Docket No. 50-423
B12880

Attachment 1

Plant Specific Details Regarding
ATWS Mitigation System Actuation Circuitry (AMSAC)
For Millstone Unit No. 3

April 1988

PLANT SPECIFIC DETAILS REGARDING
ATWS MITIGATION SYSTEM ACTUATION CIRCUITRY (AMSAC)
FOR MILLSTONE UNIT NO. 3

## INTRODUCTION

In response to 10CFR50.62, "Requirements for Reduction of Risk from Anticipated Transient Without Scram (ATWS) Event for Light-Water-Cooled Nuclear Power Plants", Westinghouse Owners' Group (WOG) submitted for review WCAP-10858, "AMSAC Generic Design Package". This document details the WOG's proposed generic ATWS Mitigation System Actuation Circuitry (AMSAC) designs for compliance with 10CFR50.62. The NRC Safety Evaluation Report (SER) of Topical Report WCAP-10858 reported the completion of the NRC Staff review of the generic design information and identified plant-specific design information required by the NRC Staff to verify compliance with 10CFR50.62. The plant specific information applicable to Millstone Unit No. 3 is provided in the following paragraph.

Northeast Nuclear Energy Company (NNECO) has selected and will implement an AMSAC Actuation Logic which detects a loss of heat-sink by monitoring the level in each of the Steam Generators. The Actuation Logic is depicted in Figure 1. This Actuation Logic incorporates an automatic arming and block circuitry based upon turbine load by monitoring the first-stage turbine impulse chamber pressure. This signal, referred to as the C-20 signal, blocks AMSAC actuation at low power levels to prevent spurious trips during plant startup.

The following is the response to the fourteen (14) items requested in the NRC SER of the AMSAC Generic Design Package for the plant specific submittal.

PLANT SPECIFIC DETAILS REGAPPING
ATWS MITIGATION SYSTEM ACTUATION CIRCUITRY (AMSAC)
FOR MILLSTONE UNIT NO. 3

QUESTION 1

Diversity

The plant specific submittal should indicate the degree of diversity that exists between the AMSAC equipment and the existing Reactor Protection System. Equipment diversity to the extent reasonable and practicable to minimize the potential for common cause failures is required from the sensors output to, but not including, the final actuation device; e.g., existing circuit breakers may be used for the auxiliary feedwater initiation. The sensors need not be of a diverse design or manufacture. Existing protection system instrument-sensing lines, sensors, and sensor power supplies may be used. Sensor and instrument sensing lines should be selected such that adverse interactions with existing control systems are avoided.

RESPONSE:

For Millstone Unit No. 3, the existing transmitters, transmitter power supplies, and isolators associated with the turbine impulse chamber pressure and the narrow range steam generator level from the 7300 process protection system provides input to the AMSAC system. This is consistent with 10CFR50.62 requirements; mitigating system instrument channel components (excluding sensors and isolation devices) must be diverse from the existing reactor protection system. The Westinghouse AMSAC design is a microprocessor-based system with the capability to incorporate three different actuation logic schemes; Millstone Unit No. 3 will employ actuation on low-low steam generator level. The reactor trip system utilizes an analog-based process protection system and discrete component logic system and therefore, Millstone Unit No. 3 fulfills the requirement of diversity through the types of Technology (analog versus digital). Additionally, diversity is accomplished through the hardware utilized for the same function in both AMSAC and the reactor trip

QUESTION 1 (continued)

system, since the components used in AMSAC are provided from a different manufacturer. For example, relays are utilized in both systems for interfacing with the final actuation circuits. At Millstone Unit No. 3, Potter & Brumfield relays are utilized within the reactor trip system, while Struthers-Dunn relays are used within AMSAC for this function.

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QUESTION 2

Logic Power Supplies

The plant specific submittal should discuss the logic power supply design. According to the rule, the AMSAC logic power supply is not required to be safety related (Class 1E). However, logic power should be from an instrument power supply that is independent from the Reactor Protection System (RPS) power supplies. Our review of additional information submitted by WOG indicated that power to the logic circuits will utilize RPS batteries and inverters. The Staff finds this portion of the design unacceptable, therefore, independent power supplies should be provided.

RESPONSE

According to the NRC final rule, the AMSAC logic power supply is not required to be safety related. However, the logic power supply should be from an instrument power supply that is independent from the Reactor Protection System power supplies. The Millstone Unit No. 3's AMSAC logic power supply is provided by an independent inverter which is backed by a battery that is totally independent from the existing battery supply for the Reactor Protection System. This power supply is connected to a motor control center which is backed by diesel generators when needed.

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QUESTION 3

Safety Related Interface

The plant specific submittal should show that the implementation is such that the existing protection system continues to meet all applicable safety criteria.

RESPONSE

The AMSAC inputs for measuring turbine impulse chamber pressure and narrow range steam generator water level are derived from existing transmitters and channels within the 7300 process protection system. Connections to these channels are made down-stream of Class 1E isolation devices which are located within the protection cabinets. These isolation devices ensure that the existing protection system continues to meet all applicable safety criteria by providing isolation as demonstrated in Appendix A of this submittal. Buffering of the AMSAC outputs from the safety related final actuation device is achieved through qualified relays. The relays selected for this application are widely used throughout the industry in both safety and non-safety applications. To demonstrate the capability of these isolation devices, the devices were qualified in a manner consistent with the requirements of Appendix A of the NRC SER. Details of this test can be found in Appendix A of this submittal.

