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Final
Environmental Impact Statement
on 10 CFR Part 61 "Licensing Requirements for Land Disposal of Radioactive Waste"

Summary and Main Report

U.S. Nuclear Regulatory Commission

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VOLUME I

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At specific sites where such a possibility can occur, additional measures intended to eliminate this possibility will be considered.

6. WASTE CLASSIFICATION

The waste classification system developed for the Part 61 regulation follows directly from the performance objectives and technical criteria. It is intended to ensure as far as possible on a non-site-specific basis that the Part 61 requirements are met.

Three classes of waste are established:

1. Wastes for which there are no stability requirements but which must be disposed of in a segregated manner from other wastes. These wastes, termed Class A "segregated" wastes, are defined in terms of maximum allowable concentrations of certain isotopes and certain minimum requirements on waste form and packaging that are necessary for safe handling.

2. Wastes which need to be placed in a stable form and disposed in a segregated manner from unstable waste forms. These wastes, termed Class B "stable" wastes are also defined in terms of allowable concentration of isotopes and requirements for a stable waste form as well as minimum handling requirements.

3. Wastes which need to be placed into a stable form, disposed in a segregated manner from nonstable waste forms, and disposed of so that a barrier is provided against potential inadvertent intrusion after institutional controls have lapsed. These wastes are termed Class C "intruder protected" wastes and are also defined in terms of allowable concentrations of isotopes and requirements for disposal by deeper burial or some other barrier.

Finally, a "fourth" class of waste is established which is that waste which exceeds the classification limits and is generally considered unacceptable for near-surface disposal. Disposal of this waste at near-surface disposal facilities would require case-by-case determinations.

A significant number of comments and issues were raised with respect to the waste classification system. Major issues raised related to:

- Calculated waste classification limits;
- Isotopes considered;
- Volume reduction;
- Compliance;
- De minimis levels for waste;
- Classification by total hazard; and
- Manifest tracking system

6.1 Calculated Waste Classification Limits

The numerical basis for the limits calculated for the three waste classes is presented in Chapter 7, Volume 2, of the draft EIS. The principal basis used for setting the classification limits was limiting exposures to a potential inadvertent intruder, although a number of other considerations went into setting the values--principally long-term environmental concerns, disposal facility stability, institutional control costs, and financial impacts to small entities. Waste classification represents a combination of waste form, radioisotope characteristics, radioisotope concentrations, the method of emplacement, and to some extent the site characteristics.

A number of comments were received on the calculated limits for Class C waste. NRC staff has evaluated these comments and has concluded that a rise in the Class C limits by a factor of 10 is warranted for all radionuclides. This is due to consideration of (1) the reduced likelihood of significant intruder exposures with incorporation of passive warning devices at the disposal facility, (2) the difficulty of contacting waste disposed of at greater depths, and (3) average concentrations in waste which would be expected to be considerably less than peak concentrations. The effect of the change in the Class C concentration is analyzed in Chapter 5 and summarized below.

Two cases are analyzed. In the first case, Class C limits are assumed which correspond to those established for the final Part 61 rule. For example, the limit for disposal of alpha-emitting (except Cm-242) transuranic radionuclides by near-surface disposal is set at 100 nCi/gm. The results of this case are obtained from the "preferred case" (Alternative 3) analysis presented earlier. The second case corresponds to Class C limits which were proposed for the draft Part 61 rule.

Only slight differences are observed between the two cases. Most of the differences in the calculated impact measures appear to be derived from the slightly reduced volume of waste delivered to the disposal facility for the case corresponding to the limits established in the proposed Part 61 rule. A reduced amount of waste processing is also projected for the proposed rule case relative to the final rule case. Unit disposal costs are slightly raised for the proposed rule case, however, which is due to the reduced volume of waste delivered to the disposal facility.

