CHARACTERIZATION OF LOW-LEVEL WASTE FROM THE INDUSTRIAL SECTOR, AND NEAR-TERM PROJECTION OF WASTE VOLUMES AND TYPES*

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ABSTRACT

A telephone survey of low-level waste generators has been carried out in order to make useful estimates of the volume and nature of the waste which the generators will be shipping for disposal when the compacts and states begin operating new disposal facilities. Emphasis of the survey was on the industrial sector, since there has been little information available on characteristics of industrial LLW. Ten large industrial generators shipping to Richland, ten shipping to Barnwell, and two whose wastes had previously been characterized by BNL were contacted. The waste volume shipped by these generators accounted for about two-thirds to three-quarters of the total industrial volume. Results are given in terms of the categories of LLW represented and of the chemical characteristics of the different wastes. Estimates by the respondents of their near-term waste volume projections are presented.

INTRODUCTION

According to LLW burial site records of the last few years, about 60% of the LLW being shipped for disposal during this period has been from utilities and 30-35% from the industrial sector (1,2). The remainder--probably 10% in 1985--is classed as institutional and government (non-DOE). A large fraction of this last category is composed of liquid scintillation waste and other organic liquids. These waste types constitute mixed wastes and as such are now excluded from LLW disposal sites, so current institutional and government waste undoubtedly represent a small fraction of total LLW than in 1985.

It is thus probable that industrial wastes now make up nearly 40% of the LLW volume, and information on the types of waste comprising it is sparse. While power plant wastes have been characterized in a number of EPRI and DOE reports (3-5), and institutional wastes in two reports from the University of Maryland (6,7), industrial wastes are not well characterized. They have been described as "varied and difficult to categorize" (8), and as the "least characterized category" (2).

A detailed survey has been made of the LLW (including industrial) generated in Massachusetts (9), but so far as is known, such information has not been published for other states. Industrial waste from several companies [Union Carbide, Tuxedo, NY (now Cintichem), New England Nuclear, and General Electric, Vallecitos, CA] had been characterized by BNL in a series of reports (10-12), but this waste did not represent a large fraction of total LLW, and was of interest to NRC because of characteristics (specific activity, waste form and package) other than its volume.

For a study required by NRC on characterization of the internal environment of proposed alternative LLW disposal structures, it was necessary to know the nature of the waste to be placed in the structures. Utility waste appeared to be sufficiently well characterized for purposes of the study, but the industrial waste obviously was not. The BNL reports (10-12), while they contained detailed information, covered only a small fraction of the total volume, and information was needed on the rest of the industrial LLW. In the opinion of personnel at the disposal sites, most of the industrial waste is made up of routine shipments by a relatively few large generators, and occasional large shipments by others who are disposing of waste from a one-of-a- kind cleanup (e.g., from decommissioning activity). Thus, reasonably comprehensive characterization of LLW from the industrial sector should be possible from accurate information on the waste from these large generators. Accordingly, a telephone survey was conducted of the 10 largest industrial generators shipping to each of the Richland and Barnwell sites. Three of the generators whose wastes had previously been characterized by BNL (10-12) were also contacted for up-to-date information. One of these was, in fact, among the 10 largest shippers to Richland.

RESULTS OF SURVEY

<u>Extent of Coverage</u>

The list of top generators and the volumes shipped in 1985, or projected to be shipped in 1987, are given in Table

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I. [Code letters (R for shippers to Richland and B for shippers to Barnwell) are used for the generators.] Since one of the 10 largest generators shipping to Richland was also among the 10 largest shipping to Barnwell, names of 19 separate generators were obtained from this listing. Of the 3 generators whose wastes had previously been characterized by BNL, one was among the top 10 shippers to Richland. Thus names of only 2 new generators were added to the list from that source. Altogether 21 different generators were surveyed and relevant information was obtained from 20 of them.

Of these 20 generators, 3 were brokers (R-2, R-3, and R-5), 3 were service companies (R-1, R-4, and B-7), and the remainder were manufacturing companies, 5 of whom were fuel-cycle generators and 9 non-fuel-cycle. The waste handled by the brokers is largely institutional, but a sizeable fraction comes from biotechnology firms and testing labs, which belong in the industrial category. The service companies surveyed perform decontamination anddecommissioning work for both industrial and utility companies. The fact that the 5 largest shippers to Richland in 1985 were brokers or service companies significantly affects the survey results, in that the total waste from truly industrial sources was considerably less than that indicated in Table I. This does not affect the extent of coverage achieved by the survey, since all the listed generators were categorized by the burial site operator as industrial. However, it means that a smaller than expected fraction of the true industrial waste shipped to Richland was able to be characterized.

