BNL-NUREG--31826

DE82 022050

BNL-NUREG-31826

Conf-820854--7

STUDY OF NON-FUEL-CYCLE WASTES*

Evelyn P. Gause
Brookhaven National Laboratory
Department of Nuclear Energy
Upton, New York 11973

MASTER

ABSTRACT

The low-level radioactive waste generated by many non-fuel cycle industries and institutions is not as well characterized as that produced by nuclear power plants. To better understand the variety of non-fuel cycle waste products now being disposed of by commercial shallow land burial (SLB) and to assess specific packages in advance of the enactment of the proposed regulation, 10 CFR Part 61 (dated June 29, 1981), "Licensing Requirements for Land Disposal of Radioactive Waste," the United States Nuclear Regulatory Commission (NRC) requested Brookhaven National Laboratory (BNL), under FIN A-3165, (in April of 1981), to provide technical assistance in expanding the data base on the physical and chemical characteristics of these wastes. With the cooperation of two major corporations, this program enabled the NRC to examine the achievability of the proposed 10 CFR Part 61 criteria, prior to the enactment of the regulation.

INTRODUCTION

In April of 1981, Brookhaven National Laboratory (BNL) initiated a program of technical assistance to the U.S. Nuclear Regulatory Commission (NRC) in the area of non-fuel cycle wastes. Non-fuel cycle wastes comprise nearly half of the activity of the low-level radioactive waste buried at commercial shallow land burial sites. Therefore, these wastes constitute a significant part of the source-term evaluation. The non-fuel cycle waste contribution to the source term needs to be better defined so that the NRC may be able to: (1) predict the source term, (2) assess site performance, and (3) provide criteria to regulate the type of waste form generated from non-fuel cycle operations. Generators

*Work performed under the auspices of the United States Nuclear Regulatory Commission.

of non-fuel cycle wastes are institutions, hospitals, medical laboratories, radiochemical manufacturers, and research laboratories. Technical assistance was provided in expanding the data base on the chemical and physical characteristics of the low-level radioactive waste of two major corporations. Evaluations were done on the basis of criteria for Class B Stable Waste packages as specified in proposed 10 CFR Part 61 (dated June 29, 1981).

BACKGROUND

Each regional U. S. NRC Office of Inspection and Enforcement (I and E) requested licensees to respond in 1979 to questions listed in I and E Bulletin No. 79-19, entitled, "Packaging of Low-Level Radioactive Waste for Transport and Burial."

From the response of the Union Carbide Corporation (UCC), it was determined that during 1978 and the first half of 1979, UCC shipped approximately 8,700 cu ft of waste, with a total activity content of approximately 140,000 Ci. This amounted to a contribution by UCC of 15% of the total activity and less than 1% of the total volume of radioactive waste sent for disposal at commercial shallow land burial in that period. UCC produces Mo-99 by the neutron irradiation of targets containing enriched uranium. Approximately 75% of the curie content of the waste was due to short-lived solidified mixed fission products of U-235 (having less than 1% burn-up), which had decayed for 30 days.

From the response of the New England Nuclear Corporation (NEN), it was determined that during 1978 and the first half of 1979, NEN shipped approximately 37,000 cu ft of waste, with a total activity content of approximatly 24% of the total activity and less than 5% of the total volume of radioactive waste sent for disposal at commercial shallow land burial during that period. The predominant isotope in the waste is tritium, which is used in the production of tritium-labeled compounds.

PROGRAM DESCRIPTION

The following areas were examined for the generators identified by the NRC (i.e. UCC and NEN):

A. (1) the identification of concerns and gaps in knowledge with respect to the criteria set forth in proposed 10 CFR Part 61 regarding waste package performance and possible degradative mechanisms (e.g., corrosion, biodegradation, and radiolysis) that are operative during storage and after burial, and (2) the recommendation of actions necessary to resolve these concerns or develop the information necessary to do so.

B. the identification of the type of information that should be submitted by the waste generator on the shipping form to permit adequate assessment of the relative hazards of both the radioactive and chemical aspects of the waste.

C. the identification of aspects of the waste package which could adversely affect burial site performance, such as, reduced soil retention of radionuclides.

D. (1) the review of the state-of-the art post-emplacement monitoring at burial sites; (2) recommendations for improvements in monitoring techniques (where necessary) to account for any chemical and/or radiological hazard that was identified.

PROPOSED 10 CFR PART 61.55 - WASTE CLASSIFICATION

Under proposed 10 CFR Part 61.55, radioactive wastes suitable for SLB are defined to fall within one of three classes, A, B, or C.

The characteristics of Class A segregated waste are that: (1) the radioisotopic concentration does not exceed the limit for Class A segregated waste; (2) it is segregated from other waste at the disposal site; and (3) it is disposed of with only minimum requirements on waste form and characteristics as set forth in proposed 10 CFR Part 61.56a.

The characteristics of Class B stable waste are that: (1) the radioisotopic concentration does not exceed the limit for Class B stable waste; (2) it must meet more rigorous requirements on waste form to assure stability after disposal; and (3) physical form and characteristics of the waste must meet the minimum and stability requirements as set forth in proposed 10 CFR Part 61.56a and proposed 10 CFR Part 61.56b.

