Hanford Waste Treatment Plant – History and Technical Issues

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The Waste Treatment Plant (WTP) at Hanford is the keystone for cleanup of the Hanford site. The Hanford site contains 53 million gallons of nuclear High-Level Waste (HLW) in 177 Single and double shell underground storage tanks (SST, DST) sized up to 75 foot diameter and 1.3 million gallons. The waste contains toxic chemicals, solvents, heavy metals and radioactive elements, including plutonium, cesium, strontium and uranium. Sixty-seven tanks are confirmed leakers and nearly all are well beyond their design lifespan.

In 1989, the US Department of Energy (DOE), US Environmental Protection Agency (EPA) and the Washington State Department of Ecology (WDOE) issued the Hanford Federal Facility Agreement and Consent Order (HFFACO, commonly known as the Tri-Party Agreement or TPA). The TPA set requirements and schedules for cleanup of major portions of the Hanford site including milestones for the WTP. The original TPA schedule included start of WTP hot commissioning in 2007, retrieval of all Single-Shell Tank wastes by 2018, closure of all SST farms by 2024, and complete processing of all tank wastes by 2028. In the 19 year history of the TPA, the WTP has been plagued with programmatic changes, delays, cost increases, and technical issues.

In 1994 DOE decided to privatize the project with two competing vendors, each with pilot plants and production facilities. As this progressed and costs were identified, DOE decided to design and build a single WTP complex with a 40 year operating life. A single contract was awarded to a private vendor. In 2000 it was decided that the price for privatized services was too high and the contract was terminated. DOE proceeded with an architect-engineer and a conventional cost-plus-incentive fee contract but including a close-coupled design and build philosophy. Since 2000, the WTP has been subject to several independent cost and technical reviews. The costs have ballooned from approximately $6 billion to greater than $12 billion. The TPA startup milestone was revised to 2011 (4 year delay). Construction on the Pretreatment and HLW vitrification facilities was stopped while seismic criteria were re-evaluated and resulting seismic designs were revised. Independent technical and safety reviews of the WTP were performed and a number of deficiencies identified. This has resulted in a pilot plant being constructed to validate the design of equipment systems already procured and partially installed. The results of the pilot plant testing will result in future modifications, cost increases and potential additional delays. The pilot plant testing may cost approximately $100 million.

The administration has limited funding of WTP construction to a nominal $690 million per year while the total cost has increased. This results in stretch out of the construction schedule. DOE has initiated a renegotiation of the TPA to revise WTP and tank waste cleanup milestones. DOE is currently proposing revision of WTP startup to 2019 (8 year delay), retrieval of SST wastes by 2040 (22 year delay), and completing treatment of all tank wastes by 2047 (19 year delay). DOE has not provided technical rationale for the 11 to 14 year additional mission length over the 8 year delay in startup. In addition, there are currently unresolved technical issues with the WTP. The proposed TPA delays and $12 billion cost estimate do not include the impact of resolving these technical issues.

The $12 billion WTP will vitrify only 25-50% of the chemical content to be converted to glass. DOE has spent several years and over $100 million in an unsuccessful development program of a supplemental vitrification process for the additional Low-Activity Waste (LAW) glass. No request has been made to congress for the several billion dollar additional capital cost to expand the waste treatment capability.

The Pretreatment Facility uses caustic (sodium hydroxide) to wash tank waste solids (sludges) and remove most of the aluminum and sulfate solids. The aluminum and sulfate content limit the concentration of HLW glass. Large amounts result in large amounts of HLW glass and longer operating times. Laboratory investigations have revealed the assumptions used to design the WTP facilities may have been too optimistic with less removal of aluminum and sulfate and/or significantly greater amounts of new caustic addition requirements. The amount of caustic addition may double the amount of LAW glass over the previous assumed values. The process chemistry and estimated resulting HLW and LAW glass volumes is to be determined during the pilot plant testing of the process and equipment this year. The pilot plant testing also addresses the issue if the equipment selected is suitable for the scale, production throughput, and conditions of the WTP.

The equipment and design philosophy utilized for the Pretreatment facility has technical issues. The filters specified may plug, require lengthy reconditioning, and/or not deliver the specified throughput thus extending the mission length. The process tanks and agitation system may not scale up successfully to the sizes specified. These issues will be evaluated in the pilot plant testing this year. The Pretreatment facility uses "black cells" to contain some of the equipment. The black cell equipment is designed to last the 40 year life of the facility as no entry for equipment repair or replacement is made after hot startup. If critical equipment in a black cell fails, the facility is inoperable. This can result in termination of tank waste treatment until a replacement pretreatment facility is constructed. These equipment and facility uncertainties result in a very high risk that the WTP complex will be unable to fulfill the mission requirements.

DOE has been deficient in "Systems Engineering" of the complete tank waste treatment system including feed supply, tank waste retrieval, and disposal of WTP "secondary waste" effluents. The currently planned waste retrieval system is limiting and results in unproductive downtime of the WTP. The WTP produces "secondary wastes", liquid effluents and failed/loaded process equipment that contain unacceptable, high concentrations of mobile radionuclides. These secondary waste radionuclides may result in exceeding site waste disposal requirements. DOE has not provided systems or defined future capital and operating cost funding to treat these secondary wastes.

There is a potential solution to the WTP problems. The WTP process is based on extension of borosilicate glass formulations developed for commercial nuclear fuel reprocessing HLW. The borosilicate glass has limitations in absorbing chemicals such as sulfate, sodium, aluminum, and chromium found in defense production HLW. The Russian defense waste program developed and used a phosphate glass formulation that incorporates higher concentrations of these chemicals. Reformulation of the Russian phosphate glasses for Hanford HLW and LAW can eliminate the Pretreatment sludge washing and potentially the pretreatment facility with significantly reduced glass production, mission duration, and total costs. There is potential to reduce the Hanford tank waste

treatment program by up to 15 years and 20 billion dollars. A presentation was made to congressional staff members in April, 2007 on this concept in more detail. The presentation is attached.