Commonwealth Edison Company
1400 Opus Place
Downers Grove, IL 60515

ComEd

January 5, 1998

United States Nuclear Regulatory Commission
Washington, D. C. 20555-0001

Attention: Document Control Desk

SUBJECT: 90 Day Response to Generic Letter 97-04

Braidwood Nuclear Power Station, Units 1 and 2
Byron Nuclear Power Station, Units 1 and 2
Dresden Nuclear Power Station Units 2 and 3
LaSalle County Nuclear Power Station, Units 1 and 2
Quad Cities Nuclear Power Station, Units 1 and 2
Zion Nuclear Power Station, Units 1 and 2
NRC Docket Numbers 50-456 and 50-457
NRC Docket Numbers 50-454 and 50-455
NRC Docket Numbers 50-237 and 50-249
NRC Docket Numbers 50-373 and 50-374
NRC Docket Numbers 50-254 and 50-265
NRC Docket Numbers 50-295 and 50-304

Reference: a) Generic Letter 97-04, "Assurance of Sufficient Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal Pumps", dated 10/7/97

On October 7, 1997, the Nuclear Regulatory Commission issued the referenced Generic Letter regarding an issue which may have generic implications for Emergency Core Cooling System and Containment Heat Removal System pumps. The generic letter required, within 90 days, that licensees provide the information outlined below for each of their facilities:

1. Specify the general methodology used to calculate the head loss associated with the ECCS suction strainers.

2. Identify the required NPSH and the available NPSH.

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4. Specify whether containment overpressure (i.e., containment pressure above the vapor pressure of the sump or suppression pool fluid) was credited in the calculation of available NPSH. Specify the amount of overpressure needed and the minimum overpressure available.

5. When containment overpressure is credited in the calculation of available NPSH, confirm that an appropriate containment pressure analysis was done to establish the minimum containment pressure.

By this letter, ComEd is providing the required 90-day response. Please direct any comments that you may have with regard to this matter to this office.

Attachment: Generic Letter 97-04 Requested Information

cc: Regional Administrator - RIII
Director, Project Directorate III-2 - NRR
Braidwood Project Manager - NRR
Byron Project Manager - NRR
LaSalle Project Manager - NRR
Dresden Project Manager - NRR
Quad Cities Project Manager - NRR
Zion Project Manager - NRR
Senior Resident Inspector - Braidwood
Senior Resident Inspector - Byron
Senior Resident Inspector - Dresden
Senior Resident Inspector - LaSalle County
Senior Resident Inspector - Quad Cities
Senior Resident Inspector - Zion
Office of Nuclear Facility Safety - IDNS

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STATE OF ILLINOIS   Docket Nos.   50-456 and 50-457
50-454 and 50-455
50-237 and 50-249
50-373 and 50-374
50-254 and 50-265
50-295 and 50-304

IN THE MATTER OF

COMMONWEALTH EDISON (COMED) COMPANY

BRAIDWOOD NUCLEAR POWER STATION, UNITS 1 and 2
BYRON NUCLEAR POWER STATION, UNITS 1 and 2
DRESDEN NUCLEAR POWER STATION, UNITS 2 and 3
LASALLE COUNTY NUCLEAR POWER STATION, UNITS 1 and 2
QUAD CITIES NUCLEAR POWER STATION, UNITS 1 and 2
ZION NUCLEAR POWER STATION, UNITS 1 and 2

AFFIDAVIT

I affirm that the content of this transmittal is true and correct to the best of my knowledge, information and belief.

J. Hosmer
J. Hosmer
Vice President, Engineering

Subscribed and sworn to before me, a Notary Public in and for the State above named, this 5 day of JANUARY, 1998.

Brian J. Peterson
Notary Public   January 5, 1998

OFFICIAL SEAL
BRIAN J. PETERSON
NOTARY PUBLIC, STATE OF ILLINOIS
MY COMMISSION EXPIRES 4-11-99

Generic Letter 97-04 Requested Information
Dresden Station

1. *Specify the general methodology used to calculate the head loss associated with the ECCS suction strainers.*

This will be answered in terms of the methodology used for NPSH determination, including the head loss associated with the ECCS suction strainers. Beginning with the NPSH equation:

$$NPSHA = h_a + h_{st} - h_{vpa} - h_L$$

h_a = absolute pressure (in feet of liquid) on the surface of the liquid supply level

Containment overpressure is credited in the Dresden ECCS pumps' NPSH analysis. See response to Item # 4 for further discussion.

h_{st} = static height in feet that the liquid supply level is above or below the pump

The Technical Specification minimum suppression pool level was used including post-LOCA drawdown. The static height is referenced to the pump centerline.

h_{vpa} = absolute vapor pressure of the liquid in feet

NPSH-limiting containment response (pressure-temperature versus time) models were generated for both short and long-term post-LOCA scenarios. The suppression pool temperature responses generated as part of this effort are time-dependent and are provided in Reference 3.

h_L = all suction line losses (in feet) including entrance losses and friction losses

- ECCS suction strainer head loss was determined via a calculation (Reference 7) that used an equation for head loss based on an empirical data. Per discussions between the BWR Owners Group and the NRC Staff (Reference 10), strainer head loss information is limited to the current strainer design.
- A strainer plugging criteria of 1 out of 4 strainers 100% blocked was used per the original licensing basis (Reference 9).
- Pump runout flows (GE SIL 151) were used for short-term analyses.
- Throttled pump flows were used for long-term analyses.
- Pump suction side friction losses were increased to account for pipe aging.

