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System Energy Resources, Inc.
1340 Echelon Parkway
Jackson, MS 39286-1995

CNRO-2004-00050

August 10, 2004

U. S. Nuclear Regulatory Commission
Washington, DC 20555-0001
Attention: Document Control Desk

DOCKET: 52-009

SUBJECT: Response to Request for Additional Environmental Information Related to Early Site Permit Application (Partial Response No. 4)

REFERENCE:

1. System Energy Resources, Inc. (SERI) letter to USNRC – Early Site Permit Application (CNRO-2003-00054), dated October 16, 2003.
2. USNRC letter to SERI – Request for Additional Information Related to the Staff's Review of the Environmental Report for the Grand Gulf Early Site Permit (ESP) Application (TAC No. MC1379), CNRI-2004-00007, dated May 19, 2004.
3. SERI letter to USNRC – Response to Request for Additional Environmental Information Related to Early Site Permit Application (Partial Response No. 1) (CNRO-2004-00043), dated July 2, 2004
4. SERI letter to USNRC – Response to Request for Additional Environmental Information Related to Early Site Permit Application (Partial Response No. 2) (CNRO-2004-00045), dated July 19, 2004
5. SERI letter to USNRC – Response to Request for Additional Environmental Information Related to Early Site Permit Application (Partial Response No. 3) (CNRO-2004-00047), dated July 22, 2004
6. SERI letter to USNRC - Followup to Early Site Permit Application Environmental Audit - Response 2 (CNRO-2004-00032), dated May 19, 2004

CONTACT:

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DOCUMENT COMPONENTS:

One (1) CD-ROM is included in this submission. The CD-ROM contains the following thirty-nine (39) files:

001_GGNSABWR.INP, 49 KB, publicly available
002_GGNSPWR.INP, 48 KB, publicly available
003_GGNSEARLY.INP, 16 KB, publicly available
004_GGNSCHRONC.INP, 12 KB, publicly available
005_METGGNS2001.INP, 163 KB, publicly available
006_METGGNS2002.INP, 163 KB, publicly available
007_METGGNS2003.INP, 163 KB, publicly available
008_GGNSSIT.INP, 13 KB, publicly available
009_Soil Survey_Claiborne County.pdf, 7039 KB, publicly available
010_ESPSE.CXC, 5 KB, publicly available
011_ESPSEL.CXC, 5 KB, publicly available
012_ESPSM.CXC, 5 KB, publicly available
013_ESPSML.CXC, 5 KB, publicly available
014_ESPWE.CXC, 5 KB, publicly available
015_ESPWEL.CXC, 5 KB, publicly available
016_ESPWM.CXC, 5 KB, publicly available
017_ESPWML.CXC, 5 KB, publicly available
018_ESPSE.CX3, 12 KB, publicly available
019_ESPSEL.CX3, 12 KB, publicly available
020_ESPSM.CX3, 12 KB, publicly available
021_ESPSML.CX3, 12 KB, publicly available
022_ESPWE.CX3, 12 KB, publicly available
023_ESPWEL.CX3, 12 KB, publicly available
024_ESPWM.CX3, 12 KB, publicly available
025_ESPWML.CX3, 16 KB, publicly available
026_ESPSE.CXD, 2 KB, publicly available
027_ESPSEL.CXD, 2 KB, publicly available
028_ESPSM.CXD, 2 KB, publicly available
029_ESPSML.CXD, 2 KB, publicly available
030_ESPWE.CXD, 2 KB, publicly available
031_ESPWEL.CXD, 2 KB, publicly available
032_ESPWM.CXD, 2 KB, publicly available
033_ESPWML.CXD, 2 KB, publicly available
034_GGNSABWR2001.OUT, 922 KB, publicly available
035_GGNSABWR2002.OUT, 921 KB, publicly available
036_GGNSABWR2003.OUT, 915 KB, publicly available
037_GGNSPWR2001.OUT, 736 KB, publicly available
038_GGNSPWR2002.OUT, 736 KB, publicly available
039_GGNSPWR2003.OUT, 731 KB, publicly available

In the referenced May 19, 2004, letter (Reference 2) the U.S. Nuclear Regulatory Commission requested additional information to support review of the SERI ESP Application. This letter transmits information as outlined in Attachment 1 to this letter and includes responses to:

E4.1-2 (final), E5.3-1 (Corrected), E7.2-1, E7.2-2, E7.2-3, E7.2-4.

Responses to the following requests for additional information contained in Reference 2 will be submitted at a later date:

S2.1-1, S2.1-2

Should you have any questions, please contact me.

I declare under penalty of perjury that the foregoing is true and correct.
Executed on August 10, 2004.

Sincerely,

George A. Zinke
Project Manager
System Energy Resources Inc.

