concluded that operators would have adequate time to make use of alternate water sources (25–35 minutes). The staff also notes that the probability of the initiating event is low. The actions requested in this bulletin will ensure that the ECCS can perform its safety function and minimize the need for operator action to mitigate a LOCA.

Discussion

The results of the staff study, initially documented in the draft NUREG/CR–6224, demonstrate that for the reference plant, there is a high probability that the available NPSH margin for the ECCS pumps will be inadequate following dislodging of insulation caused by a LOCA and transport of insulation debris to the suction strainers. In addition, the study calculated that the loss of NPSH could occur quickly (less than 10 minutes into the event). The study also demonstrated that determining the adequacy of NPSH margin for an ECCS system is highly plant-specific because of the large variations in such plant characteristics as containment type, ECCS flow rates, insulation types, plant layout, and available NPSH margin. The final version of NUREG/CR–6224 is scheduled for issuance in September 1995.

The Barsebäck event demonstrated that a pipe break can generate and transport large quantities of insulation debris to the suppression pool where they can be deposited onto strainer surfaces and potentially cause the ECCS to lose NPSH. The Perry events further demonstrated that fibrous insulation debris combined with corrosion products present in the suppression pool (sludge) can exacerbate the problem. This phenomenon was confirmed in the staff study which showed that the calculated loss of NPSH could occur soon (less than 10 minutes) after ECCS initiation. The effect of filtering sludge from the suppression pool water by fibrous debris deposited on the strainer surface was further confirmed in NRC-sponsored testing conducted at the Alden Research Laboratory which demonstrated that the pressure drop across the strainer was greatly increased by this filtering effect. Additional testing sponsored by the NRC at Alden Research Laboratory demonstrated that the energy conveyed to the suppression pool during the ''chugging'' phase of a LOCA is sufficient to ensure that the fibrous debris and sludge are well-mixed and evenly distributed in the suppression pool, and can remain suspended for a sufficiently long period of time to allow large quantities to be deposited onto the strainer surfaces. The staff has concluded that this problem is applicable to all domestic BWRs. The basis for the staff's conclusion is as follows: (1) there does not appear to be any features specific to a particular plant, class of plants, or containment type which would mitigate or prevent the generation, transport to the suppression pool, or deposition on the ECCS strainers of sufficient material to clog the strainers, and (2) parametric analyses performed in support of the NUREG/CR–6224 study using parameter ranges which bound most domestic BWRs failed to find parameter ranges which would prevent BWRs with other containment types from being susceptible to this problem. In addition, the staff study was conducted on a Mark I; Barsebäck had a strainer clogging event and is similar in design to a Mark II; and Perry, a Mark III, also had a strainer clogging event.

Section 50.46 of Title 10 of the Code of Federal Regulations (10 CFR 50.46) requires that licensees design their ECCS systems to meet five criteria, one of which is to provide long-term cooling capability of sufficient duration following a successful system initiation so that the core temperature shall be maintained at an acceptably low value and decay heat shall be removed for the extended period of time required by the long-lived radioactivity remaining in the core. The ECCS is designed to meet this criterion, assuming the worst single failure. Experience gained from operating events and detailed analysis, as previously discussed, demonstrate that excessive buildup of debris from thermal insulation, corrosion products, and other particulates on ECCS pump strainers is highly likely to occur, creating the potential for a common-cause failure of the ECCS, which could prevent the ECCS from providing long-term cooling following a LOCA. The staff concludes; therefore, that this issue must be resolved by licensees in order to ensure compliance with the regulations; specifically, to ensure that long-term cooling can be provided in accordance with 10 CFR 50.46.

Plant-specific analyses to resolve this issue are difficult to perform because a substantial number of uncertainties are involved. Examples of these uncertainties include the amount of debris that would be generated by a pipe break for various insulation types; the amount of the debris that would be transported to the suppression pool; the characteristics of debris reaching the suppression pool (e.g., size and shape); and head loss correlations for various insulation types combined with suppression pool corrosion products, paint chips, dirt, and other particulates. Many of these uncertainties would be plant-specific because of the differences in plant characteristics, such as plant layout, insulation types, ECCS flow rates, containment types, and NPSH margin. Testing may be required to quantify these uncertainties for licensees to demonstrate compliance with 10 CFR 50.46.

The staff has also closely followed the work of the BWROG to resolve this issue. The BWROG has evaluated several potential solutions, and is currently testing three new strainer designs: two passive strainer designs and one self-cleaning design. The ongoing BWROG effort is consistent with the options proposed in this bulletin for resolution of the the ECCS potential strainer clogging issue. These options are discussed in the next section under Requested Actions. The BWROG is also developing a utility resolution guidance (URG) document for providing the utilities with: 1) guidance on evaluation of the ECCS potential strainer clogging issue for their plant, 2) a standard industry approach to resolution of the issue which is technically sound, and 3) guidance which is consistent with the requested actions in this bulletin for demonstrating compliance with 10 CFR 50.46. The staff considers this document to be an important part of the implementation of the final resolution of this issue, and will closely monitor the development and application of the URG.

Requested Actions

All BWR licensees are requested to implement appropriate measures to ensure the capability of the ECCS to perform its safety function following a LOCA. The staff has identified three potential resolution options; however, licensees may propose others which provide an equivalent level of assurance that the ECCS will be able to perform its safety function following a LOCA. The three options identified by the staff are as follows:

Option 1: Installation of a large capacity passive strainer design. Draft Regulatory Guide DG–1038, proposed Revision 2 of Regulatory Guide 1.82 (RG 1.82), ''Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident,'' has been revised to provide additional technical guidance to BWR licensees on the conduct of evaluations to ensure compliance with 10 CFR 50.46. If this option is selected by a licensee, the strainer design used should have sufficient capacity to ensure that debris loadings equivalent to a scenario calculated in accordance with Section C.2.2 of DG–1038 do not cause