

U.S. Department of Energy
Office of River Protection

P.O. Box 450, MSIN H6-60
Richland, Washington 99352

07-WTP-278

OCT 29 2007

Mr. C. M. Albert, Project Manager
Bechtel National, Inc.
2435 Stevens Center Place
Richland, Washington 99354

Dear Mr. Albert:

CONTRACT NO. DE-AC27-01RV14136 – TRANSMITTAL OF THE U.S. DEPARTMENT OF ENERGY, OFFICE OF RIVER PROTECTION (ORP) DESIGN OVERSIGHT ASSESSMENT ON POST-FILTRATION PRECIPITATION

ORP's Waste Treatment and Immobilization Plant Engineering Division staff conducted a preliminary assessment of the potential for post-filtration precipitation in the Pretreatment Facility.

Post-filtration precipitation issues have been previously identified for Cesium Ion Exchange Process System, and the Cesium Nitric Acid Process system. These issues are currently being addressed by the Technology Steering Group. Based on a review of the Treated Low-Activity Waste (LAW) Evaporation and Concentrate Storage Process evaporator and the LAW concentrate storage vessel it appears that conditions may also arise in this system that will result in the precipitation and accumulation of large quantities of alumina and other solids. As such, ORP is concerned that the capability of the mixing system in the LAW concentrate storage vessel to adequately mix and mobilize LAW solids may be inadequate. ORP requests that the Technology Steering Group evaluate and resolve the identified discrepancy.

This letter is not considered to constitute a change to the Contract. In the event the Contractor disagrees with this interpretation, it must immediately notify the Contracting Officer orally, and in writing within five working days in accordance with the Contract (Section H, Clause H.1 "Technical Direction").

If you have any questions, please contact me, or your staff may contact James H. Wicks, Director, WTP Engineering Division, (509) 376-3522.

Sincerely,

John R. Eschenberg, Project Manager
Waste Treatment and Immobilization Plant Project

WTP:DHA

(Attachment titles and cc's page 2)

Mr. C. M. Albert
07-WTP-278

-2-

OCT 29 2007

Attachment

cc w/attach:
R. Brouns, BNI
R. Voke, BNI
W. Tamosaitis, WGI
BNI Correspondence

Attachment
to
07-WTP-278

Design Assessment Waste Treatment and Immobilization Plant (WTP) Design Assessment of
Pretreatment Facility Post-Filtration Precipitation

September 2007

Design Oversight: D-07-DESIGN-053

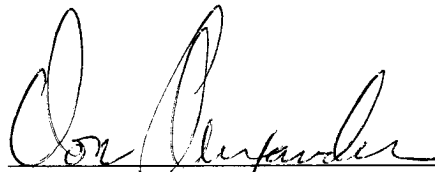
DESIGN ASSESSMENT

WASTE TREATMENT AND IMMOBILIZATION PLANT (WTP) DESIGN ASSESSMENT OF PRETREATMENT FACILITY POST- FILTRATION PRECIPITATION

SEPTEMBER 2007

DESIGN OVERSIGHT: D-07-DESIGN-053

Team Lead:



Don Alexander, Chemical Processing
Waste Treatment and Immobilization Plant Project
Engineering Division (WED)

Team Member:

Lloyd McClure, Chemical Processing Support, WED

EXECUTIVE SUMMARY

The U.S. Department of Energy, Office of River Protection (ORP) Waste Engineering Division staff conducted a follow-on design oversight of the potential for post-filtration precipitation in the Waste Treatment and Immobilization Plant Pretreatment (PT) Facility. As part of this assessment, the team specifically reviewed the PT Facility with respect to the Cesium Ion Exchange Process System (CXP), Cesium Nitric Acid Recovery Process System (CNP), and the Treated Low-Activity Waste (LAW) Evaporation and Concentrate Storage Process evaporator (TLP-SEP-00001) and the LAW concentrate storage vessel (TCP-VSL-00001).

Post-filtration precipitation issues have been previously identified for CXP-VSL-0001, and the CNP. These issues are currently being addressed by the Technology Steering Group. Based on a review of the Treated LAW Evaporation and Concentrate Storage Process evaporator (TLP-SEP 00001) and the LAW concentrate storage vessel (TCP-VSL-00001) it appears that conditions may also arise in this system that will result in the precipitation and accumulation of large quantities of alumina and other solids.

