Response to Defense Nuclear Facilities Safety Board (DNFSB) Comments in DNFSB Letter dated November 4, 2002

The following information identifies each of the DNFSB comments or issues and provides a U.S. Department of Energy (DOE) response, identifies actions taken to date, and actions that are currently planned to support construction activities.

Safety Requirements

DNFSB Comment/Issue Number 1:

The safety criteria and methodology presented in the Safety Requirements Document (SRD), as applied by Bechtel National, Inc. (BNI), do not reflect several key requirements for preparation of a Preliminary Safety Analysis Report (PSAR) as set forth in DOE O 420.1, *Facility Safety*, and DOE standard DOE-STD-3009-94, Change Notice 2, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports.*

DOE Response:

DOE agrees that some of the safety analysis criteria and methodology presentations to the DNFSB staff, and some portions of the PSAR, were not consistent with the requirements for preparation of a PSAR as set forth in DOE O 420.1, nor were they consistent with DOE-STD-3009-94, Change Notice 2. However, DOE considers that the safety analysis criteria and methodology, when properly applied, meet the requirements of DOE O 420.1A, and are consistent with DOE-STD-3009-94, Change Notice 2. DOE considers that the observed deficiencies occurred because some BNI staff were not properly interpreting the project requirements. DOE's safety evaluations have partially identified similar deficiencies, and required corrective action (see Attachment 2 for a listing of related findings.).

Reason for the Issue:

As discussed further in the responses for issues 2 through 6 below, the observations of the DNFSB, including its staff, demonstrate that the methodology must be more clearly described in the project procedures, the safety analysts' training must be reinforced to ensure they consistently understand and implement the methodology, and the PSAR must be revised to clearly present the unmitigated safety analysis that was performed.

Other Information:

The safety criteria are found in the SRD. These criteria do not use evaluation guidelines as fixed criteria for determining the acceptability of the design.

In this methodology, the unmitigated consequences are compared to the criteria in SRD Appendix A, Table A-1 to identify control strategies. This process is comparable to that in DOE-STD-3009 Appendix A, except that it is applied to all populations. Based on these criteria, tentative control strategies are selected. Then, knowing the tentative control strategies, the mitigated consequences are compared to the radiation exposure standards in SRD SC 2.0-1 (including Table 2-1) to evaluate the mitigated accident consequences and ensure the calculated exposures are far enough below the Table 2-1 standards to account for uncertainties in the analysis and provide for sufficient design margin and operational flexibility. By applying these standards, the calculated unmitigated consequences were significantly reduced or prevented with the credited control features in place. That is, the reduction in the unmitigated consequences to the public or co-located worker ranged from 3 to 7 orders of magnitude (See Attachment 1-A). DOE considers that by showing reductions of unmitigated consequences in the range from 3 to 7 orders of magnitude, the calculated exposures are far enough below the SRD Table 2-1 mitigated standards to account for uncertainties in the analysis, and provide for sufficient design margin.

DOE-STD-3009-94, Change Notice 2, is not included in the contract and is not required during this phase of the project. However, DOE has attempted to remain consistent with this guidance, where appropriate for a new construction facility, and with a view to its eventual use for the Documented Safety Analysis for the facility. Although 10 CFR 830 allows the use of DOE-STD-3009-94 as a safe harbor method for the Documented Safety Analysis, it is not required for the Preliminary Documented Safety Analysis (PDSA). Moreover, as noted on page 1 of this standard

> *For new facilities in which conceptual design or construction activities are in progress [i.e., Preliminary Documented Safety Analysis (PDSAs)] elements of this guidance may be more appropriately handled as an integral part of the overall design requirements process (e.g., preliminary design to design criteria). The methodology provided by this Standard focuses more on characterizing facility safety (i.e., back-end approach) with or without well-documented information than on the determination of facility design (i.e., front end approach). Accordingly, contractors for facilities that are documenting conceptual designs for PDSAs should apply the process and format of the Standard to the extent it is judged to be of benefit.*

BNI, per contract with the DOE, has used this standards setting process to develop the project safety requirements. These requirements were used in developing the PSAR (or PDSA). A detailed review of differences between DOE-STD-3009-94 and these requirements has been performed by DOE Office of River Protection (ORP) in ORP/OSR 2001-06, Revision 2, *Office of Safety Regulation Position on Applying Project Specific Safety Analysis Methodology Consistent with the DOE-STD-3009 Safety Analysis Methodology for the RPP-WTP*. ORP concluded that the WTP safety analysis criteria and methodology meet or exceed the intent of DOE-STD-3009-94. This was confirmed in a DOE memorandum (Memorandum dated October 9, 2001, R. S. Scott, M. W. Frei, and R. L. Black to H. Boston, *Approach to Compliance with 10 CFR Part 830 for the River Protection Project-Waste Treatment Plant).*

Corrective steps taken or to be taken:

Procedure 24590-WTP-GPP-SANA-001, *Procedure: Accident Analysis,* will be revised to clearly describe the above methodology (i.e., comparison of mitigated consequences to unmitigated consequences). Additional training of the safety analysts will be conducted to ensure a consistent understanding and implementation of the methodology. The PSAR will be revised to more clearly reflect the results of using the above safety criteria and methodology.

These actions are discussed further in the responses to DNFSB Issues 2, 3, 4, 5, and 6.

Dates for completion of corrective steps:

See responses to DNFSB Issues 2, 3, 4, 5, and 6 for completion dates for actions discussed above.

Additionally, the design basis event (DBE) calculations and the PSARs will be revised as part of the first annual PSAR update in June 2003.

DNFSB Comment Number 2:

The numerical value of 25 rem given as the radiological exposure standard in Table 2-1 of the SRD for protection of the public is consistent with the evaluation guideline established in DOE-STD-3009-94 for identification of safety-class systems, structures and components (SSCs). The DOE evaluation guideline was intended to be used in conjunction with the unmitigated accident consequences for identification of safety-class SSCs. However, the staff's review identified several instances in which SSCs were credited in comparing the consequences with the criteria given in Table 2-1 of the SRD. For example, Section 3.4.1.1.5 of the PSAR for the High Level Waste (HLW) facility credits the high-efficiency particulate air (HEPA) filters in calculating the consequences for comparison with the SRD. This is in contrast to the recommended approach in DOE-STD-3009-94 that the unmitigated consequences should be compared with the evaluation guidelines for classification of the SSCs. As a result, the safety significance of the HEPA filters may have been masked due to the lack of knowledge of the unmitigated consequences.

Follow-up discussions with the contractor revealed that the guidance on using the mitigated accident consequences as the basis for comparison with the radiological exposure standards in Table 2-1 of the SRD was provided by ORP. Any changes to this approach would require negotiations between the contractor and DOE, which are pending at this time.

DNFSB Issue Number 2:

Several instances were noted in which SSCs were credited in comparing the [unmitigated] consequences with the criteria given in Table 2-1 of the SRD. Section 3.4.1.1.5 of the PSAR for the HLW facility credits the HEPA filters in calculating the consequences for comparison with the SRD. This is in contrast to the recommended approach in DOE-STD-3009-94 that the unmitigated consequences should be compared with the evaluation guidelines for classification of the SSCs. As a result, the safety significance of the HEPA filters may have been masked due to the lack of knowledge of the unmitigated consequences.

DOE Response:

The DNFSB's staff's comments have led DOE to recognize that the methodology needs to be clarified to make explicit DOE's expectation that all Severity Level (SL)-1 events with public consequences near the DOE-STD-3009 guidelines will credit Safety Design Class (SDC) SSCs to ensure that public exposure is well below the SRD, Table 2-1 standards. DOE and BNI consider that this expectation was used (albeit informally) by analysts during the analyses.

Moreover, DOE agrees that the PSAR must be revised to clarify the approach for classification of SSCs. Furthermore, the presentations to the DNFSB staff did not clearly explain the process that was used to determine the required control strategies and safety classifications.

Due to these weaknesses in the documentation of the methodology, inadequate explanation in the PSAR, and in the presentations to the DNFSB staff, the impression was created that SSC safety classification on this project is influenced by the comparison of mitigated accident consequences to the mitigated accident consequence criteria in Table 2-1 of the SRD. This impression is incorrect. Further discussion is provided in the next paragraphs related to this issue.

Reason for the Issue:

The Waste Treatment and Immobilization Plant (WTP) PSAR does not clearly reflect the WTP process that was used to determine classification of SSCs based on comparison of unmitigated consequences to evaluation guidelines. The PSAR documents a comparison of the mitigated event consequences to the SRD, Table 2-1 standards to show that safety margin exists as required by SRD Safety Criteria 2.0-1. An example of this comparison is in PSAR Section 3.4.1.1.5, the section referenced by this DNFSB comment. This comparison is intended to go beyond the unmitigated consequence guidelines of Appendix A of DOE-STD-3009-94. The process of safety classification of SSCs, as discussed below, is intended to have more controls to ensure adequate safety than use of DOE-STD-3009-94 alone would provide.

Unmitigated consequences (which in the WTP analysis methodology determine event Severity Level) are compared to Table A-1 of the SRD (Section 4.3.1), to assign Severity Levels (i.e., SL-1, SL-2, SL-3, or SL-4) to events. Table 2-1 of the SRD, which relates to mitigated event consequences, is not to be used for this purpose. The SLs thus identified are to be used to identify control strategies, including important-to-safety (ITS) SSCs. Also, depending on the SL classification reached, whether the ITS SSCs are required to meet single failure criterion, and the number of physical barriers required, are determined, as shown in the following table. This system of safety classification is considered to be consistent with Appendix A of DOE-STD-3009 because any event with unmitigated consequences in the range of 25 rem to the public would be considered a SL-1 event and would require controls meeting the Table 1 criteria. The resulting controls for an SL-1 event are comparable to those required for a safety class SSC. One weakness in the documented methodology that will be corrected, however, is the addition of an explicit statement that any SL-1 event to the public will have an associated SDC SSC credited in its control strategy. (This feature was informally imposed by analysts during their safety review, so no revisions to control strategies are anticipated as a result of this change. This feature is not explicit in the current methodology, and was not recognized until DNFSB staff comments described above were reviewed.)

Table 1. Implementation of Defense in Depth by SSCs.

Severity Level	Control Options for Implementation of Defense in Depth
SL-1	Two or more independent physical barriers. The single failure criterion shall be applied as appropriate.
SL-2	Two or more independent physical barriers. The single failure criterion shall be considered.
SL-3	At least one physical barrier shall be provided. Two or more independent physical barriers shall be considered.
SL-4	Physical design features and/or administrative controls per 10 CFR 835.1001
Administrative controls alone may be credited as the controls that protect facility workers, when appropriate. Timely evacuation from the vicinity of the hazard is considered to be an administrative control. Physical barriers are not required for those events that are prevented.	

By assuming an unmitigated release and by establishing the requirement that all SL-1 events require two independent ITS controls, a concise and conservative set of ITS controls are identified. The criteria in the Table were provided to assure that all of the defense-in-depth principles defined in the project safety criteria will be achieved. As a further strategy that goes beyond the guidance of DOE-STD-3009, a comparison of mitigated accident consequences to SRD Table 2-1 with the selected mitigating features is performed, to ensure that the mitigated consequences of events are well below the Table 2-1 standards. This comparison establishes that a margin of safety exists, (or, during initial analysis iterations, that additional controls beyond those required by the unmitigated analysis are appropriate).

In the issue example cited (Section 3.4.1.1.5 of the HLW PSAR), the mitigated consequences of the event were compared to SRD Table 2-1 to ensure the calculated exposures were well below the Table 2-1 values, to account for uncertainties in the analysis and provide for sufficient design margin and operational flexibility. As noted above, analysts imputed the HEPA filters classification to be SDC, based on the SL-1 consequences of concern, even though no formal requirement to do so existed. The HEPA filter safety significance, was well understood, rather than masked. The following summary (taken from Attachment 1) shows that by crediting the HEPA filters in the mitigated analysis, the consequences to the co-located worker and public were reduced by approximately 6 orders of magnitude.

DBE	Severity Level	Unmitigated consequences		Mitigated consequences Intact HEPA Filters	
		CLW	Public	CLW	Public
		rem	rem	rem	rem
Liquid Spills					
HLW CRV failure	1	7.E+02	5.E-01	7.E-04	1.E-06

During the presentations to the DNFSB staff, the process followed to confirm an adequate safety margin, via the comparison of the mitigated event consequences to the RES, was not clearly communicated. The process actually followed ensures that the appropriate controls are identified and that an adequate safety margin exists. However, there is a need to accurately describe this approach in the PSAR, in the DBE calculations, in the governing procedure, and to ensure that the WTP safety analysts clearly understand the revision to the analysis requirements described above.

Corrective steps taken or to be taken:

As a result of the identified issue the following actions will be accomplished:

1. Procedure 24590-WTP-GPP-SANA-001, *Procedure: Accident Analysis*, will be revised to require a comparison of the severity level consequences or unmitigated consequences to the mitigated consequences in the DBE calculation.

2. Additional clarification will be added to the PSARs indicating that the comparison of the mitigated consequences to the RES is only to demonstrate that safety margin exists.

3. A comparison of the unmitigated consequences to the mitigated consequences will also be provided in the PSAR to demonstrate the significance or importance of the selected controls and ensure the need for additional controls is not over looked.

4. Desk Instruction 24590-ESH-DI-SANA-003, *Format and Content for Design Basis Event Calculations* will be revised to more clearly reflect that the comparison to the RES is provided only to demonstrate that safety margin exists, and also to require a comparison of the severity level consequences or unmitigated consequences to the mitigated consequences in the DBE calculation, as required in 24590-WTP-GPP-SANA-001.

5. The DBE analysts will be trained to the requirements of 24590-WTP-GPP-SANA-001 and 24590-ESH-DI-SANA-003 as revised in Actions 1 and 4.

6. Procedure 24590-WTP-GPP-SANA-002 will be revised to include an explicit statement that any SL-1 event to the public will have an associated SDC SSC credited in its control strategy.

Dates for completion of corrective steps:

Procedure 24590-WTP-GPP-SANA-001 will be revised by January 31, 2003, to include a requirement for a comparison of the unmitigated consequences to the mitigated consequences and to indicate that the comparison of the mitigated consequences to the RES is provided only to demonstrate that safety margin exists.

The DBE calculations and the PSAR revisions, described above, will be revised as part of the first PSAR annual update. The annual update is scheduled to be submitted to DOE in June 2003, and reviewed by DOE in the next 60 days.

Desk instruction 24590-ESH-DI-SANA-003, *Format and Content for Design Basis Event Calculations* will be revised following approval of 24590-WTP-GPP-SANA-001.

Training in the pending procedure and desk instruction revisions will be completed by January 17, 2003.

Procedure 24590-WTP-GPP-SANA-001 will be revised to include a requirement that any SL-1 event to the public will have an associated SDC SSC credited in its control strategy by February 28, 2003.

DNFSB Issue Number 3:

Appendix A to DOE-STD-3009-94 states that the evaluation guidelines are not to be used as firm criteria when determining the acceptability of control strategies/systems. Discussions with contractor representatives revealed that these radiological exposure standards are generally regarded as cut-offs for determining the effectiveness of a control system.

DOE Response:

DOE agrees that during the presentations to the DNFSB staff, the WTP analysts did not clearly demonstrate a consistent understanding of the documented process for determining the required control strategies and safety classifications.

Moreover, the documented process was not adequately clear in that only unmitigated event consequences were to be used in determining the classification of events with consequences to the public in the range of the Appendix A to DOE-STD-3009 guidelines. (Notwithstanding this deficiency, analysts classified events with such unmitigated consequences as SL-1 events, and classified the associated credited portions of the control strategies as SDC SSCs.)

Reason for the Issue:

Due to a lack of understanding of SRD Safety Criteria 2.0-1, some WTP analysts mistakenly regarded the standards in this criterion as cut-offs for determining the effectiveness of a control system. However, the methodology's approach to mitigation is only to evaluate mitigated event to ensure the mitigated consequences are far enough below standards to account for uncertainties in the analysis and provide for sufficient design margin and operational flexibility, not to consider this criteria as a "cut-off.". (See SRD Table 2-1 footnote 3.)

The purposes of the DBE analyses, established in the methodology, are to (1) validate the adequacy of the selected control strategies/systems as preventive or mitigative barriers; (2) Identify additional control strategies/systems if sufficient consequence margins do not exist and (3) establish quantitative performance requirements for the selected control strategies/systems. As noted in the previous issue response, the calculated unmitigated consequences were significantly reduced or prevented with the credited control features in place. That is, the reduction in the unmitigated consequences to the public or co-located worker was approximately 6 orders of magnitude in the HEPA filter example discussed above in Issue 2. The controls selected to prevent or mitigate this event are identified as SDC, are required to be single failure proof, and are protected via TSRs. In addition, the defense-in-depth principle (established in DOE/RL-96-0006, *Top-Level Radiological, Nuclear, and Process Safety Standards and Principles for the RPP Waste Treatment Plant Contractor*, Section 4.1.1, and implemented by SRD Appendices A and B) requires WTP to identify additional measures, such as, additional engineered barriers or personnel selection and operator training to prevent the event, or radiation protection programs and emergency response actions to mitigate the event (i.e., limit the duration).

Facility worker consequences also were treated similarly. For those events resulting in high unmitigated consequences, mitigated consequence analyses were performed to determine the adequacy of the selected barriers. Typically, barriers selected to protect the facility worker were preventive (e.g., shield walls, doors, and windows). Where, based on the DBE analysis, it was determined that the barriers identified may not provide an adequate margin of safety, additional process safety analysis meetings were held to address the event. As a result of these meetings, additional engineered barriers or administrative controls (TSRs) were identified.

This validation of the selected control strategies and the identification, when necessary, of additional engineered or administrative controls, all of which are protected with TSRs, ensures an adequately safe design.

During the presentation to the DNFSB staff, BNI staff made statements that indicated that the SRD Table 2-1 standards were regarded as "cut-offs" in determining the adequacy of control strategies. These statements were not consistent with the approved methodology. However, as far as can be determined, the analysis process followed by BNI's analysts generally ensured that the appropriate controls were identified and that adequate safety margin exists. As noted in Issue 2 above, clarification of the methodology is necessary, and will be performed on the schedule stated there. Specifically, on this issue, all analysts responsible for the selection of controls and the DBE analysis will be trained on these clarifications to the methodology, to ensure that they clearly understand them.

Corrective steps taken or to be taken:

As a result of the identified issue the following actions will be accomplished:

1. Procedure 24590-WTP-GPP-SANA-001, *Procedure: Accident Analysis*, will be revised to require a comparison of the severity level consequences or unmitigated consequences to the mitigated consequences in the DBE calculation.

2. Desk Instruction 24590-ESH-DI-SANA-003, *Format and Content for Design Basis Event Calculations* will be revised to more clearly reflect that the comparison to the RES is provided only to demonstrate that safety margin exists, and also to require a comparison of the severity level consequences or unmitigated consequences to the mitigated consequences in the DBE calculation, as required in 24590-WTP-GPP-SANA-001.

3. The DBE analysts will be trained to the requirements of 24590-WTP-GPP-SANA-001 and 24590-ESH-DI-SANA-003 as revised in Actions 1 and 2. Training will be conducted with all analysts clearly communicating the purpose of the comparison to the RES.

Dates for completion of corrective steps:

Procedure 24590-WTP-GPP-SANA-001 will be revised by January 31, 2003, to include a requirement for a comparison of the unmitigated consequences to the mitigated consequences and to indicate that the comparison of the mitigated consequences to the RES is provided only to demonstrate that safety margin exists.

Desk instruction 24590-ESH-DI-SANA-003, *Format and Content for Design Basis Event Calculations* will be revised following approval of 24590-WTP-GPP-SANA-001.

Training in the pending procedure and desk instruction revisions will be completed by January 17, 2003.

DNFSB Comment Number 4:

BNI is using target probabilities given in Appendix B of the SRD as acceptance criteria without considering the uncertainties involved in the analysis. For example, an SL-1 event with a calculated frequency of 0.65E-6 per year was given no further consideration because the target frequency of 1.0E-6 per year was not exceeded. This approach does not reflect the substantial uncertainties in this frequency estimate and could yield a design that does not fully develop the defense-in-depth concept articulated in the SRD. Specific examples of the uncertainties discovered in several of BNI's frequency estimates are cited below:

- The probabilities used in frequency estimates were sometimes inappropriately based on a best estimate rather than a conservative estimate.
- When data on the failure probability of some systems were unavailable, assumptions used by BNI regarding the applicability of similar data did not appear to be technically justified. Moreover, the extrapolation of these data for use within the DBE analysis did not appear to have been done in a conservative fashion.

Follow-up discussions with DOE and its contractor confirmed the staff's findings and resulted in a potential change to the defense-in-depth methodology applied to the WTP design. While the contractor has proposed replacing the quantitative frequency requirements with qualitative determination of the adequacy of the control set, there does not appear to be a clear methodology for identifying the required SSCs, their classification, and a concise definition of their boundaries. This activity appears to be work in progress and may impact the design of the SSCs important to safety if not completed in a timely manner.

