4. ENVIRONMENTAL CONSEQUENCES

4.1 OVERVIEW OF ENVIRONMENTAL IMPACTS

The impacts associated with incident-free operation and during postulated accidents are presented and discussed in this chapter. Supplemental information and supporting data are given in Appendices B through F. Many of the impacts in this chapter are different from the impacts presented in the Draft EIS. Some of the changes occurred because DOE re-evaluated many of the processing technologies. DOE also changed the frequency of severe damage due to earthquakes at Buildings 707 and 707A at Rocky Flats because structural calculations were finished after the Draft EIS was published. Furthermore, the calculations of the potential for worker health impacts due to exposure to hazardous chemicals were changed to account for more realistic assumptions.

4.1.1 Presentation of the Environmental Impacts

Nineteen categories and subcategories of plutonium residues and scrub alloy are analyzed in this Environmental Impact Statement (EIS). The material in each category can be processed with various technologies, some of which would require transporting the material from the Rocky Flats Environmental Technology Site (Rocky Flats) to another U.S. Department of Energy (DOE) site.

For each material category, the impacts associated with any given procesing technology can be compared to the impacts associated with other processing technologies for the same material category. This analytical approach allows decision makers and the public to understand the impacts of each processing technology for each material category and subcategory independently. The impacts of each processing technology for the 19 material categories and subcategories are presented and compared to each other in Sections 4.2 through 4.11.

The first processing technology listed under each material category in Sections 4.2 through 4.11 is the no action processing technology. To calculate the total impacts of processing all the plutonium residues and scrub alloy under the No Action Alternative, DOE summed the impacts that would result from the no action processing technologies for all material categories. The total environmental impacts of the No Action Alternative are presented in Section 4.20.

The Preferred Alternative is a set of specific processing technologies, one for each material category. To calculate the total impacts of processing all the plutonium residues and scrub alloy under the Preferred Alternative, DOE summed the impacts that would result from the preferred processing technologies for each material category. The total environmental impacts of the Preferred Alternative are presented in Section 4.21.

In addition to the No Action and Preferred Alternatives, DOE analyzed six other strategic management approaches. The environmental impacts of all eight strategic management approaches are compared to each other in Section 4.22.

Finally, DOE has determined the lowest and highest potential impacts associated with all materials in this EIS at each site to obtain the range of potential impacts at each site. These impacts are presented in Section 4.23. Similarly, transportation from Rocky Flats to other sites for processing would generate impacts, and the range of these impacts is presented in Section 4.24. Cumulative impacts are discussed in Section 4.25.

The primary impacts of concern are products and wastes and impacts on the public and occupational health and safety associated with the various plutonium residue and scrub alloy management activities. Additional impacts and topics covered in Chapter 4 include the following:

- Nuclear Nonproliferation
- Air Quality
- Water Quality
- Post-processing Storage
- Post-processing Transportation
- Disposal/Disposition Activities
- Environmental Justice
- Costs
- Socioeconomics
- Materials, Utilities, and Energy
- Short-term versus Long-term Resource Commitments
- Irreversible and Irretrievable Resource Commitments.

Several kinds of impacts are not discussed in Chapter 4 because they will not occur, they will be extremely small, and/or they are covered by other analyses:

❒ **Land—**The management of plutonium residues and scrub alloy would not require the construction of new facilities on previously undisturbed land at Rocky Flats, the Savannah River Site, or Los Alamos National Laboratory. If any additional waste storage buildings are required, they would be constructed on land which has already been used for industrial purposes. New construction, if necessary, would have no impact on undisturbed land resources. In the event of a major accident, some radioactive material could be deposited on the land downwind of the accident site. Analysis of this impact is covered in site-specific and facility-specific environmental and safety documentation.

❒ **Intrasite Transportation—**The incident-free impacts of intrasite transportation are limited to radiation exposure to workers loading and unloading trucks and are included in the overall worker dose values presented for each process. The accident risks are bounded by the site accident risk analysis. Strict site safety procedures and short travel distances limit the impacts to workers.

❒ **Noise—**Noise impacts at the processing sites should be minor and limited to noises generated during operations. If a new building is required for storage of residues at Rocky Flats, impacts from construction noise would not extend beyond the site boundaries. No offsite noise impacts are expected except for minor changes in traffic noise levels.

❒ **Ecological Resources—**Because no new construction in undisturbed areas would be required for DOE's management of plutonium residues and scrub alloy, there would be no clearing of native vegetation. Thus, there would be no negative impacts from construction on terrestrial or aquatic plants or animals.

Scientific evidence indicates that chronic radiation doses below 0.1 rad per day do not harm animal or plant populations (IAEA 1992). This is equivalent to 100 mrem per day for direct radiation and greater than 100 mrem per day for ingestion of plutonium. Compliance with DOE Order 5400.5 to limit the exposure of the most exposed member of the public to 100 mrem per year (i.e., about 0.3 mrem per day) makes it highly probable that dose rates to plants and animals in the same area would be less than 0.1 rad per day.

Therefore, no radiological damage to plant and animal populations would be expected as the result of the plutonium residue and scrub alloy management activities.

Chemicals emitted to the environment during routine processing activities are presented in Appendix D, Section D.4.3. In addition, Section 4-12 contains modeled airborne concentrations for the chemicals emitted that have the potential to impact plants or animals. Most of these chemicals should not impact plants or animals because either the amounts emitted are very low or the chemicals have little potential for causing negative effects. However, at high enough concentrations the strong acids (e.g., nitric acid, hydrochloric acid), carbon tetrachloride, volatile organic compounds, and the gaseous fluorides have the potential to cause negative impacts in certain environments (e.g., water bodies).

DOE is continuing informal consultation with the U.S. Fish and Wildlife Service to comply with Section 7 of the Endangered Species Act. DOE has determined, based on analyses in this Final EIS, that the proposed action, including the preferred alternative, is not likely to adversely affect threatened or endangered species or critical habitats. DOE will forward this determination to the U.S. Fish and Wildlife Service to complete the consultation prior to issuing the Record of Decision.

For the reasons discussed above, no adverse impacts to ecological resources would be expected to occur due to DOE's management of plutonium residues and scrub alloy.

❒ **Cultural and Paleontological Resources—**Any new facility construction would be in previously disturbed areas, where any near-surface cultural or paleontological resources probably would have been obliterated by past construction. Any new facilities required for residues storage probably would be prefabricated buildings that could be erected with only limited excavation.

4.1.2 Products and Wastes

❒ **Generation—**All the processing options in this EIS would change plutonium residues or scrub alloy into other forms. Plutonium residues and scrub alloy are the inputs—products and wastes are the outputs. The products and wastes are better suited for storage, transportation, and disposal or other disposition than the existing plutonium residues and scrub alloy. The products and wastes fall into several distinct categories:

- **Stabilized residues** would be generated under Alternatives 1 and 4. As the term is used in this EIS, stabilized residues contain plutonium concentrations in excess of the safeguards termination limits. Thus, stabilized residues would not be acceptable for disposal at the Waste Isolation Pilot Plant (WIPP) unless a variance to the safeguards termination limits is applied. DOE has approved variances for several specific stabilized residues. These stabilized residues from Alternative 4 would be acceptable for disposal in WIPP as transuranic waste.

- **Transuranic waste** refers to processed materials that contain plutonium concentrations below the safeguards termination limits. It also refers to secondary waste, such as disposable clothing and laboratory equipment. Transuranic waste would be generated from all plutonium residues and scrub alloy under all the processing technologies. This waste could be disposed of in WIPP.

- Materials to be managed as **high-level waste** would be generated only at the Savannah River Site. The final form would be solid glass inside stainless steel canisters. This waste would be stored at the Savannah River Site until a monitored geologic repository is ready to receive it.

- ♦ **Separated plutonium** from the residues and/or scrub alloy would be in either a metal or oxide form. The separated plutonium would be stored in secure facilities along with the plutonium already in storage until decisions can be made about its disposition. DOE would not use this plutonium for nuclear explosive purposes (DOE 1994b).

- ♦ **Low-level waste** would be generated from all plutonium residues and scrub alloy under all the processing options. This waste would be disposed of in existing facilities using routine procedures.

- ♦ **Saltstone** would be generated only at the Savannah River Site. Saltstone is a form of concrete containing low levels of radioactivity and would be disposed of onsite.

❐ **Waste Minimization—**DOE would incorporate the best available practices into all the processing technologies at all three sites in order to generate the smallest possible amounts of wastes, and to comply with DOE's waste minimization and pollution prevention goals. The preferred processing technology for a residue category may not always exhibit the lowest amount of waste among all the possible processing technologies, but waste generation impacts were an important consideration in identifying the preferred processing technologies and will be considered again by DOE in making decisions on processing technologies.

In 1996, Rocky Flats, through its commitment to waste minimization, was able to reduce waste generation by an estimated total of 980 cubic meters (34,600 cubic feet) at an estimated cost savings of $66,000. Rocky Flats reduced radioactive waste generation in 1996 by 10 percent compared to 1993 baseline levels, whereas, mixed waste generation was reduced by 90 percent and hazardous waste generation was reduced by 32 percent. Eight percent of sanitary waste was recycled in 1996, and 74 percent of the materials purchased under the affirmative procurement process were U.S. Environmental Protection Agency- (EPA-) designated recycled products (DOE 1997b).

The Savannah River Site conducted pollution prevention projects in 1996 that reduced waste generation by an estimated 8,400 cubic meters (296,600 cubic feet) at a cost savings of $17.4 million. Radioactive waste generation in 1996 was reduced by 63 percent compared to 1993 baseline levels. Hazardous waste generation was reduced by 12 percent, and sanitary waste generation was reduced by 58 percent compared to baseline levels. Thirty-one percent of sanitary waste was recycled in 1996, and 36 percent of the materials purchased under the affirmative procurement process were EPA-designated recycled products (DOE 1997b).

In 1996, the Los Alamos National Laboratory conducted pollution prevention projects that reduced radioactive waste generation by 70 percent compared to 1993 baseline levels. Mixed waste generation was reduced by 42 percent, hazardous waste generation was reduced by 71 percent, and sanitary waste was reduced by 26 percent over baseline levels (DOE 1997b).

4.1.3 General Radiological and Chemical Health Consequences

The methodologies used to evaluate potential radiological and chemical health effects are described in Appendix D. This section provides information about the development and interpretation of the health risk estimates.

❐ **Radiological—**The effect of radiation on people depends upon the kind of radiation exposure (alpha, beta, and neutron particles and gamma and x-rays) and the total amount of tissue exposed to radiation. The amount of radiant energy imparted to tissue from exposure to ionizing radiation is referred to as absorbed dose. The sum of the absorbed dose to each tissue, when multiplied by certain quality and weighting factors that take into account radiation quality and different sensitivities of these various tissues, is referred to as effective dose equivalent.

An individual may be exposed to radiation from outside the body, or from inside the body because radioactive materials may enter the body by ingestion or inhalation. External dose is different from internal dose in that it is delivered only during the actual time of exposure. An internal dose, however, continues to be delivered as long as the radioactive source is in the body (although both radioactive decay and elimination of the radionuclide by ordinary metabolic processes decrease the dose rate with the passage of time). The dose from internal exposure is calculated over 50 years following the initial exposure.

The regulatory annual radiation dose limits to the maximally exposed member of the public from total operations at a DOE site are 10 mrem from atmospheric pathways, 4 mrem from the drinking water pathway, and 100 mrem from all pathways combined (DOE Order 5400.5 and 40 Code of Federal Regulations (CFR) Part 61, Subpart H). The potential doses associated with the normal processing and storage of plutonium residues and scrub alloy are very small factions of these values, and total site doses will remain well within these DOE limits. For comparison, DOE estimates that the average individual in the United States receives a dose of approximately 350 mrem per year from all radiation sources combined, including natural and medical sources.

The maximally exposed individual worker doses listed in this chapter assume that an individual worker receives the maximum annual dose allowed under current DOE regulations and guidance, instead of being based on the total amount of residue. Maximally exposed individual worker doses will be kept below the DOE Standard of 5,000 mrem per year (10 CFR Part 835). Furthermore, as low as reasonably achievable principles will be exercised to maintain individual worker doses below the DOE Administrative Control Level of 2,000 mrem per year (DOE 1994d). Each DOE site also maintains its own Administrative Control Level; for the sake of consistency, however, DOE used the 2,000 mrem per year level throughout this EIS. Transportation workers (i.e., drivers) will be held to an annual limit of 100 mrem per year because they are not certified radiation workers. All worker doses are routinely monitored; if any individual worker's dose approaches the annual limit, he or she would be rotated into another job.

The collective or "population" dose to an exposed population is calculated by summing the estimated doses received by each member of the exposed population. The total population dose received by the exposed population is measured in person-rem. For example, if 1,000 people each received a dose of 0.001 rem, the population dose would be 1.0 person-rem (1,000 persons × 0.001 rem = 1.0 person-rem). The same population dose (1.0 person-rem) would result if 500 people each received a dose of 0.002 rem, (500 persons × 0.002 rem = 1 person-rem).

Radiation can cause a variety of adverse health effects in people. A large dose of radiation can cause prompt death. At low doses of radiation, the most important adverse health effect for depicting the consequences of environmental and occupational radiation exposures (which are typically low doses) is the potential inducement of cancers that may lead to death in later years. This effect is referred to as latent cancer fatalities because the cancer may take years to develop and for death to occur.

In addition to latent cancer fatalities, other health effects could result from environmental and occupational exposures to radiation. These effects include nonfatal cancers among the exposed population and genetic effects in subsequent generations. **Table 4–1** shows the dose-to-effect factors for these potential effects as well as for latent cancer fatalities. For simplicity, this EIS presents estimated effects of radiation only in terms of latent cancer fatalities. Nonfatal cancers and genetic effects are less probable consequences of radiation exposure.

Table 4–1 Risk of Latent Cancer Fatalities and Other Health Effects from Exposure to One Rem of Radiation [a]

Population [b]	*Latent Cancer Fatalities*	*Nonfatal Cancers*	*Genetic Effects*	*Total Detriment*
Workers	0.0004	0.00008	0.00008	0.00056
Public	0.0005	0.0001	0.00013	0.00073

[a] When applied to an individual, units are lifetime probability of latent cancer fatalities per rem of radiation dose. When applied to a population of individuals, units are excess number of cancers per person-rem of radiation dose. Genetic effects as used here apply to populations, not individuals.

[b] The difference between the worker risk and the general public risk is attributable to the fact that the general population includes more individuals in the more sensitive age group of less than 18 years of age.

Note: One rem equals 1,000 mrem.

The factors used in this EIS to relate a dose to its effect is 0.0004 latent cancer fatalities per person-rem for workers and 0.0005 latent cancer fatalities per person-rem for individuals among the general population. The latter factor is slightly higher because some individuals in the public, such as infants and children, are more sensitive to radiation than workers. These factors are based on the *1990 Recommendations of the International Commission on Radiological Protection* (ICRP 1991), and are consistent with those used by the U.S. Nuclear Regulatory Commission in its rulemaking *Standards for Protection Against Radiation* (NRC 1991). The factors apply where the dose to an individual is less than 20 rem and the dose rate is less than 10 rem per hour. At higher doses and dose rates, the factors used to relate radiation doses to latent cancer fatalities are doubled. At much higher doses, prompt effects, rather than latent cancer fatalities, may be the primary concern.

These concepts may be applied to estimate the effects of exposing a population to radiation. For example, if 100,000 people were each exposed only to natural background radiation (0.3 rem per year), 15 latent cancer fatalities per year would be expected (100,000 persons × 0.3 rem per year × 0.0005 latent cancer fatalities per person-rem = 15 latent cancer fatalities per year).

Sometimes, calculations of the number of latent cancer fatalities associated with radiation exposure do not yield whole numbers and, especially in environmental applications, may yield numbers less than 1.0. For example, if 100,000 people were each exposed to a total dose of only 1 mrem (0.001 rem), the population dose would be 100 person-rem, and the corresponding estimated number of latent cancer fatalities would be 0.05 (100,000 persons × 0.001 rem × 0.0005 latent cancer fatalities per person-rem = 0.05 latent cancer fatalities).

The *average* number of deaths that would result if the same exposure situation were applied to many different groups of 100,000 people is 0.05. In most groups, nobody (zero people) would incur a latent fatal cancer from the one mrem dose each member would have received. In a small fraction of the groups, one latent fatal cancer would result; in exceptionally few groups, two or more latent fatal cancers would occur. The average number of deaths over all the groups would be 0.05 latent fatal cancers (just as the average of 0,0,0, and 1 is 1/4, or 0.25). The most likely outcome is zero latent cancer fatalities.

These same concepts apply to estimating the effects of radiation exposure on a single individual. Consider the effects, for example, of exposure to natural background radiation over a lifetime. The “number of latent cancer fatalities” corresponding to a single individual’s exposure to 0.3 rem per year over a (presumed) 72-year lifetime is:

1 person × 0.3 rem per year × 72 years × 0.0005 latent cancer fatalities per person-rem = 0.011 latent cancer fatalities or slightly more than one chance in 100 of a latent cancer fatality.

Again, this should be interpreted in a statistical sense; that is, the estimated effect of natural background radiation exposure on the exposed individual would produce a 1.1 percent chance that the individual would incur a latent fatal cancer. Alternatively, this method estimates that about 1 person in 91 would die of cancers induced by natural background radiation.

The estimates of health effects from radiation doses used in this EIS are based on the linear no-threshold theory of radiation carcinogenesis, which postulates that all radiation doses, even those close to zero, are harmful. A recent examination of low radiation studies has reported that no statistically significant low-dose radiation study was found to support the linear no-threshold theory (Polycove 1997). This finding is supported by the National Council of Radiation Protection and Measurements in a report on collective dose that states ". . . essentially no human data can be said to prove or even to provide direct support for the concept of collective dose with its implicit uncertainties of nonthreshold, linearity and dose-rate independence with respect to risk" (NCRP 1995). Accordingly, calculations of health impacts based on the linear no-threshold theory may overstate the actual impacts of low radiation doses and should be viewed as an upper bound on the potential health effects.

❒ **Chemical—**The potential impacts of exposure to hazardous chemicals released to the atmosphere as a result of the processing of plutonium residues and scrub alloy were evaluated for the incident-free operation of processing facilities at Rocky Flats and at the Savannah River Site. No hazardous chemicals are expected to be released from the proposed processing at Los Alamos National Laboratory. The receptors considered in these evaluations include the offsite population in the vicinity of the sites and noninvolved workers located onsite at Rocky Flats and the Savannah River Site. Impacts were also evaluated for the maximally exposed individual member of the offsite and worker populations. The health effect endpoints evaluated in this analysis include excess incidences of latent cancers and chemical-specific noncancer health effects. The maximally exposed individual is located in the region with the highest estimated concentration. The Hazard Index results for the maximally exposed individual member of the public and the maximally exposed individual worker are different from those presented in the Draft EIS because the earlier calculations were more conservative than necessary and process source terms have been revised. In addition, the Final EIS considers only those chemicals which are toxic by the inhalation route of exposure. The cancer incidence probability estimates have also been revised in the Final EIS based on the revised process source terms. At Rocky Flats, the maximum concentration for the noninvolved worker is estimated to occur at a distance of 170 meters (m) (560 feet [ft]) south-southeast of Building 371. The maximum modeled offsite concentration occurred on the facility boundary 1.6 kilometers (km) (1.0 mile [mi]) northwest of the stack location. At the Savannah River Site, the maximum modeled onsite concentration occurred at a distance of 370 m (1,230 ft) west-southwest of the stack location. The maximum modeled offsite concentration occurred just outside the site boundary, at a distance of approximately 10 km (6.1 mi) northwest of the stack location (SAIC 1998).

Appendix D, Section D.4 describes the methods, assumptions, and source terms used in evaluating the health impacts of exposures to hazardous chemicals. Not all of the chemicals potentially released from the proposed action processing at Rocky Flats and the Savannah River Site that are listed in Appendix D were used to estimate health risks. Some of the chemicals are inert (e.g., argon), some are innocuous in ambient air (e.g., calcium, calcium oxide, water vapor, and carbon dioxide) and some (e.g., fluorides) are not toxic by inhalation exposure. The toxicity of some of the chemicals is not well characterized (e.g., tributyl phosphate and n-dodecane), and some are addressed as air pollutants in Section 4.12 (e.g., volatile organic compounds, NO_x). Of the chemicals potentially released in the processing of plutonium residues and scrub alloy, only the following hazardous chemicals have Reference Concentration (RfC) values or cancer inhalation unit risk factors available in EPA's Integrated Risk Information System (EPA 1991a, 1991b, 1995a, 1995b):

Chemical	***Cancer Inhalation Unit Risk Factor***	***Reference Concentration***
Carbon tetrachloride	0.000015 per µg/m^3	Not available
Hydrochloric acid	Not available	0.02 mg/m^3
Phosphoric acid	Not available	0.01 mg/m^3
Ammonium nitrate (as ammonia)	Not available	0.1 mg/m^3

The potential health risks resulting from exposure to hazardous chemicals released as a result of accidents at processing facilities were not quantitatively evaluated for any of the processing options considered in this EIS. The impacts of chemical exposures from relevant facility accidents at Building 371 at Rocky Flats and at the F- and H-Area separation facilities of the Savannah River Site have been evaluated in other investigations, such as the *Rocky Flats Cumulative Impacts Document* (DOE 1997), *the Rocky Flats Environmental Technology Site, Basis for Interim Operation, Building 371/374 Complex* (KHC 1997) and the Savannah River Site *Final Environmental Impact Statement, Interim Management of Nuclear Materials* (DOE 1995b). The results of these analyses are summarized in Appendix D, Section D.4.5, and are incorporated in this EIS by reference. The results indicate that the consequences for the most exposed member of the offsite population and onsite noninvolved workers would be low and could be mitigated by emergency response actions. Workers involved in the facility processes may experience serious injury or fatalities as a result of their proximity to the release sources. The impacts of chemical releases as a result of accidents at the proposed plutonium residue and scrub alloy processing facilities at Building 371 at Rocky Flats and the F-Area at Savannah River Site are addressed and estimated in these other investigations. These analyses are representative of potential chemical accident risks for the proposed actions because they address the same or similar facilities using similar chemicals in relevant scenarios. Because chemical inventories for the H-Area separation facilities of the Savannah River Site are similar to those estimated for the F-Area, potential impacts also are expected to be similar.

At the Los Alamos National Laboratory, no hazardous chemicals would be used in the distillation of pyrochemical salts, and only relatively small amounts of hydrochloric acid would be used in the water leach and the acid dissolution processing of direct oxide reduction pyrochemical salts. Therefore, the potential impacts of hazardous chemical exposures from facility accidents at this site were not quantitatively evaluated in this EIS. Additional information on chemical accident risks at Los Alamos, which is incorporated by reference, is presented in the Draft Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory (DOE 1998c).

4.1.4 Risks

Another concept important to the presentation of results in this EIS is the concept of risk. Risks are most important when presenting accident analysis results. The chance that an accident might occur during the conduct of an operation is called the probability of occurrence. An event that is certain to occur has a probability of 1.0 (as in a 100 percent certainty). If an accident is expected to happen once every 50 years, the frequency of occurrence is 0.02 per year (1 occurrence every 50 years = 0.02 occurrences per year). A frequency estimate can be converted to a probability statement. If the frequency of an accident is 0.02 per year, the probability of the accident occurring in a 10-year program is 0.2 (10 years × 0.02 occurrences per year).

Once the frequency (occurrences per year) and the consequences (for radiation effects, measured in terms of the number of latent cancer fatalities caused by the radiation exposure) of an accident are known, the risk can be determined. The risk per year is the product of the annual frequency of occurrence times the number of latent cancer fatalities. This annual risk expresses the expected number of latent cancer fatalities per year, taking account of both the annual chance that an accident might occur and the estimated consequence if it does occur.

For example, if the frequency of an accident were 0.2 occurrences per year and the number of latent cancer fatalities resulting from the accident were 0.05, the risk would be 0.01 latent cancer fatalities per year (0.2 occurrences per year × 0.05 latent cancer fatalities per occurrence = 0.01 latent cancer fatalities per year). Another way to express this risk (0.01 latent cancer fatalities per year) is to note that if the operation subject to the accident continued for 100 years, one latent cancer fatality would be likely to occur because of accidents during that period. This is equivalent to 1 chance in 100 that a single latent cancer fatality would be caused by the accident source for each year of operation. This risk can be related to the risk of death from other accidental causes for comparison. As an example, the risk of dying from a motor vehicle accident is about 1 chance in 80. Similarly, the risk of death for the average American from fire is approximately 1 chance in 500, and from death from accidental poisoning, the risk is about 1 chance in 1,000 (NNPP 1993).

The accident risks presented in this EIS do not always agree with the accident risks presented in site-specific safety documentation (e.g., Los Alamos National Laboratory Safety Analysis Reports, Rocky Flats Cumulative Impacts Document, etc.). The differences in the results may be attributed to differences in one or more of the following:

- Computer codes used for analysis
- Analysis data bases (e.g., population, weather, agriculture, etc.)
- Accident scenarios
- Analysis ground rules and assumptions
- Materials at risk
- Source terms released to the environment
- Source term isotopic breakdowns
- Accident frequencies
- Process durations.

4.1.5 Comparison of Health and Safety Risks with Common Risks to the Public

This section compares the increased risks to the public associated with the management of plutonium residues and scrub alloy to those of common activities, such as smoking, flying, receiving a medical x-ray, and so forth.

❒ **Risks in this EIS—**Succeeding sections in Chapter 4 evaluate the risks from radiological and nonradiological incident-free operations and accidents for all materials and processing options.

The highest increase in the incident-free population risk to the general public living near any of the DOE management sites involved in these alternatives would be 0.00019 latent cancer fatalities, as shown in Table 4–85 in Section 4.23. This risk would occur at the Savannah River Site.

The highest increase in the accident population risk to the general public living near any of the DOE management sites would be 0.66 latent cancer fatalities, as shown in Table 4–83 in Section 4.23. This risk would occur at the Rocky Flats Site.

The highest increase in the population risk to the general public along the transportation routes due to radiation exposure during ground transport would be 0.010 latent cancer fatalities (Table 4–91 in Section 4.24), if the maximum number of shipments is assumed (208 from Rocky Flats to the Savannah River Site).

Nonradiological fatalities are also unlikely. The highest increases in the risk of nonradiological fatalities to the public is through a traffic accident involving a truck transporting plutonium residues or scrub alloy. Assuming the same number of shipments (208 to the Savannah River Site), the increase in the population risk to the general public along the transportation routes would be 0.021 fatalities (Table 4–92 in Section 4.24).

❒ **Common Radiological Risks—Table 4–2** presents several typical sources of exposure to radiation from everyday life (DOE 1993b). The average person in the United States receives about 300 mrem each year from natural sources of radiation and about another 50 mrem from manmade sources of radiation. The largest dose listed in Table 4–2 is the 200 mrem per year from exposure to naturally-occurring radon gas. This is much higher than the dose any member of the general public would receive as the result of activities associated with the management of plutonium residues and scrub alloy.

Table 4–2 Typical Sources of Radiation, Average Individual Exposures, and Average Individual Risks

Source	***Dose Rate (mrem/yr)***	***Risk (Probability of a Latent Cancer Fatality/yr)***
Radon	200	0.0001
Internal	39	0.000020
Diagnostic x-rays	39	0.000020
Soil, rocks	28	0.000014
Cosmic rays	27	0.000014
Nuclear medicine	14	0.000007
Nuclear fuel cycle	less than 1	less than 5×10^{-7}
Fallout	less than 0.01	less than 5×10^{-9}

There are also large variations in radiation dose to which people are routinely exposed. For example, people who live at high altitudes receive more radiation dose than people who live at sea level. People who live or work in brick, granite, or marble buildings receive more radiation dose than people who live or work in wooden structures. People who live in well-insulated houses receive more radiation dose from trapped radon gas than people who live in well-ventilated houses. Taking all the various factors into account, the annual U.S. dose from background radiation can easily range from 100 mrem for people who live in well-ventilated wooden houses on sandy soil at sea level to about 1,000 mrem for people who live in well-insulated houses in the Denver area (de Planque 1994). Thus, in addition to the average annual radiation dose, routine variations in annual radiation dose are also much larger than the dose any member of the general public would be likely to receive under any of the alternatives.

