



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D. C. 20555

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION  
RELATED TO AMENDMENT NO. 57 TO FACILITY OPERATING LICENSE NO. DPR-22

NORTHERN STATES POWER COMPANY  
MONTICELLO NUCLEAR GENERATING PLANT

DOCKET NO. 50-263

1.0 INTRODUCTION

By letter dated March 1, 1988, Northern States Power Company (NSP or the licensee) proposed changes to Sections 3.4 and 4.4 of the Technical Specifications (TSs) appended to Facility Operating License No. DPR-22 for the Monticello Nuclear Generating Plant. The proposed changes would reflect an increased Boron-10 enrichment in the sodium pentaborate solution used for the Standby Liquid Control System (SLCS). The changes proposed conform with: (1) the technical bases proposed by NSP for meeting the Anticipated Transients Without Scram (ATWS) Rule as set forth in 10 CFR 50.62(c)(4), originally incorporated into Facility Operating License No. DPR-22 by Amendment No. 56; and (2) the technical bases upon which the exemption from the minimum pump flow rate requirement specified in 10 CFR 50.62(c)(4) was granted on December 11, 1987.

The specific TS changes proposed are summarized as follows:

- o Reduce the pump minimum flow rate in Paragraph 4.4.A.1 from 26 gpm to 24 gpm.
- o Add a sentence in Paragraph 4.4.A.1 which reads, "Comparison of the measured pump flow rate against equation 2 of paragraph 3.4.C.1 shall be made to demonstrate operability of the system in accordance with the ATWS Design Basis".
- o Add the words "indicated" and "measured" in the variable definitions contained in Paragraph 3.4.C.1.
- o Delete the sentence in Paragraph 4.4.C.1 which reads, "In addition, the boron enrichment shall be determined any time new chemicals are added to the liquid poison tank".
- o Replace Figure 3.4-1 which allows operation for B-10 enrichments greater than 39.6% with a new Figure 3.4-1 which allows operation for B-10 enrichments greater than 55.0%.

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- ° Revise the sentence in the bases which reads, "The described minimum system parameters (equivalent to 26 gpm, 13.7% concentration and 39.6 atom percent Boron-10 enrichment) will ensure an equivalent injection capability that meets the ATWS rule requirement," to read, "The described minimum system parameters (equivalent to 24 gpm, 10.7% concentration and 55 atom percent Boron-10 enrichment) will ensure an equivalent injection capability that meets the ATWS rule requirement".

## 2.0 DISCUSSION

The proposed changes were requested because, subsequent to the licensee's June 22, 1987, TS change request and the issuance of License Amendment No. 56 (December 11, 1987), it was learned that the vendor could supply pre-mixed sodium pentaborate certified to 55 atom percent Boron-10 enrichment in lieu of enriched boric acid which would be mixed on site with borax to form sodium pentaborate with a 39.6 atom percent Boron-10 enrichment. This approach offers a number of advantages. The additional enrichment enables the return of the required pump minimum flow rate to the original value of 24 gpm and still meet the ATWS Rule (10 CFR 50.62). It eliminates the possibility of error when mixing the boric acid and borax on site and allows removal of the requirement for mid-cycle enrichment checks when adding chemicals. Finally, when performing surveillance tests, less material is lost since the solution is at a lower concentration.

In addition, certain other changes were proposed to provide clarity to the plant operator. These changes were based on questions received during training of the operators on the TSs which incorporated the requirements of the ATWS Rule and the use of enriched boron.

Substantive changes that have been proposed to the TSs include a) decreasing the required pump flow rate from 26 to 24 gpm, b) incorporating a new Figure 3.4-1 which is based on 55 atom percent enriched boron, and c) deleting the requirement for mid-cycle boron enrichment surveillance when new chemicals are added.

