DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Washington, DC 20004-2901

August 6, 2010

The Honorable Daniel B. Poneman
Deputy Secretary of Energy
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-1000

Dear Deputy Secretary Poneman:

The Defense Nuclear Facilities Safety Board (Board) recently scheduled a public meeting and hearing concerning safety-related aspects of the design and construction of the Department of Energy's (DOE) Waste Treatment and Immobilization Plant (WTP) at the Hanford Site. Starting in Fiscal Year 2009, DOE made major changes to the WTP design philosophy and design, including the safety approach. The changes included reductions in the assumed radioactivity of the waste due to radioactive decay, and more realistic assumptions about the waste feed. The Board has worked closely with DOE and its contractors to follow the design changes as they have evolved during the past two years. During this period, the Board raised a number of concerns regarding the design and safety strategy, summarized in recent correspondence.[1, 2, 3, 4]

DOE has advised the Board that it is transitioning the WTP from Design/Construction to Construction/Commissioning ("pivoting the project") and concurrently finalizing resolution to open technical issues or developing a clearly defined path forward to achieve resolution. Consistent with the Board's statutory obligations, the public meeting and hearing will provide the Board the opportunity to obtain the information it needs to advise the Secretary appropriately to ensure adequate protection of public health and safety. Technical issues to be discussed include: (1) changes in safety-related design criteria resulting from modification of the material-at-risk, (2) changes in design strategy to address hydrogen in pipes and ancillary vessels, (3) criticality safety concerns and other safety-related risks for the pulse jet mixing system, (4) reclassification of safety-related systems, structures, and components, and (5) safety-related design aspects of new facilities or modifications of existing facilities needed to deliver high-level waste feed. The meeting and hearing will take place October 7–8, 2010.

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[1] January 6, 2010, letter to the Assistant Secretary for Environmental Management (EM-1).
[2] May 5, 2010, letter to the Assistant Secretary for Environmental Management (EM-1).
[3] May 21, 2010, letter to the Under Secretary of Energy and the Chief, Health, Safety and Security Officer.
[4] April 15, 2010 (most recent), Quarterly Report to Congress on the Status of Significant Unresolved Issues with the Department of Energy's Design and Construction Projects.

The Board has prepared the enclosed list of questions to establish the final agenda and determine the list of desired witnesses for the upcoming meeting and hearing. The author or authors of each answer should be identified by name, affiliation, and title. Responses to these questions will be entered into the record of the meeting and hearing as if read and posted on the Board's internet website (www.dnfsb.gov) prior to the meeting and hearing. The questions outline the areas of interest to the Board and are calculated to foster a full and open discussion of the issues to be considered. They should be viewed as a starting point for the discussions that will occur during the hearing and meeting.

Pursuant to 42 U.S.C. § 2286b(d), the Board requests that DOE provide the Board with written responses to the enclosed questions no later than September 7, 2010.

Sincerely,

Peter S. Winokur, Ph.D.
Chairman

Enclosure

Enclosure

The Board has prepared this list of questions to establish the final agenda and determine the list of desired witnesses for the hearing. The author or authors of each answer should be identified by name, affiliation, and title. Answers will be entered into the record of the hearing as if read and will be posted on the Board's internet website (www.dnfsb.gov) prior to the hearing.

1. Compare the Department of Energy's (DOE) most recent assessment to previous estimates of the material-at-risk contained in the Hanford tank waste. Provide an introductory explanation of recent DOE activities as they relate to safety of the planned process, the site, future workers and the public.

   A. Provide a qualitative assessment of the variety and quantities of high level radioactive waste recipes currently isolated in the Hanford underground tanks, and provide an assessment of the relative challenges involved in stabilizing the various formulations.

      1. For the purposes of this explanation, divide these wastes into process types and provide specific estimates as to the challenges and hazards of transporting them from the tank farms to the new waste treatment plant and any distinctions as to processing/stabilization. How has this changed from previous estimates? See also question 22 Waste Characterization in support of Waste Feed Delivery below.

      2. Provide current planning estimates on processing (schedule and cost).

   B. Based upon the most recent DOE assessment of the reduced material-at-risk what opportunities has DOE been able to capture in the Waste Treatment and Immobilization Plant (WTP) design and schedule? Specifically address modifications to the safety-related design criteria.

   C. With respect to emptying the tanks, completing the stabilization, and closing the legacy tank farms—what are the significant unresolved issues that remain unplanned/unfunded (e.g., additional vitrification; supplemental pre-treatment)? See also question 23 Design Status of Waste Feed Delivery system below.

   D. What are DOE's plans with respect to maintaining the site boundary and restricting access in the foreseeable future (e.g., until significant reductions in tank waste have occurred)?

   E. Describe the basis of current knowledge of Hanford tank waste, and where applicable, how and why confidence has increased in DOE's understanding of waste chemistry and process knowledge.

   F. What is the status of developing the cold (i.e., with simulants, no radioactive waste) testing plan and when is it expected to be fundamentally complete? How long does DOE expect to operate the WTP in a cold test mode before beginning to process tank waste?

2. Waste Treatment and Immobilization Plant Safety Design Strategy

   A. Safety-Related Design Criteria

      1. Describe the status of the safety-related design criteria (24590-WTP-SRD-ESH-01-001-02, Rev 5t, *Safety Requirements Document, Volume II* (SRD)).

         a) Describe each SRD change since October 1, 2008.

            (1) Which SRD changes were needed to address major changes in the design (pulse jet mixing, control of hydrogen, changes to the process flowsheet to address solids precipitation, etc.)?

            (2) What was the technical basis for each change identified in (1) above?

            (3) What impact did each change identified in (1) above have on the Pretreatment Facility (PTF) margin-of-safety?

         b) Why was each change necessary given the advanced state of the PTF design?

         c) What SRD changes are anticipated prior to startup (e.g., remaining unresolved safety issues)?

            (1) What is the technical basis for each anticipated change?

            (2) What impact will each anticipated change have on the PTF margin-of-safety?

            (3) Describe the expected benefit of each anticipated change.

