NRC DISTRIBUTION FOR PART 50 DOCKET MATERIAL
(TEMPORARY FORM)

CONTROL NO: 1242

FILE:

FROM: Consumers Pwr Co Jackson, Michigan R C Bauman	DATE OF DOC 2-3-76	DATE REC'D 2-9-76	LTR XXX	TWX	RPT	OTHER
TO: DL	ORIG one signed	CC	OTHER	SENT NRC PDR XX SENT LOCAL PDR XX		
CLASS	UNCLASS XXXXXX	PROP INFO	INPUT	NO CYS REC'D 1	DOCKET NO: 50-329/330	

DESCRIPTION:

Ltr re our 12-23-75 ltr...trans the following:

THIS DOCUMENT CONTAINS
POOR QUALITY PAGES

ENCLOSURES:

Addl info concerning implementation of Reg Guides....concerning electrical engineering ....(10 cys encl rec'd)

PLANT NAME: Midland 1 & 2

FOR ACTION/INFORMATION ENV130 2-10-76 eht

SAFETY

ASSIGNED AD

BRANCH CHIEF MacKay

PROJECT MANAGER

LIC. ASST. W/ CYS ACRS

ASSIGNED BRANCH CHIEF

PROJECT MANAGER

LIC ASST. W/ ACRS

INTERNAL DISTRIBUTION

REG FILES
NRC PDR
OELD
GOSSICK/STAFF
I&E (2)
MIPC

PROJECT MANAGEMENT
BOYD
P. COLLINS
HOUSTON
PETERSON
MELTZ
HELTEMES

SYSTEMS SAFETY
HEINEMAN
SCHROEDER

ENGINEERING
MACCARY
KNIGHT
SIHWEIL
PAWLICKI

REACTOR SAFETY
ROSS
NOVAK
ROSETOCZY
CHECK

PLANT SYSTEMS
TEDESCO
BENAROYA
LAINAS
IPPOLITO

OPERATING REACTORS
STELLO

OPERATING TECH.
EISENHUT
SHAO
BAER
SCHWENCER
GRIMES

SITE SAFETY & ENVIRO ANALYSIS
DENTON
MULLER

ENVIRO TECH.
ERNST
BALLARD
SPANGLER

SITE TECH.
GAMMILL
STEPP
HULMAN

SITE ANALYSIS
VOLLMER
BUNCH
J. COLLINS
KREGER

AT&I
SALTZMAN
RUTBERG

MISCELLANEOUS

Muscuso C Miller

EXTERNAL DISTRIBUTION

LOCAL PDR Midland, Mi
TIC
NSIC
ASLB

NATIONAL LAB W/ CYS
REGION V-I&E-(WALNUT CREEK)
LA PDR
CONSULTANTS

BROOKHAVEN NAT. LAB
ULRIKSON (ORNL)

8006060 624 A

Consumers
Power
Company

General Offices: 212 West Michigan Avenue, Jackson, Michigan 49201 • Area Code 517 788-0550

February 3, 1976

RECEIVED
FEB 9 1976
U.S. NUCLEAR REGULATORY COMMISSION
Mail Section

Director of Nuclear Reactor Regulation
Attention: Mr Roger Boyd, Director
Division of Project Management
U. S. Nuclear Regulatory Commission
Washington, DC 20555

MIDLAND PROJECT
DOCKET NUMBERS 50-329, 50-330
REGULATORY GUIDE IMPLEMENTATION
FILE: 0505 SERIAL: 2121

The enclosed information responds to Mr A. Schwencer's December 23, 1975 letter requesting additional information on implementation of Regulatory Guides for the Midland Plant. These guides deal with electrical engineering and were discussed with your staff on November 13, 1975.

RCBauman

R. C. Bauman
Project Engineer

RCB/lmc

1242

221.1 Provide a list of the Regulatory Guides which are fully implemented in your system designs.

Response

Below is a listing of electrical control and instrumentation Regulatory Guides, up to and including Regulatory Guides 1.75. These guides were discussed during the November 13, 1975 meeting.

NSS Scope of Supply

Regulatory Guides 1.22, 1.47, 1.53, and 1.62 are fully implemented for B&W's scope of supply.