2. *Identify NPSH Required (NPSHR) and NPSH Available (NPSHA)*

NPSHR is specific to each pump type and is dependent on flow rate. The source of NPSHR for the Dresden LPCI and Core Spray pumps are the original vendor pump curves (references 5 and 6). NPSHA is dependent on containment pressure, number of pumps operating (common suction), piping configuration and suppression pool temperature. NPSHR and NPSHA for the limiting cases for pumps taking suction from the suppression pool following a DBA-LOCA are provided in Table 1 below:

ECCS Pump	NPSHA (ft)	NPSHR (ft)	NPSH Margin (ft)
Short Term			
LPCI	46.2	35.8	10.4
Core Spray	45.5	38.5	7.0
Long Term			
LPCI	31.0	30.0	1.0
Core Spray	32.6	27.0	5.6

Table 1

The results provided for short-term are limited to less than 240 seconds post-LOCA, thus bounding the time of Peak Clad Temperature. Between 240 and 600 seconds, some cavitation may occur. Long-term is defined as greater than 600 seconds post-LOCA and includes operator action to throttle the ECCS pumps. NPSH margin is presented as a time-dependent curve in Dresden License Amendment submittal (reference 3, Attachment E, Figure 6.3-80).

3. *Specify whether the current design-basis NPSH analysis differs from the most recent analysis reviewed and approved by the NRC for which a safety evaluation was issued.*

References 5 and 6 identify the most recent NPSH analyses, which has been reviewed and approved by the NRC for which an SER was issued (License Basis), and this is documented in references 3 and 4. Dresden's current NPSH design basis analysis is equivalent to the above documented basis.

4. *Specify whether containment overpressure (i.e., containment pressure above the vapor pressure of the sump or suppression pool fluid) was credited in the calculation of available NPSH. Specify the amount of overpressure needed and the minimum overpressure available.*

Containment overpressure was credited in calculation of NPSHA (references 5 and 6). The amount of overpressure needed and the minimum overpressure available are provided in Table 2. The overpressure required and available are based on the current design basis and reflect values shown by the analysis. The containment overpressure available is the actual minimum pressure predicted in the containment analyses (references 1 and 2).

ECCS Pump	Containment Overpressure Required (psig)	Containment Overpressure Available (psig)
Short Term		
LPCI	5.1	11.7
Core Spray	6.5	11.7
Long Term		
LPCI	2.1	2.9
Core Spray	0.2	2.9

Table 2

If no containment overpressure is available (References 5 and 6):

a) in the short-term, the Core Spray pumps will cavitate immediately, resulting in reduced capacity.

b) in the long-term, with 3 or more LPCI pumps running, the pumps will begin cavitating at about 20 minutes post-LOCA. If there are 2 LPCI pumps or less running, no overpressure is required to satisfy NPSH requirements and the pumps will perform adequately.

5. *When containment overpressure is credited in the calculation of available NPSH, confirm that an appropriate containment pressure analysis was done to establish the minimum containment pressure.*

References 1 and 2 show the analyses performed to establish the minimum containment overpressure. The methodology used is consistent with the guidance provided in IN 96-55 and in Branch Technical Position CSB 6-1. Some of the methods used to minimize containment overpressure are:

- modelled drywell shell, vent system and torus shell as heat sinks to reduce pressures
- used conservative mixing factors (break flow to drywell atmosphere)
- used conservative initial conditions (minimized non-condensables, etc.)
- GE SIL 151 LPCI break flow modelled as spray to reduce short-term pressures
- modelling of containment spray to reduce long-term pressures

References

1. GENE-T2300740-1, "Dresden Nuclear Power Station, Units 2 and 3, Containment Analyses of the DBA-LOCA Based on Long-Term LPCI/Containment Cooling Configuration of One LPCI/Containment Cooling System Pump and 2 CCSW Pumps," December 1996.
2. GENE-T2300740-2, "Dresden Nuclear Power Station, Units 2 and 3, Containment Analyses of the DBA-LOCA Based on Long-Term LPCI/Containment Cooling Configuration of One LPCI/Containment Cooling System Pump and 2 CCSW Pumps-Additional Sensitivity Analyses," December 1996.
3. J. Stephen Perry Letter to U.S. NRC, dated February 17, 1997; Dresden Nuclear Power Station Units 2 and 3, Application for Amendment to Facility Operating Licenses DPR-19 and DPR-25, Appendix A, Technical Specifications, Section 3/4.7.K. "Suppression Chamber," and Section 3/4.8.C. "Ultimate Heat Sink." Docket Nos. 50-237 and 50-249
4. J. F. Stang Letter to Irene Johnson, dated April 30, 1997, Issuance of Amendments (TAC Nos. M97983 and M97984).
5. DRE-97-0010 Dresden LPCI/Core Spray NPSH Analysis Post-DBA LOCA: Long Term-Design Basis, Rev. 1
6. DRE-97-0012 Dresden LPCI/Core Spray NPSH Analysis Post-DBA LOCA: Short Term-Design Basis, Rev. 1
7. "ECCS Suction Hydraulic Analysis without the Strainers", Duke Engineering & Services Calculation Number DRE-96-0241, dated December 20, 1996.
8. "Supporting Calculations for the ECCS Suction Strainer Modification", Nutech File No. 64.313.3119, Rev. 1, dated June 22, 1983.
9. Dresden FSAR, Unit 3, Amendment 22, page 2-6
10 "BWROG Template for Utility 90-day Response to Generic Letter 97-04 (NPSH)", T. Rausch letter BWROG-97096 dated December 4, 1997

