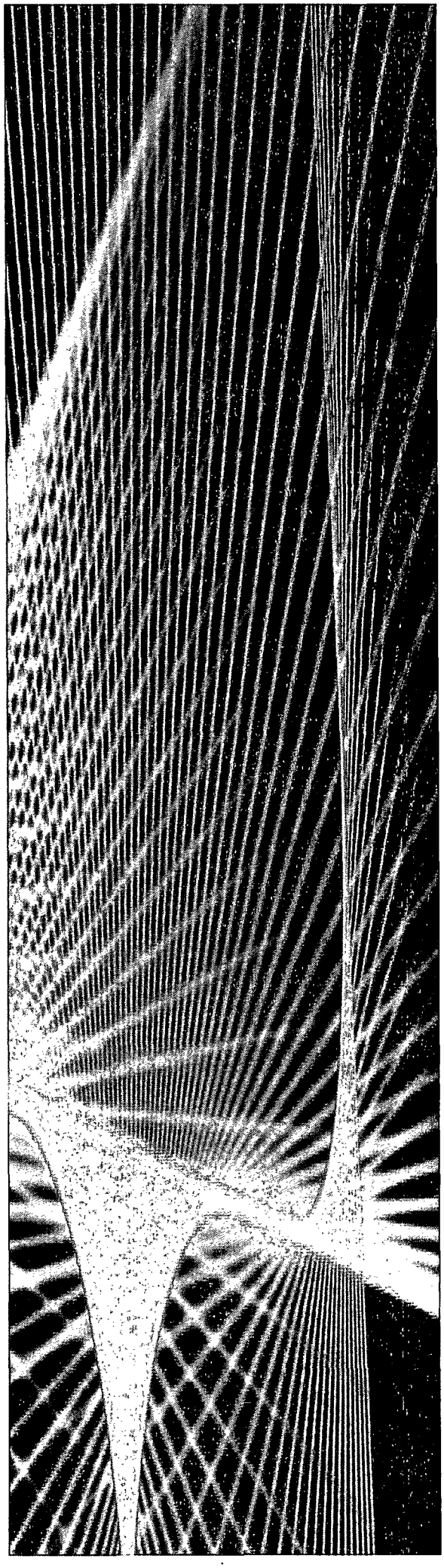
GE-HITACHI GLOBAL LASER ENRICHMENT LLC COMMERCIAL FACILITY

WILMINGTON, NORTH CAROLINA



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ACRONYMS

A/E	Architect/Engineering
ACP	American Centrifuge Plant
AEGL	Acute Exposure Guideline Levels
AEP	Annual Exceedance Probability
ALARA	As Low As Reasonably Achievable
ALI	Annual Limit on Intake
ANS	American Nuclear Society
ANSI	American National Standards Institute
APF	Assigned Protection Factor
AST	Autoclave Surge Tank
ASTM	American Society for Testing and Materials
BDC	Baseline Design Criteria
BOD	Biochemical Oxygen Demand
CAA	Controlled Access Area
CAAS	Criticality Accident Alarm System
CAP	Corrective Action Plan
CBA	Cost-Benefit Analysis
CDE	Committed Dose Equivalent
CEDE	Committed Effective Dose Equivalent
CEO	Chief Executive Officer
CFPM	Commercial Facility Project Manager
CFR	Code of Federal Regulations
CJHA	Chemical Job Hazards Analysis
CM	Configuration Management
CSA	Criticality Safety Analysis
CTPS	Cold Trap Purification System
CY	Calendar Year
DAC	Derived Air Concentration
DFP	Decommissioning Funding Plan
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DP	Decommissioning Plan
ECC	Emergency Control Center
ECF	Entry Control Facility
EDMS	Electronic Document Management System
EHS	Environmental, Health, and Safety
EMT	Emergency Medical Technician
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ER	Environmental Report
ERO	Emergency Response Organization
ERT	Emergency Response Team
ETA	Event Tree Analysis

FCS	Facility Control System
FHA	Fire Hazards Analysis
FMO	Fuel Manufacturing Operation
FNMCP	Fundamental Nuclear Material Control Plan
FOCI	Foreign Ownership, Control, Influence
FPLTF	Final Process Lagoon Treatment Facility
FSRC	Facility Safety Review Committee
FTA	Fault Tree Analysis
FVC	Feed Vaporization Chamber
GE	General Electric Company
GEH	GE-Hitachi Nuclear Energy Americans LLC
GEMER	Geometry Enhanced MERIT
GET	General Employee Training
GLE	GE-Hitachi Global Laser Enrichment LLC
GNF-A	Global Nuclear Fuel – Americas, LLC
HAZOP	Hazards and Operability Analysis
HEGA	High-Efficiency Gas Absorption
HEPA	High-Efficiency Particulate Air
HEU	High-Enriched Uranium
HFCVB	Heated Flow Control Valve Box
HVAC	Heating, Ventilation, and Air Conditioning
IBC	International Building Code
ICEA	Industry Cabling Engineers Association, Inc.
ICRP	International Commission on Radiological Protection
IEEE	Institute of Electrical and Electronics Engineers
IFC	International Fire Code
IROFS	Items Relied on for Safety
ISA	Integrated Safety Analysis
ISAS	Integrated Safety Analysis Summary
ITM	Inspection, Testing, and Maintenance
JHA	Job Hazards Analysis
LA	License Application
LEL	Lower Explosive Limit
LES	Louisiana Energy Services, L.P.
LEU	Low Enriched Uranium
LLMW	Low-Level Mixed Waste
LLRW	Low-Level Radioactive Waste
LTTS	Low Temperature Take-off Station
M&TE	Measuring and Test Equipment
MC&A	Material Control and Accounting
MCA	Moderation Controlled Area
MDC	Minimum Detectable Concentration
MCES	Monitored Central Exhaust System

MMS	Minimum Margin of Subcriticality
MOU	Memorandum of Understanding
MRA	Moderation Restricted Area
MSDS	Material Safety Data Sheet
MSW	Municipal Solid Waste
NC DAQ	North Carolina Division of Air Quality
NC DWQ	North Carolina Division of Water Quality
NCS	Nuclear Criticality Safety
NEF	National Enrichment Facility
NELAC	National Environmental Laboratory Accreditation Conference
NEPA	National Environmental Policy Act
NFPA	National Fire Protection Association
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
NMSS	Nuclear Material Safety and Safeguards
NPDES	National Pollutant Discharge Elimination System
NPH	Natural Phenomena Hazard
NRC	U.S. Nuclear Regulatory Commission
NSI	Nuclear Safety Instruction
NSSL	National Severe Storms Laboratory
NUREG	Nuclear Regulation
NVLAP	National Voluntary Laboratory Accreditation Program
OJT	On-the-Job Training
OSHA	Occupational Safety and Health Administration
OSTV	Onsite Transfer Vehicle
P&ID	Piping and Instrumentation Diagram
PHA	Process Hazards Analysis
PLC	Programmable Logic Controllers
PM	Preventive Maintenance
PMT	Post-Maintenance Testing
PNC	Potential Noncompliance
PPE	Personal Protective Equipment
PRA	Probabilistic Risk Assessment
PSP	Physical Security Plan
QA	Quality Assurance
QAPD	Quality Assurance Program Description
QL	Quality Level
QRA	Quantitative Risk Assessment
RA	Response Agreements
RASCAL	Radiological Assessment System for Consequence Analysis
RC&EP	Radiological Contingency and Emergency Plan
RCA	Radiological Controlled Area
RCRA	Resource Conservation and Recovery Act

RD	Restricted Data
RLETS	Radiological Liquid Effluent Treatment System
RM	Records Management
RP	Radiation Protection
RSA	Radiological Safety Assessements
RSC	Radiation Safety Committee
RWP	Radiation Work Permit
SCA	Sample Containment Autoclave
SEM	Standard Error of Measurements
SFS	Solid Feed Station
SNM	Special Nuclear Material
SPPP	Standard Practice Procedures Plan
SRD	Secret Restricted Data
SSC	System, Structure, and Component
SSLCB	Single-Sided Lower Confidence Band
SSLTB	Single-Sided Lower Tolerance Band
SSLTL	Single-Sided Lower Tolerance Limit
SWU	Separative Work Unit
TEDE	Total Effective Dose Equivalent
TLD	Thermo Luminescent Dosimeters
TSDF	Treatment, Storage, and Disposal Facility
UBC	Uniform Building Code
UIR	Unusual Incident Report
UL	Underwriters Laboratory
UNC-W	University of North Carolina – Wilmington
U.S.	United States
USEC	United States Enrichment Corporation, Inc.
USGS	U.S. Geological Survey
USL	Upper Subcritical Limit
VRCT	Volume Reducing Compressor Train
WFPP	Wilmington Fire Protection Program
WWTF	Waste Water Treatment Facility

^{40}K	potassium-40
^{99}Tc	technetium-99
^{222}Rn	radon-222
^{226}Ra	radium-226
^{232}Th	thorium-232
^{235}U	uranium-235
^{238}U	uranium-238 (depleted ^{235}U)
°F	Fahrenheit
ADU	ammonium diuranate
bgs	below ground surface
Bq	Becquerel
cc	cubic centimeters
CFC	chlorofluorocarbon
Ci	curie
cm	centimeter
cm^2	square centimeters
CO	carbon monoxide
CO_2	carbon dioxide
cP	continental polar
dBa	a-weighted decibels
DCE	cis-1,2 dichloroethylene
dpm	disintegrations per minute
ft	foot
ft^2	square foot
g	gram
gal	gallon
gpd	gallons per day
gpm	gallons per minute
GWe	gigawatt electrical
ha	hectare
HF	hydrogen fluoride
hz	hertz
in	inches

CHEMICALS AND UNITS OF MEASURE

kg	kilogram
km	kilometers
kts	knots
lb	pound
L_{DN}	day-night average sound levels
Lpd	liters per day
m	meter
m^2	square meter
Mg	megagram
mg	milligram
mm	millimeter
mph	miles per hour
mrem	millirem
mrem/yr	millirem per year
msl	mean sea level
mSv	millisievert
mSv/yr	millisievert per year
mT	maritime tropical
MWe	megawatt electrical
NO_2	nitrous oxide
O_3	ozone
Pb	lead
pCi	picocurie
PM	particulate matter
PM_{10}	particulate matter with aerodynamic diameter of 10 µm or less
PM_{25}	particulate matter with aerodynamic diameter of 2.5 µm or less
ppm	parts per million
psi	pound per square inch
PU	Plutonium
scfph	standard cubic feet per hour
sL/m	standard liters per minute
SO_2	sulfur dioxide
Sv	sieverts

TCE	trichloroethylene
TSP	total suspended particulates
TSS	total suspended solids
U_3O_8	triuranium octaoxide
UF_4	uranium tetrafluoride
UF_6	uranium hexafluoride
UO_2	uranium dioxide
UO_2F_2	uranyl fluoride
µCi	micocuries
µm	micrometer
VC	vinyl chloride
wt	weight
yd^3	cubic yard
yr	year

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100-Year Flood – A flood elevation (for a given area) that has a 1 percent chance of being equaled or exceeded each year. Thus, the 100-year flood could occur more than once in a relatively short period of time. The 100-year flood, which is the standard used by most federal and state agencies, is used by the National Flood Insurance Program (NFIP) as the standard for floodplain management and to determine the need for flood insurance. The term 100-year flood is synonymous with the one percent annual chance flood. [FEMA]

500-Year Flood – Refers to the flood elevation for a given area that has a 0.2 percent chance of being equaled or exceeded each year. This term is synonymous with the 0.2 percent annual chance of flood. [FEMA]

Absorbed Dose – The energy imparted by ionizing radiation per unit mass of irradiated material. [10 CFR 20.1003]

Accident Sequence – An unintended sequence of events that, given the failure of certain items relied on for safety (IROFS) identified in the sequence, would result in environmental contamination, radiation exposure, release of radioactive material, inadvertent nuclear criticality, or exposure to hazardous chemicals (provided that the chemicals are produced from licensed radioactive material). The term "accident" may be used interchangeably with "accident sequence." [NUREG-1520]

Act – The Atomic Energy Act of 1954 (68 Stat 919), including any amendments thereto. [10 CFR 70.4]

Active Engineered Control – A physical device that uses active sensors, electrical components, or moving parts to maintain safe process conditions without any required human action. [NUREG-1520]

Administrative Control – Either an augmented administrative control or a simple administrative control. [NUREG-1520]

Airborne Radioactive Material – Radioactive material dispersed in the air in the form of dusts, fumes, particulates, mists, vapors, or gases. [10 CFR 20.1003]

Airborne Radioactivity Area – A room, enclosure, or area in which airborne radioactive materials, composed wholly or partly of licensed material, exist in concentrations in excess of the derived air concentrations (DACs) specified in 10 CFR 20.1001 through 20.2401, Appendix B; or to such a degree that an individual present in the area without respiratory protective equipment could exceed, during the hours an individual is present in a week, an intake of 0.6 percent of the annual limit on intake (ALI) or 12 DAC-hours. [10 CFR 20.1003]

Alert – Events may occur, are in progress, or have occurred that could lead to a release of radioactive material(s) but that the release is not expected to require a response by an offsite response organization to protect persons offsite. [10 CFR 70.4]

Annual Limit on Intake (ALI) – The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by the reference man that would result in a committed effective dose equivalent of five rems (0.05 Sv) or a committed dose equivalent of 50 rems (0.5 Sv) to any individual organ or tissue. (ALI values for intake by ingestion or inhalation of selected radionuclides are given in 10 CFR 20.1001 through 10 CFR 20-2401, Appendix B, Table 1, Columns 1 and 2. [10 CFR 20.1003]

Area Manager – Individual responsible for implementation of nuclear safety requirements in an assigned area. The generic title "Area Manager" does not necessarily refer to the title of any specific position in the GLE organization or position nomenclature. [GLE Definition]

Area of Environmental Concern – Designated by the North Costal Resources Commission within 20 North Carolina counties as areas of natural importance that may be easily destroyed by erosion or floodwater or may have environmental, social, economic, or aesthetic values to the state. [GLE ER]

As Low As Reasonably Achievable (ALARA) – Making every reasonable effort to maintain exposures to radiation as far below the dose limits in 10 CFR 20 as is practical, consistent with the purpose for which the licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and licensed materials in the public interest. [10 CFR 20.1003]

Assessments – An assessment is used to determine the effectiveness of activities in achieving applicant-specified objectives that provide reasonable assurance of the continued availability and reliability of IROFS. [NUREG-1520]

Assigned Protection Factor (APF) – The expected workplace level of respiratory protection that would be provided by a properly functioning respirator or a class of respirators to properly fitted and trained users. Operationally, the inhaled concentration can be estimated by dividing the ambient airborne concentration by the APF. [10 CFR 20.1003]

Audits – An audit is used to monitor compliance with regulatory requirements and license commitments. [NUREG-1520]

Augmented Administrative Control – A procedurally required or prohibited human action, combined with a physical device that alerts the operator that the action is needed to maintain safe process conditions, or otherwise adds substantial assurance of the required human performance. [NUREG-1520]

Available and Reliable to Perform Their Function When Needed – Based on the analyzed, credible conditions in the integrated safety analysis (ISA), items relied on for safety (IROFS) will perform their intended safety function when needed, and management measures will be implemented that ensure compliance with the performance requirements of 10 CFR 70.61, considering factors such as necessary maintenance, operating limits, common-cause failures, and the likelihood and consequences of failure or degradation of the times and measures. [10 CFR 70.4]

Background Radiation – Radiation from cosmic sources; naturally occurring radioactive material, including radon (except as a decay product of source or special nuclear material; and global fallout as it exists in the environment from the testing of nuclear explosive devices or from past nuclear accidents such as Chernobyl, that contribute to background radiation and are not under the control of the licensee. "Background Radiation" does not included radiation from source, byproduct, or special nuclear materials regulated by the U.S. Nuclear Regulatory Commission. [10 CFR 20.1003]

Baseline Design Criteria – A set of criteria specifying design features and management measures that are required and acceptable under certain conditions for new processes or facilities specified in 10 CFR 70.64. In general, these criteria are the acceptance criteria that apply to safety design for new facilities and new processes. [NUREG-1520]

Bias – The systematic difference between calculated results and experimentally measured values of k_{eff} for a fissile system. [GLE Definition]

Bias Uncertainty – The integrated uncertainty in experimental data, calculational methods, and models, estimated by a valid statistical analysis of calculated k_{eff} values for critical experiments. [GLE Definition]

Bioassay (Radiobioassay) – The determination of kinds, quantities or concentrations, and in some cases, the locations of radioactive material in the human body, whether by direct measurement (in vivo counting) or by analysis and evaluation of materials excreted or removed from the human body. [10 CFR 20.1003]

Collective Dose – The sum of the individual doses received in a given period of time by a specified population from exposure to a specified source of radiation. [10 CFR 20.1003]

Commencement of Construction – Any clearing of land, excavation, or other substantial action that would adversely affect the natural environment of a site but does not include changes desirable for the temporary use of the land for public recreational uses, necessary borings to determine site characteristics or other preconstruction monitoring to establish background information related to the suitability of a site or to the protection of environmental values. [10 CFR 70.4]

Commercial Grade Item or Service – An item or service that: (1) is not subject to design or specification requirements that are unique to nuclear facilities; (2) is used in applications other than nuclear facilities; and (3) is to be ordered from the manufacturer/supplier on the basis of a specification set forth in the manufacturer's published product description (for example, catalog). [GLE Definition]

Configuration Management (CM) – A management measure that provides oversight and control of design information, safety information, and records of modifications (both temporary and permanent) that might impact the ability of items relied on for safety to perform their functions when needed. [10 CFR 70.4]

Consequence – Any result of interest caused by an event or sequence of events. In this context, "adverse consequence" refers to adverse health or safety effects on either workers, the public, or the environment. [NUREG-1520]

Constraint – A value above which specified licensee actions are required. [10 CFR 20.1003]

Contractor Personnel – All persons who are not GLE/GEH/GNF employees, active pensioners, or variable workers. Contract Workers have been contracted to provide a service or activity for GE. [GLE Definition]

Controlled Area – An area, outside of a restricted area but inside the site boundary, access to which can be limited by the licensee for any reason. [10 CFR 20.1003]

Controlled Parameter – A measurable parameter that is maintained within a specified range by one or more specific controls to ensure the safety of an operation. [NUREG-1520]

Corrective Action – A measure taken to rectify significant conditions adverse to quality and to preclude repetition. [GLE Corrective Action Procedure]

Critical Mass of Special Nuclear Material – Special nuclear material in a quantity exceeding 700 grams of contained ^{235}U; 520 grams of ^{233}U; 450 grams of plutonium; 1500 grams of contained ^{235}U; if no uranium enriched to more than four percent by weight of ^{235}U is present; 450 grams of any combination thereof; or one-half such quantities if massive moderators or reflectors made of graphite, heavy water, or beryllium may be present. [10 CFR 70.4]

Declared Pregnant Woman – A woman who has voluntarily informed the licensee, in writing, of her pregnancy and the estimated date of conception. The declaration remains in effect until the declared pregnant woman withdraws the declaration in writing or is no longer pregnant. [10 CFR 20.1003]

Decommission – To remove a facility or site safety from service and reduce residual radioactivity to a level that permits: (1) release of the property for unrestricted use and termination of the license; or (2) release of the property under restricted conditions and termination of the license. [10 CFR 70.4]

Dedication Process – Process to provides reasonable assurance that a commercial grade item or service will perform its intended function when used in an application that is important to safety. [GLE Definition]

Derived Air Concentration (DAC) – The concentration of a given radionuclide in air which, if breathed by the reference man for a working year of 2,000 hours under conditions of light work (inhalation Rate 1.2 cubic meters of air per hour), results in an intake of one ALI. DAC values are given in 10 CFR 20.1001 through 20.2401, Appendix B, Table 1, Column 3. [10 CFR 20.1003]

Derived Air Concentration-Hour (DAC-Hour) – The product of the concentration of radioactive material in air (expressed as a fraction or multiple of the DAC for each radionuclide) and the time of exposure to that radionuclide, in hours. A licensee may take 2,000 DAC-hours to represent one ALI, equivalent to a committed effective dose equivalent of five rems (0.05 Sv). [10 CFR 20.1003]

Double Contingency Principle – Process designs should incorporate sufficient factors of safety to require at least two unlikely, independent, and concurrent changes in process conditions before a criticality accident is possible. [10 CFR 70.4]

Double Contingency Protection – A characteristic or attribute of a process that has incorporated sufficient safety factors to that at least two unlikely, independent, and concurrent changes in process conditions are required before a nuclear criticality accident is possible. [NUREG-1520]

Effective Dose Equivalent – The sum of the products of the dose equivalent to the body organ or tissue and the weighting factors applicable to each of the body organs or tissues that are irradiated. Weighting factors are: 0.25 for gonads; 0.15 for breast; 0.12 for red bone marrow; 0.12 for lungs, 0.03 for thyroid; 0.03 for bone surface, and 0.06 for each of the other five organs receiving the highest dose equivalent. [10 CFR 70.4]

Effective Kilograms of Special Nuclear Material – (1) For plutonium and ^{233}U, their weight in kilograms; (2) For uranium with an enrichment in the isotope ^{235}U of 0.01 (one percent) and above, its element weight in kilograms multiplied by the square of its enrichment expressed as a decimal weight fraction; and (3) For uranium with an enrichment in the isotope ^{235}U below 0.01 (one percent), by its element weight in kilograms multiplied by 0.0001. [10 CFR 70.4]

Engineered Control – See active engineered control or a passive engineered control. [NUREG-1520]

Entrance or Access Point – Any location through which an individual could gain access to radiation areas or to radioactive materials. This includes entry or exit portals of sufficient size to permit human entry, irrespective of their intended use. [10 CFR 20.1003]

Exposure – Being exposed to ionizing radiation or to radioactive materials. [10 CFR 20.1003]

External Dose – The portion of the dose equivalent received from radiation sources outside the body. [10 CFR 20.1003]

External Event – An event for which the likelihood cannot be altered by changes to the regulated facility or its operation. This would include all natural phenomena events, plus airplane crashes, explosions, toxic releases, fires, etc., occurring near or on the plant site. [NUREG-1520]

GLE Commercial Facility – The structures, systems, and components that comprise the GLE Site infrastructure established to support the enrichment processing and support operations. The GLE Commercial Facility includes the Operations Building, multiple administrative and support buildings or areas, a parking lot, retention basins, cylinder storage pads, and connecting roadways. A cleared security buffer surrounds the entire GLE Commercial Facility and defines both the Restricted Area and the Protected Area of the facility. [GLE Definition]

GLE Site – The approximate 100 acres of land upon which the GLE Commercial Facility is built. [GLE Definition]

GLE Study Area – The area of the Wilmington Site evaluated in the GLE Environmental Report which includes the GLE Site as well as additional land surrounding the GLE Site. [GLE Definition]

Hazardous Chemicals Produced from Licensed Materials – Substances having licensed material as precursor compound(s) or substances that physically or chemically interact with licensed materials; and that are toxic, explosive, flammable, corrosive, or reactive to the extent that they can endanger life or health if not adequately controlled. These include substances commingled with licensed material, and include substances such as hydrogen fluoride that is produced by the reactor of uranium hexafluoride and water, but do not include substances prior to process addition to licensed material or after process separation from licensed material. [10 CFR 70.4]

High Radiation Area – An area, accessible to individuals, in which radiation levels from radiation sources external to the body could result in an individual receiving a dose equivalent in excess of 0.1 rem (1 mSv) in one hour at 30 centimeters from the radiation source or 30 centimeters from any surface that the radiation penetrates. [10 CFR 20.1003]

Individual Monitoring – (1) The assessment of dose equivalent by the use of devices designed to be worn by an individual; (2) The assessment of committed effective dose equivalent by bioassay or by determination of the time-weighted air concentrations to which an individual has been exposed; or (3) The assessment of dose equivalent by the use of survey data. [10 CFR 20.1003]

Individual Monitoring Devices – Devices designed to be worn by a single individual for the assessment of dose equivalent such as film badges, thermo luminescence dosimeters (TLDs), pocket ionization chambers, and personal ("lapel") air sampling devices. [10 CFR 20.1003]

Integrated Safety Analysis (ISA) – A systematic analysis to identify facility and external hazards and their potential for initiating accident sequences, the potential accident sequences, their likelihood and consequences, and the items relied on for safety. As used here, integrated means joint consideration of, and protection from, all relevant hazards, including radiological, nuclear criticality, fire, and chemical. However, with respect to compliance with the regulations of this part, the NRC requirement is limited to consideration of the effects of all relevant hazards on radiological safety, prevention of nuclear criticality accidents, or chemical hazards directly associated with NRC licensed radioactive material. An ISA can be performed process by process, but all processes must be integrated, and process interactions considered. [10 CFR 70.4]

Integrated Safety Analysis (ISA) Summary – A document or documents submitted with the license application, license amendment application, license renewal application, or pursuant to 10 CFR 70.62(c)(3)(ii) that provides a synopsis of the results of the integrated safety analysis and contains the information specified in 10 CFR 70.65(b). The ISA Summary can be submitted as one document for the entire facility, or as multiple documents that cover all portions and processes of the facility. [10 CFR 70.4]

Internal Dose – The portion of the dose equivalent received from radioactive material taken into the body. [10 CFR 20.1003]

Items Relied on for Safety (IROFS) – Structures, systems, equipment, components, and activities of personnel that are relied on to prevent potential accidents at a facility that could exceed the performance requirements in 10 CFR 70.61 or to mitigate their potential consequences. This does not limit the licensee from identifying additional structures, systems, equipment, components, or activities of personnel (i.e., beyond those in the minimum set necessary for compliance with the performance requirements) as items relied on for safety. [10 CFR 70.4] All safety controls, as defined in NUREG-1520, are IROFS.

Licensed Material – Source material, special nuclear material, or byproduct material received, possessed, used, transferred, or disposed of under a general or specific license issued by the U.S. Nuclear Regulatory Commission. [10 CFR 20.1003]

Licensee – Holder of a license from the U.S. Nuclear Regulatory Commission. [10 CFR 20.1003]

Limits – The permissible upper bounds of radiation doses. [10 CFR 20.1003]

Line Management – Managers who are charged with the administration of a group of people having a common organizational function. Line Managers are responsible for the assigned organization's output. [GLE Definition]

Management Measures – The functions performed by the licensee, generally on a continuing basis, that are applied to items relied on for safety, to ensure the items are available and reliable to perform their functions when needed. Management measures include Configuration Management, Maintenance, Training and Qualifications, Procedures, Audits and Assessments, Incident Investigations, Records Management, and other Quality Assurance elements. [10 CFR 70.4]

Member of the Public – Any individual except when that individual is receiving an occupational dose. [10 CFR 20.1003]

Minimum Margin of Subcriticality (MMS) – An allowance for any unknown (or difficult to identify or quantify) errors or uncertainties in the method of calculating k_{eff}, that may exist beyond those which have been accounted for explicitly in calculating bias and bias uncertainty. [GLE Definition]

Mitigative Control – A control intended to reduce the consequence of an accident sequence, not to prevent it. When a mitigative control works as intended, the results of the sequence are called the mitigated consequences. [NUREG-1520]

Monitoring (Radiation Monitoring) – The measurement of radiation levels, concentrations, surface area concentrations or quantities of radioactive material and the use of the results of these measurements to evaluate potential exposures and doses. [10 CFR 20.1003]

Natural Phenomena Event – Earthquakes, floods, tornadoes, tsunamis, hurricanes, and other events that occur in the natural environment and could adversely affect safety. Natural phenomena events may be credible or incredible, depending on their likelihood of occurrence. [NUREG-1520]

New Processes at Existing Facilities – Systems-level or facility-level design changes to processes equipment, process technology, facility layout, or types of licensed material possessed or used. Generally, this definition does not include component-level design changes or equipment replacement. [NUREG-1520]

Occupational Dose – The dose received by an individual in the course of employment in which the individual's assigned duties involve exposure to radiation or to radioactive material from licensed and unlicensed sources of radiation, whether in the possession of the licensee or other person. Occupational dose does not include doses received from background radiation, from any medical administration the individual has received, from exposure to the individuals administered radioactive material and released under 10 CFR 35.75, from voluntary participation in medical research programs, or as a member of the public. [10 CFR 20.1003]

Out-of-Specification Cylinder – A cylinder that contains material that is outside of a design specification parameter or cylinder design parameters (capacity, volume, enrichment, wall thickness, etc.) [GLE Definition]

Over-Filled Cylinder – A cylinder that contains more than the design capacity/volume of material. [GLE Definition]

Passive Engineered Control – A device that uses only fixed physical design features to maintain safe process conditions without any required human action. Assurance is maintained through specific periodic inspections or verification measurement(s), as appropriate. [NUREG-1520]

Plutonium Processing and Fuel Fabrication Plant – A plant in which the following operations or activities are conducted: (1) Operations for manufacture of reactor fuel containing plutonium including any of the following: (i) preparation of fuel material; (ii) formation of fuel material into desired shapes; (iii) application of protective cladding; (iv) recovery of scrap material; and (v) storage associated with such operations; or (2) Research and development activities involving any of the operations described in Paragraph (1) of this definition except for research and development activities utilizing unsubstantial amounts of plutonium. [10 CFR 70.4]

Preventive Control – A control intended to prevent an accident (such as, any of the radiological or chemical consequences described in 10 CFR 70.61. [NUREG-1520]

Procedure – A document that specifies or describes how an activity is to be performed. [GLE Definition]

Protected Area – An area encompassed by physical barriers and to which access is controlled. [10 CFR 73.2]

Public Dose – The dose received by a member of the public from exposure to radiation or to radioactive material released by a licensee, or to any other source of radiation under the control of a licensee. Public dose does not include occupational dose or doses received from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released under 10 CFR 35.75, or from voluntary participation in medical research programs. [10 CFR 20.1003]

Qualitative Fit Test (QLFT) – A pass/fail fit test to assess the adequacy of respirator fit that relies on the individual's response to the test agent. [10 CFR 20.1003]

Quantitative Fit Test (QNFT) – An assessment of the adequacy of respirator fit by numerically measuring the amount of leakage into the respirator. [10 CFR 20.1003]

Radiation (Ionizing Radiation) – Alpha particles, beta particles, gamma rays, x-rays, neutrons, high-speed electronics, high-speed protons, and other particles capable of producing ions. Radiation does not include non-ionizing radiation, such as radio-waves or microwaves, or visible, infrared, or ultraviolet light. [10 CFR 20.1003]

Radiation Area – An area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem (0.05 mSv) in one hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates. [10 CFR 20.1003]

Radiological Controlled Area (RCA) – An area to which access is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials. For regulatory purposes, a radiological controlled area is equivalent to a restricted area, as defined in 10 CFR 20.1003.

Research and Development – (1) Theoretical analysis, exploration, or experimentation; or (2) The extension of investigative finding and theories of a scientific or technical nature into practical application for experimental and demonstration purposes, including the experimental production and testing of models, devices, equipment, materials, and processes. [10 CFR 70.4]

Residual Radioactivity – Radioactivity in structure, materials, soils, groundwater, and other media at a site resulting from activities under the licensee's control. This includes radioactivity from all licensed and unlicensed sources used by the licensee, but excludes background radiation. It also includes radioactive materials remaining at the site as a result of routine or accident releases of radioactive material at the site and previous burials at the site, even if those burials were made in accordance with the provisions of 10 CFR 20. [10 CFR 20.1003]

Respiratory Protective Device – An apparatus, such as a respirator, used to reduce the individual's intake of airborne radioactive materials. [10 CFR 20.1003]

Restricted Area – An area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials. Restricted area does not include areas used as residential quarters, but separate rooms in a residential building may be set apart as a restricted area. [10 CFR 20.1003]

Restricted Data – All data concerning (1) design, manufacture, or utilization of atomic weapons; (2) the production of special nuclear material; or (3) the use of special nuclear material in the production of energy, but shall not include data declassified or removed from the Restricted Data category pursuant to Section 142 of the Act. [10 CFR 70.4]

Safety Control – A system, device, or procedure that is intended to regulate a device, process, or human activity to maintain a safe state. Controls may be engineered controls or administrative (procedural) controls, and may be either preventive or mitigative. All safety controls are IROFS. [NUREG-1520]

Sanitary Sewerage – A system of public sewers for carrying off waste water and refuse, but excluding sewage treatment facilities, septic tanks, and leach fields owned or operated by the licensee. [10 CFR 20.1003]

Sealed Source – Any special nuclear material that is encased in a capsule designed to prevent leakage or escape of the special nuclear material. [10 CFR 70.4]

Simple Administrative Control – A procedural human action that is prohibited or required to maintain safe process conditions. [NUREG-1520]

Single-Sided Lower Confidence Band (SSLCB): Estimates bias uncertainty to ensure, at a 95% level of confidence, a future calculation of k_{eff} for a critical system or process is actually above the lower confidence limit. The SSLCB may be used when there is a clear trend in the calculated critical benchmark results. [GLE Definition]

Single-Sided Lower Tolerance Band (SSLTB): Estimates the bias uncertainty to ensure, at a 95% level of confidence, at least 95% of future calculations of k_{eff} for critical systems or processes are actually above the lower tolerance limit. The SSLTB may be used when there is a clear trend in the calculated critical benchmark results. [GLE Definition]

Single-Sided Lower Tolerance Limit (SSLTL): Estimates the bias uncertainty to ensure, at a 95% level of confidence, at least 95% of future calculations of k_{eff} for critical systems or processes are actually above the lower tolerance limit. The SSLTL is used when there are no trends apparent in the calculated critical benchmark results. [GLE Definition]

Site Area Emergency – Events may occur, are in progress, or have occurred that could lead to a significant release of radioactive material and that could require a response by offsite response organization to protect persons offsite. [10 CFR 70.4]

Site Boundary – The line beyond which the land or property is not owned, leased, or otherwise controlled by the licensee. [10 CFR 20.1003] For the GLE Commercial Facility, the Site Boundary is coincident with the Wilmington Site boundary.

Source Material – (1) Uranium or thorium or any combination of uranium and thorium in any physical or chemical form; or (2) Ores that contain, by weight, one-twentieth of one percent (0.05 percent), or more, of uranium, thorium, or any combination of uranium and thorium. Source material does not include special nuclear material. [10 CFR 20.1003]

Special Nuclear Material (SNM) – (1) Plutonium, ^{233}U, uranium enriched in the Isotope 233 or in the Isotope 235, and any other material which the Commission, pursuant to the provisions of Section 51 of the Atomic Energy Act, determines to be special nuclear material, but does not include source material; or (2) Any material artificially enriched by any of the foregoing but does not include source material. [10 CFR 70.4]

Special Nuclear Material of Low Strategic Significance – (1) Less than an amount of special nuclear material of moderate strategic significance as defined in Paragraph (1) of the definition of strategic nuclear material of moderate strategic significance, but more than 15 grams of ^{235}U (contained in uranium enriched to 20 percent or more in ^{235}U isotope) or 15 grams of ^{233}U or 15 grams of plutonium or the combination of 15 grams when computed by the equation, grams = (grams contained ^{235}U) + (grams plutonium) + (grams ^{233}U); or (2) Less than 10,000 grams but more than 1,000 grams of ^{235}U (contained in uranium enriched to 10 percent or more but less than 20 percent in the ^{235}U isotope); or (3) 10,000 grams or more of ^{235}U (contained in uranium enriched above natural but less than 10 percent in the ^{235}U isotope). This class of material is sometimes referred to as a Category III quantity of material. [10 CFR 70.4]

Special Nuclear Material of Moderate Strategic Significance – (1) Less than a formula quantity of strategic special nuclear material but more than 1,000 grams of ^{235}U (contained in uranium enriched to 20 percent or more in the ^{235}U isotope) or more than 500 grams of ^{233}U or plutonium, or in a combined quantity of more than 1,000 grams when computed by the equation, grams = (grams contained ^{235}U) + 2 (grams ^{233}U + grams plutonium); or (2) 10,000 grams or more of ^{235}U (contained in uranium enriched to 20 percent or more in the ^{235}U isotope), ^{233}U, or plutonium. This class of material is sometimes referred to as a Category II quantity of material. [10 CFR 70.4]

Special Nuclear Material Scrap – The various forms of special nuclear material generated during chemical and mechanical processing, other than recycle material and normal process intermediates, which are unsuitable for use in their present form, but all or part of which will be used after further processing. [10 CFR 70.4]

Strategic Special Nuclear Material – ^{235}U (contained in uranium enriched to 20 percent or more in ^{235}U isotope), ^{233}U, or plutonium. [10 CFR 70.4]

Survey (Radiological) – An evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or their sources of radiation, When appropriate, such an evaluation includes a physical survey of the location of radioactive material and measurements or calculations of levels of radiation, or concentrations or quantities of radioactive material present. [10 CFR 20.1003]

Tail Cylinder – A 48-inch, UF_6 cylinder that contains less than 0.72 percent weight ^{235}U material. [GLE Definition]

Total Effective Dose Equivalent – Means the sum of the effective dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures). [10 CFR 20.1003]

Unacceptable Performance Deficiencies – Deficiencies in the items relied on for safety or the management measures that need to be corrected to ensure an adequate level of protection as defined in 10 CFR 70.61(b), (c), or (d). [10 CFR 70.4]

Unrestricted Area – An area, access to which is neither limited nor controlled by the licensee. [10 CFR 20.1003]

Uranium Enrichment Facility – (1) Any facility used for separating the isotopes of uranium or enriching uranium in the Isotope 235, except laboratory scale facilities designed or used for experimental or analytical purposes only; (2) Any equipment or device, or important component part especially designed for such equipment or device, capable of separating the isotopes or uranium or enriching uranium in the Isotope 235. [10 CFR 70.4]

Very High Radiation Area – An area, accessible to individuals, in which radiation levels from radiation sources external to the body could result in an individual receiving an absorbed dose in excess of 500 rads (five grays) in one hour at one meter from a radiation source or one meter from any surface that the radiation penetrates. [10 CFR 20.1003]

Waste – Those low-level radioactive wastes containing source, special nuclear, or byproduct material that are acceptable for disposal in a land disposal facility. For the purposes of this definition, low-level radioactive waste means radioactive waste not classified as high-level radioactive waste, transuranic waste, spent nuclear fuel, or byproduct material. [10 CFR 20.1003]

Wilmington Site – The approximately 1600 acre GE property located in Wilmington, NC, where various nuclear and non-nuclear industrial facilities are located, including the GLE Commercial Facility. [GLE Definition]

Worker – An individual who receives an occupational dose as defined in 10 CFR 20.1003. [10 CFR 70.4]

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1. GENERAL INFORMATION

This application requests a license from the U.S. Nuclear Regulatory Commission (NRC) to possess and use source material, special nuclear material (SNM), and byproduct material to construct and operate a commercial uranium enrichment facility. This application is filed by the GE-Hitachi Global Laser Enrichment LLC (GLE). GLE is requesting a license for a period of 40 years.

This chapter provides an overview of the GLE Commercial Facility. The facility enriches uranium for use in the manufacturing of nuclear fuel used in commercial power plants. This chapter provides a description of the facility and enrichment process along with a description of the GLE Site. Institutional information is provided to identify the applicant, describe the applicant's financial qualifications, and describe the proposed licensed activities.

This license application (LA) is being submitted pursuant to the following:

- Atomic Energy Act of 1954, as amended (Ref. 1-1),
- 10 CFR 70, Domestic Licensing of Special Nuclear Material (Ref. 1-2),
- 10 CFR 40, Domestic Licensing of Source Material (Ref. 1-3), and
- 10 CFR 30, Rules of General Applicability to Domestic Licensing of Byproduct Material (Ref. 1-4).

1.1 FACILITY AND PROCESS DESCRIPTION

This section provides an overview of the GLE Site, the GLE Commercial Facility layout, and a summary of the GLE enrichment process.

1.1.1 Facility Location

The GLE Commercial Facility is located on an existing General Electric Company (GE) industrial site in Wilmington, North Carolina (herein referred to as the Wilmington Site). The Wilmington Site is a 1621-acre tract of land, located west of North Carolina Highway 133 (also known as Castle Hayne Road). The Wilmington Site lies between latitudes (North) 34° 19' 4.0"and 34° 20' 28.9" and longitudes (West) 77° 58' 16.4" and 77° 55' 19.8", and is approximately six miles north of the City of Wilmington in New Hanover County, North Carolina (see Figure 1-1, *Wilmington Site and County Location*, and Figure 1-2, *Wilmington Site, New Hanover County, and Other Adjacent Counties*). The Wilmington Site is also the GLE "controlled area" (or "owner controlled area") for the purpose of meeting the requirements of 10 CFR 70.61(f), *Performance Requirements (Ref. 1-5)*.

The GLE Commercial Facility is located on approximately 100 acres of the Wilmington Site. In addition to the GLE Commercial Facility, the Wilmington Site contains the following GE facilities (see Figure 1-3, *Wilmington Site*):

- Global Nuclear Fuel – Americas, LLC (GNF-A) Fuel Manufacturing Operations (FMO) facility operated under the NRC SNM License-1097 *(Ref. 1-6)*;
- Wilmington Field Service Center (WFSC) in which used reactor control rod drive mechanisms are decontaminated, refurbished, and temporarily stored;
- GE Aircraft Engines (AE) facility which is not involved in nuclear fuel manufacturing operations;
- GE Services Components Operation (SCO) facility in which non-radioactive reactor components are manufactured;
- Fuel Components Operation (FCO) facility in which non-radioactive components for reactor fuel assemblies are manufactured; and
- Miscellaneous administrative and support buildings and site infrastructure such as roads and parking lots.

To the east of the Wilmington Site border is North Carolina Highway 133 and some commercially and residentially developed properties. Located to the east of North Carolina Highway 133, is a GE-owned 24-acre parcel that is undeveloped except for a GE employee park and a leased portion of property used as a transportation terminal. To the southwest of the Wilmington Site border is the Northeast Cape Fear River.

The majority of the north, northwest, and south perimeters are undeveloped forestlands. A small segment (approximately 1,000-feet of the north property line) borders the Wooden Shoe residential subdivision. A portion of the south property line is bordered by Interstate Highway 140 (otherwise known as the Wilmington Bypass). Residential properties are located directly south of the Wilmington Bypass.

The surrounding terrain is typical of coastal North Carolina with an elevation averaging less than 40 feet above mean sea level (msl). The terrain is characterized as gently rolling terrain consisting of forest, rivers, creeks, and swamps/marshlands.

1.1.2 Facility Description

The GLE Commercial Facility is shown on Figure 1-4, *GLE Commercial Facility Site Plan*. The GLE Commercial Facility includes the Operations Building where the enrichment processing systems and enrichment processing support systems are contained, several administrative and support buildings, a parking lot, retention basins, uranium hexafluoride (UF_6) cylinder pads, and connecting roadways. A cleared security buffer surrounds the entire GLE Commercial Facility and defines both the Restricted Area and the Protected Area of the facility. The major structures and areas of the facility are described below.

1.1.2.1 GLE Operations Building

The overall layout of the Operations Building is shown in Figure 1-4. The Operations Building includes the following process and support areas:

- Cylinder Shipping and Receiving Area,
- UF_6 Feed and Vaporization Area,
- Product Withdrawal Area,
- Tails Withdrawal Area,
- Cascade/Gas Handling Area,
- Blending Area,
- Sampling Area,
- Radioactive Waste Area,
- Heating, Ventilation, and Air Conditioning (HVAC) Equipment Area,
- Decontamination/Maintenance Area,
- Laboratory Area, and
- Laser Area.

The main process and support areas of the Operations Building and the associated operations are described below.

1.1.2.1.1 Cylinder Shipping and Receiving Area

The Cylinder Shipping and Receiving Area contains the necessary equipment to perform the following functions:

- Receive 30- and 48-inch cylinders from offsite;
- Weigh cylinders and perform other material control and radiological functions during receiving and when preparing for storage or offsite shipment;
- Provide interim storage of cylinders inside the Operations Building;
- Prepare cylinders and transfer them to onsite transfer vehicles (OSTVs) for transfer between the Operations Building and the UF_6 Cylinder Pads;
- Provide interim storage of product, feed, and sample/blend cylinders;

- Prepare cylinders and transfer them to OSTVs for transfer to other process areas within the Operations Building;
- Prepare product cylinders for offsite shipment and intra-site transfer; and
- Prepare 48-inch tails and heel cylinders for offsite shipment.

UF_6 feed is received at the GLE Commercial Facility in American National Standards Institute (ANSI) N14.1-compliant UF_6 cylinders on semi-trailer trucks, typically with one full 48-inch cylinder per shipping trailer. A compliant 48-inch feed cylinder contains a maximum of 12,501 kg of UF_6 *(Ref: 1-7)*.

When UF_6 cylinders are received at the GLE Commercial Facility, the cylinders are inspected, verified, and processed per approved written Operations, Security, and Radiation Protection (RP) procedures. Empty 30- and 48-inch cylinders are also received at the GLE Commercial Facility.

At the Cylinder Shipping and Receiving Area, cylinders are off-loaded and transferred to an adjacent weighing and scanning area. After acceptance, feed cylinders are moved to an interim cylinder storage area inside the Cylinder Shipping and Receiving Area. From the interim cylinder storage area, feed cylinders may be moved to a feed station to begin processing, or to the In-Process Pad. An overhead bridge crane and transfer cart are used to handle the UF_6 cylinders.

Source material is used in this area.

1.1.2.1.2 UF_6 Feed and Vaporization Area

The UF_6 Feed and Vaporization Area contains the necessary equipment to perform the following operations:

- Receive UF_6 feed cylinders from the Cylinder Shipping and Receiving Area;
- Purge the light gases contained within the feed cylinders;
- Capture the light gases for disposal;
- Vaporize the UF_6 contained within the feed cylinders;
- Feed the vaporized UF_6 to the feed header between the Vaporization Area and the Cascade/Gas Handling Area within the Operations Building;
- Maintain design basis UF_6 feed rates to the feed header within the design basis temperature and pressure range; and
- Recover residual UF_6 from the feed cylinders to meet U.S. Department of Transportation (DOT) offsite cylinder shipping requirements for empty cylinders.

The UF_6 Feed and Vaporization Area is divided into feed vaporization chambers (FVCs). Each of the FVCs typically contains: solid feed stations (SFS) to vaporize the UF_6 feed; a cold trap purification station (CTPS) to remove light gases from the feed stream; a low temperature take-off station (LTTS) to remove feed cylinder UF_6 down to heel quantities; and a heated flow control valve box (HFCVB) for each SFS that contains the valves and pipe connections from each SFS.

Source material and SNM are used in this area.

1.1.2.1.3 Product Withdrawal Area

The Product Withdrawal Area contains the necessary equipment to perform the following functions:

- Receive empty UF_6 cylinders from interim storage within the Cylinder Shipping and Receipt Area;
- Maintain design basis UF_6 product withdrawal rates from the Cascade main discharge header;
- Separate the light gases from the UF_6 for disposal; and
- Provide filled 30- and 48-inch cylinders with ≤ 8.00 wt% ^{235}U for interim storage and later disposition.

The Product Withdrawal Area contains: volume reducing compressor trains (VRCTs) that move UF_6 product material from the Cascade/Gas Handling System to the product Withdrawal Stations; LTTSs to collect the UF_6 product material; a CTPS to remove non-condensable light gases from the product stream; and a HFCVB for each LTTS that contains the valves and pipe connections from each LTTS.

Source material and SNM are used in this area.

1.1.2.1.4 Tail Withdrawal Area

The Tail Withdrawal Area contains the necessary equipment to perform the following functions:

- Receive empty UF_6 cylinders from interim storage within the Cylinder Shipping and Storage Area;
- Maintain design-basis UF_6 tails withdrawal rates from the enrichment system main discharge header;
- Separate the light gases from the UF_6 for disposal; and
- Provide filled UF_6 cylinders with ≤ 0.72 wt% ^{235}U for interim storage and later disposition.

The Tail Withdrawal Area contains: VRCTs that move UF_6 tails from the Cascade/Gas Handling System to the Tail Withdrawal Stations; LTTSs to collect the UF_6 tails material; a CTPS to remove non-condensable light gases from the tails stream; and a HFCVB for each LTTS that contains the valves and pipe connections from each LTTS.

Source material is used in this area.

1.1.2.1.5 Cascade/Gas Handling Area

The Cascade/Gas Handling Area contains the equipment necessary to perform the laser-based enrichment process. The UF_6 gas is exposed to laser-emitted light and two process streams are generated; one enriched in ^{235}U and one depleted in ^{235}U.

Technical details of the GLE laser-based enrichment process are proprietary, subject to export control by U.S. laws and regulations, and in many cases may also fall into the categories of security-related, safeguards, or classified information, access to which is further limited per U.S. laws and regulations.

Source material and SNM are used in this area.

1.1.2.1.6 Blending Area

The Blending Area contains the necessary equipment to perform the following functions:

- Receive 30- or 48-inch donor cylinders from interim storage within the Cylinder Shipping and Receiving Area;
- Purge the light gases contained within the cylinders;
- Capture the light gases for disposal;
- Vaporize the UF_6 contained within the donor cylinders;
- Feed the vaporized UF_6 to receiver cylinders;
- Recover residual UF_6 from the donor cylinders to meet DOT cylinder shipping requirements for empty cylinders; and
- Provide empty donor cylinders and filled receiver cylinders for interim storage.

The Blending Area contains blending donor stations (which are similar to the SFS) and blending receiver stations (which are similar to the product withdrawal LTTS) described under the Product Withdrawal Area above.

SNM is used in this area.

1.1.2.1.7 Sampling Area

The Sampling Area contains the necessary equipment to perform the following functions:

- Receive filled UF_6 cylinders from interim storage within the Cylinder Shipping and Receipt Area;
- Purge the light gases contained within the cylinders;
- Capture the reactive light gases for disposal and vent the nonreactive light gases;
- Homogenize and sample the UF_6 contained within the cylinders; and
- Maintain design basis UF_6 cylinder rates to support a six million separative work unit (SWU) facility.

The function of the product liquid sampling system is to obtain an assay sample from filled product cylinders. The sample is used to validate the enrichment level of UF_6 in the filled product cylinders before the cylinders are sent to the fuel processor. This is the only system in the GLE Commercial Facility that converts solid UF_6 to liquid UF_6.

The Sampling Area contains: sample containment autoclaves (SCAs) to support liquefaction, sampling, and solidification of UF_6 in the cylinders; CTPS to remove light gases vented from the cylinders being sampled; LTTSs to capture UF_6 vented from the cylinders during sampling; HFCVB for each SCA that contains the valves and pipe connections between units within the sampling area; an autoclave surge tank (AST) that provides UF_6 surge capacity if an autoclave relief device actuates.

Source material and SNM are used in this area.

1.1.2.1.8 Liquid and Solid Radioactive Waste Areas

Quantities of radiologically contaminated, potentially contaminated, and non-contaminated aqueous liquid effluents are generated in a variety of the GLE Commercial Facility operations and processes. Aqueous liquid effluents are collected in tanks located in the Radioactive Liquid Effluent Collection and Treatment Room. The collected effluent is sampled and analyzed to determine if treatment is required before release.

Operation of the GLE Commercial Facility also generates refuse and other hazardous and non-hazardous solid wastes. These wastes may be designated as Resource Conservation and Recovery Act (RCRA) hazardous wastes, low-level radioactive waste (LLRW), high-activity waste, or low-level mixed waste (LLMW). Solid-waste systems are designed to process both wet and dry low-level radioactive solid waste. Solid radioactive waste material is accumulated, monitored for criticality control and other regulatory requirements, stored in temporary accumulation areas, and then transferred to one of the solid-waste storage buildings located on the GLE Site for storage pending eventual offsite shipment/disposition.

1.1.2.1.9 HVAC Equipment Areas

Various ventilation systems are used to condition the environment inside the buildings and areas to meet requirements for personnel, process equipment, and supporting systems and utilities. The HVAC systems also control the room pressure in different areas or zones of the buildings relative to adjacent areas and relative to the outdoors as part of the radioactive or hazardous material containment function.

The ventilation system requirements of each area are dependent on the process performed, and on variables such as the indoor air temperature, relative humidity, relative room pressure, and safety requirements.

Ventilation systems that have the potential to exhaust radioactive or hazardous materials interface with the Monitored Central Exhaust System (MCES). The MCES functions to remove uranium particulates as well as UF_6 and HF gas from process gas streams and room air during normal and abnormal events. The system maintains areas under negative pressure relative to ambient and adjacent areas. This prevents the release of radioactive or hazardous materials, which protects workers and the public. The MCES discharges through a monitored exhaust stack located in the Operations Building.

The ventilation and MCES equipment serving the Operations Building is located in various locations throughout the Operations Building.

1.1.2.1.10 Decontamination/Maintenance Area

The Decontamination/Maintenance Area provides a place for personnel to remove contamination from, and make repairs to, equipment and process components used in UF_6 systems, waste handling systems, and other areas of the facility.

Source material and SNM are contained in this area.

1.1.2.1.11 Laboratory Area

The Laboratory Area is located just north of the Cylinder Shipping and Receiving Area, on the east side of the Operations Building. Within the Laboratory Area there are areas for mass spectroscopy equipment, wet chemistry activities, safety and regulatory testing and analysis, standard analytical laboratory equipment, and fume collection and exhaust hoods.

Source material and SNM are used in this area.

1.1.2.1.12 Laser Area

The Laser Area contains the necessary equipment to operate the laser systems that are part of the GLE laser-based enrichment technology; and produce the specific wavelength of light required to affect the uranium isotope necessary for the enrichment process.

The Laser Area contains: lasers to generate the required wavelength of light needed for the enrichment process, and a Laser Repair Shop located adjacent to the Laser Area to perform maintenance on the laser systems including calibration, repair, and preventive maintenance.

No source material or SNM is used in this area.

1.1.2.2 UF_6 Cylinder Pads

The UF_6 Cylinder Pads include three outdoor cylinder pads each serving a different function. The three pads are described below. See Figure 1-4 for the location of the UF_6 Cylinder Pads.

1.1.2.2.1 Product Pad

The Product Pad is used to store product in 30-inch cylinders. The Product Pad is approximately 48,000 square feet and constructed similar to the other storage pads to provide for rainwater drainage. Saddles are used to store the cylinders and the cylinders are not typically stacked.

SNM is contained in this area.

1.1.2.2.2 In-Process Pad

The In-Process Pad is used to store feed material, as well as any cylinders containing heels and empty cylinders. It is approximately 130,000 square feet and constructed similar to the other pads to provide for rainwater drainage. Saddles are used to store the cylinders and the cylinders are not typically stacked.

Source material is contained in this area.

1.1.2.2.3 Tails Pad

The Tails Pad is designed to provide storage for 48-inch cylinders containing less than or equal to 0.72 percent weight ^{235}U. The Tails Pad is sized to accommodate the cylinders resulting from ten years of facility operation.

The Tails Pad occupies approximately 465,000 square feet. The pad is sloped to provide drainage to the edges of the pad. The surrounding site is graded to provide collection and drainage of rainwater to an onsite retention basin. The cylinders may be stacked two high and are stored using Saddles.

Source material is contained in this area.

1.1.2.3 Other Facility Buildings and Supporting Infrastructure

See Figure 1-4 for the location of the following buildings and supporting infrastructure.

There are three administrative buildings. Two of the administrative buildings primarily contain office space for the GLE support staff and conference rooms. The third administrative building contains the personnel Entry Control Facility (ECF) and is located at the entrance to the Protected Area. Personnel requiring access to the Protected Area must pass through the ECF. The ECF is designed to facilitate and control the passage of authorized facility personnel and visitors. General parking is located outside of the Protected Area.

Waste storage buildings are used to store solid LLRW. The waste is packaged in transportation containers and surveyed prior to being stored in the warehouse.

An electrical substation and diesel generators provide electrical power to the GLE Commercial Facility. The diesel generators are used during short-term power losses to support an orderly shutdown of the enrichment processes upon loss of power or until normal electrical service is restored. A loss of GLE Site electrical power does not have any public safety implications.

Potable and process water supply lines run to the GLE Commercial Facility from the existing Wilmington Site water supply infrastructure. Sanitary waste, process wastewater, and treated liquid radiological wastewater are routed from the GLE Commercial Facility via underground lines to lift stations. The lift stations deliver the respective wastewaters to the existing Wilmington Site Sanitary Waste Water Treatment Facility (WWTF) and Final Process Lagoon Treatment Facility (FPLTF) through underground pipes.

Two retention basins receive stormwater runoff from the GLE Commercial Facility. The majority of the runoff from the GLE Commercial Facility, including the Operations Building, drains to a collection basin on the Wilmington Site. The remaining runoff, including runoff from the UF_6 Cylinder Pads, drains to a GLE Site retention basin.

There is a water tower, a firewater retention basin, and associated pumps and piping located on the GLE Site. The water in the tower is designated for process water, but has a reserved level for fire fighting. The firewater retention basin and associated diesel powered firewater pumps are designed as a backup source for fire protection systems.

The road leading to the entrance of the GLE Commercial Facility is located off of Castle Hayne Road (see Figure 1-3). There is also a road exiting the GLE Commercial Facility leading to the GNF-A FMO Facility. Both of these roads are located on the Wilmington Site and are maintained by GE.

1.1.3 Process Description

This section provides an overview of the GLE laser-based enrichment process. A more detailed description of the process is provided in the Integrated Safety Analysis (ISA) Summary. The ISA Summary also contains a description of the other systems supporting the GLE Commercial Facility including the utility systems; HVAC systems, process water system, and the various cylinder-handling systems used to move UF_6 cylinders.

1.1.3.1 Process Overview

The GLE Commercial Facility is a uranium enrichment facility that utilizes laser-based enrichment technology. The GLE Commercial Facility is designed to separate a feed stream containing the naturally occurring proportions of uranium isotopes into a product stream (enriched in the ^{235}U isotope) and a tails stream (depleted in the ^{235}U isotope).

The GLE Commercial Facility utilizes industry standard UF_6 containers and processes for material handling aspects of enrichment facility operations similar to those utilized at other uranium enrichment facilities. These similar UF_6 handling processes include the movement of uranium feed stock from its solid UF_6 form in cylinders to gaseous form used in the enrichment cascade via vaporization techniques, the filling of UF_6 cylinders with UF_6 gas condensed into solid UF_6 form after the enrichment process, and the blending of UF_6 gas of different enrichments to create specific desired product enrichments.

The GLE Commercial Facility uses the laser-based enrichment technology within an area of the facility known as the Cascade/Gas Handling Area. The process enriches natural UF_6, containing approximately 0.72 weight percent ^{235}U, to a UF_6 product containing ^{235}U enriched up to 8 weight percent. The nominal capacity of the facility is six million SWU per year.

The uranium enrichment process utilized by the GLE Commercial Facility utilizes lasers tuned to specific frequencies to selectively excite UF_6 gas molecules to enable separation of the ^{235}U isotope in UF_6 feed stock. The result is a UF_6 product stream enriched in the ^{235}U isotope and a UF_6 tails stream in which the fraction of ^{235}U isotope is reduced or depleted. Technical details of the GLE laser-based enrichment technology are proprietary, subject to export controls by U.S. laws and regulations, and in many cases also fall into the categories of security-related, safeguards, or classified information, access to which is further limited per U.S. laws and regulations.

1.1.3.2 Process System Descriptions

The GLE Commercial Facility enrichment process consists of the following four major systems and two enrichment support systems:

Major Enrichment Process Systems

1. UF_6 Feed and Vaporization
2. Cascade / Gas Handling
3. Product Withdrawal
4. Tail Withdrawal

Enrichment Support Systems

1. Blending
2. Sampling

An overview of each process system or support system is provided below.

1.1.3.2.1 UF_6 Feed and Vaporization System

The major function of the UF_6 Feed Vaporization System is to provide a continuous supply of gaseous UF_6 from the feed cylinders to the Cascades. The nominal UF_6 feed flow rate is based on a six million SWU/year facility capacity. Approximately 900 48-inch cylinders are processed annually.

The major equipment used in the UF_6 Feed Vaporization Process are the SFSs. Feed cylinders are loaded into SFSs; vented for removal of light gases, primarily air and hydrogen fluoride, and heated to sublime the UF_6. The light gases and UF_6 gas generated during feed purification are routed to the Feed Purification Subsystem where the UF_6 is desublimed. The Feed Purification Subsystem consists of UF_6 cold traps, a vacuum pump/chemical trap set, and a LTTS. The Feed Purification Subsystem removes any light gases such as air and hydrogen fluoride from UF_6 prior to introduction into the Cascade/Gas Handling Area. The UF_6 is captured in UF_6 cold traps and ultimately recycled as feed, while hydrogen fluoride is captured on chemical traps.

1.1.3.2.2 Cascade / Gas Handling System

After purification, UF_6 from the SFS is routed to the Cascade/Gas Handling Area. The gas is exposed to laser-emitted light, and the UF_6 gas is separated into two streams, one enriched in ^{235}U and one depleted in ^{235}U.

1.1.3.2.3 Product Withdrawal System

Enriched UF_6 from the Cascade/Gas Handling Area is desublimed in the Product Withdrawal LTTS. Pumps and compressors transport the UF_6 from the Cascade/Gas Handling Area to the Product Withdrawal LTTS. The heat of desublimation of the UF_6 is removed by cooling air routed through the LTTS. Filling of the product cylinders is monitored with a load cell system, and filled cylinders are transferred to the Product Cylinder Sampling System for sampling.

1.1.3.2.4 Tail Withdrawal System

Depleted UF_6 from the Cascade/Gas Handling Area is desublimed in the Tail Withdrawal LTTS. Pumps and compressors transport the UF_6 from the Cascade/Gas Handling Area to the Product LTTS. The heat of desublimation of the UF_6 is removed by cooling air routed through the LTTS. Filling of the tail cylinders is monitored with a load cell system, and filled cylinders are transferred to the Tails Pad.

1.1.3.2.5 Blending System

The primary function of the Blending System is to blend UF_6 donor cylinders with differing enrichments into a receiver cylinder. The assay in the receiver cylinder is one that meets customer specifications as well as transportation standards.

1.1.3.2.6 Sampling System

UF_6 sampling operations are performed in the Sampling Area. Current American Society for Testing and Materials (ASTM) International standards require that UF_6 samples be taken from homogenized UF_6. Therefore, the design criteria require liquefaction of UF_6 during sampling operations. In addition, sampling of a statistical basis set of feed and tails cylinders is required to support Material Control and Accounting (MC&A) requirements.

Autoclaves with heating and cooling capability are used to liquefy UF_6 in the cylinders, homogenize the liquefied material, obtain a representative sample of the contents of the cylinders, and then solidify the UF_6 in the cylinders before they are removed from the autoclave. The cylinders may be any approved UF_6 cylinder, per ANSI N14.1, which meets nuclear criticality safety (NCS) requirements. The autoclaves are designed to contain a UF_6 release in the autoclave. Electrically heated air is the heating medium and cold air is used for cooling.

1.1.4 Waste Management

1.1.4.1 Solid Wastes

Operation of the GLE Commercial Facility generates refuse and other nonhazardous solid waste, wastes designated as RCRA hazardous wastes, and LLRWs. No high-level radioactive wastes are generated by GLE Commercial Facility operations. The types, sources, and estimated quantities of solid wastes generated by GLE Commercial Facility operations are summarized in Table 1-1, *Typical Types, Sources, Quantities of Solid Wastes Generated by GLE Commercial Facility Operations*, and Table 1-2, *Management of Solid Wastes*.

GLE Commercial Facility operations generate an estimated 380 tons of municipal solid waste (MSW) per year. This waste is collected and placed in roll-off type containers. A commercial refuse collection service regularly collects the filled containers and transports the waste to a RCRA permitted Subtitle D landfill for disposal.

In addition to MSW, an estimated 107 tons of non-hazardous solid wastes are generated per year as a result of equipment maintenance for GLE Commercial Facility operations. Examples of these wastes are spent coolant and used filter media. These wastes are collected and temporarily stored in containers appropriate for the waste type. Depending on the composition of the non-hazardous waste, these materials are either shipped directly to a permitted RCRA Subpart D landfill for treatment and burial, or routed to other approved facilities for reuse, reclamation, or treatment.

The GLE Commercial Facility generates approximately 12 tons of RCRA hazardous waste per year. This waste is collected, packaged in DOT-approved shipping containers, and temporarily stored onsite for shipment to a RCRA-permitted Subtitle C treatment, storage, and disposal facility.

The sources and typical quantities of LLRW generated by GLE Commercial Facility operations are summarized in Table 1-1. LLRW is collected in containers appropriate for the waste form and shipped by truck to an approved disposal facility as indicated in Table 1-2.

1.1.4.2 Liquid Wastes

The sources and estimated quantities of wastewater generated by GLE Commercial Facility operations are summarized in Table 1-3, *Typical Types, Sources, and Quantities of Wastewater Generated by GLE Commercial Facility Operations*, and Table 1-4, *Management of Wastewater Generated by GLE Commercial Facility Operations.*

The liquid radioactive wastes generated in the Operations Building are collected in closed drain systems that discharge to an accumulator tank. The liquid is treated to remove uranium through precipitation; the liquid is then treated to remove fluoride through evaporation. The resulting solids are dried and disposed of as LLRW.

The treated wastewaters from the Radiological Liquid Effluent Treatment System (RLETS) are discharged to the existing Wilmington Site Sanitary WWTF and FPLTF. The FPLTF receives Wilmington Site process wastewater, including the treated effluent from the GNF-A Radiological Waste Treatment System. The treated effluent from the FPLTF is discharged via National Pollutant Discharge Elimination System (NPDES)-permitted Outfall 001 to the Wilmington Site effluent channel where it is combined with stormwater, discharging groundwater, and treated sanitary wastewater effluent. The effluent channel flows to the unnamed Tributary No. 1 to the Northeast Cape Fear River.

The cooling tower for the GLE Commercial Facility is a closed loop system that does not contact any uranium materials or uranium-contaminated wastewater streams. To minimize the amount of dissolved solids and other impurities in the circulating water, standard operating practice is to regularly remove a portion of the circulating water from the cooling tower loop and discharge the water to an evaporation pond (adding fresh water to the cooling tower loop to make up for corresponding water loss). Approximately 30,000 gallons per day (gpd) is removed and pumped directly to the existing Wilmington Site FPLTF.

Operation of the GLE Commercial Facility generates approximately 10,500 gpd of sanitary waste. The sanitary wastes are collected in a sewer system connected to the existing Wilmington Site Sanitary WWTF. This facility uses an Activated Sludge Aeration Process. The treated effluent from the Wilmington Site Sanitary WWTF is re-used as process water.

Stormwater runoff from outdoor impervious surfaces within the GLE Commercial Facility is collected in drainage conduits and channels flowing into retention basins used for collection of runoff. The retention basins are routed to the unnamed Tributary No. 1, which flows into the Northeast Cape Fear River.

1.1.5 Depleted Uranium Management

Depleted uranium (also referred to as UF_6 tails) from GLE Commercial Facility operations is temporarily stored at the GLE Commercial Facility in 48-inch cylinders before being shipped offsite to a depleted uranium conversion facility. There is no onsite disposal of the UF_6 tails at the Wilmington Site. Section 3113 of the United States Enrichment Corporation (USEC) Privatization Act *(Ref. 1-8)* directs the U.S. Department of Energy (DOE) to "accept for disposal" depleted uranium, such as the UF_6 tails generated by the GLE Commercial Facility.

The Tails Pad is designed to provide storage capacity for approximately 9,000 48-inch cylinders, which is equivalent to ten years of facility operation. It is anticipated that DOE will have begun accepting possession of the UF_6 tails before the storage pad capacity is reached. The pad design layout permits double stacking of the 48-inch cylinders and allows the cylinders to be moved with gantry cranes and flatbed trucks. The storage pad occupies approximately 465,000 square feet. To provide stormwater drainage, the pad is sloped at the edges. The terrain surrounding the storage pad is graded to provide collection and drainage of stormwater to a retention basin.

Saddles are used to stack and store the cylinders above the Tails Pad surface. To transfer the UF_6 tails between the Cylinder Shipping and Receiving Area and the Tails Pad, dedicated diesel-powered flatbed trucks are used. At the Tails Pad, a diesel-powered, self-propelled gantry crane is used to unload the cylinder from the flatbed truck, move the cylinder to the appropriate storage location on the pad, and place the cylinder on its pad cradle. Work practices to manage the Tails Pad include periodic inspections and radiological surveys to ensure cylinder integrity. Operators are trained in safe cylinder handling and cylinder maintenance procedures.

1.1.6 Liquid and Air Effluents

1.1.6.1 Process Wastewaters

Uranium enrichment operations performed inside the Operations Building generate process wastewater from decontamination, cleaning wash water, and laboratory wastes. The waste streams contain small concentrations of uranium and are collectively referred herein as liquid radioactive waste. Liquid radioactive waste is treated to remove uranium and fluoride as described in Section 1.1.4, *Waste Management.*

The treated wastewaters from the RLETS are discharged to the existing Wilmington Site FPLTF. This facility currently receives Wilmington Site process wastewater, including the treated effluent from the GNF-A FMO Facility Radiological Waste Treatment System. The treated effluent from the FPLTF is discharged via NPDES-permitted Outfall 001 to the Wilmington Site effluent channel where it is combined with stormwater, discharging groundwater, and treated sanitary wastewater effluent. The effluent channel flows to the unnamed Tributary No. 1 to the Northeast Cape Fear River.

1.1.6.2 Air Effluents

The laser-based enrichment process is a closed process with no vents needed for routine venting of process gases. Some short-term gaseous releases occur inside the Operations Building during activities associated with operations such as the connection/ disconnection of UF_6 cylinders to process equipment and process equipment maintenance activities. These gaseous releases are routed through the building's ventilation system. The ventilation system air stream passes through a series of emissions-control devices consisting of high-efficiency particulate air (HEPA) filters and high-efficiency gas absorption (HEGA) filters. The exhaust air stream from these emission controls is vented to the atmosphere. Table 1-5, *Typical GLE Air Emissions*, shows the typical air effluent concentrations from the Operations Building and the required regulatory limits.

1.1.7 Raw Materials, By-Products, Wastes, and Finished Products

The raw materials used in the laser-based enrichment process include UF_6 feed, gases used to support laser operation, oils used to support mechanical operations, process water, and solvents used in cleaning equipment. The by-product of the laser-based enrichment process is depleted uranium tails in the form of solid UF_6. The wastes from the laser-based enrichment process include solid wastes, process wastewaters, and air effluents. Further description of these wastes is contained in Section 1.1.4. The finished product from the laser-based enrichment process is solid UF_6 enriched in ^{235}U. GLE will not use or possess any moderator or reflector with special characteristics, such as beryllium or graphite.

1.2 INSTITUTIONAL INFORMATION

This section describes the corporate identity, financial qualifications, type of license, and the requested special authorizations and exemptions.

1.2.1 Corporate Identity

The applicant name and address, corporate structure and ownership control, and physical location of the facility are provided below.

1.2.1.1 Applicant Name and Address

This application for an NRC license is filed by GE-Hitachi Global Laser Enrichment LLC. GLE is headquartered in Wilmington, North Carolina.

The full address of the applicant is as follows:

Mailing Address:

Global Laser Enrichment
P.O. Box 780, Wilmington, North Carolina 28402

Physical Address:

Global Laser Enrichment
3901 Castle Hayne Road, Wilmington, North Carolina 28401.

1.2.1.2 Organization and Management of Applicant

The corporate ownership structure is shown in Figure 1-5, *GLE Ownership*. GLE is a Delaware limited liability company and currently the only subsidiary of majority owner GE-Hitachi Nuclear Energy Americas LLC (GEH), a global supplier of nuclear energy-related equipment and services, and which is itself a Delaware limited liability company and a wholly-owned subsidiary of GE-Hitachi Nuclear Energy Holdings LLC (Holdings). Holdings is a subsidiary of majority owner GENE Holding LLC (GENE), which is a Delaware limited liability company wholly owned by General Electric Company (GE), a U.S. corporation, and of minority owner Hitachi America, Ltd., which is a wholly owned subsidiary of Hitachi Ltd., a Japanese corporation. GLE also has two minority owners, Cameco Enrichment Holdings, LLC ("Cameco Enrichment"), with 24% ownership interest in GLE, and GENE, which owns 13.5% of GLE. Cameco Enrichment is a Delaware limited liability company wholly owned by Cameco US Holdings, Inc., a Nevada corporation, which is in turn wholly owned by Cameco Corporation, a Canadian corporation.

