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WASTE SEGREGATION

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ABSTRACT

A scoping study has been undertaken to determine tne state-of-the-art of waste segregation technology as applied to the management of low-level waste (LLW). Present-day waste segregation practices were surveyed through a review of the recent literature and by means of personal interviews with personnel at selected facilities. Among the nuclear establishments surveyed were Department of Energy (DOE) laboratories and plants, nuclear fuel cycle plants, public and private laboratories, institutions, industrial plants, and DOE and commercially operated shallow land burial sites. These survey data were used to analyze the relationship between waste segregation practices and waste treatment/disposal processes, to assess the developmental needs for improved segregation technology, and to evaluate the costs and benefits associated with the implementation of waste segregation controls.

This task was planned for completion in FY 1981. It should be noted that LLW management practices are now undergoing rapid change such that the technology and requirements for waste segregation in the near future may differ significantly from those of the present day.

OBJECTIVES AND PROCEDURE

Currently, little or no waste segregation is practiced at shallow land burial sites used for the disposal of LLW. In some cases, the resultant intermixing of various waste types in the burial trenches has resulted in disposal site problems such as subsidence, trench cap deterioration, and migration of radioactivity. For example, organic chelating materials have been disposed of in the same trenches as solidified wastes, providing a mode for affecting radionuclide sorption capacity

(K_d) of the disposal site geology. Corrosive compounds, frequently present, promote a rapid loss of integrity of metallic waste containers and enhance radioactivity release from the waste forms. Other chemical interactions also occur when diverse waste types are disposed of without regard to segregation. Some wastes in shallow land burial may primarily be chemical or toxic hazards (rather than radioactive hazards) and, as such, benefits may result from more waste-specific disposal practices. Subsidence and trench cap deterioration problems may be minimized by segregation of organic wastes susceptible to microbial decomposition and compaction under the weight of the overburden.

This study was undertaken with the goal of achieving several objectives as shown in Figure 1. Completion of this task and achievement of these objectives has yielded the following: (1) determination of the state-of-the-art of LLW segregation technology, (2) the ascertaining of current waste segregation practices for both DOE and commercial LLW, (3) analysis of the relationship between segregation practices and waste/treatment disposal processes, (4) recommendations regarding changes and developmental needs for the establishment of improved segregation controls, and (5) a limited assessment of the associated costs and benefits of implementing waste segregation procedures.

The types of facilities for which waste segregation practices were investigated are shown in Figure 2. These facilities included major DOE laboratories and plants, nuclear fuel cycle installations (fuel fabrication plants, nuclear power plants), institutions (universities, hospitals, medical research centers), industrial concerns (producers of radioisotopes or radiopharmaceuticals), waste brokers, and shallow land burial sites (both DOE and commercial).

Information relevant to the evaluation of waste segregation practices at each of these facilities was also obtained on the characteristics of as-generated LLW (see Figure 3). This included data on waste types and corresponding radionuclide content as follows: liquid wastes (organic liquids and oils, decontamination solutions, aqueous concentrates, etc.); wet solid wastes (spent ion exchange resins, evaporator bottoms, sludges, etc.); dry solid wastes (combustible and non-combustible trash containing plastics, cellulosics, rubbers, filters, metals, etc.; discarded equipment consisting of decommissioning and renovation items, etc.); and the corresponding radionuclide type(s) and specific activity range(s).

The annual generation rates for LLW produced in the U.S.A. are shown in Figure 4. Appoximately one-third of the domestically-produced LLW volume is from government sources, and two-thirds is commercially generated.[1] Of the commercial wastes, approximately 60% by volume is attributable to nuclear fuel cycle operations. Government wastes, for the most part, have been disposed of by shallow land burial at what are now DOE sites. Much lesser amounts have been disposed of by ocean dumping (during the period of 1946-1970) and by shallow land burial at commercial sites. Since 1979, the small percentage of DOE waste that formerly was disposed of at commercial facilities has been shipped to

DOE burial sites to avoid reducing the limited capacity of existing commercial sites. However, a small percentage of LLW from government sources (e.g., Department of Defense wastes from the Navy and from veterans hospitals) continues to be disposed of at commercial burial sites.