Generic Letter 97-04 Requested Information
Quad Cities Station

This attachment provides the Quad Cities Nuclear Power Station 90-day response to NRC Generic Letter 97-04, dated October 7, 1997, "Assurance of Sufficient Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal Pumps." This Generic Letter requested information that is identified and described in the five items of this attachment.

1. *Specify the general methodology used to calculate the head loss associated with the ECCS suction strainers.*

The head loss across the Emergency Core Cooling System (ECCS) suction strainers is one of the parameters that affects the net positive suction head available (NPSHA) at the ECCS pumps. NPSHA was determined using the following formula:

$$NPSHA = h_a + h_{st} - h_{vpa} - h_L$$

h_a = absolute pressure (in feet of liquid) on the surface of the liquid supply level

- This term is the containment pressure credited in the analysis. The amount of containment pressure credited in the NPSH analysis is detailed in Item Number 4 of this attachment.

h_{st} = static height in feet that the liquid supply level is above or below the pump

- This value is the height of the suppression pool water level above the centerline of the pump.
- Static height is based on the minimum suppression pool water level and includes consideration of suppression pool drawdown and recovery as applicable.

h_{vpa} = absolute vapor pressure of the liquid in feet

- This value is based on the temperature of the fluid being pumped. For the RHR and CS pumps, the maximum suppression pool temperature during the short term was used to determine the vapor pressure for the short term and the maximum pool temperature during the long term was used to determine the vapor pressure for the long term.

h_L = all suction line losses (in feet) including entrance losses and friction losses

- Includes losses for ECCS suction strainers and the piping and fittings between the strainers and the pump suctions.
- The clean head loss across the suction strainers is determined by calculation. Per discussions between the BWR Owners Group and the NRC Staff (Reference 9), strainer head loss information is limited to the current strainer design.
- One strainer on the common ECCS ring header is assumed 100% blocked, while the remaining three strainers are assumed clean.
- Pipe aging is considered by increasing the piping lengths by 20 percent.

2. *Identify NPSH Required (NPSHR) and NPSH Available (NPSHA)*

The NPSHR is determined from vendor supplied curves and is dependent on flow rate. NPSHA is dependent on containment pressure, number of pumps operating (if common suction), piping configuration and suppression pool temperature (see response to #1):

RHR and CS: Design Basis LOCA

Per Refs. 3 and 4, the bounding case for RHR and Core Spray NPSH is the Design Basis LOCA:

ECCS Pump	NPSHA (feet)	NPSHR (feet)	NPSH Margin (feet)	
Short Term				(Ref. 3)
RHR	48.0	40.2	7.8	
Core Spray	48.9	43.7	5.2	
Long Term				(Ref. 4)
RHR	32.6	30.0	2.6	
Core Spray	36.6	26.8	9.8	

The results provided for short term are limited to the first 240 seconds post-LOCA, thus bounding the time of peak clad temperature. Between 240 and 600 seconds post-LOCA, some cavitation may occur. During this time, there is no margin between NPSHA and NPSHR. Pump cavitation during this time is acceptable because the pumps will continue to supply adequate flow to the reactor, and tests performed on the pumps demonstrate that they can operate for up to 60 minutes in full cavitation without damaging pump internals. Short term cavitation has also been previously approved for Quad Cities Station by an SER (Ref. 7). The long term is defined as greater than 10 minutes post-LOCA and includes operator action to throttle the ECCS pumps.

HPCI: Small Break LOCA

Per Ref. 5, the bounding case for HPCI NPSH is a small break LOCA. For this case:

ECCS Pump	NPSHA (feet)	NPSHR (feet)	NPSH Margin (feet)	
HPCI	24.7	20.0	4.7	(Ref. 5)

3. *Specify whether the current design-basis NPSH analysis differs from the most recent analysis reviewed and approved by the NRC for which a safety evaluation was issued.*

The current and original Licensing Basis NPSH analysis, as documented in Section 6.3.3.2.9 of the Quad Cities UFSAR (Ref. 6), defines the bounding case for ECCS NPSH as the long term following a Design Basis LOCA when the suppression pool reaches its peak temperature. This section of the UFSAR describes how there is adequate containment overpressure available to provide sufficient NPSHA at the pumps in this bounding case. The original NPSH analysis, as approved by Ref. 8, stated that a few psi of containment pressure would be available to ensure sufficient NPSH for the pumps.

