February 08, 2001

Mr. Michael G. Edison, Chairman
ASIC Subgroup
Westinghouse Owners Group
P.O. Box 1295
Birmingham, AL 35242

SUBJECT: REVIEW OF WESTINGHOUSE TOPICAL REPORT WCAP-15413, "WESTINGHOUSE 7300A ASIC-BASED REPLACEMENT MODULE LICENSING SUMMARY REPORT" (TAC NO. M96513)

Dear Mr. Edison

The NRC staff has completed its review of the subject Westinghouse Electric Company topical report which was submitted by letter dated June 21, 2000. Westinghouse Electric Company developed this Application Specific Integrated Circuit-Based Replacement Module (ABRM) to replace the existing 7300 Process Protection and Control System analog cards at individual plant sites with ABRMs under Section 50.59 of Title 10 of the *Code of Federal Regulations* (10 CFR 50.59). However, the staff finds that the unique configuration of each plant makes it imperative that each licensee analyze whether the ABRM can be installed under 10 CFR 50.59. Therefore, the enclosed safety evaluation (SE) addresses only the generic issues associated with installing the ABRM. Licensees may reference this SE, as applicable, when performing a 10 CFR 50.59 determination.

On the basis of our review, the staff finds that WCAP-15413 dated June 21, 2000, is acceptable for referencing in license applications to the extent specified, and under the limitations delineated in the report, and in the enclosed SE. The SE defines the basis for NRC acceptance of the report. In general, the staff finds that the ABRMs can be used to replace the existing 7300 Process Protection and Control System cards. However, the staff finds that because each plant's configuration and operating conditions are unique, a licensee must confirm (before installing the ABRMs) that the tested qualification levels envelop the extreme conditions expected at its plant.

Pursuant to 10 CFR 2.790, we have determined that the enclosed SE does not contain proprietary information. However, we will delay placing the SE in the public document room for a period of ten (10) working days from the date of this letter to provide you with the opportunity to comment on the proprietary aspects only. If you believe that any information in the enclosure is proprietary, please identify such information line by line and define the basis pursuant to the criteria of 10 CFR 2.790.

We do not intend to repeat our review of the matters described in the report, and found acceptable, when the report appears as a reference in license applications, except to assure that the material presented is applicable to the specific plant involved. Our acceptance applies only to matters approved in the report.

In accordance with procedures established in NUREG-0390, "Topical Report Review Status," we request that Westinghouse Electric Company publish an accepted version of this topical report within 3 months of receipt of this letter. The accepted version shall incorporate this letter and the enclosed safety evaluation between the title page and the abstract. It must be well indexed such that information is readily located. Also, it must contain in appendices historical review information, such as questions and accepted responses, and original report pages that were replaced. The accepted version shall include an "-A" (designated accepted) following the report identification symbol.

Should our criteria or regulations change so that our conclusions as to the acceptability of the report are invalidated, Westinghouse Electric Company and/or the applicants referencing the topical report will be expected to revise and resubmit their respective documentation, or submit justification for the continued applicability of the topical report without revision of their respective documentation.

If you have further questions, you may contact Raynard Wharton at (301) 415-1396.

Sincerely,

/RA/

Stuart A. Richards, Director
Project Directorate IV and Decommissioning
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Project No. 694

Enclosure: Safety Evaluation

cc w/encl:
Mr. Andrew Drake, Project Manager
Westinghouse Owners Group
Westinghouse Electric Corporation
Mail Stop ECE 5-16
P.O. Box 355
Pittsburgh, PA 15230-0355

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

WESTINGHOUSE ELECTRIC COMPANY TOPICAL REPORT WCAP-15413

"WESTINGHOUSE 7300A ASIC-BASED REPLACEMENT MODULE

LICENSING SUMMARY REPORT"

PROJECT NO. 700

1.0 INTRODUCTION

By letter dated June 21, 2000, Westinghouse Electric Company submitted its final non-proprietary Topical Report WCAP-15413, "Westinghouse 7300A ASIC-Based Replacement Module Licensing Summary Report," for review by the NRC staff. In support of its topical report, Westinghouse submitted the following proprietary topical reports:

- WCAP-14975, "7300 ASIC-Based Replacement Module Reliability Assessment and Failure Mode and Effect Analysis,"
- WCAP-15215, "Seismic Test Report Westinghouse ASIC-Based Replacement Module for 7300 Process Protection System,"
- WCAP-15371, "Fault Conditions Test Report Westinghouse ASIC-Based Replacement Module for 7300 Process Protection System,"
- WCAP-15378, "Environmental Test Report Westinghouse ASIC-Based Replacement Module for 7300 Process Protection System," and
- WCAP-15403, "Electromagnetic Compatibility Test Report Westinghouse ASIC-Based Replacement Module for 7300 Process Protection System."

Westinghouse developed this Application Specific Integrated Circuit (ASIC)-Based Replacement Module (ABRM) as a spare part to serve as a pin-for-pin replacement for the Westinghouse-supplied 7300 Process Protection System (PPS) and Process Control System (PCS) modules, which are currently used in a number of nuclear plants.

Westinghouse developed the ABRMs under the direction of an industry alliance between the Westinghouse Owners Group (WOG) utilities, the Electric Power Research Institute (EPRI), and Westinghouse Electric Company. The primary purpose of this alliance is to develop, license, and manufacture ABRMs that will replace the obsolete 7300-series analog cards, while meeting the current design- and licensing-basis requirements, so that the utilities can replace their existing analog modules with the ASIC-based modules under their current replacement parts programs.

Westinghouse's objective in submitting this topical report was to obtain the staff's safety evaluation and approval so that licensees can replace the existing 7300 PPS and PCS modules at their plants with ABRMs under Section 50.59 of Title 10 of the Code of Federal Regulations (10 CFR 50.59). However, the staff finds that the unique configuration of each plant makes it imperative for each licensee to analyze whether the ABRMs can be installed under 10 CFR 50.59. Therefore, this safety evaluation (SE) addresses only the generic issues associated with installing the ABRMs. Nonetheless, licensees may reference this SE, as applicable, when performing a 10 CFR 50.59 determination.

