NUCLEAR ENERGY INSTITUTE

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April 27, 2010

The Honorable Gregory B. Jaczko
Chairman
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Subject: Additional Information in Support of April 15 Commission Briefing on GSI-191

Project Number: 689

Dear Chairman Jaczko:

The purpose of this letter is to provide NEI[1] perspectives on resolution paths discussed during the April 15, 2010 Commission briefing on GSI-191 and to provide the commission with information that will assist efforts to resolve this longstanding issue. During the briefing, NRC staff and industry representatives discussed the resolution status of GSI-191. This discussion served to highlight the complexity of issues surrounding GSI-191 and the difficulty in reaching resolution using deterministic methods. Two resolution paths discussed during the briefing were the use of General Design Criterion 4 and potential use of proposed changes to 10 CFR 50.46 (e.g., large break LOCA redefinition).

General Design Criterion (GDC) 4

As noted in NEI's April 7, 2010 letter to NRR Director Eric Leeds, industry views the exclusion of local dynamic effects for qualified piping systems under GDC-4 to be directly applicable to debris generation. GDC-4 is used by all pressurized water reactors (PWR) as the basis for excluding the impact of local dynamic effects on a wide range of instrumentation, valves, sensors, and structures (both in-vessel and ex-vessel) as part of design basis analyses required to demonstrate compliance with 10 CFR 50.46. The use of GDC-4 has avoided the need for, and problems associated with, unnecessary pipe whip restraints and jet impingement shields that otherwise would be required.

To deny application of GDC-4 to debris generation introduces a major inconsistency in the rule application. This inconsistency will result in equipment and structures that apply the GDC-4 exclusion

[1] NEI is the organization responsible for establishing unified industry policy on matters affecting the nuclear energy industry, including the regulatory aspects of generic operational and technical issues. NEI's members include all entities licensed to operate commercial nuclear power plants in the United States, nuclear plant designers, major architect/engineering firms, fuel fabrication facilities, nuclear materials licensees, and other organizations and entities involved in the nuclear energy industry.

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positioned next to insulation materials for which the exclusion is denied. Both would be exposed to the same forces from postulated breaks. Several PWRs currently exclude, under GDC-4, local dynamic effects from breaks that would directly impinge upon the strainers. Local dynamic effects that directly impact strainer operation are allowed to be excluded, yet exclusion of local dynamic effects that indirectly impact the strainers through debris generation is not allowed.

Because PWR designs and supporting analyses do not exclude debris generation for GDC-4 qualified piping systems, the designs conservatively account for debris generation for the full spectrum of breaks, up to and including a full double-ended guillotine break of the largest pipe in the reactor coolant system. In applying GDC-4 to debris generation, the existing debris generation calculations and strainer designs, based on the full break spectrum, would continue to stand. To demonstrate compliance with 10 CFR 50.46 and resolve GSI-191, a licensee would need to show that existing calculations conservatively bound debris generation for breaks in piping systems that do not meet GDC-4 qualification requirements. This could be accomplished using debris generation modeling readily acceptable to NRC staff, and any deltas between calculated and tested debris volumes would be retained as margin.

Responses to anticipated questions on how PWRs would apply GDC-4 as part of their resolution of GSI-191 are provided as an attachment to this letter.

Proposed changes to 10 CFR 50.46

During the April 15 briefing, NRC staff discussed the potential for resolving GSI-191 based on a commission decision on proposed revisions to 10 CFR 50.46. NEI agrees that the proposed rule could provide a means to resolve GSI-191, however, the novelty of the rule and the absence of implementation guidance raise doubts relative to its effectiveness and timeliness in resolving GSI-191.

Upon final issuance of a revision to 10 CFR 50.46 regulations, an evaluation framework will be established. This will then enable industry to develop necessary implementation guidance and will allow NRC to develop review guidance. Completion of this first-time effort will take time and will be necessary in advance of any application to the resolution of GSI-191. Given uncertainties in rule language and the time and effort that will be needed to develop implementation and review guidance, we do not view the proposed revision to 10 CFR 50.46 to be a timely course of action to resolve GSI-191.

NEI appreciates the commission's attention and action on this important matter.

Sincerely,

Anthony R. Pietrangelo

c: The Honorable Kristine L. Svinicki, Commissioner, U.S. Nuclear Regulatory Commission
The Honorable William D. Magwood, IV, Commissioner, U.S. Nuclear Regulatory Commission
The Honorable William C. Ostendorff, Commissioner, U.S. Nuclear Regulatory Commission
The Honorable George Apostolakis, Commissioner, U.S. Nuclear Regulatory Commission
Mr. Stephen Burns, Esq., General Counsel, U.S. Nuclear Regulatory Commission
Mr. R. William Borchardt, Executive Director for Operations, U.S. Nuclear Regulatory Commission

Application of GDC-4 to Debris Generation Calculations in Support of GSI-191

General Design Criterion (GDC) 4 in Appendix A to 10 CFR Part 50 requires structures, systems and components important to safety to be designed to accommodate the effects of postulated accidents. However, GDC-4 allows local dynamic effects associated with ruptures in certain qualified piping systems to be excluded based on the extremely low probability of rupture. Specifically:

Criterion 4 - Environmental and dynamic effects design bases. *Structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents. These structures, systems and components shall be appropriately protected against dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids, that may result from equipment failures and from events and conditions outside the nuclear power unit. However, dynamic effects associated with postulated pipe ruptures in nuclear power units may be excluded from the design basis when analyses reviewed and approved by the Commission demonstrate that the probability of fluid system piping rupture is extremely low under conditions consistent with the design basis for the piping. [emphasis added]*

Considering application of GDC-4 to Generic Safety Issue (GSI) 191, the following questions may be asked:

1. What PWR piping systems are approved as qualified piping systems under GDC-4?
2. How are licensees applying GDC-4 for their qualified piping?
3. How would PWR debris generation calculations change if GDC-4 is applied?