DNFSB Issue Number 4:

BNI is using target probabilities given in Appendix B of the SRD as acceptance criteria without considering the uncertainties involved in the analysis.

DOE Response:

DOE agrees that a clear separation of deterministic DBE analysis and risk based Operational Risk Assessment was not maintained. This resulted in the inappropriate use of target frequencies based on a combination of conservative and best estimate frequencies to demonstrate compliance with the (then existing) target frequency requirements of Appendix B of the SRD. In view of the several valid concerns expressed by DNFSB staff concerning the uncertainties in the target frequency information used (as well as the method of its use), the requirements for the use of target frequencies in Appendix B of the SRD have been eliminated as an element of the Defense in Depth methodology by a DOE approved change to the project requirements.

Reason for the Issue:

The target frequency determination was intended to satisfy an existing SRD Appendix B requirement for this comparison. (This requirement was intended to provide additional assurance that adequate safety margin existed with the selected control strategies. Identification of target frequencies was thought to have the potential to provide early supplementary guidance to the Integrated Safety Management (ISM) teams for design of credited controls (e.g., three trains of components to achieve very high electrical system reliability, in cases where the qualitative defense in depth criteria would have provided two trains, early in the design, before the complete operational risk assessment results were known).

However, in attempting to meet this requirement, conservative frequency estimates to use in such a comparison with the SRD Table 2-1 standards were not consistently available. As an expedient, best estimate data was inappropriately used in such cases. This significantly reduced the value of the comparison.

Notwithstanding the intent of the target frequency requirement, the concerns expressed by DNFSB staff concerning the uncertainties in the target frequency information used are valid. Also, as a result of the DNFSB staff comment, DOE better recognized that it is important to not commingle the deterministic DBE analyses and the probabilistic operational risk assessment (to assess integrated risk vulnerability). Therefore, the target frequency element of the Defense-in-Depth methodology in Appendix B of the SRD has been removed. The impact of this change will be reflected in the DBE revisions supporting the PSAR annual update scheduled to be submitted in June, 2003.

DOE considers that the remaining required aspects of the methodology in the SRD will still provide adequate safety. As previously discussed, classification of the event Severity Level, and classification of the associated SSC controls is expected to be based on the unmitigated consequences documented in severity level calculations. This preferred control strategy selection is performed by the ISM analyst teams. The teams ensure that the Defense in Depth requirements defined in Appendix B of the SRD are met for the various credible accident sequences. The classification criteria are not dependent on initiating event frequencies. Therefore, the selected controls are not dependent on uncertainties associated with frequency data. Compliance with the defense in depth criteria ensures ITS barriers and controls are specified based on the unmitigated consequences of the event.

Corrective steps taken or to be taken:

As a result of the identified issue the following actions have been taken:

1. Appendix B of the SRD has been revised to eliminate the requirement for calculating target frequencies.

2. The requirements for calculating or reporting target frequencies in 24590-WTP-GPP-SANA-001, *Procedure: Accident Analysis* and 24590-ESH-DI-SANA-003 have been removed.

Dates for completion of corrective steps:

Appendix B of the SRD has been revised to eliminate the need for target frequencies. The DBE calculations and the PSARs will be revised as part of the annual update. The annual update is scheduled to be submitted to DOE in June 2003.

DNFSB Comment Number 5:

While the contractor has proposed replacing the quantitative frequency requirements with qualitative determination of the adequacy of the control set, there does not appear to be a clear methodology for identifying the required SSCs, their classification, and a concise definition of their boundaries. This activity appears to be work in progress and may impact the design of the SSCs important to safety if not completed in a timely manner.

DNFSB Issue Number 5:

There does not appear to be a clear methodology for identifying the required SSCs, their classification, and a concise definition of their boundaries. This activity appears to be work in progress and may impact the design of the SSCs important to safety if not completed in a timely manner.

DOE Response:

DOE agrees that identifying required SSCs, their classification, and a concise definition of their boundaries is a work in progress, and could impact the design of the SSCs important to safety if not completed in a timely manner. As discussed below, to avoid this impact, DOE is taking the necessary actions to complete this activity in a timely manner.

Reason for the Issue:

The reason for the issue is the preliminary state of the systems design at the time of the DNFSB presentations. Specifically, none of the drawings which will document the classification of SSCs and define ITS system boundaries had been issued for construction. The boundaries for quality levels, seismic classification, and ITS designation are being identified on the drawings as the design progresses and the drawings are issued for construction and procurement.

As the design progresses and the drawings for construction are issued, clear system breaks will be identified showing ITS designation, quality levels, and seismic categorizations in accordance with the requirements in 24590-WTP-3DP-G04T-0905, *Determination of Quality Levels*. Clear methodology exists for identifying required system level SSCs and their classifications. Criteria currently exist in the SRD for the selection of ITS controls. These criteria define the minimum number of engineered SSCs and/or administrative controls required to protect against the consequences of events (based on unmitigated analysis) as well as the need to consider design requirements for the selected suite of controls. These criteria are implemented via the ISM process through procedure 24590-WTP-GPP-SANA-002, in accordance with SRD, SC 1.0-8.

As discussed previously, one purpose of the DBE analysis is to validate the adequacy of the selected engineered SSCs and/or administrative controls as preventive or mitigative barriers. The DBE analysis also identifies engineered ITS SSC requirements, that is, the safety function (e.g., filtration, airflow), performance requirements (e.g., pre- or post- seismic) and environmental challenges (e.g., moisture). The initial ITS designation (i.e., SDC or SDS) of a system (e.g., C5 ventilation system) is documented in the PSAR.

The Control Strategy Development, and Safety Case Requirements for the SSCs are identified in the ISM process and documented as required by 24590-WTP-GPP-SANA-002. This information is used to identify the appropriate quality level designation for the SSCs shown on the engineering drawings and documents as applicable, in accordance with 24590-WTP-3DP-G04T-0905, *Determination of Quality Levels*. The boundary of the required SSCs is determined based on the SCRs and is shown on the drawings using notes and/or flags.

Sub-components have the same classification as the parent component unless an evaluation is completed to ensure the sub-component is not required for the system or parent component to perform its credited safety function. The definition of the ITS component boundaries, including sub-components classification, is an ongoing activity and is being completed as the design progresses and the documents are issued for construction and procurement. In support of this, the Mechanical Systems Discipline has issued guidance document 24590-WTP-GPG-M-036, *Determining Quality and Seismic Classification of Sub-Components, Assemblies, and Parts*. This provides guidance for determining the classification of sub-components, assemblies, and parts where this is desired.

The design process described in 24590-WTP-3DP-G04B-00046, *Engineering Drawings*, 24590-WTP-3DP-G04B-0049, *Engineering Specifications*, and 24590-WTP-GPP-MGT-007, *Document Administration* requires that the initiation, checking, review, and approval of documents conform with the Authorization Basis. As part of this development, the quality levels are identified on the P&IDs. The identification of quality levels and the boundaries at the system level on the P&IDs is done by class break indicators, which ensures that all components are classified.

Corrective steps taken or to be taken:

As the design progresses and the documents for construction are issued, the boundaries for ITS designation, quality levels, and seismic categorizations will be identified in accordance with the requirements in 24590-WTP-3DP-G04T-0905, *Determination of Quality Levels*. Guidance will be provided to identify classification of sub-components or parts of components differently than the parent component, when a need is recognized. Guidance is already provided for mechanical equipment in 24590-WTP-GPG-M-036, *Determining Quality and Seismic Classification of Sub-Components, Assemblies, and Parts.*

Dates for completion of corrective steps:

As discussed above, appropriate criteria currently exists for identifying SSCs, their classification, and their boundaries for this stage of the project. As the design progresses, additional guidance for specific engineering disciplines will be provided when necessary to identify classification of sub-components or parts of components differently than the parent component.

DNFSB Comment Number 6:

The safe harbor to Title 10 of the Code of Federal Regulations, Part 830 (10 CFR 830), *Nuclear Safety Management,* for the WTP is DOE standard DOE-STD-3009-94. Section 3.4.3 of DOE-STD-3009-94 states that an evaluation be performed that simply provides insight into the magnitude of consequences of beyond design basis accidents (DBAs). This insight from beyond DBA analysis has the potential for identifying additional facility features that could prevent or reduce severe beyond DBA consequences. BNI, however, does not evaluate the consequences of chemical hazards if the unmitigated probability of an event is estimated to be less than 1.0E-6 per year. This practice may discount chemical hazards with significant consequences (but low probability) that may warrant additional controls to protect the public and workers.

DNFSB Issue Number 6:

BNI does not evaluate the consequences of chemical hazards if the unmitigated probability of an event is estimated to be less than 1.0E-6 per year. This practice may discount chemical hazards with significant consequences (but low probability) that may warrant additional controls to protect the public and workers.

DOE Response:

In May 2002, the time of the initial DNFSB reviews, beyond design basis chemical events and the consequences associated with beyond design basis chemical accidents had not been not determined. However, the *WTP Risk Analysis – Risk Goal Confirmation,* 24590-WTP-U7C-50-00001, (referred to as the ORA), in preparation at the time of the staff visits, and since completed in December 2002, considers beyond design basis chemical events that are initiators for radiological releases, and in addition other non-radiological beyond design basis chemical events have been evaluated (as described further, below).

Reason for the Issue:

During the May and October 2002, DNFSB staff review meetings, the PSARs did not include a discussion of beyond design basis accidents for chemical releases.

Some chemical events determined to be beyond extremely unlikely (i.e., frequency of occurrence less than 1E-06/yr) during the ISM process were evaluated further to identify additional features that may be credited to reduce receptor consequences. This evaluation is in the ORA (referenced above) for radiological events and for chemical events that may result in a radiological release. The results of the evaluation will be incorporated in the next annual update of the PSAR. Based on the ISM reviews there are three types of chemical hazards at WTP that may potentially result in unacceptable exposures to workers due to a beyond design basis event. These are ammonia releases, melter off-gas releases, and nitric acid releases.

It was concluded in 24590-WTP-RPT-ESH-01-001, *Determination of Extremely Hazardous Substances*, based on an evaluation of the proposed chemical usage at the WTP, that ammonia and nitric acid should be considered extremely hazardous substances. This extremely hazardous designation was based on the quantity of each chemical and its respective health hazards. No credit is taken for degraded systems or structures that may provide a decontamination factor, probability of release is equal to 1, and no preventive/mitigative controls are credited during the release or determination. Neither of the chemicals exceed the 29 CFR 1910.119 or 40 CFR 68 threshold quantities or concentration limits. As a result of this extremely hazardous substance identification, engineered and administrative requirements, in accordance with the EPA *General Duty Clause* (EPA 550-F-99-010) and DOE/RL-96-0006, have been imposed to ensure safe operations.

Similarly deterministic analyses have also been conducted to evaluate effects of a variety of chemical releases, including ammonia and nitric acid, on habitability of the WTP control rooms. Either the bounding release rate of each chemical or the complete release of the bounding quantity in 10 minutes was analyzed under very conservative dispersion conditions without consideration of cause, initiating event frequency, preventive measures, or mitigative controls. The minute-by-minute concentrations in each control room were calculated and the results were compared with appropriate thresholds for both peak and time-averaged exposures. Based on the unmitigated exposures, the ability of workers to remain at their stations and perform required control and shutdown actions was assessed. Where indicated by the results, design requirements for ventilation and monitoring systems were developed to ensure that the Main Control Room would remain habitable throughout any of the analyzed chemical release events.

In response to a DOE comment (HLW-PSAR-218), a beyond design basis event was analyzed (24590-HLW-U0C-30-00005, *Analysis of Consequences to Facility Worker during HLW Melter Offgas Event Using HADCRT Computer Code*) to determine the adequacy of the controls identified in the PSAR. This analysis is not currently addressed in the PSAR. This analysis was prompted by the short evacuation time required to maintain facility worker exposures below ERPG-3 given a loss of power event (i.e., C5 ventilation system unavailable). Using NO as an indicator, the maximum concentration in the melter cave is approximately 950 parts per million (ppm) in 90 minutes and 900 ppm at 120 minutes. These areas are unoccupied. However, the concentration in adjacent areas that may be occupied during the time of the event (up to 120 minutes following loss of power) is less than 8 ppm. Therefore, sufficient time is available for the facility worker to evacuate adjacent areas. Also based on this analysis, it can be concluded, assuming that a small fraction of the offgas escapes from the melter cave to adjacent areas and considering dispersal throughout the facility, impacts to the co-located worker and the public are also well below exposure limits. In addition, assuming electrical power or emergency power can be established in a timely manner (loss of power not due to an external or man-made external event), the consequences to the public and co-located worker would be further reduced as the melter offgas system resumes operation.

In summary, although the evaluation was not complete at the time of the DNFSB staff visits, all known chemical hazards that could result in unacceptable exposures due to beyond design basis events have subsequently been identified and evaluated in 24590-WTP-RPT-ESH-01-001. Based on the results of that evaluation no new beyond design basis chemical event analyses are planned. However, should any new chemical hazards be identified, where appropriate, a beyond design basis event analysis will be performed and documented in the PSAR.

Corrective steps taken or to be taken:

As a result of the identified issue the following actions are planned:

1. The general volume (Volume I) of the PSAR will be revised to include a summary of 24590-WTP-RPT-ESH-01-001 in a beyond design basis chemical accident summary.

2. The general volume (Volume I) of the PSAR will be revised to include a summary of 24590-WTP-U7C-50-00001 in Chapter 3.

3. The Pretreatment Facility PSAR will be revised to include the results of the control room habitability analysis.

4. The HLW Vitrification Facility PSAR will be revised to include the results of the loss of power or melter offgas release event.

5. New chemicals or changes in chemical quantities will be evaluated using the approved authorization basis change process to determine the applicability of the results and conclusions reached in 24590-WTP-RPT-ESH-01-001.

Dates for completion of corrective steps:

The PSARs will be revised as part of the annual update. The annual update is scheduled to be submitted in June 2003.

A review of the beyond design basis hazards, if any, of new chemicals or changes in chemical quantities will be completed within the timeframes of the approved authorization basis change process.

DNFSB Comment Number 7:

Hydrogen is a significant hazard within the WTP. The current control strategy is to maintain hydrogen concentrations below 25 percent of the lower flammability limit (LFL). BNI's design approach involves providing sufficient dilution ventilation during all plant conditions (e.g., normal operating and upset conditions) and therefore requires an accurate understanding of hydrogen generation rates within each WTP vessel. Dilution air is provided by the process vessel purge (PVP) system.

BNI has chosen to model hydrogen generation rates using a model developed for the tank farms. This model was developed in the early 1990s to better understand flammable gas generation in Tank SY-101. The model is based on thermodynamic data taken from a single grab sample of Tank SY-103 and excludes other data produced since that time. BNI believes that these data conservatively predict hydrogen generation rates. In developing the estimates for tank-by-tank hydrogen generation rates, however, BNI is relying on the use of conservative inputs for only some of the first-order parameters (temperature, total organic carbon, aluminum, and radionuclide concentrations). This approach may not produce sufficiently conservative generation rate values since it does not address other important variables involved in hydrogen generation.

For example, under certain temperature and waste conditions, thermolysis rather than radiolysis will be the dominant contributor to the hydrogen generation rate. An understanding of thermolysis conditions in each tank is therefore necessary. In particular, when thermolysis is the driving mechanism, the hydrogen generation rate is exponentially dependent upon input values for temperature and activation energy. It is unknown whether a PVP system sized for generation rates at maximum operating temperature using the current estimation of activation energy (91 kJ/mole) would adequately bound generation rates expected under the higher temperatures of accident scenarios. Furthermore, evidence exists to suggest that 91 kJ/mole is not a conservative estimate of the activation energy within this system.

In at least one instance, the model underpredicted by approximately 25 percent the hydrogen generation within Tank AW-101 compared to that tank's measured generation rates. This discrepancy is significant as Tank AW-101 will provide feed during the initial WTP operating period (Phase 1). Moreover, this discrepancy demonstrates that the current model may not yield conservative or bounding hydrogen generation rates. A proper understanding of the driving mechanisms behind hydrogen generation and the sensitivity of various inputs is required, rather than an increase in the conservative estimates for some individual inputs. Additionally, as the PVP system is currently in design and nearing procurement, a sufficiently conservative predictive model for hydrogen generation rates needs to be developed in a timely manner.

DNFSB Issue Number 7:

BNI has chosen to model hydrogen generation rates using a model developed for the tank farms. This model was developed in the early 1990s to better understand flammable gas generation in Tank SY-101. This approach may not produce sufficiently conservative generation rate values since it does not address other important variables involved in hydrogen generation. In at least one instance, the model underpredicted by approximately 25 percent the hydrogen generation within Tank AW-101 compared to that tank's measured generation rates.

DOE Response:

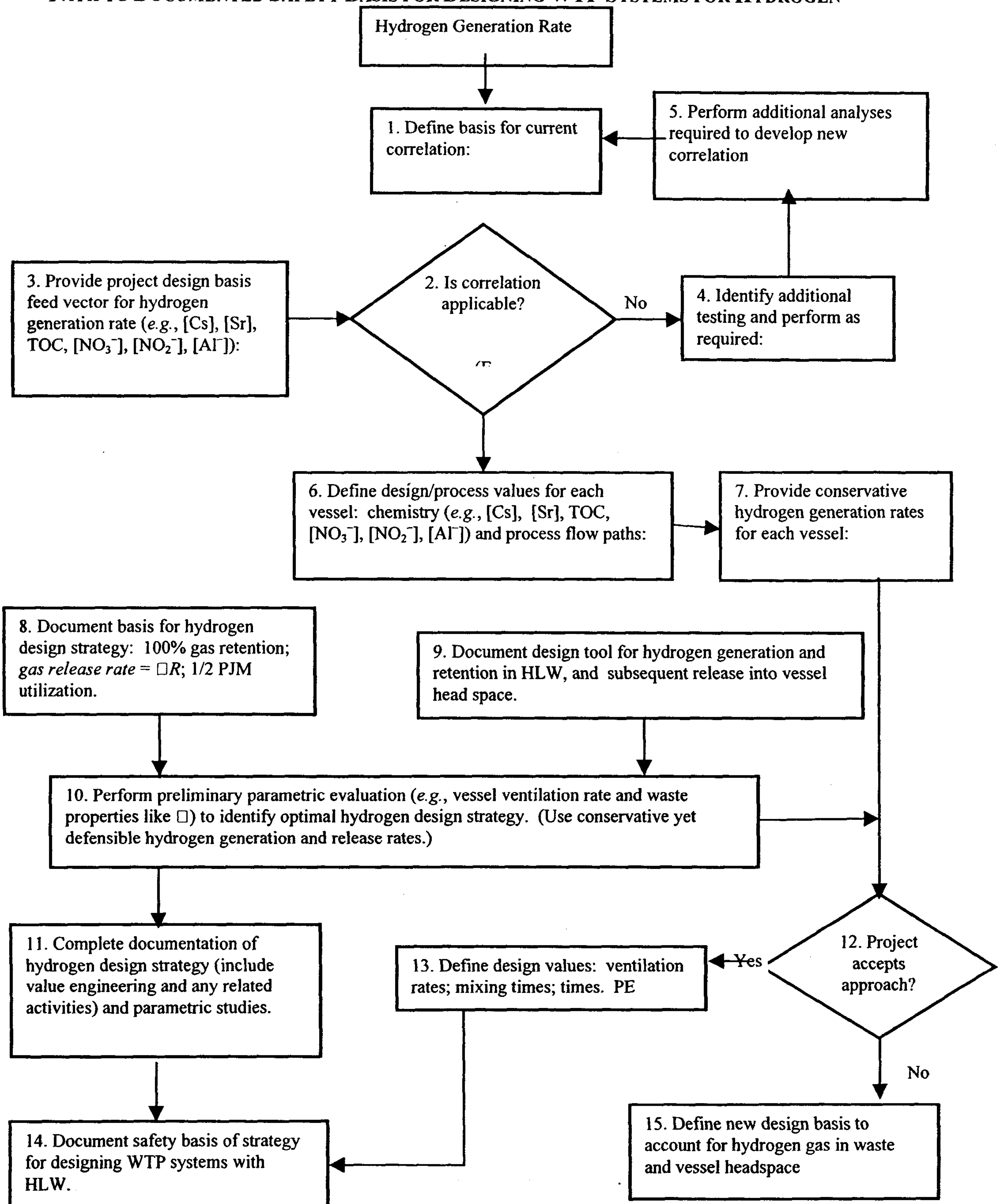
DOE agrees that using the 1997 hydrogen model developed for the tank farms and conservative input values to model hydrogen generation rates may not produce sufficiently conservative generation rate values.