An estimate of the extent of the survey's coverage in terms of the total industrial waste can be made on the basis of the 1985 data and the estimated 1987 data. Volume categorized by Richland as industrial in 1985 was 345,000 ft^3. One can assume that roughly the same volume was shipped to Barnwell that year by the listed shippers to Barnwell. This assumption is supported by the figure in Table I for the total estimated 1987 shipments to Barnwell of 322,000 ft^3. This is only slightly lower than the 1985 figure for Richland though total LLW shiphipments and presumably industrial waste shipments, declined by some 30% from 1985 to 1986, and probably declined further in 1987. Thus on the order of 700,000 ft^3 is estimated to have been shipped in 1985 by the gen erators covered in the survey. This is approximately 70% of the total volume categorized as industrial in 1985 (2). This coverage is considered good, and a disproportionate amount of effort

TABLE I

LLW Volumes of Largest Generators Listed as Industrial Who Shipped to Barnwell and Richland.

Richland		Barnwell	
Shipper	Actual Volume Shipped in 1985, ft^3	Shipper	Approximate Annual Volume,[a] ft^3
R-1	91,411	B-1	50,000
R-2	43,697	B-2	50,000
R-3	42,325	B-3	40,000
R-4	33,836	B-4	35,000
R-5	26,090	B-5	35,000
R-6	25,552	B-6	30,000
R/B-1	22,355	B-7	25,000
R-7	21,691	B-8	24,000
R-8	19,378	R/B-1	18,000
R-9 (NF-2)[b]	19,320	B-9	15,000
Total	345,655	Total	322,000

[a] Estimates supplied by generators to State of South Carolina for volumes to be shipped in 1987.

[b] This non-fuel-cycle generator was one of those whose wastes had previously been characterized by BNL (12).

would be required to increase the coverage appreciably, due to the relatively large number of small-volume generators who would have to be surveyed.

Characteristics of the Industrial Waste

Waste from the generators which are manufacturing companies is obviously industrial. The information was not available to us to permit determination of the amount of waste from service companies which should be assigned to industrial companies as opposed to utilities. However, the nature of the service company waste is known, and is the same whether originating from utilities or industrial companies, i.e, decontamination and decommissioning waste. Descriptions of the waste from the manufacturing companies and from the service companies are given below under separate headings.

Waste from Manufacturing Companies

A summary of the main features of the wastes presently being produced by the listed generators is presented in Tables II and III. Table II contains information on the classification of the waste and its chemical content. Table III provides an estimate of the relative amounts of the different waste types (DAW, solidified, and non-DAW unsolidified) produced by each generator. In these tables the code letters NF- are used to designate the non-fuel-cycle generators whose wastes had previously been characterized by BNL (10-12).

The first column of Table II gives the kind of waste being shipped, and the class if it is by-product material. All kinds of LLW are represented among the wastes shipped by these large generators, including NARM waste. The 3 generators shipping mostly or entirely by-product material all generate Class A and B waste, and small amounts of Class C. They are generators whose wastes were characterized by BNL several years ago, and only one of whom was in the lists of the 10 top industrial generators. Their volumes are lower than hose of almost all the generators of other waste types. Thus, the bulk Characteristics of Radioactive Waste Shipped by Surveyed Industrial Generatorsof the industrial waste from generators surveyed is composed of material contaminated with source, SNM and NARM constituents. In the cases of all the generators surveyed, the amounts of radioactivity associated with these last types of waste were very small.

The other two columns of the table give information on the chemical nature of the various wastes. The only waste type containing appreciable amounts of material potentially harmful to structural concrete of a disposal facility appears to be compactible solid trash with its cellulosic and plastic constituents which are susceptible to biodegradation to form organic acids.

The precise proportions of organic material in the DAW is not known, but in most cases the general trash which contains it is not the main component of a generator's waste. Organic ion exchange resins, which can degrade by radiolysis or biodegradation to form products potentially harmful to concrete, rep resent only a very small fraction of the total waste, and were reported only by Generator NF-2 or R-9. That company's resin waste is contained in cement-solidified waste of all classes (A, B, and C). For most generators, the largest fraction of their waste is dry inorganic solids--metals, oxides, fluorides, and silicates. One generator (B-8) has essentially a single waste stream which is a wet waste (metal hydroxide filter cake) shipped unsolidified in standard metal containers. Generator NF-2 (or R-9) has as its largest fraction cement-solidified evaporator bottoms.

