ATTACHMENT 2

NRC STAFF COMMENTS ON NEI 02-01, "CONDITION ASSESSMENT GUIDELINES: DEBRIS SOURCES INSIDE PWR CONTAINMENTS"

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May 30, 2002

ATTACHMENT 2

GENERAL COMMENTS

- Generally, the NRC staff finds NEI 02-01 to be reasonable and thorough
- However, the NRC staff has identified several areas where guidance should be improved
  - Additional scoping considerations
  - Certain guidance may be overly flexible or possibly contrary to NRC staff expectations

NECESSITY OF CONTAINMENT WALKDOWNS

- NEI guidance suggests that licensees with adequate records may not need to perform containment walkdowns
- The NRC staff believes containment walkdowns are essential, though depth of investigation be reduced by good record-keeping

CONSIDERATION OF RETURN FLOWPATHS

- NEI guidance lacks specific direction on walkdowns of containment flowpaths

- The NRC staff believes that insufficient information may be collected on flowpaths from upper elevations of containment to the sump
  - Debris accumulation at "choke-points" in return flow paths can divert water from sump & reduce expected NPSH margin
  - If interdicting structures (e.g. floor grating) will be credited with stopping large debris, there must be a documented basis

PRIMARY PIPE BREAK LOCATIONS

- NEI guidance does not provide specific direction on the locations of pipe breaks to be considered

- The NRC staff believes that PWR licensees should approach break locations similar to BWRs
  - Staff position documented in SER on URG and RG 1.82
  - Analysis should consider break locations which are most limiting for NPSH requirements
  - For compliance with 10 CFR 50.46, it is not sufficient to consider only high-stress locations

SECONDARY PIPE BREAK LOCATIONS

- NEI guidance does not emphasize secondary system high-energy line breaks

- Secondary pipe breaks such as a MSLB may require containment sprays to maintain peak containment pressure below design value
  - If spray recirculation is necessary for successful mitigation of a secondary break, sump evaluation must consider expected debris loads
  - Otherwise, secondary pipe break analysis must demonstrate that spray recirculation is unnecessary

ZONE OF INFLUENCE

- NEI guidance recommends using line-of-sight considerations for determining scope of walkdown

- The NRC staff believes that the guidance concerning the "direct line-of-sight" criterion is not precisely defined
  - Guidance does not adequately consider the reflection of jet impingement and pressure waves to zones beyond direct line-of-sight
  - Guidance does not include the caution that credit to intervening structures should be applied only to qualified, robust, and large structures

ZONE OF INFLUENCE

- NEI guidance suggests the use of a 12-D sphere for walkdown purposes, which may be truncated due to line-of-sight considerations

- The NRC staff does not have assurance that this truncated spherical approach appropriately models the volume over which energy dissipation from the pipe break would actually occur
  - 12-D sphere is based on an approximation
  - Any new modeling approach should have a realistic technical basis

COMMENTS ON INSULATION TYPES

- NEI guidance suggests that a 12-D sphere is sufficient for surveying all insulation materials
- Debris can be generated from unjacketed calcium-silicate insulation (and similar insulation types) due to erosion caused by the impingement of hot spray water

- NEI guidance does not emphasize the distinction between different types of reflective metallic insulation (RMI)
- RMI behaves quite differently based upon its material composition (e.g., stainless steel, aluminum) and construction (e.g., spot-welded, reinforced)

TREATMENT OF COATINGS

- NEI guidance suggests that coatings addressed under GL 98-04 programs may be considered to have a negligible contribution to sump clogging

- The NRC staff believes that it is unrealistic not to include all coatings within the scope of plant-specific evaluations
  - Unqualified coatings would be an expected debris source
  - NRC's acceptance of GL 98-04 responses does not imply that coatings are an insignificant factor in an integrated evaluation of recirculation sump performance

DETAILS OF SUMP DESIGN

- NEI guidance does not emphasize the collection of sump design details through a walkdown or a review of sump screen structural capability

- The NRC staff believes that sump design details have a significant effect upon sump clogging and that a physical inspection of sump would add value
  - As-constructed details of sump may have minor, yet significant differences from design
  - Structural design of sump screens may not account for loadings due to currently expected debris accumulation

CONDITION OF INSULATION

- NEI guidance emphasizes determining the type of insulation and its fastening and jacketing, but not the condition of these items

- The NRC staff believes that walkdowns should describe the general condition of insulation and fastening and jacketing materials
  - Destruction pressure of degraded materials may be less than experimental values
  - Degraded insulation materials may already be handled in a licensee's corrective action program

REACTOR VESSEL INSULATION

- NEI guidance does not specifically recommend surveying all insulation on the reactor vessel (though "vessel heads" is specified as a potential target area)
- Reactor vessel could potentially be a target for debris generation as a result of postulated breaks

NEI 02-01
Revision 1 (Draft)

Condition Assessment Guidelines: Debris Sources Inside PWR Containments

August 2002

NEI 02-01
Revision 1 (Draft)

Nuclear Energy Institute

Condition Assessment Guidelines: Debris Sources Inside PWR Containments

August 2002

Nuclear Energy Institute, 1776 I Street N. W., Suite 400, Washington D C. (202.739.8000)

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NOTICE

EXECUTIVE SUMMARY

NUREG/CR-6224[1] documented Nuclear Regulatory Commission (NRC) findings regarding blockage of boiling water reactor Emergency Core Coolant System (ECCS) suction strainers. The report suggested that only a small amount of fibrous insulation material transported to the ECCS suction strainers could result in a significant increase in head loss, potentially sufficient to cause the system to operate in a degraded condition. The NRC staff also concluded that these findings could be applicable to pressurized water reactor (PWR) containment sump performance. The NRC created Generic Safety Issue GSI-191[2], *Assessment of Debris Accumulation on PWR Sumps Performance*, to address this potential PWR concern.

NRC Research, as part of GSI-191 technical assessments, performed parametric evaluations of PWR sump performance. These evaluations are documented in Los Alamos National Laboratory report, LA-UR-01-4083, Revision 1, *GSI-191: Parametric Evaluations for Pressurized Water Reactor Recirculation Sump Performance*, dated August 2001. The parametric study was based on industry survey data, volunteer plant data and assumptions based on NRC research. The report demonstrates that it is conceivably possible for a significant number of PWR plants, following a small, medium or large break loss of coolant accident (LOCA), to experience a loss of net positive suction head design margin. This loss of head results from the generation of debris due to the LOCA blowdown and subsequent transport and buildup of fibrous and particulate debris on containment sump screens.

The parametric study used certain assumptions and generalizations to reach its conclusions. The study did not use plant specific information and cannot be used to determine if debris generation and transport resulting from a LOCA at a specific plant would result in the containment sumps being in a degraded condition. Therefore, the NRC Office of Nuclear Reactor Regulatory Research recommended to the Office of Nuclear Reactor Regulation that plant specific assessments be performed to determine if debris transported following a LOCA might result in unacceptable loss of head for containment sump pumps.