Reason for the Issue:

The hydrogen correlation currently used by DOE was developed initially to address the Hanford Tank flammable gas safety issue. The hydrogen correlation was documented in RPT-W375-SA00002, *Topical Report on the Management of Risks Posed by Explosive Hazards Present at the RPP-WTP*. As identified in the Topical Report the correlation under predicted the hydrogen generation rates in one double-shell and one single-shell tank. The Topical Report also compares hydrogen generation rates using contract maximum and best estimate input values. The report concludes that the correlation, when using contract maxima, exceeds the best estimate values with a sufficient margin to bound uncertainties. Additionally, the correlation did not consider the alpha particle emitters' contributions. This lack of consideration was due to the fact that the alpha emitters' contributions (considered to arise from settled solids in the tank farms) are in limited contact with the liquid wastes; however, at WTP the solids will be suspended and alpha will be in direct contact with the liquid waste.

In light of the issues raised by the DNFSB staff regarding the shortcomings of the correlation, (i.e., under prediction and no consideration of alpha), an effort was undertaken to demonstrate that by using conservative input parameters, including the effect of alpha emitters, a bounding defensible hydrogen generation rate could be developed. The plan to remove uncertainty in the understanding of hydrogen generation is shown graphically in the following Figure.

PATH TO DOCUMENTED SAFETY BASIS FOR DESIGNING WTP SYSTEMS FOR HYDROGEN



BNI has completed the activities identified in boxes 1 through 7 of the Figure, and concluded the correlation identified in RPT-W375-SA00002 is not a conservative methodology for predicting hydrogen generation rates (See 24590-WTP-RPT-RT-02-006, *Predicting Hydrogen Generation Rates in Radioactive Waste* Materials for further discussion) (referred to as the R&T report). Using conservative input values for envelopes A and B the Topical Report correlation under predicted hydrogen generation in Tank AW-101; however, for envelope C, the correlation over predicted hydrogen generation in Tank AW-101.

In addition to evaluating the Topical Report correlation, the R&T report evaluated the correlation by T. A. Hu (HNF-3851, *Empirical Rate Equation Model and Rate Calculations of Hydrogen Generation for Hanford Tank Waste*, see Blocks 4 and 5) which is used at the Hanford Tank Farms. As discussed in the R&T report, the Hu correlation features a temperature dependent G value to account for organic radiolysis and two waste characterization parameters, a reactivity coefficient, associated with the lumped parameter—total organic carbon concentration, [TOC]—and the waste liquid fraction. This updated correlation is an improved statistical fit of the Hanford tank waste data. While the Topical Report correlation under predicts Tank 241-AW-101 behavior, the Hu correlation bounds it. The R&T report also concludes, that for low temperatures the Topical Report correlation predicts a higher G value but for temperatures higher than 330 K (~134 F) the Hu correlation predicts a higher G value and for temperatures above about 370 K (~206 F) the increase is about an order of magnitude.

Therefore, based on the conclusions reached in 24590-WTP-RPT-RT-02-006, R&T, E&NS, and Process Engineering agreed to implement the Hu correlation and continue with further R&T activities to validate the Hu correlation for use at the WTP (see Blocks 3, 4, and 5) (CCN 048855).

In addition to hydrogen, other flammable gases (e.g., ammonia, methane) are being evaluated to determine their impact on the design of the ITS mitigation systems (i.e., purge). As discussed in 24590-HLW-Z0C-H01T-00001, ammonia and other gases do not significantly impact the hydrogen lower flammability limit (LFL). That is, considering hydrogen, ammonia and methane concentrations at 96%, 3.1% and 0.9%, respectively, the LFL for mixture, normalized to hydrogen would be 3.9%, rather than 4%.

Other information:

Attachment 2 provides references to related PSAR review questions, and resulting Authorization Agreement conditions of approval which were imposed by DOE, to ensure that an acceptable analysis of explosive gas hazards, including hydrogen, is performed.

Corrective steps taken or to be taken:

As a result of the identified issue the following actions have been completed:

1. The correlation identified in RPT-W375-SA00002 was evaluated, and is not a conservative methodology for predicting hydrogen generation rates (24590-WTP-RPT-RT-02-006) (see Block 1 and 2).

2. The Hu correlation (HNF-3851, *Empirical Rate Equation Model and Rate Calculations of Hydrogen Generation for Hanford Tank Waste*) (see Blocks 4 and 5) is used at the Hanford Tank Farms (24590-WTP-RPT-RT-02-006) was also evaluated, and appears to be a conservative methodology.

3. The Hu correlation will be implemented at WTP.

As a result of the issue and the actions identified above, the following actions are in progress or are planned:

1. The Hu correlation will be further validated at WTP (see Blocks 4 and 5).

2. Develop and document conservative design or process variables for each vessel within the Pretreatment Facility (see Block 6).

3. Develop and document conservative hydrogen generation rates for each vessel in the pretreatment Facility (see Block 7).

4. Develop and document design requirements based on the results of Activities 5 and 6.

5. Revise the HLW Vitrification Facility hydrogen DBE calculation (24590-HLW-Z0C-H01T-00001) to incorporate the new hydrogen generation rates, impacts of other flammable gases, and times to LFL.

6. Revise the Pretreatment Facility hydrogen DBE calculation (24590-PTF-Z0C-H01T-00002) to incorporate the new hydrogen generation rates, impacts of other flammable gases, and times to LFL.

7. Revise the HLW Vitrification Facility hydrogen PSAR DBE calculation summary to incorporate the new hydrogen generation rates, impacts of other flammable gases, and times to LFL.

8. Revise the Pretreatment Facility hydrogen PSAR DBE calculation summary to incorporate the new hydrogen generation rates and times to LFL.

Dates for completion of corrective steps:

R&T is currently identifying an individual and the scope for an independent review of the applicability of the Hu correlation to WTP. The individual and the scope of the review will be completed by January 31, 2003. It is estimated that the review will be completed by the end of February 2003.

A document (24590-PTF-M4C-V11T-00010, *Estimated Hydrogen Generation Rates*) will be issued by Pretreatment Process Engineering documenting conservative design or process variables and hydrogen generation rates and subsequently system design requirements for use in the design of preventive/mitigative systems by the end of January 2003.

The HLW and Pretreatment DBE calculations and the PSARs will be revised as part of the annual update. The annual update is scheduled to be delivered to the OSR in June 2003.

DNFSB Comment Number 8 (repeated from Comment Number 7 for convenience):

Hydrogen is a significant hazard within the WTP. The current control strategy is to maintain hydrogen concentrations below 25 percent of the LFL. BNI's design approach involves providing sufficient dilution ventilation during all plant conditions (e.g., normal operating and upset conditions) and therefore requires an accurate understanding of hydrogen generation rates within each WTP vessel. Dilution air is provided by the process vessel purge (PVP) system.

BNI has chosen to model hydrogen generation rates using a model developed for the tank farms. This model was developed in the early 1990s to better understand flammable gas generation in Tank SY-101. The model is based on thermodynamic data taken from a single grab sample of Tank SY-103 and excludes other data produced since that time. DOE believes that these data conservatively predict hydrogen generation rates. In developing the estimates for tank-by-tank hydrogen generation rates, however, BNI is relying on the use of conservative inputs for only some of the first-order parameters (temperature, total organic carbon, aluminum, and radionuclide concentrations). This approach may not produce sufficiently conservative generation rate values since it does not address other important variables involved in hydrogen generation.

For example, under certain temperature and waste conditions, thermolysis rather than radiolysis will be the dominant contributor to the hydrogen generation rate. An understanding of thermolysis conditions in each tank is therefore necessary. In particular, when thermolysis is the driving mechanism, the hydrogen generation rate is exponentially dependent upon input values for temperature and activation energy. It is unknown whether a PVP system sized for generation rates at maximum operating temperature using the current estimation of activation energy (91 kJ/mole) would adequately bound generation rates expected under the higher temperatures of accident scenarios. Furthermore, evidence exists to suggest that 91 kJ/mole is not a conservative estimate of the activation energy within this system.

In at least one instance, the model underpredicted by approximately 25 percent the hydrogen generation within Tank AW-101 compared to that tank's measured generation rates. This discrepancy is significant as Tank AW-101 will provide feed during the initial WTP operating period (Phase 1). Moreover, this discrepancy demonstrates that the current model may not yield conservative or bounding hydrogen generation rates. A proper understanding of the driving mechanisms behind hydrogen generation and the sensitivity of various inputs is required, rather than an increase in the conservative estimates for some individual inputs. Additionally, as the PVP system is currently in design and nearing procurement, a sufficiently conservative predictive model for hydrogen generation rates needs to be developed in a timely manner.

DNFSB Comment/Issue Number 8:

Hydrogen is a significant hazard within the WTP. BNI's design approach involves providing sufficient dilution ventilation during all plant conditions (e.g., normal operating and upset conditions) and therefore requires an accurate understanding of hydrogen generation rates within each WTP vessel. Dilution air is provided by the PVP system. Additionally, as the PVP system is currently in design and nearing procurement, a sufficiently conservative predictive model for hydrogen generation rates needs to be developed in a timely manner.

DOE Response:

As discussed in the previous response, DOE agrees that using the 1997 hydrogen model developed for the tank farms and conservative input values to model hydrogen generation rates may not produce sufficiently conservative generation rate values. DOE further agrees that a sufficiently conservative predictive model for hydrogen generation rates needs to be developed in a timely manner.

Reason for the Issue:

As discussed in the previous DNFSB Issue Number 7, the hydrogen correlation currently used by DOE was presented in the February 2000 topical. As identified in the Topical Report the correlation under predicted the hydrogen generation rates in one double-shell and one single-shell tank and did not consider the alpha emitters contributions.

As discussed previously, a revised hydrogen correlation (Hu correlation) has been selected for use at the WTP (CCN 048855).

The activities shown in blocks 8 and 9 of the previous Figure have been completed (24590-101-TSA-W000-0004-120-03 *Analytical Models Describing Global Hydrogen Retention and Release in WTP Mixing Vessels* [CCN: 048258]). This report characterizes and discusses the following:

- The gas generation rate, together with the retention characteristics of mixed sludge waste; determine how much gas can accumulate in the waste in WTP vessels. The volume and rate of a gas release into a vessel headspace, not the generation rate, determine whether flammable concentrations result.

- A simple model that has been effective in describing gas release events in Hanford Double Shell Waste Tanks is assumed to characterize Pulse Jet Mixer (PJM) performance. The release from the PJM is completely described by any two of the following three parameters; release volume, maximum release rate, or time to maximum release rate.

- Mass-balance models are presented which demonstrate the evolution of gas in waste and vessel headspace subject to assumed PJM-induced gas release and background release. Peak hydrogen concentrations in the headspace are found to depend on only two parameters; non-dimensional release and ventilation rates. The evolution of gas within the waste is also described, with the required interval for PJM operation with no net gas accumulation being derived.

Based on the results discussed in the previous DNFSB Issue and the results of the R&T activity discussed above, the WTP Project (Block 12) has accepted the approach presented in the facility specific PSARs. That is, upon loss of normal sweep air (PVVS) or mixing (e.g., PJMs) ITS air is required to purge the vessel headspace and provide drive air to the PJMs. Therefore, conservative design/process variables for each pretreatment vessel are being developed and documented, and hydrogen generations rates and times to LFL are being calculated for designing the Safety Design Class hydrogen preventive/mitigative systems. PJM operation is also being evaluated to develop PJM utilization, mixing durations and cycle times (quiescent or Q times). These activities are identified in Blocks 6, 7, 10, 11, and 13.

To ensure a conservative design process, engineering is using conservative process/design inputs to establish design requirements. The conservative process/design inputs, which are identified below, provide sufficient margin to allow for uncertainties. Thus, a conservative design will be established that should not be significantly impacted if the project chooses to use a different correlation or modifies the existing correlation based on the results of the planned R&T activities (see previous DNFSB Issue):

- Assume that an ITS preventive/mitigative system is required for vessels that can reach the LFL in a reasonable time frame to allow for compensatory measures as determined by the ISM teams
- Assume all vessels contents are at maximum temperature following a one-year loss of cooling event
- Assume the vessels are filled to overflow
- Establish a purge rate at least 100 times the worst case hydrogen generation rate to assure no accumulation of flammable gases including hydrogen in the vessel head space
  - Establishing air supply requirements based on contract maximum radionuclide concentrations and potential impacts to stream chemical compositions due to Pretreatment processes (e.g., ultrafiltration - leaching)
  - Develop a control strategy that can increase/decrease air supply to vessels to ensure purge is at least 100 times hydrogen generation rate at any vessel
- Assume all vessels with greater than 5 wt % solids require mixing
- Assume that 50% hydrogen generated is retained in the waste on loss of power, the other 50% is released continuously
- Assume that mixing will provide a controlled release of hydrogen from the waste to the head space
  - Develop a control strategy to degas the waste following loss of power
- Implement the Hu correlation to develop bounding conditions based on the following assumptions.
  - Include alpha emitters' contributions in the calculation

- Assume conservative concentrations (non zero) for the nitrates and nitrites where applicable

- Assume radionuclide concentrations are at contract maximums

It is assumed that the PJMs are designed to mix the waste, thus releasing trapped hydrogen. The PJM design establishes PJM operating modes during the loss of power event or during degassing (i.e., normal operations or drive mode only), the number of PJMs required (i.e., loss of power and during degassing), and PJM cycle times during loss of power event (i.e., continuous versus intermittent).

The results of these efforts, (i.e., establishing purge and PJM design requirements) will be used to refine ITS air compressor size requirements and design requirements (e.g., air supply piping).

Additionally, a CFD analysis is in progress by E&NS to determine the effectiveness of the ITS purge in sweeping vessel headspaces. This analysis will also evaluate the effectiveness of the ITS purge to sweep releases of other flammable gases including ammonia releases caused by PJM operation. The results of this analysis will be incorporated into the HLW and Pretreatment hydrogen deflagration DBE calculations, as performance requirements.

Corrective steps taken or to be taken:

In addition to the activities identified in the preceding DNFSB Issue discussion, the following activities are in progress or are planned:

The results of parametric studies, the revised design basis, and hydrogen prevention/mitigation system design requirements will be documented (see Blocks 10, 11, 12 and 13). This will include developing and documenting conservative design or process variables and hydrogen generation rates, system design requirements, and applying the design basis to the HLW Facility and the Laboratory waste collection vessels in the facility specific DBE calculations and PSARs.

Dates for completion of corrective steps:

A document (24590-PTF-PTF-V11T-00010, *Estimated Hydrogen Generation Rates*) will be issued by Pretreatment Process Engineering documenting conservative design or process variables and hydrogen generation rates and subsequently system design requirements for use in the design of preventive/mitigative systems by the end of January 2003.

The Draft report, *Hydrogen Generation Rates and Times to the Lower Flammability Limit in Vessels located in the Pretreatment Facility, the Low Active Waste Vitrification Facility and the High Level Waste Vitrification Facility,* will be revised to incorporate the Laboratory, and the design basis. This will be completed by February 2003.

The DBE calculations and the PSARs will be revised as part of the annual update. The annual update is scheduled to be submitted to DOE in June 2003.

DNFSB Comment Number 9:

The staff performed a preliminary review of the project's design activities aimed at determining procurement requirements for the piping systems. The project has increased the pipe wall thickness by 0.125 inch to allow for the predicted erosion of pipes due to the movement of waste containing solid particles. This allowance is based on the corrosion and erosion of similar materials in straight pipes within the chemical industry. However, it does not account for higher erosion in nonlinear segments, particularly in bends and elbows.

DNFSB Issue Number 9:

It [the corrosion allowance] does not account for higher erosion in nonlinear segments, particularly in ends and elbows.

DOE Response:

DOE agrees that BNI failed to clearly communicate, that the erosion and corrosion allowances previously discussed with the DNFSB did consider elbows and bends.

Reason for the Issue:

During the DNFSB staff review there was apparently some confusion with respect to the specified wear allowance that would be provided for pipe bends. What was meant to be conveyed was that the wear allowance is chosen for the pipe including bends and that that wear allowance is retained on the outside wall of the pipe after it is bent. No additional allowance is added for the nonlinear segments of the pipe. The specified erosion wear allowances of 0.0937 inch for lines containing high concentrations of solids (≥ 2 wt %) and of 0.125 inch for lines containing glass formers do account for nonlinear segments such as bends and elbows.

Lines without glass formers have erosion rates that are expected to be small, possibly as low as the estimated erosion rates of 0.4 mils per year (mpy) in the Hanford transfer lines. Erosion in bends of these lines has not been shown to be a concern.

In lines with glass formers, the design, however, does not rely on achieving a 40-year erosion resistance. The low activity waste (LAW) and HLW lines containing glass formers are replaceable. If erosion is higher than expected, the HLW jumpers or LAW installed piping can be replaced.

The other area with significant potential for erosion is lines with two-phase (water and steam) flow. In WTP, there are a limited number of applications with two phase flow, for example, downstream of steam ejectors and the steam heating system. The steam ejectors are used infrequently and the steam heating is low velocity so erosion in these lines should be minimal.

The WTP piping system design will provide adequate wear allowance in pipe bends as well as in straight runs of pipe. The wear rates in the process streams are currently being verified. This effort should be completed by February 28, 2003.

Three cases of metal loss due to erosion and corrosion in WTP high solid streams were considered to determine appropriate wear allowances: waste stream with glass formers, HLW high solids waste streams without glass formers, and LAW streams which have been filtered by the ultrafilters. Most process flow streams use type 304L and type 316L austenitic stainless steel.

Waste Streams with Glass Formers

Waste streams with glass formers consist mainly of melter feed for both the low activity waste LAW and HLW melter preparation and feed systems. The glass former particles will be approximately 40 μm in diameter, or approximately a 300 mesh size according to Schumacher (Schumacher, RF, 2000, *BNFL Report, Glass formers Characterization*, TRPT-W375-00-00015, Rev 0). The melter feed and preparation glass former streams will have a maximum velocity of approximately 8 fps.

The literature does not address specific WTP type conditions. Preliminary estimates indicate that the wear should be less than the currently specified 0.125 inch wear allowance. The assumptions and methodology used to determine the wear allowance are being checked to ensure that the specified wear allowance is adequate.

None of the piping containing glass formers is located in "black cells". All of this piping is accessible for monitoring and repair.

HLW High Solids Waste Streams without Glass Formers

The waste received from the Hanford double-shell tanks will contain insoluble solids consisting mostly of precipitated hydroxy-oxides, sulfates, nitrates, and will be fine grained. Work done at Battelle (Smith, HD and MR Elmore, 1992, *Corrosion Studies of Carbon Steel under Impinging Jets of Simulated Slurries of Neutralized Current Acid Waste (NCAW) and Neutralized Cladding Removal Waste (NCRW)*, PNL-7816) suggests wear rates of carbon steel at 8 fps will be about 2 mpy. The insoluble solids will also contain small amounts of sand and crushed mill scale from the walls of the tank, but this will be a minor fraction of the total amount of solids. The wear rate of stainless steel under similar conditions is expected to be less.

Particle size is one of the parameters which affects the wear rate. Jewitt (Jewett, JR, DA Reynolds, SD Estey, L Jensen, NW Kirch, & Y Onishi, 2002, *Values of Particle Size, Particle Density, and Slurry Viscosity to Use in Waste Feed Delivery Transfer System Analysis*, RPP-9805, Rev 0) suggests the particles have a mean diameter of 7.5 microns; any larger particles are mostly agglomerates that are expected to break up under flow conditions. This latter conclusion is confirmed by Bechtold (Bechtold, et al, 2002, *Particle Property Analyses of High-Level Waste Tank Sludges*, HNF-8862, Rev 2.). As a consequence, little erosive wear is expected due to larger particle sizes.

Wear rates as low as 0.4 mpy were estimated based on Larrick. (Larrick, AP, 1991, Internal Memo: *Recommendation on Material Selection for Replacement of the Cross-Site Transfer line, Project W-058*, Ref #: 77120-91-030). The wear rates in these lines are expected to be much smaller than in the lines with glass formers, and preliminary estimates indicate the wear will be less than the 0.0937 inch allowance specified for waste lines containing high solid waste streams. The assumptions and methodology are being checked to ensure that the specified wear allowance is adequate.

Filtered LAW Streams

LAW streams are filtered through 0.1 micron pore size filters and consequently contain no large waste particles. No significant erosion is expected in these lines.

Selection of Piping for Wear in High Solids Systems

Wear allowances are specified for the entire pipe run, including bends. Often, because of other considerations, a larger pipe schedule is used than required from the pressure, temperature, and wear conditions alone. When pipe is selected for a specific pipe class, the required minimum wall thickness is determined by pressure and temperature conditions plus an allowance for corrosion and wear. For pipe that is to be bent, the wall thickness is increased by 20% to allow for wall thinning due to bending to ensure the minimum required wall thickness is maintained. The schedule of pipe is chosen which has equal to or greater than the required wall thickness. Therefore, the available wall thickness for corrosion and erosion is often larger than the required wear allowance. When straight pipe is bent, the remaining wall on the outside of the bend has to be equal to or greater than the required minimum wall thickness which includes the allowance for corrosion and erosion wear.

Corrective steps to be taken:

1. Lines without glass formers have erosion rates that are expected to be small, possibly as low as the estimated erosion rates in the Hanford transfer lines. For these lines, erosion in bends has not been shown to be a concern.

