SODIUM-BEARING WASTEWATER PROCESSING AT THE WEST VALLEY DEMONSTRATION PROJECT

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ABSTRACT

The West Valley Demonstration Project (WVDP) has successfully completed the processing and solidification of 490,000 liters (130,000 gallons) of radioactive sodium-bearing wastewater removed from the former High-level Waste (HLW) Tank Farm. The radioactive and hazardous mixed waste liquid was pretreated to remove over 99% of the Cs-137 content and then this decontaminated liquid was concentrated by evaporation to 43,500 liters (11,500 gallons). The concentrate was sampled and characterized for physical properties, radiochemical content and potential Resource Conservation and Recovery Act (RCRA) hazardous constituents. Based upon this characterization, a stabilization treatment and solidification process was developed to convert the mixed waste liquid into a low-level radioactive waste solid suitable for land disposal. The process development involved laboratory-scale processing, first with non-radioactive surrogate and then with actual samples of the decontaminated sodium-bearing concentrate. Following treatment and solidification optimization testing in the laboratory, a full-scale 4.8 cubic meter (170 cubic foot) prototypic container of non-radioactive surrogate was produced with the actual processing equipment; all waste processing took place in the actual waste container utilizing its internal mixer shaft and blades. Samples were obtained from this waste product and analyzed to confirm that the stabilization and solidification treatment resulted in a non-hazardous waste suitable for land disposal. A special Type Industrial Package (IP)-2 waste container was designed and qualified to accommodate the processing of the actual sodium-bearing waste. The waste processing equipment was then installed at the WVDP and integrated with the site's systems. Following initial equipment and system integration tests, the decontaminated sodium-bearing waste concentrate was successfully processed during October and November 2004 in seventeen Type IP-2 waste containers each having a maximum gross mass/weight of 9,480 kilograms (20,900 pounds). Toxicity Characteristic Leaching Procedure (TCLP) testing on samples from the processed waste confirmed that the mixed waste treatment process resulted in a low-level radioactive waste that was no longer RCRA hazardous. The end-product, a stabilized cement form encapsulating the low-level radioactive wastewater, is expected to be disposed of as Class B non-hazardous radioactive low-level waste at the Nevada Test Site.

INTRODUCTION

The WVDP is located about 30 miles south of Buffalo, New York, on the site of a former commercial spent fuel reprocessing facility which operated from 1966 to 1972. Approximately 640 metric tons of commercial and defense fuels were reprocessed at the site using the PUREX and THOREX processes. In

1980, the West Valley Demonstration Project Act was signed, directing the U.S. Department of Energy (DOE) to solidify the HLW remaining from reprocessing operations; develop containers for the permanent disposal of the solidified HLW; transport the HLW to a federal repository; dispose of low-level and transuranic (TRU) wastes resulting from HLW solidification; and decontaminate and decommission the HLW storage tanks, solidification facilities, and any materials/hardware used during the Project. A private company, West Valley Nuclear Services Company (WVNSCO), was awarded the operations contract and has been the primary contractor since February 1982. Although the DOE is responsible for this cleanup project, New York State owns the site property and funds 10% of Project costs.

At the start of the Project, approximately 2.3 million liters (600,000 gallons) of neutralized PUREX high-level radioactive waste remained on the site in an underground, carbon steel tank designated Tank 8D-2. This waste consisted of insoluble hydroxides and other salts that precipitated out of the highly concentrated waste solution to form a bottom sludge layer, and a liquid (supernatant) upper layer rich in sodium nitrate and sodium nitrite (Reference 1). In addition, approximately 31,000 liters (8,200 gallons) of acidic THOREX waste, commingled with the recovered thorium, remained in a smaller, underground, stainless steel storage tank designated Tank 8D-4 (Reference 1).

BACKGROUND

The PUREX and THOREX high-level wastes were pretreated at the WVDP between 1988 and 1995 to partition these wastes into a high activity waste stream that was to be vitrified into a borosilicate glass and a low activity, mixed waste fraction that was treated/solidified during this time frame into a low-level radioactive waste form. The low activity waste stream consisted of decontaminated supernatant and sludge wash solutions, resulting from processing these liquids through zeolite columns to remove the soluble Cs-137. Following decontamination and concentration in the LLW evaporator, these low activity mixed waste liquids were stabilized/solidified into 19,877 270-liter (71-gallon) square drums, each weighing approximately 450 kg (1,000 pounds). The resulting waste met TCLP criteria in effect at that time for a RCRA non-hazardous waste, Nuclear Regulatory Commission (NRC) stability criteria, and was classified per 10CFR61 as Class A and C LLW.