In this ownership structure, GE maintains an indirect majority, that is 51% ownership, controlling interest, and no foreign entity has the ability to exercise control over GLE operations and management or has access to, or use rights in, GLE's nonpublic enrichment technology, including classified information. GLE Governing Board resolutions and, as applicable, Governing Board member voting proxies are utilized to assure that only Governing Board members who are U.S. citizens with appropriate U.S. government clearances have access to, or exercise control over activities affecting the protection of, classified information. Foreign ownership, control, and influence (FOCI) information is initially submitted, and periodic updates thereto are provided, to the NRC in accordance with 10 CFR 95, *Facility Security Clearance and Safeguards of National Security Information and Restricted Data (Ref. 1-9).*

The current principal officers of GLE and their citizenship are listed below:

- Tammy G. Orr, President and Chief Executive Officer — United States
- Jose I. Garcia, Chief Financial Officer — Spain
- Harold J. Neems, Secretary and General Counsel — United States

GLE's immediate parent, GEH, is the parent company of NRC licensees that are licensed under 10 CFR 50, *Domestic Licensing of Production and Utilization Facilities (Ref. 1-10)*, 10 CFR 70, and 10 CFR 72, *Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor Related Greater Than Class C Waste (Ref. 1-11)*, at facilities in Sunol, California and Morris, Illinois. GLE's affiliate, GNF-A, also a controlled subsidiary of GE, is the current holder of an NRC license under 10 CFR 70 for an existing facility on the Wilmington Site.

1.2.1.3 Address of Facility and Site Location Description

The address of the facility is the same as the physical address of the applicant. A description of the facility site location is provided in Section 1.1.1, Facility Location.

1.2.2 Financial Qualifications

1.2.2.1 Capital Cost Estimate

GLE estimates that the total capital investment required to construct a six million SWU facility is approximately [Proprietary Information withheld from disclosure per 10 CFR 2.390] (in 2009 dollars), excluding capital depreciation, UF_6 tails disposition, decommissioning and any replacement equipment required during the life of the facility. The basis for the cost estimate is provided in Table 1-6, *GLE Commercial Facility Capital Cost Estimate*

The cost estimate is based on a phased construction approach that is expected to take approximately six years from the time the license is issued to reach the full six million SWU capacity. The first phase of the GLE Commercial Facility will be a three million SWU facility (Unit 1) that will be deployed in one million SWU and two million SWU incremental production capacity. GLE is expected to start production on Unit 1 approximately three years from the issuance of the NRC license that GLE is seeking through this application. The second phase will be a three million SWU facility (Unit 2) deployed in a similar step fashion as Unit 1. The Unit 2 phase is expected to leverage efficiencies gained from the initial deployments to expedite the construction process and increase the SWU capacity that can be deployed at one time.

1.2.2.2 Funding Commitments

Construction of the first phase (Unit 1) shall not commence before funding is fully committed. Of this full funding (equity and/or debt), GLE will have: (1) minimum equity contributions of 30% of project costs from the parents and affiliates of the partners; and (2) firm commitments ensuring funds for the remaining project costs. The construction of the second phase (Unit 2) will have the same requirements listed for the first phase, except, that expected profits from Phase 1 sales may be used as a funding source.

GLE shall not proceed with the project unless it has in place long-term conditional enrichment contracts (that is, five years or longer) with price expectations sufficient to cover operating costs (including facility depreciation and decommissioning), with a return on investment.

The foregoing funding commitments, which will be in place prior to GLE Commercial Facility construction and operation, as applicable, are consistent with the license condition approved by the NRC in previous uranium enrichment facility licensing proceedings. See CLI-97-15, 46 NRC 294, 309 (1997) (Claiborne Enrichment Center); CLI-04-3, 59 NRC 10, 23 (2004) (National Enrichment Facility); and CLI-04-30, 60 NRC 426, 437 (2004) (American Centrifuge Plant).

GLE LA Chapter 10, *Decommissioning,* describes how reasonable assurance is provided that funds will be available to decommission the facility as required by 10 CFR 70.22(a)(9), *Contents of Applications (Ref. 1-12)*, 10 CFR 70.25, *Financial Assurance and Recordkeeping for Decommissioning (Ref. 1-13)*, and 10 CFR 40.36, *Financial Assurance and Recordkeeping for Decommissioning (Ref. 1-14).*

1.2.2.3 Financial Resources

GLE is currently funded by three parent companies, General Electric, Hitachi, and Cameco. The parent organizations have contributed cash and notes to fund the project through the design validation stage of the program and stand committed to provide additional funding pending the successful validation of the design concept. GLE currently expects to fund the construction costs through additional equity contributions provided by the parent companies. However, GLE may explore other funding options including, but not limited to additional equity owners (pending approval of the current parent companies) or long-term debt instruments.

A summary of the parent companies' total assets and net income for 2008 are provided below. All three of the parent organizations are publicly traded and additional information, including annual reports, are available on the companies' respective websites.

For the year ending December 31, 2008, GE had total assets (U.S. Dollars) of $797,769,000,000, with cash assets of $48,187,000,000. GE's net income in 2008 was $17,335,000,000.

For the year ending December 31, 2008, Hitachi had total assets (Japanese Yen) of JPY10,530,847,000,000, with cash assets of JPY622,249,000,000. Hitachi had a net loss in 2008 of JPY58,125,000,000.

For the year ending December 31, 2008, Cameco had total assets (Canadian Dollars) of C$7,010,601,000, with cash assets of C$269,176,000. Cameco's net income in 2008 was C$450,117,000.

1.2.2.4 Liability Insurance

GLE shall, in accordance with 10 CFR 140.13b, *Amount of Liability Insurance Required for Uranium Enrichment Facilities (Ref. 1-15)*, and prior to and throughout operation of the GLE Commercial Facility, have and maintain nuclear liability insurance in the amount of up to $300 million to cover liability claims arising out of any occurrence within the United States, causing, within or outside the United States, bodily injury, sickness, disease, or death, or loss of or damage to property, or loss of use of property arising out of or resulting from the radioactive, toxic, explosive, or other hazardous properties of chemical compounds containing source material or SNM.

The amounts of nuclear energy liability insurance required may be furnished and maintained in the form of:

- An effective facility form (non-indemnified facility) policy of nuclear energy liability insurance from nuclear facility underwriters;
- Such other type of nuclear energy liability insurance as the NRC may approve; or
- A combination of the foregoing.

The aforementioned insurance will take effect upon the receipt at the GLE Commercial Facility of source material or SNM. Until such time, GLE will rely on the liability coverage of its parent companies assuming this liability is not to exceed $1 million during the construction period. Self-insurance of standard liability is a standing policy for the three parent organizations, and given the limited materiality ($1M), GLE will utilize the parent organizations as back-stops if necessary in lieu of a specific insurance policy.

1.2.3 Type, Quantity, and Form of Licensed Material

GLE proposes to acquire, deliver, receive, possess, produce, use, transfer, and/or store source material and SNM meeting the criteria of SNM of low strategic significance as described in 10 CFR 70.4, *Definitions (Ref. 1-15)*. Details of the SNM are provided in Table 1-7, *Type, Quantity, and Form of Licensed Special Nuclear Material*. It is anticipated that other source and by-product materials will be used for instrument calibration purposes. These materials will be identified during subsequent design phases and the LA will be revised, as necessary.

1.2.4 Requested Licenses and Authorized Uses

GLE is engaged in the production and sale of uranium enrichment services to electric utilities or fuel fabrication facilities for the purpose of manufacturing fuel to be used to produce electricity in commercial nuclear power plants. GLE also may purchase and enrich uranium for direct sale to fuel fabrication facilities. In addition, GLE may provide enrichment services for the U.S. government under certain contractual agreements.

This GLE LA is necessary for licenses issued under 10 CFR 30, 10 CFR 40, and 10 CFR 70 to construct, own, use, and operate facilities described herein as an integral part of the GLE Commercial Facility. This includes licenses for byproduct material, source material, and SNM. The license requested is for a 40-year period. See Section 1.1, *Facility and Process Description*, for a summary description of the GLE activities.

1.2.5 Special Authorizations and Exemptions

1.2.5.1 Authorized Guidelines For Contamination-Free Articles

GLE requests authorization to use the guidelines, contamination, and exposure rate limits developed by the NRC and included as Appendix A of this chapter titled *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material,* for decontamination and survey of surfaces or premises and equipment prior to abandonment or release for unrestricted use. These guidelines are included as a regulatory acceptance criterion in NUREG-1520, *Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility (Ref. 1-17).*

1.2.5.2 Exemption to Posting Requirements

GLE requests authorization to post areas within Radiological Controlled Areas (RCAs) in which radioactive materials are processed, used, or stored with a sign stating "Every container in this area may contain radioactive material," in lieu of the labeling requirements in 10 CFR 20.1904, *Labeling Requirements (Ref. 1-18).*

The requested exemption is authorized by law because there is no statutory prohibition on the proposed posting of a single sign indicating that every container in the posted area has the potential for internal contamination. Indeed, to reduce unnecessary regulatory burden, the NRC issued a final rule in 2007 that, in part, modified 10 CFR 20.1905, *Exemptions to Labeling Requirements (Ref. 1-19)*, thereby exempting certain containers holding licensed material from the labeling requirements of 10 CFR 20.1904 if certain conditions are met. Although the 2007 rulemaking only applied to facilities licensed under 10 CFR 50 and 10 CFR 52, *Licenses, Certifications, and Approvals for Nuclear Power Plants (Ref. 1-20)*, the rationale underlying the rule supports the exemption request. Exempting GLE from this requirement will reduce licensee administrative and information collection burdens, but serve the same health and safety functions as the current labeling requirements. Therefore, the exemption does not affect the level of protection for either the health and safety of workers and the public or for the environment; nor does it endanger life or property or the common defense and security.

The NRC approved a similar exemption from 10 CFR 20.1904 requested by a prior uranium enrichment facility license applicant. In approving the exemption, the NRC concluded:

"Under 10 CFR 20.2301, the Commission may grant exemptions from the requirements of the regulations, if it determines that the request will be authorized by law and will not result in undue hazard to life or property. Also, 10 CFR 20.1905(c) already exempts containers from 10 CFR 20.1904, if the containers are attended by an individual who takes the precautions necessary to prevent the exposure of individuals in excess of the limits established. The staff agrees that it would be impractical to label each and every container in restricted areas at this facility because of the large number of potential containers. Labeling each container may also reduce radiation safety by desensitizing the worker to radiation warning signs. Since there is no statutory provision prohibiting the granting of this exemption, the staff concludes that the request is authorized by law. Also, the exemption request is consistent with those approved previously at the gaseous diffusion plants and other fuel cycle facilities. Experience at facilities that have received the exemption from the labeling requirement demonstrates that the applicant's request will provide an equivalent amount of safety, and will not result in an undue hazard to individuals. Accordingly, the staff finds that the request will not be an undue hazard to life or property. Therefore, exemption to the requirements of 10 CFR 20.1904 is recommended." (Ref. 1-19)

1.2.5.3 Exemption to Decommissioning Funding Requirements

The following proposed exemption from the requirements of 10 CFR 70.25(e) and 10 CFR 40.36(d) addressing the decommissioning funding requirements is identified in the Decommissioning Funding Plan (DFP) and GLE LA Chapter 10, *Decommissioning*.

10 CFR 70.25(e) and 10 CFR 40.36(d) require, in part, that *"The decommissioning funding plan must also contain a certification by the licensee that financial assurance for decommissioning has been provided in the amount of the cost estimate for decommissioning...".* In accordance with the DFP, GLE will incrementally fund that portion of its total decommissioning costs associated with the disposition of UF_6 tails generated by facility operation. Specifically, GLE will provide financial assurance for the disposition of UF_6 tails based on the expected amount of UF_6 tails to be generated annually, in a forward-looking manner. The NRC has previously approved the same incremental decommissioning financial assurance approach for USEC's American Centrifuge Project (ACP) and Louisiana Energy Services', L.P. (LES) National Enrichment Facility (NEF).

This exemption is justified for the following reasons:

- It is authorized by law because there is no statutory prohibition on incremental funding of decommissioning costs.

- The requested exemption will not endanger life or property or the common defense and security because UF_6 tails are generated incrementally over the life of the plant. GLE will provide financial assurance for UF_6 tails already generated that require disposal and the projected UF_6 tails to be generated in the next year. As such, requiring financial assurance for the disposition of UF_6 tails to be generated over the full licensed operating life of the enrichment facility – at the time of initial license issuance – would impose an unnecessarily large financial burden on the licensee.

- Granting this exemption is in the public interest for the same reasons stated above. Moreover, by eliminating an unnecessarily large financial burden on the licensee, the exemption will facilitate the deployment of an advanced, next-generation enrichment technology in the United States, in furtherance of important national energy objectives.

Finally, providing financial assurance for UF_6 tails disposition on an incremental basis is justified in view of GLE's commitments to: (1) provide full financial assurance for facility decommissioning at startup; (2) update its UF_6 tails dispositioning cost estimate annually, on a forward-looking basis, to ensure that the financial assurance reflects the current projected inventory of UF_6 tails at the facility (including any previously-generated tails still requiring disposition); and (3) adjust other decommissioning costs periodically, and no less frequently than every three years. This approach will allow GLE to consider available operating experience and other relevant information, including actual UF_6 tails inventory values and generation rates, and to ensure that sufficient decommissioning financial assurance is available at any point during the licensed operating life of the facility.

1.2.5.4 Authorization to Use ICRP 68

GLE requests authorization to use the derived air concentration (DAC) and annual limit on intake (ALI) values based on dose coefficients published in International Commission on Radiological Protection (ICRP) Publication No. 68, *Dose Coefficients for Intakes of Radionuclides by Workers (Ref. 1-21)*, in lieu of the values in Appendix B of 10 CFR 20, *Standards for Protection Against Radiation (Ref. 1-22)*, in accordance with approved written procedures.

The ICRP 68 guidance was promulgated after the 10 CFR 20, Appendix B criteria were established, and provides an updated and revised internal dosimetry model. Use of the ICRP 68 models provide more accurate dose estimates than the models used in 10 CFR 20, and allows GLE to implement an appropriate level of internal exposure protection. The NRC has established precedent for this exemption request from 10 CFR 20 in SECY-99-077.

1.2.6 Security of Classified Information

GLE has requested a facility security clearance, in accordance with 10 CFR 95, in a separate submittal. The use, processing, storage, reproduction, transmission, transportation or handling of classified information necessary to support this license application is currently controlled under the NRC authorized GNF-A facility security clearance at the Secret Restricted Data (SRD) level. As a result, access to restricted data (RD) or national security information (NSI) for the GLE Commercial Facility shall continue to be controlled by GNF-A in accordance with 10 CFR 25, *Access Authorization (Ref. 1-23)*, 10 CFR 95, and any other requirements that the NRC imposes through the issuance of Orders, until such time NRC processes GLE for an approved facility security clearance at the SRD level. Classified information associated with this LA, but not part of the facility security clearance request has been transmitted in a separate submittal.

1.3 SITE DESCRIPTION

This section contains a summary description of the Wilmington Site and surrounding areas. The GLE Environmental Report (ER) *(Ref. 1-24)* contains more detailed information regarding the site and its environs.

1.3.1 Site Geography

This section contains information regarding the site location, including nearby highways, bodies of water, and other geographical features.

1.3.1.1 Site Location Specifics

The GLE Commercial Facility is located on an existing industrial site in Wilmington, North Carolina. The existing Wilmington Site is situated on a 1621-acre tract of land, located west of North Carolina Highway 133 (also known as Castle Hayne Road). The Wilmington Site lies between latitudes (North) 34° 19' 4.0"and 34° 20' 28.9" and longitudes (West) 77° 58' 16.4" and 77° 55' 19.8", and is approximately six miles north of the City of Wilmington in New Hanover County, North Carolina (see Figure 1-1 and Figure 1-2). For further information, see Section 1.1.1.

The southeastern corner of the Wilmington Site is adjacent to the interchange of Interstate 140 with Castle Hayne Road. Current access to and from the Wilmington Site by trucks and other vehicle traffic is from Castle Hayne Road. Northbound Castle Hayne Road from the Interstate 140 interchange bordering the Wilmington Site is a four-lane road that continues for approximately one-half mile before narrowing to two lanes. The Wilmington Metropolitan Planning Organization designated Castle Hayne Road as an urban principal arterial south of Interstate 140 and as an urban minor arterial north of the Interstate 140 interchange.

1.3.1.2 Features of Potential Impact to Accident Analysis

The surrounding terrain is typical for coastal Carolina. The terrain has an average elevation of less than 40 feet above msl and is characterized by gently rolling land, with rivers, creeks, swamps, and marshlands. Approximately 182 acres of the southwest portion of the Wilmington Site are classified as swamp forest. There are no mountain ranges nearby. The terrain of the GLE Site is very gently sloping (gradients less than 2 percent) with little relief; therefore, landslides are not credible events. There is no volcanic or glacial activity in the region or vicinity of the Wilmington Site.

The elevation of the GLE Site is above the 500-year coastal still water flood elevation (coastal still water elevations factor in potential impacts from storm surge, including tidal and wind setup effects). The GLE Commercial Facility is located outside both the 100- and 500-year flood plains and there are no dams in the vicinity that could contribute to a rapid flood event.

Due to the curvature of the coastline in the area, the ocean lies approximately 10 miles east and 26.4 miles south of the Wilmington Site. The Federal Emergency Management Agency defines the geographic threshold for concern regarding a tsunami as one mile inland from the coast with an elevation of 25 ft above msl. Given the distance of the Wilmington Site from the ocean, there are no direct threat effects of a potential tsunami. Because of the distance of the Wilmington Site upstream from the Atlantic Ocean (approximately 23 river miles) and the height of the GLE Site above the 500-year floodplain, the indirect effects of flooding in the Northeast Cape Fear River as a result of a potential tsunami are minimal.

The Mid-Atlantic Coastal Plain province counties in North Carolina are in a low potential zone for the presence of radon gas relative to other regions in the state.

Soil samples collected at the GLE Site typically do not have high amounts of natural organic material. In addition, no peat deposits that could be a potential source of methane gas have been identified at the GLE Site. There are no municipal landfills on or in the immediate vicinity of the Wilmington Site that could generate methane gas; therefore, methane gas buildup beneath the Wilmington Site is not credible.

The projected lowering of the potentiometric surface at the GLE Site, as a result of the groundwater withdrawals from the aquifer on and in the vicinity of the Wilmington Site, is minimal, and no greater than the historical seasonal fluctuations observed in groundwater levels. In addition, the absence of a thick or regionally continuous confining bed at the GLE Site further minimizes the potential for subsidence as a result of lowered groundwater levels; therefore, subsidence due to dewatering is not credible. Likewise, there are no active mines adjacent to the Wilmington Site or known economic deposits of minerals, stone, or fuel materials that could cause subsidence at the GLE Site.

1.3.2 Demographics

This section provides the current census results (calendar year [CY] 2000) for the area surrounding the Wilmington Site, to include specific information about populations, public facilities, and industrial facilities. Land use and nearby bodies of water are also described.

1.3.2.1 Latest Census Results

According to the U.S. Census Bureau's 2000 Decennial Census *(Ref. 1-25)*, a total of 321 census blocks fall within a five-mile radius of the Wilmington Site. The majority of these census blocks (261) is within New Hanover County and includes 12,997 persons and 4,953 households. A total of 57 Pender County census blocks are within the five-mile radius, with a combined population of 3,305 persons and 1,274 households. An examination of census block data from CY 2000 reveals a total of three census blocks in Brunswick County with some portion of the total area inside the five-mile radius. The total population of these three census blocks is 36 persons in 17 households. Blocks with any portion of their area inside the five-mile radius were included in this population count. (See GLE ER Section 3.10.1 for additional information.)

1.3.2.2 Description, Distance, and Direction to Nearby Population Area

The region around the site is lightly settled with large areas of heavily timbered tracts of land. Farms, single-family dwellings, and light commercial activities are located along North Carolina Highway 133. In the eastern and southern vicinities of the Wilmington Site, residential uses are dominant due to the presence of the Wrightsboro (south), Skippers Corner (east), and Castle Hayne (northeast) communities. Wrightsboro has a population of approximately 4500, Skippers Corner has a population of approximately 1200, and Castle Hayne has a population of approximately 1100. (See GLE ER Section 3.1 for additional information.)

1.3.2.3 Proximity to Public Facilities

Figure 1-6, *Community Characteristics Near the Wilmington Site*, shows the location of schools and parks with respect to the five-mile Wilmington Site radius. There are a total of 90 public and private elementary, middle, and high schools in the three-county region. In addition to these primary and secondary schools, colleges such as the University of North Carolina at Wilmington (UNC-W), Brunswick Community College, and Cape Fear Community College are located in the region. Out of the 90 schools in the region, one is within a four-mile radius of the GLE Site (Wrightsboro Elementary) and 21 schools are within an eight-mile radius of the GLE Site. The nearest hospital, New Hanover Regional Medical Center, is approximately six miles from the Wilmington Site.

No state or federal parks are located within five miles of the Wilmington Site. There are 18 parks, three trails, and three gardens maintained by New Hanover County. Four of the parks are located within a five-mile radius of the Wilmington Site.

1.3.2.4 Nearby Industrial Facilities

The Northeast Cape Fear River borders the Wilmington Site to the west, and industrial land uses are dominant on the opposite (west) side of the river. The BASF Corporation, Elementis Chromium Facilities, and the L.V. Sutton coal-fired power plant operated by Progress Energy are examples of industrial operations located in this area. The industrial area sits between the Northeast Cape Fear River and the main branch of the Cape Fear River.

1.3.2.5 Land Use within a Five Mile Radius

The land use in the vicinity of the Wilmington Site is discussed below and generally covers the five-mile radius around the Wilmington Site. The Wilmington Site is a 1,621-acre parcel, owned by the GE, located west of Castle Hayne Road (otherwise known as North Carolina Highway 133). The property is currently zoned I-2, which is described in the New Hanover County zoning code as intended for heavy industrial uses. No portion of the property is currently used for agricultural purposes.

Immediately north of the Wilmington Site is a large parcel of approximately 4,069 acres owned by Hilton Properties. The current zoning designation for this property is Rural Agricultural, which is designed for low-density residential development with an emphasis on farming and open-space preservation. This parcel is locally known as the Sledge Forest and is currently used for timber management and as a private hunting area. Access to the Sledge Forest is provided via a private, unpaved road that intersects with Castle Hayne Road and closely follows the northern property line of the Wilmington Site.

The Northeast Cape Fear River borders the Wilmington Site to the west, and industrial land uses are dominant on the opposite (west) side of the river. The BASF Corporation, Elementis Chromium facilities, and the L.V. Sutton coal-fired power plant operated by Progress Energy are examples of industrial operations located in this area. The industrial area sits between the Northeast Cape Fear River and the main branch of the Cape Fear River. In the eastern and southern vicinities of the Wilmington Site, residential uses are dominant due to the presence of the Wrightsboro (south), Skippers Corner (east), and Castle Hayne (northeast) communities.

Three public schools are located within five miles of the Wilmington Site: Wrightsboro Elementary School, Emma B. Trask Middle School, and Emsley A. Laney High School. Trask Middle School also serves as an emergency shelter for New Hanover County.

The Wilmington International Airport (ILM) is located approximately five miles south-southeast from the Wilmington Site. The New Hanover County Landfill is located approximately four miles southwest of the Wilmington Site.

1.3.2.6 Land Use Within One Mile of the Facility

As described above, the Wilmington Site is bordered on the north by the Sledge Forest and on the west by the Northeast Cape Fear River. Castle Hayne Road borders the eastern portion of the site. Further north along Castle Hayne Road, are four mobile homes located on the opposite side of the street from the Wilmington Site. Adjacent to the site on the northeast side is the Wooden Shoe residential subdivision. Located adjacent to the Wilmington Site's eastern boundary across Castle Hayne Road, are the North Carolina State University Horticultural Crops Research Station, a truck parking lot, and a small recreational park for use by Wilmington Site employees (owned by GE). Directly south of the site is the Interstate 140, and beyond the interstate is a small residential area.

1.3.2.7 Uses of Nearby Bodies of Water

A portion of the Wilmington Site borders the Northeast Cape Fear River. Both commercial and recreational fishing occur on the Northeast Cape Fear River. Commercial fishing is more prevalent downstream of the Wilmington Site and in the Cape Fear River Estuary.

1.3.3 Meteorology

1.3.3.1 Primary Wind Directions and Average Wind Speeds

On an annual basis, the wind direction (direction from where the wind is blowing) at Wilmington International Airport is predominantly southwesterly *(Ref. 1-26)*; thus, reflecting the general synoptic scale wind pattern. In contrast, the predominant wind direction during the fall and winter is often northerly, due largely to the influence of invading polar air masses and changes in global circulation *(Ref. 1-26; Ref. 1-27)*. Figure 1-7, *Wind Rose for Wilmington International Airport*, shows the overall wind rose for Wilmington International Airport. The annual prevailing wind speed at the airport is 10.4 mph (9 knots) *(Ref. 1-26)*.

1.3.3.2 Annual Precipitation – Amounts and Forms

The mean annual precipitation in eastern North Carolina is heaviest in the southeast corner of the state and steadily decreases toward the north and west. The higher precipitation amounts are due to higher levels of moisture provided by the Atlantic Ocean. The area along the North Carolina coast experiences afternoon showers and thunderstorms often during the summer months. These storms form along a sea breeze front as it moves inland from the coast. The mean annual precipitation for the area around the GLE Commercial Facility is approximately 55.0 inches/year according to the 1948 to 1995 dataset *(Ref. 1-26)* and 57.1 inches/year according to the 1971 to 2000 dataset *(Ref. 1-28)*.

Due to the moderate climate, Wilmington receives very little snowfall, except on rare occasions. On average, only about 2.1 inches of snowfall occurs annually. December and January are expected to receive the most average snowfall, at 0.6 inches *(Ref. 1-28)*. Wilmington also receives only a small amount of sleet. The mean recurrence interval for measurable sleet in Wilmington, North Carolina, is approximately 4.6 years, or an annual probability about 22 percent. Sleet greater than 0.25 inches has a mean recurrence interval of only once every 46 years, or an annual probability of about 2 percent *(Ref. 1-29)*. Freezing rain usually poses a higher risk to power systems and trees than sleet. Freezing rain does not occur often in Wilmington, although it occurs more often than sleet *(Ref. 1-29)*. Measurable accumulations occur in Wilmington with a mean recurrence interval of about 1.5 years, or an annual probability of 67 percent. More significant accumulations of less than 0.25 inches occur with a mean recurrence interval of 7.7 years, or an annual probability of 13 percent. Accumulations of less than 0.5 inches, which are very likely to affect power lines and trees, are expected to occur in Wilmington at a mean recurrence interval of 46 years, or an annual probability of 2 percent.

1.3.3.3 Severe Weather

1.3.3.3.1 Extreme Temperature

The highest recorded temperature at Wilmington International Airport for the period of record is 104.0°F, which occurred during June 1952 *(Ref. 1-28)*. The lowest recorded temperature of 0.0°F occurred in December 1989 *(Ref. 1-28)*. This shows that the maximum annual temperature range at the Wilmington Site is about 104.0°F.

1.3.3.3.2 Extreme Precipitation

Tropical storms and hurricanes occur in and around the southeastern United States, making Wilmington prone to high amounts of rainfall over a short time period. The highest recorded 24-hour rainfall amount of 13.38 inches at Wilmington International Airport occurred during September 1999 due to the effects of Hurricane Floyd making landfall on the North Carolina Coast *(Ref. 1-28)*. Considering the expected precipitation intensity, Wilmington International Airport has a 1 in 50 annual exceedance probability (AEP) of receiving precipitation at a rate of 11.86 inches/hour for a duration lasting five minutes. The AEP for precipitation with a rate of 16.05 inches/hour occurring for five minutes is about 1 in 1,000. Generally, the intensity of rainfall that could occur for a given AEP decreases as the duration of the precipitation event increases *(Ref. 1-30)*.

On rare occasions, Wilmington can receive large snowfall amounts. During a storm event in late December 1989, the area received 9.6 inches of snow in a 24-hour period *(Ref. 1-27 and 1-31)*. This December 1989 storm also matched a previous record snow depth of 13 inches. The roof design parameters for the GLE Commercial Facility as required by the International Building Code (IBC) for the region exceed the expected loadings from snow and ice.

1.3.3.3.3 Extreme Winds

Extreme winds may occur at Wilmington International Airport due to localized events, such as thunderstorm downdrafts, microbursts, or tornadoes. In addition, the airport lies in a particularly vulnerable location for hurricane-force winds. As of 1995, the highest wind gust measured at the airport was approximately 78 mph (68 knots) *(Ref. 1-26)*; however, since that time, Wilmington has experienced Hurricanes Fran (1996), Floyd (1999), and Charley (2004). Hurricane Fran had a peak gust of approximately 86 mph (75 knots) measured at the Wilmington International Airport. Hurricane Floyd similarly caused a wind gust of approximately 86 mph (75 knots) at the airport *(Ref. 1-32)*. Hurricane Charley had somewhat lower wind gusts of approximately 74 mph (64 knots) at the airport *(Ref. 1-33)*.

1.3.3.3.4 Thunderstorms

Rainfall in the region during the summer months comes primarily from thunderstorms. These storms occur on approximately 33 percent of days during June through August in the vicinity of the Wilmington Site and are scattered and uneven in coverage *(Ref. 1-26)*. Although the inland advance of the sea breeze front often causes summer thunderstorms, other primary causes of thunderstorms in the Wilmington area are tropical storms or hurricanes approaching from the south and southeast, and large-scale synoptic fronts approaching from the north and west. The latter two causes of thunderstorms also increase the chance of severe weather. For example, hail is observed in the Wilmington area on an average of about once per year *(Ref. 1-26)* and is most likely to be associated with synoptic frontal thunderstorms. Severe thunderstorms may produce damaging straight-line winds greater than 57 mph (50 knots). According to the National Severe Storms Laboratory (NSSL) *(Ref. 1-34)*, the area surrounding the Wilmington Site experiences approximately four days per year of damaging thunderstorm winds or winds less than 57 mph (50 knots) due to a thunderstorm.

1.3.3.3.5 Lightning

Another hazard of thunderstorms is lightning, which can strike miles from a thunderstorm and often occurs without warning. Besides the obvious danger to personnel working outside, lightning can disrupt electrical circuits and cause fires. The region surrounding the Wilmington Site has experienced a lightning flash density ranging from 4 to 8 flashes/km^2/year over the period from 1996 through 2000.

1.3.3.3.6 Tornados

Fifteen tornadoes are known to have touched down in New Hanover County, North Carolina, between 1950 and 2004, including waterspouts in the sound and on the Atlantic Ocean. The strongest of these 15 tornadoes occurred on June 13, 1962 in the western part of the county and measured F2 on the Fujita scale (meaning it was capable of producing considerable damage). Wind speeds associated with an F2 tornado are between 113 - 157 miles per hour (mph).

Based on evaluation of data from the National Severe Storms Laboratory *(Ref. 1-34)*, a tornado would be expected to occur within 25 miles of the Wilmington Site on 0.4 to 0.6 days per year. The ocean covers a significant portion of the area within 25 miles of the Wilmington Site; therefore, some of these tornadoes could occur as waterspouts. Tornado design basis guidance indicates that tornadoes in the Wilmington area would be expected to have 200-mph maximum winds with an exceedance probability of 10^{-7} per year. Immediately west of the Wilmington Site, tornadoes would be expected to be more intense, with 230-mph maximum winds at an exceedance probability of 10^{-7} per year *(Ref. 1-35)*. This change in expected intensity would not be abrupt, but due to the coarse nature of the grid cells used in Regulatory Guide 1.76, *Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants (Ref. 1-35)*, to calculate the intensity regions, there is a sharp demarcation between regions.

1.3.3.3.7 Tropical Storms and Hurricanes

The area of New Hanover County could expect the following return periods for each category of hurricane passing within approximately 86 miles (75 nautical miles):

- Category 1, 6 to 10 years;
- Category 2, 23 to 30 years;
- Category 3, 33 to 44 years;
- Category 4, 79 to 120 years; and
- Category 5, 191 to 250 years (Ref. 1-36).

Because winds are stronger on the right side of the storm's eye, causing more wind damage and higher storm surges, the greatest meteorological threat to New Hanover County comes from hurricanes that strike land in the approximate area between the South Carolina border and the outlet of the Cape Fear River. In addition, the strongest bands of rain occur in front of a hurricane as it approaches, resulting in a great deal of heavy, flooding rain in New Hanover County when a storm approaches this area of coastline. Between 1954 and 2004, three hurricanes, ranging from Category 1 through Category 3, made landfall in the area. Two of the hurricanes, Hurricanes Hazel (1954) and Fran (1996), were Category 3 storms that made landfall with winds between 111 to 130 mph. According to the examination of NOAA storm surge data *(Ref. 1-33)*, most portions of the Wilmington Site, including the GLE Commercial Facility would not be directly affected by the highest storm surge.

1.3.3.3.8 Floods

The GLE Site does not fall within 100-year or 500-year floodplains *(Ref. 1-37 and 1-38)*; however, some of the low-lying areas on the Wilmington Site contain swamp forest that borders the Northeast Cape Fear River. Much of this swamp forest is in the floodplain and may flood upstream during extreme rain events.

1.3.4 Hydrology

The section contains descriptions of nearby water bodies, groundwater on and near the Wilmington Site, and design basis flood events.

1.3.4.1 Characteristics of Nearby Rivers, Streams, and Other Bodies of Water

Bodies of water in the vicinity of the Wilmington Site are the Northeast Cape Fear River (which borders the Wilmington Site to the west) and its associated tributaries and creeks. The Northeast Cape Fear River is a blackwater river with relatively low levels of dissolved oxygen and higher turbidity than the Cape Fear River. The Northeast Cape Fear River and its tributaries have a naturally low pH and are classified as swamp water by the North Carolina Department of Environment and Natural Resources Division of Water Quality. At the Wilmington Site, the river is tidally influenced. Salinity concentrations vary with the rate of freshwater input and the amount of tidal exchange.

On the Wilmington Site, there are three streams that provide habitat to aquatic wildlife. Two of the streams, unnamed Tributaries No. 1 and No. 2 (located in the Swamp Forest community in the Western Site Sector), drain to the Northeast Cape Fear River. The remaining stream is located on the Eastern Site Sector and drains northward to Prince George Creek. The first two are unnamed tributaries to the Northeast Cape Fear River and are classified as freshwater streams, but their lower reaches are tidally influenced by the river. The third stream, the unnamed tributary to Prince George Creek, is a freshwater stream and is not tidally influenced within the Wilmington Site. All three streams are capable of accommodating the aquatic species associated with the neighboring Northeast Cape Fear River. However, the tidal variations in dissolved oxygen and salinity may affect the suitability of the habitat for some species.

In addition, there are three (3) small ephemeral ponds in the Western Site Sector and North-Central Site Sector, along with wetland areas throughout the Site that provide habitat. These areas provide a water source for wildlife found on the Wilmington Site.

1.3.4.2 Depth to the Groundwater Table

On the Wilmington Site, the water table is generally located near the land surface averaging approximately 9 feet below ground surface (bgs) with a range from 0 to 20 feet bgs.

1.3.4.3 Groundwater Hydrology

The Wilmington Site is within the North Carolina Coastal Plain physiographic province, which extends from the Piedmont eastward to the North Carolina coast. The coastal aquifer system is an eastward-dipping and eastward-thickening wedge of depositional sediments and sedimentary rock underlain by a crystalline, eroded surface of igneous and metamorphic rock (Precambrian or Early Paleozoic age). Six regional aquifers are present in the region surrounding the Wilmington Site, including the Surficial Aquifer, Castle Hayne Aquifer, Peedee Aquifer, Black Creek Aquifer, and the Upper and Lower Cape Fear Aquifers. The aquifers are water-yielding formations that are more permeable than the finer-grained formations (confining units) that are typically above and/or beneath these coastal aquifers. In most areas, a less-permeable confining unit, with the exception of the Surficial Aquifer, overlies each aquifer that is under water-table conditions. The aquifers and confining units consist of sands, conglomerates, silts, clays, shell hash, and fossiliferous limestones deposited in nearshore and deltaic to offshore marine environments *(Ref. 1-39)*.

1.3.4.4 Characteristics of the Uppermost Aquifer

The Surficial Aquifer includes undifferentiated, stratified sediments. These sediments typically include terraced and barrier beach deposits, fossil sand dunes, and stream channel deposits. The sediment texture varies from medium- to fine-grained sands to silts and clays. This aquifer is recharged directly by rainfall, and the water table is generally located relatively near the land surface (approximately averaging 9 feet bgs with a range from 0 to 20 feet bgs). The hydraulic conductivity of the Surficial Aquifer has been estimated to be approximately 130 feet/day.

The Surficial Aquifer discharges into streams, drainage canals/ditches, and the low-lying swampy areas on the Wilmington Site. In addition, the Surficial Aquifer recharges groundwater into the underlying Peedee Aquifer (referred to as the Principal Aquifer). Due to yield limitations, water supply from the Surficial Aquifer is primarily restricted to domestic use.

The Wilmington Site wells produce from the Peedee Aquifer, which is the principal aquifer under the site. Groundwater is used at the existing Wilmington Site for industrial process water and drinking water. The average annual withdrawal is approximately 1.0 million gpd. Water levels measured in wells that tap the Peedee Aquifer at the Wilmington Site were evaluated in terms of the long-term sustainability of the water resource. The water levels in the aquifer do not show a long-term downward trend. A review of potential future changes to the withdrawal rates indicate that the existing water use and future estimates (approximately 10 percent increase) do not exceed the sustainable yield of the aquifer in this area (See GLE ER). The hydraulic conductivity of the Peedee Aquifer has been estimated to be approximately 38 feet/day.

1.3.4.5 Design Basis Flood Events Used for Accident Analysis

The GLE Commercial Facility is located on a high bluff, outside the 100-year (10^{-2}) and 500-year (2×10^{-3}) floodplains (that is, 0.2% chance of a catastrophic flood occurring at the level of a 500-year floodplain during any year). These flood levels occur at approximately 20 – 25 feet above msl. The Operations Building first floor elevations are above 25 feet msl.

1.3.5 Geology and Seismology

This section describes the geology and seismology at the Wilmington Site, including soil characteristics, earthquake magnitudes and return periods, and other geologic hazards.

1.3.5.1 Characteristics of Soil Types and Bedrock

Generally flat topography characterizes most of the Wilmington Site's physiography; however, the GLE Site is positioned on a topographic high compared to the adjacent land in that area of the Wilmington Site. The ground surface begins to gently roll into small low hills in the Northwestern Wilmington Site Sector, suggesting the presence of possible sand dune or remnant terrace deposits from shoreline migration in the recent geologic past. The Northeast Cape Fear River and its floodplain are the most prominent physiographic features bordering the Western and Northwestern Wilmington Site sectors. High bluffs and extensive estuarine areas along this reach of the river help protect the GLE Site from flooding events. The area west of the river channel scar, which is clearly visible in aerial images, marks an ancient flow boundary of the Northeast Cape Fear River. The abandoned part of the channel is today an estuarine area of low topographic relief bordering the current river's edge.

Surficial sedimentary deposits at the Wilmington Site are interpreted to be mostly a result of deposition in the geologic past associated with the ancient Northeast Cape Fear River system. These surficial deposits overlie the Peedee Formation at the Site and are largely undifferentiated and unconsolidated alluvial sands, clayey sands, and clays. Some of these deposits are previously deposited marine sediments that were reworked and re-deposited by alluvial processes.

The sedimentary sequence in the GLE Site is comprised of 10 to 30 feet of thin layers of silty fine sands, silty fine clayey sands, fine sandy silts, and fine sandy clays that overlie the Peedee Formation. Surficial sands are present in the area with an apparent average thickness of less than 5 feet. Thicker surficial sand deposits of approximately 10 feet thick are present in some areas. Surficial sediments in the uppermost 4 to 10 feet of this sector range from dark brown and black sand with some organic material to gray and tan fine- to medium-grained sand with minimal gravel. Beneath these sands, a dark gray, very silty and clayey fine sand is present in some locations.

At the base of the surficial deposits in many locations on the Wilmington Site lies a substantial marine clay layer considered to be part of the Peedee Formation. The Peedee Clay layer is encountered at a typical depth range of 20 to 30 feet. Hydraulically, the Peedee Clay forms an important semi-confining unit overlying the Peedee Aquifer, which is the source of process water for the existing Wilmington Site. The presence of glauconite throughout the Peedee Clay and the absence of reworked sediments more characteristic of shallower alluvial deposits suggest the Peedee Clay is of marine origin; therefore, this marine clay layer is stratigraphically considered part of the Peedee Formation. The Peedee Clay varies in both thickness and distribution across the Site.

Field observations of samples collected during investigations of the GLE Site indicate that the consistency of the Peedee Clay is generally firm, but can be softer if located near the ground surface. In general, this clay layer contains more silt than sand and is easily distinguished from other surficial alluvial clays present in some areas of the GLE Site by the uniform presence of glauconite and the Peedee Clay's characteristic gray to dark gray color.

The potential for differential settlement, or the difference in settlement across a foundation, was considered when preparing facility and roadway engineering designs. No soil types on the GLE Site pose any construction concerns.

1.3.5.2 Earthquake Magnitudes and Return Periods

Earthquake epicenters in the southeastern United States generally extend in a northeasterly orientation along the axis of the Appalachian Mountain range. In North Carolina, the vast majority of seismic activity is concentrated in the western mountainous regions, where sutures and faults are predominantly associated with North American collisional tectonics. There are clusters of events scattered throughout South Carolina, and a few isolated occurrences of singular events along the coast. A small number of events are recorded along the Mid-Atlantic Coastal Plain physiographic province. In summary, seismicity levels are low outside of the Charleston region and the mountains to the west. In the Wilmington Site region, seismicity levels are relatively low.

Since the mid-1990s, the U.S. Department of the Interior has published probability of exceedance maps for ground shaking at one and five hertz (Hz) for a 50-year time span *(Ref. 1-31)*. A spectral acceleration of one Hz represents low frequency ground shaking (appropriate for Rayleigh and Love surface waves), whereas a five-Hz spectral acceleration represents high-frequency ground shaking related to body waves (P-waves and S-waves). For many cases of interest, the primary controlling earthquake is the postulated event that governs the spectral accelerations in the five-to ten-Hz range *(Ref. 1-40)*. The maps are developed for peak horizontal ground acceleration or spectral accelerations with two percent, five percent, or

ten percent probability of being exceeded in 50 years on uniform firm-rock site conditions (Vs30 = 760 m/s). These data present the peak acceleration for earthquakes believed to be likely near a given site. The Wilmington Site has a peak acceleration of approximately 0.1 g at two percent probability for five Hz wave over 50 years. This corresponds to a peak acceleration of approximately 0.03 g for a ten percent probability of exceedance in 50 years (500-yr earthquake).

There are no significant geological features in the Wilmington region that would produce a major earthquake. The IBC has identified this area as Zone 1 and considers seismic events of minor magnitude (Mercalli VI, Richter 5.5 – 6.0).

The Charleston, S.C., earthquake of 1886 was felt in Wilmington, producing effects equivalent to Mercalli V– VI (Richter 4.8 – 5.4). Since then there have been nine recorded seismological events in the Wilmington area, all of which have been minor in nature, producing effects no greater than Mercalli IV (Richter 4.5). The U.S Geological Survey predicts the probability of a Richter 4.75 event at 2 x 10-4 and a Richter 5.0 at 2 x 10–5.

Based on the U.S. Geological Survey, documented historical events, the IBC design criteria, and the design margins used both in establishing the IBC criteria and the building designs to meet the IBC, it is improbable that an earthquake would affect the structures on the GLE Commercial Facility Site in such a way as to cause an accident scenario resulting in consequences exceeding the performance criteria in 10 CFR 70.61.

1.3.5.3 Other Geologic Hazards

As described in Section 1.3.1.2, other geologic hazards are not present at the Wilmington Site. There are no mountain ranges nearby. The terrain of the GLE Site is very gently sloping (gradients less than two percent) with little relief; therefore, landslides are not credible events. There is no volcanic or glacial activity in the region or vicinity of the Wilmington Site.

Soil samples collected at the Wilmington Site typically do not have high amounts of natural organic material. In addition, no peat deposits that could be a potential source of methane gas have been identified within the GLE Site.

The projected lowering of the potentiometric surface in the GLE Site as a result of the groundwater withdrawals from the aquifer on and in the vicinity of the Wilmington Site is minimal, and no greater than the historical seasonal fluctuations have been observed in groundwater levels. In addition, the absence of a thick or regionally continuous confining bed on the GLE Site further minimizes the potential for subsidence as a result of lowered groundwater levels; therefore, subsidence due to dewatering is not credible.

There are no active mines adjacent to the Wilmington Site or known economic deposits of minerals, stone, or fuel materials that could cause subsidence at the GLE Site.

1.4 REFERENCES

1-1. Atomic Energy Act of 1954

1-2. 10 CFR 70, *Domestic Licensing of Special Nuclear Material*, U.S. Nuclear Regulatory Commission, 2008.

1-3. 10 CFR 40, *Domestic Licensing of Source Material,* U.S. Nuclear Regulatory Commission, 2008.

1-4. 10 CFR 30, Rules *of General Applicability to Domestic Licensing of Byproduct Material*, U. S. Nuclear Regulatory Commission, 2008.

1-5. 10 CFR 70.61, *Performance Requirements*, U.S. Nuclear Regulatory Commission, 2008.

1-6. NRC License SNM-1097, *License Renewal Application for Global Nuclear Fuel – Americas, LLC*, Docket 70-1113, April 2007.

1-7. USEC-651, *Uranium Hexafluoride: A Manual of Good Handling Practices*, Uranium Enrichment Corporation, Revision 7, January 1995.

1-8. USEC Privatization Act, Pub. L. 104-134, Title III, Section 3113, United States Enrichment Corporation, April 1996.

1-9. 10 CFR 95, *Facility Security Clearance and Safeguards of National Security Information and Restricted Data*, U.S. Nuclear Regulatory Commission, 2008.

1-10. 10 CFR 50, *Domestic Licensing of Production and Utilization Facilities,* U.S. Nuclear Regulatory Commission, 2008.

1-11. 10 CFR 72, *Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and reactor Related Greater Than Class C Waste*, U.S. Nuclear Regulatory Commission, 2008.

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Table 1-1. Typical Types, Sources, Quantities of Solid Wastes Generated by GLE Commercial Facility Operations.

Waste Type	Waste Source	Estimated Average Annual Quantity Generated
Municipal Solid Waste (MSW)	General worker operations, maintenance, and administrative activities not involving the handling of or exposure to uranium	380 ton/yr
Non-hazardous Industrial Wastes	Non-hazardous wastes from equipment cleaning and maintenance activities (for example, used coolant, non-hazardous caustic, and filter media) that are recyclable or not accepted by MSW landfill	107 ton/yr
Resources Conservation and Recovery Act (RCRA) hazardous waste	Wastes designated as RCRA hazardous wastes from equipment and maintenance activities (for example, used cleaning solvents and used solvent-contaminated rags)	12 ton/yr
Low-Level Radioactive Waste (LLRW)	Laboratory waste from UF_6 feed sampling and analysis	97 lb/yr
	Combustible, uranium-contaminated used items (for example, worker personal protection equipment, swipes, step-off pads)	92 ton/yr
	Noncombustible, uranium-contaminated, used items (for example, spent filters from HVAC systems, liquid radiological waste treatment system, and area monitors) and corrective maintenance items (defective pigtails, valves, and other safety equipment that needs replacement)	863 yd^3/yr
	Liquid radiological waste treatment system filtrate/sludge	670 lb/yr

Table 1-2. Management of Solid Wastes.

Solid Waste Source	Onsite Waste Management	Offsite Waste Treatment/Disposal
Municipal solid waste (MSW)	Collected and temporarily stored in roll-off containers	Filled roll-off containers transported by commercial refuse collection service to an approved disposal site
Non-hazardous wastes from operations equipment cleaning and maintenance activities that are recyclable or not accepted by MSW landfill	Collected and temporarily stored in containers	Filled containers transported by truck to an approved disposal site[a]
Wastes designated as Resource Conservation and Recovery Act (RCRA) hazardous wastes	Collected and temporarily stored in containers	Filled containers transported by truck to an approved disposal site[b]
Laboratory waste from UF_6 feed sampling and analysis	Collected and temporarily stored in containers	Either transported by truck to an approved disposal site or transported to an approved uranium recovery vendor.
Combustible used or spent uranium-contaminated materials	Collected and temporarily stored in containers	Either transported by truck to an approved disposal site or transported to an approved uranium recovery vendor.
Non-combustible used or spent uranium-contaminated materials	Collected and temporarily stored in boxes	Filled boxes transported by truck to an approved disposal site[c]
Liquid Radiological Waste Treatment System filtrate/sludge	Collected and temporarily stored in metal cans	Filled cans transported by truck to an approved disposal site

[a] Licensed RCRA Subpart D landfill.

[b] Licensed RCRA Subpart C Treatment, Storage, and Disposal Facility (TSDF).

[c] Licensed Low-Level Radioactive Waste Disposal Facility.

Table 1-3. Typical Types, Sources, and Quantities of Wastewater Generated by GLE Commercial Facility Operations.

Wastewater Type	Wastewater Source	Typical Average Daily Quantity Generated
Process liquid radiological waste	Wastewaters from the Operations Building Decontamination/Maintenance Area; process area floor drains, sinks, sumps, and mop water; Laboratory Area floor drains, sinks, sumps, and mop water; change room showers and sink; and aqueous process liquids that have the potential to contain uranium	5,000 gpd
Cooling tower blowdown	Operations Building HVAC cooling tower	30,000 gpd
Sanitary Waste	Sanitary waste from building areas used by GLE personnel (for example, restrooms, break rooms)	10,500 gpd
Stormwater	Stormwater runoff from impervious surfaces (for example, building roofs, parking lots, service roads, outdoor storage pads, and other maintained areas)	Variable depending on local precipitation

Table 1-4. Management of Wastewater Generated by GLE Commercial Facility Operations.

Wastewater Type	Onsite Waste Management	Offsite Waste Treatment/Disposal
Process liquid radiological waste	Wastewaters collected in closed drain system connected to Radiological Liquid Waste Treatment System (RLETS). Treated radiological waste effluent discharged to existing Wilmington Site process wastewater aeration basin and Final Process Lagoon Treatment Facility (FPLTF)	Treated effluent from the Wilmington Site FPLTF is discharged at NPDES-permitted Outfall 001 to the onsite effluent channel
Cooling tower blowdown	Blowdown pumped from cooling tower to existing Wilmington Site FPLTF	Treated effluent from the Wilmington Site FPLTF discharged at NPDES-permitted Outfall 001 to the onsite effluent channel
Sanitary Waste	Sanitary waste collected in sewer system connected to existing Wilmington Site Sanitary Wastewater Treatment Plant. Waste stream treated by activated sludge aeration process.	Treated effluent from the Wilmington Site Sanitary Wastewater Treatment Plant is discharged at NPDES-permitted Outfall 002 to the onsite effluent channel
Stormwater	Stormwater runoff collected in drainage conduits and channels flowing to onsite retention basins.	Stormwater from onsite retention basins is discharged per requirements of NPDES storm water permit.

Table 1-5. Typical GLE Air Emissions.

Constituent	Amount	Regulatory Limit
Uranium	$8x10^{-15}$ µCi/mL [a]	$3x10^{-12}$ µCi/mL [b]
Hydrogen Fluoride	< 0.50 lb/day	~0.50 lb/day [c]

[a] Per Global Laser Enrichment Environmental Report, December 2008.

[b] Per 10 CFR 20, Appendix B.

[c] Best estimate provided as the actual limit is specified on the North Carolina Department of Environment and Natural Resources air permit to be issued prior to operations.

Table 1-6. GLE Commercial Facility Capital Cost Estimate.

[This table contains Proprietary Information which is withheld from public disclosure per 10 CFR 2.390]

Table 1-7. Type, Quantity, and Form of Licensed Special Nuclear Material.

Source and/or Special Nuclear Material	Physical and Chemical Form	Maximum Amount to be Possessed at any One Time
Uranium (natural and depleted) and daughter products	Physical: solid, liquid, and gas Chemical: UF_6, UF_4, UO_2F_2, oxides and other compounds	140,000,000 kg
Uranium enriched in isotope ^{235}U up to 8 percent by weight and uranium daughter products	Physical: solid, liquid, and gas Chemical: UF_6, UF_4, UO_2F_2, oxides and other compounds	2,600,000 kg

Figure 1-1. Wilmington Site and County Location.

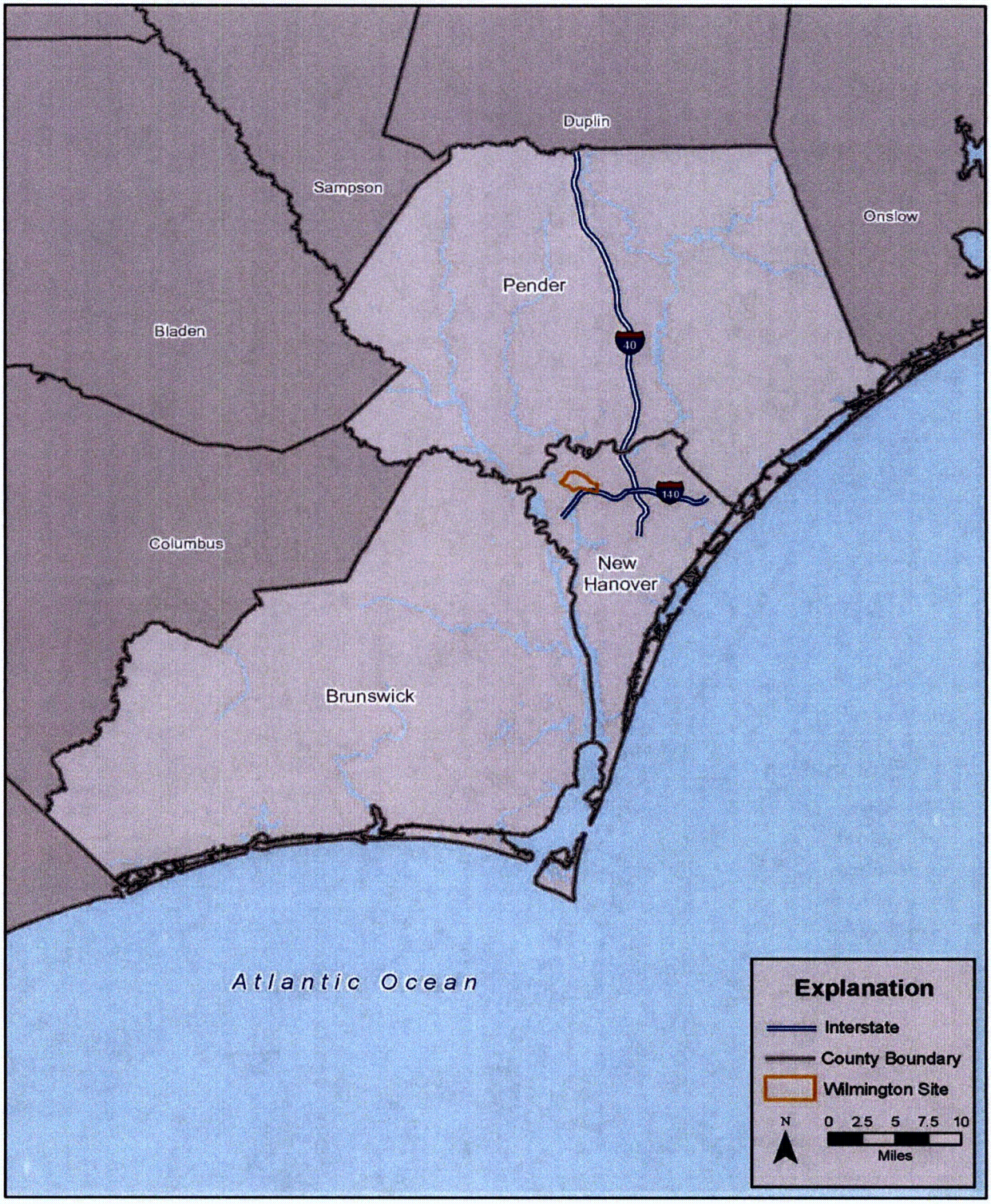


Figure 1-2. Wilmington Site, New Hanover County, and Other Adjacent Counties.

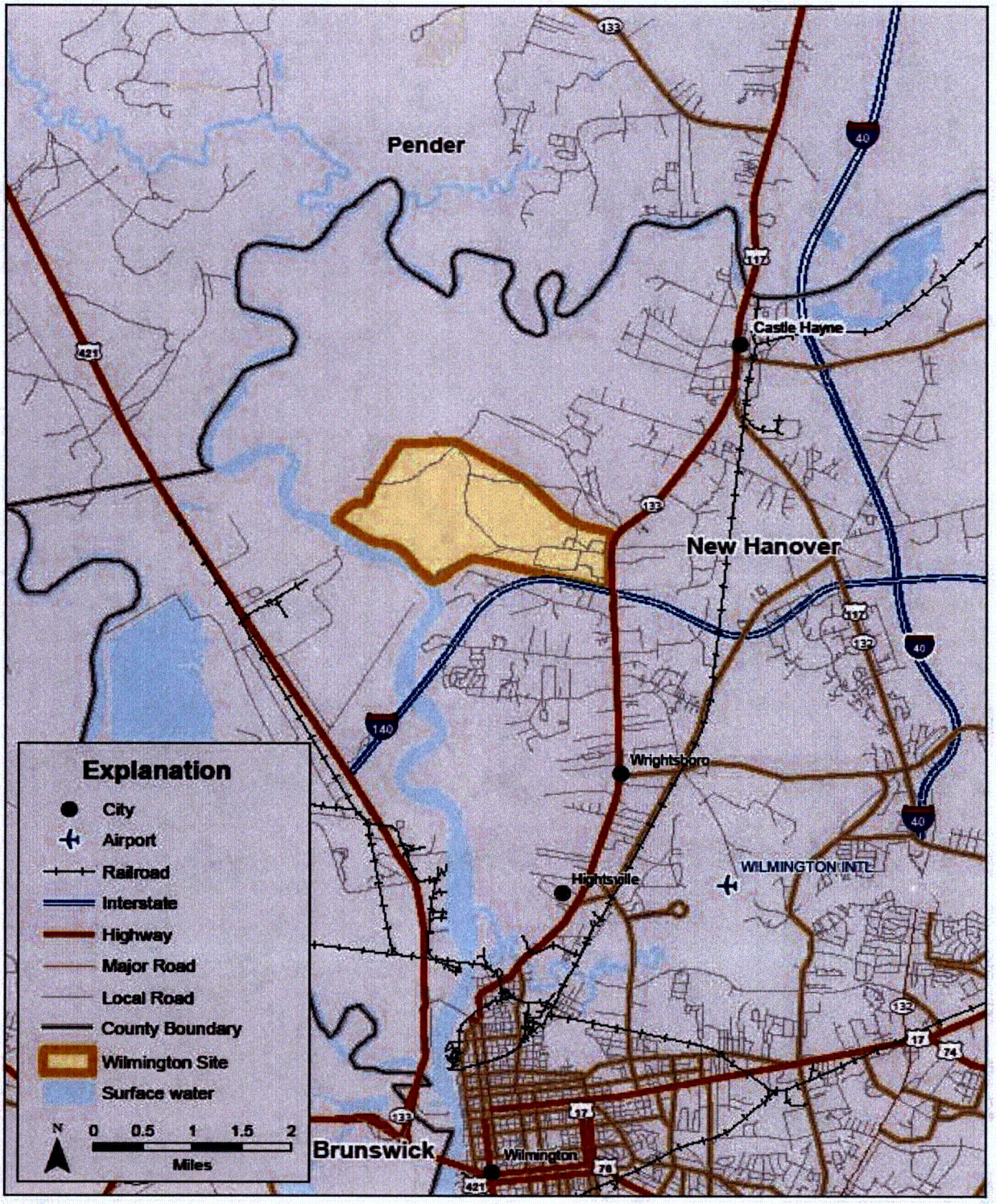


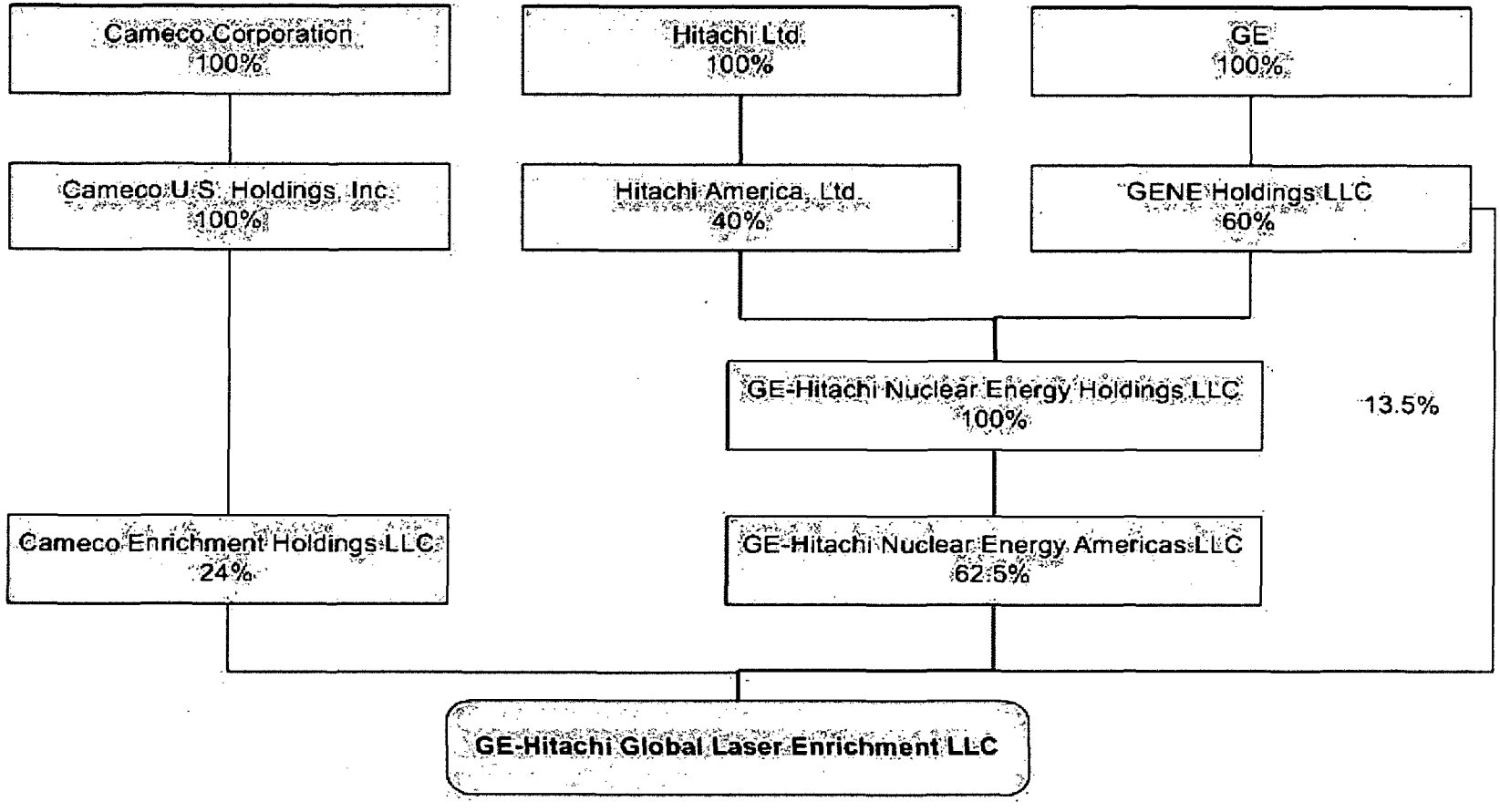
Figure 1-3. Wilmington Site Plan.

[This figure Contains Security-Related Information Withheld from Public Disclosure per 10 CFR 2.390]

Figure 1-4. GLE Commercial Facility Site Plan.

[This Figure Contains Security-Related Information Withheld from Public Disclosure per 10 CFR 2.390]

Figure 1-5. GLE Ownership.



GE Indirect Membership Interest:	51%	(60% x 62.5% + 13.5%)
Hitachi, Ltd. Indirect Membership Interest:	25%	(40% x 62.5%)
Cameco Corporation Indirect Membership Interest:	24%	

Figure 1-6. Community Characteristics Near the Wilmington Site.

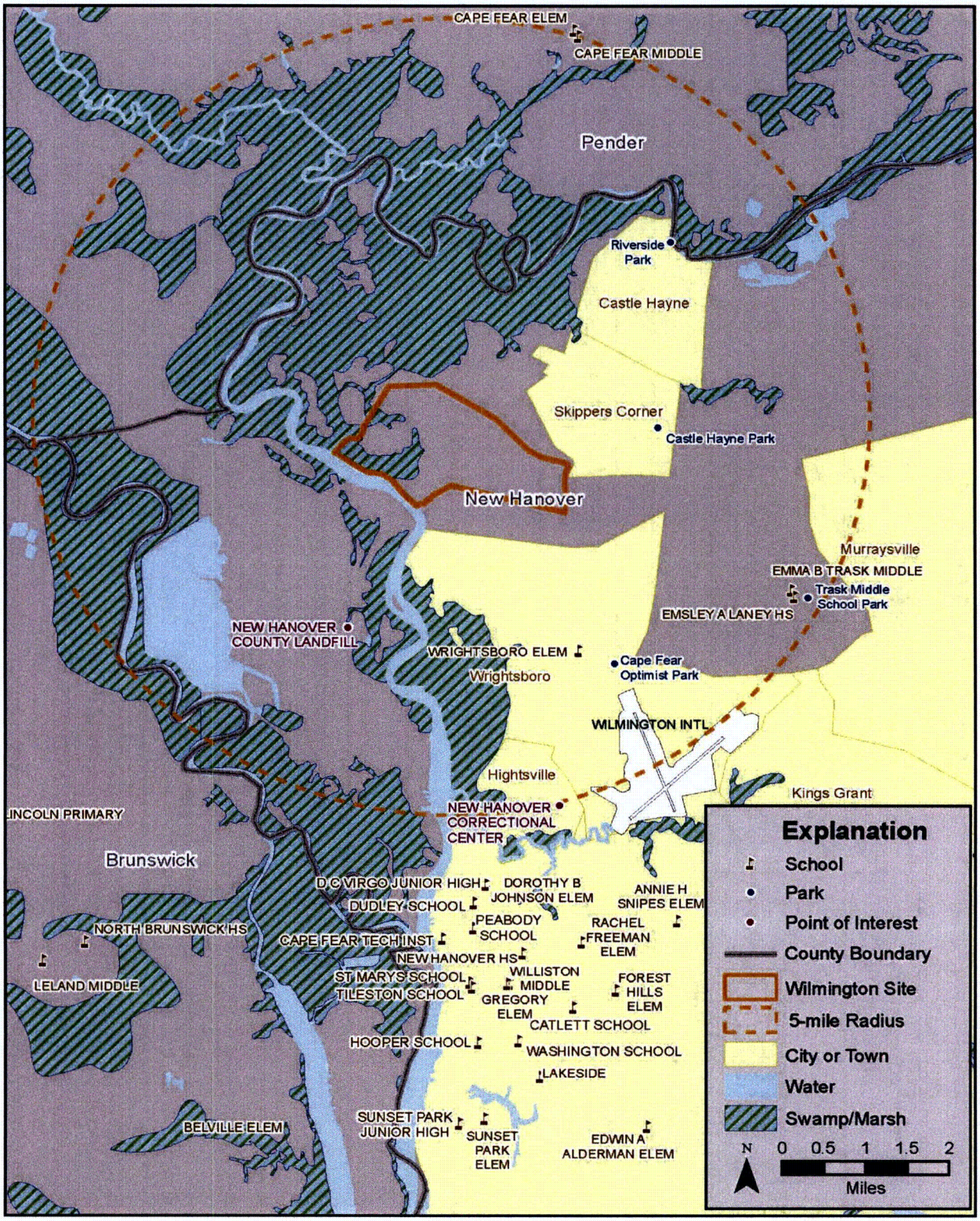
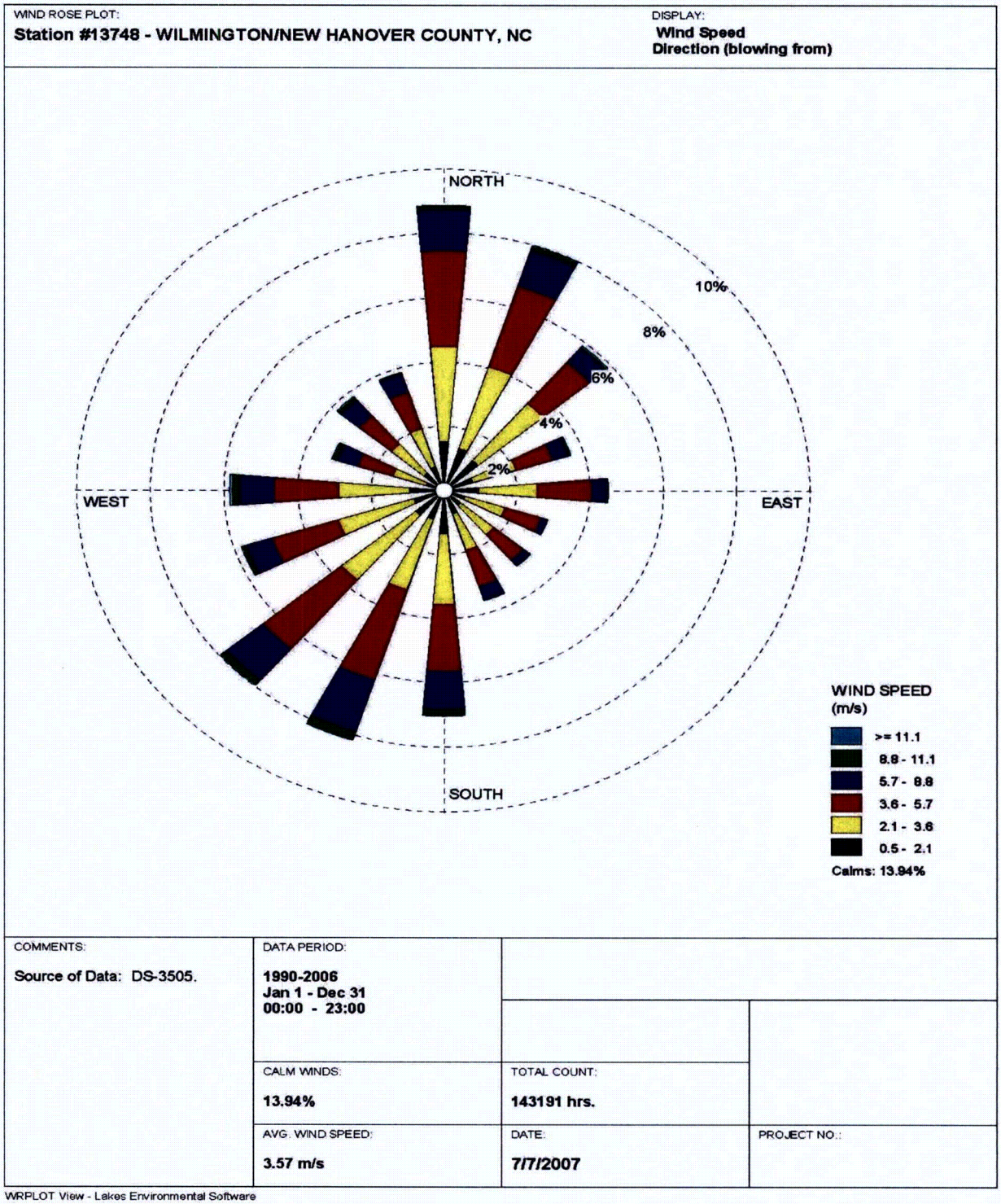


Figure 1-7. Wind Rose for Wilmington International Airport.



