APPENDIX K
COST-BENEFIT ANALYSIS METHODOLOGY AND RESULTS

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1. Introduction

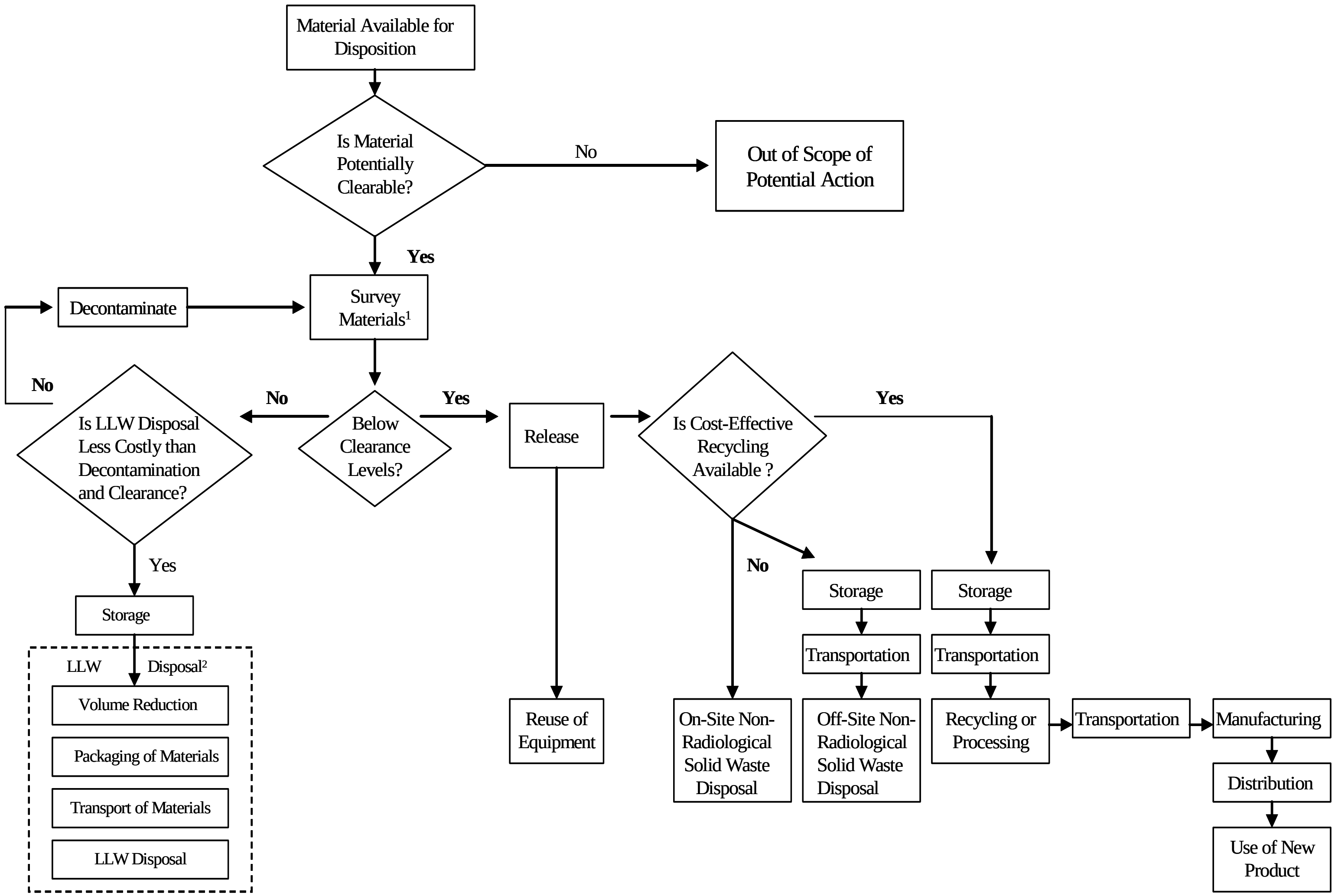
This Appendix presents the methodology used in preparing the cost-benefit analysis that is summarized in Chapter 4. According to NUREG/BR-0184 (NRC 1997b) a cost-benefit analysis should examine the costs and benefits of a proposed action. These costs and benefits are divided into 18 categories, described as attributes. Each attribute might contribute to costs or benefits or both. This analysis attempts to quantify both the costs and the benefits of the affected attributes. The costs and benefits within each attribute are driven by factors such as the different types of licensees, the different types of materials, and the life cycle of materials generated for release. The net benefit for each alternative is the difference between the sum of the benefits of all attributes and the sum of the costs of all attributes.

The analysis measures the incremental impacts of each alternative relative to a baseline, which is how things would be if the alternative were not imposed (i.e., the No Action Alternative). The baseline used in this analysis assumes full licensee compliance with existing NRC requirements, including current regulations. This is consistent with the *Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission*, which state that "...in evaluating a new requirement for existing plants, the staff should assume that all existing NRC and Agreement State requirements have been implemented."(NRC 2000c).

Exhibit 1 depicts the life cycle of materials generated for disposal or release for the Unrestricted Release Alternative. In the other alternatives, one or more of the pathways may not be allowed. The analysis is driven by how materials flow through the different paths of the life cycle. The main decision points in the life cycle flow path determination are (1) whether the material potentially has residual radioactivity; (2) whether the material is below the clearance level; (3) whether disposal as low-level waste is less costly than decontamination and release; and (4) whether cost-effective recycling is available for the material. Exhibit 1 also shows the four possible endpoints for radioactively contaminated materials that have been released: reuse of equipment, on-site disposal, off-site disposal, and recycling for use in new products.[1] For each of the alternatives and each of the materials, the analysis assumed that released materials will be recycled, reused, or sent to a municipal solid waste (MSW) landfill or incinerator, and that materials not meeting clearance levels will be sent to a low-level waste (LLW) facility for disposal. Table K-1 identifies the assumptions made for each alternative/material combination.

[1] On-site disposal is not considered in this analysis. Disposal in an on-site landfill is unlikely because (1) it would hurt the resale value of the property and (2) doses from the on-site landfill would have to be included in the dose analysis conducted in the licensee's decommissioning analysis. Reuse of equipment is only considered qualitatively because data on the amount of equipment that would be available for reuse were not available.

Exhibit 1: Generalized Material Life Cycle for Potentially Cleared Material



1 Survey may include knowledge of where material was located and/or measurement of radioactivity levels.

2 Material can be disposed of under other NRC regulations, such as 10 CFR Subpart K § 20.2002.

Table K-1 Disposition of Material under the Baseline and Alternatives

Alternative	Concrete	Ferrous metal	Trash
Baseline/No Action	Recycled	Recycled	MSW Landfill
Unrestricted Release	Recycled	Recycled	MSW Landfill
EPA-Regulated Landfill Disposal	MSW Landfill	MSW Landfill	MSW Landfill
LLW Disposal	LLW	LLW	LLW
Limited Dispositions	Recycled	MSW Landfill	MSW Landfill

MSW = municipal solid waste; LLW = low-level waste

* Because it is more expensive to transport material to, and dispose of material in, an MSW incinerator than in an MSW landfill, the analysis assumes that facilities will not choose to send their trash to an MSW incinerator, even if allowed to do so, but instead will dispose of their trash in a MSW landfill. Consequently, the costs and benefits of EPA-regulated trash incineration are the same as the RCRA Subtitle D Landfill Alternative.

Section 2 of this appendix describes the analytic approach used to evaluate each of the 18 "attributes" as defined in NUREG/BR-0184 (NRC 1997b). An in-house model was developed which draws upon input data including quantities and dose from SC&A 2003, survey costs from NRC 2004a, and various unit cost factors described in this appendix. SC&A 2003 presented data broken out by year. Consequently, the model calculates the costs in each year in which material is assumed to be released and then calculates the net present value for each alternative considered in 2003 dollars. For each attribute, Section 2 presents a description of the attribute and the equations used to quantify the associated costs and benefits. Section 2 also describes how costs are discounted to net present value. Section 3 provides the incremental results for each alternative (and dose option) considered, as well as a summary of these results.

2. Estimation of the Costs and Benefits by Attribute

This section describes how costs and benefits are estimated for each of the 18 attributes that must be considered in the cost-benefit analyses under NUREG/BR-0184. Of these 18 attributes, 11 are expected to be affected by the proposed action:[2]

- Environmental Considerations,
- Industry Operation,
- Public Health (Routine),
- Occupational Health (Routine),
- Public Health (Accident),
- Industry Implementation,
- NRC Implementation,
- NRC Operation,
- Other Government,
- Regulatory Efficiency, and
- Other Considerations.

These 11 attributes are discussed in Sections 2.1 through 2.11. Each section describes the attribute and presents the equations used to analyze the attribute. The section addressing environmental considerations has a more detailed discussion because the analysis of this attribute draws on different factors. Some of the attributes are partitioned into "sub-attributes" where more detailed analysis is required.

The equations present the cost or benefit in a given year for a material being cleared from light water reactors. As described in Chapter 4, although other types of facilities are affected by this rule, sufficient information was not available to calculate quantitative costs or benefits for these other types of facilities. The costs and benefits are calculated for each year in 2004 dollars in the analysis time horizon (2003-2049), converted to present value, and summed to calculate the net present value, as described in Section 2.12.

To determine the incremental benefit or cost relative to the baseline, the analysis subtracts the baseline benefits or costs from each alternative's benefits or cost. Negative results indicate net costs, while positive results indicate net benefits. The incremental costs associated with the No Action Alternative would be zero (because there is no change relative to the baseline). All unit costs are presented as negative numbers in the tables and assumptions following the equations, under the description where the numerical value of the cost is presented. The unit costs for the analysis are given in the format of a negative number so that the result of the equations, when calculated using numbers, yield the appropriate value indicating whether the alternative results in a net benefit or cost for that attribute.

[2] The following seven attributes are not expected to be affected by the proposed action: occupational health (accidental), offsite property, onsite property, other costs to general public (such as increased cleaning costs, property value losses, or inconveniences), improvements in knowledge, antitrust considerations, and safeguards and security considerations.

2.1 Attribute - Environmental Considerations

This section discusses the methodology for calculating the environmental benefits of the rule under each alternative. Most of the incremental environmental benefits are expected to result from air emissions avoided as a result of changes in transportation destinations and increases in recycling (i.e., reductions in manufacturing using virgin materials) due to clearance of additional materials. This section provides a detailed analysis of these benefits for structural ferrous metal, concrete, and trash. Due to data limitations and the small total volume of materials, the analysis presents discussions of the benefits associated with the reuse of aluminum and copper products in aggregate terms without the level of detail for the other materials.

The environmental benefits due to changes in transportation needs, which cause changes in air emissions, are calculated for the relevant solid materials by multiplying the changes in net miles (i.e., miles traveled under a specific alternative minus miles traveled under the baseline) by the appropriate emission factors for different pollutants and different transportation modes. These air emission changes are then monetized by multiplying by the price per ton for each pollutant. Aggregate environmental benefit estimates are then derived by summing over four pollutants (Sulfur Dioxide (SO_2), Nitrogen Oxides (NO_x), Particulate Matter (PM), and Carbon Dioxide (CO_2)).

Similarly, environmental benefits caused by changes in manufacturing needs for the relevant materials are calculated by multiplying the changes in the amount of recyclable material that are estimated to be released under this rule by the appropriate emission factors for relevant pollutants. Again, to monetize these benefits, total emission changes are multiplied by the price per ton for each pollutant. Finally, aggregate environmental benefits are derived by summing over the four pollutants.

Note that the overall methodology described above, while appropriate, has not been applied for all the different materials released under this rule. For example, environmental benefits due to recycling of released concrete are not expected to be significant and therefore, have been left out of the analysis. Sections 2.1.1 through 2.1.5 discuss the estimation of environmental benefits in detail for each material.

The quantities of materials released under this rule are not expected to be large enough to have a disruptive effect on the current market conditions, in terms of its impact on the recycling rates or the current demand/supply conditions. For example, the ferrous metal industry is likely to have the largest potential impact from recycling scrap ferrous metal as a result of this proposed rule. The net amount of scrap ferrous metal salvaged under the rulemaking alternatives (i.e., the amount salvaged relative to the No Action Alternative) would range between a maximum increase of 0.03 million tons and a maximum decrease of 0.13 million tons annually. According to the most recent data, annual U.S. production of ferrous metal is approximately 100 million tons. This means that the changes in ferrous metal scrap due to this rule would be approximately a tenth of a percent of the total U.S. ferrous metal market and therefore not expected to have any significant disruptions. Section 2.1.6 presents a brief discussion of the market share analysis for ferrous metal.

2.1.1 Ferrous Metal

Under the Unrestricted Release Alternative, the most significant environmental benefit is the recycling of ferrous metal released under this rule, which means less virgin ferrous metal is produced.[3] Virgin ferrous metal is produced in integrated ferrous metal mills using a three-step process that involves cokemaking, ironmaking, and Basic Oxygen Furnace (BOF) technology. Cokemaking and ironmaking processes have the greatest impact on the environment because large quantities of SO_2, NO_x, PM, and CO_2 are emitted. Electric Arc Furnace (EAF) facilities, often referred to as minimills, use up to 100 percent of scrap metal to produce ferrous metal. EAF technology does not require cokemaking and ironmaking processes. As a result, minimills emit less SO_2, NO_x, PM, and CO_2 per unit of output relative to integrated mills.

Under the EPA-Regulated Disposal Alternative, which prohibits recycling, environmental benefits result primarily from a reduction in the amount of fuel burned compared to the LLW Disposal Alternative. Less fuel is used because fewer vehicle miles are traveled (MSW landfills are located closer to NRC-licensed facilities than LLW facilities).

The following two sections explain the methodology for estimating environmental benefits in transportation and ferrous metal manufacturing sectors.

Benefits Due to Transportation Changes

The analysis calculates the change in air emissions by multiplying the net miles traveled by the corresponding emission factors for different pollutants. The following section explains how the emission factors are derived.

Based on the geographic location of NRC-licensed facilities relative to rail and highway infrastructure, the analysis assumes that ferrous metal scrap is transported by trucks. Depending on the alternative, one-way haul distances range from approximately 60 miles to over 1,500 miles. Given the range of haul distances, the analysis assumes that both short- and long-haul trucks transport ferrous metal scrap from NRC-licensed facilities. For the purpose of this analysis, long-haul trucks are characterized as: (1) class 8b heavy-duty diesel trucks; (2) trucks traveling long distances (greater than 200 miles from their home base); and (3) trucks traveling at higher speeds over longer distances. Short-haul trucks are characterized as: (1) class 8b heavy-duty diesel trucks; (2) trucks traveling less than 200 miles from their home base; and (3) trucks operating mostly in urban areas.

The air emissions standards for short- and long-haul trucks are expected to change over the period covered by this analysis. Therefore, the study models emission factors assuming that, on average, every five years a new standard for on-road vehicle emissions would be established. Thus, the standard established in 2003 would stay in effect until 2009 and a new standard would

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[3] The ferrous metal industry has stated that it will not reprocess radiation-contaminated scrap ferrous metal. If true, this would substantially reduce the rule's environmental benefits. This analysis, however, assumes that recyclable ferrous metal will be recycled because it is not clear from available information how the steel industry views released steel. It is possible that it is currently being released and disposed, rather than released and recycled.

be established in 2010. This new standard would be applicable in 2010 and would stay in effect until 2014. The emission factors are not modeled past 2030 to avoid excessive speculation. Therefore, the standard established in 2030 is assumed to stay in effect until 2049. Fleet age and replacement also influence these factors, accounting for the increases seen in the CO_2 emission factors. The emission factors by pollutant for long-haul and short-haul trucks are presented in Tables K-2 and K-3, respectively.

Table K-2 Emission Factors (in grams/mile) for Long-Haul Trucks

Year	SO_2	NO_x	PM_{10}	CO_2
2003	0.3440	27.919	0.3096	1615.2
2010	0.0110	9.720	0.1471	1611.6
2015	0.0110	2.612	0.0910	1613.0
2020	0.0110	1.235	0.0779	1613.4
2025	0.0110	0.997	0.0770	1613.5
2030	0.0110	0.960	0.0767	1613.5

Table K-3 Emission Factors (in grams/mile) for Short-Haul Trucks

Year	SO_2	NO_x	PM_{10}	CO_2
2003	0.3557	25.779	0.6184	1665.2
2010	0.0111	13.765	0.2599	1617.6
2015	0.0110	6.394	0.1591	1612.1
2020	0.0110	2.737	0.0989	1612.6
2025	0.0110	1.143	0.0836	1613.2
2030	0.0110	0.702	0.0781	1613.4

Source: ICF Analyses using EPA MOBILE 6.2 emissions factor model and 1997 Vehicle Inventory and Use Survey (VIUS).

Benefits Due to Manufacturing Changes

Although this analysis assumes no significant disruptions to the ferrous metal market as a result of the rule (see market share analysis presented below), the slight change in the market price of ferrous metal is important to the analysis of virgin ferrous metal displacement. The ferrous metal market consists of ferrous metal products made from iron ore (i.e., using BOF technology) and those made from scrap (i.e., using EAF technology). Under the Unrestricted Release Alternative, the supply of ferrous metal products made from scrap would increase. The increase in the supply of ferrous metal made from scrap would ultimately lead to an overall increase in the supply of all ferrous metal. Based on the economic principles of supply and demand, this would cause the price of ferrous metal to decrease slightly.[4] The slight drop in the price of ferrous metal is expected to lead to a slight increase in quantity demanded for ferrous metal. In addition, the quantity supplied of virgin ferrous metal is expected to decrease slightly as a result of the decrease in the market price of ferrous metal.

[4] Assuming that the demand for ferrous metal is downward sloping and the supply of ferrous metal is upward sloping, the magnitude of the price change would depend on the elasticities of the supply and demand of ferrous metal. Although the price change estimation is beyond the scope of this analysis, the change in price is not expected to be significant as the increase in supply is relatively small.

The general approach used in this analysis is to estimate the quantity of ferrous metal scrap that would be recycled under each regulatory alternative relative to the baseline, determine the quantity of domestic virgin ferrous metal that would be displaced, derive emission factors for each pollutant emitted in the production of virgin ferrous metal, and then multiply emission factors by quantity of virgin ferrous metal displaced.

The industry data indicate that minimills use, on average, 1.07 kilograms of scrap to produce 1 kilogram of ferrous metal (IISI 2002). The study uses this ratio of scrap to ferrous metal to estimate the amount of ferrous metal that would be produced from licensees' scrap. As previously explained, the increase in the supply of ferrous metal made from NRC scrap would cause a slight decrease in the price of ferrous metal and, in turn, increase the quantity of ferrous metal demanded. In order to estimate how much of the ferrous metal would be replaced by the ferrous metal made from scrap generated by this rule, the study makes a simplifying assumption that the elasticities of supply and demand are equal. Under this assumption, an increase of one million ton in the supply of ferrous metal products made from ferrous metal scrap (released by licensees) generated by this rule would result in 0.5 million ton increase in quantity demanded of ferrous metal, and 0.5 million ton decrease in the quantity supplied of ferrous metal (both virgin ferrous metal and ferrous metal made from scrap). The assumed decreased supply of scrap metal would not be limited to material not generated by this rule. It is assumed that the decrease in supply could be from scrap generated by this rule or scrap not generated by this rule. This assumption is based on the idea that once the scrap metal enters the market, it becomes part of the total scrap market and no differentiation is made as to whether it was generated as a result of the rule or not.

The quantity of virgin ferrous metal consumed domestically is supplied by both domestic and foreign producers. The analysis, however, focuses only on air emissions avoided through the displacement of domestic virgin ferrous metal. In reality, CO_2 does have trans-boundary implications. Estimating the increase in ambient concentration of CO_2 in the US resulting from foreign production of virgin ferrous metal is, however, beyond the scope of this analysis.

To understand how much of domestic virgin ferrous metal can be replaced with the scrap generated by this rule under various alternatives, the study first estimates the share of virgin ferrous metal in the total domestic consumption of ferrous metal, and then calculates the share of US virgin ferrous metal consumed domestically.

The average annual US production of ferrous metal is 98 million tons (for the period 1997-2001), with 53 million tons of ferrous metal products produced using iron ore (i.e, virgin ferrous metal using BOF technology). In order to account properly for air emissions in manufacturing of virgin ferrous metal, the study assumes that all of the U.S. virgin ferrous metal is consumed domestically. Therefore, for the purpose of this analysis, the U.S. consumption of virgin ferrous metal is equal to the U.S. production of virgin ferrous metal plus the U.S. imports of virgin ferrous metal. Based on the estimated amount of foreign virgin ferrous metal imported annually, the estimated total amount of virgin ferrous metal available for domestic consumption is 77 million tons per year.[5]

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[5] Using the USGS data for 1997-2001, the study estimates that approximately 75 percent of the

(continued...)

The next step in the analysis is to estimate the share of domestic virgin ferrous metal in the U.S. consumption of ferrous metal. The U.S. Geological Survey (USGS) data for 1997-2001 (USGS 2004e; USGS 2004f) indicate that the average annual U.S. consumption of ferrous metal is approximately 117 million tons. Based on the study estimates presented above, virgin ferrous metal products account for 66 percent of the total ferrous metal consumption in the U.S. (77 million tons / 117 million tons = 66 percent). Out of 77 million tons of virgin ferrous metal products consumed domestically, 53 million tons, or 69 percent, is produced domestically. Therefore, to derive the amount of domestic virgin ferrous metal displaced, the study first multiplies the total quantity of ferrous metal displaced by 0.66 to derive the amount of virgin ferrous metal displaced in the domestic consumption, and then by 0.69 to calculate the amount of domestic virgin ferrous metal displaced.

As stated previously, virgin ferrous metal production includes cokemaking and ironmaking processes. These two processes are not required when using EAF technology (i.e., when making ferrous metal products from ferrous metal scrap). The industry data indicate that the production of ferrous metal by BOF technology requires about 0.7 tons of pig iron and between 0.35 and 0.65 tons of coke (DOE 2000; IISI 2002). The study uses these factors to estimate the amount of pig iron and coke required to produce the amount of domestic virgin ferrous metal that would be displaced by the NRC ferrous metal scrap.[6]

The next step in the analysis is to estimate the total amount of emissions avoided through the displacement of domestic virgin ferrous metal. The analysis uses the emission factors for the iron and ferrous metal industry derived by DOE (DOE 2000). The emission factors are presented in Table K-4.

Table K-4 Emission Factors for Criteria Pollutants by Ferrous Metalmaking Process

Process	Units	SO_2	NO_x	PM	CO_2
Integrated Mills					
Cokemaking	lbs/ton of coke	4.1	0.98	1.374	389.17
Ironmaking	lbs/ton of ferrous metal	26.47	10.27	7.624	2,000.0

Source: DOE.

To estimate the total amount of emissions avoided, the study multiplies the emission factors by the amount of coke and pig iron saved through recycling of NRC ferrous metal scrap.

[5] (...continued)
world production of ferrous metal is produced from virgin ferrous metal (i.e., using BOF technology). The study then assumes that 75 percent of the ferrous metal products imported by the U.S. are made from virgin ferrous metal. The analysis estimates that out of 32 million tons of ferrous metal imported annually, approximately 24 million tons are virgin ferrous metal products (32 million tons * 75 percent = 24 million tons). Based on the estimated amount of imported virgin ferrous metal, the total amount of virgin ferrous metal available for domestic consumption is 77 million tons per year (53 million tons + 24 million tons = 77 million tons).

[6] Using the mid point of the 0.36-0.65 range yields an average ratio of coke to ferrous metal of 0.5.