      2. Beginning in late 2008, DOE approved changes to the safety-classification methodology applied to the WTP design.

         a) What changes were made and how did they affect the margin-of-safety?

         b) Describe the intent of each change.

         c) Describe the technical basis for each change.

         d) Describe the consideration given to changes in DOE policy regarding the application of evaluation guidelines for the safety classification of components established in DOE Order 420.1B, *Facility Safety,* when modifying the safety classification system for protection of the collocated worker.

         e) Describe how unmitigated dose consequences to the collocated worker were calculated and evaluated.

f) What impact will each change to the safety classification system have on PTF safety-related systems, structures, and components (SSCs)? Describe which SSCs were affected by the changes in classification system including the impact on component quality level and safety-related design criteria.

3. Describe the status of the Basis of Design (24590-WTP-DB-ENG-01-001).

   a) Describe each change to the Basis of Design since October 1, 2008.

      (1) Which changes to the Basis of Design were needed to address major changes in the PTF design (e.g., pulse jet mixing, control of hydrogen)?

      (2) Why was it necessary to make each of the changes identified in (1) above?

      (3) What was the technical basis for each change identified in (1) above?

      (4) What impact did each Basis of Design change identified in (1) above have on the PTF margin-of-safety?

         (a) Describe the impacts.

         (b) How was the impact, or lack of impact, determined?

         (c) Describe why it was acceptable to proceed with the change (technical justification) in cases where the design change had the potential to adversely impact the PTF margin-of-safety?

      (5) Why was each change identified in 3.a) above necessary given the advanced state of the PTF design? Describe the expected reduction in design and/or operational complexity from each change.

   b) What changes to the Basis of Design are anticipated prior to startup?

      (1) What is the technical basis for each anticipated change?

      (2) What are the potential impacts of each anticipated change on the PTF margin-of-safety?

         (a) Describe the potential impacts.

         (b) How was the impact, or lack of impact, determined?

         (c) For each anticipated change, describe the justification to proceed with the change, in cases where there are potential adverse impacts to the PTF margin-of-safety?

(d) Why are the anticipated changes in the Basis of Design necessary given the advanced state of the PTF design? Describe the expected reduction in design and/or operational complexity from each change.

3. Pretreatment Facility Safety

A. In late 2008, DOE began an initiative to reduce the complexity of the PTF design. Describe the basis for reducing the complexity of the PTF design, the results of this effort, and management controls necessary to prevent the final design from becoming too complicated to operate.

1. When and how did Bechtel National, Incorporated (BNI) determine that the PTF design was overly complex?

2. What three PTF systems were the most complex and how was this determined?

a) Describe the details for each system, including a description of the overly complex aspects of these system designs, and how this was determined.

b) Describe the operational complexity that resulted from the original design.

c) Describe how BNI proposed to remove the complexity.

d) Describe the potential impacts on operations from removing the overly complex aspects of the design (including changes in classification of safety-related SSCs).

(1) Will operation of the PTF be more or less flexible due to changes in design? Describe the impact changes in design had on operational flexibility.

(2) Has the availability and maintainability of the systems changed? Describe the impact changes in design had on availability and maintainability.

(3) Have there been changes in mean time to failure and mean time to repair? Describe the impact changes in design had on mean time to failure and mean time to repair.

(4) Has there been an impact on the margin-of-safety? Describe each impact on the margin-of-safety.

3. How did DOE determine that the PTF was too complex to operate?

a) When and how was the determination made?

b) Describe the method/process/criteria used to make this determination.

4. Describe actions taken by DOE and BNI to ensure that removing design complexity does not adversely impact the PTF margin-of-safety.

   a) Did reducing the PTF design complexity require changes to the safety design strategy for the PTF (e.g., Hydrogen in Pipes and Ancillary Vessels [HPAV])?

   b) Describe each of these changes and their impact on risk to the worker and public.

5. Describe the changes in the preliminary documented safety analysis (PDSA) necessary to support removal of design and/or operational complexity from the PTF design.

   a) Did any of the necessary changes to the PDSA impact the margin-of-safety for the PTF? If so, describe the impact.

   b) Have changes to the PTF PDSA to reduce operational complexity impacted the complexity of the safety basis?

      (1) Describe each change to the PTF PDSA needed to reduce operational complexity and its impact on the PDSA.

      (2) Are all of the necessary PDSA changes complete?

      (3) If not, are the impacts to the PDSA known? Describe the potential impact(s).

      (4) Did the PTF technical safety requirements (TSRs) change as a result of removing design and/or operational complexity? Describe the changes.

      (5) Is the resulting set of TSRs more or less complicated than the set of TSRs that existed prior to removal of design and/or operational complexity?

         (a) How is this measured (e.g., number of TSRs, number of safety-related SSCs, number of administrative programs, or some other means of comparison)?

         (b) How have first of a kind design approaches to remove operational complexity (e.g., use of quantitative risk analysis [QRA]), impacted the complexity of the safety basis (i.e., TSRs)?

         (c) If the impacts from using first of a kind design approaches on the safety basis are not yet known, when will they be known?

         (d) Describe the technical basis supporting the decision to reduce operational complexity?

(6) What has been the net effect on the technical aspects of the safety basis and the PDSA from removing design and/or operational complexity?

(7) Has reliance upon Specific Administrative Controls (SAC) increased or decreased as a result of reductions in complexity; has reliance upon engineered controls increased or decreased as a result of reductions in complexity? Are there any cases where engineered controls have been replaced with SACs?

c) Describe the critical elements for DOE's system for maintaining control over the consistency of the design and safety bases. How are these elements intended to maintain consistency between the design and safety bases? Provide one example.

d) Are the current PTF design and PDSA fully consistent?

(1) Has the project finalized the process flowsheet? For example, changes in the pulse jet mixing design potentially impacted the process flowsheet; have these impacts (or others) been fully incorporated into the design and safety bases?

(2) Have the changes from revising the HPAV safety design strategy been fully incorporated into the safety and design bases? If not, what changes are required and when will these changes be complete?

e) If the PTF design and PDSA are not fully consistent:

(1) What remains to be done to align the PTF design and the PDSA?

(2) When will the design and safety bases be fully consistent?

(3) Which PTF system designs are not consistent with the current PDSA? Describe why the system design is not consistent with the current PDSA and provide the basis for each inconsistency.

(4) For the PTF systems that are not consistent with the current safety basis, is BNI authorized to continue to procure safety related SSCs?

(5) For the systems that are not consistent with the current safety basis, which have components in fabrication?

(a) Does the lack of consistency impact component design criteria?

(b) If the lack of consistency impacts component design criteria has the fabrication of these components been placed on "hold" until the safety basis and design are consistent?

