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Letter number MFN-09-709
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Global Laser Enrichment
Docket Number 70-7016

Document Control Desk
ATTN: Andrea Kock, Chief
Environmental Review Branch
Division of Waste Management and Environmental Protection
Office of Federal and State Materials and Environmental Management Programs
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

SUBJECT: GE-HITACHI GLOBAL LASER ENRICHMENT RESPONSE (#2) TO REQUEST FOR ADDITIONAL INFORMATION RELATED TO NRC REVIEW OF GLE ENVIRONMENTAL REPORT

Dear Ms. Kock,

GE-Hitachi Global Laser Enrichment LLC (GLE) hereby submits the response to the Nuclear Regulatory Commission's Request for Additional Information Questions 4-1-A and 4-10-A dated October 7, 2009.

If you have any questions, or require additional information, please contact Julie Olivier of my staff at 910-819-4799, or at Julie.Olivier@ge.com; or myself at 910-819-1925 or at Alberte.Kennedy@ge.com.

Sincerely,

for AEK

Albert Kennedy
Environmental Health and Safety Manager, GLE

Enclosures:

1. Enclosure 1 – Response to Request for Additional Information for Questions 4-1-A and 4-10-A
2. Enclosure 2 – Memo to file regarding GENII modeling for Question 4-1-A of October 7, 2009 Request for Additional Information

NMSS01

cc: without enclosures:

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Enclosure 1 to MFN-09-709

4-1 Public Health Impacts from Liquid Effluent Releases:

A. Provide the information specified below to support an analysis the dose contributions of liquid effluents from the proposed Global Laser Enrichment (GLE) facility.

1. Provide estimated doses to the maximally exposed member of the public and the collective dose to the population in the region of influence from liquid effluent releases attributable to the proposed GLE facility.

2. Provide the estimated radionuclide concentration in the liquid effluent releases from the proposed GLE facility, dilution factors at the receiving water bodies where humans may be exposed, and applicable exposure pathways.

Basis: The ER does not include public impacts from liquid effluent releases. Section 4.12.2.2.2 indicates that "any impacts on human health to nearby resident or on-site workers from these effluents or from receiving waters are anticipated to be SMALL" without providing supporting information. The total annual dose to the public from all exposure pathways will be compared to the dose limits in 10 CFR 20.1301 and 40 CFR 190.

Response 1:

In order to assess potential public health impacts from liquid effluents that would be discharged from the Proposed GLE Facility, dose estimates associated with these discharges were calculated using GENII (version 2.06). GENII input and output files are provided as part of this RAI response. GENII was developed for EPA to provide a set of programs for calculating radiation dose and risk from radionuclides released to the environment. It implements dosimetry models recommended by the International Commission on Radiological Protection (ICRP) in Publications 26, 30, 48, and 56 through 72, and the related risk factors published in Federal Guidance Report 13. For this analysis, the option to calculate doses and/or risks using ICRP-30 and -48 factors (Federal Guidance Reports 11 and 12) was selected because these methods have been approved by the DOE. The ICRP dosimetry and risk models are considered to be state-of-the-art by the international radiation protection community and have been adopted by most national and international organizations as their standard dosimetry methodology (Napier, 2007).

There are two potential water-based recreationally related exposure pathways to the general public associated with the Northeast Cape Fear River, which would receive the liquid effluent discharging from the Proposed GLE Facility: fish ingestion and recreational surface water use (i.e., swimming, boating, and shoreline activity). Details about these exposure pathways are discussed under Response 2 (see exposure factor discussion below).

The potential radiological impacts to an adult were assessed through calculations estimating the annual effective dose equivalent. The term "dose equivalent" refers to a 50-year committed dose equivalent. The sum of the ingestion-related doses (i.e., eating

fish and drinking water) and direct dose equivalents provides an estimate of the total effective dose equivalent (TEDE).

Maximally Exposed Member of the Public

Generally, dose equivalents for adults engaging in recreational activities along the Northeast Cape Fear River were calculated by potential exposure pathway for the total body. Concentration inputs to GENII were taken from the uranium concentrations attributable to liquid effluent that would be discharged from the Proposed GLE Facility calculated for the portion of the Northeast Cape Fear River between the confluence of Unnamed Tributary #1 with Northeast Cape Fear River (i.e., adjacent to the GE Wilmington Site) to the confluence with a branch of the Cape Fear River (see GLE ER Figure 3.4-19)[1]. This 6.3-mile long segment of the Northeast Cape Fear River is hereafter referred to as the "reach-of-interest".

Maximum in-stream concentrations would occur in the reach-of-interest at the confluence with Unnamed Tributary #1 to Northeast Cape Fear River, and these concentrations are used for the maximally exposed member of the general public. Moreover, the maximally exposed member of the public is assumed to be engaged in all of the recreational activities shown in Table 4.1(A-1). Details about in-river dilution of the effluent discharge are discussed under Response 2 (see dilution factor discussion below) as are details about the exposure pathways (see applicable exposure pathways discussion below).