The NEI PWR Sump Performance Task Force reviewed the NRC GSI-191 assessment and supporting research. Based upon this review, the task force recommended development of guidance that PWR plant operators could use to assess the ability of their containment sumps to perform in a manner consistent with design basis requirements following a LOCA[3]. The initial step of the overall guidance is for plant operators to determine the types of debris sources and their locations inside containment at the time of the LOCA. This document provides a guideline for this step. NEI is developing additional guidance to further assist plant operators in determining if their PWR containment sumps are subject to the concerns identified in GSI-191

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1 NUREG/CR6224, *Parametric Study of the Potential for BWR ECCS Strainer Blockage due to LOCA Generated Debris*, October 1995.

2 GSI-191 is documented in NUREG 0933, see footnotes 1691 and 1692

3 Some plants may require recirculation from the sump for licensing basis events other than the postulated LOCA. It is recommended that plants review their licensing basis and implement this guideline accordingly.

and, if it is demonstrated the concerns are applicable, provide guidance toward evaluating and establishing appropriate corrective actions.

This guideline is provided so that plant operators may perform plant condition assessments and appropriate supporting walkdowns during scheduled outages. The purpose of these walkdowns is to collect information for use with future sump performance assessment guidance. Obtaining the information identified in this guideline is expected to facilitate future evaluations performed to assess containment sump design and performance.

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CONDITION ASSESSMENT GUIDELINES:

DEBRIS SOURCES INSIDE PWR CONTAINMENTS

1 INTRODUCTION

NUREG/CR-6224[4] documented Nuclear Regulatory Commission (NRC) findings regarding blockage of boiling water reactor Emergency Core Coolant System (ECCS) suction strainers. This report suggested that only a small amount of fibrous insulation material transported to the ECCS suction strainers was sufficient to result in significant head loss, potentially causing the system to operate in a degraded condition. The NRC staff also concluded that these findings could be applicable to pressurized water reactor (PWR) containment sump performance. The NRC created Generic Safety Issue GSI-191[5], *Assessment of Debris Accumulation on PWR Sumps Performance*, to address this potential PWR concern. Following a technical assessment of GSI-191 issues, NRC Research concluded that actions might be warranted to ensure adequate net positive suction head (NPSH) margin for PWR ECCS pumps taking suction from the containment sump. NRC Research recommended that plant specific analyses be conducted to determine whether debris accumulation in PWR containments will impede or prevent ECCS operation during recirculation.

The NEI PWR Sump Performance Task Force reviewed the NRC GSI-191 assessment and supporting research. Based upon this review, the task force recommended development of guidance that PWR plant operators could use to assess the ability of their containment sumps to perform in a manner consistent with design basis requirements following a loss of coolant accident (LOCA)[6]. The initial step of the overall guidance is for plant operators to determine the types of potential debris sources and their locations inside containment as a consequence of a postulated LOCA. This document describes information needed to perform an assessment of post-accident sump performance in the recirculation mode of operation, and suggests sources, means and methods for collecting the information. NEI is developing a second guideline that will establish a methodology for PWR plant operators to apply in assessing if PWR sumps will perform as designed following a LOCA.

The guidance in this document is provided so that plant operators may perform plant condition assessments and appropriate supporting walkdowns during scheduled outages to collect information for use with future performance assessment guidance. Obtaining this information prior to issuance of PWR sump performance assessment guidance will permit, in many cases, a timely assessment of sump performance by plant operators.

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4 NUREG/CR6224, *Parametric Study of the Potential for BWR ECCS Strainer Blockage due to LOCA Generated Debris*, October 1995.

5 GSI-191 is documented in NUREG 0933, see footnotes 1691 and 1692

6 Some plants may require recirculation from the sump for licensing basis events other than the postulated LOCA. It is recommended that plants review their licensing basis and implement this guideline accordingly.

2 GUIDELINE PURPOSE

This guideline provides an approach that plant operators can use to gather information on the sources, types and location of potential debris that could be transported to the containment sump screen following a small, medium or large break LOCA. Preparation activities include collecting and compiling facility design and license commitment documentation pertinent to sump performance. Documentation is expected to include descriptions of ongoing configuration management programs, such as site-specific coatings and foreign material management programs. Detailed walk-down guidance is also provided. However, the level of walk-down guidance implemented on a site specific basis is expected to vary depending on factors such as the level of documentation available regarding coatings applied to structures, systems and components inside containment.

Information gathered as a result of implementing this guideline will be used in conjunction with future guidance on assessing PWR sump performance.

3 BACKGROUND

As part of the GSI-191 and BWR related efforts, the NRC has conducted research in:

- Coatings performance and failure,
- Debris generation due to a high-energy pipe break,
- Debris transport to the containment sump screen,
- Accumulation of debris on the sump screen, and
- Head loss across containment sump screens due to debris bed formation.

In July 2001, NRC issued a draft report documenting results of parametric plant evaluations. The report documented a total of 69 cases for each of three LOCA scenarios: small (2-inch break), medium (6-inch break) and large (double-ended guillotine). Each case was related to, but did not specifically represent, specific operating PWR plants.

The NEI PWR Sump Performance Task Force submitted comments on the draft report to the NRC. The NRC staff considered these comments prior to issuing the final version of the report as LA-UR-01-4083, *GSI-191: Parametric Evaluations for Pressurized Water Reactor Recirculation Sump Performance*, in September 2001. However, the NRC did not make any significant changes to the report as a result of the comments submitted by NEI.

The report demonstrates that $NPSH_{AVAILABLE}$ is likely to be less than $NPSH_{REQUIRED}$ when the following conditions result from the transport and subsequent accumulation of debris on the sump screen following a LOCA:

- A uniform fibrous buildup greater than 1/8 inch on the sump screen and
- The presence of a small amount of particulate debris in the recirculating flow.

The report noted that many plants have large amounts of fibrous material inside containment. This was based on responses to an NEI survey on plant-specific sump-related design features conducted in 1999 and early 2000. Thus, there exists a reasonable possibility to generate and transport sufficient fibrous debris to result in significant degradation of the sump operation following a LOCA.

The PWR Sump Performance Task Force reviewed the report and concluded that for PWR containments that used fibrous insulation, rigorously accounting for plant-specific features within the framework of the parametric study was not likely to eliminate concerns over PWR sump blockage. Furthermore, the NRC Office of Nuclear Regulatory Research (RES) program included many conservative assumptions and neglected plant-specific design and operating characteristics that could influence the potential for debris generation and the subsequent transport and accumulation of debris on containment sump screens. Therefore, the task force recommended development of guidance for use with PWR plants that would account for plant-specific debris sources, containment features and operating characteristics to assess containment sump performance following a LOCA.