(6) If a decision is made to proceed at risk (prior to assuring design and PDSA are consistent) with fabrication and/or installation, describe how that risk is quantified (in terms of schedule and cost) and communicated to DOE.

6. Does the current PDSA meet all the requirements of 10 Code of Federal Regulations (CFR) Part 830? If not, describe the requirements that are not met and what is being done to address these deficiencies? If there are cases where the requirements are ambiguous or poorly defined, provide details of how the ambiguities affect the project?

7. Describe how BNI determined the resulting impact on operational complexity from changing the PTF design.

   a) Which operating procedures have been developed for the PTF?

   b) Provide a list of these procedures and describe the design basis.

   c) Describe the degree of complexity in the current procedures.

8. Based on the current state of procedure development, is the PTF too complicated to operate? Describe how this was determined. Describe steps taken by BNI and DOE to ensure that the final design is not too complicated to operate.

   a) What metrics are in place to monitor the effectiveness of management controls necessary to prevent the final design from becoming too complicated to operate? When were the metrics developed and implemented?

   b) Describe each metric, how the metric is tracked, and the measured effectiveness of each (if known).

   c) What actions are taken in response to unacceptable metrics?

9. Has DOE documented the lessons learned resulted from the design being too complex to operate?

   a) Describe each lesson learned.

   b) Describe what was done to communicate these lessons learned to other Department of Energy-Environmental Management projects and other DOE organizations.

B. Management of Safety-Related Risk. BNI and DOE have a number of processes in place to manage technical and project risks. Describe these processes, their intended objectives, and the methods of managing technical and safety risk.

1. Describe the processes in place for the management of WTP critical safety-related design risk.

    a) Describe the process to manage critical design risks and the need to develop, when required, alternate designs for risk mitigation.

    b) Is BNI currently carrying alternate designs forward as a means of risk mitigation?

        (1) If yes, describe each design alternative and the risks these alternatives are intended to mitigate.

        (2) For each alternative design, what information (e.g., tests, evaluations) is required to determine which design alternative to pursue?

        (3) When will all the decisions related to these design risks be complete?

        (4) What is the likely impact on each part of the high-level waste treatment system (i.e., waste retrieval, waste feed qualification, pretreatment, and vitrification) from implementing alternate designs later in the project?

2. Describe the parts of the PTF design that have the greatest safety-related design risk.

    a) Describe the impact and the safety-related risks resulting from the revised HPAV safety design strategy and the resolution of pulse jet mixing design issues on each part of the high-level waste treatment system.

    b) Describe the impact safety-related risks have on plant operability. How were these impacts determined and how are they being managed?

    c) Describe the potential impact these safety-related risks have on the feed delivery system. How are these impacts determined and how are they managed?

    d) Describe the potential cost and schedule impacts on each part of the high-level waste system resulting from safety-related risks in the PTF design.

    e) Describe any safety-related design risks that will not be resolved until "cold" commissioning.

        (1) What are the potential cost and schedule impacts from carrying these safety-related design risks into cold commissioning? For example, consider the Pulse Jet Mixing System:

            a If large-scale pulse jet mixing tests were delayed until cold commissioning and the pulse jet mixing design did not perform as anticipated—what are the potential cost and schedule impacts from carrying these risks to that time?

b What is the range of potential impacts to the PTF if the Pulse Jet Mixing System design does not perform as anticipated?

c What is the range of potential impacts on the ability to vitrify tank farm wastes, consistent with the current plan, if the Pulse Jet Mixing System design does not perform as anticipated?

d What is the range of potential impacts on the feed delivery system from the pulse jet mixing design not performing as anticipated?

(2) What alternate means are available to resolve these safety-related design risks earlier?

f) For those areas of the design with the greatest safety-related risk, how closely coupled is design and construction (duration between approval of the confirmed design and construction).

4. Waste Treatment and Immobilization Plant Safety Analysis

A. Accident Analysis Calculations

1. What value will be used for deposition velocity in calculating unmitigated dose calculations? Provide the technical basis for this value that justifies its use as being representative of the Hanford Site and WTP-specific conditions?

2. Discuss the technical basis for the WTP-specific methodology for spray leak scenarios.

a) Describe the technical basis supporting the WTP-specific methodology.

b) What are the results from the DOE requested review of the WTP-specific methodology for spray leaks by DOE's Office of Health, Safety, and Security (HSS). If the results are incomplete, when will the HSS review be completed?

3. What specific accident analysis research would improve the accuracy and certainty of the WTP Safety Analysis and provide the worker and the public greater confidence in the calculations?

B. PTF primary confinement design

1. Describe the safety design strategy for the PTF confinement boundary.

2. Describe the active and passive features of the PTF primary confinement credited for safety purposes.

3. Describe the safety classification and quality levels for each credited safety feature.

4. Describe the unmitigated dose consequences to the public and collocated workers from radioactive releases postulated to occur from a breach in the primary confinement boundary.

   a) What initiating events can result in a breach of the primary confinement boundary?

   b) What are the unmitigated dose consequences from breaches in the primary confinement boundary?

   c) Which accident scenarios result in unmitigated dose consequences above the evaluation guidelines?

5. Describe the strategy for meeting defense-in-depth requirements from DOE Order 420.1B, as applied to the design of the PTF primary confinement.

6. What requirements are applicable to the PTF design for the detection of leaks from the primary boundary?

   a) Describe the performance characteristics of the PTF leak detection system from the Basis of Design.

   b) Given the non-Newtonian character of some fluids in the PTF, what is the technical basis supporting the as-designed leak detection system's ability to meet the Basis of Design requirements for leaks involving these fluids?

   c) What other features of the PTF design, relative to detecting or containing leaks and spills, serve a defense-in-depth function?

   d) What are the performance requirements of these features?

7. Describe the consideration given DOE policy for design of the confinement boundary established in DOE Order 420.1B, in the current seismic design specification for piping and vessels for protection of collocated workers.

   a) For those piping systems, inline components, and vessels that are currently designated with a lower seismic design requirement, what consideration was given to revising the seismic design requirements to be consistent with DOE's stated expectations (i.e., a higher seismic design requirement when needed for collocated worker protection)?

(1) Describe the expectations from DOE policy and how they are addressed.

