UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

AUG 4 1992

MEMORANDUM FOR: John Hickey, Chief
Fuel Cycle Safety Branch
Division of Industrial
and Medical Nuclear Safety, IMNS

RECEIVED BY
AUG 1 1992

FROM: John H. Austin, Chief
Decommissioning and Regulatory
Issues Branch
Division of Low-Level Waste Management
and Decommissioning, NMSS

SUBJECT: GROUNDWATER DOSE ASSESSMENT FOR DISPOSAL OF CONTAMINATED CALCIUM SULFATE IN THE GSX HAZARDOUS WASTE LANDFILL, PINEWOOD, SOUTH CAROLINA

As requested, I am providing a copy of our evaluation of the potential doses via the groundwater pathway to the public from the disposal of $CaSO_4$ waste contaminated with small quantities of low-enriched uranium in the GSX hazardous waste landfill, Pinewood, South Carolina. This assessment was performed by the Regulatory Issues Section to estimate the annual dose to the maximum reasonably-exposed individual via the groundwater pathway.

On July 20, 1992, the Regulatory Issues Section staff contacted the South Carolina Department of Health and Environmental Control (DHEC) staff members Ken Taylor, Robert Ede, and Willie Morgan to collect site specific information on the general and hydrological characteristics of the GSX landfill. Additional information was received by the NRC staff from DHEC on August 3, 1992. The producer of the $CaSO_4$, GE Wilmington, was also contacted to collect information on the waste characteristics by Ed Flack, of your staff. We used the information in the RESRAD dose assessment code to estimate potential doses associated with the groundwater pathway. Conservative assumptions were employed and a detailed explanation of these assumptions is contained in the attached report.

The peak doses produced from this assessment indicate that the potential releases from the disposal of the contaminated $CaSO_4$ in the GSX landfill are sufficiently low to ensure protection of the public health and safety. Even

under conservative conditions, the resulting annual dose to an off-site resident through the groundwater pathway is less than 1 mrem/yr. A more realistic exposure scenario would be expected to yield lower doses.

If you have any further questions, please contact Heather Astwood on 504-3466.

/S/ By Michael Weber for

John H. Austin, Chief
Decommissioning and Regulatory
Issues Branch
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and Decommissioning, NMSS

Enclosure: As Stated

Groundwater Dose Assessment for Disposal of Contaminated Calcium Sulfate in the GSX Hazardous Waste Landfill, Pinewood, South Carolina

Prepared by
Division of Low-Level Waste Management and Decommissioning
U.S. Nuclear Regulatory Commission
August 3, 1992

1. Introduction

In 1985, the Nuclear Regulatory Commission (NRC) approved a license amendment request from General Electric (GE) located in Wilmington, North Carolina. This amendment allows GE to dispose of industrial waste containing small amounts of low enriched uranium at the GSX Hazardous Waste Landfill in Pinewood, South Carolina. The amendment was made to the Exemptions and Special Authorization section of the Special Nuclear Material (SNM) license 1907 with the addition of section 1.8.5.2.

GE is allowed under the license condition to dispose of waste containing small quantities of low enriched uranium in accordance with Option 2 of the 1981 Branch Technical Position, "Disposal or Onsite Storage of Thorium or Uranium Waste from Past Operations"[1] with a maximum concentration of 250 pCi/g (insoluble) or 100 pCi/g (soluble).

Since 1986, GE has been disposing of calcium fluoride with an average concentration of 30 pCi/g of uranium in the Pinewood facility in compliance with the condition. On June 22, 1992, GE informed the NRC of plans to dispose of calcium sulfate ($CaSO_4$) waste material in the Pinewood Hazardous Waste disposal facility under the same condition[2].

Although $CaSO_4$ is covered in the 1985 condition (e.g., the condition does not limit the waste type other than total specific activity of U), NRC performed a reevaluation of the potential doses produced from the disposal of this waste. This assessment evaluates the potential doses via the groundwater pathway to individual members of the public resulting from the disposal of $CaSO_4$ containing low-enriched uranium in the Pinewood facility.

2. Calcium Sulfate Waste

Calcium sulfate is produced as a byproduct from the recovery of uranium from on-site lagoon sludge at the Wilmington site. GE states that the uranium content in the $CaSO_4$ meets the limits in the license condition. The average concentration of uranium in the waste is 50 pCi/g with a maximum of 250 pCi/g uranium. The uranium is enriched to 4% uranium-235. This enrichment is equivalent to stating that approximately 95.97% of the uranium will be U-238, 4% will be U-235, and 0.03% will be U-234[4]. GE plans to send approximately 280 cubic meters of $CaSO_4$ to Pinewood over a two-year period.

3. Pinewood Landfill

The Pinewood facility is located in Pinewood, South Carolina and is operated by the GSX Corporation. NRC staff members contacted the South Carolina Department of Health and Environmental Control (DHEC) to assemble information on the GSX site necessary to support the evaluation of potential groundwater dose. Additional information was received by the NRC staff from DHEC on August 3, 1992. GSX plans to bury a majority of the waste in cell 3A. This is a lined cell, which has a volume of approximately 360,000 cubic meters (289 acre feet). The cell, as measured on the site map supplied by DHEC, is approximately 57,600 m^2 (620,000 ft^2) with an average depth of 6 m (20 ft) and a maximum depth of 23 m (75 ft).

Over the two years GE will be sending waste to the landfill, GSX will continue to place other forms of solid waste in the cell. This will effectively dilute the $CaSO_4$ waste with the total volume of waste in the cell. The activity of the $CaSO_4$ waste was assumed to be at a maximum of 250 pCi/g. DHEC reported to the NRC staff that approximately 800 tons ($7.26x10^5$ Kg assuming a density of 2.602 g/cm^3 for $CaSO_4$) of $CaSO_4$ was going to be disposed of at the landfill. This is equivalent to a total inventory of 0.18 curies of uranium.

Considering that the inhalation and ingestion pathways are the principal pathways for potential exposures, this activity was then assumed to be diluted with the total volume of waste in the cell, thereby reducing the activity in the cell to 0.31 pCi/g. This is considered to be a conservative value since the actual average uranium concentration in the waste, was reported by GE to be approximately 50 pCi/g for the $CaSO_4$. Using this value, the average concentration over the volume of the cell would be 0.06 pCi/g.

The $CaSO_4$ will be disposed of in a moist sludge form and placed into three separate synthetic bags (polyester, polypropylene, and polyvinyl-chloride) before being tied to wooden pallets to be placed into the cell. The cell will be constructed as depicted in Figure 1.

4. Groundwater Model

To assess potential doses to a member of the public who might install a well near the landfill and extract groundwater, NRC staff modeled leaching and subsequent transport of the uranium from cell 3A into the groundwater. The RESRAD code version 4.1, which was developed by Argonne National Laboratory, was used to estimate the maximum annual dose which could be received by a member of the general public. A description of the code and its methodology can be found in ANL/ES-160[3].

RESRAD assumes an intruder-family farm scenario to estimate dose (Figure 2). In this scenario, an intruder builds a residence directly on top of the contaminated area and drills a well into the groundwater below and at the down gradient edge of the contaminated zone. The water obtained from this well is then assumed to be used in all water uses (e.g., drinking, bathing, cooking, irrigation of crops and watering farm animals). The code also simulates other pathways not associated with the groundwater, such as direct radiation, ingestion of soils and contaminated foods, and inhalation of dust and radon.

However, this assessment only evaluated potential doses via the groundwater pathway. Estimated doses via the other pathways are bounded by the technical basis for the 1981 BTP (e.g., approximately 20 mrem/yr EDE from inhalation of optimally respirable insoluble high enriched uranium).

To estimate a dose to the maximum reasonably exposed individual, conservative assumptions were used in the RESRAD calculations. The waste being considered in this evaluation is low-enriched uranium, which contains U-238, U-235, and U-234. The specific activity of U-234 is the highest of the three isotopes of uranium. Therefore, to be conservative, the entire inventory of uranium was assumed to be U-234.

The dose calculations were made assuming the inventory in the cell leached into the groundwater at rates proportional to the distribution coefficient values of 50, 35, and 25 cm^3/g for uranium in the waste, unsaturated zone and saturated zone respectively. Distribution coefficients for uranium in clay soils are typically two orders of magnitude higher (e.g., less leaching into water) than those for sandy soils[5]. A conservative value for sandy soils is approximately 35 cm^3/g. Therefore, 25 cm^3/g was chosen as a conservative value in the sandy saturated zone. A slightly higher value was then chosen for the unsaturated sandy/clay zone, and an even higher value for the clay surrounding the waste. These are very conservative values in clay soils and the actual coefficients in the waste and unsaturated zones are probably much higher. In addition, the calculations were made assuming there was no liner in the cell and the waste was covered with one meter of soil with no synthetic barriers, and no erosion of the contaminated zone.

A list of the site specific parameters collected from DHEC by phone which were used in the RESRAD code are contained in Table 1. All site specific data obtained from DHEC were incorporated into the RESRAD calculations. Other values which were incorporated into the RESRAD analysis were taken from the default values contained in RESRAD. These default values represent average soil conditions and were considered to adequately represent the conditions at this site. Many conservative assumptions were made in the analysis which should bound any effect in the dose produced from variations in the default values. Appendix A contains the output from the RESRAD code and shows the site specific hydrological data, and the default values used in the model.

5. Results

Using the RESRAD code and the assumptions described above, estimated potential doses to a member of the public who uses groundwater obtained from directly beneath the contaminated cell are on the order of 0.18 mrem/yr EDE using the distribution coefficients mentioned above and an initial concentration of 0.06 pCi/g. Larger doses, on the order of 0.96 mrem/yr EDE, were estimated using a an initial concentration of 0.31 pCi/g. These results are illustrated in Figures 3 and 4.