2.0 SYSTEM DESCRIPTION

The ABRMs replace the following 7300-series analog modules:

- NAC — Analog Comparator Card
- NAL — Signal Comparator Card
- NCB — Controller Card
- NCD — Controller Driver Card
- NCH — Function Generator Card
- NLL — Lead/Lag Amplifier Card
- NLP — Isolator and Loop Power Supply
- NMA — Mixing Amplifier Card
- NMD — Multiplier/Divider Card
- NRA — RTD Amplifier Card
- NSA — Summing Amplifier Card
- NSA5 (MSS) — Median Signal Selector Card
- NSC — Signal Converter Card
- NTD — Tracking Driver Card
- NVP — Voltage-to-Pulse Converter

An ABRM is a digital module that can perform the various process functions required by the protection channels. More importantly, each ABRM performs the same process functions as the 7300-series analog module that it replaces.

2.1 Configuration

The physical configuration of the ABRM consists of a personality module (PM) and a main board (MB), as two independent circuit boards. The PM is a plug-in module that configures the MB to perform the desired process functions. As a result, there is a corresponding PM for each of the 7300-series analog module types to be replaced. The MB, which is identical for all ABRMs, includes the ASIC chip, controller programable read only memory (PROM), clock circuit, external memory devices, operator interface, input and output signal conditioning circuits, and power supplies.

The main functions of the MB are to (1) process the data obtained from the input signal conditioning circuitry, (2) transmit processed data to the PM, and (3) provide the interface and mounting for the PM. The main functions of the PM are to (1) select the starting address for the segment of the controller PROM that contains the desired sequence of ASIC codes, (2) provide additional components that condition the input and output signals, and (3) align the input and output signals to the proper pin assignments on the 42-pin card edge connector.

2.2 Power Supplies

The power supply and distribution circuit of the ABRM receives nominal 24 or 26 Volts dc from the main power supplies in the 7300 cabinet. Multiple onboard dc to dc converters provide all necessary dc power for each type of ABRM.

2.3 Input, Analog Output, and Digital Actuation Output Signal Conditioning

The input and analog output signal conditioning circuits are housed on the MB. By contrast, the digital actuation output circuitry is housed on the PM for the NAC and NAL. The input signal conditioning circuits perform the signal conditioning, process noise filtering, calibrating, and analog-to-digital conversion (ADC). The analog output signal conditioning circuitry performs the digital-to-analog conversion (DAC), signal conditioning and filtering, calibration, and isolation and surge protection functions. The digital actuation output circuits generate the on/off control functions to the protection logic relays.

2.4 Operator Interface (OI)

The OI is the mechanism through which the process function setpoints and tuning constants are entered, stored, and changed. The OI is designed to emulate the current method for entering and changing setpoints and tuning constants. Therefore, all setpoints and tuning constants continue to be entered as voltages instead of numerical values.

The OI consists of logic and memory circuitry located on the MB, as well as card-edge mounted components to perform the following functions:

- Store up to 100 setpoints and tuning constants.
- Allow the operator to enter or change numbers using an up/down switch in conjunction with a push-button and digital volt meter (DVM).
- Maintain the existing scaling methodology, in which volts represent engineering units.

- Eliminate the need for a battery backup through the use of non-volatile memory.
- Allow online adjustment of setpoints and tuning constants.
- Allow access to all components from the front of the module (without requiring removal of the module).

2.5 ASIC's Internal Circuitry and Functions

The ASIC is the main component of the ABRM. It contains eight independent circuits, each of which performs one basic mathematical or interface operation, including (1) add/subtract, (2) multiply/divide, (3) compare, (4) square root, (5) ADC control, (6) DAC control, (7) storage registers, and (8) controller/counter. A mathematical function is accomplished by enabling some interface operation circuits and an individual mathematical operational circuit or a combination of mathematical operational circuits in a given sequence.

The ABRM accomplishes all of the process functions that were performed by the 7300-Series analog cards by performing a mathematical function or a combination of mathematical functions. The controller PROM stores the sequences of mathematical and interface operations to be performed to accomplish specific functions. The counter steps through the sequence of enable codes in the selected segment of the controller PROM without interrupt, jump, or decision-making operations. While performing a process function, the intermediate values for process computations are stored in eight internal registers. If the process computation requires additional registers, the ASIC uses external random access memory (RAM) on the MB to store additional temporary or intermediate values.

To avoid the complexities of floating-point computations, the ASIC is designed to use fixed-point arithmetic for its computations. Numbers are represented as binaries, with 16 bits to the left of the decimal point and 23 bits to the right of the decimal point. The largest decimal numbers that can be represented are $\pm$65,536 with a resolution equal to 1.2E-7. The ASIC represents numbers in sign-magnitude format, where bit 39 is the sign and bits 0 through 38 are the magnitude.

The ASIC design includes limited diagnostics, such as error flags for overflow by addition, subtraction, multiplication, and division (including division by zero). However, these diagnostics are not used to prevent incorrect operation of the ASIC. Rather, the error flags and controlled failure modes provide some assistance for detecting a failure without creating a nuisance alarm scenario. When an error is detected, an error flag is set and the ASIC continues its operation without interruption. When an error results from a temporary condition, the error flag is removed when the temporary condition goes away. However, when an error results from a permanent hardware failure, the error flag remains activated to signal the need for correction or repair of the problem. This operation is similar to that of the existing analog cards. These limited diagnostics were not designed to detect all failures. Those undetected failures will be detected during scheduled surveillances.

2.6 Controller

The ABRM controller is a 64K PROM that is divided into 64 "segments." A segment comprises 1,024 memory locations in the controller PROM that contains the control codes that enable the eight circuits in the ASIC. Each ASIC circuit has its own unique control code. As the segment sequences through the control codes, the ASIC circuits are enabled, one-at-a-time, in the proper sequence to perform the desired process function.

The ASIC performs the required process functions using 29 mathematical algorithms that are stored in the controller. An algorithm is a set of commands that enables (turns on) the ASIC circuits in the proper sequence to perform a specific process function. These algorithms are stored in one to eight segments of the PROM (controller). There are 256 unique commands available for use in the algorithms. These commands do not include any interrupt, jump, or decision-making commands. A set of commands in an algorithm may range from less than 1,024 to as many as 8,192 commands. Every command in a given algorithm is executed sequentially during its cycle.

2.7 Alarms, Test Points, and Indicators

Each ABRM incorporates alarms, test points, and indicators, such that the current plant procedures and the existing maintenance and test equipment are minimally impacted.