(2) Describe the technical basis for determining that a higher seismic design requirement was not needed to protect collocated workers.

b) If the unmitigated dose from an accidental release of radioactive material to the collocated worker is above the established evaluation guidelines what consideration was/is being given to revising the seismic design requirements for those components?

c) In the PTF hot cell, describe design alternatives being developed to address the release of radioactive material due to a seismic event.

(1) Describe the critical performance characteristics of these design alternatives.

(2) Does the design alternative provide an equivalent margin-of-safety as would be provided by a higher seismic design requirement when needed for worker protection?

(3) Describe the results of the analysis to determine that the design alternative provides an equivalent margin-of-safety.

5. Hydrogen in Pipes and Ancillary Vessels

A. Describe the current (revised) HPAV safety design strategy, and describe the anticipated changes prior to cold start up.

B. To what extent, if any, has DOE determined that gaseous deflagrations/detonations within the WTP primary confinement barrier (process piping systems and components) are acceptable in the WTP design? Describe the basis supporting this determination and the extent to which it will be incorporated into the WTP design. Is this a change from the pre-2008 design acceptance criteria, and if so, why was this change necessary?

C. Identify other defense nuclear facilities that allow gaseous deflagrations/detonations in process piping systems that form the primary confinement boundary. If known, what is the safety design strategy for these facilities?

D. DOE approved the HPAV safety design strategy allowing permanent plastic deformation of piping (bulging) in the PTF hot cell. Why is this design approach preferable?

E. Describe the safety-related benefits from allowing permanent plastic deformation to piping systems from gaseous detonations. What impact on the margin-of-safety resulted from allowing this design approach? How was the change in the margin-of-safety justified?

F. What alternatives did DOE evaluate prior to deciding to allow permanent plastic deformation?

G. Does DOE anticipate the possibility of leakage out of the primary confinement barrier as a result of a boundary breach resulting from gaseous deflagrations/detonations, and if so how will the leakage be confined and mitigated? What alternatives were considered?

H. From a safety perspective, why were the other alternatives inferior to allowing permanent plastic deformation or leakage of the primary confinement barrier?

6. Potential impacts on the WTP mission from hydrogen explosions in WTP piping

   A. Describe the design features capable of detecting deflagrations/detonations in process piping and inline components in the PTF (e.g., black cell and hot cell)?

   B. Recovery from leaks and spills from process piping

      1. What design features aid in the recovery from a leak in the black cell (e.g., the ability to isolate process piping in the black cell, existence of redundant flow paths)?

         a) What design features restrict the amount of process fluids released from the primary confinement boundary following a leak from a black cell pipe?

         b) What are the immediate recovery actions necessary to isolate and limit the loss of material from the primary confinement boundary?

         c) What is the potential maximum volume of radioactive material that could be released from the primary confinement boundary?

      2. What is the estimated cost and process interruption required to fully recover from a pipe leak in the black cell (e.g., the repair of damaged equipment and a return to operations)?

         a) Describe the potential actions required in recovery (e.g., spill clean-up, repair of piping, inspection of impacted components).

         b) Describe restrictions on recovery posed by the limited accessibility to a black cell (e.g., limited inspection capability, congestion, potentially high radiation dose).

         c) Describe the results of DOE's evaluation of the cost and operational impacts from recovery.

         d) What are the potential hazards for workers attempting to conduct repairs in a black cell (e.g., potential radiological exposures)?

e) How were potential worker hazards factored into DOE's approval of the HPAV safety design strategy? Describe the rationale for accepting the potential hazards to workers.

C. If a hydrogen detonation significantly damaged a hot cell pipe or component (e.g., the component is no longer operable, or a breach of primary confinement occurs) describe the worst case consequences to facility operations.

1. Describe the potential actions required in recovery (e.g., spill clean-up, repair of piping, inspection of impacted components).

2. Describe restrictions on recovery posed by the limited accessibility to the hot cell (e.g., inspection capability, congestion, potentially high radiation dose).

3. Describe the existing capability to remotely repair piping and components in the hot cell.

a) What functional design requirements specifically support the repair, and mitigate the effects of damage to piping and components in resulting from an explosion in the hot cell?

b) What is the range of the planned PTF repair capability of piping and components damaged by the effects of explosions?

4. Does the planned repair capability specifically address deformation of piping and components?

a) What is the current capability to replace piping and repair or replace inline components that have been deformed by a hydrogen detonation?

(1) If an inline component damaged by a hydrogen detonation cannot be removed from the hot cell, what will be the capability to repair components in-place?

(2) If an inline component damaged by a hydrogen detonation cannot be removed or repaired in-place, what alternatives are incorporated in the design to bypass the damaged component?

b) Describe the results of DOE's evaluation of the cost and operational impacts from the recovery due to a detonation event in the hot cell.

c) If manned entry were required, what is DOE's assessment of the hazards, particularly estimated radiological exposures, for workers entering the hot cell to conduct repairs?

(1) Describe DOE's assessment methods and results.

(2) How did DOE's evaluation of the potential worker hazards impact the decision to approve the revised HPAV safety design strategy?

(3) Describe the rationale for accepting the potential hazards to workers.

7. Discuss the use of American Society of Mechanical Engineers (ASME) design codes.

   A. Is DOE relying upon ASME B31.3, *Process Piping*, provisions for the design of piping systems to withstand gaseous deflagrations/detonations? If not, then upon what consensus design code is DOE relying?

      1. What is the maximum plastic deformation allowed ASME B31.3?

      2. What is the maximum plastic deformation allowed by the DOE approved HPAV safety design strategy?

      3. Does the ASME design code require periodic inspection in piping systems that allow permanent plastic deformation? If yes, how does DOE propose to perform these inspections?

      4. How will DOE determine if permanent plastic deformation has occurred?

   B. DOE has approved the use of strain-rate-dependent material properties for the WTP piping design.

      1. Does ASME B31.3 explicitly allow the use of strain-rate-dependent material properties?

      2. If yes, under what conditions?

      3. Does DOE's allowed use of strain-rate-dependent material properties require the same conditions?

   C. Has DOE submitted a "code case" to the ASME regarding revised HPAV safety design strategy?

      1. If yes, describe the code case.

      2. If not, does DOE intend to submit a code case?

      3. If DOE does not intend to submit a code case, describe the basis for this decision.

8. Testing in support of the revised safety design criteria for pipes and inline components.

   A. Describe the test plan to verify that all inline components can withstand the effects of detonation. For example, describe the test plans for pumps, PUREX connectors, valves, and safety-related instrumentation.