The adult TEDE for the maximally exposed member of the public, based on the assumptions mentioned above, was calculated to be 5.09E-05 mrem per year. These doses are well below the EPA 25 mrem per year standard (40 CFR 190) and the NRC TEDE 100 mrem per year limit (10 CFR 20). Therefore, radiological impacts to off-site receptors attributable to liquid effluent that would be discharged from the Proposed GLE Facility are anticipated to be SMALL.

Table 4.1(A-1). Calculated Effective Dose Equivalent for the Maximally Exposed Member of the Public.

Exposure Pathway	***Effective Dose Equivalent for GLE* (mrem/year)***
Boating	*2.00E-12*
Shoreline activities	*2.00E-06*
Swimming (immersion and incidental water ingestion)	*6.30E-07*
Fish ingestion	*4.82E-05*
Sum Total (TEDE)	*5.09E-05*

[1] As discussed in ER Section 3.12.2, effluents from the Wilmington Site final process lagoon facility (which would receive the liquid effluents from the Proposed GLE Facility) drain to the effluent channel (Discharge Location 001 on GLE ER Figure 3.12-1), which also receives stormwater and groundwater discharge. The Site dam, shown on GLE ER Figure 3.4-19, marks the approximate boundary between the industrial effluent channel and a natural stream channel, referred to as "Unnamed Tributary #1 to Northeast Cape Fear River". This stream may be locally known as Brickyard Creek; however, the name is not officially recognized by any federal or State regulatory agency.

** Effective Dose Equivalent estimates are the dose attributable to liquid effluent that would be discharged from the Proposed GLE Facility.*

Collective Dose to the Population in the Region of Influence

Collective dose is calculated by multiplying the average individual dose by the number of people exposed to the individual dose. As shown in Table 4.1(A-2), the collective does is estimated to be 0.16 persons-mrem/year (0.0002 persons-rem/year).

In this analysis, collective dose was estimated as follows:

1. *Downstream concentrations were estimated for locations where the general public could potentially come in contact with waters of the reach-of-interest (i.e., the portion of the Northeast Cape Fear River potentially impacted by liquid effluents from the Proposed GLE Facility). These locations and concentrations are listed in Table 4.1(A-2) and discussed in Response 2 (see dilution factor discussion below).*
2. *Individual dose was estimated for each of the three potential exposure locations using the same calculation method and scenario as used for the maximally exposed member of the public. That is, the exposure scenario shown in Table 4.1(A-1) is assumed to be the same at each location but the concentrations vary due to downstream dilution. These concentrations are shown in Table 4.1(A-2).*
3. *The number of people engaged in water-based recreation (e.g., boating, swimming, fishing, and shoreline activity) associated with each potential exposure location shown in Table 4.1(A-2) was estimated. The calculation method for estimating the number of people engaged in water-based recreation on the Northeast Cape Fear River is discussed separately below.*
4. *For each location shown in Table 4.1(A-2), the number of people was multiplied by the dose to estimate the collective dose.*
5. *Finally, the collective dose at each location was summed to estimate the collective dose in the region of interest.*

Table 4.1(A-2). Calculated Collective Dose to the Population in the Region of Influence.

Potential Exposure Location	Modeled Total Uranium Concentration* (pCi/mL)	Dilution Factor**	Recreational Activity	Dose (mrem/yr)	Potentially Exposed Population	Collective Dose (person-mrem/yr)
Confluence with Unnamed Tributary #1 to Northeast Cape Fear River	1.17E-06	4.9E-6	Fish Ingestion	4.82E-05	1051	5.07E-02
			Swimming	6.30E-07	1417	8.93E-04
			Boating	2.0E-12	1244	2.49E-09
			Shoreline	2.0E-06	915	1.83E-03
			Subtotal			5.34E-02
Just South of GE Wilmington Site Boundary	1.17E-06	4.9E-6	Fishing	4.82E-05	1051	5.04E-02
			Swimming	6.30E-07	1417	8.93E-04
			Boating	2.0E-12	1244	2.49E-09
			Shoreline	2.0E-06	915	1.83E-03
			Subtotal			5.34E-02
Highway 133 Bridge	1.13E-06	4.7E-6	Fishing	4.64E-05	1051	4.88E-02
			Swimming	6.07E-07	1417	8.60E-04
			Boating	1.93E-12	1244	1.83E-03
			Shoreline	1.92E-06	915	1.76E-03
			Subtotal			5.14E-02
All Locations					Total:	1.58E-01

** The GENII model input requires isotopic concentrations, which were calculated from total uranium concentrations using the following isotopic weight fractions for enriched uranium that would be produced by the Proposed GLE Facility: ^{234}U: 8.64×10^{-4}; ^{235}U: 8.02×10^{-2}; and ^{238}U: 9.19×10^{-1}.*
*** Dilution factor is the modeled in-stream uranium concentration divided by the concentration in the liquid effluent that would be discharged from the GLE Radioactive Liquid Effluent System.*

