UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

NOV 15 1973

Docket No. STN-50-447

Voss A. Moore, Assistant Director for Boiling Water Reactors, L

REQUEST FOR ADDITIONAL INFORMATION FOR GENERAL ELECTRIC STANDARD SAFETY ANALYSIS REPORT (GESSAR)

Plant Name: GESSAR
Docket No.: STN-50-447
Licensing Stage: NA
NSSS Supplier: General Electric
Architect Engineer: NA
Containment Type: Mark III
Responsible Branch & Project Manager: BWR #2; D. Crutchfield
Requested Completion Date: October 26, 1973
Applicant's Response Date: Not Established
Review Status: Awaiting Information

The attached first round question list requesting additional information for the review of GESSAR has been prepared by the Containment Systems Branch after having reviewed the applicable portions of the SAR for which we have responsibility. We have also reviewed the responses to certain questions previously submitted to the applicant by the preliminary review.*

At this point in our review we have the following general comments regarding the GESSAR application:

1. We believe that General Electric should specifically reference in GESSAR, the Mark III quarterly reports (NEDM-10848 and NEDM-10976) as the basis for the Mark III analytical model and the source of small-scale Mark III test data comparisons. We are performing our review based on the information contained in these reports and therefore believe that this should be formally acknowledged in GESSAR.

2. We have noted a number of inconsistencies in the SAR and we believe that General Electric should thoroughly review and revise where necessary, Section 6.2 of GESSAR to provide consistency of information in this section.

* The areas identified in the enclosure as requiring information have been generally requested in the Standard Format.

B/47

3. Our review of balance of plant interfaces with the nuclear island has been limited, to some degree, as GE's submittal of complete interface information will not occur until December 15, 1973.

In the course of our review we have identified the following as significant review items. It should be noted that the concerns expressed below are essentially the same as those raised in the Grand Gulf review:

1. The blowdown mass and energy rates must be justified as conservative for containment design purposes.

2. The objectives and methods to be used in the large-scale test program must be described in detail and justified as sufficient to establish the validity of GE's analytical models.

3. Pressure response analyses must be provided for all subcompartments within primary containment and demonstrated to be conservative.

4. The applicant has been requested to justify the post-blowdown drywell depressurization phase of the containment response. If this phenomenon cannot be adequately demonstrated, some positive means may need to be provided to reduce the drywell pressure and ensure the return of air from the containment to the drywell.

5. The design and operation of the hydrogen control system must be more clearly defined to ensure proper coordination with the containment system.

In addition, we believe that our approval of the containment design presented in GESSAR must be predicated on the successful completion of a sufficient amount of large-scale testing to validate the Mark III analytical models used by General Electric. In this regard we are actively following and communicating with GE about the test program and are planning a meeting with the GE staff in San Jose on November 28 and 29, 1973.

RLTedesco

Robert L. Tedesco, Assistant Director
for Containment Safety
Directorate of Licensing

Enclosure:
As stated

DISTRIBUTION: See next page

DISTRIBUTION:

w/o encl.
A. Giambusso
W. McDonald

w/encl.
J. M. Hendrie
S. H. Hanauer
J. Stolz
D. Crutchfield
G. Lainas
J. Glynn
R. Cudlin
L - Reading
CS - Reading
CSB - Reading
Docket File No. STN-50-447

REQUEST FOR ADDITIONAL INFORMATION
GESSAR
DOCKET NO. STN-50-447

1. Provide curves which illustrate the sensitivity of containment response to each of the following parameters (include which parameter range would be the subject of appropriate testing):

   a. vent flow resistance factors

   b. vent clearing resistance factors

   c. vent areas

   d. vent submergences

   e. drywell air carryover rates to the containment

   f. blowdown flow and energy rates (recirculation line break)

   g. initial suppression pool temperatures

   h. decay heat rates

   i. level swell time (steam line break)

   Aside from the parameter under consideration all other initial conditions and variables should be as assumed in the SAR analysis of containment response to the DBA-LOCA. Each of the (a) through (i) parameters should be specified as to the nominal value used in the SAR analysis, the manner by which it was determined (e.g., calculated or experimental) and an estimate of the accuracy to which the value of the parameter is known.

