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Report Title: RADMAN Topical Report

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Originating Organization: Waste Management Group, Inc. (WMG)

Reviewed by: Low-Level Waste Licensing Branch (WMLL), NMSS

1.0 BACKGROUND

1.1 Regulations

By Federal Register Notice dated December 27, 1982 (47 FR 57446), NRC amended its regulations to provide specific requirements for licensing of facilities for the land disposal of low-level radioactive waste. The majority of these requirements are contained in a new Part 61 to Title 10 of the Code of Federal Regulations (10 CFR Part 61) entitled "Licensing Requirements for Land Disposal of Radioactive Waste." Some additional requirements governing certification and use of shipping manifests were concurrently published as a new Section 20.311 of 10 CFR Part 20 ("Standards for Protection Against Radiation"). Other minor modifications, mostly of a procedural or administrative nature, were also made to other parts of the Commission's regulations. These new regulations are a final version of a set of proposed regulations for radioactive waste disposal published in the Federal Register on July 24, 1981 (46 FR 38081).

The effective date of 10 CFR Part 20, Section 20.311 is December 27, 1983; while the effective date of 10 CFR Part 61 and all other amendments is January 26, 1983. Section 20.311 requires that any licensee who transfers radioactive waste to a land disposal facility or to a licensed waste collector or processor must classify the waste according to Section 61.55 ("Waste Classification") of 10 CFR Part 61. Licensed waste processors who treat or repackage radioactive waste for disposal into a land disposal facility must also classify their waste according to Section 61.55. This section defines radioactive waste suitable for disposal as falling into one of three classes (Class A, Class B, or Class C), and waste is determined to fall into one of the classes by comparison to limiting concentrations of some particular listed radionuclides. All classes of waste must meet certain minimum requirements while Class B and Class C waste must meet additional structural stability requirements as set forth in Section 61.56 ("Waste Characteristics"). Section 20.311 also requires that waste generators record on shipment manifests a description of the transferred waste as well as a certification that the manifest is filled out correctly. Finally, Section 20.311 requires that licensees conduct a quality control program to ensure that waste classification is conducted in a reasonable manner.

To provide guidance to licensees in advance of the December 1983 deadline, the NRC Low-Level Waste Licensing Branch (WMLL) prepared and published in May 1983 a Technical Position on radioactive waste classification. The waste classification Technical Position describes overall procedures acceptable to NRC staff which may be used by licensees to determine the presence and concentration of the radionuclides listed in Section 61.55, and thereby classifying waste for near-surface disposal. This Technical Position also provides guidance on the types of information which should be included in shipment manifests accompanying waste shipments to near-surface disposal facilities. Previous draft versions of the Technical Position had been made available to interested members of the public for their review and comment.

1.2 Topical Report

As the Part 61 rulemaking action progressed, the principals of WMG perceived a need by waste generators of a computer based methodology to characterize packaged waste, classify waste packages in accordance with the Part 61 criteria, and prepare the documentation required by 10 CFR Part 61, the Department of Transportation (DOT), and license conditions at existing near-surface disposal facilities. This perceived need led WMG to develop RADMAN. RADMAN is also intended to significantly reduce the manpower requirements currently needed to prepare radioactive waste shipment manifests and reports.

Preparation of a Topical Report for the RADMAN methodology was discussed on a number of occasions by WMG and WMLL staff. These discussions included a demonstration of the RADMAN program to NRC staff on June 3, 1982. A draft version of the RADMAN Topical Report was received by WMLL via cover letter dated November 11, 1982 and later supplemented with further information, including a draft users manual for the code, some revised code listings, and an example sheet containing microscopic cross sections for shielding calculations for various waste types. The draft Topical Report (WMG 101P, October 1982) is a two volume set containing proprietary business information.

The draft Topical Report was reviewed by WMLL staff as well as the regulatory staffs of the states having currently operating low-level waste disposal sites--i.e., South Carolina, Washington, and Nevada. Comments and questions generated by these reviews were forwarded to WMG by letter dated March 28, 1983. Written responses to NRC and state comments were prepared by WMG and forwarded to NRC by letters dated April 4, 1983 and April 13, 1983. In addition, the NRC and state comments (and WMG responses) were discussed at an April 6, 1983 meeting between WMG and WMLL. Modifications to the RADMAN methodology to better reflect NRC's intent under the Part 61 requirements were agreed upon and summarized in the April 6 meeting minutes. WMG responses to state comments were also forwarded to the states for their review, along with copies of NRC comments, WMG responses to NRC comments, and the April 6 meeting minutes. Their response, as relayed by the NRC Office of State Programs (OSP), was that they had no negative reaction to the WMG response and to the April 6 agreements.

