

4.3.4 TECHNOLOGY AND SITE-SPECIFIC IMPACTS FOR BLENDING HIGHLY ENRICHED URANIUM TO 0.9-PERCENT LOW-ENRICHED URANIUM AS METAL

Under this process, surplus HEU metal would be melted down and mixed with molten DU to attain the appropriate enrichment level of 0.9-percent assay. The homogeneous molten mixture then would be converted to oxide form. This process would be used only for surplus HEU to be discarded as waste.

Assessment of impacts of blending HEU to 0.9-percent LEU as metal is based on an annual throughput of 3.1 t of 50-percent assay HEU (impure U/Al metal alloy) blended to approximately 264 t/yr LEU. The resultant product would be an impure U/Al metal alloy containing 0.9-percent assay uranium metal, which would be subsequently converted to oxide form prior to disposal. When oxidized, including aluminum, the total mass of the waste product would be 278 t/yr. The blendstock for this alternative would be DU, requiring a blending ratio of 70 to 1 (each metric ton of HEU would require about 70 t of blendstock). The Y-12 Plant is considered for this alternative because it is the only site where metal blending capability currently exists.

4.3.4.1 Site Infrastructure

Operation of facilities to blend HEU to 0.9-percent LEU as metal would potentially affect site infrastructure, mainly electrical power, fuel, and water/steam supply. Site infrastructure requirements are discussed in Section 2.2.2.2 and detailed in Table 4.3.4.1-1 for the Y-12 Plant. The discussion of impacts on site infrastructure is presented for all the sites collectively.

Due to the use of existing facilities at the Y-12 Plant and the estimated metal blending facility utility requirements, there is no anticipated need for modifications to onsite or offsite road and rail access or right-of-way access corridors for such services as electrical transmission lines, natural gas and water supply pipelines, and telecommunications. The existing road, rail, and other utility services at the Y-12 Plant are considered adequate to support the projected needs of the metal blending facility.

The annual electrical service requirements of the metal blending facility are 3,800 MWh with a maximum peak demand in any 1-hour period estimated at 1 MWe. This requirement is less than 1 percent of current annual consumption at the Y-12 Plant.

The fuel and water requirements to support the metal blending facility represent relatively small fractions of current annual usage or available capacity at ORR. Natural gas is available and in use at the Y-12 Plant. [Text deleted.] Annual fuel oil consumption at ORR is 416,000 l (110,000 gal); however, none of this oil is used at the Y-12 Plant. Coal fired boilers are in use for the production of process steam. The fuel requirements for the metal conversion and blending facility represent only 0.2 percent of current fuel consumption at ORR. Annual raw water requirements to support the blending facility operations represent only 0.2 percent of current usage at ORR.

As a result of the extensive site infrastructure already existing at Y-12, minimal effect, in terms of the percentage increase in site infrastructure resource usage, can be expected due to the development, operation, and decommissioning of the metal blending facility. In addition, the metal blending facility's site infrastructure resource requirements are well within the available capacity at the Y-12 Plant.

4.3.4.2 Air Quality and Noise

Operation of facilities to blend HEU to 0.9-percent LEU as metal would generate criteria and toxic/hazardous pollutants. Concentrations of pollutants resulting from this alternative were estimated for ORR and are presented in Table 4.3.4.2-1.

Air Quality. Air pollutant emissions associated with the operation of the metal blending facility consist of criteria pollutants from the operation of boilers to produce steam and toxic/hazardous pollutants such as nitric acid used or generated in the blending process. These pollutants are controlled using liquid scrubbing prior to HEPA filtration to remove chemical vapors and particulates.

The 24-hour concentration of SO₂ at ORR is approximately 9 percent of the standard, which is the highest percent of a standard for the criteria

Table 4.3.4.1-1. Additional Site Infrastructure Resources for Blending 3.1 t/yr Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Metal

Site	Access		Electrical		Natural Gas (m ³ /yr)	Fuel		Water	
	Road (km)	Rail (km)	Energy (MWh/yr)	Peak Load (MWe)		Diesel/ oil (l/yr)	Coal (t/yr)	Water (million l/yr)	Steam (kg/hr)
Metal facility	0	0	3,800	1	708	37,850	127	12	0
Y-12 baseline	42	11	421,000	62	66,600,000	0	2,940	7,530	99,300
Y-12 percent change [Text deleted.]	0	0	0.9	1.6	0.07 ^a	NA ^b	4.4	0.16	0

^a Percent change includes required natural gas or oil energy equivalent.

^b Natural gas is the primary fuel at Y-12, and all of the blending facility oil requirements have been converted to a natural gas energy equivalent; fuel oil (0.96 kg/l) is assumed to be 41,800 BTUs/kg or 40,128 BTUs/l, and natural gas is assumed to be 35,315 BTUs/m³ (that is, 37,850 of fuel oil=43,065 m³ natural gas).
[Text deleted.]

Note: NA=not applicable; MWh=megawatt hour; MWe=megawatt electric; BTU=British thermal unit.

Source: OR LMES 1995c; OR MMES 1995a.

Table 4.3.4.2-1. Estimated Concentrations of Criteria Pollutants Based Upon Blending 3.1 t/yr Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Metal

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines ($\mu\text{g}/\text{m}^3$)	Metal Blending Alternative Concentration for Y-12 ^a ($\mu\text{g}/\text{m}^3$)
Carbon monoxide (CO)	8 hours	10,000 ^b	6.7
	1 hour	40,000 ^b	31
Lead (Pb)	Calendar Quarter	1.5 ^b	^c
Nitrogen dioxide (NO ₂)	Annual	100 ^b	0.47
Particulate matter (PM ₁₀)	Annual	50 ^b	0.02
	24 hours	150 ^b	0.27
Sulfur dioxide (SO ₂)	Annual	80 ^b	0.86
	24 hours	365 ^b	10.2
	3 hours	1,300 ^b	56.2
Mandated by Tennessee			
Total suspended particulates (TSP)	Annual	60 ^d	2.37 ^e
	24 hours	150 ^d	28.16
Gaseous fluorides (as HF)	1 month	0.8 ^d	^c
	1 week	1.6 ^d	^c
	24 hours	2.9 ^d	^c
	12 hours	3.7 ^d	^c
	8 hours	250 ^d	^c

^a Model results.

^b Federal standard.

^c No emissions from this process.

^d State standard or guideline.

^e No State standard or guideline.

Note: Ozone, as a criteria pollutant, is not directly emitted or monitored by the candidate sites. Pollutant concentrations shown for Y-12 include other ORR operations.

Source: 40 CFR 50; OR LMES 1995c; TN DEC 1994a; TN DHE 1991a.

pollutants at ORR. The metal blending would contribute 3 and 19 percent to the 24-hour concentration of SO₂ and TSP at ORR respectively. The remaining criteria pollutant concentrations would be less than 20 percent of the respective standard.

[Text deleted.]

Table 4.3.4.2-2 presents the total concentrations of no action criteria pollutants plus blending at the Y-12 site. During operation, impacts from the metal blending with respect to the concentrations of criteria and toxic/hazardous air pollutants are expected to be within Federal and State regulations and guidelines for ORR.

Noise. Operation of the metal blending facilities in an existing building at ORR would result in little or no contribution to noise levels at offsite receptors. Existing buildings are located at a sufficient distance from offsite noise sensitive receptors that the contribution to offsite noise levels would continue to be small.

Noise impacts associated with increased traffic on access routes would be small considering that the facility would require a maximum of 72 employees during operation (OR LMES 1995c:20), many of whom would be employees currently working at the site.

**Table 4.3.4.2-2. Estimated Total Concentrations of Criteria Pollutants for No Action Plus Blending
3.1 t/yr Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Metal**

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines ($\mu\text{g}/\text{m}^3$)	No Action Plus Blending Concentration at Y-12 ^a ($\mu\text{g}/\text{m}^3$)
Carbon monoxide (CO)	8 hours	10,000 ^b	11.7
	1 hour	40,000 ^b	42
Lead (Pb)	Calendar Quarter	1.5 ^b	0.05
Nitrogen dioxide (NO ₂)	Annual	100 ^b	3.47
Particulate matter (PM ₁₀)	Annual	50 ^b	1.02
	24 hours	150 ^b	2.27
	Annual	80 ^b	2.86
Sulfur dioxide (SO ₂)	24 hours	365 ^b	42.2
	3 hours	1,300 ^b	136
Mandated by Tennessee			
Total suspended particulates (TSP)	Annual	60 ^c	3.37 ^d
	24 hours	150 ^c	30.16
Gaseous fluorides (as HF)	1 month	0.8 ^c	0.2
	1 week	1.6 ^c	0.3
	24 hours	2.9 ^c	<0.6
	12 hours	3.7 ^c	<0.6
	8 hours	250 ^c	0.6

^a Model results.

^b Federal standard.

^c State standard or guideline.

^d No State standard.

[Text deleted.]

Note: Ozone, as a criteria pollutant, is not directly emitted or monitored by the candidate sites. Pollutant concentrations shown for Y-12 include other ORR operations.

Source: 40 CFR 50; DOE 1995i; OR LMES 1995c; TN DEC 1994a; TN DHE 1991a.

Potential measures to minimize noise impacts on workers include providing workers in noisy environments with appropriate hearing protection devices that meet OSHA standards. As required, noise levels would be measured in worker areas, and a hearing protection program would be conducted.

4.3.4.3 Water Resources

Environmental impacts associated with the operation of metal blending facilities would affect surface and groundwater resources. Water resource requirements and discharges provided in Section 2.2.2.2 were used to assess impacts to surface water and groundwater. The discussion of impacts are provided for each site separately.

Oak Ridge Reservation

Surface Water. Operation of metal blending facilities would require an additional 12 million l/yr (3.2 MGY) of water or less than 1 percent of the Clinch River's average flow (132 m³/s [4,647 ft³/s]).

The wastewater generated from the operations would be conveyed to the Y-12 Central Pollution Control Facility or the Y-12 West End Treatment Facility for processing. Approximately 11.7 million l/yr (3.1 MGY) of additional treated sanitary and wastewater would be discharged to East Fork Poplar Creek, not exceeding 1 percent of the creek's average flow (1.3 m³/s [45 ft³/s]), and therefore these discharges should not result in any downstream flow

effects. Releases to the Clinch River would represent less than 1 percent of the average flow ($132 \text{ m}^3/\text{s}$ [$4,661 \text{ ft}^3/\text{s}$]). All discharges would be monitored to comply with NPDES permit limits. Stormwater runoff from the main plant area would be collected in detention ponds, monitored, and if acceptable, discharged to nearby streams. Stormwater runoff from outside the main plant area, except those facilities that require onsite management controls by regulations such as sanitary treatment plants and landfills, would be discharged to nearby streams.

The Y-12 Plant is currently involved with the remediation of East Fork Poplar Creek under CERCLA because East Fork Poplar Creek was contaminated by past releases from the Y-12 Plant. Future NPDES permits would be written after review of the current water quality and how it is affected by discharges from Y-12. In addition, discharges from the treatment plants are required to meet all permit limits, therefore, no impacts to water quality are expected.

Domestic wastewater from the Y-12 Plant, including some sinks in process areas, are discharged to the sanitary sewer for treatment under an industrial user's permit. This permit allows the Y-12 Plant to discharge wastewater to be treated at the Oak Ridge Wastewater Treatment Facility through two main sewage lines into the Oak Ridge sanitary sewer system in accordance with effluents limitations,

monitoring requirements, and other conditions set forth in the permit. Radiological and nonradiological parameters are monitored for these sewer lines.

The proposed area for the metal blending facility lies outside the 100- and 500-year floodplains.

Groundwater. No groundwater would be used at Y-12 given the plentiful surface water supplies; therefore, no impacts on groundwater levels are expected.

Groundwater quality would not be affected by the operation of metal blending facilities. Because there would be no direct discharge of process wastewater to groundwater, and wastewater would be treated at either the Y-12 Central Pollution Control Facility or at the Y-12 West End Treatment Facility before being released to surface waters, no impacts on groundwater quality are expected. Groundwater contamination at ORR has been the result of past practices that have since been discontinued. The Y-12 Plant implements a Comprehensive Groundwater Monitoring Plan to monitor groundwater flow, quality, and content by sampling groundwater monitoring wells across the facility. Water quality of East Fork Poplar Creek would be protected by the extensive Y-12 efforts to protect water quality.

[Text deleted.]

4.3.4.4 Biotic Resources

The operation of the metal blending facilities at the Y-12 Plant is not expected to have significant adverse impacts on biotic resources. Operations would be conducted within existing buildings. There would be no loss of habitat; therefore, no impacts on wildlife are anticipated. The increase of water intake or discharges to site streams would be minimal (less than 1 percent of stream flow rates), which would cause no impacts to aquatic resources.

Impacts to wetlands would not occur since these resources are not located in the proposed area of activities. No Federal- or State-listed threatened or endangered species would be affected.

4.3.4.5 Socioeconomics

This section describes the potential socioeconomic impacts resulting from operation of facilities for the blending of HEU to 0.9-percent LEU as metal at the Y-12 Plant at ORR. Any upgrades/modifications required at either site would be accomplished by the site's existing workforce, and no new jobs would be created; however, operation of the blending facility at

either location would require additional employees, creating some minor economic benefits to the region.

Operation of the metal blending facilities would require 72 employees. Some workers needed for operation are currently employed at these sites; however, to assess the maximum potential impact of this alternative, the analysis assumes that both candidate sites would need 72 additional employees to blend HEU to LEU as metal. The project would also create 184 indirect jobs within the ORR REA (Figure 4.3.4.5-1). The regional unemployment rate would decrease from 4.9 to 4.8 percent at ORR. Earnings also would increase slightly in the region as a result of the project.

Available labor in each region is sufficient to fill the new jobs created directly by the project and additional indirect jobs; therefore, it is unlikely that there would be any in-migration to the region. Without any project-related in-migration, there would be no additional demands for housing units, community services, or transportation. The effects on housing and community services in the ROI would be the same as for the No Action Alternative.

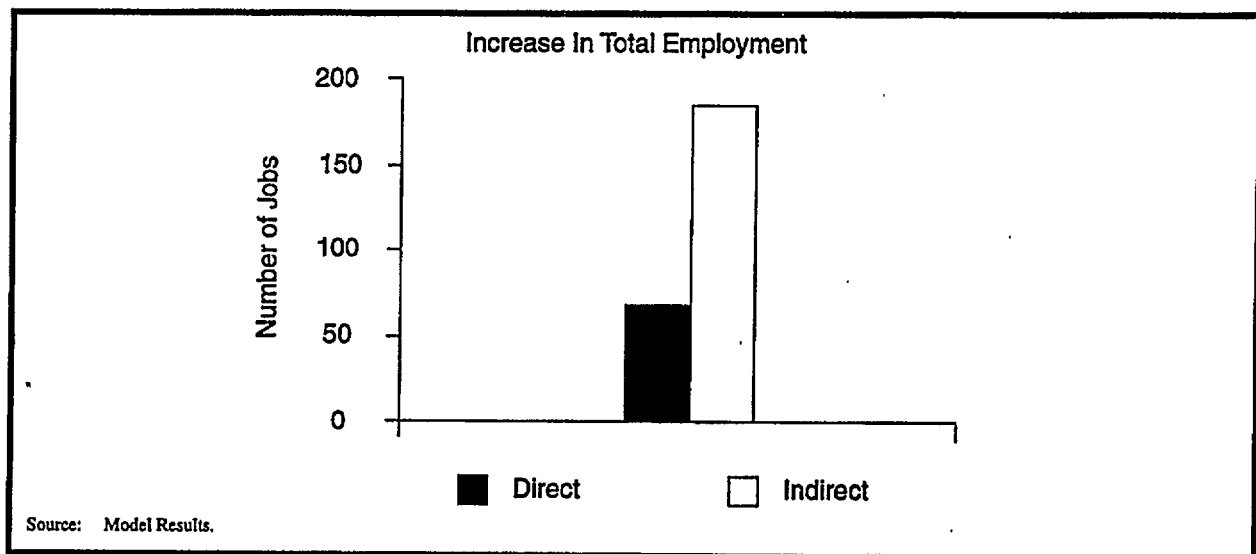


Figure 4.3.4.5-1. Increase in Total Project-Related Employment (Direct and Indirect) at Oak Ridge Reservation Resulting From Blending 3.1 t/yr Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Metal.

4.3.4.6 Public and Occupational Health

This section describes the radiological and hazardous chemical releases and their associated impacts resulting from either the normal operation or potential accidents for blending HEU to 0.9-percent LEU as metal at ORR. Summaries of the radiological impacts to the public and workers associated with normal operation at ORR are presented in Tables 4.3.4.6-1 and 4.3.4.6-2. Chemical impacts to these same groups are presented in Table 4.3.4.6-3, and accident impacts are presented in Table 4.3.4.6-4. (Further supplementary information is presented in Appendix E.)

Normal Operation

Radiological Impacts. Incremental radiological impacts to the public resulting from normal operation of the metal blending facilities at ORR are presented

in Table 4.3.4.6-1. The impacts from total site operations, including the metal blending facilities, also are given in the table. These impacts are provided to demonstrate compliance with applicable regulations governing total site operations. To put operational doses into perspective, a comparison is made with the doses from natural background radiation. As shown in Table 4.3.4.6-1, the dose to the MEI of the public from annual total site operations is within radiological limits and would be 2.0 mrem at ORR. The annual population dose within 80 km (50 mi) would be 28.1 person-rem at ORR.

Incremental and total site doses to onsite workers from normal operations are given in Table 4.3.4.6-2. The annual incremental dose to involved workers at the blending and conversion facility would be 110 mrem to the average worker and 7.9 person-rem to the entire facility workforce (DOE 1993n:7; NRC 1995b; OR LMES 1995c).

Table 4.3.4.6-1. Potential Radiological Impacts to the Public Resulting From Normal Operation of Blending 3.1 t/yr Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Metal

Receptor	ORR	
	Incremental	Total Site ^a
Maximally Exposed Individual (Public)		
From atmospheric release pathway (mem/yr) ^b	2.6×10^{-2}	1.4
From total liquid release pathway (mrem/yr) ^b	0	0.6
From atmospheric and liquid release pathways combined (mrem/yr) ^b	2.6×10^{-2}	2
Percent of natural background ^c	8.8×10^{-3}	0.68
Risk of fatal cancer per year of site operation ^d	1.3×10^{-8}	1.0×10^{-6}
Population Within 80 km		
From atmospheric release pathways dose (person-rem/yr) ^e	0.11	26.1
From total liquid release pathways (person-rem/yr) ^e	0	2
From atmospheric and liquid release pathways combined (person-rem/yr) ^e	0.11	28.1
Percent of natural background ^c	3.6×10^{-5}	9.2×10^{-3}
Number of fatal cancers per year of site operations ^d	5.5×10^{-5}	1.4×10^{-2}

^a Includes impacts from all site operations that are expected to continue during the interim of blending process operations (reference environment).

^b The applicable radiological limits for an individual member of the public from total site operations are 10 mrem/yr from the air pathways, 4 mrem/yr from the drinking water pathway, and 100 mrem/yr from all pathways combined. [Text deleted.]

^c Annual natural background radiation levels at ORR: the average individual receives 295 mrem; and the population within 80 km receives 306,000 person-rem.

^d Representative of material processed at the rate of 3.1 t/yr.

^e Proposed 10 CFR 834 (58 FR 16268) includes the requirement that the contractor who operates a DOE site notify DOE if the potential annual population dose exceeds 100 person-rem from all pathways combined.

Source: Appendix E.

Table 4.3.4.6-2. Potential Radiological Impacts to Workers Resulting From Normal Operation of Blending 3.1 t/yr Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Metal

Receptor	ORR
Involved Workforce^a	
Average Worker	
Dose (mrem/yr) ^b	110
Risk of fatal cancer per year of site operation	4.4×10^{-5}
Total	
Dose (person-rem/yr)	7.9
Number of fatal cancers per year of site operation	3.2×10^{-3}
Noninvolved Workforce^c	
Average worker	
Dose (mrem/yr) ^b	4
Risk of fatal cancers per year of site operation	1.6×10^{-6}
Total	
Dose (person-rem/yr)	68
Number of fatal cancers per year of site operation	2.7×10^{-2}
Total Site Workforce^d	
Dose (person-rem/yr)	76
Number of fatal cancers per year of site operation	3.0×10^{-2}

^a The in-plant (involved) worker is a worker associated with operations of the blending and conversion facilities. The estimated number of in-plant workers is 72.

^b The radiological limit for an individual worker is 5,000 mrem/yr (10 CFR 835).

^c The noninvolved worker is a worker on site but not associated with operations of the blending and conversion facilities. The estimated number of noninvolved workers is 16,928 at ORR.

^d The total site workforce is the summation of the in-plant worker impacts and the noninvolved worker impacts. The estimated number of workers in the total site workforce is 17,000 at ORR.

Source: DOE 1993n:7; NRC 1995b; OR LMES 1995c.

[Text deleted.]. All resulting doses are within radiological limits and are well below levels of natural background radiation.

Hazardous Chemical Impacts. Hazardous chemical impacts to the public resulting from blending HEU to 0.9-percent LEU as metal at Y-12 are presented in Table 4.3.4.6-3. The increment of potential adverse noncancer health effects and cancer risks posed by this action at the various sites is shown, followed by the total risk (that is, incremental risk plus no action contribution to risk) at each unique site. There are no cancer risks for those sites where there are no known carcinogens among the hazardous chemicals released, and therefore the slope factor is 0 for all chemicals.

The incremental and site total HIs for the public MEI contributed by this alternative are all less than 1.0 at Y-12 showing that all hazardous chemical concentrations are below EPA's concentrations

(Reference Concentrations). The cancer risks to the MEI of the public are below the value of 1.0×10^{-6} (40 CFR 300.430).

The incremental and total site HIs for the onsite workers contributed by this alternative are less than 1.0 at Y-12. [Text deleted.] The incremental and total cancer risks to the workers at Y-12 are below the value of 1.0×10^{-6} .

Facility Accidents

A set of potential accidents have been postulated for which there may be releases of radioactivity that could impact noninvolved onsite workers and the offsite population. A set of accident scenarios was selected to represent bounding cases. In assessing the bounding accident scenarios for the conversion and blending facility, the following parameters were evaluated: 1) material at risk, 2) energy sources (fires, explosions,

Table 4.3.4.6-3. Potential Hazardous Chemical Impacts to the Public and Workers Resulting From Blending 3.1 t/yr of Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Metal at Y-12

Receptor	Incremental ^a	Total Site ^b
Maximally Exposed Individual (Public)		
Hazard index ^c	2.24×10^{-4}	3.97×10^{-2}
Cancer risk ^d	9.25×10^{-16}	9.25×10^{-16}
Worker Onsite		
Hazard index ^e	8.82×10^{-4}	0.155
Cancer risk ^f	2.40×10^{-14}	2.40×10^{-14}

^a Incremental=contribution only from single activity at the site.

^b Total=total site includes any background emissions that would be present in the absence of site operations plus site emissions that exist at the present time.

^c Hazard index for MEI=sum of individual hazard quotients (noncancer adverse health effects) for MEI.

^d Lifetime cancer risk for MEI=(emissions concentrations) x (0.286 [converts concentrations to doses]) x (slope factor).

^e Hazard index for workers=sum of individual hazard quotients (noncancer adverse health effects) for workers.

^f Lifetime cancer risk for workers=(emissions for 8-hour) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).

Source: OR LMES 1995c.

earthquakes, and process design-related events), 3) barriers to release, and 4) protective features of the facility.

No toxic chemicals were identified among the materials at risk. The accident scenarios that were considered included a tornado, straight winds, an aircraft crash, a truck crash, nuclear criticality, process related accidents, and an evaluation basis earthquake. With the exception of the filter fire (with continuous exhaust flow) all of the accident scenarios that are considered potentially bounding can be initiated by the evaluation basis earthquake; therefore, it is concluded that the evaluation basis earthquake would result in the worst-case atmospheric release of radioactivity and hazardous chemicals. The evaluation basis earthquake is assumed to initiate the nuclear criticality and other release scenarios.

In a filter fire accident, it is assumed that a fire occurs that releases all the uranium in the bag filters, traps, and HEPA filters to the atmosphere in a matter of minutes. The quantity of material assumed to be released is 0.15 kg (0.33 lb) of HEU.

In an earthquake-induced criticality accident, it is assumed that storage racks containing multiple critical masses of uranium metal are damaged directly by seismic shaking and indirectly by falling debris. Safe spacing is lost and moderators added as water from the

fire system. This results in the possible formation of one or more critical assemblies. In an accidental criticality, it is assumed that 1.0×10^{19} fissions occur prior to reaching a stable, subcritical condition and that all material releases occur within a 2-hour period (NRC 1979b: 3.34-4). The amount of radioactive material released as fission products created by the nuclear criticality is 46,000 Ci of krypton isotopes, 65,000 Ci of xenon isotopes, and 1,600 Ci of iodine isotopes.

In the evaluation basis earthquake accident scenario, it is assumed that the building collapses, resulting in ruptured containers, piping, and tanks releasing uranium mixtures, water, and reactive liquids. This is assumed to result in the release of 2.1 millicurie (mCi) of uranium isotopes (48 percent of the activity is U-232 and 33 percent of the activity is U-234).

The accidents that release radioactivity and their consequences are presented in Table 4.3.4.6-4. The accident with the highest consequences is a criticality. If it were to occur (in conjunction with the evaluation basis earthquake), there would be an estimated 2.5×10^{-3} latent cancer fatalities in the general population within 80 km (50 mi) of Y-12. For the MEI, there would be an increased likelihood of latent cancer fatality of 3.3×10^{-5} at ORR. Based on the spatial distribution of noninvolved workers located at

ORR, the estimated number of latent cancer fatalities in the worker population is 2.1×10^{-2} . The accident risks, reflecting both the probability of the accident occurring and the consequences, also are shown in the tables. For the general population, MEI, and noninvolved worker population, the fatal cancer risks are 2.5×10^{-7} , 3.3×10^{-9} , and 2.1×10^{-6} per year, respectively. In addition to the potential impacts to noninvolved workers, there are potential impacts to involved workers, who are located in the facilities analyzed in this EIS. Potential radiological consequences to the involved worker range to several thousand rem in the case of a criticality. The combined evaluation-basis earthquake and earthquake-induced criticality would probably result in fatal doses to the involved worker. Furthermore, fatalities to the involved workers would be expected as a result of the building collapse (from the earthquake) and the criticality (OR DOE 1994d:6-26, 6-27). [Text deleted.]

[Table deleted.]

4.3.4.7 Waste Management

Operation of facilities required to blend surplus HEU to 0.9-percent LEU as metal would affect current waste management practices at ORR. There is no spent nuclear fuel, HLW, or TRU waste associated with the blending; however, generation of low-level, mixed low-level, hazardous, and nonhazardous wastes would increase. This section summarizes the impacts on treatment, storage, and disposal facilities at ORR resulting from blending HEU to 0.9-percent LEU as metal.

The blending process would result in the generation of low-level, mixed low-level, and nonhazardous wastes (as presented in Table 2.2.2.2-2). Table 4.3.4.7-1 presents the increased sitewide waste generation resulting from the blending process. [Text deleted.] Table 2.2.2.2-2 also provides the resultant waste volume after treatment (effluent) using a proposed treatment scheme as outlined in Figures

Table 4.3.4.6-4. Accident Consequences and Risk of Major Accidents for Blending 3.1 t/yr Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Metal at Y-12

Accident Description	Filter Fire	Earthquake Induced Criticality	Evaluation Basis Earthquake Scenario
Accident frequency (per year)	10^{-3a}	10^{-4b}	10^{-4b}
Consequences			
Noninvolved Workers			
Dose (person-rem)	11	38	14
Latent cancer fatalities per accident	4.2×10^{-3}	1.5×10^{-2}	5.6×10^{-3}
Risk (cancer fatalities per year)	4.2×10^{-6}	1.5×10^{-6}	5.6×10^{-7}
Maximally Exposed Individual			
Dose (rem)	1.0×10^{-2}	5.1×10^{-2}	1.4×10^{-2}
Latent cancer fatality per accident	5.2×10^{-6}	2.6×10^{-5}	6.8×10^{-6}
Risk (cancer fatality per year)	5.2×10^{-9}	2.6×10^{-9}	6.8×10^{-10}
Population Within 80 km (1,040,000 in 2010)			
Dose (person-rem)	1.5	3	1.9
Latent cancer fatalities per accident	7.7×10^{-4}	1.5×10^{-3}	9.7×10^{-4}
Risk (cancer fatalities per year)	7.7×10^{-7}	1.5×10^{-7}	9.7×10^{-8}

^a Accident annual frequency estimated in the range of 10^{-4} to 10^{-2} , 10^{-3} chosen for use in comparing alternatives.

^b Accident annual frequency estimated in the range of 10^{-5} to 10^{-3} , 10^{-4} chosen for use in comparing alternatives. The probability or frequency of a criticality induced by an earthquake would be lower.

Source: Results shown are derived from accident analyses; see Appendix E.5.

4.3.4.7-1 through 4.3.4.7-3. Liquid LLW from decontamination could go through a uranium recovery process first. The liquid effluent then would go to a radioactive wastewater treatment facility. The resultant sludge would be immobilized for disposal as solid LLW, and the treated effluent would be discharged through a permitted outfall. The sump collection wastes from general plant operations would be precipitated and filtered in a radioactive liquid waste treatment facility. The resultant sludge would be immobilized for disposal, and the treated effluent would be discharged through a permitted outfall. Solid LLW generated by the blending process would consist of lab wastes, decontamination solids, graphite, slag, brick and insulation, oil filters, air sampling filters, HEPA filters, and miscellaneous contaminated solids. Decontamination solids could go through a uranium recovery process before being packaged for disposal. All other solid LLW could be compacted and immobilized as appropriate to meet the waste acceptance criteria of an onsite or offsite LLW disposal facility. The solid LLW radiological content would include U-232, U-234, U-235, U-236, and U-238. Liquid include mixed LLW consisting of spent solvents and lab waste could be incinerated, thus eliminating the hazardous constituent. The resultant ash could be immobilized and packaged for disposal as solid LLW. Other solid mixed LLW would consist of contaminated gloves and wipes. After

compaction, they would be packaged for storage until sufficient volume had accumulated for disposal in an offsite RCRA-permitted facility.

Liquid nonhazardous waste such as sewage wastewater would be treated and disposed of using current site practices and facilities. Solid nonhazardous waste would primarily consist of solid sanitary waste, trash, waste paper, scrap metal, air filters, personnel respirators, plastic bags, and gloves. Nonrecyclable portions of this waste would be disposed of in a permitted landfill per site practice.

The wastes quantified in Table 4.3.4.7-1 result only from the process of blending 12.52 t/yr of impure U/A1 metal alloy that contains 3.1 t of HEU to 0.9-percent LEU as metal. The end product from this process will be an LEU waste that may be staged temporarily at ORR in existing facilities until there is sufficient quantity for cost-effective shipment to the disposal site(s). The blending process of 3.1 t of HEU will result in approximately 260 t/yr of LEU waste (OR LMES 1995c:1). Using a loading of 90-kg (55-gal) drum, it can be determined that this blending process will result in approximately 610 m³/yr (21,500 ft³/yr) of LEU waste. In a DOE LLW disposal facility, this waste would require from 0.07 to 0.18 ha/yr (0.18 to 0.46 acres/yr) of space, based on usage factors for DOE facilities that range from 3,300 to

Table 4.3.4.7-1. Estimated Annual Waste Volumes Generated for Blending 3.1 t/yr Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Metal at Oak Ridge Reservation

Waste Category	No Action (m ³)	With Metal Blending (m ³)	Increase (Percent)
Low-Level			
Liquid	2,576	2,856	11
Solid	8,030	8,575	7
Mixed Low-Level			
Liquid	84,210	84,219	<1
Solid	960	960	0
Hazardous			
Liquid	32,640	32,641	<1
Solid	1,434	1,434	0
Nonhazardous			
Liquid	1,743,000	1,754,664	<1
Solid	52,730	53,200	1

Source: OR LMES 1995c; Tables 3.3.10-1, 3.3.10-2, and 3.3.10-3.

8,600 m³/ha (47,200 to 123,000 ft³/acre), respectively. The annual and total quantities of the LEU "end product" (as LLW) for disposal and transportation of the LLW to a representative disposal site are discussed in Sections 4.4 and 4.5. The following discussion of ORR for this blending alternative present analyses for the wastes generated by the blending process and not the ultimate management of the LEU waste end-product.

Depending on the alternative, the total amount of HEU that potentially would be blended to LEU as waste could vary between 30 t (15 percent of surplus inventory) and 200 t (100 percent of surplus inventory) as stated in Chapter 2. Multiple sites would be used for all alternatives (except no action) necessary to blend the surplus inventory to LLW, as explained in Chapter 2.

Oak Ridge Reservation. Current waste generation rates and treatment, storage, and disposal capacities are presented for ORR in Tables 3.3.10-1 through 3.3.10-3. Liquid and solid LLW treatment facilities at ORR would not be greatly impacted due to this action. The liquid LLW treatment facility at ORR has the capacity to treat the 11-percent increase in liquid LLW generated. Solid LLW generated at ORR would be compacted, smelted, and incinerated offsite and then stored onsite pending the completion of a proposed LLW Class II facility that is due to be operational in 2002. The amount of solid LLW generated by this action that will eventually be transferred to the LLW disposal facility would be 364 m³/yr (12,850 ft³/yr). Assuming a usage factor of 3,300 m³/ha (47,200 ft³/acre) (OR DOE 1995e:1), this waste will require 0.11 ha/yr (0.27 acre/yr) in the new LLW Class II facility. The small increase in liquid mixed LLW could be handled by the onsite mixed LLW treatment facility. This action would increase liquid sanitary waste generation to 1,755,000 m³/yr (464 MGY). The onsite facility has a capacity of 4,930,000 m³/yr (1,300 MGY) so the increase is within the facility capacity. The increase in solid sanitary waste would not greatly reduce the design life of the onsite landfill. The nonhazardous recyclable solid wastes generated by this process could be easily accommodated in the site's current recycling practices.

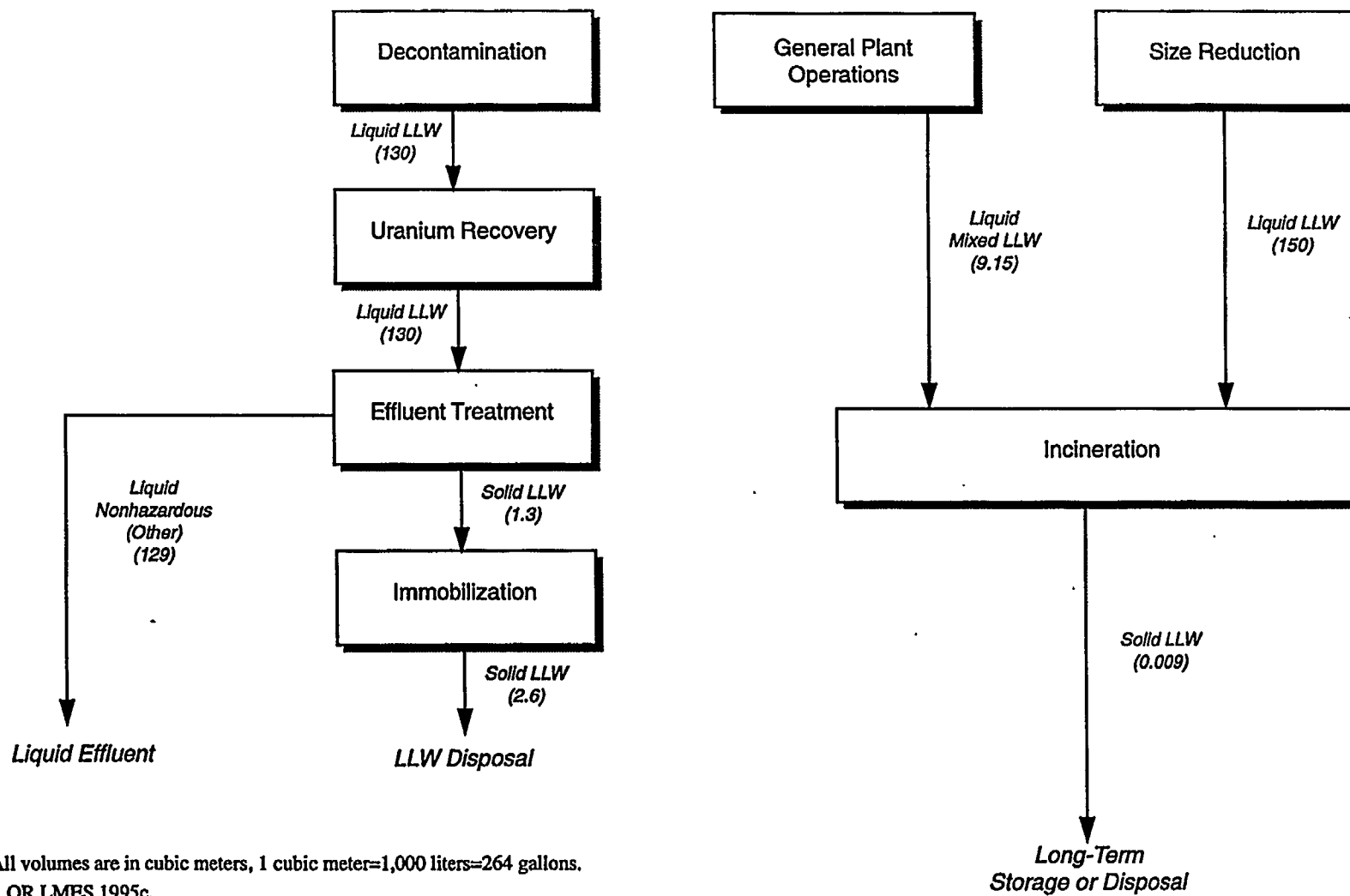
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4.3.5

CONVERSION OF THE BLENDSTOCK FROM URANIUM HEXAFLUORIDE TO URANIUM OXIDE AT GENERAL ELECTRIC WILMINGTON

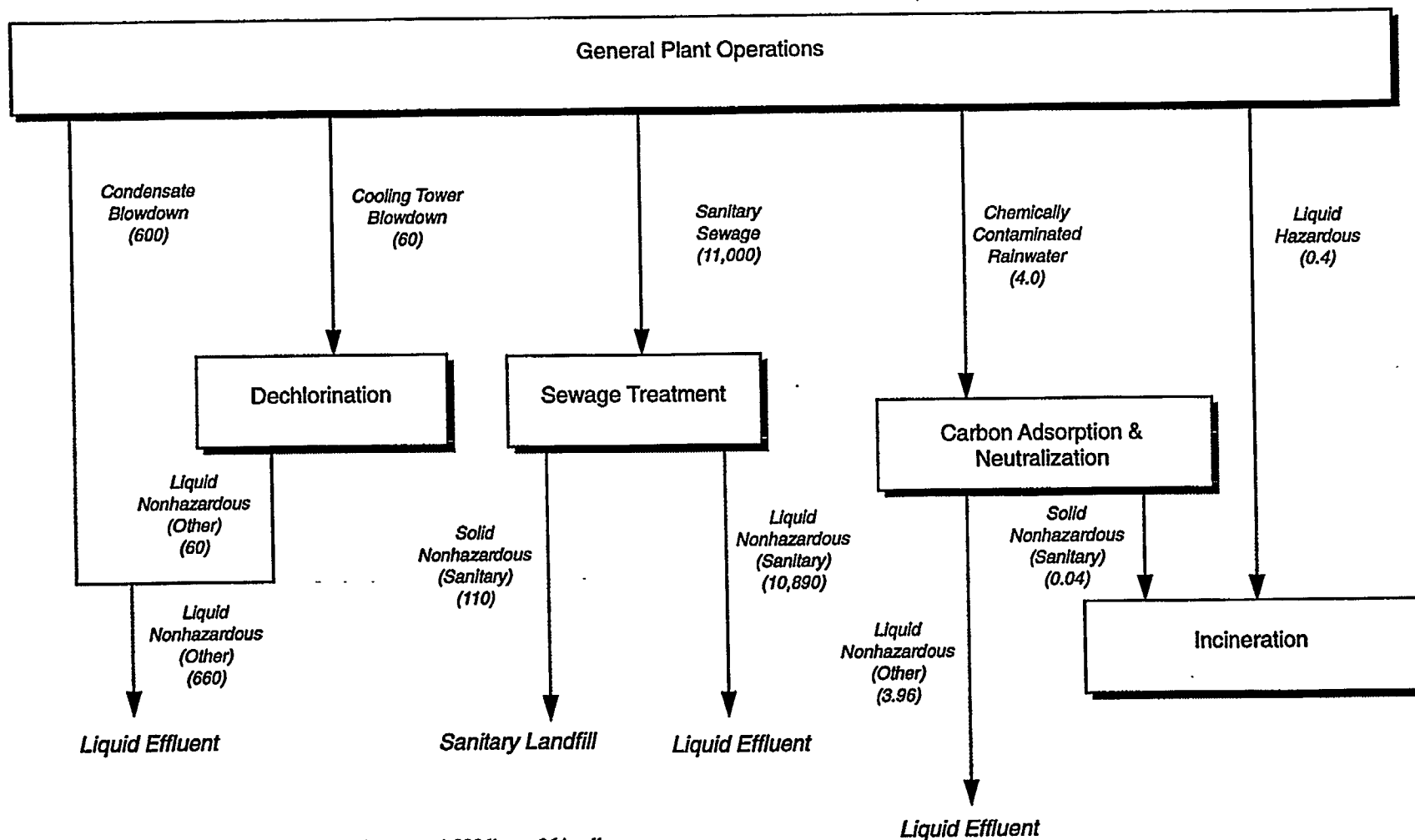
The General Electric (GE) Nuclear Fuel Plant at Wilmington, North Carolina operates under NRC License SNM-1097, Docket Number 70-1113. The most recent NEPA document addressing its operations is the *Environmental Impact Appraisal for Renewal of Special Nuclear Material License No. SNM-1097* (NUREG-1078, June 1984). This section discusses the potential impacts associated with the conversion of the UF₆ blendstock to uranium oxide blendstock at GE Wilmington. The conversion of UF₆ to uranium oxide is a process that GE Wilmington has performed for over 25 years and currently performs under its NRC license. This license permits GE Wilmington to process up to 50 t of U-235 contained in uranium to a maximum, nominal enrichment of 6-percent U-235 in the form of UF₆, UO₂, U₃O₈, and other intermediate forms characteristic of LEU fuel fabrication activities (GE 1995b:I-1.3). GE Wilmington is authorized in their most recent license application to convert UF₆ to uranium oxide by the ammonium diuranate process, the GE UF₆ to UO₂ conversion process, and a dry conversion process (GE 1995b:I-1.6).

Operation of the GE Wilmington plant has had no adverse effects on land use in the past, and there are no plans to expand the facility. Therefore, no additional impacts to land resources, pre-historic and historic sites, Native American resources, floodplains, or wetlands will result from this action. Any future construction at GE Wilmington would be a business decision, and is not proposed or necessitated by the proposed action or alternatives. For blending HEU to 4-percent LEU, up to 207 t of NU blendstock in a UF₆ form could be shipped to GE Wilmington representing approximately 17 percent of the average yearly quantity of UF₆ converted at GE Wilmington. For blending HEU to 0.9-percent LEU, up to 219 t of DU blendstock in a UF₆ form could be shipped to GE Wilmington, representing approximately 18 percent of the average yearly quantity of UF₆ converted at GE Wilmington. These values assume that all blendstock for the UNH blending process would be UF₆ and therefore represent maximum values. A more likely scenario is that only small portion of the blendstock would be UF₆ and therefore the amount of material



Note: All volumes are in cubic meters, 1 cubic meter=1,000 liters=264 gallons.
Source: OR LMES 1995c.

