RADIATION PROTECTION STANDARDS FOR SCRAP METAL: PRELIMINARY COST-BENEFIT ANALYSIS

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EXECUTIVE SUMMARY

INTRODUCTION

The U.S. Environmental Protection Agency (EPA) prepared this cost-benefit analysis to support the Agency's development of preliminary draft regulations on release standards for scrap metal from nuclear facilities. Upon their completion, EPA plans to release the preliminary draft regulations for public comment. This solicitation of comments will not constitute proposed or final Agency action or a proposed or final EPA rule. Rather, with this solicitation the Agency will begin a two-year, publicly accessible process that will culminate in the publishing of final regulations. Once final, these regulations would replace existing release limits (e.g., the Nuclear Regulatory Commission's Regulatory Guide 1.86) and would likely provide clearance standards for scrap metal exhibiting either surface or volumetric contamination; current guidance exists only for surface contamination.

EPA anticipates that establishing new standards will alter the management of scrap metal from Department of Energy (DOE) facilities and facilities licensed by the Nuclear Regulatory Commission (NRC), with resulting implications for scrap metal management costs and human health risks. Our preliminary assessment indicates that these impacts vary considerably across three analytic options: a 0.1 mrem standard, a 1.0 mrem standard, and a 15.0 mrem standard.[1] For example, the analysis suggests that scrap metal management costs under a 1.0 mrem standard are likely to be similar to those under current standards; the estimated cost impact of a 1.0 mrem standard ranges from zero to a savings of $20 million (1997 dollars, present value). In addition, our preliminary analysis suggests that a 1.0 mrem standard would be somewhat more protective of human health than current standards, reducing cancer incidence (i.e., the number of total cancer cases predicted to occur over 1,000 years) by six to 10 cases relative to baseline conditions. In contrast, we estimate that a

[1] These options have been developed to illustrate potential impacts across dramatically different release standards. They do not reflect specific regulatory options under consideration by EPA.

0.1 mrem standard would increase costs relative to the baseline by $200 million to $500 million and reduce cancer incidence by eight to 14 cases, while a 15.0 mrem standard would save $1.4 billion to $1.7 billion but increase cancer incidence by 19 to 29 cases.

We note that these results are preliminary and based on a number of simplifying assumptions. As a result, they should be interpreted with caution. We believe, however, that the results provide a good indication of the relationship of each of the three analytic options to current standards. In upcoming months, EPA intends to conduct further research to strengthen this preliminary analysis.

This summary contains three sections. The first outlines the analytic approach employed to generate the preliminary results. The second section presents the results of the analysis for each of the three options analyzed, discussing results for scrap metal from both DOE facilities and NRC-licensed commercial nuclear power reactors. The third section discusses the potential implications of these results, as well as the limitations of the analysis.

OVERVIEW OF ANALYTIC APPROACH

The cost-benefit analysis described in this report compares estimated scrap metal management costs and human cancer risks under three analytic scenarios to the costs and risks associated with the standards that currently govern the release of scrap metal from DOE and NRC-licensed nuclear facilities. Exhibit ES-1 illustrates the approach employed to assess these effects. As shown in this exhibit, the analysis requires first predicting likely current and future practices under existing standards, then comparing these "baseline" practices to likely practices under alternate clearance standards. The disposition practices analyzed include: (1) disposing of the scrap metal in burial facilities; (2) fabricating the metal into products for reuse within the nuclear complex (generally referred to as "restricted recycling"); and (3) releasing scrap metal for unconditional use. EPA's preliminary draft regulations would affect practices relating to option three, releasing scrap metal for unconditional use.[2]