6. Discussion

The potential doses from disposal of the $CaSO_4$ waste are low. For comparison, the proposed EPA drinking water standard for uranium is 30 pCi/liter (56 FR

33050; July 18, 1991). This standard equates to a dose of about 6 mrem/yr EDE. Therefore, using reasonable distribution coefficient estimates and the maximum diluted concentration of uranium in the waste, disposal of the waste would result in contamination ten times less than the proposed EPA standard. Even for the conservative analysis performed by the NRC staff, disposal of the waste would not pose a significant risk to members of the public from the disposal of this waste in the GSX landfill.

Actual doses would be expected to be considerably less than estimated in this assessment. This was a very conservative analysis and probably overestimated the doses that might actually occur at this site. One of the most conservative assumptions made in this analysis was the location of the intruder well. In actuality, an intruder would probably build along the boundary of the site. There are institutional controls placed on the site, which should be somewhat effective in preventing the public from having access to the site over the next several decades. If, however, these controls fail, an individual drilling a well into a hazardous waste landfill would most likely realize that this was a burial site and discontinue drilling. The concentrations of uranium in a well off-site would be further decreased due to dispersion and retardation that would occur between the cell and the well. Therefore, potential doses to people off-site would be much less than those calculated here.

The distribution coefficients used in this analysis also contribute to the conservatism of the estimated dose. Clay soils generally have high coefficients and, therefore, highly retard uranium transport in groundwater. In this assessment very little credit for the clay in the soils was taken. The soils were assumed to be predominately sandy. Therefore, the mobility of the uranium was probably overestimated in this analysis.

The analysis also did not incorporate any synthetic barriers in the cover, and assumed no liner in the cell. Although the liner cannot be assumed to remain intact indefinitely, there will realistically be some retardation of the uranium by the liners. Even in the event of a failure by the synthetic barriers, the cover should remain somewhat effective in reducing the amount of precipitation passing through the waste, and will thereby reduce the mobilization of the uranium. The liners will also inhibit the release of the nuclides into the ground, to some extent, even if they are not completely intact. Since no credit was given for either type of barrier in the analysis, the estimated doses are also overestimated.

Taking into account all of the conservative assumptions incorporated in this assessment, the dose to the general public in this area would most likely be much lower than the doses in this analysis. Therefore, disposal of the contaminated $CaSO_4$ waste in the GSX landfill will not pose a significant risk to the public via potential leaching and transport of uranium in groundwater.

REFERENCES

1. U.S. Nuclear Regulatory Commission, Uranium Fuel Licensing Branch Technical Position, "Disposal or Onsite Storage of Thorium or Uranium Waste from Past Operations," Federal Register (46 FR 52061), October 23, 1981.

2. Memo to file dated June 22, 1992, from Ed Flack. Subject: "Disposal of Industrial Waste Products Containing Uranium".

3. "A Manual for Implementing Residual Radioactive Material Guidelines", Argonne National Laboratory, June 1989; ANL/ES-160, DOE/CH/8901.

4. Letter to file dated July 31, 1991, from Ed Flack. "Cascade Gradients - U-234, U-236 versus U-235 for June 30, 1991".

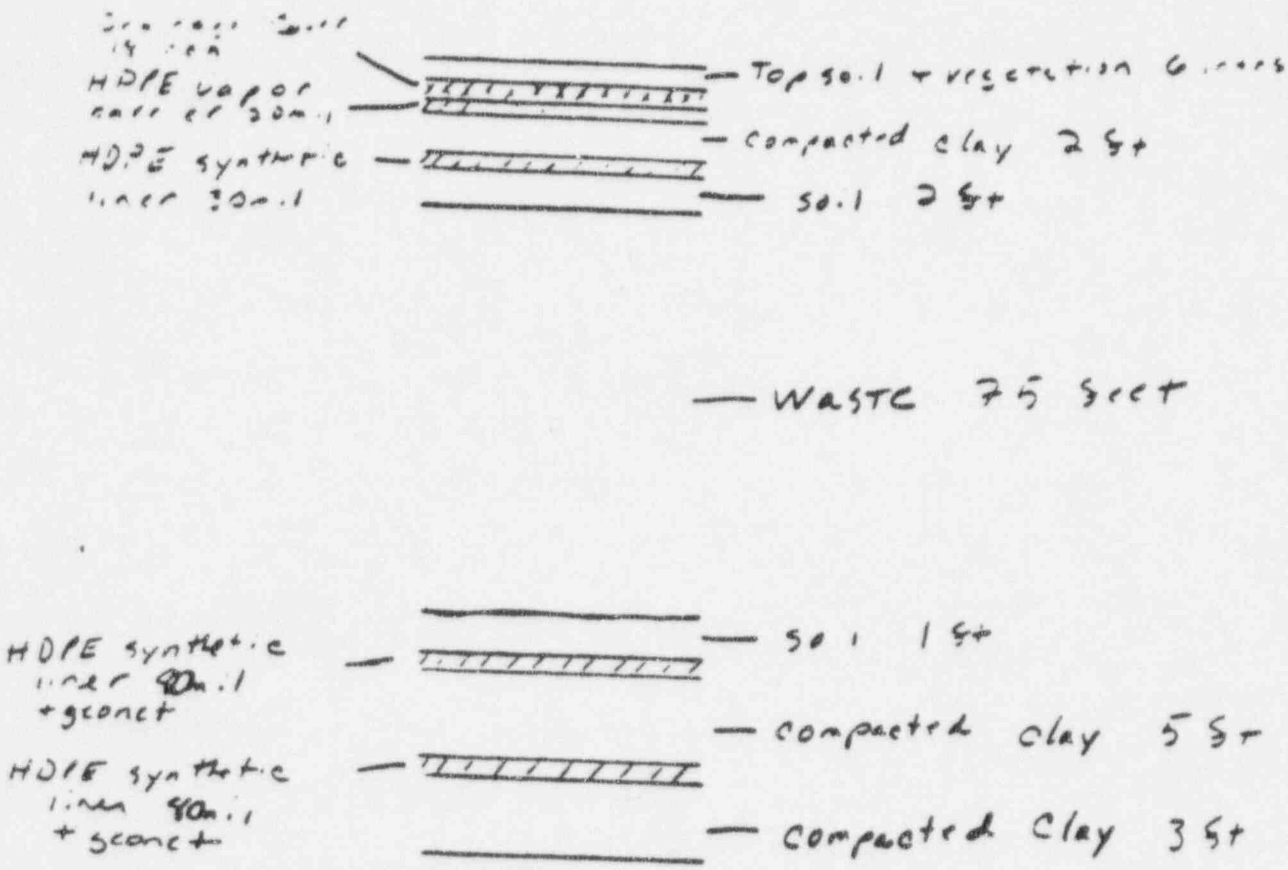
5. Sheppard, M. and D. Thibault, "Default Soil Solid/Liquid Partition Coefficients, K_ds, for Four Major Soil Types: A Compendium" Health Physics Vol. 59 No. 4, pp 471-482, 1991.

Table 1. A list of the information received by phone from DHEC July 20, 1992

Volume of cell 3A	approx. 289-300 acre feet
Depth of cell 3A	maximum of 75 feet
Cell liner from bottom up	10 feet claystone 3 feet compacted clay 80 mil synthetic liner (HDPE) and geonet 5 feet compacted clay 80 mil synthetic liner (HDPE) and geonet 1 foot soil Drainage above each layer
Cell cover from bottom up	2 feet soil 30 mil synthetic liner (HDPE) 2 feet compacted clay 20 mil vapor barrier 18 inch drainage cover 6 inch topsoil and vegetation
Permeability of clay stone	10^{-7} to 10^{-8} cm/sec
Permeability of clay layers	10^{-7} cm/sec
Effective porosity	approx. 15-25%
Hydraulic gradient	approx. 0.0035 SW
Annual precipitation	approx. 42 inches
Distance from bottom of cell to the next saturated unit	10 feet minimum
Distance from cell to next cell	approx. 500-800 feet
Distance from cell to lake	approx. 2500 feet
Distance from cell to buffer zone	approx. 1000 feet

