A CRITICAL REVIEW OF SOLID RADIOACTIVE WASTE PRACTICES AT NUCLEAR POWER PLANTS

A. H. Kibbey
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Chemical Development Section B

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A. H. Kibbey
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MARCH 1974

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Oak Ridge, Tennessee 37830
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A CRITICAL REVIEW OF SOLID RADIOACTIVE WASTE PRACTICES

AT NUCLEAR POWER PLANTS

A. H. Kibbey and H. W. Godbee

ABSTRACT

A survey was made of solid radioactive waste (radwaste) practices at light-water-cooled nuclear power plants. Plant operating reports from initial criticality to December 31, 1972, were the main sources of information. A comparison of boiling water reactors (BWRs) and pressurized water reactors (PWRs) shows that BWRs consistently shipped a larger total volume of solid radwaste per thermal megawatt-hour than PWRs. At the end of 1972, the cumulative thermal megawatt-hour output was 2.2×10^8 for BWRs and 2.5×10^8 for PWRs included in this survey. The corresponding cumulative volume of solid radwaste shipped from BWRs was approximately $3.3 \times 10^5 \text{ ft}^3$ and from PWRs was $1.4 \times 10^5 \text{ ft}^3$, or 1.5×10^{-3} and $0.6 \times 10^{-3} \text{ ft}^3/\text{MWhr(t)}$ for BWRs and PWRs, respectively. The cumulative total curie (uncorrected for decay) contents of these wastes were $6.7 \times 10^3 \text{ Ci}$ for the BWRs and $7.7 \times 10^3 \text{ Ci}$ for the PWRs, which give average specific activities of 2×10^{-2} and $5.5 \times 10^{-2} \text{ Ci/ft}^3$ for the BWR and PWR wastes, respectively. Through the end of 1972, the average number of curies shipped offsite to licensed burial grounds per unit of thermal output is the same for both types of reactor, namely, $3 \times 10^{-5} \text{ Ci/MWhr(t)}$. The PWRs made fewer radwaste shipments of higher specific activity per thermal megawatt-hour output. Shipments per 10^6 MWhr(t) averaged about 3 for BWRs and about 1-1/3 for PWRs.

A separation of the reactors into two categories, those with $<1,000 \text{ MW(t)}$ and those with $\geq 1,000 \text{ MW(t)}$ installed power, was made. This breakdown shows that for a thermal output of $1.8 \times 10^8 \text{ MWhr(t)}$, the solid radwaste volume shipped per MWhr(t) from the large BWRs was a factor of 3 greater than for the large PWRs, i.e., 1.4×10^{-3} vs 0.43×10^{-3} . The specific activity of these large PWR wastes ($9.3 \times 10^{-2} \text{ Ci/ft}^3$) was nearly a factor of 8 higher than that of the large BWRs ($1.2 \times 10^{-2} \text{ Ci/ft}^3$). The volume of waste per thermal megawatt-hour output increased for the small BWRs with increasing operating time, whereas the small PWRs show little or no change. During 1970-72, these small, older reactors generated ~20 vol % of the total radwaste shipped while contributing 10% of the total thermal megawatt-hours.

Most operating plants dewater spent bead resins and ship them in drums or casks with disposable liners without binding in a matrix. Approximately half of the BWRs dewater their filter sludges also and ship them without a binding agent. Evaporator concentrates, filter sludges, and neutralized chemical wastes from about half the BWRs are placed in 55-gal drums or casks containing adsorbents and shipped for burial without a binder. Nearly all PWRs routinely incorporate spent filter cartridges and evaporator concentrates in cement for shipment in drums or

disposable cask liners. Almost all plants use hydraulic balers to compact low-level dry compressible wastes into drums for offsite burial. Compacted waste comprises ~10 to 50% of the total solid radwaste volume at BWRs and ~5 to 10% at PWRs.

The trend throughout the industry is toward incorporation of spent resins, filter sludges, filters, and evaporator concentrates in cement or urea formaldehyde using disposable shipping casks or cask liners. However, the 55-gal drum is still widely used as a container for most of these wastes. Design of remotely operated equipment for handling solid radwaste is continually being upgraded, but manual operations have not been eliminated. More adequate reporting of personnel exposures and monitoring methods is needed where manual operations are necessary.

1.0 SUMMARY AND RECOMMENDATIONS

The relationships between solid radioactive waste (radwaste) volume, curie content, and size and number of shipments were studied. These radwaste variables were normalized on the basis of thermal megawatt-hours. All operating light water reactors (LWRs), starting with Dresden Unit 1, were considered from first criticality through December 31, 1972. Plant operating reports and docket materials, supplemented with earlier similar open literature summaries,¹⁻⁶ were the main sources of information. In addition, selected plants known to be planning or undergoing revisions in solid radioactive waste handling procedures were contacted directly. Waste core components were excluded from the analysis because this study was concerned mainly with the trends of routine solid radwaste generated from operation of the liquid waste treatment system. The routine wastes considered in this study are filters, filter sludges, spent demineralizer resins, evaporator concentrates, and dry compressible wastes which are shipped for offsite burial. In the overall analysis, these are grouped together and referred to as total solid radwaste shipped.

Comparison of boiling water reactors (BWRs) and pressurized water reactors (PWRs) indicates that BWRs generate a larger volume of solid radwaste per thermal megawatt-hour than PWRs but that the curies (uncorrected for decay) shipped per thermal megawatt-hour is the same for both types of reactor. At the end of 1972, the cumulative thermal megawatt-hour output was 2.2×10^8 for BWRs and 2.5×10^8 for PWRs included in this survey. The corresponding cumulative volume of solid radwaste shipped from BWRs was approximately 3.3×10^5 ft³ and from PWRs was 1.4×10^5 ft³. The cumulative total curie contents of these wastes were 6.7×10^3 Ci for BWRs and 7.7×10^3 Ci for PWRs. From 1960 to 1972, BWRs made more than 2.5 times as many shipments as PWRs per thermal megawatt-hour, with an average BWR shipment equivalent to about 500 ft³ as compared to about 430 ft³ for PWRs. Thus, the tendency has been for PWRs to make fewer shipments of higher specific activity (Ci/ft³) waste per thermal megawatt-hour than BWRs. For each year since 1967, the normalized annual BWR solid radwaste volume has been a factor of 2 to 6 greater than that for the PWRs. Since 1970, PWR curie content per unit volume of waste

has exceeded that of BWRs by factors of 2 to 8. This may be related to the number of PWRs that started operating during this period or possibly to changes in waste treatment procedures, e.g., increased use of evaporation. In-depth studies that consider basic differences in the waste management philosophy of the nuclear steam supply system (NSSS) vendors, architect-engineers, and utility companies are needed before more definitive evaluations can be made.

The practice of merely dewatering spent demineralizer bead resins and packaging them in disposable cask liners or drums without a binder is widespread among both types of plant. The PWRs have a greater propensity than the BWRs for incorporating solid wastes in cement since all PWRs, except San Onofre-1 and Palisades, have evaporators on the dirty waste systems.⁷ The concentrates from the waste evaporators, containing high concentrations of boric acid from the reactor coolant treatment system or highly salted solutions from demineralizer resin regeneration, are incorporated in cement. The PWRs which have cementing equipment generally also incorporate their disposable filter cartridges and sludges in cement. A number of BWRs do not have evaporators and use a maximum-recycle filter-demineralizer system with no resin regeneration. These plants produce relatively large amounts of sludge, which they dewater and package in the same way as they treat bead resins. In plants that have no evaporator and inadequate cementing equipment, chemical wastes are sometimes adsorbed on such materials as vermiculite or Microcell in disposable cask liners or drums and shipped for offsite burial without a binder. There has been a recent trend away from these practices, and many BWR plants are now installing waste evaporators and equipment for incorporating sludges in a matrix. The use of urea formaldehyde as an agent for incorporating radwastes is receiving more consideration, and many of the package units now available from vendors for incorporating radwastes can be converted from one agent to the other. More information on the leach rates of fission products, especially cesium, from urea formaldehyde products is needed as well as greater knowledge of their physical and chemical properties under conditions of long-term storage. This type of information is more readily available for cement. Another

recognized need is a more precise definition of "solid" which sets acceptable limits on the basis of physical and chemical properties such as compressive strength, flammability, chemical inertness, and the ease with which it is dispersed by the natural forces of wind, rain, and groundwater.

2.0 BACKGROUND

The purpose of this work was to evaluate solid radwaste treatment systems on the basis of operating experience at U.S. nuclear power plants. This compilation of available information on solid radwastes generated at the various plants includes: volume and curie content of the wastes, packaging methods used, and size and number of shipments made through December 1972. It should prove useful on all facets of the nuclear power industry for appraising and improving the handling of solid radwastes. Other earlier surveys that touch on solid radwaste practices at nuclear power plants are included in refs. 1-3 and 5.

This study has been broken into two major divisions, the first dealing with BWR plants and the second with PWR plants. Both BWRs and PWRs use light water as the coolant which circulates through the reactor core taking up heat to produce steam for turning the turbines that generate electricity. In the BWR, the coolant itself is the source of steam, which after going through the turbine is condensed and returned to the reactor. In a PWR, the hot primary coolant is in a closed loop that passes through a steam generator (heat exchanger) and so produces steam external to the reactor system. In most PWRs the primary coolant contains boric acid as a chemical shim for reactivity control. In both types of reactor, the coolant picks up corrosion products from the reactor system, which, along with the water, become radioactive through neutron interactions. In addition to this induced radioactivity, some fission products are released into the coolant from defects in the fuel elements. These dissolved and particulate impurities are removed by filters and ion exchange beds. Other liquids such as decontaminating solutions, contaminated floor drain wastes, and slightly radioactive laundry water are also treated in this way. The filters, filter sludges, and spent ion-exchange resins from these treatments represent a major portion (volume and radioactivity) of the solid radwaste generated. If bead resin demineralizers are regenerated, the neutralized effluent liquid is frequently evaporated, and the evaporator concentrates are adsorbed on a material such as vermiculite or incorporated in a matrix such as cement. Nearly all PWRs use evaporation to concentrate boric acid solutions prior to incorporation in a

matrix. Thus, evaporator concentrates incorporated in a matrix, such as cement, account for a large part of nuclear power plant solid radwaste. Dry, compressible radioactive wastes such as rags, paper, clothing, etc., make up the remaining significant portion. All of the above-mentioned solid wastes lend themselves readily (with respect to volume, weight, and radioactivity) to routine handling and packaging procedures. Diagrams showing typical systems for processing solid radwastes at boiling water and pressurized water nuclear power plants are shown in Figs. 1 and 2, respectively.

Only those solid wastes that are generated as a by-product of the liquid radwaste treatment system and compressible dry wastes are considered for purposes of this report. Used core components and structurals to be shipped for burial are placed in a separate category, since the radioactivity associated with them is very high and they have odd shapes and sizes that require special handling. Long decay times are required and shipments are sporadic. These data have been excluded from the PWR and BWR solid radwaste analysis since they tend to skew and obscure the trends of normal day-to-day waste operations. They have, however, been included in tabular form in the Appendix.

For completeness, pertinent information on Peach Bottom 1, the one operating high-temperature gas-cooled reactor (HTGR), is given in the Appendix but is not included in the analysis. Even though it generates very little solid radwaste and is scheduled to be decommissioned in 1974, this reactor has shown a recent trend toward shipping tritiated water sorbed on a drying agent.

Plots of the relationships between thermal output, volume, and curie content of solid waste and the number, size, and frequency of offsite waste shipments were made. Specific isotopes are usually not identified and the method and time of measurement of the radioactivity are not reported. Thus, all curies are assumed to be the same and are uncorrected for decay in this analysis.

As part of the study, several solid radwaste treatment systems that are available as package units from vendors were examined. Included were

Fig. 1. Typical System for Treatment of Solid Radioactive Wastes at a Boiling Water Reactor.

Fig. 2. Typical System for Treatment of Solid Radioactive Wastes at a Pressurized Water Reactor.

systems for incorporating salts, sludges, and resins in various media such as cement, gypsum, asphalt, and urea formaldehyde.

3.0 ANALYSIS OF OPERATING DATA FROM LWR PLANTS

Nuclear power plants that were operating as of December 31, 1972, were considered in this survey. The data used were taken from Preliminary Safety Analysis Reports (PSARs), Final Safety Analysis Reports (PSARs), and their various amendments, Environmental Reports and Supplements, Environmental Statements, and Safety Evaluation Reports, together with plant operating reports covering the period from first criticality to the end of 1972. This information for BWRs is tabulated in chronological order in Tables A-1a, -1b, -1c, and -1d of Appendix A. For PWRs, it is tabulated in chronological order and according to NSSS vendors in Tables A-2a, -2b, -2c, and -2d of Appendix A. Summary tables for individual reactors and those sharing a common radwaste treatment system are given in Appendix B: Tables B-1 through B-12 for BWRs, Tables B-13 through B-23 for PWRs, and Tables B-24 and B-25 for the one operating HTGR. For completeness, Table C-1 in Appendix C gives a summary of the curie content and number of shipments as well as the years in which shipments were made of waste core components and structurals. These solids are not considered in this analysis since they are not solids generated as a by-product of the liquid radwaste treatment system.

Thermal output is one basis for comparing nuclear reactor waste generation, and it is used in this review as the common denominator for comparisons of practices in the management of solid radwaste at BWRs and PWRs. Thus, the outputs, as thermal megawatt-hours [MWhr(t)], for both types of reactor as a function of time (from ref. 8) are given in Fig. 3. This plot shows that from 1967 to 1969, the PWRs had a higher annual total thermal output than the BWRs, which is a reflection of the larger PWRs [$>1,000$ MW(t)] starting to operate. In 1970, the year after the first larger BWRs [$>1,000$ MW(t)] began operation, annual BWR thermal output approximately equaled that of the PWRs. In the year 1972 the BWR thermal output slightly exceeded that for the PWRs. This is presented only as background material and not as an attempt to estimate future power trends. To use the thermal output data for correlation purposes, cumulative totals were calculated as a function of time. In Fig. 4, a plot of these cumulative thermal output curves is given for both types of reactor and shows

Fig. 3. Annual Thermal Output
(from ref. 8).

Fig. 4. Cumulative Thermal Output.

that from 1960 to the end of 1972 the cumulative thermal outputs are 2.22×10^8 and 2.50×10^8 MWhr(t) for BWRs and PWRs, respectively.

A second variable studied was the total amount of radioactivity routinely shipped offsite to licensed burial grounds in the form of spent resins, filter sludges, evaporator concentrates, and dry compressible wastes. The annual total curies (uncorrected for decay) for BWRs and PWRs are plotted as a function of time in Fig. 5. Again for correlation purposes, cumulative totals were calculated for the two types of reactor, and these results are shown in Fig. 6. The cumulative curves indicate that, as of 1972, the PWRs had shipped a slightly greater number of curies of waste than the BWRs, i.e., approximately 7.7×10^3 vs 6.7×10^3 Ci. Since the nuclides generally were not identified and the times at which the curies were measured were not reported, this difference may not be significant.

A third variable considered was the volume of the solid radwaste shipped. The annual total cubic feet for BWRs and PWRs are plotted against time in Fig. 7. The curves show a marked increase in the waste shipped by both reactor types since 1970. Calculated cumulative totals for the BWR and PWR waste volumes are shown in Fig. 8. At the end of 1972 these amounted to approximately 3.3×10^5 and 1.4×10^5 ft³ for BWRs and PWRs, respectively.

The curie content of the waste shipped each year (Fig. 5) divided by the thermal output for that year (Fig. 3) is shown in Fig. 9. The volume of waste shipped each year (Fig. 7) divided by the thermal output for that year (Fig. 3) is also shown in Fig. 9. The cumulative curies (Fig. 6) and the cumulative cubic feet of waste shipped (Fig. 8) as of the end of each year divided by the cumulative thermal output (Fig. 4) over the same time period are presented in Fig. 10. The cumulative radioactivity curve shows no difference in BWRs and PWRs with respect to curies contained in their wastes per thermal megawatt-hour at the end of 1972, namely, 3×10^{-5} for each. The cumulative waste volume curve, however, shows that the BWRs have consistently shipped a larger average volume of solid radwaste per thermal megawatt-hour than the PWRs, and at

Fig. 5. Total Radioactivity Shipped Annually.

Fig. 6. Cumulative Radioactivity Shipped in Solid Waste.

ORNL DWG 73-8604R1

Fig. 9. Annual Radioactivity and Solid Waste Volume Shipped per Megawatt Hour of Thermal Output.

ORNL DWG. 73-8566R1

Fig. 10. Cumulative Number of Curies and Cumulative Volume of Solid Waste Shipped per Cumulative Thermal Output in Megawatt Hours.

the end of 1972 the volumes are approximately 1.5×10^{-3} and 0.6×10^{-3} $\Sigma \text{ ft}^3/\Sigma \text{ MWhr(t)}$ for BWRs and PWRs, respectively. The activity levels of these wastes expressed in terms of curies per cubic foot for each year are shown in Fig. 11. In Fig. 12, the cumulative totals of curies divided by the corresponding totals of cubic feet shipped at the end of each year by BWRs and PWRs are shown as a function of time. The values obtained at the end of 1972 for $\Sigma \text{ Ci}/\Sigma \text{ ft}^3$ are 2.0×10^{-2} and 5.5×10^{-2} for the BWRs and PWRs, respectively. In Figs. 11 and 12 the increase in the installed power of LWRs from $<1,000 \text{ MW(t)}$ to $\geq 1,000 \text{ MW(t)}$ is indicated by first criticals for San Onofre 1, a 1,347-MW(t) PWR, and for Oyster Creek, a 1,930-MW(t) BWR. The first PWR to approach the power level of Oyster Creek was Connecticut Yankee when its licensed power rating was increased from 1,473 to 1,825 MW(t) in 1968.

A fourth variable considered was the numbers of shipments made annually from BWRs and PWRs, which are shown in Fig. 13 along with the cumulative total at the end of each year. Information concerning the size and number of trucks in a shipment is usually not reported. From 1960 to the end of 1972, the BWRs made a cumulative total of 656 shipments after a cumulative total thermal output of $2.22 \times 10^8 \text{ MWhr(t)}$; corresponding values for the PWRs were 331 shipments and $2.50 \times 10^8 \text{ MWhr(t)}$. The calculated number of shipments per 10^6 MWhr(t) is 2.9 for BWRs and 1.3 for PWRs. From the 1972 cumulative total volumes of solid radwaste shipped from both types of reactor, similar calculations give average values for the cubic feet per shipment of 496 for BWRs and 426 for PWRs.

A further breakdown of these data into values for reactors of $<1,000 \text{ MW(t)}$ and $\geq 1,000 \text{ MW(t)}$ installed power (Table 1) shows that the large, newer BWRs (1969-72) shipped about 3 times as large a volume per MWhr(t) as the large, newer PWRs (1967-72). In comparison, over their entire lives (1960-72) the small, older BWRs consistently shipped about 1.5 to 2.5 times as large a volume per MWhr(t) as the small, older PWRs. The large and small BWRs shipped approximately the same volume of solid radwaste per MWhr(t) initially, but after ~ 20 to 40 reactor operating years, the small BWR units nearly doubled the average volume of waste shipped for each MWhr(t). Long-term storage (seven or more years) of spent

ORNL DWG 73-6603R1

Fig. 11. Ratio of Total Radioactivity to the Total Volume Shipped Each Year.

Fig. 12. Ratio of Cumulative Radioactivity to Cumulative Volume of Waste.

ORNL DWG. 73-8561

Fig. 13. Annual and Cumulative Shipments of Radioactive Solid Waste.

Table 1. Effect of Increasing Thermal Output of PWRs and BWRs from <1,000 MW(t) to >1,000 MW(t) on Solid Radioactive Waste Curie Content and Volume and on Size and Number of Waste Shipments

Reactor Type ^a	Reactor Power, MW(t), each	No. of Units	Time Operated, Σ Years ^b	Thermal Output, Σ MWhr(t)	Waste Shipped		Σ Shipments	$\frac{\Sigma \text{ MWhr(t)}}{\Sigma \text{ Years}}$	$\frac{\Sigma \text{ Ci}}{\Sigma \text{ Years}}$	$\frac{\Sigma \text{ ft}^3}{\Sigma \text{ Years}}$	$\frac{\Sigma \text{ Shipments}}{\Sigma \text{ Years}}$	$\frac{\Sigma \text{ Ci}}{\Sigma \text{ MWhr(t)}}$	$\frac{\Sigma \text{ ft}^3}{\Sigma \text{ MWhr(t)}}$	$\frac{\Sigma \text{ Ci}}{\Sigma \text{ ft}^3}$	$\frac{\Sigma \text{ Shipments}}{\Sigma \text{ MWhr(t)}}$	$\frac{\Sigma \text{ ft}^3}{\Sigma \text{ Shipments}}$
					$\Sigma \text{ Ci}$	$\Sigma \text{ ft}^3$										
BWRs																
1960-1968	<1,000	4	22.9	39,101,491	2,409	49,851	70	1.7×10^6	105	2.2×10^3	3.1	6.2×10^{-5}	1.3×10^{-3}	4.83×10^{-2}	1.8×10^{-6} (1.8 shipments/ 10^6 MWhr(t))	712 (=97 drums) ^c
1969 ^d -1972	<1,000	4	16.0	25,970,080	1,611	61,000	78	1.6×10^6	101	3.8×10^3	4.9	6.2×10^{-5}	2.3×10^{-3}	2.6×10^{-2}	3.0×10^{-6} (3.0 shipments/ 10^6 MWhr(t))	782 (=106 drums) ^c
	>1,000	10	19.3	157,316,041	2,638	214,422	308	8.2×10^6	137	11.1×10^3	26.3	1.7×10^{-5}	1.4×10^{-3}	1.2×10^{-2}	3.2×10^{-6} (3.2 shipments/ 10^6 MWhr(t))	422 (=57 drums) ^c
	<1,000 + >1,000	14	35.3	183,286,121	4,249	275,422	57	5.2×10^6	120	7.8×10^3	16.6	2.3×10^{-5}	1.5×10^{-3}	1.5×10^{-2}	3.2×10^{-6} (3.2 shipments/ 10^6 MWhr(t))	470 (=64 drums) ^c
PWRs																
1960-1966	<1,000	2	10.8	29,664,595	218	25,793	59	2.7×10^6	20	2.4×10^3	5.5	0.74×10^{-5}	0.87×10^{-3}	0.85×10^{-2}	2.0×10^{-6} (2.0 shipments/ 10^6 MWhr(t))	437 (=59 drums) ^c
1967 ^e -1972	<1,000	2	12.0	41,569,085	344	38,389	98	3.5×10^6	29	3.2×10^3	8.2	0.83×10^{-5}	0.92×10^{-3}	0.90×10^{-2}	2.4×10^{-6} (2.4 shipments/ 10^6 MWhr(t))	392 (=53 drums) ^c
	>1,000	10	21.6	172,343,253	7,154	76,676	174	8.3×10^6	331	3.5×10^3	8.1	4.0×10^{-5}	0.43×10^{-3}	9.3×10^{-2}	0.98×10^{-6} (~1 shipment/ 10^6 MWhr(t))	441 (=60 drums) ^c
	<1,000 + >1,000	12	33.6	219,912,338	7,498	115,065	272	6.5×10^6	223	3.4×10^3	8.1	3.4×10^{-5}	0.52×10^{-3}	6.5×10^{-2}	1.2×10^{-6} (1.2 shipments/ 10^6 MWhr(t))	423 (=58 drums) ^c

^aAlso see Tables B-24 and B-25 in Appendix B for comparison with Peach Bottom 1 (HTGR).

^bNot corrected for refueling downtime and other outages.

^cFor comparison purposes, waste volumes are normalized to 55-gal drums by dividing by 7.35 ft³/drum.

^dFirst critical for Oyster Creek.

^eFirst critical for San Onofre-1.

resins, evaporator concentrates, and filter sludges and then shipping them all at once is a prevalent practice at the small BWRs, and the increase in the average waste volume per MWhr(t) shipped by these reactors after several years of operation probably reflects this. The small PWRs shipped about twice as large a waste volume per MWhr(t) as the large PWR units during the first 22 reactor operating years of both the small and large units. At this point, the volumes of waste shipped per MWhr(t) from the small PWRs show little or no change with increasing reactor operating time.

Table 1 also shows that after equivalent reactor operating times of ~20 years, the average number of curies of radioactivity shipped per MWhr(t) by the large PWRs was ~2 times that for the large BWRs, 4 times that for the small PWR units, but only ~2/3 of that for the small BWRs. The specific activity of radwaste shipped from the large PWRs is nearly 8 times as high as for wastes from BWRs of comparable size, more than 10 times as high as for wastes from the small PWRs, and about 2 to 4 times as high as for radwaste from the small BWRs.

For comparison, some similar data are given for the HTGR, Peach Bottom 1, in Table B-25 in Appendix B.

4.0 AGENTS USED TO INCORPORATE RADWASTES

The principal methods or unit operations used in the treatment of liquid radwaste at nuclear power plants are filtration, ion exchange,⁹ and evaporation,⁷ as illustrated in Figs. 1 and 2. These give rise to sludges, spent resins and/or regenerant solutions, and evaporator concentrates. The incorporation of these wastes in an inert matrix is desirable since the resulting product is safer to handle, transport, and store. Radwastes have been incorporated in cements, plastics, asphalts, and similar materials¹⁰⁻¹³ in attempts to prepare products that will hold virtually all radioactivity during short-term storage, transport, and long-term disposal. The importance of reduced solubility during transport is indicated by recently revised International Atomic Energy Agency (IAEA) regulations for the safe transport of radioactive materials that include leach rate among the criteria for such products.¹⁴ The reduced solubility of wastes incorporated in an inert matrix becomes increasingly important when long-term disposal is considered.

