**From:** "Pinto, Pat"
**To:** <andrewt@dnfsb.gov>
**Date:** 8/1/2011 5:40 PM
**Subject:** FW: Response to Communication Dated June 17, 2011 Regarding Safety Issues at the Waste Treatment Plant (WTP)
**Attachments:** CriticalReportFinal.pdf

> _______________________________________________
> From: Pinto, Pat
> Sent: Monday, June 20, 2011 4:34 PM
> To:
> Cc:
> M (WTP)
> Subject: Response to Communication Dated June 17, 2011 Regarding
> Safety Issues at the Waste Treatment Plant (WTP)
>
> Honorable Secretary and Deputy Secretary Chu and Poneman,
> US Department of Energy
> In a communication dated June 17, 2011, Deputy Secretary Daniel
> Poneman commented on a recommendation released by the Defense Nuclear
> Safety Board (DNFSB) on the safety culture at Hanford's Waste
> Treatment Plant (WTP). The communication mentioned that two
> independent offices within DOE, each conducted a thorough,
> professional investigation and found that the framework was in place
> for a strong nuclear safety culture at WTP.
> Unfortunately, the two independent offices within DOE probably only
> looked at the Nuclear Safety and Quality Culture (NSQC) at WTP in
> light of whether there was sufficient safety and whether persons could
> complain without fear of retribution when corners were cut in the area
> of safety. They did not look at NSQC as a whole. NSQC is needed to
> produce a product of high quality which results in low radiation
> exposure to operating personnel and the environment. Making radiation
> exposure to operating personnel as low as reasonably achievable
> (ALARA) can be achieved by following a genuine ALARA program. ALARA
> requires that various process alternatives be considered and the one
> with the lowest radiation exposure to operating personnel be selected
> unless the cost is prohibitive and the cost benefit analysis shows
> that process to be unacceptable. The two independent agencies did not
> look at the ALARA program at the WTP, because if they had, they would
> have found it to be nonexistent.
> The River Protection Project - Waste Treatment Plant (WTP) design
> which has been evolving for more than ten years uses unsuitable and
> inefficient processes resulting in continued waste of taxpayer money
> without guaranteed success. It is true that you have a responsibility
> for the safety of our Complex and to the federal and contractor
> employees and to the American people. However, you have an equally
> important duty to ensure that tax payer money is not wasted on poor

> cost benefit safety analyses decisions.  Staying in bed all day is not
> an acceptable fix to avoiding a traffic accident.
> The attached report has more information to back up my assertion that
> taxpayer money is being squandered by DOE and the DNFSB.  It is
> imperative and crucial that an organization independent of the DOE
> investigate the WTP to determine if the interests of the American
> people are being well served.  This investigation should be launched
> and completed promptly considering the size of this project and the
> costs that are accuring every day.
>
>  <<CriticalReportFinal.pdf>>
> Respectfully submitted,
>
> A. Patrick Pinto
> Bechtel National Inc.
> Mechanical Systems
> Main/H-152  Mail Stop 5-H

# A Critical Evaluation of Certain Aspects in the Design of the RPP-WTP Project

**by A. Patrick Pinto**

**June 20, 2011**

## 1. Introduction

### 1.1. Problem Statement

The purpose of this report is to show that the basis for the selection of ultrafiltration as the process for concentrating the suspended solids in the River Protection Project-Waste Treatment Plant (RPP-WTP) is inherently flawed, as it is based on a faulty criterion that the radioactive liquid waste be kept constantly agitated and well mixed inside the WTP facilities for safety reasons.. The hazards that are allegedly guarded against by this criterion are explosion due to the build up of flammable gas and a nuclear criticality. The extremely small potential for a flammable gas explosion can be reduced to zero by simply purging affected pipes and vessel head space. A nuclear criticality at the WTP due to plutonium is virtually impossible. However, if it were assumed to be possible, keeping the waste constantly agitated could be shown to make the problem worse. This specious criterion has caused the WTP to be designed to the wrong flow sheet, thereby unnecessarily increasing installed and operating costs, increasing radiation exposure to operating personnel and the environment, and has caused alternative flow sheets using appropriate suspended solids concentrating technologies to be bypassed. This report will show that one of the alternate approaches, namely gravity settling would be orders of magnitude less expensive, more robust, and would have stabilized the waste in less time, while producing significantly less radioactive waste.