Based upon the NRC and state review, WMG committed to preparing a final version of the Topical Report (WMG-102, May 1983) which incorporates the modifications to the RADMAN methodology as mutually agreed upon. This revised Topical

Report is a three volume set. The first volume is a non-proprietary summary of the RADMAN program while the last two volumes contain proprietary business information. Draft sections of the final Topical Report have been reviewed by NRC staff. These sections are substantive and contain sufficient information for NRC staff to determine whether the agreed upon revisions to the RADMAN methodology have been made, and whether RADMAN is an acceptable vehicle for licensees to use as part of compliance with the NRC waste classification requirements. The material reviewed included the revised proprietary RADMAN computer code listings. To publish the final Topical Report, WMG will add a section which mainly addresses compliance with state requirements as well as a section providing an example application of RADMAN to a plant-specific data base. The former section will be written when the states complete their modifications to the existing disposal site license conditions to incorporate the NRC waste classification requirements. The latter section will be essentially a minor update of information already provided to NRC by WMG in the draft Topical Report and in other submittals.

2.0 SUMMARY OF TOPICAL REPORT

RADMAN is essentially a set of computer codes which can be used by radioactive waste generators to characterize packaged waste, classify waste packages in accordance with Part 61 waste classification requirements, and prepare documentation required by 10 CFR Part 61, DOT regulations, and license conditions at existing low-level waste disposal sites. The RADMAN program operates on a waste stream characteristics data base which is specific to the types and forms of waste generated by individual facilities, as well as to the facility- and waste stream-specific distributions of radionuclides and chelating agents. The efficacy of the RADMAN program depends on the adequacy of the waste-specific data base initially input by the waste generator and regularly updated.

The Topical Report serves to describe the design and operational characteristics so that waste generators may reference it as part of demonstrating compliance with the Part 61 requirements. (Principal users of RADMAN are expected to include nuclear power plants and other nuclear facilities which generate low-level waste streams containing a multitude of isotopes, including most or all of the isotopes listed in Tables 1 and 2 of Section 61.55.) The Topical Report describes the design of RADMAN, the operations it performs on a facility-and waste-specific data base, and the methods used to compile and update the data base. Typical data bases are defined and computer printouts from the operation of RADMAN on these data bases are presented as illustrations of RADMAN operation and output.

Operational activities covered by the RADMAN computer codes include:

- Estimate packaged waste radionuclide content from direct gamma radiation measurements.
- Estimate packaged waste radionuclide content from sample data.
- Estimate radionuclide content in disposable demineralizer vessels using influent/effluent or core sample data.

- Classify packaged radwaste according to 10 CFR Part 61 criteria.
- Provide a record of radwaste sampling activities and data.
- Maintain an inventory of packaged radwaste.
- Decay correct stored radwaste package content prior to shipment.
- Classify radwaste packages according to the new DOT package type criteria (48 FR 10218).
- Track packaged radwaste from generation through disposal.
- Prepare shipment manifests and disposal site RSR's.
- Prepare disposal site documentation for dewatered resin materials.
- Prepare Regulatory Guide 1.21 radwaste reports.
- Prepare internal reports on radwaste generation, inventory and shipment activities.
- Track and document changes to the original plant data base.

Data base updating activities include:

- Add new waste types to the initial data base.
- Remove waste types from the data base.
- Revise regulatory limits to conform to new regulations.
- Periodically update the waste sample data base by waste type.
- Periodically update the waste characteristic data base by waste type.
- Change the routine information printed on shipping papers.
- Analyze multiple samples for a waste type before entry into the data base.
- Change the radionuclide library in the plant data base.

RADMAN also provides a mechanism for waste generators to conduct a quality control program to aid in compliance with the waste classification requirements.

3.0 SUMMARY OF REGULATORY EVALUATION

3.1 Summary of Regulatory Bases Considered

The Topical Report has been reviewed for conformance with appropriate sections of 10 CFR Parts 20 and 61, as well as the final (May 1983) Low-Level Waste

Licensing Branch Technical Position on Radioactive Waste Classification. Specific areas reviewed include:

- Waste classification
- Part 61 information requirements in shipping manifests
- DOT requirements
- Waste tracking
- Quality control
- RADMAN use and updates
- Disposal site licensing conditions