Balance of Plant Scope of Supply

The following Regulatory Guides are fully implemented in the Midland Balance of Plant system design:

R. G. 1.6	Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems
R. G. 1.9	Selection of Diesel Generator Set Capacity for Standby Power Supplies
R. G. 1.11	Instrument Lines Penetrating Primary Reactor Containment: At this time there are no instrument lines penetrating the primary reactor containment. If, at some future time, penetrations of this kind must be made, it will be done in compliance with the Regulatory Guide.
R. G. 1.12	Instrumentation for Earthquakes
R. G. 1.22	Periodic Testing of Protection System Actuation Functions
R. G. 1.32	Use of IEEE Standard 308-1971 "Criteria for Class 1E Electric Systems for Nuclear Power Generating Stations"
R. G. 1.41	Preoperational Testing of Redundant Onsite Electric Power Systems to Verify Proper Load Group Assignments
R. G. 1.45	Reactor Coolant Pressure Boundary Leakage Detection Systems

R. G. 1.47	Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems
R. G. 1.53	Application of Single Failure Criterion to Nuclear Power Plant Protection Systems
R. G. 1.62	Manual Initiation of Protective Actions

221.2 The staff has reviewed the exception to position C.1 of Regulatory Guide 1.63.

A detailed description of the plant design criteria to be implemented which is to satisfy General Design Criteria 50 (in lieu of Regulatory Guide 1.63) was presented to NRC during the November 13, 1975 meeting.

A. Provide detailed description of these criteria for staff review. This response should also address the following requirements which NRC understands are included in the criteria.

   1. The containment is not breached due to any electrical fault in a circuit or circuits that go through a penetration. This includes an electrical fault in the penetration assembly or directly outside.

   2. Assurance that the design criteria requirements of the devices or methods included in the design which protect the penetration against failure due to any electrical faults are of a high quality and perform these functions with a high degree of confidence.

   3. Assurance that an electrical fault occurring in any portion of a circuit passing through a penetration will be cleared in a manner that protects the penetration as required in (1) above, prevents loss of power to redundant safety loads, prevents further equipment damage and maintains the validity of the bases and assumptions used in the Accident Analysis.

B. It is stated that overload protection is not provided for low energy and instrumentation circuits when analysis demonstrates that a sustained maximum overload cannot cause mechanical failure of the penetration. Provide a description which identifies the analysis methods to be used for these circuits. In addition, provide a description of the types of overload protection (circuit breakers, fuses, etc.) to be utilized in the plant design for the remainder of the circuits which pass through penetrations.

C. Indicate full conformance with the remainder of Regulatory Guide 1.63 or identify and justify each exception.

Response

A. The following plant design criteria have been adopted to satisfy the requirements of General Design Criterion 50.

1. Any electrical fault, including a fault in the penetration assembly or directly outside, occurring in a circuit or circuits that pass through an electrical penetration will not result in a breach of the containment.

2. Devices or methods utilized in the design which protect the penetration against failure due to any electrical fault are of high quality and reliability and perform their intended functions with a high degree of confidence; devices may not be Class 1E nor located in seismic Category I structures if the circuit in which they are utilized is a non-Class 1E circuit.

3.1. An electrical fault occurring in any portion of a circuit that is provided with backup fault protection and passes through an electrical penetration will be cleared in a manner that:

a. Protects the penetration against damage that could result in a breach of the containment.

b. Prevents loss of power to redundant safety loads.

c. Prevents further equipment damage.

d. Will not degrade Class 1E systems below an acceptable level.

3.2. Analyses are performed to demonstrate that an electrical fault occurring in any portion of a circuit that is not provided with backup overload protection and passes through an electrical penetration will not cause:

a. Damage to the penetration which could result in a breach of the containment.

b. Loss of power to redundant safety systems.

c. Further equipment damage.

d. Degradation of Class 1E systems below an acceptable level.

B. The following system designs have been adopted to ensure that the electrical penetration assemblies will withstand, without loss of mechanical integrity, any electrical fault occurring in a circuit or circuits that pass through the penetration:

1. Medium Voltage Power (6.9kV)

For medium voltage power circuits feeding loads in the containment, the circuit breaker associated with each load serves as the primary overload protection, and the main breaker to the individual bus serves as the backup protection. The relaying on the load and main breakers is well coordinated, and in the event the load breaker or load breaker protection fails to operate, the main breaker would clear any fault prior to penetration damage.