Appendix A

Figure 1. Construction of cell 3A



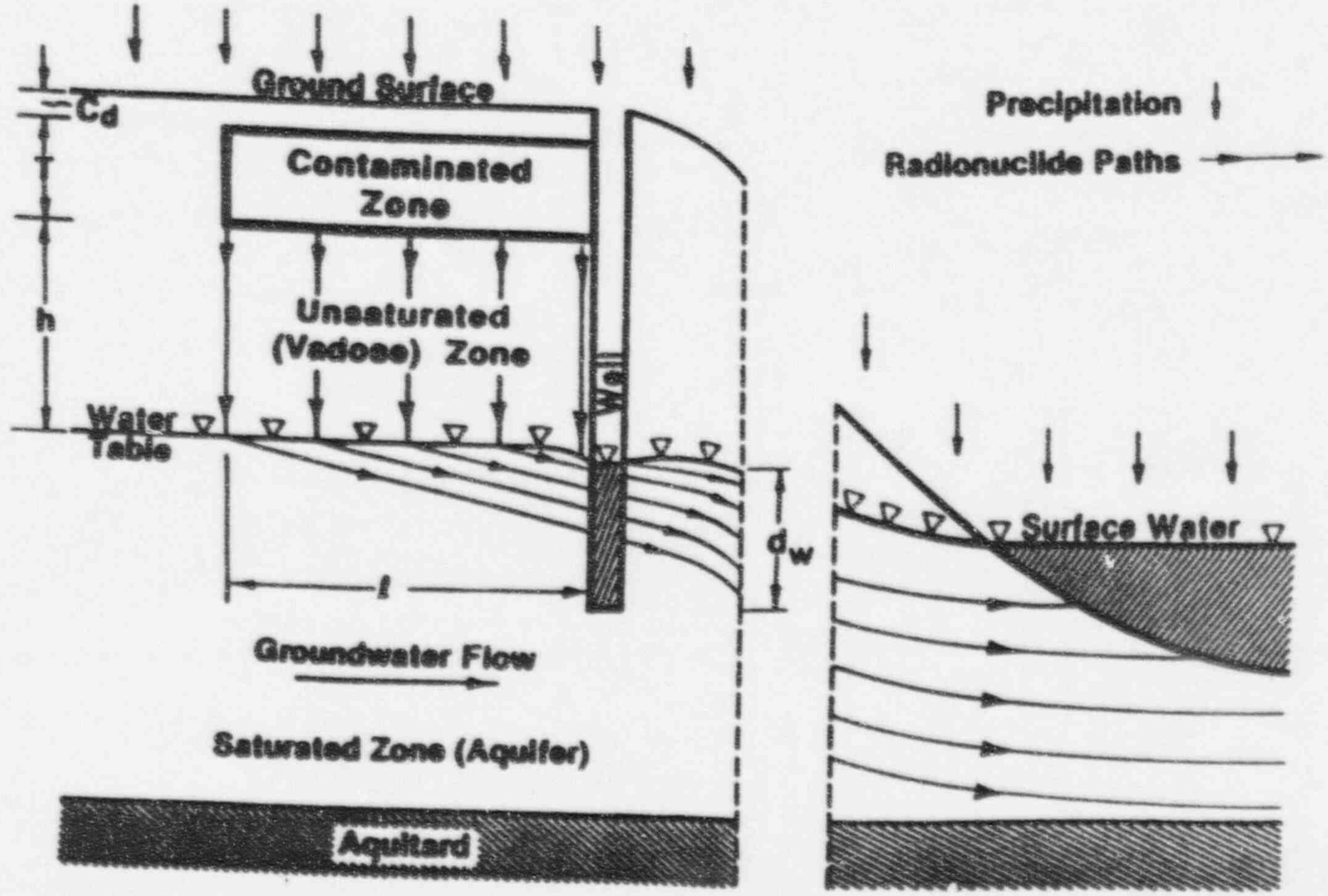


FIGURE 2. Schematic Representation of the Water Pathway Segments

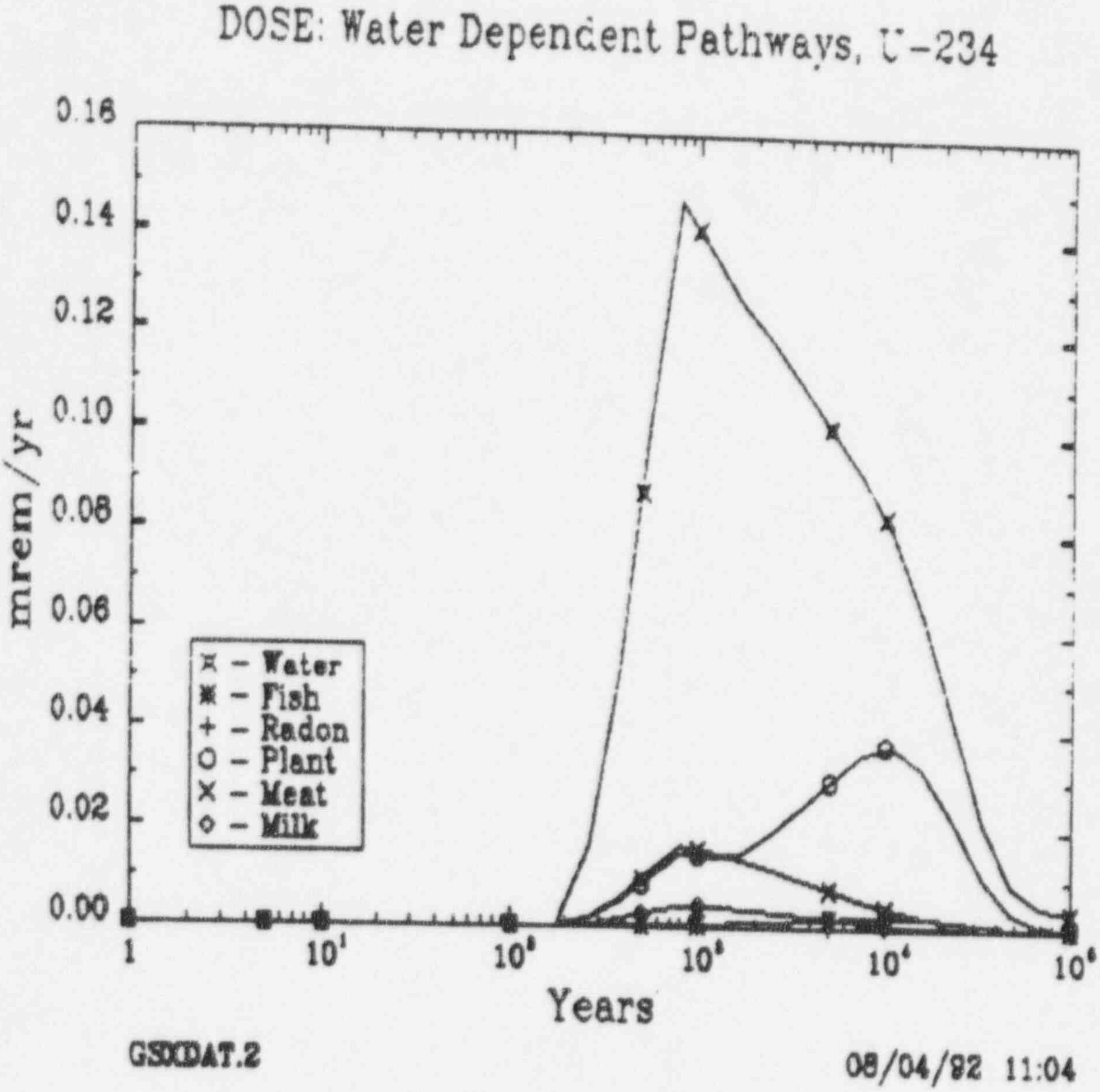


Figure 3. Estimated dose assessment using a concentration of 0.06 pCi/g. Maximum dose of 0.18 mrem/yr at 716 years.

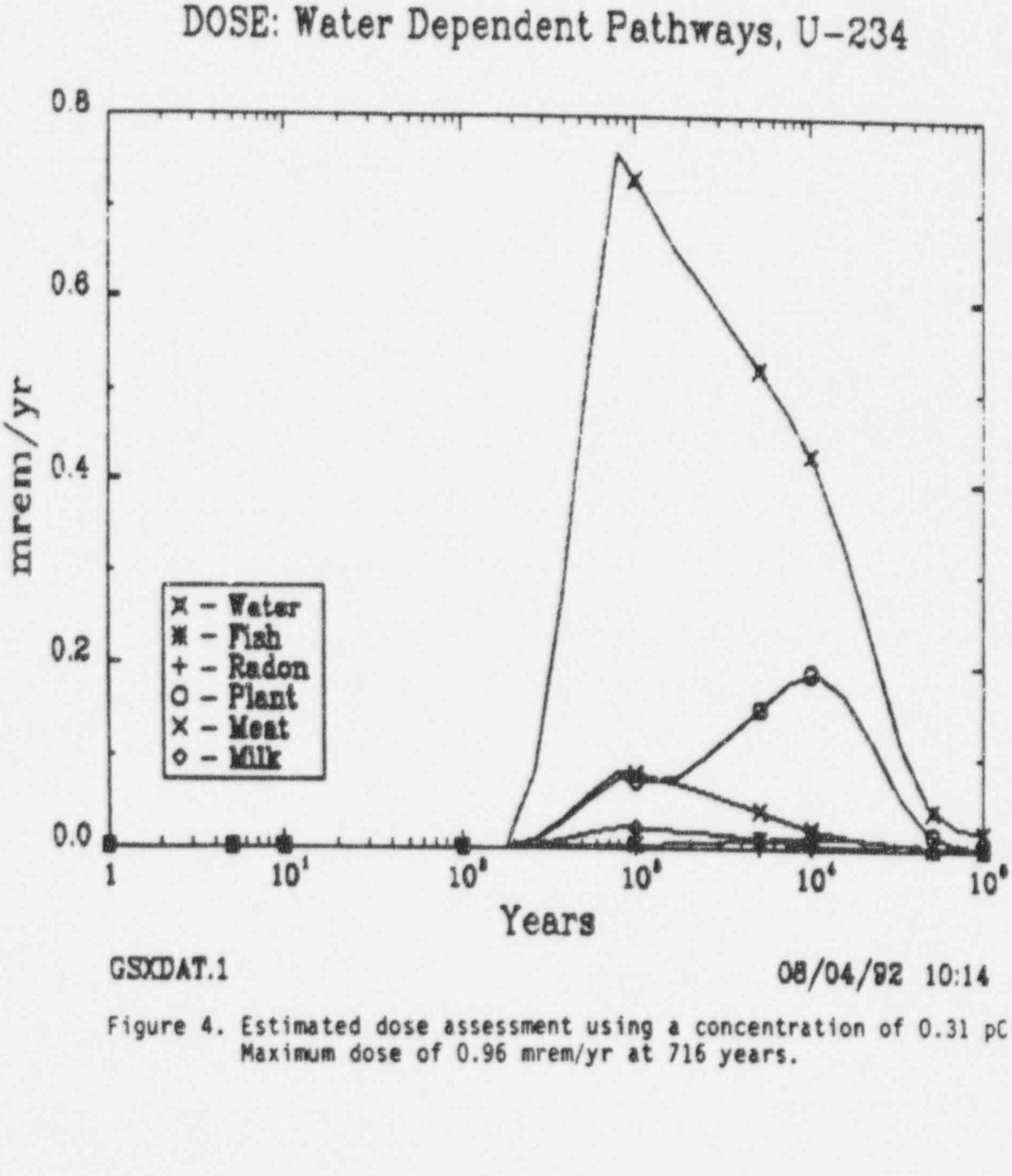


Figure 4. Estimated dose assessment using a concentration of 0.31 pCi/g. Maximum dose of 0.96 mrem/yr at 716 years.

