Office of Enterprise Assessments Review of the Hanford Site Waste Treatment and Immobilization Plant Project
Engineering Processes

October 2015

Office of Nuclear Safety and Environmental Assessments
Office of Environment, Safety and Health Assessments
Office of Enterprise Assessments
U.S. Department of Energy

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ACRONYMS

ANSI	American National Standards Institute
APPS	Aspen Process Performance Simulation
ASME	American Society of Mechanical Engineers
ASX	Autosampling System
ATS	Action Tracking System
BNI	Bechtel National, Incorporated
BOD	Basis of Design
BOF	Balance of Facilities
CDR	Construction Deficiency Report
CFR	Code of Federal Regulations
CM	Configuration Management
CRAD	Criteria, Review and Approach Document
DCP	Design Change Package
DOE	U.S. Department of Energy
DX	Direct Expansion
EA	Office of Enterprise Assessments
EDMS	Electronic Document Management System
EIA	Electronics Industries Alliance
EIE	Engineering Impact Evaluation
ETG	Emergency Turbine Generator
FCU	Fan Cooled Unit
FDD	Facility Design Description
HLW	High-Level Waste
HMH	HLW Melter Handling
ITS	Important to Safety
LAW	Low-Activity Waste
LVE	Low Voltage Power Distribution System
MIP	Managed Improvement Plan
NCR	Non-conformance Report
OE	Organizational Effectiveness
ORD	Operations Requirements Document
ORP	DOE Office of River Protection
P&ID	Piping and Instrumentation Diagram
PDSA	Preliminary Documented Safety Analysis
PIBOD	Process Inputs Basis of Design
PIER	Project Issues Evaluation Report
SC	Safety Class
SDD	System Design Description
SRD	Safety Requirements Document
SSC	System, Structure, or Component
STD	Standard
TRB	Technical Requirements Baseline
TRMS	Technical Requirements Management System
TSR	Technical Safety Requirement
UPE	Uninterruptible Power Electrical
UPS	Uninterruptible Power Supply
VRLA	Valve-Regulated Lead Acid
WTP	Hanford Site Waste Treatment and Immobilization Plant

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EXECUTIVE SUMMARY

The U.S. Department of Energy Office of Environment, Safety and Health Assessments, within the independent Office of Enterprise Assessments (EA), conducted a review of engineering processes at the Hanford Site Waste Treatment and Immobilization Plant (WTP) Project. EA evaluated the effectiveness of engineering process improvements implemented by the contractor engineering organization in response to significant issues identified by the DOE Office of River Protection (ORP). Over a period of time beginning in 2011, ORP had identified a number of technical and performance issues with the engineering and construction contractor (Bechtel National, Incorporated (BNI)) on WTP. Those issues led to major work stoppages and resource intensive recovery efforts which were documented by BNI in a Managed Improvement Plan (MIP). The MIP was a complex compilation of commitments and deliverables to be accomplished over a multi-year effort. BNI completed MIP commitments related to engineering processes in 2014.

This review sampled the flowdown of safety basis requirements, from the authorization basis to the system design descriptions, lower-tier piping and instrumentation diagrams, calculations, specifications, and other detailed design documents. The review of engineering processes focused on the quality of engineering procedures governing essential areas of the design function and an examination of process upgrades driven by commitments in the BNI MIP. The review also assessed the configuration management program for the implementation of an adequate design change control process. Corrective action and internal assessment processes within the engineering organization were also reviewed.

The updated engineering procedures generally provided a sound basis for acceptable performance in the areas reviewed. Overall record quality is adequate, although some minor concerns were noted. The electronic document management system was effective, especially with its ability to create trackable relationships between documents and input references to facilitate identification of how changes in one document may impact the information in other documents. With a few exceptions, the configuration management program is well designed and documented in approved procedures.

Completed corrective actions reviewed from a limited non-statistical sampling of recent problem reports within the engineering organization were adequate. However, problems were noted in an older corrective action document in which actions were closed without accomplishing the needed corrective action.

The self-assessment program within the BNI engineering organization was well defined and was implemented adequately in the sample reviewed. Recently developed system design descriptions provided a much more detailed and comprehensive set of system requirements and were an improvement over the previous system descriptions, although system design description development is an ongoing process and further refinements are needed. Finally, engineering calculations and other design documents were generally of acceptable quality and in compliance with applicable procedures.

Overall, BNI has been successful in developing and implementing major improvements in engineering processes and procedures, including improvements in the configuration management program, the internal assessment program, and the corrective action program. The BNI engineering program is now fundamentally sound, however, some areas for improvement were identified.

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1.0 PURPOSE

The U.S. Department of Energy (DOE) Office of Environment, Safety and Health Assessments, within the independent Office of Enterprise Assessments (EA), conducted a review of engineering processes at the Hanford Site Waste Treatment and Immobilization Plant (WTP) Project. The purpose of this EA assessment effort was to evaluate the effectiveness of engineering process improvements implemented for that project within the contractor engineering organization.

EA performed this review at the Bechtel National, Incorporated (BNI) offices in Richland, Washington from April 13 through May 21, 2015. This report discusses the scope, background, methodology, results, and conclusions of the review. A summary of the opportunities for improvement identified by the review team is included.

2.0 SCOPE

This review examined WTP engineering processes with a focus on process improvements made by the principal project contractor, BNI, in response to significant issues identified by the DOE Office of River Protection (ORP). BNI developed a Managed Improvement Plan (MIP) containing specific commitments, including several that impacted engineering procedures and processes. Revision 1 of the MIP, issued August 28, 2014, formed the basis for portions of the review. EA reviewed the procedures that implemented the planned process improvements and a representative sampling of engineering deliverables produced under the revised processes, consistent with the assessment scope defined in the *Plan for the Office of Enterprise Assessments Review of Engineering Processes and Compliance at the Hanford Tank Waste Treatment and Immobilization Plant Project*, dated April 2015.

3.0 BACKGROUND

ORP was established in 1998 to manage the 56 million gallons of liquid or semi-solid radioactive and chemical waste stored in 177 underground tanks at the Hanford Site. ORP serves as DOE line management for two functions: the Tank Farms, which maintain the 177 underground storage tanks; and the WTP, which is under construction and will be used for retrieval, treatment, and disposal of the waste stored in the underground tanks.

EA's oversight program is designed to enhance DOE safety and security programs by providing DOE and contractor managers, Congress, and other stakeholders with an independent evaluation of the adequacy of DOE policy and requirements and the effectiveness of DOE and contractor line management performance in safety and security and other critical functions as directed by the Secretary of Energy. The DOE independent oversight program is described in and governed by DOE Order 227.1, *Independent Oversight Program*, and EA implements the program through a comprehensive set of internal protocols, operating practices, inspector guides, and process guides.

4.0 METHODOLOGY

Criteria used to define the scope of this review were found in Criteria, Review and Approach Document (CRAD) 45-58, *Review of Documented Safety Analysis Development for the Hanford Site Waste Treatment and Immobilization Plant (LBL Facilities)*, Section 5 and in CRAD 31-4, *Integrated Safety Basis and Engineering Design Review*, Criteria 6 through 9. Each CRAD includes inspection criteria, activities, and lines of inquiry structured to support the review.

EA initially identified and reviewed the engineering procedures governing key processes for the development of engineering deliverables and control of the facility configuration. Procedure revisions used by BNI to implement process improvement commitments were included in this scope. EA assessed compliance with the upgraded processes by defining the initial scope of documents to be reviewed based on the population of system design descriptions (SDDs) that had completed the first phase of the upgrade process. EA examined the flowdown of safety basis requirements, both from the authorization basis to the SDDs and from those documents to lower-tier piping and instrumentation diagrams (P&IDs), calculations, specifications, and other design documents. EA also interviewed personnel responsible for developing and executing the process upgrades, including working level engineers who use those processes on a daily basis.

The scope of this review does not include oversight of the ORP WTP Engineering Division contractor oversight process, as that will be the subject of a follow up review in FY2016.

The members of the EA review team, the Quality Review Board, and EA management responsible for this review are listed in Appendix A. A detailed list of the documents reviewed and personnel interviewed relevant to the findings and conclusions of this report is provided in Appendix B.

5.0 RESULTS

5.1 Process Reviews

Criteria

The key design documents, including SSC [system, structure, or component] *design basis and supporting documents, are identified and consolidated to support facility safety basis development and documentation. They are kept current using formal change control and work processes. (CRAD 45-58) (10 CFR 830)*

Configuration management must be used to develop and maintain consistency among system requirements and performance criteria, documentation, and physical configuration for the SSCs within the scope of the program. (CRAD 31-4) (DOE Order 420.1B, Change 1)

Background

EA's review of engineering processes initially focused on the quality of engineering procedures governing essential areas of the design function and included examination of process upgrades driven by commitments in the MIP. EA then assessed the configuration management (CM) program to determine whether those procedures could collectively implement adequate design change control. Finally, EA looked at application of the corrective action and internal assessment processes within the engineering organization to determine whether adequate mechanisms were in place and in use to detect and correct any future problems that might occur.

5.1.1 Engineering Procedures

24590-WTP-3DP-G04B-00037, *Engineering Calculations*, appropriately defines the requirements for preparing, checking, approving, revising, filing, retaining, and releasing calculations. The procedure also defines what constitutes Preliminary, Committed, or Confirmed calculations and when and how the results of those different stages of a calculation may be used. Assumptions are documented and, if unverified, must be resolved before the calculation goes to Confirmed status. A revision on November 26, 2014, appropriately added such items as a Calculation Procedure Compliance Checklist, direction on establishing Electronic Document Management System (EDMS) links to calculation references, direction to initiate an Operations Requirements Document (ORD) Change Notice for assumptions that establish operational limits, and direction on when to conduct an engineering impact evaluation (EIE). The procedure requires each calculation to include a Tracked References section listing source references that, if revised, could impact the content or results of the calculation. The procedure also appropriately requires tracked reference relationships to be linked and retrievable in EDMS. This approach is considered a strength, or best practice, from a CM standpoint, because when those source documents are revised, the calculation can be readily identified as a potentially impacted document. Implementation of this instruction for engineering calculations produced after the initial issuance of the MIP is discussed in Section 5.3 of this report.

24590-WTP-3DP-G04T-00906, *Isometric drawings and Associated Calculations*, governs calculations performed by the stress analysis and commodity support design groups and is an adjunct procedure to *Engineering Calculations*, discussed above. An interview with the Engineering Group Supervisor for the Low-Activity Waste (LAW) facility stress and support group indicated that most of that group's calculations remain in "interim" status, neither Committed nor Confirmed. Interim calculations are kept on a shared drive in ProjectWise (engineering computer file storage software) rather than in the formal document control system. In this status, they are not access-controlled and may be revised completely apart from any formal approval process. These calculations form the design basis for commodity support location, fabrication, and installation drawings that have been issued for construction. This uncontrolled process is a CM concern and is discussed further in Section 5.1.2 below.