The distribution of LLW disposed of at commercial burial sites in 1979 (based on data in Reference 2) is shown in Figure 5. Except for the wastes from nuclear power plants, fuel cycle LLWs from fuel fabrication, etc. are included in the industry classification. With the continued growth of nuclear power, an increasing percentage of LLW can be expected to be attributable to nuclear power plants in the future.

The management of LLW involves a series of unit operations as shown in Figure 6. To a varying degree, waste segregation may be applied at any of the stages indicated in Figure 6. However, segregation is best accomplished early on and as close to the point of generation as is technically feasible. It then will serve as a key determinant of all subsequent operations (i.e., waste treatment and processing, interim storage, transportation and final disposition of LLW).

It is recognized that specific benefits are derived from the application of segregation controls by the LLW generator (see Figure 7). Efficient segregation of non-radioactive waste from radioactive wastes at the point of generation can drastically reduce the volume and cost of waste requiring treatment and disposal. Segregation of wastes can also lead to more efficient waste processing by which, for example, personnel exposures can be reduced and solidification can be directed towards certain "problem" wastes. Other benefits include an enhanced ability to discriminate between wastes and to maintain accurate records, and overall improved operations and radionuclide retention at burial sites.

The investigative approach used in this task included the conduction of both literature and field surveys. Very little information has been published concerning waste segregation technology, and the literature search disclosed only a few current examples of its application to LLW management. It was therefore necessary to rely upon extensive personal contacts and field visits for most of the data obtained in this study. This was very time-consuming and only a limited number of site visits could be completed during this period. However, a representative sampling of relevant practices was obtained during this scoping study.

The accomplishments for the Waste Segregation Task in FY 1981 are shown in Figure 8. These have included the following: (1) a literature survey of LLW generation rates and segregation practices, (2) a survey of the current state of LLW segregation technology at selected facilities, involving both personal contact and site visits to representative facilities, (3) a determination of need for new or improved segregation techniques based on information obtained in the segregation technology survey, (4) the issuance of an interim report with preliminary recommendations concerning LLW segregation technologies, and (5) the completion of the end-of-year annual summary report and technology transfer document.

The information obtained in this study and presented in the final summary report should be useful for the future planning and development of treatment options leading to improved management of LLW. This information provides input to the milestones of the National Low-Level Waste Management Program (NLLWMP), and in particular to Milestone B (the development of technology for waste treatment-handling-packaging to support shallow land burial).

STATUS OF LLW SEGREGATION

All waste generators practice some degree of segregation of their various waste streams (although the terminology "waste segregation" is not in common usage).* Because of the rapidly increasing costs of LLW disposal and restrictions which have been imposed over the past two years at commercially operated shallow land burial sites, there has been an increasing concern among waste producers to reduce the volumes of LLW which must be shipped for disposal. Volume-reduction treatments are specific to certain waste types and therefore require segregation as a pretreatment. Thus, the technology and requirements for waste segregation are undergoing rapid development at the present time.

Waste segregation is now recognized as being an essential element of the LLW management system if the problems attendant to shallow land burial are to be either solved or alleviated. As they are currently being proposed for application to commercial sites, future regulations can be expected to mandate the implementation of disposal site segregation controls which will permit the application of specific disposal methods or specific site locations of LLW on the basis of its type, form, chemical composition and radionuclide content. Only by means of segregation can there be established a capability of discriminating among wastes based on their physical, chemical and radiological properties, thus permitting selection of a disposal method related to the hazard of the waste.

*It should be noted that the proposed 10 CFR Part 61 recently issued by the NRC uses the term "segregation" in a different context.

Waste segregation can be utilized for the exercise of different disposal options. The recent NRC changes in 10 CFR Parts 20.301, 20.303, 20.305 and 20.306 (Federal Register/Vol. 46, No. 47, March 11, 1981, pp. 16230-16234), which allow for the disposal of certain biomedical waste "without regard to its radioactivity," have already resulted in a significant reduction in volume of LLW shipped from several institutions. While the alternate disposition of these wastes is in some cases uncertain, this deregulation by the NRC is generally considered to have been a significant improvement in the management of LLW.

