
Draft Safety Evaluation Report
on the Construction Authorization Request
for the Mixed Oxide Fuel Fabrication Facility
at the Savannah River Site, South Carolina,
Revision 1

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Duke Cogema Stone & Webster, L.L.C.

U.S. Nuclear Regulatory Commission
Office of Nuclear Material Safety and Safeguards



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ACRONYMS

AC	alternating current	ECR	Emergency Control Room
AEC	active engineered control	ECRAS	Emergency Control Room Air-Conditioning System
AEGL	Acute Exposure Guideline Level	EDMS	electronic data management system
AFS	alternate feedstock	EFT	effluent treatment facility
AHJ	Authorities Having Jurisdiction	EIS	Environmental Impact Statement
ALARA	as low as reasonably achievable	EMMH	external man-made hazard
ALI	allowable limit on intake	ENDF	Evaluation Nuclear Data File
ALOHA	areal locations of hazardous atmospheres	ER	Environmental Report
A-MIMAS	advanced micronized master blend	ERDA	U.S. Energy Research and Development Administration
ANS	American Nuclear Society	ERPG	Emergency Response Planning Guidelines
ANSI	American National Standards Institute		
AOA	area of applicability	FHA	Fire Hazards Analysis
AP	aqueous polishing	FM	Factory Mutual
ARF	atmospheric release fraction	FNMC	Fundamental Nuclear Material Control
ASHRAE	American Society of Heating, Refrigeration, and Air-Conditioning	FTS	fluid transport system
ASTM	American Society for Testing and Materials		
AWS	American Welding Society	HA	hazards analysis
		HAAW	high alpha activity waste stream (containing uranium, americium, and other radioactive decay products)
BA	Bachelor of Arts	HAN	hydroxylamine nitrate
BDC	baseline design criteria	HAZOP	hazard and operability (analysis)
BMF	fuel fabrication building	HD	high depressurization
BS	Bachelor of Science	HEPA	high efficiency particulate air
		HEU	high enriched uranium
CAAS	Criticality Accident Alarm System	HFE	human factors engineering
CAM	continuous air monitor	HPT	hydrogenated propylene tetramer
CAR	Construction Authorization Request	HSI	human-system interface
CCU	criticality control unit	HVAC	heating, ventilation, and air conditioning
CEDC	committed effective dose equivalent		
CFM	cubic feet per minute	ICN	immediate control network
CFR	Code of Federal Regulations	ICRP	International Commission on Radiation Protection
CGA	Compressed Gas Association	ICSBEP	International Criticality Safety Benchmark Experiments
CM	configuration management	IEEE	Institute of Electrical and Electronics Engineers
CRT	cargo restraint transporter	IROFS	items relied on for safety
CSE	criticality safety evaluation	I&C	Instrumentation and control
		ISA	integrated safety analysis
DC	direct current		
DCF	dose conversion factor	JSHU	jar storage and handling unit
DCP	double contingency principle		
DCS	Duke Cogema Stone & Webster	LANL	Los Alamos National Laboratory
DOE	U.S. Department of Energy	LFL	lower flammability limit
DR	damage ratio	LIN	local industrial network
DSER	draft safety evaluation report	LLW	low level waste
DU	depleted uranium		
DUO ₂	depleted uranium dioxide		
EALF	Energy of Average Lethargy causing Fission		