6.2 Isotopes Considered for Waste Classification Purposes

In the draft EIS, a total of 23 different radionuclides were considered in the numerical analysis. These nuclides were nearly all moderately or long-lived radionuclides. Based upon these 23 radionuclides, concentration limits were proposed in the draft EIS for 11 individual radionuclides plus alpha-emitting transuranics, enriched uranium and depleted uranium. In response to public comments, limits for ^{135}Cs, enriched uranium, and depleted uranium have been eliminated, as have been limits for ^{59}Ni and ^{94}Nb except as contained in activated metal. A separate limit is provided for ^{242}Cm, a transuranic nuclide with a 162.9 day half-life.

These changes are principally in response to comments on proposed Part 61 regarding the costs and impacts of compliance with the waste classification requirements. In particular, many commenters were concerned that they would have to directly measure every isotope in every waste package. This would be difficult since measurement of many of the listed isotopes--which would usually be present only in trace quantities--could not be performed except by complex radiochemical separation techniques by laboratories. Commenters were concerned that costs and personnel radiation exposures would be significantly increased.

Thus to ease the burden of compliance, the number of isotopes treated generically in the waste classification table was reduced to those judged to be needed on a generic basis for waste classification purposes. Other isotopes may be added later either generically or in specific waste streams.

6.3 Volume Reduction

Some commenters were concerned that the waste classification requirement would discourage volume reduction. This concern is believed to be alleviated by the increase in the Class C waste disposal limits. As an illustration, the volumes of waste determined to be unacceptable for near-surface disposal under extreme volume reduction conditions (waste spectrum 4) may be compared against the proposed and final Part 61 limits.

These comparative volumes are as follows:

	Unacceptable Volumes (m^3)	Percent of Total Generated
Proposed Part 61 Limits	9.42 E+3	4
Final Part 61 Limits	1.93 E+3	1

6.4 Compliance with Waste Classification

Many commenters on the draft Part 61 rule were concerned regarding acceptable procedures for determining compliance with the waste classification requirements. It was recognized in the draft EIS that developing a reasonable approach to compliance would be an important consideration. A balance is needed between the need for knowledge of waste contents and practical limitations in measurement. Based upon discussions with licensees and other interested parties, and comments on the draft EIS, a draft technical position paper has been prepared.

The staff's position is that all licensees must carry out a compliance program to assure proper classification of waste. Licensee programs to determine radionuclide concentrations and waste classes may, depending upon the particular operations at the licensee's facility, range from simple programs to very complex ones. In general, more sophisticated programs would be required for licensees generating Class B or Class C waste, for licensees generating waste for which minor process variations may cause a change in classification, or for licensees generating waste for which there is a reasonable possibility of the waste containing concentrations of radionuclides which exceed limiting concentration limits for near-surface disposal. Some licensees, such as nuclear power facilities, are expected to employ a combination of methods.

There are four basic programs, however, which may be potentially used either individually or in combination by licensees:

- Materials accountability;
- Classification by source;

structural support (e.g., use of a high integrity container), or special disposal facility design. For this EIS, waste solidification is estimated to cost in the range of \$1280 to \$1450 per m^3 of input waste. Use of a high integrity container to achieve stabilization is estimated to cost in the neighborhood of \$450 per m^3 of waste. For purposes solely of analysis in this case study, compliance with the waste stabilization requirement for this case is assumed to be principally achieved by solidification of some waste streams (e.g., LWR concentrated liquids, isotope production facility waste, some LWR ion exchange resins and filter sludge) and by emplacement of other waste streams (e.g., most LWR ion exchange resins and filter sludge) into HICs prior to disposal. All things equal, most waste generators would be expected to adopt the least expensive approach to meeting a particular requirement. All compressible waste streams are compacted, either at the waste generator's facility or at a centralized processing center.

3. Several improvements are made in the ability of the disposal facility to minimize contact of waste by water and to improve long-term site stability. Waste emplaced into the disposal cells is backfilled with a very permeable material such as sand or gravel. An improved cover is placed over the disposal cells. This improved cover may take a number of forms. For purposes of cost/impact analysis, the improved cover in this EIS is assumed to consist of a 2 meter thick earthern cover having a high clay content. The backfill and disposal cell cover are compacted by improved compaction techniques such as use of vibratory compactors or sheepsfoot rollers. (The compaction technique which would be used for an actual site would be dependent upon site specific soil and environmental conditions.)

