FLORIDA POWER CORPORATION
CRYSTAL RIVER UNIT 3
DOCKET NO. 50-302/LICENSE NO. DPR-72
REQUEST NO. 195, REVISION 0
CONTROL ROD POSITION INDICATION

LICENSE DOCUMENT INVOLVED: Technical Specifications

PORTIONS: Specification 3.1.3.3, Page 3/4 1-21
Specification 4.1.3.3, Page 3/4 1-22
Specification Bases 3/4.1.3, Page B 3/4 1-4

DESCRIPTION OF REQUEST:

This change request deletes the individual control rod position accuracy requirement from Crystal River Unit 3 (CR-3) Technical Specification 3.1.3.3. A description of what constitutes an operable position indication channel has been added to the associated Bases. The request further defines a reed switch position indicator channel for the purposes of this specification. New acceptance criteria are also provided in Specification 4.1.3.3 for determining agreement between reed switch and pulse stepping indicator channels.

REASON FOR REQUEST:

Proposed operability requirements for reed switch and relative position indication channels are based upon their accuracy relative to control rod group average position. The change from an accuracy requirement based upon individual rod position to one based upon group average and the proposed acceptance criteria for determining reed switch and pulse stepping indicator channel agreement provide a Technical Specification limitation with a reconstitutable basis tied to the CR-3 safety analysis. The definition of a reed switch position indication channel is an aid for operating personnel using the specification. This enhancement was considered necessary given the significant change to the new reed switch position indicator channel design and the potential for conflicting interpretations given the current wording of the specification.

EVALUATION OF REQUEST:

Two methods of rod position indication are provided for the control rod drive system; the reed switch or absolute position indication (API) and the pulse stepping or relative position indication (RPI). The absolute position transducer consists of a series of magnetically operated reed switches mounted in a tube parallel to the control rod drive motor (CRDM) motor tube extension. Switch contacts close when a permanent magnet mounted on the upper end of the control rod assembly leadscrew extension comes near. As the lead screw (and the control rod assembly) moves, the switches operate sequentially, producing an analog voltage proportional to the position.

The APIs currently installed at CR-3 are the Type A API, manufactured by the Diamond Power Specialty Corporation (a subsidiary of Babcock & Wilcox). This position transducer is a voltage divider circuit made up of 48 resistors of equal value connected in series. A 5-volt DC power supply is connected across the resistors such that 5 volts is present at the top end of the circuit. This represents the full-out position for the control rod. Zero volts is present at the bottom end of the circuit. This represents the full-in position of the control rod. The Type A API is designed such that either one or two reed switches are closed at any one time.

During the upcoming Refuel 8 outage, Type A-R4C APIs will be installed at CR-3. These API are also manufactured by Diamond Power Supply Corporation and they work on the same basic principle of a magnet, reed switches, and resistor network as the Type A API. However, the Type A-R4C position transducer has two parallel sets of voltage divider circuits made up of 36 resistors each connected in series. The reed switches making up each circuit are offset such that the switches for channel A are staggered with the switches for channel B. This provides two output signals for position indication within each reed switch position indicator channel. The Type A-R4C API is designed such that either two or three reed switches are closed in the vicinity of the magnet. Thus, the Type A-R4C API provides redundant output signals for individual rod position indication.

Another feature of the Type A-R4C API are the isolation switches mounted on the API amplifier card. These switches provide for isolation of an output signal in the event a reed switch closes and fails to open when the magnet is moved away. Isolating the output signal (sub-channel) containing the faulted reed switch allows for continued operation of the API for that rod. With one sub-channel isolated, the API for the given rod operates at a reduced accuracy but this has been considered in the error analysis supporting this change. The ability of the API to continue to perform its' technical-specification function with one sub-channel inoperable is the basis for the reed switch position indication channel definition provided as a footnote to the specification.

The operating benefits of the Type A-R4C circuit are best represented by its ability to compensate for component failure. Operating history for the Type A API demonstrates that the major component failure is the failure of the reed switch to function properly (fails to open or fails to close as required). The design of the Type A API does not provide any compensation for a failed reed switch. Either type of failure of one reed switch out of the 48 present in each API circuit requires the change out of the API assembly and this repair cannot be performed with the plant on-line. The increased number of switch overlap enables the Type A-R4C to function with a faulty switch (open) without losing its output signal. If a switch fails closed, that parallel circuit can be isolated and the API will continue to function, albeit at reduced accuracy. Thus, the A-R4C will allow for continued unrestricted plant operation with a faulty component.