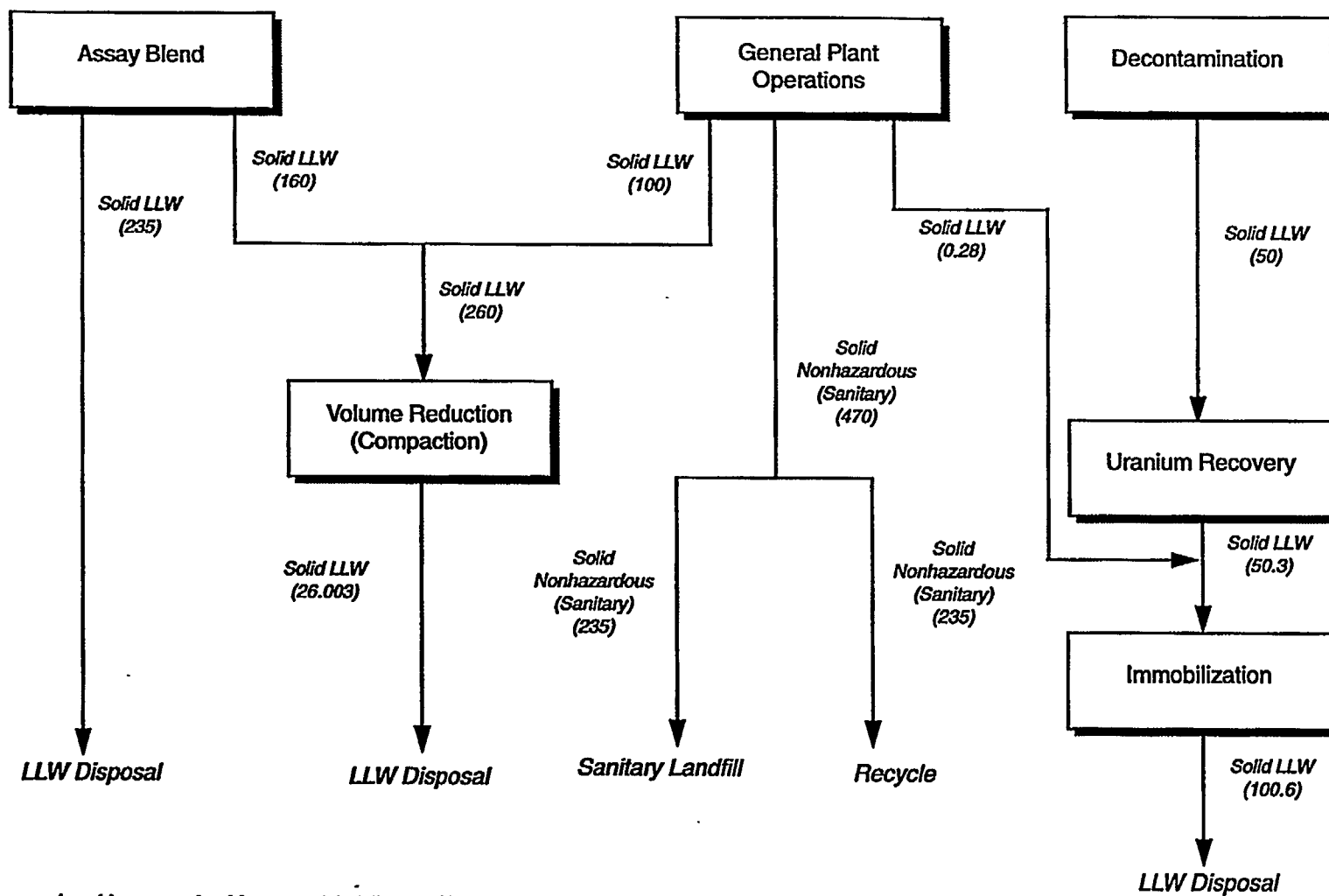
Figure 4.3.4.7-1. Radioactive Liquid Waste Management for Conversion and Blending 3.1 t/yr of Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Metal.



Note: All volumes are in cubic meters, 1 cubic meter=1,000 liters=264 gallons.

Source: OR LMES 1995c.

Figure 4.3.4.7-2. Liquid Nonradioactive Waste Management for Conversion and Blending 3.1 t/yr of Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Metal.



Note: All volumes are in cubic meters, 1 cubic meter=1,000 liters=264 gallons.
Source: OR LMES 1995c.

Figure 4.3.4.7-3. Solid Waste Management for Conversion and Blending 3.1 t/yr of Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Metal.

that GE Wilmington would process would be much less.

Operation of facilities to blend HEU to 4-percent or 0.9-percent LEU as UNH would potentially affect site infrastructure—mainly electric power, fuel, and water/steam supply. As a result of the site infrastructure already existing at GE Wilmington, minimal effects in terms of the percentage increase in site infrastructure resource usage would result from the operation of the UF₆ conversion facility. Normal operation of GE Wilmington's fuel fabrication facility is not expected to have a significant effect on nonradiological air quality parameters. The North Carolina Department of Natural Resources and Community Development has reviewed GE's process discharges and issued permits to operate air pollution control equipment for the different release points. Operation of the UF₆ conversion facility in an existing building would result in little or no change in the contribution to noise levels at offsite receptors (GE NRC 1984a:60). Direct effects on surface waters are controlled by requirements of the NPDES permit and NRC license. GE's liquid effluent during the 1978 to 1982 period met the applicable limits for radiological and nonradiological constituents at the point of release. Because these discharge limits are low, and because the waste stream is very small compared to the average flow of the Northeast Cape Fear River, significant impacts to the river are not expected (GE NRC 1984a:61-62). Continued operation of the GE plant would have no significant impacts on terrestrial vegetation or wildlife other than the continued use of potential habitat by industrial facilities. Because no new construction on underdeveloped areas is planned, there is no additional loss of habitat. No threatened or endangered species are known to frequent the area,

and none should be affected by continued plant operation (GE NRC 1984a:62).

No upgrades or modifications of this facility would be required by the proposed action or alternatives. Any future consideration would be a business decision and is not necessitated by this proposed action or alternatives. In the event upgrades or modifications are undertaken, they would be performed by the existing site workforce, and no new jobs would be created. Because the operation is consistent with current operation, no additional employees are assumed to be needed to convert LEU from UF₆ to U₃O₈. During normal operations at GE Wilmington, the dose to the MBI is estimated to be 0.13 mrem/yr. This dose is about 14 percent of the EPA standard. Therefore, normal operation of the GE plant has resulted in maximum annual doses to the nearest resident that are well below the limits outlined in 40 CFR 190. The 1980 population within a 80-km (50-mi) radius of the plant is almost 370,000 people. During normal operations at GE Wilmington, the cumulative dose to the surrounding population within 80 km (50 mi) of the site is approximately 0.15 person-rem/yr. The natural background dose rate is 82 mrem/yr along the North Carolina coastal plain, which results in a population dose within 80 km (50 mi) around GE of 30,000 person-rem. The total body dose of 0.15 person-rem is negligible compared to the background dose (GE NRC 1984a:62-65). GE Wilmington would dispose of the solid low-level waste offsite. The State of North Carolina is a member of the Southeast Compact, which utilizes an NRC/State of South Carolina-licensed burial facility operated by Chem Nuclear Systems, Inc., in Barnwell, South Carolina. GE Wilmington would utilize this facility to dispose of this waste (GE 1995b:I-1.8-I-1.9).

4.4 INTERSITE TRANSPORTATION

For this EIS, intersite transportation is the transport of radioactive materials between sites in truckload shipments by DOE safe secure trailer (SST) or commercial conveyance. The SSTs are vehicles designed specifically for the safety and security of the cargo. These radioactive materials receive continual surveillance and accountability by DOE's Transportation Safeguards Division at Albuquerque, New Mexico. Shipments by SSTs are accompanied by armed guards and are monitored by a tracking system. Using a computer code, the health risks were calculated for transportation between sites of various forms of surplus HEU, NU or DU blendstock, LEU for commercial use, and LEU for waste disposal (as LLW) as defined for each alternative. Quantities of materials, distance between sites, material forms, handling procedures, transportation modes, types of packaging, and other shipment criteria are identified for each alternative and used for the transportation analyses. Results obtained (health risk impacts) are presented in terms of potential radiological and nonradiological impacts to transport crew members and the public under accident and accident-free scenarios.

4.4.1 METHODOLOGY

This section presents the methodology used in this EIS to determine the potential risks from intersite transportation. A comparison of potential transportation impacts for the alternatives considered and the cumulative annual impacts also are presented. Impacts are presented for the No Action Alternative and for all the blending alternatives.

Under the No Action Alternative, surplus HEU would remain in storage at the Y-12 Plant and would not be blended to LEU; thus, there would be no transportation risk.

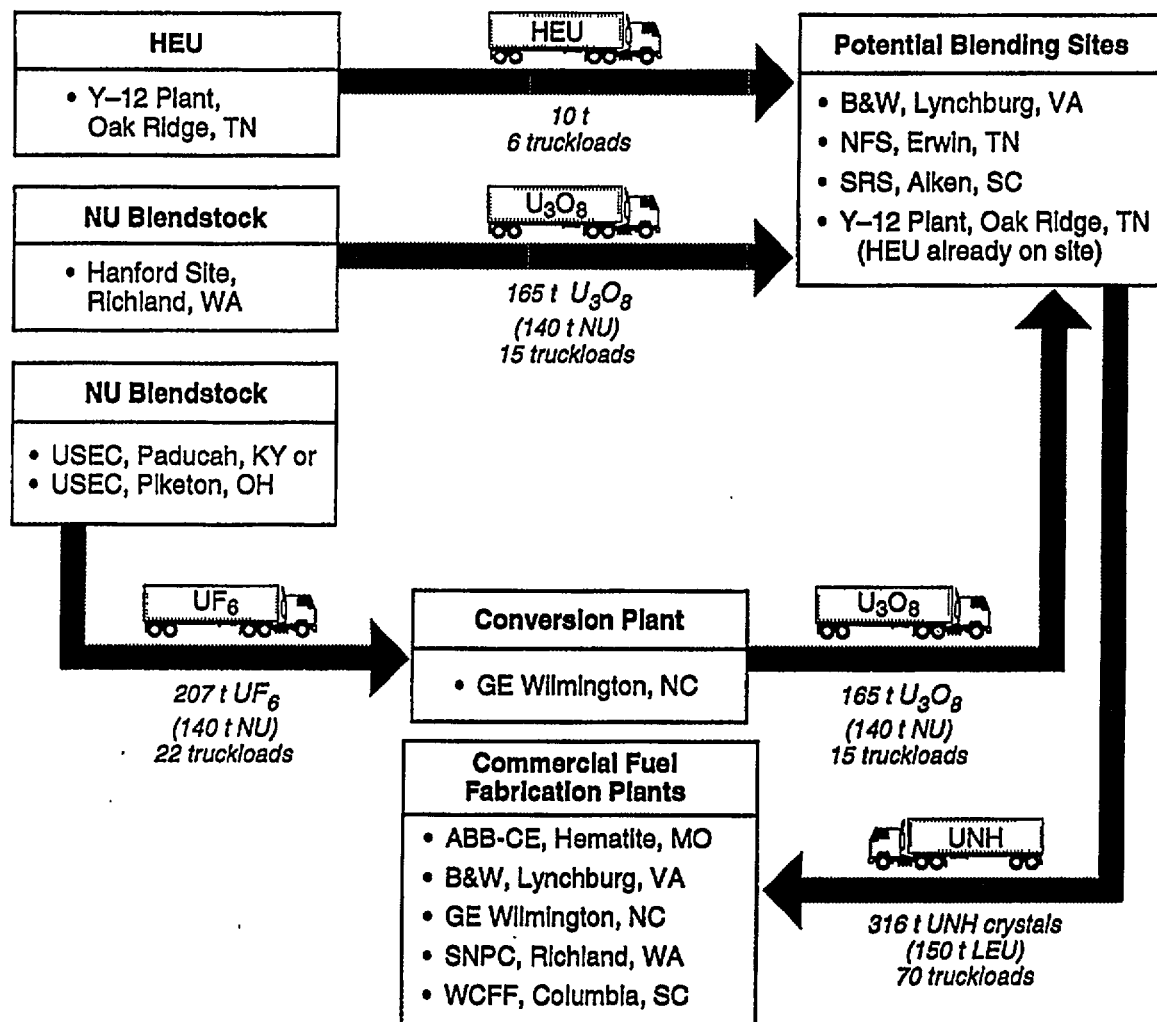
Under alternatives associated with blending HEU to LEU for commercial use, surplus HEU would be transported by DOE-owned SSTs from the Y-12 Plant to one or more of the three candidate blending sites: SRS, B&W, or NFS. There would be no SST transportation risk at ORR since both surplus HEU and the blending facilities are located at the Y-12 Plant.

For blending HEU to 4-percent LEU as UNH (crystals), HEU would be transported in SSTs from the Y-12 Plant to SRS, B&W, or NFS.¹ The NU blendstock material in either oxide or UF₆ form would be transported from its sources to these blending sites (or to a conversion plant first in the case of NU in UF₆ form). The blended LEU product then would be shipped to a fuel fabrication plant as UNH (crystals) for use in commercial reactor fuel. An overview of the transportation modes associated with blending HEU to LEU as UNH (crystals) is presented in Figure 4.4.1-1.

For blending HEU to 4-percent LEU as UF₆, HEU would be transported in SSTs from the Y-12 Plant to B&W or NFS. The NU blendstock material in UF₆ form could be transported from its sources to these blending sites (in this case NU in UF₆ form does not need conversion to oxide because blending would occur in UF₆ form). The blended LEU product then would be shipped to a fuel fabrication plant as UF₆ for use in commercial reactor fuel. An overview of the transportation modes associated with blending HEU to LEU as UF₆ is presented in Figure 4.4.1-2.

For the blending processes, NU or DU blendstock would be required. NU blendstock (in oxide or UF₆

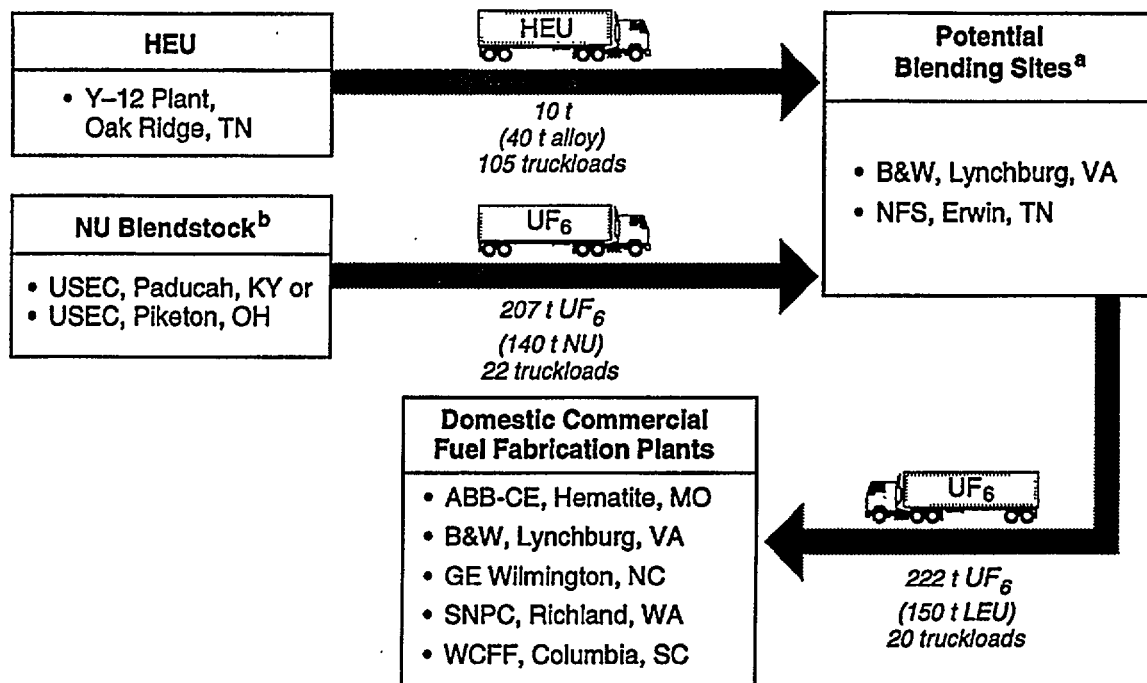
¹ The approximately 20 t of HEU solutions at SRS could be blended to approximately 617 t of 4-percent UNH solution. The UNH solution could be transported from SRS using NRC-certified liquid cargo tank trailers (for example, DOE-specification MC-312, NRC Certificate of Compliance Number 509) or other DOT-approved Type A fissile packaging to one of several offsite facilities that could perform the solidification of the material. SRS is close to existing commercial fuel fabrication facilities in both South Carolina and North Carolina that could perform the solidification. The South Carolina facility (97 km [61 mi] from SRS) is assumed as a representative solidification site for the purpose of analysis only (it is not proposed at this time). This project (transportation for solidification of 617 t of LEU solution) would require about 350 truckloads of 16,800 kg (37,040 lb) of UNH solution (includes 1.8 t uranium per truckload). The impact from nonradiological would be about 3.7×10^{-3} fatalities for the entire project. The risk from radiological accidents is estimated to be 3.9×10^{-5} fatalities for the entire project. The impacts from normal (accident-free) transportation, including handling and air pollution would be about 1.9×10^{-2} fatalities. The combined impact for the total campaign would be about 2.3×10^{-2} fatalities. The location of such offsite solidification and the extent of any transportation may depend in part on future proposals concerning the off-spec material as SRS and/or construction of a UNH solidification facility. Additional NEPA review would be conducted, as appropriate.



Note: ABB-CE=Alstom Brown-Boveri Combustion Engineering; SNPC=Siemens Nuclear Power Corporation; WCFF=Westinghouse Columbia Fuel Facility.
Source: Derived from OR LMES 1995b.

2840/HEU

Figure 4.4.1-1. Annual Transportation for the Production of Uranyl Nitrate Hexahydrate Crystals From 10 t/yr Highly Enriched Uranium for Commercial Use.



^a For this EIS, the new UF₆ site is assumed to be located at B&W or NFS.

^b Transportation risk calculations are based on existing availability of blendstock. LEU (1.5-percent assay) could be used in lieu of NU; the cumulative risk would be similar.

Note: ABB-CE=Asea Brown-Boveri Combustion Engineering; B&W=Babcock & Wilcox; GE=General Electric; HEU=highly enriched uranium; LEU=low-enriched uranium; NFS=Nuclear Fuel Services; SNPC=Siemens Nuclear Power Corporation; UF₆=uranium hexafluoride; USEC=United States Enrichment Corporation; WCFF=Westinghouse Columbia Fuel Facility.

Source: Derived from OR LMES 1995a.

2548/HEU

Figure 4.4.1-2. Annual Transportation for the Production of Uranium Hexafluoride From 10 t/yr Highly Enriched Uranium for Commercial Use.

form) could be provided from several Government or commercial sources and transported directly to the blending site. For this EIS, DOE's Hanford Site in Washington is used as a representative source for NU (in oxide form) because its location is farthest from the potential blending sites. DU blendstock (in metal form) would be obtained from the Fernald Environmental Management Project in Fernald, Ohio (Fernald), the Y-12 Plant, or SRS. Fernald is used as a representative site for assessing the transportation of DU (metal) blendstock. NU blendstock (in UF_6 form) would be provided by representative sources from the USEC Paducah Gaseous Diffusion Plant at Paducah, Kentucky (USEC Paducah), or the USEC Portsmouth Gaseous Diffusion Plant at Piketon, Ohio (USEC Piketon). The NU blendstock (as UF_6) may need to be transported to a site where it would be converted to uranium oxide as U_3O_8 . The GE Nuclear Fuel Plant at Wilmington, North Carolina, is used as a representative conversion site for this analysis. The U_3O_8 then would be shipped to the selected blending site (Y-12, SRS, B&W, or NFS) for the UNH blending process. For blending HEU to LEU as UF_6 , the UF_6 blendstock would not need to be converted to U_3O_8 and would be transported directly from USEC Paducah or USEC Piketon to the UF_6 blending site, B&W or NFS.

When HEU is blended down to 4-percent LEU for commercial use, it would require transportation, either as UNH crystals or UF_6 , to one of five potential domestic fuel fabrication plants: Asea Brown-Boveri Combustion Engineering at Hematite, Missouri (ABB-CE); B&W; GE Wilmington; Siemens Nuclear Power Corporation at Richland, Washington; and Westinghouse Columbia Fuel Facility at Columbia, South Carolina.

Under alternatives associated with blending HEU to LEU for disposal as waste, surplus HEU would be transported to SRS, B&W, and NFS. Blending at Y-12 would not require offsite transportation of surplus HEU.

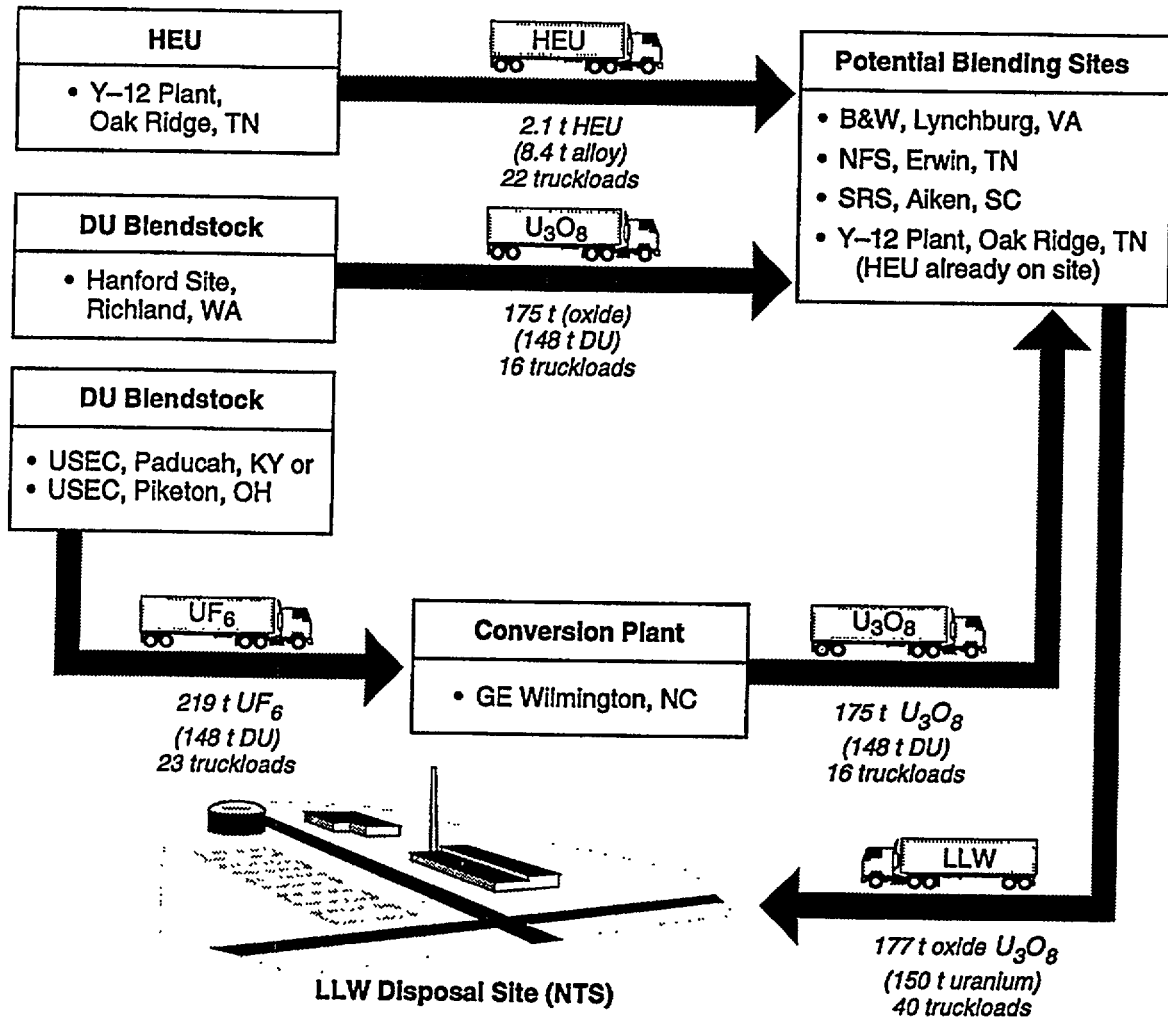
For blending HEU to 0.9-percent LEU as UNH, the transportation modes would be similar to the UNH blending alternative explained above except for the destination of the LEU product. In this alternative, the blended LEU product would be converted to oxide form and shipped to an LLW disposal site. For the analyses in this EIS, the transportation route from

blending sites to NTS was used as a representative route. NTS is one of only two DOE LLW sites accepting offsite DOE waste. NTS has accepted similar waste forms for disposal in the past. Non-DOE sites take only a limited amount of DOE waste. Use of NTS as a representative route for transportation risk analyses does not imply that this site necessarily would be the LLW disposal site; other DOE sites—and although less likely non-DOE sites—in lieu of or in combination with NTS could be the disposal site(s). An overview of the transportation modes associated with blending HEU to 0.9-percent LEU as UNH (converted to oxide form prior to transportation for disposal as waste) is presented in Figure 4.4.1-3.

Blending HEU to 0.9-percent LEU as metal would be performed at the Y-12 Plant. As in the UNH alternative, no off-site transportation would be required for metal blending at the Y-12 Plant. The DU blendstock (metal) would be shipped from Fernald, which is used as the representative route for the analyses in this EIS. The resulting LEU product would be converted to oxide form and transported to an LLW disposal site, which is NTS for the purposes of the analyses in this EIS. An overview of the transportation modes associated with blending HEU to 0.9-percent LEU as metal (converted to oxide form prior to transportation for disposal as waste) is presented in Figure 4.4.1-4.

Actual and projected inventories of HEU, NU, and DU materials were used for the transportation risk analysis. The additional annual projected quantities of LLW generated from the project are estimated. It is assumed that HEU would be stabilized and packaged for shipment at the originating site (Y-12 Plant) to meet DOT, NRC, and DOE requirements.

Unit risk factors were developed for each form of material to estimate the potential risk of transporting truckload shipments by SST or commercial conveyance over intersite routes. These factors were used, in conjunction with distance and the number of shipments, to estimate potential radiological and nonradiological impacts to transport crew members and the public. The unit risk factors were determined by using average rural, suburban, and urban populations along each route; an average container or truckload of material; and the risk per kilometer for each of the material forms.

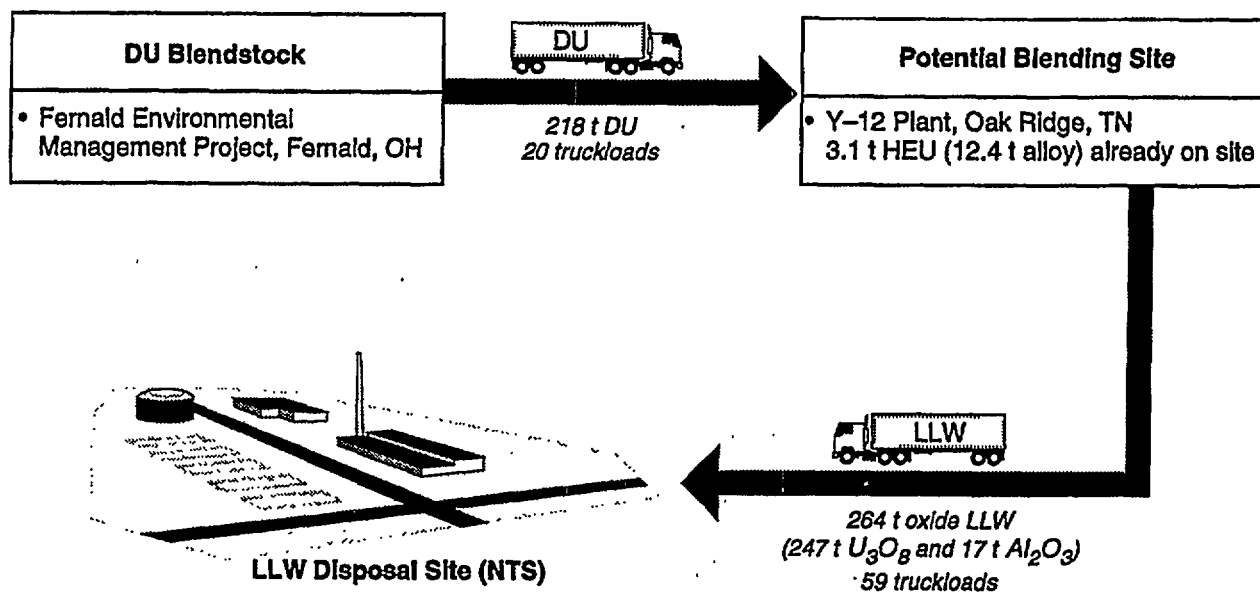


Note: NTS=Nevada Test Site

Source: Derived from OR LMES 1995d.

Figure 4.4.1-3. Annual Transportation for the Production of Low-Enriched Uranium (Oxide) as Waste for Disposal From 2.1 t/yr Highly Enriched Uranium Under the Uranyl Nitrate Hexahydrate Alternative.

2547/HEU



Note: NTS=Nevada Test Site; Al_2O_3 = aluminum oxide.
Source: Derived from OR LMES 1895c.

2549/HEU

Figure 4.4.1-4. Annual Transportation for the Production of Low-Enriched Uranium (Oxide) as Waste for Disposal From 3.1 t/yr Highly Enriched Uranium Under the Metal Alternative.

The health risks were analyzed using the RADTRAN Version 4 computer code in conjunction with the projected inventories of material forms (nuclide composition) and the most direct routing between sites for each alternative. The potential annual health risk impacts were tabulated and presented for both accident and accident-free scenarios. Appendix G presents a summary of the RADTRAN transportation risk analysis methodology.

4.4.2 AFFECTED ENVIRONMENT

Included in the evaluation are the vehicle loading, transport, and unloading of 200 t of surplus HEU. The HEU would be placed in DOT-specification packaging and transported in a maximum of 105 truckloads per year. In addition, the risks of loading, transporting by commercial truck, and unloading the blendstock materials (oxide, metal, and UF_6), the UNH and UF_6 reactor fuel feed material, and the LEU LLW (oxide) are assessed. To produce reactor fuel feed material, the blendstock material would consist of a maximum of 165 t/yr of U_3O_8 (140 t NU) or a maximum of 207 t/yr of less than 3-percent NU blendstock in the UF_6 form (140 t NU) to be shipped from USEC Paducah or USEC Piketon to either the blending site or conversion plant, depending on the blending process. For the UNH reactor fuel feed material alternative, approximately 165 t/yr of U_3O_8 could be shipped from GE Wilmington to the blending plant. To produce LLW using UNH blending, approximately 175 t/yr of U_3O_8 (148 t DU) or approximately 219 t/yr of depleted UF_6 (148 t DU) converted to U_3O_8 would be required, depending on the blending process. To produce LLW using metal blending, approximately 218 t/yr of DU metal would be required. The blending process would produce approximately:

- 316 t/yr of UNH (crystals) reactor fuel feed material, including 150 t (90 kg per container, 3,511 containers, 70 shipments)
- 222 t/yr of UF_6 reactor fuel feed material, including 150 t LEU (2,275 kg per container, 20 shipments)
- 177 t/yr of U_3O_8 (oxide) LLW from UNH blending, including 150 t of uranium (90 kg per container, 40 shipments)

- 264 t/yr of LLW (oxide) from metal blending, including 247 t U_3O_8 and 17 t aluminum oxide (Al_2O_3) (90 kg per container, 59 shipments)

All of the health risks from transporting these materials are calculated on an annual basis.

Although DOE has experienced traffic accidents related to the intersite transport of radioactive materials, there has never been a traffic accident involving a release of radioactive material causing injury or death during transportation.² Risk impacts were determined using standard analysis criteria and accepted computer models.

The Department of Energy's unclassified radioactive and other hazardous materials are transported by commercial carrier (truck, rail, or air). Special nuclear materials, such as HEU, are transported by DOE-owned and -operated SSTs.

4.4.2.1 Site Transportation Interfaces for Hazardous Materials

The existing transportation modes that serve each of the four candidate blending sites and the links to those modes for the intersite transport of hazardous materials are summarized in Table 4.4.2.1-1. Although hazardous materials could be transported by rail, truck, air, and barge modes, the materials in this EIS would be transported only by truck. HEU would be transported exclusively by SST. Radioactive blendstock, LEU fuel feed material, and LLW would be transported by certified commercial truck carriers. There would be no rail, barge, or air

² DOE's hazardous material (radioactive and nonradioactive) shipments are small compared to the large shipment volume from non-DOE hazardous material transport activities. DOT estimates that approximately 3.6 billion t/yr of regulated hazardous materials are transported and that approximately 500,000 movements of hazardous materials occur each day (Public Law 101-615, Section 2(1)). There are approximately 2 million annual shipments of radioactive materials involving about 2.8 million packages, which represents about 2 percent of the annual hazardous materials shipments. Most radioactive shipments involve small or moderate quantities of material in relatively small packages. In comparison, the DOE Nuclear Weapons Complex ships about 6,200 radioactive packages (commercial and classified) annually among its sites. DOE's annual shipments of radioactive packages represent less than 0.3 percent of all radioactive shipments in the United States.

Table 4.4.2.1-1. Transportation Modes and Comparison Ratings for the Candidate Sites

Site	Onsite Railroad Service	Nearest Interstate Highway (km)	Distance to Airport for Cargo Shipments (km)	Barge Service	Possible Weather Delays ^a	Overall Level of Transport Service
ORR	Yes	6	61	Yes	Minimal	Good
SRS	Yes	48	32	Yes	Minimal	Good
B&W	Yes	108	18	No	Minimal	Good
NFS	No	2	66	No	Minimal	Good

^a DOE Transportation Safeguards System shipments.

Source: BW 1995b:1; DOE 1991j; NFS 1995b:2.

shipments; thus, there would be zero impacts from transportation by these modes.

In the *Nuclear Weapons Complex Reconfiguration Site Evaluation Panel Report* (October 1991), two sites (ORR and SRS) were given a comparative rating based on the strengths and weaknesses of their transportation services (DOE 1991j:7). For consistency, the rating methodology and evaluation procedures established by the Nuclear Weapons Complex Reconfiguration Site Evaluation Panel also were applied to the B&W and NFS sites.

4.4.2.2 Packaging

Approved packaging refers to a container and all accompanying components or materials necessary to perform its containment function. Packages used by DOE for hazardous materials shipments are either certified to meet specific performance requirements or built to specifications described in the DOT hazardous materials regulations. For relatively low-level radioactive materials, DOT-specification, Type A packagings are used. These packagings are designed to retain their contents under normal transportation conditions. More sensitive radioactive materials shipments, including HEU and UF₆, require the use of highly sophisticated Type B packaging, which is designed to prevent the release of contents under all credible transportation accident conditions.

For this assessment, a stainless steel model 6M, Type B packaging, which resembles a 55-gal drum, would be used for HEU shipments in SSTs from the Y-12 Plant to the blending site. A more detailed description of the 6M packaging is given in Appendix G. DOT-specification, Type B packaging would also be

used for transporting NU (as UF₆) blendstock and UF₆ fuel feed material by commercial conveyance. Historically, the use of Type B packaging has demonstrated that an accidental release of radioactive material is unlikely. Type A packaging would be used for transporting NU (as U₃O₈), DU (as U₃O₈ and metal), U₃O₈ blendstock, UNH (crystals) fuel feed material, and LLW (oxide).

4.4.2.3 Safe Secure Transport

Nuclear materials, which include HEU, require special measures to ensure physical security and protection from radiation during transportation. DOE's Transportation Safeguards Division, located at Albuquerque, New Mexico, has the responsibility to provide for the transport of these materials. The Transportation Safeguards Division was established in 1975 and has accumulated over 112 million km (70 million mi) of over-the-road experience with no accidents causing a fatality or release of radioactive material. DOE's transportation vehicle, the SST is a specially designed part of an 18-wheel tractor-trailer truck that incorporates various deterrents to prevent unauthorized removal of the cargo. The SST is designed to protect the cargo, in the event of an accident, through superior structural characteristics and a highly reliable cargo tie down system similar to that used in aircraft. The thermal characteristics of the SST allow the trailer to be totally engulfed in a fire without incurring damage to the cargo. The tractor-trailers and their escort vehicles are equipped with communications, electronic, radiological monitoring, and other equipment, which further enhance en route safety and security.

Armed nuclear materials couriers, who are Federal officers, accompany each shipment containing special nuclear material. These couriers are trained in tractor-trailer driving, electronic and communication systems operation, and are authorized by the *Atomic Energy Act* to carry firearms and make arrests in the performance of their duties. They drive the tractor-trailers, escort vehicles, and operate the communications and other convoy equipment. The couriers must meet periodic qualification requirements for firearms, physical fitness, and driving proficiency. They also must pass an annual medical examination and are subject to random drug and alcohol testing.

The Department of Energy makes every effort to ensure that its convoys travel at safe speeds and do not travel during inclement weather. Should the convoys encounter adverse weather, provisions exist for them to seek secure shelter at previously identified facilities. A liaison program provides State and local law enforcement officers information on what actions to take to assist one of these vehicles should it be involved in an accident. A DOE control center maintains an emergency contact directory of Federal, State, and local response organizations located throughout the contiguous United States.

4.4.3 ENVIRONMENTAL CONSEQUENCES

4.4.3.1 No Action

Under no action, surplus HEU would remain in storage at the Y-12 Plant; therefore, there would be no transportation or transportation risk.

4.4.3.2 Surplus Highly Enriched Uranium Disposition Alternatives

This section describes the health effects from the intersite transportation of surplus HEU, LEU, and LLW based on the results of RADTRAN analyses. Impacts are presented for each disposition alternative: blend to 4-percent LEU as UNH (crystals) or as UF₆ reactor fuel feed material or blend to 0.9-percent (oxide) LLW.

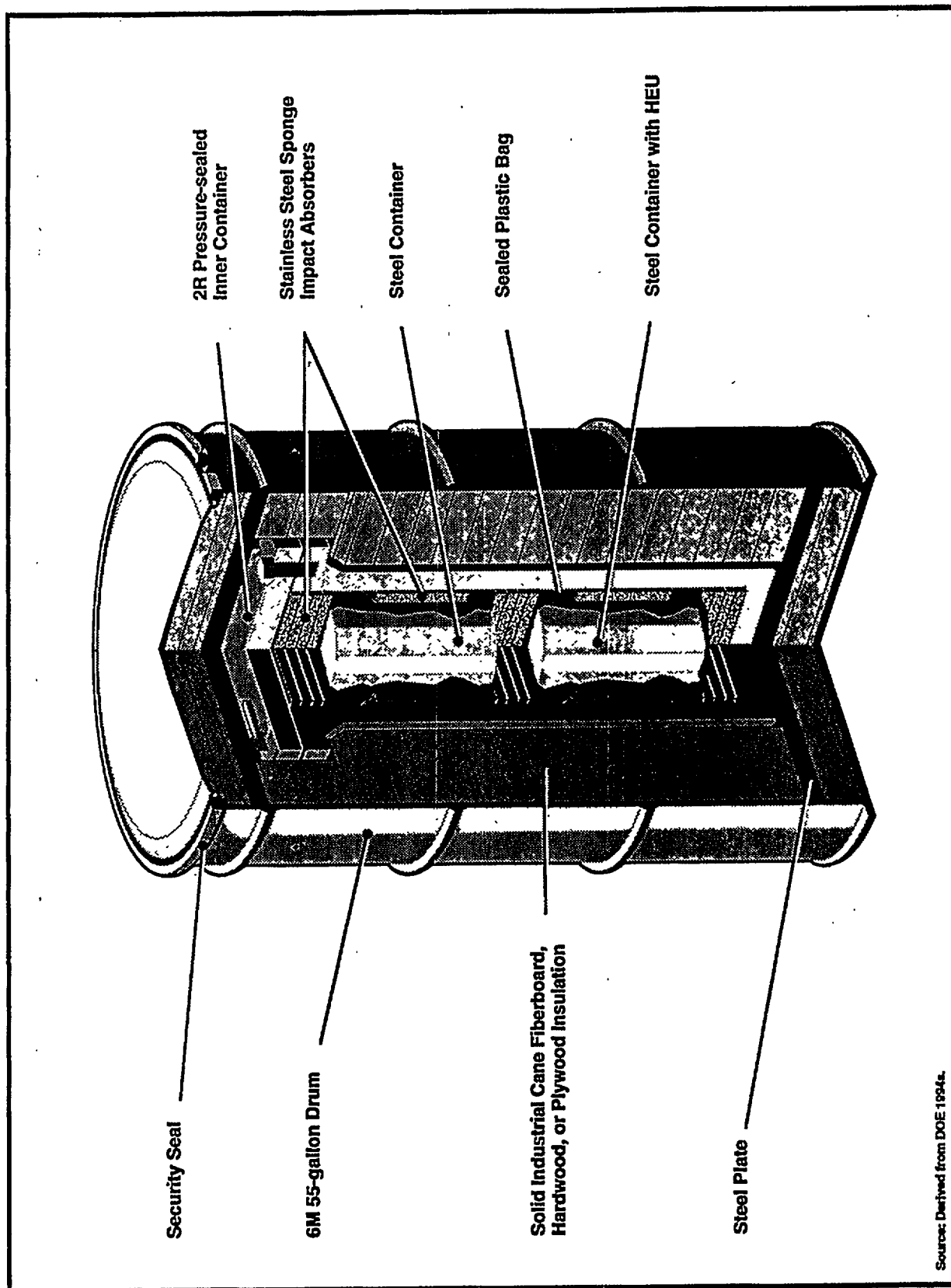
Transport of Highly Enriched Uranium from the Y-12 Plant to Babcock & Wilcox, Nuclear Fuel Services, and Savannah River Site

The shipments of HEU would consist of an average of approximately 10 t/yr of HEU as metal and metal alloys, oxides, compounds, and nitrates. The maximum amount of HEU to be shipped would not exceed 10 t/yr to any one site; therefore, this rate was used for transportation risk calculations. HEU would be shipped in cans (similar in size and shape to a coffee can); the cans would be placed in a Type 2R inner container (a containment barrier); and the Type 2R inner container then would be placed in a 6M, Type B (DOT specification), stainless steel packaging, which resembles a 55-gal drum. Up to three cans could be placed in a 6M packaging. A maximum of 20 t/yr could be shipped to multiple sites; however, no more than 5,000 packages would be shipped per year to any one blending site. Figure 4.4.3.2-1 shows a representative 6M packaging array for HEU considered in this assessment.

Eight 6M packages could be placed in a cargo restraint transporter (CRT), which is a method of palletizing the cargo and constraining it during transport. A diagram of a typical CRT, loaded with 6M packages, is shown in Figure 4.4.3.2-2. Each SST carries up to six CRTs. The 6M package testing is described in Appendix G.

Onsite Transportation Impacts at the Y-12 Plant. Highly enriched uranium that would be blended at the Y-12 Plant would be transported between facilities by means of Blue Goose vehicles (trucks for onsite transport of HEU). There has never been a Blue Goose accident that resulted in the release of radioactive material. The Y-12 EA includes information on a postulated bounding criticality accident. This criticality could result in yields of 1.0×10^{19} fissions (spike and total). Radiation exposure would vary from greater than 600 rem at the site of the accident to 50 rem at 36.6 m (120 ft). This would produce acute radiation sickness within a radius of up to 36.6 m (120 ft) with a probable fatality rate of less than 5 percent. At distances less than 15.2 m (50 ft), the fatality rate would be 100 percent (OR DOE 1994d:6-55).