4. There is no segregation of unstable waste streams. However, there is segregation of waste streams containing chelating or chemical agents.

5. As in Case 1, there is assumed to be operating practices involving preferential emplacement of waste packages having high surface radiation levels. However, there is assumed to be no such similar operating practices for layering of other high activity wastes.

6. As in the preceding case, the site is operated for 20 years, followed by a two-year closure period prior to transfer of the site license to the site owner. Again, no observation and maintenance period is assumed.

4.3.3 Part 61 Requirements (Preferred Alternative)

This case provides a representation of disposal practices which would minimally meet the requirements of the final Part 61 regulation. In this case, waste streams determined to be acceptable for near-surface disposal are classified into three waste classes: Class A, Class B, and Class C. A summary of the classification limits assumed in the analysis for this case is presented as Table 4.5. This case is summarized below:

1. All higher activity (Class B and Class C) waste streams are required to be stabilized prior to disposal. As the previous case, possible waste stabilization methods could include processing the waste into a stable waste form (solidification), placing the waste into a container providing structural support (e.g., an HIC), or by special

Table 4.5 Waste Classification Limits Assumed for the Part 61 Case

Isotope	Class Limits ($\mu Ci/cm^3$) Class A	Class B	Class C
H-3	4.0E+1*	**	**
C-14#	8.0E-1	8.0E-1	8.0E+0
Fe-55	7.0E+2	**	**
Ni-59#	2.2E+0	2.2E+0	2.2E+1
Co-60	7.0E+2	**	**
Ni-63#	3.5E+0	7.0E+1	7.0E+2
Nb-94#	2.0E-3	2.0E-3	7.0E+2
Sr-90	4.0E-2	1.5E+2	7.0E+3
Tc-99	3.0E-1	3.0E-1	3.0E+0
I-129	8.0E-3	8.0E-3	8.0E-2
Cs-135	8.4E+1	8.4E+1	8.4E+2
Cs-137	1.0E+1	4.4E+1	4.6E+3
U-235	4.0E-2	4.0E-2	4.0E-1
U-238	5.0E-2	5.0E-2	5.0E-1
TRU	1.0E+1##	1.0E+1##	1.0E+2##
Pu-241	3.5E+2##	3.5E+2##	3.5E+3##

*The notation 4.0E+1 means 4.0 x 10^1.
**No limit is set for these isotopes and classes.
#For activated metals, the limits for these isotopes are raised by a factor of 10.
##The limits for these isotopes are given in units of nCi/gm rather than $\mu Ci/cm^3$

disposal facility design. As before, it is assumed that some waste streams are solidified and other are emplaced into high integrity containers. This is assumed solely for this case analysis in order to achieve a common basis for comparison with the previous case (i.e., if different stabilization techniques were assumed for this case than for the previous case, then the results of the two cases could not be conveniently compared and the cost/impact attributes of the Part 61 rule easily assessed).

2. Concentration limits for disposal are placed upon a number of radionuclides. For example, a limit of 100 nCi/gm is placed upon alpha-emitting transuranic elements (except for Cm-242). Concentrations less than 10 nCi/gm are treated as Class A waste, while concentrations between 10 and 100 nCi/gm are treated as Class C waste.

3. Disposal facility design is the same as the previous case, with the exception of segregation of compressible waste. That is, compressible (unstable) Class A waste streams are disposed in separate disposal units segregated from stable Class A, Class B, and Class C waste

Limits for Class C Waste Disposal. The second item concerns the limits for Class C waste disposal. A number of comments were received on the calculated limits, including the following:

- Rather than setting restrictive limits based on protection of a potential inadvertent intruder, NRC should consider requiring warning devices which would warn an intruder against excavating into the disposal facility.

- NRC should consider and incorporate a probability that intrusion will occur.

- NRC should consider that at the end of 500 years, Class C waste disposed under 5 meters of cover would still be difficult to contact; and that if someone did contact the waste, it would be considerably diluted by lower activity waste.

- NRC should consider that actual waste concentrations will typically exhibit an activity distribution with average concentrations well below the maximum permissible concentration.

