ENVIRONMENTAL SYNOPSIS OF INFORMATION PROVIDED IN RESPONSE TO THE REQUEST FOR PROPOSALS FOR MOX FUEL FABRICATION AND REACTOR IRRADIATION SERVICES

April 1999

1.0 INTRODUCTION

In the aftermath of the Cold War, significant quantities of weapons-usable fissile materials (primarily plutonium and highly enriched uranium) have become surplus to national defense needs both in the United States and Russia. President Clinton announced, on September 27, 1993, the establishment of a framework for United States efforts to prevent the proliferation of weapons of mass destruction. As key elements of the President's policy, the United States will:

X Seek to eliminate, where possible, accumulation of stockpiles of highly enriched uranium and plutonium,
X Ensure that where these materials already exist, they are subject to the highest standards of safety, security, and international accountability, and
X Initiate a comprehensive review of long-term options for plutonium disposition, taking into account technical, nonproliferation, environmental, budgetary, and economic considerations.

In January 1994, President Clinton and Russian President Yeltsin agreed that the proliferation of weapons of mass destruction and their delivery systems represent an acute threat to international security. They declared that both Nations would cooperate actively and closely with each other, and also with other interested nations, for the purpose of preventing and reducing this threat.

The Secretary of Energy and the Congress took action in October 1994 to create a permanent Office of Fissile Materials Disposition (MD) within the Department of Energy (DOE) to focus on the important national security objective of eliminating surplus weapons-usable fissile materials. As one of its major responsibilities, MD is tasked with determining how to disposition surplus weapons-usable plutonium. In January 1997, DOE issued a Record of Decision (ROD) for the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (S&D PEIS)[1]. In that decision document, DOE decided to pursue a strategy that would allow for the possibility of both the immobilization of surplus plutonium and the use of surplus plutonium as mixed oxide (MOX) fuel in existing domestic, commercial reactors. In July, 1998, DOE issued the *Draft Surplus Plutonium Disposition Environmental Impact Statement* (SPD Draft EIS)[2] which analyzes sites for plutonium disposition activities and plutonium disposition technologies to support this strategy.

To support the timely undertaking of the surplus plutonium disposition program, DOE initiated a procurement action to contract for fuel fabrication and reactor irradiation services. On May 19, 1998, DOE issued a Request for Proposals (RFP) for these services (Solicitation Number DE-RP02-

[1] DOE/EIS-0229; December 1996
[2] DOE/EIS-0283D; July 1998

98CH10888). The services requested in this procurement process include design, licensing, construction, operation, and eventual decontamination and decommissioning of a MOX facility as well as irradiation of the MOX fuel in existing domestic, commercial reactors should the decision be made by DOE in the SPD EIS ROD to go forward with the MOX program.

In accordance with DOE's National Environmental Policy Act (NEPA) regulations (10 CFR 1021.216), DOE required offerors to submit reasonably available environmental data and analyses as a part of their proposals. DOE independently evaluated and verified the accuracy of the data provided by the offeror in the competitive range, and prepared and considered an Environmental Critique before the procurement selection was made.

As required by Section 216, the Environmental Critique included a discussion of the purpose of the procurement; the salient characteristics of the offeror's proposal; any licenses, permits or approvals needed to support the program; and an evaluation of the potential environmental impacts of the offer. In March 1999, after considering the Environmental Critique, DOE awarded a contract for MOX fuel fabrication and reactor irradiation services. Under this contract, MOX fuel would be fabricated at a DOE site to be selected in the SPD EIS ROD and then irradiated in six domestic commercial nuclear reactors at three commercial reactor sites. Additionally, under the contract only limited activities may be performed prior to issuance of the SPD EIS ROD. These activities include non-site-specific work primarily associated with the development of the initial conceptual design for the fuel fabrication facility, and plans (paper studies) for outreach, long lead-time procurements, regulatory management, facility quality assurance, safeguards, security, fuel qualifications, and deactivation. There would be no construction started on a MOX fuel fabrication facility until the SPD EIS ROD is issued. The MOX facility, if built, would be government-owned, licensed by the Nuclear Regulatory Commission (NRC), and located at one of four candidate DOE sites.

This Synopsis is based on the Environmental Critique and provides a publicly available assessment of the potential environmental impacts associated with the proposal based on an independent review of the representations and data contained in the proposal. The Synopsis serves as a record that DOE has considered the environmental factors and potential consequences of the reasonable alternatives analyzed during the selection process. The Synopsis will be filed with the U.S. Environmental Protection Agency and made publicly available. The Synopsis will also be incorporated into a Supplement to the SPD Draft EIS, which is to be issued in the near future.

2.0 ASSESSMENT METHODS

The analyses in this Synopsis (and in the Environmental Critique) were performed using information submitted by the offeror in the competitive range, independently developed information, publicly available information, and standard computer models and techniques.

In order to evaluate the reasonableness of the offeror's projected environmental impacts compared to those projected by DOE, the offeror's data for the MOX facility was compared to information in the SPD Draft EIS; for the use of MOX fuel in domestic commercial reactors, the offeror's data was compared to information in the S&D PEIS. [3]

Data developed independently to support these analyses include the projection of populations around the proposed reactor sites[4] and information related to the topography surrounding the proposed reactor sites for evaluating air dispersal patterns. Information was also provided by Oak Ridge National Laboratory (ORNL) on the expected ratio of radionuclide activities in MOX fuel compared to that in low enriched uranium (LEU) fuel for use in reactor accident analyses. Standard models for determining radiation doses from normal operations and accident scenarios, and air pollutant concentrations at the proposed disposition facility sites and reactors were run using data provided by the offeror. Reactor accident analyses assumed a 40 percent MOX core because this is a conservative estimate of the amount of MOX fuel that would be used in each of the reactors. The environmental analyses were prepared using the following computer models: GENII for estimating radiation doses to the public from normal operation of the MOX fuel fabrication facility and the proposed reactors; MACCS2 for design-basis and beyond-design-basis accident analyses at the proposed reactors; and ISC3 and SCREEN3 for estimated air pollutant concentrations as a result of normal MOX facility and reactor operations.

3.0 DESCRIPTION OF THE OFFER

The offeror has proposed to build a MOX facility on a DOE site[5] with subsequent irradiation services being provided in six existing reactors at three commercial nuclear power plants in the Eastern United States.

The proposed MOX facility design, which is based on an existing MOX facility in France, will be modified to meet U.S. regulations. Under the proposed design, plutonium dioxide powder would be received from DOE's proposed pit disassembly and conversion facility. The plutonium dioxide would be aqueously processed (polished) to ensure that it meets the agreed-to fuel specification for MOX fuel. Following the polishing step, the plutonium in solution would then be converted back into plutonium dioxide. At that point, the process proposed by the offeror would be similar to that described in Chapter 2 of the SPD Draft EIS[6]. The plutonium dioxide would be mixed with uranium dioxide and formed into MOX fuel pellets.

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[3] Such information is also summarized in the SPD Draft EIS.

[4] Population projections for the area encompassed in a 50-mile radius around the proposed reactor sites were projected to 2015 to approximate the mid-point of the irradiation services program. By 2015, the MOX program would be firmly established at all of the proposed reactor sites and would be expected to remain stable through the end of the program. Using 1990 census data as the base year and state-provided population increase factors for all counties included in this analysis, the population around the sites was projected for 2015. Baseline projections were needed for two of the reactor sites because the population information provided in the proposal was based on 1970 census data. Recent (i.e., 1990) census data were provided for the other proposed site and projected by the offeror to the years 2010 and 2020. From these data points, 2015 projections were interpolated.

[5] This site would be selected in the SPD EIS ROD. As explained in the SPD Draft EIS, DOE's preference is to locate the MOX fuel fabrication plant at DOE's Savannah River site.

[6] The SPD Draft EIS also included evaluation of an aqueous processing facility in Appendix N, that could be added to either the pit conversion or the MOX facility. Based on public comments received and information presented by the offeror subsequent to the release of the SPD Draft EIS, DOE is now considering whether to add the aqueous polishing process to the front end of the MOX facility. The environmental impacts associated with this option will be presented in Chapter 4 of the SPD Final EIS.

These pellets would be baked at high temperature, ground to exact dimensions, then loaded into fuel rods. The MOX fuel rods would then be bundled with standard LEU fuel rods to form MOX fuel assemblies. The MOX fuel assemblies would be shipped to the proposed reactor sites in DOE-provided safe, secure transport vehicles on a near just-in-time basis to minimize the amount of time the fresh MOX fuel would be stored at a reactor site prior to loading into the reactor.

