NRR-PMDAPEm Resource

From: Harrison Albon [awharrison@STPEGS.COM]
Sent: Monday, August 18, 2014 6:55 PM
To: Singal, Balwant
Cc: Oesterle, Eric; Mitchell, Eliza
Subject: RE: Out-of-Office (August 18 to August 29, 2014)
Attachments: 8-20-14 NRC Meeting - main.pptx

Here is the main set of slides for the STP risk-informed GSI-191 meeting on 8/20/14.

Call me if you have questions.

Wayne Harrison
STP Licensing
(979) 292-6413

From: Singal, Balwant [mailto:Balwant.Singal@nrc.gov]
Sent: Thursday, August 14, 2014 2:45 PM
To: Harrison Albon
Cc: Oesterle, Eric; Mitchell, Eliza
Subject: RE: Out-of-Office (August 18 to August 29, 2014)

Wayne,

Wayne,

Please copy the following NRC staff members on your e-mail forwarding the presentation slides:

Oesterle, Eric Eric.Oesterle@nrc.gov
Mitchell, Eliza Eliza.Mitchell@nrc.gov

Thanks.

Balwant K. Singal
Senior Project Manager (Comanche Peak, STP, Diablo Canyon, and Palo Verde)
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From: Harrison Albon [mailto:awharrison@STPEGS.COM]
Sent: Thursday, August 14, 2014 12:58 PM
To: Singal, Balwant
Cc: Lyon, Fred; Blossom, Steven; Kee, Ernie
Subject: RE: Out-of-Office (August 18 to August 29, 2014)

Balwant,

You asked yesterday when we would have slides to you for the 8/20 meeting. We'll have them to you (or Fred) by COB on Monday, probably before.

Regards,
Wayne Harrison
STP Licensing
(979 292-6413

From: Singal, Balwant [mailto:Balwant.Singal@nrc.gov]
Sent: Thursday, August 14, 2014 10:30 AM
To: 'Hope, Timothy' (Timothy.Hope@luminant.com); Sterling, Lance; Harrison Albon; Carl.Stephenson@aps.com; pns3@pge.com
Cc: Lyon, Fred; Watford, Margaret; Oesterle, Eric; Markley, Michael
Subject: Out-of-Office (August 18 to August 29, 2014)

I will be out-of-office from August 18 to August 29, 2014. Please contact the following NRC staff members for Project Manager assistance:

Fred Lyon at 301-415-2296 for Comanche Peak, South Texas Project, and Diablo Canyon.
Eric Oesterle at 301-415-1014 for Palo Verde.

Thanks.

Balwant K. Singal
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Received Date: 8/18/2014 6:56:07 PM
From: Harrison Albon

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South Texas Project
Pilot Risk-Informed GSI-191
Licensing Application

Meeting with NRC Staff

August 20, 2014

STP Meeting Participants

- Mike Murray, Manager Regulatory Affairs
- Steve Blossom, Risk-Informed GSI-191 Project Manager
- Ernie Kee, STP Risk-Informed GSI-191 Technical Team Lead
- Wayne Harrison, STP Licensing Lead
- Drew Richards, STP Licensing
- David Johnson, ABS Consulting
- Bruce Letellier, Alion Science & Technology
- Janet Leavitt, Alion Science & Technology
- Rodolfo Vaghetto, Texas A & M University
- Zahra Mohaghegh, University of Illinois, Champagne/Urbana
- Edward D. Blandford, University of New Mexico
- David Morton, University of Texas, Austin
- John Hasenbein, University of Texas, Austin

Meeting Purpose and Desired Outcomes

- Purpose:
  - Provide opportunity to gain understanding of Open Issues from the NRC Staff Review
  - Initiate Resolution Process for Open Issues from the NRC Staff Review
  - Gain alignment on topics the Staff wants the Licensee to present to the ACRS on 9/3/2014
- Desired Outcomes:
  1. Alignment on the nature of the open issues
  2. Propose next action for each item
  3. Alignment on ACRS topics

