RADWASTE EXPERIENCE AT WNP-2 - THE FIRST TWO YEARS

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ABSTRACT

Radwaste characteristics and generation rates for waste filter sludges and spent resins and dry active wastes produced at WNP-2 (an 1100 MW(e) GE BWR) during the first two years of operations are presented. Factors leading to the initial and subsequent selection of radwaste processing services vendors are described. Future plans for handling radwaste generated at WNP-2 are also discussed.

BACKGROUND AND INTRODUCTION

WNP-2 is an 1100 MW(e) GE BWR located on the DOE's Hanford Reservation north of Richland, WA and operated by the Washington Public Power Supply System (WPPSS). Fuel was loaded starting in December 1983, power first produced in May 1984, and commercial operation officially commenced on December 13, 1984. WNP-2 has a reasonably standard GE - supplied condensate polishing and liquid radwaste processing system using predominately powdered resins with no regeneration. Early in the project it was decided not to purchase the in-drum cement solidification system then offered by GE for processing liquids and resins in favor of a Hittman urea formaldehyde (UF) solidification system. By 1979, however, it was perceived that UF systems were not adequately meeting changing regulatory requirements and criteria, so the Hittman system was abandoned and a cement-sodium silicate solidification system was purchased from United Nuclear Corp. (UNC).

In early 1983, to save construction capital, completion of the installation of the UNC cement system was deferred and selection of a radwaste processing services vendor initiated. A contract was awarded to Chem Nuclear Systems Inc. (CNSI) for processing of contaminated liquids and wet solids and transportation to the U.S. Ecology disposal site located approximately 12 miles northwest of WNP-2 on the Hanford reservation. CNSI was the radwaste services vendor for the first two years of operation at WNP-2, and performed very well during our initiation into the radwaste generating business.

The factors that influenced the decision to defer installation of the permanent cement solidification system included economic, technological and regulatory questions. Installation completion estimates were escalating, presumably because of better understanding of the amount of work required. As usual near the end of a long construction project, there was substantial competition for remaining construction capital. Despite a relatively short calculated payback period, reallocation of the approximately $4 million dollars estimated to be required for completion of the installation was therefore a strong incentive for deferral. In addition, the solidification system as designed had no provisions for dewatering waste, necessitating solidification of all wet wastes, an additional economic penalty.

Technological issues centered around problems experienced at other plants with installed solidification systems similar to our UNC cement system. The main questions were whether the pneumatic cement transfer subsystem would function reliably, and whether the progressive cavity waste-cement mixing pump was of sufficient size and strength to be durable and prevent in-pump caking and seizing of the action. Although the unit functioned well in shop tests, some doubts remained, providing incentive for deferral.

Regulatory questions also existed as to the ability of WPPSS to obtain the required NRC 10CFR61 approvals for the in-plant system in a timely enough manner to support the projected fuel load date. Waste form qualification testing and establishment of thorough, approved process control procedures were seen as the major obstacles. It was felt that selection of a qualified radwaste processing services vendor in lieu of completion of the installation of the permanent system would avoid the foregoing problem areas in an optimum fashion.

One of the difficulties faced during the initial efforts for selection of a radwaste services vendor was the lack of much significant readily available data on waste characteristics and volumes expected during the startup and initial operational phases of a new 1100 MW plant. This paper is offered to provide such data for the benefit of any others who may be in a similar quandry.

Even though there was no detectable activity in processed liquids or spent resins until the reactor was run at power levels above initial criticality and low power testing, for lack of "de minimis" criteria, the NRC ruled that all spent resins generated after fuel load were "radwaste" and required disposal as such. 10CFR61 became effective right after WNP-2's initial fuel loading commenced, so WNP-2 also faced compliance with waste classification issues without any previous activity levels or sample correlations as a basis for scaling factors. Therefore, generic values for estimating the amounts present of H-3, C-14, I-129, Tc-99, TRU, Pu-241, Cm-242 and Ni-63 were used based on an AIF report[1].

Because WNP-2 does not have a wet laundry at the plant, there is little contaminated liquid detergent or other "chemical" waste generated. A set of evaporator concentrators is installed in the plant, but they have not been used. Chemical waste including laboratory drains, decontamination solutions and contaminated shower drains are currently routed to one of the spent resin phase separator tanks where the unexpended ion-exchange capacity of resins discharged because of high delta pressure buildup is used to absorb the activity in the waste. The liquids are thoroughly mixed with the resins in the phase separator tank, the contents are then allowed to settle, and the liquids subsequently decanted from the resins. The liquids are then sampled and routed to one of the filter demineralizer systems for processing. To date, this method has precluded contamination of the highly complex evaporator concentrators, and has minimized the amount of liquids requiring solidification or absorption for disposal.

