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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

DIVISION OF LICENSING

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1.0 Introduction

Over the past several years, a number of instances of control rods failing to fully insert on scram have occurred at GE BWRs. These failures to fully insert on scram (FFIS) have involved one or more rods stopping short of the fully inserted position (notch position "00") and then settling back to six inches short of full insertion (notch position "02").

2.0 Causes

Both General Electric (GE) and utilities experiencing such problems have identified the apparent cause of the problem as leakage past worn stop and drive piston seals which allows scram water to build up in the buffer area of the drive. This results in a hydraulic lock of the drives between notch positions "02" and "00". When a force balance is achieved, the buffer area and the underside of the drive piston pressures equalize allowing the control rod drive to settle back into notch position "02."

Orifices near the upper end of the control rod drive (CRD) piston tube are progressively closed by the drive piston as the full rod insertion position is approached. This slows the CRDs and prevents seal damage as a result of the drive piston slamming into the stop piston. However, in the event of excessive leakage past the stop piston seals, the final piston tube buffer orifice cannot pass all of the water during a scram. Consequently, the hydraulic lock referred to earlier is created which prevents the final increment of rod insertion.

General Electric Company has recommended a revised Control Rod Drive Venting Procedure which required the CRDs to be vented until no air could be detected with a Differential Pressure Cell in the CRD Hydraulic System. By following this procedure, a water hammer condition would not be created by the presence of excessive air in the buffer area. Such a condition could result in slamming the drive piston into the stop piston resulting in seal degradation.

An additional cause of seal deterioration has been attributed to high crud levels in reactor coolant during operation. Some BWRs such as Dresden 2 (which has had the highest number of FFIS events) require a pressure breakdown of reactor coolant before purification, with a resultant low volumetric cleanup rate. The high crud levels may interfere with the tight tolerances around the stop piston seals causing binding, breakage, and subsequent FFIS events.

3.0 Evaluation

In all FFIS events reported in response to our letters of August 29, 1978 and January 10, 1980, control rods which failed to fully insert inserted to notch position "02." In all cases, subsequent manual insertion by the operator resulted in the rods being fully inserted.

Even with all rods inserted only to the "02" notch position instead of the "00" fully inserted position, sufficient shutdown margin exists to preclude FFIS from being a safety problem. The addition of reactivity to the core as a result of all rods being withdrawn to six inches short of full insertion is less than that of the most reactive rod being stuck in the fully withdrawn position, according to calculations performed by Brookhaven National Laboratories (BNL).

Although this problem appears to be a cumulative one (i.e., rods which initially fail to fully insert continue to fail along with additional rods on subsequent scram), it also appears to be a random type failure (as opposed to a failure mechanism which results in "clustered" non-insertion of rods such as that which occurred at Browns Ferry 3 on June 28, 1980). In addition, these failures are time dependent, which allows for an increased likelihood of detection and correction of these failures. This deficiency is typically corrected by removing and overhauling the affected CRDs at an outage subsequent to the recognition of the FFIS event.

Technical Specifications pertaining to the reactivity margin required to be available and to the operability of control rods provide adequate assurance of the capability to place and maintain the plant in a safe shutdown condition.

In summary, the failures of control rods to fully insert as described herein does not present a safety problem since there is negligible effect on reactivity even if all rods should insert to only the "02" position, the capability to manually insert control rods is retained, the overhaul of affected rod drives during subsequent outages rectifies the problem, and existing Technical Specification requirements provide adequate assurance of the capability to place and maintain the plant in a safe shutdown condition.