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2) 57,600 *	1.359E+04	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	2.300E+01	1.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m) 240 *	~~1.248E+02~~	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	2.500E+01	1.000E+02	---	BRLD
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E-01	1.000E+00	---	T(2)
R011	Times for calculations (yr)	5.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	1.000E+02	3.000E+01	---	T(5)
R011	Times for calculations (yr)	5.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	1.000E+03	3.000E+02	---	T(7)
R011	Times for calculations (yr)	5.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	1.000E+04	3.000E+03	---	T(9)
R011	Times for calculations (yr)	1.000E+05	1.000E+04	---	T(10)
R012	Initial principal radionuclide (pCi/g): U-234	6.000E-02	0.000E+00	---	S(4)
R012	Concentration in groundwater (pCi/L): U-234	not used	0.000E+00	---	W(4)
R013	Cover depth (m)	1.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.600E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	0.000E+00	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.600E+00	1.600E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	0.000E+00	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone effective porosity .031 *	2.000E-01	2.000E-01	---	EPCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	3.400E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Evapotranspiration coefficient	6.000E-01	6.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.000E+00	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	2.000E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R014	Density of saturated zone (g/cm**3)	1.600E+00	1.600E+00	---	DENSAQ
R014	Saturated zone total porosity	4.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.000E-01	2.000E-01	---	EPSZ
R014	Saturated zone hydraulic conductivity (m/yr) 3 *	~~3.200E-02~~	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	3.500E-03	2.000E-02	---	HGWT
R014	Saturated zone b parameter	5.300E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	0.000E+00	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
014	Individual's use of groundwater (m**3/yr)	1.500E+02	1.500E+02	---	UW
R015	Number of unsaturated zone strata	1	1	---	NS
R015	Unsat. zone 1, thickness (m)	3.000E+00	4.000E+00	---	H(1)

R015	Unsat. zone 1, soil density (g/cm**3)	1.600E+00	1.600E+00	...	DENSUZ(1)
R015	Unsat. zone 1, total porosity	4.000E-01	4.000E-01	...	TPUZ(1)
R015	Unsat. zone 1, effective porosity	2.000E-01	2.000E-01	...	EPUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	5.300E+00	5.300E+00	...	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	.031* ~~1.000E+02~~	1.000E+02	...	HCUZ(1)

* Adjustments to input values due to additional information received from DHEC on Aug. 3, 1992.

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for U-234				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCACTC(4)
R016	Unsaturated zone 1 (cm**3/g)	3.500E+01	5.000E+01	---	DCACTU(4,1)
R016	Saturated zone (cm**3/g)	2.500E+01	5.000E+01	---	DCACTS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.163E-04	RLEACH(4)
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCACTC(1)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+02	1.000E+02	---	DCACTU(1,1)
R016	Saturated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCACTS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.084E-04	RLEACH(1)
R016	Distribution coefficients for daughter Ra-226				
R016	Contaminated zone (cm**3/g)	1.000E+02	7.000E+01	---	DCACTC(2)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+02	7.000E+01	---	DCACTU(2,1)
R016	Saturated zone (cm**3/g)	1.000E+02	7.000E+01	---	DCACTS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.084E-04	RLEACH(2)
R016	Distribution coefficients for daughter Th-230				
R016	Contaminated zone (cm**3/g)	1.000E+03	6.000E+04	---	DCACTC(3)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+03	6.000E+04	---	DCACTU(3,1)
R016	Saturated zone (cm**3/g)	1.000E+03	6.000E+04	---	DCACTS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.087E-05	RLEACH(3)
R017	Inhalation rate (m**3/yr)	not used	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	not used	2.000E-04	---	MLINH
R017	Dilution length for airborne dust, inhalation (m)	3.000E+00	3.000E+00	---	LM
R017	Occupancy factor, inhalation	not used	4.500E-01	---	FO3
R017	Occupancy and shielding factor, external gamma	not used	6.000E-01	---	FO1
R017	Shape factor, external gamma	not used	1.000E+00	---	FS1
R017	Fractions of annular areas within AREA:				
R017	Outer annular radius (m) = √(1/π)	not used	1.000E+00	---	FRACA(1)
R017	Outer annular radius (m) = √(10/π)	not used	1.000E+00	---	FRACA(2)
R017	Outer annular radius (m) = √(20/π)	not used	1.000E+00	---	FRACA(3)
R017	Outer annular radius (m) = √(50/π)	not used	1.000E+00	---	FRACA(4)
R017	Outer annular radius (m) = √(100/π)	not used	1.000E+00	---	FRACA(5)
R017	Outer annular radius (m) = √(200/π)	not used	1.000E+00	---	FRACA(6)
R017	Outer annular radius (m) = √(500/π)	not used	1.000E+00	---	FRACA(7)
R017	Outer annular radius (m) = √(1000/π)	not used	1.000E+00	---	FRACA(8)
R017	Outer annular radius (m) = √(5000/π)	not used	1.000E+00	---	FRACA(9)
R017	Outer annular radius (m) = √(1.E+04/π)	not used	1.000E+00	---	FRACA(10)
R017	Outer annular radius (m) = √(1.E+05/π)	not used	0.000E+00	---	FRACA(11)
R017	Outer annular radius (m) = √(1.E+06/π)	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	1.600E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	1.400E+01	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	9.200E+01	9.200E+01	---	DIET(3)

R018	Meat and poultry consumption (kg/yr)	6.300E+01	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	5.400E+00	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	9.000E-01	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	not used	3.650E+01	---	SOIL

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2) 57,600 *	[illegible]	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	2.300E+01	1.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m) 240 *	1.248E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	2.500E+01	1.000E+02	---	BRLD
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E-01	1.000E+00	---	T(2)
R011	Times for calculations (yr)	5.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	1.000E+02	3.000E+01	---	T(5)
R011	Times for calculations (yr)	5.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	1.000E+03	3.000E+02	---	T(7)
R011	Times for calculations (yr)	5.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	1.000E+04	3.000E+03	---	T(9)
R011	Times for calculations (yr)	1.000E+05	1.000E+04	---	T(10)
R012	Initial principal radionuclide (pCi/g): U-234	3.100E-01	0.000E+00	---	S(4)
R012	Concentration in groundwater (pCi/L): U-234	not used	0.000E+00	---	W(4)
R013	Cover depth (m)	1.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.600E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	0.000E+00	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.600E+00	1.600E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	0.000E+00	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone effective porosity	2.000E-01	2.000E-01	---	EPCZ
R013	Contaminated zone hydraulic conductivity (m/yr) .031 *	3.400E-04	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Evapotranspiration coefficient	6.000E-01	6.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.000E+00	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	2.000E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R014	Density of saturated zone (g/cm**3)	1.600E+00	1.600E+00	---	DENSAQ
R014	Saturated zone total porosity	4.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.000E-01	2.000E-01	---	EPSZ
R014	Saturated zone hydraulic conductivity (m/yr) 3.0 *	5.200E-02	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	3.500E-03	2.000E-02	---	HGWT
R014	Saturated zone b parameter	5.300E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	0.000E+00	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Individual's use of groundwater (m**3/yr)	1.500E+02	1.500E+02	---	UW
R015	Number of unsaturated zone strata	1	1	---	NS
R015	Unsat. zone 1, thickness (m)	3.000E+00	4.000E+00	---	H(1)

R015	Unsat. zone 1, soil density (g/cm**3)	1.600E+00	1.600E+00	...	DENSUZ(1)
R015	Unsat. zone 1, total porosity	4.000E-01	4.000E-01	...	TPUZ(1)
R015	Unsat. zone 1, effective porosity	2.000E-01	2.000E-01	...	EPUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	5.300E+00	5.300E+00	...	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr) .031	*.000E+02	1.000E+02	...	HCUZ(1)

* Adjustments to input values due to additional information received from DHEC on Aug. 3, 1992.

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for U-234				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCACTC(4)
R016	Unsaturated zone 1 (cm**3/g)	3.500E+01	5.000E+01	---	DCACTU(4,1)
R016	Saturated zone (cm**3/g)	2.500E+01	5.000E+01	---	DCACTS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.[illegible]63E-04	RLEACH(4)
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCACTC(1)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+02	1.000E+02	---	DCACTU(1,1)
R016	Saturated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCACTS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.084E-04	RLEACH(1)
R016	Distribution coefficients for daughter Ra-226				
R016	Contaminated zone (cm**3/g)	1.000E+02	7.000E+01	---	DCACTC(2)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+02	7.000E+01	---	DCACTU(2,1)
R016	Saturated zone (cm**3/g)	1.000E+02	7.000E+01	---	DCACTS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.084E-04	RLEACH(2)
R016	Distribution coefficients for daughter Th-230				
R016	Contaminated zone (cm**3/g)	1.000E+03	6.000E+04	---	DCACTC(3)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+03	6.000E+04	---	DCACTU(3,1)
R016	Saturated zone (cm**3/g)	1.000E+03	6.000E+04	---	DCACTS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.087E-[illegible]	RLEACH(3)
R017	Inhalation rate (m**3/yr)	not used	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	not used	2.000E-04	---	MLINH
R017	Dilution length for airborne dust, inhalation (m)	3.000E+00	3.000E+00	---	LM
R017	Occupancy factor, inhalation	not used	4.500E-01	---	FO3
R017	Occupancy and shielding factor, external gamma	not used	6.000E-01	---	FO1
R017	Shape factor, external gamma	not used	1.000E+00	---	FS1
R017	Fractions of annular areas within AREA:				
R017	Outer annular radius (m) = √(1/π)	not used	1.000E+00	---	FRACA(1)
R017	Outer annular radius (m) = √(10/π)	not used	1.000E+00	---	FRACA(2)
R017	Outer annular radius (m) = √(20/π)	not used	1.000E+00	---	FRACA(3)
R017	Outer annular radius (m) = √(50/π)	not used	1.000E+00	---	FRACA(4)
R017	Outer annular radius (m) = √(100/π)	not used	1.000E+00	---	FRACA(5)
R017	Outer annular radius (m) = √(200/π)	not used	1.000E+00	---	FRACA(6)
R017	Outer annular radius (m) = √(500/π)	not used	1.000E+00	---	FRACA(7)
R017	Outer annular radius (m) = √(1000/π)	not used	1.000E+00	---	FRACA(8)
R017	Outer annular radius (m) = √(5000/π)	not used	1.000E+00	---	FRACA(9)
R017	Outer annular radius (m) = √(1.E+04/π)	not used	1.000E+00	---	FRACA(10)
R017	Outer annular radius (m) = √(1.E+05/π)	not used	0.000E+00	---	FRACA(11)
R017	Outer annular radius (m) = √(1.E+06/π)	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	1.600E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	1.400E+01	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	9.200E+01	9.200E+01	---	DIET(3)

