EA Operational Awareness Record	**Report Number:** EA-WTP-LAW-2016-01-25
Site: Hanford Site Office of River Protection	**Subject:** Review of the Waste Treatment and Immobilization Plant Low-Activity Waste Facility Preliminary Documented Safety Analysis Change Package for the Effluent Management Facility
Dates of Activity: 01/25/2016 thru 02/05/2016	**Report Preparer:** James O. Low

Activity Description / Purpose:

At the request of the U.S. Department of Energy (DOE) Office of River Protection (ORP) (reference 1), the Office of Environment, Safety and Health Assessments, within the Office of Enterprise Assessments (EA), reviewed the proposed changes to the Low-Activity Waste Facility (LAW) Preliminary Documented Safety Analysis (PDSA) that address direct feed to the LAW and the addition of the Effluent Management Facility (EMF). The EMF, a hazard category (HC) 3 nuclear facility, was designed to provide a mechanism to reduce the LAW recycle stream volume back to the tank farms. The specific objectives of this EA review were to determine the adequacy of selected aspects of the process hazards analysis (PrHA), derived hazard controls, and functional classification that ensure adequate protection of DOE workers, the public, and the environment. EA reviewed and commented on the PDSA change package (CP) and, following receipt of Bechtel National, Inc. (BNI) responses, met with BNI to clarify the comments and responses. Following receipt of BNI responses to the comments, EA personnel met with BNI representatives to clarify the comment responses. After the meeting, BNI provided EA with revised responses (reference 2). This EA review activity is part of a planned multi-phase review (reference 3) focusing on the technical adequacy of selected BNI-issued documents that are related to the development of documented safety analyses (DSAs) and technical safety requirements of the Waste Treatment and Immobilization Plant LAW. The LAW DSA is scheduled for review and approval by ORP in calendar year 2017.

ATTACHMENT:

ATTACHMENT 1 – EA-31 [Office of Nuclear Safety and Environmental Assessments] Comments on the EMF PDSA CP Comments, BNI responses, and resolution of EA-31 comments on the PDSA change package.

Result:

EA reviewed the PDSA CP and selected supporting documents (references 4-9), which BNI submitted for ORP review in December 2015. The PDSA CP is based on a 30 percent preliminary design, which BNI plans to further develop when the PDSA CP is approved. The PDSA CP consists of two attachments. Attachment 1 addresses updates to the LAW PDSA resulting from the decision to provide direct feed to the LAW from the Hanford Tank Farms. Attachment 2 provides a new appendix to the LAW PDSA that describes the EMF, documents the PrHA, and identifies the necessary safety controls, as required by DOE-STD-3009-94, Change Notice 3. Chapter 3 of attachment 2 includes tables that present the results of hazard identification, "what-if" analysis, and PrHAs that BNI conducted. These tables are the first submitted hazard analysis documents using the BNI Nuclear Safety Engineering updated safety analysis procedures that were issued in mid-2015.

EA provided comments on the PDSA CP and, following receipt of BNI responses, met with BNI to clarify the comments and responses.

EA determined the following:

- The EMF preliminary designation as HC 3 is appropriate.
- The hazard identification process was mostly complete for a 30 percent design.
- Overall, the what-if analysis was appropriate.
- Consistent with the graded approach, the PrHA tables are generally adequate to support the PDSA CP.
- The safety significant specific administrative controls, which maintain the facility as HC 3, are generally adequate.

Nonetheless, EA identified the following weaknesses:

- The hazard identification and what-if analysis did not fully document all incoming material into the facility from the LAW Pretreatment System and LAW and the resulting potential for hazardous events in the EMF.
    - Design media identify the potential for high activity waste to enter the EMF (via the low point drain tank) during normal or abnormal operations, and the what-if analysis in the PDSA CP does not fully document the evaluation of the potential hazard events in the EMF downstream processes. (See comment 1.)
    - The PDSA CP does not address the potential for mercury and mercury compounds to accumulate in the EMF as a result of EMF separator concentrate that is recycled to the LAW facility and back to the EMF. (See comment 4.)
    - The hazard identification checklist (and the subsequent what-if analysis) does not fully document the potential for adverse chemical reactions resulting from the LAW process transfers and subsequent internal transfers. (See comment 5.)
- The discussions of defense-in-depth and worker safety in the PDSA CP do not fully document a complete technical evaluation of the effectiveness of the non-safety controls to justify the decision to not elevate the controls to safety significant. For example, fire, hydrogen explosion/deflagration, and loss of confinement events (with facility worker high chemical consequences) cite system characteristics (e.g., vessel/piping robustness and materials of construction) as a sufficient "design solution," without technically justifying the adequacy of the system characteristics to prevent or mitigate these hazards. (See comments 2 and 3.)
- The Criticality Safety Evaluation Report (and consequently the PrHA) does not evaluate criticality safety in the EMF process (e.g., filters, accumulating vessels) where solids or soluble components can be concentrated. (See comment 6.)