In parallel with this review, ORP completed a series of Technology Readiness Assessments (TRA)¹ for the WTP facilities; in particular, the PT TRA encompasses the CXP and CNP. As a result of the TRA reviews, ORP identified system design and operating issues with the CXP and CNP. In response, ORP and Bechtel National, Inc. (BNI) are preparing two Issue Response Plans (IRP) as follows:

- The CXP IRP will evaluate the adequacy of the design concept for the cesium ion exchange vessel, CXP-VSL-00001 to resolve issues of solids precipitation.
- The CNP IRP proposes to resolve design issues, including management of solids, through equipment modifications or additions to be defined in a CNP issue resolution closure report.

The Assessment Team identified an additional concern beyond those identified separately in the PT TRA:

The functions and requirements (2.12.1) of the Flowsheet Bases, Assumptions, and Requirements² states that the Treated LAW Evaporation and Concentrate Storage Process “*system is designed to concentrate the treated LAW feed ...without causing solids to precipitate in the treated LAW concentrate storage vessel (TCP-VSL-00001).*” However, section 2.12.3.16.7 of the same document identifies the potential for rapid precipitation of solids with a range of compositions.

Therefore, to resolve this discrepancy, ORP requests that the Technology Steering Group evaluate and resolve the identified discrepancy.

¹ DOE/ORP-2007-02, *Technology Maturation Plan – Technology Readiness Assessment Reports for the Waste Treatment and Immobilization Plant Project Facilities*, Volume II, draft, September 2007.

² 24590-WTP-RPT-PT-02-005, Rev. 3, Flowsheet Bases, Assumptions, and Requirement.

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LIST OF ACRONYMS

BNI	Bechtel National, Inc.
CNP	Cesium Nitric Acid Recovery Process System
CXP	Cesium Ion Exchange Process System
DOE	U.S. Department of Energy
HLW	High-Level Waste [Facility]
IRP	Issue Response Plan
IX	ion exchange
LAW	Low-Activity [Facility]
ORP	Office of River Protection
PT	Pretreatment [Facility]
TLP	Treated LAW Feed Evaporator System
TMP	Technology Maturation Plan
TRA	Technology Readiness Assessment
TRL	Technology Readiness Level
UFP	Ultrafiltration Process System
WED	Waste Engineering Division
WTP	Waste Treatment and Immobilization Plant

1.0 INTRODUCTION

The U.S. Department of Energy (DOE), Office of River Protection's (ORP) mission is to retrieve and treat Hanford Site tank waste and close the tank farms to protect the Columbia River. In order to complete one major component of this mission, ORP awarded Bechtel National, Inc. (BNI) a contract for the design, construction, and commissioning of the Waste Treatment and Immobilization Plant (WTP) at the Hanford Site in Richland, Washington.

As part of its oversight responsibilities, ORP performs various assessments of BNI activities during the design and construction phase. The purpose of this assessment is to evaluate the adequacy of Pretreatment (PT) Facility to manage post-filtration precipitation of solids.

2.0 BACKGROUND

An earlier Design Oversight Assessment Report was issued on the potential for Alumina Entrainment within the WTP PT Facility.⁴ As a follow up, the Assessment Team evaluated these issues as they pertain specifically to the potential for precipitation in the PT Facility post-filtration. Therefore, the Assessment Team reviewed the issue with respect to the Cesium Ion Exchange Process System (CXP), the Cesium Nitric Acid Recovery Process System (CNP), and the Treated Low-Activity Waste (LAW) Evaporation and Concentrate Storage Process system.

Subsequently, a draft Technology Readiness Assessment (TRA)⁵ was completed for the PT Facility in which two primary issues were raised with the CXP and the CNP. These issues were not further evaluated within this design oversight review. The following is a summary of the TRA finding and path forward:

- **Mixing in CXP-VSL-0001:** Confirmatory testing to validate the mixing performance of Pulse Jet Mixers (PJM) mixed vessels containing low-solid concentrations (e.g., Newtonian fluids) has not been completed. Specific, quantifiable design requirements for the PJM technology have not been established to support testing evaluation and design confirmation. The mixing functional requirements will consider the credited safety functions of the vessels and the anticipated waste characteristics in this vessel.
- **Immature CNP Design:** As part of the PT Facility TRA, the CNP was numerically rated as a Technology Readiness Level (TRL) 3⁶ because testing to measure the physical properties of the anticipated process waste solutions and provide information for thermodynamic modeling has only been completed on a laboratory scale. Confirmation testing of the CNP equipment components (reboiler, separator vessel, condenser, demisters, and rectifier column) has not been completed. Computer simulation of the

⁴ ORP letter from J. R. Eschenberg to C. M. Albert, "Transmittal of the U.S. Department of Energy (DOE), Office of River Protection (ORP) Design Assessment, D-07-DESIGN-040: Review of Aluminum Entrainment in Bechtel National Inc.'s (BNI) Feed Receipt and Evaporator Systems," 07-WTP-091.