The characteristics of Class C intruder waste are that: (1) the radioisotopic concentration does not exceed the limit for Class C intruder waste; (2) it must meet more rigorous requirements on waste form to assure stability and also requires special measures at the disposal facility to protect against inadvertent intrusion; and (3) physical form and characteristics of the waste must meet the minimum and stability requirements as set forth in proposed 10 CFR Part 61.56a and proposed 10 CFR Part 61.56b.

PROPOSED 10 CFR PART 61.56 - REQUIREMENTS FOR CLASS B STABLE WASTE

The minimum requirements for all classes of waste are detailed by proposed 10 CFR Part 61.56a. The evaluations done by BNL were on the

Class B stable waste packages of UCC and NEN. The stability requirements for Class B stable waste, as specified in proposed 10 CFR Part 61.56b, are:

(1) Waste must have structural stability for at least 150 years. A structurally stable waste form will maintain its physical dimensions to within 5% under the expected disposal conditions of a compressive load of 50 psi and factors such as the presence of moisture, and microbial activity, and internal factors such as radiation effects and chemical changes.

(2) Liquid wastes, or wastes containing liquid, must be converted into a form that contains as little free noncorrosive liquid as is reasonably achievable, but in no case shall the liquid exceed 1% of the volume of the waste.

(3) Void spaces within the waste and between the waste and its package must be reduced to the extent practicable.

OBSERVATIONS AND CONCLUSIONS

During the characterization and evaluation of specific Class B waste packages, the following observations and conclusions were made:

CHARACTERIZATION

(1) Non-fuel cycle waste packages are heterogeneous.

(2) Packages can contain mixtures of:

(a) lab trash (e.g. cellulosics, plastics, and glass);
(b) non-compressible metallic items (e.g. vacuum pumps);
(c) concrete;
(d) adsorbent (e.g. sand and clay);
(e) compacted metallics.

(3) Waste can be in the form of contaminated solids, adsorbed or solidified liquid, or gas.

(4) Chemical waste in the package can include organics, solvents, decontaminating agents, and sludges.

(5) Radionuclides in the waste can be alpha, beta, and gamma emitters, with a wide range of half-lives.

(6) Low-level radioactive waste does not necessarily mean low-activity.

STABILITY AND CONTAINMENT

(1) Some data is available on the corrosion behavior of buried metals. The review of pertinent corrosion data indicated that:

(a) A standard 55-gal carbon steel drum will not remain structurally stable for 150 yrs.

(b) 304 SS probably will not contain over a 150 yr-period because of pitting.

(c) The extent of corrosion of aluminum and its alloys can vary from none to severe.

(d) Biogenic corrosion is a significant contributor to corrosion of buried metals. (However, the published data of corrosion in soils includes this factor, because the soils were not sterilized.)

(e) The corrosion of concrete by an aggressive agent (e.g. sulfate ion) depends on the presence of moisture.

(f) The corrosion of metal encased in concrete is an electrochemical process.

(g) Corrosive agents can be generated by biodegradative and radiolytic mechanisms.

(h) Short-term tests are not available to predict 150-yr behavior of metals or concrete buried in soil.

(2) Radiolysis of water (in cement), organics, plastics, and cellulosics can produce large quantities of gas. Biodegradation also has the potential to generate large quantities of gas. Some of the packages that were characterized were thought to be self-sterilizing.

Gas generation in a sealed container may cause overpressurization of the container. Gas pressure buildup will not occur in a standard 55-gal drum because the drum will leak.

SHIPPING OF WASTE

(1) Sample filled-in shipping forms were obtained. Information requested on the form was evaluated as to its usefulness for future documentation of the contents, both in terms of radionuclides and chemicals.

(2) DOT regulations for package Quantity type and radionuclide Transport Groups were reviewed.

(3) NRC regulations (e.g. Certificates of Compliance) were reviewed.

(4) EPA regulations on toxic and hazardous waste were reviewed. Hazards that were considered included pyrophoricity, flammability, explosivity, reactivity, carcinogenicity, toxicity, and gas generation.

(5) Recommendations for additional information to be included on a shipping form included: performance of quality assurance procedures; the range of the measured radionuclide values; and identification of organics by Chemical Abstracts Registry Number.

EFFECTS OF WASTE ON BURIAL SITE

(1) Information was obtained on the commercial shallow-land burial sites as regards:

(a) geology;
(b) hydrology;
(c) climate;
(d) seismic considerations; and
(e) waste trench designs.

(2) Estimates were made for the following:

(a) time to breach of containment and availability of radionuclides to the burial environment; and
(b) loss of gaseous contents by permeation through potential barriers inside packages.

(3) Assuming that particular radionuclides are available for contact with the burial site environment, the following have to be considered:

(a) individual rates of radionuclide migration;
(b) waste-soil interactions;
(c) complexation characteristics elements; and
(d) current burial site monitoring practices.

WORK PLANS FY 1983

New generators are in the process of being selected. Their Class B stable waste packages will be characterized. These packages will be evaluated in terms of the finalized regulation, 10 CFR Part 61.

REFERENCES

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