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US Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555-0001

**Subject: Clarifications Requested by NRC Staff on BiMAC Material
Performance in the ESBWR**

The purpose of this letter is to submit for information, per NRC staff request, clarification on BiMAC material performance in the ESBWR to support the DCD Chapter 19 FSER. The requested information is provided in Enclosure 1.

If you have any questions or require additional information, please contact me.

Sincerely,

Richard E. Kingston
Vice President, ESBWR Licensing

Enclosure:

1. *Clarification of BiMAC Material Performance in ESBWR.*

cc: AE Cabbage USNRC (with enclosure)
JG Head GEH/Wilmington (with enclosure)
DH Hinds GEH/Wilmington (with enclosure)
CW Bagnal GEH/Wilmington (with enclosure)

D068
N/A

Enclosure 1 Clarification of BiMAC Material Performance in ESBWR

Evaluation of BiMAC Under Ex-Vessel Steam Explosion Loads

As discussed in NEDO-33201 Revision 6, Section 21.4.4.4, the BiMAC device was evaluated for the fragility under Ex-vessel Steam Explosion loads using a conservative model. The model assumed 4" diameter pipes covered by 10 cm of concrete.

The purpose of the analysis was to evaluate the collapsing of the BiMAC pipes, as pipes without large deformation or crushing are required for the BiMAC to function.

The analysis showed that at around 200 kPa.s (29 psi.s) a thin portion of the pipes yield significantly, however, the remaining material remains basically intact while the pipe cross-sectional area is still largely intact. This point was taken as the level of incipient failure by crushing.

As a result of The MAC Experiments: Fine-tuning of the BiMAC Design, Proprietary Report by T. G. Theofanous, NEDE-33392P, the configuration of the BiMAC was revised to reduce the size and the inclination of the BiMAC pipes.

Reducing the inclination of the BiMAC pipes allows additional concrete on top of the BiMAC pipes.

Reducing the size of the BiMAC pipes also results in increased resistance to crushing loads. This can be shown using the equation for collapsing pressure for thin-wall cylinder in MARKS Standard Handbook for Mechanical Engineers, Ninth Edition, page 5-49. The collapsing pressure is proportional to the cube of cylinder thickness over the cube of the outside diameter. For example, it can be seen that the collapsing pressure of schedule 80 pipe increases as diameter decreases.

$$4" \text{ schedule 80 pipe} = 0.337^3/4.5^3 = 4.20\text{E-}4$$

$$3" \text{ schedule 80 pipe} = 0.3^3/3.5^3 = 6.30\text{E-}4$$

$$2" \text{ schedule 80 pipe} = 0.218^3/2.375^3 = 7.73\text{E-}4$$

$$1" \text{ schedule 80 pipe} = 0.179^3/1.315^3 = 2.52\text{E-}3$$

Therefore, the analysis for the original configuration of the BiMAC Device under Steam Explosion loads still bounds the new configuration of the BiMAC Device – smaller diameter pipes buried under additional concrete.