2.7.1 General Alarm Indicator

The ABRM general alarm function replaces the existing power supply failure alarm on the 7300-series cards. The general alarm indicates permanent failures, such as failure of the ASIC circuits or the power supply circuits on the card. The general alarm circuit, located on the MB, monitors the onboard power supplies, the RAMLogic field programmable gate arrays (FPGAs), and the ASIC monitor pulse. The output of the general alarm circuit is normally energized by applying an open circuit to the alarm output pin, and illuminating the red LED on the front edge of the card to indicate that the card is operating normally. Upon failure of (1) any of the onboard power supplies, (2) configuration of the RAMLogic FPGA, or (3) the ASIC monitor pulse, the output of the general alarm circuit is grounded. This extinguishes the red LED on the front edge of the card. If a plant is currently wired to show the power supply failure alarm in the main control room, the general alarm will also appear in the main control room.

The ASIC monitor pulse is generated by the ASIC every millisecond, once during each PROM segment. The ASIC monitor pulse is connected to a deadman timer circuit, with its output normally energized as long as the ASIC monitor pulse occurs every millisecond. The ASIC monitor pulse will stop, causing the deadman timer circuit to de-energize, if any one of the following components fails:

- 1-MHz clock circuit;
- controller (i.e., the ASIC stops getting control codes);
- ASIC address generator; or
- ASIC itself.

2.7.2 Trouble Alarm Indicator

An amber LED on the font edge of the card indicates the status of the trouble alarm function. The trouble alarm circuit is part of the RAMLogic FPGA located on the MB. It monitors the OI circuit, digital output overcurrent conditions, and the ADC self-calibration. The output of the trouble alarm circuit is normally de-energized, and the amber LED is off. Upon failure of the OI circuit to properly configure when energized, an overcurrent condition detected on the NAL PM output, or failure of the ADCs to self-calibrate, the output of the trouble alarm circuit will energize. This illuminates the amber LED on the front edge of the card.

2.7.3 NAC and NAL Indicators

To replicate the LED indicators found on the 7300-series NAL and NAC cards, red LEDs have been added on the front edge of the NAC and NAL PMs to indicate the on/off state of the current sinking transistors in the low-side switch circuitry of the digital actuation outputs. The transistors in this circuit can be either normally conducting or normally cut off (i.e., open).

2.7.4 Test Points

The MB has 27 test points, of which 7 are located on the front edge of the card to measure output signals, and the other 20 are located throughout the card to measure power supply voltages and intermediate signals. Some test points are also located on the front edge of a PM, if necessary. The test points are provided to help the maintenance personnel locate failed ABRMs.

3.0 ACCEPTANCE CRITERIA

This SE discusses the acceptability of the Westinghouse ABRM for use as a replacement for existing safety-related 7300-series analog modules in nuclear power plants. The general design criteria (GDC) listed in Appendix A to 10 CFR Part 50 establish minimum requirements for the design of nuclear power plants. The Regulatory Guides (RG) and the endorsed industry codes and standards listed in Table 7-1 of the Standard Review Plan (NUREG-0800), which is also known as the SRP, are the guidelines used as the basis for this evaluation. Specifically, SRP Sections 7.1, 7.2, and 7.3 identify the following acceptance criteria and guidelines for reviewing a safety-related reactor protection system, such as the ABRM, for use as a replacement module in the Westinghouse 7300 protection systems:

- 10 CFR 50.55a(a)(1), “Quality Standards for Systems Important to Safety”
- 10 CFR 50.55a(h), "Protection Systems"
- 10 CFR 50.62, “Reduction of Risk from Anticipated Transients Without Scram (ATWS)”
- 10 CFR 50, Appendix A, “General Design Criteria”
    - GDC 1 – Quality Standards and Records
    - GDC 2 – Design Basis for Protection Against Natural Phenomena

- GDC 3 – Fire Protection
- GDC 4 – Environmental and Dynamic Effects Design Bases
- GDC 13 – Instrumentation and Control
- GDC 17 – Electric Power Systems
- GDC 20 – Protection System Functions
- GDC 21 – Protection System Reliability and Testability
- GDC 22 – Protection System Independence
- GDC 23 – Protection System Failure Modes
- GDC 24 – Separation of Protection and Control Systems
- GDC 25 – Protection System Requirements for Reactivity Control Malfunctions
- GDC 29 – Protection Against Operational Occurrences

The following RGs are applicable to this review:

- RG 1.75, "Physical Independence of Electrical Systems" (which endorses IEEE Std 384, "Criteria for Separation of Class 1E Equipment and Circuits").

- RG 1.89, "Qualification of Class 1E Equipment for Nuclear Power Plants" (which endorses IEEE Std 323, "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations").

- RG 1.100, "Seismic Qualification of Class 1E Equipment for Nuclear Power Plants" (which endorses IEEE Std 344, "Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations").

- RG 1.105, "Instrument Spans and Setpoints" (which endorses ISA-67.04, "Setpoints for Nuclear Safety-Related Instrumentation Used in Nuclear Power Plants").

4.0 EVALUATION

The staff concentrated on the following topics for its evaluation of the ABRMs:

- ASIC quality,

- common-mode failure evaluation of the ABRM,

- deterministic operation of the ABRM,

- reliability assessment of the ABRM,

- elimination of periodic response time testing of the ABRMs, and

- qualification of the ABRM.

4.1 ASIC Quality

Westinghouse, Oak Ridge National Laboratory (ORNL), and Northrop Grumman Advanced Technology Center (ATC) developed the ASIC. Westinghouse served as technical lead, while ORNL was responsible for the ASIC design, layout, and fabrication of prototype chips for evaluation. ATC was responsible for simulation testing of the ORNL ASIC design, testing of the ASIC prototypes, and fabrication and testing of ASIC chips for qualification and production. Because ORNL and ATC are commercial-grade suppliers, the services and products that they provided are considered commercial-grade items. Westinghouse, which is an approved supplier under 10 CFR Part 50 Appendix B, dedicated the ASIC as a safety-grade component through its commercial-grade dedication survey and testing.

Westinghouse performed the commercial-grade dedication in accordance with its topical report WCAP-12885, "Westinghouse Nuclear Services Division Commercial Dedication Program," Revision 0. Westinghouse reviewed the "ATC Quality Assurance Manual, Product Specification Abbreviated Form (PSAF)," for ASIC mask set 4457, non-Westinghouse-related specific trip tickets, as well as supporting procedures and records. In addition, Westinghouse conducted interviews at the offices and/or workstations of personnel who performed the activities associated with the commercial-grade dedication, which activities are contained in Westinghouse Commercial Dedication Instruction Number SEP-0662, dated February 17, 1997. The results of the survey are documented in the Commercial-Grade Survey Report, WES-97-172, dated June 6, 1997.