Data on Pollutant Prices

The study estimates the monetary value of environmental benefits by multiplying the estimated net emissions by the estimated allowance price for each pollutant. Under competitive market conditions, allowance prices are expected to provide the estimated monetary value for reducing a unit of the relevant pollutant. For SO_2 and NO_x, allowance prices used are based on EPA's projections for 2006 to 2020 for the proposed multi-pollutant scenario, known as the Clear Skies Act found in ICF Consulting's Integrated Planning Model (an analytical model designed to evaluate various aspects of electric power production, including air pollution). Allowance prices for SO_2 and NO_x used in this analysis are as shown in Table K-5.

Table K-5 Allowance Prices for SO_2 and NO_x

Year	SO_2 ($/ton)	NO_x ($/ton)
2006	493	1844
2010	605	1,063
2015	785	1,081
2020	1,018	1,402

Note that the prices were not estimated past 2020 to avoid speculation. For the years past 2020, the estimated allowance price for 2020 is used.

For particulate matter and CO_2, this study uses the 1990 Pace University Study (Ottinger et al. 1990)[7] estimate of $3,516 per ton of particulate matter and $20 per ton of CO_2. The Pace study, prepared for the New York State Energy Research and Development Authority and DOE examines the environmental costs associated with a variety of energy sources and environmental effects (e.g., air pollution, global warming, land use).

2.1.2 Concrete

Benefits Due to Transportation Changes

Most of the incremental environmental benefits would be provided through reduction in fuel burned by decreasing haul distances. The study used the same methodology for estimating environmental benefits from the change in air emissions as presented above for ferrous metal.

Benefits Due to Manufacturing Changes

Recycled concrete is used in place of virgin aggregate primarily as road base material. The analysis assumes that concrete cleared from NRC-licensed facilities would be used in the same capacity. The available publications on concrete recycling, however, do not indicate that there are considerable environmental benefits in terms of emissions avoided from using recycled

[7] Reproduced from U.S. Congress, Office of Technology Assessment, Studies of the Environmental Costs of Electricity, OTA–ETI–134 (Washington, DC: U.S. Government Printing Office, September 1994, page 24).

concrete, instead of virgin aggregate, in road construction (DOT 2003). Therefore, the study does not estimate environmental benefits from recycling of concrete.

2.1.3 Trash

Benefits Due to Transportation Changes

Under both the Unrestricted Release and EPA-Regulated Disposal Alternatives, trash from NRC-licensed facilities would be disposed in MSW landfills or low-level waste facilities. Trash would not be recycled or used for any purpose that would yield environmental benefits. The type and location of permitted landfills, however, would vary depending on the alternative. Thus, some environmental benefits would be provided through reduction in fuel burned by decreasing the distances that material is hauled. The study uses the same methodology for estimating environmental benefits from the change in air emissions as presented above for ferrous metal. For the EPA-Regulated Disposal Alternative, no incineration of trash is expected because it is less expensive to send material to an MSW landfill for disposal.

2.1.4 Copper

This analysis presents a brief discussion of the environmental benefits from recycling copper. The analysis is constrained by the lack of detailed data on the quantity of copper expected to be recycled due to this rule. SC&A 2003 estimates there are about 6,584 tons of potentially clearable copper; this is about one-quarter percent of the total mass of ferrous metals (which is about 2.4 million tons). Also, lack of detailed annual estimates of potentially clearable copper for different alternatives precludes estimating incremental environmental benefits due to this rule (i.e., benefits over a No Action “baseline”). However, copper is a valuable material and any quantity generated by this rule can be expected to be recycled with tangible environmental benefits, since recycling copper is generally considered less energy-intensive than producing copper from ore.[8] Given the limitations of the data, this analysis does not quantify this environmental benefit but notes that the estimated 6,584 tons of potentially clearable copper will provide finite environmental benefits.

2.1.5 Aluminum

SC&A 2003 estimates there are about 212 tons of potentially clearable aluminum from decommissioning all licensed facilities; this is about a tenth of a percent of the total mass of ferrous metals.[9] Again, because of data limitations, this analysis does not attempt to quantify the incremental environmental benefits from this amount, but notes that the environmental benefit from this small amount of aluminum can be expected to be finite but less than that for copper.

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[8] See for example, “The Life Cycle of Copper, its Co-Products and By-Products,” International Institute for Environment and Development (IIED), 2002.

[9] *Ibid.*

2.1.6 Market Share Analysis

This section provides a market share analysis for ferrous metal, copper, and aluminum. The analysis provides a description of the effects that the proposed action could have on the market for these metals, if any.

Ferrous metal

In the period 1997-2001, U.S. production of ferrous metal was, on average, almost 100 million metric tons. Approximately 54 percent of ferrous metal products were produced from virgin materials such as iron ore and coal using BOF technology. The remainder, 46 percent, was produced from ferrous metal scrap in EAF facilities. These data show that the U.S. ferrous metal industry already has a high recycling rate. The rate is expected to increase under the Unrestricted Release Alternative. Although most of the U.S. demand is satisfied through domestic production, ferrous metal imports account for 25 to 30 percent of annual consumption of ferrous metal. The summary statistics for the U.S. iron and ferrous metal industry are presented in Table K-6 (USGS 2004e; USGS 2004f).

Table K-6 U.S. Iron and Ferrous Metal Industry Summary Statistics from USGS (in million metric tons of metal)

	1997	1998	1999	2000	2001[1]
Pig Iron Production	49.6	48.2	46.3	47.9	44.2
Ferrous Metal Production	98.5	98.6	97.4	102	92.9
Basic Oxygen Furnaces	55.4	54.1	52.3	54.1	49.4
Electric Arc Furnaces	43.1	44.5	45.1	47.9	43.5
Imports of Ferrous Metal Mill Products	28.3	37.7	32.4	34.4	26.2
Exports of Ferrous Metal Mill Products	5.5	5.0	4.9	5.9	5.6
Apparent Ferrous Metal Consumption[2]	114	118	116	119	118

[1] Estimated values.
[2] Apparent consumption = production + imports – exports + adjustment for industry stock changes + adjustment for imports of semi-finished ferrous metal products.

Source: USGS, 2004e, USGS 2004f

The net amount of scrap salvaged under the alternatives (i.e., the amount salvaged relative to the base case) would range between a maximum increase of 0.03 million tons to a maximum decrease of 0.13 million tons annually, or between 0.03 percent and 0.13 percent of the annual consumption, respectively. These quantities are relatively small compared to the total amount of ferrous metal products consumed annually. Therefore, the rule is not expected to cause any significant disruptions to the U.S. market for ferrous metal.

Copper

In the period 1997-2001, average annual U.S. production of copper was almost 3 million metric tons. Approximately 63 percent of copper products were produced from virgin materials such as ore, concentrate, or precipitate. The remaining 37 percent was produced from old scrap (secondary production), new scrap, or refinery scrap. Old scrap refers to obsolete or discarded end-use items that are recycled. New scrap represents the copper that is recovered from scrap generated during manufacturing (e.g., stampings, defective parts, etc.), and returned to smelters, refineries, or mills for reprocessing. Refinery scrap may have been processed through smelting and electrolytic refining or directly processed at a fire refinery. Although most of the U.S. demand is satisfied through domestic production, copper imports account for around 30 percent of annual consumption of copper. The summary statistics for the U.S. copper industry are presented in Table K-7 (USGS 2004c).

Table K-7 U.S. Copper Industry Summary Statistics from USGS (in million metric tons of metal)

	1997	1998	1999	2000	2001
Primary Production	2.07	2.14	1.89	1.59	1.63
Secondary Production	0.498	0.466	0.381	0.357	0.316
New Scrap	0.967	0.956	0.949	0.955	0.833
Refinery Scrap	0.396	0.349	0.23	0.208	0.172
Imports	0.632	0.683	0.837	1.06	0.991
Exports	0.0929	0.0862	0.0252	0.0936	0.0225
Apparent Copper Consumption[1]	2.94	3.03	3.13	3.13	2.5

[1] Apparent consumption = primary production + secondary production + imports – exports ± adjustment for industry stock changes.

Source: USGS, 2003a.

The net amount of scrap salvaged under the rulemaking alternatives (i.e., the amount salvaged relative to the base case) would total 6,584 tons. This quantity is relatively small compared to the total amount of copper consumed annually. Even if all of this copper was generated in the same year, it would only represent 0.22 percent of the average U.S. annual copper consumption. Therefore, the rule is not expected to cause any significant disruptions to the U.S. market for copper.

Aluminum

In the period 1996-2000, average annual U.S. production of aluminum was just over 7 million metric tons. Approximately 51 percent of aluminum products were produced from virgin materials. The remaining 49 percent was produced from secondary sources. Secondary production includes metal recovered from post-consumer aluminum scrap and fabrication aluminum scrap. Although the majority of the U.S. demand is satisfied through domestic production, aluminum imports account for about 48 percent of annual consumption of aluminum. The summary statistics for the U.S. aluminum industry are presented in Table K-8 (USGS 2004d).

The net amount of scrap salvaged under the rulemaking alternatives (i.e., the amount salvaged relative to the base case) would total 212 tons. This quantity is relatively small compared to the total amount of aluminum consumed annually. Even if all of this aluminum was generated in the same year, this amount would only represent 0.003 percent of the average U.S. annual aluminum consumption. Therefore, the rule is not expected to cause any significant disruptions to the U.S. market for aluminum.

Table K-8 U.S. Aluminum Industry Summary Statistics from USGS (in million metric tons of metal)

	1996	1997	1998	1999	2000
Primary Production	3.577	3.603	3.713	3.779	3.668
Secondary Production	3.31	3.55	3.44	3.69	3.45
Imports	2.81	3.08	3.55	4	3.91
Exports	1.5	1.57	1.59	1.64	1.76
Apparent Aluminum Consumption[1]	6.61	6.72	7.09	7.77	7.53

[1] Apparent consumption = primary production + secondary production + imports – exports ± adjustment for industry stock changes.

Source: USGS, 2002a

2.2 Attribute – Industry Operation

2.2.1 Attribute Definition and Identification of Driving Factors

Industry Operation measures yearly net incremental cost and benefits (e.g., relevant capital, operating, and maintenance costs) due to changes in industry operations, including incremental costs and savings for each of the following four sub-attributes:[10] (1) ongoing decision making/paperwork, (2) survey of materials, (3) solid waste disposal, recycling, or reuse, and (4) transportation.

1. *Sub-Attribute - Decision Making/Paperwork.* This sub-attribute captures the costs associated with preparing any required documents for the clearance of materials.

2. *Sub-Attribute - Survey of Materials.* Unit cost estimates for surveying materials reflect variations in the type of material to be surveyed, the physical shape of the material, contamination potential of the material, dose option that must be met, the initial activity level of the material, and whether materials are surveyed on or off site.

3. *Sub-Attribute - Solid Waste Disposal or Recycling.* This sub-attribute includes cost or revenue information for the following three elements: (1) Low-Level Waste Disposal, (2) Off-Site Solid Waste Disposal, and (3) Recycling. Unit costs include tipping fees and revenue from recycling materials.

[10] If decontamination were conducted, it also would be counted as a cost under industry operation. However, this analysis assumes that it is not cost-effective to decontaminate and re-survey materials in order to clear them.

4. *Sub-Attribute - Transportation*. Unit cost estimates for transportation reflect: (1) the average distances between licensees and the nearest LLW disposal facilities, EPA-regulated landfills, recycling facilities, or reuse facilities; (2) the average capacity of trucks used, and (3) the cost per ton-mile to ship cleared material versus controlled material.

The quantities of materials (ferrous metal, concrete, and trash) that are released in the baseline and for each alternative are taken from the collective dose assessment report, as described in Table K-9. For the alternatives with dose options (Unrestricted Release and EPA-Regulated Disposal), quantity information was provided for the 0.03 mrem/yr, 0.1 mrem/yr, 1 mrem/yr, and 10 mrem/yr options. For the IAEA Safety Guide No. RS-G-1.7 dose option, the quantities were assumed to be equal to the 1 mrem/yr dose option.

Table K-9 Quantity Sources in SC&A 2003

Description in Cost-Benefit Analysis	Description in SC&A 2003
Baseline/No Action	No Action (Case A)[11]
Unrestricted Release: Material-Specific Limits	Case A
Unrestricted Release: Material-Independent Limits	Case B
EPA-Regulated Disposal without Incineration	Case C
EPA-Regulated Disposal with Trash Incineration	Case C2
LLW Disposal	No Action (Case A)
Limited Disposition	Case B (Concrete); Case C (Ferrous metal and Trash)

[11] The collective dose report (SC&A 2003) presents different values for the dose associated with the No Action Alternative. This cost-benefit analysis assumes the most appropriate version of the quantities and dose associated with the No Action Alternative (and hence the baseline) is in fact the No Action Alternative in the collective dose report (SC&A 2003) associated with the Unrestricted Release Alternative.

Table K-10 presents the total quantities of material released under the baseline (No Action Alternative) and each alternative. As can be seen, different amounts of material are released under each alternative and dose option. That is, not only could a different amount of material be released between the 0.03 mrem/yr dose option and the 0.1 mrem/yr dose option, but within the 0.03 mrem dose options, different amounts are released depending on the alternative. In the 0.03 mrem/yr dose option in any alternative, less material clears and is available for release than in the baseline (or No Action Alternative). Positive values in the change in quantity released column indicate that more material meets release levels under the alternative than in the baseline. This “newly releasable” material is assumed to be sent to disposal in a LLW facility in the baseline. Often this change in the quantity that can be released drives the results of the cost modeling. Table K-11 presents the quantities of each type of material (ferrous metals, concrete, and trash) that could be released under each alternative and dose option. The totals in tables K-10 and K-11 are different from those presented in Chapter 3 because Chapter 3 uses an absolute analysis rather than an incremental analysis.

Table K-10 Material Quantities Released by Alternative

Alternative	Dose	Baseline Tons Released	Alternative Quantity Released	Change in Quantity Released
No Action	NA	17,954,742	17,954,742	0
Unrestricted Release Material Specific Limits	0.03	17,954,742	15,735,586	(2,219,156)
	0.1	17,954,742	18,768,310	813,568
	1	17,954,742	21,525,814	3,571,072
	10	17,954,742	21,909,149	3,954,407
Unrestricted Release Material Independent Limits	0.03	17,954,742	15,247,765	(2,706,977)
	0.1	17,954,742	18,080,580	125,838
	1	17,954,742	21,044,465	3,089,723
	10	17,954,742	21,709,582	3,754,840
	RS-G-1.7	17,954,742	21,044,465	3,089,723
EPA/State-Regulated Disposal (Landfill)	0.03	17,954,742	16,888,904	(1,065,838)
	0.1	17,954,742	19,570,465	1,615,723
	1	17,954,742	21,790,651	3,835,909
	10	17,954,742	21,928,420	3,973,678
	RS-G-1.7	17,954,742	21,790,651	3,835,909
LLW Disposal/ Prohibition	NA	17,954,742	17,954,742	-
Limited Disposition	RS-G-1.7	17,954,742	21,694,631	3,739,890

Table K-11 Quantities Released Under Baseline and Alternatives by Dose Option and Material

Alternative	Dose	Baseline Tons Released			Alternative Tons Released			Change in Quantity Released		
		Steel	**Concrete**	**Trash**	**Steel**	**Concrete**	**Trash**	**Steel**	**Concrete**	**Trash**
No Action	NA	1,803,602	16,130,738	20,402	1,803,602	16,130,738	20,402	0	0	0
Unrestricted Release	0.03	1,803,602	16,130,738	20,402	759,254	14,962,692	13,640	(1,044,347)	(1,168,047)	(6,762)
Material Specific	0.1	1,803,602	16,130,738	20,402	1,256,607	17,490,696	21,007	(546,995)	1,359,958	605
Limits	1	1,803,602	16,130,738	20,402	1,940,589	19,544,245	40,979	136,987	3,413,507	20,577
	10	1,803,602	16,130,738	20,402	2,171,232	19,671,833	66,084	367,630	3,541,094	45,682
Unrestricted Release	0.03	1,803,602	16,130,738	20,402	284,888	14,962,692	186	(1,518,714)	(1,168,047)	(20,216)
Material Independent	0.1	1,803,602	16,130,738	20,402	589,452	17,490,696	432	(1,214,150)	1359958	(19,970)
Limits	1	1,803,602	16,130,738	20,402	1,498,424	19,544,245	1,796	(305,178)	3,413,507	(18,606)
	10	1,803,602	16,130,738	20,402	2,031,852	19,671,833	5,897	228,250	3541094	(14,505)
	RS-G-1.7	1,803,602	16,130,738	20,402	1,498,424	19,544,245	1,796	(305,178)	3,413,507	(18,606)
EPA/State-Regulated	0.03	1,803,602	16,130,738	20,402	1,332,548	15,542,717	13,640	(471,054)	(588,021)	(6,762)
Disposal (Landfill)	0.1	1,803,602	16,130,738	20,402	1,742,296	17,807,161	21,007	(61,306)	1,676,423	605
	1	1,803,602	16,130,738	20,402	2,109,407	19,640,265	40,979	305,805	3,509,527	20,577
	10	1,803602	16,130,738	20,402	2,190,503	19,671,833	66,084	386,901	3,541,094	45,682
	RS-G-1.7	1,803602	16,130,738	20,402	2,109,407	19,640,265	40,979	305,805	3,509,527	20,577
LLW Disposal/ Prohibition	NA	1,803602	16,130,738	20,402	1,803,602	16,130,738	20,402	-	-	-
Limited Disposition	RS-G-1.7	1,803,602	16,130,738	20,402	2,109,407	19,544,245	40,979	305,805	3,413,507	20,577

2.2.2 Attribute Equations

The following four equations are used to calculate the net change in costs and benefits due to the Industry Operation attribute.

Equation 1 - Decision Making/Paperwork

The administrative costs associated with decision making and paperwork of the *Industry Operation* attribute are estimated as follows:

$$Decision\ Making/Paperwork = (HOURS_{Technical} \times WAGE_{Technical})$$

Parameter	Description
$HOURS_{Technical}$	The number of additional hours required for administrative tasks by technical workers (see assumptions below)
$WAGE_{Technical}$	The loaded hourly wage per technical labor (see assumptions below)

Assumptions

- The number of administrative hours per licensee undergoing their first year of decommissioning required by technical staff ($HOURS_{Technical}$) is equal to 200 hours.[12]

- The hourly wage rates used throughout the equations in this appendix for each labor category are as follows:[13]

  (1) Technical labor ($WAGE_{Technical}$) = -$33.84 per hour per person (OPM, 2004)[14]
  (2) Managerial labor ($WAGE_{Managerial}$) = -$48.22 per hour per person (OPM, 2004)[15]
  (3) Attorney or lawyer labor ($WAGE_{Legal}$) = -$67.04 per hour per person (OPM, 2004)[16]
  (4) Clerical labor ($WAGE_{Clerical}$) = -$20.58 per hour per person (OPM, 2004)[17]

Equation 2 - Survey costs

The net survey costs associated with the *Industry Operation* attribute are estimated as follows:

[12] Based on Best Professional Judgement and guidance in NUREG-6477 (NRC 1998).

[13] As discussed in Section 2, the unit costs are presented as negative in order to provide results that correctly identify benefits as positive and costs as negative.

[14] GS-11, Step 1 with a standard overhead factor of 1.6.

[15] GS-13, Step 1 with a standard overhead factor of 1.6.

[16] GS-15, Step 1 with a standard overhead factor of 1.6.

[17] GS-6, Step 1 with a standard overhead factor of 1.6.

$$Survey = [(COST_{ferrous\ metal\ dose\ survey} \times QUANTITY_{ferrous\ metal\ dose}) + (COST_{concrete\ dose\ survey} \times QUANTITY_{concrete\ dose}) + (COST_{trash\ dose\ survey} \times QUANTITY_{trash\ dose})] - [(COST_{ferrous\ metal\ baseline\ survey} \times QUANTITY_{ferrous\ metal\ baseline}) + (COST_{baseline\ concrete\ survey} \times QUANTITY_{concrete\ baseline}) + (COST_{trash\ baseline\ survey} \times QUANTITY_{trash\ baseline})]$$

Parameter	Description
$COST_{baseline\ concrete\ survey}$	Baseline survey costs per ton of concrete (see table K-12 below)
$COST_{ferrous\ metal\ baseline\ survey}$	Baseline survey costs per ton of ferrous metal (see table K-12 below)
$COST_{trash\ baseline\ survey}$	Baseline survey costs per ton of trash (see table K-12 below)
$QUANTITY_{concrete\ baseline}$	Baseline total tons of concrete
$QUANTITY_{ferrous\ metal\ baseline}$	Baseline total tons of ferrous metal
$QUANTITY_{trash\ baseline}$	Baseline total tons of trash
$COST_{concrete\ dose\ survey}$	Survey costs per ton of concrete under dose option (see table K-12 below)
$COST_{ferrous\ metal\ dose\ survey}$	Survey costs per ton of ferrous metal under dose option (see table K-12 below)
$COST_{trash\ dose\ survey}$	Survey costs per ton of trash under dose option (see table K-12 below)
$QUANTITY_{concrete\ dose}$	Total tons of concrete to be released under dose option
$QUANTITY_{ferrous\ metal\ dose}$	Total tons of ferrous metal to be released under dose option
$QUANTITY_{trash\ dose}$	Total tons of trash to be released under dose option

Assumptions

- The available survey costs from the Clearance Survey Cost Report (ORISE 2004) are summarized in Table K-12.

- Because survey costs are dependent on MARSSIM classification, the survey costs were weighted to reflect the relative proportion of MARSSIM Class 2 and Class 3 material. The percentages for ferrous metal were taken from SC&A 2003. Based on data in tables on pages 3-10, 3-20, and the scaling factors from page 3-23, the relative proportion of Class 2 material was 27 percent and Class 3 material was 73 percent. Similar information was not available for concrete and trash in SC&A 2003. Attachment 1 describes the relative proportion of Class 1, 2, and 3 material for ferrous metal, concrete, and trash. Assuming that only Class 2 and Class 3 material would be surveyed to be released, this analysis calculates that 11 percent of concrete would be Class 2 and 89 percent would be Class 3. For trash, 50 percent is assumed to be Class 2 and 50 percent is assumed to be Class 3.

Table K-12: Survey Costs by Dose Option

Dose Option Level and MARSSIM Classification	Cost	Units	Source in Feb 2004 Clearance Survey Cost Report
Concrete Rubble			
baseline/no action	-26	$/ton	p. 7-9
0.03 mrem/yr - Class 2	Not Feasible		
0.1 mrem/yr- Class 2	-314	$/ton	p. 7-10
1 mrem/yr - Class 2	-84	$/ton	p. 7-10
10 mrem/yr - Class 2	-84	$/ton	p. 7-10
IAEA Standard - Class 2	-84	$/ton	Assumed to be equal to 1 mrem/yr
0.03 mrem/yr - Class 3	Not Feasible		
0.1 mrem/yr- Class 3	-85	$/ton	p. 7-10
1 mrem/yr - Class 3	-30	$/ton	p. 7-10
10 mrem/yr - Class 3	-30	$/ton	p. 7-10
IAEA Standard - Class 3	-30	$/ton	Assumed to be equal to 1 mrem/yr
Structural Ferrous Metal			
baseline/no action	-176	$/ton	p. 7-26
0.03 mrem/yr - Class 2	Not Feasible		
0.1 mrem/yr- Class 2	-89	$/ton	p. 7-28
1 mrem/yr - Class 2	-82	$/ton	p. 7-28
10 mrem/yr - Class 2	-82	$/ton	p. 7-28
IAEA Standard - Class 2	-82	$/ton	Assumed to be equal to 1 mrem/yr
0.03 mrem/yr - Class 3	Not Feasible		
0.1 mrem/yr- Class 3	-30	$/ton	p. 7-28
1 mrem/yr - Class 3	-27	$/ton	p. 7-28
10 mrem/yr - Class 3	-27	$/ton	p. 7-28
IAEA Standard - Class 3	-27	$/ton	Assumed to be equal to 1 mrem/yr
Trash			
baseline/no action	-50	$/ton	Assumed to be twice 0.1 mrem/yr (for class 3)
0.03 mrem/yr - Class 2	-246	$/ton	Assumed to be twice 0.1 mrem/yr
0.1 mrem/yr- Class 2	-123	$/ton	p. 7-53
1 mrem/yr - Class 2	-123	$/ton	p. 7-53
10 mrem/yr - Class 2	-123	$/ton	p. 7-53
IAEA Standard - Class 2	-123	$/ton	Assumed to be equal to 1 mrem/yr
0.03 mrem/yr - Class 3	-50	$/ton	Assumed to be twice 0.1 mrem/yr
0.1 mrem/yr- Class 3	-25	$/ton	p. 7-53
1 mrem/yr - Class 3	-25	$/ton	p. 7-53
10 mrem/yr - Class 3	-25	$/ton	p. 7-53
IAEA Standard - Class 3	-25	$/ton	Assumed to be equal to 1 mrem/yr

- It is not feasible to survey concrete and ferrous metal at the 0.03 mrem/yr dose option level, because the data quality objectives for the survey demand a very large number of samples (ORISE 2004). As a result, in the 0.03 mrem/yr dose options of the Unrestricted Release and EPA-Regulated Disposal Alternatives, ferrous metal and concrete are assumed to be sent for LLW disposal rather than surveyed and released.