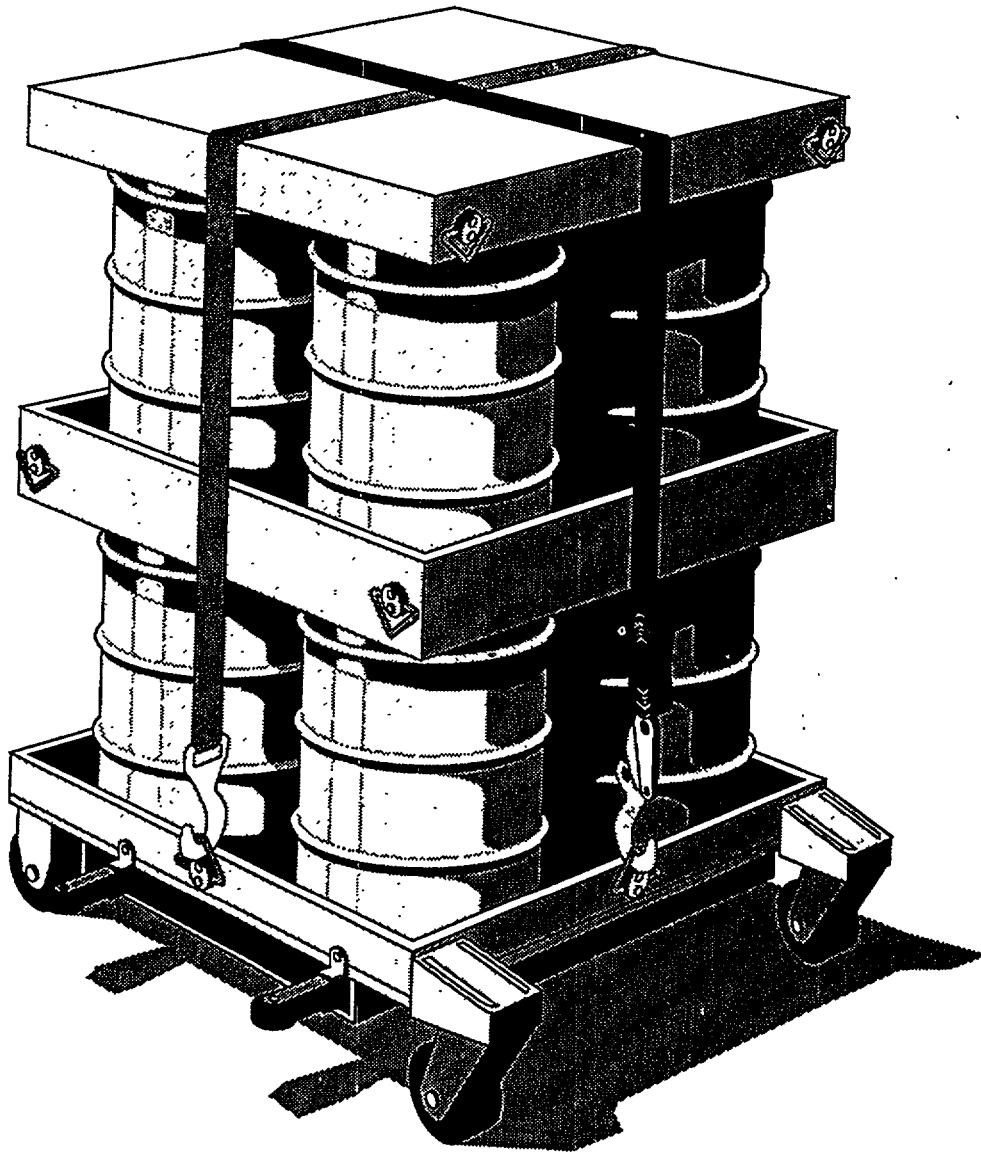
For HEU that would be blended at sites other than the Y-12 Plant, HEU would be removed from storage,



Source: Derived from DOE 1994a.

2632/HEU

Figure 4.4.3.2-1. A Representative 6M Packaging Array.



Source: Derived from SNL 1988b.

2631/HBU

Figure 4.4.3.2-2. A Typical Cargo Restraint Transporter Configured with 6M Containers.

loaded onto SSTs at the storage facility, and transported away from the Y-12 Plant. There would be no other onsite transportation. Onsite risks would be limited to loading operations. Onsite over-the-road risks are included in the analysis of the SST transportation to the blending plant.

The potential health risks associated with the loading of SSTs at the Y-12 Plant are based on the following criteria:

- There would be an average of 10 t/yr of HEU material to be transported to blending facilities for 5 years, or 50 t of HEU total, in the initial campaign. Following this initial campaign, the remaining 150 t of surplus HEU inventory would continue to be transported at the same postulated rate of 10 t/yr (for a total of 200 t over a 40-year period, depending on the alternative). All subsequent shipments of additional surplus HEU that may be generated by the Nuclear Weapons Complex are calculated against this same criterion of 10 t/yr.
- Up to six CRTs would be loaded into each SST.
- HEU would be transferred directly from storage into the SSTs within the Y-12 Plant's protected area.
- It would take about 8 hours to prepare and stage HEU for each SST load. This includes preparation of documentation, radiation surveys, and actual loading. Most of the transportation-related radiation exposure would occur during the 15 minutes it would take for two cargo handlers to load each CRT into an SST. The complete transfer of all CRTs into 105 SSTs would take about 840 hrs/yr, collectively.
- The SSTs would mount flush with the storage facility shipping dock for ease of loading.

- Only fork lifts would be utilized to move the material from storage, place it in the CRTs, and load the SSTs for shipment.
- There would be only two cargo handlers. Thirty-five other workers would be within 50 m (164 ft) of the loading site. This includes 10 people involved in the loading of the SSTs (warehouse, health physics, and nuclear material control and accountability personnel). The other workers are not subdivided into Government or civilian personnel.

The Y-12 Plant has no record of a transportation-related accident or incident involving special nuclear materials (ORR 1995a:10). Because of the low speeds involved in transferring HEU from the storage facility to the SSTs and the rigid design standards for Type B packagings to withstand an accident (for example, a fork lift puncture), it is extremely unlikely that a Type B package would be breached. It is extremely unlikely that a package could be damaged so severely that both the inner and outer containers would fail, that some fraction of the contents would be dispersed, and that a worker or citizen fatality would occur as a result of an accident during the transfer of HEU.

Accident-free radiological exposures to cargo handlers, other workers, and the public while transferring HEU from the storage facility to an SST are summarized in Table 4.4.3.2-1. The exposed groups of workers are the two cargo handlers and 35 other workers within a 50-m (164-ft) radius. Because the loading would occur onsite in a secured area away from the general public, there would be no exposure to the public under accident-free conditions.

The highest dose to an average individual would be received by a cargo handler and is estimated to be a total of 0.03 rem over the duration of the loading activity. The collective dose to the two cargo handlers is estimated to be 0.06 person-rem. Using the worker dose-to-risk conversion factor of 4×10^{-4} cancer fatalities per person-rem multiplied by the collective dose, 2.4×10^{-5} latent cancer fatalities are estimated. This means there is a probability of 2.4×10^{-5} or about 1 chance in 42,000 that any excess cancer fatalities would occur among the workers as a result of accident-free exposure during HEU transfer activities.

The risk of fatalities resulting from additional air pollution caused by the operation of equipment is too small to measure.

Impacts From Transportation of Surplus Highly Enriched Uranium From the Y-12 Plant to Savannah River Site, Babcock & Wilcox, and Nuclear Fuel Services. HEU material would be transported to the blending sites by DOE-owned and -operated SSTs. Typical SST transport routes were selected for the analysis. The exact routes, when determined, would be classified for security and theft/diversion purposes. The routes selected for analyses maximize the use of interstate highways, as established by INTERSTAT (a computer routing code). Rural, suburban, and urban population data were used to define the properties and characteristics along the routes. Credit was not given for the special shielding provided by the SST walls, which provide additional protection and decrease radiation exposure.

The RADTRAN computer code, developed by SNL, was used to determine radiological risks. Release fractions are characterized in RADTRAN in terms of eight accident severity categories, which are determined by a combination of crush force and 982 °C (1,800 °F) or hotter fire durations. For this analysis, the release fraction was assumed to be zero for accident Categories I through VII. The release fractions for Category VIII accidents were conservatively estimated to be 0.1 for the strictly controlled SST shipments of HEU and 1.0 for the transport of other radioactive materials. The Category VIII accident is one with crush forces of 2.2×10^6 newtons (2.2×10^{11} dynes) or greater, a 982 °C (1,800 °F) fire duration of 1.5 hrs or more, or a combination of force and fire of similar destructive

capability. The physical states (characteristics that would affect the fractions that are airborne, inhaled, and deposited in the lungs) and the chemical forms were estimated. The methodology for conducting the transportation risk analysis is described in greater detail in Appendix G.

Annual radiological risks from the transportation of surplus HEU from the Y-12 Plant to the blending sites are shown in Appendix G, Table G.1-5. The maximum impact would be to the public, and the highest collective dose to the public is estimated to be 3.7 person-rem, resulting in 1.9×10^{-3} fatal cancers from transportation to B&W for the UF₆ blending alternative.

Nonradiological risks of highway transportation (those risks that are caused by added air pollution or by highway accidents not involving a radiological release) are summarized in Appendix G, Table G.1-5. The risk of fatalities resulting from additional air pollution caused by the operation of trucks was estimated on the basis of 1.0×10^{-7} fatalities per km of travel in urban zones (SNL 1982a:11). Accident fatalities incurred by the crew and public were estimated on the basis of fatality rates per kilometer of travel in rural, suburban, and urban zones. These rates are as follows: 1) for occupational risks per km, 1.5×10^{-8} rural, 3.7×10^{-9} suburban, and 2.1×10^{-9} urban; and 2) for public risks per km, 5.3×10^{-8} rural, 1.3×10^{-8} suburban, and 7.5×10^{-9} urban (SNL 1986a:167). The nonradiological risks are greater than those from radiological effects; however, they are no greater than similar nonradiological risks experienced by the vehicle population as a whole.

A summary of potential radiological and nonradiological annual health impacts from the

Table 4.4.3.2-1. Accident-Free Radiological Exposure From Transferring Materials per Shipment Between the Storage Site and a Truck

Types of Population ^a	Population Size	Dose	Latent Cancer Fatality
Cargo Handlers			
Collective population	2	6.0×10^{-2} person-rem	2.4×10^{-5}
Average individual dose	1	3.0×10^{-2} rem	1.2×10^{-5}
Other Workers			
Collective population	35	4.0×10^{-3} person-rem	1.6×10^{-6}
Average individual dose	1	1.2×10^{-4} rem	4.6×10^{-8}

^a Under normal (accident-free) conditions, the public does not receive a measurable dose.

Source: RADTRAN model results.

transportation of HEU from the Y-12 Plant to the blending sites is shown in Table 4.4.3.2-2. The risk due to handling (loading and unloading) is higher than the relative contribution from transportation risk, which is comparable at each site. This handling risk is added to the transportation risk in the analysis of determining health impacts. The highest impact is estimated to be 1.3×10^{-2} potential fatalities from transporting HEU to B&W under the UF₆ blending alternative for commercial reactor fuel feed material. Additional information is included in Appendix G.

Table 4.4.3.2-2. Annual Health Impacts From Transportation of Highly Enriched Uranium (93-Percent U-235^a) From Y-12 to Blending Sites

Blending Site	Total Health Effect ^b
UNH Blending for	
Commercial Reactor	
Fuel (10 t/yr HEU)	
B&W	7.4×10^{-4}
NFS	5.1×10^{-4}
SRS	7.2×10^{-4}
Y-12 ^c	3.1×10^{-4}
UNH Blending for LLW	
Disposal (2.1 t/yr HEU)	
B&W	2.7×10^{-3}
NFS	1.9×10^{-3}
SRS	2.6×10^{-3}
Y-12 ^c	1.1×10^{-3}
UF₆ Blending for	
Commercial Reactor	
Fuel (10 t/yr HEU)	
B&W	1.3×10^{-2}
NFS	8.9×10^{-3}
Metal Blending for LLW	
Disposal (3.1 t/yr HEU)	
[Text deleted.]	
Y-12 ^c	1.7×10^{-3}

^a A bounding value per Appendix G.

^b Fatalities.

^c Only handling risk.

Source: RADTRAN model results.

Impacts From Transportation of Surplus Highly Enriched Uranium From United States Enrichment Corporation Piketon (Portsmouth Gaseous Diffusion Plant) to Blending Sites. Approximately 10 t of HEU at USEC Piketon could be transported directly to the blending sites rather than being placed in interim storage first at the Y-12 Plant. Table

4.4.3.2-3 summarizes the potential radiological and nonradiological annual health impacts from the transport of HEU from USEC Piketon for each alternative. The annual amount of HEU to be transported would remain unchanged; 10 t for blending to 4-percent LEU as commercial reactor fuel, 2.1 t for blending to 0.9-percent LEU as UNH for disposal as LLW, and 3.1 t for blending to 0.9-percent LEU as metal for disposal as waste. Handling risk is also included in annual health impacts presented in Table 4.4.3.2-3. The incremental change as compared to the transport of an equivalent amount of HEU from the Y-12 Plant to the same sites (that is, the difference in risk from that shown in Table 4.4.3.2-2) becomes insignificant when included in the cumulative total health impact from transporting all materials under each blending alternative for the campaign of the proposed action. The basic impact assessment for intersite transportation uses the Y-12 Plant as the representative source of surplus HEU in the analysis since most of DOE's surplus HEU would be located at Y-12. If surplus HEU located at USEC Piketon is shipped from any of these sites, the impacts can be calculated from Table 4.4.3.2-3. The inventory in this scenario would only last 1 to 7 years.

Onsite Transportation Impacts at Blending Sites.

The B&W site, NFS, and the Y-12 Plant have never experienced a transportation-related accident involving special nuclear materials. SRS has experienced two leaks resulting in some contamination (BW 1995b:1; NFS 1995b:2; ORR 1995a:10; SRS 1995a:5). The health effects of unloading the trucks and placing the HEU into interim storage at the blending site are presented in Table 4.4.3.2-1.

Upon arrival at the blending site, HEU would be immediately unloaded from the SSTs and placed in the interim storage facility. Onsite road risks from the site gate to the unloading dock are included in the line haul transport assessment from the Y-12 Plant to the blending site. There would be no other onsite transportation at any blending facility. A radiological accident is unlikely to occur during the unloading of SSTs and the transfer of materials to an interim storage facility for the same reasons presented for transferring the materials at the Y-12 Plant. It is extremely unlikely that a Type B container would be accidentally breached and the contents dispersed;

Table 4.4.3.2-3. Annual Health Impacts from Transportation of Highly Enriched Uranium (93-Percent U-235^a) From United States Enrichment Corporation Piketon to Blending Sites

Blending Site	Total Health Effect ^b
UNH Blending for Commercial Reactor Fuel (10 t/yr HEU)	
B&W	1.04×10^{-3}
NFS	1.09×10^{-3}
SRS	1.30×10^{-3}
Y-12	9.42×10^{-4}
UNH Blending for LLW Disposal (2.1 t/yr HEU)	
B&W	3.81×10^{-3}
NFS	3.99×10^{-3}
SRS	4.75×10^{-3}
Y-12	3.45×10^{-3}
UF₆ Blending for Commercial Reactor Fuel (10 t/yr HEU)	
B&W	1.82×10^{-2}
NFS	1.90×10^{-2}
Metal Blending for LLW Disposal (3.1 t/yr HEU)	
Y-12	5.17×10^{-3}

^a A bounding value per Appendix G.

^b Fatalities.

Source: RADTRAN model results.

therefore, the probability of an accident-induced radiological exposure or fatality during the transfer of the HEU from SSTs to storage at the blending site is negligible.

Accident-free radiological exposures to cargo handlers, other workers, and the public while transferring HEU from the SSTs to the blending site interim storage facility are summarized in Table 4.4.3.2-1. The exposed workers would be the two cargo handlers and 35 other workers (for example, guards) within a 50-m (164-ft) radius. Because the unloading would occur onsite in a secured area away from the general public, there would be no exposure to the public under accident-free conditions.

The highest dose to an average individual would be received by a cargo handler and is estimated to be 0.03 rem. The collective dose to two cargo handlers

is estimated to be 0.06 person-rem; 2.4×10^{-5} latent cancer fatalities are estimated.

Transport of Blendstock Materials

The blending of uranium by the UNH process for commercial use (4-percent U-235 enrichment) could require the transport of 165 t/yr of NU blendstock (as U₃O₈) from Hanford (a representative site) to the blending sites, or 207 t of UF₆ from either USEC Paducah or USEC Piketon to GE Wilmington for conversion to U₃O₈. UNH blending for waste disposal (0.9-percent U-235 enrichment) would require 175 t/yr of DU as oxide, which is also assumed to be shipped from the representative site at Hanford, or 219 t/yr of depleted UF₆ from USEC Paducah or USEC Piketon to GE Wilmington for conversion to U₃O₈ and then shipment of 175 t/yr of U₃O₈ to the blending sites. For blending HEU to LLW under the metal alternative, 218 t/yr of DU as metal would be required from Fernald and shipped to the blending site. The estimated impacts from accident-free radiological exposure from transferring blending materials from storage to a truck are summarized in Table 4.4.3.2-1.

Transport of Natural Uranium Blendstock From Hanford to the Blending Site. NU blendstock (oxide) would be of 0.71-percent enrichment and shipped as a solid. A maximum of 165 t/yr of U₃O₈ (140 t NU) would be transported in DOT-specification metal box packages by commercial carrier. A typical Type A metal box packaging is shown in Figure 4.4.3.2-3. The annual radiological and nonradiological impacts from transporting NU blendstock are presented in Appendix G, Table G.1-6. The highest total impact is 1.1×10^{-2} fatalities (from Hanford to SRS). Potential impacts from loading trucks at origin and unloading trucks at the blending site are shown in Table 4.4.3.2-1.

Transport of Natural Uranium or Depleted Uranium as Uranium Hexafluoride Blendstock From Either United States Enrichment Corporation Paducah or United States Enrichment Corporation Piketon to Wilmington. The UF₆ blendstock would be of less than 3-percent enrichment and would be shipped as a solid. A maximum of 207 t/yr of UF₆ (140 t NU) would be required for blending to fuel feed material or 219 t/yr

of UF_6 (148 t DU) for blending to LLW. The material would be placed in a specification UF_6 cylinder (inner packaging), which then would be placed in an approved Type B protective overpack (outer packaging for added protection) for shipment by commercial carrier. Up to 23 cylinders, each containing 9 t of material, would be required per year. It is estimated that up to 23 truckloads per year (one cylinder per truckload) would be needed to transport the material. The IAEA assessed and approved the adequacy of UF_6 transport regulations as pertaining to radiological and chemical hazards. This material has been successfully transported throughout the world via ship, rail, and truck without loss of life or property due to a radiological or chemical release. The annual radiological and nonradiological impacts from transportation of UF_6 from USEC Paducah or USEC Piketon to GE Wilmington, B&W, or NFS are presented in Appendix G, Table G.1-6. The overall annual risk of transporting UF_6 is estimated to be small. Figure 4.4.3.2-4 presents an illustration of a commercial truck loaded with 9 t, Type B overpack that is typically used for the transport of UF_6 material.

Transport of Triuranic-Octaoxide From General Electric Wilmington to the Blending Sites. At GE Wilmington, the UF_6 would be converted into U_3O_8 , which would be shipped to B&W, NFS, SRS, or the Y-12 Plant. A maximum of 165 t of U_3O_8 (140 t of uranium) per year would be transported in a maximum of 75 DOT-specification, Type A metal box packages for blending as UNH (4-percent U-235) fuel feed material. Each package would contain about 2,200 kg (4,850 lb) of uranium, depending upon the material assay. The material would be transported by an estimated 15 commercial flatbed truckloads per year to the selected blending site. For UNH of 0.9-percent U-235, approximately 175 t of U_3O_8 would be transported by an estimated 16 commercial shipments. The radiological and nonradiological impacts for the transport of U_3O_8 from GE Wilmington to the potential blending plants are presented in Appendix G, Table G.1-6. The annual risk of transporting U_3O_8 is estimated to be small. The estimated radiological impacts from transferring UF_6 and U_3O_8 between storage facilities and trucks at both origins and destinations are shown in Table 4.4.3.2-1.

Transport of Natural Uranium as Uranium Hexafluoride Blendstock From Either United States Enrichment Corporation Paducah or United States Enrichment Corporation Piketon to a Uranium Hexafluoride Blending Site. For the UF_6 blending alternative, UF_6 blendstock would be transported from either USEC Paducah or USEC Piketon directly to a UF_6 blending site, located at either B&W or NFS. The UF_6 alternative would not require the conversion of UF_6 blendstock into U_3O_8 at GE Wilmington (as required for the UNH option) before being transported to the blending site. For this option, 207 t/yr of UF_6 (140 t NU) would be transported.

Both the UF_6 and U_3O_8 are low-enriched materials that are routinely shipped in DOT/NRC-approved shipping containers by commercial truck. There are no unusual shipping criteria (as are required for special nuclear materials) other than meeting standards established by DOT and presented in 49 CFR and supplemented by State, local, and DOE regulations. These standards require the shipper to comply with selecting the proper, authorized packaging for the material; preparing hazardous materials shipping papers; properly certifying what is being shipped; properly marking, labeling, loading, blocking, and bracing the material; and meeting safety requirements.

The potential health effects from transporting UF_6 from USEC Paducah or USEC Piketon to B&W or NFS are presented in Appendix G, Table G.1-6. The highest impact is estimated to be 4.2×10^{-3} fatalities for the transport of UF_6 blendstock material from USEC Paducah to B&W. Potential impacts from unloading the trucks at the blending site and placing the material in interim storage are presented in Table 4.4.3.2-1.

Transport of Depleted Uranium (Metal) From Fernald to the Y-12 Plant. Under the metal alternative, to blend HEU to LLW (oxide) for disposal, 218 t/yr of DU (metal) blendstock material would be required to be transported from Fernald directly to the blending site at the Y-12 Plant. DU would be shipped in DOT-specification shipping containers by commercial truck. As is required of all shippers and carriers of hazardous materials, the handling and transportation procedures for this material must comply with Federal, State, and local

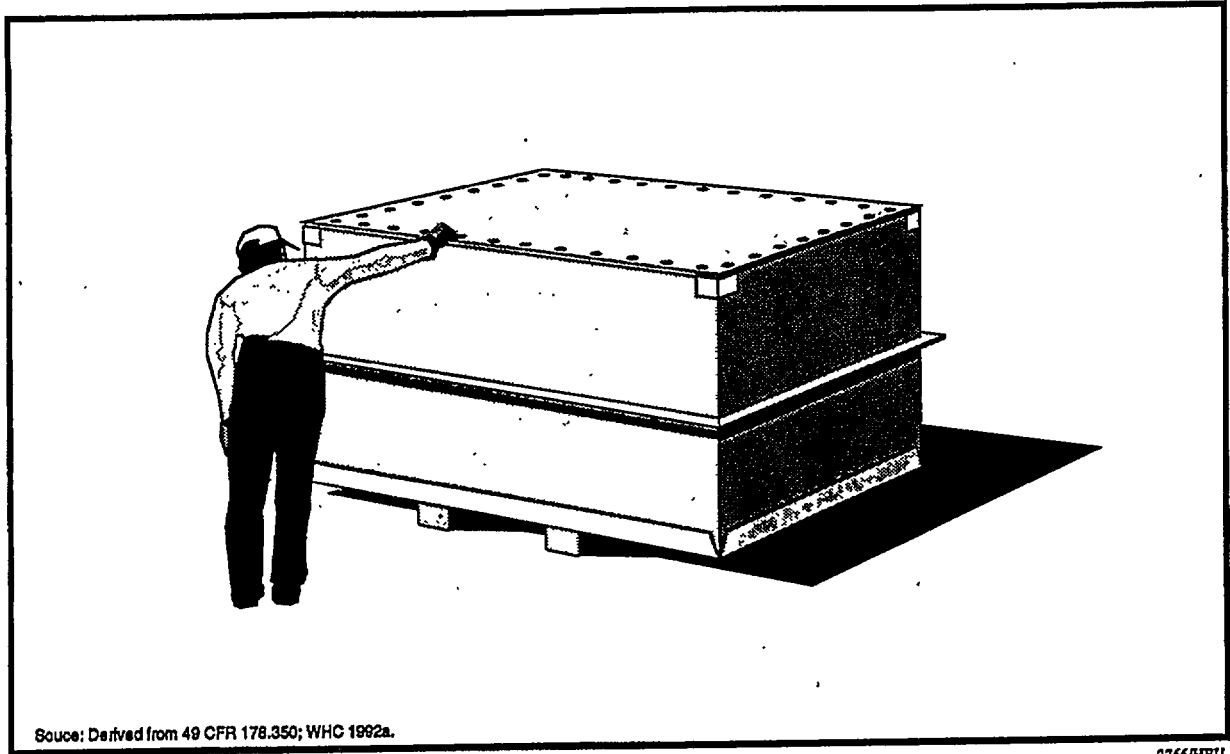


Figure 4.4.3.2-3. A Typical Department of Transportation-Specification 7A, Type A Metal Box Packaging for the Transport of Most Blendstock Materials.

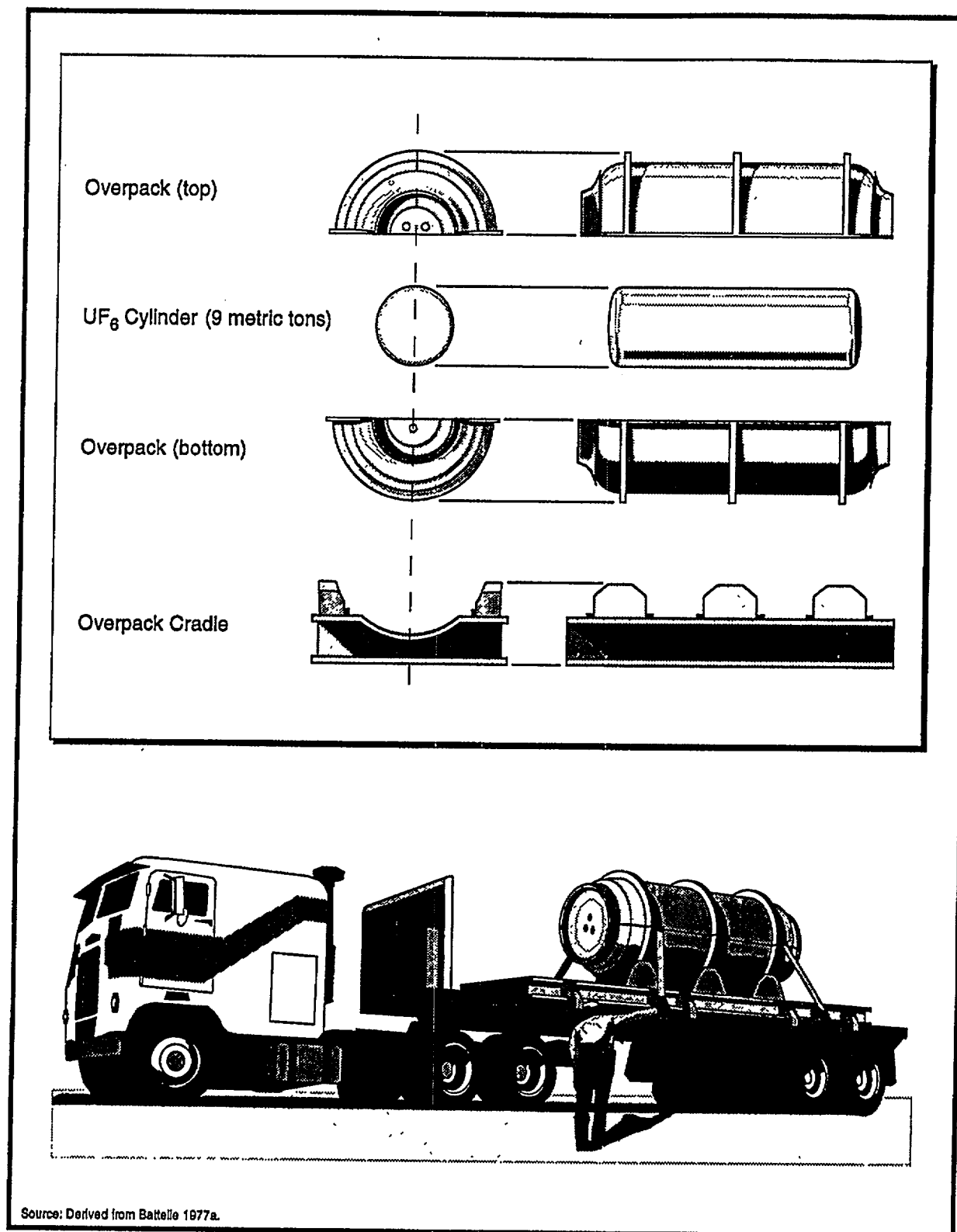


Figure 4.4.3.2-4. Uranium Hexafluoride Cylinder with Two-Part Nuclear Regulatory Commission-Certified Type B Overpack (9 metric tons).

regulatory standards. The impacts from transporting DU (metal) from Fernald to the blending sites are presented in Appendix G, Table G.1-6. This annual risk of transporting DU (metal) is estimated to be 2.3×10^{-3} fatalities. The potential impacts from loading trucks at origin and unloading trucks at destination are presented in Table 4.4.3.2-1.

Transportation of Low-Enriched Uranium From Fernald to Blending Sites. Approximately 191 t of LEU (1.25-percent enrichment), located at Fernald, could be used in lieu of NU only for the alternative to blend HEU to UNH crystals for use as commercial fuel. The LEU blendstock (in oxide U_3O_8 or UO_3 form) would be transported in 48 truckloads (80 t LEU, 1 t U-235) per year from Fernald to any of the four blending sites (SRS, the Y-12 Plant, B&W, and NFS). The highest risk from transporting LEU would be 8.44×10^{-3} fatalities per year (Fernald to SRS), compared to 1.10×10^{-2} fatalities per year from transporting NU (Hanford to SRS). NU was used for the transportation analysis in general because: (1) it is the material most likely to be used for blending, and (2) the 191 t of LEU at Fernald would not fulfill the total blendstock requirement for the life of the project (it would suffice for less than 3 years). As shown in Table 4.4.3.2-4, the blendstock risk is bounded by the transport of NU from Hanford to the blending sites. The total annual health impact from transporting NU blend stock from Hanford versus transporting LEU from Fernald is summarized in Table 4.4.3.2-4.

Transport of Uranyl Nitrate Crystals, Low-Level Waste (Oxide) from Blending Sites to a Fuel Fabrication Plant or Waste Disposal Facility. There are three probable products from the blending process: UNH reactor fuel feed material that is 4-percent enrichment in U-235, UF_6 fuel feed material that is 4-percent enrichment in U-235, or LLW (oxide) that is 0.9-percent enrichment.

The UNH (crystals) or UF_6 reactor fuel feed materials (4-percent enrichment) and LLW (0.9-percent enrichment) would be transferred from storage and loaded onto trucks at the blending site. The estimated impacts of these loading activities, on a per-shipment basis, are presented in Table 4.4.3.2-1.

The UNH crystals are the product of the UNH fuel feed material blending process. Once HEU is

Table 4.4.3.2-4. Comparison of Annual Health Impact From Transporting Natural Uranium From Hanford and Fernald to Blending Sites

Blending Site	Total Health Effect ^a	
	Hanford NU (0.71 percent)	Fernald LEU (1.25 percent)
B&W	1.10×10^{-2}	8.02×10^{-3}
NFS	1.00×10^{-2}	6.78×10^{-3}
Y-12	9.70×10^{-3}	5.57×10^{-3}
SRS	1.10×10^{-2}	8.44×10^{-3}

^a Fatalities.

Source: RADTRAN model results.

blended into a material containing 4-percent enriched UNH in hydrated form (crystals), the material would be shipped in NRC-certified, Type A fissile packaging via commercial carrier to a fuel fabrication plant. Approximately 14 t of blendstock are required for each metric ton of HEU; thus, 10 t/yr of HEU and 165 t/yr of U_3O_8 would be required to produce the maximum output of 316 t of UNH crystals (150 t/yr LEU) fuel feed material. It is estimated that 70 truckloads per year would be required to transport the UNH crystals to a fuel fabrication plant. The risk of transporting this material is presented in Appendix G, Table G.1-7.

Under the UF_6 alternative, 222 t of UF_6 (150 t LEU) fuel feed material of 4-percent enrichment would be transported to a fuel fabrication plant per year. This material would be placed in a DOT-specification UF_6 cylinder (inner packaging), which is then placed in an NRC-certified, Type B packaging (overpack) for shipment by commercial carrier. Approximately 98 cylinders, each containing approximately 2.3 t, would be required per year. It is estimated that 20 truckloads would be needed per year to transport UF_6 to a fuel fabrication plant.

The UNH or UF_6 reactor fuel feed materials would be transported by commercial truck in compliance with DOT (49 CFR 171-180) and other regulatory requirements that govern the movement of hazardous materials. The UNH would be transported in NRC-certified, Type A fissile packaging (for example, BU-7 which has a Certificate of Compliance Number 9019).

Four sites (the Y-12 Plant, SRS, B&W, and NFS) would be capable of blending HEU to 0.9-percent LLW for disposal.

To blend down HEU to LLW (0.9-percent enrichment), approximately 70 t of blendstock are required for each metric ton of HEU. Based on the blending site's assumed blending rates and associated output, it is estimated that 40 truckloads per year would be required to transport the LLW (oxide) obtained from UNH blending to a waste disposal facility.

Metal forms would be blended down to 0.9-percent enrichment and further converted to oxide form for waste disposal only. This LLW (oxide) "end product" material would be placed in DOT-specification, Type A packages and transported by commercial truck to a waste disposal site (NTS is used for risk calculations). Approximately 59 truckloads would be required to transport 264 t of LLW per year.

The risks of transporting UNH of 4-percent or 0.9-percent enrichment, UF_6 of 4-percent enrichment, or metal LLW of 0.9-percent enrichment are small. The potential transportation health risks for these types of shipments are summarized in Appendix G, Table G.1-7.

4.4.3.3 Cumulative Summary of Transportation Environmental Impacts

The high and low range of cumulative radiological and nonradiological annual health impacts from transporting radioactive materials for alternatives in this EIS are presented in Table 4.4.3.3-1. Additional information is included in Appendix G, Table G.1-8.

The maximum potential impacts, by alternative, are summarized as follows:

- The maximum annual transportation health impacts from blending HEU to LEU as UNH (4-percent enrichment) fuel feed material would be 0.061, or approximately one excess fatality in 16 years. This option requires the transportation of HEU from the Y-12

Plant to SRS, NU blendstock from Hanford to SRS, and the transportation of fuel feed material (UNH crystals) from SRS to the fuel fabrication plant at the Siemens Nuclear Power Corporation site.

- The maximum annual transportation health impacts from blending HEU to LEU as UF_6 (4-percent enrichment) fuel feed material would be 0.031, or approximately one excess fatality in 32 years. This option requires the transportation of HEU from the Y-12 Plant to B&W, UF_6 blendstock from USEC Paducah to B&W, and the transport of UF_6 fuel feed material from B&W to the Siemens Nuclear Power Corporation Site.
- The maximum annual transportation impacts from blending HEU under the UNH alternative to LLW (0.9-percent enrichment) for disposal would be 0.038, or approximately one excess fatality in 26 years. This option requires the transport of HEU from the Y-12 Plant to B&W, DU blendstock from Hanford to B&W, and the transport of LLW from B&W to NTS for disposal.
- The annual transportation health impacts from blending HEU metal (0.9-percent enrichment) to LLW at the Y-12 Plant would be 0.035, or approximately one excess fatality in 29 years. This option requires blending of HEU to LLW at the Y-12 Plant, the transportation of DU (metal) blendstock from Fernald to the Y-12 Plant, and the transport of LLW from the Y-12 Plant to NTS for disposal.

The lowest transportation risk alternative would be to produce UNH fuel feed material of 4-percent enrichment at B&W. This would require the transport of HEU from the Y-12 Plant to B&W, the transport of UF_6 blendstock material from USEC Paducah to GE Wilmington, and the transport of U_3O_8 from GE Wilmington to B&W. This risk would be 0.012, or one excess fatality in 83 years; however the risk differences between all other alternatives and sites are not significant.

**Table 4.4.3.3-1. Summary of High and Low Transportation Risk
for Each Blending Alternative (per year)**

HEU Origin	Blending Material Origin	Conversion Site	Blending Site	Fuel Fabrication or LLW Site	Total Health Risk ^a
Fuel Feed Material as Uranyl Nitrate Crystals (10 t/yr)					
Y-12 Plant	Hanford	—	SRS	SNPC	6.1×10^{-2} , ^b
Y-12 Plant	Paducah	GE	B&W	B&W	1.2×10^{-2}
Uranyl Nitrate LLW as Oxide (2.1 t/yr)					
Y-12 Plant	Hanford	—	B&W	NTS	3.8×10^{-2}
Y-12 Plant	Paducah	GE	Y-12	NTS	3.0×10^{-2}
Fuel Feed Material as UF₆ (10 t/yr)					
Y-12 Plant	Paducah	—	B&W	SNPC	3.1×10^{-2}
Y-12 Plant	Paducah	—	NFS	WCFF	1.5×10^{-2}
Metal LLW as Oxide (3.1 t/yr)					
[Text deleted.]					
Y-12 Plant	Fernald	—	Y-12	NTS	3.5×10^{-2}

^a Estimated fatalities per year.

^b Highest risk for all transportation options.

Source: RADTRAN model results.

4.5 TOTAL CAMPAIGN IMPACTS

This section describes the impacts of the various alternatives evaluated for disposing HEU at the four candidate sites. The annual operational impacts of each of the blending technologies or the resources of the candidate sites are fully described in Sections 4.3 and 4.4. In this section, the combined impacts of each alternative for disposing the 200 t of surplus HEU inventory, which may involve multiple technologies, sites, and end products, are summarized and shown in Table 2.4-1.

For each alternative analyzed other than the No Action Alternative, there are two potential processes for blending to commercial fuel (UNH and UF_6) and two potential processes for blending to waste (UNH and metal). The impacts and, in the case of blending to waste, the processing rate of the respective processes differ. In other words, the magnitude of expected impacts and the time required to complete disposition actions depend on the process selected.

The analyses in Sections 4.3 and 4.4 for the four candidate sites are based on one rate for each process so that a valid comparison can be made between the site-specific impacts. While it is recognized that some of the sites may be able to process material at a higher rate, a comparison between the impacts at the maximum rate for each site could be misleading. For example, if one site is processing material at 10 t/yr to 4-percent UNH and a second site is processing material at 40 t/yr to 4-percent UNH, then the impacts from the analysis for the second site may be greater based on the increased production rather than the site. It is also assumed that each site can process the material at the blending rates analyzed, although at some sites this may preclude other blending not associated with this proposed action.

Material could be blended to waste at the two DOE sites using UNH or Y-12 using metal blending. Similarly, material could be blended to commercial fuel feed at the two commercial sites using either UNH or UF_6 blending. To provide conservatism in the site-specific analyses below, where there is such a choice of applicable processes at a site (that is, only for blending to waste at the DOE sites and blending to commercial fuel feed at the commercial sites), the value given for each resource area is based on whichever process produces the greatest impact.

For blending to waste at DOE sites, the UNH process would produce the greatest impact in all resource areas except four. The metal process would produce the greatest impacts for liquid LLW generated, solid LLW generated, solid LLW after treatment, and transportation; therefore, the analyses below conservatively use the metal impacts for these four resource areas and the UNH impacts for all other resource areas.

For blending to commercial fuel feed at the commercial sites, the UF_6 process would produce the greatest impacts in all resource areas except three. The UNH process would produce the greatest impacts for liquid hazardous waste generated, solid nonhazardous waste after treatment, and transportation. The analyses below conservatively use the UNH impacts for these three resource areas, and the UF_6 impacts for all other resource areas.

The results indicate that all four sites have the capacity to process material with minimal impacts to the workers, the public, or the environment. For the two DOE sites, the generation of waste based on an increased usage of utilities represents small increases—less than 5 percent over current operations. For the two commercial sites, the generation of waste based on an increased usage of utilities represents increases of over 20 percent, but both facilities have adequate capacities to accommodate the increases since neither site is currently operating at full capacity. The NFS site would require a large increase in water usage (35.1 percent) and fuel requirements (933 percent). This is because NFS is currently processing material at a reduced rate; therefore, use of these utilities (water and fuel) is currently very low. Because the quantity of water and fuel used in the past for similar operations was also used for the proposed action and in the analyses in this EIS, it is anticipated that the increase in these requirements can easily be accommodated at NFS.

For most resource areas, the impacts from a given blending process would not vary from site to site. Three exceptions to this are the radiological dose to the MEI, the dose to the public, and the total health risk during transportation. The first two exceptions are due to the MEI and the population within 80 km (50 mi) being at different distances from the blending facility for each site. The last exception is due to the

different transportation distances between various affected sites and the different distributions of populations along the shipping routes where HEU originates, blendstock originates, fuel fabrication is performed, and waste disposal is carried out. This section analyzes and compares the incremental impact over the life of the campaign for blending 200 t for each alternative. These analyses are based on the maximum impact for each resource at each site (that is, the maximum electricity needed for either UNH or UF_6 blending to fuel or UNH or metal blending to waste). The impacts will vary for different scenarios depending on the sites and processes selected.

As noted in Chapter 1, several blending technologies and facilities are likely to be used for different portions of the surplus inventory, and the decisions regarding those technologies and facilities are likely to be made in part by USEC, other private entities as marketing agents for DOE, or DOE. Thus, specific decisions concerning the locations where surplus HEU disposition actions will be implemented will be multi-dimensional and will likely involve multiple decisionmakers. The impacts of both the Russian and U.S.-origin surplus HEU on the domestic producers will be limited by provisions of the *USEC Privatization Act* enacted in April 1996. Under provisions of the act, the quantity of surplus HEU that can be transferred to commercial end users will be constrained to a level that would not adversely affect the domestic market. Hence, because the quantity of U.S. material is relatively small and the *USEC Privatization Act* prevents unrestricted transfer of the material to end users, the incremental impacts of the proposed action on the domestic nuclear fuel industry would be small. The alternatives as described are not intended to represent exclusive choices among which DOE (or other decisionmakers) must choose, but rather to provide a range of reasonable alternatives.

4.5.1 NO ACTION

Under the No Action Alternative, DOE will continue to store surplus HEU (primarily at DOE's Y-12 Plant). As stated in Section 1.4.2, storage of surplus HEU is analyzed for a period up to 10 years in the Y-12 EA. Storage of weapons-usable fissile materials beyond the 10-year period (2005), including surplus HEU up to the point of disposition, is being

addressed in the Storage and Disposition PEIS. Current operations as described in Section 2.2.3 at each of the potential HEU blending sites (Y-12, SRS, B&W, and NFS) would continue. The impacts from this No Action Alternative are described in Section 4.2.

4.5.2 NO COMMERCIAL USE

Under this second alternative, DOE would blend the entire stockpile of surplus HEU (200 t) to LEU and dispose of it as waste. This would include surplus HEU with or without commercial value. The blending of all surplus HEU would be performed at all four sites. Although this alternative would not recover any of the economic value of HEU for the Government or provide peaceful beneficial use of the material, it would meet nonproliferation objectives and is included to provide a comprehensive evaluation of a full range of alternatives in the HEU EIS.