2. Low Voltage Power

a. For low voltage power high energy circuits fed directly from a 480 volt load center, the same philosophy of protection is applied as for medium voltage circuits, whereby the main breaker serves as back up protection to the load breaker.

b. For low voltage high energy power circuits fed from 480 volt motor control centers (MCC), the circuit breaker associated with each load serves as the primary overload protection, and the load center breaker to the individual MCC serves as the backup protection.

c. For low voltage low energy power circuits fed from 480 MCCs, analyses will be performed to demonstrate that a sustained maximum overload cannot produce an unacceptable temperature rise within the electric penetration that would jeopardize its mechanical integrity. If the analysis should prove the contrary, then one of the following design methods will be utilized to provide backup overload protection:

1. Individual loads will be fed from a circuit breaker or fuse of a limited capacity bus fed through an MCC circuit breaker that will serve as the backup protection. The circuit breaker or fuse in the limited capacity bus serves as the primary overload protection.

2. Fuses in series with the load MCC circuit breaker.

3. Low Voltage Control

   The majority of low voltage control circuits are self-limiting in that the circuit resistance limits the fault current to a level which does not damage the penetration. Where, on a case by case analysis, a circuit is found not to be self-limiting, sub-feeder breakers, fuses, or an individual backup breaker of low ampere capacity will be provided to obtain the necessary backup overload protection.

4. Instrument Systems

   The inherent energy levels in the instrument systems are sufficiently low that no damage can occur to the penetration as a result of an electrical fault. Nevertheless, analyses will be performed to demonstrate that the instrument circuits are self-limiting in that the fault current is held to a level that does not damage the penetration. Adequate physical separation is applied to ensure that high energy circuits do not come in contact with low energy instrument circuits.

C. The remaining portions of Regulatory Guide 1.63, namely Regulatory Positions C-2, C-3, and C-4, are fully implemented in the Midland system design.

221.3 Your response to Regulatory Guide 1.73 states that the BOP valves have been type tested to Draft 13 of IEEE Std 382-1972. Define and justify the bases for using this version of the standard vs the corrected version dated April 10, 1973. Define and describe any differences between the two versions. If the Draft 13 version type tests are less conservative than the corrected version dated April 10, 1973, justify its acceptability for use in conjunction with Regulatory Guide 1.73.

Response

The following differences exist between Draft 13 and the April 10, 1973 version of IEEE-382 environmental testing program for electric motor operators.

1. The definition of electric valve operators in Draft 13 provides examples of electric and mechanical components not included in the April 10, 1973 version.

2. The April 10, 1973 version specifically prohibits maintenance of the operator during type testing whereas Draft 13 does not address maintenance.

3. The initial phase of steam exposure for Design Basis Accident Environment Simulation as dictated in the April 10, 1973 version is to increase the environmental temperature to 280°F and environmental pressure to at least 70 psig in ten seconds with temperature increase to 340°F in 5 minutes. Draft 13 requires environmental conditions of 340°F and at least 70 psig in 10 seconds.

Discussion:

Since Draft 13 does not provide less conservative testing requirements, we feel its application is justified for Midland. Midland has accepted Franklin Institute Research Laboratories Final Report F-C3441 prepared for Limitorque Corporation as meeting the environmental testing requirements of IEEE-382 Draft 13. At the time of valve quotations, this report provided the most extensive electric motor operator containment environmental testing program available. Although several corrective actions were taken during the test as described in the report, no maintenance of the equipment was performed during the test.

221.4 Due to the degree and number of areas of exception you have to Regulatory Guide 1.75, we require additional information to complete our review. As part of your response, the following information should be provided:

1. Basic criteria included in the plant design.

2. Sketches and drawings that define the areas of your design where exceptions exist.

3. A supporting discussion that explicitly defines these areas and degree of conformance.

4. In case of equipment in fabrication or fabricated, photographs are acceptable in lieu of sketches and drawings.

5. Justify exceptions to the recommendations of the Regulatory Guide.

Response

Balance of Plant

The following information is offered in response to NRC Question 221.4 and as a supplement to our response to Regulatory Guide 1.75.

1. Reference: Paragraph C-1 of R. G. 1.75.

   Isolation of Class 1E power circuits will be provided by a single circuit interrupting device (Class 1E circuit breaker) actuated (tripped) under design basis accident conditions by an accident signal. The accident tripping signal will be in addition to any tripping signal that may be derived from fault current or its effects.

   Restoration of power to the load served by the isolation device once disconnected by the accident signal will be permitted by remote-manual operator action initiated under administrative control.

   Isolation devices such as relays and operational amplifiers will be used in control and instrument circuits when analysis reveals degradation of Class 1E circuits below an acceptable level. Isolation devices will be Class 1E and located within seismic Category I structures or areas.

