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RIVER PROTECTION PROJECT – WASTE TREATMENT PLANT CONCEPT AND APPROACH

M. J. Lawrence, British Nuclear Fuels Ltd., Inc.

ABSTRACT

The River Protection Project – Waste Treatment Plant (RPP-WTP) is a privatized facility to be built for processing and vitrifying of radioactive tank waste at the U.S. Department of Energy's (DOE) Hanford Site in Richland, Washington. As the leader of the RPP-WTP Project team, British Nuclear Fuels Ltd., Inc., entered into contract with DOE for a 24-month design period (August 1998 to August 2000). Information derived during this design period will be used as the basis to establish fixed-unit prices for the waste treatment services.

This paper describes the concept of the RPP-WTP Project, outlines the privatization approach, presents the strengths behind this approach, and summarizes the technical progress that has been made toward accomplishing the cleanup goals.

INTRODUCTION

In August 1998, the U.S. Department of Energy (DOE) signed a privatization contract with British Nuclear Fuels Ltd., Inc. (BNFL). This contract authorized a 24-month design period for the RPP-WTP. The RPP-WTP is the facility to be used for treatment of tank wastes at DOE's Hanford Site, located in southeast Washington State (Fig. 1). The design period, ending in August 2000, is expected to result in sufficient engineering and financial maturity to establish fixed-unit prices for treatment services and to finalize project financing.

Based on the design, development, and testing performed during this period, BNFL is expected to submit a firm fixed price proposal to DOE by April 24, 2000. DOE will decide, by August 24, 2000, whether to proceed with the subsequent construction and operation portion of the RPP-WTP Project. If DOE decides to proceed, BNFL will build and operate the RPP-WTP for a minimum of 10 years during which approximately 10 percent of the Hanford tank waste by mass and up to 25 percent by radioactivity will be processed and vitrified.

PROJECT CONCEPT

The proposed RPP-WTP will be located at the center of the Hanford Site, adjacent to the 200 East Area and in the vicinity of the underground storage tanks (see Fig. 1). Under DOE management, the contractor responsible for storage and retrieval of the tank waste, CH2M HILL Hanford Group, Inc. (CHG), would provide selected tank waste for treatment at the RPP-WTP. Treatment of the tank waste comprises two major steps:

1. Pretreatment to minimize waste volume and separate the tank waste into high-level waste (HLW) and low-activity waste (LAW) streams.