Enclosure: One CD-ROM

Attachment: Attachment 1

cc: Mr. R. K. Anand, USNRC/NRR/DRIP/RNRP
Mr. C. Brandt, PNL
Ms. D. Curran, Harmon, Curran, Spielberg, & Eisenberg, L.L.P.
Mr. W. A. Eaton (ECH) (w/o enclosure)
Mr. B. S. Mallett, Administrator, USNRC/RIV
Mr. J. H. Wilson, USNRC/NRR/DRIP/RLEP

Resident Inspectors' Office: GGNS

ATTACHMENT 1

SECTION 4.1. LAND-USE IMPACTS

Request:

E4.1-2 Section 4.1 of ER (Land Use Impacts). The following is stated: "Review of the Claiborne County Soil Survey issued in 1963 and inquiry with the Claiborne County Natural Resources Conservation Service (NRCS) indicates the presence of soil types, which may be considered "Prime Farmland" at the GGNS site (Reference 4). However, some exclusions apply. If land is frequently flooded during the growing season or is already in or committed to urban development or water storage, it is not considered "prime farmland" (References 4, 5, 6 and 7)." References 4, 6, and 7 do not appear to be publicly available or are not cited completely enough to permit acquiring them. During the site audit the applicant indicated that these references would be made available:

4. United States Department of Agriculture, Soil conservation Service, in Cooperation with the Mississippi Agricultural Experiment Station, "Claiborne County Soil Survey," issued July 1963.
6. Carver, A.D. and J.E. Yahner, Defining Prime Agricultural Land and Methods of Protection Purdue Cooperative Extension Service, AY-283.
7. United States Department of Agriculture, Soil Conservation Service, May 28, 1992, Obtained from the Claiborne County NRCS, Port Gibson, MS, February 21, 2003.

Response:

(Final Response) Attached is Reference 4. (References 6 and 7 above were provided in Cover Letter Reference 5)

See file: 009_Soil Survey_Claiborne County.pdf

SECTION 5.3, COOLING SYSTEM IMPACTS

Request:

E5.3-1 **Section 5.3.2.1 (Thermal Description and Physical Impacts).** Provide input files (electronic) for CORMIX model simulations.

Response:

CORRECTED RESPONSE: The CORMIX input files provided with Cover Letter Reference 6 (and referenced in Cover Letter Reference 4) were not the latest files used for the application. Included with this response are the latest input files. Also included are the output files.

See files:

Input Files:
010_ESPSE.CXC
011_ESPSEL.CXC
012_ESPSM.CXC
013_ESPSML.CXC
014_ESPWE.CXC
015_ESPWEL.CXC
016_ESPWM.CXC
017_ESPWML.CXC

Output Files:
018_ESPSE.CX3
019_ESPSEL.CX3
020_ESPSM.CX3
021_ESPSML.CX3
022_ESPWE.CX3
023_ESPWEL.CX3
024_ESPWM.CX3
025_ESPWML.CX3
026_ESPSE.CXD
027_ESPSEL.CXD
028_ESPSM.CXD
029_ESPSML.CXD
030_ESPWE.CXD
031_ESPWEL.CXD
032_ESPWM.CXD
033_ESPWML.CXD

SECTION 7.2, SEVERE ACCIDENTS

Request:

E7.2-1 Section 7.2.2. Please provide an up-to-date, site-specific assessment of the adverse health effects from fallout onto open bodies of water, considering the ESP site parameters (e.g., water flow rates and containment residence times). Justify that the generic conclusion with respect to such matters that was reached in NUREG-1437 is valid for a future reactor at the ESP site.

Response:

In NUREG-1437 (GEIS), Grand Gulf is one of just four sites described as a "large river site" for the purpose of evaluating fallout into open bodies of water. Table 5.16 of NUREG-1437 shows that large river sites are generically the most advantageous in terms of annual edible aquatic food harvest, whole body population dose, and total exposure per reactor-year in person-rem. This is due to the high dilution effect and low residence times associated with a large river. Table 5.15 of NUREG-1437 shows Grand Gulf is bounded by analyses performed at Fermi, and Table 5.14 shows the following results in comparison to that site (the far right column is from Table 5.16 of NUREG-1437):

Plant	Type of site	Residence time (years)	Surface area to volume ratio	Potentially affected population [1]	Percentage of population likely to be affected	Population Exposure per Reactor Year
Fermi	Lake	2.6	5.6×10^{-2}	6,647,763	41	1400
Grand Gulf	Large River	1.2×10^{-3}	1.7×10^{-1}	504,930	18	0.4

These conclusions are applicable to a future reactor at the Grand Gulf site. The water flow rates[2] have not changed significantly. Contaminant resident times are not expected to change relative to that documented in NUREG-1437. However, it is recognized that a large river has the ability to remove contaminants rapidly; that is, in terms of days or weeks rather than years (for a large river site such as Grand Gulf).[3] Given this characteristic, variations over time in parameters important to residence time (for a large river site) can be expected to have little impact on overall results and conclusions.

The population in the area surrounding the GGNS site has not grown significantly[4] and would continue to be much smaller than the Fermi site values. Therefore, the GEIS generic conclusions that:

- doses due to fallout to surface water at Grand Gulf will be bounded by a large margin in comparison to the NUREG-1437 documented Fermi analysis, and
- doses due to fallout to surface water are expected to be a small fraction of the atmospheric dose path at Grand Gulf continues to remain valid for a future reactor at the ESP site.