Westinghouse's commercial-grade dedication is founded on the premise that the ASIC is thoroughly testable because the ASIC performs basic mathematical operations using its eight independent circuits. Therefore, Westinghouse conducted its qualification and validation test programs to demonstrate that the ASIC will perform its intended safety-related functions.

The ABRM ASIC is assembled from logic blocks, such as a 2-bit adder. Before assembling these blocks, ORNL tests the logic blocks to confirm that they perform as required. The logic blocks are then added one at a time. Each time a block is added, tests are performed to confirm that the new block performs as required.

After all of the circuits in the ASIC were assembled, Westinghouse performed functional testing and design testing to verify that the ASIC design and fabrication are both correct. For functional testing, Westinghouse used a set of test vectors to test whether each of the eight independent circuits in the ASIC is operating properly to show that each of the circuits is correctly designed. Fabrication testing exercised nodes in the ASIC to determine whether the manufacturing process resulted in any faulty components in the ASIC. For these tests, Westinghouse used two sets of test vectors, totaling 225,000 test vectors. These tested 100 percent of the functions and exercised 99.8 percent of the nodes.

Requirements for qualifying commercial-grade items for nuclear power plant use are described in 10 CFR Part 21, which states, "This assurance is achieved by identifying the critical characteristics of the item and verifying their acceptability by inspections, tests, or analyses performed by the purchaser or third-party dedicating entity after delivery, supplemented as necessary by one or more of the following: commercial grade surveys, product inspections or witness at hold points at the manufacturer's facility, and analysis of historical records for acceptable performance." Guidance on dedicating commercial items for nuclear power plant use is provided in EPRI NP-5652-1988, "Guideline for the Utilization of Commercial-Grade Items in Nuclear Safety Applications (NCIG-07)," which is referenced in the SRP, and in EPRI TR-102348, "Guideline on Licensing Digital Upgrades," which is endorsed by Generic Letter 95-02, "Use of NUMARC/EPRI Report TR-102348 in Determining Acceptability of Performing Analog-to-Digital Replacements Under 10 CFR 50.59," dated April 26, 1995. Commercial-grade dedication is an acceptance process for demonstrating that a commercial-grade item to be used as a basic component will perform its intended safety functions and, in this respect, is equivalent to an item designed and manufactured under a quality assurance program that conforms to the requirements of 10 CFR 50 Appendix B.

Based on the information reviewed on the ASIC development and the 225,000 test vectors that covered 100 percent of the functions and 99.8 percent of the nodes, the staff concludes that Westinghouse successfully validated the identified critical characteristic through testing. Therefore, the staff concludes that the ASIC satisfies the quality requirements of 10 CFR Part 50 Appendix B through the application of the guidance in TR-102348.

4.2 Common-Mode Failure Evaluation of the ABRM

Westinghouse addressed common-mode failure issues associated with the ABRMs by performing the following activities to ensure that the ASIC, the controller PROM, the OI and RAMLogic PROMs, and the Hi-Memory PROM operate as intended:

- Perform the 225,000 validation tests to provide reasonable assurance that the ASIC design and fabrication are correct.

- Perform functional tests on all of the algorithms being used. Because all of the commands in an algorithm are executed sequentially in every cycle without using interrupt, jump, or decision-making operations, successful testing of each algorithm provides assurance that the enable codes in the controller PROM are correctly programmed.

- Perform checksum verification to confirm that the data stored in the RAMLogic PROMs are correct.

- Manually check each of the data elements stored in the PROMs before use. This check also detects any corrupted data in those PROMs.

In addition, the ABRMs operate asynchronously. Each module has its own clock and operates independently of all other modules. Consequently, a failure in one ABRM cannot affect the performance of another ABRM or analog module.

The regulatory guidance regarding common-mode failure is provided in Branch Technical Position (BTP) HICB-19, "Guidance for Evaluation of Defense-in-Depth and Diversity in Digital-Based I&C Systems," which addresses the NRC’s concern regarding common-mode software failures in digital-system-based instrumentation and control systems. Most digital systems cannot be proven to be error-free and, therefore, are considered to be susceptible to common-mode software failures because identical copies of the software are present in redundant channels of safety-related systems. The staff reviewed the design, operation, and error detection mechanism of the ASIC chip, the controller PROM, the OI and RAMLogic PROMs, and the Hi-Memory PROM. On the basis of that review, the staff concluded that the testing conducted on the ABRMs provides adequate assurance that the ABRMs are not a significant source of common-cause failure resulting from software errors and, therefore, are acceptable. However, licensees need to ensure that the implementation of ABRMs will not adversely affect the existing functional diversity within the protection systems and the way the plant presently meets the requirements of IEEE Std 279, Section 4.17, "Manual Initiation," and Section 4.20, "Information Read-Out," as well as 10 CFR 50.62, "Requirements for Reduction of Risk from Anticipated Transients without Scram." The way that licensees meet the requirements of 10 CFR 50.62 vary from plant to plant. Therefore, the licensee may take credit for the existing plant design, with regard to the requirements of 10 CFR 50.62, after confirming that the plant's defense-in-depth and diversity are not adversely impacted by the implementation of the ABRMs.

4.3 Deterministic Operation of the ABRM

The controller PROM contains control codes that enable certain sections of the ASIC circuitry to perform the basic mathematical or interface operations. All of the control codes within a controller segment are sequenced (or stepped) by a counter in the ASIC. Each set of control codes ranges from less than 1,024 to 8,192 control codes (i.e., 1 to 8 segments). A set of control codes sequentially enables an ASIC circuit to perform the desired process function.

The counter for the control codes runs at 1 MHz. Because control codes are sequenced without any interrupts or branching, the cycle time for any one segment is 1,024 clock cycles, which is equal to 1.024 ms. Therefore, the time used to run a set of control codes can be 1.024 ms to 8.192 ms, depending on the number of segments in the control code set; however, the time used to run a given code set does not vary.

Regulatory guidance regarding deterministic operation is provided in BTP HICB-21, "Guidance on Digital Computer Real-Time Performance," which states the following:

- Any non-deterministic delays should be noted, and a basis provided for assurance that such delays are not part of any safety functions, and cannot impede any protective action.

- Risky design practices (such as non-deterministic data communications, non-deterministic computation, use of interrupts, multitasking, dynamic scheduling, and event-driven design) should be avoided. Where such practices are allowed, the applicant/licensee should describe methods for controlling the associated risk.