2. Vitrification of the HLW and LAW.

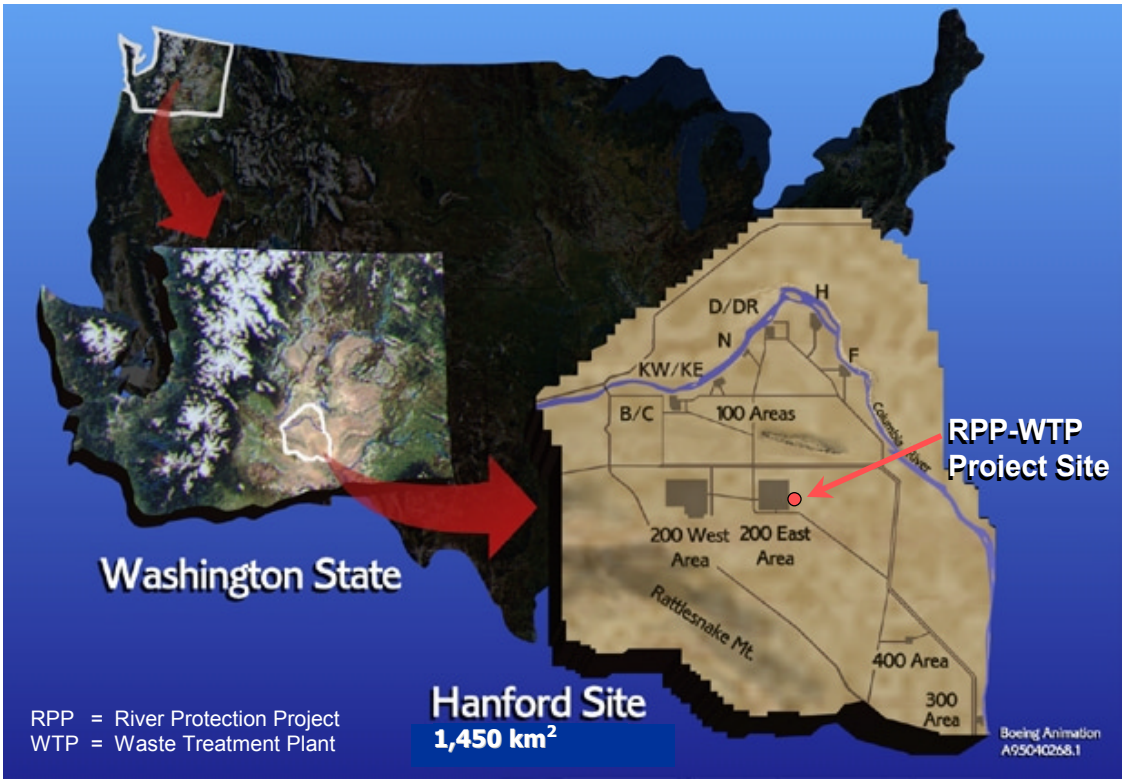

Fig. 1. Location of the Hanford Site in Washington State, showing the location of the River Protection Project – Waste Treatment Plant.

The treatment process begins with CHG transferring the liquid fraction from the Hanford Site tanks to an evaporator feed tank at the RPP-WTP. The liquid feed is concentrated through a forced circulation evaporator and cooled to about 30 ºC. The concentrated liquid then is processed through a cross-flow filter unit to remove solids. For a part of the liquid containing strontium and transuranic elements, a precipitation process is used to remove these constituents. The resulting filtrate is fed through ion exchange columns (organic-based resins) to separate out cesium and technetium. Sulfate is also removed by means of a precipitation process and disposed of as radioactive mixed solid waste. After removal of all these elements, the liquid becomes decontaminated LAW and is concentrated in a forced circulation evaporator. Glass formers are added to this concentrate, and the mixture is vitrified into LAW glass that is poured into containers.

The HLW sludge from selected Hanford Site tanks is slurried and transferred through double-walled underground pipeline to the HLW feed receipt tanks at the RPP-WTP. This slurry along with radionuclides removed from the LAW pretreatment process are blended with glass formers, vitrified into HLW glass, and poured into canisters.

After vitrification, all glass containers/canisters are sealed, decontaminated, and delivered by BNFL to CH2M Hill. The DOE disposes of the LAW containers on site and ships the HLW canisters to an onsite storage facility for interim storage, then to a geologic repository in accordance with requirements of the *Nuclear Waste Policy Act*. The project concept is depicted in Fig. 2.

