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U.S. NUCLEAR REGULATORY COMMISSION

DIVISION OF WASTE MANAGEMENT

LOW-LEVEL WASTE LICENSING BRANCH

TECHNICAL POSITION PAPER ON

NEAR-SURFACE DISPOSAL FACILITY DESIGN AND OPERATION

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1.0 BACKGROUND

The Atomic Energy Act of 1954 and the Energy Reorganization Act of 1974 gave the Nuclear Regulatory Commission (NRC) the responsibility of the licensing and regulation of commercial nuclear facilities from the standpoint of public health and safety. In keeping with this responsibility, NRC recently issued a proposed rule, 10 CFR Part 61, which specifies licensing and regulatory requirements for near-surface disposal of low-level radioactive wastes. The rule is scheduled to be issued in final form by the end of 1982 with several Regulatory Guides to assist applicants in compliance to be issued in 1983 and 1984.

The proposed 10 CFR Part 61 specifies licensing procedures, performance objectives and minimum technical requirements for near-surface disposal facilities. The performance objectives are intended to establish overall objectives to be achieved by the waste disposal facility but to allow flexibility in achieving them. However, there are some requirements, relating to components of the facility, that have been judged necessary in light of past experience at disposal facilities. These requirements have been listed as the minimum technical requirements for an overall disposal system at a given site.

The NRC is aware that both individual states and regional compacts of states have taken or are taking initial steps which could lead to development of new sites for near-surface disposal of low-level radioactive wastes. The purpose of this technical position paper is to provide these parties with guidance on facility design and operations well in advance of the issuance of formal Regulatory Guides for 10 CFR Part 61.

2.0 INTRODUCTION

This position paper covers that period of time from issuance of a license to permit disposal and continues to application for an amendment to permit site closure. This discussion provides an explanation of the staff interpretation of the technical requirements related to disposal site design and facility operations in 10 CFR Part 61 (Subsections 61.51 and 61.52). Examples of design and operational concepts that are considered acceptable or desirable for meeting the minimum technical requirements and achieving the performance objectives of the proposed rule are included.

The remainder of this paper is grouped into two sections: one dealing with disposal site design and the other with facility operations. The structure of each section is alike: the minimum technical requirements as a group are followed by a discussion of design features and operational procedures relating to the requirements.

3.0 FACILITY DESIGN REQUIREMENTS

The proposed 10 CFR Part 61 sets forth six minimum technical requirements in §61.51 for near-surface disposal site design. Design requirements for other than near-surface disposal have not been identified in rulemaking at this time and therefore, will not be addressed in this paper. The requirements of §61.51 are as follows:

(1) Site design features must be directed toward long-term isolation and avoidance of the need for continuing active maintenance after site closure.

(2) The disposal site design and operation must be compatible with the disposal site closure and stabilization plan and lead to disposal site closure that provides reasonable assurance that the performance objectives will be met.

(3) The disposal site must be designed to complement and improve where appropriate, the ability of the disposal site's natural characteristics to assure that the performance objectives will be met.

(4) Covers must be designed to minimize to the extent practicable water infiltration, to direct percolating or surface water away from the disposed waste, and to resist degradation by surface geologic processes and biotic activity.

(5) Surface features must direct surface water drainage away from disposal units at velocities and gradients which will not result in erosion that will require ongoing active maintenance in the future.

(6) The disposal site must be designed to minimize to the extent practicable the contact of water with waste during storage, the contact of standing water with waste during disposal, and the contact of percolating or standing water with wastes after disposal.

The disposal site will be discussed in the following pages in three parts relative to these requirements: general disposal site design, disposal unit design and surface water management.

3.1 General Disposal Site Design

As defined in §61.7(a)(2) of the proposed 10 CFR Part 61, a near-surface disposal facility includes all of the land and buildings necessary to disposal of radioactive waste. The disposal site, however, is that portion of the disposal facility which is used for disposal of wastes. It consists of the disposal units and buffer zone (§61.2). This is not to say that ancillary activities such as waste storage or shipment inspection cannot be carried out within the confines of the disposal site, but rather that disposal of waste in accordance with the requirements of Part 61 is the primary activity of the disposal site.

Preliminary disposal site design activities should begin during site selection as a part of the basis for identifying a preferred site. As data is acquired and evaluated during site characterization, the applicant should be developing and refining a preliminary site design. The design should consider the need for long-term waste isolation and avoidance of the need for continuing active maintenance.

