UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555-0001

March 14, 1996

NRC INFORMATION NOTICE 96-16: BWR OPERATION WITH INDICATED FLOW LESS THAN NATURAL CIRCULATION

Addressees

All holders of operating licenses or construction permits for boiling-water reactors (BWRs).

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to alert addressees to two instances of power operation in which the core flow appeared to be less than that normally attributed to operation on or near the natural circulation line. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances

Nine Mile Point Nuclear Station Unit 1

On February 1, 1995, Nine Mile Point Unit 1 (NMP1) had a recirculation pump runback event as a result of pump maintenance activities. The reactor was being operated at 77 percent of rated power and on the 78-percent rod line. When the runback occurred, one of the five pumps was out of service for maintenance. Speed of the four operating pumps was reduced to about 10 percent of rated speed. The resulting minimum indicated flow was about 13 percent and the corresponding power level was about 30 percent. (The facility operating procedures require that flow be greater than 20 percent to be in the RUN mode.) With four pumps operating at 10-percent speed, the resulting flow would be expected to be a little higher than at natural circulation. Natural circulation flow for NMP1 is generally shown as being about 21 to 26 percent for a power of about 30 percent. Thus, the indicated flow rate was lower than the rate that would normally be considered for the natural circulation line on the power/flow map.

There was a turbine trip from a high water level signal as a result of a steam and feedwater flow mismatch, but no reactor scram occurred since steam flow was within turbine bypass capacity. Operators reduced power by inserting high worth control rods and increased the indicated flow to above the natural circulation line by increasing the speed of the recirculation pumps. Investigation by the utility, General Electric, and an NRC inspection team attributed the indicated low flows to inaccurate instrumentation, with lack of recent low-flow calibration as a suspected cause. The indicated low flow was

not compatible with previous analysis and measurements, which indicated the flow rate would be at least 24 percent following a trip of all 5 pumps from similar initial conditions.

Peach Bottom Atomic Power Station Unit 2

On June 3, 1995, while the reactor was being operated at about 32 percent of rated power and in single-loop operation prior to planned maintenance, a full recirculation pump runback to minimum speed occurred. This was the result of maintenance activities while attempting to place a reactor feed pump in standby. Reactor power was reduced to 26 percent, and the indicated core flow was about 32 percent of rated flow. The operator knew the reason for the runback and, as directed by the control room supervisor, restored core flow to conditions that existed before the event. After the event, the reactor engineer reviewed core performance during the reduced-flow condition and determined that the power/flow had apparently reached a flow that was 0.5 to 2.0 percent (depending on the instrumentation used) lower than the flow corresponding to the natural circulation line-flow (as displayed, for example, in Figure 1.1-1 of the Peach Bottom Technical Specifications).

Discussion

NRC staff investigation of these two events indicates that some plant operators may not have a complete understanding of at least four aspects of such events.

(1) Natural circulation may not occur, or may not appear to occur, precisely where it is depicted on the power/flow maps normally available to operators, for example, in technical specifications, the Bases or procedures. Usually, these maps are only intended to be illustrative and approximate. The correct values change with cycle, time in cycle, and other core and coolant system characteristics. In addition, the observed flow also depends on the accuracy of the relevant instruments and may not be correct because of, for example, calibration problems.

(2) Flow instruments are usually calibrated at high flow rates. Calibration information obtained at low flows can reduce uncertainties about the accuracy of the instruments involving low flow situations.

(3) Operation (on a given rod line) at flow lower than that on the natural circulation line, if real, can be more unstable than operation on the natural circulation line. For the NMP1 event, the NRC inspection team calculated that the reactor would have been unstable at the indicated minimum flow (13 percent) if the event had been initiated from conditions on a somewhat higher rod line. The stability regions for NMP1 have now been conservatively extended below the natural circulation line, and operators are aware of the potential for increased instability at lower flows.

(4) It was pointed out in NRC inspection report Reference No. 50-220/95-80 [9504070141] for the NMP1 event that the technical specification for the NMP1 safety limit with low flow, did not have a logical or sufficient Basis (B 2.1.1.b) for the safety limit. The specification, which says, in part, that the power should be less than 25 percent of rated thermal if the flow is less than 10 percent of rated, does not follow from the information in the Basis.