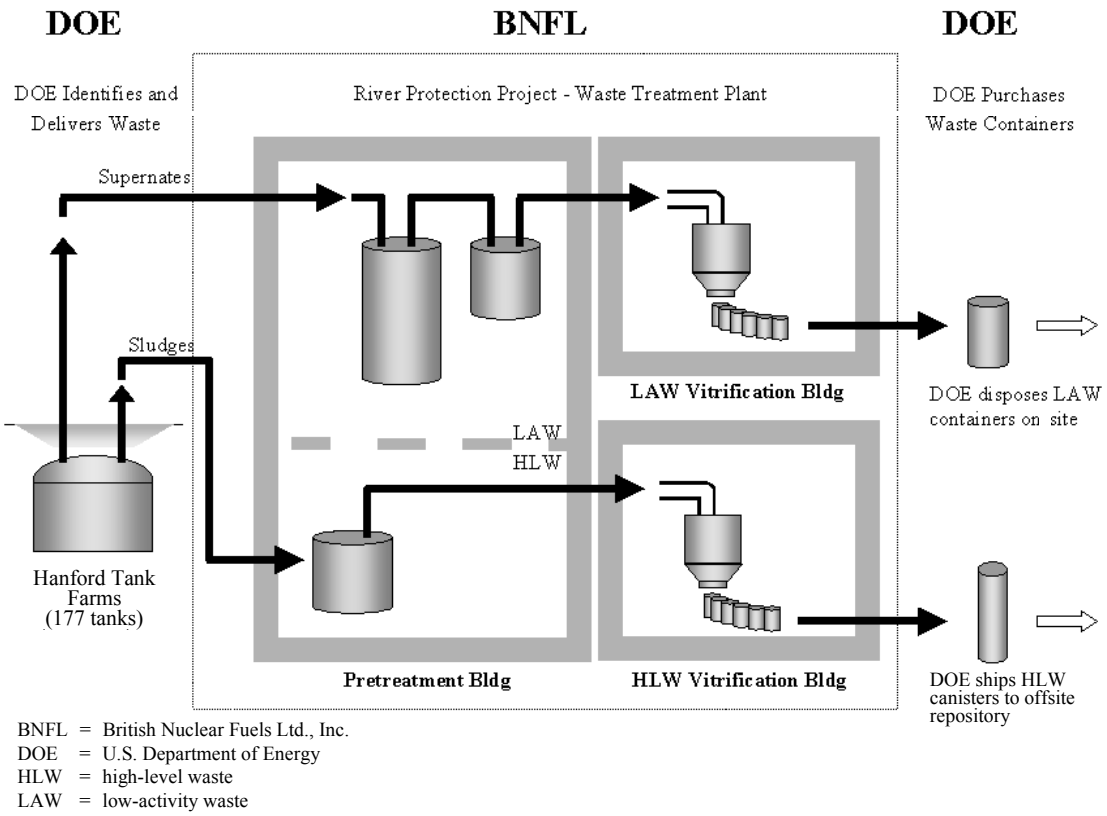

Fig. 2. The River Protection Project – Waste Treatment Plant Project Concept.

Vitrification of HLW has been done successfully in the United Kingdom, France, Japan, and in the U.S. at the West Valley Project at West Valley, NY, and the Defense Waste Processing Facility (DWPF) Project at the Savannah River Site, SC. Vitrification of LAW has been demonstrated successfully at the M-Area melter at the Savannah River Site, SC. The West Valley melter and the M-Area melter were used as the basis for design of the proposed HLW and LAW melters, respectively, at the RPP-WTP. In addition, an HLW pilot melter at Washington, D.C., and an LAW pilot melter at Columbia, MD, are being used to test the design concept and verify the proposed melter capacities. Summaries of the melter experience and the RPP-WTP Project melters appear in Tables I and II.

Conceptual design of the RPP-WTP includes a pretreatment building, an HLW vitrification building, an LAW vitrification building, and allocated space for a future LAW vitrification building the same size as the existing one (so that the throughput can be doubled). A site model for the RPP-WTP is shown in Fig. 3. Initially, 10 percent of the tank waste containing up to 25 percent of the total radioactivity will be immobilized by 2018 for an estimated $6.9 billion (in 1997 dollars). The plant is designed to vitrify HLW at 1.5 metric tons per day and LAW at 30 metric tons per day. One HLW melter and three LAW melters will be used to meet this generation rate. The base load over the initial period is 600 HLW canisters (1,860 metric tons glass) and approximately 6,000 LAW containers (40,400 metric tons glass).

Table I. Summary of Melter Experience.

Location	Melter Type	Waste Type	Melter Capacity (t/day)	Number of Melters	Number of Years	Total Glass Produced (t)
La Hague, France	Inductively Heated	HLW	0.6	6	10	?
Sellafield, United Kingdom	Inductively Heated	HLW	0.4	2	10	750[a]
Pamela, Belgium	Joule-Heated	HLW	0.25	1	6	490
West Valley, New York	Joule-Heated	HLW	0.9	1	2	640
DWPF at SRS, South Carolina	Joule-Heated	HLW	2.4	1	3	1,500[a]
M-Area at SRS, South Carolina	Joule-Heated	LAW	4.8	1	0.9	1,000

[a]Still in operation.