These output buffering relays are normally de-energized and as a result, will not initiate actuations upon a loss of power to the relays or upon a relay coil failing open. Challenges to the existing safety systems are minimized through this approach and the use of redundant hardware with a majority vote to energize the relay coils. In the unlikely event of a random failure where a relay contact would operate spuriously, starting of an auxiliary feedwater pump or tripping of the turbine could occur.

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**QUESTION 4**

Quality Assurance

The plant specific submittal should provide information regarding compliance with Generic Letter 85-06, "Quality Assurance Guidance for ATWS Equipment That Is Not Safety-Related".

**RESPONSE**

Generic Letter (GL) 85-06 provided the explicit QA guidance for non-safety related ATWS equipment as required by 10CFR50.62. The GL specifically states that the QA program for the non-safety related ATWS equipment does not need to meet 10CFR50 Appendix B requirements, nor would compliance be judged in terms of the Appendix. Detailed QA guidance is provided in the enclosure to the GL. For manufacturing, the Westinghouse program exceeds the above requirement. The AMSAC design verification, installation, and testing is being performed in accordance with procedures for non-safety related equipment at Millstone Unit No. 3 that is consistent with guidance contained in GL 85-06.

QUESTION 5

Maintenance Bypasses

The plant specific submittal should discuss how maintenance at power is accomplished and how good human factors engineering practice is incorporated into the continuous indication of bypass status in the control room.

RESPONSE

Maintenance at power is accomplished through bypassing by way of a permanently installed bypass switch. This method complies with the NRC SER by not involving lifting leads, pulling fuses, tripping breakers, or physically blocking relays. Placement of the AMSAC bypass switch to the bypass position inhibits operation of the system's output relays which operate the final actuation devices. Status outputs to the plant computer and main control board, indicating that a general warning condition exists with AMSAC, are initiated when the bypass switch is placed in the bypass position.

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QUESTION 6

Operating Bypasses

The plant specific submittal should state that operating bypasses are continuously indicated in the control room; provide the basis for the 70% or plant specific operating bypass level; discuss the human factors design aspects of the continuous indication; and discuss the diversity and independence of the C-20 permissive signal (defeats the block of AMSAC).

RESPONSE

The Millstone Unit No. 3 AMSAC design includes an operating bypass which is continuously indicated in the control room via an annunciator on the main control board. WOG Letter OG-87-10 dated February 26, 1987, has been submitted to the NRC by the WOG providing the basis for the C-20 setpoint. The basis is as follows: short term protection against high reactor coolant system pressures is not required until 70% of nominal power. However, in order to minimize the amount of reactor coolant system voiding during an ATWS, AMSAC will operate at and above 40% of nominal power. Furthermore, since the potential exists for spurious AMSAC actuations during startup at the lower power levels, to assure the above requirements are met, AMSAC will be automatically blocked at turbine loads less than 40% by the C-20 permissive. The C-20 permissive signal uses the existing turbine impulse chamber pressure sensors. The indication of the bypass status is consistent with existing bypass design philosophy used for the control room. For guidance on diversity and independence for the process signals and power supplies, see these specific questions/responses.

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QUESTION 7

Means for Bypassing

The plant specific submittal should state that the means for bypassing is accomplished with a permanently installed, human factored, bypass switch or similar device, and verify that disallowed methods mentioned in the guidance are not utilized.

RESPONSE

The means for bypassing AMSAC is accomplished with a permanently installed, human factored, bypass switch. It does not involve lifting leads, pulling fuses, tripping breakers, or physically blocking relays.

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QUESTION 8

Manual Initiation

The plant specific submittal should discuss how a manual turbine trip and auxiliary feedwater actuation are accomplished by the operator.

RESPONSE

Manual initiation of the auxiliary feedwater pumps and tripping of the turbine are achieved through existing plant controls.

Each of the auxiliary feedwater pumps, both motor driven and turbine pumps, has a manual start control on the main control board for use in starting the individual pumps. Likewise, a manual control exists on the main control board for tripping the turbine through the auto stop trip solenoid valves and emergency trip fluid solenoid valves.

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QUESTION 9

Electrical Independence from Existing Reactor Protection System

The plant specific submittal should show that electrical independence is achieved. This is required from the sensor output to the final actuation device at which point non-safety-related circuits must be isolated from safety related circuits by qualified Class 1E isolators. Use of existing isolators is acceptable. However, each plant specific submittal should provide an analysis and tests which demonstrates that the existing isolator will function under the maximum worst case fault conditions. The required method for qualifying either the existing or diverse isolators is presented in Appendix A.

RESPONSE

Electrical independence from the existing Reactor Trip System (RTS) is required from the sensor output to, but not including, the final actuation device. This is to separate safety related circuits from non-safety related circuits. The Millstone Unit No. 3 AMSAC fulfills this requirement. For the turbine impulse chamber pressure and steam generator level inputs, NNECO has elected to use the existing pressure and steam generator level transmitters, loop power supplies, and new isolation devices being added within the 7300 system process protection cabinets. Electrical independent between the non-Class 1E AMSAC logic circuitry and the Class 1E process protection cabinet circuits is provided through isolation devices which have been tested as described in Appendix A of this document. Moreover, the non-Class 1E logic circuitry and outputs of AMSAC are isolated from Class 1E circuits.