❒ **Risks from Common Activities—**Every activity carries some risk. **Table 4–3** shows activities estimated to increase an individual's chance of death in any year by one in one million (Slovic 1986). Most of these activities would not be considered unusually risky actions, and they can be compared to the risks presented in this chapter for perspective only.

Table 4–3 Risks Estimated To Increase Chance of Death in any Year by One Chance in a Million

Activity	*Cause of Death*
Smoking 1.4 cigarettes	Cancer; heart disease
Living 2 days in New York or Boston	Air pollution
Traveling 16 km (10 mi) by bicycle	Accident
Flying 1,600 km (1,000 mi) by jet	Accident
Living 2 months in Denver on vacation from New York	Cancer caused by cosmic radiation
One chest x-ray	Cancer caused by radiation

4.1.6 Estimated Radiation Dose Rate Near the Plutonium Transportation Containers

The regulatory external radiation dose limit for ground transport is 10 mrem per hour at 2 m (6.6 ft) from the vehicle (49 CFR 173.441). Historical data from actual plutonium residue and scrub alloy handling experience during transportation have shown dose rates below this regulatory limit. Dose rates at 2 m (6.6 ft) from the Type 9975 and Type 6M containers have typically been between 0.15 and 0.6 mrem per hour, depending on the age and type of residue. Although Safe Secure Trailers carry up to 30 Type 9975 or 38 Type 6M containers, dose rates around the vehicle must be kept lower than the regulatory limit. If DOE makes any shipments in commercial vehicles, the same regulatory limit would also apply.

To be conservative, the analyses in this chapter use the regulatory limit of 10 mrem per hour at 2 m (6.6 ft) from the side of the transport vehicle. This conservative value was used in the calculations of incident-free doses to members of the public traveling along the highway and to ground transport workers. For radiation workers handling containers at the DOE sites, the dose rate close to the shipping containers was estimated by the conservative methodology presented in Appendix D.

4.1.7 Plutonium and Americium Toxicity

The adverse health effects experienced following exposure to plutonium result predominantly from its radiological toxicity rather than its chemical toxicity. Plutonium is not readily absorbed from the gastrointestinal tract following ingestion or through the intact skin following dermal exposure; inhalation is the most common route of human exposure. Once inhaled, the rate of clearance from the lungs is influenced by particle size, specific isotope, and chemical form. Following inhalation exposure, plutonium partitions to the lungs, liver, and bone. The radiotoxicity of plutonium results from its emission of ionizing radiation, primarily in the form of alpha particles, although low-energy gamma radiation and low-energy neutrons are also released. In studies with laboratory animals, exposure to high radiation doses of plutonium isotopes has resulted in decreases in lifespans, diseases of the respiratory tract, and cancer (ATSDR 1990, DOE 1997d). Plutonium residues and scrub alloy contain a number of different isotopes of plutonium.

In addition to plutonium isotopes, scrub alloy and some plutonium residues contain substantial amounts of americium-241, which is formed by the decay of plutonium-241. Americium-241 is radiotoxic because it produces high gamma radiation doses and also emits alpha particles and neutrons. Like plutonium, the radiotoxicity of americium is of much greater concern than its chemical toxicity (DOE 1997d).

4.1.8 WIPP Waste Acceptance Criteria

As noted in Section 4.1.2, processing the plutonium residues would produce transuranic wastes which would require disposal at WIPP. Analysis in the EIS assumes that the transuranic wastes would be transported in the safest, cost-effective manner, which would be TRUPACT II shipping containers. Each TRUPACT II is assumed to contain approximately 2,800 fissile gram equivalents of radioactive material (primarily plutonium and americium). The Nuclear Regulatory Commission (NRC 1997) certified the 2,800 fissile gram equivalents load for the TRUPACT II in February 1997. The WIPP Supplemental EIS (DOE 1997e) analyzed the impacts of transporting the Rocky Flats wastes utilizing the 2,800-fissile-gram-equivalent TRUPACT II loading. The WIPP planning basis waste acceptance criteria has recently been revised to allow this loading.

4.1.9 Nuclear Nonproliferation Considerations

For over 40 years, the United States has supported international efforts to prevent the spread of nuclear weapons to states that do not already have them. Although the cold war has ended, national support for the nonproliferation of nuclear weapons remains undiminished. As one of its fundamental nonproliferation strategies, the United States seeks to prevent the unauthorized acquisition of materials, such as plutonium, that could be used to manufacture nuclear weapons. United States efforts to prevent unauthorized access to plutonium are based on longstanding national policies, as well as on our obligations under the Nuclear Nonproliferation Treaty and the Treaty on the Physical Protection of Nuclear Material.

The current framework for U.S. nonproliferation policy was issued by the President on September 27, 1993. Several key elements of this framework dealt with plutonium policy. The policies most directly pertinent to this EIS stated that the United States would:

- Seek to eliminate where possible the accumulation of stockpiles of highly enriched uranium or plutonium, and to ensure that where these materials already exist they are subject to the highest standards of safety, security, and international accountability;
- Submit U.S. fissile material no longer needed for our deterrent to inspection by the International Atomic Energy Agency; and
- Initiate a comprehensive review of long-term options for plutonium disposition, taking into account technical, nonproliferation, environmental, budgetary and other economic considerations.

The framework document also stated that the "United States does not encourage the civil use of plutonium and, accordingly, does not itself engage in plutonium reprocessing for either nuclear power or nuclear explosive purposes."

The materials covered by this EIS (approximately 40 percent of the plutonium residues and all of the scrub alloy stored at Rocky Flats) contain nearly 2,800 kg (6,200 lb) of plutonium that could be used in nuclear weapons, if diverted. The proliferation consequences of each alternative must be considered in conjunction with considerations of the health and safety benefits (both near-term and long-term) that would be associated with implementation of the proposed action. The nonproliferation consequences of each alternative for management of these materials are discussed below.

❒ **Alternative 1 (No Action: Stabilize and Store)—**Under the No Action Alternative, the entire Rocky Flats inventory of plutonium residues and scrub alloy would be stabilized and stored there pending disposition. Materials containing nearly 2,800 kg (6,200 lb) of plutonium would remain an attractive target for theft by those interested in the manufacture of nuclear weapons. Theft would be prevented by continued operation of the physical security system at Rocky Flats. From the viewpoint of nuclear weapons nonproliferation, the No Action Alternative has no clearly defined endpoint. The stabilization efforts under the No Action Alternative would result in a very small reduction in proliferation risk.

- ❒ **Alternative 2 (Process without Plutonium Separation)—**Implementation of Alternative 2 would render the Rocky Flats plutonium residues and scrub alloy unattractive as source of plutonium for the manufacture of nuclear weapons. From the viewpoint of nuclear weapons nonproliferation, the endpoint is clearly defined as completion of processing for the entire inventory, at which time the resulting materials would pose a greatly reduced proliferation risk. Under this alternative, the high level of physical security required under Alternatives 1 and 3 would no longer be required for the processed plutonium residues and scrub alloy. This alternative would cause the largest reduction in the risk of proliferation and this risk reduction would occur in the near term.

- ❒ **Alternative 3 (Process with Plutonium Separation)—**Under this alternative, the chemical separation of the plutonium from the residues and scrub alloy would be conducted in the process of accomplishing the health and safety related stabilization required to comply with Defense Nuclear Facilities Safety Board Recommendation 94-1. The separated plutonium would be converted into a form that would be more attractive as a potential target for theft or diversion until its disposition if it were left unprotected. However, in the interim, prior to its disposition, this plutonium would be stored at the separation site(s) under the protection of the safeguards and security systems already in operation at those sites to provide protection for the plutonium already in storage at those sites. The separated plutonium would be disposed of in accordance with decisions to be made under the *Surplus Plutonium Disposition Draft Environmental Impact Statement*. The ultimate disposition of this plutonium would be in a monitored geologic repository as a ceramic waste form embedded in canisters of vitrified high-level radioactive waste. As a result, while there would be a slight and manageable increase in proliferation concerns in the near-term until the plutonium is dispositioned, implementation of this alternative would ultimately result in a reduction in the risk of proliferation. The waste resulting from the separation processes would not pose a proliferation risk because only minute quantities of plutonium would be present in this waste.

- ❒ **Alternative 4 (Combination of Processing Technologies)—**This alternative is a combination alternative comprised of elements of the technologies analyzed under Alternatives 1 and 2. Materials subject to processes under Alternative 4 have been granted a variance to safeguards termination limits subject to their plutonium concentration levels being below 10 percent. The variance was approved by the DOE Office of Safeguards and Security for many of the residues only after it was determined that these residues would not be in a form that is attractive for theft as a source of plutonium for use in nuclear weapons or terrorist activities. The proliferation risk is therefore very low under this alternative.

Safeguards Termination Limits

"Safeguards" are part of the process of ensuring that unauthorized persons or organizations do not obtain materials (e.g., uranium or, for this EIS, plutonium) that could be used to manufacture nuclear weapons. Safeguards termination limits are limits on the maximum concentration of plutonium that may exist in a material without causing the material to be subject to the strict material control and accountability requirements applied under "safeguards" requirements. These concentration limits are established based on a determination of how low the plutonium concentration must be for any given material form to make the material unattractive as a source of plutonium. DOE granted a variance to the safeguards termination limits for certain residues when evaluations demonstrated that the proposed processing method for the material, the controls in place for normal handling of transuranic waste, and the limited quantity of plutonium present in any particular place and time preclude the need to take additional measures to address threats of diversion and theft. When safeguards termination limit variances are applied, the residue material is no longer subject to strict material control and accountability as special nuclear material. The materials, however, are still controlled and guarded based on DOE's management practices and physical security procedures.

4.2 IMPACTS OF MANAGING ASH RESIDUES

The inventory of ash residues assessed in this EIS weighs 20,060 kg (44,224 lb) including 1,164 kg (2,566 lb) of plutonium. This inventory is stored in 1,281 drums (with approximately 6,400 internal metal containers) and 531 other small individual containers. As discussed in Chapter 2, the ash residues are divided into four subcategories. The subcategories of ash residues are listed in **Table 4–4**, along with the inventory data for each one.

Table 4–4 Ash Residues

Ash Subcategories	*Residue Mass (kg)* [a]	*Plutonium Mass (kg)* [a]	*Number of Drums*	*Number of Other Individual Containers*
Incinerator Ash (including firebrick fines)	14,056	909.8	1,016	54
Sand, Slag, and Crucible	3,062	128.9	138	214
Graphite Fines	899	74.0	81	26
Inorganic Ash	2,043	50.9	46	237
Totals	20,060	1,164	1,281	531

[a] To convert to pounds, multiply by 2.2.

Each subcategory has the same basic processing technology under the No Action Alternative: to cement and store the residue at Rocky Flats. Each subcategory has the same two or three processing technologies under the Process without Plutonium Separation Alternative. The technologies within the Process with Plutonium Separation Alternative are more complicated: the incinerator ash subcategory has two technologies, the sand, slag, and crucible subcategory has one technology, the graphite fines subcategory has one technology, and there are no technologies for the inorganic ash subcategory. Each subcategory has the same two processing technologies under Alternative 4. The preferred processing technology for all ash residues except sand, slag, and crucible residues is repackaging at Rocky Flats. The preferred processing technology for sand, slag, and crucible residues is preprocessing at Rocky Flats and Purex at the Savannah River Site.

One of the residues in the incinerator ash subcategory is not included in one of the incinerator ash processing technologies. The firebrick fines residue (Item Description Code [IDC] 378) is not included in the Purex process technology because this processing may not be feasible for this residue. This residue has a mass of 26 kg (57 lb), including 10.8 kg (23 lb) of plutonium. If DOE decides to implement this processing technology for the incinerator ash residues, then the firebrick fines residue would have to be managed under one of the other seven processing technologies. The residue mass of 26 kg (57 lb) represents less than 0.2 percent of the total residue mass in this subcategory, so DOE performed the impact calculations as if the firebrick fines were included along with the rest of the incinerator ash residues in this technology. This assumption is reasonable because the inventory of firebrick fines is very small compared to the total amount of residue in this subcategory.

This section presents the environmental impacts of managing the entire inventory of ash residues under each of the processing technologies. The results in this section were used in the calculation of the total impacts of the No Action Alternative and the Preferred Alternative which are presented in Sections 4.20 and 4.21, respectively, and of the management approaches which are presented in Section 4.22.

4.2.1 Products and Wastes

Under every processing technology for ash residues, DOE would generate transuranic waste and would prepare this waste for disposal in WIPP. Every technology would also result in low-level waste, which would be disposed of routinely using existing procedures at each site. A small portion of the low-level waste generated at Rocky Flats could possibly be low-level mixed waste, but this waste would also be disposed of routinely using existing procedures. The No Action Alternative would result in stabilized residues that would have to remain in storage indefinitely. In the processing technologies under the Process without Plutonium Separation Alternative, DOE would generate transuranic waste directly from the residue. In some of the processing technologies the stabilized residues and transuranic waste would be placed in pipe components inside 208-liter (55-gallon [gal]) drums as shown in Figure 2-13 in Chapter 2. If DOE applies variances to the stabilized residues (Alternative 4), then the stabilized residues could be disposed of in WIPP as transuranic waste.

Material to be managed as high-level waste (hereafter in this chapter called high-level waste) and saltstone would be generated only at the Savannah River Site if the residues were shipped to that site for plutonium separation. The final form of the high-level waste would be glass poured into stainless steel canisters, which would be stored at the Savannah River Site until a monitored geologic repository is ready to receive them. Saltstone is a cement form of low-level waste that is generated as a byproduct of the Savannah River Site tank farm operations and is routinely disposed of onsite in concrete vaults. If plutonium is separated at the Savannah River Site, it would be stored securely onsite until a decision is made on its disposition. No increase in proliferation risk would result and this plutonium would not be used for nuclear explosive purposes. The americium from residues sent to the Savannah River Site would go into the high-level waste.

The solid plutonium-bearing products and wastes that would be generated from ash residues under each of the technologies are presented in **Table 4–5**. The shaded areas of Table 4–5 indicate types of solid products and wastes that would not be generated under the various processing technologies. The products and wastes from the preferred processing technologies are presented in bold type.

- ❒ **Incinerator Ash and Firebrick Fines—**The largest amount of transuranic waste (6,430 drums) would be generated in the calcine and blend down technology, but the vitrify and cold ceramify technologies would generate almost as much (over 5,000 drums). These three technologies would generate much more transuranic waste than the other technologies, which would generate no more than 1,310 drums. The stabilized residues generated in Alternative 4 could be disposed of in WIPP, just like transuranic waste.

Thus, the two technologies under Alternative 4 would each generate over 5,500 drums (transuranic waste plus stabilized residues) to be sent to WIPP. The quantities of high-level waste, low-level waste, and saltstone are low under all the technologies and the sites would manage these wastes using routine procedures. The maximum amount of plutonium that could be separated from incinerator ash residues is 901 kg (1,986 lb).

- **Sand, Slag, and Crucible Residues—**The largest amount of transuranic waste (almost 1,400 drums) would be generated in the calcine and blend down technology, but the vitrify technology would generate almost as much (almost 1,200 drums). These two technologies would generate much more transuranic waste than the other technologies, which would generate fewer than 300 drums. The stabilized residues in Alternative 4 could be disposed of in WIPP, just like transuranic waste. Thus, the two technologies under Alternative 4 would each generate over 1,000 drums (stabilized residue plus transuranic waste) to be sent to WIPP. The quantities of high-level waste, low-level waste, and saltstone are low under all the technologies and the sites would manage these wastes using routine procedures. The maximum amount of plutonium that could be separated from sand, slag, and crucible residues is 128 kg (282 lb).

Table 4–5 Products and Wastes from Ash Residues

	Stabilized Residues (Drums[a])	*Transuranic Waste (Drums[a])*	*High-Level Waste (Canisters of Glass[b])*	*Separated Plutonium (kg[c])*	*Low-Level Waste (Drums[a])*	*Saltstone (cubic meters)*
Incinerator Ash and Firebrick Fines						
Alternative 1 (No Action)						
Calcine, Cement, and Store at Rocky Flats	4,379	1,310			2,860	
Alternative 2 (without Plutonium Separation)						
Vitrify at Rocky Flats		5,428			1,187	
Cold Ceramify at Rocky Flats		5,379			1,187	
Calcine and Blend Down at Rocky Flats		6,430			1,187	
Alternative 3 (with Plutonium Separation)						
Preprocess at Rocky Flats		593	–	–	1,187	–
Purex at Savannah River Site		150	4	890	394	1,351
Preprocess at Rocky Flats		593	–	–	1,187	–
Mediated Electrochemical Oxidation/Purex at Savannah River Site		253	26	901	373	670
Alternative 4 (Combination)						
Calcine and Cement at Rocky Flats	4,379[d]	1,310			2,860	
Repackage at Rocky Flats	**4,987[d]**	**593**			**1,187**	
Sand, Slag, and Crucible Residues						
Alternative 1 (No Action)						
Calcine, Cement, and Store at Rocky Flats	954	278			607	
Alternative 2 (without Plutonium Separation)						
Vitrify at Rocky Flats		1,175			242	
Calcine and Blend Down at Rocky Flats		1,394			242	
Alternative 3 (with Plutonium Separation)						
Preprocess at Rocky Flats		**122**	**–**	**–**	**242**	**–**
Purex at Savannah River Site		**12**	**4**	**128**	**58**	**357**
Alternative 4 (Combination)						
Calcine and Cement at Rocky Flats	954[d]	278			607	
Repackage at Rocky Flats	773[d]	278			607	
Graphite Fines						
Alternative 1 (No Action)						
Calcine, Cement, and Store at Rocky Flats	280	87			186	
Alternative 2 (without Plutonium Separation)						
Vitrify at Rocky Flats		350			79	
Calcine and Blend Down at Rocky Flats		414			79	
Alternative 3 (with Plutonium Separation)						
Preprocess at Rocky Flats		41	–	–	79	–
Mediated Electrochemical Oxidation/Purex at Savannah River Site		16	2	73	24	43
Alternative 4 (Combination)						
Calcine and Cement at Rocky Flats	280[d]	87			186	
Repackage at Rocky Flats	**319[d]**	**41**			**79**	

	Stabilized Residues (Drums[a])	***Transuranic Waste (Drums[a])***	***High-Level Waste (Canisters of Glass[b])***	***Separated Plutonium (kg[c])***	***Low-Level Waste (Drums[a])***	***Saltstone (cubic meters)***
Inorganic Ash						
Alternative 1 (No Action)						
Calcine, Cement, and Store at Rocky Flats	637	181			395	
Alternative 2 (without Plutonium Separation)						
Vitrify at Rocky Flats		779			152	
Calcine and Blend Down at Rocky Flats		924			152	
Alternative 4 (Combination)						
Calcine and Cement at Rocky Flats	637[d]	181			395	
Repackage at Rocky Flats	**725**[d]	**77**			**152**	

[a] Standard 55-gallon (208-liter) drums. (208 liters is equal to 0.208 cubic meters.)
[b] Each canister is 2 feet (61 cm) in diameter, 10 feet (300 cm) tall, and contains approximately 3,700 pounds (1,680 kg) of high-level waste glass.
[c] To convert to pounds, multiply by 2.2.
[d] These stabilized residues could be disposed of in WIPP as transuranic waste.

Notes: Shaded areas indicate the types of solid products and waste that would not be generated. Products and wastes from the preferred processing technologies are presented in bold type. The storage capacities at each site are adequate to store the products and wastes listed in this table.

- **Graphite Fines—**The largest amount of transuranic waste (414 drums) would be generated in the calcine and blend down technology, but the vitrify technology would generate almost as much (350 drums). These two technologies would generate much more transuranic waste than the other technologies, which would generate no more than 87 drums. The stabilized residues in Alternative 4 could be disposed of in WIPP, just like transuranic waste. Thus, the two technologies under Alternative 4 would each generate over 350 drums (stabilized residue plus transuranic waste) to be sent to WIPP. The quantities of high-level waste, low-level waste, and saltstone are low under all the technologies and the sites would manage these wastes using routine procedures. The maximum amount of plutonium that could be separated from graphite fines residues is 73 kg (160 lb).

- **Inorganic Ash—**The largest amount of transuranic waste (over 900 drums) would be generated in the calcine and blend down technology, but the vitrify technology would generate almost as much (almost 800 drums). These two technologies would generate much more transuranic waste than the other technologies, which would generate no more than 181 drums. The stabilized residues in Alternative 4 could be disposed of in WIPP, just like transuranic waste. Thus, the two technologies under Alternative 4 would each generate over 800 drums (stabilized residue plus transuranic waste) to be sent to WIPP. The quantities of low-level waste are low under all the technologies and the site would manage this waste using routine procedures. No plutonium would be separated from inorganic ash residues under any processing technology.

4.2.2 Public and Occupational Health and Safety Impacts

This section describes the radiological and hazardous chemical impacts that could result from the alternatives associated with the management of ash residues. These impacts are presented for incident-free operation and postulated accident scenarios. The detailed site and transportation analyses are presented in Appendices D and E, respectively.

The round-trip highway distance from Rocky Flats to the Savannah River Site is 5,233 km (3,250 mi). If DOE decides to ship the incinerator ash to the Savannah River Site for Purex processing or mediated electrochemical oxidation/Purex processing, then the number of shipments would be 116 or 86, respectively, and the total round-trip shipping distances would be 607,000 km (376,400 mi) or 450,000 km (279,000 mi), respectively. Shipping the sand, slag, and crucible would require 26 shipments, and the total round-trip shipping distance would be 136,100 km (84,400 mi). Similarly, shipping the graphite fines to the Savannah River Site would require 7 shipments, and the total round-trip shipping distance would be 36,600 km (22,700 mi).

No construction of new processing facilities is required for any of the alternatives at Rocky Flats but DOE may need to modify certain existing facilities and construct new waste storage buildings. For some activities performed at the Savannah River Site, DOE may need to perform decontamination and decommissioning and also modify existing facilities. Mitigation measures during these activities would ensure that only very limited radiological and chemical releases occur. However, workers would be exposed to contaminated materials. Such exposures would be limited to ensure that doses are maintained as low as reasonably achievable.

4.2.2.1 Incident-Free Operations

❒ Radiological Impacts

- *Incinerator Ash and Firebrick Fines*—The radiological impacts to the public and the workers associated with incident-free operations of each processing technology for incinerator ash and firebrick fines are presented in **Table 4–6**. The impacts due to the preferred processing technology are presented in bold type. The impacts are those which are anticipated to occur as a result of process operations and transportation over whatever time period is necessary to process the entire inventory of these residues. The length of time necessary to process these residues will depend on which technology DOE decides to implement. Impacts associated with subsequent incident-free storage of stabilized residues, separated plutonium, and waste would be much smaller than from processing or transportation.

  The highest estimated public maximally exposed individual dose in Table 4–6 is 11 mrem, which could occur only during transportation. This is a bounding estimate of the dose to a maximally exposed individual. It probably exceeds actual potential exposure by a factor of 5. This hypothetical individual's latent cancer fatality risk would be increased by about 5.5×10^{-6}, or less than one chance in one hundred thousand. The public maximally exposed individual risks near the sites would be much lower under all of the technologies. The highest total of the public population radiation doses listed in Table 4–6 would occur if DOE decides to implement the Purex processing technology at the Savannah River Site. The sum of these doses is approximately 11.6 person-rem, which would cause far less than one additional latent cancer fatality among the population living near both sites and traveling along the truck route. The population living near the truck route would receive a much smaller radiation dose. Estimates of population exposure due to transportation are based on very conservative assumptions designed to overestimate potential risk. See Section E.8 of Appendix E for a discussion of uncertainties and conservatism in the EIS assessment of transportation risk.

  The highest involved worker population radiation dose would be 394 person-rem, which would occur if DOE decides to implement the Purex processing technology at the Savannah River Site. This dose would cause 0.16 additional latent cancer fatalities among the workers directly involved in the operation. Onsite workers who are not involved with the actual processing of the residues are designated as "noninvolved workers." The impacts to these workers would be expected to be much smaller than the impacts to the involved workers.

- *Sand, Slag, and Crucible Residues*—The radiological impacts to the public and the workers associated with incident-free operations of each technology for sand, slag, and crucible residues are presented in Table 4–6. The impacts are those which are anticipated to occur as a result of process operations and transportation over whatever time period is necessary to process the entire inventory of these residues. The length of time necessary to process these residues will depend on which technology DOE decides to implement. Impacts associated with subsequent incident-free storage of stabilized residues, separated plutonium, and waste would be much smaller than from processing or transportation.

