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Environmental Impact Statement on the Construction and Operation of a Proposed Mixed Oxide Fuel Fabrication Facility at the Savannah River Site, South Carolina

Chapters 1 through 8 and Appendices A through E

Final Report

U.S. Nuclear Regulatory Commission
Office of Nuclear Material Safety and Safeguards
Washington, DC 20555-0001

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ABSTRACT

The U.S. Department of Energy (DOE) has contracted with Duke Cogema Stone & Webster (DCS) to design, construct, and operate a proposed Mixed Oxide (MOX) Fuel Fabrication Facility that would convert depleted uranium and weapons-grade plutonium into MOX fuel. The proposed MOX facility would be located on the DOE's Savannah River Site in South Carolina. Use of the proposed facility to produce MOX fuel would be part of the DOE's surplus plutonium disposition program. The purpose of the DOE program is to ensure that plutonium produced for nuclear weapons and declared excess to national security is converted to proliferation-resistant forms.

This final environmental impact statement (FEIS) was prepared in compliance with the National Environmental Policy Act (NEPA), the U.S. Nuclear Regulatory Commission's (NRC's) regulations for implementing NEPA, and the guidance provided by the Council on Environmental Quality regulations implementing the procedural provisions of NEPA. This FEIS evaluates the potential environmental impacts of the proposed action. The document discusses the purpose and need for the proposed action, describes the proposed action and its reasonable alternatives, describes the environment potentially affected by the proposal, presents and compares the potential environmental impacts resulting from the proposed action and its alternatives, and identifies mitigation measures that could eliminate or lessen the potential environmental impacts. The document also includes comments received on the draft environmental impact statement and NRC's responses.

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EXECUTIVE SUMMARY

The consortium of Duke Project Services Group, Inc., COGEMA, Inc., and Stone & Webster, Inc., has formed a Limited Liability Company called Duke Cogema Stone & Webster (DCS). DCS has been hired by the U.S. Department of Energy (DOE) to design, construct, and operate a facility (the proposed MOX facility) that would convert depleted uranium and surplus weapons-grade plutonium into mixed oxide (MOX) fuel. The DOE is responsible for the surplus plutonium disposition program for the United States. Within this program, the U.S. Nuclear Regulatory Commission (NRC) has the independent responsibility of determining whether the proposed MOX facility can be built and operated in a safe and environmentally acceptable manner. The proposed action requiring the February 2003 draft environmental impact statement (DEIS) and this NRC final environmental impact statement (FEIS) involves a decision by the NRC whether to authorize DCS to construct and later operate the proposed MOX facility at DOE's Savannah River Site (SRS) in South Carolina. DCS has submitted to the NRC, among other documents, a revised Construction Authorization Request (CAR) and a revised environmental report (ER), in seeking authority to begin constructing the proposed MOX facility.

This FEIS was prepared by the staff of the NRC and its contractor, Argonne National Laboratory, and complies with the National Environmental Policy Act (NEPA), NRC regulations for implementing NEPA (Title 10, Part 51 of the *Code of Federal Regulations* [10 CFR Part 51]), and the applicable Council on Environmental Quality (CEQ) regulations.

The proposed MOX facility would convert 34 metric tons (MT) (37.5 tons) of surplus weapons-grade plutonium into MOX fuel. This facility would be built on 16.6 ha (41 acres) of land in the F-Area of the SRS. If the NRC approves the CAR, DCS plans to request a 10 CFR Part 70 license to possess and use special nuclear material at the proposed MOX facility. Such a license would allow DCS to operate the proposed MOX facility for 20 years. The facility would be designed for a maximum annual throughput of 3.5 MT (3.9 tons) of plutonium.

Feedstock (surplus plutonium dioxide and depleted uranium dioxide) would be required to be transported to the SRS to make the MOX fuel. The surplus plutonium is currently stored at seven DOE facilities at various locations in the United States. Additionally, depleted uranium hexafluoride would need to be transported from a DOE site (assumed to be the gaseous diffusion uranium enrichment facility in Portsmouth, Ohio) to a commercial fuel fabrication facility (assumed to be the Global Nuclear Fuel Americas, LLC, in Wilmington, North Carolina), where it would be converted to depleted uranium dioxide, which would then be transported to the SRS. Once manufactured, the MOX fuel would be transported to mission reactors, where it would be irradiated. For purposes of complying with NEPA's requirements, it is assumed that one or more reactors will later be authorized by the NRC to use MOX fuel, and the FEIS includes a generic evaluation of using MOX fuel in a reactor. In order for a specific commercial reactor to use MOX fuel, an amendment to its 10 CFR Part 50 NRC license would be required. The NRC would analyze the site-specific environmental impacts related to such an amendment if and when such a request was made to the NRC. Following irradiation and storage at reactor sites, the spent MOX fuel would be transported to a geologic repository (assuming one is later licensed by the NRC to operate) for final disposal, and the FEIS includes a discussion of spent MOX fuel transportation impacts.

