license expiration date. As part of the license renewal process, NRC requires license renewal applicants to "assess the impact of the proposed action on threatened or endangered species in accordance with the Endangered Species Act." The NRC will consult with the U.S. Fish and Wildlife Service under Section 7 of the Endangered Species Act and may also seek your assistance in the identification of important species and habitats in the project area. By contacting your office early in the application process, we hope to identify any issues that we may need to address or any information that we should provide to your office to expedite your evaluation of the potential impact of the continued operation of QCNPS on threatened and endangered species.

Exelon has operated QCNPS and its associated transmission lines since 1972. As shown on Attachment A, QCNPS is located in Rock Island County, Illinois, approximately seven miles southwest of Clinton, Iowa. As shown on Attachment B, the QCNPS site consists of 560 acres, and includes two nuclear reactors, intake and discharge canals, several buildings, switchyards, and a retired spray canal that is now utilized for aquaculture

As shown on Attachment C, five transmission lines were built to connect QCNPS to the regional transmission system Portions of two of these transmission lines are located in Scott and Clinton Counties, Iowa. Beginning at QCNPS, one line runs south from the Station, turns west, crosses the Mississippi River, and ends north of Davenport, Iowa. One line runs through the industrial park just north of QCNPS and then crosses the Mississippi River, terminating near Comanche, Iowa.

January 11, 2002
Department of Natural Resources
Divisions of Parks, Recreation & Preserves
Page 2

EGC is committed to the conservation of significant natural habitats and protected species, and expects that operation of QCNPS and its transmission lines since 1972 has had no adverse impact on any threatened or endangered species. Any maintenance activities necessary to support license renewal would be limited to previously disturbed areas No additional land disturbance is currently anticipated in support of license renewal We believe that operation of QCNPS, including maintenance of the transmission lines, over the license renewal period would not adversely affect any threatened or endangered species. Accordingly, we request your concurrence with our determination that a renewed license would have no effect on listed or proposed endangered or threatened species.

After your review, we request receiving your input by March 29, 2002. In your response, please detail any concerns you may have about state-listed species or ecologically significant habitats in the vicinity of QCNPS or in the associated transmission corridors (rights-of-way), or concurring with our conclusion that continued operation of QCNPS and the associated transmission corridors would not affect any threatened or endangered species This will enable us to meet our NRC application submittal schedule Exelon will include a copy of this letter and your response in the Environmental Report that will be submitted to the NRC as part of the QCNPS license renewal application.

Should you have any questions concerning this letter, please contact Mr. Terry Steinert at (630) 657-3213.

Respectfully,

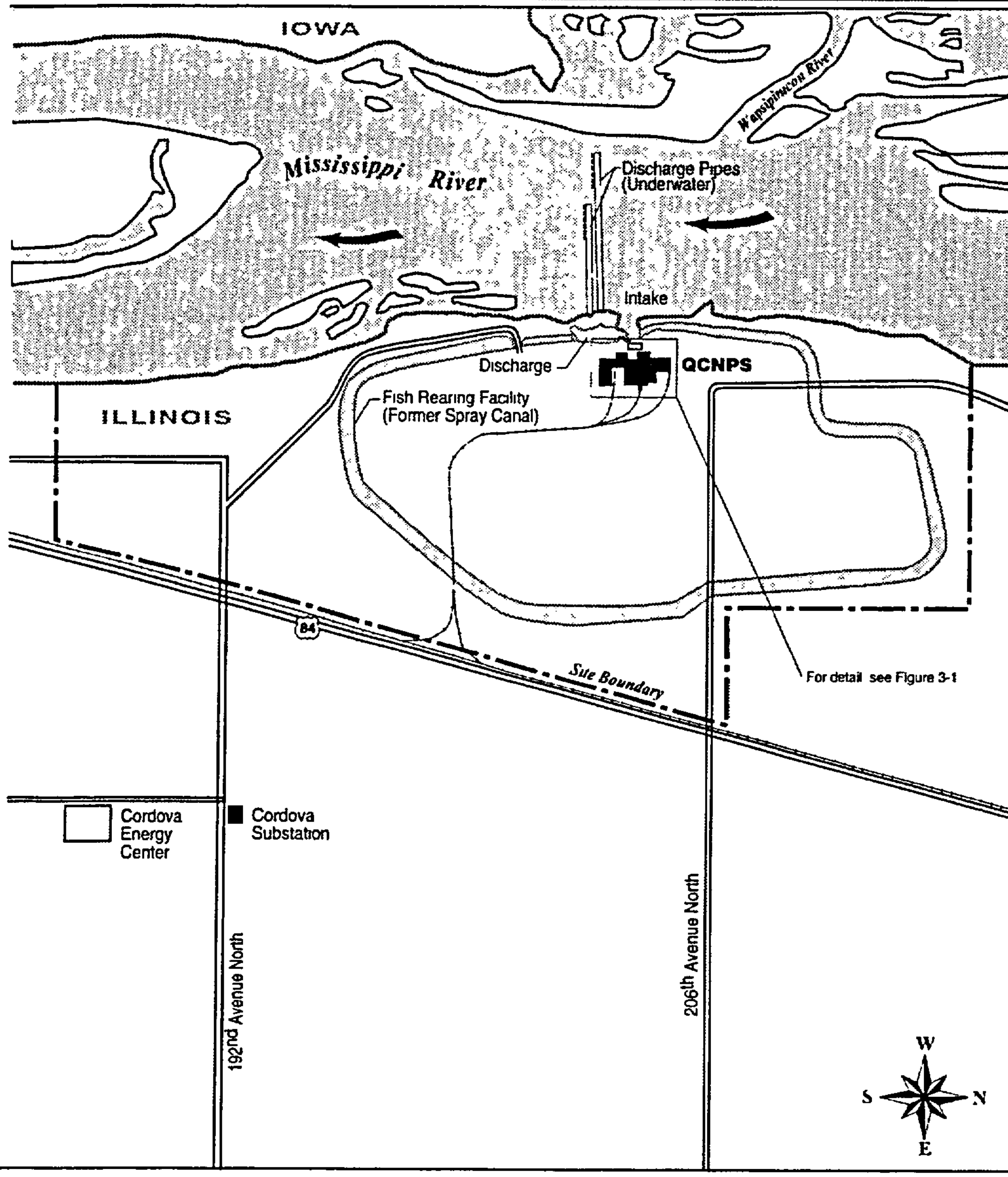
K. R. Jury
Director – Licensing
Mid-West Regional Operating Group

Attachments: Attachment A: Figure 2-1, 50-Mile Vicinity Map
Attachment B: Figure 2-3, Site Boundary
Attachment C: Figure 3-2, Transmission Line Map

LEGEND

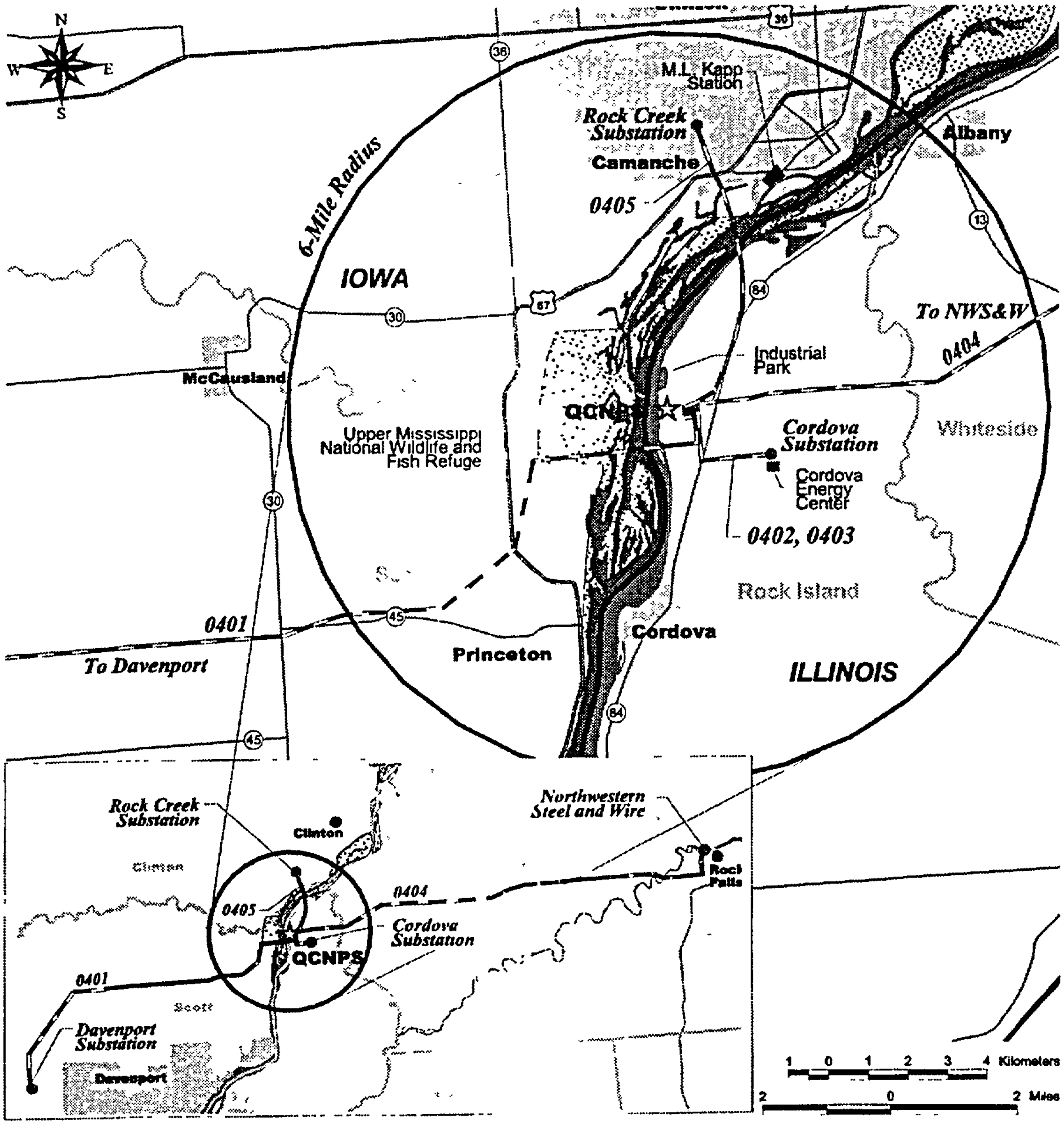
- ☆ Nuclear Power Plants
- County Boundaries
- Lakes and Rivers
- Urban

FIGURE 2-1
50-Mile Vicinity Map



Utility/Exelon/Quad_Cities/Grfx/2 3 Quad site bnd.ai

FIGURE 2-3
Site Boundary.



LEGEND

- Substations
- Quad Cities Nuclear Station
- Transmission Lines
- County Boundaries
- Cities

NWS&W = Northwestern Steel and Wire

FIGURE 3-2
Transmission Line Map

Fields of Opportunities

STATE OF IOWA

THOMAS J. VILSACK, GOVERNOR
SALLY J. PEDERSON, LT. GOVERNOR

DEPARTMENT OF NATURAL RESOURCES
JEFFREY R. VONK, DIRECTOR

February 6, 2002

Ms. K.R. Jury
Exelon Generation
4300 Winfield Road
Warrenville, IL 60555

RE: License renewal for the Quad Cities Nuclear Power Station Units 1 and 2

Dear Ms. Jury:

Thank you for inviting our comments on the impact of the above referenced project on protected species and rare natural communities.

We have searched our records of the project area and found no records of rare species or significant natural communities. However, our data are not the result of thorough field surveys. Based on the information provided, we do not think the project will affect protected species or rare natural communities. If listed species or rare communities are found during the planning or construction phases, additional studies and/or mitigation may be required.

This letter is a record of review for protected species and rare natural communities in the project area. It does not constitute a permit and before proceeding with the project, you may need to obtain permits from the DNR or other state and federal agencies.

If you have any questions about this letter or if you require further information, please contact Keith Dohrmann at (515) 281-8967.

Sincerely,

MIKE BRANDRUP
IOWA DEPARTMENT OF NATURAL RESOURCES

MB:kd

02-760L.doc

WALLACE STATE OFFICE BUILDING / DES MOINES, IOWA 50319
515-281-5918 TDD 515-242-5967 FAX 515-281-6794 WWW.STATE.IA.US/DNR

Exelon Nuclear

Exelon Generation
4300 Winfield Road
Warrenville IL 60555

www.exeloncorp.com

RS-02-041

February 22, 2002

Mr Keith Shank
Manager
Endangered Species Consultation Program
Illinois Division of Natural Resources
320 W. Washington St.
Springfield, IL 62704

Subject: Quad Cities Nuclear Power Station, Units 1 and 2 License Renewal. Request For Information On State-Listed Species And Important Habitats

Exelon Generation Company (EGC), LLC (formerly Commonwealth Edison Company) is preparing an application to the U S Nuclear Regulatory Commission (NRC) to renew the operating licenses for Quad Cities Nuclear Power Station (QCNPS) Units 1 and 2 The current operating licenses for Unit 1 and 2 expire in 2012. The renewal term would be for an additional 20 years beyond the original license expiration date. As part of the license renewal process, NRC requires license renewal applicants to "assess the impact of the proposed action on threatened or endangered species in accordance with the Endangered Species Act." NRC will consult with the U S. Fish and Wildlife Service under Section 7 of the Endangered Species Act and may also seek your assistance in the identification of important species and habitats in the project area. By contacting your office early in the application process, we hope to identify any issues that we may need to address or any information that we should provide to your office to expedite your evaluation of the potential impact of the continued operation of QCNPS on threatened or endangered species.

Exelon has operated QCNPS and its associated transmission lines since 1972. As shown on Attachment A, QCNPS is located in Rock Island County, Illinois. As shown on Attachment B, the QCNPS site consists of 560 acres, and includes two nuclear reactors, intake and discharge canals, several buildings, switchyards, and a retired spray canal that is now utilized for aquaculture.

As shown on Attachment C, five transmission lines were built to connect QCNPS to the regional transmission system. The transmission lines within Illinois are located in Rock Island and Whiteside Counties. Beginning at QCNPS, one line runs south from the Station and then turns west, crossing the Mississippi River. One line runs east for approximately 33 miles, terminating near Rock Falls, Illinois. One line runs through the industrial park just north of QCNPS and crosses the Mississippi River into Iowa

February 22, 2002
Illinois Division of Natural Resource
Page 2

Two other lines terminate within two miles of the Station Copies of 7.5 minute USGS Quadrangle maps with the associated transmission corridors highlighted are provided as enclosures to aid you in this review.

EGC is committed to the conservation of significant natural habitats and protected species, and believes that operation of the QCNPS and its transmission lines since 1972 has had no adverse impact on any threatened or endangered species. Any maintenance activities necessary to support license renewal would be limited to previously disturbed areas No additional land disturbance is currently anticipated in support of license renewal. We believe that operation of QCNPS, including maintenance of the transmission lines, over the license renewal period would not adversely affect any threatened or endangered species. Accordingly, we request your concurrence with our determination that a renewed license would have no effect on listed or proposed endangered or threatened species.

After your review, we request receiving your input by April 30, 2002. In your response, please detail any concerns you may have about state-listed species or ecologically significant habitats in the vicinity of QCNPS or in the associated transmission corridors or concurring with our conclusion that continued operation of QCNPS and the associated transmission corridors would not affect any threatened or endangered species. This will enable us to meet our NRC application submittal schedule. EGC will include a copy of this letter and your response in the Environmental Report that will be submitted to the NRC as part of the QCNPS license renewal application

Should you have any questions concerning this letter, please contact Mr. Terry Steinert at (630) 657-3213.

Respectfully,

Keith R. Jury

Keith R. Jury
Director – Licensing
Mid-West Regional Operating Group

Attachments: Attachment A: Figure 2-1, 50-mile Vicinity Map
Attachment B: Figure 2-3, Site Boundary
Attachment C: Figure 3-2, Transmission Line Map

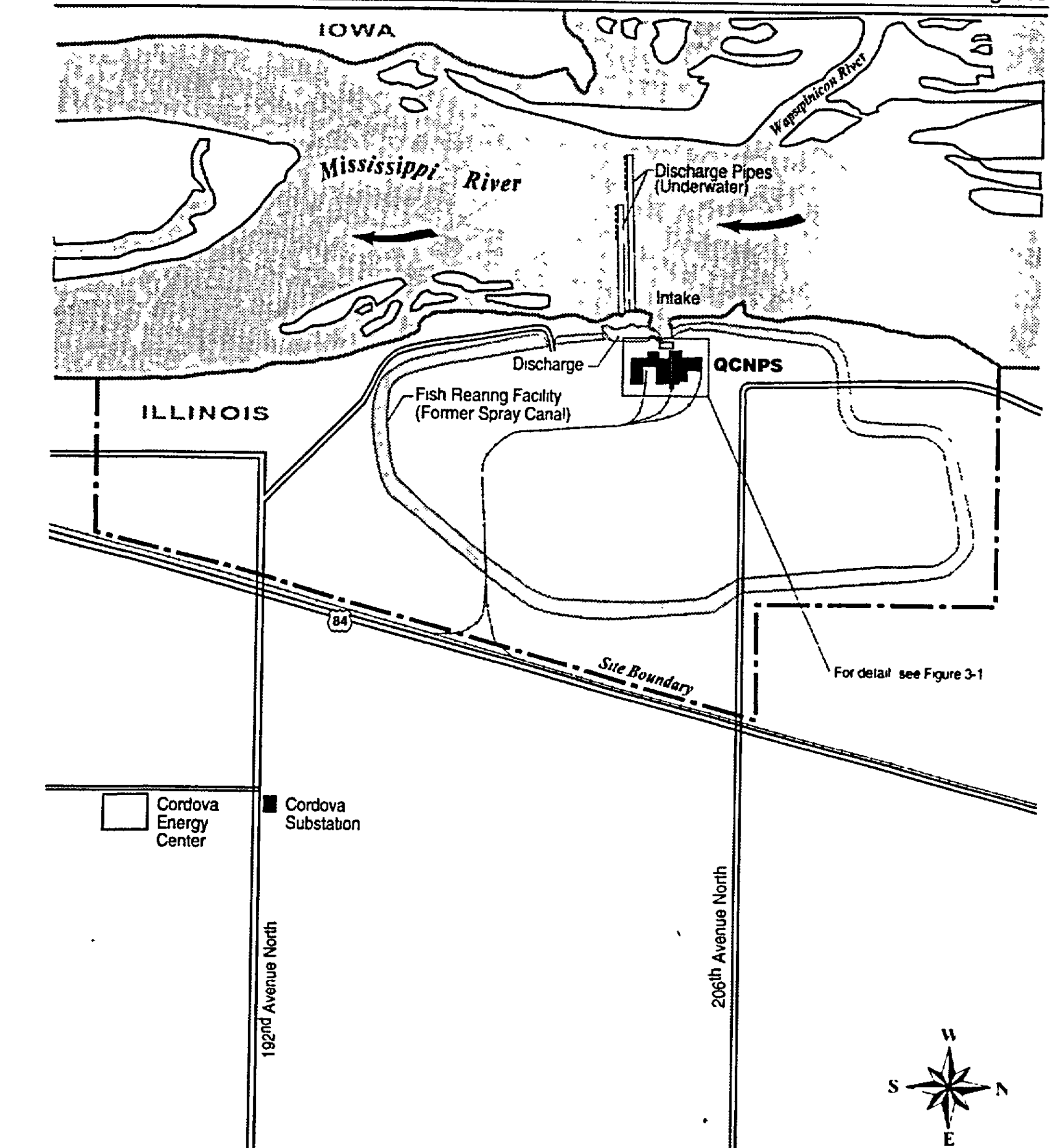
Enclosures: 7.5 Minute USGS Quadrangle maps in IL:

Camanche	Como
Clinton	Sterling
Union Grove	Erie NW
Morrison	Cordova

LEGEND

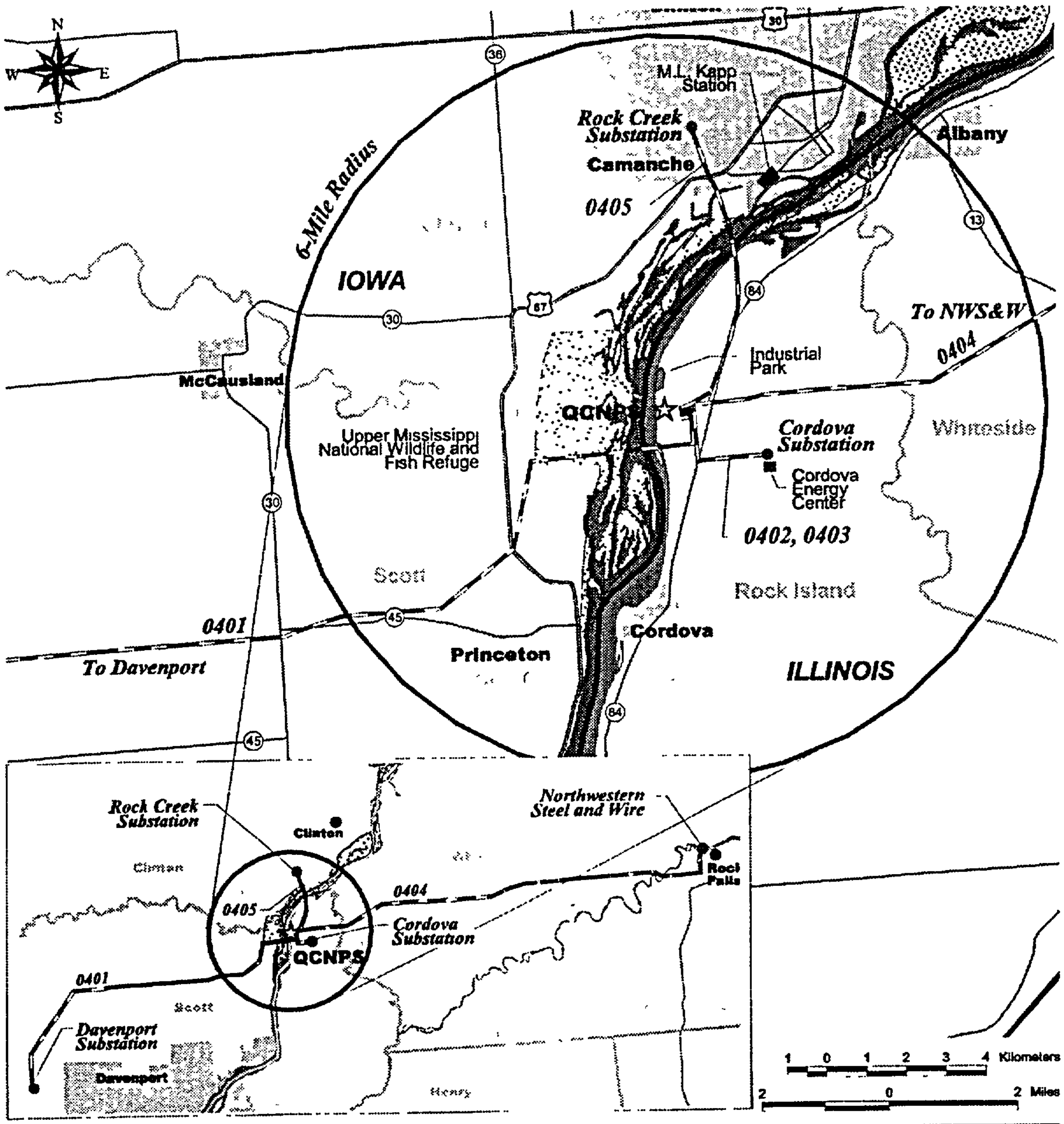
- ☆ Nuclear Power Plants
- County Boundaries
- Lakes and Rivers
- Urban

FIGURE 2-1
50-Mile Vicinity Map



Utility/Exelon/Quad Cities/Grfx/2 3 Quad site bnd ai

FIGURE 2-3
Site Boundary.



LEGEND

- Substations
- Quad Cities Nuclear Station
- Transmission Lines
- County Boundaries
- Cities

NWS&W = Northwestern Steel and Wire

FIGURE 3-2
Transmission Line Map

Illinois
Department of
Natural Resources

Code # 0201014

524 South Second Street • Springfield

George H. Ryan, Governor • Brent Manning, Director

April 22, 2002

Mr. Keith Jury
Exelon Generation
4300 Winfield Road
Warrenville, IL 60555

RE: **Quad Cities Nuclear Power Station, Units 1 & 2 License Renewal**
Rock Island and Whiteside Counties
Endangered Species Consultation Program
Natural Heritage Database Review # 0201014

Dear Mr. Jury:

Thank you for submitting the Quad Cities Nuclear Power Station, Units 1 & 2 operating license renewal application for consultation in accordance with the *Illinois Endangered Species Protection Act* [520 ILCS 10/11], the *Illinois Natural Areas Preservation Act* [525 ILCS 30/17], and Title 17 *Illinois Administrative Code* Part 1075. The electric transmission lines associated with the plant traverse the above-referenced counties.

The Natural Heritage Database has identified the presence of State protected resources within the vicinity of portions of the existing transmission lines. In **Rock Island County** the transmission line crosses the Mississippi River-Cordova Illinois Natural Area twice. This Illinois Natural Area provides known habitat for the the Federal and State endangered Higgins Eye mussel, *Lampsilis higginsii*, the Federal and State threatened Bald Eagle, *Haliaeetus leucocephalus*, the State endangered Western Sand Darter, *Ammocrypta clarum*, Pallid Shiner, *Hybopsis amnis*, Butterfly mussel, *Ellipsaria lineolata*, and Black Sandshell mussel, *Ligumia recta*, the State threatened River Otter, *Lontra canadensis* and the Western Hognose Snake, *Heterodon nasicus*. In **Whiteside County**, the corridor passes within 1/4 mile north of Lyndon-Agnew Railroad Prairie Illinois Natural Area and Lyndon Prairie Nature Preserve. In addition, the Federal and State threatened Bald Eagle, *Haliaeetus leucocephalus*, and State threatened River Otter, *Lontra canadensis* are known to occur within the Rock River watershed. Please review the enclosed Camanche-Cordova and Como quad color maps showing the general locations of these protected resources in relation to the corridor, which is highlighted. The Natural Heritage Database contains no further records of protected State resources in the immediate vicinity of the corridor as described on the Clinton, Sterling, Union Grove, Erie NW, and Morrison quad maps.

This itemization of protected resources within the transmission line corridor is intended to describe known information concerning protected resources in the vicinity. Further project information is needed to adequately assess whether or not any improvements to the existing transmission line will adversely impact the aforementioned protected resources. Consequently, **this consultation must remain open at the present time.** Please include the attached Detailed Action Report with further project information as it becomes available.

Code # 0201014

The Natural Heritage Database cannot provide a conclusive statement as to the presence, absence, or condition of significant natural features in any specific location; consultation cannot replace detailed site surveys The Department is unable to state, without reservation, that no listed species exist within the project area boundary, nor can it exclude the possibility that listed species other than that mentioned exist within the vicinity.

Consultation is limited to State-listed threatened or endangered species, Illinois Natural Areas and dedicated Land & Water Reserves and Nature Preserves, it does not entail a comprehensive environmental impact assessment The Department may raise concerns through other venues regarding potential impacts to other natural resources as it deems appropriate.

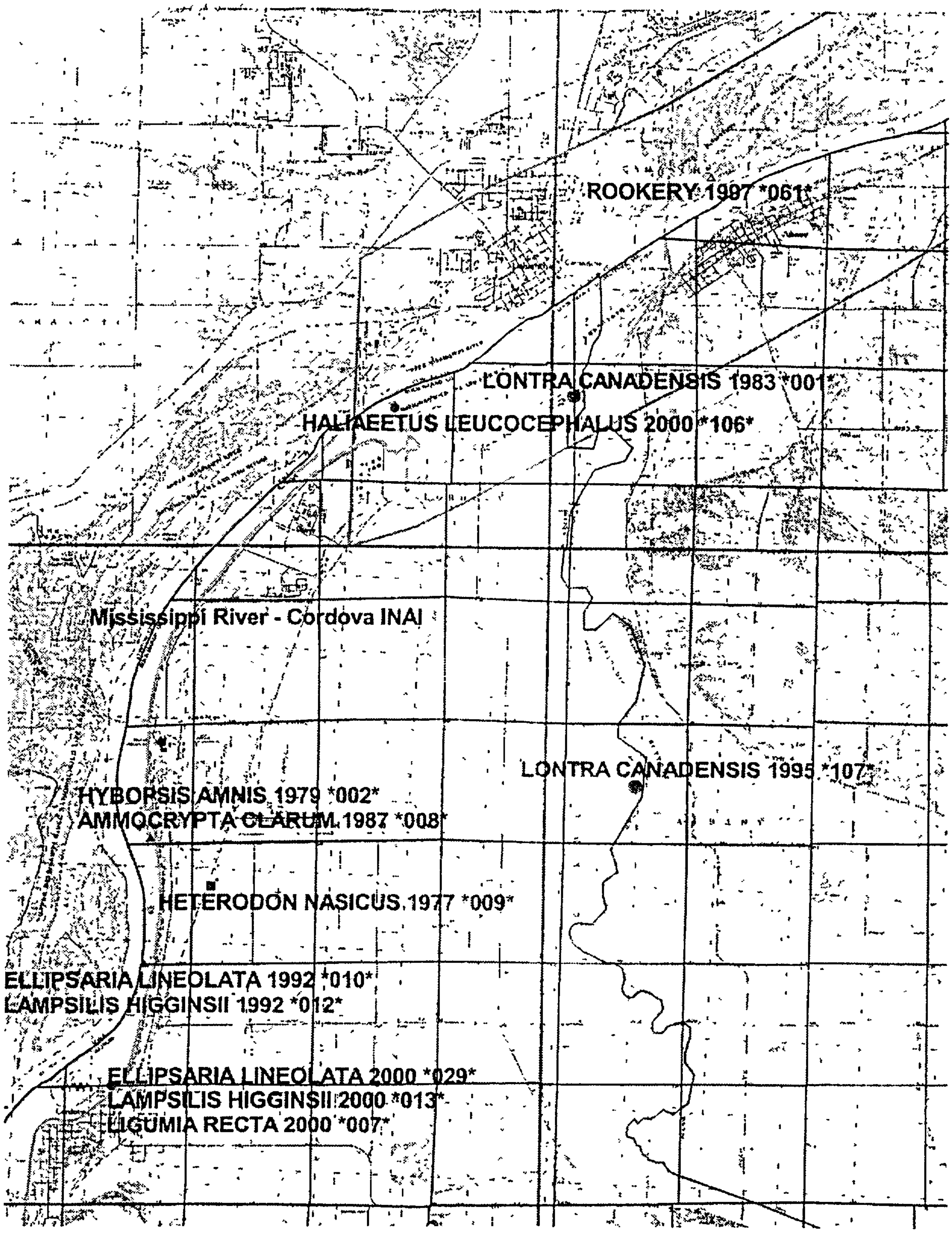
Should you need additional information regarding the consultation process, or should you have any questions, please do not hesitate to contact me

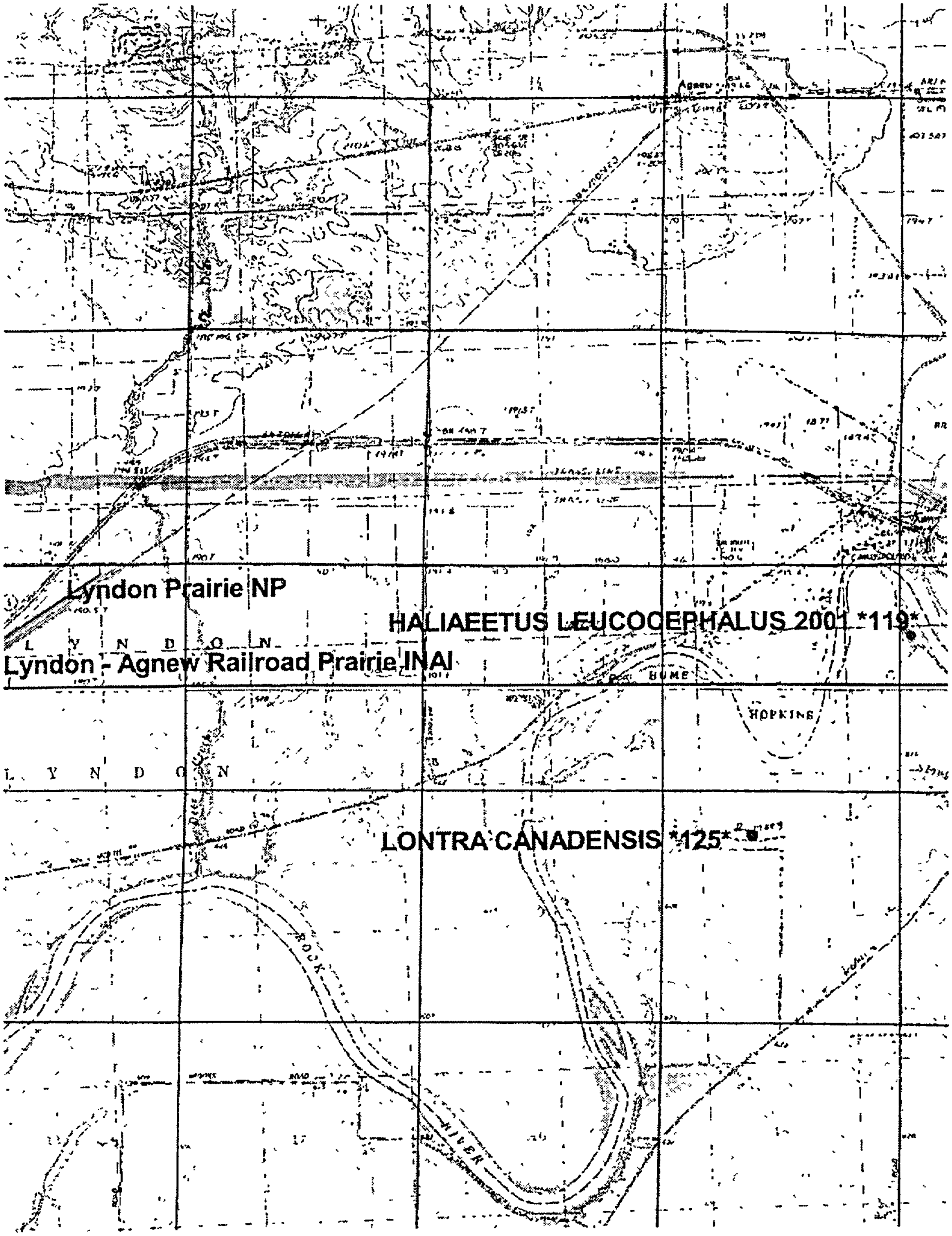
Sincerely,

Rick Pietruszka, Project Manager
Endangered Species Consultation Program
Division of Natural Resource Review and Coordination
Ph (217) 785-5500
Fax (217) 557-0728

Enclosures Map, Detailed Action Report-Exelon

cc. Anne Mankowski, IDNR/ORC/District 4
John Alesandrini, INPC/Area 1


ROOKERY 1987 *061*
LONTRA CANADENSIS 1983 *001*
HALIAEETUS LEUCOCEPHALUS 2000 *106*
Mississippi River - Cordova INAI
LONTRA CANADENSIS 1995 *107*
HYBOPSIS AMNIS 1979 *002*
AMMOCRYPTA CLARUM 1987 *008*
HETERODON NASICUS 1977 *009*
ELLIPSARIA LINEOLATA 1992 *010*
LAMPSILIS HIGGINSII 1992 *012*
ELLIPSARIA LINEOLATA 2000 *029*
LAMPSILIS HIGGINSII 2000 *013*
LIGUMIA RECTA 2000 *007*


Lyndon Prairie NP
HALIAEETUS LEUCOCEPHALUS 2001 *119*
L Y N D O N
Lyndon - Agnew Railroad Prairie INAI
HOPKINS
L Y N D O N
LONTRA CANADENSIS *125*
ROCK
RIVER

Illinois Department of Natural Resources

http://dnr.state.il.us

524 South Second Street • Springfield, Illinois 62701 • George H. Ryan, Governor • Brent Manning, Director

ENDANGERED SPECIES CONSULTATION PROGRAM
DETAILED ACTION REPORT

Date Submitted ____________

PROJCODE: 0201014
DATE DUE: ____________
For Office Use Only

Agency Name: ____________

Contact Person: ____________ Phone ____________

Agency Address: ____________

____

Project Description

Project Name (if any) ____________

Project Location Township: _____ Range: _____ Section _____ County ____________

*Please enclose an area map with the project site clearly delineated. An appropriate scale and legend should accompany this map

Total Number of Acres in Project Area: ____________

Estimated Starting/Completion Dates: ____________

Brief Description of Proposed Action: ____________

____

____

____

Please mark the appropriate response for each of the items below:

Water Supply
- private wells ___
- community well ___
- public system ___

Waste Treatment
- individual septic systems ___
- private treatment facility ___
- public treatment facility ___

Printed on recycled and recyclable stock

Return this report with a copy of each of the items listed below (if available):

Subdivision/Development Plat	________
County Natural Resource Inventory Report	________
Drainage/Stormwater Management Plan	________
Detailed Erosion Control Procedures	________
Existing & Proposed Topographic Contours	________
List of Landscaping Plant Species	________
Aerial Photograph of Site	________
Wetland Delineation Report	________
Wetland Mitigation Plan	________
U.S Army Corps of Engineers Correspondence	________
Restrictive Deeds/Conservation Easement Plans	________
Homeowner Covenants and Restrictions	________
Percolation Test Results (For Septic Systems Only)	________
Soil Boring Data	________
Tree Inventory/Protection Plan	________

Other **Transmission Line Corridor Improvements and Further Project Information Requested as it Becomes Available**

What measures have been, or can be, included in the project plans to minimize adverse effects to endangered or threatened species or natural areas/nature preserves? (Use additional pages if necessary)

____

____

Completion of the consultation requirement is mandatory before any State agency and/or local unit of government performs, funds or approves any environmentally altering activity To facilitate effective coordination, please identify all agencies/local governments involved in the project, including primary contact person, and indicate each agency's/local government's respective role in the project

Agency/Municipality	Contact Person	Perform	Fund	Authorize

Please send all materials to:

Endangered Species Consultation Program
Division of Natural Resource Review & Coordination
Illinois Department of Natural Resources
524 South Second Street
Springfield, Illinois 62701-1787

Exel n
Nuclear

Exelon Generation
4300 Winfield Road
Warrenville IL 60555

www.exeloncorp.com

RS-01-295

January 11, 2002

Ms. Jody Millar
Assistant Field Supervisor
U.S Fish and Wildlife Service
4469 48th Ave. Ct.
Rock Island Field Office
Rock Island, IL 61201

Subject: Quad Cities Nuclear Power Station, Units 1 and 2 License Renewal: Request For Information On Threatened And Endangered Species

Exelon Generation Company (EGC), LLC (formerly Commonwealth Edison Company) is currently preparing an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating licenses for Quad Cities Nuclear Power Station (QCNPS) Units 1 and 2 The current operating licenses for Unit 1 and 2 expire in 2012. The renewal term would be for an additional 20 years beyond the original license expiration date. As part of the license renewal process, the NRC requires license renewal applicants to "assess the impact of the proposed action on threatened or endangered species in accordance with the Endangered Species Act." The NRC will consult with your office under Section 7 of the Endangered Species Act. By contacting your office early in the application process, we hope to identify any issues that we may need to address or any information we should provide to your office to expedite the NRC's consultation.

Exelon has operated QCNPS and its associated transmission lines since 1972. As shown on Attachment A and B, QCNPS is located in Rock Island County, Illinois, approximately seven miles southwest of Clinton, Iowa. The QCNPS site is owned by EGC and consists of 560 acres, and as shown on Attachment C, includes two nuclear reactors, intake and discharge canals, several buildings, switchyards, and a retired spray canal that is now utilized for aquaculture.

As shown on Attachment D, five transmission lines were built to connect QCNPS to the regional transmission system. The transmission lines are located in Rock Island and Whiteside Counties, Illinois, and in Scott and Clinton Counties, Iowa. Beginning at QCNPS, one line runs south from the Station, turns west, crosses the Mississippi River, and ends north of Davenport, Iowa. One line runs eastward approximately 33 miles, terminating near Rock Falls, Illinois. One line runs through the industrial park just north of QCNPS and then crosses the Mississippi River into Iowa, terminating near Comanche, Iowa. Two other lines terminate within two miles of QCNPS.