Incorporation of radwaste in cement has been widely and routinely used at nuclear research and production sites^{10,11,13} for over two decades and at power reactor plants for over a decade.^{1,2} Surveys concerning the results of laboratory studies and operating experiences at nuclear research and production sites with cement are given in refs. 10 and 13. Cement or cement with additives, such as vermiculite, bentonite, and Grundite, have been used. Portland cement type I has been most commonly used. However, other types have been used,¹³ in particular, Portland cement type II because it is normally more resistant to sulfate deterioration.¹⁵ Incorporation-in-cement processes, for the most part, are operated at ambient temperatures. Equipment used for incorporation of radwaste in cement at nuclear power plants ranges from conventional batch mixers to semiautomatic continuous units such as at Monticello. Since transport of fresh cement paste from a mixer into final storage drums can present difficulties, in particular with "flash" or premature hardening of the mix, processes in which mixing takes place in the final storage drum have been developed. Equipment of this type will be installed at Salem. The radiation stability of radwaste-cement products has not been found to be a problem.¹³ Leach

rates are relatively low for a large number of radionuclides; however, the more soluble nuclides, such as cesium, generally require a clay additive to ensure a low leach rate for these isotopes. The volume of material for final disposal is increased by incorporation in cement, usually by a factor of about 2. However, this cement provides shielding. In general, cement-radwaste products with satisfactorily high mechanical strength and low leach rate contain about 5 to 10 wt % waste solids, with a rapid decrease in strength reported^{3,13} when the waste solids exceed 10 to 15 wt %. Cement is noncombustible, and the presence of oxidizing agents, such as nitrates and nitrites, does not have the same possibly detrimental effects (matrix embrittlement, lowered flash points, and exothermic reactions) as they can have when mixed with carbon-based materials such as waxes and asphalts. Attack by microorganisms on cement-radwaste products buried in the ground appears to be insignificant. However, there is a need to study further such attack in tightly sealed drums of cement products containing large amounts of material that can ferment, such as organic resins and cellulosic filter aids.

Incorporation of radwaste in asphalt has been used at nuclear research and production sites abroad for about a decade.^{10,12,13} Although an incorporation-in-asphalt process has not been used by U.S. nuclear power plants, it is a viable process, and a brief description of the product is presented. Surveys concerning the results of laboratory studies and operating experience at nuclear research and production sites with asphalt as well as brief outlines of the equipment used in the various processes are given in refs. 12 and 13. Asphalt-incorporation processes generally operate in the range 130° to 230°C, and in most of the processes a low-melting wax or thermoplastic such as polyethylene could be substituted¹⁶ for asphalt. The radiation stability of radwaste-asphalt products has not been found to be a serious problem at the integrated radiation doses that can be realized with power reactor wastes.^{12,13} The leach rates of asphalt products are lower than those of cement products, in some instances, several orders of magnitude lower. The amounts of ¹³⁷Cs that can be expected to be leached from asphalt and cement products incorporating the same amount of waste solids are compared in Table 2 and

Table 2. Comparison of the Predicted Amounts of ^{137}Cs Leached from Products Incorporating Evaporator Concentrates and Filter Sludges in Asphalt and Cement^a

Time (years)	Fraction Leached, $\left(\frac{\sum a_n}{A_0}\right)$			
	Evaporator Concentrates		Filter sludges	
	Asphalt ^{b,c}	Cement ^{d,e}	Asphalt ^{d,f}	Cement ^{d,g}
0.1	1.9×10^{-4}	3.7×10^{-3}	9.0×10^{-6}	5.2×10^{-4}
0.5	4.2×10^{-4}	8.8×10^{-3}	2.0×10^{-5}	1.6×10^{-3}
1.0	5.9×10^{-4}	1.3×10^{-2}	2.8×10^{-5}	3.0×10^{-3}
10.0	1.5×10^{-3}	6.2×10^{-2}	7.1×10^{-5}	2.2×10^{-2}
30.0	1.7×10^{-3}	1.1×10^{-1}	7.8×10^{-5}	4.1×10^{-2}
100.0	6.0×10^{-4}	7.1×10^{-2}	2.8×10^{-5}	2.7×10^{-2}
300.0	1.0×10^{-5}	2.1×10^{-3}	4.8×10^{-7}	8.5×10^{-4}

^aEach product contains 10 wt % bone-dry solids from waste and has a surface (S) to volume (V) ratio comparable to that of a 55-gal drum, i.e., an S/V of $1.99 \times 10^4 \text{ cm}^2/2.08 \times 10^5 \text{ cm}^3$. The surface of the product ($1.99 \times 10^4 \text{ cm}^2$) is considered to be continuously exposed to water. The half life (λ) of ^{137}Cs is taken to be 30 years. Equations describing time (t) dependence, effective diffusivities (D_e), and dissolution rate constants (k) are from ref. 17.

$$^b \left(\frac{\sum a_n}{A_0}\right) = 2 \left(\frac{S}{V}\right) \left(\frac{D_e}{\pi}\right)^{1/2} t^{1/2} e^{-\lambda t},$$

where $\sum a_n$ is the accumulative amount of the species leached and A_0 is the original amount of the species in the product.

$$^c D_e = 1.0 \times 10^{-12} \text{ cm}^2/\text{sec}.$$

$$^d \left(\frac{\sum a_n}{A_0}\right) = \left(\frac{S}{V}\right) (D_e k)^{1/2} \left[\left(t + \frac{1}{2k}\right) \text{erf}(kt)^{1/2} + \left(\frac{t}{k\pi}\right)^{1/2} e^{-kt} \right] e^{-\lambda t}.$$

$$^e D_e = 3.7 \times 10^{-10} \text{ cm}^2/\text{sec} \text{ and } k = 1.5 \times 10^{-8} \text{ sec}^{-1} \text{ (illite clay added to hold cesium).}$$

$$^f D_e = 2.2 \times 10^{-15} \text{ cm}^2/\text{sec} \text{ and } k = 8.7 \times 10^{-13} \text{ sec}^{-1}.$$

$$^g D_e = 5.5 \times 10^{-12} \text{ cm}^2/\text{sec} \text{ and } k = 1.5 \times 10^{-7} \text{ sec}^{-1}.$$

show that, in this case, about 20 to 2,000 times more would be expected to be leached from the cement product. The volume of material for final disposal is decreased by incorporation in asphalt in those cases, e.g., evaporator concentrates and filter sludges, where water is removed. In many cases the volume is reduced by a factor of about 2. In general, asphalt-radwaste products with satisfactorily high mechanical strength and low leach rate may contain about 40 to 60 wt % waste solids. Asphalt is combustible, and the risk of fire during processing, short-term storage, transportation, and long-term disposal should be considered. Considerable evidence^{12,13} indicates that the presence of oxidizing agents in the waste can have the possibly detrimental effects mentioned above on asphalt. Bacterial attack on asphalt-radwaste products appears to be insignificant.¹³ However, such attack in tightly sealed drums containing materials that can ferment appears to need further study.

Incorporation of radwaste in urea formaldehyde polymers is a relatively new process when compared to incorporation in cement and asphalt. Since it is a new process, only limited results of operating experience are available. However, the waste burial facility at Morehead, Kentucky, is reported to have been using the process for approximately a year for treating liquid radwastes. Several nuclear power stations, e.g., Trojan and Palisades, have ordered units using urea formaldehyde for installation this year. Limited data are available on the physicochemical properties, such as radiation stability, leach rate, volume increase, mechanical strength, weight percent waste solids included, the effect of oxidizing agents, etc., for urea formaldehyde-radwaste products. Attack by microorganisms would probably be negligible in the presence of formaldehyde. The products appear to lose water and formaldehyde, if not sealed. More information and further studies on urea formaldehyde are needed before definitive comparisons can be made with other agents.

5.0 OBSERVATIONS AND CONCLUSIONS

The information gathered in this survey pointed up certain deficiencies in reporting and in the solid radwaste treatment systems themselves. Problem areas are discussed and developing trends in solid waste handling are noted in the following sections.

5.1 Reporting of Operating Data and the Need for More Explicit Information on Solid Radwaste Treatment

This study revealed many unique and diverse problems associated with preparing solid radwastes for transport to offsite burial grounds. Remote handling systems are continually being developed and upgraded, but frequently the necessity for partial manual operations, such as drum decontamination, truck loading, and drum capping, still persists, even at some relatively new power plants (Nine Mile Point, Ginna, and Millstone 1). The methods of monitoring personnel involved in specific solid radwaste treatment operations are rarely described, and the information available with respect to exposure levels is scattered and indefinite in the dockets. Detailed data of this kind are not adequately or consistently reported at all stations.

Methods of reporting need to be upgraded so that meaningful statistical analysis can be made on plant operation data for purposes of planning in all segments of the industry. Specifically, there should be a system of solid radwaste classification. A preliminary attempt was made in the tables of Appendix A.

Routine reporting of shipment weights exclusive of shielding, in addition to shipment volumes, decay times of curies at shipment, and specification of the principal isotopes for which curie levels are given, would be useful. This kind of information has only limited coverage in the dockets. The techniques used to measure curies are seldom described and activity levels of specific isotopes in solid radwaste shipments are rarely given. Information on onsite storage times for various types of solid waste and the inventory of these items is almost nonexistent in the operating reports. Reporting by the small, older reactors was generally

more detailed and complete, and a noticeable change in the quality of reporting occurred in 1968-69 after the large, newer units began operating (arithmetic and typographical errors as well as discrepancies between numerical values given in the monthly and semiannual or annual operating reports covering the same period occasionally occur).

Design estimates of the amount of solid radwaste generated at BWRs and PWRs have often been low by a factor of 2 or more. For example, the estimate for Quad-Cities Units 1 and 2 at the time of licensing for 20% power operation in January 1972 was approximately 16,200 ft³ per year, and operating experience subsequently showed nearly 38,000 ft³ actually shipped from the site during the first year of commercial operation. The FSAR for Ginna estimated 660 to 1100 ft³ of solid radwaste expected per year, but again, operating experience for 1972, which was a reasonably normal year, showed shipments totaling more than 12,900 ft³. The basis used for design estimates is usually not found in the docket materials.

Another data deficiency occurred in not reporting the volume reduction factors obtained and the amounts of dry, combustible wastes incinerated at Yankee-Rowe prior to 1967. Such data may be of use in the future. Although the practice has been discontinued at this plant and is prohibited except by specific AEC authorization, incineration was considered as a partial solution to the solid radwaste problem in the Supplement to the Environmental Report for the Donald C. Cook Nuclear Plant dated November 8, 1971. The method is widely used in the United States and Europe for volume reduction of solid radioactive wastes at nuclear research and production sites.^{18,19}

5.2 Current Trends in Power Plant Operation and the Need for New Solid Radwaste Criteria

This survey indicated a recent tendency toward short onsite storage times for routine radioactive solid wastes from nuclear power plants. Reusable concrete or lead-steel shipping casks with disposable liners are routinely used for transporting spent resins and filter sludges from these installations. Ion exchange resins from both BWRs and PWRs are normally dewatered and packaged without incorporation in a matrix, but an adsorbent

is sometimes added. All nuclear reactors operated by Commonwealth Edison (Dresden Units 1, 2, and 3, Quad-Cities Units 1 and 2, and Zion Units 1 and 2), Monticello, and Indian Point 1 incorporate their spent bead resins in cement. The filter sludges, especially finely ground anion-cation resins (Powdex), cellulose filter aids, and diatomaceous earths from BWRs, are also dewatered and shipped in casks or drums, often without incorporation in cement or other agents. The sludges normally account for a large portion, and in some cases nearly all, of the solid radwaste from a BWR. The disposable filter cartridges used at Big Rock Point, Humboldt Bay, LaCrosse, and Monticello and at nearly all PWRs are normally allowed to decay in shielded drums for varying time periods before imbedding in cement for shipment. At Dresden Units 2 and 3, these spent cartridges are packaged with an unspecified adsorbent material for offsite shipment. Normally, evaporator concentrates are incorporated in cement at nearly all the PWRs except San Onofre 1 and Palisades. These reactors are the only PWRs which have no waste evaporators and use filtration, ion-exchange, and dilution prior to discharge as the treatment for boric acid wastes. Palisades Nuclear Plant is converting to a urea formaldehyde incorporation process which is scheduled for operation in 1974. This system will be capable of incorporating spent resins and filter cartridges as well as evaporator concentrates. Evaporator concentrates from BWRs containing high concentrations of sodium sulfate originate largely from sulfuric acid regeneration of deep bed demineralizers. Some BWR plants that do not regenerate resins do not have evaporators. Of the 14 BWRs considered in this study, 6 have no evaporators (see Table A-1a and ref. 7). Most of the BWRs incorporate evaporator concentrates in cement for offsite shipment. A number of these plants are able to store evaporator concentrates for a year or more for decay before incorporation. Still others adsorb these liquids on such substances as vermiculite and Microcell in disposable cask liners or drums and ship them as solid wastes. It would be useful to have a more exact definition of "solid" which states more specifically the quality criteria required for acceptance of waste at burial sites. Methods should be developed to assure that drum or cask contents form a solid matrix. Sampling by boring or ultrasonic methods have been suggested as approaches to the problem, but little work has

been done in this regard. As the language difficulties are resolved, the present trend toward incorporation in cement, asphalt, urea formaldehyde, or similar agents is expected to increase. Nine Mile Point has been using a mobile urea formaldehyde unit for processing evaporator concentrates. It is their intention also to use it for spent resins.

The dry compacted wastes make up a significant fraction of nuclear power plant wastes, i.e., up to nearly 50% of the total volume of wastes and do not appear at this time to pose any problem. It may be desirable to develop methods for achieving volume reductions greater than the 3 or 5 to 1 now produced by hydraulic baling.

6.0 ACKNOWLEDGMENTS

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Appendix A

**SOLID RADWASTE OPERATING DATA FOR LWR NUCLEAR POWER
PLANTS IN OPERATION AS OF DECEMBER 31, 1972**

Table A-1a. Summary of Solid Radioactive Waste Treatment at Boiling Water Reactors (BWRs) in Operation: Ion-Exchange Resins and Evaporator Bottoms

NRS: Reactor [Capacity]	Year	Thermal Output [MWh(t)]	Solid Waste Treatment	Types of Solid, Volume, Activity, and Number of Drums or Casks Shipped				
				(1) Ion-Exchange Resins				
				Treatment	ft ³	Ci	No. of Drums = d Casks = c	Treatment
General Electric:								
Dresden I [630 MW(t)]	1959	(low power tests)	Packaged in suitable containers and stored onsite in properly shielded area to await offsite shipment. There are two 1200 ft ³ concrete storage vaults, a 2000 ft ³ storage building, and a 2500 ft ³ dry waste shelter ^a .	Spent resins are collected and stored onsite until approach to storage capacity is reached. Then the resin is pumped into disposable shielded shipping containers and solidified for offsite shipment. ^{b,c}	0 ^b	0	0	No evaporator.
	1960	908,887		0	0	0		
	1961	1,808,575		0	0	0		
	1962	4,032,427		0	0	0		
	1963	3,136,675		270 ^b	Not reported	Not reported		
	1964	2,238,510		0	0	0		
	1965	3,315,583		0	0	0		
	1966	4,781,128		0	0	0		
	1967	2,768,700		4,110	12	Large concrete tubs ^b		
	1968	3,199,385		0	0	0		
	1969	2,191,837		0	0	0		
	1970	4,772,040		0	0	0		
	1971	2,577,872		0	0	0		
	1972	3,762,787		No shipments since 1967. ^b	0	0	0	
Big Rock Point [240 MW(t)]	1962	2,000	Resins are stored onsite until enough is accumulated to package and ship. Filter cartridges and core components are also stored onsite to allow for radio-decay prior to shipment. Low-level compressible waste is packaged and stored in a dry waste shelter to await offsite shipment. A maximum of 40,000 Ci of solid waste is permitted onsite. The concrete storage vault has a volume of 1200 ft ³ .	Shipped to a storage tank designed to accommodate 5 years of operation.	0	0	0	No evaporator. ^a
	1963	400,267		0	0	0		
	1964	629,516		0	0	0		
	1965	593,192		768	378	Not reported		
	1966	1,142,246		0	0	0		
	1967	1,718,576		0	0	0		
	1968	1,414,506		833	1,727.2	Not reported		
	1969	1,302,207		0	0	0		
	1970	1,176,288		0	0	0		
	1971	1,205,599		0	0	0		
	1972	1,195,550		1,250	1,116.5	Not reported		
Humboldt Bay [165 MW(t)]	1963	565,344	Spent resins ^a and evaporator bottoms ^d are accumulated for as many as 9 years or more before packaging for offsite shipment. Spent filters are stored in 55-gal drums, and dry wastes are stored in fiberboard boxes to await offsite shipment. The storage building has 2,000 ft ³ and the concrete vault has a 1,200 ft ³ capacity. 50,000 Ci is the maximum amount of activity allowed to be stored onsite.	Stored in a 10,000-gal (1300 ft ³) storage tank. Accumulation rate is estimated at 50 ft ³ /yr. When tank gets full, resins are to be packaged for off-site shipment.	0	0	0	About 8,000 gal of evaporator slurry is stored onsite. This is an accumulation from 9 years of operation and its disposal is currently under study. ^d
	1964	1,222,440		0	0	0		
	1965	891,922		0	0	0		
	1966	585,086		0	0	0		
	1967	1,126,634		0	0	0		
	1968	1,507,500		0	0	0		
	1969	1,278,499		0	0	0		
	1970	1,398,874		0	0	0		
	1971	1,140,734		0	0	0		
	1972	1,250,385		0	0	0		
LaCrosse [165 MW(t)]	1967	420	All solid wastes are packaged in 55-gal drums for offsite shipment. The waste disposal processing unit is behind concrete walls to reduce background radiation levels.	Spent resins ^f can be shipped to a 1,000-gal storage tank to decay or can be transferred directly to the drumming station for packaging in concrete-lined drums (30-gal drum inside a 55-gal drum with concrete in the annulus) followed by storage in the dry storage pit to await offsite shipment.	0	0	0	Evaporator bottoms are enclosed directly in 55-gal drums and mixed with cement and absorbent to form a solid mass. When this is not feasible, the residue is stored in a concentrated waste storage tank from which the slurry can be pumped into 55-gal drums and mixed with cement for offsite shipment.
	1968	21,852		0	0	0		
	1969	245,784		230	0.960	Not reported		
	1970	447,816		Included with "Dry Compressible Waste."	0	0		
	1971	707,256		0	0	0		
Oyster Creek [1600 MW(t)]	1967	816,552	All solids are drummed in 55-gal drums and temporarily stored to await offsite shipment.	Dried resins being discharged by gravity into a hopper below to be fed into 55-gal drums for offsite shipment.	100	Not reported	Not reported	Evaporator bottoms are mixed with absorbent (Mic cell) in 55-gal drums for offsite shipment. ^g
	1969	1,195,344			0	0	0	
	1970	10,603,148			0	0	0	
	1971	11,679,781			0	0	0	
	1972	12,941,053			353	1,256	48d	
Nine Mile Point [1538 MW(t)]	1969	294,998	All solids are drummed in 55-gal drums and temporarily stored to await offsite shipment. ^h	Stored in spent resin storage tank until dewatered by centrifugation. Dried resin is dropped into a hopper and from there loaded into 55 gal drums for offsite shipment. ^h	0	0	0	Evaporator bottoms are mixed with absorbent and drummed in 55-gal drums to await offsite shipment. ^h
	1970	5,940,025			Included under "Evaporator Bottoms." Spent resins account for approximately 1/3 of the solid waste.	0	0	
	1971	9,937,980						
	1972	10,010,626						
Dresden 2 & 3 [2527 MW(t)] ex.	1970	4,111,690	All solids are barreled in 55-gal drums for offsite shipment.	Spent resins are dewatered by centrifugation, then fed by hopper into 55-gal drums containing solidifying agent. Next, drums are moved to storage by conveyor to await offsite shipment.	Included under "Evaporator Bottoms." Spent resins account for about 9.3% of solid waste. ^c			Evaporator bottoms are mixed with a solidification agent in 55-gal drums and then stored to await offsite shipment.
	1971	12,324,787						
	1972	25,193,067						
Millstone Point I [2011 MW(t)]	1970	287,709	Solids are packaged in 55-gal drums and stored in shielded facilities to await offsite shipment.	Resins are periodically dewatered by centrifugation. The solids are dropped into a hopper and from there into drums. Drums are capped and moved to storage on a conveyor.	0	0	0	Evaporator bottoms are stored about 30 days to allow for decay, then filtered, analyzed, and if suitable, discharged to the circulating water. ⁱ
	1971	11,112,012			Included under "Filter Sludges." Spent resins account for about 10% of waste.			
	1972	9,687,612						
Monticello	1970	(low power tests)	All solid wastes are co-	Stored in two 3,000-gal phase-	0	0	0	

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the account for 67.7% of solid

0	0
0	0
0	0

Waste Treatment at Boiling Water Reactors (BWRs) in Operation: Ion-Exchange Resins and Evaporator Bottoms

Types of Solid, Volume, Activity, and Number of Drums or Casks Shipped							
(1) Ion-Exchange Resins				(2) Evaporator Bottoms			
Treatment	ft ³	Ci	No. of Drums = d Casks = c	Treatment	ft ³	Ci	No. of Drums = d Casks = c
Spent resins are collected and stored onsite until approach to storage capacity is reached. Then the resin is pumped into disposable shielded shipping containers and solidified for offsite shipment. ^{b,c}	0 ^b 0 0 0 270 ^b 0 0 0 4,110 0 0 0 0 0	0 0 0 0 Not reported 0 0 0 12 0 0 0 0 0	0 0 0 0 Not reported 0 0 0 Large concrete tubs ^b 0 0 0 0 0	No evaporator.	0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0
No shipments since 1967 ^b	0	0	0				
Shipped to a storage tank designed to accommodate 5 years of operation.	0 0 0 768 0 0 833 0 0 0 1,250	0 0 0 378 0 0 1,727.2 0 0 0 1,116.5	0 0 0 Not reported 0 0 Not reported 0 0 0 Not reported	No evaporator. ^a	0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0
Stored in a 10,000-gal (1300 ft ³) storage tank. Accumulation rate is estimated at 50 ft ³ /yr. When tank gets full, resins are to be packaged for off-site shipment.	0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0	About 8,000 gal of evaporator slurry is stored onsite. This is an accumulation from 9 years of operation and its disposal is currently under study. ^d	0 0 0 0 0 0 0 0 0 0 0 605.5	0 0 0 0 0 0 0 0 0 0 0 2.06	0 0 0 0 0 0 0 0 0 0 0 50d ^e + 7c

2

Spent resins ^f can be shipped to a 1,000-gal storage tank to decay or can be transferred directly to the drumming station for packaging in concrete-lined drums (30-gal drum inside a 55-gal drum with concrete in the annulus) followed by storage in the dry storage pit to await offsite shipment.	0 0 230 0 100	0 0 0.980 0 Not reported	0 0 Not reported 0 Not reported	Evaporator bottoms are enclosed directly in 55-gal drums and mixed with cement and absorbent to form a solid mass. When this is not feasible, the residue is stored in a concentrated waste storage tank from which the slurry can be pumped into 55-gal drums and mixed with cement for offsite shipment.	Assume reported as "Dry Compressible Waste."
Shipped to 3,000-gal storage tank. Eventually the slurry is dewatered by centrifugation, the dried resins being discharged by gravity into a hopper below to be fed into 55-gal drums for offsite shipment.	0 0 0 353	0 0 0 1,256	0 0 0 48d	Evaporator bottoms are mixed with absorbent (Micro-cell) in 55-gal drums for off-site shipment. ^g	0 0 2,974 10,304.5 15,045 44.657 2,047d
Stored in spent resin storage tank until dewatered by centrifugation. Dried resin is dropped into a hopper and from there loaded into 55-gal drums for offsite shipment. ^h	0 Included under "Evaporator Bottoms." Spent resins account for approximately 1/3 of the solid waste.	0 0	0 418d	Evaporator bottoms are mixed with absorbent and drummed in 55-gal drums to await offsite shipment. ^h	0 3,070 12,910 15,097 264.88 2,054d
Spent resins are dewatered by centrifugation, then fed by hopper into 55-gal drums containing solidifying agent. Next, drums are moved to storage by conveyor to await offsite shipment.	Included under "Evaporator Bottoms." Spent resins account for about 9.3% of solid waste. ^c			Evaporator bottoms are mixed with a solidification agent in 55-gal drums and then stored to await offsite shipment.	13,160.4 19,687.15 35,880 119.0 4,882d
Resins are periodically dewatered by centrifugation. The solids are dropped into a hopper and from there into drums. Drums are capped and moved to storage on a conveyor.	0 Included under "Filter Sludges." Spent resins account for about 10% of waste.	0 0	0 0	Evaporator bottoms are stored about 30 days to allow for decay, then filtered, analyzed, and if suitable, discharged to the circulating water. ⁱ	0 0 0 0 0
Stored in two 3,000-gal phase-	0	0	0	No evaporator. All wastes re-	0 0 0 0 0

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shipment. A maximum of 40,000 Ci of solid waste is permitted onsite. The concrete storage vault has a volume of 1,200 ft³.

