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NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

NORTHERN STATES POWER COMPANY

MONTICELLO NUCLEAR GENERATING PLANT

SAFETY/RELIEF VALVE BLOWDOWN CONTROL SYSTEM

1.0 INTRODUCTION AND SUMMARY

The licensee (Northern States Power Company) has proposed modifications consisting of the addition of a safety/relief valve (SRV) blowdown control system at the Monticello nuclear plant to prevent any SRV from opening when there is an elevated water leg in the respective discharge line. A high water leg is formed immediately following SRV closure due to the vacuum caused by condensed steam in the discharge line. If the SRV reopens before the water leg returns to normal, the water clearing thrust loads on the SRV discharge line may exceed their design limit. The SRV blowdown control system is designed to ensure a minimum water leg clearing time (i.e., the time required for the vacuum breakers in the discharge lines to equalize the pressure in the discharge lines and the drywell) between any SRV closure and subsequent actuation. The minimum water leg clearing time (i.e., close to open duration for the three SRVs controlled by the blowdown control system) is 10 seconds.

The Monticello design included eight Target Rock SRVs. Three of these are automatic depressurization system (ADS) valves, three other valves are controlled by the blowdown control system (these three SRVs are referred to as low-low set valves), and the remaining two SRVs are mechanically (spring) actuated only. The SRV blowdown control system is functionally independent of the ADS. Previous SRV control systems reviewed by the staff for other plants monitor all SRVs for actuation, and upon actuation, automatically assign lower opening and closing setpoints to selected (low-low set) SRVs. These SRVs will remain open longer, and have a close-to-open duration long enough to allow the water leg created from the initial SRV opening to return to its normal level, thus reducing thrust loads from subsequent actuations to within their design limits. The Monticello blowdown control system only monitors the three low-low set valves (RV2-71E, G, and H) for actuation. However, the blowdown control system setpoints for the low-low set valves ensure that they will be the first SRVs to open and the last to close. Therefore, the remaining SRVs need not be monitored for actuation. The open and close setpoints for the low-low set valves coupled with a time delay (10 seconds) in the blowdown control system logic ensure that the water leg in the SRV discharge line has cleared prior to subsequent actuations. The delay between successive SRV actuations provided by the blowdown control system is considered a function required for safety.

The evaluation provided below in section 2.1 is the circuitry review of the SRV blowdown control system at Monticello, and section 2.2 is the transient and accident review.

2.0 EVALUATION

2.1 Circuitry

Each low-low set SRV will open when either of its two solenoids becomes energized. Power to the solenoids is controlled by the blowdown control system. Each solenoid and its associated logic is powered from a redundant Class 1E 125 V dc source. For either blowdown control system logic channel to energize its associated solenoid for the initial opening of a given low-low set SRV, reactor pressure must exceed the open setpoint for that SRV (as sensed by two separate pressure switches; i.e., a 2-out-of-2 energize to actuate logic), a reactor scram must have occurred (also a 2-out-of-2 logic), and the respective SRV control switch must be in the "AUTO" position. Annunciation is provided in the control room when a low-low set SRV control switch is not in the AUTO position, "BLOWDOWN CONTROL SRV NOT IN AUTO." The reactor scram interlock is provided to prevent inadvertent SRV actuations while at power. The scram signals are provided by relays in parallel with the backup scram solenoids which are energized by the reactor protection system when a condition requiring a reactor trip (scram) is sensed. Since the low-low set SRV open setpoints (1060, 1050, and 1040 psig for SRVs RV2-71E, G and H, respectively) are lower than the reactor high pressue scram setpoint (1075 psig), these valves will open when reactor pressure reaches 1075 psig. If reactor pressure is above the low-low set SRV open setpoints, but below 1075 psig when a scram occurs (i.e., a scram caused by other than reactor high pressure), the low-low set SRVs will open at the time of the scram. The mechanical (spring actuated) open setpoint for the remaining SRVs is 1108 psig. Thus, the low-low set SRVs will open first.

Actuation of a low-low set SRV is detected by four differential pressure switches located in each low-low set SRV discharge line (two switches for each blowdown control system logic channel). When the pressure differential between the discharge line and the drywell is 50 psid or greater (indicating that the SRV has opened) as sensed by either pressure switch in a given logic channel, its associated time delay relay becomes energized. Subsequent actuation of the SRV via the associated solenoid is prevented for at least 10 seconds after the time delay relay deenergizes (i.e., after the differential pressure between the discharge line and the drywell returns to, or below, 50 psid). The low-low set SRV close setpoints for valves RV2-71E, G, and H are 980, 970, and 960 psi, respectively. Thus, there is an 80 psi close to reopen window for the low-low set SRVs. The licensee has determined that the time required to repressurize to the open setpoints exceeds the time required for the 10 second time delay to time out following SRV closure. Two SRVs are required to perform the low-low set function. Three SRVs are controlled by the blowdown control system to allow for single failures.

Differential pressure switches have also been added to the discharge lines of the non low-low set SRVs. These switches provide SRV position indication (amber lights in the control room), "SRV OPEN" annunciation, and inputs to the plant computer. Position indication is provided for the low-low set SRVs from the differential pressure switches used in the blowdown control system. The SRV blowdown control system circuitry is Class 1E except for the amber lights, annunciation, and the computer inputs. Coil-contact separation is used to isolate the Class 1E circuits from the non-Class 1E circuits. Class 1E (indirect) indication of SRV status is provided at the SRV control switches via red and green status lights that indicate electrical demand (solenoid energized) and no electrical demand respectively. Annunciation "SRV BLOWDOWN CONTROL TROUBLE" is provided on loss of power and trip unit out of file or inoperative.