Surplus HEU could be blended to waste either as UNH or metal at a rate of up to 2.1 t/yr or 3.1 t/yr, respectively. All the blending sites have UNH blending capabilities. Only ORR is considered as a blending site for metal blending because SRS, B&W and NFS neither have nor plan to build metal blending facilities. Utilizing the metal process, the time required to blend all 200 t would be more than 64 years. Utilizing the UNH process at only one of the commercial sites, the time required to blend all of the 200 t would be more than 95 years. No combination of fewer than three sites could complete the task in less than 30 years. For this alternative, all four sites would be used to blend 50 t each. If all four sites were to process material, it would take 23.8 years to finish converting all 200 t of HEU to LEU as waste.

The blending of surplus HEU to waste would not be initiated before an LLW disposal facility was identified to accept the LLW. Surplus HEU would remain in interim storage at DOE's Y-12 Plant, or at another storage facility pursuant to the Storage and Disposition PEIS, pending identification of the LLW disposal facility.

For the DOE sites, blending to waste (that is, blending 100 t at DOE sites with each site blending 50 t HEU) would take 23.8 years if the UNH process is used, and 16.1 years if the metal process is used. For the commercial sites, blending to waste (that is,

blending 100 t at the commercial sites with each commercial site blending 50 t HEU) would take 23.8 years using the UNH process. (Therefore, if all four sites were to process the material, it would take 23.8 years to convert all of the 200 t of surplus HEU to LEU as waste.) The total or maximum incremental impacts for each resource under this alternative are presented in Table 2.4-1 under Alternative 2.

[Tables deleted.]

4.5.3 LIMITED COMMERCIAL USE (25/75 FUEL/WASTE RATIO)

Under this third alternative, 50 t of the surplus HEU would be blended to commercial fuel while the remaining 75 percent (150 t) would be disposed of as waste. First, the title to 50 t of surplus HEU (with 7,000 t NU as UF_6) would be transferred to USEC. USEC (or the successor private corporation) then would select blending sites for blending 50 t of surplus HEU to LEU for use in commercial fuel. The remaining quantity would be blended into waste.

[Text deleted.]

The third alternative would blend the 50 t of HEU at the commercial sites, each blending 25 t of material.

[Text deleted.] The two DOE sites would not blend any commercial HEU material. The remaining 150 t of HEU material would be blended into waste using all four blending sites. Each DOE and commercial site would receive 37.5 t of material for blending.

[Text deleted.] The total or maximum incremental impacts for each resource under this alternative are presented in Table 2.4-1 under Alternative 3.

[Tables deleted.]

4.5.4 SUBSTANTIAL COMMERCIAL USE (65/35 FUEL/WASTE RATIO)

Under this fourth alternative, all of the commercial material (130 t) would be blended to commercial fuel, and all of the off-spec (40 t) and non-commercial material (30 t) would be blended to waste. Thirty-five percent of the HEU would be blended and disposed of as waste while the remainder would be blended for commercial use. First, the title to 50 t of surplus HEU (with 7,000 t NU as UF_6) would be transferred to USEC. USEC (or the successor private corporation) would then select sites

for blending 50 t of surplus HEU to LEU for use in commercial fuel. The remaining quantity of commercially usable HEU (80 t) would be blended at any or all of the four sites to LEU for fabrication into commercial reactor fuel. The remaining 70 t of surplus HEU would be blended to waste.

All three alternative blending processes could be used for this purpose: blending as UNH and/or UF_6 for 4-percent commercial fuel feed, and blending as UNH and/or as metal for 0.9-percent waste feed. Surplus HEU could be blended to commercial fuel as either UNH or UF_6 at a rate of 10 t/yr. Surplus HEU could be blended to waste as either UNH or as metal at a rate of up to 2.1 t/yr or 3.1 t/yr, respectively. All the blending sites have UNH blending capability. Only B&W and NFS are considered as blending sites for UF_6 . Only ORR is considered as a blending site for metal blending.

Four variations of this alternative would use combinations of different sites. These particular different combinations of sites are representative only. DOE, USEC, or another private entity might choose others, depending on programmatic, commercial, or other considerations.

4.5.4.1 Substantial Commercial Use at Department of Energy Sites (65/35 Fuel/Waste Ratio)

The first variation of the fourth alternative would blend all of the HEU at the two DOE sites, with the HEU split equally between them. ORR and SRS would each blend 65 t of HEU to LEU for commercial fuel and 35 t of HEU to LEU for disposal as waste. Utilizing the DOE sites only, blending to both commercial fuel and waste would take 23.2 years if the UNH process were used for blending the 35 t to waste, and 17.7 years if the metal process were used for blending the 35 t to waste. The total or maximum incremental impacts for each resource under this variation are presented in Table 2.4-1 under Alternative 4, Variation a.

4.5.4.2 Substantial Commercial Use at Commercial Sites (65/35 Fuel/Waste Ratio)

The second variation of the fourth alternative would blend all of the HEU at the two commercial sites,

with the HEU split equally between them. B&W and NFS would each blend 65 t of HEU to LEU for commercial fuel and 35 t of HEU to LEU for disposal as waste. Utilizing the commercial sites only, blending to both commercial fuel and waste would take 23.2 years whether the UNH or UF₆ process were used for blending. The total or maximum incremental impacts for each resource under this variation are presented in Table 2.4-1 under Alternative 4, Variation b.

[Tables deleted.]

4.5.4.3 Substantial Commercial Use at All Four Sites (65/35 Fuel/Waste Ratio)

The third variation of the fourth alternative would blend all of the surplus HEU at all four sites, with the HEU split equally among them. ORR, SRS, B&W, and NFS would each blend 32.5 t of HEU to LEU for commercial fuel and 17.5 t of HEU to LEU for disposal as waste. [Text deleted.] The total or maximum incremental impacts for each resource under this variation are presented in Table 2.4-1 under Alternative 4, Variation c.

4.5.4.4 Substantial Commercial Use at a Single Site (65/35 Fuel/Waste Ratio)

The fourth variation of the fourth alternative would blend all of the surplus HEU at only one site. ORR, SRS, B&W, or NFS would blend 130 t of HEU to LEU for commercial fuel, and 70 t of HEU to LEU for disposal as waste. [Text deleted.] The fourth variation is each site blending twice the amount of material as in the first and second variations of this alternative. The incremental impacts for each resource for either of the DOE sites are the same as either the total or the maximum impacts presented in Table 2.4-1 under Alternative 4, Variation a. The incremental impacts for each resource for either of the commercial sites are the same as either the total or the maximum impacts presented in Table 2.4-1 under Alternative 4, Variation b. The only exception is the normal operations dose and risk to the MBI of the public. The doses to the MBI for Y-12, SRS, B&W, and NFS are 1.81, 0.116, 0.109, and 7.92 mrem, respectively. The risks of cancer fatalities per campaign are 9.06×10^{-7} , 5.80×10^{-8} , 5.46×10^{-8} , and 3.96×10^{-6} , respectively. The doses to the population within 80 km (50 mi) are 7.41, 7.41, 0.982, and 69.9

person-rem, respectively. The risks of cancer facilities per campaign are 3.7×10^{-3} , 3.7×10^{-3} , 4.9×10^{-4} , and 3.5×10^{-2} , respectively.

[Tables deleted.]

4.5.5 MAXIMUM COMMERCIAL USE (85/15 FUEL/WASTE RATIO)

Under this fifth alternative, all of the commercial (170 t) and off-spec material would be blended to fuel. This alternative assumes that only 15 percent of the surplus HEU would be blended to LLW and disposed of as waste (30 t). This increases the amount of material that can be used for commercial use to 85 percent. First, the title to 50 t of surplus HEU (with 7,000 t NU as UF₆) would be transferred to USEC. USEC (or the successor private corporation) would then select commercial sites for blending 50 t of surplus HEU to LEU for use in commercial fuel. For the remaining quantity of potentially commercially usable HEU (120 t), DOE or USEC (or the successor private corporation) could have it blended at any or all of the four sites. The LEU product, following blending, then would be sold in the market for use in commercial reactor fuel. The remaining 30 t of surplus HEU would be blended to waste. The same processes and site variations of the fourth alternative also apply to the fifth alternative.

4.5.5.1 Maximum Commercial Use at Department of Energy Sites (85/15 Fuel/Waste Ratio)

The first variation of the fifth alternative would blend all of the surplus HEU at the two DOE sites, with the HEU split equally between them. ORR and SRS would each blend 85 t of HEU to LEU for commercial fuel and 15 t of HEU to LEU for disposal as waste. [Text deleted.] The total or maximum incremental impacts for each resource under this variation are presented in Table 2.4-1 under Alternative 5, Variation a.

[Tables deleted.]

4.5.5.2 Maximum Commercial Use at Commercial Sites (85/15 Fuel/Waste Ratio)

The second variation of the fifth alternative would blend all of the surplus HEU at the two commercial sites, with the HEU split equally between them. B&W and NFS would each blend 85 t of HEU to LEU for commercial fuel and 15 t of HEU to LEU for disposal as waste. [Text deleted.] The total or maximum incremental impacts for each resource under this variation are presented in Table 2.4-1 under Alternative 5, Variation b.

[Tables deleted.]

4.5.5.3 Maximum Commercial Use at All Four Sites (85/15 Fuel/Waste Ratio)

The third variation of the fifth alternative would blend all of the surplus HEU at all four sites, with the HEU split equally among them. ORR, SRS, B&W, and NFS would each blend 42.5 t of HEU to LEU for commercial fuel feed and 7.5 t of HEU to LEU for disposal as waste. [Text deleted.] The maximum or total incremental impacts for each resource under this variation are presented in Table 2.4-1 under Alternative 5, Variation c.

[Tables deleted.]

4.5.5.4 Maximum Commercial Use at a Single Site (85/15 Fuel/Waste Ratio)

The fourth variation of the fifth alternative would blend all of the surplus HEU at only one site. ORR, SRS, B&W, or NFS would blend 170 t of HEU to LEU for commercial fuel, and 30 t of HEU to LEU for disposal as waste. [Text deleted.] The fourth variation is each site blending twice the amount of material as in the first and second variations of this alternative. The incremental impacts for each resource for either of the DOE sites are the same as either the total or the maximum impacts as presented in Table 2.4-1 under Alternative 5, Variation a. The incremental impacts for each resource for either of the commercial sites are the same as either the total or the maximum impacts as presented in Table 2.4-1 under Alternative 5, Variation b. The only exception is the normal operations dose and risk to the MEI of the public. The doses to the MEI for Y-12, SRS,

B&W, and NFS are 1.22, 0.078, 0.0864, and 6.24 mrem, respectively. The risks of cancer fatalities per campaign are 6.08×10^{-7} , 3.9×10^{-8} , 4.32×10^{-8} , and 3.12×10^{-6} , respectively. The doses to the population within 80 km (50 mi) are 5.01, 5.01, 0.787, and 56.3 person-rem, respectively. The risks of cancer fatalities per campaign are 2.5×10^{-3} , 2.5×10^{-3} , 3.9×10^{-4} , and 2.8×10^{-2} , respectively.

4.5.6 SUMMARY OF ALTERNATIVES ANALYSIS

The analysis of the impacts of alternatives above is based on four particular points on the fuel/waste spectrum: 0-, 25-, 65-, and 85-percent fuel. The reader could readily calculate a reasonable estimate of the impacts of other points on the fuel/waste spectrum by interpolating the results as presented. For example, the impacts of a 75/25 fuel/waste ratio for a given set of sites would be between those presented for alternatives 4 (65/35) and 5 (85/15) for the same sites.

The impacts for particular sites could also be approximated for different site combinations than those that are analyzed above. To determine the impacts of blending a different quantity of material at a particular site than is analyzed above, the assumed quantity can be divided by the appropriate process rate (10 t/yr for blending to fuel as UF_6 or UNH, 3.1 t/yr for blending to waste as metal, and 2.1 t/yr for blending to waste as UNH) to yield the time period necessary to blend that quantity at that rate. Multiplying the resultant time period by the annual impact figures for resource areas that are additive (site infrastructure, water, radiological exposure, waste management, and transportation yields the total impacts for that quantity and site). For the remaining resources (air quality, socioeconomics, and chemical exposure) adding annual impacts does not provide a meaningful measure. For those resources, the best measure of total campaign impacts would be the maximum of any applicable annual impact.

The analyses in this section are based on annual blending rates which depend in part on DOE's ability to supply HEU to one or more sites at the process blending rates. If DOE is unable to supply material to multiple sites at the blending rates analyzed (for example, 10 t/yr for blending to fuel feed as UNH),

the impacts in a given year (as described in Sections 4.3 and 4.4) would be reduced accordingly. However, since the impacts in this section are based upon blending the entire 200 t, the total campaign impacts would be similar to those described in the previous tables, only spread over a longer time period.

Calculating the impacts that would result from the use of different process rates is less precise, as the relationships between process rates and impacts are in some cases not linear. For example, doubling the process rate for a particular process and facility would probably approximately double the air emissions, water usage, and waste generation, but it would not necessarily double the required workforce. Nonetheless, as the expected impacts from all alternatives are small during normal operations, a reasonable approximation of the impacts from different process rates could be obtained by assuming linear relationships.

The analysis supports several preliminary conclusions. For most resource areas, the impacts decrease as the portion of material blended for commercial use increases. This conclusion is based on the analysis of impacts from blending operations and transportation of materials only. It does not include the impacts from the endpoints: use of

commercial nuclear fuel in reactors³ (and of the licensing process for nuclear plants, existing or anticipated environmental documents for sites for disposal of the LLW (such as the anticipated sitewide management of the resulting spent fuel) or disposal of LLW. Those impacts are or will be assessed as part EIS for NTS, and the anticipated EIS concerning a repository for commercial spent fuel). Since the use of LEU derived from HEU in reactors supplants the use of LEU from mined uranium, the preferred alternative involves no incremental use of nuclear fuel (or spent fuel to be managed) than that which would otherwise occur. In contrast, the LLW to be disposed of from HEU that is blended to waste does represent an incremental quantity of LLW that would not need to be disposed of in the absence of this proposed action. This distinction, together with the avoided environmental impacts from uranium mining, milling, and enrichment (Section 4.7), further enhances the preferability of maximizing commercial use of surplus HEU.

The analyses show some differences between the impacts of the different blending processes. For example, for blending to waste, metal blending generates considerably more process LLW than does UNH blending.

³ An indirect impact of the preferred alternative would be the generation of spent fuel under alternatives 3, 4, and 5, which would need to be managed and disposed of in a repository such as the Yucca Mountain Site (Yucca site is currently being characterized; preparation of an EIS has been postponed until further notice, due to lack of funding). Since the nuclear fuel derived from HEU would replace nuclear fuel that would have been created from newly mined uranium without this proposed action, there would be no additional spent fuel generated. No spent fuel would be generated for the alternatives 1 (no action) and 2 (blend all surplus HEU to waste).

4.6 CUMULATIVE IMPACTS

4.6.1 DESCRIPTION OF CUMULATIVE IMPACTS

Impacts from blending surplus HEU to LEU (assessed in Chapter 4) would be cumulative when added to impacts from existing and planned activities at each of the candidate sites evaluated in this EIS. This type of an assessment is important because significant cumulative impacts can result from several smaller actions that by themselves do not have significant impacts.

A cumulative impact is defined as the "impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal), private industry, or individuals undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR 1508.7). This section discusses potential impacts from other facilities, operations, and activities that, in combination with potential impacts from the disposition of surplus HEU proposal, may contribute to cumulative impacts.

The cumulative impacts assessment considered a wide-ranging view of the Department's programs, environmental management, and other outside interactions. Numerous NEPA documents recently completed for proposed actions at candidate sites were used to determine site-specific impacts contributed from each action. If NEPA documents were in draft form, alternatives that posed the highest potential for environmental impacts were identified and used for cumulative impact assessment. However, if a decision has been made for the proposed action (that is, ROD is published), then the impacts associated with the alternative selected were used. NEPA documents currently being prepared also were listed and qualitatively discussed as to how impacts anticipated from the respective proposed actions would contribute to the cumulative impacts at each site.

The following documents and the associated proposed actions were considered in assessing the cumulative impacts at the candidate sites:

Oak Ridge Reservation

- *EA for the Proposed Interim Storage of Enriched Uranium Above the Maximum Historical Storage Level at the Y-12 Plant Oak Ridge, Tennessee*, DOE/EA-0929, October 1995 (FONSI published 60 FR 54089)

[Text deleted.]

- *Waste Management PEIS for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste*, DOE/EIS-0200-D (draft issued, August 1995)
- *Storage and Disposition of Weapons-Usable Fissile Materials PEIS*, DOE/EIS-0229-D (draft issued, February 1996)
- *PEIS for Stockpile Stewardship and Management*, DOE/EIS-0236 (draft issued, February 1996)
- *Medical Isotope Production Project: Molybdenum-99 and Related Isotopes EIS*, DOE/EIS-0249F (final issued, April 1996)

Savannah River Site

- *Interim Management of Nuclear Materials EIS*, DOE/EIS-0220, October 1995 (ROD published 60 FR 65300)
- *PEIS for Tritium Supply and Recycling* DOE/EIS-0161, October 1995 (ROD published)
- *F-Canyon Plutonium Solutions EIS*, DOE/EIS-0219, December 1994 (ROD published)
- *Supplemental EIS Defense Waste Processing Facility (DWPF)*, DOE/EIS-0082-S, November 1994 (ROD published)
- *EIS on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign*

Research Spent Nuclear Fuel, DOE/EIS-0218F (final issued, February 1996)

- *DOE Programmatic Spent Nuclear Fuel Management and INEL Environmental Restoration and Waste Management Programs EIS*, DOE/EIS-0203-F, April 1995 (ROD published)
- *Savannah River Site Waste Management EIS*, DOE/EIS-0217F, July 1995 (ROD published)
- *Waste Management PEIS for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste*, DOE/EIS-0200-D (draft issued, August 1995)
- *Storage and Disposition of Weapons-Usable Fissile Materials PEIS*, DOE/EA-0229-D (draft issued, February 1996)
- *PEIS for Stockpile Stewardship and Management*, DOE/EIS-0236 (draft issued, February 1996)

Babcock & Wilcox

[Text deleted.]

- *Disposition of Highly Enriched Uranium Obtained from the Republic of Kazakhstan EA*, DOE/EA-1063, May 1995 (FONSI published)

Blending of Kazakhstan HEU is part of B&W's current licensed operations.

Nuclear Fuel Services

No activities are planned at this site other than current licensed operations.

[Text deleted.]

4.6.2 SITE-SPECIFIC CUMULATIVE IMPACTS

The following sections discuss the cumulative impacts identified for site infrastructure, air quality

and noise, water resources, socioeconomic, public and occupational health, and waste management. The discussions include the highest potential incremental impact from the blending alternatives evaluated in this EIS for each site. Because no new facility is assumed and neither land disturbance nor wastewater discharges constituting more than 1 percent of the stream flow would occur as a result of the implementation of the proposed action, the alternatives analyzed would not contribute to cumulative impacts at any of the potential blending sites for land resources, biotic resources, geology and soil resources, or cultural resources.

4.6.2.1 Site Infrastructure

The site infrastructure impacts resulting from the proposed action for disposition of surplus HEU would contribute to cumulative impacts when added to impacts resulting from existing and planned activities. This section discusses how impacts associated with the surplus HEU disposition proposed action affect each site cumulatively when combined with the No Action baseline and other proposed actions.

Oak Ridge Reservation. [Text deleted.] The ORR is proposed as an alternative site for actions associated with the Storage and Disposition PEIS and the five documents identified in Section 4.6.1. It is under consideration as a regional treatment and disposal site for LLW and mixed LLW in the Waste Management PEIS. In addition, environmental restoration activities at ORR are expected to continue for 30 years and therefore would coincide with the operation of the proposed surplus HEU blending facilities as well as the other applicable program activities described above. Impacts considered in the Y-12 EA are included in the No Action Alternative of this EIS.

The ORR was considered as a site for a centralized storage facility in the *DOE Programmatic Spent Nuclear Fuel Management and INEL Environmental Restoration and Waste Management EIS*; however, in the RODs associated with this EIS, DOE decided to regionalize by fuel type the management of its spent fuel at three locations: the Hanford Site, INEL, and SRS. Therefore, the packaging and shipment of materials is the only activity that will result at ORR from this action and the impacts are minimal. [Text deleted.]

Table 4.6.2.1-1 provides a listing of the site infrastructure related impacts associated with those applicable NEPA actions for which published data are available. [Text deleted.] The cumulative impact of implementing the proposed blending facilities in conjunction with other proposed activities is expected to have little or no impact on the onsite road and rail network. Electrical power requirements for the proposed activities are well within the site and regional power pool capacity or availability. [Text deleted.] Although fuel consumption during operation of blending facilities would increase over current usage, the additional natural gas, oil, and coal requirements for the proposed actions can be satisfied through normal contractual means and would not be limiting.

Savannah River Site. The SRS is a candidate site for the 10 documents identified in Section 4.6.1. This includes the location of an accelerator in the *PEIS for Tritium Supply and Recycling* and the location of a centralized storage facility in the *DOE Programmatic*

Spent Nuclear Fuel Management and INEL Environmental Restoration and Waste Management EIS. [Text deleted.]

Highly enriched uranium material proposed for blending for the purpose of stabilization in the SRS IMNM EIS is the same material proposed for blending for the purpose of disposition in this EIS. SRS is proposed as an alternative site for actions associated with the Storage and Disposition PEIS and for the stockpile management functions in the *Draft PEIS for Stockpile Stewardship and Management*. It is also under consideration as a regional treatment and disposal site for LLW and mixed LLW in the Waste Management PEIS. In addition, environmental restoration activities at SRS are expected to continue for 30 years and therefore would coincide with the operation of the proposed surplus HEU and blending facilities as well as the other applicable program activities described above.

Table 4.6.2.1-1. Site Infrastructure Cumulative Impacts at Oak Ridge Reservation

Category	No Action ^a	Waste Management	Storage and Disposition ^b		Stockpile Stewardship and Management ^c	Medical Isotopes Facility	HEU ^d	Total
			Storage	Disposition				
[Text deleted.]								
Energy (MWh/yr)	726,000	776,200	68,000	69,000	94,000	500	5,000	1,738,700
Peak Load (MWe)	110	e	11	15	14	e	2	152
Natural Gas (m ³ /yr)	95,000,000	e	949	10,426,000	4,000,000	e	19,800	109,446,750
Diesel/oil (l/yr)	416,000	e	49,000	208,059,750	213,000	e	56,800	208,794,550
Coal (t/yr)	16,300	e	6,600	0	800	e	363	24,063
Water (million l/yr)	14,210	814	370	60,560	550	120	19	76,643
[Text deleted.]								

^a Includes actions from the Y-12 EA.

^b Storage data is based on the maximum applicable alternative operational requirement. Pu disposition data is based on the summation of the applicable alternatives maximum operational requirements.

^c Data presented is the maximum change in site requirements due to No Action or downsizing secondary and case fabrication.

^d Data represents the maximum value for the blending options at Y-12.

^e Data not reported.

Note: MWe=megawatt electric.

Source: DOE 1995cc; DOE 1995dd; DOE 1996a; DOE 1996b; DOE 1996h; OR DOE 1994d; OR MMES 1995i.

Table 4.6.2.1-2 provides a listing of the site infrastructure related impacts associated with existing and other proposed actions at SRS. The cumulative impact of implementing the proposed blending facilities in conjunction with other proposed activities is expected to have little or no impact on the onsite road and rail network. The cumulative electrical power requirements for the proposed activities would be limiting. This results primarily from consideration of the accelerator production of tritium alternative of the Tritium Supply and Recycling program. Cumulative fuel consumption and water/steam supply requirements for all the proposed actions are readily available in the area and can be satisfied through normal contractual means.

Babcock & Wilcox. There are no proposed actions at B&W in the reasonably foreseeable future other than the blending of HEU received from Kazakhstan, which is currently being implemented. [Text deleted.] This action is part of B&W's current licensed operation, and because of this small quantity of HEU (approximately 600 kg [1,320 lb]), the blending operation is anticipated to be completed prior to the proposed action associated with this EIS.

Nuclear Fuel Services. No future activities are currently proposed for NFS other than existing licensed operations. Therefore, cumulative impacts at NFS would be similar to impacts analyzed for each alternative in this EIS.

4.6.2.2 Air Quality and Noise

Cumulative impacts to air quality constitute emission sources at each facility including no action and planned or proposed emissions. Only the cumulative impacts for criteria pollutants are presented since there are no anticipated toxic/nonradiological hazardous air pollutant releases from the surplus HEU disposition proposal. Cumulative radiological air emission impacts are considered in the public and occupational health section (Section 4.6.2.5). Concentrations of criteria pollutants are calculated from these emissions using site-specific meteorology, dispersion characteristics, terrain, and stack parameters. These criteria pollutant concentrations then are compared to Federal and state regulations and guidelines to determine compliance.

Each of the candidate sites, ORR, SRS, B&W, and NFS, is currently in compliance with Federal as well as state regulations and guidelines. Air emissions from the planned or proposed activities plus the no action emissions would increase concentrations of criteria pollutants. The cumulative impacts are presented in Tables 4.6.2.2-1 through 4.6.2.2-4 for each candidate site, respectively. The resulting concentrations from cumulative impacts would be in compliance with Federal and state regulations at each candidate site.

Oak Ridge Reservation. Cumulative impacts to air quality at ORR include impacts from no action emissions, HEU blending activities and the five documents listed in Section 4.6.1. Incremental increases in air pollutants result from each of these proposed activities and contribute to the cumulative impacts at the site. Estimated cumulative concentrations of criteria pollutants at ORR are presented in Table 4.6.2.2-1. The baseline includes impacts from the Y-12 EA and FONSI. [Text deleted.]

Savannah River Site. Cumulative impacts with respect to air quality at SRS include impacts from no action emissions, HEU blending activities and the 10 documents listed in Section 4.6.1. [Text deleted.] The resulting cumulative concentrations of criteria pollutants at SRS are shown in Table 4.6.2.2-2.

Babcock & Wilcox. Cumulative impacts to air quality at B&W include impacts from no action emissions of pollutants and HEU to LEU conversion and blending. Table 4.6.2.2-3 presents cumulative impacts for B&W.

Nuclear Fuel Services. Cumulative impacts to air quality at NFS include emissions of pollutants from no action and HEU to LEU conversion and blending. Table 4.6.2.2-4 presents cumulative impacts for NFS.

Cumulative noise impacts include contributions from existing and planned facilities plus proposed facilities at each of the candidate sites. Noise impacts may result both from onsite noise sources and from offsite sources such as traffic. Noise impacts on individuals from this alternative are expected to be small, resulting in little or no increase in noise levels at offsite areas. Little or no increase in cumulative noise impacts to individuals offsite is expected to occur.

Table 4.6.2.1-2. Site Infrastructure Cumulative Impacts at Savannah River Site

Category	No Action	SRS Consolidated Actions ^a	Tritium Supply and Recycle ^b	Foreign Research Reactor Spent Nuclear Fuel	Waste Management	Storage and Disposition ^c		Stockpile Stewardship and Management	HEU ^d	Total
						Storage	Disposition			
[Text deleted.]										
Energy (MWh/yr)	659,000	963,400	4,534,000	1,500	120,000	76,000	69,000	9,700	5,000	6,437,600
Peak Load (MWe)	130	^d	666	^e	^e	13	15	1.6	2	828
Natural Gas (m ³ /yr)	0	0	0	^e	^e	0	10,426,000 ^f	0	19,800 ^g	10,445,800
Diesel/oil (l/yr)	28,400,000	4,070,000	9,180,000	^e	^e	49,000	208,059,750	28,400	56,800	249,843,950
Coal (t/yr)	210,000	2,580	221,400	^e	^e	4,990	0	1,090	363	440,423
Water (million l/yr)	153,687	6,430	4,595	1.9	325	60,560	459	46	19	226,114
[Text deleted.]										

^a Includes actions from Interim Management of Nuclear Material; F-Canyon Plutonium Solutions; Defense Waste Processing Facility; and Programmatic INEL Spent Nuclear Fuel; SRS Waste Management EIS data not reported.

^b An Accelerator Production of Tritium is to be constructed at SRS.

^c Storage data is based on the maximum applicable alternative operational requirement. Pu disposition data is based on the summation of the applicable alternatives maximum operational requirements.

^d Data represents the maximum value for the blending options at SRS.

^e Data not reported.

^f Natural gas is not available at SRS; therefore, diesel/oil gas (approximately 14.8 million l) would be substituted for a natural gas requirement of 10.4 million m³/year.

^g Natural gas is not available at SRS; therefore, diesel/oil gas (approximately 28,200 l) would be substituted for a natural gas requirement of 19,800 m³/year.

Note: MWe=megawatt electric.

Source: DOE 1995i; DOE 1995p; DOE 1995cc; DOE 1995dd; DOE 1996a; DOE 1996b; DOE 1996g; SR DOE 1994a; SR DOE 1994b; SR DOE 1995b; SR DOE 1995c; SR DOE 1995e; SRS 1993a:3.

Table 4.6.2.2-1. Estimated Cumulative Concentrations of Criteria Pollutants at Oak Ridge Reservation

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines ($\mu\text{g}/\text{m}^3$)	Cumulative Concentration			
			No Action ($\mu\text{g}/\text{m}^3$)	Other Onsite Activities ^a ($\mu\text{g}/\text{m}^3$)	HEU ($\mu\text{g}/\text{m}^3$)	Total ($\mu\text{g}/\text{m}^3$)
Carbon monoxide (CO)	8 hours	10,000 ^b	5	9.7	11.5	26.2
	1 hour	40,000 ^b	11	29.5	53	93.5
Lead (Pb)	Calendar Quarter	1.5 ^b	0.05	c	d	0.05
Nitrogen dioxide (NO ₂)	Annual	100 ^b	3	0.9	1.33	5.23
Particulate matter (PM ₁₀)	Annual	50 ^b	1	9.6	0.03	10.63
	24 hours	150 ^b	2	27.6	0.37	29.97
Sulfur dioxide (SO ₂)	Annual	80 ^b	2	43.7	2.46	48.16
	24 hours	365 ^b	32	20.2	29.3	81.5
	3 hours	1,300 ^b	80	718	161	959
Mandated by Tennessee						
Total suspended particulates (TSP)	24 hours	150 ^e	2	27.6	80.16	109.76
Gaseous fluorides (as HF)	1 month	1.2 ^c	0.2	c	d	0.2
	1 week	1.6 ^c	0.3	c	d	0.3
	24 hours	2.9 ^c	<0.6	c	d	<0.6
	12 hours	3.7 ^c	<0.6	c	d	<0.6
	8 hours	250 ^e	0.6	c	d	0.6

^a Other onsite activities including the Y-12 EA, Waste Management, Storage and Disposition, Stockpile Stewardship and Management, and Medical Isotope Production EIS.

^b Federal standard.

^c Data not available.

^d No emissions from the proposed HEU blending activities.

^e State standard or guideline.

[Text deleted.]

Note: Ozone, as a criteria pollutant, is not directly emitted or monitored by the candidate sites.

Source: 40 CFR 50; DOE 1995i; DOE 1995cc; DOE 1996a; DOE 1996b; DOE 1996h; OR LMES 1995b; OR LMES 1995d; TN DEC 1994a; TN DHE 1991a.

Table 4.6.2.2-2. Estimated Cumulative Concentrations of Criteria Pollutants at Savannah River Site

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines ($\mu\text{g}/\text{m}^3$)	Cumulative Concentration			
			No Action ($\mu\text{g}/\text{m}^3$)	Other Onsite Activities ^a ($\mu\text{g}/\text{m}^3$)	HEU ($\mu\text{g}/\text{m}^3$)	Total ($\mu\text{g}/\text{m}^3$)
Carbon monoxide (CO)	8 hours	10,000 ^b	22	383	0.07	405.07
	1 hour	40,000 ^b	171	1708	0.14	11879.14
Lead (Pb)	Calendar Quarter	1.5 ^b	0.0004	^c	^d	0.0004
Nitrogen dioxide (NO ₂)	Annual	100 ^b	5.7	21	0.01	26.71
Particulate matter (PM ₁₀)	Annual	50 ^b	3	0.2	<0.01	3.21
	24 hours	150 ^b	50.6	8.5	<0.01	59.11
Sulfur dioxide (SO ₂)	Annual	80 ^b	14.5	2.2	0.02	59.11
	24 hours	365 ^b	196	53.3	0.32	249.62
	3 hours	1,300 ^b	823	335	0.71	1158.71
Mandated by South Carolina						
Total suspended particulates (TSP)	Annual	75 ^e	12.6	0.2	0.05	12.85
Gaseous fluorides (as HF)	1 month	0.8 ^e	0.09	^c	^d	0.09
	1 week	1.6 ^e	0.39	^c	^d	0.39
	24 hours	2.9 ^e	1.04	^c	^d	1.04
	12 hours	3.7 ^e	1.99	^c	^d	1.99

^a Other onsite activities including the Interim Management of Nuclear Materials, Tritium Supply and Recycling, F-Canyon Plutonium Solutions, Defense Waste Processing Facility, Foreign Research Spent Nuclear Fuel, INEL Spent Nuclear Fuel Management, SRS Waste Management, Waste Management, Storage and Disposition, and Stockpile Stewardship and Management.

^b Federal standard.

^c Data not available.

^d No emissions from the HEU blending activities.

^e State standard or guideline.

Note: Ozone, as a criteria pollutant, is not directly emitted nor monitored by the candidate sites.

Source: 40 CFR 50; DOE 1995i; DOE 1995p; DOE 1995cc; DOE 1996a; DOE 1996b; DOE 1996g; OR LMES 1995b; OR LMES 1995d; SC DHEC 1992b; SR DOE 1994a; SR DOE 1994b; SR DOE 1995b.

Table 4.6.2.2-3. Estimated Cumulative Concentrations of Criteria Pollutants at Babcock & Wilcox

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines ($\mu\text{g}/\text{m}^3$)	Cumulative Concentration		
			No Action ($\mu\text{g}/\text{m}^3$)	HEU ($\mu\text{g}/\text{m}^3$)	Total ($\mu\text{g}/\text{m}^3$)
Carbon monoxide (CO)	8 hours	10,000 ^a	4	5.43	9.43
	1 hour	40,000 ^a	13.1	17.63	30.73
Lead (Pb)	Calendar Quarter	1.5 ^a	^b	^c	^b
Nitrogen dioxide (NO ₂)	Annual	100 ^a	3.5	0.14	3.64
Particulate matter (PM ₁₀)	Annual	50 ^a	0.02	0.03	0.05
	24 hours	150 ^a	0.16	0.19	0.35
Sulfur dioxide (SO ₂)	Annual	80 ^a	0.34	0.4	0.74
	24 hours	365 ^a	2.28	2.74	5.02
	3 hours	1,300 ^a	11.8	14.11	25.91
Mandated by Virginia					
Total suspended particulates (TSP)	Annual	60 ^d	0.03	0.03	0.06
	24 hours	150 ^d	0.22	0.19	0.41

^a Federal standard.^b Data not available.^c No emissions from the proposed HEU blending activities.^d State standard or guideline.

Note: Ozone, as a criteria pollutant, is not directly emitted or monitored by the candidate sites.

Source: 40 CFR 50; DOE 1995a; OR LMES 1995b; VA APCB 1993a; VA DEQ 1995a; VA DEQ 1995b.

Table 4.6.2.2-4. Estimated Cumulative Concentrations of Criteria Pollutants at Nuclear Fuel Services

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines ($\mu\text{g}/\text{m}^3$)	Cumulative Concentration		
			No Action ($\mu\text{g}/\text{m}^3$)	HEU ($\mu\text{g}/\text{m}^3$)	Total ($\mu\text{g}/\text{m}^3$)
Carbon monoxide (CO)	8 hours	10,000 ^a	1.97	0.62	2.59
	1 hour	40,000 ^a	2.52	0.80	3.32
Lead (Pb)	Calendar Quarter	1.5 ^a	b	c	b
Nitrogen dioxide (NO ₂)	Annual	100 ^a	0.62	0.03	0.65
Particulate matter (PM ₁₀)	Annual	50 ^a	0.03	<0.01	0.04
	24 hours	150 ^a	0.21	0.03	0.24
Sulfur dioxide (SO ₂)	Annual	80 ^a	0.02	0.05	0.07
	24 hours	365 ^a	0.15	0.40	0.55
	3 hours	1,300 ^a	0.35	0.96	1.31
Mandated by Tennessee					
Total suspended particulates (TSP)	24 hours	150 ^d	0.21	0.03	0.24
Gaseous fluorides (as HF)	1 month	1.2 ^d	0.02	trace ^e	0.02
	1 week	1.6 ^d	<0.06	trace ^e	<0.06
	24 hours	2.9 ^d	0.06	trace ^e	0.06
	12 hours	3.7 ^d	0.10	trace ^e	0.10
	8 hours	250 ^d	0.11	trace ^e	0.11

^a Federal standard.

^b Data not available.

^c No emissions from the proposed HEU blending activities.

^d State standard or guideline.

^e Hydrofluorination is anticipated to be a closed system with a scrubber filter exhaust system. Therefore, emission of gaseous fluorides is estimated to be a trace amount.

[Text deleted.]

Note: Ozone, as a criteria pollutant, is not directly emitted or monitored by the candidate sites.

Source: 40 CFR 50; NF NRC 1991a; OR LMES 1995b; TN DEC 1994a; TN DEC nda; TN DHE 1991a.

4.6.2.3 Water Resources

Implementation of decisions associated with the HEU disposition proposed action would contribute minimal water resource impacts at each site. The potential effect of these actions on cumulative impacts for each site is discussed below.

Oak Ridge Reservation. The operation of a UNH blending facility alternative would have the greatest impact on water resources at ORR, among other blending alternatives evaluated in this EIS. Other operations and new facilities planned that could add cumulative impacts to water resources are those associated with the five other DOE programs identified in Section 4.6.1 and current DOE operations. [Text deleted.]

Table 4.6.2.3-1 summarizes the estimated cumulative water usage from the Clinch River. Water requirements during the operation of all the proposed projects would be obtained from the Clinch River. Total cumulative water requirements for the site (76,643 million l/yr [20,247 MGY]) would be 1.8 percent of the Clinch River's average flow (132 m³/s [4,661 ft³/s]). The proposed UNH blending facility would account for approximately 0.03 percent of the cumulative water usage.

Among the alternatives evaluated in this EIS, the operation of a UNH blending facility alternative would have the greatest impact on water quality at ORR. Table 4.6.2.3-2 summarizes the estimated cumulative water discharge to the Clinch River via Bear Creek, McCoy Branch, Rogers Quarry, and East Fork Poplar Creek. [Text deleted.] Total estimated cumulative wastewater discharge (13,141 million/yr [3,472 MGY]) would be discharged to East Fork Poplar Creek and Clinch River. The proposed UNH blending facility would account for 0.1 percent of the total estimated cumulative wastewater discharge.

If all the wastewater were to be discharged to East Fork Poplar Creek, the total cumulative amount (13,141 million l/yr [3,472 MGY]) would represent approximately 32 percent of the average flow (1.3 m³/s [45 ft³/s]). All wastewater effluent from treatment facilities would be released on a continuous basis, without causing impacts to the creek or to downstream users. Unlike wastewater effluent from treatment facilities, cooling system

Table 4.6.2.3-1. Cumulative Annual Water Usage at Oak Ridge Reservation^{a, b}

Program	Water Requirement (million l/yr)
No Action	14,210 ^c
[Text deleted.]	
Waste Management	814.5 ^b
Storage and Disposition	60,930 ^{b, d}
Stockpile Stewardship and Management	550
Proposed Medical Isotope Production	120 ^b
HEU	19 ^b
Total annual cumulative water usage	76,644

^a Includes both groundwater and surface water usage.

^b Data represents the maximum value for the comparative alternative scenario.

^c Y-12 EA included in current ORR water usage.

^d Includes 370 million l/yr for the storage alternative and 60,560 million l/yr for the disposition alternative.

[Text deleted.]

Source: DOE 1995cc; DOE 1996a; DOE 1996b; DOE 1996h; OR LMES 1995b; OR MMES 1995i.

Table 4.6.2.3-2. Cumulative Annual Wastewater Discharge at Oak Ridge Reservation

Program	Nonhazardous Sanitary and Industrial (million l/yr)
No Action	1,858 ^{a, b}
[Text deleted.]	
Waste Management	101.9 ^c
Storage and Disposition	11,162 ^{c, d}
Stockpile Stewardship and Management	0 ^e
Proposed Medical Isotope Production	f
HEU	18.7 ^c
Total annual cumulative treated wastewater discharged	13,141

^a Includes nonhazardous sanitary and nonhazardous wastewater discharges from ORR activities.

^b Y-12 EA, no number was reported.

^c Based on the highest treated volumes from the alternative scenario.

[Text deleted.]

^d Includes wastewater from the storage alternative 185 million l/yr and 10,977 million l/yr for the disposition alternative.

^e Would not releasing additional wastewater.

^f No number was reported.

Source: DOE 1995cc; DOE 1996a; DOE 1996b; DOE 1996h; OR LMES 1995b; OR MMES 1995i.

blowdown activities associated with the Storage and Disposition Program would discharge greater quantities over a shorter period of time. These discharges would cause scouring of streambeds, erosion of stream channels, increased turbidity, and potential flooding of areas.

All the wastewater discharged to the sub-drainage basins on the ORR flows directly to the Clinch River. The total cumulative wastewater discharge (13,141 million l/yr [3,472 MGY]) would represent approximately 0.3 percent of the average flow of the river (132 m³/s [4,647 ft³/s]) and would therefore have no adverse effect on flow or downstream users. All discharges would be monitored to comply with NPDES permit limits.

Existing ORR treatment facilities could accommodate all the new cumulative process and wastewater streams. The expected total cumulative wastewater discharge to the tributaries, 13,141 million l/yr (3,472 MGY), would continue to meet NPDES limits and reporting requirements. DOE is currently involved with the remediation of East Fork Poplar Creek under CERCLA, because the creek was contaminated by past releases from the Y-12 Plant. Significant clean-up activities are required on- and off-site.

Savannah River Site. Among the alternatives evaluated in this EIS, the operation of a UNH blending facility would have the greatest impact on water resources at SRS. Table 4.6.2.3-3 summarizes the estimated cumulative water usage from the Savannah River and groundwater. Water requirements during operation of all the proposed projects would be obtained from existing or new well fields at SRS and from the Savannah River. Total cumulative water requirements for the site (226,115 million l/yr [59,733 MGY]) would be a 47-percent increase over current usage. Of the 226,115 million l/yr (59,733 MGY), approximately 200,000 million l/yr (52,840 MGY) would be supplied by surface water. This amount is 2.3 percent of the Savannah River's average flow and 3.5 percent of the river's minimum flow. After treatment, most of the water withdrawn is returned to the Savannah River through its onsite tributaries and would not affect downstream users. The remaining water requirements would be withdrawn from groundwater sources. Suitable groundwater from the deep aquifers at the site is

Table 4.6.2.3-3. Cumulative Annual Water Usage at Savannah River Site

Program	Water Requirement (million l/yr) ^a
No Action	153,687
Interim Management of Nuclear Materials	5,100 ^b
Tritium Supply and Recycling	4,595 ^c
F-Canyon Plutonium Solutions	1,190 ^b
Defense Waste Processing Facility	91.2 ^b
Foreign Research Spent Nuclear Fuel	1.9 ^b
Programmatic INEL Spent Nuclear Fuel Management	49 ^b
Waste Management	325 ^{b, d}
Storage and Disposition	61,010 ^{b, d, e}
Stockpile Stewardship and Management	46 ^{b, d}
HEU	19 ^b
Total annual cumulative water usage	226,114

^a Includes both groundwater and surface water usage.

^b Based on comparative alternative scenario.

[Text deleted.]

^c An accelerated production of tritium facility is to be constructed at SRS.

^d Based on preliminary data.

^e Includes 450 million l/yr for the storage alternative and 60,560 million l/yr for the disposition alternative.