24590-WTP-3DP-G04T-00901, *Design Change Control*, governs the revision processes for most types of engineering documents. This procedure is generally adequate, although section 3.4.1 of the procedure allows issuance of drawing revisions without incorporation of other identified impacts, indicating a weakness in the design control process. Guidance for incorporating formal change documents (procedure section 3.4.5.1) is more rigorous, with limits that drive the revision process based on the number of outstanding changes against a document. However, the provisions of that section do not apply to documents with an alpha character revision level (BNI applies alpha character revision levels to documents in Committed status and uses numeric revision levels once a document reaches Confirmed status). Documents in that status could accumulate numerous open changes, resulting in a challenge to the design control process. (See **OFI- BNI-01**.)

24590-WTP-3DP-G04B-00027, *Design Verification*, establishes a strong process for design verification and design reviews.

24590-WTP-3DP-G04B-00093, *System and Facility Design Descriptions*, appropriately defines requirements for preparation, review, approval, and control of SDDs and facility design descriptions (FDDs). It defines an SDD as a compilation of the technical requirements to be implemented in the design of a system. The procedure requires the SDD/FDD to describe interfaces, cite sources for individual requirements, clearly designate HOLDs on requirements that may not yet be suitable for implementation in the final design, identify Action Tracking System (ATS) items for tracking and resolution of each HOLD, and explain how the individual requirements should be verified to be met. The procedure also requires the SDD/FDD originator to coordinate Requirement Developer review and validation of the described requirements and to prepare an EIE concurrent with supporting required SDD/FDD independent checking, engineering reviews, concurrences, and final approval. Implementation of this instruction is discussed in Section 5.2 of this report.

Electrical engineering group design criteria 24590-WTP-DC-E-01-001, *Electrical Design Criteria*, summarizes, in a single document, the electrical design parameters for the WTP project. EA's review was limited to sections 6.6, *Uninterruptible Power Supply Distribution, UPE System Equipment*, and 7.6, *SC Uninterruptible Power Supply Distribution, UPE System Equipment*. These sections of the design criteria add significantly to the Uninterruptible Power Electrical (UPE) SDD design requirements for the uninterruptible power supply (UPS), associated batteries, bypass transformers, alarms and indications, and power feeds and were consistent with the requirements listed in the UPE SDD. EA did not review implementation of this instruction since no recent High-Level Waste (HLW) facility UPE design products have been created or revised using the current revision.

5.1.2 Configuration Management

DOE Order 413.3B, *Program and Project Management for the Acquisition of Capital Assets*, states that "A configuration management process must be established that controls changes to the physical configuration of project facilities, structures, systems and components in compliance with ANSI/EIA-649A and DOE STD 1073-2003." DOE Standard (STD) 1073-2003, *Configuration Management*, details an acceptable methodology for meeting these CM requirements. Title 10 Code of Federal Regulations (CFR) Part 830, *Nuclear Safety Management*; DOE Order 420.1B, *Nuclear Facility Safety*; and DOE Order 433.1, *Maintenance Management Program for DOE Nuclear Facilities*, also contain requirements pertinent to various aspects of a CM program. For WTP, BNI captures CM requirements in 24590-WTP-PL-MG-01-002, *Configuration Management Plan*, and repeats them in its Quality Assurance Manual. The plan incorporates requirements derived from International Standards Organization 10007:1995, *Quality management systems - Guidelines for Configuration Management*; American National Standards Institute/Electronics Industries Alliance (ANSI/EIA)-649-A, *National Consensus Standard for Configuration Management*; and American Society of Mechanical Engineers (ASME) Nuclear Quality Assurance -1-2000 Part I, *Requirements for Quality Assurance Programs for Nuclear Facilities*. In addition to these documents, BNI has implemented definitions from DOE STD 1073, tailored for use on the WTP project, to help develop the CM program.

BNI has aligned the WTP process with the following elements, per the requirements derived from the aforementioned documents; DOE STD 1073 process elements have been mapped to the WTP project:

- Configuration planning and management.
- Configuration identification and documentation.
- Configuration control (change management).
- Configuration status tracking and reporting.
- Configuration verification and audit.

The requirements for each of these elements are described in detail in Section 2 of the CM Plan. These requirements are implemented by several procedures and guides that define the various processes used for the WTP project, such as design changes, calculations, field changes, and engineering drawings. The CM Plan identifies over 100 procedures and guides that are used to implement the CM program.

In examining the CM program, this review focused on change control and document control – the areas most closely related to the engineering function. Among other documents, SDDs, calculations, and design change packages (DCPs) were reviewed to verify implementation of the requirements in the CM Plan and implementing procedures. One of the primary documents used to implement the design change process is procedure 24590-WTP-3DP-G04T-000901, *Design Change Control*. It defines the process for managing changes to design documents and provides an appropriate level of detail.

EA reviewed two DCPs (24590-BOF-DCP-FP-15-0001, *Modification to FSW Diesel Alternator Belt Guard on FSW-SP-00001*, and 24590-BOF-DCP-E-15-0001, *Cathodic Protection System – Addition of New Detail for Anode Wire Crossing Obstruction*) to sample implementation of the design change process. These DCPs were selected for review because they were completed after the latest revision of the CM Plan (approved in February 2015). Both DCPs were completed in accordance with the approved procedure, 24590-WTP-3DP-G04T-00907, *Design Change Package*; identified the appropriate affected documents and approval authorities; and provided a level of detail adequate for the significance of the changes that are described.

A significant aspect of the CM program is the identification of how a proposed change impacts other project documents. For example, a revision to a design temperature calculation performed by the mechanical discipline might have far-reaching impacts on analyses performed by the piping stress analysis group. An acceptable design change process as described by DOE STD 1073 ensures that changes are evaluated to identify impacts on other documents (and other disciplines) so that the impacted documents can be revised as necessary to keep the overall design consistent. 24590-WTP-GPG-ENG-0170, *Impact Evaluation*, is used for that purpose at WTP. When changes are proposed, an EIE form is circulated to other disciplines to identify their impacted documents, and those disciplines are then required to revise their documents once the change is approved. However, tracking of impacted documents within the disciplines to implement the required revisions proved to be problematic. Interviews with two discipline group supervisors indicated that one used an ATS, but the other used no tracking system beyond keeping a copy on his desk. The EIE process is actually governed by a "guide" rather than a procedure. However, several individuals stated that guides must be followed like procedures, and BNI provided a copy of management policy statement 24590-WTP-G63-MGT-012, *Procedure and Guide Use and Adherence*, which states that, "Procedures and guides are followed as written."

A December 4, 2014, revision of 24590-WTP-GPG-ENG-0170 allowed the exclusion of alpha character revisions and revision 0 documents from the EIE process. Consistency of design across discipline and system boundaries requires that the impacts from a design change be identified at every stage of the design development process, including the initial documents. (See **OFI-BNI-01**.)

BNI limits the number of outstanding changes against engineering documents and requires a document revision to incorporate those changes once the limit is reached. The limit is reduced when the associated system has been turned over to startup. Infoworks (an EDMS overlay) is used to track unincorporated changes but is not used to drive the revision process. This aspect of the document control process is beneficial, since it limits the potential impact of multiple design changes on a single document.

In the document control area, a positive aspect of the CM program is that BNI uses EDMS to identify relationships between documents. When a new document is entered into EDMS, relationships are created between that document and any documents referenced in it, as discussed above in Section 5.1.1 with regard to the engineering calculation procedure. Document control entries are also verified by being checked by a second person within 24 hours of origination.

The process for creating interim calculations established in procedure *Isometric drawings and Associated Calculation,* section 5.1.1, governing stress analysis and commodity support calculations, may result in design output drawings being issued for construction without the calculations being formally issued or placed into document control. These calculations exist only in ProjectWise (engineering computer file storage software) on a shared drive and are not tied to source documents, as is the case with documents in EDMS. Consequently, the document control process cannot identify interim calculations as impacted documents when an upstream higher-tier or design input document is revised. This weakness is exacerbated by lack of any specific guidance in *Isometric drawings and Associated Calculations* to ensure that all design input references are re-checked and verified to be current when updating this group of calculations to Committed or Confirmed status. These characteristics of the process created in *Isometric drawings and Associated Calculations* for a very specific population of calculations create challenges to the design organization's ability to ensure that these interim calculations are kept current and that changes to design inputs affecting these calculations can be identified and evaluated. (See **OFI- BNI-02** and **OFI-BNI-03**.)

5.1.3 Internal Assessments and Corrective Action Program

Internal Assessments

The BNI engineering organization at WTP is divided into two functional groups directly under the engineering manager: the Design Authority and the Design Agency. Each one has distinct responsibilities for engineering work quality, and each has a line organization to fulfill its responsibilities to ensure engineering quality. BNI Project Instruction 24590-WTP-3DP-G04T-00912, *Design Authority and Design Agency*, defines the respective responsibilities of the two groups.

The Design Authority effectively sets the rules – i.e. the design basis and the codes and standards applicable to the project. The Design Authority includes the Process Assurance organization, which manages the self-assessment function within engineering to ensure that approved engineering practices are followed and project design requirements are met. The Process Assurance Manager within the Design Authority group owns the engineering self-assessment program and relies on the BNI Organizational Effectiveness (OE) organization for assessors to perform engineering self-assessments. Currently, three assessors from OE are assigned to the Process Assurance Manager to perform assessments of WTP engineering activities for the Design Authority.

The Design Agency organization within the BNI engineering organization produces the design output documents implementing the design basis: engineering drawings, calculations, and equipment specifications for construction and procurement. The Design Agency includes the Quality Engineering organization, which performs in-line reviews of such design activities as calculations, specifications, drawings, material requisitions, field changes, and selected supplier submittals. The Quality Engineering reviews are part of the BNI engineering product development process, not self-assessments. At the time of this review, the Quality Engineering Manager had a Quality Engineering Supervisor and six quality engineers performing this function, with two additional quality engineer positions to be filled.

The BNI engineering self-assessment function is well defined. The BNI OE organization owns the applicable procedures, which address assessment planning, scheduling, and performance. The *WTP Assessment Guide*, 24590-WTP-GPG-MGT-034, recommends using subject matter experts. However, the BNI procedures addressing the self-assessment program do not require assessors to have expertise in conducting assessments and there are no qualification standards for assessors. Additionally, the self-assessment procedures do not require management and other assigned individuals who perform engineering self-assessments to have minimum training or familiarization on the self-assessment procedures or assessment techniques. (See **OFI-BNI-04**.)

The various divisions within the Design Authority and Design Agency perform internal self-assessments of their activities on a planned and scheduled basis. The Design Authority Process Assurance Manager maintains the annual schedule of planned engineering self-assessments and monitors completion of planned assessments. BNI performed 77 engineering self-assessments between March 2014 and February 2015, covering a wide range of engineering activities that included calculations, construction, material reviews, and surveillance of vendor compliance with specifications. A sample of five engineering self-assessments reviewed by EA were performed satisfactorily by the Design Authority and Design Agency. A sample of three non-conformance reports (NCRs) and two construction deficiency reports (CDRs) addressing engineering products reviewed by EA were also satisfactorily dispositioned.