Sump performance evaluation guidance, currently being developed, will utilize the following information, collected in part by this document:

- The range of postulated pipe break locations inside containment corresponding to LOCA event initiators where sump recirculation is required,
- Location and characteristics of potential debris sources (i.e., fiberglass, calcium silicate, mineral wool, etc.) present within a region potentially affected by impinging jets from identified pipe break locations,
- Information regarding the types and amounts of coatings used in containment,
- Information regarding foreign materials controls and accountability implemented at the reactor site, and
- Plant-specific fluid velocities expected in the water pool formed on the containment floor that may be significant in debris transport modeling.

In September 2001[7], the NRC RES transmitted its recommendations for resolution of Generic Safety Issue GSI-191. RES recommended the following:

- Plant specific analyses should be conducted to determine whether debris accumulation in PWR containments will impede or prevent ECCS operation during recirculation,
- If it is determined that debris accumulation will impede or prevent ECCS operation, then appropriate corrective actions should be implemented.

[7] Memorandum from A. C. Thadani to S. J. Collins, dated September 28, 2001

The RES staff briefed the Advisory Committee on Reactor Safeguards (ACRS) on the GSI-191 technical assessment[8]. The ACRS, in a memorandum to the NRC executive director[9], agreed with the staff that potential issues associated with the performance of PWR containment sumps exist and that they should be expeditiously resolved.

4 GUIDELINE SCOPE

This guideline recommends that PWR plant operators identify, locate and characterize potential sources of debris that could challenge the post-accident operability of the containment sump. Performance of containment walkdown surveys is also recommended to verify or supplement design or maintenance documentation. This is necessary due to possible changes in insulation that may have been replaced during plant modifications or weld inspections, and possible changes in coatings used inside containment from those initially used during construction. Therefore, the *as currently built* insulation(s) and coatings may be different than those called for in the initial design of the plant.

Areas where containment walkdowns may be useful in verifying current as built conditions include the following:

- The location and amount of insulation materials,
- The location and amount of unqualified coatings, and,
- The location and amount of foreign materials.

Therefore, while the extent of walkdown activities required to support sump performance assessments will vary from plant-to-plant, it is recommended that, as a minimum, all plants perform a containment walkdown to confirm that materials and quantities are consistent with current plant design. Variability in plant-specific design control and documentation programs may lead some facilities to develop supplemental documentation that others already possess. Also, facilities will likely vary in the degree of ongoing condition assessment programs (e.g., coatings assessment programs) that they can readily apply in addressing GSI-191 issues.

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8 July 12, 2001 and September 5, 2001

9 September 24, 2001

5 PWR CONTAINMENT DEBRIS SOURCE ASSESSMENT

This PWR debris source assessment guidance recommends the following actions:

- Preparations,
- Containment walkdown to support the following,
  - Identification of insulation used inside containment
  - Evaluation of coatings used inside containment, and,
  - Foreign materials evaluation for the containment.

5.1 PREPARATIONS

This section identifies a minimum set of actions that are recommended to prepare for sump performance issue resolution and containment condition assessment walkdown activities:

5.1.1 Design and Licensing Considerations

The walkdown team should review information regarding the design basis and licensing commitments for the sump. This information includes, but is not limited to, the following:

- ***Containment sump design considerations.*** List the design requirements of the containment sump. Locate, retrieve and review existing containment pool height, pool temperature and sump NPSH calculations and the basis for those calculations. Locate and retrieve sump civil and structural drawings.
- ***Licensing basis for the sump.*** Identify, locate, extract and list the licensing basis requirements and commitments for the containment sump. Note that, depending upon plant-specific designs, design basis transients other than LOCA may require recirculation from the containment sump, particularly for containment spray for postulated non-LOCA (secondary system) events.
- ***Historical debris sources.*** Identify sources of debris that have been identified in the operating history of the plant. Examples of these include, but are not limited to, coatings failures and foreign materials (electrician's tape, etc.) found inside containment during operations.
- ***Transport calculations.*** Locate, retrieve and review calculations of local fluid velocities, debris considered in the calculations and hydraulic characteristics of that debris.

- *Sump blockage considerations.* Locate, retrieve and review previous evaluations of sump blockage potential. This may be included in the topic immediately above.

5.1.2 Construction and Maintenance Records

Prior to the walkdown, the team should attempt to locate, retrieve and review construction and maintenance records associated with materials (insulation, coatings, etc.) that have been identified as being of concern with regard to post-accident sump operability. These records include, but are not limited to:

5.1.2.1 Records of Insulation Installation

- What insulation was used inside containment,
- Where it was used (on equipment, in penetrations, on piping, etc.),
- How it was installed; encapsulated, banded, etc.,
- Inspection records, if appropriate or available, and
- Design changes that may have changed insulation used.

5.1.2.2 Records of Coatings Used Inside Containment

- What coatings were applied,
- Where they were applied,
- QA program requirements,
- Application specification(s),
- Inspection records,
- What coatings were applied to purchased equipment and the coatings program used to apply them, and
- "Exempt" or "Unqualified" coatings log, if used at the site.

5.1.2.3 Foreign Materials Exclusion Program

The walkdown team should review and be aware of the site-specific foreign materials exclusion program to identify specific items and exclusions addressed under the program.

5.1.3 Selection of Regions of Containment for Detailed Walkdowns

It may be possible to perform detailed containment walkdowns in limited areas or regions of containment. The following general guidance is offered to assist in establishing those areas or regions within the containment for the detailed walkdowns.

1) Identify the design basis transients for which recirculation from the sump will be needed. Note that, depending upon plant-specific designs, design basis transients other than LOCA may require recirculation from the containment sump, particularly for containment spray for postulated non-LOCA (secondary system) events.
2) Identify potential break locations for the transients identified from Step 1.
3) Identify areas or regions of containment for detailed inspection based on an appropriate zone of destruction from a resulting jet (see Footnote 11) and in the direct line of sight[10] from the postulated break location.
4) Identify special conditions and zones that warrant additional inspection and material quantification.
5) Develop a plan for general inspection for secondary destruction effects (spray and submergence).

Once the plan is developed, all insulation materials, coatings and foreign materials are to be carefully inventoried within the areas or regions to be inspected in detail. A more general inspection may be conducted for the rest of containment to ensure that all other insulation materials outside the detailed inspection zones are not subject to destruction by containment spray or by submersion.

5.1.4 Materials to Support the Walkdown

As a minimum, the following materials are recommended to be available to the walkdown team to support their effort.

- Topographical containment layout drawings for markup,
- Piping isometric drawings for markup,
- Process diagrams for markup,
- Radiation protection survey drawings,
- Scaffolding and ladders, as appropriate,
- Measuring tape,
- Measuring probe (ruler), to determine thickness of insulation,
- Flashlights or other high-intensity light sources, as appropriate,

[10] Credit for intervening structures should be taken only when the intervening structures are robust and large structures, such as walls, that will block or deflect jets or pressure waves resulting from postulated breaks.

- Cameras, choice of digital, Polaroid, 35mm, video camera (voice recording may be useful),
- Non-destructive magnetic pull gauge (for measuring paint thickness on ferrous metals),
- Sample bags (for collecting samples of insulation, failed coatings and other materials of interest),
- Sample knife, and
- Marking pen(s).