Space Utilization

The disposal site should be bounded so as to permit efficient land utilization and maximum waste volume allocation, while maintaining a design directed toward long-term stability and isolation. Factors such as shape, size and orientation of disposal units topography, access roads, and variations in soil types should be considered in establishing the boundaries of the disposal area. At the same time, the layout of disposal units within the disposal area should allow sufficient space between disposal units to assure wall integrity, to permit the movement of equipment and personnel during disposal operations, to provide for surface water drainage, and to provide adequate space for disposal unit covers such that previously experienced problems with sidewall cracking and capture of surface drainage are eliminated.

The positioning of the disposal units within the disposal site must allow for a buffer zone between the disposal units and the site boundary as required in §61.52. The purpose of this zone is to provide an area between disposal units and the site boundary where monitoring systems may be established to detect radionuclide migration from the units and remedial actions may be taken to intercept such migration, if necessary. By definition, waste disposal is not allowed in the buffer zone, but other surface activities may be located in this area. It would be permissible to use this area as office space or temporary waste storage, as long as these other uses do not interfere with monitoring activities.

The buffer zone should surround all waste disposal units and should be within the radiation-controlled portion of the disposal facility. The applicant has a wide degree of latitude in determining the size and configuration of the buffer zone for a specific facility. It is the staff's position that at a minimum, a 30 meter buffer zone should be maintained on all sides. In the direction of ground water flow, the buffer zone may need to be wider to allow for remedial actions which may be needed in advance of a migrating front of radionuclides. Among factors which should be considered in establishing the limits of the buffer zone are topography, soil characteristics, direction and velocity of ground-water flow, and location of off-site receptors.

The disposal site should be designed so that closure and stabilization is an ongoing process and not an activity added at the end of disposal operations. The planned sequence of use for disposal units over the site lifetime should reflect the need to conduct adequate closure and stabilization operations as each unit is filled. The location of roads and disposal unit covers, use of heavy equipment, establishment of vegetative cover, and management of surface water should be planned such that operations may be conducted at each disposal unit without damage to closed disposal units. Location and access to fill and borrow areas should also be planned to assure that they do not compromise the integrity of completed disposal units.

Slope Design

To meet the requirements of §61.51(a)(1) and (5) final slopes should be designed to minimize erosion and failure of the slopes. Both potential problems can be minimized by controlling the slope angle, particle size of the soil, degree of compaction or cementation, and vegetative cover. In arid regions, where infiltration of water is not as much of a concern and where vegetation may be difficult to establish, gravel or cobbles may be used to protect the slope in place of vegetation.

Where temporary relatively steep slopes are required, such as are used for the sidewalls of trench type disposal units or large drilled caissons, the slopes should still be protected from erosion and should be excavated to stand without failure. At the Barnwell facility, the operator has successfully used plastic sheets to provide temporary protection of the sidewalls from precipitation. The slope angles in the trenches at currently active disposal sites have usually been designed using a limiting equilibrium analysis of a free body which has provided for stable walls in the trenches. Slope angles should be determined on the basis of information obtained during site characterization and modified as necessary based on ongoing field investigations during site operation.

Access Roads

To assure that roads on the site do not interfere with the site closure and stabilization plans, they should be designed so that construction equipment and other anticipated vehicles will not damage completed disposal areas during normal operational activities. Roads will need to be sufficiently wide and of sufficient trafficability such that the vehicles may be safely operated on the roads without damaging nearby disposal units which are operating or have been closed. Road surfaces should be designed so as to not provide locations of concentrated infiltration or runoff which would interfere with other design objectives, i.e., minimizing infiltration, providing a stable site surface and establishing a vegetative cover.

3.2 Disposal Unit Design

Earthen trenches have historically been the most common type of disposal unit in commercial waste disposal operations, however, the staff does not consider any specific disposal unit design to be optimal. The disposal unit design should reflect the specifics of the site as well as the characteristics of the waste form to be received.

In order to provide the long-term isolation required in §61.51(1) many design features of a near surface disposal facility, such as intruder barriers, slopes and disposal unit covers, are expected to have a design life on the order of several hundred years. This is longer than for most types of civil engineering projects and therefore, some common engineering materials may not be suitable for use in low-level waste disposal facilities unless careful planning is utilized. A critical examination should be made into the design life of each component of a disposal unit and compared to that of the unit as a whole.

For example, geotextiles and geomembranes may not have a design life of sufficient length to last as long as the disposal unit as a whole.

However, if the facility is designed in anticipation of the eventual breakdown of these man-made materials, they can be used as beneficial elements of the design.

The following paragraphs discuss various aspects of disposal unit design and relate them to requirements listed in the proposed rule.

General Disposal Unit Configuration

Disposal units have historically been earthen trenches into which low-level waste has been placed. However, the requirements of the proposed 10 CFR Part 61 do not prescribe trenches or any other specific disposal unit design. In fact, the waste classification system contained in §61.55 opens the way for several discrete types of disposal units to be used at the same facility, each designed on the basis of the type of waste to be received.