In addition to presenting the potential environmental impacts of the proposed MOX facility and the related fuel cycle impacts, this FEIS discusses two proposed DOE facilities — the Pit Disassembly and Conversion Facility (PDCF) and the Waste Solidification Building (WSB) — which would also be located at the SRS, that would be required to support operation of the proposed MOX facility. The PDCF would be required to convert approximately 25.6 MT (28.2 tons) of surplus plutonium from a metallic form to plutonium dioxide powder. The remaining quantity of surplus plutonium, called "alternate feedstock," would be in a form that would be suitable to go directly to the proposed MOX facility. The proposed MOX facility would remove impurities from the plutonium dioxide and mix it with depleted uranium dioxide to make MOX fuel.

The WSB would process liquid waste streams from the PDCF and proposed MOX facility. The WSB may also be used for temporary storage and processing of other waste forms generated at the proposed MOX facility and the PDCF before such wastes are transferred to the SRS waste management system or shipped off-site for disposition. In addition, infrastructure upgrades would be needed to support the proposed MOX facility. These upgrades would include constructing waste transfer pipelines, realigning electric utility lines, and adding access roads.

A brief summary of FEIS Chapters 1-6 follows. Chapter 1 of the FEIS discusses the purpose and need for this action and its relationship to the DOE's surplus plutonium disposition program. The fundamental purpose of this DOE program is to ensure that surplus weapons-grade plutonium is converted to proliferation-resistant forms. The DOE's program is intended to lay the foundation for parallel disposition of excess Russian plutonium, thereby protecting against proliferation of materials capable of making weapons of mass destruction.

Chapter 2 of this FEIS describes the proposed action and alternatives to the proposed action, including the no-action alternative. The no-action alternative consists of the continued storage of surplus plutonium at various locations throughout the DOE complex, in the event the NRC does not approve the proposed MOX facility. This alternative is evaluated in detail in Chapter 4. Other alternatives to the proposed action discussed in Chapter 2 include alternate locations for the proposed MOX facility in the F-Area, alternate technology and design options, immobilizing surplus plutonium instead of producing MOX fuel, deliberately making off-specification MOX fuel, the "MIX MOX" alternative, and the Parallex Project (which involves irradiating the MOX fuel in Canadian deuterium uranium reactors).

Chapter 3 describes the environment that would be affected by the proposed action and includes discussions on soils, hydrology, air quality, local ecology, waste management, risks to human health, and socioeconomic issues.

Chapter 4 evaluates and compares the environmental effects of the proposed action and the no-action alternative. Significant or more important potential impacts are discussed in Chapter 4, which includes the following topics: (1) human health, (2) air quality, (3) hydrology,

(4) waste management, (5) accident impacts, (6) decommissioning, and (7) environmental justice. Indirect impacts of transportation of radioactive materials, conversion of depleted uranium, and reactor use are discussed in Chapter 4. The following potential impacts for the no-action alternative and proposed action are considered to be less significant and are discussed in Appendixes G and H: (1) geology, seismology, and soils; (2) noise; (3) ecology; (4) land use; (5) cultural and paleontological resources; (6) infrastructure; and (7) socioeconomics. A summary of the significant or more important potential impacts discussed in Chapter 4 is presented below.

The annual collective dose to members of the public (i.e., those living and working within 80 km [50 mi] of the SRS) produced by routine operation of the proposed MOX facility, the PDCF, and the WSB would be expected to result in a latent cancer fatality (LCF) rate of approximately 0.0009/yr or less. Routine operation of the proposed MOX facility, the PDCF, and the WSB is expected to produce small air quality impacts and would not cause exceedance of any ambient air quality standard level for criteria pollutants at the SRS.

Construction and routine operation of the proposed facilities would not be expected to cause any disproportionately high and adverse impacts to low-income or minority populations in the SRS vicinity. Of the accidents evaluated, a hypothetical PDCF tritium release accident had the highest estimated short-term impacts, approximately 3 LCFs among members of the off-site public. Such an accident also had the highest estimated 1-year exposure impact, including the ingestion dose, of up to 100 LCFs among members of the off-site public. However, it is regarded as highly unlikely that such an accident would occur, and the risk to any population, including low-income and minority communities, is considered to be low. Nevertheless, the communities most likely to be affected by a significant accident would be minority or low-income, given the demographics and prevailing wind direction. The extent to which low-income or minority population groups would be affected would depend on the amount of material released and the direction and speed of the wind.