Corrective Action Program

EA reviewed a limited non-statistical sample of seven recent corrective action documents from a listing of all corrective action documents originated by engineering within the previous six months. In general, the engineering organization adequately identified and completed this sample of recent corrective actions. However, in reviewing older corrective action documents pertinent to other areas of this review, EA identified two concerns.

The first concern involves 24590-WTP-PIER-MGT-10-0129-C, *Equipment Penetrating Fire Barriers and Shielded Hatch Requirement Not Met [RVP]*. (New BNI corrective action documents are called Condition Reports, while older ones were called Project Issue Evaluation Reports, (PIERs). Of the many items that penetrate fire barriers, shield doors present a particular challenge because of the requirement that shield doors have an engineered air gap to support cascade ventilation for contamination control. Four corrective actions were created to address the issue of shield doors in fire rated walls. Corrective Action CA-19-24590-WTP-PIER-MGT-10-0129-C identified the particular shield doors that were problematic, while the other three corrective actions were created to address the problematic equipment on a facility-by-facility basis. CA-20-24590-WTP-PIER-MGT-10-0129-C is the HLW facility-specific corrective action to address several shield doors with engineered air gaps in one-hour fire rated barriers. A meeting determined that the one-hour fire rated barriers were correctly classified, and the response to the corrective action reads, "Meeting was held on 7/25/2012. Evaluation recorded in meeting minutes issued in CCN 250726." The action was incorrectly closed July 27, 2012, and verified on August 24, 2012, without ever identifying appropriate corrective action for the shield doors in one-hour fire rated walls in the HLW facility. WTP management added the appropriate action to 24590-WTP-PIER-MGT-10-0129-C.

The second example, 24590-WTP-MGT-PIER-13-1270-C, *Review of Design Required for LAW CM DX Air Conditioners*, addresses which refrigerant (R-22 or one more environmentally friendly) would be used in certain specific air conditioners. As part of the corrective actions, BNI engineering placed HOLDs on numerous design documents until the appropriate path forward could be determined. While this issue was in process, additional corrective actions were added to address similar systems in the HLW facility.

In October 2014, the related Condition Report was closed, with all actions verified as complete. However, the resolution of the underlying issue was to install R-22 based on equipment already purchased. No actions were created to remove the HOLDs on numerous design drawings. As an example, Drawing Change Notice 24590-HLW-M8N-C2V-00046, *Place HOLD on HLW C2V DX Fan Coil and Condenser Units*, was approved September 22, 2014, justifying the change by citing PIER 24590-WTP-PIER-MGT-13-1270-C. The required modification to the design documents includes noting that the HOLDs are "Pending resolution to 24590-WTP-PIER-MGT-13-1270-C," even though it had already been resolved and closed. The Drawing Change Notice, if not cancelled, will cause BNI to expend resources to modify three different drawings (adding the HOLDs) and will later cause expenditure of additional resources to remove the HOLDs. In addition, a Condition Report may be required to document the existence of the HOLDs without any open corrective action program item to address the removal of the HOLDs. (See **OFI-BNI-05**.)

5.2 Safety Basis Implementation Reviews

Criteria

System design basis documentation and supporting documents must be compiled and kept current using formal change control and work control processes. When design basis information is not available, documentation must include (a) system requirements and performance criteria essential to performance of the system's safety functions, (b) the basis for the system requirements, and (c) a description of how the current system configuration satisfies the requirements and performance criteria. (CRAD 31-4) (DOE Order 420.1B, Change 1)

Background

The WTP project began a time of transition in 2013, driven by the significant issues identified by ORP and the process improvement commitments that resulted. The transition was still ongoing during this EA review. In addition to the aforementioned upgrades to many engineering processes and procedures, the BNI nuclear safety basis procedures, guides, and desktop instructions were under revision. Facility and system descriptions were being replaced with facility and SDDs. The technical requirements management system (TRMS) was transitioning to IBM Rational DOORS tracking software. The Nuclear Safety Engineering organization experienced a self-imposed suspension of work under 24590-WTP-MSOW-NS-15-0001, *NSE EDPI/Design Guide Conflicts with ORP Letter of Technical Direction.* The WTP project, as a whole, was undergoing internal changes and process revisions in response to multiple critiques, findings, and oversight reports documenting deficiencies in historical engineering processes, as well as project changes imposed by the BNI MIP.

The WTP technical requirements baseline (TRB) is defined in 24590-WTP-RPT-ENG-01-001, *Technical Baseline Description.* The TRB is the collective set of criteria statements, from various sources, that define the envelope of functional, performance, safety, and interface criteria with which the completed design is expected to comply. Primary design basis and criteria baseline documents include the BNI Contract, DE-AC27-01RV14136; 24590-WTP-DB-ENG-01-001, *Basis of Design;* 24590-WTP-SRD-ESH-01-001-02, *Safety Requirements Document Volume II*; and 24590-WTP-PSAR-ESH-01-002-04, *Preliminary Documented Safety Analysis to Support Construction Authorization; HLW Facility Specific Information* (PDSA).

The Preliminary Documented Safety Analysis (PDSA) provides safety analyses and control information for the WTP. EA reviewed the PDSA for content and the subsequent identification of controls, safety designation, safety function, performance criteria, and functional requirements. PDSA Chapters 3 and 4 provide the requisite information to conclude that the final design should meet functional requirements as they are translated from the PDSA into the design process. The BNI WTP engineering design process is described in WTP EDPI 24590-WTP-3DP-G03B-00001, *Design Process*. Additionally, PDSA Chapter 5 provides preliminary technical safety requirement (TSR) assignments for designated controls, along with anticipated surveillance requirements. These assignments provide additional design input regarding expected system access, operability, and testing.

The WTP design effort requires integrating design codes and standards, functional requirements, and performance criteria. 24590-WTP-3DP-G04B-00001, *Design Criteria*, adequately defines the requirements for identifying, selecting, controlling, and documenting project design criteria from source documents and for controlling changes and revisions to 24590-WTP-DB-ENG-01-001, *Basis of Design* (BOD) and 24590-WTP-SRD-ESH-01-001-02, *Safety Requirements Document Volume II* (SRD).

The basis of design (BOD) document provides, among other information, WTP design requirements and applicable codes, standards, regulations, and guidelines. In the design process, the BOD is supplemented by the SRD and PDSA which provide additional codes, standards, and design requirements applicable to the safety functions of safety components.

All WTP technical design requirements are managed in accordance with 24590-WTP-3DP-G04B-00004, *Technical Requirements Management.* This procedure establishes processes for identifying, validating, allocating, implementing, verifying, and controlling technical requirements that pertain to WTP design. The TRMS is the primary technical requirement management tool and the source for all subsequent design-related documents. System, facility, and functional requirements are derived from the TRB, through the TRMS.

Derived from the WTP contract, BOD, SRD, PDSA, and other documents in the TRB, the SDD is prepared in accordance with 24590-WTP-3DP-G04B-00093, *System and Facility Design Descriptions.* The SDD is a compilation of the technical requirements for system design and describes system inputs, outputs, functions, technical requirements, and interfaces providing the basis for design. SDDs also establish bases for verifying that requirements have been appropriately incorporated. Since the WTP project only recently began to generate SDDs and many system designs have not reached maturity, some verification requirements and methods do not currently appear but will ultimately be included. The Design Authority organization is responsible for preparing and maintaining SDDs until the included systems are turned over to Operations. Thereafter, the Plant Engineering organization is responsible for maintaining the document; however, the engineering Design Authority organization retains responsibility for establishing and defining design requirements. The SDD integrates BOD and PDSA requirements and criteria at the system/component level and provides traceability from the design back to the TRB.

MIP corrective action commitment MIP-51, *Requirements Flow Down and Design Change Management*, committed BNI to updating and validating the technical baseline and the development of SDDs and FDDs. The stated purpose of the SDDs and FDDs is to document the comprehensive set of requirements for each specific system or facility to support design engineers in developing system design and procurement documentation, while also establishing the methods for verifying that each requirement is met. The plan called for development of the SDDs/FDDs using a phased approach based on project phases and priorities. The initial Phase 1 development effort currently under way is intended to flow down upper-tier design requirements from the PDSA, SRD, BOD, ORD, and WTP contract in a manner that ensures correct interpretation, incorporation, and verification. Phase 1 SDDs/FDDs are not required to include information related to the TSRs, Operation & Maintenance procedures, discipline/function-specific standards, or any other requirement not yet formally established. Later SDD/FDD development is intended to update the Phase 1 documents after development of the design, before turnover to startup, and during commissioning. Continued development of the SDDs through the multi-phase process described here will be the subject of an EA follow-up review.

System Design Description Reviews

SDDs are being prepared for safety related and mission critical systems. BNI’s design review process includes multi-discipline reviews of SDDs at the 30%, 60%, and 90% completion milestones. Completion milestones for systems roughly follow those of the facility, with LAW approaching 90%, HLW approaching 60%, and the Pretreatment Facility less than 30%. These reviews are intended to ensure consistency of design approach across disciplines for each system and to validate compliance with the safety authorization basis. All requirements from the authorization basis are captured in a requirements database, and a requirements verification matrix is used to validate system compliance.

SDDs are initially issued with an alpha revision level if they are not fully aligned to the PDSA—e.g. if they contain requirements aligned with the Safety Design Strategy. BNI intends to move these documents to a numeric revision following expected updates to the PDSA and associated alignment of the requirements. Where there is full alignment with the PDSA, the SDDs may go directly to a numeric revision. Issuance of the numeric revision does not preclude the placement of HOLDs on specific requirements within the SDD/FDD, based on various factors that may warrant restricting application of that requirement in design.

The current revision of 24590-HLW-3ZD-C5V-00001, *HLW C3, C5, and Atmospheric Reference Ventilation Systems Design Description,* documents requirements pertaining to that system but lacks other information necessary to constitute an adequate source of design information. BNI management has described a multi-step process of future revisions that will add additional information over several months. Validation Sheet signatures confirm that Requirement Developers reviewed and agreed with the SDD's stated requirement interpretations. All individual upper tier SSC design requirements, where documented in the SDD, include references to their associated sources and proposed means of verification that each requirement is met. As required, the SDD also flags requirements with a HOLD notation and an associated ATS reference where the requirement statement involves an unresolved technical issue or known inconsistencies among source requirements, or where additional work is required for resolution.