- The fact that Class C waste will be in an improved waste form will help to lessen the likelihood that extensive intrusion activities will occur; and if they do occur, will lessen the potential for airborne dispersion or uptake by plant roots.

- Since Class C limits have been raised by a factor of 10 for Cs-137, why not do the same for other radionuclides?

NRC staff has evaluated these comments and has concluded that an increase in the Class C limits by a factor of 10 is warranted for all radionuclides except for Cs-137.

It is very difficult to set a numerical value on the probability that an intrusion event will occur, and on the probability of the event's extensiveness. One can say, however, that the probability will probably increase with the passage of time. Given the uncertainty, some judgment is required as to the likelihood and extensiveness of intrusion. Based upon much consideration, the best approach was judged by NRC staff to first conservatively assume that an intrusion event occurs, and after that, to try and assume a range of reasonable activities on the part of the intruder. As commenters have observed, one way to further reduce the possibility for intrusion is to establish long lasting warning markers on the disposal site. The staff feels that this is a reasonable suggestion that can be implemented inexpensively and it has been incorporated into the final Part 61 rule.

It is also believed to be true that waste which has been disposed beneath a cover at least 5 meters thick would be difficult to contact extensively even after 500 years. In the calculations for the draft EIS, it was assumed that at the end of 500 years the 5-meter intruder barrier was no longer effective. The scenario was taken to be the same as that which was used to determine the Class A waste limits. The only difference was that a 500-year radioactivity decay period was used instead of a 100-year decay period. This is believed to be very conservative since if Class C waste was brought to the surface it would probably be considerably diluted with soil and lower activity waste. The degree of dilution is difficult to estimate but is believed to be at least an order of magnitude.

It is also true that past data on waste streams indicates that the average radioactivity concentration within waste would be expected to be well below peak concentrations. For example, the authors of one reference (Ref. 4) refer to survey of five major Department of Energy disposal sites in which it was estimated that greater than 97% of the material disposed at these sites is either only very slightly radioactive or is suspected of being radioactive (due to the place where the waste is generated). The five DOE sites surveyed cover 86% of the total DOE waste volume and 99+% of the activity. The authors state that if it was assumed that the 3% of the waste that is contaminated is at a maximum level and 97% of the low activity or suspect waste was clean, then a dilution factor on the order of 30 would occur (Ref. 4). The authors (Ref. 4) also cite data obtained from room trash generated at a plutonium facility at Los Alamos National Laboratory.

The authors suggest caution in interpreting the data, however. They note that the data is limited and that wastes such as sludges or oils would probably be more uniform than waste such as trash (Ref. 4). "The use of incineration will tend to increase the uniformity of the transuranium content of individual packages, and the sludges from treatment of wastes have a similar characteristic of relatively constant concentrations." In conclusion, the authors suggest that two dilution factors be considered for DOE waste. A dilution factor of about 20 is suggested for routine trash and decommissioning types of waste, while a dilution factor of 1 (no dilution) is suggested for ash from oxidized combustibles, sludges from water treatment, and artifacts (either solid items with surface contamination or trash types of waste contained in nondegradable plastic containers).

Data more directly applicable to waste disposed in commercial disposal facilities has been obtained and is presented in Appendix C of this final EIS. Table C.35 lists for wet wastes generated by light water power reactor plants, the volume-percent distribution of gross concentration (Ci/ft^3) as determined from two years (1978 and 1979) of shipment records to disposal facilities. Six different waste streams are shown: PWR resins, PWR filter sludge, PWR concentrated liquids, BWR resins, BWR filter sludge, and BWR concentrated liquids. The data from which Table C.35 was prepared covers 79% and 77%, respectively, of the total volume of waste disposed in the country during the two years (Ref. 5).

The data illustrates that most of the LWR waste process waste activity is well below the maximum observed. For example, less than 0.1% of the BWR resin volume would exceed 10 Ci/ft^3 (353 Ci/m^3), while almost 70% of the volume is in a range of .01 to 0.5 Ci/ft^3 (.35 Ci/m^3 to 17.7 Ci/m^3). The average activity across this distribution is in fact about 0.16 Ci/ft^3 (5.6 Ci/m^3).