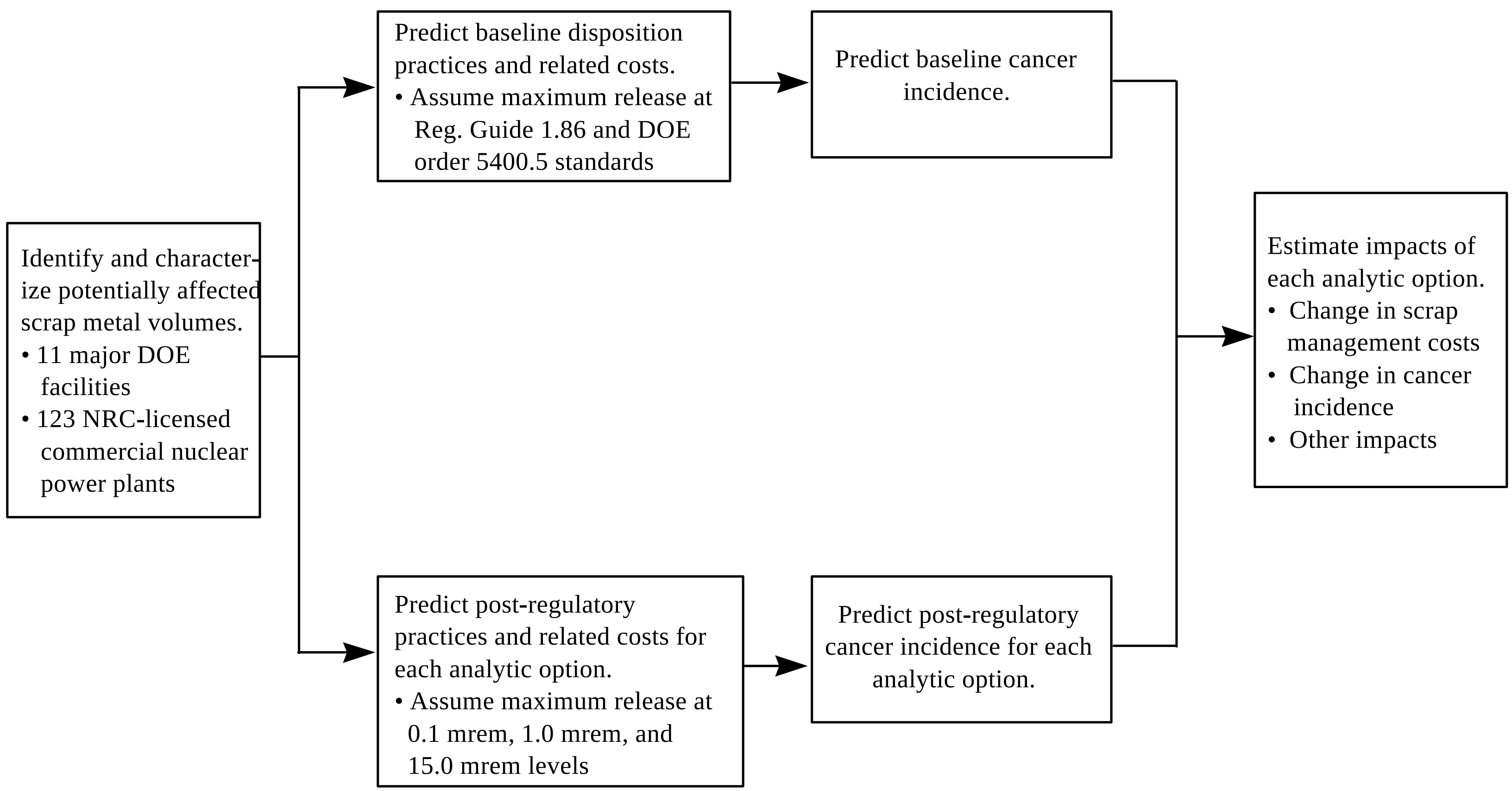
In this phase of our assessment of the potential effects of EPA's preliminary draft regulations, we identified the major sources of scrap metal potentially affected by the rulemaking. These sources include 11 large DOE facilities and 123 NRC-licensed commercial nuclear power reactors.[3] The analysis considers 936 thousand metric tons of scrap metal likely to be generated by the DOE

[2] Throughout this report, we use the term unconditional to refer to the determination that residual levels of radioactivity in scrap metal from Federal or NRC-licensed nuclear facilities are low enough that the metal need not be managed as radioactive material, but instead can be released from the institutional control of the nuclear facility with no limitations.

[3] We may address additional Federal and nonfederal sources of scrap metal in future analyses.