The 24 gpm minimum pump flow requirement is a return to the flow rate contained in the TSs prior to implementation of the ATWS Rule. It had been raised to 26 gpm when it was planned to utilize a lower enriched sodium pentaborate solution (39.6 atom percent) to allow for the lowest possible solution concentration (13.7 wt percent) in meeting the ATWS Rule. With the use of a 55.0 atom percent sodium pentaborate solution, the solution concentration can be maintained as low as 10.7 wt percent with the minimum pump flow rate returned to 24 gpm and still meet the ATWS Rule. This restores the original margin between the design value of the SLCS pump flow rate and the minimum pump flow rate contained in the TSs.

The curves in Figure 3.4-1 provide the boundaries which define an area of operation that ensures the original design basis and the ATWS Rule are satisfied. The equation for the lefthand curve or boundary is as provided in the discussion below entitled, "Comparison with the original design basis for the SLCS." The lower boundary is provided by a straight line at 10.7 wt percent below which the requirements of the ATWS Rule are not met if a pump flow rate

of 24 gpm and boron enrichment of 55.0 atom percent or 2.78 times that naturally occurring are assumed.

Surveillance requirements would be deleted for verifying boron enrichment during mid-cycle addition of chemicals to the storage tank. These requirements are no longer necessary because rather than buying enriched boric acid which then needed to be mixed on site with borax to obtain sodium pentaborate, the licensee would procure pre-mixed and certified sodium pentaborate directly from the vendor. The once per cycle requirement to verify enrichment is therefore adequate to ensure continued high system reliability.

Those changes which are proposed to provide clarification include a) the addition of a sentence which states that when the monthly flow rate surveillance is performed, that it should be compared to the equation which defines the ATWS Design Basis for the SLCS, and b) the addition of the words "indicated" and "measured" in the definitions of the variables used in the calculations defined by the formulas.

#### Comparison with the original design basis for the SLCS

The original design objective of the SLCS was to provide the capability of bringing the reactor from full power to a cold, xenon-free shutdown assuming that none of the withdrawn control rods could be inserted. To meet this objective, the SLCS was designed to inject a quantity of boron which produces a concentration of 660 ppm of boron in the reactor in less than 125 minutes. In addition, a 25 percent boron concentration margin was added to account for possible imperfect mixing of the chemical solution in the reactor water and dilution from the water in the cooldown circuit. This resulted in the requirement to inject a quantity of boron which produces a concentration of 825 ppm of boron in the reactor in less than 125 minutes. With a sodium pentaborate solution with natural Boron-10 isotopic enrichment of 19.8 atom percent, a volume of 1400 gallons of solution having a 21.4 wt percent sodium pentaborate concentration was required to meet the shutdown requirement. At a boron concentration of 10.8 wt percent, a volume of solution equal to the maximum tank capacity of 2895 gallons was required. With a flow rate of 24 gpm, the contents of the tank could be pumped into the reactor vessel in less than 121 minutes.

According to the licensee, the proposed modified SLCS will utilize enriched boron and a flow rate value of 24 gpm. The decreased value for the flow rate returns to the value utilized in the TSs prior to the implementation of the ATWS Rule. The planned boron enrichment of the sodium pentaborate solution is a Boron-10 level of 55.0 atom percent or greater as compared to 19.8 atom percent (naturally occurring Boron-10). This is equivalent to an enrichment ratio of 2.78. With the enriched boron being utilized, the required boron concentration level (concentration of B-10 and B-11) can be reduced by the ratio of enrichment. The weight of sodium pentaborate necessary to meet the shutdown requirement as calculated by the licensee is as follows:

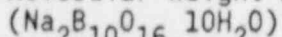
$$SB = (W)(BC/10^6)(1.25)(1/MW)(19.8/E) \text{ where;}$$

W = Weight of the Water to be Borated = 715,000 lbs  
 including; a) Reactor Coolant Weight = 521,440 lbs  
 (level 8 @ 70°F)  
 b) Reactor Recirculation Loops = 61,780 lbs  
 c) RHR Loops (in shutdown cooling mode) =  
 130,000 lbs

