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SUBJECT: Submits response to GL 97-04, "Assurance of Sufficient Net Positive Suction Head for Emergency Core Cooling & Containment Heat Removal Pumps," dtd 971007.

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ROBERT C. MECREDY
Vice President
Nuclear Operations

January 6, 1998

U.S. Nuclear Regulatory Commission
Document Control Desk
Attn: Guy S. Vissing
Project Directorate I-1
Washington, DC 20555

Subject: Response to Generic Letter 97-04
R.E. Ginna Nuclear Power Plant
Docket No. 50-244

Ref.(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

Dear Mr. Vissing:

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 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 NPSHR and the available NPSHA.

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.

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.

A076 1/1

Attachment A provides the information requested by the generic letter.

Very truly yours,

Robert C. Mecredy

Robert C. Mecredy

Attachment
GJW\490

Subscribed and sworn to before me
on this 6th day of January, 1998.

Deborah A. Piperni
Notary Public

DEBORAH A.PIPERNI
Notary Public in the State of New York
ONTARIO COUNTY
Commission Expires Nov. 23, 1999

xc: Mr. Guy Vissing (Mail Stop 14B2)
Project Directorate I-1
Washington, D.C. 20555

U.S. Nuclear Regulatory Commission
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Ginna Senior Resident Inspector

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

The only pumps at Ginna that take suction from the containment sump "B" are the Residual Heat Removal (RHR) pumps. Using a different piping line-up, these 2 pumps also provide the low head safety injection function post accident, as well as providing the decay heat removal function during a controlled cooldown to cold shutdown for refueling. Ginna does not utilize suction strainers on the inlet of the RHR pumps or containment sump suction piping. Sump "B" is a concrete well extending 8-1/2 feet below the reactor building floor elevation of 235'-8". The sump is partially covered with a checkered plate. A stainless steel grating covers the remaining area. The grating area is 13.5 feet x 3.5 feet and the openings are 3.81" x 1". Inside the sump is a 3/16" Johnson stainless steel screen. This screen is approximately vertical and extends the full width of the sump. All water falling through the grating and into the sump must travel through this screen in order to be drawn into the suction piping leading to the RHR pumps. There are two suction lines leading out of sump "B" to the RHR pumps. The piping is nominally 8" (7.62 ID) and the suction end of the piping is fitted with a 20" ID bellmouth. The centerline of the suction piping is 7'-3/4" below the containment floor. A 6" high concrete curbing also surrounds sump "B".

The general methodology used to determine the head loss across the sump "B" suction screen due to post LOCA debris was determined utilizing the following: Regulatory Guide 1.82, Rev. 1; NUREG/CR-2403, Supplement 1; NUREG/CR-2982, Rev. 1; NUREG-0897, Rev. 1; NUREG/CR-2791; and Transco Products Inc. Report TWQ-002, Rev. 3 (Thermal-Wrap Nuclear Insulation System Test Report Index). The procedure determined the volume of debris generated as a result of a large break loss of coolant accident (LBLOCA). As described in Regulatory Guide 1.82 Rev.1, insulation was assumed to be removed in a seven-pipe diameter radius from the centerline of the break, in a three-region configuration. NUREG-0897, Rev. 1 describes the three regions. As Ginna Station is an RCS leak-before-break plant, the mechanism for insulation debris reaching containment sump "B" is by transport due to the sump recirculation flow, since insulation transport directly to the sump as a result of jet forces is not considered The velocity of the fluid at the sump "B" screen was determined by considering the area of the screen and the maximum flow rate based on two-pump operation of 2500 gpm per pump. Since the emergency operating procedures require throttling of RHR flow to 1500 gpm per pump, the velocity used in the calculation was conservative by approximately 50% including RHR flow instrument uncertainty. An estimation of the head loss as a result of sump screen blockage from fibrous insulation was determined using the formula of the form

$\Delta H = a \cdot U^{b} \cdot t^{c}$,

Where,

a, b, and c are coefficients derived from experimentation for the specific fibrous material in use,

U is the approach velocity, and

t (thickness) is the volume of debris divided by screen area.

The coefficients were taken from Transco Products Test Report No. ITR-92-03N. Shreds versus fragments were assumed in the evaluation, because this represented the more conservative characteristics for each of the materials considered. The head loss equation becomes,

$$\Delta H = 72.0 \times U^{1.48} \times t^{0.938}$$

The evaluation conservatively determined the head loss to be 0.95 feet.

