Department of Energy
Washington, DC 20585

April 28, 2014

The Honorable Peter S. Winokur
Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, NW, Suite 700
Washington, DC 20004

Dear Mr. Chairman:

In December 2012, the Office of Environmental Management (EM) provided an initial response to your August 8, 2012, letter relating to the results of your review of the design of the slurry transport system in the Pretreatment Facility of the Waste Treatment and Immobilization Plant (WTP) at the Hanford Site. Your letter noted concerns involving the effect of erosion from a bed of sliding solids on pipeline wear analyses, the potential for plugging of process lines, engineering design considerations for the centrifugal slurry pump operations, and the lack of early integration of safety into the design of these slurry transport systems. The Department of Energy's (DOE) response noted that DOE was providing specific direction to the contractor on areas requiring focus to address these concerns and to ensure any proposed actions were fully integrated with the efforts of teams established to respond to an ongoing review by the previous Secretary of Energy.

As part of the process of addressing issues identified by the Secretary of Energy's review, DOE and the WTP contractor developed a strategy that will resolve Waste Acceptance Criteria (WAC) issues for WTP that could potentially affect the WTP basis of design. Key elements of this strategy include the following:

1. Reconstituting the safety basis for the Pretreatment Facility (PTF):
    a. The contractor shall prepare and DOE will accept a Safety Design Strategy (SDS). Changes to the Preliminary Documented Safety Analysis will be made to align with the PTF design basis as technical issues are resolved.
    b. Evaluate current pumping and piping instrumentation to assess the capability of the current design to monitor key slurry transfer parameters.
    c. Systematically evaluate the hazards of the PTF including the potential for pump explosion and, as necessary, the effects of sliding bed erosion.
    d. Determine necessary safety requirements to be integrated into the design of the WTP slurry transport system.

2. Reassessing the PTF non-Newtonian transfer line design strategy:
    a. Evaluate a proposed increase in slurry transport velocity to 6 feet per second
    b. Provide a comprehensive solution to resolve line plugging concerns as well as previously identified challenges with required net positive suction head.
    c. Detail the capabilities to recover from a plugged transfer line.

3. Establishing a defensible erosion basis for WTP accounting for formation of sliding beds:
   a. Perform additional analysis of sliding beds to determine whether sliding bed erosion is more aggressive than turbulent erosion.
   b. If analysis determines that sliding bed erosion is more aggressive than turbulent erosion then testing will be performed to establish the expected wear.

4. Establishing a defensible WAC:
   a. Define how the design and safety margin has been or will be applied to the WTP design with respect to the current particle size design basis for High Level Waste (HLW) feed to the Pretreatment Facility.
   b. Revise Interface Control Document 19, which will include various issues and other open items to be addressed (e.g. sampling, WAC).
   c. Finalization of the WAC will be managed through the One System Integrated Project Team (IPT).

Currently, DOE and the WTP contractor are focusing its resources on technical issue resolution for the HLW facility. This focus is necessary for a well-planned and documented path forward that will ultimately lead to a decision in 2014 to resume full production engineering and construction on HLW. Lessons learned from this process will be factored into the schedule for resolution of technical and safety issues for the PTF in an integrated manner. When those plans are further matured and more predictable schedules are available, DOE will provide an updated status to the Defense Nuclear Facilities Safety Board.

To provide some insight into the details of the approach noted above, the enclosed provides further information related to the scope of the path forward for addressing sliding bed impacts.

If you have any questions, please contact me at (202) 586-5151.

Sincerely,

David Huizenga
Acting Assistant Secretary
for Environmental Management

Enclosure

cc: Mari-Jo Campagnone, HS-1.1
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Responses to the Defense Nuclear Facilities Safety Board Concerns Regarding Plugging of Process Lines

1.0 Background

The design of the WTP slurry transport system must satisfy a number of concurrently applicable design requirements and constraints, each of which may impose a different limiting condition for the design. These design inputs/outputs and/or constraints include:

- Transport velocity, which is a function of particle and carrier fluid properties;
- Physical layout of the facility and piping;
- Transfer requirements (pumping to multiple locations through different jumper configurations);
- Flushing requirements;
- Net Positive Suction Head Available;
- Total Dynamic Head of the system;
- Required transfer times;
- Pipe sizes and schedules;
- Radiation and chemical tolerant pump designs;
- Process conditions;
- Uncertainties in the characterization of the as-received waste;
- Effects of WTP unit operations on the waste; and
- Limitations of the theoretical-flow models available for design.

