DEC 2 3 1982

Docket No. STN 50-447

General Electric Company
ATTN: Mr. Glenn G. Sherwood, Manager
Safety and Licensing Operation
Nuclear Power Systems Division
175 Curnter Avenue, Mail Code 682
San Jose, California 95125

Dear Mr. Sherwood:

Subject: Request for Additional Information Regarding Severe Accident Portion of the General Electric Application for an FDA for a Standardized Nuclear Island (GESSAR-II)

Our review of the Severe Accident Portion of your application for a Final Design Approval of your Standard Nuclear Island has identified a need for additional information. Our request is contained in the enclosure.

In order for us to maintain the relatively compressed review schedule. We will need completely adequate responses to these questions by February 1, 1983. This request for information was previously given to, and discussed with your staff in October 1982. If you have any questions regarding this request, please contact Dino Scaletti at (301) 492-9797.

Sincerely,

Original signed by
Frank J. Miraglia

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A PDR

Frank J. Miraglia, Assistant Director
for Safety Assessment
Division of Licensing

Enclosure:
As stated

"The reporting and/or recordkeeping requirements contained in this letter affect fewer than ten respondents; therefore, OMB clearance is not required under P.L. 96-511."

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DATE	12/21/82	12/22/82	12/22/82	12/23/82			

720.1. Was on-line repair or recovery modeled for all systems considered in the PRA? If not all systems, then list which systems were considered for on-line repair or recovery. How was recovery modeled? What is the difference, if any, between on-line repair and recovery?

720.2. Provide all sources for the failure data used in the PRA. Explain the criteria used for the selection of one data source over the other. What was the rationale for combining several data sources in some instances and not in others? What were the guidelines used to determine whether or not the data base should be integrated?

720.3. Provide additional information on the treatment of effects of extreme environmental conditions following core melt accidents (beyond DBA conditions) on systems and components and of common manufacturing or design errors of equipment considered in the PRA. Examples would include but not be limited to the following:

a) Effects on electrical insulation due to voltage treeing and dielectric loss.

b) ADS valves and control logic system.

c) Use of RCIC when the ambient temperature has exceeded 200°F (this high temperature condition would cause insufficient lube-oil cooling and fail RCIC).

d) Effects on instrumentation following containment failure and subsequent effects on successful injection (both automatic and manual).

e) Effects on drywell structural integrity under adverse thermal stress conditions.

f) Effects on safety-related equipment due to prolonged electrical short circuits.

720.4. Provide the GE calculations showing that core damage can be avoided if half of the active fuel remains uncovered during an accident. How sensitive is the assumption of core melt freqaency? (p. 3-50)

720.5. Provide in detail the basis for each of the success criteria used in the PRA (both ATWS and non-ATWS). If other GE analyses have been referenced, provide each reference or report for our review. This question refers to both safety and non-safety related systems, and both front-line and support systems considered in the PRA.

720.6. Provide the specifics of how the reductions in transient initiator frequencies were calculated in Table A.1-3. Discuss the bases used in this evaluation. Provide the procedures used in applying these reductions in order to arrive at the initiator frequencies in Table A.1-2.

720.8. Provide the specific method used in order to arrive at the value 0.003 for the failure to close of one safety relief valve (p. 3-242). How does this value compare with experience?

720.9. How were mechanical common-mode failures included in the unavailability of Scram or Alternate Rod Insertion (ARI) ($1x10^{-7}$)? Provide your bases for this unavailability estimate (p. 3-241).

720.10. Provide the bases for using the same unavailability value for condensate injection (CI) (.1) in small LOCA (p. 3-279) as that in turbine trip events (p.3-242). Elaborate on why the CI function was not degraded for the small LOCA since it would be difficult to transfer an adequate amount of water to the hotwell.

720.11. Explain why a failure of the containment spray could be treated as a successful sequence (Fig. C.12-1). What is the relationship between the containment spray and containment vacuum breakers in the context of Figure C.12-1?

720.12. What does CT7 signify in Figure C.15-1? The PRA consists of only six containment event trees.

720.13. In the LPCI fault tree (p. 3-397), the loss of suppression pool (LSP) function was shown to be transferred to the HPCI fault tree. Explain how the LSP function is derived and how it is related to the HPCI system in GESSAR. Review of the HPCS fault tree did not show any LSP function (p. 3-341).