January 11, 2002
U.S. Fish and Wildlife Service
Page 2

EGC is committed to the conservation of significant natural habitats and protected species, and expect that operation of QCNPS including maintenance of the transmission lines through the license renewal period would not adversely affect any threatened or endangered species EGC has no plans to alter current operations over the license renewal period. Any maintenance activities necessary to support license renewal would be limited to previously disturbed areas

After your review, we request receiving your input by March 29, 2002 In your response please detail any concerns you may have about any listed species or critical habitats in the area or confirming our conclusion that operation of QCNPS over the license renewal term would have no effect on any threatened or endangered species. This will enable us to meet our application preparation schedule. EGC will include a copy of this letter and your response in the Environmental Report that will be submitted to the NRC as part of the QCNPS license renewal application.

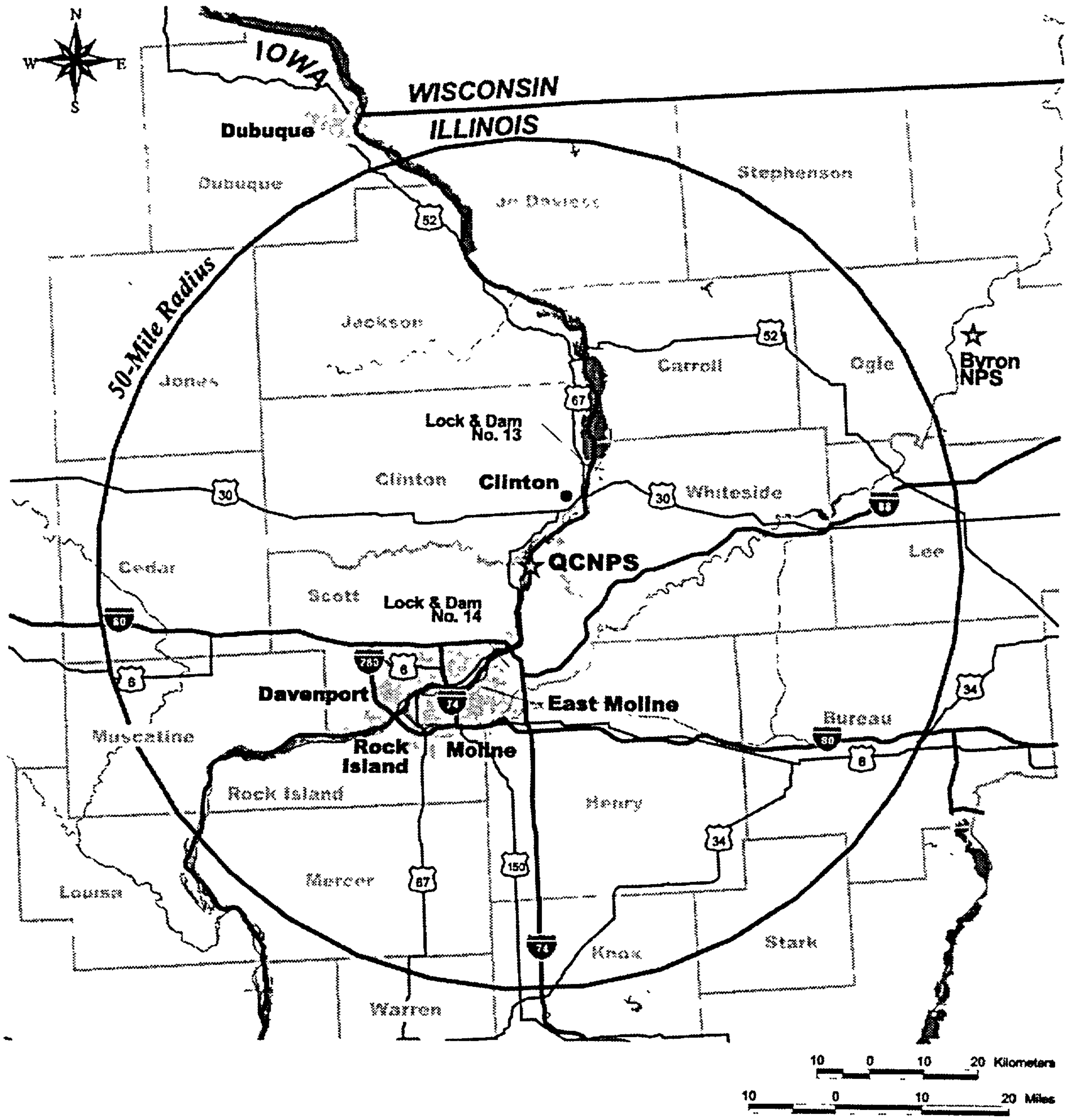
Should you have any questions concerning this letter, please contact Mr. Terry Steinert at (630) 657-3213

Respectfully,

Keith R. Jury

K. R. Jury
Director – Licensing
Mid-West Regional Operating Group

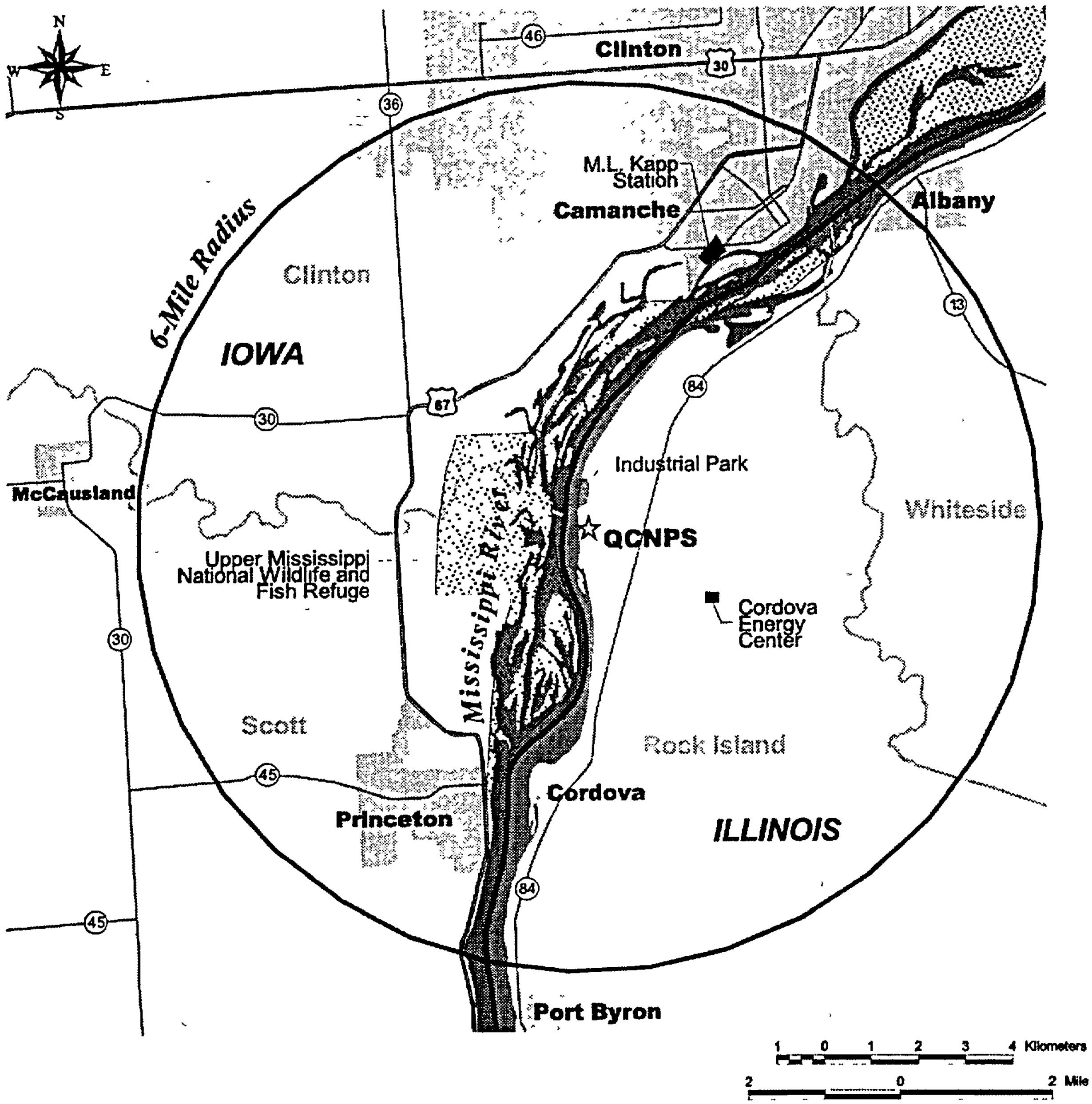
Attachments: Attachment A: Figure 2-1, 50-Mile Vicinity Map
Attachment B: Figure 2-2, 6-Mile Vicinity Map
Attachment C: Figure 2-3, Site Boundary
Attachment D. Figure 3-2, Transmission Line Map



LEGEND

- ☆ Nuclear Power Plants
- County Boundanes
- Lakes and Rivers
- Urban

FIGURE 2-1
50-Mile Vicinity Map



LEGEND

- ☆ Quad Cities Nuclear Station
- County Boundaries
- Lakes and Rivers
- Cities

FIGURE 2-2
6-Mile Vicinity Map

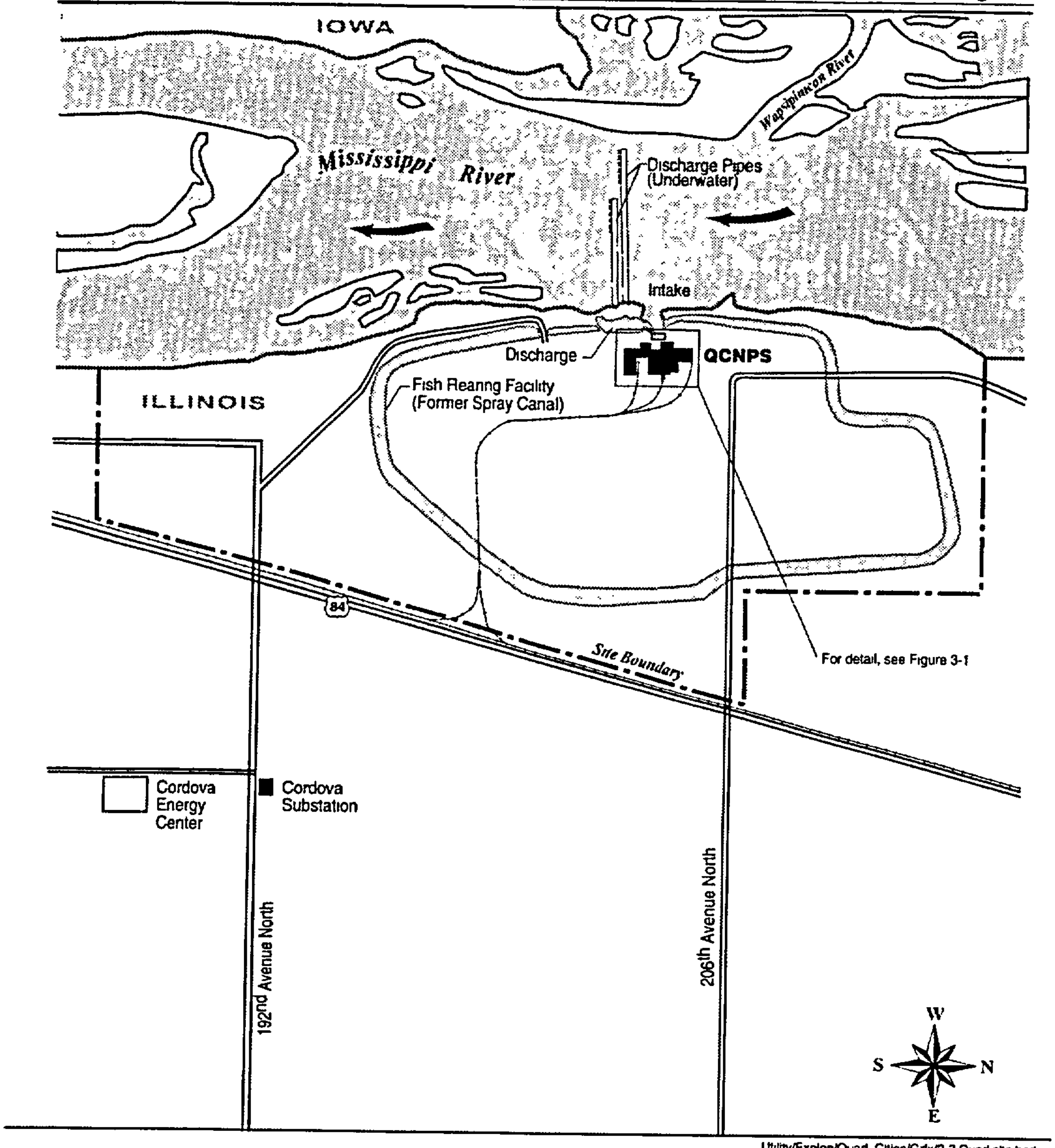
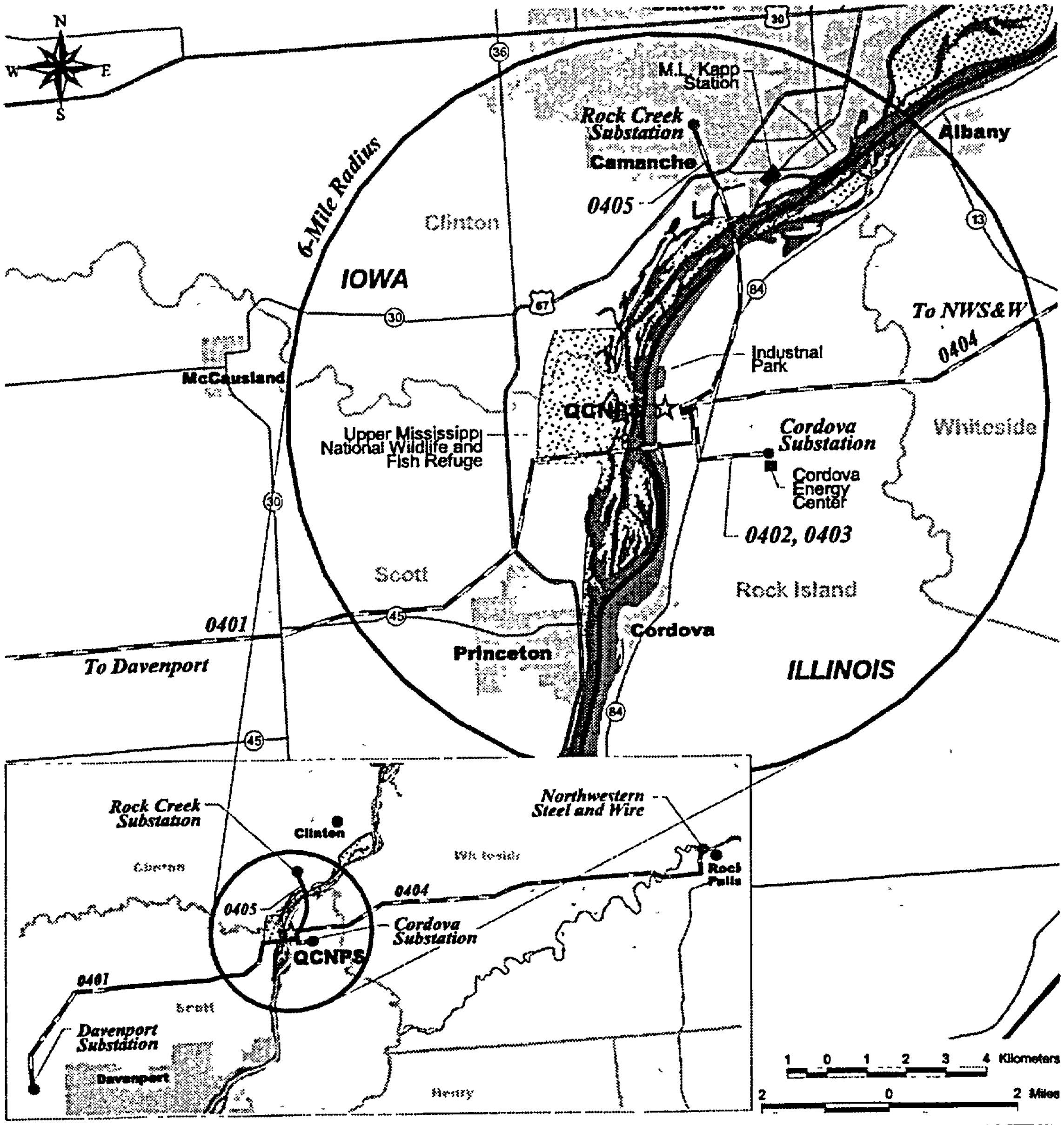


FIGURE 2-3
Site Boundary.



LEGEND

- Substations
- Quad Cities Nuclear Station
- Transmission Lines
- County Boundaries
- Cities

NWS&W = Northwestern Steel and Wire

FIGURE 3-2
Transmission Line Map

Exelon. Nuclear

Exelon Generation
4300 Winfield Road
Warrenville IL 60555

www.exeloncorp.com

RS-01-295

NO OBJECTION
U.S. Fish & Wildlife Service
Rock Island, Illinois
J. S. Millar 2/12/02
Supervisor Date

January 11, 2002

Ms. Jody Millar
Assistant Field Supervisor
U.S. Fish and Wildlife Service
4469 48th Ave. Ct.
Rock Island Field Office
Rock Island, IL 61201

Subject: Quad Cities Nuclear Power Station, Units 1 and 2 License Renewal: Request For Information On Threatened And Endangered Species

Exelon Generation Company (EGC), LLC (formerly Commonwealth Edison Company) is currently preparing an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating licenses for Quad Cities Nuclear Power Station (QCNPS) Units 1 and 2. The current operating licenses for Unit 1 and 2 expire in 2012. The renewal term would be for an additional 20 years beyond the original license expiration date. As part of the license renewal process, the NRC requires license renewal applicants to "assess the impact of the proposed action on threatened or endangered species in accordance with the Endangered Species Act." The NRC will consult with your office under Section 7 of the Endangered Species Act. By contacting your office early in the application process, we hope to identify any issues that we may need to address or any information we should provide to your office to expedite the NRC's consultation.

Exelon has operated QCNPS and its associated transmission lines since 1972. As shown on Attachment A and B, QCNPS is located in Rock Island County, Illinois, approximately seven miles southwest of Clinton, Iowa. The QCNPS site is owned by EGC and consists of 560 acres, and as shown on Attachment C, includes two nuclear reactors, intake and discharge canals, several buildings, switchyards, and a retired spray canal that is now utilized for aquaculture.

As shown on Attachment D, five transmission lines were built to connect QCNPS to the regional transmission system. The transmission lines are located in Rock Island and Whiteside Counties, Illinois, and in Scott and Clinton Counties, Iowa. Beginning at QCNPS, one line runs south from the Station, turns west, crosses the Mississippi River, and ends north of Davenport, Iowa. One line runs eastward approximately 33 miles, terminating near Rock Falls, Illinois. One line runs through the industrial park just north of QCNPS and then crosses the Mississippi River into Iowa, terminating near Comanche, Iowa. Two other lines terminate within two miles of QCNPS.

JAN 16 2002

Appendix D

Microbiological Organisms Correspondence

Table of Contents

Exelon. Nuclear

Exelon Generation
4300 Winfield Road
Warrenville, IL 60555

www.exeloncorp.com

RS-02-001

January 11, 2002

Mr. Tom McSwiggin
Manager, Permit Section
Bureau of Water
Illinois Environmental Protection Agency
1021 North Grand Ave, East
P.O Box 19276
Springfield, IL 62794-9276

Subject Quad Cities Nuclear Power Station, Units 1 and 2 License Renewal: Request For Information On Thermophilic Microorganisms

Exelon Generation Company (EGC), LLC (formerly Commonwealth Edison Company) is currently preparing an application to be sent to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating licenses for Quad Cities Nuclear Power Station (QCNPS) Units 1 and 2 The current operating licenses for Units 1 and 2 expire in 2012. The renewal term would be for an additional 20 years beyond the original license expiration date

NRC guidance directs license renewal applicants to consult with the state agency responsible for environmental health to determine if there is a concern about the presence of *Naglena fowleri* in plant receiving waters For your information an excerpt from an NRC document on this topic is included as Attachment A The NRC requires this assessment because certain microorganisms associated with cooling towers and thermal discharges are known to have deleterious impacts on human health These microorganisms include the enteric pathogens *Salmonella* sp. and *Shigella* sp. as well as the *Pseudomonas aeruginosa* bacterium. Other less common aquatic microorganisms that sometimes occur in heated waters include the Legionnaire's disease bacteria (*Legionalla* sp.) and free-living amoeba of the genus *Naeglena* (exp. *Naegleria fowleri*)

As shown in Attachment B, QCNPS is located in Rock Island County, Illinois The QCNPS cooling system is a once-through system that draws from and discharges to the Mississippi River. The QCNPS discharge temperatures, which, generally, do not exceed 111.6 °F (in July/August 2001, daily average temperatures in the discharge canal ranged from 89 7 °F to 110 °F), are below those known to be conducive to growth and survival of thermophillic pathogens.

January 11, 2002
Illinois Environmental Protection Agency
Page 2

Further, disinfection of the QCNPS sewage treatment plant effluent and the National Pollutant Discharge Elimination System (NPDES) required monitoring of fecal coliforms in the same effluent reduce the likelihood that a seed source or inoculant would be introduced to the Station's heated discharge

Discharge limits and monitoring requirements for QCNPS are set forth in NPDES Permit No. IL-000-5037, issued by the State of Illinois on May 26, 2000

We do not expect QCNPS operations and cooling systems to change significantly over the license renewal term, and there is no reason to believe that discharge temperatures will increase. However, we are requesting any information that the Illinois Environmental Protection Agency (IEPA) may have compiled on the presence of thermophilic microorganisms in the Mississippi river in the vicinity of QCNPS, including results of any monitoring or special studies that may have been conducted by IEPA or its subcontractors

We also request your concurrence with our conclusion that there is no significant threat to the public from thermophillic microorganisms attributable to QCNPS operations

After your review, we request receiving your input by March 29, 2002. In your response, please detail any concerns you may have on the presence of thermophilic microorganisms in the vicinity of QCNPS, including the results of any monitoring or special studies that might have been conducted by IEPA or its subcontractors, or concurring with our conclusion that continued operation of QCNPS would not affect the presence of thermophillic microorganisms in the vicinity of QCNPS. This will enable us to meet our NRC application submittal schedule. EGC will include a copy of this letter and your response in the Environmental Report that will be submitted to the NRC as part of the QCNPS license renewal application.

Should you have any questions concerning this letter, please contact Mr Terry Steinert at (630) 657-3213.

Respectfully,

Keith R. Jury

K. R. Jury
Director – Licensing
Mid-West Regional Operating Group

Attachments: Attachment A: Cover page and Section 4.3.6 of the Generic Environmental Impact Statement for License Renewal of Nuclear Plants
Attachment B: Figure 2-2, 6-Mile Vicinity Map

Generic Environmental Impact Statement for License Renewal of Nuclear Plants (NUREG-1437 Vol. 1)

4.3.6 Human Health

Some microorganisms associated with cooling towers and thermal discharges can have deleterious impacts on human health Their presence can be enhanced by thermal additions. These microorganisms include the enteric pathogens *Salmonella* sp. and *Shigella* sp as well as *Pseudomonas aeruginosa* and the thermophilic fungi (Appendix D). Tests for these pathogens are well established, and factors germane to their presence in aquatic environs are known and in some cases controllable. Other aquatic microorganisms normally present in surface waters have only recently been recognized as pathogenic for humans Among these are Legionnaires' disease bacteria (*Legionella* sp) and free-living amoebae of the genera *Naegleria* and *Acanthamoeba*, the causative agents of various, although rare, human infections. Factors affecting the distribution of *Legionella* sp and pathogenic free-living amoebae are not well understood. Simple, rapid tests for their detection and procedures for their control are not yet available. The impacts of nuclear plant cooling towers and thermal discharges are considered of small significance if they do not enhance the presence of microorganisms that are detrimental to water and public health

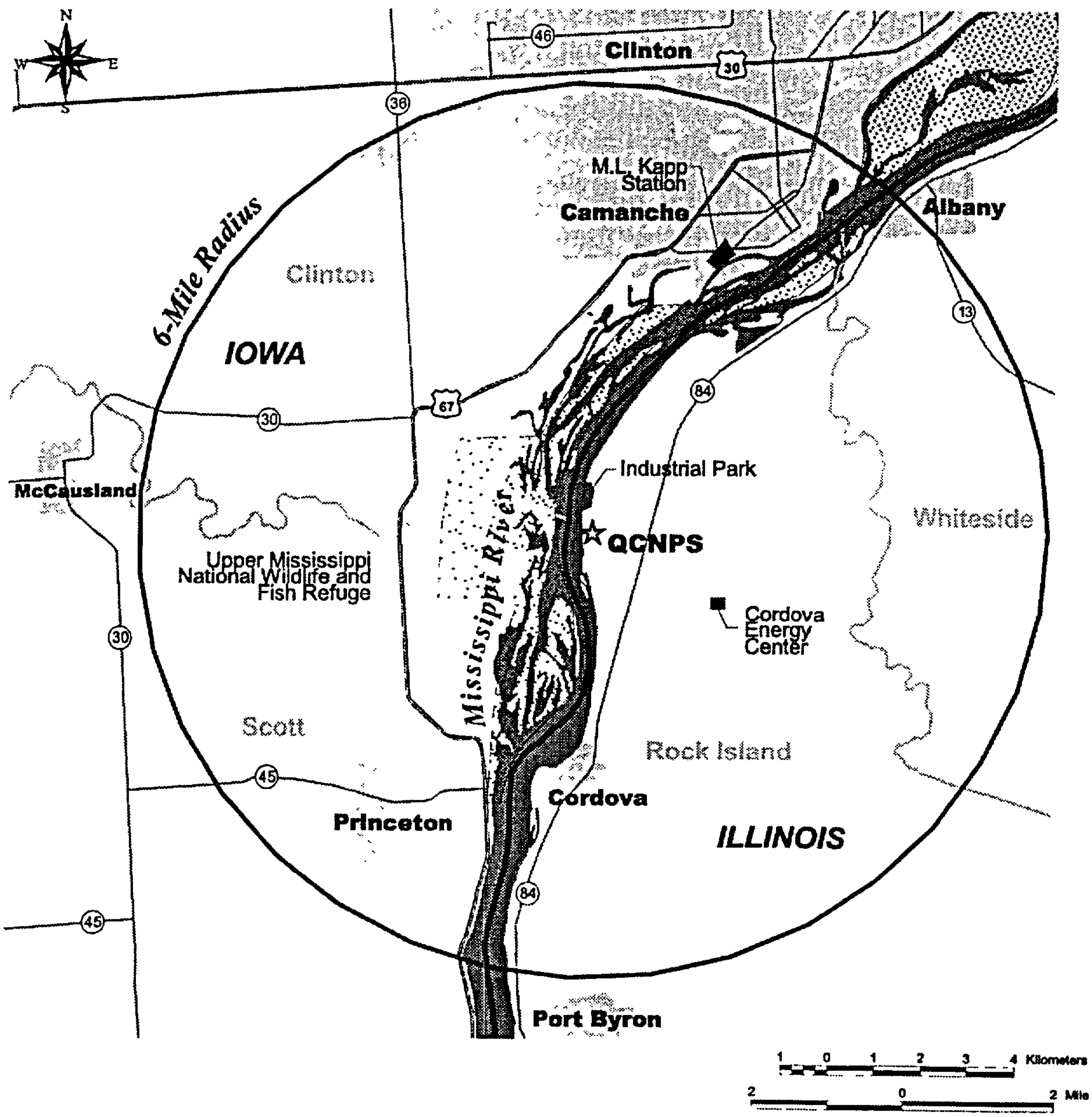
Potential adverse health effects on workers due to enhancement of microorganisms are an issue for steam-electric plants that use cooling towers. Potential adverse health effects on the public from thermally enhanced microorganisms is an issue for the nuclear plants that use cooling ponds, lakes, or canals and that discharge to small rivers. These plants are all combined in the category of small river (average flow less than 2830 m^3/s (100,000 ft^3/s) in Tables 5.18 and 5.19. These issues were evaluated by reviewing what is known about the organisms that are potentially enhanced by operation of the steam-electric plants.

Because of the reported cases of fatal *Naegleria* infections associated with cooling towers, the distribution of these two pathogens in the power plant environs was studied in some detail (Tyndall et al. 1983; see also Appendix D). In response to these various studies (Appendix D), many electric utilities require respiratory protection for workers when cleaning cooling towers and condensers However, no Occupational Safety and Health Administration (OSHA) or other legal standards for exposure to microorganisms exist at present. Also, for worker protection, one plant with high concentrations of *Naegleria fowleri* in the circulating water successfully controlled the pathogen through chlorination before its yearly downtime operation (Tyndall et al. 1983).

Changes in the microbial population and in the use of bodies of water may occur after the operating license is issued and the application for license renewal is filed. Ancillary factors may also change, including average temperature of water resulting from climatic conditions. Finally, the long-term presence of a power plant may change the natural dynamics of harmful microorganisms within a body of water by raising the level of *N. fowleri*, which are indigenous to the soils. Increased populations of *N. fowleri* may have significant adverse impacts. On entry into the nasal passage of a susceptible individual, *N. fowleri* will penetrate the nasal mucosa. The ensuing infection results in a rapidly fatal form of encephalitis. Fortunately, humans in general are resistant to infection with *N. fowleri*. Hallenbeck and Brenniman (1989) have estimated individual annual risks for primary amebic meningoencephalitis caused by the free living *N. fowleri* to swimmers in fresh water, to be approximately 4 x 10^{-6} Heavily used lakes and other fresh bodies of water may merit special attention and possibly routine monitoring for *N. fowleri*.

Thermophilic organisms may or may not be influenced by the operation of nuclear power plants The issue is largely unstudied. However, NRC recognizes a potential health problem stemming from heated effluents Occupational health questions are currently resolved using proven industrial hygiene principles to minimize worker exposures to these organisms in mists of cooling towers. NRC anticipates that all plants will continue to employ proven industrial hygiene principles so that adverse occupational health effects associated with microorganisms will be of small significance at all sites, and no mitigation measures beyond those implemented during the current term license would be warranted Aside from continued application of accepted industrial hygiene procedures, no additional mitigation measures are expected to be warranted as a result of license renewal. This is a Category 1 issue.

Public health questions require additional consideration for the 25 plants using cooling ponds, lakes, canals, or small rivers (all under the small river category in Tables 5.18 and 5.19) because the operation of these plants may significantly enhance the presence of thermophilic organisms. The data for these sites are not now at hand and it is impossible to predict the level of thermophilic organism enhancement at any given site with current knowledge. Thus the impacts are not known and are site-specific Therefore, the magnitude of the potential public health impacts associated with thermal enhancement of *N. fowleri* cannot be determined generically. This is a Category 2 issue.



LEGEND

☆ Quad Cities Nuclear Station
County Boundaries
Lakes and Rivers
Cities

FIGURE 2-2
6-Mile Vicinity Map

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

1021 NORTH GRAND AVENUE EAST P.O. BOX 19276, SPRINGFIELD, ILLINOIS 62794-9276

RENEE CIPRIANO, DIRECTOR

217-558-2012

May 16, 2002

Mr. Keith R. Jury
Mid-West Regional Operating Group
Exelon Generation
4300 Winfield Road
Warrenville, IL 60555

RE: Thermophilic Organisms, Quad Cities Nuclear Power Station

Dear Mr. Jury:

With regard to your letter addressed to Thomas McSwiggin, Manager of the Division of Water Pollution Control Permit Section, dated January 11, 2002 requesting information on thermophilic microorganisms, I regret to inform you that the Illinois EPA does not monitor these types of organisms in any way. After having consulted with others here at the IEPA, we believe that such monitoring is out of our purview. We suggest that you inquire at the Illinois Department of Public Health or the Illinois Department of Nuclear Safety

Sincerely,

Robert Mosher, Manager
Water Quality Standards Section
Bureau of Water

GEORGE H RYAN, GOVERNOR

PRINTED ON RECYCLED PAPER

Exelon. Nuclear

Exelon Generation
4300 Winfield Road
Warrenville, IL 60555

www.exeloncorp.com

RS-01-304

January 11, 2002

Mr. Clint Mudgett
Division of Environmental Health
Illinois Department of Public Health
535 W. Jefferson St
Springfield, IL 62761

Subject: Quad Cities Nuclear Power Station, Units 1 and 2 License Renewal
Request For Information On Thermophilic Microorganisms

Exelon Generation Company (EGC), LLC (formerly Commonwealth Edison Company) is currently preparing an application to be sent to the U S. Nuclear Regulatory Commission (NRC) to renew the operating licenses for Quad Cities Nuclear Power Station (QCNPS) Units 1 and 2. The current operating licenses for Unit 1 and 2 expire in 2012. The renewal term would be for an additional 20 years beyond the original license expiration date

NRC guidance directs license renewal applicants to consult with the state agency responsible for environmental health to determine if there is a concern about the presence of *Nagleria fowleri* in plant receiving waters Attached is an excerpt from an NRC document on this topic as Attachment A. The NRC requires this assessment because certain microorganisms associated with cooling towers and thermal discharges are known to have deleterious impacts on human health. These microorganisms include the enteric pathogens *Salmonella* sp. and *Shigella* sp. as well as the *Pseudomonas aeruginosa* bacterium. Other less common aquatic microorganisms that sometimes occur in heated waters include the Legionnaire's disease bacteria (*Legionalla* sp.) and free-living amoeba of the genus *Naegleria* (exp. *Naegleria fowleri*).

As shown in Attachment B, QCNPS is located in Rock Island County, Illinois The QCNPS cooling system is a once-through system that draws from and discharges to the Mississippi River. The QCNPS discharge temperatures, which, generally, do not exceed 111 6 °F (in July/August 2001, daily average temperatures in the discharge canal ranged from 89 7 °F to 110 °F), are below those known to be conducive to growth and survival of thermophillic pathogens. Further, disinfection of the QCNPS sewage treatment plant effluent and the National Pollutant Discharge Elimination System (NPDES) required monitoring of fecal coliforms in the same effluent reduce the likelihood that a seed source or inoculant would be introduced to the Station's heated discharge.

January 11, 2002
Illinois Department of Public Health
Page 2

Discharge limits and monitoring requirements for QCNPS are set forth in NPDES Permit No. IL-000-5037, issued by the State of Illinois on May 26, 2000.

We do not expect QCNPS operations and cooling systems to change significantly over the license renewal term, and there is no reason to believe that discharge temperatures will increase. However, we are requesting any information that the Illinois Department of Public Health (IDPH) may have compiled on the presence of thermophillic microorganisms in the Mississippi river in the vicinity of QCNPS, including results of any monitoring or special studies that may have been conducted by IDPH or its subcontractors.

We also request your concurrence with our conclusion that there is no significant threat to the public from thermophillic microorganisms attributable to QCNPS operations

After your review, we request receiving your input by March 29, 2002. In your response, please detail any concerns you may have on the presence of thermophillic microorganisms in the vicinity of QCNPS, including the results of any monitoring or special studies that might have been conducted by IDPH or its subcontractors, or concurring with our conclusion that continued operation of QCNPS would not affect the presence of thermophillic microorganisms in the vicinity of QCNPS This will enable us to meet our NRC application submittal schedule EGC will include a copy of this letter and your response in the Environmental Report that will be submitted to the NRC as part of the QCNPS license renewal application

Should you have any questions concerning this letter, please contact Mr Terry Steinert at (630) 657-3213

Respectfully,

K. R. Jury
Director – Licensing
Mid-West Regional Operating Group

Attachments: Attachment A. Cover page and Section 4 3.6 of the Generic Environmental Impact Statement for License Renewal of Nuclear Plants
Attachment B Figure 2-2, 6-Mile Vicinity Map

Generic Environmental Impact Statement for License Renewal of Nuclear Plants (NUREG-1437 Vol. 1)

4.3.6 Human Health

Some microorganisms associated with cooling towers and thermal discharges can have deleterious impacts on human health Their presence can be enhanced by thermal additions These microorganisms include the enteric pathogens *Salmonella* sp. and *Shigella* sp as well as *Pseudomonas aeruginosa* and the thermophilic fungi (Appendix D) Tests for these pathogens are well established, and factors germane to their presence in aquatic environs are known and in some cases controllable Other aquatic microorganisms normally present in surface waters have only recently been recognized as pathogenic for humans. Among these are Legionnaires' disease bacteria (*Legionella* sp) and free-living amoebae of the genera *Naegleria* and *Acanthamoeba*, the causative agents of various, although rare, human infections Factors affecting the distribution of *Legionella* sp. and pathogenic free-living amoebae are not well understood Simple, rapid tests for their detection and procedures for their control are not yet available. The impacts of nuclear plant cooling towers and thermal discharges are considered of small significance if they do not enhance the presence of microorganisms that are detrimental to water and public health

Potential adverse health effects on workers due to enhancement of microorganisms are an issue for steam-electric plants that use cooling towers. Potential adverse health effects on the public from thermally enhanced microorganisms is an issue for the nuclear plants that use cooling ponds, lakes, or canals and that discharge to small rivers These plants are all combined in the category of small river (average flow less than 2830 m^3/s (100,000 ft^3/s) in Tables 5 18 and 5 19 These issues were evaluated by reviewing what is known about the organisms that are potentially enhanced by operation of the steam-electric plants

Because of the reported cases of fatal *Naegleria* infections associated with cooling towers, the distribution of these two pathogens in the power plant environs was studied in some detail (Tyndall et al 1983, see also Appendix D). In response to these various studies (Appendix D), many electric utilities require respiratory protection for workers when cleaning cooling towers and condensers However, no Occupational Safety and Health Administration (OSHA) or other legal standards for exposure to microorganisms exist at present Also, for worker protection, one plant with high concentrations of *Naegleria fowleri* in the circulating water successfully controlled the pathogen through chlorination before its yearly downtime operation (Tyndall et al 1983)

Changes in the microbial population and in the use of bodies of water may occur after the operating license is issued and the application for license renewal is filed. Ancillary factors may also change, including average temperature of water resulting from climatic conditions. Finally, the long-term presence of a power plant may change the natural dynamics of harmful microorganisms within a body of water by raising the level of *N. fowleri*, which are indigenous to the soils. Increased populations of *N. fowleri* may have significant adverse impacts. On entry into the nasal passage of a susceptible individual, *N. fowleri* will penetrate the nasal mucosa The ensuing infection results in a rapidly fatal form of encephalitis. Fortunately, humans in general are resistant to infection with *N fowleri*. Hallenbeck and Brenniman (1989) have estimated individual annual risks for primary amebic meningoencephalitis caused by the free living *N. fowleri* to swimmers in fresh water, to be approximately 4 x 10^{-6}. Heavily used lakes and other fresh bodies of water may merit special attention and possibly routine monitoring for *N. fowleri*.

Thermophilic organisms may or may not be influenced by the operation of nuclear power plants. The issue is largely unstudied However, NRC recognizes a potential health problem stemming from heated effluents Occupational health questions are currently resolved using proven industrial hygiene principles to minimize worker exposures to these organisms in mists of cooling towers NRC anticipates that all plants will continue to employ proven industrial hygiene principles so that adverse occupational health effects associated with microorganisms will be of small significance at all sites, and no mitigation measures beyond those implemented during the current term license would be warranted. Aside from continued application of accepted industrial hygiene procedures, no additional mitigation measures are expected to be warranted as a result of license renewal This is a Category 1 issue

Public health questions require additional consideration for the 25 plants using cooling ponds, lakes, canals, or small rivers (all under the small river category in Tables 5.18 and 5.19) because the operation of these plants may significantly enhance the presence of thermophilic organisms. The data for these sites are not now at hand and it is impossible to predict the level of thermophilic organism enhancement at any given site with current knowledge Thus the impacts are not known and are site-specific. Therefore, the magnitude of the potential public health impacts associated with thermal enhancement of *N. fowleri* cannot be determined generically. This is a Category 2 issue.