During preparation of the modification package to replace the Type A with Type A-R4C indicators, FPC could not retrieve a specific reference for the basis of the ±2% allowable error on control rod position. Preliminary drafts of the original B&W Standard Technical Specification (1/22/75) only required operability of the absolute and relative position indicator channels. A later version of the draft Standard Technical Specifications (STS) required the position indicator channels to be operable and capable of determining control rod position within ±( )%. The loop accuracy was to be determined later. Over some time frame, 2% became the allowed value. A similar situation existed for the surveillance requirement acceptance criteria. The basis for RPI and API agreement within ±2% could not be located, but was also included in later versions of the STS. The 2% values are reflected in current CR-3 Technical Specifications which were developed based upon a later revision of the STS. Since no reconstitutable basis could be found for these two values, FPC had B&W Nuclear Services (B&WNS) undertake an extensive review effort to determine correct values for the specification. This effort considered the uses and applications of control rod position indication both within technical specifications and the safety analysis.

Regulating rod, safety rod, and axial power shaping rod positions must be known in order to verify the core is operating within the group sequence, overlap and design peaking limits and with minimum shutdown capability (insertion limits). The rod positions must also be known in order to verify that alignment limits are preserved. These limits are ensured during power operation by the following technical specifications and their associated surveillance requirements (SR).

- 3.1.3.1 Group Height - Safety and Regulating Rods
- 3.1.3.2 Group Height - Axial Power Shaping Rods
- 3.1.3.3 Position Indicator Channels
- 3.1.3.5 Safety Rod Insertion Limits
- 3.1.3.6 Regulating Rod Insertion limits
- 3.1.3.7 Rod Program
- 3.1.3.9 Axial Power Shaping Rod Insertion Limits

The safety analysis is not dependent on control rod motion or position indication (other than to assume reactor trip for certain transients). Control rod position is only important to limit the initial conditions of the accident and there are several FSAR safety analysis accidents that could be affected by an inability to measure control rod position. The analyses for the startup and rod withdrawal accidents depend on control rod <u>worth</u> assumptions, rather than control rod position indication. Cycle specific control rod group insertion limits preserve the initial condition assumptions for the loss of coolant flow accident, rod ejection accident, loss of coolant accident, and the minimum shutdown margin requirement.

The core reload analysis is the vehicle for ensuring the above safety analysis assumptions reflected by the cycle-specific control rod position limit curves are preserved. The methodology for the reload analysis has been previously reviewed and approved by the NRC. B&W has always applied a 1.5% uncertainty to the rod group average position as part of this reload maneuvering analysis. The 1.5% uncertainty accounts for the deviation of the indicated group average position from the true average position. This value forms the basis for the proposed operability requirements due to its use in the safety analysis.

The limiting condition for operation (LCO) continues to require the API and RPI for each rod to be operable, but does not specify an accuracy term. The discussion of position indicator channel operability (the accuracy term) has been relocated to the Bases for the Technical Specification. This approach provides a more meaningful Technical Specification limit for operating personnel and is consistent with the NRC's Interim Policy Statement on Technical Specification Improvement.

During normal plant operations, the RPI is reset as necessary to match the API. The API is used as the known position of the control rod assembly (CRA). This known position has an inaccuracy associated with the API instrument string. In addition, the RPI has an inherent string inaccuracy. Part of the RPI inaccuracy is the amount by which the RPI reading can deviate from the API reading before a re-calibration is necessary. The maximum amount of this deviation is established by the surveillance requirement. The LCO then, reflects both the hardware inaccuracy and the allowed deviation between RPI and API. When used in conjunction with the SR agreement criteria, it preserves the 1.5% rod group index uncertainty used in the reload analysis. In other words, the API will always meet the LCO, and its accuracy is only a small fraction of the uncertainty (unless two or more consecutive reed switches fail. In this case, there would be a large indication of rod asymmetry indicated by rod symmetry alarms.) The RPI uncertainty, including drift and calibration errors, must be assured to always meet the LCO. This is accomplished by limiting the amount RPI can deviate from API.

A channel error analysis was performed to justify the change proposed to the LCO and to determine the correct agreement criteria for the surveillance requirement. The Type A API, Type A-R4C API, and the RPI loop accuracies were calculated using the Monte Carlo simulation method (probabilistic combination of mechanical and electrical errors). The results of the evaluation are contained in BWNS Document 51-1178835-01 "CRD Type A-R4C Position Indication Evaluation."