ASSESSMENT OF CURRENT LLW SEGREGATION PRACTICES

Although recently there has been a growing interest in waste segregation technology, the generators and processors of LLW have received little guidance or encouragement for the adoption of segregation practices aside from the general speculation as to future regulatory requirements. Very little dissemination of information concerning waste segregation practices has occurred, and few personnel are aware of the technology being used at other than their own sites.

Significant savings have been reported by some sites that have implemented waste segregation. At New England Nuclear, for example, segregation of wastes is practiced to a high degree and has been shown to be very cost-effective. Segregation has been accomplished there largely through the establishment of institutional controls and increasing employee awareness of the need for waste segregation. For the most part, New England Nuclear's program involves segregation at the point of generation, this having been clearly designated as a responsibility of the individual waste generator. An important feature is the careful documentation and accountability for each discrete package. The program at New England Nuclear could serve as a model for other generators of similar types of LLW.

Experience at DOE facilities has also indicated that significant savings and reduction of volumes can be achieved through waste segregation. At ORNL, for example, a comprehensive waste segregation policy was instituted and shown to be successful, largely due to dedicated efforts for increasing worker awareness of the need to segregate all solid wastes. The effort included the coordinated use of seminars and training sessions, publication of articles in the laboratory paper, and dissemination of attractive and effective posters throughout the laboratory. This program could likewise serve as a model for similar sites.

At nuclear power plants, where the LLW streams are large and of reasonable consistency, the concept of on-site storage of all LLW is being seriously considered. It may be that the deployment of properly engineered on-site treatment/storage facilities will be accepted and become an attractive option for nuclear-based utilities in the future. If so, it can be presumed that the on-site treatment and storage of the wastes generated at nuclear power plants will require the adoption of advanced methods for collecting, handling, processing and packaging radwastes. Associated with these developments will be increasing demands for the segregation of radwastes for both treatment and storage purposes.

Many of the persons contacted in the LLW generation and segregation surveys have expressed opinions favoring improved segregation of the wastes if it can be demonstrated that the adoption of these practices would not require unreasonable operational adjustments or large cost outlays. (Disposal costs have increased dramatically within the past several years, such that the small user cannot afford much more outlay without curtailing the use of radioisotopes.)

Waste segregation is widely perceived as contributing to a more acceptable mode of waste management and disposal. However, the relative ease with which a given facility or LLW generator is able to adopt segregation technology will vary greatly depending on the diversity of the site, available personnel, and so on. At some LLW generating sites, a reasonably consistent waste stream is produced which may be amenable to the applied segregation technology, while at other sites the waste stream characteristics may present special problems or resist a straightforward application of segregation technology.

For improved processing and disposal of LLW, waste segregation should be practiced wherever it is technically feasible and cost-effective to do so.

REFERENCES

1. A.H. Kibbey and H.W. Godbee, A State-of-the-Art Report on Low-Level Radioactive Waste Treatment, ORNL/TM-7427 (September, 1980).

2. EG&G Idaho, Managing Low-Level Radioactive Wastes, A Technical Analysis, LLWMP-7 (June, 1981).

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FIGURE LIST

Caption

WASTE SEGREGATION

Objectives of the LLW Segregation Task

- DETERMINE STATE-OF-THE-ART
- ASCERTAIN CURRENT PRACTICES
- ANALYZE RELATIONSHIP BETWEEN SEGREGATION PRACTICES AND WASTE TREATMENT/DISPOSAL PROCESSES
- SUGGEST CHANGES AND DEVELOPMENTAL NEEDS FOR IMPROVED SEGREGATION PRACTICES
- ASSESS ASSOCIATED COSTS AND BENEFITS

FIG. 1

WASTE SEGREGATION

Types of Facilities for Which Waste Segregation Practices Were Investigated

- DOE LABORATORIES AND PLANTS
- NUCLEAR FUEL CYCLE INSTALLATIONS (FUEL FABRICATION, POWER PLANTS)
- INSTITUTIONS (UNIVERSITIES, HOSPITALS, MEDICAL RESEARCH)
- INDUSTRIAL CONCERNS (RADIOISOTOPE/RADIOPHARMACEUTICAL PRODUCERS)
- WASTE BROKERS
- DISPOSAL SITES (DOE, COMMERCIAL)

FIG. 2

WASTE SEGREGATION

Waste Characteristics Important to the Evaluation of Segregation Practices for LLW

WASTE TYPES

- LIQUID WASTES (ORGANIC LIQUIDS, DECONTAMINATION SOLUTIONS, AQUEOUS CONCENTRATES, OILS, ETC.)