DWPF = Defense Waste Processing Facility
HLW = high-level waste
LAW = low-activity waste
SRS = Savannah River Site
t = metric ton

Table II. River Protection Project – Waste Treatment Plant Melters.

Location	Melter Type	Waste Type	Melter Capacity (t/day)	Number of Melters	Number of Months	Total Glass Produced (t)
HLW Pilot Melter at Washington, D.C.	Joule-Heated	HLW Simulant	1	1	1[a]	5[a]
RPP-WTP at Hanford Site, Washington	Joule-Heated	HLW	1.5	1	Proposed	
LAW Pilot Melter at Columbia, Maryland	Joule-Heated	LAW Simulant	3.3	1	11[a]	490[a]
RPP-WTP at Hanford Site, Washington	Joule-Heated	LAW	10	3	Proposed	

[a]Still in operation.

HLW = high-level waste
LAW = low-activity waste
RPP-WTP = River Protection Project – Waste Treatment Plant
t = metric ton

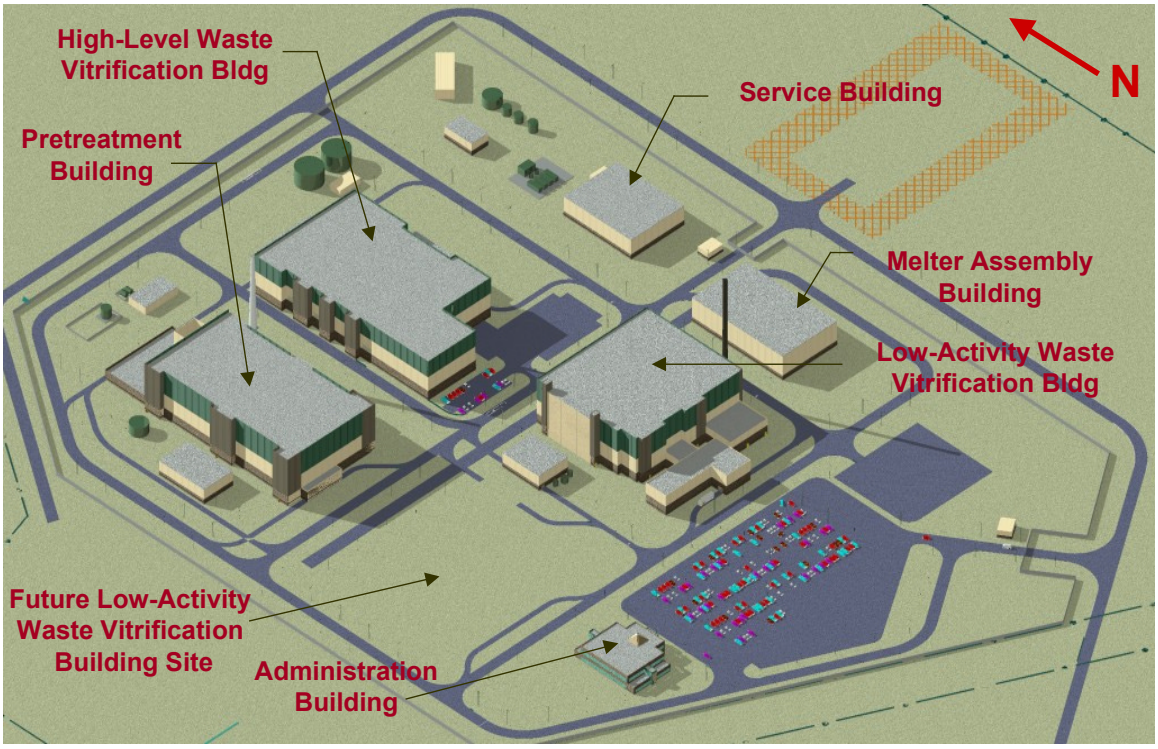

Fig. 3. Site Model of River Protection Project – Waste Treatment Plant.