In addition to these considerations, the potential for chemical reactions causing plugging must be considered. Similar to the case of the slurry transport system design, there are multiple facets to consider when dealing with conditions and constraints that could potentially lead to chemical plugging of the transport system. Elements that must be considered include:

- Uncertainties in the characterization of the as-received waste;
- Process-heating and process-temperature-stabilization limitations;
- Solubility of chemical compounds as a function of temperature and concentration of other chemical species;
- Effects of residual-heel volumes and the constituents of process-recycle streams;
- Reaction kinetics, metastable reactions, and favored thermodynamic and chemical phases;
- Line-flushing, reagent-chemical, and flush-liquid disposal requirements;
- Efficiency of the caustic and oxidative leaching processes;

- Contractual requirements and goals for the production of both Immobilized High-Level Waste (IHLW) and Immobilized Low-Activity Waste (ILAW) glass; and
- Optimum waste loading in both the ILAW and IHLW glass.

A considerable number of actions have been taken in the last several years to improve and clarify the design guidance for Newtonian and non-Newtonian waste as new information has been received and designs have been validated. In addition, recent waste-qualification program-development, formalization of sampling objectives, and data-gap analyses efforts associated with the development of process-control points for the Ultrafiltration Process System (UFP), treated Low-Activity Waste (LAW) concentrate storage process system, and other systems have shed new light on the elements of the design and operational strategy needed to avoid chemical plugging. Efforts regarding analysis of chemical plugging are discussed in more detail later in this document.

Bechtel National (BNI) has reassessed the WTP basis of design and the analyses needed to demonstrate that the design would preclude the potential for pipeline plugging. BNI has reviewed a series of key Pacific Northwest National Laboratory (PNNL) documents (WTP-RPT-175, WTP-RPT-178, and WTP-RPT-189) and used these documents to support the proposed resolution of issues pertaining to the design of the non-Newtonian slurry transfer system. In these reports, continuing analytical work has demonstrated that incorporation of a 6 feet/second target transport velocity for Newtonian and non-Newtonian slurry transfers into the WTP design will preclude the risk of plugging due to solids settling in the process-piping system during normal operations. DOE acknowledges the potential use of 6 feet/second as a means to preclude pipeline plugging in non-Newtonian pipelines; however, resultant factors that affect the feasibility and other impacts will have to be evaluated.

Implementation of the proposed actions discussed in this document and initiatives associated with the Design Completion Teams will improve the capability of demonstrating that the WTP-slurry transfer system will satisfy design requirements. Moreover, any proposed design changes recommended by the Design Completion Team will be reviewed in accordance with existing nuclear-safety requirements to perform hazards and accident analyses. These reviews will ensure concurrent integration of safety considerations into the design. During the safety-analysis and safety-control-selection process for the WTP-slurry transfer system, safety controls will be added or modified as needed to ensure the safe operation of WTP.

2.0 Reponses to the Defense Nuclear Facilities Safety Board (Board) Concerns

Responses outlining strategies and plans to address the technical issues and fundamental concerns raised in Board Staff Issue Report are presented below. References identified in the following responses are listed in Section 4 of this enclosure.

The first fundamental Board concern is related to the existing safety analysis not addressing the hazards of a centrifugal-pump explosion in the accident analyses for energetic releases due to explosion and fragmentation that would lead to a loss of primary confinement. The DOE agrees with the Board's concern and will close the concern through reconstitution of the hazard analysis, safety analysis, derivation of bounding design basis events, and selection of controls.