R018	Meat and poultry consumption (kg/yr)	6.300E+01	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	5.400E+00	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	9.000E-01	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	not used	3.650E+01	---	SOIL

ATTACHMENT 2

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CHAPTER 2.0

ORGANIZATION AND ADMINISTRATION

2.1 POLICY

The GE-Wilmington policy is to maintain a safe work place for its employees, to protect the environment, and to assure operational compliance within the terms and conditions of special nuclear material licenses and applicable NRC regulations.

2.2 ORGANIZATIONAL RESPONSIBILITIES AND AUTHORITY

2.2.1 KEY POSITIONS WITH RESPONSIBILITIES IMPORTANT TO SAFETY (FIGURE 2.1)

Responsibilities, authorities, and interrelationships among the GE-Wilmington organizational functions with responsibilities important to safety are specified in approved position descriptions and in documented and approved practices.

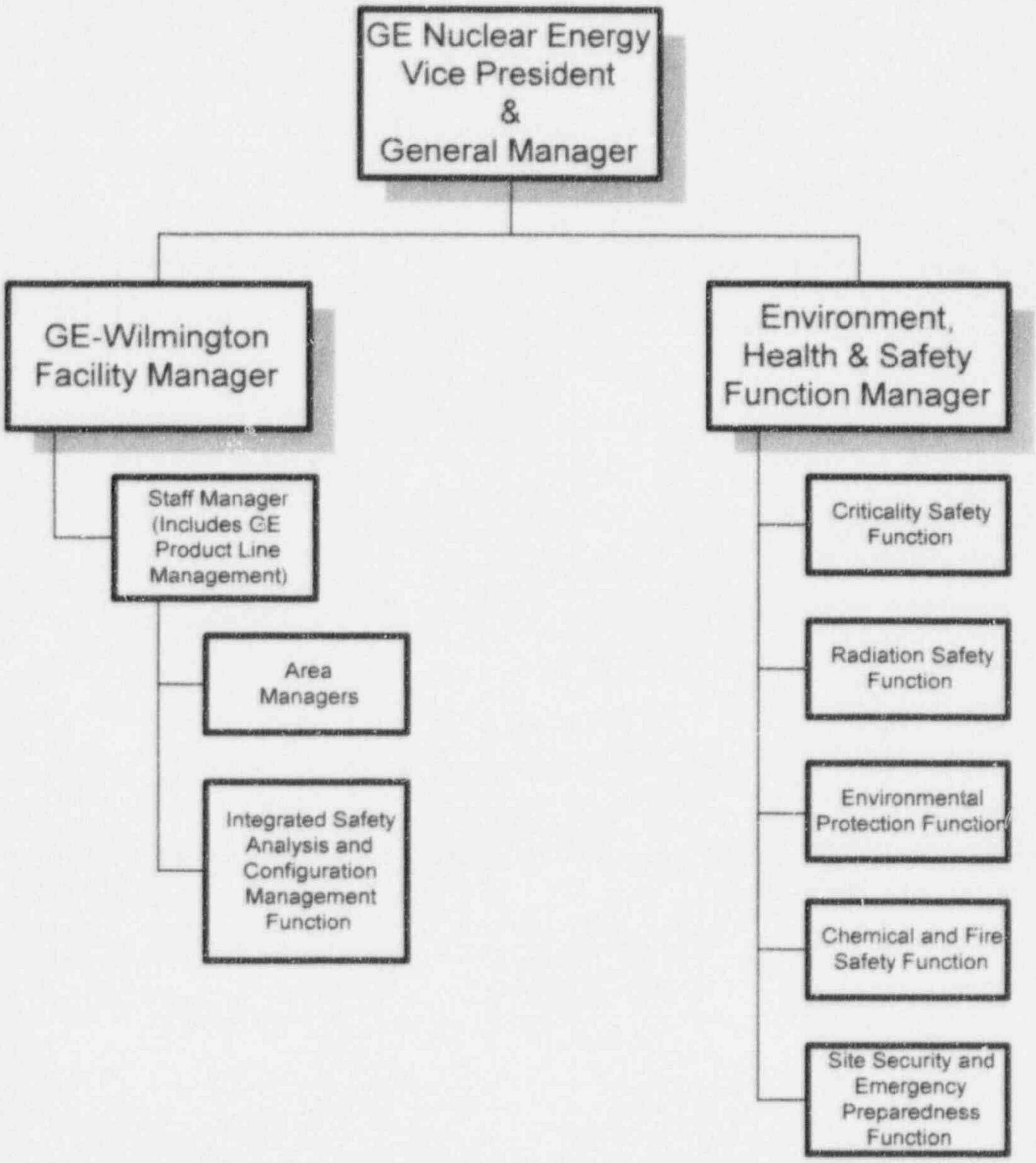
2.2.1.1 GE-Wilmington Facility Manager

The GE-Wilmington facility manager is the individual who has overall responsibility for safety and activities conducted at the GE-Wilmington facility. The GE-Wilmington facility manager directs operations by procedure, or through other management personnel. The activities of the GE-Wilmington facility manager are performed in accordance with GE policies, procedures, and management directives. The GE-Wilmington facility manager provides for safety and control of operations and protection of the environment by delegating and assigning responsibility to qualified Area Managers.

The GE-Wilmington facility manager is knowledgeable of the safety program concepts as they apply to the overall safety of a nuclear facility, and has the authority to enforce the shutdown of any process or facility.

Figure 2.1

GE-Wilmington Organization



2.2.1.2 Area Manager

The Area Manager is the designated individual who is responsible for ensuring that activities necessary for safe operations and protection of the environment are conducted properly within their designated area of the facility in which uranium materials are processed, handled or stored. Designated Area Manager responsibilities include:

- Assure safe operation, maintenance and control of activities
- Assure safety of the environs as influenced by operations
- Assure performance of integrated safety analyses for the assigned facility area, as required
- Assure application of assurance elements to safety controls, as appropriate
- Assure configuration control for safety controls for the assigned facility area, as required
- Use approved written operating procedures which incorporate safety controls and limits
- Provide adequate operator training

The minimum qualifications of an Area Manager is a BS or BA degree in a technical field, and two years of experience in manufacturing operations, one of which is in nuclear fuel manufacturing; or a high school diploma with five years of manufacturing experience, two of which are in nuclear fuel manufacturing.

Area Managers shall be knowledgeable of the safety program procedures, and shall have experience in the application of the program controls and requirements, as they relate to their areas of responsibility. The assignment of individuals to the position of Area Manager is approved by the GE-Wilmington facility manager, and the listing of Area Managers by area of responsibility is maintained current at the facility.

2.2.1.3 Integrated Safety Analysis and Configuration Management Function

The integrated safety analysis and configuration management function is administratively part of the fuel production operations at GE-Wilmington. Designated responsibilities include:

- Establish and maintain the integrated safety analysis program
- Establish and maintain the assurance program for safety controls
- Provide advice and counsel to Area Managers on matters of the integrated safety analysis program
- Establish and maintain the configuration control system for fuel manufacturing equipment and safety controls, and related record retention
- Establish and maintain the operating procedure systems

Minimum qualification requirements for the manager of the integrated safety analysis and configuration management function are a BS or BA degree in science or engineering and two years experience in related manufacturing assignments; or a high school diploma with five years of manufacturing experience. The manager of the integrated safety analysis and configuration management function shall have experience in the understanding and management of the assigned programs.

2.2.1.4 Criticality Safety Function

The criticality safety function is administratively independent of production responsibilities and has the authority to shutdown potentially unsafe operations. Designated responsibilities include:

- Establish the criticality safety program including design criteria, procedures and training
- Provide criticality safety support for integrated safety analyses and configuration control
- Assess normal and credible abnormal conditions
- Determine criticality safety limits for controlled parameters
- Perform methods development and validation to support criticality safety analyses
- Perform neutronics calculations, write criticality safety analyses and approve proposed changes in process conditions or equipment involving fissionable material
- Specify criticality safety control requirements and functionality

- Provide advice and counsel to Area Managers on criticality safety control measures, including review and approval of operating procedures
- Support emergency response planning and events
- Assess the effectiveness of the criticality safety program through audit programs

The criticality safety function manager shall hold a BS or BA degree in science or engineering, have at least two years experience in assignments involving regulatory activities, and have experience in the understanding, application and direction of nuclear criticality safety programs.

Minimum qualifications for a senior engineer within the criticality safety function are a BS or BA degree in science or engineering with at least two years of nuclear industry experience in criticality safety. A senior engineer shall have experience in the assigned safety function, and has authority and responsibility to conduct activities assigned to the criticality safety function.