720.14. In the GESSAR-II PRA, the containment isolation failure probability was assumed to be 1×10^{-5}/demand. Provide the bases and the details of the analysis in arriving at the value (p. 3-302).

720.15. In the loss of offsite power (LOOP) event tree, an initiator frequency of 0.05 was used (p. 3-257).

a) Provide the bases for the selection of the value 0.05.

b) Explain the method used in arriving at such a value and provide the basis of any recovery and the duration of outage assumed.

c) If a minimum outage duration was assumed, how were events with durations shorter than that of the minimum outage included in the analysis.

720.16. Provide the rationale and the quantitative evaluation for not considering the total or partial loss of DC power as an accident initiator.

720.17. Provide all numerical values used in system fault trees in the GESSAR-II PRA.

720.18. a) In addition to the system fault-trees that are included in the PRA, functional event-trees and functional fault-trees were used to calculate branch point probabilities in the event-trees. Provide all functional fault-trees and functional event-trees used in the analysis; furnish also numerical values used in these trees.

b) Provide a detailed discussion on how dependencies were evaluated when the event-trees quantified; these dependencies include:

i) Support system dependency - the sharing of support systems between systems and functions, for example, HPCS, LPCI, RHR, PCS, etc., depending on AC.

ii) Hardware dependency - common hardware shared between different systems, e.g., injection lines, valves, etc.

iii) System dependency between functions - in the event tree, the feedwater system and the power conversion system (PCS) were grouped together under the function U_F; later on, in the W_{2C} function, the PCS was also included for decay heat removal. How would the failure of U_F affect the success of the W_{2C} function? (pp. 3-233, 250) Discuss also the treatment of dependency between low pressure core cooling (LPCC) and W_{2C} (p 3-236).

iv) Initiator faults impacting mitigating systems.

720.19. In Section C.3.2, "Turbine Trip Without Scram," (p. 3-237) it is stated that, "In order to quickly reduce reactor power to about 15 precent of the pre-transient power level, a RPT is initiated by the redundant reactor control system (RRCS). The probability of failure of the RPT includes the RRCS common cause failure probability and is given by R. This failure may result in containment overpressure in about 10 minutes." Provide your bases for the value assigned to R.

720.20. What manual action is necessary to accomplish the feedwater runback. Describe the step by step actions involved and the locations of each action.

720.21. Provide documentation for the unavailability of feedwater and PCS values used in all event trees in the GESSAR-II PRA.

720.22. Why was the LOOP event explicitly included only in the LOCA trees but not in any other tree? Provide discussion on how transient induced LOOP was included in the analysis.

720.23. During the course of a severe accident, the main steam isolation valves (MSIVs) may be exposed to temperature conditions beyond the design limit resulting in the degradation and potential failure of these valves. Provide an assessment of the integrity of the MSIVs during limiting accident sequences accounting for the various heat inputs to the valves. Discuss the potential impact and the likelihood of releasing radionuclides through a partially failed MSIV to the environment.

720.24. The RHR system consists of two trains, each of which has two pumps for redundancy of their twin functions, shutdown and suppression pool cooling modes. However, there is only one suction path in the shutdown cooling mode. Failure of any one of three valves would disable the RHR system in the shutdown mode. In the suppression pool cooling mode, although there are two suction and two discharge paths for the pumps, that redundancy can also be negated by failure of any pair of valves in opposite discharge paths or failure of the minimum flow bypass valves. Discuss the effect of this failure on the RHR system availability.

720.25. In the event that resin within any demineralizer is broken up into fragments, provide further details on the likelihood of occurrence and progression of such an event and on how it may result in subsequent degradation or failure of coolant injection or makeup.

720.25. Provide the fault-tree by which the common cause failure of the ARI and standby liquid control systems were evaluated. Provide also the numerical values used in the fault tree (p. 3-237).

720.26. Provide all revisions to the PRA per discussion at the BNL meeting on August 26, 1982.

720.27. Provide the basic event importance during each phase of the ECCS operation for the dominant accident sequences in the GESSAR-II PRA.