DOE committed to reconstitute the safety basis for the PTF. As part of the reconstitution activities, BNI will systematically evaluate the hazards of the PTF using the updated process flow sheet and current design information. BNI will build upon recently updated hazard-analysis reports for the main process systems in PTF and will include normal, abnormal, and accident conditions and interaction hazards from one system to the next as hazardous materials are received in PTF, processed, and transferred for immobilization in either the LAW facility or HLW facility. The current baseline includes the completion of the primary-hazards-analysis report. This report will provide the foundation for the reconstitution efforts which are currently scheduled to be initiated during 2014. After the hazards analysis has been reconstituted, the balance of the safety-analysis process will be initiated, including the selection of design-basis accidents; completion of design-basis-accident calculations; and derivation of bounding parameters, representative parameters, and controls.

In advance of conducting the Hazard Analyses (HAs), the project will evaluate current pumping and piping instrumentation to assess the capability of the current design to detect precursors to line plugging. The evaluation will consider current instrumentation that provides indication of flow; for example, pressure, flow, temperature, and vessel levels. Along with identifying instrumentation, the associated interlocks, alarms, and controls will be considered to ensure that responses to potential plugging events are appropriate for the conditions. Again, any proposed design changes will be evaluated by the contractor Environmental and Nuclear Safety (E&NS) organization against the existing safety-bases documentation for the facilities (hazards-analysis, accident-analysis, and controls selection) to ensure that controls for the PTF and HLW facilities are adequate. The hazards analysis will encompass potential causes and consequences of pipeline plugging and pump failure under normal, off-normal, and accident conditions.

One of the issues that will be evaluated is whether failure of a centrifugal pump used for slurry transfer could actually result in pump explosion, and, if it can, what the nuclear safety consequences of such an explosion would be. As for the pump fragmentation portion of the concern, the report *Non-Fragmentation of Ancillary Equipment Caused by Hydrogen Detonation* (Reference 2) provides analysis regarding resistance of stainless steel to fragmentation. The pumps for WTP are being constructed of highly-ductile materials that have high-strain-rate properties that have been demonstrated by testing to provide resistance to the generation of high-energy missiles in explosive events, such as hydrogen detonations. The Preliminary Documented Safety Analysis (PDSA) has been updated to reflect the fact that austenitic stainless steel does not fail in such a way that it creates energetic fragments. Materials such as austenitic stainless steels (e.g., 304, 304L, 316, and 316L), duplex stainless steels (e.g., Alloy CD6MN), nickel-based alloys (e.g., Hastelloy C-22), and the cast counterparts of these materials (e.g., Alloy C-22, ASTM A494 Grade CX2MW) all have these properties and resist fragmentation (Reference 2) for the temperatures and pressures expected to be encountered for WTP systems.

Results of the evaluation regarding instrumentation for the detection of line plugging, the material-of-construction selection for the pumps, and material-detonation test results discussed above will be made available to support the hazards analysis and accident analysis for the WTP-slurry transfer system. The outcome of the safety-control section will specify the safety requirements to be integrated into the design of the WTP-slurry transfer system.

The second fundamental Board concern is related to wear analyses and the effects of erosion on pipelines from beds of sliding solids and the corresponding reduction in pipe strength. DOE agrees with the Board concern and will address the concern by conducting additional analysis and determining whether additional testing is necessary.

The need for additional evaluation has been identified in connection with the work by the Erosion/Corrosion Team of the Design Completion Team to validate the erosion and corrosion basis for WTP. Currently, the design recommendation for non-Newtonian systems is to design for a target transport velocity of 6 feet/second, which has been analyzed to be adequate to transport expected process streams during normal operation. The 6 feet/second target transport velocity is well below the 13 feet/second velocity in which wear rates from turbulent erosion begin to challenge the 40-year design life of piping systems in WTP.