2. In lines with glass formers, confirmation that the specified minimum corrosion-erosion allowance will exceed the predicted erosion in pipe bends is currently underway.

Dates for completion of corrective steps:

Confirmation that the specified minimum corrosion-erosion allowance will exceed the predicted erosion in pipe bends will be completed by February 28, 2003.

DNFSB Comment 10:

The cesium ion exchange process (CXP) poses significant safety challenges due to the high radiation field resulting from the accumulation of cesium-137 and the pressurized operation needed to prevent fluidization of resin particles. BNI is redesigning the CXP columns to address issues related to hydrogen accumulation. The previous design called for a gas separation vessel connected to the top of the CXP column via piping. Concerns regarding the ability of the column to adequately vent hydrogen during abnormal conditions prompted a redesign. The new design eliminates the gas separation vessel, instead carrying out the pressurized purge ventilation functions in an enlarged column headspace.

During a loss-of-power event, two hazardous conditions could impact the CXP system: (1) buildup of hydrogen gas, resulting in a deflagration; and (2) overheating of the resin material, leading to an explosion. As with all vessels, the BNI strategy for preventing a hydrogen deflagration is to provide an important-to-safety purge to the CXP columns to maintain headspace concentrations below 25 percent of the LFL. Overheating of the resin can be prevented by the addition of dilute caustic or water to the CXP columns. The current design includes an emergency elution capability; however, use of this capability has not been identified as a control strategy. While the current control strategy should adequately manage the overheating hazard, use of the emergency elution capability would eliminate the hazards associated with organic ion exchange resin under high radiation fields. It is not clear to the staff why this capability has been included in the design yet not credited as a preventive control strategy, and whether its utility for safety purposes has been fully evaluated.

DNFSB Issue Number 10:

During a loss-of-power event, two hazardous conditions could impact the CXP system: (1) buildup of hydrogen gas, resulting in a deflagration; and (2) overheating of the resin material, leading to an explosion. As with all vessels, the BNI strategy for preventing a hydrogen deflagration is to provide an important-to-safety purge to the CXP columns to maintain headspace concentrations below 25 percent of the LFL. Overheating of the resin can be prevented by the addition of dilute caustic or water to the CXP columns. The current design includes an emergency elution capability; however, use of this capability has not been identified as a control strategy. It is not clear to the staff why this capability has been included in the design yet not credited as a preventive control strategy, and whether its utility for safety purposes has been fully evaluated.

DOE Response:

The emergency elution capability has been included in the design yet not credited as a preventive control strategy based on the ISM review and selection of controls (i.e., cooling). The utility of the emergency elution system for safety purposes was delayed due to resolution of the CXP hydraulic design and hydrogen control issues.

Reason for the Issue:

The design currently has an emergency elution system; however, it has not been credited as a control strategy. The ISM Review Process conducted during the conceptual phase of the design identified resin overheating during loss of power situations as a potential concern. The emergency elution system was first proposed by the project during ISM Cycle I as a means to elute the columns if an overheating condition developed that could not be remedied by normal design features. The proposed strategy, emergency elution, was carried into ISM Cycle II. However, during ISM Cycle II, technical uncertainties associated with the emergency elution system (e.g., potential acid/resin reactions) were identified. Therefore, the ISM Team selected emergency cooling during ISM Cycle II as the preferred strategy. Emergency or backup elution capability was retained for operational flexibility.

To support ISM Cycle III, further hazards assessments and accident analysis are underway to arrive at an optimal control strategy for various events, including the seismic and loss of power scenarios. The optimum strategy requires a balance be achieved between cost, simplicity, and effectiveness. In the preliminary stages of design, justification for the optimal strategy will necessarily be somewhat subjective. Elution of the column with the emergency elution system has not been ruled out as a control strategy for loss of power events as well as for situations in which the normal elution process is unavailable. However, activation of the system under accident conditions, where the condition of the resin is not fully known or where the emergency elution cycle interrupts or does not follow the normal elution cycle, may introduce additional concerns. Examples are the loss of any future use of the resin due to caustic/acid reactions, and the formation of insoluble compounds that could plug the bed. Additionally, automatic activation of the emergency elution system upon detection of a low-column-liquid-level may result in energetic acid/resin reactions. The ISM Cycle III activities are currently evaluating the need for emergency elution as a control strategy, rather than the current preferred strategy to provide an adequate supply of emergency cooling water. The material request for the emergency elution system is scheduled to be released in February 2004.

Corrective steps taken or to be taken:

As a result of the identified issue the following actions are planned:

1. Complete the ISM Cycle III evaluation of the CXP system, specifically the safety funtion requirements, if any, for the emergency elution system.

2. If a safety functional requirement for the emergency elution system is identified, the DBE calculations and the PSAR for CXP hydrogen deflagrations and CXP overheating will be revised. The revision will incorporate emergency elution as a preventive strategy during the first subsequent revision updating the PSAR.

Dates for completion of corrective steps:

1. This item will be completed by the end of January 2003.

2. If necessary, the DBE calculations and the PSARs will be revised as part of the annual update in June 2003.

DNFSB Comment Number 11:

During the staff's initial visit, design assumptions used during safety analyses were not being tracked. BNI has taken the initiative to partially remedy this situation by developing a method for tracking the closure of unverified safety basis assumptions. The database had not been fully developed and placed into use at the time of the staff's second visit, but it was clear that significant effort had been expended to address this issue. During a follow-on discussion with representatives of Research and Technology (R&T) and Environment and Nuclear Safety

(E&NS), it did not appear that research tasks necessary for closure of some unverified assumptions were being properly communicated. Specifically, discussions concerning nitric acid/resin reactions revealed that E&NS personnel believed the data concerning aged and air-exposed resins were still pending, while R&T personnel indicated that the relevant experiments were complete, and no additional studies were necessary. The staff believes that, to ensure that all unverified safety basis assumptions are properly closed, BNI's tracking system should indicate the significance of an assumption to the design, specify necessary research needs, and prioritize verification activities. This is in addition to the data tracking and issue resolution capability already in development.

DNFSB Issue Number 11:

During the staff's initial visit, design assumptions used during safety analyses were not being tracked. BNI has taken the initiative to partially remedy this situation by developing a method for tracking the closure of unverified safety basis assumptions. To ensure that all unverified safety basis assumptions are properly closed, DOE's tracking system should indicate the significance of an assumption to the design, specify necessary research needs, and prioritize verification activities.

DOE Response:

Design assumptions used during safety analyses will be tracked. The tracking system will indicate the significance of an assumption to the results of the calculation and ultimately design, specify necessary research needs, and prioritize verification activities. An unverified assumption database had been developed in October 2001; however, guidance for documenting unverified assumptions and on the use of the database was not issued at the time of the DNFSB review.

Reason for the Issue:

At the time of the DNFSB review the unverified assumptions database was not fully populated and contained inconsistencies in the recorded information. Additionally there was no procedural guidance requiring a review of the unverified assumptions with the potential to affect design during the design process. However, DOE and BNI recognize that tracking unverified assumptions in the design and process operations is necessary to evaluate and select controls. As noted in DNFSB Technical Report 30 Section 4.1, tracking and closure of enabling assumptions was a critical activity for the Hanford Spent Nuclear Fuel project. As a result of reviewing Tech Report 30, BNI developed a method in October 2001 for identifying and tracking ISM and DBE assumptions, the Unverified Assumptions Tracking database, which is a controlled database. At the time of the DNFSB staff review, a number of unverified assumptions had been recorded in the database. The recorded assumptions were not consistent with respect to documentation and closure. Additionally, some assumptions generated during the ISM reviews were not captured.

As discussed below, actions have been completed or are currently in progress to ensure that the assumptions tracking system indicates the significance of the assumption to the design, specifies research needs, and prioritizes verification activities.

A design guide (24590-WTP-GPG-SANA-007, *Documenting, Tracking and Closure of Assumptions Used for Standards Identification and Safety Analysis*) was developed and issued in July 2002. In addition to the requirements for documenting unverified assumptions, the guide establishes requirements for documenting verified assumptions in DBE calculations.

The guide currently requires the following information for unverified assumptions:

- System #
- Statement of the assumption
- Basis as to why assumption is valid
- Sensitivity of the analysis to the assumption
- Closure method.

The guide will be revised to establish and include a priority system based on the significance of an assumption to the results of the calculation and therefore, its potential impact on design.

Currently, 24590-WTP-GPP-SANA-001, *Procedure: Accident Analysis*, 24590-WTP-GPG-SANA-007 and 24590-ESH-DI-SANA-003 are being revised to incorporate changes to the engineering calculation procedure 24590-WTP-3DP-G04B-00037, *Engineering Calculations*. Also, a new design guide is being prepared to document the critical input database including the purpose of the database, the data to be collected and recorded, and the identification of preliminary versus final design data. The database will include final design data (i.e., data based on numeric revision drawings or system descriptions) and preliminary design data (i.e., data based on alpha revision drawings or system descriptions).

As part of the process to close all unverified assumptions the BNI R&T level 4 schedule has been reviewed by the BNI accident analysts to determine if the R&T activities/reports will address currently identified unverified assumptions. For instance, where it appears the R&T report will close an unverified assumption, the released report is reviewed. The review has three possible outcomes:

- The unverified assumption is closed.

- The issue is addressed in an ISM meeting, where if appropriate, engineered design features are identified that close the unverified assumption.

- If a design feature is not developed by the ISM meeting, in accordance with 24590-WTP-GPP-RTD-001, *Technology Development,* a request for further R&T activity (Request for Technology Development [RTD]) to resolve the unverified assumption is prepared.

To date there have been approximately 20 RTDs initiated. Of these, 3 have been withdrawn or disapproved 12 have been approved and the balance are still in the discussion and approval process.

In addition, the Standards Identification Process Database (SIPD) which contains the results of the hazard evaluation (24590-WTP-GPP-SANA-003) can also generate unverified assumptions. Prior to the development of the unverified assumptions database, these unverified assumptions were captured as notes or explicitly as safety case requirements (SCRs) in SIPD. At the time of the DNFSB review the process to capture unverified SIPD assumptions was not consistently applied. These unverified assumptions, previously identified, and new, are now required to be recorded in the unverified assumptions database (24590-WTP-GPG-SANA-002). For each hazard considered, SIPD identifies assumptions affecting the release that may drive or inhibit the potential accident (e.g., quantity and form of material at risk, rate of release and relevant process conditions, and energy available). Additionally, documentation (e.g., meeting minutes) supporting the hazard analysis is provided to document control. This information includes facility and/or process information used by the ISM Team, a list of hazards of the process, including hazardous materials and energy sources and their form, location, and quantity, and open action items and plant design or operational area within the scope of the hazard analysis that remain as items requiring further resolution. Prior to approval of the *Pre-Construction PHA Screening Checklist* (24590-SANA-F00002) for respective design drawings, open assumptions requiring verification are closed. Open assumptions remain open only with the concurrence of the safety analysis manager. The open assumptions are entered in the unverified assumptions database in accordance with 24590-WTP-GPP-SANA-002.

Corrective steps taken or to be taken:

As a result of the identified issue the following actions were in progress or are planned:

- Design guide 24590-WTP-GPG-SANA-007, *Documenting, Tracking and Closure of Assumptions Used for Standards Identification and Safety Analysis*, which provides guidance for documenting unverified assumptions for both DBE calculations and for SIPD was developed and issued in July 2002. Also Desk Instruction 24590-ESH-DI-SANA-003, *Format and Content for Design Basis Calculations* was developed that provides additional guidance for DBE analysts and authors. The Design guide is currently being revised to establish and include a priority system based on the significance of the assumption. The changes to the engineering calculation procedure 24590-WTP-3DP-G04B-00037 regarding the identification and documentation of assumptions requiring further verification (i.e., unverified assumptions) have been incorporated.

- A critical input database has been developed to capture preliminary and final design data used in the DBE calculations. The preliminary data includes data that will be confirmed as the design matures. At the time of the DNFSB review a strawman identifying data requirements and database format had been developed. The format has been finalized and a design guide is being developed. This database will be a controlled, non-ITS database and a custodian within the accident analysis group will be identified. The design guide will include the purpose of the database, the data to be collected and recorded, and the identification of preliminary versus final design data.

- R&T activities will be reviewed as scheduled. This activity is a level of effort scheduled to be completed by December 2003. Ongoing activities include reviewing test specifications and final reports. The reviews are being performed by the analyst most familiar with the DBE to determine if an unverified assumption can be closed or if additional studies are required.

- Procedure 24590-WTP-GPP-SANA-001, and 24590-ESH-DI-SANA-003, are being revised to incorporate changes to the engineering calculation procedure 24590-WTP-3DP-G04B-00037 and changes to the unverified assumptions format and content requirements (i.e., prioritizing assumptions).

Dates for completion of corrective steps:

The Design guide 24590-WTP-GPG-SANA-007, and 24590-WTP-GPP-SANA-001, *Procedure: Accident Analysis*, will be revised by January 30, 2003. The Desk Instruction 24590-ESH-DI-SANA-003, will be revised following approval of 24590-WTP-GPP-SANA-001.

The design guide for the critical input database will be completed by January 30, 2003.

Training in the pending procedure and desk instruction revisions will be completed by January 17, 2002.

The requirement to prioritize the unverified assumption will be implemented in the next DBE revisions to support the annual update of the facility PSARs in June 2003.

DNFSB Comment Number 12:

In discussions with BNI and DOE personnel, the DNFSB staff expressed concern that the ISM process may not be successfully capturing critical design features being relied upon for safety. For example, BNI determined that it was impossible for CXP resin to come in contact with sodium permanganate. During analysis, minimal vessel heel volume was identified as a design feature that would dilute potential improper additions of sodium permanganate. The staff questioned whether this design feature would be preserved for implementation in future safety requirements, for example, to prevent emptying of the vessel and thereby creating a significantly increased risk of CXP resin contacting sodium permanganate. Though BNI has developed a system for tracking safety-related requirements, this minimal heel design feature was not added to the database properly. As a result of the staff's inquiry, BNI is now tracking this specific design feature correctly. A closer review of how the ISM process records other design features and assumptions and their importance to safety would be beneficial. At the time of the staff's review, senior BNI E&NS personnel indicated that a management assessment would be conducted to accomplish this review.

DNFSB Issue Number 12:

The ISM process may not be successfully capturing critical design features being relied upon for safety. A closer review of how the ISM process records other design features and assumptions and their importance to safety would be beneficial

DOE Response:

DOE agrees that the ISM process was not successfully capturing critical design features being relied upon for safety. This was due to inadequate guidance to the ISM teams regarding what is a critical design feature and how and where to consistently capture it in SIPD. A management assessment to identify inconsistencies and/or deficiencies has been conducted.

Reason for the Issue:

Relative to documentation for assumptions made during the ISM reviews, the Standards Identification Process Database procedure 24590-WTP-GPP-SANA-003 and guide 24590-WTP-GPG-SANA-001 specified the actions required for consistent documentation of these assumptions. At the time the ISM meetings were conducted for the majority of the systems, this guidance permitted capturing of design features assumptions as Safety Case Requirements (SCRs) or entering the information as part of hazardous scenario in the notes field of SIPD for linkage to SCRs at a later date. This latter guidance contributed to the omission of the previously noted design feature. This resulted in inconsistencies in documenting the design feature and if captured in the notes, the inability to search and identify the design feature.

As committed to in the exit briefing with the DNFSB staff, a management assessment (Report – Treatment of Assumptions in Safety Analyses 24590-WTP-MAR-ESH-02-016, Rev. 0) was conducted. This assessment focused on one system from each of the facilities. The purpose of the assessment was to determine whether assumptions made in the conduct of the ISM process had been appropriately identified, tracked, and carried forward into design. By selecting one system from each facility it could also be determined if the potential oversight was limited to a particular facility and ISM team or if it was a potential issue at all of the facilities. The systems selected for the review were:

- PTF: Mechanical Handling
- HLW: Melters
- LAW: Offgas.

The Management Assessment concluded the following:

- From the records reviewed, there is no evidence of assumptions made, important to the current safety analysis, that have not been captured in formal project documentation (i.e., SIPD, unverified assumptions database or design calculations).

- E&NS has a workable system to capture and track assumptions and through the critical input database a method of ensuring that the impact of future changes to these assumptions are addressed.

- There is significant work to be done to close out unverified assumptions, many of which can be closed now. This work is already underway.

- Database fields should align with the requirements of the procedure. This will allow better control of assumptions and avoid onerous "housekeeping" in the future.

Corrective steps taken or to be taken:

Revisions to the referenced procedure and guide have been drafted, (24590-WTP-GPP-SANA-003 and guide 24590-WTP-GPG-SANA-001), to delete the option of documenting assumptions in the notes field of SIPD and are currently in the approval process.

In addition, the Hazard Analysis, Development of Hazard Control Strategies, and Identification of Standards procedure 24590-WTP-GPP-SANA-002 has been revised to provide additional guidance on documenting assumptions made during the ISM reviews.

Timely closure of the identified assumptions has also been initiated as directed by the procedural requirements in 24590-WTP-GPP-SANA-002, Appendix F during ISM Cycle 3 activities. Prior to approval of the *Pre-Construction PHA Screening Checklist* (24590-SANA-F00002) for respective design drawings, open assumptions requiring verification are to be closed. Open assumptions may remain open only with the concurrence of the safety analysis manager. The open assumptions will be entered in the unverified assumptions database in accordance with 24590-WTP-GPP-SANA-002.

Dates for completion of corrective steps:

Revisions to the procedures and guides will be completed in January 2003.

A review of SIPD will be completed by March 2003 for potential omissions or inclusion in notes with respect to credited design features. For those cases where design features have not been properly identified new safety case requirements will be developed.

As numeric revision drawings are issued, identified assumptions will be closed or carried forward with appropriate justification and management approval. The timetable for issuance of numeric revision drawings varies by facility but is expected to be completed for all facilities with the exception of the Analytical Laboratory by March 2003.

DNFSB Comment/Issue Number 13: *Unanalyzed Conditions*

There may be systemic weaknesses in the ISM review process. Based on the DNFSB comments in the cover letter and in issue 12 and the following three issues 14, 15, and 16, this was identified as a generic issue. Thus it has been captured as an individual item.

DOE Response:

DOE agrees that there have been some conditions (e.g., hazardous situations or controls) that were not adequately addressed in the PSAR or captured during the BNI ISM process. These oversights when identified during the review process (e.g., management assessments, DOE and DNFSB) are evaluated. As a result of the evaluations, nothing has been identified that was significant enough to require changes in the design or selected control strategies.

Reason for the Issue:

DOE considers the ISM process to generally be sufficiently rigorous to produce a reliable safety case. The hazards analysis is an iterative process, that at this point in the project life cycle is unfinished. For example, for complex systems such as the CXP (see DNFSB Issue 10) the ISM review of the entire CXP system is ongoing and as discussed will be completed by the end of January 2003. The current selected set of controls, however, are adequate to mitigate either hydrogen gas build-up or overheating the resin. For complex hazardous situations, such as hydrogen gas generation, retention, and release (see DNFSB Issues 7 and 8) a review of the phenomenology as well as the Pretreatment process systems is in progress. As with the CXP system, the selected set of controls for hydrogen mitigation are adequate to prevent hydrogen gas build-up in the waste or vessel headspace, thus preventing deflagrations.

As discussed above, the hazards analysis process is ongoing and will be iterated through final design and commissioning. Analyses for selected systems (e.g., melter offgas, hydrogen mitigation, CXP) as well as spatial/topographic reviews are planned for 2003. The purpose of these analyses is to: (a) verify and confirm the adequacy of the design, (b) identify and specify instrumentation and controls including software, (c) assess impacts of start-up and shutdown, and (d) provide a basis for safety related procedural steps and technical safety requirements. In support of the Final Safety Analysis Report (FSAR), a final hazards analysis (typically HAZOP) will be conducted on the "as-built" design and operating procedures. However, DOE considers the process as it has been applied to the conceptual and preliminary design to be sufficiently conservative and rigorous to produce an acceptable safety case.

For example the conditions identified in DNFSB Issues 14, 15, and 16, discussed further below, were known to the ISM teams. Therefore, the ISM teams thought it was not necessary to document the conditions in SIPD or the PSAR.

- With respect to DNFSB Issue 14, increased hydrogen generation rates due to loss of cooling, the effects of increased waste temperature on the hydrogen generation rate was addressed using maximum expected waste or vessel design temperatures. It was decided in the ISM meetings, that given the minimum times to boiling (~ 270 hours for non-boiling vessels) remedial actions (e.g., cooling water additions, restoration of cooling) could be taken to prevent vessel boiling. For conservatism, a minimum purge flow rate of 100 times the hydrogen generation at the maximum expected waste or vessel design temperature was selected.

- With respect to DNFSB Issue 15, increased aerosol loading in the PVVS due to loss of cooling was also considered. The PVVS is designed to withstand potential impacts associated with boiling vessels. The preliminary evaluation, presented to the DNFSB, for an 8-hour boiling event did not consider the minimum time to boiling and remedial actions identified above or credit any other removal mechanisms (e.g., depletion, deposition, DF from scrubbers). The conclusion of the preliminary evaluation was that the PVVS HEPAs would be challenged; however, based on the conservatisms in the preliminary evaluation, it was concluded that the PVVS system could be reasonably expected to mitigate the release.

