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Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Subject: Byron Station Units 1 and 2
Braidwood Station Units 1 and 2
Locked Rotor and Shaft Break
Transients
NRC Docket Nos. 50-454, 50-455,
50-456 and 50-457

Dear Mr. Denton:

This is to provide additional information regarding reactor coolant pump locked rotor and shaft break transients at Byron and Braidwood. Review of this information should close Confirmatory Issue 34 of the Byron SER.

The Byron/Braidwood FSAR documents core performance analyses of situations involving either reactor coolant pump rotor seizure or shaft break. In both cases the reactor trips in less than one-tenth of a second and the maximum clad temperature is reached in less than four seconds. The transients are essentially over in ten seconds.

The Staff has pointed out that the turbine would also trip in such a transient and a consequential interruption of power to plant auxiliaries including reactor coolant pumps could make the transient more severe. Additional analyses of such events and a re-examination of the limiting single failure were requested. As discussed below, representative transients of this type have been evaluated and the consequences determined to be acceptable.

<u>Consequential Interruption Scenarios</u>

Consequential interruption of power to plant auxiliaries is possible in only two ways. Switching of bus feeds at the time of generator trip could involve a breaker failure that would leave one or more reactor coolant pumps without power. Trip of the turbine could disrupt grid stability that might result in low voltage or frequency trip of reactor coolant pumps.

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Switching

At Byron and Braidwood the generator trip is delayed thirty seconds past the turbine trip caused by a reactor trip in a loss of flow transient. During this delay period power flow through the main transformers reverses to maintain generator terminal voltage and supply auxiliary buses that feed reactor coolant pumps. After thirty seconds these buses are automatically switched to system auxiliary transformers fed from the 345 kv yard. This switching is delayed to provide an extra measure of turbine overspeed protection. It also precludes switching failures which could interrupt power to plant auxiliaries during the first few crucial seconds of a locked rotor or broken shaft transient.

As noted in the FSAR, the locked rotor event concurrent with a loss of offsite power at the time of generator trip has been evaluated. Without offsite power this transient ultimately results in the coastdown of the reactor coolant flow when the reactor coolant pumps are tripped. As shown by the FSAR analyses summarized earlier this will have little effect because the severity of the transient will have turned around.

Grid Stability

The turbine trip associated with a locked rotor or broken shaft transient would not cause instability on the Commonwealth Edison grid and could not complicate the transient further. From our operating experience at Zion Station, a plant similar in size, no unit trip has ever caused a noticeable instability in the grid. System voltage has never dropped to the point of tripping reactor coolant pumps.

If grid instability should ever be induced by a locked rotor or broken shaft transient, its effect on the plant would be slower than the initiating transient itself. The grid instability would manifest itself in a reduced frequency. High fault currents would then occur in the transmission lines. Automatic breaker trips would begin in a cascading manner to isolate the faults. Since the highest fault currents would be seen first at points furthest from the station, the station would be the last, or close to the last, point to be isolated from the grid. This series of events would take longer than four seconds, which is the time of the peak of the transient, and neither the frequency nor voltage decay to the point of pump trip during this time. The analysis of the locked rotor event is applicable to the broken shaft event with concurrent loss of offsite power.

Single Failure

The Staff has also suggested that these events should be analyzed assuming the worst single failure of a safety system active component.

The single active failure assumed in the Locked Rotor/Pump Shaft Break analysis presented in the Byron/Braidwood FSAR is the loss of one protection train used to initiate a reactor trip on a low flow signal. This failure, or any other failure, will not have an effect on the transient because of the transient's relatively short duration. In less than four seconds after initiation of the accident, the safety parameters of concern (departure from nucleate boiling ratio, reactor coolant pressure and clad temperature) have reached their maximum (or minimum for DNBR) values and begin to approach steady state values.

The following are additional single active failures that are assumed in other accidents. As noted, none of them will increase the severity of the Locked Rotor accident.

- Loss of a safety injection train - Safety injection is not required to mitigate the effects of this accident.
- Loss of an auxiliary feedwater pump - The Locked Rotor Accident is turned around before the auxiliary feedwater (AFW) pumps could be turned on.
- PORV stuck open - The Locked Rotor Accident is turned around before the stuck open PORV would have any effect. A stuck open PORV is analyzed in Section 15.6.1.
- Failure of a main steam isolation valve (MSIV) - The MSIVs are not required to mitigate the effects of the Locked Rotor Accident.
- Failure of a feedline isolation valve - The Locked Rotor Accident is turned around before this failure.
- Stuck open secondary side valve - Radiological effects due to a stuck open valve on the secondary side are of no consequence for the following reasons. Steam releases assumed in the radiological analysis for the locked rotor accident assumed a conservatively high steam release for eight hours. The conservatisms include (1) no steam dump to the condenser (2) a high rate of decay heat and (3) a high level of energy stored in the reactor system structure.

  Steam releases computed on the above basis will always exceed releases that could occur while bringing the plant to a shutdown condition after the accident. Therefore, a stuck open relief, safety, or dump valve is of no consequence to the radiological releases calculated.

Based on the short duration of the transient and a review of other single failures, the loss of a protection train is an appropriate single failure for the locked rotor accident both with and without offsite power available.

In summary, the generator trip delay and grid stability provide assurance that the events analyzed in the FSAR are appropriate design basis loss of flow transients. Failure of one protection train is an appropriate design basis failure for the transient.

Please direct further questions regarding this matter to this office.

One signed original and fifteen copies of this letter are provided for your use.

Very truly yours,

T. R. Tramm

T. R. Tramm
Nuclear Licensing Adminstrator

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