To estimate the number of people using the Northeast Cape Fear River for recreational purposes, we examined the land use adjacent to the River along the reach-of-interest, with particular attention to recreation access points. The reach-of-interest is where potential public exposure might occur, and extends from the confluence with Unnamed Tributary #1 to Northeast Cape Fear River (i.e., adjacent to the GE Wilmington Site) to the confluence with a branch of the Cape Fear River. There are no general public access points (e.g., parks, boat ramps) along the reach-of-interest. Much of the river along this reach is bordered by undeveloped land or industrial sites. There are few private docks associated with private residences. A boat yard and marina are located at the Highway 133 bridge, approximately 5.6 miles (9 km) downstream of the confluence with Unnamed Tributary #1 to Northeast Cape Fear River; no general public access is provided via the marina. The general public would most likely access the reach-of-interest via boating from an upstream or downstream location or via overland across undeveloped land.

To estimate the number of people who potentially may be exposed as shown in Table 4.1(A-2), the numbers of people engaged in fishing, swimming, boating, and shoreline activity on or along the Northeast Cape Fear River were estimated. These population estimates were calculated as follows:

1. *The number of people in the region of interest was determined. It was assumed that people within 15 miles are close enough to possibly use the Northeast Cape Fear River for recreational purposes on a regular basis. This distance is*

equivalent to an approximate 20 minute travel time, and is the median travel distance for boaters. As noted above, boating is likely to be the main means of access to the Northeast Cape Fear River reach-of-interest.

2. *Water bodies in the region where water-based recreation takes place were identified, and the populations estimated in Step 1 were allocated to the Northeast Cape Fear River versus the other water bodies that they may use based on the water body surface areas.*
3. *Given that access to the Northeast Cape Fear River reach-of-interest likely will be via boat or direct access from private or undeveloped (e.g., nonindustrial) land, the populations estimated in Step 2 were equally allocated to three locations along the reach-of-interest: 1) at the confluence of Unnamed Tributary #1 to Northeast Cape Fear River (i.e., where maximum in-steam concentrations would occur); 2) just south of the GE Wilmington Site boundary; and 3) at the Highway 133 bridge.*
4. *The population estimated in Step 3 (i.e., people who might use the Northeast Cape Fear River for recreational purposes at specific locations) were allocated to specific activities (i.e., fishing, boating, swimming, and other shoreline activity) using recreational survey data.*

It should be noted that there are substantial uncertainties related to this collective dose estimate. To address these uncertainties, conservative assumptions were made, that tend to over predict the estimated collective dose.

As explained above, collective dose is calculated from the estimate of the number of people from the general population who potentially would be exposed and the estimated average exposure dose. Therefore, the meaningfulness of the calculated collective dose is limited by the degree of uncertainty in both these estimates.

Regarding average dose, the same recreational user exposure scenario was used for the entire population as was used for the maximally exposed member of the population, as described in Table 4.1(A-1). The number of people potentially exposed is based, in part, on regional (southeast United States) surveys of recreational behavior. These surveys provide estimates, for example, of the number of people engaged in boating, but do not provide information on the frequency of boating activity. So, people reported to engage in boating activity may do so once a year or much more frequently. The exposure scenario used for this collective dose assessment assumes boating takes place 50 days per year. While such an assumption may be appropriate for the maximally exposed recreational boater, it is unlikely that the average boater engages in boating activity 50 days per year.

Regarding the number of people engaged in water-based recreation on the Northeast Cape Fear River reach-of-interest, there is a large degree of uncertainty in the estimate. As noted above, the number of people potentially exposed is based, in part, on regional surveys of recreational behavior that are representative of the southeast United States. Surveys of recreational behavior specific to New Hanover County have not been identified, let alone for the reach-of-interest of the Northeast Cape Fear River. In this analysis, the numbers of people estimated to engage in specific recreational activities were allocated to the Northeast Cape Fear River based on the surface area ratio of the reach-of-interest to that of competing water bodies where similar recreational activities occur. However, the Northeast Cape Fear River reach-of-interest has no public boat ramps or parks, and is bordered mostly by industrial and swamp land and little

residentially developed land. Therefore, there is very little in the way of adjacent development that would draw recreational users to the reach-of interest. For these reasons, the estimate of the number of people recreationally using the reach-of-interest is uncertain and very likely has been overestimated.

Response 2:

Provided below are the estimated radionuclide concentration in the liquid effluent that would be released from the Proposed GLE Facility, an explanation of how dilution factors were calculated for the potential locations of exposure along the Northeast Cape Fear River reach-of-interest, and descriptions of applicable exposure pathways.

