

December 21, 2000

MEMORANDUM TO: Gary M. Holahan, Director  
Division of Systems Safety and Analysis  
Office of Nuclear Reactor Regulation

FROM: Farouk Eltawila, Acting Director **/RA/**  
Division of Systems Analysis and Regulatory Effectiveness  
Office of Nuclear Regulatory Research

SUBJECT: APPLICABILITY OF 10 CFR 50.46 TO M5 AND ZIRLO CLADDING

This is a follow-up to my e-mail message to you dated December 7, 2000, and other supplementary material that I sent you on December 18, 2000.

Recently we found evidence that Russian VVER cladding becomes embrittled under LOCA conditions at an oxidation level of about 6% equivalent cladding reacted (ECR) compared with about 17% ECR for Zircaloy, as specified in our regulations. Since Framatome's M5 cladding and the Russian VVER cladding have nominally the same composition (Zr-1%Nb), it is likely that M5 will also become more embrittled than Zircaloy under LOCA conditions. This observation also raises questions about the amount of oxidation that Westinghouse's ZIRLO can sustain without becoming brittle since ZIRLO also contains niobium (as well as tin).

During the review of Framatome's licensing submittal for M5 cladding, quench tests were cited to show that M5 would not fragment below 17% ECR under LOCA conditions. It became clear during the PIRT meetings this summer that quench tests are not definitive for this purpose because of the large effect of specimen constraints, which cannot be made to be prototypical. Quench tests without specimen constraints, like those cited during the M5 review, may not fragment until very high oxidation levels (as high as 60% ECR in some recent tests). The Commission in its 1973 opinion did not rely on quench tests, but rather relied on a ductility measure provided by ring-compression tests. The data we found recently on Russian VVER cladding were, in fact, results from ring-compression tests comparing Zr-1%Nb with Zircaloy-4.

Attached is the report containing the data just mentioned and related papers. We have tried to verify these data and can find no reason to question at least the general finding of significantly reduced ductility for Zr-1%Nb compared with Zircaloy. This would seem to have significant implications regarding Chapter-15 analyses for plants with M5 cladding and perhaps for plants

with ZIRLO cladding, although we have no specific information on Zr-1%Nb-1%Sn alloys. No quench test or ductility results under LOCA conditions are available for ZIRLO as far as we know.

Attachment: As stated

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