Table 4–6 Radiological Impacts Due to Incident-Free Management of Ash Residues

	Offsite Public Maximally Exposed Individual		*Offsite Public Population*		*Maximally Exposed Individual Involved Worker*		*Involved Worker Population*	
	Dose (mrem)	*Probability of a Latent Cancer Fatality*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*	*Dose (mrem per year)*	*Probability of a Latent Cancer Fatality per year*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*
Incinerator Ash and Firebrick Fines								
Alternative 1 (No Action)								
Calcine, Cement, and Store at Rocky Flats	0.00024	1.2×10^{-10}	0.0051	2.6×10^{-6}	2,000	0.0008	376	0.15
Alternative 2 (without Plutonium Separation)								
Vitrify at Rocky Flats	0.000034	1.7×10^{-11}	0.0014	7.0×10^{-7}	2,000	0.0008	179	0.072
Cold Ceramify at Rocky Flats	0.000038	1.9×10^{-11}	0.0015	7.5×10^{-7}	2,000	0.0008	142	0.057
Calcine and Blend Down at Rocky Flats	0.00019	9.5×10^{-11}	0.0040	2.0×10^{-6}	2,000	0.0008	229	0.092
Alternative 3 (with Plutonium Separation)								
Preprocess at Rocky Flats	0.000057	2.8×10^{-11}	0.0023	1.2×10^{-6}	2,000	0.0008	145	0.058
Transport to Savannah River Site	11	5.5×10^{-6}	11.4	0.0057	100	0.00004	18	0.0072
Purex at Savannah River Site [a,b]	0.0015	7.5×10^{-10}	0.17	0.000085	2,000	0.0008	231	0.092
Preprocess at Rocky Flats	0.000056	2.8×10^{-11}	0.0023	1.2×10^{-6}	2,000	0.0008	108	0.043
Transport to Savannah River Site	11	5.5×10^{-6}	8.5	0.0042	100	0.00004	13.3	0.0053
Mediated Electrochemical Oxidation/Purex at Savannah River Site [a,b]	0.00079	4.0×10^{-10}	0.088	0.000044	2,000	0.0008	152	0.061
Alternative 4 (Combination)								
Calcine and Cement at Rocky Flats	0.00024	1.2×10^{-10}	0.0051	2.6×10^{-6}	2,000	0.0008	320	0.13
Repackage at Rocky Flats	**0.000020**	$\mathbf{1.0\times10^{-11}}$	**0.00080**	$\mathbf{4.0\times10^{-7}}$	**2,000**	**0.0008**	**90**	**0.036**
Sand, Slag, and Crucible Residues								
Alternative 1 (No Action)								
Calcine, Cement, and Store at Rocky Flats	0.000035	1.8×10^{-11}	0.00073	3.6×10^{-7}	2,000	0.0008	57	0.023
Alternative 2 (without Plutonium Separation)								
Vitrify at Rocky Flats	4.6×10^{-6}	2.3×10^{-12}	0.00019	9.5×10^{-8}	2,000	0.0008	25	0.010
Calcine and Blend Down at Rocky Flats	0.000027	1.3×10^{-11}	0.00058	2.9×10^{-7}	2,000	0.0008	32	0.013
Alternative 3 (with Plutonium Separation)								
Preprocess at Rocky Flats	$\mathbf{2.7\times10^{-6}}$	$\mathbf{1.4\times10^{-12}}$	**0.00011**	$\mathbf{5.5\times10^{-8}}$	**2,000**	**0.0008**	**27**	**0.011**
Transport to Savannah River Site	**11**	$\mathbf{5.5\times10^{-6}}$	**2.57**	**0.0013**	**100**	**0.00004**	**4**	**0.0016**
Purex at Savannah River Site [a]	**0.00013**	$\mathbf{6.5\times10^{-11}}$	**0.014**	$\mathbf{7.0\times10^{-6}}$	**2,000**	**0.0008**	**17**	**0.0068**
Alternative 4 (Combination)								
Calcine and Cement at Rocky Flats	0.000036	1.8×10^{-11}	0.00077	3.9×10^{-7}	2,000	0.0008	49	0.020
Repackage at Rocky Flats	2.7×10^{-6}	1.4×10^{-12}	0.00011	5.5×10^{-8}	2,000	0.0008	14	0.0056

	Offsite Public Maximally Exposed Individual		*Offsite Public Population*		*Maximally Exposed Individual Involved Worker*		*Involved Worker Population*	
	Dose (mrem)	*Probability of a Latent Cancer Fatality*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*	*Dose (mrem per year)*	*Probability of a Latent Cancer Fatality per year*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*
Graphite Fines								
Alternative 1 (No Action)								
Calcine, Cement, and Store at Rocky Flats	0.000020	1.0×10^{-11}	0.00042	2.1×10^{-7}	2,000	0.0008	30	0.012
Alternative 2 (without Plutonium Separation)								
Vitrify at Rocky Flats	2.7×10^{-6}	1.4×10^{-12}	0.00011	5.5×10^{-8}	2,000	0.0008	15	0.0060
Calcine and Blend Down at Rocky Flats	0.000015	7.5×10^{-12}	0.00032	1.6×10^{-7}	2,000	0.0008	18	0.0072
Alternative 3 (with Plutonium Separation)								
Preprocess at Rocky Flats	4.7×10^{-6}	2.4×10^{-12}	0.00019	9.5×10^{-8}	2,000	0.0008	8.8	0.0035
Transport to Savannah River Site	11	5.5×10^{-6}	0.69	0.00035	100	0.00004	1.1	0.00044
Mediated Electrochemical Oxidation/Purex at Savannah River Site [a, b]	0.000064	3.2×10^{-11}	0.0071	3.6×10^{-6}	2,000	0.0008	12	0.0048
Alternative 4 (Combination)								
Calcine and Cement at Rocky Flats	0.000020	1.0×10^{-11}	0.00042	2.1×10^{-7}	2,000	0.0008	26	0.010
Repackage at Rocky Flats	**1.6×10^{-6}**	**8.0×10^{-13}**	**0.000063**	**3.2×10^{-8}**	**2,000**	**0.0008**	**7.3**	**0.0029**
Inorganic Ash								
Alternative 1 (No Action)								
Calcine, Cement, and Store at Rocky Flats	0.000013	6.5×10^{-12}	0.00029	1.4×10^{-7}	2,000	0.0008	26	0.010
Alternative 2 (without Plutonium Separation)								
Vitrify at Rocky Flats	1.8×10^{-6}	9.0×10^{-13}	0.000076	3.8×10^{-8}	2,000	0.0008	9.8	0.0039
Calcine and Blend Down at Rocky Flats	0.000010	5.2×10^{-12}	0.00023	1.1×10^{-7}	2,000	0.0008	13	0.0052
Alternative 4 (Combination)								
Calcine and Cement at Rocky Flats	0.000013	6.5×10^{-12}	0.00029	1.4×10^{-7}	2,000	0.0008	18	0.0072
Repackage at Rocky Flats	**1.1×10^{-6}**	**5.5×10^{-13}**	**0.000044**	**2.2×10^{-8}**	**2,000**	**0.0008**	**5.0**	**0.0020**

[a] Impacts to the public and workers are presented for F-Canyon operations. It has been determined that H-Canyon operations result in lower impacts to these groups.

[b] If H-Canyon were used, an additional 60 person-rem (with an associated 0.024 latent cancer fatalities) would be received by workers involved with decontamination and decommissioning of highly contaminated equipment prior to installation of two new dissolvers for mediated electrochemical oxidation operations. This 60 person-rem worker population dose when added to the H-Canyon operational worker population dose would be less than the worker population dose associated with total F-Canyon mediated electrochemical oxidation operations for incinerator ash and graphite fines.

Note: The impacts from the preferred processing technology are presented in bold type.

The highest estimated public maximally exposed individual dose in Table 4–6 is 11 mrem, which could occur only during transportation. This hypothetical individual's latent cancer fatality risk would be increased by less than one in one hundred thousand. The public maximally exposed individual risks near the sites would be much lower under all of the technologies. The highest total of the public population radiation doses listed in Table 4–6 would occur if DOE decides to implement the Purex technology at the Savannah River Site. The sum of these doses is approximately 2.6 person-rem, which would cause far less than one additional latent cancer fatality among the population living near both sites and traveling along the truck route. The population living near the truck route would receive a much smaller radiation dose. The highest involved worker population radiation dose would be 57 person-rem, which would occur if DOE decides to implement the No Action calcine, cement, and store technology at Rocky Flats. This dose would cause 0.023 additional latent cancer fatalities among the workers directly involved in the operation. Onsite workers who are not involved with the actual processing of the residues are designated as "noninvolved workers." The impacts to these workers would be expected to be much smaller than the impacts to the involved workers.

- *Graphite Fines*—The radiological impacts to the public and the workers associated with incident-free operations of each technology for graphite fines are presented in Table 4–6. The impacts are those which are anticipated to occur as a result of process operations and transportation over whatever time period is necessary to process the entire inventory of these residues. The length of time necessary to process these residues will depend on which technology DOE decides to implement. Impacts associated with subsequent incident-free storage of stabilized residues, separated plutonium, and waste would be much smaller than from processing or transportation.

  The highest estimated public maximally exposed individual dose in Table 4–6 is 11 mrem, which could occur only during transportation. This hypothetical individual's latent cancer fatality risk would be increased by less than one in one hundred thousand. The public maximally exposed individual risks near the sites would be much lower under all of the technologies. The highest total of the public population radiation doses listed in Table 4–6 would occur if DOE decides to implement the mediated electrochemical oxidation/Purex processing technology at the Savannah River Site. The sum of these doses is approximately 0.70 person-rem, which would cause far less than one additional latent cancer fatality among the population living near both sites and traveling along the truck route. The population living near the truck route would receive a much smaller radiation dose.

  The highest involved worker population radiation dose would be 30 person-rem, which would occur if DOE decides to implement the No Action calcine, cement, and store technology at Rocky Flats. This dose would cause 0.012 additional latent cancer fatalities among the workers directly involved in the operation. Onsite workers who are not involved with the actual processing of the residues are designated as "noninvolved workers." The impacts to these workers would be expected to be much smaller than the impacts to the involved workers.

- *Inorganic Ash*—The radiological impacts to the public and the workers associated with incident-free operations of each technology for inorganic ash are presented in Table 4–6. The impacts are those which are anticipated to occur as a result of process operations over whatever time period is necessary to process the entire inventory of these residues. The length of time necessary to process these residues will depend on which technology DOE decides to implement. Impacts associated with subsequent incident-free storage of stabilized residues, separated plutonium, and waste would be much smaller than from processing.

The highest estimated public maximally exposed individual dose in Table 4–6 is 0.000013 mrem, which would occur during the technology to calcine and cement at Rocky Flats. This hypothetical individual's latent cancer fatality risk would be increased by less than one in one-hundred billion. The highest public population radiation dose listed in Table 4–6 would also occur if DOE decides to implement the calcine and cement technology at Rocky Flats. This dose is 0.00029 person-rem, which would cause far less than one additional latent cancer fatality among the population living near Rocky Flats.

The highest involved worker population radiation dose would be 26 person-rem, which would occur if DOE decides to implement the No Action calcine, cement, and store technology at Rocky Flats. This dose would cause 0.010 additional latent cancer fatalities among the workers directly involved in the operation. Onsite workers who are not involved with the actual processing of the residues are designated as "noninvolved workers." The impacts to these workers would be expected to be much smaller than the impacts to the involved workers.

❒ Hazardous Chemical Impacts

- *Incinerator Ash and Firebrick Fines*—The impacts of exposure to hazardous chemicals from the processing and storage of incinerator ash and firebrick fines at Rocky Flats were not evaluated because hazardous chemicals are not expected to be released from the proposed operations at this site.

  The processing of incinerator ash and firebrick fines at the Savannah River Site would involve releases of only noncarcinogenic hazardous chemicals. The noncancer health risks for the Purex process and mediated electrochemical oxidation process are the summation of releases of phosphoric acid and ammonium nitrate. The estimated offsite population and noninvolved worker Hazard Index values presented in **Table 4–7** are much less than one, which suggests that noncancer health effects are not expected. The results for the preferred processing technology are presented in bold type. The Hazard Index, which is an estimate of total potential noncancer toxicity, is computed by summing the ratios of the potential airborne concentrations of hazardous chemicals to their chemical-specific toxicity threshold levels (i.e., Reference Concentrations; see Appendix D, Section D.4). Hazard Index values of 1 or more suggest the potential for adverse noncancer health effects following long-term exposure.

- *Sand, Slag, and Crucible Residues*—The processing of sand, slag, and crucible residues at Rocky Flats would not involve airborne releases of hazardous chemicals.

  No carcinogenic chemicals would be released from the Purex process at the Savannah River Site. Noncancer health risks resulting from releases of phosphoric acid and ammonium nitrate would notbe expected. Phosphoric acid is a corrosive irritant to the eyes, skin and mucous membranes and a respiratory tract irritant following inhalation exposure (Lewis 1991, EPA 1995a).

- *Graphite Fines*—The processing of graphite fines residues at Rocky Flats would not involve airborne releases of hazardous chemicals.

  No carcinogenic chemicals would be released from the mediated electrochemical oxidation process at the Savannah River Site. Noncancer health effects resulting from releases of phosphoric acid and ammonium nitrate would not be expected.

- *Inorganic Ash*—The processing of inorganic ash residues at Rocky Flats would not involve airborne releases of hazardous chemicals.

Table 4–7 Chemical Impacts Due to Incident-Free Management of Ash Residues

	Offsite Public Maximally Exposed Individual		*Offsite Public Population*	*Maximally Exposed Individual Worker*		*Involved Worker Population*
	Probability of Cancer Incidence	*Hazard Index*	*Number of Cancer Incidences or Fatalities* [a]	*Probability of Cancer Incidence*	*Hazard Index*	*Number of Cancer Incidences or Fatalities* [a]
Incinerator Ash and Firebrick Fines						
Alternative 1 (No Action)						
Calcine, Cement, and Store at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 2 (without Plutonium Separation)						
Vitrify at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Cold Ceramify at Rocky Flats	N/E	N/E	N/E	N/E	N/E	N/E
Calcine and Blend Down at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 3 (with Plutonium Separation)						
Preprocess at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Transport to Savannah River Site	N/A	N/A	0.0015 [c]	N/A	N/A	(c)
Purex at Savannah River Site [d, e]	N/E	1×10^{-9}	N/E	N/E	2×10^{-8}	N/E
Preprocess at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Transport to Savannah River Site	N/A	N/A	0.0011 [c]	N/A	N/A	(c)
Mediated Electrochemical Oxidation/Purex at Savannah River Site [d, e]	N/E	6×10^{-10}	N/E	N/E	8×10^{-9}	N/E
Alternative 4 (Combination)						
Calcine and Cement at Rocky Flats	N/E	N/E	N/E	N/E	N/E	N/E
Repackage at Rocky Flats	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**
Sand, Slag, and Crucible Residues						
Alternative 1 (No Action)						
Calcine, Cement, and Store at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 2 (without Plutonium Separation)						
Vitrify at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Calcine and Blend Down at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 3 (with Plutonium Separation)						
Preprocess at Rocky Flats [b]	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**
Transport to Savannah River Site	**N/A**	**N/A**	**0.00034** [c]	**N/A**	**N/A**	**(c)**
Purex at Savannah River Site [d, e]	**N/E**	$\mathbf{2\times10^{-9}}$	**N/E**	**N/E**	$\mathbf{2\times10^{-8}}$	**N/E**
Alternative 4 (Combination)						
Calcine and Cement at Rocky Flats	N/E	N/E	N/E	N/E	N/E	N/E
Repackage at Rocky Flats	N/E	N/E	N/E	N/E	N/E	N/E

	Offsite Public Maximally Exposed Individual		*Offsite Public Population*	*Maximally Exposed Individual Worker*		*Involved Worker Population*
	Probability of Cancer Incidence	***Hazard Index***	***Number of Cancer Incidences or Fatalities*** [a]	***Probability of Cancer Incidence***	***Hazard Index***	***Number of Cancer Incidences or Fatalities*** [a]
Graphite Fines						
Alternative 1 (No Action)						
Calcine, Cement, and Store at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 2 (without Plutonium Separation)						
Vitrify at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Calcine and Blend Down at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 3 (with Plutonium Separation)						
Preprocess at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Transport to Savannah River Site	N/A	N/A	0.00009 [c]	N/A	N/A	(c)
Mediated Electrochemical Oxidation/Purex at Savannah River Site [d, e]	N/E	2×10^{-9}	N/E	N/E	2×10^{-8}	N/E
Alternative 4 (Combination) Calcine and Cement at Rocky Flats	N/E	N/E	N/E	N/E	N/E	N/E
Repackage at Rocky Flats	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**
Inorganic Ash						
Alternative 1 (No Action)						
Calcine, Cement, and Store at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 2 (without Plutonium Separation)						
Vitrify at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Calcine and Blend Down at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 4 (Combination)						
Calcine and Cement at Rocky Flats	N/E	N/E	N/E	N/E	N/E	N/E
Repackage at Rocky Flats	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**

N/A = Not applicable. The maximally exposed individual is undefined for vehicle emissions. N/E = No emissions.

[a] Cancer incidences and fatalities are calculated for process emissions and transportation emissions, respectively.

[b] No hazardous chemicals are released from this process; therefore, no associated health risks exist.

[c] Cancer fatalities due to vehicle emissions into the air. This impact is listed only once under public population because the vehicle emissions affect the public and worker populations collectively; however, the risk to the public dominates. See Appendix E, Section E.4 for additional details.

[d] Impacts are presented for F-Canyon operations. H-Canyon operations are expected to result in similar or lower impacts.

[e] No carcinogenic chemicals are released from the process; therefore, only noncancer health risks are evaluated.

Note: The results for the preferred processing technology are presented in bold type.

4.2.2.2 Accidents

The potential radiological impacts to the public and the noninvolved onsite workers due to accidents with ash residues are summarized and presented in this section. The detailed analysis of onsite accidents, with the associated assumptions, is presented in Appendix D, Section D.3. The detailed analysis considered a wide spectrum of potential accident scenarios, including fire, explosion, spill, criticality, earthquake, and aircraft crash. The accident scenarios with the highest consequences and risks were selected and carried forward to this section for the purpose of consequence and risk comparison. A composite of the risks due to major onsite accident scenarios in each spectrum (including the nonbounding accidents) was also computed and used for comparisons. The composite risk estimates are accurate enough for the purpose of comparing processing technologies against each other. The detailed analysis of transportation accidents, with the associated assumptions, is presented in Appendix E, Sections E.5 and E.6.

The accident frequencies and process durations of the selected accidents are presented in **Table 4–8**. The impacts due to the preferred processing technology are presented in bold type. The onsite accident frequencies are given on a per year basis because many accidents, such as earthquakes, are commonly expressed this way. The duration of each process is given in years. The actual probability of occurrence of each onsite accident can be obtained by multiplying the accident frequency by the processing technology's duration. In this way, the calculated probabilities are based on the total amount of residue in this category rather than a standard unit of time. The impacts of accidents during post-processing interim storage are presented for all the plutonium residues and scrub alloy combined in Section 4.14.

The calculation of accident probability is slightly different for traffic accident fatalities. The frequency of traffic accidents is given in terms of the number of fatal accidents per round trip shipment from Rocky Flats to the Savannah River Site. The process duration for traffic accidents is given as the number of round trip shipments. Thus, the actual probability of a fatal traffic accident can be obtained by multiplying the frequency (fatal accidents per round-trip shipment) times the duration (number of round-trip shipments).

The consequences for the public and a noninvolved onsite worker are also presented in Table 4–8 for each of the four classes of ash residue. Eight processing technologies are under consideration for the incinerator ash and firebrick fines residue; six processing technolgies are under consideration for the sand, slag, and crucible residue; seven processing technologies are under consideration for the graphite fines residue; and five processing technologies are under consideration for the inorganic ash residue.

The risks associated with each accident are calculated by multiplying the probability times the consequences. The risks to the public and an onsite worker are presented in **Table 4–9**, for each processing technology for the four subcategories of ash residue. The risk associated with the highest risk accident and a composite risk associated with all major accidents are both presented. The risks associated with the preferred processing technology are presented in bold type.

The public maximally exposed individual is a hypothetical individual who resides at the site boundary in the downwind direction. The public population is defined as the residential population within a radius of 80 km (50 mi). A noninvolved onsite worker is defined as an individual worker who is located 100 m (328 ft) or more downwind from the release point when an accidental release of radioactive material occurs.

Table 4–8 Accident Frequencies, Process Durations, and Consequences for Accidents with Ash Residues

				Offsite Public Maximally Exposed Individual Consequences		*Offsite Public Population Consequences*		*Noninvolved Onsite Worker Consequences*	
	Accident Scenario	*Accident Frequency (per year)*	*Process Duration (years)*	*Dose (mrem)*	*Probability of a Latent Cancer Fatality*	*Dose (person-rem)*	*Number of Latent Cancer or Traffic Fatalities*	*Dose (mrem)*	*Probability of a Latent Cancer Fatality*
Incinerator Ash and Firebrick Fines									
Alternative 1 (No Action)									
Calcine, Cement, and Store at Rocky Flats [a]	Earthquake (Bldg. 371)	0.000094	3.00	500	0.00025	6,940	3.5	5,830	0.0023
	Earthquake (Bldg. 707) [b]	0.0026	3.00	333	0.00017	6,940	3.5	5,830	0.0023
Alternative 2 (without Plutonium Separation)	Explosion (Bldg. 707) [c]	0.00005	2.18	480	0.00024	10,000	5.0	8,400	0.0034
Vitrify at Rocky Flats	Earthquake (Bldg. 707) [d]	0.0026	2.18	457	0.00023	9,520	4.8	8,000	0.0032
Cold Ceramify at Rocky Flats	Earthquake (Bldg. 707)	0.0026	1.31	762	0.00035	15,900	8.0	13,300	0.0053
Calcine & Blend Down at Rocky Flats	Earthquake (Bldg. 707)	0.0026	2.50	667	0.00033	13,900	7.0	11,700	0.0047
	Earthquake (Bldg. 371) [e]	0.000094	2.50	1,000	0.00050	13,900	7.0	11,700	0.0047
Alternative 3 (with Plutonium Separation)									
Preprocess at Rocky Flats	Earthquake (Bldg. 707)	0.0026	1.41	1,170	0.00059	24,300	12	20,400	0.016
Transport to Savannah River Site	Traffic Fatality	0.00010 per shipment	116 shipments	N/A	N/A	N/A	1.0 [f]	N/A	(g)
Purex at Savannah River Site	Earthquake (H-Canyon) [h]	0.000182	15.83	74	0.000037	3,330	1.7	23,600	0.019
Preprocess at Rocky Flats									
Transport to Savannah River Site	Earthquake (Bldg. 707)	0.0026	1.03	1,620	0.00081	33,800	17	28,400	0.023
	Traffic Fatality	0.00010 per shipment	86 shipments	N/A	N/A	N/A	1.0 [f]	N/A	(g)
Mediated Electrochemical Oxidation/Purex at Savannah River Site	Earthquake (H-Canyon)	0.000182	2.16	62	0.000031	2,800	1.4	19,900	0.0080
Alternative 4 (Combination)									
Calcine and Cement at Rocky Flats	Earthquake (Bldg. 371)	0.000094	3.00	500	0.00025	6,940	3.5	5,830	0.0023
	Earthquake (Bldg. 707) [b]	0.0026	3.00	333	0.00017	6,940	3.5	5,830	0.0023
Repackage at Rocky Flats	**Earthquake (Bldg. 707)**	**0.0026**	**1.07**	**1,550**	**0.0078**	**32,300**	**16**	**27,100**	**0.022**
Sand, Slag, and Crucible Residues									
Alternative 1 (No Action)									
Calcine, Cement, and Store at Rocky Flats [a]	Earthquake (Bldg. 371)	0.000094	0.42	500	0.00025	6,940	3.5	5,830	0.0023
	Earthquake (Bldg. 707) [b]	0.0026	0.42	333	0.00017	6,940	3.5	5,830	0.0023
Alternative 2 (without Plutonium Separation)	Explosion (Bldg. 707) [c]	0.00005	0.31	480	0.00024	10,000	5.0	8,400	0.0034
Vitrify at Rocky Flats	Earthquake (Bldg. 707) [d]	0.0026	0.31	457	0.00023	9,520	4.8	8,000	0.0032

				Offsite Public Maximally Exposed Individual Consequences		*Offsite Public Population Consequences*		*Noninvolved Onsite Worker Consequences*	
	Accident Scenario	***Accident Frequency (per year)***	***Process Duration (years)***	***Dose (mrem)***	***Probability of a Latent Cancer Fatality***	***Dose (person-rem)***	***Number of Latent Cancer or Traffic Fatalities***	***Dose (mrem)***	***Probability of a Latent Cancer Fatality***
Calcine and Blend Down at Rocky Flats	Earthquake (Bldg. 707)	0.0026	1.6	144	0.000072	3,010	1.5	2,530	0.0010
	Earthquake (Bldg. 371) [e]	0.000094	1.6	217	0.00011	3,010	1.5	2,530	0.0010
Alternative 3 (with Plutonium Separation)									
Preprocess at Rocky Flats	**Earthquake (Bldg. 707)**	**0.0026**	**0.31**	**768**	**0.00038**	**16,000**	**8.0**	**13,400**	**0.0054**
Transport to Savannah River Site	**Traffic Fatality**	**0.00010 per shipment**	**26 shipments**	**N/A**	**N/A**	**N/A**	**1.0 [f]**	**N/A**	**(g)**
Purex at Savannah River Site	**Earthquake (H-Canyon) [h]**	**0.000182**	**1.58**	**74**	**0.000037**	**3,330**	**1.7**	**23,600**	**0.019**
Alternative 4 (Combination)									
Calcine and Cement at Rocky Flats	Earthquake (Bldg. 371)	0.000094	0.42	500	0.00025	6,940	3.5	5,830	0.0023
	Earthquake (Bldg. 707)[b]	0.0026	0.42	333	0.00017	6,940	3.5	5,830	0.0023
Repackage at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.15	1,550	0.0078	32,300	16	27,100	0.022
Graphite Fines									
Alternative 1 (No Action)									
Calcine, Cement, and Store at Rocky Flats [a]	Earthquake (Bldg. 371)	0.000094	0.24	500	0.00025	6,940	3.5	5,830	0.0023
	Earthquake (Bldg. 707) [b]	0.0026	0.24	333	0.00017	6,940	3.5	5,830	0.0023
Alternative 2 (without Plutonium Separation)									
Vitrify at Rocky Flats	Explosion (Bldg. 707) [c]	0.00005	0.18	480	0.00024	10,000	5.0	8,400	0.0034
	Earthquake (Bldg. 707) [d]	0.0026	0.18	457	0.00023	9,520	4.8	8,000	0.0032
Calcine and Blend Down at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.20	667	0.00033	13,900	7.0	11,700	0.0047
	Earthquake (Bldg. 371) [e]	0.000094	0.20	1,000	0.00050	13,900	7.0	11,700	0.0047
Alternative 3 (with Plutonium Separation)									
Preprocess at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.08	1,620	0.00081	33,800	17	28,400	0.023
Transport to Savannah River Site	Traffic Fatality	0.00010 per shipment	7 shipments	N/A	N/A	N/A	1.0 [f]	N/A	(g)
Mediated Electrochemical Oxidation/Purex at Savannah River Site	Earthquake (H-Canyon)	0.000182	0.17	62	0.000031	2,800	1.4	19,900	0.0080
Alternative 4 (Combination)									
Calcine and Cement at Rocky Flats	Earthquake (Bldg. 371)	0.000094	0.24	500	0.00025	6,940	3.5	5,830	0.0023
	Earthquake (Bldg. 707) [b]	0.0026	0.24	333	0.00017	6,940	3.5	5,830	0.0023
Repackage at Rocky Flats	**Earthquake (Bldg. 707)**	**0.0026**	**0.09**	**1,550**	**0.0078**	**32,300**	**16**	**27,100**	**0.022**
Inorganic Ash									

				Offsite Public Maximally Exposed Individual Consequences		*Offsite Public Population Consequences*		*Noninvolved Onsite Worker Consequences*	
	Accident Scenario	*Accident Frequency (per year)*	*Process Duration (years)*	*Dose (mrem)*	*Probability of a Latent Cancer Fatality*	*Dose (person-rem)*	*Number of Latent Cancer or Traffic Fatalities*	*Dose (mrem)*	*Probability of a Latent Cancer Fatality*
Alternative 1 (No Action)									
Calcine, Cement, and Store at Rocky Flats [a]	Earthquake (Bldg. 371)	0.000094	0.17	500	0.00025	6,940	3.5	5,830	0.0023
	Earthquake (Bldg. 707) [b]	0.0026	0.17	533	0.00017	6,940	3.5	5,830	0.0023
Alternative 2 (without Plutonium Separation)	Explosion (Bldg. 707) [c]	0.00005	0.12	480	0.00024	10,000	5.0	8,400	0.0034
Vitrify at Rocky Flats	Earthquake (Bldg. 707) [d]	0.0026	0.12	457	0.00023	9,520	4.8	8,000	0.0032
Calcine and Blend Down at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.64	144	0.000072	3,010	1.5	2,530	0.0010
	Earthquake (Bldg. 371) [e]	0.000094	0.64	217	0.00011	3,010	1.5	2,530	0.0010
Alternative 4 (Combination)									
Calcine and Cement at Rocky Flats	Earthquake (Bldg. 371)	0.000094	0.17	500	0.00025	6,940	3.5	5,830	0.0023
	Earthquake (Bldg. 707) [b]	0.0026	0.17	533	0.00017	6,940	3.5	5,830	0.0023
Repackage at Rocky Flats	**Earthquake (Bldg. 707)**	**0.0024**	**0.06**	**1,550**	**0.0078**	**32,300**	**16**	**27,100**	**0.022**

N/A =not applicable

[a] The accident impacts of 20 years of storage are presented in Section 4.14 for all the materials combined under Alternative 1.

[b] Building 707 is designated as an alternate location for the Calcine and Cement process at Rocky Flats.

[c] Highest consequence accident for this processing technology.

[d] Highest risk accident for this processing technology.

[e] Building 371 is designated as an alternate location for the Calcine and Blend Down process at Rocky Flats.

[f] This fatality is due to the mechanical impact of the accident, not cancer due to radiation. The radiological consequences of a radioactive release on the highway are impossible to list as a single number because the accident could occur at any point along the route and meteorological conditions and population distributions vary greatly along the route.

[g] The consequence of a high-speed traffic accident would be at least one fatality among the transportation workers due to trauma.

[h] HB-Line operates 12.5 percent of the time. Dose estimates assumed the HB-Line was operating at the time of the accident.

Note: The impacts and results for the preferred processing technology are presented in bold type.