Agenda

- Role of CASA Grande
  - PRA input application vs 50.46 application
  - Describe Alion plan to revise the CASA Grande documentation (V&V, etc.)
- Discussion of NRC Staff identified issues (by Branch)
  - Confirm agreement on what the issue is that needs to be resolved
  - Determine the next step for each issue
- Discuss upcoming September 3, 2014 ACRS Subcommittee Meeting
- Discuss NRC plans for audit of STP application material in September, 2014

Agenda – Branch Discussions

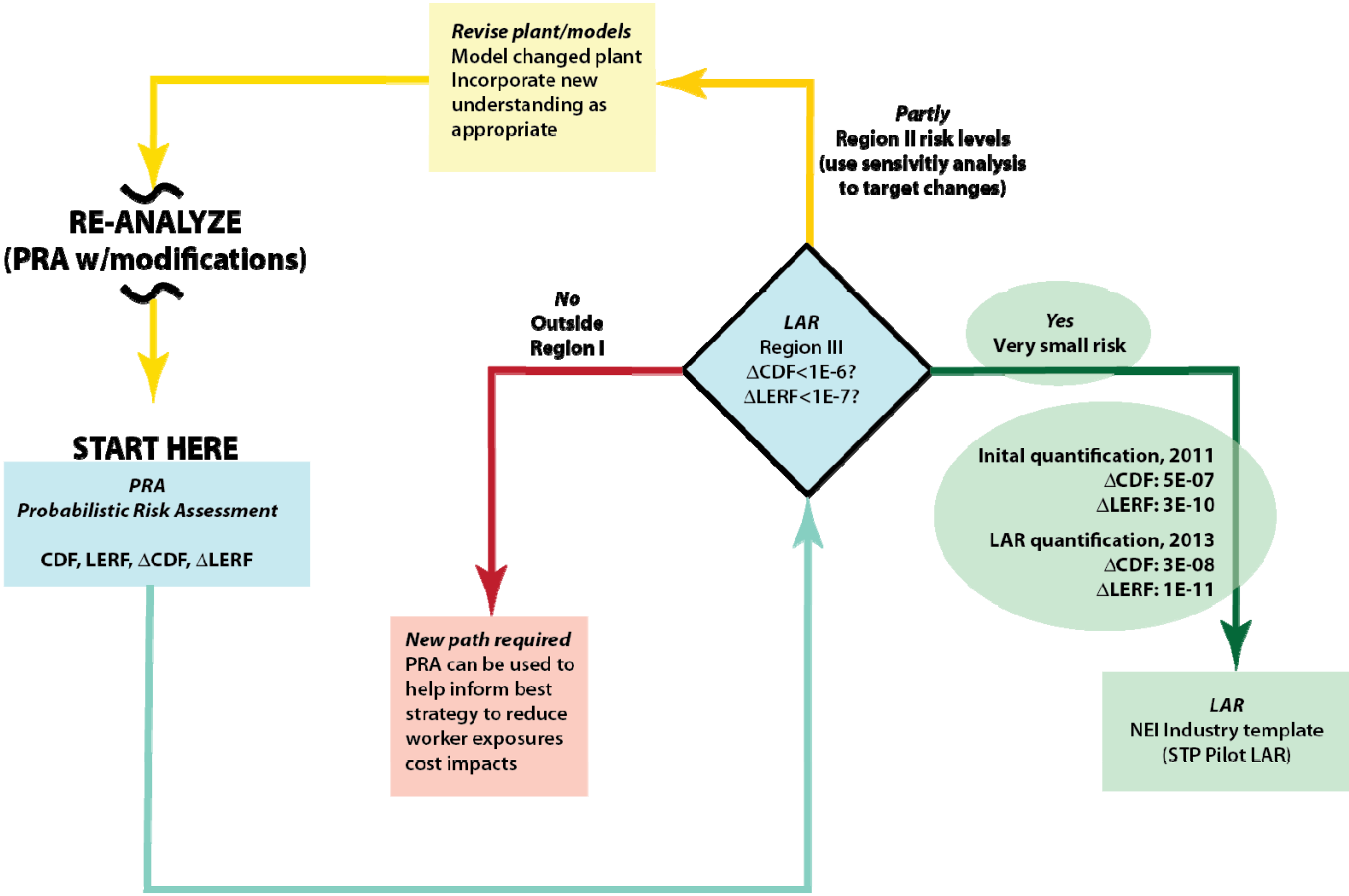
1. SSIB RAIs
   - Head loss and chemical effects bump-up (RAI 15, 16, 17, 18)
     - Includes purpose of "L-Star" correlation
     - Includes purpose of VISTA correlation
   - In-vessel and boric acid precipitation (RAI 37)
2. APLAB RAIs
   - CASA Grande – Plant Configuration: RAI 1b, 2b, 3
   - HRA: RAI 3, 5
   - Uncertainties: RAI 1, 2, 4, 5, 6
   - Stable end state: PRA Success – RAI 3c
   - Use of different distributions
3. ESGB RAIs
   - Coatings: RAI 1, 2, 6
   - Chemical Effects: RAI 1