- With respect to DNFSB Issue 16, flashing through spray leaks, the ISM teams determined that flashing would not be expected based on the design of the Pretreatment processes (i.e., low-temperature and low-pressure). For example the planned evaporators operate at a vacuum and are limited to 55 C, thus flashing is not possible. Two phase flow from a leak in a normally functioning ejector was not considered possible because the high temperature steam is quenched by the liquid as it is pulled into the ejector body. The resulting temperature of the bulk liquid in the discharge piping is below the boiling temperature of the liquid at atmospheric pressure, therefore no flashing would occur. As the temperature of the liquid being pulled into the ejector increases, the efficiency of the ejector decreases dramatically. Therefore, when the ratio of steam to water decreases to the point that the temperature of the liquid in the discharge pipe exceeds it's atmospheric boiling point, the amount of contaminated liquid (i.e., Material at Risk) is very low. Since the inherent behavior of steam ejectors was known to participants at the hazards identification meetings it was not thought necessary to document the above conclusions.

BNI is committed to performing management assessments to monitor progress, providing an independent review of the ISM conclusions, and identifying process improvements. For example, a management assessment was conducted on the Pretreatment ISM process from November 19 through November 21, 2002. The team noted that the status of the ISM hazards documentation which is entered into the project records lags the design. This lag is due to the process followed to update and approve SIPD records, however this lag does not imply that the latest design media has not been evaluated via the ISM process. That is, as a system design change is identified, an ISM meeting is convened to address the design change and the results of the meeting are captured in the safety implementation notes (SINs). Following the ISM meeting, meeting minutes are prepared and distributed for approval by the attendees. Following approval of the meeting minutes SIPD is updated and the CSD record is approved.

As part of the ISM process, the DBE calculations are relied upon to analyze the hazardous situation, confirm the adequacy of the selected controls and establish control performance requirements. The DBE's analyzed are selected from approved SIPD entries and the analysis results are reflected in the PSAR. As part of the annual update process, the DBE's are revised to reflect current design and operations as recorded in SIPD (e.g., approved entries). The combination of management assessments and DBE analysis ensures that the ISM process is comprehensive and adequate to establish a reliable safety case.

Corrective steps taken or to be taken:

1. Management assessments will be an ongoing process.

2. Lessons learned based on the results of the internal and external reviews of the ISM process and SIPD will be related to the ISM team members via a training session.

3. ISM review meetings of complex systems or hazardous conditions will be performed as the systems design matures or the hazardous condition is better defined.

Additional Actions are identified in DNFSB Issues 14, 15, and 16.

Dates for completion of corrective steps:

Management assessments will be performed to assess the ISM process as each system matures or becomes finalized. A schedule of these management assessments for 2003 will be developed by February 17, 2003.

Training in the lessons learned from internal and external reviews and assessments will be completed by January 17, 2003.

ISM reviews of complex systems and hazardous condition phenomenology analyses will continue as the systems design and process matures. The ISM review of the CXP system to support issuing revision 0 drawings will be completed by the end of January 2003. The ISM review of the HLW melter offgas system is scheduled to be completed in March 2003.

The schedule for completion of hydrogen generation, retention, and release are identified in DNFSB Issues 7 and 8.

DNFSB Comment Issue 14:

The following scenarios identified by the staff did not appear to be identified and evaluated during the ISM process:

Loss of Cooling Impacts—Currently, the cooling of vessels in the pretreatment facility is not classified as an important-to-safety function; therefore, emergency/backup power is not supplied to this system. Following a loss of cooling capability, however, increased tank temperatures would result from ongoing radioactive decay and chemical reactions. This increased tank temperature would in turn result in hazards not considered during the Hazard and Operability Analysis or the subsequent ISM review:

- Increased hydrogen generation rates — The rate of hydrogen generation due to thermolysis is exponentially dependent on the waste temperature (Arrenhius dependence). The capacity of the PVP is currently based on expected maximum operating temperatures. A loss-of-cooling accident could result in significantly higher temperatures, and thus exponentially higher hydrogen generation rates. As a result of the staff's inquiry, BNI is now evaluating the impact of this scenario on the PVP design.

DNFSB Issue Number 14:

A loss-of-cooling accident could result in significantly higher temperatures, and thus exponentially higher hydrogen generation rates. As a result of the staff's inquiry, DOE is now evaluating the impact of this scenario on the PVP design.

DOE Response:

DOE agrees that the potential for increased hydrogen generation rates was not explicitly called out in the hazard analysis as a potential consequence of loss of vessel cooling accidents.

Reason for the Issue:

The effect of temperature on hydrogen generation rates had already been incorporated into hydrogen generation rate calculations; however, not all of the vessels were analyzed at boiling temperatures. The vessels were evaluated using waste/vessel specific heat loads or where that data was not available using vessel maximum design temperatures. It was understood, however, that the generation rate equations and their correlation to WTP specific situations were not fully verified and that in some cases could be non-conservative. Therefore, the required minimum air purge rates to dilute the hydrogen to safe levels was increased by 100 times the hydrogen generation rates calculated in the HLW and Pretreatment severity level calculations. This additional conservatism was thought large enough to account for uncertainties in the calculated generation rates.

As discussed previously, hydrogen generation rates will be calculated at the maximum waste/vessel temperatures reached following a loss of cooling and the PVVS for one year. This new analysis will assume the SDC purge and the SDC C5 ventilation system continue operating during this period. As discussed previously, the hydrogen correlation and the design of preventive/mitigative systems are currently being refined.

Corrective steps taken or to be taken:

As a result of the identified issue the following action is to be taken:

Following hydrogen prevention/mitigation systems design analysis (i.e., determination of what the waste/vessels maximum temperature is following a one year loss of cooling with continued operation of the SDC purge and SDC C5 ventilation system), SIPD will be updated to identify increased hydrogen potential for those vessels at risk. Additionally, SIPD will be revised to include an entry addressing the loss of cooling event currently identified as a boiling DBE, to also be hydrogen DBE.

Dates for completion of corrective steps:

SIPD will be revised by January 31, 2003, to include loss of cooling as a potential initiating event for increased hydrogen generation, for those vessels identified as being at risk.

DNFSB Comment Number 15:

The following scenarios identified by the staff did not appear to be identified and evaluated during the ISM process:

<u>Loss of Cooling Impacts</u> — Currently, the cooling of vessels in the pretreatment facility is not classified as an important-to-safety function; therefore, emergency/backup power is not supplied to this system. Following a loss of cooling capability, however, increased tank temperatures would result from ongoing radioactive decay and chemical reactions. This increased tank temperature would in turn result in hazards not considered during the Hazard and Operability Analysis or the subsequent ISM review:

- Ventilation system loading — Significant increases in tank temperatures would result in an increased vapor and aerosol loading to the PVVS. Preliminary calculations performed by BNI in response to the staff's inquiry indicate that the increased load resulting from just one tank boiling for the duration of a loss-of-offsite-power event (8 hours) could challenge the high-efficiency particulate air filtration capacity of the PVVS.

DNFSB Issue Number 15:

Significant increases in tank temperatures would result in an increased vapor and aerosol loading to the PVVS. Preliminary calculations performed by BNI in response to the staff's inquiry indicate that the increased load resulting from just one tank boiling for the duration of a loss-of-offsite-power event (8 hours) could challenge the high-efficiency particulate air filtration capacity of the PVVS.

DOE Response:

DOE agrees that the potential for increased vapor and aerosol loading to the PVVS due to a loss of cooling event (i.e., boiling) was not identified in SIPD.

Reason for the Issue:

Early in the ISM process it was determined by the ISM teams that the PVVS should be designed to withstand the effects of a boiling; therefore, by making this determination no entry was made in SIPD recognizing that the aerosols released from a boiling vessel would impact the PVVS. However, the ISM Review Process recognized the potential for process vessels to self-heat to boiling temperatures during the conceptual design of the project. At that time, the preferred control strategy was to provide a vessel ventilation system with sufficient capacity to mitigate the effects. This strategy was chosen over preventive strategies such as safety design class cooling systems because the vessel vent system needed to be able to also mitigate other large aerosol producing events, such as a PJM over-blow. Therefore, vessel cooling was cited as a defense in depth feature. Based on the results contained in the PSAR the shortest time to boil for any vessel in Pretreatment (with the exception of the evaporator) is greater than 270 hours assuming adiabatic conditions. A preliminary estimate of the amount of aerosol that may have to be removed by the vessel vent system was developed and presented to the board. The preliminary estimate did not credit any other removal mechanisms (e.g., deposition, and depletion, DF from scrubbers) beyond the HEPA filters and postulated the tank boiled for 8 hours. The conclusion of the presentation was that the HEPA would be challenged. However, based on the design requirements of the PVVS and the conservative nature of the preliminary evaluation the system could reasonably be expected to mitigate a vessel boiling event.

Corrective steps taken or to be taken:

As a result of the identified issue the following action is to be taken:

- A detailed HADCRT analysis of vessel boiling and the impacts to the PVVS system including the HEPA is being performed. This analysis will be incorporated into the Pretreatment boiling DBE calculation to document the potential for vessels to boil and the environmental challenges and performance requirements. The results of the HADCRT analysis will be incorporated into the DBE calculation.

Dates for completion of corrective steps:

The HADCRT analysis will be completed and submitted to the ISM team prior to finalizing the revision of the Pretreatment SIPD which is scheduled for January 31, 2003.

The Pretreatment boiling DBE calculation is scheduled for release in April 2003 and will be incorporated in the PSAR at the next annual update scheduled for June 2003.

DNFSB Comment Number 16:

The following scenarios identified by the staff did not appear to be identified and evaluated during the ISM process:

<u>Flashing Through Spray Leaks</u> — Several pipes, jumpers, and vessels located within the Feed Evaporation Process system operate under temperature and pressure conditions such that a spray leak event could cause the waste to flash to vapor. The possibility of a flashing event for spray leaks was not evaluated by BNI. As discussed above, the increased vapor load resulting from a flashing event could significantly increase the release of radioactive material, and potentially result in a higher dose to the public and workers than is currently evaluated in the severity-level calculations.

DNFSB Issue Number 16:

Several pipes, jumpers, and vessels located within the Feed Evaporation Process system operate under temperature and pressure conditions such that a spray leak event could cause the waste to flash to vapor.

DOE Response:

DOE agrees that the potential for spray leaks to flash to vapor was not explicitly identified in SIPD.

Reason for the Issue:

The evaporators planned for WTP operate under vacuum such that the highest temperatures in the system are limited to 55^{o} centigrade. This is well below the normal boiling point of water. Therefore, flashing of liquid from any feed evaporator process system leak is not possible. This fact was known to the individuals conducting the ISM Review Process and, given it is a feature inherent to the evaporator design, a specific note of it was not made in either the hazards assessment reports or the accident analysis calculations.

With the exception of the steam jet ejectors, there are no high-pressure high-temperature systems within the facilities. Based on the authorized design, steam ejectors are used infrequently to empty vessels and transfer liquids. The steam within the ejector lines will collapse into the liquid phase rapidly as it mixes with the sub-cooled liquids, therefore, the possibility of a flashing spray was not evaluated. However, due to comments raised by the ORP, the impacts to the HEPA filters due to steam releases in the facilities will be evaluated in the next PSAR revision.

Corrective steps taken or to be taken:

As a result of the identified issue the following action is to be taken:

To respond to the ORP comment, a scoping calculation will be performed as part of the breakpot ISM review of a potential jet ejector overrun. There are no postulated radiological releases associated with a steam jet ejector overrun (i.e., continued operation); therefore, no DBE calculation will be performed. This will be addressed as an environmental challenge to the PVVS HEPA filters and documented in the meeting minutes.

Dates for completion of corrective steps:

The steam jet ejector overrun analysis will be completed and submitted to the ISM team prior to finalizing the revision of the Pretreatment SIPD. This is scheduled to be completed by January 31, 2003.

DNFSB Comment Number 17:

The staff's initial review of DBE and severity-level calculations revealed that these calculations lacked technical quality. The weaknesses varied from small mathematical errors to possibly inappropriate empirical correlations and unjustified assumptions. As a result of the staff's observations regarding poor-quality calculations, BNI undertook a detailed management assessment of this issue. BNI's review showed that all calculations contained some errors, with an average of 40 errors per calculation. Ultimately, DOE implemented a more rigorous peer review process, augmented by external reviewers, to address this issue. The staff considers BNI's approach regarding poor-quality calculations to be timely, aggressive, and sufficient to resolve the problems identified. However, the ability of BNI to produce high-quality technical products will continue to be challenged given the schedule necessary to support construction, and consistent management vigilance will be required.

DNFSB Issue Number 17:

The staff considers BNI's approach regarding poor-quality calculations to be timely, aggressive, and sufficient to resolve the problems identified. However, the ability of BNI to produce high-quality technical products will continue to be challenged given the schedule necessary to support construction, and consistent management vigilance will be required.

DOE Response:

DOE agrees that there were calculational errors as well as inadequate documentation of design and analysis assumptions in the DBE calculations reviewed by the DNFSB.

Reason for the Issue:

Based on the results of the root cause analysis the probable causes of the errors were due to (1) Use of preliminary and/or unapproved information in confirmed calculations; (2) Assumptions are not identified and/or justified, assumptions that must be verified are not identified, and bases for inputs are not provided; (3) Ineffective checking, reviewing, and approval of calculations; (4) Inadequate software documentation in calculations; and (5) Inability to trace uses of calculations as design inputs. It was also determined that inadequate time was allocated for checking of the calculations. BNI is committed to preparing quality technical documents. In response to Corrective Action Report (CAR) 24590-WTP-CAR-QA-02-095 (issued to address poor calculation quality), DBE calculation procedures and guidance have been developed or revised to clarify expectations. These expectations have been communicated to the DBE analysts. To ensure that quality technical documents are prepared management has committed to monitor and assess the preparation of the DBE calculations. As part of this process an Independent Review plan is being developed with the purpose to evaluate conformance to the guidance and assess the technical quality of the DBE calculations. The following describes the actions committed and completed in response to the CAR.

1. A preliminary review of the management assessment comments
2. Incorporate Management Assessment 24590-WTP-MAR-ESH-02-009 (Management Assessment) comments in DBE calculations, where appropriate
3. Revise existing procedures/guidance to address the Management Assessment concerns
4. Develop new procedures/guidance as necessary to address the Management Assessment concerns
5. Train accident analysis staff in the new procedures/guidance
6. Prepare formal responses to Category I comments (i.e., potentially non-conservative errors)
7. Issue the revised DBE calculations.

As a result of the corrective actions identified above new or revised guidance has been prepared, the Management Assessment comments have been incorporated into the DBE calculations, and a strategy for an Independent Review is being developed. The incorporation of the remaining Management Assessment comments (Categories II-VI) did not change the conclusions or change the control strategies identified in the DBE calculations. The revised DBEs have been checked internally for comment incorporation and compliance with the new/revised guidance.

With the exception of issuing the calculations, the corrective actions identified in the CAR have been completed. The DBE calculations have not been approved for release.

Corrective steps taken or to be taken:

As a result of the identified issue the following actions have been taken:

1. A preliminary management assessment was performed in May 2002 and a final management assessment was also completed in May 2002. Based on the results of the preliminary management assessment, which concluded numerous errors did exist, a CAR was issued (24590-WTP-CAR-QA-02-095). A final management assessment report was issued May 31, 2002 (24590-WTP-MAR-ESH-02-009). A review of the comments by the ES&H organization determined that the conclusions reached in the DBE calculations regarding the controls selected would not change as a result of comment incorporation.

2. Incorporate Management Assessment 24590-WTP-MAR-ESH-02-009 (Management Assessment) comments in DBE calculations, where appropriate. The original author/analyst was required to ensure the comment responses were incorporated in the DBE calculations as either the author or checker. The revised DBE calculation and a copy of the management assessment team comments were provided to the calculation checker to ensure the comments were appropriately addressed and incorporated. This activity for the LAW and HLW DBE calculations was completed in October 2002.

3. Revise existing procedures (24590-WTP-GPP-SANA-001) address the Management Assessment concerns. This activity was completed in July 2002.

4. Develop new procedures/guidance as necessary to address the Management Assessment concerns. The Desk instruction 24590-ESH-DI-SANA-003, for the format and content of DBE calculations was prepared to ensure consistency between calculations, provide guidance for documenting analysis and design inputs and assumptions, and clearly communicate management expectations. As discussed previously, the desk instruction is currently being revised and will be completed in January 2003. Also, as a result of the management assessment comments a design guide, 24590-ESH-GPG-SANA-007, was prepared that provides requirements for documenting assumptions, and documenting and tracking unverified assumptions for SIPD and the DBE calculations. This activity was completed in July 2002.

5. The seriousness of the calculation errors was discussed and continues to be discussed in the Accident Analysis Group staff meetings, as the analysts prepare to revise the calculation for the annual PSAR updates. The analysts were consulted individually and collectively in staff meetings, regarding the new or revised guidance. Additionally, as each guidance document is revised the revisions are discussed in the Accident Analysis Group staff meetings. With the exception of the DBE format and content desk instruction, revisions to the procedures and design guides are added to each individuals training profile as required reading. Additionally, training will be provided to the DBE analysts and ISM team members to reinforce the results of the management assessment, address changes to guidance documents, and discuss metrics that will be implemented to assess the DBE process and author/checker compliance to documentation requirements. Training in the procedure changes, metrics, and reinforcing the commitment to quality will be held before January 17, 2003. Initial training was completed in July 2002.

6. Formal responses to Category I comments were prepared and documented in 24590-WTP-MAR-ESH-02-015. This document was issued in August 2002. The following conclusions and recommendations were reached in the assessment of Category I comments:

   - The results of the evaluation determined that the incorporation of the MA Team comments did not change the selected and analyzed control strategies. In addition, changes in the severity level determinations, due to comment incorporation, did not change the control strategies selected.

   - As a result of the management assessment corrective actions have been or are in the process of being implemented. The corrective actions include; revising or developing new guidance for implementation during the DBE calculation revisions and future DBE calculations, revising the DBE calculations to incorporate management assessment comments, and scheduling sufficient peer review times and periodic independent DBE calculation reviews.

7. CAR was included as part of a Root Cause Analysis that was scheduled for Engineering calculations. The root cause analysis and a final report (24590-WTP-RPT-G-02-002) were completed in October 2002. E&NS is implementing the second reviewer checklist developed by engineering for tracking author/checker errors, providing training to DBE authors/analysts, implementing 24590-WTP-3DP-G04B-00037 with respect to software documentation, and requiring ISM facility leads to sign off on the calculation checklist.

Dates for completion of corrective steps:

The DBE calculations and the PSARs will be revised as part of the annual update. The annual update is scheduled to be submitted to DOE in June 2003.

Attachment 1-A. Analyzed DBE's and Consequences for Comparison

DBE	Severity Level	Unmitigated consequences (a)		Mitigated consequences Intact HEPA filters(a)(b)	
		CLW	Public	CLW	Public
		rem	rem	rem	rem
Loss of contamination control					
Release from melter overpack	2 (FW only)	Assumed to be <25 rem to the FW		Calculated to be 0.3 rem to the FW	
Process vessel cooling water	1 (FW only	Assumed to be >25 rem to the FW		prevented by design	
Blowback into service lines	1 (FW only	prevented by design		NC	NC
Vacuum into service lines	1 (FW only	prevented by design		NC	NC
Maintenance on contaminated items	1 (FW only	Assumed to be >25 rem to the FW		prevented by design	
Liquid Spills					
HLW CRV failure	1	7.E+02	5.E-01	7.E-04	1.E-06
Canister Drops					
Drop of unlidded canister C5	1	1.E+02	2.E-01	9.E-05	2.E-07
Drop of lidded canister C3	1	1.E+02	2.E-01	6.E-02	1.E-04
Drop of canister in cask in bay	1	3.E+01	5.E-02	prevented by design	
Secondary Waste Drops					
Drop of waste basket	1	2.E+04	3.E+01	1.E-02	1.E-05
Drop of drum	1	3.E+03	4.E+00	1.E-04	2.E-06
Drop of drum cask	1	1.E+03	2.E+00	prevented by design	
Drop of drum bogie movement	1	2.E+04	3.E+01	2.E-04	2.E-07
Drop of melter overpack	1 (FW only)	prevented by design		NC	NC
Molten glass spill					
Glass spill due to melter failure	1	5.E+02	5.E-01	7.E-06	1.E-08
Glass spill due to canister movement	1	5.E+02	5.E-01	1.E-04	2.E-07
Glass spill due to overflow	1	5.E+02	5.E-01	1.E-05	2.E-08
Direct Radiation					
Shine from cave following crane impact	1 (FW only)	Assumed to be >25 rem to the FW		prevented by design	
Shine from cave through open hatch	1 (FW only)	Assumed to be >25 rem to the FW		prevented by design	
Shine from cave through open door	1 (FW only)	Assumed to be >25 rem to the FW		prevented by design	
Shine from canister unlidded cask	1 (FW only)	Assumed to be >25 rem to the FW		prevented by design	
Shine from wet process cell loss of seal	1 (FW only)	Assumed to be >25 rem to the FW		prevented by design	
Shine from pour tunnel loss of door	1 (FW only)	Assumed to be >25 rem to the FW		prevented by design	
Spray Leak					
Liquid spray in wet process cell	1	3.E+01	5.E-02	5.E-05	1.E-07
Ammonia Release	AT				
HLW Facility Fire					
Fire melter offgas fans	1	8.E+02	2.E+00	6.E-03	3.E-05
Fire induced drop of material	1	2.E+04	3.E+01	prevented by design	
Fire in export bay	1 (FW only)	prevented by design		NC	NC
HLW melter offgas release					
Loss of site power	1	8.E+02	2.E+00	3.E-04	5.E-07
Failure of flow	1	8.E+02	2.E+00	6.E-03	3.E-05
High dP across HEPA/HEME	1	8.E+02	2.E+00	6.E-03	3.E-05
Failure of melter pressure control	1	8.E+02	2.E+00	3.E-04	5.E-07
Process vessel overflow					
Overflow CRV	1	7.E+02	5.E-01	2.E-05	8.E-08
Hydrogen deflagration					
Loss of purge	1	prevented by design		NC	NC
Loss of mechanical mixing	1	prevented by design		NC	NC
Loss of Fluidic mixing	1	prevented by design		NC	NC

(a) Prevented by design – System as designed will prevent the occurrence of the event. The preventive features are protected by TSRs or identified as design features. For consequence determinations these preventive features are SDC.