- WET SOLID WASTES (SPENT ION EXCHANGE RESINS, EVAPORATOR BOTTOMS, SLUDGES)

- DRY SOLID WASTES

  COMBUSTIBLE AND NON-COMBUSTIBLE TRASH (PLASTICS, CELLULOSICS, RUBBERS, FILTERS, METALS, ETC.)

  DISCARDED EQUIPMENT (DECOMMISSIONING AND RENOVATION ITEMS)

RADIONUCLIDE CONTENT

- RADIONUCLIDE TYPE(S)

- SPECIFIC ACTIVITY RANGE(S)

FIG. 3

WASTE SEGREGATION

Annual Rates of LLW Generation in the U.S.A.

SOURCE	ESTIMATED VOLUME OF LLW GENERATED IN 1981 (FT^3)	PER CENT OF TOTAL LLW VOLUME
GOVERNMENT	$\sim 1 \times 10^6$	33.
COMMERCIAL	2×10^6	67.
FUEL CYCLE	1.2×10^6	41.
NON-FUEL CYCLE	8×10^5	26.

FIG. 4

WASTE SEGREGATION

Distribution of LLW Disposed of at Commercial Burial Sites in 1979 (Data from Reference 2)

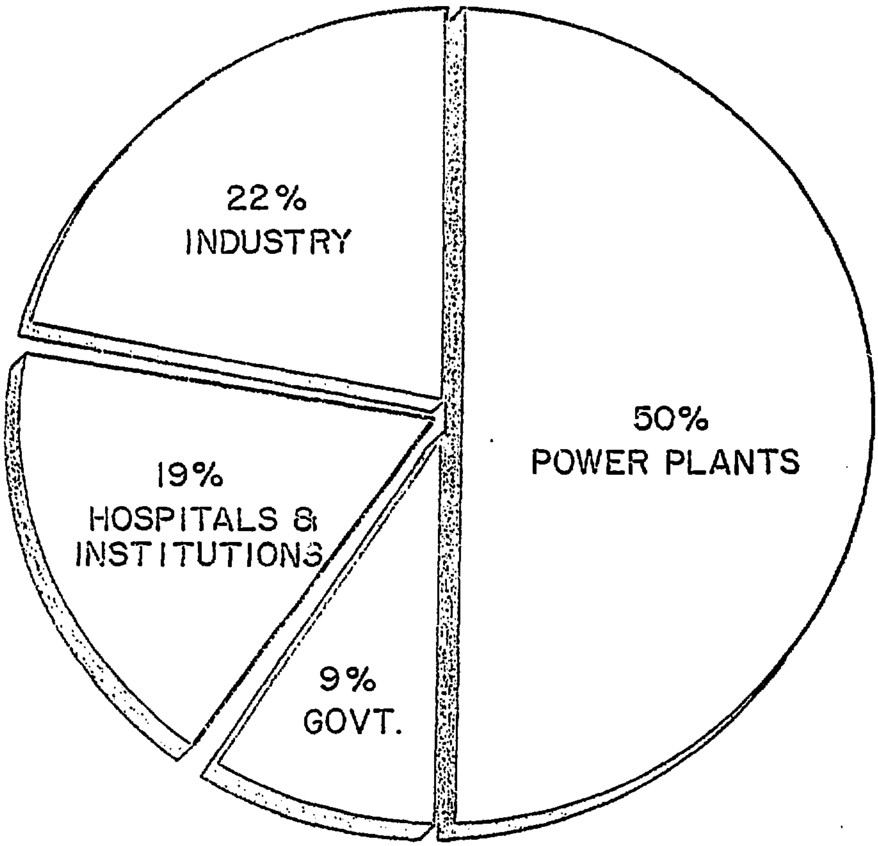

FIG. 5

WASTE SEGREGATION

Management of Low-Level Waste (LLW)