2. The containment response analysis to a LOCA provided in the SAR assumes that feedwater flow stops at time zero. Discuss the potential availability of uninterrupted feedwater flow, specify

the total amount of feedwater energy which could be added to the containment and discuss the effect of this additional energy on the long-term containment response.

3. Section 6.2.1.3.5 of the SAR references Appendix A of NEDO-10329, "Loss-of-Coolant Accident and Emergency Core Cooling Models for General Electric Boiling Water Reactors", for the reactor vessel level swell model used in the main steam line break analysis. However, since the containment design basis break is indicated to be the main steam line, the manner in which the topical report model is applied to containment analysis requires clarification as follows:

   a. reference the specific parts of Appendix A which are applicable to the level swell associated with a main steam line blowdown analysis.

   b. list any conservative assumptions which were incorporated in the model for containment analysis purposes.

   c. provide results of the level swell times that are calculated by the model considering various reactor operating conditions such as full power, hot standby etc..

   d. list the input parameters used in the above analyses.

4. To determine the containment mass and energy input rates for containment pressure analyses, the primary system was modeled as a single volume at the average primary system enthalpy.

Justify that this represents a conservative assumption for containment analysis purposes considering that the recirculation loop conditions display a significant (20 Btu/lbm) degree of subcooling. In addition, provide a blowdown table (mass and energy rates versus time) and containment response analysis for a recirculation line break assuming that the primary system is modeled as a single volume, with the total mass inventory at operating pressure and at the average enthalpy of the recirculation loops.

5. Provide an analysis of containment and drywell pressure response to a main steam line break and a recirculation line break assuming that the reactor is at hot standby and the suppression pool is at an elevated temperature corresponding to the hot standby condition at the time of the break.

6. In the discussion of a main steam line break accident (SAR Section 6.2.1.3.2) it was stated that after 4.2 seconds the isolation valves in the broken line will have closed sufficiently so that the valve flow area will be equal to the flow restrictor area and after 5.5 seconds the closure of the valves will terminate flow from one side of the break. These parameters establish the effective break area profile for the accident. It appears that the above assumptions are a departure from previous BWR containment design analyses and therefore should be justified. Previous plants have been reviewed assuming a 10-second closing time.

Justify the capability of the valves to isolate steam flow in the manner described, as follows:

a. As the isolation valves are designed for closing times from 3 to 10 seconds, discuss and reference any testing that has demonstrated that the valves can close within 5 seconds under the conditions of the accident.

b. SAR Section 5.5.3 states that the isolation valves are designed and installed such that performance of the valves is enhanced for forward steam flow conditions. As the valves located in the broken steam line will experience reverse high flow conditions, discuss the capability of the valves to start reducing the effective break area at 4.2 seconds.

c. Discuss the sensitivity of the second peak in drywell pressure (4 seconds, Figure 6.2-5) to the assumed valve closure rate.

7. The containment pressure response profile, Figure 6.2-5, indicates that choked vent flow may be experienced for a time period following vent clearing. Specify whether the vent flow at this is choked or unchoked. As indicated in Section 6.2.1.3.5, the vent flow model as described in GE Topical Report, NEDO-10320, "The General Electric Pressure Suppression Containment Analytical Model" was used to predict the critical flow threshold for the Mark III vent

system. This method is based on the principle that only the vapor region determines the sonic characteristics of the two-phase mixture. Using this assumption, ideal gas relationships have been used to predict sonic flow. There are, however, experimental and analytical data within the literature that indicate the liquid phase does lower the sonic characteristics of the mixture below the value that would be calculated for only the vapor phase.

As a result, justify the applicability of the ideal gas-choked flow model in light of the contradictory data within the field, which includes the RELAP-3 prediction comparisons of both the semiscale and Battelle blowdown experiments. Based upon typical vent conditions, compare the critical flow rate obtained from the NEDO-10320 flow model to the Moody correlation, for a range of steam quality conditions (i.e., .3 to 1). The comparisons should be made for water-steam mixtures, assuming saturated steam to be equivalent to the air fraction.

