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

# SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

## SUPPORTING AMENDMENT NO. 29 TO FACILITY OPERATING

## LICENSE NO. DPR-22

## NORTHERN STATES POWER COMPANY

## MONTICELLO NUCLEAR GENERATING PLANT

## DOCKET NO. 50-263

## 1.0 INTRODUCTION

The Northern States Power Company (NSP/the licensee) by letter dated May 30, 1984, requested changes to implement Extended Load Line Limit Analysis (ELLLA) and approval of a program of Average Power Range Monitor/ Rod Block Monitor Technical Specifications (ARTS) improvements for the Monticello Nuclear Generating Plant. The ELLLA involves the expansion of the normal operating region on the power/flow map, while the ARTS improvements involve:

1. Elimination of Average Power Range Monitor (APRM) trip setdown requirements;
2. Change from flow to power referenced setpoints for the Rod Block Monitor (RBM);
3. Power and flow dependent limits on Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) and Minimum Critical Power Ratio (MCPR) to support 1 and 2;
4. Reconfiguration of Local Power Range Monitors (LPRM), modifying normalization procedure, and new trip logic in the RBM;
5. Providing a definition of a limiting rod pattern for RBM bypass decisions; and
6. An altered rod withdrawal error at power analysis.

In addition to the Technical Specification (and corresponding bases) changes for ELLLA and ARTS, the licensee has requested, as an administrative change, the removal of the APRM Rod Block from Section 2 of the Technical Specifications.

In support of its request the licensee has submitted, along with a description and evaluation of the changes, two documents: (1) NEDC-30515, March 1984, describing ELLLA for Monticello and (2) NEDC-30492-P, April 1984 describing the ARTS program for Monticello.

The ARTS program is designed to increase plant operating efficiency, reduce the need for manual adjustment to the APRM trip setpoints when operating at less than rated core power/core flow (new operating limits have been introduced to accomplish this), improve plant instrumentation responses and accuracy, and improve the man/machine interface involved in plant operation.

## 2.0 EVALUATION

The staff, in the past, has reviewed several other ELLLA reviews (e.g., Millstone in 1981) and there was a recent review of both ELLLA and ARTS changes for the Edwin I. Hatch Plant Units 1 and 2. The Hatch changes and submittal were essentially identical to the licensee's submittal for Monticello, differing only in a few numerical details related to the specific characteristics of the reactors and the existing Technical Specifications. The Hatch change request was approved, and the reviews were documented in the staff Safety Evaluation for Amendment No. 39 to Operating License No. NPF-5.

The staff review for Hatch contained a description of the design intent of the ELLLA and ARTS program and the changes to elements of the instrument systems, modes of reactor operation, setpoint modes and analyses performed to provide setpoint values, and the bases for the various changes. These proposed changes are largely generic in scope and the discussion on the Hatch review covers the generic aspects. Thus these more extended descriptions will not be repeated here, although the same material has been reexamined for this review. A summary description of the system and changes will be given and comments will be provided where quantitative aspects specific to Monticello are involved.

### 2.1 ELLLA

The Extended Load Line Limit Analysis provides a basis for normal reactor operation in the region of the power/flow map above the 100% power/100% flow load line (presently considered the limit) and bounded by the 108% APRM rod block line and the rated (100%) power line. The slope of the APRM rod block line is changed to provide a block at no greater than 0.58 W + 50% power (where W is recirculation drive flow percent). This permits operation at 100 percent power down to 87 percent flow. Operation within this extended region permits improved power ascension capability. To justify operation within this region the licensee has examined limiting transient events and accidents at appropriate extremes of the ELLLA region.

Relevant considerations in the review of ELLLA for Monticello include:

1. The change in slope of the rod block line has been previously reviewed and approved (see, for example, the Safety Evaluation for Amendment No. 59 to the Operating License for Dresden 2) and is generically applicable.