2. Reference: Paragraph C-4 of R. G. 1.75.

   Associated circuits located in non-seismic Category I structures will comply with Paragraph 4.5(3) of IEEE Std. 384-1974. Per Paragraph C.6 of Regulatory Guide 1.75 Rev. 1, analyses associated with, and identification of such circuits will be included in the FSAR.

   Typical circuits such as alarm and computer inputs originating at Class 1E equipment and terminating at or interfacing with non-Class 1E equipment located in non-seismic Category I structures or area fall into this category.

3. Reference: Paragraph C-9 of R. G. 1.75.

   a. Exception is taken to prohibiting splices in raceways in order to permit the use of containment electrical penetrations with pigtails and allow splices in adjacent cable trays. Electrical penetration areas were designed as part of the overall plant prior to issuance of the Regulatory Guide. Included in this design were criteria allowing splicing in cable tray adjacent to the penetrations. It is impractical at this time in project life to redesign the penetration areas to accommodate other than cable splices. Efforts, however, will be made to provide the electrical penetrations with terminal blocks or connectors in order to minimize the use of splices.

      Splices, when made, will be limited to the electrical containment penetration areas and will meet the same flame test and environmental requirements as the cable in which the splice is made.

   b. The design basis for Class 1E power cables will be in accordance with Section 5.1.1.3 of IEEE Standard 384-1974.

4. Reference: Paragraph C-10 of R. G. 1.75.

   Cables will be marked at distances not to exceed 15 feet except for cables in conduit and duct banks which will be marked at points of entry and exit only. The method of marking will be color coding.

It is felt that cables marked at 15 feet maximum intervals and points of entry to and exiting from enclosed areas would be more than adequate to facilitate initial verification that the installation is in conformance with the separation criteria.

Reference: Para. 5.8 of IEEE 384-1974, Sensors and Sensor-to-Process Connections

Inputs for redundant channels of the protection systems are supplied by separate, redundant sensors. However, redundant sensors may share common sensor-to-process connections. In such cases, sensing lines to redundant sensors will be separated after leaving the sensor-to-process connection. In routing of all protection system sensing lines, consideration shall be given to protecting redundant sensing lines from credible common causes of damage.

NSS Scope of Supply

1. The Emergency Core Cooling Actuation System (ECCAS) and Reactor Protection System (RPS) comply with Regulatory Guide 1.75 Rev. 1, subject only to the clarifications and exceptions covered in the response to the remaining parts of this question.

2, 4 Photographs showing pertinent equipment features are included in this submittal.

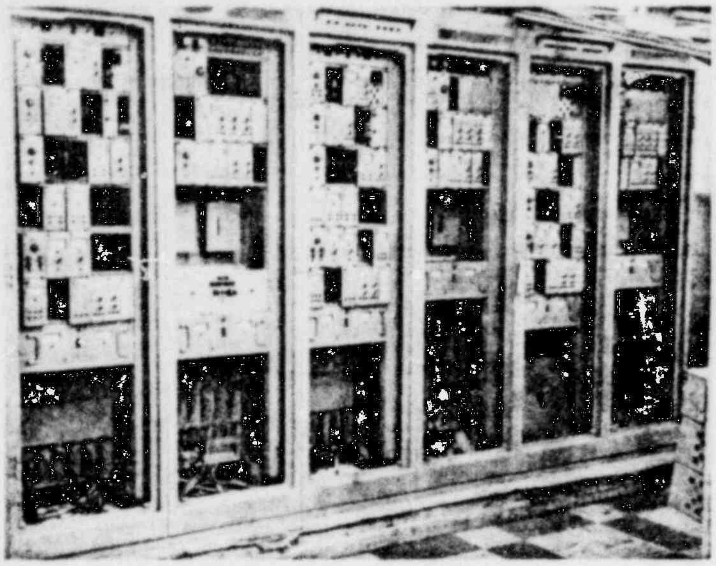
3. Supporting discussion explicitly defining the areas of interpretation or exception and degree of conformance, is provided herewith as follows:

   a. Attachment 1 was previously submitted to NRC and discussed in a Regulatory Guide conference on November 13, 1975. Part II of this attachment identifies all exceptions and clarifications to Regulatory Guide 1.75 Rev. 1 applicable to the ECCAS and RPS, and provides some supporting discussion.

