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**REVIEW OF THE WEST VALLEY THOREX WASTE  
NEUTRALIZATION PROCESS**

*Prepared for*

**Nuclear Regulatory Commission  
Contract NRC-02-93-005**

*Prepared by*

**Center for Nuclear Waste Regulatory Analyses  
San Antonio, Texas**

**September 1994**

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**Gustavo A. Cragolino**

**Center for Nuclear Waste Regulatory Analyses  
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**September 1994**

## PREVIOUS REPORTS IN SERIES

<u>Number</u>	<u>Name</u>	<u>Date Issued</u>
CNWRA 91-015	"Safety Evaluation Report on the West Valley Demonstration Project Supernatant Treatment System" Safety Analysis Report, Volume III (WVNS SAR-004 Rev. 6)	November 1991
CNWRA 93-007	Seismic Tornado Analysis Review for the Vitrification Facility at West Valley	April 1993
CNWRA 93-008	Review of Corrosion Aspects of High-Level Waste Storage Tanks at West Valley	April 1993
Letter Report	Preliminary Comments on the Draft Safety Analysis Report for Vitrification Operations and High-Level Waste Interim Storage, WVNS-SAR-003	July 1994

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## ABSTRACT

This report provides an analysis and review of the physico-chemical aspects of the THOREX neutralization processes selected for the West Valley Demonstration Project. Corrosion aspects that may affect the integrity of the tanks, the transfer lines, and the off-gas system are discussed. The structural safety of the High-Level Waste Transfer System to be used in the transfer and neutralization of the THOREX waste is also reviewed. It is concluded that the structural integrity of the various components can be maintained during these operations. The direct neutralization of the THOREX waste in the tank currently containing the PUREX waste does not promote excessive risk of accelerated corrosion, but careful monitoring is recommended.

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## QUALITY OF DATA

**DATA:** Sources of data are referenced in each chapter. The respective sources of these data should be consulted for determining their levels of quality assurance.

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# 1 BACKGROUND

The West Valley Demonstration Project (WVDP) is being undertaken by the Department of Energy (DOE) to conduct a demonstration project for the management of high-level radioactive waste (HLW) at West Valley. The main task of the project is to convert the HLW generated by prior commercial fuel reprocessing operations into borosilicate glass for ultimate disposal in a federal repository. The project involves the cleanup of over 2.5 million liters (nearly 660,000 gal.) of nuclear spent fuel reprocessing wastes. These wastes have been stored in two underground tanks containing two different waste forms since the interruption of the reprocessing activities at West Valley. Alkaline wastes from the Plutonium Uranium Recovery EXtraction (PUREX) process were stored in tank 8D-2 (approximately 2.1 million liters), and acidic THORium Recovery EXtraction (THOREX) wastes were stored in tank 8D-4 (approximately 54,000 liters). The THOREX wastes exist as a single, liquid phase of pH lower than 1.0, contained in a tank made of type 304L stainless steel (SS), which is a material resistant to general corrosion in acidic solutions. Tank 8D-2, which contains the alkaline PUREX waste, is made of carbon steel. Corrosion aspects of the carbon steel tanks were reviewed previously (Cragolino, 1993).

Initial activities that were completed in November 1990 included removal of radioactive Cs from the liquid present as a supernatant above the PUREX sludge by an ion-exchange process using zeolites, and processing of the resulting low-level waste (LLW) liquid into cement. The residual PUREX sludge has been washed through a first cycle with caustic solutions, avoiding the solubilization of Pu by maintaining a pH above 13.0. Washing is used to remove sulfates that have an adverse effect on the vitrification process. Planned activities include the transfer of the THOREX waste to tank 8D-2 and its concurrent neutralization, after completion of the PUREX sludge wash cycles. An additional operation, following the consolidation in tank 8D-2 of the PUREX and THOREX wastes and preceding the vitrification of the waste into borosilicate glass, will be the transfer into that tank of the spent zeolite, currently located in tank 8D-1. Tank 8D-2 will continue to function as the main HLW storage tank during the vitrification operations, once the THOREX transfer and neutralization, and the zeolite transfer operations are completed.