2. Transient analyses done within the ELLLA region are still limiting at 100%/100% power/flow.

3. The flow effect on LOCA analysis (generically) has been previously reviewed and approved for operation within the region (see letter from D. Eisenhut, NRC, to R. Gridley, GE, May 19, 1978).

4. The transient and accident analyses done for ARTS covered operation within the ELLLA region.

5. The power/flow point for stability analysis remains the same as for the previously reviewed standard reload. Results show the maximum core stability decay ratio is 0.63. This is acceptable and compares favorably to values for several operating reactors previously approved. In addition, Monticello presently does not have approval to operate permanently in single loop operation (SLO) where the core decay ratio can approach its maximum value.

It is thus concluded that changes in core behavior caused by the extended operating range have been acceptably accounted for.

2.2 The APRM Changes

APRM channels read selected LPRMs, the sum of which are normalized to be proportional to core power. The APRM signals are presently compared to the biased scram and rod block settings. Current Monticello Technical Specifications require the flow biased setpoints to be lowered (setdown) if, during part power operation, the core maximum fraction of limiting power density (CMFLPD) exceeds the fraction of rated power. With ARTS the setdown requirement is removed. In its place there are to be (Technical Specification required) power and flow dependent limits on MAPLHGR and MCPR. In order to obtain the multipliers (MAPFAC and $K_p$) used in this system to modify the full power/full flow MAPLHGR and MCPR, analyses were done (without setdown) covering transients over a full range of power/flow conditions. Also the LOCA analyses were reexamined. The primary controlling transients were feedwater control failure and flow runout events. The analysis results were used to define limiting MAPLHGR and MCPR as a function of power and flow. Previous LOCA analyses had assumed operation within the 0.58 W + 50% rod block line, but with setdown. Relevant LOCA analyses were done and indicate that a 0.94 MAPFAC is required below 80 percent power (below 90 percent if the rated MCPR is less than 1.28).

The LOCA and transient results are combined to produce four sets of curves defining the MAPFAC, $K_p$ and $MCPR_F$ given in the Topical Report (NEDC-30492-P) and are referenced in the Monticello Technical Specifications.

Approved methods were used to perform the analyses. The analysis process was the same as for the Hatch ARTS program. We conclude that deletion of the APRM setdown requirement is acceptable when it is replaced by the power and flow dependent operating limits described above.

2.3 The RBM Changes

For changes to the RBM, the submittal by the licensee for Monticello is identical to that for Hatch, including changes to the instrumentation

system and the new approaches, analyses and setpoints. These changes were reviewed and approved in the previously mentioned Hatch Safety Evaluations. The following summarizes the RBM changes described in more detail in those Safety Evaluations.

1. The RBM is used to block rod motion to prevent exceeding MCPR limits during control rod withdrawal at power. For ARTS there is a change in the assignment of LPRMs to RBM channels. This change provides better and more uniform sensitivity to rod motion.

2. ARTS has a more direct trip logic including a calibration to a fixed reference upon rod selection rather than calibration to the APRM, and an upscale trip level which is a step function of core power rather than a flow biased trip. A downscale trip is still used to detect abnormally low signals.

3. The changes to the system require a reevaluation of the rod withdrawal event and new analyses to provide setpoints for the system. The previous deterministic analysis is replaced with a statistical analysis using a large number of calculations of various operating states and giving results valid for all Monticello cores using GE fuel up to type P8X8R. Currently approved methods were used in the calculations. The calculations give, as a function of RBM trip setting, values of an initial MCPR which assure that 95 percent of — withdrawal errors do not violate the MCPR safety limit (1.07) with a 95 percent confidence level. This was used to select setpoints for the RBM, chosen with respect to the other ARTS APRM limits so that the withdrawal event is not limiting. The setpoints (as used for analyses) for power intervals of 25-65, 65-85 and 85-100 power are 118, 112 and 108 percent of the reference signal respectively.