Role of CASA Grande

- Relative to PRA – discussion lead by Ernie Kee
- Alion plan for documentation – discussion lead by Bruce Letellier

Risk Assessment Overview

- Probabilistic Risk Assessment (PRA) is performed in a standard way with the existing plant PRA model of record in an assessment framework
  - Uses standard plant procedures, processes, and programs for PRA analysis and assessment that support standard risk applications such as Maintenance Rule, RMTS, risk categorization, SDP
  - Uses existing industry standards for PRA quality
- To specifically analyze GSI-191 risk concerns, "engineering judgment" for recirculation risk input (failure probability) needed to be improved
  - Risk (probability) of sump failure needed improvements – enhance the simplistic demand failure probability with engineering analyses
  - A top event for in-vessel failures added for completeness as current PRA industry standards do not require consideration of long term cooling
  - Inputs for obtaining conditional failure likelihoods are supported by prudent, peer-reviewed, data and engineering analyses
  - Previously developed and accepted engineering models were adopted where possible to reduce development and regulatory review burden



In early 2011 when the flow chart was developed, the focus was on quantitative risk assessment to confirm existing qualitative evaluations indicating safe operation based on defense in depth measures and safety margins derived from plant changes already in place, such as strainer modifications, targeted insulation removal, and operations/procedure changes. Most plants have similar qualitative evaluations.