[1] Per NUREG-1437, this is a projected population (2050) for the 50 mile population around the site (NUREG-1437 Tables 5.5, 5.7, and 5.14b).
[2] River flow history was reviewed in support of the ESP ER. As noted in ER Section 2.3.1.1.4, with data updated through 2000, the river's minimum flow value continues to be set by flow measurements taken in the 1930's (i.e., approximately 100,000 cfs).
[3] NUREG-1437, Section 5.3.3.3.2.
[4] Comparing 50 mile populations from the GGNS UFSAR Table 2.1-3 (1970 census; approximately 270,000) and ESP ER Tables 2.5-1, 2.5-6; approximately 332,000), the population growth rate is <10% per decade for this 30 year period. Further, the updated projections for growth rate established in the cited ESP ER tables (from the 2000 census through 2070) confirm that population growth within 50 miles is expected to be <10% per decade through 2070.

Request:

E7.2-2 Section 7.2.2. Please provide an up-to-date, site specific assessment of the adverse health effects from potential releases to groundwater, considering the ESP site parameters. Justify that the generic conclusion with respect to such matters that was reached in NUREG-1437 is valid for a future reactor at the ESP site.

Response:

In NUREG-1437 (GEIS), Grand Gulf is one of just four sites described as a "large river site" for the purpose of evaluating potential releases to groundwater. Table 5.17 of NUREG-1437 shows that large river sites are generically the most advantageous in terms of groundwater ingestion total dose, even in comparison to coastal sites, which have higher doses from seafood ingestion. In addition, pathway interdiction can reduce the dose by an order of magnitude. This is particularly possible at Grand Gulf due to the low ground water velocities and the distance to the river. The conclusions in NUREG-1437 estimate the groundwater doses at large river sites to be about 12 person-rem per reactor year (RY). By comparison, the dose at small river sites is estimated to be 1000 person-rem/RY, and at estuarine without interdiction, 17,700 person-rem/RY.

The NUREG-1437 conclusions are based on consideration of site-specific information on groundwater travel time; retention-adsorption coefficients; distance to surface water; and soil, sediment, and rock characteristics. None of these parameters would be expected to change significantly over the life of the future ESP plant. And, as indicated in response to RAI E7.2-1, the population and predicted growth rate are relatively small such that the Grand Gulf site continues to have a relatively low population exposure.

In addition, as noted in the response to RAI E7.2-3, a MACCS2 severe accident consequence analysis has been performed for the GE Advance Boiling Water Reactor design and the Westinghouse AP 1000 design for the Grand Gulf ESP site. Due to the low site population and the low release frequencies of these designs, the total water ingestion dose risk was estimated at less than 0.005 person-rem/RY (as compared to NUREG-1437 estimates of 0.4 person-rem/RY for open bodies of water and 12 person-rem/RY for groundwater). Thus the MACCS2 analysis indicates that the generic NUREG-1437 analysis is conservative and bounding for these advance reactor designs at Grand Gulf.

Request:

E7.2-3 Section 7.2. Provide a site-specific analysis of the environmental consequences of a potential severe accident at a new reactor located on the ESP site using a Level 3 probabilistic risk assessment (PRA) consequence code such as the MACCS2 code. This could involve characterizing the spectrum of credible releases from candidate future plant designs, in terms of representative source terms and their respective frequencies, and using these release characteristics in conjunction with site-specific population and meteorology to determine site-specific risk impacts for the potential design. Release characteristics could be developed through a survey of severe accident analyses for previously certified advanced LWRs and/or operating reactors. The following information should be provided as part of this analysis:

a. a description of the computer code used as the basis for the calculations, including any modifications to the officially released version of the code and important deviations from recommended or default code input values;

b. a description of the site-specific meteorology data used in the calculation, including the treatment of rain/precipitation events and the degree to which the data represents or bounds year-to-year variations in weather at the ESP site;

c. a description of the site-specific population data used in the calculation and justification that this data is representative of the time period through which new unit operations could extend;

d. a description of the major input assumptions for modeling economic impacts, including farm and non-farm values, evacuation costs, value of crops and milk contaminated or condemned, costs of decontamination of property, and costs associated with loss of use of property as a result of the accident (including contamination and condemnation of property);

e. a description of the protective actions considered in the evaluation, including criteria for sheltering and evacuation, criteria for interdiction and condemnation of property and/or crops and the assumed level of medical support to aid the exposed population;

f. a description of the source terms used to represent the reference or surrogate plant design(s), including the radionuclide inventory and the release frequency and characteristics for each release category, including release fractions for the major radionuclide groups, release times and durations, and elevation and energy of release,

g. the results of the calculations in terms of probabilistically-weighted population dose, early and latent fatalities, economic costs, and contaminated and condemned land areas, for the reference or surrogate plant design(s) (Sufficient information should be provided to enable results to be displayed in a manner similar to later final environmental statements [FESs, e.g., Tables 5.10 through 5.13 in NUREG-0921].); and

h. a listing of the input file for the ESP site (including weather data).