3.2 Waste Classification

All licensees must classify waste sent to a disposal facility according to the requirements in 10 CFR Part 61.55, which principally consist of comparing concentrations of particular radionuclides against limiting values for these radionuclides listed in Tables 1 and 2 in Section 61.55. Since many of the radionuclides are difficult to measure on a routine basis, Section 61.55(a)(8) allows concentrations of radionuclides to be determined by indirect methods such as use of scaling factors which relate the inferred concentration of one radionuclide to another that is measured, or radionuclide material accountability, if there is reasonable assurance that the indirect methods can be correlated with actual measurements. The waste classification Technical Position sets forth a number of methods by which waste classification may be performed, and includes an Appendix A which describes a general three-tiered program for classifying wastes at nuclear power facilities. This three-tiered program consists of:

1. Periodic analysis of all nuclides listed in Tables 1 and 2 of Section 61.55;

2. Gamma-spectroscopy of certain nuclides from which waste classification nuclides are correlated; and

3. Gross radioactivity measurements which correlate activity levels of wastes from similar batches to the gamma-spectroscopy measurements.

The staff has concluded that RADMAN is compatible with the Part 20 and 61 requirements, and with the waste classification Technical Position. RADMAN requires that each different waste stream be characterized in terms of physical and chemical characteristics, and radiological isotopic distributions within the waste stream are provided by sample data specific to the waste stream. The radioisotopic content of different batches of the waste stream, or individual waste containers, may then be determined by (1) direct measurement of isotopes in samples, (2) correlating measurements of some isotopes to quantities of others, or (3) correlating gross activity measurements to isotopic quantities. Gross activity correlations are performed using a 6CEn calculation which is then corrected for geometry and other influences. RADMAN provides for periodic updating of isotopic distributions within individual waste streams by input of new sample data. For disposable demineralizers, RADMAN allows the additional option of determining isotopic quantities of concentrations by sampling inlet and effluent streams and making determinations by the calculated decontamination factor.

Once isotopic quantities and concentrations are determined, waste classification is performed in a manner consistent with Section 61.55. Individual isotopes are compared against the class limits, and then a sum-of-the-fractions analysis is performed consistent with Paragraph 61.55(a)(7). If a waste stream is identified as consisting of an activated metal, the classification limits are accordingly adjusted by RADMAN consistent with Section 61.55.

Correlations between measured and inferred radionuclides are currently as follows:

- Ce-144 to transuranic (TRU) nuclides
- Co-60 to activation product nuclides
- Cs-137 to fission product nuclides

The Ce-144/transuranic correlation has been well established by measurement programs at a number of operating reactor plants. The Co-60 and Cs-137 correlations have not been demonstrated and are expected by WMLL staff to be incorrect for a number of activation and fission products. However, there is currently insufficient data to arrive at a more accurate set of correlating radionuclides. Use of the RADMAN program will therefore require that these correlations be continuously reviewed and updated as additional data is obtained on an individual plant, individual waste stream, and generic basis. WMG has committed to these reviews and updates.

It is also noted that some commercial disposal sites may not accept waste having TRU concentrations greater than 10 nCi/gm, irrespective of the provisions in 10 CFR Part 61 which allow disposal of TRU concentrations not exceeding 100 nCi/gm. As part of waste classification, the RADMAN program provides a flag to the user which notifies him if specific waste containers exceed 10 nCi/gm.

3.3 Part 61 Information Requirements in Shipping Manifests

The RADMAN program has been reviewed against the manifesting requirements in Section 20.311. To use the RADMAN manifest preparation routine, the user inputs certain data regarding each type of waste into the code, and this data is stored. All such data is entered directly from specific loading forms. The user selects the type of manifest form to be printed out -- i.e., either the Chem-Nuclear (CNSI) or the U.S. Ecology (USE) shipping manifest -- and by interaction with the code the shipment manifest is prepared automatically by a printer attachment to the computer console.

As the code currently exists, all the information requirements required by Section 20.311 are input by the code operator using the loading forms. However at this time, not all information can be printed onto the shipment manifests. This information which is lacking includes the classification status of the waste, the quantities of 4 particular radionuclides (H-3, C-14, Tc-99, and I-129), the principal chemical form, the presence of quantities of chelating agents above 0.1% by weight, and the EPA hazardous waste identification number of the person transporting the waste to the land disposal facility. The reason for this is that disposal site operators have not yet made available revised manifest forms to conform to the new NRC (and DOT)

requirements. A revised manifest for at least the USE sites has been drafted, however. This means that the RADMAN program will have to be modified to print the additional information when revised manifest formats are available from CNSI and USE. Since the additional information required by Section 20.311 is already compiled within the RADMAN program, modification of the program output format is all that is needed to revise the manifest documentation procedure. WMG has committed to these modifications.