4. Calculations were done to examine the sensitivity of the results for core periphery rods (with fewer LPRM strings) and for LPRM failures (up to a 30 percent failure rate). The results indicated that the setpoints were suitable.

5. An analysis of the affects of filters and time delays in the system was made. The above analyses assumed no filters. Use of filters will require a reduction of setpoints, and values for adjustments required, if used, are given in NEDC-30492-P. A value of 2.0 seconds delay in the system was used in the analysis and no greater value is permitted. This value is in the Technical Specifications. The time delay was discussed in the our Safety Evaluation for Hatch.

6. The data base described above has been used to determine operating limits MCPRs such that no rod withdrawal error could lead to exceeding limits. Two MCPR values, defined for below 90 percent power and for above 90 percent power, are 1.40 and 1.70 respectively. When the operating MCPR is below these values the plant is on a "limiting control rod pattern" and the RBM system must be operable. When the operating MCPR is above these values, bypass is allowed.

We have reviewed these changes and analyses for the RBM and have concluded, as was the case in the previous ARTS review for Hatch, that the instrumentation changes, analyses, methods used, criteria and setpoints are acceptable.

2.4 Electrical Instrumentation and Control

The RBM system is designed to automatically detect and block control rod withdrawal that could violate Technical Specification safety limits during a single control rod withdrawal error (RWE) transient. It is assumed that the core is operated in compliance with plant Technical Specifications before the RWE event. There are two RBM channels, either of which can initiate a rod block (i.e., prevent control rod withdrawal). The RBM channels are power from the Reactor Protection System (RPS) buses (RBM channel A is powered from RPS bus A, and RBM channel B is powered from RPS bus B). Although the RBM system is not safety related, separation is provided between the RBM channels to allow for single failures, and to allow one channel to be bypassed at a time. Both RBM channels are operable when the switch is placed in the center (normal) position. Both local and remote indication of a RBM channel bypass are provided via indicator lights. The licensee has stated that implementation of the ARTS program will not compromise the redundancy provided between the RBM channels, and that isolation will be maintained between the RBM system and safety related circuits consistent with the existing design. The RBM output functions (i.e., recorders located on the reactor operator's console, local meters, trip units, and the on-line computer) will remain unchanged, although in some cases the signals used for these functions have been modified. The hardware changes involved in the ARTS modification include new model printed circuit (PC) cards, relays, relay sockets, mounting hardware, and wiring.

Upon selecting a control rod for movement, each RBM channel automatically computes the average of all assigned and unbypassed local power range monitor channels. The average signal is then filtered (to reduce signal noise), delayed to allow the signal to stabilize (to reach its maximum/equilibrium value), and then amplified to read the same as a fixed reference signal. This process (referred to as the RBM null sequence) is reinitiated each time a new rod is selected for movement. Control rod motion is blocked during the null sequence. Each RBM channel then compares the calibrated (nulled) signal to an automatically selected preset rod block alarm/trip setpoint (one of three power biased upscale trip setpoints is selected dependent upon the current reactor power level). The trip level is selected based on the magnitude of a reference APRM. If the local neutron flux level increases to the upscale trip setpoint, further control rod withdrawal is blocked, thus limiting the change (increase) in local power. Thus, the ARTS modification to the RBM trip logic replaces the standard RBM flow biased trips. This modification will be implemented by changes to the PC card electronics (averaging cards, null sequence cards, RBM setpoint cards, and quad trip cards).