The HLW portion of the PUREX and THOREX, consisting of the long-lived alpha-TRU and Sr-90 sludge radioactivity and the Cs-137 laden zeolite was retrieved from the HLW tanks and vitrified into 275 stainless steel canisters from 1996 to 2002. Each canister is 0.61 meter (2 feet) in diameter by 3 meters (10 feet) long with an average mass/weight of 2,070 kg (4,570 pounds). Recovery of these HLW solids from the bottoms of the large underground tanks was accomplished by agitating the settled solids within the progressively more dilute sludge wash solution using vertical, long-shafted mobilization pumps while pumping out the suspended solids slurry. A minimum amount of liquid was required in the original HLW Tank 8D-2 and its spare tank (Tank 8D-1), which stored the spent zeolite, in order to operate the mobilization pumps and HLW removal pumps. At the conclusion of HLW retrieval in July of 2002, approximately 530,000 liters (140,000 gallons) of dilute liquid existed in both of these tanks combined. The liquid consisted of dilute sludge wash solution, vitrification process vessel flush solutions, laboratory wastes, corrosion inhibitors, and miscellaneous plant wastes. Based on the high sodium content of the liquid and the sodium limitation in the borosilicate glass recipe, the WVDP determined that it was not cost effective to recover this mixed waste liquid and vitrify it. Instead, the liquid would be retrieved from the tanks and processed into a LLW solid form as was done earlier in the life of the Project.

During January and February 2003, this liquid effluent that was RCRA hazardous based on the heavy metals present, and too radioactive for treatment and release through the WVDP’s Low-level Waste Treatment Facility, was decontaminated in the WVDP Supernatant Treatment System (STS) to remove nearly all the Cs-137 content and then concentrated in the Liquid Waste Treatment System (LWTS) – just as had been done between 1988 and 1995 during HLW pretreatment. The resulting decontaminated, mixed waste liquid concentrate was stored in two of several stainless steel tanks (Tanks 5D-15A1 and 5D-15A2) in the Process Building. The sodium-bearing waste (SBW), contaminated primarily with the chromium and other RCRA metals (notably selenium, mercury, barium, cadmium, arsenic, and silver), was classified as RCRA hazardous due to the concentrations of some of these metals above characteristic limits. The inventory of these two tanks, approximately 43,500 liters (11,500 gallons) of SBW, was targeted for treatment and solidification in 2004 as a performance milestone by DOE and WVNSCO.

An engineering assessment of various alternatives identified candidate solidification methods and eliminated others. Of particular note was the potential use of the inactive Cement Solidification System that was formerly utilized at the WVDP to solidify decontaminated supernatant and sludge wash liquid from the HLW Tank Farm’s inventory into 19,877 270-liter (71-gallon) drums. Due to the system’s age and configuration, reuse for solidification of the SBW was considered not economically feasible. The system had not been operated in over nine years, operating procedures were out of date, and the turnover/reassignment of personnel would necessitate new qualification of operators and supervisors. The result of the engineering evaluation was a plan to subcontract the stabilization/solidification of this mixed waste liquid at the WVDP while using on-site personnel to support this waste processing.

SODIUM-BEARING WASTE PROCESSING

Processing of the SBW was required to treat the hazardous content of the waste so that the final waste form was non-hazardous and the liquid was converted into a solid form. The resulting low-level radioactive waste solid could then be disposed of at the Nevada Test Site (NTS) disposal facility. The final waste form would need to meet the NTS waste acceptance criteria which required that the waste be non-hazardous, in a solid form with less than 0.5% free liquid, and packaged in containers that can be handled by the NTS equipment and meet burial strength requirements. The maximum gross weight of the waste containers was specified so as to be able to ship two waste packages per truck shipment. In addition, the radiation field from the waste package was limited to be able to meet Department of Transportation (DOT) radiation criteria: 10 mR/hr at 2 meters without shielding the waste containers.

Vendor Identification

Seven vendors were identified and contracts established in early 2000 to develop candidate treatment technologies using WVDP-specified surrogate SBW, which was derived to be chemically the same as the expected final composition of the actual SBW but without any radioactive content. Three of those seven vendors developed successful processes on a laboratory-scale and submitted reports describing the recipe development and proposed treatment process in October 2000. Due to the acquisition of one of the successful vendors by another successful vendor, the available pool of potential vendors to continue process development for the SBW stabilization/solidification at the WVDP was reduced to two.