Class A waste, for example, is not required under the rule to meet the stability requirements of §61.56. When these wastes are not stable in form, §61.52 requires that they be disposed of in separate disposal units from Class B and Class C wastes. Because of the instability of the waste form, some degree of active maintenance during the operational life of the site is anticipated. The staff has placed no significant constraints on the type of disposal unit to be employed for Class A waste disposal. A potential applicant could propose to use segregated disposal trenches, disposal cells, or one of a number of disposal unit designs similar to those used for sanitary landfills. Regardless of the choice made, the disposal unit for Class A segregated waste should meet the minimum technical requirements of §61.51 as well as the performance objectives of §61 Subpart C.

Class B waste may be buried in trenches, cells, or some alternative disposal unit as long as the design selected meets the minimum requirements of §61.51. Since Class B waste must be structurally stable, disposal unit designs distinct from those used for Class A waste may be utilized. Disposal units used for Class B waste could be similar to the large trenches now used at disposal facilities, above grade structures, large diameter boreholes, slit trenches or a design of the applicants choice.

Class C waste requires intruder protections as specified in §61.52. To accomplish this, it may be necessary to segregate it from but Class B waste in the same unit, or bury it in a separate unit. Methods of meeting this requirement are discussed in section 4.1 of this paper.

Disposal Unit Size

There is no optimal disposal unit size. Determination of the dimensions is dependent upon the physical size and topography of the disposal site and the volume of waste to be buried. Soil characteristics, the need for equipment access and manuevering space, and surface water drainage before, during, and after waste emplacement should also be considered.

The depth of trenches or disposal units is wholly a site-specific matter, dependent primarily upon the depth to the ground-water table and stability of the side walls. §61.50 and 61.51 of the rule require that waste not be in contact with standing water in the trenches and to be well above maximum seasonal fluctuations in the water table. Trench depths of approximately 8 meters are common today, but regional or local variations in the maximum height of the water table may allow for greater or may require lesser trench depths.

§61.50(a)(7) would allow for a Commission-determined exception to the requirement for separation of waste from the water table provided it can be shown that molecular diffusion would be the predominant means of radionuclide movement and that the rate of movement would not interfere with the achievement of the performance objectives of Subpart C. Guidance on determining where molecular diffusion dominates is provided in the Branch Technical Position on Site Suitability, Selection and Characterization, NUREG 0902.

Disposal Unit Orientation and Spacing

Disposal units should generally be oriented parallel to topographic contours of the site. Slopes of the site should not be so steep as to result in significant elevation differences between side walls of a disposal unit. In addition, the elevation difference of the ground surface between one end of a disposal unit and the other end should be less than the combined thickness of the backfill overlying the waste and the trench cap. These criteria are intended to satisfy §61.51(a)(5) and (6) by minimizing the probability that erosion will expose wastes and minimizing the potential of water collecting in one end of a disposal unit bottom and then flowing out the top of the unit.

The spacing between disposal units at the ground surface should also be considered in establishing the overall dimensions of the units. There should be sufficient space between adjacent units to assure disposal unit integrity and provide for appropriate surface water drainage systems. In addition, the distance between units should be such that positioning and use of equipment at a newly excavated unit will not disturb the processes of closure and stabilization at a completed unit. Assuring that this disturbance does not occur is partly a function of spacing and partly a function of the sequence in which disposal units are closed. Finally, disposal unit spacing should take into account the need for a buffer zone between the closed units of the disposal site and the overall facility boundary as required by Subsection 61.52(a)(8).

Disposal Unit Covers

§61.51(a)(4) requires that disposal unit covers be designed to minimize to the expent practicable water infiltration, to direct percolating or surface water away from the buried waste, and to resist degradation by surface geologic processes and biotic activity. Existing waste disposal facilities have utilized separate covers for each disposal unit and this paper centers on that concept. However, the concept of a single cover over the entire disposal site may also be acceptable.

Design of a cap or cover for the disposal unit should have as its goal exclusion of infiltration into the unit over the long term. It is recognized that total exclusion of infiltration is not attainable because of physical stresses and various natural factors which act on the disposal cover. These stresses and factors include: the inherent permeability of natural materials, wind erosion, water erosion, root penetration, burrowing by animals, consolidation, subsidence, dessication, freeze-thaw cycles, and frost heave.