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APPENDIX A -

GUIDELINES FOR DECONTAMINATION OF FACILITIES AND EQUIPMENT PRIOR TO RELEASE FOR UNRESTRICTED USE OR TERMINATION OF LICENSES FOR BYPRODUCT, SOURCE, OR SPECIAL NUCLEAR MATERIAL

U.S. Nuclear Regulatory Commission
Division of Fuel Cycle Safety
and Safeguards
Washington, DC 20555
April 1993

APPENDIX A

The instructions in this guide, in conjunction with Table 1, specify the radionuclides and radiation exposure rate limits which should be used in decontamination and survey of surfaces or premises and equipment prior to abandonment or release for unrestricted use. The limits in Table 1 do not apply to premises, equipment, or scrap containing induced radioactivity for which the radiological considerations pertinent to their use may be different. The release of such facilities or items from regulatory control is considered on a case-by-case basis.

1. The licensee shall make a reasonable effort to eliminate residual contamination.

2. Radioactivity on equipment or surfaces shall not be covered by paint, plating, or other covering material unless contamination levels, as determined by a survey and documented, are below the limits specified in Table 1 prior to the application of the covering. A reasonable effort must be made to minimize the contamination prior to use of any covering.

3. The radioactivity on the interior surfaces of pipes, drain lines, or ductwork shall be determined by making measurements at all traps, and other appropriate access points, provided that contamination at these locations is likely to be representative of contamination on the interior of the pipes, drain lines, or ductwork. Surfaces of premises, equipment, or scrap which are likely to be contaminated but are of such size, construction, or location as to make the surface inaccessible for purposes of measurement shall be presumed to be contaminated in excess of the limits.

4. Upon request, the Commission may authorize a licensee to relinquish possession or control of premises, equipment, or scrap having surfaces contaminated with materials in excess of the limits specified. This may include, but would not be limited to, special circumstances such as razing of buildings, transfer of premises to another organization continuing work with radioactive materials, or conversion of facilities to a long-term storage or standby status. Such requests must:

   a. Provide detailed, specific information describing the premises, equipment or scrap, radioactive contaminants, and the nature, extent, and degree of residual surface contamination.

   b. Provide a detailed health and safety analysis which reflects that the residual amounts of materials on surface areas, together with other considerations such as prospective use of the premises, equipment, or scrap, are unlikely to result in an unreasonable risk to the health and safety of the public.

5. Prior to release of premises for unrestricted use, the licensee shall make a comprehensive radiation survey which establishes that contamination is within the limits specified in Table 1. A copy of the survey report shall be filed with the Division of Fuel Cycle Safety and Safeguards, U. S. Nuclear Regulatory Commission, Washington, DC 20555, and also the Administrator of the NRC Regional Office having jurisdiction. The report should be filed at least 30 days prior to the planned date of abandonment. The survey report shall:

a. Identify the premises.

b. Show that reasonable effort has been made to eliminate residual contamination.

c. Describe the scope of the survey and general procedures followed.

d. State the findings of the survey in units specified in the instruction.

Following review of the report, the NRC will consider visiting the facilities to confirm the survey.

APPENDIX A

TABLE 1
ACCEPTABLE SURFACE CONTAMINATION LEVELS

NUCLIDES[a]	AVERAGE[bcf]	MAXIMUM[bdf]	REMOVABLE[bef]
U-nat, U-235, U-238, and associated decay products	5,000 dpm α/ 100 cm^2	15,000 dpm α/ 100 cm^2	1,000 dpm α/ 100 cm^2
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1000 dpm/100 cm^2	3000 dpm/100 cm^2	200 dpm/100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5,000 dpm βγ/ 100 cm^2	15,000 dpm βγ/ 100 cm^2	1,000 dpm βγ/ 100 cm^2

[a]Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides should apply independently.

[b]As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[c]Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.

[d]The maximum contamination level applies to an area of not more than 100 cm^2.

[e]The amount of removable radioactive material per 100 cm2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

[f]The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/hr at 1 cm and 1.0 mrad/hr at 1 cm, respectively, measured through not more than 7 milligrams per square centimeter of total absorber.

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2. ORGANIZATION AND ADMINISTRATION

This chapter of the GE-Hitachi Global Laser Enrichment LLC (GLE) Commercial Facility License Application (LA) presents the organizations responsible for managing the design, construction, operation, and decommissioning of the GLE Commercial Facility. Key management and supervisory positions and functions are described, including personnel qualifications for each key position. This chapter also describes the management system and administrative procedures for effective implementation of Environmental, Health, and Safety (EHS) functions at the GLE Commercial Facility.

It is a GLE policy to maintain a safe work place for employees and assure operational compliance within the terms and conditions of the license and applicable regulations. The GLE Facility Manager has overall operational responsibility for safety and compliance to this GLE policy. In particular, GLE employs the principle of keeping radiation exposures to employees and the general public as low as reasonably achievable (ALARA).

2.1 ORGANIZATIONAL STRUCTURE

2.1.1 Corporate Functions, Responsibilities, and Authority

GLE supports the national energy security goal of maintaining a reliable and secure domestic source of enriched uranium. GLE uses the laser-based technology, which represents a cost-effective and efficient technology for the enrichment of uranium for domestic and foreign nuclear power plants.

GLE is a limited liability corporation formed to provide uranium enrichment services for commercial nuclear power plants. The GLE partnership is described in GLE LA Section 1.2, *Institutional Information*. GLE's immediate parent company, GE-Hitachi Nuclear Energy Americas LLC (GEH), is the parent company of U.S. Nuclear Regulatory Commission (NRC) licensees whom are licensed under 10 CFR 50, *Domestic Licensing of Production and Utilization Facilities (Ref. 2-1)*, 10 CFR 70, *Domestic Licensing of Special Nuclear Material (Ref. 2-2)*, and 10 CFR 72, *Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor Related Greater Than Class C Waste (Ref. 2-3)*, at facilities in Sunol, California; Wilmington, North Carolina; and Morris, Illinois. The GLE President and Chief Executive Officer (CEO) reports to, and receives policy direction from, the GEH Fuel Cycle Senior Vice President; who in turn, reports to the President and CEO of GEH.

The GLE President and CEO provides overall direction and management with respect to design, construction, operation, and decommissioning activities. Figure 2-1, *GLE Organizational Structure During Design and Construction*, details the organization of GLE during design and construction. Figure 2-2, *GLE Organizational Structure during Operations*, details the organization of GLE during operations.

2.1.2 GLE Design and Construction Organizational Structure

As the owner and operator, GLE is responsible for the design, construction, operation, maintenance, modification, and testing of the GLE Commercial Facility. The GLE President and CEO is responsible for ensuring the facility complies with applicable regulatory requirements and establishing the basic policies of the QA Program. These polices are described in the Quality Assurance Program Description (QAPD) document, are transmitted to all levels of management, and are implemented through approved written procedures.

The Engineering Manager is responsible for developing the conceptual design for the facility, which includes the development of design requirements, design bases, and design criteria for the enrichment process and supporting systems. An architect/engineering (A/E) firm has been contracted to further specify structures and systems, as well as to ensure the design meets applicable U.S. codes and standards. A contractor specializing in site evaluations has been contracted to perform the site evaluation. Nuclear consultants have been contracted to support the Integrated Safety Analysis (ISA) and to support the development of the LA. During the construction phase, preparation of construction documents, in addition to construction itself, is completed utilizing qualified contractors. The GLE QA function reviews and approves contractor QA Programs. Approval of contractor QA Programs shall be obtained prior to commencing work activities.

As shown in Figure 2-1, the Commercial Facility Project Manager (CFPM) is responsible for managing the design, construction, initial startup, and procurement activities. In addition to managing A/E and construction contracts, the CFPM also manages a group of Project Managers, the Project Controls Manager, the Configuration Management (CM) Manager, and the ISA Manager. The Project Managers are responsible for implementing procurement, construction, engineering, project engineering, project controls, and startup.

The lines of communication of key management positions during design and construction are shown in Figure 2-1. The GLE EHS and QA Organizations support the CFPM; however, the organizations are independent allowing for objective audit, review, and control activities. During design and construction, the GLE QA and Infrastructure Manager reports to the GLE President and CEO.

Position descriptions of key personnel, during the design and construction phase, shall be accessible to affected personnel and the NRC.

2.1.3 Operations Organizational Structure

The GLE organizational structure during operations is shown in Figure 2-2. GLE has direct responsibility for preoperational testing, initial startup, operation, and maintenance of the GLE Commercial Facility. The GLE Facility Manager reports to the GLE President and CEO and is responsible for the overall operation, administration, and regulatory compliance of the GLE Commercial Facility. In the discharge of these responsibilities, the GLE Facility Manager directs the activities of the following: QA, Operations, Technical Services, Business/Administration, EHS, and the Facility Safety Review Committee (FSRC).

The responsibilities, authorities, and lines of communication of key management positions within the Operations Organization are discussed in Section 2.2, *Key Management Positions, Responsibilities, and Qualifications.*

During operations, the GLE QA Manager reports to the GLE Facility Manager; however, the GLE QA Manager has the authority and responsibility to directly contact the GLE President and CEO with any QA concerns during operations. Likewise, the GLE EHS Manager has the authority and responsibility to directly contact the GLE President and CEO with any EHS concerns during operations.

2.1.4 Transition From Design and Construction to Operations

GLE is responsible for the design, QA, construction, testing, initial startup, operation, and decommissioning of the GLE Commercial Facility. When the end of construction approaches, the focus of the organization will shift from design and construction to initial startup and operation. As facility construction nears completion, GLE will staff the Operations Organization to ensure a smooth transition from construction activities to operation activities. During this transition, the GLE EHS Manager position reports directly to the GLE President and CEO (as shown in Figure 2-1) for EHS matters related to design and construction and reports directly to the GLE Facility Manager (as shown in Figure 2-2) for EHS matters related to operations. This position is intentionally duplicated to provide significant continued focus on the EHS goals during design and construction when the Operating Organization is not yet fully developed and implemented. Similarly, the QA Manager position is duplicated during the transition from design and construction to operations to ensure quality is adequately maintained throughout the transition phase.

As the construction of systems is completed, the systems undergo acceptance testing as required by approved written procedures. Following successful completion of acceptance testing, systems are transferred from the Construction Organization to the Operations Organization by means of a detailed transition plan. The turnover includes the physical systems, corresponding design information, and records. Following turnover, the Operations Organization is responsible for system maintenance and CM. The design basis for the facility is maintained during the transition from construction to operations through the CM Program described in GLE LA Chapter 11, *Management Measures.*

2.2 KEY MANAGEMENT POSITIONS, RESPONSIBILITIES, AND QUALIFICATIONS

This section describes the key functional positions responsible for managing the safe operation of the GLE Commercial Facility. The responsibilities, authorities, and lines of communication for each key management position are provided in this section. Management responsibilities, supervisory responsibilities, and nuclear criticality safety (NCS) engineering staff responsibilities related to NCS are in accordance with American National Standards Institute (ANSI)/American Nuclear Society (ANS)-8.19-2005, *Administrative Practices for Nuclear Criticality Safety (Ref. 2-4).*

Responsibilities, authorities, and inter-relationships of the GLE organizational groups with responsibilities important to safety are specified in approved written position descriptions and procedures.

Individuals who do not meet the qualification requirements described in this section are not automatically eliminated from a position if other factors provide sufficient demonstration of their abilities to fulfill the duties of the position. These factors shall be evaluated on a case-by-case basis, and approved and documented by the GLE Facility Manager.

2.2.1 Global Laser Enrichment President and Chief Executive Officer

The GLE President and CEO reports to, and receives policy direction from, the GEH Nuclear Energy Fuel Cycle Senior Vice President and is responsible for providing overall direction and management of GLE activities. The GLE President and CEO is also responsible for maintaining the basic policies of the QA Program, and ensuring those policies are transmitted to all levels of management and implemented appropriately through approved written procedures.

2.2.2 Global Laser Enrichment Facility Manager

The GLE Facility Manager reports to the GLE President and CEO and is the individual with the overall responsibility for safety and activities conducted at the GLE Commercial Facility. The activities of the GLE Facility Manager are performed in accordance with GLE's policies, procedures, and work instructions. The GLE Facility Manager provides for safety, control of operations, and protection of the environment by delegating and assigning responsibility to qualified line management and area managers.

The GLE Facility Manager shall have, as a minimum, a bachelor's degree in an engineering or scientific field and four years of experience in nuclear facility operations. The GLE Facility Manager shall be knowledgeable of the safety program concepts as applied to the overall safety of the facility, and has the authority to enforce the shutdown of any process or facility. The GLE Facility Manager must approve restart of an operation that he/she directs to be shutdown.

2.2.3 Global Laser Enrichment Quality Assurance Manager

The GLE QA Manager reports to the GLE Facility Manager and is responsible for establishing and maintaining the GLE QA Program. Line management and their staff, who are responsible for performing quality-affecting work, are responsible for ensuring implementation of and compliance with the GLE QA Program. The GLE QA Manager position is independent from other management positions at the facility to ensure the GLE QA Manager has access to the GLE Facility Manager for matters affecting quality. In addition, the GLE QA Manager has the authority and responsibility to contact the GLE President and CEO with any QA concerns.

The GLE QA Manager shall have, as a minimum, a bachelor's degree in an engineering or scientific field and four years of supervisory nuclear experience in the implementation of a QA Program. The GLE QA Manager shall have at least two years experience in a QA Organization at a nuclear facility.

2.2.4 Operations Organization

2.2.4.1 Operations Manager

The Operations Manager reports to the GLE Facility Manager and has the responsibility of directing the day-to-day operation of the facility. This includes activities such as ensuring the correct and safe operation of uranium hexafluoride (UF_6) processes, proper handling of UF_6, and the identification and mitigation of any off-normal operating conditions. In the absence of the GLE Facility Manager, the Operations Manager may assume the responsibilities and authorities of the GLE Facility Manager.

The Operations Manager shall have, as a minimum, a bachelor's degree (or equivalent) in an engineering or scientific field and four years of related nuclear experience.

2.2.4.2 Maintenance Manager

The Maintenance Manager reports to the Operations Manager and has the responsibility of directing and scheduling maintenance activities to ensure proper operation of the facility. Other Maintenance Manager responsibilities typically include, but are not limited to, activities such as: corrective and preventive maintenance of facility equipment; preparation and implementation of maintenance procedures; and coordinating and maintaining testing programs for the facility, to include testing of systems, structures, and components (SSCs) to ensure the SSCs are functioning as specified in design documents.

The Maintenance Manager shall have, as a minimum, a bachelor's degree (or equivalent) in an engineering or scientific field and four years of related nuclear experience.

2.2.4.3 Configuration Management Manager

The CM Manager reports to the Operations Manager and is responsible for establishing and maintaining a CM Program for uranium enrichment equipment and safety controls, including related record retention.

The CM Manager shall have, as a minimum, a bachelor's degree (or equivalent) in an engineering or scientific field and two years experience in related assignments; or a high school diploma with eight years of related experience. The CM Manager shall have experience in the understanding and management of the assigned programs.

2.2.4.4 Area Managers

Area managers report to the Operations Manager. Area managers are the designated individuals responsible for ensuring activities necessary for safe operations and protection of the environment are conducted properly, within their assigned area(s) of the facility, in which uranium materials are processed, handled, or stored. Designated area manager responsibilities typically include, but are not limited to, the following:

- Assure safe operation, maintenance, and control of activities;
- Assure safety of the environs as influenced by operations;

- Assure performance of ISA for the assigned facility area, as required;
- Assure application of management measures and QA elements to safety controls, as appropriate;
- Assure configuration control for Items Relied on for Safety (IROFS) in the assigned facility area, as required;
- Ensure use of approved written procedures which incorporate safety controls and limits; and
- Provide adequate operator training.

The area managers shall have, as a minimum, a bachelor's degree (or equivalent) in a technical field, and two years of experience in operations, one of which is in fuel cycle facility operations; or a high school diploma with five years of operations experience, two of which are in fuel cycle facility operations. Area managers shall be knowledgeable of the safety program procedures (including Industrial Safety, Radiation Protection [RP], NCS, and Environmental Protection) and shall have experience in the application of the program controls and requirements, as related to their assigned area of responsibility. The GLE Facility Manager shall approve the assignment of individuals to the position of area manager. A listing of area managers, by area of responsibility, shall be maintained current at the facility.

2.2.4.5 Shift Supervisors

Shift supervisors report to the Operations Manager and are the interface between management and facility operators. Designated shift supervisor responsibilities typically include, but are not limited to, the following:

- Provide day-to-day work direction to operators and other assigned workers;
- Assure safe operation and control of activities;
- Assure adherence to approved written procedures and controls;
- Provide adequate operator oversight and guidance; and
- Identify and communicate off-normal conditions.

The shift supervisors shall have, as a minimum, a high school diploma and three years of experience in a technical field. Shift supervisors shall be knowledgeable of the applicable safety program procedures (including Industrial Safety, RP, NCS, and Environmental Protection).

2.2.4.6 Integrated Safety Analysis Manager

The ISA Manager reports to the Operations Manager. ISA Manager responsibilities typically include, but are not limited to, the following:

- Establish and maintain the ISA program;
- Identify IROFS;
- Identify the management measures and QA elements to be applied to safety controls; and
- Provide advice and counsel to area managers on matters of the ISA program.

The ISA Manager shall have, as a minimum, a bachelor's degree (or equivalent) in an engineering or scientific field and four years experience in related assignments. The ISA Manager shall have experience in the understanding and management of the assigned programs.

2.2.5 Technical Services Organization

2.2.5.1 Technical Services Manager

The Technical Services Manager reports to the GLE Facility Manager and has the responsibility of providing technical support to the GLE Commercial Facility. The Technical Services Manager is responsible for providing support for facility modifications; engineering support for operations and maintenance; operation of the laboratories; and information technology support. In the absence of the GLE Facility Manager, the Technical Services Manager may assume the responsibilities and authorities of the GLE Facility Manager.

The Technical Services Manager shall have, as a minimum, a bachelor's degree (or equivalent) in an engineering or scientific field and five years of related experience. The Technical Services Manager shall have experience in the understanding and management of the assigned programs.

2.2.5.2 Projects Manager

The Projects Manager reports to the Technical Services Manager and has the responsibility for the implementation of facility modifications. The Projects Manager also provides engineering support, as needed, to support operations, maintenance, and performance testing of systems and equipment.

The Projects Manager shall have, as a minimum, a bachelor's degree (or equivalent) in an engineering or scientific field and five years of related nuclear experience.

2.2.5.3 Engineering Manager

The Engineering Manager reports to the Technical Services Manager and has the responsibility for providing engineering support for the GLE Commercial Facility. The responsibilities of the Engineering Manager include, but are not limited to, the following: ensuring the safe operation of enrichment and support equipment; providing maintenance support for equipment and systems; and supporting the development of operating and maintenance procedures. The Engineering Manager is responsible for the development of design changes to the facility.

The Engineering Manager shall have, as a minimum, a bachelor's degree (or equivalent) in an engineering or scientific field and a minimum of five years of related nuclear experience in implementing and supervising a nuclear engineering program.

2.2.5.4 Chemistry Manager

The Chemistry Manager reports to the Technical Services Manager and has the responsibility for the implementation of chemistry analysis programs and procedures for the GLE Commercial Facility. The Chemistry Manager's responsibilities typically include, but are not limited to, chemical analysis of samples and maintaining the laboratories.

The Chemistry Manager shall have, as a minimum, a bachelor's degree (or equivalent) in an engineering or scientific field and a minimum of three years of related nuclear experience associated with implementation of a chemistry program.

2.2.6 Business Organization

2.2.6.1 Business Manager

The Business Manager reports to the GLE Facility Manager and has the responsibility of providing business and administrative support to the GLE Commercial Facility. The Business Manager's responsibilities typically include, but are not limited to, procurement (sourcing), document control, records management, finance, training, and human resources.

The Business Manager shall have, as a minimum, a bachelor's degree (or equivalent) in Personnel Management, Business Administration, or a related field, and three years of related experience in implementing and supervising administrative responsibilities at a nuclear facility.

2.2.6.2 Document Control Manager

The Document Control Manager reports to the Business Manager and has the responsibility for establishing and maintaining a Document Control System for adequately controlling documentation at the GLE Commercial Facility.

The Document Control Manager shall have, as a minimum, a bachelor's degree (or equivalent) and a minimum of three years of related experience in implementing and supervising a document control program.

2.2.7 Global Laser Enrichment Environmental, Health, and Safety Organization

The GLE EHS function is administratively independent of Operations but has the authority to enforce the shutdown of any process or facility in the event that controls for any aspect of safety are not assured.

2.2.7.1 Global Laser Enrichment Environmental, Health, and Safety Manager

The GLE EHS Manager reports to the GLE Facility Manager. In addition, the GLE EHS Manager has the authority and responsibility to contact the GLE President and CEO with any EHS concerns. The GLE EHS Manager has designated overall responsibility to establish and manage the Licensing, Security and Emergency Preparedness, Material Control and Accounting (MC&A), NCS, Industrial Safety, Environmental Protection, and RP Programs to ensure compliance with applicable federal, state, and local regulations and laws. These programs are designed to ensure the health and safety of employees and the public, as well as the protection of the environment. The GLE EHS Manager must approve restart of any operation shutdown by the EHS function.

The GLE EHS Manager shall have, as a minimum, a bachelor's degree (or equivalent) in an engineering or scientific field and five years of management experience in assignments involving regulatory activities. The manager of the GLE EHS function shall have experience in the understanding and management of NCS, Environmental Protection, and Industrial Safety programs.

2.2.7.2 Nuclear Criticality Safety Function

The NCS function is administratively independent of Operations and has the authority to shutdown potentially unsafe operations. The NCS Manager reports to the GLE EHS Manager and must approve restart of any operation shutdown by the NCS function. Designated responsibilities of the NCS Manager typically include, but are not limited to, the following:

- Establish the NCS program, to include design criteria, procedures, and training;
- Provide NCS support for operations including ISAs and configuration control;
- Assess normal and credible abnormal conditions;
- Determine NCS limits for controlled parameters;
- Perform methods development and validation to support NCS analyses;
- Perform neutronics calculations, develop criticality safety analyses (CSAs), and approve proposed changes in process conditions or equipment involving fissionable material;
- Specify NCS control requirements and functionality;
- Provide advice and counsel to area managers on NCS control measures, to include review and approval of operating procedures;

- Support emergency response planning and events; and
- Assess the effectiveness of the NCS program through audit programs.

The NCS Manager shall have, as a minimum, a bachelor's degree (or equivalent) in an engineering or scientific field, at least four years of experience in assignments involving regulatory activities, and experience in the understanding, application, and direction of NCS programs.

A Senior Engineer, within the NCS function, shall have, as a minimum, a bachelor's degree (or equivalent) in an engineering or scientific field with three years of nuclear-related experience in criticality safety. A senior engineer shall have experience in the assigned safety function, and has the authority and responsibility to conduct activities assigned to the NCS function.

An Engineer, within the NCS function, shall have, as a minimum, a bachelor's degree (or equivalent) in an engineering or scientific field and experience in the assigned safety function. An NCS Engineer shall have the authority and responsibility to conduct activities assigned to the NCS function with the exception of independent verification of NCS analyses.

2.2.7.3 Material Control and Accounting Manager

The MC&A Manager reports to the GLE EHS Manager and has the responsibility for proper implementation and control of the Fundamental Nuclear Material Control Plan (FNMCP). This position is separate from, and independent of, the Operations and Technical Services Organizations to ensure a definite division between the MC&A function and the other organizations.

The MC&A Manager shall have, as a minimum, a bachelor's degree (or equivalent) in an engineering or scientific field and five years of experience in the management of a safeguards program for special nuclear material (SNM), to include responsibilities for material control and accountability. No credit for academic training may be taken toward fulfilling this experience requirement.

2.2.7.4 Security and Emergency Preparedness Manager

The Security and Emergency Preparedness functions are administratively independent of Operations. The Security and Emergency Preparedness Manager reports to the GLE EHS Manager and has designated responsibilities that typically include, but are not limited to, the following:

- Provide physical security for the GLE Site;
- Establish and maintain the Emergency Preparedness Program, to include training and program evaluations;

- Provide advice and counsel to area managers on matters of physical security and emergency preparedness; and

- Maintain agreements and preparedness with offsite emergency support groups.

The Security and Emergency Preparedness Manager shall have, as a minimum, a bachelor's degree (or equivalent) in a related field and two years of experience in related assignments; or a high school diploma with eight years of experience in related assignments.

2.2.7.5 Licensing Function

The Licensing function reports to the GLE EHS Manager and has responsibility for coordinating facility activities to ensure compliance with applicable NRC requirements. The Licensing function is also responsible for ensuring abnormal events are reported to the NRC in accordance with NRC regulations.

2.2.7.6 Industrial Safety Manager

The Industrial Safety Manager is administratively independent of Operations and has the authority to shutdown operations when potentially hazardous health and safety conditions are identified. The Industrial Safety Manager reports to the GLE EHS Manager and must approve restart of any operation shutdown by the Industrial Safety function. Designated responsibilities of the Industrial Safety Manager typically include, but are not limited to, the following:

- Identify fire protection requirements from federal, state, and local regulations which govern GLE Commercial Facility operations;

- Ensure proper implementation of the GLE Fire Protection Program and maintain the performance of the fire protection systems;

- Develop practices regarding non-radiation chemical safety affecting nuclear activities;

- Provide advice and counsel to area managers on matters of industrial safety;

- Provide consultation and review of new, existing, or revised equipment, processes, and procedures regarding industrial safety; and

- Provide industrial safety support for ISAs and configuration control.

The Industrial Safety Manager shall have, as a minimum, a bachelor's degree (or equivalent) in an engineering or scientific field and two years of experience in related assignments; or a high school diploma and eight years of related experience.

2.2.7.7 *Environmental Protection Function*

The Environmental Protection Manager is administratively independent of Operations and has the authority to shutdown operations with potentially adverse environmental impacts. The Environmental Protection Manager must approve restart of any operation shutdown by the Environmental Protection function. Designated responsibilities of the Environmental Protection Manager typically include, but are not limited to, the following:

- Identify Environmental Protection requirements from federal, state, and local regulations which govern the facility operation;
- Establish systems and methods to measure and document adherence to regulatory Environmental Protection requirements and license conditions;
- Provide advice and counsel to area managers on matters of Environmental Protection;
- Evaluate and approve new, existing, or revised equipment, processes, and procedures involving Environmental Protection activities;
- Provide Environmental Protection support for ISAs and configuration control; and
- Assure proper federal and state permits, licenses, and registrations are obtained for non-radiation discharges from the GLE Commercial Facility.

The Environmental Protection Manager shall have, as a minimum, a bachelor's degree (or equivalent) in an engineering or scientific field and two years of experience in assignments involving regulatory activities (or equivalent); or a high school diploma and eight years of experience in assignments involving regulatory activities.

2.2.7.8 *Radiation Protection Function*

The RP function is administratively independent of Operations and has the authority to shutdown potentially unsafe operations. The RP Manager must approve restart of any operation shutdown by the RP function. Designated responsibilities for the RP Manager typically include, but are not limited to, the following:

- Establish and maintain the RP Programs, procedures, and training;
- Evaluate radiation exposures of employees and visitors, and ensure the maintenance of related records;
- Conduct radiation and contamination monitoring and control programs;
- Evaluate the integrity and reliability of radiation detection instruments;
- Provide RP support for ISAs and configuration control;
- Provide advice and counsel to area managers on matters of RP;

- Support emergency response planning; and

- Assess the effectiveness of the RP Program through audit programs.

The RP Manager shall have, as a minimum, a bachelor's degree in an engineering or scientific field, three years of experience that includes assignments involving responsibility for RP, and experience in the understanding, application, and direction of RP Programs.

A senior engineer of the RP function shall have, as a minimum, a bachelor's degree (or equivalent) in an engineering or scientific field and two years of nuclear industry experience in the assigned function. Alternate minimum experience qualification for a senior member of the RP function is a professional certification in health physics. A senior member shall have experience in the assigned safety function, and has authority and responsibility to conduct activities assigned to the RP function.

2.2.8 Safety Committees

2.2.8.1 Facility Safety Review Committee

The FSRC provides the GLE Facility Manager with an independent overview of the safety of operations, and provides management with guidance relative to involvement in safety risks. The committee shall provide professional advice and counsel on Environmental Protection, NCS, RP, and Industrial Safety issues affecting nuclear activities.

A review of the ALARA program and projects shall be conducted annually. This ALARA review shall consider:

- Programs and projects undertaken by the RP function and the Radiation Safety Committee (RSC);

- Performance including, but not limited to, trends in airborne concentrations of radioactivity, personnel exposures, and environmental monitoring results; and

- Programs for improving the effectiveness of equipment used for effluent and exposure control.

The FSRC is responsible to the GLE Facility Manager. The committee's proceedings, findings and recommendations are reported in writing to the GLE Facility Manager, appropriate line management, and appropriate area manager(s) responsible for operations. Such reports shall be retained for a minimum of three years.

The committee shall consist of the Chairman and five members, at a minimum. The committee shall include competence in the applicable scientific and engineering disciplines and shall be staffed with members outside of the GLE Operations Organization. The committee shall hold a minimum of three meetings each calendar year with a maximum interval of 180 days between any two consecutive meetings.

2.2.8.2 Radiation Safety Committee

The objective of the RSC is to maintain occupational radiation exposures ALARA through improvements in operations. The committee meets monthly to maintain a continual awareness of the status of projects, performance measurement and trends, and the current radiological safety conditions of site activities. The maximum interval between meetings shall not exceed 60 days. A written report of each RSC meeting is forwarded to the appropriate line management, area managers, and the GLE EHS Manager. Records of the committee proceedings are maintained for a minimum of three years. The committee consists of managers or representatives from key functions with activities affecting radiological safety. GLE LA Chapter 4, *Radiation Protection*, provides further information regarding the RSC.

2.2.8.3 Chemical Review Committee

Before a new chemical is ordered, the requester must obtain approval from the Chemical Review Committee. The Chemical Review Committee is comprised of a representative of the EHS Organization, an area manager, and others as deemed appropriate by the EHS representative. The EHS representative leads the review and is a qualified chemical safety reviewer. The process for approval includes reviewing the health and safety risks of the chemical, as well as appropriate handling, storage, and disposal information. Every effort is made to limit the amount of hazardous chemicals used, including identifying feasible alternative chemicals or processes. GLE LA Chapter 6, *Chemical Process Safety*, provides further information on the Chemical Review Committee.

2.3 MANAGEMENT MEASURES

Management measures for the conduct and maintenance of GLE's EHS Programs are contained in approved written procedures as described in GLE LA Chapter 11. Such practices are part of a Document Control Program, and appropriately span the organizational structure and major facility activities to control inter-relationships and specify program objectives, responsibilities, and requirements. Personnel are appropriately trained to the requirements of these management controls, and compliance is monitored through internal and independent audits and assessments.

2.3.1 Configuration Management

CM is provided for IROFS throughout facility design, construction, testing, and operation. CM provides oversight and control of design information, safety information, and records of modifications (both temporary and permanent) that could impact the ability of IROFS to perform their safety functions when needed. During design and construction, the CFPM has responsibility for CM. Selected documentation is controlled under the CM Program in accordance with appropriate QA procedures associated with design control, document control, and records management. Design changes to IROFS undergo formal review, including interdisciplinary reviews as appropriate, in accordance with approved written procedures. As the project progresses from design and construction to operation, the Operations Organization will maintain the CM Program. See GLE LA Section 11.1, *Configuration Management*, for additional details on CM.

2.3.2 Maintenance

The GLE Maintenance Program shall be implemented for the operations phase of the GLE Commercial Facility. Preventive maintenance activities, surveillance, and performance trending provide reasonable and continuing assurance that IROFS will be available and reliable to perform their safety functions when needed. Maintenance activities include: corrective and preventive maintenance, surveillance/monitoring, and functional testing. These maintenance activities are discussed in further detail in GLE LA Section 11.2, *Maintenance*.

2.3.3 Training and Qualifications

Personnel training is conducted, as necessary, to provide reasonable assurance that individuals are qualified and continue to understand and recognize the importance of safety while performing assigned activities. Training is provided for each individual working at the GLE Commercial Facility, commensurate with assigned duties. Training and qualification requirements are met prior to personnel fully assuming the duties of safety-significant positions, and before assigned tasks are independently performed. The system established for training and retraining is described in GLE LA Section 11.3, *Training and Qualifications*.

2.3.3.1 *Nuclear Safety Training*

GLE training policy requires that employees complete formal nuclear safety training prior to unescorted access to Radiological Controlled Areas (RCAs). Formal training relative to nuclear safety includes, but is not limited to, the following topics:

- Radiation and radioactive materials,
- Risks involved in receiving low-level radiation exposure in accordance with 10 CFR 19.12, *Instruction to Workers (Ref. 2-5),*
- Basic criteria and practices for RP,
- Industrial safety,
- Maintaining radiation exposures ALARA,
- Maintaining radioactivity in effluents ALARA, and
- Emergency response; and
- Applicable NCS objectives contained in ANSI/ANS-8.19-2005 and ANSI/ANS-8.20-1991, *Nuclear Criticality Safety Training (Ref. 2-6).*

2.3.3.2 *Operator Training*

Operator training is performance-based and incorporates the structured elements of analysis, design, development, implementation, and evaluation. Job-specific training includes applicable procedures, safety provisions, and requirements. Emphasis is placed on safety requirements where human actions are important to safety. Operator training and qualification requirements are met prior to safety-related tasks being independently performed or before startup following significant changes to safety controls.

2.3.4 Procedures

GLE Commercial Facility activities are conducted through the use of approved written procedures. Applicable procedure and training requirements are satisfied before use of any procedure. Approved written procedures are used to control activities to ensure the activities are carried out in a safe manner.

Procedures are categorized as either operating procedures or management control procedures. Operating procedures provide specific direction for task-based work. Management control procedures describe administrative and general facility practices approved and issued by cognizant management at a level appropriate to the scope of the practice. These procedures direct and control activities across the various process functions and assign functional responsibilities and requirements for these activities.

Additional details on the use of procedures, including the preparation of procedures in accordance with the Document Control Program are provided in GLE LA Section 11.4, *Procedures.*

2.3.5 Audits and Assessments

The GLE QA Program requires periodic audits and assessments to confirm activities affecting quality comply with the QA Program and that the QA Program is being implemented effectively. Additional details on audit and assessments are provided in GLE LA Section 11.5, *Audits and Assessments.*

2.3.5.1 Facility Safety Review Committee

The FSRC provides technical and administrative reviews of facility operations that could affect facility and worker safety. The FSRC shall review audit findings and performance, including external inspections, for adequacy and timeliness of corrective actions and for trends or overall weaknesses as indicated by audit findings.

2.3.5.2 Quality Assurance Organization

The QA Organization conducts periodic audits of activities associated with the GLE Commercial Facility to verify the facility's compliance with established procedures.

2.3.5.3 Audited Organization

Audited organizations shall assure that deficiencies identified are corrected in a timely manner. Audited organizations shall transmit a response to each audit report within the time period specified in the audit report. For each identified deficiency, the response shall identify the corrective action taken or to be taken. For each identified deficiency, the responses shall also address whether or not the deficiency is considered to be indicative of other problems (for example, a specific audit finding may indicate a generic problem) and the corrective action taken or to be taken for any such identified problems. Copies of audit reports and responses are maintained in accordance with the Records Management Program.

2.3.6 Incident Investigations

Incident investigations are performed to assure that the upset condition(s) is understood, and appropriate corrective actions are identified and implemented to prevent recurrence. GLE Management measures include documenting process-upset conditions in Unusual Incident Reports (UIRs). UIRs are documented and the associated corrective actions are tracked to completion. The objectives of the incident investigation and reporting procedure(s) are to: establish the validity of the data related to the incident; develop and implement corrective action plans, as appropriate; document an event which was or could become a danger to persons or property; and ensure that proper levels of GLE management and public agencies are notified. Additional details on Incident Investigations are provided in GLE LA Section 11.6, *Incident Investigations.*

2.3.7 Records Management

Approved written procedures that control the process for submittal, receipt, processing, retention, maintenance, and storage of facility documents or records are established. Details on the Records Management Program are provided in GLE LA Section 11.7, *Records Management.*

2.4 EMPLOYEE CONCERNS

GLE is committed to providing a safe and productive work environment that encourages employees to raise issues or concerns related to the design, construction, or operation of the GLE Commercial Facility. Employees who feel that safety or quality is being compromised have the right and responsibility to initiate the "stop work" process in accordance with the applicable project or facility procedures to ensure the work environment is placed in a safe condition. Employees also have access to various resources to ensure their safety or quality concerns are addressed, including:

- Line management or other facility management (for example, ESH Manager, GLE Facility Manager, QA Manager),
- The facility safety personnel (that is, any of the safety engineers or managers);
- NRC's requirements under 10 CFR 19, *Notices, Instructions, and Reports to Workers: Inspection and Investigations (Ref. 2-7).*

In addition to the above, GLE has established an employee concerns program to provide an avenue for employees to obtain an independent evaluation of concerns.

GLE Management is committed to investigating and resolving employee concerns in an effective manner and providing timely resolutions to issues. The employee concerns program provides methods for establishing a work environment in which employees feel free to raise concerns to their management or the NRC without fear of reprisal.

2.5 WRITTEN AGREEMENTS WITH OFFSITE EMERGENCY RESOURCES

The plans for responding to emergencies at the GLE Commercial Facility are presented in detail in the Radiological Contingency and Emergency Plan (RC&EP). The RC&EP includes a description of the facility Emergency Response Organization and interfaces with offsite emergency response organizations. The RC&EP includes references to agreements with applicable offsite emergency response organizations.

2.6 REFERENCES

2-1. 10 CFR 50, *Domestic Licensing of Production and Utilization Facilities*, U.S. Nuclear Regulatory Commission, 2008.

2-2. 10 CFR 70, *Domestic Licensing of Special Nuclear Material*, U.S. Nuclear Regulatory Commission, 2008.

2-3. 10 CFR 72, *Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor Related Greater Than Class C Waste*, U.S. Nuclear Regulatory Commission, 2008.

2-4. ANSI/ANS-8.19-2005, *Administrative Practices for Nuclear Criticality Safety*, American Nuclear Society, January 2005.

2-5. 10 CFR 19.12, *Instruction to Workers*, U.S. Nuclear Regulatory Commission, 2008.

2-6. ANSI/ANS-8.20-1991, *Nuclear Criticality Safety Training*, American Nuclear Society, January 1991.

2-7. 10 CFR 19, *Notices, Instructions, and Reports to Workers: Inspections and Investigations*, U.S. Nuclear Regulatory Commission, 2008.

Figure 2-1. GLE Organizational Structure During Design and Construction.

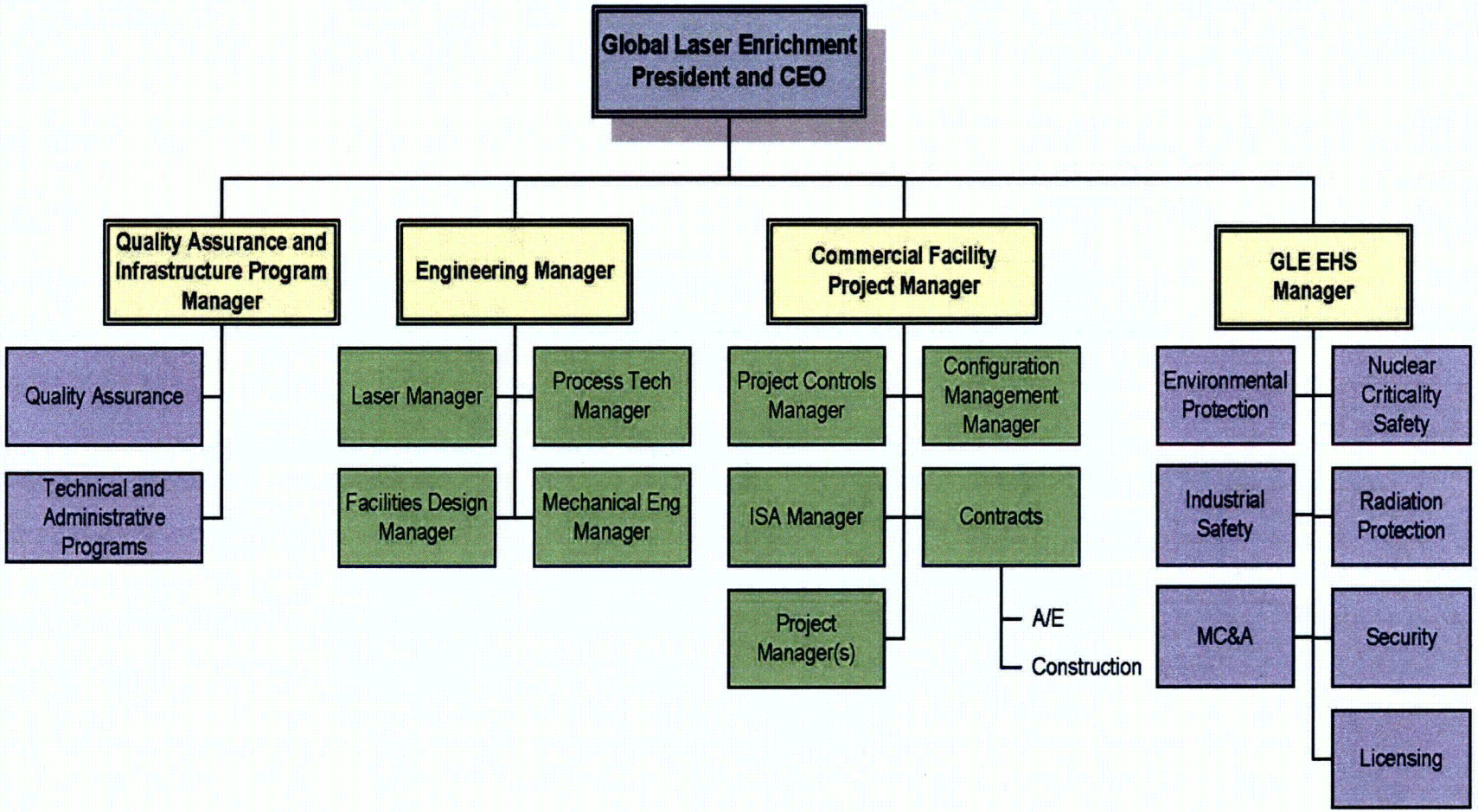
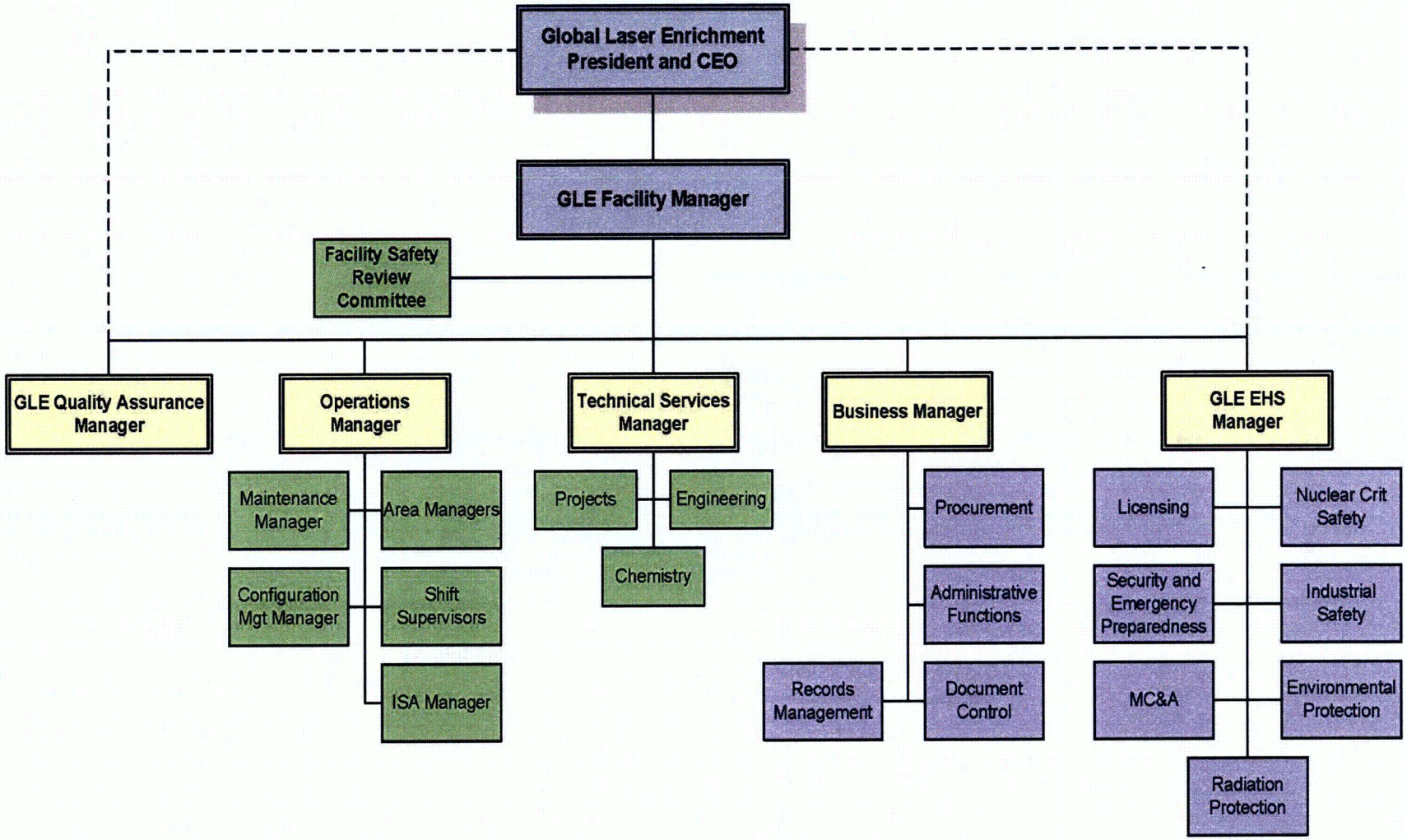


Figure 2-2. GLE Organizational Structure During Operations.



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3. INTEGRATED SAFETY ANALYSIS (ISA) AND ISA SUMMARY

This chapter presents the GE-Hitachi Global Laser Enrichment LLC (GLE) Integrated Safety Analysis (ISA) commitments and outlines the GLE ISA methodology. The approach used for performing the ISA is based on NUREG-1520, *Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility (Ref. 3-1)*, Chapter 3, Appendix A, Example Procedure for Accident Sequence Evaluation. This approach employs a semi-quantitative risk index method for categorizing accident sequences in terms of their likelihood of occurrence and their consequences of concern. The risk index method identifies which accident sequences have consequences that could potentially exceed the performance requirements of 10 CFR 70.61, *Performance Requirements (Ref. 3-2)*; and therefore require a designation of Items Relied on for Safety (IROFS) and supporting management measures. Descriptions of these general types of higher consequence accident sequences are reported in the ISA Summary.

The ISA is a systematic analysis to identify facility and external hazards, credible initiating events, potential accident sequences, the likelihood and consequences of each accident sequence, and the IROFS implemented to prevent or mitigate each credible accident. The ISA Team reviewed the hazard identified for the credible worst-case consequences. Credible high or intermediate consequence accident scenarios were assigned accident sequence identifiers and accident sequence descriptions, and a risk index determination was made. The risk index method is regarded as a screening method, not as a definitive method, of proving the adequacy or inadequacy of the IROFS for any particular accident.

The primary scope of the ISA included fires, hazardous material releases, radioactive material releases, credible nuclear criticality accident sequences, and explosions that could result in injuries to workers and/or the public, or significant environmental impacts during routine and non-routine (startup, shutdown, emergency shutdown, etc.) operations.

The accident summary resulting from the ISA identifies which engineered or administrative IROFS must fail to allow the occurrence of consequences that exceed the levels identified in 10 CFR 70.61.

The ISA was used to develop an ISA Summary that has been separated into two documents: (1) an unclassified ISA Summary to be submitted as Security–Related, Export Controlled, and Proprietary Information; and (2) a classified ISA Summary that is submitted separately as Classified, Export Controlled, and Proprietary Information.

3.1 SAFETY PROGRAM AND INTEGRATED SAFETY ANALYSIS COMMITMENTS

3.1.1 Process Safety Information

GLE has compiled and maintains up-to-date documentation of process safety information. Process safety information is used in updating the ISA and in identifying and understanding the hazards associated with the processes. The compilation of written process safety information includes information pertaining to:

- The hazards of materials used or produced in the process, which includes information on chemical and physical properties included on material safety data sheets (MSDSs) meeting the requirements of 29 CFR 1910.1200(g), *Toxic and Hazardous Substances, (Ref. 3-3).*

- Technology of the process which includes block flow diagrams or simplified process flow diagrams, a brief outline of the process, safe upper and lower limits for controlled parameters (for example, temperature, pressure, flow, and concentration), and evaluation of the health and safety consequences of process deviations.

- Equipment used in the process, including general information on topics such as the materials of construction, piping and instrumentation diagrams (P&IDs), ventilation, design codes and standards employed, material and energy balances, IROFS (for example, interlocks, detection, or suppression systems), electrical classification, and relief system design and design basis.

Process safety information is maintained up-to-date by the Configuration Management (CM) Program described in GLE license application (LA) Section 11.1, *Configuration Management.* Changes to the ISA are conducted in accordance with approved written procedures. This includes implementation of a facility change mechanism that meets the requirements of 10 CFR 70.72, *Facility Changes and Change Process (Ref. 3-4).* The development and implementation of procedures is described in GLE LA Section 11.4, *Procedures.*

GLE uses personnel with the appropriate experience and expertise in engineering and process operations to maintain the ISA. The ISA Team for the various processes consists of individuals who are knowledgeable in the ISA method(s) and the operation, hazards, and safety design criteria of the particular process. Training and qualifications of individuals responsible for maintaining the ISA are described in GLE LA Section 2.2, *Key Management Positions, Responsibilities, and Qualifications.*

3.1.2 Integrated Safety Analysis

GLE has conducted an ISA for each process, such that it identifies the following:

- Nuclear criticality hazards,

- Radiological hazards,

- Chemical hazards that could increase radiological risk,

- Facility hazards that could increase radiological risk,
- Credible accident sequences,
- Consequences and likelihood of each accident sequence, and
- IROFS including the assumptions and conditions under which they support compliance with the performance requirements of 10 CFR 70.61.

A summary of the results of the ISA, including the information specified in 10 CFR 70.65(b), *Additional Contents of Application (Ref. 3-5)*, is provided in the ISA Summary.

GLE has implemented programs to maintain the ISA and supporting documentation so that it is accurate and up-to-date. Changes to the ISA Summary are submitted to the U.S. Nuclear Regulatory Commission (NRC) in accordance with 10 CFR 70.72(d)(1) and (3). The ISA update process accounts for changes made to the facility or its processes. This update also verifies that initiating event frequencies and IROFS reliability values assumed in the ISA remain valid. Required ISA changes, as a result of the update process, are included in a revision to the ISA. Evaluation of facility changes, or a change in the process safety information, which may alter the parameters of an accident sequence, is performed using the ISA method(s) described in the ISA Summary. For any revisions to the ISA, personnel having qualifications similar to those of ISA Team members who conducted the original ISA are used. Personnel used to update and maintain the ISA and ISA Summary are trained in the ISA method(s) and are suitably qualified.

Proposed changes to the facility or its operations are evaluated using the ISA method(s). New or additional IROFS and appropriate management measures are designated as required. The adequacy of existing IROFS and associated management measures are promptly evaluated to determine if they are impacted by changes to the facility and/or its processes. If a proposed change results in a new type of accident sequence or increases the consequences or likelihood of a previously analyzed accident sequence within the context of 10 CFR 70.61, the adequacy of existing IROFS and associated management measures are promptly evaluated and the necessary changes are made, if required. Unacceptable performance deficiencies associated with IROFS are addressed through updates to the ISA.

3.1.3 Management Measures

Management measures are utilized to maintain the IROFS so that they are available and reliable to perform their safety functions when needed. Management measures ensure compliance with the performance requirements assumed in the ISA documentation. The measures are applied to particular structures, systems, components (SSCs), equipment, and activities of personnel; and may be graded commensurate with the reduction of the risk attributable to that IROFS. Management Measures are described in GLE LA Chapter 11, *Management Measures*.

3.2 INTEGRATED SAFETY ANALYSIS SUMMARY AND DOCUMENTATION

3.2.1 Site Description

The ISA Summary provides a description of the GLE Site and the surrounding Owner Controlled Area (herein referred to as the Wilmington Site). A summary description of the GLE Site and the Wilmington Site is contained in GLE LA Chapter 1, *General Information.*

3.2.2 Facility Description

The ISA Summary provides a description of the GLE Commercial Facility. A summary description of the GLE Commercial Facility is provided in GLE LA Chapter 1.

3.2.3 Process, Hazards, and Accident Sequences

The ISA Summary provides a description of the GLE Commercial Facility processes and associated SSCs, the process hazards, and a general description of the accident sequences evaluated in the ISA. A summary of the enrichment process is provided in GLE LA Chapter 1.

3.2.4 Compliance with the Performance Requirements of 10 CFR 70.61

The ISA Summary provides information that demonstrates GLE's compliance with the performance requirements of 10 CFR 70.61.

3.2.4.1 Accident Sequence Evaluation and IROFS Designation

The ISA Summary provides information that demonstrates compliance with the performance criteria of 10 CFR 70.61. The ISA Summary provides sufficient information to demonstrate that credible high consequence events are controlled to the extent needed to reduce the likelihood of occurrence to "Highly Unlikely" and credible intermediate consequence events are controlled to the extent needed to reduce the likelihood of occurrence to "Unlikely."

3.2.4.2 Management Measures

The ISA Summary provides a description of the management measures to be applied to IROFS for each accident sequence for which the consequences could exceed the performance requirements of 10 CFR 70.61.

3.2.4.3 Criticality Monitoring

The GLE Commercial Facility has a Criticality Accident Alarm System (CAAS) as required by 10 CFR 70.24, *Criticality Accident Requirements (Ref. 3-6).* Areas where special nuclear material (SNM) is handled, used, or stored in amounts at or above the 10 CFR 70.24 mass limits have CAAS coverage. The CAAS is designed, installed, and maintained in accordance with ANSI/ANS 8.3-1997, *Criticality Accident Alarm System (Ref. 3-7),* as modified by Regulatory Guide 3.71, *Nuclear Criticality Safety Standards Fuels and Material Facilities (Ref. 3-8).* The CAAS is described in GLE LA Chapter 5, *Nuclear Criticality Safety.*

3.2.4.4 New Facilities or New Processes at Existing Facilities

Baseline design criteria (BDC) that must be used for new facilities is specified in 10 CFR 70.64, *Requirements for New Facilities or New Processes at Existing Facilities (Ref. 3-9)*. The ISA accident sequences for the credible high and intermediate consequence events for the GLE Commercial Facility have defined the design basis events. The IROFS for these events and safety parameter limits ensure that the associated BDC are satisfied. IROFS safety parameter limits are available in the ISA documentation. The BDC in 10 CFR 70.64 have been used as bases for the design of the GLE Commercial Facility as described below.

3.2.4.4.1 Quality Standards and Records

SSCs that are determined by the ISA to be IROFS are designed, fabricated, erected, and tested in accordance with the applicable quality assurance (QA) criteria described in GLE LA Section 11.8, *Other Quality Assurance Elements.* Appropriate records of the design, fabrication, erection, procurement, and testing of SSCs that are IROFS are maintained throughout the life of the facility. Management Measures applicable to IROFS are discussed in GLE LA Chapter 11 and in the ISA Summary.

3.2.4.4.2 Natural Phenomena Hazards

SSCs that are determined to be IROFS are designed to withstand the effects of, and be compatible with, the environmental conditions associated with operation, maintenance, shutdown, testing, and accidents for which the IROFS are required to function.

3.2.4.4.3 Fire Protection

SSCs that are IROFS are designed and located so that they can continue to perform their safety functions effectively under credible fire and explosion exposure conditions. Non-combustible and heat resistant materials are used wherever practical throughout the facility, particularly in locations vital to the control of hazardous materials and to the maintenance of safety control functions. Fire detection, alarm, and suppression systems are designed and provided with sufficient capacity and capability to minimize the adverse effects of fires and explosion on IROFS. The design includes provisions to protect against adverse effects that may result from either the operation or the failure of the fire suppression system.

3.2.4.4.4 Environmental and Dynamic Effects

SSCs that are IROFS are protected against dynamic effects, including effects of missiles and discharging fluids, that may result from natural phenomena; accidents at nearby industrial, military, or transportation facilities; equipment failure; and other similar events and conditions both inside and outside the facility.

3.2.4.4.5 Chemical Protection

The design provides adequate protection against chemical risks produced from licensed material, facility conditions that affect the safety of licensed material, and hazardous chemicals produced from licensed material.

3.2.4.4.6 Emergency Capability

SSCs that are required to support the GLE Radiological Contingency and Emergency Plan (RC&EP) are designed for emergencies. The design provides accessibility to the equipment of onsite and available offsite emergency facilities and services such as hospitals, fire and police departments, ambulance service, and other emergency agencies.

3.2.4.4.7 Utility Services

Onsite utility service systems required to support IROFS are provided. Each utility service system required to support IROFS are designed to perform their function under normal and abnormal conditions. Utility systems are described in the ISA Summary.

3.2.4.4.8 Inspection, Testing, and Maintenance

SSCs that are determined to be IROFS are designed to permit inspection, maintenance, and testing.

3.2.4.4.9 Criticality Control

The design of process and storage systems shall include demonstrable margins of safety for the nuclear criticality parameters that are commensurate with the uncertainties in the process and storage conditions, in the data and methods used in calculations, and in the nature of the immediate environment under accident conditions. Process and storage systems are designed and maintained with sufficient factors of safety to require at least two unlikely, independent, and concurrent changes in process conditions before a criticality accident is possible. The Nuclear Criticality Safety (NCS) Program and NCS methodologies and technical practices are described in GLE LA Chapter 5.

3.2.4.4.10 Instrumentation and Controls

Instrumentation and control systems are provided to monitor variables and operating systems that are significant to safety over anticipated ranges for normal operation, abnormal operation, accident conditions, and safe shutdown. These systems ensure adequate safety of process and utility service operations in connection with their safety function.

The variables and systems that require surveillance and control include process systems having safety significance, the overall confinement system, confinement barriers and their associated systems, and other systems that affect the overall safety of the facility. Controls shall be provided to maintain these variables and systems within the prescribed operating ranges under normal conditions. Instrumentation and control systems are designed to fail into a safe state or to assume a state demonstrated to be acceptable on some other basis if conditions such as disconnection, loss of energy or motive power, or adverse environments are experienced.

3.2.4.4.11 Defense-in-Depth Practices

The facility and system designs are based on defense-in-depth practices. The design incorporates a preference for engineered controls over administrative controls to increase overall system reliability. For criticality safety, the engineered controls preference is for use of passive engineered controls over active engineered controls. The design also incorporates features that enhance safety by reducing challenges to IROFS. Facility and system IROFS are identified in the ISA Summary.

The enrichment process systems and support systems are described in the ISA Summary. In addition to identifying the IROFS associated with each system, the ISA Summary identifies the additional design and safety features (considerations) that provide defense-in-depth.

3.2.5 Integrated Safety Analysis Methodology

GLE utilized methodologies identified in NUREG-1520, Chapter 3, Appendix A, to identify hazards and evaluate accident scenarios. This approach employs a semi-quantitative risk index method for categorizing accident sequences in terms of their consequences of concern and their likelihood of occurrence. The risk index method framework identifies which accident sequences have consequences that could exceed the performance requirements of 10 CFR 70.61 and; therefore, require designation of IROFS and supporting management measures. Descriptions of these general types of higher-consequence accident sequences are reported in the ISA Summary. The ISA is a systematic analysis to identify facility and external hazards, potential accidents, accident descriptions, the likelihood and consequences of the accidents, and the IROFS.

The ISA uses a hazard analysis method, the What-If/Checklist Method, to identify the hazards relevant to each node or the facility in general. The ISA Team reviewed the hazards identified for the "credible worst-case" consequences. The credible high or intermediate severity consequence accident scenarios were assigned accident description identifiers, accident descriptions, frequency or probability, and then a risk index determination was performed. The risk index was used to evaluate unmitigated risk as unacceptable or acceptable.

For each accident scenario having an unacceptable unmitigated risk index, IROFS were defined and the mitigated likelihood determined for each accident scenario. Using the unmitigated initiating event frequency and the failure probability of each IROFS, the mitigated likelihood and mitigated risk was determined. The risk index method is regarded as a screening method, not as a definitive method, of proving the adequacy or inadequacy of the IROFS for any particular accident. The credible accidents that potentially exceed the levels identified in 10 CFR 70.61 are evaluated using a Quantitative Risk Analysis (QRA) approach. The determination of the mitigated likelihood for an accident scenario is documented in a QRA report.

The intent of the QRA reports is to evaluate unacceptable risk identified during a formal What-If analysis. The ISA provides sufficient background and operational information to understand and examine accident scenarios that result in undesired outcomes for each initiating event. Each QRA report provides details concerning an accident scenario's quantification, including the method used; initiating event frequency determination; enabling or conditional event probabilities; the IROFS credited to prevent or mitigate the initiating event(s) being analyzed; the failure probabilities for the credited IROFS; and the overall likelihood estimates. Initiating event frequencies of occurrence presented in the QRAs were conservatively selected with the maximum event frequency bounded by a frequency of once per year. The QRA reports are controlled documents and maintained up-to-date by the CM Program described in GLE LA Chapter 11.

Figure 3-1, *Integrated Safety Analysis Process Flow Diagram,* describes the ISA process steps. The following sub-sections correspond to each block in the flow diagram.

3.2.5.1 Define Nodes to be Evaluated

The first step of the ISA is for the ISA Team to systematically break down the process system, subsystem, facility area, or operation being studied into well-defined nodes. The ISA nodes establish the study area boundaries in which the various process systems and supporting systems entering or exiting the node, or activities occurring in the area, can be defined in order to allow interactions to be studied.

Operations were treated in this manner so that the entire facility was evaluated in a logical process flow approach. This approach is also used to evaluate the hazards associated with each process or operation, and to identify any new hazards resulting from modifications made to an existing process or operation. The GLE Commercial Facility defined nodes are listed in Table 3-1, *Integrated Safety Analysis Nodes*. Information used to define the nodes and to perform the process hazard analysis (PHA) includes, but are not limited to, the following:

- System descriptions,
- Process flow diagrams,
- Plot plans,
- Topographic maps,
- Equipment arrangement drawings with general equipment layout and elevations,
- Design temperatures and pressures for major process equipment and interconnected piping,
- Materials of construction for major process equipment and interconnected piping,
- MSDSs for any chemicals involved in the process (including any intermediate chemical reaction products) and other pertinent data for the chemicals or process chemistry (such as, chemical reactivity hazards),

- Utility system drawings, and
- Criticality safety analyses (CSAs) / radiological safety assessments (RSAs).

3.2.5.2 Hazard Identification

What-If analysis and Checklist methods were used for identifying the hazards for the GLE process. Event Tree Analysis was employed to assist in determining credible or non-credible events and in identifying IROFS. These methods are consistent with the guidance provided in NUREG-1520 and NUREG-1513, *Integrated Safety Analysis Document (Ref. 3-10).* The hazard identification process documents materials that are:

- Radioactive,
- Fissile,
- Flammable,
- Explosive,
- Toxic, and
- Reactive.

The hazards identification process results in identification of radiological or chemical characteristics that have the potential for causing harm to workers, the public, or to the environment. The hazards of concern for the GLE Commercial Facility are related to either a release of uranium hexafluoride (UF_6) (loss of confinement) or a criticality. In general, the loss of confinement would initially result in moisture in the air reacting with the UF_6, forming uranyl fluoride (UO_2F_2) and hydrogen fluoride (HF) as by-products. The HF, which would be in a gaseous form, could be transported through the facility and ultimately beyond the site boundary. HF is a toxic chemical with the potential to cause harm to the workers or the public. For licensed material or hazardous chemicals produced from licensed materials, chemicals of concern are those that, in the event of release, have the potential to exceed concentrations defined in 10 CFR 70, *Domestic Licensing of Special Nuclear Material (Ref. 3-11).* Criteria for evaluating potential releases and characterizing their consequence as either "High" or "Intermediate" for members of the public and facility workers are presented in Table 3-2, *Consequence Severity Categories Based on 10 CFR 70.61*, and Table 3-3, *AEGL Thresholds from the EPA for Uranium Hexafluoride, Soluble Uranium, and Hydrogen Fluoride.*

An HF release would cause a visible cloud and a pungent odor. The odor threshold for HF is less than 1 part per million (ppm) and the irritating effects of HF are intolerable at concentrations well below those that could cause permanent injury or which produce escape-impairing symptoms. Employees are trained in proper actions to take in response to a release and it can be confidently predicted that workers will take immediate self-protective action to escape a release area upon detecting any significant HF odor. Sufficient time is available for the worker to reliably detect and evacuate the area of concern. Public exposures were estimated to last for duration of 30 minutes. This is consistent with self-protective criteria for UF_6/HF plumes listed in NUREG-1140, *A Regulatory Analysis on Emergency Preparedness for Fuel Cycle and Other Radioactive Material Licensees (Ref. 3-12).* The AEGL-1, -2, and -3 values were used as the threshold concentration levels for establishing a low, intermediate, or

high severity consequence as shown in Table 3-2. AEGL values for other time periods may be utilized if more appropriate for the accident scenarios in question.

10 CFR 70.61(b)(3) states, *An intake of 30 mg or greater of uranium in soluble form by any individual located outside the controlled area identified pursuant to Paragraph (f) of this section.* The UF_6 concentration in air is not directly equivalent to soluble uranium intake. GLE uses an accepted intake value of 75 mg or greater, corresponding to the threshold for permanent renal damage consistent with a high consequence event to a worker as defined in 10 CFR 70.61(b)(4).

Dermal exposures to HF have been evaluated in the ISA Summary. Although HF is not used directly in the enrichment process, limited quantities of dilute HF (< 4%) are generated in the Laboratory and Decontamination and Maintenance Areas. The criteria for assessing the consequence severity for HF dermal exposures are provided in Table 3-2.

The "What-If/Checklist Analysis method was used for identifying process hazards for the UF_6 process systems at GLE Commercial Facility. This PHA technique combines the What-if Analysis with Checklist Analysis, which is used to identify and document items identified in the hazard analysis meetings. The hybrid method lends a more systematic nature to the "Brainstorming" character of the What-If method. For identified single-failure events (that is, those accidents that result from the failure of a single control), the What-If method is the recommended approach. Previously performed "What-If" analyses developed for similar or identical processes at the Wilmington Site were used as a checklist to ensure completeness of the GLE Commercial Facility "What-If" analyses. The primary sources were "What-If" analyses developed for onsite facilities. Implementation of the What-If/Checklist method was accomplished using the GLE Commercial Facility design and performing a What-If for each system.

The results of the ISA Team meetings are summarized in the ISA What-If/Checklist tables, which forms the basis of the hazards portion of the Hazard and Risk Determination Analysis. The What-If/Checklist tables are contained in the ISA documentation. The format for this table, which has spaces for describing the node under consideration and the date of the workshop, is provided in Table 3-4, *What-If/Checklist Example*. The What-If Checklist is divided into ten columns, which are as follows:

1. Item – This is a unique number assigned to each What-If.
2. What-If – This column provides a description of the What-If question to be analyzed.
3. Scenarios Initiator – This column provides a description of the initiating event required to cause the accident.
4. Consequence – This column provides a description of the design basis event (for example, the potential and worst case consequences from fire, potential criticality event, etc.)
5. Category – This column provides the risk category affecting workers, the public, and the environment.
6. Severity – This column identifies the estimated severity category as unmitigated hazard.

7. Likelihood – This column identifies the frequency category of the event as unmitigated hazard.

8. Risk – This column identifies whether the unmitigated risk is acceptable or unacceptable based on the estimated severity, likelihood, and the results of the risk index.

9. Safeguards – This column identifies the "IROFS Safeguards," which identifies the engineered and/or administrative protection designed to prevent the hazard from occurring.

10. References – This column provides reference to documents used by the ISA Team that provided support to the determinations made during the hazard review.

This approach was used for the process system hazard identification. The results of the unmitigated What-If/Checklists are used directly as input to the risk matrix and risk index development. In addition, the hazard identification identifies potentially hazardous process conditions. Most hazards were assessed individually for the potential impact on the discrete components of the process systems. However, hazards were assessed on a facility-wide basis for credible hazards from fires (such as, external to the process system) and external events (such as, seismic, severe weather, etc.).

As stated earlier, the hazards of concern are related to either a release of UF_6 or a postulated criticality event as a potential source of damaging energy and would result in the release of prompt radiation and airborne fission products. The radiation and airborne fission products could result in direct radiation exposure and chemical/radiological inhalation exposure to workers and the public. Each SSC that may possibly contain enriched uranium is designed with criticality safety as an objective.

For the design of new facilities, like the GLE Commercial Facility, or significant additions or changes in existing facilities, the proposed design is reviewed by the NCS function to identify potential criticality hazards. The NCS function evaluates each fissile material process to identify the normal and credible abnormal conditions, and establishes the controls required to meet the double contingency design criteria. Use of the double contingency design criteria assures that nuclear processes remain subcritical under normal and credible abnormal conditions. The NCS evaluations that provide the criticality safety basis are documented in CSAs, which describe the facility criticality hazards and the identification of criticality accident scenarios. The CSAs are an integrated part of the ISA, which document the criticality hazards and credible criticality accident scenarios. The ISA input information is included in the ISA documentation.

For the purpose of evaluating the impacts of fire hazards, the ISA Team considered the following:

- Postulated the development of a fire occurring in in-situ combustible material from an unidentified ignition source (such as, electrical shorting, or other source);

- Postulated the development of a fire occurring in transient combustible material from an unidentified ignition source (such as, electrical shorting, or other source); and

- Evaluated the uranic content in the space and its configuration (for example, UF_6 solid/gas in cylinders, UF_6 gas in piping, UF_6 and/or byproducts bound on chemical traps, UO_2F_2 particulate on solid waste or in solution). The appropriate configuration was considered relative to the likelihood of the target releasing its uranic content as a result of a fire in the area.

In order to assess the potential severity of a given fire and the resulting failures to important systems, a Fire Hazards Analysis (FHA) was consulted; however, since the design supporting the license submittal for this facility is not yet at the detailed design stage, detailed in-situ combustible loading and in-situ combustible configuration information is estimated. Therefore, in order to place reasonable and conservative bounds on the fire scenarios analyzed, the ISA Team estimated in-situ combustible loadings based on the FHA information of the in-situ combustible loading for the GLE Commercial Facility. This information indicates that in-situ combustible loads are expected to be very low.

External events were considered at the site and facility level. The external event ISA considered both natural phenomena and man-made hazards. During the external event ISA Team meeting, each area of the GLE Commercial Facility was discussed as to whether or not it could be adversely affected by the specific external event under consideration. If so, specific consequences were then discussed. If the consequences were known or identified to be a low consequence, then a specific design basis with a likelihood of "Highly Unlikely" would be selected. Each external event was assessed for both the unmitigated case and then for the mitigated case. The mitigated cases could be a specific design basis for that external event, IROFS, or a combination of both.

Natural phenomena hazards (NPH) considered for evaluation included:

- Earthquakes,
- Hurricanes (including topical storms),
- Tornados (including tornado missiles and extreme straight wind),
- Volcanoes,
- Flooding,
- Tsunamis,
- Snow and ice, and
- Local precipitation.

External man-made hazards considered for evaluation included:

- Transportation hazards onsite/offsite,
- Onsite facility hazards,
- Aircraft crashes,

- Wildland fires (range fires),
- Pipelines,
- Roadways and highways,
- Nearby industrial facilities,
- Nearby military installations,
- Railways,
- Waterways,
- Underground utilities (onsite use of natural gas and electrical services),
- Internal flooding from onsite above ground liquid storage tanks, and
- Land use impacts.