Estimated Radionuclide Concentration in the Liquid Effluent Releases from the Proposed GLE Facility

The calculated doses presented above in Response 1 are those attributable to the liquid effluent that would be discharged from the Proposed GLE Facility. The GLE Radioactive Liquid Effluent System (RLETS) is designed and will be operated to treat effluent to lower levels than required by the 10 CFR 20 standard for uranium of $3x10^{-7}$ µCi/mL. GLE has established an Administrative Limit for operation of the RLETS at 80% of the 10 CF 20 standard, or $2.4x10^{-7}$ µCi/mL. The GENII model input requires isotopic concentrations, and these concentrations were calculated from the Administrative Limit total uranium concentration of $2.4x10^{-7}$ µCi/mL using the following isotopic weight fractions for enriched uranium that would be produced by the Proposed GLE Facility: ^{234}U: $8.64x10^{-4}$; ^{235}U: $8.02x10^{-2}$; and ^{238}U: $9.19x10^{-1}$. The isotopic concentrations calculate to: ^{234}U: $2.07x10^{-10}$; ^{235}U $1.92\ x10^{-8}$; and ^{238}U $2.21\ x10^{-7}$ µCi/mL. As presented in Section 4.13.2.2.1.1 of the GLE ER, total average daily liquid effluent volume to be discharged from the GLE RLETS would be 5,000 gallons per day.

Dilution Factors at the Receiving Water Bodies Where Humans May Be Exposed

The dilution factor for the GLE RLETS effluent discharge into the Northeast Cape Fear River was calculated using the QUAL2K stream model, developed by EPA. In-stream concentrations and dilution factors are shown in Table 4-1(A-2). QUAL2K is a recent update to the QUAL2E in-stream model that has been in used since the 1980s. QUAL2K (as well as QUAL2E) simulates one-dimensional water quality within a stream (meaning the stream channel is well-mixed vertically and laterally). The stream channel is represented through segments of varying lengths and includes the opportunity to allow for tributary flow and point and diffuse sources. This model calculates in-steam concentrations at various points downstream from the effluent discharge point (i.e., the confluence of the Northeast Cape Fear River and Unnamed Tributary #1 to Northeast Cape Fear River). The model estimates water concentrations for conservative constituents such as uranium (ignoring decay). A summer average for the water flow rate in the river was used, as these rates tend to be lower than annual average flow rates, and recreational activities are most likely to occur during warmer months. This flow rate and other model settings are conservative in that they result in higher estimated water uranium concentrations.

Concentrations were calculated at various points along the Northeast Cape Fear River reach-of-interest. These locations are identified below along with the rationale for their selection:

- ***Confluence with Unnamed Tributary #1 to Northeast Cape Fear River.*** *This is the location where a member of the general public potentially could be exposed to maximum concentrations in the Northeast Cape Fear River. The model assumes uniform mixing at this location. While it is true that uniform mixing will not likely occur until further downstream, this assumption is reasonable considering the nature of the exposure pathways and scenario considered (see discussion of exposure pathways below).*
- ***Just south of the GE Wilmington Site boundary.*** *This location is adjacent to where the planned River Bluffs subdivision is proposed. While this subdivision is not planned as a water-based recreational development and will not likely provide general public access to the river, the location is nevertheless included to provide a conservative dose assessment considering its proximal downstream position to the confluence with Unnamed Tributary #1 to Northeast Cape Fear River.*
- ***Highway 133 crossing the Northeast Cape Fear River.*** *This location is approximately 5.6 miles (9 km) downstream of the confluence with Unnamed Tributary #1 to Northeast Cape Fear River. A marina and a boat yard are located at this point in the river. Although the marina supports recreational activities, it does not provide access for the general public. Aside from this marina, no other river access locations were identified other than a sole private dock and several industrial docks associated with adjacent industrial and barge operations. (Note: another boat dock that could provide recreational access was identified approximately 15 miles upstream of the reach-of-interest.)*
- ***Confluence of the Northeast Cape Fear River and a branch of the Cape Fear River.*** *This location is approximately 6.3 miles (10.2 km) downstream of the confluence with Unnamed Tributary #1 to Northeast Cape Fear River. This location was included to demonstrate where a significant drop in uranium concentrations occurs due to distance downstream of the discharge point and the additional flow from a branch of the Cape Fear River.*

Applicable Exposure Pathways

There are two potential exposure pathways to the general public associated with Site liquid effluent discharges to the Northeast Cape Fear River: fish ingestion and recreational surface water use (i.e., swimming, boating, and shoreline activity). There are no public water intakes on the Northeast Cape Fear River downstream of the confluence with Unnamed Tributary #1 to Northeast Cape Fear River. For this exposure analysis, we assume a recreational fisher and recreational user of the Northeast Cape Fear River with an exposure scenario as shown in Table 4.1(A-3).

Table 4.1(A-3). Exposure Pathways

Activity	***Scenario Description***
Boating	*Adult travels by boat for 2 hours per day, 50 days per year (independent of other activity).*
Shoreline Activity	*Shoreline activity occurs 2 hours per day, 50 days per year (independent of other activity).*
Swimming	*2 hours per day, 50 days per year (independent of other activity).*
	Ingestion of 0.042 liters per day of water during swimming for each of the 50 days, based on EPA Exposure Factor Handbook.
Fish Consumption	*44 grams for 365 days per year (approximately 3/4 pounds per week) consumed from fish caught on the Northeast Cape Fear River, based on EPA Exposure Factor Handbook.*

The exposure assumptions shown in Table 4.1(A-3) were made at each of the three assumed exposure locations along the reach-of-interest. Maximum exposures potentially occur because the maximally exposed member of the public is assumed to engage in all these activities and because these activities are assumed to take place at a point in the river where maximum water uranium concentration is modeled; that is, at the river segment containing the confluence with Unnamed Tributary #1 to Northeast Cape Fear River. The assumed location of maximum exposure is not readily accessible to the public, and public exposure to liquid effluents that would be discharged from the Proposed GLE Facility would more likely take place downstream after the effluent is further diluted by the Northeast Cape Fear River.