(b) NC – The event was prevented and consequences were not calculated.

SAFETY EVALUATION OR INSPECTIONS RELATED TO DNFSB LETTER ISSUES

DNFSB Comment Area	Specific Comment	Discussed in Safety Evaluation Report or Inspection Reports	Examples of Selected Question Nos. or Inspection Report Nos.
Safety Standards and Processes	- Unmitigated accident consequences versus mitigated accident consequences - Use of radiological exposure standards as cut-offs - Use of target probabilities as acceptance criteria	- LAW SER Section 4.1.2.2, Item 1 (SER Condition of Acceptance to include analysis related to mis-feed of high-level waste to the LAW facility) - Not observed - Target frequencies have been deleted as criteria. ABCN 24590-WTP-ABCN-ESH-02-019 (approved) and SER Section 4.3.2.2, Item 4 (in preparation)	LAW-PCAR-098
Design Basis Events	- Evaluation of beyond DBE events, such as chemical hazards	- HLW SER Section 4.2.2.2, Item 6.a, discussed beyond DBEs for glass spills - SER Section 4.6, Operations Risk Assessment considers beyond DBE earthquake and all initiating events.	HLW-PCAR-012 HLW-PSAR-191
Hydrogen Generation Rates	- Use of non-conservative hydrogen generation rates	- HLW SER Section 4.2.2.2, Item 4 and PT SER Section 4.3.2.2, Item 3 (in preparation) (SER Condition of Acceptance to revise hydrogen generation and severity level calculations)	HLW-PSAR-235 PT-PSAR-023 PT-PSAR-293 PT-PSAR-294 PT-PSAR-336
Erosion and Corrosion of Pipes and Vessels	- High erosion rates in nonlinear pipe segments	- PT SER Section 4.3.1.2, Process Description, Item 3 (in preparation) (SER Condition of Acceptance to assess tank waste characterization data and re-evaluate erosion/corrosion requirements)	HLW-PSAR-097 PT-PSAR-068 PT-PSAR-215
Cesium Ion Exchange	- Buildup of hydrogen during loss of power - Overheating of resin material during loss of power	- PT SER Section 4.3.1.1, Process Description, Item 9 (in preparation) (SER Condition of Acceptance to perform laboratory tests to determine safe upper	PT-PSAR-025 PT-PSAR-034

DNFSB Comment Area	Specific Comment	Discussed in Safety Evaluation Report or Inspection Reports	Examples of Selected Question Nos. or Inspection Report Nos.
	- Emergency elution capability	limit for nitric acid) - PT SER Section 4.3.2.2, Item 3 (in preparation) (SER Condition of Acceptance to revise hydrogen generation and severity level calculations) - PT SER, Section 4.3.2.2, Item 3 (in preparation) (SER Condition of Acceptance to reconsider the need for the emergency elution system)	
- Feedback and Improvement: Tracking of Design Assumptions Critical to Safety	- Design assumptions used during safety analyses were not being tracked (e.g. closure of unverified safety basis assumptions)	-Tracking of design assumptions was identified as a finding in Design Process Inspection (IR-02-015)	HLW-PSAR-001 PT-PSAR-103 PT-PSAR-157
- Implementation of Safety Controls: Design Features Critical to Safety	- ISM process may not capture critical design features relied on for safety (e.g., contact of CXP resin with permanganate)	- Issue was identified in an OSR Design Process Inspection (IR-02-015) - PT SER Section 4.3.2.2, Item 2 (in preparation) (SER Condition of Acceptance to verify design features for diluting sodium permanganate)	PT-PSAR-025
- Analyze Hazards: Unanalyzed Conditions	Conditions were not identified and evaluated during ISM process. For example: - Loss of Cooling Impacts (e.g., increased hydrogen generation rates and ventilation system loading)	- HLW SER Section 4.2.2.2, Item 2 (SER Condition of Acceptance to include hazard evaluation results for internal flooding events) - PT SER Section 4.3.2.2, Item 6 (in preparation) (SER Condition of Acceptance to assess failure of temperature control or steam valve failure in caustic leaching) - PT SER Section 4.3.2.2, Item 6 (in preparation) (SER Condition of Acceptance to evaluate a tank steam bump DBE)	LAW-PSAR-036 HLW-PSAR-003 PT-PSAR-098 PT-PSAR-198 PT-PSAR-256

DNFSB Comment Area	Specific Comment	Discussed in Safety Evaluation Report or Inspection Reports	Examples of Selected Question Nos. or Inspection Report Nos.
	- Flashing through Spray Leaks	- Not raised as an issue	
- Engineering Calculations	- Lack of Technical Quality	- Lack of Technical Quality was discussed in SER Section 6.3, SRD and ISMP Acceptability and Compliance, Item 1 (SER Condition of Acceptance to implement corrective actions defined in CCN: 042775, addressing engineering improvements, dated October 30, 2002) - PT SER Section 4.3.2.2, Item 3 (in preparation) (SER Condition of Acceptance to correct identified calculation errors) - OSR Inspections were performed on the Engineering process: - Configuration Management IR-02-007 - Standards Selection IR-02-013 - Standards Implementation IR-02-012 - Design Process Implementation IR-02-015 - ORP letter to BNI, 02-OSR-0480 on engineering problems, dated October 4, 2002 - BNI letter to ORP, CCN: 042775 - ORP Readiness Inspection No. A-03-OSR-RRPWTP-002	LAW-PCAR-039 LAW-PCAR-040 LAW-PSAR-211 HLW-PSAR-053 HLW-PSAR-061 HLW-PSAR-067 HLW-PSAR-156 HLW-PSAR-221 HLW-PSAR-234 PT-PSAR-023 PT-PSAR-042 PT-PSAR-199 PT-PSAR-258 PT-PSAR-259

Conditions of Acceptance for Low Activity Waste (LAW) and High Level Waste (HLW) Construction Authorization Request (CAR)

The following conditions of acceptance were identified by the U.S. Department of Energy (DOE), Office of River Protection (ORP) in its review of the Partial Construction Authorization Request (PCAR) and the subsequent CARs. The conditions were included as Appendix B of the Safety Authorization Report, ORP/OSR-2002-18, *Safety Evaluation Report for Waste Treatment and Immobilization Plant (WTP) Construction Authorization,* Revision 2, issued November 13, 2002.

Conditions of Acceptance

The conditions of acceptance for the general information evaluation and for the facility specific evaluations are shown below by the section in which they were cited.

Section 3.7 Radiation Protection

Conditions of Acceptance – Bechtel National, Inc. (BNI) must include the following provisions in the Radiological Controls Program. All of these conditions were identified in the Partial Construction Authorization[1] and remain in effect. Except for Item 2 below, these provisions must be provided with the Final Safety Analysis Report:

1. Provide detailed organizational chart that shows the radiation safety organization and its relationship to senior plant personnel and other line managers. Also, provide job descriptions defining specific authorities and responsibilities of radiation safety personnel. (See Section 3.7.2, Item 2.)

2. Specify the review and revision cycle of procedures and provide to DOE before the start of the preoperational testing phase. (See Section 3.7.2, Item 3.)

3. Describe the mechanism for ensuring that RWPs are not used past their termination dates. (See Section 3.7.2, Item 3.)

4. Describe the methods for analyzing airborne concentrations; methods for calibrating air sampling and counting equipment; actions levels and alarm setpoints; the basis used to determine action levels, investigation levels, and derived air concentrations and minimum detectable activities for the radionuclides; the frequency and methods for analyzing airborne concentrations; counting techniques; specific calculations and levels; action levels and investigation levels; locations of continuous air monitors, if used; and locations of annunciators and alarms. (See Section 3.7.2, Item 6.)

5. Identify the types and quantities of contamination monitoring equipment and the methods and types of instruments used in the radiation surveys. (See Section 3.7.2, Item 7.)

[1] ORP letter from R. J. Schepens to R. F. Naventi, BNI, "U.S. Department of Energy (DOE) Notice to Proceed with Partial Construction Activities," 02-OSR-0289, dated July 9, 2002.

6. Identify the locations of the facility's respiratory equipment. (See Section 3.7.2, Item 11.)

7. Describe the radiation measurement selection criteria for performing radiation and contamination surveys, sampling airborne radioactivity, monitoring area radiation, and performing radioactive analyses. List the types and quantities of instruments that were available, as well as their ranges, counting mode, sensitivity, alarm setpoints, and planned use. Describe the instrument storage, calibration, and maintenance facilities and laboratory facilities used for radiological analyses. (See Section 3.7.2, Item 12.)

Section 3.12 Procedures and Training

Procedures

Conditions of Acceptance – BNI must complete the following changes to Preliminary Safety Analysis Report (PSAR) Volume I, Section 12.3, with the first PSAR revision following authorization for full facility construction. All of these conditions were previously identified in the Partial Construction Authorization[2] and remain in effect:

1. Revise Section 12.3.1.1 to state: "The project readiness assessment process determines the procedure set required to support Construction activities. Procedures are developed and issued before the activity governed by the procedure takes place"; in addition, provide a table in Section 12.3.1.1 to indicate which activities are being addressed in management control procedures during design and construction, cold commissioning, and hot commissioning and operations, as committed to in response to Question LAW-PCAR-103. (See Section 3.12.2, Procedures, Item 2.)

2. Revise Section 12.3.2.2 to state: "The procedures covering the following topics are in place as needed for the construction phase of the project. Changes and additions to the procedure set will be identified before cold commissioning and scheduled for completion before the activity taking place: major management control systems, system and facility operations (including control of hazardous processes), major maintenance activities (including safe work practices), hazardous materials control activities, radiological control activities, and emergency response activities (including radiological and hazardous chemical release)," as committed to in response to Question LAW-PCAR-106. (See Section 3.12.2, Procedures, Item 4.)

3. Revise Section 12.3.1.1 as follows to clarify who can approve procedures: "The procedure process is governed by the project procedure on procedures. It requires that management associated with ES&H and QA review new procedures and concur that they are or are not within the authorization basis. ES&H and QA review changes to existing procedures if they affect the authorization basis or QA requirements. At a minimum, management associated with the relevant safety disciplines concurs with new procedures and changes to existing procedures that affect the authorization basis requirements," as committed to in response to Question LAW-PCAR-104. (See Section 3.12.2, Procedures, Item 6.)

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[2] Ibid 1.

4. Add the following to Sections 12.3.3.1 and 12.3.3.2.1: "The project procedure complies with the WTP QAM and addresses permanent procedure revisions and expedited procedure changes," as committed to in response to Question LAW-PCAR-107. (See Section 3.12.2, Procedures, Item 7.)

5. Add the following to Section 12.3.1.1: "For construction activities, the basic work planning process is based on the concept that for standard construction tasks, step-by-step work instructions are not required. A combination of technical specifications, field procedures, and drawings are used to perform the work. Individuals involved in the work are trained to the requirements. The work is planned using a construction administrative procedure addressing construction work packages. When unique or complex tasks are performed, work planning is addressed in a construction administrative procedure addressing special instruction work packages. This procedure provides for using a work package with additional controls, including, where appropriate, step-by-step instructions," as committed to in response to Question LAW-PCAR-105. (See Section 3.12.2, Procedures, Item 8.)

Training

Conditions of Acceptance – BNI must complete the following changes to Section 12.4 of Volume I of the PSAR with the first PSAR revision following authorization for full facility construction:

1. Define the periodic basis for comparing training materials with the list of tasks selected for training. (See Section 3.12.2, Training, Item 4.)

2. Clearly state in the learning objectives the knowledge, skills, and abilities the trainee must demonstrate; that learning objectives are sequenced based on their relationship to one another; the conditions under which required actions will take place; and the standards of performance the trainee should achieve when completing the training. (See Section 3.12.2, Training, Item 5.)

3. Define review and approval requirements for lesson plans, training guides, and other training materials before they are issued and used. (See Section 3.12.2, Training, Item 6.)

4. Demonstrate that when an actual task cannot be performed and is walked-through, the conditions of task performance, references, tools, and equipment reflect the actual task to the extent possible. (See Section 3.12.2, Training, Item 8.)

5. Define the periodic basis for conducting training program evaluations. (See Section 3.12.2, Training, Item 4.)

Section 3.13 Human Factors

Condition of Acceptance – BNI must complete the following action with the first PSAR revision following authorization for full facility construction:

1. As committed in the response to Question LAW-PSAR-210, implement a Human Factors Implementation Plan following Safety Requirements Document (SRD) Safety Criterion 4.3-6, SRD Appendix B (Section 2.6), which require IEEE 1023-1988, Section 6, "Implementation in the Design, Operations, Testing, and Maintenance Process." (See Section 3.13.2, Item 5.)

Section 3.15 Emergency Preparedness

Condition of Acceptance – BNI must complete the following action with the first PSAR revision following authorization for full facility construction:

1. Revise PSAR Section 15.3 to reflect that DOE/RL-94-02, *Hanford Emergency Management Plan*, Section 14.0, "Program Administration," and its requirements will be contained as part of the Emergency Response Plan, as committed to in response to Question LAW-PSAR-012. (See Section 3.15.2, Item 12.)

2. Revise PSAR Section 15 to reflect that, for WTP Emergency Response Plan program administration, BNI will provide WTP input to the Hanford Emergency Readiness Assurance Plan, develop an internal assessment of the emergency preparedness activities program and implement it before cold commissioning, and develop a vital records program to ensure documents essential to the continued functioning of WTP are available during and after an emergency. This was committed to in response to Question LAW-PSAR-129. (See Section 3.15.2, Item 12.)

3. Revise PSAR Section 15.4.6 to clarify that training and drills will be conducted using DOE G-151.1, *Emergency Management Guide*, Volume V, Section 4.0, "Training and Drills," as a guide. Clarify that the emergency manager will periodically assess the drill and training program, and the results will be used to improve the program. Clarify that all identified deficiencies from drills will be compiled in a database and tracked until adequate corrective actions are implemented. Clarify that management will attend emergency response training to determine where enhancements can be made to ensure that proper training is provided. This was committed to in response to Question LAW-PSAR-129. (See Section 3.15.2, Item 13.)

4. Revise PSAR Section 15.4.6.2 to reflect that exercises will be conducted in accordance with DOE/RL-94-02, *Hanford Emergency Management Plan*, and DOE/RL emergency procedures RLEP 3.10, "Developing Exercise Packages" (DOE-0223, *Emergency Plan Implementing Procedures*), as committed to in response to Question LAW-PSAR-129. (See Section 3.15.2, Item 14.)

Section 3.16 Deactivation and Decommissioning

Conditions of Acceptance – BNI must complete the following changes to Chapter 16 of Volume I of the PSAR with the first PSAR revision following authorization for full facility construction. All of these conditions were previously identified in the Partial Construction Authorization[3] and remain in effect.

1. In Chapter 16 of the PSAR, clarify its commitment to reduce radiation exposure to workers and the public during and following deactivation and decommissioning, as committed to in response to Question LAW-PCAR-028. (See Section 3.16.2, Item 1.)

2. Add the following statement to Section 16.3.5: "While the proposed decommissioning method has not been specified, the facility is being designed to limit contamination, facilitate decontamination, and minimize the dose and generation of waste in the event re-use or demolition of the facility is the ultimate decommissioning method," as committed to in response to Question LAW-PSAR-197. (See Section 3.16.2, Item 1.)

3. Change the R1, R2, and R3 contamination classifications listed in Section 16.3.1 consistent with current practices, i.e., C1, C2, C3, and C5 classifications, as committed to in response to Question LAW-PCAR-030. (See Section 3.16.2, Item 3.)

Section 3.17 Management, Organization, and Institutional Safety Provisions

Conditions of Acceptance – BNI must complete the following actions. Except for Item 4, the actions should be completed with the first PSAR revision following authorization for full facility construction:

1. Describe organizational responsibilities and staffing interfaces for the Configuration Management program in PSAR Volume I, Section 17.4, as committed to in response to Question LAW-PCAR-005. (See Section 3.17.2, Configuration Management, Item 1[c].)

2. Revise the first paragraph in PSAR Volume I, Section 17.4.6, to read, "The USQ process will be established during implementation of the approved FSAR, which will precede start of the hot commissioning portion of the operations phase. The USQ process will allow project management to make changes to the facility, the procedures, and the Authorization Basis documents; ..." In addition, establish a "USQ-like" process before the start of cold commissioning, and describe this process in a PSAR supplement on a schedule providing for adequate review by DOE, as committed to in response to Question LAW-PSAR-161. (See Section 3.17.2, Configuration Management, Item 5[a].)

3. Revise the last sentence of paragraph two in PSAR Volume I, Section 17.4.6, to read, "However, a USQ evaluation is required for a nonconforming or degraded condition if the resolution of the condition is to 'use as is' or 'repair.' A USQ evaluation would also be required for an interim compensatory action that is proposed to deal with the degraded or nonconforming condition as part of the disposition process," as committed to in response to Question LAW-PSAR-160. (See Section 3.17.2, Configuration Management, Item 5[b].)

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[3] Ibid 1.

4. Revise procedure 24590-WTP-GPP-SIND-001-0, *Reporting Occurrences in Accordance with DOE Order 232.1A,* to address hazards and activities for the cold commissioning phase before the start of the preoperational testing phase, as committed to in response to Question LAW-PCAR-037. (See Section 3.17.2, Incident Reporting and Investigation, Item 2).

Section 3.18 Fire Protection

Conditions of Acceptance – BNI must complete the following by the date or milestone indicated:

1. Have procedures in place as part of the March 1, 2003, implementation plan for the WTP fire protection program for performing periodic safety inspections; inspecting and tracking fire barrier penetration seals, doors, dampers, and related devices, as committed to in response to Question LAW-PSAR-218. (See Section 3.18.2, Item 1[b].)

2. Have procedures in place as part of the March 1, 2003, implementation plan for the WTP fire protection program for performing periodic evaluations of the overall WTP fire protection performance and for identifying and tracking fire safety issues, as committed to in response to Question LAW-PSAR-218. (See Section 3.18.2, Item 3[a].)

3. Fully implement the fire prevention program as part of the March 1, 2003, implementation plan for the WTP fire protection program; and revise the Non-Radiological Worker Health and Safety Plan to include the relevant fire protection requirements from Subparts F and J of 29 CFR 1926, "Safety and Health Regulations for Construction," to ensure that an adequate set of fire safety requirements are specified for work at the WTP construction site, as committed to in response to Question LAW-PSAR-215. (See Section 3.18.2, Item 3[c].)

4. Include in Chapter 2 of the HLW PFHA, with the first PSAR revision following authorization for full facility construction, the information on the ability to achieve and maintain a safe state after the loss of the melter offgas system components, as committed to in response to Question HLW-PFHA-037. (See Section 3.18.2, Item 5[c].)

Section 4.1.1 LAW Facility Description

Facility Description

Conditions of Acceptance – BNI must include the following provisions in the PSAR. Except for Item 6 below, these provisions should be provided with the first PSAR revision following authorization for full facility construction:

1. Include the evaluation of the aircraft impact on the LAW building and associated justification, as committed to in response to Question LAW-PSAR-153. (See Section 4.1.1.2, Facility Description, Item 3[f].)

2. Include the commitment to design anchorage using cracked concrete assumptions unless the structure is evaluated and determined to be uncracked, as committed to in response to Question LAW-PSAR-211. (See Section 4.1.1.2, Facility Description, Item 5[c].)