<u>Response:</u>

A severe accident consequence analysis was calculated using the Level 3 probabilistic risk assessment (PRA) MACCS2 (Melcor Accident Consequence Code System) code. An attempt was made to be consistent in terms of input and analysis methodology with a recently completed severe accident analysis of a proposed future reactor at the North Anna ESP site (Reference 1 to this response). The same types of reactors were evaluated for the Grand Gulf ESP site, using the same vendor input information.

a. Code: The analysis was performed with the MACCS2 version designated as Oak Ridge National Laboratory RSICC Computer Code Collection MACCS2 V.1.13.1, CCC-652 Code Package. MACCS2, Version 1.13.1, released in January 2004, simulates the impact of severe accidents at nuclear power plants on the surrounding environment. The principal phenomena considered in MACCS2 are atmospheric transport, mitigating actions based on dose projections, dose accumulation by a number of pathways including food and water ingestion, early and latent health effects, and economic costs. The basis model had no important deviations from the default code input values, except for site-specific values and reactor design information. The code values modified for the future designs were primarily the source term data from vendor Level 2 probabilistic safety analyses. The respective reactor vendors provided the Level 2 data for the AP1000 and ABWR designs. This data includes the radionuclide inventory, power level, release fractions and corresponding frequencies, plume release start time, plume release height, delay and duration. Values for the ATMOS input data file (one of the five input files used by MACCS2) was modified, as necessary, to use data appropriate for the ABWR or AP1000 source terms and probability frequencies. (Refer to the response to Part f.) The remaining four MACCS2 input files were reviewed and modified as necessary. All MACCS2 GGNS input files are provided per Part h. below.

b. Meteorology: Three years (2001 -2003) of site-specific hourly meteorological data were used in the analyses. These three recent, consecutive years are considered to be a representative set of data for the site and represents a reasonable bound of year-to-year variations at the ESP site. The three years are each analyzed separately. The results reported below are based on the limiting year for each result. It is noted that the year-to-year variation in meteorology data does not have a significant impact on the MACCS2 output (about 6% variation).

The hourly data (wind direction, wind speed, and precipitation) were collected on-site at the GGNS met tower. These data and their collection are described in the ESP Application SSAR. Stability class was calculated using the GGNS site meteorological data and the methodology of Regulatory Guide 1.23, Table 2 (Reference 5). Missing data were replaced by data from adjacent hours consistent with the recommendations of the EPA in Reference 6; however, when the data gap involved a long sequential period, the entire period was modeled by data from another year. This is not believed to be significant for the following reasons:

(1) The replacement data were reviewed and found to be consistent with that from adjacent periods.

(2) The volume of missing data was small (i.e., 483 hours out of 26,280 hours).

(3) The three separate yearly analyses show relatively consistent results.

Morning and afternoon mixing height values were taken from Table 2.3-125, Mixing Heights at Jackson International Airport, of the ESP SSAR, with the median values selected from Jan-Feb-March for winter season, and so on. The treatment of rain/precipitation events follows the default recommend parameter values given in the ATMOS file supplied with the MACCS2 code.

c. Population: The population distribution and land use information for the region surrounding the ESP site are specified in the SITE input data file. Contained in the SITE input data file are the geometry data used for the site (spatial intervals and wind directions), population distribution, fraction of the area that is land, watershed data for the liquid pathways model, information on agricultural land use and growing seasons, and regional economic information. Some of the detailed data in this input file supercedes certain data in the EARLY input data file.

A 50-mile radius area around the site was divided into sixteen directions that are equivalent to a standard navigational compass rosette. This rosette was further divided into inner radial rings consistent with the ESP ER Figures 2.5-1 and 2.5-2.

It is noted that this population data is associated with the year 2002. In order to extrapolate results to other years, the results can be multiplied by population growth ratios contained within NUREG-1437. The Exposure Index (EI), defined in that NUREG, was verified to be consistent with the above population and meteorology data. The average population out to 10 miles is 453 people per each of the 16 wind segments; however, the estimated EIs (10 and 150 miles) for 2000 are slightly less than the NUREG-1437 values because the prevailing winds are away from population centers. The following estimated EIs are generated for the GGNS site based on NUREG-1437 population ratios and extrapolations.

	1990	2000	2010	2030	2050	2065
Population within 50 miles	350,000	380,000	410,000	450,000	500,000	540,000
Multiplier	0.92	1.00	1.08	1.18	1.32	1.42
10-mile EI	393	427	461	506	562	607
150-mile EI	271772	295066	318361	349421	388245	419305

d. Major site assumptions other than met data and population data:

(1) The land fractions are interpolated off of ER Figures 2.5-1 and 2.5-2 (and can be seen in the input files). However, for watershed definitions in terms of ingestion factors for Sr-89, Sr-90, Cs-134, and Cs-137, it is conservative to ignore the Mississippi River and treat all segments as land.

(2) Regional indices are identified as either Mississippi or Louisiana for region indexing. The two states have similar fractional dairy, total annual farm sales in dollars per hectare, property values in dollars/hectare, and non-farm property values in dollars/person, but the land fraction devoted to farming is different within a 50 mile radius of the plant. Most of the Mississippi side of the river is forested land within this range of the site. The default economic values supplied by the code were increased by the Consumer Price Index ratio of the average value of 109.6 for 1986 (when the NUREG-1150 data above was generated) to 189.1 for May, 2004. Details regarding farm acreage for the counties within a 50-mile radius of the plant were taken from federal statistics in Reference 7.

Region #	State	Fraction farm	Fraction Dairy	Farm Sales ($/hectare)	Property value ($/hectare)	Non-farm property values ($/person)
16	LA	.655	.074	792	5665	105225
22	MISS	.284	.054	695	3595	91425

(3) The crop information required by MACCS2 input are of a slightly different format than similar information provided in the ESP ER. Values were collected from county statistics in Reference 8 for the Louisiana side of the River, and for Districts 2 and 4 on the Mississippi side. These were combined weighted by the total farmland area within the 50-mile radius to produce a single composite measure.