Table 4–9 Risks Due to Accidents with Ash Residues

	Accident Scenario	*Offsite Public Maximally Exposed Individual Risk (Probability of a Latent Cancer Fatality)*	*Offsite Public Population Risk (Number of Latent Cancer or Traffic Fatalities)*	*Noninvolved Onsite Worker Risk (Probability of a Latent Cancer Fatality)*
Incinerator Ash and Firebrick Fines				
Alternative 1 (No Action)				
Calcine, Cement, and Store at Rocky Flats [a]	Earthquake (Bldg. 371)	7.1×10^{-8}	0.00098	6.6×10^{-7}
	Composite (Bldg. 371)	1.1×10^{-7}	0.0015	1.0×10^{-6}
	Earthquake (Bldg. 707) [b]	1.3×10^{-6}	0.027	0.000018
	Composite (Bldg. 707) [b]	1.4×10^{-6}	0.028	0.000019
Alternative 2 (without Plutonium Separation)				
Vitrify at Rocky Flats	Earthquake (Bldg. 707)	1.3×10^{-6}	0.027	0.000018
	Composite	1.3×10^{-6}	0.028	0.000019
Cold Ceramify at Rocky Flats	Earthquake (Bldg. 707)	1.3×10^{-7}	0.027	0.000018
	Composite	1.3×10^{-6}	0.028	0.000019
Calcine and Blend Down at Rocky Flats	Earthquake (Bldg. 707)	2.1×10^{-6}	0.045	0.000030
	Composite (Bldg. 707)	2.2×10^{-6}	0.046	0.000031
	Earthquake (Bldg. 371) [c]	1.2×10^{-7}	0.0016	1.1×10^{-6}
	Composite (Bldg. 371) [c]	1.7×10^{-7}	0.0024	1.6×10^{-6}
Alternative 3 (with Plutonium Separation)				
Preprocess at Rocky Flats	Earthquake (Bldg. 707)	2.1×10^{-6}	0.045	0.000060
	Composite	2.2×10^{-6}	0.046	0.000061
Transport to Savannah River Site	Traffic Fatality	N/A	0.012 [d]	N/A
	Radioactive Release	N/A	0.000020	N/A
Purex at Savannah River Site	Earthquake (H-Canyon) [e]	3.5×10^{-8}	0.0016	0.000018
	Composite [e]	6.6×10^{-8}	0.0031	0.000018
Preprocess at Rocky Flats	Earthquake (Bldg. 707)	2.2×10^{-6}	0.045	0.000060
	Composite	2.2×10^{-6}	0.046	0.000061
Transport to Savannah River Site	Traffic Fatality	N/A	0.0088 [d]	N/A
	Radioactive Release	N/A	0.000020	N/A
Mediated Electrochemical Oxidation/Purex at Savannah River Site	Earthquake (H-Canyon)	1.2×10^{-8}	0.00055	3.1×10^{-6}
	Composite	2.0×10^{-8}	0.00094	3.2×10^{-6}

	Accident Scenario	*Offsite Public Maximally Exposed Individual Risk (Probability of a Latent Cancer Fatality)*	*Offsite Public Population Risk (Number of Latent Cancer or Traffic Fatalities)*	*Noninvolved Onsite Worker Risk (Probability of a Latent Cancer Fatality)*
Alternative 4 (Combination)				
Calcine and Cement at Rocky Flats	Earthquake (Bldg. 371)	7.1×10^{-8}	0.00098	6.6×10^{-7}
	Composite (Bldg. 371)	1.1×10^{-7}	0.0015	1.0×10^{-6}
	Earthquake (Bldg. 707) [b]	1.3×10^{-6}	0.027	0.000018
	Composite (Bldg. 707) [b]	1.4×10^{-6}	0.028	0.000019
Repackage at Rocky Flats	**Earthquake (Bldg. 707)**	$\mathbf{2.2\times10^{-6}}$	**0.045**	**0.000060**
	Composite	$\mathbf{2.2\times10^{-6}}$	**0.046**	**0.000061**
Sand, Slag, and Crucible Residues				
Alternative 1 (No Action)				
Calcine, Cement, and Store at Rocky Flats [a]	Earthquake (Bldg. 371)	9.9×10^{-9}	0.00014	9.2×10^{-8}
	Composite (Bldg. 371)	1.5×10^{-8}	0.00021	1.4×10^{-7}
	Earthquake (Bldg. 707) [b]	1.8×10^{-7}	0.0038	2.5×10^{-6}
	Composite (Bldg. 707) [b]	1.9×10^{-7}	0.0040	2.7×10^{-6}
Alternative 2 (without Plutonium Separation)				
Vitrify at Rocky Flats	Earthquake (Bldg. 707)	1.8×10^{-7}	0.0038	2.6×10^{-6}
	Composite	1.9×10^{-7}	0.0040	2.7×10^{-6}
Calcine and Blend Down at Rocky Flats	Earthquake (Bldg. 707)	3.0×10^{-7}	0.0063	4.2×10^{-6}
	Composite (Bldg. 707)	3.3×10^{-7}	0.0069	4.6×10^{-6}
	Earthquake (Bldg. 371) [c]	1.6×10^{-8}	0.00023	1.5×10^{-7}
	Composite (Bldg. 371) [c]	2.7×10^{-8}	0.00038	2.6×10^{-7}
Alternative 3 (with Plutonium Separation)				
Preprocess at Rocky Flats	**Earthquake (Bldg. 707)**	$\mathbf{3.1\times10^{-7}}$	**0.0064**	$\mathbf{4.3\times10^{-6}}$
	Composite	$\mathbf{3.2\times10^{-7}}$	**0.0066**	$\mathbf{4.5\times10^{-6}}$
Transport to Savannah River Site	**Traffic Fatality**	**N/A**	**0.0027** [d]	**N/A**
	Radioactive Release	**N/A**	$\mathbf{2.9\times10^{-7}}$	**N/A**
Purex at Savannah River Site	**Earthquake (H-Canyon)** [e]	$\mathbf{3.5\times10^{-9}}$	**0.00016**	$\mathbf{1.8\times10^{-6}}$
	Composite [e]	$\mathbf{6.6\times10^{-9}}$	**0.00030**	$\mathbf{1.8\times10^{-6}}$
Alternative 4 (Combination)				
Calcine and Cement at Rocky Flats	Earthquake (Bldg. 371)	9.9×10^{-9}	0.00014	9.2×10^{-8}
	Composite (Bldg. 371)	1.5×10^{-8}	0.00021	1.4×10^{-7}
	Earthquake (Bldg. 707)[b]	1.8×10^{-7}	0.0038	2.5×10^{-6}
	Composite (Bldg. 707)[b]	1.9×10^{-7}	0.0040	2.7×10^{-6}

	Accident Scenario	*Offsite Public Maximally Exposed Individual Risk (Probability of a Latent Cancer Fatality)*	*Offsite Public Population Risk (Number of Latent Cancer or Traffic Fatalities)*	*Noninvolved Onsite Worker Risk (Probability of a Latent Cancer Fatality)*
Repackage at Rocky Flats	Earthquake (Bldg. 707) Composite (Bldg. 707)	3.0×10^{-7} 3.1×10^{-7}	0.0063 0.0064	8.5×10^{-6} 8.6×10^{-6}
Graphite Fines				
Alternative 1 (No Action)				
Calcine, Cement, and Store at Rocky Flats [a]	Earthquake (Bldg. 371) Composite (Bldg. 371) Earthquake (Bldg. 707) [b] Composite (Bldg. 707) [b]	5.6×10^{-9} 8.6×10^{-9} 1.0×10^{-7} 1.1×10^{-7}	0.000078 0.00012 0.0022 0.0023	5.3×10^{-8} 8.0×10^{-8} 1.5×10^{-6} 1.5×10^{-6}
Alternative 2 (without Plutonium Separation)				
Vitrify at Rocky Flats	Earthquake (Bldg. 707) Composite	1.1×10^{-7} 1.1×10^{-7}	0.0022 0.0023	1.5×10^{-6} 1.6×10^{-6}
Calcine and Blend Down at Rocky Flats	Earthquake (Bldg. 707) Composite (Bldg. 707) Earthquake (Bldg. 371) [c] Composite (Bldg. 371) [c]	1.7×10^{-7} 1.8×10^{-7} 9.4×10^{-9} 1.4×10^{-8}	0.0036 0.0037 0.00013 0.00019	2.4×10^{-6} 2.5×10^{-6} 8.8×10^{-8} 1.3×10^{-7}
Alternative 3 (with Plutonium Separation)				
Preprocess at Rocky Flats	Earthquake (Bldg. 707) Composite	1.7×10^{-7} 1.7×10^{-7}	0.0035 0.0036	4.7×10^{-6} 4.8×10^{-6}
Transport to Savannah River Site	Traffic Fatality Radioactive Release	N/A N/A	0.0007 [b] 1.6×10^{-7}	N/A N/A
Mediated Electrochemical Oxidation/Purex at Savannah River Site	Earthquake (H-Canyon) Composite	9.6×10^{-10} 1.6×10^{-9}	0.000043 0.000074	2.5×10^{-7} 2.5×10^{-7}
Alternative 4 (Combination)				
Calcine, Cement, and Store at Rocky Flats [a]	Earthquake (Bldg. 371) Composite (Bldg. 371) Earthquake (Bldg. 707) [b] Composite (Bldg. 707) [b]	5.6×10^{-9} 8.6×10^{-9} 1.0×10^{-7} 1.1×10^{-7}	0.000078 0.00012 0.0022 0.0023	5.3×10^{-8} 8.0×10^{-8} 1.5×10^{-6} 1.5×10^{-6}
Repackage at Rocky Flats	**Earthquake (Bldg. 707)** **Composite**	$\mathbf{1.8\times10^{-7}}$ $\mathbf{1.9\times10^{-7}}$	**0.0038** **0.0039**	$\mathbf{5.1\times10^{-6}}$ $\mathbf{5.1\times10^{-6}}$

	Accident Scenario	*Offsite Public Maximally Exposed Individual Risk (Probability of a Latent Cancer Fatality)*	*Offsite Public Population Risk (Number of Latent Cancer or Traffic Fatalities)*	*Noninvolved Onsite Worker Risk (Probability of a Latent Cancer Fatality)*
Inorganic Ash				
Alternative 1 (No Action)				
Calcine, Cement, and Store at Rocky Flats [a]	Earthquake (Bldg. 371)	4.0×10^{-9}	0.000055	3.7×10^{-8}
	Composite (Bldg. 371)	6.1×10^{-9}	0.000084	5.7×10^{-8}
	Earthquake (Bldg. 707) [b]	7.4×10^{-8}	0.0015	1.0×10^{-6}
	Composite (Bldg. 707) [b]	7.7×10^{-8}	0.0016	1.1×10^{-6}
Alternative 2 (without Plutonium Separation)				
Vitrify at Rocky Flats	Earthquake (Bldg. 707)	7.1×10^{-8}	0.0015	1.0×10^{-6}
	Composite	7.4×10^{-8}	0.0015	1.0×10^{-6}
Calcine and Blend Down at Rocky Flats	Earthquake (Bldg. 707)	1.2×10^{-7}	0.0025	1.7×10^{-6}
	Composite (Bldg. 707)	1.3×10^{-7}	0.0027	1.8×10^{-6}
	Earthquake (Bldg. 371) [c]	6.5×10^{-9}	0.000090	6.1×10^{-8}
	Composite (Bldg. 371) [c]	1.1×10^{-8}	0.00015	1.0×10^{-7}
Alternative 4 (Combination)				
Calcine, Cement, and Store at Rocky Flats [a]	Earthquake (Bldg. 371)	4.0×10^{-9}	0.000055	3.7×10^{-8}
	Composite (Bldg. 371)	6.1×10^{-9}	0.000084	5.7×10^{-8}
	Earthquake (Bldg. 707) [b]	7.4×10^{-8}	0.0015	1.0×10^{-6}
	Composite (Bldg. 707) [b]	7.7×10^{-8}	0.0016	1.1×10^{-6}
Repackage at Rocky Flats	**Earthquake (Bldg. 707)**	$\mathbf{1.2\times10^{-7}}$	**0.0025**	$\mathbf{3.4\times10^{-6}}$
	Composite	$\mathbf{1.2\times10^{-7}}$	**0.0026**	$\mathbf{3.4\times10^{-6}}$

N/A = not applicable

[a] The accident impacts of 20 years of storage are presented in Section 4.14 for all the materials combined under Alternative 1.

[b] Building 707 is designated as an alternate location for the Calcine and Cement process at Rocky Flats.

[c] Building 371 is designated as an alternate location for the Calcine and Blend Down process at Rocky Flats.

[d] This risk is due to the mechanical impact of a potential accident, not cancer due to radiation. This risk includes members of the public and transportation workers.

[e] The H-Canyon operates 100 percent of the time and the HB-Line operates 12.5 percent of the time.

Note: The risks due to the preferred processing technology are presented in bold type.

- *Incinerator Ash and Firebrick Fines*—Highest consequences to all three receptors would occur if DOE decides to implement the mediated electrochemical oxidation technology at the Savannah River Site and a major earthquake strong enough to cause the collapse of Building 707 occurs during the preprocessing of residues to be shipped to the Savannah River Site for final processing.

  The highest risk to the public maximally exposed individual is estimated to be 2.2×10^{-6}, which is due to an earthquake during preprocessing of the residue at Rocky Flats for the mediated electrochemical oxidation technology at the Savannah River Site, or an earthquake during repackaging the residue with the Repackaging technology at Rocky Flats. This individual's chance of incurring a latent cancer fatality would be increased by less than one in one hundred thousand. The highest risk to the public population is estimated to be 0.045 latent cancer fatalities, which is due to an earthquake during preprocessing of the residue in Rocky Flats Building 707 for the mediated electrochemical oxidation technology at the Savannah River Site, an earthquake during processing the residue with the calcine and blend down technology in Rocky Flats Building 707, an earthquake during preprocessing of the residue in Rocky Flats Building 707 for the Purex technology at the Savannah River Site, or an earthquake during repackaging the residue at Rocky Flats. The highest risk to the individual noninvolved onsite worker is estimated to be 0.000060, which is due to an earthquake during preprocessing of the residue at Rocky Flats for the Purex technology at the Savannah River Site or an earthquake during preprocessing of the residue at Rocky Flats for the mediated electrochemical oxidation technology at the Savannah River Site, or an earthquake during repackaging the residue at Rocky Flats. This individual's chance of incurring a latent cancer fatality would be increased by less than one in ten thousand.

- *Sand, Slag, and Crucible Residues*—The highest consequence to all three receptors would occur if DOE decides to implement the Repackage technology at Rocky Flats and a major earthquake strong enough to cause the breach of Building 707 occurs.

  The highest risk to the public maximally exposed individual is estimated to be 3.1×10^{-7}, which is due to an earthquake during preprocessing of the residue at Rocky Flats for the Purex technology at the Savannah River Site. This individual's chance of incurring a latent cancer fatality would be increased by less than one in one million. The highest risk to the public population is estimated to be 0.0064 latent cancer fatalities, which is also due to an earthquake during repackaging the residue at Rocky Flats. The highest risk to the individual noninvolved onsite worker is estimated to be 8.5×10^{-6}, which is due to an earthquake during repackaging of the residue at Rocky Flats. This individual's chance of incurring a latent cancer fatality would be increased by less than one in one hundred thousand.

- *Graphite Fines*—The highest consequences to all three receptors would occur if DOE decides to implement the mediated electrochemical oxidation technology at the Savannah River Site and a major earthquake strong enough to cause the collapse of Building 707 occurs during the preprocessing of residues to be shipped to the Savannah River Site for final processing.

  The highest risk to the public maximally exposed individual is estimated to be 1.8×10^{-7}, which is due to an earthquake during repackaging of the residue at Rocky Flats. This individual's chance of incurring a latent cancer fatality would be increased by less than one in one million. The highest risk to the public population is estimated to be 0.0038 latent cancer fatalities, which is also due to an earthquake during repackaging of the residue at Rocky Flats. The highest risk to the individual noninvolved onsite worker is estimated to be 5.1×10^{-6}, which is also due to an earthquake during repackaging of the residue at Rocky Flats. This individual's chance of incurring a latent cancer fatality would be increased by less than one in a hundred thousand.

- *Inorganic Ash* —The highest consequences to all three receptors would occur if DOE decides to implement the Repackage technology at Rocky Flats and a major earthquake strong enough to cause the breach of Building 707 occurs.

  The highest risk to the public maximally exposed individual is estimated to be 1.2×10^{-7}, which is due to an earthquake during processing of the residue with the calcine and blend down technology in Rocky Flats Building 707. This individual's chance of incurring a latent cancer fatality would be increased by less than one in a million. The highest risk to the public population is estimated to be 0.0025 latent cancer fatalities, which is due to the same earthquake-initiated accident described for the maximally exposed individual. The highest risk to the individual noninvolved onsite worker is estimated to be 3.4×10^{-6}, which is due to an earthquake during repackaging of the residue in Building 707. This individual's chance of incurring a latent cancer fatality would be increased by less than one in one hundred thousand.

4.3 Impacts of Managing Pyrochemical Salt Residues

The inventory of pyrochemical salt residues assessed in this EIS is divided into four subcategories, as shown in **Table 4-10**. The inventory of pyrochemical salt residues weights 14,888 kg (32,822 lb), including 1,002 kg (2,209 lb) of plutonium. This inventory is stored in 628 drums (with approximately 3,140 internal metal containers) and 2,957 other small individual containers.

Table 4–10 Pyrochemical Salt Residues

Salt Subcategories	*Residue Mass (kg)*[a]	*Plutonium Mass (kg)*[a]	*Number of Drums*	*Number of Other Individual Containers*
IDC 409	1,474	237	272	24
Other ER/MSE	11,243	575	276	2,416
IDC 365, 413, 427	727	139	35	365
Other DOR	1,444	51	45	152
Totals	14,888	1,002	628	2,957

[a] To convert to pounds, multiply by 2.2.

All four subcategories of salt residues have the same technology options under the No Action Alternative: to pyro-oxidize and store the residue at Rocky Flats. Similarly, all four subcategories have the same processing technology under the Process without Plutonium Separation Alternative: to pyro-oxidize and blend down the residue. The technologies within the Process with Plutonium Separation Alternative are more complicated. These technologies include two technologies at Rocky Flats, three at Los Alamos, and one at the Savannah River Site. All four subcategories have the same processing technology under Alternative 4. The preferred processing technology for all salt residues except the IDC 365, 413, and 427 residues is repackaging at Rocky Flats. As discussed in Section 2.4.2, there are two preferred processing technologies for these residues: (1) acid dissolution at Los Alamos National Laboratory and (2) repackaging at Rocky Flats.

Any plutonium separated by the salt distillation or water leach processes would contain americium, while any plutonium separated by the acid dissolution or Purex processes would not. Americium emits gamma radiation, which would increase the worker doses. In the acid dissolution process at Los Alamos National Laboratory, the americium would be stabilized as transuranic waste. It would be stored at Los Alamos National Laboratory pending disposal at WIPP. In the Purex process at the Savannah River Site, the americium would go into the high-level waste. The impacts in this section take into account the gamma radiation from americium.

This section presents the environmental impacts of managing the entire inventory of each subcategory under each of the technologies. The results in this section were used in the calculation of the total impacts of the No Action Alternative and the Preferred Alternative which are presented in Sections 4.20 and 4.21, respectively, and of the management approaches which are presented in Section 4.22.

4.3.1 Products and Wastes

Every processing technology for pyrochemical salt residues would generate some quantity of transuranic waste and thus would involve preparation of this waste for disposal in WIPP. Every technology would also generate some quantity of low-level waste, which would be disposed of routinely using existing procedures at each site. A small portion of the low-level waste generated at Rocky Flats could possibly be low-level mixed waste, but this waste would also be disposed of routinely using existing procedures. The No Action Alternative would generate stabilized residues that would have to remain in storage indefinitely. The Process without Plutonium Separation Alternative would generate transuranic waste directly from the residue. In some of the processing technologies the stabilized residues and transuranic waste would be placed in pipe components inside 208-liter (55-gal) drums as shown in Figure 2-13 in Chapter 2. If DOE applies variances to the stabilized residues (Alternative 4), then the stabilized residues could be disposed of in WIPP as transuranic waste.

High-level waste and saltstone would be generated only at the Savannah River Site if the scrub alloy resulting from salt scrubbing at Rocky Flats were shipped to that site for plutonium separation. The final form for the high-level waste would be glass poured into stainless steel canisters, which would be stored at the Savannah River Site until a monitored geologic repository is ready to receive them. Saltstone is a cement form of low-level waste that is generated as a by-product of the Savannah River Site tank farm operations and is routinely disposed of onsite in concrete vaults.

If plutonium is separated at Rocky Flats, the Savannah River Site, or Los Alamos National Laboratory, it would be stored securely until a decision is made on its disposition. No increase in proliferation risk would result and this plutonium would not be used for nuclear explosive purposes.

The solid plutonium-bearing products and wastes that would be generated from pyrochemical salt residues under each of the technologies are presented in **Table 4–11.** The shaded areas of Table 4–11 indicate types of solid products and wastes that would not be generated under the various technologies. The products and wastes from the preferred processing technologies are presented in bold type. The stabilized residues from the No Action Alternative could actually be stored in small metal containers in a vault, but for the purpose of comparisons in this EIS, DOE considered that these stabilized residues would be stored in drums like the rest of the stabilized residues.

- **IDC 409 Salt Residues—**The largest amount of transuranic waste (over 1,600 drums) would be generated in the water leach technology at Rocky Flats, but the pyro-oxidize and blend down technology at Rocky Flats would generate almost as much (over 1,400 drums). The amount of waste from the water leach process is high because it is a liquid process, assumed to generate 3.4 drums of waste per kilogram of residue, with 30 percent of this being transuranic waste. The amount of waste from the pyro-oxidize and blend down process is high because blending down requires a large volume increase. These two technologies would generate much more transuranic waste than the other technologies, which would generate fewer than 200 drums. The stabilized residues generated in Alternative 4 could be disposed of in WIPP, just like transuranic waste. Thus, the technology under Alternative 4 would generate 1,500 drums (stabilized residues plus transuranic waste) to be sent to WIPP. The quantities of low-level waste are low under all the technologies and the sites would manage this waste using routine procedures. The maximum amount of plutonium that could be separated from IDC 409 salt residues is 235 kg (518 lb).

Table 4–11 Products and Wastes from Pyrochemical Salt Residues

	Stabilized Residues (Drums)[a]	*Transuranic Waste (Drums)*[a]	*High-Level Waste (Canisters of Glass)*[b]	*Separated Plutonium (kg)*[c]	*Low-Level Waste (Drums)*[a]	*Saltstone (cubic meters)*
IDC 409 Salt Residues						
Alternative 1 (No Action)						
Pyro-Oxidize and Store at Rocky Flats	1,406	90			157	
Alternative 2 (without Plutonium Separation)						
Pyro-Oxidize and Blend Down at Rocky Flats		1,445			157	
Alternative 3 (with Plutonium Separation)						
Pyro-Oxidize and Salt Distill at Rocky Flats		97		235	157	
Pyro-Oxidize and Water Leach at Rocky Flats		1,609		228	3,665	
Pyro-Oxidize at Rocky Flats		90		–	157	
Salt Distill at Los Alamos National Laboratory		85		234	106	
Salt Scrub at Rocky Flats		180	–	–	157	–
Purex at Savannah River Site		11	0.1	228	41	51
Alternative 4 (Combination)						
Repackage at Rocky Flats	**1,410**[d]	**90**			**157**	
Other Electrorefining and Molten Salt Extraction Salt Residues						
Alternative 1 (No Action)						
Pyro-Oxidize and Store at Rocky Flats	3,800	464			842	
Alternative 2 (without Plutonium Separation)						
Pyro-Oxidize and Blend Down at Rocky Flats		10,802			842	
Alternative 3 (with Plutonium Separation)						
Pyro-Oxidize and Salt Distill at Rocky Flats		519		569	842	
Pyro-Oxidize and Water Leach at Rocky Flats		11,945		552	27,600	
Pyro-Oxidize at Rocky Flats		464		–	842	
Salt Distill at Los Alamos National Laboratory		469		558	818	
Salt Scrub at Rocky Flats		1,152	–	–	842	–
Purex at Savannah River Site		84	1	553	309	384
Alternative 4 (Combination)						
Repackage at Rocky Flats	**3,800**[d]	**464**			**842**	

	Stabilized Residues (Drums)[a]	*Transuranic Waste (Drums)*[a]	*High-Level Waste (Canisters of Glass)*[b]	*Separated Plutonium (kg)*[c]	*Low-Level Waste (Drums)*[a]	*Saltstone (cubic meters)*
IDC 365, 413, and 427 Salt Residues						
Alternative 1 (No Action)						
Pyro-Oxidize and Store at Rocky Flats	583	40			58	
Alternative 2 (without Plutonium Separation)						
Pyro-Oxidize and Blend Down at Rocky Flats		708			58	
Alternative 3 (with Plutonium Separation)						
Pyro-Oxidize and Water Leach at Rocky Flats		792		133	1,788	
Pyro-Oxidize at Rocky Flats		**40**		**–**	**58**	
Acid Dissolve at Los Alamos National Laboratory		**825**		**138**	**1,797**	
Pyro-Oxidize at Rocky Flats		40		–	58	
Water Leach at Los Alamos National Laboratory		807		138	1,797	
Salt Scrub at Rocky Flats		84	–	–	58	–
Purex at Savannah River Site		5	0.1	134	20	25
Alternative 4 (Combination)						
Repackage at Rocky Flats	**826**[d]	**40**			**58**	
Other Direct Oxide Reduction Salt Residues						
Alternative 1 (No Action)						
Pyro-Oxidize and Store at Rocky Flats	306	56			110	
Alternative 2 (without Plutonium Separation)						
Pyro-Oxidize and Blend Down at Rocky Flats		1,384			110	
Alternative 3 (with Plutonium Separation)						
Pyro-Oxidize and Water Leach at Rocky Flats		1,550		49	3,547	
Pyro-Oxidize at Rocky Flats		56		–	110	
Acid Dissolve at Los Alamos National Laboratory		1,581		50	3,439	
Pyro-Oxidize at Rocky Flats		56		–	110	
Water Leach at Los Alamos National Laboratory		1,557		50	3,439	
Salt Scrub at Rocky Flats		145	–	–	110	–
Purex at Savannah River Site		11	0.1	49	40	50
Alternative 4 (Combination)						
Repackage at Rocky Flats	**306**[d]	**56**			**110**	

[a] Standard 55-gallon (208-liter) drums. (208 liters is equal to 0.208 cubic meters.)
[b] Each canister is 2 feet (61 cm) in diameter, 10 feet (300 cm) tall, and contains approximately 3,700 pounds (1,680 kg) of high-level waste glass.
[c] To convert to pounds, multiply by 2.2.
[d] These stabilized residues could be disposed of in WIPP as transuranic waste.

Notes: Shaded areas indicate the types of solid products and waste that would not be generated. The products and wastes from the preferred processing technologies are presented in bold type. The storage capacities at each site are adequate to store the products and wastes listed in this table, except as noted in the text.

- **Other Electrorefining and Molten Salt Extraction Salt Residues—**The largest amount of transuranic waste (almost 12,000 drums) would be generated in the water leach technology at Rocky Flats, but the pyro-oxidize and blend down technology at Rocky Flats would generate almost as much (almost 11,000 drums). The amount of waste from the water leach process is high because it is a liquid process, assumed to generate 3.4 drums of waste per kilogram of residue, with 30 percent of this being transuranic waste. The amount of waste from the pyro-oxidize and blend down process is high because blending down requires a large volume increase. These two technologies would generate much more transuranic waste than the other technologies, which would generate no more than about 1,100 drums. These two processing technologies would also stress the capacity for transuranic waste storage at Rocky Flats. The stabilized residues generated in Alternative 4 could be disposed of in WIPP, just like transuranic waste. Thus, the technology under Alternative 4 would generate over 4,000 drums (stabilized residues plus transuranic waste) to be sent to WIPP. The quantities of low-level waste are low under all the technologies and the sites would manage this waste using routine procedures. The maximum amount of plutonium that could be separated from other electrorefining and molten salt extraction pyrochemical salt residues is 569 kg (1,254 lb).