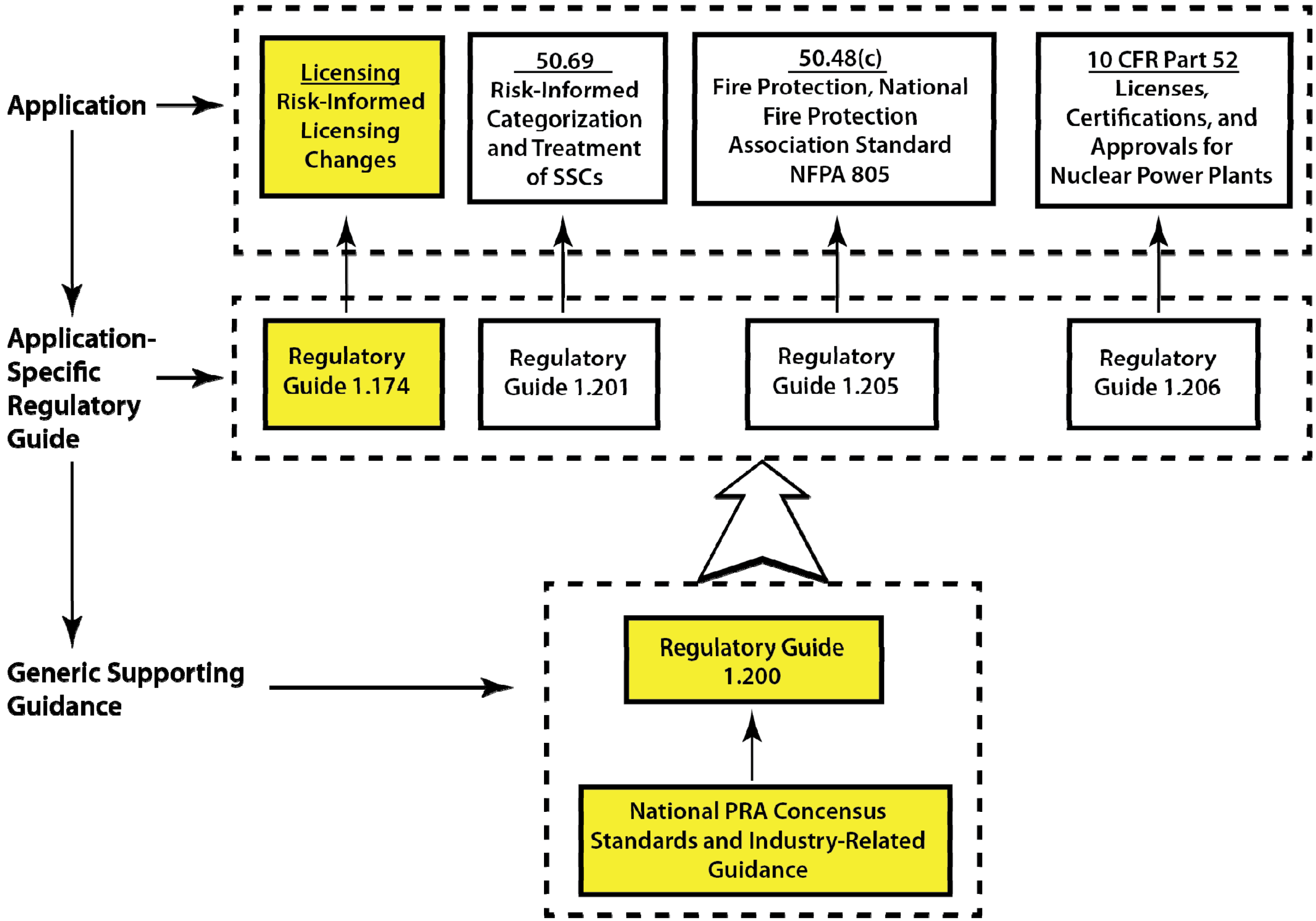


Figure 1 from RG 1.174 - Relationship of Regulatory Guide 1.174 to other risk-informed guidance

Progress since May, 2012 ACRS

- Regulatory interface
  - License Amendment Request (LAR) submitted 2013
  - Set #1 Requests for Additional Information (RAIs) – 249 RAIs responded to in 3 packages
- Additional insights and review support
  - Quantifications: 12/2011, 05/2013, 11/2013, all show “very small” risk
  - Sensitivity study methodology developed
  - Additional confirmatory chemical effects tests completed that support and enhance previous chemical effects observations (ICET, T1, T2, bench top tests)
    - T3 and T4 “overloaded” tests
    - T5 repeat of T2 (LLOCA) with “blender beds”.
  - New thermal-hydraulics capability and analyses
    - 3D modeling
    - coupling of RELAP5 and MELCOR models
    - Advanced results visualization capabilities
- Quantification of safety margin in head loss, chemical effects further demonstrating safety margin with expanded experimental database.

PRA input versus engineering analysis

- As opposed to a deterministic methodology, the objective of commercial nuclear power probabilistic risk assessment has been quantification of risk measures, typically CDF and LERF associated with plant operation and design
  - RG1.174 defines (CDF, Δελτα CDF) and (LERF, Delta LERF) measures, adding quantification of a change in risk due to some changed activity or plant modification
  - One of the plant risk assessment inputs has (until recently) included a simplistic, all-inclusive failure mode "demand failure" likelihood for ECCS recirculation failure that is, a failure of LTCC based on engineering judgment
- The risk assessment should realistically assess exposure to CDF (as a precursor) and LERF as potential exposure to significant radioactive release
  - The risk should be near zero - RG1.174 defines "small" or "very small"
  - A realistic risk estimate should be made to direct effective decision-making
- 10CFR50.46c should ask for the risk-informed evaluation to be done in a standard way using the plant PRA
  - The ECCS failure likelihood is replaced with likelihoods for potential failure modes associated with the concerns raised in GSI-191 supported by prudent, peer-reviewed engineering analyses
  - Standards, procedures, and processes that have been established for commercial nuclear power risk assessment (e.g., ASME PRA standard, RG1.200, existing plant risk assessment procedures for SDP, RMTS, NEI Initiative 5b)