Basic event importance is defined as the probability the basic event is contributing to system failure given the system is failed. The ECCS operation may be considered to be a three-phase mission, i.e., initial core cooling, suppression pool cooling, and residual heat removal. The phase boundary times for the ECCS operation should correspond to each accident sequence.

720.28. Discuss any potential impact of the ORNL's Precursors Study (NUREG/CR-2497) on the GESSAR-II PRA with respect to the core melt probability and overall risk assessment.

720.29. In the currently available GESSAR-II PRA, the procedural aspects of human errors have been emphasized, i.e., errors of omission and of commission. It is now recognized that cognitive behavior can potentially have a dominant contribution to risk. A single wrong decision based on misdiagnosis or improper priorization of tasks can lead to a series of incorrect actions. Discuss the impact of cognitive errors on the logic trees and on the PRA results by providing sensitivity analysis for the dominant accident sequences.

720.30. DELETED

720.30. In the GE suppression pool decontamination factor model, small gas bubbles were assumed. In view of the fact that in a saturated pool, coalescence of bubbles and bubble growth may become increasingly dominant, provide a discussion on how sensitive the GE model is to the small gas bubble assumption. How would the assumption on the shape of the bubble influence the result of the model?

720.31. Justify that the suppression pool decontamination factors will not decrease following a core melt accident;

(i) when the suppression pool water starts to boil off,

(ii) a large amount of fission products and corium debris are present in the suppression pool, and

(iii) fission products, organo-metallic chelate compounds, and small-sized particulates may be evaporated off into the containment air space.

720.32. In the suppression pool scrubbing model, there are at least three important parameters contained in the decontamination factor in the exponential term, i.e., particle diameter d, bubble diameter D, and bubble rise velocity V, thus an uncertainty in any of these parameters would result in great changes of the decontamination factor. Provide the expected uncertainty band for each parameter in the exponential term and discuss the sensitivity of the DFs to these uncertainty bands.

720.33. Is the in-reactor pressure vessel DF applied to the entire melt and gap release, or to that fraction of the release corresponding to the fraction of core melt in the MARCH calculation (~65%) at the point of core slumping? (Section 5.1)

720.34. The decontamination factors (DFs) for pool scrubbing are sensitive to the particle size. What experimental and/or theoretical evidence is there for choosing the particle size distribution used? Provide clarification regarding the manner in which the model accounts for changes in DF depending on accident sequence and during the course of an accident (i.e., the time dependence of DF due to changing average aerosol particle size as the larger, heavier particles settle out). Describe the accident progressions from the standpoint of mechanistic aerosol production and transport to the suppression pool, comparing how you envision aerosol production actually happening to the experiments upon which you establish your particle size and particle size distribution. (Appendix F.1; Table F.3-3)

720.35. Is a different DF used when the release is through the quenchers as opposed to a release through the first row of port holes in the drywell wall? (Appendix F.2)

720.36. Four possible combustion processes are defined: (Appendix I-1)

(a) During any one event (e.g., local combustion) is the containment volume involved assumed to have a uniform composition of all gaseous components?

(b) Can any of these four possible combustion processes interact? For example, can a "global deflagration (involving 60 percent of containment volume) be followed by a "local detonation" (involving 40 percent of containment volume).

(c) How do you know that all important/significant combustion sequences (perhaps a very large number of possibilities) are included in your considerations?

720.37. On page 15.D.3-798, a characteristic time, $t_{1/2}$, for the decay of a detonation waves, peak pressure is defined as

$$t_{1/2} = \frac{L}{2V_D}$$

a. Is this expression valid for a closed system?

b. Is this expression valid for a closed system of any geometry?

c. Does this expression take account of pressure loadings everywhere in a closed system?

720.38. After a period of steam inertion of the atmosphere, condensation may proceed (homogeneously and heterogeneously) to permit combustible/detonable compositions to exist somewhere. (Appendix I.3)

a. What assumptions are made regarding:

1. Hydrogen homogeneity during steam condensation.
2. Steam homogeneity during steam condensation.
3. Post inertion combustion/detonation.

720.39. If a detonation is extinguished as it propagates from a detonable mixture into a non-detonable (but combustible/flammable) mixture, how fast does the leading shock wave decay? Is such a process considered innocuous? (e.g., see p. 15.D.3-797).