Refs. 3 and 4 provide the current Design Basis NPSH analyses for the RHR and CS pumps. These analyses address the NPSHA in the bounding case from the Licensing Basis. However, these analyses also consider the NPSHA during the short term before the RHR and CS pumps are throttled to their design flows.

The issue of credited containment pressure at Quad Cities Station was identified as an Inspector Follow-up Item (50-254/265-96020-06) in NRC Resident Inspection Report 50-254/265-69020.

4. *Specify whether containment overpressure (i.e., containment pressure above the vapor pressure of the sump or suppression pool fluid) was credited in the calculation of available NPSH. Specify the amount of overpressure needed and the minimum overpressure available.*

Containment overpressure was credited in the calculation of NPSHA for the RHR and CS pumps (Refs. 3 and 4). The amount of containment overpressure needed and the minimum overpressure available are provided in the table below:

ECCS Pump	Containment Overpressure Available (psig)	Containment Overpressure Required (psig)	
Short Term			(Ref. 3)
RHR	9.5	6.2	
Core Spray	9.5	7.3	
Long Term			(Ref. 4)
RHR	3.4	2.3	
Core Spray	3.4	-0.7	

Containment overpressure was not credited or required in the calculation of NPSHA for the HPCI pumps (Ref. 5).

5. *When containment overpressure is credited in the calculation of available NPSH, confirm that an appropriate containment pressure analysis was done to establish the minimum containment pressure.*

The current Design Basis containment overpressure analysis for Quad Cities was performed by General Electric in 1993. This analysis, like the Licensing Basis, was concerned with operation of the ECCS pumps in the long term, following a Design Basis LOCA. The current short term Design Basis NPSH analysis utilizes a containment analysis performed for Dresden Station by General Electric in 1997. Due to similarities between Dresden and Quad Cities Stations (i.e. identical decay heat curves and containment designs among others), the Dresden containment response during the short term is applicable to Quad Cities station as well. These analyses were performed to minimize the containment overpressure available and used assumptions consistent with NRC Information Notice 96-55.

Quad Cities Station is currently working with General Electric to revise the 1993 containment analysis (Ref. 1) to provide a Quad Cities containment pressure and temperature response for the short term and the long term post-LOCA. References 3 and 4 will be updated to include any overpressure changes as part of resolving Inspector Follow-up Item 50-254/265-96020-06.

References:

1. General Electric Report GENE-637-022-0893, "Evaluation of the Minimum Post-LOCA Heat Removal Requirements to Assure Adequate NPSH for the Core Spray and LPCI/Containment Cooling Pumps - Quad Cities Units 1 and 2."
2. General Electric Report GENE-T2300740-1, "Containment Analyses of the DBA-LOCA Based on Long Term LPCI/Containment Cooling Configuration of One LPCI/Containment Cooling System Pump and 2 CCSW Pumps - Dresden Units 2 and 3."
3. Calculation No. QDC-1000-M-0454, Rev. 0, "Short Term RHR/Core Spray Pump NPSH Analysis - Design Basis LOCA."
4. Calculation No. QDC-1000-M-0535, Rev. 0, "Long Term RHR/Core Spray Pump NPSH Analysis - Design Basis LOCA."
5. Calculation No. QDC-1000-M-0189, Rev. 1, "Quad Cities HPCI NPSH Evaluation for Units 1 and 2."
6. Quad Cities UFSAR, Section 6.3.3.2.9, "Net Positive Suction Head Availability."
7. Safety Evaluation Report, "Dresden/Quad Cities LPCI/RHR Pump Runout Analysis," dated January 4, 1977.
8. Safety Evaluation by the Division of Reactor Licensing, U.S. Atomic Energy Commission in the Matter of Commonwealth Edison Company Quad Cities Station Units 1 and 2, Docket Nos. 50-254 and 50-265, dated August 25, 1971.
9. "BWROG Template for Utility 90-day Response to Generic Letter 97-04 (NPSH)", T. Rausch letter BWROG-97096 dated December 4, 1997

Generic Letter 97-04 Requested Information
LaSalle County Station

1. *Specify the general methodology used to calculate the head loss associated with the ECCS suction strainers.*

This will be answered in terms of the methodology used for NPSH determination, including the head loss associated with the ECCS suction strainers. Beginning with the NPSH equation (based on "Pump Handbook", 2nd Edition):

$$NPSHA = h_a + h_{st} - h_{vpa} - h_L$$

h_a = absolute pressure (in feet of liquid) on the surface of the liquid supply level

Containment overpressure is not credited in the LaSalle ECCS pumps' NPSH analysis per Reference 1. Therefore, this term corresponds to atmospheric pressure.

h_{st} = static height (in feet) that the liquid supply level is above or below the pump

The LaSalle Technical Specification minimum suppression pool level was used including post-LOCA drawdown. The static height is referenced to the pump suction inlet centerline.

h_{vpa} = absolute vapor pressure on the surface of the liquid supply level (in feet)

Per Reference 1, the vapor pressure at a suppression pool temperature of 212°F is used for NPSH calculations.

h_L = all suction line losses (in feet) including entrance/strainer losses and friction losses

- Current ECCS suction strainer clean and fouled head losses are based on vendor drawing (Reference 2a - dimensional information) and supporting calculation (Reference 2b). Per discussions between the BWR Owners Group and the NRC Staff (Reference 7), strainer head loss information is limited to the current strainer design. Calculations and testing have been performed for the new strainers to be installed in response to NRC Bulletin 96-03 that indicate new strainer loss is bounded by current strainer loss (References 2c and 2d).
- All strainers were assumed 50% blocked per the original licensing basis (Reference 3).
- Pump/system runout flows were used.
- Pump suction side friction losses were increased to account for pipe aging.