8. Specify the values of the individual loss coefficients used in the vent flow model, the manner by which they were determined, and describe how the Mark III test program will be used to validate or modify the originally obtained coefficients. Provide the same information for the "turning loss coefficients" that are applied to the vent velocity terms in the Mark III vent clearing model.

9. Provide the design criteria which have been applied for postulated breaks in high energy, unguarded pipe lines located within primary containment but outside the drywell. Also, provide details of the analyses performed for each break; e.g., break sizes and location, blowdown rate, lapse times for detection systems, containment pressure, which demonstrates that the amount of blowdown fluid released to the containment is within acceptable limits.

10. For the spectrum of potential energy releases to the drywell discuss the restrictions on use of the containment sprays due to interlocking with other functions of the Residual Heat Removal System.

11. Provide sensitivity analyses which relate the containment's bypass capability, for small primary system breaks, to the following means of mitigating or terminating bypass leakage:

    a. containment sprays

    b. plant shutdown times

    c. containment heat sinks (specify the sources of heat sinks and the manner by which heat sink effectiveness was determined)

    d. any other means for mitigating the effects of bypassing.

    Considering the above analyses, summarize the containment capability to withstand the effects of direct bypass of the suppression pool.

12. Provide curves of suppression pool water level as a function of time (0 to 10^6 seconds) for the design basis loss-of-coolant accident. These curves should illustrate the level of water in the containment, the weir wall annulus, and the drywell, and all relevant assumptions should be clearly stated.

13. As requested by Item 6.9 of the Preliminary Review, analyses of the effects of potential loss-of-coolant accidents occurring within the sacrificial shield or other compartments including those within primary containment, should be provided, including:
    a. the blowdown rates and energies and their bases (consideration should be given to the effects of operating conditions and possible subcooled fluid in determining the most severe blowdown conditions)
    b. the total vent area
    c. the peak calculated differential pressure
    d. the design differential pressure
    e. the analytical methods used to determine the pressure response.
14. The SAR states (pg. 6.2-10) that following reactor vessel reflood, ECCS flow out the break will condense drywell steam and cause a rapid depressurization. Provide the applicable experimental data and/or analytical models, assumptions and parameter values used to calculate the condensation rate. Discuss the significance of a less rapid or incomplete depressurization of the drywell.
15. Provide plant and section drawings which show the arrangement of RHR system suction and return lines to the suppression pool. Demonstrate that this arrangement facilitates mixing of the return water with the total pool inventory before the return water becomes available to the suction lines. Discuss the design provisions which have been taken to preclude blockage or plugging of the RHR system suction lines.

16. SAR Section 6.2.1.3.9 provides a table of core decay heat rates used in the containment response analysis. Discuss the bases used to calculate these values and justify them as being conservative for containment design purposes. Also discuss how the pump heat rate has been factored into the analysis as it does not appear directly in the long-term model equations.

17. Provide the following information relating to your analysis of containment vacuum relief requirements:

    a. justify that the negative pressure transient analyzed (i.e., the transient that results from actuation of one spray system), is the controlling event for containment vacuum relief.

    b. clarify the analysis presented in Section 3.8.2.1.3 and include the initial conditions, break size, blowdown mass and energy release rate and drywell conditions at 40 seconds.

    c. justify the assumption that only 1 of 2 containment spray pumps is actuated in the above analysis.

    d. specify the maximum calculated containment negative pressure and justify the margin allowed between this value and the design negative pressure.

    e. provide a curve of containment and drywell pressure as a function of time, from the time of the break, for the above analysis.

    f. provide a curve of the containment depressurization rate, for the above analysis, assuming no containment vacuum relief.

g. discuss the potential for containment vacuum relief to be unavailable due to isolation of the motor operated valve in series with the check valve.

18. Since the hydrogen mixing system will also serve a vacuum relief function for the drywell, provide the following:

    a. Specify all plant conditions which could require operation of the recirculation lines for vacuum relief purposes. Also estimate the frequency of these conditions.

    b. Describe in detail how the mixing system will be used to relieve drywell vacuum. Include the number of valves opened, the differential pressure at which the valves will be opened, the capability of the operator to effectively respond to the conditions outlined in (a), and plant conditions for which the operator will not be allowed to open valves.

    c. Discuss the potential for a recirculation line(s) to be open prior to a loss-of-coolant accident and discuss the consequences of such an event.

    d. Specify the closing time of these valves.