Assumptions

- Survey costs for LLW disposal are not required by the proposed action. However, disposal facilities will not accept waste that has not been surveyed. Consequently, survey costs were included for all material being sent to LLW disposal. The survey costs for the 10 mrem/yr dose option were used as a proxy for the survey costs for LLW disposal.

Equation 3 - Disposal and recycling costs

The net disposal and recycling costs associated with the *Industry Operation* attribute are estimated as follows:

$$Disposal/Recycling = [(COST_{LLW\ Disposal} \times QUANTITY_{LLW\ Dose}) + (COST_{Landfill\ Disposal} \times QUANTITY_{Landfill\ Dose}) + (REVENUE_{ferrous\ metal\ recycled} \times QUANTITY_{ferrous\ metal\ recycled\ dose}) + (COST_{concrete\ recycled} \times QUANTITY_{concrete\ recycled\ dose}) + (COST_{LLW\ Disposal} \times QUANTITY_{baseline\text{-}dose})] - [(COST_{LLW\ Disposal} \times QUANTITY_{LLW\ baseline}) + (COST_{Landfill\ Disposal} \times QUANTITY_{Landfill\ baseline}) + (REVENUE_{ferrous\ metal\ recycled} \times QUANTITY_{ferrous\ metal\ recycled\ baseline}) + (COST_{concrete\ recycled} \times QUANTITY_{concrete\ recycled\ baseline})]$$

Parameter	Description
$QUANTITY_{LLW\ baseline}$	Baseline total tons of material disposed of offsite as LLW
$QUANTITY_{Landfill\ baseline}$	Baseline total tons of material disposed of offsite as MSW
$QUANTITY_{ferrous\ metal\ recycled\ baseline}$	Baseline total tons of ferrous metal recycled
$QUANTITY_{concrete\ recycled\ baseline}$	Baseline total tons of concrete recycled
$QUANTITY_{LLW\ Dose}$	Total tons of material disposed of offsite as LLW under dose option
$QUANTITY_{Landfill\ Dose}$	Total tons of material disposed of offsite as MSW under dose option
$QUANTITY_{ferrous\ metal\ recycled\ dose}$	Total tons of ferrous metal recycled under dose option
$QUANTITY_{concrete\ recycled\ dose}$	Total tons of concrete recycled under dose option
$QUANTITY_{baseline\text{-}dose}$	Net difference in tons cleared in baseline - tons cleared under dose option
$COST_{LLW\ Disposal}$	Offsite disposal costs per ton of material at a LLW facility (see assumptions below)
$COST_{Landfill\ Disposal}$	Offsite disposal costs per ton of material at a solid waste landfill (see assumptions below)
$REVENUE_{ferrous\ metal\ recycled}$	Revenue generated from the average market price of recycling scrap ferrous metal (see assumptions below)
$COST_{concrete\ recycled}$	Recycling cost per ton of concrete (see assumptions below)

Assumptions

- The cost for disposal at a LLW facility (Envirocare) is equal to -$14.72 per cubic foot (DOE 2002b). This cost reflects disposal of DOE waste, because prices for disposal of non-DOE wastes were not publicly available.

- The cost for disposal at a municipal or industrial solid waste landfill is equal to -$32.19 per ton (REPA 2001).

- The revenue associated with the average market price of scrap ferrous metal is equal to $85 per ton (Recycler's World 2003).[18]

- The cost of recycling concrete is equal to -$5 per ton.[19]

Equation 4 - Transportation costs

The net transportation cost associated with the *Industry Operation* attribute is estimated as follows:

$$Transportation = COST_{LLW\ transport\ truck} \times DISTANCE_{LLW\ facility} \times (QUANTITY_{LLW\ dose} + QUANTITY_{baseline\text{-}dose} - QUANTITY_{LLW\ baseline}) + COST_{Cleared\ transport\ truck} [(DISTANCE_{MSW\ Landfill} \times (QUANTITY_{Landfiill\ dose} - QUANTITY_{Landfiill\ baseline})) + (DISTANCE_{Recycling\ Facility\text{-}Ferrous\ metal} \times (QUANTITY_{ferrous\ metal\ recycled\ dose} - QUANTITY_{ferrous\ metal\ recycled\ baseline})) + (DISTANCE_{Recycling\ Facility\text{-}Concrete} \times (QUANTITY_{concrete\ recycled\ dose} - QUANTITY_{concrete\ recycled\ baseline}))]$$

Parameter	**Description**
$QUANTITY_{LLW\ baseline}$	Total baseline tons of material transported to a LLW facility
$QUANTITY_{Landfiill\ baseline}$	Total baseline tons of material transported to a municipal landfill
$QUANTITY_{ferrous\ metal\ recycled\ baseline}$	Total baseline tons of ferrous metal transported to a recycling facility
$QUANTITY_{concrete\ recycled\ baseline}$	Total baseline tons of concrete transported for recycling
$COST_{LLW\ transport\ truck}$	Cost per ton-mile for transport of LLW using a truck (see assumptions below)
$COST_{Cleared\ transport\ truck}$	Cost per ton-mile for transport of cleared material using a truck (see assumptions below)
$DISTANCE_{LLW\ facility}$	Distance to a LLW facility (see assumptions below)
$DISTANCE_{MSW\ Landfill}$	Distance to a MSW landfill (see assumptions below)
$DISTANCE_{Recycling\ Facility\text{-}Ferrous\ metal}$	Distance to a ferrous metal recycling facility (see assumptions below)
$DISTANCE_{Recycling\ Facility\text{-}Concrete}$	Distance to a concrete recycling facility (see assumptions below)

[18] Because the industry will pay licensees for the ferrous metal, this is considered a negative cost (actualized benefit).://www.recycle.net/price/metals.html

[19] Agretech. Phone Interview. November 25, 2003.

Parameter	Description
$QUANTITY_{baseline-dose}$	Net difference in tons cleared in baseline minus tons cleared under dose option
$QUANTITY_{LLW\ dose}$	Total tons of material transported under dose option to a LLW facility
$QUANTITY_{Landfiill\ dose}$	Total tons of material transported under dose option to a MSW landfill
$QUANTITY_{ferrous\ metal\ recycled\ dose}$	Total tons of ferrous metal transported under dose option to a recycling facility
$QUANTITY_{concrete\ recycled\ dose}$	Total tons of concrete transported under dose option to a recycling facility

Assumptions

The following transportation costs apply:

- LLW material using a truck: -$0.12/ton-mile (DOE 1999).
- Cleared material using a truck: -$0.06/ton-mile.[20]
- LLW ferrous metal using rail: -$0.016/ton-mile (DOE 2002b).
- LLW concrete using rail: -$0.044/ton-mile.[21]

The following average distances apply:

- LLW facility: 1,544 miles.[22]
- MSW Landfill: 58 miles.[23]
- Ferrous metal recycling facility: 269 miles (SC&A 2003).[24]
- Concrete recycling facility: 198 miles.[25]

Trucks are assumed to be able to transport 25 tons per truckload of ferrous metals, concrete, or mixed materials destined for a LLW disposal facility. Trucks are assumed to transport 10 tons per truckload of trash.

Attachment 2 provides a detailed discussion of this attribute.

[20] Best professional judgement.

[21] *Ibid.*

[22] Estimate based on average distance from existing LWRs to Clive, Utah, derived from GIS analysis.

[23] Best professional judgement.

[24] Table 9.62, page 9-97.

[25] *Ibid.*

2.3 Attribute - Public Health (Routine)

2.3.1 Attribute Definition and Identification of Driving Factors

Public Health (Routine) measures the yearly incremental cost or benefit due to changes in radiation exposures to the public associated with routine NRC licensee activities. The public is defined as any person not working in the nuclear industry. Exposures may occur from the following activities: material handling activities, storage, transportation, processing or recycling, disposal in solid waste landfills, manufacturing, and distribution and use of new products.

2.3.2 Attribute Equation

The following equation can be used to calculate the net change in costs and benefits due to the Public Health (Routine) attribute.

Equation 5 - Routine radiologic exposure

The routine radiologic exposure cost associated with the *Public Health (Routine)* attribute is estimated as follows:

$$Radiological\ Exposure = (DOSE_{baseline\ public} - DOSE_{dose\ alternative\ public}) \times COST_{exposure}$$

Parameter	Description
$DOSE_{baseline\ public}$	The baseline dose to the public due to routine exposures in person rem for clearance of materials
$DOSE_{dose\ alternative\ public}$	The dose to the public due to routine exposures in person rem for clearance of materials under the alternative
$COST_{exposure}$	Cost of exposure per person-rem (see assumptions below)

Assumptions

- The cost of exposure per person is assumed to be -$2,000 per person-rem (NRC 2003f).

- The dose to the public was taken from SC&A 2003. Table K-13 describes how the alternatives in this cost-benefit analysis relate to the naming conventions used in SC&A 2003. For the dose-specific alternatives (Unrestricted Release and EPA-Regulated Disposal), dose information was provided for the 0.03, 0.1, 1, and 10 mrem/yr options. For the IAEA Safety Guide No. RS-G-1.7 dose option, the quantities were assumed to be twice the dose associated with the 1 mrem/yr dose option based on NUREG-1640 (Appendix D).

- SC&A 2003 presents the collective dose to workers, such as truck drivers and recyclers, as well as members of the general public. Dose to members of the public and workers at non-licensed facilities normally would be captured in the attribute public health-routine, and dose to workers at licensed facilities normally would be captured in the attribute occupational health-routine. Because this analysis could not separate the collective doses into these two categories on a year-by-year basis for each alternative and dose-option considered, the public health-routine and occupational health routine attributes are combined in a single attribute described as public and occupational health-routine.

- The dose associated with equipment reuse was taken from Appendix D, Section 12.

Table K-13 Description of Alternatives and Naming Conventions

Description in Cost-Benefit Analysis	Description in SC&A 2003
Baseline	No Action (Case A)[26]
Unrestricted Release: Material-Specific Limits	Case A
Unrestricted Release: Material-Independent Limits	Case B
EPA-Regulated Disposal without Incineration	Case C
EPA-Regulated Disposal with Trash Incineration	Case C2
Limited Disposition	Case B (concrete), Case C (ferrous metal and trash)
LLW Disposal	Not provided in Report. Assumed to be 0 person-rem.

2.4 Attribute - Occupational Health (Routine)

2.4.1 Attribute Definition and Identification of Driving Factors

Occupational Health (Routine) measures the yearly incremental cost or benefit due to changes in radiation exposures to occupational workers at licensed facilities associated with routine activities. Exposures may occur from the following material handling activities: storage, surveying, decontamination, volume reduction, packaging for disposal or recycling, and disposal.

2.4.2 Attribute Equation

The following equation can be used to calculate the net change in costs and benefits due to the Occupational Health (Routine) attribute.

Equation 6 - Routine occupational radiologic exposures

The routine radiological exposure cost associated with the *Occupational Health (Routine)* attribute is estimated as follows:

$$Radiologic\ Exposure = (DOSE_{baseline\ worker} - DOSE_{dose\ alternative\ worker}) \times COST_{exposure}$$

Parameter	Description

[26] SC&A 2003 presents different values for the dose associated with the No Action Alternative. This cost-benefit analysis assumes the most appropriate version of the quantities and dose associated with the No Action Alternative (and hence the baseline) is in fact the No Action Alternative in SC&A 2003 associated with the Unrestricted Release Alternative.

$DOSE_{baseline\ worker}$	The baseline dose to occupational workers due to exposure in person-rem for clearance of materials.
$DOSE_{dose\ alternative\ worker}$	The dose to occupational workers due to exposure in person-rem for clearance of materials, under the alternative.
$COST_{exposure}$	Cost of exposure per person-rem (see assumptions below)

Assumptions

- The cost of exposure per person is assumed to be -$2,000 per person-rem (NRC 2003f).

- SC&A 2003 presents the collective dose to workers, such as truck drivers and recyclers, as well as members of the general public. Dose to members of the public and workers at non-licensed facilities normally would be captured in the attribute public health-routine, and dose to workers at licensed facilities normally would be captured in the attribute occupational health-routine. Because this analysis could not separate the collective doses into these two categories on a year-by-year basis for each alternative and dose-option considered, the public health-routine and occupational health routine attributes are combined in a single attribute described as public and occupational health-routine.

2.5 Attribute - Public Health (Accident)

2.5.1 Attribute Definition and Identification of Driving Factors

Public Health (Accident) measures the yearly net incremental cost or benefit due to changes in radiation exposures to occupational workers in non-licensed facilities and the general public associated with accidents. While exposures may occur from accidents related to storage, transportation, surveying, decontamination, volume reduction, packaging of materials, and random acts, such as fires, no such exposures are quantified in this analysis because the amount of radiation in any given quantity of material being considered for clearance would not result in a significant dose in the event of these types of accidents (Section 3.3).

Another dimension of the Public Health (Accident) attribute is yearly net incremental cost or benefit due to changes in non-radiologically induced deaths and disabilities related to transportation, decontamination, volume reduction, and packaging of materials.

2.5.2 Attribute Equation

The following equation can be used to calculate the net change in costs and benefits due to the Public Health (Accident) attribute. For this analysis, accidents are due to truck transport.

Equation 7 - Deaths and disabilities due to accidents

The cost of accidental deaths and disabilities associated with the *Public Health (Accident)* attribute is estimated as follows:

$$Accidental\ Deaths\ and\ Disabilities = [(DISTANCE_{alternative\ total} - DISTANCE_{baseline\ total}) \times NUM_{accident\ deaths} \times COST_{lost\ life}] + [(DISTANCE_{alternative\ total} - DISTANCE_{baseline\ total}) \times NUM_{accident\ disabilities} \times COST_{lifetime\ disability}]$$

Parameter	**Description**
$DISTANCE_{baseline\ total}$	Total vehicle miles traveled in baseline
$DISTANCE_{alternative\ total}$	Total vehicle miles traveled in alternative
$NUM_{accident\ deaths}$	Number of deaths due to accidents per vehicle mile traveled
$COST_{lost\ life}$	Average cost of a lost life (see assumptions below)
$NUM_{accident\ disabilities}$	Number of disabilities due to accidents per vehicle mile traveled
$COST_{lifetime\ disability}$	Lifetime cost of disability

Assumptions

- The average cost of a life is assumed to be -$3,000,000 (NRC 2003f).

- This analysis does not calculate any lifetime disabilities.

- The number of accidents is based on vehicle miles traveled multiplied by the accident fatality rate. As discussed in Chapter 3 of this Draft GEIS, the fatal accident rate for a truck is 2.409 E-08 per vehicle mile traveled (NRC 1994b). This fatality rate includes both death to members of the public and to drivers.

2.6 Attribute - Industry Implementation

2.6.1 Attribute Definition and Identification of Driving Factors

Industry Implementation measures the initial incremental cost or benefit to licenses due to changes in industry implementation, including incremental costs and savings of the following: reading regulations and guidance documents; training employees on new procedures; capital outlay for new equipment (e.g., trucks, survey equipment); and researching markets and vendors for cleared material. No capital outlay is expected to be required under this rulemaking. Fees paid to NRC are not included in the analysis as they represent a transfer payment. Thus fees paid are a cost to industry and a benefit to NRC, with a net balance of zero.

2.6.2 Attribute Equation

The following equation can be used to calculate the net change in costs and benefits due to the Industry Implementation attribute.

Equation 8 - Implementation costs

The implementation costs associated with the *Industry Implementation* attribute are estimated as follows:

$$Implementation = (HOURS_{industry\ implementation\ managers} \times WAGE_{Managerial}) + (HOURS_{industry\ implementation\ legal} \times WAGE_{Legal}) + (HOURS_{industry\ implementation\ clerical} \times WAGE_{Clerical})$$

Parameter	**Description**
$HOURS_{industry\ implementation\ managers}$	The number of additional hours required for administrative implementation tasks by managers (see assumptions below)
$WAGE_{Managerial}$	The loaded hourly wage per managerial labor (see Equation 1 assumptions in Section 2.2.2)
$HOURS_{industry\ implementation\ legal}$	The number of additional hours required for administrative implementation tasks by attorneys (see assumptions below)
$WAGE_{Legal}$	The loaded hourly wage per attorney (see Equation 1 assumptions in Section 2.2.2)
$HOURS_{industry\ implementation\ clerical}$	The number of additional hours required for administrative implementation tasks by clerical workers (see assumptions below)
$WAGE_{Clerical}$	The loaded hourly wage per clerical labor (see Equation 1 assumptions in Section 2.2.2)

Assumptions

The following are the number of hours assumed, using best professional judgement:

- Number of Managerial hours: 60.
- Number of Legal hours: 10.
- Number of Clerical hours: 10.

2.7 Attribute - NRC Implementation

2.7.1 Attribute Definition and Identification of Driving Factors

NRC Implementation involves, among other considerations, NRC staff time to complete the following implementation tasks:

- Develop guidance, procedures, and aids for use by NRC and Agreement States
- Develop enforcement procedures
- Develop guidance, procedures, and aids for use by licensees

2.7.2 Attribute Equation

The following equation calculates the costs and benefits due to NRC Implementation of new control criteria.

Equation 9 - Develop guidance

The administrative costs associated with developing guidance under the *NRC Implementation* attribute are estimated as follows:

$$Develop\ Guidance = (HOURS_{NRC\ implementation\ managerial} \times WAGE_{Managerial}) + (HOURS_{NRC\ implementation\ technical} \times WAGE_{Technical}) + (HOURS_{NRC\ implementation\ clerical} \times WAGE_{Clerical})$$

Parameter	**Description**
$HOURS_{NRC\ implementation\ managerial}$	The number of additional hours required for NRC managerial staff (see assumptions below)
$HOURS_{NRC\ implementation\ technical}$	The number of additional hours required for NRC technical staff (see assumptions below)
$HOURS_{NRC\ implementation\ clerical}$	The number of additional hours required for NRC clerical staff (see assumptions below)
$WAGE_{Managerial}$	The loaded hourly wage per managerial labor (see Equation 1 assumptions in Section 2.2.2)
$WAGE_{Technical}$	The loaded hourly wage per technical labor (see Equation 1 assumptions in Section 2.2.2)
$WAGE_{Clerical}$	The loaded hourly wage per clerical labor (see Equation 1 assumptions in Section 2.2.2)

Assumptions

The following are the number of hours necessary to develop guidance for the clearance of material, for the first year only, using best professional judgement:

- Number of Managerial hours: 10.
- Number of Technical hours: 80.
- Number of Clerical hours: 10.

2.8 Attribute - NRC Operation

2.8.1 Attribute Definition and Identification of Driving Factors

NRC operation involves NRC staff time to conduct the following operational tasks on an annual basis:

- Conduct inspections;

- Conduct evaluations of licensee compliance; and
- Enforcement.

2.8.2 Attribute Equations

The following equations calculate the costs due to NRC Operations related to new control criteria.

Equation 10 - Paperwork

The administrative costs associated with the paperwork of the *NRC Operations* attribute are estimated as follows:

$$NRC\ Paperwork = (HOURS_{NRC\ Ops\ Managerial} \times WAGE_{Managerial}) + (HOURS_{NRC\ Ops\ Legal} \times WAGE_{Legal}) + (HOURS_{NRC\ Ops\ Technical} \times WAGE_{Technical}) + (HOURS_{NRC\ Ops\ Clerical} \times WAGE_{Clerical})$$

Parameter	**Description**
$HOURS_{NRC\ Ops\ Managerial}$	The number of additional hours required for NRC managerial staff, to review paperwork for the clearance of material
$HOURS_{NRC\ Ops\ Legal}$	The number of additional hours required for NRC legal staff, to review paperwork for the clearance of material
$HOURS_{NRC\ Ops\ Technical}$	The number of additional hours required for NRC technical staff, to review paperwork for the clearance of material
$HOURS_{NRC\ Ops\ Clerical}$	The number of additional hours required for NRC clerical staff, to review paperwork for the clearance of material
$WAGE_{Managerial}$	The loaded hourly wage per managerial labor (see Equation 1 assumptions in Section 2.2.2)
$WAGE_{Legal}$	The loaded hourly wage per attorney (see Equation 1 assumptions in Section 2.2.2)
$WAGE_{Technical}$	The loaded hourly wage per technical labor (see Equation 1 assumptions in Section 2.2.2)
$WAGE_{Clerical}$	The loaded hourly wage per clerical labor (see Equation 1 assumptions in Section 2.2.2)

Assumptions

The analysis assumes that no hours will be required for NRC because no additional paperwork will be submitted by licensees, and therefore Equation 10 is equal to zero.

Equation 11 - Enforcement activities

The administrative costs associated with enforcement activities of the *NRC Operations* attribute are estimated as follows:

$$NRC\ Enforcement = (HOURS_{Enforcement\ Managerial} \times WAGE_{Managerial}) + (HOURS_{Enforcement\ Legal} \times WAGE_{Legal}) + (HOURS_{Enforcement\ Technical} \times WAGE_{Technical}) + (HOURS_{Enforcement\ Clerical} \times WAGE_{Clerical}) + COST_{Inspection\ Travel}$$

Parameter	Description
$HOURS_{Enforcement\ Managerial}$	The number of additional hours required for NRC managerial staff to conduct inspections for the clearance of material
$HOURS_{Enforcement\ Legal}$	The number of additional hours required for NRC legal staff to conduct inspections for the clearance of material
$HOURS_{Enforcement\ Technical}$	The number of additional hours required for NRC technical staff to conduct inspections for the clearance of material
$HOURS_{Enforcement\ Clerical}$	The number of additional hours required for NRC clerical staff to conduct inspections for the clearance of material
$WAGE_{Managerial}$	The loaded hourly wage per managerial labor (see Equation 1 assumptions in Section 2.2.2)
$WAGE_{Legal}$	The loaded hourly wage per attorney (see Equation 1 assumptions in Section 2.2.2)
$WAGE_{Techical}$	The loaded hourly wage per technical labor (see Equation 1 assumptions in Section 2.2.2)
$WAGE_{Clerical}$	The loaded hourly wage per clerical labor (see Equation 1 assumptions in Section 2.2.2)
$COST_{Inspection\ Travel}$	The travel-related costs associated with inspection of cleared material

Assumptions

The analysis assumes that no hours will be required because no additional enforcement activities will be necessary for NRC; therefore, Equation 11 is equal to zero.

2.9 Attribute - Other Government

2.9.1 Attribute Definition and Identification of Driving Factors

This analysis estimates Other Government costs, excluding facilities that are assumed to be covered under the attributes Industry Implementation and Industry Operation, such as DOE and Department of Defense (DoD) facilities. Since regulation of LWRs is not delegated to Agreement States, they will not incur costs related to these facilities. The administrative tasks for other government agencies that have been identified are rulemakings in the Agreement States.