2. *Identify NPSH Required (NPSHR) and NPSH Available (NPSHA)*

NPSHR is specific to each pump type and is dependent on flow rate. The source of NPSHR for the LaSalle ECCS pumps are the vendor pump curves. These values were recently re-validated with the pump manufacturer. NPSHA is dependent on containment pressure, piping configuration and suppression pool temperature. NPSHR and NPSHA for pumps taking suction from the suppression pool following a DBA-LOCA are provided in Table 1 below:

Table 1

ECCS Pump (#)	NPSHA[1] (ft)	NPSHR (ft)	Strainer Loss[2] (ft)	NPSH Margin (ft)	Suction Pipe[1] Flashing Margin (ft)
RHR (3)	19.4	14.0	4.1	1.3	8.3
LPCS (1)	19.6	2.0	4.1	13.5	8.5[3]
HPCS (1)	19.0	5.0	3.1	10.9	8.5[3]

[1] Reference 4, not including strainer head loss
[2] Reference 2b
[3] For these cases, suction pipe flashing is limiting

3. *Specify whether the current design-basis NPSH analysis differs from the most recent analysis reviewed and approved by the NRC for which a safety evaluation was issued.*

LaSalle's current design basis NPSH analysis differs from the most recent analysis reviewed and approved by the NRC. Reference 5 identifies the most recent NPSH analyses which has been reviewed and approved by the NRC for which an SER was issued (Reference 6). Reference 4 identifies LaSalle's current NPSH design basis analysis, which has been performed in support of the response to NRC Bulletin 96-03 and installation of new ECCS strainers. The design basis calculation was performed in accordance with the methodology provided in Item #1 above, and is different from the License Basis calculations in the following areas:

- increased suction piping friction losses to account for pipe aging
- includes suppression pool post-LOCA drawdown
- uses actual system runout flows based on testing

4. *Specify whether containment overpressure (i.e., containment pressure above the vapor pressure of the sump or suppression pool fluid) was credited in the calculation of available NPSH. Specify the amount of overpressure needed and the minimum overpressure available.*

LaSalle County Station is a Regulatory Guide 1.1 plant; therefore no overpressure is credited.

5. *When containment overpressure is credited in the calculation of available NPSH, confirm that an appropriate containment pressure analysis was done to establish the minimum containment pressure.*

LaSalle County Station is a Regulatory Guide 1.1 plant; therefore no overpressure is credited.

References

1. U.S. NRC Regulatory Guide 1.1

2. a. Permutit Drawing 556-31977 Rev. 2
   b. "Pressure Drop Across Suppression Pool Suction Strainer", LaSalle Calculation Number L-001646, dated January 2, 1998
   c. "Test Evaluation Report for Test TPP-VL0400-02", Duke Report No. TTP-VL0400-003, Rev. 0 dated November 19, 1997
   d. "ECCS and RCIC Suppression Pool Suction Strainer Head Loss for a 50% Plugged Strainer", LaSalle Calculation No. L-001260 dated 8/28/97

3. Response to Question 21.19, LaSalle FSAR, Amendment 24, September 1977

4. "Determination of Allowable Pressure Drop for ECCS Suction Strainers", LaSalle Calculation No. L-001249, August 20, 1997

5. a. High Pressure Core Spray (HPCS) Pump Available NPSH, Sargent & Lundy Calculation No. HP-04, Revision 1, August 2, 1977
   b. Low Pressure Core Spray (LPCS) Pump Available NPSH, Sargent & Lundy Calculation No. LP-06, Revision 1, August 2, 1977
   c. Residual Heat Removal (RHR) Pump Available NPSH, Sargent & Lundy Calculation No. RH-08, Revision 1, August 2, 1977

6. a. Safety Evaluation Report NUREG-0519, March 1981
   b. Safety Evaluation Report NUREG-0519, Supplement No. 1, June 1981

7. "BWROG Template for Utility 90-day Response to Generic Letter 97-04 (NPSH)", T. Rausch letter BWROG-97096 dated December 4, 1997

Generic Letter 97-04 Requested Information
Braidwood Station

In accordance with NRC Generic Letter 97-04, Braidwood Station has reviewed the current design basis analyses used to determine the available NPSH for emergency core cooling and containment heat removal pumps. The following is Braidwood Station's response to the five questions in Generic Letter 97-04:

1. *Specify the general methodology used to calculate the head loss associated with the ECCS suction strainers.*

The Braidwood ECCS recirculation sump design consists of inner, intermediate, and outer screens. The outer screen was designed to meet the Reference 1 criteria of a maximum coolant velocity of 0.2 ft/sec with one-half of the free surface area blocked. This approach was taken because the sump geometry did not allow for an inner screen of sufficient size to achieve this low velocity.