Exhibit ES-1

ANALYTIC APPROACH FOR COST-BENEFIT ANALYSIS



facilities and 641 thousand tons likely to be generated by the power reactors. We collected information on the physical and radiological characteristics that affect decisions to decontaminate and release scrap metal for unconditional use (i.e., use outside DOE or NRC regulatory control), such as the source of the scrap metal item, the type of metal it contains, its physical form, initial radioactivity levels, and whether contamination is limited to the metal's surface or extends significantly beyond the surface (i.e., whether the item is "volumetrically" contaminated). Due to considerable uncertainty concerning the radiological profiles of the metal in this inventory, we characterized potential ranges of activity levels for each scrap metal item, based on our understanding of the operations of a particular facility.[4]

The analysis considers likely scrap metal management practices under three analytic options and compares them to current and future practices under current, or "baseline" standards. The baseline standards used for this phase of the analysis include the current surface contamination release guidelines established under NRC's Regulatory Guide 1.86 and DOE Order 5400.5. The three analytic options would establish release standards designed to limit the annual radiation dose to the reasonably maximally exposed (RME) individual to less than 0.1 mrem, 1.0 mrem, or 15.0 mrem. We assume that these standards would apply to scrap metal exhibiting either surface or volumetric contamination.[5]

We developed detailed cost estimates for two disposition options: (1) permanent disposal as low level radioactive waste; and (2) unconditional clearance, with or without prior decontamination.[6] Due to uncertainties concerning disposal costs, we considered both high-end and low-end cost estimates for scrap metal originating from both DOE facilities and NRC-licensed commercial nuclear power reactors.

To predict how scrap metal would be managed under alternate release standards, we developed an economic model. For each analytic option, the model employs data on scrap metal characteristics and the costs of alternate management practices to estimate the costs associated with

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[4] Separate radiological profiles were developed for each of the 11 DOE facilities included in the analysis. The characterization of scrap metal from NRC-licensed commercial nuclear power plants was based upon radiological profiles for a reference boiling water reactor (BWR) and pressurized water reactor (PWR).

[5] Current standards do not provide generic activity guidelines for releasing scrap metal containing volumetric contamination.

[6] We qualitatively discuss the impact of restricted recycling options on our findings; future analyses may incorporate a quantitative assessment of these impacts.

disposal or unconditional clearance. The model then compares these costs to determine the approach that would be selected under each set of standards, assuming that decision-makers will always choose the lowest cost option.

The methodology employed to characterize the effect of alternate standards on human cancer risks is based on a method used in recent analyses by EPA.[7] The basic approach for evaluating individual risk consists of estimating the dose to individuals exposed to scrap metal at various stages of the scrap recovery process, including transport, processing, and disposal workers, as well as consumers of products containing scrap metal. For example, we estimate the dose that would be received by a truck driver who transports scrap metal to a processing facility, a worker who cuts the metal prior to processing, workers exposed to the metal at various stages in the production process, workers who use tools or machinery manufactured from the recovered metal, and consumers who use products (e.g., a kitchen range or frying pan) made from recovered metal. We also estimate the dose that would be received by an individual who consumes groundwater contaminated by slag leachate from a metal recovery facility, and the dose that would be received by a subsistence farmer whose crops are contaminated by air emissions from a metal recovery plant. These doses can then be scaled to develop release standards that are protective of the most exposed individual (e.g., release standards that reduce doses to less than 1.0 mrem per year for the most exposed individual). Using models that incorporate the release standards developed in the individual risk analysis, the collective impacts analysis estimates the number of cancer cases that would occur under baseline requirements and under each of the analytic options.

The analysis described above yields three categories of impacts potentially attributable to EPA's rulemaking:

! **Cost impacts**. EPA's new standards may increase or decrease management costs for scrap metal that exhibits surface contamination, depending upon whether the standards impose release limits that are lower or higher than current limits. These impacts are the subject of Chapter 4. If EPA's release limits are lower, allowing less residual surface contamination than current standards, then scrap metal management costs are likely to increase, since more metal is likely to require decontamination prior to release. In some cases, the value of the metal to be recovered is unlikely to justify the additional decontamination costs, resulting in a decrease in the quantity of metal released and an equivalent increase in the quantity disposed. The opposite is likely to hold true if EPA's standards allow more residual surface contamination than current guidelines; more metal will qualify for release without decontamination, and more metal will be recovered rather than disposed.

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[7] The Technical Support Document (TSD), which accompanies this report, explains the method in detail.

EPA's new standards are unlikely to increase management costs for volumetrically-contaminated scrap metal, since the current lack of generic guidelines for the release of such metal would likely result in most or all of it being disposed. To the extent that decontamination and release of such metal under EPA's standards would be more cost-effective than disposal, EPA's rulemaking would reduce management costs for volumetrically-contaminated metal.