Table III gives the relative amounts of waste types being disposed of. All generators dispose of DAW, and it usually constitutes the major portion of their waste, particularly so for the fuel-cycle generators. It always contains a certain amount of discarded equipment and general trash. Two companies generate solidified dry waste, and three solidified wet waste. Only Generator NF-1 uses commercially available HICs, for disposing of hot cell wastes. Generator NF-3 uses a small number of special HICs of their own design for disposal of very high specific activity H-3 waste. These are not included in the table because their total volume is insignificant, and they are of no concern in term of damaging concrete. A large fraction of the gen erators (5 of 12) ship unsolidified wet waste in regular steel drums or boxes. Four ship only small volumes, but one ships almost all of its waste in this form.

Waste from Service Companies

The three service companies surveyed perform either decontamination or decommissioning work, or both. For example, Generator R-1's operation consists of decontaminating metal at its own plant, while Generator R-4 does mostly decommissioning at its clients' facilities. This decommissioning work results in essentially all solid waste, mostly non-compactible (metal equip ment, wooden furniture, concrete rubble, etc.), which is all shipped in 100 ft steel boxes. Generator R-1 uses mineral acids (HNO_3 , H_2SO_4 , HCl, HF, and H_3PO_4) in its metal decontamination processes. From these processes, a single waste form and type of package results--scrap metal uneconomical to clean to the point of being reusable grouted into wooden boxes using cement containing neutralized decontamination solutions.

The third service company, Generator B-7, has a more complex waste, since it does both decontamination and decommissioning. Unlike Generator R-1, it uses no acid solutions for decontaminating, only mechanical surface removal. The waste it produces consists mainly of:

- Irradiated reactor components.

TABLE II

Characteristics of Radioactive Waste Shipped by Surveyed Industrial Generators.

Generator	Type or Class of Waste	Chemical Form	
		Largest Fraction	Other Wastes
Non-Fuel Cycle			
NF-1	A, B, occasional C	Metal	Glass, cement, organic
NF-2 (R-9)	A, B, occasional C	Evap. bottoms in cement	Ion-exchange resins, general trash
NF-3	A, B occasional C	Solids--metal, glass, plastic	Cement-solidified aqueous waste
B-2	Source	Compacted CaF_2 powder	MgF_2 slag, general trash
B-3	Source	MgF_2 slag	Metal, U oxide, general trash
B-8	Source	Hydroxide filter cake	General trash
R-6	NARM	Zr silicate	ZrO_2 from calciner, general trash
R/B-1	Source	Metal	U metal, graphite, general trash
Fuel Cycle			
B-4	SNM	Metal and oxide	Incinerator ash
B-5	SNM	Metal	Hydroxide filter cake, incinerator ash
B-9	SNM	Metal	Incinerator ash
R-8	SNM	General trash	

TABLE III

Relative Amounts of Waste Supplied by Surveyed Industrial Generators

Generator	Relative Amounts					
	Unsolidified DAW		Solidified		Unsolidified	
	Compactible	Non-compactible	Dry	Wet	In HIC	Wet, Not In HIC
Non-Fuel-Cycle						
NF-1	∿2/3				∿1/3	
NF-2 (R-9)		∿1/2	∿1/4	∿1/4		
NF-3	Large					Small
B-2	∿1/2	∿1/2				
B-3	Small	Large			Small	
B-8		Very small				Almost all
R-6	Large					Small
R/B-1	∿5/8		∿1/4	∿1/8		
Fuel Cycle						
B-4		Large				Small
B-5		Large				Small
B-9	All dry solid					
R-8	All dry solid					

TABLE IV

Waste Volume Information from Surveyed Industrial Generators.

Generator	Large Volume Shipments		Annual Volume				Probable Magnitude in Compact by 1992		
	Routine	Occasional	Steady	Increasing	Decreasing	Variable	Small	Medium	Large
NF-1	X		X					X	
NF-2 (R-9)	X		X					X	
NF-3	X		X					X	
B-1		X				X	X		
B-2	X				X				X
B-3	X				X				X
B-4	X					X			X
B-5	X		X						X
B-6		X	No more LLW - all remaining waste is mill tailings						
B-8	X			X					X
B-9	X				X				X
R-6	X			X					X
R-8		X			X		X		
R/B-1	X				X				X

- Metal equipment discarded because it is uneconomical to decon taminate to the point where the metal is reusable.
- Compacted trash, largely combustible. Decontamination waste (dry) from mechanical removal of metal surfaces.

