SUPPLEMENT 1

GENERIC

SAFETY EVALUATION REPORT

BWR SCRAM DISCHARGE SYSTEM

January 12, 1981

BWR SCRAM SYSTEM

1. Introduction

On December 1, 1980 we issued our SER dealing with the BWR scram discharge system (Reference 1). In that report we recommended long-term and interim actions. For the interim action we proposed the installation of an automatic air dump system be accomplished within 2 months. We have since determined that the design, fabrication, installation and testing will require longer than the original estimate of 2 months. Accordingly, we have reevaluated the basis for continued operation of affected BWRs while the appropriate modifications are being made. This report summarizes our analysis of that issue and is largely based on an evaluation performed by the Division of Safety Technology (Reference 2). We conclude that no undue risk attends continued operation for at least three months while the air system modifications are being implemented.

2. Basis for Continued Operation.

One of the problems identified in the SER was the potential failure to scram due to loss of pressure in the instrument air system. The problem can be briefly described as follows. The scram outlet valves open at a slightly higher set point than the scram inlet valves. The control air system typically operates at about 75 PSI. If the pressure decreases to approximately 40 PSI, the scram outlet valves open. The scram inlet valves open at a lower pressure around 30 PSI. A loss of air pressure is postulated to occur such that the depressurization rate of the system is slow enough that the scram outlet valve remains slightly open while no movement of the control rods takes place. The scram discharge volume

can then fill with water before the air pressure decreases enough to open the scram inlet valves and cause control rod movement. In this event a reactor scram may not be possible because the scram discharge would have already filled with water.

It appears that an event similar to this (but with no adverse consequences) actually occurred at the Quad Cities Unit 1 reactor on January 3, 1977.

The solution proposed in the SER is to add a system that will actuate to dump the air in the control air system prior to reaching an air pressure which would open the scram outlet valves. The rate of depressurization of the control air system would then be rapid enough to cause insertion of all control rods before the scram discharge volume is filled.

The SER of December 1, 1980, recommended that this automatic air dump system be installed within two months. Since the publication of the SER, we have continued to review this requirement and have determined, based upon evaluations of installed air systems and discussions with industry representatives, that a three-month period is necessary to allow adequate time for design, procurement, fabrication, installation and testing of a suitable automatic air dump system.

The criteria for the design of this system which are listed in the generic safety evaluation report take into account the desire to install this system on a timely basis and do not require that the system meet the same quality

and design standards required for the reactor protection system. Also, as discussed in the December 1 SER this system is only required in the interim until permanent modifications are in place to improve the hydraulic coupling between the scram discharge volume and the scram level instrumentation. Thus, we do not recommend that the system be subject to the requirements of Appendices A and B to 10 CFR Part 50.

We have estimated that a postulated loss of air event that could result in a loss of scram function may have a probability of occurrence in the range of 10^{-2} to 10^{-4} per reactor year. This estimate, covering a 90% symmetric confidence interval is based on an assumed exponential distribution and the one loss of air event at Quad Cities in 1977 where it was determined that the scram discharge volume partially filled with water prior to a successful reactor scram. It should also be noted there have been other loss of air pressure events where it has not been possible to determine if water was admitted to the scram discharge volume because of lack of detailed information concerning the course of the event. Some of the trips during these events were manually initiated by the operators while the others were automatically initiated.

If one assumes that one-tenth of the Quad Cities-type events could lead to a serious ATWS scenario (i.e., a completely filled scram discharge volume prior to scram), then the frequency of an ATWS type event would range from 10^{-3} to 10^{-5} per reactor year. Even though the assumption of one-tenth is somewhat arbitrary, it seems reasonable that the actual value would be significantly less than one, but probably greater than 0.01. The actual number would of course depend on the likelihood of an automatic scram or for timely action by the operator to initiate a scram, before the

scram discharge volume is completely filled.

If there were not such a large uncertainty associated with the calculation of a frequency based on a single event, if one could be certain that the assumption of the value of 0.1 was reasonably conservative, and if there was assurance that the other loss of air events were not similar to the Quad Cities event, then an argument can be made that an interim fix as recommended in the December 1 SER is not required i.e., one could wait for the long-term fix. However, because of the uncertainties discussed, waiting for the longer term fix does not appear to be a prudent course of action. On the other hand the requirements of IE Bulletin 80-17, Supplement 3, which calls for an immediate manual scram when a low pressure occurs in the CRD air system or when other indications occur (e.g., multiple rod drift alarms or a marked change in the number of control rods that are at high temperature), the continuous monitoring of a water accumulation in the SDV headers (fast fill scenarios due to potential loss of air events are not adequately addressed by this method), as well as the estimates made for the likelihood of such events, justify an allowance of added time to design, install and test this system. In fact, system reliability dictates the establishment of a schedule that includes adequate time for preliminary design, performance analysis and evaluation, fabrication, testing and installation.

Accordingly, we conclude that, although action to reduce the likelihood of such occurrences should be taken by modifying the air system as described above, this action may be accomplished in accordance with the January 9, 1981 orders without undue risk. Permitting the extended period may in fact improve safety in the longer term by allowing the installation of a properly designed system having improved reliability.

3. Comments on the Human Factors of this Issue

We have also reevaluated the human factors involved in carrying out the requirements of Supplement 3 to IE Bulletin 80-17. This supplement requires:

1. An immediate manual scram on a low control rod drive air pressure with a minimum of 10 PSI margin above opening pressure of the scram outlet valve.
2. An immediate scram in the event of multiple rod drift alarms are a marked change in the number of control rods with high temperature alarms.

These requiremements if properly implemented provide additional assurance that timely action will be taken by an operator to mitigate the effects of a loss of air pressure event in the several month interim period while the air dump system is being developed and installed.

In reevaluating the human factors aspects of these requirements we have discovered that:

1. The number of loss-of-air annunciators (at different setpoints) may vary from plant to plant.
2. With a loss-of-air event, the number of other annunciators activated and their locations relative to the loss-of-air annunciator may vary considerably from plant to plant.
3. With a loss-of-air event, the number of other annunciators activated and their locations relative to the loss-of-air annunciator may vary considerably as a function of the type of event taking place.

4. The requirement to carry out an immediate manual scram with a loss-of-air annunciator is a unique requirement, i.e., no other single annunciator requires such action.

While a manual trip before the SDV fills is required by Supplement 3, the uncertainty associated with control room and event specifics suggests that additional assurance is desirable. A simple modification to the existing loss-of-air annunciator can greatly improve operator response certainty. In this regard it is suggested that a unique and distinctly audible alarm be associated with the loss-of-air annunciator. No other event should trigger this alarm and the only requirement is that the operator immediately scram the plant.

REFERENCES

1. Memorandum for G. C. Lainas, T. M. Novak, R. L. Tedesco, USNRC from P. S. Check, USNRC, Subject: "BWR Scram Discharge System Safety Evaluation", December 1, 1980.

2. Memorandum for H. R. Denton, USNRC, from M. L. Ernst, USNRC, Subject: "DST Evaluation of the Automatic Air Header Dump on Boiling Water Reactors", December 12, 1980.