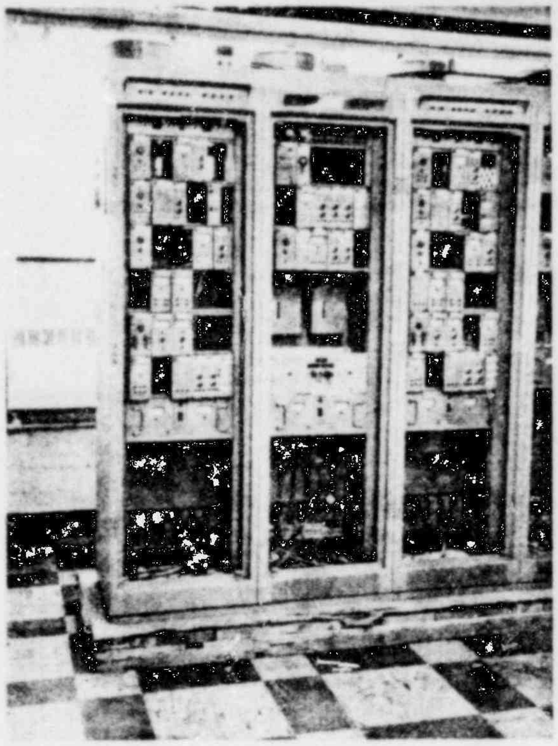
   b. Attachment 2 amplifies points made in Attachment 1.

   c. Attachment 3 supplements the above material by providing certain general descriptive material.

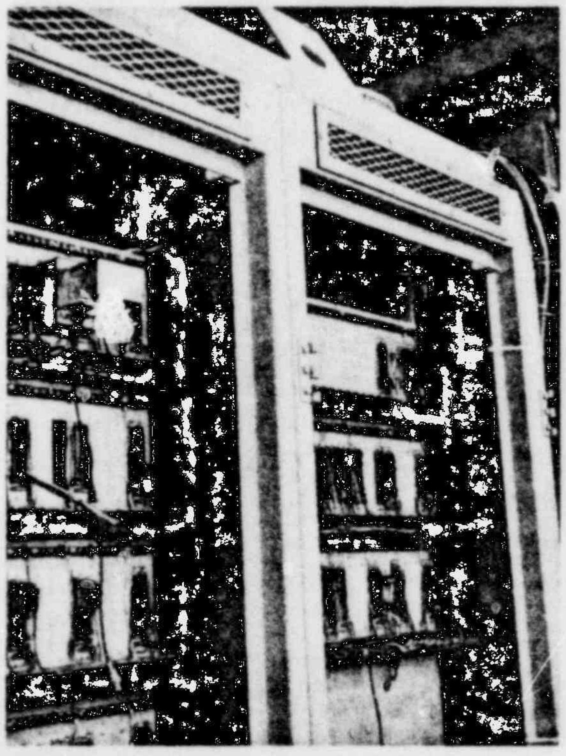
5. Justification is included in the individual discussion cited above.



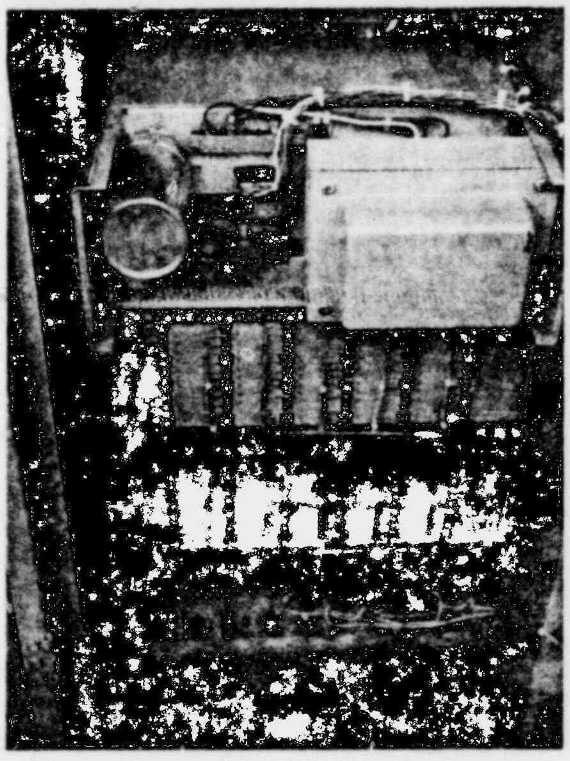
Front view of NI/RPS (3 channels) showing physical separation provided by cabinets (front doors removed during manufacture) and modular design. Each channel consists of two cabinets.



Closeup of cabinets showing field cable connection terminal strip area at bottom of cabinets (wires shown are for system checkout during manufacture.