PLANT SPECIFIC DETAILS REGARDING
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QUESTION 10

Physical Separation from Existing Reactor Protection System

Physical separation from existing reactor protection system is not required, unless redundant divisions and channels in the existing reactor trip system are not physically separated. The implementation must be such that separation criteria applied to the existing protection system are not violated. The plant specific submittal should respond to this concern.

RESPONSE

The AMSAC cabinet has been located in such a way to be physically separated from the existing reactor protection system. The cable routing for the interface to the trip systems are independent of the protection system cable. Based on this information, there will be no interaction with the reactor protection system. This requirement is based on IEEE 279-1971 (Criteria for Protection Systems for Nuclear Power Generating Stations), which states the requirements and criteria applicable to Class 1E instrumentation. The AMSAC actuation outputs to the redundant turbine trip and auxiliary feedwater pump circuits are provided from separate relay panels within the AMSAC cabinet. Separation of the Train A, B, and non-Class 1E circuits within the AMSAC cabinet is achieved through a combination of metal barriers, conduit, and distance. Additionally, the isolation fault tests mentioned in Appendix A will demonstrate that credible faults will not disable channels associated with other protection sets. All non-Class 1E AMSAC inputs and status outputs will be routed to a separate logic cabinet and therefore, will be separate from the Class 1E actuation circuits. Figure 2 depicts the system block diagram along with the cable separation groups.

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QUESTION 11

Environmental Qualification

The plant specific submittal should address the environmental qualification of ATWS equipment for anticipated operational occurrences only, not for accidents.

RESPONSE

The SER requires that only the isolation devices need to comply with environmental and seismic qualification, which is discussed in Appendix A.

The AMSAC system is not required to be safety related and therefore, is not required to meet IEEE 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations", and is not required to be qualified as safety related equipment. The AMSAC equipment located outside containment (instrument rack room) is in a mild environment and will follow the same design standard that currently exists for non-Class 1E equipment for Millstone Unit No. 3.

PLANT SPECIFIC DETAILS REGARDING
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QUESTION 12

Testability at Power

Measures are to be established to test, as appropriate, non-safety related ATWS equipment prior to installation and periodically. Testing of AMSAC may be performed with AMSAC in bypass. Testing of AMSAC outputs through the final actuation devices will be performed with the plant shutdown. The plant specific submittals should present the test program and state that the output signal is indicated in the control room in a manner consistent with plant practices including human factors.

RESPONSE

The non-safety related ATWS circuitry is testable with the plant on-line. Testing of the AMSAC outputs to the final actuation devices may be performed with the plant shutdown.

The AMSAC system for Millstone provides for periodic testing through a series of overlapping tests. These tests are performed with the AMSAC outputs bypassed. This bypass is accomplished through a permanently installed bypass switch which negates the need to lift leads, pull fuses, trip breakers, or physically block relays. Status outputs to the plant computer and main control board, indicating that a general warning condition exists with AMSAC, are initiated when the system's outputs are bypassed. Once the system bypass is established, a series of overlapping tests are performed to verify analog channel accuracy, setpoint (bistable trip) accuracy, coincidence logic operation including operation and accuracy of all timers, and continuity through the output relay coils. Switches are provided for each output relay to perform testing of AMSAC outputs through the final actuation devices with the plant shutdown. A simplified block diagram is shown in Figure 3 reflecting the test overlaps for the periodic on-line tests. A summary of each of the overlapping tests follows.

QUESTION 12 (continued)

Analog Input Channel Testing

The field input to each analog input channel is replaced with a variable test reference which is used to confirm accuracy of the channel gain and offset. The test reference is then ramped up and down throughout a portion of the channel range to verify accuracy of the channel setpoint and associated deadband. This test confirms operation of the input channel signal conditioning circuitry, analog-to-digital converters, and processor operation.

Processor Logic Testing

The second sequence of testing verifies that each actuation logic processor performs the proper coincidence logic, including timing functions, and generates the proper outputs. In this test, the field input channel for the processor under test is replaced with test references. These test references simulate the channel values as either above or below the setpoint to verify all combinations of coincidence logic and generation of the proper processor outputs to the majority voting modules is performed. This test confirms operation of the input channel signal conditioning circuitry, analog-to-digital converters, processor operation, and output circuits to the majority voters.

Majority Voter and Output Relay Tests

Each majority voting module and associated output relays are tested to verify operation of the majority vote (2 out of 3) and that continuity exists for each of the output relay coils. Integrity of the relay coils along with associated wiring is verified while exercising the voting logic.

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QUESTION 13

Completion of Mitigative Action

AMSAC shall be designed so that once actuated, the completion of mitigating action shall be consistent with the plant turbine trip and auxiliary feedwater circuitry. Plant specific submittals should verify that the protective action, once initiated, goes to completion and that the subsequent return to operation requires deliberate operator action.

RESPONSE

Once AMSAC is initiated, the completion of the mitigated actions in response to the AMSAC signal is performed through existing plant circuits for the auxiliary feedwater pumps and the turbine trip circuits. The circuit breakers for the motor driven auxiliary feedwater pumps are provided with seal-in-circuitry which requires manual action at the main control board to stop the pumps. For both motor driven auxiliary feedwater pumps, only the pump protective relays and emergency unloading signals (emergency diesel generator sequencer) will serve to automatically stop the pumps. The turbine driven auxiliary feedwater pump is provided with seal-in-circuitry which requires operator action at the main control board to stop the pump.