- **IDC 365, 413 and 427 Salt Residues—**Four of the seven processing technologies would cause over 700 drums of transuranic waste to be generated. In the other three technologies, fewer than 100 drums of transuranic waste would be generated. The stabilized residues generated in Alternative 4 could be disposed of in WIPP, just like transuranic waste. Thus, the technology under Alternative 4 would generate over 850 drums (stabilized residues plus transuranic waste) to be sent to WIPP. The quantities of low-level waste are low under all the technologies and the sites would manage this waste using routine procedures. The maximum amount of plutonium that could be separated from these salt residues is 138 kg (304 lb).

- **Other Direct Oxide Reduction Salt Residues—**Four of the seven processing technologies would cause over 1,300 drums of transuranic waste to be generated. In the other three technologies, fewer than 200 drums of transuranic waste would be generated. The stabilized residues generated in Alternative 4 could be disposed of in WIPP, just like transuranic waste. Thus, the technology under Alternative 4 would generate over 350 drums (stabilized residues plus transuranic waste) to be sent to WIPP. The quantities of low-level waste are low under all the technologies and the sites would manage this waste using routine procedures. The maximum amount of plutonium that could be separated from other direct oxide reduction salt residues is 50 kg (110 lb).

4.3.2 Public and Occupational Health and Safety Impacts

This section describes the radiological and hazardous chemical impacts that could result from the alternatives associated with the management of salt residues. These impacts are presented for incident-free operation and postulated accident scenarios. The detailed site and transportation analyses are presented in Appendices D and E, respectively.

The round-trip highway distance from Rocky Flats to the Savannah River Site is 5,233 km (3,250 mi). If DOE decides to ship scrub alloy from the IDC 409 salt residues to the Savannah River Site for Purex processing, then seven shipments would be required and the total round-trip shipping distance would be 36,600 km (22,700 mi). If DOE decides to ship scrub alloy from the other electrorefining and molten salt extraction salt residues to the Savannah River Site for Purex processing, then 15 shipments would be required and the total round-trip shipping distance would be 78,500 km (48,700 mi). Shipping scrub alloy from the IDC 365, 413, and 427 salt residues to the Savannah River Site would require three shipments, and the total round-trip shipping distance would be 15,700 km (9,700 mi). Similarly, shipping scrub alloy from the other direct oxide reduction salt residues to the Savannah River Site would require one shipment, and the total round-trip shipping distance would be 5,200 km (3,200 mi).

The round-trip highway distance from Rocky Flats to the Los Alamos National Laboratory is 1,468 km (910 mi). If DOE decides to ship the IDC 409 residues to the Los Alamos National Laboratory for processing, then six shipments would be required and the total round-trip shipping distance would be 8,800 km (5,500 mi). If DOE decides to ship the other electrorefining and molten salt extraction salt residues to the Los Alamos National Laboratory for processing, then 44 shipments would be required and the total round-trip shipping distance would be 64,600 km (40,000 m i). Shipping IDC 365, 413, and 427 salt residues to the Los Alamos National Laboratory would require three shipments, and the total round-trip shipping distance would be 4,400 km (2,700 mi). Shipping the other direct oxide reduction salt residues to the Los Alamos National Laboratory would require ten shipments, and the total round-trip shipping distance would be 14,700 km (9,100 mi).

No construction of new processing facilities is included in any of the alternatives, but DOE may need to modify certain existing facilities and construct new waste storage buildings for some of the alternatives. Mitigation measures during modifications would ensure that any radiological or hazardous chemical releases would be extremely small. Worker exposures to contaminated material would be limited to ensure that doses are maintained as low as reasonably achievable.

4.3.2.1 Incident-Free Operations

❒ **Radiological Impacts**

- *IDC 409 Salt Residues*—The radiological impacts to the public and the workers associated with incident-free operations of each technology are presented in **Table 4-12**. The impacts due to the preferred processing technology are presented in bold type. The impacts are those which are anticipated to occur as a result of process operations and transportation over whatever time period is necessary to process this inventory of salt residues. The length of time necessary to process these residues will depend on which technology DOE decides to implement. Impacts associated with subsequent incident-free storage of stabilized residues, separated plutonium, and wastes would be much smaller than from processing or transportation.

  The highest estimated public maximally exposed individual dose in Table 4–12 is 11 mrem, which could occur only during transportation. This hypothetical individual's latent fatal cancer risk would be increased by less than one in one hundred thousand. The public maximally exposed individual risks near the sites would be much lower under all of the technologies. The highest total of the public population radiation doses listed in Table 4–12 would occur if DOE decides to implement the Purex processing technology at the Savannah River Site. The sum of these doses is 0.72 person-rem, which would cause far less than one additional latent fatal cancer among the population living near both sites and traveling along the truck route. The population living near the truck route would receive a much smaller radiation dose.

  The highest involved worker population radiation dose would be 194 person-rem, which would occur if DOE decides to implement the pyro-oxidize and blend down technology at Rocky Flats. This dose would cause 0.078 additional latent cancer fatalities among the workers directly involved in the operation. Onsite workers who are not involved with the actual processing of the residues are designated as "noninvolved workers." The impacts to these workers would be expected to be much smaller than the impacts to the involved workers.

Table 4–12 Radiological Impacts Due to Incident-Free Management of Pyrochemical Salt Residues

	Offsite Public Maximally Exposed Individual		*Offsite Public Population*		*Maximally Exposed Individual Involved Worker*		*Involved Worker Population*	
	Dose (mrem)	*Probability of a Latent Cancer Fatality*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*	*Dose (mrem/ yr)*	*Probability of a Latent Cancer Fatality per year*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*
IDC 409 Salt Residues								
Alternative 1 (No Action)								
Pyro-Oxidize and Store at Rocky Flats	0.000012	6.0×10^{-12}	0.00050	2.5×10^{-7}	2,000	0.0008	104	0.042
Alternative 2 (without Plutonium Separation)								
Pyro-Oxidize and Blend Down at Rocky Flats	0.000018	9.0×10^{-12}	0.00073	3.7×10^{-7}	2,000	0.0008	194	0.078
Alternative 3 (with Plutonium Separation)								
Salt Distill at Rocky Flats	0.000022	1.1×10^{-11}	0.00088	4.4×10^{-7}	2,000	0.0008	61	0.024
Water Leach at Rocky Flats	0.00011	5.5×10^{-11}	0.0027	1.4×10^{-6}	2,000	0.0008	143	0.057
Pyro-Oxidize at Rocky Flats	9.9×10^{-6}	5.0×10^{-12}	0.00040	2.0×10^{-7}	2,000	0.0008	26	0.010
Transport to Los Alamos National Laboratory	11	5.5×10^{-6}	0.16	0.000080	100	0.00004	0.25	0.00010
Salt Distill at Los Alamos National Laboratory	0.00012	6.0×10^{-11}	0.00035	1.8×10^{-7}	2,000	0.0008	18	0.0072
Salt Scrub at Rocky Flats	0.000018	9.0×10^{-12}	0.00073	3.7×10^{-7}	2,000	0.0008	54	0.022
Transport to Savannah River Site	11	5.5×10^{-6}	0.69	0.00035	100	0.00004	1.1	0.00044
Purex at Savannah River Site[b]	0.00027	1.4×10^{-10}	0.029	0.000015	2,000	0.0008	28	0.011
Alternative 4 (Combination)								
Repackage at Rocky Flats	**0.000020**	$\mathbf{1.0\times10^{-11}}$	**0.00081**	$\mathbf{4.1\times10^{-7}}$	**2,000**	**0.0008**	**48**	**0.019**
Other Electrorefining and Molten Salt Extraction Salt Residues								
Alternative 1 (No Action)								
Pyro-Oxidize and Store at Rocky Flats	0.000026	1.3×10^{-11}	0.0011	5.5×10^{-7}	2,000	0.0008	231	0.092
Alternative 2 (without Plutonium Separation)								
Pyro-Oxidize and Blend Down at Rocky Flats	0.000043	2.2×10^{-11}	0.0018	9.0×10^{-7}	2,000	0.0008	470	0.19
Alternative 3 (with Plutonium Separation)								
Salt Distill at Rocky Flats	0.000052	2.6×10^{-11}	0.0021	1.1×10^{-6}	2,000	0.0008	148	0.059
Water Leach at Rocky Flats	0.00028	1.4×10^{-10}	0.0064	3.2×10^{-6}	2,000	0.0008	346	0.14
Pyro-Oxidize at Rocky Flats	0.000025	1.3×10^{-11}	0.0011	5.5×10^{-7}	2,000	0.0008	117	0.047
Transport to Los Alamos National Laboratory	11	5.5×10^{-6}	1.2	0.00060	100	0.00004	1.8	0.00072
Salt Distill at Los Alamos National Laboratory	0.00031	1.6×10^{-10}	0.00092	4.6×10^{-7}	2,000	0.0008	116	0.046
Salt Scrub at Rocky Flats	0.000043	2.2×10^{-11}	0.0018	9.0×10^{-7}	2,000	0.0008	131	0.052
Transport to Savannah River Site	11	5.5×10^{-6}	1.5	0.00075	100	0.00004	2.3	0.00092
Purex at Savannah River Site[a]	0.00066	3.3×10^{-10}	0.070	0.000035	2,000	0.0008	69	0.028
Alternative 4 (Combination)								
Repackage at Rocky Flats	**0.000026**	$\mathbf{1.3\times10^{-11}}$	**0.0011**	$\mathbf{5.5\times10^{-7}}$	**2,000**	**0.0008**	**182**	**0.073**

	Offsite Public Maximally Exposed Individual		*Offsite Public Population*		*Maximally Exposed Individual Involved Worker*		*Involved Worker Population*	
	Dose (mrem)	*Probability of a Latent Cancer Fatality*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*	*Dose (mrem/ yr)*	*Probability of a Latent Cancer Fatality per year*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*
IDC 365, 413 and 427 Salt Residues								
Alternative 1 (No Action)								
Pyro-Oxidize and Store at Rocky Flats	7.0×10^{-6}	3.6×10^{-12}	0.00029	1.5×10^{-7}	2,000	0.0008	57	0.023
Alternative 2 (without Plutonium Separation)								
Pyro-Oxidize and Blend Down at Rocky Flats	0.000010	5.0×10^{-12}	0.00043	2.2×10^{-7}	2,000	0.0008	113	0.045
Alternative 3 (with Plutonium Separation)								
Water Leach at Rocky Flats	0.00011	5.5×10^{-11}	0.0023	1.2×10^{-6}	2,000	0.0008	84	0.034
Pyro-Oxidize at Rocky Flats	**0.000011**	$\mathbf{5.5\times10^{-12}}$	**0.00045**	$\mathbf{2.3\times10^{-7}}$	**2,000**	**0.0008**	**9.8**	**0.0039**
Transport to Los Alamos National Laboratory	**11**	$\mathbf{5.5\times10^{-6}}$	**0.082**	**0.000041**	**100**	**0.00004**	**0.12**	**0.000048**
Acid Dissolve at Los Alamos National Laboratory	**0.00027**	$\mathbf{1.4\times10^{-10}}$	**0.00079**	$\mathbf{4.0\times10^{-7}}$	**2,000**	**0.0008**	**8.8**	**0.0035**
Pyro-Oxidize at Rocky Flats	0.000010	5.0×10^{-12}	0.00040	2.0×10^{-7}	2,000	0.0008	9.8	0.0039
Transport to Los Alamos National Laboratory	11	5.5×10^{-6}	0.082	0.000041	100	0.00004	0.12	0.000048
Water Leach at Los Alamos National Laboratory	0.000061	3.1×10^{-11}	0.00018	9.0×10^{-8}	2,000	0.0008	4.8	0.0019
Salt Scrub at Rocky Flats	0.000010	5.0×10^{-12}	0.00042	2.1×10^{-7}	2,000	0.0008	14	0.0056
Transport to Savannah River Site	11	5.5×10^{-6}	0.30	0.00015	100	0.00004	0.47	0.00019
Purex at Savannah River Site [a]	0.00016	8.0×10^{-11}	0.017	8.5×10^{-6}	2,000	0.0008	17	0.0068
Alternative 4 (Combination)								
Repackage at Rocky Flats	**0.000022**	$\mathbf{1.1\times10^{-11}}$	**0.00089**	$\mathbf{4.5\times10^{-7}}$	**2,000**	**0.0008**	**28**	**0.011**
Other Direct Oxide Reduction Salt Residues								
Alternative 1 (No Action)								
Pyro-Oxidize and Store at Rocky Flats	2.5×10^{-6}	1.3×10^{-12}	0.00010	5.0×10^{-8}	2,000	0.0008	40	0.016
Alternative 2 (without Plutonium Separation)								
Pyro-Oxidize and Blend Down at Rocky Flats	3.8×10^{-6}	1.9×10^{-12}	0.00016	8.0×10^{-8}	2,000	0.0008	42	0.017
Alternative 3 (with Plutonium Separation)								
Water Leach at Rocky Flats	0.000040	2.0×10^{-11}	0.00083	4.2×10^{-7}	2,000	0.0008	31	0.012
Pyro-Oxidize at Rocky Flats	3.8×10^{-6}	1.9×10^{-12}	0.00015	7.5×10^{-8}	2,000	0.0008	19	0.0076
Transport to Los Alamos National Laboratory	11	5.5×10^{-6}	0.27	0.00014	100	0.00004	0.42	0.00017
Acid Dissolve at Los Alamos National Laboratory	0.000099	5.0×10^{-11}	0.00029	1.5×10^{-7}	2,000	0.0008	17	0.0068
Pyro-Oxidize at Rocky Flats	3.8×10^{-6}	1.9×10^{-12}	0.00015	7.5×10^{-8}	2,000	0.0008	19	0.0076
Transport to Los Alamos National Laboratory	11	5.5×10^{-6}	0.27	0.00014	100	0.00004	0.42	0.00017
Water Leach at Los Alamos National Laboratory	0.000022	1.1×10^{-11}	0.000064	3.2×10^{-8}	2,000	0.0008	9.4	0.0038
Salt Scrub at Rocky Flats	3.8×10^{-6}	1.9×10^{-12}	0.00016	8.0×10^{-8}	2,000	0.0008	29	0.012
Transport to Savannah River Site	11	5.5×10^{-6}	0.10	0.000050	100	0.00004	0.16	0.000064
Purex at Savannah River Site[a]	0.000059	3.0×10^{-11}	0.0062	3.1×10^{-6}	2,000	0.0008	6.2	0.0025
Alternative 4 (Combination)								
Repackage at Rocky Flats	$\mathbf{2.5\times10^{-6}}$	$\mathbf{1.3\times10^{-12}}$	**0.00010**	$\mathbf{5.0\times10^{-8}}$	**2,000**	**0.0008**	**36**	**0.014**

[a]Impacts to the public and workers are presented for F-Canyon operations. It has been determined that H-Canyon operations result in lower impacts to these groups.

Note: The impacts due to the preferred processing technology are presented in bold type.

- *Other Electrorefining and Molten Salt Extraction Salt Residues*—The radiological impacts to the public and the workers associated with incident-free operations of each technology are presented in Table 4–12. The impacts due to the preferred processing technology are presented in bold type. The impacts are those which are anticipated to occur as a result of process operations and transportation over whatever time period is necessary to process this inventory of electrorefining and molten salt extraction salt residues. The length of time necessary to process these residues will depend on which technology DOE decides to implement. Impacts associated with subsequent incident-free storage of stabilized residues, separated plutonium, and wastes would be much smaller than from processing or transportation.

  The highest estimated public maximally exposed individual dose in Table 4–12 is 11 mrem, which could occur only during transportation. This hypothetical individual's latent fatal cancer risk would be increased by less than one in one hundred thousand. The public maximally exposed individual risks near the sites would be much lower under all of the technologies. The highest total of the public population radiation doses listed in Table 4–12 would occur if DOE decides to implement the Purex processing technology at the Savannah River Site. The sum of these doses is 1.6 person-rem, which would cause far less than one additional latent fatal cancer among the population living near both sites and traveling along the truck route. The population living near the truck route would receive a much smaller radiation dose.

  The highest involved worker population radiation dose would be 470 person-rem, which would occur if DOE decides to implement the pyro-oxidize and blend down technology at Rocky Flats. This dose would cause 0.19 additional latent cancer fatalities among the workers directly involved in the operation. Onsite workers who are not involved with the actual processing of the residues are designated as "noninvolved workers." The impacts to these workers would be expected to be much smaller than the impacts to the involved workers.

- *IDC 365, 413, and 417 Salt Residues*—The radiological impacts to the public and the workers associated with incident-free operations of each technology are presented in Table 4–12. The impacts due to the preferred processing technology are presented in bold type. The impacts are those which are anticipated to occur as a result of process operations and transportation over whatever time period is necessary to process this inventory of salt residues. The length of time necessary to process these residues will depend on which technology DOE decides to implement. Impacts associated with subsequent incident-free storage of stabilized residues, separated plutonium, and wastes would be much smaller than from processing or transportation.

  The highest estimated public maximally exposed individual dose in Table 4–12 is 11 mrem, which could occur only during transportation. This hypothetical individual's latent fatal cancer risk would be increased by less than one in one hundred thousand. The public maximally exposed individual risks near the sites would be much lower under all of the technologies. The highest total of the public population radiation doses listed in Table 4–12 would occur if DOE decides to implement the Purex processing technology at the Savannah River Site. The sum of these doses is 0.32 person-rem, which would cause far less than one additional latent fatal cancer among the population living near both sides and traveling along the truck route. The population living near the truck route would receive a much smaller radiation dose.

  The highest involved worker population radiation dose would be 113 person-rem, which would occur if DOE decides to implement the pyro-oxidize and blend down technology at Rocky Flats. This dose would cause 0.045 additional latent cancer fatalities among the workers directly involved in the operation. Onsite workers who are not involved with the actual processing of the residues are designated as "noninvolved workers." The impacts to these workers would be expected to be much smaller than the impacts to the involved workers.

- *Other Direct Oxide Reduction Salt Residues*—The radiological impacts to the public and the workers associated with incident-free operations of each technology are presented in Table 4–12. The impacts due to the preferred processing technology are presented in bold type. The impacts are those which are anticipated to occur as a result of process operations and transportation over whatever time period is necessary to process this inventory of direct oxide reduction salt residues. The length of time necessary to process these residues will depend on which technology DOE decides to implement. Impacts associated with subsequent incident-free storage of stabilized residues, separated plutonium, and wastes would be much smaller than from processing or transportation.

  The highest estimated public maximally exposed individual dose in Table 4–12 is 11 mrem, which could occur only during transportation. This hypothetical individual's latent fatal cancer risk would be increased by less than one in one hundred thousand. The public maximally exposed individual risks near the sites would be much lower under all of the technologies. The highest total of the public population radiation doses listed in Table 4–12 would occur if DOE decides to implement the acid dissolve technology at the Los Alamos National Laboratory. The sum of these doses is 0.27 person-rem, which would cause far less than one additional latent fatal cancer among the population living near both sides and traveling along the truck route. The population living near the truck route would receive a much smaller radiation dose.

  The highest involved worker population radiation dose would be 42 person-rem, which would occur if DOE decides to implement the pyro-oxidize and blend down technology at Rocky Flats. This dose would cause 0.017 additional latent cancer fatalities among the workers directly involved in the operation. Onsite workers who are not involved with the actual processing of the residues are designated as "noninvolved workers." The impacts to these workers would be expected to be much smaller than the impacts to the involved workers.

❒ **Hazardous Chemical Impacts—**The impacts of exposure to hazardous chemicals from the processing and storage of pyrochemical salt residues at Rocky Flats and at the Los Alamos National Laboratory were not evaluated. Hazardous chemicals are not expected to be released from the proposed operations at these sites.

The processing at the Savannah River Site of the scrub alloy that results from salt scrubbing at Rocky Flats would involve releases of only noncarcinogenic hazardous chemicals. The estimated offsite population and noninvolved worker Hazard Index values presented in **Table 4–13** are much less than one, which suggests that noncancer health effects as a result of releases of phosphoric acid and ammonium nitrate would not be expected. The impacts due to the preferred processing technology are presented in bold type.

4.3.2.2 Accidents

The potential radiological impacts to the public and the noninvolved onsite workers due to accidents with pyrochemical salt residues are summarized and presented in this section. The detailed analysis of onsite accidents, with the associated assumptions, is presented in Appendix D, Section D.3. The detailed analysis considered a wide spectrum of potential accident scenarios, including fire, explosion, spill, criticality, earthquake, and aircraft crash. The accident scenarios with the highest consequences and risks were selected and carried forward to this section for the purpose of consequence and risk comparison. A composite of the risk due to major onsite accident scenarios in each spectrum (including the nonbounding accidents) was also computed and used for comparisons. The composite risk estimates are accurate enough for the purpose of

Table 4–13 Chemical Impacts Due to Incident-Free Management of Pyrochemical Salt Residues

	Offsite Public Maximally Exposed Individual		*Offsite Public Population*	*Maximally Exposed Individual Worker*		*Worker Population*
	Probability of a Cancer Incidence	*Hazard Index*	*Number of Cancer Incidences or Fatalities* [a]	*Probability of a Cancer Incidence*	*Hazard Index*	*Number of Cancer Incidences or Fatalities* [a]
IDC 409 Salt Residues						
Alternative 1 (No Action)						
Pyro-Oxidize and Store at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 2 (without Plutonium Separation)						
Pyro-Oxidize and Blend Down at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 3 (with Plutonium Separation)						
Pyro-Oxidize and Salt Distill at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Pyro-Oxidize and Water Leach at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Pyro-Oxidize at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Transport to Los Alamos National Laboratory	N/A	N/A	0.00003 [c]	N/A	N/A	(c)
Salt Distill at Los Alamos National Laboratory [b]	N/E	N/E	N/E	N/E	N/E	N/E
Salt Scrub at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Transport to Savannah River Site	N/A	N/A	0.00009 [c]	N/A	N/A	(c)
Purex at Savannah River Site [d, e]	N/E	5×10^{-10}	N/E	N/E	5×10^{-9}	N/E
Alternative 4 (Combination)						
Repackage at Rocky Flats	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**
Other Electrorefining and Molten Salt Extraction Salt Residues						
Alternative 1 (No Action)						
Pyro-Oxidize and Store at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 2 (without Plutonium Separation)						
Pyro-Oxidize and Blend Down at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 3 (with Plutonium Separation)						
Pyro-Oxidize and Salt Distill at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Pyro-Oxidize and Water Leach at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Pyro-Oxidize at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Transport to Los Alamos National Laboratory	N/A	N/A	0.00020 [c]	N/A	N/A	(c)
Salt Distill at Los Alamos National Laboratory [b]	N/E	N/E	N/E	N/E	N/E	N/E
Salt Scrub at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Transport to Savannah River Site	N/A	N/A	0.00020 [c]	N/A	N/A	(c)
Purex at Savannah River Site [d, e]	N/E	1×10^{-9}	N/E	N/E	1×10^{-8}	N/E
Alternative 4 (Combination)						
Repackage at Rocky Flats	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**
IDC 365, 413 and 427 Salt Residues						
Alternative 1 (No Action)						
Pyro-Oxidize and Store at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 2 (without Plutonium Separation)						
Pyro-Oxidize and Blend Down at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E

	Offsite Public Maximally Exposed Individual		Offsite Public Population	Maximally Exposed Individual Worker		Worker Population
	Probability of a Cancer Incidence	*Hazard Index*	*Number of Cancer Incidences or Fatalities [a]*	*Probability of a Cancer Incidence*	*Hazard Index*	*Number of Cancer Incidences or Fatalities [a]*
Alternative 3 (with Plutonium Separation)						
Pyro-Oxidize and Water Leach at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Pyro-Oxidize at Rocky Flats [b]	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**
Transport to Los Alamos National Laboratory	**N/A**	**N/A**	**0.00001 [c]**	**N/A**	**N/A**	**(c)**
Acid Dissolve at Los Alamos National Laboratory [b]	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**
Pyro-Oxidize at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Transport to Los Alamos National Laboratory	N/A	N/A	0.00001 [c]	N/A	N/A	(c)
Water Leach at Los Alamos National Laboratory [b]	N/E	N/E	N/E	N/E	N/E	N/E
Salt Scrub at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Transport to Savannah River Site	N/A	N/A	0.00004 [c]	N/A	N/A	(c)
Purex at Savannah River Site [d, e]	N/E	3×10^{-10}	N/E	N/E	3×10^{-9}	N/E
Alternative 4 (Combination)						
Repackage at Rocky Flats	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**
Other Direct Oxide Reduction Salt Residues						
Alternative 1 (No Action)						
Pyro-Oxidize and Store at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 2 (without Plutonium Separation)						
Pyro-Oxidize and Blend Down at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 3 (with Plutonium Separation)						
Pyro-Oxidize and Water Leach at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Pyro-Oxidize at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Transport to Los Alamos National Laboratory	N/A	N/A	0.00005 [c]	N/A	N/A	(c)
Acid Dissolve at Los Alamos National Laboratory [b]	N/E	N/E	N/E	N/E	N/E	N/E
Pyro-Oxidize at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Transport to Los Alamos National Laboratory	N/A	N/A	0.00005 [c]	N/A	N/A	(c)
Water Leach at Los Alamos National Laboratory [b]	N/E	N/E	N/E	N/E	N/E	N/E
Salt Scrub at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Transport to Savannah River Site	N/A	N/A	0.00001 [c]	N/A	N/A	(c)
Purex at Savannah River Site [d, e]	N/E	1×10^{-10}	N/E	N/E	1×10^{-9}	N/E
Alternative 4 (Combination)						
Repackage at Rocky Flats	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**

N/E = no emissions   N/A = not applicable—the maximally exposed individual is undefined for vehicle emissions

[a] Cancer incidences and fatalities are calculated for process emissions and transportation emissions, respectively.

[b] No hazardous chemicals are released from process; therefore, no associated health risks exist.

[c] Cancer fatalities due to vehicle emissions into the air. This impact is listed only once under public population because the vehicle emissions affect the public and worker populations collectively. However, the risk to the public dominates. See Appendix E, Section E.4 for additional details.

[d] Impacts are presented for F-Canyon operations. H-Canyon operations are expected to result in similar or lower impacts.

[e] No carcinogenic chemicals are released from the process; therefore, only noncancer health risks are evaluated.

Note: The impacts due to the preferred processing technology are presented in bold type.

comparing processing technologies against each other. The detailed analysis of transportation accidents, with the associated assumptions, is presented in Appendix E, Sections E.5 and E.6.

The accident frequencies and process durations of the selected accidents are presented in **Table 4–14**. The impacts due to the preferred processing technology are presented in bold type. The onsite accident frequencies are given on a per year basis because many accidents, such as earthquakes, are commonly expressed this way. The duration of each process is given in years. The actual probability of occurrence of each onsite accident can be obtained by multiplying the accident frequency times the technology's duration. In this way, the calculated probabilities are based on the total amount of residue in this category rather than a standard unit of time. Impacts of accidents during post-processing interim storage are presented for all the plutonium residues and scrub alloy combined in Section 4.14.

The calculation of accident probability is slightly different for traffic accident fatalities. The frequency of traffic accidents is given in terms of the number of fatal accidents per round trip shipment from Rocky Flats to the Savannah River Site or to Los Alamos National Laboratory, as appropriate. The process duration for traffic accidents is given as the number of round trip shipments. Thus, the actual probability of a fatal traffic accident can be obtained by multiplying the frequency (fatal accidents per round-trip shipment) times the duration (number of round-trip shipments).

The consequences for the public and a noninvolved onsite worker are also presented in Table 4–14, for each of the four classes of salt residues. Six processing technologies are under consideration for the IDC 409 salt residues; eight processing technologies are under consideration for the other electrorefining and molten salt extraction salt residues; six processing technologies are under consideration for the IDC 365, 413 and 427 salt residues; and eight processing technologies are under consideration for the other direct oxide reduction salt residues.