Minimum qualifications for an engineer within the criticality safety function are a BS/BA degree in science or engineering with at least one year of nuclear industry experience in criticality safety. An engineer shall have experience in the assigned safety function, and has authority and responsibility to conduct activities assigned to the criticality safety function, with the exception of independent verification of criticality safety analyses.

2.2.1.5 Radiation Safety Function

The radiation safety function is administratively independent of production responsibilities and has the authority to shutdown potentially unsafe operations. Designated responsibilities include:

- Establish the radiation protection and radiation monitoring programs
- Establish the radiation protection design criteria, procedures and training programs to control contamination and exposure to individuals
- 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 radiation safety support for integrated safety analyses and configuration control
- Provide analysis and approval of proposed changes in process conditions and process equipment involving radiological safety
- Provide advice and counsel to Area Managers on matters of radiation safety
- Support emergency response planning and events
- Assess the effectiveness of the radiation safety program through audit programs

The radiation safety function manager shall hold a BS or BA degree in science or engineering, have at least two years experience in assignments that include responsibility for radiation safety, and have experience in the understanding, application and direction of radiation safety programs.

Minimum qualifications for a senior member of the radiation safety function are a BS or BA degree in science or engineering with at least two years of nuclear industry experience in the assigned function. Alternate minimum experience qualification for a senior member of the radiation safety function is 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 radiation safety function.

2.2.1.6 Environmental Protection Function

The environmental protection function is administratively independent of production responsibilities and has the authority to shutdown operations with potentially uncontrolled environmental conditions. Designated responsibilities include:

- Identify environmental protection requirements from federal, state and local regulations which govern the GE-Wilmington 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
- Evaluate and approve new, existing or revised equipment, processes and procedures involving environmental protection activities
- Provide environmental protection support for integrated safety analyses and configuration control
- Assure proper federal and state permits, licenses and registrations for non-radiological discharges from the facilities

Minimum qualifications for the manager of the environmental protection function are a BS or BA degree in science or engineering and two years of experience in assignments involving regulatory activities or equivalent.

2.2.1.7 Chemical and Fire Safety Function

The chemical and fire safety function is administratively independent of the production responsibilities and has the authority to shutdown operations with potentially hazardous health and safety conditions. Designated responsibilities include:

- Identify fire protection requirements from federal, state, and local regulations which govern GE-Wilmington operations
- Develop practices regarding non-radiological chemical safety affecting nuclear activities
- Provide advice and counsel to Area Managers on matters of chemical and fire safety
- Provide consultation and review of new, existing or revised equipment, processes and procedures regarding chemical safety and fire protection
- Provide chemical and fire safety support for integrated safety analyses and configuration control

Minimum qualifications of the manager of the chemical and fire safety function are a BS or BA degree in science or engineering and two years of experience in related assignments.

2.2.1.8 Site Security and Emergency Preparedness Function

The site security and emergency preparedness function is administratively independent of the production responsibilities. Designated responsibilities include:

- Provide physical security for the GE-Wilmington facility
- Establish and maintain the emergency preparedness program, including training and program evaluations
- Provide advice and counsel to Area Managers on matters of physical security and emergency preparedness
- Maintain agreements and preparedness with off-site emergency support groups

Minimum qualifications are a BS or BA degree in science or engineering, one year of experience in related assignments, or a high school diploma with three years of experience in related assignments.

2.2.1.9 Environment, Health & Safety (EHS) Function

The EHS function is administratively independent of production responsibilities 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. This function has designated overall responsibility to establish the radiation safety, criticality safety, environmental protection, chemical safety, fire protection and emergency preparedness programs to ensure compliance with federal, state and local regulations and laws governing operation of a nuclear manufacturing facility. These programs are designed to ensure the health and safety of employees and the public as well as protection of the environment. The managers of the criticality safety, radiation safety, environmental protection, chemical and fire safety, and site security and emergency preparedness functions report to the EHS function manager.

The manager of the EHS function must hold a BS or BA degree in science or engineering and have two years of management experience in assignments involving regulatory activities. The manager of the EHS function must have appropriate understanding of health physics, nuclear criticality safety, environmental protection, and chemical and fire safety programs.

2.2.2 MANAGEMENT CONTROLS

Management controls for the conduct and maintenance of the GE-Wilmington health, safety and environment protection programs are contained in documented plant practices described in Section 3.9.1, which are approved by cognizant management. Such practices are part of a controlled document system, and appropriately span the organizational structure and major plant activities to control interrelationships, and to 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 evaluations.

Management controls documented in practices address requirements including:

- Configuration Management
- Integrated Safety Analysis
- Radiation Safety
- Criticality Safety
- Environmental Protection
- Chemical Safety
- Fire & Explosion Safety
- Emergency Preparedness
- Quality Assurance
- Training
- Procedures
- Maintenance
- Audits
- Incident Investigation & Reporting
- Fissile Material Accountability and Control

2.3 SAFETY COMMITTEES

2.3.1 WILMINGTON SAFETY REVIEW COMMITTEE

The functions of the Wilmington Safety Review Committee include responsibility for the following:

- An annual ALARA review which considers:
    - Programs and projects undertaken by the radiation safety function and the Radiation Safety Committee
    - 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 used for effluent and exposure control
- Review of major changes in authorized plant activities which may affect nuclear or non-nuclear safety practices
- Professional advice and counsel on environmental protection, and criticality, radiation, chemical and fire safety issues affecting the nuclear activities.

The committee is responsible to the GE-Wilmington facility manager. Its proceedings, findings and recommendations are reported in writing to the GE-Wilmington facility manager and to appropriate staff level managers responsible for operations which have been reviewed by the committee. Such reports shall be retained for at least three years.

The committee holds at least three meetings each calendar year with a maximum interval of 180 days between any two consecutive meetings.

2.3.2 RADIATION SAFETY COMMITTEE

The objective of the Radiation Safety Committee is to maintain occupational radiation exposures as low as reasonably achievable (ALARA) through improvements in fuel manufacturing operations.

The committee meets monthly to maintain a continual awareness of the status of projects, performance measurement and trends, and the current radiation safety conditions of shop activities. The maximum interval between meetings does not exceed 60 days.

A written report of each Radiation Safety Committee meeting is forwarded to cognizant Area Managers and the manager of the EHS function. Records of the committee proceedings are maintained for three years.

The committee consists of managers or representatives from key manufacturing functions with activities affecting radiation safety.

CHAPTER 3.0

CONDUCT OF OPERATIONS

3.1 CONFIGURATION MANAGEMENT (CM)

3.1.1 CONFIGURATION MANAGEMENT PROGRAM

A formal configuration management process, governed by written, approved practices, ensures that plant design changes do not adversely impact on safety, health, or environmental protection programs at GE-Wilmington. The configuration management program ensures that the information used to operate and maintain safety controls is kept current. Safety controls are systems, structures, components and procedures which prevent and/or mitigate the risk of accidents. The use of current plant information is an integral part of the integrated safety analysis program described in Chapter 4.0.

The CM program includes the following activities:

- Maintenance of the design information for the plant
- Control of information used to operate and maintain the plant
- Documentation of changes
- Assurance of adequate safety reviews for changes
- Periodic comparison assessment of the conformance of specific safety controls to the documentation of plant design bases

3.1.2 PLANT DESIGN REQUIREMENTS

Written plant practices define the development, application, and maintenance of the design specifications and requirements. Plant design specifications and requirements are maintained as controlled information. The specific content of the information depends on the age of the design and the requirements in place at the time of design. As a minimum the information required for safe operation of the facility is available.

3.1.3 CHANGE CONTROL

Written plant practices describe the configuration management program for change management, including approval to install and operate facility changes. Facility changes are assessed by a trained and approved safety reviewer to determine if the applicable ISA is impacted, and if further review and approval is required by an ISA team as described in Chapter 4.0.

The written plant practices also prescribe controls and define the distinction between types of changes, ranging from replacement with identical designs which are authorized as part of normal maintenance, to new or different designs which require specified review and approval.

3.1.4 DOCUMENT CONTROL

Documented plant practices define the control system, including creation, revision, storage, tracking, distribution and retrieval of applicable information including :

- Operating procedures
- Drawings
- Technical specifications and requirements
- Software for safety controls
- Calibration instructions
- Functional test instructions

The documented plant practices describe the responsibilities and activities which maintain consistency between the facility design, the physical facility, and the documentation. They also describe how the latest approved revisions are made available for operations.

3.2 MAINTENANCE

The purpose of planned and scheduled maintenance for safety controls is to assure that systems are kept in a condition of readiness to perform the planned and designed functions when required. Area Managers are responsible to assure the operational readiness of safety controls in their assigned facility areas. For this reason the maintenance function is administratively part of or closely coupled to fuel production

operations. The maintenance function utilizes a systems-based program to plan, schedule, track and maintain records for maintenance activities. Maintenance instructions are an integral part of the maintenance system for maintenance activities. Discrimination between specified safety controls and other systems based on integrated safety analyses is maintained in the database. Key maintenance requirements for safety controls such as calibration, functional testing, and replacement of specified components are derived from integrated safety analyses described in Chapter 4.0, and the application of the graded approach to assurance elements.

Maintenance activities generally fall into the categories described below:

3.2.1 SCHEDULED PREVENTIVE MAINTENANCE

Examples of safety controls included for scheduled preventive maintenance are :

- Radiation Measurement Instruments
- Criticality Detection Devices
- Effluent Measurement & Control Devices
- Emergency Power Generators
- Fire Detection and Control Systems
- Pressure Relief Valves
- Air Compressors
- Steam Boilers

3.2.2 PERIODIC FUNCTIONAL TESTING

Examples of safety controls included for periodic functional testing include :

- Criticality Warning System
- Fire Alarm System
- Specified Active Engineered Controls on Process Equipment

Frequencies and requirements for functional testing of various safety controls are derived through quality and reliability activities using a graded approach to assurance

as described in Section 3.3. The integrated safety analysis is the basis for this implementation.