Transportation of uranium and plutonium feedstock materials, transuranic waste, fresh MOX fuel, and spent MOX fuel would result in approximately 3,300,000 to 8,200,000 km (2,050,000 to 5,100,000 mi) traveled by 1,497 to 3,512 truck shipments over the operations period of the proposed MOX facility. Up to 1 LCF might be expected from the radioactive nature of the cargo. (Estimated LCFs for members of the public and the transportation crews were 0.2 to 0.4 and 0.1 to 0.3, respectively.) One to two latent fatalities from vehicle emissions were estimated, and no fatalities (0.078 to 0.20 fatality) from the physical trauma of potential vehicle accidents were estimated.

Chapter 4 of the FEIS also evaluates the use of MOX fuel in a generic reactor using a 40% MOX fuel core. For both normal operations and design-basis accidents, the impacts of using MOX fuel in a reactor would not be significantly different from the impacts of a reactor using 100% low-enriched uranium fuel. For highly unlikely beyond-design-basis accidents, the impacts for a reactor using a 40% MOX fuel core could be up to 14% greater than for a reactor using 100% low-enriched uranium fuel. Since no reactor licensee has yet sought the authority to use MOX fuel, the transportation of fresh MOX fuel is also evaluated on a generic basis, using a surrogate reactor located in the Midwest.

Chapter 4 also presents the costs and benefits of the proposed action. The primary benefit of operating the proposed MOX facility would be the resulting reduction in the supply of weapons-grade plutonium available for unauthorized use. Converting surplus plutonium in this manner is viewed as being a safer use/disposition strategy than the DOE's continued storage of surplus plutonium, as would occur under the no-action alternative, because it would reduce the number of locations where the various forms of plutonium are stored. Further, converting weapons-grade plutonium into MOX fuel in the United States — as opposed to immobilizing a portion of it as the DOE had previously planned to do — lays the foundation for parallel disposition of weapons-grade plutonium in Russia, which distrusts immobilization because of its failure to degrade the plutonium's isotopic composition. Converting surplus plutonium into MOX fuel is thus viewed as a better way of ensuring that weapons-usable material will not be obtained by rogue states and terrorist groups. Implementing the proposed action is expected to promote the above nonproliferation objectives.

In addition to the above primary benefits, there would be secondary economic benefits of the proposed action. Impacts of construction on the regional economic area (REA) and region of influence (ROI) would be beneficial with respect to jobs and income. During operations, the proposed MOX facility, PDCF, and WSB would be expected to generate 490 direct and 780 indirect jobs, producing a total income of $64 million a year in the REA. The economic cost benefit analysis for the proposed action shows an overall net benefit to the ROI and REA of $1,940 million. National economic costs for the proposed MOX facility, PDCF, and WSB are estimated to be $4,064 million (in 2003 dollars). The national economic benefits would include adding employment and income in various sectors of the economy through the purchase of goods and services required during construction and operation.

Chapter 5 of the FEIS identifies mitigation measures that could eliminate or lessen the potential environmental impacts of the proposed action. The NRC evaluated proposed mitigation measures identified by DCS and identified additional measures that could reduce or eliminate adverse environmental impacts of the proposed action. On the basis of its independent review, the NRC is making a preliminary conclusion that the potential significant impacts of the proposed action can be mitigated. However, any possession and use license issued to DCS should be conditioned on the commitments made by DCS and the various proposed NRC mitigation requirements discussed in Chapter 5.

Chapter 6 presents the many federal, state, and local environmental requirements that would be applicable to the proposed MOX facility.

After weighing the costs and benefits of the proposed action, comparing alternatives, and considering the comments received on the DEIS (see FEIS Appendix J), the NRC staff, in accordance with 10 CFR 51.91(d), includes in this FEIS its final NEPA recommendation regarding the proposed action. As discussed further in Chapter 2, the NRC staff continues to recommend that, unless safety issues mandate otherwise, the action called for is the issuance of the proposed license to DCS, with conditions to protect environmental values. As stated in Chapter 2, the NRC staff concludes that (1) the applicable environmental requirements presented in FEIS Chapter 6 and (2) the proposed mitigation measures discussed in FEIS

Chapter 5 would eliminate or substantially lessen any potential adverse environmental impacts associated with the proposed action.