Reference 2 calculated the NPSH for the RH and CS pumps while in the recirculation mode of operation. This calculation assumed 50 percent of the inner ECCS sump screen to be available, which is consistent with the Reference 1 guidance. Losses through the intermediate and outer ECCS sump screens were neglected due to expected low velocities at the screens.

Calculation HELB-32 (Reference 3) is the ECCS sump blockage calculation. The methodology of this calculation consisted of determining the area in which a falling particle would impinge on the sump screen (termed "zone of influence"). The Reference 3 calculation was completed using specific undocumented/unqualified coatings inventories. Based on this, it was determined that the ECCS sump screen would potentially be approximately 81 percent blocked. Because this exceeded the originally assumed blockage of 50 percent, this calculation also included an NPSH verification. It was verified that the additional blockage (81 percent versus 50 percent) had negligible impact on NPSH margin.

2. *Identify NPSH Required (NPSHR) and NPSH Available (NPSHA)*

For the CS and RH pumps, the recirculation mode of operation gives the limiting NPSH requirement. The available NPSH for the CS and RH pumps was determined from the containment water level relative to the pump elevation and the pressure drop in the suction piping from the ECCS sump to the pumps as documented in Reference 2. For the CV and SI pumps, the end of the injection mode of operation gives the limiting NPSH requirement. For the CV and SI pumps, the available NPSH was determined from the elevation head and vapor pressure of the water in the RWST and the pressure drop in the suction piping from the RWST to the pumps as documented in Reference 4.

The required and available NPSH for the ECCS and CS pumps are listed in the table below:

Pump	NPSH Required (ft)	NPSH Available (ft)
CV*	21	35
SI*	25	37
RH**	19	25.1
CS**	22.5	26.8

* CV and SI values taken from Byron/Braidwood UFSAR Table 6.3-1

** CS and RH values taken from Calculation CS-5, Revision 3 (Reference 2)

3. *Specify whether the current design-basis NPSH analysis differs from the most recent analysis reviewed and approved by the NRC for which a safety evaluation was issued.*

A review was performed of the Byron/Braidwood UFSAR (Reference 5) and the NRC Safety Evaluation Report (Reference 6) to verify the methodology used for the current design basis NPSH analyses and the results of the analyses. This review confirmed that neither the methodology for calculating NPSH nor the acceptability of the analyses as documented in the above table have changed from that which was previously reviewed and approved by the NRC.

4. *Specify whether containment overpressure (i.e., containment pressure above the vapor pressure of the sump or suppression pool fluid) was credited in the calculation of available NPSH. Specify the amount of overpressure needed and the minimum overpressure available.*

As demonstrated in Reference 2 and stated in Reference 6, the Braidwood design basis calculation for NPSH for the RH and CS pumps conservatively assumes that the containment atmospheric pressure is equal to the vapor pressure of the liquid in the ECCS recirculation sumps ($h_a = h_{vpa}$), ensuring that no credit is taken for containment pressurization during the transient.

5. *When containment overpressure is credited in the calculation of available NPSH, confirm that an appropriate containment pressure analysis was done to establish the minimum containment pressure.*

Based on the response to Question #4 above, this question does not apply to Braidwood Station.

Generic Letter 97-04 Requested Information
Braidwood Station

References

1. NRC Regulatory Guide 1.82, Revision 0, "Sumps for Emergency Core Cooling and Containment Spray Systems"
2. Sargent & Lundy Calculation CS-5, Revision 3, "NPSHA for RHR & CS Pumps"
3. Sargent & Lundy Calculation HELB-32, Revision 0, "Containment Sump Blockage Due to the Postulated Failure of Undocumented/Unqualified Coatings"
4. Sargent & Lundy Calculation 88-0169, Revision 0, Fuel Pool Storage Tank & NPSH
5. Byron/Braidwood UFSAR Chapter 6.3, "Emergency Core Cooling Systems"
6. NUREG-0876, NRC SER for Byron Station, Section 6.2.2
7. NRC Regulatory Guide 1.1, "Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal System Pumps" (Safety Guide 1, 11/2/70)

Generic Letter 97-04 Requested Information
Byron Station

In accordance with NRC Generic Letter 97-04, Byron Station has reviewed the current design basis analyses used to determine the available NPSH for emergency core cooling and containment heat removal pumps. The following is Byron Station's response to the five questions that are contained in Generic Letter 97-04:

1. *Specify the general methodology used to calculate the head loss associated with the ECCS suction strainers.*

The Byron ECCS recirculation sump design consists of inner, intermediate, and outer screens. The outer screen was designed to meet the Regulatory Guide (R.G.) 1.82, Revision 0 design criteria (Reference 1) for maximum coolant velocity at the screen of 0.2 feet/second with one-half of the free surface area of the screen blocked. This approach was taken because the containment recirculation sump geometry did not allow for an inner screen of sufficient size to achieve the low velocity.