WASTE CHARACTERISTICS

Waste Sludges and Spent Resins

The volumes of filter sludges and spent resins generated at WNP-2 and shipped for disposal each month for the past two years are shown in Fig. 1. The volumes generated are predominantly from the condensate polishing demineralizers. The relatively large volumes of waste generated in the months of June, August, and November of 1984 correspond to periods of plant water chemistry problems mostly brought on as a result of condenser tube leaks. The importance of good integrated plant systems performance on minimizing waste production is obvious from these data.

The total activities and concentrations of the predominant nuclides derived from measurements of samples representing the waste are presented in Table I. These wastes were dewatered and packaged in CNSI 14-195 steel liners with a disposal volume of 195 cubic feet, each containing at least 180 cubic feet of waste. For the first year, all liners were shipped unshielded, three at a time on flatbed trucks for disposal. As activity built up in the plant, however, shielded casks were required for most of the shipments in 1985.

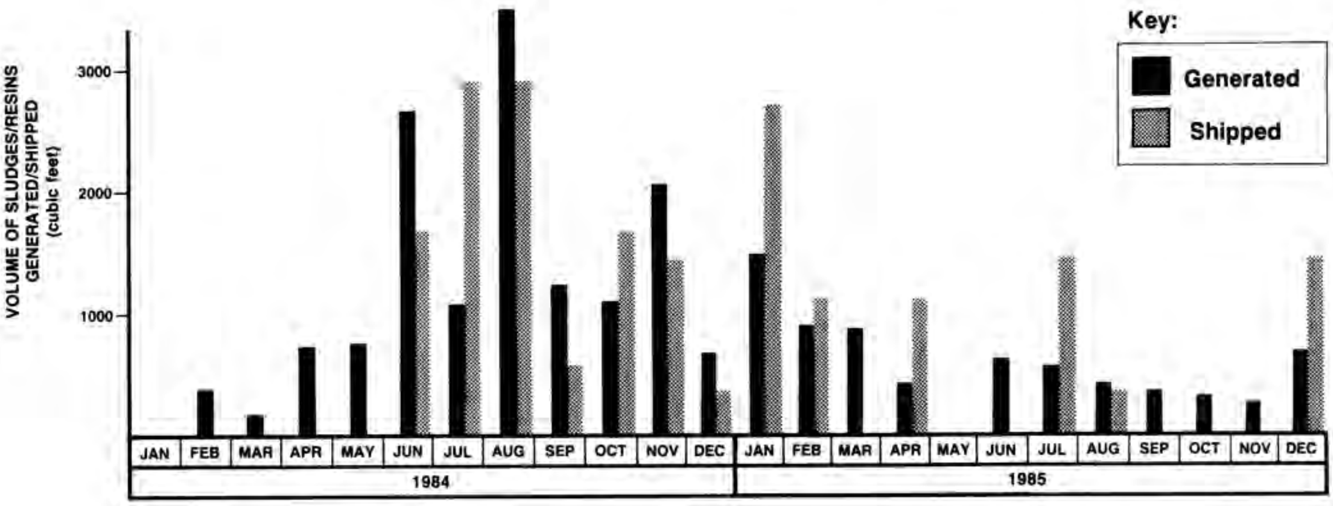

Fig. 1. Waste sludge and resin volumes generated at WNP-2 and shipped for disposal.

TABLE I

Waste Filter Sludge and Spent Resin Total Activities and Predominant Nuclide Concentrations

TIME PERIOD	TOTAL VOLUME SHIPPED (M^3)	TOTAL ACTIVITY (Ci)	CONCENTRATIONS (Ci/M^3) Cr-51	Mn-54	Co-58	Co-60	Fe-59	Zn-65
Jan-June 1984	46	0.028	4.3-4[(a)]	BDL[(b)]	1.2-4	1.3-5	1.3-5	BDL
July-Dec 1984	275	35.2	7.5-2	1.0-3	4.2-2	2.3-3	1.5-3	6.2-3
Jan-June 1985	138	195	4.0-1	2.3-2	5.5-1	7.5-2	1.0-2	3.5-1
July-Dec 1985	90.2	99.9	9.0-2	4.1-2	2.7-1	1.6-1	1.0-2	5.1-1

(a) Notation is interpreted as 4.3-4 = 4.3×10^{-4}

(b) BDL means below detection limit

The highest radioactivity contributor to the waste filter sludges and spent resins is waste from the Reactor Water Clean Up (RWCU) filter demineralizer. Approximately 5% of the volume containing 26% of the total activity of the sludges and resins shipped in 1985 were from the RWCU system. Because of burial site criteria requiring solidification when concentrations of nuclides with half lives greater than 5 years exceed 1Ci/m^3, the Co-60 concentrations are of interest. In the RWCU resins, they ranged from 0.06 to 6.7 Ci/m^3, averaging 1.1 Ci/m^3 over the year. However, the RWCU wastes are currently mixed with wastes from the condensate polishers so the average activity in the liner is low enough to allow dewatering.