5.1.5 Timing of the Walkdown

Consideration should be given to timing walkdowns conducted under this guideline to be after the containment building has been cleaned following a refueling outage and prior to restart. This consideration allows for transient foreign materials that might be introduced into containment for the outage to be removed.

5.2 CONTAINMENT WALKDOWN

The following are specific items to look for and record during the walkdown.

5.2.1 Insulation

5.2.1.1 Why Look at Insulation?

Insulation materials, particularly fibrous materials such as fiberglass insulation, filter media, fire barrier materials and fibrous cable insulation, have been identified as potential sump screen blockage debris sources in LA-UR-01-4083, *GSI-191: Parametric Evaluations for Pressurized Water Reactor Recirculation Sump Performance.* Walkdowns will be useful in verifying existing design documentation.

Insulation may have been replaced during plant operation and modifications due to piping changes and various weld inspections. Therefore, the *as currently built* insulation(s) may be different than those called for in the initial design of the plant.

5.2.1.2 Who Should Participate in the Walkdown?

The walkdown should be conducted with personnel familiar with the installation of equipment insulation and the responsible ECCS systems engineer.

5.2.1.3 What to Look For

Walkdown all piping, equipment, structures, penetrations and fire barriers and survey the installed insulation. Insulation products commonly used in PWR containments are identified in the table below. The insulation types listed in the table are not intended to be an all-inclusive list, but rather serve as an illustrative example of what to look for during the walkdown.

Insulation Products Commonly Used in PWR Containments

NUKON®	Kaowool
Calcium Silicate (Cal-Sil)	Koolphen-K®
Armaflex	Fiberfrax®
Reflective Metal Insulation (RMI)	FiberMat™
TempMat™	Unibestos block
Min-K	Asbestos

5.2.1.4 Where to Look[11] (Per plant-specific design)

The walkdown should start with the primary system and then extend to other piping, equipment, temporary equipment left inside containment, structures and penetrations within the crane wall or bioshield wall area that could be influenced by a postulated high energy line break that progresses to recirculation from the containment sump. For completeness, all primary system components and piping within the crane or bioshield wall, and areas potentially affected by openings in the crane or bioshield wall, should be surveyed.

Also, other components that may have fibrous materials applied to them should be included in the walkdown. For example, these include, but are not limited to, all insulated equipment, penetration insulation, fire barriers, HVAC air cleaning filter media, electrical cable trays and electrical cables inside containment.

5.2.1.5 Documentation

Document each type of insulation in detail, including information such as the identification of transitions from one insulation type to another (i.e., temp-mat vs. NUKON or Transco fibrous insulation, calcium-silicate vs. Unibestos block insulation, or reflective metallic insulation vs. calcium silicate). Documentation should include the following:

- Piping line numbers.
- Insulation type, location and amount on and about systems structures and equipment inside containment, including but not limited to the following:

• Piping	• Steam generators	• Pipe whip restraints
• Support structures	• Pumps	• HVAC ducts
• Valves bodies	• Penetrations	• Fire barriers
• Vessel heads	• Cable trays	• etc.

  Plants should evaluate the systems, structures and equipment to be included in the walkdown based on their location relative to postulated break locations and intervening structures that might block jet impingement and pressure waves. Intervening structures, such as walls that are robust and large enough to block or deflect jets or pressure waves resulting from postulated breaks, should be identified.
- If the insulation is RMI, also record if the insulation is aluminum or stainless steel.

[11] The NRC has used a sphere having the radius of L = 12D, where "D" is the diameter of the break and "L" is the radius of a sphere that is centered at the break location, to assess the debris generation capability of a postulated break. However, the size of the "sphere of influence" is subject to interpretation. Therefore, it is recommended that the location and characteristics of all insulation materials used inside the crane or bioshield wall, and areas potentially affected by openings in the crane or bioshield wall, be documented and confirmed by a walkdown.

- Insulation thickness/pipe size.
- Length (and width, if appropriate) of insulation.
- The type of fastening, jacketing or wrapping, if used.
- The details of the construction of jacketing (spot-welding or reinforced jacketing), as appropriate.
- The general condition of the jacketing or wrapping
- The method used to band the insulation and the number of bands used, if appropriate.
- Other relevant information regarding the type and installation of insulation.

Documentation should include, as a minimum, a marked-up set of drawings showing different insulation types and/or a spreadsheet including the above information. The location of temporary equipment left inside containment should also be identified and marked on drawings. In addition, the use of a video camera, still pictures and/or digital photographs of the insulation, jacketing, wrapping and how the jacketing and wrapping are secured/fastened to piping is also helpful for future reference.

5.2.1.6 Alternate Sources of Plant Insulation Documentation

Plant programs that control and document the use and location of various types of insulation inside containment may be used as either an alternate or supplemental source of information to support an evaluation of potential sump debris sources.

5.2.2 Coatings[12, 13]

5.2.2.1 Why Look at Coatings?

In LA-UR-01-4083, *GSI-191: Parametric Evaluations for Pressurized Water Reactor Recirculation Sump Performance*, the NRC identified coatings inside containment as one of several potential particulate debris sources.

It is also noted that all containment coatings (*acceptable, DBA qualified* or other) located within a defined *Zone of Destruction*[14] of a postulated LOCA should be characterized to fail for analytical purposes.

On July 14, 1998, the NRC issued Generic Letter (GL) 98-04, *Potential for Degradation of the Emergency Core Cooling System after a Loss-of-Coolant Accident Because of Construction and Protective Coating Deficiencies and Foreign Material in Containment.* The generic letter addressed, in part, licensee programs for the use of protective coatings inside containment at PWR facilities.

All PWR licensees have responded to GL 98-04[15]. Plant responses to GL 98-04 identify plant programs associated with "acceptable" and "DBA qualified"

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12 The emphasis of this topical area is the identification of coatings inside containment that might detach under normal or accident conditions.

13 **Definitions and Background:** ASTM D 5144-00, *Standard Guide for Use of Protective Coating Standards in Nuclear Power Plants*, contains two definitions related to coatings inside containment, which will not fail under normal or accident conditions. These definitions are:

> ***Acceptable Coating or Lining System*** – A safety-related coating or lining system for which a suitability for application review which meets the plant licensing requirements has been completed and there is reasonable assurance that, when properly applied and maintained, the coating or lining will not detach under normal or accident conditions.
>
> ***DBA Qualified Coating System*** – A coating system used inside reactor-containment that can be attested to having passed the required laboratory testing, including irradiation and simulated Design Basis Accident (DBA), and has adequate quality documentation to support its use as DBA qualified.

American National Standards Institute (ANSI) standards defining the requirements for DBA qualified coatings were issued in the 1972 to 1974 time period. Plants with licensing bases and attendant containment coating systems that are dated after the issuance of the ANSI standards typically refer to DBA qualified coatings. PWR plants with licensing bases and attendant containment coating system designs predating 1972 typically refer to acceptable coatings.