To perform these activities, several supporting systems are needed. Three of these systems are the Supernatant Treatment System (STS), the Sludge Mobilization and Wash System (SMWS), and the High-Level Waste Transfer System (HLWTS). The primary objective of the STS is to reduce the volume of liquid HLW, while the primary purpose of the SMWS is to remove sodium sulfate crystals present in the sludge which would be detrimental to the vitrification process. The HLWTS is the operating system to be used in the transfer and neutralization of the THOREX waste. The HLWTS will also be used to remove the zeolite loaded with radioactive Cs from tank 8D-1 and transfer it to tank 8D-2. An additional product of the operation of the HLWTS is the wash solution resulting from the THOREX/PUREX mixing which will be transferred from tank 8D-2 to the STS.



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## **2 PURPOSE AND SCOPE OF THIS REVIEW**

This review addresses several issues related to the physico-chemical aspects of the THOREX neutralization process and the corrosion processes that may affect the integrity of the tanks and the transfer lines during this operation. The review is essentially confined to the analysis of the document prepared by Barnes and Schiffauer (1994) on the THOREX neutralization process. In that document, several options for neutralizing the THOREX wastes were discussed, and the direct addition of the THOREX wastes into tank 8D-2 to be neutralized by the high-pH PUREX solution was recommended. In addition, the Safety Evaluation for High Level Waste Transfer System (West Valley Demonstration Project, 1994) was reviewed, taking into consideration the aspects noted above that refer to the processes finally adopted for transferring the THOREX wastes and their neutralization. The structural safety of the components of the HLWTS involved in the neutralization process is also reviewed.

The Nuclear Regulatory Commission (NRC)/Center for Nuclear Waste Regulatory Analyses (CNWRA) staff attended the West Valley Technical Advisory Group (TAG) meeting on the THOREX neutralization process held at West Valley, New York, on July 21, 1993, where alternative options and the facilities to be used for the process were evaluated. One of the main concerns expressed by the West Valley TAG related to the integrity of the carbon steel tanks as affected by an extended storage period if the neutralization process is delayed. Another concern was the risk of accelerated attack promoted by acidic species in the tank and the off-gas system during THOREX neutralization. Accordingly, this review addresses these issues.

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### 3 WEST VALLEY DEMONSTRATION PROJECT THOREX NEUTRALIZATION

The THOREX waste, currently stored in tank 8D-4, is in the form of an aqueous solution containing mostly thorium nitrate. The THOREX waste transfer process involves the neutralization of the acidic thorium nitrate waste in tank 8D-2 by using caustic in the presence of the PUREX sludge. The properties of both wastes are given in Table 3-1, and the estimated compositions in Table 3-2. The caustic will be added to the tank 8D-2 contents and then mixed using the 8D-2 mobilization pumps. The acidic THOREX (pH < 1.0) waste will be slowly added to caustic-rich tank 8D-2 (pH > 13.0) in batches in a manner that assures quick neutralization of any free acid, avoiding localized excursions of pH inside tank 8D-2. After neutralization, a dilute caustic solution will be added and the PUREX/THOREX precipitate will be washed of its salts using the SMWS. Once the PUREX/THOREX precipitate is washed, the resulting solutions will be processed through the STS. As noted before, the spent zeolite will be transferred as a slurry to tank 8D-2, after being reduced in size by passage through an on-line grinder. After the THOREX transfer to tank 8D-2 is completed, the SMWS will also provide the connections to allow water flushing of the transfer lines and tank 8D-4.