A target transport velocity of 6 feet/second is adequate to prevent plugging due to solids settling of process transfer lines in non-Newtonian systems based on work documented in PNNL studies, PNNL-17639 (WTP-RPT-175, *Deposition Velocity of Newtonian and Non-Newtonian Slurries in Pipelines* (cited by Reference 1). These reports documented layers forming at velocities below 1.5 feet/second for waste streams that consisted of 10 micron (micrometer) glass beads in thin-clay simulant, although there is a potential for the formation of sliding beds up to measured critical velocities of 3.2 feet/second for 10 micron stainless-steel particles in thick-clay simulant or 50 micron alumina particles in thick-clay simulant. The measured critical velocity increased to 4.0 feet/second for 100 micron glass beads in thick-clay simulant and as high as 5.0 feet/second for 100 micron stainless-steel particles in thick-clay simulant. The simulants were designed to possess particle-sizes, densities, and non-Newtonian rheological properties values that are similar to those expected under WTP operating conditions (PNNL-17639, Section 4.0). Hence, the laboratory test data in this report is used to support a target transport velocity of 6 feet/second.

It is conceivable that sliding beds could be present for short-time intervals of initial startup of pumps, near the end of a waste transfer, or where the target transport velocity cannot be achieved due to competing design requirements. Hence, the contractor will perform additional analysis of sliding beds to determine whether sliding-bed erosion is more aggressive than turbulent erosion in small-diameter pipelines. The additional analyses are identified in 24590-WTP-RPT-ENG-12-016, Rev. *1, Action Plan for Resolution of Erosion and Corrosion Design Issues,* issued August 11, 2012 (Reference 5), which states in section 6.3.3 that the WTP Project will specifically address sliding-bed erosion, which is typically longitudinal wear along the lower surface of piping caused by the movement of particles with low impact angle in the direction of flow. If analysis determines that sliding-bed erosion is more aggressive than turbulent erosion in small diameter pipelines (Nominal Pipe Schedule (NPS) 3 and 4 pipes are the predominate pipe sizes in the slurry transport-system), then testing will determine the amount of sliding-bed erosion expected at design-transport velocities, given the current design-basis particle size distribution and piping configurations.

The third fundamental Board concern is related to the timely incorporation of new information on waste properties into the design of the slurry transport system. DOE agrees with the Board's concern and will close the concern through development of the WAC and associated engineered features to ensure that waste delivered to WTP conforms to the WAC. The WAC will utilize the WTP Basis of Design and Criticality Safety Evaluation Report requirements as input.

This technical issue is being addressed and managed through collaborative efforts between BNI and the Tank Farm Operating Contractor. The One System Team and Pre-Conditioning Requirements Technical Team under the WTP Design Completion organization are being established as the responsible organizations to jointly resolve the WAC issues that could potentially affect the WTP basis of design. The protection of the current bases of design for the slurry transfer system relies on the WAC. As previously stated in the 2012 Plan for Updating the Criticality Safety Evaluation Report (CSER) (Reference 4), the project E&NS staff has committed to the Board to evaluate the potential safety impact of larger Plutonium (Pu) particles that could be delivered to the PTF.

Depending on the outcome of the evaluation for large Pu particles or direction from DOE Office of River Protection (ORP) regarding the basis of design for slurry physical properties currently in use, hazards and accident analyses, and safety-control selections will be required in order to integrate safety into the design and safe operation of WTP.

As part of the ongoing analysis of waste characterization, WTP reviewed report PNNL-20646, *Hanford Waste Physical and Rheological Properties Data and Gaps Data* (Reference 6), to determine how processing within WTP is affected by the physical properties of the waste. In conjunction with the review of PNNL-20646, several other reports were reviewed since they include information about minerals that may be found within the waste, either identified by sampling or computer simulation.