In the final responses to the EA comments, BNI committed to update the hazard identification checklist, what-if analysis and PrHA tables, as applicable, to add additional detail to illustrate evaluation of chemicals in the incoming streams to the EMF. BNI also committed to further illustrate evaluation of the identified hazards with respect to the candidate controls identified on the PrHA summary table.

The final comment table is provided as attachment 1.

EA Participants	**References (Key Documents, Interviews, and Observations)**
1. James O. Low (lead) 2. Kevin Bartling 3. Roy Hedtke 4. David Odland	1. E-mail J. Harris to J. Low; *Upcoming EA-31 Review at ORP*, January 14, 2016 2. E-mail B. Ritter to J. Low; *Updated EA-31 Dispositions*, February 4, 2016 3. DOE/HQ HS-45, *Plan for the Independent Oversight Review of the Hanford Site Waste Treatment Plant Low Activity Waste Facility Documented Safety Analysis Development*, April 22, 2013 4. 24590-LAW-PDACP-NS-15-0002, *DF LAW Update for LAW and Addition of the Effluent Management Facility and Transfer Lines*, 12/22/15 5. 24590-WTP-ICD-MG-01-030, ICD-30 – *Interface Control Document for Direct LAW Feed*, Rev. 0, 9/14/15 6. 24590-WTP-CSER-NS-14-0001, *Criticality Safety Evaluation Report for Direct Feed to the Low-Activity Waste Facility*, Rev. 0 7. 24590-LAW-Z0C-W14T-00022, *Initial Hazard Classification for the Effluent Management Facility (EMF)*, Rev. A, 12/22/25 8. 24590-BOF-M4C-V11T-00002, *DFLAW EMF Process (DEP) Estimated Radionuclide Concentrations for Inhalation Dose*, Rev. B, 12/2/15 9. 24590-LAW-ES-NS-15-009, *Informal Engineering Study for the EMF for the Consequences from Hydrogen and Pressurized Release Events*, Rev. 0, 12/15/15
Were there any items for EA follow-up? ☐Yes ☒No	

ATTACHMENT 1 EA-31 Comments on the EMF PDSA CP			
Document Title	**HAR Revision/Date**	**Comment Record Date**	**Comment Record Revision**
Preliminary Documented Safety Analysis Change Package, 24590-LAW-PDACP, NS-15-0002, DFLAW Update for LAW and Addition of the Effluent Management Facility and Transfer Lines	Rev. 0/12-24-15	1/28/2016	0

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1	B3-9	3.3.2.3.1/1/1	**Issue**: Although supporting calculations clearly account for the potential of waste entering the EMF (via the low point drain tank) during normal or abnormal operations, the "what-if" analysis in the PDSA CP does not fully evaluate the resulting effect on downstream processes. For example, the hazard analysis does not evaluate the potential for concentration of radiological materials in the process system filters or the introduction of organic carbons to the EMF processes through leaks or mis-feeds into the low point drain tank. Also, the facility design calls for high activity waste detected during transfers to be drained to the low point drain tank, which is not analyzed. Failure to fully analyze abnormal conditions could lead to missing hazard controls. **Action**: Fully analyze normal and abnormal transfer operations to identify any adverse process conditions that may result from operational transfer errors.	R	DJO	**BNI:** **For Mis-transfers of LAW Process Waste:** From the low point drain tank, material (including any out of specification material it contains) is transferred to the evaporator feed vessel, evaluated in process block DEP-2. The effects of unexpected products on criticality are dispositioned in What If DEP-2.3. Although not explicitly identified as resulting from leaks or mis-transfers, the adverse process conditions such as hydrogen generation (radiolysis/thermolysis) (DEP-2.13), internal flooding (DEP-2.23), build-up of radiological material on filters (DEP-2.16) or incompatible materials causing degassing (DEP-2.26) are identified and dispositioned in the "What If" due to the low