**Table 3-1. Properties of the West Valley high-level radioactive wastes (adapted from Barnes and Schiffhauer, 1994)**

Properties	Washed PUREX	THOREX
Waste Volume	1,237,000 liters	54,100 liters
Temperature	46 °C (115 °F)	43.3 °C (110 °F)
Density	1.1 g/cm <sup>3</sup>	1.7 g/cm <sup>3</sup>
pH	≥ 13	< 1

A large excess of a caustic solution containing 20 wt% NaOH will be added to tank 8D-2 using the SMWS caustic addition system before the acidic THOREX waste is pumped over from tank 8D-4. After the caustic addition and the homogenization with the centrifugal pumps, samples from the supernatant will be analyzed to confirm the presence of excess caustic. THOREX waste will be transferred in batches to tank 8D-2 at flow rates lower than 5 gal./min

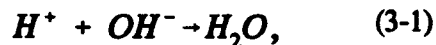
(0.315 dm<sup>3</sup>/s) through a 2 in. (5 cm) diameter transfer pipe which extends below the liquid surface to approximately 10 ft (3 m) from the tank floor. During the neutralization process, excess caustic at a concentration of about 0.2 molar will be maintained in tank 8D-2. If additional caustic is needed, it will be added to the tank.

#### 3.1 CHEMICAL REACTIONS IN THOREX NEUTRALIZATION PROCESS

All the chemical reactions considered by Barnes and Schiffhauer (1994) were reviewed. Since both wastes are composed of strong electrolytes, which are fully dissociated species with the exception of the precipitated salts and hydroxides, the various steps of the process can be described using ionic species instead of the overall chemical equations. It is established in their report that the addition of the THOREX waste to the PUREX waste involves primarily the following acid-base neutralization reaction,

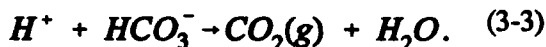
**Table 3-2. West Valley high-level radioactive waste estimated compositions (adapted from Barnes and Schiffhauer, 1994)**

Species	Washed PUREX	THOREX
Al	2,240 kg	480 kg
Cr	75 kg	350
Ni	595 kg	240 kg
B	50 kg	70 kg
Fe	1,280 kg	1,420 kg
K	15,200 kg	140 kg
Mn	2,890 kg	30 kg
Na	34,000 kg	170 kg
P	2,060 kg	40 kg
Th	—	14,020 kg
Zr	550 kg	30 kg
NO <sub>2</sub> <sup>-</sup>	0.2 mol/l	—
NO <sub>3</sub> <sup>-</sup>	0.2 mol/l	9.1 mol/l
SO <sub>4</sub> <sup>2-</sup>	0.02 mol/l	0.07 mol/l
OH <sup>-</sup>	> 0.1 mol/l	—
H <sup>+</sup>	—	> 0.1 mol/l



which is exothermic, with an enthalpy of reaction of 13.8 kcal/mol (57.8 kJ/mol). Neutralization will be accompanied by the precipitation of Th (IV) as hydroxide as a consequence of the high pH of the alkalized PUREX waste. Other metal cations, present in solution in the THOREX waste, such as Al (III), Fe (III), Cr (III), Ni (II), etc. will also precipitate as hydroxides. Hydroxide, nitrate, and nitrite will remain as the predominant anionic species in the liquid phase.

Reactions accompanied by the generation of gases, such as carbon dioxide, can take place locally according to the following equations:



Since the concentration of bicarbonate or carbonate is relatively low and carbonic acid is a weak acid, no effect on the corrosion of the tank walls above the liquid level can be expected from the liberation of CO<sub>2</sub> and its reaction with the vapor condensate.

