SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

CRYSTAL RIVER UNIT 3

DOCKET NO. 50-302

FAILURE MODE EFFECTS ANALYSIS

ON THE INTEGRATED CONTROL SYSTEM

NUREG-0737, ITEM II.K.2.9

Following the Three Mile Island Unit 2 event, the staff expressed concern regarding the response of Babcock & Wilcox (B&W) design reactors to transients. Since the staff did not perform a detailed review of failure modes and potential interactions within the Integrated Control System (ICS), it was unsure of the role the ICS might play in initiating or exacerbating transients. Therefore, the staff required a failure mode and effects analysis (FMEA) of the system. In August 1979, B&W submitted a report, BAW-1564, "Integrated Control System Reliability Analysis", which provided the results of a FMEA and an operating history review for the ICS installed at all operating B&W plants. BAW-1564 was endorsed by the licensee as applicable to Crystal River Unit 3.

The staff completed its review of BAW-1564 through a technical assistance contract with Oak Ridge National Laboratory (ORNL). As a result of this review, both the staff and ORNL concluded that the ICS itself had a relatively low failure rate and did not appear to initiate a significant number of plant upsets. However, there were aspects of the plant control system and related components outside the ICS for which improvements should be investigated. In BAW-1564, B&W recommended six actions aimed at improving system performance. In November 1979, the licensees with B&W plants (except Three Mile Island Unit 1)

were requested to address the B&W recommendations. Responses were received from the licensees including the Florida Power Corporation and reviewed by the staff.

Florida Power Corporation letter dated November 23, 1979, provided the licensee's position on the B&W recommendations as requested by the staff. Additional information concerning final resolution on the recommendations was provided in a letter dated March 31, 1982. A summary of the response on each recommendation is as follows:

1) The staff asked the licensee to address the B&W recommendation to improve the reliability of the Non-Nuclear Instrumentation (NNI)/ICS power supply. Florida Power Corporation reviewed the reliability of the power supplies for the NNI/ICS including the use of auctioneering for ICS modules. Florida Power Corporation also stated that in August, 1980, a static transfer switch was installed to transfer ICS input power to an alternate source upon ICS power feed failure.

2) The staff asked the licensee to address the B&W recommendation to improve the reliability of the input signal from the Nuclear Instrumentation/Reactor Protection System to the ICS - specifically, the Reactor Coolant flow signal. The licensee stated that the Nuclear Instrumentation/Reactor Protection System power supplies are fed from the four vital buses with DC backing via inverters. The signals from the Nuclear Instrumentation/Reactor Protection System are considered to be sufficiently reliable because of the provisions made to insure power supply availability.

3) The staff asked the licensee to address the B&W recommendation to improve ICS/Balance of Plant tuning, particularly the interaction between the feedwater condensate systems and the ICS controls. The staff further asked that the licensee address any particular operational problems experienced with the ICS, procedures used by the operator to take manual control of ICS functions, and ICS training provided for the operators. Florida Power Corporation stated that the ICS at Crystal River Unit 3 has been reliable and that system tuning has not been a problem. Minor problems have included module failures caused by component failure within a module but these occurrences have been infrequent. The operators do not intervene with ICS automatic control unless there has been a failure within the ICS, at which time the operator places the affected subloop in the manual mode. All plant Emergency and Abnormal procedures which rely upon the ICS to perform an automatic function require the operator to verify ICS actions and take manual control if necessary. Operator training for the ICS is included in simulator training and operator requalification training.

4) The staff asked the licensee to address the B&W recommendation to improve the main feedwater pump turbine drive minimum speed control. Florida Power Corporation indicated that problems have occurred with the main feedwater pump turbine governor oil system causing runback to minimum speed of the pump turbine. Evaluation of the governor oil system and corrective actions have improved the reliability of the main feedwater pump. Additional efforts will be pursued to eliminate all runbacks.

5) The staff asked the licensee to address the means of preventing or mitigating the consequences of a stuck-open main feedwater startup valve. Florida Power Corporation stated that a stuck-open main feedwater startup valve can be mitigated by closing FWV-33 or 36 from the control room.

6) The staff asked the licensee to address the means of preventing or mitigating the consequences of a stuck-open turbine bypass valve. Florida Power Corporation stated that a stuck-open turbine bypass valve can be mitigated by closing MSV-53 or 54 from the control room.

In May, 1981, subsequent to the review of the responses from the licensees on the B&W recommendations, the staff held a meeting with Duke Power Company to discuss the Duke response on the Oconee units. The meeting was held not only to review the specific Duke response to the B&W recommendations, but also to provide the staff with an opportunity to better understand the details of the ICS design and its effect on plant safety. B&W representatives were in attendance at this meeting to give a presentation on the functions of the ICS and respond to staff questions on the effects of failures in the ICS. The basic contention was that plant transients caused by ICS failures will be terminated by the Reactor Protection System prior to exceeding any plant safety limit.

Based on the meeting with Duke Power Company and reviews to date, the staff has identified no specific control system failures or actions which would lead to unacceptable consequences nor any control system design feature on B&W designed plants which violates any Commission regulation. The staff has concluded that little more can be gained by pursuing the issue of control system failures on a plant by plant basis for

operating plants, but, rather intends to pursue the issue on a broader basis which will include all vendor designs and control systems that could affect plant safety. The Commission has designated the "Safety Implications of Control Systems" (USI A-47) as an Unresolved Safety Issue (see NUREG-0705, "Identification of New Unresolved Safety Issues Relating to Nuclear Power Plants, Special Report to Congress" dated March 1981). The purpose of this Unresolved Safety Issue is to perform in-depth evaluations of control systems that are typically used during normal plant operation and to evaluate the adequacy of current licensing requirements.

In summary, the staff has reviewed the Reliability Analysis of the ICS (BAW-1564) and the licensee's response to the six recommendations contained in BAW-1564. Based upon those reviews, the staff believes that the Crystal River Unit 3 design meets all current regulatory requirements. In addition, since the staff has not identified any specific control system failures or actions that would lead to unacceptable consequences, the staff does not believe that any additional immediate licensing action is warranted at this time. However, for the longer term, USI A-47 which was begun in December 1980, has as its principle task, the assessment of the adequacy of current regulatory requirements for control systems. Resolution of A-47 will determine whether it will be necessary to impose additional and more stringent requirements on control systems in the future.