Docket File

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

February 7, 1992

Docket No. 50-605

APPLICANT: General Electric Company (GE)

PROJECT: Advanced Boiling Water Reactor (ABWR)

SUBJECT: SUMMARY OF MEETING HELD ON JANUARY 23, 1992, WITH GE TO DISCUSS CLOSURE OF SEVERE ACCIDENT ISSUES FOR THE ABWR

A public meeting was held between the Nuclear Regulatory Commission (NRC) staff and GE representatives at the USNRC Phillips Building in Bethesda, Maryland, on January 23, 1992, from 8:30 a.m. to 11:30 a.m. The purpose of this meeting was to discuss GE's plans for responding to the NRC staff's letter on severe accident design in the ABWR dated January 10, 1992. A large part of the discussion concerned clarification of the enclosures to that letter: Enclosure 1 entitled, "Closure of Containment Performance Issues for Severe Accidents; Enclosure 2 entitled, "Request for Additional Information ABWR;" and Enclosure 3 entitled, "Accident Management Topics for Discussion with GE." Although they agreed to respond to the letter, GE representatives expressed concern that the schedule for completing their submittals is in jeopardy and suggested a need for more realistic dates. Schedular concerns will be an item for discussion with NRC upper management at the upcoming January 28-29, 1992, GE/NRC management meeting at San Jose. The following items were agreed upon by NRC staff and GE representatives:

1. By February 6, 1992, GE will provide the NRC with a response to each of the 17 requests for additional information listed in Enclosure 2 of the January 10, 1992, letter. Some of these responses may be one sentence only.

2. Question 3 of Enclosure 2 of the January 10, 1992, letter will be expanded to include additional severe accident mitigation features, specifically the passive cavity flooder valves and overpressure protection system rupture disc.

3. GE will submit the technical justification and bases for the parameter values and split fractions/distributuions shown in their handouts used in the January 22, 1992, discussion with NRC staff concerning probabilistic risk assessment (PRA) backend analyses.

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4. NRC staff will provide GE with feedback from the January 22, 1992, discussion concerning PRA backend analyses.

5. NRC staff will clarify Question 12 of Enclosure 2 of the January 10, 1992, letter.

Enclosure 1 to this meeting summary is a revised copy of "Closure of Containment Performance Issues for Severe Accidents" (Enclosure 1 to the January 10, 1992, letter described above) with change bars showing where revisions occurred. Enclosure 2 to this meeting summary is a list of attendees.

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Enclosures:
As stated

cc w/enclosures:
See next page

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CLOSURE OF CONTAINMENT PERFORMANCE ISSUES FOR SEVERE ACCIDENTS

BACKGROUND AND OVERVIEW

This section is intended to establish the general guidance or criteria used to evaluate the acceptability of the power plant design to reduce the likelihood and to mitigate Severe Accidents. There are several key documents which provided the bulk of the guidance. They are the Commission's policy statement on severe accident, Part 52 to 10CFR, and SECY 90-016. It is the intention to provide a discussion which describes the overall approach and mention how each of the above sources was used in the development of the approach.

DEFENSE ON DEPTH PHILOSOPHY

The discussion will address the Commission philosophy of defense in depth and the logic of providing independent barriers. The four major barriers are generally considered to be the fuel clad, the reactor system, the containment, and the site boundary. Each of these barriers provide a measure of protection to the public and are totally independent of each other. In other words, there is no mechanistic tie among them. This concept assures that a failure to understand the sequence associated with one of the barriers will not reduce the effectiveness of the other barriers.

This concept of licensing will be discussed in connection with the guidance provided in the various documents and demonstrate how this defense in depth strategy has been maintained in the evaluation of severe accidents. As part of this discussion, the level of uncertainties associated with severe accidents will be identified and how this uncertainty is treated in the evaluation. This is an important concept since there is a significant increase in the level of uncertainty when one goes from design basis to severe accident space. In addition, uncertainty must be recognized as a consideration when one determines whether the safety goals have been met.

BALANCE BETWEEN PREVENTION AND MITIGATION

A complete consideration of the ABWR design's severe accident capabilities would include discussion of both design elements which reduce the likelihood of core damage, and features which provide accident mitigation given that a degraded core event occurs. In the areas of accident prevention, design features which GE has incorporated into ABWR which provide enhanced or alternate means of maintaining core decay heat removal, such as use of fire pumps or external connections will be discussed. Other design enhancements which reduce potentially significant severe accident initiators still also be discussed, such as alternate AC sources to reduce station blackout and fine motion rod drives and ARI with recirculation pump trip to reduce the likelihood of ATWS sequences. The important role of the ADS system to provide for alternate low pressure makeup schemes and to preclude containment challenges (a mitigation feature) will also be discussed. The containment performance aspects of the mitigation role in severe accident treatment will be discussed in more detail in following sections below.