720.40. Item by item, provide a detailed justification for each of the conditional probabilities tabulated as Tables I.4-1 and I-5 of the GESSAR-II PRA.

720.41. In the GE MARCH input for the TQUV sequence (per letter dated 8/25/82), it was stated that the initial water level in the core was "adjusted" such that core uncovery would occur at a time consistent with that predicted by GE's SAFE code. Inspection of the parameters associated with water level and total primary system coolant inventory has shown that GE's choice of these parameters results in a primary system coolant inventory of approximately 400,000 lbs. If so, why has this considerable steam source been neglected, and does this missing source result in non-conservative estimates of containment loading?

720.42. Inspection of the passive heat absorbing structures used in the GESSAR MARCH analysis reveals that the metal containment shell receives heat from the containment atmosphere on both sides of the wall. This effectively doubles the heat transfer area of the containment walls and appears to be non-conservative. Explain how you arrive at these input values.

(43-70) The most significant departure from current PRA source term estimate appears in the credit assumed for the scrubbing of fission products in the suppression pool. The assumptions are based almost entirely on the GE pool scrubbing experiments. However, no complete reporting of these experiments is available either on the GESSAR docket, or in the open literature. The description in Appendix 15D appears to be an excerpt, or a summary, of the experiments. It is lacking in such essentials as a complete description of the experimental apparatus, instrumentation, experimental conditions (for all tests) and test data. Please provide a complete reporting of these experiments, as they are crucial to the assessment of accident source terms. The following questions (-70) on the abbreviated material available will indicate the type of information necessary for our review.

720.43. Scaling of the hydrodynamic processes governing gas flow into the suppression pool by way of the SRVs and vent pipes is reasonably well understood. Please provide a scaling analysis that demonstrates that to the conditions for the scrubbing experiments are indicative of the hydrodynamic conditions anticipated in the prototype.

(a) Include therein a discussion of how the effect of surface tension is scaled so that bubble break-up is properly accounted for.

(b) Once the bubble sizes are rationalized, pool depth and terminal velocities of single bubbles and swarms of bubbles must be considered. Provide a discussion of the scaling considerations employed for the test facility that account for the pool height to bubble velocities ratio time scale.

(c) Bubbles break through a surface by a complex process that creates small liquid droplets that are thrown upward. The amount of entrained liquid be a function of the number of bubbles and their sizes. Scale will play an important role here also; please discuss.

720.44. The DF prediction focuses on iodine present as CsI associated with large particles. What would be the effect of assuming some elemental iodine or organic iodine? What would be the potential for formation of organic iodine in the drywell? To what extent would elemental and organic iodine forms limit decontamination factors?

720.45. What shape factor should be used to characterize the Eu_2O_3 in the depletion calculation? Please provide justification for your conclusions.

720.46. Considering the sensitivity of DF to particle size, the determination of an average size of 4.1 μ cannot be considered close agreement with the stated "1.87 to 3.1 μ determined by the Quantamet." Which of these values is close to the actual expected value, i.e., a better representation of reality. Which one did GE use? How does what GE used compare with either of these values?

720.47. Provide examples of the scanning electron microscopic pictures referred to on Page 49-C33.

720.48. What effects do deposition and reentrainment have on the particles as they actually enter the pool, compared to measurements made at other times or places.

720.49. Show on a copy of Figure 1-2, and discuss, the effect on the experiment of the diluter mentioned on Page 49-C34.

720.50. What are the length to diameter ratios for all the sampling lines? What effect or modification will this factor have on the measured size of particles? Will there be any appreciable expected tendency to deposit for lines of large l/d?

720.51. Page 49-C33 discusses 2 impact samplers. Figure 1-2 shows 3 (before the pool, above the pool, and after the recirculation line). Which two are meant to be referenced in the text? What does the third one sample?

720.52. The last line of Page 49-C35 states that a "high flow recycle stream" kept particles in suspension. What was the magnitude of the flow in cfm, and what velocities existed in the recycle circuit?

720.53. Tables 15 DA.1-1 and -2 give what seems to be a calibration for the impactors used. Is this what they are? How are the particle diameters in the table defined? Give the equations used in the calculation and a reference therefore. Which 2 of the 3 impactors are referenced in the tables? Are the calibration conditions typical of the flow rates in the actual experiments?