Minimization of high level waste (HLW) glass production requires the efficient removal of aluminum hydroxide from the suspended solids. In order to dissolve the aluminum hydroxide efficiently, the suspended solids need to be concentrated as much as is technically and economically feasible. Ultrafiltration is not an optimal technology selection, because the concentration of the suspended solids is painstakingly slow and inefficient, related equipment and operating costs are too high, and the waste generation rate is excessive.

## 2. The Criterion to Keep the DOE Tank Waste in the WTP Well Mixed

### 2.1. The Buoyant Displacement Gas Release Event (BDGRE) Phenomenon

One of the reasons for keeping the radioactive wastes in the WTP be constantly agitated and well mixed is supposedly the prevention of a hydrogen explosion. Hydrogen in pipes and vessels (HPAV) is a safety issue at the WTP because of BDGREs that occurred during the 1990s in some of Hanford's double shell tanks (DSTs) with salt cake. The official DOE model for the BDGREs would permit the sudden release of large quantities (hundreds of cubic feet) of flammable gas into the tank vapor space. The validity of the official DOE BDGRE model is questionable since it cannot explain why BDGREs occur only in waste tanks with salt cake, and why prior to the commissioning of the 242-S evaporator, (which resulted in the salt cake being produced in the DSTs) no BDGREs occurred in any of the Hanford waste tanks. There will be no salt cake present, the sludge inventory will not be large enough, or remain in place long enough due to its periodic removal from the bottom of the gravity settler. Consequently, a BDGRE cannot occur at the WTP, and the criterion that requires constant agitation of the waste in WTP is at best an "over-kill" reaction to a "perceived" but not real safety issue.

### 2.2. Nuclear Criticality

A nuclear criticality accident due to plutonium in the WTP is not even remotely possible. The form and distribution of the plutonium will not permit a criticality. Conditions in the DOE waste tanks over the years have been much more conducive to a criticality than conditions in the small gravity settler (if one were used) at the WTP will ever be. The quantity of suspended solids in the WTP gravity settler will be much less, and the concentration of the suspended solids could only equal but not exceed the concentration of the suspended solids in the DOE tank farm which are at their terminal settling concentration. No operations are performed in the WTP (such as gold panning), to stratify and concentrate the heavier components in the sludge. However, for argument sake if we assume an accumulation of the heavier plutonium bearing particles was possible, the way to prevent it would be to allow the sludge to settle and plug flow out of the conical bottomed gravity settler, so that if any plutonium were present it would plug flow out of the conical bottomed gravity settler with the rest of the settled suspended solids. Keeping the waste constantly agitated has the potential to stratify the heavier components in the sludge and cause them to settle out and accumulate at low points. The best, most economical, and strongest criticality control measure would be to sample the sludge periodically at the bottom of the gravity settler (which will be done anyway) and analyze for plutonium.

## 3. Dissolving Aluminum Hydroxide from the Suspended solids

### 3.1. Proposed Process for Dissolving Aluminum Hydroxide in the Suspended Solids

In the aluminum industry, aluminum hydroxide (gibbsite), along with other oxides of aluminum in bauxite is dissolved in hot (150°C) sodium hydroxide. The clear liquid consisting of the sodium hydroxide with the dissolved aluminum is separated from the solid components in bauxite by gravity settling while the slurry is still hot. The clear liquid is cooled by being routed through several thin long pencil shaped tanks in series. The pencil shaped tanks provide the surface area to cool and the residence time for gibbsite crystal growth (gibbsite crystal growth has very slow kinetics). All the sodium hydroxide that was used to dissolve the gibbsite is returned to the clear liquid when the dissolved aluminum precipitates out as gibbsite. The crystals of gibbsite grow in size and settle to the bottom of the pencil shaped tanks. The separated clear liquid contains the sodium hydroxide and is reused for the dissolution of aluminum in the next batch of bauxite.