19. Section 3.8.3 of the SAR states that the pressure decrease in the drywell (following a LOCA) is slow enough so the reverse flow can admit enough air into the drywell to maintain the negative pressure above the drywell design value (-20 psi). Justify the statement as follows:

a. describe the negative pressure transients which were considered in determining the controlling event for the drywell.

b. for the controlling event provide details of the analysis including initial conditions, drywell depressurization model, and calculations of reverse flow through the vent system.

c. provide a curve of drywell pressure as a function of time for the controlling event.

d. specify the maximum calculated drywell negative pressure and justify the margin allowed between this value and the design negative pressure.

20. In reference to the analytical models used for containment response analyses, (SAR Section 6.2.1.3.5) GE mentions a "slight modification" to the vent flow model and states that the other models are "essentially" unchanged. GE should clearly identify any differences, and provide equations as appropriate, between the analytical models used in GESSAR and those described in the referenced General Electric topical reports, NEDO-10321 and its first supplement.

21. Provide an analysis assuming maximum expected temperatures of the pumped fluid, atmospheric pressure in the containment, and minimum suppression pool water level (specify) which demonstrates that adequate NPSH is provided for containment heat removal pumps consistent with the guidelines of Regulatory Guide 1.1.

22. Describe the protective features provided to prevent loss of the containment heat removal pumps due to possible internal flooding of the lower level of the auxiliary building.

23. Your response to Item 6.10 of the Preliminary Review does not provide the requested analysis of containment spray heat removal capability. Provide this analysis and, in addition, a figure of reactor vessel steaming rate as a function of time after the LOCA. Relate the vessel steaming rate to the long-term containment energy addition rate table on page 6.2-27 of the SAR.

24. Specify the location of the vacuum relief valves which are provided on the exhaust piping of the reactor system pressure relief valves and provide drawings which illustrate the routing of the exhaust lines through the weir annulus and the drywell wall. Also discuss the analytical methods used to determine the loads on the drywell and containment walls due to actuation of the pressure relief valves.

25. Provide the following information relating to your analyses of containment response to both a main steamline and recirculation line break:

    a. Plot as a function of time (0 to 10^6 seconds) for each case:

        (1) vent flow, lb/sec

        (2) specific volume of vent flow, ft^3/lb

    b. Tabulate an energy balance of sources and sinks at initial conditions, time of maximum drywell-containment differential pressure, end of blowdown, and time of maximum containment pressure (in Btu referenced to 32°F):

        (1) reactor coolant

        (2) fuel and cladding

(3) core internals

(4) reactor vessel metal

(5) reactor coolant piping, pumps and valves

(6) blowdown enthalpy

(7) decay heat

(8) metal-water reaction energy

(9) drywell structures

(10) drywell air

(11) drywell steam

(12) containment air

(13) containment steam

(14) suppression pool water

(15) heat transferred by heat exchangers

26. Specify the source of supply air for all pneumatic systems located in the containment or drywell and specify any separate containment control air systems, if provided. Justify that your calculations of containment pressure response to a design basis loss-of-coolant accident are conservative assuming that all Category II air lines located within primary containment fail at the time of the design basis loss-of-coolant accident.

27. Describe the suppression pool liner coating materials, the qualification testing of the materials that has been performed and the test results, and describe the possible experience of its use on operating plants. Describe the surveillance programs which will monitor the condition of the coatings and liner metal during the

lifetime of the plant. Also indicate if inhibitors or chemical additives are used in the suppression pool water.