LPF	leak path factor	SA	safety analysis
LWR	light water reactor	SAR	safety analysis report
MAPE	mean annual probability of exceedance	SCALE	Standardized Computer analyses evaluation
MAR	material-at-risk	SCAPA	DOE Subcommittee on Consequence Assessment and Protective Action
MC&A	material control and accounting	SRS	Savannah River Site
MCC	motor control center	SER	safety evaluation report
MCNP	Monte Carlo Neutron Photon	SNM	special nuclear material
MDE	medium depressurization exhaust	SPDP	Surplus Plutonium Disposition Program
MFFF	mixed oxide fuel fabrication facility	SRP	standard review plan (NUREG-1718)
MFFP	MOX fresh fuel package	SRS	Savannah River Site
MMIS	manufacturing management and information system	SSC	structures, systems, and components
MOX	mixed oxide	SST	safe secure transport
MP	mixed oxide process	STEL	short-term exposure limit
MPQAP	MOX Project Quality Assurance Plan	S/U	sensitive/uncertainty
MSDS	Material Safety Data Sheet	TBP	tributyl phosphate
MTHM	metric tons heavy metal	TEDE	Total Effective Dose Equivalent
NCS	nuclear criticality control	TEEL	Temporary Emergency Exposure Limit
NCSE	nuclear criticality safety evaluation	TLV	threshold limit value
NFPA	National Fire Protection Association	TQ	threshold quantities
NRC	U.S. Nuclear Regulatory Commission	TRU	transuranic
NPH	natural phenomena hazards	TWRS-P	Tank Waste Remediation System Privatization
ORNL	Oak Ridge National Laboratory	UBC	Uniform Building Code
PAA	preliminary accident analysis	UL	Underwriters Laboratories
PAG	protective action guide	UO ₂	Uranium Dioxide
PBX	public branch exchange	USL	upper subcritical limit
PC	performance categories	UPS	uninterruptible power supplies
PDCF	pit disassembly and conversion facility	WAC	waste acceptance criteria
PEC	passive engineered control	WG	water gauge
PEP	personnel and equipment protection	WTA	work task agreement
PFOD	probability of failure on demand	XTN	X-terminal network
PHA	preliminary hazard analysis		
PIP	plutonium immobilization pit		
PLC	programmable logic controller		
Pu	plutonium		
PuO ₂	plutonium dioxide		
PUREX	plutonium uranium reduction extraction		
PSSCs	principal structures, systems and components		
QA	quality assurance		
QL	quality level		
RACB	restricted area boundary concentration		
RAI	request for additional information		
RF	respirable fraction		

List of Acronyms for MFFF Building and System Designations

Buildings	Systems		
BAD Administration Building	BAS Breathing Air System	KCD Oxalic Mother Liquor Recovery Unit	PWS Plant Water System
BAP Aqueous Polishing Area	CHH HVAC Chilled Water System	KDA Decanning Unit	RDO Diluent System
BEG Emergency Diesel Generator Bldg	CHP Process Chilled Water System	KDB Dissolution Unit	RHN Hydroxylamine Nitrate System
BMF MOX Fuel Fabrication Bldg	DCE PuO ₂ Buffer Storage Unit	KPA Purification Cycle	RHP Hydrogen Peroxide System
BMP MOX Fuel Fabrication Area (MOX Processing Area)	DCM PuO ₂ 3013 Storage Unit	KPB Solvent Recovery Cycle	RHZ Hydrazine System
BRP Reagent Processing Building	DCP PuO ₂ Receiving Unit	KPC Acid Recovery Unit	RMN Manganese Nitrate System
BSG Standby Diesel Generator Bldg	DCS Decontamination System	KPF Silver Recovery Unit	RNA Nitric Acid System
BSH Safe Haven Buildings	DDP UO ₂ Drum Emptying Unit	KWD Liquid Waste Reception Unit	ROA Oxalic Acid System
BSR Shipping and Receiving Area	DMW Demineralized Water System	KWG Offgas Treatment Unit	RSC Sodium Carbonate System
BSW Secured Warehouse Building	DRS UO ₂ Receiving and Storage Unit	MDE Medium Depressurization Exhaust System	RSH Sodium Hydroxide System
BTS Technical Support Building	EGF Emergency Diesel Generator Fuel Oil System	NBX Primary Blend Ball Milling Unit	RSN Silver Nitrate System
	GAH Argon/Hydrogen System	NBY Scrap Milling Unit	RTP Tributyl Phosphate System
	GDE Rod Decladding Unit	NCR Scrap Processing Unit	SAS Service Air System
	GHE Helium System	NDD PuO ₂ Container Opening & Handling Unit	SCE Rod Scanning Unit
	GME, GMF Rod Cladding & Decontamination Units	NDP Primary Dosing Unit	SDK Rod Inspection and Sorting Unit
	GMK Rod Tray Loading Unit	NDS Final Dosing Unit	SEK Helium Leak Test Unit
	GNO Nitrogen Oxide System	NPE, NPF Homogenization & Pelletizing Unit	SGF Standby Diesel Generator Fuel Oil System
	GNS Nitrogen System	NTM Jar Storage & Handling Unit	SPS, SPC Process Steam and Process Condensate Systems
	GOX Oxygen System	NXR Powder Auxiliary Unit	STK Rod Storage Unit
	HDE High Depressurization Exhaust System	PAD Pellet Repackaging Unit	SXE, SXF X-Ray Inspection Units
	HWS Process Hot Water System	PAR Scrap Box Loading Unit	TAS Assembly Handling and Storage Unit
	IAS Instrument Air System	PFE, PFF Sintering Units	TCK Assembly Dry Cleaning Unit
	KCA Oxalic Precipitation & Oxidation Unit	PML Pellet Handling Unit	TCL Assembly Final Inspection Unit
	KCB Homogenization Unit	POE Process Cell Exhaust System	TCP Assembly Dimensional Inspection Unit
	KCC Canning Unit	PQE Quality Control and Manual Sorting Units	TGM Assembly Mockup Loading Unit
		PRE, PRF Grinding Units	TGV Assembling Mounting Unit
		PSE Green Pellet Storage Unit	TXE Assembly Packaging Unit
		PSF Sintered Pellet Storage Unit	VHD Very High Depressurization Exhaust System
		PSI Scrap Pellet Storage Unit	VRM Radiation Monitoring Vacuum System
		PSJ Ground and Sorted Pellet Storage Unit	WVA Vehicle Access Portal
		PTE Pellet Inspection and Sorting Units	