A gravity settler, taking up less than half the space used by the current ultrafiltration equipment in the black cell, was proposed earlier as a replacement process to concentrate the suspended solids. A small fraction of the hot cell installed ultrafiltration capability would be used to polish the overheads from the gravity settler, with the remaining large area in the hot cell currently taken up by the ultrafiltration equipment becoming available for other uses. The gravity settler bottoms (concentrated suspended solids) would be withdrawn continuously or periodically when the terminal settling concentration of the suspended solids is reached. Most of the suspended solids in the Hanford wastes settle rapidly, and those wastes that settle at a slower rate still settle fast enough to be concentrated in a gravity settler to much greater than the target 20% by weight that is planned for the ultrafiltration system. The concentrated suspended solids will be treated with hot sodium hydroxide in a conical bottomed steam heated reaction vessel also designed as a gravity settler. After treatment with hot sodium hydroxide, the clear liquid with dissolved aluminum will be separated from the treated suspended solids while still hot, and sent to thin long pencil shaped tanks where the crystals of gibbsite form and grow. The larger gibbsite crystals will settle to the bottom of the thin pencil shaped tanks, leaving behind the clear liquid which will be concentrated in an evaporator and reused to dissolve the aluminum in the next batch of concentrated suspended solids. The sodium hydroxide used to dissolve the aluminum thus does not end up becoming radioactive waste glass. Figure 1 is a process flow diagram of the above described process.

### 3.2. The WTP Process for Dissolving the Aluminum Hydroxide

Initially the dissolution of aluminum at the WTP was designed to occur at 95ºC. However, since the wrong materials of construction were used for the vessels in which the dissolution of the aluminum was to be performed, BNI requested and DOE-ORP approved a contract change to permit the dissolution to be performed instead at the lower temperature of 85ºC. The ultrafiltration process at the WTP starts with the concentration of the suspended solids from the 2-4% range to approximately 17% using ultrafiltration. This step takes approximately 7 days. The required quantity of sodium hydroxide is added and the heat up to 85ºC is performed by direct injection of steam (which dilutes the suspended solids). The suspended solids are digested for 12 to 18 hours to dissolve the aluminum in the suspended solids. The slurry is then cooled to 113ºF (45ºC) prior to the separation of the interstitial liquid from the remaining suspended solids by attempting to concentrate the suspended solids to a target 20% by weight using ultrafiltration. The cooling to 113ºF is required because the ultrafilters cannot withstand a higher temperature. This second ultrafiltration step also takes approximately 7 days. There may be some wash/decant steps, and oxidative leaching steps added along with another ultrafiltration step, if required, depending on the specific nature of the suspended solids.

The WTP process for dissolving the aluminum hydroxide relies on the fact that the kinetics of gibbsite crystal growth is very slow. Hence, though some dissolved aluminum precipitates out of solution when the slurry is cooled from 85ºC to 113ºF, the crystals of gibbsite are small enough to go through the ultrafilter pores, and some removal of dissolved aluminum is accomplished. Since ultrafiltration is a time consuming process, gibbsite crystal growth occurs while ultrafiltration to concentrate the suspended solids to the target concentration of 20% is occurring (approximately 7 days). Hence, during these 7 days, any gibbsite crystals that have grown in size larger than the ultrafilter pore size, will remain with the suspended solids and become HLW glass. The quantity of HLW glass produced is therefore not minimized. The WTP process for concentrating the suspended solids using ultrafiltration cannot recycle the sodium hydroxide. Fresh sodium hydroxide has to be used for each batch of suspended solids, and the sodium hydroxide ends up becoming Low Activity Waste (LAW) glass. Hence, the taxpayer has not only to pay operations personnel for making all this unnecessary HLW and LAW glass, but has also to foot the bill to store it.

The processing of each ultrafiltration batch at the WTP entails at least two ultrafililtration steps, each taking approximately 7 days. The proposed gravity settler will process a much larger batch of suspended solids overnight. Hence, approximately what can be accomplished in two weeks of running the PTF with the ultrafiltration process can be cut down to 2 days by replacing ultrafiltration with gravity settling. This will result in the Hanford tank waste being stabilized more efficiently and over a much shorter time frame (estimated conservatively to be less than a tenth of the time).

The gibbsite crystals that pass through the ultrafilter pores and do not become HLW glass would precipitate and the solids produced would interfere negatively with the Cesium Ion Exchange Process (CXP). This was discovered after the design of the CXP process was completed and large portions of it were installed. As a result, the first CXP system design has been abandoned and a second design started. The CXP feed which was cooled in the first design is now heated. A large 69,000 gallon stainless steel vessel is being abandoned in place, and vessels are being used for purposes for which they were not originally designed. All this of course increases the design costs and nobody is held responsible for these increased costs.