While not an inclusive list, below are several of the more salient reports that were evaluated for impact on WTP's Basis of Design (BOD):

- RPP-RPT-46618, *Hanford Waste Mineralogy Reference Report* (Reference 7).
- 24590-101-TSA-W000-0004-114-00021, *Report - Estimate of Hanford Waste Insoluble Solid Particle Size and Density Distribution* (WTP-RPT-153) (Reference 8).
- 24590-WTP-RPT-PET-10-014, *Slurry Property Ranges in Non-Newtonian Vessels at WTP* (Reference 9).
- HNF-8862, *Particle Property Analysis of High-Level Waste Tank Sludges* (Reference 10).
- FINF-11585, *Identification of Solid Phases in Saltcake from Hanford Site Waste Tanks,(Reference* 11).
- RPP-9805, *Values of Particle Size, Particle Density and Slurry Viscosity to Use in Waste Feed Delivery Transfer System Analysis* (Reference 12).
- 24590-101-TSA-W000-0004-134-01, (WTP-RPT-076), *Identification of Washed Solids from Hanford Tanks 241-AN-102 and 241-AZ-101 with X-Ray Diffraction, Scanning Electron Microscopy and Light-Scattering Particle Analysis* (Reference 13).

The contractor, BNI, is reviewing the aforementioned data which is the subject of a report that is currently being developed, and recently sent DOE a letter intending to clarify the particle size distribution and maximum particle size utilized as design input for the expected waste feed for WTP [*Clarification of Feed Specification and Design Criteria Related to Particle Size Particle Hardness and Particle Density for the WTP* (Reference 14)]. DOE has not formally accepted the position stated in the correspondence, but the efforts of the One System Integrated Project Team through the revision of Interface Control Document (ICD) 19 will establish the WAC for WTP feed.

3.0 Additional Specific Issues

The Board staff Issue Report contains additional specific issues that support the Board staff's concerns discussed above. Below are responses to the additional specifics that have not yet been addressed.

The first Board staff specific issue is related to the PTF design strategy for process lines that transfer non-Newtonian slurries. The Board staff stated that the WTP project design guides rely on pressure-drop and line-slope requirements, and do not impose critical-velocity or turbulent-flow criteria. DOE agrees with the Board's concern and will close the concern through implementation of a 6 feet/second transport velocity design criteria. Where the transport velocity criterion cannot be satisfied due to competing requirements, an aggressive means of flushing the line will be required.

The current design strategy for non-Newtonian slurries does not preclude a bed of sliding solids from forming in the process line during a transfer. The WTP mechanical-system pump-design strategy is to provide a target transport velocity of 6 feet/second to avoid granular-solids settling and, thus avoid slurry-pipeline plugging. This criterion was not intended as a threshold that would prevent the formation of beds of sliding solids, but was meant to prevent plugging. Moreover, project design guidance is such that where the target-transport velocity criterion cannot be satisfied due to competing requirements, an aggressive means of flushing the line is required to clear it of solids at the end of the transfer.

The change to WTP Design Guide 24590-WTP-GPG-M-0058 of October 14, 2010, (Reference 15) incorporated supplemental guidance per CCN: 156101 (Reference 16), which recommends 6 feet/second transfer rates in NPS 3 lines. The design of the WTP slurry transfer system includes the key engineering elements of transport velocity, piping slope, transfer pipe length, transfer durations, and post-transfer flushes to remove solids that may have potentially settled during slurry transfers. Critical velocity criteria would prevent settling of solids in pipe that could lead to plugging of transfer piping. In the context of PNNL testing, critical velocity was defined as the point where a moving bed of particles begins to form on the pipe bottom during slurry-transport operations. Below the critical velocity, the slurry particles were assumed to settle on the bottom of the test module components. The determination of the required critical velocity for non-Newtonian fluid transfers can be based on stability curves documented in PNNL reports (WTP-RPT-175, Poloski, March 2009, and WTP-RPT-189, Poloski, July 2009) as cited in the report attached to Reference 1. In lieu of adopting and applying the methodology in these two reports to generate stability curves that can be used in design, the contractor has instead reviewed and identified the laboratory measured data from the reports that underpin the basis that would allow the project to establish a design criterion for a target transfer velocity of 6 feet/second.