⁵ 07-DESIGN-047, *Technology Readiness Assessment for the Waste Treatment and Immobilization Plant (WTP) Pretreatment Facility*, draft, September 2007.

⁶ The Technology Readiness Level (TRL) is a means of assessing technology maturity prior to design transition.

CNP operation has not included the full composition range of feed solutions. Proposed changes with the CNP flowsheet, including neutralization of the cesium concentrate acidic product (CNP evaporator concentrate prior to transferring the waste to the High-Level Waste [HLW] Lag Storage and Feed Blending Process System [HLP]) and potential impacts for changing the resin medium from SuperLig[®] 644 to resorcinol formaldehyde resin, have not been evaluated.

This assessment focused on the Treated LAW Evaporation and Concentrate Storage Process system.

3.0 OBJECTIVES, SCOPE, AND APPROACH

3.1 Objectives

The specific objectives of this oversight were to review the Operational Process Chemical Engineering in the post-filtration chemical processing operations of the WTP PT Facility with respect to:

- Potential for precipitation in CXP-VSL-00001
- Potential for precipitation in the CNP
- Potential for precipitation in the Treated LAW Evaporation and Concentrate Storage Process system.

3.2 Scope

The scope of this oversight assessment included review of project plans, procedures, and records associated with the process design in the WTP PT Facility.

3.3 Approach

ORP conducted this oversight within the guidelines of ORP DI 220.1, "Conduct of Design Oversight," Rev. 1, issued January 26, 2006. ORP collected information from various BNI and DOE documents and conducted interviews with BNI design staff.

4.0 CNP PROCESS CHEMICAL ENGINEERING

The process chemistry of the CNP will be evaluated under the Technology Maturation Plan (TMP). The TMP Issue Response Plan (IRP) will prescribe selected alternatives that will be modeled to confirm chemistry, energy and material balances using the Environmental Simulant Program and AspenTech simulation software packages. The Aspen operations model will be used to analyze control system response during the batch-continuous CNP operations cycle. An IRP on the CNP is being prepared that will address process chemical engineering.

5.0 CXP MIXING IN CXP-VSL-00001

The CXP is described in 24590-PTF-3YD-CXP-00001, *System Description for the Cesium Ion Exchange Process – System CXP*. The primary functions of the CXP are to receive ultrafiltration permeate from the Ultrafiltration Process System (UFP), remove cesium from the UFP permeate using Ion Exchange (IX), transfer the cesium-treated LAW (e.g., eluate) to the

Treated LAW Feed Evaporator System, and maintain hydrogen to a concentration below the lower flammability limit. UFP permeate solution is transferred from the three UFP permeate vessels to the cesium IX feed vessel (CXP-VSL-00001). Because the IX media (resin) has a limited capacity for cesium, the CXP requires an elution using dilute nitric acid and post-elution rinse to regenerate the resin media. This eluate is sent to the CNP evaporator where the nitric acid is recovered and the cesium and other salts are concentrated before transferring to the HLW Lag Storage and Feed Blending System (HLP).

There is a potential for precipitation in CXP-VSL-0001 as a consequence of the cooling of permeate passing through the ultrafiltration system. This accumulation of solids would require mixing components not currently in the CXP-VSL-0001 design. This issue was also identified as part of the PT TRA.

6.0 TREATED LAW EVAPORATION AND CONCENTRATE STORAGE PROCESS

The following are excerpts from the BNI document on Flowsheet Bases, Assumptions, and Requirements:⁷

The Treated LAW Evaporation and Concentrate Storage Process, “system is designed to concentrate the treated LAW feed to the operating concentration of the LAW vitrification process without causing solids to precipitate in the treated LAW concentrate storage vessel (TCP-VSL-00001) or piping to this vessel.”

The formation of solids in the evaporator concentrate is dependent on many factors pertaining to how the WTP process is operated and the operating setpoint of the evaporator. (Additional information is found in the referenced report SCT-MOSRLE60-00-184-01 or in evaporation for specified waste feeds reported in the list of references.)