3. Include the methodology to be used for qualifying SDC equipment in the LAW facility, as committed to in response to Question LAW-PSAR-202. (See Section 4.1.1.2, Facility Description, Item 5[g].)

4. Design ITS piping in the LAW building to ASME B31.3, "Process Piping," occasional load criteria, and include this commitment in the PSAR, as committed to in response to Question LAW-PSAR-201. (See Section 4.1.1.2, Facility Description, Item 5[h].)

5. Designate two cranes in the vicinity of the offgas system as SDS SC-III for their seismic safety function to prevent crane components or the bridge from falling on the SDC offgas SSCs. To protect against damage from the third crane (RWH-CRN-00008), provide either a protective cage surrounding the offgas duct in the process area or, if a protective cage cannot be provided, designate the third crane also as SDS SC-III for its seismic safety function to protect the SDC offgas duct from falling crane components or the bridge, as committed to in response to Question LAW-PSAR-200. (See Section 4.1.1.2, Facility Description, Item 5[i].)

6. Provide, as committed to in response to Question LAW-PSAR-207, initial information (from ISM Cycle III) in the first PSAR revision and full information when the FSAR is submitted, for the following (see Section 4.1.1.2, Facility Description, Item 8):

   (a) A detailed analysis of control room habitability for the facility (including the LAW building) to demonstrate that there is adequate time to evaluate accident conditions, to perform mitigating actions required at the LAW facility to place the facility in a safe state, and to evacuate the LAW facility safely.

   (b) A systematic evaluation of ITS SSCs and non-ITS equipment that may impact ITS SSCs and an analysis of the LAW design to identify LAW ITS controls and indications that must be provided in the PT control room design to ensure that the LAW can be placed and maintained in a safe state following any DBEs.

7. Include the following commitment, as stated in response to Question LAW-PSAR-207: LAW SDC and SDS controls and indications provided in the PT control room that are required to place/maintain the LAW facility in a safe state following any DBEs will be independent of the integrated control network controls and indications and will be designed according to the standards in SRD Safety Criterion 4.3-4. (See Section 4.1.1.2, Facility Description, Item 8.)

Process Description

Conditions of Acceptance – BNI must include the following provisions in the first PSAR revision following authorization for full facility construction:

1. Include the radiological shielding function of the wet process cell walls as an ITS function in the event of a mis-feed of HLW to the LAW facility, as committed to in response to Question LAW-PCAR-098. (See Section 4.1.1.2, Process Description, Item 1.)

Section 4.1.2 LAW Facility Hazard and Accident Analysis

Two conditions of acceptance originally identified in Section 4.1.2, "LAW Facility Hazard and Accident Analysis," in Revision 1 of the SER, were completed:

1. Revise the design calculation report 24590-LAW-DBC-S13T-00005, *Thermal Analysis for Basemat and Pour Cave Walls*, to incorporate the results of the computational fluid dynamics analysis of the pour cave. The analysis must confirm that the concrete temperatures of the melter and pour caves could be maintained within design limits during the postulated glass spill and loss of cooling accident scenario. All structural calculations affected by the computational fluid dynamics analysis must be revised, as appropriate. These should be completed before authorization for full LAW facility construction. (COMPLETE) (See Section 4.1.2.2, Item 1.)

2. Complete hazard and accident analysis of internal flooding, including identification of control strategies required to protect the safety functions of the facility structure, assuming PSAR reference structural design, before the start of full LAW facility construction. (COMPLETE; superceded by Conditions [3] and [5] below) (See Section 4.1.2.2, Item 2.)

Conditions of Acceptance – BNI must complete the following actions, except for Item 5 below, with the first PSAR revision following authorization for full facility construction:

1. Correct the discrepancies related to the CSD records identification system used in SIPD and as referenced in the LAW and HLW PSAR texts and tables, as committed to in responses to Questions LAW-PSAR-069 and -169, and as agreed in authorization for construction for walls to grade. (See Section 4.1.2.2, Item 1.)

2. Include the analysis related to the mis-feed hazardous situation, identifying control strategies that include the provision of gamma monitor activated automatic valve closure as SDC SSCs in the PT facility to prevent the mis-feed to the LAW facility and to designate certain LAW process cell shield walls as SDS SSCs to mitigate the event, as committed to in responses to Questions LAW-PCAR-098 and LAW-PSAR-056. (See Section 4.1.2.2, Item 1.)

3. Include interim information on internal flooding events, as committed to in response to Question LAW-PSAR-036. (See Section 4.1.2.2, Item 2.)
4. Include the design features for mitigating potential for steam explosion in the LAW melter, and the results of the evaluation of the potential for water injection via wash water or feed nozzle cooling water, as committed to in response Question LAW-PSAR-064. (See Section 4.1.2.2, Item 2.)

5. Submit the internal flooding event hazard evaluation (for the preliminary design) to ORP for approval, and receive DOE approval, before start of construction of the nonstructural aspects of the LAW design expected to be credited as SDC or SDS SSCs for the internal flooding event, on a schedule mutually agreed to by ORP and BNI. (See Section 4.1.2.2, Item 2.)

6. Include the results of the offgas system evaluation for ammonium nitrate deposition potential, including what control strategies, if any, will be implemented to address concerns identified through this evaluation, as committed to in response to Question LAW-PSAR-113. (See Section 4.1.2.2, Item 2.)

7. Include that approximately 30 minutes after being on UPS system power, the plant would be evacuated, therefore eliminating the need for exhauster fans to protect the facility workers from NO_x release in the LAW facility, as committed to in response to Question LAW-PSAR-029. (See Section 4.1.2.2, Item 5.)

8. Correct the omission of additional safety functions for the basemat based on the seismic DBE event being SL-2 for the facility and co-located worker, the mis-feed event being SL-1 for the facility worker, and the liquid spill/overflow from the LAW concentrate receipt vessel being SL-2 for the facility worker as agreed in authorization agreement for walls to grade construction. (See Section 4.1.2.2, Item 8.)

Section 4.1.3 LAW Facility Important-to-Safety SSCs

Condition of Acceptance – BNI must complete the following with the first PSAR revision following authorization for full facility construction:

1. Include a complete list of RRC SSCs, with associated safety functions, as committed in its response to question LAW-PSAR-066. (See Section 4.1.3.2, Item 1.)

Section 4.2.1 HLW Facility Description

Facility Description

Two conditions of acceptance originally identified in the HLW PCAR SER, and in effect in the authorization basis, were completed:

1. Perform transient computational fluid dynamics analysis of the DBE 2700-L molten glass spill before authorization for full HLW facility construction. (COMPLETE) (See Section 4.2.1.2, Facility Description, Item 3[f][i].)

2. Provide the seventeen structural calculations that demonstrate structural design adequacy of HLW walls to grade as described in Section 4.2.1.2, Facility Description, Item 3(b) of this SER. (COMPLETE)

Conditions of Acceptance – BNI must complete the following by the date or milestone indicated:

1. Include an evaluation of the aircraft impact on the HLW building and associated justification, as committed to in response to Question LAW-PSAR-153, with the first PSAR revision following authorization for full facility construction. (See Section 4.2.1.2, Facility Description, Item 3[f][iii].)

2. Include the commitment to design anchorage using cracked concrete properties, as committed to in response to Question HLW-PSAR-256, with the first PSAR revision following authorization for full facility construction (See Section 4.2.1.2, Facility Description, Item 4.)

3. Include information on the analysis of the potential effects on ventilation and air-cleaning SSCs of common-cause external events, including volcanic ashfall, in the first PSAR revision following completion of the analysis and in the FSAR, as committed to in response to Question PT-PSAR-257. (See Section 4.2.1.2, Facility Description, Item 7.)

4. Provide, as committed to in the response to Question HLW-PSAR-224, initial information (from ISM Cycle III) in the first PSAR revision and full information when the FSAR is submitted, the following (see Section 4.2.1.2, Facility Description, Item 8):

   (a) A detailed analysis of control room habitability for the facility (including the HLW building) to demonstrate that there is adequate time to evaluate accident conditions, to perform mitigating actions required at the HLW facility to place the facility in a safe state, and to evacuate the HLW facility safely.

   (b) A systematic evaluation of ITS SSCs and non-ITS equipment that may impact ITS SSCs and an analysis of the HLW design to identify HLW ITS controls and indications that must be provided in the PT control room design to ensure that the HLW can be placed and maintained in a safe state following any DBEs.

5. Include the following commitment in the first PSAR revision following authorization for full facility construction, as stated in the response to Question HLW-PSAR-224: HLW SDC and SDS controls and indications provided in the PT control room that are required to place/maintain the HLW facility in a safe state following any DBEs will be independent of the integrated control network controls and indications and will be designed according to the standards in SRD Safety Criterion 4.3-4. (See Section 4.2.1.2, Facility Description, Item 8.)

Process Description

Conditions of Acceptance – One condition of acceptance originally identified in the HLW PCAR SER and in effect in the authorization basis, was completed:

1. Revise the design drawings that were used to support the hazard and accidental analysis of the embedded C5 ventilation ductwork to reflect the configuration used in the accident analysis with the first PSAR revision following authorization for full facility construction. (COMPLETE) (See Section 4.2.1.2, Process Description, Item 5)

Conditions of Acceptance – BNI must complete the following in the first PSAR revision following authorization for full facility construction:

1. Include information on monitoring vessel vent and overflow lines to ensure their functionality, as committed to in response to Question HLW-PSAR-010. (See Section 4.2.1.2, Process Description, Item 4.)

2. Revise HLW PSAR Tables 3-3, 3-4, and 3-5 to eliminate shortcomings in the chemical compatibility assessments identified by the reviewers, as committed to in the response to Question HLW-PSAR-017. (See Section 4.2.1.2, Process Description, Item 9.)

Section 4.2.2 HLW Facility Hazard and Accident Analysis

Two conditions of acceptance originally identified in the SER for the walls to grade were completed and one remains open:[4]

1. Correct the discrepancies between the CSD records in Appendix A and the HLW PCAR and PSAR text and tables, as committed to in responses to Questions LAW-PSAR-069 and -169 and as agreed to in authorization for construction of HLW walls to grade. (See Section 4.2.2.2, Item 1.) (OPEN – must be closed as part of the first PSAR revision following authorization for full facility construction.)

2. Provide the DBE analysis of the 2700-L molten glass spill accident. (COMPLETE)

3. Complete hazard and accident analysis of internal flooding, including identification of control strategies required to protect the safety functions of the facility structure, assuming PCAR and PSAR reference structural design, before the start of full HLW facility construction. (COMPLETE; superceded by conditions 4 and 5 below)

Conditions of Acceptance – BNI must complete the following with the first PSAR revision following the authorization for full facility construction (except as noted in Items 5 and 13 below):

1. Analyze the potential for ammonia in the HLW feed to be released from the liquid phase into the gaseous phase, reaching a flammable concentration and igniting, as committed to in response to Question HLW-PSAR-240. (See Section 4.2.2.2, Item 1.)

2. Include the results of the offgas system evaluation for ammonium nitrate deposition potential, including the control strategies, if any, that will be implemented to address concerns identified through this evaluation, as committed to in response to Question HLW-PSAR-024. (See Section 4.2.2.2, Item 1.)

[4] The HLW walls to grade SER condition of acceptance (condition [2]) – submit an evaluation of the combined effects of seismically induced radiological releases from the PT, LAW, and HLW buildings on the workers, co-located workers, and the public through a seismic probabilistic risk analysis study – is addressed in Section 4.6 of this SER.

3. Include information on overflow events involving submerged bed scrubber condensate vessels, including control strategies, as committed to in response to Question HLW-PSAR-127. (See Section 4.2.2.2, Item 1.)

4. Include interim information on internal flooding events, as committed to in response to Question HLW-PSAR-003. (See Section 4.2.2.2, Item 2[a].)

5. Submit the internal flooding event hazard evaluation (for the preliminary design) to ORP for approval, and receive DOE approval, before start of construction of the nonstructural aspects of the HLW design expected to be credited as SDC or SDS SSCs for the internal flooding event, on a schedule mutually agreed to by ORP and BNI. (See Section 4.2.2.2, Item 2[a].)

6. Revise Section 4.4.4 to explicitly address all incoming feeds as sources to the concentrate receipt tank that may result in vessel overflow events, as committed to in response to Question HLW-PSAR-188. (See Section 4.2.2.2, Item 2[a].)

7. Perform a sensitivity study to compare respirable releases from a crack to an orifice and revise the calculations and PSAR, as necessary, as committed to in response to Question HLW-PSAR-128. (See Section 4.2.2.2, Item 3.)

8. Reanalyze the hydrogen generation deflagration DBE and the PSAR based on reevaluation of the hydrogen correlation used in the event analysis, as committed to in response to Question HLW-PSAR-235. (See Section 4.2.2.2, Item 3[a].)

9. Revise the PSAR to show that the HLW melter shell will be qualified to SC-II, as committed to in response to Question HLW-PSAR-150. (See Section 4.2.2.2, Item 3[b].)

10. Remove the 6600-L molten glass spill as a DBE from PSAR Section 3.4.1.4, as committed to in response to Question HLW-PSAR-253. (See Section 4.2.2.2, Item 3[b].)

11. Include a description of the 2700-L molten glass spill event and associated control strategies, as committed to in responses to Questions HLW-PCAR-012 and HLW-PSAR-191. (See Section 4.2.2.2, Item 3[b].)

12. Revise 24590-HLW-Z0C-W14T-00013, *Revised Severity Level Calculations for the HLW Facility*, and 24590-HLW-Z0C-H01T-00001, *Design Basis Event – HLW Process Vessel Hydrogen Deflagrations*, to more conservatively account for the radiolytic affects (i.e., the concentrations of the nitrate/nitrite ions by using Equation 2-3 from RPT-W375-SA00002, *Topical Report on the Management of Risks Posed by Explosive Hazards Present at the RPP-WTP*, rather than Equation 2-2) and the thermolytic affects (i.e., by establishing design air purge flow rates through vessel head spaces using an activation energy, E_a, of 100 kJ/mole [vs. 91 kJ/mole and assuming the vessels are at 220°F). This was committed to in response to Questions HLW-PSAR-235 and PT-PSAR-336. (See Section 4.2.2.2, Item 4[b].)

13. Re-evaluate transportation events as part of the control room habitability evaluations and include initial results of this HLW evaluation in the first PSAR revision following authorization for full facility construction and include final results in the FSAR. This was committed to in response to Question PT-PSAR-204. (See Section 4.2.2.2, Item 6[c][vi].

Section 4.2.3 HLW Facility Important-to-Safety SSCs

Conditions of Acceptance – BNI must complete the following with the first PSAR revision following the authorization for full facility construction:

1. Include a complete list of RRC SSCs, with associated safety functions, as committed to in responses to Questions HLW-PSAR-039, -170, -213, -250, -251, and -252. (See Sections 4.2.3.2, Item 1.)

2. Correct the information in the PSAR on the safety functions of the high-high level interlocks, quality of instrument air, design of the Hydrogen Mitigation System to meet the single failure criteria of SRD, Appendix A, the design of the C5 ventilation system for wind effects, and the seismic qualification (SC-I) of the smoke/fire dampers. This was committed to in responses to Questions HLW-PSAR-051, -098, -120, -184, -189, -190, -228, and -229. (See Section 4.2.3.2, Item 2.)

3. Correct the information in the PSAR on the functional requirements for the canister handling crane and grapple, immobilized HLW cask, impact absorbers, and HEPA filter preheaters, as committed to in responses to Questions HLW-PSAR-023, -058, -059, and -099. (See Section 4.2.3.2, Item 4.)

Section 4.3.1 PT Facility Description

Facility Description

Conditions of Acceptance – BNI must complete the following actions and obtain DOE acceptance of the information provided as conditions of acceptance before DOE authorization of PT subsurface pits, tunnels, and basemat structural concrete placement:

1. Develop a structural design evaluation summary table, as committed to in response to Question PT-PSAR-227. (See Section 4.3.1.2, Item 3[b].)

2. From the preliminary SSI analysis results, for each wall and horizontal seismic motion, tabulate (a) the in-plane shear force in the direction of the length of the wall, (b) the maximum in-plane shear stress in the direction of the length of the wall, and (c) maximum out-of-plane bending moments, one about the horizontal axis and one about the vertical axis.
Compare the out-of-plane bending moments in the subsurface walls from the preliminary SSI analysis for the horizontal seismic motions with those from the GTSTRUDL analysis of the PT building. The applied dynamic soil pressure is based on ASCE 4-98. These

were committed to in responses to Questions PT-PSAR-227. (See Section 4.3.1.2, Item 3[d].)

3. Modify the design moments and shear forces in calculation report 24590-PTF-DGC-S13T-00002, *Design of Pits, Foundations and Below Grade Walls for PT Building*, using a method similar to that used in the HLW facility design. Include this effect on demand-to-capacity ratios in the structural design evaluation summary. These commitments were provided in the responses to Questions PT-PSAR-227 and -231. (See Section 4.3.1.2, Item 3[d].)

4. Include both through-thickness thermal loads and thermal growth loads in design calculations and provide justification for not considering all load combinations, as committed to in responses to Questions PT-PSAR-225, -226, and -227. (See Section 4.3.1.2, Item 3[g].)

5. Provide a code requirement interpretation for shear wall design limits that would provide a basis for concluding that the shear forces were acceptable using ACI 349-01, as committed to in response to Question PT-PSAR-227. (See Section 4.3.1.2, Item 4.)

BNI must complete the following commitment before full PT facility construction authorization:

1. Perform a revised seismic SSI analysis based on the revised building layout in which lateral dynamic soil pressure will be calculated directly for a few critical below grade walls using soil pressure elements in the SASSI model. If soil pressure is not obtained directly from the revised SSI analyses, the SASSI-generated moment results will be used to estimate the lateral dynamic soil pressure. This was committed to in responses to Questions PT-PSAR-224 and -227. (See Section 4.3.1.2, Item 3[d].)

Section 4.3.2 PT Facility Hazard and Accident Analysis

Conditions of Acceptance – BNI must complete the following activity during the ISM Cycle III process:

1. Perform hazard analysis for water hammer, as committed to in response to Question PT-PSAR-276 (see Section 4.3.2.2, item 1), and consider water hammer loads in the design of piping supports.

BNI must also include the following revisions in the first PSAR revision following authorization for full facility construction:

1. Update PSAR Volume II Appendix B, C, and D. Tables B-1, C-1, and D-1, to correctly identify early authorization bounding hazardous conditions and safety case requirements, as committed to in response to Question PT-PSAR-335. (See Section 4.3.2.2, item 3.)

2. Correct inconsistencies in safety case requirements and CSD combinations between 24590-PTF-ESH-02-002, *Design Basis Event Selection for PTF PSAR*, and the PSAR, as committed to in response to Question PT-PSAR-327. (See Section 4.3.2.2, Item 6.)

Section 4.4.1 BOF Facility Description

Facility Description

Conditions of Acceptance – BNI must complete the following actions in the first PSAR revision following authorization for full facility construction:

1. As discussed in Section 4.4.1.2, Facility Description, Item 6:

   (a) Provide the electrical design basis for the ITS electrical ductbank, as committed to in response to Question BOF-PSAR-007.

   (b) Clarify the design basis for ITS monitoring and control circuits in the ITS electrical ductbank, as committed to in response to Question BOF-PSAR-006.

   (c) Provide a description of the system for starting EDGs, as committed to in response to Question BOF-PSAR-008.

Process Description

Conditions of Acceptance – BNI must complete the following actions in the first PSAR revision following authorization for full facility construction:

1. Describe application of the single failure criterion to the nitric acid monitor as committed to in response to Question BOF-PSAR-005. (See Section 4.4.1.2, Process Description, Item 6.)

2. Delete the ITS sodium permanganate monitor as committed to in response to Question BOF-PSAR-005. (See Section 4.4.1.2, Process Description, Item 7.)

Section 4.4.2 BOF Hazard and Accident Analysis

Conditions of acceptance – BNI must complete the following actions in the first PSAR revision following authorization for full facility construction:

1. Correct CSD and safety case requirement identification numbers in the PSAR and referenced documents, as committed to in response to Question BOF-PSAR-010. (See Section 4.4.2.2, Item 1.)

2. Analyze the potential effects of a design basis ashfall event and provide controls, as committed to in response to Question PT-PSAR-204. (See Section 4.4.2.2, Item 1.)

Section 4.4.3 BOF Important-to-Safety SSCs

Conditions of Acceptance – BNI must complete the following action in the first PSAR revision following authorization for full facility construction:

1. Correct RRC SSC identification errors between Volume II, IV, and V of the PSAR, as committed to in response to Question BOF-PSAR-016. (See Section 4.4.3.2, Item 1.)

Section 4.6 Safety Basis/Conformance with Facility Risk Goals

Conditions of Acceptance – BNI must complete the following actions as conditions of acceptance of the LAW and HLW PSARs, by the date or milestone indicated:

1. Complete the seismic probabilistic risk analysis, demonstrating compliance to the radiation exposure standards of SRD Safety Criterion 2.0-1 (excluding the Analytical Laboratory). This must be completed before authorization for full facility construction as committed to in the Authorization Agreement for HLW and LAW walls to grade construction authorization. (See Section 4.6.2, Item 1.)