The cap should be mounded to facilitate drainage and at its thinnest point should be several feet in thickness. Generally, natural materials such as clay, sand, gravel, etc. are considered most desirable for composition of the cover because their properties should remain constant over time. Clay, for example, if available locally, should constitute a major portion of the cover system because of its relatively low permeability when completed. However, to assure integrity of the clay portion of the cover, it could be insulated from the surface geologic, atmospheric and biotic processes listed above by one or more layers of other types of materials. Man-made cover materials such as stainless steel, concrete, soil-cement, asphalt, geotextiles and geomembranes are potentially useful as cover materials. However, these materials may not be feasible due to cost or other factors such as long-term performance.

The cap should extend beyond the side walls of the unit onto the original or modified grade to assure surface runoff is not directed along the side walls down into the trench. Finally, the cap design should include stabilization of some fashion to assure that it is not significantly affected by wind or water erosion. In humid or moderate climatic regimes such stabilization can be achieved by planting of a shallow-rooted vegetative cover. In arid areas where assurance of a vegetation cover is much less certain, a thick layer of gravel may obtain the same result.

Disposal Unit Sidewalls

The disposal unit should be designed to assure that the sidewalls do not jeopardize the stability of the disposal unit as a whole, during the period of waste emplacement and closure as well as over the long term. Stabilty of the waste disposal unit is a requirement of §61.51. At the present time, commercial shallow land burial operations generally employ earthen sidewalls in the trenches. These sidewalls are typically created by excavating below grade. However, as done at several trenches at the Sheffield facility, they may be constructed above grade as compacted earthen embankments. In designing the sidewalls of earthen walled disposal units, the strength of the soil will dictate the angle at which the sidewalls may safely stand without support.

At sites with poor soils, which might require low slope angles, reinforcing or lining materials could be added if they are temporary or will not adversely effect the long-term stability of the site.

Disposal Unit Drainage

§61.51(a)(6) requires that the contact of water with waste be minimized both during and after disposal. Therefore, the disposal unit should be designed to drain effectively when water enters it. The base of the disposal unit should drain faster than water will enter the top and side.

Bottom drainage can be accomplished by covering the disposal unit floor with 2-3 feet of pervious material, such as sand, and by sloping the floor across the width of the unit to a French drain. The disposal unit floor and the French drain should also be sloped along the length of the unit to a sump or sumps. This bottom layer may also serve as a barrier to the capillary rise of water from below. Inclusion of a system such as this in the basic disposal unit design also serves to rapidly drain off water entering the disposal unit before it is covered and minimizes the time any infiltrating water would be in contact with the waste. Moreover, with the addition of permanent vertical standpipes leading to the ground surface at regular intervals along the French drain, regular monitoring of trench conditions after capping can be undertaken to determine the need for early remedial action.

§61.52(a)(5) requires that the void spaces between waste packages be filled to meet this requirement and to minimize the contact of water with waste after burial, the staff recommends that a freely draining, non-cohesive material, such as a clean sand or gravel, may be used to fill the spaces between waste containers. These types of materials will promote rapid movement of water through the disposal unit. This will help minimize the length of time in which water would be available to leach the waste. In addition, if the backfill has a sufficient contrast in permeability to the material in the trench cap, capillary forces may promote unsaturated flow of interstitial water around the disposal unit instead of through it. This is due to the fact that granular soils develop significantly lower suction pressures then fine grained soils and therefore should draw less water into the disposal unit. Finally, the granular material, because it is non-cohesive, can more readily fill void spaces and achieve a higher relative density than fine grained material, thereby reducing the amount of void space and consolidation over time.

Instead of a free draining backfill, material with extremely low permeability, such as grout or concrete, could be used. Clays would probably not be suitable for backfill because of the difficulty in ensuring that void spaces were filled and difficulty in achieveing sufficient compaction to limit consolidation and permeabilities to acceptable levels. Although it is often convenient to use the excavated materials as backfill, the staff will place special emphasis on the effectiveness of any proposed backfill in providing a stable disposal unit and in limiting contract of waste with water.

3.3 Surface Water Management

The contact of water with waste shipments at any time presents the possibility for a variety of problems at a near-surface disposal facility. Perhaps the most significant of these problems are reduced waste form stability and increased potential for leaching and subsequent off-site transport of radionuclides.

The staff's position, therefore, is that such contact must be eliminated wherever possible. A surface water management system is necessary to minimize erosion and infiltration into the disposal units which could result in off-site releases. An adequate system will usually consist of three primary parts: collection, transport and discharge. The collection part of the system would collect runoff from disposal unit covers in drainage ditches. These ditches would then be sloped to allow collected water to run into larger surface transport ditches. One or more transport mains would transport all the surface runoff to a drainage collector physically removed from the active disposal area to allow discharge of the water off-site. This type of system is considered desirable for a near-surface disposal facility within humid or moderate climatic regimes. An exception to this would be if a site was capped by a uniform, crowned cover which was designed to remove the runoff by sheet wash. Because of the need to prevent the formation of rills and guillies, this system would generally be more suitable for smaller sites.