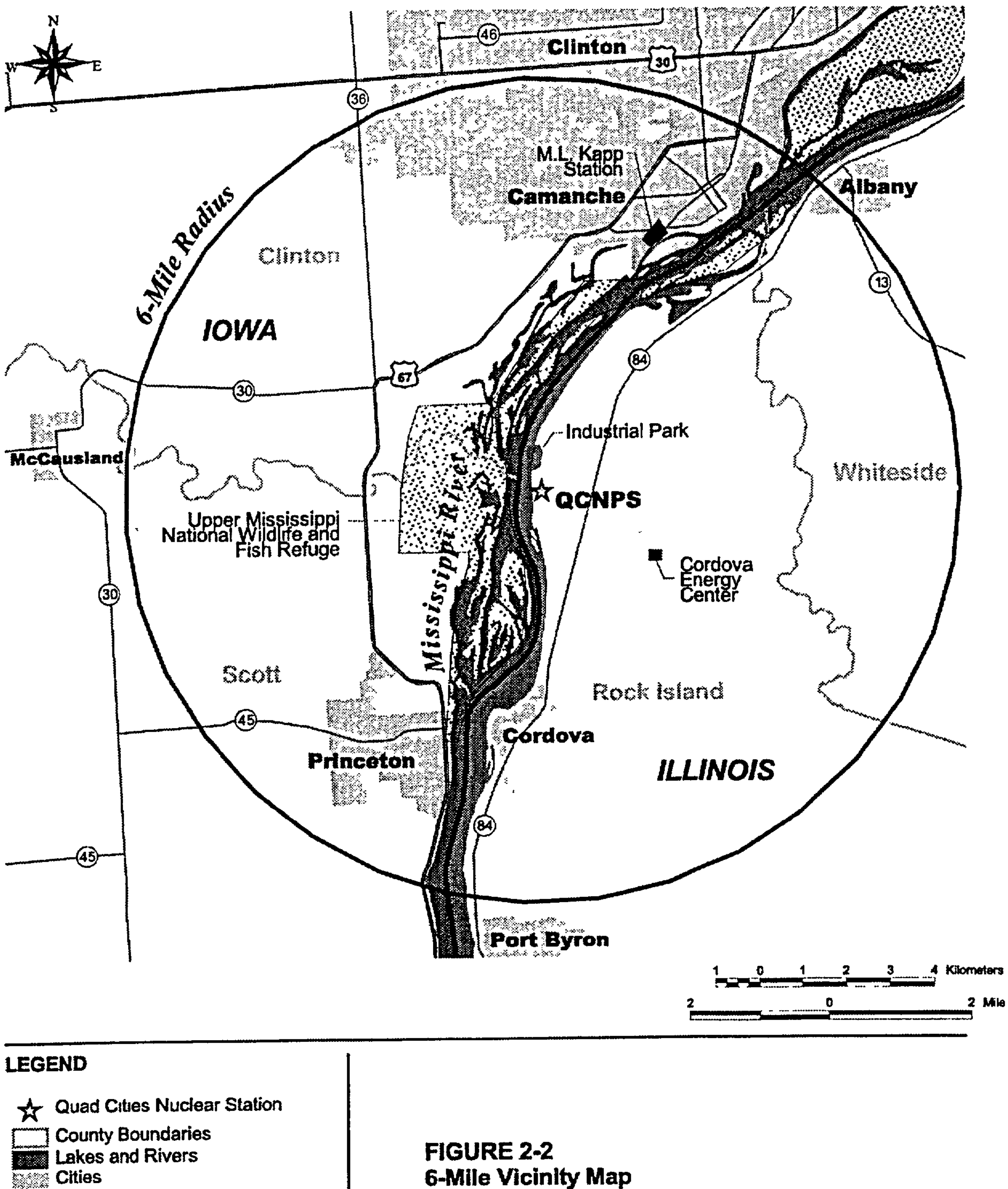


FIGURE 2-2
6-Mile Vicinity Map

Illinois Department of
Public Health

[illegible]

February 7, 2002

Keith R. Jury
Licensing Director
Mid-West Regional Operating Group
Exelon Generation
4300 Winfield Road
Warrenville, IL 60555

Dear Mr. Jury.

This letter is in response to your January [illegible], 2002 letter regarding the license renewal of the Quad Cities Nuclear Power Station, Units 1 and 2.

This Department has not conducted any sampling of the discharge area related to the presence of thermophilic microorganisms. There are no public bathing beaches regulated by this Department in the discharge area. It is our understanding that fishing and boating, including water skiing and other body contact activities, are allowed downstream of the discharge. Based on the average daily temperatures in the discharge canal as reported in your letter, as well as the dilution provided by the Mississippi River, we would not expect any appreciable public health risk due to thermophilic microorganisms to persons who contact the water.

If you have any further questions, please contact me at 217/782-5830.

Sincerely,

Clinton C. Mudgett, Chief
Division of Environmental Health

[illegible]

Exelon Nuclear

Exelon Generation
4300 Winfield Road
Warrenville IL 60555

www.exeloncorp.com

RS-01-296

January 11, 2002

Dr. Charles Barton
Bureau Chief, Bureau of Toxicology
Iowa Department of Public Health
321 E. 12th St.
Lucas State Office Building
Des Moines, IA 50319-0075

Subject: Quad Cities Nuclear Power Station, Units 1 and 2 License Renewal. Request For Information On Thermophilic Microorganisms

Exelon Generation Company (EGC), LLC (formerly Commonwealth Edison) is currently preparing an application to be sent to the U.S Nuclear Regulatory Commission (NRC) to renew the operating licenses for Quad Cities Nuclear Power Station (QCNPS) Units 1 and 2 The current operating licenses for Unit 1 and 2 expire in 2012. The renewal term would be for an additional 20 years beyond the original license expiration date.

NRC guidance directs license renewal applicants to consult with the state agency responsible for environmental health to determine if there is a concern about the presence of *Nagleria fowleri* in plant receiving waters. For your information an excerpt from an NRC document on this topic is included as Attachment A. The NRC requires this assessment because certain microorganisms associated with cooling towers and thermal discharges are known to have deleterious impacts on human health These microorganisms include the enteric pathogens *Salmonella* sp. and *Shigella* sp. as well as the *Pseudomonas aeruginosa* bacterium Other less common aquatic microorganisms that sometimes occur in heated waters include the Legionnaire's disease bacteria (*Legionalla* sp) and free-living amoeba of the genus *Naegleria* (exp. *Naegleria fowleri*).

As shown on Attachment B, QCNPS is located in Rock Island County, Illinois. The QCNPS cooling system is a once-through system that draws from and discharges to the Mississippi River. The QCNPS discharge temperatures, which, generally, do not exceed 111.6 °F (in July/August 2001, daily average temperatures in the discharge canal ranged from 89.7 °F to 110 °F), are below those known to be conducive to growth and survival of thermophilic pathogens. Further, disinfection of the QCNPS sewage treatment plant effluent and the National Pollutant Discharge Elimination System (NPDES) required monitoring of fecal coliforms in the same effluent reduce the likelihood that a seed source or inoculant would be introduced to the Station's heated discharge.

January 11, 2002
Iowa Department of Public Health
Page 2

Discharge limits and monitoring requirements for QCNPS are set forth in NPDES Permit No IL-000-5037, issued by the State of Illinois on May 26, 2000.

We do not expect QCNPS operations and cooling systems to change significantly over the license renewal term, and there is no reason to believe that discharge temperatures will increase. However, we are requesting any information that the Iowa Department of Public Health (IDPH) may have compiled on the presence of thermophilic microorganisms in the Mississippi river in the vicinity of QCNPS, including results of any monitoring or special studies that may have been conducted by IDPH or its subcontractors

We also request your concurrence with our conclusion that there is no significant threat to the public from thermophilic microorganisms attributable to QCNPS operations.

After your review, we request receiving your input by March 29, 2002. In your response, please detail any concerns, if any, you may have on the presence of thermophilic microorganisms in the vicinity of QCNPS, including the results of any monitoring or special studies that might have been conducted by IDPH or its subcontractors, or concurring with our conclusion that continued operation of QCNPS would not affect the presence of thermophilic microorganisms in the vicinity of QCNPS. This will enable us to meet our NRC application submittal schedule. EGC will include a copy of this letter and your response in the Environmental Report that will be submitted to the NRC as part of the QCNPS license renewal application

Should you have any questions concerning this letter, please contact Mr. Terry Steinert at (630) 657-3213.

Respectfully,

Keith R. Jury

K. R. Jury
Director – Licensing
Mid-West Regional Operating Group

Attachments: Attachment A, Cover page and Section 4 3 6 of the Generic Environmental Impact Statement for License Renewal of Nuclear Plants
Attachment B, Figure 2-2, 6-Mile Vicinity Map

Generic Environmental Impact Statement for License Renewal of Nuclear Plants (NUREG-1437 Vol. 1)

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Some microorganisms associated with cooling towers and thermal discharges can have deleterious impacts on human health. Their presence can be enhanced by thermal additions. These microorganisms include the enteric pathogens *Salmonella* sp. and *Shigella* sp. as well as *Pseudomonas aeruginosa* and the thermophilic fungi (Appendix D) Tests for these pathogens are well established, and factors germane to their presence in aquatic environs are known and in some cases controllable. Other aquatic microorganisms normally present in surface waters have only recently been recognized as pathogenic for humans. Among these are Legionnaires' disease bacteria (*Legionella* sp.) and free-living amoebae of the genera *Naegleria* and *Acanthamoeba*, the causative agents of various, although rare, human infections. Factors affecting the distribution of *Legionella* sp. and pathogenic free-living amoebae are not well understood. Simple, rapid tests for their detection and procedures for their control are not yet available. The impacts of nuclear plant cooling towers and thermal discharges are considered of small significance if they do not enhance the presence of microorganisms that are detrimental to water and public health

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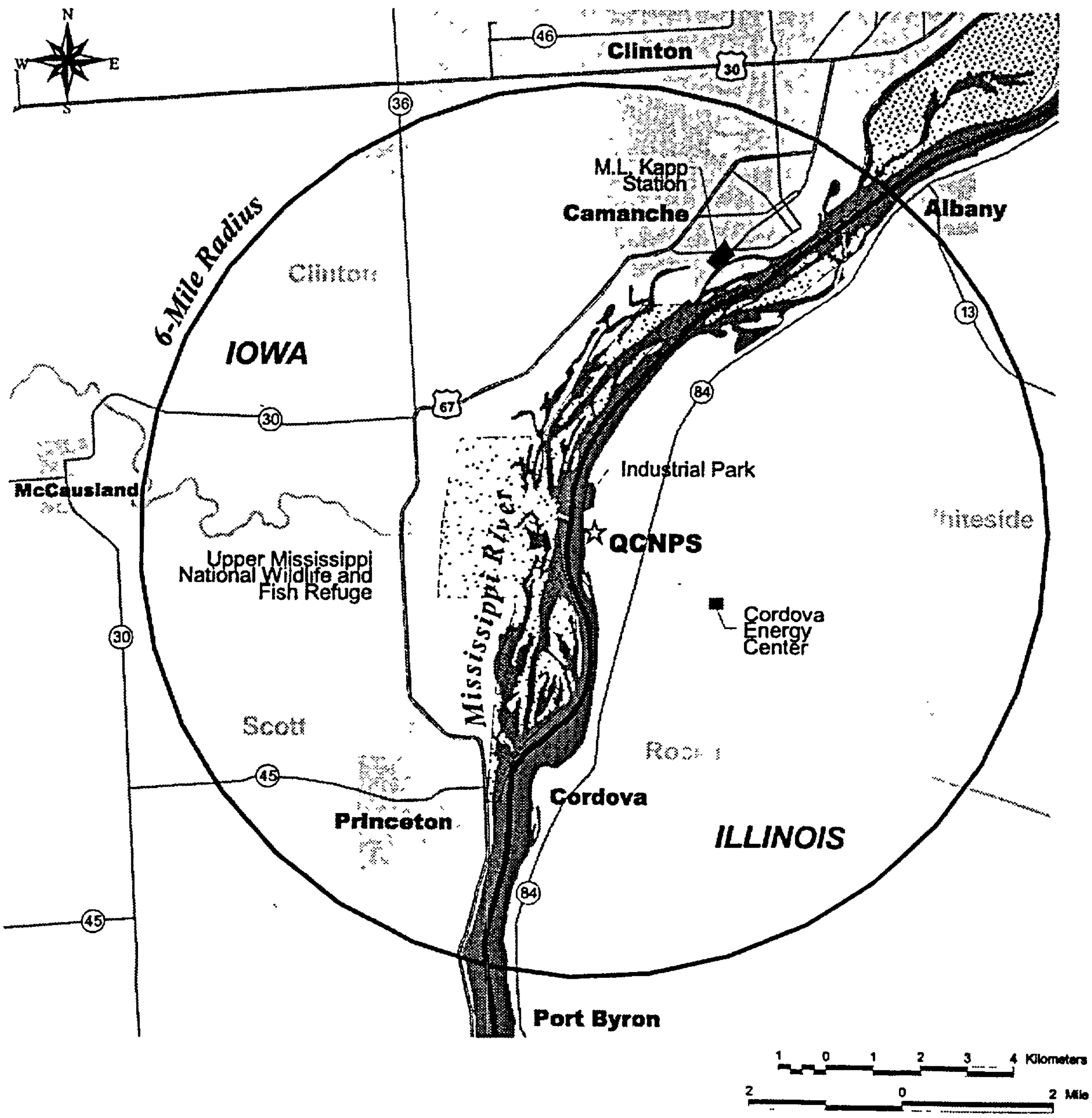
Public health questions require additional consideration for the 25 plants using cooling ponds, lakes, canals, or small rivers (all under the small river category in Tables 5.18 and 5.19) because the operation of these plants may significantly enhance the presence of thermophilic organisms The data for these sites are not now at hand and it is impossible to predict the level of thermophilic organism enhancement at any given site with current knowledge. Thus the impacts are not known and are site-specific. Therefore, the magnitude of the potential public health impacts associated with thermal enhancement of *N fowleri* cannot be determined generically This is a Category 2 issue.



LEGEND

☆ Quad Cities Nuclear Station
County Boundaries
Lakes and Rivers
Cities

FIGURE 2-2
6-Mile Vicinity Map

Fields of Opportunities

STATE OF IOWA

THOMAS J VILSACK
GOVERNOR
SALLY J PEDERSON
LT. GOVERNOR

DEPARTMENT OF PUBLIC HEALTH
STEPHEN C GLEASON D O, DIRECTOR

March 1, 2002

K. R. Jury
Director – Licensing
Mid-West Regional Operating Group

RE: Quad Cities Nuclear Power Station, Units 1 and 2 License Renewal: Request for Information on Thermophilic Microorganisms

Dear Mr. Jury:

Exelon Generation Company (EGC) is currently preparing an application to be sent to the U.S Nuclear Regulatory Commission (NRC) to renew the operating licenses for Quad Cities Nuclear Power Station (QCNPS) NRC guidance directs license renewal applicants to consult with the state agency responsible for environmental health to determine if there is a concern about the presence of *Nagleria fowleri* in plant receiving waters Although Iowa Department of Natural Resources (IDNR) is the state regulatory agency responsible for environmental health, Iowa Department of Public Health (IDPH) is responsible for ensuring that public health is not adversely impacted by the environment.

NRC requires this assessment because certain microorganisms (e.g., *Nagleria fowleri*) associated with cooling towers and thermal discharges may have deleterious impacts on human health. There has not been a history of thermophilic pathogens affecting public health in Iowa. This could be attributed to the regional climate Diseases occurring from thermophilic bacteria are relatively common in Texas and other warmer climate states, but are unheard of in Iowa. There has not been a case involving *Nagleria fowleri* in Iowa.

Since thermophilic microorganisms have not been anticipated to be present near the QCNPS, IDPH has not monitored for them. I have discussed the issue of monitoring with Dr. Nelson Moyer, the medical microbiologist for the state. He has assured me that nothing can be gained through monitoring for these microorganisms near QCNPS.

LUCAS STATE OFFICE BUILDING / 321 E 12TH ST / DES MOINES, IOWA 50319-0075
DEAF RELAY (HEARING OR SPEECH IMPAIRED) 1-800-735-2942 / INTERNET HTTP //WWW IDPH STATE IA US/

DIRECTOR'S OFFICE 515-281-5605 FAX/515-281-4958
DIV OF ADMINISTRATION 515-281 5604 FAX/515-281-4958
DIV OF COMMUNITY HEALTH 515-281 8535 FAX/515-242-6384
DIV OF HEALTH PROTECTION & ENVIRONMENTAL HEALTH 515-281-7726 FAX/515-281-4529
DIV OF HEALTH PROMOTION, PREVENTION & ADDICTIVE BEHAVIORS 515-281-3641 FAX/515-281-4535
DIV OF TOBACCO USE PREVENTION & CONTROL 515-281-6225 FAX/515-281-6475

I am in concurrence with your conclusion that that there is no significant threat to the public from thermophilic microorganisms attributable to QCNPS operations

Should you have any questions concerning this letter, please contact me.

Respectfully,

Charles Barton, Ph.D., DABT, FACT
State Toxicologist & Director,
Center for Environmental & Regulatory Toxicology
Iowa Department of Public Health
321 East 12th Street
Des Moines, IA 50319-0075
Tel: (515) 281-6881
Fax. (515) 281-4529

Appendix E

State Historic Preservation Officer Correspondence

Table of Contents

Exelon Nuclear

Exelon Generation
4300 Winfield Road
Warrenville, IL 60555

www.exeloncorp.com

RS-02-079

April 17, 2002

Mr. Douglas Jones
Archaeologist
State Historical Society of Iowa
600 East Locust St.
Des Moines, IA 50319-0290

Subject: Quad Cities Nuclear Power Station, Units 1 And 2, License Renewal: Request For Information On Historic / Archeological Resources

Exelon Generation Company (EGC), LLC (formerly Commonwealth Edison Company) is currently preparing an application to the U. S Nuclear Regulatory Commission (NRC) to renew the operating licenses for the Quad Cities Nuclear Power Station (QCNPS), Units 1 and 2. The current operating licenses for Unit 1 and 2 expire in 2012. The renewal term would be for an additional 20 years beyond the original license expiration date As part of the license renewal process, the NRC requires license renewal applicants to "assess whether any historic or archeological properties will be affected by the proposed project." By contacting your office early in the application process, we hope to identify any issues that we may need to address or any information that we should provide to your office to expedite your evaluation of the potential impact of the continued operation of QCNPS on historic and archeological resources

Exelon has operated QCNPS and its associated transmission lines since 1972. As shown on Attachment A, QCNPS is located in Rock Island County, Illinois, on the east bank of Pool 14 of the Mississippi River, about 16 miles below Dam 13 and 13 miles above Dam 14 (i.e., river mile 506.5). Although no major metropolitan areas occur within a six-mile radius, QCNPS is about four miles north of Cordova, Illinois, and seven miles southwest of Clinton, Iowa. The QCNPS site consists of 560 acres. In addition to the two nuclear reactors and their turbine buildings, intake and discharge canals, and auxiliary buildings, the site includes switchyards and a retired spray canal that is now utilized for aquaculture.

As shown on Attachment B, five transmission lines were built to connect QCNPS to the regional transmission system. Portions of two of these transmission lines are located in Scott and Clinton Counties, Iowa. Beginning at QCNPS, one line runs south from the Station, turns west, crosses the Mississippi River, and ends north of Davenport, Iowa One line runs through the industrial park just north of QCNPS and then crosses the Mississippi River, terminating near Comanche, Iowa

April 17, 2002
State Historical Society of Iowa
Page 2

EGC had requested the Office of the State Archaeologist in Iowa City to perform a Site File Search for the portions of the transmission lines within Iowa. The results of that search show that there is one State-listed site within the transmission corridor in Iowa. The site is listed as 13ST157 and it is not eligible for listing in the National Registry. EGC does not expect the operation of QCNPS, including maintenance of the identified transmission lines, through the license renewal term to adversely affect cultural or historical resources in the area or region. No major structural modifications have been identified for the purposes of supporting license renewal. Any maintenance activities necessary to support license renewal would be limited to previously disturbed areas. No additional land disturbance is anticipated in support of license renewal. Accordingly, we request your concurrence with our determination that the license renewal process would have no effect on any historic or archeological properties.

After your review, we request receiving your input by May 24, 2002. In your response, please detail any concerns you may have about historic/archeological properties in the area or confirming our conclusion that continued operation of QCNPS would have no effect on any historic or archeological properties in Iowa. This will enable us to meet our NRC application submittal schedule. EGC will include a copy of this letter and your response in the Environmental Report that will be submitted to the NRC as part of the QCNPS license renewal application.

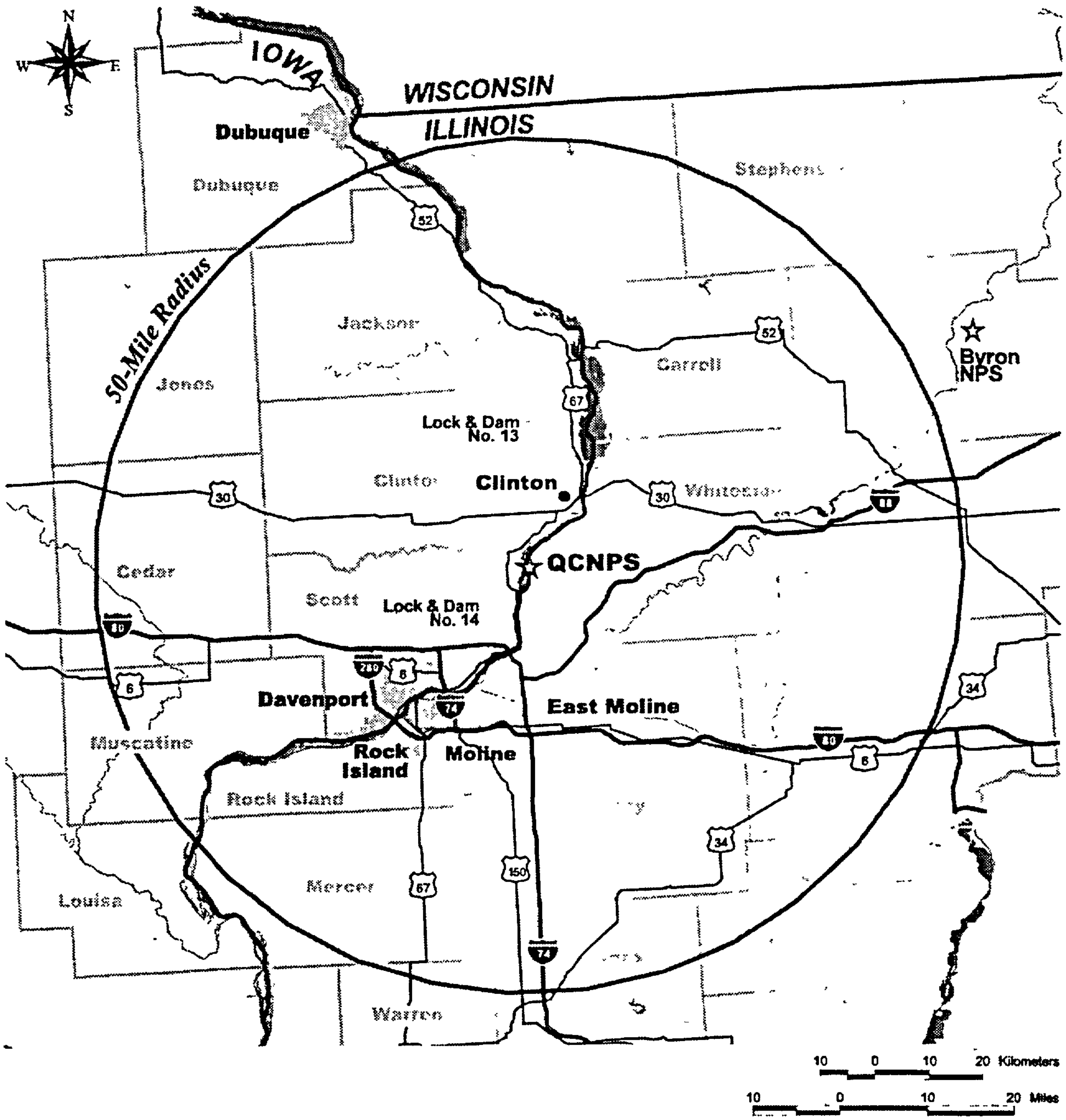
If you should have any question concerning this letter, please contact Mr. Kevin Hersey at (630) 657-3211.

Respectfully,

Keith R. Jury

Keith R. Jury
Director – Licensing
Mid-West Regional Operating Group

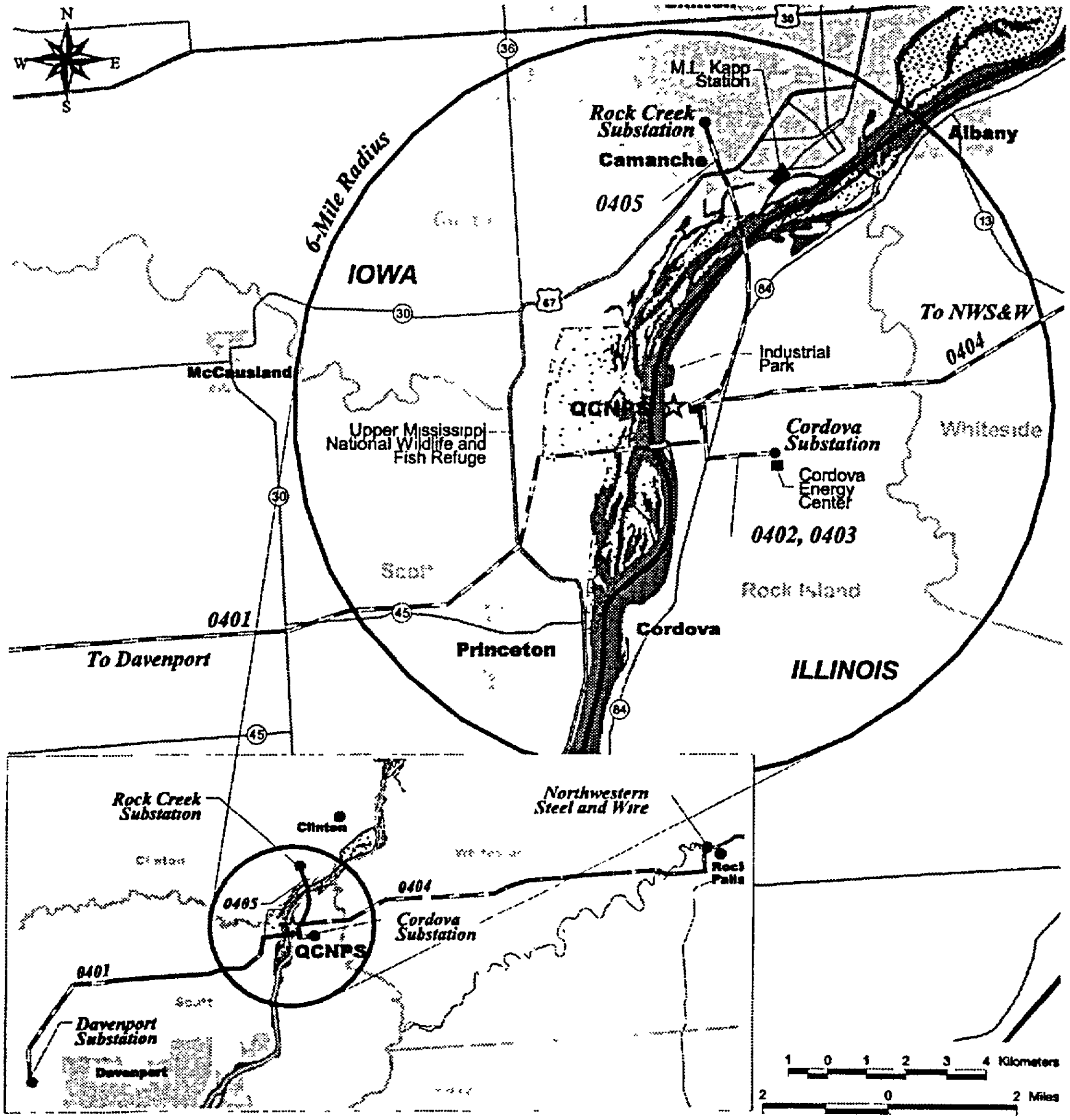
Attachments: Attachment A: Figure 2-1, 50-mile Vicinity Map
Attachment B: Figure 3-2, Transmission Line Map



LEGEND

- Nuclear Power Plants
- County Boundaries
- Lakes and Rivers
- Urban

FIGURE 2-1
50-Mile Vicinity Map



LEGEND

- ● Substations
- ☆ Quad Cities Nuclear Station
- Transmission Lines
- County Boundaries
- Cities

NWS&W = Northwestern Steel and Wire

FIGURE 3-2
Transmission Line Map

Exelon Nuclear

Exelon Generation
4300 Winfield Road
Warrenville, IL 60555

www.exeloncorp.com

RS-02-002

January 11, 2002

Mr. William Wheeler
State Historic Preservation Office Representative
Illinois Historic Preservation Agency
500 East Madison
Springfield, Il 62701

Subject: Quad Cities Nuclear Power Station, Units 1 And 2, License Renewal: Request For Information On Historic/Archeological Resources

Exelon Generation Company (EGC), LLC (formerly Commonwealth Edison Company) is currently preparing an application to the U S Nuclear Regulatory Commission (NRC) to renew the operating licenses for the Quad Cities Nuclear Power Station (QCNPS), Units 1 and 2. The current operating licenses for Unit 1 and 2 expire in 2012. The renewal term would be for an additional 20 years beyond the original license expiration date. As part of the license renewal process, NRC requires license renewal applicants to "assess whether any historic or archeological properties will be affected by the proposed project" By contacting your office early in the application process, we hope to identify any issues that we need to address or any information that we should provide to your office to expedite your evaluation of the impact of the continued operation of QCNPS on historic and archeological resources

Exelon has operated QCNPS and its associated transmission lines since 1972. As shown on Attachment A, QCNPS is located in Rock Island County, Illinois, on the east bank of Pool 14 of the Mississippi River, about 16 miles below Dam 13 and 13 miles above Dam 14 (i.e., river mile 506.5). Although no major metropolitan areas occur within a six-mile radius, QCNPS is about four miles north of Cordova, Illinois, and seven miles southwest of Clinton, Iowa. The QCNPS site consists of 560 acres. In addition to the two nuclear reactors and their turbine buildings, intake and discharge canals, and auxiliary buildings, the site includes switchyards and a retired spray canal that is now utilized for aquaculture.

As shown on Attachment B, five transmission lines were built to connect QCNPS to the regional transmission system. The transmission lines within Illinois are located in Rock Island and Whiteside Counties. Beginning at QCNPS, one line runs south from the Station and then turns west, crossing the Mississippi River. One line runs east for approximately 33 miles, terminating near Rock Falls, Illinois. One line runs through the industrial park just north of QCNPS and crosses the Mississippi River into Iowa.

January 11, 2002
Illinois Historic Preservation Agency
Page 2

Two other lines terminate within two miles of the Station.

EGC does not expect the operation of QCNPS, including maintenance of the identified transmission lines, through the license renewal term to adversely affect cultural or historical resources in the area or region. No major structural modifications have been identified for the purposes of supporting license renewal. Any maintenance activities necessary to support license renewal would be limited to previously disturbed areas. No additional land disturbance is anticipated in support of license renewal. Accordingly, we request your concurrence with our determination that the license renewal process would have no effect on any historic or archeological properties.

After your review, we request receiving your input by March 29, 2002. In your response, please detail any concerns you may have about historic/archeological properties in the area or confirming our conclusion that operation of QCNPS over the license renewal term would have no effect on any historic or archeological properties in Illinois This will enable us to meet our NRC application submittal schedule. EGC will include a copy of this letter and your response in the Environmental Report that will be submitted to the NRC as part of the QCNPS license renewal application.

Should you have any questions concerning this letter, please contact Mr. Terry Steinert at (630) 657-3213.

Respectfully,

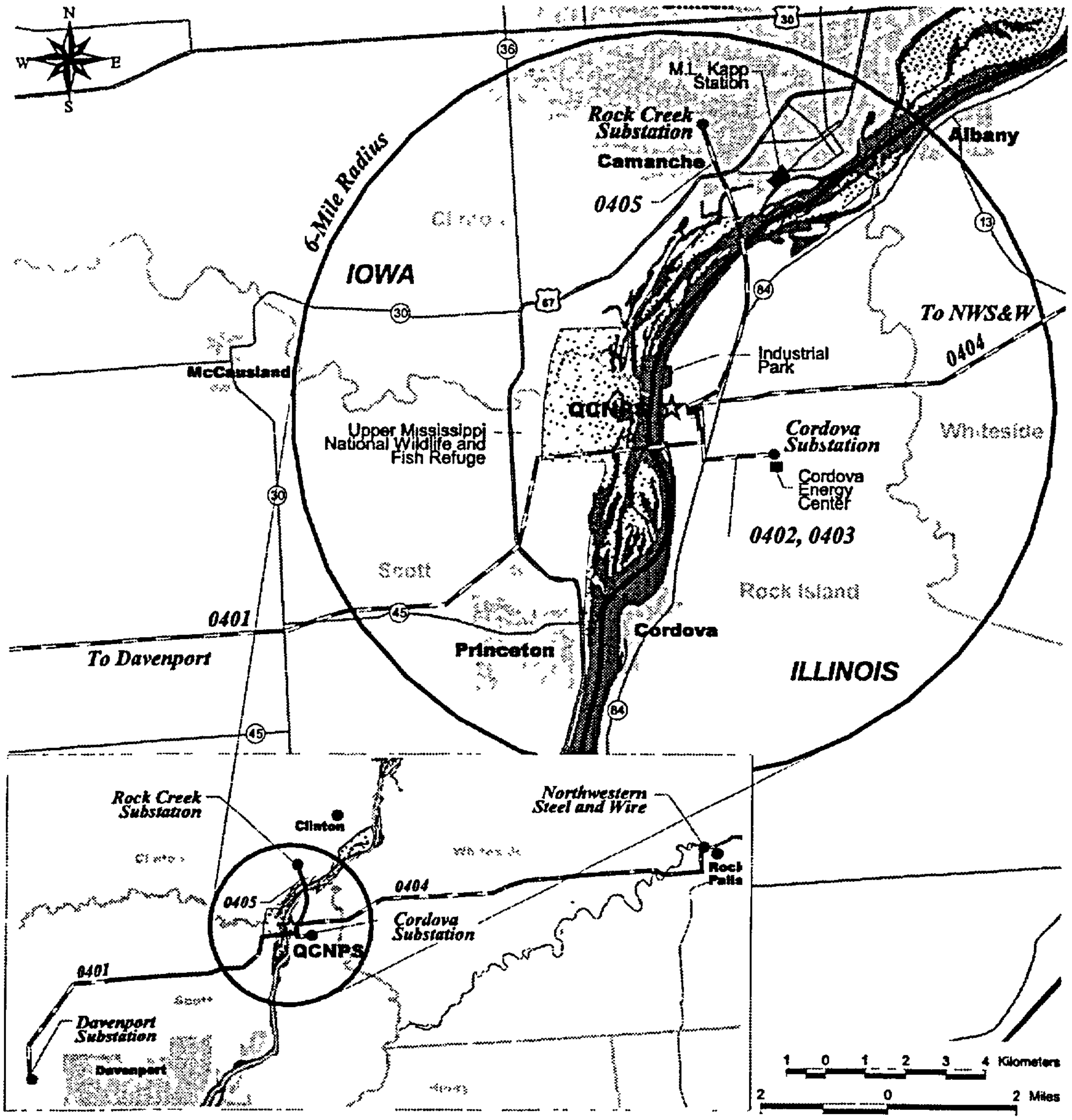
K. R. Jury
Director – Licensing
Mid-West Regional Operating Group

Attachments: Attachment A, Figure 2-1, 50-Mile Vicinity Map
Attachment B, Figure 3-2, Transmission Line Map

LEGEND

- Nuclear Power Plants
- County Boundaries
- Lakes and Rivers
- Urban

FIGURE 2-1
50-Mile Vicinity Map



LEGEND

- Substations
- Quad Cities Nuclear Station
- Transmission Lines
- County Boundaries
- Cities

NWS&W = Northwestern Steel and Wire

FIGURE 3-2
Transmission Line Map

Illinois Historic Preservation Agency

1 Old State Capitol Plaza • Springfield [illegible] • (217) 782 4836 • TTY (217) 524-7128

Various County
Rock Island & Whiteside County
Quad Cities Nuclear Power Plant Stations/Units 1 & 2 License Renewal
Transmission lines are located in Rock Island & Whiteside County
IHPA LOG #0201160038WVA

February 7, 2002

K.R. Jury
Exelon Nuclear
Exelon Generation
4300 Winfield Road
Warrenville, IL 60555

Dear Mr. Jury:

We have reviewed the documentation submitted for the referenced project(s) in accordance with 36 CFR Part 800.4. Based upon the information provided, no historic properties are affected. We, therefore, have no objection to the undertaking proceeding as planned.

Please retain this letter in your files as evidence of compliance with section 106 of the National Historic Preservation Act of 1966, as amended. This clearance remains in effect for one year from date of issuance. It does not pertain to any discovery during construction, nor is it a clearance for purposes of the Illinois Human Skeletal Remains Protection Act (20 ILCS 3440).

If you have any further questions, please contact Cody Wright, Cultural Resources Manager, Illinois Historic Preservation Agency, 1 Old State Capitol Plaza, Springfield, IL 62701, 217/785-3977.

Sincerely,

Anne E. Haaker

Anne E. Haaker
Deputy State Historic
Preservation Officer

AEH:CW:as

The History Division of the Department of Cultural Affairs

STATE HISTORICAL SOCIETY OF IOWA

Where past meets future

June 24, 2002

In reply refer to:
R&C#: 020487156

Keith R. Jury
Director – Licensing
Mid-West Regional Operating Group
Exelon Generation
4300 Winfield Road
Warrenville, Illinois 60555

RE: NRC – SCOTT COUNTY – RS-02-079 – QUAD CITIES NUCLEAR POWER STATION UNITS 1 & 2 LICENSE RENEWAL

Dear Mr. Jury,

We have received and reviewed the submitted information concerning the above referenced project We understand that there is no new construction proposed as part of the license renewal This renewal is limited to maintenance of existing transmission lines in Iowa. These activities will be limited to the currently existing R.O W We also understand that portions of the currently existing R O.W. have been previously surveyed and one previously identified archaeological site, 13ST157, is located within the R O.W. This site was previously evaluated as not eligible for listing on the National Register of Historic Places and our office concurred with that determination. Based on all of this information, we could concur with a determination of **No Historic Properties Affected** for this proposed project once that determination has been provided to our office by the responsible federal agency for this proposed federal undertaking

We have made these **comments and recommendations** according to our responsibility defined by Federal law pertaining to the Section 106 process. The responsible federal agency does not have to follow our **comments** and **recommendations** to comply with the Section 106 process. It remains the responsible federal agency's decision on whether or not to provide additional information to our office or whether or not to proceed with the project without the concurrence of this office. It also remains the responsible federal agency's decision on how you will proceed from this point for this project.

Should you have any questions please contact me at the number below

Sincerely,

Douglas W. Jones

Douglas W. Jones, Archaeologist
Community Programs Bureau
(515) 281-4358

cc Rosetta O Virgilio, Federal Preservation Officer, U S. Nuclear Regulatory Commission

American Gothic House
Eldon

Blood Run NHL
Larchwood

Centennial Building
Iowa City

Matthew Edel Blacksmith Shop
Marshalltown

Abbie Gardner Cabin
Arnolds Park

Iowa Historical Building
Des Moines

Montauk Governor's Home
Union Sunday School
Clermont Museum
Clermont

Plum Grove Governor's Home
Iowa City

Toolesboro Indian Mounds
Toolesboro

Western Historical Trails Center
Council Bluffs

IOWA HISTORICAL BUILDING
600 East Locust • Des Moines, Iowa 50319-0290
Phone. (515) 281-6412 • Fax: (515) 242-6498 or (515) 282-0502
www.uiowa.edu/~shsi/index.htm

Appendix F

SAMA ANALYSIS

Appendix F - Quad Cities Nuclear Power Station Environmental Report

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Appendix F

Severe Accident Mitigation Alternatives

The severe accident mitigation alternatives (SAMA) analysis discussed in 4.20 is presented below.