CONTAINMENT PERFORMANCE GOALS

The need to have certain containment performance goals will be discussed in this section. Guidance provided in SECY 90-016 will be relayed upon to establish the acceptable approaches. Basically two approaches have been approved by the Commission as ways to demonstrate that the containment design has met the safety goals. They are the probabilistic and deterministic methods. The discussion of these two approaches will rely heavily on the guidance provided in SECY 90-016.

In addition to the references to SECY 90-016, a discussion will be provided which updates the material obtained in the SECY paper. In particular, recent findings relative to the short comings of the probabilistic approach will be identified.

SEVERE ACCIDENT PHENOMENOLOGY

This section will provide a brief description of the most important severe acciden' henomenological, along with an evaluation based on the currently available understanding of the physics involved and existing uncertainties. The discussion should include a description of the events along with of a profile of the postulated environment that is envisioned to occur during course of the event. This section could be thought of as the source of information used to define the events described in the previous sections. The phenomena of interest should include as a minimum:

HYDROGEN GENERATION AND CONTROL

CORIUM-CONCRETE INTERACTION

CORE DEBRIS COOLABILITY

HIGH PRESSURE CORE MELT EJECTION

FUEL COOLANT INTERACTION

MELT ATTACK ON CONTAINMENT STRUCTURE

CONTAINMENT BYPASS

NOTE: This section may not be appropriate place to discuss containment bypass. It is an event, not phenomena!

DISTINCTION BETWEEN SEVERE ACCIDENTS AND DBAs

The purpose of this section will be to clearly identify the differences between how one views the criteria and requirements of current DBAs and severe accident conditions. Specific examples will include a discussion of the acceptable use of best estimate analyses for severe accidents while conservative models are more appropriate for DBAs.
From the point of view of what is sufficient to demonstrate that equipment is functional, testing has been viewed as the only acceptable method for DBA conditions. However, for severe accident conditions, some combination of test and analysis may be sufficient. The acceptability of the approach will be made on a case by case basis.

Another example of the differences will be the use of non-safety equipment. Due to the low probabilities of the severe events, it is appropriate to allow the use of non-safety equipment. However, the reliability and availability will be evaluated closely. This review will include a discussion of the specific programs and surveillance that have been committed to by the vendor. These commitments will play a key determining factor in the acceptability of this equipment.

The justification of all of the above differences will be first and foremost the low probabilities of the severe accident events. As a result, there is a basis for relaxing the very rigid requirements of a DBA event. However, the case must still be made that with the relaxed criteria there remains reasonable assurance that the equipment relied upon for the accident analysis will function as required.

CONTAINMENT PHILOSOPHY RELATIVE TO EARLY FAILURES

ACCIDENT SEQUENCES/CONTAINMENT CAPABILITY

An important element of this closure chapter will be an understanding of the various severe accident events. The first step in this process is an identification of the various challenges to the containment. To obtain these events, one should begin with a study of the Containment Event Trees developed for the supporting PRA. From this evaluation, a list of the various plant damage states and related events should be developed. This list should not be limited to power operation but, should also include shutdown operation. Of particular interest are the bypass events. Bypass can be either of the pool or the containment. In either case, the potential release from the containment boundary would not have the benefit of pool scrubbing. Therefore, the release would be unfiltered.

For each sequence, a description of the event should be provided along with the equipment and instrumentation that would be needed to monitor, accommodate, eliminate, or mitigate the event. If design provisions or actions are available which could significantly reduce the frequency of (or eliminate) the event as a risk contributor and they were not implemented, a rationale should be provided as to why they were not accepted.

PRA CONSIDERATIONS

The objective of this section is to provide a general overview of the results of the PRA analysis as they effect containment performance. The detailed discussion is expected to remain in Chapter 19. However, for purposes of continuity of the severe accident effort, a brief discussion is necessary within this closure report with particular focus on sequences for which core damage is not arrested in-vessel, and containment failure modes and severe accident phenomena important to risk. The contents should characterize the limitations of the analytical models so as to better understand any limitations of the PRA results. With respect to the results, the uncertainty and sensitivity analyses should be discussed.