Coatings inside containment that cannot be classified as either acceptable or DBA qualified may fail and have typically been included as debris sources for post-accident sump performance evaluations.

14 Zone of destruction refers to the region about the postulated break location that is subject to direct impingement to the fluid escaping from the pipe through the break.

15 The responses made by PWR licensees to GL 98-04 included the following information:

a. Service Level I coatings procured, applied and maintained by the licensee or its contractors comply with the plant licensing basis and thus are "acceptable" or "DBA qualified" as applicable.

b. The condition of Service Level I coatings are regularly assessed as part of plant procedures, including ASME Section XI IWE, Maintenance Rule (10 CFR 50.65), and/or plant-specific procedures covering coatings condition assessment. The provisions of these procedures require that defective coating areas in containment be identified, evaluated and remediated as necessary.

coatings, as applicable to that plant. The NRC has reviewed and accepted the responses to GL 98-04 made by all PWR licensees.

With the exception of those coatings located within the ZOI, PWR facilities that maintain their "acceptable" or "DBA qualified" coatings may credit those coatings as not adding significantly to coating debris that may be generated during normal plant operation and accident conditions. All coatings that are not identified as "acceptable" or "DBA qualified," or coatings that were initially applied as "acceptable" or "DBA qualified" but are observed to be degraded are to be considered as possible debris sources for design basis events that result in the recirculation from the containment sump.

A comprehensive coating program that includes clearly documented periodic containment coating assessments, evaluations of deficient coating conditions, as well as mitigation, and routine containment coating maintenance support a PWR plant's evaluation and determination of the degree to which coating debris may be a debris source for GSI-191 considerations. In the event that such documentation is not available, plant operators may choose to develop this information by performing appropriate walkdowns.

5.2.2.2 Who Should Participate in the Walkdown?

The walkdown should be conducted with a coatings specialist or personnel familiar with the application and maintenance of coatings inside containment.

5.2.2.3 What to Look for

The following table lists types of *acceptable* and *DBA qualified* coating systems commonly used in PWR containments.

Typical Coating Systems Commonly Used in PWR Containments

Concrete Substrate	Steel Substrate
Surfacer, epoxy phenolic topcoat	Inorganic zinc primer, epoxy phenolic topcoat
Surfacer, epoxy topcoat	Inorganic zinc primer, epoxy topcoat
Epoxy phenolic primer, epoxy phenolic topcoat	Epoxy phenolic primer, epoxy phenolic topcoat
Epoxy primer, epoxy topcoat	Epoxy primer, epoxy topcoat
	Inorganic zinc primer

5.2.2.4 Where to Look (Per plant-specific design)

Typical systems, structures and components to which coatings may have been applied but cannot be classified as *acceptable* or *DBA qualified* include, but are not limited to, the items listed in the following table. The review of coatings should include the general containment volume, and not be limited to the area within the crane wall or areas affected by a non-isolable primary system break as particulate debris may result from the exposure of non-qualified coatings to post-accident environmental conditions.

Systems, Structures and Components That May Be Coated with Coatings Which Are Neither "Acceptable" nor "DBA Qualified"

Accumulator tanks	Seismic platforms and tie rods
Reactor coolant system supports	Reactor internals lifting rig
Manipulator crane	Head lifting rig
Valves	Transmitters and small instruments
Electrical cabinets	Heat exchanger supports
Reactor coolant pump	Reactor coolant pump motor and motor stand
Transducers	Mounting brackets

5.2.2.5 Documentation

Using containment drawings, the walkdown should document the location of "DBA qualified" or "acceptable" coatings and unqualified or non-qualified

coatings. In regards to safety-related coatings, the type of coatings system(s) applied in the areas defined as a ZOI should be documented. If multiple safety-related coating systems have been employed in these areas then the lightest (i.e., the one with the lowest specific gravity) coating system can be assumed to be applied throughout the defined zone of destruction area (or exact documentation of all of the coating systems can also be obtained). Other data that should be obtained to the extent possible are the approximate area and thickness of the respective safety-related coating system(s). In regards to unqualified coatings, to the extent possible, the type of coating (i.e., alkyd, epoxy, etc.), approximate area, and thickness should be documented.

5.2.2.6 Sources of Plant Coatings Documentation

A comprehensive coating program that includes clearly documented periodic containment coating assessments, evaluations of deficient coating conditions, as well as mitigation, and routine containment coating maintenance support a PWR plant's evaluation and determination of the degree to which coating debris may be a debris source for GSI-191 considerations.

5.2.2.7 Industry Guidance

Extensive industry and regulatory guidance concerning containment coating condition assessment is available from a number of sources, such as:

- NRC NUREG-1801, Volume 2, April 2001, *Generic Aging Lessons Learned (GALL) Report*, Section XI.S8, *Protective Coating Monitoring and Maintenance Program*
- ASTM D 5144-00, *Standard Guide for Use of Protective Coating Standards in Nuclear Power Plants*
- ASTM D 5163-91 (1996), *Standard Guide for Establishing Procedures to Monitor the Performance of Safety-Related Coatings in an Operating Nuclear Power Plant*
- EPRI Report 1003102, Revision 1[16], *Guideline on Nuclear Safety-Related Coatings*, (Formerly EPRI TR-109937).

These references should be considered, as appropriate, for incorporation into the plant specific procedures for containment coating condition assessments.

[16] Availability of this document is restricted to EPRI members and non-EPRI members who have paid a license fee for use of the document.

5.2.3 Foreign Materials[17]

5.2.3.1 Why Look for Foreign Materials?

Foreign materials left inside containment may become transportable post accident and add to the debris loading of the sump screen. Therefore, during the containment walkdown, it is important to identify foreign material within the containment that could potentially be transported to the emergency recirculation sump by the LOCA or containment spray washdown.

5.2.3.2 Who Should Participate in the Walkdown?

The walkdown should be conducted with cognizant personnel responsible for containment decontamination and/or outage housekeeping activities. Consideration should also be given to reviewing both the walkdown plans and the walkdown results with the cognizant personnel responsible for the site foreign materials exclusion program and appropriate system engineers.

5.2.3.3 What to Look for

Note that many of the items listed below may already be removed under current plant housekeeping and/or foreign materials exclusion programs. If this is the case, it is suggested that the materials listed below that are not included in the current plant specific housekeeping and/or foreign materials exclusion program be added to the program for completeness. The types of foreign material to identify under this portion of the walkdown are as follows:

- ***Tape.*** This includes electrician's tape, duct tape, masking tape, all of which are frequently used on the containment walls to identify equipment locations. Also included is non-slip tape applied to ladders (although not readily removed under normal wear conditions, this material may become dislodged and mobile when wetted).
- ***Equipment labels.*** Included here are paper/plastic labels, stickers or signs that could be dislodged and transported. This also includes operations tags not properly secured.
- ***Construction and maintenance debris.*** This includes rags, plastic face shields, plastic bags, packaging, gasket material, excess sealant materials, foam ear plugs, sawdust from custom scaffolding construction, etc.