2.9.2 Attribute Equation

The following equation calculates the Other Government costs due to the implementation of new control criteria.

Equation 12 - Burden to Agreement States

The administrative costs associated with State agencies under the *Other Government* attribute are estimated as follows:

$$Environmental\ Agencies = \sum(HOURS_{State\ Employees}\ x\ WAGE_x)$$

Parameter	Description
$HOURS_{State\ Employees}$	The number of additional hours required for State employees for rulemakings
$WAGE_x$	The loaded hourly wage per worker type x.

Assumptions

- 33 Agreement States will need to adapt their regulations to this rulemaking.
- 25 of these States are assumed to require 520 hours of managerial labor (NRC 2003e).
- 8 of these States are assumed to require 208 hours of managerial labor (NRC 2003e).

2.10 Attribute - Regulatory Efficiency

This attribute is considered qualitatively in Section 3, regarding the significant benefits associated with the streamlining of clearance procedures in the post regulatory environment compared with baseline clearance procedures.

2.11 Attribute - Other Considerations

This attribute is considered qualitatively in Section 3, regarding public confidence in NRC.

2.12 Calculating Net Present Value

Present value is a future cash flow, or stream of cash flows, recalculated as an equivalent current amount of money. Net Present Value (NPV) is the present value of all cash flows, *positive and negative*, connected to a project. To calculate NPV, the amount and timing of the cash flows must be determined. Additionally, a discount rate must be used to find the present value. Solving for the present value of a future cash flow is also known as discounting. The following formula shows how NPV is calculated by summing the discounted cash flows that occur in each year:

$$Net\ \ Present\ Value\ = \sum_{t=1}^{n} \left[\frac{CF_t}{(1+r)^t} \right]$$

Parameter	Description
CF	cash flow in year t
t	year in which the cash flow takes place
n	life span (years) of the project
r	discount rate in year t

Assumptions

- For this analysis, the discount rate used is 7 percent, in accordance with NUREG/BR-0184, *Regulatory Analysis Technical Evaluation Handbook* (NRC 1997b).

- As a sensitivity analysis, the results also are calculated using a 3 percent discount rate.

3. Results

This section presents the results of the cost-benefit analysis. Table K-14 presents a summary of the net incremental benefits for each attribute by alternative and dose-option and the total net benefit. Tables K-15 through K-30 present the undiscounted annual incremental costs associated with each attribute for each alternative-dose option under consideration, with the exception of the No Action alternative. Note that costs appear in some years and not in others; this is a result of the distribution of plants shutting down in different years. For the periods where there are no net costs or benefits for Industry Implementation, these are years during which no active D&D is occurring at any decommissioning plant. The cost summary tables follow the information contained in SC&A 2003, Chapter 3. The following general conclusions can be drawn from these results:

- By definition, there are no benefits or costs associated with the No Action Alternative.

- The Unrestricted Release Alternative is expected to result in net incremental benefits under the 1 mem/yr, 10 mrem/yr, and IAEA Safety Guide No. RS-G-1.7 dose options. As shown in Table K-14, most of the benefits result from changes in industry operations (i.e., costs and benefits associated with survey, transportation, and recycling or disposal of material). Public health benefits arise as there are fewer vehicular accidents. Environmental benefits arise as there are fewer air emissions due to a decrease in vehicle miles traveled and as a result of favorable manufacturing tradeoffs as recycled ferrous metal replaces virgin ferrous metal. Sometimes these benefits are slightly offset by a cost resulting from a slight increase in dose to the public.

- Conversely, under the Unrestricted Release Alternative, at the 0.1 mrem/yr or 0.03 mrem/yr dose option levels, the analysis projects net costs, because more material fails to clear and, therefore, must be transported across the country for disposal as low-level waste.

- The EPA/State-Regulated Disposal Alternative, while less beneficial than the Unrestricted Release Alternative also is expected to result in substantial net incremental benefits at the 1 mrem/yr, 10 mrem/yr, and IAEA Safety Guide No. RS-G-1.7 dose options. In this alternative, benefits result from changes in industry operation. A small additional benefit results from changes in public health (routine) because the dose to the public is less than in the baseline. However, some benefit is offset by environmental costs related to a decrease in recycling.

- The LLW Disposal Alternative is projected to result in a net cost of approximately $1.4 billion. Most of this cost results from changes in industry operation, including transportation and disposal of materials as LLW. Other substantial costs result from change in public health - accidental, as a result of more deaths from the increased transportation distances. A lower collective dose to the public is the only benefit of this alternative. All of the other quantifiable attributes contribute to a net cost.

- The Limited Disposition Alternative is expected to result in a net incremental benefit of about $260 million. Most of the benefits result from changes in industry operations (i.e., benefits associated with survey, transportation, and recycling or disposal of material). Public health benefits arise from both lower radiological doses and fewer vehicular accidents. There is a slight environmental cost associated with the loss of otherwise recyclable ferrous metals being disposed in landfills. Because this material is not recycled, recycled ferrous metal cannot replace virgin ferrous metal production.

- For the 0.03 mrem/yr dose options (regardless of the Alternative) it is economically infeasible to survey concrete and ferrous metal. Consequently, these materials are sent to LLW disposal, resulting in costs similar to the LLW disposal alternative. Because trash can still be surveyed at this dose level, some trash is sent to EPA landfills, resulting in a slightly lower cost than the LLW disposal alternative.

- Note that OMB considers a rule "economically significant" under Executive Order 12866 if annual effects are greater than $100 million; by this criterion, the 47-year 7 percent discounted net cost for the LLW Disposal Alternative, and the 0.03 dose options of the Unrestricted Release and EPA-Regulated Disposal Alternatives would qualify as "economically significant."

Qualitative Results

- Regulatory Efficiency - By developing standardized procedures to clear material, there will be increased regulatory efficiency for both NRC and for facilities that are undergoing decommissioning (except under the No Action Alternative). Currently, material may be released under Regulatory Guide 1.86 on a case-by-case basis. By having clearly defined procedures for clearing materials, facilities will be more certain of the options open to them at decommissioning. At the same time, NRC will have procedures in place that address how material can be released.

- Other Considerations - Public confidence in NRC likely will be affected by this action, regardless of which one of the alternatives NRC adopts. Early public comment indicated that the public is concerned about the safety issues related to radioactive materials in consumer products. NRC will need to consider public confidence as it proceeds in the decision making process.

Table K-14 Net Incremental Benefit (Cost) Associated with Attributes by Alternative and Dose Level (2003$)

Alternative	Dose Option	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations	Total
No Action	NA	$0	$0	$0	$0	$0	$0	$0	$0	$0
Unrestricted Release Material Specific Limits	0.03	$1,174,216	($13,514,350)	($219,720)	($1,376,897,891)	($3,395)	$0	($451,377)	($12,878,667)	($1,402,791,183)
	0.1	$960,746	$0	($219,720)	($226,113,873)	($3,395)	$0	($451,377)	($618,308)	($226,445,926)
	1	($787,022)	$0	($219,720)	$293,675,372	($3,395)	$0	($451,377)	$2,125,995	$294,339,854
	10	($8,167,397)	$0	($219,720)	$329,263,365	($3,395)	$0	($451,377)	$2,801,081	$323,222,558
Unrestricted Release Material Independent Limits	0.03	$1,233,593	($13,514,350)	($219,720)	($1,378,418,237)	($3,395)	$0	($451,377)	($12,902,162)	($1,404,275,647)
	0.1	$1,205,052	$0	($219,720)	($291,974,108)	($3,395)	$0	($451,377)	($2,278,274)	($293,721,822)
	1	$713,415	$0	($219,720)	$246,021,542	($3,395)	$0	($451,377)	$987,754	$247,048,219
	10	($1,851,424)	$0	($219,720)	$306,935,439	($3,395)	$0	($451,377)	$2,352,109	$306,761,633
	RS-G-1.7	$186,142	$0	($219,720)	$246,021,542	($3,395)	$0	($451,377)	$987,754	$246,520,945
EPA/State-Regulated Disposal (Landfill)	0.03	$1,240,634	($13,514,350)	($219,720)	($1,376,897,891)	($3,395)	$0	($451,377)	($12,878,667)	($1,402,724,765)
	0.1	$1,240,530	$0	($219,720)	($281,093,000)	($3,395)	$0	($451,377)	($2,259,193)	($282,786,154)
	1	$1,239,881	$0	($219,720)	$181,462,308	($3,395)	$0	($451,377)	($1,033,674)	$180,994,024
	10	$1,237,267	$0	($219,720)	$193,637,557	($3,395)	$0	($451,377)	($922,985)	$193,277,348
	RS-G-1.7	$1,239,074	$0	($219,720)	$181,462,308	($3,395)	$0	($451,377)	($1,033,674)	$180,993,217
LLW Disposal/ Prohibition	NA	$1,240,689	($13,514,350)	$0	($1,378,439,254)	($3,395)	$0	($451,377)	($12,902,486)	($1,404,070,173)
Limited Dispositions	RS-G-1.7	$1,227,219	$0	($219,720)	$258,149,485	($3,395)	$0	($451,377)	($1,500,316)	$257,201,896

Table K-15 Net Incremental Benefit (Cost) Associated with Attributes for Unrestricted Release - Material Specific Limits - 0.03 mrem/yr ($)

Year	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations
2003	$14,362	$0	($18,848)	($73,792,689)	($3,395)	$0	($451,377)	($1,348,379)
2004	$20,530	$0	($11,309)	($40,532,801)	$0	$0	$0	($745,860)
2005	$19,384	$0	$0	($1,134,637)	$0	$0	$0	($46,077)
2006	$18,192	$0	$0	($1,134,637)	$0	$0	$0	($46,077)
2007	$17,212	$0	$0	($1,134,637)	$0	$0	$0	($46,077)
2008	$16,348	$0	$0	($1,134,637)	$0	$0	$0	($46,077)
2009	$15,600	$0	$0	($1,134,637)	$0	$0	$0	($46,077)
2010	$14,928	$0	$0	($1,134,637)	$0	$0	$0	($35,746)
2011	$14,352	$0	$0	($1,134,637)	$0	$0	$0	($35,746)
2012	$13,854	$0	$0	($1,134,637)	$0	$0	$0	($35,746)
2013	$13,392	$0	$0	($1,134,637)	$0	$0	$0	($35,746)
2014	$13,236	$0	($3,770)	($3,662,425)	$0	$0	$0	($57,614)
2015	$24,478	$0	($18,848)	($110,212,760)	$0	$0	$0	($868,326)
2016	$43,140	($3,000,000)	($26,387)	($166,548,785)	$0	$0	$0	($1,342,084)
2017	$54,720	$0	($18,848)	($113,032,649)	$0	$0	$0	($952,889)
2018	$75,220	($3,000,000)	($33,926)	($221,381,781)	$0	$0	$0	($1,765,758)
2019	$116,760	($3,000,000)	($60,314)	($370,432,493)	$0	$0	$0	($3,044,680)
2020	$165,600	($6,000,000)	($67,853)	($476,413,898)	$0	$0	$0	($3,882,032)
2021	$185,960	($3,000,000)	($41,466)	($316,584,440)	$0	$0	$0	($2,556,884)
2022	$195,360	($3,000,000)	($30,157)	($203,730,363)	$0	$0	$0	($1,775,903)
2023	$208,580	($3,000,000)	($37,696)	($230,909,345)	$0	$0	$0	($2,016,965)
2024	$204,720	$0	($22,618)	($111,286,568)	$0	$0	$0	($1,047,434)
2025	$189,280	$0	($15,078)	($53,367,953)	$0	$0	$0	($506,990)
2026	$181,220	$0	($18,848)	($81,613,878)	$0	$0	$0	($769,510)
2027	$191,200	($3,000,000)	($30,157)	($168,001,997)	$0	$0	$0	($1,572,635)
2028	$208,280	($3,000,000)	($37,696)	($253,776,649)	$0	$0	$0	($2,204,502)
2029	$221,580	($3,000,000)	($37,696)	($301,038,895)	$0	$0	$0	($2,457,628)
2030	$253,960	($6,000,000)	($52,774)	($423,645,204)	$0	$0	$0	($3,506,365)
2031	$290,020	($6,000,000)	($56,544)	($454,470,162)	$0	$0	$0	($3,841,311)
2032	$320,440	($6,000,000)	($56,544)	($465,170,953)	$0	$0	$0	($3,869,190)
2033	$343,160	($6,000,000)	($52,774)	($409,017,991)	$0	$0	$0	($3,494,670)
2034	$327,820	($3,000,000)	($22,618)	($146,593,443)	$0	$0	$0	($1,375,334)
2035	$303,260	$0	($11,309)	($95,796,042)	$0	$0	$0	($811,410)
2036	$278,580	$0	($11,309)	($94,261,732)	$0	$0	$0	($797,075)
2037	$248,200	$0	($3,770)	($24,769,000)	$0	$0	$0	($234,464)
2038	$219,860	$0	($3,770)	($5,746,314)	$0	$0	$0	($45,140)
2039	$204,620	$0	($15,078)	($70,650,437)	$0	$0	$0	($651,218)
2040	$208,460	($3,000,000)	($26,387)	($160,753,698)	$0	$0	$0	($1,434,603)
2041	$202,760	$0	($18,848)	($119,968,404)	$0	$0	$0	($1,053,780)
2042	$185,840	$0	($7,539)	($44,134,092)	$0	$0	$0	($413,940)
2043	$166,880	$0	($3,770)	($19,968,177)	$0	$0	$0	($187,148)
2044	$149,680	$0	($3,770)	($35,919,945)	$0	$0	$0	($265,184)
2045	$134,540	$0	($3,770)	($35,919,945)	$0	$0	$0	($265,184)
2046	$117,860	$0	$0	$0	$0	$0	$0	$0
2047	$107,620	$0	($3,770)	($22,049,890)	$0	$0	$0	($207,017)
2048	$103,040	$0	($7,539)	($44,154,494)	$0	$0	$0	($414,420)
2049	$97,780	$0	($7,539)	($51,774,275)	$0	$0	$0	($426,393)

Table K-16 Net Incremental Benefit (Cost) Associated with Attributes for Unrestricted Release - Material Specific Limits - 0.1 mrem/yr ($)

Year	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations
2003	$11,560	$0	($18,848)	($11,184,825)	($3,395)	$0	($451,377)	($19,826)
2004	$16,520	$0	($11,309)	($6,068,223)	$0	$0	$0	($11,345)
2005	$15,660	$0	$0	$341,960	$0	$0	$0	($3,104)
2006	$14,720	$0	$0	$341,960	$0	$0	$0	($3,104)
2007	$13,960	$0	$0	$341,960	$0	$0	$0	($3,104)
2008	$13,300	$0	$0	$341,960	$0	$0	$0	($3,104)
2009	$12,720	$0	$0	$341,960	$0	$0	$0	($3,104)
2010	$12,180	$0	$0	$341,960	$0	$0	$0	($2,467)
2011	$11,740	$0	$0	$341,960	$0	$0	$0	($2,467)
2012	$11,360	$0	$0	$341,960	$0	$0	$0	($2,467)
2013	$11,000	$0	$0	$341,960	$0	$0	$0	($2,467)
2014	$10,880	$0	($3,770)	($112,632)	$0	$0	$0	($2,468)
2015	$20,220	$0	($18,848)	($19,148,387)	$0	$0	$0	($24,671)
2016	$35,700	$0	($26,387)	($28,569,167)	$0	$0	$0	($48,994)
2017	$45,240	$0	($18,848)	($18,794,514)	$0	$0	$0	($44,321)
2018	$62,200	$0	($33,926)	($38,362,185)	$0	$0	$0	($62,318)
2019	$96,200	$0	($60,314)	($62,893,590)	$0	$0	$0	($135,006)
2020	$136,200	$0	($67,853)	($82,557,664)	$0	$0	$0	($197,561)
2021	$153,200	$0	($41,466)	($55,393,885)	$0	$0	$0	($125,416)
2022	$160,600	$0	($30,157)	($32,965,874)	$0	$0	$0	($110,930)
2023	$171,200	$0	($37,696)	($37,258,254)	$0	$0	$0	($126,882)
2024	$168,000	$0	($22,618)	($16,869,877)	$0	$0	$0	($81,219)
2025	$155,200	$0	($15,078)	($7,943,692)	$0	$0	$0	($38,385)
2026	$148,200	$0	($18,848)	($12,629,780)	$0	$0	$0	($61,374)
2027	$156,200	$0	($30,157)	($26,127,824)	$0	$0	$0	($126,524)
2028	$170,000	$0	($37,696)	($41,668,898)	$0	$0	$0	($142,292)
2029	$180,800	$0	($37,696)	($51,534,325)	$0	$0	$0	($121,991)
2030	$207,600	$0	($52,774)	($72,180,246)	$0	$0	$0	($188,050)
2031	$237,000	$0	($56,544)	($76,405,003)	$0	$0	$0	($227,927)
2032	$262,000	$0	($56,544)	($78,791,904)	$0	$0	$0	($214,203)
2033	$280,400	$0	($52,774)	($68,172,897)	$0	$0	$0	($216,099)
2034	$267,600	$0	($22,618)	($23,032,927)	$0	$0	$0	($115,351)
2035	$247,800	$0	($11,309)	($16,117,932)	$0	$0	$0	($49,027)
2036	$227,400	$0	($11,309)	($15,806,209)	$0	$0	$0	($47,115)
2037	$202,400	$0	($3,770)	($3,839,024)	$0	$0	$0	($19,525)
2038	$179,600	$0	($3,770)	($1,006,356)	$0	$0	$0	($1,323)
2039	$166,800	$0	($15,078)	($11,101,342)	$0	$0	$0	($50,654)
2040	$170,000	$0	($26,387)	($25,732,687)	$0	$0	$0	($101,016)
2041	$165,200	$0	($18,848)	($19,426,231)	$0	$0	$0	($70,901)
2042	$151,400	$0	($7,539)	($6,812,504)	$0	$0	$0	($34,285)
2043	$136,000	$0	($3,770)	($3,035,259)	$0	$0	$0	($14,935)
2044	$122,000	$0	($3,770)	($6,546,047)	$0	$0	$0	($6,713)
2045	$109,800	$0	($3,770)	($6,546,047)	$0	$0	$0	($6,713)
2046	$96,000	$0	$0	$0	$0	$0	$0	$0
2047	$87,600	$0	($3,770)	($3,438,472)	$0	$0	$0	($17,603)
2048	$83,800	$0	($7,539)	($6,904,404)	$0	$0	$0	($35,381)
2049	$79,600	$0	($7,539)	($8,857,740)	$0	$0	$0	($23,068)

Table K-17 Net Incremental Benefit (Cost) Associated with Attributes for Unrestricted Release - Material Specific Limits - 1 mrem/yr ($)

Year	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations
2003	($10,560)	$0	($18,848)	$16,743,605	($3,395)	$0	($451,377)	$237,554
2004	($15,000)	$0	($11,309)	$9,249,725	$0	$0	$0	$129,903
2005	($14,200)	$0	$0	$732,608	$0	$0	$0	$5,136
2006	($13,640)	$0	$0	$732,608	$0	$0	$0	$5,136
2007	($13,060)	$0	$0	$732,608	$0	$0	$0	$5,136
2008	($12,760)	$0	$0	$732,608	$0	$0	$0	$5,136
2009	($12,340)	$0	$0	$732,608	$0	$0	$0	$5,136
2010	($12,040)	$0	$0	$732,608	$0	$0	$0	$2,859
2011	($11,640)	$0	$0	$732,608	$0	$0	$0	$2,859
2012	($11,360)	$0	$0	$732,608	$0	$0	$0	$2,859
2013	($11,240)	$0	$0	$732,608	$0	$0	$0	$2,859
2014	($11,200)	$0	($3,770)	$1,214,413	$0	$0	$0	$6,848
2015	($17,800)	$0	($18,848)	$22,359,758	$0	$0	$0	$149,095
2016	($28,800)	$0	($26,387)	$34,175,733	$0	$0	$0	$227,935
2017	($36,800)	$0	($18,848)	$23,776,945	$0	$0	$0	$156,869
2018	($50,000)	$0	($33,926)	$45,149,318	$0	$0	$0	$301,877
2019	($76,800)	$0	($60,314)	$76,800,837	$0	$0	$0	$512,193
2020	($105,400)	$0	($67,853)	$97,322,953	$0	$0	$0	$644,834
2021	($116,000)	$0	($41,466)	$64,387,344	$0	$0	$0	$426,412
2022	($124,000)	$0	($30,157)	$44,310,196	$0	$0	$0	$289,831
2023	($134,000)	$0	($37,696)	$50,279,371	$0	$0	$0	$328,589
2024	($132,000)	$0	($22,618)	$25,376,779	$0	$0	$0	$163,806
2025	($124,200)	$0	($15,078)	$12,220,040	$0	$0	$0	$78,488
2026	($120,600)	$0	($18,848)	$18,356,316	$0	$0	$0	$119,223
2027	($130,000)	$0	($30,157)	$37,756,101	$0	$0	$0	$246,062
2028	($138,000)	$0	($37,696)	$54,101,628	$0	$0	$0	$354,459
2029	($148,000)	$0	($37,696)	$61,800,707	$0	$0	$0	$408,465
2030	($166,000)	$0	($52,774)	$87,201,747	$0	$0	$0	$577,084
2031	($190,000)	$0	($56,544)	$94,607,147	$0	$0	$0	$622,616
2032	($208,000)	$0	($56,544)	$96,936,105	$0	$0	$0	$638,232
2033	($224,000)	$0	($52,774)	$86,923,790	$0	$0	$0	$571,652
2034	($218,000)	$0	($22,618)	$32,928,364	$0	$0	$0	$214,516
2035	($200,000)	$0	($11,309)	$19,796,783	$0	$0	$0	$130,304
2036	($186,000)	$0	($11,309)	$19,555,954	$0	$0	$0	$128,407
2037	($166,000)	$0	($3,770)	$5,595,958	$0	$0	$0	$36,004
2038	($144,000)	$0	($3,770)	$1,148,336	$0	$0	$0	$7,604
2039	($138,000)	$0	($15,078)	$15,594,693	$0	$0	$0	$101,832
2040	($138,000)	$0	($26,387)	$34,848,628	$0	$0	$0	$228,383
2041	($134,000)	$0	($18,848)	$25,840,903	$0	$0	$0	$169,283
2042	($125,800)	$0	($7,539)	$10,001,286	$0	$0	$0	$65,004
2043	($111,800)	$0	($3,770)	$4,533,931	$0	$0	$0	$29,785
2044	($100,000)	$0	($3,770)	$6,893,933	$0	$0	$0	$46,325
2045	($90,000)	$0	($3,770)	$6,893,933	$0	$0	$0	$46,325
2046	($79,600)	$0	$0	$0	$0	$0	$0	$0
2047	($72,400)	$0	($3,770)	$4,991,783	$0	$0	$0	$31,973
2048	($70,000)	$0	($7,539)	$9,923,992	$0	$0	$0	$63,460
2049	($66,200)	$0	($7,539)	$10,478,626	$0	$0	$0	$68,865

Table K-18 Net Incremental Benefit (Cost) Associated with Attributes for Unrestricted Release - Material Specific Limits - 10 mrem/yr ($)