As indicated in Table 4.1(A-3), the exposure scenario assumptions are consistent with and further support the uniform mixing assumption made for the river segment that was assumed to be the location of maximum potential exposure scenario (see dilution factor discussion above); that is, 1) boating activity would likely to take place over the entire surface of the river and therefore would provide an integration or averaging of exposure across all points in this river segment; 2) fish would be traversing and integrating or averaging exposure across this river segment; 3) swimming could occur from either shoreline and may be associated with boating activity; and 4) shoreline activity could involve movement along either shoreline. As a result, while uniform mixing may not physically occur instantaneously at the confluence, the mechanisms that would result in exposure for these activities integrate the range of uranium concentrations that would exist across the entire river segment containing the confluence with Unnamed Tributary #1 to Northeast Cape Fear River, thus reasonably representing maximum potential exposures of a member of the general public.

4-10 Socioeconomic Impacts:

A. For the region of influence, provide estimates of the indirect economic impacts of site preparation (pre-construction), construction, operation, and decommissioning. Indirect impacts could be estimated using input-output multipliers taken from the RIMS II modeling framework, or other similar framework, and should include estimates of impacts on labor income ($ per year) and employment (number of job-years per year).

The project schedule now calls for pre-construction activities to take place in 2011, and actual construction to be concentrated in 2012-2017. The site preparation and preconstruction employment, estimated at 95, occurs in 2011; site employment in 2012 is projected to increase to 680, as construction activities begin. Site employment reported in the ER is unchanged from 2013 through 2057. Maintaining the assumption that 20% to 40% of the construction labor would come from outside the region, this means that between 19 and 38 of the workers would come into the region from elsewhere in 2011, and between 136 and 272 new workers would come into the region in 2012. Again, maintaining the assumptions that 65% of new workers would bring their families (including on average, a spouse and one school-age child), overall population impacts are estimated to be between 57 and 115 in 2011 and between 299 and 598 in 2012. These changes are shown below in Table 4-10-A1. While the maximum number of new residents and school children in 2012 is slightly higher than estimated before, 2012 estimates are still lower than the maximum impacts projected for 2013, so neither is likely to pose capacity problems for the housing market, public services, or the school system, based on information gathered to conduct the ER assessment.

Table 4-10(A-1) Revised Direct Impacts: Presents revisions to data for 2011 and 2012 for ER Tables 4.10-3 and 4.10-4

					New workers from outside region				Population impacts			
	Site Preparation and Construction Employment		Total Employment		Low	Low	High	High	Low	Low	High	High
Year	ER	Revised	ER	Revised	ER	Revised	ER	Revised	ER	Revised	ER	Revised
2011	290	95	290	95	58	19	116	38	133	57	267	115
2012	485	680	485	680	97	136	194	272	223	299	446	598
2013	485	485	1,035	1,035	207	207	304	304	476	476	776	776
2014	213	213	763	763	153	153	195	195	351	351	526	526
2015	174	174	724	724	145	145	180	180	333	333	490	490
2016	155	155	705	705	141	141	172	172	324	324	473	473
2017	136	136	486	486	97	97	124	124	224	224	335	335
2018–2048			350	350	70	70	70	70	161	161	210	210
2049–2050			400	400	120	120	120	120	276	276	360	360
2051–2057			50	50	50	50	50	50	115	115	150	150

Note that values from 2013 through 2057 remain unchanged from those presented in the ER.

ESTIMATING THE TOTAL REGION-WIDE ECONOMIC IMPACT OF THE PROPOSED GLE FACILITY

The economic impact of the Site-preparation, construction, operation, and decommissioning of the Proposed GLE Facility can be separated into three components:

- ***Direct Impact:*** *The jobs, income, and output created by the Proposed GLE Facility itself.*
- ***Indirect Impact:*** *The jobs, income, and output created by businesses in various industries as a result of purchases made by the Proposed GLE Facility as part of the construction, operation, and decommissioning processes.*
- ***Induced Impact:*** *The jobs, income and output created by households as they spend the extra income they receive as the regional economy grows.*

Data on the direct impacts of each phase of the Proposed GLE Facility were reported as part of the initial GLE Environmental Report in Section 4.10 and in Appendix U (proprietary). To estimate the indirect and induced impacts that are associated with these direct impacts, two primary analytical pieces were required.