Bismarck Hwy [165 MW(t)]	1963	565,344	Spent resins ^a and evaporator bottoms ^d are accumulated for as many as 9 years or more before packaging for offsite shipment. Spent filters are stored in 55-gal drums, and dry wastes are stored in fiberboard boxes to await offsite shipment. The storage building has 2,000 ft ³ and the concrete vault has a 1,200 ft ³ capacity. 50,000 Ci is the maximum amount of activity allowed to be stored onsite.	Stored in a 10,000-gal (1,300 ft ³) storage tank. Accumulation rate is estimated at 50 ft ³ /yr. When tank gets full, resins are to be packaged for off-site shipment.	G	0	0	About 8,000 gal of evaporator slurry is stored onsite. This is an accumulation from 9 years of operation and its disposal is currently under study. ^d
	1964	1,222,440						
	1965	891,922						
	1966	585,006						
	1967	1,126,634						
	1968	1,507,600						
	1969	1,278,499						
[210 MW(t)] [240 MW(t)]	1970	1,398,874	The storage building has 2,000 ft ³ and the concrete vault has a 1,200 ft ³ capacity. 50,000 Ci is the maximum amount of activity allowed to be stored onsite.		G	0	0	
	1971	1,140,734						
	1972	1,250,385						
LaCrosse [165 MW(t)]	1967	420	All solid wastes are packaged in 55-gal drums for offsite shipment. The waste disposal processing unit is behind concrete walls to reduce background radiation levels.	Spent resins ^f can be sluiced to a 1,000-gal storage tank to decay or can be transferred directly to the drumming station for packaging in concrete-lined drums (30-gal drum inside a 55-gal drum with concrete in the annulus) followed by storage in the dry storage pit to await offsite shipment.	0	0	0	Evaporator bottoms are enclosed directly in 55-gal drums and mixed with cement and absorbent to form a solid mass. When this is not feasible, the residue is stored in a concentrated waste storage tank from which the slurry can be pumped into 55-gal drums and mixed with cement for off-site shipment.
	1968	21,852						
	1969	245,784						
	1970	447,816						
	1971	707,256						
Oyster Creek [1600 MW(t)] [1830 MW(t)] [1930 MW(t)]	1969	1,195,344	All solids are drummed in 55-gal drums and temporarily stored to await offsite shipment.	Sluiced to 3,000-gal storage tank. Eventually the slurry is dewatered by centrifugation, the dried resins being discharged by gravity into a hopper below to be fed into 55-gal drums for offsite shipment.	0	0	0	Evaporator bottoms are mixed with absorbent (Micacel) in 55-gal drums for off-site shipment. ^h
	1970	10,603,148						
	1971	11,679,781						
	1972	12,981,053						
Nine Mile Point [1538 MW(t)] [1850 MW(t)]	1969	294,998	All solids are drummed in 55-gal drums and temporarily stored to await offsite shipment. ^h	Stored in spent resin storage tank until dewatered by centrifugation. Dried resin is dropped into a hopper and from there loaded into 55-gal drums for offsite shipment. ^h	0	0	0	Evaporator bottoms are mixed with absorbent and drummed in 55-gal drums to await offsite shipment. ^h
	1970	5,940,025						
	1971	9,937,980						
	1972	10,010,626						
Dresden 2 & 3 [2527 MW(t)] ea.	1970	4,111,690	All solids are barreled in 55-gal drums for offsite shipment.	Spent resins are dewatered by centrifugation, then fed by hopper into 55-gal drums containing solidifying agent. Next, drums are moved to storage by conveyor to await offsite shipment.	Included under "Evaporator Bottoms." Spent resins account for about 9.3% of solid waste. ^c			Evaporator bottoms are mixed with a solidification agent in 55-gal drums and then stored to await offsite shipment.
	1971	12,324,787						
	1972	25,193,067						
Millstone Point 1 [2011 MW(t)]	1970	287,709	Solids are packaged in 55-gal drums and stored in shielded facilities to await offsite shipment.	Resins are periodically dewatered by centrifugation. The solids are dropped into a hopper and from there into drums. Drums are capped and moved to storage on a conveyor.	0	0	0	Evaporator bottoms are stored about 30 days to allow for decay, then filters analyzed, and if suitable, discharged to the circulating water. ⁱ
	1971	11,112,012						
	1972	9,687,612						
Monticello [1670 MW(t)]	1970	(low power tests)	All solid wastes are cemented into 55-gal drums except for dry compressible wastes which are compacted. Drums are shipped in concrete and steel casks.	Stored in two 3,000-gal phase-separator tanks until transferred to a centrifuge for dewatering prior to mixing with concrete and packaging in 55-gal drums for off-site shipment.	0	0	0	No evaporator. All wastes are cycled through Powderx and Solka-Floc filter demineralizers. Some chemical and laundry wastes are used to make cement for sludge packaging.
	1971	4,300,000						
	1972	11,000,000						
Quad-Cities 1 & 2 [2511 MW(t)] ea.	1971	988 ^j	Package dewatered spent resins, filter sludges and evaporator bottoms by mixing with cement in 55-gal drums. Bale dry wastes.	Dewatered by centrifugation, mixed with concrete in 55-gal drums and stored to await off-site shipment. All operations by remote control.	Included under "Filter Sludges."			No evaporator. Uses Powderx filter-demineralizer system with no resin regeneration.
	1972	12,521,525						
Vermont Yankee [1593 MW(t)]	1972	1,479,512	Reusable concrete shipping casks are used to transport dewatered spent resins and filter sludges in disposable steel liners. The casks can also be used to carry other drummed wastes.	Exhausted Powderx resins are slurried to a centrifuge to be dewatered and then dropped into a disposable shipping cask liner directly underneath.	4,458	18,074	Not reported	No evaporator. High-level chemical wastes may be mixed with an absorbent in 55-gal drums and shipped as solids.
Pilgrim I [1998 MW(t)]	1972	2,654,184	Reusable concrete shipping casks are used to transport dewatered resins and sludges in disposable steel liners. Other dry solids are compacted into 55-gal drums for offsite shipment.	Dewater resins by slurrying to disposable shipping cask liner, and then pumping off the water prior to offsite shipment. ^k	14.7	<0.15	2d	Evaporator bottoms can be stored up to 1 yr prior to discharge or solidification and offsite shipment. ^k

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0300	0	0	0	About 8,000 gal of evaporator slurry is stored onsite.	0	0	0
0400	0	0	0	This is an accumulation from 9 years of operation and its disposal is currently under study. ^d	0	0	0
0500	0	0	0		0	0	0
0600	0	0	0		0	0	0
0700	0	0	0		0	0	0
0800	0	0	0		0	0	0
0900	0	0	0		0	0	0
1000	0	0	0		0	0	0
1100	0	0	0		0	0	0
1200	0	0	0		0	0	0
1300	0	0	0		0	0	0
1400	0	0	0		0	0	0
1500	0	0	0		0	0	0
1600	0	0	0		0	0	0
1700	0	0	0		0	0	0
1800	0	0	0		0	0	0
1900	0	0	0		0	0	0
2000	0	0	0		0	0	0
2100	0	0	0		0	0	0
2200	0	0	0		0	0	0
2300	0	0	0		0	0	0
2400	0	0	0		0	0	0
2500	0	0	0		0	0	0
2600	0	0	0		0	0	0
2700	0	0	0		0	0	0
2800	0	0	0		0	0	0
2900	0	0	0		0	0	0
3000	0	0	0		0	0	0
3100	0	0	0		0	0	0
3200	0	0	0		0	0	0
3300	0	0	0		0	0	0
3400	0	0	0		0	0	0
3500	0	0	0		0	0	0
3600	0	0	0		0	0	0
3700	0	0	0		0	0	0
3800	0	0	0		0	0	0
3900	0	0	0		0	0	0
4000	0	0	0		0	0	0
4100	0	0	0		0	0	0
4200	0	0	0		0	0	0
4300	0	0	0		0	0	0
4400	0	0	0		0	0	0
4500	0	0	0		0	0	0
4600	0	0	0		0	0	0
4700	0	0	0		0	0	0
4800	0	0	0		0	0	0
4900	0	0	0		0	0	0
5000	0	0	0		0	0	0
5100	0	0	0		0	0	0
5200	0	0	0		0	0	0
5300	0	0	0		0	0	0
5400	0	0	0		0	0	0
5500	0	0	0		0	0	0
5600	0	0	0		0	0	0
5700	0	0	0		0	0	0
5800	0	0	0		0	0	0
5900	0	0	0		0	0	0
6000	0	0	0		0	0	0
6100	0	0	0		0	0	0
6200	0	0	0		0	0	0
6300	0	0	0		0	0	0
6400	0	0	0		0	0	0
6500	0	0	0		0	0	0
6600	0	0	0		0	0	0
6700	0	0	0		0	0	0
6800	0	0	0		0	0	0
6900	0	0	0		0	0	0
7000	0	0	0		0	0	0
7100	0	0	0		0	0	0
7200	0	0	0		0	0	0
7300	0	0	0		0	0	0
7400	0	0	0		0	0	0
7500	0	0	0		0	0	0
7600	0	0	0		0	0	0
7700	0	0	0		0	0	0
7800	0	0	0		0	0	0
7900	0	0	0		0	0	0
8000	0	0	0		0	0	0
8100	0	0	0		0	0	0
8200	0	0	0		0	0	0
8300	0	0	0		0	0	0
8400	0	0	0		0	0	0
8500	0	0	0		0	0	0
8600	0	0	0		0	0	0
8700	0	0	0		0	0	0
8800	0	0	0		0	0	0
8900	0	0	0		0	0	0
9000	0	0	0		0	0	0
9100	0	0	0		0	0	0
9200	0	0	0		0	0	0
9300	0	0	0		0	0	0
9400	0	0	0		0	0	0
9500	0	0	0		0	0	0
9600	0	0	0		0	0	0
9700	0	0	0		0	0	0
9800	0	0	0		0	0	0
9900	0	0	0		0	0	0
10000	0	0	0		0	0	0
10100	0	0	0		0	0	0
10200	0	0	0		0	0	0
10300	0	0	0		0	0	0
10400	0	0	0		0	0	0
10500	0	0	0		0	0	0
10600	0	0	0		0	0	0
10700	0	0	0		0	0	0
10800	0	0	0		0	0	0
10900	0	0	0		0	0	0
11000	0	0	0		0	0	0
11100	0	0	0		0	0	0
11200	0	0	0		0	0	0
11300	0	0	0		0	0	0
11400	0	0	0		0	0	0
11500	0	0	0		0	0	0
11600	0	0	0		0	0	0
11700	0	0	0		0	0	0
11800	0	0	0		0	0	0
11900	0	0	0		0	0	0
12000	0	0	0		0	0	0
12100	0	0	0		0	0	0
12200	0	0	0		0	0	0
12300	0	0	0		0	0	0
12400	0	0	0		0	0	0
12500	0	0	0		0	0	0
12600	0	0	0		0	0	0
12700	0	0	0		0	0	0
12800	0	0	0		0	0	0
12900	0	0	0		0	0	0
13000	0	0	0		0	0	0
13100	0	0	0		0	0	0
13200	0	0	0		0	0	0
13300	0	0	0		0	0	0
13400	0	0	0		0	0	0
13500	0	0	0		0	0	0
13600	0	0	0		0	0	0
13700	0	0	0		0	0	0
13800	0	0	0		0	0	0
13900	0	0	0		0	0	0
14000	0	0	0		0	0	0
14100	0	0	0		0	0	0
14200	0	0	0		0	0	0
14300	0	0	0		0	0	0
14400	0	0	0		0	0	0
14500	0	0	0		0	0	0
14600	0	0	0		0	0	0
14700	0	0	0		0	0	0
14800	0	0	0		0	0	0
14900	0	0	0		0	0	0
15000	0	0	0		0	0	0
15100	0	0	0		0	0	0
15200	0	0	0		0	0	0
15300	0	0	0		0	0	0
15400	0	0	0		0	0	0
15500	0	0	0		0	0	0
15600	0	0	0		0	0	0
15700	0	0	0		0	0	0
15800	0	0	0		0	0	0
15900	0	0	0		0	0	0
16000	0	0	0		0	0	0
16100	0	0	0		0	0	0
16200	0	0	0		0	0	0
16300	0	0	0		0	0	0
16400	0	0	0		0	0	0
16500	0	0	0		0	0	0
16600	0	0	0		0	0	0
16700	0	0	0		0	0	0
16800	0	0	0		0	0	0
16900	0	0	0		0	0	0
17000	0	0	0		0	0	0
17100	0	0	0		0	0	0
17200	0	0	0		0	0	0
17300	0	0	0		0	0	0
17400	0	0	0		0	0	0
17500	0	0	0		0	0	0
17600	0	0	0		0	0	0
17700	0	0	0		0	0	0
17800	0	0	0		0	0	0
17900	0	0	0		0	0	0
18000	0	0	0		0	0	0
18100	0	0	0		0	0	0
18200	0	0	0		0	0	0
18300	0	0	0		0	0	0
18400	0	0	0		0	0	0
18500	0	0	0		0	0	0
18600	0	0	0		0	0	0
18700	0	0	0		0	0	0
18800	0	0	0		0	0	0
18900	0	0	0		0	0	0
19000	0	0	0		0	0	0
19100	0	0	0		0	0	0
19200	0	0	0		0	0	0
19300	0	0	0		0	0	0
19400	0	0	0		0	0	0
19500	0	0	0		0	0	0
19600	0	0	0		0	0	0
19700	0	0	0		0	0	0
19800	0	0	0		0	0	0
19900	0	0	0		0	0	0
20000	0	0	0		0	0	0
20100	0	0	0		0	0	0
20200	0	0	0		0	0	0
20300	0	0	0		0	0	0
20400	0	0	0		0	0	0
20500	0	0	0		0	0	0
20600	0	0	0		0	0	0
20700	0	0	0		0	0	0
20800	0	0	0		0	0	0
20900	0	0	0		0	0	0
21000	0	0	0		0	0	0
21100	0	0	0		0	0	0
21200	0	0	0		0	0	0
21300	0	0	0		0	0	0
21400	0	0	0		0	0	0
21500	0	0	0		0	0	0
21600	0	0	0		0	0	0
21700	0	0	0		0	0	0
21800	0	0	0		0	0	0
21900	0	0	0		0	0	0
22000	0	0	0		0	0	0
22100	0	0	0		0	0	0
22200	0	0	0		0	0	0
22300	0	0	0		0	0	0
22400	0	0	0		0	0	0
22500	0	0	0		0	0	0
22600	0	0	0		0	0	0
22700	0	0	0		0	0	0
22800	0	0	0		0	0	0
22900	0	0	0		0	0	0
23000	0	0	0		0	0	0
23100	0	0	0		0	0	0
23200	0	0	0		0	0	0
23300	0	0					

Table A-1b. Summary of Solid Radioactive Waste Treatment at Boiling Water Reactors (BWRs) in Operation: Filters, Filter Sludges and Unspecified High-Level Wastes, and Dry Wastes (Compressible)

NSSS: Reactor [Capacity]	Year	Types of Solid, Volume, Activity, and Number of Drums or Casks Shipped						
		(3) Filters, Filter Sludges, and Unspecified High-Level Wastes			(4) Dry Wastes (Compressible)			
		Treatment	ft ³	Ci	No. of Drums = d Casks = c	Treatment	ft ³	Ci
General Electric:								
Dresden 1 [630 MW(t)] [700 MW(t)]	1959	Sludges are collected by backwashing	0	0	0	A baler is used to compact soft solid	0	0
	1960	the precoat filters into a sludge storage	0	0	0	wastes such as rags, paper, clothing,	847	<0.1
	1961	tank. They are then dewatered by	0	0	0	etc. After packaging, the drums are	3,320	1.143
	1962	centrifugation and then plowed out	0	0	0	stored onsite to await offsite ship-	3,366	1.587
		of the centrifuge bowl and dropped				ment.		
	1963	into the concentrated waste storage	0	0	0	Most of the waste shipped is of this	5,702	<1.073
	1964	tank. ^a	0	0	0	type. ^c	1,919	0.443
	1965		0	0	0		3,329	0.578
	1966		0	0	0		2,012	0.582
	1967		0	0	0		8,204	1.346
	1968		0	0	0		7,747	1.848
	1969		0	0	0		2,733	1.563
	1970		0	0	0		9,622.5	2.560
	1971		0	0	0		15,311.6	1.560
	1972	No shipments to date. ^c	0	0	0		20,800	4.156
Big Rock Point [240 MW(t)]	1962	Filter cartridges are stored in drums in	0	0	0	Dry compressible wastes are	0	0
	1963	the concrete vault or dry shelter for	0	0	0	baled and stored to await offsite	0	0
	1964	decay, pending offsite shipment.	0	0	0	shipment.	0	0
	1965		0	0	0		794	0.22
	1966		0	0	0		0	0
	1967		162.3	~50.15	Not reported		Not reported	<0.008
	1968		322.	18.72	Not reported		1,124	>0.4
	1969		220.	61.1	Not reported		632.1	0.257
	1970		>7.35	112.6	1d;		0	0
					Not reported			
	1971		0	0	0		845.25	0.3
	1972		>110	11.75	Not reported		779.1	0.217
Humboldt Bay [165 MW(t)] [210 MW(t)] [240 MW(t)]	1963	Spent filter cartridges are stored in a	0	0	0	Stored in ICC-approved fiberboard	0	0
	1964	shielded 55-gal drum. When full, the	0	0	0	boxes in either the waste storage	649 ^a	0.88 ^b
	1965	drum is transferred to the concrete	195	0.68 ^m	27d	building or the concrete vault to	1,575	0.35 ^m
	1966	storage vault to await offsite ship-	0	0	0	await packaging and offsite ship-	0	0
	1967	ment.	37	<1.42 ^m	5d	ment. No baling or compaction	1,310	<1.42 ^m
	1968		0	0	0	is used.	Not reported	>0.1 ^f
	1969		0	0	0		0	0
	1970		110.25	5.31 ^a	15d		1,310.5	<0.015 ^f
	1971		0	0	0		2,376.75	3.72 ^o
LaCrosse [165 MW(t)]	1972		110.25	3.38 ^p	15d		1,296.0	<0.1 ^q
	1967	Filter cartridges are packaged in con-	0	0	0	Dry wastes are collected and com-	0	0
	1968	crete-lined drums and stored in the	0	0	0	pressed into 55-gal drums which are	550	<0.2
	1969	dry storage pit to allow for decay	0	0	0	then stored in the dry storage pit to	412	0.330
	1970	prior to offsite shipment.	0	0	0	await offsite shipment.	668.85	2.89 ^r
	1971		0	0	0		0	0
Oyster Creek [1600 MW(t)] [1830 MW(t)] [1930 MW(t)]	1972		0	0	0		780	Not reported
	1969	Solka-Floc filter sludges are back-	0	0	0	Miscellaneous dry solid wastes from	0	0
	1970	washed into a 9,000-gal sludge storage	0	0	0	operation and maintenance activities	Included in "Evaporator B"	
	1971	tank. Sludge treatment is the same as	0	0	0	are compressed into 55-gal drums and	561	>0.326
		for dewatered resins.				stored to await offsite shipment.		
Nine Mile Point [1538 MW(t)] [1850 MW(t)]	1972		0	0	0		Included in "Evaporator B"	
	1969	Stored in sludge storage tank until	0	0	0	Compacted into 55-gal drums for	0	0
	1970	dewatered by centrifugation, dropped	Included under "Evaporator Bottoms."			off-site burial. Designed compaction	Included under "Evaporator"	
	1971	by gravity into a hopper, and from	Sludges account for approximately 1/3			ratio = 5/1.	Estimate 1/2 to 1 drum of	
	1972	there into 55-gal drums for offsite	of the solid waste.				per day.	
Dresden 2 & 3 [2527 MW(t)] ea.		shipment. ^{h,s}						
	1970	Filter cartridges and sludges are	Included under "Evaporator Bottoms."			Collected in fiber boxes or drums	Included under "Evaporator"	
	1971	packed in 55-gal drums or concrete	Sludges account for 23% of solid waste. ^c			and stored until compacted into 55-		
Millstone Point 1 [2011 MW(t)]	1972	tubs with absorbent for offsite ship-				gal drums with an hydraulic baler.		
		ment. ^c				Ventilation is provided to control		
						particulates.		
Monticello [1670 MW(t)]	1970	Filter sludges are stored and periodi-	0	0	0	Compressible solids are compacted	0	0
	1971	cally sent to a centrifuge for dewater-	7,349.3	95.47	1,001d	into 55-gal drums with an hydraulic	Included in "Filter Sludges"	
	1972	ing. The dry sludges are dropped into	6,774.3	432.59	925d	baler. Ventilation is provided to	1,447.6	0.229
Quad-Cities 1 & 2 [2611 MW(t)]		a hopper and then into 55-gal drums	Sludges account for about 65% of the			prevent particulate dispersion.	Compacted wastes account	
		pending offsite shipment.	solid waste.				solid waste.	
Monticello [1670 MW(t)]	1970	Solka-Floc and diatomaceous earth	0	0	0	Collected in containers and trans-	0	0
	1971	filter sludges are stored in a 7,500-	10,903.95	17.612	1,484d	ferred to the radwaste building for	Included under "Filter Slu"	
	1972	gal sludge storage tank. They are de-	6,277.7	88.227	854d	compaction into 55-gal drums.	Compacted wastes complete	
Quad-Cities 1 & 2 [2611 MW(t)]		watered by centrifugation and the				Drums are stored to await offsite		
		moist solids are mixed with cement				shipment.		
Quad-Cities 1 & 2 [2611 MW(t)]		and packaged in 55-gal drums for off-						
		site shipment.						
Quad-Cities 1 & 2 [2611 MW(t)]	1971	Sludges dewatered by centrifugation,	2,109.5	0.0274	287d	Compressed into cakes.	Included under "Filter Slu"	
	1972	and packaged in 55-gal drums for off-	2,210.0	0.0000	287d			

Radiative Waste Treatment at Boiling Water Reactors (BWRs) in Operation: Filters, Filter Sludges and Unspecified High-Level Wastes, and Dry Wastes (Compressible)

Types of Solid, Volume, Activity, and Number of Drums or Casks Shipped						
and Unspecified High-Level Wastes			(4) Dry Wastes (Compressible)			
ft ³	Ci	No. of Drums = d Casks = c	Treatment	ft ³	Ci	No. of Drums = d Casks = c
0	0	0	A baler is used to compact soft solid wastes such as rags, paper, clothing, etc. After packaging, the drums are stored onsite to await offsite shipment.	0	0	0
0	0	0		847	<0.1	Not reported
0	0	0		3,320	1.143	Not reported
0	0	0		3,360	1.587	Not reported
0	0	0		5,702	<1.073	Not reported
0	0	0		1,919	0.443	Not reported
0	0	0		3,329	0.578	Not reported
0	0	0		2,012	0.582	Not reported
0	0	0		8,204	1.346	Not reported
0	0	0		7,747	1.840	Not reported
0	0	0		2,733	1.563	Not reported
0	0	0		9,622.5	2.560	Not reported
0	0	0		15,311.6	1.560	Not reported
0	0	0		20,800	4.156	Not reported
0	0	0	Dry compressible wastes are baled and stored to await offsite shipment.	0	0	0
0	0	0		0	0	0
0	0	0		0	0	0
0	0	0		794	0.22	Not reported
0	0	0		0	0	0
162.3	~50.15	Not reported		Not reported	<0.00025	1 bag
322.	12.72	Not reported		1,124	>0.4	153d
220.	61.1	Not reported		632.1	0.257	86d
>7.35	112.6	1d;		0	0	0
0	0	Not reported		845.25	0.3	115d
>110	11.75	Not reported		779.1	0.217	106d
0	0	0	Stored in ICC-approved fiberboard boxes in either the waste storage building or the concrete vault to await packaging and offsite shipment. No baling or compaction is used.	0	0	0
0	0	0		649 ^a	0.88 ^l	144 boxes
195	0.68 ^m	27d		1,575	0.35 ^m	350 boxes
0	0	0		0	0	0
37	<1.42 ^m	5d		1,310	<1.42 ^m	291 boxes
0	0	0		Not reported	1.911 ^m	Not reported
0	0	0		0	0	0
110.25	5.31 ⁿ	15d		1,310.5	<0.015 ^o	275 boxes; 10d
0	0	0		2,376.75	3.72 ^o	520 boxes; 5d
110.25	3.38 ^p	15d		1,296.0	<0.1 ^q	288 boxes
0	0	0	Dry wastes are collected and compressed into 55-gal drums which are then stored in the dry storage pit to await offsite shipment.	0	0	0
0	0	0		550	<0.2	75d
0	0	0		412	0.330	56d
0	0	0		668.85	2.89 ^r	91d
0	0	0		0	0	0
0	0	0		780	Not reported	106d
0	0	0		0	0	0
0	0	0		Included in "Evaporator Bottoms."		
0	0	0		561	>0.326	15 boxes; 67d
0	0	0		Included in "Evaporator Bottoms."		
0	0	0	Compacted into 55-gal drums for off-site burial. Designed compaction ratio = 5/1.	0	0	0
Included under "Evaporator Bottoms." Sludges account for approximately 1/2 of the solid waste.				Included under "Evaporator Bottoms." Estimate 1/2 to 1 drum of compacted waste per day.		
0	0	0		0	0	0
7,349.3	95.47	1,001d		Included in "Filter Sludges"		
6,774.3	432.59	925d		2,447.6	0.229	18 boxes
Sludges account for about 65% of the solid waste.				Compacted wastes account for nearly 30% of solid waste.		
0	0	0		0	0	0
10,903.95	17.612	1,484d		Included under "Filter Sludges."		
6,277.7	88.227	854d		Compacted wastes comprise ~10% of solid waste.		
2,109.5	0.0274	287d		Included under "Filter Sludges."		
37,948.8	9.235	5,163d		Volume is estimated at 10,000 ft ³ of dry com-		