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[17] Plants conduct walkdowns to identify and remove foreign materials prior to reactor restart following a shutdown. To address GSI-191 concerns, additional tasks of identifying certain materials not removed from containment and estimating and/or characterizing potential debris sources inside containment, should either be implemented as a part of the foreign materials exclusion walkdown or conducted separately.

If a walkdown to identify and remove foreign materials is not currently conducted prior to reactor restart following a shutdown, consideration should be given to implementing a walkdown using the full guidance given in this section.

- ***Temporary equipment.*** This includes scaffolding, ladders, insulation material, lead shield blankets, Herculite, toolboxes, etc. Such equipment may be a source of a range of debris, including tape, unqualified coatings or labels; and may alter flow paths to the sump.
- ***Dirt, dust and lint.*** See sub-section 5.2.3.4 for guidance.

5.2.3.4 Guidance on Dirt, Dust and Lint Characterization

Dirt, dust and lint, acting in conjunction with other debris sources and fibrous materials inside containment, are to be considered in evaluating post-accident sump performance. The purpose of collecting information on dirt, dust and lint is to provide for a quantitative assessment of this debris source. It is recognized that a direct measurement of this debris source is difficult and may not be practical. Therefore, the following guidance is provided to enable a quantification of this debris source to be performed:

- Look for and record, either by notes or photographs or both, buildup of dirt, dust and lint inside containment greater than what is found in the general areas of the containment; that is, look for concentrated areas of buildup of these items.

- If one or more areas of buildup are found:
    - Visually inspect the buildup to determine the nature of the buildup; dirt, lint, grit, sand, etc.
    - Record observations on the nature of the buildup.
    - Collect and label a sample of the buildup in plastic bags, if possible. The samples may be used at a later date to evaluate the collected dirt and dust samples for particle composition (grit, sand, lint, etc.), size and density. It is also recognized that these samples may contain some contamination and should be treated with appropriate care and in accordance with local health physics procedures.

Locations to look for dirt, dust and lint buildup inside containment include, but are not limited to: equipment surfaces, floor recesses, cable trays and ledges of walls and partitions. Guidance on the use of these observations in assessing their impact on sump performance will be given in a subsequent NEI guideline.

5.2.3.5 Where to Look (Per plant-specific design)

A general walkdown should be performed for those containment areas that the foreign materials described above may be either used in or left in, and may be affected by either containment spray, or post-accident flood up resulting from draining the refueling water storage tank following a postulated LOCA. This includes areas outside the crane wall, on ladders, behind components, items left inside containment in cages, etc.

5.2.3.6 Documentation

The walkdown should document the location and the type of foreign material inside containment. Foreign materials that may become debris sources should be characterized with respect to specific gravity and, if applicable, particle size, to the extent practical.

The location and characterization of temporary equipment inside containment should be similarly documented to support assessment of the equipment as a potential debris source (e.g., paint, labels, tape) and possible impact of flow patterns to the sump.

When practical, foreign material should be removed from containment as a general housekeeping activity.

5.2.4 Additional Considerations

The purpose of NEI-02-01 is to provide an approach that plant operators can use to gather information on the sources, types and location of potential debris that could be transported to the containment sump screen following a small, medium or large break LOCA. Insulation subjected to containment spray may result in additional debris generation. Also, in addition to debris sources, plants may find it desirable to include other considerations that may be used to address GSI-191 concerns in their containment walkdown. Identified in this section are several such considerations.

5.2.4.1 Debris Sources from Containment Spray

Insulation may also be subjected to impingement from containment spray, resulting in degradation of the insulation material and thereby generating debris. Examples of this might be piping exposed directly to containment spray or located under floor grating that provides for containment spray to drain from upper elevations of containment to the containment sump elevation. It is suggested that plants examine their containments for these configurations as part of their containment walkdown performed under this guideline.

Documentation of piping subjected to containment spray flow or drainage from upper to lower elevations may be accomplished through markups of containment topographical maps, detailed design drawings or photographs.

5.2.4.2 Containment Flowpaths

Plants may also choose to examine flowpaths to the containment sump as part of their containment walkdown performed under this guideline. Specifically, two issues might be considered when walking down the flowpaths to the sump:

- Restrictions or "choke points" in return flow paths that may provide for debris accumulation, possibly either diverting or restricting water from flowing to the sump. The possible restriction of flow to the sump by collecting debris at these "choke points" may reduce expected NPSH margin associated with the

containment sump. Examples of choke points may include, but are not limited to the following:

- Access entrances (door ways) secured with a screened gate during normal operation, and,
- Curbs and ledges placed about containment
- Pipe chases and fuel transfer canal drains
- Floor grates at upper elevations that may catch and restrict the transport of large debris from upper elevations to lower elevations.

Documentation of choke points and floor gratings may be accomplished through markups of containment topographical maps, detailed design drawings or photographs.

5.2.4.3 Sump Condition Assessment

The condition of the containment sump screen may affect performance of the sump during operation in the recirculation mode. Plants should visually confirm that the configuration and the condition of the containment sump is consistent with the design. Results of this visual confirmation should be documented (e.g., photographs, etc.).

6 RECORDS RETENTION

Documentation collected in the records review and walkdowns should be retained for future use. The documentation should also identify areas where records are incomplete or where information identified in this guideline was either not applicable or unavailable.

APPENDIX A: APPLICATION EXPERIENCE

The guidance offered by this document has been applied at several plants during the spring of 2002. The following is a summary of the collective experience of those plants. This list is not to infer that all plants implemented all items listed below. Nor is it intended to suggest that the list is all-inclusive. Rather, the summary is offered to improve and enhance the plant-application of the guidelines at other PWR facilities.

A.1 Information Collection and Walkdown Preparation

Design documentation retrieved and reviewed during the initial preparation phase was reported to include the following:

- Piping and Instrumentation Drawings
- Piping layout drawings
- Cable tray layout drawings
- Piping isometrics
- Insulation specifications
- Work orders for insulation installation, repair and modifications
- Past insulation surveys
- Past coatings surveys
- Sump blockage calculations

Events that were reported to be considered for requiring recirculation from the containment sump included:

- A review of all Design Basis Events were considered for requiring recirculation from the containment sump
- Events were screened out if recirculation from sump not required (either ECCS not actuated, or event was terminated prior to switchover to recirculation for either core cooling or containment spray

Personnel reported to have been used to perform walkdown included:

- Radiation Protection/Health Physics
- Insulators
- Systems engineers
- Outage Management personnel
- Coatings specialists
- Others, as determined appropriate on a plant-specific basis

Reported Training of Walkdown Teams

- Reviewed purpose and objective of walkdowns with team members
- Reviewed industrial safety requirements and restrictions with team members
- Reviewed radiological safety limits and requirements with team members
- Reviewed examples of different types of insulation expected to be observed inside containment during the walkdown
- Reviewed details of construction for jacketed insulation
- Reviewed cable tray fire stop construction, including orientation of fire stop in cable trays

Tools

- The list of tools provided in this document was found to be sufficient
- The list was augmented with plant-specific industrial safety items, as needed

ALARA Preparation

- Met with Health Physics/Radiation Protection personnel to plan walkdown
- Performed walkdown of some areas inside containment after installation of temporary shielding (for example, pressurizer cubicle)
- Performed walkdown of some areas inside containment to account for other outage activities (for example, walked down the area around the steam generator manway area prior to installation of nozzle dams, when the area becomes a radiologically controlled area)

A.2 Considerations in Performing a Containment Walkdown

In all cases, a clearly defined scope, purpose and set of walkdown objectives were identified.