	LA	MS-2	MS-4	Composite
Pasture	0.253	0.291	0.595	0.310

Stored Forage	0.039	0.042	0.337	0.083
Grains	0.093	0.108	0.032	0.087
Green Leafy	0	0	0	0.000
Other	0.200	0.194	0.000	0.170
Legumes/seeds	0.415	0.365	0.036	0.350
Roots/tubers	0	0	0	0.000

(4) The growth season assumed in other GGNS ESP dose calculations was conservatively assumed to be all year long. This assumption was also applied to the MACCS2 analysis.

e. Protective actions: The EARLY module of the MACCS2 code models the time period immediately following a radioactive release. This period is commonly referred to as the emergency phase. It may extend up to one week after the arrival of the first plume at any downwind spatial interval. The subsequent intermediate and long-term periods are treated by CHRONC module of the code. In the EARLY module the user may specify emergency response scenarios that include evacuation, sheltering, and dose-dependent relocation. The EARLY module has the capability for combining results from up to three different emergency response scenarios. This is accomplished by appending change records to the EARLY input data file. The first emergency-response scenario is defined in the main body of the EARLY input data file. Up to two additional emergency-response scenarios can be defined through change record sets positioned at the end of the file.

This analysis used the same assumptions as Reference 1 and the default-supplied data. The emergency evacuation model has been modeled as a single evacuation zone extending out 10 miles from the site. For the purposes of this analysis, an average evacuation speed of 1.8 m/s is used with a 7200 second delay between the alarm and start of evacuation, with no sheltering for the base case. Once evacuees were more than 20 miles from the site, they disappear from the analysis. The evacuation scenario is weighted 95%, compared to no evacuation for the purpose of composite results.

f. Source terms: The ATMOS input data file calculates the dispersion and deposition of material released "source terms" to the atmosphere as a function of downwind distance. Source term release fractions (RELFRC) for the ABWR and AP1000 are shown below, as are plume characterizations, respectively. These data include the source term inventory, power level, release fractions, plume start time, plume release height, delay and duration.

The ABWR shows 10 different source term categories (STCs). See Table 1. The release times and durations, and elevation and energy of release for the ABWR were extracted from the GE ABWR licensing submittal document (Reference 2). Parameters are assigned to each source term according to STC number. Each release plume is assumed to have only one segment. See Table 2. The scaling factor (CORSCA) was used to adjust the ABWR core inventory for a power level of 4300 MWt. The core inventory was based on the discharge exposure burnup of 35,000 MWD/MT.

Vendor data was also used to characterize the AP1000 source term category release fractions and corresponding frequencies for the MACCS2 element groups (References 3 and 4). Four plume segments of release fraction data were originally reported, but were collapsed to two in order to be consistent with the Reference 1 analysis. The process of collapsing the plume data results in the same total releases occurring in the two plumes that the vendor modeled as occurring in four plumes. Table 3 (below) provides the collapsed source term release fractions for 7 different source term categories (STCs). Timing data indicated in the table below was also revised to represent two plume segments. A plume energy level 3.0E+06 W was assigned to the first plume and 2.0E+06 W for the second plume except for the bypass sequence. The ALARM time was selected to be the same as the first plume DELAY time. The balance of the timing data of each plume is taken from the Westinghouse PRA Study document. See Table 4. The scaling factor (CORSCA) used to adjust the AP1000 core inventory for power level was (3415/3412 =) 1.0009. This was determined due to the base 3412 MWI MACCS2 pressurized water reactor default inventory and the actual AP1000 thermal power rating of 3415 MWt. The GGNS input uses slightly more conservative core inventories and slightly different REFTIM data than Reference 1 based on interpretation of Reference 4 material.

g. Results: The results of the dose and dollar risk assessments for the AP1000 and ABWR plant designs are provided in Table 5. These are the results from the year of meteorology that provided the highest risk. Risk is defined in these results as the product of source term category frequency and the dose or cost associated with the STC. The total risk is assumed to be the sum of all scenarios. Since the AP1000 and ABWR plant designs reflect different release/source term categories, use of the total/summed risk provides a common reference point.

The maximum dose risk sensitivity to the meteorological data was shown to differ by approximately 6% from the limiting case for both the AP1000 and ABWR plant designs. A similar sensitivity to the meteorological data was seen for the dollar risk. The highest mean values for affected land areas are shown in Table 5. The mean values for affected land areas are given in hectares and are not totaled for all STCs. Instead, the values reflect the maximum area associated with the worst-case single release scenario. The values for total early and latent fatalities per year were conservatively calculated as the sum of all release scenarios for the limiting meteorological data year. Tables 6, 7, and 8 support the calculated dose/year and dollars/year risks for both advanced reactor designs presented in Table 5. As can be seen from the cited tables and results, consequences from severe accidents from the two advanced reactor designs are products of significantly lower risk factors when compared to existing plant inputs (see response to Request E7.2-4). This is consistent with GEIS findings for existing plants that risk impacts from severe accidents would be small. It is also noted that the relatively low local population reduces the risk even further.

h. Input files: The following are the input file names used in this analysis. All input files have been provided:

001_GGNSABWR.INP	(ATMOS file for the ABWR design)
002_GGNSPWR.INP	(ATMOS file for the AP 1000 design)
003_GGNSEARLY.INP	(EARLY file for the GGNS site)
004_GGNSCHRONC.INP	(CHRONC file for the GGNS site)
005_METGGNS2001.INP	(Year 2001 meteorology data - GGNS site)
006_METGGNS2002.INP	(Year 2002 meteorology data - GGNS site)
007_METGGNS2003.INP	(Year 2003 meteorology data - GGNS site)
008_GGNSSIT.INP	(Data for the GGNS site)

Also provided are the output files.