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			0	0	0	type.	1,919	0.443
	1965		0	0	0		3,329	0.578
	1966		0	0	0		2,012	0.582
	1967		0	0	0		8,204	1.3
	1968		0	0	0		7,747	
	1969		0	0	0		2,733	
	1970		0	0	0		9,622.5	
	1971		0	0	0		15,311.6	
	1972	No shipments to date. ^c	0	0	0		20,800	
Big Rock Point [240 MW(t)]	1962	Filter cartridges are stored in drums in the concrete vault or dry shelter for decay, pending offsite shipment.	0	0	0	Dry compressible wastes are baled and stored to await offsite shipment.	0	
	1963		0	0	0		0	
	1964		0	0	0		0	
	1965		0	0	0		794	
	1966		0	0	0		0	
	1967		162.3	~50.15	Not reported		Not reported	
	1968		322.	18.72	Not reported		1,124	
	1969		220.	61.1	Not reported		632.1	
	1970		>7.35	112.5	1d; Not reported		0	
	1971		0	0	0		845.25	
	1972		>110	11.75	Not reported		779.1	
Humboldt Bay [165 MW(t)]	1963	Spent filter cartridges are stored in a shielded 55-gal drum. When full, the drum is transferred to the concrete storage vault to await offsite shipment.	0	0	0	Stored in ICC-approved fiberboard boxes in either the waste storage building or the concrete vault to await packaging and offsite shipment. No baling or compaction is used.	0	
	1964		0	0	0		649 ^a	
	1965		195	0.68 ^m	27d		1,575	
	1966		0	0	0		0	
	1967		37	<1.42 ^m	5d		1,310	
[210 MW(t)]	1968		0	0	0		Not reported	
[240 MW(t)]	1969		0	0	0		0	
	1970		110.25	5.31 ⁿ	15d		1,310.5	
	1971		0	0	0		2,376.75	
	1972		110.25	3.38 ^p	15d		1,296.0	
LaCrosse [165 MW(t)]	1967	Filter cartridges are packaged in concrete-lined drums and stored in the dry storage pit to allow for decay prior to offsite shipment.	0	0	0	Dry wastes are collected and compressed into 55-gal drums which are then stored in the dry storage pit to await offsite shipment.	0	
	1968		0	0	0		550	
	1969		0	0	0		412	
	1970		0	0	0		668.85	
	1971		0	0	0		0	
	1972		0	0	0		780	No
Oyster Creek [1600 MW(t)] [1830 MW(t)]	1969	Solka-Floc filter sludges are back-washed into a 9,000-gal sludge storage tank. Sludge treatment is the same as for dewatered resins.	0	0	0	Miscellaneous dry solid wastes from operation and maintenance activities are compressed into 55-gal drums and stored to await offsite shipment.	0	
	1970		0	0	0		Included in "Evaporator Bottoms."	
	1971		0	0	0		561	>
[1930 MW(t)]	1972		0	0	0		Included in "Evaporator Bottoms."	
Nine Mile Point [1538 MW(t)] [1850 MW(t)]	1969	Stored in sludge storage tank until dewatered by centrifugation, dropped by gravity into a hopper, and from there into 55-gal drums for offsite shipment. ^{h,s}	0	0	0	Compacted into 55-gal drums for off-site burial. Designed compaction ratio = 5/1.	0	
	1970		Included under "Evaporator Bottoms." Sludges account for approximately 1/3 of the solid waste.				Included under "Evaporator Bottoms." Estimate 1/2 to 1 drum per day.	
	1971							
	1972							
Dresden 2 & 3 [2527 MW(t)] ea.	1970	Filter cartridges and sludges are packed in 55-gal drums or concrete tubs with absorbent for offsite shipment. ^c	Included under "Evaporator Bottoms." Sludges account for 23% of solid waste. ^c			Collected in fiber boxes or drums and stored until compacted into 55-gal drums with an hydraulic baler. Ventilation is provided to control particulates.	Included under "Evaporator Bottoms."	
	1971							
	1972							
Millstone Point 1 [2011 MW(t)]	1970	Filter sludges are stored and periodically sent to a centrifuge for dewatering. The dry sludges are dropped into a hopper and then into 55-gal drums pending offsite shipment.	0	0	0	Compressible solids are compacted into 55-gal drums with an hydraulic baler. Ventilation is provided to prevent particulate dispersion.	0	
	1971		7,349.3	95.47	1,001d		Included in "Filter Sludges."	
	1972		6,774.3	432.59	925d		2,447.6	
			Sludges account for about 65% of the solid waste.				Compacted wastes account for 35% of solid waste.	
Monticello [1670 MW(t)]	1970	Solka-Floc and diatomaceous earth filter sludges are stored in a 7,500-gal sludge storage tank. They are dewatered by centrifugation and the moist solids are mixed with cement and packaged in 55-gal drums for off-site shipment.	0	0	0	Collected in containers and transferred to the radwaste building for compaction into 55-gal drums. Drums are stored to await offsite shipment.	0	
	1971		10,903.95	17.612	1,484d		Included under "Filter Sludges."	
	1972		6,277.7	88.227	854d		Compacted wastes account for 35% of solid waste.	
Quad-Cities 1 & 2 [2511 MW(t)] ea.	1971	Sludges dewatered by centrifugation, mixed with cement in 55-gal drums and stored to await offsite shipment. All operations are by remote control.	2,109.5	0.0274	287d	Compressed into cakes.	Included under "Filter Sludges." Volume is estimated as compacted waste per year.	
	1972		37,948.8	9.235	5,163d			
Vermont Yankee [1593 MW(t)]	1972	Filter sludges are dewatered by centrifugation and the solids fed by gravity through a hopper and into a disposable steel cask liner. ^f	Included under "Spent Demineralizer Resins."			Compacted into 55-gal drums for off-site shipment.	Included under "Spent Demineralizer Resins."	
Pilgrim-1 [1998 MW(t)]	1972	Sludges are dewatered by air drying on a conveyor belt which deposits the diatomaceous earth powder into 216 ft ³ shipping cask liners for off-site shipment. ^k	1,944	<19.4	9c (216 ft ³ ea.)	Compacted into 55-gal drums for off-site shipment.	426.1	Not reported
			Sludges account for nearly 50% of the solid waste.				Compacted wastes account for 50% of total solid waste.	

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	0	0	0	3,329	0.578	Not reported
	0	0	0	2,012	0.582	Not reported
	0	0	0	8,204	1.346	Not reported
	0	0	0	7,747	1.840	Not reported
	0	0	0	2,733	1.563	Not reported
	0	0	0	9,622.5	2.560	Not reported
	0	0	0	15,311.6	1.560	Not reported
	0	0	0	20,800	4.156	Not reported
in drums in water for month.	0	0	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	0
	0	0	0	794	0.22	Not reported
	0	0	0	0	0	0
162.3	~50.15	Not reported	Not reported	Not reported	<0.00025	1 bag
322.	18.72	Not reported	Not reported	1,124	>0.4	153d
220.	61.1	Not reported	Not reported	632.1	0.257	86d
>7.35	112.6	1d;	Not reported	0	0	0
	0	0	0	845.25	0.3	115d
>110	11.75	Not reported	Not reported	779.1	0.217	106d
boxed in a a full, the concrete to ship-	0	0	0	0	0	0
	0	0	0	649 ^a	0.88 ⁱ	144 boxes
195	0.68 ^m	27d	Stored in ICC-approved fiberboard boxes in either the waste storage building or the concrete vault to await packaging and offsite ship- ment. No baling or compaction is used.	1,575	0.35 ^m	350 boxes
0	0	0		0	0	0
37	<1.42 ^m	5d		1,310	<1.42 ^m	291 boxes
0	0	0		Not reported	1.911 ^m	Not reported
0	0	0		0	0	0
110.25	5.31 ⁿ	15d		1,310.5	<0.015 ^o	275 boxes; 10d
0	0	0		2,376.75	3.72 ^o	520 boxes; 5d
110.25	3.38 ^p	15d		1,296.0	<0.1 ^q	288 boxes
all in con- d in the decay	0	0	0	0	0	0
	0	0	0	550	<0.2	75d
	0	0	0	412	0.330	56d
	0	0	0	668.85	2.89 ^r	91d
	0	0	0	0	0	0
	0	0	0	780	Not reported	106d
back- age storage be same as	0	0	0	0	0	0
	0	0	0	Included in "Evaporator Bottoms."		
	0	0	0	561	>0.326	15 boxes; 67d
	0	0	0	Included in "Evaporator Bottoms."		
nk until n, dropped nd from offsite	0	0	0	0	0	0
	Included under "Evaporator Bottoms."		Compacted into 55-gal drums for off-site burial. Designed compac- tion ratio = 5/1.	Included under "Evaporator Bottoms."		
	Sludges account for approximately 1/3 of the solid waste.			Estimate 1/2 to 1 drum of compacted waste per day.		
s are concrete ite ship-	Included under "Evaporator Bottoms."		Collected in fiber boxes or drums and stored until compacted into 55- gal drums with an hydraulic baler. Ventilation is provided to control particulates.	Included under "Evaporator Bottoms."		
	Sludges account for 23% of solid waste. ^c					
l periodi- r dewater- pped into al drums	0	0	0	0	0	0
	7,349.3	95.47	1,001d	Included in "Filter Sludges"		
	6,774.7	432.59	925d	2,447.6	0.229	18 boxes
	Sludges account for about 65% of the solid waste.		Compressible solids are compacted into 55-gal drums with an hydraulic baler. Ventilation is provided to prevent particulate dispersion.	Compacted wastes account for nearly 30% of solid waste.		
as earth 7,500- y are de- ind the cement s for off-	0	0	0	0	0	0
	10,903.95	17.612	1,484d	Included under "Filter Sludges."		
	6,277.7	88.227	854d	Compacted wastes comprise ~10% of solid waste.		
ifugation, l drums shipment. p control.	2,109.5	0.0274	287d	Included under "Filter Sludges."		
	31,948.8	9.235	5,163d	Volume is estimated at 10,000 ft ³ of dry com- pacted waste per year.		
by centri- by gravity dis-	Included under "Spent Demineralizer Resins."		Compacted into 55-gal drums for off- site shipment.	Included under "Spent Demineralizer Resins."		
r drying points der into for off-	1,944	<19.4	9c (216 ft ³ ea.)	426.1	Not reported	58d
	Sludges account for nearly 50% of the solid waste.		Compacted into 55-gal drums for off- site shipment.	Compacted wastes account for nearly 50% of total solid waste.		

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Table A-1c. Summary of Solid Radioactive Waste Treatment at Boiling Water Reactors (BWRs) in Operation: Dry Wastes (Noncompressible) and Core Components and Structures

NRCSS: Reactor [Capacity]	Year	Types of Solid, Volume, Activity, and Number of Drums or Casks Shipped							
		(5) Dry Wastes (Noncompressible)				(6) Core Components and Spent Fuel			
		Treatment	ft ³	Ci	No. of Drums = d Casks = c	Treatment	ft ³		
General Electric:									
Dresden 1 [630 MW(t)]	1959	Small items are packaged in 55-gal drums which are sealed and stored on-site while awaiting offsite shipment.	0	0	0	Shipped in steel and concrete shipping casks for offsite shipment.	0		
	1960		300 ^a	<0.1	Not reported		0		
	1961		Included under "Dry Compressible Wastes."				1,916.8		
	1962						500 ^a		
	1963						0		
	1964						0		
	1965						195 ^a		
	1966						0		
	1967						0		
	1968						0		
	1969						0		
	1970						0		
	1971				0				
	1972				0				
			60	207	1c(?) ^b	0			
			689	280	Not reported ^c	0			
			Included under "Dry Compressible Wastes."			0			
						0			
						0			
Big Rock Point [240 MW(t)]	1962	Store either in the underground concrete vault or in the dry shelter while awaiting permanent offsite shipment.	None reported.			Storage and packaging procedure is not described.	0		
	1963						0		
	1964						0		
	1965						0		
	1966		22.05	<1.0	3d		0		
	1967		~330 ^a	<2.0	Not reported		116		
	1968		Assume reported under "Filter, Filter Sludges, and Unspecified High-Level Wastes."				58		
	1969						0		
	1970						0		
	1971						Not reported		
	1972						0		
								Not reported	
Humboldt Bay [165 MW(t)]	1963	Stored in the vault or waste storage building to await offsite shipment.	0	0	0	Held for long-term storage in the spent fuel pool prior to packaging for offsite shipment.	0		
	1964						8.7		
	1965						0		
	1966						0		
	1967						0		
	1968						Not reported		
	1969						0		
	1970						0		
	1971						0		
	1972						0		
								0	
LaCrosse [165 MW(t)]	1967		Small items are collected and stored in drums prior to offsite shipment.	0	0		0	None to date. Procedure is not described.	0
	1968					0			
	1969					0			
	1970					0			
	1971					0			
	1972					0			
Oyster Creek [1600 MW(t)] [1830 MW(t)] [1930 MW(t)]	1969	Packaged in 55-gal drums for offsite shipment.	0	0	0	Spent control rods, in-core ion chambers, etc., are allowed to decay in the fuel storage pool. Eventually they will be packaged for offsite shipment.	0		
	1970						0		
	1971						0		
	1972						0		
Nine Mile Point [1538 MW(t)] [1850 MW(t)]	1969	Packaged in 55-gal drums for offsite shipment. Large pieces are handled individually.	0	0	0	Stored for decay in the spent fuel storage pool. At shipment time, they are transferred to a shipping cask lowered into the pool. The loaded cask is raised and decontaminated for offsite shipment.	0		
	1970						0		
	1971						0		
	1972						0		
Dresden 2 & 3 [2527 MW(t)] ea.	1970	Packaged in 55-gal drums for offsite shipment.	Included under "Evaporator Bottoms."			Stored in the spent fuel pool to decay. Large pieces will be handled individually for eventual offsite shipment.	0		
	1971						0		
	1972						0		
Millstone Point 1 [2011 MW(t)]	1970	Collected and stored in suitable containers in an enclosed storage area to await offsite shipment.	0	0	0	Stored in the fuel storage pool to decay before removal for packaging and offsite shipment.	0		
	1971						0		
	1972						0		
Monticello [1670 MW(t)]	1970	Collected and stored in 55-gal drums for offsite shipment. Items too large for drumming are decontaminated and packaged according to circumstance.	0	0	0	Stored in spent fuel storage pool to decay before removal for packaging and offsite shipment.	0		
	1971						0		
	1972						0		
Quad-Cities 1 & 2 [2511 MW(t)] ea.	1971	Combined with the "Dry Compressible Waste" and baled.	Included under "Spent Demineralizer Resins."			None to date.	0		
	1972						0		

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Radioactive Waste Treatment at Boiling Water Reactors (BWRs) in Operation:
(Noncompressible) and Core Components and Structural

Types of Solid, Volume, Activity, and Number of Drums or Casks Shipped

(a) Core Components and Structural				(b) Core Components and Structural			
Types of Solid		Volume, Activity, and Number of Drums or Casks Shipped		Types of Solid		Volume, Activity, and Number of Drums or Casks Shipped	
Ci	No. of Drums = d Casks = c	Treatment	ft ³	Ci	No. of Drums = d Casks = c	Treatment	ft ³
0	0	Shipped in steel and concrete shipping casks for offsite shipment.	0	0	0		
<0.1	Not reported		0	0	0		
Shipped under "Dry Compressible Solids."			1,916.8	51.8 ⁴⁸	Not reported		
			500 ^a	560	1c		
			0	0	0		
			0	0	0		
			195 ^a	40	1c		
			0	0	0		
			0	0	0		
207	1c(?) ^u		0	0	0		
280	Not reported ^v		0	0	0		
Shipped under "Dry Compressible Solids."			0	0	0		
			0	0	0		
			0	0	0		
Not reported.		Storage and packaging procedure is not described.	0	0	0		
			0	0	0		
			0	0	0		
0.05	<1.0	3d	0	0	0		
Not reported	<2.0	Not reported	116	~4600 ^a	Not reported		
Shipped under "Filter, Filter Resins, and Unspecified High-Level Solids."			58	~2900	Not reported		
			0	0	0		
			0	0	0		
			Not reported	16,120	Not reported		
			0	0	0		
			Not reported	16,443	Not reported		
0	0	Held for long-term storage in the spent fuel pool prior to packaging for offsite shipment.	0	0	0		
Shipped under "Dry Compressible Solids."			8.7	926.76 ^w	1c		
			0	0	0		
			0	0	0		
			0	0	0		
			Not reported	56.2 ^x	Not reported		
			0	0	0		
			0	0	0		
			0	0	0		
			0	0	0		
0	0	None to date. Procedure is not described.	0	0	0		
Shipped under "Dry Compressible Solids."			0	0	0		
			0	0	0		
			0	0	0		
			0	0	0		
			0	0	0		
0	0	Spent control rods, in-core ion chambers, etc., are allowed to decay in the fuel storage pool. Eventually they will be packaged for offsite shipment.	0	0	0		
Shipped under "Evaporator Resins."			0	0	0		
			0	0	0		
			0	0	0		
0	0	Stored for decay in the spent fuel storage pool. At shipment time, they are transferred to a shipping cask lowered into the pool. The loaded cask is raised and decontaminated for offsite shipment.	0	0	0		
Shipped under "Evaporator Resins."			0	0	0		
			0	0	0		
			0	0	0		
0	0	Stored in the spent fuel pool to decay. Large pieces will be handled individually for eventual offsite shipment.	0	0	0		
Shipped under "Evaporator Resins."			0	0	0		
			0	0	0		
0	0	Stored in the fuel storage pool to decay before removal for packaging and offsite shipment.	0	0	0		
Shipped in "Filter Sludges."			0	0	0		
			0	0	0		
0	0	Stored in spent fuel storage pool to decay before removal for packaging and offsite shipment.	0	0	0		
Shipped under "Filter Sludges."			0	0	0		
			0	0	0		
0	0	None to date.	0	0	0		
Shipped under "Spent Demineralization Resins."			0	0	0		
			0	0	0		
0	0	None to date.	0	0	0		
Shipped under "Spent Demineralization Resins."			0	0	0		

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1630 MW(t)	1960	Small items are packaged in 55-gal drums which are sealed and stored onsite while awaiting offsite shipment.	0	0	0	Shipped in steel and concrete shipping casks for offsite shipment.	0	
[700 MW(t)]	1961		300 ^a	<0.1	Not reported		1,916.8	6
	1962		Included under "Dry Compressible Wastes."				500 ^a	56
	1963						0	
	1964						0	
	1965						195 ^a	
	1966						0	
	1967						0	
	1968		60	207	1c(?) ^u		0	
	1969		689	280	Not reported ^v		0	
	1970		Included under "Dry Compressible Wastes."				0	
	1971						0	
	1972						0	
Big Rock Point [240 MW(t)]	1962	Store either in the underground concrete vault or in the dry shelter while awaiting permanent offsite shipment.	None reported.			Storage and packaging procedure is not described.	0	
	1963						0	
	1964						0	
	1965		22.05	<1.0	3d		0	
	1966		~330 ^a	<2.0	Not reported		116	-46
	1967		Assume reported under "Filter, Filter Sludges, and Unspecified High-Level Wastes."				58	-29
	1968						0	
	1969						0	
	1970						Not reported	16.1
	1971						0	
	1972						Not reported	16.4
Humboldt Bay [165 MW(t)]	1963	Stored in the vault or waste storage building to await offsite shipment.	0	0	0	Held for long-term storage in the spent fuel pool prior to packaging for offsite shipment.	0	
	1964		Included under "Dry Compressible Wastes."				8.7	9
	1965						0	
	1966						0	
	1967						0	
[210 MW(t)]	1968						Not reported	
[240 MW(t)]	1969						0	
	1970						0	
	1971						0	
	1972						0	
LaCrosse [165 MW(t)]	1967	Small items are collected and stored in drums prior to offsite shipment.	0	0	0	None to date. Procedure is not described.	0	
	1968		Included under "Dry Compressible Wastes."				0	
	1969						0	
	1970						0	
	1971						0	
	1972						0	
Oyster Creek [1600 MW(t)]	1969	Packaged in 55-gal drums for offsite shipment.	0	0	0	Spent control rods, in-core ion chambers, etc., are allowed to decay in the fuel storage pool. Eventually they will be packaged for offsite shipment.	0	
[1830 MW(t)]	1970		Included under "Evaporator Bottoms."				0	
[1950 MW(t)]	1971						0	
	1972						0	
Nine Mile Point [1538 MW(t)]	1969	Packaged in 55-gal drums for offsite shipment. Large pieces are handled individually.	0	0	0	Stored for decay in the spent fuel storage pool. At shipment time, they are transferred to a shipping cask lowered into the pool. The loaded cask is raised and decontaminated for offsite shipment.	0	
[1850 MW(t)]	1970		Included under "Evaporator Bottoms."				0	
	1971						0	
	1972						0	
Dresden 2 & 3 [2527 MW(t)] ea.	1970	Packaged in 55-gal drums for offsite shipment.	Included under "Evaporator Bottoms."			Stored in the spent fuel pool to decay. Large pieces will be handled individually for eventual offsite shipment.	0	
	1971						0	
	1972						0	
Millstone Point 1 [2011 MW(t)]	1970	Collected and stored in suitable containers in an enclosed storage area to await offsite shipment.	0	0	0	Stored in the fuel storage pool to decay before removal for packaging and offsite shipment.	0	
	1971		Included in "Filter Sludges."				0	
	1972						0	
Monticello [1670 MW(t)]	1970	Collected and stored in 55-gal drums for offsite shipment.	0	0	0	Stored in spent fuel storage pool to decay before removal for packaging and offsite shipment.	0	
	1971	Items too large for drumming are decontaminated and packaged according to circumstance.	Included under "Filter Sludges."				0	
	1972						0	
Quad-Cities 1 & 2 [2511 MW(t)] ea.	1971	Combined with the "Dry Compressible Waste" and baled	Included under "Spent Demineralizer Resins."			None to date.	0	
	1972						0	
Vermont Yankee [1593 MW(t)]	1972	Sealed in 55-gal drums for offsite shipment.	Included under "Spent Demineralizer Resins."			None to date.	0	
Pilgrim-1 [1998 MW(t)]	1972	Sealed in 55-gal drums for offsite shipment.	Included under "Dry Compressible Wastes."			None to date.	0	

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Table A-1d. Summary of Solid Radioactive Waste Treatment at Boiling Water Reactors (BWRs) in Operation:
Drum or Cask Decontamination Method, Number and Type of Shipments, and Destination

NSSS: Reactor [Capacity]	Year	Drum or Cask Decontamination Method	Shipments		
			Number	Type ^y	Destination
General Electric:					
Dresden I [630 MW(t)]	1959	No description given.	0		No shipments
	1960		1 (in 2 parts)	(4), (5)	Nuclear Engineering, Inc.
[700 MW(t)]	1961		4	(4)	Nuclear Engineering, Inc.
			3	(6)	Nuclear Engineering, Inc.
	1962		4	(4)	Oak Ridge National Laboratory, Oak Ri
			1	(6)	Oak Ridge National Laboratory, Oak Ri
	1963		2	(4)	Oak Ridge National Laboratory, Oak Ri
	1964		2	(4)	Nuclear Fuel Services, West Valley, N.Y.
	1965		3	(4)	Nuclear Fuel Services, West Valley, N.Y.
			1	(6)	Nuclear Fuel Services, West Valley, N.Y.
	1966		2	(4)	Nuclear Fuel Services, West Valley, N.Y.
	1967		9	(4)	Nuclear Fuel Services, West Valley, N.Y.
			≥2	(1)	California Nuclear, Inc., Sheffield, Ill.
	1968		11	(4)	Nuclear Engineering Co., Sheffield, Ill.
			1	(3)	Atcor, Inc., Hawthorne, N.Y.
	1969		2	(4)	
			1	(5)	Nuclear Engineering Co., Sheffield, Ill.
	1970		3	(4), (5)	Nuclear Engineering Co., Sheffield, Ill.
	1971		15	(4)	Nuclear Engineering Co., Sheffield, Ill.
	1972		22	(4)	Nuclear Engineering Co., Sheffield, Ill.
Big Rock Point [240 MW(t)]	1962	No description given.	0		No shipments.
	1963		0		
	1964		0		
	1965		4	(1)	Allied Crossroads Nuclear Corp.
			1	(1), (5)	
			1	(4)	
	1966		1	(5)	Atcor, Inc., Hawthorne, N.Y.
			2	(6)	
	1967		2	(3)	U.S. Nuclear Corp. (1 shipment)
			1	(4)	Atcor, Inc., Hawthorne, N.Y.
			1	(6)	
	1968		4	(1)	Atcor, Inc., Hawthorne, N.Y. (1 shipment)
			3	(1), (4)	
			1	(4)	Nuclear Engineering Co.
			4	(3)	
	1969		2	(3)	Nuclear Engineering Co.
			1	(4)	Nuclear Engineering Co.
	1970		2	(3)	Nuclear Engineering Co., Morehead, Ky.
			8	(6)	
	1971		1	(4)	
	1972		12	(1)	
			2	(3)	
			3	(4)	
			22	(6)	
Humboldt Bay [165 MW(t)]	1963	No description given.	0		No shipments.
	1964		1	(4), (6)	Nuclear Engineering Co., Cowell, Calif.
	1965		1	(3), (4)	California Nuclear, Inc., Pleasanton, Calif.
	1966		0		No shipments.
	1967		1	(3), (4)	California Nuclear, Inc., Pleasanton, Calif.
	1968		1	(4)	Nuclear Engineering Co., Walnut Creek, Calif.
			1	(4), (6)	
	1969		0		No shipments.
	1970		1	(3)	Nuclear Engineering Co., Beatty, Nev.
			1	(4)	Nuclear Engineering Co., Richland, Wash.
[210 MW(t)]	1971		2	(4)	
	1972		1	(2), (4)	
			1	(3)	
			1	(4)	
[240 MW(t)]	1967	Drums are filled inside a concrete box which contains any spills.	0		No shipments.
	1968		2	(4)	Not reported.
	1969		1	(1)	Atcor, Inc., Hawthorne, N.Y.
			1	(4)	Nuclear Engineering Co., Sheffield, Ill.
	1970		1	(1), (4)	Nuclear Engineering Co., Sheffield, Ill.
	1971		0		No shipments.
	1972		1	(1)	Atcor, Inc.
LaCrosse [165 MW(t)]		Drums are moved semiremotely by overhead crane or on a dolly in the shielding box. Activity is checked and barrels are labelled, but no decontamination method is described.	1	(4)	Not reported.
			1	(4)	