3.2.3 REPAIR OF SAFETY CONTROLS

The maintenance planning and control system provides documentation and records of systems and components which have been repaired or replaced.

When a component of specified safety control is repaired or replaced, the component is functionally verified to assure that it has the capability to perform its 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 or the original component, the change to the safety control is specifically approved under the configuration management program and tested to assure it is likely to perform its desired function when called upon to do so.

3.3 QUALITY ASSURANCE (QA)

The application of assurance measures to safety controls at GE-Wilmington focuses on assuring that these controls are designed, installed, operated and maintained such that their planned function is not compromised.

3.3.1 ASSURANCE ELEMENTS

The following assurance elements are applied to safety controls at GE-Wilmington:

- Organization
- Program
- Equipment/System Design Control
- Procurement Documentation Control
- Instructions, Procedures, and Drawings
- Document Control
- Control of Purchased Materials, Equipment, and Services
- Identification and Control of Materials, Parts, and Components

- Control of Special Processes
- Internal Inspections
- Test Control
- Control of Measuring and Test Equipment
- Handling, Storage, and Shipping Controls
- Inspection, Test, and Operating Status
- Control of Nonconforming Materials, Parts, or Components
- Corrective Action
- Records
- Audits

3.3.2 ASSURANCE ELEMENT APPLICATION TO SAFETY CONTROLS

In accordance with documented internal practices, the assurance elements are applied to safety controls in proportion to their importance to safety, and as an integral part of the Integrated Safety Assessment program described in Chapter 4.0. This graded approach segregates safety controls and activities into three categories in applying the assurance elements:

- For safety controls intended to prevent or mitigate the consequences of the highest risk category, each of the assurance elements are specifically evaluated and applied to the control, and their application requirements documented as part of the ISA. Justification for each assurance element not applicable to a control in this category is also documented.
- For safety controls intended to prevent or mitigate the consequences of the mid-level risk category, each of the assurance elements is thoroughly evaluated and applicable assurance elements and their requirements are applied and documented.
- Safety Controls in the low risk category are operated and maintained as part of routine and prudent industry practice, and are controlled by means of normal, established manufacturing assurance systems. No extraordinary assurance element requirements are documented.

Assurance element requirements and application decisions are based on sound engineering practices and judgment.

Assurance element descriptions and application, are included in documented practices as part of the GE-Wilmington management system. These practices also specify the requirements for related record retention.

3.4 TRAINING AND QUALIFICATION

Training is provided for each individual at GE-Wilmington, 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. Formal training relative to safety includes radiation and radioactive materials, risks involved in receiving low level radiation exposure in accordance with 10CFR19.12, basic criteria and practices for radiation protection, nuclear criticality safety principles not verbatim, but in general conformance with ANSI/ANS 8.20 guidance, chemical and fire safety, maintaining radiation exposures and radioactivity in effluents As Low As Reasonably Achievable (ALARA), and emergency response.

The system established for maintaining records of training and retraining is described in Section 3.8.

3.4.1 NUCLEAR SAFETY TRAINING

Training policy requires that employees complete formal nuclear safety training prior to unescorted access in the airborne radioactivity controlled area. Methods for evaluating the understanding and effectiveness of the training includes passing an initial examination covering formal training contents and observations of operational activities during scheduled audits and inspections.

Such training is performed by trained instructors approved by the manager of the criticality safety function and the manager of the radiation safety function. Training program contents are reviewed on a scheduled basis by the manager of the criticality safety and radiation safety functions to ensure that training program contents are current and adequate.

Previously trained employees who are allowed unescorted access to the airborne radioactivity controlled area are retrained at least every two years. The effectiveness

of the training program is evaluated by an initial training exam. Visitors are trained commensurate with the scope of their visit and/or escorted by trained employees.

3.4.2 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 and 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 process safety-related tasks being independently performed or before startup following significant changes to safety controls.

3.5 HUMAN FACTORS

Human factors are an integral part of the management and operational safety philosophy at GE-Wilmington. The consideration of human factors in relation to operational safety is included in integrated safety analyses.

Human factors concepts are also considered in:

- Equipment design
- Safety control design
- Operator training
- Maintenance
- Audits and assessments
- Incident investigations

3.6 AUDITS AND ASSESSMENTS

Planned and scheduled internal and independent audits are performed to evaluate the application and effectiveness of management controls and implementation of programs related to activities significant to plant safety. Written operating procedures are based on GE-Wilmington practices, applicable regulations and license conditions. Audits are performed to assure that operations are conducted in

accordance with the operating procedures, and to assure that safety programs reflected in the operating procedures are maintained.

3.6.1 CRITICALITY, RADIATION, CHEMICAL AND FIRE SAFETY AUDITS

Representatives of the criticality safety function, the radiological safety function, and the chemical and fire safety function conduct formal, scheduled safety audits of fuel manufacturing and support areas in accordance with documented, approved practices. These audits are performed to determine that operations conform to criticality, radiation, and chemical and fire safety requirements.

Criticality and radiological audits are performed quarterly (at intervals not to exceed 110 days) under the direction of the manager of the criticality safety function and the manager of the radiation safety function. Chemical and fire safety audits are performed under the direction of the chemical and fire safety function manager. Personnel performing audits do not report to the production organization and have no direct responsibility for the function and area being audited.

Audit results are communicated in writing to the cognizant Area Manager and to the manager of the environment, health & safety function. Required corrective actions are documented and approved by the Area Manager, reported to the GE-Wilmington facility manager, and tracked to completion by the environment, health & safety function.

Radiation protection personnel within the radiation safety function conduct weekly nuclear safety inspections of fuel manufacturing and support areas in accordance with documented procedures. Inspection findings are documented and sent to the affected Area Manager for resolution.

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.

3.6.2 ENVIRONMENTAL PROTECTION AUDITS

An audit schedule of the environmental protection program is developed by the environmental protection function on an annual basis. Audits are conducted in accordance with documented practices to ensure that operational activities conform to documented environmental requirements.

Personnel under the direction of the manager of the environmental protection function perform the environmental protection audits. Personnel performing the audits do not report to the production organization and have no direct responsibility for the function and area being audited.

Audit findings are communicated to the cognizant Area Manager, who is responsible for nonconformance corrective action commitments in accordance with documented practices. The manager of the environmental protection function or delegate is responsible for resolution follow-up for identified nonconformances. Audit results in the form of corrective action items are reported to the GE-Wilmington facility manager and staff for monitoring of closure status.

3.6.3 INDEPENDENT AUDITS

The GE-Wilmington safety program elements (radiation, criticality, chemical, fire protection, industrial safety and environmental protection) are audited biennially by appropriately trained and experienced individuals who have a degree of independence of the GE-Wilmington organization, and are not involved in the routine performance of the work or program being audited. The scope of independent audits covers the adequacy of the safety program as well as compliance to requirements.

Audit results are reported in writing to the GE-Wilmington facility manager, the Area Managers, the manager of the radiation safety function, and the manager of the criticality safety function, as appropriate. The safety function and/or Area Managers, as appropriate, take necessary response actions in accordance with documented corrective action commitments.

Audit results in the form of corrective action items are reported to the GE-Wilmington facility manager and staff for tracking until closure.

3.7 INCIDENT INVESTIGATIONS

Unusual events which potentially threaten or lessen the effectiveness of health, safety or environmental protection are reviewed by the Area Manager and reported to the environment, health & safety function in accordance with documented practices and methods. Each event is considered in terms of reporting requirements in accordance with applicable regulatory requirements. The depth of investigation relates to the severity or potential severity of the event in judgment of such factors as levels of

uranium released and/or the degree of potential for exposure of workers, the public or the environment.

Documented incident investigation practices provide for:

- Formal and systematic analyses for determination of root cause(s)
- Investigations by independent, qualified teams when warranted
- Documented identification and tracking of corrective actions
- Documentation and record retention for purposes of application of "lessons learned"

The environment, health and safety function is responsible for maintaining a list of agencies to be notified, determining if a report to an agency is required, and for notifying the agency when required. This function has the responsibility for continuing communications with government agencies.

3.8 RECORDS MANAGEMENT

Records appropriate to integrated safety analyses and the application of appropriate assurance elements to resulting controls, criticality and radiation safety 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 integrated safety analyses and results are retained during the conduct of the activities analyzed and for six months following cessation of such activities to which they apply or for a minimum of three years.

Records of criticality safety analyses are maintained in sufficient detail and form to permit independent review and audit of the method of calculation and results. Such records are retained during the conduct of the activities and for six months following cessation of such activities to which they apply or for a minimum of three years.

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. The following additional radiation protection records will be maintained for at least three years:

- Records of the safety review committee 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
- Radiological safety analyses

Records associated with the environmental protection activities described in Chapter 10 are generated and retained in such a manner as to comply with the relevant requirements of 10 CFR 20 and this license.

3.9 PROCEDURES

3.9.1 PLANT PRACTICES

Licensed material activities are conducted in accordance with management control programs described in administrative and general plant practices approved and issued by cognizant management at a level appropriate to the scope of the practice. These documented practices direct and control activities across the manufacturing functions, and assign functional responsibilities and requirements for these activities. Management controls described in Chapter 2.0 are included in these practices. These practices are reviewed for updating at least every two years.

3.9.2 OPERATING PROCEDURES

Area Managers are responsible to assure preparation of written operating procedures incorporating control and limitation requirements established by the criticality safety function, the radiation safety function, the environmental protection function and the chemical and fire safety function. Integrated safety analysis results as described in Chapter 4.0 are used to identify procedures necessary for human actions important to safety. Operating procedures are initiated and controlled within the guidelines of the configuration management system described in Section 3.1. Area Managers assure

that operating procedures are made readily available in the work area and that operators are trained to the requirements of the procedures and that conformance is mandatory. Operators are trained to report inadequate procedures, and/or the inability to follow procedures.