Role of CASA Grande, VISTA, and L*

- In order to support the risk assessment, including RG1.174 requirements, engineering analyses and data are required
- RG1.174 asks for safety margin and defense in depth
  - CASA Grande produces prudent, peer-reviewed engineering analysis of the response to hypothesized LOCA that includes safety margin in head loss
  - VISTA and L* were developed in response to multiple RAIs that questioned the safety margin in retained in STP's head loss estimates
- In order to include more conventional head loss data, and address other comments with NUREG 6224, VISTA was developed and then compared to STP's implementation of 6224 that includes safety margin.
- Similarly, to address comments about the formulation of the safety margin added in chemical head loss, L* was developed as a conservative representation of head loss including more data
- It is shown that, with more data included and addressing comments about the formulation of multiplicative "bump up", STP's implementation of head loss retains safety margin

SSIB RAIs

- Head loss and chemical effects bump-up (RAI 15, 16, 17, 18)
  - Includes purpose of “L-Star” correlation
  - Includes purpose of VISTA correlation
- In-vessel and boric acid precipitation (RAI 37)

SSIB RAI 15
Conventional Debris Head Loss Correlation

(a) Validation for full range of debris loads and morphologies

Correlations help identify combinations of concern, especially across the full spectrum of RI analysis, and strainer tests provide proof of performance for the most challenging conditions identified

(b) Non-homogeneity

Inhomogeneous composition through the thickness of the bed may exist that elevates the observed head loss. Enclosure 1 relaxes this concern

(c) Validation over full flow range

Reassessed by looking at internal Reynolds number (Also 17 (c))

(d) Parameter uncertainty

Direct measurements of constituents show that more accurate estimates help to confirm results

SSIB Head Loss, RAI 16
Vertical Loop Head Loss Applicability

(a) Are STP vertical loop tests valid considering other facilities showed significantly different results?

- Tests are important and are shown to be consistent with conclusions

(b) Provide evidence that vertical loop tests conducted under site specific conditions will correlate to flume tests conducted under similar conditions

- Tests are important and are shown to be consistent with conclusions when internal flow conditions are considered

(c) Provide a basis for using a correlation that has not been validated specifically for STP plant conditions and geometries

- including the sludge-limit compaction and a factor of 5 uncertainty bound is designed to provide confidence that predictions bound realistic strainer performance for the majority of debris combinations and flow conditions that are experienced in the plant.

(d) How does NUREG/CR-6224 correlation predict the head losses that would be expected under conditions similar to those in the two flume tests conducted by STP in February and July 2008?

- The July test is not representative of STP post-LOCA conditions and is not considered further. February testing did represent conditions that could be expected at STP. It is unlikely, given the safety margin in the 5X bump up factor, that additional testing would challenge the conclusion that the 6224 correlation (as implemented) is acceptable

SSIB Head Loss RAI 17
Validation in Hypothesized STP Conditions

(a) Debris constituents in validation testing are not plant-specific

The correlation (including safety margin) is used to reveal trends in strainer performance that may challenge risk informed success criteria. STP does not have micro-porous debris

(b) Debris sizes in validation testing are not plant-specific.

The UNM vertical loop testing is considered to be part of the NUREG/CR-6224 validation effort which included a wide range of debris sizes including blender-processed fiberglass. HTVL testing conducted at Alion Hydraulics Laboratory used a modified NEI debris preparation. Therefore, prototypical debris sizes are considered to be well represented.

(c) Very little validation testing was conducted at STP velocities and none validated the correlation

Addressed in RAI 15c

(d) Validation testing did not include prototypical strainer geometries.

Validation testing includes: (1) strainer testing, (2) HTVL testing, and (3) UNM vertical column testing. Strainer testing did include prototypical STP geometry, and one series of HTVL tests was patterned after the flume test conditions, debris types and debris loading

(e) Validation testing performed in vertical loops does not simulate potentially important aspects of debris bed formation under plant conditions

See (e) above. Also, uniform beds constructed in vertical column configurations provide a more consistent basis for validation and more conservative results

(f) Conclusions from early testing must be limited

Confirmatory analysis is primarily focused on recent data (since 2010) with sufficient documentation to demonstrate applicability to plant conditions.