- An example of Scope Statements
  - Perform a survey of potential RHR sump screen debris sources which could be dislodged due to dynamic effects of a LOCA causing High Energy Line Break (HELB).
  - Examples of Purpose Statements
    - Establish as-build configuration consistent with existing design basis
    - Quantify potential debris sources for subsequent evaluation using applicable Industry Evaluation Guidelines that are to be developed
    - Verify coatings applications in accordance with plant coatings specification and unqualified coatings log
- Examples of Walkdown Objectives
  - Identify insulation types and locations within containment including, but not limited to :

  - Calcium silicate (installed on piping, tubing and equipment)
  - Fibrous blanket insulation
  - Min-K insulation blankets
- Identify miscellaneous items related to weak structures that might become debris
- Identify miscellaneous loose debris (e.g., gloves, paper, etc.)

- Allow for sufficient time to accomplish objectives
  - Consider the level of detail of the walkdown
  - Consider experience level of personnel performing walkdown

A.3 Sample of Results

The following are examples of the results of performing walkdowns using this guideline

- Identified type and amount of various insulation types inside containment
- Some insulation samples taken for future evaluation
- Developed a set of piping layout drawings for the plant showing locations of various types of insulation inside containment for use later
- Developed a set of cable tray layout drawings for the plant showing locations of various types of insulation inside containment for use later
- Obtained overall assessment of plant house-keeping and Foreign Materials Exclusion (FME) programs
- Confirmed current design configuration
- Provide reasonable assurance that current plant as-built drawings may be used for assessing GSI-191 issues

A.4 Lessons Learned

The following are examples of lessons learned from the application of the initial release of NEI-02-01. None of the observations are cause for immediate concern. Rather, they indicate an increase in knowledge of the as-built condition of affected plants:

- Identified undocumented insulation installed inside containment
- Identified undocumented field piping with fibrous insulation inside containment
- Identified differences in installed insulation versus what was shown on drawings
- Take more photographs while performing the walkdown

ATTACHMENT 3

Sunil Weerakkody
Chief, Balance-of-Plant and Containment Section
NRR\DSSA\SPLB

Objective:

- Discuss the ECCS issue communicated via Information Notice (IN) 96-27, "Potential for Clogging of High-Pressure Safety Injection Pump Throttle Valves in Pressurized Water Rectors Because of Debris Injection through Containment Sump Screens."

- Discuss its relationship to GSI-191 and the proposed Generic Letter.

- Receive feedback

Issue:

- potential for clogging of high-pressure safety injection throttle valves during the recirculation phase of a design basis LOCA due to debris

- failure may occur if the largest dimension of the openings in containment sump screen mesh (diagonal dimension) is larger than the smallest dimension in the valve flow path; throttle valves cannot be remotely actuated and are inaccessible during a design basis accident

- issue raised and closed out for Millstone 3 and Diablo Canyon in consideration of nature of debris that would pass through sump screens, capability of high-pressure pumps to fragment debris, recirculation paths that do not use HPSI, high differential pressure

Questions raised Byron/Braidwood on:

- full range of particles that would pass through the sump screen
- potential for turbulence due to spray and break flow
- difference in transportability between small and large debris
- presence of small debris detected during inspections
- insufficient evidence to support that HPSI pumps can fragment debris passing through screens

Major differences between sump screen blockage and throttle valve blockage issue:

- After extensive research, RES confirmed that sump screen blockage is credible

- No robust basis to conclude the credibility (or lack of) of the throttle valve blockage issue, i.e., credibility under investigation

- After extensive research, RES confirmed that sump screen blockage is potentially high risk-significant

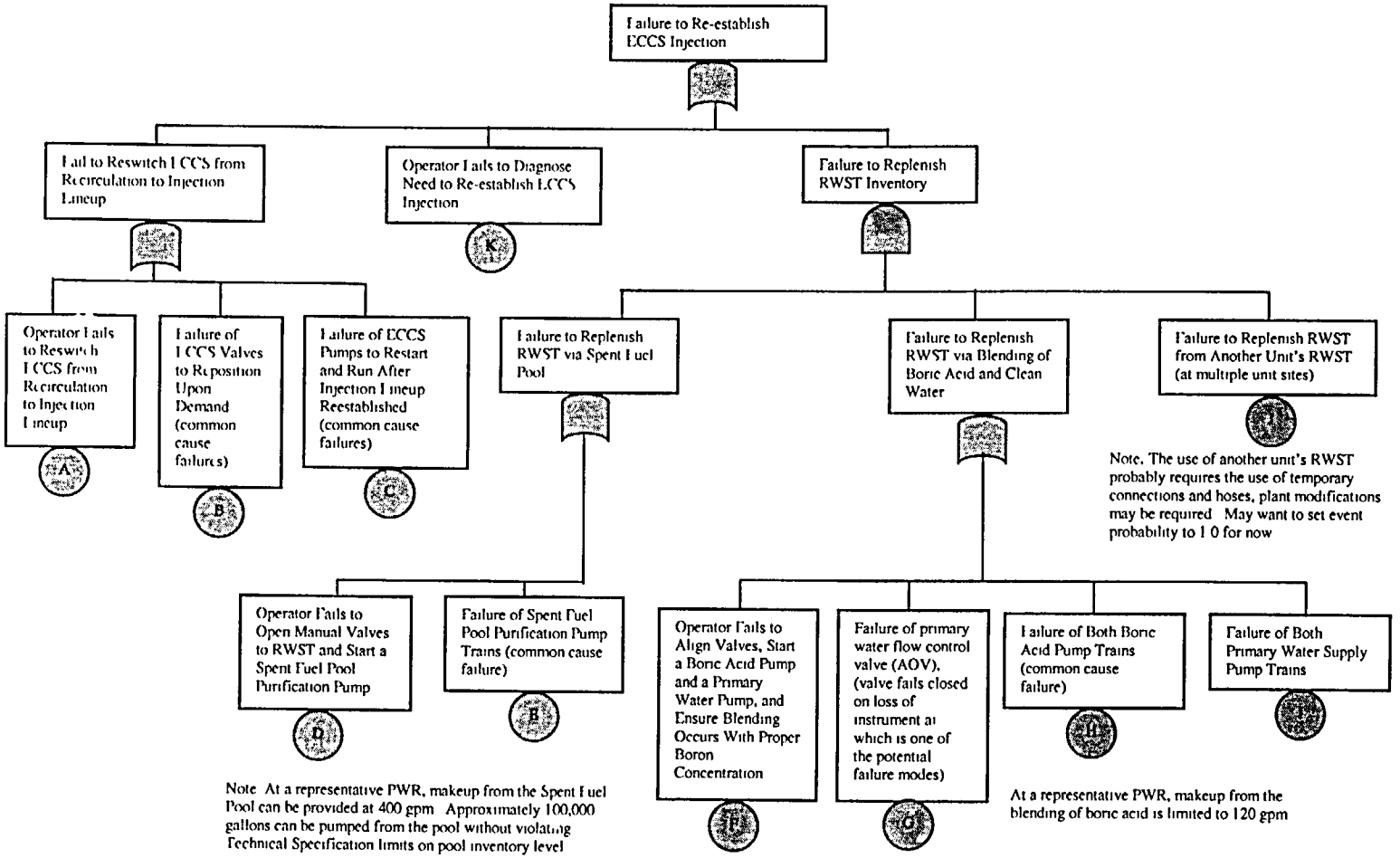
- Significant uncertainties exist in the risk-significance of throttle valve blockage issue