The next step in the vendor verification process included demonstration of SBW treatment & solidification using actual samples of decontaminated SBW concentrate on a laboratory-scale. Three, 50-

ml samples of the SBW were provided to the two vendors in May of 2001. Both vendors successfully demonstrated the effectiveness of their proposed processes through the production of a solid, non-hazardous low-level radioactive waste form using concentrate samples. These tests were summarized and reported to the WVDP in July 2001. The successful demonstrations provided the foundation for the ultimate proposals from each company in response to the WVNSCO inquiry.

Treat SBW Milestone Project Scope

Once the actual SBW was retrieved from the former HLW Tanks, decontaminated of Cs-137 and concentrated into a more manageable volume in February 2003 (Reference 2), samples were obtained and the SBW was extensively characterized for its physical properties, chemistry, and radionuclide content. Following cost estimate and schedule preparation, and project planning, a procurement package was prepared to solicit proposals from the two candidate companies who successfully processed the SBW samples on a laboratory-scale. WVNSCO developed and issued a procurement specification to solicit competitive bids from the two prospective vendors. Since a significant time had elapsed from completion of the laboratory-scale development tests in 2001 and since the final composition of the SBW liquid had been just established, the procurement specification required the bidders to optimize the previously developed processes or justify why that earlier work was still optimal to render the waste non-hazardous and minimize the resulting waste volume.

The requirements contained in the procurement specification included:

- Optimization of the waste form recipe to minimize resulting waste volume
- Process surrogate samples of waste on a laboratory-scale
- Reproduce the laboratory-scale process using actual samples of decontaminated SBW concentrate
- Ship samples of the treated SBW to an independent certified environmental laboratory for TCLP metals testing in order to confirm the successful laboratory-scale treatment process
- Design, fabricate, and test a full-scale solidification system
- Design, qualify, and fabricate waste containers with internal mixing blades that meet Type Industrial Package – 2 (IP-2) U. S. Department of Transportation requirements and comply with NTS waste acceptance criteria
- Test processing equipment as a fully-assembled, functional system
- Process a full-scale container of SBW surrogate sample to ensure the treatment process performs as expected on a production scale
- Ship samples of the full-scale treated surrogate SBW to an independent certified environmental laboratory for TCLP metals testing in order to confirm the successful production scale treatment process
- Disassemble and transport the processing equipment to the WVDP
- Assemble and install the process equipment at the WVDP
- Complete on-site check-out of equipment and demonstrate the satisfactory operation of processing equipment during system-integrated tests with interfacing WVDP supplied systems
- Process over 43,500 liters (11,500 gallons) of decontaminated SBW concentrate into seventeen Type IP-2 containers
- Following treatment of the SBW, process any necessary system flush liquid into a solid low-level waste form
- Demobilization of equipment and personnel from the WVDP

The successful subcontractor was also required to supply a price for the processing equipment such that the WVDP could potentially purchase all or part of the supplied process equipment for subsequent treatment/solidification of site wastewater that is either RCRA hazardous or too radioactive to process through the site's Low-level Liquid Waste Treatment Facility (LLWTF).

Vendor Selection

Both subcontractors submitted proposals that were initially non-responsive to the WVDP specifications. Meetings with both vendors were then conducted and each subsequently submitted a proposal which met contract technical requirements. Since each company met the contract requirements, the subcontract was awarded to the low bidder, Perma-Fix Environmental Services, Inc. (Perma-Fix).

Perma-Fix was directly responsible for the optimization of the processing recipe and the project management, and subcontracted to RWE NUKEM Corporation the design, fabrication and testing of the processing equipment and the Type IP-2 waste containers; full scale surrogate processing; equipment mobilization to the WVDP; installation and check-out of the equipment; the actual processing of the SBW; and the demobilization of the equipment from the WVDP.