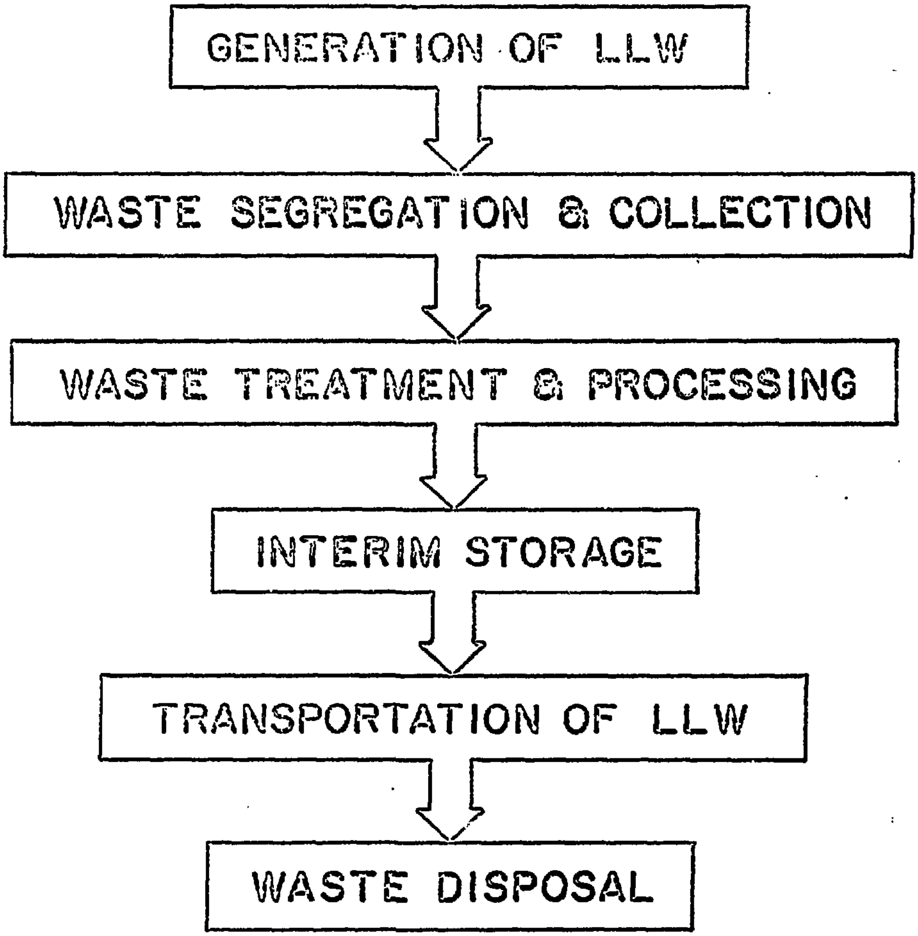

FIG. 6

WASTE SEGREGATION

Potential Benefits of Waste Segregation

- NET REDUCTION IN WASTE VOLUMES REQUIRING COSTLY TREATMENT AND DISPOSAL
- IMPROVED CAPABILITY FOR MORE EFFICIENT WASTE PROCESSING
- ENHANCED ABILITY TO DISCRIMINATE BETWEEN WASTES AND TO MAINTAIN ACCURATE RECORDS
- REDUCTION IN PERSONNEL RADIATION EXPOSURES
- IMPROVED OPERATIONS AND RADIONUCLIDE RETENTION AT BURIAL SITES

FIG. 7

WASTE SEGREGATION

Waste Segregation Task FY 1981 Accomplishments

- LITERATURE SURVEY OF LLW GENERATION RATES AND SEGREGATION PRACTICES
- SURVEY OF CURRENT STATE OF LLW SEGREGATION TECHNOLOGY (PERSONAL CONTACT/SITE VISITS)
- DETERMINATION OF NEED FOR NEW OR IMPROVED SEGREGATION TECHNIQUES
- INTERIM REPORT (PRELIMINARY RECOMMENDATIONS CONCERNING LLW SEGREGATION TECHNOLOGIES)
- END-OF-YEAR ANNUAL SUMMARY REPORT AND TECHNOLOGY TRANSFER DOCUMENT

FIG. 8