The AMSAC actuation signal is also inputted to the turbine trip circuitry. This AMSAC actuation signal is an "or" function with the reactor trip (P-4) signal along with various turbine protection trips. With any one of these present, the turbine stop valves will close resulting in a turbine trip. In an event that AMSAC calls for initiation of auxiliary feedwater flow and turbine trip, the design will ensure completion of the mitigative action and return to normal status by requiring deliberate operator action.

PLANT SPECIFIC DETAILS REGARDING
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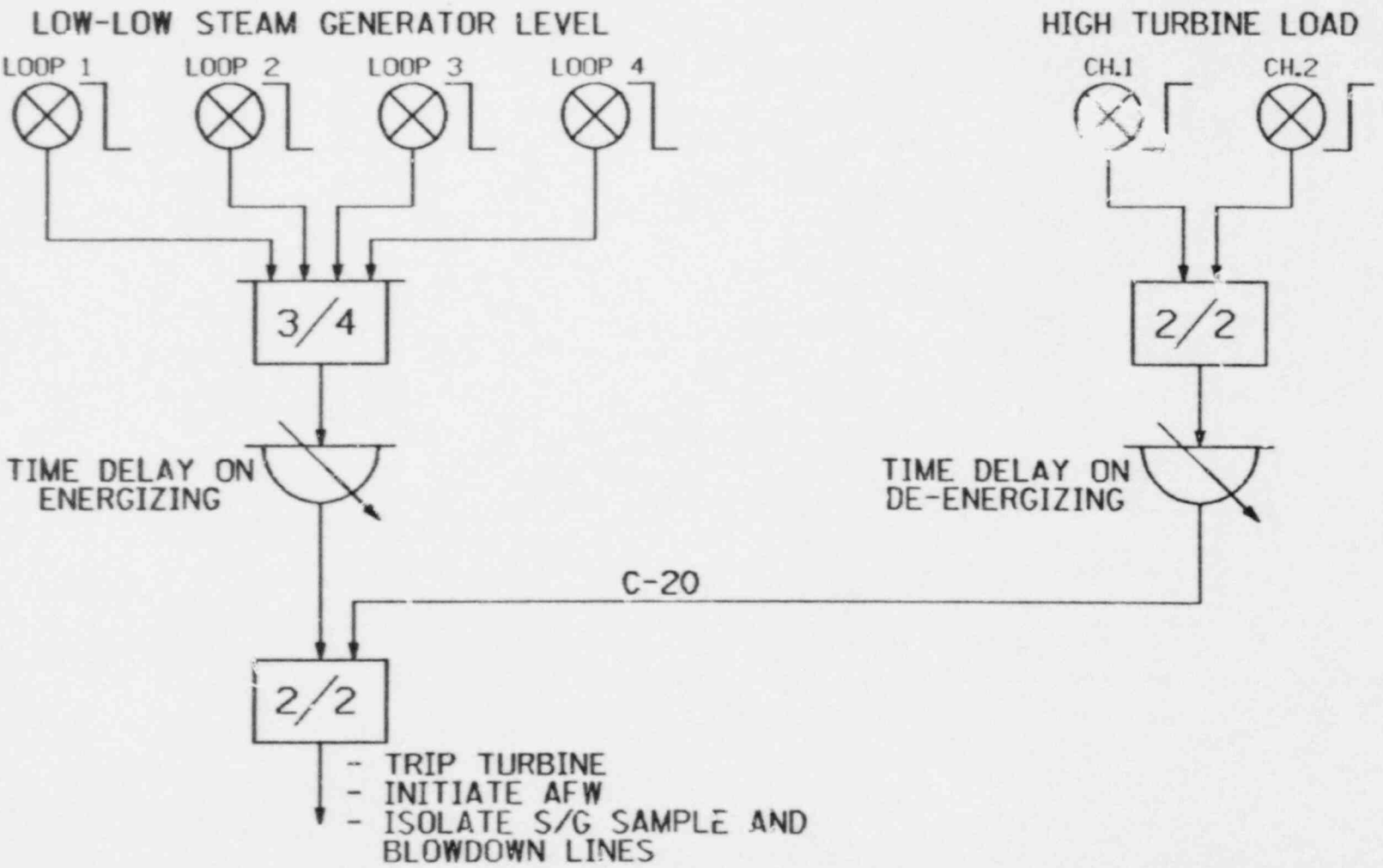
QUESTION 14

Technical Specifications

Technical specification requirements related to AMSAC will have to be addressed by plant specific submittals.

RESPONSE

Technical specification requirements for AMSAC are unnecessary, since they would not enhance overall plant safety beyond that afforded by planned administrative controls. In addition, AMSAC should not be included in the technical specifications because the system does not meet the criteria included in the NRC Interim Policy Statement on Technical Specification Improvements. The surveillance interval and action required by an AMSAC failure will be administratively controlled by means of plant procedures. This position is consistent with the WOG position on this issue, as discussed in OG-171, "WOG Comments on Proposed AMSAC Technical Specification", dated February 10, 1986 and OG-87-10, Addendum 1 to WCAP-10858-P-A and WCAP-11293-A, "AMSAC Generic Design Package", dated February 26, 1987.