Appendix J includes a summary of the comments and responses received on the DEIS. Ninety-four commenters submitted about 750 comments on the DEIS. Appendix J also identifies changes in the FEIS text based on the comments and revised accident analyses from new design information for the WSB provided by DCS since publication of the DEIS.

ACRONYMS AND ABBREVIATIONS

The following is a list of the acronyms, initialisms, abbreviations, and units of measure used in this document. Some acronyms and abbreviations used only in tables, figures, equations, or as reference callouts are defined in the respective tables, figures, equations, and reference lists.

Acronyms, Initialisms, and Abbreviations

7Q10	7-day low flow, 10-year recurrence flow
AADT	average annual daily traffic
ADU	ammonium diuranate
AEA	Atomic Energy Act
Ag	silver
$AgNO_3$	silver nitrate
ALARA	as low as reasonably achievable
ALI	annual limit on intake
ALOHA	Areal Locations of Hazardous Atmospheres (computer code)
Am	americium
ANL-W	Argonne National Laboratory-West
ANSI	American National Standards Institute
APA	aqueous polishing area
APSF	Actinide Packaging and Storage Facility
AQCR	Air Quality Control Region
BPIP	Building Profile Input Program
BRP	Reagents Processing Building
CAA	Clean Air Act
CANDU	Canadian Deuterium Uranium (reactor)
CAR	Construction Authorization Request
CAS	Chemical Abstract Services
CEDE	committed effective dose equivalent
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CH-TRU	contact-handled transuranic (waste)
CIESIN	Center for International Earth Science Information Network
CIF	Consolidated Incineration Facility
CO	carbon monoxide
CO_2	carbon dioxide
CPT	cone-penetration test
CSWTF	Central Sanitary Wastewater Treatment Facility
CWA	Clean Water Act

D&D	deactivation and decommissioning
DCP	dry conversion process
DCS	Duke Cogema Stone & Webster
DDE	deep dose equivalent
DEIS	draft environmental impact statement
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DWPF	Defense Waste Processing Facility
EA	environmental assessment
EBR-II	Experimental Breeder Reactor-II
EDE	effective dose equivalent
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ER	Environmental Report
ERPG	Emergency Response Planning Guideline
ETF	Effluent Treatment Facility
FEIS	final environmental impact statement
FGR	Federal Guidance Report
FOF	F-Area Outside Facility
FONSI	Finding of No Significant Impact
FR	*Federal Register*
FSER	final safety evaluation report
FTE	full-time equivalent
FY	fiscal year
Ga	gallium
GE	General Electric
GENII	Generation II (computer code)
GRP	gross regional product
$H_2C_2O_4$	oxalic acid
HEPA	high-efficiency particulate air (filter)
HEU	highly enriched uranium
HF	hydrogen fluoride
HI	hazard index
HLW	high-level (radioactive) waste
HQ	hazard quotient
HRCQ	highway route controlled quantity
HSWA	Hazardous and Solid Waste Amendments
HVAC	heating, ventilation, and air conditioning
HYDOX	hydride-oxidation
ICRP	International Commission on Radiological Protection
IMPLAN	Intelligent Multi-Resource Planning (computer code)

INEEL	Idaho National Engineering and Environmental Laboratory
ISA	integrated safety analysis
ISCST3	Industrial Source Complex Short-Term (version 3) model
ISFSI	interim spent fuel storage installation
ITP	in-tank precipitation
KAMS	K-Area Material Storage (SRS)
LANL	Los Alamos National Laboratory
LCF	latent cancer fatality
L_{dn}	day-night average sound level
L_{eq}	equivalent sound pressure level
LEU	low-enriched uranium
LLC	Limited Liability Company
LLNL	Lawrence Livermore National Laboratory
LLW	low-level (radioactive) waste
LSA	low specific activity
LTA	lead test assembly
MAR	material at risk
MBTA	Migratory Bird Treaty Act
MC&A	material control and accounting
MEI	maximally exposed individual
MMI	Modified Mercalli Intensity (earthquake intensity scale)
MOX	mixed oxide (plutonium dioxide and uranium dioxide)
MPQAP	MOX Project Quality Assurance Plan
MSL	mean sea level
MWMF	Mixed Waste Management Facility
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NERP	National Environmental Research Park
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NMSS	Office of Nuclear Material Safety and Safeguards (NRC)
NNSA	National Nuclear Security Administration
NO_2	nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NRHP	*National Register of Historic Places*
NSC	National Safety Council
NSPS	New Source Performance Standards