The net positive suction head (NPSH) for the Residual Heat Removal (RH) and Containment Spray (CS) pumps while in the recirculation mode of operation was calculated in Reference 2. The calculation was performed assuming 50% of the ECCS sump inner screen was blocked, which is consistent with the Reference 1 guidance. Head losses through the intermediate and outer ECCS sump screens were neglected due to the expected low coolant velocities at the screens.

Reference 3 is an ECCS sump blockage calculation that was performed in response to an identified issue at ComEd's Braidwood Station. However, the calculation is also applicable to Byron Station. The calculation was performed to evaluate the impact on the ECCS sump blockage assumptions. The methodology used for the calculation consisted of determining the area in which a falling particle would impinge on the sump screen. This area is termed the "zone of influence." The Reference 3 calculation was completed using specific undocumented/unqualified coating inventories. Based on this, it was determined that the inner ECCS sump screen would potentially be approximately 81% blocked instead of the 50% that was assumed in the design basis NPSH analysis. Because of this discrepancy with the original design basis, an additional NPSH verification was performed in Reference 4. It was verified that the additional assumed blockage (81% versus 50%) has a negligible impact on NPSH margin and therefore, the original design basis NPSH analysis remains valid.

2. *Identify NPSH Required (NPSHR) and NPSH Available (NPSHA)*

The calculation for determining the available NPSH for the RH and CS pumps is contained in Reference 2. For the RH and CS pumps, the recirculation mode of operation gives the limiting NPSH requirement. The available NPSH for the RH and CS pumps was determined from the vapor pressure and elevation head of the containment sump water level relative to the pump elevations and the pressure drop in the suction piping from the ECCS recirculation sump to the pumps. The calculation for determining the available NPSH for the Centrifugal Charging (CV) and Safety Injection (SI) pumps in contained in Reference 4. For the CV and SI pumps, the end of the injection mode of operation gives the limiting NPSH requirement. For the CV and SI pumps, the available NPSH was evaluated from the elevation head and vapor pressure of the water in the RWST and the pressure drop in the suction piping from the RWST to the pumps.

The required and available NPSH for the ECCS pumps are listed in the table below:

ECCS Pump	NPSH Required (ft)	NPSH Available (ft)
CV*	21	35
SI*	25	37
RH**	19	25.1
CS**	22.5	26.8

* CV and SI Values taken from B/B UFSAR Table 6.3-1
** RH and CS Values taken from Calculation CS-5, Revision 3 (Reference 2)

3. *Specify whether the current design-basis NPSH analysis differs from the most recent analysis reviewed and approved by the NRC for which a safety evaluation was issued.*

A review was performed of the Byron/Braidwood UFSAR (Reference 5) and the NRC Safety Evaluation Report (Reference 6) to verify the methodology used for the current design basis NPSH analysis and the results of the analysis. This review confirms that neither the methodology for calculating NPSH nor the acceptability of the analysis as documented in the above table has changed from that which was previously reviewed and approved by the NRC.

4. *Specify whether containment overpressure (i.e., containment pressure above the vapor pressure of the sump or suppression pool fluid) was credited in the calculation of available NPSH. Specify the amount of overpressure needed and the minimum overpressure available.*

The design basis calculation for NPSH for the RH and CS pumps for Byron Station is consistent with NRC Regulatory Guide 1.1, (Reference 7). In other words, the calculation assumes that the containment atmospheric pressure is equal to the vapor pressure of the liquid in the ECCS recirculation sumps. Therefore no containment overpressure is credited in the analysis.

5. *When containment overpressure is credited in the calculation of available NPSH, confirm that an appropriate containment pressure analysis was done to establish the minimum containment pressure.*

Based on the response to question #4 above, this question does not apply to Byron Station.

References

1. NRC Regulatory Guide 1.82, Revision 0, "Sumps for Emergency Core Cooling and Containment Spray Systems"
2. Sargent & Lundy Calculation CS-5, Revision 3, "NPSHA for RHR and CS Pumps," dated August 30, 1985.
3. Sargent & Lundy Calculation HELB-32, Revision 0, "Containment Sump Blockage Due to the Postulated Failure of Undocumented/Unqualified Coatings," dated December 19, 1986.
4. Sargent & Lundy Calculation 88-0169, Revision 0, "Fuel Pool Storage Tank and NPSH" dated August 1, 1988.
5. Byron/Braidwood UFSAR Chapter 6.3, "Emergency Core Cooling Systems."
6. NUREG-0876, NRC Safety Evaluation Report (SER) for Byron Station, Section 6.2.2.
7. NRC Regulatory Guide 1.1, "Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal System Pumps (Safety Guide 1, 1/2/70)."

Generic Letter 97-04 Requested Information
Zion Station

In accordance with Reference 1, Zion Station has reviewed the current design basis analyses used to determine the available Net Positive Suction Head (NPSH) for the Emergency Core Cooling System (ECCS) and Containment Spray (CS) pumps that meet either of the following criteria stated in the GL:

(1) pumps that take suction from the containment sump or suppression pool following a design-basis LOCA or secondary line break, or
(2) pumps used in "piggyback" operation that are necessary for recirculation cooling of the reactor core and containment (that is, pumps that are supplied by pumps which take suction directly from the sump or suppression pool)."

Based on this review, the information requested by the Generic Letter is provided as follows.