Projections of Amounts and Types of Industrial Wastes from Surveyed Generators

Just as the nature of the waste from the industrial sector is quite varied, so is the projected near-term annual production rate of individual generators. The volume changes expected by the manufacturing companies pre sent an interesting picture, as illustrated by the information given in Table IV. Only 5 generators expected their volumes to decrease, while one felt the annual volumes it shipped would be uncertain and quite variable. Five generators felt their production rates would remain fairly constant, since they had already put volume reduction procedures into practice. While they hoped to refine these procedures and add new ones, they were predicting that the resulting waste volume decreases would be offset by increases in production. Two generators said their waste volume was increasing and felt it would continue to increase for at least a few more years. The increase in waste volume would be entirely due to increased volume of business.

Most of the generators (7) are assessed as still being large generators in 1992 (when new disposal sites are in place), and even in their locations in compacts or states producing relatively large volumes. For example, five are located in the Southeast Compact, which has both the largest number of states and, by far, the largest volume of waste. The three assessed to be medium- sized in relation to their state or compact are all generators whose waste had been characterized by BNL several years ago. Interestingly, all three felt their waste volumes had reached a level below which they were not likely to fall. Of the three generators assessed as "small," two were the shippers of non-routine large volumes and one had been shipping reasonably large volumes but was aiming to reduce its volumes drastically and possibly eliminate them.

For the most part, generators foresee no significant changes in the character of their waste in the near term, although obviously changes in their business could occur in the longer term which would lead to product changes and hence to changes in waste composition. One generator projected a major change in his waste characteristics by virtue of attempting to eliminate some or all of his waste streams and reduce volume to zero or very low levels.

SUMMARY AND CONCLUSIONS

All categories of LLW are represented among the wastes shipped by the surveyed manufacturing companies. Only three of these generators shipped by-product material, and their volumes are lower than those of the other surveyed generators. Thus the bulk of the LLW shipped by manufacturing companies is non-by-product material--source, SNM and NARM. On the other hand, a substantial fraction, probably the bulk, of the waste shipped by service companies is by-product material. Overall, depending on the proportion of by-product material in the waste shipped by smaller generators (responsible for some 30% of the industrial LLW), apparently roughly half the total industrial waste is non-by-product material.

All the manufacturing companies surveyed ship low specific activity DAW, and it usually constitutes the larger fraction of their waste. It contains a certain amount of discarded equipment and general trash. Other types of waste shipped are solidified wet waste, solidified/encapsulated dry waste, and unsolidified wet waste. As a result of their decontamination and decommis sioning operations, service companies produce a large proportion of scrap metal and other non-compactible dry waste. In the case of one large-volume enerator, the scrap metal is grouted into wooden boxes. Most of the other service companies and manufacturing companies use steel containers--drums or bins.

No unusual wastes which might be harmful to concrete were identified. It was perhaps surprising that a considerable amount of wet waste was shipped unsolidified, but this waste contains no free water and would not be of concern otherwise. The only widespread waste type of appreciable volume which contains potentially harmful material is compactible solid trash. The organic components of this waste (e.g., cellulosics, rubber and plastics) are susceptible to biodegradation to form organic acids. Among the industrial generators surveyed, the fuel fabricator category is an exception as regards production of organic waste, since they incinerate their combustible waste and treat the ash in order to recover SNM. Most of the other industrial generators use compaction or supercompaction to achieve volume reduction of the DAW, and utilities are also beginning to use supercompaction. Thus, incineration, which could eliminate organics from LLW, may not become widespread, and organic waste may continue to be widely produced into the foreseeable future.

No attempt has been made to put the survey information on a quantitative basis. Although we obtained relatively precise figures from some generators, values given by other generators were only approximate, or amounts and proportions were couched in qualitative terms. However, the main reason for not stressing quantitative data is that they apply only to the moment and will not be valid next year, let alone at the time new disposal facilities are in operation. The LLW picture is still changing too rapidly for quantification of proportions of different waste types to be meaningful. In any case, for assessing possible effects of the internal environment on concrete structures, the chemical nature of the different wastes is the important parameter, and only a knowledge of relative proportions is required.

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