The risks associated with each accident are calculated by multiplying the probability times the consequences. The risks to the public and an onsite worker are presented in **Table 4–15**, for each of the processing technologies for pyrochemical salt residue. The risk associated with the highest risk accident and a composite risk associated with all major accidents are both presented. The risks associated with the preferred processing technology are presented in bold type.

The public maximally exposed individual is a hypothetical individual who resides at the site boundary in the downwind direction. The public population is defined as the residential population within a radius of 80 km (50 mi). A noninvolved onsite worker is defined as an individual worker who is located 100 m (328 ft) or more downwind from the release point when an accidental release of radioactive material occurs.

❒ **IDC 409 Salt Residues—**The highest consequence to all three receptors would occur if DOE decides to implement the repackage technology at Rocky Flats, and a major earthquake strong enough to collapse Building 707 occurs.

The highest risk to the public maximally exposed individual is estimated to be 0.000015 and would occur due to an earthquake during repackaging of the residue in Rocky Flats Building 707. This individual's chance of incurring a latent cancer fatality would be increased by less than one in ten thousand. The highest risk to the public population is estimated at 0.13 and would occur due to an earthquake strong enough to collapse Rocky Flats Building 707. The highest risk to the noninvolved worker is estimated to be 0.00014 and would occur due to either an earthquake during processing of the residue in Rocky Flats Building 707 for the pyro-oxidize and salt distill technology at Rocky Flats, or an earthquake during preprocessing of the residue in Rocky Flats Building 707 for the salt distillation technology at Los Alamos

National Laboratory. This individual's chance of incurring a latent cancer fatality would be increased by less than one in one thousand.

Table 4–14 Accident Frequencies, Process Durations, and Consequences for Accidents with Pyrochemical Salt Residues

				Offsite Public Maximally Exposed Individual Consequences		*Offsite Public Population Consequences*		*Noninvolved Onsite Worker Consequences*	
	Accident Scenario	*Accident Frequency (per year)*	*Process Duration (years)*	*Dose (mrem)*	*Probability of a Latent Cancer Fatality*	*Dose (person-rem)*	*Number of Latent Cancer or Traffic Fatalities*	*Dose (mrem)*	*Probability of a Latent Cancer Fatality*
IDC 409 Salt Residues									
Alternative 1 (No Action)									
Pyro-Oxidize and Store at Rocky Flats [a]	Earthquake (Bldg. 707)	0.0026	0.95	6,080	0.0030	106,000	53	68,400	0.055
Alternative 2 (without Plutonium Separation)									
Pyro-Oxidize and Blend Down at Rocky Flats	Earthquake (Bldg. 707)	0.0026	2.76	2,090	0.0010	36,600	18	23,500	0.019
	Earthquake (Bldg. 371) [b]	0.000094	2.76	3,140	0.0016	36,600	18	23,500	0.019
Alternative 3 (with Plutonium Separation)									
Pyro-Oxidize and Salt Distill at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.64	9,000	0.0045	158,000	79	101,000	0.081
Pyro-Oxidize and Water Leach at Rocky Flats	Earthquake (Bldg. 371) [c]	0.000094	0.56	15,500	0.0078	181,000	91	116,000	0.093
	Earthquake (Bldg 707A) [d]	0.0026	0.42	12,200	0.0061	227,000	114	148,000	0.12
Pyro-Oxidize at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.67	8,640	0.0043	151,000	76	97,200	0.078
Transport to Los Alamos National Laboratory	Traffic Fatality	2.9×10^{-5} per shipment	N/A	N/A	N/A	N/A	1.0[e]	N/A	(f)
Salt Distill at Los Alamos National Laboratory	Earthquake	0.0005	1.77	15,400	0.0077	20,200	1.0	166,000	0.13
Salt Scrub at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.38	9,400	0.0047	165,000	83	106,000	0.085
Transport to Savannah River Site	Traffic Fatality	0.00010 per shipment	7 shipments	N/A	N/A	N/A	1.0[e]	N/A	(f)
Purex at Savannah River Site	Earthquake (H-Canyon)	0.000182	0.53	407	0.00020	18,100	9.1	136,000	0.11
Alternative 4 (Combination)									
Repackage at Rocky Flats	**Earthquake (Bldg. 707)**	**0.0026**	**0.28**	**20,300**	**0.020**	**356,000**	**178**	**229,000**	**0.18**
Other Electrorefining and Molten Salt Extraction Salt Residues									
Alternative 1 (No Action)									
Pyro-Oxidize and Store at Rocky Flats [a]	Earthquake (Bldg. 707)	0.0026	2.30	6,080	0.0030	106,000	53	68,400	0.055
Alternative 2 (without Plutonium Separation)									
Pyro-Oxidize and Blend Down at Rocky Flats	Earthquake (Bldg. 707)	0.0026	6.70	2,090	0.0011	36,600	18	23,500	0.019
	Earthquake (Bldg. 371) [b]	0.000094	6.70	3,140	0.0016	36,600	18	23,500	0.019
Alternative 3 (with Plutonium Separation)									
Pyro-Oxidize and Salt Distill at Rocky Flats	Earthquake (Bldg. 707)	0.0026	1.56	9,000	0.0045	158,000	79	101,000	0.081
Pyro-Oxidize and Water Leach at Rocky Flats	Earthquake (Bldg. 371) [c]	0.000094	1.34	15,500	0.0078	181,000	91	116,000	0.093
	Earthquake (Bldg 707A) [d]	0.0026	1.01	12,200	0.0061	227,000	114	148,000	0.12

				Offsite Public Maximally Exposed Individual Consequences		*Offsite Public Population Consequences*		*Noninvolved Onsite Worker Consequences*	
	Accident Scenario	***Accident Frequency (per year)***	***Process Duration (years)***	***Dose (mrem)***	***Probability of a Latent Cancer Fatality***	***Dose (person-rem)***	***Number of Latent Cancer or Traffic Fatalities***	***Dose (mrem)***	***Probability of a Latent Cancer Fatality***
Pyro-Oxidize at Rocky Flats	Earthquake (Bldg. 707)	0.0026	1.62	8,640	0.0043	151,000	76	97,200	0.078
Transport to Los Alamos National Laboratory	Traffic Fatality	2.9×10^{-5} per shipment	44 shipments	N/A	N/A	N/A	1.0[e]	N/A	(f)
Salt Distill at Los Alamos National Laboratory	Earthquake	0.0005	4.28	15,400	0.0077	20,200	10	166,000	0.13
Salt Scrub at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.91	9,400	0.0047	165,000	83	106,000	0.085
Transport to Savannah River Site	Traffic Fatality	0.00010 per shipment	15 shipments	N/A	N/A	N/A	1.0 [e]	N/A	(f)
Purex at Savannah River Site	Earthquake (H-Canyon)	0.000182	1.29	407	0.00020	18,100	9.1	136,000	0.11
Alternative 4 (Combination)									
Repackage at Rocky Flats	Earthquake (Bldg. 707)	0.0026	2.30	6,080	0.0030	106,000	53	68,400	0.055
IDC 365, 413 and 427 Salt Residues									
Alternative 1 (No Action)									
Pyro-Oxidize and Store at Rocky Flats [a]	Earthquake (Bldg. 707)	0.0026	1.00	3,390	0.0017	59,300	30	38,100	0.030
Alternative 2 (without Plutonium Separation)									
Pyro-Oxidize and Blend Down at Rocky Flats	Earthquake (Bldg. 707) Earthquake (Bldg. 371) [f]	0.0026 0.000094	1.62 1.62	2,090 3,140	0.0011 0.0016	36,600 36,600	18 18	23,500 23,500	0.019 0.019
Alternative 3 (with Plutonium Separation)									
Pyro-Oxidize and Water Leach at Rocky Flats	Earthquake (Bldg. 371) [b] Earthquake (Bldg 707A) [c]	0.000094 0.0026	0.33 0.25	15,500 12,200	0.0078 0.0061	181,000 227,000	91 114	116,000 148,000	0.093 0.12
Pyro-Oxidize at Rocky Flats	**Earthquake (Bldg. 707)**	**0.0026**	**0.41**	**8,310**	**0.0042**	**145,000**	**73**	**93,500**	**0.075**
Transport to Los Alamos National Laboratory	**Traffic Fatality**	**2.9×10^{-5} per shipment**	**3 shipments**	**N/A**	**N/A**	**N/A**	**1.0 [e]**	**N/A**	**(f)**
Acid Dissolve at Los Alamos National Laboratory	**Earthquake**	**0.0005**	**0.64**	**12,300**	**0.0062**	**16,200**	**8.1**	**133,000**	**0.11**
Pyro-Oxidize at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.41	8,310	0.0042	145,000	73	93,500	0.075
Transport to Los Alamos National Laboratory	Traffic Fatality	2.9×10^{-5} per shipment	3 shipments	N/A	N/A	N/A	1.0 [e]	N/A	(f)
Water Leach at Los Alamos National Laboratory	Earthquake	0.0005	0.64	12,300	0.0062	16,200	8.1	133,000	0.11
Salt Scrub at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.22	9,400	0.0047	165,000	83	106,000	0.085
Transport to Savannah River Site	Traffic Fatality	0.00010 per shipment	3 shipments	N/A	N/A	N/A	1.0[c]	N/A	(f)
Purex at Savannah River Site	Earthquake (H-Canyon)	0.000182	0.31	407	0.00020	18,100	9.1	136,000	0.11

				Offsite Public Maximally Exposed Individual Consequences		***Offsite Public Population Consequences***		***Noninvolved Onsite Worker Consequences***	
	Accident Scenario	***Accident Frequency (per year)***	***Process Duration (years)***	***Dose (mrem)***	***Probability of a Latent Cancer Fatality***	***Dose (person-rem)***	***Number of Latent Cancer or Traffic Fatalities***	***Dose (mrem)***	***Probability of a Latent Cancer Fatality***
Alternative 4 (Combination)									
Repackage at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.17	20,300	0.020	356,000	178	229,000	0.18

				Offsite Public Maximally Exposed Individual Consequences		*Offsite Public Population Consequences*		*Noninvolved Onsite Worker Consequences*	
	Accident Scenario	***Accident Frequency (per year)***	***Process Duration (years)***	***Dose (mrem)***	***Probability of a Latent Cancer Fatality***	***Dose (person-rem)***	***Number of Latent Cancer or Traffic Fatalities***	***Dose (mrem)***	***Probability of a Latent Cancer Fatality***
Other Direct Oxide Reduction Salt Residues									
Alternative 1 (No Action)									
Pyro-Oxidize and Store at Rocky Flats [a]	Earthquake (Bldg. 707)	0.0026	0.37	3,390	0.0017	59,300	30	38,100	0.030
Alternative 2 (without Plutonium Separation)									
Pyro-Oxidize and Blend Down at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.60	2,090	0.0011	36,600	18	23,500	0.019
	Earthquake (Bldg. 371) [f]	0.000094	0.60	3,140	0.0016	36,600	18	23,500	0.019
Alternative 3 (with Plutonium Separation)									
Pyro-Oxidize and Water Leach at Rocky Flats	Earthquake (Bldg. 371) [b]	0.000094	0.12	15,500	0.0078	181,000	91	116,000	0.093
	Earthquake (Bldg 707A) [c]	0.00026	0.94	12,200	0.0061	227,000	114	148,000	0.12
Pyro-Oxidize at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.15	8,310	0.0042	145,000	73	93,500	0.075
Transport to Los Alamos National Laboratory	Traffic Fatality	2.9×10^{-5} per shipment	10 shipments	N/A	N/A	N/A	1.0 [e]	N/A	(f)
Acid Dissolve at Los Alamos National Laboratory	Earthquake	0.0005	0.24	12,300	0.0062	16,200	8.1	133,000	0.11
Pyro-Oxidize at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.15	8,310	0.0042	145,000	73	93,500	0.075
Transport to Los Alamos National Laboratory	Traffic Fatality	2.9×10^{-5} per shipment	10 shipments	N/A	N/A	N/A	1.0 [e]	N/A	(f)
Water Leach at Los Alamos National Laboratory	Earthquake	0.0005	0.30	15,100	0.0076	19,800	9.9	163,000	0.13
Salt Scrub at Rocky Flats	Earthquake (Bldg. 707)	0.0026	0.08	9,400	0.0047	165,000	83	106,000	0.085
Transport to Savannah River Site	Traffic Fatality	0.00010 per shipment	1 shipment	N/A	N/A	N/A	1.0 [d]	N/A	(e)
Purex at Savannah River Site	Earthquake (H-Canyon)	0.000182	0.12	407	0.00020	18,100	9.1	136,000	0.11
Alternative 4 (Combination)									
Repackage at Rocky Flats	**Earthquake (Bldg. 707)**	**0.0026**	**0.37**	**3,390**	**0.0017**	**59,300**	**30**	**38,100**	**0.030**

N/A = not applicable

[a] The accident impacts of 20 years of storage are presented in Section 4.14 for all the materials combined under Alternative 1.

[b] Building 371 is designated as an alternate location for the Pyro-Oxidize and Blend Down process at Rocky Flats

[c] Water Leach process in Building 371.

[d] Final calcination process in Building 707A.

[e] This fatality is due to the mechanical impact of the accident, not cancer due to radiation. The radiological consequences of a radioactive release on the highway are impossible to list in a single number because the accident could occur at any point along the route and meteorological conditions and population distributions vary greatly along the route.

[f] The consequence of a high-speed traffic accident would be at least one fatality among the transportation workers due to trauma.

Note: The impacts due to the preferred processing technology are presented in bold type.

Table 4–15 Risks Due to Accidents with Pyrochemical Salt Residues

	Accident Scenario	*Offsite Public Maximally Exposed Individual Risk (Probability of a Latent Cancer Fatality)*	*Offsite Public Population Risk (Number of Latent Cancer or Traffic Fatalities)*	*Noninvolved Onsite Worker Risk (Probability of a Latent Cancer Fatality)*
IDC 409 Salt Residues				
Alternative 1 (No Action)				
Pyro-Oxidize and Store at Rocky Flats [a]	Earthquake (Bldg. 707)	7.5×10^{-6}	0.13	0.00013
	Composite	7.6×10^{-6}	0.13	0.00014
Alternative 2 (without Plutonium Separation)				
Pyro-Oxidize and Blend Down at Rocky Flats	Earthquake (Bldg. 707)	7.5×10^{-6}	0.13	0.00013
	Composite (Bldg. 707)	7.6×10^{-6}	0.13	0.00014
	Earthquake (Bldg. 371) [b]	4.1×10^{-7}	0.0047	4.9×10^{-6}
	Composite (Bldg. 371) [b]	5.7×10^{-7}	0.0067	5.9×10^{-6}
Alternative 3 (with Plutonium Separation)				
Pyro-Oxidize and Salt Distill at Rocky Flats	Earthquake (Bldg. 707)	7.5×10^{-6}	0.13	0.00014
	Composite	7.6×10^{-6}	0.13	0.00014
Pyro-Oxidize and Water Leach at Rocky Flats	Earthquake (Bldg. 371) [c]	4.1×10^{-7}	0.0048	4.9×10^{-6}
	Composite (Bldg. 371) [c]	5.9×10^{-7}	0.0069	5.9×10^{-6}
	Earthquake (Bldg. 707A) [d]	6.7×10^{-6}	0.12	0.00013
	Composite (Bldg. 707A) [d]	6.8×10^{-6}	0.13	0.00013
Pyro-Oxidize at Rocky Flats	Earthquake (Bldg. 707)	7.5×10^{-6}	0.13	0.00014
	Composite	7.6×10^{-6}	0.13	0.00014
Transport to Los Alamos National Laboratory	Traffic Fatality	N/A	0.00017 [e]	N/A
	Radioactive Release	N/A	8.6×10^{-8}	N/A
Salt Distill at Los Alamos National Laboratory	Earthquake	6.8×10^{-6}	0.090	0.00012
	Composite	6.9×10^{-6}	0.090	0.00012
Salt Scrub at Rocky Flats	Earthquake (Bldg. 707)	4.6×10^{-6}	0.081	0.000084
	Composite	4.7×10^{-6}	0.083	0.000084
Transport to Savannah River Site	Traffic Fatality	N/A	0.00071 [e]	N/A
	Radioactive Release	N/A	4.9×10^{-8}	N/A
Purex at Savannah River Site	Earthquake (H-Canyon)	2.0×10^{-8}	0.00087	0.000010
	Composite	3.0×10^{-8}	0.0014	0.000011
Alternative 4 (Combination)				
Repackage at Rocky Flats	**Earthquake (Bldg. 707)**	**0.000015**	**0.13**	**0.00013**
	Composite (Bldg. 707)	**0.000015**	**0.13**	**0.00013**
Other Electrorefining and Molten Salt Extraction Salt Residues				
Alternative 1 (No Action)				
Pyro-Oxidize and Store at Rocky Flats [a]	Earthquake (Bldg. 707)	0.000018	0.32	0.00033
	Composite	0.000019	0.32	0.00033
Alternative 2 (without Plutonium Separation)				
Pyro-Oxidize and Blend Down at Rocky Flats	Earthquake (Bldg. 707)	0.000018	0.32	0.00033
	Composite (Bldg. 707)	0.000019	0.32	0.00033
	Earthquake (Bldg. 371) [b]	9.8×10^{-7}	0.012	0.000012
	Composite (Bldg. 371) [b]	1.4×10^{-6}	0.016	0.000014

	Accident Scenario	Offsite Public Maximally Exposed Individual Risk (Probability of a Latent Cancer Fatality)	Offsite Public Population Risk (Number of Latent Cancer or Traffic Fatalities)	Noninvolved Onsite Worker Risk (Probability of a Latent Cancer Fatality)
Alternative 3 (with Plutonium Separation)				
Pyro-Oxidize and Salt Distill at Rocky Flats	Earthquake (Bldg. 707) Composite	0.000018 0.000019	0.32 0.32	0.00033 0.00033
Pyro-Oxidize and Water Leach at Rocky Flats	Earthquake (Bldg. 371) [c] Composite (Bldg. 371) [c] Earthquake (Bldg. 707A) [d] Composite (Bldg. 707A) [d]	9.85×10^{-7} 1.4×10^{-6} 0.000016 0.000016	0.011 0.016 0.30 0.30	0.000012 0.000014 0.00031 0.00031
Pyro-Oxidize at Rocky Flats	Earthquake (Bldg. 707) Composite	0.000018 0.000019	0.32 0.32	0.00033 0.00033
Transport to Los Alamos National Laboratory	Traffic Fatality Radioactive Release	N/A N/A	0.00125 [e] 2.1×10^{-7}	N/A N/A
Salt Distill at Los Alamos National Laboratory	Earthquake Composite	0.000016 0.000017	0.022 0.022	0.00028 0.00029
Salt Scrub at Rocky Flats	Earthquake (Bldg. 707) Composite	0.000011 0.000011	0.19 0.20	0.00020 0.00020
Transport to Savannah River Site	Traffic Fatality Radioactive Release	N/A N/A	0.00018[c] 1.9×10^{-7}	N/A N/A
Purex at Savannah River Site	Earthquake (H-Canyon) Composite	4.8×10^{-8} 7.4×10^{-8}	0.0021 0.0035	0.000025 0.000026
Alternative 4 (Combination)				
Repackage at Rocky Flats	**Earthquake (Bldg. 707) Composite**	**0.000018 0.000019**	**0.32 0.32**	**0.00033 0.00033**
IDC 365, 413 and 427 Salt Residues				
Alternative 1 (No Action)				
Pyro-Oxidize and Store at Rocky Flats [a]	Earthquake (Bldg. 707) Composite	4.4×10^{-6} 4.5×10^{-6}	0.047 0.048	0.000049 0.000049
Alternative 2 (without Plutonium Separation)				
Pyro-Oxidize and Blend Down at Rocky Flats	Earthquake (Bldg. 707) Composite (Bldg. 707) Earthquake (Bldg. 371) [b] Composite (Bldg. 371) [b]	4.4×10^{-6} 4.5×10^{-6} 2.4×10^{-7} 3.4×10^{-7}	0.077 0.078 0.0028 0.0039	0.000079 0.000080 2.9×10^{-6} 3.4×10^{-6}
Alternative 3 (with Plutonium Separation)				
Pyro-Oxidize and Water Leach at Rocky Flats	Earthquake (Bldg. 371) [c] Composite (Bldg. 371) [c] Earthquake (Bldg. 707A) [d] Composite (Bldg. 707A) [d]	2.4×10^{-7} 3.5×10^{-7} 4.0×10^{-6} 4.0×10^{-6}	0.0028 0.0041 0.074 0.075	2.9×10^{-6} 3.5×10^{-6} 0.000077 0.000078
Pyro-Oxidize at Rocky Flats	**Earthquake (Bldg. 707) Composite**	**4.4×10^{-6} 4.5×10^{-6}**	**0.077 0.079**	**0.000080 0.000080**
Transport to Los Alamos National Laboratory	**Traffic Fatality Radioactive Release**	**N/A N/A**	**0.00009 [e] 5.0×10^{-8}**	**N/A N/A**

	Accident Scenario	*Offsite Public Maximally Exposed Individual Risk (Probability of a Latent Cancer Fatality)*	*Offsite Public Population Risk (Number of Latent Cancer or Traffic Fatalities)*	*Noninvolved Onsite Worker Risk (Probability of a Latent Cancer Fatality)*
Acid Dissolve at Los Alamos National Laboratory	**Earthquake** **Composite**	**2.0×10^{-6}** **2.0×10^{-6}**	**0.0026** **0.0026**	**0.000034** **0.000034**
Pyro-Oxidize at Rocky Flats	Earthquake (Bldg. 707) Composite	4.4×10^{-6} 4.5×10^{-6}	0.077 0.079	0.000080 0.000080
Transport to Los Alamos National Laboratory	Traffic Fatality Radioactive Release	N/A N/A	0.00009 [e] 5.0×10^{-8}	N/A N/A
Water Leach at Los Alamos National Laboratory	Earthquake Composite	3.0×10^{-6} 3.1×10^{-6}	0.0040 0.0040	0.000052 0.000052
Salt Scrub at Rocky Flats	Earthquake (Bldg. 707) Composite	2.7×10^{-6} 2.7×10^{-6}	0.047 0.048	0.000048 0.000049
Transport to Savannah River Site	Traffic Fatality Radioactive Release	N/A N/A	0.0003 [e] 2.9×10^{-8}	N/A N/A
Purex at Savannah River Site	Earthquake (H-Canyon) Composite	1.1×10^{-8} 1.8×10^{-8}	0.00051 0.00083	6.1×10^{-6} 6.1×10^{-6}
Alternative 4 (Combination) **Repackage at Rocky Flats**	**Earthquake (Bldg. 707)** **Composite (Bldg. 707)**	**9.0×10^{-6}** **9.1×10^{-6}**	**0.079** **0.080**	**0.000081** **0.000081**
Other Direct Oxide Reduction Salt Residues				
Alternative 1 (No Action) Pyro-Oxidize and Store at Rocky Flats [a]	Earthquake (Bldg. 707) Composite	1.6×10^{-6} 1.7×10^{-6}	0.028 0.029	0.000029 0.000030
Alternative 2 (without Plutonium Separation) Pyro-Oxidize and Blend Down at Rocky Flats	Earthquake (Bldg. 707) Composite (Bldg. 707) Earthquake (Bldg. 371) [b] Composite (Bldg. 371) [b]	1.6×10^{-6} 1.7×10^{-6} 8.6×10^{-8} 1.2×10^{-7}	0.029 0.029 0.0010 0.0015	0.000029 0.000030 1.1×10^{-6} 1.3×10^{-6}
Alternative 3 (with Plutonium Separation) Pyro-Oxidize and Water Leach at Rocky Flats	Earthquake (Bldg. 371) [c] Composite (Bldg. 371) [c] Earthquake (Bldg. 707A) [d] Composite (Bldg. 707A) [d]	8.7×10^{-8} 1.3×10^{-7} 1.4×10^{-6} 1.5×10^{-6}	0.0010 0.0015 0.026 0.027	1.0×10^{-6} 1.3×10^{-6} 0.000028 0.000028
Pyro-Oxidize at Rocky Flats	Earthquake (Bldg. 707) Composite	1.6×10^{-6} 1.6×10^{-6}	0.028 0.029	0.000029 0.000029
Transport to Los Alamos National Laboratory	Traffic Fatality Radioactive Release	N/A N/A	0.00028 [e] 1.9×10^{-8}	N/A N/A
Acid Dissolve at Los Alamos National Laboratory	Earthquake Composite	7.4×10^{-7} 7.5×10^{-7}	0.00097 0.00098	0.000013 0.000013
Pyro-Oxidize at Rocky Flats	Earthquake (Bldg. 707) Composite	1.6×10^{-6} 1.6×10^{-6}	0.028 0.029	0.000029 0.000029
Transport to Los Alamos National Laboratory	Traffic Fatality Radioactive Release	N/A N/A	0.00028 [d] 1.9×10^{-8}	N/A N/A

	Accident Scenario	*Offsite Public Maximally Exposed Individual Risk (Probability of a Latent Cancer Fatality)*	*Offsite Public Population Risk (Number of Latent Cancer or Traffic Fatalities)*	*Noninvolved Onsite Worker Risk (Probability of a Latent Cancer Fatality)*
Water Leach at Los Alamos National Laboratory	Earthquake Composite	1.1×10^{-6} 1.1×10^{-6}	0.0015 0.0015	0.000020 0.000020
Salt Scrub at Rocky Flats	Earthquake (Bldg. 707) Composite	9.8×10^{-7} 9.9×10^{-7}	0.017 0.017	0.000018 0.000018
Transport to Savannah River Site	Traffic Fatality Radioactive Release	N/A N/A	0.0001 [d] 1.1×10^{-8}	N/A N/A
Purex at Savannah River Site	Earthquake (H-Canyon) Composite	4.4×10^{-9} 6.9×10^{-9}	0.00020 0.00032	2.4×10^{-6} 2.4×10^{-6}
Alternative 4 (Combination)				
Repackage at Rocky Flats	**Earthquake (Bldg. 707)** **Composite**	**1.6×10^{-6}** **1.7×10^{-6}**	**0.028** **0.029**	**1.1×10^{-6}** **1.3×10^{-6}**

N/A = not applicable

[a] The accident impacts of 20 years of storage are presented in Section 4.14 for all the materials combined under Alternative 1.

[b] Building 371 is designated as an alternate location for the Pyro-Oxidize and Blend Down process at Rocky Flats.

[c] Water Leach process in Building 371.

[d] Final calcination process in Building 707A.

[e] This risk is due to the mechanical impact of a potential accident, not cancer due to radiation. This risk includes members of the public and transportation workers.

Note: The risks due to the preferred processing technology are presented in bold type.

- **Other Electrorefining and Molten Salt Extraction Salt Residues—**The highest consequence to the public maximally exposed individual would occur if DOE decides to implement the pyro-oxidize and water leach technology at Rocky Flats, and a major earthquake strong enough to collapse Building 371 occurs during residue processing prior to final calcination. The highest consequence to the public population would occur if DOE decides to implement the pyro-oxidize and water leach technology at Rocky Flats, and a major earthquake strong enough to collapse Building 707A occurs during the final calcination process. The highest consequence to the individual noninvolved onsite worker would occur if DOE decides to implement the salt distillation technolgoy at Los Alamos National Laboratory and an earthquake strong enough to collapse Building PF-4 at the TA-55 facility occurs during processing of the residue at Los Alamos National Laboratory.

  The highest risk to the public maximally exposed individual is estimated to be 0.000018 and would occur due to an earthquake during processing of the residue in Rocky Flats Building 707 for the pyro-oxidize and store technology, an earthquake during processing of the residue in Rocky Flats Building 707 for the pyro-oxidize and salt distill technology at Rocky Flats, an earthquake during preprocessing of the residue in Rocky Flats Building 707 for the salt distillation technology at Los Alamos National Laboratory, or an earthquake during repackaging of the residue at Rocky Flats. This individual's chance of incurring a latent cancer fatality would be increased by less than one in ten thousand. The highest risk to the public population is estimated at 0.32 and would occur due to the same earthquake-initiated accidents as described for the maximally exposed individual. The highest risk to the noninvolved worker is estimated to be 0.00033 and would occur due to the same earthquake-initiated accidents described for the maximally exposed individual and the public population. This individual's chance of incurring a latent cancer fatality would be increased by less than one in one thousand.