REFERENCES:

1. Response to 3/12/04 Environmental RAIs for North Anna ESP, E. S. Grecheck, Dominion Nuclear North Anna letter to the NRC DCD, Serial 04-170, Docket No. 52-008, dated May 17, 2004 (ADAMS Accession No. ML041450041)
2. General Electric Advanced Boiling Water Reactor (GE ABWR) Standard Safety Analysis Report 23A6100, Revision 4.
3. AP1000 Design Control Document, Westinghouse Electric Corporation, Revision 8, 2003.
4. AP1000 Probabilistic Risk Assessment Report, Westinghouse Electric Corporation.
5. Regulatory Guide 1.23, "Safety Guide 23, Onsite Meteorological Programs."
6. USEPA document, Dennis Atkinson and Russell F. Lee, "Procedures for Substituting Values for Missing NWS Meteorological Data for Use in Regulatory Air Quality Models," July 7, 1992.
7. US federal and use statistics collected from http://www.fedstats.gov/qf/states/
8. Agricultural Marketing Services branch of the United States Department of Agriculture (USDA) agricultural statistics state summary web pages at http://www.ams.usda.gov/statesummaries/LA/District.htm and http://www.ams.usda.gov/statesummaries/MS/District.htm.

Table 1
ABWR Source Term Release Fractions

STC	Xe/Kr	I-Br	Cs-Rb	Te-Sb	SR	Co-Mo	LA	CE	BA
0	4.40E-2	2.30E-5	2.30E-5	5.30E-6	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
1	1.00E+0	1.50E-7	1.30E-5	3.10E-4	6.30E-6	2.40E-11	7.90E-8	7.90E-8	6.30E-6
2	1.00E+0	5.00E-6	5.00E-6	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
3	1.00E+0	2.80E-4	2.20E-3	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
4	1.00E+0	1.60E-3	1.60E-3	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
5	1.00E+0	6.00E-3	5.30E-4	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
6	1.00E+0	3.10E-2	7.70E-2	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
7	1.00E+0	8.90E-2	9.90E-2	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
8	1.00E+0	1.90E-1	2.50E-1	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
9	1.00E+0	3.70E-1	3.60E-1	1.10E-3	9.30E-3	9.20E-8	2.80E-3	2.80E-3	9.30E-3

NOTE: STC is the source term category and refers to the Base Case 0 and the 9 stacked cases in the ATMOS input for the GE ABWR. Data from Table 19E.3-6, Reference 2, and Reference 1.

Table 2
ABWR Plume Characterization Data

STC	Alarm (s)	Number of Plume Releases	Risk-Dominant Plume	REF TIM	Plume heat (W)	Plume Release Height (m)	Plume Duration (s)	Plume Delay (s)
0	6120.0	1	1	0.0	1.38E+6	37	36000.0	9720.0
1	69120.0	1	1	0.0	1.38E+6	37	3600.0	72000.0
2	65520.0	1	1	0.0	1.38E+6	37	3600.0	68400.0
3	177120.0	1	1	0.0	1.38E+6	37	36000.0	180000.0
4	69120.0	1	1	0.0	1.38E+6	37	3600.0	72000.0
5	69120.0	1	1	0.0	1.38E+6	37	3600.0	68400.0
6	65520.0	1	1	0.0	1.38E+6	37	36000.0	68400.0
7	69120.0	1	1	0.0	1.38E+6	37	36000.0	72000.0
8	4320.0	1	1	0.0	4.19E+6	37	36000.0	7200.0
9	43920.0	1	1	0.0	1.38E+6	37	36000.0	84960.0

NOTE: Alarm time is seconds after accident that emergency conditions are reached as defined in NUREG-0654; since only one plume assumed in each scenario, the risk dominant plume is always 1; a REFTIM of 0 uses the leading edge as a locator for plume contents, the plume delay is the time after SCRAM. Data from Table 19E.3-6 of Reference 2.