F.1 METHODOLOGY

The methodology selected for this analysis involves identifying SAMA candidates that have the highest potential for reducing core damage frequency and person-rem and determining whether or not the implementation of those candidates is beneficial on a cost-risk reduction basis. This process consists of the following steps:

- Quad Cities Probabilistic Safety Assessment (PSA) Model – Use the Quad Cities (QC) PSA model as the basis for the analysis (Section F.2).
- Level 3 PSA Analysis – Use QC Level 1 and 2 PSA output and site-specific meteorology, demographic, land use, and emergency response data as input in performing a Level 3 probablistic safety assessment (PSA) using the MELCOR Accident Consequences Code System Version 2 (MAACS2) (Section F.3).
- Baseline Risk Monetization – Use NRC regulatory analysis techniques, calculate the monetary value of the unmitigated QC severe accident risk. This becomes the maximum averted cost-risk that is possible (Section F.4).
- Phase I SAMA Analysis – Identify potential SAMA candidates based on QC, NRC, and industry documents. Screen out Phase 1 SAMA candidates that are not applicable to the QC design or are of low benefit in boiling water reactors (BWRs) such as QC, candidates that have already been implemented at QC or whose benefits have been achieved at QC using other means, and candidates whose estimated cost exceeds the maximum possible averted cost-risk (Section F.5).
- Phase II SAMA Analysis – Calculate the risk reduction attributable to each remaining SAMA candidate and compare to a more detailed cost analysis to identify any net cost benefit. Probabilistic safety assessment (PSA) insights are also used to screen SAMA candidates in this phase (Section F.6).
- Uncertainty Analysis – Evaluate how a reduced discount value might affect the cost/benefit analyses.
- Conclusions – Summarize results and identify conclusions (Section F.8).

The steps outlined above are described in more detail in the subsections of this appendix and Figure F-1 provides a graphical representation of the SAMA process.

F.1.1 QC SPECIFIC SAMA

The initial list of Severe Accident Mitigation Alternative candidates for QC was developed from lists of SAMAs at other nuclear power plants (References 23, 9, 5, 7, 4, 12 and 13), NRC documents (References 1, 2, 3, 6, 8, 15, 16, and 19), and documents related to advanced power reactor designs (References 17, 10, and 11). In addition, plant specific analyses (References 68, 47) have been used to identify potential SAMAs which address QC vulnerabilities. This process is considered to adequately address the requirement of identifying significant safety improvements that could be performed at QC. The initial SAMA list, Table F-1, includes a column which documents the reference sources for each individual SAMA.

The QC IPEEE (Reference 18) also identified potential opportunities for plant improvements. As a result of the Seismic and Fire Analysis, potential plant changes were considered and dispositioned according to their importance.

Given the existing assessments of external events and internal fires at QC, the cost benefit analysis uses the internal events PSA as the basis for measuring the impact of SAMA implementation. No fire or external events models are used in this analysis as the fire and IPEEE programs are considered to have already addressed potential plant improvements related to those categories.

F.2 QUAD CITIES PSA MODEL

The 2002 update to the Quad Cities PRA is the most recent evaluation of the risk profile at the Quad Cities Unit 1 for internal event challenges. It is a periodic update, in accordance with EGC internal guidance, ER-AA-600-1015, "Full Power Internal Events (FPIE) PRA Model Update." There have been a series of probabilistic evaluations beginning with the Individual Plant Examination (IPE) issued in 1993 as requested by the NRC in Generic Letter 88-20.

The baseline CDF is 2.2E-6/yr. The radionuclide release frequencies including LERF are provided in Section F.6.

Update Revision 02B includes the following:

- Approximately 17% Extended Power Uprate (EPU) plant configuration and MAAP 4.0.4 analysis
- Revised human reliability analysis (HRA) based on the most recent operator interviews
- Operating event experience review
- Maintenance unavailability data based on the most recent plant operating experience

- Bayesian updated initiating event frequencies utilizing Quad Cities most recent operating experience
- Individual component random failure probabilities Bayesian updated (as applicable) based upon the most recent plant specific data and the most current generic sources
- Common cause failure (CCF) calculations revised to incorporate the updated individual random basic event probabilities and the most up to date Multiple Greek Letter (MGL) parameters from NUREG/CR-5497 and NUREG/CR-5485
- Revised LOOP/DLOOP analysis for initiating event frequencies and non-recovery probabilities based upon a Midwest regional data filtering approach
- Revised mechanical and electrical ATWS probabilities, based on information in NUREG/CR-5500
- Response to Quad Cities BWROG Peer Review comments using the NEI PRA Peer Review Process (NEI 00-02)
- Response to additional independent Peer Review Comments

The Quad Cities PRA model update has been performed with as-built, as-operated information, current as of June 2001. This includes plant-specific initiating event and equipment performance data for the 5-1/2-yr period ending in June 2001.
The documentation to support the PRA Update has been compiled in a set of modularized notebooks to provide the specific information needed for the PRA Update.

The PRA computer model has been developed within the CAFTA environment. The model exists in two logic formats:

- A sequence model -- PRAQUANT
- A single top fault tree model -- ONE4ALL

Both quantification methodologies (PRAQuant and ONE4ALL) use the same PRA model logic and data input. The PRAQuant sequence quantification was retained because it provides sequence-level results and CDF contribution by accident class, which are not provided by ONE4ALL. The ONE4ALL methodology permits quantification at a lower truncation limit, consistent for every sequence, and the single top model is used for most sensitivity studies and for assessing the risk of on-line maintenance.

F.2.1 ANALYSIS

The Quad Cities Plant has undergone an approximate 17% power uprate.

The approximate 17% power uprate was accompanied by hardware, set point, and power operation configuration changes that are reflected in the MOR102B model. In addition, success criteria and accident sequence timing changes resulted in changes to the PSA model to reflect the higher power operation.

Quad Cities specific MAAP 4.0.4 calculations for the approximate 17% power uprate were performed to provide the new success criteria, sequence timing, and radionuclide release fractions.

An additional quantitative difference identified for the SAMA evaluation due to power uprate is in the calculation of replacement power costs. A scaling factor is required to fit the calculation to a given plant based on net electric output. The post power uprate output of approximately 912 MWe is used for the analysis.

In summary, the Quad Cities power uprate has been explicitly included in the PSA model and the supporting thermal hydraulic analyses.

F.3 LEVEL 3 PSA ANALYSIS

F.3.1 ANALYSIS

The MACCS2 code (Reference 91) was used to perform the level 3 probabilistic risk assessment (PRA) for the Quad Cities Nuclear Power Station (QCNPS). The input parameters given with the MACCS2 "Sample Problem A," which included the NUREG-1150 food model (Reference 92), formed the basis for the present analysis. These generic values were supplemented with parameters specific to QCNPS and the surrounding area. Site-specific data included population distribution, economic parameters, and agricultural production. Plant-specific release data included the time-nuclide distribution of releases, release frequencies, and release locations. The behavior of the population during a release (evacuation parameters) was based on plant and site-specific set points (i.e., declaration of a General Emergency) and the emergency planning zone (EPZ) evacuation table (Reference 96). These data were used in combination with site-specific meteorology to simulate the probability distribution of impact risks (exposure and economic) to the surrounding (within 50 miles) population from the accident sequences at QCNPS.

F.3.2 POPULATION

The population surrounding the QCNPS site was estimated for the year 2032. Population projections within 50 miles of QCNPS were determined using a geographic information system (GIS), U.S Census block-group level population data for 2000 allocated to each sector based on the area fraction of the census block-groups in each sector, and populations growth rates estimates for each county. The projected county growth rates were weighted by the fraction of each county in the 50-mile radius. The calculated growth rate of 1.067 from 2000 to 2032 was applied uniformly to all sectors. The distribution was given in terms of population at distances to 1, 2, 3, 4, 5, 10, 20, 30, 40 and 50 miles from the plant and in the direction of each of the 16 compass points (i.e., N, NNE, NE......NNW). The total year 2032 population for the 160 sectors (10 distances × 16 directions) in the region was estimated as 700,677, the distribution of which is given in Tables F-2 and F-3.

F.3.3 ECONOMY

MACCS2 requires the spatial distribution of certain economic data (fraction of land devoted to farming, annual farm sales, fraction of farm sales resulting from dairy production, and property value of farm and non-farm land) in the same manner as the population. This was done by updating the database in the SECPOP90 code (Reference 93) for each of the 21 counties surrounding the plant to a distance of 50 miles, using the methodology in Reference 93 and data from References 94, 97, 98, 99, and 95. The values for up to 97 economic zones allocated to each of the 160 sectors were then calculated using SECPOP90 code with the updated economic and agricultural database.

In addition, generic economic data that are applied to the region as a whole were revised from the MACCS2 sample problem input when better information was available. These revised parameters include per diem living expenses (applied to owners of interdicted properties and relocated populations), relocation costs (for owners of interdicted properties), value of farm and non-farm wealth, and fraction of farm wealth from improvements (e.g., buildings, equipment).

F.3.4 AGRICULTURE

Agricultural production information was taken from the 1997 Agricultural Census (Reference 95). Production within 50 miles of the site was estimated based on those counties within this radius. Production in those counties, which lie partially outside of this area, was multiplied by the fraction of the county within the area of interest. Of the food crops, grain (51 percent of the total cropland, made up of corn and wheat), and legumes (29 percent of the total cropland, made up of soybeans) were harvested from the largest areas. Pasture (13 percent) and stored forage (6 percent of total cropland, consisting of hay) made up most of the remaining harvested cropland.

The lengths of the growing seasons for grains and legumes were obtained from Reference 100. The duration of the growing season for the remaining crop categories (pasture, stored forage, green leafy vegetables, roots/tubers and other food crops) was based on reasonable estimates. The uncertainty in these estimates does not have a significant impact due to the much smaller fraction of land dedicated to these crops.

F.3.5 NUCLIDE RELEASE

The core inventory at the time of the accident was based on the input supplied in the MACCS User's Guide (Reference 91). The core inventory corresponds to the end-of-cycle values for a 3578-MWth BWR plant. A scaling factor of 0.8264 was used to provide a representative core inventory of 2957-MWth at QCNPS. QCNPS nuclide release categories were related to the MACCS categories as shown in Table F-4. Each

QCNPS category corresponded with a single release duration (either puff or continuous).

All releases were modeled as occurring at ground level. The thermal content of each of the releases was conservatively assumed to be the same as ambient; i.e., buoyant plume rise was not modeled.

F.3.6 EVACUATION

Scram for each sequence was taken as time zero. A General Emergency is declared when plant conditions degrade to the point where it is judged that there is a credible risk to the public.

The MACCS2 User's Guide input parameters of 95 percent of the population within 10 miles of the plant (Emergency Planning Zone) evacuating and 5 percent not evacuating were employed. These values have been used in similar studies (e.g., Hatch, Calvert Cliffs, References 101 and 19) and are conservative relative to the NUREG-1150 study, which assumed evacuation of 99.5 percent of the population within the emergency planning zone (Reference 92). The evacuees are assumed to begin evacuation 15 minutes (Reference 96) after a General Emergency has been declared and are evacuated at an average radial speed of 2.4 miles per hour (1.07 m/sec). This speed is calculated from the maximum evacuation time of 250 minutes from the full 0-10mi. EPZ under daytime adverse weather conditions, and includes the average times required for leaving work, travelling home, and preparing home for evacuation (120 minutes) after having received notice of evacuation (Reference 96).

F.3.7 METEOROLOGY

Annual meteorology data sets from 1998 through 2001 were investigated for use in MACCS2. The 2000 data set was used, supplemented as follows to fill in the data gaps:

1. Available tower data were used whenever possible. For example, if the lower wind direction was unavailable, mid and/or upper directions were used to estimate the lower wind direction (or speed). If only a brief period of missing data existed, interpolation was used between hours.
2. Indirect measurements of other parameters were used to help fill data gaps (rapidly lowering temperatures may indicate a wind shift has occurred).
3. Hourly observations from Moline (Quad City Airport) were utilized to fill larger data voids.
4. Two meteorologists (one with over 20 years experience and the other with over 15 years experience) reviewed the data to interpret and suggest values to fill data gaps.
5. Wind speed and direction from the 10-meter sensor were combined with precipitation (hourly cumulative) and atmospheric stability (specified according to the vertical temperature gradient as measured between the 60-meter and 10-meter levels).

6. Atmospheric mixing heights were specified for AM and PM hours. These values were taken as 500 and 1200 meters, respectively (Reference 102).

F.3.8 MACCS2 RESULTS

Table F-5 shows the mean off-site doses and economic impacts to the region within 50 miles of QCNPS for each of eight release categories calculated using MACCS2. These impacts are multiplied by the annual frequency for each release category and then summed to obtain the risk-weighted mean doses and economic costs. Two of the 10 release categories (L2-3 and L2-4) did not have any reported release data and were not subjected to the Level 3 analysis. Table F-6 provides a summary of the QC Level 2 PRA results.

F.4 BASELINE RISK MONETIZATION

F.4.1 OFF-SITE EXPOSURE COST

This section explains how EGC calculated the monetized value of the status quo (i.e., accident consequences without SAMA implementation). EGC also used this analysis to establish the maximum benefit that a SAMA could achieve if it eliminated all QC risk.

F.4.2 OFF-SITE EXPOSURE COST

The baseline annual off-site exposure risk was converted to dollars using the NRC's conversion factor of $2,000 per person-rem (Reference 90), and discounting to present value using NRC standard formula (Reference 90):

$$W_{pha} = C \times Z_{pha}$$

Where:

W_{pha}	=	monetary value of public health risk after discounting
C	=	$[1-\exp(-rt_f)]/r$
t_f	=	years remaining until end of facility life = 20 years
r	=	real discount rate (as fraction) = 0.07/year
Z_{pha}	=	monetary value of public health (accident) risk per year before discounting ($/year)

The Level 3 analysis showed an annual off-site population dose risk of 1.67 person-rem. The calculated value for C using 20 years and a 7 percent discount rate is approximately 10.76. Therefore, calculating the discounted monetary equivalent of accident risk involves multiplying the dose (person-rem per year) by $2,000 and by the C value (10.76). The calculated off-site exposure cost is $35,948.

F.4.3 OFF-SITE ECONOMIC COST RISK (OECR)

The Level 3 analysis showed an annual off-site economic risk of $2,807. Calculated values for off-site economic costs caused by severe accidents must be discounted to present value as well. This is performed in the same manner as for public health risks and uses the same C value. The resulting value is $30,211.

F.4.4 ON-SITE EXPOSURE COST RISK

Occupational health was evaluated using the NRC methodology in Reference 90, which involves separately evaluating "immediate" and long-term doses.

Immediate Dose - For the case where the plant is in operation, the equation that NRC recommends using (Reference 90) is:

Equation 1:

$$W_{IO} = R\{(FD_{IO})_S - (FD_{IO})_A\}\{[1 - \exp(-rt_f)]/r\}$$

Where:

W_{IO}	=	monetary value of accident risk avoided due to immediate doses, after discounting
R	=	monetary equivalent of unit dose ($/person-rem)
F	=	accident frequency (events/yr)
D_{IO}	=	immediate occupational dose (person-rem/event)
$_S$	=	subscript denoting status quo (current conditions)
$_A$	=	subscript denoting after implementation of proposed action
r	=	real discount rate
t_f	=	years remaining until end of facility life.

The values used in the QC analysis are:

R	=	$2,000/person-rem
r	=	0.07
D_{IO}	=	3,300 person-rem/accident (best estimate)
t_f	=	20 years (license extension period)
F	=	2.19E-6 (total core damage frequency)

For the basis discount rate, assuming F_A is zero, the best estimate of the immediate dose cost is:

$$W_{IO} = R\,(FD_{IO})_S\{[1 - \exp(-rt_f)]/r\}$$
$$= 2{,}000*2.19E\text{-}6*3{,}300*\{[1 - \exp(-0.07*20)]/0.07\}$$
$$= \$156$$

Long-Term Dose - For the case where the plant is in operation, the NRC equation (Reference 90) is:

Equation 2:

$W_{LTO} =$ $R\{(FD_{LTO})_S - (FD_{LTO})_A\} \{[1 - \exp(-rt_f)]/r\}\{[1 - \exp(-rm)]/rm\}$

Where:

$W_{IO} =$ monetary value of accident risk avoided long-term doses, after discounting, \$

$m =$ years over which long-term doses accrue

The values used in the QC analysis are:

$R =$ \$2,000/person-rem

$r =$ 0.07

$D_{LTO} =$ 20,000 person-rem/accident (best estimate)

$m =$ "as long as 10 years"

$t_f =$ 20 years (license extension period)

$F =$ 2.19E-6 (total core damage frequency)

For the basis discount rate, assuming F_A is zero, the best estimate of the long-term dose is:

$W_{LTO} =$ $R (FD_{LTO})_S \{[1 - \exp(-rt_f)]/r\} \{[1 - \exp(-rm)]/rm\}$

$=$ $2{,}000*2.19E\text{-}6 *20{,}000*\{ [1 - \exp(-0.07*20)]/0.07\} \{[1 -\exp(-0.07*10)]/0.07*10\}$

$=$ \$678

<u>Total Occupational Exposure</u> - Combining Equations 1 and 2 above and using the above numerical values, the total accident related on-site (occupational) exposure avoided (W_O) is:

$W_O = W_{IO} + W_{LTO} =$ (\$156 + \$678) = \$834

F.4.5 ON-SITE CLEANUP AND DECONTAMINATION COST

The net present value that NRC provides for cleanup and decontamination for a single event is \$1.1 billion, discounted over a 10-year cleanup period (Reference 90). NRC uses the following equation to integrate the net present value over the average number of remaining service years:

$U_{CD} =$ $[PV_{CD}/r][1-\exp(-rt_f)]$

Where:

$PV_{CD} =$ net present value of a single event

$r =$ real discount rate

$t_f =$ years remaining until end of facility life.

The values used in the QC analysis are:

PV_{CD} = $1.1E+9
r = 0.07
t_f = 20

The resulting net present value of cleanup integrated over the license renewal term, $1.18E+10, must be multiplied by the total core damage frequency of 2.19E-6 to determine the expected value of cleanup and decontamination costs. The resulting monetary equivalent is $25,928.

F.4.6 REPLACEMENT POWER COST

Long-term replacement power costs was determined following the NRC methodology in Reference 90. The net present value of replacement power for a single event, PV_{RP}, was determined using the following equation:

$$PV_{RP} = [\$1.2E{+}8/r] * [1 - \exp(-rt_f)]^2$$

Where:

PV_{RP} = net present value of replacement power for a single event, ($)
r = 0.07
t_f = 20 years (license renewal period)

To attain a summation of the single-event costs over the entire license renewal period, the following equation is used:

$$U_{RP} = [PV_{RP} / r] * [1 - \exp(-rt_f)]^2$$

Where:

U_{RP} = net present value of replacement power over life of facility ($-year)

After applying a correction factor to account for QC's size relative to the "generic" reactor described in NUREG/BR-0184 (Reference 90)(i.e., 912 MWe/910 MWe), the replacement power costs are determined to be 7.9E+9 ($-year). Multiplying this value by the CDF (2.19E-6) results in a replacement power cost of $17,318.

F.4.7 TOTAL

The sum of the baseline costs is as follows:

Off-site exposure cost	=	$35,948
Off-site economic cost	=	$30,211
On-site exposure cost	=	$834
On-site cleanup cost	=	$25,928
Replacement Power cost	=	$17,318
Total cost	=	$110,239

EGC rounded this value up to $111,000 to use in screening out SAMAs as economically infeasible. The averted cost-risk calculations account for this rounding such that it does not impact the result. This cost estimate was used in screening out SAMAs that are not economically feasible; if the estimated cost of implementing a SAMA exceeded $111,000 it was discarded from further analysis. Exceeding this threshold would mean that a SAMA would not have a positive net value even if it could eliminate all severe accident costs. On the other hand, if the cost of implementation is less than this value, then a more detailed examination of the potential fractional risk benefit that can be attributed to the SAMA is performed.

F.5 PHASE I SAMA ANALYSIS

F.5.1 SAMA IDENTIFICATION

The initial list of Severe Accident Mitigation Alternative candidates for QC was developed from lists of SAMAs at other nuclear power plants (References 23, 9, 5, 7, 4, 12, and 13), NRC documents (References 1, 2, 3, 6, 8, 15, 16, and 19), and documents related to advanced power reactor designs (References 17, 10, and 11). In addition, plant specific analyses (References 18, 47) have been used to identify potential SAMAs which address QC vulnerabilities. This process is considered to adequately address the requirement of identifying significant safety improvements that could be performed at QC. The initial SAMA list, Table F-1, includes a column which documents the reference sources for each individual SAMA.

The QC IPEEE (Reference 18) also identified potential opportunities for plant improvements. As a result of the Seismic and Fire Analysis, potential plant changes were considered and dispositioned according to their importance.

Given the existing assessments of external events and internal fires at QC, the cost benefit analysis uses the internal events PSA as the basis for measuring the impact of SAMA implementation. No fire or external events models are used in this analysis as the fire and IPEEE programs are considered to have already addressed potential plant improvements related to those categories.

F.5.2 SCREENING

An initial list of SAMA candidates is presented in Table F-1. This initial list was then screened to remove those candidates that were not applicable to QC due to design differences or high implementation cost. In addition, SAMAs were eliminated if they were related to changes that would be made during the design phase of a plant rather than to an existing plant. These would typically screen on high cost, but they are categorized separately for reference purposes. The SAMA screening process is summarized in Figure F-1.

A majority of the SAMAs were removed from further consideration as they did not apply to the GE BWR3/Mark I design used at QC. The SAMA candidates that were found to be implemented at QC were screened from further consideration.

The SAMAs related to design changes prior to construction (primarily consisting of those candidates taken from the ABWR SAMAs) were removed as they were not applicable to an existing site. Any candidate known to have an implementation cost that far exceeds any possible risk benefit is screened from further analysis. Any SAMA candidates that were sufficiently similar to other SAMA candidates were treated in the same manner to those that they were related to either combined or screened from further consideration.

A preliminary cost estimate was prepared for each of the remaining candidates to focus on those that had the possibility of having a positive benefit and to eliminate those whose costs were beyond the possibility of any corresponding benefit (as determined by the QC baseline screening cost). When the screening cutoff of $111,000 was applied, a majority of the remaining SAMA candidates were eliminated, as their implementation costs were more expensive than the maximum postulated benefit associated with the elimination of all risk associated with full power internal events. This left 14 candidates for further analysis. Those SAMAs that required a more detailed cost benefit analysis are evaluated in Section F.6. A list of these SAMAs is provided in Table F-7.

F.6 PHASE II SAMA ANALYSIS

For each of the remaining SAMA candidates that could not be eliminated based on screening cost or PSA/application insights, a more detailed conceptual design was prepared. This information was then used to evaluate the effect of the candidates' changes upon the plant safety model. The impact that a specific SAMA has on the PSA model is conservatively evaluated to maximize the estimated cost benefit. In most instances, this averted cost value is compared qualitatively against an estimated cost to implement. A more detailed implementation cost assessment is made only if the benefit is close to the estimated implementation cost.

The final cost-risk based screening method used to determine the desirability of implementing the SAMA is defined by the following equation:

Net Value = (baseline cost-risk of plant operation – cost-risk of plant operation with SAMA implemented) – cost of implementation

If the net value of the SAMA is negative, the cost of implementation is larger than the benefit associated with the SAMA and the SAMA is not considered beneficial. The baseline cost-risk of plant operation was derived using the methodology presented in

Section F.4. The cost-risk of plant operation with the SAMA implemented is determined in the same manner with the exception that the PSA results reflect the application of the SAMA to the plant (the baseline input is replaced by the results of a PSA sensitivity with the SAMA change in effect).

Subsections F.6.1 – F.6.14 describe the detailed cost benefit analysis that was used to determine how the remaining candidates were ultimately treated.

F.6.1 PHASE II SAMA NUMBER 1

Description: Provide means for alternate SSMP room cooling.

SSMP has alternate room cooling via a manual alignment to FPS. The SAMA would be yet a further enhancement.

Evaluate the benefit of providing alternate SSMP room cooling. These options may include:

- Controls in the main Control Room for remote alignment of SW or FPS to SSMP room cooling
- Procedures for opening SSMP room doors and using portable fans for SSMP room cooling

The approach to assessing this SAMA is to assume complete reliability of the room cooling function for SSMP. This would be the maximum benefit associated with a procedure change that provides alternate cooling to the SSMP compartment

Phase II SAMA Number 1 Model Changes

Gate and / or Basic Event ID and Description	Description of Change
Gate BSS-TR210109 (Loss of SSMP room cooling)	Delete all SSMP room cooling dependencies from model

F.6.1.1 PSA Model Results for Phase II SAMA Number 1

The results from this case indicate a decrease from the base CDF of 2.19E-6/yr to 1.92E-6/yr (SAMA number 1). The decrease in CDF applies primarily to loss of DHR and late station blackout scenarios (Class II and IBL). The radionuclide release frequencies are modified as shown in Table F-8. The results of the cost benefit analysis are shown below:

Phase II SAMA Number 1 Net Value

Base Case: Cost-Risk for QC	SAMA 1 Cost-Risk for QC	Averted Cost-Risk	Cost of Implementation	Net Value
$111,000	$98,720	$12,280	Not Required	**Not Cost Beneficial**

Implementation of this SAMA would include potential procedural and hardware modifications to the plant. It is estimated that the cost of such changes would be substantially higher than the averted cost-risk. This SAMA would not be cost beneficial for Quad Cities.

F.6.2 PHASE II SAMA NUMBER 2

Description: Develop an enhanced drywell spray system.

The Fire Protection system can already provide water to the RHR system at Quad Cities; however, no procedures have been developed to use it as a containment spray source. This containment spray function could be further enhanced at Quad Cities.

The modeling approach for this SAMA is to assign complete success to the drywell spray effectiveness in Level 2 for all sequences except Class II, IV, and V.

Note, no reduction in CDF is expected from this SAMA.

Phase II SAMA Number 2 Model Changes

Gate and / or Basic Event ID and Description	Description of Change
Level 2 SI node	Change split fraction to 0.0(1)

F.6.2.1 PSA Model Results for Phase II SAMA Number 2

The results from this case indicate a slight reduction in CDF (base CDF = 2.19E-6/yr). The radionuclide release frequencies are modified as shown in Table F-9. The results of the cost benefit analysis are shown below:

(1) For depressurized RPV conditions only.

Phase II SAMA Number 2 Net Value

Base Case: Cost-Risk for QC	SAMA 2 Cost-Risk for QC	Averted Cost-Risk	Cost of Implementation	Net Value
$111,000	$100,297	$10,703	Not Required	**Not Cost Beneficial**

Implementation of this SAMA would involve engineering analysis in addition to procedural changes to the plant and is estimated to cost substantialy more than the averted cost-risk. This SAMA is not judged to be cost beneficial for Quad Cities.

F.6.3 PHASE II SAMA NUMBER 3

Description: Use fuel cells instead of lead-acid batteries.

SAMA would extend DC power availability in an SBO.

Improving battery capacity may be cost beneficial for Quad Cities. Further extension of battery life with fuel cells is estimated to have a small impact on the Quad Cities residual risk profile.

The modeling approach for this SAMA involves the assumption of indefinite (24 hours) of DC power capacity. This would allow RCIC operation until HCTL is reached in the 4 to 8 hour time frame. Therefore, the model is conservatively modeled to change the 4 hour offsite AC recovery to 8 hours to estimate the maximum benefit associated with the addition of fuel cells.

Phase II SAMA Number 3 Model Changes

Gate and / or Basic Event ID and Description	Description of Change
BACRXDLOOP4HRH-- (DLOOP non-recovery)	Change from 0.22 to 0.13
BACRXLOOP4HRSH-- (LOOP non-recovery)	Change from 0.22 to 0.13

F.6.3.1 PSA Model Results for Phase II SAMA Number 3

The results from this case indicate a decrease from the base CDF of 2.19E-6/yr to 2.06E-6/yr (SAMA number 3). The decrease in CDF applies to late station blackout scenarios (Class IBL). The radionuclide release frequencies are modified as shown in Table F-10. The results of the cost benefit analysis are shown below:

Phase II SAMA Number 3 Net Value

Base Case: Cost-Risk for QC	SAMA 3 Cost-Risk for QC	Averted Cost-Risk	Cost of Implementation	Net Value
$111,000	$106,338	$4,662	Not Required	**Not Cost Beneficial**

Implementation of this SAMA would involve hardware additions to the plant and is estimated to cost substantially more than the averted cost-risk. This SAMA would not be cost-beneficial for Quad Cities.

F.6.4 PHASE II SAMA NUMBER 4

Description: Improve 4.16-kV bus cross-tie ability.

Procedures could be developed that would allow the following cross-ties to be performed:

- Bus 14-1 to Bus 24-1 from EDG 1
- Bus 24-1 to Bus 14-1 from EDG 2
- EDG 1/2 to Buses 13-1 and 23-1

The modeling approach to be used for this SAMA is to modify the operator action HEP that currently models this action by improving the HEP by a factor of 100 given new procedures.

Phase II SAMA Number 4 Model Changes

Gate and / or Basic Event ID and Description	Description of Change
BACOP-U1U2EDGH-- (align Unit 2 EDG to Unit 1 buses)	Change HEP from 0.9 to 9E-3
BACOPXTIEBUS-H-- (Crosstie Unit 2 AC buses to Unit 1)	Change HEP from 1.1E-2 to 1.1E-4
BDGOPDG1/2ALGH-- (align swing EDG to Unit 1)	Change HEP from 5.5E-4 to 5.5E-6

F.6.4.1 PSA Model Results for Phase II SAMA Number 4

The results from this case indicate a decrease from the base CDF of 2.19E-6/yr to 2.17E-6/yr (SAMA number 4). The decrease in CDF applies to late station blackout scenarios (Class IBL). The radionuclide release frequencies are modified as shown in Table F-11. The results of the cost benefit analysis are shown below:

Phase II SAMA Number 4 Net Value

Base Case: Cost-Risk for QC	SAMA 4 Cost-Risk for QC	Averted Cost-Risk	Cost of Implementation	Net Value
$111,000	$110,242	$758	Not Required	**Not Cost Beneficial**

This SAMA would involve procedural changes to the plant and is estimated to cost substantially more than the averted cost-risk value. Implementation of this SAMA, therefore, would not be cost beneficial for Quad Cities.

F.6.5 PHASE II SAMA NUMBER 5

Description: Create a backup source for diesel cooling. (Not from existing system)

An additional EDG cooling source may be cost beneficial for Quad Cities. This load path also includes ECCS room cooling.

This SAMA is modeled by assuming that all DGCW failures can be eliminated by the "new" cooling system for the Diesels. Conceptually, this is treated as the Diesel Fire Pump connected directly to the Diesels or a cooling backup that can be manually aligned. The model therefore sets the DGCW random failures to zero and the CCF of DGCW to zero.

Phase II SAMA Number 5 Model Changes

Gate and / or Basic Event ID and Description	Description of Change
1DGPMCW1-----A-- (DGCW1 FTS)	Set Failure mode to zero.
1DGPMCW1-----M-- (DGCW1 in maint.)	Set Failure mode to zero.
1DGPMCW1-----X-- (DGCW1 FTR)	Set Failure mode to zero.
2DGPMCW2-----A-- (DGCW2 FTS)	Set Failure mode to zero.
2DGPMCW2-----M-- (DGCW2 in maint.)	Set Failure mode to zero.

Phase II SAMA Number 5 Model Changes

Gate and / or Basic Event ID and Description	Description of Change
2DGPMCW2-----X-- (DGCW2 FTR)	Set Failure mode to zero.
BDGPMCW1/2---A-- (DGCW1/2 FTS)	Set Failure mode to zero.
BDGPMCW1/2---M-- (DGCW1/2 in maint.)	Set Failure mode to zero.
BDGPMCW1/2---X-- (DGCW1/2 FTR)	Set Failure mode to zero.
BDGPM-12-FTR-XCC	Set Failure mode to zero.
BDGPM-12-FTS-ACC	Set Failure mode to zero.
BDGPM-121/2--ACC	Set Failure mode to zero.
BDGPM-121/2--XCC	Set Failure mode to zero.
BDGPM11/2-FTRXCC	Set Failure mode to zero.
BDGPM11/2-FTSACC	Set Failure mode to zero.
BDGPM21/2-FTRXCC	Set Failure mode to zero.
BDGPM21/2-FTSACC	Set Failure mode to zero.

F.6.5.1 PSA Model Results for Phase II SAMA Number 5

The results from this case indicate a minor decrease from the base CDF of 2.19E-6/yr from SAMA number 5. The decrease in CDF applies to late station blackout scenarios (Class IBL). The radionuclide release frequencies are modified as shown in Table F-12. The results of the cost benefit analysis are shown below:

Phase II SAMA Number 5 Net Value

Base Case: Cost-Risk for QC	SAMA 5 Cost-Risk for QC	Averted Cost-Risk	Cost of Implementation	Net Value
$111,000	$111,000	0	Not Required	**Not Cost Beneficial**

This SAMA has essentially no significant impact on the calculated CDF. Implementation of this SAMA, therefore, would not be cost beneficial for Quad Cities.

F.6.6 PHASE II SAMA NUMBER 6

Description: Provide procedures for (a) bypassing major DC buses; (b) locally starting equipment.

This SAMA would allow for powering specific loads given a DC bus failure and/or the ability to start equipment locally that normally requires DC power for a control room start.

The modeling approach used in this evaluation is to assume that the procedures change would completely eliminate all DC power failures as severe accidents.

Phase II SAMA Number 6 Model Changes

Gate and / or Basic Event ID and Description	Description of Change
%TDC (Loss of Div. 1 & 2 125 VDC)	Set to zero.
%TDC1A (Loss of Div. 1 125 VDC)	Set to zero.
%TDC2A (Loss of Div. 2 25 VDC)	Set to zero.

F.6.6.1 PSA Model Results for Phase II SAMA Number 6

The results from this case indicate a decrease from the base CDF of 2.19E-6/yr to 1.42E-6/yr (SAMA number 6). The decrease in CDF applies to total loss of DC scenarios (Class IE). The radionuclide release frequencies are modified as shown in Table F-13. The results of the cost benefit analysis are shown below:

Phase II SAMA Number 6 Net Value

Base Case: Cost-Risk for QC	SAMA 6 Cost-Risk for QC	Averted Cost-Risk	Cost of Implementation	Net Value
$111,000	$79,013	$31,987	Not Required	**Not Cost Beneficial**

Bypassing major DC buses at Quad Cities would require significant harware changes. It is within craft capability to locally close breakers without DC power. However, writing procedure changes to do so would require considerable engineering work to determine in advance which systems and equipment could benefit from this process and what special alignments and considerations would be necessary for each of those pieces of equipment.

This SAMA would involve engineering work, and hardware and procedural changes to the plant, and, therefore, it is estimated to cost substrantially more than the averted cost-risk value. Implementation of this SAMA, therefore, would not be cost beneficial for Quad Cities.

F.6.7 PHASE II SAMA NUMBER 7

Description: Delete High DW Pressure Signal from SDC isolation.

This SAMA would allow the initiation of SDC when the drywell is at elevated pressures.

The modeling of this SAMA is developed by setting the basic event, 1SDSYSPACIMPCT--, equal to zero. This provides the maximum benefit associated with the removal of the high drywell pressure interlock on the SDC.

Phase II SAMA Number 7 Model Changes

Gate and / or Basic Event ID and Description	Description of Change
1SDSYSPACIMPCT-- (SDC isolates on high DW pressure)	Set failure prob. to 0.0

F.6.7.1 PSA Model Results for Phase II SAMA Number 7

The results from this case indicate a decrease from the base CDF of 2.19E-6/yr to 2.17E-6/yr (SAMA number 7). The decrease in CDF applies to loss of DHR scenarios (Class II). The radionuclide release frequencies are modified as shown in Table F-14. The results of the cost benefit analysis are shown below:

Phase II SAMA Number 7 Net Value

Base Case: Cost-Risk for QC	SAMA 7 Cost-Risk for QC	Averted Cost-Risk	Cost of Implementation	Net Value
$111,000	$110,188	$812	Not Required	**Not Cost Beneficial**

This SAMA would involve procedural changes to the plant which would cost substantially more than the averted cost-risk. Implementation of this SAMA, therefore, would not be cost beneficial for Quad Cities.

F.6.8 PHASE II SAMA NUMBER 8

Description: Develop procedures to control Feedwater flow without 125 VDC power to prevent tripping Feedwater on High/Low level.

This SAMA increases the functionality of Feedwater in loss of DC scenarios and increases the probability of successful level control.

The modeling approach used in this evaluation is to assume that the procedure change would eliminate 50% of all DC power failures as severe accidents.

Phase II SAMA Number 8 Model Changes

Gate and / or Basic Event ID and Description	Description of Change
1DCRX-BUS1RECF-- (Failure to recover unit 1 battery bus)	Change recovery from 0.71 to 0.5
2DCRX-BUS2RECF-- (Failure to recover Unit 2 battery bus)	Change recovery from 0.71 to 0.5

F.6.8.1 PSA Model Results for Phase II SAMA Number 8

The results from this case indicate a decrease from the base CDF of 2.19E-6/yr to 1.79E-6/yr (SAMA number 9). The decrease in CDF applies to total loss of DC scenarios (Class IE). The radionuclide release frequencies are modified as shown in Table F-15. The results of the cost benefit analysis are shown below:

Phase II SAMA Number 8 Net Value

Base Case: Cost-Risk for QC	SAMA 9 Cost-Risk for QC	Averted Cost-Risk	Cost of Implementation	Net Value
$111,000	$94,306	$16,694	Not Required	**Not Cost Beneficial**

The difficulty of controlling feedwater without DC power at Quad Cities is not with the feedwater control system but, rather, with the leakage past the closed feedwater regulation valves. Since it is not feasible to get such throttling valves to seal tightly, and since compensating actions are difficult with a loss of DC, writing such procedures would require significant developmental work, including engineering analysis. Whatever technique might be developed would require testing and experimentation. Finally, this SAMA would involve the cost of writing and processing procedures as well as training all operator crews on the required techniques. Because this SAMA would involve so much more that just procedure changes, it is estimated to cost substantially more than the averted cost-risk value. Implementation of this SAMA, therefore, would not be cost beneficial for Quad Cities.

F.6.9 PHASE II SAMA NUMBER 9

Description: Remove Loop Select Logic.

In the event that there is no break in the recirc loops and there is a Loop "B" injection path failure, the Loop "A" injection path is precluded from use. Removal of the LPCI Loop Select Logic or installation of a bypass switch would allow use of the "A" loop for injection in the event of a "B" injection path failure.

This SAMA is modeled by assuming that the LOOP select logic basic event selecting loop B is always 0.0 probability. This gives an equal probability of selecting A or B loops and is the most optimistic assessment of the SAMA implementation.

Phase II SAMA Number 9 Model Changes

Gate and / or Basic Event ID and Description	Description of Change
1RHOPRHR-INJ-H-- (Failure to manually open LPCI A injection valve)	Change probability from 1.0 to 0.0

F.6.9.1 PSA Model Results for Phase II SAMA Number 9

The results from this case indicate a minor decrease from the base CDF of 2.19E-6/yr for SAMA number 9. The decrease in CDF applies to LOCA without makeup scenarios (Class IIIC). The radionuclide release frequencies are shown in Table F-16. The results of the cost benefit analysis are shown below:

Phase II SAMA Number 9 Net Value

Base Case: Cost-Risk for QC	SAMA 9 Cost-Risk for QC	Averted Cost-Risk	Cost of Implementation	Net Value
$111,000	$111,000	$0	Not Required	**Not Cost Beneficial**

This SAMA has essentially no impact on the calculated CDF. Implementation of this SAMA, therefore, would not be cost beneficial for Quad Cities.

F.6.10 PHASE II SAMA NUMBER 10

Description: Demonstrate RCIC operability following depressurization.

Determine if demonstrating the operability of RCIC after depressurization is a cost-beneficial effort. Alternatively, Emergency Depressurization could be directed to be stopped at 100 psig.

The modeling approach used in this evaluation is to assume that RCIC remains operable regardless of suppression pool cooling. The model places RCIC in the QUV node for all non-LOCA, non-SORV, non-ATWS sequences.

Phase II SAMA Number 10 Model Changes

Gate and / or Basic Event ID and Description	Description of Change
QUV brances in GTR, LOOP, and DLOOP event trees	Add RCIC to QUV branches where only CRD previously credited

F.6.10.1 PSA Model Results for Phase II SAMA Number 10

The results from this case indicate a decrease from the base CDF of 2.19E-6/yr to 1.73E-6/yr (SAMA number 10). The decrease in CDF applies to loss of DHR scenarios (Class II). The radionuclide release frequencies are modified as shown in Table F-17. The results of the cost benefit analysis are shown below:

Phase II SAMA Number 10 Net Value

Base Case: Cost-Risk for QC	SAMA 10 Cost-Risk for QC	Averted Cost-Risk	Cost of Implementation	Net Value
$111,000	$89,536	$21,464	Not Required	**Not Cost Beneficial**

Revising procedures to stop reactor depressurization at 100 psig would be a major EOP change (QGA 500-1), the cost of which would easily exceed the averted cost risk. Demonstrating that RCIC will run reliably at very low reactor pressure and at an elevated suppression pool temperature would require analysis and equipment testing. Also, this SAMA would involve the cost of writing and processing procedures as well as training all operator crews on the required techniques.