Source: DOE 1995i; DOE 1995p; DOE 1995cc; DOE 1996a; DOE 1996b; DOE 1996g; OR LMES 1995b; SR DOE 1994a; SR DOE 1994b; SR DOE 1995e; SRS 1995a:2.

abundant and aquifer depletion is not a problem. Pumping from the deep aquifer to meet domestic, process and other water uses has continued since the early 1950s. This usage has not adversely affected water levels in the deep aquifer. The proposed UNH blending facility would account for 0.008 percent of the total cumulative water usage.

Among the alternatives evaluated in this EIS, the operation of a UNH blending facility would have the greatest effect on wastewater discharge to the Savannah River. Table 4.6.2.3-4 summarizes the estimated treated wastewater discharge to the Savannah River. Total cumulative wastewater discharge (13,087 million l/yr [3,457 MGY]) would be 0.15 percent of the average Savannah River flow.

[Text deleted.]

The proposed UNH blending facility would account for 0.14 percent of total estimated cumulative waste water discharge to the Savannah River and

Table 4.6.2.3-4. Cumulative Annual Wastewater Discharge at Savannah River Site

Program	Nonhazardous Sanitary and Industrial (million l/yr)
No Action	731.6 ^a
Interim Management of Nuclear Materials	0 ^b
Tritium Supply and Recycling	908 ^c
F-Canyon Plutonium Solutions	^a
Defense Waste Processing Facility	52.6 ^d
Foreign Research Spent Nuclear Fuel	1.9 ^d
Programmatic INEL Spent Nuclear Fuel Management	49 ^d
Waste Management	83 ^{d, e}
Storage and Disposition	11,196.6 ^{e, f}
Stockpile Stewardship and Management	46 ^{d, e}
HEU	18.7 ^d
Total annual wastewater discharges to the Savannah River	13,087

^a Currently discharged from the Centralized Sanitary Wastewater Treatment Plant (730 million l/yr) and the F- and H-Area effluent treatment facility (1.6 million l/yr).

^b No number reported.

^c An accelerated production of tritium facility is to be constructed at SRS.

^d Based on the highest treated volumes from the alternative scenarios.

^e Based on preliminary data.

^f Includes 219.6 million l/yr for the storage alternative and 10,977 million l/yr for the disposition alternative.

Source: DOE 1995i; DOE 1995p; DOE 1995cc; DOE 1996a; DOE 1996b; DOE 1996g; OR LMES 1995b; SR DOE 1994a; SR DOE 1994b; SR DOE 1995e; SRS 1995a:2.

2.2 percent of the wastewater treated at the Centralized Sanitary Waste Water Treatment Plant.

Existing SRS treatment facilities could accommodate all the new cumulative process and

wastewater streams if a new facility is built for tritium supply and recycle operations as planned. The expected total cumulative wastewater discharge to the tributaries, 13,087 million l/yr (3,457 MGY), would continue to meet NPDES limits and reporting requirements

Downstream (approximately 130 river miles or 210 km), the Beaufort-Jasper Water Authority in South Carolina withdraws approximately 7,200 million l/yr (1,900 MGY) to a population of about 51,000 persons. By the year 2000, Beaufort-Jasper plans to supply water to 177,000 persons. The Cherokee Hill Water Treatment Plant (130 river miles or 210 km) downstream withdraws about 4,200 million l/yr (1,110 MGY) and plans to supply a domestic equivalent of 200,000 persons in the future.

Babcock & Wilcox. No future activities are currently proposed for B&W that would add cumulatively to the site's water usage or affect water quality. Therefore the cumulative impacts for water resources would be similar to the impacts analyzed for each alternative in this EIS.

[Text deleted.]

[Table deleted.]

Nuclear Fuel Services. No future activities are currently proposed for NFS that would add cumulatively to the site's water usage or affect water quality. Therefore, the cumulative impacts for water resources would be similar to the impacts analyzed for each alternative in this EIS.

[Table deleted.]

4.6.2.4 Socioeconomics

Implementation of decisions associated with the surplus HEU disposition proposed action would contribute minimal socioeconomic impacts on the regions. The potential effect of these actions on cumulative impacts for each site is discussed below.

Oak Ridge Reservation. The cumulative impacts resulting from HEU blending facilities at ORR on the regional economy, population, housing, community services, and local transportation would be minor (see Appendix F). A maximum of 125 direct jobs and

319 indirect jobs in the local economy would be created for this proposed action. In addition to the existing conditions, and the HEU blending program, there are five other DOE documents identified in Section 4.6.1 included in the cumulative analysis. [Text deleted.]

If all of the alternatives were located at this site, the maximum possible total of 9,000 peak construction jobs and 5,000 operations jobs would be created. This would generate a total of approximately 13,000 indirect jobs on the local economy. This is approximately 3 percent of the civilian labor force for the ORR REA.

These increases would generally be beneficial to the economy, providing new jobs and increased revenues in the ROI. However, in-migrating workers would be required to fill a portion of the new jobs created, which would require an increase in housing units and community services. Additionally, new road construction may be needed to handle traffic increases in the ROI.

The temporary nature of construction-related jobs coupled with the differences in peak employment years between the various alternatives would lessen any impacts associated with the construction phase. Operation-related jobs would have a more permanent impact on the region. Phasing in the operation employment and training for each program would reduce the annual level of housing demand and smooth the peak and valley effect that would occur between peak construction and full operation.

Savannah River Site. The cumulative impacts resulting from the proposed HEU blending facilities at SRS on the regional economy, population, housing, community services, and local transportation would be minor (see Appendix F). A maximum of 125 direct jobs and 245 indirect jobs in the local economy would be created. In addition to the existing conditions and the HEU blending program, there are 10 other DOE documents identified in Section 4.6.1 included in the cumulative analysis. Programs being considered for SRS include the Storage and Disposition of Weapons-Usable Fissile Materials which would generate a maximum of 8,900 peak year construction-related jobs and 6,300 operation-related jobs and Stockpile Stewardship and Management which would create

about 280 peak year construction-related and 810 operation-related jobs. The SRS IMNM EIS indicates that it is unlikely that new jobs would be created at SRS to support this program. The Tritium Supply and Recycling mission would generate approximately 1,400 peak year construction-related and 630 operation-related jobs. The *SRS Defense Waste Processing Facility Supplemental EIS* estimates this program would create a maximum of 270 peak year construction-related jobs but there would be no new operation-related jobs. Also, the *Programmatic Spent Nuclear Fuel Management and INEL Restoration and the Waste Management Program EIS* estimates this mission would generate a maximum of 2,700 peak year construction-related jobs but there would be no new operations-related jobs.

If all of the proposed alternatives were simultaneously sited at SRS, approximately 14,000 peak year construction-related and less than 8,000 operation-related jobs would be created. This would generate about 16,000 new indirect jobs during full operation in the local region which would lead to about an 8 percent increase in the civilian labor force in the SRS REA. These increases would generally be beneficial to the economy, providing new jobs and increased revenues in the ROI. However, in-migrating workers would be required to fill a portion of the new jobs created which would require an increase in housing units and community services. Additionally, new road construction may be needed to handle traffic increases in the ROI.

The temporary nature of construction-related jobs coupled with the differences in peak employment years between the various alternatives would lessen any impacts associated with the construction phase. Operation-related jobs would have a more permanent impact on the region. Phasing in the operation employment and training for each program would reduce the annual level of housing demand and smooth the peak and valley effect that would occur between peak construction and full operation.

Babcock & Wilcox. The cumulative impacts resulting from the proposed HEU blending facilities at B&W on the regional economy, population, housing, community services, and local transportation would be minor. The maximum number of direct jobs created by the HEU program

should not exceed 126 at the site and another 285 indirect jobs in the regional economy. The other programs currently being considered for B&W, the disposition of Kazakhstan HEU, would be absorbed by the current workforce. [Text deleted.] The impact of this small number of jobs generated by the HEU program would be a slight improvement in the regional economy, the housing market would not be burdened, but road congestion may worsen due to increased traffic. A summary of the socioeconomic impacts of operating an HEU blending facility at B&W are presented in Appendix F of this document.

Nuclear Fuel Services. No future activities are currently being proposed for NFS other than existing licensed operations. Therefore, cumulative impacts at NFS would be similar to the impacts analyzed for each alternative in this EIS.

4.6.2.5 Public and Occupational Health

The cumulative radiological doses and resulting health effects are summarized in Table 4.6.2.5-1 for each of the four sites being assessed in this EIS. [Text deleted.] In regard to the presented cumulative impact results, it should be noted that SRS could exceed the proposed population dose reporting limit (58 FR 16268) of 100 person-rem/yr if certain activities (as shown in Table 4.6.2.5-1) are in an operational mode during the years in which blending processes are to be in effect. Furthermore, it should also be noted that the total cumulative SRS site dose to the MEI would not exceed the 100 mrem/yr limit; however, the 10 mrem/yr limit due to airborne releases (*Clean Air Act*) could be exceeded if key potential activities at the site were operational at the same time as the blending processes. However, the 100 person-rem/yr is only a proposed notification requirement. No mitigation measures would be required at this point. With the exception of no action, the values presented in this table are projected estimates and do not reflect actual doses and resulting health effects. This potential limit exceedance however, conservatively assumes that the MEI would have to be located at several different receptor points simultaneously, therefore representing an upper-bounding scenario. The cumulative chemical exposure risk and resulting health effects are summarized in Table 4.6.2.5-2 for each of the four sites being addressed in this EIS.

4.6.2.6 Waste Management

Implementation of decisions associated with surplus HEU disposition proposed actions would impact waste management activities at each of the candidate sites. The following sections discuss how waste management activities would be affected cumulatively at each site.

Oak Ridge Reservation. ORR is a candidate site for HEU blending and in five documents identified in Section 4.6.1. The largest impact results if ORR is selected as a regional disposal site under one of the Regionalized Alternatives in the Waste Management PEIS. The next largest impact is expected from the Collocation Storage option in the Storage and Disposition PEIS. As illustrated in Table 4.6.2.6-1, it is expected that surplus HEU blending alternatives would have consistently smaller impacts than other foreseeable activities. Thus, the impact of blending HEU to LEU is small compared to the cumulative impacts of other potential actions at ORR.

Savannah River Site. The SRS is a candidate site for HEU blending and in 10 documents identified in Section 4.6.1. The largest impact on radioactive waste management would result if SRS is selected for a regional treatment and disposal facility for LLW and mixed LLW as a result of the ROD from the Waste Management PEIS. The next largest radioactive waste management impact would occur if the ROD selects the preferred actions recommended in the *Interim Management of Nuclear Materials EIS*. The largest impact on nonhazardous liquid waste management would occur as a result of the ROD from the *PEIS for Tritium Supply and Recycling* and/or if SRS were selected as a reactor site for plutonium disposition in the ROD resulting from the Storage and Disposition PEIS. The largest impact on hazardous waste management would result if SRS was selected for a mixed oxide fuel fabrication mission in the ROD from the Storage and Disposition PEIS.

As illustrated in Table 4.6.2.6-2 it is expected that the surplus HEU blending alternatives would have consistently smaller impacts than other foreseeable activities; thus, the overall impact of blending HEU to LEU would not contribute significantly to cumulative impacts at SRS.

Table 4.6.2.5-1. Estimated Average Annual Cumulative Radiological Doses and Resulting Health Effects to Offsite Population and Facility Workers

Program	Maximally Exposed Individual		Total Population Within 80 km ^a		Workers	
	Total Dose ^b (rem)	Fatal Cancer Risk ^c	Total Dose ^d (person-rem)	Number of Fatal Cancers ^c	Total Dose ^e (person-rem)	Number of Fatal Cancers ^c
Oak Ridge Reservation						
No Action	3.0x10 ⁻³	1.5x10 ⁻⁶	28	1.4x10 ⁻²	68	2.7x10 ⁻²
Y-12 Interim Storage	1.3x10 ⁻³	6.5x10 ⁻⁷	12	6.0x10 ⁻³	12.9	5.2x10 ⁻³
Waste Management	5.8x10 ⁻⁴	2.9x10 ⁻⁷	19	9.4x10 ⁻³	0.45	1.8x10 ⁻⁴
Storage and Disposition	4.6x10 ⁻⁸	2.3x10 ⁻¹¹	8.2x10 ⁻⁴	4.1x10 ⁻⁷	24	9.6x10 ⁻³
Stockpile Stewardship and Management ^f	2.0x10 ⁻⁴	1.0x10 ⁻⁷	0.6	3.0x10 ⁻⁴	-1.8	-7.2x10 ⁻⁴
Proposed Medical Isotope Production	3.1x10 ⁻⁴	1.6x10 ⁻⁷	15	7.5x10 ⁻³	25	1.0x10 ⁻²
HEU	3.9x10 ⁻⁵	2.0x10 ⁻⁸	0.16	8.0x10 ⁻⁵	11.3	4.5x10 ⁻³
[Text deleted.]						
Savannah River Site						
No Action	3.2x10 ⁻⁴	1.6x10 ⁻⁷	21.5	1.1x10 ⁻²	216	8.6x10 ⁻²
Interim Management of Nuclear Materials	2.8x10 ⁻³	1.4x10 ⁻⁶	110	5.5x10 ⁻²	140	5.6x10 ⁻²
Tritium Supply and Recycling	2.5x10 ⁻³	1.2x10 ⁻⁶	210	0.11	42	1.7x10 ⁻²
F-Canyon Plutonium Solutions	8.9x10 ⁻⁶	4.5x10 ⁻⁹	0.38	1.9x10 ⁻⁴	131	5.2x10 ⁻²
Defense Waste Processing Facility	1.0x10 ⁻⁶	5.0x10 ⁻¹⁰	7.0x10 ⁻²	3.5x10 ⁻⁵	118	4.7x10 ⁻²
Foreign Reactor Spent Fuel	1.8x10 ⁻⁷	9.0x10 ⁻¹¹	8.6x10 ⁻³	4.3x10 ⁻⁶	32	1.3x10 ⁻²
INEL Spent Nuclear Fuel	5.0x10 ⁻⁴	2.5x10 ⁻⁷	18.4	9.2x10 ⁻³	76	3.4x10 ⁻²
Waste Management ^g	3.3x10 ⁻⁵	1.7x10 ⁻⁸	1.5	7.4x10 ⁻⁴	81	3.2x10 ⁻²
Storage and Disposition	1.4x10 ⁻⁸	7.0x10 ⁻¹²	7.8x10 ⁻⁴	3.9x10 ⁻⁷	24	9.6x10 ⁻³
Stockpile Stewardship and Management	1.0x10 ⁻⁸	5.0x10 ⁻¹²	5.9x10 ⁻⁴	3.0x10 ⁻⁷	156	6.2x10 ⁻²
Vogtle Nuclear Plant ^h	1.7x10 ⁻⁴	8.5x10 ⁻⁸	5.7x10 ⁻²	2.9x10 ⁻⁵	NA	NA
HEU	2.5x10 ⁻⁶	1.3x10 ⁻⁹	0.16	8.0x10 ⁻⁵	11.3	4.5x10 ⁻³
[Text deleted.]						

Table 4.6.2.5-1. Estimated Average Annual Cumulative Radiological Doses and Resulting Health Effects to Offsite Population and Facility Workers—Continued

Program	Maximally Exposed Individual		Total Population Within 80 km ^a		Workers	
	Total Dose ^b (rem)	Fatal Cancer Risk ^c	Total Dose ^d (person-rem)	Number of Fatal Cancers ^e	Total Dose ^e (person-rem)	Number of Fatal Cancers ^e
Babcock & Wilcoxⁱ						
No Action ^j	5.0x10 ⁻⁵	2.5x10 ⁻⁸	0.35	1.8x10 ⁻⁴	18	7.2x10 ⁻³
HEU	3.5x10 ⁻⁶	1.8x10 ⁻⁹	3.2x10 ⁻²	1.6x10 ⁻⁵	14.5	5.8x10 ⁻³
[Text deleted.]						
Nuclear Fuel Services						
No Action	3.3x10 ⁻⁵	1.7x10 ⁻⁸	0.2	1.0x10 ⁻⁴	16.3	6.5x10 ⁻³
HEU	2.5x10 ⁻⁴	1.3x10 ⁻⁷	2.3	1.2x10 ⁻³	14.5	5.8x10 ⁻³
[Text deleted.]						

^a Collective dose to the 80-km population surrounding each given site.

^b The applicable limits for an individual member of the public from total site (DOE and commercial) operations are 10 mrem/yr from the air pathways, 4 mrem/yr from the drinking water pathway, 100 mrem/yr from all pathways combined for DOE sites, and 25 mrem/yr from all pathways combined for commercial sites.

^c Annual incidence of excess fatal cancers.

^d Proposed 10 CFR 834 (58 FR 16268) includes the requirement that the contractor who operates a DOE site notify DOE if the potential annual population dose exceeds 100 person-rem from all pathways combined.

[Text deleted.]

^e Dose presented is for the total workforce.

^f The negative values for worker dose and fatal cancer would be due to the proposed reduction in program operations.

^g Data presented within the SRS Waste Management EIS.

^h The Vogtle Nuclear Plant is not located within the confines of the SRS boundary.

ⁱ Included impacts from B&W Commercial Fuel Operations.

^j Includes impacts of Kazakhstan EA.

Note: NA=not applicable. Program totals are not presented because resulting summations would not accurately convey a "true" aggregate of potential site activities. This is due to different modeling techniques and parameters being employed in the respective impact evaluations.

Source: BW NRC 1991a; DOE 1993n:7; DOE 1995i; DOE 1995p; DOE 1995cc; DOE 1996a; DOE 1996b; DOE 1996g; DOE 1996h; NF NRC 1991a; NRC 1995b; OR DOE 1994c; OR DOE 1994d; SR DOE 1994a; SR DOE 1994b; SR DOE 1994e; SR DOE 1995b; SR DOE 1995e; WSRC 1994d.

Table 4.6.2.5-2. Cumulative Chemical Exposure Risk and Resulting Health Effects
at Each of the Alternative Sites

Program	Maximally Exposed Individual		Onsite Worker	
	Hazard Index ^a	Cancer Risk ^b	Hazard Index ^c	Cancer Risk ^d
Oak Ridge Reservation				
No Action	3.95x10 ⁻²	0	0.154	0
HEU	3.84x10 ⁻⁴	1.21x10 ⁻¹⁵	1.26x10 ⁻³	2.75x10 ⁻¹⁴
Total	3.99x10 ⁻²	1.21x10 ⁻¹⁵	0.155	2.75x10 ⁻¹⁴
Savannah River Site				
No Action	5.16x10 ⁻³	1.31x10 ⁻⁷	1.16	1.94x10 ⁻⁴
Tritium Supply and Recycling	4.10x10 ⁻³	0	0.71	0
Interim Management of Nuclear Material	2.81x10 ⁻³	0	1.04x10 ⁻³	0
INEL Spent Nuclear Fuel	3.00x10 ⁻³	0	1.00x10 ⁻³	0
Defense Waste Processing Facility	1.00x10 ⁻³	1.00x10 ⁻⁸	3.00x10 ⁻³	1.00x10 ⁻¹⁰
HEU	4.26x10 ⁻⁵	1.35x10 ⁻¹⁵	1.13x10 ⁻³	2.47x10 ⁻¹⁴
Total	1.61x10 ⁻²	1.41x10 ⁻⁷	1.88	1.94x10 ⁻⁴
Babcock & Wilcox				
No Action	1.15x10 ⁻⁵	1.68x10 ⁻⁸	4.07x10 ⁻³	3.94x10 ⁻⁵
HEU	1.54x10 ⁻⁶	2.74x10 ⁻¹⁶	5.70x10 ⁻⁴	6.42x10 ⁻¹³
Total	1.29x10 ⁻⁵	1.68x10 ⁻⁸	4.64x10 ⁻³	3.94x10 ⁻⁵
Nuclear Fuel Services				
No Action	9.55x10 ⁻²	0	7.57x10 ⁻³	0
HEU	2.10x10 ⁻³	1.23x10 ⁻¹⁴	7.81x10 ⁻⁴	3.24x10 ⁻¹⁴
Total	9.77x10 ⁻²	1.23x10 ⁻¹⁴	8.35x10 ⁻³	3.24x10 ⁻¹⁴

^a Hazard index=sum of individual hazard quotients (noncancer adverse health effects) for MEL.

^b Lifetime cancer risk=(Emission concentrations) x (0.286 [converts concentrations to doses]) x (slope factor)

^c Hazard index=sum of individual hazard quotients (noncancer adverse health effects) for workers.

^d Lifetime cancer risk=(Emissions for 8 hr) x ((0.286 [converts concentrations to doses]) x (0.237 [Fraction of year exposed])) x (0.571 [Fraction of lifetime working]) x (slope factor)

Source: NFS 1995b:2; OR MMES 1995i; SRS 1995a:2; SRS 1996a:1; VA DEQ 1995a.

**Table 4.6.2.6-1. Waste Management Cumulative Impacts at Oak Ridge Reservation,
Annual Generated Volumes**

Waste Category	No Action ^a (m ³)	Waste Management (m ³)	Storage and Disposition ^b (m ³)	Stockpile Stewardship and Management ^c (m ³)	Medical Isotopes (m ³)	HEU ^d (m ³)	Total (m ³)
Low-Level							
Liquid	2,576	0	17	0	Included in solid	280	2,873
Solid	8,030	16,219 ^e	1,300	0	63	545	26,157
Mixed Low-Level							
Liquid	84,210	0	0	0	0	50	84,260
Solid	960	3,543 ^f	67	0	0	0	4,570
Hazardous							
Liquid	32,640	Included in solid	2	0	0	90	32,732
Solid	1,434	1,124 ^g	2	0	0	0	2,560
Nonhazardous							
Liquid	1,743,000	64,842	171,830	0	0	19,000	1,583,672
Solid	52,730	Not analyzed	870	0	0	820	54,420

^a Includes actions from the Y-12 EA/FONSI.

^b Consolidation of Pu storage collocated with HEU storage.

^c No Action.

^d Largest generated volumes from the two blending options.

^e Regionalization alternative in which ORR treats and disposes of wastes from onsite and from Ames, ANL-E, Bettis, BNL, FEMP, Fermi, KAPL, KCP, Mound, PGDP, PORTS, PPPL, RMI, and WVDP.

^f Regionalization alternative in which ORR treats and disposes of wastes from onsite and from Ames, ANL-E, BCL, Bettis, BNL, FEMP, KAPL, KCP, Mound, PGDP, PORTS NAV, PORTS, PPPL, RMI, WVDP, and U of MO.

^g Regionalization alternative in which ORR treats and disposes of wastes from onsite and from ANL-E, Fermi, KCP and SRS.

Source: 60 FR 55249; DOE 1995cc; DOE 1995dd; DOE1996a; DOE 1996b; DOE 1996h; Table 4.2.10-1.

Table 4.6.2.6-2. Waste Management Cumulative Impacts at Savannah River Site, Annual Generated Volumes

Waste Category	1993 Generation (m ³)	SRS Consolidated Actions ^a (m ³)	Interim Management of Nuclear Materials (m ³)	Tritium Supply and Recycling (m ³)	Waste Management (m ³)	Storage and Disposition ^b (m ³)	Stockpile Stewardship and Management ^c (m ³)	HEU (m ³)	Total ^d (m ³)
Low-Level									
Liquid	0	0	No data	0	0	18,949	80	22	19,051
Solid	14,100	57,900	21,000	416	26,835 ^e	2,468	88	76	122,467
Mixed Low-Level									
Liquid	115	Included in solid	No data	0	0	0	0	46	161
Solid	18	2,203	190	5	340 ^f	235	0	0	2,986
Hazardous									
Liquid	Included in solid	Included in solid	0	0	Included in solid	45	1	88	134
Solid	74	Included in mixed	Included in mixed	2	151 ^g	191	0	0	416
Nonhazardous									
Liquid	700,000	Not analyzed	No data	925,076	35,417	23,983,500	46,200	18,773	24,783,890
Solid	6,670	Not analyzed	No data	917	0	15,069	2,900	820	25,459

^a Includes preferred alternatives or RODs from Defense Waste Processing Facility Supplemental EIS, Programmatic Spent Nuclear Fuel Management and INEL Environmental Restoration and Waste Management EIS, Proposed Nonproliferation Policy on Foreign Research Reactor Spent Fuel EIS, Stabilization of F-Canyon Plutonium Solutions EIS, and SRS Waste Management EIS.

^b Pit Conversion, Pu Conversion, MOX Fuel, and Reactor Alternatives.

^c Pit Fabrication Alternative.

^d Does not include Tritium Supply and Recycling Program because the evolutionary reactor for Storage and Disposition would also fulfill the tritium supply and recycling function.

^e Regionalization alternative in which SRS disposes of wastes from onsite and from Ames, ANL-E, Bettis, BNL, FEMP, Fermi, KAPL, KCP, Mound, ORR, PGDP, Pinellas, PMGDP, PPPL, RMI and WVDP.

^f Regionalization alternative in which SRS treats and disposes of wastes from onsite and from Bettis, Charleston, Mound, Norfolk, Pinellas, U of MO, and WVDP.

^g Decentralized alternative in which SRS treats and disposes of onsite generated wastes.

Source: 60 FR 63878; 60 FR 65300; DOE 1995i; DOE 1995p; DOE 1995cc; DOE 1995dd; DOE 1996a; DOE 1996b; DOE 1996g; SR DOE 1994a; SR DOE 1994b; SR DOE 1995b; SR DOE 1995c; SR DOE 1995e.

Babcock & Wilcox. There are no proposed actions at B&W in the reasonably foreseeable future for which an EIS is currently being prepared. [Text deleted.]. The operation of the proposed action, the blending of HEU received from Kazakhstan, is currently being implemented. This action is assumed to be part of B&W's current licensed operation and because of the small quantity of this HEU (approximately 600 kg [1,320 lb]), the blending operation is anticipated to

be completed prior to the proposed action associated with this EIS.

Nuclear Fuel Services. No future activities are currently proposed for NFS other than existing licensed operations; therefore, cumulative impacts at NFS would be similar to the impacts analyzed for each alternative in this EIS.

4.7 AVOIDED ENVIRONMENTAL IMPACTS OF BLENDING SURPLUS HIGHLY ENRICHED URANIUM TO LOW-ENRICHED URANIUM FOR NUCLEAR POWER PLANTS

In blending surplus HEU to LEU for commercial nuclear power reactor use, part of the current nuclear fuel cycle in commercial nuclear power plants can be replaced. The nuclear fuel cycle for commercial nuclear power plants normally begins with mining uranium ore and ends with the disposal of the final radioactive wastes or the reprocessing of spent nuclear fuels. The typical light water reactor fuel cycle without spent fuel reprocessing in the United States is illustrated in Table 4.7-1. The blending of surplus HEU to commercial reactor fuel will replace the fuel cycle steps from uranium ore mining through uranium enrichment.

In the light water reactor uranium fuel cycle process, the most significant contributions to the adverse impact on human health and the environment are the uranium mining, uranium milling, and uranium conversion (from U_3O_8 to UF_6). The other nuclear fuel cycle processes (for example, enrichment plants and fuel fabrication plants) have considerably lower radioactive emissions than mining, milling, and conversion. A summary of the radiological

Table 4.7-1. Comparison of Current Fuel Cycle and Highly Enriched Uranium Blending Fuel Cycle

Step	Current Fuel Cycle	HEU Blending Fuel Cycle
1	Uranium mining	NA
2	Uranium milling	NA
3	Uranium conversion	NA
4	Uranium enrichment	Blending HEU to LEU
5	Uranium preparation and uranium fuel element fabrication	Uranium preparation and uranium fuel element fabrication
6	Nuclear power plants fueling—burning in the reactor	Nuclear power plants fueling—burning in the reactor
7	Spent fuel storage	Spent fuel storage

Note: NA=not applicable.

atmospheric emissions of radioactive materials from these processes is shown in Table 4.7-2. The radionuclides released from the liquid effluent are considerably less than the atmospheric emission and are not included in this table.

Typical uranium concentration for fresh light water reactor fuel is about 4-percent U-235. The average reactor core (1,000 megawatt electric [MWe]) inventory is about 90 t and about one-third of the core will be replaced by fresh fuel elements each time the reactor is refueled. Therefore, approximately 30 t of LEU fuel is required for a light water reactor refueling annually.

Based on the assumptions described in Section 2.2.2, the blending rate for surplus HEU (with U-235 enrichment of 50 percent) at each candidate blending site would be 10 t/yr. This blending rate will subsequently produce 150 t/yr of uranium fuel with 4-percent enrichment. This amount of uranium fuel can be used to refuel about five currently operating light water reactors.

4.7.1 AVOIDED HUMAN HEALTH IMPACTS

By replacing the current uranium fuel cycle with the process of blending the surplus HEU to LEU fuel, the processes from uranium mining through uranium enrichment in the current fuel cycle are eliminated. As a result, adverse impacts to human health and the environment in the uranium fuel cycle process are significantly reduced. Although the HEU blending process would potentially create other impacts to the workers and the public, the magnitude of these impacts would be much smaller than those of the uranium mining, milling, conversion, and enrichment processes. Tables 4.7.1-1 and 4.7.1-2 compare the potential radiological impacts to the public and involved workers, respectively, between the current fuel cycle process and the proposed alternatives of blending surplus HEU to LEU for commercial nuclear fuel.

For the general public within 80 km (50 mi), the expected latent cancer fatalities per year of operation would be 0.051 for the current uranium fuel cycle process and 8.5×10^{-6} (blending HEU to LEU as UNH at B&W) to 1.2×10^{-3} (blending HEU to LEU as UF_6 at NFS) for the proposed blending process. The avoided latent cancer fatalities for the public then

Table 4.7-2. Comparison of Radionuclide Atmospheric Emissions Between Current Fuel Cycle and Highly Enriched Uranium Blending Fuel Cycle^a

Source	Principle Radionuclide	Emission Rate (Ci/yr)		
		Current Fuel Cycle ^b	Blending HEU to LEU as UNH	Blending HEU to LEU as UF ₆
Uranium mines	Rn-222	3,000	NA	NA
Uranium mills and mill tailing	Pb-210	3.1×10^{-2}	NA	NA
	Po-210	3.1×10^{-2}	NA	NA
	Rn-222	1,900	NA	NA
	Ra-226	3.1×10^{-2}	NA	NA
	Th-230	3.5×10^{-2}	NA	NA
	U-234	6.1×10^{-2}	NA	NA
	U-238	4.9×10^{-2}	NA	NA
Uranium conversion	Rn-222	0.59	NA	NA
	Ra-226	4.3×10^{-6}	NA	NA
	Pa-234m	5.3×10^{-3}	NA	NA
	Th-230	5.9×10^{-5}	NA	NA
	Th-234	5.3×10^{-3}	NA	NA
	U-234	5.3×10^{-3}	NA	NA
	U-235	1.3×10^{-4}	NA	NA
	U-238	5.3×10^{-3}	NA	NA
Uranium enrichment	Tc-99	4.3×10^{-3}	NA	NA
	U-234	1.2×10^{-2}	NA	NA
	U-235	2.9×10^{-3}	NA	NA
	U-236	2.3×10^{-5}	NA	NA
	U-238	1.3×10^{-2}	NA	NA
Blending HEU to LEU ^c	U-235	NA	6.9×10^{-5}	1.1×10^{-4}
	U-238	NA	3.2×10^{-4}	6.2×10^{-4}

^a The emissions are based on the assumption that four large LWRs (about 5,000 MWe) are needed for the HEU disposition (10 t/yr).

^b The radionuclide emissions given in EPA 1979a are for the model facilities. The emissions are adjusted according to the 5,000 MWe power output (TTI 1996c; TTI 1996d).

^c OR LMES 1995a, OR LMES 1995b.

Note: NA=not applicable.

Source: EPA 1979a; OR LMES 1995a; OR LMES 1995b.

would be 0.051/yr due to the substitution of blending surplus HEU to LEU for commercial fuel.

For the involved workers, the expected latent cancer fatalities per year of operation would be 1.7 for the current uranium fuel cycle process and 3.2×10^{-3} (blending HEU to LEU as metal at Y-12) to 5.8×10^{-3} (blending HEU to LEU as UF₆ at B&W or NFS) for the proposed blending process. For the involved

workers there would be 1.7 latent cancer fatalities avoided due to the substitution of blending surplus HEU to LEU for commercial fuel.

The total avoided latent cancer fatalities for the general public and the involved workers for each alternative are presented in Table 4.7.1-3. The total avoided latent cancer fatalities due to the substitution of blending surplus HEU to LEU for commercial fuel

Table 4.7.1-1. Comparison of Potential Radiological Human Health Impact to the General Public within 80 km (50 mi)

Fuel Cycle Process	Current Fuel Cycle ^a	Blending HEU to 4% LEU as UF ₆		Blending HEU to 4% LEU as UNH			
		B&W ^b	NFS ^b	ORR ^c	SRS ^c	B&W ^c	NFS ^c
Uranium mining (LCF/yr)	3.0x10 ⁻²	NA	NA	NA	NA	NA	NA
Uranium milling (LCF/yr)	2.0x10 ⁻²	NA	NA	NA	NA	NA	NA
Uranium conversion (LCF/yr)	1.2x10 ⁻³	NA	NA	NA	NA	NA	NA
HEU blending (LCF/yr)	NA	1.6x10 ⁻⁵	1.2x10 ⁻³	8.0x10 ⁻⁵	8.0x10 ⁻⁵	8.5x10 ⁻⁶	6.0x10 ⁻⁴
Total (LCF/yr)	5.1x10⁻²	1.6x10⁻⁵	1.2x10⁻³	8.0x10⁻⁵	8.0x10⁻⁵	8.5x10⁻⁶	6.0x10⁻⁴

^a The latent cancer fatalities for the current fuel cycle are derived for the model facilities and are adjusted for 5,000 MWe light water reactors and for consistency with risk estimators used in this EIS (TTI 1996c; TTI 1996d).

^b Table 4.3.2.6-1.

^c Table 4.3.1.6-1.

Note: LCF=latent cancer fatality; NA=not applicable.

Source: EPA 1979a.

Table 4.7.1-2. Comparison of Potential Radiological Human Health Impact to the Involved Workers

Fuel Cycle Process	Current Fuel Cycle ^a	Blending HEU to 4% LEU as UF ₆		Blending HEU to 4% LEU as UNH			
		B&W ^b	NFS ^b	ORR ^c	SRS ^c	B&W ^c	NFS ^c
Uranium mining (LCF/yr)	0.94	NA	NA	NA	NA	NA	NA
Uranium milling (LCF/yr)	0.74	NA	NA	NA	NA	NA	NA
Uranium conversion (LCF/yr)	4.6x10 ⁻³	NA	NA	NA	NA	NA	NA
HEU blending (LCF/yr)	NA	5.8x10 ⁻³	5.8x10 ⁻³	4.5x10 ⁻³	4.5x10 ⁻³	4.5x10 ⁻³	4.5x10 ⁻³
Total (LCF/yr)	1.7	5.8x10⁻³	5.8x10⁻³	4.5x10⁻³	4.5x10⁻³	4.5x10⁻³	4.5x10⁻³

^a The latent cancer fatalities for the current fuel cycle are derived for 1,000 MWe light water reactors and are adjusted for 5,000 MWe light water reactors and for consistency with risk estimators used in this EIS (TTI 1996c; TTI 1996d).

^b Table 4.3.2.6-2.

^c Table 4.3.1.6-2.

Note: LCF=latent cancer fatality; NA=not applicable.

Source: NRC 1987d.

Table 4.7.1-3. Comparison of Cumulative Potential Radiological Human Health Impact

Alternatives	Current Fuel Cycle (Latent Cancer Fatalities)			Blending HEU to LEU ^a (Latent Cancer Fatalities)			Avoided Latent Cancer Fatalities
	Public	Workers	Total	Public	Workers	Total	
Limited Commercial Use— Two Commercial Sites ^b	0.26	8.5	8.8	7.3×10^{-3}	7.0×10^{-2}	7.7×10^{-2}	8.7
Substantial Commercial Use—DOE Sites Only ^c	0.66	22	23	2.6×10^{-3}	0.14	0.14	23
Substantial Commercial Use—Commercial Sites Only ^c	0.66	22	23	1.9×10^{-2}	0.19	0.21	23
Substantial Commercial Use—All Four Sites ^d	0.66	22	23	2.2×10^{-2}	0.33	0.35	22
Substantial Commercial Use—Single Site ^e	0.66	22	23	1.9×10^{-2}	9.3×10^{-2}	0.11	23
Maximum Commercial Use—DOE Sites Only ^f	0.87	29	30	3.4×10^{-3}	0.19	0.19	30
Maximum Commercial Use—Commercial Sites Only ^f	0.87	29	30	2.6×10^{-2}	0.24	0.27	30
Maximum Commercial Use—All Four Sites ^g	0.87	29	30	2.9×10^{-2}	0.43	0.46	29
Maximum Commercial Use—Single Site ^h	0.87	29	30	2.5×10^{-2}	0.12	0.15	30

^a Because analyses for less than 10 t/yr HEU processing rate for commercial use is directly analyzed in this EIS, latent cancer fatalities obtained from Section 4.3 were used for lower processing rates in the case of multiple sites being used to process 8 t each year (anticipated amount of surplus HEU that DOE can be made available for commercial use annually as indicated in Table 2.1.2-1). Because lower processing rates would produce less human health impacts, using impacts from the Section 4.3 rate would yield conservative results.

^b Twenty-five percent of the 200 t HEU (that is, 50 t) would be blended to LEU for commercial fuel for this alternative. B&W and NFS would each process 25 t of HEU. Therefore, it would take 6 years to blend the HEU to LEU at the processing rate of 4 t/yr.

^c Sixty-five percent of the 200 t HEU (that is, 130 t) would be blended to LEU for commercial fuel for this alternative. Y-12 and SRS (or B&W and NFS) would each process 65 t of HEU. Therefore, it would take 16 years to blend the HEU to LEU at the processing rate of 4 t/yr.

^d Sixty-five percent of the 200 t HEU (that is, 130 t) would be blended to LEU for commercial fuel for this alternative. All four sites would process 32.5 t of HEU. Therefore, it would take 16 years to blend the HEU to LEU at the processing rate of 2 t/yr.

^e Sixty-five percent of the 200 t HEU (that is, 130 t) would be blended to LEU for commercial fuel for this alternative. Therefore, it would take 16 years to blend the HEU to LEU at the processing rate of 8 t/yr.

^f Eighty-five percent of the 200 t HEU (that is, 170 t) would be blended to LEU for commercial fuel for this alternative. Y-12 and SRS (or B&W and NFS) would each process 85 t of HEU. Therefore, it would take 21 years to blend the HEU to LEU at the processing rate of 4 t/yr.

^g Eighty-five percent of the 200 t HEU (that is, 170 t) would be blended to LEU for commercial fuel for this alternative. All four sites would process 42.5 t of HEU. Therefore, it would take 21 years to blend the HEU to LEU at the processing rate of 2 t/yr.

^h Eighty-five percent of the 200 t HEU (that is, 170 t) would be blended to LEU for commercial fuel for this alternative. Therefore, it would take 21 years to blend the HEU to LEU at the processing rate of 8 t/yr.

Source: TTI 1996c; TTI 1996d.

could range from 8.7 (Limited Commercial Use Alternative) to 30 (Maximum Commercial Use Alternative).

4.7.2 AVOIDED AIR QUALITY IMPACTS

The ambient air quality can be affected by emissions of chemical pollutants from the current fuel cycle process and the proposed HEU blending facilities. The chemical pollutants from the current fuel cycle originate from the uranium mining, milling, conversion and enrichment processes. The pollutant emissions are also from the fossil-fuel power plants, that supply electric power for the current uranium fuel cycle, mainly for uranium enrichment. By blending surplus HEU to LEU as fuel, the uranium fuel enrichment process would be eliminated, thereby eliminating the need for fossil-fuel power plants to produce electric power. Table 4.7.2-1 compares pollutant air emissions between the proposed HEU blending process and a typical fossil-fuel power plant that supplies electric power for the current uranium fuel cycle. The comparison shows that chemical pollutant emissions from the current fuel cycle are much higher than the potential emissions from the proposed HEU blending process.

4.7.3 AVOIDED WASTE GENERATION

The volumes of wastes would also be significantly reduced if part of the current fuel cycle were to be replaced by the HEU blending process. The total volume of waste generated from blending HEU to 4-percent LEU for commercial fuel would be approximately 430 m³/yr (15,200 ft³/yr) as LLW and as mixed LLW. Based on historical practice in the United States, on the other hand, the volume of wastes that would be generated by uranium mining, milling, and extraction would be approximately 880,000 m³/yr (31,077 ft³/yr) (DOE 1995kk:145-146,154). Using LEU fuel derived from surplus HEU would eliminate additional waste streams that would be generated during conversion (from U₃O₈ to UF₆) and enrichment. While data relating conversion and enrichment rates with waste volumes are not available, the combined volume of wastes (mixed LLW) produced at the Portsmouth Diffusion Plant (a major uranium enrichment facility) in 1992 was reported as 4,500 t of mixed LLW, and projections from 1994 to 1998 were 169 t/yr for the combined waste generation from the Paducah and Portsmouth uranium enrichment plants (DOE 1993c:16.1-3; DOE 1993g:23.4-1).

Table 4.7.2-1. Comparison of Potential Emission Rates of Pollutants Between Highly Enriched Uranium Blending and Current Fuel Cycle

Pollutant	Current Fuel Cycle ^a (kg/yr)	Blending HEU to LWR Fuel	
		To UNH ^b (kg/yr)	To UF ₆ ^c (kg/yr)
Carbon monoxide (CO)	150,000	2,160	2,258
Nitrogen dioxide (NO ₂) ^d	6,000,000	7,300	1,433
Ozone (O ₃)	NA	215	200
Particulate matter (PM ₁₀)	5,700,000	170	203
Sulfur dioxide (SO ₂) ^e	22,000,000	13,500	2,934
Total suspended particulates (TSP)	NA	37,000	203

^a Emissions from the supporting coal power plant are derived from the NRC regulation (10 CFR 51, Table S-3). The original numbers in the NRC document are for 1,000 MWe LWR. The numbers shown in the table are adjusted for 5,000 MWe LWRs.

^b Maximum emissions are presented in the blending process. The maximum emissions occur in blending HEU to LEU as UNH at Y-12 and SRS (Table C.2-1).

^c Maximum emissions are presented in the blending process. The maximum emissions occur in blending HEU to LEU as UF₆ at B&W and NFS (Table C.2-4).

^d Original source (10 CFR 51) reported as NO_x.

^e Original source (10 CFR 51) reported as SO_x.

Note: NA=not available.

4.7.4 OTHER ENVIRONMENTAL IMPACTS

In addition to the environmental impact discussed above, other positive environmental impacts will occur by blending HEU to LEU for use as commercial fuel in nuclear power plants. None of the analyzed processes would necessitate construction of new facilities, require land disturbance, or affect the VRM classification of any of the candidate sites; consequently, no impacts to land resources, geology and soils, or cultural resources are anticipated. Any future construction at B&W or NFS would be a business decision, and is not proposed by DOE or necessitated by this proposed action or alternatives. No construction of a solidification facility at SRS is proposed at this time. If any such construction at any of the sites were proposed, it could involve land disturbance and associated impacts, such as minor air emissions. Additional NEPA review would be conducted as necessary for any such new construction, if it were proposed. The following positive impacts can be qualitatively stated:

- Nuclear Proliferation. By blending the HEU to LEU as nuclear fuel, the surplus HEU would be "burned" in the reactors. This would reduce the risk of theft or diversion and subsequent consequences such as nuclear accidents.
- Land Resources. No additional land needs to be disturbed for mining operations.
- Site Infrastructure. No additional facility needs to be constructed. No additional energy resources need to be consumed.
- Water Resources. [Text deleted.] No major impact to water quality would occur since no surface runoff or leaching (mine drainage) from mining and mill tailings would occur.
- Geology and Soils. No new facilities would be constructed, therefore, limited exposure to the soil profile and soil erosion would occur as a result of wind and water action.
- Transportation. No additional onsite or offsite transportation is required to move ore from the mine to the mill, to move refined ore from the mill to the conversion facility, or move converted uranium from the conversion facility to the enrichment plant.