   B. Describe the design criteria applied to each component.

      1. Will the current criteria from the WTP Basis of Design be used; if not, then what specific design criteria will be used?

      2. For those current criteria that are qualitative, explain why qualitative criteria are adequate.

   C. Which components will be verified by analysis, and which will be verified by testing?

   D. What is the schedule for completing the testing or analysis to qualify inline components? Will testing and evaluation be completed before components intended for plant installation begin fabrication?

   E. What alternatives exist if a component cannot be qualified by testing or analysis?

   F. Discuss the results of the detonation tests performed on the 4 inches plug valve at the Southwest Research Institute.

      1. What was the evaluation criteria used? Are these criteria the same that have been included in the basis of design?

      2. What was the extent of damage to the valve in this test?

      3. Did the test achieve the desired maximum loading, i.e., a pressure reflected deflagration-to-detonation transition (PRC-DDT)?

      4. Will this valve design be used in the PTF in HPAV-affected piping systems?

   G. The basis of design does not limit the use of the HPAV safety design strategy to pipes of 4 inches or less in diameter, yet the HPAV test program only tested pipes up to 4 inches in diameter.

      1. Will the HPAV safety design strategy apply to pipes greater than 4 inches in diameter?

      2. Does the project anticipate additional testing on pipes greater than 4 inches in diameter? If yes, when will this testing be done?

9. What specific research remains to be done to fully evaluate the HPAV effects to provide greater confidence in the worker and the public accident analysis calculations (e.g., explosion limits for small volumes of explosive gases embedded in waste; response of piping systems partially filled with waste; strain rate effects in structural response; estimates of rupture and fragmentation thresholds; dispersion resulting from gaseous explosion; standardized analysis methods for safety studies; code cases and guidelines for ASME Boiler and Pressure Vessel code and B31.3 piping code)?

10. Quantitative Risk Analysis

    A. DOE does not have a policy or a standard for the use of QRA.

        1. What DOE direction and guidance was provided for allowing the use of QRA Probabilistic Risk Analysis as a design tool at the WTP in the absence of a DOE approved standard?

            a) If direction and guidance was provided, at what level was it approved and how and when was it documented?

            b) What were the major concerns identified by DOE that necessitated the need to provide direction and/or guidance?

            c) Has QRA been used as a design tool in other nuclear applications?

            d) Compare and contrast DOE QRA guidance to Nuclear Regulatory Commission guidance on PRA/QRA?

        2. Did DOE evaluate the potential conflicts between the use of QRA at WTP and other DOE standards? Describe the results of this evaluation.

        3. The Hydrogen in Pipes and Ancillary Vessels Independent Review Team (HIRT) recommended that DOE adopt a de minimis screening criteria for eliminating initiating events and event sequences that have a low frequency of occurrence. However, DOE-STD-3009, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis*, does not allow the use of cut-off frequencies to exclude operational accidents from further analysis (DOE-STD-3009, Appendix A). If this HIRT recommendation were accepted by DOE, how would the conflict between the WTP's use of QRA and DOE-STD-3009 be resolved?

        4. Has the use of QRA at the WTP been evaluated to determine if the QRA represents an acceptable method as described in 10 CFR Part 830? What was the outcome of this evaluation?

5. What role has DOE's HSS had with respect to the adoption of QRA for the WTP project?

B. The WTP is a first/one-of-a-kind facility with which DOE and BNI have no operating experience.

1. How was using QRA justified given the unique aspects of the WTP design? Provide this justification.

2. The HIRT has recommended the use of expert elicitation to develop the QRA.

   a) If this recommendation is accepted by DOE, what DOE standard(s) will be applied to the WTP's use of expert elicitation?

   b) Are these standards equivalent to the Nuclear Regulatory Commission's position on the use of expert elicitation in support of PRA?

C. The HIRT determined that the QRA was not ready for final design and has made a number of findings for which they believe corrective actions are necessary.

1. Describe the schedule for enabling the QRA to be ready for design.

   a) Who will make the determination that the QRA is ready for design?

   b) How will the determination be made?

2. Describe the safety-related risks posed by using the QRA in its current form.

3. How is DOE managing these risks?

D. How will the assumptions used in the QRA be managed over the life of the WTP?

1. What QRA assumptions have the greatest impact on the WTP piping and component design?

2. The hydrogen generation rate used in the QRA is postulated to be conservative. What is the potential impact(s) on plant operations if the hydrogen generation rate is greater than postulated in the design and safety bases (i.e., impact on PTF throughput)? How will the risks of this potential impact be managed?

E. How will the QRA be verified and validated (V&V)?

F. Will an independent entity perform the V&V?

G. What standard will be used to perform the V&V?

H. Will DOE implement a research plan to gather the data upon which to quantify and model a credible QRA. Describe the research plan?

11. Hydrogen in Pipes and Ancillary Vessels Independent Review Team

   A. On February 15, 2010, DOE approved the revised HPAV safety design strategy for use in design and procurement of PTF HPAV affected piping (beginning with Planning Area 3). The HIRT concluded that the new design approach for HPAV piping and components would not be acceptable until the models, assumptions and methodology involved in the approach were improved to resolve the HIRT's findings. What are the potential impacts on the WTP?

      1. Describe the procurement schedule for HPAV affected piping and components as compared to the schedule of activities necessary to resolve HIRT team findings.

      2. Have HPAV-affected piping and/or components been procured for any WTP facility?

         a) Are any HPAV-affected piping and/or components installed?

         b) If yes, how was the appropriate pipe schedule selected given that elements of the HPAV design strategy are not yet complete (e.g., the QRA)?

         c) Given HIRT findings and recommendations, are there any pipe or components that can no longer be used (must be discarded)?

      3. If HPAV piping or components have not been procured, is the tentative procurement schedule tied to the resolution of findings from the HIRT?

         a) Will the project wait until the HPAV safety design strategy is complete before beginning procurement of HPAV-affected piping and components (e.g., QRA and ANSYS finite element model, component testing or analysis)? If not, what are the potential safety-related impacts of this decision?

         b) When is the procurement of HPAV-affected piping and components scheduled to begin?

   B. What are the impacts to the project schedule from delaying procurement of HPAV-affected piping and components if procurement is tied to resolution of HIRT findings and completion of the HPAV safety design strategy?