BC = Boron Concentration Level = 660 ppm

1.25 = 25 percent to account for imperfect mixing

MW = Molecular Weight Ratio of boron to sodium pentaborate



SB = Weight of Sodium Pentaborate (lbs)

E = Boron Enrichment (atom percent)

$$(1/MW) = \frac{482.1 + 10(11.01 - E/100)}{10(11.01 - E/100)} = 1 + \frac{4821}{1101-E}$$

$$SB = (715,000)(660/10^6)(1.25) \left(1 + \frac{4821}{1101-E}\right)(19.8/E)$$

This equation may be used to calculate the indicated tank volume which the operator reads in the control room. The minimum indicated tank volume (gal) necessary to meet the original design basis would be calculated as follows:

$$\text{Volume} = \frac{(SB)(VC)}{(WB)(SG^{SB})(C/100)} + 128 \text{ gal}^*$$

where;

SB = Weight of Sodium Pentaborate (lbs)

VC = Volume Conversion = 7.481 gal/ft<sup>3</sup>

WB = Density of Water = 62.00 lbs/ft<sup>3</sup> at 100°F

SG<sup>SB</sup> = Specific Gravity of Sodium Pentaborate - (0.0051xC) + 0.998

C = Concentration of Sodium Pentaborate (wt percent)

\* To account for instrument inaccuracies (100 gal on the wide range 28 gal on the narrow range) an additional 128 gallons is added.

Substituting in for "SB" using the above equation and multiplying the constants together:

$$\text{Volume} = \frac{(71.18) \left(1 + \frac{4821}{1101-E}\right) (19.8/E) (100/C)}{((0.0051 \times C) + 0.998)} + 128 \text{ gal}$$

This yields a minimum indicated value of 1404.2 gallons of solution required at 10.7 wt percent is necessary to meet the original design basis with an enrichment of 55.0 atom percent. With a minimum pump flow rate value of 24 gpm, the solution necessary to bring the reactor to shutdown will be pumped in under 59 minutes.

The operator will shut the SLCS pump off at an indicated volume of 0 gallons. An indicated volume of 0 gallons results in an actual volume remaining in the tank of 335 gallons. This 335 gallons represents 225 gallons for that unusable portion of the tank volume below the suction nozzle of the pump and

100 gallons for the wide range instrument inaccuracy which is necessary to prevent pump cavitation should the instrumentation read higher than the actual level.

#### Comparison with the ATWS Rule

To comply with the ATWS Rule, the licensee stated that a higher rate of boron injection is required compared with that required under the original design basis. This rate must be equivalent to 86 gpm of sodium pentaborate at a 13 wt percent concentration and natural Boron-10 enrichment for a 251-inch reactor vessel. Monticello has a 206-inch vessel. The method of normalizing the required boron injection for a 251-inch diameter vessel to the 206-inch diameter Monticello vessel is consistent with the method approved by the Commission in its letter dated December 11, 1987, granting the licensee an exemption from the requirement of 10 CFR 50.62(c)(4) relative to minimum pump flow rate. In Generic Letter 85-03, "Clarification of Equivalent Control Capacity for Standby Liquid Control Systems", dated January 28, 1985, the Commission provided clarification of equivalent control capacity as follows:

- a) The "equivalent in control capacity" wording in 10 CFR 50.62(c)(4) was chosen to allow flexibility in the implementation of the requirement. For example, the equivalence can be obtained by increasing flow rate, boron concentration, or boron enrichment.
- b) The 86 gallons per minute and 13 wt percent sodium pentaborate were values used in General Electric Topical Report, NEDE-24222, "Assessment of BWR Mitigation of ATWS, Volumes I and II", December 1979, for BWR/4, BWR/5 and BWR/6 plants with a 251-inch vessel inside diameter. The fact that different values would be equivalent for smaller plants was recognized in NEDE-24222.