- *Data on labor and non-labor expenditures associated with the Proposed GLE Facility and what portion of these expenditures would be spent within the region of interest (ROI).*
- *A model of the ROI economy to trace the impacts these expenditures would have on businesses, households, and other institutions in the region.*

For this analysis, an Input-Output (I/O) model was constructed for the economy ROI—comprising Brunswick, New Hanover, and Pender counties—using IMPLAN economic modeling software and 2004 county-level data(MIG, 2008). This model categorizes businesses and institutions in these counties into a system of 509 industry codes. IMPLAN was selected because it is one of the most widely used I/O modeling software packages in economic development analysis.

GLE estimated expected expenditures for each phase of the Proposed Action (pre-construction, construction, operations, and decommissioning), including labor expenditures and non-labor expenditures. Labor expenditures were assumed to be entirely within the 3-county ROI. GLE estimated what share of non-labor expenditures would likely occur within the ROI. GLE's labor and non-labor expenditures within the ROI were input into the IMPLAN model in appropriate sectors. The IMPLAN model estimated the total expenditures throughout the ROI that would result from GLE's Proposed Action expenditures, including indirect and induced impacts. Similarly, IMPLAN reports the total employment impact, including indirect and induced employment impacts, estimated to result from the direct GLE employment. IMPLAN also reports

the total labor income impact within the ROI, including indirect and induced impacts, estimated to result from GLE's direct labor spending.

The quantitative data and impact estimates were provided separately in a proprietary response to the Request for Additional Information.

Limitations of the analysis

A limitation to this analysis is that it is based on the structure of the state and regional economy in 2004. The model is a highly detailed snapshot of economic relationships at that time. Over time, the structure of the economy is likely to change, which could result in larger or smaller impacts. In general, the higher the share of inputs purchased from suppliers within the region or the state, the greater the multiplier will be. If the economy grows and becomes more diversified, it may be that businesses will be able to find their supplies within the region. On the other hand, if the trend toward globalization continues, some supplies may be purchased from overseas; this would reduce the impacts. It is likely that the detailed characterization of the economy in 2004 will be less accurate for more distant time periods.

References:

Minnesota IMPLAN Group (MIG). 2008. IMPLAN Professional, Version 2.
http://www.implan.com

RTI INTERNATIONAL

Memo to File

Author: Susan Wolf **Date:** November 10, 2009

Reviewer: Tony Marimpietri **Date:** November 11, 2009

Subject: Documentation of radiation dose modeling – liquid effluent only

Section No.	Subsection No.	Figure/Table Number	Other	Page Number
RAI 4.1-A (ER Section 4.12)				

Background:

The potential radiological impacts to an adult from liquid effluents that would be discharged from the Proposed GLE Facility were assessed through calculations estimating the annual effective dose equivalent. The term "dose equivalent" refers to a 50-year committed dose equivalent. The sum of the ingestion-related doses (i.e., eating fish and drinking water) and direct dose equivalents provides an estimate of the total effective dose equivalent (TEDE).

The calculated annual dose equivalents were then compared to regulatory (EPA and NRC) radiation exposure standards as a way of illustrating the magnitude of potential impacts. The key receptors evaluated were located at 3 locations along the NE Cape Fear River (see RAI response for details). The dose impact from liquid effluent release was evaluated for aquatic food consumption and recreational surface water activities.

Doses were calculated using GENII (version 2.06), which was developed for the U.S. EPA to provide a set of programs for calculating radiation dose and risk from radionuclides released to the environment. GENII implements dosimetry models recommended by the International Commission on Radiological Protection (ICRP) in Publications 26, 30, 48, and 56 through 72, and the related risk factors published in Federal Guidance Report 13. The option to calculate doses and/or risks using ICRP-30 and -48 factors (Federal Guidance Reports 11 and 12) was selected as these methods have been approved by DOE. The ICRP dosimetry and risk models are considered to be state-of-the-art by the international radiation protection community and have been adopted by most national and international organizations as their standard dosimetry methodology (Napier, 2007).

Box A
Results:

Source	Confluence w/ Unnamed Tributary #1 w/ Northeast Cape Fear River - Adult EDE	Just South of GE Wilmington Site Boundary - Adult EDE	Highway 133 Bridge - Adult EDE	Units
Boating	2.00E-12	2.00E-12	1.93E-12	mrem
Shoreline activities	2.00E-06	2.00E-06	1.92E-06	mrem
Swimming (immersion and incidental water ingestion)	6.30E-07	6.30E-07	6.07E-07	mrem
Fish ingestion	4.82E-05	4.82E-05	4.64E-05	mrem
Sum Total	5.09E-05	5.09E-05	4.89E-05	mrem

Box B
Calculations/Logic: How was the answer to the results (Box A) obtained?

See below.

Box C
References:

Napier, Bruce A. 2007. *GENII Version 2 Users' Guide.* Prepared for U.S. Environmental Protection Agency under Contract DE-AC05-76RLO 1830.

USEPA. 1993. *Federal Guidance Report No. 12. External Exposure to Radionuclides in Air, Water, and Soil.* EPA-402-R-93-081.

USEPA. 1999. *Federal Guidance Report No. 13. Cancer Risk Coefficients for Environmental Exposure to Radionuclides.* EPA-402-R-99-001.