Because this SAMA would involve so much more than just procedure changes, it is estimated to cost substantially more than the averted cost-risk value. Implementation of this SAMA, therefore, would not be cost beneficial for Quad Cities.

F.6.11 PHASE II SAMA NUMBER 11

Description: Diversify the explosive valve operation.

An alternate means of opening a pathway to the RPV for SBLC injection would improve the success probability for reactor shutdown.

This SAMA is modeled by assuming that the random and common cause failure of the SLC explosive valves goes to zero by providing a perfectly redundant flow path.

Phase II SAMA Number 11 Model Changes

Gate and / or Basic Event ID and Description	Description of Change
1SLEV-1106A/BDCC (CCF of SLC injection valve)	Set Failure mode to zero.
1SLEV1-1106A-D-- (Failure of SLC A injection valve)	Set Failure mode to zero.
1SLEV1-1106B-D-- (Failure of SLC B injection valve)	Set Failure mode to zero.

F.6.11.1 PSA Model Results for Phase II SAMA Number 11

The results from this case indicate a decrease from the base CDF of 2.19E-6/yr to 2.16E-6/yr (SAMA number 11). The decrease in CDF applies to ATWS scenarios (Class IV). The radionuclide release frequencies are modified as shown in Table F-18. The results of the cost benefit analysis are shown below:

Phase II SAMA Number 11 Net Value

Base Case: Cost-Risk for QC	SAMA 11 Cost-Risk for QC	Averted Cost-Risk	Cost of Implementation	Net Value
$111,000	$108,416	$2,584	Not Required	**Not Cost Beneficial**

This SAMA would involve hardware changes to the plant and would cost substantially more than the averted cost-risk value. Implementation of this SAMA, therefore, would not be cost beneficial for Quad Cities.

F.6.12 PHASE II SAMA NUMBER 12

Description: Enrich Boron.

The increased boron concentration will reduce the time required to achieve the shutdown concentration. This will provide increased margin in the accident timeline for successful operator activation of SBLC.

The modeling approach used in this evaluation is to reduce the HEPs for boron initiation and RPV water level control by 50% to reflect the approximate improvement in operator success when the allowed time for action is increased due to the enriched boron.

Phase II SAMA Number 12 Model Changes

Gate and / or Basic Event ID and Description	Description of Change
1SLOP-LVLCTRLH-- (Oper. Fails to control level low early)	Change HEP from 7.4E-2 to 3.7E-02
1SLOP-LATELVLH-- (Oper. Fails to control level low late)	(Conditional HEP - no change)
1SLOP-IN-ERLYH-- (Oper. Fails to inject SLC early)	Change HEP from 7.7E-2 to 3.85E-02
1SLOP-IN-LATEH-- (Oper. Fails to inject SLC late)	(Conditional HEP - no change)

F.6.12.1 PSA Model Results for Phase II SAMA Number 12

The results from this case indicate a decrease from the base CDF of 2.19E-6/yr to 2.18E-6/yr (SAMA number 12). The decrease in CDF applies to ATWS scenarios (Class IV and IC). The radionuclide release frequencies are modified as shown in Table F-19. The results of the cost benefit analysis are shown below:

Phase II SAMA Number 12 Net Value

Base Case: Cost-Risk for QC	SAMA 12 Cost-Risk for QC	Averted Cost-Risk	Cost of Implementation	Net Value
$111,000	$110,282	$718	Not Required	**Not Cost Beneficial**

This SAMA has essentially no impact on the calculated CDF and would cost substantially more than the averted cost-risk value. Implementation of this SAMA, therefore, would not be cost beneficial for Quad Cities.

F.6.13 PHASE II SAMA NUMBER 13

Description: Passive Overpressure Relief.

This SAMA will prevent catastrophic failure of the containment. Controlled relief through a selected vent path has a greater potential for reducing the release of radioactive material than through a random break.

Quad Cities has installed a hard piped containment vent system that provides a controlled means of containment overpressure relief. The passive feature of adding a rupture disk to this system introduces competing risks that limit the usefulness of the vent over the spectrum of severe accidents.

This SAMA is modeled by assuming that vent failure modes go to zero.

Phase II SAMA Number 13 Model Changes

Gate and / or Basic Event ID and Description	Description of Change
Vent Fault Tree	Set failure modes to zero.

F.6.13.1 PSA Model Results for Phase II SAMA Number 13

The results from this case indicate a decrease from the base CDF of 2.19E-6/yr to 2.04E-6/yr (SAMA number 13). The decrease in CDF applies to loss of DHR scenarios (Class II). The radionuclide release frequencies are modified as shown in Table F-20. The results of the cost benefit analysis are shown below:

Phase II SAMA Number 13 Net Value

Base Case: Cost-Risk for QC	SAMA 13 Cost-Risk for QC	Averted Cost-Risk	Cost of Implementation	Net Value
$111,000	$103,783	$7,217	Not Required	**Not Cost Beneficial**

This SAMA would involve hardware changes to the plant and would cost substantially more than the averted cost-risk value. Implementation of this SAMA, would not be cost beneficial for Quad Cities.

F.6.14 PHASE II SAMA NUMBER 14

Description: Control containment venting within a narrow band of pressure.

This SAMA was derived from the Quad Cities Risk Insights document to establish a narrow pressure control band that would thereby prevent rapid containment depressurization when venting is implemented thus avoiding adverse impacts on the low pressure ECCS injection systems taking suction from the torus.

The modeling approach used in this evaluation is that CS and LPCI continue to successfully inject if they have been determined to be available in the accident sequence. Specifically, SSMP or CRD are not required to be operational when venting is initiated, but they would be required for the case where containment failure has led to a "vented" containment. However, for simplicity in modeling, the conservative assessment is made to assume that all Class IIV sequences can be eliminated.

Phase II SAMA Number 14 Model Changes

Gate and / or Basic Event ID and Description	Description of Change
Class IIV sequences	Change Class IIV sequences to OK sequences

F.6.14.1 PSA Model Results for Phase II SAMA Number 14

The results from this case indicate a decrease from the base CDF of 2.19E-6/yr to 1.69E-6/yr (SAMA number 14). The decrease in CDF applies to loss of DHR scenarios (Class II). The radionuclide release frequencies are modified as shown in Table F-21. The results of the cost benefit analysis are shown below:

Phase II SAMA Number 14 Net Value

Base Case: Cost-Risk for QC	SAMA 14 Cost-Risk for QC	Averted Cost-Risk	Cost of Implementation	Net Value
$111,000	$87,450	$23,550	Not Required	**Not Cost Beneficial**

The current procedures, QGA 200 and QCOP 1600-13, allow the operator considerable freedom with containment venting. The operator has to vent to stay below the Primary Containment Pressure Limit (PCPL), but beyond that requirement, the strategy is flexible. The prudent operator will wish to minimize releases, so his tendency will be to vent to get some margin below PCPL, but not go much below 45 or 50 psig in containment. Furthermore, this action is not needed until late in the event. There is plenty of time for the Emergency Response Organization to develop a strategy to supplement the limited guidance in the existing procedure.

Considering that nearly all SAMA benefits are available without procedure changes, and considering the costs of procedure changes and training, implementation of this SAMA would not be cost beneficial for Quad Cities.

F.6.15 PHASE II SAMA ANALYSIS SUMMARY

The SAMA candidates which could not be eliminated from consideration by the baseline screening process or other PSA insights required the performance of a detailed analysis of the averted cost-risk and SAMA implementation costs. SAMA candidates are potentially justified only if the averted cost-risk resulting from the modification is greater than the cost of implementing the SAMA. None of the SAMAs analyzed were found to be cost-beneficial as defined by the methodology used in this study. However, this evaluation should not necessarily be considered a definitive guide in determining the disposition of a plant modification that has been analyzed using other engineering methods. These results are intended to provide information about the relative estimated risk benefit associated with a plant change or modification compared with its cost of implementation and should be used as an aid in the decision making process. The results of the detailed analysis are shown below:

Summary of the Detailed SAMA Analyses

Phase II SAMA ID	Averted Cost- Risk	Cost of Implementation	Net Value	Cost Beneficial?
1	$12,280	Not Required	N/A	No
2	$10,703	Not Required	N/A	No
3	$4,662	Not Required	N/A	No
4	$758	Not Required	N/A	No
5	$0	Not Required	N/A	No
6	$31,987	Not Required	N/A	No
7	$812	Not Required	N/A	No
8	$16,694	Not Required	N/A	No
9	$0	Not Required	N/A	No
10	$21,464	Not Required	N/A	No
11	$2,584	Not Required	N/A	No
12	$718	Not Required	N/A	No
13	$7,217	Not Required	N/A	No
14	$23,550	Not Required	N/A	No

F.7 UNCERTAINTY ANALYSIS

The following uncertainty was further investigated as to the impact on the overall SAMA evaluation:

- Assume a discount rate of 3 percent, instead of 7 percent used in the original base case analysis.

This was investigated by re-calculating the total averted cost-risk associated with eliminating all severe accident risk with an assumed discount rate of 3 percent. The revised analysis results in a total averted cost of $142,000 compared to the base case value of $111,000. This represents a 28 percent increase in the total averted cost. The Phase 1 SAMA list was reviewed to see if any of the items screened would be impacted by this uncertainty in the assumed discount rate. None were found. In addition, increasing the cost benefit of those items analyzed in Phase II by 28 percent would not impact the overall conclusions summarized in Section F.6.

F.8 CONCLUSIONS

The benefits of revising the operational strategies in place at Quad Cities and/or implementing hardware modifications can be evaluated without the insight from a risk-based analysis. Use of the PSA in conjunction with cost benefit analysis methodologies has, however, provided an enhanced understanding of the effects of the proposed changes relative to the cost of implementation and projected impact on a much larger future population. The results of this study indicate that of the identified potential improvements that can be made at Quad Cities, none are cost beneficial based on the methodology applied in this analysis.

F.9 TABLES AND FIGURES

TABLE F-1
PHASE I SAMA

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
Improvements Related to RCP Seal LOCAs (Loss of CC or SW)							
1	Cap downstream piping of normally closed component cooling water drain and vent valves	1	SAMA would reduce the frequency of a loss of component cooling event, a large portion of which was derived from catastrophic failure of one of the many single isolation valves.	#1 - Not applicable to the Quad Cities Design	PWR RCP seal leakage issue. Although RCP seal leakage is important for PWRs, recirculation pump leakage does not significantly contribute to CDF in BWRs that do not rely on isolation condensers.	Reference 1	N/A
2	Enhance loss of component cooling procedure to facilitate stopping reactor coolant pumps	2	SAMA would reduce the potential for reactor coolant pump (RCP) seal damage due to pump bearing failure.	#1 - Not applicable to the Quad Cities Design	PWR RCP seal leakage issue. Although RCP seal leakage is important for PWRs, recirculation pump leakage does not significantly contribute to CDF in BWRs that do not rely on isolation condensers	Reference 1	N/A
3	Enhance loss of component cooling procedure to present desirability of cooling down reactor coolant system (RCS) prior to seal LOCA.	2	SAMA would reduce the potential for RCP seal failure	#1 - Not applicable to the Quad Cities Design	PWR RCP seal leakage issue. Although RCP seal leakage is important for PWRs, recirculation pump leakage does not significantly contribute to CDF in BWRs that do not rely on isolation condensers.	Reference 1	N/A
4	Provide additional training on the loss of component cooling.	2	SAMA would potentially improve the success rate of operator actions after a loss of component cooling (to restore RCP seal damage).	#1 - Not applicable to the Quad Cities Design	PWR RCP seal leakage issue Although RCP seal leakage is important for PWRs, recirculation pump leakage does not significantly contribute to CDF in BWRs that do not rely on isolation condensers	Reference 1	N/A
5	Provide hardware connections to allow another essential raw cooling water system to cool charging pump seals.	1 2	SAMA would reduce effect of loss of component cooling by providing a means to maintain the centrifugal charging pump seal injection after a loss of component cooling	#1 - Not applicable to the Quad Cities Design	PWR RCP seal leakage issue. Although RCP seal leakage is important for PWRs, recirculation pump leakage does not significantly contribute to CDF in BWRs that do not rely on isolation condensers	Reference 1	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
6	Procedure changes to allow cross connection of motor cooling for RHRSW pumps	12	SAMA would allow continued operation of both RHRSW pumps on a failure of one train of PSW.	#1 - Not applicable to the Quad Cities Design	Each RHRSW pump-motor set has a cubicle cooler. This cooler receives cooling water from the suction of the first stage pump and returns the water to the suction of the second stage pump. If there is a water supply to the pumps, then the cooling supply for the pump-motor sets is also available.	Reference 27	N/A
7	Proceduralize shedding component cooling water loads to extend component cooling heatup on loss of essential raw cooling water.	2	SAMA would increase time before the loss of component cooling (and reactor coolant pump seal failure) in the loss of essential raw cooling water sequences.	#1 - Not applicable to the Quad Cities Design	PWR RCP seal leakage issue Although RCP seal leakage is important for PWRs, recirculation pump leakage does not significantly contribute to CDF in BWRs that do not rely on isolation condensers	Reference 1	N/A
8	Increase charging pump lube oil capacity.	2	SAMA would lengthen the time before centrifugal charging pump failure due to lube oil overheating in loss of CC sequences.	#1 - Not applicable to the Quad Cities Design	PWR issue. BWRs do not have charging pumps and the potential equivalents, the CRD pumps, are not risk significant components	Reference 1	N/A
9	Eliminate the RCP thermal barrier dependence on component cooling such that loss of component cooling does not result directly in core damage.	2	SAMA would prevent the loss of recirculation pump seal integrity after a loss of component cooling. Watts Bar Nuclear Plant IPE said that they could do this with essential raw cooling water connection to RCP seals.	#1 - Not applicable to the Quad Cities Design	PWR RCP seal leakage issue. Although RCP seal leakage is important for PWRs, recirculation pump leakage does not significantly contribute to CDF in BWRs that do not rely on isolation condensers.	Reference 1	N/A
10	Add redundant DC control power for PSW pumps C & D.	3	SAMA would increase reliability of PSW and decrease core damage frequency due to a loss of SW.	#3 - Already implemented at Quad Cities	The equivalent system at Quad Cities is SW, which relies on 125V DC for pump control power. The 1/2 SW pump has a normal and reserve DC control power supply.	References 26 and 28	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
11	Create an independent RCP seal injection system, with a dedicated diesel.	1	SAMA would add redundancy to RCP seal cooling alternatives, reducing CDF from loss of component cooling or service water or from a station blackout event.	#1 - Not applicable to the Quad Cities Design	PWR RCP seal leakage issue. Although RCP seal leakage is important for PWRs, recirculation pump leakage does not significantly contribute to CDF in BWRs that do not rely on isolation condensers	Reference 1	N/A
12	Use existing hydro-test pump for RCP seal injection	4	SAMA would provide an independent seal injection source, without the cost of a new system.	#1 - Not applicable to the Quad Cities Design	PWR RCP seal leakage issue. Although RCP seal leakage is important for PWRs, recirculation pump leakage does not significantly contribute to CDF in BWRs that do not rely on isolation condensers	Reference 1	N/A
13	Replace ECCS pump motor with air-cooled motors	1	SAMA would eliminate ECCS dependency on component cooling system (but not on room cooling).	#1 - Not applicable to the Quad Cities Design	The Quad Cities RHR and Core Spray pumps/motors are not dependent on a Component Cooling System. The CS and RHR motors are air-cooled A fan on the motor blows air past the windings. In addition, each of these motors (12 for 2 units) has a special oil cooler. One of the unit 1 CS pumps has an air cooled oil cooler. The eleven others have an oil cooler that is cooled by the process fluid In the case of the RHR pumps, for purposes of use for the higher temperatures of the process fluid for shutdown cooling mode, the process fluid additionally is pre-cooled by a special heat exchanger that is cooled by RHRSW	Reference 26	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
14	Install improved RCS pumps seals	1	SAMA would reduce probability of RCP seal LOCA by installing RCP seal O-ring constructed of improved materials	#1 - Not applicable to the Quad Cities Design	PWR RCP seal leakage issue. Although RCP seal leakage is important for PWRs, recirculation pump leakage does not significantly contribute to CDF in BWRs that do not rely on isolation condensers.	Reference 1	N/A
15	Install additional component cooling water pump.	1	SAMA would reduce probability of loss of component cooling leading to RCP seal LOCA	#1 - Not applicable to the Quad Cities Design	PWR RCP seal leakage issue Although RCP seal leakage is important for PWRs, recirculation pump leakage does not significantly contribute to CDF in BWRs that do not rely on isolation condensers.	Reference 1	N/A
16	Prevent centrifugal charging pump flow diversion from the relief valves.	1	SAMA modification would reduce the frequency of the loss of RCP seal cooling if relief valve opening causes a flow diversion large enough to prevent RCP seal injection.	#1 - Not applicable to the Quad Cities Design	PWR RCP seal leakage issue. Although RCP seal leakage is important for PWRs, recirculation pump leakage does not significantly contribute to CDF in BWRs that do not rely on isolation condensers.	Reference 1	N/A
17	Change procedures to isolate RCP seal letdown flow on loss of component cooling, and guidance on loss of injection during seal LOCA.	1	SAMA would reduce CDF from loss of seal cooling.	#1 - Not applicable to the Quad Cities Design	PWR RCP seal leakage issue. Although RCP seal leakage is important for PWRs, recirculation pump leakage does not significantly contribute to CDF in BWRs that do not rely on isolation condensers.	Reference 1	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
18	Implement procedures to stagger high-pressure safety injection (HPSI) pump use after a loss of service water.	1	SAMA would allow HPSI to be extended after a loss of service water.	#4 - No significant safety benefit.	The approximate equivalents to HPSI in a BWR are the HPCI and RCIC systems. Room cooling is provided by the DGCW system. While RCIC can operate without room cooling for the mission time (given that Core Spray is not running concurrently), HPCI requires room cooling for successful operation over the 24 hour mission time Because HPCI and RCIC can operate successfully without SW, there is no need to stagger HPCI and RCIC operation on loss of SW.	Reference 26	N/A
19	Use fire protection system pumps as a backup seal injection and high-pressure makeup.	1	SAMA would reduce the frequency of the RCP seal LOCA and the SBO CDF.	#5 - Cost would be more than risk benefit	Fire protection is a low head system at Quad Cities and cannot currently be used as a HP injection source Given that recirc pump seal failure is a negligible contributor to Quad Cities risk, no consideration is given to modifying the FP system to provide seal cooling The ability to provide high pressure injection during an SBO would be beneficial, but the cost of the required modifications would be high. Installation of new high pressure piping, a high head, high flow pump (as it would also have to support the fire system) and a supporting diesel generator or pump motor is similar in scope to SAMA 185. The cost is also considered to be similar ($5 million to $10 million) and is greater than the maximum averted cost-risk for Quad Cities	Reference 19, SAMA 185	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
20	Enhance procedural guidance for use of cross-tied component cooling or service water pumps.	1	SAMA would reduce the frequency of the loss of component cooling water and service water.	#3 - Already implemented at Quad Cities.	At Quad Cities, Service Water is completely cross-tied (between units and divisions). Inter-unit RHRSW and DGCW cross-ties are available via manual valves which are normally closed. The TBCCW pumps discharge to a common header for a given unit, but no inter-unit cross-tie capability currently exists. The same is true or RBCCW. Procedural guidance is adequate.	References 27, 28, 29 and refs for DGCW and RBCCW are needed.	N/A
21	Procedure enhancements and operator training in support system failure sequences, with emphasis on anticipating problems and coping	1 2	SAMA would potentially improve the success rate of operator actions subsequent to support system failures	#2 - Similar item is addressed under other proposed SAMAs	See SAMAs 20, 27, 30, 91, 95, 96, 98, 104	N/A	N/A
22	Improved ability to cool the residual heat removal heat exchangers.	1	SAMA would reduce the probability of a loss of decay heat removal by implementing procedure and hardware modifications to allow manual alignment of the fire protection system or by installing a component cooling water cross-tie.	#2 - Similar item is addressed under other proposed SAMAs.	RHRSW can already be cross-tied to the opposite unit at Quad Cities. The potential enhancement of providing divisional cross-ties is examined in SAMA 20.	N/A	N/A
23	8 a Additional Service Water Pump	17	SAMA would conceivably reduce common cause dependencies from SW system and thus reduce plant risk through system reliability improvement	#5 - Cost would be more than risk benefit	The cost of implementing this SAMA has been estimated at approximately $5 9 million and is greater than the maximum averted cost-risk for QC.	Reference 17	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
24	Create an independent RCP seal injection system, without dedicated diesel	19	This SAMA would add redundancy to RCP seal cooling alternatives, reducing the CDF from loss of CC or SW, but not SBO.	#1 - Not applicable to the Quad Cities Design	PWR RCP seal leakage issue. Although RCP seal leakage is important for PWRs, recirculation pump leakage does not significantly contribute to CDF in BWRs that do not rely on isolation condensers	Reference 1	N/A
Improvements Related to Heating, Ventilation, and Air Conditioning							
25	Provide reliable power to control building fans.	2	SAMA would increase availability of control room ventilation on a loss of power	#4 - No significant safety benefit	Control Room HVAC has reliable power sources The B HVAC train is powered by the swing EDG in the event of a loss of offsite power. The A Division is from the unit diesel. In addition, Control Room HVAC is not required for successful accident mitigation	References 26 and 30	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
26	Provide a redundant train of ventilation.	1	SAMA would increase the availability of components dependent on room cooling.	#5 - Cost would be more than risk benefit	It has been determined that room cooling is not required for successful operation of RHR and Core Spray at Quad Cities. RCIC does not require room cooling given that it is not run concurrently with Core Spray, which is assumed to be true in the PSA model. HPCI, Feedwater, the SSMP, RHRSW, and the EDG rooms require room cooling for success over the 24 hour mission time. The cost of installing a redundant, diverse train of HVAC for a Switchgear Room has been estimated at $10 million (Reference 19) and far exceeds the maximum averted cost-risk for Quad Cities ($0 1 million). Providing a redundant train of HVAC for HPCI, Feedwater, the SSMP, and RHRSW is similar in scope and is judged to cost approximately the same; thus, these changes are also screened.	References 19 and 26	N/A
27	Procedures for actions on loss of HVAC.	12 83	SAMA would provide for improved credit to be taken for loss of HVAC sequences (improved affected electrical equipment reliability upon a loss of control building HVAC).	#2 - Similar item is addressed under other proposed SAMAs	A PRA review of the impact of loss of HVAC was conducted for the ComEd response to the 1994 NRC RAI on the Quad Cities IPE. Actions have been proceduralized for loss of HVAC. A potential additional enhancement include: See items #25 and #26.	Reference 31	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
28	Add a diesel building switchgear room high temperature alarm.	1	SAMA would improve diagnosis of a loss of switchgear room HVAC. Option 1: Install high temp alarm. Option 2: Redundant louver and thermostat	#3 - Already implemented at Quad Cities.	The Unit, Swing, and SBO DG rooms are already equipped with control room alarms for high temperatures. Switchgear are located in open areas where additional ventilation is not required	References 32 and 34	N/A
29	Create ability to switch fan power supply to DC in an SBO event.	1	SAMA would allow continued operation in an SBO event This SAMA was created for reactor core isolation cooling system room at Fitzpatrick Nuclear Power Plant.	#4 - No significant safety benefit	During a postulated SBO, HPCI and RCIC can operate for the duration of the event which is limited by DC battery life. Use of a DC powered fan would increase the drain on the batteries with no impact on the reliability of the HPCI or RCIC systems as long as there is no gland seal failure For the low probability event of an SBO and gland seal failure the crew is directed to bypass high temperature room trips. This would avoid the trip of HPCI and RCIC. Component failures of these systems could also occur, but this is judged to represent a negligible risk impact. As such there is no measurable safety benefit associated with this SAMA	Reference 26	N/A
30	Enhance procedure to instruct operators to trip unneeded RHR/CS pumps on loss of room ventilation.	12	SAMA increases availability of required RHR/CS pumps. Reduction in room heat load allows continued operation of required RHR/CS pumps, when room cooling is lost	#1 - Not applicable to the Quad Cities Design	Room cooling is not required for operation of RHR or CS at Quad Cities	Reference 26	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
31	Stage backup fans in switchgear (SWGR) rooms	19	This SAMA would provide alternate ventilation in the event of a loss of SWGR Room ventilation	#1 - Not applicable to the Quad Cities Design	Room cooling is not required for the switchgear rooms at Quad Cities because switchgear is in open areas of the reactor building and turbine building.	Reference 26	N/A
32	Provide means for alternate SSMP room cooling	83	The SSMP requires room cooling at extended times This SAMA would allow SSMP operation late in accidents when normal room cooling has failed.	#6 - Retain	SSMP has alternate room cooling via a manual alignment to FPS The SAMA would be yet a further enhancement. Evaluate the benefit of providing alternate SSMP room cooling These options may include· - Controls in the Main Control Room for remote alignment of SW or FPS to SSMP room cooling - Procedures for opening SSMP room doors and using portable fans for SSMP room cooling	N/A	1

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
Improvements Related to Ex-Vessel Accident Mitigation/Containment Phenomena							
33	Delay containment spray actuation after large LOCA.	2	SAMA would lengthen time of RWST availability.	#1 - Not applicable to the Quad Cities Design	This PWR enhancement applies to plants with automatic containment spray which takes suction on the same outside water source used by ECCS. At Quad Cities, the RHR containment spray mode is initiated manually and takes suction from the suppression pool. The CCST volume is therefore not affected by containment spray	Reference 27	N/A
34	Install containment spray pump header automatic throttle valves.	4 8	SAMA would extend the time over which water remains in the RWST, when full CS flow is not needed	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 33	N/A	N/A
35	Install an independent method of suppression pool cooling.	5 6	SAMA would decrease the probability of loss of containment heat removal. For PWRs, a potential similar enhancement would be to install an independent cooling system for sump water.	#5 - Cost would be more than risk benefit	Installation of a new, independent, suppression pool cooling system is similar in scope to installing a new containment spray system, which has been estimated to cost approximately $5.8 million. This exceeds the maximum averted cost-risk for Quad Cities	Reference 19	N/A
36	Develop an enhanced drywell spray system	5 6	SAMA would provide a redundant source of water to the containment to control containment pressure, when used in conjunction with containment heat removal	#6 - Retain	The Fire Protection system can already provide water to the RHR system at Quad Cities; however, no procedures have been developed to use it as a containment spray source. The containment spray function could be further enhanced at Quad Cities	N/A	2

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
37	Provide dedicated existing drywell spray system.	5 6	SAMA would provide a source of water to the containment to control containment pressure, when used in conjunction with containment heat removal. This would use an existing spray loop instead of developing a new spray system.	#5 - Cost would be more than risk benefit.	Installation of a new, independent, containment spray system has been estimated to cost approximately $5.8 million. This exceeds the maximum averted cost-risk for Quad Cities .	Reference 19	N/A
38	Install an unfiltered hardened containment vent.	5 6	SAMA would provide an alternate decay heat removal method for non-ATWS events, with the released fission products not being scrubbed.	#3 - Already implemented at Quad Cities	Quad Cities has hardened pipe vents installed in the Torus and Drywell areas	Reference 35	N/A
39	Install a filtered containment vent to remove decay heat.	5 6	SAMA would provide an alternate decay heat removal method for non-ATWS events, with the released fission products being scrubbed. Option 1: Gravel Bed Filter Option 2: Multiple Venturi Scrubber	#5 - Cost would be more than risk benefit	Potential to improve both the Level 1 and Level 2 results	The cost to implement this SAMA would be significantly greater than the maximum averted cost risk defined in Section F.4.7.	N/A
40	Install a containment vent large enough to remove ATWS decay heat.	5 6	Assuming that injection is available, this SAMA would provide alternate decay heat removal in an ATWS event	#5 - Cost would be more than risk benefit	Quad Cities does not have a hard pipe vent of sufficient capacity to mitigate ATWS pressurization unless other mitigation steps are successful. The cost of a larger vent is estimated to be in excess of $3 million. This exceeds the maximum averted cost-risk for Quad Cities.	The cost to implement this SAMA would be significantly greater than the maximum averted cost risk defined in Section F.4.7.	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
41	Create/enhance hydrogen recombiners with independent power supply.	5 11	SAMA would reduce hydrogen detonation at lower cost, Use either 1) a new independent power supply 2) a non-safety-grade portable generator 3) existing station batteries 4) existing AC/DC independent power supplies	#1 - Not applicable to the Quad Cities Design	The Quad Cities primary containment is inerted. The NCAD system is designed to control the O2 and H2 concentrations by venting and purging with nitrogen In addition, hydrogen recombiners are precluded from operating in conditions with high hydrogen, i e , severe accidents. In addition, because of their small processing capacity are ineffective in treating the dominant contributors to severe accident risk.	Reference 36	N/A
42	Install hydrogen recombiners.	11	SAMA would provide a means to reduce the chance of hydrogen detonation.	#1 - Not applicable to the Quad Cities Design	The Quad Cities primary containment is inerted. The NCAD system is designed to control the O2 and H2 concentrations by venting and purging with nitrogen. In addition, hydrogen recombiners are precluded from operating in conditions with high hydrogen, i e , severe accidents. In addition, because of their small processing capacity, hydrogen recombiners are ineffective in treating the dominant contributors to severe accident risk.	Reference 36	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
43	Create a passive design hydrogen ignition system.	4	SAMA would reduce hydrogen denotation system without requiring electric power.	#1 - Not applicable to the Quad Cities Design	The Quad Cities primary containment is inert The NCAD system is designed to control the O2 and H2 concentrations by venting and purging with nitrogen. Ignition or burning of hydrogen in a Mark I containment (i.e., for deinerted conditions) results in rapid overpressurization of the Mark I containment Igniters are useful for larger containments, such as the Mark III.	Reference 36	N/A
44	Create a large concrete crucible with heat removal potential under the basemat to contain molten core debris.	5 6	SAMA would ensure that molten core debris escaping from the vessel would be contained within the crucible The water cooling mechanism would cool the molten core, preventing a melt-through of the basemat	#5 - Cost would be more than risk benefit	Core retention devices have been investigated in previous studies. IDCOR concluded that "core retention devices are not effective risk reduction devices for degraded core events". Other evaluations have shown the worth value for a core retention device to be on the order of $7000 (averted cost-risk) compared to an estimated implementation cost of over $1 million (per unit).	References 24 and 25	N/A
45	Create a water-cooled rubble bed on the pedestal.	5 6	SAMA would contain molten core debris dropping on to the pedestal and would allow the debris to be cooled	#5 - Cost would be more than risk benefit	Core retention devices have been investigated in previous studies. IDCOR concluded that "core retention devices are not effective risk reduction devices for degraded core events". Other evaluations have shown the worth value for a core retention device to be on the order of $7000 (averted cost-risk) compared to an estimated implementation cost of over $1 million (per unit).	References 24 and 25	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
46	Provide modification for flooding the drywell head.	5 6	SAMA would help mitigate accidents that result in the leakage through the drywell head seal	#4 - No significant safety benefit.	BWR Mark I risk is typically dominated by events that result in early failure of the drywell shell due to direct contact with core debris and events that bypass the containment. This is also true at Quad Cities. The head flooding system would, therefore, not be expected to have any significant impact on the overall risk. The potential for competing risks due to Reactor Building flooding is considered to eliminate any positive safety benefit	Reference 37	N/A
47	Enhance fire protection system and/or standby gas treatment system hardware and procedures	6	SAMA would improve fission product scrubbing in severe accidents	#4 - No significant safety benefit.	Current Standby Gas Treatment Systems do not have sufficient capacity to handle the loads from severe accidents that result in a bypass or breach of the containment Loads produced as a result of RPV or containment blowdown would require large filtering capacities These filtered vented systems have been previously investigated and found not to provide sufficient cost benefit Quad Cities has limited fire protection sprinkler systems in the Reactor Building Use of these for fission product scrubbing in the R B could create competing risks associated with spray failures and flooding of equipment with very limited potential benefit	Reference 25	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
48	Create a reactor cavity flooding system.	1 3 7 8	SAMA would enhance debris coolability, reduce core concrete interaction, and provide fission product scrubbing.	#3 - Already implemented at Quad Cities	The Quad Cities SAMGs specify the desire to flood the drywell floor (and therefore the reactor cavity) under severe accident conditions. This is accomplished by the drywell sprays. In addition, flooding of the Quad Cities containment is proceduralized in the Severe Accident Management Guidelines. This is approximately equivalent to flooding the reactor cavity for a PWR.	Reference 38	N/A
49	Create other options for reactor cavity flooding.	1	SAMA would enhance debris coolability, reduce core concrete interaction, and provide fission product scrubbing	#2 - Similar item is addressed under other proposed SAMAs	See #36. This is approximately equivalent to flooding the reactor cavity for a PWR	Reference 38	N/A
50	Enhance air return fans (ice condenser plants).	1	SAMA would provide an independent power supply for the air return fans, reducing containment failure in SBO sequences	#1 - Not applicable to the Quad Cities Design	Quad Cities is not an ice condenser plant	Reference 37	N/A
51	Create a core melt source reduction system.	9	SAMA would provide cooling and containment of molten core debris Refractory material would be placed underneath the reactor vessel such that a molten core falling on the material would melt and combine with the material. Subsequent spreading and heat removal from the vitrified compound would be facilitated, and concrete attack would not occur	#5 - Cost would be more than risk benefit	Core retention devices have been investigated in previous studies IDCOR concluded that "core retention devices are not effective risk reduction devices for degraded core events". Other evaluations have shown the worth value for a core retention device to be on the order of $7000 compared to an estimated implementation cost of over $1 million.	References 24 and 25	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
52	Provide a containment inerting capability.	7 8	SAMA would prevent combustion of hydrogen and carbon monoxide gases.	#3 - Already implemented at Quad Cities	Containment is inerted with nitrogen during normal operation. The NCAD system is also available.	Reference 37	N/A
53	Use the fire protection system as a backup source for the containment spray system.	4	SAMA would provide redundant containment spray function without the cost of installing a new system.	#2 - Similar item is addressed under other proposed SAMAs	See SAMA's 36 and 37.	N/A	N/A
54	Install a secondary containment filtered vent	10	SAMA would filter fission products released from primary containment	#5 - Cost would be more than risk benefit	Secondary containment at Quad Cities makes extensive use of blow out panels to protect the structural integrity of the building in the event of internal pressure challenges such as steamline breaks in the reactor building or external pressure challenges such as tornadoes Major structural redesign of the reactor building would be required to make the reactor building capable of retaining and processing a primary containment failure.	N/A	N/A
55	Install a passive containment spray system	10	SAMA would provide redundant containment spray method without high cost	#5 - Cost would be more than risk benefit.	See SAMAs 36 and 53. A passive system is another alternative enhancement for the Containment Spray function. See #36	The cost to implement this SAMA would be significantly greater than the maximum averted cost risk defined in Section F 4.7.	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
56	Strengthen primary/secondary containment.	10 11	SAMA would reduce the probability of containment overpressurization to failure.	#5 - Cost would be more than risk benefit	Reference 17 discusses the cost of increasing the containment pressure and temperature capacity, which is effectively strengthening the containment This cost is estimated assuming the change is made during the design phase whereas for Quad Cities, the changes would have to be made as a retrofit. The cost estimated for the ABWR was $12 million and it is judged that retrofitting an existing containment would cost more. The cost of implementation for this SAMA exceeds the maximum averted cost-risk for Quad Cities.	Reference 17	N/A
57	Increase the depth of the concrete basemat or use an alternative concrete material to ensure melt-through does not occur.	11	SAMA would prevent basemat melt-through	#5 - Cost would be more than risk benefit	Core retention devices have been investigated in previous studies. IDCOR concluded that "core retention devices are not effective risk reduction devices for degraded core events". Other evaluations have shown the worth value for a core retention device to be on the order of $7000 compared to an estimated implementation cost of over $1 million/site.	References 24 and 25	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
58	Provide a reactor vessel exterior cooling system.	11	SAMA would provide the potential to cool a molten core before it causes vessel failure, if the lower head could be submerged in water.	#5 - Cost would be more than risk benefit	This has been estimated to cost $2.5 million and exceeds the maximum averted cost-risk for Quad Cities defined in Section F.4.7. ORNL [87] has performed thermal hydraulic calculations on BWR external cooling methods and determined that the current BWR RPV support skirt design makes it impractical to cool the RPV by external cooling to prevent RPV breach. Therefore, the modification would require RPV support skirt modification and reanalysis to allow the external cooling to be effective.	Reference 19	N/A
59	Construct a building to be connected to primary/secondary containment that is maintained at a vacuum.	11	SAMA would provide a method to depressurize containment and reduce fission product release.	#5 - Cost would be more than risk benefit	Based on engineering judgement, the cost of this enhancement is expected to greatly exceed the maximum averted cost risk for Quad Cities	N/A	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
60	Refill CST	16	SAMA would reduce the risk of core damage during events such as extended station blackouts or LOCAs which render the suppression pool unavailable as an injection source due to heat up.	#3 - Already implemented at Quad Cities	For SBO conditions, the CCST contains enough water to allow make-up injection from HPCI/RCIC for a period longer than their estimated operability (based on battery life). This assumes that the CCSTs have already been drained from their nominal level of 260,000 gallons to the level reserved for HPCI and RCIC (90,000 gallons) For LOCA initiators, the CCST does not contain enough water to provide injection for the 24 hour mission time. The CCST makeup systems do not currently have the capacity to match the inventory loss for a LOCA Feedwater and the SSMP have connections to unlimited water supplies (SBCS and Fire Protection, respectively), but the flow rate from those sources may not be large enough to keep the core covered in the event of a LOCA below TAF. CCST connections to Core Spray and LPCI already exist. The ability to refill the CCST from external water sources is considered desirable Quad Cities has implemented a procedure recently to allow rapid refill of theCCST from the Diesel Fire Pump using the Mississippi River as the source (QCOP 4100-14). No further action necessary.	N/A	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
61	Maintain ECCS suction on CST	16	SAMA would maintain suction on the CST as long as possible to avoid pump failure as a result of high suppression pool temperature	#3 - Already implemented at Quad Cities	Swap to/from CCST source is procedurally directed for HPCI and RCIC. EOPs indicate when to use the CCST and when it is OK to defeat high torus level transfer. HPCI and RCIC are aligned to the CCST and are directed to be maintained there as long as suction is available. This has been previously investigated by the BWROG EPC. SAMA not considered applicable to LPCI or CS	Reference 39	N/A
62	Modify containment flooding procedure to restrict flooding to below TAF	14	SAMA would avoid forcing containment venting and RPV venting	#3 - Already implemented at Quad Cities	The BWROG EPG/SAMG revision has substantially improved the containment flooding contingency to limit containment flooding and nearly eliminate RPV venting. These actions have resulted in substantial reductions in estimated radionuclide releases for severe accidents. EGC has taken advantage of these generic developments by implementing the BWROG EPG Rev 2 in the Quad Cities procedures	Reference 38	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
63	Enhance containment venting procedures with respect to timing, path selection and technique.	14	SAMA would improve likelihood of successful venting strategies	#3 - Already implemented at Quad Cities	The BWROG EPG/SAG revision has substantially improved the containment flooding contingency to limit containment flooding and nearly eliminates RPV venting These actions have resulted in substantial reductions in estimated radionuclide releases for severe accidents. EGC has taken advantage of these generic developments by implementing the BWROG EPG/SAG Rev 2 in the Quad Cities procedures	Reference 38	N/A
64	1.a Severe Accident EPGs/AMGs	17	SAMA would lead to improved arrest of core melt progress and prevention of containment failure	#3 - Already implemented at Quad Cities	Quad Cities has implemented the latest EPG/SAGs accepted by the BWROG	Reference 38	N/A
65	1.h Simulator Training for Severe Accident	17	SAMA would lead to improved arrest of core melt progress and prevention of containment failure	#4 - No significant safety benefit. Previously assessed by the NRC as not required to support Accident management because of marginal cost benefit.	Simulators could be upgraded and used to provide operator training for severe accidents; however, these scenarios are rare and the instruction time would compete with time required to train operators on more likely scenarios that are severe accident precursors. The benefit of simulator training is difficult to quantify as the results would be based on the improved reliability of human actions in the mitigation of severe accidents. Training can positively influence the values of HEPs, but the impact is small In addition, the TSC would be manned in a severe accident evolution and could provide additional support by personnel familiar with the SAMGs	Reference 68	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
66	2.g. Dedicated Suppression Pool Cooling	17	SAMA would decrease the probability of loss of containment heat removal.	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 35	N/A	N/A
67	3 a. Larger Volume Containment	17	SAMA increases time before containment failure and increases time for recovery	#5 - Cost would be more than risk benefit	Enlargement of the containment would be similar in scope to the ABWR design change SAMA to implement a larger volume containment, but would likely exceed the $8 million estimate for that change as a retrofit would be required This is greater than the maximum averted cost-riskdefined in F 4.7.	Reference 17	N/A
68	3 b Increased Containment Pressure Capability (sufficient pressure to withstand severe accidents)	17	SAMA minimizes likelihood of large releases	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 56	N/A	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
69	3.c. Improved Vacuum Breakers (redundant valves in each line)	17	SAMA reduces the probability of a stuck open vacuum breaker.	#5 - Cost would be more than risk benefit	The Quad Cities plant has twelve (12) individual vacuum breaker lines with a single vacuum breaker in each line. Providing redundant vacuum breakers in each line would decrease the potential for vapor suppression failure and suppression pool bypass This plant modification requires new valves, the structural changes to implement the modification, and the outage time to install. Based on the PRA results that vapor suppression failure and pool bypass are negligible risk contributors and the apparent extremely high cost, this proposed SAMA is not considered cost effective.	N/A	N/A
70	3.d. Increased Temperature Margin for Seals	17	This SAMA would reduce the potential for containment failure under adverse conditions.	#2 - Similar item is addressed under other proposed SAMAs.	See SAMA 56	N/A	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
71	3 e. Improved Leak Detection	17	The intent of this SAMA is to increase piping surveillance in order to identify leaks prior to the onset of complete failure. Improved leak detection would potentially reduce the LOCA frequency	#3 - Already implemented at Quad Cities	This is already implemented where appropriate. Quad Cities has performed a risk informed study of pipe in-service inspections (RI-ISI) and has adjusted the surveillance frequency consistent with a risk-informed approval. Increased pipe surveillance would be costly in terms of - Increased radiation - Outage time - Manpower costs The current assessment of pipe surveillance is that it is adequate "as is" except for those areas of possible relaxation of the surveillance requirements that have been the subject of a plant specific risk informed investigation (RI-ISI).	Reference 88	N/A
72	3 f. Suppression Pool Scrubbing	17	This SAMA would reduce the consequences of venting the containment by directing the vent path through the water contained in the suppression pool.	#3 - Already implemented at Quad Cities	The Quad Cities Torus Vent is located in the Wetwell airspace and releases would be filtered by the suppression pool.	Reference 35	N/A
73	3.g. Improved Bottom Penetration Design	17	SAMA reduces failure likelihood of RPV bottom head penetrations	#8 - ABWR Design Issue; not practical.	This is a SAMA which was considered for ABWR design It is not practical to backfit this modification into a plant which is already built and operating	Reference 17	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
74	4 a. Larger Volume Suppression Pool (double effective liquid volume)	17	SAMA would increase the size of the suppression pool so that heatup rate is reduced, allowing more time for recovery of a heat removal system	#8 - ABWR Design Issue; not practical.	This is a SAMA which was considered for ABWR design. It is not practical to backfit this modification into a plant which is already built and operating	Reference 17	N/A
75	5 a/d. Unfiltered Vent	17	SAMA would provide an alternate decay heat removal method with the released fission products not being scrubbed.	#2 - Similar item is addressed under other proposed SAMAs.	See SAMA 38	N/A	N/A
76	5 b/c. Filtered Vent	17	SAMA would provide an alternate decay heat removal method with the released fission products being scrubbed	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 39 and 54	N/A	N/A
77	6.a Post Accident Inerting System	17	SAMA would reduce likelihood of gas combustion inside containment	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 52	N/A	N/A
78	6.b. Hydrogen Control by Venting	17	This SAMA will prevent catastrophic failure of the containment due to hydrogen detonation by venting the hydrogen gas prior to reaching detonable concentration	#3 - Already implemented at Quad Cities	The Quad Cities SAMGs provide directions for controlling hydrogen concentration by venting Quad Cities has adopted the BWROG EPG/SAGs which provide a graded approach to combustible gas control This graded approach includes the use of purging and containment venting. No further action required for this SAMA.	Reference 40	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
79	6.c. Pre-inerting	17	SAMA would reduce likelihood of gas combustion inside containment	#2 - Similar item is addressed under other proposed SAMAs	See SAMAs 52 and 77	N/A	N/A
80	6.d. Ignition Systems	17	This SAMA will prevent catastrophic failure of the containment due to hydrogen detonation by burning the hydrogen gas prior to reaching detonable concentration	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 43	N/A	N/A
81	6 e. Fire Suppression System Inerting	17	This SAMA will prevent catastrophic failure of the containment due to hydrogen detonation by inerting the containment with the fire suppression system	#1 - Not applicable to the Quad Cities Design	Not applicable since the containment is already inerted In addition, Quad Cities has a separate NCAD system to perform post-accident inerting similar to the identified SAMA	Reference 36	N/A
82	7.a. Drywell Head Flooding	17	SAMA would provide intentional flooding of the upper drywell head such that if high drywell temperatures occurred, the drywell head seal would not fail.	#2 - Similar item is addressed under other proposed SAMAs.	See SAMA 46	N/A	N/A
83	7 b. Containment Spray Augmentation	17 83	SAMA would provide a redundant source of water to the containment to control containment pressure when used in conjunction with containment heat removal	#2 - Similar item is addressed under other proposed SAMAs	See SAMAs 33, 34, 36, 37, 53, and 55	N/A	N/A
84	12 b Integral Basemat	17	This SAMA would improve containment survivability under severe seismic activity.	#8 - ABWR Design Issue; not practical.	This is an ABWR design issue and not is not considered for retrofit due to a cost of implementation that is judged to far exceed the maximum averted cost-risk.	References 17 and 86	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
85	13.a Reactor Building Sprays	17	This SAMA provides the capability to use firewater sprays in the reactor building to mitigate release of fission products into the Rx Bldg. following an accident.	#2 - Similar item is addressed under other proposed SAMAs.	See SAMA 47	N/A	N/A
86	14.a. Flooded Rubble Bed	17	SAMA would contain molten core debris dropping on to the pedestal and would allow the debris to be cooled.	#2 - Similar item is addressed under other proposed SAMAs.	See SAMA 45	N/A	N/A
87	14 b. Reactor Cavity Flooder	17	SAMA would enhance debris coolability, reduce core concrete interaction, and provide fission product scrubbing	#2 - Similar item is addressed under other proposed SAMAs.	Addressed in SAMAs 48 & 58	N/A	N/A
88	14.c. Basaltic Cements	17	SAMA minimizes carbon dioxide production during core concrete interaction.	#8 - ABWR Design Issue, not practical.	This is a SAMA which was considered for ABWR design. It is not practical to backfit this modification into a plant which is already built and operating	Reference 17	N/A
89	Provide a core debris control system	19	(Intended for ice condenser plants): This SAMA would prevent the direct core debris attack of the primary containment steel shell by erecting a barrier between the seal table and the containment shell.	#1 - Not applicable to the Quad Cities Design	Quad Cities is not an ice condenser plant.	Reference 37	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
90	Add ribbing to the containment shell	19	This SAMA would reduce the risk of buckling of containment under reverse pressure loading.	#2 - Similar item is addressed under other proposed SAMAs.	This item is similar in nature to SAMA 56, but for protection against negative pressure.	N/A	N/A
Improvements Related to Enhanced AC/DC Reliability/Availability							
91	Proceduralize alignment of spare diesel to shutdown board after loss of offsite power and failure of the diesel normally supplying it	1 3 7	SAMA would reduce the SBO frequency.	#3 - Already implemented at Quad Cities	Quad Cities has five Diesel Generators between its two Units. Two Unit DGs, an SBO DG for each Unit, and a swing DG capable of carrying loads from either Unit. Procedures QCOA 6100-03, QCOP 6620-17, and QCOP 6500-08 have extensive guidance for alignment of these DGs given partial or full loss of AC power.	References 41, 42, and 44	N/A
92	Provide an additional diesel generator.	1 3 7 11	SAMA would increase the reliability and availability of onsite emergency AC power sources	#3 - Already implemented at Quad Cities	Quad Cities has five Diesel Generators between its two Units. Two Unit DGs, an SBO DG for each Unit, and a swing DG capable of carrying loads from either Unit. Installation of additional AC power sources would have a small impact on the PSA results	Reference 43	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
93	Provide additional DC battery capacity.	1 3 7 11 12 83	SAMA would ensure longer battery capability during an SBO, reducing the frequency of long-term SBO sequences	#3 - Already implemented at Quad Cities	Quad Cities has spare batteries installed and therefore effectively has increased battery life. These can be used to extend HPCI and RCIC operability and allow more credit for AC power recovery. This would decrease the frequency of core damage and offsite releases The next most limiting support is the 250V DC The addition of 250V DC batteries could be evaluated to provide the additional HPCI and RCIC DC power requirements However, room cooling and torus cooling would be more limiting	N/A	N/A
94	Use fuel cells instead of lead-acid batteries.	11	SAMA would extend DC power availability in an SBO.	#6 - Retain	Improving battery capacity may be cost beneficial for Quad Cities Further extension of battery life with fuel cells is estimated to have a small impact on the Quad Cities residual risk profile.	N/A	3
95	Procedure to cross-tie high-pressure core spray diesel.	1	SAMA would improve core injection availability by providing a more reliable power supply for the high-pressure core spray pumps.	#1 - Not applicable to the Quad Cities Design	Quad Cities does not have a high-pressure core spray system The HPCI (equivalent system) is turbine driven.	Reference 33	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
96	Improve 4.16-kV bus cross-tie ability.	1 83	Enhance procedures to direct 4kV bus cross-tie. If this procedural step already exists, investigate installation of hardware that would perform an automatic cross-tie to the opposite 4kV bus given failure of the dedicated diesel.	#6 - Retain	Manual cross-tie between AC buses is proceduralized for certain buses depending on the available AC source (e.g , offsite power, SBO D/G). These cross-ties are effective and further risk reduction from auto cross-tie is of marginal benefit, and could produce competing risks. Automatic cross-tie could be implemented at Quad Cities. In addition, procedures could be developed that would allow the following cross-ties to be performed -Bus 14-1 to Bus 24-1 from EDG 1 -Bus 24-1 to Bus 14-1 from EDG 2 -EDG 1/2 to Buses 13-1 and 23-1	N/A	4

