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MFN 06-370

Docket No. 52-010

October 5, 2006

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555-0001

Subject: **Response to Portion of NRC Request for Additional Information Letter No. 31 Related to ESBWR Design Certification Application – TRACG Application for ESBWR ATWS - RAI Number 21.6-49**

Enclosure 1 contains GE's response to the subject NRC RAI transmitted via the Reference 1 letter.

If you have any questions about the information provided here, please let me know.

Sincerely,

Kathy Sedney for

David H. Hinds
Manager, ESBWR

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Enclosure:

1. MFN 06-370 - Response to Portion of NRC Request for Additional Information Letter No. 31 Related to ESBWR Design Certification Application – TRACG Application for ESBWR ATWS - RAI Number 21.6-49

Reference:

1. MFN 06-203, Letter from U. S. Nuclear Regulatory Commission to Mr. David H. Hinds, *Request for Additional Information Letter No. 31 Related to ESBWR Design Certification Application,* June 23, 2006

cc: AE Cubbage USNRC (with enclosures)
GB Stramback GE/San Jose (with enclosures)
eDRF 0058-6639

ENCLOSURE 1

MFN 06-370

Response to Portion of NRC Request for

Additional Information Letter No. 31

Related to ESBWR Design Certification Application

TRACG Application for ESBWR ATWS

RAI Number 21.6-49

NRC RAI 21.6-49

Page 5-30, C15 Film Boiling (Dispersed Flow) - It should be a droplet diameter based on a critical Weber number to calculate the vapor-side interfacial heat transfer in the dispersed flow regime. Typically, film boiling dispersed flow regime is through a steam boundary layer next to the dry hot walls into a flow of dispersed droplets. So there should be no bubbles present in Film Boiling (Dispersed Flow). Since the heat transfer from the hot dry wall to the steam is across a single-phase steam boundary layer, it has some similarities to Dittus-Boelter type single-phase heat transfer. However, the presence of the dispersed droplet flow tends to effect thermal boundary layer at the hot dry walls, so it's not clear why this film boiling heat transfer would have the same uncertainty as Dittus-Boelter. In general, it would seem that film boiling heat transfer would have a higher uncertainty than Dittus-Boelter. Please provide justification for the uncertainty associated with the film boiling (dispersed flow) heat transfer coefficient.

GE Response:

We agree that the statement in Reference 21.6-49.1 should have referred to a droplet diameter, not a bubble diameter. This will be corrected in a revision to the document.

The film boiling heat transfer model in TRACG is described in Section 6.6.10 of the TRACG Model report (Reference 21.6-49.2). This model does account for the presence of dispersed droplets in the thermal boundary layer (Eq. 6.6-68). The magnitude of this effect depends on the concentration of the droplets in the flow. In the limit that the droplet concentration goes to zero, the wall heat transfer is given by the Dittus-Boelter correlation for heat transfer to steam.

For the uncertainty analysis, the major components of uncertainty in the film boiling were assumed to be the uncertainty in the Dittus Boelter correlation as it applied specifically to superheated steam in rod bundles; and in the interfacial heat transfer between droplets and vapor that controls the superheat in the steam. Note that the first factor also accounts for uncertainties due to variation in the steam superheat in the bundle. The uncertainty in the effect of the droplets in the thermal boundary layer was not specifically considered, but the uncertainty in the interfacial heat transfer between steam and droplets has a similar effect.

In the film boiling heat transfer mode, thermal radiation is also a significant contributor and the uncertainty in the thermal radiation heat transfer is separately considered through an uncertainty in the emissivity. The overall uncertainty in film boiling heat transfer should be adequately represented by these three sources of uncertainty.

Comparisons of core spray heat transfer with TRACG calculations (Reference 21.6-49.2) show that these data in the dispersed droplet film boiling regime are adequately predicted by TRACG with a small conservative bias on average. Additional sources of bias or uncertainty in film boiling heat transfer are not warranted.

References:

21.6-49.1 TRACG Application for ESBWR Anticipated Transient Without Scram Analyses, NEDE-33083P Supplement 2, January 2006.

21.6-49.2 TRACG Model Description, NEDE-32177P Revision 3, April 2006.