Three sites, each with two operating pressurized light water reactors (PWRs), have been proposed for MOX fuel irradiation. The proposed sites are: the Catawba nuclear generation station near York, South Carolina; the McGuire nuclear generation station near Huntersville, North Carolina; and the North Anna nuclear generation station near Mineral, Virginia. All of these sites have been operating safely for a number of years. Table 1 provides some general information about each of the proposed plants.

Table 1. Reactor Plant Operating Information

Plant	Operator	Capacity (net MWe)	Date of First Operation (mo/yr)
Catawba No. 1	Duke Power Co.	1,129	01/85
Catawba No. 2	Duke Power Co.	1,129	05/86
McGuire No. 1	Duke Power Co.	1,129	07/81
McGuire No. 2	Duke Power Co.	1,129	05/83
North Anna No. 1	Virginia Power Co.	900	04/78
North Anna No. 2	Virginia Power Co.	887	08/80

Table 2 shows the results of the most recent Systematic Assessment of Licensee Performance performed by NRC for each of the proposed reactors. As can be seen in this table, all the proposed reactors have been operated and maintained in a safe manner.

Table 2. Systematic Assessment of Licensee Performance Results

	Catawba	McGuire	North Anna
Date of Latest SALP	06/97	04/97	02/97
Operations	Superior	Superior	Superior
Maintenance	Good	Good	Superior
Engineering	Superior	Good	Good
Plant Support	Superior	Superior	Superior

As proposed by the offeror, both MOX and LEU fuel assemblies would be loaded into the reactor. The MOX fuel assemblies are scheduled to remain in the core for two 18-month cycles and the LEU assemblies for either two or three cycles. After completing a normal (full) fuel cycle, the spent MOX fuel assemblies would be removed from the reactor in accordance with the plant's standard refueling procedures and placed in the plant's spent fuel pool for cooling along with other spent fuel. The offeror has stated that no changes are expected in the plant's spent fuel storage plans to accommodate the spent MOX fuel. Eventually, the fuel would be shipped to a potential geologic repository to be developed by DOE for permanent disposal of commercial spent fuel.

4.0 ENVIRONMENTAL IMPACTS

Human health risk, waste management, land use, infrastructure requirements, accidents, air quality, water quality, and socioeconomics have been evaluated in this Synopsis. Cultural, paleontological and ecological resources, and transportation requirements are not expected to be impacted other than as discussed in the SPD Draft EIS and were not evaluated in this Synopsis. Although four sites are being considered by DOE for the proposed MOX facility, this Environmental Synopsis focuses primarily on environmental impacts at DOE's Savannah River Site (SRS) for the potential MOX facility because, as stated in Section 1.6 of the SPD Draft EIS, it is DOE's preferred location for the MOX facility. However, this Synopsis also discusses non-radiological impacts at other potential MOX facility sites, where appropriate. Unless otherwise noted, impacts would likely be similar at other sites.

4.1 MOX Fuel Fabrication Facility

4.1.1 Human Health Risk

The annual radiological dose from normal operations to the general population residing within 50 miles of the proposed MOX facility at the preferred site, SRS, was calculated based on radiological emissions estimated by the offeror. The major contributor to this dose would be attributable to the offeror's estimated annual release of 0.25 mg of plutonium.[7] In contrast to the "atmospheric release only" assumption presented in the SPD Draft EIS, the MOX facility data provided by the offeror includes both liquid and airborne releases because the proposed process includes some aqueous processing. Table 3 shows the projected radiological dose that would be received by the general population as a result of normal operations of the MOX facility proposed by the offeror.

The average individual living within 50 miles of the SRS site would be expected to receive an annual dose of 2.3×10^{-4} mrem/yr from normal operation of the MOX facility. The maximally exposed individual (MEI) would be expected to receive an annual dose of 3.7×10^{-3} mrem/yr from operation of the MOX facility at SRS. This dose is well below regulatory limits, which require doses resulting from DOE operations to be below 10 mrem/yr from airborne pathways, 4 mrem/yr from drinking water pathways, and 100 mrem/yr from all pathways combined. The additional dose to the general population would also be small in comparison with the average dose received from other SRS activities. For example, in 1997, the average individual living within 50 miles of SRS received a dose of 1.4×10^{-2} mrem/yr from site activities. (SPD Draft EIS, pg. 3-141)

[7] The isotopic distribution of the potential plutonium releases were modeled based on the isotopic distribution developed by Los Alamos National Laboratory for use in the SPD Draft EIS.

Table 3. Estimated Radiological Impacts on the Public from Operations of the MOX Facility at SRS

	Maximally Exposed Ind. (mrem/yr)	Latent Fatal Cancer Risk from 10 Year Operating Life	Est. Dose to Pop. within 50 mi. radius (person-rem/yr)	Latent Fatal Cancers from 10 Year Operating Life	Avg. Dose to Ind. within 50 mi. radius (mrem/yr)	Latent Fatal Cancer Risk from 10 Year Operating Life
Offeror	$3.7x10^{-3}$	$1.9x10^{-8}$	0.181	$9.1x10^{-4}$	$2.3x10^{-4}$	$1.2x10^{-9}$
SPD Draft EIS*	$3.1x10^{-4}$	$1.6x10^{-9}$	0.029	$1.5x10^{-4}$	$3.7x10^{-5}$	$1.9x10^{-10}$
SRS Base**	0.2	$1.0x10^{-6}$	8.6	$4.3x10^{-2}$	$1.4x10^{-2}$	$7.0x10^{-8}$

* Includes contributions from polishing process discussed in Appendix N in addition to those shown in Chapter 4.
** SPD Draft EIS pg. 3-141

Table 4 shows the potential radiological impacts on involved workers at the proposed MOX facility conservatively calculated from 1997 data from the offeror's European operating facility. As shown in Table 4, the average radiation worker at the offeror's proposed MOX facility would receive an annual dose of 65 mrem/yr from normal operations. The offeror has stated that in 1997 the maximum dose to an individual worker at the offeror's MOX facility was 885 mrem, well below the DOE administrative control level of 2,000 mrem/yr and the Federal regulatory limit of 5,000 mrem/yr. The offeror also estimates that fewer radiation workers would be needed to operate the MOX facility than indicated in the SPD Draft EIS. The offeror estimates that approximately 330 radiation workers would be required, rather than the 410 estimated in the SPD Draft EIS.[8]

Table 4. Potential Radiological Impacts on Involved Workers from Operations of the MOX Facility

	No. of Radiation Workers	Average Worker Dose (mrem/yr)	Latent Fatal Cancer Risk from 10 Years of Operation	Total Dose to Workers (person-rem/yr)	Latent Fatal Cancers from 10 Years of Operations
Offeror	330	65	$2.6x10^{-4}$	22	0.088
SPD Draft EIS*	410	500	$2.0x10^{-3}$	205	0.82
SRS Base**	12,500	19	$7.6x10^{-5}$	237	0.95

* Includes contributions from polishing process discussed in Appendix N in addition to the doses shown in Chapter 4.
** SPD Draft EIS pg. 3-142.

4.1.2 Accidents

Design-basis and beyond-design-basis accidents were evaluated in the SPD Draft EIS for the MOX facility and the aqueous plutonium polishing process. Accidents evaluated for the MOX facility included a criticality, fires, and earthquakes. A spill, an uncontrolled reaction resulting in an explosion, a criticality, and an earthquake were evaluated for the plutonium polishing process. Any of these accidents could occur

[8] Although it is estimated that about 385 personnel would be required to operate the facility, only about 330 of the 385 would be considered radiation workers.

in the proposed MOX facility since it would use similar processes.

Including the plutonium polishing process in the MOX facility as proposed by the offeror would make a criticality the bounding design-basis accident for the facility. As shown in Table 5, no major radiological impacts to the general population would be expected from design-basis accidents at the proposed MOX facility. The frequency of this accident, a criticality in solution, is estimated to be between 1 in 10,000 and 1 in 1,000,000 per year.