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
97	Incorporate an alternate battery charging capability.	1 8 9 83	SAMA would improve DC power reliability by either cross-tying the AC busses, or installing a portable diesel-driven battery charger.	#3 - Already implemented at Quad Cities	Quad Cities has two 125 VDC battery chargers for each battery (a normal and a standby charger for each unit). These chargers are supplied from opposite emergency AC power divisions to provide DC charging power in the event that one AC division is lost. In addition, the cross tying of AC divisions is proceduralized. This allows for the operation of a charger when its normal AC supply has failed Quad Cities is also equipped with an alternate battery and charger for each unit These chargers may be connected to the 125 VDC system, as required The 250 VDC system contains a dedicated unit battery and charger. A swing charger can be aligned to either Unit in the event that the normal 250 VDC charger cannot be used. The swing charger can be powered by either Unit A portable generator to supply critical subtier DC buses may be a cost beneficial enhancement for Quad Cities	N/A	N/A
98	Increase/improve DC bus load shedding	1 8 83	SAMA would extend battery life in an SBO event.	#3 - Already implemented at Quad Cities	The DC load shedding process is defined in detail in procedure QOA 6900-07. This procedure contains a list of loads which must be shed and a specific time frame for completing the task in order to ensure that the batteries will be able to provide power to the required loads for the SBO mission time.	Reference 46	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
99	Replace existing batteries with more reliable ones.	11 83	SAMA would improve DC power reliability and thus increase available SBO recovery time.	#3 - Already implemented at Quad Cities	Reliable batteries are already installed. Increasing battery capacity is addressed in SAMAs 93 and 94. The maintenance rule program has been implemented and monitors the reliability and availability of the batteries	Reference 88	N/A
100	Mod for DC Bus A reliability.	1 83	SAMA would increase the reliability of AC power and injection capability. Loss of DC Bus A causes a loss of main condenser, prevents transfer from the main transformer to offsite power, and defeats one half of the low vessel pressure permissive for LPCI/CS injection valves.	#3 - Already implemented at Quad Cities	Each Quad Cities Unit has 1 125V DC division bus and 1 250V DC division bus Cross-ties from the opposite Unit buses are available and the steps to implement them are proceduralized A loss of a single DC bus would not lead to loss of condenser Transfer from main transformer to offsite power would also not be affected	Reference 43	N/A
101	Create AC power cross-tie capability with other unit.	1 8 9 83	SAMA would improve AC power reliability.	#3 - Already implemented at Quad Cities	Procedure QCOP-6620-17 provides directions to cross-tie to the opposite unit's SBO DG for emergency conditions. In addition, QCOP 6500-08 provides directions for cross-tying 4 kV buses to the opposite unit given that the opposite unit's bus is not powered by an emergency diesel source. Inter-unit cross tie is addressed at Quad Cities for LOOP and non-LOOP conditions	References 42 and 44	N/A
102	Create a cross-tie for diesel fuel oil.	1	SAMA would increase diesel fuel oil supply and thus diesel generator, reliability.	#3 - Already implemented at Quad Cities	Each of the diesel fuel oil day tanks can be cross filled from existing emergency diesel fuel storage tanks This is procedurally directed in the operating procedures	References 48 and 49	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
103	Develop procedures to repair or replace failed 4-kV breakers.	1	SAMA would offer a recovery path from a failure of the breakers that perform transfer of 4.16-kV non-emergency busses from unit station service transformers, leading to loss of emergency AC power.	#3 - Already implemented at Quad Cities	This SAMA would provide a recovery path from loss of 4.16-kV power due to failure of a 4 16-kV breaker. 4 kV breaker repair and replacement is both proceduralized and part of the skill of the craft. Additional procedures are not required.	N/A	N/A
104	Emphasize steps in recovery of offsite power after an SBO.	1	SAMA would reduce human error probability during offsite power recovery.	#3 - Already implemented at Quad Cities	Restoring power from offsite sources after SBO is proceduralized (QCOA 6100-04). Numerous procedures exist for offsite AC power recovery and to cross-tie AC busses	References 41, 44, and 50	N/A
105	Develop a severe weather conditions procedure	1 13	For plants that do not already have one, this SAMA would reduce the CDF for external weather-related events.	#3 - Already implemented at Quad Cities	QCOA 010-16 and QCOA 010-10 are already available at Quad Cities to address severe weather conditions.		N/A
106	Develop procedures for replenishing diesel fuel oil.	1	SAMA would allow for long-term diesel operation	#3 - Already implemented at Quad Cities	Instructions are provided to fill a Diesel Fuel Oil Storage Tank from a fuel oil delivery truck.	Reference 49	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
107	Install gas turbine generator.	1	SAMA would improve onsite AC power reliability by providing a redundant and diverse emergency power system.	#5 - Cost would be more than risk benefit	The cost of installing a diverse, redundant, gas turbine generator is similar in scope to installing a new diesel generator. The cost of installing an additional diesel generator has been estimated at over $20 million in Reference 19. This cost of implementation for this SAMA greatly exceeds the maximum averted cost-risk for Quad Cities defined in Section F.4.7. In addition, Quad Cities already has five diverse on-site AC power sources. Installing a gas turbine would provide minimal safety benefit	Reference 19	N/A
108	Create a backup source for diesel cooling. (Not from existing system)	1	This SAMA would provide a redundant and diverse source of cooling for the diesel generators, which would contribute to enhanced diesel reliability.	#6 - Retain	A additional EDG cooling source may be cost beneficial for Quad Cities. This load path also includes ECCS room cooling.	N/A	5
109	Use fire protection system as a backup source for diesel cooling.	1	This SAMA would provide a redundant and diverse source of cooling for the diesel generators, which would contribute to enhanced diesel reliability	#2 - Similar item is addressed under other proposed SAMAs.	See SAMA 108	N/A	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
110	Provide a connection to an alternate source of offsite power.	1	SAMA would reduce the probability of a loss of offsite power event.	#5 - Cost would be more than risk benefit	Offsite power lines would be exposed to severe weather at some point along the offsite power line route While the actual cost of this SAMA will vary depending on site characteristics, the cost of connecting to an alternate source of power has been estimated at >$25 million for another commercial US nuclear plant. Implementing this SAMA at Quad Cities is considered to be within the same order of magnitude and exceeds the maximum averted cost-risk for Quad Cities as defined in Section F.4.7. In addition, Quad Cities has multiple offsite sources and multiple, diverse on-site AC power sources Providing additional AC power sources would provide minimal safety benefit	References 19 and 43	N/A
111	Bury offsite power lines.	1	SAMA could improve offsite power reliability, particularly during severe weather.	#5 - Cost would be more than risk benefit	While the actual cost of this SAMA will vary depending on site characteristics, the cost of burying offsite power lines has been estimated at a cost significantly greater than $25 million for another commercial US nuclear plant. Implementing this SAMA at Quad Cities is considered to be within the same order of magnitude and exceeds the maximum averted cost-risk for Quad Cities as defined in Section F.4 7.	Reference 19	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
112	Replace anchor bolts on diesel generator oil cooler.	1	Millstone Nuclear Power Station found a high seismic SBO risk due to failure of the diesel oil cooler anchor bolts. For plants with a similar problem, this would reduce seismic risk. Note that these were Fairbanks Morse DGs	#3 - Already implemented at Quad Cities	The Quad Cities IPEEE included an SMA assessment of the plant's ability to cope with seismic events No changes were identified for the EDG oil coolers and the current restraints are considered to be sufficient.	Reference 51	N/A
113	Change undervoltage (UV), auxiliary feedwater actuation signal (AFAS) block and high pressurizer pressure actuation signals to 3-out-of-4, instead of 2-out-of-4 logic	1	SAMA would reduce risk of 2/4 inverter failure.	#1 - Not applicable to the Quad Cities Design	PWR issue. N/A to BWR	N/A	N/A
114	Provide DC power to the 120/240-V vital AC system from the Class 1E station service battery system instead of its own battery	12	SAMA would increase the reliability of the 120-VAC Bus.	#4 - No significant safety benefit	1) Loss of 120V AC is not an Initiating Event 2) 120 VAC is not a risk significant support system	Reference 43	N/A
115	Bypass Diesel Generator Trips	16	SAMA would allow D/Gs to operate for longer.	#3 - Already implemented at Quad Cities	Trips that would be useful to bypass are automatically bypassed on auto start of the EDGs. The remaining trips, such as "DG High Differential Current" are considered to be required for adequate DG protection and are never bypassed.	Reference 32	N/A
116	2 i 16 hour Station Blackout Injection	17	SAMA includes improved capability to cope with longer station blackout scenarios.	#2 - Similar item is addressed under other proposed SAMAs	See SAMAs 93, 94, 98, and 99	N/A	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
117	9.a. Steam Driven Turbine Generator	17	This SAMA would provide a steam driven turbine generator which uses reactor steam and exhausts to the suppression pool If large enough, it could provide power to additional equipment.	#3 - Already implemented at Quad Cities	Quad Cities has turbine driven injection systems. Depressurization on HCTL typically occurs in the same time frame as battery depletion; therefore, turbine driven generators provide minimal safety benefit.	Reference 52 and 53	N/A
118	9 b. Alternate Pump Power Source	17	This SAMA would provide a small dedicated power source such as a dedicated diesel or gas turbine for the feedwater or condensate pumps, so that they do not rely on offsite power.	#2 - Similar item is addressed under other proposed SAMAs	FW and condensate require substantial AC power for their operation. The addition of a dedicated power source for their operation given failures of other C sources and RPV injection is similar to SAMA 107	Reference 54	N/A
119	9 d Additional Diesel Generator	17	SAMA would reduce the SBO frequency	#2 - Similar item is addressed under other proposed SAMAs.	See SAMAs 91, 92, and 107	N/A	N/A
120	9.e. Increased Electrical Divisions	17	SAMA would provide increased reliability of AC power system to reduce core damage and release frequencies.	#8 - ABWR Design Issue; not practical	This is a SAMA which was considered for ABWR design. It is not practical to backfit this modification into a plant which is already built and operating.	Reference 17	N/A
121	9.f. Improved Uninterruptable Power Supplies	17	SAMA would provide increased reliability of power supplies supporting front-line equipment, thus reducing core damage and release frequencies.	#4 - No significant safety benefit	1) Loss of 120V AC is not an Initiating Event 2) 120 VAC is not a risk significant support system	Reference 43	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
122	9.g. AC Bus Cross-Ties	17	SAMA would provide increased reliability of AC power system to reduce core damage and release frequencies.	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 96	N/A	N/A
123	9.h. Gas Turbine	17	SAMA would improve onsite AC power reliability by providing a redundant and diverse emergency power system	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 107	N/A	N/A
124	9.i. Dedicated RHR (bunkered) Power Supply	17	SAMA would provide RHR with more reliable AC power.	#2 - Similar item is addressed under other proposed SAMAs	Additional power supplies are addressed in other SAMAs See SAMAs 92, 118, 119, and 123	N/A	N/A
125	10.a. Dedicated DC Power Supply	17	This SAMA addresses the use of a diverse DC power system such as an additional battery or fuel cell for the purpose of providing motive power to certain components (e.g , RCIC).	#5 - Cost would be more than risk benefit	The cost of implementation for this mod is estimated at $3 million, which is greater than the maximum averted cost-risk for Quad Cities as defined in Section F.4.7. See also SAMAs 93, 94, 97, 98, 99, and 100.	Reference 17	N/A
126	10.b. Additional Batteries/Divisions	17 83	This SAMA addresses the use of a diverse DC power system such as an additional battery or fuel cell for the purpose of providing motive power to certain components (e.g., RCIC)	#3 - Already implemented at Quad Cities	Quad Cities already has two spare 125V DC batteries SAMAs 93 and 125 address this item	N/A	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
127	10 c Fuel Cells	17	SAMA would extend DC power availability in an SBO.	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 94	N/A	N/A
128	10 d DC Cross-ties	17	This SAMA would improve DC power reliability.	#3 - Already implemented at Quad Cities	Cross-Tying of DC buses is procedurally directed.	Reference 55	N/A
129	10 e. Extended Station Blackout Provisions	17	SAMA would provide reduction in SBO sequence frequencies.	#2 - Similar item is addressed under other proposed SAMAs	See SAMAs 30, 91, 93, 94, 98, 99, 104, and 106	N/A	N/A
130	Add an automatic bus transfer feature to allow the automatic transfer of the 120V vital AC bus from the on-line unit to the standby unit	19	Plants are typically sensitive to the loss of one or more 120V vital AC buses Manual transfers to alternate power supplies could be enhanced to transfer automatically.	#4 - No significant safety benefit	1) Loss of 120V AC is not an Initiating Event 2) 120 VAC is not a risk significant support system	Reference 43	N/A
131	Provide procedures for (a) bypassing major DC buses; (b) locally starting equipment	83	This SAMA would allow for powering specific loads given a DC bus failure and/or the ability to start equipment locally that normally requires DC power for a control room start.	#6 - Retain	While DC buses are reliable, procedure changes may be cost beneficial given the importance of DC power.	N/A	6

