10 CFR 61

E. Tarnuzzer, Chairman
J. Bernardy, Co-Chairman

IMPLEMENTATION OF 10 CFR PART 61
WASTE CLASSIFICATION AND WASTE FORM REQUIREMENTS

Timothy C. Johnson
Paul H. Lohaus
G. W. Roles
U.S. Nuclear Regulatory Commission
Washington, D.C.

ABSTRACT

Two important areas in the United States Nuclear Regulatory Commission regulation for low-level waste management, 10 CFR Part 61, involve the requirements for waste classification and waste form.

The waste classification system establishes three categories of wastes acceptable for near-surface disposal. These categories are determined by the concentrations of nuclides importantfor disposal. Class A wastes have low concentrations and need only meet minimum waste form requirements. Class B wastes have higher concentrations and are required to have stability to minimize disposal trench subsidence effects. Class C wastes have higher concentrations than do Class B wastes and are required to have stability and be disposed of with an intruder barrier. An intruder barrier is intended to minimize the contact of wastes by inadvertent intruders following the loss of disposal site institutional control.

Many of the nuclides listed in the waste classification system are difficult to assay. Consequently, a waste generator is allowed to establish an analytic program which utilizes inferential measurements to classify wastes. This paper discusses the guidance provided to waste generators which can be used to establish assay programs for classifying wastes.

Class B and C wastes are required to meet 10 CFR Part 61 stability requirements. This paper also discusses the approaches used to demonstrate that such wastes meet the stability criteria, including acceptable tests and test criteria which could be used by waste generators to demonstrate waste stability.

BACKGROUND

On December 27, 1982, the Nuclear Regulatory Commission (NRC) published in the Federal Register the final rule, "10 CFR Part 61 - Licensing Requirements for Land Disposal of Radioactive Waste." This rule establishes performance objectives for the land disposal of radioactive waste, minimum technical requirements for a near-surface disposal facility, and licensing procedures NRC will follow in licensing new disposal capacity for low-level radioactive waste.

Two of the most important areas in the rule involve the classification of wastes and the waste form requirements. These requirements are implemented for NRC licensees through the manifest requirements in 10 CFR Part 20.311. Waste generators have been given until December 27, 1983 to implement a program for classifying wastes and for meeting the waste form requirements.

The waste classification system establishes three categories for wastes acceptable for disposal at a near-surface burial facility. This classification system is based on the concentrations of radionuclides important for disposal. Using this system, wastes having greater radiologic hazards are required to be disposed of with greater protection.

The waste classification system in 10 CFR Part 61 consists of three classes: Class A, Class B and Class C. Class A wastes contain the lower concentrations of the nuclides important for disposal. These wastes can be disposed of with only the minimum waste form requirements. Because of the lower concentrations, waste instability will not produce significant hazards to public health and safety.

Class B wastes have higher activities than do the Class A waste materials. Due to the higher activities, Class B wastes must be segregated from Class A wastes and must be structurally stable to minimize waste degradation and the resultant subsidence of the waste trenches. Trench subsidence has resulted in a large infiltration of water into trenches at the now closed Sheffield, IL, West Valley, NY and the Maxey Flats, KY disposal sites. In order to reduce the need for major remedial actions in future sites and potentially increased groundwater pathway impacts, 10 CFR Part 61 requires segregation and stability for the higher concentration wastes. Waste form stability can be obtained by processing (e.g., solidification), use of a container or structure to provide stability (e.g., high integrity container) or by the waste itself (e.g., a large activated component). To the extent practicable, stable wastes should maintain gross physical properties and identity for 300 years.

Class C wastes have higher concentrations than do the Class B wastes. In addition to stability, Class C wastes must be disposed of with an intruder barrier to minimize the possibility of inadvertent intruders contacting the wastes following the loss of institutional control of the disposal site. Burial at least 5 meters from the surface provides an acceptable intruder barrier for Class C wastes.

The radionuclide concentration for Class A, B and C wastes are presented in 10 CFR Part 61.55. Wastes which have concentrations which exceed Class C limits are generally unsuitable for disposal at a near-surface disposal facility. The rule, however, allows case-by-case determinations of the acceptability for disposal for these wastes based on the proposed waste form, disposal method and site conditions.