24590-HLW-3ZD-UPE-00001, *HLW Uninterruptible Power Electrical (UPE) System Design Description*, is well written, informative, and generally compliant with the BNI WTP requirements and documented expectations for a Phase 1 SDD. As expected based on the multi-step development process described above, it incorporates only the requirements currently defined in the PDSA, BOD, SRD, ORD, and WTP contract; it does not currently address requirements otherwise contained in SSC design criteria, guides and specifications, or discipline/functional standards incorporated by reference. The SDD appropriately identifies system interfaces, including the safety class (SC) emergency turbine generators (ETGs), non-SC standby diesel generators, SC and non-SC low voltage electric systems, and principal electrical loads. When it was approved, it appropriately superseded the HLW section of the WTP UPE System Description and was appropriately supported by an EIE, a System Description Change Notice, and a positive Nuclear Safety Evaluation screen. However, the SDD:

- Does not specifically address the performance criteria of PDSA Section 4.3.12.4, which states that "The UPE SSCs are designed to withstand or be protected from direct liquid spray." SDD section 3.4.2.3 requires HLW UPE Safety equipment to be designed to operate and withstand the most severe environmental conditions identified in the HLW Room Environment Data Sheets; however, the referenced data sheets do not acknowledge the presence of a wet sprinkler system in HLW SC UPS room H-A217. EA acknowledges that PDSA Section 5.6.31 requires fire suppression for room H-A217 to be provided by a pre-action sprinkler system, which utilizes dry sprinkler branch piping. The WTP pre-action sprinkler systems only discharge water upon both a signal from a local fire detector and the opening of a normally closed sprinkler spray nozzle, generally occurring as a result of high temperature (fire). Further, it is acknowledged that the wet portions of the pre-action sprinkler system, which include the fire water source, control valve, actuating valve, and trim piping, are located outside of H-A217. However, the SDD does not reconcile the use of a pre-action sprinkler system with the design performance requirements of PDSA Section 4.3.12.4 and SDD Section 3.4.2.3. (See **OFI-BNI-06**.)

- Does not address the needed interface with the C1V Direct Expansion/Fan Cooled Units (DX/FCUs) required to ensure operability. PDSA Section 5.5.12 states: "The TSR operability requirements for the SC electric power (HLW systems only) include the following elements:
  - SC power (ETGs at the BOF [Balance of Facilities]) are operable.
  - The HLW SC UPE distribution system is operable.
  - The C1V safety battery room ventilation system fan coil units (FCU) and condensers are operable."

  PDSA Section 3.3.6.1.2.1 states: "The credited SC controls to protect the SSCs in the Safety battery room include: …Temperature-compensated charging to prevent thermal runaway. This will limit over-voltage/overcurrent charging across the expected temperature range ensured by the room cooling unit."

  PDSA Section 3.3.6.1.3.1, Requirements for Selected Control Strategy, states that "The following rooms will have safety classified cooling, supplied with power from emergency generators, with the same safety classification as the SS [safety significant] or SC SSCs located in the room or corridor that are to be protected." The section then follows with a table listing areas (rooms) and the safety equipment protected. The only listed safety equipment protected for the SC UPE Battery Rooms H-A303B and H-A217 are the Safety UPS batteries, not any of the other electrical equipment located in those rooms. Similar stated requirements for SC DX/FCU cooling of HLW SC UPS batteries are found in PDSA Sections 4.3.17 and 4.4.25. The Interface section of the SDD does not include the SC C1V DX/FCUs. (See **OFI-BNI-07**.)

- Does not explain the basis for the required difference in the low voltage power distribution system (LVE) configuration for the power fed to the SC and non-safety UPE equipment. Each SC UPS and associated bypass transformer are fed power from the same LVE source, while each non-safety UPS and associated bypass transformer are fed from different redundant LVE sources. The SDD format requires inclusion of a basis for each requirement. However, because the UPE power feed configuration requirements are specified in 24590-WTP-DC-E-01-001, *Electrical Design Criteria*, a discipline/function-specific standard, BNI does not currently require the Phase 1 SDD to explain those design details. BNI plans to address additional design details in the Phase 2 SDD development effort, as discussed earlier in this report.

- Does not explain the basis for requiring each SC UPS battery to consist of two paralleled redundant series strings of battery cells with separate isolation switches. (See **OFI-BNI-07**.)

- Sometimes does not explain the basis of stated requirements, either being silent or just paraphrasing the requirement; e.g., what constitutes acceptable quality of UPS output power, or why SC UPS input and bypass power must be from an ETG- backed source. (See **OFI-BNI-07**.)

The following documents are referenced in SDD 24590-HLW-3ZD-UPE-00001 and UPE SSC-related design documentation supporting the SDD:

- BNI report 24590-WTP-RPT-E-12-001, *Analysis of VLRA DC-UPS Installations in the WTP Facilities for Hydrogen Generation*, concluded that:
  - The valve-regulated lead acid (VRLA) battery design complies with all applicable industry codes and standards.
  - The current design presents no realistic potential for hydrogen emission buildup from the DC/UPS batteries to exceed the maximum allowable gas concentration within a reasonable time. A minimum time to reach the maximum allowable 1% hydrogen concentration was calculated at

not less than seven hours of continued emissions, with no credit taken for a forced ventilation system.

EA verified through independent calculation that BNI's conclusion about hydrogen emission buildup was correct based on published maximum VRLA battery hydrogen emission rates, float charge current per 100 amp-hour rating, individual battery bank cell counts, battery cell 8-hour amp-hour ratings, standard cell temperatures, 1% hydrogen concentration limit, and conservative estimates of battery installation room volumes without any forced ventilation.

- Engineering Calculation 24590-HLW-E1C-UPE-0000, *Non-ITS* [Important to Safety] *Uninterruptible Power Supply Sizing Calculation*, used an appropriate process for determining the two HLW non-SC UPS sizes as 200 kVA each, based on the assumed loads at that time.

- Engineering Calculation 24590-HLW-E1C-UPE-00001, *HLW Facility ITS Uninterruptible Power Supply Calculation*, dated July 26, 2005, determined that both HLW SC UPS sizes should be 15 kVA. However, the June 7, 2005 HLW SC UPE load list and the UPS sizing calculations are not consistent regarding the loads on each SC UPE panel and whether all UPE panels were addressed. The calculation did not consider the additional non-SC loads attached to the UPE panels that would remain energized from the UPS on loss of offsite power. Additionally, later revisions of the ITS UPS UPE-UPS-30001A & B Single Line Diagrams indicate that additional loads have been added. As a result, the adequacy of the sizes of the indicated 30KVA SC UPE UPS equipment and the associated batteries identified in SDD Table 4-1 cannot be confirmed. (See **OFI-BNI-07**.)

The HLW C1 and C2 Ventilation SDD, 24590-HLW-3ZD-C1V-00001, is well written and informative, and generally meets the BNI WTP requirements and documented expectations for a Phase 1 SDD. The EA review focused principally on verifying the adequacy of the C1V ventilation system to perform its support role for the HLW UPE system. Listed C1V SSC design requirements and system performance criteria address appropriate normal and abnormal (loss of offsite power and or seismic event) UPE SSC environmental conditions required for operability. The SDD indicates that during normal operations, the C1V is appropriately operated with a slight positive pressure relative to atmosphere to promote hydrogen exfiltration without interfering with the cascade design of the contiguous contaminated area ventilation systems. The requirement for C1V Battery Room exhaust is currently designated HOLD with ATS 14-0391 for resolution until it is determined whether the VRLA batteries with temperature-compensated charging require a dedicated exhaust capability. In addition to non-safety air handling units, heaters, fans, humidifiers, and DX/FCUs, the SDD indicates that the SC DX/FCUs backed up by SC ETGs provide necessary UPE SSC room temperature control during loss of offsite power and/or seismic events. However, the SDD:

- Incorrectly indicates that two of six DX/FCUs (C1V-FCU 00008 and C1V-FCU-00010) are designated SC. BNI calculations 24590-HLW-M8C-C1V-00004, *C1V Office Area Load Calculation and Equipment Selection*, and 24590-HLW-M8C-C1V-00003, *C1V Control Room HVAC Load Calculation and Equipment Selection*, demonstrate that these DX/FCUs are not SC. Further, drawing 24590-HLW-M8-C1V-00008001, *C1V FCU Schedule*, indicates that these DX/FCUs are non-safety. EA informed BNI engineering of this discrepancy, and CR 15-00781 was initiated to address it.

- Does not require physical verification that the SC DX/FCUs can maintain the area immediately around the SC VRLA batteries at 77 ± 3 degrees Fahrenheit in the middle of a summer day throughout an 8-hour test with other SC loads operating and the C1V ventilation shutdown simulating a loss of offsite power. This verification requirement is similar to the demonstration requirement of SDD paragraph 3.5.2.1 and the corresponding test acceptance criteria listed in SDD Appendix A, but is more specific to demonstrating the required capability of the SC DX/FCUs and their capability to support VRLA battery operability. Safety Evaluation 24590-WTP-SE-ENS-10-0012 changed the hydrogen control strategy for the HLW UPS batteries in the ITS battery room(s) by establishing a new credited safety control of temperature-compensated charging as replacement for the previously credited safety control of requiring air flow through the battery hydrogen plume. The safety evaluation states: "Temperature-compensated charging to prevent thermal runaway, will limit over-voltage/over-current charging across the expected temperature range ensured by the important to safety (ITS) room cooling Unit," indicating that the new SC requirement depends in part on the SC DX/FCUs providing an expected benign room temperature range in the vicinity of the battery banks. Section 2.5 of the SDD indicates that room temperatures are monitored by temperature instrumentation on each DX cooling unit to maintain local area temperatures within the equipment qualification requirements. The DX/FCUs act as room air conditioners controlled by integral thermostats and are located at some distance from the VRLA batteries. Each SC UPE Battery Room has another thermostat hung on the wall at a distance from the SC VRLA batteries; however, these thermostats do not provide a DX/FCU control function and serve only to alarm on high temperature. The requirement for SC DX/FCU cooling to support SC UPE VRLA battery operability is indicated in PDSA Sections 3.3.6.1.2.1, 3.3.6.1.3.1, 4.3.17, 4.4.25, and 5.5.12, as discussed above under SDD Reviews. Therefore, the existing requirements do not verify that in the event of a loss of offsite power, temperature-compensated charging alone will ensure that air temperatures in the vicinity of the SC VRLA batteries will remain appropriate to prevent thermal runaway. (See **OFI-BNI-08**.)

Further, there were some deficiencies with the SDD referenced documents and C1V SSC related design documentation.

- The UPS Battery Room ventilation design does not address the potential fire and explosion hazard introduced by larger VRLA battery hydrogen emission rates in the first several months of operation. Air Force Pamphlet 32-1186, *Valve-Regulated Lead-Acid Batteries For Stationary Applications*, describes this phenomenon. Specifically, section 2.4.4.3.4 of the pamphlet states, "Although it is true that a VRLA cell operating in the recombinant mode will vent very little gas, there are conditions under which the VRLA cell can vent as much hydrogen as a vented cell." Section 2.4.4.3.5 states that "Under the following conditions, a VRLA cell will vent hydrogen… 2.4.4.3.5.3. During the first few months of operation for a gelled electrolyte cell until it vents enough water to finally become recombinant." (See **OFI-BNI-08**.)