4.8 IMPACTS ON URANIUM MINING AND NUCLEAR FUEL CYCLE INDUSTRIES

4.8.1 BACKGROUND

The impacts of surplus HEU disposition on the uranium mining and nuclear fuel cycle sectors⁴ will depend in large part on the degree to which supply and demand in the nuclear fuel market are balanced during the period of delivery to the market. Because the surplus HEU from Russia and the United States will increase the supply of nuclear feed material (LEU), there is potential for adverse impacts on domestic markets. This section examines changes in supply due to the purchase of Russian surplus HEU and this proposed action, and analyzes potential impacts on each of the affected sectors. An overview of the nuclear fuel cycle industry, including recent price and employment trends, is also presented.

Uranium Mining and Milling—From 1947 through 1970, the U.S. Government, through the Atomic Energy Commission, instituted a program to obtain uranium for nuclear weapons production. The commercial nuclear fuel cycle market evolved out of this program, and the uranium market gradually changed from one in which the Government was the sole purchaser to one which was almost entirely commercial. Early in the procurement program, the Atomic Energy Commission provided incentives for uranium ore exploration and production and agreed to buy all the uranium ore at a set price. The incentives were such that, by the 1960s, the Atomic Energy Commission had largely satisfied its needs, and the procurement program was phased out. This program coincided with the development and growth of the private sector nuclear energy industry. In 1964, the *Private Ownership of Special Nuclear Materials Act* (Public Law 88-489) allowed private ownership of nuclear fuels. Privatization spurred exploration efforts and construction of mills so that in a few years available production capability exceeded uranium oxide (as U₃O₈) requirements of the infant nuclear energy industry. Prices fell and the industry underwent a period of contraction.

⁴ The cycle consists of: mining (including conventional mining, *in situ* leaching, and recovery as a byproduct of phosphate production), milling, conversion (from uranium concentrate to UF₆), uranium enrichment, fuel fabrication, energy generation, and disposal of spent fuel.

After the rapid increase in oil prices in 1973 and 1974, the pace of new orders for nuclear power plants throughout the world accelerated. Fears of future uranium shortages led to a sharp increase of uranium oxide prices between 1975 and 1976. The rapid increase in uranium prices stimulated new exploration and additional production. Once again the market became unbalanced, with an excess of quantity supplied over quantity demanded. As a result, the price of uranium declined throughout the 1980s and early 1990s. Contributing to the price decline was the entry of the former Soviet Union into the market with its low-cost uranium oxide, and the further discovery of large, low-cost uranium ore deposits in Canada, Australia, and Africa.

The market (spot) price of uranium oxide reached a low of \$18.39/kg (\$8.34/lb) in 1992, but has recently begun to increase. In 1994, the spot price rose to \$21.52/kg (\$9.76/lb); by the summer of 1995, it had risen above \$24.25/kg (\$11.00/lb) and reached \$26.90/kg (\$12.20/lb) by the end of 1995. Recent (1995) forecasts predicted that the spot price would increase by about 2 percent annually through 2005 (EIA 1995a:32). However, the uranium oxide market is currently in a state of flux. In fact, it was recently reported that in the first two months of 1996, uranium oxide spot market prices have increased 18 percent to about \$33/kg (\$15/lb) (WSJ 1996a:C1). The current fluctuation in the spot price could be due to commercial inventory drawdowns occurring at a faster pace than was estimated last year. This would lead to a higher demand in the near future and sharp price increases if there is a perceived near-term shortage.

In 1993, the United States was the tenth largest uranium-producing country in the world, behind Canada, Nigeria, Kazakhstan, Russia, Uzbekistan, Australia, France, Namibia, and South Africa. As seen in Figure 4.8.1-1, U.S. production had been in sharp decline over the past 15 years, until 1995 when production rose sharply. During that period, domestic production declined from a high of 20 million kg (44 million lb) in 1980 to a low of 1.4 million kg (3.1 million lb) in 1993 (EIA 1995a:25). In 1994, U.S. output supplied only about 2 percent of the world's uranium requirements of 75 million kg (165 million lb). Responding to more favorable market conditions, U.S. firms have increased production. Domestic production of uranium oxide for the year 1995 was 2.8 million kg (6.1 million lb),

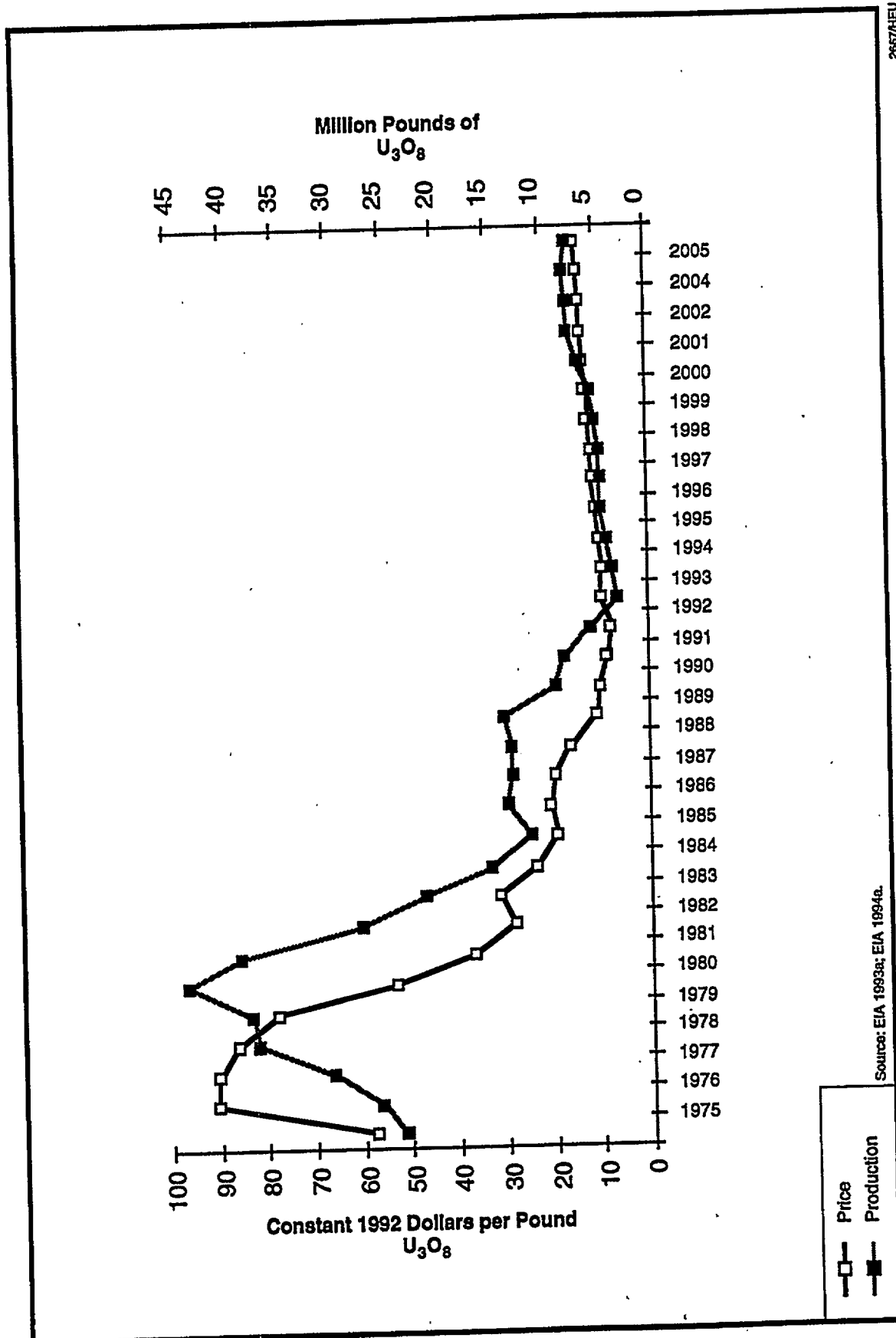


Figure 4.8.1-1. Comparison of Historic and Estimated Spot Price With U.S. Uranium Production, 1975-2005.

nearly 80 percent more than the amount produced in 1994 and higher than forecasted value shown in Figures 4.8.1-1 and 4.8.1-2. Much of this increase was the result of the reopening of a mill and the addition of an in situ leaching plant.

Additional sources of uranium oxide are inventories held by utilities, uranium producers, brokers, and governments. At the end of 1994, commercially owned inventories totaled approximately 39 million kg (86 million lb) of uranium oxide equivalent, compared to 48 million kg (106 million lb) at the end of 1993. DOE projections indicate that commercial inventories over the next 10 years will fall below a level adequate to meet 2 years of forward reactor requirements⁵ (EIA1995a:31). Projections indicate a continuing decline each year between now and 2005 before stabilizing at a level equivalent to annual domestic reactor requirements. Commercial inventories, which totaled 34.9 million kg (76.9 million lb) in 1995, are projected to decrease to 20.5 million kg (45.2 million lb) in 2005. It should be noted that Government inventories at the end of 1994 totaled 33.7 million kg (74.3 million lb) of uranium oxide equivalent (EIA 1995a:27).

The 1995 uranium oxide requirement of U.S. nuclear power plants was about 20.6 million kg (45.4 million lb), while domestic production was 2.8 million kg (6.1 million lb) (EIA 1995a:32). The balance of 17.8 million kg (39.3 million lb) was made up from imports and inventory drawdowns of both uranium oxide and LEU. The United States, which was a net exporter in 1980, is projected to import almost 80 percent of its commercial needs throughout this decade. However, as noted above, recent price increases have stimulated production, which is projected to increase to 4 million kg (8.9 million lb) by the year 2005. Net imports are projected to rise from the current level of 15.2 million kg (33.5 million lb) to 17 million kg (37.4 million lb) in 2003 and decrease to 14.7 million kg (32.3 million lb) by 2005. Commercial inventories are projected to decrease from 34.9 million kg (76.9 million lb) in 1995 to 20.5 million kg (45.2 million lb) in 2005 (EIA 1995a:32).

Historically, U.S. uranium oxide production has been sensitive to changes in the current spot price. In

addition, employment in this sector has been sensitive to production levels. These relationships are shown in Figures 4.8.1-1 and 4.8.1-2, which give historical relationships and projections of production, future spot prices, and employment, based on 1995 Energy Information Administration estimates.

As shown in Figures 4.8.1-1 and 4.8.1-2, immense reductions in uranium oxide production and employment have already taken place due to lower prices. Employment in 1994 was 452 person-years for mining, milling, and processing; however, there were 528 additional person-years for reclamation activities that are not related to production (EIA 1995b:20). Increases in uranium industry employment in the future are only possible if production increases above the levels shown. The forecast shown in Figure 4.8.1-1 predicts spot price increases from \$21.52/kg (\$9.76/lb) in 1994 to \$31.22/kg (\$14.16/lb) in 2005, and production increases from 1.5 million kg (3.3 million lb) to 4 million kg (8.9 million lb) of uranium oxide during the same period. Employment increases are projected to increase from 452 person-years in 1994 to 1,187 person-years in 2005. Using this as a basis, each \$1 change in price would result in approximately a 0.55 million-kg (1.2 million-lb) change in production, and each 0.55 million-kg (1.2 million-lb) change in production would result in approximately a 160 person-year change in employment.

Uranium Conversion—Uranium conversion in the nuclear fuel cycle refers to the conversion of uranium oxide to UF₆. ConverDyn, a subsidiary of Allied Signal, Inc., is one of the five largest commercial converters in the world. The plant, located in Metropolis, Illinois, employs about 380 workers and is the last remaining conversion facility in the United States. The facility provides UF₆ to nuclear utilities in the United States, Asia, and Europe. With a production capacity of 12,700 metric tons of uranium (MTU)/yr as UF₆,⁶ the facility is capable of supplying about 19 percent of the world's conversion services.

The UF₆ market, like the market for uranium oxide, was depressed throughout the 1980s and early 1990s.

⁵ Amount of uranium required to ensure uninterrupted operation of nuclear power plants.

⁶ In this discussion of conversion, UF₆ quantities are expressed as MTU contained in the product.

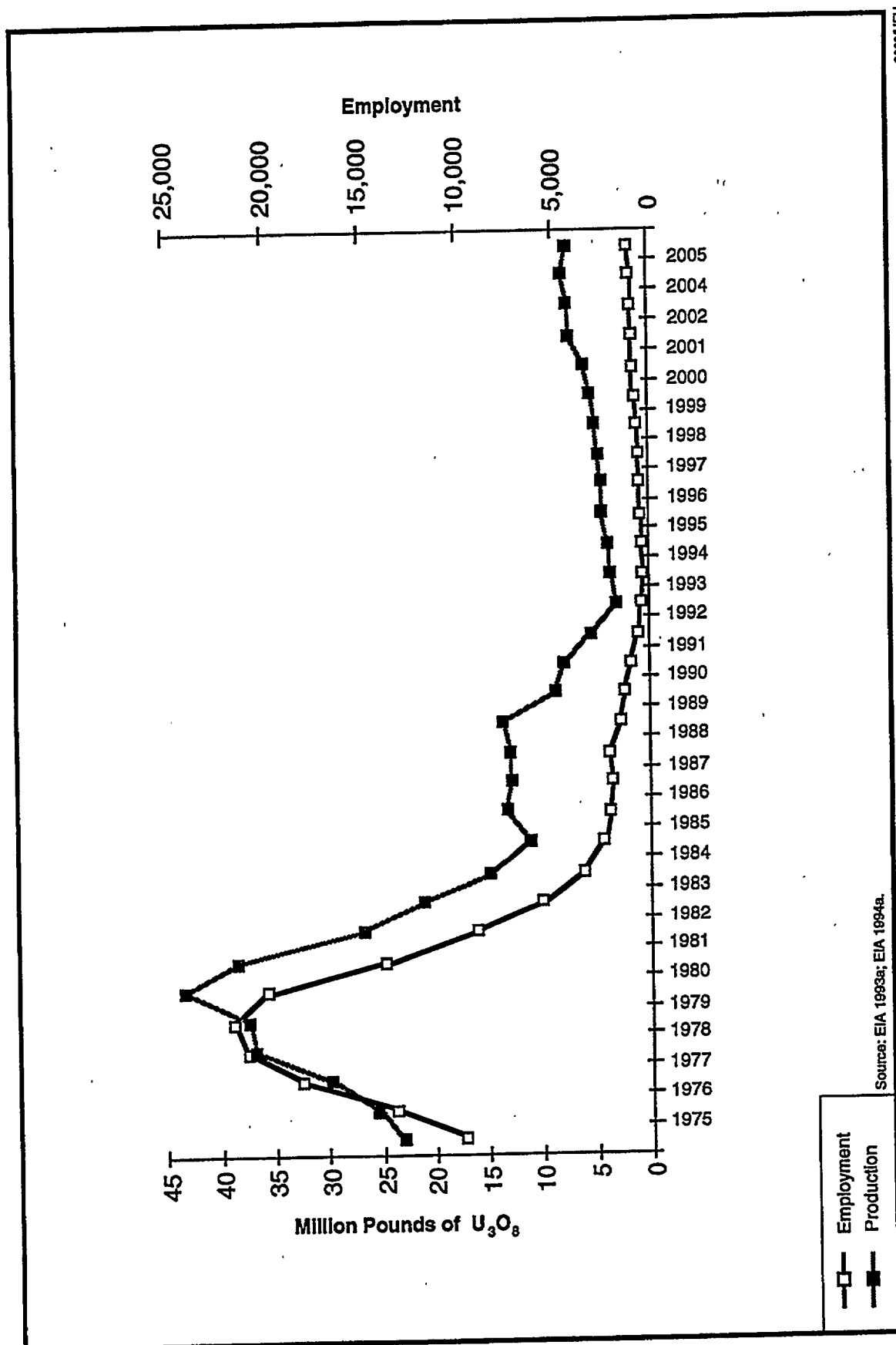


Figure 4.8.1-2. Comparison of Historic and Estimated U.S. Uranium Production With Employment, 1975-2005.

This led to shutdowns and a decrease in production. For example, a second U.S. facility, owned by Sequoyah Fuels and located in Oklahoma, was closed at the end of 1992. However, with the decrease in capacity and the recent increase in demand, the price of conversion services has increased over 70 percent since 1992. Projected increases in utility demands should permit a more stable market for the only remaining U.S. conversion facility. All of the commercial conversion facilities world-wide are operating at almost full capacity and are expected to operate at or above 90-percent capacity for the foreseeable future.

Uranium Enrichment—The enrichment levels of UF_6 from the conversion plant are increased at an enrichment plant to meet a utility's specified level of 3- to 5-percent U-235. USEC, one of the four major enrichers in the world uranium market and the only enricher in the United States, operates the Paducah Gaseous Diffusion Plant and the Portsmouth Gaseous Diffusion Plant in Kentucky and Ohio, respectively. Before 1993, when USEC assumed responsibility from DOE for the enrichment operations, DOE was the largest supplier of enrichment services in the world. The U.S. market position, however, has steadily eroded since the mid-1970s as foreign competitors have entered the market. By 1995, the two U.S. plants represented only 39 percent of worldwide installed enrichment capacity.

Fuel fabricators convert the enriched UF_6 to uranium oxide pellets. Most countries with large civil nuclear power programs have their own fuel fabrication facilities. Together, five U.S. companies represent 35 percent of the world's fabrication capacity. The five domestic commercial fuel fabrication plants are listed in Figure 2.1.1-1. The proposed action is not expected to have any impact on the fuel fabrication sector.

USEC Privatization Act—As noted in Section 1.3, the *USEC Privatization Act* was signed into law in April 1996 (see Appendix J). The Act specifically authorizes the transfer of up to 50 t of HEU and up to 7,000 t of NU from DOE stockpiles to USEC, and specifies numerical restrictions on the delivery of that material for commercial end use in the United States (Public Law 104-134, Section 3112(c)). The Act also authorizes additional sales from DOE's stockpiles of uranium, including LEU derived from HEU. Such additional sales may not be made unless: 1) the

material is declared surplus; 2) the Secretary of Energy determines that the sale will not have an adverse material impact⁷ on the domestic uranium mining, conversion, or enrichment industry, taking into account the sales of uranium under the Russian HEU Agreement and the Suspension Agreement; and 3) the price paid is not less than the fair market value of the material (Public Law 104-134, Section 3112(d)). The discussion that follows assesses the likely impacts of the U.S. HEU disposition program in light of the statutory "adverse material impact" standard, also taking into account the material entering the market from the Russian HEU Agreement and the Suspension Agreement.

4.8.2 ECONOMIC CONSEQUENCES OF RUSSIAN HIGHLY ENRICHED URANIUM

As a result of a formal agreement with Russia signed in February 1993, the United States, through an executive agent, will purchase 15,260 t of LEU⁸ (or 22,550 t of UF_6), derived from blending 500 t of HEU from nuclear weapons materials inventories. All blending services are being performed in Russia, and delivery of LEU will take place over a 20-year period that began in 1995. The most recent schedule calls for deliveries of LEU to USEC in HEU equivalence of 6 t in 1995, 12 t in 1996, 10 t/yr from 1997 through 1999, and approximately 30 t/yr from 2000 to 2015. Importing that quantity of material into the domestic market, even over a 20-year period, would have some adverse impact on the domestic uranium mining and nuclear fuel cycle industries. Because the Russian LEU will be in a form ready for fuel fabrication, the demand for domestic uranium feed, and for conversion and enrichment services would likely be reduced. The transfer of Russian LEU to the U.S. would not affect the fuel fabrication sector.

⁷ The *USEC Privatization Act* does not define the term "adverse material impact." For purposes of this analysis only, DOE assumes that it means long-term market impacts on price, or long-term impacts on employment levels or plant closures, not brought about by other activities. The analysis and discussion in this section is based on Public Law 104-134 as it appeared in the Congressional Record on April 25, 1996 (Internet version). This discussion is not, and should not be, construed to be an official interpretation of Public Law 104-134 by DOE for any other purpose.

⁸ One ton of Russian HEU would generate about 30.5 t of LEU containing 3- to 5-percent U-235.

Under Section 3112(b) of the *USEC Privatization Act*, Russian LEU delivered to the U.S. executive agent (currently USEC) on or after January 1, 1997 may not be transferred to domestic end users at a rate exceeding the schedule shown in Table 4.8.2-1.

By limiting the quantity of Russian material that can be delivered for consumption by commercial end users in the United States, Section 3112 of the *USEC Privatization Act* would help to protect the domestic market from oversupply of uranium feed material.⁹

Table 4.8.2-1. Annual Maximum Deliveries of Uranium Oxide to End Users

Year	Uranium Oxide Million Pounds Equivalent (million kg)
1996	0 (0)
1997	0 (0)
1998	2 (0.9)
1999	4 (1.8)
2000	6 (2.7)
2001	8 (3.6)
2002	10 (4.5)
2003	12 (5.4)
2004	14 (6.4)
2005	16 (7.3)
2006	17 (7.7)
2007	18 (8.2)
2008	19 (8.6)
2009 and each year thereafter	20 (9.1)

Source: Public Law 104-134, Section 3112(b)5.

The legislation does not limit the ability to export this material for use in nuclear reactors outside the United States, or to use this material for overfeeding¹⁰ of the enrichment plants. The *USEC Privatization Act* also permits this material to be used in matched sales pursuant to the Uranium Anti-dumping Suspension Agreements.¹¹

In addition, Russian LEU derived from approximately 18 t of HEU (6.3 million kg [14

million lb] U_3O_8 equivalent) is being delivered to the United States in 1995 and 1996. That material can be sold in 1996 as part of matched sales; sold at any time either for overfeeding in the United States or for end use outside the United States; or sold in 2001 for delivery to end users beginning in 2002, in quantities not to exceed 1.4 million kg (3 million lb) U_3O_8 equivalent per year (Public Law 103-134, Section 3112 (b)(2)). For purposes of this analysis only, it is assumed that 6 t would be sold in 1996 as part of matched sales, and 12 t would be delivered beginning in 2002, subject to the limitations just noted.¹²

Uranium Mining and Milling Sector Impacts—The economic impacts of the Russian LEU were analyzed in USEC's and DOE's *Environmental Assessment for the Purchase of Russian Low Enriched Uranium Derived from the Dismantlement of Nuclear Weapons in the Countries of the Former Soviet Union* (USEC/EA-94001, DOE/EA-0837, January 1994). However, the analysis in that EA was based on the assumption that the Russian LEU would be transferred to end users during the same year the material is delivered to the United States (that is, 10 t delivery to USEC in 1997 would add 10 t of nuclear fuel to the domestic market in the same year). Because the *USEC Privatization Act* restricts entry of the Russian LEU into the domestic market (with the exceptions noted in the preceding paragraph), adverse impacts to the uranium mining and milling sector would be reduced

¹¹The Uranium Anti-dumping Suspension Agreements arose from charges by U.S. uranium producers and the Oil, Chemical, and Atomic Workers International Union (which represents some U.S. enrichment plant workers) that Russia and other member states of the former Soviet Union were dumping uranium into the United States. In October 1992, the U.S. Department of Commerce suspended its investigation of those charges based on an agreement between the U.S. petitioners and the former Soviet states to restrict the volume of imports into the United States. In March 1994, the Russian Suspension Agreement was amended to include the matched sales concept, which links Russian imports with sales of newly produced U.S. uranium. Matched sales must also fall within yearly quotas set in the Russian Suspension Agreement, as amended. Pursuant to the *USEC Privatization Act*, this feed material may be used in matched sales under the Suspension Agreement. Such matched sales are not subject to the numerical limits on deliveries to end users as specified in the schedule in Table 4.8.2-1.

¹²Such transactions are not proposed at this time. If such transactions are proposed, the details and impacts may differ from those analyzed, and DOE will conduct appropriate NEPA review.

⁹ The sale of the conversion component is not restricted (Section 3112 (b)(8)).

¹⁰Overfeeding involves increasing the rate at which uranium feed is used in the enrichment process, with a corresponding reduction in the energy consumed for separative work.

from those projected in the USEC EA. For example, the USEC EA assumed that the Russian LEU would displace about 3.6 million kg (8 million lb) of uranium annually in the U.S. market during the first 5 years of delivery.¹³ This quantity represents approximately 19 percent of domestic utility requirements. However, because of the legislation, the quantity transferred to end users during the same 5-year period (1995 through 1999) may not exceed 2.7 million kg (6 million lb) uranium oxide equivalent for the entire period.¹⁴ This total compares to 17.4 million kg (38.4 million lb) that could be displaced over that period without the *USEC Privatization Act's* restrictions. This is an 85-percent reduction from the original USEC estimate.

The largest economic impact would be to foreign producers, who, before the Russian Agreement, were expected to supply up to 80 percent of the uranium oxide used by U.S. utilities during the delivery period. If the displaced uranium were prorated between domestic and foreign producers (based on current production and procurement patterns), domestic uranium producers would experience about a 4-percent reduction in delivery orders.

Under the agreement with Russia, during the period 2000 to 2015, annual deliveries from Russia to USEC would triple to 30 t of HEU that would be converted to LEU, the equivalent of 10.9 million kg (24 million lb) of uranium oxide. However, the *USEC Privatization Act* allows the delivery, for consumption by commercial end users in the United States, of only 2.7 million kg (6 million lb) uranium oxide equivalent in the year 2000. As indicated in Table 4.8.2.-1, the quantity increases each year, reaching 8.6 million kg (19 million lb) in 2008. In 2009 and each year thereafter, up to 9 million kg (20 million lb) uranium oxide equivalent could be delivered to end users. Displacement of domestic uranium oxide could range from about 30 percent per year on average during the period 2000 to 2009, to 50 percent in 2009 and thereafter.¹⁵

The reduction in feed requirements could adversely affect the economic prospects of domestic uranium producers, particularly beginning in 2005 when the

Russian LEU could begin to displace more than 7.2 million kg (16 million lb) of uranium oxide annually and up to 9.1 million kg (20 million lb) in 2009 and each year thereafter. For example, the future expansion of domestic production capacity through the reopening of mining and milling facilities could be postponed or canceled in that period because supply requirements could be met with the Russian LEU. If Russian deliveries were at their maximum in 2009 and thereafter (9.1 million kg [20 million lb] U_3O_8), some domestic producers could be substantially impacted.

Both USEC and DOE estimated in the EA for purchase of Russian HEU that these adverse impacts to domestic uranium producers could be significantly diminished if USEC (or a successor private corporation) maintains its current uranium feed requirements while producing less LEU (USEC 1994a:6-28. Under this scenario, USEC would continue to receive uranium feed from utilities as provided in existing contracts, but would produce less LEU product, because USEC would already possess the Russian LEU. To prevent the buildup of uranium feed inventories, which would further depress the market price for uranium, USEC could overfeed the gaseous diffusion plants. By overfeeding, USEC would use greater amounts of uranium feed per ton of LEU produced. In this way, the gaseous diffusion plants would maintain demand for uranium even though the ability to supply LEU would be increased due to the availability of Russian LEU. Although overfeeding represents a less efficient use of the uranium feed, this cost would be somewhat offset by reduced electricity requirements. One potential disadvantage of overfeeding is that the concentration of U-234 per gram of U-235 in the LEU would increase, and during the latter years (when Russian deliveries would increase) ASTM specifications could be exceeded if USEC overfed all of the excess uranium feed. Nonetheless, by overfeeding the gaseous diffusion plants, USEC might be able to diminish the losses to the uranium production sector. It also should be noted, however, that the ability of USEC to overfeed its gaseous

¹³Based on an average of 10 t of HEU converted to LEU.

¹⁴Based on a total of 7.5 t of HEU converted to LEU.

¹⁵This estimate assumes that the majority of domestic utility demand for uranium feed will continue to be supplied by foreign producers. Displacement estimates also assume that 12 t of the 18 t of Russian material delivered to the United States during 1995 and 1996 are transferred to domestic users beginning in 2002.

diffusion plants would depend on the prevailing market conditions over the delivery period.¹⁶

Impacts on the Uranium Conversion Sector—As discussed earlier, commercial uranium conversion facilities were operating at about 90 percent capacity in 1995, and are expected to operate at almost full capacity for the foreseeable future. The improved market conditions are a result of a strengthening in world demand for conversion products and a reduction in conversion capacity. The addition of the Russian HEU converted to LEU into the commercial market could lead to some market surplus, but not likely until after 2005 when deliveries of Russian material to domestic users begins to exceed 7.3 million kg (16 million lb) U_3O_8 equivalent of HEU (6,000 MTU UF_6) per year. The *USEC Privatization Act*, by limiting the annual delivery of the Russian material to end users, mitigates economic impacts on the conversion sector. For example, because the *USEC Privatization Act* limits domestic end user deliveries to 9.1 million kg (20 million lb) per year of HEU beginning in 2009, displacement of U.S. production could total 7,500 MTU as UF_6 per year, compared to 9,000 MTU as UF_6 per year if 30 t of HEU per year could be delivered to end users.

Impacts on the Uranium Enrichment Sector—The Russian LEU would also reduce the demand for enrichment services at the gaseous diffusion plants because the Russian material would be directly processed for fuel production. Delivery of the Russian LEU to end users would peak in 2009, when approximately 4.8 million Separative Work Units,^{17,18} (SWUs) of enrichment services could be displaced. Based on USEC estimates that demand for

enrichment services could average about 12 million SWUs per year over the delivery period, the Russian LEU could decrease domestic annual gaseous diffusion plant production to 7.25 million SWUs. If USEC overfed the gaseous diffusion plants, production would fall to about 5 million SWUs, because less of the U-235 material would be removed from the NU feed. USEC has estimated that utility orders in excess of 7 million SWUs from the gaseous diffusion plants would be required to continue operating both enrichment plants. The *USEC Privatization Act* restricts the delivery of the Russian material to end users such that annual demand would still be sufficient to operate both plants unless USEC employed overfeeding. However, the impacts of the Russian feed material on the domestic market for enrichment services would be for a longer period, but less severe, under provisions of the *USEC Privatization Act*, because it would take an additional 13 years to eliminate the entire inventory of Russian material.

4.8.3 ECONOMIC CONSEQUENCES OF THE PROPOSED ACTION

The proposed action would introduce into the global uranium market additional quantities of LEU derived from surplus HEU. As stated in Section 1.3, this EIS addresses disposition of a nominal 200 t of HEU, consisting of 175 t declared surplus to date, plus 25 t of HEU (not yet identified) that may be declared surplus in the future. Of the 175 t presently declared surplus, about 72 t are in forms that are not expected to be available or suitable for commercial use in the next 10 to 15 years. Of the remaining 103 t, 13 t have already been transferred to USEC (pursuant to the *Energy Policy Act* of 1992) and 50 t are proposed to be transferred to USEC over the next 6 years (pursuant to the *USEC Privatization Act*). The rate of commercialization of that material would be limited by DOE's ability to make material available, industrial infrastructure, market conditions, and legislative requirements.¹⁹ The *USEC Privatization Act* contains three requirements for any sales by DOE of its uranium stockpile; one requirement is that the Secretary of Energy determine that the sale not have an adverse material impact on the domestic uranium mining, conversion, and enrichment industries. DOE

¹⁶The current market conditions (1996) of rising uranium prices and stagnant electricity prices would render this scenario impractical in the short term. The analysis in this EIS is not based on the assumption that adverse impacts on the uranium mining and milling sector would be mitigated by overfeeding. Rather, the limitations in the *USEC Privatization Act* are expected to better serve the objective.

¹⁷A Separative Work Unit is a measure of the separation work achieved in a uranium enrichment plant after separating uranium of a given U-235 content into two components, one having a higher percentage of U-235 than the other component.

¹⁸USEC estimated that SWU demand from the gaseous diffusion plant would decrease to 6.3 million SWUs during the period when Russian imports would total 30 t/yr. However, under the *USEC Privatization Act*, no more than 25 t of HEU would be transferred to end users.

¹⁹DOE may propose to sell additional remaining inventories of NU and surplus LEU in the future. These decisions will be addressed by future NEPA reviews, as appropriate.

will conduct an analysis of the potential impact prior to any proposed sale, as required by the Act.

Impacts on the Mining and Milling Sector—The Department of Energy estimates that an average of about 10 t of surplus HEU would be blended down to LEU for commercial use each year starting in 1998.²⁰ Blending down 10 t of HEU to 4-percent enrichment could displace demand for approximately 3.9 million pounds of uranium oxide annually. For the 103 t of HEU that may be commercialized, this would be the equivalent of just over 40 million pounds of uranium oxide. This is only about 10 percent of the uranium oxide equivalent displaced by the Russian HEU. Furthermore, DOE surplus HEU (uranium oxide equivalent) represents only about 4 percent of projected U.S. utility requirements or 1.5 percent of non-U.S. requirements (1996 through 2016). Nonetheless, the U.S. material would likely result in some small additional adverse impacts to the uranium mining and milling industries. However, these impacts would be small compared to any impacts already caused by the Russian HEU.

Domestic uranium producers, who supply less than 20 percent of the U.S. utility requirements, would incur smaller market losses than would foreign producers. Based on current market shares, the U.S. HEU could displace approximately 353,806 kg (780,000 lb) of domestically produced uranium oxide and reduce sector employment by approximately 100 person-years. This quantity represents less than 10 percent of the domestic market share per year for uranium oxide during the period 1998 to 2002. Transfers of the U.S.-origin HEU would likely diminish after 2002, and by the year 2009, the impacts of the U.S.-origin HEU would be inconsequential as the inventory would be almost fully depleted and transfers to end users would be minimal. As discussed in the previous section, displacement of domestic production by Russian HEU could average up to 30 percent during the period 2000 to 2009, and over 50 percent thereafter. Hence, marginal impacts of the U.S. material on the uranium mining and milling sector would occur primarily at the beginning of the delivery period, when transfers of the Russian material to end users would be severely restricted and when the market is

²⁰If DOE is able to make available only 8 t/yr after 2002, and market conditions are favorable, the transfer of the entire 103 t would be completed in 2009.

projected to be relatively robust. One factor, however, that may diminish the impact of both the Russian- and U.S.-origin HEU on the uranium market is that large domestic and foreign inventories of uranium are being depleted and worldwide uranium production is now only one-half of world-wide demand. Demand for uranium oxide will likely increase as the remaining stocks continue to decrease. Utilities may increase their purchases beyond what would be required to meet reactor needs in order to replenish inventories.

Impacts on the Uranium Conversion Sector—The U.S. surplus HEU may have some impact on the uranium conversion market, particularly in the later years of delivery when together, the Russian and U.S. HEU could create a surplus of supply. The U.S. surplus HEU could displace up to 1,500 MTU of conversion services.²¹ The cumulative impact in the year 2001, when delivery to the domestic market of the Russian LEU reaches 10 t, could be displacement of up to 4,500 MTU as UF₆. If delivery to the domestic market of the Russian material reaches 9.1 million kg (20 million lb) beginning 2009, up to 8,250 MTU as UF₆ could be displaced. In the short term, impacts on the UF₆ conversion are likely to be small. The market has improved and prices have risen to reflect increases in demand. As stated earlier, conversion facilities are expected to operate at almost full capacity in the foreseeable future. The major impact in the longer term would be from the Russian HEU, which represents a much larger share of the additional supply. Because DOE would not release the final 40 t of surplus HEU that might be commercialized unless favorable market conditions prevail, any incremental impact to the conversion industry from the U.S. HEU should be minimal.

Impacts on the Uranium Enrichment Sector—The U.S.-origin surplus HEU would further decrease the market for enrichment services provided by the Paducah and Portsmouth gaseous diffusion plants. As noted by commentors to the HEU Draft EIS, if surplus HEU is commercialized at a rate of 10 t/yr, up to 800,000 SWU per year would be displaced.²²

²¹Based on the conversion factor of 2.61 pounds of U₃O₈ to 1 kg of UF₆.

²²A total of 640,000 SWU would be displaced if 8 t/yr of surplus HEU is made available to end users.

The cumulative effect of the Russian and U.S. surplus HEU could peak in the year 2007, when up to 5.1 million SWUs could be displaced. In the year 2007, domestic production could fall to 6.9 million SWUs, a level at which, according to the USEC EA, one plant could meet all of the projected demand. Production would increase above 7 million SWUs again in 2008, when the current inventory of 103 t of expected commercial U.S.-origin surplus HEU would be almost fully commercialized (only 5 t of U.S.-origin surplus HEU would remain at the beginning of 2009). If DOE were to transfer only 8 t of HEU annually after 2002, the gaseous diffusion plant production would fall below 7 million SWUs for 2 years (2008 and 2009).

The decision to maintain operation of one or two enrichment plants would be made by USEC or its successor. However, the *USEC Privatization Act* prohibits the sale of DOE material unless the Secretary of Energy determines that such sale will not have adverse material impacts on the domestic nuclear fuel cycle industry, taking into account sales under the Russian HEU Agreement and the Suspension Agreement. Accordingly, delivery of the U.S. material to end users might be extended over a slightly longer period to ensure that the enrichment plants are not adversely affected.

4.8.4 SUMMARY

The transfer of U.S.-origin HEU to commercial end users is not expected to have an adverse material impact on the nuclear fuel cycle industries. Although some impacts to each of the industry sectors (uranium mining and milling, uranium conversion, and uranium enrichment) would result from the proposed action, these impacts are likely to be minor and temporary. There are several factors that will ameliorate potential adverse economic impacts to these sectors.

- The *USEC Privatization Act* limits the delivery of both U.S. and Russian HEU to end users so as to avoid adverse material impacts on domestic production.
- Transfer of the U.S. HEU to end users would peak when Russian transfers are still small, thus limiting the cumulative impacts.

- Short term demand for uranium products (oxide, UF₆, and LEU) is currently strong, with producers in each of the affected sectors operating at highest capacities.

The cumulative impacts from the U.S.-origin HEU and the Russian HEU would vary over the period of delivery. During the period 1995 to 2000, impacts to the nuclear fuel cycle industries would be minimal because of the limitations on deliveries to end users pursuant to the *USEC Privatization Act*. The largest cumulative impacts to these industries would occur during the period 2000 to 2009, during which deliveries of U.S.-origin HEU to end users would peak under the Preferred Alternative, and delivery allowances of Russian HEU would also increase on a yearly basis. During this period, the surplus U.S. and Russian HEU could displace up to 40 percent of the domestic uranium oxide production. However, most of the displacement would be due to the Russian HEU.²³

The impacts on the conversion and enrichment sectors would appear to be smaller than for the uranium mining and milling sector. World demand for conversion services is projected to be strong during this period, and as stated earlier, all commercial plants are expected to be operating at almost full capacity in the foreseeable future. The enrichment sector would also suffer some displacement of its services. However, the loss of some market in the short term is not expected to result in significant employment impacts. After the year 2009, the U.S.-origin HEU would be almost fully commercialized, and any impacts to domestic nuclear fuel cycle industries would be solely attributable to the Russian HEU.

²³ Also contributing to cumulative impacts would be the 7,000 t of NU that is proposed to be transferred to USEC along with 50 t of HEU. The marginal impact of this material on the uranium mining and conversion sectors is expected to be modest, as the rate of its delivery to end users is limited by the *USEC Privatization Act* (Section 3112 (c)(2)), and it is expected to be commercialized in the early years before Russian shipments increase to substantial levels. The NU would not impact the enrichment sector, as it would still need to be enriched.

4.9 IMPACTS OF TRANSFERRING NATURAL URANIUM TO UNITED STATES ENRICHMENT CORPORATION

The proposal to transfer title to 50 t of HEU to USEC includes within it the transfer of title to 7,000 t of NU now owned by DOE. This material is in the form of UF_6 and is part of a larger quantity of UF_6 that is in storage at DOE's Portsmouth and Paducah Gaseous Diffusion Plants, which are currently being leased to USEC for uranium enrichment operations. The NU was originally purchased by DOE to be enriched for use in nuclear weapons but is no longer needed for that purpose.

The most likely disposition of the 7,000 t of NU is eventual use as feedstock for enrichment to nuclear power plant fuel, the usual business of the enrichment plants. If it is so used, and follows the typical path of NU that is enriched for commercial use, it would probably be enriched to about 2 percent U-235 at the Paducah Plant, then transported to the Portsmouth Plant for additional enrichment to an appropriate commercial material, generally about 4 percent. From there the enriched UF_6 would be transported to a commercial fuel fabrication plant for conversion and fabrication of nuclear fuel.

Transportation of much larger quantities of identical material to, from, and between DOE's two enrichment plants occurs on a continuing basis as part of the normal operation of those facilities. All shipments are made in conformance with DOE O 460.1, *Packaging and Transportation Safety* and O 460.2, *Departmental Materials Transportation and Packaging Management*, Department of Transportation regulation 49 CFR Subchapter C, and the IAEA Safety Series No. 6. All UF_6 shipping containers are required to meet American National Standards Institute N14.1-1972 specifications. The material would be placed in a specification UF_6 cylinder (inner packaging), which would then be placed in a 21-PF, Type B, protective overpack (outer packaging is for added protection) for shipment by commercial carrier (see Section 4.4.3.2 for a more detailed discussion of impacts of transportation of UF_6 blendstock material).

The ongoing normal operations of the enrichment plants, including transportation of materials, are covered by existing NEPA documents²³, which, as

applicable, are incorporated herein by reference. Potential environmental impacts from the operation of the Portsmouth Gaseous Diffusion Plant include the following:

- Damage to the terrestrial ecology caused by drift salts from the cooling towers within the vicinity of 300 m (1,000 ft);
- Detectable vegetation damage or excessive deposition of trace contaminants (for example, zinc) within an area of 1 km (0.6 mi) from the cooling towers;
- Increasing fogging and icing up to 70 hr/yr up to 0.63 km (1 mi) from the plant;
- Liquid discharges that increase the chemical concentrations in the Scioto River to levels above ambient. This includes residual chlorine, uranium, aluminum, sulfates, and total nitrogen; and
- The total population within 80 km (50 mi) may receive a total dose of 0.32 person rem/yr from plant releases to the atmosphere. The maximum exposed individual dose is 0.25 mrem/yr.

The shipment of 7,000 t of NU (0.71 percent enrichment) in the UF_6 form from Paducah to Portsmouth has been evaluated for this EIS. This analysis is based on 9,540 kg (21,000 lb) of material per package and 734 packages for the entire 7,000 t. The total health risk as described in Section 4.4.1 would be 0.129 fatalities for the entire 7,000 t. If the material is enriched to 2 percent LEU before transporting from Paducah to Portsmouth, the 7,000 t of NU would be reduced to 2,490 t of LEU. The total health risk would be 0.0458 fatalities for the 2,490 t. These impacts include the loading and unloading of trucks and the return of empty vehicles to the origin.

²³Energy Research and Development Administration (ERDA), *Final Environmental Statement, Portsmouth Gaseous Diffusion Plant Expansion, Piketon, OH*, ERDA-1549, Washington, DC, 1977; ERDA, *Final Environmental Impact Statement, Portsmouth Gaseous Diffusion Plant Site, Piketon, OH*, ERDA-1555, Washington, DC, 1977; DOE, *Final Environmental Impact Assessment of the Paducah Gaseous Diffusion Plant Site, Paducah, KY*, DOE/EA-0155, Washington, DC, 1982.

4.10 ENVIRONMENTAL JUSTICE IN MINORITY AND LOW-INCOME POPULATIONS

[Text deleted.]

Pursuant to Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations*, DOE and other Federal agencies identify and address appropriate disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority and low-income populations. DOE is in the process of finalizing its Environmental Justice Strategy. [Text deleted.] Because the Department is still in the process of developing guidance, the approach taken in this analysis may differ somewhat from whatever guidance is eventually issued.