USEPA. 2009. *Exposure Factors Handbook, 2009 Update (External Review Draft).* Washington, DC, EPA/600/R-09/052A.

Rationale for Model Selection:

GENII (version 2.06) was developed for the U.S. EPA to provide a set of programs for calculating radiation dose and risk from radionuclides released to the environment. GENII implements dosimetry models recommended by the ICRP in Publications 26, 30, 48, and 56 through 72, and the related risk factors published in Federal Guidance Report 13. The ICRP dosimetry and risk models are considered to be state-of-the-art by the international radiation protection community and have been adopted by most national and international organizations as their standard dosimetry methodology (Napier, 2007). The GENII model is fully documented, reviewed, and tested. GENII (version 1.0) was released by DOE in 1988. EPA released version 2.0 in 2002, incorporating improved transport models, exposure options, dose and risk estimation, and user interfaces. It is being actively maintained and updated by an EPA contractor.

Maximally Exposed Individual (Due to Liquid Effluent) Documentation:

Constituent Module (linked to all 4 other modules)

- Selected GENII Radionuclide Database. This module allows the user to select constituents of concern. The database also provides some key chemical properties for other modules.
- Selected U234, U235, U238, Th231, and Th234. Note that user is required to include thorium automatically when selecting uranium constituents (because thorium is the resulting decay product); we did not populate or utilize any input, intermediate, or output data for thorium (assumed to be zero).
- Used all default chemical/physical properties.

User_Defined Module (= surface water-dissolved module linked to Exposure_Pathways)

- Data are same for year = 0 and 1.
- Data are presented in Table 1, below.

Table 1. Uranium concentration input data.

	total uranium	U-234	U-235	
Isotopic weight fractions for 8% enriched uranium		8.639E-04	8.015E-02	
Locations 1&2 [1,2]	1.170E-06	1.011E-09	9.378E-08	
Location 3 [3]	1.130E-06	9.762E-10	9.057E-08	

1. Location 1 is the confluence with Unnamed Tributary #1 to Northeast Cape Fear River ("confluence" river segment)
2. Location 2 is just south of the GE Wilmington Site Boundary ('boundary" river segment)
3. Location 3 is Highway 133 Bridge ("Highway 133" river segment)

Exposure_Pathways Module (linked to Receptor_Intakes)

- Selected *GENII V.2 Chronic Exposure Module*. The GENII chronic exposure module may be used to estimate concentrations in exposure media for groundwater, surface water, and atmospheric transport pathways. The results of the analysis are written in annual increments for the duration of exposure defined by the user. Various exposure pathways are available in GENII. **For this RAI response, only aquatic food consumption and recreational surface water activities were considered.**
- The **main control screen** ("Controls") for the GENII chronic exposure user interface allows the user to make general selections on exposure pathways to include, and to define some basic parameters for the exposure analysis. The general selections allow inclusion (control box checked) or exclusion of general classes of exposure pathways.
  - Animal product ingestion (UNCHECKED)
  - Terrestrial food ingestion (UNCHECKED)
  - Aquatic food ingestion (CHECKED)
  - Recreational surface water exposures (CHECKED)
- *Duration of exposure* is the time period over which the individual is exposed. It is measured from the time given for the start of exposure. VALUE ENTERED = 1.0 yr
- *End of release period* is the elapsed time measured from time zero to the end of the release. Exposures may be evaluated beyond this time period for exposure to residual activity. VALUE ENTERED = 1.0 yr
- *Time from start to exposure* is the time from zero to the beginning of the intake analysis. The duration of exposure begins at the end of the "time from start to exposure." VALUE ENTERED = 0.0 yr

- **Pathways Screen**

  The selection of exposure pathways is controlled on this screen. Each pathway may be selected for inclusion in the analysis for the current exposure location. GENII includes the following pathways and we indicate which ones were selected.
  - Animal product (meat, poultry, milk, eggs) ingestion – GRAYED OUT (grayed out means the option cannot be selected)
  - Food crop (leafy vegetables, root vegetables, fruit, grains) ingestion – GRAYED OUT.

- Aquatic food (fish, mollusks, crustacea, aquatic plants) ingestion – SELECTED – only fish selected because edible mollusks, crustacean, and aquatic plants are not commonly found in this waterbody.
- Drinking water ingestion – NOT SELECTED because there are no public water intakes on the Northeast Cape Fear River downstream of the confluence with Unnamed Tributary #1 to Northeast Cape Fear River.
- Inadvertent shower water ingestion – NOT SELECTED because there are no public water intakes on the Northeast Cape Fear River downstream of the confluence with Unnamed Tributary #1 to Northeast Cape Fear River.
- Inadvertent swimming water ingestion – SELECTED.
- Inadvertent soil ingestion (based solely on RESIDENTIAL soils) – NOT SELECTED because not part of the liquid effluent exposure scenario.
- Inhalation of outdoor air contaminated from atmospheric transport. For complete exposure coverage, also select Indoor air. – GRAYED OUT.
- Inhalation of indoor air, which includes contributions from outdoor air plus contaminants released from domestic water during showering and other uses. For complete coverage, also include outdoor air. – NOT SELECTED because not part of the liquid effluent exposure scenario.
- Inhalation of suspended soil from prior air or irrigation deposition – NOT SELECTED because not part of the liquid effluent exposure scenario.
- External exposure from waterborne activity while swimming – SELECTED.
- External exposure from waterborne activity while boating – SELECTED.
- External exposure from sediment activity while on shoreline – SELECTED.
- External exposure from soil activity (based solely on RESIDENTIAL soils) – NOT SELECTED because not part of the liquid effluent exposure scenario.
- External exposure to airborne activity from atmospheric transport – GRAYED OUT.