3.2.5.3 Identify Accident Scenarios

The goal is to identify credible accident scenarios or sequences by analyzing single initiating events. Using approved methods, the ISA Team identified potential accident scenarios associated with a process or operation, including possible worse-case consequences, causes (events that can initiate the accident), and safeguards or controls that are available to prevent the cause of the event or mitigate the consequences. Safeguards are design features or administrative programs that provide defense-in-depth, but are not credited as IROFS. Consequences of interest include nuclear criticality accidents, radiological material releases, radiation exposures, chemical/toxic exposures from licensed material or hazardous chemicals produced from licensed material, and fires and explosions. Hazards are defined to be materials, equipment, or energy sources with the potential to cause injury or illness to humans.

An important product of an ISA consists of a description of accident scenarios identified and recorded during the analysis process. An accident scenario involves an initiating event, any factors that allow the accident to propagate (enablers), and any factors that reduce the risk (likelihood or consequence) of the accident (controls). The accident scenario is a scenario of specific real events.

When analyzing accident scenarios, the ISA Team considered process deviations, human errors, internal facility events, and credible external events, including natural phenomena. Natural phenomenon events, such as hurricanes, tornadoes/high winds, seismic events, and external events (such as aircraft crashes) are addressed separately in Chapter 2 of the ISA Summary. FCSS ISG-08, *Natural Phenomena Hazards (Ref. 3-13)*, was used as guidance when evaluating natural phenomena hazards as initiating events. The team evaluated common mode failures and systems interactions where preventive actions and/or control measures are required to prevent and/or mitigate accident scenarios. The team-listed scenarios considered not credible. In addition to normal conditions, the team considered abnormal conditions including startup, shutdown, maintenance, and process upsets.

For each accident scenario, enabling conditions, and conditional events that affect the outcome of the accident scenario (for example, conditions that affect the likelihood of the scenario or could mitigate the consequences to either workers or the public) were identified where appropriate.

An enabling condition does not directly cause the scenario but must be present for the initiating event to proceed to the consequences described. Enabling conditions are expressed as probabilities and can reflect such things as the mode of operation (for example, percent of operational online availability).

Conditional events that affect the probability of the undesired outcome were also identified. These include probabilistic consideration of individual or administrative actions that would not be considered IROFS but would affect the overall likelihood of the accident. For example, if a scenario involves personal injury hazards, at least one worker must be present in the affected area at the time of the event for the injury to occur. Thus, the presence of workers in the affected area is a conditional modifier for a consequence involving personal injury. Another example of a conditional event is the probability that a worker can successfully evacuate from an area given that a hazard is present.

In considering accident scenarios at the GLE Commercial Facility, it is necessary to determine which scenarios are considered not credible and which are credible. When conducting the PHA, the ISA Team considered each accident scenario as credible, unless the scenario could be determined to be not credible. See Section 3.2.5.5, *Determine Unmitigated Likelihood,* for the criteria GLE used to determine if an accident scenario is credible.

3.2.5.4 Determine Consequence Severity

Table 3-2 presents the radiological and chemical consequences severity limits of 10 CFR 70.61 for each of the three accident consequences categories. Table 3-3 provides information on the chemical dose limits specific to the GLE Commercial Facility.

For each credible accident scenario identified, the ISA Team assigned a severity ranking for the consequences using the consequence severity rankings provided in Table 3-2. Assigning a severity ranking allowed each accident scenario to be categorized in terms of the performance requirements outlined in 10 CFR 70.61(b), (c), and (d). The Severity Ranking System is outlined below:

- A severity ranking of 3 corresponds to high consequences,
- A severity ranking of 2 corresponds to intermediate consequences, and
- A severity ranking of 1 corresponds to low consequences.

When estimating the possible "worst-case" consequences of an accident scenario, the ISA Team members used experience, guidance from NUREG/CR-6410, *Nuclear Fuel Cycle Facility Accident Analysis Handbook (Ref. 3-13)*, and best judgment.

10 CFR 70.61 specifies two categories for a credible accident description consequence: "Credible High Consequence" and "Intermediate Consequence." Implicitly there is a third category for accidents that produce consequence less than "Intermediate." These are referred to as "Low Consequence" accident descriptions. The primary purpose of PHA is to identify the uncontrolled and unmitigated accident descriptions. These accident descriptions are then categorized into one of the three consequence categories (high, intermediate, low) based on their forecast radiological, chemical, and/or environmental impacts. For evaluating the magnitude of the accident consequence, calculations were performed using the methodology described in the ISA documentation. The consequence of concern is the chemo-toxic exposure to HF and UO_2F_2. The dose consequence for each of the accident descriptions were evaluated and compared to the criteria for "High" and "Intermediate" consequences.

The inventory or uranic material for each accident considered was dependent on the specific accident description. For potential criticality accidents, the consequence was conservatively assumed to the high for the worker, the public, and the environment. Scenarios that resulted in a severity rank of 2 or 3 are: criticality, large UF_6/HF release (such as a multiple cylinder failure or cascade failure), and a heated cylinder release. A solid or gas release of a cold trap, low-temperature takeoff station (LTTS), or single cylinder that is not heated does not exceed intermediate consequence requirements. For a severity level of 1, there is "No Safety Consequence of Concern." There is no further action and the What-If checklist is updated.

3.2.5.5 Determine Unmitigated Likelihood

The likelihood of an accident scenario occurring was determined for the unmitigated case (unmitigated likelihood). Unmitigated likelihood is the likelihood or frequency that the initiating event or cause of the accident sequence occurs. This likelihood/frequency estimate assumes that none of the available safeguards or IROFS are available to perform their intended safety function. Table 3-5, *Unmitigated Likelihood Categories,* shows the likelihood of occurrence limits of 10 CFR 70.61 for each of the three likelihood categories. The team assigned a likelihood level for each accident scenario using the defined categories in Table 3-6, *Event Likelihood Categories*, and Table 3-7, *Determination of Likelihood Category.* When assigning a likelihood category, the team made use of process knowledge, accident scenario information, operating history, and manufacturers/product information to determine which category of likelihood was appropriate. For accident scenarios where multiple initiating events have been identified, the team estimated the likelihood for the most credible initiating event. This helped ensure that the accident scenario was screened using the most conservative estimate of risk.

The definitions of likelihood terms are presented in the following sections.

3.2.5.5.1 Highly Unlikely

The guideline for acceptance of the definition of "Highly Unlikely" has been derived as the highest acceptable frequency that is consistent with a goal of having no inadvertent nuclear criticality accidents and no accidents of similar consequences in the industry. To within an order of magnitude, this is taken to mean a frequency limit of less than one such accident in the industry every 100 years. This has been translated into a guideline limiting the frequency of individual accidents to 10^{-5} per-event per-year. As the goal is to have no such accidents, accident frequencies should be reduced substantially below this guideline when feasible.

3.2.5.5.2 *Unlikely*

Intermediate consequence events include significant radiation exposures to workers (those exceeding 0.25 Sieverts or 25 rem). No increase in the rate of such significant exposures is the NRC's goal. This has been translated into a guideline of 4.0×10^{-5} per-event per-year. This guideline may be more generally considered as a range between 10^{-4} and 10^{-5} per-event per-year since exact frequencies at such levels cannot accurately be determined.

3.2.5.5.3 *Not Credible*

The definition of "Not Credible" is also taken from NUREG-1520. If an event is "Not Credible," IROFS are not required to prevent or mitigate the event. The fact that an event is "Not Credible" must not depend on any facility feature that could credibly fail to function. One cannot claim that a process does not need IROFS because it is "Not Credible" due to characteristics provided by IROFS. The implication of "Credible" in 10 CFR 70.61 is that events that are "Not Credible" may be neglected. Any one of the following independent acceptable sets of qualities could define an event as "Not Credible:"

- An external event for which the frequency of occurrence can conservatively be estimated as less than once in a million years.

- A process deviation that consists of a description of many unlikely human actions or errors for which there is no reason or motive. In determining that there is no reason for such actions, a wide range of possible motives, short of intent to cause harm, must be considered. Necessarily, no such description of events can ever have actually happened in any fuel cycle facility.

- Process deviations for which there is a convincing argument, given physical laws that they are not possible, or are unquestionably extremely unlikely.

3.2.5.5.4 *Credible*

A "Credible" accident is any event that does not meet the definition of "Not Credible" as defined above.

3.2.5.6 *Determine Unmitigated Risk*

Credible accident scenarios identified for the facility, which have the capability of producing conditions that fail to meet the performance requirements of 10 CFR 70.61(b), (c) or (d), are included in the scope of the ISA Summary. For each credible accident scenario, the ISA Team used the severity category ranking and unmitigated likelihood level to assign an unmitigated risk level. (The unmitigated risk is determined from the product of the severity category and the unmitigated-likelihood category.) The ISA Team used the risk matrix in Table 3-8, *Unmitigated Risk Assignment Matrix*, to determine the unmitigated risk. The unmitigated risk associated with each accident scenario indicates the relative importance of the associated controls. Accident scenarios of which the consequences and likelihoods yield an unacceptable risk index require further evaluation to determine IROFS and mitigated risk, as described in Section 3.2.5.8, *Develop IROFS and Frequency Determination.*

If the unmitigated risk is less than or equal to 4, the unmitigated risk is acceptable and no further action is required. The What-If table is updated to reflect this conclusion of no further action and the Qualitative Risk Analysis is performed.

3.2.5.7 Perform Quantitative Risk Analysis

The QRA identifies the GLE Commercial Facility nodes to which it applies, describes the node operations and operational areas, presents the QRA layout including the PHA reference nodes, accident description, initiating events evaluated, potential preventive and mitigative features, and describes management measures. An event tree analysis is provided and the overall likelihood of the accident is given. The QRA accident evaluations follow analytical methods for probabilistic risk assessment (PRA) developed for commercial nuclear power units, and was reviewed by engineers and scientists with nuclear facility operations PRA experience.

3.2.5.8 Develop IROFS and Frequency Determination

For each accident scenario having an unacceptable unmitigated risk index, IROFS must be defined and the mitigated likelihood determined for each accident scenario. Using the unmitigated initiating event frequency and the failure probability of each IROFS, the mitigated likelihood is determined.

The QRAs present an accident evaluation including a detailed discussion concerning the selection of initiating events, IROFS, and the quantification of the accident sequences through the use of event trees. Determination of the mitigated likelihood for an accident scenario is documented in a QRA Report. The intent of the QRA reports is to provide sufficient background and operational information to understand and examine accident scenarios that result in undesired outcomes for each initiating event. Each QRA report provides details concerning an accident scenario's quantification, including method used, initiating-event frequency determination, the IROFS credited to prevent or mitigate the initiating event(s) being analyzed, the failure probabilities for the credited IROFS, and the overall likelihood estimates. The QRA reports are controlled documents and are maintained up-to-date by the CM Program described in GLE LA Section 11.1. The quantification results from each QRA are summarized in this ISA Summary.

The mitigated likelihood of the accident scenario occurring with the preventive or mitigating IROFS in-place must meet the requirements in 10 CFR 70.61, which requires that unacceptable consequences be limited. The values of the index numbers for an accident scenario, depending on the number of events involved, are added to obtain a total likelihood index, "T." Accident scenarios are then assigned to one of the three likelihood categories of the risk matrix, depending on the value of the likelihood index in accordance with Table 3-6.

The reliability and availability of an IROFS to perform is a function of the management measures applied to each IROFS. The management measures provide the overall management oversight and assurance that the GLE safety program is maintained and functions properly. These management measures are described in GLE LA Chapter 11. ISA Summary, Appendix C, provides a consolidated list of IROFS.

In this document, safety controls and IROFS are synonymous. Safeguards are design features or administrative programs that provide defense-in-depth, but are not IROFS and are not credited with preventing or mitigating accident scenarios. 10 CFR 70.64 states that the design process must be founded on defense-in-depth principles, and incorporate, to the extent practicable, preference for engineered controls over administrative controls, and reduction of challenges to the IROFS that are frequently or continuously challenged. Safety controls used at the facility can be characterized as either administrative or engineered. Administrative controls are generally not considered to be as reliable as engineered controls since human errors usually occur more frequently than equipment failures. Engineered controls may be categorized as being "Passive" or "Active." Passive controls include pipes or vessels that provide containment. Active controls include equipment such as pumps or valves that perform a specific function related to safety. In general, passive controls are considered to be less prone to failure than active controls.

IROFS are those engineered or administrative controls, or control systems, which comprise the SSCs that form the preventive and/or mitigating barriers identified by the ISA. The IROFS selected for each accident scenario may be a control that helps reduce the likelihood that the initiating event occurs, detects or mitigates the consequences, or helps reduce the amount of hazardous material released. IROFS are the barriers that prevent and/or mitigate the unacceptable consequences identified by the performance requirements of 10 CFR 70.61(b), (c) and (d). When selecting IROFS, the IROFS must be independent of the initiating event (for example, occurrence of the initiating event does not cause failure of the IROFS) and other credited IROFS (for example, failure of one IROFS does not cause failure of another IROFS).

GLE commits to identify IROFS as a part of the ISA process and include the identification of the IROFS in the ISA Summary prepared and maintained for the GLE Commercial Facility. The IROFS are defined in such a way as to delineate their boundaries, to describe the characteristics of the preventive/mitigating function, and to identify the assumptions and conditions under which the item is relied on.

3.2.5.9 Update What-If/Checklist, Risk Index, and ISA Summary

The QRA document results in the development of IROFS and the overall accident sequence frequency determination based on the event tree evaluation of the potential accident. This information was then used to update the what-if/checklist table, including the unmitigated likelihood and the unmitigated risk.

Based on the updated what-if/checklist and the QRA, the Accident Sequence Summary and Risk Index (Table 3-9) is completed. For accident sequences that are of low consequence, or that have a risk index of 4 or less, the risk is acceptable and Table 3-9 requires no entries (that is, "N/A") for the initiating event frequency, IROFS and their failure probabilities, or likelihood index.

The ISA process is an iterative process. The ISA Summary provides an overview of the ISA based upon the existing design level of detail. The ISA Summary that supports the License Application is based on the level of design necessary to establish the safety basis for the GLE Commercial Facility and support the licensing effort.

The final step of the ISA process (see Figure 3-1) is to update supporting ISA documentation and then develop the ISA Summary. As the design of the GLE Commercial Facility progresses, the ISA and supporting documents will be revised, or new supporting documents developed.

3.2.5.10 ISA Integration

The ISA is intended to give assurance that the potential failures, hazards, accident descriptions, scenarios, and IROFS have been investigated in an integrated fashion, so as to adequately consider common mode and common cause situations. Included in this integrated review is the identification of IROFS function that may simultaneously be beneficial and harmful with respect to different hazards, and interactions that might not have been considered in the previously completed sub-analyses. This review is intended to ensure that the designation of one IROFS does not negate the preventive or mitigative function of another IROFS. The ISA Team performed an integrated review during the process hazard review and an overall integration review after the Nodes were completed. Some items that warrant special consideration during the integration process evaluation are:

- Common mode failures and common cause situations.
- Support system failures such as loss of electrical power or city water. Such failures can have a simultaneous effect on multiple systems.
- Divergent impacts of IROFS. Assurance must be provided that the negative impacts of an IROFS, if any, do not outweigh the positive impacts; that is, to ensure that the application of an IROFS for one safety function does not degrade the defense-in-depth of an unrelated safety function.
- Other safety and mitigating factors that do not achieve the status of IROFS that could impact system performance.
- Identification of scenarios, events, or event descriptions with multiple impacts, that is, impacts on chemical, fire, criticality, and/or radiation safety. For example, a flood might cause both a loss of confinement and moderation impacts.
- Potential interactions between processes, systems, areas, and buildings; any interdependence of systems or potential transfer of energy or materials.
- Major hazards or events that tend to be common cause situations leading to interactions between processes, systems, buildings, etc.

3.2.6 Integrated Safety Analysis Team

The ISA was performed, and is maintained, by a team with expertise in engineering, safety analysis, and enrichment process operations. The team included personnel with experience and knowledge specific to each process or system being evaluated. The team was comprised of individuals who have experience, individually or collectively, in the following:

- Nuclear criticality safety,
- Radiological safety,
- Fire safety,
- Chemical process safety,
- Operations and maintenance, and
- ISA methods.

The ISA team leader is trained and knowledgeable in the ISA method(s) chosen for the hazard and accidents evaluations. Collectively, the team had an understanding of the process operations and hazards under evaluation. The ISA Manager is responsible for the overall direction of the ISA. Additional information on the ISA Team is provided in ISA Summary Chapter 1, *General ISA Information.*

3.2.7 Descriptive List of IROFS

The ISA Summary provides a list of IROFS in the identified high and intermediate accident sequences.

3.2.8 Sole Items Relied On For Safety

Sole IROFS are not used for the GLE Commercial Facility. Instead, a minimum of two independent IROFS are typically selected.

3.3 REFERENCES

3-1. NUREG-1520, *Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility*, U.S. Nuclear Regulatory Commission, March 2002.

3-2. 10 CFR 70.61, *Performance Requirements*, U.S. Nuclear Regulatory Commission, 2008.

3-3. 29 CFR 1910.1200, *Toxic and Hazardous Substances*, Occupational Safety and Health Administration, 2008.

3-4. 10 CFR 70.72, *Facility Changes and Change Process*, U.S. Nuclear Regulatory Commission, 2008.

3-5. 10 CFR 70.65, *Additional Content of Application*, U.S. Nuclear Regulatory Commission, 2008.

3-6. 10 CFR 70.24, *Criticality Accident Requirements*, U.S. Nuclear Regulatory Commission, 2008.

3-7. ANSI/ANS 8.3-1997 (R2003), *Criticality Accident Alarm System*, American Nuclear Society, January 1997.

3-8. Regulatory Guide 3.71, *Nuclear Criticality Safety Standards for Fuels and Material Facilities*, U.S. Nuclear Regulatory Commission, Revision 1, October 2005.

3-9. 10 CFR 70.64, *Requirements for New Facilities or New Processes at Existing Facilities*, U.S. Nuclear Regulatory Commission, 2008.

3-10. NUREG-1513, *Integrated Safety Analysis Guidance Document*, U.S. Nuclear Regulatory Commission, May 2001.

3-11. 10 CFR 70, *Domestic Licensing of Special Nuclear Material,* U.S. Nuclear Regulatory Commission, 2008.

3-12. NUREG-1140, *A Regulatory Analysis on Emergency Preparedness for Fuel Cycle and Other Radioactive Material Licensees*, U.S. Nuclear Regulatory Commission, January 1988.

3-13. FCSS ISG-08, *Natural Phenomena Hazards,* U.S. Nuclear Regulatory Commission, Revision 0, October 2005.

3-14. NUREG/CR-6410, *Nuclear Fuel Cycle Facility Accident Analysis Handbook*, U.S. Nuclear Regulatory Commission, March 1998.

3-15. 10 CFR20, *Standards for Protection Against Radiation,* U.S. Nuclear Regulatory Commission, 2008.

Table 3-1. Integrated Safety Analysis Nodes.

Node Number / Designation	Node Description/Name
4100-00	Cylinder Storage and Handling
4200-00	Feed/Vaporization
4300-00	Product Withdrawal
4400-00	Tails Withdrawal
4500-00	*Intentionally Left Blank*
4600-00	Cascade / Gas Handling
4700-00	Blending
4800-00	Sampling
4900-00	Radioactive Waste (Liquid/Solid)
5000-00	HVAC/MCES
5100-00	Utilities
5200-00	Decontamination/Maintenance
5300-00	*Intentionally Left Blank*
5400-00	Laboratory Operations
5500-00	Laser System
5600-00	External Events
5700-00	Balance of Plant

Table 3-2. Consequence Severity Categories Based on 10 CFR 70.61.

Severity Ranking	Consequence Description		
	Workers	**Offsite Public**	**Environment**
3	Radiological dose greater than 1 Sv (100 rem)	Radiological dose greater than 0.25 Sv (25 rem)	N/A
	75 mg soluble uranium intake	30 mg soluble uranium intake	
	Chemical exposure greater than AEGL-3 (10 minute exposure)	Chemical exposure greater than AEGL-2 (30 minute exposure)	
	A criticality accident occurs	A criticality accident occurs	
	Dermal exposure from an HF solution that endangers the life of the worker	Dermal exposure to HF solution resulting in irreversible or other serious long-lasting effects	
2	Radiological dose greater than 0.25 Sv (25 rem) but less than or equal to 1 Sv (100 rem)	Radiological dose greater than 0.05 Sv (5 rem) but less than or equal to 0.25 Sv (25 rem)	Radioactive release greater than 5,000 times 10 CFR 20, Appendix B, Table 2
	Chemical exposure greater than AEGL-2 but less than or equal to AEGL-3 (10 minute exposure)	Chemical exposure greater than AEGL-1 but less than or equal to AEGL-2 (30 minute exposure)	
	Dermal exposure to HF solution resulting in irreversible or other serious long-lasting health effects	Dermal exposure from HF solution resulting in mild transient health effects	
	Direct eye contact with any HF solution (leads to irreversible or other serious long-lasting health effects)		
1	Accidents with radiological and/or chemical exposures to workers less than those above	Accidents with radiological and/or chemical exposures to the public less than those above	Radioactive releases to the environment producing effects less than those specified above

Sv = Sieverts

AEGL = Acute Exposure Guideline Level

The MSDS for chemicals used in the GLE process were reviewed for hazards to the workers. HF solution was determined to present a potential serious or long-lasting health hazard and is therefore included in above table. No other chemicals were identified as presenting potential serious or long-lasting health hazards as used in the GLE process.

Table 3-3. AEGL Thresholds from the EPA for Uranium Hexafluoride, Soluble Uranium, and Hydrogen Fluoride.

Uranium hexafluoride [mg/m^3]					
	10 min	30 min	60 min	4 hr	8 hr
AEGL 1	3.6	3.6	3.6	NR	NR
AEGL 2	28	19	9.6	2.4	1.2
AEGL 3	216	72	36	9	4.5
Soluble Uranium [mg/m^3]					
	10 min	30 min	60 min	4 hr	8 hr
AEGL 1	2.4	2.4	2.4	NR	NR
AEGL 2	19	13	6.5	1.6	0.8
AEGL 3	145	48	24	6	3.0

Soluble Uranium = UF_6 x Uranium fraction [0.67]

Hydrogen fluoride [mg/m^3]					
	10 min	30 min	60 min	4 hr	8 hr
AEGL 1	0.8	0.8	0.8	0.8	0.8
AEGL 2	78	28	20	10	10
AEGL 3	139	51	37	18	18

Table 3-4. What-If/Checklist Example.

GLE Commercial Facility		Site: Wilmington, North Carolina	Unit: TR-XXXX.XX	System:
Method: What-If/Checklist		Design Intent		
No: XX		Description:		

Item	What-If..?	Scenarios Initiators	Consequences	Cat	S	UL	UR	Safeguards	References

Table 3-5. Unmitigated Likelihood Categories.

Likelihood Category	Qualitative Description
1	Consequence Category 3 accidents must be "Highly Unlikely"
2	Consequence Category 2 accidents must be "Unlikely"
3	"Not Unlikely"

Table 3-6. Event Likelihood Categories.

	Likelihood Category	Frequency or Probability of Occurrence*
Not Unlikely (Credible)	**3**	More than or equal to 10^{-4} per-event per-year
Unlikely (Credible)	**2**	Between 10^{-4} and 10^{-5} per-event per-year
Highly Unlikely	**1**	Less than or equal to 10^{-5} per-event per-year

Note: Based on approximate order-of-magnitude ranges.

Table 3-7. Determination of Likelihood Category.

Likelihood Category	Likelihood Index T* (= sum of index numbers)
1	$T \leq -5$
2	$-5 < T \leq -4$
3	$-4 < T$

*The likelihood category is determined by calculating the likelihood index, T, then using this table. The term T is calculated as the sum of the indices for the events in the accident sequence.

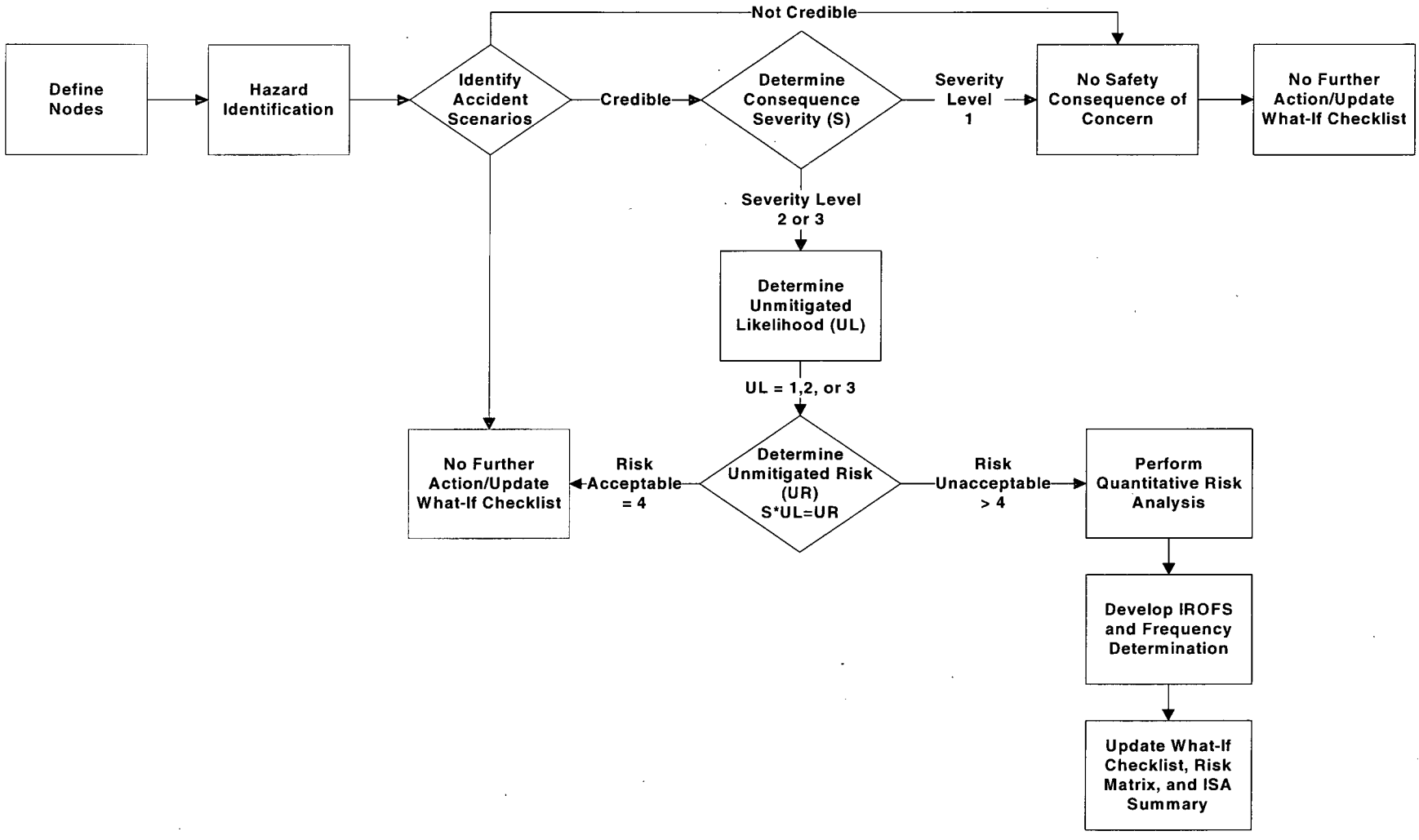
Table 3-8. Unmitigated Risk Assignment Matrix.

Severity of Consequences	Likelihood of Occurrence		
	Likelihood Category 1 Highly Unlikely (1)	**Likelihood Category 2 Unlikely (2)**	**Likelihood Category 3 Not Unlikely (3)**
Consequence Category 3 – High (3)	Acceptable Risk 3	Unacceptable Risk 6	Unacceptable Risk 9
Consequence Category 2 – Intermediate (2)	Acceptable Risk 2	Acceptable Risk 4	Unacceptable Risk 6
Consequence Category 1 – Low (1)	Acceptable Risk 1	Acceptable Risk 2	Acceptable Risk 3

Table 3-9. Accident Sequence Summary and Risk Index Evaluation.

Accident Identifier	Initiating Event	Initiating Event	Safety Parameter 1 or IROFS 1	Failure Probability Index 1	Preventive Safety Parameter 2 or IROFS 2	Failure Probability Index 2	Preventive Safety Parameter 3 or IROFS 3	Failure Probability Index 3	Likelihood Index T Uncontrolled / Controlled (c+e+g+i)	Likelihood Category	Consequence Evaluation Reference	Consequence Category	Risk Index (l=iXk)	Comments and Recommendations
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)

Figure 3-1. Integrated Safety Analysis Process Flow Diagram.



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4. RADIATION PROTECTION

4.1 RADIATION PROTECTION PROGRAM

The purpose of this chapter is to define the GE-Hitachi Global Laser Enrichment LLC (GLE) Radiation Protection (RP) Program. The RP Program protects the radiological health and safety of workers and the public and complies with the following:

- 10 CFR 19, Notices, Instructions, and Reports to Workers: Inspection and Investigations *(Ref. 4-1)*,
- 10 CFR 20, Standards for Protection Against Radiation *(Ref. 4-2)*,
- 10 CFR 70, Domestic Licensing of Special Nuclear Material *(Ref. 4-3)*, and
- Regulatory Guide 8.2, Guide for Administrative Practices in Radiation Monitoring *(Ref. 4-4)*.

The RP Program also provides protection to workers in the event of an accident as defined in the Integrated Safety Analysis (ISA).

4.1.1 Requirements of 10 CFR 20, Subpart B

In accordance with 10 CFR 20.1101, *Radiation Protection Programs (Ref. 4-5)*, the RP Program uses approved written procedures and engineering controls based on sound RP principles to achieve occupational and public doses below the U.S. Nuclear Regulatory Commission (NRC) established limits. The RP Program is focused on implementing RP principles necessary to achieve compliance with the requirements of 10 CFR 20.1201, *Occupational Dose Limits for Adults (Ref. 4-6)*, and to maintain exposure to radiation As Low As Reasonably Achievable (ALARA). The content and implementation of the RP Program is reviewed annually, at a minimum. In addition, constraints on atmospheric releases are established such that no member of the public is expected to receive a total effective dose equivalent (TEDE) in excess of 0.1 millisievert per year (mSv/yr) (10 millirem per year [mrem/yr]) from these releases. Occupational radiation exposures are maintained ALARA through the following:

- Exposure monitoring is consistent with the guidance in 10 CFR 20.1501, General (Ref. 4-7), and 10 CFR 20.1502, Conditions Requiring Individual Monitoring of External and Internal Occupational Dose *(Ref. 4-8)*,
- Frequent interactions between the Radiation Safety Committee (RSC) and Operations personnel, and
- Annual RP Program assessments with senior management.

Administrative personnel exposure limits are set below the limits specified in 10 CFR 20.1201.

4.1.2 Responsibilities of Key Program Personnel

The technical qualifications of GLE staff, to include training and experience, are provided in the GLE License Application (LA) in accordance with 10 CFR 70.22, *Contents of Applications (Ref. 4-9)*. Staffing is consistent with guidance provided in Regulatory Guide 8.2 and Regulatory Guide 8.10, *Operating Philosophy for Maintaining Occupational Radiation Exposures As Low As Is Reasonably Achievable (Ref. 4-10)*. Further discussion regarding the qualifications of GLE management and the delineation of safety responsibilities is provided in GLE LA Chapter 2, *Organization and Administration*.

4.1.2.1 Global Laser Enrichment Facility Manager

The GLE Facility Manager has the overall responsibility for safety and activities conducted at the GLE Commercial Facility. The duties of the GLE Facility Manager are performed in accordance with approved written policies and procedures. The GLE Facility Manager provides for safe and controlled operations and protection of the environment by delegating and assigning responsibility to qualified line management and area managers. Line management and area manager qualifications are detailed in GLE LA Chapter 2.

4.1.2.2 Global Laser Enrichment Environmental, Health, and Safety Manager

The GLE Environmental, Health, and Safety (EHS) Manager reports to the GLE Facility Manager and has responsibility for directing activities to ensure that the GLE Commercial Facility complies with appropriate rules, regulations, and codes. The GLE EHS Manager directs the following functions: Nuclear Criticality Safety (NCS), RP, Material Control and Accounting (MC&A), Security and Emergency Preparedness, Licensing, Industrial Safety, and Environmental Protection. The GLE EHS Organization provides independent oversight of Operations. The qualifications for this position are described in GLE LA Chapter 2.

4.1.2.3 Radiation Protection Manager

The RP Manager reports to the GLE EHS Manager and is responsible for the overall implementation of the RP Program. In matters involving RP, the RP Manager has direct access to the GLE Facility Manager. The RP Manager shall have, at a minimum, a bachelor's degree in an engineering or scientific field, three years experience in assignments that include responsibility for RP, and experience in the understanding, application, and direction of RP Programs. The RP staff, including engineers, technicians, administrative support personnel, and contractors specifically assigned to the RP Program, report to the RP Manager.

4.1.2.4 Global Laser Enrichment Facility Personnel

GLE personnel working with or near radioactive materials are required to take basic RP training, as well as any other specialized training deemed appropriate by assigned management. The GLE Training Program is further described in Section 4.5, *Radiation Protection Training*.

4.1.3 Radiation Protection Program Staffing

The RP Manager ensures that the GLE Commercial Facility is staffed with suitably trained RP personnel to implement an effective program. RP staff qualifications and training are consistent with the guidance in American National Standards Institute (ANSI)/American Nuclear Society (ANS)-3.1-1993, *Selection, Qualification, and Training of Personnel for Nuclear Power Plants (Ref. 4-11)*. It is the responsibility of the RP Manager and his/her staff to:

- Establish and maintain the RP Program;
- Generate and maintain RP procedures;
- Assure ALARA is practiced by GLE personnel;
- Review and audit the effectiveness of the RP Program in regards to compliance with NRC, applicable regulatory guides, and other governmental regulations;
- Modify the program based on experience and facility history;
- Adequately staff the RP Organization to successfully implement the RP Program;
- Establish and maintain a Respiratory Protection Program;
- Monitor worker doses (both internal and external);
- Control sealed sources;
- Implement contamination minimization activities;
- Comply with the radioactive materials possession limits for the facility;
- Handle radioactive wastes when disposal is needed;
- Calibrate and maintain radiological instrumentation, including verification of required lower limits of detection or alarm levels;
- Establish and maintain RP training for personnel working in Radiological Controlled Areas (RCAs);
- Perform audits of the RP Program on an annual basis;
- Establish and maintain the Radiological Environmental Monitoring Program; and
- Post the RCAs, and within the RCAs post: Radiation, Airborne Radioactivity, High Radiation, and Contaminated Areas, as appropriate.

RP Technicians report to the RP Manager and are responsible for implementing the RP Program. Further description of the RP Technician duties and training is provided Section 4.3, *Organization and Personnel Qualifications*.

4.1.4 Independence of the Radiation Protection Program

The RP Program is independent of GLE Operations. The management of the RP Program is conducted through the GLE EHS Manager and the RP Manager, both of whom function independent of Operations. This independence ensures the RP Program maintains objectivity to ensure safety takes priority over production.

4.1.5 Annual Review of the Radiation Protection Program

In accordance with 10 CFR 20.1101(c), the RP Program is reviewed annually by the Facility Safety Review Committee (FSRC), an independent advisory committee to the GLE Facility Manager. The review considers facility changes, new technologies, or other process enhancements that could improve overall program effectiveness. Further detail regarding the FSRC's review is provided in Section 4.2.6, *Review of ALARA Program.*

4.2 AS LOW AS REASONABLY ACHIEVABLE (ALARA) PROGRAM

This section describes GLE's commitment to an ALARA Program. The ALARA Program functions as a subset of the RP Program. Approved written policies and procedures document and govern the implementation of the ALARA goals.

4.2.1 ALARA Program

The design and implementation of the ALARA Program is consistent with the guidance contained in Regulatory Guide 8.2, Regulatory Guide 8.13, *Instruction Concerning Prenatal Radiation Exposure (Ref. 4-12)*, Regulatory Guide 8.29, *Instruction Concerning Risks from Occupational Radiation Exposure (Ref. 4-13)*, and Regulatory Guide 8.37, *ALARA Levels for Effluents from Materials Facilities (Ref. 4-14)*.

Documented RP Program policies are implemented to ensure the ALARA goal is met. Procedures incorporate the ALARA philosophy into routine GLE Commercial Facility operations and ensure exposures are maintained below 10 CFR 20.1101(d) limits. As discussed in Section 4.7.15, *Access Control*, RCAs are established within the GLE Commercial Facility. RCAs contain radioactive material or have radiation-generating devices, and are identified through signs, ropes, gates, fences, or other visible means. Each RCA has specific entry, survey, and dosimetry requirements. The establishment of RCAs supports the ALARA commitment to minimize the spread of contamination and reduce unnecessary exposure of personnel to radiation.

4.2.2 ALARA Policies and Procedures

To ensure occupational doses are maintained ALARA, work activity restrictions are imposed when an individual's exposure exceeds 80 percent of the applicable 10 CFR 20.1201 limit. The establishment of RCAs contributes to keeping exposures ALARA by minimizing the spread of contamination and reducing unnecessary exposure to radiation.

Doses to declared pregnant workers are maintained below the regulatory limit specified in 10 CFR 20.1208, *Dose Equivalent to an Embryo/Fetus (Ref. 4-15)*, and are maintained ALARA. Female employees are advised of the RP policy for declared pregnant workers during the basic RP training. The policy for occupational exposures to pregnant workers is consistent with the guidance in Regulatory Guide 8.13.

Constraints on atmospheric releases are established for the GLE Commercial Facility such that no member of the public is expected to receive a TEDE in excess of 0.1 mSv/yr (10 mrem/yr) from these releases. Approved written procedures dictate atmospheric releases to be monitored and measured. Doses to the public are calculated to ensure compliance with the requirements of 10 CFR 20.1101(d). Numerous controls exist to ensure public exposure resulting from the GLE Commercial Facility operations remains below the 10 CFR 20.1301, *Radiation Dose Limits for Individual Members of the Public (Ref. 4-16)* limits, to include stack and fence line monitoring. See GLE LA Chapter 9, *Environmental Protection*, for further information regarding implemented measures to keep public doses ALARA.

4.2.3 ALARA Goals

In accordance with 10 CFR 20.1101, the RP Program is designed to achieve occupational and public doses that are ALARA. The RP Manager is responsible for implementation of the ALARA Program. The RSC provides oversight of the RP Program as described in Section 4.2.4, *Radiation Safety Committee*. In order to keep exposures ALARA, the following principles guide the RP Program:

- Radiation exposures and the release of radioactive effluents shall be monitored.
- Individual exposures shall be controlled to be less than applicable regulatory limits.

Specific goals of the ALARA Program include maintaining occupational exposures, as well as environmental releases, as far below regulatory limits as is reasonably achievable. The ALARA concept is also incorporated into the design and operation of the GLE Commercial Facility. The size and number of areas with higher dose rates are minimal. Per approved written procedures, the time spent in these areas is controlled and projects are evaluated to ensure workers receive the minimum exposure. Areas where personnel spend significant amounts of time are designed to maintain the lowest dose rates reasonably achievable.

4.2.4 Radiation Safety Committee

The RSC provides oversight of the RP Program and functions as the ALARA Committee. The objectives of the RSC include, but are not limited to, the following:

- Promote continued improvement in limiting employee radiological exposures;
- Identify potential radiological and safety hazards;
- Advise the GLE Facility Manager on RP concerns;
- Monitor trends in radiation levels, contamination levels, effluent releases, occupational exposure, and selected RP issues;
- Review proposed activities with regard to contamination control and ALARA; and
- Review results of audits performed by RP.

The membership of the RSC consists of a Chairperson (the RP Manager or designee) and representatives from RP, Environmental Protection, Industrial Safety, Operations Management, Operations, Engineering, and Maintenance. The committee meets on a monthly basis to review nuclear safety trends and to establish and monitor projects. This review includes a determination as to whether or not there are any upward trends in personnel exposure (for identified categories of workers and types of operations), effluent releases, or contamination levels.

The Chairperson compiles and maintains nuclear safety trend information and project status summaries for committee review. The Chairperson distributes monthly meeting summaries to the GLE Facility Manager and appropriate line managers and area managers and maintains records of the committee proceedings for a minimum of three years. The maximum interval between meetings is not to exceed 60 days. Recommendations of the RSC are documented and tracked to completion.

4.2.5 Interaction Between Radiation Protection and Operations Personnel

The ALARA Program is one of several ways RP personnel interact with Operations personnel. RP and Operations personnel serve on the RSC. RP personnel are also involved in preparation of Radiation Work Permits (RWPs), which are further discussed in Section 4.4.3, *Radiation Work Permit Procedures*. To prepare an RWP, RP personnel must interact with Operations personnel to fully understand the activity and facility conditions in order to assess the associated radiological hazards. RP personnel also interact with Operations personnel when participating in safety audits. Lastly, RP personnel perform routine surveys of operational areas in order to ensure occupational doses are ALARA.

4.2.6 Review of ALARA Program

The FSRC is an independent advisory committee that reports to the GLE Facility Manager. The FSRC is responsible for the following:

- An annual ALARA review that considers:
  - Programs and projects undertaken by the RP Manager and the RSC;
  - RP training including, but not limited to, the effectiveness and adequacy of the curriculum and instructors;
  - Performance including, but not limited to, trends in airborne concentrations of radioactivity, personnel exposures, and environmental monitoring results;
  - Programs for improving the effectiveness of equipment and procedures used for effluent and exposure control;
- Review of major changes in authorized activities affecting nuclear or non-nuclear safety practices;
- Evaluation of contamination minimization and/or removal activities;
- Professional advice and counsel on Environmental Protection, NCS, RP, and Industrial Safety issues affecting nuclear activities; and
- Evaluation of new approaches, technologies, procedures, or facility changes that could potentially reduce radiation exposures.

The proceedings, findings, and recommendations of the FSRC are reported in writing to the GLE Facility Manager and appropriate line managers and area managers. Such reports are retained for a minimum of three years. Based upon expected improvement, updated performance data, economics, and consideration of other site priorities, decisions are made as to which of the FSRC recommendations are pursued. If a specific recommendation is pursued, a task owner is assigned and the action is tracked to completion. The committee holds a minimum of three meetings each calendar year with a maximum interval of 180 days between any two consecutive meetings.

4.3 ORGANIZATION AND PERSONNEL QUALIFICATIONS

This section provides information pertaining to the structure of the RP Organization and the staff qualifications.

4.3.1 Radiation Protection Personnel

The technical qualifications are provided in the GLE LA, to include training and experience of GLE staff, in accordance with 10 CFR 70.22(a)(6). Further discussion regarding the qualifications of GLE management and the delineation of the safety authority and responsibilities is provided in GLE LA Chapter 2. The organization of the RP staff is consistent with the guidance in Regulatory Guides 8.2 and 8.10.

RP personnel technical qualifications are provided in this section as well as in Section 4.1.2, *Responsibilities of Key Program Personnel.* RP personnel include the RP Manager and his/her staff. Typically, the RP Manager's staff consists of at least one Radiation Safety Engineer and several RP Technicians.

4.3.2 Organizational Relationships

The organizational relationships were previously described in Section 4.1.2. The RP Program is independent from the Operations and Technical Services Organizations and the RP Manager reports to the GLE EHS Manager.

4.3.3 Radiation Protection Manager

The position of RP Manager was previously described in Section 4.1.2.3, *Radiation Protection Manager.* The RP Manager has direct access to the GLE Facility Manager, which ensures independence from the Operations and Technical Services Organizations. In addition to being responsible for establishing and implementing the RP Program, the RP Manager is skilled in interpretation of data and regulations pertinent to RP, is familiar with the operation of the GLE Commercial Facility and RP concerns of the GLE Site, and is used as a resource in management decisions regarding RP.

4.3.4 Radiation Protection Staff Responsibilities

RP Technicians, Engineers, and Managers perform the functions of assisting and guiding workers in radiological aspects of the job. These individuals have the responsibility and authority to stop radiological work or mitigate the effect of an activity if it is suspected that the initiation or continued performance of a job, evaluation, or test will result in the violation of approved RP requirements.

4.3.5 Minimum Training of Radiation Protection Staff

The RP Training Program is designed and implemented consistent with the guidance in ANSI/ANS-3.1-1993 and American Society for Testing and Materials (ASTM) E1168-95, *Standard Guide for Radiological Protection Training for Nuclear Facility Workers (Ref. 4-17)*. The RP staff is trained in accordance with the requirements for their specific job function. The level of RP training is commensurate with the RP responsibility held by the individual. At a minimum, the RP staff completes basic RP training. In addition, Radiation Safety Engineers are required to have a technical degree. RP Technicians shall have a minimum of two years experience in their specialty.

4.4 COMMITMENT TO APPROVED PROCEDURES

This section describes the GLE commitment to prepare and maintain approved written RP procedures.

4.4.1 Radiation Protection Procedures

Operations at the GLE Commercial Facility involving licensed materials are conducted through the use of approved written procedures as required by 10 CFR 70.22(a)(8). RP procedures are prepared, reviewed, and approved to carry out activities related to the RP Program. Approved written procedures are used to control RP activities in order to ensure activities are carried out in a safe, effective, and consistent manner. RP procedures are reviewed and revised, as necessary, to incorporate any facility or operational changes or changes to the ISA.

4.4.2 Preparation, Authorization, Approval, and Distribution of Radiation Protection Procedures

The RP staff, or an area manager, prepares draft procedures that are reviewed by affected personnel to ensure the procedures are appropriate and reasonable to implement. The RP Manager reviews and approves final RP procedures, as well as proposed revisions to RP procedures. GLE LA Section 11.4, *Procedures*, provides additional information on GLE procedures.

RP procedures are distributed to appropriate Managers. RP procedures are available to GLE employees electronically. For certain activities, paper copies are available at the activity location. Certain RP procedures are required to be reviewed on a periodic basis by employees, depending on their job function. The assigning and documenting of the employee's review of the procedure(s) is tracked. Requirements for procedure control and approval authority are documented.

4.4.3 Radiation Work Permit Procedures

Routine work performed in RCAs is administered by the use of approved written procedures described in GLE LA Chapter 11, *Management Measures*. Non-routine activities, particularly those performed by non-GLE employees generally not covered by approved written procedures, are administered by the RWP System. An example of a non-routine activity would be unanticipated maintenance on, or repair of, a piece of equipment. The RWP System is described in approved written procedures. An RWP requires RP Manager, or designee, approval prior to issuance. The RWP specifies the necessary radiation safety controls, as appropriate, to include personnel monitoring devices, attendance of RP staff, protective clothing, respiratory protective equipment, special air sampling, and additional precautionary measures to be taken. The RWP also contains a description of the radiological conditions in the immediate work area covered by the RWP.

Prior to commencing work that requires an RWP, employees performing the job must review the RWP and document their review. Work is monitored, as required, by an RP Technician. RWPs are available to workers for re-review at any time and include expiration dates. An RP Technician or the RP Manager (or designee) reviews the status of issued RWPs on a periodic basis. RWPs are closed out when the applicable work activity for which it is written is complete and terminated. A copy of RWPs and any associated records are kept for the life of the facility.

4.5 RADIATION PROTECTION TRAINING

4.5.1 Design and Implementation of Radiation Protection Training Program

The RP Training Program is designed and implemented to be consistent with the guidance in ASTM E1168-95. As described in Section 4.5.3, *Level of Training*, the RP Training Program is compliant with regulations in 10 CFR 19.12, *Instruction to Workers (Ref. 4-18)*, and 10 CFR 20.2110, *Form of Records (Ref. 4-19)*.

4.5.2 Training of Personnel and Visitors

Training programs are established for various job functions (such as, Operations, RP Technicians, contractor personnel) commensurate with NCS and RP responsibilities. Visitors to RCAs are either trained in the formal RP Training Program or are given a general training session regarding radioactive materials in the workplace and are escorted by trained personnel.

4.5.3 Level of Training

The required level of RP Training is based on the potential radiological health risks associated with an employee's work responsibilities. In accordance with 10 CFR 19.12(a), any individual working at the facility likely to receive, in one year, an occupational dose in excess of 1 mSv (100 mrem) is:

- Informed of the storage, transfer, or use of radioactive material;
- Instructed in health protection issues associated with exposure to radiation and radioactive material, precautions or procedures to minimize exposure, and the purpose and function of protective devices employed;
- Required to observe, to the extent within the worker's control, the applicable provisions of the NRC regulations and licenses for protection of personnel from exposure to radiation and radioactive material;
- Instructed of their responsibility to promptly report to management any condition that may lead to or cause a violation of NRC regulations and licenses, or result in unnecessary exposure to radiation and radioactive material;
- Instructed on the appropriate response to warnings made in the event of any unusual occurrence or malfunction that may involve exposure to radiation and radioactive material; and
- Advised of the various notifications and reports that a worker may request pursuant to 10 CFR 19.13, *Notifications and Reports to Individuals (Ref 4-20)*.

In accordance with 10 CFR 19.12(b), when determining if a worker is likely to receive 1 mSv (100 mrem), management considers the worker's assigned activities during normal and abnormal situations. The instructions provided to the worker, as described above, are commensurate with potential radiological conditions present in the workplace.

4.5.4 Incorporation of 10 CFR 19 Training Requirements

The RP Training Program complies with 10 CFR 19.12 and 10 CFR 20.2110 requirements and takes into consideration a worker's normally assigned work activities. The following topics are covered during basic RP training:

- Radiation safety principles, policies, and procedures,
- Radiation hazards and health risks,
- Correct handling of radioactive materials,
- Location of and adherence to RP procedures,
- Minimization of exposures to radiation and radioactive materials,
- Contamination control,
- Access and egress controls,
- Monitoring for internal and external exposures,
- ALARA and exposure limits,
- Exposure monitoring methods and instrumentation,
- Personal and area dosimetry,
- Donning and doffing of personal protective equipment (PPE), and
- Emergency response.

Abnormal situations involving exposure to radiation and radioactive material, which can reasonably be expected to occur during the life of the facility, are evaluated and additional training is assigned as appropriate.

4.5.5 Review of Radiation Protection Training Program

The contents of the RP Training Program are reviewed bi-annually by the RP and NCS Managers. The review addresses changes in policies, procedures, requirements, and changes to the ISA.

The periodicity of RP refresher training required by a worker is dependent on the worker's responsibilities; however, the basic RP refresher training occurs annually (not to exceed 15 months) and includes an exam. Training requirements are documented and tracked for employees. Training records are managed and stored in accordance with 10 CFR 20.2110.

4.5.6 Evaluation of the Radiation Protection Training Program

Training records are kept in a database managed by the RP Manager or designee. RP training is typically computer-based but may be performed by authorized instructors. The contents of the RP Training Program are reviewed bi-annually by the RP and NCS Managers, and are periodically audited by Operations personnel to evaluate the effectiveness and adequacy of the program.

4.6 VENTILATION AND RESPIRATORY PROTECTION PROGRAMS

In accordance with the regulations in 10 CFR 20, Subpart H, *Respiratory Protection and Controls to Restrict Internal Exposure in Restricted Areas (Ref. 4-21)*, control of the release of radiation or radioactive materials is a fundamental requirement for facility and equipment design for areas in which uranium and other sources of radiation are handled, processed, or used in processes. The following sections describe the containment, ventilation, and respiratory protection equipment utilized to keep exposure to airborne radiation below regulatory limits.

4.6.1 Ventilation and Containment

In accordance with 10 CFR 20.1701, *Use of Process or Other Engineering Controls (Ref. 4-22)*, the containment of uranium hexafluoride (UF_6), and therefore the concentration of radioactive material in air, is accomplished through several engineered controls. These engineered controls include containment and ventilation systems.

The containment of UF_6 within process equipment is the primary control. UF_6 is transported and stored primarily in ANSI N14.1 compliant 30- and 48-inch cylinders. Enrichment process systems are designed for the containment of UF_6. UF_6 process systems are operated so that leaks are into the system and not into work areas. Process system components that are equipped with removable covers or hatch openings are equipped with seals and mechanical closure devices to ensure containment of UF_6. UF_6 is processed in the UF_6 Feed and Vaporization, Product Withdrawal, Tails Withdrawal, and Cascade and Gas Handling Areas. Ventilation systems serving these areas include design features that provide for confinement of radiological contamination. The ventilation systems for the enrichment process areas are described below.

4.6.1.1 Ventilation System Description

Ventilation systems for potentially contaminated areas exhaust to the environment through the Operations Building Stack. All air released from potentially contaminated areas is filtered to remove radioactive particulates before it is released. Ventilation equipment is designed to provide airflow from areas of lesser potential contamination to areas of higher potential contamination. Direction of airflow between areas is checked bi-weekly or after significant modifications to the ventilation system. If insufficient airflow results in airborne concentrations greater than the established procedural action limits, the affected processes are shut down. Specific facilities and capabilities of ventilation systems are detailed in Table 4-1, *Specific Facilities and Capabilities of Ventilation Systems.*

Potentially contaminated air is exhausted through high-efficiency filter media that are at least 99.97 percent efficient for removal of 0.3 micron particles. High-efficiency particulate air (HEPA) filters in the exhaust system are equipped with a device for measuring differential pressure. In accordance with approved written procedures, filters are not operated at a differential pressure exceeding the manufacturer's ratings for the filter. Prefilters, or other appropriate devices, are provided where necessary to treat effluents before filtration to ensure filter effectiveness is maintained. Air exits the Operations Building through HEPA and high-efficiency gas absorption (HEGA) filters. Additional information on the ventilation systems is provided in the ISA Summary.

Hoods and other localized ventilation designs are utilized to minimize personnel exposure to airborne uranium. Activities and process equipment which generate airborne uranium are designed with filtered enclosures, hoods, dust capturing exhaust ports, or other devices that maintain air concentrations of radioactivity in work areas such that personnel exposures are below administrative and regulatory limits under normal operating conditions. Air flows through hood openings and localized vents are maintained in accordance with the values in Table 4-1, *Specific Facilities and Capabilities of Ventilation Systems*. Additionally, differential pressure indicators are installed across exhaust system filters to monitor system performance. The flows and differential pressures are checked monthly or after significant changes to the ventilation system. If insufficient airflow results in airborne concentrations greater than 10 times the derived air concentration (DAC) as defined in 10 CFR 20.1003, *Definitions (Ref. 4-23)*, the affected processes are shut down in accordance with approved written procedures.

4.6.1.2 Management Measures for Ventilation and Containment Systems

The Items Relied on for Safety (IROFS) are monitored on a regular basis as a routine part of the operating process. Operations and maintenance are performed using approved written procedures as described in GLE LA Section 11.4. The various programs that pertain to preventive and corrective maintenance are described in GLE LA Section 11.2, *Maintenance*. See GLE LA Chapter 11 for a description of the management measures applied to IROFS.

4.6.1.3 Design Criteria for Ventilation and Containment Systems

Redundancy and engineered controls are integrated into the design of ventilation systems. Degradations or failures in normally operating systems or components result in the automatic operation of standby equipment. Room isolation or the safe shutdown of operations and equipment is implemented if a release exceeds the system's ability to maintain protection of the workers and public.

The ventilation system design requirements provide a safety margin between normal and accident conditions so that no single failure could result in the release of significant hazardous material. Standby power sources allow continuous operation of the ventilation systems upon a loss of power. Instrumentation is provided to detect abnormal process conditions so that the process can be returned to normal by operator actions.

The ventilation systems are sized to maintain ambient temperatures in the facility for the comfort and safety of the workers. The size of the ventilation system in the Operations Building is adequate to ensure potential airborne concentrations of radioactivity do not exceed the DAC values specified by International Commission on Radiological Protection (ICRP)-68, *Dose Coefficients for Intakes of Radionuclides by Workers (Ref. 4-24)*, during normal operations.

4.6.1.4 *Testing of the Ventilation and Containment Systems*

Several measures are in place to ensure effective operation of the ventilation systems. Differential pressure across HEPA filters, in potentially contaminated ventilation exhaust systems, is monitored at least monthly or automatically monitored and alarmed. Approved written operating procedures specify limits and setpoints on the differential pressure consistent with manufacturers' recommendations. Filters are changed if they fail to function properly, or if the differential pressure exceeds the manufacturers' ratings. Filter inspection, testing, maintenance, and change-out criteria are specified in approved written procedures. Change-out frequency is based on considerations of filter loading, operating experience, differential pressure data, and any UF_6 releases indicated by hydrogen fluoride alarms.

4.6.2 Respiratory Protection Program

The Respiratory Protection Program is a subset of the RP Program and is conducted in accordance with 10 CFR 20, Subpart H. In accordance with 10 CFR 20.1703(c)(1-2), *Use of Individual Respiratory Protection Equipment (Ref. 4-25)*, the Respiratory Protection Program includes air sampling to identify potential hazards, permit proper equipment selection, and estimate occupational doses. Surveys and bioassays are also performed, as necessary, to evaluate actual intakes. The Respiratory Protection Program is consistent with the guidance in Regulatory Guide 8.15, *Acceptable Programs for Respiratory Protection (Ref. 4-26)*.

4.6.2.1 *Respiratory Protection Requirements of 10 CFR 20, Subpart H*

In accordance with 10 CFR 20.1701, the GLE Commercial Facility is designed and operated to use, to the maximum extent practical, process and engineering controls to minimize the concentration of radioactive material in air. In accordance with 10 CFR 20.1702(a), *Use of Other Controls (Ref. 4-27)*, when it is not practical to apply process or other engineering controls, ALARA principles to include access control to the affected area, limitations on exposure times, and use of respiratory protection equipment are applied. In accordance with 10 CFR 20.1703(a), respiratory protection equipment specifically tested and certified by the National Institute for Occupational Safety and Health (NIOSH) is used.

4.6.2.2 *Procedures for Using Respiratory Protection Equipment*

In accordance with 10 CFR 20.1703(c)(4), approved written procedures are used to control the following activities:

- Monitoring, including air sampling and bioassays,
- Supervision and training of respirator users,
- Fit testing of respirators,
- Respirator selection,
- Breathing air quality,
- Inventory and control of respirators,

- Cleaning of respirators,
- Storage, issuance maintenance, repair, and testing of respiratory protection equipment,
- Recordkeeping, and
- Limitations on respirator use and relief from respirator use.

4.6.2.2.1 Selection of Respiratory Protection Equipment

In accordance with 10 CFR 20.1702(b), when performing ALARA analysis to determine if respiratory equipment should be used, other safety factors are considered including the impact of respiratory protection equipment use on industrial safety and health.

In accordance with 10 CFR 20.1703(e), consideration is given to the limitations appropriate to the type and mode of respiratory device use. Provisions are made for vision correction, adequate communication, low temperature work environments, and the concurrent use of other safety or RP equipment. Per approved written procedure(s), RP personnel select the appropriate type of respiratory device to be used for activities involving potential exposure to airborne radioactivity.

4.6.2.2.2 Fitting of Respiratory Protection Equipment

Approved written procedures describe the proper techniques for performing fit tests. An adequate fit is determined for face-sealing respirators using either a quantitative fit test method or a qualitative method. In accordance with 10 CFR 20.1703(c)(6), qualitative fit testing is acceptable if: (1) it is capable of verifying a fit factor of 10 times the assigned protection factor (APF) for face pieces operated in a negative pressure mode; or (2) it is capable of verifying a fit factor of at least 500 for face pieces operated in a positive pressure mode. Mask fits are re-evaluated at least annually. Also in accordance with 10 CFR 20.1703(h), no objects, materials, substances (such as facial hair), or any conditions that may interfere with the facepiece seal or valve function and that are under the control of the respirator wearer, shall be present between the skin of the wearer's face and the sealing surface of a tight-fitting respirator facepiece.

4.6.2.2.3 Issuance of Respiratory Protection Equipment

Approved written procedures prescribe the actions to be taken when issuing respiratory protection equipment. In accordance with 10 CFR 20.1703(c)(5), individuals designated to use respiratory protection equipment are evaluated by the Medical function to determine if the individual is medically fit to use respiratory protection devices. Individuals are evaluated periodically thereafter, at a frequency specified by the Medical function.

4.6.2.2.4 Maintenance of Respiratory Protection Equipment

Respiratory protection equipment is cleaned, serviced, tested, and inspected in accordance with the instructions specified by the manufacturer per NIOSH for each respiratory protection device. The GLE Commercial Facility is equipped with a suitable location for cleaning and storage of respirators and other reusable PPE. Contaminated items remain inside the RCA where the items are cleaned until they are successfully decontaminated. Cleaned PPE, such as face shields and respirators that come into contact with the wearer's face, must be inspected after cleaning before reuse. Approved written procedures prescribe the actions to be taken for maintenance of respiratory protection equipment. The liquid waste resulting from cleaning respirators and other reusable PPE is sent to the Radioactive Liquid Effluent Treatment System (RLETS).

4.6.2.2.5 Testing of Respiratory Protection Equipment

In accordance with 10 CFR 20.1703(c)(3), respirators are tested for operability (user seal check for face-sealing devices and functional check for others) immediately prior to each use, per the instructions in approved written procedures.

4.6.2.2.6 Training on Use of Respiratory Protection Equipment

If there are no medical restrictions precluding respirator use, the individual is provided respiratory training and fitting by a qualified instructor. Additional training on the use and limitations of self-contained breathing devices is provided to designated individuals, per approved written procedures.

In accordance with 10 CFR 20.1703(d), each respirator user is advised that he/she may leave the area at any time for relief from respirator use in the event of equipment malfunction, physical or psychological distress, procedural or communication failure, significant deterioration of operating conditions, or any other condition that may require such relief.

4.6.2.2.7 Monitoring Areas Requiring Respiratory Protection

In accordance with approved written procedures, an area requiring respiratory protection is monitored by the RP staff for airborne radioactivity in order to estimate the dose to the individual wearing respiratory protection. This monitoring could include air sampling, bioassay, and/or other method(s) deemed appropriate by RP personnel.

4.6.2.2.8 Recordkeeping for the Use of Respiratory Protection Equipment

Records regarding the use of respiratory protection equipment are maintained in accordance with approved written procedures and comply with 10 CFR 20, Subpart L, *Records (Ref. 4-28)*. The GLE Records Management Program is described in GLE LA Section 11.7, *Records Management*.

4.6.2.3 Revision of Respiratory Protection Procedures

Respiratory protection procedures are developed and revised, as needed, in accordance with the procedure development process described in GLE LA Section 11.4.2, *Procedure Development Process*.

4.6.2.4 Respiratory Protection Program Records

Records of the Respiratory Protection Program (including training for respirator use and maintenance) are maintained in accordance with the Records Management Program as described in GLE LA Section 11.7.

4.7 RADIATION SURVEYS AND MONITORING PROGRAMS

Routine radiological surveys and monitoring are conducted at a regular frequency to ensure occupational exposures are ALARA. This includes airborne and surface contamination surveys and personnel dosimetry. The survey and monitoring programs are consistent with the guidance in Regulatory Guide 8.2, Regulatory Guide 8.7, *Instructions for Recording and Reporting Occupational Radiation Dose Data (Ref. 4-29)*, and Regulatory Guide 8.9, *Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program (Ref. 4-30)*.

4.7.1 Radiation Surveys and Monitoring Programs Meeting Requirements of 10 CFR 20, Subpart F

In accordance with 10 CFR 20.1501(a) and (b), GLE conducts surveys that are necessary to comply with the applicable regulations, and are reasonable to evaluate the magnitude and extent of radiation levels, concentrations, or quantities of radioactive material and the potential radiological hazards. Section 4.7.6, *Air Sampling Program*, discusses air sampling, and Section 4.7.8, *Minimization of Contamination*, discusses the Contamination Survey Program.

In accordance with 10 CFR 20.1501(b), instruments and equipment are calibrated periodically. Section 4.7.12, *Equipment and Instrumentation Sensitivity*, discusses equipment calibrations.

In accordance with 10 CFR 20.1501(c), personnel dosimeters are processed by a National Voluntary Laboratory Accreditation Program (NVLAP) accredited vendor. Section 4.7.3, *External Occupational Radiation Exposures*, discusses external dose and personnel dosimetry.

In accordance with 10 CFR 20.1502, GLE monitors exposure to radiation and radioactive material to demonstrate compliance with occupational dose limits. Sections 4.7.3 and 4.7.4 discuss monitoring for external and internal dose, respectively.

4.7.2 Approved Procedures for Radiation Surveys and Monitoring Programs

The approved written procedures include an outline of survey and monitoring objectives, sampling procedures and data analysis methods, types of equipment and instrumentation to be used, frequency of measurements, recordkeeping and reporting requirements, and actions to be taken in the event measurements exceed administrative or regulatory limits.

4.7.3 External Occupational Radiation Exposures

External occupational dose is measured in accordance with 10 CFR 20.1501(a). Deep-dose equivalent and shallow-dose equivalent from external sources of radiation are determined by individually assigned dosimeters. Thermo luminescent dosimeters (TLDs) are issued to persons entering RCAs. TLDs are sensitive to beta, gamma, and neutron radiation. Per approved written procedures, personnel dosimeters are distributed to individuals based on their job functions, commensurate with the amount of time an individual spends working with or near radioactive materials. Personnel dosimeters are processed by a NVLAP accredited vendor. The capability exists to process dosimeters expeditiously if there is an indication of an exposure in excess of established action guides. Action guides for external exposures are established in

approved written procedures. Work activity restrictions are imposed when an individual's exposure exceeds 80 percent of the applicable 10 CFR 20.1201 limit.

Any time an administrative limit is exceeded, the RP Manager is notified. The RP Manager then determines the need for investigation and/or corrective action. When the results of individual monitoring are unavailable or are invalidated by unusual exposure conditions, external exposures may be calculated by the RP staff on the basis of data obtained by investigation.

4.7.4 Internal Occupational Radiation Exposures

The Personnel Monitoring Program is designed and implemented for internal occupational radiation exposures based on the requirements of 10 CFR 20.1201, 10 CFR 20.1204, *Determination of Internal Exposure (Ref. 4-31)*, 10 CFR 20.1502(b), and 10 CFR 20.1704(i), *Further Restrictions on the Use of Respiratory Protection Equipment (Ref. 4-32)*. Intakes are assigned to individuals based upon one or more types of measurements as follows: air sampling (described in Section 4.7.6), urinalysis, and/or in vivo lung counting. The type and frequency of measurement(s) for an individual are determined by their job function. The measurements are commensurate with the amount of time an individual spends working with or near radioactive material. Intakes are converted to committed dose equivalent (CDE) and committed effective dose equivalent (CEDE) for the purposes of limiting and recording occupational doses. Action levels are established in approved written procedures to prevent an individual from exceeding the occupational exposure limits specified in 10 CFR 20.1201. Work activity restrictions are imposed when an individual's exposure exceeds 80 percent of the 10 CFR 20.1201 limit. Control actions include temporarily restricting the individual from working in an area containing airborne radioactivity, and actions are taken as necessary to prevent recurrence.

4.7.4.1 Urinalysis Program

The Urinalysis Program is conducted primarily to evaluate the intake of soluble uranium to assure the 10 CFR 20.1201(e) intake limit of 10 milligram (mg) per week is not exceeded. Personnel assigned to work in areas where soluble airborne uranium compounds are present in concentrations likely to result in intakes in excess of 10 percent of the applicable limits in 10 CFR 20.1201 are monitored by urinalysis. The minimum sampling frequency for these individuals is specified in approved written procedures. Urinalysis may also be used to monitor individuals involved in non-routine operations, perturbations, or incidents.

Urine sampling frequencies and action levels are established in approved written procedures based on the appropriate biokinetic models for the present uranium compounds. Results above the applicable action level are investigated. Work activity restrictions are imposed when an individual's exposure (TEDE) exceeds 80 percent of the occupational dose limit in 10 CFR 20.1201(a). Exceeding action levels will result in a temporary work restriction for the individual to prevent additional exposure and allow a more accurate assessment of the intake.

4.7.4.2 In Vivo Lung Counting Program

Routine in vivo lung counting frequencies are established for personnel who regularly work in areas where insoluble uranium compounds are processed. Baseline and termination counts are typically performed. Lung counting frequencies are based upon individual airborne exposure assignments and previous counting results. The minimum count frequency for individuals with an assigned intake greater than 10 percent of the Annual Limit on Intake (ALI), as defined in 10 CFR 20.1003, is annual.

Appropriate actions are taken based upon in vivo lung counting results to ensure the ALI is not exceeded. If an individual's lung burden indicates an intake greater than the applicable action level, the individual is temporarily restricted from working in areas containing airborne uranium. Work activity restrictions are imposed when an individual's exposure exceeds 80 percent of the occupational dose limit in 10 CFR 20.1201(d).

4.7.5 Summation of External and Internal Occupational Radiation Exposures

Per approved written procedures, the summation of external and internal occupational radiation exposure is reported as a TEDE and is calculated in accordance with 10 CFR 20.1202(a)-(d), *Compliance with Requirements for Summation of External and Internal Doses (Ref. 4-33)*. The calculation is consistent with the guidance in Regulatory Guide 8.34, *Monitoring Criteria and Methods to Calculate Occupational Radiation Doses (Ref. 4-34)*.

4.7.6 Air Sampling Program

An Air Sampling Program is designed and implemented in areas of the GLE Commercial Facility that are potential Airborne Radioactivity Areas. This program includes procedures to conduct air surveys, and to calibrate and maintain RP airborne sampling equipment in accordance with the manufacturers' recommendations.

4.7.7 Control of Airborne Radioactive Material

Air samples are continuously taken from each main process area where airborne concentrations are likely to exceed 0.1 DAC when averaged over 40 hours to assess the concentrations of uranium in the air. Per approved written procedures, the air samples are collected in such a way that the concentrations of uranium measured are representative of the air which workers breathe. Air sampling results and individual personnel exposure assignments are monitored by the RP function to evaluate the effectiveness of personnel exposure controls.

Evaluations of air sampling effectiveness are performed in accordance with the methods and acceptance criteria in Regulatory Guide 8.25, *Air Sampling in the Workplace (Ref. 4-35)*. Filters from air samplers are changed each shift during normal operating periods, or at more frequent intervals following the detection of an event that may have released airborne uranium, based upon knowledge of the particular circumstances. Filters are not changed as frequently during periods when no work is in progress. The filters are processed to determine the uranium concentration in the air for each area.

Each air sampler is equipped with a rotameter to indicate flow rate of air sampled. These rotameters are calibrated or replaced every 18 months, at a minimum. Air sampling results in excess of 2.5 DAC (eight hour sample) and not resulting from a specific known cause are investigated to determine the probable cause. Operations or equipment will be shut down and immediate corrective action will be taken at locations where an air samples exceeds 10 DAC without a specific known cause.

In addition to the activities described above, exposure to airborne radioactive material is controlled through limiting access to areas, limiting exposure time, and the use of respiratory equipment.

4.7.8 Minimization of Contamination

The GLE Commercial Facility is designed and operated in accordance with 10 CFR 20.1406, *Minimization of Contamination (Ref. 4-36),* to minimize contamination, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of radioactive waste. Removing radioactive material from equipment, to the extent reasonably possible prior to servicing, reduces exposures to personnel who work around and service contaminated equipment. Surface contamination is removed to minimize its spread to other areas of the facility. Surfaces such as floors and walls are designed to be smooth, nonporous, and free of cracks so that they can be more easily decontaminated. In addition, minimization of contamination is accomplished through compliance with labeling and packaging requirements in 10 CFR 20.1904, *Labeling Containers (Ref. 4-37)*, 10 CFR 20.1905, *Exemptions to Labeling Requirements (Ref. 4-38)*, 10 CFR 20.1906, *Procedures for Receiving and Opening Packages (Ref. 4-39)*, 10 CFR 20, Subpart K, *Waste Disposal (Ref. 4-40)*. The following are examples of GLE methods for minimizing contamination:

- Containment of radioactive material throughout the facility,
- Monitoring for equipment leaks,
- Providing overflow vessels to capture potential spills,
- Minimizing the use of nonradioactive process equipment in locations subject to potential contamination,
- Providing local air filtration in areas with potential airborne contamination to preclude its spread,
- Use of protective clothing (training on donning and doffing),
- Use of respiratory protection,
- Training on proper techniques for handling radioactive material, and
- Airflow from areas of low radioactivity to higher radioactivity.

4.7.9 Contamination Survey Program

Routine surveys are performed in areas that are most likely to be contaminated, as well as in all other operational areas. The RP staff determines survey frequencies, compares the survey results to action guide values as specified in approved written procedures, and ensures the appropriate responses are taken. If the results exceed the action guide values, the RP Manager (or designee) is informed, and he/she determines if an investigation and/or corrective actions are necessary.