A reaction that deserves attention is the formation of nitrous acid as an initial step in the generation of nitrogen oxides,

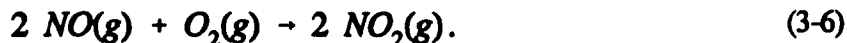


The decomposition of nitrous acid has been considered in detail by Barnes and Schiffhauer (1994), according to the following reaction:

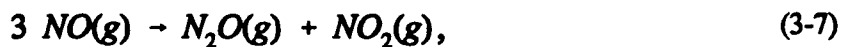


The kinetics of this reaction increases significantly with temperature, and it is relatively fast at 45 °C. Nitric oxide, NO, is slightly soluble in water, but it can react with the oxygen present in the air in the tank plenum as follows,

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Nitric oxide is also thermodynamically unstable above 25 °C (Melia, 1965), according to the reaction

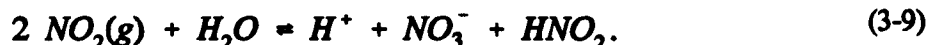


but this reaction is kinetically slow at low pressures.

Nitrogen dioxide,  $\text{NO}_2$ , exists in equilibrium with its dimer, dinitrogen tetroxide,



In general, these nitrogen oxides ( $\text{NO}$  and  $\text{NO}_2$ ) are designated as  $\text{NO}_x$ , and the main product of their dissolution in water is the formation of nitric and nitrous acids:



Since nitric acid is a strong acid, the formation of concentrated solutions on the wet tank walls above the liquid level may lead to accelerated corrosion of the carbon steel. To prevent accelerated corrosion, addition of the THOREX waste to the PUREX waste will be done slowly enough to control the rate of formation of  $\text{NO}$  and, consequently, of  $\text{NO}_2$  and  $\text{HNO}_3$ . The caustic concentration will be determined before each addition to avoid any pH excursions to lower values.

From the previous analysis, it can be concluded that Barnes and Schiffhauer (1994) made a careful evaluation of all the chemical aspects of the neutralization process in Section 2 of their report.

### 3.2 METHODS FOR THE THOREX NEUTRALIZATION PROCESS

Barnes and Schiffhauer (1994) qualitatively compared several alternative methods for the neutralization of the THOREX wastes. The methods considered were:

- (i) Direct neutralization with the high-pH PUREX waste in tank 8D-2
- (ii) Recycle loop neutralization with the high-pH PUREX waste in pit 8Q-2 jumper
- (iii) Addition of THOREX waste to the Concentrator Feed Make-up Tank (CFMT) during vitrification operations
- (iv) Neutralization with pure caustic in CFMT, followed by transfer to tank 8D-2
- (v) Neutralization with high-pH PUREX waste in a small tank to be emplaced in pit 8Q-2
- (vi) Neutralization with pure caustic added in-line in pit 8Q-2 jumper

The advantages and disadvantages of the different methods were evaluated, as well as their potential impacts on the process and the equipment to be used. Most of the methods were discarded on

the basis of the complexities of the operations required. Although the initial method selected by WVDP was the neutralization of the THOREX with PUREX in the recycle mode, the complexity of this operation led to the selection of the direct neutralization process in tank 8D-2. The main concerns in this case are related to the potential for accelerated corrosion of the carbon steel tank and the off-gas system components in the presence of a strong acid. Indeed, Barnes and Schiffhauer (1994) indicate in Table 4 of their report that the disadvantages and the potential negative impact on the equipment of the direct neutralization of THOREX waste in tank 8D-2 are mostly due to the potential for corrosion through the direct action of the THOREX addition or indirectly through the release of  $\text{NO}_x$  and the formation of  $\text{HNO}_3$ .

### **3.3 POTENTIAL CORROSION PROBLEMS IN THE DIRECT NEUTRALIZATION METHOD**

Accelerated corrosion of tank 8D-2 and its off-gas system, according to Barnes and Schiffhauer (1994), may be the result of the following actions:

- (i) Splashing of the acidic THOREX waste on the tank walls
- (ii) Corrosion of the tank floor due to the difference in specific gravity between the PUREX and THOREX solutions
- (iii) Corrosion of the walls, roof, and off-gas system components by the acidic condensate formed from  $\text{NO}_x$ .