- **IDC 365, 413, and 417 Salt Residues—**The highest consequence to all three receptors would occur if DOE decides to implement the repackage technology at Rocky Flats, and a major earthquake strong enough to collapse Building 707 occurs.

  The highest risk to the public maximally exposed individual is estimated to be 9.0×10^{-6} and would occur due to an earthquake during repackaging of the residue in Rocky Flats Building 707. This individual's chance of incurring a latent cancer fatality would be increased by less than one in one hundred thousand. The highest risk to the public population is estimated at 0.079 and would occur due to an earthquake during repackaging the residue in Rocky Flats Building 707. The highest risk to the noninvolved worker is estimated to be 0.000081 and would also occur due to an earthquake during repackaging of the residue at Rocky Flats Building 707. This individual's chance of incurring a latent cancer fatality would be increased by less than one in ten thousand.

- **Other Direct Oxide Reduction Salt Residues—**The highest consequence to the public maximally exposed individual would occur if DOE decides to implement the pyro-oxidize and water leach technology at Rocky Flats, and a major earthquake strong enough to collapse Building 371 occurs during residue processing prior to final calcination. The highest consequences to the public population would occur if DOE decides to implement the pyro-oxidize and water leach technology at Rocky Flats, and a major earthquake strong enough to collapse Building 707A occurs during the final calcination process. The highest consequence to the noninvolved onsite worker would occur if DOE were to implement the water leach technology at Los Alamos National Laboratory and an earthquake occurs strong enough to collapse Building PF-4 of the TA-55 facility while processing the residue at Los Alamos.

  The highest risk to the public maximally exposed individual is estimated to be 1.6×10^{-6} and would occur due to an earthquake during processing of the residue in Rocky Flats Building 707 for the pyro-oxidize technology under Alternative 1, an earthquake during processing the residue with the pyro-oxidize and blend down technology in Rocky Flats Building 707, an earthquake during preprocessing of the residue in Rocky Flats Building 707 for the acid dissolution technology at Los Alamos National Laboratory, an earthquake during preprocessing of the residue in Rocky Flats Building 707 for the water leach technology at Los Alamos National Laboratory, or an earthquake during repackaging of the residue at Rocky Flats. This individual's chance of incurring a latent cancer fatality would be increased by less than one in a hundred thousand. The highest risk to the public population is estimated at 0.029 and would occur due to an earthquake during processing of the residue in Rocky Flats Building 707 for the pyro-oxidize and blend down technology. The highest risk to the noninvolved onsite worker is estimated to be 0.000029 and would occur due to the same earthquake-initiated accidents described for the maximally exposed individual. The noninvolved worker's chance of incurring a latent cancer fatality would be increased by less than one in ten thousand.

4.4 IMPACTS OF MANAGING COMBUSTIBLE RESIDUES

The inventory of combustible residues assessed in this EIS weighs 1,140 kg (2,513 lb), including 21.3 kg (47 lb) of plutonium. This inventory is stored in 69 drums with no internal metal containers.

As discussed in Chapter 2, the alternatives for combustible residues include one technology under the No Action Alternative, three technologies under the Process without Plutonium Separation Alternative, one technology under the Process with Plutonium Separation Alternative and one technology under Alternative 4. The first and last processing technologies are combinations of three different types of processes, one for each subcategory of combustible residues. The preferred processing technology is Alternative 4.

This section presents the environmental impacts of managing the entire inventory of combustible residues under each of the six technologies. The results in this section were used in the calculation of the total impacts of the No Action Alternative and the Preferred Alternative which are presented in Section 4.20 and 4.21, respectively, and of the management approaches which are presented in Section 4.22.

4.4.1 Products and Wastes

Every processing technology for combustible residues would generate some quantity of transuranic waste and would prepare this waste for disposal in WIPP. Every technology would also generate some quantity of low-level waste, which would be disposed of routinely using existing procedures at Rocky Flats. A small portion of the low-level waste generated at Rocky Flats could possibly be low-level mixed waste, but this waste would also be disposed of routinely using existing procedures. The No Action Alternative would generate stabilized residues, containing plutonium in excess of the safeguards termination limits. The Process without Plutonium Separation Alternative would generate transuranic waste directly from the residue. In some of the processing technologies the stabilized residues and transuranic waste would be placed in pipe components inside 208-liter (55-gal) drums as shown in Figure 2-13 in Chapter 2. If DOE applies variances to the stabilized residues (Alternative 4), then the stabilized residues could be disposed of in WIPP as transuranic waste.

High-level waste and saltstone would not be generated from combustible residues because none of the technologies involve shipping the residues to the Savannah River Site for plutonium separation. If plutonium is separated at Rocky Flats, it would be stored securely onsite until a decision is made on its disposition. No increase in proliferation risk would result and this plutonium would not be used for nuclear explosive purposes. This separated plutonium would also contain the americium from the combustible residues.

The solid plutonium-bearing products and wastes that would be generated from combustible residues under each of the technologies are presented in **Table 4–16**. The shaded areas of Table 4–16 indicate types of solid products and wastes that would not be generated under the various technologies. The products and wastes from the preferred processing technology are presented in bold type. The largest amount of transuranic waste (1,275 drums) would be generated in the catalytic chemical oxidation technology, but the mediated

Table 4–16 Products and Wastes from Combustible Residues

	Stabilized Residues (Drums)[a]	*Transuranic Waste (Drums)*[a]	*High-Level Waste (Canisters of Glass)*[b]	*Separated Plutonium (kg)*[c]	*Low-Level Waste (Drums)*[a]	*Saltstone (cubic meters)*
Alternative 1 (No Action) Neutralize & Dry/Desorb & Passivate/Repackage and Store at Rocky Flats	916	92			229	
Alternative 2 (without Plutonium Separation) Sonic Wash at Rocky Flats		423			229	
Catalytic Chemical Oxidation at Rocky Flats		1,275			2,727	
Blend Down at Rocky Flats		220			229	
Alternative 3 (with Plutonium Separation) Mediated Electrochemical Oxidation at Rocky Flats		1,219		21	2,727	
Alternative 4 (Combination) **Neutralize & Dry/Desorb & Passivate/Repackage at Rocky Flats**	**916**[d]	**92**			**229**	

[a] Standard 55-gallon (208-liter) drums. (208 liters is equal to 0.208 cubic meters.)
[b] Each container is 2 feet (61 cm) in diameter, 10 feet (330 cm) tall, and contains approximately 3,700 pounds (1,680 kg) of high-level waste glass.
[c] To convert to pounds, multiply by 2.2.
[d] These stabilized residues could be disposed of in WIPP as transuranic waste.

Notes: Shaded areas indicate the types of solid products and waste that would not be generated. The products and wastes from the preferred processing technologies are presented in bold type. The storage capacities at each site are adequate to store the products and wastes listed in this table.

electrochemical oxidation technology would generate almost as much (1,219 drums). These two technologies would generate much more transuranic waste than the other technologies, which would generate no more than 423 drums. The stabilized residues generated in Alternative 4 could be disposed of in WIPP, just like transuranic waste. Thus, this technology would generate over 1,000 drums (stabilized residue plus transuranic waste) to be sent to WIPP. The quantities of low-level waste are low under all the technologies and the site would manage this waste using routine procedures. The maximum amount of plutonium that could be separated from combustible residues is 21 kg (46 lb).

4.4.2 Public and Occupational Health and Safety Impacts

This section describes the radiological and hazardous chemical impacts that could result from the alternatives associated with the management of combustible residues. These impacts are presented for incident-free operation and postulated accident scenarios, respectively. The detailed site analyses are presented in Appendix D. No construction of new processing facilities is included in any of the alternatives, but DOE may need to modify certain existing facilities and construct new waste storage buildings for some of the alternatives. Mitigation measures during modifications would ensure that any radiological or hazardous chemical releases would be extremely small. Worker exposures to contaminated material would be limited to ensure that doses are maintained as low as reasonably achievable.

4.4.2.1 Incident-Free Operations

❒ **Radiological Impacts—**The radiological impacts to the public and the workers associated with incident-free operations of each technology are presented in **Table 4–17**. The impacts due to the preferred processing technology are presented in bold type. The impacts are those which are anticipated to occur as a result of process operations over whatever time period is necessary to process the entire inventory of combustible residues. The length of time necessary to process the combustible residues will depend on which technology DOE decides to implement. Impacts associated with subsequent incident-free storage of stabilized residues, separated plutonium, and wastes would be much smaller than from processing.

The highest estimated public maximally exposed individual dose in Table 4–17 is 7.4×10^{-6} mrem, which would occur during the mediated electrochemical oxidation process at Rocky Flats. This hypothetical individual's latent fatal cancer risk would be increased by less than one in one-hundred billion. The highest public population radiation dose listed in Table 4–17 would also occur for the mediated electrochemical oxidation process, if DOE decides to implement this technology. This dose is estimated to be 0.00016 person-rem, which would cause far less than one additional latent fatal cancer among the population living near Rocky Flats.

The highest involved worker population radiation dose would be 42 person-rem, which would occur if DOE decides to implement the catalytic chemical oxidation technology. This dose would cause 0.017 additional latent fatal cancers among the workers directly involved in the operation. Onsite workers who are not involved with the actual processing of the residues are designated as "noninvolved workers." The impacts to these workers would be expected to be much smaller than the impacts to the involved workers.

Table 4–17 Radiological Impacts Due to Incident-Free Management of Combustible Residues

	Offsite Public Maximally Exposed Individual		*Offsite Public Population*		*Maximally Exposed Individual Involved Worker*		*Involved Worker Population*	
	Dose (mrem)	*Probability of a Latent Cancer Fatality*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*	*Dose (mrem per year)*	*Probability of a Latent Cancer Fatality per year*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*
Alternative 1 (No Action)								
Neutralize & Dry/Desorb & Passivate/Repackage and Store at Rocky Flats	3.6×10^{-6}	1.8×10^{-12}	0.000081	4.1×10^{-8}	2,000	0.0008	32	0.013
Alternative 2 (without Plutonium Separation)								
Sonic Wash at Rocky Flats	7.0×10^{-6}	3.5×10^{-12}	0.00015	7.5×10^{-8}	2,000	0.0008	17	0.0068
Catalytic Chemical Oxidation at Rocky Flats	4.5×10^{-6}	2.3×10^{-12}	0.000096	4.8×10^{-8}	2,000	0.0008	42	0.017
Blend Down at Rocky Flats	3.0×10^{-6}	1.5×10^{-12}	0.000064	3.2×10^{-8}	2,000	0.0008	6.8	0.0027
Alternative 3 (with Plutonium Separation)								
Mediated Electrochemical Oxidation at Rocky Flats	7.4×10^{-6}	3.7×10^{-12}	0.00016	8.0×10^{-8}	2,000	0.0008	11	0.0044
Alternative 4 (Combination)								
Neutralize & Dry/Desorb & Passivate/Repackage at Rocky Flats	$\mathbf{3.6\times10^{-6}}$	$\mathbf{1.8\times10^{-12}}$	**0.000081**	$\mathbf{4.1\times10^{-8}}$	**2,000**	**0.0008**	**20**	**0.0080**

Note: The impacts due to the preferred processing technology are presented in bold type.

- **Hazardous Chemical Impacts—**The processing and storage of combustible residues at Rocky Flats involves potential releases of carcinogenic and noncarcinogenic chemicals. Under Alternative 1, the thermal desorption processing of organic contaminated combustible residues would release the carcinogen carbon tetrachloride. The probability of excess latent cancer incidence to the public maximally exposed individual as a result of exposure to carbon tetrachloride would be 6×10^{-11} (**Table 4–18**). The impacts due to the preferred processing technology are presented in bold type. This hypothetical individual's latent cancer incidence risk would be increased by less than one in ten billion. Carbon tetrachloride is no longer used at Rocky Flats, but is present in small amounts in some of the residues. Carbon tetrachloride produces central nervous system, pulmonary system, gastrointestinal system, and other systemic toxic effects in humans (Sax and Lewis 1987). The compound is an eye and skin irritant and damages the liver, kidneys, and lungs (Lewis 1991). The liver is the primary target organ for carbon tetrachloride toxicity (EPA 1991a). Less than one excess latent cancer incidence is estimated to occur in the offsite population of 2.4 million individuals living within an 80-km (50-mi) radius of Rocky Flats. The maximally exposed individual worker probability of excess latent cancer incidence is 3×10^{-9}. If all site workers were exposed to the maximally exposed individual concentration of carbon tetrachloride, which is an extremely conservative and unrealistic assumption, less than 1 excess latent cancer would be expected to occur in the workforce population.

  The catalytic chemical oxidation process at Rocky Flats would involve the release of hydrochloric acid. Hydrochloric acid is toxic following ingestion and inhalation exposure. The compound is a strong eye, skin, and mucous membrane irritant (Lewis 1991). The estimated Hazard Index values presented in Table 4–18 are much less than one for both the offsite population maximally exposed individual and the noninvolved worker maximally exposed individual, which suggests that noncancer health effects are not expected.

4.4.2.2 Accidents

The potential radiological impacts to the public and the noninvolved onsite workers due to accidents with combustible residues are summarized and presented in this section. The detailed analysis of onsite accidents, with the associated assumptions, is presented in Appendix D, Section D.3. The detailed analysis considered a wide spectrum of potential accident scenarios, including fire, explosion, spill, criticality, earthquake, and aircraft crash. The accident scenarios with the highest consequences and risks were selected and carried forward to this section for the purpose of consequence and risk comparison. A composite of the risks due to major onsite accident scenarios in each spectrum (including the nonbounding accidents) was also computed and used for comparisons. The composite risk estimates are accurate enough for the purpose of comparing processing technologies against each other.

The accident frequencies and process durations of the selected accidents are presented in **Table 4–19**. The impacts due to the preferred processing technology are presented in bold type. The onsite accident frequencies are given on a per year basis because many accidents, such as earthquakes, are commonly expressed this way. The duration of each process is given in years. The actual probability of occurrence of each onsite accident can be obtained by multiplying the accident frequency times the technology's duration. In this way, the calculated probabilities are based on the total amount of residue in this category rather than a standard unit of time. The impacts of accidents during post-processing interim storage are presented for all the plutonium residues and scrub alloy combined in Section 4.14.

Table 4–18 Chemical Impacts Due to Incident-Free Management of Combustible Residues

	Offsite Public Maximally Exposed Individual		*Offsite Public Population*	*Maximally Exposed Individual Worker*		*Worker Population*
	Probability of Cancer Incidence	*Hazard Index*	*Number of Cancer Incidences*	*Probability of Cancer Incidence*	*Hazard Index*	*Number of Cancer Incidences*
Alternative 1 (No Action)						
Neutralize & Dry/Desorb & Passivate/Repackage and Store at Rocky Flats [a]	6×10^{-11}	N/E	<1 [b]	3×10^{-9}	N/E	<1 [c]
Alternative 2 (without Plutonium Separation)						
Sonic Wash at Rocky Flats [a]	1×10^{-11}	N/E	<1 [b]	7×10^{-10}	N/E	<1 [c]
Catalytic Chemical Oxidation at Rocky Flats [d]	N/E	5×10^{-11}	N/E	N/E	5×10^{-9}	N/E
Blend Down at Rocky Flats [e]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 3 (with Plutonium Separation)						
Mediated Electrochemical Oxidation at Rocky Flats [e]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 4 (Combination)						
Neutralize & Dry/Desorb & Passivate/Repackage at Rocky Flats	**6×10^{-11}**	**N/E**	**< 1[b]**	**3×10^{-9}**	**N/E**	**< 1 [c]**

N/E = no emissions
[a] Only carcinogenic chemicals are released from the process; therefore, only cancer health risks are evaluated.
[b] In population of 2.4 million individuals living within 80 km (50 mi) of Rocky Flats.
[c] Based on the extremely conservative assumption that entire Rocky Flats workforce is exposed to the maximally exposed individual concentration.
[d] No carcinogenic chemicals are released from the process; therefore, only noncancer health risks are evaluated.
[e] No hazardous chemicals are released from process; therefore, no associated health risks exist. See Section 4.12 for additional information.
Note: The impacts due to the preferred processing technology are presented in bold type.

Table 4–19 Accident Frequencies, Process Durations, and Consequences for Accidents with Combustible Residues

				Offsite Public Maximally Exposed Individual Consequences		*Offsite Public Population Consequences*		*Noninvolved Onsite Worker Consequences*	
	Accident Scenario	*Accident Frequency (per year)*	*Process Duration (years)*	*Dose (mrem)*	*Probability of a Latent Cancer Fatality*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*	*Dose (mrem)*	*Probability of a Latent Cancer Fatality*
Alternative 1 (No Action)									
Neutralize, Dry, and Store at Rocky Flats [a] (Aqueous Contaminated Residue)	Dock Fire (Bldg. 371) [b] Room Fire (Bldg. 371) [c]	2.0×10^{-6} 0.0005	0.15 0.15	1,800 219	0.00090 0.00011	21,000 2,560	11 1.3	14,000 1,710	0.0056 0.00068
Thermally Desorb, Steam Passivate, and Store at Rocky Flats (Organic Contaminated Residue)	Dock Fire (Bldg. 371) [b] Room Fire (Bldg. 371) [c]	2.0×10^{-6} 0.0005	0.39 0.39	1,800 59	0.00090 0.000029	21,000 683	11 0.34	14,000 455	0.0056 0.00018
Repackage and Store at Rocky Flats (Dry Contaminated Residue)	Dock Fire (Bldg. 707) [b] Earthquake (Bldg. 707) [c]	2.0×10^{-6} 0.0026	0.023 0.023	1,200 312	0.00060 0.00016	21,000 5,460	11 2.7	14,000 3,640	0.0056 0.0015
Alternative 2 (without Plutonium Separation)									
Sonic Wash at Rocky Flats	Dock Fire (Bldg. 371) [b] Room Fire (Bldg. 371) [c]	2.0×10^{-6} 0.0005	0.31 0.31	1,800 151	0.00090 0.000076	21,000 1,760	11 0.88	14,000 1,170	0.0056 0.00047
Catalytic Chemical Oxidation at Rocky Flats	Dock Fire (Bldg. 371) [b] Room Fire (Bldg. 371) [c]	2.0×10^{-6} 0.0005	1.03 1.03	1,800 110	0.00090 0.000055	21,000 1,280	11 0.64	14,000 854	0.0056 0.00034
Blend Down at Rocky Flats	Dock Fire (Bldg. 371) [b] Room Fire (Bldg. 371) [c] Dock Fire (Bldg. 707) [b, d] Earthquake (Bldg. 707) [c, d]	2.0×10^{-6} 0.0005 2×10^{-6} 0.0026	0.059 0.059 0.059 0.059	1,800 1,260 1,200 492	0.00090 0.00063 0.00060 0.00025	21,000 14,700 21,000 8,600	11 7.4 11 4.3	14,000 9,820 14,000 5,730	0.0056 0.0039 0.0056 0.0023
Alternative 3 (with Plutonium Separation)									
Mediated Electrochemical Oxidation at Rocky Flats	Dock Fire (Bldg. 371) [b, e] Room Fire (Bldg. 371) [c, e] Dock Fire (Bldg. 707A) [b, f] Earthquake (Bldg. 707A) [b, f]	2.0×10^{-6} 0.0005 2.0×10^{-6} 0.0026	0.16 0.16 0.13 0.13	1,800 473 1,200 105	0.00090 0.00024 0.00060 0.000053	21,000 5,510 25,000 2,190	11 2.8 13 1.1	14,000 3,680 21,000 1,840	0.0056 0.0015 0.017 0.0074
Alternative 4 (Combination)									
Neutralize and Dry at Rocky Flats (Aqueous Contaminated Residue)	**Dock Fire (Bldg. 371) [b]** **Room Fire (Bldg. 371) [c]**	**2.0×10^{-6}** **0.0005**	**0.15** **0.15**	**1,800** **219**	**0.00090** **0.00011**	**21,000** **2,560**	**11** **1.3**	**14,000** **1,710**	**0.0056** **0.00068**
Thermally Desorb and Steam Passivate at Rocky Flats (Organic Contaminated Residue)	**Dock Fire (Bldg. 371) [b]** **Room Fire (Bldg. 371) [c]**	**2.0×10^{-6}** **0.0005**	**0.39** **0.39**	**1,800** **59**	**0.00090** **0.000029**	**21,000** **683**	**11** **0.34**	**14,000** **455**	**0.0056** **0.00018**
Repackage at Rocky Flats (Dry Contaminated Residue)	**Dock Fire (Bldg. 707) [b]** **Earthquake (Bldg. 707) [c]**	**2.0×10^{-6}** **0.0026**	**0.023** **0.023**	**1,200** **312**	**0.00060** **0.00016**	**21,000** **5,460**	**11** **2.7**	**14,000** **3,624**	**0.0056** **0.0015**

[a] The accident impacts of 20 years of storage are presented in Section 4.14 for all the materials combined under Alternative 1.
[b] Highest consequence accident for this processing technology.
[c] Highest risk accident for this processing technology.
[d] Mediated electrochemical oxidation process in Building 371.
[e] Building 707 is designated as an alternate location for the Shred and Blend Down process at Rocky Flats.
[f] Final calcination process in Building 707A.
Note: The impacts due to the preferred processing technology are presented in bold type.

The consequences for the public and a noninvolved onsite worker are also presented in Table 4–19 for each of the six combustible residue processing technologies. The public maximally exposed individual is a hypothetical individual who resides at the site boundary in the downwind direction. The public population is defined as the residential population within a radius of 80 km (50 mi). A noninvolved onsite worker is defined as an individual worker who is located 100 m (328 ft) or more downwind from the release point when an accidental release of radioactive material occurs. The highest consequence to the maximally exposed individual would occur if DOE decides to implement either the neutralize and dry, the thermal desorption and steam passivation, the sonic wash, the catalytic chemical oxidation, the blend down, or the mediated electrochemical oxidation technology at Rocky Flats and a fire occurs on the loading dock of Building 371. The highest consequence to the public population and the noninvolved onsite worker would occur if DOE decides to implement the mediated electrochemical oxidation process at Rocky Flats and a dock fire occurs in Building 707A during the final calcination.

The risks associated with each accident are calculated by multiplying the probability times the consequences. The risks to the public and an onsite worker are presented in **Table 4–20** for each of the six combustible residue processing technologies. (The No Action and Combination processing options are actually combinations of three processing technologies, one for each kind of combustible residue.) The risk associated with the highest risk accident and a composite risk associated with all major accidents are both presented. The risks associated with the preferred processing technology are presented in bold type.

The highest risk to the public maximally exposed individual is estimated to be 3.8×10^{-8}, which is due to an earthquake during processing of the residue with the blend down technology at Rocky Flats. This individual's chance of incurring a latent cancer fatality would be increased by less than one in ten million. The highest risk to the public population is estimated to be 0.00066 latent cancer fatalities, which is also due to an earthquake during processing of the residue with the blend down technology. The highest risk to the individual noninvolved onsite worker is estimated to be 3.5×10^{-7}, which is due to the same accident scenario in the same technology. This individual's chance of incurring a latent cancer fatality would be increased by less than one in one million.

4.5 Impacts of Managing Plutonium Fluoride Residues

The inventory of plutonium fluoride residues assessed in this EIS weighs 315 kg (694 lb), including 142 kg (313 lb) of plutonium. This inventory is stored in 256 small individual containers.

As discussed in Chapter 2, the alternatives for plutonium fluoride residues include one technology under the No Action Alternative, one technology under Process without Plutonium Separation Alternative, and two technologies under the Process with Plutonium Separation Alternative. There is no processing technology under Alternative 4. The preferred processing technology is to repackage the residues at Rocky Flats and to use Purex at the Savannah River Site.

This section presents the environmental impacts of managing the entire inventory of plutonium fluoride residues under each of the four technologies. The results in this section were used in the calculation of the total impacts of the No Action Alternative and the Preferred Alternative which are presented in Sections 4.20 and 4.21, respectively, and of the management approaches which are presented in Section 4.22.

Table 4–20 Risks Due to Accidents with Combustible Residues

	Accident Scenario	*Offsite Public Maximally Exposed Individual Risk (Probability of a Latent Cancer Fatality)*	*Offsite Public Population Risk (Number of Latent Cancer Fatalities)*	*Noninvolved Onsite Worker Risk (Probability of a Latent Cancer Fatality)*
Alternative 1 (No Action)				
Neutralize, Dry, and Store at Rocky Flats [a] (Aqueous Contaminated Residue)	Room Fire (Bldg. 371) Composite	8.2×10^{-9} 9.4×10^{-9}	0.000096 0.00011	5.1×10^{-8} 5.9×10^{-8}
Thermally Desorb, Steam Passivate, and Store at Rocky Flats (Organic Contaminated Residue)	Room Fire (Bldg. 371) Composite	5.7×10^{-9} 7.0×10^{-9}	0.000067 0.000082	3.5×10^{-8} 4.4×10^{-8}
Repackage and Store at Rocky Flats (Dry Contaminated Residue)	Earthquake (Bldg. 707) Composite	9.3×10^{-9} 1.3×10^{-8}	0.00016 0.00022	8.7×10^{-8} 1.2×10^{-7}
Alternative 2 (without Plutonium Separation)				
Sonic Wash at Rocky Flats	Room Fire (Bldg. 371) Composite	1.2×10^{-8} 1.4×10^{-8}	0.00014 0.00016	7.3×10^{-8} 8.4×10^{-8}
Catalytic Chemical Oxidation at Rocky Flats	Room Fire (Bldg. 371) Composite	2.8×10^{-8} 7.4×10^{-8}	0.00033 0.00039	1.8×10^{-7} 2.2×10^{-7}
Blend Down at Rocky Flats	Room Fire (Bldg. 371) Composite (Bldg. 371) Earthquake (Bldg. 707) [b] Composite (Bldg. 707) [b]	1.9×10^{-8} 2.1×10^{-8} 3.8×10^{-8} 5.1×10^{-8}	0.00022 0.00024 0.00066 0.00088	1.2×10^{-7} 1.3×10^{-7} 3.5×10^{-7} 4.7×10^{-7}
Alternative 3 (with Plutonium Separation)				
Mediated Electrochemical Oxidation at Rocky Flats	Room Fire (Bldg. 371) [c] Composite Earthquake (Bldg. 707A) [d] Composite	1.9×10^{-8} 2.8×10^{-8} 1.8×10^{-8} 2.5×10^{-8}	0.00022 0.00030 0.00037 0.00053	1.2×10^{-7} 1.3×10^{-7} 2.5×10^{-8} 3.6×10^{-7}
Alternative 4 (Combination)				
Neutralize and Dry at Rocky Flats (Aqueous Contaminated Residue)	**Room Fire (Bldg. 371)** **Composite**	$\mathbf{8.2\times10^{-9}}$ $\mathbf{9.4\times10^{-9}}$	**0.000096** **0.00011**	$\mathbf{5.1\times10^{-8}}$ $\mathbf{5.9\times10^{-8}}$
Thermally Desorb and Steam Passivate at Rocky Flats (Organic Contaminated Residue)	**Room Fire (Bldg. 371)** **Composite**	$\mathbf{5.7\times10^{-9}}$ $\mathbf{7.0\times10^{-9}}$	**0.000067** **0.000082**	$\mathbf{3.5\times10^{-8}}$ $\mathbf{4.4\times10^{-8}}$
Repackage at Rocky Flats (Dry Contaminated Residue)	**Earthquake (Bldg. 707)** **Composite**	$\mathbf{9.3\times10^{-9}}$ $\mathbf{1.3\times10^{-9}}$	**0.00016** **0.00022**	$\mathbf{8.7\times10^{-8}}$ $\mathbf{1.2\times10^{-8}}$

[a] The accident impacts of 20 years of storage are presented in Section 4.14 for all the materials combined under Alternative 1.
[b] Building 707 is designated as an alternate location for the Shred and Blend Down process at Rocky Flats.
[c] Mediated electrochemical oxidation process in Building 371.
[d] Final calcination process in Building 707A.