720.54. There was in the presentation by a GE representative to the American Chemical Society in Kansas city in September, 1982, a statement that the impactor at the top of the tank may have modified the particle size. Is this GE's position? If so, why might this same condition not have occurred on either of the other 2 samplers? How would the comparison of the experiment with the model be changed?

720.55. The paragraph at the top of Page 49-C36 seems to indicate that all starting and final locations of Eu_2O_3 were sampled. This should allow a mass balance to be performed. Did GE do this? If so, what are the results? If not, what places remained unaccounted for?

720.56. On Page 49-C37 an "entrance effect" is discussed. What is your definition of an entrance effect? How was it calculated? Is it a function of particle size? Give a reference. How are values given in Figure 15 DA.1-3 (curves or data) modified for this effect?

720.57, The same page refers to the particle size distribution in Table 15 DA.1-5. The table purports to contain fractions of mass of Eu_2O_3 vs average particle size. The mass fractions do not add to unity. What is the particle size distribution? Considering the extreme sensitivity of DF to particle size, are the bins of particle sizes in that table sufficiently small so as not to cause uncertainty in DF assumptions? Give sample calculations. Since only one size distribution is given, is it correct to assume that <u>all</u> the many experiments had exactly the same size distribution? Were the distributions not measured by the impact samplers in every experiment?

720.5 . How do you get the correct diameter to calculate the Cunningham slip factor and the diffusivity, if an <u>assumed</u> value is input for the density? How much uncertainty can be introduced in the calculated DF as a result?

720.59. In Paragraph (2), on Page 49-C38, the statement was made that the experimental results exhibited the trend of DF versus particle size given by the model. No data are given which would allow this to be reviewed. Provide the data and the comparison.

720.60. Paragraph (6) on 49-C40 discusses the water as a perfect sink. The statement is made that water will absolutely absorb the particle (Emphasis added). Provide references or supporting data for this absolute statement.

720.61. Paragraph (7) on Page 49-C41 states that super-heated steam could play an important role in promoting particle growth. Discuss the mechanism by which this takes place. Provide references or other supporting information.

720.62. Paragraph (8) on Page 49-C41 states that the scrubbing factors are conservative from a temperature standpoint because thermophoresis was neglected. Thermophoresis would, if calculated, increase the DF. However, there is an effect in the opposite direction, diffusophoresis. This effect may be larger than thermophoresis. Show why the DFs should be considered conservative.

720.63. In table 15DA.1-4, data are given for tests on 12/11, 12/14, and 12/15. Given GE's model, these tests would all be expected to give the same results. There is over a factor of 4 difference in the results, however. Does this represent scatter in the data? Explain.

720.64. Provide justification for the statement on Page 49-C43 that the large bubble shatters within about one bubble radius, especially considering the statements on Page 49-C45, 2nd paragraph. In the justification, consider especially problems of scale.

720.65. Justify the submergence of 3 and 5 feet used in the experiment from the point of view of scale. What are the minimum, maximum, and average submergency values of the horizontal vents in the within plant case?

720.66. For Figure 15DA.2-3, what is the basis for the solid curve? It does not appear to be a "best fit" to the data. Was the parameter bubble rise velocity as a function of flow rate used in the analysis? If so, please present the values used and justify. Is the "bubble rise velocity" really the swarm velocity, or is it measured for the first 1-3 bubble radii?

720.67. In Equation (7) on Page 49-C50, should there not be a factor for acceleration due to gravity reflection of Taylor instability theory over the range of wave length possible? Further, this equation is not applicable to determination of a stability threshold as implied in the last sentence of that paragraph; please discuss.

720.68. Charge of the particles, due for instance to B decays during the transit of the pool, has not been evaluated as a difference between the tests and actual accidents. Discuss.

720.69. Entrainment form the pool has been neglected. Justify.

720.70. We understand that some experiments were performed with CsI. Is this true? If so, provide the data and their evaluation.

720.71. Justify not considering the evolution of iodine from the pool due to such processes as radiolysis.

720.72. GE's model does not appear to differentiate between bubble rise velocity and swarm rise velocity. We believe this distinction to be an important one, in that it has an effect on calculated DF values. Please clarify the terms used for diffusion and inertial removal, and justify the velocity used.