SSIB Head Loss RAI 18
Head Loss and Chemical Effects Bump Up

(a) Provide justification that homogeneous beds represent of the plant

Mixing flows and migration processes tend to homogenize any strata that might initially be formed by sequential arrival.

(b) Describe why the LDFG density assumption is valid and why it does not significantly affect the results

A sensitivity test using the sludge limit as a plausible compression condition resulted in a ΔCDF increase by a factor of 1.8

(c) Explain how the NUREG/CR-6224 correlation compression function is applied

The STP LAR intends to impose sludge-limit packing density for all cases. This was not implemented and a 1.8X increase would be expected when implemented

(d) Explain why mass weighting is acceptable

Calculations between mass and volume weighting show no significant increase in ΔCDF with STP-specific inputs

(e) Provide the potential ranges of packing factors for coating materials

All coating materials have a similar packing fraction to acrylic coatings (0.39 as described in STP LAR Enclosure 4-3, Reference 24) is reasonable because the constituents are comparable in size, approximately 10 microns. Non-coating particulate debris was assumed to have a packing fraction similar to iron oxide sludge (0.20). NUREG/CR-6224 cites the packed density of iron oxide sludge as 65 lb/ft3.

APLAB RAIs

- CASA Grande – Plant Configuration: RAI 1b, 2b, 3
- HRA: RAI 3, 5
- Uncertainties: RAI 1, 2, 4, 5, 6
- Stable end state: PRA Success RAI 3c
- Use of different distributions

APLAB RAI 1b
CASA Grande – Plant Configuration

- Provide a technical justification for using only nominal values or calculate core damage frequency (CDF), large early release frequency (LERF), delta-CDF (ΔCDF), and delta-LERF (ΔLERF) using time-temperature curves that maximize the probability of sump and core blockage for the entire assumed duration of the event
  - The use of nominal pool temperature profiles is consistent with a holistic risk-informed approach and provides a more realistic evaluation of risk.

APLAB RAI 2b
CASA Grande – Plant Configuration

- Provide a technical justification for assuming only nominal operating conditions or calculate CDF, LERF, ΔCDF, and ΔLERF using flow rates or other thermal-hydraulic conditions that maximize the probability of sump and core blockage for the entire assumed duration of the event
  - Using nominal values provides results that are reasonable, probable and that may be used in a holistic, risk-informed evaluation

APLAB RAI 3
CASA Grande – Plant Configuration

- (a),(b),(c) Justify a combination of pumps failing in the same train is "worse" than the same set of pumps failing in different trains and clarify if an engineering analysis was performed in support of this assumption
  - Details documenting the rationale for selecting pump state 22 to demonstrate the impact of the assumption, the analysis approach and results are found in Enclosure 1

APLAB RAI 3
Human Reliability Analysis

(a) State if the CASA Grande models the plant conditions (e.g., sump flow rates, washdown rates, refueling water storage tank (RWST) drain-down times, etc.) that would occur if three containment spray trains were running (i.e., if the manual actions modeled by top event OSI are unsuccessful.)

- Statistical sampling does not preclude selection of a very long task performance time that effectively represents failure of manual action but no strategies are employed to ensure that this condition is always represented in the statistical design

(b) State if the CASA Grande models the plant conditions (e.g., sump flow rates, washdown rates, RWST drain-down times, etc.) that would occur if the operators fail to secure containment spray long term once containment pressure and iodine levels are suitably low (i.e., the manual actions associated with OFFS are unsuccessful)

- CASA Grande does not model the plant conditions that would occur if the operators fail to secure containment spray long term once containment pressure and iodine levels are suitably low

(c) Provide a technical basis and explain how the PRA meets the ASME HLR-HR-G requirement

- The PRA model does include logic to represent failure to trip one running containment spray pump as well as failure to trip all containment spray pumps late in the sequence. However, there are no results from CASA Grande that are representative of these failure conditions