General Information
The pumps which fit the above criteria are the Safety Injection (SI), Charging, and Residual Heat Removal (RHR) pumps. The RHR pumps are the only pumps that take suction directly from the recirculation sump following a Loss of Coolant Accident (LOCA). During the injection phase of a LOCA the ECCS and CS pumps take suction from the Refueling Water Storage Tank (RWST). During the recirculation phase of a LOCA the RHR pumps supply suction to the SI and Charging pumps. During recirculation, the RHR pumps also supply flow to the containment spray nozzles (but not to the CS pumps), if necessary. The CS pumps are not required during the recirculation phase of a LOCA.

1. *Specify the general methodology used to calculate the head loss associated with the ECCS suction strainers.*

The general methodology used to calculate the head loss associated with the ECCS suction strainers is described in Reference 2 which was provided to the NRC in Reference 3. The methodology is based on a Sargent & Lundy engineering standard. The relevant portion of this standard was provided to the NRC in Reference 4. This standard uses the ratio of screen open area to screen total area. A loss coefficient associated with this ratio is then read from a figure. The source of the figure in the Sargent & Lundy standard is "Local Resistance to Flow," Louis Dodge, Product Engineering - March 1974, page 68 (Reference 5).

2. *Identify NPSH Required (NPSHR) and NPSH Available (NPSHA)*

The required and available NPSH are as follows:

Pump	Required NPSH	Available NPSH	Suction Source
SI	25 ft	82 ft	RHR pump discharge
Charging	23 ft	33 ft	RHR pump discharge
RHR	20 ft	21.44 ft	Recirculation Sump

3. *Specify whether the current design-basis NPSH analysis differs from the most recent analysis reviewed and approved by the NRC for which a safety evaluation was issued.*

The most recent NPSH analysis reviewed and approved by the NRC for which a safety evaluation was issued for the RHR pumps is the analysis described in the FSAR (response to FSAR Q 6.16). This analysis was not explicitly mentioned in the original Safety Evaluation Report (SER) dated October 10, 1972. Neither, the FSAR, nor the SER describe the NPSH analysis for the SI and Charging pumps while in the "piggyback" operation. However, the FSAR stated that the minimum NPSH for the SI and Charging pumps would occur when the pumps were taking suction from the RWST.

The current design basis RHR pump NPSH analysis differs from that described in the FSAR. The required and available RHR pump NPSH values stated in UFSAR Table 6.0-1 have been modified by UFSAR Change Request 97-004. The changes to the NPSH values have been approved under the 10CFR50.59 process by Zion Safety Evaluation 97-002. The required NPSH for the RHR pumps was conservatively revised from 19 ft to 20 ft to account for uncertainties in reading the required NPSH value from the original equipment manufacturer's pump curve. The available RHR pump NPSH was revised from 24.9 ft to 21.44 ft to reflect the more recent calculation (Reference 2). This analysis was subsequently provided to the NRC in Reference 3.

The current design basis NPSH analysis for the SI and Charging pumps in the recirculation mode is documented in a calculation (Calculation NED-M-MSD-83 Rev. 1, 1/15/94, "Zion Safety Injection and Charging Pumps NPSH Evaluation - Recirculation Mode") which determines the available NPSH for the SI and Charging pumps while they are used in "piggyback" operation with water supplied by the RHR pumps. The minimum available NPSH for the SI pumps is 82 feet. The minimum available NPSH for the Charging pumps is 33 feet. This analysis has not been reviewed and approved by the NRC. Although UFSAR Table 6.0-1 indicates that the required SI pump NPSH is 22 ft at a runout flow of 650 gpm, the pump manufacturer's pump curves show that the required NPSH at a flow of 650 gpm is approximately 24-25 ft. Accordingly, a value of 25 ft has been conservatively provided in the response to Question 2, and ComEd has initiated action to ensure that the correct value is indicated in the UFSAR.

4. *Specify whether containment overpressure (i.e., containment pressure above the vapor pressure of the sump or suppression pool fluid) was credited in the calculation of available NPSH. Specify the amount of overpressure needed and the minimum overpressure available.*

As described in References 2 and 4, the containment pressure above the vapor pressure of the sump fluid is not credited in the calculation of available NPSH for the RHR pumps. The RHR NPSH calculation assumes that the sump water is saturated such that the vapor pressure of the sump water is equal to the containment pressure.

5. *When containment overpressure is credited in the calculation of available NPSH, confirm that an appropriate containment pressure analysis was done to establish the minimum containment pressure.*

As described in the response to question 4, containment overpressure is not credited in the calculation of available NPSH.

References

1) NRC GL 97-04, "Assurance of Sufficient Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal Pumps," dated October 7, 1997

2) "RHR Pump Available NPSH During the Post-LOCA Recirculation Phase," Calculation 22S-B-008M-092 Rev. 2, January 17, 1997

3) "Submittal of Requested Documentation," letter from J. Mueller, ComEd to NRC, dated February 5, 1997

4) "Response to Request for Additional Information Concerning Containment Coatings," letter from J. Brons, ComEd to NRC, dated September 5, 1997

5) "Local Resistance to Flow," Louis Dodge, Product Engineering - March 1974, page 68