It is apparent that the above considerations would tend to reduce potential inadvertent intruder impacts and therefore increase the allowable concentrations. However, there are other considerations which could also tend to increase potential inadvertent intruder impacts. Some of these include differences in waste form characteristics such as waste density or the size and solubility class of dispersed respirable particles. Another factor is the observation that the average activity across most commercial waste streams has been rising over the past several years. This is due to the reduced availability of waste disposal space in conjunction with rising disposal costs, resulting in much increased use of volume reduction techniques. This phenomenon is expected to be even more pronounced in the future, since regional disposal facilities (or disposal facilities serving a compact) are likely to be small operations disposing of relatively small volumes of waste. These small operations will likely need to charge higher disposal fees than larger operations. The result will be an incentive for licensees to drive concentrations in waste to the allowable limits.

Another factor is the accelerated NRC program for identifying low activity waste streams which may disposed by less restrictive means. Such disposal will tend to reduce dilution of higher activity waste streams by lower activity waste streams.

Other considerations include the potential for future changes or improvements in health physics methodologies and consideration of site-specific environmental conditions. For example, dispersion of contaminated dust into the air where it may be inhaled by humans may be expected to be greater at arid sites than at humid sites. This will probably be counter balanced to some extent by an expected reduced rate of waste degredation at arid sites in comparison with humid sites. In addition, wastes can be generally disposed at greater depths at arid sites than at humid sites, thus reducing the potential for human contact.

Finally, there is the potential for localized areas of higher activity ("hot spots") within waste containers. However, this would tend to be mitigated through averaging areas of higher concentration over areas of lower concentration. When concentration limits are calculated using the waste classification methodology, what is really being established is the average concentration across the volume of waste contacted. This could be several hundred cubic meters of soil and waste material.

In conclusion, the Class C limits have been raised by a factor of 10. This is due to consideration of (1) the reduced likelihood of significant intruder exposures with incorporation of passive warning devices at the disposal facility, and (2) the difficulty of contacting waste disposed at greater depths. Another consideration is that the average concentrations in waste would be expected to be less than the peak concentrations, although it is difficult to totally account for this given the other factors discussed above. The effect of the change in the Class C concentrations is illustrated in Table 5.2.

Two cases are considered in Table 5.2. In the first case, Class C limits are assumed which correspond to those established for the final Part 61 rule. For example, the limit for disposal of alpha-emitting (except Cm-242) transuranic radionuclides are set at 100 nCi/gm. The results of this case are in fact obtained from the "preferred case" analysis performed in Chapter 4. The second case corresponds to Class C limits which were proposed for the proposed Part 61 rule. In both cases, a low level of postoperational costs is projected for the stable waste streams while a moderate level of postoperational costs is projected for the unstable waste streams.

As can be seen in Table 5.2, only slight differences are observed between the two cases. Most of the differences in the calculated impact measures appear to be directly derived from the slightly reduced volume of waste delivered to the disposal facility for the case corresponding to the limits proposed in the proposed Part 61 rule. For example, groundwater impacts are slightly lower, as are impacts to a potential inadvertent intruder and population exposures due to waste transportation.

Table 5.2 Comparison of Impacts and Costs of the Proposed and Final Part 61 Waste Classification Requirements

	Final Part 61	Proposed Part 61
I. Long-Term Individual Exposures (mrem/yr):		
Intruder - construction		
o 100 yrs - Body	1.84E+2*	1.84E+2
Bone	1.87E+2	1.87E+2
Thyroid	1.84E+2	1.84E+2
o 500 yrs - Body	3.02E+0	2.31E+0
Bone	1.63E+1	1.03E+1
Thyroid	2.42E+0	2.01E+0
Intruder - agriculture		
o 100 yrs - Body	2.02E+2	2.02E+2
Bone	2.08E+2	2.08E+2
Thyroid	2.01E+2	2.01E+2
o 500 yrs - Body	3.04E+0	2.47E+0
Bone	9.17E+0	6.46E+0
Thyroid	9.02E+0	7.65E+0
Boundary well		
o Body	1.11E-1	1.11E-1
o Bone	3.70E-2	8.23E-3
o Thyroid	4.16E+0	4.14E+0
Population well		
o Body	3.33E-3	3.32E-3
o Bone	8.24E-3	8.23E-3
o Thyroid	1.32E+0	1.31E+0
Surface water		
o Body	1.44E-4	1.43E-4
o Bone	3.37E-4	3.36E-4
o Thyroid	5.99E-2	5.96E-2

See footnote(s), last page of table.