## 4. Cesium Ion Exchange (CXP)

The Cesium Ion Exchange Process (CXP) System removes cesium from the interstitial clear liquid. Three Ion Exchange Columns (IXCs) in series are used in the CXP system. The CXP system design is also not simple or robust. The CXP system uses a single pump to force the CXP feed liquid through three IXCs in series. There are valve manifolds to direct flows to desired locations at the inlet and outlet ends of each IXC. The provision of a valve on a jumper increases the cost of a jumper from approximately $5000 to over $50,000, and the CXP has over sixty jumpers. Inadvertent transfers detrimental to operational efficiency and safety will occur when valves leak. Valve leakage has the potential for cesium contamination of the LAW melter through gradual migration. Cesium contamination of the LAW melter will result in increased radiation exposure to operating personnel at the LAW facility. The IXC design consists of a complicated gas detection and purge system. This unnecessary additional complication makes the CXP system extremely difficult to operate.

In 2003 an alternative CXP flow sheet, where valve manifolds were not used, was proposed to the WTP project. This CXP proposal is described in the Difference of Professional Opinion (DPO) submitted to DOE-ORP and DOE-HQ, and involved the use of ion exchange resin cartridges, which permitted the elimination of the Cesium Resin Addition (CRP) and Cesium Resin Disposal (RDP) systems. The CRP and RDP systems are both multimillion dollar systems.

**5. Nuclear Safety and Quality Culture (NSQC)**

The WTP NSQC focus, quoting from their posters, relies on leadership, employee engagement and organizational learning. NSQC is needed to produce a product of high quality which results in low radiation exposure to operating personnel and the environment. Making radiation exposure to operating personnel as low as reasonably achievable (ALARA) can be achieved by following a genuine ALARA program. ALARA requires that various process alternatives be considered and the one with the lowest radiation exposure to operating personnel be selected unless the cost is prohibitive and the cost benefit analysis shows that process to be unacceptable. Comparing the two processes, ultrafiltration and gravity settling head to head from an ALARA perspective, gravity settling wins hands down. Periodically replacing failed ultrafiltration equipment, and the sparging of vessels containing radioactive waste will subject operating personnel to radiation exposure. The installed and operating costs are high in terms of the cost of equipment, the compressed air, and longer operational time (not to mention the 150 million dollar pilot plant). Since the WTP did not do this basic comparison of available processes at any time, let alone the start of the project, an impartial person would have to conclude that the WTP does not have an acceptable ALARA program. Without an acceptable ALARA program, it is surprising how one could have a good NSQC. In a recent communication, the Deputy Secretary of the Department of Energy stated, and I quote, "The Secretary and I were very concerned when allegations were initially raised about the safety culture on the project, which is why two independent offices within DOE - the Office of the General Counsel and the Office of Health, Safety and Security (HSS) - each conducted a thorough, professional investigation to review aspects of the allegations. The Office of the General Counsel examined specific concerns raised by the Defense Board following its October 2010 hearing and concluded that neither DOE nor contractor employees had acted inappropriately. In its review, HSS noted that the framework is in place for a strong nuclear safety culture at WTP, but also noted that there are areas for improvement."

**6. Permitting by the State of Washington Department of Ecology (Ecology)**

The State of Washington Department of Ecology (Ecology) regulates the WTP. Ecology was contacted when the DPO process with BNI, DOE-ORP, and DOE-HQ failed to produce desired results. Ecology claimed that they did not have the technical expertise to tell BNI that their process was the wrong process. The main benefit to the taxpayer from the permitting process is ensuring that the best available technology is used. If the Ecology did not have the expertise, they needed to hire a qualified consultant. Relying on BNI destroys the independence and validity of the regulating agency.

**7. Final Comments and Conclusions**

In the best interest of public welfare, the current WTP design must be discarded as soon as possible. A new design based on utilizing a more ideally suited suspended solids concentration technology must be implemented. The choice is abundantly clear. We can stay the course and produce a lot more radioactive waste than needed, unnecessarily use large quantities of compressed air, run the risk of having to abandon large portions of the black cell due to vibration and erosion caused leaks, run the risk of exposing LAW facility operating personnel to radiation exposure, and take longer than necessary to stabilize the tank waste. The taxpayer will have to foot the bill for the compressed air (whose costs will increase along with the cost of energy), and for operating personnel salaries for producing more waste glass than necessary, and then pay for storage of the extra glass.