720.73. After the change to the central estimate dose model (letter dated July 16, 1982) the comparison with WASH-1400 composite site and GE calculation of site 6 show large factors of disparity (See Table 7.2-1). Does GE still wish to justify site 6 as an average site? If so, provide the justification. If not, state the types of sites for which the PRA will be applicable.

720.74. Since GE expects that the particle size distribution of a core aerosol will be significantly modified by passage through the pool (due to orders of magnitude differences in GE's DF versus particle sizes), provide a review of dose conversion factors and expected consequences, considering that penetrating aerosols will be preferentially emitted.

720.75. Explain the influence of different event sequences on the estimate of operator reliabilities for similar actions, (e.g., for actions such as "operator manually opens the ADS upon the failure of control circuits," describe the methods for evaluating human reliability in both a loss of off-site power sequence and an ATWS sequence). Also explain which human actions are considered independent within the dominant accident sequences given in GESSAR-II PRA. Provide, also, the basis for deciding the degree of dependency between individual sequence, and the basis for dependencies assessed between members of a team for an action.

720.76. Provide in a tabular form showing how the human factor analysis was documented in GESSAR-II PRA, e.g., Figure 4-19, page 4-58 of NUREG/CR-2300.

720.77. List the key uncertainties in modeling that were addressed.

Indicate:

(a) How were these identified (e.g., literature survey, sensitivity studies);

(b) Were any uncertainties treated by making conservative assumptions;

(c) What quantitative measures were used for the modeling uncertainties and what techniques were used to determine them (e.g., response surface models, judgment applied to sensivity studies)?

(d) How are these quantitative measures to be interpreted (e.g., stochastic variation of physical processes, expert opinion about likelihood of various options)?

720.78. Provide a brief description of how uncertainties were propagated through the analysis. Include in the discussion:

(a) For which parts of the PRA (e.g., systems analysis, containment response analysis, in-plant consequence and ex-plant conquence analyses) uncertainties were propagated.

(b) How uncertainties in different parts of the analysis were combined.

(c) A description of any computer codes used and how uncertainties related to the codes were treated.

(d) A description of the special features of the analysis (e.g., correlation between parameter uncertainties for like components).

720.79. Unresolved Safety Issues (USI), applicable to BWRs, should be evaluated under GESSAR-II PRA. Provide a list of USIs not evaluated and the bases for their exclusion from GESSAR-II.

720.80. The discussion (p.15.D.3-569) of DF's assumed for plugging of drywell or containment cracks states that the values used ranged from 1.0 to infinity. Please be a little more precise concerning the values used. Discuss the crack size and particle size assumed. Provide a basis for your assumptions and discuss the applicability of the Morewitz model. (Note that the results of the Marviken containment tests (1974) directly contradict the Morewitz model predictions). Discuss the significance of other leakage paths bypassing the suppression pool in this context.

720.81. The PRA consequence calculations are purported to be realistic, or somewhat conservative. The evacuation delay assumption for the CRAC analyses, however, is that full-scale mass evacuation preparations can be accomplished instantaneously. This is neither realistic nor conservative. Please discuss the effects of a realistic (non-zero) estimate of evacuation delay times.

720.82 In Section 15D.4.2, you discuss GESSAR-II relative to rules and proposed rules which consider severe accidents. Because conformance to these rules is being considered as necessary requirements in the severe-accident rule-making (SECY-82-1A), it is important to have a clear understanding of the areas in which GESSAR-II is in conformance as well as the areas in which it is not. Specific areas where GESSAR-II appears not to conform with these rules are:

(1) GESSAR-II has no provision for hydrogen control (the CP/ML rule* requires preliminary design information on hydrogen control).

(2) GESSAR-II has no provision for a blanked-off three-foot equivalent containment penetration for possible use in a containment-vent system or containment heat removal system. (The CP/ML rule requires such a penetration.)

(3) GESSAR-II does not meet the service-level C capability of 45 psig for the primary containment as specified in the CP/ML rule (although on page 15D.4-9, it states that the ultimate pressure capability significantly exceeds 45 psig).

Provide confirmation of these apparent non-conformance items or corrections to the staff's interpretation of Section 15D.4. Specifically, provide analyses or appropriate references to the analyses which demonstrate meeting the 45 psig Level C requirement, if this be the case.