Table 5.2 (Continued)

	Final Part 61	Proposed Part 61
II. Other Long-Term Exposures:		
Offsite releases from intrusion		
o Waterborne (mrem/yr)		
Body	1.16E-2	1.17E-2
Bone	2.42E-2	2.43E-2
Thyroid	4.78E-4	4.78E-4
o Airborne (man-mrem/yr)		
Body	2.39E-1	2.39E-1
Bone	2.25E+0	2.25E+0
Thyroid	8.62E-2	8.62E-2
III. Short-Term Whole Body Exposures (total man-mrem over 20 yrs):		
Occupational		
o Process by waste** generator	+4.50E+5	+4.60E+5
o Process by regional process center	1.25E+5	1.25E+5
o Waste transport	4.97E+6	4.92E+6
o Waste disposal	2.14E+6	2.11E+6
To population		
o Process by waste** generator	+1.26E+2	+0.
o Process by regional process center	0.	0.
o Waste transport	4.76E+5	4.72E+5
IV. Costs (total $ over 20 yrs):		
Waste generation and transport		
o Process by waste** generator	+8.20E+7	+7.70E+7
o Process by regional process center	3.63E+7	3.63E+7
o Waste transport	1.72E+8	1.71E+8
Waste disposal		
o Design & op.	3.50E+8	3.50E+8
o Postoperational		
Closure	3.87E+6	3.87E+6
Obs. & maint.	1.13E+6	1.13E+6
Inst. control	1.57E+7	1.57E+7
Total post op.	2.07E+7	2.07E+7
o Total disp. cost	3.71E+8	3.71E+8
o Unit cost ($/m^3)	5.73E+2	5.76E+2

Table 5.2 (Continued)

		Final Part 61	Proposed Part 61
V.	Energy Use (equivalent gallons of fuel oil)**:	-1.42E+6	-1.97E+6
VI.	Land Use (m^2):	2.25E+5	2.24E+5
VII.	Waste Volume (m^3):		
	Volume acceptable		
	o Class A unstable	4.23E+5	4.23E+5
	o Class A stable	1.61E+5	1.61E+5
	o Class B	5.95E+4	5.95E+4
	o Class C	3.47E+3	0.
	o HWF	0.	0.
	o Total volume acceptable	6.48E+5	6.44E+5
	Volume not acceptable	2.20E+4	2.74E+4

*The notation 1.84E+2 means 1.84×10^2.

**In this table, population exposures due to waste processing by waste generators, occupational exposures due to waste processing by waste generators, and energy use are presented as impacts and costs in addition to those associated with the base case as set forth in Chapter 4.

As discussed earlier, the calculated increase in intruder exposures at 500 years for the final rule case is probably an overestimate, since no credit is taken for an intruder barrier after 500 years. If a factor of 10 credit at 500 years is assumed for layered waste, then individual intruder impacts associated with the final rule case would be the following:

	Body	Bone	Thyroid
Intruder-construction scenario (mrem/yr)	2.37E+0	1.09E+1	2.04E+0
Intruder-agriculture scenario (mrem/yr)	2.52E+0	6.70E+0	7.75E+0

As shown, if such credit is taken, the difference in potential inadvertent intruder impacts between the final and proposed rule cases is significantly reduced.

A reduced amount of waste processing is also projected for the proposed rule case relative to the final rule case. This results in somewhat lower population exposures due to waste incineration for the proposed rule case as well as lower total waste processing costs and occupational exposures. Most of these differences are due to the increased use of volume reduction technology for the final rule case. Unit disposal costs are slightly raised for the proposed rule case, however, which is due to the reduced volume of waste delivered to the disposal facility.