Year	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations
2003	($105,560)	$0	($18,848)	$18,975,651	($3,395)	$0	($451,377)	$295,470
2004	($155,200)	$0	($11,309)	$10,624,203	$0	$0	$0	$164,154
2005	($156,200)	$0	$0	$1,127,062	$0	$0	$0	$13,061
2006	($157,440)	$0	$0	$1,127,062	$0	$0	$0	$13,061
2007	($158,460)	$0	$0	$1,127,062	$0	$0	$0	$13,061
2008	($159,360)	$0	$0	$1,127,062	$0	$0	$0	$13,061
2009	($160,140)	$0	$0	$1,127,062	$0	$0	$0	$13,061
2010	($160,840)	$0	$0	$1,127,062	$0	$0	$0	$7,646
2011	($161,440)	$0	$0	$1,127,062	$0	$0	$0	$7,646
2012	($161,960)	$0	$0	$1,127,062	$0	$0	$0	$7,646
2013	($162,440)	$0	$0	$1,127,062	$0	$0	$0	$7,646
2014	($164,000)	$0	($3,770)	$1,659,095	$0	$0	$0	$12,429
2015	($238,000)	$0	($18,848)	$24,946,800	$0	$0	$0	$188,170
2016	($352,400)	$0	($26,387)	$38,036,241	$0	$0	$0	$290,582
2017	($420,200)	$0	($18,848)	$26,618,558	$0	$0	$0	$205,058
2018	($550,600)	$0	($33,926)	$50,134,101	$0	$0	$0	$382,867
2019	($810,800)	$0	($60,314)	$85,221,386	$0	$0	$0	$658,094
2020	($1,105,400)	$0	($67,853)	$107,887,663	$0	$0	$0	$836,424
2021	($1,228,000)	$0	($41,466)	$71,376,167	$0	$0	$0	$550,662
2022	($1,290,000)	$0	($30,157)	$49,315,056	$0	$0	$0	$386,193
2023	($1,374,000)	$0	($37,696)	$55,979,397	$0	$0	$0	$439,957
2024	($1,342,000)	$0	($22,618)	$28,445,874	$0	$0	$0	$227,831
2025	($1,246,200)	$0	($15,078)	$13,791,563	$0	$0	$0	$109,745
2026	($1,208,600)	$0	($18,848)	$20,622,590	$0	$0	$0	$165,456
2027	($1,276,000)	$0	($30,157)	$42,196,128	$0	$0	$0	$339,505
2028	($1,374,000)	$0	($37,696)	$60,225,271	$0	$0	$0	$474,312
2029	($1,458,000)	$0	($37,696)	$68,575,749	$0	$0	$0	$531,340
2030	($1,644,000)	$0	($52,774)	$96,815,447	$0	$0	$0	$756,609
2031	($1,854,000)	$0	($56,544)	$105,165,132	$0	$0	$0	$825,706
2032	($2,042,000)	$0	($56,544)	$107,453,319	$0	$0	$0	$837,002
2033	($2,178,000)	$0	($52,774)	$96,443,459	$0	$0	$0	$757,652
2034	($2,114,000)	$0	($22,618)	$36,721,286	$0	$0	$0	$296,432
2035	($1,940,000)	$0	($11,309)	$22,012,568	$0	$0	$0	$172,593
2036	($1,786,000)	$0	($11,309)	$21,746,406	$0	$0	$0	$170,186
2037	($1,596,000)	$0	($3,770)	$6,275,605	$0	$0	$0	$50,322
2038	($1,404,000)	$0	($3,770)	$1,289,270	$0	$0	$0	$9,665
2039	($1,322,000)	$0	($15,078)	$17,414,991	$0	$0	$0	$140,288
2040	($1,340,000)	$0	($26,387)	$38,764,819	$0	$0	$0	$308,980
2041	($1,302,000)	$0	($18,848)	$28,682,859	$0	$0	$0	$226,773
2042	($1,195,800)	$0	($7,539)	$11,123,450	$0	$0	$0	$89,203
2043	($1,071,800)	$0	($3,770)	$5,037,197	$0	$0	$0	$40,533
2044	($960,000)	$0	($3,770)	$7,611,559	$0	$0	$0	$57,429
2045	($862,000)	$0	($3,770)	$7,611,559	$0	$0	$0	$57,429
2046	($755,600)	$0	$0	$0	$0	$0	$0	$0
2047	($688,400)	$0	($3,770)	$5,556,406	$0	$0	$0	$44,270
2048	($655,200)	$0	($7,539)	$11,065,139	$0	$0	$0	$88,317
2049	($618,800)	$0	($7,539)	$11,659,353	$0	$0	$0	$90,704

Table K-19 Net Incremental Benefit (Cost) Associated with Attributes for Unrestricted Release - Material Independent - 0.03 mrem/yr ($)

Year	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations
2003	$15,145	$0	($18,848)	($73,918,704)	($3,395)	$0	($451,377)	($1,351,148)
2004	$21,659	$0	($11,309)	($40,656,978)	$0	$0	$0	($748,588)
2005	$20,457	$0	$0	($1,256,768)	$0	$0	$0	($48,760)
2006	$19,216	$0	$0	($1,256,768)	$0	$0	$0	($48,760)
2007	$18,194	$0	$0	($1,256,768)	$0	$0	$0	($48,760)
2008	$17,293	$0	$0	($1,256,768)	$0	$0	$0	($48,760)
2009	$16,511	$0	$0	($1,256,768)	$0	$0	$0	($48,760)
2010	$15,810	$0	$0	($1,256,768)	$0	$0	$0	($37,086)
2011	$15,209	$0	$0	($1,256,768)	$0	$0	$0	($37,086)
2012	$14,689	$0	$0	($1,256,768)	$0	$0	$0	($37,086)
2013	$14,208	$0	$0	($1,256,768)	$0	$0	$0	($37,086)
2014	$14,046	$0	($3,770)	($3,784,630)	$0	$0	$0	($58,955)
2015	$25,790	$0	($18,848)	($110,334,964)	$0	$0	$0	($869,427)
2016	$45,298	($3,000,000)	($26,387)	($166,670,917)	$0	$0	$0	($1,343,184)
2017	$57,442	$0	($18,848)	($113,151,384)	$0	$0	$0	($953,959)
2018	$78,932	($3,000,000)	($33,926)	($221,498,041)	$0	$0	$0	($1,766,805)
2019	$122,504	($3,000,000)	($60,314)	($370,546,753)	$0	$0	$0	($3,045,709)
2020	$173,658	($6,000,000)	($67,853)	($476,522,308)	$0	$0	$0	($3,882,983)
2021	$194,958	($3,000,000)	($41,466)	($316,683,843)	$0	$0	$0	($2,557,756)
2022	$204,904	($3,000,000)	($30,157)	($203,820,426)	$0	$0	$0	($1,776,693)
2023	$218,834	($3,000,000)	($37,696)	($230,997,130)	$0	$0	$0	($2,017,735)
2024	$214,848	$0	($22,618)	($111,367,514)	$0	$0	$0	($1,048,144)
2025	$198,718	$0	($15,078)	($53,445,682)	$0	$0	$0	($507,669)
2026	$190,354	$0	($18,848)	($81,689,214)	$0	$0	$0	($770,169)
2027	$200,896	($3,000,000)	($30,157)	($168,076,981)	$0	$0	$0	($1,573,291)
2028	$218,814	($3,000,000)	($37,696)	($253,847,702)	$0	$0	$0	($2,205,122)
2029	$232,756	($3,000,000)	($37,696)	($301,105,132)	$0	$0	$0	($2,458,206)
2030	$266,602	($6,000,000)	($52,774)	($423,706,158)	$0	$0	$0	($3,506,898)
2031	$304,404	($6,000,000)	($56,544)	($454,525,519)	$0	$0	$0	($3,841,795)
2032	$336,242	($6,000,000)	($56,544)	($465,214,150)	$0	$0	$0	($3,869,568)
2033	$360,124	($6,000,000)	($52,774)	($409,053,376)	$0	$0	$0	($3,494,979)
2034	$344,194	($3,000,000)	($22,618)	($146,617,220)	$0	$0	$0	($1,375,542)
2035	$318,342	$0	($11,309)	($95,813,031)	$0	$0	$0	($811,558)
2036	$292,474	$0	($11,309)	($94,277,207)	$0	$0	$0	($797,210)
2037	$260,634	$0	($3,770)	($24,781,927)	$0	$0	$0	($234,577)
2038	$230,794	$0	($3,770)	($5,758,047)	$0	$0	$0	($45,242)
2039	$214,872	$0	($15,078)	($70,662,169)	$0	$0	$0	($651,321)
2040	$218,862	($3,000,000)	($26,387)	($160,765,263)	$0	$0	$0	($1,434,704)
2041	$212,890	$0	($18,848)	($119,976,328)	$0	$0	$0	($1,053,850)
2042	$195,172	$0	($7,539)	($44,137,577)	$0	$0	$0	($413,970)
2043	$175,272	$0	($3,770)	($19,970,346)	$0	$0	$0	($187,167)
2044	$157,168	$0	($3,770)	($35,920,962)	$0	$0	$0	($265,193)
2045	$141,252	$0	($3,770)	($35,920,962)	$0	$0	$0	($265,193)
2046	$123,740	$0	$0	$0	$0	$0	$0	$0
2047	$112,996	$0	($3,770)	($22,051,117)	$0	$0	$0	($207,028)
2048	$108,222	$0	($7,539)	($44,156,969)	$0	$0	$0	($414,442)
2049	$102,658	$0	($7,539)	($51,776,375)	$0	$0	$0	($426,412)

Table K-20 Net Incremental Benefit (Cost) Associated with Attributes for Unrestricted Release - Material Independent - 0.1 mrem/yr ($)

Year	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations
2003	$14,754	$0	($18,848)	($15,859,375)	($3,395)	$0	($451,377)	($159,941)
2004	$21,092	$0	($11,309)	($8,699,774)	$0	$0	$0	($88,736)
2005	$19,916	$0	$0	($109,642)	$0	$0	$0	($13,569)
2006	$18,694	$0	$0	($109,642)	$0	$0	$0	($13,569)
2007	$17,690	$0	$0	($109,642)	$0	$0	$0	($13,569)
2008	$16,804	$0	$0	($109,642)	$0	$0	$0	($13,569)
2009	$16,038	$0	$0	($109,642)	$0	$0	$0	($13,569)
2010	$15,348	$0	$0	($109,642)	$0	$0	$0	($9,505)
2011	$14,758	$0	$0	($109,642)	$0	$0	$0	($9,505)
2012	$14,248	$0	$0	($109,642)	$0	$0	$0	($9,505)
2013	$13,774	$0	$0	($109,642)	$0	$0	$0	($9,505)
2014	$13,616	$0	($3,770)	($631,696)	$0	$0	$0	($11,129)
2015	$25,124	$0	($18,848)	($23,006,590)	$0	$0	$0	($113,097)
2016	$44,226	$0	($26,387)	($35,019,321)	$0	$0	$0	($199,643)
2017	$56,104	$0	($18,848)	($23,964,935)	$0	$0	$0	($164,367)
2018	$77,140	$0	($33,926)	($46,636,165)	$0	$0	$0	($256,952)
2019	$119,700	$0	($60,314)	($78,452,965)	$0	$0	$0	($504,598)
2020	$169,740	$0	($67,853)	($101,477,497)	$0	$0	$0	($678,976)
2021	$190,600	$0	($41,466)	($67,533,324)	$0	$0	$0	($433,171)
2022	$200,300	$0	($30,157)	($43,072,339)	$0	$0	$0	($366,869)
2023	$213,880	$0	($37,696)	($48,789,185)	$0	$0	$0	($419,463)
2024	$209,940	$0	($22,618)	($23,703,776)	$0	$0	$0	($253,521)
2025	$194,120	$0	($15,078)	($11,274,456)	$0	$0	$0	($120,761)
2026	$185,900	$0	($18,848)	($17,705,374)	$0	$0	$0	($188,539)
2027	$196,160	$0	($30,157)	($36,418,806)	$0	$0	$0	($387,304)
2028	$213,660	$0	($37,696)	($54,228,478)	$0	$0	$0	($461,336)
2029	$227,300	$0	($37,696)	($63,730,261)	$0	$0	$0	($431,902)
2030	$260,440	$0	($52,774)	($90,168,567)	$0	$0	$0	($646,417)
2031	$297,360	$0	($56,544)	($97,011,487)	$0	$0	$0	($753,557)
2032	$328,520	$0	($56,544)	($98,759,123)	$0	$0	$0	($723,923)
2033	$351,860	$0	($52,774)	($87,405,235)	$0	$0	$0	($707,295)
2034	$336,220	$0	($22,618)	($32,064,015)	$0	$0	$0	($345,735)
2035	$311,020	$0	($11,309)	($20,466,917)	$0	$0	$0	($159,760)
2036	$285,720	$0	($11,309)	($20,084,861)	$0	$0	$0	($156,104)
2037	$254,580	$0	($3,770)	($5,401,096)	$0	$0	$0	($59,040)
2038	$225,460	$0	($3,770)	($1,199,716)	$0	$0	$0	($5,831)
2039	$209,860	$0	($15,078)	($15,263,308)	$0	$0	$0	($156,797)
2040	$213,780	$0	($26,387)	($34,387,521)	$0	$0	$0	($322,227)
2041	$207,920	$0	($18,848)	($25,570,643)	$0	$0	$0	($227,958)
2042	$190,600	$0	($7,539)	($9,514,335)	$0	$0	$0	($103,346)
2043	$171,160	$0	($3,770)	($4,260,362)	$0	$0	$0	($46,228)
2044	$153,500	$0	($3,770)	($7,499,693)	$0	$0	$0	($31,096)
2045	$137,960	$0	($3,770)	($7,499,693)	$0	$0	$0	($31,096)
2046	$120,840	$0	$0	$0	$0	$0	$0	$0
2047	$110,340	$0	($3,770)	($4,793,703)	$0	$0	$0	($52,264)
2048	$105,660	$0	($7,539)	($9,610,936)	$0	$0	$0	($104,602)
2049	$100,260	$0	($7,539)	($11,006,085)	$0	$0	$0	($78,007)

Table K-21 Net Incremental Benefit (Cost) Associated with Attributes for Unrestricted Release - Material Independent - 1 mrem/yr ($)

Year	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations
2003	$8,340	$0	($18,848)	$13,418,392	($3,395)	$0	($451,377)	$142,936
2004	$12,020	$0	($11,309)	$7,255,578	$0	$0	$0	$75,691
2005	$11,480	$0	$0	$168,496	$0	$0	$0	($5,669)
2006	$10,820	$0	$0	$168,496	$0	$0	$0	($5,669)
2007	$10,300	$0	$0	$168,496	$0	$0	$0	($5,669)
2008	$9,860	$0	$0	$168,496	$0	$0	$0	($5,669)
2009	$9,460	$0	$0	$168,496	$0	$0	$0	($5,669)
2010	$9,100	$0	$0	$168,496	$0	$0	$0	($3,387)
2011	$8,800	$0	$0	$168,496	$0	$0	$0	($3,387)
2012	$8,540	$0	$0	$168,496	$0	$0	$0	($3,387)
2013	$8,300	$0	$0	$168,496	$0	$0	$0	($3,387)
2014	$8,240	$0	($3,770)	$600,554	$0	$0	$0	($581)
2015	$15,460	$0	($18,848)	$19,380,272	$0	$0	$0	$86,144
2016	$27,260	$0	($26,387)	$29,461,816	$0	$0	$0	$123,749
2017	$34,200	$0	($18,848)	$20,039,265	$0	$0	$0	$75,669
2018	$47,000	$0	($33,926)	$39,178,995	$0	$0	$0	$167,442
2019	$72,200	$0	($60,314)	$65,971,458	$0	$0	$0	$262,120
2020	$102,800	$0	($67,853)	$84,066,938	$0	$0	$0	$315,696
2021	$115,800	$0	($41,466)	$55,758,237	$0	$0	$0	$214,214
2022	$120,800	$0	($30,157)	$37,375,753	$0	$0	$0	$120,028
2023	$128,200	$0	($37,696)	$42,389,042	$0	$0	$0	$134,332
2024	$125,400	$0	($22,618)	$20,717,459	$0	$0	$0	$51,169
2025	$115,200	$0	($15,078)	$9,852,682	$0	$0	$0	$23,970
2026	$109,600	$0	($18,848)	$14,885,463	$0	$0	$0	$36,542
2027	$114,800	$0	($30,157)	$30,890,787	$0	$0	$0	$77,247
2028	$125,200	$0	($37,696)	$45,583,568	$0	$0	$0	$143,438
2029	$133,600	$0	($37,696)	$53,336,462	$0	$0	$0	$198,469
2030	$153,800	$0	($52,774)	$74,869,268	$0	$0	$0	$268,667
2031	$175,400	$0	($56,544)	$80,592,498	$0	$0	$0	$271,138
2032	$194,200	$0	($56,544)	$83,268,822	$0	$0	$0	$294,697
2033	$207,800	$0	($52,774)	$73,956,030	$0	$0	$0	$245,300
2034	$196,800	$0	($22,618)	$26,997,098	$0	$0	$0	$65,784
2035	$182,600	$0	($11,309)	$16,820,600	$0	$0	$0	$56,034
2036	$167,400	$0	($11,309)	$16,642,459	$0	$0	$0	$55,620
2037	$148,800	$0	($3,770)	$4,554,848	$0	$0	$0	$10,519
2038	$132,400	$0	($3,770)	$983,419	$0	$0	$0	$4,256
2039	$122,400	$0	($15,078)	$12,851,053	$0	$0	$0	$33,086
2040	$124,800	$0	($26,387)	$29,130,525	$0	$0	$0	$84,190
2041	$121,400	$0	($18,848)	$21,756,129	$0	$0	$0	$66,255
2042	$110,600	$0	($7,539)	$8,231,138	$0	$0	$0	$20,360
2043	$99,200	$0	($3,770)	$3,732,438	$0	$0	$0	$9,614
2044	$89,200	$0	($3,770)	$6,187,055	$0	$0	$0	$28,472
2045	$80,400	$0	($3,770)	$6,187,055	$0	$0	$0	$28,472
2046	$70,400	$0	$0	$0	$0	$0	$0	$0
2047	$64,200	$0	($3,770)	$4,107,966	$0	$0	$0	$9,645
2048	$61,200	$0	($7,539)	$8,153,607	$0	$0	$0	$18,737
2049	$58,200	$0	($7,539)	$9,008,663	$0	$0	$0	$31,735

Table K-22 Net Incremental Benefit (Cost) Associated with Attributes for Unrestricted Release - Material Independent - 10 mrem/yr ($)

Year	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations
2003	($24,560)	$0	($18,848)	$17,313,589	($3,395)	$0	($451,377)	$254,977
2004	($35,000)	$0	($11,309)	$9,381,712	$0	$0	$0	$136,282
2005	($33,800)	$0	$0	$343,833	$0	$0	$0	($999)
2006	($32,840)	$0	$0	$343,833	$0	$0	$0	($999)
2007	($31,860)	$0	$0	$343,833	$0	$0	$0	($999)
2008	($31,160)	$0	$0	$343,833	$0	$0	$0	($999)
2009	($30,340)	$0	$0	$343,833	$0	$0	$0	($999)
2010	($29,840)	$0	$0	$343,833	$0	$0	$0	$42
2011	($29,240)	$0	$0	$343,833	$0	$0	$0	$42
2012	($28,760)	$0	$0	$343,833	$0	$0	$0	$42
2013	($28,440)	$0	$0	$343,833	$0	$0	$0	$42
2014	($28,400)	$0	($3,770)	$860,222	$0	$0	$0	$4,459
2015	($44,800)	$0	($18,848)	$23,411,217	$0	$0	$0	$163,770
2016	($71,200)	$0	($26,387)	$35,976,200	$0	$0	$0	$253,707
2017	($87,400)	$0	($18,848)	$24,891,088	$0	$0	$0	$175,747
2018	($117,200)	$0	($33,926)	$47,724,349	$0	$0	$0	$337,092
2019	($180,800)	$0	($60,314)	$81,344,324	$0	$0	$0	$577,239
2020	($249,400)	$0	($67,853)	$103,249,196	$0	$0	$0	$730,426
2021	($278,000)	$0	($41,466)	$68,184,587	$0	$0	$0	$480,447
2022	($294,000)	$0	($30,157)	$46,701,157	$0	$0	$0	$329,620
2023	($314,000)	$0	($37,696)	$53,072,560	$0	$0	$0	$375,694
2024	($310,000)	$0	($22,618)	$26,602,875	$0	$0	$0	$189,853
2025	($288,200)	$0	($15,078)	$12,681,057	$0	$0	$0	$90,074
2026	($280,600)	$0	($18,848)	$19,181,885	$0	$0	$0	$137,149
2027	($300,000)	$0	($30,157)	$39,744,030	$0	$0	$0	$285,504
2028	($326,000)	$0	($37,696)	$57,265,437	$0	$0	$0	$407,005
2029	($346,000)	$0	($37,696)	$65,602,724	$0	$0	$0	$463,177
2030	($388,000)	$0	($52,774)	$92,688,108	$0	$0	$0	$658,608
2031	($442,000)	$0	($56,544)	$100,544,873	$0	$0	$0	$714,586
2032	($486,000)	$0	($56,544)	$102,944,105	$0	$0	$0	$727,365
2033	($522,000)	$0	($52,774)	$92,221,838	$0	$0	$0	$654,454
2034	($506,000)	$0	($22,618)	$34,777,896	$0	$0	$0	$249,735
2035	($462,000)	$0	($11,309)	$20,992,713	$0	$0	$0	$148,582
2036	($428,000)	$0	($11,309)	$20,751,891	$0	$0	$0	$146,653
2037	($384,000)	$0	($3,770)	$5,881,302	$0	$0	$0	$41,730
2038	($336,000)	$0	($3,770)	$1,180,040	$0	$0	$0	$8,174
2039	($318,000)	$0	($15,078)	$16,499,508	$0	$0	$0	$118,350
2040	($322,000)	$0	($26,387)	$36,925,771	$0	$0	$0	$263,602
2041	($314,000)	$0	($18,848)	$27,384,292	$0	$0	$0	$194,707
2042	($289,800)	$0	($7,539)	$10,569,439	$0	$0	$0	$75,535
2043	($259,800)	$0	($3,770)	$4,779,947	$0	$0	$0	$34,248
2044	($232,000)	$0	($3,770)	$7,385,450	$0	$0	$0	$51,809
2045	($208,000)	$0	($3,770)	$7,385,450	$0	$0	$0	$51,809
2046	($181,600)	$0	$0	$0	$0	$0	$0	$0
2047	($166,400)	$0	($3,770)	$5,274,950	$0	$0	$0	$37,265
2048	($159,200)	$0	($7,539)	$10,498,179	$0	$0	$0	$74,207
2049	($148,800)	$0	($7,539)	$11,189,626	$0	$0	$0	$79,022

Table K-23 Net Incremental Benefit (Cost) Associated with Attributes for Unrestricted Release - Material Independent - RS-G-1.7 ($)