28. Section 6.2.1.2.7 of GESSAR states that the adequacy of the design margin applied to the calculated drywell differential pressure will be confirmed by full-scale testing. The following information is required to evaluate the capability of the planned test program to provide this assurance:

    a. Discuss the chronology of the planned tests and describe the test objective of each test series.

    b. Discuss the differences between the actual plant configuration and the test facility. Describe how these differences will be evaluated or included in the test to analytical comparisons. (e.g., discuss the effects due to presence of the side walls within the test facility pool and the presence of pool water beyond the radial plates.)

    c. Define the time within the test program which will yield concept and design margin verification.

    d. Describe the method of data transmission between GE and the staff including the type of information to be supplied and the timing of transmittals.

    e. Describe the philosophy to be used to correlate the test results with the analytical program. For example, what procedures will be used to determine experiment error, what comparisons will be made, what deviation between test and analytical results will be allowed prior to code modification.

f. Discuss the timing of analytical to test comparisons, i.e., will it be on a test-to-test basis or a test group.

29. It appears that certain characteristics of the containment pressure response to a loss-of-coolant accident are not considered in the analytical modeling and therefore the significance of these effects must be determined empirically from the test program. In particular, the following effects should be addressed and in each case a discussion included of the capability of the test facility to evaluate the phenomenon and the testing methods which have been selected to implement the study:

   a. non-uniform vent clearing and flow maldistribution effects,
   b. vent interaction effects in both the radial and vertical directions,
   c. suppression pool dynamics as related to the potential for pool bypass (i.e., pool separation during air carryover phase),
   d. measurement of structural loads to containment structures and components during blowdown,(e.g., pool splashing)
   e. potential backpressure feedback effects during vent clearing due to air-steam bubble formation.

30. Provide the following additional information with respect to the secondary containment:

a. Show on appropriate plant elevation and section drawings, those structures and areas that will be maintained at negative pressure following a loss-of-coolant accident and that were considered in the dose calculational model,

b. provide the proposed Technical Specification limit for leakage from the primary containment to the atmosphere which may bypass the Standby Gas Treatment System filters, (e.g., valve leakage and guard pipe leakage),

c. discuss the methods of testing which will be used to verify that the systems provided are capable of reducing to and maintaining a negative pressure of 0.25" w.g. within all secondary containment volumes.

31. For each penetration of the primary containment, as listed in Table 6.2.9, provide the following:

a. Indicate which lines could be open to the containment or drywell atmosphere and interface with the outside atmosphere following a loss-of-coolant accident. Examples of the types of lines which should be considered include: lines which are normally open to containment (e.g., purge, ventilation, and vacuum breakers); non-Category I lines, and lines with guard pipes.

b. For each line in (a), specify the number and type of leakage barriers which are assumed to be available following an accident.

c. For each line in (a), specify the amount of bypass leakage which is used in the analysis of the radiological consequences of an accident and discuss the tests that will be performed to validate the assumption.

32. Provide a pressure response profile for the shield building annulus following the DBA-LOCA. Include your assumptions, the heat transfer coefficients used for heating the annulus, the manner in which thermal expansion of the containment shell was considered, and the chronological sequence associated with accident signal generation, realignment of system dampers, and startup of the Standby Gas Treatment System.

33. Item 13 of the Containment Design Bases section (page 6.2-2 of the SAR) states that the secondary containment structures are designed to withstand the calculated design temperatures and pressures which could result from postulated DBA's in their enclosed volume. List the high energy lines associated with each secondary containment volume, specify which postulated rupture is the DBA for the volume, and provide the results of the analyses for each DBA.

34. Discuss the design adequacy of the Standby Gas Treatment System (SGTS) in the event that radioisotope decay heat raises the filter carbon temperatures to the desorption or ignition range. Justify the failure mode (closed) of the valve in the cross tie line between the two trains of the SGTS.

35. Discuss the adequacy of the Standby Gas Treatment System with respect to physical separation of redundant components.

36. For those containment isolation valves, including those valves connecting the drywell to the containment, which have seats fabricated from resilient material, specify:

    a. the number and type of valves,

    b. the long-term life and service characteristics of the material, and

    c. any service experience with the material in other nuclear plants justifying its use in the containment environment.

37. Our review of GESSAR Section 6.2.4, Containment Isolation System, and the accompanying tables and figures, has indicated that in some areas information is incomplete and/or inconsistent and requires clarification to ensure that:

    (1) all penetrations of primary containment and the drywell are included and clearly identified,

    (2) design details are consistent between various GESSAR sections, tables and figures pertaining to isolation or to particular systems,

    (3) where isolation arrangements are in exception to the GDC they are identified and appropriate justification is provided.