Table 3
PWR Source Term Release Fractions

STC	Noble Gases	I	CS	TE	SR	RU	LA	CE	BA
CFI	7.98E-1	3.33E-3	3.32E-3	4.35E-4	2.18E-2	9.28E-3	8.06E-3	4.32E-5	1.65E-2
"	1.22E-1	0.0E+0	0.0E+0	6.04E-6	0.0E+0	0.0E+0	1.12E-2	4.06E-5	0.0E+0
CFE	8.21E-1	5.66E-2	5.49E-2	1.39E-3	3.48E-3	1.42E-2	6.54E-5	1.00E-6	5.28E-3
"	1.42E-1	0.0E+0	0.0E+0	6.04E-7	0.0E+0	0.0E+0	0.0E+0	0.0E+0	0.0E+0
DIRECT	4.43E-3	3.61E-5	3.46E-5	2.42E-6	3.22E-5	3.94E-5	4.06E-6	1.76E-8	3.61E-5
"	3.50E-3	0.0E+0	0.0E+0	5.44E-9	0.0E+0	0.0E+0	0.0E+0	0.0E+0	0.0E+0
IC	1.48E-3	1.20E-5	1.15E-5	8.09E-7	1.07E-5	1.31E-5	1.36E-6	5.88E-9	1.20E-5
"	1.17E-3	0.0E+0	0.0E+0	1.81E-9	0.0E+0	0.0E+0	0.0E+0	0.0E+0	0.0E+0
BP	1.0E+0	2.15E-1	1.96E-1	9.39E-3	3.57E-3	4.48E-2	1.30E-4	3.19E-6	8.93E-3
"	0.0E+0	2.34E-1	7.60E-2	6.89E-3	0.0E+0	0.0E+0	0.0E+0	0.0E+0	1.00E-6
CI	6.86E-1	4.56E-2	2.10E-2	1.65E-3	2.03E-2	4.04E-2	2.39E-4	2.97E-6	3.16E-2
"	8.40E-2	0.0E+0	0.0E+0	9.37E-5	0.0E+0	0.0E+0	0.0E+0	0.0E+0	0.00E+0
CFL	1.53E-3	1.21E-5	1.15E-5	1.02E-6	1.67E-5	1.71E-5	1.17E-5	4.79E-8	1.68E-5
"	9.79E-1	2.13E-5	1.19E-5	3.67E-5	2.83E-3	1.42E-3	1.41E-1	5.34E-4	2.60E-3

NOTE: STC is the source term category. The second row for each STC applies to the second plume. Data are developed from Table 49-2 of Reference 4.

Table 4
PWR Plume Characterization Data

STC	Alarm (s)	Number of Plume Releases	Risk-Dominant Plume	REFTIM	Plume heat (W)	Plume Release Height (m)	Plume Duration (s)	Plume Delay (s)
CFI	2924	2	1	0.0	3.0E+6	30	53830	2924
CFI	2924	2	1	0.5	2.0E+6	30	86400	32590
CFE	3004	2	1	0.0	3.0E+6	30	70160	3004.
CFE	3004	2	1	0.0	2.0E+6	30	86400	19810.
DIRECT	4378	2	1	0.5	3.0E+6	30	80432	4378.
DIRECT	4378	2	1	0.0	2.0E+6	30	86400	84810.
IC	4378	2	1	0.5	3.0E+6	30	80432	4378.
IC	4378	2	1	0.0	2.0E+6	30	86400	84810.
BP	31890	2	1	0.5	3.0E+6	30	40050	31890.
BP	31890	2	1	0.0	3.0E+6	30	86400	46440.
CI	100.8	2	1	0.5	3.0E+6	30	86380	100.8
CI	100.8	2	1	0.5	2.0E+6	30	75300	50020.
CFL	2922	2	1	0.5	3.0E+6	30	81640	2922.
CFL	2922	2	1	0.5	2.0E+6	30	86400	26360.

NOTE: Alarm time is seconds after accident that emergency conditions are reached as defined in NUREG-0654; in all cases, the first plume is dominant in terms of risk, the REFTIM value of 0.5 uses the midpoint of the plume as content locator; the plume delay is the time after SCRAM. Data is condensed from Table 49-2 of Reference 4.

Table 5
Results Summary Comparison of Plant Designs

Plant Design	Dose Risk (Person-Rem/yr)	Dollar Risk (per year)	Affected Land (in Hectares)	Early Fatalities (per year)	Latent Fatalities (per year)
ABWR	0.002	2.82	158,000	1.51E-12	1.05E-6
AP1000	0.013	26.7	152,000	$<10^{-12}$	6.94E-6

NOTE: Results are for 0-50 mile radius from the ESP Site.

Table 6
ABWR Mean Value for Total Dose Risk Assessment

STC	STC Freq. (per year)	Case 1A (2001 data)	Case 1B (2002 data)	Case 1C (2003 data)
0	1.34E-07	8.20E-04	1.13E-03	8.60E-04
1	2.08E-08	9.32E-05	1.24E-04	9.82E-05
2	1.00E-10	1.44E-07	1.95E-07	1.61E-07
3	1.00E-10	1.96E-05	2.27E-05	1.32E-05
4	1.00E-10	1.24E-05	1.31E-05	9.16E-06
5	1.00E-10	4.64E-06	4.98E-06	3.82E-06
6	1.00E-10	5.84E-05	5.43E-05	4.71E-05
7	3.91E-10	2.41E-04	2.32E-04	2.13E-04
8	4.05E-10	3.56E-04	3.52E-04	3.39E-04
9	1.70E-10	1.82E-04	1.77E-04	1.68E-04
Total		1.79E-03	2.11E-03	1.75E-03

NOTE: Data is in Person-Rem/year. The three cases refer to the three different years of meteorological data. The worst-case year is used to select the data for Table 5. STC Freq. is from Table 19E.3-6, Reference 2.