The bounding beyond-design-basis accident would be an earthquake of sufficient magnitude to collapse the MOX facility. An earthquake of this magnitude would be expected to result in major radiological impacts. However, an earthquake of this magnitude would also be expected to result in widespread damage across the site and throughout the surrounding area. The frequency of an earthquake of this magnitude is estimated to be between 1 in 100,000 and 1 in 10,000,000 per year. Table 5 shows the impact of this accident on SRS. At the other candidate sites, the estimated dose to the general population from this accident would range from $2.0H10^{3}$ to $5.7H10^{4}$ with the corresponding number of LCFs expected to range from 1.0 to 28 LCFs. The maximum dose to a person at the site boundary at the time of the accident would be expected to range from 16 to 25 rem with a corresponding risk of latent cancer fatality of $8.0H10^{-3}$ to $1.2H10^{-2}$. A noninvolved worker would be exposed to a dose in the range of $2.2H10^{2}$ to $6.4H10^{2}$ rem with a corresponding risk of latent cancer fatality of $8.8H10^{-2}$ to $2.3H10^{-1}$.

Table 5. Bounding Accidents for the Proposed MOX Facility

	Noninvolved Worker (rem)	Probability of Cancer Fatality per Accident	Estimated Dose at Site Boundary (rem)	Probability of Cancer Fatality per Accident	Estimated Dose to Pop. Within 50 mi. radius (person-rem)	Latent Cancer Fatalities per Accident
Criticality at SRS*	$3.0x10^{-1}$	$1.2x10^{-4}$	$1.6x10^{-2}$	$8.0x10^{-6}$	$1.6x10^{1}$	$8.0x10^{-3}$
Beyond-design-basis earthquake**	$2.2x10^{2}$	$8.8x10^{-2}$	8.9	$4.5x10^{-3}$	$2.1x10^{4}$	10.6

*SPD Draft EIS pg. N-15
**SPD Draft EIS pgs. K-50 and N-15

No major consequences for the maximally exposed involved worker would be expected from leaks, spills, and smaller fires. These accidents are such that involved workers would be able to evacuate immediately or would not be affected by the events. However, explosions could result in immediate injuries from flying debris, as well as the uptake of plutonium and uranium particulates through inhalation. If a criticality were to occur, workers within tens of meters could receive very high to fatal radiation exposures from the initial neutron burst. The dose would strongly depend on the magnitude of the criticality (number of fissions), the distance from the criticality, and the amount of shielding provided by the structures and equipment between the workers and the criticality. Earthquakes could also result in substantial consequences to workers, ranging from workers being killed by collapsing equipment and structures to high radiation exposures and uptakes of radionuclides. For all but the most severe accidents, immediate emergency response actions should reduce the magnitude of the consequences to workers near the accident.

4.1.3 Waste Management

The MOX facility would be expected to produce TRU waste, low-level radioactive waste (LLW), mixed LLW, hazardous waste and sanitary waste in the course of its normal operations. As shown in Table 6, the offeror's estimated generation rates for radioactive wastes are consistent with those estimated in the SPD Draft EIS. None of these estimates is expected to impact the proposed sites in terms of their ability to handle these wastes. The ability to store, treat, and/or dispose of radioactive waste is limited at Pantex. If Pantex were chosen as the site for the MOX facility, the wastes would presumably be handled as discussed in the SPD Draft EIS. TRU waste would have to be stored in the MOX facility until it could be shipped to the Waste Isolation Pilot Plant (WIPP) for permanent disposal. Mixed LLW would be handled in the same manner as current mixed waste that is shipped offsite for treatment and disposal. LLW would be treated and stored onsite until shipped to the Nevada Test Site or a commercial facility for disposal.[9]

Table 6. Estimated Annual Waste Generation Rates

	TRU Waste	Mixed LLW	LLW	Hazardous Waste	Sanitary Waste
Offeror					
Liquid (l/yr)	500	0	300	1,200	11 million
Solid (m^3/yr)	~67	3	94	0.1	150
SPD Draft EIS*					
Liquid (l/yr)	0.5	0.1 l	0.3	1,740	18 million
Solid (m^3/yr)	~67	3	94	1.2	440
SRS Generation Rate**					
Liquid (l/yr)	na	na	na	Na	416 million
Solid (m^3/yr)	431	1,135	10,043	74	6,670

na – not available
*Includes contributions from the polishing process discussed in Appendix N of the SPD Draft EIS, in addition to the wastes shown in Chapter 4.
**SPD Draft EIS pg. 3-130.

4.1.4 Land Use

It is estimated that a total of 6.2 hectares (15.3 acres) would be needed for the MOX facility. This estimate includes 1.0 hectares (2.5 acres) for the process building, 0.2 hectares (0.58 acres) for support facilities, and 5 hectares (12.4 acres) for parking and a security buffer. This is very close to the 6.0 hectares (14.9 acres) estimated in the SPD Draft EIS (pg. E-10). As indicated in the SPD Draft EIS, there is sufficient space available to accommodate the proposed MOX facility at any of the candidate sites.

[9] DOE would ensure that any such disposal would be consistent with the RODs for the *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste*, DOE/EIS-0200F, May 1997.

4.1.5 Infrastructure Requirements

The proposed MOX facility would use electricity, natural gas, water, and fuel oil. As shown in Table 7, the offeror's proposed facility would use more of these materials than estimated in the SPD Draft EIS.

Table 7. Estimated MOX Facility Infrastructure Requirements

	Electricity (MWh/yr)	Natural Gas (m^3/yr)	Water (10^6 l/yr)	Fuel Oil (l/yr)
Offeror	30,000	1,070,000	68	63,000
SPD Draft EIS*	17,520	920,000	44	43,000
SRS F-Area Available Capacity**	482,700	na***	1,216	na****

*Includes contributions from the polishing process as discussed in Appendix N in addition to the infrastructure requirements shown in Chapter 4.
**SPD Draft EIS pg. 3-165.
***Heat in F-Area provided by steam.
****Fuel oil trucked in as needed and stored at MOX facility.

4.1.5 Air Quality

Operation of the proposed MOX facility would result in the release of a small amount of nonradiological air pollutants that would be expected to slightly increase the ambient air pollutant concentrations at the selected site. The majority of these pollutants would be associated with routine maintenance and testing runs of the facility's emergency diesel generator and emissions from facility heating. Table 8 shows the estimated increases in ambient air pollutant concentrations for the proposed facility and the national standards for these pollutants. The projected emissions are a very small fraction of the national standards. Although some small radionuclide discharges are expected from the proposed MOX facility, these discharges are not expected to have a major impact on air quality. As explained in Section 4.1.1, these discharges would result in a very small dose to the general public.

Table 8. Estimated Nonradiological Ambient Air Pollutant Concentrations from the Proposed MOX Facility

	Carbon Monoxide 8 hour 1 hour	Nitrogen Dioxide Annual	PM_{10} Annual 24 hour	Sulfur Dioxide Annual 24 hour 3 hour
National Ambient Air Quality Standards (μg/m^3)	10,000 40,000	100	50 150	80 365 1,300
Offeror (μg/m^3)	0.123 0.371	0.011	0.001 0.011	0.039 0.531 1.39
SPD Draft EIS* (μg/m^3)	0.109 0.345	0.011	0.001 0.010	0.031 0.420 1.11
SRS Base** (μg/m^3)	64 279	9.3	4.14 56.4	15.1 219 962

*Includes contributions from the polishing process discussed in Appendix N in addition to the pollutant concentrations shown in Chapter 4.
**SPD Draft EIS pg. 4-6

4.1.6 Water Quality

Table 9 shows a comparison of water resources information described in the SPD Draft EIS to that provided by the offeror. Although the proposed water use is higher than that analyzed in the SPD Draft EIS, the amount of water needed is estimated to be from 0.9 to 6.0 percent of the site's estimated annual water requirements. Therefore, the additional water use is not expected to have a major impact on water resources. Although some small radionuclide discharges are expected from the proposed MOX facility, these discharges are not expected to have a major impact on water quality. As explained in Section 4.1.1, these discharges would result in a very small dose to the general public.