The RPP-WTP is designed for a 40-year life and can be expanded to deal with the remainder of the tank waste at a significantly lower unit cost since the plant's capital cost will be paid for in the initial phase.

PROJECT APPROACH

The RPP-WTP Project is being implemented through privatization. Specific provisions were built into the contract between DOE and BNFL to develop the necessary technical, operational, regulatory, and business elements to reduce uncertainties and provide performance assurance for the project. Financial risks are being shared by DOE and BNFL to provide incentives as well as a balance between the two parties. Under this approach, the project includes the following major features:

- BNFL owns, designs, constructs, operates, and deactivates the RPP-WTP.
- The DOE is the customer and regulates radiological, nuclear, process, and industrial safety.
- The Washington State Department of Ecology, Washington State Department of Health, and the U.S. Environmental Protection Agency issue environmental permits.
- The U.S. Department of Transportation and the Washington State Department of Ecology regulate offsite waste shipment.

- BNFL performs design and development before both parties commit to the price and schedule of the treatment services.
- The DOE buys services at fixed prices.
- Congressional appropriations are only set-asides and will not be expended until BNFL delivers the conforming product.

Using this project approach to complete treatment of the prescribed tank waste by 2018 requires that a number of milestones be accomplished. The target dates for accomplishing these milestones are listed in Table III.

Table III. Milestone Dates for River Protection Project – Waste Treatment Plant.

Milestone	Contract Target Date
Begin construction (first pour)	July 2001
Pretreatment hot start	April 2006
Begin pretreatment service	November 2006
HLW hot start	February 2007
LAW hot start	January 2008
Begin HLW treatment service	July 2008
Begin LAW treatment service	April 2009
Complete all treatment services	February 2018
Complete RPP-WTP deactivation	February 2019

HLW = high-level waste
LAW = low-activity waste
RPP-WTP = River Protection Project – Waste Treatment Plant

STRENGTHS OF THE PROJECT

Implementing the above project approach is a tremendous challenge that requires a long-term commitment from both parties. For BNFL, the first step in demonstrating its capabilities and commitment to meet this challenge is to assemble a world-class team. This team consists of BNFL, Bechtel, Science Applications International Corporation (SAIC), and GTS Duratek.

BNFL is a pioneer in the nuclear industry with over 50 years of experience in fuel cycle operation and waste management, including radioactive waste processing and vitrification. Created out of United Kingdom Atomic Energy Authority in 1971 to operate commercially in a privatized manner, BNFL has processed more than 400 million curies since 1990. This amount is more than double the Hanford Site tank waste inventory of 190 million curies. Bechtel is the most experienced and successful nuclear construction company in the world, with experience both in commercial and in DOE nuclear facilities. SAIC is a world leader in regulatory compliance; it has performed nuclear compliance and permit application at the Hanford Site for

more than 10 years. GTS Duratek is a national leader in LAW and mixed-waste vitrification; it has successfully vitrified LAW at the Savannah River Site under a privatization contract.

At the present, the RPP-WTP Project team comprises more than 600 professionals (including 100 from the United Kingdom) doing the design and development work necessary to support a firm fixed-price proposal to DOE in April 2000. In addition, the project team is involved in research, development, and laboratory testing of pretreatment and vitrification technologies using expertise from around the country. Individual groups supporting this effort include members from the Savannah River Technology Center, Pacific Northwest National Laboratory, and Vitreous States Laboratory at Catholic University. This design and development phase before the fixed-price proposal is a critical difference between this and previous DOE privatization contracts; it will lead to a realistic cost/schedule estimate and build confidence that the project can meet its cleanup goals.

Based on our current estimates, BNFL expects its proposed fixed-unit price will be less than half the unit cost of vitrifying waste at Savannah River (Table IV). Under the contract with DOE, BNFL is taking cost, schedule, and operational performance risks associated with the RPP-WTP Project. For example, the BNFL team is making an equity commitment of up to $500 million -- at risk – to fund the project and is borrowing the balance from financial institutions. The taxpayer will pay for this service only when the product is delivered.

Table IV. Unit Cost of Vitrification.