Solid Radioactive Waste Treatment at Boiling Water Reactors (BWRs) in Operation:
Contamination Method, Number and Type of Shipments, and Destination

Contamination Method	Shipments		
	Number	Type	Destination
	0		No shipments.
	1 (in 2 parts)	(4), (5)	Nuclear Engineering, Inc.
	4	(4)	Nuclear Engineering, Inc.
	3	(6)	Nuclear Engineering, Inc.
	4	(4)	Oak Ridge National Laboratory, Oak Ridge, Tenn.
	1	(5)	Oak Ridge National Laboratory, Oak Ridge, Tenn.
	2	(4)	Oak Ridge National Laboratory, Oak Ridge, Tenn. (rail)
	2	(4)	Nuclear Fuel Services, West Valley, N.Y.
	3	(4)	Nuclear Fuel Services, West Valley, N.Y.
	1	(6)	Nuclear Fuel Services, West Valley, N.Y.
	2	(4)	Nuclear Fuel Services, West Valley, N.Y.
	9	(4)	Nuclear Fuel Services, West Valley, N.Y.
	>2	(1)	California Nuclear, Inc., Sheffield, Ill.
	11	(4)	Nuclear Engineering Co., Sheffield, Ill.
	1	(3)	Atcor, Inc., Hawthorne, N.Y.
	2	(4)	
	1	(5)	Nuclear Engineering Co., Sheffield, Ill.
	3	(4), (5)	Nuclear Engineering Co., Sheffield, Ill.
	15	(4)	Nuclear Engineering Co., Sheffield, Ill.
	22	(4)	Nuclear Engineering Co., Sheffield, Ill.
	0		No shipments.
	0		
	0		
	4	(1)	Allied Crossroads Nuclear Corp.
	1	(1), (5)	
	1	(4)	
	1	(5)	Atcor, Inc., Hawthorne, N.Y.
	2	(6)	
	2	(3)	U.S. Nuclear Corp. (1 shipment)
	1	(4)	Atcor, Inc., Hawthorne, N.Y.
	1	(6)	
	4	(1)	Atcor, Inc., Hawthorne, N.Y. (1 shipment)
	3	(1), (4)	
	1	(4)	Nuclear Engineering Co.
	4	(3)	
	2	(3)	Nuclear Engineering Co.
	1	(4)	Nuclear Engineering Co.
	2	(3)	Nuclear Engineering Co., Morehead, Ky.
	8	(6)	
	1	(4)	
	12	(1)	
	2	(3)	
	3	(4)	
	22	(6)	
	0		No shipments.
	1	(4), (6)	Nuclear Engineering Co., Cowell, Calif.
	1	(3), (4)	California Nuclear, Inc., Pleasanton, Calif.
	0		No shipments.
	1	(3), (4)	California Nuclear, Inc., Pleasanton, Calif.
	1	(4)	Nuclear Engineering Co., Walnut Creek, Calif.
	1	(4), (6)	
	0		No shipments.
	1	(3)	Nuclear Engineering Co., Beatty, Nev.
	1	(4)	Nuclear Engineering Co., Richland, Wash.
	2	(4)	
	1	(2), (4)	
	1	(3)	
	1	(4)	
in concrete	0		No shipments.
spills.	2	(4)	Not reported.
remotely by	1	(1)	Atcor, Inc., Hawthorne, N.Y.
holly in the	1	(4)	Nuclear Engineering Co., Sheffield, Ill.
is checked	1	(1), (4)	Nuclear Engineering Co., Sheffield, Ill.
but no	0		No shipments.
is described.	1	(1)	Atcor, Inc.
	1	(4)	Not reported.
	0		No shipments.
Not reported	Not reported		Not reported

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	1969		2	(3)	Nuclear Engineering Co.
			1	(4)	Nuclear Engineering Co.
	1970		2	(3)	Nuclear Engineering Co., Mo
			8	(6)	
	1971		1	(4)	
	1972		12	(1)	
			2	(3)	
			3	(4)	
			22	(6)	
Humboldt Bay	1963	No description given.	0		No shipments.
[165 MW(t)]	1964		1	(4), (6)	Nuclear Engineering Co., Co
	1965		1	(3), (4)	California Nuclear, Inc., Plo
	1966		0		No shipments.
	1967		1	(3), (4)	California Nuclear, Inc., Plo
[210 MW(t)]	1968		1	(4)	Nuclear Engineering Co., Wa
			1	(4), (6)	
[240 MW(t)]	1969		0		No shipments.
	1970		1	(3)	Nuclear Engineering Co., Ba
			1	(4)	Nuclear Engineering Co., Ri
	1971		2	(4)	
	1972		1	(2), (4)	
			1	(3)	
			1	(4)	
LaCrosse	1967	Drums are filled inside a concrete	0		No shipments.
[165 MW(t)]	1968	box which contains any spills.	2	(4)	Not reported.
	1969	Drums are moved semiremotely by	1	(1)	Atcor, Inc., Hawthorne, N.Y
		overhead crane or on a dolly in the	1	(4)	Nuclear Engineering Co., Sh
	1970	shielding box. Activity is checked	1	(1), (4)	Nuclear Engineering Co., Sh
	1971	and barrels are labelled, but no	0		No shipments.
	1972	decontamination method is described.	1	(1)	Atcor, Inc.
			1	(4)	Not reported.
Oyster Creek	1969	No description given.	0		No shipments.
[1600 MW(t)]	1970		Not reported	Not reported	Not reported
[1830 MW(t)]	1971		18	(2), (4)	Nuclear Engineering Co., Mo
[1930 MW(t)]	1972		7	(1)	Nuclear Engineering Co., Mo
			38	(2)	Nuclear Engineering Co., Mo
Nine Mile Point	1969	No description given.	0		No shipments.
[1538 MW(t)]	1970		3	(1), (2), (3), (4), (5) ²	Nuclear Engineering Co., Mo
[1850 MW(t)]	1971		44	(1), (2), (3), (4), (5) ²	Nuclear Engineering Co., Mo
	1972		60	(1), (2), (3), (4), (5) ²	Nuclear Engineering Co., Mo (Soon to start shipping to Ba
Dresden 2 & 3	1970	Most drums are low enough in	25	(1), (2), (3), (4), (5) ²	Nuclear Engineering Co., Sh
[2527 MW(t)] ea.		radioactivity to be handled by			
	1971	contact.	41	(1), (2), (3), (4), (5) ²	
	1972		91	(1), (2), (3), (4), (5) ²	
Millstone Point 1	1970	Designed for remote operation but	0		No shipments.
[2011 MW(t)]		drum capping is sometimes done			
	1971	manually. Decontamination is done	28	(1), (3), (4) (5)	Not designated.
		manually by scrubbing with long-	3	(3)	
	1972	handled brushes.	29	(1), (3), (4), (5)	
Monticello	1970	Decontamination of drums prior to	0		No shipments.
[1670 MW(t)]		shipment and storage is done remotely			
	1971	with steam spray.	15	(1), (3), (4), (5)	Nuclear Engineering Co., Sh
			13	(1), (3), (4), (5)	Nuclear Engineering Co., Sh
Quad-Cities 1 & 2	1971	No description given.	4	(1), (2), (3), (4), (5) ²	Nuclear Engineering Co., Sh
[2511 MW(t)] ea.					
	1972		72	(1), (2), (3), (4), (5) ²	
Vermont Yankee	1972	No description given.	13	(1), (3), (4), (5)	Nuclear Fuel Services, West V
[1593 MW(t)]					
Pilgrim-I	1972	No description given.	4	(1), (3), (4), (5)	Nuclear Engineering Co., Mo
[1998 MW(t)]					

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	1	(4)	Nuclear Engineering Co.
	4	(3)	
	2	(3)	Nuclear Engineering Co.
	1	(4)	Nuclear Engineering Co.
	2	(3)	Nuclear Engineering Co., Morehead, Ky.
	8	(6)	
	1	(4)	
	12	(1)	
	2	(3)	
	3	(4)	
	22	(6)	
	0		No shipments.
	1	(4), (6)	Nuclear Engineering Co., Cowell, Calif.
	1	(3), (4)	California Nuclear, Inc., Pleasanton, Calif.
	0		No shipments.
	1	(3), (4)	California Nuclear, Inc., Pleasanton, Calif.
	1	(4)	Nuclear Engineering Co., Walnut Creek, Calif.
	1	(4), (6)	
	0		No shipments.
	1	(3)	Nuclear Engineering Co., Beatty, Nev.
	1	(4)	Nuclear Engineering Co., Richland, Wash.
	2	(4)	
	1	(2), (4)	
	1	(3)	
	1	(4)	
crete	0		No shipments.
B.	2	(4)	Not reported.
ely by	1	(1)	Atcor, Inc., Hawthorne, N.Y.
in the	1	(4)	Nuclear Engineering Co., Sheffield, Ill.
cked	1	(1), (4)	Nuclear Engineering Co., Sheffield, Ill.
no	0		No shipments.
described.	1	(1)	Atcor, Inc.
	1	(4)	Not reported.
	0		No shipments.
	Not reported	Not reported	Not reported
	18	(2), (4)	Nuclear Engineering Co., Morehead, Ky.
	7	(1)	Nuclear Engineering Co., Morehead, Ky.
	38	(2)	Nuclear Engineering Co., Morehead, Ky.
	0		No shipments.
	3	(1), (2), (3), (4), (5) ²	Nuclear Engineering Co., Morehead, Ky.
	44	(1), (2), (3), (4), (5) ²	Nuclear Engineering Co., Morehead, Ky.
	60	(1), (2), (3), (4), (5) ²	Nuclear Engineering Co., Morehead, Ky. (Soon to start shipping to Barnwell, S.C.)
is	25	(1), (2), (3), (4), (5) ²	Nuclear Engineering Co., Sheffield, Ill.
by	41	(1), (2), (3), (4), (5) ²	
	91	(1), (2), (3), (4), (5) ²	
on but	0		No shipments.
done	28	(1), (3), (4) (5)	Not designated.
is done	3	(3)	
long-	29	(1), (3), (4), (5)	
prior to	0		No shipments.
remotely	15	(1), (3), (4), (5)	Nuclear Engineering Co., Sheffield, Ill.
	13	(1), (3), (4), (5)	Nuclear Engineering Co., Sheffield, Ill.
	4	(1), (2), (3), (4), (5) ²	Nuclear Engineering Co., Sheffield, Ill.
	12	(1), (2), (3), (4), (5) ²	
	13	(1), (3), (4), (5)	Nuclear Fuel Services, West Valley, N.Y.
	4	(1), (3), (4), (5)	Nuclear Engineering Co., Morehead, Ky.

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Footnotes for Tables A-1a, -1b, -1c, and -1d

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- ^aFrom ref. 1.
- ^bContracted by California Nuclear Inc., Sheffield, Illinois.
- ^cLetter from W. P. Worden, superintendent (Dresden Station) to A. H. Kibbey (ORNL), Sept. 13, 1973.
- ^dPersonal correspondence, J. C. Carroll (Pacific Gas and Electric Co.) and H. W. Godbee (ORNL), July 6, 1972.
- ^eSolidified evaporator bottoms containing ⁶⁰Co, ^{134,137}Cs, and ⁵⁴Mn.
- ^fOn April 1, 1972, a new type of colloidal separation demineralizing bed was installed.
- ^gReported as "dry radioactive waste."
- ^hIn process of changing over to urea formaldehyde solidification in disposable concrete casks in August 1973.
- ⁱ30 gpm evaporator and chemical solidification system should be operable in summer of 1974.
- ^jQuad-Cities "Semi-Annual Operations Report No. 1, July 1-Dec. 31, 1971," and "AEC Discussions on Authorizing 20% Operation."
- ^kNow have waste from 12 bed regenerations stored onsite. Powdex and Solka-Floc, filter-demineralizers, from main reactor system are given the "Solidipak" treatment consisting of dewatering by pumping through a disposable canvas bag filter mounted in a disposable shipping cask liner. No solidification agent is used with spent resins and sludges, although the station has operable cementing equipment.
- ^lMostly ⁶⁵Zn, ⁵⁹Fe, and ⁶⁰Co.
- ^mMostly ⁶⁵Zn and mixed fission products.
- ⁿMostly ⁶⁰Co and ⁵⁴Mn.
- ^oMostly ⁶⁰Co and mixed fission products.
- ^pMostly ⁶⁰Co, ⁶⁵Zn, and ⁵⁴Mn.
- ^qMostly mixed fission products.
- ^rMostly ^{58,60}Co.
- ^sHigh-level filter sludge from reactor clean-up filter demineralizer is decanted in phase separator tanks where sludge is held for decay and then transferred to the spent resin storage tank. From there the sludge is put into a shielded shipping container and stored.
- ^tThere is no program initiated as yet for solidifying these Powdex sludges which account for nearly all the solid waste. Do expect to review and evaluate solidification.
- ^uThis waste was labeled only "high level"; it could possibly have been decayed core components, since the activity level is high for the volume reported.
- ^vThis waste had no special description but since there are no evaporator bottoms and no resin or sludge shipment and dry compressible wastes are normally low level, this has been placed in this category; it may be decayed core components.
- ^wIrradiated poison curtains, mostly ⁵¹Cr, ⁶³Ni, ⁵⁹Fe.
- ^xIn-core fission chambers (0.321 g ²³⁵U, fission products and transuranics).
- ^ySee numerical designation under "Types of Solids" column.
- ^zIn reporting, no differentiation is made between resins, filter sludges, evaporator bottoms, and compacted dry waste.

Table A-2a. Summary of Solid Radioactive Waste Treatment at Pressurized Water Reactors (PWRs) in Operation: Demineralizer Resins and Evaporator Bottoms

NSSS Reactor [Capacity]	Year	Thermal Output [MWhr(t)]	Solid Waste Treatment	Types of Solid, Volume, Activity, and Number of Drums or Casks Shipped				Treatment
				(1) Ion-Exchange Resins			(2) E	
				Treatment	ft ³	Ci		
Westinghouse								
Yankee-Rowe [485 MW(t)] [540 MW(t)] [600 MW(t)]	1960	126.852	Until 1967, some combustible low-level wastes were incinerated. Since then all dry compressible wastes are compacted into 55-gal drums. Evaporator bottoms and filters and sludges are cemented into drums for offsite shipment. Resins are dewatered and shipped in casks.	Dewater and ship in concrete-shielded drums or ship in 40 ft ³ concrete casks. (Such a cask holds resin from 2 ion exchange capsules.) Where possible, decontaminate the capsules for reuse.	0	0	0	Shipped as liquid.
	1961	2,992.983			0	0	0	Concrete in 55-gal drums.
	1962	2,321.242			0	0	0	
	1963	3,287.372			0	0	0	
	1964	4,200.951			360.15	91.770	49d	
	1965	3,400.357			>461.15	>93.017	1d, 9c, 4 special d	
	1966	4,514.275			0	0	0	
	1967	4,507.719			0	0	0	
	1968	4,290.227			0	0	0	
	1969	3,959.567			240	150.05	6c	
	1970	4,127.520			0	0	0	
	1971	5,016.512			0	0	0	
	1972	2,396.226			0	0	0	
San Onofre-1 [1347 MW(t)]	1967	1,183.703	Spent demineralizer resins are shipped offsite in casks. Used disposable filters are put in 55-gal drums for shipping. Dry compressible wastes are compacted into 55-gal drums with an hydraulic baler. Drums and larger contaminated items are stored in the 2000 ft ³ concrete storage vault for up to 3 yrs.	None to date.	0	0	0	No waste evaporator. ^c
	1968	4,046.499			0	0	0	
	1969	7,898.832			0	0	0	
	1970	9,151.990		Transferred to shipping cask.	75	2.00	1(?)c	
	1971	9,956.701		None this year.	0	0	0	
	1972	8,528.772		Transferred to shipping casks.	200	72.0	3(?)c	
Conn. Yankee [1473 MW(t)] [1825 MW(t)]	1967	1,697.464	Contaminated evaporator bottoms from the boron recovery system are cemented into 55-gal drums for offsite shipment. Dry compressible materials are compacted into drums, and spent resin are dewatered in disposable containers and shipped in reusable concrete casks.	None to date.	0	0	0	None to date.
	1968	9,492.857			0	0	0	Concrete in 55-gal drums.
	1969	11,544.534			0	0	0	Switched to filtration
	1970	11,406.386		Sluiced to disposable shipping containers enclosed in reusable shipping casks. Excess water is removed by pumping out through a strainer in the bottom of the container.	555	235.017	4(?)c	and demineralization in June, so no more mixed drums in evaporator bottoms. (However, a new 15 gph waste evaporator is included in current radiowaste system modifications to be completed in January 1974.)
	1971	13,416.373			1,045.6	260.9	7(?)c	
	1972	13,780.524			1,495	4,752.5 ^e	13(?)c	
Ginna [1300 MW(t)] [1520 MW(t)]	1969	153.720	Evaporator bottoms are mixed with vermiculite and cement in 55-gal drums. Spent resins are dewatered and shipped in shielded drums. Compressible solids are compacted into drums for offsite shipment.	Discharged to 30-gal drums placed inside 55-gal drums with lead shielding in the annular space. Sluicing water drains out of this shipping container and into the waste hold-up tank.	0	0	0	Solids land by pumping into a 55-gal drum containing vermiculite and cement.
	1970	6,840.240			0	0	0	
	1971	8,504.065			Reported under "Evaporator Bottoms."			
	1972	7,707.240			Not reported.			
Robinson-2 [2209 MW(t)]	1970	63.694	All solid waste to be packaged in 55-gal drums for offsite shipment.	Sluiced into a battery of 6 lead-shielded drums. Dewatered, and if desired, absorbent added. Drums are remotely moved to storage area by bridge and trolley crane. The crane is also used for truck loading.	0	0	0	Pumped into a battery of 6 lead-shielded drums which are prefilled with cement and vermiculite.
	1971	7,850.675				Not reported.		
	1972	15,536.932				Not reported.		
Pt. Beach 1 & 2 [1518 MW(t)] ea.	1970	632.255	Resins dewatered and shipped in disposable collection tanks. Compressible solids are compacted into 55-gal drums, and evaporator bottoms are cemented into 55-gal drums.	Collected in a disposable shielded resin storage tank. When full, resin is dewatered by pumping and then entire tank and shield is moved by crane to a truck and hauled offsite.	0	0	0	Pump into 55-gal drums prefilled with cement. Roll drums to mix. Move with remotely operated crane to shielded storage area to await offsite shipment.
	1971	10,025.688			0	0	0	
	1972	9,959.016			125	4	2 tanks (in 2c)	
Surry 1 & 2 [2441 MW(t)] ea.	1972	1,288.550	Solids are packaged in 55-gal drums whenever possible and shielded in reusable concrete shipping casks when necessary. Special drumming of highly active small items involves putting concrete shielding inside a drum with a central tubular insert for holding the material.	Spent resins are collected in a catch tank to decay prior to transfer to a 55-gal drum inside a reusable concrete shipping cask located at a piping outlet equipped with proper fittings in the decontamination building.	No operating report issued as of June 15, 1973.			Batch process using cement and/or diatomaceous earth mixed with evaporator concentrate as it enters the drum. The drums are transported by overhead monorail to a drum roller for mixing. Next they are transported to a storage area.
Turkey Pt. 3 & 4 [2200 MW(t)] ea.	1972	285.340	Resins dewatered and shipped in 55-gal drums. Evaporator concentrates are mixed in drums with filler and binder and shipped offsite. Dry compressible wastes are compacted into 55-gal drums.	Resins are discharged to spent resin storage tank, and from there are sluiced to a battery of 6 shielded drums. After dewatering, the drums are moved by a remotely operated trolley crane to a shielded storage area.	0	0	0	Evaporator bottoms are pumped to a battery of 6 shielded drums prefilled with filler and binder. The drums are then handled in the same way as the drummed resins.
Maine Yankee	1972	1,439.873	A reusable truck-mounted	Spent resins are allowed to decay	0	0	0	Pumped into 55-gal drums

Waste Treatment at Pressurized Water Reactors (PWRs) in Operation: Demineralizer Resins and Evaporator Bottoms

Types of Solid, Volume, Activity, and Number of Drums or Casks Shipped							
(1) Ion-Exchange Resins				(2) Evaporator Bottoms			
Treatment	ft ³	Ci	No. of Drums or Casks	Treatment	ft ³	Ci	No. of Drums or Casks
Shipped in concrete-shielded drums or shipped in 40 ft ³ casks. (Such a cask holds ion exchange capsules for reuse.)	0	0	0	Shipped as liquid	95.55	<0.00001	13d
Concrete in 55-gal drums	0	0	0	Concrete in 55-gal drums	588.0	0.107	80d
360.15	91.770	49d			3,799.95	1.484	517d ^a
>461.15	>93.017	1d, 9c, 4 special d			3,682.35	3.272	501d
0	0	0			3,356.05	3.258	443d
0	0	0			4,718.7	6.6321	642d
0	0	0			3,241.35	2.8685	441d
0	0	0			6,078.45	4.7820	827d
0	0	0			3,638.25	1.35	419d
240	150.05	6c			3,888.15	1.9181	529d
0	0	0			3,660.5	2.2238	498d
0	0	0			3,388.35	2.9647	461d
0	0	0			7,798.35 ^b	-1.8917	1,061d
0	0	0		No waste evaporator ^c	0	0	0
0	0	0			0	0	0
0	0	0			0	0	0
0	0	0			0	0	0
to shipping cask	75	2.00	11 ⁷ k		0	0	0
0	0	0			0	0	0
to shipping casks	200	72.0	34 ⁷ k		0	0	0
0	0	0		None to date	0	0	0
0	0	0		Concrete in 55-gal drums	411.6	0.1436	56d
0	0	0		Stripped to filtration and demineralization in June, so no more treated drums in evaporator bottoms. (However, a new 15 gph waste evaporator is included in current radiowaste system modifications to be completed in January 1974.)	2,293.2	2.1276 ^d	312d
possible shipping container in reusable shielded water in re-wrapping out through a in bottom of the container	555	235.017	41 ⁷ k				
1,045.6	260.9	71 ⁷ k					
1,495	4,752.5 ^e	134 ⁷ k					
0	0	0		Solidified by pumping into a 55-gal drum containing vermiculite and cement	0	0	0
0	0	0			1,815.65	4.640	Not reported
Reported under "Evaporator Bottoms" Not reported					24,780.4 ^f	47.3155 ^f	Not reported
					12,939.6 ^g	1,412.06 ^g	Not reported
0	0	0		Pumped into a battery of 6 lead-shielded drums which are prefilled with cement and vermiculite	0	0	0
Not reported	Not reported	Not reported			855	Not reported	117d
					2,477.5	Not reported	336d
0	0	0		Pump into 55-gal drums prefilled with cement. Roll drums to mix. Move with remotely operated crane to shielded storage area to await offsite shipment	0	0	0
0	0	0			2,701	3.504	Not reported
125	40.0	2 Lanks (in 2c)			6,701.9	173.440	Not reported
0	0	0		Batch process using cement and/or distillate with mixed with evaporator concentrate as it enters the drum. The drums are transported by overhead monorail to a drum roller for mixing. Next they are transported to a storage area.			
No operating report issued as of June 15, 1973				Operating report not issued as of June 15, 1973			
0	0	0		Evaporator bottoms are pumped to a battery of 6 shielded drums prefilled with cement and vermiculite. The drums are then handled in the same way as the drummed resins.	0	0	0
0	0	0		Pumped into 55-gal drums			