The laboratory data and results in WTP-RPT-189, *Deposition Velocities of Non-Newtonian Slurries in Pipelines: Complex Simulant Testing* (cited by Reference 1), support a WTP non-Newtonian transfer-line design strategy to operate at a target transport velocity of 6 feet/second. The PTF non-Newtonian transfer line design strategy will be reassessed based on resizing pumps and transfer lines to meet a target transport velocity of 6 feet/second. In addition, pumps having the capability to increase head with increased flow rate using Adjustable Speed Drives (ASD) will be assessed where appropriate. Based on the graphs in Appendix A of WTP-RPT-189, Figures A.1 to A.10, slurries are typically considered unstable in an NPS 3 pipe at velocities below 2 to 4 feet/second. Moreover, there is only one case where slurry was considered unstable in an NPS 3 pipe below 5 feet/second. The term "unstable" refers to unstable flow that is observed using pressure-measurement instrumentation. The interpretation of an unstable regime is that this is where the pipe will eventually clog. Thus, the proposed target transport velocity of 6 feet/second is approximately 20% higher than the highest-analyzed unstable test velocity of 5 feet/second.

Additional laboratory data besides WTP-RPT-189 and WTP-RPT-175 are available to support the use of a target transport velocity of 6 feet/second in non-Newtonian piping systems.

The test results of PNNL report, WTP-RPT-178, *A Qualitative Investigation of Deposition Velocities of a Non-Newtonian Slurry in Complex Pipeline Geometries*

(Reference 18) were also reviewed. Plots of pressure drop versus pipeline velocity for the complex-geometry module data are documented in Figure 7.3 of the report. The starting velocity was 8 feet/second and was reduced to as low as 0.5 feet/second. In the Findings, section 10 of the report, a complete flow blockage by pipe plugging did not occur, even at the lowest flow velocity used for the testing. In the overflow-relief-piping test with an NPS 8, gravity-driven, partially-filled pipe at a slope of 1:20, no deposition occurred at any of the flow rates in the testing. Therefore, the findings from this report provide additional confirmation that piping will not plug when operated below a target transport velocity of 6 feet/second for either pressurized or unpressurized piping systems.

The resolution of the Board staff's concern is to design for a target transport velocity of 6 feet/second for non-Newtonian piping systems to prevent plugging due to solids settling. The velocity will be balanced in a tradeoff between competing objectives of providing adequate Net Positive Suction Head (NPSH) available for pump suction ("NPSH available" should be higher than the "NPSH required" by the pump) and maintaining adequate transport velocity to avoid plugging of transfer lines. In addition, efforts are ongoing through the Design Completion Team to establish the ability to recover from plugging in at-risk transfer lines. The current PTF design is equipped with four Plant Wash and Disposal (PWD) vessels that have the capability to heat, to add reagent, and to pneumatically push either hot water or reagents through slurry-pump suction piping via PWD wash racks. In addition, BNI is currently investigating available technologies to mechanically remove plugs in process piping at risk of plugging. Plug removal would be done via the jumper connections in the Hot Cell.

It is important to recognize that a transport velocity of 6 feet/second may not always be achievable at all rheologies in some non-Newtonian systems, and that in these cases a post transfer flush will be required. While the post transfer flush is designed to remove residual waste to preclude plugging, the risk of a sliding bed during normal transfer operations may be possible depending on waste slurry properties. As stated in the response to the Board concern regarding sliding beds, the additional analyses being conducted associated with 24590-WTP-RPT-ENG-12-016, Rev. *1, Action Plan for Resolution of Erosion and Corrosion Design Issues (Reference 5),* should provide additional information to determine whether any design changes are necessary for non-Newtonian systems.

The second Board staff specific issue is related to process lines containing Newtonian slurries that may instead contain non-Newtonian slurries under certain operational conditions. DOE agrees with the Board concern and will close the concern through the development of safety control strategies to prevent or mitigate the abnormal condition where a non-Newtonian slurry is in a line intended for Newtonian service.