Processing Equipment

The Subcontractor's processing system shown in Figures 1 and 2 consisted of:

- Waste container fill head assembly
- Liquid chemical pumping & metering system
- Solid ingredient auger conveyor system
- Solid ingredient bag break station
- Hydraulic power supply
- HEPA filtered vacuum system
- Control system

Fig. 1. Subcontractor Testing of Processing System

The fill head mates with the fill port on the top of the Type IP-2 waste container and includes the hydraulic motor that turns the waste container internal mixer shaft, recipe ingredient addition lines and valves, container ventilation port, B&W camera to view the in-container additions and mixing, air and water lines to clean the camera view port, thermocouple junction, container level sensor and high alarm, and provisions for sampling both the liquid waste and the cement-solidified waste slurry. The chemical delivery system consists of a pump and flow controller that transfers a preset quantity of the chemical solution into the waste for pretreatment prior to adding the solidification solid ingredients. Portland cement and other solid ingredients are supplied to the waste container fill head by a series of auger conveyors. Solid ingredients, packaged in nominal 23 kg (50-pounds) bags are added into the auger conveyor at the bag break station. The main auger conveys the solids into an intermediate hopper. From this hopper, the solids can be directed to either of two fill head processing locations by a pair of shorter intermediate auger conveyors. Due to the limited number of waste containers being processed at the WVDP and consequently the desire to only have one waste container fill station, only one of the two intermediate augers and its corresponding fill head was employed. A hydraulic power system, equipped with a redundant pump and motor, provided the energy to the container mixer motor to turn the in-container mixing blades. A commercial HEPA vacuum was used to maintain constant ventilation on the waste container and a negative pressure within the container during waste addition, processing, and curing. A control system was employed to operate remotely actuated valves, augers, hydraulic power supply, container mixer blades and the waste container ventilation system. The system also provided a video image from the fill head camera, temperature recorders to document the temperature of the curing waste product, waste container level display, and chemical addition flow totalizer/display.

Fig. 2 . WVDP Process Area

Full Scale Surrogate Processing

Following satisfactory functional testing of the process equipment to a WVDP-approved procedure, the Subcontractor prepared the full scale surrogate SBW inside a prototype IP-2 waste container at the RWE NUKEM facility in Columbia, SC on July 22, 2004. The liquid surrogate was prepared to be as chemically similar to the actual SBW as possible but with no radioactive compounds present and a hexavalent chromium concentration of 1,400 mg/L, approximately 10% higher than the composition of the actual SBW. Treatment/solidification of the surrogate was performed on August 3, 2004. Immediately following the processing, six core-type samples were obtained from the top of the already hardening waste billet. In addition, ten core samples were obtained from the solidified waste billet two days after processing: three from the top surface, four through the side of the container and into the waste and three from the bottom knuckle portion of the waste billet, all in accordance with the RWE NUKEM prepared Sampling Plan. These samples were sent to a certified lab for Toxicity Characteristic Leaching Procedure (TCLP) metals analysis. All results, presented in Table I, indicated that the treatment process resulted in a non-hazardous waste form. The average TCLP chromium results were a factor of ten below the required 0.6 mg/L Universal Treatment Standard (UTS). In addition, sample results indicated that the easier surface sampling of the just-processed waste was conservatively identical to the subsequent core drilled sample data at various locations in the waste billet. These results supported the planned production sampling method for the processed SBW.

Table I. TCLP Chromium Results (mg/L) from Full-scale Surrogate Processing

Samples from Top Surface Immediately After Processing Was Completed	Samples from Top, Side and Bottom After Two Days of Curing
0.0554	0.0438 Top
0.063	0.0602 Top
0.0464	0.0475 Top
0.0522	0.0172 Side
0.0176	0.0466 Side
0.0542	0.0451 Side
	0.00762 Side
	0.0102 Bottom
	0.0129 Bottom
	0.0519 Bottom
Average: 0.0481	Average: 0.0343
Standard Deviation: 0.0145	Standard Deviation: 0.0189

WVDP Waste Facility Modifications

Several on-site modifications were required prior to the initiation of SBW processing. They included changes to the liquid waste supply system, installation of a containment tent, erection of the fill head and auger overhead support structure, ventilation system modifications, installation of waste container material handling (rail cart) system, the installation of an iodine absorber on the container off-gas system, and preparations to support subcontractor equipment installation.

A series of modifications to the waste supply system were required to deliver the SBW concentrate from the storage tanks located in the Uranium Product Cell (UPC) of the Process Building to the solidification area established in a portion of the former Cement Solidification System (CSS) area. They included bypassing the Waste Dispensing Vessel, previously used to dispense the liquid waste into the old CSS high-shear mixers, with new piping to avoid using this old tank with its discharge valve that may not operate and eliminate ventilation issues with the tank. A new pump and valve skid was also installed in the CSS Process Cell with a remotely operated control system to boost existing pump delivery flow and measure the volume of SBW concentrate transferred. A pump was also installed to return flush wastewater back to Liquid Waste Treatment System Tank 5D-15A1.