Previous sections of Chapter 3 describe the employment and income, population, housing, and community services surrounding each candidate site. Impacts to these socioeconomic issue areas from implementation of the proposed alternatives at these sites are discussed in Chapter 4. Selected demographic characteristics of the socioeconomic ROI for each of the four candidate sites are presented in Tables 4.10-1 through 4.10-4. [Text deleted.] Demographic characteristics for the 80-km (50-mi) surrounding public and occupational health ROI for each of the four candidate sites, are presented in Figures 4.10-1 to 4.10-8.

Any disproportionately high and adverse human health or environmental effects on minority populations and low income populations that could result from the alternatives being considered are assessed for an 80-km (50-mi) area surrounding each of the candidate sites. These are consistent with those used in the public and occupational health and safety analysis. Other considerations were given to biological, water, soil, and cultural resources. The shaded areas in Figures 4.10-1, 4.10-3, 4.10-5, and 4.10-7 show Census tracts where racial or ethnic minorities comprise 50 percent or more (simple majority) of the total population in the Census tract, or where minorities comprise less than 50 percent, but greater than 25 percent, of the total population in the Census tract. Figures 4.10-2, 4.10-4, 4.10-6, and 4.10-8 show low-income communities generally

defined as those where 25 percent or more of the population is characterized as living in poverty (income of less than \$8,076 for a family of two). [Text deleted.]

Any impacts to surrounding communities would most likely result from toxic/hazardous air pollutants and radiological emissions. Sections 4.3.1.6, 4.3.2.6, 4.3.3.6, and 4.3.4.6, which describe public and occupational health impacts from normal operations and accidents, show that air emissions and releases are within regulatory limits during normal operations. The analysis also shows that cumulative effects of continuous accident free operation over time would result in low levels of exposure to workers and the public. The public health impact analysis conducted for all alternatives estimates that the maximum additional cancer fatalities from operational activities would occur at ORR from either the blending of HEU to LEU as UNH for commercial fuel or the blending of HEU to LEU as metal. Under all blending alternatives, the maximum radiation dose to the public is 2.0 mrem annually, and the fatal cancer risk is 2.0×10^{-5} for 20 years for normal operations. For postulated accidents, the maximum latent cancer fatality per campaign for the alternatives to the MBI ranges from 5.7×10^{-4} to 1.9×10^{-2} ; the total campaign risk (cancer fatality probability for the total campaign) ranges from 1.4×10^{-6} to 1.7×10^{-5} . The maximum latent cancer fatalities from accidents per campaign for the alternatives in the population within 80 km (50 mi) ranges from 6.9×10^{-2} to 1.4; the total campaign risk ranges from 1.6×10^{-4} to 1.2×10^{-3} . The probability of the severe accidents is about 10^{-4} per year and ranges from about 10^{-3} to 10^{-5} . Given the low probability of these accidents, there would not be any disproportionate risk of significant high and adverse impacts to particular populations, including low-income and minority populations, from accidents. Except SRS, the analysis of the demographics data presented in Figures 4.10-1 through 4.10-8, Tables 4.10-1 through 4.10-4, and for the communities surrounding the four candidate sites indicates that even if there were any health impacts to these communities, these impacts would not appear to disproportionately affect minority or low-income populations.

Table 4.10-1. Selected Demographic Characteristics for Oak Ridge Reservation Region of Influence

Characteristic/Area	Anderson County	Knox County	Loudon County	Roane County	Total Region of Influence (percent)
Persons by Race/Ethnicity					
Non-Hispanic, White	64,320	300,040	30,700	45,274	440,334 91.3
Hispanic	381	2,067	83	212	2,743 0.6
Non-Hispanic, American Indian	236	775	52	95	1,158 0.2
Non-Hispanic, Black	2,753	29,483	400	1,456	34,092 7.1
Non-Hispanic, Asian/Pacific Islander	537	3,263	49	186	4,035 0.8
Non-Hispanic, Other	23	121	3	4	151 0
Total 1990 Population	68,250	335,749	31,287	47,227	482,513
[Text deleted.]					
1989 Low-Income					
Persons Below Poverty					
Number	9,664	45,608	4,192	7,467	66,931
Percent ^a	18.4	14.1	13.6	16	14.8

^a In calculating percentages, certain categories of individuals are not included as part of the county population: inmates of institutions, Armed Forces members, and individuals under 15 years of age.

Note: May not total 100 percent due to rounding.

Source: Census 1993s; Census 1994a.

Table 4.10-2. Selected Demographic Characteristics for Savannah River Site Region of Influence

Characteristic/Area	South Carolina			Georgia			Total Region of Influence (percent)	
	Aiken County	Allendale County	Bamberg County	Barnwell County	Columbia County	Richmond County		
Persons by Race/Ethnicity								
Non-Hispanic, White	90,130	3,598	6,428	11,421	56,141	103,009	270,727	63.6
Hispanic	867	161	75	146	962	3,707	5,918	1.4
Non-Hispanic, American Indian	213	11	22	31	150	491	918	0.2
Non-Hispanic, Black	29,176	7,939	10,356	8,677	7,239	79,221	142,608	33.5
Non-Hispanic, Asian/Pacific Islander	528	7	20	17	1,518	3,186	5,276	1.2
Non-Hispanic, Other	26	6	1	1	21	105	160	0
Total 1990 Population	120,940	11,722	16,902	20,293	66,031	189,719	425,607	
[Text deleted.]								
1989 Low-Income Persons Below Poverty								
Number	16,671	3,837	4,547	4,367	4,255	32,590	66,267	
Percent ^a	14	35.8	28.2	21.8	6.6	18.2	16.2	

^a In calculating percentages, certain categories of individuals are not included as part of the county population: inmates of institutions, Armed Forces members, and individuals under 15 years of age.

May not total 100 percent due to rounding.

Census 1993s; Census 1994o.

Table 4.10-3. Selected Demographic Characteristics for the Babcock & Wilcox Region of Influence

Characteristic/Area	Amherst County	Appomattox County	Bedford County	Bedford City	Campbell County	Lynchburg	Total Region of Influence (percent)	
Persons by Race/Ethnicity								
Non-Hispanic, White	22,507	9,402	41,698	4,635	40,371	47,595	166,208	80.6
Hispanic	211	27	230	56	166	432	1,122	0.5
Non-Hispanic, American Indian	80	33	68	—	56	85	322	0.2
Non-Hispanic, Black	5,752	2,819	3,605	1,328	6,861	17,465	37,830	18.3
Non-Hispanic, Asian/Pacific Islander	28	14	47	54	110	441	694	0.3
Non-Hispanic, Other	—	3	8	—	8	31	50	0
Total 1990 Population [Text deleted.]	28,578	12,298	45,656	6,073	47,572	66,049	206,226	
1989 Low-Income								
Persons Below Poverty								
Number	2,594	1,501	3,162	927	4,763	9,889	22,836	
Percent ^a	9.8	12.4	7	16.4	10.1	16.4	11.6	

^a In calculating percentages, certain categories of individuals are not included as part of the county population: inmates of institutions, Armed Forces members, and individuals under 15 years of age.

Note: May not total 100 percent due to rounding.

Source: Census 1993s; Census 1994o.

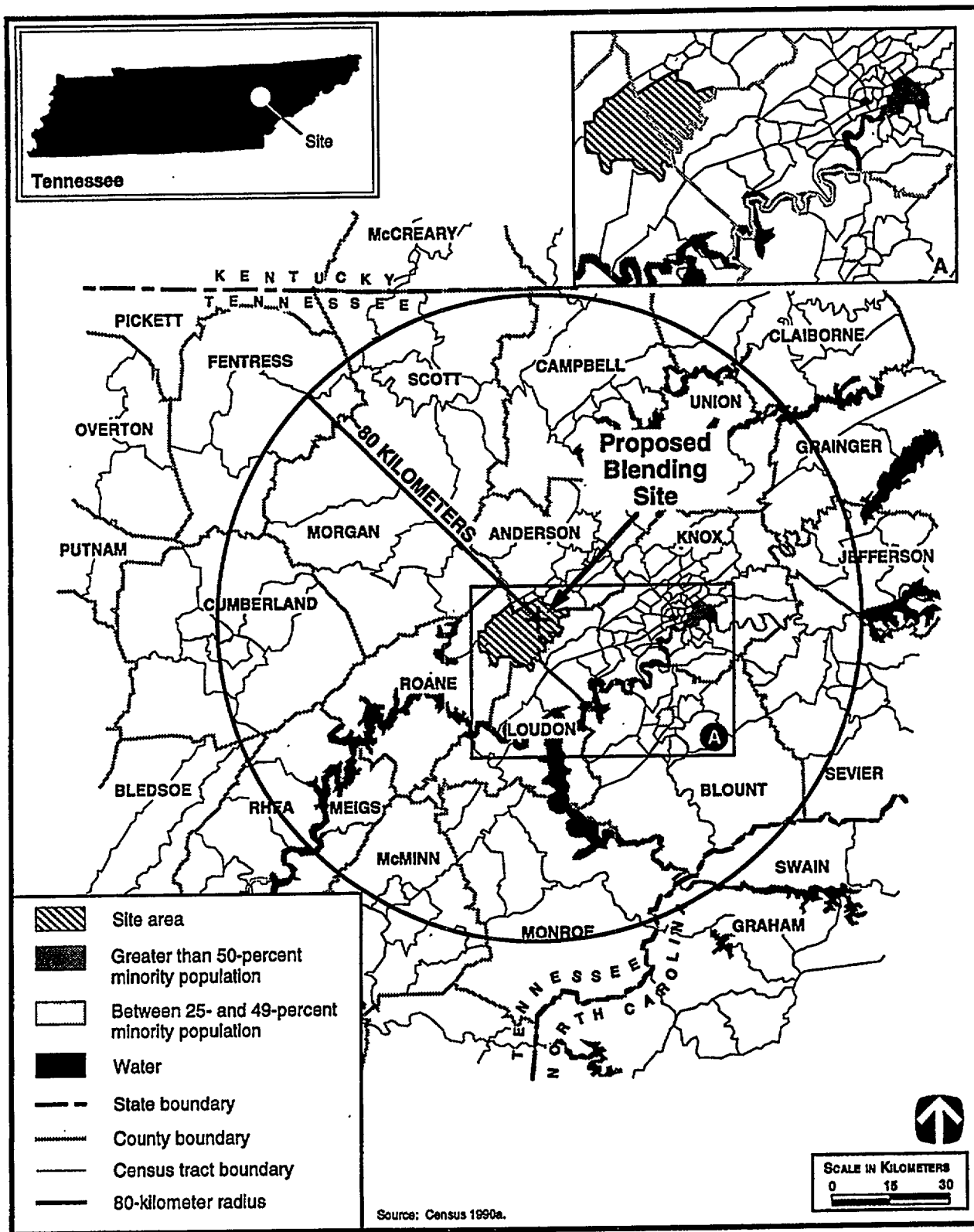
Table 4.10-4. Selected Demographic Characteristics for the Nuclear Fuel Services Region of Influence

Characteristic/Area	Carter County	Sullivan County	Unicoi County	Washington County	Total Region of Influence (percent)	
Persons by Race/Ethnicity						
Non-Hispanic, White	50,618	139,850	16,434	88,198	295,100	97.1
Hispanic,	199	362	99	519	1,179	0.4
Non-Hispanic, American Indian	142	508	—	175	825	0.3
Non-Hispanic, Black	437	2,364	2	3,085	5,888	1.9
Non-Hispanic, Asian/Pacific Islander	95	500	14	323	932	0.3
Non-Hispanic, Other	14	12	—	15	41	0
Total 1990 Population	51,505	143,596	16,549	92,315	303,965	
[Text deleted.]						
1989 Low-Income Persons Below Poverty						
Number	9,027	19,133	2,787	13,656	44,603	
Percent ^a	18	13.5	17.1	15.6	15.1	

^a In calculating percentages, certain categories of individuals are not included as part of the county population: inmates of institutions, Armed Forces members, and individuals under 15 years of age.

Note: May not total 100 percent due to rounding.

Source: Census 1993s; Census 1994o.



2719/HEU

Figure 4.10-1. Minority Population Distribution for Oak Ridge Reservation and Surrounding Area.

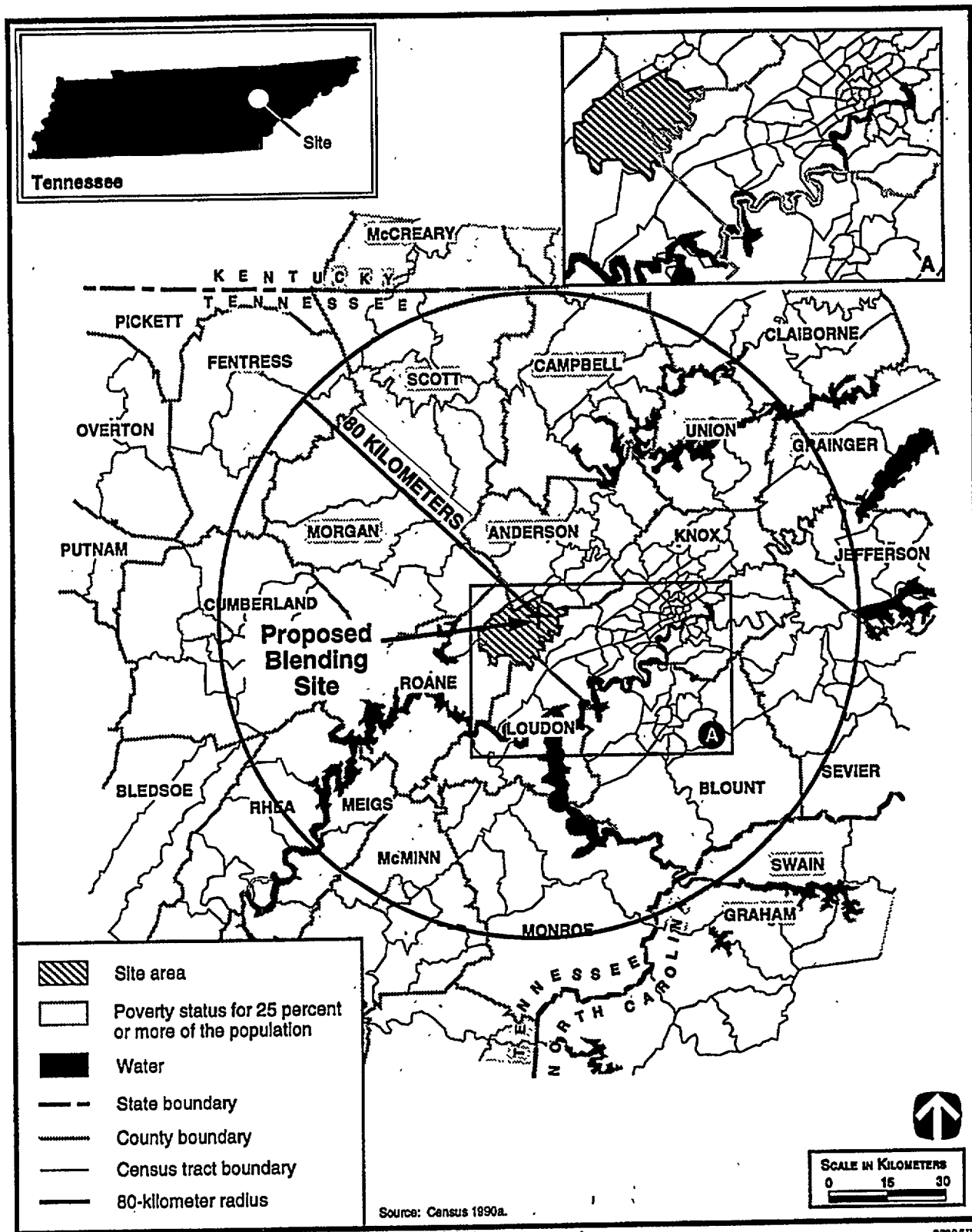


Figure 4.10-2. Low-Income Distribution by Poverty Status for Oak Ridge Reservation and Surrounding Area.

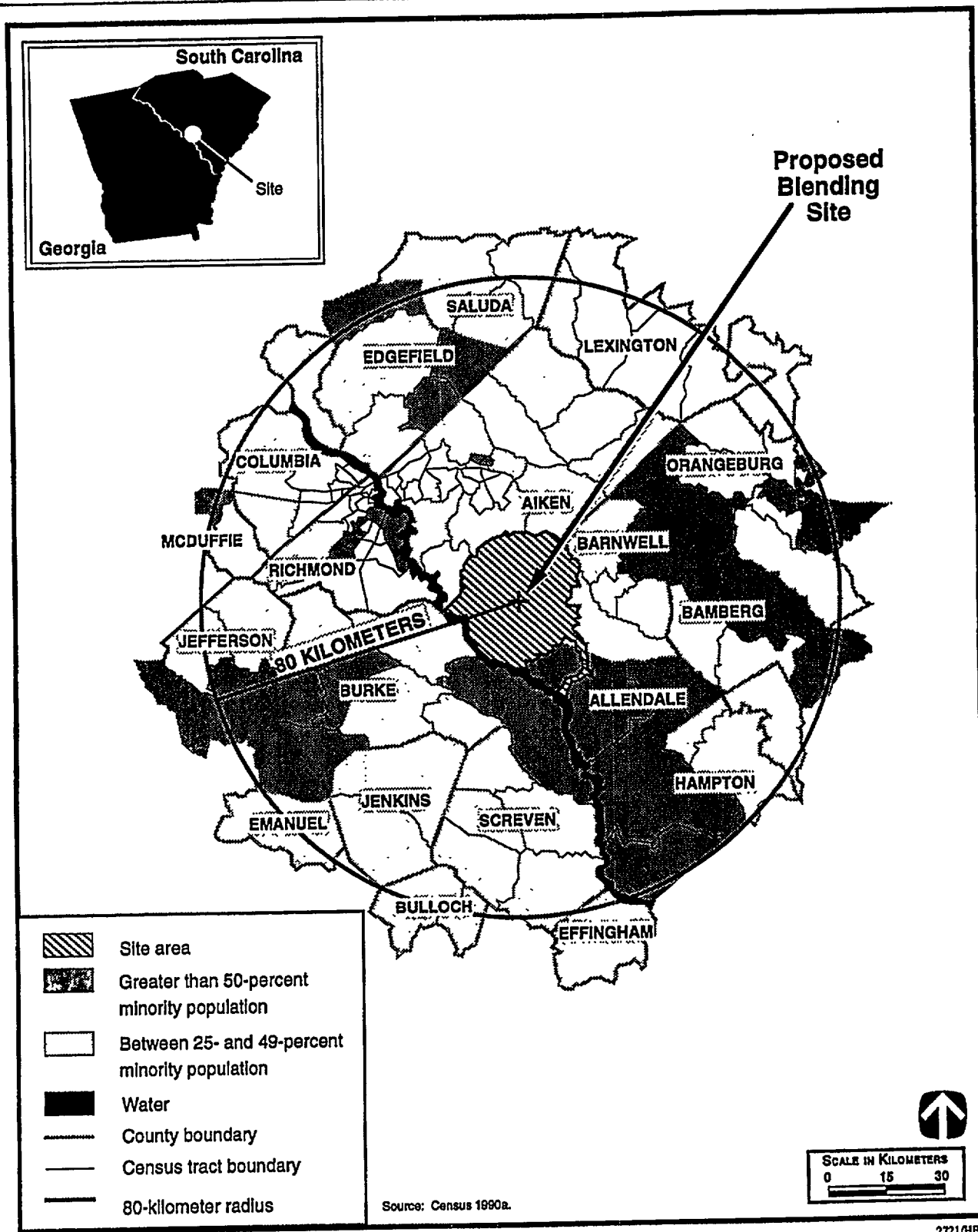


Figure 4.10-3. Minority Population Distribution for Savannah River Site and Surrounding Area.

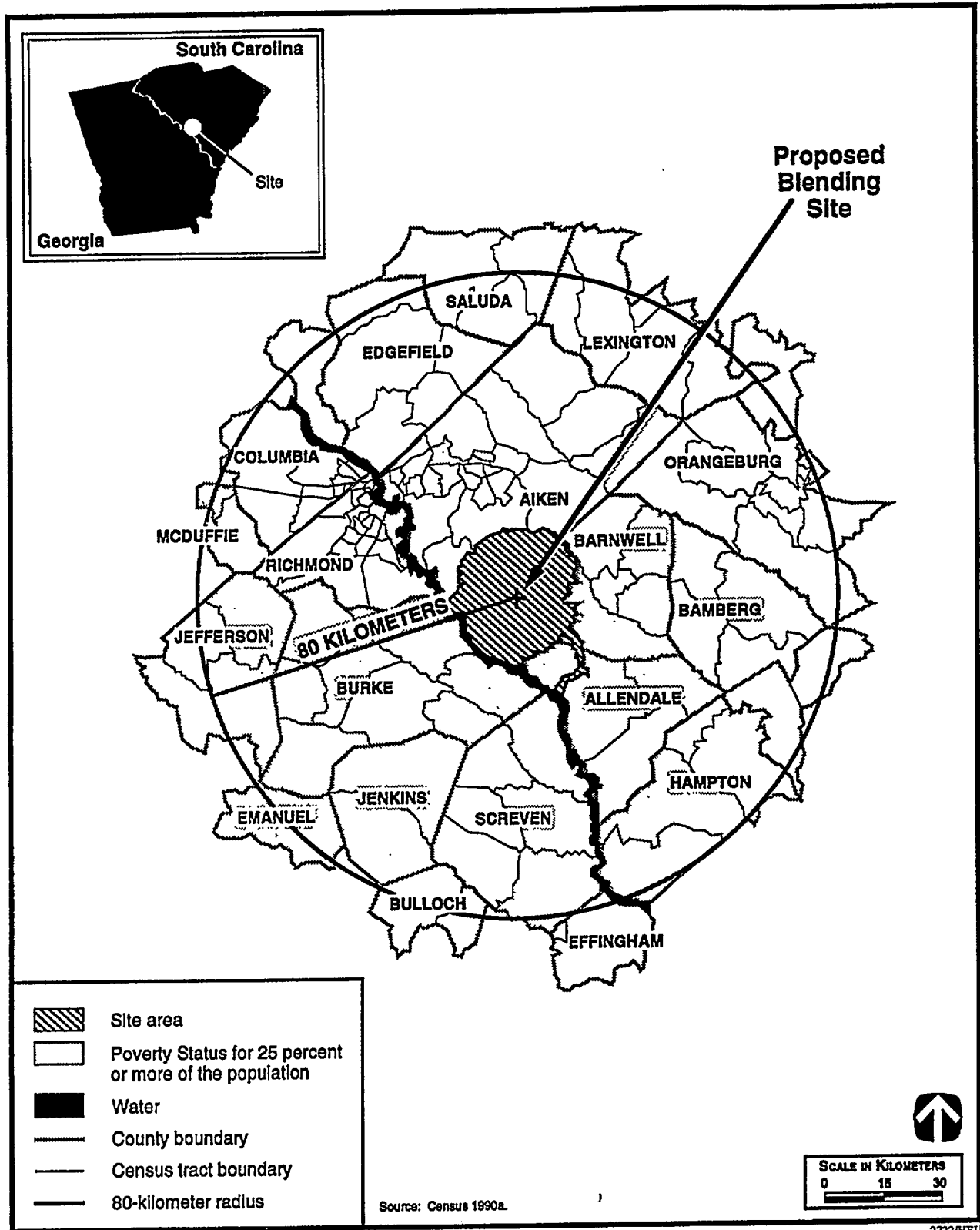


Figure 4.10-4. Low-Income Distribution by Poverty Status for Savannah River Site and Surrounding Area.

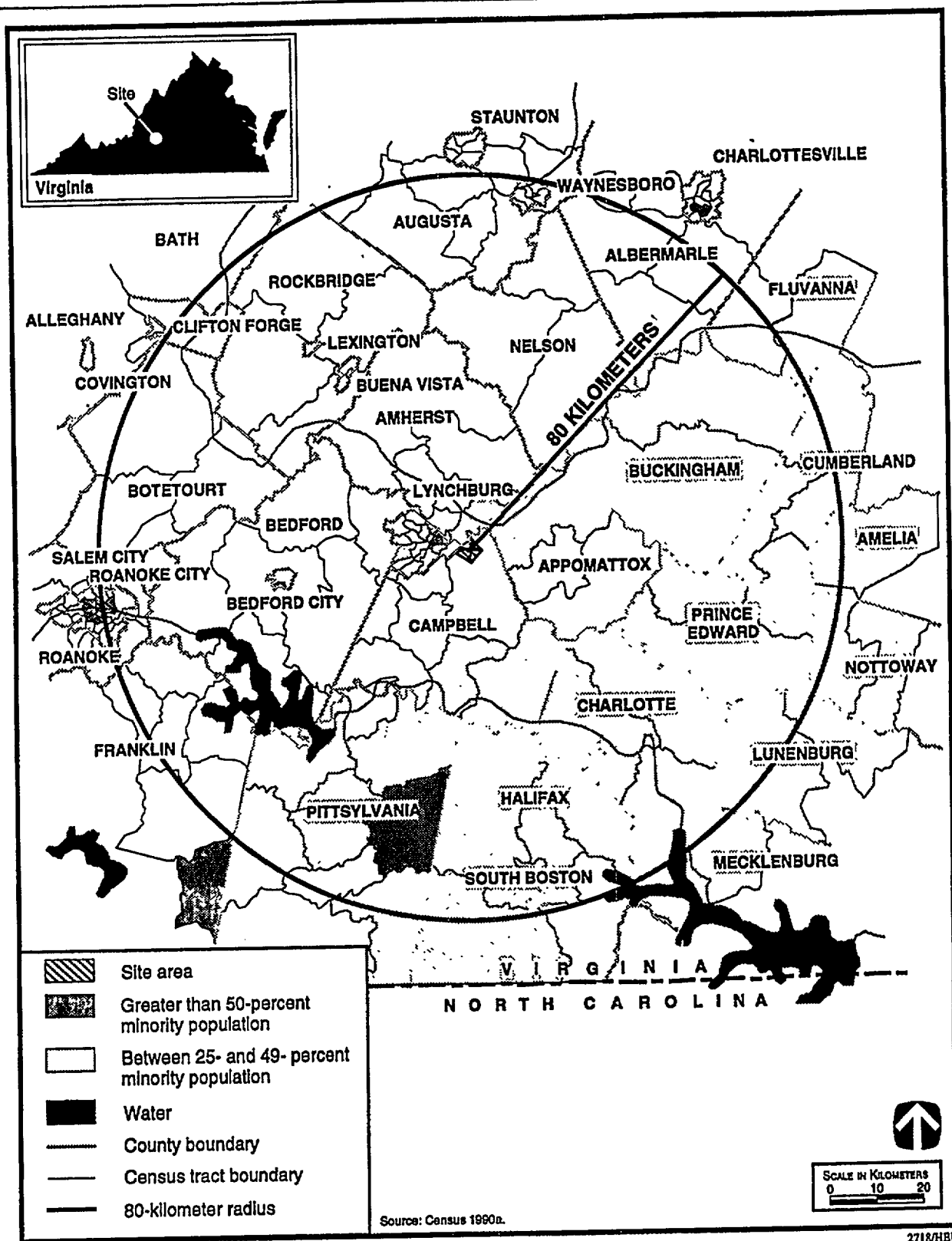


Figure 4.10-5. Minority Population Distribution for Babcock & Wilcox and Surrounding Area.

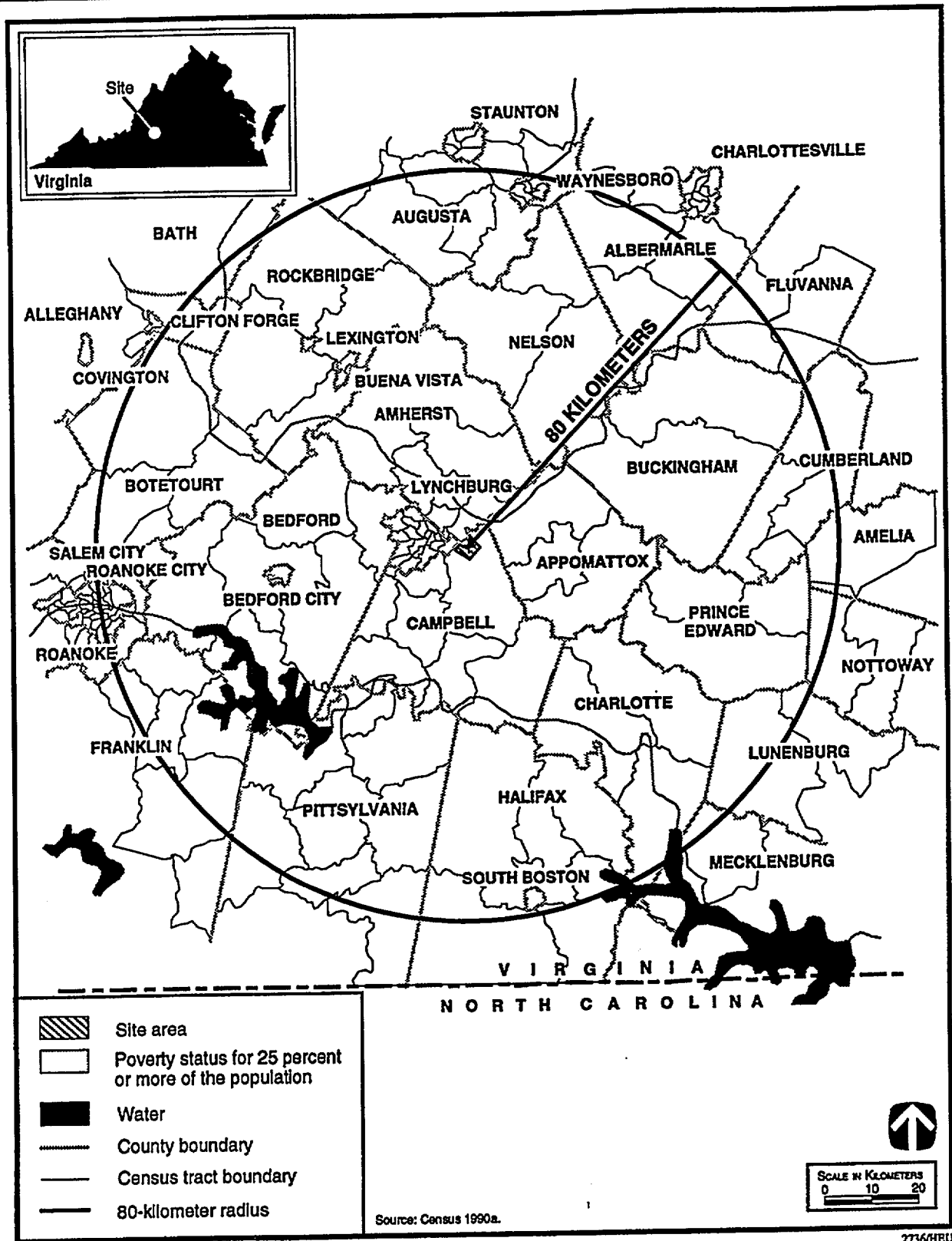
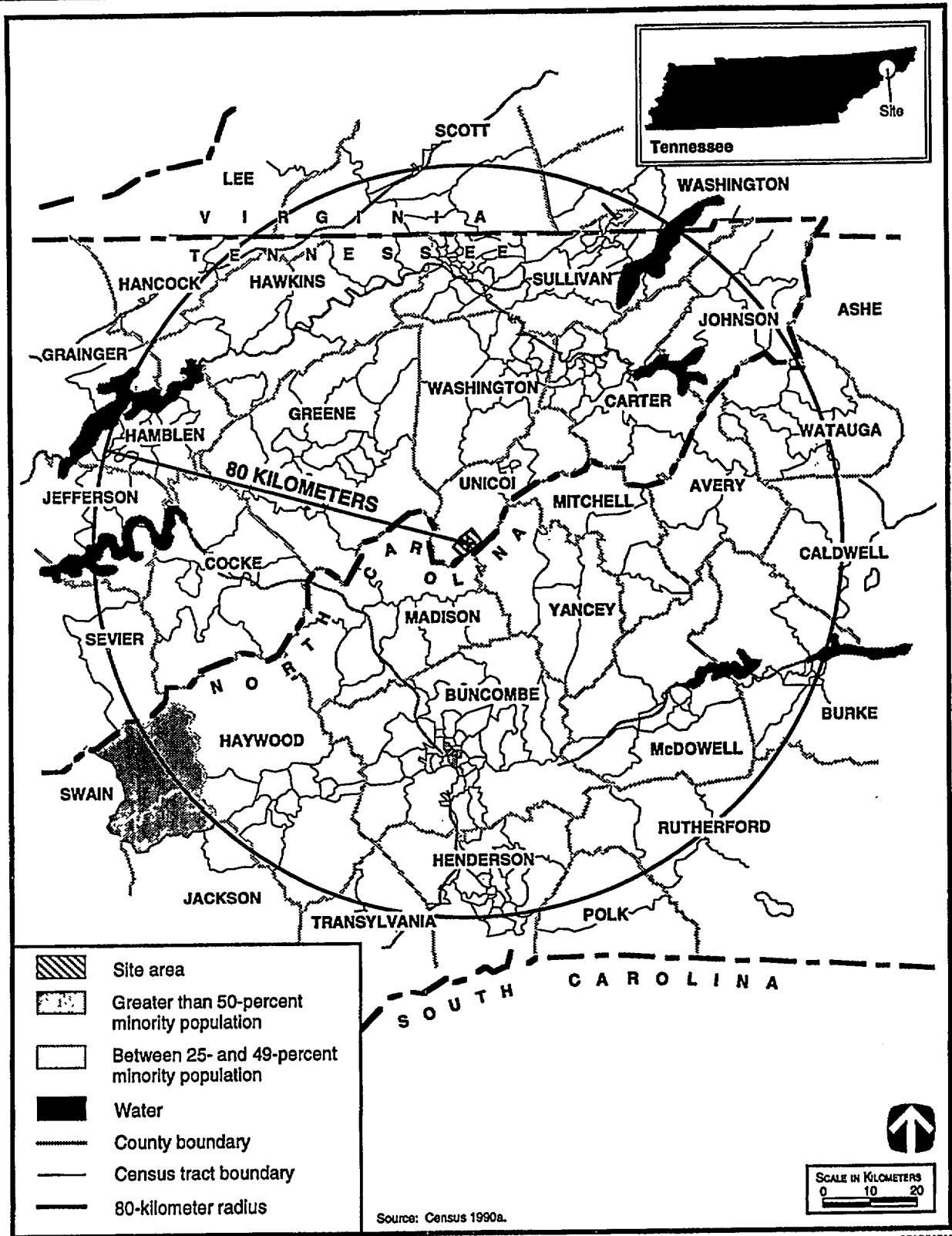


Figure 4.10-6. Low-Income Distribution by Poverty Status for Babcock & Wilcox and Surrounding Area.



2717/HBU

Figure 4.10-7. Minority Population Distribution for Nuclear Fuel Services and Surrounding Area.

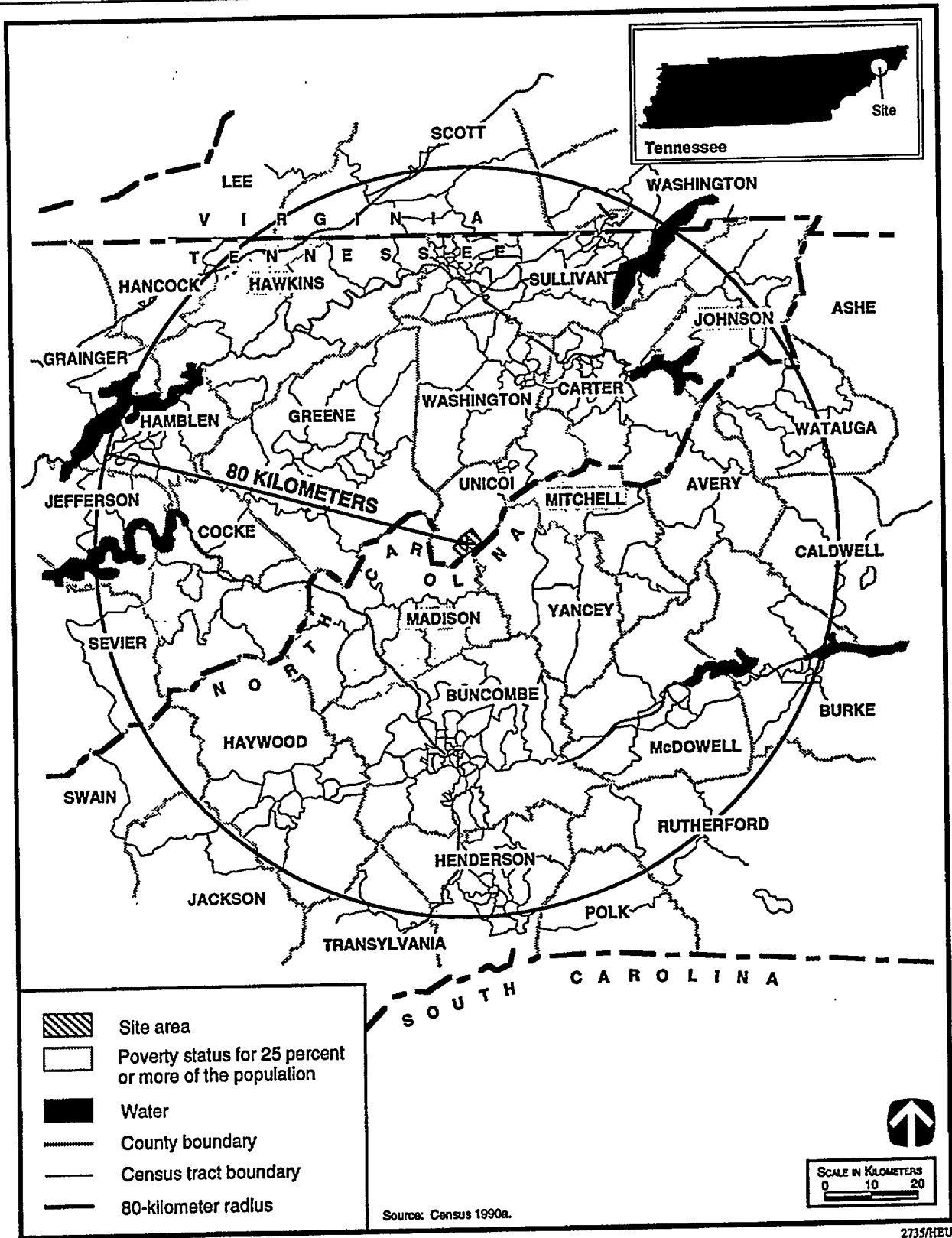


Figure 4.10-8. Low-Income Distribution by Poverty Status for Nuclear Fuel Services and Surrounding Area.

4.11 UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS

Transportation of surplus HEU and blendstock materials and blending facility operation would result in adverse environmental impacts. The impact assessment conducted in this EIS has identified potential adverse impacts along with mitigative measures that could be implemented to either avoid or minimize these impacts. The residual adverse impacts remaining following mitigation are unavoidable and the worst case impacts of all alternatives at all candidate sites are discussed below.

Air pollutant concentrations during operation would be no greater than 63 percent of the NAAQS 3-hour concentration for SO_2 at SRS. This is due to the no action contribution while the HEU blending contribution concentrations are negligible. While the air pollutant concentrations are expected to remain within Federal and State ambient air quality standards, the emission of criteria pollutants represents a minimal unavoidable impact.

Some amount of radiation would be released unavoidably by normal HEU blending operations. The greatest radiation dose to the maximally exposed member of the public would be 1.4 mrem/yr from atmospheric releases and 0.60 mrem/yr from liquid releases at ORR. The associated annual risk of fatal cancers from operations with these doses is 1.0×10^{-6} . The greatest annual population dose from total site operations is 28 person-rem, which occurs at ORR. The associated annual risk of fatal cancers from operations with this dose is 1.4×10^{-2} . The largest average annual dose to a site worker is 115 mrem and would result in an associated annual risk of fatal cancer of 4.6×10^{-5} from operations. The greatest annual dose to the total site workforce is 227 person-rem occurring at SRS and would result in an annual risk of 9.1×10^{-2} fatal cancers. This is due to the no

action contribution; the HEU blending contribution concentrations are negligible.

Since hazardous and toxic chemicals are present during operation of HEU blending facilities, worker exposure to these chemicals is unavoidable. The maximum hazard to site workers, based solely on emissions of hazardous chemicals, is represented by a hazards index of 1.16 at SRS, which is greater than the OSHA action level of 1. This is due to the no action contribution while the blending contribution concentrations are negligible. The maximum hazard to the public is represented by a hazard index of 9.76×10^{-2} at NFS, which does not exceed 1. Cancer risks to the site workers and public are 1.94×10^{-4} and 1.31×10^{-7} respectively, at SRS. The site worker cancer risk value exceeds the standard of 1.0×10^{-6} . This is due to the no action contribution while the blending contribution concentrations are negligible.

Although each site would implement waste minimization techniques, generation of additional low-level, hazardous, and nonhazardous wastes is unavoidable. Generation of additional hazardous or mixed wastes would not require expansion of existing or planned treatment, storage, and disposal facilities for these wastes at sites. Generation of additional nonhazardous wastes would not require expansion of existing, or construction of new, liquid and solid waste treatment facilities but would slightly reduce the lifetimes of current solid waste landfills.

Transportation of radioactive materials between sites presents health risks and accident risks to the public and workforce. The maximum annual risk of fatalities for the transportation of HEU to SRS for blending to 4-percent UNH is 6.1×10^{-2} . For this scenario the blendstock would be sent from Hanford and the UNH crystals would be sent for fuel fabrication to the Siemens Nuclear Power Corporation facility.

4.12

**IRREVERSIBLE AND
IRRETRIEVABLE
COMMITMENTS OF
RESOURCES**

This section describes the major irreversible and irretrievable commitments of resources. A commitment of resources is irreversible when its primary or secondary impacts limit the future options for a resource. An irretrievable commitment refers to the use or consumption of resources neither renewable nor recoverable for later use by future generations. This section discusses two major categories that are committed irreversibly or irretrievably to the proposed action: materials and energy.

Material. The irreversible and irretrievable commitment of material resources during the process of blending HEU to LEU includes materials that are rendered radioactive and cannot be decontaminated, and materials consumed or reduced to unrecoverable forms of waste. Consumption of miscellaneous

chemicals (propylene glycol, nitric acid, etc.) and gases (argon and nitrogen), while irretrievable, would not constitute a permanent drain on local sources or involve any material in critically short supply in the United States as a whole. Materials consumed or reduced to unrecoverable forms of waste are irretrievably lost.

Energy. The irretrievable commitments of resources during operation of blending facilities would include the consumption of natural gas, oil (diesel), and coal. Coal is used at both Y-12 and SRS but not at B&W and NFS. Natural gas is available and used at all sites except SRS which uses oil as the major fuel source. Oil is used at all sites except at Y-12. The electrical energy expended to operate the blending facilities would also be irretrievable. Site infrastructure percent change in energy resource usage at Y-12 and SRS are minimal due to the extensive existing site infrastructure. B&W and NFS both have higher percent increases in energy resources mainly because the facilities are currently operating below capacity.

4.13

FLOODPLAIN ASSESSMENT

As required by DOE's regulations on protection of floodplains and wetlands (10 CFR 1022), this section assesses whether the proposed action would impact or be impacted by the floodplains at the involved sites. The proposed action in this EIS, as described in Section 1.1.2, involves actions (blending activities) that would be accommodated within existing facilities at Y-12, SRS, B&W, and NFS. The locations of facilities at the candidate sites, Y-12, SRS, B&W, and NFS, with respect to delineated floodplains, are presented in the maps shown in Figures 3.3.4-2, 3.4.4-2, 3.5.1-2, and 3.6.4-1, respectively.