The postulated scenario in which a process line thought to contain Newtonian slurries actually contains non-Newtonian slurries is considered an abnormal condition. A nuclear-safety control strategy will be derived from the reconstituted safety basis for the PTF to prevent or mitigate such events. The operational strategy for recovery from such an event could be dilution of the waste and/or increasing the transport velocity to the pump's maximum capability. In addition, dilution of waste slurries may be required in order to obtain sufficient NPSH to transfer slurry batches forward. In some cases, design changes may be the preferred method for resolving off-normal transfer conditions. Pump HLP-PMP-00021 has already been redesigned to handle a fluid viscosity of 50 mPa-s (Reference 19) to account for the potential stratification of solids in HLP-VSL-00022 that may be encountered during the initial vessel-pump-out phase of a transfer. This is a new level of protection to prevent plugging in process transfer piping in the event of unexpected rheological behavior of the slurry or the unexpected presence of a particular slurry type itself. Adoption of a target transport velocity of 6 feet/second may provide yet another layer of defense-in-depth for the postulated event of line plugging. However, a target transport velocity of 6 feet/second will require a reduced batch volume, which may have nuclear safety implications. The selection of the final nuclear safety controls will ensure that the selected controls are reliable, feasible, and maintainable.

The third Board staff specific issue is related to the WTP design not currently having the capability to obtain representative waste samples and, therefore, having only a limited ability to prevent material from outside of the design basis from being present in the WTP process lines. Hence, the Board staff states that the HLW properties used to develop critical-velocity and line-flush requirements have to be properly justified as bounding. DOE agrees with the Board's concern and will close the concern through development of the WAC and associated engineered features to assure waste delivered to WTP conforms to the WAC. These engineered features will provide the capability to characterize waste to ensure it conforms to the WAC. Waste that does not conform to the WAC will not be transferred to WTP without further analysis of acceptability. Alternative treatment strategies for waste that does not conform to the WAC will be developed.

The WTP WAC must be demonstrated to have been met before a feed batch can be transferred to WTP. This process is outlined in 24590-WTP-ICD-MG-01-019, *ICD-19 - Interface Control Document for Waste Feed.* ICD-19 will specify the WAC, including the allowable critical velocity. The feed-basis particle size and density associated with the critical velocity is identified as an open issue and will need to be resolved through the ICD-19 team efforts in future revisions. The determination of critical velocity is planned to be measured in a test loop on the tank-farm staging tank to confirm the waste will meet requirements. The One System organization is developing a tank waste characterization and sampling capability to address concerns with providing representative samples as well as providing assurance that the WAC can be met per ICD-19.

WTP sampling data is not used to establish critical velocity or prevent material outside the design basis from being processed. Furthermore, assurance that the critical velocity will be met for transfer and flushing within WTP piping systems is established by calculations that follow applicable design guides using inputs from the basis of design.

Sampling within WTP is necessary for process control and potentially for some safety applications. Previously in Board Recommendation 2010-2 identified the potential difficulties in obtaining representative samples within WTP in Sub-recommendation 4. A test program will demonstrate sampling capabilities to resolve technical issues related to the ability of the Isolok sampler to obtain representative samples from WTP process vessels. The initial briefing on WTP's sampling strategy is documented in a letter from BNI to ORP (Reference 20). A sampling execution plan is being developed by the Black Cell Analysis Technical Team.

The fourth Board staff specific issue pertains to a decision criterion in a WTP design guide on line sizing for Bingham-plastic fluids. DOE agrees with the Board concern and has addressed it through clarification of the design guide. The decision criterion, the "Y-factor" (i.e., the yield-stability parameter), in the design guide was confusing and misleading. Mechanical System Design Guide 24590-WTP-GPG-M-016, *Pipe Sizing for Lines with Liquids Containing Solids - Bingham Plastic Model* (Reference 21), was revised on August 8, 2012, to clarify that the "Y-factor" is only used to evaluate whether the design-guide methodology can be appropriately applied to the fluid in question.

The Board staff briefly made reference to chemical plugging concerns. DOE agrees with the Board staff's concern and will close the concern through development of controls to mitigate line plugging. These controls will be derived from the reconstituted safety basis for the PTF which will include normal, abnormal, and accident conditions.