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Year:									
	1972	8,528,772	Wastes are compacted into 55-gal drums with a h. hydraulic baler. Drums and larger contaminated items are stored in the 2300 ft ³ concrete storage vault for up to 3 yrs.	Transferred to shipping casks.	200	72.0	34%		
Conn. Yankee [1473 MW(t)] [1825 MW(t)]	1967	1,697,464	Contaminated evaporator bottoms from the boron recovery system are cemented into 55-gal drums for offsite shipment.	None to date	0	0	0	None to date	
	1968	9,492,847	Dry compressible materials are compacted into drums, and spent resins are dewatered in disposable containers and shipped in reusable concrete casks.		0	0	0	Concrete in 55-gal drums	
	1969	11,544,534			0	0	0	Switched to filtration and demineralization	
	1970	11,406,386		Shipped to disposable shipping containers enclosed in reusable shipping casks. Excess water is removed by pumping out through a strainer in the bottom of the container.	555	235,017	4(%)	in June, so no more drums in evaporator bottoms. (However, a new 8 gph waste evaporator is included in current radiation system modifications to be completed in January 1973.)	
	1971	13,416,373			1,045.6	260.9	7(%)		
	1972	13,780,524			1,495	4,752.5	13(%)		
Cinna [1300 MW(t)] [1520 MW(t)]	1969	153,720	Evaporator bottoms are mixed with vermiculite and cement in 55-gal drums. Spent resins are dewatered and shipped in shielded drums. Compressible solids are compacted into drums for offsite shipment.	Discharged to 30-gal drums placed inside 55-gal drums with lead shielding in the annular space. Sluicing water drains out of this shipping container and into the waste hold-up tank.	0	0	0	Solidified by pumping into a 55-gal drum containing vermiculite and cement.	
	1970	6,840,240			0	0	0		
	1971	8,504,065			Reported under "Evaporator Bottoms"				
	1972	7,707,240			Not reported.				
Robinson-2 [2200 MW(t)]	1970	63,694	All solid waste to be packaged in 55-gal drums for offsite shipment.	Shipped into a battery of 6 lead-shielded drums. Dewatered, and if desired, absorbent added. Drums are remotely moved to storage area by bridge and trolley crane. The crane is also used for truck loading.	0	0	0	Pumped into a battery of lead-shielded drums which are prefilled with cement and vermiculite.	
	1971	7,850,675				Not reported.			
	1972	15,536,932				Not reported.			
Pt. Beach 1 & 2 [1518 MW(t)] on	1970	632,255	Resins dewatered and shipped in disposable collection tanks. Compressible solids are compacted into 55-gal drums, and evaporator bottoms are cemented into 55-gal drums.	Collected in a disposable shielded resin storage tank. When full, resin is dewatered by pumping and then entire tank and shield is moved by crane to a truck and hauled offsite.	0	0	0	Pump into 55-gal drums prefilled with cement. Fill drums to max. Move with remotely operated crane to shielded storage area to await offsite shipment.	
	1971	10,025,688			0	0	0		
	1972	9,959,016			125	40.0	2 tanks (in 2c)		
Sany 1 & 2 [2441 MW(t)] on	1972	1,288,550	Solids are packaged in 55-gal drums whenever possible and shielded in reusable concrete shipping casks when necessary. Special drumming of highly active small items involves putting concrete shielding inside a drum with a central tubular insert for holding the material.	Spent resins are collected in a catch tank to decay prior to transfer to a 55-gal drum inside a reusable concrete shipping cask located at a piping outlet equipped with proper fittings in the decontamination building.	No operating report issued as of June 15, 1973.			Batch process using concrete and/or distillate with cement mixed with evaporator bottoms concentrate as it enters the drum. The drums are supported by overhead monorails to a drum roller for moving. Next they are transported to a storage area.	
Turkey Pt. 3 & 4 [2280 MW(t)] on	1972	285,340	Resins dewatered and shipped in 55-gal drums. Evaporator concentrates are mixed in drums with filter and binder and shipped offsite. Dry compressible wastes are compacted into 55-gal drums.	Resins are discharged to spent resin storage tank, and from there are shipped to a battery of 6 shielded drums. After dewatering, the drums are moved by a remotely operated trolley crane to a shielded storage area.	0	0	0	Evaporator bottoms are pumped to a battery of 6 shielded drums prefilled with filter and binder. The drums are then handled in the same way as the drummed resins.	
Maine Yankee [2440 MW(t)]	1972	1,439,873	A reusable truck-mounted cask with disposable liner is used to transport spent resins and all drummed wastes.	Spent resins are allowed to decay in a storage tank. For shipment they are moved to a reusable truck-mounted cask equipped with a disposable liner in which they are dewatered.	0	0	0	Pumped into 55-gal drums containing dry cement. Drums are rolled to max. and then stored in shielded area to solidify.	
Subcock & Wilcox									
Indian Pt. 1 [615 MW(t)]	1962	216,679	All solid wastes are mixed with concrete in 55-gal drums for shipment offsite.	Mixed with cement in 55-gal drums.	0	0	0	Pumped into 55-gal drums partially filled with cement. After filling and sealing, drums are rolled to max. thoroughly. When hardened, the drums are placed in storage for offsite shipment.	
	1963	2,148,129			0	0	0		
	1964	1,374,070			0	0	0		
	1965	2,448,285			Not specifically reported, no appears under "Dry Compressible Waste."				
	1966	2,613,400							
	1967	3,677,371							
	1968	3,475,288							
	1969	3,762,765							
	1970	794,519							
	1971	2,867,507							
	1972	2,693,864							
Combustion-Engineering									
Pakades [2212 MW(t)]	1971	800	At present all solids except resins are packaged in 55-gal drums. Resins are dewatered in a disposable tank which is shielded for shipment. (Solidification of filters, resins and evaporator bottoms in 50 ft ³ disposable containers should begin in 1974.)	Store in disposable collection tank until full. Dewater and ship in cask.	0	0	0	No evaporator at present. Will solidify in 50 ft ³ disposable cask liners for offsite shipment after new evaporator installation is complete.	
	1972	5,910,520			340	1.85	2 tanks (in 2c)		

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	75	2 00	117c		0	0	0
	0	0	0		0	0	0
	200	72 0	347c		0	0	0
	0	0	0	None to date	0	0	0
	0	0	0	Concrete in 55-gal drums	411 6	0 1436	56d
	0	0	0	Switched to filtration and demineralization in June, so no more aerated drums in evaporator bottoms. (However, a new 15 gph waste evaporator is included in current radwaste system modifications to be completed in January 1974.)	2,293 2	2 1276 ^d	312d
con-	555	235 017	4(?)c				
ly-	1,045.6	260 9	7(?)c				
	1,495.	4,752 5 ^e	13(?)c				
ph a							
pos-							
	0	0	0	Solidified by pumping into a 55-gal drum containing vermiculite and cement.	0	0	0
load	0	0	0		1,815 65	4 640	Not reported
shalt-					24,780.4 ^f	47 3155 ^f	Not reported
ing	Reported under "Evaporator Bottoms"				12,939 6 ^g	1,412 06 ^g	Not reported
ing	Not reported						
hold-							
	0	0	0	Pumped into a battery of 6 lead-shielded drums which are prefilled with cement and vermiculite.	0	0	0
nt-		Not reported.			855	Not reported	117d
nd		Not reported.			2,477.5	Not reported	336d
Avran							
p							
ne.							
nk							
	0	0	0	Pump into 55-gal drums prefilled with cement. Roll drums to mix. Move with remotely operated crane to shielded storage area to await offsite shipment.	0	0	0
Med	0	0	0		2,701	3,504	Not reported
,rein	0	0	0		6,761.9	173.440	Not reported
then	125	40.0	2 tanks (in 2c)				
nd by							
offsite.							
	No operating report issued as of June 15, 1973.			Batch process using cement and/or bentonite earth mixed with evaporator concentrate as it enters the drum. The drums are transported by overhead monorail to a drum roller for mixing. Next they are transported to a storage area.	Operating report not issued as of June 15, 1973.		
	0	0	0	Evaporator bottoms are pumped to a battery of 6 shielded drums prefilled with filler and binder. The drums are then handled in the same way as the drummed resins.	0	0	0
	0	0	0	Pumped into 55-gal drums containing dry cement. Drums are rolled to mix and then stored in shielded area to solidify	0	0	0
	0	0	0	Pumped into 55-gal drums partially filled with cement. After filling and sealing, drums are rolled to mix thoroughly. When hardened, the drums are placed in storage for offsite shipment.	0	0	0
	0	0	0		0	0	0
	0	0	0		0	0	0
	Not specifically reported, so appears under "Dry Compressible Waste."				Not specifically reported, so appears under "Dry Compressible Waste."		
	0	0	0	No evaporator at present. Will solidify in 50 ft ³ disposable cask liners for offsite shipment after new evaporator installation is complete.	0	0	0
	340	1 85	2 tanks (in 2c)				

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Table A-2b. Summary of Solid Radioactive Waste Treatment at Pressurized Water Reactors (PWRs) in Operation: Filters, Filter Sludges and Unspecified High-Level Wastes, and Dry Wastes (Compressible)

NSSS Reactor [Capacity]	Year	Types of Solid, Volume, Activity, and Number of Drums or Casks Shipped						
		(3) Filters, Filter Sludges, and Unspecified High-Level Wastes				(4) Dry Wastes (Compressible)		
		Treatment	ft ³	Ci	No. of Drums = d Casks = c	Treatment	ft ³	
Westinghouse								
Yankee-Rowe [185 MW(t)] [140 MW(t)] [600 MW(t)]	1960	Place in an individual drum and ship in concrete shielding cask.	0	0	0	Incinerate low-level combustibles and drum ashes with evaporator bottoms.	0	
	1961		0	0	0		0	
	1962		0	0	0		0	
	1963		0	0	0		0	
	1964		0	0	0		0	
	1965		Not reported	4.5	4c		0	
	1966		44.10	<3.29	4d		0	
	1967		205.8	1.546	28d (in 4c) (in 2c)	Incineration of low-level wastes apparently discontinued. ¹	0	
	1968		142.9	15.241	14d (in 1c)		0	
	1969		205.8	11.284	28d (in 2c)	None reported except under more specific categories.	0	
	1970		102.9	4.405	14d (in 1c)		118	
	1971		0	0	0	Assume these were dry wastes and no compaction.	1,101.9	
	1972		0	0	0		43.2	
	San Onofre-1 [1347 MW(t)]	1967	None to date.	0	0	0	None to date.	0
1968		Unspecified.	Not reported	<0.028	3 boxes	Compacted in drums with hydraulic baler.	382.20	
1969		None unless included in "Dry Compressible Wastes."	0	0	0		1,411.20	
1970		None unless reported in "Noncompressible Wastes."	0	0	0		1,359.75	
1971			0	0	0		374.95	
1972			0	0	0		1,403.85	
Conn. Yankee [1473 MW(t)] [1825 MW(t)]	1967	None to date.	0	0	0	None to date.	0	
	1968		0	0	0	Probably included under "Evaporator Bottoms."	0	
	1969	Transfer filters to individual 55-gal drums held inside individual concrete shipping casks. Fill the drums with concrete prior to shipping offsite.	22.05	~49.	3d	Compacted into 55-gal drums along with some small noncompressible items. Fill void spaces with concrete.	624.75	
	1970		29.4	66.02	4d (in 4c)		1,484.7	
	1971		44.10	11.26	6d		2,594.55	
	1972		308.8	13.336	42d		4,851.	
Glasco [1300 MW(t)] [1520 MW(t)]	1969	Stored to permit decay, then packaged for shipment.	0	0	0	Transferred to the drumming area where they are compacted into 55-gal drums.	0	
	1970		A set of HEPA filters is included with "Evaporator Bottoms."				Included with "B"	
	1971		Included with "Evaporator Bottoms."			Included with "B"		
	1972		Not reported			Included with "B"		
Robinson-2 [2200 MW(t)]	1970	Store in drums and then compact before shipping.	0	0	0	Hydraulic baler, equipped with a dust shroud, is manually operated from a local station to compact dry, low-level, compressible material into 55-gal drums.	0	
	1971			Not reported			Included with "B"	
	1972			Not reported			Included with "B"	
Pt. Beach 1 & 2 [1518 MW(t)] ca.	1970	Treatment not mentioned for the disposable filter cartridges.	0	0	0	Compacted into 55-gal drums with an hydraulic baler.	0	
	1971		Included in "Evaporator Bottoms."				Included with "B"	
	1972		Included in "Evaporator Bottoms."				Included with "B"	
Surrey 1 & 2 [2441 MW(t)] ca.	1972	Filter cover opened manually using proper tools and shielding. Filter cartridges in their disposable baskets are raised to a shield and placed in a concrete-shielded shipping container. When possible, 55-gal drums are used.	No operating report issued as of June 15, 1973			Compressed into 55-gal drums a layer at a time until drum is filled. During the operation the baling area is closed and the ventilation air is filtered to remove particulates.	No operating report 1973.	
Turkey Pt. 3 & 4 [2200 MW(t)] ca.	1972	Treatment not specifically mentioned for filter cartridges.	0	0	0	Hydraulic baler, equipped with dust shroud, is manually operated from a local station to compact the dry compressible wastes into 55 gal drums.	0	
Maine Yankee [2440 MW(t)]	1972	Cartridges are raised into a shield and moved by crane to a concrete shipping cask. Low-activity filters are packaged in 55-gal drums.	0	0	0	Compacted into 55-gal drums.	0	
Babcock & Wilcox								
Indian Pt. 1 [615 MW(t)]	1962	Cemented into 55-gal drums.	0	0	0	Cemented into 55-gal drums. Apparently no compaction is used.	0	
	1963		0	0	0		0	
	1964		0	0	0		823.2'	
	1965		Not specifically reported, so appears under the "Dry Compressible Waste."				1,499.4'	
	1966						1,991.45	
	1967							

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(4) Dry Wastes (Compressible)

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	1967		205.8	1,546	28d (in 2c)	Incineration of low-level wastes apparently discontinued ¹	0
	1968		142.9	13,241	14d (in 1c)	None reported except under more specific categories.	0
	1969		205.8	11,284	28d (in 2c)		0
	1970		102.9	1,405	14d (in 1c)	Assume these were dry wastes and no compaction.	118
	1971		0	0	0		1,101.9
	1972		0	0	0		43.2
San Onofre-1 [1347 MW(t)]	1967	None to date.	0	0	0	None to date.	0
	1968	Unspecified.	Not reported	<0.038	3 boxes	Compacted in drums with hydraulic baler.	382.20
	1969	None unless included in "Dry Compressible Wastes."	0	0	0		1,411.20
	1970	None unless reported in "Noncompressible Wastes."	0	0	0		1,352.75
	1971		0	0	0		374.85
	1972		0	0	0		1,403.85
Conn. Yankee [1473 MW(t)] [1825 MW(t)]	1967	None to date.	0	0	0	None to date.	0
	1968		0	0	0	Probably included under "Evaporator Bottoms."	0
	1969	Transfer filters to individual 55-gal drums held inside individual concrete shipping casks. Fill the drums with concrete prior to shipping offsite.	22.05	~49.	3d	Compacted into 55-gal drums along with some small noncompressible items. Fill void spaces with concrete.	624.75
	1970		29.4	66.02	4d (in 4c)		1,464.7
	1971		44.10	11.26	6d		2,594.55
	1972		308.8	13,336	42d		4,851.
Ginna [1300 MW(t)] [1520 MW(t)]	1969	Stored to permit decay, then packaged for shipment.	0	0	0	Transferred to the drumming area where they are compacted into 55-gal drums.	0
	1970		A set of HEPA filters is included with "Evaporator Bottoms."				Included with "B"
	1971		Included with "Evaporator Bottoms."				Included with "B"
	1972		Not reported				Included with "B"
Robinson-2 [2200 MW(t)]	1970	Store in drums and then compact before shipping.	0	0	0	Hydraulic baler, equipped with a dust shroud, is manually operated from a local station to compact dry, low-level, compressible material into 55-gal drums.	0
	1971			Not reported			Included with "B"
	1972			Not reported			Included with "B"
Pt. Beach 1 & 2 [1518 MW(t)] ea.	1970	Treatment not mentioned for the disposable filter cartridges.	0	0	0	Compacted into 55-gal drums with an hydraulic baler.	0
	1971		Included in "Evaporator Bottoms."				Included with "B"
	1972		Included in "Evaporator Bottoms."				Included with "B"
Surry 1 & 2 [2441 MW(t)] ea.	1972	Filter cover opened manually using proper tools and shielding. Filter cartridges in their disposable basket are raised to a shield and placed in a concrete-shielded shipping container. When possible, 55-gal drums are used.	No operating report issued as of June 15, 1973.			Compressed into 55-gal drums a layer at a time until drum is filled. During the operation the baling area is closed and the ventilation air is filtered to remove particulates.	No operating report 1973.
Turkey Pt. 3 & 4 [2200 MW(t)] ea.	1972	Treatment not specifically mentioned for filter cartridges.	0	0	0	Hydraulic baler, equipped with dust shroud, is manually operated from a local station to compact the dry compressible wastes into 55-gal drums.	0
Maine Yankee [2440 MW(t)]	1972	Cartridges are raised into a shield and moved by crane to a concrete shipping cask. Low-activity filters are packaged in 55-gal drums.	0	0	0	Compacted into 55-gal drums.	0
Babcock & Wilcox:							
Indian Pt. 1 [615 MW(t)]	1962	Cemented into 55-gal drums.	0	0	0	Cemented into 55-gal drums.	0
	1963		0	0	0	Apparently no compaction is used.	0
	1964		0	0	0		823.2 ¹
	1965		Not specifically reported, so appears under the "Dry Compressible Waste."				1,499.4 ¹
	1966						1,991.45
	1967						1,051.05
	1968						>1,117.20
	1969						948.15
	1970						859.95
	1971						565.95
	1972						>3,234.0 ⁰
Combustion-Engineering:							
Palisades [2212 MW(t)]	1971	No specific mention except that cartridges are replaceable. They are drummed and stored for decay prior to solidifying in 50 ft ³ disposable cask liners for offsite shipment	0	0	0	Compacted into 55-gal drums by using an hydraulic baler. Accounts for 30-40% of solid waste.	0
	1972		7 filters, total of 40 Ci. stored.				~800 ft ³ low-level

0
0
0

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Incineration of low-level wastes apparently discontinued	0	0	0
None reported except under more specific categories	0	0	0
	0	0	0
Assume these were dry wastes and no compaction	118	0 011	Packages + also 12d
	1,101 9	0 013	Unspecified containers
	412	0 414	Unspecified containers
None to date	0	0	0
Compacted in drums with hydraulic bales	382 20	- 1 463	52d
	1,411 20	8 107	192d
	1,359 75	- 8 4694 ¹	185d
	374 85	< 1 1877 ^h	51d
	1,403 85	< 7 67 ^h	191d
None to date	0	0	0
Probably included under "Evaporator Bottoms."	0	0	0
Compacted into 55-gal drums along with some small noncomp cable stems. Fill void spaces with concrete	624 75	Not reported	85d
	1,484 7	15 02	202d
	2,594 55	1 7668	353d
	4,851	2 773	559d
Transferred to the drumming area where they are compacted into 55-gal drums.	0	0	0
	Included with "Evaporator Bottoms."		
	Included with "Evaporator Bottoms"		
	Included with "Evaporator Bottoms"		
Hydraulic bales, equipped with a dust shroud, is manually operated from a local station to compact dry, low-level, compressible material into 55-gal drums.	0	0	0
	Included with "Evaporator Bottoms"		
	Included with "Evaporator Bottoms"		
Compacted into 55-gal drums with a hydraulic bales.	0	0	0
	Included with "Evaporator Bottoms"		
	Included with "Evaporator Bottoms"		
Compacted into 55-gal drums a layer at a time until drum is filled. During the operation the baling area is closed and the ventilation air is filtered to remove particulates.	No operating report issued as of June 15, 1973		
Hydraulic bales, equipped with dust shroud, is manually operated from a local station to compact the dry compressible wastes into 55-gal drums	0	0	0
Compacted into 55-gal drums	0	0	0
Cemented into 55-gal drums. Apparently no compaction is used.	0	0	0
	0	0	0
	823 2 ¹	> 0 475 ^m	112d
	1,499 4 ¹	< 1 167	204d
	1,991 45	1 513	271d
	1,051 05	0 636	143d
	> 1,117 20	< 21 638	152d.
			1 lead pkg. ⁿ
	948 55	0 785	129d
	859 95	6 452	97d
	565 95	2 149	77d
	> 3,234 0 ⁿ	> 79 115 ⁿ	> 440d ⁿ
Compacted into 55-gal drums by using a hydraulic bales. Accounts for 30-40% of solid waste	0	0	0
	- 800 ft ³ low-level drummed waste stored		

Table A-2c. Summary of Solid Radioactive Waste Treatment at Pressurized Water Reactors (PWRs) in Operation:
Dry Wastes (Noncompressible) and Core Components and Structural

NSSS Reactor [Capacity]	Year	Types of Solid Volume, Activity, and Number of Drums or Casks Shipped					
		(5) Dry Wastes (Noncompressible)			(6) Core Components and		
		Treatment	ft ³	Ci	No of Drums = d Casks = c	Treatment	ft ³
Westinghouse							
Yankee Rowe [485 MW(t)]	1960	None to date	0	0	0	0	
[540 MW(t)]	1961	None to date	0	0	0	0	
[600 MW(t)]	1962	None to date	0	0	0	0	
	1963	Except for the 3 boxes, this was residue from decontaminating core shield tank cavity liner.	>968.15	1.6	3 boxes; 2 pkg; 129d	Small parts (hole plugs and dashpots) shipped in concrete shielded drums; control rods (99.98% of activity) shipped in special cask accompanied by 2 Yankee couriers by ICC special permit.	>176.4
	1964	No special treatment	110.25	0.292	15d		Not reported
	1965	Shipped in concrete casks.	Not reported	3.7464	1 pkg; 5c	None this year.	0
	1966	Solid K ₂ MnO ₄ decontaminant in drums.	44.10	0.017	6d	Control rod followers, guide tubes, dashpots, drive shaft, neutron source, specimen baskets shipped in concrete casks.	Not reported
	1967	None other than those reported under specific categories.	0	0	0		Not reported
	1968		0	0	0	Shipped as described above.	Not reported
	1969		0	0	0	None this year.	0
	1970		0	0	0		0
	1971		0	0	0		0
	1972		0	0	0		0
San Onofre-1 [1347 MW(t)]	1967	None to date.	0	0	0	None to date.	0
	1968	Contaminated lumber disposed of offsite.	Not reported	<0.038	1 pkg	In-core detector (⁶⁰ Co) disposed of offsite.	Not reported
	1969	None this year unless included in "Dry Compressible Waste."	0	0	0	None this year.	0
	1970	Contaminated wood disposed of offsite.	22.0	<8.4694 ^j	3 pkg		0
	1971	Contents not specified.	432.0	<0.2127 ^k	3 boxes		0
	1972		2,520.0	<0.1 ^k	15 boxes		0
Conn. Yankee [1473 MW(t)]	1967	None to date.	0	0	0	None to date.	0
[1825 MW(t)]	1968		0	0	0		0
	1969		0	0	0		0
	1970		0	0	0		0
	1971		0	0	0		0
	1972		0	0	0		0
Genoa [1300 MW(t)]	1969	Small noncompressible items are placed in empty spaces in drums	0	0	0	No description of handling. Any shipment made to date is included in the annual totals appearing under "Dry Compressible Wastes" or "Evaporator Bottoms."	0
[1520 MW(t)]	1970	of compressible waste and are included in the "Dry Compressible Waste" or "Evaporator Bottoms."	0	0	0		0
	1971		0	0	0		0
	1972		0	0	0		0
Robinson-2 [2200 MW(t)]	1970	Not mentioned.	0	0	0	None to date.	0
	1971			Not reported			0
	1972			Not reported			0
Pt. Beach 1 & 2 [1510 MW(t)] ea.	1970	Not mentioned.	0	0	0	None to date.	0
	1971			Not reported			0
	1972			Not reported			0
Surry 1 & 2 [2441 MW(t)]	1972	Metallic materials and other highly contaminated objects are placed inside a cylindrical concrete core at the center of a 55-gal drum. Annulus between core and drum and drum bottom is concreted before inserting the material and more concrete is added after loading.	No operating report issued as of June 15, 1973.			Not mentioned.	No operating
Turkey Pt. 3 & 4 [2200 MW(t)] ea.	1972	Not mentioned.	0	0	0	None to date.	0
Maine Yankee [2440 MW(t)]	1972	Contaminated metallic materials and highly contaminated solid objects are placed inside shielded 55-gal drums.	0	0	0	None to date. Treatment not mentioned.	0
Babcock & Wilcox							
Indian Pt. 1 [615 MW(t)]	1962	Concrete shielding placed inside	0	0	0	Stored in spent fuel storage pit. No	0
	1963	55-gal drums before inserting all	0	0	0	mention of packaging for offsite	0
	1964	items to be shipped; then more	0	0	0	shipment.	0
	1965	concrete is added.	Not specifically reported, so appears under				Not specific
	1966		"Dry Compressible Wastes."				"Dry Compr
	1967						
	1968						
	1969						
	1970						
	1971						
	1972						

(f) Solid Radioactive Waste Treatment at Pressurized Water Reactors (PWRs) in Operation:
 Dry Wastes (Noncompressible) and Core Components and Structures

Types of Solid, Volume, Activity, and Number of Drums or Casks Shipped						
(a) (Noncompressible)			(b) Core Components and Structures			
ft ³	Ci	No of Drums = d Casks = c	Treatment	ft ³	Ci	No of Drums = d Casks = c
0	0	0		0	0	0
0	0	0		0	0	0
0	0	0		0	0	0
968.15	1.6	3 boxes; 2 pkg; 129d	Small parts (link plugs and dashpots) shipped in concrete shielded drums. control rods (99.98% of activity) shipped in special cask accompanied by 2 Yankee couriers by ICC special permit.	>176.4	>60,011.1 ^p	26d, 1c
110.25	0.292	15d		Not reported	60,000	1c
Not reported	3.7464	1 pkg; 5c	None this year	0	0	0
44.10	0.017	5d	Control rod followers, guide tubes, dashpots, drive shaft, neutron source, specimen baskets shipped in concrete casks.	Not reported	486+<2	4c, 2d (w. 2c)
0	0	0		Not reported	37,000	2c
0	0	0	Shipped as described above.	Not reported	600	1c
0	0	0	None this year	0	0	0
0	0	0		0	0	0
0	0	0		0	0	0
0	0	0		0	0	0
0	0	0	None to date.	0	0	0
Not reported	<0.038	1 pkg	In-core detector (⁶⁰ Co) disposed of offsite.	Not reported	6	1c
0	0	0	None this year.	0	0	0
22.0	<8.4694 ^j	3 pkg		0	0	0
432.0	<0.2127 ^k	3 boxes		0	0	0
1,520.0	<0.1 ^x	15 boxes		0	0	0
0	0	0	None to date.	0	0	0
0	0	0		0	0	0
0	0	0		0	0	0
0	0	0		0	0	0
0	0	0		0	0	0
0	0	0		0	0	0
0	0	0	No description of handling. Any ship- ment made to date is included in the annual totals appearing under "Dry Compressible Wastes" or "Evaporator Bottoms."	0	0	0
0	0	0		0	0	0
0	0	0		0	0	0
0	0	0		0	0	0
0	0	0	None to date.	0	0	0
0	Not reported	0		0	0	0
0	Not reported	0		0	0	0
0	0	0	None to date.	0	0	0
0	Not reported	0		0	0	0
0	Not reported	0		0	0	0
operating report issued as of June 15, 1973.			Not mentioned	No operating report issued as of June 15, 1973		
0	0	0	None to date.	0	0	0
0	0	0	None to date. Treatment not mentioned.	0	0	0
0	0	0		0	0	0
0	0	0	Stored in spent fuel storage pit. No mention of packaging for offsite shipment.	0	0	0
0	0	0		0	0	0
0	0	0		0	0	0
Specifically reported, so appears under "Compressible Wastes."				Not specifically reported, so appears under "Dry Compressible Wastes."		

