August 29, 2001

MEMORANDUM TO: John T. Larkins, Executive Director
Advisory Committee on Reactor Safeguards

FROM: Michael E. Mayfield, Director /RA/
Division of Engineering Technology
Office of Nuclear Regulatory Research

SUBJECT: RES'S PROPOSED RECOMMENDATION FOR RESOLUTION OF GSI-191, "ASSESSMENT OF DEBRIS ACCUMULATION ON PWR SUMP PERFORMANCE"

On September 5, 2001, the Office of Nuclear Regulatory Research (RES), is scheduled to brief the Advisory Committee on Reactor Safeguards (ACRS), on the status of Generic Safety Issue 191 (GSI-191), "Assessment of Debris Accumulation on PWR Sump Performance." GSI-191 deals with the possibility that debris could accumulate on the Emergency Core Cooling System (ECCS) sump screen resulting in a loss of net positive suction head margin ($NPSH_{margin}$), and the potential loss of ECCS cooling. The purpose of coming to ACRS is to inform them of the process that will be followed in the resolution of GSI-191; present risk, benefit, and cost results; and to share proposed RES recommendations to the Office of Nuclear Reactor Regulation (NRR) . Although not specifically requested, RES will welcome comments from the ACRS, and will consider them as we finalize the recommendations that will be sent to NRR.

Based on a user need request from NRR, RES designated the sump screen blockage concern a GSI in 1996, under the generic issue process contained in RES Office Letter 7, "Procedures for Identification, Prioritization, Resolution, and Tracking of Generic Issues," and NUREG-0933, "A Prioritization of Generic Safety Issues." NRC is currently finalizing Management Directive 6.4 (MD 6.4), "Generic Issue Process," to ensure an effective and efficient generic issue resolution process. GSI-191 is being transitioned into the MD 6.4 process. In the NUREG-0933 process, GSI-191 is near the end of the Resolution Stage, which corresponds to the Technical Assessment: Stage 3, in MD 6.4. Upon completion of this stage, RES will transmit the findings and its recommendation for resolution of GSI-191 to the Director, NRR. NRR will have lead responsibility for the remaining steps in the generic issue process: Regulation and Guidance Development: Stage 4, Regulation and Guidance Issuance: Stage 5, Implementation: Stage 6, and Verification: Stage 7.

In July 2001, RES briefed the ACRS on the GSI-191 parametric evaluation performed to determine whether loss of $NPSH_{margin}$ was a credible concern. The GSI-191 study included data collection from operating PWRs, phenomenological testing, computational simulation, and engineering analyses. The following provides an overview of (1) parametric evaluation, (2) core damage frequency contribution estimates, and (3) benefit and cost analyses.

1. In the event of a LOCA within the containment of a PWR, thermal insulation and other materials (e.g., coatings and concrete) in the vicinity of the break may be damaged and dislodged. A fraction of this material may be transported to the recirculation (or

emergency) sump and accumulate on the screen. The debris that accumulates on the sump screen could form a bed that acts as a filter. Excessive head loss across the debris bed may exceed the $NPSH_{margin}$ of the ECCS or containment spray pumps. For sump screens that are only partially submerged by water on the containment floor, excessive head loss across the debris bed may prevent water from entering the sump. Thus, excessive head loss could prevent or impede the flow of water into the core.

From information collected during a survey of operating PWRs, two volunteer plants, and other readily available information, 69 parametric cases were evaluated that represented predominant variations (e.g., quantities of thermal insulation, different $NPSH_{margin}$) among operating PWRs. For each case, the minimum amount of debris accumulation on the sump screen needed to exceed $NPSH_{margin}$ was calculated. Then, using favorable and unfavorable conditions, a range of debris that would be damaged, transported, and accumulate on the sump screen was calculated. If the calculated range was greater than the minimum amount of debris, then loss of $NPSH_{margin}$ was considered very likely. If the calculated range was less than the minimum amount of debris, then loss of $NPSH_{margin}$ was considered unlikely.

Loss of $NPSH_{margin}$ to pumps taking suction from the sump is likely to occur in some PWRs because of debris accumulation on sump screens. Because of the large number of plant-specific variations, it is not possible to generically identify which plants may lose $NPSH_{margin}$. A more complete description of the parametric evaluation methods and findings are provided in Attachment 1.