Year	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations
2003	$1,440	$0	($18,848)	$13,418,392	($3,395)	$0	($451,377)	$142,936
2004	$2,240	$0	($11,309)	$7,255,578	$0	$0	$0	$75,691
2005	$2,360	$0	$0	$168,496	$0	$0	$0	($5,669)
2006	$2,280	$0	$0	$168,496	$0	$0	$0	($5,669)
2007	$2,260	$0	$0	$168,496	$0	$0	$0	($5,669)
2008	$2,280	$0	$0	$168,496	$0	$0	$0	($5,669)
2009	$2,260	$0	$0	$168,496	$0	$0	$0	($5,669)
2010	$2,240	$0	$0	$168,496	$0	$0	$0	($3,387)
2011	$2,240	$0	$0	$168,496	$0	$0	$0	($3,387)
2012	$2,240	$0	$0	$168,496	$0	$0	$0	($3,387)
2013	$2,240	$0	$0	$168,496	$0	$0	$0	($3,387)
2014	$2,280	$0	($3,770)	$600,554	$0	$0	$0	($581)
2015	$4,920	$0	($18,848)	$19,380,272	$0	$0	$0	$86,144
2016	$8,920	$0	($26,387)	$29,461,816	$0	$0	$0	$123,749
2017	$10,600	$0	($18,848)	$20,039,265	$0	$0	$0	$75,669
2018	$14,600	$0	($33,926)	$39,178,995	$0	$0	$0	$167,442
2019	$21,200	$0	($60,314)	$65,971,458	$0	$0	$0	$262,120
2020	$31,000	$0	($67,853)	$84,066,938	$0	$0	$0	$315,696
2021	$35,600	$0	($41,466)	$55,758,237	$0	$0	$0	$214,214
2022	$35,600	$0	($30,157)	$37,375,753	$0	$0	$0	$120,028
2023	$36,400	$0	($37,696)	$42,389,042	$0	$0	$0	$134,332
2024	$34,800	$0	($22,618)	$20,717,459	$0	$0	$0	$51,169
2025	$30,600	$0	($15,078)	$9,852,682	$0	$0	$0	$23,970
2026	$27,800	$0	($18,848)	$14,885,463	$0	$0	$0	$36,542
2027	$27,600	$0	($30,157)	$30,890,787	$0	$0	$0	$77,247
2028	$30,400	$0	($37,696)	$45,583,568	$0	$0	$0	$143,438
2029	$33,200	$0	($37,696)	$53,336,462	$0	$0	$0	$198,469
2030	$39,600	$0	($52,774)	$74,869,268	$0	$0	$0	$268,667
2031	$44,800	$0	($56,544)	$80,592,498	$0	$0	$0	$271,138
2032	$50,400	$0	($56,544)	$83,268,822	$0	$0	$0	$294,697
2033	$53,600	$0	($52,774)	$73,956,030	$0	$0	$0	$245,300
2034	$47,600	$0	($22,618)	$26,997,098	$0	$0	$0	$65,784
2035	$45,200	$0	($11,309)	$16,820,600	$0	$0	$0	$56,034
2036	$40,800	$0	($11,309)	$16,642,459	$0	$0	$0	$55,620
2037	$35,600	$0	($3,770)	$4,554,848	$0	$0	$0	$10,519
2038	$32,800	$0	($3,770)	$983,419	$0	$0	$0	$4,256
2039	$28,800	$0	($15,078)	$12,851,053	$0	$0	$0	$33,086
2040	$29,600	$0	($26,387)	$29,130,525	$0	$0	$0	$84,190
2041	$28,800	$0	($18,848)	$21,756,129	$0	$0	$0	$66,255
2042	$25,000	$0	($7,539)	$8,231,138	$0	$0	$0	$20,360
2043	$22,200	$0	($3,770)	$3,732,438	$0	$0	$0	$9,614
2044	$20,400	$0	($3,770)	$6,187,055	$0	$0	$0	$28,472
2045	$18,800	$0	($3,770)	$6,187,055	$0	$0	$0	$28,472
2046	$16,400	$0	$0	$0	$0	$0	$0	$0
2047	$14,800	$0	($3,770)	$4,107,966	$0	$0	$0	$9,645
2048	$13,600	$0	($7,539)	$8,153,607	$0	$0	$0	$18,737
2049	$13,200	$0	($7,539)	$9,008,663	$0	$0	$0	$31,735

Table K-24 Net Incremental Benefit (Cost) Associated with Attributes for EPA/State-Regulated Disposal (Landfill) - 0.03 mrem/yr ($)

Year	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations
2003	$15,236	$0	($18,848)	($73,792,689)	($3,395)	$0	($451,377)	($1,348,379)
2004	$21,798	$0	($11,309)	($40,532,801)	$0	$0	$0	($745,860)
2005	$20,600	$0	$0	($1,134,637)	$0	$0	$0	($46,077)
2006	$19,360	$0	$0	($1,134,637)	$0	$0	$0	($46,077)
2007	$18,340	$0	$0	($1,134,637)	$0	$0	$0	($46,077)
2008	$17,440	$0	$0	($1,134,637)	$0	$0	$0	($46,077)
2009	$16,660	$0	$0	($1,134,637)	$0	$0	$0	($46,077)
2010	$15,960	$0	$0	($1,134,637)	$0	$0	$0	($35,746)
2011	$15,360	$0	$0	($1,134,637)	$0	$0	$0	($35,746)
2012	$14,840	$0	$0	($1,134,637)	$0	$0	$0	($35,746)
2013	$14,360	$0	$0	($1,134,637)	$0	$0	$0	($35,746)
2014	$14,200	$0	($3,770)	($3,662,425)	$0	$0	$0	($57,614)
2015	$25,997	$0	($18,848)	($110,212,760)	$0	$0	$0	($868,326)
2016	$45,595	($3,000,000)	($26,387)	($166,548,785)	$0	$0	$0	($1,342,084)
2017	$57,796	$0	($18,848)	($113,032,649)	$0	$0	$0	($952,889)
2018	$79,393	($3,000,000)	($33,926)	($221,381,781)	$0	$0	$0	($1,765,758)
2019	$123,187	($3,000,000)	($60,314)	($370,432,493)	$0	$0	$0	($3,044,680)
2020	$174,584	($6,000,000)	($67,853)	($476,413,898)	$0	$0	$0	($3,882,032)
2021	$195,990	($3,000,000)	($41,466)	($316,584,440)	$0	$0	$0	($2,556,884)
2022	$205,991	($3,000,000)	($30,157)	($203,730,363)	$0	$0	$0	($1,775,903)
2023	$219,990	($3,000,000)	($37,696)	($230,909,345)	$0	$0	$0	($2,016,965)
2024	$215,994	$0	($22,618)	($111,286,568)	$0	$0	$0	($1,047,434)
2025	$199,797	$0	($15,078)	($53,367,953)	$0	$0	$0	($506,990)
2026	$191,396	$0	($18,848)	($81,613,878)	$0	$0	$0	($769,510)
2027	$201,992	($3,000,000)	($30,157)	($168,001,997)	$0	$0	$0	($1,572,635)
2028	$219,990	($3,000,000)	($37,696)	($253,776,649)	$0	$0	$0	($2,204,502)
2029	$233,990	($3,000,000)	($37,696)	($301,038,895)	$0	$0	$0	($2,457,628)
2030	$267,985	($6,000,000)	($52,774)	($423,645,204)	$0	$0	$0	($3,506,365)
2031	$305,983	($6,000,000)	($56,544)	($454,470,162)	$0	$0	$0	($3,841,311)
2032	$337,983	($6,000,000)	($56,544)	($465,170,953)	$0	$0	$0	($3,869,190)
2033	$361,984	($6,000,000)	($52,774)	($409,017,991)	$0	$0	$0	($3,494,670)
2034	$345,992	($3,000,000)	($22,618)	($146,593,443)	$0	$0	$0	($1,375,334)
2035	$319,996	$0	($11,309)	($95,796,042)	$0	$0	$0	($811,410)
2036	$293,996	$0	($11,309)	($94,261,732)	$0	$0	$0	($797,075)
2037	$261,999	$0	($3,770)	($24,769,000)	$0	$0	$0	($234,464)
2038	$232,000	$0	($3,770)	($5,746,314)	$0	$0	$0	($45,140)
2039	$215,997	$0	($15,078)	($70,650,437)	$0	$0	$0	($651,218)
2040	$219,993	($3,000,000)	($26,387)	($160,753,698)	$0	$0	$0	($1,434,603)
2041	$213,995	$0	($18,848)	($119,968,404)	$0	$0	$0	($1,053,780)
2042	$196,198	$0	($7,539)	($44,134,092)	$0	$0	$0	($413,940)
2043	$176,199	$0	($3,770)	($19,968,177)	$0	$0	$0	($187,148)
2044	$157,999	$0	($3,770)	($35,919,945)	$0	$0	$0	($265,184)
2045	$141,999	$0	($3,770)	($35,919,945)	$0	$0	$0	($265,184)
2046	$124,400	$0	$0	$0	$0	$0	$0	$0
2047	$113,599	$0	($3,770)	($22,049,890)	$0	$0	$0	($207,017)
2048	$108,798	$0	($7,539)	($44,154,494)	$0	$0	$0	($414,420)
2049	$103,198	$0	($7,539)	($51,774,275)	$0	$0	$0	($426,393)

Table K-25 Net Incremental Benefit (Cost) Associated with Attributes for EPA/State-Regulated Disposal (Landfill) - 0.1 mrem/yr ($)

Year	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations
2003	$15,229	$0	($18,848)	($14,151,766)	($3,395)	$0	($451,377)	($83,417)
2004	$21,794	$0	($11,309)	($7,800,722)	$0	$0	$0	($53,266)
2005	$20,599	$0	$0	$71,845	$0	$0	$0	($26,236)
2006	$19,359	$0	$0	$71,845	$0	$0	$0	($26,236)
2007	$18,339	$0	$0	$71,845	$0	$0	$0	($26,236)
2008	$17,439	$0	$0	$71,845	$0	$0	$0	($26,236)
2009	$16,659	$0	$0	$71,845	$0	$0	$0	($26,236)
2010	$15,959	$0	$0	$71,845	$0	$0	$0	($25,837)
2011	$15,359	$0	$0	$71,845	$0	$0	$0	($25,837)
2012	$14,839	$0	$0	$71,845	$0	$0	$0	($25,837)
2013	$14,359	$0	$0	$71,845	$0	$0	$0	($25,837)
2014	$14,199	$0	($3,770)	($482,717)	$0	$0	$0	($26,339)
2015	$25,990	$0	($18,848)	($23,629,392)	$0	$0	$0	($103,257)
2016	$45,584	$0	($26,387)	($35,182,862)	$0	$0	$0	($183,249)
2017	$57,788	$0	($18,848)	($23,309,568)	$0	$0	$0	($164,729)
2018	$79,380	$0	($33,926)	($47,062,983)	$0	$0	$0	($226,471)
2019	$123,162	$0	($60,314)	($77,247,910)	$0	$0	$0	($461,968)
2020	$174,554	$0	($67,853)	($100,888,590)	$0	$0	$0	($655,713)
2021	$195,971	$0	($41,466)	($67,627,427)	$0	$0	$0	($416,605)
2022	$205,976	$0	($30,157)	($40,823,039)	$0	$0	$0	($384,018)
2023	$219,972	$0	($37,696)	($46,142,690)	$0	$0	$0	($438,533)
2024	$215,984	$0	($22,618)	($21,165,364)	$0	$0	$0	($282,650)
2025	$199,792	$0	($15,078)	($10,090,514)	$0	$0	$0	($141,690)
2026	$191,388	$0	($18,848)	($15,775,067)	$0	$0	$0	($213,365)
2027	$201,976	$0	($30,157)	($32,462,176)	$0	$0	$0	($426,534)
2028	$219,970	$0	($37,696)	($51,366,526)	$0	$0	$0	($481,596)
2029	$233,970	$0	($37,696)	($63,153,664)	$0	$0	$0	($422,482)
2030	$267,957	$0	($52,774)	($88,410,978)	$0	$0	$0	($640,737)
2031	$305,951	$0	($56,544)	($93,741,172)	$0	$0	$0	($762,763)
2032	$337,952	$0	($56,544)	($96,557,829)	$0	$0	$0	($719,021)
2033	$361,955	$0	($52,774)	($83,659,322)	$0	$0	$0	($720,361)
2034	$345,979	$0	($22,618)	($28,443,165)	$0	$0	$0	($376,032)
2035	$319,989	$0	($11,309)	($19,791,386)	$0	$0	$0	($162,866)
2036	$293,989	$0	($11,309)	($19,417,851)	$0	$0	$0	($158,358)
2037	$261,996	$0	($3,770)	($4,768,605)	$0	$0	$0	($65,480)
2038	$231,999	$0	($3,770)	($1,250,548)	$0	$0	$0	($6,604)
2039	$215,990	$0	($15,078)	($13,748,598)	$0	$0	$0	($169,196)
2040	$219,979	$0	($26,387)	($31,792,317)	$0	$0	$0	($338,949)
2041	$213,985	$0	($18,848)	($23,963,999)	$0	$0	$0	($236,966)
2042	$196,194	$0	($7,539)	($8,453,233)	$0	$0	$0	($112,050)
2043	$176,197	$0	($3,770)	($3,784,511)	$0	$0	$0	($50,218)
2044	$157,997	$0	($3,770)	($7,951,527)	$0	$0	$0	($23,948)
2045	$141,997	$0	($3,770)	($7,951,527)	$0	$0	$0	($23,948)
2046	$124,400	$0	$0	$0	$0	$0	$0	$0
2047	$113,596	$0	($3,770)	($4,249,220)	$0	$0	$0	($56,418)
2048	$108,793	$0	($7,539)	($8,530,045)	$0	$0	$0	($113,019)
2049	$103,195	$0	($7,539)	($10,845,065)	$0	$0	$0	($76,314)

Table K-26 Net Incremental Benefit (Cost) Associated with Attributes for EPA/State-Regulated Disposal (Landfill) - 1 mrem/yr ($)

Year	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations
2003	$15,188	$0	($18,848)	$10,196,041	($3,395)	$0	($451,377)	$60,330
2004	$21,768	$0	($11,309)	$5,605,693	$0	$0	$0	$27,713
2005	$20,590	$0	$0	$401,448	$0	$0	$0	($20,943)
2006	$19,349	$0	$0	$401,448	$0	$0	$0	($20,943)
2007	$18,329	$0	$0	$401,448	$0	$0	$0	($20,943)
2008	$17,429	$0	$0	$401,448	$0	$0	$0	($20,943)
2009	$16,648	$0	$0	$401,448	$0	$0	$0	($20,943)
2010	$15,948	$0	$0	$401,448	$0	$0	$0	($23,194)
2011	$15,348	$0	$0	$401,448	$0	$0	$0	($23,194)
2012	$14,827	$0	$0	$401,448	$0	$0	$0	($23,194)
2013	$14,347	$0	$0	$401,448	$0	$0	$0	($23,194)
2014	$14,186	$0	($3,770)	$704,185	$0	$0	$0	($21,343)
2015	$25,948	$0	($18,848)	$14,031,442	$0	$0	$0	($13,996)
2016	$45,519	$0	($26,387)	$21,329,573	$0	$0	$0	($50,056)
2017	$57,734	$0	($18,848)	$14,685,257	$0	$0	$0	($74,658)
2018	$79,298	$0	($33,926)	$28,249,757	$0	$0	$0	($48,958)
2019	$123,023	$0	($60,314)	$47,735,563	$0	$0	$0	($168,625)
2020	$174,384	$0	($67,853)	$60,430,917	$0	$0	$0	($285,375)
2021	$195,858	$0	($41,466)	$40,043,951	$0	$0	$0	($167,667)
2022	$205,883	$0	($30,157)	$27,557,562	$0	$0	$0	($226,453)
2023	$219,869	$0	($37,696)	$31,280,028	$0	$0	$0	($260,469)
2024	$215,921	$0	($22,618)	$15,593,721	$0	$0	$0	($197,501)
2025	$199,756	$0	($15,078)	$7,477,842	$0	$0	$0	($101,084)
2026	$191,339	$0	($18,848)	$11,161,184	$0	$0	$0	($150,512)
2027	$201,886	$0	($30,157)	$23,030,455	$0	$0	$0	($297,893)
2028	$219,862	$0	($37,696)	$33,322,099	$0	$0	$0	($288,630)
2029	$233,862	$0	($37,696)	$38,458,390	$0	$0	$0	($192,053)
2030	$267,800	$0	($52,774)	$54,026,834	$0	$0	$0	($317,955)
2031	$305,772	$0	($56,544)	$58,382,683	$0	$0	$0	($418,052)
2032	$337,778	$0	($56,544)	$60,276,909	$0	$0	$0	($361,832)
2033	$361,790	$0	($52,774)	$53,919,204	$0	$0	$0	($404,564)
2034	$345,899	$0	($22,618)	$20,073,968	$0	$0	$0	($262,852)
2035	$319,946	$0	($11,309)	$12,144,670	$0	$0	$0	($90,924)
2036	$293,950	$0	($11,309)	$12,044,746	$0	$0	$0	($87,495)
2037	$261,980	$0	($3,770)	$3,418,544	$0	$0	$0	($46,335)
2038	$231,993	$0	($3,770)	$713,046	$0	$0	$0	($2,047)
2039	$215,950	$0	($15,078)	$9,522,377	$0	$0	$0	($116,076)
2040	$219,904	$0	($26,387)	$21,385,944	$0	$0	$0	($218,816)
2041	$213,932	$0	($18,848)	$15,911,160	$0	$0	$0	($146,779)
2042	$196,168	$0	($7,539)	$6,125,910	$0	$0	$0	($78,454)
2043	$176,184	$0	($3,770)	$2,777,188	$0	$0	$0	($35,324)
2044	$157,985	$0	($3,770)	$4,351,403	$0	$0	$0	$3,632
2045	$141,985	$0	($3,770)	$4,351,403	$0	$0	$0	$3,632
2046	$124,397	$0	$0	$0	$0	$0	$0	$0
2047	$113,585	$0	($3,770)	$3,059,277	$0	$0	$0	($39,412)
2048	$108,769	$0	($7,539)	$6,066,406	$0	$0	$0	($79,193)
2049	$103,172	$0	($7,539)	$6,464,498	$0	$0	$0	($37,645)

Table K-27 Net Incremental Benefit (Cost) Associated with Attributes for EPA/State-Regulated Disposal (Landfill) - 10 mrem/yr ($)

Year	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations
2003	$15,032	$0	($18,848)	$10,947,420	($3,395)	$0	($451,377)	$72,939
2004	$21,643	$0	($11,309)	$6,186,051	$0	$0	$0	$37,452
2005	$20,497	$0	$0	$763,279	$0	$0	$0	($14,872)
2006	$19,252	$0	$0	$763,279	$0	$0	$0	($14,872)
2007	$18,227	$0	$0	$763,279	$0	$0	$0	($14,872)
2008	$17,323	$0	$0	$763,279	$0	$0	$0	($14,872)
2009	$16,539	$0	$0	$763,279	$0	$0	$0	($14,872)
2010	$15,835	$0	$0	$763,279	$0	$0	$0	($20,162)
2011	$15,233	$0	$0	$763,279	$0	$0	$0	($20,162)
2012	$14,710	$0	$0	$763,279	$0	$0	$0	($20,162)
2013	$14,228	$0	$0	$763,279	$0	$0	$0	($20,162)
2014	$14,063	$0	($3,770)	$1,082,335	$0	$0	$0	($18,174)
2015	$25,750	$0	($18,848)	$15,056,026	$0	$0	$0	($6,949)
2016	$45,274	$0	($26,387)	$22,662,750	$0	$0	$0	($40,886)
2017	$57,522	$0	($18,848)	$15,670,225	$0	$0	$0	($67,883)
2018	$79,014	$0	($33,926)	$29,901,486	$0	$0	$0	($37,597)
2019	$122,602	$0	($60,314)	$50,164,318	$0	$0	$0	($151,919)
2020	$173,900	$0	($67,853)	$63,497,935	$0	$0	$0	($264,826)
2021	$195,506	$0	($41,466)	$42,171,597	$0	$0	$0	($153,412)
2022	$205,584	$0	($30,157)	$28,946,326	$0	$0	$0	($217,148)
2023	$219,546	$0	($37,696)	$32,822,650	$0	$0	$0	($250,133)
2024	$215,704	$0	($22,618)	$16,411,646	$0	$0	$0	($192,021)
2025	$199,603	$0	($15,078)	$7,982,041	$0	$0	$0	($97,719)
2026	$191,150	$0	($18,848)	$11,792,948	$0	$0	$0	($146,296)
2027	$201,608	$0	($30,157)	$24,093,204	$0	$0	$0	($290,801)
2028	$219,542	$0	($37,696)	$34,919,551	$0	$0	$0	($277,969)
2029	$233,534	$0	($37,696)	$40,410,416	$0	$0	$0	($179,025)
2030	$267,366	$0	($52,774)	$56,618,999	$0	$0	$0	($300,652)
2031	$305,304	$0	($56,544)	$61,112,951	$0	$0	$0	($399,827)
2032	$337,316	$0	($56,544)	$63,061,762	$0	$0	$0	($343,242)
2033	$361,352	$0	($52,774)	$56,283,908	$0	$0	$0	($388,779)
2034	$345,678	$0	($22,618)	$20,877,457	$0	$0	$0	($257,489)
2035	$319,811	$0	($11,309)	$12,728,683	$0	$0	$0	($87,025)
2036	$293,817	$0	($11,309)	$12,620,983	$0	$0	$0	($83,648)
2037	$261,906	$0	($3,770)	$3,582,327	$0	$0	$0	($45,242)
2038	$231,947	$0	($3,770)	$780,242	$0	$0	$0	($1,598)
2039	$215,833	$0	($15,078)	$9,920,166	$0	$0	$0	($113,421)
2040	$219,702	$0	($26,387)	$22,266,518	$0	$0	$0	($212,938)
2041	$213,782	$0	($18,848)	$16,571,919	$0	$0	$0	($142,368)
2042	$196,094	$0	($7,539)	$6,352,559	$0	$0	$0	($76,941)
2043	$176,139	$0	($3,770)	$2,878,845	$0	$0	$0	($34,645)
2044	$157,940	$0	($3,770)	$4,583,305	$0	$0	$0	$5,180
2045	$141,942	$0	($3,770)	$4,583,305	$0	$0	$0	$5,180
2046	$124,379	$0	$0	$0	$0	$0	$0	$0
2047	$113,545	$0	($3,770)	$3,174,033	$0	$0	$0	($38,646)
2048	$108,708	$0	($7,539)	$6,299,100	$0	$0	$0	($77,640)
2049	$103,117	$0	($7,539)	$6,781,883	$0	$0	$0	($35,526)

Table K-28 Net Incremental Benefit (Cost) Associated with Attributes for EPA/State-Regulated Disposal (Landfill) - RS-G-1.7