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	1969		0	0	0	None this year	0
	1970		0	0	0		0
	1971		0	0	0		0
	1972		0	0	0		0
San Onofre-1 [1347 MW(t)]	1967	None to date.	0	0	0	None to date.	0
	1968	Contaminated lumber disposed of offsite.	Not reported	<0.038	1 pkg	In-core detector (⁶⁰ Co) disposed of offsite.	Not reported
	1969	None this year unless included in "Dry Compressible Waste."	0	0	0	None this year	0
	1970	Contaminated wood disposed of offsite.	22.0	<8.4694 ¹	3 pkg		0
	1971	Contents not specified.	432.0	<0.2127 ^k	3 boxes		0
	1972		2,520.0	<0.1 ^k	15 boxes		0
Conn. Yankee [1473 MW(t)] [1825 MW(t)]	1967	None to date.	0	0	0	None to date.	0
	1968		0	0	0		0
	1969		0	0	0		0
	1970		0	0	0		0
	1971		0	0	0		0
	1972		0	0	0		0
Genoa [1300 MW(t)]	1969	Small noncompressible items are placed in empty spaces in drums of compressible waste and are included in the "Dry Compressible Waste" or "Evaporator Bottoms."	0	0	0	No description of handling. Any shipment made to date is included in the annual totals appearing under "Dry Compressible Wastes" or "Evaporator Bottoms."	0
	1970		0	0	0		0
	1971		0	0	0		0
	1972		0	0	0		0
Robinson-2 [2200 MW(t)]	1970	Not mentioned.	0	0	0	None to date.	0
	1971			Not reported			0
	1972			Not reported			0
Pt. Beach 1 & 2 [1518 MW(t)] ea.	1970	Not mentioned.	0	0	0	None to date.	0
	1971			Not reported			0
	1972			Not reported			0
Surry 1 & 2 [2441 MW(t)]	1972	Metallic materials and other highly contaminated objects are placed inside a cylindrical concrete core at the center of a 55-gal drum. Annulus between core and drum and drum bottom is concreted before inserting the material and more concrete is added after loading.	No operating report issued as of June 15, 1973.			Not mentioned.	No operating report
Turkey Pt. 3 & 4 [2200 MW(t)] ea.	1972	Not mentioned.	0	0	0	None to date.	0
Maine Yankee [2440 MW(t)]	1972	Contaminated metallic materials and highly contaminated solid objects are placed inside shielded 55-gal drums.	0	0	0	None to date. Treatment not mentioned.	0
<u>Babcock & Wilcox:</u>							
Indian Pt. 1 [615 MW(t)]	1962	Concrete shielding placed inside 55-gal drums before inserting small items to be shipped, then more concrete is added.	0	0	0	Stored in spent fuel storage pit. No mention of packaging for offsite shipment.	0
	1963		0	0	0		0
	1964		0	0	0		0
	1965		Not specifically reported, so appears under "Dry Compressible Wastes."				Not specifically reported
	1966						"Dry Compressible Wastes."
	1967						
	1968						
	1969						
	1970						
	1971						
	1972						
<u>Combustion-Engineering:</u>							
Palesades [2212 MW(t)]	1971	Small items placed in 55-gal drums but not baled.	0	0	0	Stored in underground vault in the restricted area.	0
	1972		0	0	0		0

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			0	0	0
0.838	1 pkg	In-core detector (⁶⁰ Co) disposed of offsite	Not reported	6	1c
0	0	None this year	0	0	0
0.4694	3 pkg		0	3	0
0.2127 ^k	3 boxes		0	0	0
0.1 ^k	15 boxes		0	0	0
0	0	None to date	0	0	0
0	0		0	0	0
0	0		0	0	0
0	0		0	0	0
0	0		0	0	0
0	0		0	0	0
0	0	No description of handling. Any shipment made to date is included in the annual totals appearing under "Dry Compressible Wastes" or "Evaporator Bottoms."	0	3	0
0	0		0	0	0
0	0		0	0	0
0	0			Not reported	
0	0	None to date.	0	0	0
Not reported			0	0	0
Not reported			0	0	0
0	0	None to date.	0	0	0
Not reported			0	0	0
Not reported				Not reported	
issued as of June 15, 1973.		Not mentioned		No operating report issued as of June 15, 1973.	
0	0	None to date.	0	0	0
0	0	None to date. Treatment not mentioned.	0	0	0
D	0	Stored in spent fuel storage pit. No mention of packaging for offsite shipment.	0	0	0
D	0		0	0	0
D	0		0	0	0
ried, so appears under Wastes."				Not specifically reported, so appears under "Dry Compressible Wastes."	
D	0	Stored in underground vault in the restricted area.	0	0	0
D	0		0	0	0

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Table A-2d. Summary of Solid Radioactive Waste Treatment at Pressurized Water Reactors (PWRs) in Operation:
Drum or Cask Decontamination Method, Number and Type Shipments, and Destination

NSSS: Reactor [Capacity]	Year	Drum or Cask Decontamination Method	Shipments		
			Number	Type ^q	Destination
Westinghouse:					
Yankee-Rowe [485 MW(t)] [540 MW(t)] [600 MW(t)]	1960	Place on yard decontamination pad and scrub manually using water jet-type brush.	1	(2)	Not designated.
	1961		5	(2)	
	1962		7	(2)	Burial ground not designated.
	1963		6	(2)	
			2	(5)	
			3	(6)	23 Core I control rods buried at Oak Ridge Burial ground not designated.
	1964		3	(2)	
			4	(1), (2)	24 Core II control rods buried at Oak Ridge Not designated.
			1	(6)	
	1965		12(?) total	(1), (2), (3), (5)	Not designated.
	1966		7	(2)	
			1	(2), (5)	
			4	(6)	
	1967		15	(2)	
			2	(3)	
			2	(6)	Spent control rod shipped to undesignated Not designated.
	1968		9	(2)	
			2	(3)	Control and shim rod sections shipped to ground. Not designated.
			1	(6)	
	1969		8	(2)	Not designated.
			1	(2), (3), (1)	
			5	(1)	
			1	(3)	
	1970		8	(2)	
			1	(2), (4)	
			1	(3)	
	1971		7	(2)	
			1	(2), (4)	
	1972		17	(2)	
			1	(2), (4)	
San Onofre-1 [1347 MW(t)]	1967	Decontamination pad is mentioned, but specific method is not described.	0		No shipments.
	1968		Not reported	(3), (4), (5), (6)	Not designated.
	1969		3	(4)	
	1970		Not reported	(1), (4), (5)	
	1971			(4), (5)	
	1972			(1), (4), (5)	
Conn. Yankee [1473 MW(t)] [1825 MW(t)]	1967	Decontamination pad is mentioned, but specific method is not described.	0		No shipments.
	1968		1	(2)	Not designated.
	1969		5	(2)	
			2	(3), (4)	
	1970		4	(1)	
			4	(3)	
			3	(4)	
	1971		7	(1)	
			2	(3)	
			5	(4)	
	1972		13	(1)	
			3	(3)	
			5	(4)	
Ginna [1300 MW(t)] [1520 MW(t)]	1969	No mention of cleaning method, but drums are lead-shielded and are moved remotely with a trolley crane to storage area and/or to contractor's truck.	0		Shipped by McCormack's Highway Transport Nuclear Fuel Services, West Valley, N.Y. 43 shipments to Nuclear Fuel Services, 8 shipments to Nuclear Engineering Co.,
	1970		3	(4), (3)	
	1971		24	(2) ^f	
	1972		51	(2) ^g	
Robinson-2 [2200 MW(t)]	1970	Same as for Ginna above.	0		No shipments.
	1971		2	(2)	Chem. Nuclear Services, Inc., Barnwell, S.C.
	1972		5	(2)	Chem. Nuclear Services, Inc., Barnwell, S.C. (stored).
Pt. Beach 1 & 2 [1518 MW(t)] ea.	1970	Cleaning method not mentioned, but drumming station is remotely operated and automatically monitored for radioactivity.	0		No shipments.
	1971		6	(2)	Not designated.
	1972		2	(1)	
			13	(2)	
Surry 1 & 2 [2441 MW(t)] ea.	1972	Radioactivity on contact with surface of the drum is measured, recorded, and attached to drum. Method is not de-	No operating report issued as of June 15, 1973		Maxey Flats, Ky.

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Radioactive Waste Treatment at Pressurized Water Reactors (PWRs) in Operation:
Removal Method, Number and Type Shipments, and Destination

	Shipments		
	Number	Type ^a	Destination
Spent and type	1	(2)	Not designated.
	3	(2)	
	7	(2)	
	6	(2)	Burial ground not designated.
	2	(5)	
	3	(6)	23 Core I control rods buried at Oak Ridge, Tenn.
	3	(2)	Burial ground not designated.
	4	(1), (2)	
	1	(6)	24 Core II control rods buried at Oak Ridge, Tenn.
	12(?) total	(1), (2), (3), (5)	Not designated.
	7	(2)	
	1	(2), (5)	
	4	(6)	
	15	(2)	
	2	(3)	
	2	(6)	Spent control rod shipped to undesignated burial ground.
	9	(2)	Not designated.
	2	(3)	
	1	(6)	Control and shim rod sections shipped to unnamed burial ground.
	8	(2)	Not designated.
	1	(2), (3), (1)	
	5	(1)	
	1	(3)	
	8	(2)	
	1	(2), (4)	
	1	(3)	
	7	(2)	
	1	(2), (4)	
	17	(2)	
	1	(2), (4)	
Spent, but not reported.	0		No shipments.
	Not reported	(3), (4), (5), (6)	Not designated.
	3	(4)	
	Not reported	(1), (4), (5)	
		(4), (5)	
		(1), (4), (5)	
Spent, but not reported.	0		No shipments.
	1	(2)	Not designated.
	5	(2)	
	2	(3), (4)	
	4	(1)	
	4	(3)	
	3	(4)	
	7	(1)	
	2	(3)	
	5	(4)	
	13	(1)	
	3	(3)	
	5	(4)	
Spent, but not reported, moved to storage tank.	0		No shipments.
	3	(4), (3)	Shipped by McCormack's Highway Transportation, Inc. to Nuclear Fuel Services, West Valley, N.Y.
	24	(2) ^f	43 shipments to Nuclear Fuel Services, West Valley, N.Y.
	51	(2) ^g	8 shipments to Nuclear Engineering Co., Morehead, Ky.
	0		No shipments.
	2	(2)	Chem. Nuclear Services, Inc., Barnwell, S.C.
	5	(2)	Chem. Nuclear Services, Inc., Barnwell, S.C. (~116 drums stored).
Spent, but not reported, moved to storage tank, and for radio-	0		No shipments.
	6	(2)	Not designated.
	2	(1)	
	13	(2)	
Surface of, and	No operating report issued as of June 15, 1973		Maxey Flats, Ky.

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	1972		1	(2), (4)	
			17	(2)	
			1	(2), (4)	
San Onofre-1 [1347 MW(t)]	1967	Decontamination pad is mentioned, but specific method is not described.	0		No shipments.
	1968		Not reported	(3), (4), (5), (6)	Not designated.
	1969		3	(4)	
	1970		Not reported	(1), (4), (5)	
	1971			(4), (5)	
	1972			(1), (4), (5)	
Conn. Yankee [1473 MW(t)] [1825 MW(t)]	1967	Decontamination pad is mentioned, but specific method is not described.	0		No shipments.
	1968		1	(2)	Not designated.
	1969		5	(2)	
			2	(3), (4)	
	1970		4	(1)	
			4	(3)	
			3	(4)	
	1971		7	(1)	
			2	(3)	
			5	(4)	
	1972		13	(1)	
			3	(3)	
			5	(4)	
Ginna [1300 MW(t)] [1520 MW(t)]	1969	No mention of cleaning method, but drums are lead-shielded and are moved remotely with a trolley crane to storage area and/or to contractor's truck.	0		
	1970		3	(4), (3)	Shipped by McCormack's Highway.
	1971		24	(2) ^f	Nuclear Fuel Services, West Valley,
	1972		51	(2) ^g	43 shipments to Nuclear Fuel Serv 8 shipments to Nuclear Engineering
Robinson-2 [2200 MW(t)]	1970	Same as for Ginna above.	0		No shipments.
	1971		2	(2)	Chem. Nuclear Services, Inc., Barn
	1972		5	(2)	Chem. Nuclear Services, Inc., Barn stored).
Pt. Beach 1 & 2 [1518 MW(t)] ea.	1970	Cleaning method not mentioned, but drumming station is remotely operated and automatically monitored for radioactivity.	0		No shipments.
	1971		6	(2)	Not designated.
	1972		2	(1)	
			13	(2)	
Surry 1 & 2 [2441 MW(t)] ea.	1972	Radioactivity on contact with surface of the drum is measured, recorded, and attached to drum. Method is not described nor is cleaning procedure.	No operating report issued as of June 15, 1973		Maxey Flats, Ky.
Turkey Pt. 3 & 4 [2200 MW(t)] ea.	1972	Cleaning is not mentioned, but drumming station is remotely operated and drums are moved by crane.	0		No shipments. (16 drums containk stored).
Maine Yankee [2440 MW(t)]	1972	No mention of cleaning method.	0		No shipments. (In the future they Fuel Services, West Valley, N.Y.)
<u>Babcock & Wilcox:</u>					
Indian Pt. 1 [615 MW(t)]	1962	Only a facility for decontaminating spent fuel casks is mentioned.	0		No shipments.
	1963		0		No shipments.
	1964		3	(4) ¹	Not designated.
	1965		5	(4) ¹	
	1966		5	(4) ¹	
	1967		3	(4) ¹	
	1968		4	(4) ¹	
	1969		2	(4) ¹	
	1970		2	(4) ¹	
	1971		1	(4) ¹	
	1972		>7 ⁰	(4) ¹	
	<u>Combustion-Engineering:</u>				
Palisades [2212 MW(t)]	1971	Cleaning method not mentioned.	0		No shipments.
	1972		2	(1)	Nuclear Engineering Co., Morehead

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7	(2)	
1	(2), (4)	
17	(2)	
1	(2), (4)	
0		No shipments.
Not reported	(3), (4), (5), (6)	Not designated.
3	(4)	
Not reported	(1), (4), (5)	
	(4), (5)	
	(1), (4), (5)	
0		No shipments.
1	(2)	Not designated.
5	(2)	
2	(3), (4)	
4	(1)	
4	(3)	
3	(4)	
7	(1)	
2	(3)	
5	(4)	
13	(1)	
3	(3)	
5	(4)	
0		
3	(4), (3)	Shipped by McCormack's Highway Transportation, Inc. to
24	(2) ^f	Nuclear Fuel Services, West Valley, N.Y.
51	(2) ^g	43 shipments to Nuclear Fuel Services, West Valley, N.Y.
		8 shipments to Nuclear Engineering Co., Morehead, Ky.
0		No shipments.
2	(2)	Chem. Nuclear Services, Inc., Barnwell, S.C.
5	(2)	Chem. Nuclear Services, Inc., Barnwell, S.C. (~110 drums stored).
0		No shipments.
6	(2)	Not designated.
2	(1)	
13	(2)	
No operating report issued as of June 15, 1973		Maxey Flats, Ky.
0		No shipments. (16 drums containing $<6.4 \times 10^{-4}$ Ci stored).
0		No shipments. (In the future they may go to Nuclear Fuel Services, West Valley, N.Y.)
0		No shipments.
0		No shipments.
3	(4) ¹	Not designated.
5	(4) ¹	
5	(4) ¹	
3	(4) ¹	
4	(4) ¹	
2	(4) ¹	
2	(4) ¹	
1	(4) ¹	
>7°	(4) ¹	
0		No shipments.
2	(1)	Nuclear Engineering Co., Morehead, Ky.

Footnotes for Tables A-2a, -2b, -2c, and -2d

^aYankee-Rowe Monthly Operations Report, January 1963, in summary for previous year

^bThis large volume increase is unexplained, but may include wastes that were formerly incinerated

^cBoric acid evaporation system was added after plugging was experienced at the end of 1968

^dMostly ^{58,60}Co and ⁵⁴Mn

^eCrud burst in March 1970

^fNo breakdown was made as to the amount of each type of waste shipped. There were some filters, some resins, a sizeable amount of evaporator bottoms and compacted dry waste, but almost ²/₃ of the total volume reported was low level liquid absorbed on vermiculite

^gNo breakdown was made as to the amount of each type of waste shipped. Approximately ¹/₂ the volume was evaporator bottoms and compressible dry waste, but the composition of the other half was not specified

^hAs of December 1972, plans were to install a urea formaldehyde solidification system for evaporator bottoms and spent resins

ⁱ9 drums of incinerator ash are included under evaporator bottoms

^jActivity was reported for 135 drums of dry compressible waste and 3 packages of wood with no breakdown as to distribution

^kActivity was reported inclusive for drums and boxes

^lFor 1964 and 1965, this was reported as "rubbish," but from 1966 to the present, the only designation has been "solid radioactive waste"

^mMostly ^{58,60}Co and ⁵⁴Mn

ⁿLead pig volume is not given, nor is it specifically designated as waste, but only as a "radioactive offsite shipment"

^oData for the last 3 months of 1972 was not reported at press time.

^p60,000 Ci for 23 Core 1 control rods (ref. 2).

^qSee numerical designation under "Types of Solids . . ." column.

Appendix B

HISTORICAL DATA TABLES FOR THE INDIVIDUAL REACTORS INCLUDING:
FIRST CRITICALITY, ANNUAL AND CUMULATIVE THERMAL OUTPUT
AND WASTE GENERATION, AND REFUELING SCHEDULES

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**Table B-1. Amount of Solid Radioactive Waste Compared with Gross Thermal Energy Produced:
Dresden I**

(Through December 31, 1972)

Type: Boiling Water Reactor

Power: 700 MW(t), 200 MW(e) net

Initial criticality: October 15, 1955^a

Year	Gross Solid Waste Shipped Offsite				Gross Thermal Energy Produced (MWhr)	
	Volume (ft ³)		Radioactivity (Ci)		Annual Amount	Cumulative Total
	Annual Amount	Cumulative Total	Annual Amount	Cumulative Total		
1959	b	b	b	b	c	c
1960	1,147	1,147	0.1	0.1	908,887	908,877
1961	3,320	4,467	1	1	1,858,575	2,717,462
1962	3,360	7,827	2	3	4,032,427	6,749,889
1963	5,972	13,799	1	4	3,136,675	9,886,564
1964	1,919	15,718	0.4	4	3,328,510	13,215,074
1965	3,329	19,047	0.6	5	3,315,583	16,530,657
1966	2,012	21,059	0.6	6	4,781,128	21,311,785
1967	12,314 ^d	33,373	13 ^d	19	2,768,700	24,080,485
1968	7,807 ^e	41,180	209 ^e	228	3,199,385	27,279,870
1969	3,422	44,602	282	510	2,891,837	30,171,707
1970	9,623	54,225	3	513	4,772,040	34,943,747
1971	15,312	69,537	2	515	2,377,872	37,321,619
1972	20,800	90,337	4	519	3,762,787	41,084,406

^aRefueling schedules: Nov. 7–Dec. 20, 1962; Apr. 12–June 9, 1962; Mar. 28–May 29, 1965; Jan. 13–May 29, 1967; Feb. 3–June 2, 1968; Sept. 6, 1969–Jan. 1, 1970; Sept. 10, 1971–Feb. 1, 1972.

^bNot reported.

^cLow-power tests.

^dIncludes 4,110 ft³ of spent resin containing 12 Ci of radioactivity.

^eIncludes 60 ft³ of high-level waste containing 209 Ci.

Table B-2. Amount of Solid Radioactive Waste Compared with Gross Thermal Energy Produced:
Big Rock Point

(Through December 31, 1972)

Type: Boiling Water Reactor

Power: 240 MW(t), 70.3 MW(e) net

Initial criticality: September 27, 1962^a

Year	Gross Solid Waste Shipped Offsite				Gross Thermal Energy Produced (MWhr)	
	Volume (ft ³)		Radioactivity (Ci)		Annual Amount	Cumulative Total
	Annual Amount	Cumulative Total	Annual Amount	Cumulative Total		
1962 ^b	c	c	c	c	2,000	2,000
1963 ^b	c	c	c	c	400,287	402,287
1964 ^b	c	c	c	c	629,516	1,031,803
1965	1,584 ^d	1,584	379 ^d	379	593,192	1,624,995
1966	330	1,914	<2.0	381	1,142,246	2,767,241
1967	>162 ^e	2,076	50 ^e	431	1,718,576	4,485,817
1968	2,279 ^f	4,355	1,746 ^f	2,177	1,414,506	5,900,323
1969	852 ^g	5,207	61 ^g	2,238	1,302,207	7,202,530
1970	>7	5,214	113	2,351	1,176,288	8,378,818
1971	845	6,059	0.3	2,351	1,205,599	9,584,417
1972	>2,139 ^h	>8,198	1,128 ^h	3,479	1,195,550	10,779,967

^aRefueling schedule: May 1–May 4 and July 13–Aug. 9, 1964; remove core: Sept. 18, 1964–Mar. 16, 1965; reload: Mar. 17–27 and Aug. 20–Sept. 4, 1965; Apr. 10–May 8 and Sept. 17–Oct. 11, 1966; May 19–June 14, 1967; Feb. 11–Mar. 15 and June 21–July 16, 1968; Apr. 18–May 19, 1969; Feb. 13–Mar. 29, 1970; Feb. 12–Mar. 13, 1971; Mar. 18–May 13, 1972.

^bAnalysis and testing.

^cNot reported.

^dIncludes 1,562 ft³ of spent demineralizer resins containing total activity of 378 Ci.

^e48 ft³ of waste contained 50 Ci.

^f1,446 ft³ low-level dry waste containing >19 Ci; 833 ft³ spent resins containing 1,727 Ci.

^g220 ft³ high-level waste containing 61 Ci; 632 ft³ low-level waste containing 0.3 Ci.

^h1,250 ft³ spent resin accounted for 1,116 Ci.

**Table B-3. Amount of Solid Radioactive Waste Compared with Gross Thermal Energy Produced:
Humboldt Bay**

(Through December 31, 1972)

Type: Boiling Water Reactor
Power: 240 MW(t), 68.5 MW(e) net
Initial criticality: February 16, 1963^a

Year	Gross Solid Waste Shipped Offsite				Gross Thermal Energy Produced (MWhr)	
	Volume (ft ³)		Radioactivity (Ci)		Annual Amount	Cumulative Total
	Annual Amount	Cumulative Total	Annual Amount	Cumulative Total		
1963	0	0	0	0	565,344	565,344
1964 ^b	649	649	1 ^c	1	1,222,440	1,787,784
1965 ^b	1,770	2,419	1	2	891,922	2,679,706
1966 ^b	0	2,419	0	2	585,086	3,264,792
1967 ^b	1,347	3,766	1	3	1,126,634	4,391,426
1968	d	>3,766	2 ^e	5	1,507,600	5,899,026
1969	0	>3,766	0	5	1,278,499	7,177,525
1970	1,421	5,187	>5 ^f	>10	1,398,874	8,576,399
1971	2,377	7,564	4 ^g	>14	1,140,734	9,717,133
1972	2,012	9,576	5 ^h	>19	1,250,385	10,967,518

^aRefueling schedule: Aug. 16–Sept. 13, 1964; Sept. 20–Dec. 1, 1965; Nov. 18–Dec. 20, 1966; Mar. 29–Apr. 5 and Oct. 4–Oct. 28, 1967; Oct. 5–Oct. 26, 1968; June 14–July 20, 1969; Apr. 17–May 9, 1970; June 5–Aug. 25, 1971; Aug. 25–Oct. 6, 1972.

^bJ. O. Blomeke and F. E. Harrington, ORNL-4070 (January 1968) (Ref. 1).

^cMiscellaneous waste with principal activities being ⁶⁵Zn, ⁵⁹Fe, and ⁶⁰Co.

^dNot reported.

^eLow-level waste with ⁶⁵Zn the principal activity.

^fIncludes 110 ft³ (15 drums) high-level waste containing 5 Ci of ⁶⁰Co and ⁵⁴Mn, and 73 ft³ (10 drums) containing less than 0.00003 Ci of mixed fission products and ⁶⁰Co.

^gMixed fission products and ⁶⁰Co.