APLAB RAI 5
Human Reliability Analysis

- Please explain how the CASA Grande results were developed to address the various combinations of success and failure of these operator actions. Please also explain how the consistency between the actual PRA scenario and the GSI-191 basic event failure probabilities developed in CASA Grande was assured
  - The operator actions on Page 37 of Volume 3 are listed as:
    1. Securing one Containment Spray System (CSS) pump if all three CSS pumps are successfully initiated
    2. Securing all CSS pumps later in the event
    3. Switchover to Emergency Core Cooling System (ECCS) sump recirculation after the Refueling Water Storage Tank (RWST) has been drained
    4. Switchover to hot leg injection

APLAB RAI 1
Results Interpretation-Uncertainty Analysis

(a) Please identify all sources of key model uncertainty as defined by RG 1.200

Success criteria for fuel blockage and boron precipitation, Fiber penetration of the sump strainer, Head loss correlation at sump strainer, Debris generation, including size and shape of zone of influence, Debris transport to the sump, Ability of chemical precipitates to cause increased strainer head loss and fuel blockage

(b) Please identify the key assumptions as defined by RG 1.200

Table provided

(c) Describe the potential effect of the key assumptions on the results

Items addressed: discrete pump operability states; failure conditions at one sump; head loss correlation used, including ‘bump up factors’, is conservative; boron precipitation following Medium cold leg breaks is likely conservative; breaks occur on a leg equipped with SI yields a slightly conservative result;

APLAB RAI 2
Results Interpretation-Uncertainty Analysis

- Provide CDF, LERF, ΔCDF, and ΔLERF using the arithmetic mean aggregation of LOCA frequencies in NUREG-1829
  - CASA has not been rerun, initially, Delta cdf is 1.54e-7 and delta lerf is 2.56e-10

APLAB RAI 4
Results Interpretation-Uncertainty Analysis

(a) Explain why the STP evaluation departs from the regulatory position in RG 1.174 regarding the use of mean values

- Mean values are used by the PRA for the initiating event frequencies, ΔCDF and ΔLERF actually use the mean values from NUREG-1829

(b) Provide a technical justification for the selection of the scale parameter λ

- Increasing the scale factor to a factor of 100 times the 95th percentile of the frequencies elicited from experts in NUREG-1829 produces less than a 2% increase in ΔCDF

(c) Provide the maximum expected difference between the CDF, LERF, ΔCDF, and ΔLERF developed from bounded Johnson distributions that consider alternative values of the scale parameter λ

- Estimates of CDF and LERF differ from ΔCDF and ΔLERF by values that do not depend on λ

(d) Justify the apparent use of different bounded Johnson distributions in the PRA and CASA Grande

- The distributions derived from the fitted bounded Johnson distributions were scaled for use in the PRA. This was done to match the resulting mean values with the means interpolated directly from NUREG-1829

APLAB RAI 5
Results Interpretation-Uncertainty Analysis

- Either calculate CDF, LERF, ΔCDF, and ΔLERF accounting for the state-of-knowledge correlation or demonstrate that it is unimportant to this application
  - Dependence of the PRA and CASA Grande on different parameters of the LOCA break frequencies is sufficient so as to not warrant correlation between the PRA and CASA Grande

APLAB RAI 6
Results Interpretation-Uncertainty Analysis

- Provide the results of an aggregate analysis that quantifies the integrated impact on CDF, LERF, ΔCDF, and ΔLERF from all sensitivity studies that were performed
  - A sensitivity analysis was performed by 1) developing the scope of potentially important contributors to ΔCDF and then 2) analyzing their individual contributions in a one-way sensitivity study. The study was then expanded to include aggregate contributions from the two highest contributors, fiber penetration through the emergency core cooling system strainers and the success criteria for boron precipitation (boron fiber limit)

APLAB RAI 3c
PRA Success

- State what plant conditions and configuration is assumed for the “safe, stable end state” in the PRA model. Please describe
  - To reach the one, safe stable end state in response to a medium or large LOCA requires
    - Successful reactor trip,
    - Successful safety injection actuation,
    - MSIV closure or turbine trip or the reactor withstanding a potential PTS overcooling challenge,
    - Sufficient accumulator injection,
    - Low head pump injection to the RCS
    - High head pump injection (not required if a large LOCA)
    - Low head pumps in sump recirculation mode
    - Sump available for recirculation considering GSI-191 issues
    - No in-vessel flow blockage
    - No boron precipitation leading to loss of core cooling, and
    - Decay heat removal by either the RHR heat exchangers or the containment fan coolers
  - The most likely safe, stable end state is that all containment fan coolers are operating and that cooling to the secondary side of each RHR heat exchanger aligned for low head pump sump recirculation is available. These are the only safe, stable end states credited in the STP PRA for medium and large LOCAs