Overall costs to disposal facility customers, however, would be reduced. Under the Final Part 61 rule, waste streams having a transuranic content between 10 and 100 nCi/gm must be stabilized and disposed as Class C waste. Approximately 3500 m^3 of waste (after processing) is estimated to fall within this class. If the limit were 10 nCi/gm, then this waste would be projected to be unacceptable for near-surface disposal. (The difference between the non-acceptable volumes for the two cases is about 5400 m^3, which is about 1900 m^3 higher than the Class C waste volume. This increase in volume is due to increased waste processing by volume reduction assumed for the final rule case. If waste processing were to result in the waste stream being unacceptable for near-surface disposal, then the processing would not be performed.) Costs for the additional processing run at an average of about \$1428 per m^3 of packaged waste, much of which is due to increased use of volume reduction technology for the final rule case. If the waste streams in question were merely stabilized, then stabilization costs could be as low as \$450/m^3, although disposal costs (due to the increased volume) would be somewhat raised. This may be contrasted by estimated costs for disposal into a geologic repository. Based upon an estimated \$5200 per m^3 of waste, which includes costs for retrievable storage, retrieval, processing, transportation, and disposal, costs for geologic disposal of 3500-5400 m^3 of waste would run at about \$18.2 million to \$28.1 million over 20 years.

Isotopes Considered for Waste Classification Purposes

In the draft EIS, a total of 23 different radionuclides were considered in the numerical analysis. These nuclides were nearly all moderate- or long-lived radionuclides. Based upon these 23 radionuclides, concentration limits were proposed in the proposed Part 61 rule for 11 individual radionuclides plus alpha-emitting transuranics, enriched uranium, and depleted uranium. The individual isotopes included ^{3}H, ^{14}C, ^{59}Ni, ^{63}Ni, ^{60}Co, ^{94}Nb, ^{99}Tc, ^{129}I, ^{135}Cs, ^{137}Cs, and ^{241}Pu (a beta emitter). For the final rule, limits for ^{135}Cs, enriched uranium, and depleted uranium are eliminated, as are limits for ^{59}Ni and ^{94}Nb except as contained in activated metal. A separate limit for ^{242}Cm, a transuranic nuclide with a 162.9 day half-life, is provided.

The isotope deletions came about principally in response to commenters on the proposed Part 61 who were concerned regarding the costs and impacts of compliance with the waste classification requirements. In particular, many commenters were concerned that they would have to directly measure every isotope in every waste package. This would be difficult since measurement of many of the listed isotopes--which would usually be present only in trace quantities--could not be performed except by complex radiochemical separation techniques by laboratories. (Isotopes which are pure beta emitters, for example.) Commenters were concerned that costs and personnel radiation exposures would be significantly increased.

Development of a workable approach to compliance with the waste classification requirement received much attention between the time of preparation of the draft EIS and preparation of the final EIS. A preliminary draft of a technical position paper on compliance was prepared and forwarded to a number of interested parties. (Ref. 6) This technical position is discussed further below. To further ease the burden of compliance, the number of isotopes listed in the waste classification table were reduced to those judged to be needed on a generic basis for waste classification purposes, as well as those judged to be most needed for assessment of potential impacts from groundwater migration. Other isotopes may be added later either generically or in specific waste streams.

Cesium-135 was removed because it is present in wastes in very small concentrations, and because Cs-135 is a pure beta emitter which is very difficult to measure. Waste classification for waste containing Cs-135 will be determined by the presence of other isotopes such as Cs-137. Similarly, the radionuclides Ni-59 and Nb-94 have been removed except as they may be contained in activated metals. Based upon examination of the waste source data used for the EIS, these nuclides are, at this time, believed to be present in reactor wastes (other than activated metals) in such small concentrations as to be insignificant. Again, other than the possible case of activated metals, waste classification of waste containing Ni-59 and Nb-94 will be determined by other isotopes.