Dry Active Waste (DAW)

The volumes of dry active waste (DAW) collected from the plant and shipped for disposal each month are shown in Fig. 2. Increases in volumes produced correspond to the major outages (two planned and one significant unplanned) experienced, as well as a general upward trend corresponding to the gradual buildup of activity in plant systems.

The total activities and concentrations of the predominant nuclides assumed to comprise the contamination in the DAW are presented in Table II. The values presented for the DAW shipped in 1985 include 99 55-gallon drums, 91 of which each contained about 6 gallons of potentially contaminated oils absorbed in kitty litter, the remaining 8 drums containing oily rags or sludges packaged with an absorbent material. The balance of the DAW was packaged in 86 Container Products Corp. (CPC) 90 cubic foot steel compactor boxes. The volumes reported are the compacted or packaged volumes as shipped for disposal. All filled containers were shipped to the disposal site unshielded on flatbed trucks. Typical compacted waste densities of 30 to 36 pounds per cubic foot are achieved in the CPC box type compactor.

The activities and concentrations of nuclides in the DAW were determined by using dose-to-curic conversion factors based on container geometries and the nuclide distribution in primary coolant representative of the time the wastes were generated. This method assumes that the distribution of activity contained in the clean-up materials, trash, disposable protective clothing, etc. making up the DAW is essentially the same as that in the original source of the contamination, the primary reactor coolant. These calculated activities are also consistent with smear surveys taken in the various plant locations where DAW is generated.

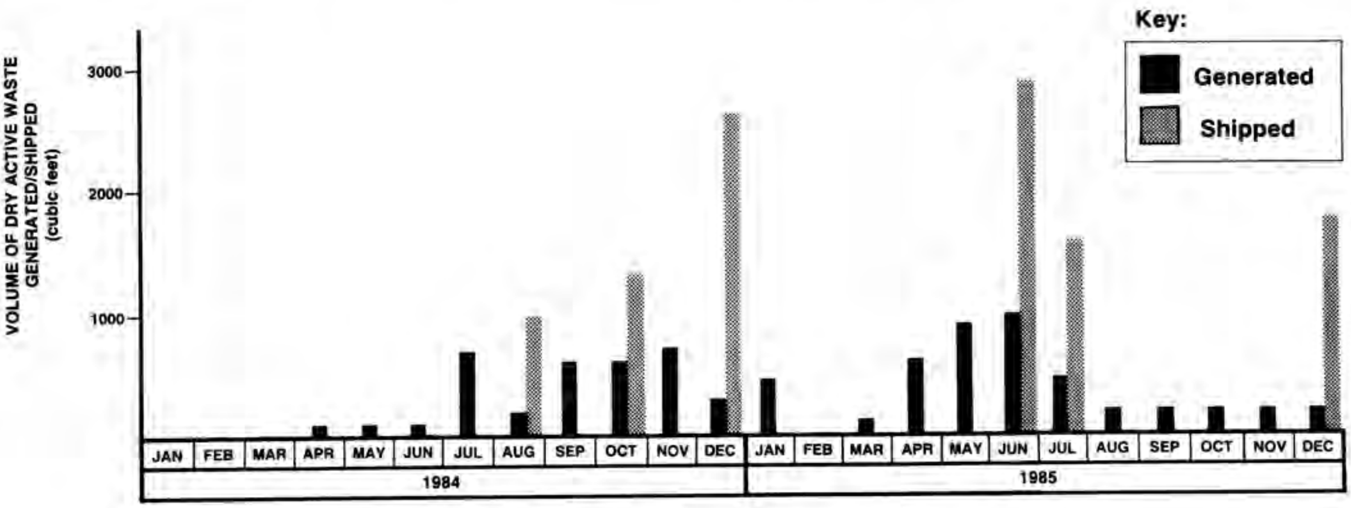

Fig. 2. Dry active waste volumes generated at WNP-2 and shipped for disposal.

TABLE II

Dry Active Waste Total Activities and Predominant Nuclide Concentrations

TIME PERIOD	TOTAL VOLUME SHIPPED (M^3)	TOTAL ACTIVITY (Ci)	CONCENTRATIONS (Ci/M^3) Cr-51	Mn-54	Co-58	Co-60	Fe-59	Zn-65
Jan-June 1984	0	NS(a)	NS	NS	NS	NS	NS	NS
July-Dec 1984	66.3	0.545	5.8-3(b)	4.7-5	2.0-3	1.2-4	1.1-5	1.6-4
Jan-June 1985	81.6	0.031	8.7-5	1.0-5	1.3-4	4.7-5	1.0-5	7.0-5
July-Dec 1985	92.0	0.353	5.5-4	1.4-4	8.4-4	2.7-4	5.9-6	1.1-3