2. Identify the required and the available NPSH.

During the injection phase post-accident, the emergency core cooling system (ECCS) pumps take suction from the refueling water storage tank (RWST). Following postulated loss of coolant accidents (LOCA), once the RWST has been depleted to the specified level (28%), actions are initiated to transfer the suctions of the RHR pumps to containment sump "B". The only pumps at Ginna that take suction directly from sump "B" are the RHR pumps. Each RHR pump discharges through a heat exchanger and control valves, and injects to the reactor vessel upper plenum via separate headers, through core deluge valves. The other ECCS pumps are the high head safety injection pumps (SI) and the containment spray (Spray) pumps. Ginna has three SI pumps and two Spray pumps. The SI and Spray pumps have the ability to take suction from the RHR pumps' discharge piping. Operators direct valve re-alignment to the sump recirculation phase by emergency procedures.

In accordance with Ginna emergency procedures, at a specified RWST level the RHR pumps are stopped. The suctions of the RHR pumps are then transferred to sump "B", and the pumps are re-started, while the SI and Spray pumps continue to take suction from the RWST. At the specified level, SI and Spray pumps are stopped. This ensures a continuation of ECCS flow during switchover to the sump recirculation phase. Criteria have been developed, to ensure adequate core cooling, for operators to restart one or two SI pumps taking suction from the RHR pumps, if needed. For the Ginna design, there are no design-basis accidents that define the need to re-start a Spray pump in the sump recirculation phase, since there are no analyzed accidents that demonstrate a repressurization of containment in the sump recirculation phase. Beyond design-basis conditions were examined to formulate criteria to be applied in emergency procedures that would allow re-start of a Spray pump while providing adequate NPSH for the RHR pump. The criteria for containment pressure was determined to be 22 psig minimum, assuming sump "B" is saturated at 28 psia, which is the highest pressure that could exist at the earliest time of switchover to sump recirculation.

RG&E has performed analyses to determine NPSH results for the ECCS pumps for design-basis accidents, during the injection and recirculation phases post-accident. The analyses performed showed that the assumptions made to generate the limiting accident analysis results (Chapter 15) for parameters such as core integrity, peak clad temperature, and containment response were not the limiting assumptions with respect to NPSH. Consequently, the limiting assumptions for NPSH were developed and form the basis for the NPSH analyses. Since the generic letter requests NPSH for pumps taking suction from the containment sump, the results included in this response apply to the sump recirculation phase and not the injection phase. In all cases, the recirculation phase represented the limiting set of results.

The results reported below involve the limiting conditions based on pump combinations.

Condition	Pump	NPSHA (ft) *	NPSHR (ft)
1	RHR pump A	13.8	8.2
2	RHR pumps A and B	13.3**	6.7
3	RHR pump A	13.5	8.9
	SI pump C	192	35
4	RHR pump A	11.45	10.4
	SI pump A	163	22
	SI pump B	164	20.5
5	RHR pump A	27.0	13.7
	SI pump C	66.3	31
	Spray pump A	73.5	27

* Values exclude loss due to sump "B" suction screen

** The NPSHA benefit due to the subcooling of inlet water from the cooler RHR minimum flow recirculated water is not included in this value, since there is a large NPSH margin.

<u>Condition 1</u>

- One RHR pump operating alone (No SI or Spray)
- One suction valve from sump "B" to RHR pump fails to open
- Both reactor deluge injection lines open
- RHR pump head/capacity assumed non-degraded
- Sump "B" water and containment pressure assumed saturated at 14.7 psia
- RHR flow throttled to 1500 gpm prior to switchover

<u>Condition 2</u>

- Two RHR pumps operating (No SI or Spray)
- Two suction lines from sump "B" to RHR pumps open
- Both reactor deluge injection lines open
- RHR flow throttled to 1500 gpm prior to switchover
- RHR pump head/capacity assumed non-degraded
- Sump "B" water and containment pressure assumed saturated at 14.7 psia

<u>Condition 3</u>

- One RHR pump and one SI pump operating
- One suction valve from sump "B" to RHR pump fails to open
- Both reactor deluge injection lines open
- RHR flow throttled to 1500 gpm prior to switchover
- RHR and SI pump head/capacity assumed non-degraded
- Sump "B" water and containment pressure assumed saturated at 14.7 psia
- Core exit temperature and RVLIS level meet start criteria for one SI pump

Condition 4

- One RHR pump and two SI pumps operating
- One suction valve from sump "B" to RHR pump fails to open
- Both reactor deluge injection lines open
- RHR flow throttled to 1500 gpm prior to switchover
- RHR and SI pumps head/capacity assumed non-degraded
- Sump "B" water and containment pressure assumed saturated at 14.7 psia
- Core exit temperature and RVLIS level meet start criteria for two HHSI pumps