Table 9. Comparison of Water Resources Information for the MOX Facility

	Water Use (10^6 liters/yr)	Sanitary Wastewater Discharged (10^6 liters/yr)	Radionuclide Emissions to Water (Ci)
SPD Draft EIS	44	18	0
Offeror	68	11	0.0025

4.1.7 Socioeconomics

The proposed MOX facility would employ about 385 workers, somewhat fewer than the 435 workers estimated in the SPD Draft EIS. An increase of 385 workers would not be expected to have a major impact on any of the candidate sites. At three of the four candidate sites (i.e., INEEL, Pantex, and SRS), the workforce is projected to be falling at the same time the proposed MOX facility would begin operations. The additional MOX facility workers would help mitigate the negative socioeconomic impacts associated with such reductions. The SPD Draft EIS concluded that, at Hanford, although the increase in workforce requirements for proposed surplus plutonium disposition facilities (including MOX) would coincide with an increase in the site's overall workforce (as a result of the planned tank waste remediation system), the projected changes would not have a major impact on the level of community services currently offered in the region of influence. (SPD Draft EIS pg. 4-37)

4.2 Proposed Reactor Sites

The offeror is proposing to use a partial MOX core (up to approximately 40 percent of the fuel in the core at equilibrium) in each of the proposed reactors. The S&D PEIS analyzed a full MOX core at a generic reactor site.

4.2.1 Human Health Risk

Risk to human health was assessed for the proposed reactor sites based on information provided by the offeror and compared to the generic reactor information in the S&D PEIS. The offeror stated that there would be no difference in dose to the general public from normal operations based on the use of MOX fuel versus LEU fuel in the proposed reactors. This is consistent with findings in the S&D PEIS that showed a very small range in the expected difference ($-1.1x10^{-2}$ to $2x10^{-2}$ person-rem, S&D PEIS pg. 4-729). The doses shown in this section reflect the projected dose in the year 2015.

The annual radiological dose from normal operations to the general population residing within 50 miles of the proposed reactor sites was estimated based on radiological emissions estimated by the offeror. As shown in Table 10, the average individual living within 50 miles of one of the proposed reactor sites could expect to receive an annual dose of between $2.7x10^{-3}$ to $9.9x10^{-3}$ mrem/yr from normal operation of these reactors regardless of whether the reactors were using MOX fuel or LEU fuel.

Table 10. Estimated Dose to the General Population from Normal Operations of the Proposed Reactors in the Year 2015 (Partial MOX or LEU Core)

	Maximally Exposed Individual (mrem/yr)	Latent Fatal Cancer Risk	Est. Dose to Pop. within 50 mi. radius (person-rem/yr)	Annual Number of Latent Cancer Fatalities	Avg. Dose to Ind. within 50 mi. radius (mrem/yr)
Catawba[a]	0.73	$3.7x10^{-7}$	6.1	$3.1x10^{-3}$	$2.7x10^{-3}$
McGuire[b]	0.31	$1.6x10^{-7}$	10.7	$5.4x10^{-3}$	$4.2x10^{-3}$
North Anna[c]	0.37	$1.9x10^{-7}$	20.3	$1.0x10^{-2}$	$9.9x10^{-3}$
S&D PEIS (high)*	0.17	$8.5x10^{-8}$	2.0	$1.0x10^{-3}$	$7.8x10^{-4}$

*S&D PEIS pg. 4-729

[a] The population for the year 2015 is estimated to be 2,265,000.

[b] The population for the year 2015 is estimated to be 2,575,000.

[c] The population for the year 2015 is estimated to be 2,042,000.

The offeror also stated that the workers at the proposed reactor sites would be expected to receive about the same amount of radiation dose as a result of their job activities regardless of the plant's decision to use

MOX fuel. As shown in Table 11, the average radiation worker at the proposed reactor sites could expect to receive an annual dose of between 46 and 123 mrem/yr from normal operations. This is lower than the worker dose range estimated in the S&D PEIS (281 to 543 mrem/yr). The offeror's statement that the use of MOX fuel would not change the estimated worker dose is consistent with data presented in the S&D PEIS that showed an incremental increase in worker dose of less than 0.1 percent due to the use of MOX fuel. (S&D PEIS pg. 4-730)

Table 11. Estimated Dose to Workers from Normal Operations of the Proposed Reactors with MOX Fuel

	No. of Radiation Workers*	Total Dose to Workers (person-rem/ year)	Annual Number of Latent Cancer Fatalities	Average Worker Dose (mrem/yr)	Annual Latent Fatal Cancer Risk
Catawba	3,400	265	0.11	78	3.1x10^{-5}
McGuire	4,000	492	0.20	123	4.9x10^{-5}
North Anna	2,240	103	0.041	46	1.8x10^{-5}
S&D PEIS (high)**	2,220	1,204	0.48	543	2.2x10^{-4}

*The number of radiation workers at the proposed reactor sites was estimated based on the total dose to workers given by the offeror divided by the average worker dose, also supplied by the offeror.
**S&D PEIS pg. 4-730; adjusted to reflect a two reactor site for comparison to the proposed reactor sites.

4.2.2 Accidents

Two design-basis accidents, a large break loss-of-coolant accident (LOCA) and a fuel handling accident (FHA), were evaluated for the Environmental Critique and are reflected in this Synopsis. These accidents were chosen because they are the limiting reactor and non-reactor design-basis accidents at the proposed facilities. As shown in Tables 12 through 14, only small increases in the estimated impacts would be expected from a LOCA at the proposed reactor sites due to the use of MOX fuel. In a FHA, the consequences (defined as latent cancer fatalities) would decrease as a result of using MOX fuel rather than LEU fuel. This is because the end-of-cycle krypton inventory is less in MOX fuel than in LEU fuel and krypton is one of the greatest contributors to radiation dose from a FHA.

Beyond-design-basis accidents, if they were to occur, would be expected to result in major impacts to workers, the surrounding communities, and the environment regardless of whether the reactor was using a LEU or a partial MOX core. As shown in Tables 15 through 17, the probability of a beyond-design-basis accident happening and the risk to an individual living within 50 miles of the proposed reactors is very low.

The largest estimated risk of a latent cancer fatality for the maximally exposed individual (MEI) at any of the proposed reactors is estimated to be 2.86H10^{-5} for a steam generator tube rupture at one of the North Anna reactors when using a partial MOX core. If this same accident were to happen at the reactor when it was using a LEU core, the estimated risk would be 2.46H10^{-5}. In either case, the risk of a latent cancer fatality is estimated to be less than 3 in 100,000 over the 16 year period the reactors would be using MOX fuel.

For beyond-design-basis accidents, the scenarios that lead to containment bypass or failure were evaluated because these are the accidents with the greatest potential consequences. The public and environmental consequences would be significantly less for accident scenarios that do not lead to containment bypass or failure. A steam generator tube rupture, early containment failure, late containment failure, and an interfacing systems loss-of-coolant accident (ISLOCA) were chosen as the representative set of beyond-design-basis accidents.

Commercial reactors, licensed by the NRC are required to complete Individual Plant Examinations (IPE) to assess plant vulnerabilities to severe accidents. An acceptable method of completing the IPEs is to perform a probabilistic risk assessment (PRA). A PRA analysis evaluates, in full detail (quantitatively), the consequences of all potential events caused by the operating disturbances (known as internal initiating events) within each plant. The PRA uses realistic criteria and assumptions in evaluating the accident progression and the systems required to mitigate each accident. The PRAs for the proposed reactors provided the required data to evaluate beyond-design-basis accidents.

As shown in Table 18, the difference in accident consequences for reactors using MOX fuel versus LEU fuel is generally very small. For beyond-design-basis accidents, the consequences would be expected to be slightly higher, with the largest increase associated with an ISLOCA. This is because the MOX fuel will release a higher actinide inventory in a severe accident. The impacts of an ISLOCA are estimated to be about 10 to 15 percent (an average of about 13 percent) greater to the general population living within 50 miles of the reactor operating with a partial MOX core instead of a LEU core. It should be noted that this accident has a very low estimated frequency of occurrence, an average of 1 in 3.2 million per year of reactor operation for the reactors being proposed.