C. The HIRT found that elements of the HPAV safety design strategy were not complete, e.g., critical calculations supporting the safety basis were draft or not yet complete and the QRA was not finished.

1. What was DOE's basis for approving the HPAV safety design strategy when critical parts of the design methodology were not complete?

2. What is the timeline for completion of modifying the HPAV safety design strategy to address HIRT findings/recommendations?

3. Which HIRT recommendations will DOE accept?

4. What is the basis for rejecting the remaining HIRT recommendations?

5. How will DOE verify that HIRT findings have been properly addressed consistent with the HIRT's intent?

D. Will DOE require a separate independent review of those elements of the HPAV safety design strategy that were not reviewed by the HIRT? If yes, describe this review.

12. DOE engaged outside experts in addition to the HIRT to evaluate the revised HPAV safety design strategy, i.e., Dr. Joseph Shepherd of the California Institute of Technology, and ASME code experts Mr. George Rawls and Mr. Ronald Haupt. Have the concerns expressed by these experts been satisfactorily resolved?

A. For example, Dr. Shepherd expressed concerns regarding Dominion Engineering Incorporated calculations in a letter to DOE dated March, 27, 2010. Were the concerns expressed by Dr. Shepherd in this and other correspondence resolved (e.g., strain data from the pressure reflected deflagration-to-detonation transition (PRC-DDT) tests conducted at the SwRI)?

B. Describe the process for resolving Dr. Shepherd's technical concerns. If the concerns expressed by Dr. Shepherd have not been resolved, are the concerns tracked by DOE and will the concerns be formally resolved? Will Dr. Shepherd verify that their resolution is technically acceptable? If not, describe how his and other DOE outside expert's concerns will be resolved.

13. Safety Aspects of Pulse Jet Mixing Design

A. Describe the small-scale test platform.

1. What scale factors were chosen for each vessel simulated in the WTP?

a) What is the technical basis for their selection?

b) What are the technical strengths and weaknesses in the selection of these scale factors?

c) Were the vessels tested a geometric match to the actual vessel design? If not, please identify and discuss the significance of any differences.

d) What are the technical risks associated with performing scaled tests in vessels that lack geometric similarity?

B. Describe the safety-related test objectives that were closed with the small-scale testing.

1. What was the testing strategy for resolving solids accumulation issues?

2. What was the testing strategy for resolving gas retention and release issues?

3. What are the technical strengths and weaknesses in these testing strategies?

4. Discuss how the results of the small-scale testing change the design of the WTP.

a) What physical changes to the vessels were made to improve mixing performance?

b) What operational changes to the process were made to improve mixing performance?

c) What changes to the process flow were made to improve mixing performance?

d) What systems are or have been added to detect and mitigate accumulation of solids in the vessel heel?

(1) What are the functional requirements of these new systems?

(2) What is the current design status of these systems?

(3) Has testing of these new systems been performed to see if these functional requirements have been met?

C. Are there any vessels that were not tested in the small-scale platform? If so, explain the technical basis for not performing tests for a particular vessel.

D. How do the results from Mid-Columbia Engineering (MCE) testing compare with results of similar testing performed by Pacific Northwest National Laboratory (PNNL)?

1. What is the magnitude of the differences?

2. Describe the safety significance of the differences. If the differences do not have safety significance, provide the technical justification for this determination.

3. How do the differences translate to full-scale performance?

4. Describe how the differences were resolved.

5. How are differences being managed to prevent safety issues from arising during WTP operations?

E. What are the open safety issues associated with pulse jet mixer performance?

1. Describe each open safety-related issue.

2. Describe the schedule for resolving each open safety-related issue.

F. Has BNI finalized the design of the pulse jet mixed vessels?

1. If not, are there limits on BNI's ability to procure pulse jet mixed vessels or related components? Describe these limits.

2. If the vessel designs are not finalized and BNI has been authorized to procure pulse jet mixed vessels or related components, describe the safety-related risks associated with allowing procurement in the absence of large-scale testing?

3. Describe the justification for accepting these risks.

G. Discuss the past and future uses of computational models (i.e., Low Order Accumulation Model (LOAM) and FLUENT™) to resolve safety-related issues.

1. Describe why the computational model is needed and why it was or will be used instead of experimental test results.

2. How was the model v & v to ensure accurate predictions?

   a) What technical standard(s) was (were) used for verification and validation?

   b) How do test results compare with the computational model predictions? Have these comparisons been done at multiple scales?

   c) What is the relative error in the computational model predictions?

   d) How are the predictive errors managed to prevent safety issues from arising during WTP operations?

   e) Were the applicable models updated with actual test results to provide improved predictive capabilities?

3. Describe the technical basis supporting the development of each computational model.

4. What are the relative strengths and weaknesses of each computational model?

5. How are the technical weaknesses managed to prevent safety issues from arising during WTP operations?

H. Discuss the simulant physical properties used in small-scale testing.

1. What are the physical properties of solids used to develop the design basis for the WTP? Discuss the following properties:

    a) Particle size;

    b) Particle density;

    c) Solids content;

    d) Rheological properties including viscosity, shear strength, Bingham yield stress, and Bingham plastic viscosity.

2. What is the technical basis supporting selection of the design basis properties delineated in 1 above?

3. What are the technical strengths and weaknesses associated with the design basis properties?

4. What are the uncertainties associated with the selection of these design basis properties?

    a) Are additional waste characterization data needed to reduce this uncertainty?

    b) Discuss what additional data are required to reduce this uncertainty.

    c) If no additional data are required, what are the potential impacts on the operation of the PTF due to the current level of uncertainty?

5. How are these uncertainties being managed to prevent safety issues from arising during WTP operation?

I. Describe the pulse jet mixer test velocities used for the small-scale testing.

1. What is the technical basis supporting the selection of these velocities?

2. What are the technical strengths and weaknesses from selecting these test velocities?

3. What uncertainties are associated with scaling-up the test results from small-scale to full-scale?

4. How are these uncertainties managed to prevent safety issues from arising during WTP operations?

14. Consortium for Risk Evaluation and Stakeholder Participation (CRESP) Findings (*CRESP Review Team Letter Report 7 – PJM Vessels*)

A. Will DOE accept the recommendations from the CRESP report?

1. If yes, describe the action(s) taken by DOE to address the technical content of each recommendation.

2. If not, which recommendations will not be accepted and what is the basis supporting DOE's action.

B. If DOE is still evaluating the CRESP findings, when will DOE decide how to address the CRESP recommendations?

C. What role will the CRESP have in the review of DOE responses to CRESP recommendations?

15. In the event that testing and modeling does not resolve remaining issues related to pulse jet mixing, what alternatives are being studied?