The following items are noted as examples of the deficiencies we have noted:

a. Table 6.2.9 shows a globe valve for penetration 24 whereas

Figure 6.2-15g shows a check valve. Also no isolation signals are shown for these valves.

b. Penetrations 30 and 31, Table 6.2.9, are listed as purge supply and exhaust lines, however it is not clear what systems in Section 9.4.5 are represented by these penetrations.

c. There does not appear to be any justification provided for allowing remote manual isolation of the instrument air and recirculation pump seal water supply lines (pg. 6.2-52). The seal water line does not seem to appear in the isolation tables and figures at the end of Section 6.2.

d. It is not clear as to what systems the combustible gas control lines listed in Table 6.2.9 relate.

e. Penetration 18, Figure 6.2-15e should also show a check valve.

f. Penetration 38, Figure 6.2-151, should show indicate control room readout to be consistent with page 6.2-52.

g. Section 6.2.4.3.2.2.2.1 does not adequately justify the isolation valve arrangement of one, remote manual valve. In the case of the RHR and LPCS lines, the motor operated valve is normally open and therefore on loss of electrical power, containment isolation capability would be lost.

h. The ECCS discharge line fill system suction line (pg. 6.2-51) and bypass return line (pg. 6.2-50), RHR heat exchanger vent lines (pg. 6.2-51), and recirculation system sample lines (pg. 6.2-49) do not appear in the isolation tables and figures in 6.2.

i. The justification provided in Section 6.2.4.3.2.2.1.2 is not evident.

j. The justification for remote manual isolation of the RCIC line (Section 6.2.4.3.2.1.1.5) is not evident.

38. Provide the following information with respect to the Drywell-Containment Mixing System:

a. a P&I diagram

b. discuss the bases used to establish the flow rate of the mixing fans

c. discuss all interlocks which are provided on the system to prevent inadvertent or untimely initiation

d. describe the types of analyses which were performed to demonstrate adequate mixing throughout the drywell, containment, and subcompartments before and after the mixing system has started. Mixing without benefit of the recirculation system should be considered over long time periods as the system has no definite actuation time.

d. provide or reference a drawing which shows the location of the mixing system fans.

f. discuss any limitations on the initiation of the mixing system due to pressure differentials between the drywell and containment.

39. Provide a schematic of the hydrogen sampling system which shows the number and distribution of analyzers in the drywell and containment. Justify that the system is adequate to detect potentially non-uniform hydrogen concentrations within these volumes.

40. Provide the results of an analysis of the plant's capability to allow initiation of the hydrogen recirculation system at 10 minutes following a loss-of-coolant accident. Define the spectrum of primary system break sizes for which this capability may exist and discuss the specific limitations which determine the unacceptable break ranges. As a minimum, the following possible limitations should be addressed:

    a. containment spray heat capacity

    b. RHR system interlocks

    c. capability of the recirculation system to effectively mix the drywell and containment atmospheres considering the evolution rate of hydrogen due to metal-water reaction

    d. interlocks on the recirculation system

    e. requirements for operator action

41. Describe all secondary sources of hydrogen which were considered in designing the combustible gas control systems. Specify the expected magnitude of hydrogen generation from each source and provide the analytical and experimental bases to support these expectations.

42. Provide the following with respect to the design and testing of the hydrogen recombiner system:

a. State all applicable criteria, codes and standards to which the recombiner has been designed. Identify and justify any deviations from AEC General Design Criteria or Regulatory Guides, as applicable.

b. As satisfactory design and operation of the heater is essential to the performance of the recombiner system, detailed engineering information, appropriately supported by references or test information should be provided for each bank of heaters as follows:

(1) mechanical design

(2) thermal design

(3) materials

(4) table of design range and operation limits for selected heaters

(5) power supply and electrical connections

(6) cross section drawing showing physical arrangement of heaters and the gas flow path.

c. Demonstration test results covering the full range of operation should be presented and discussed to verify satisfactory performance.