Table 12. Design-Basis Accident Impacts for Catawba with LEU and Mixed Oxide Fuels

			Noninvolved Worker			Maximally Exposed Offsite Individual			Population		
Accident Release Scenario	Accident Scenario Frequency (per year)	LEU or MOX Core	Dose (rem)	Probability of Latent Cancer Fatality Given Dose to Noninvolved Worker[1]	Risk of Latent Cancer Fatality (over campaign)[2]	Dose (rem)	Probability of Latent Cancer Fatality Given Dose at Site Boundary[1]	Risk of Latent Cancer Fatality (over campaign)[2]	Dose (person-rem)	Number of Latent Cancer Fatalities in the Population within 80 km[3]	Risk of Latent Cancer Fatalities (over campaign)[4]
Loss-of-Coolant Accident	$7.50\text{x}10^{-6}$	LEU	3.78	1.51×10^{-3}	1.81×10^{-7}	1.44	7.20×10^{-4}	8.64×10^{-8}	$3.64\times10^{+3}$	1.82	2.19×10^{-4}
		MOX	3.85	1.54×10^{-3}	1.86×10^{-7}	1.48	7.40×10^{-4}	8.88×10^{-8}	$3.75\times10^{+3}$	1.88	2.26×10^{-4}
Spent Fuel Handling Accident[5]	$1.00\text{x}10^{-4}$	LEU	0.275	1.10×10^{-4}	1.78×10^{-7}	0.138	6.90×10^{-5}	1.10×10^{-7}	$1.12\times10^{+2}$	5.61×10^{-2}	8.98×10^{-5}
		MOX	0.262	1.05×10^{-4}	1.68×10^{-7}	0.131	6.55×10^{-5}	1.05×10^{-7}	$1.10\times10^{+2}$	5.48×10^{-2}	8.77×10^{-5}

1 Increased likelihood (probability) of cancer fatality to a hypothetical individual - a noninvolved worker at a distance of 640 meters or the maximally exposed offsite individual located at the site boundary (762 m) - if exposed to the indicated dose.

2 Increased likelihood (probability) of cancer fatality over the estimated 16 year campaign (frequency weighted) to a hypothetical individual - a noninvolved worker at a distance of 640 meters or the maximally exposed offsite individual located at the site boundary (762 m).

3 Estimated number of cancer fatalities in the entire offsite population out to a distance of 80 kilometers (50 miles) if exposed to the indicated dose.

4 Estimated number of cancer fatalities over the estimated 16 year campaign (frequency weighted) in the entire offsite population out to a distance of 80 kilometers (50 miles).

5 Accident scenario frequency estimated in lieu of plant specific data.

Table 13. Design-Basis Accident Impacts for McGuire with LEU and Mixed Oxide Fuels

			Noninvolved Worker			Maximally Exposed Offsite Individual			Population		
Accident Release Scenario	Accident Scenario Frequency (per year)	LEU or MOX Core	Dose (rem)	Probability of Latent Cancer Fatality Given Dose to Noninvolved Worker[1]	Risk of Latent Cancer Fatality (over campaign)[2]	Dose (rem)	Probability of Latent Cancer Fatality Given Dose at Site Boundary[1]	Risk of Latent Cancer Fatality (over campaign)[2]	Dose (person-rem)	Number of Latent Cancer Fatalities in the Population within 80 km[3]	Risk of Latent Cancer Fatalities (over campaign)[4]
Loss-of-Coolant Accident	$1.50\text{x}10^{-5}$	LEU	5.31	2.12×10^{-3}	5.10×10^{-7}	2.28	1.14×10^{-3}	2.74×10^{-7}	$3.37\times10^{+3}$	1.68	4.03×10^{-4}
		MOX	5.46	2.18×10^{-3}	5.25×10^{-7}	2.34	1.17×10^{-3}	2.82×10^{-7}	$3.47\times10^{+3}$	1.73	4.16×10^{-4}
Spent Fuel Handling Accident[5]	$1.00\text{x}10^{-4}$	LEU	0.392	1.57×10^{-4}	2.51×10^{-7}	0.212	1.06×10^{-4}	1.70×10^{-7}	99.1	4.96×10^{-2}	7.94×10^{-5}
		MOX	0.373	1.49×10^{-4}	2.38×10^{-7}	0.201	1.01×10^{-4}	1.62×10^{-7}	97.3	4.87×10^{-2}	7.79×10^{-5}

[1] Increased likelihood (probability) of cancer fatality to a hypothetical individual - a noninvolved worker at a distance of 640 meters or the maximally exposed offsite individual located at the site boundary (762 m) - if exposed to the indicated dose.
[2] Increased likelihood (probability) of cancer fatality over the estimated 16 year campaign (frequency weighted) to a hypothetical individual - a noninvolved worker at a distance of 640 meters or the maximally exposed offsite individual located at the site boundary (762 m).
[3] Estimated number of cancer fatalities in the entire offsite population out to a distance of 80 kilometers (50 miles) if exposed to the indicated dose.
[4] Estimated number of cancer fatalities over the estimated 16 year campaign (frequency weighted) in the entire offsite population out to a distance of 80 kilometers (50 miles).
[5] Accident scenario frequency estimated in lieu of plant specific data.

Table 14. Design-Basis Accident Impacts for North Anna with LEU and Mixed Oxide Fuels

			Noninvolved Worker			Maximally Exposed Offsite Individual			Population		
Accident Release Scenario	Accident Scenario Frequency (per year)	LEU or MOX Core	Dose (rem)	Probability of Latent Cancer Fatality Given Dose to Noninvolved Worker[1]	Risk of Latent Cancer Fatality (over campaign)[2]	Dose (rem)	Probability of Latent Cancer Fatality Given Dose at Site Boundary[1]	Risk of Latent Cancer Fatality (over campaign)[2]	Dose (person-rem)	Number of Latent Cancer Fatalities in the Population within 80 km[3]	Risk of Latent Cancer Fatalities (over campaign)[4]
Loss-of-Coolant Accident	$2.10x10^{-5}$	LEU	0.114	4.56×10^{-5}	1.53×10^{-8}	3.18×10^{-2}	1.59×10^{-5}	5.34×10^{-9}	39.4	1.97×10^{-2}	6.62×10^{-6}
		MOX	0.115	4.60×10^{-5}	1.55×10^{-8}	3.20×10^{-2}	1.60×10^{-5}	5.38×10^{-9}	40.3	2.02×10^{-2}	6.78×10^{-6}
Spent Fuel Handling Accident[5]	$1.00x10^{-4}$	LEU	0.261	1.04×10^{-4}	1.66×10^{-7}	9.54×10^{-2}	4.77×10^{-5}	7.63×10^{-8}	29.4	1.47×10^{-2}	2.35×10^{-5}
		MOX	0.239	9.56×10^{-5}	1.53×10^{-7}	8.61×10^{-2}	4.31×10^{-5}	6.90×10^{-8}	27.5	1.38×10^{-2}	2.21×10^{-5}

1 Increased likelihood (probability) of cancer fatality to a hypothetical individual - a noninvolved worker at a distance of 640 meters or the maximally exposed offsite individual located at the site boundary (1349 m) - if exposed to the indicated dose.

2 Increased likelihood (probability) of cancer fatality over the estimated 16 year campaign (frequency weighted) to a hypothetical individual - a noninvolved worker at a distance of 640 meters or the maximally exposed offsite individual located at the site boundary (1349 m).

3 Estimated number of cancer fatalities in the entire offsite population out to a distance of 80 kilometers (50 miles) if exposed to the indicated dose.

4 Estimated number of cancer fatalities over the estimated 16 year campaign (frequency weighted) in the entire offsite population out to a distance of 80 kilometers (50 miles).

5 Accident scenario frequency estimated in lieu of plant specific data.

Table 15. Beyond-Design-Basis Accident Impacts for Catawba with LEU and Mixed Oxide Fuels

			Maximally Exposed Offsite Individual			Population		
Accident Release Scenario	Accident Scenario Frequency (per year)	LEU or MOX Core	Dose (rem)	Probability of Latent Cancer Fatality Given Dose at Site Boundary[1]	Risk of Latent Cancer Fatality (over campaign)[2]	Dose (person-rem)	Number of Latent Cancer Fatalities in the Population within 80 km[3]	Risk of Latent Cancer Fatalities (over campaign)[4]
Steam Generator Tube Rupture[5]	6.31×10^{-10}	LEU	$3.46\times10^{+2}$	0.346	3.49×10^{-9}	$5.71\times10^{+6}$	$2.86\times10^{+3}$	2.88×10^{-5}
		MOX	$3.67\times10^{+2}$	0.367	3.71×10^{-9}	$5.93\times10^{+6}$	$2.96\times10^{+3}$	2.99×10^{-5}
Early Containment Failure	3.42×10^{-8}	LEU	5.97	2.99×10^{-3}	1.63×10^{-9}	$7.70\times10^{+5}$	$3.85\times10^{+2}$	2.11×10^{-4}
		MOX	6.01	3.01×10^{-3}	1.65×10^{-9}	$8.07\times10^{+5}$	$4.04\times10^{+2}$	2.21×10^{-4}
Late Containment Failure	1.21×10^{-5}	LEU	3.25	1.63×10^{-3}	3.15×10^{-7}	$3.93\times10^{+5}$	$1.96\times10^{+2}$	3.79×10^{-2}
		MOX	3.48	1.74×10^{-3}	3.38×10^{-7}	$3.78\times10^{+5}$	$1.89\times10^{+2}$	3.66×10^{-2}
Interfacing System Loss of Cooling Accident	6.90×10^{-8}	LEU	$1.40\times10^{+4}$	1	1.10×10^{-6}	$2.64\times10^{+7}$	$1.32\times10^{+4}$	1.46×10^{-2}
		MOX	$1.60\times10^{+4}$	1	1.10×10^{-6}	$2.96\times10^{+7}$	$1.48\times10^{+4}$	1.63×10^{-2}

[1] Increased likelihood (probability) of cancer fatality to the maximally exposed offsite individual located at the site boundary (762 m) - if exposed to the indicated dose.