All these potential risks were considered and addressed satisfactorily through the design of the operation and equipment. Splashing of the THOREX waste will be avoided using a transferring pipe of 2 in. (5 cm) diameter with a flow distribution baffle that extends below the PUREX waste liquid level up to approximately 10 ft (3 m) from the tank floor. Taking into consideration the low flow rate of the addition (between 1 and 5 gal./min) and the turbulent flow to be imposed on the PUREX liquid by the action of the three sludge mobilization pumps, it can be expected that the THOREX waste will not make contact with the tank floor before being neutralized by the PUREX waste despite its greater density.

Although it was not considered in the report by Barnes and Schiffhauer (1994), the potential for localized boiling arising from the heat released by the neutralization reaction should be evaluated. This was done in the Safety Evaluation for High Level Waste Transfer System (West Valley Demonstration Project, 1994) where the possibility of surface boiling was analyzed as a means of transporting acid to the tank walls. Although it is claimed that the heat released would increase the temperature of the liquid by only 3 °F (1.7 °C), the calculation is based on the assumption that all the liquid available absorbs the heat during the 4-day neutralization cycle. The issue is the local increase in temperature. On the basis of the heat of neutralization and the rate of addition of THOREX waste, it can be estimated that the thermal power input is about 1.8 kW. It is doubtful that this limited power input will lead to some localized boiling action, but additional discussion should be provided in the reviewed documents.

The third action of concern which is related to the effect of any acidic condensate formed by  $\text{NO}_x$  in the plenum of the tank and the off-gas system was analyzed in detail following the arguments and experimental evidences provided by Barnes and Schiffhauer (1994). Although the experiments and calculations were conducted at Pacific Northwest Laboratories (PNL), the PNL report is not included as

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a reference or attached as an appendix. A reference to the PNL report is recommended for inclusion in the Safety Evaluation for High Level Waste Transfer System (West Valley Demonstration Project, 1994). The computer codes used in certain calculations were included in the Barnes and Schiffhauer report. These codes, written in BASIC, were used for modeling the generation of NO obtained in simulated neutralization experiments (NOxGEN) and for calculating the concentration of NO<sub>x</sub> to be attained in the vapor space of tank 8D-2 (NOxCONC). The codes were analyzed but not exercised during the course of the current review. Calculations provided in the report indicate that a maximum concentration of 60 ppm can be reached after neutralizing 10,260 liters of THOREX waste with a reduction in pH of the PUREX waste from 13.3 to 13.0, assuming two rates of THOREX addition (1 and 5 gal./min) coupled with two tank ventilation flow rates (100 and 500 scfm, respectively). The NO<sub>x</sub> concentration was calculated to decrease below 5 ppm after 12 and 70 hr for THOREX waste flow rates of 5 and 1 gal./min, respectively. The authors pointed out that both conditions can be achieved with the existing equipment.

The authors of the report make two estimates of the wall thickness decrease promoted by corrosion. In the first one, it is assumed that the concentration of free acid in the THOREX is 1 molar. This acid will react with all the nitrite available in the PUREX waste to generate NO and HNO<sub>3</sub> stoichiometrically. Assuming uniform corrosion of the exposed surfaces in the vapor space by nitric acid, the authors calculate a thickness loss of 6 mils (152 μm). However, there is not enough data supplied in the report to confirm this calculation. The report authors claim that the estimate is conservative because the free acid concentration is lower than 0.1 molar and only 0.4 percent of the acid reacts with nitrite ions. Although the assumptions seem to be reasonable, more detailed calculations should be provided.