A containment tent was erected in the Truck Bay of CSS area to provide contamination control during waste processing evolutions and provide a means of rebalancing the existing ventilation to achieve the required air flow rate and negative pressure during waste processing. A portable ventilation unit (PVU) was also installed to provide additional ventilation, if required. The PVU could be activated at variable speeds through remote means using the control panel.

In order to support the Subcontractor's fill head assembly and the auger that supplies dry ingredients to the fill head, an overhead beam was needed to anchor the auger and fill head chain hoist. This support structure was constructed and erected inside the containment tent using an existing building rafter to support one end on the beam and a commercially obtained gantry to support the other end. The challenge was to provide the maximum height possible since the existing building roof was severely limiting the operating height of the processing equipment.

A shielded rail cart system was installed to provide a method of moving waste containers into and out of the CSS building. An octagonal shaped steel container that travels on a fixed rail system provided a secondary containment system during solidification activities and provided additional radiation shielding for the solidified SBW. Rail system features include a set of tracks leading into the CSS, a motorized waste container shield cart, and a pendant control system for moving the container cart. Figures 2 and 3 illustrate the use of the rail cart system with the IP-2 waste container.

Based on the amount of Iodine-129 existing in the SBW liquid, it was determined that an iodine absorber was required on the Subcontractor's waste container ventilation system, even though no significant I-129 emissions were anticipated. WVDP personnel procured a suitable absorber system and equipped it with inlet and outlet sample taps and differential pressure indicator and remote transmitter. The exhaust from the container ventilation iodine absorber was routed to an existing monitored discharge stack. The ventilation flow was also measured and monitored remotely to ensure a continuous ventilation draw on the waste container being processed and adequate contamination control.

Due to potential Western New York weather impacts on waste processing in the fall timeframe, heated weather shelters were erected to enclose the outdoor liquid chemical addition system and bag break station. The chemical system was placed in a relocated wooden structure. A deck was constructed to support the Subcontractor's hydraulic skid and bag break station. The deck was sized to utilize an existing tent support structure, which was modified and fitted with new fabric.

Fig. 3. Removal of Waste Container from Shield Cart

Additional modifications included emergency lighting installation, utility water and compressed air extensions, drain modifications, and toxic gas monitoring system implementation. A Personnel Contamination Monitor (PCM) was relocated into the CSS Change Room to support access to the processing system inside the CSS Truck Bay containment tent. Prior to implementing the WVDP facility modifications, the planned processing areas were cleared of all unnecessary equipment used during the 1988 to 1995 production of the 19,877 270-liter (71-gallon) cemented waste drums of decontaminated supernatant and sludge wash concentrate..

Sodium-Bearing Waste Processing Summary

Seventeen, 170 cubic foot capacity Type IP-2 containers of treated/solidified decontaminated SBW concentrate were produced during the SBW processing campaign, which was initiated on October 11, 2004 and concluded on November 15, 2004. A summary of the solidification process follows. Table II presents summary processing data. The length of time required to add the dry ingredients decreased with additional processing experience and resulted in different waste consistencies at sampling and sampling techniques. Also, some dry ingredient addition times were so long that the container mixer stalled due to the thickening of the cement slurry.

Table II. Sodium-bearing Wastewater Summary Processing Data

Sequential Container Number	Date Solidified	Dry Ingredient Addition Time (min)	Total Dry Ingredient Mix Time (min)	Container Internal Mixer Stall (Yes/No)	Waste Surface Sample Method	Waste Sample Consistency
1	11-Oct-04	325	325	Yes	Core	Hard
2	21-Oct-04	224	235	Yes	Core	Hard
3	22-Oct-04	285	285	Yes	Core	Hard
4	25-Oct-04	158	185	No	Core	Hard
5	28-Oct-04	176	206	No	Core	Clay
6	29-Oct-04	184	204	Yes	Core	Clay
7	02-Nov-04	210	248	Yes	Core	Clay
8	05-Nov-04	214	249	Yes	Core	Clay
9	06-Nov-04	188	213	No	Core	Slurry
10	07-Nov-04	181	196	No	Dipper	Slurry
11	08-Nov-04	141	181	No	Dipper	Slurry
12	09-Nov-04	138	155	No	Dipper	Slurry
13	10-Nov-04	142	177	No	Dipper	Slurry
14	11-Nov-04	130	160	No	Dipper	Slurry
15	12-Nov-04	145	180	No	Dipper	Slurry
16	13-Nov-04	132	160	No	Dipper	Slurry
17	14-Nov-04	152	167	No	Dipper	Slurry

The SBW from Tank 5D-15A1 was sampled and analyzed by the Analytical & Process Chemistry (A&PC) Laboratory at the WVDP immediately prior to the start of processing to ensure that the waste characteristics had not changed from previous sample analyses. In addition, process control plan samples were prepared and treated/solidified on a lab-scale according to the nominal, high ingredient solids and low ingredient solids recipes. All three recipes processed easily, quickly set up, and solidified. There was less than 0.5% free liquid on the thinnest sample, only a few drops on the nominal recipe, and no liquid on the stiffest recipe after three days of curing.