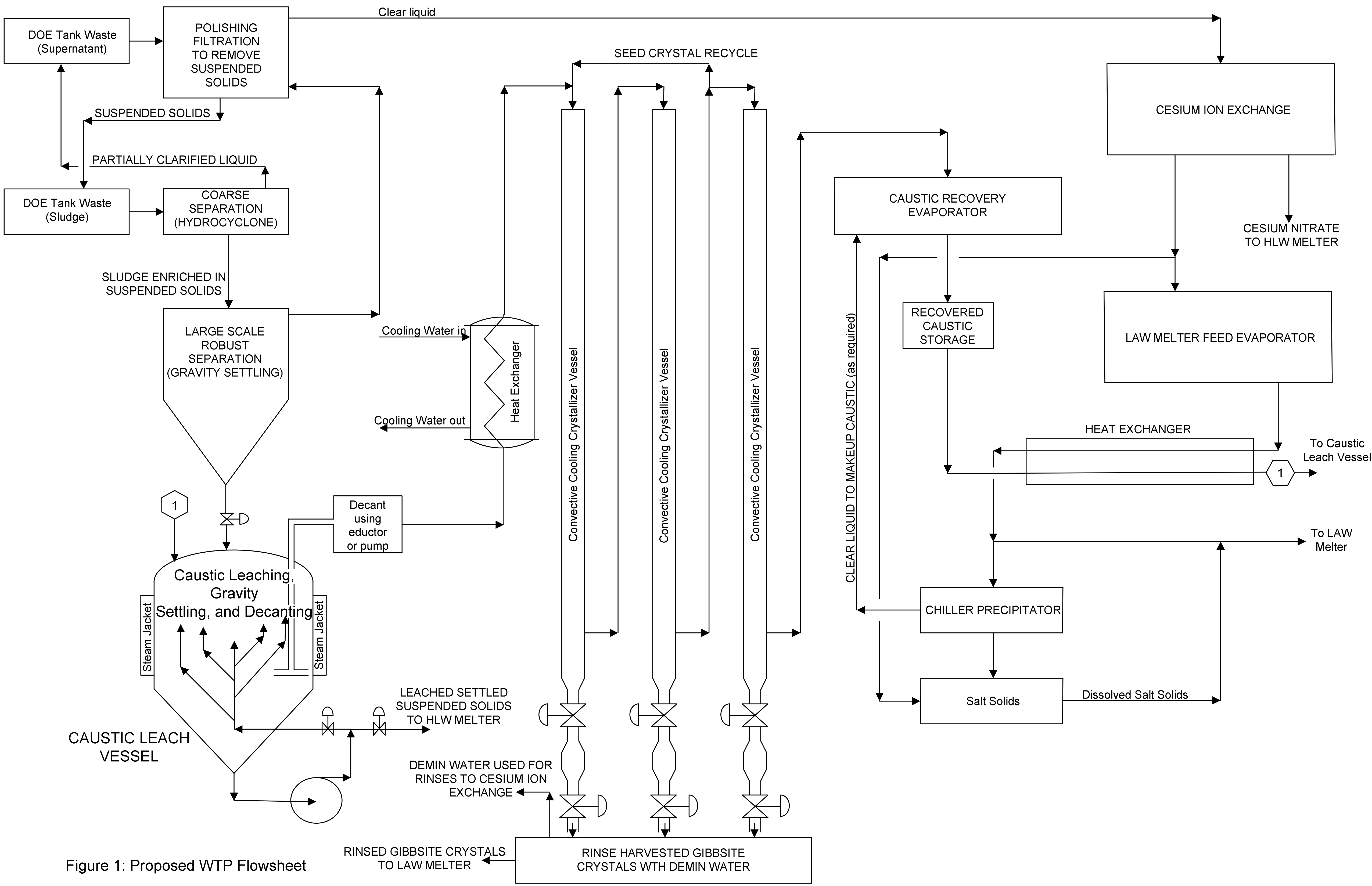


Figure 1: Proposed WTP Flowsheet

# A Critical Evaluation of the Design of the RPP-WTP Project

## Attachment 1: Efforts in Remedying Critical WTP Technical Design Flaws

Flow sheet and process improvements were communicated to the BNI supervisors in charge of the systems where the improvements could be used. When the process improvement proposals were ignored and the situation remained business as usual, Difference of Professional Opinion (DPO) reports were used, as per WTP and DOE operating procedures. The first DPO (CCN 150888), was submitted to BNI in early April 2007. The proposal in the DPO submitted to BNI suggested using gravity settling to concentrate the suspended solids, with the use of ultrafiltration to polish the overhead stream from the gravity settler. The suspended solids in the gravity settler would thus have several days to settle and concentrate. BNI had three external reviewers who were quite complimentary of the proposal during the DPO review meeting. One of the reviewers even commended the proposal as being a neat way to marry two disparate technologies together, and said on three separate occasions during the review, "when this plant does not work you will be able to say, I told you so". However, the final review report mysteriously recommended against implementation of the proposal. Unfortunately, no meeting minutes were recorded.

The DPO was then submitted to DOE-ORP with the CXP valve leakage problem and its proposed solution added to the scope. In their response rejecting the DPO, DOE-ORP stated the following with respect to the issues raised (in most cases I am quoting verbatim). With respect to significantly more LAW glass being produced, DOE-ORP stated that the PTF is designed with the flexibility to leach tank waste in relatively dilute slurry in UFP-VSL-00001A/B or concentrated slurry in UFP-VSL-00002A/B. With the current flow sheet, this is an area of optimization being addressed by the WTP project as part of the effort to close EFRT issue M12, "undemonstrated leaching process". Additionally, optimization of the WTP flow sheet is a key activity embedded in ORP's strategy to manage the sodium added to the waste in the WTP Pretreatment process. This DOE-ORP response is puzzling. Leaching of dilute solids is meaningless, and will only result in wasted chemicals and operating time. Suspended solids need to be as concentrated as possible for efficient dissolution of aluminum. As far as managing the sodium added to the waste, DOE-ORP's sincerity should be seriously questioned. The flow sheet proposed to them in the DPO reduces the added sodium to ZERO, and it was not enough to attract their interest. On Dec 2, 2008, in CCN 190858, DOE-ORP admits that