Uranium has also been removed as a limiting element for waste classification. Analysis of the data base for the Part 61 EIS indicates that the types of uranium-bearing wastes being typically disposed of by NRC licensees do not present a sufficient hazard to warrant limitation on the concentration of this naturally occurring material. Both depleted and enriched uranium typically do not contain daughter products in any quantity because of the relatively short time since the uranium was refined from ore, compared to the half-lives of the uranium isotopes. The daughter products are disposed of primarily as uranium mill tailings.

However, NRC is aware of some uranium-daughter-contaminated material which is typically being stored today and which may in the future be disposed as low-level waste. In addition, there are quantities of low activity waste material which also may be sent to disposal sites and which are not covered under the Atomic Energy Act and are not subject to NRC license. Such material may be generated by rare earth processing facilities, for example. This material, which is primarily contaminated soil, has characteristics sufficiently different from other low-level waste streams that separate treatment is warranted. NRC staff intends to examine specific disposal guidance for such material in the near future.

The remaining isotopes in the waste classification table are included due to (1) their presence in a wide variety of waste types, (2) concern due to their radiotoxicity, or (3) their importance in the groundwater migration pathway.

The radionuclide curium-242 was deleted from the overall combined transuranic limit and is considered separately for waste classification purposes. While Cm-242 is a relatively short-lived nuclide (163 days), it decays to plutonium-238, an alpha emitting transuranic nuclide with a half-life of nearly 90 years. A concentration of 20,000 nanocuries per gram for Cm-242 will result in a concentration of 100 nanocuries per gram of Pu-238.

Several commenters on the proposed rule inquired about the disposal of waste containing radium-226, a radioisotope which is not currently listed. It appears that there are two types of radium wastes to be considered: (1) small concentrated sources of radium such as radiation sources or luminescent dials, and (2) wastes which contain small amounts of radium incidental to other radioisotopes, such as radium contained in wastes from uranium separation processes.

The former is not subject to regulation by the Commission, since radium is a naturally-occurring isotope and is not included in the provisions of the Atomic Energy Act of 1954, as amended. The Environmental Protection Agency has a program for collection of radium sources. This program may be phased out in the next few years. Such sources are expected to be transferred to the Department of Energy for storage and disposal.

As for radium incidental to other types of waste, the Commission has made provisions for disposal of small quantities of uranium tailings as Class A waste. For purposes of this provision, a small quantity is defined as 10,000 kilograms containing not more than 5 millicuries of radium-226. This concentration is typical of uranium mill tailings (0.5 nanocuries per gram). The quantity of radium-226 is that contained in 150 pounds of natural uranium at equilibrium with its daughter products. 10 CFR Part 40 permits some persons to possess and use under general license 150 pounds of source material per year. Permitting the disposal of such a quantity in a near-surface disposal facility is judged to be acceptable. For large quantities, an additional evaluation would be appropriate. As discussed above, NRC staff plans to further examine guidance for disposal of such waste material in the future.

For the final Part 61 rule, limits for alpha-emitting transuranic radionuclides are given not in terms of individual radionuclides, but in terms of combined concentration limits for all alpha-emitting radionuclides having half lives greater than five years. This approach is believed to be the easiest to comply with by most licensees, although NRC recognizes that there may be exceptions to this based upon the particular distribution of transuranic isotopes within a particular licensee's waste. A discussion of the process by which NRC converted from individual transuranic radionuclide limits to a single combined limit is included in Appendix C.

Volume Reduction

Some commenters were concerned that the waste classification requirement would discourage volume reduction. This concern is believed to be alleviated by the increase in the Class C waste disposal limits. As an illustration, the volumes of waste determined to be unacceptable for near-surface disposal under extreme volume reduction conditions (waste spectrum 4) may be compared against the proposed and final Part 61 limits.

These comparative volumes are as follows:

	Unacceptable Volumes (m^3)	Percent of Total Generated
Proposed Part 61 Limits	9.42 E+3	4
Final Part 61 Limits	1.93 E+3	1

Compliance with Waste Classification

As discussed above, many commenters on the draft Part 61 rule were concerned regarding acceptable procedures for determining compliance with the waste classification requirements. The concern focused on how one estimates and