Facilities in arid climatic regimes would generally not be required to institute such an elaborate surface water management system. However, for arid sites there is the potential for cloudburst storms of short duration and high intensity which can result in local flooding and erosion of a site. Therefore, the surface drainage system for an arid site should consider the effects of local flooding (including debris flow) on disposal units. For example, the Beatty disposal facility has used a berm around the site to prevent floods from entering the site.

In developing a surface water management system and in post-closure site grading, applicants should assure that slopes in the disposal site are such that water runoff quantities and velocities will no cause significant erosion. The applicant should design a surface water management system based on the Probable Maximum Precipitation for the site. Guidance is provided in NRC Regulatory Guide 1.59, Design Basis Floods for Nuclear Power Plants.

Large scale engineering modifications of the upstream drainage area or near site surface water system are not anticipated because of the cost which would be involved. However, some modification of surface water flow may be proposed by the licensee and acceptable to the staff. The use of culverts or pipes to divert surface water, on a permanent basis, would generally not be acceptable because of the limited design life of most culvert materials and the possibility of the pipes becoming clogged with debris. Modifications to the land surface would be acceptable if the area was properly revegetated or stabilized to prevent slope failures or excessive erosion. Periodic inspection of modified areas would be necessary to ensure that the stabilization efforts had been successful.

Waste shipments in storage at a disposal site should likewise not be in contact with water according to the requirements in §61.51(a)(6). Current practice at the operating near-surface disposal facilities is that waste shipments, once accepted, proceed to the disposal area as soon as possible. Storage of incoming shipments at these sites is not commonly practiced, nor does the staff anticipate that future near-surface disposal facilities will utilize extensive storage of waste. Nevertheless, there will be occasions on which incoming shipments will have to be temporarily stored for one reason or another and therefore, provisions must be made for eliminating contact of water with such shipments. A designated storage area should be physically identified by an applicant in his facility layout.

A variety of approaches are available for assuring that such contact does not occur and most of them are relatively straight forward. One way to control contact with precipitation in this area is to provide a shelter of some fashion. This could be as simple as placing tarpaulins over shipments for temporary protection or as permanent as creating a roof or other shelter over the storage area.

Wastes in storage should also be separated from contact with surface runoff. Grading the storage area and tying it into the facility surface water management system is one approach. Yet another is to place waste container in storage on frames or platforms to remove them from contact with the ground surface. Alternative approaches to eliminating water contact with stored wastes may be considered by applicants and presented as part of the license applications.

The requirements in §61.51(a)(6) also state that contact of waste shipments with water during disposal should be minimized or eliminated. Again, the approaches which the staff feels will assure such contact does not take place are relatively straight forward. Closing down site disposal operations during rainy weather is one obvious approach. Another is to assure that backfill is placed over the waste soon after its emplacement in the disposal unit. Although it may be impractical to do this on a shipment-by-shipment basis, it is the staff's position that disposed waste should be backfilled as often as practicable. During freezing conditions, backfill should be used which is not frozen so that it can be readily placed and compacted without interference from frozen pieces of soil or ice.

4.0 Facility Operation

The proposed 10 CFR Part 61 identifies eleven minimum technical requirements for near-surface disposal facility operation and closure. These requirements are individually identified below along with staff guidance or positions on meeting these requirements. Operation and closure requirements for other than near-surface disposal have not been identified in rulemaking at this time and, therefore, will not be addressed in this paper. The requirements of §61.52 are as follows:

(1) Wastes designated as Class A pursuant to §61.55, must be segregated from other wastes by placing in disposal units which are sufficiently separated from disposal units for the other waste classes so that any interaction between Class A

wastes and other wastes will not result in the failure to meet the performance objectives This segregation is not necessary for Class A wastes if they meet the stability requirements in §61.56(b).

(2) Wastes designated as Class C pursuant to §61.55 must be disposed of so that the top of the waste is a minimum of 5 meters below the top surface of the cover or must be disposed of with intruder barriers that are designed to protect against an inadvertent intrusion for at least 500 years.

(3) All wastes shall be disposed of in accordance with the requirements of paragraphs (4) through (11) of this section.

(4) Wastes must be emplaced in a manner that maintains the package integrity during emplacement, minimizes the void spaces between packages, and permits the void spaces to be filled.

(5) Void spaces between waste packages must be filled with earth or other material to reduce future subsidence within the fill.