In the second estimate, it was assumed that localized corrosion occurs as a consequence of the localized presence of the acidic condensate in specific locations. By measuring the pH of aqueous solutions obtained by bubbling NO<sub>2</sub>/air mixtures in water at 40 °C, it was concluded at PNL that a minimum pH of about 3.9 can be attained using the calculated value of 60 ppm for the concentration of NO<sub>x</sub> in the vapor space of tank 8D-2. Using the NOxCONC code to calculate the variation of the NO<sub>x</sub> concentration with time for different flow rates of THOREX waste addition and for the tank vent, in conjunction with data for the corrosion of carbon steels as a function of pH, the maximum penetration varied from 1 to 5 mils (25 to 127 μm). This estimate seems to be reasonable and consistent with the experimental results discussed below. It can be reduced by a factor of two, according to additional PNL data, if the NaOH concentration is maintained at approximately 0.2 molar (Barnes and Schiffhauer, 1994).

The authors emphasize that the calculations above are based in the assumption that the conversion of NO in NO<sub>2</sub> and the dissolution of NO<sub>2</sub>/N<sub>2</sub>O<sub>4</sub> in the aqueous condensate are both instantaneous, while the fact is that the kinetics of these two processes will tend to reduce the calculated values of the corrosion rate. Obviously, the argument is acceptable for a fully available surface. However, some risk of accelerated corrosion can be anticipated at crevices or other poorly accessible areas of the tank and the off-gas system where the average vent flow rate used in the calculations may be not applicable.

Simple but useful corrosion tests conducted at PNL are also reported by Barnes and Schiffhauer (1994). Steel specimens were exposed for 20 days to the vapor phase, the liquid phase, and the vapor/liquid interface in vessels in which a mixture of N<sub>2</sub>, O<sub>2</sub>, and NO<sub>2</sub> gases was bubbled into water at a rate of 20 liters/hr at 40 and 50 °C. In other vessels, also at 40 and 50 °C, the specimens were barely covered with water to simulate the tank surface in contact with condensate. The range of corrosion

rates observed varied from 0.5 to 1.0 mils per yr (0.013 to 0.25 mm/yr) for specimens exposed to the vapor phase (Barnes and Schiffhauer, 1994), from 4.8 to 5.5 mils per yr (0.122 to 0.140 mm/yr) for those barely covered with water (Barnes and Schiffhauer, 1994), and from 13.7 to 15.3 mils per yr (0.348 to 0.389 mm/yr) for those exposed to the vapor/liquid interface (West Valley Demonstration Project, 1994). These results allow the authors to conclude that, during the 2-month period required for conducting the THOREX neutralization process and transfer, the total thickness loss due to corrosion would range from 0.1 to 2.6 mils (2.5 to 66  $\mu\text{m}$ ). The values estimated from the corrosion experiments, as Barnes and Schiffhauer noted, are lower than the two previous estimates and very small in relation to the 0.250 in. (6.35 mm) provided in the tank design as corrosion allowance.

It appears that the corrosion experiments provide a reasonable estimate of the decrease in wall thickness. However, it should be emphasized that any delay or interruption in the neutralization processes may have a detrimental impact that goes beyond what was assessed on the basis of the exposure time under operating conditions. Once acidic conditions are established in pockets or other occluded areas, the risk of accelerated attack by the local presence of acidic conditions could be unavoidable. An additional concern arises from the fact that at 40 °C, the corrosion rate of steel increases almost two times [from approximately 5.0 to 9.5 mils per yr (0.127 to 0.241 mm/yr)] by decreasing the pH from 4.0 to 3.5. (Uhlig and Revie, 1985). It is noted in the report that the concentration of  $\text{NO}_x$  will be monitored by using an analyzer in the tank plenum. Although this is highly recommended, it does not remove the concern regarding the importance of the local conditions discussed above.