! **Predicted changes in cancer risks**. EPA's new standards may increase or decrease the number of cancer cases predicted to occur in the population over the next 1,000 years. The direction of the change depends on the amount of scrap metal released and on whether the release limits that EPA establishes are higher or lower than existing standards. These changes are the subject of Chapter 5.

! **Other impacts**. EPA's rulemaking may have a variety of other impacts in addition to those cited above. These impacts include changes in the markets for scrap metal and waste disposal capacity, as well as effects on non-cancer human health risks, ecological impacts, and demand for virgin materials. In this phase of the analysis, we address these issues qualitatively. These impacts are the subject of Chapter 6.

We discuss these impacts in detail below.

COMPARISON OF COSTS AND BENEFITS

Exhibit ES-2 summarizes the results of the preliminary analysis for each of the three analytic options considered. We include the results for both the low and high disposal cost scenarios, assuming initial activity levels at the midpoint of the ranges estimated for the scrap metal of interest. Future disposal costs have been discounted to 1997 dollars using a real discount rate of seven percent. The results of the human health risk analysis indicate the change in number of cancer cases predicted to occur over 1,000 years.

0.1 Mrem Option

As illustrated in the exhibit, we estimate that the 0.1 mrem option would increase scrap metal management costs by $0.2 to $0.5 billion and decrease cancer incidence by eight to 14 cases. This result is expected, since a 0.1 mrem standard would set lower release limits than current standards,

Exhibit ES-2

POTENTIAL IMPACTS OF EPA CLEARANCE STANDARDS

Impact[1]	**0.1 mrem Option**			**1.0 mrem Option**			**15.0 mrem Option**		
	Total	**DOE Facilities**[5]	**NRC Facilities**[6]	**Total**	**DOE Facilities**[5]	**NRC Facilities**[6]	**Total**	**DOE Facilities**[5]	**NRC Facilities**[6]
Change in Costs[2]	$0.20 - $0.47	$0.03 - $0.06	$0.17 - $0.41	$0.0 - ($0.02)	($0.04) - ($0.04)	$0.04 - $0.03	($1.40) - (1.65)	($1.36) - ($1.58)	($0.04) - ($0.08)
Change in Cancer Incidence[3]	(8.2) - (14.3)	negligible	(8.2) - (14.3)	(6.3) - (10.0)	negligible	(6.3) - (10.0)	19.2 - 28.8	1.2 - 1.2	17.9 - 27.6
Other Impacts[4]	uncertain			uncertain			uncertain		

Notes:

1 Low and high values represent results under low and high disposal cost scenarios, respectively, relative to current release guidelines (Regulatory Guide 1.86). The values shown are based upon initial levels of radioactivity at the logarithmic midpoint of the range reported for each scrap metal item.

2 Expressed in billions of 1997 dollars; costs discounted to their present value using a real discount rate of seven percent.

3 Total cases (fatal and non-fatal) predicted to occur over 1,000 years.

4 Includes other economic impacts potentially attributable to the rulemaking such as effects on scrap metal markets and non-cancer human health and environmental effects. These impacts are likely to be small, and insignificant relative to impacts on scrap metal management costs and cancer incidence.

5 Includes scrap metal generated by 11 large DOE facilities.

6 Includes scrap metal generated by 123 NRC-licensed commercial nuclear power reactors.

making it more costly to decontaminate scrap metal to meet the limits and lowering the residual activity in released metal. A change in the disposition of scrap metal from NRC-licensed commercial nuclear power reactors accounts for nearly all of the cost increase, as only 11 to 31 percent of available scrap metal from these facilities would be released under the 0.1 mrem standard, compared to 62 percent to 74 percent under current standards. In contrast, the analysis suggests that changes in the management of scrap metal from the 11 major DOE facilities would have little impact on costs; we estimate that only six to nine percent of the DOE facilities' scrap metal would be released under current standards, and that none of this metal would be released under the 0.1 mrem standard.

With more scrap metal flowing to burial under the 0.1 mrem option and lower activity levels in the scrap metal that is released, the 0.1 mrem standard yields an estimated reduction in cancer risks of eight to 14 cases. Again, a change in the management of scrap metal from NRC-licensed commercial nuclear power reactors accounts for most of the predicted impact, as metal that would be released under the current standards would instead flow to burial.[8] The estimated change in cancer incidence associated with management of scrap metal from DOE facilities is minimal, since most of the affected scrap metal would be buried under both current standards and the 0.1 mrem option.