The formation of sodium-alumino-silicate solids formed after seven days.

For AN-102, a bench-scale study was described as follows: The final boil-down demonstrated a dramatic solubility endpoint at ~8.2 M Na, changing from 2% to 16% insoluble solids in a few minutes. The major precipitant at the endpoint was identified by XRD as sodium carbonate hydrate.

For AN-107, “insoluble solids increase only slightly during concentration from approximately 8.3 M Na. Exhibiting a sharp transition, the evaporator concentrate within a 1-2 minute period went from a green semi-translucent liquid to a viscous greenish-white gel.”

For AP-101, the LAW hot commissioning tank...it was observed that the material at 4.9 M sodium did not contain visible solids. However, solids did precipitate during the evaporation to 6 M sodium concentration and beyond. These solids were identified to be primarily sodium nitrate and possibly potassium carbonate.

7.0 CONCLUSIONS

The ORP Assessment Team identified an additional concern beyond those identified separately in the PT TRA:

⁷ 24590-WTP-RPT-PT-02-005, Rev 3. Flowsheet Bases, Assumptions, and Requirement.

The functions and requirements (2.12.1) of the Flowsheet Bases, Assumptions, and Requirements⁸ states that the Treated LAW Evaporation and Concentrate Storage Process “*system is designed to concentrate the treated LAW feedwithout causing solids to precipitate in the treated LAW concentrate storage vessel (TCP-VSL-00001).*” However, section 2.12.3.16.7 of the same document identifies the potential for rapid precipitation of solids with a range of compositions. Thus, the mixing system within the Concentrate Storage Process Vessel may not be adequate.

Therefore, to resolve the discrepancy, ORP requests that the Technology Steering Group evaluate and resolve the identified discrepancy.

8.0 REFERENCES

- 07-DESIGN-047, *Technology Readiness Assessment for the Waste Treatment and Immobilization Plant (WTP) Pretreatment Facility*, draft, U.S. Department of Energy, Richland, Washington, September 2007;
- 24590-PTF-3YD-CXP-00001, *System Description for the Cesium Ion Exchange Process – System CXP*, Rev. 0, Bechtel National Inc., Richland, Washington, September 11, 2002;
- 24590-PTF-MV-CNP-VSL-00003, Rev. 1, *Equipment Assembly Cesium Eluate Breakpot CNP-BRKPT-00002*, April 16, 2007;
- 24590-PTF-MV-CXP-VSL-00001, Rev. 1, *Equipment Assembly Cs IX Vessel – CXP-VSL-0001 (Q)*, draft;
- 24590-PTF-MV-CXP-VSL-00004, Rev. 1, *Conceptual Design of Cesium Ion Exchange Column – CXP-VSL-0001 (Q)*, draft;
- 24590-WTP-3PS-MV00-TP001, *Engineering Specification for Pressure Vessel Design and Fabrication*, Rev. 2, Bechtel National Inc., Richland, Washington, July 12, 2004;
- 24590-WTP-SRD-ESH-01-001-02, *Safety Requirements Document, Volume II*, Rev. 4j, Bechtel National Inc., Richland, Washington, July 17, 2007, Appendix H, “Ad Hoc Implementing Standard for Erosion/Corrosion and Assessments;”
- DOE/ORP-2007-02, *Technology Maturation Plan – Technology Readiness Assessment Reports for the Waste Treatment and Immobilization Plant Project Facilities*, Volume II, draft, U.S. Department of Energy, Richland, Washington, September 2007;
- 24590-WTP-RPT-PT-02-005, Rev. 3. Flowsheet Bases, Assumptions, and Requirement;
- ORP letter from R. J. Schepens to J. P. Henschel, BNI, “Black Cell Access,” 04-WED-034, dated July 2, 2004; and

⁸ 24590-WTP-RPT-PT-02-005, Rev. 3. Flowsheet Bases, Assumptions, and Requirement.

ORP letter from R. J. Schepens to J. P. Henschel, BNI, "Submittal of U.S. Department of Energy, Office of River Protection (ORP) Design Oversight Report on Black Cell Design Adequacy," 04-WEC-005, dated February 11, 2004.