Nuclear safety control procedure requirements for workers in uranium processing areas are incorporated into the appropriate operating, maintenance and test procedures in place for uranium processing operations .

The safety program design requires the establishment and maintenance of documented procedures for environmental, health and safety limitations and requirements to govern the safety aspects of operations. Requirements for procedure control and approval authorities are documented. Procedure review for updating frequencies are as follows:

Document	Review Frequency	Reviewing & Approving Functional Manager
Operating Procedures (OPs) {Note: Nuclear Safety Release/Requirement (NSR/R) limitations and requirements are incorporated into OPs}	When changed (1)	Area Manager and Affected EHS Discipline (Radiation, Criticality, Environmental, Industrial, or MC&A)
Operating Procedures (OPs)	Every 3 Years (3)	Area Manager and Affected EHS Discipline (Radiation, Criticality, Environmental, Industrial, or MC&A)
Nuclear Safety Instructions (NSIs)	Every 2 Years (2)	Radiation & Criticality Safety
Environmental Protection Instructions (EPIs)	Every 2 Years (2)	Environmental Protection

1) The safety awareness portions of these OPs are reviewed and updated by the appropriate environment, health, and safety (EHS) discipline when warranted based on process related facility change requests.

2) Every 2 years means a maximum interval of 26 months.

3) Every 3 years means a maximum interval of 39 months .

Nuclear safety control procedure requirements for workers in uranium processing areas are incorporated into the appropriate operating, maintenance and test procedures in place for uranium processing operations.

CHAPTER 4.0

INTEGRATED SAFETY ANALYSIS

4.1 INTEGRATED SAFETY ANALYSIS

Integrated Safety Analysis (ISA) is the focal point for safety at GE-Wilmington. ISA is a process in which multifunctional teams analyze the hazards at the site to determine accident scenarios and risk, and ensure that controls are in place to prevent and/or mitigate accidents. The risk associated with an accident scenario is used to judge the level of ongoing assurance that is applied to controls which are in place to prevent the accident. The broad scope of the team's analysis includes criticality safety, radiological safety, environmental protection and industrial safety including chemical safety and fire protection. The accident scenarios identified in the ISA are reviewed by the appropriate safety functions to ensure that the plant continues to comply with site safety policy and regulatory limits.

This program applies to the Dry Conversion Process (DCP) and other process areas as they become baselined using the ISA process.

4.2 SITE DESCRIPTION

A general description of the site is included in Chapter 1.0. More detailed site information is included in the Environmental Report described in Chapter 10.0. The credible external events which are considered by the ISA teams are defined in an established written practice.

4.3 FACILITY DESCRIPTION

Safety-significant information describing the facility, including arrangement of buildings on the site, location with respect to the site boundary, and the facility's ability to withstand credible external events, is included in drawings and reports maintained under configuration management.

4.4 PROCESS DESCRIPTION

Processes covered by this license are summarized in Chapter 1.0. Detailed information concerning these processes is typically included in technical reports, nuclear safety analyses, operating procedures, Process & Instrumentation Drawings (P&IDs), and other detailed process information, which is maintained under configuration management.

4.5 PROCESS SAFETY INFORMATION

Process technology information is gathered and maintained for future use by ISA teams. Technical reports, which typically include process chemistry, intended inventories, and safe upper and lower limits for process variables such as temperature, pressure, flow, and composition, are maintained under configuration management.

Process equipment information is maintained in accurate condition through configuration management. Examples include P&IDs, materials of construction, electrical classification, ventilation system design, and safety systems including interlocks, detection, and suppression systems.

Hazardous material information, including toxicity, permissible exposure limits, physical data, reactivity data, corrosivity data, and thermal and chemical stability data, is available to employees and ISA teams in the form of Material Safety Data Sheets (MSDS's).

4.6 TRAINING AND QUALIFICATIONS OF THE ISA TEAM

ISAs are conducted by teams of individuals with diverse, pertinent knowledge and experience. The team members are chosen to provide operational and technical expertise in the study area, and appropriate safety expertise based on the hazards that are known to exist in the study area. The composition of the team is defined in an established plant practice.

4.7 ISA METHODS

The hazards in the facility are identified and analyzed using methodology that is widely accepted throughout the chemical industry. Examples of the methodology are

described in Guidelines for Hazard Evaluation Procedures, published by the Center for Chemical Process Safety of the American Institute of Chemical Engineers (1992). Hazards are analyzed using established methods, for example:

- Preliminary Hazards Analysis
- What If / Checklist
- Hazards and Operability Analysis
- Failure Mode and Effect
- Fault Tree
- Event Tree
- Human Reliability Analysis

Procedural guidance is provided to the ISA teams in the form of a written plant practice that outlines the special treatment these methods require when applied to processes in the nuclear industry. Examples of this special treatment includes the consideration of criticality and radiological hazards. In this procedure, the teams are instructed to consider start-up, shutdown, upsets, and maintenance, in addition to normal operating conditions. Guidance is provided concerning the external events which must be considered in ISAs.

The written plant practice also provides guidelines for ranking accident scenarios according to risk, that is, unmitigated consequence and likelihood. The team then ensures that the controls that prevent or mitigate accidents are of the appropriate quality and reliability.

4.8 RESULTS OF THE ISA

The results of the ISA team's analysis are communicated in a summary report to appropriate levels of management. This report summarizes the elements that are important to safety in the area studied. The lists of hazards and accident scenarios are compiled and maintained by the configuration management function. Guidance to the teams is provided in a written plant practice to ensure comprehensive reports.

4.9 CONTROLS FOR PREVENTION AND MITIGATION OF ACCIDENTS

Controls which are relied upon to prevent or mitigate serious accidents are maintained in a ready state through the application of a wide range of assurances. Examples of assurances typically used at GE-Wilmington include: preventative maintenance, functional tests, purchasing specifications, training, procedures, and inspections. The level of assurance applied is consistent with the level of risk associated with the specific accident scenario. Responsible risk management requires consideration of the components of risk, specifically consequences and likelihood. Accident scenarios are rated by the ISA teams in terms of unmitigated consequences and likelihood of an initiating event according to criteria defined in written plant practices.

The general categories of consequences are defined as follows: the highest category is assigned to accidents that could result in injury to the public located outside the site boundary and to extreme on-site catastrophes. The middle level is assigned to accidents that would result in regulatory violations and/or serious on-site consequences. All other accidents are assigned to the lower level. These categories are summarized in Table 4.1.

Table 4.1
Consequence Levels

Severity Ranking	Radiological/ Criticality	Environmental/ Industrial/Chemical
3	• exposure to an individual member of the public off-site (5 rem, 30 mg intake of U) • severe exposure to an employee (400 rem internal plus external dose or 230 mg intake of U)	• fatality medical treatment for a member of the public off-site • permanent disability • off-site contamination above regulatory standards
2	• exceed regulatory limits for employee exposure (5 rem, 10 mg U internal)	• serious injury • exceed permit limits or regulatory limits • lost time injury • reportable release
1	• exceed administrative limits on daily air samples, lung counts, bioassays, contamination, TLDs • 10% of annual exposure limit	• OSHA recordable injury • first aid • exceed internal limits • spill inside containment • UIR

Accident scenarios are rated according to the likelihood of occurrence. The likelihood is categorized in qualitative terms that can easily be applied by the ISA teams. The highest category of likelihood is applied to initiating events that could occur at any time in the immediate future. The middle category is for events that are likely to occur during the life of the operation. The lowest likelihood category is used for events that are not expected to occur during the life of the facility. In order to provide consistency in ranking, quantitative levels are provided as guidelines to the teams. These levels are summarized in Table 4.2.

Table 4.2
Likelihood Levels

LEVEL	FREQUENCY	LIKELIHOOD
3	more frequent than once every two years	likely to occur in the immediate future
2	every two to fifty years	likely to occur during the life of the facility
1	less frequent than once every fifty years	not likely to occur during the life of the facility
0	incredible	likelihood is indistinguishable from zero

The levels of consequence and likelihood are combined to estimate the level of risk of initiating a particular accident. Figure 4.1 demonstrates the risk assignment matrix. This risk assignment is used by the teams to determine the level of assurance that will be applied to the controls that protect against that particular accident.

Figure 4.1
Risk Assignment Matrix

Consequence				
	3	Mid-level Risk	Highest Risk	Highest Risk
	2	Low Risk	Mid-level Risk	Highest Risk
	1	Low Risk	Low Risk	Mid-level Risk
		1	2	3
			Likelihood	

Controls that prevent or mitigate events in the highest risk category receive full evaluation and appropriate application of all assurance elements defined in Chapter 3.0. Appropriate assurance elements are applied to mid-level risk controls. Low risk controls are treated with normal, prudent attention.

4.10 ADMINISTRATIVE CONTROL OF THE ISA

The ISA is maintained current through a configuration management program that ensures that: 1) facility changes receive adequate integrated safety review, and 2) changes are adequately documented.

Proposed facility changes are reviewed by a trained and approved integrated safety reviewer to determine if the change impacts the existing ISA. If so, an ISA team is assembled, and the change is analyzed. The results of the ISA and the recommendations of the team are used in approving or rejecting the proposed change. After the change is implemented, the revised ISA becomes a part of the controlled documentation for the facility.

The trained and approved integrated safety reviewer possesses the experience, training and skills to consider criticality, radiological, environmental, chemical, and industrial impact within a predefined set of limits. The reviewer is approved by the

manager of the EHS function and reports organizationally to the manufacturing product line. This organizational structure gives ownership of operational safety to the manufacturing function.