- The C1V-TT-3817, ITS UPS/UPE Battery Room (C1 V-FCU-00010/11) Ambient Air Temperature transmitter, is shown in two different rooms on 24590-HLW-J2-30-00038, Instrument Location Plan, Elev-37. This transmitter provides the signal for a room high-temperature alarm, which could indicate malfunction of the associated SC DX/FCUs. (See **OFI-BNI-09**.)

- HLW SC UPE room ventilation requirement calculations 24590-HLW-M8C-C1V-00004, *C1V Office Area Load Calculation and Equipment Selection*, *Elev-14*, and 24590-HLW-M8C-C1V-00003, *C1V Control Room HVAC Load Calculation and Equipment Selection, Elev-37*, treat the entire room as a single node, without ensuring that the area immediately around the VRLA batteries is maintained within an appropriate temperature range.

24590-HLW-3ZD-HMH-00001, *HLW Melter Handling (HMH) System Design Description* is well written and contains significant information about the equipment, indicating that much of the equipment in the Melter Handling system has already been procured. However, the procedure contains some deficiencies:

- The Validation page lacks a signature for the HVAC Design Requirement Area. The Originators, Checker, Concurrence Reviews, and final Approver did not detect this omission during multiple reviews. EA notified BNI of this discrepancy, and the Systems Engineering manager initiated Condition Report 24590-WTP-GCA-MGT-15-00766, *Validation Review/Signature Not Obtained on SDD*, to address it.

- The verification method does not always reflect the current status of the delivered equipment and its documentation. For example:
    - The verification method for requirement 3.4.1.2.4 Seismic Design includes analysis. The supplier had already provided a portion of this analysis but never resolved all comments on the analysis. The supplier has since gone out of business. The SDD does not reflect the current state of the analysis.
    - The verification method for 3.4.1.2.5 Seismic Interaction includes analysis to demonstrate the SSC's ability to withstand seismic loadings to prevent interactions. The notes say that this analysis will be documented in an Equipment Seismic Qualification Form or supplier seismic design report. However, as noted above, BNI already has all the reports the supplier provided before going out of business. The SDD does not reflect the current, known state of the reports. (See **OFI-BNI-10**.)

- In many cases, the basis discussions do not meet the requirements defined in DOE-STD-3024, *Content of System Design Descriptions.* Although the BNI contract does not require use of DOE-STD-3024, 24590-WTP-3DP-G04B-00093, *System and Facility Design Descriptions*, does state "Minimum SDD and FDD content was developed using DOE-STD-3024, *Content of System Design Descriptions* as guidance." For example:
    - Requirement 3.4.1.1 is a General Requirement for Unloading and Loading Melters. The basis discussion for the requirement does not support the requirement, and instead addresses that the melter overpack is not in the current contract scope.
    - Requirement 3.4.4.2 Emergency Stop Buttons has a basis which discusses which E-Stops will have local indication. There is no statement in the basis about halting equipment operation before injury or other damage can occur.
    - Requirement 3.4.4.3 Emergency Stop Reporting has no basis.
    - Requirement 3.4.4.4.1 Equipment Decontamination has a basis that essentially restates the requirement.
    - Requirement 3.5.1.2 Containment Door Sealing has no basis.
    - Requirement 3.7.3.1 Overpack Door Remote Removal and Replacement has no basis. Since the Overpack is outside of the current BNI contract, the absence of this type of interface requirement results in an incomplete set of requirements to verify that the system will operate as intended. (See **OFI-BNI-10**.)

- As noted previously, there is a fundamental conflict with requirements for shield doors to support cascade ventilation and also serve as fire-rated barriers. For this SDD, the requirements are 3.5.1.1 Engineered Air Gap and 3.5.2.1 Fire Barriers. Neither of these requirements is on HOLD, and this conflict was not addressed during the requirement validation process. (See **OFI-BNI-10**.)

5.3 Technical Product Reviews

Criteria

Key design documents must be identified and consolidated to support facility safety basis development and documentation. (CRAD 31-4) (DOE Order 420.1B, Change 1)

In addition to the SDD assessments documented in Section 5.2.1 above, EA also reviewed a limited number of engineering and design technical products created or revised after the MIP was initially issued.

5.3.1 Mechanical Design Documents

EA reviewed over 150 engineering design documents in the Mechanical discipline, including P&IDs, ventilation and instrumentation diagrams, engineering calculations, vendor submitted calculations, vendor submitted machine design drawings, and EIEs. In general, work products were of high quality, and the comment resolution process for vendor supplied designs showed evidence of detailed review. However, the documents contained the following two errors:

- Vendor submittal 24590-QL-POA-FH00-00001-03-00007, *HLW Canister Grapple - Grapple Arrangement*, has notes on the drawing requiring 316/316L stainless steel for all materials. These conflict with 24590-QL-POA-FH00-00001-03-00048, *HLW Canister Grapple - Lifting Arm Detail*, and 24590-QL-POA-FH00-00001-08-00002, *Calculation - HLW Grapples*, both of which specify that the lifting arm is fabricated from Nitronic 50. This discrepancy was brought to the attention of the responsible engineer, who agreed to notify the vendor of the error.

- Drawing Change Notice 24590-HLW-M8N-C2V-00046, *Place HOLD on HLW C2V DX Fan Coil and Condenser Units*, modifies three design documents by placing HOLDs on the air conditioning systems and notes that the HOLDs are "Pending resolution to 24590-WTP-PIER-MGT-13-1270-C," even though the associated PIER has already been documented as resolved and closed. (See **OFI-BNI-05**.)

5.3.2 Electrical and Instrumentation Design Documents

Committed calculation 24590-LAW-E1 C-UPE-00002, *Safety System- Uninterruptible Power Supply Sizing*, was a well done, complete calculation revision. It provided additional detail not addressed in older UPS sizing calculations, used updated UPS loads and vendor data, added UPS and battery margin calculations, and was generally consistent with the requirements of the engineering calculation procedure. It did not include an evaluation of hydrogen emission from the UPS batteries or a harmonic analysis. The calculation appropriately concluded that the planned UPS units and associated batteries were undersized. Although the calculation identified reference sources and assumptions that needed to be verified, including equipment data for equipment not yet procured, it did not include a Tracked Reference section as required by section 3.5.2 of 24590-WTP-3DP-G04B-00037, *Engineering Calculations*, to ensure that earlier assumptions remain valid. However, this calculation was issued before the calculation procedure was revised to add the Tracked References requirement. Currently assumptions that require verifications are being tracked in WTP's CalcTrac software. WTP intends to add the required Tracked References when the calculation is revised and reissued as "Confirmed".

5.3.3 Piping and Commodity Support Design Documents

EA reviewed a sample of calculations in this area selected from a listing of recently issued calculations representing both the Richland, Washington and Reston, Virginia engineering offices. Overall, the calculations reflected positively on efforts by these groups. Documentation of calculation inputs and results was generally acceptable. However, more attention is needed to ensure that adequate technical justification is provided for design input assumptions. Procedural guidance was appropriate in this area; however one calculation contained a compliance issue. Calculation 24590-LAW-P6C-LOP-10034 contained an assumed value for an instrument weight. This value was assumed in the absence of specific vendor information; however, no defensible technical justification was provided for the value used, and the assumption was not identified as unverified. 24590-WTP-3DP-G04B-00037, *Engineering Calculations*, specifically identifies this type of assumption as requiring verification. The calculation was in Confirmed status. Calculations in this status are not permitted to contain unverified assumptions. Control of unverified assumptions is an essential element of an effective CM program. Additionally, this is a repeat issue previously documented in ORP WTP Engineering Department reviews. (See **OFI-BNI-11**.)

5.3.4 Radiological Engineering Design Documents

For the WTP project, the radiological model of the vitrification process often drives the physical design of the facility. In particular, the Radiological Engineering group analyzes the predicted direct radiological shine doses from sources in the various process vessels and lines of the WTP facilities, and then designs the shielding required to allow for system function and safe occupancy. Radiological Engineering's calculations depend directly on the data that defines the characteristics of given streams (e.g., mass, volume, radionuclide concentrations, and specific activity). This data is taken from the steady-state model of the vitrification process. EA reviewed a number of procedures, calculations, and other design documents associated with both process modeling and radiological engineering.

The Process Design Engineering group maintains and runs the process model. During this review, the process model used for design calculations was the Aspen Process Performance Simulation (APPS), built on the Aspen code. The vitrification process model was originally built using a complex system of linked spreadsheets to simulate the process at steady state; this system was called WTP Engineering Baseline Process Performance Software. Over the last 15 years, the WTP project transitioned, and continues to transition, to the use of more advanced codes for accurate process modeling. The history of process model changes is not documented in any one location or controlled document, and undocumented institutional knowledge is the primary source of concise information about how the WTP vitrification process model has evolved. **(OFI-BNI-12**.)

For calculations using the APPS process model, responsible engineers implement 24590-WTP-3DP-G04B-00037, *Engineering Calculations*, which guides them through the origination, checking, approval, revision, filing, retaining, and releasing processes associated with calculations. Section 5.1.1 of this report provides the review results of this procedure.

24590-WTP-M4C-V11T-00011, *Revised Calculation of Hydrogen Generation Rates and Time to Lower Flammability Limit for WTP*, and 24590-WTP-M4C-V11T-0004, *Calculation of Hydrogen Generation Rates and Time to Lower Flammability Limit for WTP* were reviewed. Overall, the calculations were in accordance with BNI requirements; however, there were a few minor issues. For example, calculation 24590-WTP-M4C-V11T-00011 incorporates process model changes and a "settled layer" method throughout, which increases the analyzed time to reach the lower flammability limit of hydrogen gas beyond that assessed in 24590-WTP-M4C-V11T-0004. BNI provided no explanation of why both of these calculations existed, and why the second calculation did not supersede the first. Additionally, the calculations referenced two different sources for the half-lives of cesium-137 and strontium-90. Neither of the references were the Chart of Radionuclides, which is the typically accepted source for these values, and neither the reference selection nor the inconsistency was explained. There was no evidence that the assumptions in section 6.1 "requiring verification" were being tracked in either calculation. (See **OFI-BNI-13**.)

In addition, 24590-WTP-DB-PET-09-0001, Rev. 1, *Process Inputs Basis of Design (PIBOD),* and 24590-WTP-M4C-V11T-00010, *Process Engineering Mass Balance for WTP* were reviewed. The process inputs basis of design (PIBOD), 24590-WTP-DB-PET-09-0001, is used to support mechanical design (e.g., equipment and line sizing) and is intended to summarize the calculated outputs of 24590-WTP-M4C-V11T-00010. However, there is no procedural requirement to routinely update the 24590-WTP-M4C-V11T-00010 calculation. The process and mechanical groups informally communicate about planning and changes to the process model and rely on interim calculations as a stopgap until the PIBOD is updated. These interim calculations are to be assessed after the revised PIBOD is issued. Nevertheless, because the process model is updated and changed periodically, this approach risks creating a misalignment between the design calculations and the BOD. 24590-WTP-DB-PET-09-0001, *PIBOD*, is shown to officially supersede the 24590-WTP-M4C-V11T-00010 calculation. This is an administrative concern, because the PIBOD does not replace the calculation; it simply captures and condenses its results. In this condition, there is a risk of losing track of this relationship, especially when there is no procedural requirement to update the calculation. (See **OFI-BNI-14**.)