(a) NS means none shipped
(b) Notation is interpreted as 5.8-3 = 5.8×10^{-3}

ECONOMIC EVALUATIONS AND FUTURE PLANS

Prior to the expiration of the initial radwaste processing services contract at WNP-2, an economic evaluation using the EPRI engineering economics methodology in Ref. 2 was performed. The alternatives evaluated in this study involved continuation of use of a services vendor versus installation with or without modification of the permanent cement solidification system. Inclusion of capital for modification of the permanent system to accommodate dewatering was evaluated. Various options on installation labor costs and schedules were included. This evaluation provided further input into the decision concerning which course of action was most prudent for the immediate future.

Although operation of an installed in-plant system provided an apparent annualized operating cost savings of $300 to $400 thousand dollars per year based on a given waste characteristics projection, capital installation costs and the time value of money factors reduced the magnitude of the apparent incentive to install the permanent system. Reasonable values for interest rates, escalation and fixed charge rates were used with a thirty year evaluation period in this study. No penalties nor additional inflation factors were included to account for regulatory uncertainties, and disposal costs were assumed to stabilize somewhat compared to current escalation rates.

The equivalent capital investment (ECI) values from this study are summarized in Table III. These values were based on the current contract prices and relatively high waste volume projections. The ECI values show little difference in alternatives for the thirty year evaluation period. WPPSS was reluctant to commit to installation of the permanent system using existing maintenance labor forces as a filler activity to levelize work loads between outages because of schedule uncertainties and possibly interfering priorities. Based on the values projected in this evaluation, there was little perceived risk in extending the use of a radwaste processing services vendor for a couple of years, and little real incentive to install the permanent system.

Therefore, an invitation to bid was extended to known radwaste processing service vendors, and bids opened in October 1985. Respondents proposed standard resin dewatering and solidification processes, as well as advanced volume reduction methods like GE's AZTECH system. An uniform projection of waste volumes and activities was presented as the basis for the bids, and was used to ensure that the various bids were fairly and equivalently evaluated. 9720 cubic feet of sludges and resins and 9600 cubic feet of DAW each year for two years were projected. Review of the bids reinforced the intuitive conclusion that, in general, advanced volume reduction processes are more expensive than dewatering, but recouped to some extent by lower shipping and disposal costs. As disposal costs escalate, the incentives for more advanced volume reduction measures increase. The overall costs to the utility are also sensitive to assumptions on ratios of waste requiring solidification or high integrity container (HIC) packaging.

Bids were evaluated for technical responsibility, responsiveness to the somewhat restrictive contract terms and conditions, and economic advantage. Based on this evaluation, Pacific Nuclear System, Inc. was selected as the current radwaste processing services vendor at WNP-2. Total evaluated costs included equipment rental, operator support, waste processing, containers, packaging, shipping, cask use, and disposal based on current U.S. Ecology prices for the Hanford disposal site and the projected processed waste characteristics. Total evaluated costs ranged from $45 to $70 per cubic foot of total waste volume processed over a two year period. The total evaluated costs did not include resin replacement, WPPSS systems operations nor radwaste costs associated with in-plant radwaste processing. The competition was very close and the bids evidenced the current complexity of pricing and processing options.

During the current two year contract period, WPPSS will again evaluate the various options available, and attempt to select an efficient, effective and approved processing system that also has sufficient flexibility to meet changing regulatory requirements. If such a system can be shown to be economically attractive, it will be purchased and installed. If none meeting this criteria are found, WPPSS will continue to use a radwaste processing services vendor for radwastes generated at WNP-2.

REFERENCES

1. A.D. Miller, W.A. Rodger, J.B. McIlvaine, J.A. Lieberman, Methodologies for Classification of Low-Level Radioactive Wastes from Nuclear Power Plants, AIF/NESP, November 1983.

2. EPRI NP-3577 "Low-Level Radwaste Engineering Economics" EPRI Project 1557-1 Topical Report, July 1984.

TABLE III

Equivalent Capital Investment (ECI) Cost Comparison of Alternative Waste Processing Methods
(All Costs in Thousands of Dollars)

ALTERNATIVE	ANNUAL AVERAGE OPERATING COSTS			INITIAL CAPITAL INVESTMENT	EQUIVALENT CAPITAL INVESTMENT (ECI)
	OPERATIONS & MAINTENANCE	SHIPPING	DISPOSAL		
Continue Dewatering Services	899	45	456	0	34,444
Continue Dewatering Services with RWCU Solidification	932	55	487	0	36,567
Install Permanent Cement Solidification System	356	111	646	4,078	34,609
Install Permanent System and Modify for Dewatering (use as maintenance "filler" activity to lower labor costs)	518	58	477	2,086	29,558