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MEMORANDUM FOR: Ashok C. Thadani, Associate Director
for Inspection and Technical Assessment

THRU: Brian W. Sheron, Director
Division of Engineering

FROM: Jack R. Strosnider, Jr., Chief
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SUBJECT: ISSUES FROM MAY 26, 1994 MEETING WITH CECo
ON BWR CORE SHROUD CRACKING

On May 26, 1994, the NRC staff met with representatives from Commonwealth Edison Company (CECo) and the Boiling Water Reactor Owners Group (BWROG) to discuss core shroud and reactor vessel internals cracking in boiling water (BWR) reactor plants. As you are aware, the morning session of the meeting was a high level discussion between senior NRC and industry management. During this session, senior industry representatives described their plans for addressing cracking of shrouds and other BWR reactor vessel internals. In the afternoon session, more detailed technical discussions were held between the NRC staff and industry representatives. The purpose of this memorandum is to highlight several important issues that were identified during the technical discussions.

First, during the technical discussions the industry representatives could not respond completely to questions regarding the effects of blowdown loads associated with a postulated loss-of-coolant (recirculation suction line break) accident on a cracked core shroud. The concern identified by the staff is that asymmetric depressurization could create lateral loadings on the core shroud resulting in displacement, rotation or local deformation of the shell that could open a pre-existing crack; thereby causing significant by-pass flow and jeopardizing maintenance of 2/3 core coverage. This subject was discussed briefly during the morning session and industry consultants indicated that the blow-down loads, assuming an instantaneous pipe break, would be of too short a duration to affect the shroud. However, during the afternoon session it was determined that this response was in reference to the acoustic wave generated by the postulated break. The industry representatives could not address the issue of the depressurization loads, and it wasn't clear that these analyses had been performed. Scoping calculations performed by the staff indicate that the potential exists for asymmetric blowdown loads to result in crack opening areas with associated by-pass leakage rates large enough to challenge core re-flood capability. However, more sophisticated analyses considering three dimensional pressure profiles and time history responses are necessary to address this issue. The industry representatives indicated that they understood the issue and that they would address it as part of their plant-specific (CECo) and generic plant evaluations. The resolution of this issue is very important in that the acceptance criteria that have been proposed by the industry are based on structural integrity analyses to

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demonstrate that existing cracks will not propagate unstably under postulated accident loadings and result in failure (separation) of the shroud. However, it is possible that consideration of crack opening areas and associated by-pass leakage could result in more limiting acceptance criteria.

The staff also raised two concerns related to the industry's approach to applying limit load analyses used to determine acceptable crack lengths. The first concern is that the industry proposed to take credit for a fillet weld between the horizontal support ring and the vertical shroud cylinder at the H-5 weld location. This would effectively increase the cross sectional thickness assumed in the limit load analysis by 1 inch. Limit load analysis calculates ultimate loading capacity based on the area of the fully plastic cross section that is developed. For the specific joint configuration of concern it may be possible to develop a fully plastic cross section at a lower load or with an area smaller than that assumed if credit is taken for the fillet weld. A sophisticated analysis that considers the actual geometry, stress intensification, strength mis-matches, etc. of the joint would be necessary to determine what, if any, credit could be given for the fillet weld. In addition, results of a preliminary staff analysis indicate that the existing cracks at Dresden Unit 3 could grow through wall within a 24 month operating cycle if the thickness used in the analysis is the thickness without the fillet weld (2 inches). The second concern relates to the use of ASME Code Section XI IWB-3640 equations for calculating limit load. These equations were developed and verified for piping geometries and the code limits their application to cylindrical geometries with a diameter to thickness (d/t) ratio of 100 or less. However, BWR core shrouds have higher d/t ratios (on the order of 120.) For these high d/t ratios buckling may be a problem. Limit load is an appropriate analysis method for ductile materials such as stainless steel which the shroud is fabricated from; however, application of the methodology requires appropriate consideration of specific joint and overall structural geometries. These issues were identified to the industry representatives and they indicated they would address these issues in future submittals.

A final issue discussed was the potential for stress corrosion cracking in creviced locations. Drawings provided by CECo show that in some plants portions of the lower shroud where stainless steel is joined to Inconel were fabricated with backing rings thereby creating a crevice. Such a condition enhances the potential for stress corrosion cracking, and these welds have not been routinely inspected. Welds having this crevice condition include those that join the shroud support columns to the reactor vessel lower head. Cracking in these locations could cause concerns for shroud support structure integrity.

The staff identified the above issues to the CECo and BWROG representatives and indicated that these issues should be addressed in future submittals. The staff noted that CECo has an important project management decision to make regarding justification of restart of Dresden Unit 3 and Quad Cities Unit 1.

In particular, it was noted that resolution of the first two items discussed above may require extensive, sophisticated analyses and that the schedule and likely outcome of these analyses should be considered in making a decision on whether or not to initiate repairs of the cracked shrouds. Without satisfactory resolution of these technical issues, we believe that large cracks such as that in the H-5 weld of Dresden Unit 3 should be repaired.

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