Calculation 24590-WTP-M4C-V11T-0020, *Estimated Radionuclide Concentrations for Shielding Based on TFCOUP6 Feed Vector*, provides the input of source term data to support Radiological Engineering's shielding calculations. Fundamentally, all steady-state process mass balance model calculations, including calculation 24590-WTP-M4C-V11T-0020, must assume that any batch of waste to be processed will result from a combination of streams with a given set of parameters from the various tanks; this is referred to as a feed vector. This project has over 500 possible batches of waste, so the feed vector must be established to produce a conservative calculation of radionuclide concentrations in the various streams and vessels of the process. Currently, the project is using feed vector TFCOUP Revision 6 (TFCOUP6), but Process Engineering management stated that the intent is to move to a new feed vector soon that will better characterize melter throughput. For conservatism, calculation 24590-WTP-M4C-V11T-0020 assumes that all radionuclides important to shielding are at their "contract maximum" quantities when entering the process from the waste tanks, regardless of what TFCOUP6 identifies. This assumption reflects an unrealistic process feed scenario, but it is meant to bound the uncertainties in the waste feed. This assumption is what allows the facility to be designed without having to further characterize the tank waste and place significant limits on the waste feed. Calculation 24590-WTP-M4C-V11T-0020 was consistent with the applicable procedure. In addition to this calculation, Radiological Engineering uses process model calculations maximized for radionuclides that dominate inhalation dose (e.g., Americium) and equipment dose on wetted surfaces (e.g., strontium-90): 24590-WTP-M4C-V11T-00021, *Estimated Radionuclide Concentrations for Inhalation Dose Based on TFCOUP6 Feed Vector*, and 24590-WTP-M4C-V11T-00027, *Highest Expected 90Sr Concentrations in WTP Process Streams During Normal Operations for TFCOUP Rev. 6 Feed Vector*, respectively. These calculations were similarly of high quality.

For design of shielding, the primary calculation input is the source term. As discussed, for WTP, the source term is based on the steady-state process mass balance model and is maintained by the Process Design Engineering group. The Radiological Engineering group uses calculation 24590-WTP-M4C-V11T-0020 in performing shielding calculations. WTP shielding calculations are prepared in accordance with the guidance provided in both 24590-WTP-3DP-G04B-00037, *Engineering Calculations* and 24590-WTP-GPP-SRAD-001, *Radiation Dose Rate Calculations*. The latter document establishes the responsibilities for dose rate calculations and generally defines the procedure. 24590-WTP-GPP-SRAD-

001 further references 24590-WTP-GPG-SRAD-0006, *Guidance for and Documentation of Technical Bases for Assessment of Dose Rate, Flux, Energy Deposition Rate, and/or Shielding Calculations*, which provides specific guidance on selecting methods of analyzing dose for developing radiation dose rate and shielding calculations. The WTP project primarily uses the combination of these three guidance documents to guide the development of shielding calculations. Specifically for shielding calculations, 24590-WTP-GPG-SRAD-0006 provides the detailed justification for a number of the key assumptions that must be made for all analyses of shielding effectiveness, such as source term, material composition and density, energy distribution, and flux-to-dose conversion factors. In addition, 24590-WTP-GPG-SRAD-0006 provides a good discussion on selecting the appropriate computer code to use for a given shielding analysis; this discussion has also been approved and included on the project baseline. The methodology described therein accurately suggests point-kernel codes (e.g., MicroShield) for simple geometries and very limited scatter potential, and Monte Carlo probabilistic particle transport codes (e.g., MCNP) for complex geometries, neutron sources, and non-time sensitive analyses. In addition to the codes discussed in 24590-WTP-GPG-SRAD-0006, the WTP project has added the Attila code to the project baseline, allowing for analysis of more complex geometries than MicroShield and faster tallying of doses than MCNP. The Attila code is still gradually being rolled out for use in the WTP project. The WTP project's chosen method of capturing the "generic" shielding calculation assumptions and methodologies in one guidance document appears to be effective and has allowed efficient completion of many shielding calculations by the Radiological Engineering group. These calculations were appropriately simple, based on a sampling review, referenced 24590-WTP-GPG-SRAD-0006 for justification, when applicable, and were consistent in format.

During a walkdown of the WTP facilities under construction, EA observed that the Autosampling System (ASX) sample transfer lines travel between the facilities, overhead and unshielded. Calculation 24590-LAB-Z0C-80-00002, Rev. 0, *Shielding/Dose Calculation for the BOF and Laboratory PTS Piping and Laboratory ASX Components*, addresses the shielding and distance requirements associated with the transfer of the anticipated 15 and 35 milliliter sample bottles that will travel from the process facilities to the laboratory through the pneumatic transfer lines. This calculation used the MicroShield computer code to model shielded and unshielded sample bottles at varying distances above a point source representing a facility worker near the transfer lines. The use of MicroShield was appropriate for this analysis because of the simple geometry, few scattering surfaces, and well-understood buildup materials. The source term for this calculation was derived from 24590-WTP-M4C-V11T-0020, and subsequently 24590-WTP-Z0C-50-00008, *Source Terms for Use in Shielding Calculations*. Calculation 24590-WTP-Z0C-50-00008 accounts for uncertainty in the source term based on PNNL-12003, Ferryman, T. A., et al., *Summary of Uncertainty Estimation Results for Hanford Tank Chemical and Radionuclide Inventories*, and prescribes a percentage increase to accompany the concentrations of given radioisotopes that are the primary sources of radiation of importance to shielding analyses, such as cobalt-60, cesium-137, and europium-154. Therefore, 24590-LAB-Z0C-80-00002 conservatively includes this increase in the gamma source term it uses for calculation of dose rates. The results of this calculation accurately define the distance and shielding necessary to operate the ASX within established dose limits, and without invalidating posted classifications of Radiation and High Radiation Areas. However, no dose rate calculation directly addresses a "stuck" sample bottle scenario, which would require closer and longer-term access. In addition, a vendor calculation within submittal number 24590-QL-HC4-HAHH-00001-11-00041, *WTP Autosampling System ASX Shielding Calculation for PTF and HLW Autosamplers*, addressed ASX shielding as well, but it does not reference, nor is it referenced in, 24590-LAB-Z0C-80-00002. These two calculations do not share any reviewers or responsible parties. This disconnect between related calculations and conditions similar to it could lead to disparities and inconsistent design. (See **OFI-BNI-15**.)

The Radiological Engineering staff is well-trained and knowledgeable. Staff engineers and managers were able to provide clear and accurate discussion of their process for producing shielding calculations, consistent with their procedures. In addition, at the time of this review, the vast majority of the engineers had taken vendor-provided training on the particular computer codes that they use. In general, the Radiological Engineering group is adequately and effectively functioning to produce accurate and defensible calculations of dose rates and radiation shielding.

6.0 CONCLUSIONS

This review focused on improvements in BNI's engineering processes and procedures, and included both interviews and document reviews to assess the implementation process. The engineering process reviews included examination of the effectiveness of the CM program, the internal assessment program, and the corrective action program. The implementation of planned process improvements was reviewed by examining engineering SDDs, drawings, calculations, and other similar documents.

The updated engineering procedures are generally adequate in quality and provide a sound basis for acceptable performance in the areas reviewed. BNI's use of EDMS to identify relationships between documents and input references to facilitate identification of change impacts is an effective process. One concern was noted in the calculation procedure for isometric drawings and associated calculations. It permits issuance of drawings for construction based on calculations that are in interim status, are not in EDMS, and are not part of the Tracked Reference process used to identify impacts from design changes. Some weaknesses were identified in the CM program, notably issuance of drawing revisions without incorporating outstanding impacts and the lack of adequate guidance to control tracking and resolution of change-impacted documents.

The self-assessment program within the BNI engineering organization is well defined and is being adequately implemented based on the sample reviewed. However, the program's effectiveness could be enhanced by training assessors assigned to execute the program on established assessment techniques.

Recent corrective action documents within the engineering organization examined in a limited sampling were generally adequate to resolve the problems identified. Some older corrective action documents had action steps closed without accomplishing appropriate corrective action for part of the identified problem.

The new SDDs showed improvement over the previous system descriptions. Some weaknesses were identified with the reviewed SDDs including sizing issues for the HLW UPS and cooling issues for the HLW UPS batteries. BNI's addition of a method for verifying authorization basis compliance is a positive enhancement. However, the reviewed SDDs did not require verification of some design requirements.

The reviewed calculations were of good quality and complied with applicable procedures. One reviewed calculation did not appropriately identify an unverified assumption for tracking and closure. This is significant because the ORP WTP Engineering Division had previously documented similar problems with unverified assumptions.

Overall, BNI has been successful in developing and implementing improvements in engineering processes and procedures, including improvements in the CM, internal assessment, and corrective action programs. The BNI engineering program is fundamentally sound, however, some areas for improvement were identified.

7.0 FINDINGS

EA identified no findings during this review.

8.0 OPPORTUNITIES FOR IMPROVEMENT

This EA review identified 15 OFIs. These potential enhancements are not intended to be prescriptive or mandatory. Rather, they are suggestions offered by the EA review team that may assist project management in implementing best practices, or provide potential solutions to minor issues identified during the conduct of the review. In some cases, OFIs address areas where program or process improvements can be achieved through minimal effort. It is expected that the responsible line management organizations will evaluate these OFIs and accept, reject, or modify them as appropriate, in accordance with project-specific program objectives and priorities.

OFI- BNI-01 Consider revising 24590-WTP-GPG-ENG-0170, *Impact Evaluation*, to apply the EIE form impact evaluation process to all engineering design document revisions, including alpha character revisions and revision 0 numeric revisions.

OFI- BNI-02 Consider entering interim calculations into both EDMS and ProjectWise to facilitate identification of impacts from revisions to design inputs and to enhance the configuration control process.

OFI-BNI-03 Consider revising procedure 24590-WTP-3DP-G04T-00906, *Isometric drawings and Associated Calculations,* to include specific guidance to ensure that input data is re-verified when a calculation status is updated (i.e., Committed to Confirmed).

OFI-BNI-04 Consider establishing training on self-assessment techniques and on the BNI self-assessment program for BNI engineering managers and staff who are involved in that function.

OFI-BNI-05 Consider determining the extent of condition for drawing changes associated with the resolution of 24590-WTP-PIER-MGT-13-1270-C and canceling drawing changes (HOLDs) that have been superseded by the decision to install the R-22 units.