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						consequences to all receptors for radiological and chemical or are passed on to PrHA Tables. **For Mis-transfers of High Level Waste:** The mis-transfer of high level waste to LAW is an initial condition which is protected with a TSR SAC. It is only credible as a result of the independent failure of multiple TSR-level controls in place to prevent such an event (e.g., a failure at LAWPS to incorrectly create the batch, a failure of the permissive sample hold point, plus a failure of the high gamma monitor/isolation valve interlock). As such, a transfer of high level waste to EMF would necessitate special recovery actions which would be evaluated and identified at that time due to TSR violations and would be governed by USQ and JCO processes, rather than the DSA and its supporting accident analysis. **The HID checklist, What-if Analysis and PrHA tables will be updated as applicable to add additional detail to illustrate**

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						evaluation of chemicals in the incoming streams to the EMF. **Closure Verification:**
2	B3-11 B3-14 B3-15	3.3.2.3.3, 3.3.2.3.5/3/1 3.3.2.3.6/1/1	**Issue:** Fire, hydrogen explosion/deflagration, and loss of confinement events with FW high chemical consequences cite system characteristics, e.g., vessel/piping robustness and materials of construction, as a sufficient "design solution" to obviate the need to elevate the control to SS but do not provide a technical evaluation of the effectiveness of the control set. A documented control evaluation for FW high events is required by 15-NSD-0017, page 4. Failure to properly evaluate the effectiveness of proposed design characteristics used to justify no SS controls may lead to misclassification of systems, structures, and components and an inadequate control set. **Action:** Fully evaluate the effectiveness of the proposed piping/vessel properties relied on to obviate the need for SS controls for FW high chemical consequence events relating to fire, loss of confinement, and vessel explosion/deflagration.	R	KEB	**BNI:** Qualitative assessments were done for each of these categories with respect to impacts to the FW. These qualitative assessments were conducted during the Hazards Analysis (HA) meetings with the applicable subject matter experts. The HA formed the basis for citing materials of construction, SMPs and even a SAC as sufficient to address hazards to the FW. With respect to the materials of construction and design configuration, calculations have been done to demonstrate that Code requirements are met. SMPs govern the FW's procedural compliance and use of protective equipment when working in the vicinity of equipment. For example, page B3-13 of the PDSA, provides the evaluation for loss of confinement resulting in a spray release to the CLW. This discussion also applies to the FW: *"For a loss of confinement event resulting in a spray release, the*

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						configuration of SSC design provides a sufficient level of protection and does not necessitate elevation to safety significant controls for chemical exposure to the CLW in EMF. Design solutions include use of appropriate materials (e.g., stainless steel or AL6XN piping systems), welding piping where practicable, the use of secondary containment (e.g., shrouds or doghouses) over equipment more likely to involve liquid leaks, and locating the majority of jointed piping runs in enclosed/covered localized structures. In addition, the chemical consequence methodology for spray releases was evaluated and contains substantial conservatisms (e.g., spray hole size, constant dead heading pressure, derivation of the chemical constituents in the waste), which when applied together result in over an order of magnitude in consequence estimation. In addition, the SMPs for radiation protection, hazardous material protection, operational safety program, and maintenance programs were identified as providing additional

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						protection. Interlocks for overflow events were also identified as defense-in-depth" Similar discussions are provided for other types of events (e.g., hydrogen explosions). Based on these detailed qualitative assessments and consideration for SS and SC controls, no further quantitative technical assessments should be required. **The HID checklist, What-if Analysis and PrHA tables and relevant chapter 3 discussions will be updated as applicable to add additional details to illustrate evaluation of the identified hazards, with respect to the candidate controls identified on the PRHA Summary table.** **Closure Verification:**
3	B3-11/ B3-114	3.3.2.3.3/4/1 PrHA ID No. 12	**Issue:** The DiD controls in the Explosion/Deflagration event description are not supported by the PrHA table (12). The description identifies appropriate materials, vessel design, and adequate air purge controls as providing sufficient protection for the FW and justification for not elevating the controls to a	R	RRH/ KEB	**BNI:** Contingent on the disposition of other DOE comments, the PrHA table will be revised to correctly reflect the discussion of the control set provided in Section 3.3.2.3.3