Condition 5

- One RHR pump, one SI pump, and one Spray pump operating
- One suction valve from sump "B" to RHR pump fails to open
- Both reactor deluge injection lines open
- RHR flow throttled to 1500 gpm prior to switchover
- RHR, SI, and Spray pump head/capacity assumed non-degraded
- Containment sump "B" water saturated at 28 psia (246.4 °F)
- Containment pressure at 22 psig
- RCS pressure 57 psi above containment pressure

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.**

An NRC SER for NPSH has not been developed for Ginna. An NRC review of RG&E NPSH calculations, however, has been performed several times during safety system functional (SSFI) and engineering inspections. The SSFI on the RHR system, Inspection 89-81 dated May 9, 1990, documented an unresolved item 89-81-03 involving RHR NPSH. As follow-up to that review, the following inspections documented the closure of NRC review of RG&E Design Analysis NSL-0000-DA-027, "Residual Heat Removal (RHR) Pump NPSH Calculations During Accident Conditions": NRC Inspection 90-26 dated January 26, 1991, Section 3.3; NRC Inspection 91-11 dated June 6, 1991, Section 3.2.2; and NRC Inspection 92-08 dated June 11, 1992, Section 6.2.1. The NPSH calculations were again reviewed during the R. E. Ginna Nuclear Power Plant Design Inspection, NRC Inspection Report 97-201, dated September 24, 1997. Item E1.3.2.2 (d) of that report discussed several items pertaining to NPSH, and, as a result, RG&E stated that a revision to the Design Analysis would be prepared to update the analysis to include several changes that had the effect of slightly increasing the NPSH margin. Revision of the analysis was identified as an inspector follow-up item, 97-201-12. The revised NPSH results are those tabulated above.

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 has not been assumed in the calculations for NPSH available for RHR or SI pumps for plant design basis events, involving any postulated single active

failures. This means that in the equation, $NPSHA = P_{atm} + P_{el} - P_{loss} - P_{vp}$, the $P_{atm} - P_{vp}$ terms equate to zero. It has been assumed in the calculations that the sump and containment pressures are saturated at 14.7 psia, and the limiting component failures occur. This would represent the limiting case with respect to NPSH. The containment pressure profile based on the containment integrity LOCA analysis is depicted on Figure 6.2-1 of the UFSAR. This is associated with the combination of operating ECCS components that result in the highest containment pressure. Based on the number of components assumed to be operating, the time to switchover can be estimated. It has been found that in this particular analysis the containment pressure would not have been reduced to atmospheric conditions at the time of switchover. Depending on the assumed component failures, the containment pressure and fluid temperature of the sump would also vary accordingly. Other analyses could lead to a shorter time to reach switchover, but would also result in lower containment pressure. Such factors as the number of containment recirculation fan coolers and number of Spray pumps in operation during the injection phase, the number of RHR heat exchangers, the number of component cooling water heat exchangers, and number of service water pumps in operation affect the temperatures as well. As each transient progressed, the rate of containment and sump fluid cooldown would also vary. The evaluation of sump performance during recirculation concluded that saturated conditions would eventually be reached if the containment fan coolers were operated. Hence, without regard for the time after switchover, RG&E has assumed saturated conditions between containment pressure and the fluid temperature of the sump for the limiting NPSH calculations. Since NPSH margin exists for the ECCS pumps when taking suction from sump "B", there is no need to assume an overpressure condition for the Ginna design basis events.

- It is noted that as part of the Ginna RHR system design, cooler water from the RHR minimum flow piping is returned to the pump suction piping where it mixes with the hotter water from sump B. This produces a subcooling of the water upstream of the pumps resulting in an NPSHA benefit.

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.**

Containment overpressure is not credited for any design-basis accidents, involving any postulated single active failures. The emergency operating procedures specify the value of containment pressure to be applied as criteria for re-initiation of containment spray if a single RHR pump is operating. The value of containment pressure applied as criteria represents a beyond-design-basis condition only.

Although containment overpressure is not credited, a review of containment pressure and temperature versus time curves indicates that containment overpressure would exist at the beginning of Sump "B" recirculation. Since Ginna Station was licensed prior to the publication of Regulatory Guide 1.1, and has never committed to use that guide, containment overpressure could be credited to add margin to the NPSH calculations. RG&E at this time has not chosen to do so.