O_3	ozone
OAQPS	Office of Air Quality Planning and Standards (EPA)
OFASB	Old F-Area Seepage Basin
OHER	Office of Health and Environmental Research (DOE)
OML	oxalic mother liquor
ORR	Oak Ridge Reservation
OSHA	Occupational Health and Safety Administration
PAG	protective action guide
PAH	polycyclic aromatic hydrocarbon
Pb	lead
PDCF	Pit Disassembly and Conversion Facility
PEIS	programmatic environmental impact statement
PM	particulate matter
PM_{10}	particulate matter with a diameter less than or equal to 10 micrometers
$PM_{2.5}$	particulate matter with a diameter less than or equal to 2.5 micrometers
PMF	probable maximum flood
PSD	Prevention of Significant Deterioration
PSSCs	principal structures, systems, and components
Pu	plutonium
Pu (IV)	tetravalent plutonium
Pu (III)	trivalent plutonium
PuO_2	plutonium oxide
QA	quality assurance
RCRA	Resource Conservation and Recovery Act
REA	regional economic area
REG	mitigation measures instituted to ensure compliance with regulations, permits, and guidelines
RFETS	Rocky Flats Environmental Technology Site
ROD	Record of Decision
ROI	region of influence
S&D PEIS	Storage and Disposition Programmatic Environmental Impact Statement
SA	Supplement Analysis
SAAQS	State Ambient Air Quality Standard
SC	South Carolina; state route
SCAPA	Subcommittee on Consequence Assessment and Protective Action (DOE)
SCDHEC	South Carolina Department of Health and Environmental Control
SCDNR	South Carolina Department of Natural Resources
SCSHPO	South Carolina State Historic Preservation Officer
SER	safety evaluation report
SGT	Safeguards Transporter
SHPO	State Historic Preservation Office
SIP	state implementation plan

SNF	spent nuclear fuel
SNM	special nuclear material
SO_2	sulfur dioxide
SO_x	sulfur oxides
SPCC	spill prevention control and countermeasures
SPD	surplus plutonium disposition
SPD EIS	Surplus Plutonium Disposition Environmental Impact Statement
SPL	sound pressure level
SR	State Route
SRARP	Savannah River Archaeological Research Program
SREL	Savannah River Ecology Laboratory
SRS	Savannah River Site
SWB	standard waste box
TAP	toxic air pollutant
TCDD	tetrachlorodibenzo-para-dioxin
TEDE	total effective dose equivalent
TEEL	temporary emergency exposure limit
TI	transport index
TIGR	thermally induced gallium removal
TRAGIS	Transportation Routing Analysis Geographic Information System
TRU	transuranic (radioactive waste)
TRUPACT	transuranic package transporter
TSCA	Toxic Substances Control Act
TSD	Transportation Safeguards Division (DOE Albuquerque Operations Office)
TSP	total suspended particulates
U	uranium
UF_6	uranium hexafluoride
UO_2	uranium dioxide
U.S.C.	*United States Code*
VOC	volatile organic compound
VRM	visual resource management
WAC	waste acceptance criteria
WIPP	Waste Isolation Pilot Plant
WM PEIS	*Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste*
WMA	Wildlife Management Area
WSB	Waste Solidification Building

Units of Measure

Bq	becquerel(s)
Btu	British thermal unit(s)
Ci	curie(s)
μCi	microcurie(s)
cm	centimeter(s)
d	day(s)
dB	decibel(s)
dBA	A-weighted decibel(s)
dps	disintegration(s) per second
°C	degree(s) Celsius
°F	degree(s) Fahrenheit
ft	foot (feet)
ft^2	square foot (feet)
ft^3	cubic foot (feet)
g	gram(s) or gravitational acceleration
μg	microgram(s)
gal	gallon(s)
gpm	gallon(s) per minute
h	hour(s)
ha	hectare(s)
hg	mercury
Hz	hertz
in.	inch(es)
K	kelvin degrees (temperature)
kg	kilogram(s)
km	kilometer(s)
km^2	square kilometer(s)
kV	kilovolt(s)
L	liter(s)
lb	pound(s)
m	meter(s)
m^2	square meter(s)
m^3	cubic meter(s)
μm	micrometer(s)
mg	milligram(s)
mi	mile(s)
mi^2	square mile(s)
min	minutes
mm	millimeter(s)
mo	month(s)
mph	mile(s) per hour
mrem	millirem(s)
mSv	millisievert(s)
MT	metric ton(s)
MWh	megawatt-hour(s)
nCi	nanocurie(s)
Pa	Pascal(s)
ppb	part(s) per billion
ppm	part(s) per million
s	second(s)
Sv	sievert(s)
yd^3	cubic yard(s)
yr	year(s)