Receptor_Intakes Module (linked to Health_Impacts)

Only data pertaining to **AQUATIC FOOD INGESTION AND RECREATIONAL SURFACE WATER ACTIVITIES** are provided below (all other data left as default but not utilized by the model)

- Selected *GENII V.2 Receptor Intake Module*. The GENII V.2 intake module may be used to estimate annual, time-integrated intakes from exposure to contaminated soil, groundwater, surface water, and atmospheric transport pathways. Up to 6 age groups may be specified.

  1 age group selected. Age group 1 (adult) defined as 20 – 70 yr because available data for the recreational water use pathways are for adults.

  - Pathway = *external exposure while swimming*
    - *Frequency of swimming event* = 1.0 evt/day (DEFAULT)
    - *Duration of swimming event* = 2.0 hr (DEFAULT)
    - *Swimming days* = 50.0 day (DEFAULT)
    - *Ingestion rate of water while swimming* = 0.021 L/hr (Exposure Factors Handbook, 2009)

- Pathway = external exposure while boating
  - *Shielding factor* = 1.0 (DEFAULT)
  - *Frequency of boating event* = 1.0 evt/day (DEFAULT)
  - *Duration of boating event* = 2.0 hr (DEFAULT)
  - *Boating days* = 50.0 day (DEFAULT)
- Pathway = external exposure to shoreline
  - *Frequency of shoreline use* = 1.0 evt/day (DEFAULT)
  - *Duration of shoreline use events* = 2.0 hr
  - *Shoreline days* = 50.0 day (duration and days made consistent with boating activity because location primarily accessible by boat).
  - *Shoreline width factor* = 0.2 (DEFAULT)
- Pathway = *aquatic food ingestion*
  - *Fish consumption rate* = 44.0 g/day (Exposure Factors Handbook, 2009 – Alabama recreational fisher data)
  - *Fish consumption period* = 365 day/yr
  - *Mollusc, crustacean, and aquatic plants consumption rate* = 0
- Pathway = *water ingestion while swimming*
  - *Frequency of swimming event* = 1.0 evt/day (DEFAULT)
  - *Duration of swimming event* = 2.0 hr (DEFAULT)
  - *Swimming days* = 50.0 day (DEFAULT)
  - *Ingestion rate of water while swimming* = 0.021 L/hr (Exposure Factors Handbook, 2009)

Health_Impacts Module

- Selected *GENII V.2 Health Impact Module*. The GENII V.2 health impact module calculates health impacts from intake or exposure to radionuclides. Radionuclide health impacts may be reported as radiation dose, cancer incidence, or fatal cancer incidence. Radiation risk calculations can be based on ICRP dosimetry and health effects conversion factors (user defined), or on EPA/HEAST radionuclide slope factors.
  - **Method Selections** Screen. Three options are available to choose from.
    - **Calculate dose and risk using ICRP-30/48 factors (Federal Guidance Reports 11 and 12)**: This option allows calculation of doses and/or risks using DOE-approved methods. The radiation dosimetry is based on ICRP Publication 30 (as updated), as provided in Federal Guidance Reports 11 and 12 or DOE compilations DOE/EH-0070 and DOE/EH-0071. THIS OPTION SELECTED.
    - **Calculate dose and/or risk using ICRP-60/72 and EPA risk factors**: This option allows calculation of doses and/or risks using EPA-approved methods. The radiation dosimetry is based on ICRP Publications 60 and 72, as provided in the supporting documents for Federal Guidance Reports 12 and 13. NOT SELECTED
    - **Calculate risk using EPA slope factors:** This option allows calculation of radiation risk using EPA slope factors. Slope factors were originally provided in

the EPA Health Effects Assessment Summary Tables (HEAST); HEAST is no longer published by EPA and the slope factors are now taken from the Federal Guidance Report No. 13 values for adults. NOT SELECTED

- Selection of **Calculate dose and risk using ICRP-30/48 factors** activates a "Method Parameters" tab. Options for calculating radiation dose, fatal cancers, or cancer incidence are available. One or more option may be selected. ONLY "Calculate Radiation Effective Dose Equivalent Commitment (CEDE)" SELECTED.

  Note: The doses calculated by GENII for each pathway are summed together outside of GENII to calculate TEDE; the individual and summed pathway values are shown in the results table in this memo.