4.7.10 Corrective Action Program for Personnel Contamination

Protective clothing is provided to persons who are required to enter the RCAs, where the potential for personnel contamination exists as determined by the RP staff. The amount and type of protective clothing required for a specific area or operation is determined by operational experience and the potential for contamination. Available clothing includes caps, hoods, laboratory coats, coveralls, safety glasses, boots, overshoes, shoe covers, rubber and cloth gloves, and safety shoes. The minimum clothing requirements for RCA entry are defined in Table 4-2, *Personnel Protective Clothing*. The protective clothing is removed in the change rooms upon exit. In the Laboratory Area, where uranium is handled, the minimum protective clothing requirement for entry is a laboratory coat and safety glasses. PPE and anti-contamination clothing is segregated and disposed of in accordance with the following:

- Labeled radioactive material bags are provided for placement of disposable PPE; and
- Used, disposable PPE, respirator cartridges, and other disposable items are containerized and taken to the Radiological Waste Area.

RP Technicians perform routine contamination surveys in the change rooms and the Laboratory Area.

Personnel contamination surveys are required for external contamination on clothing and the body by personnel exiting the change rooms. If contamination is found in excess of background levels, the individual attempts self-decontamination (except for facial contamination) at the facilities provided in the change rooms. If decontamination attempts are not successful, or if facial contamination is detected, decontamination assistance is provided by the RP function (typically an RP Technician). If skin or personal clothing is still contaminated above background levels, the individual is not permitted to leave the area without the prior approval (per approved written procedure) of the RP function.

4.7.11 Corrective Action Program for Airborne Occupational Exposure

Corrective actions are implemented and documented based on the frequency and magnitude of events causing releases of airborne uranium that exceed administrative limits. Routine air sampling is supplemented by portable air sample surveys as required to evaluate non-routine activities or breaches in containment. RP and Operations staff investigate the cause of the release and implement recommended actions to prevent future releases.

4.7.12 Equipment and Instrumentation Sensitivity

Appropriate radiation detection instruments are available in sufficient number to ensure adequate radiation surveillance can be accomplished. Selection criteria for portable and laboratory counting equipment are based on the types of radiation detected, maintenance requirements, ruggedness, interchangeability, and upper and lower limits of detection capabilities. The RP staff reviews the appropriateness of the types of instruments being used for each monitoring function annually. Table 4-3, *Types and Uses of Available Instrumentation (Typical)*, lists examples of the types and uses of available instrumentation and includes the type of equipment, the sensitivity (typical range), and the routine use.

Portable instrumentation is calibrated in accordance with manufacturing recommendations before initial use, after major maintenance, and on a routine basis following the last calibration. Calibration consists of a performance check on each range scale of the instrument with a radioactive source of known activity traceable to a recognized standard such as the National Institute of Standards and Technology (NIST). Prior to each use, operability checks are performed on monitoring and laboratory counting instruments. The background and efficiency of laboratory counting instruments are determined on a daily basis when in use.

4.7.13 Policies for Removal of Equipment and Materials from Radiological Controlled Areas

When removing equipment and materials from RCAs, the guidance contained in Branch Technical Position, *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material (Ref. 4-41)* is followed. Per approved written procedures, the RP staff has to approve release of equipment and/or materials from RCAs.

4.7.14 Sealed Sources

When not in use, sources shall be stored in a closed container adequately designed and constructed to contain radioactive material that may otherwise be released during storage. Sealed sources are controlled and periodically inventoried. The sources shall be leak-tested in accordance with ISO 2919, *Radiation Protection – Sealed Radioactive Sources – General Requirements and Classifications (Ref. 4-42).*

4.7.15 Access Control

Access control is accomplished through compliance with the requirements in 10 CFR 20.1601(a)-(c), *Control of Access to High Radiation Areas (Ref. 4-43),* and 10 CFR 20.1602, *Control of Access to Very High Radiation Areas (Ref. 4-44).* For most RCAs, routine access points are established through change rooms. Each change room includes a step-off area provided between the contamination controlled and non-controlled areas. Instructions controlling entry and exit from RCAs are posted at the entry points. Survey meters are provided in the step-off area of each change room for use by personnel leaving the RCA. Posted instructions address the use of the survey meters, donning and doffing protective clothing, and appropriate decontamination methods. Alternate access points to RCAs are established for specific activities not accommodated by the change rooms. Such access is governed by approved written procedures or RWPs, which establish controls to prevent the spread of contamination to non-controlled areas.

RCAs that may pose a risk to employees are identified and posted in compliance with the requirements in 10 CFR 20.1901, *Caution Signs (Ref. 4-45),* 10 CFR 20.1902, *Posting Requirements (Ref. 4-46),* and 10 CFR 20.1903, *Exceptions to Posting Requirements (Ref. 4-47).* Access to these areas is controlled so that only appropriately trained individuals are allowed entry. Signs are regularly inspected for conformance. In accordance with definitions provided in 10 CFR 20.1003, the following areas are identified and posted:

- Radiation Area,
- High Radiation Area,
- Airborne Radioactivity Area, and
- Radioactive Material Area.

In addition, contamination areas are posted in accordance with approved written procedures. Signs are posted at the entry points of areas requiring protective clothing. RP training and approved written procedures instruct employees on requirements for entering and working in posted areas.

4.7.16 Radiation Reporting Program

A Radiation Reporting Program is established to maintain records of the RP Program, radiation survey results, results of Corrective Action Program referrals, RWPs, and planned special exposures. The Radiation Reporting Program is consistent with the guidance in Regulatory Guide 8.7.

The Radiation Reporting Program commits to report to the NRC, any event resulting in an occupational exposure to radiation exceeding the dose limits in 10 CFR 20.1201, within the time specified in 10 CFR 20.2202, *Notification of Incidents (Ref. 4-48),* 10 CFR 30.50, *Reporting Requirements (Ref. 4-49),* 10 CFR 40.60, *Reporting Requirements (Ref. 4-50),* and 10 CFR 70.74, *Additional Reporting Requirements (Ref. 4-51).* The Radiation Reporting Program also commits to prepare and submit, to the NRC, an annual report of individual monitoring results, as required by 10 CFR 20.2206(b), *Reports of Individual Monitoring (Ref. 4-52).*

Radiation exposure data for an individual, and the results of any measurements, analyses and calculations of radioactive material deposited or retained in the body of an individual, shall be reported to the individual as specified in 10 CFR 19.13. Individuals are advised of their right to request radiation exposure data in basic RP training. In accordance with 10 CFR 19.11, *Posting of Notices to Workers (Ref. 4-53),* GLE posts current copies of the following documents:

- The regulations in 10 CFR 19 and 10 CFR 20;
- The license, license conditions, or documents incorporated into the license by reference, and amendments thereto; and
- The operating procedures applicable to licensing activities.

4.8 ADDITIONAL PROGRAM COMMITMENTS

The following sections provide commitments to achieve compliance with the regulations in 10 CFR 20, Subpart L, 10 CFR 20, Subpart M, *Reports (Ref. 4-54)*, and 10 CFR 70.74.

4.8.1 Records

In accordance with 10 CFR 20, Subpart L, GLE maintains records of the GLE RP Program (including program provisions, audits, and reviews of the program context and implementation), radiation survey results (air sampling, bioassays, external exposure data from monitoring individuals, internal intakes of radioactive material), and results of corrective action program referrals, RWPs, and planned special exposures. GLE recordkeeping is further described in GLE LA Section 11.7.

4.8.2 Event Reporting

Approved written procedures dictate that GLE will report, to the NRC, within the time specified by 10 CFR 20, Subpart M, and 10 CFR 70.74, any event resulting in an occupational exposure to radiation exceeding the dose limits in 10 CFR 20. Approved written procedures contain instructions for when and how to report events to the NRC and other regulatory agencies.

4.8.3 Annual Dose Monitoring Report

GLE prepares and submits, to the NRC, an annual report of the results of individual monitoring, as required by 10 CFR 20.2206(b).

4.8.4 Corrective Action Reporting

Any radiation incident resulting in an occupational exposure that exceeds the dose limits in 10 CFR 20.1201, or is required to be reported per 10 CFR 20, Subpart M, 10 CFR 30.50, 10 CFR 40.60, and 10 CFR 70.74 will be evaluated within the Corrective Action Program. The corrective actions taken (or planned) to protect against a recurrence and the proposed schedule to achieve compliance are reported to the NRC.

4.9 REFERENCES

4-1. 10 CFR 19, *Notices, Instructions, and Reports to Workers: Inspection and Investigations*, U.S. Nuclear Regulatory Commission, 2008.

4-2. 10 CFR 20, *Standards for Protection Against Radiation*, U.S. Nuclear Regulatory Commission, 2008.

4-3. 10 CFR 70, *Domestic Licensing of Special Nuclear Material*, U.S. Nuclear Regulatory Commission, 2008.

4-4. Regulatory Guide 8.2, *Guide for Administrative Practices in Radiation Monitoring*, U.S. Nuclear Regulatory Commission, February 1973.

4-5. 10 CFR 20.1101, *Radiation Protection Programs*, U.S. Nuclear Regulatory Commission, 2008.

4-6. 10 CFR 20.1201, *Occupational Dose Limits for Adults*, U.S. Nuclear Regulatory Commission, 2008.

4-7. 10 CFR 20.1501, *General*, U.S. Nuclear Regulatory Commission, 2008.

4-8. 10 CFR 20.1502, *Conditions Requiring Individual Monitoring of External and Internal Occupational Dose*, U.S. Nuclear Regulatory Commission, 2008.

4-9. 10 CFR 70.22, *Contents of Applications*, U.S. Nuclear Regulatory Commission, 2008.

4-10. Regulatory Guide 8.10, *Operating Philosophy for Maintaining Occupational Radiation Exposures As Low As Is Reasonably Achievable*, U.S. Nuclear Regulatory Commission, Revision 1-R, May 1977.

4-11. ANSI/ANS 3.1-1993 (R1999), *Selection, Qualification, and Training of Personnel for Nuclear Power Plants*, American Nuclear Society, April 1993.

4-12. Regulatory Guide 8.13, *Instruction Concerning Prenatal Radiation Exposure*, U.S. Nuclear Regulatory Commission, Revision 3, June 1999.

4-13. Regulatory Guide 8.29, *Instruction Concerning Risks from Occupational Radiation Exposure*, U.S. Nuclear Regulatory Commission, Revision 1, February 1996.

4-14. Regulatory Guide 8.37, *ALARA Levels for Effluents from Materials Facilities*, U.S. Nuclear Regulatory Commission, July 1993.

4-15. 10 CFR 20.1208, *Dose Equivalent to an Embryo/Fetus*, U.S. Nuclear Regulatory Commission, 2008.

4-16. 10 CFR 20.1301, *Radiation Dose Limits for Individual Members of the Public*, U.S. Nuclear Regulatory Commission, 2008.

4-17. ASTM E1168-95 (2008), *Standard Guide for Radiological Protection Training for Nuclear Facility Workers*, American Society of Testing and Materials, February 2008.

4-18. 10 CFR 19.12, *Instruction to Workers*, U.S. Nuclear Regulatory Commission, 2008.

4-19. 10 CFR 20.2110, *Form of Records*, U.S. Nuclear Regulatory Commission, 2008.

4-20. 10 CFR 19.13, *Notifications and Reports to Individuals*, U.S. Nuclear Regulatory Commission, 2008.

4-21. 10 CFR 20, Subpart H, *Respiratory Protection and Controls to Restrict Internal Exposure in Restricted Areas*, U.S. Nuclear Regulatory Commission, 2008.

4-22. 10 CFR 20.1701, *Use of Process or Other Engineering Controls*, U.S. Nuclear Regulatory Commission, 2008.

4-23. 10 CFR 20.1003, *Definitions*, U.S. Nuclear Regulatory Commission, 2008.

4-24. ICRP Publication 68, *Dose Coefficients for Intakes of Radionuclides by Workers*, International Commission on Radiological Protection, July 1995.

4-25. 10 CFR 20.1703, *Use of Individual Respiratory Protection Equipment*, U.S. Nuclear Regulatory Commission, 2008.

4-26. Regulatory Guide 8.15, *Acceptable Programs for Respiratory Protection*, U.S. Nuclear Regulatory Commission, Revision 1, October 1999.

4-27. 10 CFR 20.1702, *Use of Other Controls*, U.S. Nuclear Regulatory Commission, 2008.

4-28. 10 CFR 20, Subpart L, *Records*, U.S. Nuclear Regulatory Commission, 2008.

4-29. Regulatory Guide 8.7, *Instructions for Recording and Reporting Occupational Radiation Dose Data*, U.S. Nuclear Regulatory Commission, Revision 2, November 2005.

4-30. Regulatory Guide 8.9, *Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program*, U.S. Nuclear Regulatory Commission, Revision 1, July 1993.

4-31. 10 CFR 20.1204, *Determination of Internal Exposure*, U.S. Nuclear Regulatory Commission, 2008.

4-32. 10 CFR 20.1704, *Further Restrictions on the Use of Respiratory Protection Equipment*, U.S. Nuclear Regulatory Commission, 2008.

4-33. 10 CFR 20.1202, *Compliance with Requirements for Summation of External and Internal Doses*, U.S. Nuclear Regulatory Commission, 2008.

4-34. Regulatory Guide 8.34, *Monitoring Criteria and Methods to Calculate Occupational Radiation Doses*, U.S. Nuclear Regulatory Commission, July 1992.

4-35. Regulatory Guide 8.25, *Air Sampling in the Workplace*, U.S. Nuclear Regulatory Commission, Revision 1, June 1992.

4-36. 10 CFR 20.1406, *Minimization of Contamination*, U.S. Nuclear Regulatory Commission, 2008.

4-37. 10 CFR 20.1904, *Labeling Containers*, U.S. Nuclear Regulatory Commission, 2008.

4-38. 10 CFR 20.1905, *Exemptions to Labeling Requirements*, U.S. Nuclear Regulatory Commission, 2008.

4-39. 10 CFR 20.1906, *Procedures for Receiving and Opening Packages*, U.S. Nuclear Regulatory Commission, 2008.

4-40. 10 CFR 20, Subpart K, *Waste Disposal*, U.S. Nuclear Regulatory Commission, 2008.

4-41. Branch Technical Position, *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material*, U.S. Nuclear Regulatory Commission, April 1993.

4-42. ISO 2919, *Radiation Protection – Sealed Radioactive Sources – General Requirements and Classifications*, International Organization for Standardization, February 1999.

4-43. 10 CFR 20.1601, *Control of Access to High Radiation Areas*, U.S. Nuclear Regulatory Commission, 2008.

4-44. 10 CFR 20.1602, *Control of Access to Very High Radiation Areas*, U.S. Nuclear Regulatory Commission, 2008.

4-45. 10 CFR 20.1901, *Caution Signs*, U.S. Nuclear Regulatory Commission, 2008.

4-46. 10 CFR 20.1902, *Posting Requirements*, U.S. Nuclear Regulatory Commission, 2008.

4-47. 10 CFR 20.1903, *Exceptions to Posting Requirements*, U.S. Nuclear Regulatory Commission, 2008.

4-48. 10 CFR 20.2202, *Notification of Incidents*, U.S. Nuclear Regulatory Commission, 2008.

4-49. 10 CFR 30.50, *Reporting Requirements*, U.S. Nuclear Regulatory Commission, 2008.

4-50. 10 CFR 40.60, *Reporting Requirements*, U.S. Nuclear Regulatory Commission, 2008.

4-51. 10 CFR 70.74, *Additional Reporting Requirements*, U.S. Nuclear Regulatory Commission, 2008.

4-52. 10 CFR 20.2206(b), *Reports of Individual Monitoring*, U.S. Nuclear Regulatory Commission, 2008.

4-53. 10 CFR 19.11, *Posting of Notices to Workers*, U.S. Nuclear Regulatory Commission, 2008.

4-54. 10 CFR 20, Subpart M, *Reports*, U.S. Nuclear Regulatory Commission, 2008.

Table 4-1. Specific Facilities and Capabilities of Ventilation Systems.

Facility	Alarms, Interlocks and Safety Features	Purpose
Hoods	Airflow during operation > 80 linear feet per minute	Prevents spread of radioactive materials
	Effluent air filtered with HEPA filters and/or other appropriate filtration mechanisms	Prevents release of radioactive materials to environs
High Velocity Local Ventilation	Airflow designated to maintain an average of 200 linear feet per minute	Prevents spread of radioactive materials from work area to immediate room area
Recirculating Air Systems and Exhaust Air Systems	Air filtered in potentially contaminated zones with HEGA and HEPA filters	Removes essentially all contaminants from room and exhaust to environs
	Pressure drop indicator set to alarm at a setpoint differential pressure across final filter	Maintains adequate circulation for removal of dust and contaminants from the room air
	Low flow and no flow alarms	Detects clogged filters
	Final effluent air double-filtered with HEPA and HEGA filters prior to release through the stack	Prevents release of radioactive materials in environs

Table 4-2. Personnel Protective Clothing.

Area Workers	Inspectors and Visitors Only Observing Operations
Shoe covers or work area shoes	Shoe covers
Coveralls	Laboratory coats
Rubber gloves	Rubber gloves (as needed)
Safety glasses	Safety glasses

Table 4-3. Types and Uses of Available Instrumentation (Typical).

Type	Typical Range	Routine Use
Dose Rate Meters		
GM Low Range	0.01 mR – 2000 mR	Area Dose Rate Survey, Shipment Survey
GM High Range	0.1 mR - 1000 R	Emergency Monitoring
Ion Chamber - Low Range	0.1 mR - 10 R	Area Dose Rate Survey Shipment Survey
Ion Chamber - High Range	1 mR - 1000 R	Emergency Monitoring
Alpha Survey Meters	50 cpm - 2 x 106 cpm	Direct Personnel and Equipment Surveys
Neutron Meters	0.5 mR - 5 R	Special Dose Rate Surveys
Laboratory Instrumentation		
Automatic air sample counter	N/A	Lab Analysis
Fixed geometry Geiger-Mueller counter	N/A	Lab Analysis
Scintillation Counter	N/A	Lab Analysis
In Vivo Lung Counter	N/A	Lung Deposition Measurements

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5. NUCLEAR CRITICALITY SAFETY

5.1 MANAGEMENT OF THE NUCLEAR CRITICALITY SAFETY PROGRAM

5.1.1 Nuclear Criticality Safety Design Philosophy

In accordance with baseline design criterion (9) contained in 10 CFR 70.64(a), *Requirements for New Facilities or New Processes at Existing Facilities (Ref. 5-1)*, the design of fissile material processes must "provide for criticality control including adherence to the double contingency principle." The double contingency principle, as identified in American National Standard Institute (ANSI)/American Nuclear Society (ANS) 8.1-1998, *Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors (Ref. 5-2)*, is the fundamental technical basis for design and operation of fissile material processes within the GE-Hitachi Global Laser Enrichment LLC (GLE) Commercial Facility. As such, process designs shall incorporate sufficient margins of safety to require at least two unlikely, independent, and concurrent changes in process conditions before a criticality accident is possible. As used in the double contingency principle, the term "concurrent" means: if the effect of the first process change persists until a second change occurs, an inadvertent nuclear criticality could result. It does not mean the two initiating events must occur simultaneously. The possibility of an inadvertent nuclear criticality can be markedly reduced if failures of nuclear criticality safety (NCS) controls are rapidly detected and processes rendered safe.

The established NCS design criteria and NCS reviews are applicable to: (1) new and existing processes, facilities, or equipment which process, store, transfer, or otherwise handle fissile materials; and (2) any change in existing processes, facilities, or equipment which may have an impact on the established basis for NCS. For fissile material operations, double contingency protection may be provided by either control of at least two independent parameters, or control of a single parameter using a system of multiple independent controls. The defense of one or more system parameters provided by at least two independent controls is documented in the GLE Criticality Safety Analyses (CSAs).

In accordance with the requirements contained in 10 CFR 70.61(d), *Performance Requirements (Ref. 5-3)*, "the risk of nuclear criticality accidents must be limited by assuring that under normal and credible abnormal conditions all nuclear processes are subcritical." The NCS Program evaluates each fissile material process to identify the normal and credible abnormal conditions, and establish the controls required to meet the double contingency design criteria. Use of the double contingency design criteria assures that all nuclear processes remain subcritical under credible conditions. As required in 10 CFR 70.62, *Safety Program and Integrated Safety Analysis (Ref. 5-4)*, the Integrated Safety Analysis (ISA) documents the credible accident sequences that could lead to an inadvertent nuclear criticality, and identifies the likelihood of occurrence for each potential accident sequence. For these credible accident sequences, the engineered and administrative NCS controls required to prevent an inadvertent nuclear criticality and meet the overall likelihood requirements specified in GLE LA Chapter 3, *Integrated Safety Analysis,* are designated as Items Relied on for Safety (IROFS). For each IROFS identified, appropriate management measures are applied to assure the control is available and reliable to perform its function when needed. The ISA methodology is described in GLE LA Chapter 3, and the ISA Summary.

5.1.2 Nuclear Criticality Safety Program Objectives

The NCS Program establishes and maintains NCS safety limits and operating limits for controlled parameters in nuclear processes. Qualified NCS personnel evaluate operations involving fissile material to determine the basis for safety of operation based on the assessment of both normal and credible abnormal conditions. Functional requirements for criticality safety controls are specified commensurate with the NCS design criteria, and management measures are applied to ensure the availability and reliability of the controls. The GLE NCS Program management commits to the following objectives:

- Develop, implement, and maintain an NCS Program that meets the regulatory requirements of 10 CFR 70, *Domestic Licensing of Special Nuclear Material (Ref. 5-5)*;
- Provide sufficient IROFS and defense-in-depth, and demonstrate an adequate margin of safety to prevent an inadvertent nuclear criticality in operations in which fissile material is present;
- Protect against the occurrence of accident sequences identified in the ISA Summary, which could result in an inadvertent nuclear criticality;
- Comply with NCS performance requirements in 10 CFR 70.61;
- Establish and maintain NCS controlled parameters and procedures;
- Establish and maintain NCS subcritical limits and operating limits for identified IROFS;
- Conduct NCS evaluations, herein referred to as CSAs, to assure under normal and credible abnormal conditions, fissile material processes remain subcritical and maintain an adequate margin of safety;
- Establish and maintain NCS postings, training, and emergency procedure training;
- Establish and maintain NCS IROFS, based on current NCS determinations;
- Adhere to NCS baseline design criteria requirements in 10 CFR 70.64(a), for new facilities and new processes at existing facilities requiring a license amendment under 10 CFR 70.72, *Facility Changes and Change Process (Ref. 5-6)*;
- Comply with NCS ISA Summary requirements in 10 CFR 70.65(b), Additional Content of Applications (Ref. 5-7);
- Comply with NCS ISA Summary configuration management (CM) requirements in 10 CFR 70.72.

5.1.3 Evaluation of Nuclear Criticality Safety

As part of the design of new facilities, or significant additions or changes in existing facilities, the proposed design is reviewed and approved by the NCS function. Prior to operation of a new or modified facility/process, an evaluation is performed to demonstrate that the entire process will remain subcritical under both normal and credible abnormal conditions. When NCS considerations are impacted by a change, the NCS function recommends changes to the process parameter necessary to maintain safe operation of the facility, and specifies appropriate controls and management measures required for safety. The approval by the NCS function is required prior to operation of a new or modified facility/process. This NCS approval is documented in accordance with established practices and conforms to the CM Program described in GLE LA Section 11.1, *Configuration Management.*

GLE personnel initiate proposed changes to the facility (such as, design changes, changes to processes, operating and maintenance procedures, IROFS, and management measures) through use of a change request. Change requests are processed in accordance with approved written procedures. Change requests, which establish or involve a change in existing criticality safety parameters, require a Senior NCS Engineer to disposition the proposed change with respect to impacts to the safety basis and the need for a CSA. If a new analysis or a revision to an existing analysis is required, the change is not placed into operation until the CSA is complete and preoperational requirements specified by the NCS function are fulfilled. This assures that the documented safety basis is applicable to the current configuration of the facility.

5.2 ORGANIZATION AND ADMINISTRATION

5.2.1 General Organization and Administrative Methods

The GLE organizational structure and administrative practices have been established consistent with the guidance in ANSI/ANS 8.1-1998 and ANSI/ANS 8.19-2005, *Administrative Practice for Nuclear Criticality Safety (Ref. 5-8)*. Organizational positions, experience, and qualification requirements of personnel and functional responsibilities are described in GLE LA Chapter 2, *Organization and Administration*, which includes an outline of the organizational relationships. The GLE Operations Organization shall be provided adequate resources to ensure an effective NCS Program is implemented.

5.2.2 Nuclear Criticality Safety Organization

The NCS function is administratively independent of the Operations Organization and has the authority to shutdown potentially unsafe operations. The NCS function consists of an NCS Manager responsible for implementation of the NCS Program, and at least one Senior NCS Engineer to allow independent reviews of NCS evaluations. Specific details of the responsibilities and qualification requirements for the NCS Manager, Senior NCS Engineer, and NCS Engineer are described in GLE LA Chapter 2.

NCS personnel are trained in the interpretation of data pertinent to NCS and are familiar with the operation of the GLE Commercial Facility prior to being qualified as a member of the NCS function. Training and qualification of NCS personnel is described in Section 5.3.1, *Training and Qualification of the Nuclear Criticality Staff.*

5.2.3 Operating Procedures

Fissile material operations are performed in accordance with approved written operating procedures. If personnel encounter a condition not covered by the operating procedure, the individual is required to safely stop the operation and report the defective condition to the NCS function, either directly or through Operations management. The operation may not be restarted until the NCS function has evaluated the situation and the necessary procedure instructions are provided. Operations personnel are trained in this procedural compliance policy.

Procedures that govern the handling of enriched uranium are reviewed and approved by the NCS function. The Operations Organization is responsible for developing and maintaining operating procedures that incorporate limits and controls established by the NCS function. GLE management assures operators and other affected personnel review and understand these procedures through postings, training programs, and/or other written, electronic, or verbal notifications.

Documentation associated with the review and approval of operating procedures, and operator training or orientation is maintained within the CM Program and further described in GLE LA Chapter 11, *Management Measures.*

5.2.4 Postings and Labeling

NCS requirements defined by the NCS function are made available at workstations in the form of approved written or electronic operating procedures, and/or clear visible postings. Postings may include the placement of signs and/or marking on walls, floors, or process equipment to summarize key NCS requirements and limits, to designate approved work and storage areas, or to provide instructions or specific precautions to personnel. Information that may be displayed on postings include: limits on material types and forms, allowable quantities by weight or number, required spacing between units, critical control steps in the operation, and control limits (when applicable) on quantities such as moderation, density, or enrichment. Storage postings are located in conspicuous places and include, as appropriate: material type, container identification, number of items allowed, and mass, volume, moderation, and/or spacing limits. In addition, when administrative controls or specific actions/decisions by operators are involved, postings include pertinent requirements identified within the CSA.

Where practical, fissile material containers are labeled such that the material type, ^{235}U enrichment, and gross and/or net weight can be clearly identified or determined. Exceptions to this labeling process include the following:

- Large process vessels in which the content is continuously changing;
- Shipping containers which are labeled as required for shipment;
- Uranium hexafluoride (UF_6) cylinders containing heels in which the net weight is known but the exact fissile content is not quantified;
- Containers of one liter volume or less, or where labeling is not practical;
- In limited circumstances, where the exact enrichment of the material contained is not known (for example, equipment cleanout material or sludge removed from sumps); and
- Waste boxes/drums and contaminated items in which the exact fissile content is very small and not quantified.

Where labeling does not indicate the exact material type, enrichment, and gross and/or net weight, other methods are used to identify the presence of fissile material such as postings, procedures, and training.

5.3 NUCLEAR CRITICALITY SAFETY MANAGEMENT MEASURES

5.3.1 Training and Qualifications of the Nuclear Criticality Safety Staff

Training and qualification of NCS staff is conducted consistent with the guidance in ANSI/ANS 8.26-2007, *Criticality Safety Engineer Training and Qualification Program (Ref. 5-9).* As such, GLE has established a formalized NCS Engineer Training and Qualification Program that is periodically reviewed and maintained by the qualified NCS engineers. This program includes on-the-job training (OJT), demonstration of proficiency, periodic required technical classes or seminars, and participation in offsite professional development activities.

The NCS Engineer Training and Qualification Program content emphasizes on-the-job experience to fully understand the processes, procedures, and personnel required to assure that NCS controls on identified NCS parameters are properly implemented and maintained.

5.3.2 Auditing, Assessing, and Upgrading the Nuclear Criticality Safety Program

NCS audits and assessments are performed consistent with the guidance in ANSI/ANS 8.19-2005. Details of the GLE NCS Audit and Assessment Program are described in GLE LA Section 11.5, *Audits and Assessments.*

NCS audits are conducted by approved NCS personnel and documented in accordance with approved written procedures. Findings, recommendations, and observations are reviewed with the GLE Environmental, Health, and Safety (EHS) Manager to determine if other safety impacts exist. NCS audit findings are transmitted to applicable line managers and area managers for appropriate action and are tracked to completion.

NCS professionals, independent of GLE NCS personnel, conduct periodic NCS Program reviews. The program review provides a means to independently assess the effectiveness of GLE NCS Program components. The audit team is composed of individuals recommended by the NCS Manager, and the team's audit qualifications are approved by the GLE Facility Manager or GLE EHS Manager. Audit results are reported in writing to the NCS Manager, who disseminates the report to line management. Results in the form of corrective action requests are tracked to completion.

5.3.3 Integrated Safety Analysis Summary Revisions and the Nuclear Criticality Safety Program

In accordance with ANSI/ANS 8.19-2005, the CSA is a collection of information that "provides sufficient detail, clarity, and lack of ambiguity to allow independent judgment of the results." The CSA documents the safety basis for the defined fissile process, establishes the subcritical limits on associated controlled parameters, and establishes controls on said parameters to satisfy the double contingency principle.

Documented CSAs are controlled elements of the ISA methodology described in GLE LA Chapter 3 and the ISA Summary. The CSA establishes the NCS bases for a particular system under normal and credible abnormal conditions. CSAs are prepared or updated for new or significantly modified fissile units, processes, or facilities within the GLE Commercial Facility in accordance with the established CM Program described in GLE LA Chapter 11. When a facility change requires a CSA to be re-evaluated or modified, the modifications are carefully evaluated for effects on the ISA Process Hazards Analysis (PHA) and ISA Summary. Likewise, when changes are made to the PHA or ISA Summary, the changes are evaluated for effects on the documented CSAs. Documentation of the ISA Team review and approval of changes made to the PHA or ISA Summary is maintained in accordance with the CM Program.

5.3.4 Modifications to Operating and Maintenance Procedures

Operating and maintenance procedures are maintained consistent with the guidance in ANSI/ANS 8.19-2005. The Operations Organization is responsible for developing and maintaining operating procedures that incorporate limits and controls established by the NCS function. GLE management assures that appropriate GLE personnel and contractors review and understand these procedures through processes such as postings, training programs, and/or other written, electronic, or verbal notifications.

Procedures that govern the operation and maintenance of equipment involved in fissile material processes are reviewed and approved by the NCS function. Based on the review, the NCS function verifies that the required limits and controls have been incorporated into the procedure. In addition, the NCS function assures no single, inadvertent departure from a procedure could cause an inadvertent nuclear criticality and recommends modifications to the procedures to reduce the likelihood of occurrence of an inadvertent nuclear criticality. Documentation of the procedure review and approval process is maintained as described in GLE LA Sections 11.1 and 11.4.

5.3.5 Nuclear Criticality Accident Alarm System

The Criticality Accident Alarm System (CAAS) is designed and maintained to ensure compliance with requirements in 10 CFR 70.24, *Criticality Accident Requirements (Ref. 5-10)*, and ANSI/ANS 8.3-1997, *Criticality Accident Alarm System (Ref. 5-11)* as modified by Regulatory Guide 3.71, *Nuclear Criticality Safety Standards for Fuels and Material Facilities (Ref. 5-12)*. The location and spacing of the detectors are selected taking into account shielding by massive equipment or materials. Spacing between detectors is reduced where high-density building materials such as brick, concrete, or grout-filled cinder block shield a potential accident area from the detector. Low-density materials of construction, such as wooden stud construction walls, plaster, or metal corrugated panels, doors, non-load walls, and steel office partitions, are accounted for with conservative modeling approximations in determining detector placement.

The CAAS initiates immediate evacuation of the facility to ensure radiation exposure to workers is minimized. Employees are trained to recognize the evacuation signal and to evacuate promptly to a designated safe location. This system and proper response protocol is described in the GLE Radiological Contingency and Emergency Plan (RC&EP). Emergency response planning, procedures, and training to address an inadvertent criticality are consistent with the guidance in ANSI/ANS 8.23-1997, *Nuclear Criticality Accident Emergency Planning and Response (Ref. 5-13)*.

GLE commits to having a CAAS that:

- Is uniform throughout the facility for the type of radiation detected, mode of detection, alarm signal, and system dependability;
- Provides coverage in each area that needs CAAS coverage by a minimum of two detectors; and
- Is clearly audible in areas that must be evacuated, or provides alternate visual notification methods documented to be effective in notifying personnel of a necessary evacuation.

The CAAS is maintained through routine response checks and scheduled functional tests conducted in accordance with approved written procedures. In the event of loss of normal power, emergency power is automatically supplied to the CAAS. In the event that CAAS coverage is lost and not restored to an area, affected operations are promptly rendered safe. The exact amount of time necessary to shut down the operation, or place it in a safe state, is dependent on the exact process and operating conditions present during the time the CAAS is not functional. While the CAAS is not functional, compensatory measures such as limiting access to the area and halting special nuclear material (SNM) movement are employed.

5.3.6 Corrective Action Program

A regulatory compliance tracking system is used to track planned corrective or preventive actions in regard to procedural, operational, regulatory, or safety-related deficiencies. NCS Program management assures that unacceptable performance deficiencies, which could result in an inadvertent nuclear criticality, are addressed using the Corrective Action Program. The Corrective Action Program is described in GLE LA Section 11.6, *Incident Investigations.*

5.3.7 Nuclear Criticality Safety Records Retention

Records of CSAs are maintained in sufficient detail and form to permit independent review and audit of the calculation method and results. Such records are retained during the conduct of activities and in accordance with approved written procedures following cessation of such activities. Records of employee nuclear safety training and NCS related documents under configuration control are maintained as described in GLE LA Section 11.7, *Records Management.*

5.4 NUCLEAR CRITICALITY SAFETY METHODOLOGIES AND TECHNICAL PRACTICES

5.4.1 Nuclear Criticality Safety Analysis Methods

5.4.1.1 K_{eff} Limits

Validated analytical methods may be used to evaluate individual process operations or potential system interaction. When analytical methods are used, the effective neutron multiplication factor (k_{eff}) of the system, plus three times the standard deviation of the analytical method, must be less than or equal to the established upper subcritical limit (USL) for both normal and credible process upset (accident) conditions; that is:

$$k_{eff} + 3\sigma \leq USL$$

Normal operating conditions assume the optimum credible conditions (that is, most reactive) expected to be encountered when the criticality control systems function properly. Credible process upsets assume optimum credible conditions anticipated for each off-normal or credible accident condition, and must be demonstrated critically safe in accordance with Section 5.1.1, *Nuclear Criticality Safety Design Philosophy.* The NCS function derives safety limits and operating limits by using these criteria to ensure processes remain subcritical under both normal and credible abnormal conditions. Safety and operating limits are established with sufficient margin of safety taking into consideration variability and uncertainty in process parameters under control to protect against a limit being accidentally exceeded. The sensitivity of key controlled parameters are evaluated with respect to the effect on k_{eff} for each system to assure adequate criticality safety controls are defined for the analyzed system. These studies are performed to correlate the change in k_{eff} that occurs as a result of a change to a controlled parameter.

5.4.1.2 Analytical Methods

Methodologies currently employed by the NCS function include hand calculations utilizing published experimental data (such as, ARH-600, Criticality Handbook [*Ref. 5-14*]), and Monte Carlo codes (specifically, Geometry Enhanced Merit [GEMER]) that utilize stochastic methods to approximate a solution to the three-dimensional neutron transport equation. Additional Monte Carlo code packages (such as, SCALE, MCNP) or S_n Discrete Ordinates codes (such as, ANISN, DORT, TORT, or the DANTSYS code package) may be used after validation has been performed as described in Section 5.4.1.3, *Validation Techniques,* and Section 5.4.1.4, *Validation Reports.*

The primary analytical method used for GLE criticality calculations is the GEMER Monte Carlo Program. GEMER is a multi-group Monte Carlo Program that approximates a solution to the neutron transport equation in three-dimensional space. The GEMER Criticality Program is based on 190-energy group structure to represent the neutron energy spectrum. In addition, GEMER treats resolved resonances explicitly by tracking the neutron energy and solving the single-level Breit-Wigner Equation at each collision in the resolved resonance range in regions containing materials whose resolved resonances are explicitly represented. The cross-section treatment in GEMER is especially important for heterogeneous systems since the multi-group treatment does not accurately account for resonance self-shielding.

5.4.1.3 *Validation Techniques*

The validity of the calculational method (computer code and nuclear cross-section data) used for the evaluation of NCS must be demonstrated and documented in validation reports according to approved written procedures. The validation of the computer code must determine its calculational bias, bias uncertainty, and the minimum margin of subcriticality (MMS) using well-characterized and adequately documented critical experiments. The following definitions apply to the documented validation report(s):

Bias – The systematic difference between calculated results and experimentally measured values of k_{eff} for a fissile system.

Bias Uncertainty – The integrated uncertainty in experimental data, calculational methods, and models estimated by a valid statistical analysis of calculated k_{eff} values for critical experiments.

Minimum Margin of Subcriticality (MMS) – An allowance for any unknown (or difficult to identify or quantify) errors or uncertainties in the method of calculating k_{eff}, that may exist beyond those which have been accounted for explicitly in calculating bias and bias uncertainty.

GLE validation methodologies are consistent with the guidance in ANSI/ANS 8.1-1998 and ANSI/ANS 8.24-2007, *Validation of Neutron Transport Methods for Nuclear Criticality Safety Calculations (Ref. 5-15).* In accordance with the requirements of these national consensus standards, the GLE criteria to establish subcriticality requires the calculated k_{eff} to be less than or equal to an established USL, as presented in the validation report, for a system or process to be considered subcritical. The validation of the calculational method and cross-sections considers a diverse set of parameters that include, but are not limited to:

- Fuel enrichment, composition, and form of associated uranium materials,
- Homogeneity or heterogeneity of the system,
- Presence of neutron absorbing materials,
- Characterization of the neutron energy spectra,
- Types of neutron moderating materials,
- Types of neutron reflecting materials,
- Degree of neutron moderation in the system (such as, H/fissile atom ratio), and
- Geometry configuration of the system (such as, shape, size, spacing, reflector).

Within the validation, various areas of applicability are established based on parameters having a significant effect on the calculation of k_{eff}, bias, and bias uncertainty. The areas of applicability are established by grouping experiments with common parameters of importance to determine bias and bias uncertainty. Parameters with a significant effect on the calculation include: (1) neutron energy spectrum; (2) neutron absorbing materials; and (3) heterogeneity (for low-enriched uranium [LEU] systems). Based on these known parameters of importance, a typical grouping of areas of applicability for a validation may be as follows:

- Homogeneous LEU systems (thermal spectrum),
- Heterogeneous LEU systems (thermal spectrum),
- Common absorber systems (such as, boron, cadmium, gadolinium).

In performing CSA, the appropriate area of applicability shall be applied based on a comparison of parameters being evaluated to parameters covered by the area of applicability. For GLE Commercial Facility Operations, the most common area of applicability is homogeneous LEU systems based on the fact that materials evaluated are typically: (1) homogeneous (uranium hexafluoride and uranyl fluoride); (2) low-enriched ($\leq$ 10 wt% ^{235}U); and (3) slightly to optimally moderated (thermal spectrum). When applying the validation outside an area of applicability, justification must be provided in the CSA. The selection of critical experiments, for each identified area of applicability of the NCS computer code validation, incorporates the following considerations:

- Experimental data for validation is assessed for completeness, accuracy, and applicability to operations prior to selection and use as a critical benchmark.
- Selection of experiments must encompass appropriate parameters spanning the range of normal and credible abnormal conditions that are anticipated to be evaluated using the calculational method.
- To minimize systematic error, benchmark data selected for validation are drawn from multiple, independent series, and sources of critical experiments. The range of parameters characterized by selected critical experiments is used to define the area of applicability for the code.
- The calculational method used to analyze the set of critical benchmarks incorporates the same analytic techniques used to analyze systems or processes to which the validation is applied.

The calculational bias, bias uncertainty, and USL over each defined area of applicability are determined by statistical methods as described in the following sections.

5.4.1.3.1 Calculational Bias

The bias is determined either as a constant, if no trends exist, or as a smooth and well-behaved function of a selected characteristic parameter (for example, hydrogen-to-fissile ratio) by regression analysis. Regression analysis may be used when trends exist with parameters statistically significant over the area of applicability.

Bias is determined from the calculated benchmark k_{eff} data, which are weighted using the overall uncertainty of each calculated data point. The overall uncertainty accounts for calculation uncertainty and benchmark uncertainty. Bias is applied over its negative range and assigned a value of zero over its positive range.

5.4.1.3.2 Bias Uncertainty

The bias uncertainty may be estimated using one of the following statistical methods. The details of each statistical method are documented in the validation report. Additional methods may be used when necessary.

Single-Sided Lower Confidence Band (SSLCB): Estimates bias uncertainty to ensure, at a 95% level of confidence, a future calculation of k_{eff} for a critical system or process is actually above the lower confidence limit. The SSLCB may be used when there is a clear trend in the calculated critical benchmark results.

Single-Sided Lower Tolerance Band (SSLTB): Estimates the bias uncertainty to ensure, at a 95% level of confidence, at least 95% of future calculations of k_{eff} for critical systems or processes are actually above the lower tolerance limit. The SSLTB may be used when there is a clear trend in the calculated critical benchmark results.

Single-Sided Lower Tolerance Limit (SSLTL): Estimates the bias uncertainty to ensure, at a 95% level of confidence, at least 95% of future calculations of k_{eff} for critical systems or processes are actually above the lower tolerance limit. The SSLTL is used when there are no trends apparent in the calculated critical benchmark results.

5.4.1.3.3 Data Normality

Where no trends to a characteristic parameter exist (SSLTL), the normality of calculated k_{eff} values for the set of critical experiments must be verified prior to estimation of bias and bias uncertainty. Where trends to a characteristic parameter do exist (SSLCB and SSLTB), normality of the regression analysis residuals must be verified prior to estimation of the bias and bias uncertainty.

5.4.1.3.4 Upper Subcritical Limit (USL)

The USL is established based on calculated bias, bias uncertainty, and MMS for the area of applicability as follows:

$$USL = 1 + bias - bias\ uncertainty - MMS$$

At GLE, a minimum $MMS = 0.03$ is used to establish acceptance criteria for criticality calculations, which compared to the uncertainty in calculated k_{eff} values, is large.

The following acceptance criteria, considering worst-case credible accident conditions, must be satisfied, when using k_{eff} calculations by Monte Carlo methods, to establish subcritical limits for the GLE Commercial Facility:

$$k_{eff} + 3\sigma \leq USL$$

where σ is the standard deviation of the k_{eff} value obtained from the calculational method.

5.4.1.4 Validation Reports

Validation reports are documented, reviewed, and approved for each analytical method used to derive NCS limits. Validation reports are created, revised, reviewed, and approved by the NCS function and are controlled under the CM Program. The following requirements apply to Validation reports documented by the NCS function:

- Describe the NCS analytical method to which the validation applies.
- Clearly describe the theory of the validation methodology in sufficient detail to allow understanding of the methodology and independent duplication of results.
- Describe the mathematical and statistical operations used in the validation methodology to determine bias and bias uncertainty, including statistical testing performed to verify the acceptability of results.
- Provide a description or summary of the benchmark experiments or critical experiments selected for the validation, which indicate experiment characteristics important to the area of applicability and a reference to reliable experimental data.
- Identify the bias, uncertainty in the bias, uncertainty in calculated data, uncertainty in the benchmark experiments, and margin of subcriticality. If the derived bias is positive, it must be assigned a value of zero.
- Summarize the range in (or values of) NCS parameters describing the area of applicability. The area of applicability should be consistent with the values of parameters used in selected benchmark experiments. Any extrapolation beyond the area of applicability should be supported by an established mathematical methodology or sound engineering judgment.
- Provide a description of the analytical method verification process and assurance that only verified software and hardware are used in the validation process.

5.4.1.5 Computer Software and Hardware Configuration Control

The software and hardware used within the criticality safety calculational system is configured and controlled in accordance with CM approved written procedures. Software changes are conducted in accordance with CM Program described in GLE LA Section 11.1.

Software, designated for use in NCS, are compiled into working code versions with executable files traceable by length, time, date, and version. Working code versions of compiled software are validated against critical experiments using an established methodology with differences in experiment and analytical methods being used to calculate bias and uncertainty values to be applied to the calculational results.

Each individual workstation is verified to produce results equivalent to the development workstation prior to use of the software for criticality safety calculation demonstrations on the production workstation. The verification results are documented for each individual workstation. Modifications to software and nuclear data affecting the calculational logic require re-validation of the software. Modifications to hardware or software that do not affect calculational logic are followed by code operability verification; in which case, selected calculations are performed to verify equivalent results from previous verifications. Deviations noted in code verification that may alter the bias or uncertainty requires re-qualification of the code prior to release for production use.

5.4.2 Control Practices

CSAs identify specific independent controls necessary to provide safe double contingent protection of a process. As discussed in Section 5.1.1, controls identified in the CSA are selected to assure no single credible event or failure can result in a criticality accident. As such, it is demonstrated that the process will remain subcritical under both normal and credible abnormal conditions. Prior to use in any enriched uranium process, NCS controls are verified against CSA criteria. The ISA methodology described in GLE LA Chapter 3 implements performance based management of process requirements and specifications important to NCS.

5.4.2.1 Verification and Maintenance of Controls

Reliable methods and instruments are used when NCS parameters are controlled by measurement. To assure continued reliability, required periodic verification and maintenance of controls are performed as described in GLE LA Section 11.2, *Maintenance*. The purpose of the verification program is to ensure the controls selected and installed fulfill the requirements identified in the CSA.

Processes are examined in the "as-built" condition to validate safety design and to verify the installation conforms to control specifications identified in the CSA. NCS personnel observe or monitor the performance of initial functional tests, and conduct preoperational audits to verify the controls function as intended, and the installed configuration agrees with the control specifications identified in the CSA. Operations personnel are responsible for subsequent verification of controls through the use of periodic functional testing or verification. When necessary, control calibration and routine maintenance are normally provided by the Instrument and Calibration and/or Maintenance functions. The purpose of the Maintenance Program is to ensure that the effectiveness of NCS controls designated for a specific process are maintained at the original level of intent and functionality. This requires a combination of routine maintenance, functional testing, and verification of design specifications on a periodic basis.

Verification and maintenance activities are performed per established practices documented through the use of forms and/or computer tracking systems. NCS personnel randomly review control verifications and maintenance activities to assure controls remain effective. Details of the Maintenance Program are described in GLE LA Section 11.2.

5.4.2.2 Consideration of Material Composition (Heterogeneity)

The CSA for each process determines the effects of material composition (for example, type, chemical form, physical form) within the process being analyzed, and identifies the basis for selection of compositions used in subsequent system modeling activities. In considering material composition, it is especially important to distinguish between homogeneous and heterogeneous system conditions. Heterogeneous effects are particularly relevant for LEU processes where all other parameters being equal; heterogeneous systems are typically more reactive than homogeneous systems. Systems involving uranium hexafluoride and uranyl fluoride are typically homogeneous; however, solid forms of uranium oxides may be heterogeneous. Evaluation of systems where the particle size varies must take into consideration effects of heterogeneity, as appropriate, for the process being analyzed.

5.4.3 Means of Control

The relative effectiveness and reliability of controls are considered during the CSA process. Passive engineered controls are preferred over other system controls and are utilized when practical and appropriate. Active engineered controls are the next preferred method of control. Administrative controls are the least preferred; however, augmented administrative controls are preferred over simple administrative controls. A criticality safety control must be capable of preventing a criticality accident independent of operation or failure of any other criticality control for a given credible initiating event.

5.4.3.1 Passive Engineered Controls

A device using only fixed physical design features to maintain safe process conditions without any required human action. Assurance is maintained through specific periodic inspections or verification measurement(s), as appropriate.

5.4.3.2 Active Engineered Controls

A physical device using active instrumentation, electrical components, or moving parts to maintain safe process conditions without any required human action. Assurance is maintained through specific periodic functional testing, as appropriate. Active engineered controls are designed to be fail-safe (that is, failure of the control results in a safe condition).

5.4.3.3 Administrative Controls

Either an augmented administrative control or a simple administrative control as defined herein:

Augmented Administrative Control – A procedurally required or prevented human action, combined with a physical device, which alerts an operator when action is needed to maintain safe process conditions or otherwise adds substantial assurance of the required human performance.

Simple Administrative Control – A procedural human action prohibited or required to maintain safe process conditions.

Use of administrative controls is limited to situations where passive and active engineered controls are not practical. Administrative controls may be proactive (requiring action prior to proceeding) or reactive (proceeding unless action occurs). Proactive administrative controls are preferred. Assurance is maintained through periodic verification, audit, and training.

5.4.4 Control of Parameters

NCS is achieved by controlling one or more parameter(s) of a system within established subcritical limits. The CM Program may require NCS staff review of proposed new or modified processes, equipment, or facilities to ascertain impact on controlled parameters associated with the particular system. Assumptions relating to processes, equipment, or facility operations, including material composition, function, operation, and credible upset conditions, are justified and documented in the CSA and independently reviewed.

Identified below are specific controlled parameters, which include mass, geometry, enrichment, reflection, moderation, concentration, interaction, neutron absorption, and process characteristics that may be considered during the NCS review process.

5.4.4.1 Mass

Mass control may be used for NCS control alone or in combination with other control methods. Mass control may be utilized to limit the quantity of uranium within specific process operations or vessels and within storage, transportation, or disposal containers. Mass may be controlled by direct measurement (for example, use of certified scales) through the use of fixed geometric dimensions and the assumption of a conservative fissile material density, or by using analytical or non-destructive methods.

Establishment of mass limits involves consideration of enrichment, potential moderation, reflection, geometry, spacing, and material composition. The CSA considers normal operations and credible process upsets in determining actual mass limits for the system and for defining additional controls. When only administrative controls are used for mass-controlled systems, double batching is considered to ensure adequate safety margin.

Where mass is the only parameter being controlled, and double batching is considered credible, the mass of any single accumulation shall not exceed either: (1) a safe batch, which is defined to be 45 percent of the minimum critical mass; or (2) 50 percent of the safe mass limit derived using validated analytical methods and an approved MMS.

Where mass is one of two parameters being controlled, or where engineered controls prevent over batching, the mass of any single accumulations shall not exceed either: (1) 75 percent of the minimum critical mass; or (2) the safe mass limit derived using validated analytical methods and an approved MMS.

5.4.4.2 Geometry

Geometry may be used for NCS control alone or in combination with other control methods. Favorable geometry is based on limiting dimensions of defined geometrical shapes to established subcritical limits. Structure and/or neutron absorbers that are not removable constitute a form of geometry control. At the GLE Commercial Facility, favorable geometry is developed conservatively assuming full water or concrete equivalent reflection, optimal hydrogenous moderation, worst credible heterogeneity, and maximum credible enrichment. Examples of parameters used for engineered geometry controls include cylinder diameters, annulus inner and outer radii, slab thickness, and/or fixed volumes.

Subcritical limits for geometry controls may be derived using either validated analytical methods and an approved MMS or experimental data. Where experimental data are used, the margins of safety are 90 percent of the minimum critical cylinder diameter, 85 percent of the minimum critical slab thickness, and 75 percent of the minimum critical sphere volume.

Geometry control systems are analyzed and evaluated allowing for fabrication tolerances and dimensional changes that may likely occur through corrosion, wear, or mechanical distortion. Before beginning operations, dimensions and nuclear properties applicable to the geometry control are verified using appropriate instrumentation. The CM Program is used to maintain these dimensions and nuclear properties within acceptable limits. Provisions are also made for periodic inspection, if credible conditions exist in which changes in the dimensions or nuclear properties of the equipment could occur, resulting in the inability to meet established NCS limits.

5.4.4.3 Enrichment

Enrichment control may be utilized to limit the weight percent ^{235}U within a process, vessel, or container, thus providing a method for NCS control. Enrichment controls may be used to segregate materials of different enrichment or to prevent material from being enriched above an NCS limit. Where enrichment is controlled, active engineered or administrative controls are required to measure or verify the enrichment, or to prevent the introduction of uranium at unacceptable enrichment levels within a defined subsystem. In cases where enrichment control is not utilized, the maximum credible enrichment for the particular process or subsystem is utilized in the CSA.

5.4.4.4 Reflection

Most systems are designed and operated with the assumption of 12-inch water or optimum reflection surrounding the system. In such cases, controls limiting reflection are not required since optimum reflection has been demonstrated safe. However, subject to approved controls limiting reflection, certain system designs may be analyzed, approved, and operated in situations where the analyzed reflection is less than optimum. In the CSA, the neutron reflection properties of the credible process environment are also considered. For example, reflectors more effective than water (such as, concrete) and adjacent structural materials are considered when appropriate.

5.4.4.5 Moderation

Moderation control may be used for NCS control alone or in combination with other control methods. Moderation controls are used to limit the amount of moderation present within fissile material. Where moderation is used as an NCS controlled parameter, moderation controls are implemented consistent with the guidance in ANSI/ANS 8.22-1997, *Nuclear Criticality Safety Based on Limiting and Controlling Moderators (Ref. 5-16).* When moderation is used in conjunction with other control parameter(s), the area is posted as a Moderation Controlled Area (MCA). Operations in MCAs must be demonstrated safe under a complete loss of moderation condition based on a control of a separate independent controlled parameter (such as, mass or geometry).

When moderation control is the designated as the primary controlled parameter for a fissile material process, the area is posted as a Moderation Restricted Area (MRA). An MRA is any process area in which loss of moderation control alone could result in a criticality. Moderation is typically the primary controlled parameter for processing of enriched UF_6 cylinders and for unfavorable geometry systems that handle UF_6. In such systems, the required number of moderation controls for each credible accident sequence must be established in accordance with the double contingency principle. In evaluating systems where the primary controlled parameter is moderation, the following requirements apply:

- Identify credible sources of moderation intrusion and either preclude or control the ingress of moderation in accordance with the double contingency principle;
- Design physical structures, barriers, and/or equipment involved in the system to limit or control the ingress of moderation;
- Use qualified instrumentation where moderation control requires the moderation content or other system parameters to be measured or monitored;
- Use redundant independent sampling methods where moderation control relies on sample analysis; and
- Control combustible materials, document fire-fighting methods in approved written procedures, and provide for approved sprinkler systems, manual means, or non-hydrogenous chemicals for fire fighting as specified by the process analysis.

When the worst credible accident is considered, the safety moderation limit (typically in units of %HF or equivalent) must provide a sufficient factor of safety above the process moderation limit. This moderation safety factor, which is the ratio of the safety moderation limit to the process moderation limit, is normally three or higher but never less than two. The value of the moderation safety factor depends on the likelihood and time required for the system being considered to transition from the process moderation limit to the safety moderation limit.

In some cases, increased depth of protection may be required; however, the minimum protection is never less than two independent controls on moderation for each credible accident sequence, which must fail before a criticality accident is possible. The quality and basis for selection of the controls is documented in accordance with the ISA Process described in GLE LA Chapter 3. The introduction and use of moderating materials (such as, cleaning agents, oils, or lubricants) within MRAs are subject to controls/limits that are approved by the NCS function.

5.4.4.6 Concentration (or Density)

Concentration control may be used for NCS control alone or in combination with other control methods. Concentration controls are established to ensure the concentration level is maintained within defined limits for the system. Each process relying on concentration control has engineered controls in place to detect and/or mitigate the effects of high concentration within the system; otherwise, the most reactive credible concentration (density) is assumed.

Concentration control is typically used in processes containing solution with low uranium concentrations such as a liquid effluent system. In evaluating systems containing concentration-controlled solution, the following requirements apply:

- Preclude a high concentration of uranium in a process unless the process is demonstrated safe at any credible concentration (for example, a favorable geometry tank);
- Equip the tank/vessel with backflow prevention controls (for example, air break, siphon breaks, overflow lines) where appropriate and inspect periodically for buildup; and
- Take precautions where precipitating agents are added to ensure agents are not inadvertently introduced.

When concentration is the only parameter controlled to prevent criticality, concentration may be controlled by two independent combinations of measurement and physical control, with each physical control capable of preventing the concentration limit from being exceeded in an unsafe location. The preferred method of attaining independence is to ensure that at least one of the two combinations is an active engineered control.

5.4.4.7 Interaction (or Unit Spacing)

Interaction/spacing control may be used for NCS control alone or in combination with other control methods. Interaction controls are based on either neutronic isolation or spacing of interacting units to control neutron leakage. Physical separation between process operations, vessels, or containers may be provided by either engineered or augmented administrative controls depending on the application. Where engineered spacing controls are required the structural integrity of the engineered feature must be sufficient for normal and credible abnormal conditions.

Units may be considered effectively non-interacting (isolated) if they are: (1) separated by 12-inches of full density water equivalent; (2) separated by the larger of 12-foot air distance or the greatest distance across an orthographic projection of the largest fissile accumulation on a plane perpendicular to the line joining their centers; or (3) shown to be non-interacting based on comparison of the calculated effective multiplication factor for the unit and that of the entire system.

5.4.4.8 Neutron Absorbers

Neutron absorbing materials may be utilized to provide a method for NCS control for a process, vessel, or container. Stable compounds such as boron carbide fixed in a matrix (such as, aluminum or polyester resin, elemental cadmium clad in appropriate material, elemental boron alloyed stainless steel, or other solid neutron absorbing materials) with an established dimensional relationship to the fissionable material are recommended. The use of neutron absorbers in this manner is defined as part of a passive engineered control. When evaluating the absorber effectiveness for an application, the neutron spectrum is considered in the CSA.

Where neutron absorbers are used as an NCS controlled parameter, fixed neutron absorbers controls are implemented consistent with the guidance in ANSI/ANS 8.21-1995, *Use of Fixed Neutron Absorbers in Nuclear Facilities Outside Reactors (Ref. 5-17).*

5.4.4.9 Process Characteristics

Within certain fissile material operations, credit may be taken for physical, chemical, and nuclear properties of the process and/or materials as NCS controls. Use of process characteristics is based upon the following requirements:

- Identify the bounding conditions and operational limits in the CSA and communicate, through training and procedures, to appropriate Operations personnel.
- Base bounding conditions for such process and/or material characteristics on established physical, chemical, or nuclear reactions, known scientific principles, and/or facility-specific experimental data supported by operational history.
- The devices and/or procedures, which maintain the limiting conditions, must have the reliability, independence, and other characteristics required of a criticality safety control.

5.4.5 Criticality Safety Analyses

The scope and content of any particular CSA reflects the needs and characteristics of the system being analyzed and typically includes the applicable information requirements listed below.

Scope – Defines the stated purpose of the analysis.

General Discussion – Presents an overview of the process affected by the proposed change. This section includes, as appropriate: process description, flow diagrams, normal operating conditions, system interfaces, and other important to design considerations.

Criticality Safety Controls/Bounding Assumptions – Defines the controlled parameter(s) and summarizes the criticality safety controls on each identified parameter that are imposed as a result of the evaluation. This section also clearly presents a summary of the bounding assumptions used in the analysis. Bounding assumptions include: worst credible contents (for example, material composition, density, enrichment, and moderation), boundary conditions, inter-unit water, and a statement on assumed structure. In addition, this section may include a statement summarizing interface considerations with other units, subareas, and/or areas.

Model Description – Presents a narrative description of the actual model used in the analysis. An identification of both normal and credible upset (accident) conditions and model file naming convention is provided. Key input listings and corresponding geometry plot(s) for both normal and credible upset cases are also provided.

Calculational Results – Identifies how the calculations were performed, what tools or reference documents were used, and when appropriate, presents a tabular listing of the calculational result and associated uncertainty (for example, $K_{eff} + 3\sigma$) results as a function of the key parameter(s) (for example, wt. fraction H_2O). When applicable, the assigned bias of the calculation is also clearly stated and incorporated into both normal and/or accident limit comparisons.

Safety During Upset Conditions – Presents a concise summary of the upset conditions considered credible for the defined unit or process system. This section includes a discussion as to how established NCS limits and controls address each credible process upset (accident) condition to maintain subcriticality.

Specifications and Requirements for Safety – When applicable, presents both design specifications and criticality safety requirements for correct implementation of established controls. These requirements are incorporated into operating procedures, training, maintenance, and quality assurance (QA) as appropriate to implement the specifications and requirements.

Compliance – Concludes the analysis with pertinent summary statements and includes a statement regarding license compliance.

Verification – A qualified Senior NCS Engineer, who was not involved in the analysis, verifies each CSA in accordance with GLE LA Section 5.4.5.1, *Technical Reviews.*

Appendices – Where necessary, include a summary of information ancillary to calculations such as parametric sensitivity studies, references, key inputs, model geometry plots, equipment sketches, useful data, etc., for each defined system.

5.4.5.1 Technical Reviews

Independent technical reviews of proposed criticality safety control limits specified in the CSA are performed. A Senior NCS Engineer is required to perform the independent technical review. The independent technical review consists of a verification that the neutronics geometry model and configuration used adequately represent the system being analyzed. In addition, the reviewer verifies that the proposed material characterizations such as density, concentration, etc., adequately represent the system. The reviewer also verifies that the proposed criticality safety controls are adequate. The independent technical review of the specific calculations and computer models is performed using one of the following methods:

- Verify the calculations with an alternate computational method;
- Verify methods with an independent analytic approach based on fundamental laws of nuclear physics;
- Verify the calculations by performing a comparison to results from a similar design or to similar previously performed calculations; or
- Verify the calculations by performing specific checks of the computer codes used, and by performing evaluations of code input and output.

Based on one of these prescribed methods, the independent technical review provides a reasonable measure of assurance that the chosen analysis methodology and results are correct.

5.5 REPORTING REQUIREMENTS

A program for evaluating the criticality significance of NCS events is established for making the required notification to the NRC Operations Center. Qualified individuals make the determination of the significance of NCS events. The determination of loss or degradation of double contingency protection is made against the documented CSA, the License, and 10 CFR 70, Appendix A. GLE commits to the following NCS reporting requirements:

- The reporting criteria of 10 CFR 70, Appendix A and the report content requirements of 10 CFR 70.50, *Reporting Requirements (Ref. 5-18)*, are incorporated into approved written procedures.

- If it cannot be ascertained within one hour of the discovery of an event, whether the criteria of 10 CFR 70, Appendix A, Paragraph (a) applies, the event should be treated as a one-hour reportable event.

- If it cannot be ascertained within 24 hours of discovery of an event, whether the criteria of 10 CFR 70, Appendix A, Paragraph (b) applies, the event should be treated as a 24-hour reportable event.

- The required report is issued when the IROFS credited is lost, irrespective of whether the safety limits of the associated parameters are actually exceeded.

5.6 REFERENCES

5-1. 10 CFR 70.64, *Requirements for New Facilities or New Processes at Existing Facilities*, U.S. Nuclear Regulatory Commission, 2008.

5-2. ANSI/ANS 8.1-1998, *Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors*, American Nuclear Society, January 1998.

5-3. 10 CFR 70.61, *Performance Requirements,* U.S. Nuclear Regulatory Commission, 2008.

5-4. 10 CFR 70.62, *Safety Program and Integrated Safety Analysis,* U.S. Nuclear Regulatory Commission, 2008.

5-5. 10 CFR 70, *Domestic Licensing of Special Nuclear Material*, U.S. Nuclear Regulatory Commission, 2008.

5-6. 10 CFR 70.72, *Facility Changes and Change Process*, U.S. Nuclear Regulatory Commission, 2008.

5-7. 10 CFR 70.65, *Additional Content of Applications,* U.S. Nuclear Regulatory Commission, 2008.

5-8. ANSI/ANS 8.19-2005, *Administrative Practice for Nuclear Criticality Safety*, American Nuclear Society, January 2005.

5-9. ANSI/ANS 8.26-2007, *Criticality Safety Engineer Training and Qualification Program*, American Nuclear Society, June 2007.

5-10. 10 CFR 70.24, *Criticality Accident Requirements*, U.S. Nuclear Regulatory Commission, 2008.

5-11. ANSI/ANS 8.3-1997 (R2003), *Criticality Accident Alarm System*, American Nuclear Society, January 1997.

5-12. Regulatory Guide 3.71, *Nuclear Criticality Safety Standards for Fuels and Material Facilities*, U.S. Nuclear Regulatory Commission, Revision 1, October 2005.

5-13. ANSI/ANS 8.23-1997, *Nuclear Criticality Accident Emergency Planning and Response*, American Nuclear Society, January 1997.

5-14. ARH-600, *Criticality Handbook*, R. D. Carter, G. R. Kiel, and K. R. Ridgway, Atlantic Richfield Hanford Co. Report, 1968.

5-15. ANSI/ANS 8.24-2007, *Validation of Neutron Transport Methods for Nuclear Criticality Safety Calculations*, American Nuclear Society, 2007.

5-16. ANSI/ANS 8.22-1997 (R2006), *Nuclear Criticality Safety Based on Limiting and Controlling Moderators*, American Nuclear Society, January 1997.

5-17. ANSI/ANS 8.21-1995 (R2001), *Use of Fixed Neutron Absorbers in Nuclear Facilities Outside Reactors*, American Nuclear Society, January 1995.

5-18. 10 CFR 70.50, *Reporting Requirements*, U.S. Nuclear Regulatory Commission, 2008.

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6. CHEMICAL PROCESS SAFETY

This chapter describes the chemical classification process, the hazards of chemicals of concern, process interactions with chemicals affecting licensed materials and/or hazardous chemicals produced from licensed material, the methodology for evaluating hazardous chemical consequences, and the chemical safety assurance features.

The GE-Hitachi Global Laser Enrichment LLC (GLE) Chemical Process Safety Program has been developed consistent with the guidance in Chapter 6 of NUREG-1520, *Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility (Ref. 6-1)*, and complies with 10 CFR 70.61, *Performance Requirements (Ref. 6-2)*, 10 CFR 70.62, *Safety Program and Integrated Safety Analysis (Ref. 6-3)*, and 10 CFR 70.64, *Requirements for New Facilities or New Processes at Existing Facilities (Ref. 6-4).*

6.1 PROCESS CHEMICAL RISK AND ACCIDENT SEQUENCES

It is GLE Policy to provide a safe and healthy work place by minimizing the risk of chemical exposure from licensed material and other hazardous chemicals to employees, the public, and the environment. This is accomplished through the Integrated Safety Analysis (ISA), the controls resulting from the ISA, and through the implementation of the Chemical Safety Program. This chapter discusses chemical safety issues related to: radiation and chemical risks of licensed materials; hazardous chemicals produced from licensed material; and facility conditions that affect or may affect the safety of licensed material resulting in an increased radiation risk to personnel, the public, or the environment.

6.1.1 Process Descriptions

The GLE process descriptions are provided in the ISA Summary. The descriptions are intended to allow a basic understanding of the chemical process hazards including radiological hazards caused by or involving chemical accidents. Summaries of the process descriptions are also included in GLE license application (LA) Chapter 1, *General Information.*

6.1.2 Consequences and Likelihoods of Accident Sequences

An ISA has been performed as required by 10 CFR 70.62. The ISA provides a list of the accident sequences that have the potential to result in radiological and non-radiological releases of chemicals; provides reasonable estimates for the likelihood and consequence of each accident identified; and applies acceptable methods to estimate potential impacts of accidental releases. The ISA also identifies the engineering and/or administrative controls for each accident sequence of significance; satisfies principles of the baseline design criteria (BDC) and performance requirements in 10 CFR 70.61 by applying defense-in-depth to high-risk chemical release scenarios; and assures adequate levels of these controls are provided so Items Relied on for Safety (IROFS) will satisfactorily perform their safety function when needed.

Accident sequences involving licensed materials, and those chemicals that may impact licensed materials, have been analyzed in the ISA and summarized in the ISA Summary. The accident sequences identified by the ISA were categorized into one of three consequence categories (high, intermediate, or low) based on their radiological, chemical, and/or environmental impacts. The radiological and chemical consequence severity limits, defined by 10 CFR 70.61 for the high and intermediate categories, are presented in Table 6-1, *Chemical Consequence Severity Levels from 10 CFR 70.61*. The ISA considers the potential interactions of process chemicals with confinement vessels, and with process equipment in which initiating events include releases of uranium hexafluoride (UF_6) from equipment, including vessels, pipes, valves, and cylinders. Interactions between process chemicals and personnel are considered both in the ISA, and during the preparation of procedures to include industrial safety protective measures.

The measures to mitigate the consequences of accident sequences identified in the ISA Summary are consistent with protective actions described in the GLE Radiological Contingency and Emergency Plan (RC&EP) *(Ref. 6-5)*. The site emergency response team is prepared to respond to various emergency conditions, including a chemical accident.

6.1.3 Chemical Release Scenario Techniques and Assumptions

This section describes the techniques and assumptions used to estimate the concentrations or to predict the "toxic" footprint for potential releases of hazardous chemicals produced by licensed material or by abnormal facility conditions that could affect the safety of licensed materials.

6.1.3.1 Worker Exposure Assumptions

Any release from UF_6 systems and/or cylinders at the GLE Commercial Facility would predominately consist of hydrogen fluoride (HF), uranyl fluorde (UO_2F_2), and potentially some UF_6. The release would cause a visible cloud and a pungent odor. The odor threshold for HF is less than one parts per million (ppm). The irritating effects of HF are typically intolerable at concentrations well below those that cause permanent injury or which produce escape-impairing symptoms. Workers are trained to take immediate self-protective action to escape a release upon sensing HF effects. For the purpose of evaluating personnel exposure in cases where a worker would be expected to be in the immediate proximity of a release, the 10-minute Acute Exposure Guideline Levels (AEGL) values have been used for HF and UF_6. Table 6-2, *Chemical Consequence Values*, shows the numeric values used as chemical consequence thresholds. Once a release is detected, the worker is assumed to evacuate the area of concern. Sufficient time is available for the worker to reliably detect and evacuate the area of concern.

6.1.3.2 Public Exposure Assumptions

Potential exposures to the public were evaluated using conservative assumptions for both exposure concentrations and durations. Exposure was evaluated for consequence severity against chemotoxic, radiotoxic, and radiological dose. Public exposures were estimated to last for a duration of 30 minutes. This is consistent with self-protection criteria for UF_6/HF plumes listed in NUREG-1140, *A Regulatory Analysis on Emergency Preparedness for Fuel Cycle and Other Radioactive Material Licensees (Ref. 6-6)*.

6.1.4 Source Term and Dispersion Models

The methodologies used to determine the source term are those prescribed in NUREG/CR-6410, *Nuclear Fuel Cycle Facility Accident Analysis Handbook (Ref. 6-7)*, and supporting documents. The specific modeling methods utilized follow consistent and conservative methods for source term determination, release fraction, dispersion factors, and meteorological conditions. For releases inside of buildings, conservative leak path fractions were assumed as recommended by NUREG/CR-6410.

6.1.5 Description of Chemical Dispersion Models

The computer codes used in chemical consequence analyses were RASCAL 3.0.5 (Radiological Assessment System for Consequence Analysis) *(Ref. 6-8)* and ARCON 96, both of which are widely-accepted by the nuclear industry as appropriate for chemical dispersion modeling.

6.1.6 Chemical Exposure Standards

To quantify criteria of 10 CFR 70.61 for chemical exposure, standards for each applicable hazardous chemical must be applied to determine exposure that could: endanger the life of a worker; lead to irreversible or other serious long-lasting health effects in an individual; and cause mild transient health effects to an individual. Per NUREG-1520, acceptable exposure standards include the AEGL established by the National Advisory Committee for Acute Guideline Levels for Hazardous Substances. Consistent with the NUREG-1520 guidance, GLE uses the AEGL standard to assess the consequences of postulated chemical releases The only accident sequences resulting in chemical consequences exceeding the criteria in 10 CFR 70.61 involve the release of UF_6 and its hydrolysis products HF and UO_2F_2. These accident sequences are presented in the ISA Summary.