(6) Waste must be placed and covered in a manner that limits the radiation dose rate at the surface of the cover to levels that at a minimum will permit the licensee to comply with all

provisions of §20.105 at the time the license is transferred pursuant to §61.30.

(7) The boundaries and locations of each diposal unit (e.g., trenches) must be accurately located and mapped by means of a land survey. Near-surface disposal units must be marked in such a way that the boundaries of each unit can be easily defined. Three permanent survey marker control points, referenced to United States Geological Survey (USGS) or National Geodetic Survey (NGS) survey control stations, must be established on the site to facilitate surveys. The USGS or NGS control stations must provide horizontal and vertical controls as checked against USGS or NGS record files.

(8) A buffer zone of land must be maintained between any buried waste and the disposal site boundary and beneath the disposed waste. The buffer zone shall be of adequate dimensions to carry out environmental monitoring activities specified in §61.53(d) and take mitigative measures if needed.

(9) Closure and stabilization measures as set forth in the approved site closure plan must be carried out as each disposal unit (e.g., each trench) is filled and covered.

(10) Active waste disposal operations must not have an adverse effect on completed closure and stabilization measures.

(11) Only wastes containing or contaminated with radioactive materials shall be disposed of at the disposal site.

The disposal facility will be discussed in the following pages in three parts relative to these requirements: waste handling and emplacement; disposal unit completion and closure, and miscellaneous aspects of operation.

4.1 Waste Handling and Emplacement

In developing the proposed 10 CFR Part 61, the staff determined that a waste classification system was necessary to effectively deal with the range of potential disposal problems presented by varying forms, concentrations and constituents of low-level radioactive waste. The staff decided, after a review of alternative approaches to developing a waste classification, that the system should be a three-part classification system which relates concentrations of selected isotopes and waste form to disposal requirements.

Under this classification system, Class A segregated waste is considered the least hazardous waste category. The specific requirements for Class

A segregated waste are listed in §61.55 and have been discussed in a previous technical position paper. For the purposes of this paper it should suffice to say that this category of waste contains radionuclides of low activity and short half-life. Because concentrations are low and the half-lives are short, Class A waste should have lost its radiological hazard prior to the end of the active maintenance period. Consequently, the rule requires that Class A waste meet only minimum requirements on waste form and packaging when it is disposed of in separated from Class B or C waste.

The rule requires that Class A waste be segregated physically from other waste and buried in discrete disposal units unless it meets the stability requirements for Class B and C wastes. The rationale behind this requirement is that if Class A waste were to be buried along with other classes of waste, its inherently unstable form could lead to differential subsidence of the disposal unit contents and ultimately, of the disposal unit cap or cover. This subsidence could then result in significant infiltration into the disposal unit (depending on the climatic regime) and potential leaching and off-site transport of radionuclides from wastes having higher activity levels. In addition, if Class A waste is buried separately, stabilization of Class B and C disposal areas can be completed as an ongoing process since subsidence will be minimized. It is possible that Class A waste disposal units will exhibit subsidence even after the end of the active maintenance period.

Even with separate burial of Class A waste, subsidence of the Class A disposal unit covers could affect disposal units containing other wastes. For example, if large quantities of surface water infiltrated the Class A disposal units through cracks in the cover, it could locally raise the water table causing water to come into contact with waste in other disposal units. Consequently, §61.52(a)(1) requires that when Class A waste is disposed of in separate units, the Class A wastes must be sufficiently separated from other units to assure that there is no interaction between them. The staff does not have in mind a particular linear distance that in all cases will provide sufficient separation between Class A waste disposal units and other waste disposal units. Rather, the staff is looking for a demonstration that the Class A disposal units will not adversely affect the Class B or C disposal units. The applicant's proposed Class A disposal units should be planned to minimize subsidence as much as possible and procedures should be specified for dealing with subsidence rapidly and effectively, should it occur. Mixing of leachate plumes from different types of disposal units would not be considered an adverse effect.

The concentration and waste form requirements for Class B and C waste are listed in §61.55 and §61.56 and will also be discussed in detail in a subsequent technical position paper. Concentrations for Class B waste are higher than those of Class A segregated waste but are limited by ceilings established in §61.55. Moreover, Class B and C waste must meet not only the minimum standards applied to Class A waste, but also a series of requirements intended to provide stability of the waste form to ensure that the waste form does not degrade and affect the overall stability of the disposal unit. Class C waste represents the greatest potential radiological hazard of waste acceptable for near-surface disposal and is subject to the same minimum and stability requirements imposed on Class B waste. In addition, Class C waste must be disposed of using additional measures to protect against inadvertent intrusion.