2. Include in the first PSAR revision following authorization for full facility construction, a table of risk dominant events for the LAW facility, as committed to in response to Question LAW-PSAR-168. (See Section 4.6.2, Item 2.)
3. Submit an update of the operations risk assessment, using the latest available SIPD entries consistent with the LAW, HLW, PT, and BOF facility designs, to document a fully integrated facility-wide analysis that will include LAW, HLW, PT, and BOF facilities before full facility construction authorization, as committed to in response to Question HLW-PSAR-206. (See Section 4.6.2, Item 1.)

Section 6.3.2 SRD and ISMP Acceptability and Compliance

Conditions of Acceptance – BNI must complete the following by the date or milestone indicated:

1. BNI will implement the corrective actions specified in Attachment 2, "Assessment of the Effect of Design Process Implementation Issues on Construction Authorization Readiness," to the BNI letter dated October 30, 2002.[5] These corrective actions must be completed by the dates provided in the letter.

[5] BNI letter from R. F. Naventi to R. J Schepens, ORP, "Hanford Tank Waste Treatment and Immobilization Plant – Construction Authorization Readiness in Consideration of Recent Assessments and Inspections of Engineering Activities," CCN: 042775, dated October 30, 2002.

Construction Authorization Request Review Team Education and Experience

Review Team Member	Education and Experience	Areas of Review				
		LAW	HLW	PT	BOF	Anal. Lab
George Abatt	B.S. and M.S., Engineering Mechanics, Michigan State University; Ph.D., Theoretical and Applied Mechanics, University of Illinois at Urbana-Champaign. Over 13 years experience in structural analysis seismic analysis, soil-structure interaction analysis, dynamics, and finite element analysis of structures.		X			
Jim Adams	B.S., Nuclear Engineering, Texas A&M University. Over 30 years experience related to nuclear operations and oversight of nuclear operations. Qualified as an ANSI Level III Test Engineer and a Senior Reactor Operator. Expertise in conduct of operations.	X	X			
Mike Black	B.S., Geological Engineering, University of Idaho. Over 28 years experience in ground support and excavation, including both mining and civil applications. Experience with drill and blast, ripping, scrapers, power shovels, and front-end loaders on jobs ranging from striping operations for open pit mining to basement excavations for residential homes.					
Jay Boudreau	Ph. D., Engineering, University of California at Los Angeles. Over 30 years experience in nuclear reactor design, safety, fuel cycle technology and economics, waste management, and mission and systems analysis for NASA and the U.S. Department of Defense (DOD) nuclear power applications (terrestrial and space). Instrumental in helping the OSR establish and implement the WTP regulatory program.	X	X	X		
Pat Carier	B.S., Mechanical Engineering, Penn State University; Master's in Management, University of Phoenix. OSR Verification and Confirmation Official. Senior reactor operator certification; QA training and facilitating. More than 16 years experience in nuclear power licensing and system integration, regulatory affairs, and QA.					
Bruce Carpenter	B.S., Architectural Engineering, University of Colorado; M.S., Civil Engineering, Structures, Stanford University. Registered professional engineer with over 15 years experience on commercial and DOE projects. Expertise in structural engineering and seismic design for structural steel and reinforced concrete.			X		
Ko Chen	B.S., Chemical Engineering, National Taiwan University; Ph.D., Mechanical Engineering, University of California Berkeley. Licensed mechanical engineer. More than 20 years experience in nuclear safety, fluid mechanics, mass transfer, and heat transfer.	X	X	X		
Tony Chung	B.S.M.E., Taiwan Chung-Hsing University, M.S.M.E., Washington State University. Licensed structural engineer. Over 25 years engineering experience, including over 17 years in structural and thermal analysis.	X	X			

Review Team Member	Education and Experience	Areas of Review				
		LAW	HLW	PT	BOF	Anal. Lab
Dick Cooper	B.S. Marine Engineering, U.S. Naval Academy, Masters Program (non-degreed), Radiation Health Physics, Georgetown University. QA lead auditor certification through Consolidated Edison. Over 30 years experience in nuclear power, including constructing, designing, operating, regulating, and providing safety oversight. Over 13 years with the NRC.	X	X			
James Cunnane	Ph.D., Nuclear Radiochemistry, Purdue University. Over 20 years experience in radioactive waste processing, evaluation of waste forms, vitrification of radioactive wastes, and radiochemistry.		X			
Dean Davis	B.S., University of Montana. Certified professional engineer in fire protection. Over 45 years experience in fire protection, including 14 years with DOE Richland Operations, and 15 years as Chief, Fire Protection, U.S. Army, Europe.	X	X	X		
Bob Defayette	B.A., Chemistry, St. Ambrose College; M.S., Physical Chemistry, Iowa State University. Over 35 years experience in the nuclear field with the NRC, DOE, and nuclear utilities. Extensive experience in assessing operational performance, QA programs, employee safety concerns, corrective action programs, and emergency preparedness.	X	X			
Richard Evans	B.A., Mathematics, Pomona College; B.S., Air Conditioning and Refrigeration, California Polytechnic Institute. Licensed professional engineer. Over 40 years experience in HVAC design and engineering, control systems, and mechanical systems.			X		
Vic Ferrarini	B.S.M.E., University of Massachusetts at Dartmouth; M.S.M.E., University of Rhode Island. Registered professional engineer. Over 30 years experience in designing, analyzing, inspecting and auditing piping, pipe supports, pressure vessels, valves, pumps, and other mechanical components, including heat transfer and fatigue analysis of ASME (American Society of Mechanical Engineers) Class I components.	X	X			
Rick Garrison	B.S., Electrical Engineering, Washington State University. More than 17 years experience in systems engineering, design, installation, startup, operations, and maintenance of instrumentation, control, power, and data management systems at DOD and DOE facilities.		X			
Yvonne Gibbons	B.S., Civil Engineering, Arizona State University; M.S., Civil Engineering, Old Dominion University. More than 10 years experience in foundation design, geotechnical investigations and analysis, environmental investigations and analysis, slope stability analysis, and seismic analysis.					
Rob Gilbert	B.S., Metallurgical Engineering, University of Washington. Five years nuclear Navy and 10 years experience in waste vitrification technology and design, Hanford tank waste storage and treatment system design, and pressure vessel steel material performance.	X	X	X		

Review Team Member	Education and Experience	Areas of Review				
		LAW	HLW	PT	BOF	Anal. Lab
Robert Griffith	B.S., Mechanical Engineering, University of Arizona; M.S., Mechanical Engineering, Stanford University. Registered professional engineer. More than 26 years experience in systems engineering, licensing support, safety engineering, and environmental qualification at DOE, commercial power plants, and the Savannah River Site.		X			
Ann Hansen	B.S., Mathematics and Physics, Florida Southern College; M.S., Physics, Virginia Polytechnic Institute; M.S., Nuclear Engineering, Carnegie Mellon University. Over 25 years experience in hazard and accident analyses, safety analysis report development, and technical safety requirement development and analysis.	X	X	X		
Al Hawkins	B.S., Chemical Engineering, University of Washington; MBA, Operations Research, Washington State University. OSR Openness Coordinator. More than 27 years experience in operations, oversight, safety, and QA. Former manager of Compliance Assurance and Director of Environment, Safety, Health and Quality Assurance at NRC.	X	X			
Quazi Hossain	B.S., Civil Engineering, Bangladesh University of Engineering & Technology; M.S., Structural Engineering, Texas A&M University; Ph.D., Structural Engineering, University of California, Davis. Licensed civil engineer. Fellow, American Society of Civil Engineers. Over 35 years experience in structural and seismic engineering, safety system classification, and safety design and analysis.	X	X	X		
Neal Hunemuller	B.S., Nuclear Engineering, Iowa State University. Certified NRC Operator Licensing Examiner; Licensed NRC senior operator; NRC-certified incident investigation team member. More than 20 years experience in commercial nuclear power and the NRC. Expertise in standards identification process, conformance/compliance reviews, and training and qualifications.	X				
Ninu Kaushal	B.A., B.S., and M.S. in Physics, Punjab University; MBA, Northern Illinois University; Ph.D., Nuclear Physics, Rensselaer Polytechnic Institute. More than 20 years experience in the commercial nuclear industry in nuclear physics, nuclear safety evaluations, nuclear criticality, electrical design, and instrument and controls; 10 years experience in nuclear research applying state-of-the-art instrumentation techniques.	X				
Bill Kennedy	B.S., Nuclear Engineering, Kansas State University; M.S., Nuclear Engineering, Kansas State University. Over 25 years experience in environmental and health physics. Nationally and internationally recognized expert in environmental radiological controls, environmental assessment, environmental regulations, radiation dosimetry, environmental pathway analysis, safety assessment and risk analysis, radiation shielding, health physics, and statistical analysis.	X	X			

Review Team Member	Education and Experience	Areas of Review				
		LAW	HLW	PT	BOF	Anal. Lab
Dennis Kirsch	B.S. and M.S., Electrical Engineering, Montana State University. Registered Professional Engineer. More than 23 years with the NRC including position as Division Director of Reactor Safety and Projects; 5 years commercial experience. Expertise in mechanical and electrical construction inspection, power reactor operations, QA, and preoperational testing of mechanical and electrical systems.					
James Leivo	B.S., Electrical Engineering, Carnegie-Mellon University. Registered professional engineer. Over 30 years experience in the nuclear power industry and related energy systems, including instrumentation, control, and electrical and computer systems for nuclear power plants and DOE facilities. Has provided independent consulting services to NRC for operating, pre-operating, and advanced reactor plants.			X		
Ron Lerch	B.A., Chemistry, Pacific Lutheran University; Ph.D., Inorganic Chemistry, Oregon State University. More than 30 years experience in nuclear waste management, nuclear technology development, nuclear fuel reprocessing, environmental cleanup, and project management; 2 years as Deputy Manager of Hanford tank farms.	X	X	X		
Barclay Lew	B.A., Mathematics, and B.S., Nuclear Engineering, University of California, Santa Barbara; M.S., Engineering; Ph.D., Nuclear Engineering, UCLA. Over 28 years experience in nuclear safety analysis, heat transfer, mass transfer and fluid flow, computational fluid dynamics, and analysis of safety analysis reports.	X	X	X		
Ron Light	B.A., Mathematics, and M.B.A., University of South Dakota. Over 30 years of experience in management systems, business management, program controls, and financial management. Regulatory process administrator in OSR.	X				
Chung-King Liu	B.S., Zoology, Fu-Jen Catholic University (Taiwan); M.S., Chemistry, Kansas State College - Pittsburgh; Ph.D., Nuclear Radiochemistry, University of Arkansas. NQA-1 lead nuclear auditor. Over 23 years experience in nuclear waste management, radiochemistry laboratory management, and environmental cleanup. Expertise in the areas of chemical process safety, nuclear process safety, and health physics.	X	X	X		
Surya Maruvada	Master of Engineering, Electrical Power Engineering/Indian Institute of Science. Licensed professional engineer. Over 30 years experience in nuclear safety and hazard analyses, probabilistic risk assessment, responsibility assignment matrix analyses, and electrical power and control systems.	X	X	X		

Review Team Member	Education and Experience	Areas of Review				
		LAW	HLW	PT	BOF	Anal. Lab
Omar Mazzoni	B.S., Electrical Engineering/Mechanical Engineering, National Litoral University (Argentina); M.S., Electrical Engineering, Polytechnic Institute of Brooklyn; D.Sc. Electrical Engineering, George Washington University. Certified professional engineer. Over 30 years experience in electrical engineering, high- and low-voltage power, instrumentation and control, and functional design reviews.					
Steve Merwin	B.S., Environmental Engineering, Northwestern University; M.S., Health Physics, Colorado State University. Certified health physicist and certified industrial hygienist. Over 15 years experience in health physics, risk assessment, and accident analysis.			X		
Ellen Messer-Wright	B.S., Electrical Engineering, University of New Mexico; M.S., Environmental Science, Washington State University. Certified health physicist. Over 10 years experience in occupational radiation protection, ALARA, and radiological compliance assessments.	X	X	X		
Milon Meyer	B.S., Mechanical Engineering, University of Iowa. Over 35 years experience in structural analysis, equipment qualification, and finite element analysis related to nuclear, gas turbine, rockets, and aerospace.	X	X	X		
Lew Miller	B.S., Physics, Massachusetts Institute of Technology; M.S., Nuclear Engineering Science, University of California, Berkeley. OSR Safety and Standards Review Official. Certified license examiner, senior resident inspector. More than 29 years experience with the nuclear Navy and the NRC. Expertise in nuclear safety oversight, safety analysis reviews assessments, and incident investigations.	X	X	X	X	
Matt Moeller	A.B., Mathematics, Cornell University; M.S., Environmental Health Physics, Harvard University. Certified health physicist. Over 20 years experience in health physics, radiation protection, industrial safety and hygiene, risk assessment, and emergency preparedness.	X	X	X		
Joe Panchison	B.S., Mechanical Engineering, Drexel University. Licensed professional engineer. Over 23 years experience in mechanical engineering design, thermal hydraulic analysis, fluid systems analysis, HVAC, power piping, and nuclear component codes and standards. Direct experience in plant modifications and configuration management.		X	X		
Keith Parkinson	B.S., Electrical Engineering, Purdue University. Certified reactor operator. Over 35 years experience in the nuclear field, including 24 years in the nuclear Navy and 10 years as an NRC inspector and NRC operator license examiner. Expertise in training, fire protection, operations, and electrical distribution systems.	X	X			
Walter Pasciak	B.S., Physics, New York University; M.S., Nuclear Engineering, The Catholic University of America; Ph.D., Environmental Engineering, John Hopkins University. Over 28 years experience in nuclear power involving environmental, radiological, and safety oversight; 27 years with the NRC.					

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		LAW	HLW	PT	BOF	Anal. Lab
Michael Plunkett	B.S.M.E., Mechanical Engineering, University of New Haven; M.S.M.E., Mechanical Engineering, University of Rhode Island. Licensed professional engineer. Over 29 years experience in designing, analyzing, inspecting, and auditing piping, pipe supports and other mechanical components in the power industry, fire protection, and NRC audits.	X	X			
Jeanie Polehn	B.S., Nuclear Engineering Technology, Oregon State University; M.S., Health Physics, Georgia Institute of Technology. Certified health physicist. Registered Environmental Manager. More than 20 years experience in radiation protection including occupational, environmental, and emergency response at commercial power plants and with DOE.	X	X	X		
Ross Potter	B.S., Nuclear Engineering, University of New Haven; M.S.M.E., Mechanical Engineering, University of Rhode Island. Licensed professional engineer. Over 29 years experience in designing, analyzing, inspecting, and auditing piping, pipe support, and other mechanical components in the power industry, fire protection, and NRC audits.	X	X	X		
Gerald Ritter	B.A., Chemistry, Pacific Lutheran University; B.S., Chemical Engineering, University of Washington; M.S., Chemical Engineering, University of California, Berkeley. Over 33 years experience in nuclear fuel fabrication and processing, nuclear waste management, and preparation and evaluation of safety analysis reports			X		
Grant Ryan	B.S., Physics, Frostburg State University; B.S., Nuclear Engineering, University of Maryland. Licensed professional engineer. Over 11 years experience in probabilistic risk analysis, radiological and toxicological consequence analysis, hazard analysis, and control selection methodologies.		X	X		
Jean Savy	Ph.D., Civil-Geophysics, Stanford University. Licensed civil engineer. Over 25 years experience in hazard analyses, risk analyses, and structural safety. Experience in seismic, tornado, and flood methodology development for probabilistic analyses.					
Ken Scown	B.S., Management Science, California State University, Hayward. Over 18 years nuclear fire protection auditing and consulting, including inspections for fire protection, emergency planning, and security. Worked 7 years fighting fires, servicing equipment, and training fire fighters; worked 6 years as a health and safety technician.	X	X			
Vern Severud	B.S., Civil Engineering, California State University-Chico; M.S., Civil Engineering, University of Arizona. Licensed professional engineer. Fellow of American Society of Mechanical Engineers. Over 40 years experience in seismic design and analysis, and elevated temperature design and analysis.	X	X			

Review Team Member	Education and Experience	Areas of Review				
		LAW	HLW	PT	BOF	Anal. Lab
William Sherbin	B.S., Mechanical Engineering, Bucknell University; M.S., Mechanical Engineering, University of Maryland. Registered professional engineer. Over 30 years experience in heat exchange, fluid systems, ventilation systems, and seismic design requirements. Participant in over 40 nuclear power plant safety system functional inspections.		X			
Michael Shlyamberg	B.S.M.E., Polytechnic Institute, Lvov, USSR. Registered professional engineer. Over 20 years experience in design of nuclear safety support systems, thermal hydraulic calculations, safety evaluations, containment analysis, and preparation of safety analysis reports. Participant in over 45 NRC inspections and utility assessments.					
Bob Smoter	U.S. Navy Nuclear Power School. Over 20 years experience in commercial and DOE nuclear regulatory development, safety analysis reports, licensing, project management, and nuclear plant operations and maintenance.	X	X			
Allan Stalker	B.S., Chemistry, Idaho State University; M.S., Chemistry, Carnegie Institute of Technology; Ph.D., Chemistry, Carnegie-Mellon University. Over 40 years experience in the nuclear industry with expertise in nuclear chemistry, nuclear safety, spectroscopy, hazardous chemical analysis, and safety analyses.		X			
Robin Sullivan	B.S., Mechanical Engineering, University of Washington. Over 10 years experience in hazard analysis, risk assessment, safety licensing review, authorization basis development and maintenance, and regulatory compliance reviews.		X			
Mark Summers	B.S., Civil Engineering, Walla Walla College; M.S., Civil Engineering, Oklahoma State University. Over 21 years experience in structural engineering on various U.S. Army Corp of Engineer projects.	X	X			
John Swanson	B.A., Chemistry, Reed College. Over 50 years Hanford experience in nuclear process technology, fuel reprocessing, solvent extraction chemistry, ion exchange, radiochemistry, and nuclear waste processing.					
Cindy Taylor	B.A., Business Management, Eckerd College; M.B.A., Engineering Management and Technology, City University. ANSI/ASME NQA-1 lead auditor. Over 13 years experience in QA program development and project management. QA support to DOE, NRC, OCRWM, and DOD-regulated projects.	X	X			
Susan Thraen	B.S., Nuclear Engineering, Pennsylvania State University. Over 17 years experience, including 6 with the NRC in regulatory process, nuclear facility design, construction, and operations. Expertise in safety analysis, radiation protection, emergency preparedness, regulatory compliance, and conduct of operations.	X	X	X		

Review Team Member	Education and Experience	Areas of Review				
		LAW	HLW	PT	BOF	Anal. Lab
Russ Treat	B.S., Chemical Engineering, Washington State University. Over 30 years experience in chemical and process engineering including nuclear waste management, processing of nuclear waste, and development of waste vitrification processes.			X		
James Troske	B.S., Electrical Engineering, Gonzaga University; M.S., Electrical Engineering, Montana State University. Licensed professional engineer. Over 30 years experience in electrical and control system engineering.		X			
Brian Vonderfecht	Ph. D., Nuclear Physics, Washington University. Over 11 years nuclear experience in the areas of nuclear criticality safety, accident analysis, probabilistic risk analysis, radiation shielding, and nuclear physics. Expertise in thermal-hydraulics, heat-transfer, diffusion, and chemical or thermal explosions.	X	X	X		
Frank Wenslawski	B.A., Physics, Rutgers University. Over 35 years of nuclear experience, including various management assignments in the U.S. Atomic Energy Commission, DOE, NRC, and the International Atomic Energy Agency. Expertise in radiation protection and emergency preparedness.					
Bob Winkel	B.S. and M.S., Civil Engineering, Brigham Young University; Ph.D., Structural Engineering, University of Colorado. Registered professional engineer. Over 31 years experience in structural analysis and evaluation of nuclear structures and equipment using American Society of Mechanical Engineers, American Institute for Steel Construction, and ACI engineering design codes.	X	X			
Joe Yedidia	B.S., Mechanical Engineering, Israel Institute of Technology; M.S., Nuclear Science, Israel Institute of Technology; MBA, University of Pittsburgh. Over 30 years experience in spent fuel systems, reactor utility requirements, liquid metal reactor development, and mechanical and fluid reactor systems.		X			
Jonathan Young	B.A., Mathematics, Lincoln University. Over 30 years experience in systems and safety engineering, safety analysis, probabilistic safety assessment, and system security activities in the aerospace and nuclear industries. Principal instructor and course developer for numerous probabilistic safety assessment courses, both in the United States and abroad.			X		
Greg Yuhas	B.A., Management, St Mary's of California. National Registry of Radiation Protection Technologists. Over 24 years experience in radiation safety, including 17 years with the NRC and 3 years with DOE. Expertise in occupational radiation safety, effluent and environmental monitoring, and decommissioning.	X	X			