[2] Increased likelihood (probability) of cancer fatality over the estimated 16 year campaign (frequency weighted) to a hypothetical individual - a noninvolved worker at a distance of 640 meters or the maximally exposed offsite individual located at the site boundary (762 m).

[3] Estimated number of cancer fatalities in the entire offsite population out to a distance of 80 kilometers (50 miles) if exposed to the indicated dose.

[4] Estimated number of cancer fatalities over the estimated 16 year campaign (frequency weighted) in the entire offsite population out to a distance of 80 kilometers (50 miles).

[5] McGuire timing and release fractions were used to compare like scenarios.

Table 16. Beyond-Design-Basis Accident Impacts for McGuire with LEU and Mixed Oxide Fuels

			Maximally Exposed Offsite Individual			Population		
Accident Release Scenario	Accident Scenario Frequency (per year)	LEU or MOX Core	Dose (rem)	Probability of Latent Cancer Fatality Given Dose at Site Boundary[1]	Risk of Latent Cancer Fatality (over campaign)[2]	Dose (person-rem)	Number of Latent Cancer Fatalities in the Population within 80 km[3]	Risk of Latent Cancer Fatalities (over campaign)[4]
Steam Generator Tube Rupture	5.81×10^{-9}	LEU	$6.10\times10^{+2}$	0.610	5.66×10^{-8}	$5.08\times10^{+6}$	$2.54\times10^{+3}$	2.37×10^{-4}
		MOX	$6.47\times10^{+2}$	0.647	6.02×10^{-8}	$5.28\times10^{+6}$	$2.64\times10^{+3}$	2.45×10^{-4}
Early Containment Failure	9.89×10^{-8}	LEU	12.2	6.10×10^{-3}	9.65×10^{-9}	$7.90\times10^{+5}$	$3.95\times10^{+2}$	6.26×10^{-4}
		MOX	12.6	6.30×10^{-3}	9.97×10^{-9}	$8.04\times10^{+5}$	$4.02\times10^{+2}$	6.37×10^{-4}
Late Containment Failure	7.21×10^{-6}	LEU	2.18	1.09×10^{-3}	1.26×10^{-7}	$3.04\times10^{+5}$	$1.52\times10^{+2}$	1.76×10^{-2}
		MOX	2.21	1.11×10^{-3}	1.28×10^{-7}	$2.96\times10^{+5}$	$1.48\times10^{+2}$	1.71×10^{-2}
Interfacing System Loss of Cooling Accident	6.35×10^{-7}	LEU	$1.95\times10^{+4}$	1	1.02×10^{-5}	$1.79\times10^{+7}$	$8.93\times10^{+3}$	0.091
		MOX	$2.19\times10^{+4}$	1	1.02×10^{-5}	$1.97\times10^{+7}$	$9.85\times10^{+3}$	0.10

[1] Increased likelihood (probability) of cancer fatality to the maximally exposed offsite individual located at the site boundary (762 m) - if exposed to the indicated dose.

[2] Increased likelihood (probability) of cancer fatality over the estimated 16 year campaign (frequency weighted) to a hypothetical individual - a noninvolved worker at a distance of 640 meters or the maximally exposed offsite individual located at the site boundary (762 m).

[3] Estimated number of cancer fatalities in the entire offsite population out to a distance of 80 kilometers (50 miles) if exposed to the indicated dose.

[4] Estimated number of cancer fatalities over the estimated 16 year campaign (frequency weighted) in the entire offsite population out to a distance of 80 kilometers (50 miles).

Table 17. Beyond-Design-Basis Accident Impacts for North Anna with LEU and Mixed Oxide Fuels

			Maximally Exposed Offsite Individual			Population		
Accident Release Scenario	Accident Scenario Frequency (per year)	LEU or MOX Core	Dose (rem)	Probability of Latent Cancer Fatality Given Dose at Site Boundary[1]	Risk of Latent Cancer Fatality (over campaign)[2]	Dose (person-rem)	Number of Latent Cancer Fatalities in the Population within 80 km[3]	Risk of Latent Cancer Fatalities (over campaign)[4]
Steam Generator Tube Rupture[5]	7.38×10^{-6}	LEU	$2.09\times10^{+2}$	0.209	2.46×10^{-5}	$1.73\times10^{+6}$	$8.63\times10^{+2}$	0.102
		MOX	$2.43\times10^{+2}$	0.243	2.86×10^{-5}	$1.84\times10^{+6}$	$9.20\times10^{+2}$	0.109
Early Containment Failure[5]	1.60×10^{-7}	LEU	19.6	1.96×10^{-2}	5.02×10^{-8}	$8.33\times10^{+5}$	$4.17\times10^{+2}$	1.07×10^{-3}
		MOX	21.6	2.16×10^{-2}	5.54×10^{-8}	$8.42\times10^{+5}$	$4.21\times10^{+2}$	1.08×10^{-3}
Late Containment Failure[5]	2.46×10^{-6}	LEU	1.12	5.60×10^{-4}	2.21×10^{-8}	$4.04\times10^{+4}$	20.2	7.95×10^{-4}
		MOX	1.15	5.75×10^{-4}	2.26×10^{-8}	$4.43\times10^{+4}$	22.1	8.70×10^{-4}
Interfacing System Loss of Cooling Accident[5]	2.40×10^{-7}	LEU	$1.00\times10^{+4}$	1	3.84×10^{-6}	$4.68\times10^{+6}$	$2.34\times10^{+3}$	8.99×10^{-3}
		MOX	$1.22\times10^{+4}$	1	3.84×10^{-6}	$5.41\times10^{+6}$	$2.70\times10^{+3}$	1.04×10^{-2}

1 Increased likelihood (probability) of cancer fatality to the maximally exposed offsite individual located at the site boundary (1349 m) - if exposed to the indicated dose.

2 Increased likelihood (probability) of cancer fatality over the estimated 16 year campaign (frequency weighted) to a hypothetical individual - a noninvolved worker at a distance of 640 meters or the maximally exposed offsite individual located at the site boundary (1349 m).

3 Estimated number of cancer fatalities in the entire offsite population out to a distance of 80 kilometers (50 miles) if exposed to the indicated dose.

4 Estimated number of cancer fatalities over the estimated 16 year campaign (frequency weighted) in the entire offsite population out to a distance of 80 kilometers (50 miles).

5 McGuire release durations and warning times were used in lieu of site specific data.

Table 18. Ratio of Accident Impacts for Mixed Oxide Fueled and Uranium Fueled Reactors (Mixed Oxide Impacts/LEU Impacts)

	Catawba		McGuire		North Anna		S&D PEIS	
Accident Scenario	MEI	Population	MEI	Population	MEI	Population	MEI	Population
Design-Basis Accidents								
Loss-of-Coolant Accident	1.03	1.03	1.01	1.03	1.03	1.03	NA	NA
Fuel Handling Accident	0.95	0.98	0.90	0.94	0.95	0.98	NA	NA
Beyond-Design-Basis Accidents								
Steam Generator Tube Rupture	1.06	1.04	1.16	1.07	1.06	1.04	0.94	0.94
Early Containment Failure	1.01	1.05	1.10	1.01	1.03	1.02	0.96	0.97
Late Containment Failure	1.07	0.96	1.03	1.09	1.01	0.97	1.07	1.08
Interfacing System Loss of Cooling Accident	1.14	1.12	1.22	1.15	1.12	1.10	0.92	0.93

Key: MEI – Maximally Exposed Individual; NA – not available

Note: The number 1 represents the consequences equal to the accident occurring in the proposed reactors with an LEU core

Table 19 shows the number of prompt fatalities estimated from a postulated ISLOCA and a beyond-design-basis steam generator tube rupture. As shown in this table, the differences due to the use of MOX fuel rather than LEU are small. None of the other accidents evaluated in this Synopsis are expected to result in prompt fatalities.