Year	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations
2003	$15,136	$0	($18,848)	$10,196,041	($3,395)	$0	($451,377)	$60,330
2004	$21,737	$0	($11,309)	$5,605,693	$0	$0	$0	$27,713
2005	$20,579	$0	$0	$401,448	$0	$0	$0	($20,943)
2006	$19,339	$0	$0	$401,448	$0	$0	$0	($20,943)
2007	$18,318	$0	$0	$401,448	$0	$0	$0	($20,943)
2008	$17,417	$0	$0	$401,448	$0	$0	$0	($20,943)
2009	$16,636	$0	$0	$401,448	$0	$0	$0	($20,943)
2010	$15,936	$0	$0	$401,448	$0	$0	$0	($23,194)
2011	$15,335	$0	$0	$401,448	$0	$0	$0	($23,194)
2012	$14,815	$0	$0	$401,448	$0	$0	$0	($23,194)
2013	$14,334	$0	$0	$401,448	$0	$0	$0	($23,194)
2014	$14,173	$0	($3,770)	$704,185	$0	$0	$0	($21,343)
2015	$25,896	$0	($18,848)	$14,031,442	$0	$0	$0	($13,996)
2016	$45,439	$0	($26,387)	$21,329,573	$0	$0	$0	($50,056)
2017	$57,668	$0	($18,848)	$14,685,257	$0	$0	$0	($74,658)
2018	$79,197	$0	($33,926)	$28,249,757	$0	$0	$0	($48,958)
2019	$122,845	$0	($60,314)	$47,735,563	$0	$0	$0	($168,625)
2020	$174,168	$0	($67,853)	$60,430,917	$0	$0	$0	($285,375)
2021	$195,716	$0	($41,466)	$40,043,951	$0	$0	$0	($167,667)
2022	$205,765	$0	($30,157)	$27,557,562	$0	$0	$0	($226,453)
2023	$219,737	$0	($37,696)	$31,280,028	$0	$0	$0	($260,469)
2024	$215,842	$0	($22,618)	$15,593,721	$0	$0	$0	($197,501)
2025	$199,712	$0	($15,078)	$7,477,842	$0	$0	$0	($101,084)
2026	$191,278	$0	($18,848)	$11,161,184	$0	$0	$0	($150,512)
2027	$201,772	$0	($30,157)	$23,030,455	$0	$0	$0	($297,893)
2028	$219,724	$0	($37,696)	$33,322,099	$0	$0	$0	($288,630)
2029	$233,724	$0	($37,696)	$38,458,390	$0	$0	$0	($192,053)
2030	$267,600	$0	($52,774)	$54,026,834	$0	$0	$0	($317,955)
2031	$305,544	$0	($56,544)	$58,382,683	$0	$0	$0	($418,052)
2032	$337,556	$0	($56,544)	$60,276,909	$0	$0	$0	($361,832)
2033	$361,580	$0	($52,774)	$53,919,204	$0	$0	$0	($404,564)
2034	$345,798	$0	($22,618)	$20,073,968	$0	$0	$0	($262,852)
2035	$319,892	$0	($11,309)	$12,144,670	$0	$0	$0	($90,924)
2036	$293,899	$0	($11,309)	$12,044,746	$0	$0	$0	($87,495)
2037	$261,960	$0	($3,770)	$3,418,544	$0	$0	$0	($46,335)
2038	$231,986	$0	($3,770)	$713,046	$0	$0	$0	($2,047)
2039	$215,901	$0	($15,078)	$9,522,377	$0	$0	$0	($116,076)
2040	$219,809	$0	($26,387)	$21,385,944	$0	$0	$0	($218,816)
2041	$213,864	$0	($18,848)	$15,911,160	$0	$0	$0	($146,779)
2042	$196,136	$0	($7,539)	$6,125,910	$0	$0	$0	($78,454)
2043	$176,168	$0	($3,770)	$2,777,188	$0	$0	$0	($35,324)
2044	$157,970	$0	($3,770)	$4,351,403	$0	$0	$0	$3,632
2045	$141,971	$0	($3,770)	$4,351,403	$0	$0	$0	$3,632
2046	$124,395	$0	$0	$0	$0	$0	$0	$0
2047	$113,569	$0	($3,770)	$3,059,277	$0	$0	$0	($39,412)
2048	$108,738	$0	($7,539)	$6,066,406	$0	$0	$0	($79,193)
2049	$103,144	$0	($7,539)	$6,464,498	$0	$0	$0	($37,645)

Table K-29 Net Incremental Benefit (Cost) Associated with Attributes for LLW Disposal/Prohibition ($)

Year	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations
2003	$15,240	$0	$0	($73,920,446)	($3,395)	$0	($451,377)	($1,351,186)
2004	$21,800	$0	$0	($40,658,693)	$0	$0	$0	($748,626)
2005	$20,600	$0	$0	($1,258,455)	$0	$0	$0	($48,797)
2006	$19,360	$0	$0	($1,258,455)	$0	$0	$0	($48,797)
2007	$18,340	$0	$0	($1,258,455)	$0	$0	$0	($48,797)
2008	$17,440	$0	$0	($1,258,455)	$0	$0	$0	($48,797)
2009	$16,660	$0	$0	($1,258,455)	$0	$0	$0	($48,797)
2010	$15,960	$0	$0	($1,258,455)	$0	$0	$0	($37,104)
2011	$15,360	$0	$0	($1,258,455)	$0	$0	$0	($37,104)
2012	$14,840	$0	$0	($1,258,455)	$0	$0	$0	($37,104)
2013	$14,360	$0	$0	($1,258,455)	$0	$0	$0	($37,104)
2014	$14,200	$0	$0	($3,786,318)	$0	$0	$0	($58,973)
2015	$26,000	$0	$0	($110,336,652)	$0	$0	$0	($869,442)
2016	$45,600	($3,000,000)	$0	($166,672,604)	$0	$0	$0	($1,343,199)
2017	$57,800	$0	$0	($113,153,026)	$0	$0	$0	($953,974)
2018	$79,400	($3,000,000)	$0	($221,499,649)	$0	$0	$0	($1,766,820)
2019	$123,200	($3,000,000)	$0	($370,548,333)	$0	$0	$0	($3,045,724)
2020	$174,600	($6,000,000)	$0	($476,523,809)	$0	$0	$0	($3,882,996)
2021	$196,000	($3,000,000)	$0	($316,685,220)	$0	$0	$0	($2,557,769)
2022	$206,000	($3,000,000)	$0	($203,821,677)	$0	$0	$0	($1,776,704)
2023	$220,000	($3,000,000)	$0	($230,998,348)	$0	$0	$0	($2,017,746)
2024	$216,000	$0	$0	($111,368,638)	$0	$0	$0	($1,048,154)
2025	$199,800	$0	$0	($53,446,760)	$0	$0	$0	($507,678)
2026	$191,400	$0	$0	($81,690,258)	$0	$0	$0	($770,178)
2027	$202,000	($3,000,000)	$0	($168,078,021)	$0	$0	$0	($1,573,300)
2028	$220,000	($3,000,000)	$0	($253,848,686)	$0	$0	$0	($2,205,131)
2029	$234,000	($3,000,000)	$0	($301,106,048)	$0	$0	$0	($2,458,214)
2030	$268,000	($6,000,000)	$0	($423,707,002)	$0	$0	$0	($3,506,905)
2031	$306,000	($6,000,000)	$0	($454,526,287)	$0	$0	$0	($3,841,802)
2032	$338,000	($6,000,000)	$0	($465,214,749)	$0	$0	$0	($3,869,573)
2033	$362,000	($6,000,000)	$0	($409,053,868)	$0	$0	$0	($3,494,984)
2034	$346,000	($3,000,000)	$0	($146,617,553)	$0	$0	$0	($1,375,545)
2035	$320,000	$0	$0	($95,813,268)	$0	$0	$0	($811,560)
2036	$294,000	$0	$0	($94,277,422)	$0	$0	$0	($797,212)
2037	$262,000	$0	$0	($24,782,108)	$0	$0	$0	($234,579)
2038	$232,000	$0	$0	($5,758,210)	$0	$0	$0	($45,244)
2039	$216,000	$0	$0	($70,662,333)	$0	$0	$0	($651,322)
2040	$220,000	($3,000,000)	$0	($160,765,424)	$0	$0	$0	($1,434,706)
2041	$214,000	$0	$0	($119,976,438)	$0	$0	$0	($1,053,851)
2042	$196,200	$0	$0	($44,137,625)	$0	$0	$0	($413,971)
2043	$176,200	$0	$0	($19,970,375)	$0	$0	$0	($187,167)
2044	$158,000	$0	$0	($35,920,975)	$0	$0	$0	($265,193)
2045	$142,000	$0	$0	($35,920,975)	$0	$0	$0	($265,193)
2046	$124,400	$0	$0	$0	$0	$0	$0	$0
2047	$113,600	$0	$0	($22,051,134)	$0	$0	$0	($207,028)
2048	$108,800	$0	$0	($44,157,004)	$0	$0	$0	($414,442)
2049	$103,200	$0	$0	($51,776,404)	$0	$0	$0	($426,412)

Table K-30 Net Incremental Benefit (Cost) Associated with Attributes for Limited Dispositions Alternative ($)

Year	Public and Occupational Health Routine	Public and Occupational Health Accident	Industry Implementation	Industry Operation	NRC Implementation	NRC Operation	Other Government	Environmental Considerations
2003	$15,018	$0	($18,848)	$14,197,311	($3,395)	$0	($451,377)	$9,867
2004	$21,561	$0	($11,309)	$7,782,076	$0	$0	$0	$197
2005	$20,420	$0	$0	$401,448	$0	$0	$0	($20,943)
2006	$19,197	$0	$0	$401,448	$0	$0	$0	($20,943)
2007	$18,192	$0	$0	$401,448	$0	$0	$0	($20,943)
2008	$17,305	$0	$0	$401,448	$0	$0	$0	($20,943)
2009	$16,536	$0	$0	$401,448	$0	$0	$0	($20,943)
2010	$15,845	$0	$0	$401,448	$0	$0	$0	($23,194)
2011	$15,254	$0	$0	$401,448	$0	$0	$0	($23,194)
2012	$14,742	$0	$0	$401,448	$0	$0	$0	($23,194)
2013	$14,268	$0	$0	$401,448	$0	$0	$0	($23,194)
2014	$14,109	$0	($3,770)	$849,614	$0	$0	$0	($22,412)
2015	$25,692	$0	($18,848)	$20,294,026	$0	$0	$0	($51,928)
2016	$45,061	$0	($26,387)	$30,757,208	$0	$0	$0	($106,862)
2017	$57,250	$0	($18,848)	$21,009,910	$0	$0	$0	($112,490)
2018	$78,422	$0	($33,926)	$40,815,886	$0	$0	$0	($124,802)
2019	$121,496	$0	($60,314)	$68,608,128	$0	$0	$0	($294,188)
2020	$172,373	$0	($67,853)	$87,381,423	$0	$0	$0	($434,816)
2021	$193,702	$0	($41,466)	$57,994,670	$0	$0	$0	($267,221)
2022	$203,688	$0	($30,157)	$38,925,140	$0	$0	$0	($289,311)
2023	$217,635	$0	($37,696)	$44,177,926	$0	$0	$0	($331,556)
2024	$213,780	$0	($22,618)	$21,717,759	$0	$0	$0	($230,606)
2025	$197,731	$0	($15,078)	$10,393,612	$0	$0	$0	($115,989)
2026	$189,368	$0	($18,848)	$15,610,281	$0	$0	$0	($173,396)
2027	$199,810	$0	($30,157)	$32,237,495	$0	$0	$0	($345,142)
2028	$217,742	$0	($37,696)	$47,458,259	$0	$0	$0	($362,202)
2029	$231,732	$0	($37,696)	$55,452,885	$0	$0	$0	($281,346)
2030	$265,320	$0	($52,774)	$77,845,672	$0	$0	$0	($440,936)
2031	$302,587	$0	($56,544)	$83,836,251	$0	$0	$0	($548,861)
2032	$334,024	$0	($56,544)	$86,511,515	$0	$0	$0	($496,572)
2033	$357,912	$0	($52,774)	$76,840,506	$0	$0	$0	($522,109)
2034	$342,330	$0	($22,618)	$28,115,088	$0	$0	$0	($303,341)
2035	$316,753	$0	($11,309)	$17,495,562	$0	$0	$0	($118,441)
2036	$291,053	$0	($11,309)	$17,314,591	$0	$0	$0	($114,640)
2037	$259,388	$0	($3,770)	$4,767,711	$0	$0	$0	($53,191)
2038	$229,664	$0	($3,770)	$1,039,773	$0	$0	$0	($3,727)
2039	$213,803	$0	($15,078)	$13,394,872	$0	$0	$0	($135,806)
2040	$217,751	$0	($26,387)	$30,288,586	$0	$0	$0	($264,217)
2041	$211,768	$0	($18,848)	$22,595,140	$0	$0	$0	($180,834)
2042	$194,122	$0	($7,539)	$8,546,877	$0	$0	$0	($90,711)
2043	$174,291	$0	($3,770)	$3,869,445	$0	$0	$0	($40,888)
2044	$156,223	$0	($3,770)	$6,409,222	$0	$0	$0	($7,249)
2045	$140,340	$0	($3,770)	$6,409,222	$0	$0	$0	($7,249)
2046	$122,899	$0	$0	$0	$0	$0	$0	$0
2047	$112,196	$0	($3,770)	$4,273,399	$0	$0	$0	($45,512)
2048	$107,476	$0	($7,539)	$8,492,696	$0	$0	$0	($91,404)
2049	$101,981	$0	($7,539)	$9,366,489	$0	$0	$0	($52,720)

Attachment 1 to Appendix K

Distribution of "MARSSIM" Survey Unit Classes Associated with Controlling the Disposition of Solid Materials

In assessing the conduct of release surveys, there is a need to determine how materials might be distributed among the three survey classes of "MARSSIM." The survey classification system includes Class 1, 2, and 3. Under Class 1, contamination levels are expected to be above the release criteria over some portion of the material. For Class 2, materials are expected to have contamination levels near but not exceed the release criteria anywhere on the material. Under Class 3, the material are expected to have contamination levels well below release criteria anywhere on the material. Also, the determination of the appropriate classification is fundamentally premised on the specific value of the release criterion for a given radionuclide. That is, it appears reasonable to expect that 70 percent of some material coming from an area within a reactor building to be Class 3 if the release criterion were 10 mrem/yr; however, it is unlikely that a Class 3 designation would be 70 percent if the release criterion were 0.1 mrem/yr instead. This connection of a release criterion to classification distributions is an important consideration which can only be addressed with facility and material specific information. NUREG-1761 on survey methodology for solid materials and the ORISE report on survey costs provide further discussions on these topics (NRC 2004, ORISE 2004).

The types of contaminants and contamination levels are expected to reflect the operational history of such materials in impacted areas, i.e., radiologically controlled areas. For example, steel reinforcement bars used in structures are expected to be mostly free of contamination given that they were encapsulated in concrete during the operating life of a plant, excluding neutron activated materials (i.e., rebars and concrete in bioshields). On the other hand, some process systems may be both externally and internally contaminated. Internal contamination may be associated with process fluids that contained radioactivity, while external contamination may be due to spills and leaks from nearby components. Another consideration addresses how materials were processed and removed out of controlled areas. For example, if precautions were taken in the handling and removal process, external surface contamination levels might be kept to levels that may not warrant a Class 1 designation. Accordingly, such considerations would be addressed as part of an initial assessment, including the use of current operational survey results and by conduct scoping and characterization surveys to supplement that information.

Given the objective of the GEIS, the assignment of survey unit classification focuses on the major types of materials. This discussion does not consider materials that would be shipped as low-level radioactive waste. It is assumed that the provisions of a release rule would only apply to materials considered to be relatively free of both internal and external surface or volumetric contamination, with levels that straddle release criteria. In other words, the provisions of the release rule is not expected to change the practice in identifying and segregating materials with contamination levels that warrant disposal as low-level radioactive waste. Moreover, it is assumed that if decontamination were considered as a precursor to releasing materials, the initial contamination levels would be such that release criteria could be readily achieved given the selection of a proper decontamination method. This recognizes that if contamination levels were too high or the decontamination factor were too low, it would be a futile exercise to spend any time and resources on decontamination. Finally, these considerations are assumed to apply as well to the reuse of equipment and tools in their original form or intended applications.

The discussions that follow address metals, concrete, trash, and equipment reuse with results summarized in Table 1.

1. Metals

Metals include ferrous and non-ferrous metals, such as aluminum and copper. In the context of the release rule, metals can be grouped into three categories by origins, (i) metals that were completely encapsulated, (ii) metals that were contained in enclosures or isolated with some degree of protection, and (iii) metals that were exposed to ambient conditions or were part of some systems or components. The best example of metals that were completely encapsulated is structural rebars used in concrete structures. Such metals are expected to be essentially all Class 3. Metals that were contained in enclosures or isolated with some degree of protection may be found in utility chases, pipe penetrations, overhead spaces, or contained in electrical panels or conduits. This category also includes some structural steel and pipe hangers. Most of this material is expected to be Class 2. Metals that were exposed to ambient conditions are assumed to be characterized by contamination levels that would be at or above release criteria. Such metals would originate from radiologically controlled areas, be part of systems and components, pipe hangers, and include some structural steel. Most of this type of metal would be Class 1.

A review of material inventories compiled in the SC&A report (SC&A 2003) indicates that rebars from a BWR plant comprise about 60 to 85 percent of the metals inventory that is potentially releasable, also assumed to be representative of PWRs as well. The balance consists of structural steel, pipe hangers, and other miscellaneous ferrous metals. A Class 3 designation is assigned to the inventory of rebars, assuming that 70 percent of metals are rebars. For the balance, it is assumed that 20 percent is Class 2 and 10 percent is Class 1, given the discussion above on the grouping of metals by origins. Finally, metals that would be subject to decontamination are assumed to have an equal distribution among Class 1, 2, and 3, lacking specific information.

2. Concrete

Essentially all of the concrete present in facilities is associated with structures and building foundations. However, some concrete is used as equipment pedestals and perimeter curbing around floor and equipment drains. Accordingly, contamination profiles of concrete are expected to be primarily surficial in nature for most areas, and volumetric in areas where the contamination is associated with liquid spills and leaks from components. In addition, some volumetric contamination is expected around embedded piping servicing floor and equipment drains, and at wall-to-floor joints and floor-to-floor joints. Generally, the decontamination of concrete is undertaken when the contamination is present within the near surface (few inches) and its distribution is well known. For areas where contamination levels are present at depths or is due to neutron activation, the practice is to remove the entire layer and dispose of it as low-level waste. The methods rely on aggressive techniques, e.g., scabbler or jack hammers, with the removal of a layer that overshoots the original depth of the contamination. This approach is used to remove the contamination on the first pass, as it is costly to repeat such procedures in serial steps involving more decontamination and surveys. Given such aggressive methods, it is expected that most of the contamination would be removed, thereby, leaving exposed concrete surfaces that would most likely be below cleanup criteria.

A review of the material inventories presented in the SC&A report (SC&A 2003) indicates that nearly all concrete from BWR and BWR plants are expected to be below or near release criteria. The balance is expected to come from areas that were decontaminated and, as a result, would reflect a classification initially assigned to the area before decontamination. Lacking specific information, a Class 3 designation is assigned to 80 percent of the total inventory of releasable concrete. For the balance, it is assumed that 10 percent is Class 2 and 10 percent is Class 1.

3. Trash

Trash is expected to be generated routinely out of radiologically controlled areas. Various types of materials fall in the designation of trash. Trash generally consists of paper, wood, plastic, glass, cloth, filters, rubber, cardboard, small metallic objects, among others. Other types of materials may be included in trash when quantities are too small and do not warrant segregation for disposal via other means. Such additional materials may include concrete rubble, bricks, asphalt, metal scraps, and discarded tools and equipment. Given that trash is being generated frequently, licensees are routinely surveying and segregating trash, with some items being disposed of as LLW depending on radioactivity levels. For expediency and cost considerations, this segregation process tends to err on the side of safety by labeling some items as being contaminated while more detailed surveys might reveal otherwise. As a result, this process tends to generate trash that might have a greater number of items with Class 2 and 3 distributions than Class 1.

Trash can be grouped into three categories by origins, (i) items that have introduced in a radiologically controlled area with little potential of being contaminated, (ii) items that have been introduced in a radiologically controlled area and have become contaminated at levels at or above release criteria, and (iii) items that have been in a radiologically controlled area and have become contaminated at significant levels. In illustrating the first example, a pallet used to deliver some equipment would fall in this category. The pallet might be protected with some covering. Once the equipment is removed, the pallet would be taken out of the controlled area as part of that same operation. In the second category, the pallet might become contaminated and contamination levels would dictate whether it can be released or should be disposed of as radioactive waste, assuming that decontamination is not feasible. For the third category, an example might include the use of a disposable covering (e.g., plastic sheeting) to protect some equipment during some maintenance evolution. Once the work is completed, the covering would be removed and surveyed to determine whether it can be released or needs to be disposed of as radioactive waste, assuming that decontamination is not feasible. Given the relative protection afforded by plastic wrappings or any other forms of encapsulation methods, it cannot be assumed that this level of protection would be totally effective against contamination, as a result a lesser survey classification than Class 1 could not be justified. Given the variability of the radiological properties of trash that might be potentially released, trash is assumed to have an equal distribution among Class 1, 2, and 3 considering the potential heterogeneous distributions of contaminants.

4. Equipment, Tools, and Vehicles

As with materials described above, it is known that different types of equipment and tools are used in radiologically controlled areas and later taken out. The types of equipment that could be potentially released from nuclear facilities for reuse in an environment free of radiological controls ranges from small items, such as hand tools, to very large ones, such as mechanized equipment and industrial vehicles. The following are examples of potentially reusable equipment, tools, and miscellaneous items:

- small hand tools (wrenches, screw drivers, etc.) and power tools (drills, saws, etc.)
- electrical equipment, such as control panels, motors, pumps, and generators
- office furniture (desks, chairs, filing cabinets, etc.) and office equipment (copiers, computers, printers, fax machines, etc.)
- construction equipment, such as scaffolding, noise or dust-control barriers, wheelbarrows, etc.
- mechanized equipment, such as backhoes, bulldozers, cranes, drill rigs, etc.
- vehicles, such as dump trucks, flat-bed trucks, pickup trucks, vans, etc.
- materials and supplies for use in their original forms, but taken out as excess, such as piping, tubing, electrical wiring, floor covering, ductwork, sheet metal, pipe hangers, light fixtures, wall board, and sheet glass.

It should be noted that these examples are assumed to characterize the profile of equipment, tools, and miscellaneous items that may be released by various types of licensees.

It is recognized that the release of equipment is an extremely dynamic process involving different types of facilities and activities, such as routine operations, research and development, major and minor power plant outages, refurbishment, decommissioning, etc. In addition, this process is taking place simultaneously at thousands of facilities across the nation and conducted every hour of the day and every day of the week. As a result, it is not readily possible to define what types of objects and how many are routinely used in radiologically controlled areas, and what fraction is surveyed and released for reuse *versus* those that are discarded as LLW.

In practice, equipment and tools are surveyed before being taken out of radiologically controlled areas. The survey consists of conducting a scan with a portable radiation survey meter and taking wipes to assess the presence of removable surface activity. The presence of radioactivity on wipes is evaluated using separate instrumentation. Some survey methods involve the introduction of the item into an instrument (e.g., gamma tool monitor) that measures radioactivity *in toto* from all external and internal surfaces. Depending on the results of surveys, the items are either cleaned to meet release criteria, not taken out of the controlled area and set aside for later use in any controlled area, or simply discarded as LLW.

Given that equipment, tools, and vehicles have a productive life cycle, it is assumed that the impetus will be keep on using equipment to their maximum useful lives. The productive cycle lof equipment is driven by operational conditions and economic considerations, taking into account replacement costs *vs.* cost of repairs, amortization rates, and cost of money. These factors are expected to be different among facilities. Accordingly, it is expected that licensees will take all appropriate measures to protect equipment, tools, vehicles, etc.

Together, these practices are expected to mitigate the presence of residual radioactivity on potentially releasable equipment and should result in residual levels that are below release criteria for most items. As a result, it is expected that most of the equipment will be Class 2 and 3, with a smaller fraction being Cass 1. Given the paucity of information and potential for heterogeneous distributions of contaminants, it is assumed that 50 percent of the potentially release equipment is Class 3, 30 percent is Class 2, and 20 percent is Class 1.

Table 1 Assignment of Survey Classification to Potentially Releasable Materials and Equipment

Material	**Percent of Material**		
	Class 1	**Class 2**	**Class 3**
Metals - no decon	10	20	70
Metals - with decon	33	33	33
Concrete	10	10	80
Trash	33	33	33
Equipment, tools, vehicles, etc.	20	30	50

Note: The assumed distributions of survey classifications for concrete and steel do not consider the presence of neutron activation products. The presence of radionuclides associated with neutron activation is too complex of an issue to be addressed generically and should be dealt with on a case-by-case basis.

References

ORISE 2004 Oak Ridge Institute for Science and Education, "Clearance Survey Costs - Technical Bases for Developing Survey Costs," Oak Ridge, TN, prepared for the NRC under contract, draft report, February 2004.

SC&A 2003 S. Cohen & Associates, Inc., Collective Doses Associated with Clearance of Material from NRC/Agreement State-Licensed Facilities, 2nd draft, Dec. 2003, McLean, VA.

NRC 2004 U.S. Nuclear Regulatory Commission, Radiological Surveys for Controlling Release of Solid Materials, NUREG-1761, Washington, DC, June 2004.