GDCs 20, 21, 23, and 25 provide the regulatory basis for BTP HICB-21.

For this evaluation, the staff reviewed the controller PROM design and operation. On the basis of that review, the staff concludes that the ABRMs operate in a deterministic manner, and therefore, they satisfy the requirements of BTP HICB-21.

4.4 Reliability Assessment of the ABRM

Westinghouse performed a reliability assessment of the ABRMs by calculating the mean time between failures (MTBF) and performing failure mode effect analyses (FMEAs) on the ABRMs and their equivalent 7300-series modules, and comparing those calculated and analyzed results.

4.4.1 Mean Time Between Failures

Westinghouse performed the MTBF calculations using the Parts Count prediction method specified in MIL-HDBK-217F, Notices 1 and 2. Using that method, the failure rate for a component is obtained by looking up a generic failure rate and quality factors in Appendix A to MIL-HDBK-217F. When the failure rate for a given component is not available in MIL-HDBK-217F, Westinghouse obtained the failure rate from the component vendor. The MTBF rate for the ASIC is calculated by ATC on the basis of how the ASIC is fabricated, the type of technology used, and the expected usage of the ASIC. ATC regularly performs such calculations for the ASIC chips that it fabricates for its customers. The MTBF for an ABRM and a 7300-series module is calculated by summing the MTBF rates for all of the components in the given module.

The results of the MTBFs for the ABRMs and the equivalent 7300-series analog modules are provided in Attachment A to WCAP-14975. The MTBF calculations showed that the MTBF for each type of ABRM is longer than for its equivalent 7300-series analog module.

The requirements for performing MTBF calculations are provided in IEEE Std 603, which requires that reliability goals be established and that reliability assessments be performed to demonstrate that the reliability goals are met. Section 5.3 of IEEE Std 603 also states that "components and modules shall be of a quality that is consistent with minimum maintenance requirements and low failure rates." Section 4.3.6 of IEEE Std 577 states that "the failure data shall be obtained from credible sources," while Section 4.3.7 states that "failure rates that are predicted on judgement may be used, provided that the basis for the judgement is described and documented in the analysis."

For this evaluation, the staff reviewed WCAP-14975 and Section 7 of WCAP-15413. On the basis of that review, the staff concludes that the reliability goals and assessments for the ABRMs conform to the requirements of IEEE Std 603 and the guidance in IEEE Std 577, Sections 4.3.6 and 4.3.7, and, therefore, are acceptable.

4.4.2 Failure Mode Effect Analysis of the ABRMs

Westinghouse performed FMEAs of the ABRMs using the traditional FMEA methodology described in MIL-STD-1629A and functional block analysis (FBA). Westinghouse has used the FBA methodology for complex digital components where FMEA is not practical. Unlike FMEA, FBA assesses possible failure of functional blocks, rather than the specific hardware components. Westinghouse performed the ABRM card-level FMEA using the results of building block FMEAs and FBAs in order to support the comparisons with the 7300-series analog cards that are to be replaced.

For the FBA assessment, Westinghouse covered only the basic functions that the ASIC performs for all configurations of the 7300-series analog cards. In addition, Section 7.5.2.1 of WCAP-15413 lists the assumptions that Westinghouse made for the FMEA/FBAs and a summary of the methodologies that were used for the FMEA/FBAs.

The results of the FMEA show that the general alarm feature in the ABRM immediately detects many failures, including power failures, ASIC control failures, and logic failures. However, this feature does not detect all failures. The failures that are not detected by the general alarm feature are detected by the surveillance program, which includes calibration and functional testing, performed at intervals dictated by the technical specifications. The results of the FMEA/FBAs are provided in WCAP-14975, "7300 ASIC-Based Replacement Module Reliability Assessment and Failure Mode Effect Analysis."

The regulatory guidance regarding performing an FMEA is provided in IEEE Std 352, "IEEE Guide for General Principle of Reliability Analysis of Nuclear Power Generating Station Safety Systems." Section 3.4.1 of IEEE Std 352 states that the FMEA is usually the first reliability activity performed to provide a better understanding of the failure potential of a design. Section 4.1 of IEEE Std 352 provides a specific method for an FMEA, and Section 4.1.4 states that for electronic or control systems using integral modular units as system building blocks, the modular units (rather than their parts) may be listed in the FMEA table (Table 1 of IEEE Std 352.)

For its evaluation, the staff reviewed WCAP-14975, and audited the failure modes analyzed in the report. Given the information reviewed, the staff found that the FMEA/FBA method used by Westinghouse meets IEEE Std 352, Section 4.1.4. Additionally, on the basis of the audit of failure modes analyzed in WCAP-14975, the staff concludes that Westinghouse's FMEA is acceptable.

4.5 Elimination of Periodic Response Time Testing of the ABRMs

Westinghouse proposed to eliminate response time testing (RTT) of the NLP, NSA, NLL, NAL, NCH, NMD, and NRA ABRMs. Westinghouse previously submitted Topical Report WCAP-14036-P-A, Revision 1, "Elimination of Periodic Protection Channel Response Time Tests," dated October 1998, and obtained an SE that allowed elimination of RTT on some of the 7300-series analog cards. Because the ABRMs are direct replacements for the 7300-series analog cards, Westinghouse would like to maintain the elimination of RTT when an analog card is replaced with the equivalent ABRM. To do so, Westinghouse included justifications for eliminating periodic RTT for those ABRMs in WCAP-15413.

In WCAP-14036-P-A, Revision 1, Westinghouse proposed to eliminate periodic RTT requirements for selected protection channel equipment installed in the reactor trip system (RTS) and engineered safety features actuation system (ESFAS). Westinghouse performed an FMEA to show that any component failure that degrades sensor response time beyond a limiting response time can be detected during surveillance tests.

Westinghouse used the methodology in WCAP-14036-P-A, Revision 1, to analyze the ABRMs. As part of its FMEA and bounding response time calculation, Westinghouse performed the following activities:

- identified response time-sensitive components on the MB and selected PMs;
- evaluated the impact on the response time if a component fails or degrades;
- identified detectability of degraded components via calibration;
- identified components that impact calibration, but not response time; and
- calculated the circuit response time assuming that (1) a capacitor can degrade by increasing its capacitance by 50 percent, and (2) a resistor can degrade by increasing its resistance by 200 percent (increases in capacitance and resistance increase the response time).

Table 9-1 of WCAP-15413 compares the ABRMs' bounding response times with those of the equivalent 7300-series analog cards.