The blowdown control system is designed to allow testing of the time delay relays during power operation. Channel functional tests can also be performed at power for the reactor pressure instrument channels used to provide the low-low set SRV open and close setpoints and the SRV discharge line differential pressure channels and relays. Although the capability to test at power is provided, the licensee has not proposed technical specification surveillance requirements (e.g., channel functional tests and calibrations, etc.) or limiting conditions for operation for the blowdown control system. Proposed technical specifications should be submitted by the licensee for staff review and acceptance prior to SRV blowdown control system operation.

There are no operating bypasses or overrides associated with the SRV blowdown control system, nor is the system used to perform any control (non-safety) functions. Physical separation and electrical isolation is maintained between redundant portions of the blowdown control system logic. This system is designed to perform its function given any single electrical failure. In addition, no single failure in the electrical circuits could be found which would cause a spurious SRV actuation.

Based on our review, we have determined that the Monticello SRV blowdown control system is designed in accordance with the requirements of IEEE Standard 279-1971, and therefore, is acceptable. The Monticello Technical Specifications should be revised, however, to include surveillance for the blowdown control system prior to operation.

2.2 Transient and Accidents

The safety/relief valves (SRVs) provide overpressure protection to the reactor coolant pressure boundary. Overpressure transients may cause rapid cycling of SRVs which may result in excessive thrust and pressure loads to submerged structures, the torus shell and the safety/relief valve discharge line (SRVDL) in a BWR with a Mark I Containment.

Following an SRV closure, a water column is drawn into the SRVDL from the suppression pool (torus) due to condensation in the SRVDL. The water column will return to its normal water level when the vacuum breaker on the discharge line equalizes the pressure in the SRVDL and the drywell. However, if the SRV reopens before the water column recedes to normal level, the water-clearing thrust loads on the SRVDL may exceed the design limit. There is an additional potential for the drywell air drawn into the SRVDL through the vacuum breaker to become heated by the steam in the SRVDL. This could affect the torus loading if the warmer air can produce higher pressure air bubbles in the pool. To circumvent major structural modifications to accommodate the effects of these loads, a low-low setpoint logic design modification is proposed by the licensee.

Monticello is equipped with eight Target Rock three stage safety/relief valves. Three non-ADS SRVs are selected as LLS SRVs. The nominal opening/closing setpoints for all SRVs are 1108/1078 psig. The opening and closing setpoints for three LLS SRVs are 1060, 1050, 1040 psig and 980, 970, 960 psig, respectively.

The opening and closing setpoints for LLS SRVs are more widely separated than for normal SRV setpoints. Hence, the extent of reactor depressurization (blowdown) before reclosing an open SRV is increased when compared to the blowdown for normal SRV setpoint. Thus, more steam will be released each time a LLS SRV opens and more energy will be required for repressurization before a SRV reopens. This results in a longer blowdown, lowered reactor pressure and reduces subsequent actuations of SRVs.

The proposed design modification (LLS logic) is an automatic SRV control system. To initiate LLS logic, reactor pressure must exceed the opening setpoint of LLS SRV and a reactor scram must occur. These two signals are sensed by four separate pressure switches (i.e., 2-out-of-2 energize to actuate logic). In addition, SRV control switch must be in the "AUTO" position. Differential pressure switches are provided to the LLS SRV discharge lines. These pressure switches provide SRV position indication in the control room. These pressure switches sense the pressure differential between the drywell and SRV discharge lines. When the differential pressure between the drywell and SRV discharge line is below 50 psi, a ten second timer is actuated to ensure water leg clearing in the SRV discharge line (water leg clearing time is about 5.75 seconds) by preventing subsequent actuations for at least ten seconds.

GE performed an evaluation considering abnormal operational transients, design basis accidents and the anticipated transient without scram (ATWS) events to determine the impact of this design modification on overall plant safety margin.

The LLS logic will not have any adverse effects on anticipated operational transients because the limiting pressure and ΔCPRs occur early in the limiting transients before the reactor pressure response is affected by the opening and closing of the LLS SRVs.

2.3 Loss-of-Coolant-Accidents (LOCA)

The LOCA evaluation shows that the LLS logic has no effect on the limiting Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) because the rapid reactor depressurization precludes the actuation of LLS SRVs during the design basis accident.

The design change will have some possible effects on the small break LOCA. GE analysis shows that the proposed design change will tend to increase the small break peak cladding temperature (PCT) by a small amount. The highest calculated small break PCT with the LLS logic is about 1675°F. This is substantially less than the 2200°F PCT limit. Therefore, it is concluded that there will be no significant change in ECCS performance if a LLS logic is implemented.

2.4 Anticipated Transients Without Scram (ATWS)

For ATWS events, the LLS logic has no effects because the LLS logic would not affect the peak pressure or the suppression pool temperature.

We find this design modification (LLS logic) acceptable because it will not adversely affect plant performance or safety margin. Also this design modification is compatible with normal plant operation and other safety systems.

The staff requires that the Technical Specifications be revised to include the selected LLS setpoint changes.

This conclusion is based upon our review of the plant specific reports NEDC-24374 (1) and NSP-48-1103 (2) which indicates that the proposed design modification do not:

(1) Involve a significant increase in the probability or consequences of an accident previously evaluated;

(2) Create the possibility of an accident of a type different from any evaluated previously; or

(3) Involve a significant reduction in a margin of safety.

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References

(1) NEDC-24374, December 1981, General Electric Company, "Evaluation of Mark I S/RV Load Cases C3.1, C3.2 and C3.3 for the Monticello Nuclear Generating Plant."

(2) NSP-48-1103, Revision 1, May 1983, NUTECH Engineers, "System Description, SRV Blowdown Control System for Monticello Nuclear Generating Plant."