Note: The risks due to the preferred processing technology are presented in bold type.

4.5.1 Products and Wastes

Every processing technology for plutonium fluoride residues would generate some quantity of transuranic waste and would prepare this waste for disposal in WIPP. Every technology would also generate some quantity of low-level waste, which would be disposed of routinely using existing procedures at each site. A small portion of the low-level waste generated at Rocky Flats could possibly be low-level mixed waste, but this waste would also be disposed of routinely using existing procedures.

The No Action Alternative would generate stabilized residues that would have to remain in storage indefinitely. The Process without Plutonium Separation Alternative would generate transuranic waste directly from the residue. In some of the processing technologies the stabilized residues and transuranic waste would be placed in pipe components inside 208-liter (55-gal) drums as shown in Figure 2-13 in Chapter 2.

High-level waste and saltstone would be generated only at the Savannah River Site if the residues are shipped to that site for plutonium separation. The final form for the high-level waste would be glass poured into stainless steel canisters, which would be stored at the Savannah River Site until a monitored geologic repository is ready to receive them. Saltstone is a cement form of low-level waste that is generated as a by-product of the Savannah River Site tank farm operations and is routinely disposed of onsite in concrete vaults.

If plutonium is separated at Rocky Flats or the Savannah River Site, it would be stored securely onsite until a decision is made on its disposition. No increase in proliferation risk would result and this plutonium would not be used for nuclear explosive purposes. Any plutonium separated at Rocky Flats would contain americium, while at the Savannah River Site the americium would go into the high-level waste.

The solid plutonium-bearing products and wastes that would be generated from plutonium fluoride residues under each of the technologies are presented in **Table 4–21**. The shaded areas of Table 4–21 indicate types of solid products and wastes that would not be generated under the various technologies. The products and wastes from the preferred processing technology are presented in bold type. The largest amount of transuranic waste (3,923 drums) would be generated in the blend down technology. This amount is much higher than the other technologies, which would generate no more than 333 drums of transuranic waste.

The quantities of high-level waste, low-level waste, and saltstone would be very low under all the technologies and the sites would manage these wastes using routine procedures. The maximum amount of plutonium that could be separated is 141 kg (310 lb).

4.5.2 Public and Occupational Health and Safety Impacts

This section describes the radiological and hazardous chemical impacts which could result from the alternatives associated with the management of plutonium fluoride residues. These impacts are presented for incident-free operation and postulated accident scenarios, respectively. The detailed site and transportation analyses are presented in Appendices D and E, respectively.

The round-trip highway distance from Rocky Flats to the Savannah River Site is 5,233 km (3,250 mi). If DOE decides to ship the plutonium fluoride residues to the Savannah River Site for Purex processing, then seven shipments would be required and the total round-trip shipping distance would be 36,600 km (22,700 mi).

Table 4–21 Products and Wastes from Plutonium Fluoride Residues

	Stabilized Residues (Drums) [a]	*Transuranic Waste (Drums)* [a]	*High-Level Waste (Canisters of Glass)* [b]	*Separated Plutonium (kg)* [c]	*Low-Level Waste (Drums)* [a]	*Saltstone (cubic meters)*
Alternative 1 (No Action)						
Dissolve, Oxidize, and Store at Rocky Flats	141	333			750	
Alternative 2 (without Plutonium Separation)						
Blend Down at Rocky Flats		3,923			60	
Alternative 3 (with Plutonium Separation)						
Acid Dissolve at Rocky Flats		333		141	750	
Preprocess at Rocky Flats		**28**	**–**	**–**	**60**	**–**
Purex at the Savannah River Site		**12**	**0.2**	**141**	**45**	**18**

[a] Standard 55-gallon (208-liter) drums. (208 liters is equal to 0.208 cubic meters.)
[b] Each canister is 2 feet (61 cm) in diameter, 10 feet (300 cm) tall, and contains approximately 3,700 pounds (1,680 kg) of high-level waste glass.
[c] To convert to pounds, multiply by 2.2.

Notes: Shaded areas indicate the types of solid products and waste that would not be generated. The products and wastes from the preferred processing technology are presented in bold type. The storage capacities at each site are adequate to store the products and wastes listed in this table.

No construction of new processing facilities is included in any of the alternatives, but DOE may need to modify certain existing facilities and construct new waste storage buildings for some of the alternatives. Mitigation measures during modifications would ensure that any radiological or hazardous chemical releases would be extremely small. Worker exposures to contaminated material would be limited to ensure that doses are maintained as low as reasonably achievable.

4.5.2.1 Incident-Free Operations

- **Radiological Impacts—**The radiological impacts to the public and the workers associated with incident-free operations of each technlogy are presented in **Table 4–22**. The impacts due to the preferred processing technology are presented in bold type. The impacts are those which are anticipated to occur as a result of process operations and transportation over whatever time period is necessary to process the entire inventory of plutonium fluoride residues. The length of time necessary to process the plutonium fluoride residues will depend on which technology DOE decides to implement. Impacts associated with subsequent incident-free storage of stabilized residues, separated plutonium, and wastes would be much smaller than from processing or transportation.

  The highest estimated public maximally exposed individual dose in Table 4–22 is 11 mrem, which could occur only during transportation. This hypothetical individual's latent fatal cancer risk would be increased by less than one in one hundred thousand. The public maximally exposed individual risks near the sites would be much lower under all of the technologies. The highest total of the public population radiation doses listed in Table 4–22 would occur if DOE decides to implement the option to perform Purex processing at the Savannah River Site. The sum of these doses is 0.71 person-rem, which would cause far less than one additional latent fatal cancer among the population living near both sites and traveling along the truck route. The population living near the truck route would receive a much smaller radiation dose.

  For these residues, the workers would be exposed to neutron radiation from the alpha-neutron reaction between plutonium and fluorine in addition to the normal radiations from plutonium and americium. As explained in DOE's Response to Comment Number 10 in Chapter 9, this neutron radiation is included in the dose estimates in this section. The highest involved worker population radiation dose would be 356 person-rem, which would occur if DOE decides to implement the option to blend down at Rocky Flats. This dose would cause 0.14 additional latent cancer fatalities among the workers directly involved in the operation. Onsite workers who are not involved with the actual processing of the residues are designated as "noninvolved workers." The impacts to these workers would be expected to be much smaller than the impacts to the involved workers.

- **Hazardous Chemical Impacts—**The processing of plutonium fluoride residues at Rocky Flats would not involve airborne releases of hazardous chemicals.

  No carcinogenic chemicals would be released from the Purex process at the Savannah River Site. Noncancer health risks resulting from releases of phosphoric acid and ammonium nitrate are low; the Hazard Index values presented in **Table 4–23** are much less than one. Phosphoric acid, the constituent of the process source term that accounts for the largest increment of noncancer risk, is a corrosive irritant to the eyes, skin and mucous membranes and a respiratory tract irritant following inhalation exposure (Lewis 1991, EPA 1995a). The impacts due to the preferred processing technlogy are presented in bold type.

Table 4–22 Radiological Impacts Due to Incident-Free Management of Plutonium Fluoride Residues

	Offsite Public Maximally Exposed Individual		*Offsite Public Population*		*Maximally Exposed Individual Involved Worker*		*Involved Worker Population*	
	Dose (mrem)	*Probability of a Latent Cancer Fatality*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*	*Dose (mrem per year)*	*Probability of a Latent Cancer Fatality per year*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*
Alternative 1 (No Action)								
Dissolve, Oxidize, and Store at Rocky Flats	0.000043	2.2×10^{-11}	0.00098	4.9×10^{-7}	2,000	0.0008	47	0.019
Alternative 2 (without Plutonium Separation)								
Blend Down at Rocky Flats	N/E	–	N/E	–	2,000	0.0008	356	0.142
Alternative 3 (with Plutonium Separation)								
Acid Dissolve at Rocky Flats	0.000043	2.2×10^{-11}	0.00098	4.9×10^{-7}	2,000	0.0008	45	0.018
Preprocess at Rocky Flats	**9.9×10^{-6}**	**5.0×10^{-12}**	**0.00021**	**1.1×10^{-7}**	**2,000**	**0.0008**	**41**	**0.016**
Transport to Savannah River Site	**11**	**5.5×10^{-6}**	**0.69**	**0.00035**	**100**	**0.00004**	**1.1**	**0.00044**
Purex at Savannah River Site [a]	**0.00020**	**1×10^{-10}**	**0.022**	**0.000011**	**2,000**	**0.0008**	**34**	**0.013**

N/E = no emissions—therefore, there are no radiological impacts to the public

[a] Impacts to the public and workers are presented for F-Canyon operations. It has been determined that H-Canyon operations result in lower impacts to these groups.

Note: The impacts due to the preferred processing technology are presented in bold type.

Table 4–23 Chemical Impacts Due to Incident-Free Management of Plutonium Fluoride Residues

	Offsite Public Maximally Exposed Individual		*Offsite Public Population*	*Maximally Exposed Individual Worker*		*Worker Population*
	Probability of Cancer Incidence	*Hazard Index*	*Number of Cancer Incidences or Fatalities [a]*	*Probability of Cancer Incidence*	*Hazard Index*	*Number of Cancer Incidences or Fatalities [a]*
Alternative 1 (No Action)						
Dissolve, Oxidize, and Store at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 2 (without Plutonium Separation)						
Blend Down at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Alternative 3 (with Plutonium Separation)						
Acid Dissolve at Rocky Flats [b]	N/E	N/E	N/E	N/E	N/E	N/E
Preprocess at Rocky Flats [b]	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**	**N/E**
Transport to Savannah River Site	**N/A**	**N/A**	**0.00009 [c]**	**N/A**	**N/A**	**(c)**
Purex at Savannah River Site [d, e]	**N/E**	**1×10^{-9}**	**N/E**	**N/E**	**2×10^{-8}**	**N/E**

N/E = no emissions N/A = not applicable—the maximally exposed individual is undefined for vehicle emissions

[a] Cancer incidences and fatalities are calculated for process emissions and transportation emissions, respectively.

[b] No hazardous chemicals are released from this process; therefore, no associated health risks exist.

[c] Cancer fatalities due to vehicle emissions into the air. This impact is listed only once under public population because the vehicle emissions affect the public and worker populations collectively; however, the risk to the public dominates. See Appendix E, Section E.4 for additional details.

[d] Impacts are presented for F-Canyon operations. H-Canyon operations are expected to result in similar or lower impacts.

[e] No carcinogenic chemicals are released from the process; therefore, only noncancer health risks are evaluated.

Note: The impacts due to the preferred processing technology are presented in bold type.

4.5.2.2 Accidents

The potential radiological impacts to the public and the noninvolved onsite workers due to accidents with plutonium fluoride residues are summarized and presented in this section. The detailed analysis of onsite accidents, with the associated assumptions, is presented in Appendix D, Section D.3. The detailed analysis considered a wide spectrum of potential accident scenarios, including fire, explosion, spill, criticality, earthquake, and aircraft crash. The accident scenarios with the highest consequences and risks were selected and carried forward to this section for the purpose of consequence and risk comparison. A composite of the risks due to major onsite accident scenarios in each spectrum (including the nonbounding accidents) was also computed and used for comparisons. The composite risk estimates are accurate enough for the purpose of comparing processing technlogies against each other. The detailed analysis of transportation accidents, with the associated assumptions, is presented in Appendix E, Sections E.5 and E.6.

The accident frequencies and process durations of the selected accidents are presented in **Table 4–24**. The impacts due to the preferred processing technology are presented in bold type. The onsite accident frequencies are given on a per year basis because many accidents, such as earthquakes, are commonly expressed this way. The duration of each process is given in years. The actual probability of occurrence of each onsite accident can be obtained by multiplying the accident frequency times the technology's duration. In this way, the calculated probabilities are based on the total amount of residue in this category rather than a standard unit of time. The impacts of accidents during post-processing interim storage are presented for all the plutonium residues and scrub alloy combined in Section 4.14.

The calculation of accident probability is slightly different for traffic accident fatalities. The frequency of traffic accidents is given in terms of the number of fatal accidents per round trip shipment from Rocky Flats to the Savannah River Site. The process duration for traffic accidents is given as the number of round trip shipments. Thus, the actual probability of a fatal traffic accident can be obtained by multiplying the frequency (fatal accidents per round-trip shipment) times the duration (number of round-trip shipments).

The consequences for the public and a noninvolved onsite worker are also presented in Table 4–24, for each of the four plutonium fluoride residue processing technologies. The public maximally exposed individual is a hypothetical individual who resides at the site boundary in the downwind direction. The public population is defined as the residential population within a radius of 80 km (50 mi). A noninvolved onsite worker is defined as an individual worker who is located 100 m (328 ft) or more downwind from the release point when an accidental release of radioactive material occurs

The highest consequences to all three receptors would occur if DOE decides to implement the preferred processing technology and a major earthquake strong enough to cause the breach of Building 371 occurs during the 0.17 years of preprocessing the residue at Rocky Flats.

The risks associated with each accident are calculated by multiplying the probability times the consequences. The risks to the public and an onsite worker are presented in **Table 4–25**, for each of the four plutonium fluoride residue processing technologies. The risk associated with the highest risk accident and a composite risk due to all major accidents are both presented. The risks associated with the preferred processing technology are presented in bold type.

Table 4–24 Accident Frequencies, Process Durations, and Consequences for Accidents with Plutonium Fluoride Residues

				Offsite Public Maximally Exposed Individual Consequences		*Offsite Public Population Consequences*		*Noninvolved Onsite Worker Consequences*	
	Accident Scenario	*Accident Frequency (per year)*	*Process Duration (years)*	*Dose (mrem)*	*Probability of a Latent Cancer Fatality*	*Dose (person-rem)*	*Number of Latent Cancer or Traffic Fatalities*	*Dose (mrem)*	*Probability of a Latent Cancer Fatality*
Alternative 1 (No Action)									
Dissolve, Oxidize, and Store at Rocky Flats [a]	Earthquake (Bldg. 371) [b]	0.000094	0.49	1,600	0.00080	18,600	9.3	12,400	0.0050
	Earthquake (Bldg 707A) [c]	0.0026	0.34	760	0.00038	15,800	7.9	13,300	0.0053
Alternative 2 (without Plutonium Separation)									
Blend Down at Rocky Flats	Earthquake (Bldg. 707)	0.0026	1.57	330	0.00017	5,780	2.9	3,850	0.0015
	Earthquake (Bldg. 371) [d]	0.000094	1.57	496	0.00025	5,780	2.9	3,850	0.0015
Alternative 3 (with Plutonium Separation)									
Acid Dissolve at Rocky Flats	Earthquake (Bldg. 371) [b]	0.000094	0.49	1,600	0.00080	18,600	9.3	12,400	0.0050
	Earthquake (Bldg 707A) [c]	0.0026	0.34	760	0.00038	15,800	7.9	13,300	0.0053
Preprocess at Rocky Flats	**Earthquake (Bldg. 371)**	**0.000094**	**0.17**	**4,490**	**0.0023**	**52,400**	**26**	**34,900**	**0.028**
Transport to Savannah River Site	**Traffic Fatality**	**0.00010 per shipment**	**7 shipments**	**N/A**	**N/A**	**N/A**	**1.0** [e]	**N/A**	**N/A** [f]
Purex at Savannah River Site	**Earthquake (H- Canyon)** [g]	**0.000182**	**1.58**	**74**	**0.000037**	**3,330**	**1.7**	**23,600**	**0.019**

N/A = not applicable

[a] The accident impacts of 20 years of storage are presented in Section 4.14 for all the materials combined under Alternative 1.

[b] Acid dissolution process in Building 371.

[c] Final calcination process in Building 707A.

[d] Building 371 is designated as an alternate location for the Blend Down process at Rocky Flats.

[e] This fatality is due to the mechanical impact of the accident, not cancer due to radiation. The radiological consequences of a radioactive release on the highway are impossible to list in a single number because the accident could occur at any point along the route and meteorological conditions and population distributions vary greatly along the route.

[f] The consequence of a high-speed traffic accident would be at least one fatality among the transportation workers due to trauma.

[g] HB-Line operates 12.5 percent of the time. Dose estimates assumed the HB-Line was operating at the time of the accident.

Note: The impacts due to the preferred processing technology are presented in bold type.

Table 4–25 Risks Due to Accidents with Plutonium Fluoride Residues

	Accident Scenario	*Offsite Public Maximally Exposed Individual Risk (Probability of a Latent Cancer Fatality)*	*Offsite Public Population Risk (Number of Latent Cancer or Traffic Fatalities)*	*Noninvolved Onsite Worker Risk (Probability of a Latent Cancer Fatality)*
Alternative 1 (No Action)				
Dissolve, Oxidize, and Store at Rocky Flats [a]	Earthquake (Bldg. 371) [b]	3.7×10^{-8}	0.00043	2.3×10^{-7}
	Composite	5.9×10^{-8}	0.00063	2.5×10^{-7}
	Earthquake (Bldg. 707A) [c]	3.4×10^{-7}	0.0070	4.7×10^{-6}
	Composite	3.4×10^{-7}	0.0070	4.7×10^{-6}
Alternative 2 (without Plutonium Separation)				
Blend Down at Rocky Flats	Earthquake (Bldg. 707)	6.7×10^{-7}	0.012	6.3×10^{-6}
	Composite (Bldg. 707)	6.8×10^{-7}	0.012	6.4×10^{-6}
	Earthquake (Bldg. 371) [d]	3.7×10^{-8}	0.00043	2.3×10^{-7}
	Composite (Bldg. 371) [d]	4.5×10^{-8}	0.00053	2.8×10^{-7}
Alternative 3 (with Plutonium Separation)				
Acid Dissolve at Rocky Flats	Earthquake (Bldg. 371) [b]	3.7×10^{-8}	0.00043	2.3×10^{-7}
	Composite	5.9×10^{-8}	0.00063	2.5×10^{-7}
	Earthquake (Bldg. 707A) [c]	3.4×10^{-7}	0.0070	4.7×10^{-6}
	Composite	3.4×10^{-7}	0.0070	4.7×10^{-6}
Preprocess at Rocky Flats	**Earthquake (Bldg. 371)**	**3.6×10^{-8}**	**0.00042**	**4.5×10^{-7}**
	Composite	**3.7×10^{-8}**	**0.00043**	**4.5×10^{-7}**
Transport to Savannah River Site	**Traffic Fatality**	**N/A**	**0.0007 [d]**	**N/A**
	Radioactive Release	**N/A**	**3.1×10^{-6}**	**N/A**
Purex at Savannah River Site	**Earthquake (H-Canyon) [f]**	**3.5×10^{-9}**	**0.00016**	**1.8×10^{-6}**
	Composite [e]	**6.6×10^{-9}**	**0.00030**	**1.8×10^{-6}**

N/A = not applicable

[a] The accident impacts of 20 years of storage are presented in Section 4.14 for all the materials combined under Alternative 1.

[a] Acid dissolution process in Building 371.

[b] Final calcination process in Building 707A.

[c] Building 371 is designated as an alternate location for the Blend Down process at Rocky Flats.

[d] This risk is due to the mechanical impact of a potential accident, not cancer due to radiation. This risk includes members of the public and transportation workers.

[e] The H-Canyon operates 100 percent of the time and the HB-Line operates 12.5 percent of the time.

Note: The risks due to the preferred processing technology are presented in bold type.

The highest risk to the public maximally exposed individual is estimated to be 6.7×10^{-7}, which is due to an earthquake during processing of the residue with the blend down technology in Rocky Flats Building 707. This individual's chance of incurring a latent cancer fatality would be increased by less than one in one million. The highest risk to the public population is estimated to be 0.012 latent cancer fatalities, which is also due to an earthquake at Rocky Flats during processing of the residue with the blend down technology in Building 707. The highest risk to the individual noninvolved onsite worker is estimated to be 6.3×10^{-6}, which is due to the same accident scenario in the same technology. This individual's chance of incurring a latent cancer fatality would be increased by less than one in one hundred thousand.

4.6 IMPACTS OF MANAGING FILTER MEDIA RESIDUES

The inventory of filter media residues assessed in this EIS weighs 2,624 kg (5,785 lb), including 112 kg (247 lb) of plutonium. This inventory is stored in 281 drums and 8 other small individual containers. As discussed in Chapter 2, the filter media residues are divided into three categories. These subcategories are listed in **Table 4–26**, along with the inventory data for each one.

Table 4–26 Filter Media Residues

Filter Media Subcategories	*Residue Mass (kg)*[a]	*Plutonium Mass (kg)*[a]	*Number of Drums*	*Number of Other Individual Containers*
IDC 331	800	19.6	74	1
IDC 338	1,700	90.4	195	6
Other Filter Media	124	2.0	12	1
Totals	2,624	112	281	8

[a] To convert to pounds, multiply by 2.2.

As discussed in Chapter 2, the processing technologies for the three subcategories of filter media residues are rather similar. All three have the same one technology under the No Action Alternative, two technologies under the Processing without Plutonium Separation Alternative, and one technology under the Processing with Plutonium Separation Alternative. The IDC 338 and Other High-Efficiency Particulate Air Filter Media include the technology of vitrification and they have one technology under Alternative 4. There is no processing technology for IDC 331 residues under Alternative 4. The preferred processing technologies for the IDC 331, IDC 338, and other filter media residues are blend down, neutralize/dry, and repackage at Rocky Flats, respectively.

This section presents the environmental impacts of managing the entire inventory of each subcategory of filter media residues under each of the technologies. The results in this section were used in the calculation of the total impacts of the No Action Alternative and the Preferred Alternative which are presented in Sections 4.20 and 4.21, respectively, and of the management approaches which are presented in Section 4.22.

4.6.1 Products and Wastes

Every processing technology for filter media residues would generate some quantity of transuranic waste and would prepare this waste for disposal in WIPP. Every technology would also generate some quantity of low-level waste, which would be disposed of routinely using existing procedures at the Rocky Flats. A small portion of the low-level waste generated at Rocky Flats could possibly be low-level mixed waste, but this waste would also be disposed of routinely using existing procedures. The No Action Alternative would generate stabilized residues that would have to remain in storage indefinitely. The Process without Plutonium Separation Alternative would generate transuranic waste directly from the residue. In some of the processing technologies the stabilized residues and transuranic waste would be placed in pipe components inside 208-liter

(55-gal) drums as shown in Figure 2-13 in Chapter 2. If DOE applies variances to the stabilized residues (Alternative 4), then the stabilized residues could be disposed of in WIPP as transuranic waste.

High-level waste and saltstone will not be generated from filter media residues because none of the technologies involve shipping the residues to the Savannah River Site for plutonium separation. If plutonium is separated at Rocky Flats, it would be stored securely onsite until a decision is made on its disposition. No increase in proliferation risk would result and this plutonium would not be used for nuclear explosive purposes. This separated plutonium would also contain the americium from the filter media residues.

The solid plutonium-bearing products and wastes that would be generated from high-efficiency particulate air filter media residues under each of the technologies are presented in **Table 4–27**. The shaded areas of Table 4–27 indicate types of solid products and wastes that would not be generated under the various technologies. The products and wastes from the preferred processing technologies are presented in bold type.

- **IDC 331 Ful Flo Filter Media Residues—**The largest amount of transuranic waste (860 drums) would be generated in the mediated electrochemical oxidation at Rocky Flats processing technology. The amount of waste from this process is high because it is a liquid process, assumed to generate 3.4 drums of waste per kilogram of residue, with 30 percent of this being transuranic waste. This technology would generate much more transuranic waste than the other technologies, which would generate fewer than 400 drums. The quantities of low-level waste are low under all the technologies and the site would manage this waste using routine procedures. The maximum amount of plutonium that could be separated from the IDC 331 Ful Flo Filter Media Residues is 19 kg (42 lb).

- **IDC 338 High-Efficiency Particulate Air Filter Media Residues—**The largest amount of transuranic waste (1,827 drums) would be generated in the mediated electrochemical oxidation at Rocky Flats processing technology. The amount of waste from this process is high because it is a liquid process, assumed to generate 3.4 drums of waste per kilogram of residue, with 30 percent of this being transuranic waste. This technology would generate much more transuranic waste than the other technologies, which would generate fewer than 800 drums. The stabilized residues generated in Alternative 4 could be disposed of in WIPP, just like transuranic waste. Thus, this technology would generate over 3,300 drums (stabilized residues plus transuranic waste) to be sent to WIPP. The quantities of low-level waste are low under all the technologies and the site would manage this waste using routine procedures. The maximum amount of plutonium that could be separated from the IDC 338 High-Efficiency Particulate Air Media Residues is 88 kg (194 lb).

- **Other High-Efficiency Particulate Air Filter Media Residues—**The largest amount of transuranic waste (133 drums) would be generated in the mediated electrochemical oxidation at Rocky Flats processing technology. The amount of waste from this process is high because it is a liquid process, assumed to generate 3.4 drums of waste per kilogram of residue, with 30 percent of this being transuranic waste. This technology would generate much more transuranic waste than the other technologies, which would generate no more than about 50 drums. The stabilized residues generated in Alternative 4 could be disposed of in WIPP, just like transuranic waste. Thus, this technology would generate almost 100 drums (stabilized residues plus transuranic waste) to be sent to WIPP. The quantities of low-level waste are low under all the technologies and the site would manage this waste using routine procedures. The maximum amount of plutonium that could be separated from the Other High-Efficiency Particulate Air Media Residues is 2 kg (4 lb).

Table 4–27 Products and Wastes from Filter Media Residues

	Stabilized Residues (Drums) [a]	*Transuranic Waste (Drums)* [a]	*High-Level Waste (Canisters of Glass)* [b]	*Separated Plutonium (kg)* [c]	*Low-Level Waste (Drums)* [a]	*Saltstone (cubic meters)*
IDC 331 Ful Flo Filter Media						
Alternative 1 (No Action) Neutralize/Dry and Store at Rocky Flats	1,517	65			166	
Alternative 2 (without Plutonium Separation) **Blend Down at Rocky Flats**		**269**			**166**	
Sonic Wash at Rocky Flats		343			166	
Alternative 3 (with Plutonium Separation) Mediated Electrochemical Oxidation at Rocky Flats		860		19	1,919	
IDC 338 High-Efficiency Particulate Air Filter Media						
Alternative 1 (No Action) Neutralize/Dry and Store at Rocky Flats	3,223	138			360	
Alternative 2 (without Plutonium Separation) Vitrify at Rocky Flats		656			360	
Blend Down at Rocky Flats		572			360	
Sonic Wash at Rocky Flats		730			360	
Alternative 3 (with Plutonium Separation) Mediated Electrochemical Oxidation at Rocky Flats		1,827		88	4,085	
Alternative 4 (Combination) **Neutralize/Dry at Rocky Flats**	**3,223** [d]	**138**			**360**	
Other High-Efficiency Particulate Air Filter Media						
Alternative 1 (No Action) Neutralize/Dry and Store at Rocky Flats	96	10			25	
Alternative 2 (without Plutonium Separation) Vitrify at Rocky Flats		48			25	
Blend Down at Rocky Flats		42			25	
Sonic Wash at Rocky Flats		53			25	
Alternative 3 (with Plutonium Separation) Mediated Electrochemical Oxidation at Rocky Flats		133		2	297	
Alternative 4 (Combination) **Repackage at Rocky Flats**	**87** [d]	**10**			**25**	

[a] Standard 55-gallon (208-liter) drums. (208 liters is equal to 0.208 cubic meters.)
[b] Each canister is 2 feet (61 cm) in diameter, 10 feet (300 cm) tall, and contains approximately 3,700 pounds (1,680 kg) of high-level waste glass.
[c] To convert to pounds, multiply by 2.2.
[d] These stabilized residues could be disposed of in WIPP as transuranic waste.

Notes: Shaded areas indicate the types of solid products and waste that would not be generated. The storage capacities at each site are adequate to store the products and wastes listed in this table.

The impacts due to the preferred processing technologies are presented in bold type.