It should be noted that an adjustable time delay ($t_d2$, 1 to 50 seconds + 0.5 seconds) has been added to delay the calibrated (nulled) average local neutron flux signal to the RBM trip logic. The purpose of this delay is to allow minimum rod movements despite abnormally high signal noise not removed by filtering. The Monticello Technical Specifications require that $t_d2$ be set at less than or equal to 2 seconds. The licensee has provided analyses which show that delays of 2 seconds or less are short enough to limit rod movement well below that which could cause a thermal limits violation. However, if this time delay is greater than 2 seconds, the associated RBM channel is considered to be bypassed since the analyses did not consider time delays in excess of this value. The licensee has stated that testing and calibration of the time delay $t_d2$ (as well as the other RBM time delay, filter, and trip setpoints) will be performed quarterly as part of the RBM system calibration procedure. General Electric Company report NEDC-30492-P, dated April 1984, submitted by the licensee in support of the ARTS modification, states that time delay $t_d2$ shall only be set above the minimum value as a means of bypassing the RBM. The staff's position is that manual adjustment of the $t_d2$ setpoint as a means of bypassing a RBM channel in lieu of using the existing RBM channel bypass switch (which provides automatic indication of the bypass condition) is not acceptable and should not be permitted. The licensee has, however, stated that only the RBM bypass switch will be used to effect a RBM channel bypass.

Other RBM trip functions include too few LPRM inputs (either inoperative or bypassed), downscale (RBM signal abnormally low), and instrument inoperative (e.g., calibrate-operate switch is not in operate position, and RBM equipment interlocks such as module removed and failure to null to the reference signal). The licensee has stated that the response time and accuracy (including drift) of the new RBM circuitry either equals or exceeds that of the existing design. All rod blocks are alarmed. The upscale rod block can only be reset by deselecting the rod, and selecting another rod for movement. Reselection will result in a recalibration to the reference signal. Locally mounted color coded lights are provided to indicate the type of rod block (upscale - amber, instrument inoperative and downscale - white).

The RBM system is required to be operable whenever a limiting rod pattern exists. A limiting rod pattern exists when any control rod in the core would result in violation of the safety limit MCPR if it were fully withdrawn. During operation with a limiting rod pattern, both RBM channels should be operable. If only one RBM channel is operable, an instrument functional test of the operable (unbypassed) channel must be performed prior to withdrawal of any control rods. If the inoperable channel is not restored within 24 hours, then all control rod withdrawal shall be blocked. If both RBM channels are inoperable, then all control rod withdrawal shall be blocked immediately.

An instrument functional test is performed on each RBM channel monthly. This test is defined by the Monticello Technical Specifications as "the

injection of a simulated signal into the instrument (not primary sensor) to verify the proper instrument channel response, alarm and/or initiating action." The licensee has proposed to delete a Technical Specification requirement to perform this test prior to withdrawal of control rods when the plant is operating on a limiting rod pattern and daily thereafter (this testing is currently required in addition to the monthly testing). The BWR Standard Technical Specifications (STS) also require that each RBM channel be demonstrated to be operable by performing a channel functional test prior to control rod withdrawal when the reactor is operating on a limiting rod pattern. The STS do not require testing daily thereafter. Prior to implementation of the ARTS program, a limiting rod pattern was determined based on the margin between the operating minimum critical power ratio and the safety limit MCPR. Because of the large margin between these two values inherent in the Monticello design, the reactor was very rarely operated on a limiting rod pattern. Therefore, the requirement to perform an instrument functional test prior to control rod withdrawal when operating on a limiting rod pattern does not result in additional RBM testing above the normally scheduled periodic (monthly) surveillance.

Implementation of the ARTS program includes a new definition of a limiting control rod pattern. Specifically, a limiting rod pattern exists whenever thermal power is below 90% of rated and the MCPR is less than 1.70, or thermal power is 90% of rated or above and the MCPR is less than 1.40. Because this new definition is more conservative, the reactor will be operated on a limiting rod pattern more frequently (although operation in this region is still rare), and the RBM will be required to be operable a greater portion of the time. However, margins to fuel integrity limits following implementation of the ARTS program will be equal to or larger than those in existence prior to the ARTS program. The requirement to perform an instrument functional test prior to withdrawal of control rods when in a limiting rod pattern could result in unnecessary RBM testing (i.e., testing in excess of that required by the STS), and excessive testing during startup if the reactor repeatedly enters and returns from a limiting rod pattern condition. The staff believes that deleting the requirement from the Technical Specifications as requested by the licensee will result in surveillance test frequencies more consistent with the Standard Technical Specifications.