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			SS level. However, the PrHA Table only cites vessel ventilation and SMPs as providing protection for the FW. Failure to correctly identify non-TSR DiD controls can lead to inadequate justification for not elevating controls to SS level. **Action:** Correctly identify the suite of non-TSR DiD controls for the event and revise the justification for not elevating the controls to a SS level.			As discussed in Section 3.3.2.3.3, the adequacy of the control set considers the significant amount of time in which an event has to operate in an abnormal condition before a hazardous condition is reached, and the support SMPs can provide in assuring abnormal conditions are recognized and responded to appropriately and in a timely fashion. It also considers the degree of conservatism present in the calculation of consequences due to a hydrogen event. In consideration of these factors, the presented controls provide adequate protection without elevation to safety significance. **The HID checklist, What-if Analysis and PrHA tables and relevant chapter 3 discussions will be updated as applicable to add additional details to illustrate evaluation of the identified hazards, with respect to the candidate controls identified on the PRHA Summary table.** **Closure Verification:**

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4	B3-25 B3-49	HID checklist What-if Questions	**Issue:** The PDSA does not address the potential for accumulation of mercury and mercury compounds in the EMF due to recycle of EMF separator concentrate to the LAW facility. The EMF recycles separator concentrate to the LAW concentrate receipt system for vitrification. A large portion of mercury present in LAW feed returns to the EMF through RLD system transfer to the evaporator feed vessel. Failure to evaluate the potential for accumulation of mercury and mercury compounds in EMF can adversely affect worker consequence evaluations in the EMF and result in an inadequate control set. **Action:** Evaluate the potential for recycle and accumulation of mercury and mercury compounds in the EMF PDSA and determine required controls.	R	KEB	**BNI:** BNI will confirm with process engineering mercury accumulation/concentration levels, chemical forms, locations and re-evaluate the potential hazard as appropriate. **Closure Verification:**
5	B3-29	HID Checklist/ Chemical Reactions	**Issue:** This section of the HID checklist (and the carry forward into the "what-if" analysis) does not address the potential for adverse chemical reactions resulting from process transfers into EMF and subsequent internal transfers. For example, the HID checklist does not consider the chemical constituents of transfers from LVP-TK-00001 and the potential chemical interactions in the overhead sample tank (normal transfer) or subsequent transfer to the evaporator condensate vessel (abnormal transfer) (e.g., ammonia/nitrite interactions). Failure to address potential chemical incompatibilities could result in inadequate hazard analysis and control set. **Action:** Revise the HID checklist and "what-if" analysis to address chemical incompatibility in both primary and secondary transfers within the process.	R	DJO	**BNI:** The Hazards Analysis (HA) process identified the potential for adverse chemical reactions resulting from process transfers into EMF and subsequent internal transfers. LVP-TK-00001 interfaces with Process Block 4 (DEP 4) in the hazards analysis. In the HID checklist, ammonia generation, an unexpected combination formed from unexpected drainage, and process generated explosive gas are all considered and dispositioned as appropriate for DEP-4.

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						Although abnormal transfers/unexpected products are not explicitly identified as the initiator of the event, the effects of abnormal transfers are adequately considered. For example, unexpected products could cause increased hydrogen generation and explosion (DEP-4.5), overflows (DEP-4.12), production of aerosol/vapor (DEP-4.16). **The HID checklist, What-if analysis and PrHA tables will be updated as applicable to add additional detail to illustrate evaluation of chemicals in the incoming streams to the EMF.** **Closure Verification:**
6	B3-61, et al	DEP-3.5	**Issue:** The CSER (and PrHA) does not evaluate criticality safety in the EMF process areas where solids or soluble components can be concentrated. Fissile material can potentially be concentrated in the filters, the evaporator, or the storage vessels. Failure to support the PrHA with an adequate CSER evaluation of potential criticality events can lead to an inadequate control set. **Action:** Complete a CSER that adequately evaluates criticality hazards associated with accumulation of fissile materials in the EMF storage vessels, filters, and evaporator.	R	RRH	**BNI:** A draft CSER has been developed and submitted for ORP review. EA-31 comment resolution/incorporation will be worked for this CSER to have the appropriate statement to demonstrate a criticality is incredible in EMF. **Closure Verification:**
7	B4-1 B4-3	4.5.1 4.5.2	**Issue:** The MAR and Evaporator Concentration SACs are lacking appropriate functional requirements and adequate SAC	R	RRH	**BNI:** BNI concurs that further functional requirement and