Task# ORP-WTP-2007-0278

E-STARS^R Report
Task Detail Report
10/29/2007 0250

TASK INFORMATION			
Task#	ORP-WTP-2007-0278		
Subject	(Concur 07-WTP-278) TRANSMITTAL OF THE U.S. DEPARTMENT OF ENERGY, OFFICE OF RIVER PROTECTION (ORP) DESIGN OVERSIGHT ASSESSMENT ON POST-FILTRATION PRECIPITATION		
Parent Task#		Status	CLOSED 10/29/2007
Reference		Due	
Originator	Licht, Sarah (Licht, Sarah)	Priority	High
Originator Phone	(509) 376-6611	Category	None
Origination Date	09/28/2007 1456	Generic1	
Remote Task#		Generic2	
Deliverable	None	Generic3	
Class	None	View Permissions	Normal
Instructions	<p>Hard copy of the correspondence is being routed for concurrence. Once you have reviewed the correspondence, please approve or disapprove via E-STARS and route to the next person on the list. Thank you.</p> <p>bcc: MGR RDG file WTP OFF file WTP RGD file M. K. Barrett, AMD T. M. Williams, AMD D. H. Alexander, WTP J. R. Eschenberg, WTP R. W. Griffith, WTP J. H. Wicks, WTP</p>		
ROUTING LISTS			
1	Route List		Inactive
	<ul style="list-style-type: none"> ● Alexander, Donald H - Review - Concur - 10/01/2007 0720 <i>Instructions:</i> ● Griffith, Robert W - Review - Concur - 10/09/2007 0930 <i>Instructions:</i> ● Eschenberg, John R - Approve - Approved - 10/29/2007 1323 <i>Instructions:</i> 		
ATTACHMENTS			
Attachments	<ol style="list-style-type: none"> 1. 07-WTP-278.DHA.Albert.doc 2. 07-WTP-278.DHA.Attach1.Design Assessment Plan-CsIX and Post-Filtration August 2007.doc 3. 07-WTP-278.DHA.Attach2.Post Filtration Assessment Report.doc 		
COLLABORATION			

RECEIVED

OCT 29 2007

DOE-ORP/ORPCC

Task# ORP-WTP-2007-0278
COMMENTS
<i>No Comments</i>
TASK DUE DATE HISTORY
<i>No Due Date History</i>
SUB TASK HISTORY
<i>No Subtasks</i>

-- end of report --

Task# ORP-WTP-2007-0278

E-STARS[®] Report
 Task Detail Report
 09/28/2007 0258

TASK INFORMATION			
Task#	ORP-WTP-2007-0278		
Subject	(Concur 07-WTP-278) TRANSMITTAL OF THE U.S. DEPARTMENT OF ENERGY, OFFICE OF RIVER PROTECTION (ORP) DESIGN OVERSIGHT ASSESSMENT ON POST-FILTRATION PRECIPITATION		
Parent Task#		Status	Open
Reference		Due	
Originator	Licht, Sarah (Licht, Sarah)	Priority	High
Originator Phone	(509) 376-6611	Category	None
Origination Date	09/28/2007 1456	Generic1	
Remote Task#		Generic2	
Deliverable	None	Generic3	
Class	None	View Permissions	Normal
Instructions	Hard copy of the correspondence is being routed for concurrence. Once you have reviewed the correspondence, please approve or disapprove via E-STARS and route to the next person on the list. Thank you. bcc: MGR RDG file WTP OFF file WTP RGD file M. K. Barrett, AMD T. M. Williams, AMD D. H. Alexander, WTP J. R. Eschenberg, WTP R. W. Griffith, WTP		
ROUTING LISTS			
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	<ul style="list-style-type: none"> • Alexander, Donald H - Review - Awaiting Response - Due Date <i>9/28/07</i> <i>Instructions:</i> • Griffith, Robert W - Review - Awaiting Response - Due Date <i>23 Oct 07</i> <i>Instructions:</i> • Eschenberg, John R - Approve - Awaiting Response - Due Date <i>10/23/07</i> <i>Instructions:</i> 	<i>Wicks, James H.</i> <i>James H. Wicks</i> <i>On w/ comment</i>	
ATTACHMENTS			
Attachments	1. 07-WTP-278.DHA.Albert.doc 2. 07-WTP-278.DHA.Attach1.Design Assessment Plan-CsIX and Post-Filtration August 2007.doc 3. 07-WTP-278.DHA.Attach2.Post Filtration Assessment Report.doc		
COLLABORATION			

Task# ORP-WTP-2007-0278
COMMENTS
<i>No Comments</i>
TASK DUE DATE HISTORY
<i>No Due Date History</i>
SUB TASK HISTORY
<i>No Subtasks</i>

-- end of report --