The proposed rule establishes procedures to protect the inadvertent intruder, as well as workers on site, from radiological hazards of Class C waste. Applicants may select from a number of acceptable approaches for assuring this protection. One such approach is to provide a minimum of 5 meters of material between the top of the Class C waste and the surface of the cover. Perhaps the most space efficient variation of this method is to bury Class C waste at the bottom, or in a slit trench at the bottom, of a disposal unit, cover with several meters of Class B stable waste, and complete the disposal unit with a cap or cover. If, however, because of site conditions or other factors, this first approach was determined to be impractical, the applicant has several options. For example, the applicant could meet the 5 meter minimum by placement of sufficient overburden material above the Class C waste. This practice would meet the requirement, but would result in reduced land use efficiency at the site.

Other options to protect an inadvertent intruder involve the use of engineered intruder barriers having an estimated protection lifetime of at least 500 years. The staff realizes that few manmade or earth materials will provide an absolute barrier to excavation over a period of 500 years. Instead, the intent is discourage intrusion and to make the intruder aware that he is not digging in a natural system. Intruder barriers of man-made or natural materials may be employed to protect against intrusion. For example, caissons, corregated pipe or reinforced concrete pipe may be placed in slit trenches or other disposal units, filled with waste and backfill and then capped with concrete or large boulders. After a series of these tubes are filled in a given disposal unit, the disposal unit would be backfilled and covered much as a standard disposal unit would be.

Another engineering barrier to guard against inadvertent intrusion would be a concrete-walled disposal unit having walls made of reinforced concrete. Waste would be placed in the trench and interpackage voids would be filled with earth materials. Upon completion of a trench, a reinforced concrete cap would be poured followed by a layer of overburden graded to permit drainage as with a standard trench. If grout was used as backfill in a trench type structure, the concrete walls and cap would not be needed since the grout/waste monolith would serve as a formidable intruder barrier.

Layered earth materials could be used as an intruder barrier. The intent of such a barrier would be twofold. Excavation should be made difficult to minimize the risk of accidental intrusion. This could be accomplished by using large boulders. In addition, the barrier should be recognizable to an intruder as a constructed system. This could be done by including materials which would contrast with those found adjacent to the excavation.

Historically, waste emplacement and disposal has been done in a random fashion with little or no thought given to package integrity or stability. Waste-laden drums were and are commonly dumped off trucks and other waste containers were placed in the trench on an as-received basis. It is the staff's position that improper waste handling and random placement of waste are inconsistent with the goals of 10 CFR Part 61.

To properly dispose of waste applicants must, in addition to waste segregation, demonstrate that waste emplacement and handling will be consistent with §61.52(a)(4). This approach should describe how disposal will proceed to assure that package integrity is not routinely jeopardized. The license should also specify how waste will be physically handled in emplacement and how the handling procedures will maintain occupational exposures to as low as reasonably achievable (ALARA). (The staff notes here that there are no specific technological fixes in achieving proper waste handling and emplacement. More often than not, it is a matter of employing common sense practices of good site housekeeping.)

4.2 Disposal Unit Completion and Closure

The rule requires in §61.52(a)(5) that void spaces between waste packages be filled with earth or other material. This requirement is intended to assure stable disposal unit caps, covers and sidewalls and to provide lateral support for the waste form. The applicant has available to him several options which the staff considers will meet the intent of this part of the rule. Perhaps most obvious, an applicant may propose to fill void spaces using earth removed during the excavation process. This option is desirable only if compaction of fill in voids can be assured. Where cohesive soils prevail, this may not be possible. Another option is to fill with an earth material, such as gravel, which even when dumped in place, has a fairly high relative density and correspondingly low, long term settlement. In addition to, or independent of, the earth backfill, an applicant may propose to use grouting as a means of filling void spaces. As mentioned earlier, this latter technique provides greater structural stability than earth fill and also serves as an intruder barrier. Regardless of which technique is chosen, the applicant should make efforts to maximize the probability of the backfill or cement reaching all the void spaces in any given area at a relative density such that consolidation of the backfill will not result in significant subsidence.

The rule requires that in the process of disposal unit completion and closure, waste must be placed and covered so as to limit the radiation dose rate at the surface of the cover. The applicant's task in meeting this requirement is to consider the type of waste to be buried, the probable amounts of waste in a given disposal unit and the shielding presented by the waste container. Using this information the applicant should then determine how to cover the waste to assure the requirement is met. There are several cover options known to the staff and considered acceptable to ensure that radiation levels at the cover surface meet the requirements of §20.105. One of these is to fill a disposal unit with waste to within one meter of the original grade, add compacted earth up to the original grade and follow with a cap or cover about 1 meter in thickness. This approach is considered suitable for most waste received at a typical near-surface disposal facility. It may also be augmented by layering, that is, placing of Class C waste in the bottom of the disposal unit with Class B waste above it or by utilizing thicker trench caps. Still other techniques designed to protect against the inadvertent intruder, such as caissons, concrete-walled disposal units, and grouting, will also aid in reducing surface radiation levels.