EXECUTIVE SUMMARY

On October 31, 2002, Duke Cogema Stone & Webster (DCS or the applicant) submitted to the U.S. Nuclear Regulatory Commission (NRC) a revised construction authorization request (CAR), pertaining to a proposed Mixed Oxide (MOX) Fuel Fabrication Facility (MFFF) on the U.S. Department of Energy's (DOE) Savannah River Site (SRS). If NRC approved construction of the MFFF, the MFFF would be a key asset of DOE's Surplus Plutonium Disposition Program (SPDP). The SPDP is being implemented as a result of a bilateral agreement with the Russian Federation. The U.S. and the Russian Federation agreed that each nation would convert 37.5 U.S. tons (34 metric tons) of weapons-grade plutonium (declared excess to national security needs) into forms less usable in nuclear weapons. The SPDP would convert surplus U.S. weapons-grade plutonium into MOX fuel. In implementing its SPDP, the DOE decided in early 2002 not to pursue its immobilization option for the disposition of surplus weapons-grade plutonium. The DOE decided to instead convert all such material into MOX fuel. As a result of this decision, design changes to the proposed MFFF were required in order to accommodate material containing greater amounts of impurities, as reflected in the revised CAR.

The revised CAR replaces, in its entirety, the CAR submitted by DCS on February 28, 2001. The purpose of this revised CAR is to describe changes necessary to process plutonium feed materials from DOE sources other than the proposed Pit Disassembly and Conversion Facility (PDCF), incorporate information previously provided in DCS' responses to NRC's requests for additional information and provide additional information to address open items identified in the NRC staff's initial Draft Safety Evaluation Report (DSER), issued on April 30, 2002. The revised CAR also contains general information about the applicant and information about the ability of the proposed facility to resist natural phenomena and consequences of potential accidents. In support of its revised CAR, DCS had previously submitted several items to the NRC, including a Quality Assurance Plan, Revision 3 (dated March 26, 2002) and a revised Environmental Report (dated July 11, 2002). In this revised DSER, the NRC staff documents its review and conclusions concerning the revised CAR and the other safety-related information submitted by DCS in support of its revised CAR.

Pursuant to 10 CFR Part 70, applicants seeking authorization to construct a plutonium processing and fuel fabrication facility must obtain NRC approval before starting construction. The regulation governing construction, 10 CFR 70.23(b), states that NRC will approve construction of the principal structures, systems and components (PSSCs) of a plutonium processing and fuel fabrication facility if the NRC finds that the design bases of the PSSCs and the quality assurance program provide reasonable assurance of protection against natural phenomena and the consequences of potential accidents.

DESCRIPTION OF THE FACILITY

The MFFF that DCS proposes to build would receive depleted uranium (DU) dioxide (DUO_2) and plutonium dioxide (PuO_2), purify the plutonium dioxide to remove impurities such as gallium and americium, fabricate MOX fuel consisting of uranium and plutonium dioxides, assemble fuel rods and fabricate fuel assemblies. The completed fuel assemblies would be subsequently irradiated in commercial nuclear power plants authorized by the NRC to use MOX fuel. The design of the MFFF is based on aspects of the LaHague and Melox facilities in France.

The site of the proposed MFFF is in F-Area of DOE's SRS in southwest South Carolina near Aiken. The MFFF would be located near the proposed PDCF, a facility which the DOE plans to build and operate. The proposed PDCF would not be under the NRC's jurisdiction. The F-Area is restricted, and there are no unrestricted public roads in the vicinity. Nearby, the principal body of water is the Savannah River, which forms the SRS's southwest boundary. The MFFF site encompasses approximately 41 acres (0.17 km^2), of which, approximately 17 acres (0.07 km^2) would be developed with roads, facilities, or buildings if the revised CAR is approved. No roads, railroads, or waterways now traverse the MFFF site.