Dermal exposures to HF have been evaluated in the ISA Summary. Although HF is not used directly in the enrichment process, limited quantities of dilute HF (< 4%) are generated in the Laboratory and Decontamination/Maintenance Areas. The criteria for assessing dermal exposures are listed in Table 6-3, *HF Dermal Exposure Consequence Severity Levels.*

6.2 ITEMS RELIED ON FOR SAFETY AND MANAGEMENT MEASURES

This section describes the identification and management measures associated with chemical process safety IROFS.

6.2.1 Chemical Safety Approach

Safety in normal operations is maintained through the implementation of the defense-in-depth engineering design philosophy. The ISA Summary describes the basis for providing successive levels of protection such that the health and safety of employees and the public are not wholly dependent upon any single element of the design, construction, maintenance, or operation of the facility. The schemes employed to ensure safe operation of the facility include management measures that provide for the reliability of IROFS. These measures include configuration management (CM), maintenance, procedures, training, audits/ assessments, emergency planning, incident investigation, human factors, records, and reporting. Management measures are fully described in GLE LA Chapter 11, *Management Measures*.

6.2.1.1 Chemical Safety Program

The Chemical Safety Program is applicable to the chemicals associated with the authorized activities described in GLE LA Chapter 1, and includes UF_6 and hydrofluoric acid as well as other hazardous chemicals associated with licensed material activities. The Chemical Safety Program provides oversight of the handling, use, and storage of chemicals at the GLE Commercial Facility. The Chemical Safety Program is documented in approved written procedures that ensure processes and operations comply with applicable Federal and State regulations pertaining to chemical safety.

The Chemical Safety Program falls within the Environmental, Health, and Safety (EHS) Organization and overlaps with several other disciplines including: Operations, Maintenance, Radiation Protection (RP), Emergency Preparedness, Environmental Protection, Industrial Safety, and Nuclear Criticality Safety (NCS). Prior to starting a new activity involving chemicals, a job hazards analysis (JHA) is performed to ensure that the work is conducted safely and the appropriate training, authorizations, and procedures are completed. This ensures that appropriate controls are in place for adequate protection of the general public and safe use by employees, and that the use of chemicals does not create potential conditions that adversely affect the handling of licensed materials. Employees and contractors using hazardous materials are trained to ensure safe handling, use, and disposal.

EHS management reviews and approves JHAs prior to initial issuance. The review and approval is to affirm that the criticality, radiation, chemical, process, fire, and explosion risks associated with the process or facility under evaluation is understood and proper safety measures are in place. GLE LA Chapter 2, *Organization and Administration*, contains a description of the GLE Organization, including the responsibilities of the EHS Manager.

6.2.1.1.1 Chemical Evaluation and Approval

Prior to new hazardous materials being brought onsite or being used in an activity, the materials are approved through a formal process initiated when a request for procurement of a new chemical is submitted. Before a new chemical is ordered, the requester must obtain approval from the Chemical Review Committee. The Chemical Review Committee is comprised of a representative of the EHS Organization, an area manager, and others as deemed appropriate by the EHS representative. The EHS representative leads the review and is a qualified chemical safety reviewer. The process for approval includes reviewing the health and safety risks of the chemical, as well as appropriate handling, storage, and disposal information. Every effort is made to limit the amount of hazardous chemicals used, including identifying feasible alternative chemicals or processes. The EHS representative coordinates with representatives from Environmental Protection, Industrial Safety, RP, and NCS. The formal approval process consists of evaluations for the physical, health, and fire/explosive hazards; as well as the potential impact on the handling of licensed material. The conclusions of this approval process may dictate some or all of the following for assurance of chemical process safety:

- New procedures or changes to existing procedures,
- Maintenance programs for equipment,
- CM controls,
- Addition of material safety data sheet(s) (MSDS) to database/CD,
- Emergency planning modifications, and/or
- Training requirements.

The process for approving new hazardous materials being brought onsite or used in a process is applicable to GLE employees and contractors. If a contractor is using a new chemical, the contractor must notify the GLE point-of-contact and the GLE approval process is initiated. If an existing hazardous chemical is used in a new process or an existing process that has not previously used the chemical, then the change would be evaluated through the 10 CFR 70.72, *Facility Changes and Change Process (Ref. 6-9)*, process described in GLE LA Chapter 11.

6.2.1.1.2 Labeling and Identification

Hazardous materials or conveyance systems are labeled or identified to meet applicable regulations. The proper identification of hazardous materials decreases the likelihood of improper use, handling, and disposal reducing potential negative consequences.

The hazards of chemicals are identified for personnel through the MSDSs. These documents are available on the GLE intranet.

6.2.1.1.3 Chemical Inventories

Chemical inventories at the GLE Commercial Facility are maintained below the threshold quantities set forth in 29 CFR 1910.119, *Process Safety Management of Highly Hazardous Chemicals (Ref. 6-10),* and 40 CFR 68, *Chemical Accident Prevention Provisions (Ref. 6-11)* (also referred to as the Risk Management Program); therefore, these regulations are not applicable to GLE.

Inventories of chemicals are tracked through the procurement process. In addition, the GLE RC&EP contains an inventory, including amounts and locations, of bulk chemicals as required by EPA's Emergency Planning and Community Right-to-Know-Act (EPCRA), Section 312, Tier II *(Ref. 6-12)*. The GLE RC&EP, as well as GLE Commercial Facility MSDSs, are provided to applicable offsite responders. The GLE RC&EP is updated annually.

6.2.1.1.4 Hazardous Chemicals and Chemical Interactions

Chemicals utilized at the GLE Commercial Facility that have the potential to affect licensed material, either directly or indirectly, are evaluated to determine the consequence level for a particular accident sequence. The main process chemicals of concern at the GLE Commercial Facility are UF_6, and two hydrolysis products, HF and UO_2F_2. If UF_6 is released into the atmosphere, the uranium compounds and HF that are formed by reaction with moisture in the air are chemically toxic. Uranium is a heavy metal that, in addition to being radioactive, can have toxic chemical effects primarily on the kidneys if it enters the bloodstream by means of ingestion or inhalation. HF is an extremely corrosive gas that can damage the lungs and cause death if inhaled at sufficiently high concentrations.

The ISA process evaluates the potential for UF_6 releases, as well as the interaction of non-licensed chemicals impacting licensed materials. Details of this process and the results of this evaluation are presented in the ISA Summary. For new chemicals brought onsite, the process described in Section 6.2.1.1.1, *Chemical Evaluation and Approval*, includes an evaluation of the potential hazardous interactions between process chemicals.

6.2.1.2 Materials of Construction, Sizing of Equipment, System Fabrication, and Process Control Schemes

The design of the chemical process systems includes numerous controls for maintaining safe conditions during operations. These controls include, but are not limited to: managing the arrangement and size of material containers and processes; selection and use of materials compatible with process chemicals; providing inherently safe operating conditions (such as, UF_6 confinement); and providing process interlocks, controls, and alarming within the chemical processes. These facility and equipment features help prevent chemical releases. Process piping and components (such as, separators, traps, vents, etc.) are maintained safe by limits placed on their operating parameters.

6.2.1.2.1 *Materials of Construction*

Interactions between process equipment and process fluids/gasses were considered in the design of the GLE Commercial Facility. The GLE Commercial Facility will utilize approved materials of construction throughout the process and operations areas that are compatible with UF_6 and/or are corrosion resistant to UF_6. These materials of construction are also compatible with the process operational physical parameters of pressure and temperature accordingly. The materials of construction meet the applicable standard engineering specifications required by the International Building Code *(Ref. 6-13)* and/or other building codes, and their use is consistent with standard industry practice for processing UF_6.

The cylinders to be used at the GLE Commercial Facility for transport, processing, and storage of UF_6 are designed and maintained in accordance with ANSI N14.1, *Nuclear Materials: Uranium Hexafluoride – Packaging for Transport (Ref. 6-14)*. These containers are appropriate due to the resistance of the materials to corrosion by UF_6. These cylinders are painted to resist corrosion from atmospheric conditions. The cylinders are also inspected on a routine basis to assess corrosion and corrosion rates.

6.2.1.2.2 *Sizing of Equipment*

The sizing of process equipment is based on the amount of material to be used in the process. The design of preventive and/or mitigative features is based on conservative assumptions to allow for unusual conditions. For example, tanks that contain bulk chemicals are designed to provide for more than the maximum volume expected during normal operations. In addition, overflow alarms and mitigative devices (curbs, sumps, overflow tanks) are available for use during upset conditions.

6.2.1.2.3 *System Fabrication*

Within the GLE Commercial Facility, systems are fabricated with safety as a priority. Conservative assumptions are used for sizing and geometry, and materials of construction are chosen to avoid corrosion. Preventive maintenance is routinely scheduled for replaceable parts. The systems are designed to provide easy access for maintenance.

6.2.1.2.4 *Process Control Schemes*

Process control schemes are chosen with safety as a priority. The process control schemes that are associated with IROFS are described in the ISA Summary.

6.2.2 Chemical Process Safety Controls

Chemical process safety controls, including administrative controls, engineered controls, and management measures, are identified in the ISA Summary. The ISA Summary describes the controls to prevent or mitigate chemical process risks, the hazard being mitigated, and the risk category.

A defense-in-depth approach is followed during the design of chemical process systems. The ISA Summary has identified a number of generic and inherent safeguards protecting against or mitigating process material releases. Many of these reduce the likelihood or severity of hazardous releases from process equipment. Others help the operators respond more quickly and/or efficiently to limit the effect(s) of releases of hazardous materials. These safeguards include, in order of preference, passive controls (such as, curbs around chemical tanks), active engineered controls (such as, high temperature shutdown interlock), and administrative controls (such as, operator training and approved written procedures). Some safeguards, such as gas alarm systems, provide a mitigative function by alerting operators to evacuate the facility rapidly, thus limiting radiation and chemical exposure during an event.

6.2.3 Chemical Process Safety Management Measures

There are a number of safety features in place to help prevent, detect, and mitigate potential releases of UF_6. Some of these features are classified as IROFS as determined in the ISA. A listing of chemical process safety IROFS is presented in the ISA Summary. Management measures, as described in GLE LA Chapter 11, are implemented to assure the reliability and availability of chemical process safety IROFS.

6.2.3.1 Procedures to Ensure Reliable Operation of Engineered Controls

GLE maintains approved written procedures to ensure reliable operation of engineered controls (for example, inspection and testing procedures and frequencies, calibration programs, functional tests, corrective and preventive maintenance programs, criteria for acceptable test results).

6.2.3.2 Procedures to Ensure Proper Implementation of Administrative Controls

GLE maintains approved written procedures to ensure administrative controls are correctly implemented, when required (for example, employee training and qualification in procedures, refresher training, safe work practices, development of procedures, and training program evaluation).

6.3 REQUIREMENTS FOR NEW FACILITIES

GLE LA Chapter 3, *Integrated Safety Analysis*, and the ISA Summary describe the methodology for satisfying the principles of the baseline design criteria in 10 CFR 70.64.

The GLE Commercial Facility is designed using a defense-in-depth approach for protecting against chemical accidents. In accordance with 10 CFR 70.64(a)(5), the design provides for adequate protection against chemical risks produced from licensed material, facility conditions that affect the safety of licensed material, and hazardous chemicals produced from licensed material. For chemical process safety, the facility design considered the following:

- Preference for the selection of engineered controls over administrative controls to increase overall system reliability; and
- Features that enhance safety by reducing challenges to IROFS.

The main design feature to ensure chemical process safety is the robust equipment that contains UF_6 during the enrichment process. [Security-Related Information withheld from public disclosure per 10 CFR 2.390.]

Examples of mitigative features include temperature controls on process equipment, pressure sensors in process vessels, solenoid and control valves on the UF_6 Gas Handling System, auxiliary ventilation systems in UF_6 process areas, and gas detection/alarm systems.

GLE is not proposing any facility-specific or process-specific relaxations or additions to the baseline design criteria of 10 CFR 70.64.

6.4 REFERENCES

6-1 NUREG-1520, *Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility*, U.S. Nuclear Regulatory Commission, March 2002.

6-2 10 CFR 70.61, *Performance Requirements*, U.S. Nuclear Regulatory Commission, 2008.

6-3 10 CFR 70.62, *Safety Program and Integrated Safety Analysis*, U.S. Nuclear Regulatory Commission, 2008.

6-4 10 CFR 70.64, *Requirements for New Facilities or New Processes at Existing Facilities*, U.S. Nuclear Regulatory Commission, 2008.

6-5 Radiological Contingency and Emergency Plan, GE-Hitachi Global Laser Enrichment LLC, April 2009.

6-6 NUREG-1140, *A Regulatory Analysis on Emergency Preparedness for Fuel Cycle and Other Radioactive Material Licensees*, U.S. Nuclear Regulatory Commission, January 1988.

6-7 NUREG/CR-6410, *Nuclear Fuel Cycle Facility Accident Analysis Handbook*, U.S. Nuclear Regulatory Commission, March 1998.

6-8 NUREG-1887, *RASCAL 3.0.5: Description of Model and Methods*, U.S. Nuclear Regulatory Commission, August 2007.

6-9 10 CFR 70.72, *Facility Changes and Change Process*, U.S. Nuclear Regulatory Commission, 2008.

6-10 29 CFR 1910.119, *Process Safety Management of Highly Hazardous Chemicals*, Occupational Safety and Health Standards, Hazardous Materials, 2008.

6-11 40 CFR 68, *Chemical Accident Prevention Provisions*, Environmental Protection Agency, 2008.

6-12 Emergency Planning and Community Right-to-Know-Act, Environmental Protection Agency, 2008.

6-13 2006 International Building Code (IBC), International Code Council, March 2006.

6-14 ANSI N14.1-2001, *Nuclear Materials: Uranium Hexafluoride – Packaging for Transport*, American National Standards Institute, January 2001.

Table 6-1. Chemical Consequence Severity Levels from 10 CFR 70.61.

	Workers	Offsite Public	Environment
High Consequence	• Radiological dose greater than 1 Sv (100 rem) • Chemical exposure greater than AEGL-3 (10 minute exposure) • A criticality accident occurs	• Radiological dose greater than 0.25 Sv (25 rem) • 30 mg soluble uranium intake • Chemical exposure greater than AEGL-2 (30 minute exposure) • A criticality accident occurs	A criticality accident occurs
Intermediate Consequence	• Radiological dose greater than 0.25 Sv (25 rem) but less than or equal to 1 Sv (100 rem) • Chemical exposure greater than AEGL-2 but less than or equal to AEGL-3 (10 minute exposure)	• Radiological dose greater than 0.05 Sv (5 rem) but less than or equal to 0.25 Sv (25 rem) • Chemical exposure greater than AEGL-1 but less than or equal to AEGL-2 (30 minute exposure)	Radioactive release greater than 5,000 times 10 CFR 20, Appendix B, Table 2

Table 6-2. Chemical Consequence Values.

	Workers	Offsite Public	Environment
Category 3 High Consequence	Soluble U intake > 75 mg HF > 139 mg/m^3 UF_6 > 216 mg/m^3	Soluble U intake > 30 mg HF >28 mg/m^3 UF_6 >19 mg/m^3	N/A
Category 2 Intermediate Consequence	HF > 78 but $\leq$ 139 mg/m^3 UF_6 > 28 but $\leq$ 216 mg/m^3	HF> 0.8 but $\leq$ 28 mg/m^3 UF_6 > 3.6 but $\leq$ 19 mg/m^3	Radioactive release>5000 times of 10 CFR 20, Appendix B, Table 2
Category 1 Low Consequence	Accidents of lower radiological and chemical exposures than those above in this column	Accidents of lower radiological and chemical exposures than those above in this column	Radioactive releases with lower effects than those referenced above in this column

Table 6-3. HF Dermal Exposure Consequence Severity Levels.

	Workers	Offsite Public
Category 3 High Consequence	Dermal exposure from an HF solution that endangers the life of the worker	Dermal exposure to HF solution resulting in irreversible or other serous long-lasting health effects Direct eye contact with HF solution that leads to irreversible or other serious long-lasting health effects
Category 2 Intermediate Consequence	Dermal exposure to HF solution resulting in irreversible or other serious long-lasting health effects Direct eye contact with HF solution that leads to irreversible or other serious long-lasting health effects	Dermal exposure from HF solution resulting in mild transient health effects

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7. FIRE SAFETY

This chapter describes the features that enable an effective Fire Protection Program at the GE-Hitachi Global Laser Enrichment LLC (GLE) Commercial Facility located in Wilmington, North Carolina. The GLE Commercial Facility is located on the Wilmington Site, which also contains the Global Nuclear Fuel-Americas, LLC (GNF-A) Fuel Manufacturing Operations (FMO) facility, as well as other GE-owned facilities. See GLE LA Chapter 1, *General Information*, for a description of the GLE Site and the Wilmington Site.

The fire protection strategy for the GLE Commercial Facility minimizes the risk from potential fires and explosions to protect the health and safety of the workers, the public, and the environment. The Fire Protection Program is developed and implemented in accordance with the following:

- 10 CFR 30.33, *General Requirements for Issuance of Specific Licenses (Ref. 7-1)*;
- 10 CFR 40.32, *General Requirements for Issuance of Specific Licenses (Ref. 7-2)*;
- 10 CFR 70.22, *Contents of Applications (Ref. 7-3)*;
- 10 CFR 70.61, *Performance Requirements (Ref. 7-4)*;
- 10 CFR 70.62, *Safety Program and Integrated Safety Analysis (Ref. 7-5)*;
- 10 CFR 70.64, *Requirements for New Facilities or New Processes at Existing Facilities (Ref. 7-6)*;
- 10 CFR 70.65, *Additional Content of Applications (Ref. 7-7)*;

7.1 FIRE SAFETY MANAGEMENT MEASURES

The GLE Fire Protection Program is based on National Fire Protection Association (NFPA) 801, *Standard for Fire Protection for Facilities Handling Radioactive Materials (Ref. 7-8)*, which contains fire safety management measures intended to reduce the risk of fires and explosions at facilities that handle radioactive materials. These management measures are applicable to locations where radioactive materials are stored, handled, or used in quantities, and under conditions, requiring government oversight and/or a license to possess or use these materials.

Fire safety management measures establish fire protection policies and practices for the GLE Commercial Facility. The objective of the Fire Protection Program is to prevent and mitigate fire incidents through education, prevention, controls, detection, and extinguishment.

7.1.1 Fire Protection Items Relied on for Safety

Fire protection Items Relied on for Safety (IROFS) are intended to prevent or mitigate chemical and radiological risks associated with postulated fire events and are defined in the Integrated Safety Analysis (ISA) Summary.

7.1.2 Management Policy and Direction

GLE Management commits to a program that promotes life safety, the conservation of property and essential equipment, and the protection of the environment. GLE maintains fire safety awareness among personnel through general employee training (GET). Training programs are described in GLE LA Section 11.3, *Training and Qualifications.*

The primary responsibility for fire protection resides within the Environmental, Health, and Safety (EHS) Organization. The GLE EHS Manager is assisted by the Industrial Safety Manager, whose direct responsibility is to ensure the day-to-day safe operation of the facility in accordance with occupational safety and health regulations, including the fire safety program. The personnel qualification requirements for the ESH Manager and the Industrial Safety Manager are provided in GLE LA Chapter 2, *Organization and Administration.*

The Facility Safety Review Committee (FSRC) reviews issues affecting the safety of GLE Commercial Facility operations, including fire safety. The FSRC is described in GLE LA Chapter 2.

7.1.3 Fire Protection Program

The GLE Fire Protection Program complies with the criteria in NFPA 801 to ensure fire protection requirements are adequately implemented. The Fire Protection Program implements applicable NFPA and/or other nationally recognized codes and standards to ensure nuclear fire protection requirements are adequately implemented. The Fire Protection Program documents upper level mechanisms by which the GLE Facility Manager achieves and maintains a high degree of fire safety at the GLE Commercial Facility. The GLE Facility Manager ensures the Fire Protection Program is adequately implemented and requirements are provided to GLE personnel. The program is designed to ensure fire safety at the facility as well as to promote protection of life safety, property, essential equipment, the environment and the continuity of operations. The Fire Protection Program is closely integrated within the Design, Operations, and Maintenance Organizations to ensure widespread awareness, while enhancing effective and efficient implementation. The Fire Protection Program is implemented through detailed administrative and implementing procedures. The Fire Protection Program includes the following elements.

7.1.3.1 Management Policy and Direction (Section 7.1.2)

Approved plans and procedures describe the overall management and implementation of the GLE Fire Protection Program. The following ensures fire safety is appropriately incorporated into GLE Operations and that facility modifications are reviewed for fire safety:

- Administrative controls for changes in processes, equipment, or facilities (see GLE LA Section 11.1, *Configuration Management*), and

- Fire protection and management review of planned activities and modifications to ensure building design and operating features are maintained in an analyzed condition.

7.1.3.2 Fire Hazards Analysis (Section 7.2)

A documented Fire Hazards Analysis (FHA) has been initiated, and will be updated as necessary, when significant facility design or operation configuration changes are made, to ensure the fire prevention and fire protection requirements of NFPA 801 have been evaluated.

7.1.3.3 Fire Prevention Program

The Fire Protection Program includes a documented Fire Prevention Program, implemented by approved written procedures, that describes the following:

- Communication of basic fire safety information for GLE personnel and contractors, including familiarization with procedures for fire prevention, emergency alarm response, and reporting of fires;
- Requirements for conducting documented facility inspections, including provisions for remedial action to correct conditions that increase fire hazards;
- Description of the general housekeeping practices and the control of transient combustibles;
- Control of flammable and combustible liquids, gases, and oxidizers in accordance with the applicable NFPA codes and standards;
- Control of ignition sources, including hot work (grinding, welding, and cutting) in accordance with NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work (Ref. 7-9)*;
- Fire reports, including an investigation and a statement regarding the corrective action to be taken in accordance with NFPA 901, *Standard Classifications for Incident Reporting and Fire Protection Data (Ref. 7-10);*
- Fire prevention surveillance in accordance with NFPA 601, *Standard for Security Services in Fire Loss Prevention (Ref. 7-11)*;
- Restriction of smoking to designated areas, and
- Safeguarding construction, demolition, and renovating activities in accordance with the criteria within NFPA 241, *Standard for Safeguarding Construction, Alteration, and Demolition Operations (Ref. 7-12).*

7.1.3.4 Inspection, Testing, and Maintenance (Section 7.5.6)

Inspection, Testing, and Maintenance (ITM) of fire protection systems is performed using approved written procedures. The results and follow-up actions are recorded and specific acceptance criteria provided for each test. The ITM Program is implemented to ensure fire protection systems and equipment remains operable and functions properly to detect and control fire, when needed.

7.1.3.5 Control of Impairments

Approved written fire protection system impairment procedures are implemented to include:

- Identification, tagging, and tracking of impaired equipment,
- Identification of personnel to be notified, and
- Determination of needed compensatory fire protection and fire prevention measures.

7.1.3.6 Onsite Emergency Response Organizations (Section 7.6.1)

See Section 7.6.1 for a description of the GLE onsite fire emergency response organization (ERO).

7.1.3.7 Offsite Emergency Response Organizations (Section 7.6.2)

See Section 7.6.2 for a description of the GLE offsite fire emergency response organizations.

7.1.3.8 Pre-Incident Planning (Section 7.6.3)

Identification of chemical and radiological risks through development of a FHA that is integrated with the ISA.

7.2 FIRE HAZARDS ANALYSIS

An FHA was performed at the beginning of the facility design process and is revised, as necessary, when significant changes are made to ensure the fire prevention and protection requirements have been evaluated per NFPA 801. The FHA evaluation considers the facility specific design, layout, and anticipated operating needs. Additionally, the FHA considers acceptable means for separation or control of hazards, the control or elimination of ignition sources, and the suppression of fires. The FHA also considers the storage and use of radioactive materials under fire or explosion conditions, which can result in a severe hazard.

The FHA presents a comprehensive, qualitative evaluation of the chemical and radiological releases associated with postulated fire at the GLE Commercial Facility. Based on facility design (construction, fire rated separation [fire barriers], locations of hazardous processes and materials, levels of combustibles, systems response, etc.) and on operations practices, the FHA in concert with the ISA, evaluates credible fire scenarios to establish the radiological and toxic chemical consequences of an unmitigated fire. From these scenarios, the FHA and ISA describe and evaluate preventive and mitigative controls that make up the fire protection IROFS for the GLE Commercial Facility. Evaluation of scenarios for unmitigated fire events includes, as applicable, the building/area construction, fuel loading, process equipment and hazards, possible fire initiators, ventilation system response, propagation potential, and building/area response.

The FHA estimates damage (or thermal insult) to the process and/or monitoring operations, and licensed radiological material. Estimates for potential chemical and radiological releases (consequence analyses) are done outside the FHA, as described in the GLE LA Chapter 3, *Integrated Safety Analysis*. The FHA is reviewed and updated as needed for current conditions and accuracy to ensure effective implementation of the Fire Protection Program is maintained.

7.3 FACILITY DESIGN

7.3.1 Baseline Design Criteria and Defense-In-Depth

The FHA and the ISA demonstrate that the design and construction of the GLE Commercial Facility structures complies with the baseline design criteria of 10 CFR 70.64(a), the defense-in-depth requirements of 10 CFR 70.64(b), and are consistent with the requirements of NFPA 801. The facility design incorporates defense-in-depth concepts such that health and safety are not completely dependent on any single element of the design, construction, maintenance, or operation of the facility.

The GLE Commercial Facility design incorporates limits on areas and equipment subject to contamination for facilities handling radioactive materials. In addition, the design includes facilities, equipment, and utilities intended to facilitate decontamination. The location of the GLE Commercial Facility is such that a fire or explosion event would not affect other important facilities or operations.

The GLE Commercial Facility buildings and supporting infrastructure are described in GLE LA Chapter 1, *General Information*. Additional design details are provided in the GLE ISA Summary. GLE Commercial Facility support buildings that may contain special nuclear material (SNM) or source material are constructed to meet applicable requirements of the International Building Code (IBC)-2006 *(Ref. 7-13)* and the general fire-related design criteria discussed in this section. The Operations Building is the primary structure where the enrichment processing systems and enrichment processing support systems are contained. The fire-related design criteria for the Operations Building are described in the following sections.

7.3.2 Operations Building Construction

The Operations Building is constructed of noncombustible materials meeting the requirements of Type IA or IB construction as described in Chapter 6 of IBC-2006. The Operations Building is a mixed occupancy of Factory Industrial (F-1) and High Hazard (H-3) as classified by Chapter 3 of IBC-2006. The Operations Building is also designed to limit the potential for contamination and to facilitate decontamination. See GLE LA Chapter 4, *Radiation Protection*, for additional information regarding radiological controls.

Type IA construction requires structural frame and the exterior and interior bearing wall elements to meet the requirement of 3-hour fire-rated construction. Type IB construction requires the structural frame and the exterior and interior bearing walls to meet the requirements of 2-hour fire-rated construction. These construction features meet the requirements of NFPA 801, Section 5.5, for fire resistant or noncombustible construction (typically Type I or Type II as defined in NFPA 220, *Standard on Types of Building Construction (Ref. 7-14)*.

7.3.2.1 Interior Surface

The interior surface is designed to meet the requirements of NFPA 801, Section 5.8.1 and 5.8.2. The interior surface finish of walls and ceilings in process and storage areas are Class A in accordance with NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials (Ref. 7-15)*. The floor finish is Class I in accordance with NFPA 253, *Standard Method of Test for Critical Radiant Flux for Floor Covering Systems Using a Radiant Heat Energy Source (Ref. 7-16)*. Exit enclosures (egress corridors and exit paths) meet the requirements of NFPA 101®, *Life Safety Code® (Ref. 7-17)*, Section 40.3.3, Class A or B for walls and ceilings and not less than Class II for floors.

7.3.2.2 Storage

Chemicals, materials, and supplies are stored, to the extent practical, in separate storerooms located in areas where no work with radioactive materials is conducted. Only those quantities of chemicals, materials, and supplies needed for immediate or continuous use are present.

7.3.3 Fire Area Separation

The Operations Building is subdivided into separate fire areas, as determined by the FHA, for the purposes of limiting the spread of fire, protecting facility personnel, and limiting consequential damage to the facility. The subdivided design approach provides passive fire protection features, while minimizing:

- The spread of potential contamination,
- Equipment damage and loss,
- Clean-up cost and time,
- Operational down time, and
- Damage to one-of-a-kind types of equipment.

The fire area separation approach employs fire barriers, with fire resistance commensurate with the potential fire severity, between the major process areas (such as, Laser Area) with further subdivision provided, as practicable, to minimize fire areas within the process areas.

Fire rated barriers meet the minimum requirements of the IBC-2006, Chapter 7, *Fire Resistance Rated Construction.* Openings and penetrations within the envelope of each fire area are sealed with protective assemblies (penetration firestop systems, fire dampers, fire/smoke dampers, etc.) consistent with the designated fire rating in accordance with NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls (Ref. 7-18)*. Door openings are protected with fire rated doors, frames, and hardware in accordance with NFPA 80, *Fire Door Openings and Other Opening Protectives (Ref. 7-19)*. Fire dampers are provided where ventilation ductwork penetrates fire rated barriers in accordance with NFPA 90A, *Installation of Air-Conditioning and Ventilating Systems (Ref. 7-20)*.

7.3.4 Power Supply and Distribution Systems

Electrical systems are designed in accordance with NFPA 70®, *National Electrical Code®* *(Ref. 7-21)*. Switchgear, motor control centers, panel boards, uninterruptible power supply systems, and control panels are mounted in metallic enclosures and contain only small amounts of combustible material. Cable trays and conduits are metallic and the cables in cable trays meet the requirements of UL 1277, *Electrical Power and Control Tray Cables with Optional-Fiber Members (Ref. 7-22)*. Less hazardous dielectric fluids are used, where practicable, in place of hydrocarbon-based insulating oils for transformers and capacitors located inside buildings, or in any location where an exposure hazard to important facilities is posed.

The lights, ventilation, and operation of the majority of the equipment are dependent upon a reliable source of electrical power. Transformers, switches, and control panels are located so that maintenance work can be done without direct exposure to process conditions.

7.3.5 Life Safety

In accordance with IBC-2006, the Operations Building is classified as mixed occupancy, Factory Industrial (F-1) and High Hazard 3 (H-3). In accordance with NFPA 101®, the facility is classified as a Special Purpose Industrial Occupancy, with a hazard classification of ordinary hazard. Life safety features (such as, occupancy separation, means of egress, illumination, and exit marking and signage, etc.) meet the requirements of NFPA 101® and IBC-2006. Rated fire barriers in accordance with NFPA 101® and the FHA are provided to prevent unacceptable fire propagation.

7.3.6 Ventilation, Containment, and Filtration Systems

The need for effective ventilation both during and immediately following an emergency such as a fire is of considerable importance. The design of the ventilation, confinement, and filtration systems is intended to provide effective ventilation both during and immediately following an emergency such as a fire, and is in accordance with applicable NFPA and/or nationally recognized codes and standards. Where shutdown of the ventilation system is not appropriate, fire/smoke dampers are not required for ventilation duct penetrations. When fire/smoke dampers are not used, an alternative means of protecting against fire propagation is provided.

Ductwork, accessories, and support systems are designed and tested in accordance with, as applicable, NFPA 801, NFPA 90A, NFPA 90B, *Installation of Warm Air Heating and Air-Conditioning Systems (Ref. 7-23)*, and NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids (Ref. 7-24)*. Flexible air duct couplings in ventilation and filter systems are noncombustible. Ductwork from areas containing radioactive materials, passing through non-radioactive areas, are noncombustible construction and are protected from possible exposure fires by materials having a fire resistance rating as determined by IBC-2006, NFPA, and/or other nationally recognized codes and standards. Air entry filters are approved filter media that produce a minimum amount of smoke (UL Class I) when subjected to heat.

The Monitored Central Exhaust System (MCES) is designed to automatically balance and maintain negative pressure from areas of lesser potential contamination to areas of higher potential contamination. Ventilation systems serving normally non-contaminated areas exhaust a percentage of the handled air to the atmosphere. The heating, ventilation, and air conditioning (HVAC)/MCES, serving potentially contaminated areas, exhaust 100% of the handled air to the environment through filtered exhaust paths. In addition to removing uranium particulates from room air, the MCES is designed to remove uranium hexafluoride (UF_6) and hydrogen fluoride (HF) from process gas streams and room air during normal and abnormal operating conditions.

High-efficiency particulate air (HEPA) and/or high-efficiency gas absorption (HEGA) filtration systems are utilized in various areas as part of the confinement function of the HVAC system.

Smoke control systems are designed in accordance with IBC-2006, NFPA, and/or other nationally recognized codes and standards. Smoke control is also accomplished by the onsite ERO and the offsite responding fire departments utilizing portable smoke removal equipment.

7.3.7 Facility Control, Computer, and Telecommunication Rooms

Facility control, computer, and telecommunications rooms meet the applicable requirements of NFPA 75, *Standard for the Protection of Information Technology Equipment (Ref. 7-25),* and/or other nationally recognized codes and standards.

7.3.8 Drainage and Control of Contaminated Runoff

Water that may discharge from the Firewater System or from firefighting activities (water runoff) that could be contaminated with radioactive materials is confined in accordance with NFPA 801, Section 5.10, stored, sampled, and treated if necessary. Water runoff from the UF_6 Cylinder Pads is collected in the Retention Basin. Liquid effluent monitoring associated with the Retention Basin is discussed in GLE Environmental Report (ER) Chapter 6, *Environmental Measurements and Monitoring Programs.* Drainage or confinement of firewater within the facility is provided and accomplished by one or more of the following methods:

- Floor drains,
- Floor trenches,
- Open doorways or other wall openings,
- Curbs for confining or directing drainage,
- Equipment pedestals, and
- Pits, sumps, and sump pumps.

7.3.9 Water Control (Moderation) Consideration

Within the GLE Commercial Facility, there are process areas where water is undesirable due to nuclear criticality safety (NCS) concerns. Redundant fire protection features are provided to ensure effective mitigation, including automatic detection, fire barriers, ignition controls, combustible loading controls, and emergency response activities. When called upon, the ERO and/or responding offsite fire departments typically extinguish fire in these areas with the use of portable and wheeled dry chemical fire extinguishers. In the unlikely event extinguishers cannot control or extinguish the fire, the Emergency Command Center (ECC) and the onsite and offsite EROs act appropriately. The pre-incident plans (see Section 7.6.3, *Pre-Incident Planning*) for fires and explosions include firefighting guidance governing restrictions on the use of water in certain areas of the facility.

7.3.10 Lightning Protection

The lightning protection system is in accordance with applicable portions of NFPA 780, *Standard for the Installation of Lightning Protection Systems (Ref. 7-26),* and/or other nationally recognized codes and standards.

7.3.11 Wildland Fire Protection

Wildland fire protection was assessed in the FHA in accordance with applicable portions of NFPA 1143, *Standard for Wildland Fire Management (Ref. 7-27)* and NFPA 1144, *Standard for Reducing Structure Ignition Hazards from Wildfire (Ref. 7-28).* The FHA determined the wildland fire threat for the GLE Site is a moderate hazard. Current configurations do not require additional fire protection measures.

7.3.12 Physical Security Concerns

As described in Section 7.3.5, *Life Safety*, the design of buildings and facilities provides for safe egress in case of fire, chemical events, or other emergencies. Security requirements will not prevent safe means of emergency egress as required by the NFPA 101® and IBC-2006. The GLE Physical Security Plan (PSP) addresses the establishment of permanent and temporary Controlled Access Areas. The PSP and Radiological Contingency and Emergency Plan (RC&EP) identify the ingress and egress methodology during both normal and emergency conditions, respectively. This includes emergency response personnel both onsite and offsite.

7.4 PROCESS FIRE SAFETY

GLE has addressed process fire safety through the facility design and operations. Fire hazards are identified and addressed through the ISA and the FHA. The ISA uses the information identified in the FHA and considers the potential accident scenarios and establishes the IROFS necessary to ensure the health and safety of GLE personnel and the public. The GLE Commercial Facility is designed in accordance with IBC-2006, NFPA, and other nationally recognized codes and standards. The GLE Commercial Facility hazardous areas are identified as part of the pre-incident plans (otherwise known as pre-fire plans) as discussed in Section 7.6.3, *Pre-Incident Planning.* The ISA methodology is discussed in GLE LA Chapter 3. The ISA Summary provides details of the ISA, including fire hazards and associated IROFS.

The following discussion describes the principle process fire hazards associated with the laser-based enrichment technology.

7.4.1 Principal Hazardous Materials

The major process material of concern is UF_6. UF_6 is not flammable or combustible; however; UF_6 is not compatible with organics and can react with non-fomblin lubricating oils at high temperatures. The two byproducts resulting from a UF_6 release (in the presence of moist air) are HF gas and uranyl fluoride (UO_2F_2). Neither byproduct presents a process fire safety hazard.

Although UF_6 is not considered a fire hazard, exposure of UF_6 cylinders to heat and/or fire does create the potential for loss of cylinder integrity and an associated UF_6 release hazard. The potential failure of UF_6 cylinders due to exposure to fire is evaluated in the FHA.

7.4.2 Principal Fire Hazards

7.4.2.1 Lasers

Laser-based enrichment technology, which is utilized in the GLE uranium enrichment process, presents two potential fire hazards of concern: hydrogen and oil. The Laser Area does not contain radioactive material.

[Proprietary Information withheld from disclosure per 10 CFR 2.390]

Areas where hydrogen is present are designed to meet Class I, Division 2 hazardous locations in accordance with NFPA 70®, Article 500, *Hazardous Locations*.

Laser operations and equipment meet the requirements of NFPA 115, *Standard for Laser Fire Protection (Ref. 7-32)*.

7.4.2.2 Flammable/Explosion Hazards

Process equipment subject to fire or explosion hazards is evaluated in the ISA and FHA. IROFS have been established to prevent or mitigate fire hazards, as may be required by 10 CFR 70.61. In addition to IROFS, the following features, attributes, and controls are in place to prevent a large fire or explosion that could result in a UF_6 release:

- Fire Protection Program;
- Automatic sprinkler systems;
- Automatic smoke, chemical, and fire detection;
- Compartmentalization with fire barriers;
- Emergency response operations;
- Nitrogen inerting of select equipment;

- Natural or mechanical ventilation or other controls provided to ensure that flammable concentrations do not exceed 25 percent of the LEL.
- Fire rated boundaries;
- Structural steel fire proofing;
- Ignition sources are minimized;
- Robust and/or qualified UF_6 cylinder construction;
- Noncombustible construction; and
- HVAC system response.

The GLE Commercial Facility may generate hydrogen at battery-charging stations throughout the facility. Hydrogen controls in battery-charging stations are provided. Specifically, natural or mechanical ventilation or other controls are provided to ensure that hydrogen concentrations do not exceed 25 percent of the LEL.

7.4.2.3 Combustible Liquid Hazards

Combustible liquids are utilized as a cooling medium in process equipment. The following features ensure this specific fire hazard is prevented or mitigated:

- Fire Protection Program,
- Combustible liquid containment,
- Automatic sprinkler systems,
- Automatic smoke or heat detection system,
- Fire barriers,
- Emergency response operations, and
- Use of high flashpoint combustible liquids.

7.5 FIRE PROTECTION SYSTEMS

7.5.1 Firewater Supply System

The existing Wilmington Site firewater supply and distribution system consists of a 300,000 gal (100,000 devoted to fire) Water Storage Tank and Water Reservoir (~675,000 gal) which distributes water throughout an underground 10-inch looped gridded firewater distribution system, supplying water to existing facilities and hydrants, via 1,500 gpm electric and diesel fire pumps.

The fire water supply system for the GLE Commercial Facility is installed, in accordance with NFPA 801, Section 6.2., with fire pumps arrangement and installation meeting the requirements of NFPA 20, *Installation of Stationary Pumps for Fire Protection (Ref. 7-33)*. The system is designed to supply the largest single automatic sprinkler system plus a 250 gpm hose stream allowance. The system is sized for an Ordinary Hazard, Group 2, sprinkler system. Therefore, the required water flow for sprinklers is 940 gpm at a residual pressure of 20 psi at the system riser. The firewater distribution system is a looped system with cross connections into the various buildings to prevent a single piping component failure from disabling significant portions of the system. The International Fire Code (IFC)-2006 *(Ref. 7-34)*, Table B105.1, for Type I buildings of greater than 295,900 sq ft, requires a minimum firewater flow of 6,000 gpm for four hours. However, IFC-2006, Section B105, exception permits a flow reduction of up to 75% if the building is sprinklered throughout. The GLE Commercial Facility is in excess of 1,200,000 sq ft (including the upper elevations) and is provided with automatic fire suppression throughout except as indicated in the FHA. Therefore, the minimum firewater flow required is 1,500 gpm for four hours (360,000 gal).

For reliability, firewater is supplied from two independent supplies, each with adequate capacity to provide continuous water supply at the above flow rate for a minimum duration of four hours. The firewater distribution piping and supplies will be designed to IBC-2006 seismic requirements.

7.5.2 Fire Detection and Alarm Systems

Automatic fire detection is provided for fire areas in accordance with the requirements of IBC-2006, Section 907; NFPA 101®, Section 40.3.4.1; and NFPA 801, Section 6.8. The type of detection provided is based on the fire hazards present and the need for early warning or very early warning detection as determined by analysis. The fire alarm system is designed and installed per the requirements of NFPA 72®, *National Fire Alarm Code® (Ref. 7-35)*.

Manual pull stations are located at exits and throughout the facility to allow occupants to initiate an alarm. Area detection is provided as well as detection for automatic closing doors, fire/smoke damper operation, and air handler shutdown. Suppression system activation is also monitored by the fire alarm system.

Fire/smoke dampers located in supply air ducts are activated by smoke or heat. Smoke detectors are provided in the supply and return of air handling units. Individual air handlers are shut down by the fire alarm system when local duct detectors are in alarm. Fire/smoke dampers located in exhaust ducts at fire barriers are activated by heat detection. Exhaust fans are not shut down by the fire alarm system.

Audible and visible appliances provide occupant notification. The fire alarm system communicates with a 24-hour seven day a week ECC. Remote annunciation of alarms is provided at building entry points and control room.

7.5.3 Automatic Suppression Systems

Automatic sprinkler protection is required in designated areas of the facility to control fires in accordance with IBC-2006, NFPA 13, Section 4.1, and NFPA 801, Section 6.1.2. An Ordinary Hazard, Group 2, system is installed with a design density of 0.15 gpm per square foot (ft^2) over the most hydraulically remote 4,000 ft^2 area.

Automatic sprinkler protection may be omitted from a room or space where sprinklers are considered undesirable because of the nature of the contents in accordance with IBC-2006, Section 903.3.1.1.1. See Section 7.3.9, *Water Control (Moderation) Consideration,* for additional information.

In those areas where automatic sprinkler systems are not provided, alternative fire protection is considered. Alternatives may include an automatic clean agent extinguishing system in accordance with NFPA 2001, *Clean Agent Fire Extinguishing Systems (Ref. 7-36),* or an automatic detection system(s) coupled with manual use of a standpipe system. The omission of automatic sprinklers from any area is subject to approval by the Authority Having Jurisdiction.

7.5.4 Standpipes

Standpipe systems installed in accordance with NFPA 14, *Standard for the Installation of Standpipe and Hose Systems (Ref. 7-37),* are provided in each required exit stairway as required by IBC-2006. Hose connections are located at each intermediate landing as specified by NFPA 14, Section 7.3.

7.5.5 Portable Extinguishers

Fire extinguishers are provided throughout the facility in accordance with NFPA 10, *Portable Fire Extinguishers (Ref. 7-38),* as required by NFPA 801. In areas where water control is considered, carbon dioxide and dry chemicals are provided so that an uncontrolled moderator source is not created.

7.5.6 Inspection, Testing, and Maintenance of Fire Protection Systems

Fire protection systems and features are inspected and tested in accordance with the requirements in NFPA 25, *Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems (Ref. 7-39),* and other applicable NFPA codes and standards.

Testing, inspection, and maintenance are documented by means of approved written procedures, with the results and follow-up actions recorded, and specific acceptance criteria provided for each test. Routine inspection and testing of the Fire Protection System are conducted by GLE personnel and/or contract personnel under GLE direction. Responsibility for maintenance, operation, and engineering of the Fire Protection System and equipment is specified in approved written procedures. The fire protection equipment is maintained as part of the formal, planned preventative maintenance program at the GLE Commercial Facility.

7.6 FIRE EMERGENCY RESPONSE READINESS

7.6.1 Onsite Emergency Response Organization

NFPA 801, Section 4.7, requires a fire emergency organization that meets the requirements of either an on-site industrial fire brigade (NFPA 600, *Standard on Industrial Fire Brigades [Ref. 7-40]*), or a Fire Department (NFPA 1500, *Fire Department Occupational Safety and Health Program [Ref. 7-41]*). Due to the facility's remote location and the lack of sufficient local fire department staff capabilities relative to fire involving nuclear materials, the GLE Commercial Facility provides for a fully staffed onsite fire brigade that is trained for interior structure fire fighting. The size and complexity of the fire emergency organization is based on the size of the facility, presence of fire hazards, and the availability of offsite fire fighting response capability. Documented training and drills are conducted to demonstrate proficiency. Appropriate equipment, including portable communications, lighting, thermal protective clothing, and protective equipment is available in sufficient quantities and sizes to fit each fire brigade member expected to enter the hot and warm zones.

The Wilmington Site ERO is comprised of two teams that provide emergency response support. These two teams include the ERO, which is responsible for fire suppression and hazardous material control activities and the Emergency Medical Technicians (EMTs), which are responsible for emergency medical services. In addition, the ERO provides support services for bomb threat searches, severe weather preparedness, emergency preparedness, confined space evaluations, hazard prevention and elimination, community service and education, and offsite mutual aid assistance. Currently, the ERO is trained and qualified (as a minimum) to fight incipient stage fires.

The New Hanover County Department of Fire Services will be notified when:

- A fire is beyond the incipient stage; or
- The scope of a fire exceeds the capabilities of onsite resources.

7.6.2 Offsite Emergency Response Organizations

Per the GLE RC&EP, response agreements are in place to request emergency offsite assistance when needed. Most responding organizations are located in close proximity to the Wilmington Site. Current response agreements in place include Castle Hayne Volunteer Fire Rescue, which in-turn could call in additional mutual aid departments listed below:

- Wrightsboro Volunteer Fire and Rescue,
- Ogden Volunteer Fire and Rescue,
- New Hanover County Fire and Rescue,
- Federal Point Volunteer Fire and Rescue,
- Myrtle Grove Volunteer Fire and Rescue,

- City of Wilmington Fire Department, and
- New Hanover County Forestry Service.

The EROs listed above provide fire suppression, rescue (including confined space), and hazardous materials response support activities. The organizations listed below provide the services indicated.

- New Hanover Sheriff's Office provides law enforcement, crowd, and traffic control,
- New Hanover County Department of Emergency Management provides coordination of mass casualty, communications, radiological detection, and multi-agency coordination activities, and
- New Hanover Regional Medical Center and New Hanover Regional Emergency Medical Services provide medical treatment and transport to the hospital (including treatment and transport of radiologically contaminated personnel).

7.6.3 Pre-Incident Planning

NFPA 801, Section 4.8.1 requires written pre-fire plans (also known as pre-incident plans). Pre-fire plans are developed with the assistance of the facility fire emergency organization. NFPA 801, Section A.4.8.1, specifies the minimum content of pre-fire plants as follows:

- Fire and chemical hazards in area,
- Radiation hazards,
- Egress access,
- Emergency lighting,
- Fire protection systems/equipment in area,
- Special fire-fighting instructions (water controlled [moderation] consideration areas, lasers),
- Ventilation systems/airflow path,
- Utilities, and
- Special considerations on adjoining areas.

Pre-fire plans are developed in accordance with NFPA 801 and NFPA 1620, *Recommended Practice for Pre-Incident Planning (Ref. 7-42)*. Once developed, these plans are provided to the onsite and offsite EROs.

7.6.4 Emergency Response Personnel Training and Qualification

Onsite ERO members are required to complete initial training to become ERO members and continuing education classes to maintain ERO membership. The primary purpose of the onsite ERO is to provide quick response personnel who are familiar with the GLE Commercial Facility and the Wilmington Site, and trained in firefighting techniques, first aid procedures, and emergency response to mitigate emergency incidents.

7.6.5 Fire Drills

ERO training requirements and drill frequencies necessary to demonstrate proficiency are implemented in accordance with the RC&EP. Drills are critiqued and documented as outlined in the RC&EP.

7.6.6 Fire Investigations and Fire Reports

A Fire Prevention Program is implemented to include fire reports (including an investigation and a statement on the corrective action to be taken).

7.7 REFERENCES

7-1 10 CFR 30.33, *General Requirements for Issuance of Specific Licenses*, U.S. Nuclear Regulatory Commission, 2008.

7-2 10 CFR 40.32, *General Requirements for Issuance of Specific Licenses*, U.S. Nuclear Regulatory Commission, 2008.

7-3 10 CFR 70.22, *Contents of Applications*, U.S. Nuclear Regulatory Commission, 2008.

7-4 10 CFR 70.61, *Performance Requirements*, U.S. Nuclear Regulatory Commission, 2008.

7-5 10 CFR 70.62, *Safety Program and Integrated Safety Analysis*, U.S. Nuclear Regulatory Commission, 2008.

7-6 10 CFR 70.64, *Requirements for New Facilities or New Processes at Existing Facilities*, U.S. Nuclear Regulatory Commission, 2008.

7-7 10 CFR 70.65, *Additional Content of Applications*, U.S. Nuclear Regulatory Commission, 2008.

7-8 NFPA 801, *Standard for Fire Protection for Facilities Handling Radioactive Materials*, National Fire Protection Association, 2008.

7-9 NFPA 51B; *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work,* National Fire Protection Association, 2009.

7-10 NFPA 901, *Standard Classifications for Incident Reporting and Fire Protection Data,* National Fire Protection Association, 2006.

7-11 NFPA 601, *Standard for Security Services in Fire Loss Prevention,* National Fire Protection Association, 2005.

7-12 NFPA 241, *Standard for Safeguarding Construction, Alteration, and Demolition Operations*, 2004.

7-13 2006 International Building Code (IBC), International Code Council, March 2006.

7-14 NPFA 220, *Standard on Types of Building Construction*, National Fire Protection Association, 2009.

7-15 NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials,* National Fire Protection Association, 2006.

7-16 NFPA 253, *Standard Method of Test for Critical Radiant Flux for Floor Covering Systems Using a Radiant Heat Energy Source,* National Fire Protection Association, 2006.

7-17 NFPA 101®, *Life Safety Code®*, National Fire Protection Association, 2009.

7-18 NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls*, National Fire Protection Association, 2009.

7-19 NFPA 80, *Fire Door Openings and Other Opening Protectives,* National Fire Protection Association, 200

7-20 NFPA 90A, *Installation of Air Conditioning and Ventilating Systems*, National Fire Protection Association, 2009.

7-21 NFPA 70®, *National Electrical Code®*, National Fire Protection Association, 2008.

7-22 UL 1277, *Electrical Power and Control Tray Cables with Optional-Fiber Members*, Underwriters Laboratory, November 2001.

7-23 NFPA 90B, *Installation of Warm Air Heating and Air-Conditioning Systems*, National Fire Protection Association, 2009.

7-24 NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids*, National Fire Protection Association, 2004.

7-25 NFPA 75, *Standard for the Protection of Information Technology Equipment*, National Fire Protection Association, 2009.

7-26 NFPA 780, *Standard for the Installation of Lightning Protection Systems*, National Fire Protection Association, 2008.

7-27 NFPA 1143, *Standard for Wildland Fire Management*, National Fire Protection Association, 2009.

7-28 NFPA 1144, *Standard for Reducing Structure Ignition Hazards from Wildfire,* National Fire Protection Association, 2008

7-29 NFPA 30, *Flammable and Combustible Liquids Code,* National Fire Protection Association, 2008

7-30 NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*, National Fire Protection Association, 2007

7-31 NFPA 69, *Standard on Explosion Prevention Systems*, National Fire Protection Association, 2008.

7-32 NFPA 115, *Standard for Laser Fire Protection*, National Fire Protection Association, 2008.

7-33 NFPA 20, *Installation of Stationary Pumps for Fire Protection*, National Fire Protection Association, 2007.

7-34 IFC-2006, International Fire Code, 2006

7-35 NFPA 72®, *National Fire Alarm Code®,* National Fire Protection Association, 2007.

7-36 NFPA 2001, *Clean Agent Fire Extinguishing Systems*, National Fire Protection Association, 2008.

7-37 NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, National Fire Protection Association, 2007.

7-38 NFPA 10, *Portable Fire Extinguishers*, National Fire Protection Association, 2007.

7-39 NFPA 25, *Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, National Fire Protection Association, 2008.

7-40 NFPA 600, *Standard on Industrial Fire Brigades*, National Fire Protection Association, 2005.

7-41 NFPA 1500, *Fire Department Occupational Safety and Health Program*, National Fire Protection Association, 1500.

7-42 NFPA 1620, *Recommended Practice for Pre-Incident Planning,* National Fire Protection Association, 2003.

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8. EMERGENCY RESPONSE

Plans for handling emergencies at the GE-Hitachi Global Laser Enrichment LLC (GLE) Commercial Facility are presented in the Radiological Contingency and Emergency Plan (RC&EP). The RC&EP has been developed for the entire Wilmington Site and includes the GLE Commercial Facility and the Global Nuclear Fuel – Americas, LLC (GNF-A) Fuel Manufacturing Facility.

The RC&EP was developed in accordance with 10 CFR 70.22(i)(3), *Contents of Applications (Ref. 8-1)* and 10 CFR 40.31(j), *Applications for Specific Licenses (Ref. 8-2).* The RC&EP is consistent with the guidance presented in Regulatory Guide 3.67, *Standard Format and Content for Emergency Plans for Fuel Cycle and Materials Facilities (Ref. 8-3).* The RC&EP also addresses the specific acceptance criteria in NUREG-1520, *Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility (Ref. 8-4)*, Chapter 8, *Emergency Management.*

GLE maintains Memorandums of Understanding (MOUs) with offsite support organizations identified in the RC&EP. These organizations, in addition to the State of North Carolina Division of Emergency Management and the State of North Carolina Division of Environment and Natural Resources Radioactive Materials Section, reviewed the RC&EP pursuant to the requirement in 10 CFR 70.22(i)(4) and 10 CFR 40.31(j)(4). Review comments from these organizations were included with the RC&EP submittal to the NRC.

8.1 REFERENCES

8-1. 10 CFR 70.22, *Contents of Applications*, U.S. Nuclear Regulatory Commission, 2008.

8-2. 10 CFR 40.31, *Application for Specific Licenses,* U.S. Nuclear Regulatory Commission, 2008.

8-3. Regulatory Guide 3.67, *Standard Format and Content of Emergency Plans for Fuel Cycle and Materials Facilities*, U.S. Nuclear Regulatory Commission, January 1992.

8-4. NUREG-1520, *Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility*, U.S. Nuclear Regulatory Commission, March 2002.

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9. ENVIRONMENTAL PROTECTION

9.1 ENVIRONMENTAL REPORT

GE-Hitachi Global Laser Enrichment LLC (GLE) personnel have prepared an Environmental Report (ER) *(Ref. 9-1)* which meets the requirements contained in 10 CFR 51, Subpart A, *National Environmental Policy Act—Regulations Implementing Section 102(2) (Ref. 9-2)*. In particular, the ER addresses the requirements in 10 CFR 51.45(a)-(e), *Environmental Report (Ref. 9-3)*, and follows the general format of NUREG-1748, *Environmental Review Guidance for Licensing Actions Associated with NMSS Programs (Ref. 9-4)*. The ER presents the purpose and the applicable regulatory requirements of the GLE Commercial Facility (GLE ER Chapter 1), discusses alternatives (GLE ER Chapter 2), describes the facility and the affected environment (GLE ER Chapter 3), and discusses potential impacts of the proposed action (GLE ER Chapter 4). Mitigation measures are described in GLE ER Chapter 5, environmental measurements and monitoring programs are described in GLE ER Chapter 6, a cost-benefit analysis (CBA) is provided in GLE ER Chapter 7, and a summary of environmental consequences is contained in GLE ER Chapter 8. References are listed in GLE ER Chapters 9 and 10, respectively. Where applicable, this chapter of the license application (LA) refers to the ER in order to address the acceptance criteria contained in NUREG-1520, *Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility (Ref. 9-5)*.

9.1.1 Date of Application

As required by 10 CFR 70.21(f), *Filing (Ref. 9-6)*, the date of the GLE Commercial Facilities License Application is at least nine months prior to facility construction.

9.1.2 Environmental Considerations

The GLE ER addresses the requirements of 10 CFR 51.45(b) as discussed below.

9.1.2.1 Description of Proposed Action

The proposed action is the issuance of a U.S. Nuclear Regulatory Commission (NRC) specific license under 10 CFR 30, *Rules of General Applicability to Domestic Licensing of Byproduct Material (Ref. 9-7)*, 10 CFR 40, *Domestic Licensing of Source Material (Ref. 9-8)*, and 10 CFR 70, *Domestic Licensing of Special Nuclear Material (Ref. 9-9)*, to possess and use byproduct material, source material, and special nuclear material (SNM); as well as to construct and operate an uranium enrichment facility in New Hanover County, North Carolina. The GLE Commercial Facility will be co-located on the Wilmington Site with the Global Nuclear Fuel – Americas, LLC (GNF-A) Fuel Manufacturing Operations (FMO) facility (License SNM-1097) and several other General Electric (GE)-owned facilities. The enriched uranium produced by the GLE Commercial Facility is intended primarily for use in commercial nuclear power plants.

A description of the GLE Commercial Facility is contained in ER Chapter 1, *Introduction of the Environmental Report*, and Chapter 3, *Description of Affected Environment*. A complete description of the Wilmington Site, along with specific facility design and operating parameters, are also included. A discussion of the method utilized to process the source material (uranium hexafluoride [UF_6]) to produce uranium enriched in uranium-235 (^{235}U) is described in ER Section 1.1 (this section also includes the proposed project schedule). Additional information regarding the proposed action, to include significant characteristics of the GLE Commercial Facility, associated outbuildings, and facility design/operating features, is contained in ER Section 2.1.2.1 and the Integrated Safety Analysis (ISA) Summary.

9.1.2.2 Purpose and Need for Proposed Action

The GLE ER Section 1.2, *Purpose and Need for the Proposed Action*, demonstrates the need for an additional uranium enrichment facility in the United States. The proposed action is intended to satisfy the need for an additional reliable and economical domestic source of enriched uranium supply, particularly as existing aging and less efficient production facilities cease operation. By supplying enrichment services to commercial nuclear power plants, the proposed GLE Commercial Facility will support the continued operation of existing nuclear power plants, and the future operation of proposed new plants.

9.1.2.3 Description of Affected Environment

GLE ER Chapter 3 contains a description of the affected environment. The chapter provides a baseline characterization of the GLE Site and its environs prior to any disturbances associated with construction, operation, or decommissioning of the facility. GLE ER Chapter 3 is arranged as follows:

- Regional, local and vicinity land use,
- Transportation,
- Geology and Soils,
- Water Resources,
- Ecological Resources,
- Meteorology, Climatology, and Air Quality,
- Noise,
- Historic and Cultural Resources,
- Visual/Scenic Resources,
- Socioeconomics,
- Public and Occupational Health, and
- Waste Management.

Each subsection discusses the regional, local, and site conditions as they currently exist in order to establish a baseline. In GLE ER Chapter 4, *Summary of Environmental Impacts*, the baseline is then compared to deviations (impacts) arising from the construction, operation, and decommissioning of the GLE Commercial Facility. The information was gathered from Federal, State, and County sources along with onsite data. The information represents both seasonal and long-term environmental trends.

9.1.2.4 Discussion of Considerations

The following discussion summarizes the information in the GLE ER with respect to the environmental impacts from, and the alternatives to, the GLE Commercial Facility.

9.1.2.4.1 Impact of the Proposed Action on the Environment

In accordance with 10 CFR 51.45(b)(1), GLE ER Chapter 4 discusses the impact of the proposed action on the environment, with the impacts discussed in proportion to significance. Each subsection in GLE ER Chapter 3 has a corresponding section in GLE ER Chapter 4.

9.1.2.4.2 Adverse Environmental Effects

The adverse environmental effects are discussed in each subsection of GLE ER Chapter 4, as well as in GLE ER Chapter 8, *Summary of Environmental Consequences*. These sections satisfy the requirements in 10 CFR 51.45(b)(2). Three areas were identified as having moderate adverse environmental effects requiring mitigation. These include increased traffic on Castle Hayne Road, increased noise on and near the Wilmington Site during construction, and disruption of the wildlife habitat on the Wilmington Site during construction.

GLE ER Chapter 4 has an additional section that discusses Environmental Justice, a Federal policy under which each agency identifies and addresses disproportionately high and adverse human health or environmental effects of agency policies and activities on minority and low-income populations. No disproportionately high and adverse human health or environmental effects were identified.

9.1.2.4.3 Alternatives to the Proposed Action

GLE ER Chapter 2, *Alternatives*, discusses alternatives to the proposed action pursuant to Section 102(2)(E) of the National Environmental Policy Act (NEPA) *(Ref. 9-10)* and 10 CFR 51.45(b)(3). Environmental impacts of the proposal and alternatives, to include the no-action alternative, are presented in comparative form. A discussion of siting and design alternatives is also included.

9.1.2.4.4 Relationship Between Short-Term Uses and Long-Term Productivity

In accordance with 10 CFR 51.45(b)(4), Chapter 8 of the GLE ER discusses the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity from GLE Commercial Facility operation.

GLE ER Chapter 7, *Cost Benefit Analysis*, contains a CBA that considers short-term and long-term benefits and costs of the GLE Commercial Facility in terms of both economic and environmental impacts. The short-term economic benefits include local jobs created and tax revenues to be generated by the GLE Commercial Facility. Economic costs include costs to GLE associated with site preparation, construction, operation, and decommissioning of the GLE Commercial Facility. The short-term environmental benefits of constructing and operating the GLE Commercial Facility include increased energy security in the United States, and energy generation with fewer emissions of criteria pollutants and carbon. The impacts to the environment which have been categorized as Moderate (sufficient to alter noticeably, but not to destabilize important attributes of a resource) and need mitigation, include increased traffic on Castle Hayne Road, increased noise on and near the Wilmington Site during construction, and disruption of wildlife habitat on the Wilmington Site during construction. No adverse impacts on the long-term productivity of the environment, after decommissioning of the facility, have been identified. GLE intends to decommission the facility for future use without restrictions.

9.1.2.4.5 Irreversible and Irretrievable Commitments of Resources

In order to satisfy 10 CFR 51.45(b)(5), Chapter 8 of the GLE ER also discusses the irreversible and irretrievable commitments of resources necessary to construct, operate, and decommission the facility. No commitments of environmental resources at or in proximity to the Wilmington Site were identified for the construction, operation, and decommissioning of the GLE Commercial Facility that ultimately could not be restored (that is, become irretrievable) after facility closure and decommissioning for unrestricted use. The only irreversible result from the construction, operation, and decommissioning of the GLE Commercial Facility is land use resources at the offsite land disposal facilities used for the permanent disposal of wastes generated by the construction, operation, and decommissioning of the GLE Commercial Facility.

9.1.3 Analysis of Effects of Proposed Action and Alternatives

The analysis of the effects in regards to the proposed action and alternatives in accordance with 10 CFR 51.45(c) is discussed in the GLE ER Chapter 2. This discussion includes information about the environmental, economic, social, and other benefits and costs associated with the Proposed Action. Chapter 2 also provides an impact summary of the proposed action, to include cumulative effects. GLE ER Chapter 4 contains a description of impacts. GLE ER Chapter 7 discusses the economic and environmental cost and benefits of the Proposed Action.

The analysis presented in GLE ER Chapter 2 considered and balanced the environmental effects of the proposed action, the environmental impacts of alternatives to the proposed action, and alternatives available for reducing or avoiding adverse environmental effects. The analysis considered technology alternatives to the GLE laser-based technology, design alternatives and alternative site locations.

9.1.4 Status of Compliance

Numerous Federal, State, County, and local government laws and regulations apply to the GLE Commercial Facility during construction, operation, and decommissioning. As required by 10 CFR 51.45(d), GLE ER Section 1.4, *Applicable Regulatory Requirements, Permits, and Required Consultations*, summarizes the applicable environmental regulatory requirements, permits, licenses, or approvals, as well as the current status of each, as of the effective date of the ER.

9.1.5 Adverse Information

In accordance with 10 CFR 51.45(b)(2) and (e), several sections in the GLE ER discuss adverse environmental effects. GLE ER Chapter 2 compares the potential impacts of the GLE Commercial Facility to the alternatives. GLE ER Chapter 4 details environmental and socioeconomic impacts due to site preparation/construction, operation, and decommissioning of the GLE Commercial Facility. GLE ER Chapter 5, *Mitigation Measures*, describes mitigation measures to minimize potential adverse impacts. Finally, GLE ER Chapter 8 provides a summary of the environmental consequences.

The majority of the impacts resulting from GLE Commercial Facility operation have been determined to be **Small** (defined as, environmental impacts from an action are not detectable or so minor they will neither destabilize nor noticeably alter any important attribute of an applicable environmental resource). Four of the impacts were determined to be **Moderate** (defined as, the environmental impacts from an action are sufficient to noticeably alter, but not destabilize, important attributes of a resource). The Moderate impacts are summarized below:

- Additional traffic volume on Castle Hayne Road and an increase in the potential for traffic congestion during peak commuting hours resulting from construction and operation activities,
- Temporarily generated short duration noises resulting from construction equipment, site preparation, and other activities typical of building construction sites,
- Removal of forested biotic communities would noticeably alter the composition of the habitat, but would not destabilize the existence of these communities, and
- Wildlife populations on the Wilmington Site would be altered; however, the existence of these species would not be destabilized.

Each of these impacts are controlled to the greatest extent possible through the use of mitigation measures and best management practices, described in Chapter 5 of the GLE ER.

9.2 ENVIRONMENTAL PROTECTION MEASURES

GLE maintains an Environmental Protection Program for the GLE Commercial Facility, which builds on the existing Wilmington Site Environmental Protection Program. The primary purpose of the Environmental Protection Program is to ensure exposure of the workers, public, and environment to radioactive materials used in facility operations is kept as low as reasonably achievable (ALARA). This is accomplished through facility design, effluent controls, engineering controls, administrative controls, staff training and qualification, effluent and environmental monitoring, and best management practices. The Environmental Protection Program is consistent with the guidance contained in Regulatory Guide 8.37, *ALARA Levels for Effluents from Materials Facilities (Ref. 9-11).*

The Environmental Protection Program has required training and qualifications for managers and staff commensurate with the responsibilities of their positions. The qualifications and responsibilities of the manager of the Environmental Protection function are described in GLE LA Chapter 2, *Organization and Administration.*

9.2.1 Radiation Safety

9.2.1.1 Radiological (ALARA) Goals for Effluent Control

Compliance and the ALARA concept are inherent in the GLE Environmental Protection Program in terms of comprehensive monitoring, analysis, and evaluation of air emissions, liquid effluents, and disposition of solid waste. Management controls, quality assurance (QA), and program implementation provide representative measurements of radioactivity in the highest potential exposure pathways, and accuracy verification of the Effluent Monitoring Program of the environmental exposure pathways. Trends are assessed using monitoring results to evaluate the following: (1) facility operations, in terms of "control-at-the-source" of contamination and the containment of radioactivity; (2) the projections of potential dose to offsite populations; and (3) the detection of any unanticipated pathways for the transport of radionuclides within the environment. Monitoring with periodic evaluations is summarized and presented to senior management on an annual basis. The ALARA and Radiation Protection (RP) Programs are described in GLE LA Chapter 4, *Radiation Protection.*

9.2.1.2 Effluent Controls to Maintain Public Doses ALARA

Effluent controls are used to maintain public doses ALARA. Air effluents are filtered through high-efficiency particulate air (HEPA) and/or high-efficiency gas absorption (HEGA) filters prior to release through the Operations Building Stack. GLE LA Section 4.6.1, *Ventilation and Containment*, describes the filtration system used to prevent the release of radioactive air effluents to the environment. The stack is sampled continuously to measure radioactivity of the exhaust air. GLE LA Section 9.2.2.2.2, *Monitoring*, describes the stack sampling and measurements.

Liquid effluents are treated to remove uranium and fluoride prior to release to the environment. GLE LA Section 9.2.2.2.2 describes the Radioactive Liquid Effluent Treatment System (RLETS). RLETS is sampled throughout the process in order to determine the amount of uranium present in each step of the process. There are administrative controls in place to re-route the effluent through the treatment system if the uranium levels exceed the limit for a step in the process. In addition, tanks and pipes are fitted with automatic leak detection to prevent accidental spills. The final step in the treatment process involves sampling the treated effluent for total uranium and total fluorides prior to release to the GNF-A Final Process Lagoon Treatment Facility (FPLTF).

9.2.1.3 ALARA Reviews and Reports to Management

The Environmental Protection Program is reviewed as part of the annual ALARA review as described in GLE LA Section 4.2.6, *Review of ALARA Program.* This review includes analysis of trends in release concentrations, environmental monitoring data, and radionuclide usage; determines whether operational changes are needed to achieve the ALARA effluent goals; and evaluates designs for system installations or modifications. The results of the ALARA review are reported to senior management, along with recommendations for changes in facilities or procedures that are necessary to achieve ALARA goals.

9.2.1.4 Waste Minimization

The GLE Commercial Facility is designed and operated in accordance with 10 CFR 20.1406, *Minimization of Contamination (Ref. 9-12),* to minimize contamination, facilitate eventual decommissioning, and minimize to the extent practicable the generation of radioactive waste. GLE LA Section 4.7.8, *Minimization of Contamination*, describes GLE waste minimization practices. The waste minimization practices during design and operation of the GLE Commercial Facility are consistent with the guidance in Regulatory Guide 4.21, *Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning (Ref. 9-13).*

9.2.2 Effluent and Environmental Controls and Monitoring

Effluent and environmental controls and monitors are maintained at and around the GLE Commercial Facility in order to ensure that doses to the workers, the public, and the environment remain ALARA. The Environmental Protection Program is consistent with the guidance contained in Regulatory Guide 4.16, *Monitoring and Reporting Radioactivity in Releases of Radioactive Materials in Liquid and Gaseous Effluents from Nuclear Fuel Processing and Fabrication Plants and Uranium Hexafluoride Production Plants (Ref. 9-14).*

9.2.2.1 Effluent Monitoring

As described below, liquid, solid, and air effluents are monitored prior to release from the GLE Commercial Facility.

9.2.2.1.1 Expected Concentrations

The expected concentrations of radioactive materials in airborne and liquid effluents were estimated using conservative assumptions. The concentrations are controlled to be ALARA and below the limits specified in 10 CFR 20, *Standards for Protection Against Radiation (Ref. 9-15)*, Appendix B, Table 2.

9.2.2.1.2 Calculation of Total Effective Dose Equivalent

Dose projections to members of the public are performed monthly to ensure the annual dose to members of the public are kept ALARA (that is, does not exceed the regulatory limit of 0.1 mSv/yr [10 mrem/yr]) in accordance with approved written procedures. Compliance with the dose limits to members of the public is demonstrated through either the calculation of the total effective dose to the individual likely to receive the highest dose (as described in 10 CFR 20.1302(b)(1), *Compliance with Dose Limits for Individual Members of the Public [Ref.9-16]*); or through the calculation of annual average concentrations of radioactive material released in gaseous and liquid effluents (as described in 10 CFR 20.1302(b)(2)). The guidance in Regulatory Guide 4.20, *Constraint on Releases of Airborne Radioactive Materials to the Environment for Licensees Other than Power Reactors (Ref. 9-17)*, is followed to determine compliance with dose limits to members of the public. Compliance with the dose limits to members of the public is reported to the NRC in the semi-annual effluent report as required by 10 CFR 70.59, *Effluent Monitoring Reporting Requirements (Ref. 9-18).*

If the monthly dose impact assessment indicates a trend in effluent releases, that if not corrected could cause the administrative limit to be exceeded, appropriate corrective action is initiated to reduce the discharges and ensure subsequent releases are in compliance with the annual dose constraint. In addition, an evaluation of the need for increased sampling is performed. Corrective actions may include, for example, source term investigation, HEPA and/or HEGA filter changeout, or operational modifications.