OFI-BNI-06 Consider revising the HLW Room Environment Data Sheet for room H-A217 to acknowledge the presence of a pre-action water sprinkler system. Also consider the need to further ensure that the SC UPE SSCs in that room are adequately designed to withstand or be protected from direct liquid spray as required by PDSA performance criteria (Section 4.3.12.4).

OFI-BNI-07 Consider revising the HLW UPE SDD to:

- Address the required interfaces with SC C1V DX/FCUs that are needed to support SC UPE SSCs, as outlined in PDSA Sections 3.3.6.1.3.1, 4.3.17, 4.4.25, and 5.5.12.
- Explain the purpose of requiring each SC UPS battery to consist of two paralleled redundant series strings of battery cells with separate isolation switches.
- Require additional physical verification (beyond initial design review) that the stated requirements are met, with some form of testing or inspection where appropriate.

- Ensure that the basis of each requirement is explained and that the explanation is included in the SDD.
- Ensure that the specified sizes of the HLW SC UPE UPS equipment and associated batteries identified in HLW UPE SDD Table 4-1 are correct after revision of the HLW Facility ITS Uninterruptible Power Supply Calculation and HLW SC UPE load lists, including the additional non-SC loads attached to the UPE panels that would remain energized from the UPS on loss of offsite power.

OFI-BNI-08 Consider confirming that the design of SC VRLA battery supporting systems is adequate by:

- Physically verifying that SC DX/FCUs can maintain the area immediately around the batteries at 77 ± 3 degrees Fahrenheit in the middle of a summer day throughout an 8-hour test with other SC loads operating and with the C1V ventilation shut down, simulating a loss of offsite power. This verification requirement is similar to the demonstration requirement of HLW C1 and C2 Ventilation SDD paragraph 3.5.2.1 and the corresponding test acceptance criteria listed in SDD Appendix A, but is more specific to demonstrating the required capability of the SC DX/FCUs and their capability to support VRLA battery operability. Alternatively, an appropriate multi-node room model analytical technique may be used.
- Verifying that each UPS Battery Room ventilation system adequately addresses the concerns expressed in Air Force pamphlet AFPAM32-1186, sections 2.4.3.2.3 and 2.4.4.3.5.3, regarding higher VRLA battery hydrogen emission rates in the first several months of operation.

OFI-BNI-09 Consider verifying that Ambient Air Temperature transmitter C1V-TT-3817 is appropriately located in the ITS UPS/UPE Battery Room (C1V-FCU-00010/11) and revising drawing 24590-HLW-J2-30-00038, *Instrument Location Plan, Elev-37*, to correctly indicate that location.

OFI-BNI-10 Consider revising 24590-HLW-3ZD-HMH-00001, *HLW Melter Handling (HMH) System Design Description*, to incorporate:

- An appropriate method for seismic qualification of the equipment, with recognition that SA Technologies is no longer in business.
- Meaningful basis statements for all requirements.
- Documented HOLDs on conflicting requirements in sections 3.5.1.1 and 3.5.2.1 until 24590-WTP-PIER-MGT-10-0129-C has been satisfactorily closed.

OFI-BNI-11 Consider revising calculation 24590-LAW-P6C-LOP-10034 to document an unverified assumption related to the assumed instrument weight.

OFI-BNI-12 Consider formally documenting the evolution of the WTP vitrification process model in a single document to capture the step-by-step transition in a repeatable way.

OFI-BNI-13 Consider clarifying the purpose and assumption bases of calculations 24590-WTP-M4C-V11T-00011 and 24590-WTP-M4C-V11T-0004.

OFI-BNI-14 Review the status of 24590-WTP-DB-PET-09-0001 and 24590-WTP-M4C-V11T-00010 and consider requiring routine updates of both calculations.

OFI-BNI-15 Consider augmenting the dose rate and shielding calculations for the ASX system to consider a stuck sample transfer bottle scenario.

9.0 ITEMS FOR FOLLOW-UP

EA will follow up on the continued development of the SDDs through the multi-phase process described in Section 5.2. Additional oversight is also planned for the ORP WTP Engineering Division to review field office contractor oversight processes.

Appendix A
Supplemental Information

Dates of Review

Onsite Review: April 13-16, 2015
May 12-21, 2015

Office of Enterprise Assessments (EA) Management

Glenn S. Podonsky, Director, Office of Enterprise Assessments
William A. Eckroade, Deputy Director, Office of Enterprise Assessments
Thomas R. Staker, Director, Office of Environment, Safety and Health Assessments
William E. Miller, Director, Office of Nuclear Safety and Environmental Assessments
Patricia Williams, Director, Office of Worker Safety and Health Assessments

Quality Review Board

William A. Eckroade
Karen L. Boardman
John S. Boulden
Thomas R. Staker
William E. Miller
Patricia Williams
Michael A. Kilpatrick

EA Site Lead for Hanford WTP

Robert Farrell

EA Reviewers

Charles Allen - Lead
David Adair
Aleem Boatright
Robert Farrell
Timothy Martin
Gregory Teese

Appendix B
Key Documents Reviewed and Interviews

Documents Reviewed

24590-BOF-HAR-NS-13-0001-06, *Hazards Analysis Report for the Balance of Facilities, Volume 6, Electrical Systems*, Revision 0, August 12, 2014
24590-CM-MRA-EU00-00001, *Uninterruptible Power Supply (UPS) -Non ITS, Material Requisition,* Revision 6, November 16, 2010
24590-CM-POA-EU00-00001-03-00009, *Purchase Order for HLW NSC UPS, Electrical Data Sheets,* Revision C, August 29, 2008
24590-HLW-3PS-HCTH-T0002, *Engineering Specification for System HMH Melter Transport Bogie System,* Revision 0, March 11, 2010
24590-HLW-3ZD-30-00001, *HLW Facility Design Description,* Revision A, February 20, 2015
24590-HLW-3ZD-C1V-00001, *HLW C1 and C2 Ventilation Systems Design Description,* Revision 1, January 24, 2015
24590-HLW-3ZD-C5V-00001, *HLW C3, C5, and Atmospheric Reference Ventilation Systems Design Description,* Revision A, March 18, 2015
24590-HLW-3ZD-HFP-00001, *HLW Melter Feed Process (HFP) and Concentrate Receipt Process (HCP) System Design Description,* Revision A, October 23, 2014
24590-HLW-3ZD-HMH-00001, *HLW Melter Handling (HMH) System Design Description,* Revision 0, March 9, 2015
24590-HLW-3ZD-HPS-00001, *HLW High Pressure Steam (HPS) and Low Pressure Steam (LPS) System Design Description,* Revision A, February 24, 2015
24590-HLW-3ZD-PJV-00001, *HLW Pulse Jet Ventilation (PJV) System Design Description,* Revision 0, November 26, 2014
24590-HLW-3ZD-RLD-00001, *HLW Radioactive Liquid Waste Disposal System Design Description,* Revision A, January 26, 2015
24590-HLW-3ZD-UPE-00001, *HLW Uninterruptible Power Electrical (UPE) System Design Description,* Revision 0, February 26, 2015
24590-HLW-E1C-UPE-00001, *HLW Facility ITS Uninterruptible Power Supply Calc*, Revision B, July 27, 2005
24590-HLW-E1C-UPE-00002, *Non ITS Uninterruptible Power Supply Sizing Calc*, Revision A, March 19, 2004
24590-HLW-E1-UPE-00001, *HLW Vitrification Bldg Safety UPS UPE-UPS-30001A Single Line Diagram,* Revision 3, March 9, 2011
24590-HLW-E1-UPE-00002, *HLW Vitrification Bldg Safety UPS UPE-UPS-30001B Single Line Diagram,* Revision 3, March 9, 2011
24590-HLW-E8-UPE-30001, *HLW Vitrification Building ITS UPS 208-120V Panel Schedule UPE-PNL-30001A*, Revision 0, July 25, 2006
24590-HLW-E8-UPE-30002, *HLW Vitrification Building ITS UPS 208-120V Panel Schedule UPE-PNL-30001B*, Revision 0, July 25, 2006
24590-HLW-EC-LVE-00001, *MCC Schedule, LVE-MCC-30001A, Elev-14,* Revision 2, June 5, 2009
24590-HLW-EC-LVE-00002, *MCC Schedule, LVE-MCC-30001B, Elev-37,* Revision 1, June 5, 2009
24590-HLW-EDR-MH-14-0007, *Updated Drawing & Calculation References; Updated Safety and Quality Classifications, Deleted HSH-CRN-00010 & HSH-CRN-00012 Hoist High Hook Limit Indication from Radio Controls,* Revision 0, March 12, 2014
24590-HLW-EIE-M-14-0001, *HLW - Authorization from DOE or Place HOLD on Test Type Other Than Hydrostatic Leak Test (24590-HLW-M6N-30-00048),* Revision 0, February 2, 2015