The following attempts to respond to these questions.

1. What PWR piping systems are approved as qualified piping systems under GDC-4?

The Leak-Before-Break (LBB) Knowledge Management Document[2] provides a listing of PWR piping systems that have been approved for exclusion of local dynamic effects under GDC-4. These include:

- Main coolant lines,
- Pressurizer surge lines
- Residual heat removal lines
- Accumulator lines,
- Reactor coolant bypass lines,
- Safety injection system lines into cold and hot legs
- CE System 80+ direct vessel injection lines,
- CE System 80+ shutdown coolant lines
- AP1000, AP600, and CE System 80+ main steam line inside containment

[2] Memorandum, Evans to Grobe, "Leak-Before-Break Knowledge Management Document", May 29, 2007, ADAMS Accession ML092430585

The specific PWR piping systems approved as "LBB qualified" vary from plant to plant. However, all operating PWRs maintain LBB approval for main coolant lines (e.g., hot leg and cold leg piping). In addition to main coolant lines, many PWRs have LBB approval for pressurizer surge lines and residual heat removal lines. Few PWRs have LBB approval for accumulator lines and safety injection system lines. No LBB approval has been granted for any high pressure piping with a nominal diameter of 6" or less.

2. How are licensees applying GDC-4 for their LBB qualified piping?

In applying GDC-4, PWR plant designs have been modified to remove (or exclude from original design) rigid pipe whip restraints and jet impingement barriers. These would otherwise be necessary to protect a variety of instrumentation and equipment from direct jet impingement and pipe whip. For some plants, GDC-4 has been used to exclude direct jet impingement on their containment sump strainers. In addition, vessel internals, including fuel bundle designs, credit GDC-4 to exclude the pipe break reaction forces.

> LBB Knowledge Management Document, page 3
> *When LBB is approved for a particular piping system, applicants are to exclude from the design basis only local dynamic effects associated with postulated pipe ruptures in that system in the nuclear power unit. The local dynamic effects are:*
> - *Missiles,*
> - *Pipe whipping,*
> - *Pipe break reaction forces, and*
> - *Discharging fluids.*

> LBB Knowledge Management Document, page 3
> *For each local dynamic effect listed above, the applicant, upon NRC approval, is permitted to perform a well-defined plant activity as a result of excluding this dynamic effect from the design basis. The permitted plant activities are, in the order of local dynamic effects:*
> - *Remove jet impingement barriers or shields,*
> - *Remove pipe whip restraints,*
> - *Redesign pipe connected components their supports and their internals, and other related changes, and*
> - *Disregard jet impingement forces on adjacent components, decompression waves within the intact portion of the piping system, and dynamic or nonstatic pressurization in cavities, subcompartments, and compartments.*

3. How would PWR debris generation calculations change if GDC-4 is applied?

Licensees that operate PWRs calculate debris generation based on a conservatively determined spherical zone of influence (ZOI) surrounding the postulated break location. The spherical geometry encompasses a zone which considers multiple jet reflections at targets, offset between broken ends of a guillotine break, and pipe whip.

Debris generation for LBB qualified piping systems

In response to GSI-191, PWR designs and calculations do not exclude local dynamic effects for LBB qualified piping systems. As a result, the designs account for the effects of debris generation for a

full spectrum of breaks up to and including a full double-ended guillotine break of the largest pipe in the reactor coolant system.

Typical PWR debris generation results are shown below for two PWRs utilizing NUKON fiberglass insulation and a ZOI based on testing sponsored by the PWR Owners Group.

	Spherical ZOI	NUKON debris generation
Plant X	7D ZOI (19' radius)	740 ft3
Plant Y	7D ZOI (19' radius)	560 ft3

Due to ongoing questions on the use of PWROG ZOI test results, many PWRs are considering the application of larger ZOIs based on air-jet tests performed in the 1980s. These results significantly increase the sphere of damage (ZOI), increasing the debris generation by a factor of 3 to 4.

	Spherical ZOI	NUKON debris generation
Plant X	17D ZOI (45' radius)	2152 ft3
Plant Y	17D ZOI (45' radius)	2300 ft3

In applying GDC-4 to GSI-191, PWRs licensees could exclude local dynamic effects from breaks postulated to occur in LBB qualified piping systems, but would continue to address these effects for non-LBB qualified piping.

Debris generation for non-LBB qualified piping systems

Although local debris generation would be excluded for LBB qualified piping, debris generation would continue to be assessed for non-LBB qualified piping systems. For most PWRs, the largest non-LBB piping is approximately 12" in diameter. The debris generation assessment for non-LBB piping is greatly simplified in instances where it can be shown that current calculations and strainer test results for postulated breaks in large bore piping (LBB qualified piping) bound the debris generation for postulated breaks in non-LBB piping. Such bounding assessments would enable PWRs to demonstrate that current designs meet 10 CFR 50.46 acceptance criteria, using NRC approved methods, with minimal additional effort.

	Debris generation for 32" LBB piping using reduced ZOI 7D ZOI (19' radius)	Debris generation for 12" non-LBB piping using NEI-04-07 ZOI 17D ZOI (17' radius)
Plant X	740 ft3	~530 ft3
Plant Y	560 ft3	~400 ft3