A recent example of project focus regarding chemical-plugging issues can be found in connection with Cesium Ion Exchange Process Systems (CXP) pipeline design. An extensive hazard analysis was performed as part of the CXP Equipment Option Implementation design change, and the information is documented in *Hazard Analysis Report for Cesium Ion Exchange Process System Design Change* (Reference 22). In addition, specific areas of concern associated with the potential for waste precipitation have been identified and are being tracked in the Project Issues Evaluation Reporting (PIER) System. The additional issues currently being tracked are documented in the following PIERs:

- 24590-WTP-PIER-MGT-12-0656-C; *PT UFP-CXP Process Control to Prevent Unwanted Precipitation of Solids.*
- 24590-WTP-PIER-MGT-12-0787-C, *LAW/HLW Waste Rheology and Potential LAW Waste Precipitation Issues Post Ion Exchange.*

WTP currently implements the guidance of 24590-WTP-GPG-M-0059, *Avoiding Chemical Line Plugging - Plant Design Considerations* (Reference 23), to preclude chemical line plugging.

Nuclear safety controls for line plugging will be derived from the reconstituted safety basis for PTF which will include normal, abnormal, and accident conditions. Control of plugging within the range of normal process control is ensured by adherence to a WTP process control strategy. The strategy is laid out by identification of process control points within the WTP facilities. The process control points identify the control parameters and the range of these parameters to ensure normal operation of the design to carry out the intended functions as outlined in WTP system descriptions for each respective system. The WTP project team is currently engaged in an effort to further define the process control strategy for future operations of the current design. This effort ultimately will be documented in an updated revision to the *WTP Integrated Process Strategy Description* (WIPSD), report 24590-WTP-3YD-50-00002 (Reference 24), currently under development. The WIPSD is used to reflect the basis underpinning the process control strategy. It provides a logical basis for control parameters and establishes a justification for their application in the process. Process control parameters and their respective range of operations as described in the WIPSD are reflected in the WTP's *Initial Data Quality Objectives for WTP Monitoring and Process Control* document, 24590-WTP-RPT-MGT-12-014 (Reference 3). The process control points are also used to establish a basis for the sample and analysis performed in support of process control where physical samples are pulled from the process stream and analyzed in the laboratory as opposed to employing on-line instrumentation for monitoring process parameters. Laboratory samples are described in the WTP's *Integrated Sampling and Analysis Plan (ISAP),* 24590-LAB-PL-OP-12-0001 (Reference 17).

In conclusion, DOE is addressing each of the Board staff's concerns. There are plans to evaluate pump explosions during hazard analyses and in the reconstitution of the PDSAs for the PTF and HLW; and the Design Completion Team efforts on erosion/corrosion, process-transfer-line-plugging, and process-sampling issues will provide input to the hazards-analysis teams (as appropriate) and support resolution of current design issues that relate to the Board staff's concerns. Continuing analytical work has demonstrated that incorporation of a 6 feet/second target for Newtonian and non-Newtonian slurry transfers into the WTP design will preclude plugging due to solids settling in WTP process piping system and the ability to recover from line plugging, if it occurs, is being incorporated into the design. Any proposed design change as recommended by the Design Completion Teams will follow existing nuclear-safety requirements pertaining to the conduct of hazards safety-analysis and safety-control-selection processes for WTP' s slurry transfer system, safety controls will be added or modified, as needed, to ensure safe operation of WTP and the successful completion of its mission.

4.0 References

1) CCN: 252307, Letter from P.S. Winokur, DNFSB to D. Huizenga, DOE, "DNFSB Staff Review of the Slurry Transport System Design in the Pretreatment Facility of the Waste Treatment And Immobilization Plant (WTP) at the Hanford Site", dated August 8, 2012.

2) 24590-WTP-RPT-ENG-11-010, Rev. 0, Report, *Non-Fragmentation of Ancillary Equipment Caused by Hydrogen Detonation,* March 10, 2011.

3) 24590-WTP-RPT-MGT-12-014, Rev. 0, Report, *Initial Data Quality Objectives for WTP Monitoring and Process Control,* March 10, 2011.
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