The generic bounding response time for ABRMs was developed so that licensees can verify the specific response time for each protection system function on the basis of a given plant's as-built configuration. Therefore, if a licensee has eliminated its plant's periodic RTT in accordance with WCAP-14036, it needs to analyze the impact on the RTS/ESFAS response time result from installing an ABRM in place of the equivalent 7300-series analog card. However, Westinghouse does not require a licensee to conduct a new RTS/ESFAS baseline RTT when installing the ABRMs.

Regulatory guidance regarding RTT is provided in IEEE Std 338-1977, as endorsed by RG 1.118, Revision 2, "Periodic Testing of Electric Power and Protection Systems," which states that RTT is not required if (1) in lieu of RTT, the response time of the safety equipment is verified by functional testing, calibration checks, or other tests, and (2) it can be demonstrated that changes in response time beyond acceptable limits are accompanied by changes in performance characteristics, which are detectable during routine periodic tests. In addition, IEEE Std 279, Section 3(9), NUREG-0800, Section 7.1 and Appendix B, Item 9, require that the applicant/licensee should verify that the response time of the instruments that produce the protection system inputs are consistent with the analysis provided in Chapter 15 of the Safety Analysis Report (SAR).

Based on its review of the information presented in the Section 9 of WCAP-15413, the staff agrees that significant degradation of instrumentation response times can be detected during the performance of calibrations and other currently required surveillance tests. The staff also finds that the bounding response times determined by the FMEA and listed in Table 9-1 of WCAP-15413 are acceptable. Therefore, the staff concludes that, for a plant that has already eliminated RTT in accordance with WCAP-14036-P-A, Revision 1, the existing TS surveillance requirements would provide reasonable assurance that the safety functions of the plant's instrumentation will be satisfied without the need for periodic RTT. However, the staff finds that the licensee needs to perform response time analyses to ensure that the ABRMs' bounding response times do not adversely affect the overall response time of the safety systems. In addition, as required by IEEE Std 279, Section 3(9), and augmented by the guidance in NUREG-0800, Section 7.1 Appendix B, Item 9, the staff finds that the applicant/licensee needs to verify that the response time of the ABRMs-upgraded instruments that produce the protection system inputs are consistent with the analysis provided in Chapter 15 of the SAR.

4.6 Qualification of the ABRM

GDCs 2 and 4 require that the safety system be designed to withstand the effects of natural phenomena, and be qualified to operate in the environmental conditions to which it is exposed during normal and postulated accident conditions. To ensure that the ABRMs will perform their intended function(s) under the environmental conditions to which they will be subjected, the staff reviewed the environmental qualification of the ABRMs for (1) temperature and humidity, (2) seismic conditions, (3) fault testing, and (4) electromagnetic and radio frequency interference. RG 1.89, "Environmental Qualifications of Certain Electric Equipment Important to Safety for Nuclear Power Plants," which endorses IEEE Std 323-1974, "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations," provides an acceptable basis for demonstrating equipment qualification. To demonstrate qualification of the ABRMs, Westinghouse used IEEE Std 323-1983, Section 6.3.2(3).

The following sections discuss the staff's evaluation of the ABRM qualification for (1) temperature and humidity, (2) seismic conditions, (3) fault testing, and (4) electromagnetic and radio frequency interference.

4.6.1 Temperature and Humidity Qualification

Section 6.3.2(3) of IEEE Std 323-1983 states that the test sample shall be operated to the extremes of all performance and electrical characteristics given in the equipment specifications, excluding design-basis and post-design-basis event conditions, unless these data are available from other tests on identical or similar equipment.

Westinghouse installed the ABRMs in a 7300-Series double-card frame, and subjected them to the abnormal environmental conditions shown by the two cycles in Figure 3 of WCAP-15378. These two cycles simulate a temporary change in the internal environmental conditions of a 7300 cabinet. These test conditions envelop the original performance testing of the printed circuit boards for the 7300 PPS. The ABRM's performance requirements for the environmental tests are listed in Section 3.2 of WCAP-15378. Section 6.2 of WCAP-15378 identifies the anomalies that were observed during the tests, as well as the justifications for those anomalies.

Based on the information reviewed, the staff finds that with the exception of the NCB module, the ABRMs are qualified to the tested abnormal environmental conditions shown by the two cycles in Figure 3 of WCAP-15378. Therefore, the NCB module is only qualified to the plant environment that is enveloped by the tested condition. The staff finds that because the ABRMs can actually be exposed to different environmental conditions, the licensees need to ensure (before installing the ABRMs) that the tested qualification levels envelop the plant's expected extreme conditions.

4.6.2 Seismic Qualification

To perform seismic testing, Westinghouse mounted the ABRMs to an independent tri-axial seismic simulator table at the Westinghouse Cheswick facility and subjected them to a series of simulated seismic conditions, including resonance search tests and random multifrequency tests. The random tri-axial multifrequency tests, which simulate a series of earthquake environments, were performed in accordance with IEEE Std 344-1987. The results of the tests are reported in Westinghouse Topical Report WCAP-15215, "Seismic Test Report Westinghouse ASIC-Based Replacement Module for 7300 Process Protection System," dated May 1999. Seismic conditions used for the test are described in Figure 3 in WCAP-15215.

The staff reviewed WCAP-15215, and found that the ABRMs successfully completed the performance requirements in accordance with IEEE Std 344-1987 and, therefore, are acceptable with regard to the seismic levels defined in Figure 3 of WCAP-15215.

4.6.3 Fault Condition Testing

Westinghouse performed fault testing, and reported the results in Topical Report WCAP-15371, "Fault Conditions Test Report Westinghouse ASIC-Based Replacement Module for 7300 Process Protection System," dated February 2000. The ABRMs are required to be in compliance with the isolation capabilities described in IEEE 603-1998, Section 5.6.3.1(b).

The staff reviewed the test report and concluded that the ABRMs meet the performance requirements described in IEEE 603-1998, Section 5.6.3.1(b), when subjected to the prescribed fault conditions on the isolated outputs from the two types of replacement Westinghouse 7300 process protection and control system modules (NLP and NSC) that interface with non-Class 1E circuits and are, therefore, acceptable.