**C.A.D.**

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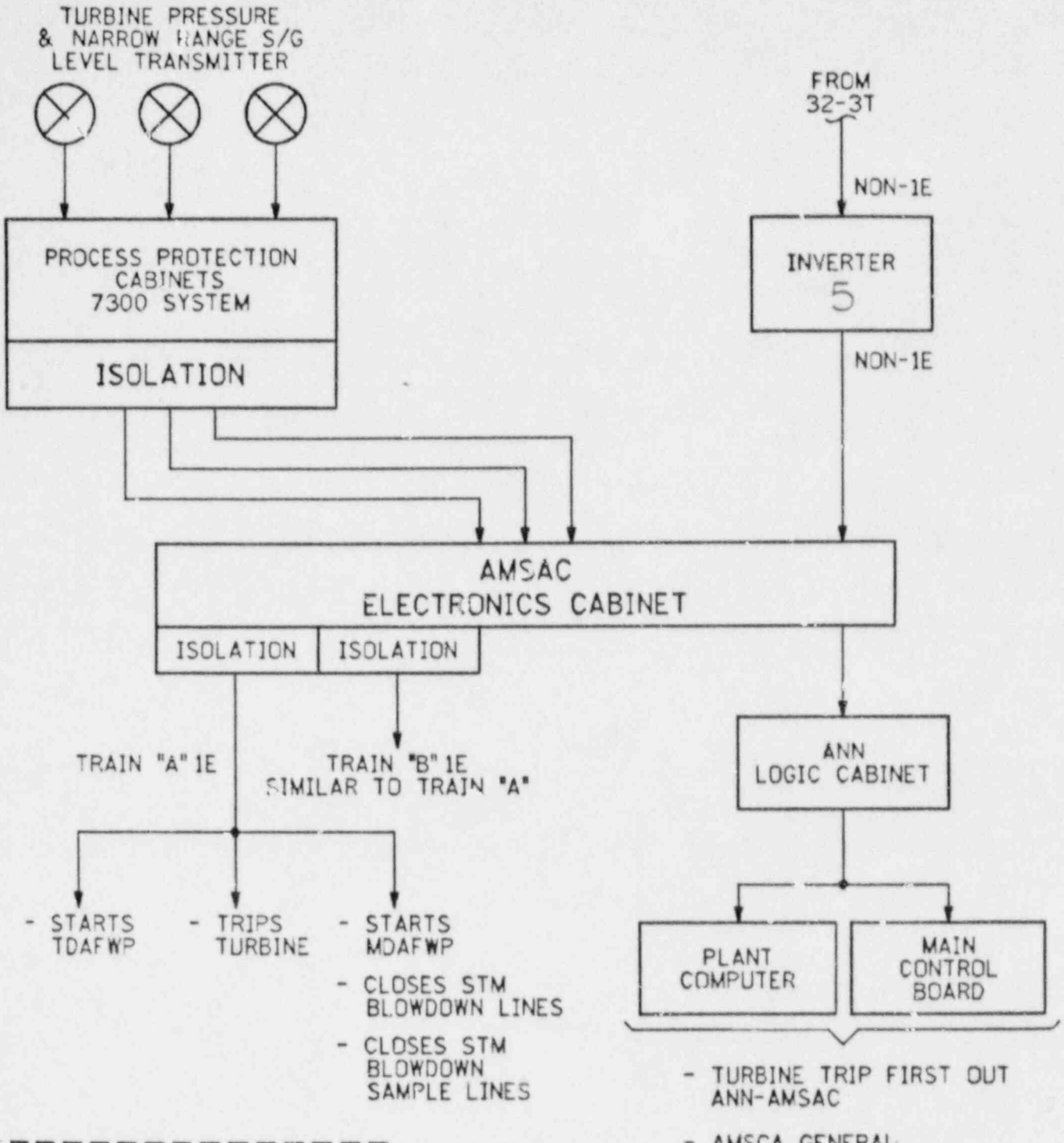
NORTHEAST UTILITIES SERVICE CO.

FOR NORTHEAST NUCLEAR POWER CO.

TITLE MILLSTONE NUCLEAR POWER STATION UNIT 3

# AMSAC ACTUATION LOGIC

| BY M.R.BABISI | CHKD. | APP. | APP. |
|---|---|---|---|
| DATE 2-5-88 | DATE | DATE | DATE |
| SCALE NONE | | DWG. NO. | FIGURE 1 |
| P.A.# 85-156 | | | |

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NORTHEAST UTILITIES SERVICE CO.