1.0 Mrem Option

Our analysis of the 1.0 mrem option shows minimal cost impacts relative to the current standards (savings of zero to $20 million) and a decrease in predicted cancer incidence of six to 10 cases over the 1,000-year modeling period. The estimated cost savings, which are attributable entirely to the management of scrap metal from DOE facilities, largely stem from the availability of a volumetric release standard. Under current guidelines, no generic standards exist for the release of volumetrically contaminated metal; this not only limits the recovery of volumetrically contaminated items, but generally rules out melting as a scrap metal decontamination and recovery option. As a result, disposal is the only practical management method for volumetrically contaminated scrap metal or for items for which melting is the only feasible or cost-effective recovery technology. The establishment of a volumetric clearance standard under EPA's rulemaking would create opportunities to recover volumetrically contaminated metal, and would also make melting a more viable metal recovery practice, thus allowing material that otherwise would be buried to be released instead.

In contrast to the change in scrap management costs, the change in predicted cancer incidence under the 1.0 mrem option is primarily attributable to changes in the management of scrap metal from NRC-licensed commercial nuclear power reactors. We estimate that the same volume of scrap metal from these reactors (61 to 85 percent of the total) would be released under both current standards and the 1.0 mrem option. The 1.0 mrem standard, however, would establish lower release limits for the indicator radionuclides at NRC facilities, thereby increasing the extent to which it would be

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[8] In this preliminary analysis, we assume that burial has zero cancer risk.

necessary to decontaminate such metal prior to release. The resulting assumed reduction in residual activity levels accounts for the predicted reduction in cancer incidence.[9]

15.0 Mrem Option

A 15.0 mrem standard would allow higher release limits than the current standards, yielding estimated cost savings of $1.4 billion to $1.7 billion but prompting an increase in predicted cancer incidence of 19 to 29 cases. Again, a change in the management of scrap metal from DOE facilities accounts for most of the estimated cost savings, as 98 percent of the DOE facilities' total scrap metal inventory would be released for unconditional use (compared to only six to nine percent under current standards). Most of this scrap metal (94 percent) would not require prior decontamination. We estimate that NRC-licensed commercial nuclear power reactors would release up to 84 percent of their total scrap metal inventory under this option, which is slightly more than under current standards, and would also realize some savings due to lower decontamination costs. Unlike the DOE facilities, approximately 72 percent of the scrap metal released from the commercial nuclear power reactors would require decontamination prior to release.

Despite the large increase in the quantity of DOE scrap metal likely to be released, this scrap metal accounts for only a small percentage of the projected increase in cancer incidence under the 15.0 mrem standard. This result is largely due to the higher activity levels that are assumed to be associated with scrap metal from the commercial nuclear power reactors. Our analysis assumes that final activity levels in scrap metal items decontaminated prior to release are at the maximum levels allowed under each option, while final activity levels in scrap metal released directly from facilities with no prior decontamination are equal to starting activity levels. As noted above, we estimate that 94 percent of the DOE facilities' scrap metal could be released under the 15.0 mrem option without prior decontamination, compared to only 28 percent of scrap metal from NRC-licensed commercial nuclear power reactors. As a result, the analysis treats final activity levels for scrap metal released from DOE facilities as lower, on average, than final activity levels for the scrap metal generated by the commercial power reactors. In addition, the radionuclides and exposure pathways that drive the cancer risk analysis also differ for the two source categories. In the analysis of scrap metal from DOE facilities, U-238 is responsible for virtually all of the change in predicted cancer incidence; the key exposure pathway is exposure to workers handling slag. In contrast, Co-60 accounts for the majority of predicted cancer cases related to exposure to scrap metal from NRC-licensed commercial nuclear power reactors; in this case, the dominant exposure pathway is through consumer products. These

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[9] In this preliminary analysis, the radionuclide primarily responsible for the health impacts attributed to scrap metal from NRC-licensed commercial nuclear power plants is Cobalt-60 (Co-60). The surface activity limit (dpm/100cm^2) corresponding to a 1.0 mrem dose for Co-60 is approximately one-fifth of the limit currently prescribed in Regulatory Guide 1.86.

differences indicate that our assumptions concerning the types of nuclides present in the scrap metal and related activity levels can significantly affect the results of our risk assessment.