3.4 DOT Requirements

The RADMAN routine was reviewed against DOT regulations and guidance for waste transportation, including classifying waste packages according to DOT criteria and preparation of shipment manifests. From this review, NRC staff have concluded that a waste generator using RADMAN will be able to comply with these DOT requirements. RADMAN is set up to implement new transportation regulations promulgated by DOT on March 10, 1983 (48 FR 10218). Radionuclides are listed in shipment manifests in accordance with DOT guidelines as referenced in a March 25, 1983 letter from R. Rawl, DOT, to WMG, and the waste classification Technical Position.

3.5 Waste Tracking

Section 20.311 requires that persons shipping waste to a disposal site have the receipt of waste acknowledged by the disposal site operator, and investigate shipments of waste for which this acknowledgement has not been received within a specified time limit. RADMAN assists licensees in complying with this requirement by setting up a waste tracking system. On user demand, RADMAN lists waste shipments which are en route to a disposal site. As notification that waste shipment has reached the disposal site has been received, the user would then update this list by deleting received shipments from the list. This feature provides the waste generator with a mechanism to identify if any waste became lost in transit.

3.6 Quality Control

Paragraph 20.311(d)(3) requires that waste shippers conduct a quality control program to assure compliance with paragraphs 61.55 and 61.56 of 10 CFR Part 61. This program must include management evaluation of audits.

RADMAN provides a mechanism for waste generators to conduct a quality control program to aid in compliance with the waste classification requirements in Section 61.55. Some of the features available using RADMAN include:

- Sample data are flagged which exceed criteria for radionuclide fractional abundances and isotopic distributions. Guidelines are provided to the code operator for acceptability of a particular set of sample data based on the above criteria.

- Records are maintained of changes to waste sample data, deletion of sample data, or addition of data for a new waste type.

- Records are maintained of changes to the characteristic files maintained for the various waste types, including packaged waste and demineralizers.

- Records are maintained of changes made to individual waste packages involving waste volume, package weight, or the activity correction factor.

- Reports of the contents of sample and waste characteristic files for each waste type.

- Access to various RADMAN functions by different levels of management and staff.

In addition, preparation of and changes to waste characteristics files are made using a particular set of loading forms which are signed and maintained separately. In this way, individual accountability is enhanced.

3.7 RADMAN Use and Updates

Users of the RADMAN code are instructed in its use through a series of initial training sessions as well as later updates as part of a RADMAN maintenance agreement. A RADMAN users manual is also provided.

From time to time, updates to RADMAN software will also be required to:

- implement revised radionuclide correlations

- implement new manifesting procedures

- implement any future changes in disposal site license conditions

- implement any future new regulatory requirements

- implement any other changes as needed to improve RADMAN utility (new features, etc.)

Under the RADMAN maintenance agreement, WMG has committed to provide users with documentation and revised RADMAN Operating Manual sections on all code changes.

3.8 Disposal Site License Conditions

RADMAN has been reviewed by NRC staff and by staffs of the states of South Carolina, Nevada, and Washington. (The states of South Carolina, Nevada, and Washington are all Agreement States.) Documentation of dewatered resin waste is provided as required by South Carolina for the Barnwell site.

NRC staff anticipates that the disposal site license conditions will be modified to reflect the Part 61 requirements, including those for waste classification and manifesting set forth in paragraph 20.311. Since the 20.311 requirements do not become effective before December 27, 1983, such revisions to site license conditions have not at this time been implemented. When such revisions are made, WMG will need to review RADMAN operations for consistency and revise RADMAN as necessary.

4.0 REGULATORY POSITION

Based on WMG submittals, and NRC staff review of the submittals, WMLL staff have concluded that RADMAN provides an acceptable vehicle which can be used by licensees as part of compliance with the requirements in Section 20.311 and 61.55.

This conclusion is predicated on completion of the final Topical Report according to the review agreements and upon the following conditions:

(1) That radionuclide correlations are updated on a waste stream, plant, or generic basis as additional sampling data becomes available. WMLL staff believe that many correlations currently assumed in RADMAN between Co-60 and activation products, and between Cs-137 and fission products, may not be valid. The current lack of data, however, precludes establishing verified correlations at this time in RADMAN.

(2) That the manifest formatting provisions are updated to include the Section 20.311 information when revised manifests reflecting the Section 20.311 requirements are made available by disposal site operators.

(3) That RADMAN is appropriately updated as state (South Carolina, Washington, Nevada) provisions for compliance with the Part 61 waste classification and manifesting requirements are made available.

(4) That RADMAN is updated as required to remain consistent with future modifications to NRC, DOT, State or other regulatory requirements as such requirements become effective, as well as changes to disposal site license conditions.