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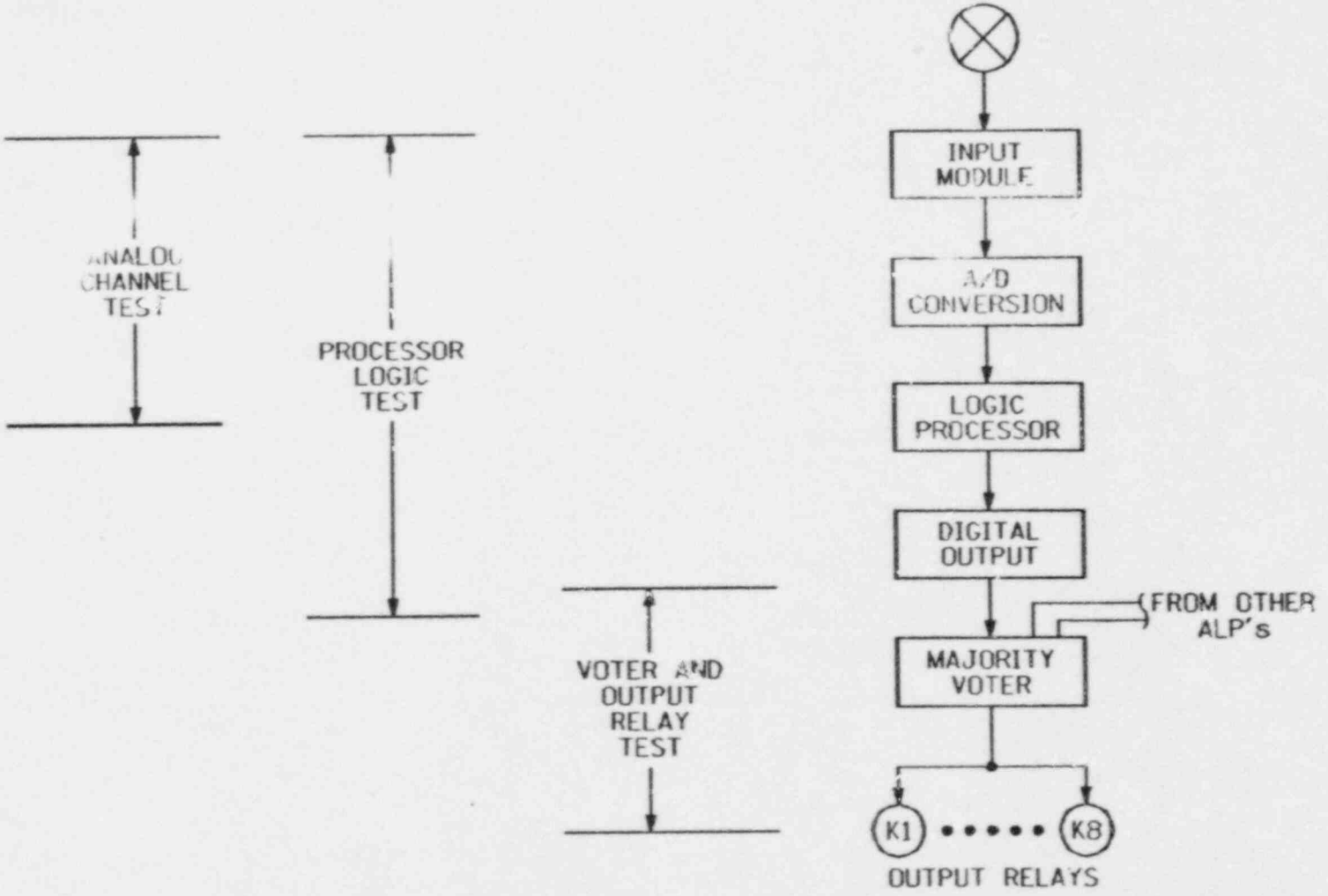
TITLE: MILLSTONE NUCLEAR POWER STATION UNIT 3

AMSAC BLOCK DIAGRAM

| BY | M.R. BIBIS | CHK'L | | APP. | | APP. | |
|---|---|---|---|---|---|---|---|
| DATE | 2-5-88 | DATE | | DATE | | DATE | |
| SCALE | NONE | | | DWG. NO. | FIGURE 2 | | |
| P.A.* | 85-156 | | | | | | |

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NORTHEAST UTILITIES SERVICE CO.
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TITLE MILLSTONE NUCLEAR POWER STATION UNIT 3

# ON-LINE TESTING OVERLAPS (AMSAC)

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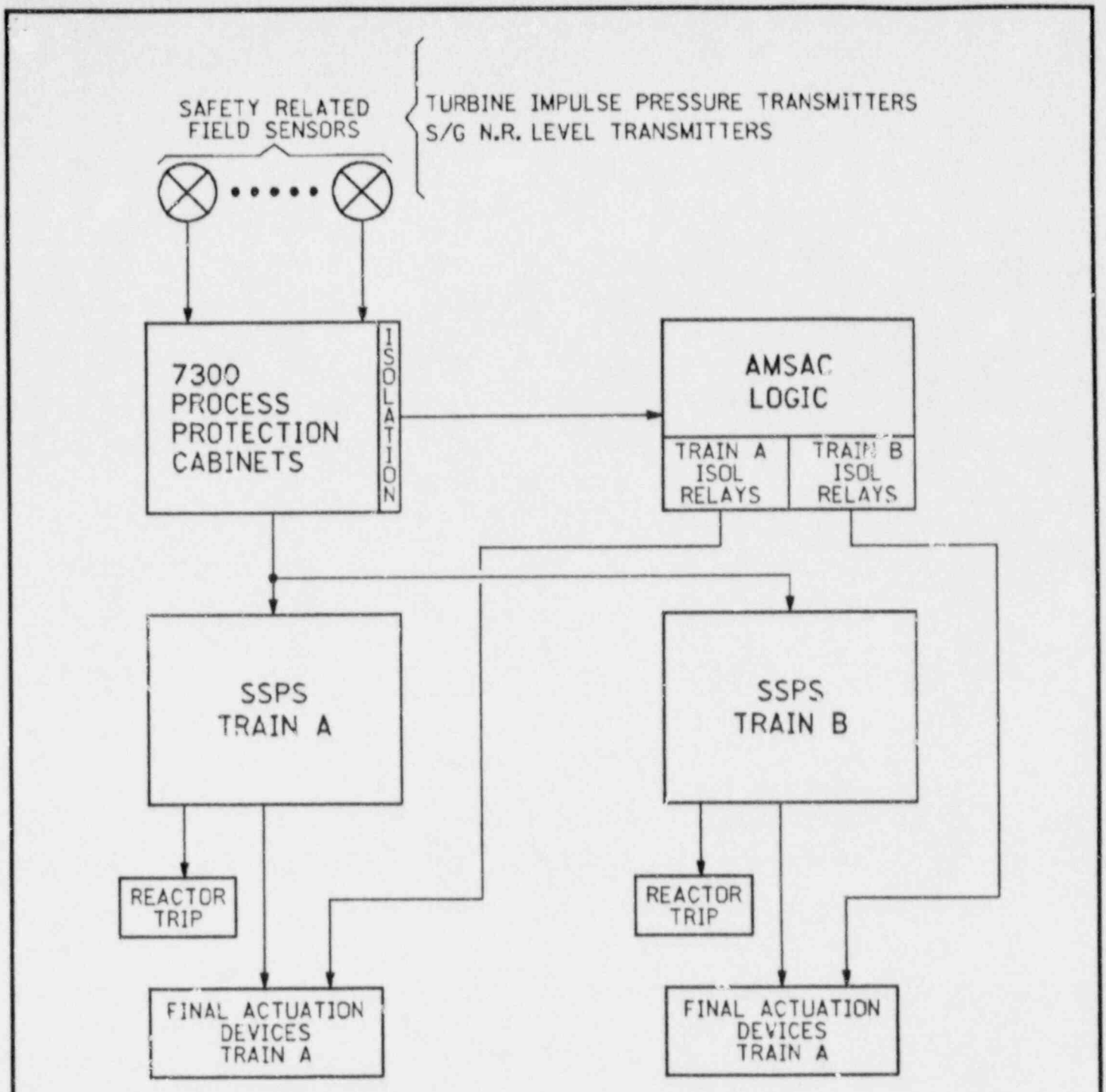
|---|---|---|---|
| BY M.R.BIRISI | CHKD. | APP. | APP. |
| DATE 2-8-88 | DATE | DATE | DATE |
| SCALE NONE | | DWG. NO. | |
| P.A.* 85-156 | | FIGURE 3 | |