the quantity of sodium hydroxide needed was earlier grossly underestimated, as the actual sodium added was 61% more than was initially estimated. The DOE-HQ review of the DPO conducted by DOE's Chief of Nuclear Safety found no problem with ultrafiltration, but acknowledged that valve manifolds around the CXP IXCs was a problem. It is surprising however, that he later accepted a report with a questionable design fix as a solution to the valve manifold problem, and permitted construction to proceed, because the design fix is itself a valve manifold where a leaking valve could be the problem. If a leak occurred at this valve manifold at an inopportune moment, there would be a real potential for cesium contamination of the cesium ion exchange product vessels. Once the cesium ion exchange product vessels became contaminated with cesium it would be only a matter of time before cesium migrated to the essentially contact maintained LAW melter.

When all WTP avenues for fixing the serious design issues failed to correct any of the problems, a document titled, "Report on the RPP-WTP Project in Richland, WA" which is essentially a precursor to this report, was prepared and e-mailed to Mr. Riley Bechtel. Mr. Bechtel's response titled "WTP Letter to Mr. A. Patrick Pinto" basically said that I had followed all the procedures and submitted DPO reports and that BNI and DOE had resolved the DPOs, and that it is too bad the resolutions are not to my satisfaction. In a rebuttal to the WTP letter to me, I stated that if BNI, DOE-ORP, or DOE-HQ could justify the use of ultrafiltration, I would withdraw all objections. I am still waiting for a response to this rebuttal.  All correspondence referenced in this report is part of the project records, and is obtainable from the WTP Project Document Control.

The State of Washington Department of Ecology (Ecology) regulates the WTP.  Ecology was contacted when the DPO process with BNI, DOE-ORP, and DOE-HQ failed to produce desired results. Ecology claimed that they did not have the technical expertise to tell BNI that their process was the wrong process.  The EPA was also contacted, and the head of the Richland, WA office of the EPA was sympathetic, but claimed that the EPA did not have the staff to look into the matter, and had to rely on Ecology to do its job.

A complaint then launched with the DOE Inspector General's (DOE-IG) office.  The DOE-IG office was contacted several times with the same result.  The investigation is still open, but information as to when the investigation will be completed, or what has been determined cannot be divulged.  So, we have several governmental agencies refusing to do their job, and the waste of taxpayer money continues, including support of these inept agencies.