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			evaluations, as required by DOE-STD-3009-94 CN3 and DOE-STD-1186-2004. For example, the MAR SAC does not identify requirements needed to control the radionuclide inventory and the SAC evaluation does not describe the performance criteria required to meet the SAC functional requirements. Failure to define SAC requirements can lead to ineffective safety significant controls. **Action:** Develop the functional requirements and evaluations necessary to meet the SAC safety functions in accordance with DOE-STD-3009-94 and DOE-STD-1186-2004.			evaluations for SACs are needed to be compliant with DOE-STD-1186-04 and DOE-STD-3009-94 CN3. However, we recognize that the PDSA submittal was based on preliminary (~30%) design information, and the SAC will be developed more as the design progresses. Section 3.3.2.3.4 *Planned Design and Operational Safety Improvements* will be updated to add a task to address the performance criteria and functional requirements required to ensure the effectiveness of the control prior to incorporating DFLAW into the LAW DSA. **Closure Verification:**
8	B4-2 B4-3	4.5.1.4 4.5.2.4	**Issue:** The MAR and Evaporator Concentration SACs do not identify equipment and instrumentation necessary to support the requirements of the SAC and their safety function. Examples include the mixing systems (e.g., agitators/eductors) and flow meters. DOE-STD-1186-04, section 3.3 provides expectations for evaluating instrumentation, controls, and equipment that support SAC implementation. Failure to identify the system elements necessary to support SAC functional requirements can lead to an inadequate design. **Action:** Identify the components/ instrumentation and the associated performance requirements necessary to ensure the SAC can be implemented.	R	KEB/ RRH	**BNI:** BNI concurs that further functional requirement and evaluations for SACs are needed to be compliant with DOE-STD-1186-04. However, we recognize that the PDSA submittal was based on preliminary (~30%) design information, and the SAC will be developed more as the design progresses. Section 3.3.2.3.4 *Planned Design and Operational Safety Improvements*, will be updated to add a task to address the performance criteria and functional requirements

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						required to ensure the effectiveness of the control prior to incorporating DFLAW into the LAW DSA. **Closure Verification:**
9	B5-2	5.5.2/2/1	**Issue:** The second paragraph of the "Derivation Criteria" would allow SAC implementation to be suspended under some circumstances of very low activity waste; however, the discussion does not adequately define the entry conditions under which the SAC is suspended. In addition, the derivation criteria exclusion would make implementing the SAC operationally difficult. For example, if the inventory is not maintained at all times, the facility would need to be placed in a known state (e.g., empty) prior to receiving waste where the feed is greater than 15% of the facility limit. Errors in tracking the MAR could result in operating the facility outside the analyzed safety basis. **Action:** Delete the derivation criteria exclusion paragraph.	R	DJO	**BNI:** Contingent on the disposition of other DOE comments, the SAC will be clarified. It will read, "For the processing of feed batches where the treated LAW feed…" as the HCSOF is determined for each batch of LAWPS feed, and each transfer of LAWPS feed from that batch would have similar characteristics. While the operational difficulties identified in the operational performance of the SAC are noted, this exclusion will be retained in the 30% PDSA until a more refined SAC is defined. The Hazard Categorization is based on a very conservative evaluation of the process. For the Hazard Categorization to be exceeded, all volume available in the concentrate tanks would need to be filled with waste derived at the maximum limits of both 1) HCSOF radionuclides allowed in to the facility, 2) the

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						concentration ability of the evaporator, and 3) deviating from operational procedures (i.e., one vessel full and sampled awaiting transfer, one vessel being filled and the third empty, awaiting filling). While the hypothesized configuration, Including ongoing precipitation, is theoretically possible, it is very unlikely to occur during operations. If even a single tank can be verified to be empty or have been derived from waste at 15% of the HCSOF limits (e.g., it contributes 0 or .15 instead of 1 to the sum of fractions), it is assured that the Hazard Categorization cannot be exceeded, even allowing for an appropriate margin in the establishment of the facility limit. **Closure Verification:**

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