§61.52(a)(9) requires that adequate closure and stabilization measures must be carried out as each disposal unit is filled and covered. The purpose of this requirement is primarily to minimize the number and extent of activities to be performed at the time of site closure. By closing and stabilizing disposal units as they are completed, the operator will be able to focus final closure and stabilization efforts on known problem areas. Moreover, early closure and stabilization will help to minimize infiltration, lower dose rates to site personnel and protect waste package integrity. Finally, if completed disposal units are not promptly closed and stabilized, the probability of achieving long-term isolation and avoidance of the need for continuing active maintenance could be compromised. Therefore, an applicant should provide, as part of the application, a closure and stabilization plan be implemented upon completion of any given disposal unit. Guidance on the objectives of closure and stabilization has been provided by the staff in a previous branch technical position on site closure and stabilization. The types of actions employed to meet the objectives will vary according to site characteristics, disposal facility design and waste types recieved. The staff has outlined below appropriate measures for a typical disposal unit receiving Class B waste and employing an earthen cover.

Backfill should be added over and between the waste canisters as each layer of waste is placed and appropriate compaction techniques used to consolidate the fill material. When an entire disposal unit is completed a cover or cap should be constructed over the unit and shaped to facilitate drainage. Stabilization measures should then be employed in accordance with the approved preliminary site closure and stabilization plan. In humid climates, these measures could include planting of a short-rooted vegetative cover over the disposal unit cover, overall site grading and shaping, and use of rip-rap or similar methods on steep slopes to protect against wind and water erosion. In arid regions, where establishment and continuance of a vegetative cover might be of questionable success over the long-term, the use of gravel or cobbles over the disposal unit cover could achieve the same result. Finally, completed and capped disposal unit should be tied into a surface water managment system to assure that drainage off the cap is not allowed to form ponds in the disposal area, but is instead removed rapidly for discharge off-site.

Although implementation of closure and stabilization procedures is important, quality control in the form of regular inspections of completed disposal units is equally important. These inspections should identify areas of unsuccessful vegetative stabilization, cap or cover subsidence, water ponding, or other problems. Responsibility for correcting these problems should be explicitly defined by the applicant and a subsequent inspection of the effectiveness of the corrective action should be planned.

The rule also requires that active waste disposal operations must not have an adverse effect on completed closure and stabilization measures. The purpose of this requirement is to assure that the work undertaken to fulfill completion and closure requirements is not undone by a lack of planning in carrying out active waste disposal operations. As with several of the previous requirements, the staff's position is that meeting this requirement is primarily a matter of advance planning, common sense, and good site housekeeping. Adequate distance between disposal units should be available for the movement of equipment without disturbing a closed and stabilized disposal unit. Access roads to active disposal areas should have adequate clearance from closed and/or stabilized trenches. Drainage from the periphery of current waste disposal areas should be directed away from closed and/or stabilized disposal units. Other considerations may be developed on a site-specific basis and the staff encourages potential applicants to utilize advance planning to minimize the potential for disturbing these areas.

4.3 Miscellaneous Aspects of Facility Operation

The proposed 10 CFR Part 61 includes in §61.52(a)(7) specific requirements for recording and marking the location of disposal units according to established survey control systems. The purpose of these requirements is twofold: to ensure a permanent record of the boundaries of disposal units at a near-surface disposal facility and to ensure that the system for establishing these boundaries is tied into a recognized standard control system for land surveys. Surveying and mapping of the site and disposal units within the site which follows well-recognized survey procedures, performed by qualified personnel, and is referenced to USGS or NGS control stations, should and be acceptable to the staff. Third order, Class III surveying control will usually be sufficient for identifying the location of disposal units and site boundaries.

Upon completion of each disposal unit, the applicant should plan to identify each corner of the unit with a permanent marker keyed to the site's permanent control points. These markers should be emplaced such that they will remain immobile and should have a record of the coordinates of each location prominently attached or inscribed. The applicant should demonstrate the immobility of the markers under reasonable site conditions as well as the permanence of both the marker and its recorded information. A fifth marker identifying the disposal unit number or name its radiological inventory and the coordinate of the boundaries of the unit may also be required by the staff for each disposal unit. This marker could also serve to meet §61.31(c)(2) which requires that permanent markers be installed warning against intrusion.