*FR 1/15/82 p2286-2305 and 2/1/82 p4497-4498

720.83 In Section 15D.4, you discuss, in a very general way, additional mitigation features, the small safety benefit (risk reduction) that would result from these features, and why you believe such features are not needed for GESSAR-II. We believe additional information is required in this area. In particular:

(1) Provide the analyses which show that the risk reduction from hydrogen control is less than 30%. In your submittal, you should discuss (i) how you considered uncertainties, (ii) the functional requirements that you imposed on the hydrogen control system, and (iii) the risk measures used.

(2) Provide the analyses which allowed you to conclude that a stronger primary containment system will "...not significantly reduce risk due to severe accidents." Consider as a variation on this, the provision of a primary system vent or filtered vent as an alternative to a stronger containment.

(3) Provide an estimate of the time to basemat penetration, the corium composition at the time of penetration (fission products inc.), and the amount of water (if any) that will be released from the containment together with the fission product inventory in this water. Why have you not considered core-retention materials as a replacement for portions of the basemat? If your answer is in terms of risk reduction, provide the analyses that lead to those values.

720.84 The core power used in MARCH calculations for the ATWS sequence has been given as about 15% (p. 3 - 542). Prior to leveling off at this power level, there is a power surge up to 570% Po. Although this short-duration power rise may not be important in considering long-term effects, it may be important in determining initial SRV discharge, vessel water inventory and vessel water level. Since MARCH does not model this power rise, it is not clear if MARCH has been used in a manner that consistently treats SRV discharge and vessel water inventory. Please provide the details of how the REDY analysis of the initial stages of the ATWS event was performed and how you matched REDY output to the specific input in MARCH. Is the SRV discharge and water-level adequately assessed using MARCH?

720.85 (a) Provide a list of primary and drywell containment electric penetration assemblies (CEPA's) in the GESSAR-II plant, indicating the location and limiting survivable environmental conditions such as pressure, temperature, radiation, hydrogen, and humidity, corresponding to the dominant severe accident sequences.

(b) Describe the type of termination used in the GESSAR-II plant, such as terminal blocks, crimping lugs, and junction boxes, and indicate the limiting survivable environmental conditions as given above.

(c) Provide justification that electrical penetrations through the drywell or the primary containment would be able to maintain their electrical as well as mechanical integrity when subjected to prolonged multi-phase short-circuiting and beyond-DBA ambient conditions during the core-melt accidents. In an event of local hydrogen combustion or detonation, provide a discussion on the likelihood of penetration material failure that may result in breaching of the respective compartment.

720.86 Following a reactor scram in the GESSAR-II plant, the scram discharge volume (SDV) system becomes the reactor coolant retaining boundary outside the primary containment. In the event of a pipe break downstream of the scram outlet valves and upstream of the SDV system vent or drain valves, any reactor coolant system blowdown will not be terminated by the automatic closure of the vent or drainline isolation valves because these valves are located downstream of the break location. In such an event, closure of all scram outlet valves would be the only available option to isolate the system and to prevent any release of fission products outside the primary containment. The successful closure of all scram outlet valves, however, would depend on the operator to manually reset the reactor protection system, override any trip signals, the availability of AC power, and to start the motors for closing the valves, in addition to control air supply and the functioning of electric motors and control circuits which are both non-Class 1E, i.e., not having been qualified for DBA conditions. The non-Class 1E equipment incorporates electrical insulating materials which could undergo deterioration under normal plant operating conditions such as the lowering of resistivity.

Provide an analysis to show the probability for the successful closure of all scram outlet valves in such an event. Provide a list of non-class 1E equipment which would lead to common-cause failure and result in the unavailability of other safety-related equipment in a severe accident.

720.87 For a complete station blackout with the loss of off-site and on-site AC power, RCIC system would be the only available source of makeup flows in the GESSAR-II plant. However, RCIC system could also become unavailable on demand when there is present a sudden pressure surge during the startup and the RCIC system is isolated.

(a) Discuss the failure probability of RCIC system, taking into account all potential modes of isolation upon demand.

(b) Discuss the impact on the core-melt probability in sequences which have assumed the availability of RCIC.