The flow related-safety limit addresses flow below 10 percent and flow above 10 percent. Above 10-percent flow, the limit is stated in terms of the minimum critical power ratio (MCPR) and the MCPR safety limit. The Basis states that there are sufficient data to validate the MCPR correlation down to about 10-percent flow. Thus, with power/flow information for any given state of the reactor, the relationship to the MCPR safety limit can be determined. However, no relevant information for below 10-percent flow is provided as a basis for the stated 25-percent power safety limit. The basis (which, like the specification, is essentially the same for most BWRs, and the new standard specification NUREG-1434) indicates that the critical power ratio correlations are valid down to about 10-percent flow, but does not address the below-10-percent-flow critical power correlations or any other relevant data or analysis for that region. Instead, it states that minimum flow will be no less than about 20 percent, the lowest flow that was anticipated under low-flow conditions as a result of the BWR flow geometry. At this flow, a power of 50 percent was found to be within minimum critical power limits and thus, it is stated, the specification of a 25-percent limit is conservative. However, no information is provided to validate the translation to 10 percent or lower flow conditions, the flow range of the low-flow specification. This aspect of the safety limit will be further examined by the NRC, and action may be taken to correct NUREG-1434.

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact one of the technical contacts listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

Dennis M. Crutchfield, Director
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96-14	Degradation of Radwaste Facility Equipment at Millstone Nuclear Power Station, Unit 1	03/01/96	All holders of OLs or CPs for nuclear power reactors
96-13	Potential Containment Leak Paths Through Hydrogen Analyzers	02/26/96	All holders of OLs or CPs for nuclear power reactors
96-12	Control Rod Insertion Problems	02/15/96	All holders of OLs or CPs for nuclear power reactors
96-11	Ingress of Demineralizer Resins Increases Potential Stress Corrosion Cracking of Control Rod Drive Mechanism Penetrations	02/14/96	All holders of OLs or CPs for pressurized water nuclear power reactors
96-10	Potential Blockage by Debris of Safety System Piping Which is Not Used During Normal Operation or Tested During Surveillances	02/13/96	All holders of OLs or CPs for nuclear power reactors
96-09	Damage in Foreign Steam Generator Internals	02/12/96	All holders of OLs or CPs for pressurized water reactors
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OL = Operating License
CP = Construction Permit

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original signed by

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less than 25 percent of rated thermal if the flow is less than 10 percent of rated, does not follow from the information in the Basis.

The flow related-safety limit addresses flow below 10 percent and flow above 10 percent. Above 10-percent flow, the limit is stated in terms of the minimum critical power ratio (MCPR) and the MCPR safety limit. The Basis states that there are sufficient data to validate the MCPR correlation down to about 10-percent flow. Thus, with power/flow information for any given state of the reactor, the relationship to the MCPR safety limit can be determined. However, no relevant information for below 10-percent flow is provided as a basis for the stated 25-percent power safety limit. The basis (which, like the specification, is essentially the same for most BWRs, and the new standard specification NUREG-1434) indicates that the critical power ratio correlations are valid down to about 10-percent flow, but does not address the below-10-percent-flow critical power correlations or any other relevant data or analysis for that region. Instead, it argues that minimum flow will be no less than about 20 percent. It indicates, in brief, that a critical power test was done at a flow of 3.5 kg/sec [28,000 lb/hr], which is about 22 percent of rated flow for NMP1 (and is a similar range for other BWRs). That flow was chosen because that is the lowest flow that was anticipated under low-flow conditions as a result of the BWR flow geometry. At this flow, a power of 50 percent was found to be within minimum critical power limits and thus, it is stated, the specification of a 25-percent limit is conservative. However, the referenced test was at 22-percent flow, and no information is provided to validate the translation to the 10-percent or lower flow conditions, the flow range of the low-flow specification. Thus, no logical basis is provided to establish that operation is acceptable at 25-percent power (or any other power) at or below 10-percent flow. This aspect of the safety limit will be further examined by the NRC, and action may be taken to correct NUREG-1434.

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