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CONSIDERATION OF HYDROGEN GENERATION FROM METAL-WATER REACTION - MARK III CONTAINMENT

SUMMARY

The Staff has made the decision* that the new G.E. product line, BWR/6 Reactor - Mark III Containment, will be required to meet the combustible gas control provisions of Safety Guide 7. This Safety Guide provides certain limitations on hydrogen and oxygen concentrations in the containment to prevent a combustible mixture of these two gases, and specifies that the short-term hydrogen release should be based on 5% of the zircaloy fuel cladding reacting with water. As described in an amendment to the PSAR for the Grand Gulf application the Mark III Containment design has been changed to comply with Safety Guide 7. However, the design basis for hydrogen evolution contains certain assumptions as to the rate at which the metal-water reaction proceeds. (Safety Guide 7 does not address metal-water reaction rate considerations.) No decision has yet been made by the Staff in regard to the acceptability of this design basis for establishing the time rate of metal-water reaction and the resulting flow of hydrogen out of the pressure vessel. We are concerned that further delay in determining the acceptability of the hydrogen evolution design basis could effect the Grand Gulf review schedule.

DISCUSSION

In the Mark III Containment design, as incorporated in the Grand Gulf application, short-term combustible gas control is accomplished by providing a forced circulation system which mixes the drywell atmosphere (280,000 Cu. Ft.) with the larger containment volume (1,400,000 Cu. Ft.). The volume of the drywell is insufficient to maintain the hydrogen concentration below the level of four per cent as specified in Safety Guide 7. However, the total volume of the containment and the drywell is sufficient to dilute the potential hydrogen released from a 5% metal-water reaction to an acceptable level.

In previous BWR containment designs an inerted atmosphere is relied on to prevent a combustible mixture; the Mark III Containment cannot be inerted primarily because personnel access into the containment is necessary during normal operation. The time rate of hydrogen release from the metal-water

* "Safety Evaluation by the Directorate of Licensing, US AEC, in the Matter of General Electric Company Mark III Containment Concept," issued 10/5/72.

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reaction in an inerted containment has no effect on the design requirements. However, in the Mark III Containment, atmosphere mixing must be delayed until the "blow-down" is completed and the energy in the drywell is reduced to an acceptably low level to avoid over-pressurization and excessive temperatures in the containment when atmosphere mixing (which bypasses the suppression pool) is initiated. Thus the maximum time rate of hydrogen generation must be defined so that the containment can be designed to meet the requirements for both energy suppression and atmosphere mixing.

In amendments to the Grand Gulf application MP&L has proposed a particular design basis and calculational model, developed by G.E., for calculating the maximum rate of hydrogen evolution. Briefly, the assumption is made in the model that the peak clad temperature following a LOCA goes immediately to 2300 F and stays at that temperature indefinitely. The resulting hydrogen evolution rate is calculated using the procedure given in the G.E. Topical Report NEDO-11013-77, "An Analytical Procedure For the Conservative Calculation of Core Metal-Water Reaction Following a Design Basis Loss-of-Coolant Accident", dated May, 1972. It should be noted that no mechanistic rationale has been suggested to support this 2300 F assumption. The originally submitted containment design has been modified to maintain the hydrogen concentration (as calculated from this model) within the Safety Guide 7 limits. Using this model for the Grand Gulf design the calculated hydrogen concentration in the drywell reaches the combustible gas control limit in about one hour. Thus, the atmosphere mixing and energy suppression features of the containment are designed assuming that atmosphere mixing between the drywell and the containment to control the hydrogen concentration will not be initiated until after a significant fraction of an hour elapses from the time of the design basis LOCA.

Although the staff has completed the first round review of the containment design and has issued appropriate questions to MP&L, the responsible Branch, Containment Systems, has stated that they are continuing their "review of the ... modeling to include a time dependent metal-water reaction rate suitable to model the provisions of Safety Guide 7." In a recent discussion on this matter G. Lainus stated that a decision on an acceptable hydrogen generation basis had not yet been made but he assured us that if the applicant were proceeding down the "wrong path" in their containment design he would have so informed Reactor Projects. Although this assurance by Lainus is helpful, a firm and definitive Staff position is needed. MP&L and the prospective BWR/6 - Mark III applicants are expending considerable resources in developing designs based on this proposed basis and model. We believe further delay in formulating a firm policy not only could affect the Grand Gulf review schedule

but reduces the Staff's flexibility to issue an independent judgement which might result in a significantly different hydrogen evolution design basis than the basis given in the Grand Gulf application.

Higher management attention needs to be focused on this key decision to reduce the possibility that significant redesign will be required or that our review of the Grand Gulf application might be delayed. If you agree that it is appropriate and would be useful in expediting a decision, I will arrange a meeting between IR & RP personnel to discuss the current status of the problem and, hopefully, to establish a schedule for reaching a firm staff position in this matter.

Original signed by
Gerald Owsley

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