Table 7
PWR Mean Value for Total Dose Risk Assessment

STC	STC Freq. (per year)	Case 1A (2001 data)	Case 1B (2002 data)	Case 1C (2003 data)
CFI	1.89E-10	5.82E-05	6.07E-05	6.01E-05
CFE	7.47E-09	2.81E-03	2.72E-03	2.80E-03
IC	2.21E-07	6.98E-04	9.06E-04	7.71E-04
BP	1.05E-08	9.02E-03	8.63E-03	8.90E-03
CI	1.33E-09	4.19E-04	4.12E-04	4.14E-04
CFL	3.45E-13	1.48E-09	1.44E-07	1.43E-09
Total		1.30E-02	1.27E-02	1.30E-02

NOTE:Data is in Person-Rem/year. The three cases refer to the three different years of meteorological data. The worst-case year is used to select the data for Table 5. STC Freq. is from Table 19.59-16 of Reference 3.

Table 8
Dollar Risk Assessment

Design	STC	Case 1A (2001 data)	Case 1B (2002 data)	Case 1C (2003 data)
ABWR	All	2.64	2.82	2.02
PWR	All	26.1	26.1	26.3

NOTE: Data is in Dollars/year.

Response

E7.2-3 Section 7.2 (response continued, final page)

See files:	Input Files:	001_GGNSABWR.INP
		002_GGNSPWR.INP
		003_GGNSEARLY.INP
		004_GGNSCHRONC.INP
		005_METGGNS2001.INP
		006_METGGNS2002.INP
		007_METGGNS2003.INP
		008_GGNSSIT.INP
	Output Files:	034_GGNSABWR2001.OUT
		035_GGNSABWR2002.OUT
		036_GGNSABWR2003.OUT
		037_GGNSPWR2001.OUT
		038_GGNSPWR2002.OUT
		039_GGNSPWR2003.OUT

Request:

E.7.2-4 Section 7.2. Provide a comparison of the (probabilistically weighted) environmental risk of severe accidents for a future reactor at the ESP site with:

a. the risks (doses) associated with normal and anticipated operational releases from a future reactor at the ESP site; and

b. the risk of severe accidents for the current generation of operating plants (at their respective sites), as characterized in such studies as NUREG-1150, *Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants*, and the plant-specific risk study for Grand Gulf Nuclear Station.

Response:

a. The probabilistically weighted environmental risks of severe accidents are quantified in response to RAI E7.2-3. Due to the relatively low population density, and the extremely low frequency of severe accidents in the ABWR and AP1000 PRA results, the environment risks of severe accidents are extremely low. The weighted total dose risk is less than 0.013 person-rem/year.

From the ESP ER Section 5.4, the normal and anticipated operational releases from a future reactor at the ESP site are also very low, but still greater than the weighted risk of severe accidents. ER Table 5.4-13 lists the estimated population[5] whole body dose from airborne releases as 3.37 person-rem/yr. The conclusion is that the weighted environmental risks of severe accidents are much less than those associated with normal operation.

It is emphasized that the environmental risks of normal operation are themselves very low. As stated in the ER Section 5.4.3.2, existing background radiation sources amount to about 130 mrem/yr. The worst case calculated individual dose due to a future reactor is shown in ER Table 5.4-11B to be less than 4 mrem/yr, and that calculated maximum is a bounding value that is not expected to actually occur.

b. The results of severe accidents for current generation reactors as characterized in NUREG-1150, the plant-specific study conducted for Grand Gulf in NUREG/CR-4551, and the ESP submittal for the North Anna site were all reviewed and compared to the severe accident risk calculated in the MACCS2 analysis discussed in RAI E7.2-3. The conclusions are:

(1) the Grand Gulf ESP site's low population provides low risk (even with current reactor design), and

[5] Annual radiation exposure associated with gaseous releases from the ER Table 5.4-13 is associated with the population with a 50-mile radius of the GGNS site (ER 5.4.3.2).

(2) the low frequency of releases associated with the ABWR and AP1000 designs make the severe accident risk of a future unit at this site extremely low.

Plant	Population Dose (50 miles) (person-rem/yr)
Zion (Reference 1)	5.47E+01
Grand Gulf Existing Unit (Reference 2)	5.2E-01
Surry (Reference 3)	6.E+00
North Anna (Reference 4)	2.51E+01
North Anna AP1000 (Reference 4)	8.28E-02
North Anna ABWR (Reference 4)	5.93E-03
Grand Gulf AP1000	1.3E-02
Grand Gulf ABWR	2.0E-03

REFERENCES:

1. NUREG/CR-4551, "Evaluation of Severe Accident Risks: Zion, Unit 1," U. S. Nuclear Regulatory Commission, Table 5.1-1, Vol. 7, Rev.1, Part 1, March 1993.

2. NUREG/CR-4551, "Evaluation of Severe Accident Risks: Grand Gulf, Unit 1," U. S. Nuclear Regulatory Commission, Table 5.1-1, Vol. 6, Rev.1, Part 1, December 1990.

3. NUREG-1150, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants Final Summary Report," U. S. Nuclear Regulatory Commission, Table 12, Vol. 1, December 1990.

4. Response to 3/12/04 Environmental RAIs for North Anna ESP, E. S. Grecheck, Dominion Nuclear North Anna letter to the NRC DCD, Serial 04-170, Docket No. 52-008, dated May 17, 2004 (ADAMS Accession No. ML041450041)