Because HEU blending activities associated with the proposed action and its alternatives could be accommodated in existing facilities without structural modifications, no positive or negative impacts on floodplains would be expected at any of the candidate sites. Similarly, since no new construction activity is proposed at any of the candidate sites and blending facilities are not located in the vicinity of wetlands, no impacts to wetlands are anticipated.

In addition to the No Action Alternative, four alternatives are analyzed in this EIS that involve various combinations of end products (fuel or waste), technologies, and facilities to blend down the surplus HEU. As described in detail in Section 2.1.2, Alternative 2 involves no commercial use and represents blending the entire surplus inventory (200 t) to waste using metal and UNH blending processes using all of the candidate blending sites. Alternative 3 involves limited commercial use and assumes that only 25 percent of the surplus inventory would be blended to fuel at the two commercial sites using the UNH and UF_6 processes. The remaining inventory would be blended to waste at all four sites using the metal and UNH processes. Alternatives 4 and 5 involve substantial commercial use (65 percent to fuel and 35 percent to waste), and maximum commercial use (85 percent to fuel and 15 percent to waste), respectively, with blending to be accomplished at one, two, or four sites using the UNH and UF_6 processes for fuel, and metal and UNH processes for waste.

As previously discussed in Sections 3.3.4 and 3.5.4, and shown in Figures 3.3.4-2 and 3.5.1-2, blending operations at the Y-12 Plant and B&W, respectively, would be accommodated in facilities located outside the 100- and 500-year floodplains. At SRS, the F- and H-Canyons that could be used for blending also fall outside the 100-year floodplains of the Fourmile Branch and the Upper Three Runs Creek (Section 3.4.4). However, no information currently is available on 500-year floodplain limits at SRS. The NFS site is partially located on the floodplain of the Nolichucky River and Martin Creek (as determined by FEMA, Flood Insurance Rate Map, January 3, 1985) and is occupied by both 100- and 500- year floodplains. However, as described in Section 3.6.4 and below, mitigation measures have been and would continue to be implemented to reduce potential flooding of the site and the likelihood of adverse impacts to site operations.

The blending alternatives at SRS would not likely affect, or be affected by the 500-year floodplain of either the Fourmile Branch or Upper Three Runs Creek because the F- and H-Canyons are located at an elevation of about 91 m (300 ft) above mean sea level and are approximately 33 m (107 ft) and 64 m (210 ft) above these streams and at distances from these streams of 0.8 km (0.5 mi) to 1.5 km (0.94 mi), respectively. The maximum flow that has occurred on the Upper Three Runs Creek was in 1990, with a flow rate of about $58 \text{ m}^3/\text{s}$ ($2,040 \text{ ft}^3/\text{s}$). At that time the creek reached an elevation of almost 30 m (98 ft) above mean sea level (SR USGS 1996a:1). The elevations of the buildings in F- and H-Canyons are located more than 62 m (202 ft) above the highest flow elevation of the Upper Three Runs Creek. The maximum flow that has occurred on the Fourmile Branch was in 1991 with a rate of approximately $5 \text{ m}^3/\text{s}$ ($186 \text{ ft}^3/\text{s}$), and an elevation of about 61 m (199 ft) above mean sea level (SR USGS 1996a:1). Elevations of the buildings in F- and H-Areas are located more than approximately 30 m (101 ft) higher than the maximum flow level that has occurred.

4.13.1 PROPOSED STATEMENT OF FINDINGS

Four candidate sites, two DOE (Y-12 and SRS) and two commercial (B&W and NFS), were considered in this EIS as potential sites where the proposed action could be implemented. These candidate sites were selected for evaluation because they currently

have technically viable HEU conversion and blending capabilities and could blend surplus HEU to LEU for commercial fuel or waste. In addition, the commercial sites considered are the only ones in the United States licensed for the processing of HEU.

As described above, all facilities except NFS that are proposed to be used for this proposed action at the candidate sites would be outside the limits of the 100-year floodplain and are at least one foot above the 100-year floodplain elevation and, therefore would conform to both State and local floodplain requirements.

The floodplains of the Nolichucky River and Martin Creek at NFS, as previously presented in Figure 3.6.4-1, cover approximately one- and two-thirds of the NFS site's northern portion under 100-year and 500-year floodplain conditions, respectively. Based on the Flood Insurance Rate Map and the flood profiles, both published by FEMA, floodplain elevations at the NFS site are determined to be 499.5 m (1639 ft) and 500 m (1640 ft) above mean sea level, respectively. As stated in the NFS EA, elevations of the building floors are between 500 m (1640 ft) and 510 m (1660 ft) above mean sea level. At the time of construction of the plant (1956), there were no local, State, or NRC requirements prohibiting construction or operation of nuclear facilities in 100- or 500-year floodplains. Presently, the State of Tennessee has no requirements pertaining to building in 100- or 500-year floodplains. Local standards require that any new construction or substantial improvement of any commercial,

industrial, or non-residential structure should have the lowest floor, including basement, elevated no lower than one foot above the level of base flood elevation. Because NFS was built prior to 1974, site operations are grandfathered, and this local requirement does not apply to NFS. NRC, which regulates the NFS site, also has no regulations against building or operating nuclear facilities in floodplains. Nevertheless, with the widening of the site's culvert, upgraded drainage system, rechanneling of the Nolichucky River, and rerouting of Martin Creek to enter the Nolichucky River farther downstream, the chance of flood levels at the site has been slightly lowered. In addition, warning devices and systems have been placed by the State of Tennessee along the river to warn the public and the NFS plant of the chance of possible flooding. In addition, NFS and the State of Tennessee have emergency action plans to mitigate potential flood impacts and protect the public water supply from any possible contamination.

There are two alternatives in addition to no action that could be considered to remediate potential flooding of facilities at NFS. One would be to use the facilities in the 300 Area for blending activities which are outside both the 100- and 500-year floodplain limits. Facilities in the 300 Area have building floor elevations of at least 500.5 m (1642 ft) above mean sea level, which would conform to the local requirement of at least one foot above the 100-year floodplain and would also fall outside of the 500-year floodplain. The second alternative is to eliminate NFS as a candidate blending site.

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The references are obtained from a database that contains references common to the *Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling* (DOE/EIS-0161, October 1995), the *Draft Programmatic Environmental Impact Statement for Stockpile Stewardship and Management* (DOE/EIS-0236, February 1996), the *Storage and Disposition of Weapons-Usable Fissile Materials Draft Programmatic Environmental Impact Statement* (DOE/EIS-0229-D, February 1996), and the *Disposition of Surplus Highly Enriched Uranium Environmental Impact Statement* (DOE/EIS-0240). Therefore, the list of references may include perceived gaps in references. For example, NT DOE 1993c may not appear, while NT DOE 1993b and NT DOE 1993d both do. These gaps occur because the references are all a part of a larger set of references, not all of which appear in this Environmental Impact Statement.

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*Disposition of Surplus Highly
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Glossary

Air Quality Control Region (AQCR): An interstate area designated by the Environmental Protection Agency for the attainment and maintenance of National Ambient Air Quality Standards.

Air quality standards: The level of pollutants in the air prescribed by regulations. These levels may not be exceeded during a specified time in a defined area.

Alloy: A homogeneous mixture of two or more metals.

Alluvium: Earth, sand, gravel, and other materials that have been carried by moving surface water and deposited at points of weak water flow.

Alpha particle: A positively charged particle (the nucleus of a helium atom) that is emitted from the nucleus of certain elements during radioactive decay. It is the least penetrating of the three common types of radiation (alpha, beta, and gamma).

Ambient: Surrounding.

American Indian Religious Freedom Act of 1978: Establishes national policy to protect and preserve for Native Americans their inherent right of freedom to believe, express, and exercise their traditional religions. This includes the rights of access to religious sites, use and possession of sacred objects, and the freedom to worship through traditional ceremonies and rites.

Anadromous: Migrating from salt water to fresh water to spawn.

Anhydrous: Without water.

Aquatic (biota): The sum total of living organisms within any designated area of water.

Aquifer: An underground layer of the earth's crust (that is, porous rock, etc.) containing water; water in an aquifer is known as groundwater.

Aquitard: An underground layer of the earth's crust that is not permeable enough to transmit significant quantities of water. Aquitards separate aquifers.

Archaeological and Historic Preservation Act of 1974: Preserves historic and archaeological data that could be destroyed or compromised as a result of Federal construction or other Federally licensed or assisted activities.

Archaeological resources (sites): Any locations where humans have altered the terrain or discarded artifacts during either prehistoric or historic times.

Archaeological Resources Protection Act of 1979: Protects archaeological resources on Federal lands. It requires a permit for archaeological excavations or removal of any archaeological resources located on public or Native American lands. It prohibits interstate or foreign trafficking of archaeological resources taken in violation of state or local laws and requires Federal agencies to develop plans for surveying lands under their control.

Assay: Qualitative or quantitative analysis of a substance. An amount of a particular type of material in a sample.

Atomic Energy Act of 1954: This act was originally enacted in 1946 and amended in 1954. For the purpose of this Environmental Impact Statement, "...a program for Government control of the possession, use, or production of atomic energy and special nuclear material whether owned by the Government or others, so directed as to make the maximum contribution to the common defense and security and the national welfare and to provide continued assurance of the Government's ability to enter into and enforce agreements with nations or groups of nations for the control of special nuclear materials and atomic weapons..." (Section 3(c)).

Atomic Energy Commission: A five-member commission, established by the *Atomic Energy Act*, to supervise nuclear weapons design, development, manufacturing, maintenance, modification, and dismantlement. In 1974, the Atomic Energy Commission was abolished and all functions were transferred to the Nuclear Regulatory Commission (NRC) and the Administrator of the Energy Research and Development Administration. The Energy Research and Development Administration was later terminated and the functions vested by law in the

Administrator were transferred to the Secretary of Energy.

Attainment area: An area considered to have air quality as good as or better than the national ambient air quality standards as defined in the *Clean Air Act*. An area may be an attainment area for one pollutant and a non-attainment area for others.

Background radiation: Ionizing radiation present in the environment from cosmic rays and natural sources in the earth; background radiation varies considerably with location.

Badged worker: A worker who has the potential to be exposed to radiation and is equipped with an individual dosimeter.

Bald and Golden Eagle Protection Act: This act states that it is unlawful to take, pursue, molest, or disturb the American bald and golden eagle, and their nests and their eggs, anywhere in the United States.

Baseline: A quantitative expression of conditions, costs, schedule, or technical progress to serve as a base or standard for measurement; the established plan against which the status of resources and the progress of a program can be measured.

Benthic: Dwelling at the bottom of oceans, lakes, rivers, and other surface waters.

Beta particle: A positively or negatively charged particle (with the same mass as an electron) that is emitted from the nucleus of certain elements during radioactive decay. It is more penetrating than an alpha particle and typically less penetrating than gamma radiation.

Biotic: Pertaining to biota; the plant and animal life of a particular region.

Biotic resources: Biotic resources include terrestrial, wetlands, and aquatic resources as well as threatened and endangered species.

Blend down (blending): The dilution of highly enriched uranium by mixing with blendstock of the same chemical form to yield low-enriched uranium material.

Blendstock: Depleted, natural, or low-enriched uranium that is used to dilute highly enriched uranium into low-enriched uranium. The depleted, natural, and low-enriched uranium is in a chemical form identical to the highly enriched uranium that it is being blended with to form the low-enriched uranium product.

Bounding case: A case that would represent the extreme (high or low) boundaries of a possible situation.

Bryozoa: A phylum consisting of various small aquatic animals that reproduce by budding and form colonies attached to stones or seaweed.

Capable fault: A geological fault as defined by 10 CFR 100, Appendix A:

- Movement at or near the ground surface at least once during the past 35,000 years or movement of a recurring nature within the past 500,000 years.
- Macro-seismicity (a high tendency for the occurrence of earthquakes) instrumentally determined with records of sufficient precision to demonstrate a direct relationship with the fault.
- A structural relationship to a capable fault according to characteristics such that movement on one could be reasonably expected to be accompanied by movement on the other.

Carolina bays: Ovate, intermittently flooded depression of a type occurring on the coastal plain from New Jersey to Florida.

Clean Air Act Amendments of 1990: Expands the Environmental Protection Agency's enforcement powers and adds restrictions on air toxics, ozone depleting chemicals, and stationary and mobile emissions implicated in acid rain and global warming.

Clean Water Act of 1972, 1987 (CWA): This Act regulates the discharge of pollutants from a point source into navigable waters of the United States in compliance with a National Pollution Discharge

Elimination System (NPDES) permit as well as regulates discharges to or dredging of wetlands.

Code of Federal Regulations (CFR): All Federal regulations in force are published in codified form in this document.

Coliform: Normally harmless types of bacteria that reside in the intestinal tract of humans and other animals and whose presence in water is an indicator that the water may be contaminated with other disease-causing organisms found in untreated human and animal waste.

Colluvium: Soil and other nonconsolidated rock material on hill slopes; not transported by water.

Community (biotic): An aggregation of plants and animals having mutual relationships among themselves and to their environment.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA or Superfund): This Act provides a regulatory framework for remediation of past contamination from hazardous waste. If a site meets the Act's requirements for designation, it is ranked along with other "Superfund" sites and is listed on the National Priorities List. This ranking is the Environmental Protection Agency's way of determining the sites that have the highest priority for cleanup.

Confined aquifer: A permeable geological unit with an upper boundary that is at a pressure higher than atmospheric pressure.

Cosmic radiation: Streams of highly penetrating, charged particles, composed of protons, alpha particles, and a few heavier nuclei, that bombard the earth from outer space.

Coastal Zone Management Act: This act establishes a national policy of preservation, protection from development, and, where possible, the restoration and enhancement of the nation's coastal zone.

Criteria pollutants: Six air pollutants for which national ambient air quality standards are established by the Environmental Protection Agency (EPA): sulfur dioxide, nitric oxides, carbon monoxide,

ozone, particulate matter (smaller than 10 microns in diameter), and lead.

Critical habitat: As defined in the *Endangered Species Act* of 1973, specific areas within the geographical area occupied by an endangered or threatened species that are essential to the conservation of the species and that may require special management considerations or protection; and specific areas outside of the geographical area occupied by the species that are essential for the conservation of the species.

Criticality: A reactor state in which a self-sustaining nuclear chain reaction is achieved.

Curie: A unit of radioactivity equal to 37 billion disintegrations per second; also a quantity of any nuclide or mixture of nuclides having 1 curie of radioactivity.

Decay (radioactive): The decrease in the amount of any radioactive material with the passage of time, due to the spontaneous transformation of unstable nuclides into different nuclides or into a different state of the same nuclide. The emission of nuclear radiation (alpha, beta, and gamma) is part of the process.

Decibel: A unit of sound measurement. In general, a sound doubles in volume for every increase of 10 decibels.

Decontamination: The removal of radioactive or chemical contamination from facilities, equipment, or soils by washing, heating, chemical or electrochemical action, mechanical cleaning, or other techniques.

Depleted uranium (DU): Uranium with a content of the isotope uranium-235 of less than 0.7 percent, which is the uranium-235 content of naturally occurring uranium.

Derived concentration guide: The concentration of a radionuclide in the air or water of which, under conditions of continuous exposure by one exposure mode (for example, ingestion of water) for one year, a "reference person" would receive the most restrictive: 1) an effective dose equivalent or 100

mmrem, or 2) a dose equivalent of 5 rem to any tissues, including skin and the lens of the eye.

Design-basis event: A postulated disturbance in a process variable that has the potential to lead to a design-basis accident.

Dolomite: Calcium magnesium carbonate, a limestone-like material.

Dose: The energy imparted to matter by ionizing radiation. The unit of absorbed dose is the rad.

Dose commitment: The dose an organ or tissue would receive during a specified period of time (for example, 20 to 30 years) as a result of intake (as by ingestion or inhalation) of one or more radionuclides from a defined release, frequently over a year's time.

Dose equivalent: The product of the absorbed dose in rad (or gray) and the effect of this type of radiation in tissue and a quality factor. Dose equivalent is expressed in units of rem or Sievert, where 1 rem equals 0.01 Sievert. The dose equivalent to an organ, tissue, or whole body will be that received from the direct exposure plus 50-year committed dose equivalent received from radionuclides taken into the body during the year.

Dosimeter: A small device (instrument) carried by a worker that measures the cumulative radiation dose (for example, film badge or ionization chamber).

Drawdown: The lowering of the water level in a reservoir, water table, or other body of water.

Effective dose equivalent: The summation of the products of the dose equivalent received by specified body tissues and a tissue-specific weighting factor. The sum is a risk-equivalent value and can be used to estimate the health effects risk of the exposed individual. The tissue-specific weighting factor represents the fraction of the total health risk resulting from uniform whole-body irradiation that would be contributed by that specific tissue. The effective dose equivalent includes the committed effective dose equivalent from internal deposition of radionuclides and the effective dose equivalent due to penetrating radiation from sources external to the body. Effective dose equivalent is expressed in units of rem or Sievert.

Effluent: A gas or fluid discharged into the environment.

Endangered species: Defined in the *Endangered Species Act of 1973* as "any species which is in danger of extinction throughout all or a significant portion of its range."

Endangered Species Act of 1973: This act requires Federal agencies, with the consultation and assistance of the Secretaries of the Interior and Commerce, to ensure that their actions will not likely jeopardize the continued existence of any endangered or threatened species or adversely affect the habitat of such species.

Enrichment: A process whereby the proportion of fissile U-235 is increased above its naturally occurring value of 0.7 percent. Enrichment to 3 percent is typical of fuel for power reactors. Weapons-grade uranium may be enriched to 20 percent or more.

Entrainment: The involuntary capture and inclusion of organisms in streams of flowing water, a term often applied to the cooling water systems of power plants or reactors. The organisms involved may include phyto- and zooplankton, fish eggs and larvae (ichthyoplankton), shellfish larvae, and other forms of aquatic life.

Environment, safety, and health program: In the context of the Department of Energy, this program encompasses those Department of Energy requirements, activities, and functions in the conduct of all Department of Energy-controlled operations that are concerned with impacts to the biosphere; compliance with environmental laws, regulations, and standards controlling air, water, and soil pollution; limiting risks to the well-being of both operating personnel and the general public to acceptably low levels; and adequately protecting property against loss or damage. Typical activities and functions related to this type of program include, but are not limited to, environmental protection, occupational safety, fire protection, industrial hygiene, health physics, occupational medicine, process and facilities safety, nuclear safety, emergency preparedness, quality assurance, and radioactive and hazardous waste management.

Environmental assessment (EA): A written environmental analysis that is prepared pursuant to the *National Environmental Policy Act* (NEPA) to determine whether a Federal action would significantly affect the environment and thus require the preparation of a more detailed environmental impact statement. If the action does not significantly affect the environment, a Finding of No Significant Impact (FONSI) is prepared.

Environmental impact statement (EIS): A document required of Federal agencies by the *National Environmental Policy Act* for major proposals significantly affecting the environment. A decisionmaking tool, it describes the positive and negative effects of the proposed action and alternatives.

Epidemiology: The science concerned with the study of events that determine and influence the frequency and distribution of disease, injury, and other health-related events and their causes in a defined human population.

Evaluation basis accident: For nuclear facilities, a postulated abnormal event that is used to establish the performance requirements of structures, systems, and components that are necessary to: 1) maintain them in a safe shutdown condition indefinitely; or 2) prevent or mitigate the consequences of such an accident so that the general public and operating staff are not exposed to radiation in excess of appropriate guideline values.

Exposure limit: The level of exposure to a hazardous chemical (set by law or a standard) at or below which adverse human health effects are not expected to occur:

- Reference dose is the chronic exposure dose (mg/kg/day) for a given hazardous chemical at or below which adverse, non-carcinogenic human health effects are not expected to occur.
- Reference concentration is the chronic exposure concentration (mg/m³) for a given hazardous chemical at or below which adverse non-carcinogenic human health effects are not expected to occur.

Fault: A fracture or zone of fractures within a rock formation along which vertical, horizontal, or transverse slippage has occurred.

Fauna: Animals, especially those of a specific region, considered as a group.

Finding of No Significant Impact (FONSI): A document by a Federal agency briefly presenting the reasons why an action, not otherwise excluded, will not have a significant impact on the human environment and will not require an environmental impact statement.

Fish and Wildlife Coordination Act: This act requires that consideration be given to the conservation of fish and wildlife resources during the development of projects that affect water resources directly or indirectly.

Fissile material: An element or isotope that can undergo fission.

Fission: The splitting of a heavy nucleus, as of uranium or plutonium, into two approximately equal parts, accompanied by the conversion of mass to energy, the release of this energy, and the production of free neutrons, gamma rays, and other radiation. Fission can occur spontaneously or be induced by neutron bombardment.

Fission products: Nuclei formed by the fission of heavy elements (primary fission products); also the nuclei formed by the decay of the primary fission products, many of which are radioactive.

Floodplain: The lowlands adjoining inland and coastal waters and relatively flat areas with a chance of 1 percent or greater that the area will be inundated by a flood in any given year. The base floodplain is defined as the 100-year (1-percent) floodplain. The critical action floodplain is defined as the 500-year (0.2-percent) floodplain.

Flora: Plants, especially those of a specific region, considered as a group.

Forward Reactor Requirements: Amount of uranium required to assure uninterrupted operation of nuclear power plants.

Gamma particles: High-energy, short-wavelength electromagnetic particles emitted from the nucleus of atoms of certain elements during fission or decay. Gamma radiation is very penetrating and can be stopped only by dense materials (such as lead) or a thick layer of shielding materials.

Glove box: An airtight box used to work with hazardous material, vented to a closed filtering system, with gloves attached inside of the box to protect the user.

Groundwater: The supply of water found beneath the earth's surface, usually in aquifers, which may supply wells and springs.

Half-life (radiological): The time in which half the atoms of a radioactive substance disintegrate to another nuclear form; this varies from milliseconds to billions of years, depending on the isotope.

Hazard index (HI): A summation of the Hazard Quotients for all chemicals now being used at a site and those proposed to be added to yield cumulative levels for a site. A Hazard Index value of 1.0 or less means that there should be no adverse human health effects (non-carcinogenic).

Hazardous material: Any material, as defined by 40 CFR 171.8, which poses a risk to health, safety, and property when transported or handled.

Hazardous/toxic waste: Any solid, semisolid, liquid, or gaseous material that is ignitable, corrosive, toxic, or reactive, as defined by the *Resource Conservation and Recovery Act* and identified or listed in 40 CFR 261 or by the *Toxic Substances Control Act*.

High efficiency particulate air (HEPA) filter: A filter used to remove solid particles from dry, gaseous effluent streams.

High-level waste (HLW): The highly radioactive waste material that results from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid waste derived from the liquid. High-level waste contains a combination of transuranic waste and fission products in concentrations requiring permanent isolation.

Highly enriched uranium (HEU): Uranium enriched in isotope U-235 to 20 percent or above, which becomes suitable for weapons use.

Historic resources: Archaeological sites, architectural structures, and objects produced after the advent of written history dating, in the United States, from 1492.

Hydrology: The science dealing with the properties, distribution, and circulation of natural water systems.

Igneous rock: Class of rock formed by the solidification of molten or partly molten parent material.

Impingement: The process by which aquatic organisms that are too large to pass through the screens of a water intake structure become caught on the screens and are unable to escape.

Impoundment: A collection area for water, usually for irrigation purposes.

Incident-free risk: The radiological or chemical impacts resulting from the normal vehicular transport of packages. This includes the radiation of a hazardous chemical exposure of specific populations, such as crew, passengers, and bystanders. No accident or incident risks are involved.

Indirect economic effects: Indirect economic effects result from the need to supply industries experiencing direct economic effects with additional outputs to allow them to increase their production. The additional output from each directly affected industry requires inputs from other industries within a region (that is, purchasers of goods or services). This results in a multiplier effect to show the change in total economic activity as firms increase their labor inputs.

Infrastructure: The basic facilities, services, and installations needed for the functioning of a plant or other site, such as transportation and communication systems.

Interim storage: Providing safe and secure capacity in the near term to support continuing operations in the interim period (10 years).

Intermittent stream: A stream or reach of a stream that flows primarily during seasonal wet periods.

Involved worker: A worker that is directly associated with any of the blending and conversion facility operations.

Ion exchange: A unit physiochemical process that removes ions (both positively and negatively charged), including radionuclides, from liquid streams (usually water) for the purpose of purification or decontamination.

Ionizing radiation: Radiation that can displace electrons from atoms or molecules, thereby producing ions.

ISCST2: A computerized dispersion program used to calculate ground-level concentrations of air pollutants (Version 2).

Isotope: An atom of an element with a specific atomic number and atomic mass. Isotopes of the same element have the same atomic number (i.e., the same number of protons) but have the different numbers of neutrons and different atomic masses. Isotopes are identified by the name of the element and the total number of protons and neutrons in the nucleus.

Joule: A metric unit of energy, work, or heat that is equivalent to 1 watt-second, 0.239 calories or 1 newton-meter.

Land resources: Land resources are comprised of all of the terrestrial areas available for economic production, residential or recreational use, Government activities (such as military bases), or natural resources consumption.

Latent fatalities: Fatalities associated with acute and chronic environmental exposure to chemical or radiation which occur years after an exposure takes place.

Low-enriched uranium (LEU): Uranium with a content of the uranium isotope U-235 greater than 0.7 percent and less than 20 percent.

Low-level waste (LLW): Waste that contains radioactivity but is not classified as high-level or

transuranic waste, spent nuclear fuel, or "11e(2) byproduct material" as defined by Department of Energy Order 5820.2A, *Radioactive Waste Management*. Test specimens of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as low-level waste, provided the concentration of transuranic waste is less than 100 nanocuries per gram.

Maximally exposed individual (MEI): A hypothetical person who could potentially receive the maximum dose of radiation or hazardous chemicals.

Megawatt: A unit of power equal to 1 million watts. "Megawatt thermal" is commonly used to describe heat, while "megawatt electric" describes electricity.

Metamorphic rocks: Class of rock formed in the solid state in response to pronounced changes in the temperature, pressure or chemical environment.

Mixed waste: Waste that contains both radioactive and hazardous wastes as described in this glossary.

Migration: The seasonal movement of animals from one area to another.

Migratory Bird Treaty Act: This act states that it is unlawful to pursue, take, attempt to take, capture, possess, or kill and migratory bird, or any part, nest, or egg of any such bird other than permitted activities.

Modified Mercalli Intensity scale: A measure of the perceived intensity of earthquake ground shaking with 12 divisions, from I (not felt by people) to XII (damage nearly total).

National Ambient Air Quality Standards (NAAQS): Air quality standards established by the *Clean Air Act*, as amended. The primary National Ambient Air Quality Standards are intended to protect the public health with an adequate margin of safety. The secondary National Ambient Air Quality Standards are intended to protect the public welfare from any known or anticipated adverse effects of a pollutant.

National Emissions Standards for Hazardous Air Pollutants (NESHAP): A set of national emission standards for listed hazardous pollutants emitted from specific classes or categories of new and existing sources. These were implemented in the *Clean Air Act* Amendments of 1977.

National Environmental Policy Act of 1969 (NEPA): This Act is the basic national charter for the protection of the environment. It requires the preparation of an environmental impact statement for every major Federal action that may significantly affect the quality of the human or natural environment. Its main purpose is to provide environmental information to decision-makers so that their actions are based on an understanding of the potential environmental consequences of a proposed action and its reasonable alternatives.

National Environmental Research Park: An outdoor laboratory set aside for ecological research to study the environmental impacts of energy developments. National environmental research parks were established by the Department of Energy to provide protected land areas for research and education in the environmental sciences and to demonstrate the environmental compatibility of energy technology development and use.

National Historic Preservation Act of 1966, as amended: This Act provides that property resources with significant national historic value be placed on the National Register of Historic Places. It does not require any permits but, pursuant to Federal Code, if a proposed action might impact a historic property, it mandates consultation with the appropriate agencies.

National Pollution Discharge Elimination System (NPDES): The Federal permitting system required for hazardous effluents regulated through the *Clean Water Act*, as amended.

National Register of Historic Places (NRHP): A list of districts, sites, buildings, structures, and objects of prehistoric, historic, local, state, or national significance that is maintained by the Secretary of the Interior. The list is expanded as authorized by Section 2(b) of the *Historic Sites Act* of 1935 (16 U.C. 462) and Section 101(a)(1)(A) of the *National Historic Preservation Act* of 1966, as amended.

Natural uranium (NU): Uranium that has the same isotopic composition as naturally occurring uranium. The isotopic composition of natural uranium is approximately 99.3 percent U-238 and 0.71 percent U-235.

Native American Graves and Repatriation Act of 1990: Established to protect Native American graves and associated funerary objects. This law requires Federal agencies and museums to inventory human remains and associated funerary objects and to provide culturally affiliated tribes with the inventory of collections. Requires repatriation, on request, to the culturally affiliated tribes.

Neutron: An uncharged elementary particle with a mass slightly greater than that of a proton, found in the nucleus of every atom heavier than hydrogen-1; a free neutron is unstable and decays, with a half-life of about 13 minutes, into a proton and an electron.

Nitrogen oxides: Refers to the oxides of nitrogen, primarily nitrogen oxide (NO) and nitrogen dioxide (NO₂). These are produced in the combustion of fossil fuels and can constitute an air pollution problem. When nitrogen dioxide combines with volatile organic compounds, such as ammonia or carbon monoxide, ozone is produced.

Noise Control Act of 1972: This Act directs all Federal agencies to carry out programs in a manner that furthers a national policy of promoting an environment free from noise that jeopardizes health or welfare.

Noninvolved worker: A worker that is located onsite but is not associated with any of the blending facility operation.

Normal operation: A predetermined set of facility processes or functions whereby and expected or "standard" output is the result.

Notice of Intent (NOI): A notice printed in the *Federal Register* announcing that a Federal agency is going to prepare an environmental impact statement.

Nuclear power plant: A facility that converts nuclear energy into electrical power. Heat produced in a nuclear reactor is used to make steam, which in

turn drives a turbine connected to an electric generator.

Nuclear reactor: A device in which a fission chain reaction is maintained and which is used for irradiation of materials or to produce heat for the generation of electricity.

Nuclide: A species of atom characterized by the constitution of its nucleus and hence by the number of protons, the number of neutrons, and the energy content.

Occupational dose limit: The NRC's promulgated radiological exposure limits to occupational workers. To the whole body, it is established to be 5,000 millirem per year.

Occupational Safety and Health Administration (OSHA): Oversees and regulates workplace health and safety, created by the *Occupational Safety and Health Act* of 1970.

Outfall: The discharge point of a drain, sewer, or pipe as it enters a body of water.

Overfeeding: The process that involves increasing the rate at which uranium feed is used in gaseous diffusion plants with a corresponding decrease in energy consumed for separative work.

Oxidation: The combination of a substance with oxygen. During this reaction, the atoms in the element combined with oxygen lose electrons and the element's valence (the capacity to combine with other elements) is correspondingly increased.

Packaging: The assembly of components necessary to perform containment function and ensure compliance with Federal regulations. It may consist of one or more materials, spacing structures, thermal insulation, radiation shielding, and devices for cooling or for absorbing mechanical shocks. The vehicle tie-down system and auxiliary equipment may be designated as part of the packaging.

Paleontology: The study of extinct plant and animal life that existed in former geologic times, especially fossils.

Paleozoic Era: The longest era of geological time that extends from the Cambrian through the Permian periods, occurring 230 million to 600 million years ago, characterized by the appearance of marine invertebrates, primitive fishes, amphibians, reptiles, and seed-bearing land plants.

Palustrine wetland: Nontidal wetlands dominated by trees, shrubs, and emergent vegetation.

Pathway: A route or course through which a human can be exposed to radiation or chemicals (that is, ingestion, inhalation, absorption, etc.).

PCB: PCBs (polychlorinated biphenyl) are any of a family of chlorinated chemicals that are noted as dangerous environmental pollutants that can accumulate in animal tissues with resultant pathogenic or teratogenic (causing birth defects) effects.

Perennial stream or creek: A stream or reach of a stream that flows continually throughout the year and whose upper surface generally stands lower than the water table in the region adjoining the stream.

Permeable: In geology, rock or soil that is able to transmit a fluid.

Person-rem: The unit of collective radiation dose commitment to a given population; the sum of the individual doses received by a segment of the population.

pH: A numeric value that indicates the relative acidity or alkalinity of a substance on a scale of 0 to 14, with the neutral point at 7.0. Acid solutions have pH values lower than 7.0 and basic (alkaline) solutions have pH values higher than 7.0.

Piedmont region: An area of rolling topography between the Appalachian Mountains and the coastal plain that extends from New Jersey to Alabama.

Plume: The elongated pattern of contaminated air or water originating at a point source, such as a smokestack or hazardous waste disposal site.

Plutonium: A heavy, radioactive, metallic element with the atomic number 94. It is produced artificially in a reactor by bombarding uranium with neutrons.

Plutonium is used in the production of nuclear weapons.

Prehistoric: Predating written history. In North America, before 1492.

Prevention of Significant Deterioration (PSD): Regulations established by the 1977 *Clean Air Act* Amendments to limit increases in criteria air pollutant concentrations above baseline.

Prime farmland: Land that has the best combination of physical and chemical characteristics for producing food, feed, fiber, forage, oil-seed, and other agricultural crops with a minimum input of fuel, fertilizer, pesticides, and labor without intolerable soil erosion, as determined by the Secretary of Agriculture (*Farmland Protection Policy Act* of 1981, 7 CFR 7, paragraph 658).

Protected area: An area encompassed by physical barriers, subject to access controls, surrounding material access areas, and meeting standards of Department of Energy Order 5632.1C, *Protection and Control of Safeguards and Security Interests*.

Quaternary: The second geologic period of the Cenozoic Era, occurring from 2 million years ago to the present, characterized by the appearance of human beings.

Rad: The unit of measure expressing the physical absorption of radiation. It is equal to the amount of radiation that leads to the deposition of 0.01 joule of energy per kilogram of absorbing material.

Radiation: The emitted particles or photons from the nuclei of radioactive atoms. Some elements are naturally radioactive; others are induced to become radioactive by bombardment in a reactor. Naturally occurring radiation is indistinguishable from induced.

Radioactive waste: Materials from nuclear operations that are radioactive or contaminated with radioactive materials and for which use, reuse, or recovery are impractical.

Radioactivity: The emission of radiation, either spontaneously from unstable atomic nuclei or as a consequence of a nuclear reaction.

Radioisotopes: Radioactive nuclides of the same element (same number of protons in their nuclei) that differ in the number of neutrons.

Radionuclide: A radioactive, naturally occurring or manmade element characterized according to its atomic mass and atomic number. Radionuclides can have a long life as soil or water pollutants and are believed to have potentially mutagenic or carcinogenic effects on the human body.

Radon: A gaseous, radioactive element with the atomic number 86 that results from the radioactive decay of radium. Radon occurs naturally in the environment and can collect in unventilated enclosed areas, such as basements. Large concentrations of radon can cause lung cancer in humans.

RADTRAN: A computer code that combines user-determined, demographic, transportation, packaging, and materials with health physics data to calculate the expected radiological consequences and accident risk of transporting radioactive material.

Raptor: A bird of prey, such as an eagle, hawk, or falcon.

Receiving waters: Rivers, lakes, oceans, or other bodies of water into which wastewaters are discharged.

Recharge: Replenishment of water to an aquifer.

Record of Decision (ROD): A public document that records the final decision(s) concerning a proposed action. The Record of Decision is based in whole or in part on information and technical analysis generated during the *Comprehensive Environmental Release, Compensation, and Liability Act* (CERCLA) process or the *National Environmental Policy Act* (NEPA) process, both of which take into consideration public comments and community concerns.

Regional Economic Area (REA): Geographical area defined by the Bureau of Economic Analysis (BEA) that is used to assess economic impacts of proposed alternatives.

Region of Influence (ROI): Geographical area where approximately 90 percent of DOE and

contractor employees reside. ROI's are used to assess demographic, housing or public service impacts of proposed alternatives.

Rem: The abbreviation for "roentgen equivalent man," which is the unit of radiation dose for biological absorption. It is equal to the product of the absorbed dose, in rads, and a quality factor that accounts for the variation in biological effectiveness of different types of radiation. Abbreviated as "rem."

Resource Conservation and Recovery Act, as amended (RCRA): The Act that provides a "cradle to grave" regulatory program for hazardous waste and that established, among other things, a system for managing hazardous waste from its generation until its ultimate disposal.

Richter Scale: A logarithmic scale used to express the total amount of energy released by an earthquake; it has 10 divisions, from 1 (not felt by humans) to 10 (nearly total damage).

Riparian: On or around rivers or streams.

Risk: A qualitative or quantitative expression of possible loss that considers both the probability that a hazard will cause harm and the consequences of that event.

Runoff: The portion of rainfall, melted snow, or irrigation water that flows across the ground surface and eventually enters a stream.

Safe Drinking Water Act, as amended: This Act protects the quality of public water supplies, water supply and distribution systems, and all sources of drinking water.

Safe secure trailer (SST): A specially designed semi-trailer, pulled by an armored tractor, that is used for the safe, secure transportation of cargo containing nuclear weapons or special nuclear material.

Safety analysis report (SAR): A report, prepared in accordance with DOE Orders 5481.1B and 5480.23, that summarizes the hazards associated with the operation of a particular facility and defined minimum safe requirements.

Safety document: A document prepared specifically to ensure that the safety aspects of part or all of the activities conducted at a nuclear facility are formally and thoroughly analyzed, evaluated, and recorded (for example, technical specifications, safety analysis reports and addenda, and documented reports of special safety reviews and studies). Safety Analysis Reports (SAR) and Safety Evaluation Reports (SER) are similar except that the governing regulatory agency is DOE or NRC, respectively.

Sanitary wastes: Wastes generated by normal housekeeping activities, liquid or solid (includes sludge), that are not hazardous or radioactive.

Sedimentary Rocks: These rocks are composed of materials that have been transported and then deposited, materials that have been precipitated from marine waters, or remains of organisms.

Sedimentation: The settling out of soil and mineral solids from suspension in water.

Seepage basin: An unlined pit in the ground that receives aqueous effluent.

Seismic: Pertaining to any earth vibration, especially an earthquake.

Seismic zone: An area defined by the Uniform Building Code (1991), designating the amount of damage to be expected as the result of earthquakes. The United States is divided into six zones: 1) Zone 0—no damage; 2) Zone 1—minor damage, corresponds to intensities V and VI of the Modified Mercalli Intensity Scale; 3) Zone 2A—moderate damage, corresponds to intensity VII of the Modified Mercalli Intensity Scale (eastern United States); 4) Zone 2B—slightly more damage than 2A (western United States); 5) Zone 3—major damage, corresponds to intensity VIII or higher of the Modified Mercalli Intensity Scale; 6) Zone 4—areas within Zone 3 determined by proximity to major fault systems.

Separate Work Unit (SWU): A measure of the separation achieved in a uranium enrichment plant after separating uranium of a given U-235 content into two components, one having a higher percentage of U-235 than the other component.

Core accident: An accident with a frequency rate less than 10^{-6} per year that would have more severe consequences than a design-basis accident, in terms of damage to the facility, offsite consequences, or both.

Siltstone: A sedimentary rock composed of fine textured minerals.

Source term: The estimated quantities of radionuclides or chemical pollutants released to the environment.

Spallation: Any nuclear reaction where several particles result from a collision, e.g., a chain reaction in a nuclear reactor.

Special nuclear materials: As defined in Section 11 of the *Atomic Energy Act* of 1954: (1) plutonium, uranium enriched in the isotopes 233 or 235, and any other material which the Nuclear Regulatory Commission determines to be special nuclear material; (2) any material artificially enriched by any of the aforementioned materials.

Spent nuclear fuel: Fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated.

Standardization (Epidemiology): Techniques used to control the effects of differences (e.g., age) between populations when comparing disease experience. There are two main methods:

- Direct method, in which specific disease rates in the study population are averaged, using the distribution of the comparison population as a weight.
- Indirect method, in which the specific disease rates in the comparison population are averaged, using the distribution of the study population as a weight.

State Historic Preservation Officer: State officer established to carry out the duties associated with the *National Historic Preservation Act*, for identification and protection of prehistoric and historic resources.

Sulfur oxides: Common air pollutants, primarily sulfur dioxide (SO_2) considered a major air pollutant, a heavy, bad-smelling, colorless gas usually formed in the combustion of coal and sulfur trioxide (SO_3).

Surface water: Water on the earth's surface, as distinguished from water beneath the surface (groundwater).

Tailwaters: Water below a dam.

Terrestrial (biotic): The sum total of living organisms within any designated land area.

Threatened species: Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Toxic Substances Control Act of 1976 (TSCA): This Act authorizes the Environmental Protection Agency to secure information on all new and existing chemical substances and to control any of these substances determined to cause an unreasonable risk to public health or the environment. This law requires that the health and environmental effects of all new chemicals be reviewed by the EPA before they are manufactured for commercial purposes.

Transuranic waste: Waste contaminated with alpha particles emitting radionuclides with half-lives greater than 100 nanocuries per gram at the time of assay. It is not a mixed waste.

Tributary: Any stream which contributes water to another stream or river.

Tritium: A radioactive isotope of the element hydrogen with two neutrons and one proton. Common symbols for the isotope are H-3 and T.

Unconfined aquifer: A permeable geological unit that has a water-filled pore space (saturated), the capability to transmit significant quantities of water under ordinary differences in pressure, and an upper water boundary that is at atmospheric pressure.

Unsaturated zone (vadose): A region in a porous medium in which the pore space is not filled with water.

Uranium: A heavy, silvery-white metallic element with an atomic number of 92. It has many radioactive isotopes: Uranium-235 is most commonly used as a fuel for nuclear fission; Uranium-238 is transformed into fissionable Plutonium-239 following its capture of a neutron in a nuclear reactor.

Visual Resource Management Class: A Visual Resource Management (VRM) Class defines the different degrees of modifications to the basic elements of the landscape: (1) Class 1 is applied to wilderness areas, wild and scenic rivers, and other similar environments; (2) Class 2 contrasts are seen but do not attract attention; (3) Class 3 contrasts caused by a cultural activity are evident, but remain subordinate to the existing landscape; (4) Class 4 contrasts attract attention and are dominant features of the landscape in terms of scale but repeat the contrast of the characteristic landscape; (5) Class 5 is applied to areas where unacceptable cultural modifications have lowered the scenic quality (where the natural characteristics of the landscape have been disturbed to the point where rehabilitation is needed to bring it up to one of the other four classes).

Vitrification: A waste treatment process that uses glass (for example, borosilicate glass) to encapsulate or immobilize radioactive wastes to prevent them from reacting in disposal sites.

Volatile organic compounds (VOCs): A broad range of organic compounds, often halogenated, that vaporize at ambient or relatively low temperatures (for example, benzene, chloroform, and methyl alcohol).

Wastewater: Spent water originating from all aspects of human sanitary water use (domestic wastewater) and from a myriad of industrial processes that use water for a variety of purposes (industrial wastewater).

Water quality standards and criteria: Concentration limit of constituents or characteristics allowed in water; often based on water use classifications (for example, drinking water, recreation use, propagation of fish and aquatic life, and agriculture and industry use). Water quality standards are legally enforceable; water quality criteria are non-enforceable recommendations based on biotic impacts.

Water table: Water under the surface of the ground occurs in two zones: an upper, unsaturated zone; and the deeper, saturated zone. The boundary between the two zones is the water table.

Weapons-grade: Fissionable material in which the abundance of fissionable isotopes is high enough that the material is suitable for use in thermonuclear weapons.

Wetland: Land or areas exhibiting hydric soil conditions, saturated or inundated soil during some portion of the year, and plant species tolerant of such conditions.

Wind rose: A depiction of wind speed and direction frequency for a given period of time.