^hIncludes 605.5 ft³ of solidified evaporator bottoms (50 drums plus 7 shipping cask liners (?) of 34 ft³ each) containing 2 Ci of ⁶⁷Co, ¹³⁴Cs, ¹³⁷Cs, and ⁵⁴Mn; 110 ft³ (15 drums) of high-level waste containing 3 Ci of ⁶⁰Co, ⁵⁴Mn, and ⁶⁵Zn. The remaining volume contains a total of less than 0.1 Ci of mixed fission products. This is the first shipment of evaporator bottoms ever to be shipped offsite.

**Table B-4. Amount of Solid Radioactive Waste Compared with Gross Thermal Energy Produced:
La Crosse**

(Through December 31, 1972)

Type: Boiling Water Reactor
Power: 165 MW(t), 53.2 MW(e) net
Initial criticality: July 11, 1967^a

Year	Gross Solid Waste Shipped Offsite				Gross Thermal Energy Produced (MWhr)	
	Volume (ft ³)		Radioactivity (Ci)		Annual Amount	Cumulative Total
	Annual Amount	Cumulative Total	Annual Amount	Cumulative Total		
Core I						
1967	0	0	0	0	420	420
1968	550	550	<0.2	<0.2	21,852	22,272
1969	642 ^b	1,192	1	1	245,784	268,056
Core II						
1970	669	1,861	3	4	447,816	715,872
1971	0	1,861	0	4	707,256	1,423,128
1972	880 ^c	2,741	d	>4	816,552	2,239,680

^aRefueling schedule: May 4–June 29, 1969; Nov. 1, 1969–May 1, 1970; Sept. 4–Dec. 25, 1971; Aug. 19–Oct. 14, 1972.

^bMostly compacted dry waste and resin in concrete.

^c100 ft³ of this was spent resin.

^dNot reported.

**Table B-5. Amount of Solid Radioactive Waste Compared with Gross Thermal Energy Produced:
Oyster Creek**

(Through December 31, 1972)

Type: Boiling Water Reactor
Power: 1,930 MW(t), 340 MW(e) net
Initial criticality: May 3, 1969^a

Year	Gross Solid Waste Shipped Offsite				Gross Thermal Energy Produced (MWhr)	
	Volume (ft ³)		Radioactivity (Ci)		Annual Amount	Cumulative Total
	Annual Amount	Cumulative Total	Annual Amount	Cumulative Total		
1969	0 ^b	0	0 ^b	0	1,195,344	1,195,344
1970	7,700	7,700	3	3	10,603,148	11,798,492
1971	10,866	18,566	5	8	11,679,781	23,478,273
1972	15,398 ^c	33,964	1,301 ^c	1,309	12,981,053	36,459,326

^aRefueling schedule: Sept. 18–Nov. 11, 1971; May 1–June 20, 1972.

^b1,073 ft³ containing 0.4 Ci was stored.

^cIncludes 353 ft³ of spent resin containing 1,256 Ci gross radioactivity.

**Table B-6. Amount of Solid Radioactive Waste Compared with Gross Thermal Energy Produced:
Nine Mile Point**

(Through December 31, 1972)

Type: Boiling Water Reactor
Power: 1,850 MW(t), 625 MW(e) net
Initial criticality: September 5, 1969^a

Year	Gross Solid Waste Shipped Offsite				Gross Thermal Energy Produced (MWhr)	
	Volume (ft ³)		Radioactivity (Ci)		Annual Amount	Cumulative Total
	Annual Amount	Cumulative Total	Annual Amount	Cumulative Total		
1969	0	0	0	0	294,998	294,998
1970	3,070	3,070	4	4	5,940,025	6,235,023
1971	12,910	15,980	201	205	9,937,980	16,173,003
1972	15,097	31,077	265	470	10,010,626	26,183,629

^aRefueling schedule: Sept. 18–Oct. 26, 1971; Apr. 1–June 15, 1972.

**Table B-7. Amount of Solid Radioactive Waste Compared with Gross Thermal Energy Produced:
Dresden 2 and 3**

(Through December 31, 1972)

Type: Boiling Water Reactor
Power: 2,527 MW(t), 809 MW(e) net, each
Initial criticality: Unit 2, January 7, 1970;^a Unit 3, January 31, 1971

Year	Gross Solid Waste Shipped Offsite				Gross Thermal Energy Produced (MWhr)	
	Volume (ft ³)		Radioactivity (Ci)		Annual Amount	Cumulative Total
	Annual Amount	Cumulative Total	Annual Amount	Cumulative Total		
1970	13,160	13,160	9	9	4,111,690	4,111,690
1971	19,687	32,847	49	58	12,324,787	16,436,477
1972	35,880	68,727	119	177	25,193,067	41,629,544

^aRefueling schedule (Unit 2): June 5–Aug. 11, 1970; Feb. 26–May 29, 1971; Feb. 19–May 10, 1972.

**Table B-8. Amount of Solid Radioactive Waste Compared with Gross Thermal Energy Produced:
Millstone Point 1**

(Through December 31, 1972)

Type: Boiling Water Reactor
Power: 2,011 MW(t), 652.1 MW(e) net
Initial criticality: October 26, 1970^a

Year	Gross Solid Waste Shipped Offsite				Gross Thermal Energy Produced (MWhr)	
	Volume (ft ³)		Radioactivity (Ci)		Annual Amount	Cumulative Total
	Annual Amount	Cumulative Total	Annual Amount	Cumulative Total		
1970	0 ^b	0 ^b	0 ^b	0 ^b	287,709	287,709
1971	7,349	7,349	95	95	11,112,012	11,599,721
1972	9,222	16,571	433	528	9,687,612	21,087,333

^aRefueling schedule: Sept. 1, 1972–until after Dec. 31, 1972.

^b12 ft³ containing 1 Ci was stored.

**Table B-9. Amount of Solid Radioactive Waste Compared with Gross Thermal Energy Produced:
Monticello**

(Through December 31, 1972)

Type: Boiling Water Reactor
Power: 1,670 MW(t), 545 MW(e) net
Initial criticality: December 11, 1970

Year	Gross Solid Waste Shipped Offsite				Gross Thermal Energy Produced (MWhr)	
	Volume (ft ³)		Radioactivity (Ci)		Annual Amount	Cumulative Total
	Annual Amount	Cumulative Total	Annual Amount	Cumulative Total		
1970	0	0	0	0	0	0
1971	10,904	10,904	18	18	4,300,000	4,300,000
1972	6,278	17,182	88	106	11,000,000	15,300,000

**Table B-10. Amount of Solid Radioactive Waste Compared with Gross Thermal Energy Produced:
Quad-Cities 1 and 2**

(Through December 31, 1972)

Type: Boiling Water Reactor
Power: 2,511 MW(t), 800 MW(e) net, each
Initial criticality: Unit 1, October 7, 1971; Unit 2, April 26, 1972

Year	Gross Solid Waste Shipped Offsite				Gross Thermal Energy Produced (MWhr)	
	Volume (ft ³)		Radioactivity (Ci)		Annual Amount	Cumulative Total
	Annual Amount	Cumulative Total	Annual Amount	Cumulative Total		
1971	2,109	2,109	0.03	0.03	988 ^a	988
1972	37,949	40,058	9	9	12,521,525	12,522,513

^aQuad-Cities 1 and 2 Semi-Annual Operating Report No. 1.

**Table B-11. Amount of Solid Radioactive Waste Compared with Gross Thermal Energy Produced:
Vermont Yankee**

(Through December 31, 1972)

Type: Boiling Water Reactor
Power: 1,593 MW(t), 513.9 MW(e) net
Initial criticality: March 24, 1972

Year	Gross Solid Waste Shipped Offsite				Gross Thermal Energy Produced (MWhr)	
	Volume (ft ³)		Radioactivity (Ci)		Annual Amount	Cumulative Total
	Annual Amount	Cumulative Total	Annual Amount	Cumulative Total		
1972	4,458	4,458	18	18	1,479,512	1,479,512

**Table B-12. Amount of Solid Radioactive Waste Compared with Gross Thermal Energy Produced:
Pilgrim 1**

(Through December 31, 1972)

Type: Boiling Water Reactor
Power: 1,998 MW(t), 564 MW(e) net
Initial criticality: June 16, 1972

Year	Gross Solid Waste Shipped Offsite				Gross Thermal Energy Produced (MWhr)	
	Volume (ft ³)		Radioactivity (Ci)		Annual Amount	Cumulative Total
	Annual Amount	Cumulative Total	Annual Amount	Cumulative Total		
1972	2,335	2,385	<20	<20	2,654,184	2,654,184

**Table B-13. Amount of Solid Radioactive Waste Compared with Gross Thermal Energy Produced:
Yankee-Rowe**

(Through December 31, 1972)

Type: Pressurized Water Reactor
Power: 600 MW(t), 175 MW(e) net. Note: Full power for August 1960–December 1960 was 392 MW(t); January 1961–May 1962, 485 MW(t); September 1962–mid-December 1963, 540 MW(t); mid-December 1963–present, 600 MW(t)
Initial criticality: August 19, 1960^a

Year	Gross Solid Waste Shipped Offsite				Gross Thermal Energy Produced (MWhr)	
	Volume (ft ³)		Radioactivity (Ci)		Annual Amount	Cumulative Total
	Annual Amount	Cumulative Total	Annual Amount	Cumulative Total		
1960	96	96	<0.00001	<0.00001	126,852	126,852
1961	588 ^b	684	0.1	0.1	2,992,983	3,119,835
	(70 concrete drums)					
1962	3,800	4,484	1	1	2,321,242	5,441,077
1963	>4,650	9,134	5	6	3,287,372	8,728,449
1964	3,826 ^c	12,960	95 ^d	101	4,200,951	12,929,400
1965	>5,180 ^e	18,140	107	208	3,400,357	16,329,757
1966	3,330	21,470	<6	<214	4,514,275	20,844,032
1967	6,284	27,754	6	<220	4,507,719	25,351,751
1968	3,781	31,535	15	<235	4,290,227	29,641,978
1969	4,334	35,869	163	<398	3,959,567	33,601,545
1970	3,881	39,750	4	<402	4,127,520	37,729,065
1971	4,490	44,240	3	<405	5,016,512	42,745,577
1972	7,842	52,082	2	<407	2,396,226	45,141,803

^aRefueling schedule: May 18–Sept. 12, 1962; Sept. 2–Nov. 8, 1963; Aug. 2–Aug. 30, 1964; Aug. 9–Nov. 8, 1965; Oct. 4–Nov. 1, 1966; Mar. 23–Apr. 29, 1968; Aug. 2–Sept. 17, 1969; Oct. 24–Nov. 27, 1970; Feb. 18–May 11, 1972.

^b74 ft³ of this total were evaporator bottoms in concrete.

^cDuring 1964, a total of 3,418 ft³ of solid waste (containing 101 Ci) was prepared in drums, but 3,826 ft³ were shipped.

^d92 Ci of this were ion exchange resins.

^eResins in 27 special drums are included.

**Table B-14. Amount of Solid Radioactive Waste Compared with Gross Thermal Energy Produced:
San Onofre 1**

(Through December 31, 1972)

Type: Pressurized Water Reactor

Power: 1,347 MW(t), 430 MW(e) net

Initial criticality: June 14, 1967^a

Year	Gross Solid Waste Shipped Offsite				Gross Thermal Energy Produced (MWhr)	
	Volume (ft. ³)		Radioactivity (Ci)		Annual Amount	Cumulative Total
	Annual Amount	Cumulative Total	Annual Amount	Cumulative Total		
1967	0	0	0	0	1,183,703	1,183,703
1968	>382	382	<2	<2	4,046,499	5,230,202
1969	1,411	1,793	8	<10	7,898,832	13,129,034
1970	1,457 ^b	3,250	<11 ^b	<21	9,191,990	22,321,024
1971	807	4,057	<2	<23	9,956,701	32,277,725
1972	4,124 ^c	8,181	80 ^c	<103	8,528,772	40,806,497

^aRefueling schedule: Oct. 7–Nov. 20, 1970; Dec. 25, 1971–Feb. 24, 1972.

^bIncludes 75 ft³ spent resin containing 2 Ci.

^cIncludes 200 ft³ spent resin containing 72 Ci.

**Table B-15. Amount of Solid Radioactive Waste Compared with Gross Thermal Energy Produced:
Connecticut Yankee**

(Through December 31, 1972)

Type: Pressurized Water Reactor

Power: 1,825 MW(t), 575 MW(e) net

Initial criticality: July 24, 1967^a

Year	Gross Solid Waste Shipped Offsite				Gross Thermal Energy Produced (MWhr)	
	Volume (ft. ³)		Radioactivity (Ci)		Annual Amount	Cumulative Total
	Annual Amount	Cumulative Total	Annual Amount	Cumulative Total		
1967	0	0	0	0	1,697,464	1,697,464
1968	412	412 ^b	0.1	0.1	9,492,857	11,190,321
1969	2,940	3,352	51	51	11,544,534	22,734,855
1970	2,069 ^c	5,421	316 ^c	367	11,406,386	34,141,241
1971	3,684 ^d	9,105	274 ^d	641	13,416,373	47,557,614
1972	6,655 ^e	15,760	4,769	5,410	13,780,524	61,338,138

^aRefueling schedule: Apr. 18–June 20, 1970; Apr. 16–May 21, 1971; June 10–July 14, 1972.

^bTotal weight of solid waste shipped was 16,800 lb.

^cIncludes 455 ft³ of spent resin containing 127 Ci of activity.

^dIncludes 1,046 ft³ of spent resin containing 261 Ci of activity.

^eIncludes 1,495 ft³ of spent resin containing 4,752 Ci of activity.

Table B-16. Amount of Solid Radioactive Waste Compared with Gross Thermal Energy Produced:
Gir na

(Through December 31, 1972)

Type: Pressurized Water Reactor
Power: 1,300 MW(t), 420 MW(e) net
Initial criticality: November 9, 1969^a

Year	Gross Solid Waste Shipped Offsite				Gross Thermal Energy Produced (MWhr)	
	Volume (ft ³)		Radioactivity (Ci)		Annual Amount	Cumulative Total
	Annual Amount	Cumulative Total	Annual Amount	Cumulative Total		
1969	0	0	0	0	153,720	153,720
1970	1,816	1,816	5	5	6,840,240	6,993,960
1971	24,780	26,596	47	52	8,504,065	15,498,025
1972	12,940 ^b	39,536	1,412	1,464	7,707,240	23,205,265

^aRefueling schedule: Feb. 26–May 12, 1971; Apr. 14–June 20, 1972.

^bMay be ~50 ft³ high because of a 2-day overlap (June 26 and 27) in the semiannual totals reported in June and December.

Table B-17. Amount of Solid Radioactive Waste Compared with Gross Thermal Energy Produced:
H. B. Robinson No. 2

(Through December 31, 1972)

Type: Pressurized Water Reactor
Power: 2,200 MW(t); 700 MW(e)
Initial criticality: September 20, 1970

Year	Gross Solid Waste Shipped Offsite				Gross Thermal Energy Produced (MWhr)	
	Volume (ft ³)		Radioactivity (Ci)		Annual Amount	Cumulative Total
	Annual Amount	Cumulative Total	Annual Amount	Cumulative Total		
1970	0 ^a	0	0 ^a	0	63,694	63,694
1971	855 ^b	855	c	c	7,850,675	7,914,369
1972	2,478 ^d	3,333	c	c	15,536,932	23,451,301

^aStored about 125 ft³ containing less than 0.003 Ci of activity.

^bStored about 794 ft³ containing unknown number of Ci of activity.

^cNot reported.

^dStored about 808 ft³ containing unknown number of Ci of activity.

**Table B-18. Amount of Solid Radioactive Waste Compared with Gross Thermal Energy Produced:
Point Beach 1 and 2**

(Through December 31, 1972)

Type: Pressurized Water Reactor

Power 1,518 MW(t), 497 MW(e) net, each

Initial criticality: Unit 1, November 2, 1970;^a Unit 2, April 30, 1972

Year	Gross Solid Waste Shipped Offsite				Gross Thermal Energy Produced (MWhr)	
	Volume (ft ³)		Radioactivity (Ci)		Annual Amount	Cumulative Total
	Annual Amount	Cumulative Total	Annual Amount	Cumulative Total		
1970	0	0	0	0	632,255	632,255
1971	2,701	2,701	4	4	10,025,688	10,657,943
1972	6,827 ^b	9,528	213	217 ^b	9,959,016	20,616,959

^aRefueling schedule (Unit 1): Oct. 1, 1972 – still in progress at the end of 1972.

^bIncludes 125 ft³ of spent resin containing 40 Ci of activity.

**Table B-19. Amount of Solid Radioactive Waste Compared with Gross Thermal Energy Produced:
Surry 1 and 2**

(Through December 31, 1972)

Type: Pressurized Water Reactor

Power: 2,441 MW(t), 788 MW(e) net, each

Initial criticality: Unit 1, July 1, 1972; Unit 2, May 1973 (scheduled)

Year	Gross Solid Waste Shipped Offsite				Gross Thermal Energy Produced (MWhr)	
	Volume (ft ³)		Radioactivity (Ci)		Annual Amount	Cumulative Total
	Annual Amount	Cumulative Total	Annual Amount	Cumulative Total		
1972	a	a	a	a	1,288,550	1,288,550

^aNot available at press time.

**Table B-20. Amount of Solid Radioactive Waste Compared with Gross Thermal Energy Produced:
Turkey Point 3 and 4**

(Through December 31, 1972)

Type: Pressurized Water Reactor

Power: 2,200 MW(t), 693 MW(e) net, each

Initial criticality: Unit 3, October 20, 1972; Unit 4, not in operation yet

Year	Gross Solid Waste Shipped Offsite				Gross Thermal Energy Produced (MWhr)	
	Volume (ft ³)		Radioactivity (Ci)		Annual Amount	Cumulative Total
	Annual Amount	Cumulative Total	Annual Amount	Cumulative Total		
1972	0 ^a	0	0 ^a	0	285,340	285,350

^aSolid radioactive waste stored onsite: 118 ft³ containing less than 6×10^{-4} Ci.

Table B-21. Amount of Solid Radioactive Waste Compared with Gross Thermal Energy Produced:
Maine Yankee

(Through December 31, 1972)

Type: Pressurized Water Reactor
Power: 2,440 MW(t), 790 MW(e) net
Initial criticality: October 23, 1972

Year	Gross Solid Waste Shipped Offsite				Gross Thermal Energy Produced (MWhr)	
	Volume (ft ³)		Radioactivity (Ci)		Annual Amount	Cumulative Total
	Annual Amount	Cumulative Total	Annual Amount	Cumulative Total		
1972	0	0	0	0	1,439,873	1,439,873

Table B-22. Amount of Solid Radioactive Waste Compared with Gross Thermal Energy Produced:
Indian Point I

(Through December 31, 1972)

Type: Pressurized Water Reactor
Power: 615 MW(t), 265 MW(e) net
Initial criticality: August 2, 1962^a

Year	Gross Solid Waste Shipped Offsite				Gross Thermal Energy Produced (MWhr)	
	Volume (ft ³)		Radioactivity (Ci)		Annual Amount	Cumulative Total
	Annual Amount	Cumulative Total	Annual Amount	Cumulative Total		
1962	0	0	0	0	216,579	216,679
1963	0	0	0	0	2,148,129	2,364,808
1964	823	823	<0.5	<0.5	1,374,070	3,738,878
1965	1,499	2,322	<1	<2	2,468,285	6,207,163
1966	1,992	4,314	<2	<4	2,613,400	8,820,563
1967	1,051	5,365	0.6	<5	3,677,371	12,497,934
1968	1,117	6,482	<22	<27	3,475,288	15,973,222
1969	948	7,430	0.8	<28	3,762,765	19,735,987
1970	860	8,290	6	<34	794,519	20,530,506
1971	566	8,856	2	<36	2,867,507	23,398,013
1972	≥3,234 ^b	12,090	≥79 ^b	115	2,653,864	26,051,877

^aRefueling schedule: Oct. 20, 1965–Mar. 27, 1966; Sept. 29–Dec. 13, 1967; Feb. 11–Mar. 23, 1969; Mar. 20–May 19, 1970 (operated 1 day); May 26, 1970–Feb. 8, 1971 (shutdown for primary coolant system repair); scheduled for Oct. 1, 1972 (report for last quarter of 1972 was not issued at report time).

^bData for 4th quarter of 1972 unavailable at report time.

**Table B-23. Amount of Solid Radioactive Waste Compared with Gross Thermal Energy Produced:
Palisades**

(Through December 31, 1972)

Type: Pressurized Water Reactor
Power: 2,212 MW(t), 700 MW(e) net
Initial criticality: May 24, 1971

Year	Gross Solid Waste Shipped Offsite				Gross Thermal Energy Produced (MWhr)	
	Volume (ft ³)		Radioactivity (Ci)		Annual Amount	Cumulative Total
	Annual Amount	Cumulative Total	Annual Amount	Cumulative Total		
1971	0 ^a	0 ^a	0 ^a	0 ^a	800	800
1972	340 ^b	340 ^b	2 ^b	2 ^b	5,910,530	5,911,330

^aAbout 1 ft³ containing samples measuring 0.003 Ci was stored onsite.

^b800 ft³ containing 0.6 Ci and spent Chemical and Volume Control System reactor coolant filters containing 40 Ci of activity were stored onsite.

**Table B-24. Amount of Solid Radioactive Waste Compared with Gross Thermal Energy Produced:
Peach Bottom I**

(Through December 31, 1972)

Type: High-Temperature Gas-Cooled Reactor
Power: 115 MW(t), 40 MW(e) net
Initial criticality: March 3, 1966^a

Year	Gross Solid Waste Shipped Offsite				Gross Thermal Energy Produced (MWhr)	
	Volume (ft ³)		Radioactivity (Ci)		Annual Amount	Cumulative Total
	Annual Amount	Cumulative Total	Annual Amount	Cumulative Total		
Core I						
1966 ^b	63	63	c	c	7	7
1967	342	405	c	c	436,951	436,958
1968	417	822	c	c	390,534	827,492
1969	160	982	<0.003	<0.003	418,604	1,246,096
Core II						
1970	692	1,674	>0.09	>0.09	423,956	1,670,052
1971	1,115 ^d	2,789	113 ^d	113	622,512	2,292,564
1972	1,749	4,538	48 ^e	161	332,407	2,624,971

^aRefueling schedule:

Core I: Jan. 11–May 6, 1968 (failed fuel); Oct. 31, 1968–Feb. 28, 1969 (failed fuel); Oct. 3, 1969–July 14, 1970 (failed fuel).

Core II: Apr. 25–July 12, 1971; Jan. 7–June 17, 1972.

^bOperating sporadically at less than 1 MW(t) during testing and training programs.

^cLow-level tests.

^dMore than 108 Ci of ³H₂O sorbed on drying agent was shipped. About 60 gal of ³H₂O was shipped the first half of 1971, and two more shipments containing nearly all the radioactivity were shipped the last half of 1971. Also included was 1 Ci of mixed fission products on spent demineralizer resin.

^e2 Ci of ¹³⁷Cs on spent resin and 46 Ci of ³H₂O on drying agent.

**Table B-25. Waste Generation at Peach Bottom 1 (HTGR)
Compared to BWRs and PWRs**

Year	$\Sigma \text{ft}^3 / \Sigma \text{MWhr(t)}$	$\Sigma \text{Ci} / \Sigma \text{MWhr(t)}$	$\Sigma \text{Ci} / \Sigma \text{ft}^3$
Core I			
1966	9	NR ^b	NR ^b
1967	7.8×10^{-4}	NR ^b	NR ^b
1968	1.1×10^{-2}	NR ^b	NR ^b
1969	3.8×10^{-4}	NR ^b	NR ^b
Core I Total	7.9×10^{-4}	$< 2.4 \times 10^{-5}$	$< 3.1 \times 10^{-6}$
Core II			
1970	1.6×10^{-3}	2.1×10^{-7}	1.3×10^{-4}
1971	1.8×10^{-3}	1.8×10^{-4}	1.0×10^{-1}
1972	5.3×10^{-3}	1.5×10^{-4}	2.8×10^{-2}
Core II Total	2.6×10^{-3}	1.2×10^{-4}	4.5×10^{-2}
Total			
Overall Total ^a	1.7×10^{-3}	6.1×10^{-5}	3.6×10^{-2}

^aThese results are comparable to those for BWRs of <1,000 MW(t) during approximately the first decade of operation (cf. Figs. 9a and 9b, 10a and 10b, 11, 12, and Table 1).

^bNot reported.

Appendix C

COMPILATION OF DATA REPORTED ON WASTE CORE COMPONENTS AND
STRUCTURALS SHIPPED OFFSITE INCLUDING CURIE CONTENT,
VOLUME AND YEAR OF SHIPMENT

Table C-1. Waste Core Components and Structural^a from BWRs and PWRs Reported Shipped Offsite for Permanent Disposal as of December 31, 1972

Reactor Type and Name	Core Component Shipments			
	Σ ft ³	Σ Ci	Σ Shipments	Dates Shipped
PWRs				
Yankee Rowe	>176	158,097	11	1963, 1964, 1966,
(plus 11 more casks)				1967, 1968
San Onofre-1	Not reported	6	1	1968
Total	>176	158,103	12	(1963-1972)
BWRs				
Dresden-1	1,612	66,2	5	1961, 1962, 1965
Big Rock Point	1,199	40,261	13	1965, 1966, 1970,
(plus 2 more casks)				1972
Three-Mile-Island BWR	10	281	2	1964, 1968
Total	2,821	41,548	45	(1961-1972)

You had the various all-ways control rods, control rod blades control rod channels, fuel channels, neutron absorbers. You were using a pump system, you had a thermal shield and a hold-down device, control rod drive shafts, various control rods, various fuel rods, various different channel plugs, channel pieces, and various other things.