The main MFFF building would be the MOX fuel fabrication building. This building would contain all of the plutonium dioxide handling, fuel processing, and fuel fabrication operations of the MFFF. Plans call for a reinforced concrete building having a footprint of approximately 300 feet (91.4 m) by 450 feet (137 m), and this building would be approximately 73 feet (22.3 m) above grade. The MOX fuel fabrication building would have three major functional areas as follows: the MOX processing area, the aqueous polishing (AP) area, and the shipping and receiving area. In the AP area, plutonium dioxide (PuO_2) received from the proposed PDCF and other DOE sources would be purified as referenced above. This PuO_2 would be transported to the shipping and receiving area of the MFFF in approved shipping containers and would be unloaded and inspected in accordance with material control and accounting (MC&A) and radiation protection programs. The MFFF would receive depleted uranium dioxide (DUO_2) at the material receipt area of the secured warehouse building, where it would also be inspected in accordance with MC&A and radiation protection programs. The DUO_2 would be trucked to the shipping and receiving area of the MFFF as needed for processing. After leaving the AP area and entering the MOX processing (MP) area in the main processing building, the purified PuO_2 would then be blended with DU powder and processed into MOX fuel and, ultimately, fuel assemblies. Fresh MOX fuel assemblies would be stored in the assembly storage vault in the MFFF before shipping offsite. For shipping to the candidate commercial power plants, the assemblies would be moved to the shipping and receiving area of the MFFF where they would be loaded into an NRC-approved MOX fresh fuel transportation package, and then loaded onto a secure transport vehicle for transport to the commercial power plants for irradiation.

SAFETY OF THE FACILITY

Potential accidents evaluated by the applicant include loss of confinement of licensed nuclear material, fire, load handling events, explosions, nuclear criticality, natural phenomena events, external man-made events, external exposure, and those related to chemical interactions. The set of natural phenomena hazards identified by the applicant and evaluated by the staff include earthquakes, high wind, tornadoes and tornado-generated missiles, extreme temperatures, rain, snow, ice, lightning, and fires external to the MFFF. For most of the postulated hazards, the applicant has chosen a mitigation strategy, but for the explosion and nuclear criticality hazards, the applicant has chosen a prevention strategy. In revised DSER Chapter 5, the staff reviews the methodology used by the applicant in performing the safety assessment of the facility design bases, to determine if the safety assessment adequately considered all appropriate natural phenomenon, external man-made, and internal process hazards. The NRC staff reviewed the applicant's hazard assessments, the formulation of a safety strategy and the identification of PSSCs to meet the 10 CFR 70.61 performance requirements. To approve the revised CAR, the staff will need to find that the applicant's safety assessment describes an adequate strategy which, if effectively applied, will ensure that the 10 CFR § 70.61 performance requirements will be met, should the facility later be authorized to operate. In Chapter 5 of this draft Safety Evaluation Report, the staff evaluates the hazards that have been addressed by DCS, and finds that most, but not all, of these hazards are adequately controlled by the PSSCs designated by DCS. Issues that remain unresolved include the explosion potential related to tributyl phosphate (i.e., "red oil") and hydroxylamine nitrate (HAN), the adequacy of the criticality safety validation report, the adequacy of fire barriers, and the performance of high efficiency particulate air (HEPA) filters.

A complete list of the unresolved or open items is provided in Appendix A. The open items are discussed in the relevant chapters of the revised DSER. Items that were open in the staff's April 30, 2002, DSER that have since been resolved are discussed in Appendix B.

SUMMARY

The staff concluded in a separate Safety Evaluation Report, and in Chapter 15 of this revised draft Safety Evaluation Report, that the Quality Assurance program at the proposed MOX facility will provide reasonable assurance of protection against natural phenomena and the consequences of potential accidents. The scope of this conclusion pertains to the construction of the facility's principal SSCs, and includes all related design, procurement and fabrication activities, but does not include any start-up testing or operation of the proposed facility.

In the revised DSER, the NRC staff concludes that DCS has not met all of the applicable requirements pertaining to construction of the proposed MFFF. Based on the staff's review of the revised CAR and supporting information provided by the applicant, the staff finds that, due to the open items discussed in the revised DSER, DCS has not met the Baseline Design Criteria (BDC) set forth in 10 CFR 70.64(a). Further, until the open items are closed, the staff cannot conclude, pursuant to 10 CFR 70.23(b), that the design bases of the PSSCs identified by the applicant will provide reasonable assurance of protection against natural phenomena and the consequences of potential accidents.

The revised DSER is a snapshot of the NRC staff's present positions, based on information received to date. The staff's review will continue, and the staff expects to issue a final safety evaluation report on the proposed MFFF construction after evaluating further information to be submitted by DCS.