Table 19. Estimated Prompt Fatalities from Beyond-Design-Basis Reactor Accidents

Reactor Site	LEU Core	MOX Core
Steam Generator Tube Rupture		
Catawba	1	1
McGuire	1	1
North Anna	0	0
Interfacing System Loss of Cooling Accident		
Catawba	815	843
McGuire	398	421
North Anna	54	60

4.2.3 Waste Management

The proposed reactors would be expected to continue to produce mixed LLW, LLW, hazardous waste, and nonhazardous waste as part of their normal operations. According to the offeror, the volume of waste generated is not expected to increase as a result of the reactors using MOX fuel. This is consistent with information presented in the S&D PEIS that stated the use of MOX fuel is not expected to increase the amount or change the content of the waste being generated. (S&D PEIS, pg. 4-734) Table 20 shows the annual waste volume that would be generated during operation of the proposed reactors.

Table 20. Estimated Waste Generation Rates

Reactor Site	Mixed LLW (m^3/yr)	LLW (m^3/yr)	Hazardous Waste (m^3/yr)	Nonhazardous Waste Solid (m^3/yr)
Catawba (per unit)	0.3	25	15	455
McGuire (per unit)	0.1	21	14	568
North Anna (per unit)	0.0	118	6	5,200
S&D PEIS*	na	178	na	na

na - not available.
*S&D PEIS pg. 4-734.

As shown in Table 20, the estimated LLW generation for each of the proposed reactors is less than the amount estimated in the S&D PEIS. None of these waste estimates are expected to impact the proposed reactor sites in terms of their ability to handle these wastes. The wastes would continue to be handled in the same manner as they are today with no change required due to the use of MOX fuel at the reactors.

4.2.4 Spent Fuel

As shown in Table 21, it is likely that some additional spent fuel would be generated by using a partial MOX core in the proposed reactors. The amount of additional spent nuclear fuel generated is estimated to range from approximately 2 to 16 percent of the total amount of spent fuel that would be generated by the proposed reactors during the time period MOX fuel would be used. The offeror intends to manage the spent MOX fuel the same as its spent LEU fuel, by storing it in the reactor's spent fuel pool or in dry storage. According to the offeror, the amount of additional spent fuel is not expected to impact spent fuel management at the reactor sites.

Table 21. Total Additional Spent Fuel Assemblies Generated for the MOX Fuel Option

	Number of Spent Fuel Assemblies Generated with no MOX Fuel	Number of Additional Spent Fuel Assemblies with MOX Fuel	Percent Increase
S&D PEIS (based on a shorter fuel cycle)			
Typical PWR*	48/yr	32/yr	66.7%
Offeror's Reactors			
Total Over MOX Campaign	3,732	199	5.3%

*S&D PEIS pg. 4-734

For the four units at Catawba and McGuire, all of the additional spent nuclear fuel assemblies would be generated during the transition cycles from LEU to MOX fuel. Additional assemblies help to maintain peaking below design and regulatory limits, and compensate for the greater end-of-cycle reactivity. Once equilibrium is reached in the partial MOX core, additional fuel assemblies would not be required.

Like Catawba and McGuire, the North Anna units are expected to require additional LEU assemblies during the first transition cores. However, additional assemblies will also be required during equilibrium cycles because the smaller North Anna cores (157 fuel assemblies compared to 193 each for the McGuire and Catawba units) are more prone to neutron leakage and provide less flexibility with respect to meeting power peaking limits.

As designs are finalized and optimized for MOX fuel it may be possible to reduce MOX fuel assembly peaking and thereby reduce the number of additional assemblies required (and spent fuel generated) at the proposed reactors. As it currently stands, the North Anna site could generate approximately 16 percent more spent fuel by using MOX fuel than if the plants continued to use LEU fuel. The total amount of additional spent fuel generated by all six proposed reactors is estimated to be approximately 92 metric tons heavy metal. However, such MOX spent fuel is included in the inventory for the potential Nuclear Waste Policy Act geologic repository being studied by DOE. DOE is in the process of completing an environmental impact statement for a geologic repository.

4.2.5 Land Use

The offeror has stated that the proposed reactor sites would not require any additional land to support the use of MOX fuel in their reactors. This statement is consistent with information presented in the S&D PEIS. (S&D PEIS, pg. 4-720)

4.2.6 Infrastructure Requirements

The offeror has stated that the proposed reactor sites would not require any additional infrastructure to support the use of MOX fuel in their reactors. This statement is consistent with information presented in the S&D PEIS. (S&D PEIS, pg. 4-721)

4.2.7 Air Quality

Continued operation of the proposed reactor sites would result in a small amount of nonradiological air pollutants being released to the atmosphere, mainly due to the requirement to periodically test emergency diesel generators. The estimated air pollutants resulting from operation of the proposed reactors would not be expected to increase due to the use of MOX fuel in these reactors. Table 22 shows the estimated air pollutant concentrations and the national standards for these pollutants at the proposed sites. The impact of radiological releases is included in Section 4.2.1.

Table 22. Nonradiological Ambient Air Pollutant Concentrations with or without MOX Fuel from the Continued Operation of the Proposed Reactors

	Carbon Monoxide 8 hour 1 hour	Nitrogen Dioxide Annual	PM_{10} Annual 24 hour	Sulfur Dioxide Annual 24 hour 3 hour
National Ambient Air Quality Standards (μg/m^3)	10,000 40,000	100	50 150	80 365 1,300
Catawba (μg/m^3)	978 1400	3.26	0.102 65.4	0.0418 26.9 60.4
McGuire (μg/m^3)	1060 1510	2.6	0.08 71.2	0.03 29.9 67.4
North Anna (μg/m^3)	416 594	0.01	0.004 15.4	0.02 63 142

4.2.8 Water Quality

The offeror stated that there would be no change in water usage or discharge of nonradiological pollutants resulting from use of MOX fuel in the proposed reactors. Each of the reactor sites discharges nonradiological wastewater in accordance with a National Pollutant Discharge Elimination System

(NPDES) Permit, or an analogous state-issued permit. Permitted outfalls discharge conventional and priority pollutants from the reactor and ancillary processes that are similar to discharges from most reactor sites. Discharge Monitoring Reports (DMRs) for North Anna (May 1994 through April 1998) and Catawba (calendar years 1995 through 1997) showed that for the most part, there were only occasional noncompliances with permit limitations, only one of which occurred at an outfall receiving reactor process discharges. (The offeror did not provide DMRs for McGuire.) During the period reviewed, Catawba experienced four noncompliances, two in 1995 and two in early 1996. North Anna has exceeded the chlorine limitation at its sewage treatment facility, but this would neither affect nor be affected by, the use of MOX fuel. The impact of radiological releases is included in Section 4.2.1.

4.2.9 Socioeconomics

The offeror has stated that the proposed reactor sites would not need to employ any additional workers to support the use of MOX fuel in their reactors so there would not be any expected socioeconomic impacts. This statement is consistent with information presented in the S&D PEIS which concluded that the use of MOX fuel could result in small increases in the worker population at the reactor sites (between 40 and 105), but that any increase would be filled from the area's existing workforce. Therefore, there would be little impact on the local economy and communities (S&D PEIS, pgs. 4-727).

5.0 REQUIRED PERMITS AND LICENSES

Both the MOX fabrication facility and the selected reactors will require permitting and licensing activities to support the proposed fabrication and use of MOX fuel. The MOX fabrication facility will be constructed and operated at an existing DOE-owned site, but will be licensed by the NRC. The selected reactors are all U.S. operating, commercial PWRs, licensed by the NRC. The MOX facility, in particular, has special licensing considerations apart from most facilities that are built and operated in the United States today. This section discusses the particular licensing and permitting requirements of both facilities.