In addition, those conditions which would be expected to result in failure of a RBM channel (e.g., loss of power, failure to null, card out of file, instrument left in the test mode, etc.) are annunciated in the control room. These indications of RBM inoperability coupled with RBM periodic surveillance (i.e., monthly instrument functional tests and quarterly calibrations) are judged by the staff to be sufficient to ensure RBM operability during a limiting rod pattern. In order for a rod withdrawal error to result in violation of the safety limit MCPR, a limiting rod pattern must exist, both RBM channels must be failed and undetected, and the operator must make a gross withdrawal error (i.e., the rod must be withdrawn many notches as opposed to a single notch, the typical increment of rod movement during power operation, and indications of approaching the

safety limit MCPR must be ignored). Furthermore, the licensee has provided information demonstrating the high reliability of the RBM system.

For the reasons listed above, the staff finds the Monticello Technical Specification requirements for RBM system operability and the associated Limiting Conditions for Operation (LCOs) to be acceptable. It should be noted that the operators are responsible for determining whether a limiting rod pattern exists (and therefore, for determining RBM system operability requirements) prior to control rod withdrawal in accordance with plant operating procedures. The staff has found this to be acceptable. The APRM and RBM instrument surveillance requirements (i.e., instrument functional tests and calibrations) have not changed as a result of implementation of the ARTS improvement program.

2.5 Technical Specification Changes

Implementation of the ELLLA and ARTS operations requires revisions to the Technical Specifications. The licensee has requested revisions to accomplish the necessary change. They include:

1. For ELLLA (item 2 of Exhibit A of the submittal), change the equations for APRM scram and rod block to 0.58 W + 62% and 0.58 W + 50% to permit operation within the ELLLA domain.

2. For ARTS APRM setdown removal (item 1 of Exhibit A), eliminate setdown requirement and associated definitions, and add new restrictions on MCPRs and MAPLHGRs as a function of core power and flow. The restrictions are incorporated by reference to figures 3-2, 3-3, 3-4 and 3-5 of NEDC-30492-P. (It should be noted that the original NEDC-30492-P has a typographical error in figure 3-5. MAPMULT in the box should refer to 80% rather than 90%.)

3. For ARTS RBM, change RBM flow biased trip equation to power dependent setpoints. The setpoint values requested (105, 109 and 115 rather than 108, 112, 118 as previously discussed) correspond to the nominal settings when using the RBM filter. A delay time of less than 2.0 seconds is specified. The "limiting control rod pattern" is specified as discussed above.

4. Also included is the elimination of the APRM rod block from Section 2 (Limiting Safety System Systems) of the Specifications. This block is not used in safety analyses and does not belong as a safety system setting. More recent Technical Specifications do not have it in Section 2. The block is discussed in Section 3.

5. The bases for various Technical Specifications have been modified to account for the above changes.

Our review of these Technical Specification changes indicates that they are appropriate to carry out the programs that have been discussed.

Based on our review, discussed above, we conclude that the proposed ELLLA and ARTS programs are acceptable for use in Monticello and that the supporting documents, NEDC-30515 and NEDC-30492-P, are acceptable references for Technical Specification changes needed to implement the programs. We thus conclude that the requested Technical Specifications changes are acceptable. The revised operating limits and procedures do not result in reductions to safety margins relative to current values.

## 3.0 ENVIRONMENTAL CONSIDERATIONS

The Notice of Environmental Assessment and Finding of No Significant Impact was published in the Federal Register on November 16, 1984 (49 FR 45512).

## 4.0 CONCLUSIONS

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 the 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: November 16, 1984