The values developed for the surveillance requirement (4.1.3.3) are derived from appropriate combinations of the results of API/RPI difference observation and control rod bank rod index uncertainty for one, two and three banks of regulating rods. Because the API/RPI difference observation is for a single rod and the control rod bank uncertainty results apply for 8 or more rods, an assumption was made to combine these two results. The assumption is that if the control rod bank rod index uncertainty is less than the analysis bound (1.5%) then the rods in the bank can be mis-calibrated in the non-conservative direction to the extent that uncertainty plus miscalibration is 1.5%. This "allowable" mis-calibration is then added to the API/RPI single rod difference to establish the surveillance criteria. Different agreement criteria were developed based upon the instrumentation used to perform the surveillance. The results of the analysis was that for a rod group position uncertainty of 1.5% the amount of deviation allowed for a single CRA should be 2.7% when the comparison is performed using the plant computer. The value of 3.5% is applicable when the comparison is performed using the panel meters on the main control board. The surveillance requirement has been changed accordingly.

In summary, the LCO preserves the 1.5% rod group index uncertainty used in the core reload analysis. The surveillance preserves the individual CRA uncertainty, which preserves the LCO. If the Surveillance is not met, the RPI requires calibration (re-adjusted to API) or the PI hardware (API or RPI) is not functioning correctly. PI hardware which does not function correctly is handled in accordance with the required Technical Specification Action.

POSITION INDICATOR CHANNELS

LIMITING CONDITION FOR OPERATION

3.1.3.3 All safety, regulating and axial power shaping control rod reed switch position indicator channels* and pulse stepping position indicator channels shall be OPERABLE.

APPLICABILITY: MODES 1 and 2.

ACTION:

a. With a maximum of one reed switch position indicator channel per control rod group or one pulse stepping position indicator channel per control rod group inoperable either:

1. Reduce THERMAL POWER to ≤ 60% of the THERMAL POWER allowable for the Reactor Coolant Pump combination and reduce the Nuclear Overpower Trip Setpoint to ≤ 70% of the THERMAL POWER allowable for the reactor coolant pump combination within 8 hours, or

2. Operation may continue provided:

a) The position of the control rod with the inoperable position indicator is verified within 8 hours by actuating its 0%, 25%, 50%, 75% or, 100% position reference indicator, and

b) The control rod group(s) containing the inoperable position indicator channel is subsequently maintained at the 0%, 25%, 50%, 75% or, 100% withdrawn position and verified at this position at least once per 12 hours thereafter, and

c) Operation is within the limits of Specification 3.1.3.6.

b. With more than one pulse stepping position indicator channel inoperable, operation in MODES 1 and 2 may continue for up to 24 hours provided all of the reed switch position indicator channels are OPERABLE.

*At least one reed switch string OPERABLE along with all other necessary functions needed to indicate rod position.

SURVEILLANCE REQUIREMENTS

4.1.3.3 Each reed switch and pulse stepping position indicator channel shall be determined to be OPERABLE by verifying that the pulse stepping position indicator channels and the reed switch position indicator channels agree within the limits specified below at least once per 12 hours except during time intervals when the Asymmetric Rod Monitor is inoperable, then compare the pulse stepping position indicator and reed switch position indicator channels at least once per 4 hours.

Indicator Channel Agreement Criteria

a) 2.7% when comparison is performed using the plant computer, or

b) 3.5% when comparison is performed using panel meters on the main control board.

3/4.1.3 MOVABLE CONTROL ASSEMBLIES (Continued)

The maximum rod drop time permitted is consistent with the assumed rod drop time used in the safety analyses. Measurement with $T_{avg} \geq 525°F$ and with reactor coolant pumps operating ensures that the measured drop times will be representative of insertion times experienced during a reactor trip at operating conditions.

Control rod positions and OPERABILITY of the rod position indicators are required to be verified on a nominal basis of once per 12 hours with frequent verifications required if an automatic monitoring channel is inoperable. These verification frequencies are adequate for assuring that the applicable LCO's are satisfied.

OPERABILITY of either rod position indicator (API or RPI) and satisfying the associated surveillance requirement agreement criteria assures the ability to determine group average position within 1.5%.

The limitation on Axial Power Shaping Rod insertion is necessary to ensure that power peaking limits are not exceeded.