Both DOE and NRC have their origins in the Atomic Energy Act (AEA). The AEA first established their predecessor agency, the Atomic Energy Commission (AEC) to promote and regulate the use of atomic energy in the United States. The AEC was subsequently split into two organizations that have since become DOE and NRC. DOE was authorized to manage defense-related nuclear activities, while NRC was given the responsibility of regulating civilian uses of nuclear materials. Both DOE and NRC publish their regulations in Title 10 of the *Code of Federal Regulations* (10 CFR), with NRC publishing in Parts 0–199, and DOE, Parts 200–1099. DOE supplements its regulations with a series of Orders, while NRC uses Regulatory Guides to further establish specific methods of implementation of its regulations. The proposed actions that are the subject of this Synopsis are unique in that DOE and NRC each have regulatory responsibility for certain parts of the activities.

The AEA authorizes DOE to establish standards to protect health or minimize dangers to life or property for activities under DOE's jurisdiction. Through a series of DOE orders and regulations, an extensive system of standards and requirements has been established to ensure safe operation of facilities. The DOE orders have been revised and reorganized to reduce duplication and eliminate obsolete provisions (though some older orders remain in effect during the transition). For DOE orders, the new organization is by Series and is generally intended to include all DOE policies, manuals, requirements documents, notices, guides, and orders. For proposed actions involving fuel qualification, relevant DOE regulations include 10 CFR 820, Procedural Rules for DOE Nuclear Activities; 10 CFR 830, Nuclear Safety Management; 10 CFR.834, Radiation Protection of the Public and the Environment (Draft); 10 CFR 835, Occupational Radiation Protection; 10 CFR 1021, Compliance with the National Environmental Policy Act; and 10 CFR 1022, Compliance with Floodplains/Wetlands Environmental Review Requirements. DOE orders include those in new Series 400, which deals with Work Process; and within this Series, DOE Order 420.1 addresses Facility Safety; 425.1 addresses Startup and Restart of Nuclear Facilities; 452.1A addresses Nuclear Explosive and Weapons Surety Programs; 452.2A addresses the Safety of Nuclear Explosives Operations; 452.4 addresses the Security and Control of Nuclear Explosives; 460.1A addresses Packaging and Transportation Safety; 470.1 addresses the Safeguards and Security Program; and 474.1 addresses the Control and Accountability of Nuclear Materials. In addition, DOE (older number) Series 5400 addresses environmental, safety, and health programs for DOE operations. Not all of these DOE regulations and orders would apply to operation of the proposed MOX fuel fabrication facility, and most would not apply to use of the proposed reactors.

There are a number of Federal environmental statutes dealing with environmental protection, compliance, or consultation. In addition, certain environmental requirements have been delegated to state authorities for enforcement and implementation. Certain statutes and regulations require DOE to consult with Federal, State, and local agencies and federally recognized Native American groups. Most of these consultations are related to biotic resources, cultural resources, and Native American resources. Biotic resources consultations generally pertain to the potential for activities to disturb sensitive species or habitats. Cultural resources consultations relate to the potential for disruption of important cultural resources and archaeological sites. Finally, Native American consultations are concerned with the potential for disturbance of Native American sites and resources. DOE has conducted appropriate consultations at the candidate sites and will report the results of these consultations in the SPD Final EIS.

It is DOE policy to conduct its operations in an environmentally safe manner in compliance with all applicable statutes, regulations, and standards. Although this chapter does not address pending or future regulations, DOE recognizes that the regulatory environment is subject to change, and that the construction, operation, and decommissioning of any surplus plutonium disposition facility must be conducted in compliance with all applicable regulations and standards.

5.1 Regulatory Activities

It is likely that new or modified permits will be needed before the proposed surplus plutonium disposition facilities may be constructed or operated. Permits regulate many aspects of facility construction and operations, including the quality of construction, treatment and storage of hazardous waste, and discharges of effluents to the environment. These permits will be obtained from appropriate Federal, state, and local agencies. NRC issues operating licenses for major facilities such as commercial nuclear power reactors and fuel fabrication facilities, although the regulations under which these two facilities would be licensed are different.

5.1.1 The MOX Facility

The MOX facility would be licensed to operate by NRC under its regulations at 10 CFR 70, *Domestic Licensing of Special Nuclear Materials*. Because the facility would be located at a DOE site, however, certain DOE requirements affecting site interfaces and infrastructure will also be applicable. In addition, as would be the case regardless of where the facility were built, Federal or state regulations implementing certain provisions of the Clean Water Act, Clean Air Act, and Resource Conservation and Recovery Act would be applicable. These regulations are implemented through permits. Evaluation would be required to determine whether MOX facility emissions and activities would necessitate modification of any of these permits. Analyses in the SPD Draft EIS have shown that there would be minimal impact from construction and operation of the MOX facility.

MOX facility design and operating parameters will be imposed by requirements of 10 CFR 70. Facility robustness, worker health and safety, and material and personnel security are all specified by 10 CFR 70. This regulation incorporates and refers the licensee to provisions of other NRC regulations such as those found at 10 CFR 20, *Radiation Protection Standards.* Safety and environmental analyses will be required to support the license application for the MOX facility.

Integral to the NEPA process is consideration of how the proposed action might affect biotic, cultural, and Native American resources, and the need for mitigation of any potential impacts. Required consultations with agencies and recognized Native American groups have been conducted.

5.1.2 Reactors

Nuclear power reactors undergo a lengthy licensing process under 10 CFR 50, *Domestic Licensing of Production and Utilization Facilities*, beginning before facility construction commences. This process includes preparation of safety analysis and environmental reports. The safety analysis report remains a living document that serves as the licensing basis for the plant, and is updated throughout the life of the plant. Public hearings before a licensing board are conducted prior to a license being issued. Once issued, operating licenses may be amended only with proper evaluation, review and approval as specified in 10 CFR 50.90. This prescriptive process requires demonstration that a proposed change does not involve an unreviewed environmental or safety question and provides for public notice and opportunity to comment prior to issuance of the license amendment. Minor license amendments can be processed fairly expeditiously, but more involved amendments can require multiple submittals before the NRC is assured that the proposed action will not reduce the margin of safety of the plant. All submittals, except portions that contain proprietary information, are available to the public.

The regulatory process for requesting reactor license amendments to use MOX fuel will be the same as for any 10 CFR 50 Operating License amendment request. The reactor licensee submitting an operating license amendment request in accordance with 10 CFR 50.90 initiates this process. Safety and environmental analyses commensurate with the level of potential impact are submitted in support, and as part, of the amendment request. NRC reviews the submitted information and denies or approves the request. The review process can involve submittal of additional information and face-to-face meetings between the licensee and NRC, and can result in modified license amendment requests. NRC provides notice in the *Federal Register* for certain steps in the process. The notice for the amendment request initially appears in the *Federal Register* with a Notice of Opportunity for Public Hearing. *Federal Register* notices are also required for the Proposed No Significant Hazards Determination, associated environmental documents, Consideration of Issuance of the License Amendment, and issuance of the final amendment. Certain of these notices allow for the opportunity to provide written comments, and for potentially affected parties to petition to intervene or request public hearings.

The six reactors proposed to use MOX fuel have been operating for a number of years. Revisions to each of their operating licenses will be required prior to MOX fuel being brought to the reactor sites and loaded into the reactors. The license amendment request will need to include a discussion of all potential impacts and changes in reactor operation that could be important to safety or the environment. This will include fresh and spent fuel handling, security and operational changes, as well as complete core load analysis and safety analyses, including potential changes to the severe accident analyses. Because the offeror has indicated that no new construction would be required to accommodate the use of MOX fuel, it is unlikely that any biotic, cultural or Native American resources would be impacted by the proposed action. The analyses performed for the Environmental Critique have demonstrated very little difference between the impacts from using a partial MOX core over a LEU core.

The need for modifications to site permits will be evaluated by the individual plants as part of their licensing activities. The offeror has indicated, and the analyses and reviews performed for the Environmental Critique, support the assertion, that there would be minimal or no change in effluents, emissions, and wastes (both radiological and nonradiological). Therefore, it is expected that few, if any, environmental permits or agreements will require modification for use of MOX fuel.

6.0 CONCLUSION

No major impacts to the environment surrounding the proposed MOX facility or reactor sites are expected to result from normal operation of these facilities. Environmental impacts from operation of the proposed reactors are not expected to change appreciably due to the use of MOX fuel. Impacts from construction and operation of the MOX facility are expected to be generally consistent with those presented in the SPD Draft EIS, and impacts at the reactor sites are expected to be generally consistent with those in the S&D PEIS.