High-level Waste Vitrification Project	Average Unit Cost (dollars per t glass)	Product Cost Ratio
Proposed River Protection Project – Waste Treatment Plant at Hanford Site, Washington	300,000	1
Defense Waste Processing Facility at Savannah River Site, South Carolina	670,000	2.2
West Valley Demonstration Project at West Valley, New York	1,228,000	4

t = metric ton

A benefit of the privatization contract is that it provides BNFL with the flexibility to follow “best commercial practices” and procure at “best value”. The project will create a large number of domestic jobs over its lifetime. Employment level will grow to more than 3,500 at the peak of construction in 2003, then level out with an operations staff of approximately 500 from 2010 on. Local wages during the design and construction phase will be $60 million to $90 million per year with an estimated $50 million of non-labor services purchased.

RECENT PROGRESS

Since the beginning of the project, BNFL has spent more than $50 million on development and laboratory testing and has invested another $34 million in private funding on pilot melters to test

the RPP-WTP vitrification concepts. The HLW pilot melter (two-thirds scale) located at Catholic University, Washington, D.C., has produced 5 metric tons of glass in the first10 days of operation. Test results have been analyzed for use in the design of the full-scale HLW melter. Performance of the LAW pilot melter at Columbia, MD, has been spectacular. The full-scale, one-third-length pilot melter has produced more than 330 metric tons of glass in the first nine months with a glass production rate of 4.8 metric tons per day, exceeding its design capacity by 50 percent.

Pretreatment testing of both HLW and LAW is also underway. The purpose of pretreatment is to reduce the volume (waste minimization) and improve the quality of the glass. The test strategy includes simulant and actual tank waste samples supplied by DOE through CH2M HILL. Simulant tests provide a range of variation, while tank waste tests provide verification.

For HLW pretreatment testing, DOE selected five candidate tanks for removal of constituents such as sodium and aluminum. BNFL has completed testing samples from three tanks, and results indicated that the pretreatment process was working well within expectation. Testing of all candidate tanks will be completed and the results reported by August 2000.

For LAW pretreatment testing, DOE selected up to ten candidate tanks for removal of various elements including cesium, technetium, strontium, transuranic elements, and sulfate. Testing to date has shown that products from the ion exchange and precipitation processes proposed for the RPP-WTP can comply with regulatory requirements. However, trials have shown difficulty in meeting product and process control limits for sulfate. The ion exchange method established as the baseline process for sulfate removal failed to achieve the removal requirements. Alternative approaches are being evaluated at this time.

As we discussed earlier, under the privatization contract BNFL performs design and development before both parties commit to the price and schedule of the treatment services. The benefit of this contracting approach is demonstrated in the selection of a suitable process for sulfate removal. Results of the sulfate removal testing and all other LAW pretreatment testing will be reported by August 2000.

CONCLUSION

Cleaning up Hanford Site tank waste is the most challenging environmental project facing the United States today. The Clinton Administration continues to fully support the River Protection Project, and an outstanding team of DOE Office of River Protection (ORP), CH2M HILL, and the BNFL team is dedicated to meet this challenge.

The RPP–WTP will be the largest capital project in the federal government. The project team led by BNFL is making progress to demonstrate its capabilities and commitment to accomplish the cleanup goals. This progress also indicates that a privatization approach can be successful if risks are shared efficiently and the required project funding is set aside by Congress as planned.

The initial single shell tanks are over twenty years past their design life, and almost half have leaked. Further failure of these tanks and transfer lines are inevitable. Delaying cleanup will only result in greater costs and environmental damage. On April 24, 2000 BNFL will submit a

fixed price proposal to DOE ORP to begin treating this waste. After negotiation and Congressional review we hope to receive Authorization to Proceed by August 24, 2000.

The Hanford Site tank waste was created in the winning of both World War II and the Cold War, and we must complete the process of safely disposing of it. There is a childhood saying that goes "When you're finished playing, put away your toys." It certainly applies to the Hanford waste. We have the best available means to do it now. Let's get on with it!