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TITLE MILLSTONE NUCLEAR POWER STATION UNIT 3
RPS - AMSAC
DIAGRAM

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| BY M.R. BIBISI | ENGR. | APP. | APP. |
| DATE 2-8-88 | DATE | DATE | DATE |
| SCALE NONE | | DWG. NO. FIGURE 4 | |
| P.A.# 85-156 | | | |

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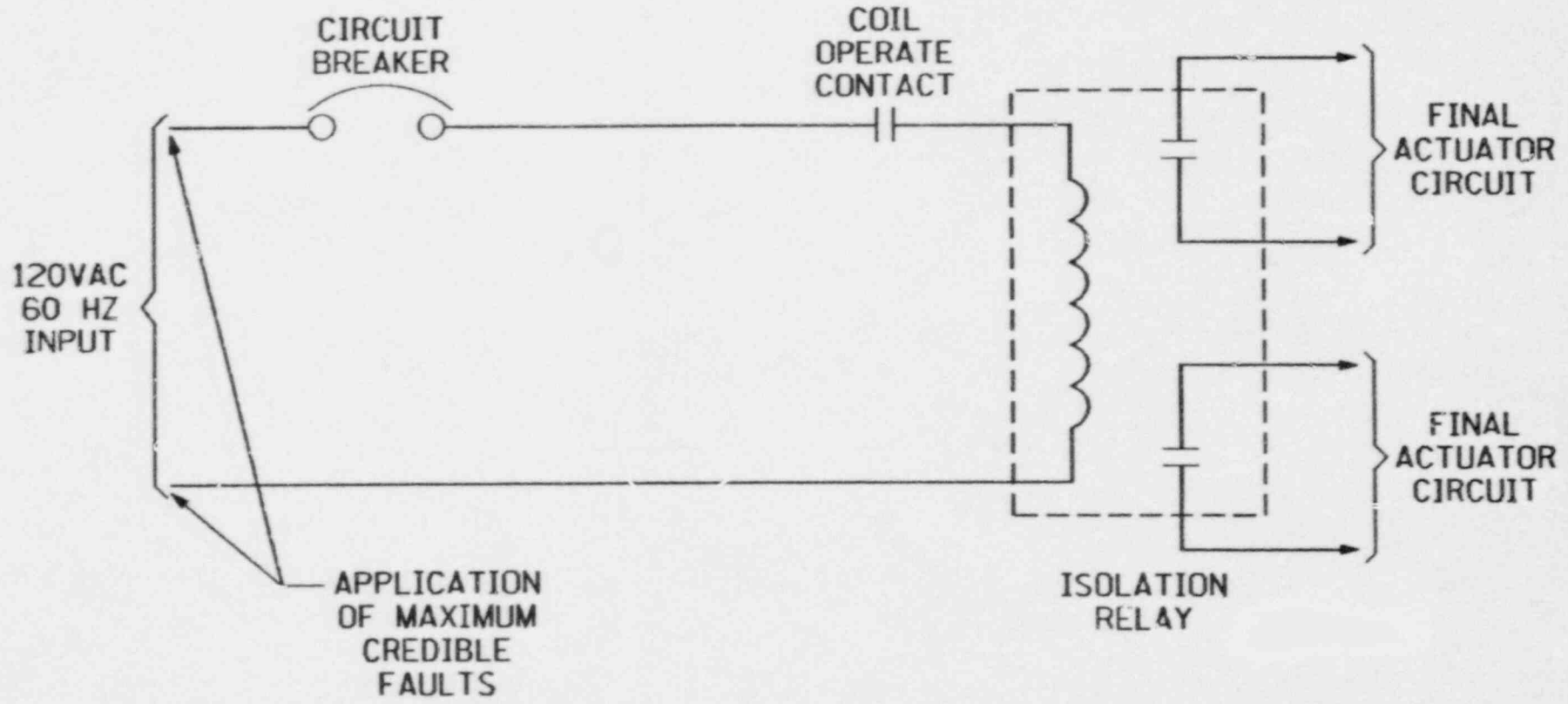