Delays and interruptions in the neutralization process may have an undesirable effect on the corrosion of tank 8D-2 merely by the action of the PUREX waste. Corrosion rates ranging from 2.2 to 4.5 mils per yr (0.114 mm/yr) have been reported for *in situ* probes located in the vapor phase of tank 8D-2 (Meess, 1993; Cragolino, 1993). In the current proposal, it can be estimated that eight neutralization cycles with a total duration of about 4 days each will be required for processing all the THOREX waste. This implies a campaign of about 2 months. This observation has been used by Barnes and Schiffhauer to indicate that the alternative of neutralizing the THOREX waste in the CFMT of the vitrification facility will add several months to the extension of the vitrification campaign, leading to a reduction of the wall thickness of tank 8D-2 as pointed out above. A total of approximately 1.5 to 2.5 mils (38 to 64  $\mu\text{m}$ ) of additional thickness loss should be considered the result of an extended waste storage period.

No such effect can be expected in the case of the tank 8D-4. According to information provided in Section 2.3.2.5 on Waste Containment Metal Corrosion of the Safety Evaluation for High Level Waste Transfer System (West Valley Demonstration Project, 1994), it can be estimated that the corrosion rate in the presence of the acidic THOREX waste was 0.016 mils per yr (0.0004 mm/yr), by using the data from specimens removed in 1987 after being exposed for 7.5 yr. The design corrosion allowance for this tank made of stainless steel is 70 mils (1.778 mm). It should be noted that in the report, no mention is made of the existence and operation of *in situ* corrosion probes located in tank 8D-2 (Meess, 1993), although information is provided on wall thickness measurements performed in 1982. This point should be clarified. Corrosion monitoring during the neutralization process using the *in situ* probes is strongly recommended.

The experimental observation that the corrosion rate was significantly higher on the specimens exposed to the vapor/solution interface in the PNL experiments suggests that additional precautions should be adopted to avoid enhanced attack at the location of this interface in tank 8D-2 during the entire period of THOREX neutralization activity. The internal walls of the tank should be washed down using a

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20 percent caustic solution every time the addition of a batch of THOREX waste is completed. This procedure may be useful for eliminating local acidic conditions at the vapor/solution interface as soon as neutralization of the batch is completed and the pH has decreased from 13.3 to 13.0.

A final comment in this section refers to the improper terminology adopted by Barnes and Schiffhauer in their report when they refer to the potential for corrosion of tank 8D-2 and auxiliary systems. They repeatedly use the expression "corrosion potential." The same terminology is used in the text of the Safety Evaluation for High Level Waste Transfer System (West Valley Demonstration Project, 1994). The expression "corrosion potential" has a well-defined meaning in the corrosion literature and represents the electrochemical potential at which the anodic and cathodic currents on a metal surface are identical. It is also named open-circuit potential or rest potential, and it can be measured with a high impedance voltmeter and an appropriate reference electrode. This potential is an important parameter for the characterization of a metal/solution system in terms of different corrosion processes that could be relevant in the case of the carbon steel tanks (Cragolino, 1993). It is recommended that "corrosion potential" be replaced in both documents by potential for corrosion or likelihood of corrosion depending upon the specific sentence.



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## 4 STRUCTURAL SAFETY ASPECTS OF THE NEUTRALIZATION PROCESS TRANSFER SYSTEM

To facilitate the proper transfer of high level wastes from tanks 8D-1 and 8D-4 to tank 8D-2, modifications to the existing facilities were performed by WVNS. These modifications and the associated analyses are presented in the document on Safety Evaluation for High Level Waste Transfer System (West Valley Demonstration Project, 1994).

The review presented in this section is based on the protection of the radiological health and safety of the public from the components of the HLWTS that are in addition to those reviewed previously (Tschoepe et al., 1991; Pomerening et al., 1993). The components of the HLWTS that form part of the vitrification process are not considered in this review. Those components will be part of the Vitrification Safety Analysis Report (WVNS-SAR-003) review in the future. The HLWTS components reviewed include the following.