A pre-start readiness evaluation was conducted to ensure that both WVNSCO and Subcontractor processes, procedures and personnel were ready to safely process the SBW. Readiness to begin processing was declared on October 8, 2004, with the first container of treated waste being produced on October 11, 2004. Following completion of the first waste container of processed waste, there was a hold point prior to continuing the processing of the SBW to allow time for sampling of the first solidified material to confirm that the resultant waste form met non-hazardous low-level radioactive waste criteria. The waste samples underwent TCLP testing at two laboratories — the WVDP on-site Analytical & Process Chemistry Laboratory and an off-site independent certified laboratory, General Engineering Laboratories, LLC (GEL). The GEL results are presented in Table III in the column for the 1st container, serial number 10086-02. Following confirmation of the acceptability of the decontaminated waste form from both laboratories, processing of the remaining SBW resumed on October 17, 2004. The higher chromium TCLP result for the first container is attributed to the fact that the full amount of one dry ingredient was not able to be added due to the long addition time and resulting mixer stall.

Table III. TCLP Results (mg/liter) from actual Sodium-bearing Wastewater Processing

Metal	UTS	1st	4th	6th	7th	17th	Average	Std. Dev.
		10086-02	10086-08	10086-04	10086-11	10086-17		
Antimony	1.15	**0.0584**	**0.0833**	**0.0337**	**0.0261**	**0.0619**	**0.0527**	0.0206
Arsenic	5	<0.0238	<0.475	<0.475	<0.475	0.051	0.051	N/A
Barium	21	**0.167**	0.319	**0.278**	0.420	0.483	0.3282	0.101
Beryllium	1.22	<0.00279	<0.00279	<0.00279	<0.00279	<0.00279	<0.00279	N/A
Cadmium	0.11	<0.00386	<0.00386	<0.00386	<0.00386	**0.00715**	**0.00715**	N/A
Chromium	0.6	0.194	**0.0304**	0.0818	0.0705	**0.0454**	0.0844	0.0577
Lead	0.75	<0.0266	<0.0266	<0.0266	<0.0266	<0.0266	<0.0266	N/A
Mercury	0.025	**0.00123**	<0.000472	<0.000472	<0.000472	<0.000472	**0.00123**	N/A
Nickel	11	0.0656	**0.0289**	**0.0304**	0.0523	0.0673	**0.0489**	0.0166
Selenium	1.0	<0.169	0.0851	<0.676	<0.676	<0.0338	0.0851	N/A
Silver	0.1	<0.0118	<0.0118	<0.0118	<0.0118	<0.0118	<0.0118	N/A
Thallium	0.2	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	N/A
Vanadium	1.6	**0.0472**	0.162	0.0735	<0.00587	<0.00587	0.0942	0.0491

NOTE: Selenium toxicity characteristic of 1.0 is more limiting than its 5.7 mg/liter UTS
Bolded results indicate that the value is below the lab's reporting limit
< (less than) results indicate that the value is below the lab's detection limit

Processing of the waste continued using SBW retrieved from WVDP storage Tank 5D-15A1 until the tank level reached a sufficiently low level to permit acceptance of the inventory of SBW stored in Tank 5D-15A2. At this point, the contents of Tank 5D-15A2 were transferred into Tank 5D-15A1 thus emptying this smaller tank. The blended waste was sampled and analyzed to ensure a consistent composition, and process control plan samples were mixed by A&PC Lab personnel to verify the continued processibility of the SBW. The blended SBW physical and chemical analyses were essentially the same as for the original SBW liquid from Tank 5D-15A1, and the laboratory-scale process control plan treatment/solidification produced the same results. The first six containers of waste were produced from SBW stored initially in Tank 5D-15A1 alone; containers seven through seventeen were produced using the remaining inventory of blended waste from both tanks. Based on production processing data, there was no apparent difference between the original SBW processed and the subsequently blended SBW from the two storage tanks. A sample of the cemented waste slurry from the top of each waste container was obtained immediately after processing was completed for either archiving or TCLP metal analysis as specified in the WVDP sample and analysis plan.