24590-HLW-EIE-MH-14-0006, *Impact Evaluation: Adding HFH-MHAN-00018 to HFH Mechanical Handling Equipment List*, Revision 0, November 18, 2014
24590-HLW-EIE-MH-14-0026, *Updated Drawing & Calculation Reference, Updated Safety and Quality Classification, Deleted HSH-CRN-00010 & HSH-CRN-00012 Hoist High Hood Limit Indication From Radio Controls,* Revision 0, October 20, 2014
24590-HLW-EIE-MS-14-0004, *EIE for Revision of Line List 24590-HLW-M6WX-HSH-00004002,* Revision 0, October 17, 2014
24590-HLW-EIE-MS-14-0005, *Incorporate Flow Down of IEEE 344 and IEEE 382 for Autosampler (ASX) System,* Revision 0, September 8, 2014
24590-HLW-EIE-MS-14-0006, *Incorporate Revised Shielding Dose and Contact Does Rates Calculations Into ASX Equipment Specification and Mechanical Datasheet,* Revision 0, September 8, 2014
24590-HLW-EIE-MS-14-0008, *HLW-HOP Safety Siphon Line HOLDs (24590-HLW-M6N-30-00045),* Revision 0, July 28, 2014
24590-HLW-EIE-MS-14-0009, *24590-HLW-M6N-30-00047 - Add HOLDs to the HFP and HMP Jumpers that Connect the ADS Pumps to the Melters*, Revision 0, August 25, 2014
24590-HLW-EIE-MS-14-0012, *Impact Evaluation of 24590-HLW-M6E-NLD-00009,* Revision 0, August 8, 2014
24590-HLW-EIE-MS-14-0014, *EIE for 24590-HLW-M6N-ASX-00022,* Revision 0, July 31, 2014
24590-HLW-EIE-MS-14-0015, *EIE for 24590-HLW-M6N-ASX-00023,* Revision 0, September 22, 2014
24590-HLW-EIE-MS-14-0018, *Impact Evaluation of HLW Process Service Water System Distribution, 24590-HLW-M6-PSW-00001001 Rev. 0,* Revision 0, December 18, 2014
24590-HLW-EIE-MS-14-0020, *DCN to Provide Dimension Criteria for Loop Seals (Hydraulic Seal) on Select Non-Radioactive Liquid Disposal (NLD) P&IDS,* Revision 0, October 16, 2014
24590-HLW-EIE-MS-14-0023, *HLW DOW System Line Sizing Calculation EIE,* Revision 0, December 23, 2014
24590-HLW-EIE-MS-14-0028, *Engineering Impact Evaluation of Addition of Final User Pressures in Attachments A Through C of 24590-HLW-M6C-PSW-00002,* Revision 0, January 9, 2015
24590-HLW-EIE-SYSE-14-0003, *Engineering Impact Evaluation for Initial issue of the HLW UPE SDD,* Revision 0, February 26, 2015
24590-HLW-EUD-UPE-00001, *Electrical Data Sheet*, Revision 3, April 3, 2011
24590-HLW-J2-30-00026, *Instrument Location Plan, Elev 14-0, Area 5,* Revision 0, September 2, 2011
24590-HLW-J2-30-00038, *Instrument Location Plan, Elev 37-0, Area 5,* Revision 0, September 23, 2011
24590-HLW-J3-C1V-01006, *C1V FCU Temp Instruments,* Revision 0, April 21, 2009
24590-HLW-M0-HMH-00021001, *HLW Vitrification System HMH Design Proposal Drawing Melter Overpack Assembly,* Revision 0, March 11, 2010
24590-HLW-M0-HMH-00021002, *HLW Vitrification System HMH Design Proposal Drawing Melter Overpack Details,* Revision 0, March 11, 2010
24590-HLW-M0N-M10T-00064, *Updated Drawing & Calculation References; Updated Safety and Quality Classifications; Deleted HSH-CRN-00010 & HSH-CRN-00012 Hoist High Hook Limit Indication from Radio Controls*, October 20, 2014
24590-HLW-M0Q-HMH-00002, *Equipment Qualification Datasheet for Melter Transport Bogie,* Revision 0, July 2, 2009
24590-HLW-M0Q-HMH-00005, *Equipment Qualification Datasheet for Melter Overpack (Melter 1),* Revision 0, July 2, 2009
24590-HLW-M0Q-HMH-00006, *Equipment Qualification Datasheet for Melter Overpack (Melter 2),* Revision 0, July 2, 2009
24590-HLW-M6-DOW-00001001, *P&ID - HLW Domestic (Potable) Water System Distribution,* Revision 2, December, 22, 2014
24590-HLW-M6-DOW-00002001, *P&ID - HLW Domestic Water Distribution,* Revision 2, December 22, 2014

24590-HLW-M6-PSW-00001001, *P&ID - HLW Process Service Water System Distribution,* Revision 0, December 24, 2014
24590-HLW-M6-PVV-00002001, *P&ID - HLW Process Vessel Vent Exhaust System PVV-Bulge-00001,* Revision 00A, May 15, 2015
24590-HLW-M6-PVV-00002002, *P&ID - HLW Process Vessel Vent Exhaust System PVV-Bulge-00001,* Revision 00A, May 15, 2015
24590-HLW-M6-RLD-00018001, *P&ID - HLW Radioactive Liquid Waste Disposal System RLD-Bulge-00008 and RLD-PMP-00018*, Revision 00A, May 15, 2015
24590-HLW-M6-RLD-00018002, *P&ID - HLW Radioactive Liquid Waste Disposal System RLD-Bulge-00008,* Revision 00A, May 15, 2015
24590-HLW-M6-RLD-00018003, *P&ID - HLW Radioactive Liquid Waste Disposal System RLD-Bulge-00009 and RLD-PMP-00019*, Revision 00A, May 15, 2015
24590-HLW-M6-RLD-00018004, *P&ID - HLW Radioactive Liquid Waste Disposal System RLD-Bulge-00009,* Revision 00A, May 15, 2015
24590-HLW-M6C-DIW-00003, *Design Pressure and Temperature Calculation for the Demineralized Water System (DIW),* Revision 1, October 29, 2014
24590-HLW-M6C-DOW-00001, *HLW Domestic Water System Line Sizing,* Revision 0A, December 18, 2014
24590-HLW-M6C-DOW-00005, *Design Pressure and Temperature Calculation for Domestic Water System (DOW),* Revision 0A, December 18, 2014
24590-HLW-M6C-PSW-00003, *Design Pressure and Temperature Calculation for the Process Service Water (PSW) System,* Revision 1, December 15, 2014
24590-HLW-M6E-NLD-00010, *Loop Seal Addition to 24590-HLW-M6C-NLD-00003,* October 17, 2014
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24590-HLW-M6N-30-00045, *HFP, HOP, PVV and ISA HOLDS Related to HOP-SBS Siphon Protection,* July 28, 2014
24590-HLW-M6N-30-00047, *Add HOLDS to the HFP and HMP Jumpers That Connect the ADS Pumps to the Melters*, August 25, 2014
24590-HLW-M6N-30-00048, *HLW - Update HLW Line Lists to Note DOE Approval of Testing That is Other Than Hydro Testing (Pneumatic, etc.) and Place a HOLD on Lines Not Yet Approved*, February 10, 2015
24590-HLW-M6N-ASX-00022, *Add Redundant Level Switches (Thermal) to ASX-SMPLR-00029 and ASX-SMPLR-00042,* July 30, 2014
24590-HLW-M6N-ASX-00023, *HLW ASX - Place Sample Lines on HOLD*, September 22, 2014
24590-HLW-M6N-NLD-00048, *NLD Loop Seal (Hydraulic Seal),* October 17, 2014
24590-HLW-M7N-HEH-00008, *Add Dangerous Waste Permit Affecting Notation to HEH-CRN-00001,* March 19, 2015
24590-HLW-M8-C1V-00003001, *C1V Annex Air Distribution Sheet 1 of 3*, Revision 4, December 2, 2013
24590-HLW-M8-C1V-00003002, *C1V Annex Air Distribution Sheet 2 of 3*, Revision 4, November 26, 2013
24590-HLW-M8-C1V-00008001, *C1V FCU Schedule*, Revision 4, November 26, 2013
24590-HLW-M8-C2V-00003001, *HLW Vitrification Building System C2V Volumetric V&ID Air Distribution El. 37-0 Sheet 1 of 2*, Revision 3, July 15, 2014
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24590-HLW-M8-C2V-00004002, *HLW Vitrification Building System C2V Volumetric V&ID Air Distribution El. 14-0 Sheet 2 of 2*, Revision 3, January 29, 2015

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24590-HLW-M8C-C1V-00003, *C1V Control Room HVAC Load Calculation and Equipment Selection, Elev 37*, Revision 1, June 12, 2013
24590-HLW-M8C-C1V-00004, *C1V Office Area Load Calculation and Equipment Selection*, Revision 1, May 22, 2013
24590-HLW-M8C-C2V-00003, *HLW C2V System Cooling, Heating, and Humidification Load Calculation, Elevation 14 Feet - 0 Inches,* Revision 2, January 6, 2015
24590-HLW-M8E-C2V-00028*, Replacement FCUs at Elevation -21 Ft,* April 16, 2015
24590-HLW-M8N-C2V-00046, *Place HOLD on HLW C2V DX Fan Coil and Condenser,* September 22, 2014
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24590-HLW-M8N-C2V-00048, *Relocation of C2V FCUs*, April 17, 2015
24590-HLW-P1-P23T-00207, *HLW Equipment Location Plan, Elev 14, Area 207*, Revision 3, July 8, 2009
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24590-HLW-PL-ENS-13-0001, *Safety Design Strategy for the High-Level Waste Facility*, Revision A, October 23, 2014
24590-HLW-SIPD-ENS-04-0011, *CSDs for HLW System HM*,* Revision 23, July 1, 2012
24590-HLW-U0D-W16T-00001, *HLW Room Environment Data Sheet*, Revision 1, October 14, 2010
24590-HLW-U1-60-00002, *HLW Vitrification Building Fire Barrier Drawing Plan at El 0'-0"*, Revision 0, October 26, 2010
24590-LAW-E1C-UPE-00002, *Safety System-Uninterruptible Power Supply Sizing*, Revision D, September 11, 2014
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24590-LAW-P6C-LVP-30002
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24590-LAW-PHC-CDG-00028
24590-LAW-PHC-LVP-30004
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24590-QL-MRA-EU00-00001, *Uninterruptible Power Supply (UPS) –ITS, Material Requisition*, Revision 1, December 22, 2004
24590-QL-MRA-MJKH-00001, *High Integrity Cask Handling Cranes*, Revision 4, March 19, 2015
24590-QL-POA-FH00-00001-03-00007, - *Drawing - HLW Canister Grapple - Grapple Arrangement,* Revision 00I, April 23, 2015
24590-QL-POA-FH00-00001-03-00008, - *Drawing - HLW Canister Grapple - Grapple Arrangement, Detail Views*, Revision 00G, April 23, 2015
24590-QL-POA-FH00-00001-03-00036, - *Drawing - HLW Canister Grapple - Grapple Assembly,* Revision 00H, April 23, 2015
24590-QL-POA-FH00-00001-03-00037, - *Drawing - HLW Canister Grapple - Grapple Base Assembly,* Revision 00F, April 23, 2015
24590-QL-POA-FH00-00001-03-00038, - *Drawing - HLW Canister Grapple - Center Base Tube Details,* Revision 00F, April 23, 2015
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Interviews

- Acting HLW System Engineering Integration Lead
- Architect
- Civil, Structural, Architectural Functional Manager
- Control and Instrumentation Functional Manager
- Electrical Functional Manager
- FDD/SDD Supervisor
- Fire Protection Lead Engineer
- HLW Assistant Project Engineer
- HLW Chemical Engineer
- HLW Engineering Electrical Lead
- HLW Nuclear Safety Engineer
- HLW Nuclear Safety Manager
- Mechanical Engineering Group Supervisor (2)
- Mechanical Engineering HVAC Engineer
- Mechanical Systems and Mechanical Handling Functional Manager
- Nuclear Safety Manager
- Nuclear Safety Engineer – Safety Analysis
- Nuclear Safety Analyst
- Plant Design Engineering Group Supervisor

- Plant Design Functional Manager
- Process Assurance Manager
- Process Assurance Manager's Designate
- Procurement Responsible Engineer
- Program Integration and Performance Assurance Nuclear Safety Engineer
- Project Fire Protection Engineer/Authority Having Jurisdiction
- Project Technical Director
- Quality Engineering Manager
- Quality Engineering Supervisor
- Radiological Engineering Engineers (2)
- Safety Analysis Manager
- System Engineers and SDD Authors(4)
- Systems Engineering Manager
- WTP Nuclear Safety Manager
- WTP Process Design Engineering Group Supervisor
- WTP Process Design Engineering Engineer