EXPERIENCE AND RESEARCH INSIGHTS

This section is intended to present an overview of the existing experience with the various containment subsystems, as well as a status of research (performed and/or ongoing) efforts regarding containment integrity, including both experimental and analytical work. For each of the containment or primary systems considered to either eliminate or mitigate an event, a discussion of the operating experience accumulated to date should be provided. The objective would be to provide some insight into whether or not the system is based on proven technology or to identify those areas that could be considered as advanced in nature. Included in this area, would be the identification of any components whose reliability/availability value used in the PRA is substantially greater than existing data would permit.

Research and testing insights are meant to bridge the gap between the discussion contained in SECY 90-016 and the present. Since this document is more than two years old, the intent of this section is to provide an update on the various research programs that are applicable to the ABWR design. For example, there have been several tests performed as part of the ACE/MACE programs. The results of these tests as they pertain to the ABWR design should be discussed as well as the justification which supports the ABWR design. Where appropriate, analytical models and their results would be discussed within this section along with the rationale of how these analytical efforts are integrated with the experimental data base. Of particular note would be the identification of any programs that are underway but are not yet completed. These programs should be discussed in light of the licensing schedule.

Finally, this section should end with a series of conclusions relative to how the ABWR design is supported via testing and analytical studies. This summary should clearly identify any areas that are solely based on analytical results and indicate why supporting test data are not necessary.

FEATURES TO PREVENT AND MITIGATE SEVERE ACCIDENTS

This section is aimed at describing those features which were identified within the PRA that either prevent core damage, prevented an accident sequence from releasing a significant source term from containment or mitigated the consequences of the event. Of particular interest are those features which were added to the design as a result of the initial PRA analyses. If a weakness was identified as a significant risk contributor (either preventive or mitigative), design changes may have been implemented to eliminate this weakness. On the other hand, the weakness may have been shown to not represent a significant and therefore not merit any further consideration. In other words, it is an opportunity to document the value of having a PRA early in the design of both the reactor coolant system as well as the containment. To accomplish this objective, the PRA in conjunction with the Containment Event Trees will be considered. From them, with support from GE, the various design features would be extracted to form the basis for the section. The key features of the section are envisioned to include the following features.

A LIST OF DESIGN FEATURES

For each feature, an overview of the RCS and containment conditions during the postulated spectrum of severe accidents or severe accident precursors should be presented along with a discussion of when and how the feature will either prevent core damage, eliminate or mitigate the consequences of the event. In addition, a discussion of how the component or system was added to the design should be provided. For example, it may be a component used in existing designs or it may be a device added to the plant or enhanced as a result of early PRA results. Understanding how the design was influenced by considering severe accidents is an important aspect of any advanced design concept.

EFFECTIVENESS OF EACH FEATURE

One of the most important issues of the severe accident activities is the question of equipment survivability to assure that components remain functional as identified in the PRA. The basic question is whether equipment will survive post-accident conditions to be able to function the way it is intended. An important part of this section will be a discussion of the "envelope" of severe accident conditions and the philosophy of testing vs analysis as a means of demonstrating equipment qualification. Such considerations as the overall importance of the piece of equipment under review, the timing of the function, and the complexity of the function may all play a role into developing the program necessary to adequately demonstrate the level of desired operability. ADS functionality and reliability are also issues which require treatment. The ADS not only allows for a low pressure injection success path, but for those sequences where no RCS makeup is available, provides primary system depressurization prior to vessel failure, precluding DCH containment challenge.

OVER PRESSURE PROTECTION OR VENTING SYSTEM

This section will include a detailed discussion of role the over pressure protection system is expected to play in dealing with the severe accident matrix. To begin the discussion, a description of each of the components should be provided along with the design criteria for the components. For example, the question of seismic design of both the piping and supports should be discussed.

Along with this discussion would be a description of how the system is intended to function. In particular, for each sequence, an indication of whether or not the system is needed to satisfy any safety goals should be clearly stated. If it is not needed to satisfy a safety goal, a clear statement as to why the system has been incorporated into the design should be made.

Relative to the operation of the system, the discussion should include the expected release points and the basis upon which one can conclude that the system will not fail for the severe accident environmental conditions associated with the event in question. If operator action is necessary for any sequence, the sequence should be identified and the information that would be used by the operator in taking the action should be discussed.

The philosophy of how the set point of the rupture disc should be provided within this section. In particular, the role of PRA should be identified if appropriate. The section should discuss how the design pressure and ultimate strength of the containment factored into the selection.

ACCIDENT MANAGEMENT

This section will address accident management (AM) concept as an extension of the defense-in-depth philosophy. AM will be presented as a coordinated enhancement of several key elements which contribute to the capability to prevent and mitigate severe accidents and minimize their consequences. These elements are identified in SECY-89-012, and include emergency procedures (and supplementary accident management procedures and guidelines now under development by the NSSS vendors as part of the US industry AM program); severe accident training for operators, technical support staff, and utility managers; and instrumentation and information needs for diagnosing and responding to severe accidents.