16. Feed Qualification

A. Describe the development of feed qualification requirements for WTP.

1. Given the assumed material-at-risk, physical properties of the waste, and limitations of the WTP design, describe the expected range of feed compositions.

a) Did the simulants used in the small-scale testing and computational fluid dynamics (CFD) modeling include the expected range of properties?

b) Did the simulants selected for small-scale testing represent all of the physical and rheological properties of WTP feed important for determining mixing performance?

c) What physical and rheological properties not represented in the simulant selected pose the greatest uncertainty? Describe these uncertainties. Describe the safety-related risks that are associated with these uncertainties.

d) What are the safety-related risks associated with establishing feed qualification requirements using simulants?

e) Will these risks be addressed during large-scale testing and cold commissioning? Describe how these risks will be addressed.

2. What are the implications of processing feed that diverges from the feed requirements?

3. How does diverging from feed requirements affect the safety-related aspects of pulse jet mixing performance?

4. Given batch-to-batch variability and complexity, how was the worst-case (bounding) feed selected for evaluating mixing power requirements and zone of influence (ZOI)?

B. Sampling

1. The ability to sample from WTP vessels is required for a number of purposes (e.g., safety and operations).

   a) What are the precision and accuracy requirements for safety-related samples taken from WTP vessels?

   b) What implications does this have for criticality control?

2. Have the sampling strategies required for the operation of the pulse jet mixed vessel been demonstrated to meet safety-related requirements? Describe the testing conducted to verify performance of the sampling system.

   a) What were the results of the testing?

   b) Was the testing conducted with a bounding simulant? Describe the physical and chemical properties of the bounding simulant.

   c) How was the wide variation in WTP feed accounted for in these tests?

17. Savannah River National Laboratory (SRNL) review of non-Newtonian mixing

A. The non-Newtonian Independent Review Team in their report (SRNL-RP-2010-00898, *Independent Technical Review of the Assessment of Pulse-Jet Mixing Performance in Vessels Containing Non-Newtonian Sludge at the WTP*) indicated that given additional time, a more detailed review of the waste characteristics could provide a higher level of confidence. Will the non-Newtonian Independent Review Team be given the opportunity to complete its review?

B. The non-Newtonian Independent Review Team concluded that the minimum static yield stress for the non-Newtonian vessels (UFP-2 A/B, HLP-27 A/B, and HLP-28) be maintained above 6 Pascal and below 30 Pascal.

1. Has BNI adopted this processing strategy? If not, what is the technical basis for not accepting this recommendation—describe the adopted processing strategy and the technical basis for its selection?

2. The non-Newtonian Independent Review Team believed that only one of the three methods discussed for controlling rheology will be successful (i.e., measuring permeate production).

    a) Describe the technical basis supporting control of the rheological operating window.

    b) Is the design of the controls supporting the rheological operating window complete? If not, what activities remain to be completed (e.g., development activities to validate the selected control strategy)? Discuss the technical scope of these activities and when they would be performed.

C. The non-Newtonian Independent Review Team concluded that the logic processes in the WTP mixing vessel assessments supporting a determination of "confirmation ready" were inadequately described in the draft report provided to the review team. Will the non-Newtonian Independent Review Team perform a follow-up review on the final mixing vessel assessments to assess the logic processes used to determine the confirmation ready status of non-Newtonian vessels? If not, will there be a follow-up review, who will do it, and why is this acceptable?

D. The non-Newtonian Independent Review Team concluded that too little data exists for yield stresses between 0 and 6 Pa to assure accurate scaling or confirm suspension of the expected waste slurry with a high degree of confidence.

1. What vessels will contain slurries with Bingham Plastic yield stresses at the vessel bottoms between 0 to 6 Pa?

2. What control strategy will be used to avoid operating in this rheological window (0 to 6 Pa)? What are the potential safety-related mixing concerns associated with Bingham Plastic fluids with yield stresses between 0 Pa and 6 Pa?

E. The non-Newtonian Independent Review Team recommended that ZOI data for non-Newtonian vessels be assessed to determine if the Pulse Jet Mixer systems mobilize the entire vessel bottom at a yield stress of 30 Pa.

1. Will DOE require these data be analyzed? If yes, when will this analysis occur? Provide a description of the analysis and results.

2. Are any additional research activities needed to increase confidence in vessel performance at full-scale in this range of rheological properties? Describe these activities.

F. The non-Newtonian Independent Review Team stated that they found the heel management program to be a prudent engineering design feature for vessels that are expected to be in service for at least 50 years. Describe the heel management features that are going to be installed on the non-Newtonian process vessels.

G. The non-Newtonian Independent Review Team recommended that additional data analysis be performed to determine if a model that can predict the mixing performance in non-Newtonian tanks over the entire range of experimentation is needed. Will this reassessment occur? If so, when? What alternative exists if it is determined that a model cannot predict mixing performance?

H. The non-Newtonian Independent Review Team stated that CFD simulations will be beneficial to the project and recommended that the project continue to pursue CFD without software validation.

1. Are CFD simulations without verification and validation of the code going to be used in the design of these vessels?

2. When will the verification and validation of non-Newtonian process vessels be performed?

3. What experimental data will be used in the verification and validation process?

4. Will the experimental data used for verification and validation of non-Newtonian process vessels include features such as spargers and recirculation pumps? If yes, describe the data.

I. The non-Newtonian Independent Review Team recommends that integration of the Pulse Jet Mixers, spargers, and recirculation pump should be considered in the respective vessel assessments. Has DOE accepted this recommendation? If yes, describe when and how integration of the Pulse Jet Mixers and pargers/recirculation pump will be considered?

18. Pacific Northwest National Laboratory

   A. PNNL has had considerable involvement with the design and testing of the pulse jet mixed vessels at the WTP. What is PNNL's technical opinion regarding the existing technical basis for the design of Pulse Jet Mixing System?