- Removal Pumps
- Pump Pits (8Q-1, 8Q-2, and 8Q-4)
- Utility Pits
- Transfer Trench including the trench structure, tank-to-tank transfer piping, the utility system, and the control system

The sections and pages cited below are with respect to the document on Safety Evaluation for High Level Waste Transfer System (West Valley Demonstration Project, 1994). The major structural changes to existing facilities included those listed in paragraphs 2.2.1.1 and 2.2.1.2. These modifications will not significantly change the integrity of the structure. The penetration into the steel tanks appears to be adequately designed. Support of the additional structures using the existing pump support truss effectively eliminates any additional loading of the steel tanks. There is a bellows in the riser to allow for axial relative motion. In addition, there is a gap of 1 in. in the horizontal direction, paragraph 2.2.3.2.2. Based on an adequate definition of the localized response of the tanks, it will be possible to determine the adequacy of these components to isolate the pumps and the tanks. The additional loads imposed on the support truss appear to be addressed. A point to consider is the torsion response of the truss structure and foundations due to pump operational loads, paragraph 2.2.3.2.4.

New facility construction is addressed in paragraph 2.2.2. The pump pits are supported on their respective tank vaults. Analysis has been performed on the modified vaults to insure their integrity is not adversely effected. The transfer trench was designed in 50-ft sections to limit differential motion problems. The piping design appears to be adequate, although no detailed review of the three references given in paragraph 2.2.3.2.6 was performed.

The defined earthquake loading conditions are a 0.1 g horizontal and 0.067 g vertical RG 1.60 earthquake. Based on an earlier review (Pomerening et al., 1993), this may be low. There is no justification for the levels given based on the expected event at the site. The values used have been based on historical analysis and the desire to maintain consistency. If the levels used can be justified, then this approach is acceptable. Otherwise, the results may be nonconservative.

The document provides only limited quantitative information on the degree of acceptability of the designs. Everything is couched in terms of no net effect due to the modifications on the response of the various

structural systems. There is no real indication of a margin of safety for the various systems. The results need to be presented in terms of the material allowance, calculated results, and margins of safety. This relates to both yield and fatigue considerations.

To interpret the fatigue results, page 1-8, it will be necessary to define the properties of the materials in terms of the ultimate, yield, and fatigue limits. It is important to include considerations of stress concentrations for the fatigue analysis, especially for the welded structures.

It is noted on page 2-10 that an earlier analysis performed to evaluate installation of two new pump risers in tank 8D-2 demonstrated the adequacy of modifications to the tank under gravity loads. This is mainly due to the support system for the pumps being external to tank 8D-2. The same analysis applies here, and the modifications are expected to be structurally adequate.

The pump riser will impact the pump column at approximately half of the design basis earthquake (DBE), page 2-11, although no structural failure is apparent until  $4 \times$  the DBE. The details of the model in terms of the local response of the structures was not presented for evaluation.

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## 5 SUMMARY AND CONCLUSIONS

After reviewing the Safety Evaluation for High Level Waste Transfer System (West Valley Demonstration Project, 1994) on those points pertaining to the physico-chemical and corrosion aspects of the THOREX neutralization process and the report issued by Barnes and Schiffhauer (1994), it can be concluded that the selection of the direct neutralization in tank 8D-2 does not possess excessive risk in terms of accelerated corrosion of the tank. Careful monitoring during the operation is recommended to avoid any risk of accelerated attack, mainly promoted by the formation of nitric acid as a secondary reaction of the neutralization of the THOREX waste with PUREX waste. Monitoring of the concentration of  $\text{NO}_x$  in the tank plenum should be coupled with careful monitoring of the *in situ* corrosion probes currently installed in tank 8D-2.

In the area of structural safety, the design of the modified structures that will be used in the neutralization process has minimized the potential for additional structural loading on any of the existing structures. From the review of the Safety Evaluation for High Level Waste Transfer System (West Valley Demonstration Project, 1994) there appears to be adequate conservatism incorporated in the design of the modifications such that the structural integrity of the various components can be maintained during the neutralization process operations. However, the Safety Evaluation for High Level Waste Transfer System (West Valley Demonstration Project, 1994) should provide additional clarification on the details of various analyses that were performed.

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