Additional TCLP metals testing confirmed the solidified waste stream continued to meet non-hazardous waste acceptability criteria throughout SBW processing. In addition to testing the 1st container processed, this testing was performed on samples extracted from the 4th, 6th, 7th, and 17th waste containers produced, with all analysis results well below the Universal Treatment Standard (UTS) maximum allowable criteria. All TCLP metal results are presented above in Table III as chronologically processed together with the actual serial number (10086-XX) of the waste package. Table IV presents a chronology of significant SBW project activities.

Table IV. Project chronology

April 17, 2003	Inquiry package issued to prospective bidders
August 15, 2003	Perma-Fix Environmental Services, Inc. awarded the SBW stabilization/solidification subcontract based on low bid
February 18, 2004	WVNSCO witnessed lab-scale processing at Perma-Fix Laboratory in Florida
April 12, 2004	RWE NUKEM performed Type IP-2 container drop tests
July 21, 2004	RWE NUKEM completed functional testing of equipment
July 22, 2004	Full scale surrogate prepared in full scale liner
August 3, 2004	Processed/solidified full scale liner of surrogate and obtained top surface samples of processed waste
August 5, 2004	Cored full scale surrogate waste to obtain additional samples at top, sides and bottom of liner
August 23, 2004	Installed shielded rail car on the newly installed tracks and verified operability
September 1, 2004	RWE NUKEM cargo container with processing equipment arrived and was offloaded at the WVDP
October 2, 2004	Completed process equipment installation and integrated testing of RWE NUKEM and WVNSCO systems
October 8, 2004	Declared readiness to process the SBW
October 11, 2004	Added the first SBW into the first waste container and processed into a solid non-hazardous waste form
November 1, 2004	Combined the SBW contents of Tank 5D-15A2 with the contents of Tank 5D-15A1, sampled, performed analyses and PCP tests
November 14, 2004	Processed the last container of SBW from Tank 5D-15A1 liquid
November 15, 2004	Subcontractor began demobilization of process equipment
November 30, 2004	NTS approved the SBW waste profile
December 2, 2004	Subcontractor completed demobilization of process equipment

Waste Stream Characteristics/Disposition

The processed SBW waste stream has been fully characterized and meets the approved waste profile for non-hazardous low-level radioactive waste in accordance with Nevada Test Site (NTS) waste acceptance criteria. WVNSCO sought approval for this waste profile and obtained waste acceptance from NTS on November 30, 2004, ensuring the processed SBW is eligible for disposal at the facility. Figure 4 illustrates fork truck movement of the IP-2 waste container using its top-mounted tine pockets. The processed SBW, which is Class B LLRW per 10CFR61 based on the high Sr-90 content, will be stored on-site at the WVDP since the site doesn't currently have authorization to ship Class B or C LLW.

Fig. 4. Processed SBW Container Being Moved to Storage

Lessons Learned and Operational Observations

Production of the first container of waste and the subsequent hold point while waiting for lab results to confirm that the waste product was acceptable provided an opportunity to critically evaluate the Subcontractor and WVDP work instructions governing the processing against the first waste container processed. In addition, minor equipment adjustments and modifications were made during this week-long period to improve the production efficiency for the remaining 16 containers.

Transfer of the dry ingredients from the Bag Break Station to the Intermediate Hopper inside the CSS containment tent took significantly more time than was expected during production of the first container; the actual time was over five hours (Table II) compared to the two hours demonstrated during the full-scale surrogate processing in Columbia, SC. The slower than expected addition rate was attributed primarily to difficulties in feeding one of the very fine and lightest dry ingredients through the auger conveyor and obstructions inside the auger pipe caused by clumps/"rocks" of dry ingredients that resulted in plugging and stalling of the auger system. A minor modification was made to the grating over the inlet area of the break station to further limit the size of these hard clumps of solids, thereby reducing the maximum size of the dry ingredients being transported by the auger system. In addition, the auger internal screw length was shortened to provide greater clearance with the auger tube and reduce the chances of binding when clumps of dry ingredients caused the internal auger screw to extend in length. These modifications eliminated nearly all the stalling of the auger system and greatly reduced the transfer rate of the dry ingredients to the Intermediate Hopper as indicated in Table II.