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
132	Provide procedures to allow cross-tie of the 1/2 EDG to a bus which can supply the SSMP (14-1, 24-1, or 31)	83	This would provide additional diversity in the SSMP's power supply.	#5 - Cost would be more than risk benefit	A procedure change may be a cost beneficial enhancement for Quad Cities. However, the ability to cross-tie among divisions has so many competing risks and requires hardware changes that make this SAMA unacceptable given the low maximum averted for Quad Cities	N/A	N/A
Improvements in Identifying and Mitigating Containment Bypass							
133	Install a redundant spray system to depressurize the primary system during a steam generator tube rupture (SGTR).	1	SAMA would enhance depressurization during a SGTR.	#1 - Not applicable to the Quad Cities Design	PWR issue. N/A to BWR	N/A	N/A
134	Improve SGTR coping abilities.	1 4 11	SAMA would improve instrumentation to detect SGTR, or additional system to scrub fission product releases	#1 - Not applicable to the Quad Cities Design	PWR issue N/A to BWR	N/A	N/A
135	Add other SGTR coping abilities.	4 10 11	SAMA would decrease the consequences of an SGTR	#1 - Not applicable to the Quad Cities Design	PWR issue N/A to BWR	N/A	N/A
136	Increase secondary side pressure capacity such that an SGTR would not cause the relief valves to lift	10 11	SAMA would eliminate direct release pathway for SGTR sequences.	#1 - Not applicable to the Quad Cities Design	PWR issue. N/A to BWR	N/A	N/A
137	Replace steam generators (SG) with a new design.	1	SAMA would lower the frequency of an SGTR.	#1 - Not applicable to the Quad Cities Design	PWR issue N/A to BWR	N/A	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
138	Revise emergency operating procedures to direct that a faulted SG be isolated.	1	SAMA would reduce the consequences of an SGTR.	#1 - Not applicable to the Quad Cities Design	PWR issue N/A to BWR	N/A	N/A
139	Direct SG flooding after a SGTR, prior to core damage.	10	SAMA would provide for improved scrubbing of SGTR releases	#1 - Not applicable to the Quad Cities Design	PWR issue N/A to BWR	N/A	N/A
140	Implement a maintenance practice that inspects 100% of the tubes in a SG.	11	SAMA would reduce the potential for an SGTR.	#1 - Not applicable to the Quad Cities Design	PWR issue N/A to BWR	N/A	N/A
141	Locate residual heat removal (RHR) inside of containment.	10	SAMA would prevent intersystem LOCA (ISLOCA) out the RHR pathway.	#5 - Cost would be more than risk benefit	Competing risks associated with such a design are manifold and would require extensive analysis to demonstrate capability. For an existing plant, the cost of moving an entire system is judged to greatly exceed the maximum averted cost-risk for Quad Cities as defined in Section F.4.7.	Reference 86	N/A
142	Install additional instrumentation for ISLOCAs.	3 4 7 8	SAMA would decrease ISLOCA frequency by installing leak monitoring instruments in between the first two pressure isolation valves on low-pressure inject lines and RHR suction lines.	#4 - No significant safety benefit	Related to mitigation of an ISLOCA Per IN-92-36 and its additional supplement, ISLOCA contributes little risk for BWRs. For Quad Cities, ISLOCA and Large Break Outside Containment have CDF based Risk Reduction Worth values of 1 005 and 1.000, respectively. ISLOCA sequences comprise less than 1% of the LERF at Quad Cities.	References 47 and 56	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
143	Increase frequency for valve leak testing	1	SAMA could reduce ISLOCA frequency.	#4 - No significant safety benefit	The PIV interface valves at Quad Cities are leak tested. Related to mitigation of an ISLOCA. Per IN-92-36 and its additional supplement, ISLOCA contributes little risk for BWRs. For Quad Cities, ISLOCA and Large Break Outside Containment have CDF based Risk Reduction Worth values of 1.005 and 1.000, respectively. ISLOCA sequences comprise less than 1% of the LERF at Quad Cities. Competing Risk. Valve leak testing may actually increase risk because on-line valve manipulation is required	References 47 and 56	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
144	Improve operator training on ISLOCA coping.	1	SAMA would decrease ISLOCA effects.	#4 - No significant safety benefit	Related to mitigation of an ISLOCA. Per IN-92-36 and its additional supplement, ISLOCA contributes little risk for BWRs. For Quad Cities, ISLOCA and Large Break Outside Containment have CDF based Risk Reduction Worth values of 1.005 and 1.000, respectively. ISLOCA sequences comprise less than 1% of the LERF at Quad Cities In addition, the Quad Cities EOPs provide secondary containment monitoring parameters which include room specific temperature, room specific radiation, vent radiation, and room specific water level. The instrumentation and procedural guidance help locate and isolate breaks which have bypassed primary containment.	N/A	N/A
145	Install relief valves in the CC System.	1	SAMA would relieve pressure buildup from an RCP thermal barrier tube rupture, preventing an ISLOCA.	#1 - Not applicable to the Quad Cities Design	PWR issue. N/A to BWR	N/A	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
146	Provide leak testing of valves in ISLOCA paths.	1	SAMA would help reduce ISLOCA frequency. At Kewaunee Nuclear Power Plant, four MOVs isolating RHR from the RCS were not leak tested.	#4 - No significant safety benefit	Related to mitigation of an ISLOCA. Per IN-92-36 and its additional supplement, ISLOCA contributes little risk for BWRs. For Quad Cities, ISLOCA and Large Break Outside Containment have CDF based Risk Reduction Worth values of 1 005 and 1.000, respectively. ISLOCA sequences comprise less than 1% of the LERF at Quad Cities. Competing Risk: Valve leak testing may actually increase risk because on-line valve manipulation is required	References 47 and 56	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
147	Revise EOPs to improve ISLOCA identification.	1	SAMA would ensure LOCA outside containment could be identified as such. Salem Nuclear Power Plant had a scenario where an RHR ISLOCA could direct initial leakage back to the pressurizer relief tank, giving indication that the LOCA was inside containment.	#1 - Not applicable to the Quad Cities Design	At Westinghouse PWR's, RHR suction relief valves, which are outside containment, dump their discharge back into the PRT inside containment. Therefore, an untrained operator could fail to diagnose an ISLOCA from the low-pressure RHR system. The Quad Cities CS and RHR relief valves are aligned to discharge outside containment to the Reactor Building equipment drain tank Therefore, the plant configurations are not the same. In addition, the Quad Cities EOPs provide secondary containment monitoring parameters which include room specific temperature, room specific radiation, vent radiation, and room specific water level. The instrumentation and procedural guidance help locate and isolate breaks which have bypassed primary containment	Reference 57	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
148	Ensure all ISLOCA releases are scrubbed.	1	SAMA would scrub all ISLOCA releases One example is to plug drains in the break area so that the break point would be covered with water.	#4 - No significant safety benefit	ISLOCA and Large Break Outside Containment have CDF based Risk Reduction Worth values of 1.005 and 1.000, respectively. ISLOCA sequences comprise less than 1% of the LERF at Quad Cities. The cost of performing the analysis to identify all ISLOCA pathways and to ensure that any physical modifications implemented to mitigate ISLOCAs are not detrimental to the plant (e.g., cause flooding hazards) combined with the cost of installing the required equipment is judged to greatly exceed any benefit Additionally, the suggested enhancement of plugging drain lines would not guarantee a release would be scrubbed as the release may occur prior to the submergence of the break. Room flooding equipment and waterproofing of mitigative components would be required to make this SAMA potentially effective. Such changes would be extremely costly and potential competing risk appears to significantly outweigh any possible safety benefit	References 47 and 56	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
149	Add redundant and diverse limit switches to each containment isolation valve.	1	SAMA could reduce the frequency of containment isolation failure and ISLOCAs through enhanced isolation valve position indication	#4 - No significant safety benefit	Related to mitigation of an ISLOCA Per IN-92-36 and its additional supplement, ISLOCA contributes little risk for BWRs. For Quad Cities, ISLOCA and Large Break Outside Containment have CDF based Risk Reduction Worth values of 1.005 and 1.000, respectively. ISLOCA sequences comprise less than 1% of the LERF at Quad Cities.	References 47 and 56	N/A
150	Early detection and mitigation of ISLOCA	16	SAMA would limit the effects of ISLOCA accidents by early detection and isolation	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 142	N/A	N/A
151	8.e. Improved MSIV Design	17	This SAMA would decrease the likelihood of containment bypass scenarios	#4 - No significant safety benefit	There is no evidence of poor MSIV performance Redundant MSIVs are designed to isolate on severe accidents that could lead to radionuclide release and bypass containment These include breaks outside containment. The MSIVs are leak tested to ensure their adequacy The Maintenance Rule program monitors the performances of the MSIVs providing early feedback on any degradation. The PRA has determined that the risk contribution from MSIV failures to isolate is very small.	N/A	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
152	Proceduralize use of pressurizer vent valves during steam generator tube rupture (SGTR) sequences	19	Some plants may have procedures to direct the use of pressurizer sprays to reduce RCS pressure after an SGTR. Use of the vent valves would provide a back-up method	#1 - Not applicable to the Quad Cities Design	PWR issue. N/A to BWR	N/A	N/A
153	Implement a maintenance practice that inspects 100% of the tubes in an SG	19	This SAMA would reduce the potential for a tube rupture.	#1 - Not applicable to the Quad Cities Design	PWR issue. N/A to BWR	N/A	N/A
154	Locate RHR inside of containment	19	This SAMA would prevent ISLOCA out the RHR pathway	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 141	N/A	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
155	Install self-actuating containment isolation valves	19	For plants that do not have this, it would reduce the frequency of isolation failure.	#3 - Already implemented at Quad Cities	Containment isolation failure for Quad Cities is found to be a negligible contributor to CDF and LERF. The containment isolation configuration at Quad Cities is reliable. The lines which penetrate the primary containment are all equipped with automatic isolation logic with the exception of those lines required for mitigating a LOCA, such as ECCS injection lines. (All low pressure ECCS injection lines have one check valve to provide containment isolation) Feedwater has multiple check valves, HPCI and RCIC have 2 MOVs on the steam supply and a check valve and MOV on the injection line. Specific logic groups are defined which isolate on reactor or containment parameters significant to the associated group in order to provide automatic valve closures appropriate for a given set of conditions. Containment isolation valves from the containment atmosphere to the environment are, in general, air operated valves that fail closed (isolation position) if power or air is lost. The exception to this is the wetwell	Reference 58	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
Improvements In Reducing Internal Flooding Frequency							
156	Modify swing direction of doors separating turbine building basement from areas containing safeguards equipment	1	SAMA would prevent flood propagation, for a plant where internal flooding from turbine building to safeguards areas is a concern.	#4 - No significant safety benefit	Quad Cities plant is not susceptible to flood propagation from the turbine building to adjacent buildings with safety equipment. Flooding from Turbine Hall into adjacent buildings considered to have negligible impact. Electrical Equipment (MCCs, diesel generators, batteries, SSMP) are located at the 595' El. or above. There are Turbine Building access "roll-up" doors at the 595' El. Flooding is not expected to reach the 595' El., if it does, then discharge to the outside should preclude any further rise	Reference 59	N/A
157	Improve inspection of rubber expansion joints on main condenser.	1	SAMA would reduce the frequency of internal flooding, for a plant where internal flooding due to a failure of circulating water system expansion joints is a concern	#3 - Already implemented at Quad Cities	On June 7, 1972, the failure of a rubber expansion joint caused flooding of the condensate and service water pump room. As a result, water-tight Class I vaults with water-tight Class I bulkhead doors have been constructed to isolate the RHR service water pumps and diesel generator cooling water pumps from all other equipment in the condensate pump rooms and to protect the pumps from being flooded by a failure of either the condensate, condensate transfer or clean demineralized water systems	Reference 59	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
158	Implement internal flood prevention and mitigation enhancements	1 59	This SAMA would reduce the consequences of internal flooding	#5 - Cost would be more than risk benefit.	The Quad Cities Internal Flooding Analysis states that there do not appear to be any flood specific response procedures for catastrophic flood events. The existing procedures appear to be completely adequate for small leaks; however, they are judged not to provide specific directions to respond to large flow rate breaks. As a result, relatively high failure probabilities are estimated for the mitigative actions required to prevent extensive damage. Internal flood enhancements would include: - Curbs around the corner room stairwells to the RHR compartments - Coping procedures for SW floods in the Reactor Building For example, a specific pipe break scenario has been postulated that would disable 4kV buses 13 and 14 Given the consequential failure of Unit 1 TBCCW, several compensatory options exist: The internal flood evaluation in the IPE calculated a CDF that would be less than 10% of the current Quad Cities CDF. This translates into approximately $10,000 as the maximum cost that can be shown to be cost beneficial. No procedures or plant modification is judged to be possible for this cost and therefore this SAMA is found not to be cost beneficial	Reference 59	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
159	Implement internal flooding improvements such as those implemented at Fort Calhoun.	1	This SAMA would reduce flooding risk by preventing or mitigating rupture in the RCP seal cooler of the component cooling system, ISLOCA in a shutdown cooling line, and an auxiliary feedwater (AFW) flood involving the need to remove a watertight door.	#1 - Not applicable to the Quad Cities Design	PWR issue. N/A to BWR	N/A	N/A
160	Shield electrical equipment from potential water spray	59	SAMA would decrease risk associated with seismically induced internal flooding	#3 - Already implemented at Quad Cities.	Protecting equipment from spray may be a cost beneficial means of reducing risk at Quad Cities. The internal flood evaluation in the IPE calculated a CDF that would be less than 10% of the current Quad Cities CDF This translates into approximately $10,000 as the maximum cost that can be shown to be cost beneficial. No procedures or plant modification is judged to be possible for this cost and therefore this SAMA is found not to be cost beneficial.	N/A	N/A
161	13 c. Reduction in Reactor Building Flooding	17	This SAMA reduces the Reactor Building Flood Scenarios contribution to core damage and release	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 158	N/A	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
162	Review Circulating Water Pump Auto Trip procedure to determine its applicability to a condenser pit flooding scenario	59	This is a Quad Cities specific SAMA that is related to the procedural direction to start the standby Circulating Water pump on trip of the initially running pump given high Condenser Pit level. Use of the current procedure may exacerbate the flooding and result in an overflow into the Turbine Basement (which contains the condensate pumps and RHRSW vaults)	#4 - No significant safety benefit	Risk contribution is so low due to this postulated scenario that cost cannot be justified.	Reference 59	N/A
163	Consider dual unit flood effects in the EOPs	59	The current Quad Cities EOPs (QGAs) do not consider the impact of a flooding event in the opposite unit on the equipment of the given unit A flood in certain compartments of one unit will result in a challenge to equipment in the opposite unit due to plant configuration Updating the QGAs to account for the potential loss of equipment given a flood in the opposite unit will allow the operators to prepare for a scram and plan for the use of appropriate alternative systems	#4 - No significant safety benefit	Quad Cities flood induced risk is quite low and that due to any dual unit issues negligible. Changes cannot be implemented on a cost beneficial basis	N/A	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
164	Examine the potential for RHRSW vault failure and consequential Turbine Basement flooding	59	The RHRSW vaults at Quad Cities contain piping from the discharge from one or more other RHRSW pumps. A break in the piping not co-located with the pump will flood the RHRSW vault and result in an internal pressure build up. The potential exists for the vault to collapse and result in Turbine Basement flooding. Resolution of this SAMA would decrease the contribution of internal flooding in this area.	#5 - Cost would be more than risk benefit.	The internal flood probabilistic analysis includes the quantification of the RHRSW pipe breaks and the resulting quantification shows that the subject insight has a negligible impact on plant risk. The estimated cost of structural analysis, structural changes, instrument changes, or procedure changes would not be cost justified, i.e , would be far in excess of the total internal flood risk contribution >>$10,000.	Reference 59	N/A
Improvements Related to Feedwater/Feed and Bleed Reliability/Availability							
165	Install a digital feedwater upgrade.	1	This SAMA would reduce the chance of a loss of main feedwater following a plant trip.	#3 - Already implemented at Quad Cities	Already installed at Quad Cities	Reference 65	N/A
166	Perform surveillances on manual valves used for backup AFW pump suction.	1	This SAMA would improve success probability for providing alternative water supply to the AFW pumps.	#1 - Not applicable to the Quad Cities Design	PWR issue. N/A to BWR	N/A	N/A
167	Install manual isolation valves around AFW turbine-driven steam admission valves.	1	This SAMA would reduce the dual turbine-driven AFW pump maintenance unavailability.	#1 - Not applicable to the Quad Cities Design	PWR issue. N/A to BWR	N/A	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
168	Install accumulators for turbine-driven AFW pump flow control valves (CVs).	4 8	This SAMA would provide control air accumulators for the turbine-dnven AFW flow CVs, the motor-driven AFW pressure CVs and SG power-operated relief valves (PORVs). This would eliminate the need for local manual action to align nitrogen bottles for control air during a LOOP.	#1 - Not applicable to the Quad Cities Design	PWR issue N/A to BWR	N/A	N/A
169	Install separate accumulators for the AFW cross-connect and block valves	19	This SAMA would enhance the operator's ability to operate the AFW cross-connect and block valves following loss of air support.	#1 - Not applicable to the Quad Cities Design	PWR issue N/A to BWR	N/A	N/A
170	Install a new condensate storage tank (CST)	19	Either replace the existing tank with a larger one, or install a back-up tank.	#5 – Cost would be more than risk benefit	Installation of an additional CST may be a cost beneficial means of reducing risk at Quad Cities The availability of significantly larger CST volume could be used by LPCI or CS to provide continuous RPV injection regardless of torus conditions.	The cost to implement this SAMA would be significantly greater than the maximum averted cost risk defined in Section F.4.7.	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
171	Provide cooling of the steam-driven AFW pump in an SBO event	19	This SAMA would improve success probability in an SBO by: (1) using the FP system to cool the pump, or (2) making the pump self cooled.	#1 - Not applicable to the Quad Cities Design	The turbine driven injection systems at Quad Cities (HPCI and RCIC) are self cooled pumps. No additional cooling required for the SBO duration. For SBO sequences, the limiting or controlling factor for HPCI operation is DC power or lack of suppression pool cooling. Nevertheless, room cooling could eventually be a limiting factor to HPCI operation under certain very low frequency SBO sequences. These are not currently considered credible and are not modeled in the PSA Therefore, a negligible benefit is calculated for this SAMA RCIC does not require room cooling even for the 24 hour mission time as long as there is no gland seal failure	References 52 and 53	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
172	Proceduralize local manual operation of AFW when control power is lost.	19	This SAMA would lengthen AFW availability in an SBO. Also provides a success path should AFW control power be lost in non-SBO sequences.	#2 - Similar item is addressed under other proposed SAMAs.	HPCI and RCIC are the turbine driven injection systems for Quad Cities. The available injection time for these systems is limited by factors such as battery life, depressurization on HCTL, and injection source volume HCTL is reached in the suppression pool at approximately 7 hours after the initiating event. Providing local, manual control capability for the HPCI and RCIC systems (removing the DC dependence) could extend injection an additional three hours beyond the 4 hour battery life This is already part of operator training See resolution of SAMA 94.	References 52, 53, and 61	N/A
173	Provide portable generators to be hooked into the turbine driven AFW, after battery depletion.	19	This SAMA would extend AFW availability in an SBO (assuming the turbine driven AFW requires DC power)	#2 - Similar item is addressed under other proposed SAMAs.	HPCI and RCIC are the turbine driven injection systems for Quad Cities. The available injection time for these systems is limited by factors such as battery life, depressurization on HCTL, and injection source volume. HCTL is reached in the suppression pool at approximately 7 hours after the initiating event. Extending DC power availability to HCTL could allow an additional three hours of injection beyond the 4 hour battery life would provide a small marginal benefit for RPV injection See also SAMAs 93, 94, 97, 98, 127, and 128	References 52, 53, and 61	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
174	Add a motor train of AFW to the Steam trains	19	For PWRs that do not have any motor trains of AFW, this would increase reliability in non-SBO sequences.	#1 - Not applicable to the Quad Cities Design	Quad Cities is equipped with both motor driven and turbine driven injection systems.	References 27, 52, 53 and 60	N/A
175	Create ability for emergency connections of existing or alternate water sources to feedwater/condensate	19	This SAMA would be a back-up water supply for the feedwater/condensate systems.	#3 - Already implemented at Quad Cities	The Standby Coolant Supply is available as an alternate water source to the condenser.	Reference 28	N/A
176	Use FP system as a back-up for SG inventory	19	This SAMA would create a back-up to main and AFW for SG water supply.	#1 - Not applicable to the Quad Cities Design	PWR issue. N/A to BWR	N/A	N/A
177	Procure a portable diesel pump for isolation condenser make-up	19	This SAMA would provide a back-up to the city water supply and diesel FP system pump for isolation condenser make-up	#1 - Not applicable to the Quad Cities Design	Quad Cities does not have an Isolation Condenser system.	Reference 26	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
178	Install an independent diesel generator for the CST make-up pumps	19	This SAMA would allow continued inventory make-up to the CST during an SBO.	#4 - No significant safety benefit	HPCI and RCIC are the turbine driven injection systems for Quad Cities The CCSTs each have a nominal water supply of 260,000 gallons and the reserved volume (only accessible by SSMP, HPCI, and RCIC) is 90,000 gallons. Given a battery life of 4 hours (required for HPCI/RCIC operation) and an initial volume of 90,000 gallons, no additional water source would be required for injection during the 4 hour SBO mission time Minimal benefit would be gained from this SAMA Similar item is addressed under proposed SAMA #60	References 61 and 62	N/A
179	Change failure position of condenser make-up valve	19	This SAMA would allow greater inventory for the AFW pumps by preventing CST flow diversion to the condenser if the condenser make-up valve fails open on loss of air or power.	#3 - Already implemented at Quad Cities	The condenser makeup valve fails closed on loss of air.	Reference 65	N/A
180	Create passive secondary side coolers.	19	This SAMA would reduce CDF from the loss of Feedwater by providing a passive heat removal loop with a condenser and heat sink.	#1 - Not applicable to the Quad Cities Design	Secondary side cooling is a PWR issue.	N/A	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
181	Replace current PORVs with larger ones such that only one is required for successful feed and bleed.	19	This SAMA would reduce the dependencies required for successful feed and bleed.	#3 - Already implemented at Quad Cities	Quad Cities has multiple SRVs that provide the capability to support "feed and bleed" operation, i e , RPV depressurization.	Reference 39	N/A
182	Install motor-driven feedwater pump.	1 12	SAMA would increase the availability of injection subsequent to MSIV closure.	#3 - Already implemented at Quad Cities	Quad Cities has three motor driven Feedwater pumps	Reference 63	N/A
183	Use Main FW pumps for a Loss of Heat Sink Event	82	This SAMA involves a procedural change that would allow for a faster response to loss of the secondary heat sink. Use of only the feedwater booster pumps for injection to the SGs requires depressurization to about 350 psig; before the time this pressure is reached, conditions would be met for initiating feed and bleed. Using the available turbine driven feedwater pumps to inject water into the SGs at a high pressure rather than using the feedwater booster alone allows injection without the time consuming depressurization	#1 - Not applicable to the Quad Cities Design	Quad Cities does not have Steam Generators Main feedwater is already used routinely after reactor scram.	Reference 63	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
Improvements in Core Cooling Systems							
184	Provide the capability for diesel driven, low pressure vessel make-up	19	This SAMA would provide an extra water source in sequences in which the reactor is depressurized and all other injection is unavailable (e g , FP system)	#3 - Already implemented at Quad Cities	The Quad Cities Fire System is equipped with diesel driven pumps which are capable of providing low pressure injection to the RPV by pumping through the idle SSMP or by hose connection to the RHR.	Reference 54	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
185	Provide an additional HPSI pump with an independent diesel	19	This SAMA would reduce the frequency of core melt from small LOCA and SBO sequences	#3 - Already implemented at Quad Cities	This is primarily a PWR insight where RPV depressurization is not as easily available. The availability of an additional high pressure water injection source is not a significant risk reduction measure for Quad Cities because of the existing design Quad Cities has substantial high pressure RPV inventory control methods. These include. - HPCI - RCIC - Feedwater (motor driven) - CRD pumps - SSMP These methods represent substantial high pressure inventory control methods. HPCI and RCIC are turbine driven systems that operate initially independent of AC power FW depends on offiste AC power to provide high pressure injection. Onsite AC power is available from either unit EDG the swing EDG, or either SBO DG (5 sources) to support CRD operation	Reference 64, SAMA 132	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
185 (Cont'd)					Quad Cities has a Safe Shutdown Makeup Pump Available (SSMP) whose purpose is to provide an alternative to the Reactor Core Isolation Cooling (RCIC) system for safe shutdown. Onsite AC power is available from either unit EDG or either SBO DG (4 sources). A more cost effective solution that providing a dedicated diesel fo rht eSSMP would be to enable cross-tie to the 1/2 EDG This is examined in SAMA 132.		
186	Install an independent AC HPSI system	19	This SAMA would allow make-up and feed and bleed capabilities during an SBO.	#2 - Similar item is addressed under other proposed SAMAs.	See SAMA 185	N/A	N/A
187	Create the ability tomanually align ECCS recirculation	19	This SAMA would provide a back-up should automatic or remote operation fail.	#3 - Already implemented at Quad Cities	Quad Cities has the capability to align ECCS for recirculation via local valve manipulation.	N/A	N/A
188	Implement an RWT make-up procedure	19	This SAMA would decrease CDF from ISLOCA scenarios, some smaller break LOCA scenarios, and SGTR	#2 - Similar item is addressed under other proposed SAMAs	For a BWR, the functional equivalent would be CST make-up See SAMA 60	References 42 and 80	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
189	Stop low pressure safety injection pumps earlier in medium or large LOCAs.	19	This SAMA would provide more time to perform recirculation swap over.	#1 - Not applicable to the Quad Cities Design	There is no true equivalent of the PWR "swap over to recirculation" action at Quad Cities. The normal alignment of RHR in LPCI mode is already a recirculation-like flowpath which takes suction from the suppression pool, passes through the RHR heat exchangers, and injects to the RPV. Suction sources for other injection systems are aligned as directed in the EOPs based on CCST and suppression pool levels The procedures were developed based on providing adequate NPSH to the pumps and preventing overfill of the containment. In addition, other injection systems (or the opposite RHR loop) can provide make-up water to the RPV concurrent with RHR suppression pool cooling so that it is not necessary to stop one function prior to beginning the other.	References 27 and 39	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
190	Emphasize timely swap over in operator training.	19	This SAMA would reduce human error probability of recirculation failure.	#1 - Not applicable to the Quad Cities Design	There is no true equivalent of the PWR "swap over to recirculation" action at Quad Cities The normal alignment of RHR in LPCI mode is already a recirculation-like flowpath which takes suction from the suppression pool, passes through the RHR heat exchangers, and injects to the RPV. Suction sources for other injection systems are aligned as directed in the EOPs based on CCST and suppression pool levels The procedures were developed based on providing adequate NPSH to the pumps and preventing overfill of the containment In addition, other injection systems (or the opposite RHR loop) can provide make-up water to the RPV concurrent with RHR suppression pool cooling so that it is not necessary to stop one function prior to beginning the other.	References 27 and 39	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
191	Upgrade Chemical and Volume Control System to mitigate small LOCAs.	19	For a plant like the AP600 where the Chemical and Volume Control System cannot mitigate a Small LOCA, an upgrade would decrease the Small LOCA CDF contribution	#5 - Cost would be more than risk benefit	A potential functional equivalent for Quad Cities would be the enhancement of the RWCU system such that injection flow rates on the order of 1000 gpm were possible This change is considered to be similar in function, scope, and cost to SAMA 185 ($5-$10 million) with the exception of the independent power source. However, new power circuits and wiring would likely be needed for the larger pumps The low end of the cost of implementation estimate ($5 million) is judged to be applicable for this SAMA, which is greater than the maximum averted cost risk for Quad Cities as defined in Section F 4 7	Reference 19	N/A
192	Install an active HPSI system.	19	For a plant like the AP600 where an active HPSI system does not exist, this SAMA would add redundancy in HPSI.	#3 - Already implemented at Quad Cities	The SSMP, RCIC, and HPCI systems provide high pressure injection at Quad Cities	References 52, 53, and 64	N/A
193	Change "in-containment" RWT suction from 4 check valves to 2 check and 2 air operated valves	19	This SAMA would remove common mode failure of all four injection paths.	#1 - Not applicable to the Quad Cities Design	Not a BWR issue. Common cause failure of CCST suction valves does not disable the low pressure injection systems Adequate redundancy in design already exists	Reference 47	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
194	Replace 2 of the 4 safety injection (SI) pumps with diesel-powered pumps.	19	This SAMA would reduce the SI system common cause failure probability. This SAMA was intended for the System 80+, which has four trains of SI.	#4 - No significant safety benefit	Quad Cities has a diverse set of injection systems and more than one method of containment heat removal. Common cause failure of the 4 train RHR system is a low contributor to risk and removing the 4/4 system failures would have minimal impact on the results. The CCF of all four RHR pumps to run (1RHPM1ABCD—XCC) has a Risk Reduction Worth of 1.000 (with respect to CDF) The CCF of all four RHR pumps to fail to start (1RHPM1ABCD---ACC) does not appear in any CDF cutsets above the truncation limit for the plant model and would not impact the results if it were improved.	Reference 47	N/A
195	Align low pressure core injection or core spray to the CST on loss of suppression pool cooling	19	This SAMA would help to ensure low pressure ECCS can be maintained in loss of suppression pool cooling scenarios.	#3 - Already implemented at Quad Cities	Quad Cities design and procedure flexibility allow this to be performed at the operator's discretion.	Reference 66	N/A
196	Raise high pressure core injection/reactor core isolation cooling backpressure trip setpoints	19	This SAMA would ensure high pressure core injection/reactor core isolation cooling availability when high suppression pool temperatures exist.	#4 - No significant safety benefit	The HPCI high backpressure trip is already set at a pressure above the containment ultimate pressure, thus, raising the trip limit would have very limited impact. The RCIC trip limit could be increased or bypassed, but the benefit would also be small because RPV depressurization is required before containment conditions are above these back pressure set points. Therefore, no benefit is gained from increasing these numerical values.	Reference 33 and 67	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
197	Improve the reliability of the automatic depressurization system.	19	This SAMA would reduce the frequency of high pressure core damage sequences.	#5 - Cost would be more than risk benefit	High pressure melt scenarios are significant contributors to the Quad Cities CDF. The SAMA is interpreted to mean improved reliability of the ERVs and Target Rock SRVs and their support systems A plant modification to eliminate dependence on DC power to increase the success probability of these valves would reduce the high pressure injection accident classes of IA and IE No such design is currently available This would require a research and development project	N/A	N/A
198	Disallow automatic vessel depressurization in non-ATWS scenarios	19	This SAMA would improve operator control of the plant	#3 - Already implemented at Quad Cities	The Quad Cities EOPs provide directions for the operators to inhibit ADS under specific non-ATWS conditions. Successful performance of this step demonstrates control of the plant Given that the operator is not able to complete the ADS inhibit action, the automatic depressurization action is desirable to ensure the next step is taken to ensure adequate core cooling.	Reference 39	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
199	Create automatic swap over to recirculation on RWT depletion	19	This SAMA would reduce the human error contribution from recirculation failure.	#1 - Not applicable to the Quad Cities Design	There is no true equivalent of the PWR "swap over to recirculation" action at Quad Cities The normal alignment of RHR in LPCI mode is already a recirculation-like flowpath which takes suction from the suppression pool, and injects to the RPV. Suction sources for other injection systems are aligned as directed in the EOPs based on CCST and suppression pool levels The procedures were developed based on providing adequate NPSH to the pumps and preventing overfill of the containment. In addition, other injection systems (or the opposite RHR loop) can provide make-up water to the RPV concurrent with RHR suppression pool cooling so that it is not necessary to stop one function prior to beginning the other.	References 27 and 39	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
200	Proceduralize intermittent operation of HPCI.	1	SAMA would allow for extended duration of HPCI availability.	#3 - Already implemented at Quad Cities	Limitations on HPCI operation in an SBO are based on battery depletion. Multiple starts and stops of the system are a larger drain on the battery than continuous operation with excess flow directed to the torus. In addition, multiple starts of the system introduce additional start demands which may increase the system failure probability for a given period of operation. The principal sequence dependent limitation for operation of HPCI is battery life in SBO and HCTL in other sequences where RHR suppression pool cooling is not available. Negligible benefit has been identified for this SAMA at Quad Cities HPCI pump operation must be controlled for SBO to preclude the minimum flow valve operation from dumping excessive amounts of CCST water to the torus HPCI in the CCST pressure control mode is recommended and currently preferred operating mode of HPCI.	References 52 and 61	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
201	Increase available net positive suction head (NPSH) for injection pumps	1	SAMA increases the probability that these pumps will be available to inject coolant into the vessel by increasing the available NPSH for the injection pumps.	#5 - Cost would be more than risk benefit	Requires major plant changes such as new RHR pumps, moving the RHR pumps, a new suppression pool design, a larger CCST (only applicable for injection phase), or an additional containment cooling system. The cost of these changes would exceed the maximum averted cost-risk for Quad Cities as defined in Section F.4.7.	N/A	N/A
202	Modify Reactor Water Cleanup (RWCU) for use as a decay heat removal system and proceduralize use	1	SAMA would provide an additional source of decay heat removal	#5 - Cost would be more than risk benefit	In order to make RWCU a viable heat removal system, the piping, pumps, heat exchangers, and power sources would have to be upgraded This SAMA is considered to be similar in scope to SAMA 191. The cost of implementation for such a change (approximately $5 million) is greater than the maximum averted cost-risk for Quad Cities.	N/A	N/A
203	CRD Injection	16 83	SAMA would supply an additional method of level restoration by using a non-safety system. At Quad Cities, CRD injection is already directed However, if the procedures were enhanced to direct alignment of both CRD pumps into a high flowrate configuration, CRD would become a valuable high pressure injection source.	#3 - Already implemented at Quad Cities	CRD is procedurally directed for RPV injection. CRD is credited in the PRA as adequate for RPV injection after initial success of other injection sources No change in this success criteria is anticipated if the procedure is further enhanced to immediately align both CRD pumps for RPV injection at maximum flow. In addition, such a change could detract from other immediate operator actions thereby introducing competing risks.	N/A	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
204	Condensate Pumps for Injection	16 83	SAMA to provide an additional option for coolant injection when other systems are unavailable or inadequate	#3 - Already implemented at Quad Cities	Condensate injection is directed in the EOPs.	Reference 39	N/A
205	Align EDG to CRD for Injection	16	SAMA to provide power to an additional injection source during loss of power events	#3 - Already implemented at Quad Cities	QCOA 6100-03 directs the operators to power the normal AC buses from the emergency AC buses when the normal power supply is lost to allow operation of required equipment.	Reference 41	N/A
206	Re-open MSIVs	16	SAMA to regain the main condenser as a heat sink by re-opening the MSIVs	#3 - Already implemented at Quad Cities	There are two important aspects of the MSIV closure response. - For non-ATWS condtions, the ability to rapidly respond to MSIV closure and restore the main condenser as a heat sink is not explicitly directed. However, training and simulation practice is to re-open the MSIVs as quickly as possible. This has been demonstrated in the simulator - For ATWS conditions, Quad Cities EOPs direct MSIV low level closure bypass using QCOP 250-2 in order to retain the main condenser as a heat sink. Operator interviews suggest that while the action to re-open the MSIVs is not proceduralized, the operators would perform the action to re-establish a heat sink	References 69 and 83	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
207	Bypass RCIC Turbine Exhaust Pressure Trip	16	SAMA would allow RCIC to operate longer.	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 196	N/A	N/A
208	2.a. Passive High Pressure System	17	SAMA will improve prevention of core melt sequences by providing additional high pressure capability to remove decay heat through an isolation condenser type system	#5 - Cost would be more than risk benefit	The cost of this enhancement has been estimated to be $1 7 million in Reference 17. This is greater than the maximum averted cost-risk for Quad Cities as defined in Section F 4.7.	Reference 17	N/A
209	2.c. Suppression Pool Jockey Pump	17	SAMA will improve prevention of core melt sequences by providing a small makeup pump to provide low pressure decay heat removal from the RPV using the suppression pool as a source of water.	#5 - Cost would be more than risk benefit	From a review of the contributors to the Quad Cities risk profile it is found that the availability of low pressure pumps for RPV make up is not a dominant contributor. The low pressure pump availability for RPV injection is a negligible contributor to the risk profile. The expense of adding another low pressure injection system without introducing severe competing risks is expected to be high. It can be concluded that the cost will not be able to be justified.	N/A	N/A
210	2 d. Improved High Pressure Systems	17 83	SAMA will improve prevention of core melt sequences by improving reliability of high pressure capability to remove decay heat.	#3 - Already implemented at Quad Cities	Existing reliability improvement program for HPCI/RCIC: - GE SILs regarding HPCI/RCIC reliability improvements - Maintenance rule		N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
211	2 e. Additional Active High Pressure System	17	SAMA will improve reliability of high pressure decay heat removal by adding an additional system.	#2 - Similar item is addressed under other proposed SAMAs	See SAMAs 185, 186, 192, and 208	N/A	N/A
212	2.f. Improved Low Pressure System (Firepump)	17	SAMA would provide fire protection system pump(s) for use in low pressure scenarios.	#3 - Already implemented at Quad Cities	The Fire Protection pump at Quad Cities is Capable of serving as a low pressure injection systems or a suction source for other plant injection systems	Reference 54	N/A
213	4.b. CUW Decay Heat Removal	17	This SAMA provides a means for Alternate Decay Heat Removal.	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 202. The CUW system in ABWR is equivalent to the RWCU system at Quad Cities.	N/A	N/A
214	4.c. High Flow Suppression Pool Cooling	17	SAMA would improve suppression pool cooling for ATWS response	#5 - Cost would be more than risk benefit	Increasing the capabilities of suppression pool would require new pumps, heat exchangers, piping, and other equipment. The implementation cost of this change is considered to be approximately equivalent to SAMA 35 ($5.8 million) and is screened from further review as it is significantly greater than the maximum averted cost-risk for Quad Cities as defined in Section F 4 7	SAMA 35	N/A
215	8.c. Diverse Injection System	17	SAMA will improve prevention of core melt sequences by providing additional injection capabilities	#2 - Similar item is addressed under other proposed SAMAs.	See SAMAs 184, 185, 186, 192, 208, 210, and 211	N/A	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
216	Delete High DW Pressure Signal from SDC isolation	83	This SAMA would allow the initiation of SDC when the drywell is at elevated pressures.	#6 - Retain	SDC could be used for DHR in conditions where it is currently precluded from use Removal of this logic is not a cost beneficial modification but would be a safety enhancement if justified on other bases	N/A	7

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
217	Use SSMP to provide injection to Unit 1 and Unit 2 simultaneously	83	The SSMP provides injection to one unit at a time. Injection to both units simultaneously could be beneficial in cases where only SSMP injection is available This would eliminate the need to alternate injection between the units	#4 - No significant safety benefit	This SAMA only applies to dual unit initiators For single unit initiators, SSMP can be dedicated to the shutdown unit The SSMP flow rate is sufficient to support a single unit for adequate core cooling if it is the sole injection source and the event resembles an MSIV closure from full power. In that case, sharing of SSMP is not an effective option. For other less severe cases (e.g , reduced power operation, other injection sources available), the SSMP is sufficient to refill the RPV to Level 8 Therefore, the number of SSMP "cycles" to alternate between units is relatively low, i e , approximately ten over the 24-hour mission time. The SSMP can be easily switched from one unit to the other through the manipulation of two MOVs In addition to the MOVs, there are four check valves that also need to open per "cycle." This results in a small change in SSMP failure probability of 6 4E-3[1] (12% of the SSMP unavailability not counting the support systems) and a negligible change to the Quad Cities risk profile.	N/A	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
218	Install a high level SSMP pump trip to avoid water solid operation of the RPV.	83	This would help prevent inadvertent overpressurization of the RPV.	#5 - Cost would be more than risk benefit	The impact of this SAMA is very low Water solid overpressurization is currently modeled in the PSA to be a negligible contributor to risk.	N/A	N/A
219	Develop procedures to control Feedwater flow without 125 VDC power to prevent tripping Feedwater on High/Low level	83	This SAMA increases the functionality of Feedwater in loss of DC scenarios and increases the probability of successful level control.	#6 - Retain	Evaluate the benefit of improved Feedwater level control given loss of DC.	N/A	8
220	Remove Loop Select Logic	83	In the event that there is no break in the recirc loops and there is a Loop "B" injection path failure, the Loop "A" injection path is precluded from use. Removal of the LPCI Loop Select Logic or installation of a bypass switch would allow use of the "A" loop for injection in the event of a "B" injection path failure.	#6 - Retain	Evaluate the benefit removal or bypass of LPCI Loop Select Logic.	N/A	9
221	Demonstrate RCIC operability following depressurization	83	This SAMA would increase the operators' options for low pressure vessel injection	#6 - Retain	Determine if demonstrating the operability of RCIC after depressurization is a cost-beneficial effort Alternatively, Emergency depressurization could be directed to be stopped at 100 psig	N/A	10

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
Instrument Air/Gas Improvements							
222	Modify EOPs for ability to align diesel power to more air compressors.	19	For plants that do not have diesel power to all normal and back-up air compressors, this change would increase the reliability of IA after a LOOP.	#3 - Already implemented at Quad Cities	QCOA 6100-03 directs the operators to power the normal AC buses from the emergency AC buses when the normal power supply is lost to allow operation of required equipment. Performance of this procedure provides the Instrument Air system and its support systems with power	Reference 41	N/A
223	Replace old air compressors with more reliable ones	19	This SAMA would improve reliability and increase availability of the IA compressors.	#3 - Already implemented at Quad Cities	- Adequate reliability now exists - Loss of IA is not a significant contributor to risk - Maintenance rule program monitors reliability and provides early warning to system degradation - Cost is expected to exceed any risk benefit	Reference 85	N/A
224	Install nitrogen bottles as a back-up gas supply for safety relief valves.	19	This SAMA would extend operation of safety relief valves during an SBO and loss of air events (BWRs).	#1 - Not applicable to the Quad Cities Design	Quad Cities depressurization capability is primarily supported by DC power. The EMRVs are powered by 125V DC and are available during an SBO. The single Target Rock SRV uses Drywell Air as the motive power to open the valve against spring pressure, but 125V DC is still required for valve control. An accumulator is available to allow a limited number of SRV openings after loss of Instrument Air Service	Reference 70	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
225	Allow cross connection of uninterruptable compressed air supply to opposite unit.	12 13 83	SAMA would increase the ability to vent containment using the hardened vent.	#3 - Already implemented at Quad Cities	An inter-unit Instrument Air crosstie valve already exists at Quad Cities and can be opened locally. A connection to the Service Air System also exists for each unit (the unit Service Air compressors output to a common header such that the two units are normally fully cross-tied). A plant modification is already approved to increase instrument air reliability for such things as venting for long-term sequences, by providing for connection of a truck-mounted compressor. Unit 1 & 2 Instrument Air Mods (EC 335806 and EC335807, respectively) add ability to tie in truck-mounted IA compressor to IA system to allow opening of containment vents in cases of extended loss of IA/containment heat removal The modification to be installed by 12/31/02 provides the necessary piping and supports to permit temporary hook-up of a 1600 CFM, diesel Driven, Air Compressor to a 3" NPT Threaded connection on the Instrument Air System Several area rental facilities have been contacted and all have stated that they have the ab	Reference 71	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
226	Allow local, manual operation of Instrument Air isolation valves	82	This SAMA will allow re-establishment of Instrument Air flow to the Pressurizer PORVs and subsequent alignment of feed and bleed for sequences in which the accumulators have been depleted and the IA isolation valves' air operators fail to cycle on an "open" signal (assuming Instrument Air is available)	#1 - Not applicable to the Quad Cities Design	PWR issue. N/A to BWR	N/A	N/A
ATWS Mitigation							
227	Install MG set trip breakers in control room	19	This SAMA would provide trip breakers for the MG sets in the control room. In some plants, MG set breaker trip requires action to be taken outside of the control room. Adding control capability to the control room would reduce the trip failure probability in sequences where immediate action is required (e g , ATWS).	#1 - Not applicable to the Quad Cities Design	PWR feature, not applicable to BWRs.		N/A
228	Add capability to remove power from the bus powering the control rods	19	This SAMA would decrease the time to insert the control rods if the reactor trip breakers fail (during a loss an MSIV closure ATWS which has a rapid pressure excursion)	#1 - Not applicable to the Quad Cities Design	- Only PWRs have reactor trip breakers - Quad Cities has backup scram capability via the ARI system		N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
229	Create cross-connect ability for standby liquid control trains	19	This SAMA would improve reliability for boron injection during an ATWS event.	#1 - Not applicable to the Quad Cities Design	Each unit's SLC system has two trains which have common suction and discharge headers Redundant suction and discharge paths exist beyond these headers, which can be isolated, if required No further cross connection is beneficial between the trains of a given unit An inter unit cross-tie is a potential enhancement but the potential competing risk of flow diversion is considered to far outweigh the benefits	Reference 72	N/A
230	Create an alternate boron injection capability (back-up to standby liquid control)	19	This SAMA would improve reliability for boron injection during an ATWS event	#3 - Already implemented at Quad Cities	RWCU can be used as an alternate boron injection system as described in QCOP 1200-10	Reference 72	N/A
231	Remove or allow override of low pressure core injection during an ATWS	19	On failure on high pressure core injection and condensate, some plants direct reactor depressurization followed by 5 minutes of low pressure core injection. This SAMA would allow control of low pressure core injection immediately.	#3 - Already implemented at Quad Cities	Currently included as part of simulator training program	Reference 73	N/A
232	Install a system of relief valves that prevents any equipment damage from a pressure spike during an ATWS	19	This SAMA would improve equipment availability after an ATWS.	#3 - Already implemented at Quad Cities	This is primarily a PWR insight. BWRs are already equipped with adequate pressure control methods even for the worst case ATWS. The pressure relief function during an ATWS at Quad Cities is assumed to require 12 of 13 SVs with RPT.	Reference 74	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
233	Create a boron injection system to back up the mechanical control rods.	19	This SAMA would provide a redundant means to shut down the reactor.	#3 - Already implemented at Quad Cities	Quad Cities already has boron injection capabilities.	Reference 72	N/A
234	Provide an additional instrument system for ATWS mitigation (e g , ATWS mitigation scram actuation circuitry).	19	This SAMA would improve instrument and control redundancy and reduce the ATWS frequency	#3 - Already implemented at Quad Cities	An alternate instrument system exists at Quad Cities.	N/A	N/A
235	Increase the safety relief valve (SRV) reseat reliability.	1	SAMA addresses the risk associated with dilution of boron caused by the failure of the SRVs to reseat after standby liquid control (SLC) injection.	#3 - Already implemented at Quad Cities	The SRV reseat reliability at Quad Cities is based on plant specific data and is not judged to be of low reliability This reliability is already monitored by the Maintenance Rule Program. The SRV reseat reliability has been factored into the PRA and has indicated that the SRV failure to reseat under failure to scram conditions represents a negligible contribution to risk.	N/A	N/A
236	Use control rod drive (CRD) for alternate boron injection	1	SAMA provides an additional system to address ATWS with SLC failure or unavailability	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 230. RWCU is used in place of CRD.	N/A	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
237	Bypass MSIV isolation in Turbine Trip ATWS scenarios	83	SAMA will afford operators more time to perform actions The discharge of a substantial fraction of steam to the main condenser (i e , as opposed to into the primary containment) affords the operator more time to perform actions (e g , SLC injection, lower water level, depressurize RPV) than if the main condenser was unavailable, resulting in lower human error probabilities	#6 - Retain	Bypass of MSIV isolation is procedurally directed in the EOPs; however, this action requires the use of jumpers. A dedicated switch for bypassing the low level interlock would be desirable	Reference 69	N/A
238	Enhance operator actions during ATWS	1	SAMA will reduce human error probabilities during ATWS	#3 - Already implemented at Quad Cities	Operator actions during ATWS scenarios are clearly directed in the Quad Cities EOPs (QGAs) and receive substantial emphasis in training.	Reference 73	N/A
239	Guard against SLC dilution	16	SAMA to control vessel injection to prevent boron loss or dilution following SLC injection	#3 - Already implemented at Quad Cities	SLC initiation and existing procedures guard against dilution (RWCU isolation and overfill prevention).	Reference 75	N/A
240	11.a. ATWS Sized Vent	17	This SAMA would be provide the ability to remove reactor heat from ATWS events.	#2 - Similar item is addressed under other proposed SAMAs.	See SAMA 40	N/A	N/A
241	11.b. Improved ATWS Capability	17	This SAMA includes items which reduce the contribution of ATWS to core damage and release frequencies.	#2 - Similar item is addressed under other proposed SAMAs.	Addressed by SAMAs 234 through 240, 242, and 243	N/A	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
242	Diversify the explosive valve operation	83	An alternate means of opening a pathway to the RPV for SBLC injection would improve the success probability for reactor shutdown.	#6 - Retain	SBLC injection failure is a dominant contributor to ATWS mitigation failure. Evaluate SBLC system improvements	N/A	11
243	Enrich Boron	83	The increased boron concentration will reduce the time required to achieve the shutdown concentration This will provide increased margin in the accident timeline for successful operator activation of SBLC	#6 - Retain	Increasing the boron concentration for SBLC may be a cost effective means of reducing ATWS risk	N/A	12
Other Improvements							
244	Provide capability for remote operation of secondary side relief valves in an SBO	19	Manual operation of these valves is required in an SBO scenario High area temperatures may be encountered in this case (no ventilation to main steam areas), and remote operation could improve success probability	#1 - Not applicable to the Quad Cities Design	Quad Cities does not have secondary side relief valves critical to SBO mitigation An approximate functional equivalent to the secondary side relief valves at Quad Cities are the SRVs, but these are already operated from the control room since the valves are located within the primary containment.	Reference 70	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
245	Create/enhance RCS depressurization ability	19	With either a new depressurization system, or with existing PORVs, head vents, and secondary side valve, RCS depressurization would allow earlier low pressure ECCS injection. Even if core damage occurs, low RCS pressure would alleviate some concerns about high pressure melt ejection.	#5 - Cost would be more than risk benefit	PWR issue related to the limited depressurization capability of the PWR. In addition, reference 19 estimates the cost of this SAMA to range between $500,000 and $4 6 million. For Quad Cities, more effective depressurization capabilities would require significant hardware changes and/or additions on top of the analysis that would be required to implement the change. The cost estimate for the modification is considered to be on the high end of the range provided in Reference 19. The cost of implementation for this SAMA is judged to greatly exceed the maximum averted cost-risk for Quad Cities as defined in Section F.4.7.	Reference 19, 85	N/A
246	Make procedural changes only for the RCS depressurization option	19	This SAMA would reduce RCS pressure without the cost of a new system	#3 - Already implemented at Quad Cities	The EOP procedures recognize the importance of depressurization. A list of all alternate depressurization systems is included in the EOPs as well as reference to procedures where applicable. EGC continues to follow closely the BWROG development of generic EOP/SAGs and implements the latest procedural guidance as they become available.	References 39, 73, and 76	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
247	Defeat 100% load rejection capability	19	This SAMA would eliminate the possibility of a stuck open PORV after a LOOP, since PORV opening would not be needed.	#1 - Not applicable to the Quad Cities Design	This SAMA is a PWR specific issue raised based on the estimated importance of stuck open PORVs at the Calvert Cliffs Nuclear Power Plant. No relevant, beneficial functional equivalent has been identified for BWRs.	Reference 19	N/A
248	Change control rod drive flow CV failure position	19	Change failure position to the "fail-safest" position.	#3 - Already implemented at Quad Cities	The control rod drive valves are set to fail in a position that will result in a scram given failure of supporting motive or control power.	Reference 46	N/A
249	Install secondary side guard pipes up to the MSIVs	19	This SAMA would prevent secondary side depressurization should a steam line break occur upstream of the main steam isolation valves. This SAMA would also guard against or prevent consequential multiple SGTR following a Main Steam Line Break event.	#5 - Cost would be more than risk benefit	This is primarily a PWR issue. The steam lines for a BWR inside the inboard MSIV are completely within the containment requiring no guard pipe Between the two MSIVs is a very short length of pipe that contributes a negligible amount to the CDF and LERF. The addition of a guard pipe to the steam tunnel for the short pipe length is judged to be very expensive and substantially in excess of any potential benefit associated with risk reduction .	Reference 46	N/A
250	Install digital large break LOCA protection	19	Upgrade plant instrumentation and logic to improve the capability to identify symptoms/precursors of a large break LOCA (leak before break)	#5 - Cost would be more than risk benefit	Large break LOCA risk is low. Upgraded instrumentation is unproven, benefit is not known, cost is highly uncertain. The implementation could not be realistically justified.	Reference 86	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
251	Increase seismic capacity of the plant to a high confidence, low probability failure of twice the Safe Shutdown Earthquake.	19	This SAMA would reduce seismically -induced CDF.	#1 - Not applicable to the Quad Cities Design	Seismic issues were examined in the Quad Cities IPEEE and the cost-effective means of reducing plant risk were implemented as part of the program. This SAMA was considered in the System 80+ original design submittal and is not applicable to an existing plant.	Reference 19	N/A
252	Enhance the reliability of the demineralized water (DW) make-up system through the addition of diesel-backed power to one or both of the DW make-up pumps	19	Inventory loss due to normal leakage can result in the failure of the CC and the SRW systems. Loss of CC could challenge the RCP seals. Loss of SRW results in the loss of three EDGs and the containment air coolers (CACs).	#3 - Already implemented at Quad Cities	The Clean Demineralized Water pumps are powered by MCCs that can be powered from buses which are aligned to the EDGs in a LOOP scenario. The Diesel Generator Cooling Water System pumps are already powered from diesel backed buses and are also not closed loop cooling systems.	References 78 and 79	N/A
253	Increase the reliability of safety relief valves by adding signals to open them automatically.	12	SAMA reduces the probability of a certain type of medium break LOCA. Hatch evaluated medium LOCA initiated by an MSIV closure transient with a failure of SRVs to open. Reducing the likelihood of the failure for SRVs to open, subsequently reduces the occurrence of this medium LOCA.	#3 - Already implemented at Quad Cities	Safety valves open against spring pressure, i.e., they open automatically and on a real demand. Modification already in place at Quad Cities Refer to SAMAs 197 and 257.	Reference 47	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
254	Reduce DC dependency between high-pressure injection system and ADS.	1	SAMA would ensure RPV depressurization and high-pressure injection upon a DC failure.	#3 - Already implemented at Quad Cities	The Quad Cities plant has redundant DC power supplies that supply high pressure injection systems and the RPV depressurization system. DC power dependencies for ADS and HPCI are capable of being cross tied to opposite unit division. The available 125V DC sources at Quad Cities are used to supply control power to both the ERV/SRV and the HPCI and RCIC systems. Only a complete failure of 125V DC would preclude the availability of DC to one of these systems	References 52, 53, and 70	N/A
255	Increase seismic ruggedness of plant components	11 13 51	SAMA would increase the availability of necessary plant equipment during and after seismic events.	#3 - Already implemented at Quad Cities	Refer to SAMA 251. Seismic issues were examined in the Quad Cities IPEEE and the cost-effective means of reducing plant risk were implemented as part of the program These changes include: Replacing mercury switches in the Fire Protection System Improving MCC mounting and anchor welds Enhancing battery restraints .	Reference 51	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
256	Enhance RPV depressurization capability	15	SAMA would decrease the likelihood of core damage in loss of high pressure coolant injection scenarios	#2 - Similar item is addressed under other proposed SAMAs	Refer to SAMAs 245, 246, 253, 254. At Quad Cities all SRVs have two redundant 125 VDC power supplies. Quad Cities Unit 1 has dedicated ERVs that do not require pneumatic supplies to operate for depressurization. Unit 2 has PORVs that also depend solely on 125V DC Each unit also has one Target Rock valve acts as a diverse, redundant component that implements nitrogen as the motive force to operate the valve A three-way 125VDC solenoid valve controls the nitrogen supply to the valve An accumulator and check valve arrangement stores sufficient nitrogen to operate the Target Rock valve for several cycles in the event of a loss of the normal nitrogen supply to the valve	Reference 70	N/A
257	Enhance RPV depressurization procedures	15	SAMA would decrease the likelihood of core damage in loss of high pressure coolant injection scenarios	#3 - Already implemented at Quad Cities	The EOP procedures recognize the importance of depressurization A list of all alternate depressurization systems is included in the EOPs as well as reference to procedures where applicable. See SAMA 246 and 197	N/A	N/A
258	1.b. Computer Aided Instrumentation	17	SAMA will improve prevention of core melt sequences by making operator actions more reliable.	#3 - Already implemented at Quad Cities	The Quad Cities control room is equipped with an information display system that is linked to the plant computer. This system displays critical reactor and containment parameters in a single location for the operators' reference during an accident (not during SBO).	Reference 80	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
259	1.c/d. Improved Maintenance Procedures/Manuals	17	SAMA will improve prevention of core melt sequences by increasing reliability of important equipment	#3 - Already implemented at Quad Cities	The maintenance rule has been implemented in the industry to balance reliability and availability and in doing so attempts to optimize the maintenance process. Root cause analysis is required as part of this program and will result in procedure enhancements where they are necessary and where they will be effective in reducing maintenance errors	Reference 85	N/A
260	1.e. Improved Accident Management Instrumentation	17	SAMA will improve prevention of core melt sequences by making operator actions more reliable.	#5 - Cost would be more than risk benefit	The risk as measured by CDF, LERF, and population dose is low The instrumentation available to the operating crew at Quad Cities is comparable to that available at other BWRs Based on a review of the accident sequences that contribute to the Quad Cities risk profile, the estimated risk reduction associated with additional accident mitigation instrumentation is judged to be negligible	N/A	N/A
261	1.f. Remote Shutdown Station	17	This SAMA would allow alternate system control in the event that the control room becomes uninhabitable.	#3 - Already implemented at Quad Cities	Quad Cities already has remote shutdown stations located outside the control room.	Reference 51	N/A
262	1 g. Security System	17	Improvements in the site's security system would decrease the potential for successful sabotage	#3 - Already implemented at Quad Cities	Electronic safety measures and trained security personnel provide surveillance for the Quad Cities site A security system diesel generator also exists to provide power to surveillance and protective equipment in the event that the normal power supply is cut	Reference 81	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
263	2.b. Improved Depressurization	17	SAMA will improve depressurization system to allow more reliable access to low pressure systems.	#2 - Similar item is addressed under other proposed SAMAs.	Addressed in SAMAs 245, 246, 253, 254, 257, and 258	N/A	N/A
264	2 h. Safety Related Condensate Storage Tank	17	SAMA will improve availability of CST following a Seismic event	#2 - Similar item is addressed under other proposed SAMAs	See SAMA 170	N/A	N/A
265	4.d. Passive Overpressure Relief	17	This SAMA will prevent catastrophic failure of the containment Controlled relief through a selected vent path has a greater potential for reducing the release of radioactive material than through a random break.	#6 - Retain	This SAMA may be a cost effective means of reducing risk at Quad Cities Quad Cities has installed a hard piped containment vent system that provides a controlled means of containment overpressure relief. The passive feature of adding a rupture disk to this system introduces competing risks that limit the usefulness of the vent over the spectrum of severe accidents.	N/A	13
266	8.b. Improved Operating Response	17	This SAMA would improve the likelihood of success of operator actions taken in response to an abnormal condition	#3 - Already implemented at Quad Cities	Operator response has been a focus at Quad Cities over the past decade. EPG/SAG Rev. 2 has been implemented at Quad Cities. Training has been improved and procedures have been re-written in an ongoing effort to improve operator reliability.	References 38 and 39	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
267	8 d. Operation Experience Feedback	17	This SAMA would provide information on the effectiveness of maintenance practices and equipment reliability	#3 - Already implemented at Quad Cities	The Maintenance Rule has enforced the industry trend of tracking component performance. This issue is judged to be addressed by the Maintenance Rule.	Engineering judgement.	N/A
268	8.e. Improved SRV Design	17	This SAMA would improve SRV reliability, thus increasing the likelihood that sequences could be mitigated using low pressure heat removal	#2 - Similar item is addressed under other proposed SAMAs	See SAMAs 235, 245, 246, 253, 254, 257, 258, and 271	N/A	N/A
269	12 a. Increased Seismic Margins	17	This SAMA would reduce the risk of core damage and release during seismic events.	#2 - Similar item is addressed under other proposed SAMAs.	See SAMAs 112 and 255	N/A	N/A
270	13.b. System Simplification	17	This SAMA is intended to address system simplification by the elimination of unnecessary interlocks, automatic initiation of manual actions or redundancy as a means to reduce overall plant risk.	#2 - Similar item is addressed under other proposed SAMAs.	Addressed by SAMAs 13, 108, 114, 149, 253, and 254	N/A	N/A
271	Train operations crew for response to inadvertent actuation signals	19	This SAMA would improve chances of a successful response to the loss of two 120V AC buses, which may cause inadvertent signal generation.	#4 - No significant safety benefit	The 120V AC system is not risk significant at Quad Cities While other plants have identified specific 120V AC failure scenarios that would lead the generation of inadvertent signals, no comparable vulnerabilities have been identified at Quad Cities.	Reference 43	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
272	Install tornado protection on gas turbine generators	19	This SAMA would improve onsite AC power reliability.	#4 - No significant safety benefit.	Additional measures could be taken to improve the protection of the on-site AC power sources; however, the IPEEE investigated risk from high wind events and found it to be negligible. Specifically, the emergency diesel generators are in safety category I structures	Reference 51	N/A
273	Provide additional protection for cables required for safe shutdown	51	SAMA would provide additional fire suppression for 1) cables identified as susceptible to fire and 2) those areas containing cables which control redundant divisions of equipment. This improvement would reduce the likelihood that a fire will progress to the point where it will fail the local cables and help prevent fires which will fail multiple divisions of equipment.	#3 - Already implemented at Quad Cities	This fire related risk mitigation measure has been considered as part of the fire PRA and the reevaluation of methods to enhance response to a fire. Mitigation, if justified, was implemented. As such, no further actions are deemed cost effective		N/A
274	Enhance procedures to consider selectively stripping control circuits from identified buses in the event of a fire	51	SAMA would reduce the amount of manual actions required in the QCARPs and may reduce the number of spurious actuations during a fire.	#3 - Already implemented at Quad Cities	This fire related risk mitigation measure has been considered as part of the fire PRA and the reevaluation of methods to enhance response to a fire. Mitigation, if justified, was implemented. As such, no further actions are deemed cost effective.		N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
275	Install and use additional Transfer/Isolation switches	51	SAMA would reduce the number of spurious actuations during a fire.	#3 - Already implemented at Quad Cities	This fire related risk mitigation measure has been considered as part of the fire PRA and the reevaluation of methods to enhance response to a fire. Mitigation, if justified, was implemented. As such, no further actions are deemed cost effective.		N/A
276	Reduce hot short potential	51	This SAMA is intended to address the potential for fires to cause cable short circuits that will preclude further use of equipment. The configurations of certain equipment are such that a short will cause undesired activation of the equipment For example, a short in an MOV's control cable may cause the MOV to receive a permanent "close" signal that could run the motor to failure or work against local valve manipulations	#3 - Already implemented at Quad Cities	Equipment identified in the IPEEE as susceptible to hot shorts has been modified or placed under control of revised procedures that mitigate the effects of the hot shorts	Reference 51	N/A
Containment Heat Removal							
277	Use RHRSW cross tie from opposite unit	83	This SAMA was identified as part of the risk insights from the Quad Cities PRA	#4 - No significant safety benefit.	The physical capability to establish the cross tie exists. There are system procedures to perform the alignment. The insight merely is to establish additional training and to specify when it can be used This insight while considered useful for further investigation is a safety enhancement that results in a small unmeasurable risk reduction benefit.	Reference 83	N/A