4.6.4 Electromagnetic Compatibility

Westinghouse tested the ABRMs for the nuclear plant electromagnetic (EM) environment using the recommendations in EPRI Topical Report TR-102323, "Guideline for Electromagnetic Interference Testing in Power Plants." TR-102323 provides recommendations on generic electromagnetic interference and radio frequency interference (EMI/RFI) susceptibility test levels and allowed emission levels that can be used in establishing equipment electromagnetic compatibility (EMC) for nuclear power plant environment applications.

For the EMC tests, the ABRMs were mounted in a 7300-series card frame (without the cabinet) using standard mounting hardware. The card frame was powered from a standard 7300-series cabinet power supply, and input and output cables were attached to the card edge connectors to simulate internal cabinet wiring. Using this configuration, Westinghouse measured the EMI/RFI emitted from the ABRMs, and performed EMI/RFI susceptibility tests on the ABRMs as individual cards.

The regulatory guidance regarding EMC for the safety equipment is provided in RG 1.180, "Guidelines for Evaluating Electromagnetic and Radio-Frequency Interface in Safety-Related Instrumentation and Control Systems," and the staff's SE that endorses TR-102323. The NRC published RG 1.180 in January 2000, and the SE on TR-102323 in April 1995. Either of these documents provide an EMC qualification method that is acceptable to the NRC.

For emission measurements, Westinghouse measured the EMI/RFI from five modules, as noted in Table 1 of WCAP-15403, "Electromagnetic Compatibility Test Report Westinghouse ASIC-Based Replacement Module for 7300 Process Protection System." The five ABRMs selected for the emission measurements are representative of all ABRMs for the following reasons:

- The major source of radiated and conducted emissions is the MB, which is the same for all of the ABRMs.

- The five PM designs of ABRMs used for emission measurements are similar to those of the ABRMs that were not used for emission measurements. Additionally, characteristics of signals that go through those five PMs are similar to the other PMs.

The staff reviewed the results of the EM emission measurements, which are documented in WCAP-15403, Section 6.2.2, and concluded that the EM emissions from ABRMs conform to the guidance in RG 1.180 and are, therefore, acceptable.

Westinghouse performed the susceptibility tests on 14 of the ABRMs listed in Table 1 of WCAP-15403. The low-frequency radiated susceptibility tests, low-frequency conducted susceptibility tests, and electrical fast transient tests, were successfully performed in accordance with TR-102323. On the basis of the test results, the staff concludes that the ABRMs are qualified for low-frequency radiated susceptibility, low-frequency conducted susceptibility, and electrical fast transient conditions at plant locations that are enveloped by TR-102323 or RG 1.180.

For the three tests that follow, the ABRMs failed when the test levels recommended in TR-102323 were applied. Westinghouse performed these susceptibility tests using levels that were less conservative than those recommended in TR-102323:

- high- frequency radiated susceptibility test:

  TR-102323 recommends exposing equipment to 10 V/m for frequency range 10 KHz to 1 GHz. With the exception of the NAL, the ABRMs did not meet the frequency guidelines at some frequencies when exposed to 10 V/m. All of the unacceptable deviations were at frequencies below 200 MHz. Most of the unacceptable deviations were at frequencies between 500 KHz and 30 MHz. Because of these unacceptable deviations, Westinghouse performed a high-frequency radiated susceptibility test that exposed the ABRMs to 1 V/m or 5 V/m for certain frequency ranges. (For details of the field strength (1 V/m or 5 V/m) and frequency ranges at which each ABRM was tested, see Appendix C of WCAP-15403.) Given its assumption that the cabinet that houses the 7300-series card will attenuate the high-frequency radiated EM fields by at least 10 dB, Westinghouse concluded that its test is equivalent to exposing the ABRMs to high-frequency radiated susceptibility that is 10 dB greater than the tested levels. In order for the staff to accept Westinghouse’s conclusion, Westinghouse or the licensee needs to provide a detailed analysis showing how the 7300 system cabinet attenuates radiated signals by 10 dB, or needs to test the ABRMs at levels that are 10 dB greater than the test levels that were used in tests performed without a cabinet.

- high-frequency conducted susceptibility test:

  TR-102323 recommends injecting equipment with 103 dBuA for a frequency range of 50 KHz to 400 MHz. However, Westinghouse performed a high-frequency conducted susceptibility test injecting ABRMs with noise current that is 8 dB greater than the maximum plant emission levels collected for preparing TR-102323. The red line in Figure 1 of WCAP-15403 shows the actual test level used.

- surge test:

  TR-102323 recommends exposing equipment to a 3KV surge. Westinghouse performed the surge test by exposing the ABRMs to the lesser voltage level of ±500V.

For high-frequency radiated susceptibility, high-frequency conducted susceptibility, and surge conditions, the staff finds that the ABRMs are qualified only to the levels to which they have been tested. For those conditions, the licensees need to ensure that the worst expected plant EM conditions are enveloped by the test levels listed in WCAP-15403 or perform additional testing to demonstrate qualification.

5.0 CONCLUSIONS

The GDCs listed in Appendix A, 10 CFR Part 50 establish minimum requirements for the design of nuclear power plants. IEEE Std 603 is also incorporated in 10 CFR 50.55a(h). The Regulatory Guides and the endorsed industry codes and standards listed in Table 7-1 of the SRP are the guidelines used as the basis for this evaluation. This section of this SE summarizes the staff's findings, with regard to the acceptability of the ABRMs, as they apply to the regulatory requirements.

The staff finds that the quality criteria for the ABRMs have been satisfied either by the Westinghouse Quality Assurance (QA) program, which meets the requirements of Appendix B to 10 CFR Part 50, or by the dedication of commercial-grade digital hardware and software components through procedures that conform to the guidance in EPRI TR-102348, "Guideline on Licensing Digital Upgrades."

The quality standards specified in 10 CFR 50.55a(a)(1) for systems that are important to safety are addressed by conformance with the codes and standards listed in the SRP. Westinghouse also uses codes, standards, and commercial-grade dedication in the development of the ABRMs that are the same as or equivalent to the standards in the SRP and are, therefore, in conformance with this requirement.

Section 50.55a(h) of 10 CFR endorses IEEE Std 603, which addresses both system-level design issues and quality criteria for qualifying devices. Westinghouse has addressed these issues in the ABRM topical report. The staff finds that the ABRMs meet the criteria of IEEE Std 603, as well as supplemental standard IEEE Std 7-4.3.2-1996, and concludes that the ABRM design is compliant with this requirement.