Bulging of the bottoms of the 17 1.9-meter (74.5-inch) diameter by 2.0-meter (77.4-inch) high Type IP-2 waste containers was observed to different degrees, from less than 1 cm (0.4 inch) to at least 5 cm (2 inches). This was attributed to the internal generation of gas pressure during the initial waste billet curing and perhaps the added weight of the ingredients on the container bottom combined with residual waste container stresses resulting from container fabrication. The waste containers bottoms were purposely specified flat or concave upward to ensure that they rest firmly on the bed of the truck planned to haul them to the disposal site. The resulting bulging of the bottoms will necessitate special cribbing to support the bottom circumference of the waste containers. This bulging may be eliminated in future waste containers by increasing the concavity of the bottom head or by specifying post weld heat treatment.

Bulging of the tops of three of the first six Type IP-2 waste containers was observed after processing and cover installation on the sixth container. The bulging was much more pronounced on the sixth container: at least 5 cm (2 inches), and further investigation indicated two other containers had slightly bulged tops. Installation of the final cover on the seventh container of SBW processed was placed on hold until the issue could be addressed and a corrective action implemented. The expansion was determined to be caused by gas pressure generated during the initial curing of the waste, and potentially capping the waste containers too soon following waste treatment. Gas analysis indicated the presence of hydrogen sulfide, moisture, and a trace concentration of ammonia. The addition of a High Efficiency Particulate Air (HEPA) filter vent in the 3-inch sample port flange on the tops of waste containers 7 through 17 allowed the solidifying waste to safely vent during the curing process. Containers 1 through 6 were returned to the CSS Truck Bay containment tent after SBW processing was completed to safely vent internal gas pressure and replace the sample port blind flange with a HEPA filter-vented flange.

Post-production inspection of the containers was conducted to detect the presence of any free liquid on the top of the solidified waste. The first three containers contained no free liquid, however, containers 4 through 17 did reveal the presence of varying amounts (0.2 to 25 liters [0.05 to 7 gallons]) of free liquid up to 0.55% of container volume despite recipe modifications within the process control plan to attempt to eliminate this nuisance liquid. The cemented waste slurry archive sample from the first container that exhibited this excess liquid was sent off-site for TCLP metals testing to confirm the acceptability of the chromium stabilization. The results from the certified lab indicated that the leachable chromium was a factor of twenty lower that the Universal Treatment Standard. TCLP testing by the WVDP lab also indicated that the chromium was well below the UTS. Samples of the free liquid obtained from the surface of the curing waste billets were analyzed for chromium with all the results below RCRA regulatory limits. Depending upon the quantity of free liquid observed over the solidified waste surface, the liquid was either pumped from the container and returned to the system for inclusion in the remaining containers or absorbed through the addition of dry portland cement on top of the waste surface.

Post-Processing Status

The 17 vented IP-2 waste containers filled with the processed SBW were externally decontaminated prior to the release of each from the processing containment tent and relocated via forklift to the on-site storage location. The containers were covered with herculite weather protection jackets while awaiting authorization for shipment to the NTS.

Future Applicability

Additional inventories of low-level and mixed waste liquids remain in storage at the WVDP and are unsuitable for processing through the site’s Low-level Liquid Waste Treatment Facility. Approximately 95,000 liters (25,000 gallons) of these liquids remain in Tanks 8D-3 & 8D-4 in the WVDP Tank Farm and in Main Plant Tanks 5D-15B, 7D-2 and 7D-14. Additional liquids originating from the plant ventilation system, the A&PC Laboratory, and plant sumps are currently being accumulated and stored in the tanks in the Process Building. Future sources of liquid waste that are expected to exceed the site’s interceptor processing criteria may be produced from decontamination activities in the Remote-Handled Waste Facility, Process Building, and the Vitrification Facility.

CONCLUSIONS

The WVDP sodium-bearing wastewater was successfully processed from a mixed waste liquid into a RCRA non-hazardous low-level radioactive waste suitable for land disposal. The scope of work was split between WVNSCO and the Subcontractor based on the expertise required. With this partnership, the recipe development, qualification of the Type IP-2 waste container, design & testing of processing systems, preparation of the WVDP facility and the actual SBW processing were expedited.

Successful processing of the SBW demonstrated that this type of in-container processing and support equipment are viable for stabilization/solidification of other mixed waste liquids and radioactive waste streams that currently are being stored on site. The SBW solidification campaign provided valuable lessons learned for future waste stabilization and solidification applications at the WVDP.

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