ESGB RAIs

- Coatings: RAI 1, 2, 6
- Chemical Effects: RAI 1

ESGB RAI 1
Coatings

- Specify the epoxy coating in question and provide a basis (i.e., testing) for assuming it fails in pieces larger than fines
  - The unqualified coatings size distribution of Table 2.2.18 (LAR Enclosure 4-3) was taken from LAR Enclosure 4-3, Reference [12], Table 7, Page 32. This calculation references the epoxy size distributions from paint chip characterization of DBA coatings testing document "TXU Paint Chip Characterization"

ESGB RAI 2
Coatings

- The ZOI used to calculate these quantities is not provided. Please provide the ZOI used for both epoxy and inorganic zinc (IOZ) qualified coatings (e.g. epoxy = 4D, IOZ = 10D)
  - A ZOI was created for each of the four different break sizes in three bounding locations which determine a realistic maximum amount of surface area for the different epoxy, polyamide primer, and IOZ coatings. Due to the different inner diameters of pipes, the 4D ZOI radius is used for the epoxy and inorganic zinc (IOZ) qualified coatings as suggested by WCAP-16568-P

ESGB RAI 6
Coatings

(a) Describe what STP has done in terms of documentation review or testing of plant materials in order to ensure that the plant-specific unqualified coatings at STP are the same as the coatings used in the EPRI testing

- The generic type of each unqualified coating (i.e. epoxy, alkyd, etc.) is documented in the STP unqualified coatings inventory log (LAR Enclosure 4-3, Reference [12]). The specific product description, however, is unavailable for many unqualified coatings. Product descriptions are also unavailable for many of the coatings tested in the EPRI study (LAR Enclosure 5, Reference [3]), the extent of comparison is made to applicable generic coating types that are available

(b) The testers stated that they made no attempt to quantify debris on the filters, please provide additional justification for using this test data to assign a failure time to unqualified coatings

- Interpretation of the data implies that ranking filters by discoloration (visually dominated by heavily pigmented alkyds) may conservatively bias inferred failure timing to the maximum unqualified coatings failure rate of alkyds. A single estimated failure rate was applied for all upper-containment unqualified coatings types in the STP LAR Enclosure 4-3 analysis

(c) Provide additional justification for the current analysis or provide a revised value for the failure timing

- Because alkyd coatings have the greatest influence on subjective interpretation of photographs (by virtue of distinctive coloration), and have the highest average substrate detachment, inferred failure rates can only be biased towards the maximum unqualified coatings failure rate of alkyds. See discussion in response to ESGB RAI 6b

ESGB RAI 1
Chemical Effects

(a) Based on the NRC staff's experience observing testing, head loss for a given quantity of chemical precipitates should be related to both the type of precipitate and the filtering characteristics of the debris bed

- Although chemical effects have not been found to be significant contributors to STP post-LOCA sump conditions, CASA Grande evaluates a chemical contribution based on break size to provide safety margin in the analysis

(b) A relative frequency plot of chemical effects as a histogram showing chemical head loss (feet) on the x-axis and number of occurrences on the y-axis would be very useful to the staff

- Histograms of chemical head loss vs frequency for CASA Grande Case 01 (all equipment operates) are presented by Figures 1 and 2

(c) Please supply the basis for choosing the exponential form of the PDF over others

- The single-parameter exponential PDF was chosen for shape and for convenience of fitting the desired statistics of the mean and a truncated tail probability

(d) In general, finer fiber beds tend tolead to greater head loss.

- Means of the exponential PDFs were determined from evaluation of STP ECCS strainer testing (LAR Enclosure 4-3, Reference [53]) as discussed in the ESGB RAI 1c response

ACRS Preparation

- Discuss ACRS Topics to be presented and discussed with ACRWS

Audit Plan

- Discuss scope of audit
- Agree on audit location and dates