      1. What are the technical strengths and weaknesses of the existing design given the information currently available?

      2. What are the potential safety-related implications of these technical weaknesses?

   B. What concerns did PNNL express to DOE regarding the current pulse jet mixer design basis?

      1. Given the concerns identified by PNNL, what additional testing, if any, would be needed to resolve these concerns?

      2. Has PNNL been asked to assist in the resolution of these concerns? Describe the extent of PNNLs involvement in the resolution of the remaining pulse jet mixing design issues.

19. Path Forward

   A. DOE has committed to perform large-scale tests (May 17, 2010, EM-1 letter). Describe additional testing needed to prevent safety issues during WTP operations from inadequate mixing.

      1. Is a series of large-scale tests needed?

         a) If large-scale testing is needed, what are the technical objectives and scope?

            (1) How does this technical scope mitigate the technical uncertainties of small scale testing?

            (2) Will performance of the WTP sampling system be tested?

            (3) Will heel detection/dilution/cleanout abilities be tested?

         b) If large-scale testing is not needed, what is the technical justification supporting this decision? How will the remaining technical risk be resolved?

      2. When would a large-scale test be performed?

         a) Where does this fall in relation to the construction schedule?

b) Which of the vessels in question will be fabricated and/or installed in the facility before the testing?

c) Discuss the capability of the project to modify vessel designs based on large-scale test results.

B. How would additional vessel modifications impact startup milestones for hot operations of WTP?

20. WTP criticality program (24590-WTP-CSER-ENS-08-0001, *Preliminary Criticality Safety Evaluation Report for the WTP*)

A. Describe the current WTP criticality safety limits (CSL).

B. What are the technical bases for establishing these CSLs?

C. What set of documents and standards are required by DOE to establish these CSLs?

D. What are the process chemistry assumptions underlying these CSLs? Does the current flow sheet support their use?

E. What WTP performance metrics are required to meet CSLs?

F. How will these metrics be monitored?

G. What technical weaknesses have been identified in establishing the criticality control strategy?

H. What development activities are associated with resolving these technical weaknesses?

I. When will these activities be performed?

J. What is the technical scope of these activities?

K. The Criticality Safety Support Group (CSSG) Report (Attachment to 10-WTP-049, *Review of the Washington River Protection Solutions Tank Farm Operating Contractor Criticality Safety Technical Basis*) found that the pulse jet mixer operation may break up the agglomerated solids and solids with weak chemical bonds, and has the potential to separate the lighter material from the heavier particles.

1. Was preferential separation of heavy and light materials observed in the small-scale testing?

2. How will separation of heavy and light materials impact the development of the criticality safety evaluation report (CSER)?

3. The CSSG found that the December 2009 vessel design does not assure heel removal from the mixing tank and observed heavier particles. What is the criticality risk if the heavier particles are predominately plutonium?

4. Will the proposed heel dilution/cleanout systems be used to mitigate or prevent criticality events in the WTP?

5. The CSSG observed that the WTP preliminary assumes sampling of input batches would have an uncertainty of five percent, and the CSSG found that this is no longer a reasonable assumption (further data is needed to determine the sampling uncertainty).

   a) Will criticality sampling testing be performed with a large-scale vessel under fully prototypic conditions and bounding simulants?

   b) If so, has the testing decision been made and when is this testing scheduled? If the decision has been made not to test, how was this decision technically justified? Describe the technical basis for design?

21. Waste Feed Delivery

A. WTP Waste Acceptance Criteria (WAC)

1. Describe the impact on the WTP WAC from the resolution of pulse jet mixing issues.

   a) What are the physical and rheological properties that must be controlled to assure that the validity of the small-scale testing applies to the full scale tanks?

   b) What gaps exist between the current WTP WAC and the required physical and rheological properties supporting scaled testing?

2. What activities are needed to resolve gaps between the scaled testing feed acceptance requirements and the current WTP WAC?

   a) When will these activities be performed?

   b) How much of waste will not meet existing feed acceptance requirements?

   c) How will off-specification waste be treated?

B. Feed Delivery Schedule

1. How is the WTP lifecycle affected by the pulse jet mixer design changes?

2. Describe the impacts on the baseline WTP processing schedule from the reduction of solids loading in WTP vessels due to pulse jet mixer design requirements?

3. Provide a description of the results from process models used to assess PTF operations.

   a) What are the processing assumptions used to determine the baseline and revised schedule?

   b) Describe major assumptions used in the analysis to predict the impact on PTF operations due to changes in pulse jet mixer design? How are these assumptions being protected?

   c) Describe the results of DOE's review of the impacts on PTF operation from changes in pulse jet mixer design.

22. Waste Characterization in support of Waste Feed Delivery

   A. Data Quality Objectives (DQOs)

      1. What DQOs are established for the Waste Feed Delivery system?

      2. How have these DQOs been revised to incorporate changes resulting from small-scale mixing tests (including criticality sampling)?

         a) What development activities are needed to develop a defensible set of DQOs?

         b) When will these activities be performed?

   B. Functional Requirements

      1. How have DQOs for the Waste Feed Delivery system been mapped to functional requirements for the systems and components?

      2. Do these Waste Feed Delivery system functional requirements consider changes resulting from small-scale mixing tests?

      3. How does the current Waste Feed Delivery system meet these functional requirements?

      4. What development activities are needed to have a Waste Feed Delivery system that meets these functional requirements?

      5. When will these activities be performed?

23. Design Status of Waste Feed Delivery system.

   A. Current mission and status of waste feed delivery (including the Waste Retrieval Facility [WRF])

1. What is the mission of the Waste Feed Delivery system?

   a) Describe the functional requirements for delivery of feed to the WTP.

   b) Describe the degree of "pretreatment" planned as a part of feed delivery to the WTP.

   c) Describe how the sizing requirements for the Waste Feed Delivery system will be determined?

2. Qualification of WTP feed.

   a) What elements of the Waste Feed Delivery system will be needed to qualify WTP feed?

   b) What operations will be used to limit particle size, particle density, solids content, and the rheological properties for feed sent to WTP?

   c) What are the functional requirements applicable to sampling?

3. Will the feed delivery design strategy attempt to resolve PTF design concerns? What is the current design status of the each element of the Waste Feed Delivery system?

4. What is the WRF design schedule?

5. When will feed be delivered to WRF? Describe the feeds sent to WRF.

6. What research and development activities are needed to support the design of waste feed delivery?

B. Impacts to Supplemental Treatment—how have changes in the designs supporting waste feed delivery and WTP affected options under review for supplemental treatment of low activity waste?