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ISOLATION RELAY (AMSAC)

| BY M.R. BIBISI | CHKD. | APP. | APP. |
|---|---|---|---|
| DATE 2-8-88 | DATE | DATE | DATE |
| SCALE NONE | | DWG. NO. FIGURE 5 | |
| P.A.* 85-156 | | | |

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## APPENDIX A - AMSAC ISOLATION DEVICE

Electrical independence of AMSAC from the existing reactor trip system (RTS) is provided through several means for Millstone Unit No. 3. A block diagram showing the relationship of AMSAC to the existing RTS is provided in Figure 4 which details the AMSAC/RTS connections and points of isolation.

The steam generator narrow range level inputs to AMSAC are derived from existing isolated signals from the process protection system. These signals are provided from differential pressure transmitters to the process protection cabinet to AMSAC. This arrangement does not require the use of new isolators to provide electrical independence of these instrument channels from the existing RTS. However, to prevent overloading of the existing current loops, several isolators of the existing type were added.

For measuring turbine load at the first stage, NNECO has elected to utilize the existing pressure transmitters. As with the narrow range steam generator inputs, the isolated signals are from the process protection cabinet.

Isolation is provided in the process protection cabinet for the signals used as input for AMSAC. As reported in WCAP-9982A, Westinghouse 7300 Series Process Control System Noise Tests, these isolation devices, which are powered by a Class 1E source, have been tested to demonstrate that the device is acceptable for its application. The purpose of the tests was to determine whether or not protection circuitry could be perturbed to the extent that protective action would be prevented by the pick-up or presence of credible interference on control wiring in close proximity to protection wiring within the process control racks. Isolation devices are used in the Process Control Systems 7300 Series equipment to electrically isolate the protection circuits inside the process control racks from control circuits outside the cabinets. The system was subjected to tests that included magnetic noise tests, output cable voltage faults (maximum credible voltages: 550 VAC, 250 VAC), cross talk, random noise, etc. The acceptance criteria for these test were a) the postulated fault should not prevent required protective action and b) spurious protective action caused by the postulated fault should be acceptable.

As mentioned, the subject of interferences that could negate protective actions was covered in various tests carried out for the WCAP, for the Westinghouse 7300 Series Process Control System Noise Tests. This report includes a series of tests that were performed before any faults or circuitry abnormalities were applied. These tests were carried out to demonstrate that a credible perturbation in the control wiring would not degrade protection action or be reflected back into the protection

wiring. Any of these interferences (i.e. noise, crosstalk, etc.) that would be generated by AMSAC falls under the same category as those tested for in the test report. Since AMSAC is separate from the RTS and the cable is not routed in an area that exceeds the 550 VAC 250 VDC test limits, any interference from AMSAC would not affect the RTS.

Under all tested conditions the protection circuitry operated as intended. The test showed conclusively that electrical interference imposed onto the isolator output wiring (control wiring) is not a consideration as to the proper operation of the perturbed channel nor any adjacent channels. The recordings verified that the interference imposed onto the control wiring was not induced into the protection wiring. The magnitude of the electrical interference introduced into the system and the stringent test procedures far exceeded any conditions that would be present in actual plant operations.

Relays are provided at the output of AMSAC for isolating the non-Class 1E AMSAC circuits from the Class 1E final actuator circuits. For Millstone, the AMSAC outputs are provided from separate relay panels within the AMSAC cabinet. Separation of the Train A, B, and Non-Class 1E circuits within the AMSAC cabinet is achieved through a combination of metal barriers, conduit, and distance. These relays have been tested with a maximum credible fault applied to the relay coil in the transverse mode. Tests have been performed with the relay coil operating contact in both the open and closed position. Figure 5 depicts the simplified diagram of this output isolation circuit, and point of application for the maximum credible faults. Details of the actual tests, fault levels and their origin, test data, and the pass/fail acceptance criteria will be submitted in the AMSAC Equipment Qualification Report.

Additionally, the SER requires that the isolation devices comply with the environmental qualifications (10CFR50.49) and with the seismic qualifications which were the basis for plant licensing. The isolation device at the output of AMSAC is the boundary between safety related and non-safety related circuits and therefore must be qualified. For the Millstone configuration, the AMSAC output isolation device will be qualified in accordance with the current Westinghouse seismic qualification program.

This program has developed and implemented the requirements of IEEE-344-1975, "IEEE Standard for Seismic Qualification of Class 1E Electrical Equipment for Nuclear Power Generating Stations" for Westinghouse supplied instrumentation and control systems. The isolations provided at the protection system have been seismically qualified. Environmental Qualification Reports, however, are not applicable to the AMSAC output relays since

these are located in a mild environment. The methodology for qualification is contained in WCAP-8587 Rev. 6.A, (Methodology for Qualifying Westinghouse WRD Supplied NSSS Safety Related Electrical Equipment).

The Class 1E loads operated by the isolation relay contacts are powered from a Class 1E source. The plant specific details of the wiring configuration can be found on the Millstone Unit No. 3's elementary drawings if needed.