Section 50.62 of 10 CFR specifies requirements for reducing the risk from an anticipated transient without scram. The staff notes that replacement of 7300 analog cards with ABRMs does not appear to adversely affect a plant’s existing safety protection designs that meet the requirements in IEEE Std 279, Sections 4.17, "Manual Initiation," and 4.20, "Information Read-Out." Additionally, the staff notes that the replacements do not appear to affect the functional diversity that exists within the protection and safety systems and the existing diverse ATWS. The way that the licensees have met the requirements of 10 CFR 50.62 vary from plant to plant. Therefore, the licensee may take credit for the existing plant design, with regard to the requirements of 10 CFR 50.62, after confirming that the plant’s defense-in-depth and diversity are not adversely impacted by the implementation of the ABRMs.

The ABRMs are environmentally, seismically, and electromagnetically qualified to the levels and conditions at which they performed appropriately during the tests submitted in the topical report, as evaluated in this SE. The ABRMs were type tested in accordance with ANSI/IEEE Std 323, "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations," and IEEE Std 344, "Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Generating Stations." For EMC testing, the ABRMs were tested using the methods recommended in EPRI TR-102323, "Guidelines for Electromagnetic Interference Testing in Power Plants." However, some of the limits used during those tests are less than the limits recommended in TR-102323. Because each plant has unique environmental conditions, licensees will need to ensure (before installing the ABRMs) that the plant’s environments are enveloped by the tested conditions indicated in the topical report, or conduct additional testing as is discussed in Section 4.6.4 of this SE.

The staff conducted a review of the safety system descriptions in WCAP-15413 for conformance to the guidelines in the regulatory guides and industry codes and standards that apply to these modules. On the basis of that review, the staff concludes that Westinghouse adequately identified the guidelines that apply to these modules. In addition, on the basis of its review of the ABRM design approaches for conformance to the guidelines, the staff concludes that the requirements of GDC 1 and 10 CFR 50.55a(a)(1) have been met.

The staff's conclusions are based on the requirements of ANSI/IEEE Std 603, as they apply to the ABRMs. The staff found that the ABRM design satisfies the requirements of 10 CFR 50.55a(h), with regard to ANSI/IEEE Std 603, and is, therefore, acceptable.

The staff finds that Westinghouse has identified the extent to which the ABRM modules must be designed to survive the effects of earthquakes, other natural phenomena, abnormal environments, and missiles, and has qualified them to show that they meet those requirements. Therefore, the staff finds that the ABRMs satisfy the requirements of GDCs 2 and 4.

The staff finds that the ABRMs are designed to provide equivalent fire protection to that provided by the existing analog modules and, therefore, satisfy the requirements of GDC 3.

The ABRMs appropriately support actions to safely operate the nuclear power unit under normal conditions, and to maintain it in a safe condition under accident conditions. Therefore, the staff concludes that the ABRMs satisfy the requirements of GDC 13.

The ABRMs consume less power than the existing 7300 analog modules. Consequently, the staff finds that installing the ABRMs has no adverse impact on the power supply. Based on this, the staff concludes that using ABRMs in place of 7300-series analog cards meets GDC 17.

The staff finds that the PPS design has not changed, and that the installation of an ABRM does not adversely impact the ability of the protection system to sense and respond to plant conditions by initiating appropriate action. Based on this, the staff concludes that using ABRMs in place of 7300 analog modules satisfies GDC 20.

Based on its review of WCAP-14975, "7300A ASIC-Based Replacement Module Reliability Assessment and Failure Modes and Effects Analysis," the staff finds that the calculated mean time between failure of a given ABRM exceeds that of the equivalent 7300 analog module that it replaces. As with the analog modules, all failure modes that affect the ABRMs are detectable by surveillance testing, and the provisions for testability remain the same. Based on its review, the staff concludes that the ABRMs satisfy the requirements of GDC 21 for reliability and testability.

The staff finds that the ABRMs conform to the guidelines in RG 1.75 for protection system independence, and implementing the ABRM will not adversely affect a plant's existing compliance with RG 1.75. On the basis of its review, the staff concludes that the ABRMs satisfy the requirement of IEEE Std 603 with regard to system independence. Therefore, the staff concludes that the ABRMs satisfy the requirements of GDC 22.

The protection system is designed with consideration of the most probable failure mode, which in the case of either the 7300 analog modules or the ABRMs is to initiate the protective action on loss of power. The ABRMs are designed to replicate the 7300 analog system and a de-energize-to-trip mode has been implemented. On the basis of its review of WCAP-14975, the staff concludes that the ABRMs satisfy the requirements of GDC 23.

The staff finds that the protection and control systems are designed to be separate and distinct. In some cases, the control system input is derived from the protection system through an isolator. The ABRM isolators have been successfully tested to guard against a potential protection system impact by the application of a fault to the control side of the isolator. These fault tests are documented in WCAP-15371, "Fault Conditions Test Report, Westinghouse ASIC-Based Replacement Module for the 7300 Process Protection System." Based on its review of the above, the staff concludes that the ABRMs satisfy the requirements of GDC 24.

Based on its review of the FMEA (WCAP-14975, "7300A ASIC-Based Replacement Module Reliability Assessment and Failure Modes and Effects Analysis"), the staff finds that installation of an ABRM in the control system does not impact the single failure analysis of the reactivity control system since the 7300 analog system, and the ABRMs have the same failure modes. The staff, therefore, concludes that the ABRMs satisfy the requirements of GDC 25.

Based on its review, the staff finds that the use of ABRMs does not adversely affect the reliability of the existing protection and reactivity control systems. On this basis, the staff concludes that using ABRMs in place of 7300-series analog modules satisfies the requirements of GDC 29.

A Westinghouse objective in submitting this topical report was to obtain the staff approval so that licensees can replace the existing 7300-Series analog modules at individual plants with ABRMs under the provisions of 10 CFR 50.59. However, the staff finds that the unique configuration of each plant makes it imperative for each licensee to analyze whether the ABRMs can be installed under 10 CFR 50.59. Therefore, this SE addresses only the generic issues associated with installing the ABRMs. Nonetheless, licensees may reference this SE, as applicable, when performing a 10 CFR 50.59 determination.

In summary, based on the forgoing review of Topical Report WCAP-15413, and the supporting topical reports, the staff concludes that the ABRMs meet the requirements of 10 CFR Part 50, Appendix A, GDCs 1, 2, 3, 4, 13, 17, 20, 21, 22, 23, 24, 25, and 29, and IEEE Std 603 for the design of safety-related reactor protection systems, engineered safety features systems, and any applicable plant systems and are, therefore, acceptable.

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