TABLE F-1
PHASE I SAMA (Cont'd)

Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Screening Criteria [See Notes]	Disposition	Disposition Reference	Phase II SAMA ID number
278	Provide mechanical stops on AOVs for venting	83	This SAMA seeks to physically prevent rapid containment depressurization during venting by imposing physical stops on the vent valves.	#4 - No significant safety benefit.	Calculation for BWR containment depressurization rates show that such physical stops are not adequate by themselves for this purpose.		N/A
279	Control containment venting within a narrow band of pressure	83	This SAMA was derived from the Quad Cities Risk Insights document to establish a narrow pressure control band that would thereby prevent rapid containment depressurization when venting is implemented thus avoiding adverse impacts on the low pressure ECCS injection systems taking suction from the torus.	#6 - Retain	There is a minor potential risk reduction associated with the SAMA and a cost associated with procedure changes, training, and documentation.		14
280	Modify EALs so that a General Emergency can be declared in long term loss of decay heat removal scenarios when a release can be anticipated	83	This change will allow the declaration of a General Emergency when decay heat removal has been lost and repair is not anticipated prior to containment failure and a subsequent radioactive release.	#3 - Already implemented at Quad Cities	The EALs include directions on the declaration of a General Emergency that allow sufficient latitude in the declaration of a General Emergency (GE) to allow the Emergency Director (ED) to declare a GE for loss of decay heat removal events (HG2).	Reference 84	N/A

(shaded)	Indicates Retained Item

Notes to Table F-1

#1	Not applicable to the QC Design
#2	Similar item is addressed under other proposed SAMAs
#3	Already implemented at QC
#4	No significant safety benefit associated with the systems / items associated with this SAMA
#5	The cost of implementation is greater than the cost-risk averted for the plant change or modification
#6	Retain
#7	Not Used
#8	ABWR design issue; not practical

TABLE F-2
ESTIMATED POPULATION DISTRIBUTION WITHIN A 10-MILE RADIUS OF QCNPS, YEAR 2032

Sector	0-1 mile	1-2 miles	2-3 miles	3-4 miles	4-5 miles	5-10 miles	10-mile total
N	17	168	142	97	84	649	1157
NNE	8	70	310	405	121	4385	5299
NE	8	23	39	153	337	13646	14206
ENE	8	23	39	45	27	920	1062
E	8	23	39	48	23	226	367
ESE	8	23	39	46	24	222	362
SE	8	23	39	54	68	414	606
SSE	8	23	39	51	56	410	587
S	8	23	39	43	49	1207	1369
SSW	7	14	28	86	163	3721	4019
SW	6	14	23	177	291	688	1199
WSW	5	14	23	35	127	489	693
W	5	14	24	33	42	555	673
WNW	5	16	41	36	48	428	574
NW	20	33	59	43	48	362	565
NNW	48	70	64	87	72	374	715
Total	176	573	986	1438	1579	28691	33443

TABLE F-3
ESTIMATED POPULATIOIN DISTRIBUTION WITHIN A 50-MILE RADIUS OF QCNPS, YEAR 2032

Sector	0-10 miles	10-20 miles	20-30 miles	30-40 miles	40-50 miles	50-mile total
N	1157	1156	2548	3712	8703	17276
NNE	5299	3240	6328	1948	5996	22811
NE	14206	17988	2500	5631	5987	46312
ENE	1062	4023	2569	3565	8867	20086
E	367	3416	6153	36792	22968	69696
ESE	362	2748	2535	2487	4946	13078
SE	606	1616	974	3125	8258	14579
SSE	587	5184	6895	13784	8224	34674
S	1369	7127	3726	4451	5036	21709
SSW	4019	51321	11810	6977	3355	77482
SW	1199	120381	71742	4078	6170	203570
WSW	693	35397	22647	4479	30175	93391
W	673	3744	2091	7305	7689	21502
WNW	574	3186	2392	3166	5673	14991
NW	565	5389	2735	3089	3006	14784
NNW	715	989	5420	4724	2888	14736
Total	33443	266895	153055	109303	137931	700677

TABLE F-4
MACCS RELEASE CATEGORIES VS. QCNPS RELEASE CATGEGORIES

MACCS Release Categories	QCNPS Release Categories
Xe/Kr	1 – noble gases
I	2 – CsI
Cs	6 – CsOH
Te	10 - Sb (TeO2 & Te2 fractions are smaller)
Sr	4 – SrO
Ru	5 – MoO2 (Mo is in Ru MACCS category)
La	8 – La2O3
Ce	9 – CeO2 (included UO2 in this category)
Ba	7 – BaO

TABLE F-5
MACCS RESULTS

MAAP Run	Release Category	Dose (Sv)	Costs($)	Frequency	Wtd. Dose (p-rem)	Wtd. Cost ($)
QC0053	L2-1	2.16E+04	4.08E+09	2.50E-07	5.40E-01	1.02E+03
QC0082	L2-2	1.62E+04	3.70E+09	4.10E-08	6.64E-02	1.52E+02
QC0085	L2-4	1.53E+04	2.81E+09	2.50E-07	3.83E-01	7.03E+02
QC0061	L2-5	6.14E+03	9.07E+08	8.00E-07	4.91E-01	7.26E+02
QC0057	L2-7	8.54E+03	1.25E+09	9.70E-09	8.28E-03	1.21E+01
QC0058	L2-8	3.35E+03	3.15E+08	3.20E-07	1.07E-01	1.01E+02
QC0070	L2-9	4.11E+04	5.23E+09	1.80E-08	7.40E-02	9.41E+01
QC0074	L2-10	4.36E+00	1.26E+04	5.00E-07	2.18E-04	6.30E-03
Frequency Weighted Totals (p-rem and $)				2.189E-06	1.67E+00	2806.8713

TABLE F-6
ACCIDENT SEQUENCE TIMINGS AS A FUNCTION OF CONSEQUENCE CATEGORY - BASE CASE

Consequence Category	Dominant Release Category	MAAP Case	Time of Initial Release	Time of Gen. Emg. Declaration	Time of End of Release	EAL Basis	Release Frequency (Per Rx Yr)
L2-1	H/E (LERF)	QC 0053 IA-L2-1A-NSPR	4.4 hr	60 min	36 hr	FG1	2.5E-7[1]
L2-2	H/I	QC 0082 IIA-L2-9C[4]	51.4 hr	15 hr	72 hr	HG2	4.1E-8[2]
L2-3	H/L	None	--	--	--	--	--
L2-4	M/E	QC-0085 IVA-L2-14B-ED-WW	55 min	55 min	36 hr	FG1	2.5E-7
L2-5	M/I	QC 0061 IIA-l2-9a	39.3 hr	15 hr	72 hr	HG2	8.0E-7[3]
L2-6	M/L	None	--	--	--	--	--
L2-7	L/E or LL/E	QC-057 ID-L2-7B NSPR	5.7 hr	45 min	36 hr	FG1	9.7E-9
L2-8	L/I or LL/I or L/L or LL/L	QC 0058 ID-L2-7BA-SPRY	25.9 hr	15 hr	36 hr	HG2	3.2E-7
L2-9	Class V	QC OO70 V-L2-17	17 min	20 min	36 hr	FG1	1.8E-8
L2-10	Intact	QC 0074 IB-L2-22	48 min	60 min	36 hr	FG1	5.0E-7

(1) Does not include Class V (see L2-9)
(2) Includes H/I and H/L
(3) Includes M/I and M/L
(4) Containment fails at 45.9 hr.

TABLE F-7
PHASE II SAMA

Phase II SAMA ID number	Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Potential Cost	Phase 2 Disposition
1	32	Provide means for alternate SSMP room cooling	83	The SSMP requires room cooling at extended times. This SAMA would allow SSMP operation late in accidents when normal room cooling has failed	Not Required	Not cost beneficial See Section F.6.1.
2	36	Develop an enhanced drywell spray system.	5 6	SAMA would provide a redundant source of water to the containment to control containment pressure, when used in conjunction with containment heat removal	Not Required	Not cost beneficial. See Section F 6 2.
3	94	Use fuel cells instead of lead-acid batteries	11	SAMA would extend DC power availability in an SBO.	Not Required	Not cost beneficial. See Section F 6 3

TABLE F-7
PHASE II SAMA (CONT'D)

Phase II SAMA ID number	Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Potential Cost	Phase 2 Disposition
4	96	Improve 4.16-kV bus cross-tie ability.	1 83	Enhance procedures to direct 4kV bus cross-tie. If this procedural step already exists, investigate installation of hardware that would perform an automatic cross-tie to the opposite 4kV bus given failure of the dedicated diesel.	Not Required	Not cost beneficial See Section F 6.4.
5	108	Create a backup source for diesel cooling. (Not from existing system)	1	This SAMA would provide a redundant and diverse source of cooling for the diesel generators, which would contribute to enhanced diesel reliability.	Not Required	Not cost beneficial. See Section F 6.5.
6	131	Provide procedures for (a) bypassing major DC buses; (b) locally starting equipment	83	This SAMA would allow for powering specific loads given a DC bus failure and/or the ability to start equipment locally that normally requires DC power for a control room start	Not Required	Not cost beneficial. See Section F 6 6
7	216	Delete High DW Pressure Signal from SDC isolation	83	This SAMA would allow the initiation of SDC when the drywell is at elevated pressures	Not Required	Not cost beneficial. See Section F.6.7.
8	219	Develop procedures to control Feedwater flow without 125 VDC power to prevent tripping Feedwater on High/Low level	83	This SAMA increases the functionality of Feedwater in loss of DC scenarios and increases the probability of successful level control.	Not Required	Not cost beneficial. See Section F 6.8
9	220	Remove Loop Select Logic	83	In the event that there is no break in the recirc loops and there is a Loop "B" injection path failure, the Loop "A" injection path is precluded from use. Removal of the LPCI Loop Select Logic or installation of a bypass switch would allow use of the "A" loop for injection in the event of a "B" injection path failure	Not Required	Not cost beneficial. See Section F 6 9

TABLE F-7
PHASE II SAMA (CONT'D)

Phase II SAMA ID number	Phase I SAMA ID number	SAMA title	Source Reference of SAMA	Result of potential enhancement	Potential Cost	Phase 2 Disposition
10	221	Demonstrate RCIC operability following depressurization	83	This SAMA would increase the operators' options for low pressure vessel injection	Not Required	Not cost beneficial. See Section F 6 10.
11	242	Diversify the explosive valve operation	83	An alternate means of opening a pathway to the RPV for SBLC injection would improve the success probability for reactor shutdown.	Not Required	Not cost beneficial. See Section F 6.11
12	243	Enrich Boron	83	The increased boron concentration will reduce the time required to achieve the shutdown concentration. This will provide increased an increased margin in the accident timeline for successful operator activation of SBLC.	Not Required	Not cost beneficial See Section F 6.12.
13	265	4.d. Passive Overpressure Relief	17	This SAMA will prevent catastrophic failure of the containment. Controlled relief through a selected vent path has a greater potential for reducing the release of radioactive material than through a random break.	Not Required	Not cost beneficial See Section F.6 13
14	279	Control containment venting within a narrow band of pressure	83	This SAMA was derived form the Quad Cities Risk Insights document to establish a narrow pressure control band that would thereby prevent rapid containment depressurization when venting is implemented thus avoiding adverse impacts on the low pressure ECCS injection systems taking suction from the torus	Not Required	Not cost beneficial. See Section F 6.14.

TABLE F-8
ACCIDENT SEQUENCE RELEASE FREQUENCIES AS A FUNCTION OF CONSEQUENCE CATEGORY - SAMA #1

Consequence Category	Dominant Release Category	MAAP Case	Release Frequency (Per Rx Yr)	
			Base	SAMA
L2-1	H/E (LERF)	QC 0053 IA-L2-1A-NSPR	2.5E-7[(1)]	2.5E-7[(1)]
L2-2	H/I	QC 0082 IIA-L2-9C[(4)]	4.1E-8[(2)]	3.3E-8[(2)]
L2-3	H/L	None	--	--
L2-4	M/E	QC-0085 IVA-L2-14B-ED-WW	2.5E-7	2.4E-7
L2-5	M/I	QC 0061 IIA-I2-9a	8.0E-7[(3)]	5.6E-7[(3)]
L2-6	M/L	None	--	--
L2-7	L/E or LL/E	QC-057 ID-L2-7B NSPR	9.7E-9	9.7E-9
L2-8	L/I or LL/I or L/L or LL/L	QC 0058 ID-L2-7BA-SPRY	3.2E-7	3.2E-7
L2-9	Class V	QC OO70 V-L2-17	1.8E-8	1.8E-8
L2-10	Intact	QC 0074 IB-L2-22	5.0E-7	4.9E-7

(1) Does not include Class V (see L2-9)
(2) Includes H/I and H/L
(3) Includes M/I and M/L
(4) Containment fails at 45.9 hr.

TABLE F-9
ACCIDENT SEQUENCE TIMINGS AS A FUNCTION OF CONSEQUENCE CATEGORY - SAMA #2

Consequence Category	Dominant Release Category	MAAP Case	Release Frequency (Per Rx Yr)	
			Base	SAMA
L2-1	H/E (LERF)	QC 0053 IA-L2-1A-NSPR	2.5E-7[(1)]	1.7E-7[(1)]
L2-2	H/I	QC 0082 IIA-L2-9C[(4)]	4.1E-8[(2)]	4.1E-8[(2)]
L2-3	H/L	None	--	--
L2-4	M/E	QC-0085 IVA-L2-14B-ED-WW	2.5E-7	2.6E-7
L2-5	M/I	QC 0061 IIA-I2-9a	8.0E-7[(3)]	5.9E-7[(3)]
L2-6	M/L	None	--	--
L2-7	L/E or LL/E	QC-057 ID-L2-7B NSPR	9.7E-9	9.7E-9
L2-8	L/I or LL/I or L/L or LL/L	QC 0058 ID-L2-7BA-SPRY	3.2E-7	4.2E-7
L2-9	Class V	QC OO70 V-L2-17	1.8E-8	1.8E-8
L2-10	Intact	QC 0074 IB-L2-22	5.0E-7	6.6E-7

(1) Does not include Class V (see L2-9)
(2) Includes H/I and H/L
(3) Includes M/I and M/L
(4) Containment fails at 45.9 hr.

TABLE F-10
ACCIDENT SEQUENCE TIMINGS AS A FUNCTION OF CONSEQUENCE CATEGORY - SAMA #3

Consequence Category	Dominant Release Category	MAAP Case	Release Frequency (Per Rx Yr)	
			Base	SAMA
L2-1	H/E (LERF)	QC 0053 IA-L2-1A-NSPR	2.5E-7[(1)]	2.5E-7[(1)]
L2-2	H/I	QC 0082 IIA-L2-9C[(4)]	4.1E-8[(2)]	3.4E-8[(2)]
L2-3	H/L	None	--	--
L2-4	M/E	QC-0085 IVA-L2-14B-ED-WW	2.5E-7	2.5E-7
L2-5	M/I	QC 0061 IIA-I2-9a	8.0E-7[(3)]	7.3E-7
L2-6	M/L	None	--	--
L2-7	L/E or LL/E	QC-057 ID-L2-7B NSPR	9.7E-9	9.7E-9
L2-8	L/I or LL/I or L/L or LL/L	QC 0058 ID-L2-7BA-SPRY	3.2E-7	3.2E-7
L2-9	Class V	QC OO70 V-L2-17	1.8E-8	1.8E-8
L2-10	Intact	QC 0074 IB-L2-22	5.0E-7	4.5E-7

[(1)]Does not include Class V (see L2-9)
[(2)]Includes H/I and H/L
[(3)]Includes M/I and M/L
[(4)]Containment fails at 45.9 hr.

TABLE F-11
ACCIDENT SEQUENCE TIMINGS AS A FUNCTION OF CONSEQUENCE CATEGORY - SAMA #4

Consequence Category	Dominant Release Category	MAAP Case	Release Frequency (Per Rx Yr)	
			Base	SAMA
L2-1	H/E (LERF)	QC 0053 IA-L2-1A-NSPR	2.5E-7[(1)]	2.5E-7[(1)]
L2-2	H/I	QC 0082 IIA-L2-9C[(4)]	4.1E-8[(2)]	4.0E-8[(2)]
L2-3	H/L	None	--	--
L2-4	M/E	QC-0085 IVA-L2-14B-ED-WW	2.5E-7	2.5E-7
L2-5	M/I	QC 0061 IIA-I2-9a	8.0E-7[(3)]	7.9E-7[(3)]
L2-6	M/L	None	--	--
L2-7	L/E or LL/E	QC-057 ID-L2-7B NSPR	9.7E-9	9.7E-9
L2-8	L/I or LL/I or L/L or LL/L	QC 0058 ID-L2-7BA-SPRY	3.2E-7	3.2E-7
L2-9	Class V	QC OO70 V-L2-17	1.8E-8	1.8E-8
L2-10	Intact	QC 0074 IB-L2-22	5.0E-7	4.9E-7

[(1)]Does not include Class V (see L2-9)
[(2)]Includes H/I and H/L
[(3)]Includes M/I and M/L
[(4)]Containment fails at 45.9 hr.

TABLE F-12
ACCIDENT SEQUENCE TIMINGS AS A FUNCTION OF CONSEQUENCE CATEGORY - SAMA #5

Consequence Category	Dominant Release Category	MAAP Case	Release Frequency (Per Rx Yr)	
			Base	SAMA
L2-1	H/E (LERF)	QC 0053 IA-L2-1A-NSPR	2.5E-7[(1)]	2.5E-7[(1)]
L2-2	H/I	QC 0082 IIA-L2-9C[(4)]	4.1E-8[(2)]	4.1E-8[(2)]
L2-3	H/L	None	--	--
L2-4	M/E	QC-0085 IVA-L2-14B-ED-WW	2.5E-7	2.5E-7
L2-5	M/I	QC 0061 IIA-I2-9a	8.0E-7[(3)]	8.0E-7[(3)]
L2-6	M/L	None	--	--
L2-7	L/E or LL/E	QC-057 ID-L2-7B NSPR	9.7E-9	9.7E-9
L2-8	L/I or LL/I or L/L or LL/L	QC 0058 ID-L2-7BA-SPRY	3.2E-7	3.2E-7
L2-9	Class V	QC OO70 V-L2-17	1.8E-8	1.8E-8
L2-10	Intact	QC 0074 IB-L2-22	5.0E-7	5.0E-7

(1)Does not include Class V (see L2-9)
(2)Includes H/I and H/L
(3)Includes M/I and M/L
(4)Containment fails at 45.9 hr.

TABLE F-13
ACCIDENT SEQUENCE TIMINGS AS A FUNCTION OF CONSEQUENCE CATEGORY - SAMA #6

Consequence Category	Dominant Release Category	MAAP Case	Release Frequency (Per Rx Yr)	
			Base	SAMA
L2-1	H/E (LERF)	QC 0053 IA-L2-1A-NSPR	2.5E-7[(1)]	1.5E-7[(1)]
L2-2	H/I	QC 0082 IIA-L2-9C[(4)]	4.1E-8[(2)]	3.6E-8[(2)]
L2-3	H/L	None	--	--
L2-4	M/E	QC-0085 IVA-L2-14B-ED-WW	2.5E-7	2.0E-7
L2-5	M/I	QC 0061 IIA-I2-9a	8.0E-7[(3)]	7.7E-7[(3)]
L2-6	M/L	None	--	--
L2-7	L/E or LL/E	QC-057 ID-L2-7B NSPR	9.7E-9	1.3E-9
L2-8	L/I or LL/I or L/L or LL/L	QC 0058 ID-L2-7BA-SPRY	3.2E-7	4.3E-8
L2-9	Class V	QC OO70 V-L2-17	1.8E-8	1.8E-8
L2-10	Intact	QC 0074 IB-L2-22	5.0E-7	2.0E-7

(1) Does not include Class V (see L2-9)
(2) Includes H/I and H/L
(3) Includes M/I and M/L
(4) Containment fails at 45.9 hr.

TABLE F-14
ACCIDENT SEQUENCE TIMINGS AS A FUNCTION OF CONSEQUENCE CATEGORY - SAMA #7

Consequence Category	Dominant Release Category	MAAP Case	Release Frequency (Per Rx Yr)	
			Base	SAMA
L2-1	H/E (LERF)	QC 0053 IA-L2-1A-NSPR	2.5E-7[(1)]	2.5E-7[(1)]
L2-2	H/I	QC 0082 IIA-L2-9C[(4)]	4.1E-8[(2)]	4.1E-8[(2)]
L2-3	H/L	None	--	--
L2-4	M/E	QC-0085 IVA-L2-14B-ED-WW	2.5E-7	2.5E-7
L2-5	M/I	QC 0061 IIA-I2-9a	8.0E-7[(3)]	7.8E-7[(3)]
L2-6	M/L	None	--	--
L2-7	L/E or LL/E	QC-057 ID-L2-7B NSPR	9.7E-9	9.7E-9
L2-8	L/I or LL/I or L/L or LL/L	QC 0058 ID-L2-7BA-SPRY	3.2E-7	3.2E-7
L2-9	Class V	QC OO70 V-L2-17	1.8E-8	1.8E-8
L2-10	Intact	QC 0074 IB-L2-22	5.0E-7	5.0E-7

(1) Does not include Class V (see L2-9)
(2) Includes H/I and H/L
(3) Includes M/I and M/L
(4) Containment fails at 45.9 hr.

TABLE F-15
ACCIDENT SEQUENCE TIMINGS AS A FUNCTION OF CONSEQUENCE CATEGORY - SAMA #8

Consequence Category	Dominant Release Category	MAAP Case	Release Frequency (Per Rx Yr)	
			Base	SAMA
L2-1	H/E (LERF)	QC 0053 IA-L2-1A-NSPR	2.5E-7[1]	2.0E-7[1]
L2-2	H/I	QC 0082 IIA-L2-9C[4]	4.1E-8[2]	3.9E-8[2]
L2-3	H/L	None	--	--
L2-4	M/E	QC-0085 IVA-L2-14B-ED-WW	2.5E-7	2.2E-7
L2-5	M/I	QC 0061 IIA-I2-9a	8.0E-7[3]	7.8E-7[3]
L2-6	M/L	None	--	--
L2-7	L/E or LL/E	QC-057 ID-L2-7B NSPR	9.7E-9	5.5E-9
L2-8	L/I or LL/I or L/L or LL/L	QC 0058 ID-L2-7BA-SPRY	3.2E-7	1.8E-7
L2-9	Class V	QC OO70 V-L2-17	1.8E-8	1.8E-8
L2-10	Intact	QC 0074 IB-L2-22	5.0E-7	3.5E-7

(1)Does not include Class V (see L2-9)
(2)Includes H/I and H/L
(3)Includes M/I and M/L
(4)Containment fails at 45.9 hr.

TABLE F-16
ACCIDENT SEQUENCE TIMINGS AS A FUNCTION OF CONSEQUENCE CATEGORY - SAMA #9

Consequence Category	Dominant Release Category	MAAP Case	Release Frequency (Per Rx Yr)	
			Base	SAMA
L2-1	H/E (LERF)	QC 0053 IA-L2-1A-NSPR	2.5E-7[(1)]	2.5E-7[(1)]
L2-2	H/I	QC 0082 IIA-L2-9C[(4)]	4.1E-8[(2)]	4.1E-8[(2)]
L2-3	H/L	None	--	--
L2-4	M/E	QC-0085 IVA-L2-14B-ED-WW	2.5E-7	2.5E-7
L2-5	M/I	QC 0061 IIA-I2-9a	8.0E-7[(3)]	8.0E-7[(3)]
L2-6	M/L	None	--	--
L2-7	L/E or LL/E	QC-057 ID-L2-7B NSPR	9.7E-9	9.7E-9
L2-8	L/I or LL/I or L/L or LL/L	QC 0058 ID-L2-7BA-SPRY	3.2E-7	3.2E-7
L2-9	Class V	QC OO70 V-L2-17	1.8E-8	1.8E-8
L2-10	Intact	QC 0074 IB-L2-22	5.0E-7	5.0E-7

[(1)]Does not include Class V (see L2-9)
[(2)]Includes H/I and H/L
[(3)]Includes M/I and M/L
[(4)]Containment fails at 45.9 hr.

TABLE F-17
ACCIDENT SEQUENCE TIMINGS AS A FUNCTION OF CONSEQUENCE CATEGORY - SAMA #10

Consequence Category	Dominant Release Category	MAAP Case	Release Frequency (Per Rx Yr)	
			Base	SAMA
L2-1	H/E (LERF)	QC 0053 IA-L2-1A-NSPR	2.5E-7[(1)]	2.5E-7[(1)]
L2-2	H/I	QC 0082 IIA-L2-9C[(4)]	4.1E-8[(2)]	2.8E-8[(2)]
L2-3	H/L	None	--	--
L2-4	M/E	QC-0085 IVA-L2-14B-ED-WW	2.5E-7	2.3E-7
L2-5	M/I	QC 0061 IIA-I2-9a	8.0E-7[(3)]	3.7E-7[(3)]
L2-6	M/L	None	--	--
L2-7	L/E or LL/E	QC-057 ID-L2-7B NSPR	9.7E-9	9.7E-9
L2-8	L/I or LL/I or L/L or LL/L	QC 0058 ID-L2-7BA-SPRY	3.2E-7	3.2E-7
L2-9	Class V	QC OO70 V-L2-17	1.8E-8	1.8E-8
L2-10	Intact	QC 0074 IB-L2-22	5.0E-7	5.0E-7

[(1)]Does not include Class V (see L2-9)
[(2)]Includes H/I and H/L
[(3)]Includes M/I and M/L
[(4)]Containment fails at 45.9 hr.

TABLE F-18
ACCIDENT SEQUENCE TIMINGS AS A FUNCTION OF CONSEQUENCE CATEGORY - SAMA #11

Consequence Category	Dominant Release Category	MAAP Case	Release Frequency (Per Rx Yr)	
			Base	SAMA
L2-1	H/E (LERF)	QC 0053 IA-L2-1A-NSPR	2.5E-7[1]	2.5E-7[1]
L2-2	H/I	QC 0082 IIA-L2-9C[4]	4.1E-8[2]	4.1E-8[2]
L2-3	H/L	None	--	--
L2-4	M/E	QC-0085 IVA-L2-14B-ED-WW	2.5E-7	2.2E-7
L2-5	M/I	QC 0061 IIA-I2-9a	8.0E-7[3]	8.0E-7[3]
L2-6	M/L	None	--	--
L2-7	L/E or LL/E	QC-057 ID-L2-7B NSPR	9.7E-9	9.7E-9
L2-8	L/I or LL/I or L/L or LL/L	QC 0058 ID-L2-7BA-SPRY	3.2E-7	3.2E-7
L2-9	Class V	QC OO70 V-L2-17	1.8E-8	1.8E-8
L2-10	Intact	QC 0074 IB-L2-22	5.0E-7	5.0E-7

[1]Does not include Class V (see L2-9)

[2]Includes H/I and H/L

[3]Includes M/I and M/L

[4]Containment fails at 45.9 hr.

TABLE F-19
ACCIDENT SEQUENCE TIMINGS AS A FUNCTION OF CONSEQUENCE CATEGORY - SAMA #12

Consequence Category	Dominant Release Category	MAAP Case	Release Frequency (Per Rx Yr)	
			Base	SAMA
L2-1	H/E (LERF)	QC 0053 IA-L2-1A-NSPR	2.5E-7[(1)]	2.5E-7[(1)]
L2-2	H/I	QC 0082 IIA-L2-9C[(4)]	4.1E-8[(2)]	4.1E-8[(2)]
L2-3	H/L	None	--	--
L2-4	M/E	QC-0085 IVA-L2-14B-ED-WW	2.5E-7	2.4E-7
L2-5	M/I	QC 0061 IIA-I2-9a	8.0E-7[(3)]	8.0E-7[(3)]
L2-6	M/L	None	--	--
L2-7	L/E or LL/E	QC-057 ID-L2-7B NSPR	9.7E-9	9.7E-9
L2-8	L/I or LL/I or L/L or LL/L	QC 0058 ID-L2-7BA-SPRY	3.2E-7	3.2E-7
L2-9	Class V	QC OO70 V-L2-17	1.8E-8	1.8E-8
L2-10	Intact	QC 0074 IB-L2-22	5.0E-7	5.0E-7

(1) Does not include Class V (see L2-9)

(2) Includes H/I and H/L

(3) Includes M/I and M/L

(4) Containment fails at 45.9 hr.

TABLE F-20
ACCIDENT SEQUENCE TIMINGS AS A FUNCTION OF CONSEQUENCE CATEGORY - SAMA #13

Consequence Category	Dominant Release Category	MAAP Case	Release Frequency (Per Rx Yr)	
			Base	SAMA
L2-1	H/E (LERF)	QC 0053 IA-L2-1A-NSPR	2.5E-7(1)	2.5E-7(1)
L2-2	H/I	QC 0082 IIA-L2-9C(4)	4.1E-8(2)	3.7E-8(2)
L2-3	H/L	None	--	--
L2-4	M/E	QC-0085 IVA-L2-14B-ED-WW	2.5E-7	2.4E-7
L2-5	M/I	QC 0061 IIA-I2-9a	8.0E-7(3)	6.6E-7(3)
L2-6	M/L	None	--	--
L2-7	L/E or LL/E	QC-057 ID-L2-7B NSPR	9.7E-9	9.7E-9
L2-8	L/I or LL/I or L/L or LL/L	QC 0058 ID-L2-7BA-SPRY	3.2E-7	3.2E-7
L2-9	Class V	QC OO70 V-L2-17	1.8E-8	1.8E-8
L2-10	Intact	QC 0074 IB-L2-22	5.0E-7	5.0E-7

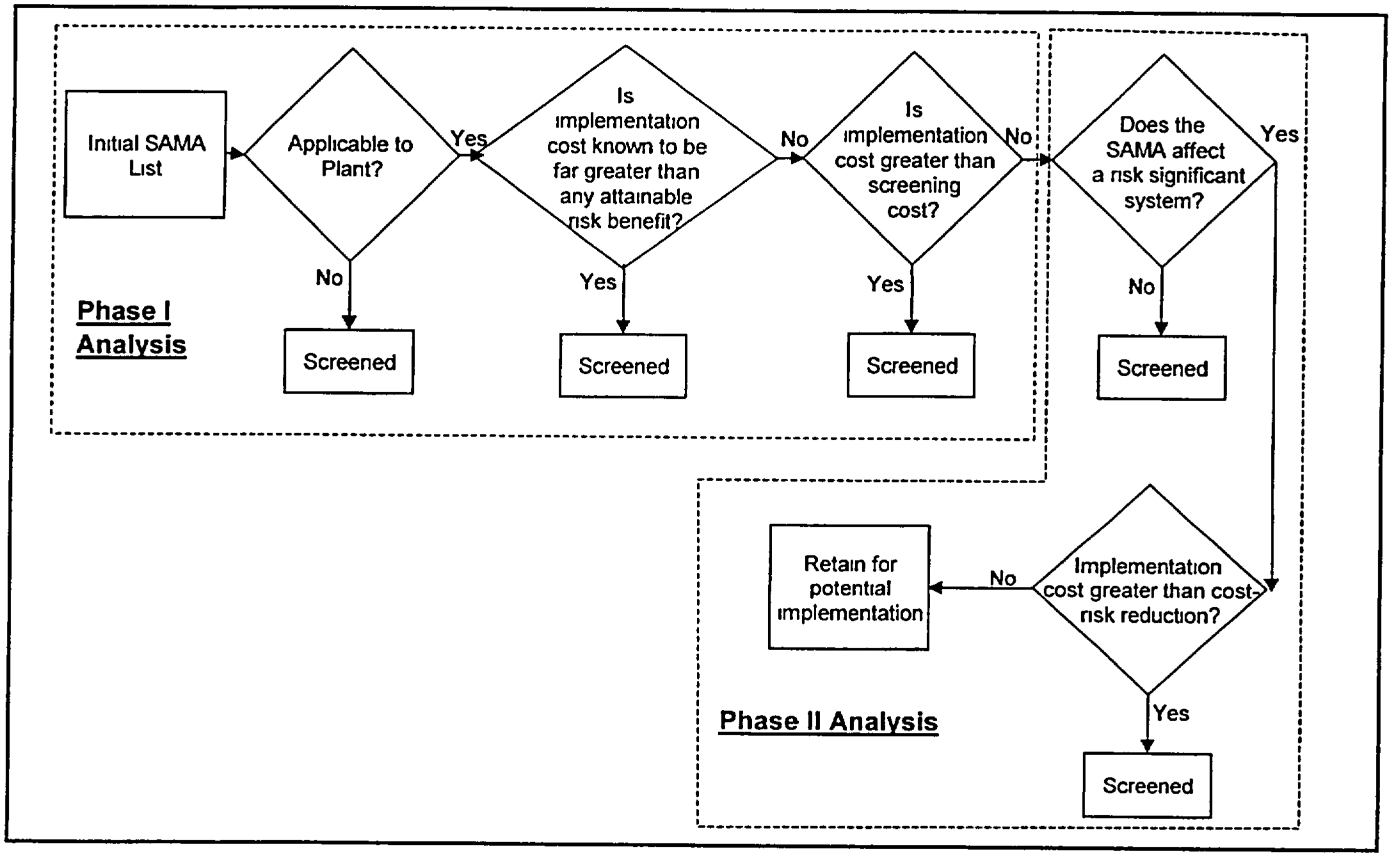
(1)Does not include Class V (see L2-9)
(2)Includes H/I and H/L
(3)Includes M/I and M/L
(4)Containment fails at 45.9 hr.

TABLE F-21
ACCIDENT SEQUENCE TIMINGS AS A FUNCTION OF CONSEQUENCE CATEGORY - SAMA #14

Consequence Category	Dominant Release Category	MAAP Case	Release Frequency (Per Rx Yr)	
			Base	SAMA
L2-1	H/E (LERF)	QC 0053 IA-L2-1A-NSPR	2.5E-7[(1)]	2.5E-7[(1)]
L2-2	H/I	QC 0082 IIA-L2-9C[(4)]	4.1E-8[(2)]	2.7E-8[(2)]
L2-3	H/L	None	--	--
L2-4	M/E	QC-0085 IVA-L2-14B-ED-WW	2.5E-7	2.2E-7
L2-5	M/I	QC 0061 IIA-I2-9a	8.0E-7[(3)]	3.4E-7[(3)]
L2-6	M/L	None	--	--
L2-7	L/E or LL/E	QC-057 ID-L2-7B NSPR	9.7E-9	9.7E-9
L2-8	L/I or LL/I or L/L or LL/L	QC 0058 ID-L2-7BA-SPRY	3.2E-7	3.2E-7
L2-9	Class V	QC OO70 V-L2-17	1.8E-8	1.8E-8
L2-10	Intact	QC 0074 IB-L2-22	5.0E-7	5.0E-7

[(1)]Does not include Class V (see L2-9)
[(2)]Includes H/I and H/L
[(3)]Includes M/I and M/L
[(4)]Containment fails at 45.9 hr.

FIGURE F-1
SAMA SCREENING PROCESS



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