2. For the cases evaluated in the parametric study, the average core damage frequency contribution associated with the increased potential for loss of $NPSH_{margin}$ caused by debris accumulation on ECCS sump screens was calculated. The accident sequences included initiating events that would require recirculation from the sump to mitigate the accident, the need to go to recirculation, the probability that the sump blocks and the ECCS recirculation fails, and the success of actions to re-initiate ECCS suction from the sump. The quantification of the accident sequence considered the type of initiating event, the plant type, and containment type. The probability for sump blockage and ECCS recirculation failure was based on the GSI-191 parametric evaluation results. The average core damage frequency contribution estimates are described in Attachment 2.

3. For both the benefit and cost estimates, it was assumed that the surface area of the sump screen would be increased.

   The benefits are the averted costs of an accident, if the sump screen blockage problem is fixed. Benefits are typically categorized as offsite and onsite averted costs. The benefits are dominated by averted onsite costs which include clean-up and decontamination at the site, and the incremental costs of replacing the power that would have been available absent an accident.

   The costs to physically modify the plant to increase the sump screen surface area are categorized as either: (1) up-front analytical activities; (2) physical

modification activities; and (3) other cost elements. The up-front costs include regulatory actions by NRC, development of generic guidance by industry, and plant-specific analyses by industry. The physical modification costs include administrative, engineering, testing, materials & labor, and waste disposal by industry. Other costs include verification by NRC and recurring expenses for industry.

An increase of sump screen surface area to reduce the vulnerability to loss of $NPSH_{margin}$ caused by debris accumulation on sump screen is net beneficial (i.e., benefits exceed costs). For the evaluations performed in Attachments 2 and 3, the net benefits ranged from approximately $27M to $58M.

On July 26 and 27, 2001, the NRC staff presented the parametric evaluation results, CDF contribution estimates, and benefit estimates at a public meeting. The Nuclear Energy Institute (NEI) and other external stakeholders provided several comments on the parametric evaluation during the public meeting, and NEI plans to formally submit comments to the NRC by September 7, 2001. The NRC staff will assess whether the comments provided by interested stakeholders will effect the proposed resolution of GSI-191.

The GSI-191 parametric evaluation is a generic study; therefore, it is ill-suited for making plant-specific decisions. The proposed recommendation is that plant-specific analyses be conducted to determine the vulnerability of individual plants to loss of $NPSH_{margin.}$ If a vulnerability is identified, then appropriate corrective actions should be implemented. The NRC staff plans to continue interacting with external stakeholders as this issue is resolved.

RES plans to transmit its proposed recommendation to the Director, NRR, by the end of September 2001. Accordingly, the lead for GSI-191 will be formally transferred from RES to NRR, and GSI-191 will move from Technical Assessment: Stage 3, to Regulation and Guidance Development: Stage 4, of the MD 6.4 generic issue process. As stated earlier, although not specifically requested, RES will welcome comments and advice from the ACRS, and will consider them in the development of recommendations that will be sent to NRR.

Attachments:
(1) Rao, D., et. al., “GSI-191: Parametric Evaluations for Pressurized Water Reactor Recirculation Sump Performance,” LA-UR-XXXX, Los Alamos National Laboratory, Los Alamos, New Mexico, July 2001.
(2) Buslik, A., Risk Considerations and Benefits Associated with GSI-191, “Assessment of Debris Accumulation on PWR Sump Performance,” U.S. NRC, August 8, 2001.
(3) Feld, S., Cost Analysis for GSI-191, “Assessment of Debris Accumulation on PWR Sump Performance,” U.S. NRC, August 14, 2001.

Distribution: See Next Page

SEE PREVIOUS CONCURRENCE:
DOCUMENT NAME: C:\Program Files\Adobe\Acrobat 4.0\PDF Output\GSI-191 memo to ACRS.wpd
OAR in ADAMS? (Y or N) Y ADAMS ACCESSION NO.: ML012430047 TEMPLATE NO. RES-
Publicly Available? (Y or N) Y DATE OF RELEASE TO PUBLIC 8/31/01 SENSITIVE? N
To receive a copy of this document, indicate in the box: "C" = Copy without enclosures **"E"** = Copy with enclosures **"N"** = No copy

OFFICE	ERAB/RES		ERAB/RES		D/DSARE/RES		D/DRAA/RES		NRR	
NAME	M.Marshall*		D.Dorman*		T. King*		S. Newberry*		G.Imbro*	
DATE	8/23/01		8/23/01		8/24/01		8/24/01		8/28/01	

OFFICE	D/DET/RES			
NAME	M. Mayfield*			
DATE	8/29/01			

OFFICIAL RECORD COPY

Distribution:

w/o attachments:
A. Thadani/R. Zimmerman
M. Cunningham
J. Flack
H. Vandermollen
D. Matthews
G. Hollahan
G. Hubbard
J. Hannon

w/ attachments:
M. Fields
R. Elliott
ERAB r/f