Other Impacts

EPA's rulemaking may have additional impacts on a variety of factors, including: (1) scrap metal market prices and the demand for low level radioactive waste disposal capacity; (2) non-carcinogenic human health risks; (3) ecological impacts; and (4) demand for virgin materials (e.g., iron ore). Based on our preliminary review of these issues, it is likely that these impacts are small and insignificant compared to direct cost effects and impacts on cancer risks. As a result, we have not attempted to quantify these impacts or to differentiate their magnitude across the three analytic options.[10] We may revisit these issues in subsequent phases of this analysis.

CONCLUSIONS

Although these results are preliminary and subject to considerable uncertainty, we can draw the following initial conclusions from the analysis.

- **The analysis provides useful information on the relative impacts of the three analytic options.** The results provide rough measures of the relationship of each option to the current standards; however, they should not be interpreted as providing precise absolute estimates of either disposition costs or potential cancer incidence.

- **Cost impacts and predicted cancer risks vary considerably across the three analytic options.** The predicted change in scrap metal management costs ranges from an increase of up to $0.5 billion under the 0.1 mrem standard to savings of up to $1.7 billion under the 15.0 mrem standard. In addition, the 0.1 mrem standard yields an estimated decrease in cancer incidence of up to 14 cases over 1,000 years, while the 15.0 mrem standard yields an estimated increase of up to 28 cases. These results, however, are highly dependent on a range of assumptions, including those concerning baseline practices and numerous others embedded in our risk modeling.

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[10] This preliminary analysis does not address several other potentially significant impacts, including environmental justice issues, effects on small businesses, and the relationship of EPA's standards to other governmental programs. Assessments of these potential impacts may be conducted over the next several months.

- **The relationship between predicted changes in costs and predicted changes in cancer risks varies across the three analytic options.** Under the 15.0 mrem standard, costs are predicted to decrease relative to costs under the current standards, while cancer risks are predicted to increase. The 0.1 mrem standard yields the opposite result, with a predicted increase in costs but a predicted decrease in cancer risks. In contrast, the analysis suggests that scrap metal management costs would remain relatively unchanged under the 1.0 mrem option, while cancer risks are predicted to decline.

- **The results of the analysis are highly dependent upon the assumed radiological profiles of affected scrap metal.** For example, the differences in predicted cost and cancer impacts for scrap metal from DOE facilities and scrap metal from NRC-licensed commercial nuclear power reactors are largely attributable to differences in the assumed mix of dominant radionuclides and related activity levels in the scrap metal generated by the respective complexes. The results of the analysis are extremely sensitive to variation in radiological profiles.

KEY UNCERTAINTIES AND NEXT STEPS

Each component of the analysis, including identifying and characterizing affected volumes of scrap metal, estimating baseline and post-regulatory scrap metal management practices and costs, and estimating changes in human cancer risks, has associated limitations. The key areas of uncertainty include:

- **Scrap metal characteristics data.** Available information on the year in which scrap metal is likely to become available for recycling, the metal's radiological characteristics, and its physical form is limited and highly uncertain. These uncertainties may lead us to either under- or overstate the effects of alternate release standards.[11]

- **Future scrap metal disposition practices and related costs.** The analysis does not consider restricted recycling, which may lead us to overstate total scrap metal management costs and the quantities of metal likely to be disposed

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[11] In addition, the analysis probably understates the total amount of scrap metal potentially affected by EPA's rule, since it focuses only on metal from 11 major DOE facilities and NRC-licensed commercial nuclear power plants; other Federal and non-federal facilities will also be affected by the rulemaking.

or released for unconditional use. Moreover, decontamination costs are likely to change as the industry evolves, and disposal options are difficult to predict, creating additional analytic uncertainty. Finally, the analysis assumes that generators will select the least-cost disposition option, ignoring the effects of non-economic factors (e.g., public opinion) that may discourage release of scrap metal. To the extent that non-economic factors influence decision-making, we likely understate scrap metal management costs and overstate the quantity of metal likely to be released for unconditional use.

! **Predicted cancer risks.** The risk model employs a number of conservative assumptions that may lead it to overestimate doses under various exposure scenarios. In addition, our cost model estimates the maximum quantity of scrap metal that could be released for unconditional use under the proposed standards and assumes that decontamination efforts reduce activity levels only to the maximum permitted under each release standard, leading to potential overstatement of collective cancer impacts. We are uncertain, however, how these limitations may affect our assessment of the relative effects of each of the analytic options.

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