The waste classification and waste form requirements in 10 CFR Part 61 are relatively general. The NRC staff intentionally refrained from listing prescriptive requirements to allow as much flexibility as possible because of the multitude of different waste forms and types of waste generators who ship to commercial disposal sites. In order to provide more specific guidance, the NRC staff has prepared Technical Positions (TP's) on waste classification and waste form. It is intended that these TP's will eventually become regulatory guides. TP's provide several acceptable methods for demonstrating compliance with the rule. It should be understood that these methods are not the only methods for demonstrating compliance. In order to minimize problems regarding inspections in this area, waste generators should discuss individual difficulties with the appropriate inspectors and other NRC staff. These discussions can be the basis for developing acceptable and practical programs for demonstrating compliance.

WASTE CLASSIFICATION

Several of the nuclides in the waste classification tables are difficult to perform assays on. These nuclides, however, are important from a disposal viewpoint and, therefore, there is a need to know the inventories of these nuclides upon closure of the burial site. In order for waste generators to develop programs which provide nuclide inventory data yet are practicable to implement, the waste classification TP was developed. The objective of the TP is to provide guidance regarding acceptable methods for performing assays and determining nuclide quantities in wastes.

The waste classification TP discusses four acceptable methods for classifying wastes. These methods are:

1. Materials Accountability
2. Classification by Source
3. Gross Radiation Methods
4. Direct Measurement

The materials accountability method would be generally used by institutional waste generators who receive known quantities of specific nuclides. By knowing how much activity is used in an experiment, the quantities of nuclides can be computed. This method is currently used by most institutional waste generators for determining activity levels in waste shipments. Because the licensee receives only specific nuclides, he would not be required to assay for the other nuclides in the waste classification tables.

Classification by source is an extension of the materials accountability method. An example of this method might be a university who has varied experiments underway using several nuclides in separated laboratories. If the licensee can demonstrate segregation of wastes, he would need only to account for the nuclides used in the separate laboratories. In other words, the classification would be based on materials accountability at the source of waste generation.

Gross radiation measurements can be applied to heterogeneous materials, such as trash, if the gross survey reading can be correlated to a measured nuclide distribution. An example of this method might be a power plant who has obtained a nuclide distribution for trash by assaying a consolidated series of smears taken from inside the facility. Due to the difficulty in analyzing individual pieces of trash, the gross radiation measurement of the container could be correlated to the measured distribution and quantities of the waste classification nuclides determined.

The method of direct measurement allows the use of scaling factors for determining quantities of the difficult-to-measure nuclides in the wastes. In applying this method a waste generator would analyze samples of the major waste streams at his facility. From this analysis he would develop scaling factors between easily measured nuclides using gamma spectroscopy and those which are difficult to directly measure. An example of such a scaling method is the Ce^{144}-$Pu^{239,240}$ correlation which is currently used at several power facilities. In this case, chemically similar nuclides have been correlated and scaling factors computed. Using this method the TP recommends updating the correlation factors by waste stream reanalysis on an annual basis for Class B and C wastes and on a biannual basis (every two years) for Class A wastes.

The NRC staff expects many questions from waste generators regarding difficulties which are expected in the development and use of waste classification programs. The primary concern of waste generators is the demonstration of compliance with the 10 CFR Part 61 requirements in light of the practical difficulties in sampling highly active waste streams. In addition, there can be difficulty in obtaining accurate nuclide measurements of highly active samples using conventional gamma spectroscopy equipment at high detector deadtimes. The NRC staff recognizes the practicalities involved and inspectors will evaluate the adequacy of a waste generators classification program based on the principal consideration that a reasonable effort should be made to ensure that a realistic representation of the nuclides in the waste is made.

The NRC staff has an effort underway to demonstrate that a waste classification program for nuclear power plants can be developed which is acceptable to NRC staff and is also practical to implement. In cooperation with the Maine Yankee and Vermont Yankee power plants, the NRC staff has visited and reviewed the current plant practices for determining the activities in wastes. The sampling procedures and frequencies currently used at the two Yankee plants are consistent with the TP. No modifications to equipment would be needed to implement the 10 CFR Part 61 waste classification requirements. The NRC staff and the Yankee staff, therefore, believe the impacts on these facilities would be minimal.

The Yankee demonstration program also includes assays of major plant waste streams and the generation of correlation factors. To date, samples from each plant have been shipped to Science Applications, Inc. for analysis. Following another series of sampling and analysis, a report will be prepared documenting the experiences gained.

The NRC staff held meetings in January 1982 with the staff at each of the NRC Regional Offices. One objective of these meetings was to explain 10 CFR Part 61 and the TP's so that inspections of waste generator programs would be performed consistently and with an understanding of the objectives of the rule.