Per NEDE-24222, pp 2-15, the flow rates were normalized from a 251-inch diameter vessel plant to a 218-inch diameter vessel plant, i.e., the 66 gpm control liquid injection rate in a 218 is equivalent to 86 gpm in a 251 to bound the analysis.

- c) The important parameters to consider in establishing equivalence are vessel boron concentration required to achieve shutdown and the time required to achieve that vessel boron concentration. The minimally acceptable system should show an equivalence in the parameters to the 251-inch diameter vessel studied in NEDE-24222.

The equivalency requirements can be demonstrated if the following relationship is shown to be true:

$$(Q/86 \text{ gpm}) (M_{251}/M) (C/13 \text{ wt percent}) (E/19.8 \text{ atom percent}) \geq 1$$

where the plant-specific parameters are defined as:

Q = minimum SLCS flow rate (one or two pump operation as appropriate), gpm.

M = mass of water in the reactor vessel and recirculation system at the hot rated conditions, lbs.

C = minimum sodium pentaborate solution concentration, wt percent.

E = minimum expected Boron-10 isotope enrichment (19.8 atom percent for natural boron), atom percent.

The value of  $M_{251}$  (the mass of the water in the reactor vessel and recirculation system at rated conditions in the reference plant) is 628,300 lbs for a BWR 3/4. This value was calculated by the licensee based on rated temperature, rated void content, normal water level, control rods fully withdrawn, expected minimum vessel dimensions, and nominal vessel internals dimensions. The plant specific values chosen by the licensee for Monticello, which are reflected in the proposed TS changes, are a flow rate (Q) of 24 gpm, a boron concentration (C) of 10.7 wt percent and a boron enrichment (E) of 55.0 atom percent. The mass of water in the reactor vessel and recirculation system at the hot rated conditions (M) for Monticello is 400,000 lbs. Using the Monticello specific values yields:

$$(24/86) (628,300/400,000) (10.7/13) (55.0/19.8) = 1.0022$$

### 3.0 EVALUATION

We have evaluated the acceptability of the proposed TS changes and the licensee's calculations as discussed above, the technical justification provided in support of the proposed changes, the original technical bases for effectuating License Amendment No. 56, and the basis for the exemption granted to 10 CFR 50.62(c)(4) and agree with the licensee's findings and determinations that the proposed changes will have no effect on the physical operation of the SLCS. The sodium pentaborate solution to be utilized has similar properties to the solution already in use and will pose no unknown factors to plant operating personnel; i.e., Boron-10 is a stable isotope and no degradation of the enrichment level over time is expected, and its other solution characteristics (such as concentration) are within the ranges which have been utilized in the past. The changes will in no way detract from the ability of the SLCS to meet its original design basis, nor its ability to meet the requirements of the ATWS Rule. As was documented in the exemption to 10 CFR 50.52(c)(4) granted for the Monticello facility on December 11, 1987, a decrease in minimum pump flow rate commensurate with an increase in Boron-10 enrichment is acceptable in that this will continue to maintain the ATWS Rule goal of reducing the time necessary to achieve cold shutdown in the event of an accident. Finally, the proposed TS changes for the SLCS at Monticello constitute an added safety margin due to the utilization of a pre-mixed and vendor-certified sodium pentaborate solution precluding the possibility of an accident that could occur by mixing the solution on site. As such, we also agree with the licensee that there is no longer a need for mid-cycle surveillance of the sodium pentaborate solution.

In view of these findings and determinations, we consider the proposed TS changes to be acceptable.

### 4.0 ENVIRONMENTAL CONSIDERATION

This amendment involves changes in the installation or use of a facility component located within the restricted areas as defined in 10 CFR Part 20 and changes in a surveillance requirement. We have determined that the

amendment involves no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously published a proposed finding that this amendment involves no significant hazards consideration and there has been no public comment on such finding. Accordingly, this amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR §51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of this amendment.

#### 5.0 CONCLUSION

We have concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner; and (2) such activities will be conducted in compliance with the Commission's regulations, and the issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public.

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Dated: September 23, 1988