DECONTAMINATION AND DISPOSAL OF Sb-124 AT PALO VERDE NUCLEAR GENERATING STATION

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ABSTRACT

Palo Verde Nuclear Generating Station (PVNGS) is a three unit Combustion Engineering pressurized water reactor site. Each unit consists of an identical, self contained 1270 MWe reactor. This standardized design allows sharing of design improvements and equipment leading to optimum operation of the individual units. One design improvement, identified early into the operation of Unit 1, involved the elemental antimony content of the seals and bearings within the reactor coolant pumps. Normal wear of these components releases small amounts of elemental antimony. This antimony in turn deposits on in-core surfaces and activates to produce the isotopes Sb-122 and Sb-124. These isotopes emit highly energetic gamma rays which contribute significantly to the exposure and radwaste disposal charges at PVNGS. For these reasons, the Antimony Removal Program was undertaken to remove the radioactive and elemental antimony from the nuclear steam supply system at all three units. The work presented here describes the antimony decontamination and disposal.

BACKGROUND

The four reactor coolant pumps at each unit of PVNGS contain seals and bearings containing large concentrations of elemental antimony. These seals wear or corrode and release antimony to the primary system. This antimony enters the reactor coolant and participates in the familiar activation mechanism of the other corrosion products: transport, deposition, neutron activation, release, redeposition and removal. Under this mechanism, the antimony deposits on the fuel and activates by the neutron flux to form the two radioactive activation products of antimony. Sb- 122 is created from the natural Sb-121 (57.3%), and Sb-124 is created from the natural Sb-123 (42.7%). These isotopes, when released to the coolant and accumulated in the waste and out-of- core surfaces contribute significantly to both occupational exposure and disposal costs. Nuclear plants without the large source of antimony do not have the extra burden from the activated antimony isotopes.

During reactor shutdowns and other transients, the antimony isotopes and other fission and activation products increase in concentration. These crud spikes and fission product spikes are commonly observed at most power plants with appreciable levels of activity. Table I lists the maximum activity observed during various shutdowns of Unit 1 and 2 at PVNGS. These maximum activities exceeded the steady state power values by factors of about 10 to 100.

The total amount of activity which passed through the purification system during these shutdown transients is listed in Table II.

The above data show that during shutdown transients have released as much as 2500 curies of Sb-124 in Unit 1 and 1300 Ci of Sb-124 in unit 2. The actual release total shows a correlation with time at full power. Work by EPRI at various PWRs has shown that the time necessary for the release of activity can be decreased by addition of hydrogen peroxide to the reactor coolant system. While the consensus of opinion is that no overall increase in the activity released occurs, the time over which the release occurs is significantly decreased. This allows more effective removal of activity from the RCS and decreases exposure to personnel involved

TABLE I

Maximum Concentrations During Shutdown Transients
μCi/ml.

Unit	Date	Co-58	Co-60	Sb-122	Sb-124	Days FullPower
1	1/86	1.7E-2	4.5E-3	2.5E-2	1.4E-2	19
1	3/86	3.3E-2	1.5E-3	1.3E-0	4.1E-1	26
1	1/87	2.1E-1	1.2E-2	2.3E-0	1.4E-0	54
1	6/87	2.1E-1	1.3E-1	1.2E-1	3.0E-1	29
1	10/87	8.0E-2	1.1E-2	3.4E-1	2.4E-1	
2	1/87	1.8E-1	7.5E-3	1.8E-0	7.8E-1	
2	5/87	7.6E-2	7.9E-2	1.4E-1	6.2E-2	

TABLE II

Total Curies Through Purification System During Plant Shutdowns.

Unit	Date	Co-58	Co-60	Sb-122	Sb-124	Days at Full Power
1	1/86	20	3	35	16	19
1	3/86	200	10	800	1900	26
1	1/87	300	20	2300	2500	54
1	6/87	700	100	300	1500	29
1	10/87	90	20	300	300	
2	1/87	400	25	1600	1300	
2	5/87	80	40	100	100	

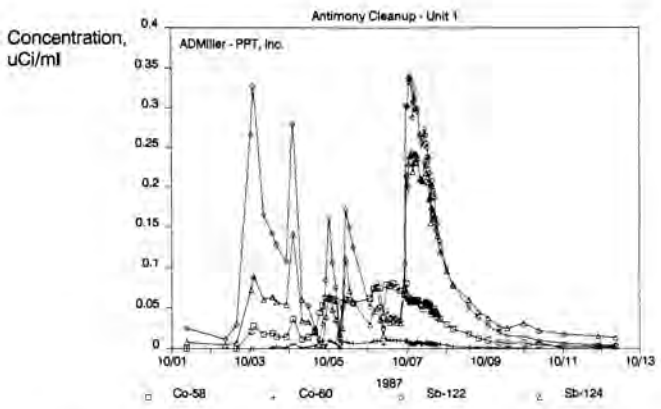

Fig. 1. Radionuclide Concentration vs. Time.

in refueling activities. For these reasons, the decision was made to add hydrogen peroxide to the RCS as soon as the system was degassed and the temperature was brought below 200 F. The actual procedures and parameters for the system cleanup used the EPRI techniques as described in the literature. Bechtel and KWU were contracted to assist in the process.

RESULTS

Alternatives for waste handling were developed and implemented to handle the worst case activity removal estimates. Special metallic high integrity containers were designed for dewatering and disposing of the potentially highly radioactive resins used in the cleanup program. These containers were designed to dewater the resin, even if the resin had suffered a degree of damage from the high levels of activity projected to be possible.

As the unit was brought off-line (October 3 at 16:20) and cooldown started, the reactor coolant activity increased as expected. The first injection of hydrogen peroxide was made about three days later. Several sharp increases in activity were observed corresponding operational changes and the hydrogen peroxide injections. Figure 1 shows the concentration of several radionuclides as a function of time during this period. As shown, the maximum concentration of Sb-124 was 0.24 μCi/ml and occurred about 1 1/2 hours after the first injection of hydrogen peroxide. The Sb-122 concentration peaked at about the same time at 0.34 μCi/ml. The Co-60 and Co-58 concentrations peaked about twelve hours before the hydrogen peroxide injection at 0.01 and 0.08 μCi/ml respectively. The total quantity of activity released during the shutdown is illustrated in Fig. 2. As shown, about

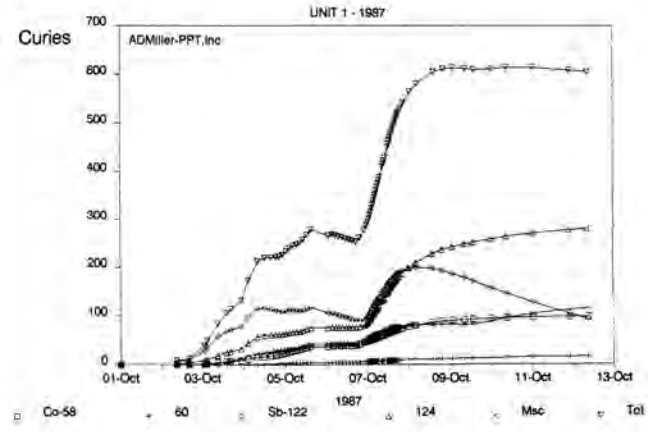

Fig. 2. Integrated Curies on Resin.

600 curies of activity was released and captured on the purification demineralizer.

The same procedures and processes will be used in Unit 2 when it shuts down for its first refueling outage.