WASTE FORM

The rule, 10 CFR Part 61, specifies that Class B and C waste must be in a structurally stable form and should generally maintain its physical dimensions and its form under the expected disposal conditions. Thus stability would need to be demonstrated under the mechanical loads expected in a radiation environment, and in the presence of moisture and microbial activity.

The objective of the waste form TP is to provide guidance on acceptable methods for demonstrating stability for Class B and C wastes. The TP provides guidance on developing and qualifying process control programs for waste solidification processes, designing high integrity containers, packaging filter cartridges and loading organic ion-exchange resins.

For the solidification of Class B and C wastes acceptable test methods and test results for demonstrating stability are shown in Table I. The compression strength of 0.34 MPa (50 psi) is based on a conservative mechanical loading a waste form would undergo in a disposal trench. The radiation accumulated dose of 10^8 Rads is based on the upper limit of current, routinely generated wastes. The biodegradation tests are short term tests that provide go, no-go results. If microbial attack is observed, additional testing may need to be performed to confirm that waste forms are not subject to substantial biodegradation. The leachability index (LIX) of 6 is calculated using the method described in ANS 16.1. This leachability index is not highly restrictive, but is intended, in part, to be a measure of structural stability. Waste form data suggest that products with poor leach resistance also have poor stability properties. The immersion test can be performed in conjunction with the leaching test. The thermal degradation will be important for wastes held in storage prior to disposal. During storage the stability of the waste form should not be affected by changes in temperature. The free liquid test limit is the only prescriptive waste form requirement in 10 CFR Part 61 and is intended to allow trace quantities of liquids which might result from condensation during handling and transport.

Table I

Solidified Product Guidance

	Test	Method	Result
1.	Compression strength	ASTM C39 or D621	0.3 MPa(50 psi)
2.	Radiation stability		0.3 MPa after 10^8 Rads
3.	Biodegradation	ASTM G21 and G22	No Growth
4.	Leachability	ANS 16.1	LIX of 6
5.	Immersion		0.3 MPa after 90 days
6.	Thermal cycling	ASTM B553	0.3 MPa after 30 cycles from -40C to 60C
7.	Free liquid	ANS 55.1	0.5 percent
8.	Full-scale tests		Homogeneous and correlates to lab size test results

An acceptable approach for implementing the TP tests for solidified Class B and C wastes would be through the qualification of a process control program (PCPO. The full battery of tests need only be performed at the time of PCP qualification. The PCP should, however, be periodically reverified to ensure that the system is operating as designed. The reverification could be accomplished with a short series of tests. The use of generic test data for PCP qualification would be acceptable.

Testing may be performed on simulated, non-radioactive wastes. If laboratory size specimens are used, these samples should be correlated with full-scale waste forms to demonstrate that the actual waste products will have similar properties as the specimens tested.

As an option to solidification, the rule allows waste generators the flexibility of using high integrity containers (HIC's) to provide stability. The TP provides guidance on the design of HIC's. This guidance is summarized in Table II. The HIC should have as a design goal a lifetime of 300 years. It should also be able to meet the Department of Transportation (DOT) Type A package qualification. An important aspect in the design and use of HIC's is a quality assurance (QA) program. The QA program should give special consideration to fabrication, testing and use of the containers. For certain containers materials specific wastes may need to be restricted from contact with the containers. The QA program should carefully address this area. Finally, a PCP should be developed to ensure that the one percent free liquid requirement will be met.

Table II

High Integrity Container Design Guidance

1. Design for 300 year lifetime objective
2. Design to withstand corrosive and chemical environment
3. Design to withstand loads of burial
4. Materials designed to withstand 10^8 Rads
5. Materials resistant to biodegradation
6. Design to DOT Type A package qualification
7. Conduct prototype testing
8. Have quality assurance program
9. Use process control program to demonstrate

For packaging filter cartridges, the TP allows the use of encapsulation or an HIC. The TP also recommends that organic ion-exchange resins not be loaded such that the total accumulated dose exceeds 10^8 Rads. Above 10^8 Rads radiation degradation in organic resins can produce acidic products as well as hydrogen gas.

CONCLUSION

The rule, 10 CFR Part 61, provides performance objectives, technical requirements and a framework for licensing land disposal facilities for low-level radioactive wastes. NRC licensed waste generators are affected by this rule in that they will be required to classify wastes and meet the waste form requirements in the rule beginning on December 27, 1983. In order to provide more guidance to waste generators, the NRC staff has prepared TP's on waste classification and waste form.