9.2.2.1.3 Effluent Discharge Locations

Figure 9-1, *Air Monitoring Locations*, shows the location of the Operations Building Stack and the air effluent discharge point. Figure 9-2, *Map of Wilmington Site Outfalls, Effluent Channel, and Process Lagoons*, shows the location of the liquid effluent discharges.

9.2.2.1.4 Continuous Sampling Airborne Effluents

The source of air emissions from the GLE Commercial Facility is from the Operations Building Stack (see Figure 9-1). The stack is sampled continuously to measure radioactivity of the exhaust air. The collection filter in the sample system is removed on a daily schedule during initial operation and analyzed for gross alpha activity. The periodicity of sampling will eventually decrease to weekly if the results are shown to be continually low during normal operations.

9.2.2.1.5 Sample Collection and Analysis

Based on historical information available from the GNF-A FMO facility on the Wilmington Site, the Environmental Protection Program has established appropriate sample collection and analysis methods and frequencies for the effluent medium and the radionuclide(s) being sampled. Sampling methods ensure that representative samples are obtained using appropriate sampling equipment and sample collection and storage procedures. Monitoring instruments are calibrated at least annually, or more frequently if suggested by the manufacturer.

9.2.2.1.6 Radionuclide-Specific Analysis

Radionuclide-specific analyses are performed on selected composited samples (see Table 9-1, *Summary of the GLE Environmental Monitoring Program*). Monitoring reports in which the quantities of individual radionuclides are estimated on the basis of methods other than direct measurement include an explanation and justification of how the results were obtained.

Radionuclide analyses are performed more frequently than usual as follows: (1) at the beginning of the monitoring program until a predictable and consistent radionuclide composition in effluents is established; (2) whenever there is a significant, unexplained increase in gross radioactivity in effluents; and (3) whenever a process change or other circumstance may cause a significant variation in the radionuclide composition.

9.2.2.1.7 Minimum Detectable Concentrations

Minimum detectable concentrations (MDCs) for both effluent and environmental samples are listed in Table 9-2, *Summary of Minimum Detectable Concentrations for the GLE Environmental Monitoring Program*. The listed MDCs are typical for the analytical methods employed as previously established for the existing Wilmington Site Monitoring Program (see the GNF-A Wilmington Environmental Report Supplement *[Ref. 9-19]*).

9.2.2.1.8 Laboratory Quality Control

The laboratory quality control procedures are adequate to validate the analytical results. The procedures include the use of established standards such as those provided by the National Institute of Standards and Technology (NIST), as well as standard analytical procedures such as those established by the National Environmental Laboratory Accreditation Conference (NELAC).

9.2.2.1.9 Action Levels

The action level for environmental measurements is the concentration (or mass) of an analyte that indicates that some action needs to be taken, such as an investigation or, if the level is high enough, shut down of operations. Action levels are specified in approved written procedures according to the type of sample and the specific analysis. Such action levels provide guidance in assuring compliance within 10 CFR 20 limits.

9.2.2.1.10 Federal and State Standards for Discharges

GLE has been issued an air permit from the North Carolina Division of Air Quality (NC DAQ) that contains the regulatory requirements for the emission of fluoride from the Operations Building Stack. The air permit also contains requirements for the operation of the diesel back-up generators.

Stormwater runoff from the GLE Commercial Facility is monitored in accordance with the National Pollutant Discharge Elimination System (NPDES) stormwater management permit issued by the North Carolina Division of Water Quality (NC DWQ).

The GNF-A NPDES industrial wastewater treatment permit regulates the monitoring and sampling for the release of treated process water to the environment because the GLE treated process water is pumped to the FPLTF prior to release to the environment. The composite samples are analyzed for uranium, gross alpha, gross beta, fluoride, ammonia, nitrite, nitrate, copper, nickel, chromium, silver, zinc, total suspended solids, cadmium, lead, nickel, phosphate, and biochemical oxygen demand (BOD) on a prescribed frequency based upon the NPDES permit.

9.2.2.1.11 Leakage Detection Systems

Leak detection systems are operated and maintained in areas where liquid effluents are processed. This includes leak detection on tanks, pipes, sumps, and drains to prevent unplanned releases to groundwater, surface water, and soil. The ISA Summary contains a description of the leak detection systems for the RLETS, Laboratory Area, and the Decontamination/Maintenance Area.

9.2.2.1.12 Releases to Sewer Systems

It is not anticipated that the GLE Commercial Facility will release liquid effluents to the sewer system. Drains from showers and handwash stations in contaminated area change rooms are routed to the RLETS. Sanitary effluents from the GLE Commercial Facility are pumped to the Wilmington Site Sanitary Wastewater Treatment Facility (WWTF).

9.2.2.1.13 Reporting procedures

Reporting procedures comply with the requirements of 10 CFR 70.59 and the guidance specified in Regulatory Guide 4.16. The semi-annual effluent report contains the concentrations of principal radionuclides released to unrestricted areas in liquid and gaseous effluents and includes the MDC for the analysis and the error for each data point.

9.2.2.1.14 Waste Management procedures

Liquid effluents are treated to remove uranium and fluoride prior to their release to the environment. See GLE LA Section 9.2.2.2.2 for a description of the RLETS. The discharges from the RLETS are monitored and controlled to ensure that the uranium and fluoride concentrations in the FPLTF effluent are in compliance with the concentrations and mass limits stipulated in the NPDES permit, as well as in compliance with 10 CFR 20.1301, *Dose Limits for Individual Members of the Public (Ref. 9-20)*, and 10 CFR 20.1302 thereby meeting the NRC's unrestricted release limit. A description of liquid waste treatment and disposal is provided in the ISA Summary.

Solid waste management facilities, with sufficient capability to enable preparation, packaging, storage, and transfers to licensed disposal sites in accordance with the regulations, are provided and maintained in proper operating condition as required to support the operation of the facility. The ISA Summary contains a description of solid waste processing, packaging, and storage.

9.2.2.2 Environmental Monitoring

9.2.2.2.1 Background and Baseline Measurements

The Wilmington Site Environmental Protection Program has established historical data to provide information about the site environs. Prior to facility operations, soil and groundwater samples were collected from the GLE Commercial Facility location on the Wilmington Site and were analyzed to determine a baseline to be used in evaluating changes in potential environmental conditions caused by facility operation. Air and water samples are collected from remote locations in order to provide background data during operations.

9.2.2.2.2 Monitoring

Direct Radiation Monitoring

Direct radiation monitoring for the UF_6 Cylinder Pads and other outdoor storage areas is accomplished by use of thermo luminescent dosimeters (TLDs). In addition, RP Program procedures require periodic surveys to be performed in and around outdoor storage areas to ensure direct radiation doses are maintained ALARA. Environmental dosimeters are used at the fenceline to measure direct radiation readings.

Air Monitoring

Air emission control systems are designed and operated to assure compliance with regulatory requirements. Operations that could potentially exhaust radioactive materials have air emission controls that are monitored by representative stack sampling to demonstrate compliance with regulations. Samples are collected and analyzed to be representative of the discharges during operations. The ventilation and exhaust systems are described in GLE LA Chapter 4 and in the ISA Summary.

In addition to stack monitoring, air monitoring for radioactive emissions occurs in proximity to the GLE Commercial Facility. A total of eleven (11) active air monitors are used for analysis of a weekly composite sample for gross alpha activity and concentrations of uranium isotopes. Nine monitors are placed around the restricted area fenceline of the GLE Site. These locations are shown on Figure 9-1 and are based on the predominant wind directions. Three of these monitors are placed at the fenceline to the south of the UF_6 Cylinder Pads and monitor for levels of radioactive material from the storage pads and the stack during periods when the wind is northerly (that is, wind blowing from the north). Three monitors are placed on the north and northeastern fenceline to monitor levels of radioactive materials during periods where the wind blows from its predominant southwesterly direction. One additional monitor is placed at the fenceline to the east of the UF_6 Cylinder Pads, and two additional monitors are placed at the fenceline on the western side of the GLE Site. Additionally, one monitor is placed on the Wilmington Site property boundary near the point of highest potential impact from the Operations Building Stack, as predicted by air dispersion modeling performed in the ER Section 4.6, *Air Quality Impacts,* using XOQDOQ. Air monitoring of the ambient levels of radioactive materials in the atmosphere is also performed. An active air monitor is placed approximately 0.5 miles (0.8 km) to the west-northwest of the Operations Building Stack. This location was chosen because it is located in the least-predominant downwind direction from the GLE Commercial Facility. It is also located along an existing access road to minimize environmental impacts associated with accessing the monitoring location. Figure 9-2 shows the location of the ambient air monitor in relation to the GLE Commercial Facility. The sampling program includes analysis of a weekly composite sample for gross alpha activity and concentrations of uranium isotopes.

Wastewater Effluent and Surface Water Monitoring

Radioactive liquid waste treatment in the GLE Commercial Facility consists of a system to remove uranium and fluoride. Uranium removal is accomplished through pH adjustment, followed by flocculation and filtration. Fluoride is removed through the addition of a salt to form a solid fluoride precipitate, followed by either filtration or evaporation. The final step in the treatment process involves sampling the treated effluent for total uranium and total fluorides just prior to release to the GNF-A FPLTF.

Treated effluent is routed to a pump station, which then pumps the effluent to the existing Wilmington Site FPLTF. The treated effluent is discharged from the FPLTF to the effluent channel via NPDES–permitted Outfall 001. The effluent channel flows to the unnamed Tributary No. 1 to the Northeast Cape Fear River. The discharges from the GLE RLETS are controlled to assure that the uranium and fluoride concentrations in the FPLTF effluent are in compliance with the concentrations and mass limits stipulated in the NPDES permit, as well as in compliance with 10 CFR 20.1301 and 20.1302, thereby meeting the NRC's unrestricted release limit. Continuous proportional samples of the treated process wastewater effluent are collected daily at the outfall (NPDES Outfall 001). The sampling program includes analysis of the daily composite samples for uranium content; analysis of a weekly composite of the daily samples for gross alpha activity and gross beta activity; and analysis of quarterly composites (prepared from the weekly composite samples) for ^{99}Tc.

The GLE Monitoring Program includes the current GNF-A surface water monitoring activities. Gross alpha activity, gross beta activity, and uranium concentrations currently are monitored in the effluent channel; Northeast Cape Fear River near Castle Hayne, NC (upstream of the Wilmington Site); and Northeast Cape Fear River at the GE Dock (downstream of the Wilmington Site. These grab samples are taken on a monthly basis.

Groundwater Monitoring

The current GNF-A Radiological Groundwater Monitoring Program includes analysis of samples from a large number of wells across the Wilmington Site (See the GNF-A Wilmington Environmental Report Supplement). Thirteen additional monitoring wells are constructed around the GLE Commercial Facility, and these wells and the eight existing wells within the GLE Commercial Facility are added to the sampling protocol as part of the expanded monitoring program. These 21 wells are positioned in seven clusters, with three wells installed at different depths per cluster. Wells with an A-suffix identification are the shallowest wells, completed within the Surficial Aquifer at or just below the water table. Wells with B- and C-suffix identifications are progressively deeper wells, completed at horizons corresponding to the upper portion of the Principal (Peedee) Aquifer and intermediate depths of the Principal Aquifer, respectively. These well locations, shown on Figure 9-3, *Groundwater Monitoring Locations*, are west of the western extent of the less-permeable clay semiconfining layer (see ER Section 3.4.1.1.2.2, *Semiconfining Layer*); therefore, the Surficial and Principal aquifers serve hydraulically as one unit across the portion of the GLE Site that is monitored.

Initially, samples are collected quarterly from the 21 GLE monitoring network wells for analysis of uranium. If the validated uranium analytical result exceeds 0.02 mg/L, the subsequent quarterly sample from that well is also analyzed for gross alpha activity and gross beta activity. The monitoring frequency for each well is reviewed and potentially adjusted after a sufficient dataset is developed to perform statistically valid trend analyses.

Soil Monitoring

Figure 9-4, *Soil Sampling Locations*, shows the GLE soil sampling locations that were established considering the location of the Operations Building Stack and the prevailing wind directions. The soil-sampling procedures established for the existing GNF-A Soil Monitoring Program apply to the expanded monitoring program. The soil samples are collected using decontaminated hand-sampling tools from the upper four inches and are analyzed for uranium concentrations.

Sediment Monitoring

As part of the existing GNF-A Environmental Monitoring Program, sediment samples are collected semiannually in the effluent channel downstream from the final process basins (See the GNF-A Wilmington Environmental Report Supplement). Since the GLE Commercial Facility is contributing to the flow into these process basins, but not creating any new outfalls, the current sediment sampling locations are sufficient. The sediment sampling procedures established for the existing GNF-A Sediment Monitoring Program will continue, and sediment samples are collected and analyzed annually for uranium.

Stormwater Monitoring

Stormwater runoff from the GLE Commercial Facility is monitored in accordance with the NPDES permit issued by the NC DWQ.

9.2.2.2.3 Sampling Location, Frequency, and Analysis

Table 9-1 contains a summary of the Environmental Monitoring Program. The table includes the sample medium, sampling location, sample type, sample analyte, and the sample frequency.

9.2.2.2.4 Analytical Methods and Instrumentation

Appropriate sampling and analytical methods were selected based on their sensitivity and reliability to support application of the action levels.

9.2.2.2.5 Action Levels

The action level for environmental measurements (effluent and other measurements) is the concentration (or mass) of an analyte that indicates some action needs to be taken, such as an investigation or, if the level is high enough, shut down of operations. Action levels are specified in approved written procedures according to the type of sample and the specific analysis. Such action levels provide guidance in assuring compliance within 10 CFR 20 limits.

9.2.2.2.6 Minimum Detectable Concentration

MDCs for both effluent and environmental samples are listed in Table 9-2. The listed MDCs are typical for the analytical methods employed, as established for the existing Wilmington Site Monitoring Program (see the GNF-A Wilmington Environmental Report Supplement).

9.2.2.2.7 Data Analysis

As specified in approved written procedures, data analysis methods and criteria used in evaluating and reporting the environmental sampling results are appropriate and indicate when an action level is being approached in time to take corrective actions.

9.2.2.2.8 Federal, State and Local requirements

The Federal, State, and local requirements for environmental monitoring are followed in accordance with the licenses and permits described in GLE LA Section 9.2.2.1, E*ffluent Monitoring.*

9.2.2.2.9 Impacts Assessment

Data from the Environmental Monitoring Program can be used to assess impacts to the environment from potential radioactive and nonradioactive releases.

9.2.3 Integrated Safety Analysis

The GLE Project has established and maintains a safety program demonstrating compliance with the performance requirements of 10 CFR 70.61, *Performance Requirements (Ref. 9-21)*. The safety program utilizes approved written procedures for performing an ISA that contains the appropriate level of detail for the complexity of each process. The program applies graded management measures commensurate with the reduction of the risk attributable to the item.

GLE has prepared an ISA in accordance with 10 CFR 70.60, *Applicability* (Ref. 9-22), which includes the evaluation of high and intermediate consequence events involving releases of radioactive material to the environment. The ISA process is described in GLE LA Chapter 3, *Integrated Safety Analysis*.

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9-18. 10 CFR 70.59, *Effluent Monitoring Reporting Requirements*, U.S. Nuclear Regulatory Commission, 2008.

9-19. GNF-A Wilmington Environmental Report Supplement, *Site Environmental Report Supplement for the Period 1995-2005*, Global Nuclear Fuel-Americas, LLC, March 2007.

9-20. 10 CFR 20.1301, *Dose Limits for Individual Members of the Public*, U.S. Nuclear Regulatory Commission, 2008.

9-21. 10 CFR 70.61, *Performance Requirements*, U.S. Nuclear Regulatory Commission, 2008.

9-22. 10 CFR 70.60, *Applicability*, U.S. Nuclear Regulatory Commission, 2008.

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Table 9-1. Summary of GLE Environmental Monitoring Program.

Medium	Sample Locations	Sample Type	Analyte/Parameter Frequency
Direct Radiation	Fenceline	TLDs and environmental dosimeters	Gamma and neutron activity
	Outdoor storage areas	TLDs and environmental dosimeters	Gamma and neutron activity
Air	GLE operations building stack	Continuous air particulate filter	Gross alpha activity – Weekly Gross beta activity – Weekly Fluoride – Weekly
	GLE facility perimeter, site boundary point of highest potential impact, and background	Continuous air particulate filter	Gross alpha activity – Weekly Gross beta activity - Weekly
Surface water	Site dam	Grab sample	Gross alpha/beta activities – Monthly Total uranium – Monthly
Treated process wastewater effluent	NPDES outfall 001	Continuous proportional sample of liquid effluent	Total uranium – Daily composite Gross alpha/beta activities – Weekly composite ^{99}Tc – 6-month composite NPDES permit requirements
Groundwater	21 monitoring wells	Grab sample after typical 3-well purge	Total uranium – Quarterly Gross alpha/beta activities – Only if total uranium concentration in previous sample >0.02 mg/L Fluoride – Quarterly
Stormwater	Detention ponds	Grab sample	NPDES permit requirements
Soil	See Figure 9-4	Shallow soil grab sample	Total uranium – semi-annual
Sediment	Above site dam	Sediment grab sample	Total uranium - annual

Table 9-2. Summary of Minimum Detectable Concentrations for the GLE Environmental Monitoring Program.

Medium	Gross Alpha Activity	Typical Minimum Detectable Concentrations for Radiological Environmental Monitoring Program
Air (particulate filter) - Stack	Gross beta activity	20 picocuries per liter (pCi/L)
	Gross alpha activity	1.0×10^{-12} microcuries per milliliter (µCi/mL)
Air (particulate filter) – At access area fence line, Site boundary point of highest potential impact, and ambient (background)	Gross alpha activity	1.0×10^{-12} µCi/mL
	Gross beta activity	20 pCi/L
Surface Water	Total uranium	0.02 parts per million (ppm)
	Gross alpha activity	5 pCi/L
	Gross beta activity	20 pCi/L
Treated process wastewater effluent	Total uranium	0.02 ppm
	Gross alpha activity	3.0×10^{-8} µCi/mL
	Gross beta activity	5.0×10^{-8} µCi/mL
	^{99}Tc	20 pCi/L
Groundwater	Total uranium	0.02 ppm
	Gross alpha activity	20 pCi/L
	Gross beta activity	5 pCi/L
Soil	Total uranium	0.02 ppm
Sediment	Total uranium	0.02 ppm

Figure 9-1. Air Monitoring Locations.

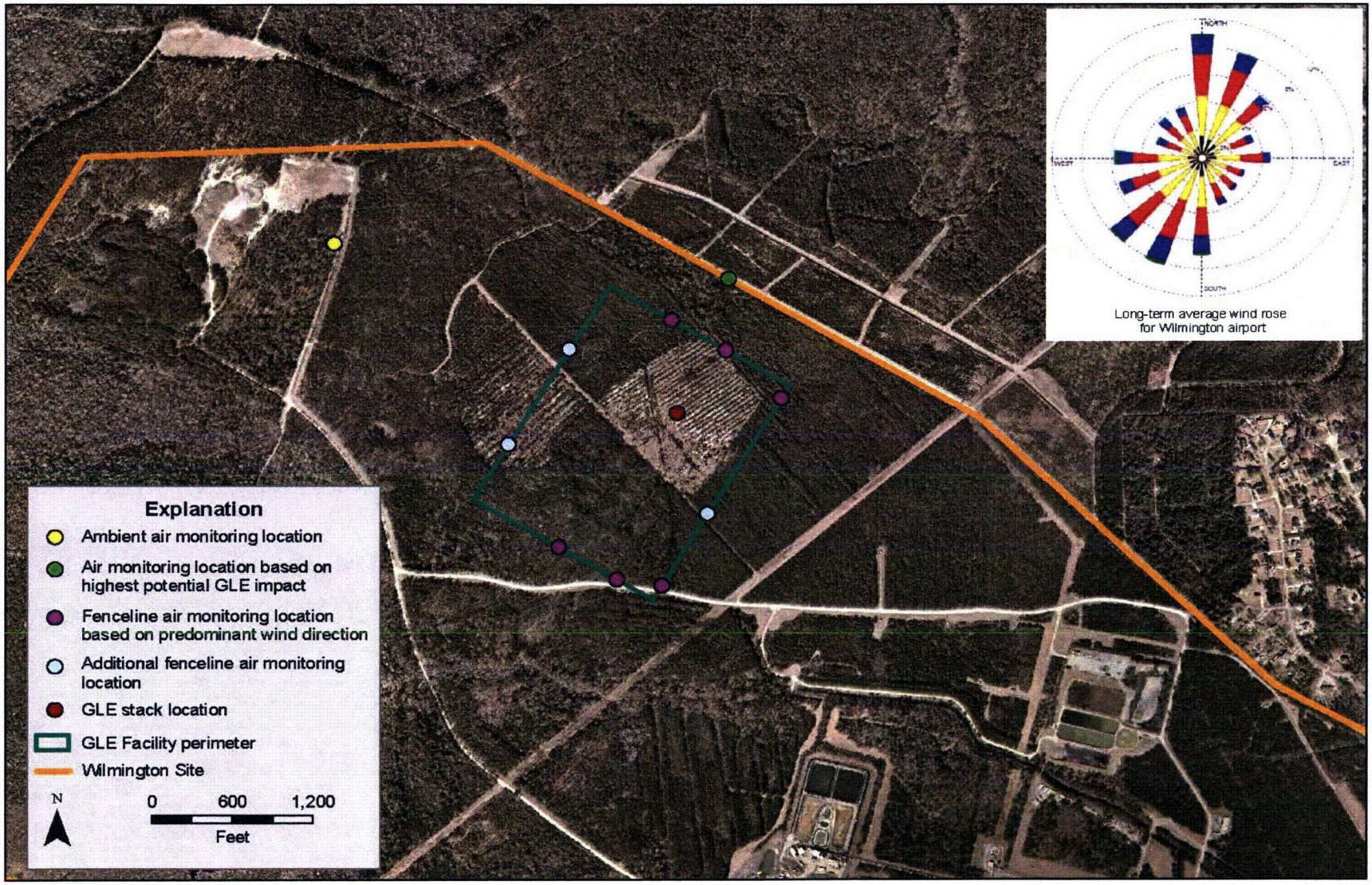


Figure 9-2. Map of Wilmington Site Outfalls, Effluent Channel, and Process Lagoons.

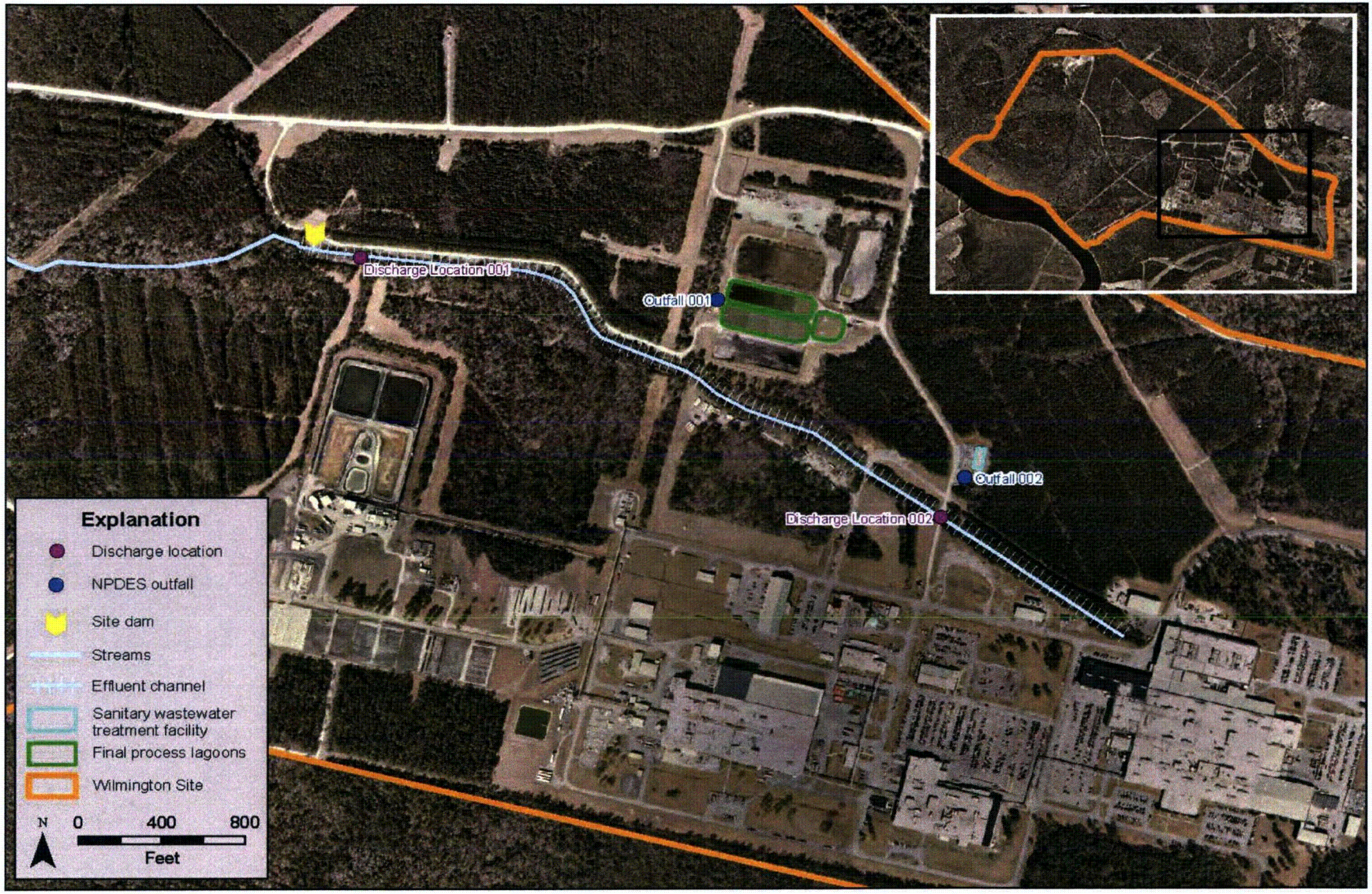


Figure 9-3. Groundwater Monitoring Locations.

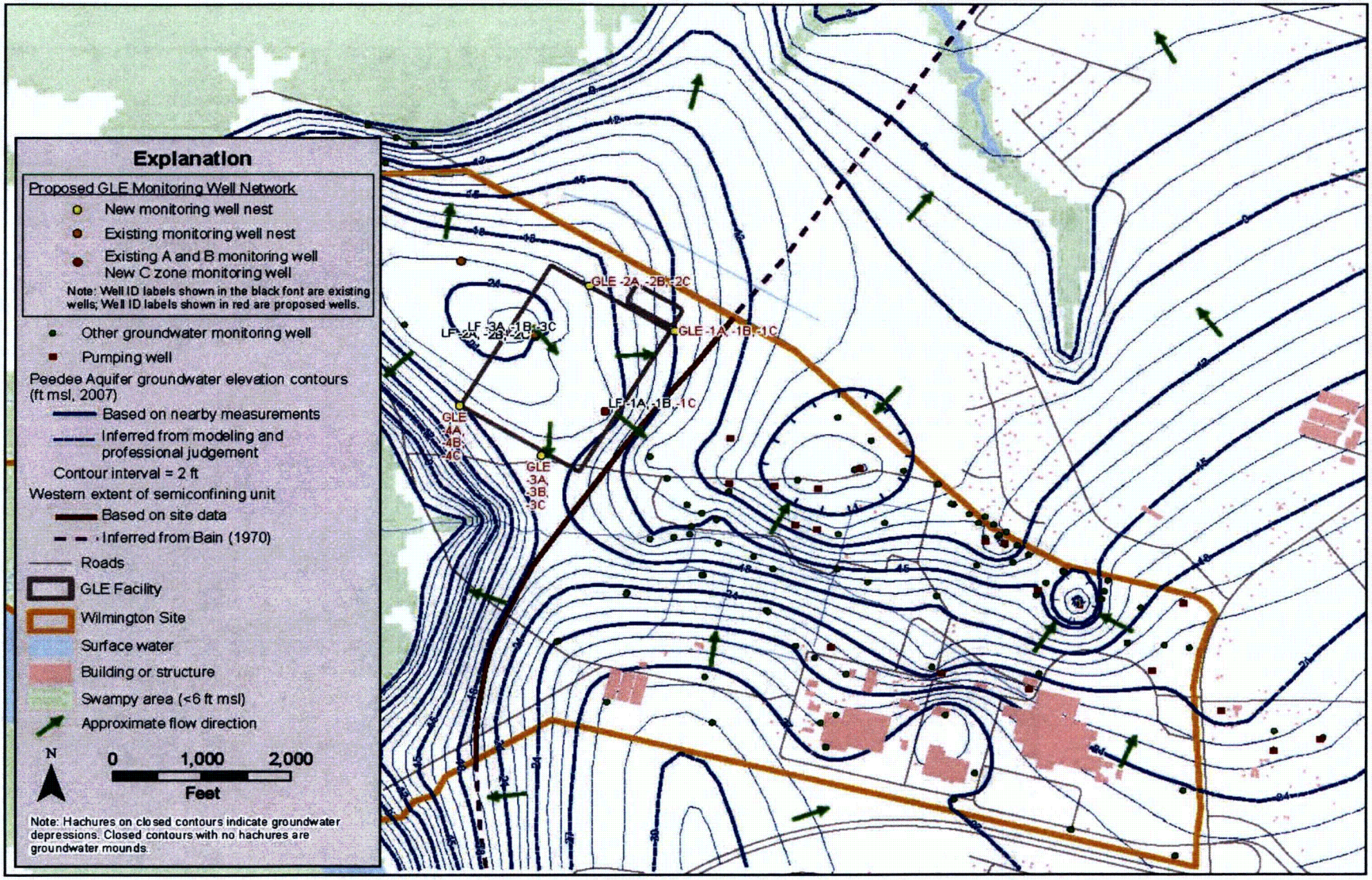
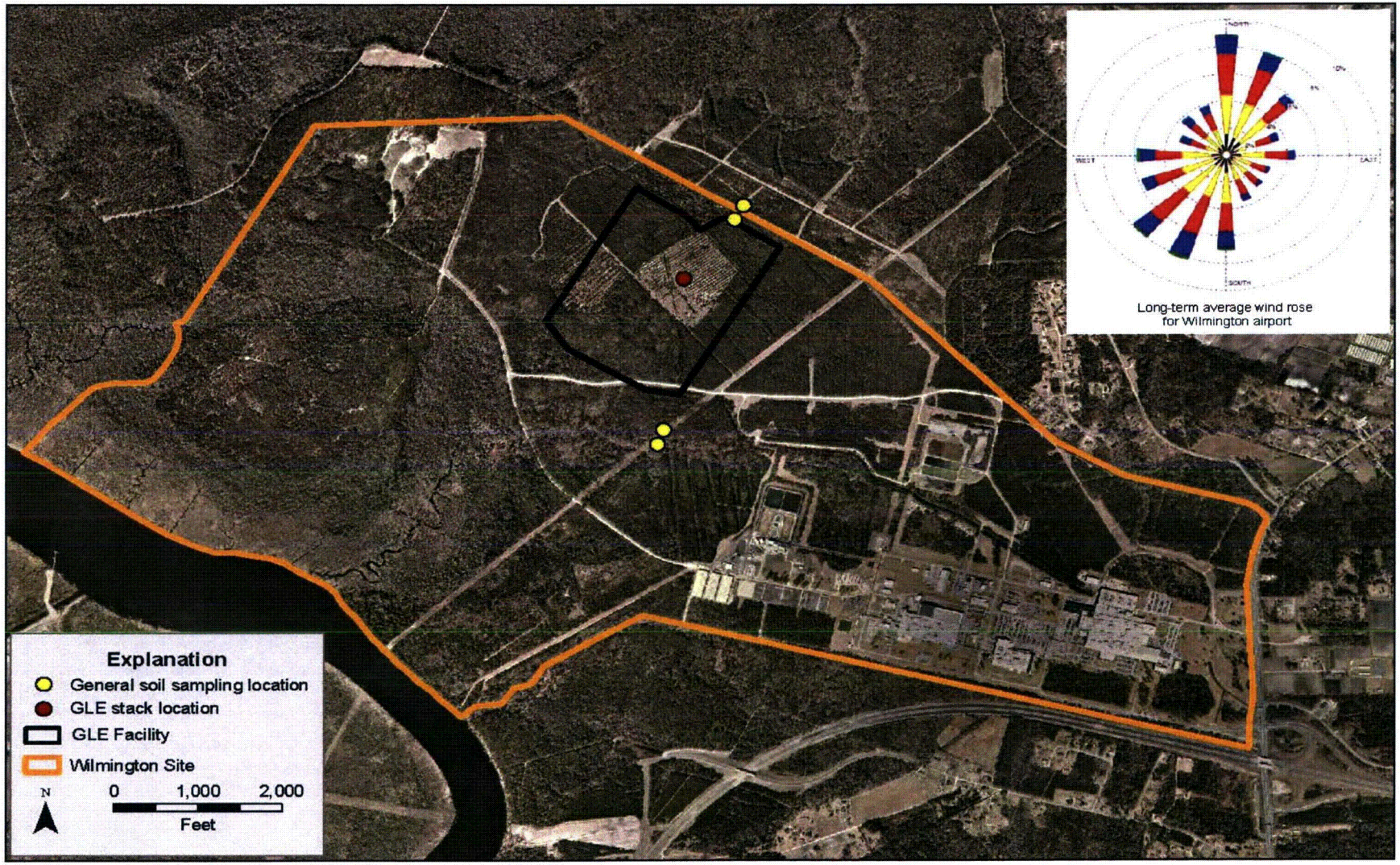


Figure 9-4. Soil Sampling Locations.



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10. DECOMMISSIONING

10.1 CONCEPTUAL DECONTAMINATION AND DECOMMISSIONING PLAN

The GE-Hitachi Global Laser Enrichment LLC (GLE) Commercial Facility is designed and operated in accordance with 10 CFR 20.1406, *Minimization of Contamination (Ref. 10-1)*, to minimize contamination, facilitate eventual decommissioning, and minimize to the extent practicable, the generation of radioactive waste. As a result, worker exposure to radiation and radioactive waste volumes during operations and decommissioning are maintained as low as reasonably achievable (ALARA).

In accordance with 10 CFR 70.25, *Financial Assurance and Recordkeeping for Decommissioning (Ref. 10-2)*, a Decommissioning Funding Plan (DFP) was submitted concurrent with the GLE license application that contains a cost estimate for decommissioning and a description of the method of assuring funds for decommissioning. The DFP was prepared consistent with the guidance in NUREG-1757, *Consolidated NMSS Decommissioning Guidance (Ref. 10-3).*

10.1.1 Decommissioning Strategy

It is the intent of GLE to decommission the GLE Commercial Facility after facility shutdown to reduce the level of radioactivity remaining in the facility to residual levels acceptable for release of the facility for unrestricted use and for U.S. Nuclear Regulatory Commission (NRC) license termination pursuant to 10 CFR 20.1401, *General Provisions and Scope (Ref. 10-4)*, and 10 CFR 20.1402, *Radiological Criteria for Unrestricted Use (Ref. 10-5).* Prior to decommissioning, an assessment of the radiological status of the GLE Commercial Facility will be made. Decommissioning and closure activities will include the cleaning and removal of radioactive and hazardous waste contamination that may be present on materials, equipment, and structures. Overall, decommissioning is estimated to require approximately 3.5 years from facility shutdown to completion of the final status survey of radiological conditions. The GLE decommissioning schedule is presented in Figure 10-1, *Decommissioning Schedule.*

Before decommissioning activities begin, a Decommissioning Plan (DP) will be prepared and submitted to the NRC pursuant to 10 CFR 70.38, *Expiration and Termination of Licenses and Decommissioning of Sites and Separate Buildings or Outdoor Areas (Ref. 10-6).* The DP will provide information concerning the GLE Commercial Facility, the types of items to be decontaminated, the disposition of facilities used for hazardous materials, the assumptions upon which the cost of decommissioning is derived, and an estimated schedule for decommissioning and closing the facility.

10.1.1.1 Radioactive Contamination Control

The GLE Commercial Facility is operated in a manner to control radioactive contamination. The following are examples of methods for minimizing contamination:

- Containment of radioactive material throughout the facility;
- Posting areas within the Restricted Area boundary to alert personnel to the presence of elevated radiation levels and/or radioactive materials (designated as Radiological Control Areas [RCAs]);
- Monitoring for equipment leaks;
- Compliance with labeling and packaging requirements in 10 CFR 20.1904, *Labeling Containers (Ref. 10-7)*, 10 CFR 20.1905, *Exemptions to Labeling Requirements (Ref. 10-8)*, 10 CFR 20.1906, *Procedures for Receiving and Opening Packages (Ref. 10-9)*, 10 CFR 20, Subpart K, *Waste Disposal (Ref. 10-10)*;
- Providing overflow vessels to capture potential spills;
- Minimizing the use of nonradioactive process equipment in locations subject to potential contamination;
- Providing local air filtration in areas with potential airborne contamination to preclude its spread;
- Use of personnel protective equipment (PPE) and training on its use;
- Use of respiratory protection;
- Training on proper techniques for handling radioactive material; and
- Airflow from areas of low radioactivity to higher radioactivity.

10.1.1.2 Worker Exposure and Waste Volume Control

The following features primarily serve to minimize worker exposure to radiation and minimize radioactive waste volumes during decommissioning activities. As a result, the spread of contamination is minimized as well.

Minimization of Worker Exposure:

- Ample access is provided for efficient equipment dismantling and removal of equipment that may be contaminated. This minimizes the time of worker exposure.
- Design drawings prepared for the facility simplify the planning and implementing of decontamination procedures.

- Worker access to contaminated areas is controlled to assure that workers wear proper protective equipment and limit worker time in the areas.

- Remote equipment will be used, when feasible.

Waste Volume Minimization:

- When necessary, sealed, nonporous pipe insulation is used in areas likely to be contaminated. This will reduce waste volume during decommissioning.

- Surface contamination will be removed, to the extent possible, to levels acceptable for release.

- Tanks are provided with accesses for decontamination. Design provisions are also made to allow complete draining of the wastes contained in the tanks.

- Connections in the process systems provided for required operation and maintenance allow for thorough purging at facility shutdown. This will remove a significant portion of radioactive contamination prior to disassembly.

- Volume reduction measures will be employed, when feasible.

10.1.2 Decommissioning Steps

Decommissioning activities will generally include: (1) shutdown and purging/draining of process systems; (2) dismantling and removal of equipment; (3) decontamination and destruction of classified material; (4) sales of salvaged materials; (5) disposal of wastes; and (6) completion of a final radiation survey. The following areas have radiological material handled or stored within; therefore, have the potential to be contaminated at the end of facility life:

- Cylinder Shipping and Receiving Area,

- UF_6 Feed and Vaporization Area,

- Product and Tails Withdrawal Areas,

- Cascade/Gas Handling Area,

- Blending Area,

- Sampling Area,

- Decontamination/Maintenance Area,

- Laboratory Area,

- Radiological Liquid Effluent Treatment System (RLETS) Area,

- Final Filter Room,

- UF_6 Cylinder Pads, and
- Waste Storage Warehouses.

Decontamination of facility components and structures will not require installation of new facilities dedicated for that purpose, as the Decontamination/Maintenance Area in the Operations Building will be utilized for decommissioning. This area is designed to accommodate cleaning of equipment and maintenance/cleaning of large components.

10.1.2.1 Overview

The list below details the general guidelines that will apply to the decommissioning and closure effort.

- A reasonable effort will be made to eliminate residual contamination.
- Radioactivity on equipment or surfaces shall not be covered by paint, plating, or other covering material unless contamination levels are below the limits specified in the DP prior to applying the covering.
- The radioactivity on the interior surfaces of pipes, drain lines, and ductwork shall be determined by making measurements at traps and other appropriate access points, provided that contamination at these locations is likely to be representative of contamination on the interior of the pipes, drain lines, or ductwork.
- Surfaces of premises, equipment, or scrap that are likely to be contaminated, but are of such size, construction, or location that the surfaces are inaccessible for purposes of measurement, shall be presumed to be contaminated in excess of the limits specified in the DP.
- Classified material, components, and documents will be destroyed or disposed of in accordance with the GLE approved written procedures and applicable regulatory requirements.
- Requirements for Material Control and Accounting (MC&A) will be maintained during decommissioning in a manner similar to the programs in force during operation of the GLE Commercial Facility.
- Depleted UF_6 material, if not sold or disposed of prior to decommissioning, will either be sold, disposed of by the U.S. Department of Energy (DOE), or will be converted to a stable, non-volatile uranium compound and disposed of in accordance with regulatory requirements.
- Radioactive wastes will be disposed of at licensed low-level radioactive waste (LLRW) disposal sites.
- Hazardous wastes will be treated or disposed of in permitted hazardous waste facilities.

- Radiation exposure limits shall be consistent with allowable limits specified in 10 CFR 20, *Standards for Protection against Radiation (Ref. 10-11).*

- Shipments of radioactive materials associated with decommissioning and closure shall conform to the regulations of 49 CFR, *Transportation (Ref. 10-12)*, for transporting hazardous materials.

- Prior to release for unrestricted use, a comprehensive radiation survey will establish that contamination levels and dose rates are within the limits approved at the time of decommissioning.

- The facility will be closed in a manner that minimizes the need for further maintenance and controls to the extent necessary to protect human health and the environment.

- Independent reviews of the premises will be made to verify that hazardous waste and radioactive contamination have been removed to acceptable levels and that the premises meet regulatory release limits.

Decommissioning to levels acceptable for unrestricted use requires residual radioactivity to be reduced below specified limits. Current NRC guidelines for release serve as the basis for decontamination costs estimated herein. Portions of the facility, which do not exceed contamination limits, may remain as is without further decontamination measures applied. The intent of decommissioning the facility is to remove enrichment-related equipment from the buildings such that only the building shells and site infrastructure remain. The removed equipment includes piping and components from systems providing UF_6 containment, systems in direct support of enrichment, radioactive and hazardous waste handling systems, contaminated heating, ventilation, and air conditioning (HVAC) filtration systems, etc. The remaining infrastructure will include services such as electrical power supply, treated water, fire protection, HVAC, cooling water, and communications.

Unclassified decontaminated components may be reused or sold as scrap. Equipment that is to be reused or sold as scrap will be decontaminated to a level at which further use is unrestricted. Materials that cannot be decontaminated will be disposed of in a licensed radioactive waste disposal facility. Credit is not taken in the DFP for salvage value that may be realized from the sale of potential assets (that is, recovered materials or decontaminated equipment) during or after decommissioning.

UF_6 tails remaining on site will be removed during decommissioning. Depending on technological developments occurring prior to facility shutdown, the tails may have become marketable for further enrichment or other processes. The disposition of UF_6 tails and relevant funding provisions are discussed in Section 10.2.2, *Depleted Uranium Disposition.* The cost estimate takes no credit for value that may be realized in the future due to the potential marketability of the stored tails.

Contaminated portions of the buildings will be decontaminated as required. Structural contamination is expected to be limited to structures in the Restricted Area. Good housekeeping practices during normal operation will minimize contamination in other areas of the facility.

When decontamination is complete, onsite areas and facilities will be surveyed to verify that further decontamination is not required. Decontamination activities will continue until the entire site is demonstrated to be suitable for unrestricted use.

10.1.2.2 Shutdown and Purging

At the end of useful operation, the GLE Commercial Facility will be shut down, and UF_6 material will be removed to the fullest extent possible by normal process operation. This will be followed by evacuation and purging of process systems. Connections in the process systems provided for required operation and maintenance allow for thorough purging at facility shutdown. This will remove a significant portion of radioactive contamination prior to disassembly.

10.1.2.3 Dismantling and Removal

Dismantling is the process of disassembling, disconnecting, or cutting of components requiring removal. The dismantling and removal activities are simple but labor intensive and generally require the use of protective clothing or equipment. The work process will be optimized considering the following:

- Minimizing the spread of contamination and the need for protective clothing or equipment;
- Balancing the number of cutting and removal operations with the resultant decontamination and disposal requirements;
- Optimizing the rate of dismantling with the rate of decontamination facility throughput;
- Providing storage and laydown space required, as impacted by retrievability, radiation protection, criticality safety, and security; and
- Balancing the cost of decontamination with the cost of disposal.

Details of the complex optimization process will be decided near the end of facility useful life, taking into account specific contamination levels, market conditions, and available waste disposal sites. The dismantling process will be coordinated with the decontamination process in order to avoid laydown space and contamination problems.

10.1.2.4 Decontamination

The decontamination process is addressed separately in Section 10.1.8, *Decontamination*. The estimated decommissioning costs are based on decontaminating the facility to the radiological criteria for unrestricted use in 10 CFR 20.1402.

10.1.2.5 Sale of Salvaged Materials

Items to be removed from the facilities can be categorized as potentially re-usable equipment (whether contaminated or decontaminated), recoverable decontaminated scrap, and wastes. Based on a 40-year facility operating life, operating equipment is not assumed to have a significant re-use value. Some metals from uncontaminated equipment and components can be recovered and sold at market price. However, for conservatism, no credit is taken for salvage value in the DFP. Other items are considered waste with no salvage value.

10.1.2.6 Disposal of Wastes

Wastes produced during decommissioning will be collected, handled, and disposed of in a manner similar to that described for those wastes produced during normal operation. Wastes will consist of normal industrial trash, non-hazardous chemicals and fluids, small amounts of hazardous materials, and radioactive wastes. The radioactive waste will consist primarily of process equipment, trash, and citric cake. Citric cake consists of uranium and metallic compounds precipitated from citric acid decontamination solutions. It is estimated that approximately 664,000 cubic feet of radioactive waste will be generated over the five-year decommissioning operations period. This waste is subject to further volume reduction processing prior to disposal; however, volume reduction was not assumed for the purposes of calculating the disposal costs

Radioactive wastes will ultimately be disposed of in licensed LLRW disposal facilities. Hazardous wastes will be disposed of in hazardous waste disposal facilities. Non-hazardous and nonradioactive wastes will be disposed of in a manner consistent with good industrial practice and in accordance with applicable regulations. A complete estimate of the wastes and effluent to be produced during decommissioning will be provided in the DP, which will be submitted prior to initiating the decommissioning of the GLE Commercial Facility.

Classified components and documents onsite shall be disposed of in accordance with the requirements of 10 CFR 95, *Facility Security Clearance and Safeguarding of National Security Information and Restricted Data (Ref. 10-13).* Such classified portions of the processing equipment will be destroyed, documents will be destroyed, and other items will be handled in an appropriate manner.

10.1.2.7 Final Radiation Survey

A final radiation survey must be performed to verify proper decontamination to allow the site to be released for unrestricted use. The evaluation of the final radiation survey is based in part on an initial radiation survey performed prior to initial operation. The initial survey determines the natural background radiation of the area; therefore, it provides a datum for measurements that determine any increase in levels of radioactivity.

The final survey will systematically measure radioactivity over the entire site. The intensity of the survey will vary depending on the location (such as, the buildings, the immediate area around the buildings, and the remainder of the site). The survey procedures and results will be performed in accordance with current NRC guidance. The results will be analyzed and shown to be below allowable residual radioactivity limits; otherwise, further decontamination will be performed.

10.1.3 Management and Organization

An appropriate organizational strategy will be developed to support the decommissioning schedule. The organizational strategy will ensure that adequate numbers of experienced and knowledgeable personnel are available to perform the technical and administrative tasks required to decommission the facility.

Management of the decommissioning program will assure proper training and procedures are provided to assure worker health and safety. The programs will focus on minimizing waste volumes and worker exposure to hazardous or radioactive materials. Qualified contractors assisting with decommissioning will be subject to GLE security and training requirements and procedural controls.

10.1.4 Health and Safety

Consistent with the policy during operation of the GLE Commercial Facility, the policy during decommissioning shall be to keep individual and collective occupational radiation exposures ALARA. The Radiation Protection (RP) Program will identify and control sources of radiation, establish worker protection requirements, and direct the use of survey and monitoring instruments. The Nuclear Criticality Safety (NCS) function will continue to ensure that special nuclear material (SNM) is safely processed, packaged, and stored. Items Relied on for Safety (IROFS) will be maintained during decommissioning, until such a time that they are deemed unnecessary, at which point GLE will follow the change process identified in Chapter 11, *Management Measures*, for their removal. Similarly, management measures implemented to ensure the reliability and availability of IROFS shall be maintained until they are no longer necessary.

10.1.5 Waste Management

Radioactive and hazardous wastes produced during decommissioning will be collected, handled, and disposed of in accordance with regulations applicable to the GLE Commercial Facility at the time of decommissioning. Generally, procedures will be similar to those described for wastes produced during operation. These wastes will ultimately be disposed of in licensed radioactive, or hazardous waste disposal facilities. Non-hazardous and nonradioactive wastes will be disposed of consistent with good industrial practice, and in accordance with applicable regulations.

10.1.6 Security and Nuclear Material Control

Requirements for information/physical security and for nuclear MC&A will be maintained during decommissioning in a manner similar to the programs in force during operation of the GLE Commercial Facility. The DP submitted near the end of facility life will provide a description of necessary revisions to these programs and associated plans.

10.1.7 Recordkeeping

Records important for safe and effective decommissioning of the GLE Commercial Facility are maintained in accordance with the Records Management procedural requirements and the regulatory requirements of 10 CFR 70.25(g). Information maintained in these records include:

- Records of spills or other unusual occurrences involving the spread of contamination in and around the facility, equipment, or site. Records of spills or other unusual occurrences may be limited only to instances when contamination remains after cleanup procedures or when there is reasonable likelihood that contaminants may have spread to inaccessible areas as in the case of possible seepage into porous materials such as concrete. These records will include known information on identification of involved radionuclides, quantities, forms, and concentrations.

- As-built drawings and modifications of structures and equipment in areas where radioactive materials are used or stored, including locations that may be inaccessible (such as, buried pipes which may be subject to contamination).

- A list contained in a single document that is updated every two years of the following:

  - Areas designated, and formerly designated, as Restricted Areas as defined under 10 CFR 20.1003, *Definitions (Ref. 10-14)*,

  - Areas outside of Restricted Areas that require documentation under 10 CFR 70.25(g)(1),

  - Areas outside of restricted areas where current and previous wastes have been buried as documented under 10 CFR 20.2108, *Records of Waste Disposal (Ref. 10-15)*, and

  - Areas outside of Restricted Areas that contain material such that, if the license expired, GLE would be required to either decontaminate the area to meet the criteria for decommissioning in 10 CFR 20, Subpart E, *Radiological Criteria for License Termination (Ref. 10-16)*, or would apply for NRC approval for disposal under 10 CFR 20.2002, *Method for Obtaining Approval of Proposed Disposal Procedures (Ref. 10-17)*.

- Records of the cost estimate performed for the DFP, and records of the funding method used for assuring funds, including a copy of the financial assurance mechanism and supporting documentation.

10.1.8 Decontamination

10.1.8.1 Overview

The actual decontamination method or methods to be used to decontaminate and decommission the GLE Commercial Facility will be established based upon the site characterization survey performed during the decommissioning planning and preparation phase, and will be described in detail in the DP to be submitted to the NRC prior to commencing decommissioning activities. GLE will call upon past experience and lessons learned from previous decommissioning efforts to effectively and efficiently decontaminate the GLE Commercial Facility. Steps for decontamination typically include: removing surface contamination on equipment and building internals and purging lines to remove SNM "holdup."

At the end of useful facility life, some of the equipment, most of the buildings, and the outdoor areas are expected to be acceptable for release for unrestricted use in accordance with 10 CFR 20.1402. If these areas were inadvertently contaminated during enrichment operations, they would likely be cleaned up when the contamination is discovered. This limits the scope of necessary decontamination at the time of decommissioning.

10.1.8.2 Facilities

Decontamination will be accomplished in existing facility areas. The Decontamination/Maintenance Area will be used for decontamination of large and small pieces of equipment, and to package radioactive wastes prior to temporary storage or shipment to a license disposal facility.

10.1.8.3 Procedures

Procedures for decontamination will be developed and approved by GLE Commercial Facility management in accordance with the management measures described in GLE LA Chapter 11. The goal of the procedures will be to minimize worker exposure and waste volumes, and to assure work is carried out in a safe manner.

10.1.8.4 Results

Recoverable items will be externally decontaminated and suitable for reuse except for a small amount of internally contaminated items where recovery and reuse is not feasible. There is potentially a small amount of salvageable scrap material. Material requiring disposal will be process piping, trash, and residue from the effluent treatment systems. There are no anticipated problems that will prevent the facilities from being released for unrestricted use.

Although decommissioning operations are planned to be underway while the activities considered in the Integrated Safety Analysis (ISA) continue to occur in the other portions of the facility, the current ISA has not considered these decommissioning risks. An updated ISA will be performed at a later date, but prior to decommissioning, to incorporate the risks from decommissioning operations.

10.2 DECOMMISSIONING COSTS AND FINANCIAL ASSURANCE

10.2.1 Facility Decommissioning Cost Estimate

This section provides a general description of decommissioning costs and explains the arrangements made to assure funding is available to cover these costs. A more detailed description of these costs is provided in the DFP.

10.2.1.1 Summary of Costs

Table 10-1, *Total Decommissioning Costs*, provides a summary of the cost estimate for the decommissioning of the GLE Commercial Facility. Costs are provided in FY 2009 dollars with a 25 percent contingency factor added based on the NRC guidance in NUREG-1757. Since costs will likely change between the time of license issuance and actual decommissioning, GLE will adjust the cost estimate no less frequently than every three years consistent with the requirements of 10 CFR 70.25(e). The method for adjusting the cost estimate will consider the following:

- Changes in general inflation (such as, labor rates, consumer price index),
- Changes in price of goods (such as, packing materials),
- Changes in price of services (such as, shipping and disposal costs),
- Changes in facility condition or operations,
- Changes in decommissioning technologies and equipment, and
- Changes in decommissioning procedures or regulations.

The elements of the decommissioning cost estimate are explained below.

10.2.1.1.1 Planning and Preparation

Activities anticipated during this phase include:

- Development of the project execution plan and schedule (including the organization and staffing plan and needed services);
- Development and submittal of the DP;
- Development and implementation of the site characterization plan;
- Review and approval of the DP by the NRC; and
- Development of the decommissioning procedures.

10.2.1.1.2 Decontamination and/or Dismantling of Radioactive Facilities

This is based upon utilizing salary and hourly workers at their respective average cost over a five-year duration. Estimated decommissioning costs are based on decontaminating the facility to the radiological criteria for unrestricted use in 10 CFR 20.1402. Activities anticipated during this phase include:

- Internal decontamination of facilities
- Dismantling equipment to include waste segregation and staging,
- Dismantling facilities and components, and
- Tails cylinder movement/disposition to include material transfer to DOE, or to a commercial DUF_6 conversion facility, should one become available.

10.2.1.1.3 Restoration of Contaminated Areas on Facility Grounds

No facility grounds contamination is anticipated because routine radiological surveys will detect contamination and remove it. If an accidental release of radiological material was to occur and the facility grounds were contaminated to an extent that decontamination during operations is not feasible, the DFP will be updated to include remediation costs to be incurred during final decommissioning.

10.2.1.1.4 Final Radiation Survey

Activities anticipated during this phase include:

- Development and implementation of survey plans,
- Collection and analyzing data,
- Performance of confirmatory surveys,
- Development of final survey report, and
- Preparation of a License Amendment to terminate the license.

10.2.1.1.5 Site Stabilization and Long-Term Surveillance

Site stabilization and long-term surveillance (that is, institutional controls) will not be required because the site will be released for unrestricted use. Costs associated with maintaining site controls after GLE Commercial Facility operations cease, but before license termination, are contained in other aspects of the facility decommissioning cost estimate. These costs include critical programs such as NCS, RP, Environmental Monitoring, MC&A, and IROFS maintenance.

10.2.1.1.6 Packing Material, Shipping, and Waste Disposal

This is based upon shipping and disposal of the cascade components, feed and withdrawal equipment, and other components totaling approximately 560,760 cubic feet of solid waste and 103,000 cubic feet of classified waste. The packaging cost includes over 560 Sealand containers.

10.2.1.1.7 Equipment and Supplies

This includes the purchase or lease of decontamination equipment and chemicals, small tools, RP supplies, safety equipment, and survey equipment.

10.2.1.1.8 Laboratory

This includes labor costs for sampling, transport, testing, and analysis of samples.

10.2.1.1.9 Miscellaneous

This includes NRC review and inspection fees for the approved DP, license fees, business insurance, utility fees, security fees, administrative/computer supplies, worker training costs, and taxes.

10.2.1.2 Major Assumptions

Key assumptions underlying the decommissioning cost estimate are listed below:

- The facility will be decontaminated such that it is acceptable for unrestricted release;
- Costs are not included for the removal or disposal of nonradioactive structures and materials beyond that necessary to terminate the NRC license;
- Credit is not taken for salvage value that may be realized from the sale of potential assets;
- Decommissioning activities will be performed in accordance with current day regulatory requirements; and
- Decommissioning costs are presented in FY 2009 dollars.

10.2.1.3 Adjusting Decommissioning Costs and Funding

In accordance with 10 CFR 40.36(d), *Financial Assurance and Recordkeeping for Decommissioning (Ref. 10-18)* and 10 CFR 70.25(e), GLE will update the decommissioning cost estimate and the associated funding levels over the life of the facility. These updates will take into account changes resulting from inflation or site-specific factors, such as changes in facility conditions or expected decommissioning procedures. These funding level updates will also address accumulated tails.

As required by the applicable regulations 10 CFR 70.25(e), such updating will occur no less frequently than every three years. A record of the update process and results will be retained for review as discussed in Section 10.2.3, *Financial Assurance*. The NRC will be notified of material changes to the decommissioning cost estimate and associated funding levels (for example, a significant increase in costs beyond anticipated inflation). To the extent the underlying instruments are revised to reflect changes in funding levels, the NRC will be notified as appropriate.

10.2.1.4 Recordkeeping Plans Related to Decommissioning Funding

In accordance with 10 CFR 70.25(g), GLE will retain records, until the termination of the license, of information that may have a material effect on the ultimate costs of decommissioning. These records will include information regarding: (1) spills or other contamination that cause contaminants to remain following cleanup efforts; (2) as-built drawings of structures and equipment, and modifications thereto, where radioactive contamination exists (such as, from the use or storage of such materials); (3) original and modified cost estimates of decommissioning; and (4) original and modified decommissioning funding instruments and supporting documentation.

10.2.2 Depleted Uranium Disposition

UF_6 tails are stored in standard cylinders until they can be processed in accordance with the disposal strategy established by GLE. Depending on technological developments and the existence of facilities available prior to GLE shutdown, the tails may have commercial value and may be marketable for further enrichment or other processes. However, for the purposes of calculating the UF_6 tails' disposition cost, GLE assumes that the total quantity of tails generated during operation are processed by the DOE UF_6 conversion facilities in Piketon, Ohio or Paducah, Kentucky.

As with facility decommissioning, the cost estimate will likely change between the time of license issuance and actual decommissioning. GLE commits to adjust the cost estimate for UF_6 tails disposal annually. The method for adjusting the cost estimate will consider the same factors as previously described in Section 10.2.1.3 of this chapter. At full capacity, GLE will generate approximately 10,500 MT of UF_6 tails annually. As with other decommissioning costs, the disposal cost estimate for UF_6 tails disposal is provided in FY 2009 dollars. The total estimated cost to dispose of UF_6 tails over the 40-year license, including a six-year ramp up to full capacity and the 25 percent contingency factor, is approximately $2.4 billion. The basis for this estimate is provided in the DFP. As described in GLE LA Chapter 1, GLE is requesting an appropriate exemption to incrementally fund the disposition of DUF_6 tails. In this manner, financial assurance will be available when needed and will be made available as the decommissioning liability is incurred.

10.2.3 Financial Assurance

GLE presently intends to utilize a surety instrument to provide reasonable assurance of decommissioning funding, pursuant to 10 CFR 70.25(f). At least six months prior to startup, GLE will provide NRC the financial assurance instrument that GLE intends to execute. Upon finalization of the specific funding instruments to be utilized and at least 21 days prior to the commencement of enrichment operations, GLE will supplement its application to include the signed, executed documentation.

The surety bond will provide an ultimate guarantee that decommissioning costs will be paid in the unexpected event GLE is unable to meet its decommissioning obligations at the time of decommissioning. A copy of a model surety bond is provided in the DFP, Appendix A.

With respect to the surety bond, GLE presently anticipates providing for the following attributes: First, a company that is listed as a qualified surety in the Department of Treasury's most recent edition of Circular 570 for the State where the surety was signed with an underwriting limitation greater than or equal to the level of coverage specified in the bond will issue the bond. Second, the bond will be written for a specified term and will be renewable automatically unless the issuer serves notice at least 90 days prior to expiration of intent not to renew. Such notice must be served upon the NRC, the trustee of the external or standby trust, and GLE. Further, in the event GLE is unable to provide an acceptable replacement within 30 days of such notice, the full amount of the bond will be payable automatically, prior to expiration, without proof of forfeiture. The surety bond will require that the surety company will deposit any funds paid under its terms directly into either an external trust or a standby trust.

10.3 REFERENCES

10-1 10 CFR 20.1406, *Minimization of Contamination*, U.S. Nuclear Regulatory Commission, 2008.

10-2 10 CFR 70.25, *Financial Assurance and Recordkeeping for Decommissioning*, U.S. Nuclear Regulatory Commission, 2008.

10-3 NUREG-1757, *Consolidated Decommissioning Guidance*, U.S. Nuclear Regulatory Commission, September 2006.

10-4 10 CFR 20.1401, *General Provisions and Scope*, U.S. Nuclear Regulatory Commission, 2008.

10-5 10 CFR 20.1402, *Radiological Criteria for Unrestricted Use*, U.S. Nuclear Regulatory Commission, 2008.

10-6 10 CFR 70.38, *Expiration and Termination of Licenses and Decommissioning of Sites and Separate Buildings or Outdoor Areas*, U.S. Nuclear Regulatory Commission, 2008.

10-7 10 CFR 20.1904, *Labeling Containers*, U.S. Nuclear Regulatory Commission, 2008.

10-8 10 CFR 20.1905, *Exemptions to Labeling Requirements*, U.S. Nuclear Regulatory Commission, 2008.

10-9 10 CFR 20.1906, *Procedures for Receiving and Opening Packages*, U.S. Nuclear Regulatory Commission, 2008.

10-10 10 CFR 20, Subpart K, *Waste Disposal*, U.S. Nuclear Regulatory Commission, 2008.

10-11 10 CFR 20, *Standards for Protection Against Radiation*, U.S. Nuclear Regulatory Commission, 2008.

10-12 49 CFR, *Transportation*, Office of the Secretary of Transportation, 2008.

10-13 10 CFR 95, *Facility Security Clearance and Safeguarding of National Security Information and Restricted Data*, U.S. Nuclear Regulatory Commission, 2008.

10-14 10 CFR 20.1003, *Definitions*, U.S. Nuclear Regulatory Commission, 2008.

10-15 10 CFR 20.2108, *Records of Waste Disposal*, U.S. Nuclear Regulatory Commission, 2008

10-16 10 CFR 20, Subpart E, *Radiological Criteria for License Termination*, U.S. Nuclear Regulatory Commission, 2008.

10-17 10 CFR 20.2002, *Method for Obtaining Approval of Proposed Disposal Procedures*, U.S. Nuclear Regulatory Commission, 2008.

10-18 10 CFR 40.36, *Financial Assurance and Recordkeeping for Decommissioning*, U.S. Nuclear Regulatory Commission, 2008.

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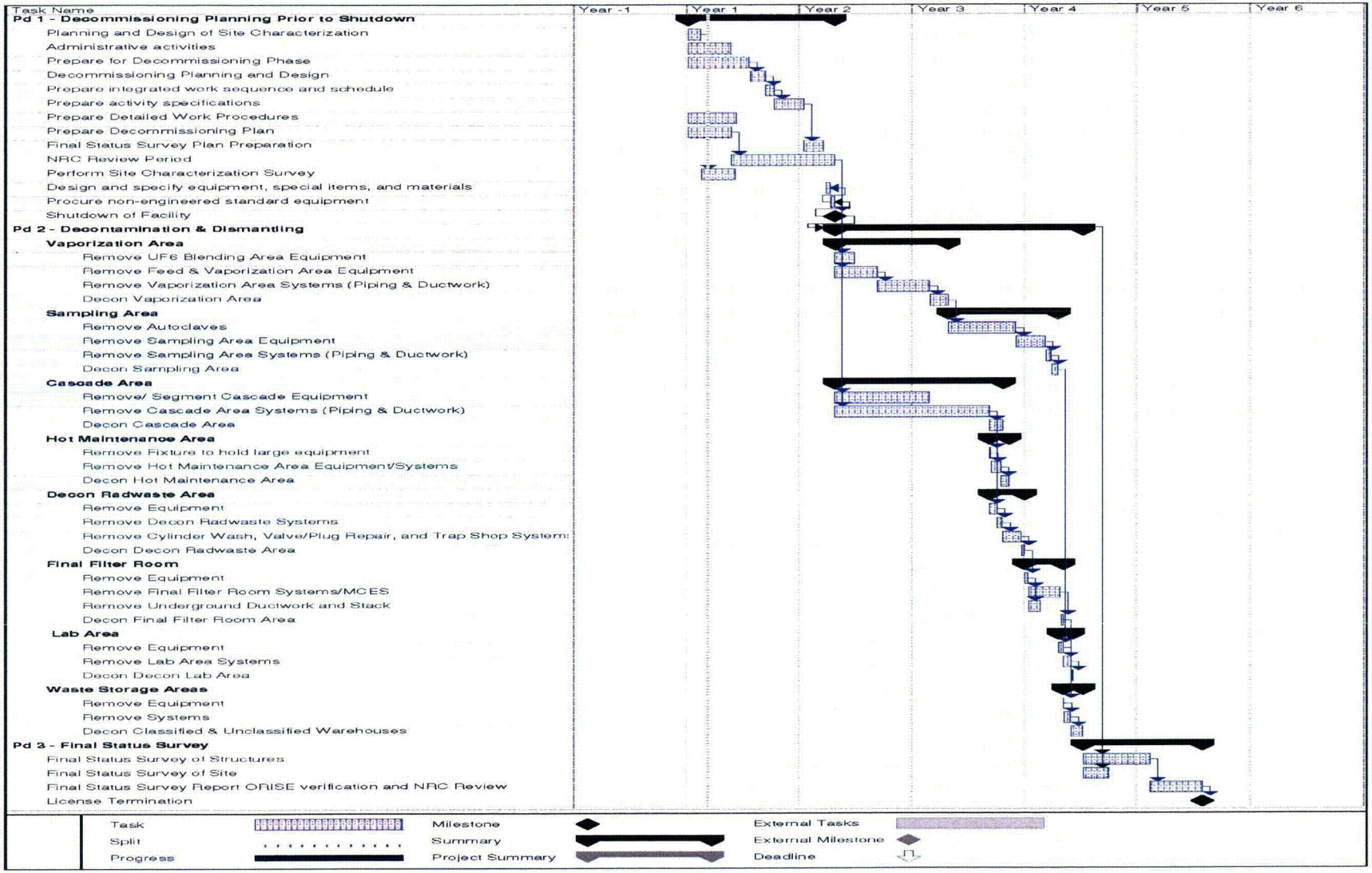
Table 10-1. Total Decommissioning Costs.

Task/Component	Cost ($000)	Percentage
Planning and Preparation	$5,484	3.9%
Decontamination and/or Dismantling of Radioactive Facility Components	$26,186	18.6%
Restoration of Contaminated Areas on Facility Grounds	$0	0.0%
Final Radiation Survey	$9,441	6.7%
Site Stabilization and Long-Term Surveillance	$0	0.0%
Packing Material	$139	0.1%
Shipping	$13,053	3.2%
Waste Disposal	$65,508	46.5%
Equipment and Supplies	$13,121	9.3%
Laboratory	$689	0.5%
Miscellaneous	$15,913	11.3%
SUBTOTAL	$149,534	100.0%
25% Contingency (Facility)	$37,384	
TOTAL	**$186,918**	
UF_6 Tails Disposal	$2,427,25	
25% Contingency (UF_6 Tails)	$606,815	
UF_6 Tails Disposal Total	**$3,034,073**	
GRAND TOTAL	**$3,220,991**	

Figure 10-1. Decommissioning Schedule.



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11. MANAGEMENT MEASURES

This chapter describes the management measures established by GE-Hitachi Global Laser Enrichment LLC (GLE) that are applied to Items Relied on for Safety (IROFS). GLE commits to apply management measures to IROFS on a continuing basis to provide reasonable assurance that IROFS are available and able to perform their intended functions when needed. Implementation of the management measures ensures the GLE Commercial Facility can be operated safely, and provides adequate protection of the workers, the public, and the environment from credible hazards presented in the Integrated Safety Analysis (ISA).

The GLE management measures provide oversight and assurance that the GLE Safety Program is maintained and functions properly. GLE applies management measures in a graded approach based on unmitigated risks as described in the ISA Summary. According to criteria defined in approved written procedures, the relative importance of an IROFS is determined using both the severity of consequence and unmitigated likelihood of an initiating event. Based on the assigned importance, the appropriate type and number of management measures are assigned to assure the IROFS are functional when needed.

11.1 CONFIGURATION MANAGEMENT

The objective of the Configuration Management (CM) Program is to ensure the information used to design, construct, operate, and maintain IROFS is current. Safety controls (IROFS) are structures, systems, and components (SSCs) and procedures that prevent or mitigate the risk of credible accidents. The elements of the CM Program provide consistency among the GLE Commercial Facility design and operations, physical configuration, and documentation.

11.1.1 Configuration Management Policy

GLE commits to maintain a formal CM Program in accordance with 10 CFR 70.72, *Facility Changes and Change Process (Ref. 11-1)*. The CM process is implemented by approved written procedures and ensures that changes from the GLE Commercial Facility Technical Design Baseline are identified and controlled. The CM Program includes the following activities:

- Maintenance of facility design information,
- Identification of IROFS,
- Control of information used to operate and maintain the facility,
- Documentation of changes,
- Assurance of adequate safety reviews for changes, and
- Periodic performance assessment of specific safety controls to ensure conformance to design basis documentation.

The level of CM applied to the SSCs, processes, equipment, software, and personnel activities is based on the associated quality level (QL) designation. QLs are defined in GLE license application (LA) Section 11.8.2, *Quality Assurance Program.*

The CM Program is managed by the CM Manager. During design and construction, the CM Manager reports to the Commercial Facility Project Manager (CFPM). During the operational phase, the CM Manager reports to the Operations Manager. See GLE LA Chapter 2, *Organization and Administration*, for additional information on the GLE organization.

During the design phase, CM is based on the design control, and associated procedural controls, to establish and maintain the Technical Design Baseline. Design documents, including the ISA, provide design input, analysis, and/or results specifically for IROFS. Design documents undergo interdisciplinary review prior to initial issue and during each subsequent revision. During the construction phase of the project, changes to drawings and specifications issued for construction, procurement, or fabrication are systematically reviewed, verified, evaluated for impact (including impact to the ISA), and approved prior to implementation. Proper implementation is verified and reflected in the design basis documentation.

In order to provide continued safe and reliable operation of GLE Commercial Facility SSCs, controls are implemented to ensure the quality of the SSCs is not compromised by planned changes (modifications). The following items are addressed prior to implementing a facility change:

- Technical basis for the change,
- Impact on safety, health, and control of licensed material,
- Required modifications to existing procedures, to include any necessary training prior to operation,
- Authorization requirements for the change,
- For temporary changes, the approved duration (expiration date) of the change, and
- Impacts or modifications to the ISA, ISA Summary, and any other component of the overall safety program.