Appropriate to discuss now because:

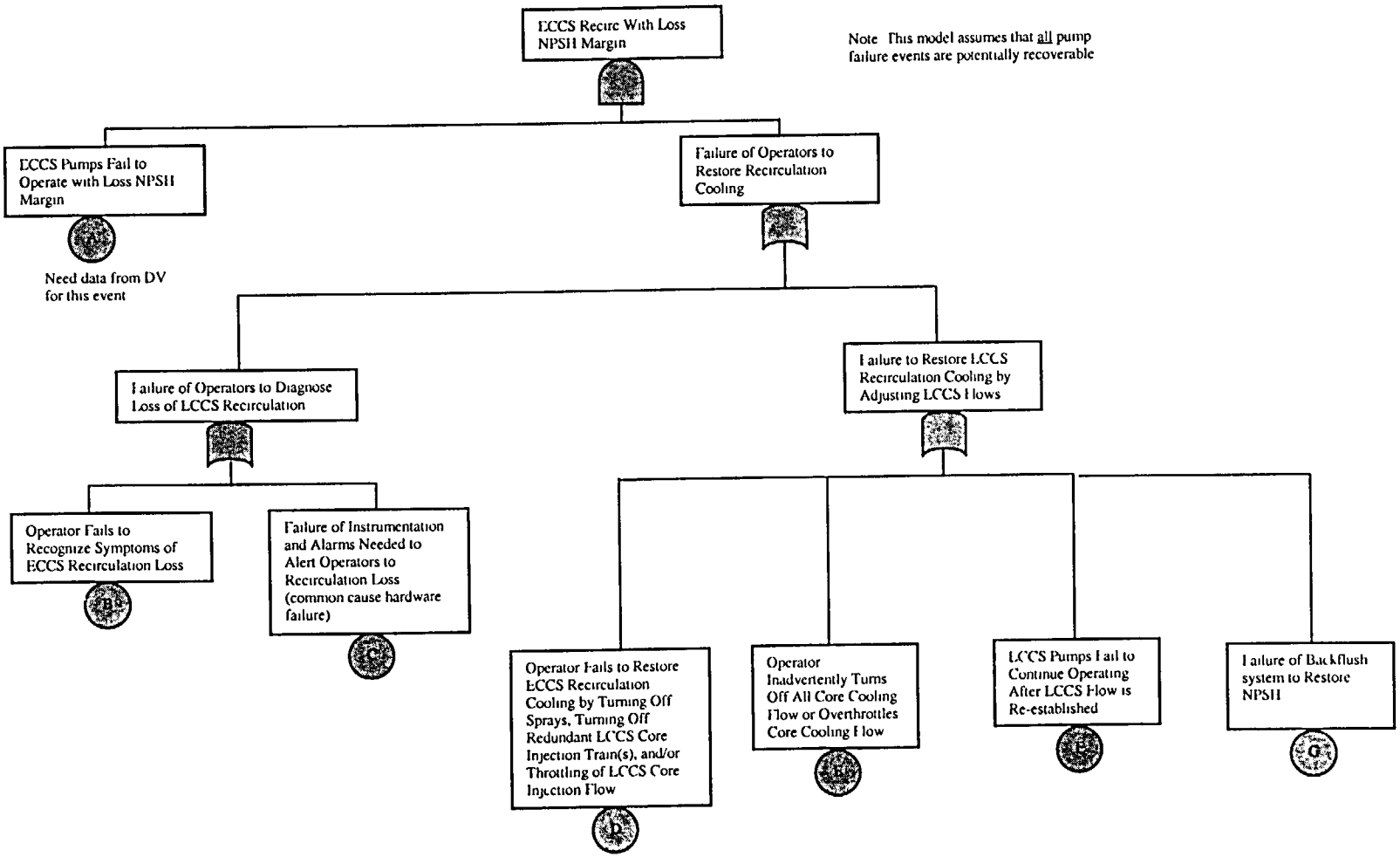
- accident sequences which affect GSI-191 are potentially affected by this issue as well
- information collected to resolve GSI-191 (nature and quantity of debris that approaches the screen) will support addressing this issue as well
- licensee actions that address GSI-191 may influence throttle valve blockage
- credibility of the issue is unresolved
- the generic letter will focus on ECCS recirc flow path

ATTACHMENT 4

Given below is a fault tree model for failure to re-establish ECCS injection. This fault tree model could be used to represent all or part of the fault tree needed for the event tree heading "Recover from loss of ECCS Recirc. due to Debris." Even if it is possible to recover loss of recirculation by proceeding to cold shutdown, continued RCS makeup will be required for many break locations.



Given below is an updated version of the fault tree for the event tree heading "ECCS Recirc with Loss NPSH Margin."



ATTACHMENT 5

Table of Contents

ATTACHMENT 6

Work Product	NRC Meeting	Finish Date
Issue NEI-02-01, Condition Assessment Guidance	N/A	4/2002
Data Evaluation and Needs Identification	8/15/2002	9/20/2002
Document methodology, guidance on use of data, selection of break locations, use of probabilities, etc.	9/27/2002	10/31/2002
Develop Sump Performance Evaluation Tools, Groundrules	~~11/31/2002~~ Dec '02	1/17/2003
Sensitivity Studies	1/31/2003	2/21/2003
Draft Sump Performance Evaluation Guidance	3/28/2003	4/25/2003
Sump Performance Evaluation Sensitivities	5/16/2003	6/27/2003
Decision Analysis Tools / Final Program Documents	8/22/2003	9/26/2003