Attachment 2 to Appendix K

Description of Industry Operation Attribute

This attachment provides a detailed description of how the benefits and costs were calculated for one of the attributes - Industry Operation - which is by far the most significant of the cost-benefit attributes shown in Tables 4-3 and K-14. The Industry Operation attribute includes four sub-attributes, but two in particular -- transportation and disposal -- are the significant drivers in the analysis. The information provided here is intended to help the reader understand how the cost-benefit analysis is performed and also to provide the values of the assumed parameters necessary to duplicate the Industry Operation portion of the analysis in the year 2020 for three Alternatives compared to No Action. (The sample year 2020 was chosen because it is a year with a higher volume of potentially clearable solid material.) This will be helpful in understanding the extent to which transportation and disposal activities influence the overall analysis.

1. Description of the Model's Calculations

The cost-benefit model is based on a set of linked calculations (via spreadsheets). The spreadsheets contain information on potentially clearable solid materials (steel, concrete and trash in units of tons) for each of the Alternatives and for each dose option. The spreadsheets also contain parameters used to model costs, for example truck transportation in units of $/ton-mile and concrete rubble surveys in units of $/ton.

The cost-benefit model considered inventories of potentially clearable solid materials that may accumulate during the dismantlement of commercial nuclear power reactors. The dismantlement of these facilities is the major source of potentially clearable materials. The inventories are developed as a function of time based on the scheduled shutdown dates of the existing nuclear power plants. Dismantlement of a facility is assumed to be completed in 7 years, with 5 years for post-shutdown activities and 2 years for dismantlement.

Table K-31 shows a summary of the total inventory of clearable solid materials over the study period. The solid materials shown below are either “released” or they are disposed in a LLW facility. Two examples of release destinations are (1) an EPA/State-Regulated landfill used for trash, concrete and/or ferrous metals, or (2) a recycling facility used to process released concrete only for use as roadbed material. For the comparison of Alternatives in this attachment, the Unrestricted Release and EPA/State-Regulated Disposal Alternatives all have a dose option of 1 mrem/yr based on NUREG-1640. The Limited Dispositions Alternative is based on IAEA Safety Guide No. RS-G-1.7, which is derived from a dose of 1 mrem/yr.

The Unrestricted Release inventory is for material-independent values. Note that in Table K-31 the amount of tons of concrete released under the Unrestricted Release Alternative is larger than the inventory of concrete released under the No Action Alternative. However, for steel the situation is reversed. This is because the material-independent values are based on the most limiting scenario, which is concrete, and thus inventory values for steel are normalized to a lower value. The concept of material-independent values is explained on page 3-20 and in Appendix D of this GEIS.

The cost-benefit results are generated by multiplying material amounts by unit costs, on an annual basis for each of the Alternatives and dose options. Using the convention described earlier in this Appendix, negative numbers represent either costs or decreases in benefits, while positive numbers represent either benefits or decreases in costs. The costs and benefits associated with the No Action Alternative are subtracted from the costs and benefits associated with each Alternative, to estimate the incremental cost of the rule. After the annual incremental total costs are calculated in current year dollars, these dollars are discounted to present value 2003$ on an annual basis. Summing over all years provides the total discounted cost or benefit for an attribute (e.g., Industry Operation, Environmental Considerations) for each Alternative (e.g., Unrestricted Release, Limited Disposition) and dose option (e.g., 1 mrem/yr). A final sum over all of the attributes provides the Total Net Incremental Benefit or Cost (2003$) for the Alternative and dose option compared to the No Action Alternative. Table 4-3 presents these results.

Table K-31: Total Inventory of Clearable Solid Materials - All Alternatives Except No Action are for a 1 mrem/yr Dose Option (Thousand Tons)

	No Action	Unrestricted Release	EPA/State-Regulated Disposal	Limited Dispositions
Material Recycled				
Steel	1,800	1,500	NA	NA
Concrete	16,000	20,000	NA	20,000
Trash	NA	NA	NA	NA
Material Disposed at EPA/State-Regulated Landfills				
Steel	0	0	2,100	2,100
Concrete	0	0	20,000	0
Trash	20	1.8	41	41

Source: SC&A 2003 Tables 4.6, 4.7, 10.3 and 10.7. For steel, the decontaminated quantity was not included in the release volumes because of the high cost of steel decontamination.

The overall analysis covers the years 2003 through 2049, but this discussion presents results only for a single sample year, 2020. It is important to keep in mind that the amount of solid material normally varies from year to year, and some years have very little material generated from decommissioning. The sample year 2020 represents a high volume year. The annual tonnage of potentially clearable solid material is based on three items in the analysis methodology:

- dismantlement activity in that year,
- the method by which the materials are managed for the Alternative (recycled or disposed), and
- the dose at which materials are allowed to be released.

With the amount of potentially clearable solid material changing each year, the dollar impacts – either cost or benefit – also change each year. These changes are seen in the stream of current year dollars (both benefits and costs compared to No Action) in Table K-23 for Unrestricted

Release, Table K-28 for EPA/State-Regulated Disposal, and Table K-30 for Limited Dispositions. All three tables show major annual <u>benefits</u> under the Industry Operation attribute, and to a lesser extent under the Public and Occupational Health Routine attribute. These tables also show major annual <u>costs</u> under the Environmental Considerations and Industry Implementation attributes.

Table K-32 shows the quantity of potentially clearable solid materials in the sample year 2020, and how the specific quantities are managed for each material. These quantities are shown for the No Action, Unrestricted Release, EPA/State-Regulated Disposal, and Limited Dispositions Alternatives. The amounts of material (in metric tons) in the year 2020 serve as a starting point to describe how the analysis is performed for the Industry Operation attribute.

Table K-32: Inventory of Clearable Solid Materials for the Industry Operation Attribute in the Year 2020 - All Alternatives Except No Action are for a 1 mrem/yr Dose Option (Thousand Tons)

		No Action	**Unrestricted Release**	**EPA/State-Regulated Disposal**	**Limited Dispositions**
Material Recycled					
Steel		120	99	NA	NA
Concrete		1,293	1,564	NA	1,564
Trash		0	0	NA	NA
Material Disposed at EPA/State-Regulated Landfills					
Steel		0	0	141	141
Concrete		0	0	1,572	0
Trash		1	< 1	1	1
Material Disposed at LLW Facility					
Steel	Unrestricted	0	22		
	EPA/State	21		0	
	Limited Disp	21			0
Concrete	Unrestricted	271	0		
	EPA/State	279		0	
	Limited Disp	271			0
Trash	Unrestricted	0	1		
	EPA/State	1		0	
	Limited Disp	1			0

Because different amounts of each material clear in each Alternative, the No Action Alternative is divided into three baselines, one corresponding to each of the other Alternatives (Unrestricted Release, EPA/State-Regulated Disposal, and Limited Dispositions). The unaccounted for material (for example, the 271,000 ton difference in the amount of concrete released in the No Action and Unrestricted Release Alternatives) is added back to the No Action – Unrestricted Release baseline, so like quantities are compared. Because any material that does not clear would need to be sent to a LLW disposal facility, this change in quantity is assumed to be disposed of at a LLW disposal facility.

As noted above, the Industry Operation attribute has four "sub-attributes," or cost components. These sub-attributes are (in their order of cost significance):

- transportation;
- disposal and recycling;
- survey; and
- paperwork.

The next sections explain how the costs and benefits are calculated for the year 2020. Assumed parameters are discussed to provide transparency on how costs and benefits are calculated. These sections illustrate the large beneficial impacts due to transportation and disposal activities associated with each of the three 1 mrem/yr Alternatives.

When the impacts from the four sub-attributes are summed for each Alternative at the end of this section, the resulting total net benefits for the Industry Operation attribute (compared to No Action) will match the following values with some allowance for rounding:

- $84,066,938 for Unrestricted Release shown in Table K-23
- $60,430,917 for EPA/State-Regulated Disposal shown in Table K-28
- $87,381,423 for Limited Dispositions shown in Table K-30.

2. Transportation Sub-Attribute

The annual net benefits or costs attributed to transportation are calculated for each year of the analysis, 2003-2049, by subtracting the estimated transportation costs of the No Action approach (or "baseline") from the estimated transportation costs of the Alternative under consideration. Lower costs for the Alternative produce positive values, or net "benefits." Higher costs for the Alternative produce negative values, or net "costs." These annual values are calculated first in current year dollars and then discounted to 2003$ for present value comparison.

Transportation costs are estimated by multiplying the quantity (tons) of each material released in a year by (1) the number of miles traveled to the appropriate destination, and (2) the $ per ton-mile rate for transporting the material by truck.

Table K-33 shows the assumed unit costs used to calculate transportation costs.

Table K-34 shows net transportation costs and benefits in sample year 2020 for the Alternatives in 2020$.

The released solid material is either transported to a recycling facility (steel and concrete only) or to an EPA/State-Regulated landfill. Solid material also is transported to a LLW facility. Multiplying the tons released (Table K-32) by the unit cost assumptions provides the transportation costs for each Alternative compared to No Action.

Table K-33
Assumed Parameters for Transportation Cost Calculations

Transportation Cost Component	Cost or Mileage
Cost per ton-mile for non-LLW (truck)	-$0.06
Cost per ton-mile for LLW (truck)	-$0.12
Number of miles to an MSW Landfill	58 miles
Number of miles to a steel recycling facility	269 miles
Number of miles to a concrete recycling facility	198 miles
Number of miles to a LLW facility	1,544 miles

Transportation of concrete to a LLW facility under the No Action baseline is the most significant influence in the transportation costs. The Alternatives that use the 1 mrem/yr dose option release more concrete compared to the No Action baseline, and their costs for these releases are much less than the baseline assumption of sending the material to a LLW facility. The Unrestricted Release Alternative has the added cost of transporting steel a greater distance to a recycling facility compared to transporting steel to a mixed solid waste (MSW) landfill for the EPA/State-Regulated Disposal and Limited Dispositions Alternatives.

In summary, there are three differences associated with the Unrestricted Release, EPA/State-Regulated Disposal, and Limited Dispositions Alternatives compared to the No Action Alternative in the year 2020:

- more tons of concrete are released for the 1 mrem/yr dose option,
- each ton of concrete released and transported to a landfill is about 3.5 times closer (58 miles compared to 198 miles) than the concrete sent to a recycling facility, and
- the Unrestricted Release Alternative has an additional $4 million cost in year 2020 for transporting steel to LLW compared to the EPA/State-Regulated Disposal and Limited Dispositions Alternatives.

3. Disposal and Recycling Sub-Attribute

The annual net benefits or costs attributed to disposal and recycling activities are calculated for each year of the analysis, 2003-2049. The estimated costs of the No Action approach (or "baseline") are subtracted from the estimated costs of the other Alternative under consideration. These annual values are calculated first in current year dollars and then discounted to 2003$ for present value comparison.

Disposal and recycling costs are estimated by multiplying the quantity (tons) of each material released in a year by the $ per ton unit cost for disposal and recycling activities.

Table K-35 shows the assumed unit costs used to calculate disposal and recycling costs. Note that there is a cost to recycle concrete but a benefit to recycle steel.

Table K-34
Calculation of Transportation Benefits and Costs (Year 2020)
(Millions 2020$)

		No Action Baseline	Unrestricted Release	EPA/State-Regulated Disposal	Limited Dispositions
Material Recycled Assumptions: 269 miles to steel recycling facility 198 miles to concrete recycling facility $0.06 cost per ton-mile for truck transport					
Steel		-1.9	-1.6	0	0
Concrete		-15.4	-18.6	0	-18.6
Trash		0	0	0	0
Material Disposed at EPA/State-Regulated Landfills Assumptions: 58 miles to a MSW landfill $0.06 cost per ton-mile for truck transport					
Steel		0	0	-0.5	-0.5
Concrete		0	0	-5.5	0
Trash		< 0.1	< 0.1	< 0.1	< 0.1
Material Disposed at LLW Facility Assumptions: 1,544 miles to LLW facility $0.12 cost per ton-mile for truck transport					
Steel	Unrestricted	0	-4.0		
	EPA/State	-3.8		0	
	Limited Disp	-3.8			0
Concrete	Unrestricted	-50.3	0		
	EPA/State	-51.7		0	
	Limited Disp	-50.3			0
Trash	Unrestricted	0	-0.1		
	EPA/State	-0.1		0	
	Limited Disp	-0.1			0
Alternative Total $					
	Unrestricted	-67.6	-24.3		
	EPA/State	-72.9		-6.0	
	Limited Disp	-71.5			-19.1
Net Benefit (Cost) compared to No Action			+43.3	+66.9	+52.4

Table K-35
Assumed Parameters for Disposal and Recycling Cost Calculations

Disposal, Recycling and Reuse Cost Component	Cost ($/ton)
Steel, concrete and trash disposal in a landfill	-32.19
Concrete recycling	-5.00
Steel recycling revenue	+85.00
Steel, concrete and trash disposal in a LLW facility	-164.00

Table K-36 shows net disposal and recycling costs and benefits in sample year 2020 for the Alternatives in 2020$.

The released solid material is either disposed at a recycling facility (steel and concrete only) or at an EPA/State-Regulated landfill. Solid material also is disposed at a LLW facility. Multiplying the tons released (Table K-32) by the disposal unit cost assumptions provides the disposal costs and recycling revenue for each Alternative compared to No Action.

As shown in Table K-36, both Unrestricted Release and Limited Disposition Alternatives have significant benefits compared to No Action, while the EPA/State-Regulated Disposal Alternative is more costly than No Action. The No Action baseline is about the same for all three Alternatives (i.e., $40-$45 million). The EPA/State-Regulated Disposal Alternative has a $50 million expense in disposing of concrete in a landfill at $32.19 per ton. The Unrestricted Release Alternative obtains a benefit of about $8 million in 2020 from the sale of steel to a recycling facility, but not as much steel is recycled as that for the No Action Alternative ($10 million). The significant benefit for the Unrestricted Release and Limited Dispositions Alternatives compared to No Action is in the disposal of concrete at a recycling facility at $5.00 per ton compared to disposal at a LLW facility at $164.00 per ton.

In summary, there are three differences associated with the Unrestricted Release, EPA/State-Regulated Disposal, and Limited Dispositions Alternatives compared to the No Action Alternative in the year 2020:

- the amount of concrete disposed in a landfill compared to the amount released for recycling,
- the cost of disposing of concrete in a landfill is more than 6 times the cost ($32.19/ton compared to $5/ton) of releasing concrete to a recycling facility, and
- the amount of concrete sent to a LLW facility.

4. Survey Costs Sub-Attribute

The annual net benefits or costs attributed to survey activities are calculated for each year of the analysis, 2003-2049. The estimated costs of the No Action approach (or “baseline”) are subtracted from the estimated costs of the Alternative under consideration. These annual values are calculated first in current year dollars and then discounted to 2003$ for present value comparison.

Survey costs are estimated by multiplying the quantity (tons) of each material released in a year by the $ per ton survey cost.

Table K-36
Calculation of Disposal and Recycle Benefits and Costs (Year 2020)
(Millions 2020$)

		No Action Baseline	**Unrestricted Release**	**EPA/State-Regulated Disposal**	**Limited Dispositions**
Material Recycled					
Assumptions: $85.00 revenue per ton for steel; $ 5.00 cost per ton for concrete					
Steel		+10.2	+8.4	0	0
Concrete		-6.5	-7.8	0	-7.8
Trash		0	0	0	0
Material Disposed at EPA/State-Regulated Landfills					
Assumptions: $32.19 cost per ton for steel, concrete, and trash					
Steel		0	0	-4.5	-4.5
Concrete		0	0	-50.6	0
Trash		< -0.1	< -0.1	< -0.1	< -0.1
Material Disposed at LLW Facility					
Assumption: $164.00 cost per ton for steel, concrete and trash					
Steel	Unrestricted	0	-3.5		
	EPA/State	-3.4		0	
	Limited Disp	-3.4			0
Concrete	Unrestricted	-44.4	0		
	EPA/State	-45.7		0	
	Limited Disp	-44.4			0
Trash	Unrestricted	0	-0.1		
	EPA/State	-0.1		0	
	Limited Disp	-0.1			0
Alternative Total $					
	Unrestricted	-40.7	-3.0		
	EPA/State	-45.5		-55.1	
	Limited Disp	-44.2			-12.3
Net Benefit (Cost) compared to No Action			+37.7	-9.6	+31.9

Table K-37 shows the assumed unit costs used to calculate survey costs.

Table K-37
Assumed Parameters for Survey Cost Calculations

Survey Cost Components	Cost ($/ton)
Trash survey for baseline	-50.00
Steel survey for baseline	-176.00
Concrete survey for baseline	-26.00
Trash survey for 1 mrem/yr dose option	-74.00
Steel survey for 1 mrem/yr dose option	-41.85
Concrete survey for 1 mrem/yr dose option	-35.94

Table K-38 show net survey costs and benefits in sample year 2020 for the Alternatives in 2020$.

Note that for survey activities, the net benefit of each Alternative compared to No Action is exactly the same, $3.3 million. This equality seems counter intuitive, as the number of tons surveyed under each Alternative in the year 2020 is different. The incremental net benefit of one Alternative compared to another Alternative is the same (relative to No Action) because the unit costs for surveying material going to a landfill are the same as those going to a LLW facility. The extra material released for the Limited Dispositions Alternative compared to the Unrestricted Release Alternative in 2020 is also assumed for the Limited Disposition No Action baseline compared to the Unrestricted Release No Action baseline. Thus, incremental amounts among Alternatives cancel each other out because the same increment is in both the Alternative and the baseline for that Alternative.

Limited Disposition survey costs are about $1 million more costly than Unrestricted Release survey costs in 2020 ($62.2 million compared to $61.2 million) due to more steel surveyed prior to release to a landfill. This added cost is offset by a lesser amount of steel going to a LLW facility in the baseline ($64.5 million compared to $65.5 million).

In summary, there are two conclusions from the survey cost sub-attribute:

- an approximate $3.3 million benefit in 2020 is obtained for each of the three Alternatives compared to No Action, and
- the benefit is due to the cost difference in surveying steel for the Alternatives, $41.85 per ton compared to $176.00 per ton for No Action, and to the quantity of concrete surveyed prior to LLW disposal for No Action compared to no tons for the Alternatives.

Table K-38
Calculation of Survey Costs (Year 2020)
(Millions 2020$)

		No Action Baseline	Unrestricted Release	EPA/State-Regulated Disposal	Limited Dispositions
Material Recycled					
Assumptions: $ 35.94 cost per ton for concrete survey for 1 mrem/yr dose option; $ 26.00 cost per ton for concrete No Action baseline survey; $ 41.85 cost per ton for steel survey for 1 mrem/yr dose option; $176.00 cost per ton for steel No Action baseline survey					
Steel		-21.2	-4.1	0	0
Concrete		-33.6	-56.2	0	-56.2
Trash		0	0	0	0
Material Disposed at EPA/State-Regulated Landfills					
Assumptions: $41.85 cost per ton for steel survey for 1 mrem/yr dose option; $35.94 cost per ton for concrete survey for 1 mrem/yr dose option; $74.00 cost per ton for trash survey for 1 mrem/yr dose option; $50.00 cost per ton for trash No Action baseline survey					
Steel		0	0	-5.9	-5.9
Concrete		0	0	-56.4	0
Trash		< -0.1	< -0.1	-0.1	-0.1
Material Disposed at LLW Facility					
Assumptions: $41.85 cost per ton for steel survey; $35.94 cost per ton for concrete survey; $74.00 cost per ton for trash survey					
Steel	Unrestricted	0	-0.9		
	EPA/State	-0.9		0	
	Limited Disp	-0.9			0
Concrete	Unrestricted	-9.7	0		
	EPA/State	-10.0		0	
	Limited Disp	-9.7			0
Trash	Unrestricted	0	< -0.1		
	EPA/State	0		0	
	Limited Disp	< -0.1			0
Alternative Total $					
	Unrestricted	-64.5	-61.2		
	EPA/State	-65.7		-62.4	
	Limited Disp	-65.5			-62.2
Net Benefit (Cost) compared to No Action			+3.3	+3.3	+3.3

5. Paperwork Sub-Attribute

The Paperwork sub-attribute is exactly the same value each year for each of the three Alternatives. This sub-attribute cost is associated with the administrative technical labor hours required of the licensees in their preparation and submittal of information supporting the release of solid material from their facilities.

Eighteen facilities are involved in decommissioning activities in the year 2020.

As described in Section 2.2.2 of Appendix K, the number of administrative technical labor hours for each licensee per facility is assumed to be 200, and the labor rate cost is assumed to be $33.84 per hour.

Thus, the value of -$121,824 is assigned to each Alternative (Unrestricted Release, EPA/State-Regulated Disposal and Limited Dispositions) as a cost in 2020 compared to the No Action Alternative. Thus, as with the survey sub-attribute, the paperwork sub-attribute has no differentiation value in ranking the Alternatives compared to No Action.

6. Summary of Industry Operation Benefits and Costs

Table 4-3 in this draft GEIS shows the Industry Operation attribute is by far the most significant of the eight cost attributes quantified in the cost-benefit analysis of the Alternatives compared to No Action. Table 4-3 is in units of present value 2003$, with the analysis having been performed over the years 2003 through 2049.

This attachment provided a discussion of the assumed parameters used for calculations and the results of those calculations for the Industry Operation cost-benefit analysis in the year 2020. The dollar values in this attachment are in current year dollars (2020$). The cost-benefit is for the Unrestricted Release, EPA/State-Regulated Disposal, and Limited Dispositions Alternatives compared to No Action.

The methodology evaluates four cost sub-attributes within the Industry Operation attribute. Two of these -- transportation and disposal – are the significant drivers in the analysis. Table K-39 summarizes the results for the Industry Operation attribute in the year 2020 for the three Alternatives compared to No Action.

The transportation of about 270,000 tons of concrete by truck to a LLW facility (1,544 miles distant) under the No Action baseline is the most significant influence in the transportation costs. (More tonnage is released under the 1 mrem/yr Alternatives than under the No Action dose option.) For the three other Alternatives, this volume of concrete is assumed to be transported either to a concrete recycling facility (198 miles distant) or to a landfill (58 miles distant). For the Unrestricted Release Alternative, there is a larger cost of transporting steel a greater distance to a recycling facility (269 miles) compared to a landfill (58 miles) used in the EPA/State-Regulated Disposal and Limited Disposition Alternatives. As with concrete, the landfill is only 58 miles away, whereas the LLW facility is 1,544 miles. Also, the truck unit cost to the LLW facility is about double, at $0.12 per ton-mile, compared to $0.06 per ton-mile to the landfill.

Table K-39
Summary of Industry Operation Sub-Attribute Benefits and (Costs)
Year 2020 Compared to No Action
(Millions 2020$)

	No Action Baseline	**Unrestricted Release**	**EPA/State-Regulated Disposal**	**Limited Dispositions**
Transportation	0	+43.3	+66.9	+52.4
Disposal and recycle	0	+37.7	-9.6	+31.9
Survey	0	+3.3	+3.3	+3.3
Paperwork	0	-0.1	-0.1	-0.1
Net Benefit (Cost) compared to No Action		+84.2	+60.5	+87.5

For the disposal costs, both the Unrestricted Release and Limited Disposition Alternatives have significant benefits compared to No Action, but the EPA/State-Regulated Disposal Alternative is more costly than No Action. This is due to the EPA/State-Regulated Disposal Alternative having an additional $50 million expense in disposing of concrete in a landfill at $32.19 per ton compared to $5.00 per ton disposal cost at a concrete recycling facility for the other Alternatives. The disposal of steel by selling it as recycled scrap in the Unrestricted Release Alternative provides a benefit of about $8 million in 2020 compared to the other two Alternatives.

This section provided a discussion using year 2020 data. Since the unit costs remain constant and the volume of cleared material changes each year in the analysis, all other years in the analysis would provide similar results as the year 2020 relative to the number of facilities entering their dismantlement activities in that year. The number of facilities starting dismantlement is the basis of the tonnage of solid material available for clearance in 2020 and other years. Eighteen facilities are involved in decommissioning in 2020. In the years 2003 through 2049, the number of facilities entering dismantlement each year ranges from none to 18.

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