11.1.2 Design Requirements

Procedures define the development, application, and maintenance of the design specifications and requirements. Design requirements are developed to support safety functions, environmental impact-oriented functions, and mission-based functions. IROFS identified in the ISA Summary and design documents, are maintained current as IROFS and are identified in more detail during the final design. Design requirements for IROFS and other SSCs are developed with the baseline design criteria defined in 10 CFR 70.64, *Requirements for New Facilities or New Processes at Existing Facilities (Ref. 11-2).* The design requirements to support the IROFS and other SSCs are developed by the Engineering Organization and documented in design documents. Prior to approval, the design documents are reviewed to determine adequacy, accuracy, and completeness. After approval, the design documents and

the ISA Summary provide the Technical Design Baseline for the facility. Design documents and the ISA are controlled documents. Changes to design documents or the ISA are subject to the Change Control Process. See GLE LA Section 11.8.3, *Design Control*, for additional information on the Design Control Process.

11.1.3 Document Control

Document Control, as defined in approved written procedures, includes creation, revision, storage, tracking, distribution, and retrieval of applicable information, to include, but not limited to, manuals, instructions, drawings, procedures, design documents, specifications, plans, and other documents that pertain to the CM function. Procedures are established to control the life-cycle of documents. Appropriate measures have been established to ensure documents are adequately reviewed, approved, and released for use by authorized personnel.

Document control is implemented in accordance with approved written procedures. An electronic document management system (EDMS) is used to file project records and to make available the latest revision (that is, the controlled copy) of controlled documents. Indices of controlled documents, which are uniquely numbered (including revision number), are maintained and available to affected personnel. Controlled documents are maintained in the EDMS until cancelled or superseded. A cancelled or superseded controlled document continues to be maintained as a record. Hardcopy distribution of controlled documents is provided when needed in accordance with approved written procedures (for example, when the EDMS is not available or the complexity of a task requires that the procedure be in-hand).

11.1.4 Change Control

GLE maintains approved written procedures describing the CM process for controlling design changes, including approval to install facility, process, or equipment design changes. Per approved written procedures, a trained safety reviewer is required to review and approve changes to controlled documents to determine if the ISA is impacted by the proposed change. If there is an impact to the ISA, the change is flagged for review and approval by an ISA team in accordance with the process described in the ISA Summary. Approved written procedures also detail the controls and define the distinction between types of changes, ranging from a replacement with an identical design authorized as part of normal maintenance, to new or different designs which require specified review and approval.

During the design phase the method of ensuring consistency between documents, including consistency between design changes and the ISA, is the interdisciplinary review process. When the project enters the construction phase, changes to documents issued for construction, fabrication, and procurement are documented, reviewed, approved, and posted against each affected design document. Vendor drawings and data also undergo an interdisciplinary review to ensure compliance with procurement specifications and drawings, and to incorporate interface requirements into controlled documents.

During the operations phase, changes to design are documented, reviewed, and approved prior to implementation. GLE's change process fully implements the provisions of 10 CFR 70.72. Measures are provided to ensure responsible facility personnel are made aware of design changes and modifications that may affect the performance of their duties. After completion of a modification to a SSC, the appropriate area manager, or designee, shall ensure that applicable testing has been completed to ensure correct operation of the system(s) affected by the modification and documentation regarding the modification is complete. In order to ensure operators are able to operate a modified system safely, when a modification is complete, necessary documents (such as, the revised process description, checklists for operation and flow sheets) are made available to the Operations and Maintenance Organizations once the modified system becomes "operational." Appropriate training on the modification is completed prior to the system being placed in operation. A formal notice of a modification being completed is distributed to appropriate managers. As-built drawings incorporating the modification are completed promptly. These records shall be identifiable and retained for the duration of the facility license.

11.1.5 Assessments

Planned internal and independent assessments are performed to evaluate the application and effectiveness of management measures and implementation of programs related to facility safety. Periodic assessments of the CM Program are conducted to determine the programs effectiveness and correct any identified deficiencies. These assessments include review of documentation and system walk downs of the as-built facility. CM assessments are performed, at a minimum, on an annual basis.

11.2 MAINTENANCE

The purpose of planned and scheduled maintenance of IROFS is to assure systems are kept in a condition of readiness to perform designed functions when required. Area managers are responsible for assuring the operational readiness of safety controls in assigned areas of the GLE Commercial Facility.

The Maintenance function utilizes a systems-based program to plan, schedule, track, and maintain records for maintenance activities. Maintenance procedures and instructions are an integral part of the Maintenance Program. Maintenance procedures are described in GLE LA Section 11.4, *Procedures*. Key maintenance requirements for safety controls, such as calibration, functional testing, and replacement of specified components, are derived from the analyses described in the ISA Summary.

The selection and qualification of Maintenance personnel is documented and implemented through approved written procedures. Contractors working on or performing activities that could affect IROFS are required to follow the same procedures as Maintenance personnel. Maintenance activities generally fall into one of the four categories described below.

11.2.1 Corrective Maintenance

Corrective maintenance refers to situations where repairs, replacements, or major adjustments such as re-calibration occur. GLE commits to promptly perform corrective actions to remediate unacceptable performance deficiencies in IROFS. The Maintenance Planning and Control System provides documentation and records of SSCs that have been repaired or replaced. When a component of a specified safety control is repaired or replaced, the component is functionally verified via post-maintenance testing to ensure it has the capability to perform the planned and designed function when called upon to do so. If the performance of a repaired or replaced safety control could be different from that of the original component, the change to the safety control is specifically approved under the CM Program and preoperationally tested to ensure it will perform its desired function when called upon to do so.

11.2.2 Preventive Maintenance

Preventive maintenance (PM) is performed on a periodic basis to prevent failures, facilitate performance, and maintain or extend the life of equipment. PMs help ensure IROFS are available and reliable. The bases for PM tasks are developed through a review of manufacturer recommendations, available industry standards, and historical operating information, where available. PMs are included in the work control process to facilitate planning, scheduling, and execution of these tasks.

Establishment of a PM task is coordinated by the Maintenance Organization and requires input from various disciplines within the Engineering and Operations Organizations. The formal documented bases for the tasks are developed, evaluated, and approved by the Engineering Organization. PM tasks may be changed, new tasks added or deleted, and recommendations made by Operations, Maintenance, or Engineering personnel. Feedback from PM, corrective maintenance, and incident investigations is used, as appropriate, to modify the frequency or scope of a PM activity. Specifically, preventive measures to alleviate premature

failure may be added to the PM activity, or a reduction in frequency of a particular PM due to as-found conditions indicating that the PM is occurring more often than necessary.

After conducting PM on IROFS, and prior to returning an IROFS to operational status, functional testing of the SSC, if necessary, is performed to ensure the IROFS performs its intended safety function. Records pertaining to PM are maintained in accordance with the Records Management (RM) System.

11.2.3 Surveillance and Monitoring

The ISA Summary identifies the IROFS that are to be available and reliable to perform their design function for the prevention or mitigation of credible events. The Surveillance and Monitoring Program provides a periodic check of the ability of IROFS to perform their design safety function when called upon to do so. Surveillances are in the form of performance checks, calibrations, tests, and inspections.

GLE utilizes active engineered controls that are integrated into routine operations to the degree practical. The IROFS are monitored as a routine part of the operating process. IROFS associated with passive engineered systems are typically fixed physical design features to maintain safe process conditions. Availability and reliability of IROFS is maintained through preoperational audits and periodic verifications as prescribed in the ISA, and includes consideration of the importance of the IROFS as well as available quality and reliability information. IROFS relying on geometry-based controls, where the geometry is subject to undetected change in routine operation, are periodically verified on a schedule commensurate with the potential for change in the parameters of interest.

Surveillances are included in the work control process to permit timely planning, scheduling, establishment of system or facility conditions, execution of the activity, and creation of documentation that identifies the results of the surveillance. The established frequencies are determined by the IROFS degree of safety importance. The results of surveillance activities are trended to support the determination of performance trends for IROFS. When potential performance degradation is identified, PM frequencies are adjusted or other corrective actions are taken as appropriate.

Incident investigations may identify the root cause of a failure that is related to the type or frequency of maintenance. The lessons learned from such investigations are factored into the Surveillance and Monitoring Program and the PM Program, as appropriate. Maintenance procedures prescribe compensatory measures, if appropriate, for surveillance tests of IROFS that can only be performed while equipment is out of service.

11.2.4 Functional Testing

Functional testing of IROFS is performed as appropriate, following initial installation as part of periodic surveillance testing and after corrective maintenance, PM, or calibration to ensure that the item is capable of performing the designed safety function when required. GLE commits to perform functional tests in accordance with approved written procedures that define the method for the test and the required acceptable results. The results of the tests are recorded and maintained.

Administrative controls that are identified as IROFS are documented in approved written procedures. Administrative controls are assured to be available and reliable during operations by applying the applicable management measures described in this LA Chapter, including the use of procedures and the employee training programs. See GLE LA Section 11.3, *Training and Qualifications*, and Section 11.4 for additional information on how these management measures are applied to administrative controls.

11.2.4.1 Preoperational Testing

Preoperational testing at the facility consists of testing conducted to initially determine various facility parameters and to initially verify the capability of SSCs to meet performance requirements. The major objective of preoperational testing is to verify that IROFS, essential to the safe operation of the facility, are capable of performing their intended function. Initial startup testing is performed beginning with the introduction of uranium hexafluoride (UF_6) and ending with the startup. The purpose of initial startup testing is to ensure safe and orderly UF_6 feeding, and to verify parameters assumed in the ISA. Records of the preoperational and startup tests required prior to operation are maintained. These records include testing schedules and results for IROFS.

11.2.4.2 Post-Maintenance Testing

Post-maintenance testing (PMT) is established to provide assurance that IROFS will perform their intended function following maintenance activities. This test confirms the maintenance performed was satisfactory, the identified deficiency has been corrected, and the maintenance activity did not adversely affect the reliability of the item. This test is performed, with acceptable results, prior to returning the equipment to service.

PMT requirements are developed and included in work packages during the work planning process. The Engineering Organization may provide support to the Operations and Maintenance Organizations in identifying PMT requirements. The PMT meets applicable codes and technical requirements and specifies acceptance criteria. The results of the PMT are documented and retained in the work package with other documentation generated during the maintenance evolution.

11.3 TRAINING AND QUALIFICATIONS

The Training Program is designed to ensure personnel who perform activities relied on for safety have the applicable knowledge and skills necessary to design, operate, and maintain the GLE Commercial Facility in a safe manner. Performance-based training is used for analyzing, designing, developing, conducting, and evaluating training. Personnel are trained and tested as necessary to ensure they are qualified on practices important to public and worker safety, safeguarding licensed material, and protection of the environment. Exceptions from training requirements may be granted when justified and documented in accordance with approved written procedures and approved by the appropriate level of management.

11.3.1 Organization and Management of the Training Function

Training Programs for personnel who perform activities relied on for safety, are provided through shared responsibility between the Environmental, Health, and Safety (EHS) disciplines and line management. Line managers are responsible for the content and effective conduct of training for assigned personnel. Training responsibilities for line managers are included in position descriptions, and line managers are given the authority to implement training for assigned personnel. The GLE Training function provides support to line management. Performance-based training is used as the primary management tool for analyzing, designing, developing, conducting, and evaluating training. Area managers are responsible for the content and effective conduct of training for Operations personnel.

Approved written procedures establish the requirements for indoctrination and training of personnel performing activities relied on for safety and ensures the Training Program is conducted in a reliable and consistent manner. Lesson plans or training guides are used for classroom and on-the-job training (OJT) to provide a consistent subject matter. When design changes or facility modifications are implemented, updates of applicable lesson plans are included in the change control process of the CM Program. Personnel may be exempt from training if an individual's prior training, qualifications, and job performance history provides information demonstrating that the individual has achieved the necessary required skills. Exemptions from training shall be documented and approved by management.

Training records are maintained to support management information needs associated with personnel training, job performance, and qualifications. Training records are retained in accordance with RM approved written procedures.

11.3.2 Types of Required Training

Training is provided for each individual at the GLE Commercial Facility, commensurate with assigned roles and responsibilities. Training and qualification requirements are met prior to personnel fully assuming the duties of safety-significant positions, and before assigned tasks are independently performed.

The objective of the Training Program is to ensure safe and efficient operation of the facility and ensure compliance with applicable regulatory requirements. Training requirements shall be applicable to, but not restricted to, those personnel who have a direct relationship to the operation, maintenance, testing, or other technical aspects of IROFS.

Contractor personnel shall meet the minimum training and qualification requirements. The line manager responsible for the contracted activity shall verify contractor training. The Radiological Contingency and Emergency Plan (RC&EP) provides additional information on personnel training for emergency response activities. Training courses are kept up-to-date to reflect facility modifications and changes to procedures when applicable.

- Required training may be grouped into one of five categories:
- General Employee Training (GET),
- Nuclear Safety Training,
- Industrial Safety Training,
- Technical Training, and
- Professional Development.

These categories of training are discussed in the following sections. Specific training requirements associated with the Emergency Response Organization (ERO) are addressed in the RC&EP.

11.3.2.1 General Employee Training

GET encompasses those Quality Assurance (QA), Radiation Protection (RP), Industrial Safety, Environmental Protection, Security and Emergency Response, and administrative procedures established by management and in accordance with applicable regulations. The Industrial Safety Training complies with 29 CFR 1910, *Occupational Safety and Health Standards (Ref. 11-3)*, and 10 CFR 19, *Notices, Instructions, and Reports to Workers: Inspection and Investigations (Ref. 11-4)*. Continuing training is conducted in these areas, as necessary, to maintain proficiency. All personnel (including contractors) must participate in GET. However, certain support personnel, depending on normal work assignment, may not participate in all topics of GET. Temporary maintenance and service personnel receive GET to the extent necessary to assure safe execution of assigned duties. Certain portions of GET may be included in New Employee Orientation. GET topics are listed below:

- General administrative controls and procedures and their use,
- QA policies and procedures,
- Nuclear safety (criticality and radiological),
- Industrial safety,
- RC&EP and implementing procedures associated with alarm response and evacuation,
- Fire protection and fire brigade,
- New employee orientation, and
- Environmental Protection.

11.3.2.2 Nuclear Safety Training

Training Programs are established for various job functions (for example, operations, RP technicians, contractor personnel) commensurate with criticality and RP responsibilities. Visitors to Radiological Controlled Areas (RCAs) are trained in the formal Training Program or are escorted by trained personnel.

Formal nuclear safety training includes information about radiation and radioactive materials, risks involved in receiving low-level radiation exposure in accordance with 10 CFR 19.12, *Instruction to Workers (Ref. 11-5)*, basic criteria and practices for RP, nuclear criticality safety (NCS) principles in conformance with applicable objectives contained in the American National Standards Institute (ANSI)/American Nuclear Society (ANS) 8.19-2005, *Administrative Practices for Nuclear Criticality Safety (Ref. 11-6)*, and ANSI/ANS 8.20-1991, *Nuclear Criticality Safety Training (Ref. 11-7)*.

The training policy requires employees to complete nuclear safety training prior to unescorted access in an RCA. Methods for evaluating the understanding and effectiveness of the training include passing an initial examination covering formal training contents and observations of operational activities during scheduled audits and inspections. Such training is typically computer based training, but may be performed by authorized instructors. The Training Program contents are reviewed on a scheduled basis by the NCS and RP functions to ensure the Training Program contents are current and adequate. Previously trained employees who are allowed unescorted access to an RCA are retrained annually at a minimum. The effectiveness of the Training Program is evaluated by either an initial training exam or a re-training exam. Visitors are trained commensurate with the scope of their visit and/or are escorted by trained employees.

11.3.2.3 Industrial Safety Training

Orientation of new or transferred employees to industrial safety is an important part of establishing the proper safety attitude among GLE employees, and insuring employees are aware of safety procedures, rules, and hazards involved in assigned duties. New employee orientation may include, as appropriate, the review of:

- Occupational Safety and Health Administration (OSHA) General Duty Clause,
- Employee/Employer Responsibilities,
- General Site Safety Rules,
- Hazard Communication Training,
- Fire Extinguisher Training,
- Emergency Evacuation Procedure,
- Job Hazards Analysis (JHA) and Chemical Job Hazards Analysis (CJHA), and
- Lockout/Tagout Awareness.

11.3.2.4 Technical Training

Technical training is designed, developed, and implemented to assist Operations and Maintenance personnel gain an understanding of the applicable fundamentals, procedures, and technical practices common to a nuclear fuel enrichment facility. Technical training consists of initial training, OJT, continuing training, and special training, as applicable to specific assigned technical duties. This may include, but is not limited to: process specific training; mechanical maintenance; controls, instrumentation, electrical maintenance; and chemistry.

11.3.2.5 Professional Development

Professional development is a broad category implemented to assist GLE personnel in gaining additional understanding of fundamentals and technical practices common to their assigned job functions. Professional development typically utilizes internal or external professionals via formal workshop, tutorials, and select training programs.

11.3.3 Job-Specific Training Requirements

Operator training is performance-based and incorporates the structured elements of analysis, design, development, implementation, and evaluation commensurate with assigned duties. Minimum training requirements are developed for positions with activities that are relied on for safety. Initial identification of job-specific training requirements is based on individual employee experience. Entry-level criteria (such as, education, technical background, and experience) for these positions are contained in position descriptions. Job-specific training is performance-based and established with the relevant technical EHS safety discipline and Operations leadership to develop a list of qualifications for assigned duties. Changes to facilities, processes, equipment, or job duties are incorporated into revised lists of qualifications.

11.3.4 Basis of Training and Objectives

The Training Program is designed to prepare initial and replacement personnel for safe, reliable, and efficient operation of the GLE Commercial Facility. Emphasis is placed on safety requirements where human actions are important to safety.

Learning objectives are established to identify the training content and to define satisfactory trainee performance for the task, or a group of tasks, selected for training from the job analysis. Learning objectives state the requisite knowledge, skills, and abilities the trainee must demonstrate. The conditions under which the required actions take place and the standards of performance required of the trainee are also determined in development of the learning objectives. Learning objectives are sequenced within training materials based on the relationship to one another. Learning objectives are documented in lesson plans and training guides, and are revised as necessary, based on changes in procedures, facility SSCs, or job scope.

11.3.5 Organization of Instruction

Lesson plans are developed from learning objectives, which are based on job performance requirements. Lesson plans are reviewed by line management and by the responsible organization for the subject matter. Lesson plans are approved prior to issue or use.

11.3.6 Evaluation of Trainee Accomplishment

Trainee understanding and proficiency is evaluated through observation, demonstration, oral, or documented examinations, as appropriate. Such evaluations measure the trainee's skill and knowledge of job performance requirements. Evaluations are performed by individuals qualified in the training subject matter. Operator training and qualification requirements are met prior to process safety related tasks being independently performed or prior to startup, following significant changes to safety controls.

11.3.7 On-the-Job Training

OJT is a systematic method of providing the required job related skills and knowledge for a position. OJT is conducted in the work environment. Applicable tasks and related procedures make up the OJT Qualifications Program for each technical area which is designed to supplement and complement training received through formal classroom, laboratory, or simulator training. The objective of the program is to assure the trainee's ability to proficiently perform job duties as required for the assigned role. Completion of OJT is demonstrated through actual task actions using the conditions encountered during the performance of assigned duties including the use of references and tools, and equipment conditions reflecting the actual task to the extent practical.

11.3.8 Evaluation of Training Effectiveness

Periodic evaluations of Training Program content and requirements are performed to assess program effectiveness. The trainees provide feedback after completion of classroom or computer based training sessions to provide data for this evaluation. These evaluations identify program strengths and weaknesses, determine whether training content matches current job needs, and determines if corrective actions are needed to improve program effectiveness.

Independent audits of the EHS safety disciplines may also be used to provide independent evaluations of the overall Training Program effectiveness as it relates to the ISA, IROFS implementation, and protection of the public, worker, and environment. Evaluation objectives applicable to the overall organization and management of the Training Program may include, but are not limited to:

- Management and administration of training programs,
- Development and qualification of the matrix organization,
- Design and development of training programs, content, and conduct of training, and trainee examinations and evaluations,
- Training Program interface with the CM Program, and
- Training Program assessments and evaluations.

11.3.9 Personnel Qualification

The qualification requirements for key management positions are described in GLE LA Chapter 2. Qualification and training requirements for Operations personnel shall be established and implemented in accordance with approved written procedures.

11.3.10 Provisions for Continuing Assurance

Continuing or periodic retraining shall be established, when applicable, to ensure personnel remain proficient. Periodic training is generally conducted to ensure retention of knowledge and skills important to Operations. The training may consist of periodic retraining exercises, instructions, or review of subjects as appropriate to maintain the proficiency of personnel assigned to the facility. Retraining is required due to facility modifications, procedure changes, and QA Program changes resulting in new or changed information. The results of the retraining are documented.

11.4 PROCEDURES

GLE utilizes a hierarchy of policies, plans, and procedures to document management expectations and commitments, as well as to provide instructions and guidance to GLE personnel. Activities involving licensed special nuclear material (SNM) or IROFS are conducted in accordance with approved written procedures. Policies and plans are upper tier documents that define and describe senior management expectations and guidelines for safe operation of the GLE Commercial Facility and compliance with state and federal regulations, permits and licenses. Procedures are used to ensure implementation of the requirements set forth in policies and plans.

11.4.1 Types of Procedures

Procedures are categorized as management control procedures or operating procedures/instructions. Management control procedures describe administrative and general practices approved and issued by management at a level appropriate to the scope of the practice. These procedures direct and control activities across the various organizational functions, and assign functional responsibilities and requirements for these activities. Operating procedures provide specific direction for task-based work and are used to directly control process operations at the workstation.

11.4.1.1 Management Control Procedures

Management control procedures are used for activities that support the process operations. These procedures are used to manage activities such as design, CM, procurement, construction, RP, maintenance, QA, training and qualification, audits and assessments, incident investigations, RM, NCS, industrial safety, and reporting requirements.

11.4.1.2 Operating Procedures/Instructions

Operating procedures/instructions include direction for normal operations, off-normal operations, maintenance, alarm response, and emergency operations caused by failure of an IROFS or human error. These procedures provide reasonable assurance of RP, NCS, industrial safety, security and emergency preparedness, and environmental protection. Operating procedures/instructions contain the following elements, as applicable:

- Purpose,
- Regulations, policies, and guidelines governing the procedure,
- Type of procedure,
- Steps for each operating process phase,
- Initial startup,
- Normal operations,
- Temporary operations,

- Emergency operations and shutdown,
- Normal shutdown,
- Startup following an emergency or extended downtime,
- Hazards and safety considerations,
- Operating limits,
- Precautions necessary to prevent exposure to hazardous chemicals (resulting from operations with SNM) or to licensed SNM,
- Measures to be taken if contact or exposure occurs,
- IROFS associated with the process and associated functions, and
- The timeframe for which the procedure is valid.

Maintenance procedures involving IROFS for corrective and preventive maintenance, testing after maintenance, and surveillance maintenance activities describe the following, as needed:

- Qualifications of personnel authorized to perform the maintenance or surveillance,
- Controls on, and specification of, any replacement components or materials to be used,
- Post-maintenance testing to verify operability of the equipment,
- Tracking and RM of maintenance activities,
- Safe work practices (such as, lockout/tagout, confined space entry; moderation control or exclusion area requirements; radiation or hot work permits; and criticality, industrial, and environmental issues),
- Pre-maintenance activities require reviews of the work to be performed, including procedure reviews for accuracy and completeness, and
- Steps that require notification of affected parties (technicians and supervisors) before performing work and on completion of maintenance work. The discussion includes potential degradation of IROFS during the planned maintenance.

Alarm response procedures provide information that identifies the symptoms of the alarm, possible causes, automatic actions, the immediate operator action to be taken, and the required supplementary actions. Off-normal procedures describe actions to be taken during unusual or out-of-the ordinary situations. Emergency operating procedures direct actions necessary to mitigate potential events or events in progress that involve needed protection of onsite personnel; public health and safety; and the environment.

11.4.2 Procedure Development Process

11.4.2.1 Identification

Line managers, or designees, are responsible for the identification of procedures for assigned functional areas. Area managers are responsible for the identification of procedures incorporating control and limitation requirements established by the NCS, RP, Environmental Protection, and Industrial Safety functions. ISAs are used to identify procedures necessary for human actions important to safety. Approved written procedures have a unique identifier assigned by the Document Control function.

11.4.2.2 Development

Line managers, or designees, are responsible for procedure development. Procedure development is accomplished in accordance with approved written procedures. Procedures are initiated, developed, and controlled by a Document Control Program. Nuclear safety control requirements for workers are incorporated into the appropriate operating, maintenance, and test procedures for uranium enrichment operations.

Activities that require skills normally possessed by qualified personnel do not require detailed step-by-step delineation in a procedure. These activities are performed in accordance with documents of a type appropriate to the circumstances such as planning sheets, job descriptions, external manuals, or other applicable form.

11.4.2.3 Verification/Validation

Prior to initial use, procedures are verified and validated. Verification is a process that ensures the technical accuracy of the procedure. Validation verifies that the procedure can be performed as written. The document owner verifies the procedure during procedure development or during the change process. There are two basic attributes of the verification process. The first is the technical accuracy verification. This verification ensures technical information including formulas, set points, and acceptance criteria are correctly identified in the procedure. The second is administrative, in that it verifies the procedure format and style and verifies that the procedure meets the requirements in the approved written CM procedures.

The purpose of procedure validation is to ensure that no technical errors or human factor issues were inadvertently introduced during the procedure development or review process. Validation is required for new procedures and for procedure changes. Validation is performed in the field by qualified personnel, and may be accomplished by detailed scrutiny of the procedure as part of a walk-through exercise or as part of a walk-through drill (particularly for emergency or off-normal procedures). If the particular system or process is not available for a walk-through validation, talk-through may be performed in the particular training environment. Performance of procedure validation is documented.

11.4.2.4 Review/Approval

Drafts of new procedures and procedure changes are distributed for technical reviews, safety discipline reviews (such as, NCS, Industrial Safety, and RP), and cross-discipline reviews, as needed. Comments/questions generated during the review process are resolved with the originating organizations. Following the resolution of review comments, procedures are approved. Approval authority rests with the applicable organization manager responsible for the activity. Managers have the responsibility to ensure that appropriate training is completed on new and revised procedures.

The QA function reviews QA implementing procedures for compliance and consistency with the QA Program and to ensure that the provisions of the QA Program are effectively incorporated into QA implementing procedures.

11.4.2.5 Issuance and Distribution

Controlled documents and approved revisions are distributed in a controlled manner in accordance with the Document Control Program. Line managers, or designees, shall be responsible for ensuring personnel doing work that requires the use of procedures have access to controlled copies of the required procedures.

11.4.3 Temporary Changes to Procedures

Temporary changes to procedures can be made, provided the change does not result in a change to the ISA as determined by the 10 CFR 70.72 review; and the change does not constitute an intent change (that is, a change in scope, method, or acceptance criteria that has safety significance). Temporary procedure changes must be documented per approved written procedures. Temporary procedure changes may be used for an identified period of time, which should not exceed 30 days or a period for which the temporary condition exists, whichever is greater. Temporary changes needing to exceed this period are assessed to ensure it is appropriate to extend the use of the temporary change or if a permanent change should be processed. Temporary changes may be made permanent once the change is reviewed and approved per the requirements of Section 11.4.2, *Procedure Development Process*.

11.4.4 Temporary Procedures

Temporary procedures are typically issued to address changes in normal conditions not addressed in operating procedures. These conditions can be related to safety, quality, production, or maintenance concerns. Three types of temporary procedures are used: (1) emergency; (2) standard (valid for up to 90 days from initial start); and (3) long-term (valid for periods not to exceed one year). Long-term temporary procedures are issued for major projects that require a long-term startup phase before facility acceptance and/or process qualification. New temporary procedures of this type require equivalent signatures to new operating procedures.

11.4.5 Periodic Reviews

Periodic reviews of procedures are performed to assure their continued accuracy and usefulness. At a minimum, operating procedures are reviewed every three years, and emergency procedures are reviewed annually. In addition, procedures are reviewed following unusual incidents (such as, an accident, unexpected transient, significant operator error, or equipment malfunction) to determine if changes are appropriate based on the cause and corrective action determination for the particular incident. Periodic reviews of controlled documents shall be conducted at a frequency listed in Table 11-1, *Procedure Periodic Reviews*.

11.4.6 Use and Control of Procedures

Line managers and area managers ensure procedures are made readily available in the work area and that personnel are trained to the requirements of the procedures; compliance is mandatory. Personnel are trained to immediately report inadequate procedures or the inability to follow procedures.

11.4.7 Records

The Safety Program design requires the establishment and maintenance of approved written procedures for EHS limitations and requirements to govern the safety aspects of operations. Requirements for procedure control and approval authorities are documented.

11.4.8 Topics to be Covered in Procedures

Activities defined in Section 11.4.1, *Types of Procedures*, are the minimum activities to be covered by controlled documents. Maintenance activities listed below may be covered by approved written procedures, documented work instructions, or drawings; whichever is appropriate to the circumstance. The list below is not intended to be all-inclusive, as many other activities carried out during operations may be covered by procedures not included in the list. Similarly, this listing is not intended to imply that procedures need to be developed with the same titles as those in the list. This listing provides guidance on topics to be covered rather than specific procedures.

Management Control Procedures

- Training
- Audits and inspections
- Investigations and reporting
- Records management and document control
- Changes in facilities and equipment
- Modification design control
- QA

- Equipment control (lockout/tagout)
- Shift turnover
- Work and management control
- Nuclear criticality safety, fire safety, chemical process safety
- Radiation protection
- Radioactive waste management
- Maintenance
- Environmental protection
- Operations
- IROFS surveillances
- Calibration control
- Procurement

System Procedures that Address Start-Up, Operation, and Shutdown

- Electrical power
- Ventilation
- Shift routines, shift turnover, and operating practices
- Sampling
- UF_6 cylinder handling
- UF_6 material handling equipment
- Decontamination operations
- Facility air and nitrogen
- Cooling, sanitary, and facility water
- Temporary changes in operating procedures
- Purge and evacuation vacuum systems
- Installation and removal of centrifuge machines

Abnormal Operation/Alarm Response

- Loss of cooling, instrument air, and/or electrical power
- Fires
- Chemical process releases
- Loss of feed or withdrawal capacity
- Loss of purge vacuum

Maintenance Activities That Address System Repair, Calibration, Inspection, and Testing

- Repairs and preventive repairs of IROFS
- Calibration and functional testing of IROFS
- High-efficiency particulate air filter maintenance
- Safety system relief valve replacement
- Surveillance/monitoring
- Piping integrity testing
- Containment device testing
- Repair of UF_6 valves
- Testing of cranes
- UF_6 cylinder inspection and testing
- Centrifuge assembly/installation

Emergency Procedures

- Toxic chemical releases (including UF_6)

11.5 AUDITS AND ASSESSMENTS

GLE implements a system of audits and assessments to help ensure that the EHS functions, as described in this LA are adequate and effectively implemented. The system is designed to ensure comprehensive program oversight at least once every three years.

11.5.1 Activities to be Audited or Assessed

11.5.1.1 Assessments

Management performs assessments to verify the effective implementation of the Safety Program elements (RP, NCS, Industrial Safety, Security and Emergency Preparedness, and Environmental Protection), management measures, and QA Program elements. Personnel from the area being assessed may perform the assessment, provided that they do not have direct responsibility for the specific activity being assessed. Results of assessments are documented. The responsible line manager resolves any observations from these programmatic assessments. In addition, GLE commits to perform independent assessments of its safety program elements. The assessment scope includes compliance to procedures, conformance to regulations, and the overall adequacy of the safety program. Assessment results are documented and reported as specified in the approved written procedures. Provisions are made for reporting and corrective action, where warranted, in accordance with the Corrective Action Program.

11.5.1.2 Audits

Representatives of the NCS, RP, and Industrial Safety functions conduct formal scheduled safety audits of uranium enrichment and process support areas in accordance with approved written procedures. These audits are performed to determine if operations conforms to NCS, RP, and Industrial Safety requirements. Audit results are reported in writing to the GLE Facility Manager, the GLE EHS Manager, the NCS Manager, area managers, the manager of the safety function being audited, and other line management as appropriate.

11.5.2 Scheduling of Audits and Assessments

An assessment of each management measure (such as, CM) is performed annually. The assessment may focus on a single organizational element or the entire organization. NCS and RP audits are performed quarterly (at intervals not to exceed 110 days) under the direction of the manager of the NCS and RP functions. Facility personnel conduct weekly nuclear criticality safety walkthroughs of uranium enrichment and process support areas in accordance with approved written procedures. Walkthrough findings are documented and sent to the affected line manager or area manager for resolution. In addition, GLE commits to perform triennial independent assessments of its safety program elements. The Environmental Protection function develops an audit schedule for the Environmental Protection Program on an annual basis.

11.5.3 Procedures for Audits and Assessments

Industrial safety audits are performed under the direction of the Industrial Safety Manager. Audit results are communicated in writing to the responsible line manager, GLE Facility Manager, area managers, and to the GLE EHS Manager. Environmental Protection audits are conducted in accordance with approved written procedures to ensure operational activities conform to documented environmental requirements.

Required corrective actions are documented and approved by management and tracked to completion by the EHS function. Records of the audit or inspection, instructions and procedures, persons conducting the audits or inspections, audit or inspection results, and corrective actions for identified violations of license conditions are maintained in accordance with procedural requirements for a minimum period of three years.

11.5.4 Qualifications and Responsibilities for Audits and Assessments

Personnel performing audits do not report to the audited organization and have no direct responsibility for the function being audited. The audit team consists of appropriately trained and experienced individuals. The responsible line manager, or area manager, is responsible for nonconformance corrective action commitments in accordance with approved written procedures. The Environmental Protection Manager, or delegate, is responsible for resolution of identified nonconformances associated with the Environmental Protection Program. Audit results in the form of corrective action items are reported to the GLE Facility Manager and staff for monitoring of closure status.

11.6 INCIDENT INVESTIGATIONS

Incident investigations are performed to assure that the upset condition(s) is understood and appropriate corrective actions are identified and implemented to prevent recurrence. Management Measures include documenting upset conditions in unusual incident reports (UIRs). UIRs are documented and the associated corrective actions tracked to completion. The objectives of the incident investigation and reporting procedures are to establish the validity of the data related to the incident, to develop and implement corrective action plans (CAPs) when appropriate, to document an event which was or could become a danger to persons or property, and to ensure that proper levels of GLE Management and public agencies are notified.

11.6.1 Incident Identification, Categorization, and Notification

GLE commits to maintain a system to identify, track, investigate, and implement corrective actions for abnormal events (unusual incidents). Through this system, GLE will investigate abnormal events that may occur during operation of the facility, determine the specific or generic root cause(s) and generic implications, recommend corrective actions, and report to the U.S. Nuclear Regulatory Commission (NRC) as required by 10 CFR 70.50, *Reporting Requirements (Ref. 11-8)*, and 10 CFR 70.74, *Additional Reporting Requirements (Ref. 11-9)*. The Corrective Action System includes the following requirements and features:

- Operates in accordance with approved written procedures;
- Document, track, and report abnormal events to GLE management;
- Identify abnormal events associated with IROFS or their associated management measures;
- Consider each event in terms of regulatory reporting criteria and in terms of severity, where precursor events are considered unusual events and events concerning compliance with regulations or license conditions are considered potential non-compliances (PNC);
- UIRs require investigation, a determination of root or most probable (proximate) cause, and the identification of required corrective action(s);
- More significant UIRs and PNCs require a formal, systematic determination of root cause (typically using an independent qualified team), creation of a CAP, and a higher level management review and approval of the investigation and corrective actions;
- Issue monthly reports covering the status of UIRs and PNCs to GLE management;
- Grade events for the purpose of an ongoing management evaluation of facility performance and used as one element in driving safety culture focus;
- Maintain records of the events and the documented evidence of closure for a minimum of three years; and
- Use UIR and PNC information where appropriate when performing ISAs.

11.6.2 Conduct of Incident Investigations

Incident investigations are implemented according to approved written procedures. The investigation process includes a prompt risk-based evaluation. The investigator(s) is independent from the function(s) involved with the incident under investigation and are assured of no retaliation for participating in investigations. Investigations shall begin within 48 hours of the abnormal event, or sooner, depending on safety significance of the event. The record of IROFS failures, as required by 10 CFR 70.62(a)(3), *Safety Program and Integrated Safety Analysis (Ref. 11-10)*, shall be reviewed as part of the investigation. Record revisions necessitated by post-failure investigation conclusions shall be made within five working days of the completion of the investigation.

Qualified internal or external investigators are appointed to serve on investigating teams when required. The teams include at least one process expert and at least one team member trained in root cause analysis.

GLE maintains auditable records and documentation related to abnormal events, investigations, and root cause analyses so that "lessons learned" may be applied to future operations of the facility. For each abnormal event, the incident report includes a description, contributing factors, a root cause analysis, findings, and recommendations. Relevant findings are reviewed with affected personnel. Details of the event sequence are compared with accident sequences already considered in the ISA, and the ISA Summary will be modified, if necessary, to include evaluation of the risk associated with accidents of the type actually experienced. The Incident Investigation Process consists of the following steps:

- Investigate the problem;
- Derive an understanding of the issues and drivers, and determine the fundamental or root cause(s);
- Develop appropriate corrective and preventive actions;
- Assign responsible individual(s) to address each corrective or protective action, determine the required timing for each action, and provide scheduled target date for each action;
- Compile adequate records (hard copy or electronic files) to demonstrate completion or closure of the corrective actions;
- Conduct an investigation to determine if the corrective action(s) was appropriate;
- Assure identified corrective actions are completed in an appropriate and timely manner;
- Input the corrective action completion data, documentation, and any related notes of interest in a hard copy or electronic copy file;

- Provide appropriate GLE management with closure documentation for internal type items (such as, UIRs) or input the closure documentation electronically into the controlled electronic file in sufficient detail to demonstrate closure of the action; and

- Provide the Licensing Organization with closure documentation for external agency items (that is, NRC, State of North Carolina, American Nuclear Insurers, Factory Mutual, etc.) or input the documentation electronically into the controlled electronic file.

11.6.3 Written Follow-Up Report

Upon completion of the incident investigation, a report on the incident and the associated investigation is made to ensure sufficient corrective and preventive actions has been defined and completed. The report contains sufficient detail to demonstrate closure of the action. At least quarterly, a status report is issued by the EHS function and distributed to individuals responsible for corrective actions and management.

11.6.4 Corrective Actions

The line managers and area managers have the responsibility to ensure proper action is taken to control the incident in the assigned area of responsibility to include: consulting EHS for a determination as to whether or not the investigation of an incident is required, notifying appropriate management, participating in the investigation as required, and assuring adequate corrective actions are completed. The line managers and area managers are responsible for reviewing and approving the corrective actions associated with each UIR in their area of responsibility. This is accomplished by the creation of a corrective action within each UIR.

11.7 RECORDS MANAGEMENT

11.7.1 Records Management Program

RM shall be performed in a controlled and systematic manner in order to provide identifiable and retrievable documentation. Applicable design specifications, procurement documents, or other documents specify the QA records to be generated by, supplied to, or held in accordance with approved written procedures. QA records are not considered valid until they are authenticated and dated by authorized personnel.

The GLE QA Program requires procedures for reviewing, approving, handling, identifying, retention, retrieval, and maintenance of QA records. These records include the results of tests and inspections required by applicable codes and standards, construction, procurement and receiving records, personnel certification records, design calculations, purchase orders, specifications and amendments, procedures, incident investigation results and approvals or corrective action taken, various certification forms, source surveillance and audit reports, component data packages, and any other QA documentation required by specifications or procedures. These records are maintained at locations where they can be reviewed and audited to establish that the required quality has been assured.

For computer codes and computerized data used for activities relied on for safety, as specified in the ISA Summary, procedures are established for maintaining readability and usability of older codes and data as computing technology changes. For example, procedures allow older forms of information and codes for older computing equipment to be transferred to contemporary computing media and equipment.

RM shall maintain a Master File to which access is controlled. Documents in the Master File shall be legible and identifiable as to the subject to which they pertain. Documents shall be considered valid only if stamped, initialed, signed or otherwise authenticated, and dated by authorized personnel. Documents in the Master File may be originals or reproduced copies. Computer storage of data may be used in the Master File. In order to preclude deterioration of records in the Master File, the following requirements are applicable:

- Records shall not be stored loosely. Records shall in binders or placed in folders or envelopes. Records shall be stored in steel file cabinets.
- Special processed records, such as, radiographs, photographs, negatives, microfilm, which are light-sensitive, pressure-sensitive, and/or temperature-sensitive, shall be packaged and stored as recommended by the manufacturer of these materials.
- Computer storage of records shall be done in a manner to preclude inadvertent loss and to ensure accurate and timely retrieval of data. Dual-facility records storage uses an electronic data management system and storage of backup tapes in a fireproof safe.

The Master File storage system shall provide for the accurate retrieval of information without undue delay. Approved written instructions shall be prepared regarding the storage of records in a Master File, and a supervisor shall be designated the responsibility for implementing the requirements of the instructions. These instructions shall include, but not necessarily be limited to, the following:

- A description of the location(s) of the Master File and an identification of the location(s) of the various record types within the Master File;
- The filing system to be used;
- A method for verifying that records received are in good condition and in agreement with any applicable transmittal documents. This is not required for documents generated within a section for use and storage in the same sections' satellite files;
- A method for maintaining a record of the records received;
- The criteria governing access to and control of the Master File;
- A method for maintaining control of and accountability for records removed from the Master File; and
- A method for filing supplemental information and for disposing of superseded records.

Record storage areas (including satellite files) shall be evaluated to assure records are adequately protected from damage by fire.

11.7.2 Record Retention

Records appropriate for ISAs, IROFS, the application of management measures to IROFS, NCS and RP activities, training/retraining, occupational exposure of personnel to radiation, releases of radioactive materials to the environment, and other pertinent safety activities are maintained in such a manner as to demonstrate compliance with license conditions and regulations.

Records of criticality safety analyses (CSAs) are maintained in sufficient detail and form to enable independent review and audit of the calculational method and results. Records associated with personnel radiation exposures are generated and retained in such a manner as to comply with the relevant requirements of 10 CFR 20, *Standards for Protection Against Radiation (Ref. 11-11)*. In addition, the following RP records are maintained for at least three years:

- Records of the Facility Safety Review Committee (FSRC) meetings,
- Surveys of equipment for release to unrestricted areas,
- Instrument calibrations,
- Safety audits,

- Personnel training and retraining,
- Radiation work permits,
- Surface contamination surveys,
- Concentrations of airborne radioactive material in the facility, and
- Radiological safety analyses.

Records associated with Environmental Protection activities described in GLE LA Chapter 9, *Environmental Protection*, are generated and retained in such a manner as to comply with the relevant requirements of 10 CFR 20.

11.7.3 Organization and Administration

11.7.3.1 Responsibilities

The Quality Assurance and Infrastructure Manager is responsible for the RM Program during the design and construction phases of the project. The Business Manager is responsible for the RM Program during the Operations phase. The RM Program functions include directing the development, implementation, and maintenance of methods and procedures encompassing a RM Program, and assuring the laws, codes, standards, regulations, and company procedures pertaining to record keeping requirements are met.

11.7.3.2 Training and Qualifications

Appropriately trained and qualified personnel manage the RM Program. No specific experience related to the control of documents or management of records is required, although previous technical or RM experience is recommended.

11.7.3.3 Employee Training

General training in RM is provided to employees as part of the general topics covered in GET. Specific professional development training shall be provided on an as needed basis.

11.7.3.4 Examples of Records

The following are examples of the types of records maintained by the RM Program.

General Information

- Construction records
- Safety analyses, reports, and assessments
- Facility and equipment descriptions and drawings
- Design criteria, requirements, and bases for IROFS

- Records of facility changes and associated ISAs
- Records of site characterization measurements and data
- Records pertaining to onsite disposal of radioactive or mixed wastes in surface landfills
- Procurement records, including specifications for IROFS

Organization and Administration

- Administrative procedures with safety implications
- Change control records for Material Control and Accounting (MC&A) Program
- Organization charts, position descriptions, and qualification records
- Safety and health compliance records, medical records, personnel exposure records
- QA records
- Safety inspections, audits, assessments, and investigations
- Safety statistics and trends

Integrated Safety Analysis

- ISA and ISA-related analyses

Radiation Safety

- Bioassay data
- Exposure records
- Radiation protection (and contamination control) records
- Radiation training records
- Radiation work permits

Nuclear Criticality Safety

- Nuclear criticality control approved written procedures and statistics
- NCS evaluations
- Records pertaining to nuclear criticality inspections, audits, investigations

- Records pertaining to nuclear criticality incidents, unusual occurrences, or accidents
- Records pertaining to NCS evaluations

Chemical Safety

- Chemical process safety procedures, plans, diagrams, charts, and drawings
- Records pertaining to chemical process inspections, audits, investigations, and assessments
- Records pertaining to chemical process incidents, unusual occurrences, or accidents
- Chemical process safety reports and analyses
- Chemical process safety training

Fire Safety

- Fire Hazard Analysis
- Fire prevention measures, including hot-work permits and fire watch records
- Records pertaining to inspection, maintenance, and testing of fire protection equipment, and records pertaining to fire protection training and retraining of response teams
- Pre-fire emergency plans

Emergency Management

- Emergency plan(s) and procedures, and comments on emergency plan from outside emergency response organizations
- Emergency drill records
- Memoranda of understanding (MOU) with outside emergency response organizations
- Records of actual events, records pertaining to the training and retraining of personnel involved in Emergency Preparedness functions, and records pertaining to the inspection and maintenance of emergency response equipment and supplies

Environmental Protection

- Environmental release and monitoring records
- Environmental report and supplements to the environmental report, as applicable

Decommissioning

- Decommissioning records, cost estimates, and procedures
- Financial assurance documents
- Site characterization data
- Final survey data

Management Measures

- Configuration Management
  - Safety analyses, reports, and assessments that support the physical configuration of process designs and changes to those designs
  - Validation records for computer software used for safety analyses or MC&A
  - ISA documents, including process descriptions, facility drawings and specifications, purchase specifications for IROFS
  - Approved current operating procedures and emergency operating procedures
- Maintenance
  - Record of IROFS failures (required by 10 CFR 70.62)
  - PM records, including trending and root cause analysis
  - Calibration and testing data for IROFS
  - Corrective maintenance records
- Training and Qualification
  - Personnel training and qualification records
  - Training procedures and modules
- Operating procedures and functional test procedures
- Audits and Assessments of safety and environmental activities
- Incident Investigations
  - Investigation reports
  - Changes recommended by investigation reports, how and when implemented

- Summary of reportable events for the term of the license
- Incident investigation policy

- Records Management
  - Policy
  - Material storage records
  - Records of receipt, transfer, and disposal of radioactive material

- Other QA Elements
  - Inspection records
  - Test records
  - Corrective action records

11.8 OTHER QUALITY ASSURANCE ELEMENTS

GLE has developed a QA Program that applies to the design, construction, operation, and decommissioning of the GLE Commercial Facility. Application of the QA Program is mandatory for items (SSCs, equipment, and activities) identified as IROFS in accordance with 10 CFR 70.4, *Definitions (Ref. 11-12)*, 10 CFR 70.61, *Performance Requirements (Ref. 11-13)*, and 10 CFR 70.64. The QA Program, in conjunction with the other management measures, ensures IROFS will be available and reliable to perform the required safety functions when needed.

11.8.1 Organization

GLE operates to a documented organizational structure in which responsibility and authority is clearly identified. GLE LA Chapter 2 describes the organizational structure of GLE. The GLE QA Program defines the roles and responsibilities of personnel related to QA. Personnel who are responsible for ensuring that appropriate QA has been established have the authority, access to work areas, and organizational independence to carry out their responsibilities.

11.8.2 Quality Assurance Program

The GLE QA Program applies to GLE workers at all levels of the organization, including contractor personnel, who perform quality-affecting activities associated with safety related aspects of the GLE Commercial Facility. The QA Program is risk-informed and utilizes only those elements and principles appropriate for assuring the quality-related aspects of the facility.

GLE contractors may work under the GLE QA Program or their respective QA Programs per approved written procurement procedures. Contractor QA Programs shall be consistent with the requirements of the GLE QA Program for quality-affecting activities. The interfaces between contractors and GLE shall be documented. GLE and contracted personnel have the responsibility to identify quality problems.

The QA Program states GLE policies, assigns responsibilities, and specifies requirements governing implementation of the QA Program for the design, construction, operation, and decommissioning of the GLE Commercial Facility. Specific processes and controls, which implement the provisions of the QA Program, are delineated in approved written procedures. When work cannot be accomplished as specified in implementing QA procedures, or accomplishment of such work would result in an unsafe condition, work is stopped until proper corrective action is taken. If procedures cannot be used as written, then work is stopped until the procedures are modified.

The QA Program is applied to the design, fabrication, testing, operation, procurement, inspection, maintenance, and modification of IROFS and activities affecting those IROFS. The QA Program is applied in a graded approach based on an item's importance to safety.

Personnel performing or managing activities affecting quality are indoctrinated or trained on the QA Program and the appropriate QA implementing procedures. Each manager is responsible for the applicable indoctrination, training, and qualification of their personnel. Line management of the organizations implementing the QA Program, or portions thereof, regularly assesses the adequacy of the program for which they are responsible through an appropriate combination of reviews, self-assessments, or audit processes, thereby assuring its effective implementation. Responsible line managers regularly assess the adequacy and effective implementation of the QA Program through methods such as review meetings and reviewing audit reports and CAPs.

Three QA Levels have been established and apply throughout the life of the facility from design and construction through testing, startup, operation, maintenance, modification, and decommissioning. The three QA levels are defined below.

11.8.2.1 QA Level 1

QA Level 1 (QL-1) is applied to single IROFS (sole IROFS) preventing or mitigating a high consequence event. All QA Program requirements are applied to QL-1 IROFS.

11.8.2.2 QA Level 2

QA Level 2 (QL-2) is applied where two or more IROFS are credited to prevent or mitigate a high consequence event, or any single IROFS (sole IROFS) preventing or mitigating an intermediate consequence event. QA Program requirements are applied to QL-2 IROFS using a graded approach. The graded approach is implemented through approved written procedures taking into consideration the following:

- Risk significance,
- Applicable regulations, industry codes, and standards,
- Complexity or uniqueness of an item/activity and the environment in which it has to function,
- Quality history of the item in service or activity,
- Degree to which functional compliance can be demonstrated or assessed by test, inspection, or maintenance methods,
- Anticipated life span,
- Degree of standardization,
- Importance of data generated, and
- Reproducibility of results.

By appropriately balancing considerations of importance and process capability, an appropriate level of quality is achieved commensurate with the item's importance to safety. The results of the application of the graded approach to quality are incorporated into design requirement documents, specifications, procedures, instructions, drawings, inspection plans, test plans, procurement documents, and other documents that establish the requirements for items or activities.

11.8.2.3 QA Level 3

QA Level 3 (QL-3) covers safety controls that are not QL-1 and QL-2. QL-3 items are controlled in accordance with standard commercial practice and do not require the maintenance of quality records.

11.8.3 Design Control

GLE approved written procedures outline a program to provide design control for IROFS including the management measures necessary to assure successful operation (see Section 11.1, *Configuration Management*). The Engineering Organization utilizes approved written procedures to control the design process including inputs, analysis, outputs, reviews/checks/approvals, change control, technical interfaces, and administrative activities. Design procedures assure applicable requirements are correctly translated into design documents.

Design is based on sound engineering judgment, scientific principles, applicable codes, and standards. Design management ensures that design documents are prepared, reviewed, checked, and approved by qualified individuals. Design documents include requirement documents, drawings, reports, criteria, specifications, analysis, computer programs, system descriptions, technical reports, and the ISA. Work scope and responsibilities between design groups and disciplines are defined. The Engineering function includes:

- Organizations within which the Design Control System is to be implemented;
- Design interface responsibilities between internal and external organizations;
- Exchange of technical information between internal and external organizations;
- Use of approved written design procedures;
- Establishment of technical requirements and design standards;
- Selections and performance of design practices, including review methods;
- Preparation of design documents;
- Extent of design reviews, including technical reviews, peer reviews, modeling, and alternate calculations, as appropriate;
- Design output document control, including review, approval, release status identification, distribution, and revision of documents;

- Determination and specification of acceptance criteria, required tests and inspections, and program requirements for records;
- Maintenance and retention of design documents; and
- Controls for design change.

Determination of the required rigor of design control is based upon the design phase and the ISA performed in compliance with 10 CFR 70, *Domestic Licensing of Special Nuclear Material (Ref. 11-14)*. The ISA establishes the identification and functions of IROFS, and the significance to safety of functions performed by those IROFS. The design of SSCs that involve a higher than normal level of risk, including those SSCs designated as IROFS, are subject to a greater degree of design control and verification.

Design output documents for IROFS such as specifications, system descriptions, and drawings contain requirements for appropriate inspections, testing, and maintenance. Useful life expectancy is a design consideration to facilitate development of GLE Commercial Facility decommissioning, disassembly, and disposal plans. Software used to produce or manipulate data that is used directly in the design, analysis, and operation of SSCs relied on for safety is developed, validated, and controlled. Approved written procedures are used to implement these software controls. Commercially available software is not validated but the results are independently reviewed and verified. The details and implementation of requirements pertaining to design control are performed in accordance with applicable approved written procedures.

11.8.4 Procurement Control

Provisions for control of the procurement process (sourcing), procurement documents, and procured material, components, and services are described in approved written procurement procedures. Design bases and other requirements necessary to provide reasonable assurance of quality are included or referenced in documents for procurement of items or services relied on for safety. Requirements are established for content, review, approval, and change of procurement documents. Changes to the procurement documents shall be subject to the same degree of control as used in the preparation of the original procurement document.

QL-1 and QL-2 items may be procured as commercially available items provided they are subjected to a dedication process. Items and services that are not relied on for safety may be designated as QL-2 or QL-3 and may be procured as commercially available items.

11.8.5 Instructions, Procedures, and Drawings

Activities affecting the availability or reliability of IROFS are prescribed by and accomplished in accordance with documented specifications, requirements, procedures, instructions, and drawings of a type appropriate to the circumstances. These documents include or reference appropriate acceptance criteria for determining that prescribed activities have been satisfactorily accomplished. Standard guidelines for the format, content, review, and approval processes for GLE documents are established (see Section 11.4).

Adherence to policies and procedures is mandatory. In the case of conflict or error involving a procedure, the activity in question shall be placed in a safe condition and the procedure shall be corrected or changed before proceeding to implement the procedure.

11.8.6 Document Control

Documents and changes to documents that prescribe or specify quality requirements or activities affecting the availability and/or reliability of IROFS are controlled in a manner that assures the use of correct documents. Such documents, including changes thereto, are reviewed for adequacy and approved for release in accordance with approved written procedures.

Procedures and instructions assure that documents are: prepared; reviewed for adequacy, correctness, and completeness by a qualified individual; approved for release; and used when performing the activity. Obsolete or superseded documents are removed or appropriately identified. Approved written procedures identify documents to be controlled; responsibility for preparing, reviewing, approving, and issuing documents to be used; and require the establishment of current and updated distribution lists. Procedures are maintained under revision control.

11.8.7 Control of Purchased Items and Services

The procurement of items and services is controlled to ensure conformance with requirements. The controls provide for the following, as appropriate: supplier (source) evaluation and selection, evaluation of objective evidence of quality furnished by the supplier, source inspection, audit, and examination of items or services upon delivery or completion.

Procurement activities are planned and documented to assure a systematic approach to the procurement process. The Procurement function is responsible for procurement planning and bid evaluation. The QA function provides procurement QA support such as verification, surveillance, or qualification of the suppliers QA Program; receipt inspections; installation inspections; and review of procurement documents during receipt inspections. The Engineering function assists the QA and Procurement functions by performing evaluations of supplier's technical capabilities. The Engineering function is also responsible for determining specific methods of acceptance to be applied to purchased items and reviewing the specific method of acceptance to be applied to services. The Engineering function is also responsible for the approval of dispositions and technical evaluation of supplier nonconformances for items and services dispositioned as "repair" or "use-as-is."

Supplier selection is based, in part, on an evaluation of the supplier's capability to provide items or services in accordance with the requirements of procurement documents. Supplier evaluations may include audits or assessments of the supplier program or system for ensuring quality or an evaluation of the supplier's history of providing an identical or similar product that performs satisfactorily in actual use. Measures are established to interface with the supplier and to verify supplier's performance, as necessary.

A supplier working to the GLE QA Program shall be indoctrinated or trained on the QA Program and the applicable approved written procedures that govern the work being performed. Supplier work performed under the GLE QA Program is subject to the same controls implemented for GLE personnel.

Supplier-generated documents are reviewed for acceptability. Acceptability verification activities are based on quality level, complexity, and quantity of items or services provided. Technical documents used as input to design processes, such as analyses, calculations, or drawings require an independent technical review. Supplier furnished material, equipment, or services related to safety are reviewed for acceptability by performing, as appropriate, one or more of the following:

- Monitoring, witnessing, or observing activities performed by the supplier;
- Receiving inspection; and/or
- Post-installation testing.

Supplier nonconformances may be identified either by GLE or by the supplier. Nonconforming items are not released for use until the nonconforming condition is reviewed and accepted by GLE and the implementation of the disposition is verified, except under conditional release provisions. Records of supplier nonconformance are maintained.

11.8.8 Identification and Control of Materials, Parts, and Components

Controls are established for QL-1 and QL-2 items and services to assure that only correct and accepted items and services are used or installed. Identification is maintained on the items, in documents traceable to the items, or in a manner that assures identification is established and maintained as described in this section.

Items are identified and controlled, as necessary, from initial receipt and fabrication of the items, up to and including installation and use, to assure that only correct and accepted items are used or installed. Physical identification is used to the maximum extent possible. When physical identification is either impractical or insufficient to control the item, physical separation, procedural controls, or other means are employed. When markings are used, measures are established to ensure the markings are clear, legible, or machine readable, and do not have a detrimental affect on the function or service life of the item. Markings are transferred to each part of an identified item when subdividing and are not to be obliterated by surface treatments or coatings unless other means of identification are provided.

Traceability of items to specific records is provided when specified by codes, standards, or specifications. Where specified, items having a limited operating or shelf life are identified and controlled to preclude use of items whose operating or shelf life has expired.

11.8.9 Control of Special Processes

Special processes affecting quality of items and services are controlled. Procedures, instructions, drawings, checklists, travelers, work orders, or other appropriate means are used to control special processes. These means assure that special process parameters are controlled and that specified environmental conditions are maintained.

Special processes that control or verify quality (such as, those used in welding, heat treating, and nondestructive examination) are performed by qualified personnel using approved written procedures in accordance with specified requirements, codes, or standards. When the outcome of the process is highly dependent on personal skills, such individuals are certified in accordance with specified requirements. When the outcome is highly dependent on control of process parameters, the process and equipment are pre-qualified in accordance with specified requirements. Special process procedures prescribe the necessary equipment, process parameters, calibration, and acceptance criteria. Records are maintained of currently qualified personnel, processes, and equipment for special processes.

11.8.10 Inspections

Planned inspections are performed, as required, to verify conformance of items or activities to specified requirements. Inspection requirements are specified in approved written procedures, with provisions for documenting and evaluating the inspection results. Personnel performing inspections are qualified based on experience, education, or certification, as appropriate. Personnel other than those who performed or directly supervised the work being inspected, perform inspection for acceptance. Inspection planning may utilize hold points, where applicable, to ensure work does not bypass required inspections. The hold points are established in documents that control the work. Work does not proceed beyond an inspection hold point without specific documented consent of the designated inspection representative.

The planning of inspection activities, methods, and attributes is based on the importance of the item or activity to be inspected; mandatory inspections required by codes, standards, regulatory requirements and commitments; the complexity of the item or activity; and the quality history of the process. Inspection planning includes characteristics to be inspected; responsibility; method; measuring and test equipment; acceptance criteria; and referenced instructions and design documents. When a sample is used to verify acceptability of a group of items, the sampling procedure is documented and clearly identifies the sampling basis.

If inspection of completed work is impossible or disadvantageous, indirect verification by process monitoring is provided. Both inspection and process monitoring are provided, when necessary, to ensure quality.

Final inspections include record review of the results and resolution of any nonconformance(s) identified by prior inspections. Acceptance by final inspection verifies conformance of the item to specified requirements. Modifications, repairs, or replacements of items performed subsequent to final inspection require re-inspection or re-test, appropriate to the circumstances, to verify acceptability.

11.8.11 Test Control

Tests required for conformance verification of an item or computer program to specified requirements and to demonstrate satisfactory performance for service are planned and executed. Characteristics to be tested and test methods to be employed are specified. Test results are documented and their conformance with acceptance criteria is evaluated. Tests required to collect data, such as for siting or design input, shall be planned, executed, documented, and evaluated.

Tests include design verification tests, acceptance tests, preoperational and operational tests, and post-maintenance tests. Planning for tests may include mandatory hold points, as required. Test procedures contain the following information, as appropriate:

- Test purpose or objectives, responsibilities, characteristics to be tested, hold points, and test methods to be employed;
- References and related documents;
- Provisions for ensuring that prerequisites for a given test have been met, to include, as applicable: calibrated instrumentation, appropriate equipment, trained personnel, condition of test equipment and the item to be tested, and provisions for data acquisition;
- Adequate instrumentation is available and suitable environmental conditions are maintained;
- Provisions for documenting and evaluating the test results for conformance with acceptance criteria; and
- Qualifications for test personnel.

Approved written test procedures, may incorporate appropriate sections of related documents (such as, American Society for Testing and Materials' [ASTM] methods, external manuals, maintenance instructions, or approved drawings. Such documents must include adequate instructions to ensure the required quality of work. Test records contain the following information: item tested, test date, tester or data recorder, type of observation, test procedure or reference, results and acceptability, actions taken in connection with any deviations noted, and person evaluating the results.

11.8.12 Control of Measuring and Test Equipment

Measuring and Test Equipment (M&TE) used in activities affecting the availability or reliability of IROFS are controlled, calibrated, and adjusted at specified intervals to maintain equipment performance within required limits. Procedures ensure that devices and standards used for measurement, tests, and calibration activities are of the proper type, range, and accuracy. Calibration control is not necessary for rulers, tape measures, levels, and other such devices. A list of devices is established to identify those items within the Calibration Control System. This identification listing includes, as a minimum, the due date of the next calibration and any use limitations (when it is calibrated for limited use). M&TE is calibrated at specified intervals or prior to use against equipment having a known valid relationship to nationally recognized standards. If no nationally recognized standard exists, the basis for calibration is documented. M&TE is properly handled and stored to maintain accuracy.

When M&TE is found to be out of calibration, as-found data are recorded and an evaluation is made and documented as to the validity of previous inspection and test results and of the acceptability of items previously inspected or tested. Out-of-calibration devices are tagged or segregated and are not used until re-calibrated. When M&TE is consistently found to be out of calibration, it is repaired or replaced. Additionally, calibrations are performed when personnel performing measurements and tests deem the accuracy of the equipment suspect. Records are maintained and equipment is suitably marked or otherwise identified to indicate its calibration status.

11.8.13 Handling, Storage, and Shipping Controls

Material and equipment are handled, stored, and shipped in accordance with design and procurement requirements to protect against damage, deterioration, or loss. Special coverings, equipment, and protective environments are specified and provided where necessary for the protection of particular items from damage or deterioration. When such special protective features are required, their existence is verified and monitored as necessary to ensure they continue to serve the intended function.

Special handling tools and equipment are provided where necessary to ensure items can be handled safely and without damage. Special handling tools and equipment are controlled and maintained in a manner such that they will be ready and fit to serve the intended function when needed. Such control includes periodic inspection and testing to verify special handling tools and equipment has been properly maintained.

Operators of special equipment are experienced or trained as required. Attention is given to marking and labeling items during packaging, shipment, and storage. Additional marking or labeling is provided as necessary to ensure that items can be properly maintained and preserved. This includes indication of the presence of special environments or the need for special control. Special handling, preservation, storage, cleaning, packaging, or shipping instructions are established and used when essential to maintain acceptable quality.

11.8.14 Inspection, Test, and Operating Status

Approved written procedures are established to ensure the status of inspection and test activities are either marked or labeled on the item, or in documents traceable to the item. This activity is required when it is necessary to ensure required inspections and tests are performed, and to ensure items that have not passed the required inspections and tests are not inadvertently installed, used, or operated. Status indicators (such as, physical location and tags, markings, work controlling documents, stamps, inspection records, or other suitable means) are utilized when required. This includes indicating the operating status of systems and components (for example, by tagging valves and switches) to prevent inadvertent operation. Authority for the application and removal of tags, markings, labels, and stamps is specified.

11.8.15 Control of Nonconforming Items

Items and related activities that do not conform to specified requirements are controlled to prevent inadvertent installation or use. Nonconforming items are identified in a manner that does not adversely affect the end use of the item, by markings, tagging, and other appropriate methods. Nonconforming items are segregated, when practical, by placing them in a clearly identified and designated area until properly dispositioned. When segregation is impractical or impossible due to physical conditions (that is, size, weight, or access limitations), other measures are employed to preclude inadvertent use of the item.

Nonconforming items are reviewed and dispositioned as "reject," "rework," "repair," or "use-as-is." Further processing, delivery, installation, or use of the nonconforming item is controlled pending an evaluation and approved disposition by personnel as authorized in approved written procedures, and documented notification to affected organizations is provided.

The responsibility and authority for the evaluation and disposition of nonconforming items is defined. The personnel performing evaluations to determine the dispositions have demonstrated competence in the specific area being evaluated, have an adequate understanding of the requirements, and have access to pertinent background information. The disposition of nonconforming items is identified and documented as required to carryout the disposition. Technical justification for the acceptability of nonconforming items dispositioned "repair" or "use-as-is" is documented and subject to design control measures described in Section 11.8.3. The disposition process includes consideration of the need for design documents to be "as-built" to facilitate operations, maintenance, or modification. The as-built records, if the disposition determines such records to be required, reflect the accepted deviation. Repaired or reworked items are re-examined in accordance with the original acceptance criteria unless the nonconforming item disposition has established alternate acceptance criteria. Nonconformance documentation identifies the nonconforming item, describes the nonconformance, contains the disposition and any re-inspection requirements, and contains the appropriate signatures approving the disposition.

11.8.16 Corrective Action

Conditions adverse to quality are identified and corrected as soon as practical. In the case of a significant condition adverse to quality, the cause of the condition is determined, and corrective action is taken to preclude recurrence. Significant conditions, their causes, and corrective actions are documented, reported to appropriate levels of management, and follow-up action is taken to verify implementation of corrective actions. Approved written procedures specify requirements for identification and classification of conditions adverse to quality, trending of significant conditions adverse to quality, criteria for determining trends, and follow-up action to be taken to verify implementation of corrective action.

11.8.17 Quality Assurance Records

GLE produced QA records that furnish documentary evidence of quality, shall be specified, prepared, and maintained in accordance with applicable regulatory requirements and applicable approved written procedures. QA records shall be legible, identifiable, and retrievable, and shall be protected against damage, deterioration, and loss for the specified record retention duration. A RM Program and Records Center shall be established as early as practicable, consistent with the work activities and in compliance with QA Program requirements. Specific requirements and responsibilities for generation, classification, retention, receiving, storage, and preserving of QA records are established in approved written procedures.

11.8.18 Assessments and Audits

Audits are performed to verify compliance with the QA Program and to determine its effectiveness. Audits of organizations performing quality-affecting activities associated with safety related aspects of the facility are performed at a frequency commensurate with the status and importance of the activity. Audits are performed on both internal and external organizations providing products or services to the project. Audits are performed in accordance with plans, procedures, or checklists by personnel who do not have direct responsibility for performing the activities being audited. A plan is prepared for each audit to identify the audit scope, requirements, audit personnel, activities to be audited, applicable documents, organizations to be audited, schedule, and approved written procedures, instructions, or checklists. Auditors (including technical specialists) have training or experience commensurate with the scope, complexity, or special nature of the audit.

Organizations being audited provide access and assistance to the audit personnel. Objective evidence is examined to determine if the QA Program elements are being implemented effectively. Conditions requiring prompt corrective action are reported immediately to the management of the audited organization. Audit results are documented, and reported to and reviewed by responsible management. Management of the audited organization or activity investigates adverse audit findings, schedules corrective action, including measures to prevent recurrence (if appropriate), and notifies the QA Organization of the action taken. Adequacy of audit responses is evaluated by the QA Organization and verification of corrective action is documented. Follow-up action is taken to verify the implementation and effectiveness of the corrective action and to determine if repetitive problems require further corrective action. Audit records include audit plans, audit reports, written responses to the audit findings, and the record of completion of corrective action.

11.8.19 Provisions for Change

The QA Program is reviewed and revised as necessary to reflect any changes that occur during the design, construction, operation, and decommissioning phases. In addition, the QA Program is revised when corrective actions, regulatory, organizational, or work scope changes warrant changes to the QA Program.

The QA Program is maintained current through design, construction, operation, and decommissioning of the facility. The QA Program is kept current as the design, construction, operation, and decommissioning activities progress and appropriate changes are made based on any of the following:

- Lessons learned from audit and assessment findings;
- Program improvements identified from analysis of trends;
- Changes due to regulations, commitments, re-organizations, revised project schedule, or program improvements from continuous review of assessment results and process improvement initiatives.

QA Program changes are controlled by 10 CFR 70.72. Changes not requiring NRC approval prior to implementation are submitted to the NRC annually, in accordance with 10 CFR 70.72.

11.9 REFERENCES

11-1. 10 CFR 70.72, *Facility Changes and Change Process*, U.S. Nuclear Regulatory Commission, 2008.

11-2. 10 CFR 70.64, *Requirements for New Facilities or New Processes at Existing Facilities,* U.S. Nuclear Regulatory Commission, 2008.

11-3. 29 CFR 1910, *Occupational Safety and Health Standard,* Occupational Safety and Health Administration, 2008.

11-4. 10 CFR 19, *Notices, Instructions, and Reports to Workers: Inspection and Investigation,* U.S. Nuclear Regulatory Commission, 2008.

11-5. 10 CFR 19.12, *Instruction to Workers*, U.S. Nuclear Regulatory Commission, 2008.

11-6. ANSI/ANS 8.19-2005, *Administrative Practices for Nuclear Criticality Safety,* American Nuclear Society, January 2005.

11-7. ANSI/ANS 8.20-1991 (R1999), *Nuclear Criticality Safety Training*, American Nuclear Society, January 1991.

11-8. 10 CFR 70.50, *Reporting Requirements*, U.S. Nuclear Regulatory Commission, 2008.

11-9. 10 CFR 70.74, *Additional Reporting Requirements*, U.S. Nuclear Regulatory Commission, 2008.

11-10. 10 CFR 70.62, *Safety Program and Integrated Safety Analysis,* U.S. Nuclear Regulatory Commission, 2008.

11-11. 10 CFR 20, *Standards for Protection Against Radiation*, U.S. Nuclear Regulatory Commission, 2008.

11-12. 10 CFR 70.4, *Definitions*, U.S. Nuclear Regulatory Commission, 2008.

11-13. 10 CFR 70.61, *Performance Requirements*, U.S. Nuclear Regulatory Commission, 2008.

11-14. 10 CFR 70, *Domestic Licensing of Special Nuclear Material*, U.S. Nuclear Regulatory Commission, 2008.

Table 11-1. Procedure Periodic Reviews.

Document	Review Frequency	Reviewing and Approving Functional Manager
Business Policy	When changed	CEO of affected GEH business unit(s)
Management Control Procedure	When changed [(a)]	Area manager, line manager, and affected EHS functions (radiation, criticality, environmental, industrial [(d)], or material control and accounting)
Operating Procedure	Every 3 Years [(c)]	Area manager, line manager, and affected EHS functions (radiation, criticality, environmental, industrial [(d)], or material control and accounting)
Nuclear Safety Instruction	Every 2 Years [(b)]	Radiation and criticality safety
Environmental Protection Instruction	Every 2 Years [(b)]	Environmental protection
Emergency Procedure	Annually	Area manager, line manager, and affected EHS function

[(a)] The safety awareness portions of these procedures are reviewed and updated by the appropriate environment, health, and safety (EHS) function when warranted based on process related facility change requests.

[(b)] Every two (2) years means a maximum interval of 26 months.

[(c)] Every three (3) years means a maximum interval of 39 months.

[(d)] EHS function - industrial means normal worker safety, chemical safety, and fire and explosion protection.