The review will include an assessment of the following areas:

1. Aspects or features of the ABWR design which: (1) either alleviate the need for or facilitate the implementation of accident management measures, or (2) require further assessment by GE or the utility as part of developing an accident management plan. This will include assessment of planned strategies for dealing with potential severe accidents, use of PRA by GE to identify and assess potential strategies, and any plans or commitments to expand the scope of the PRA for this purpose.

2. GE's planned approach for assuring that each of the five elements of accident management defined in SECY-89-012 will be appropriately addressed by the vendor or licensee in developing the plant-specific accident management plan for the ABWR. This will include consideration of the identified responsibilities of GE and the licensee for addressing each of the elements, and any m[illegible]ods and/or guidance that are expected to be used in this process.

ACCIDENT MITIGATION PROCEDURES
SEVERE ACCIDENT AND CONTAINMENT PERFORMANCE CLOSURE

BACKGROUND AND OVERVIEW

* DEFENSE IN DEPTH PHILOSOPHY

  SEVERE ACCIDENT POLICY
  PART 52 FOR SEVERE ACCIDENTS
  SAFETY GOAL AND UNCERTAINTIES
  NEED FOR BARRIER CONCEPT

* PREVENTION AND MITIGATION

  PREVENTATIVE FEATURES WHICH REDUCE RISK
  MITIGATIVE FEATURES WHICH REDUCE RISK

* CONTAINMENT PERFORMANCE GOALS

  PROBABILISTIC/DETERMINISTIC
  SECY 90-016 CRITERIA
  RECENT ACTIVITIES

SEVERE ACCIDENT PHENOMENOLOGY

* HYDROGEN GENERATION AND CONTROL
* CORIUM-CONCRETE INTERACTION
* DEBRIS COOLABILITY
* HIGH PRESSURE CORE MELT EJECTION
* FUEL COOLANT INTERACTION
* MELT ATTACK ON CONTAINMENT STRUCTURES

  FOR EACH OF THE PHENOMENA IDENTIFIED ABOVE, A PARAGRAPH DISCUSSION WILL BE PROVIDED TO DETERMINE IF IT IS A CREDIBLE EVENT. IF IT IS INCREDIBLE, DISCUSS WHETHER IT HAS BEEN ELIMINATED DUE TO EITHER PRA ALONE OR WHETHER A DESIGN FEATURE HAS ELIMINATED IT FROM CONSIDERATION. IF IT IS THE LATTER, ?XSB WILL BE EXPECTED TO PROVIDE AN INPUT.

DISTINCTION BETWEEN SEVERE ACCIDENTS AND DESIGN BASIS ACCIDENTS

* BEST ESTIMATE VS CONSERVATIVE APPROACH
* ROLE OF TESTING
* USE OF NON-SAFETY EQUIPMENT
* LOW PROBABILITY EVENTS

DESIGN FEATURES TO REDUCE THE LIKELIHOOD OF CORE MELT EVENTS

* PRA insights; vulnerabilities which have been addressed through ABWR design features.
* Design Enhancements to provide alternate paths for RCS inventory makeup and DHR, station blackout reduction features.
* Reductions in ATWS likelihood
* ADS system reliability

CONTAINMENT PHILOSOPHY RELATIVE TO EARLY FAILURE

* ACCIDENT SEQUENCES/CONTAINMENT CAPABILITY
  - OPERATIONS (BOTH POWER AND SHUTDOWN CONDITIONS)
  - DEMONSTRATION OF EQUIPMENT FUNCTIONALLY

* PRA CONSIDERATIONS
  - GENERAL SCOPE AND DEFINITIONS
  - LIMITATIONS CONSIDERING INCOMPLETENESS AND LEVEL OF MODELLING DETAIL
  - UNCERTAINTIES VS SENSITIVITIES
  - SELECTED ACCIDENT SEQUENCES

* EXPERIENCE AND RESEARCH INSIGHTS
  - OPERATING EXPERIENCES
  - RESEARCH RESULTS
  - STUDIES PERFORMED

CONTAINMENT FEATURES TO MITIGATE SEVERE ACCIDENTS

* LIST OF FEATURES
* DEMONSTRATION OF FUNCTIONALLY OF EACH FEATURE
* OVER PRESSURE RELIEF OR VENTING SYSTEM

Docket No. 50-605 Enclosure 2

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