Rear view of cabinets showing module backplane internal wiring and physical separation provided by cabinets.



Rear view of cabinet showing internal wiring to rear of field cable connection terminal strip area.

REGULATORY GUIDE 1.75

PHYSICAL INDEPENDENCE OF ELECTRICAL SYSTEMS

RESPONSE TO REGULATORY POSITION

The Midland Plant separation criteria complies with the requirements of R. G. 1.75, Rev. 1, with the following exceptions:

I. BALANCE OF PLANT

1. Reference: Paragraph C-1 of R.G. 1.75

   The Midland separation criteria considers power circuit breakers actuated by accident signals to be isolation devices.

2. Reference: Paragraph C-4 of R.G. 1.75

   The Midland separation criteria will treat, identify and color-code the associated cables in the same way as the Class 1E cables they are associated with. When leaving Seismic Category I structures, the associated cables will be routed in exclusive non Class 1E raceways.

3. Reference: Paragraph C-9 of R.G. 1.75

   The Midland criteria will permit cable splicing in electrical penetration areas on a restricted basis. The Midland criteria will permit tray filling above side rails for single layers of single conductors, three conductors, and triplexes' power cables.

4. Reference: Paragraph C-10 of R.G. 1.75

   The Midland criteria will require that raceways and cables be marked at distances not to exceed 15 feet, except for embedded and underground raceways and cables in conduits and ducts which will be marked at the points of entry and exit only.

II. NUCLEAR STEAM SUPPLY SYSTEM

1. Reference: Paragraph C-16 of R.G. 1.75, Rev. 1

   Exception is taken to the imposition of IEEE 384-1974, Section 5.6, to instrumentation cabinets. The following specific exceptions are to Section 5.6 of IEEE 384-1974.

a. Reference: Paragraph 5.6.2 of IEEE Std. 384-1974

The minimum separation distance of six (6) inches is not applied within the cabinets, where the potential hazards (Paragraph 4.1) are limited to internally generated occurrences. The use of isolation amplifiers and relays is employed throughout the systems when conveying signals between channels and between the channels and other systems and components. In addition, single failure analysis has been done to support areas where redundant channels are inputs to a single device (e.g., trip logic modules).

b. Reference: Paragraph 5.6.3 of IEEE Std. 384-1974

Identification per 5.6.3 begins at the terminal strips and continues outward to field wiring. Internal cabinet wiring is identified on a functional basis using industry cabinet wiring practices. Identification of cabinets and equipment makes the class of equipment easily distinguishable. Factory system functional and preoperational testing is used to ensure proper wiring.

c. Reference: Paragraph 5.6.4 of IEEE Std. 384-1974

The provisions of Paragraph 5.6.2 are not met where redundant circuits are terminated on a common device. The nature of protection system logic and the modular design of these systems (to meet IEEE 279, 4.21) is such that redundant signals must come together to provide the proper coincidence. The RPS and ESFAS on the Midland Plant contain four and two coincidence logic respectively, each of which is housed in a separate system cabinet. No two redundant logics are powered by the same vital bus. Single failure analysis performed on the coincidence logic modules has shown that single failures do not degrade the system below minimum safety level. The modules and equipment used on the Midland Plants are of the Oconee type which have shown excellent operational performance.

d. Reference: Paragraph 5.6.5 of IEEE Std. 384-1974

All nonprotection signals from protection channels are generated in isolation devices such as isolation amplifiers and relays. The quality of wiring within the cabinets is uniform throughout with respect to flame retardancy, etc., the only difference being functional in nature. For these reasons, the separation distances (5.6.2) are not followed within the cabinets.

e. Reference: Paragraph 5.6.6 of IEEE Std. 384-1974

The protection system cabinets are designed for bottom cable entry and will accept cable and/or conduit from the cable tray system on the Midland Plants.

2. Reference: Paragraph 5.8 of IEEE Std. 384-1974 as Imposed by Regulatory Guide 1.75, Rev. 1

Specific acceptability requirements have not been determined in the application of this paragraph to plants of this design type. Compliance cannot be determined and cannot be claimed until the above acceptability requirements are clarified.

Further clarification of items previously submitted as exceptions to IEEE Std 384-1974 as modified by Regulatory Guide 1.75, Rev. 1:

II.1.2: Par. 5.6.2 of IEEE 384-1974, Internal Separation

The B&W protection systems design utilizes separate and redundant cabinets for each protection channel. Each cabinet provides physical protection of internal circuitry from external hazards. All modules mounted within any given cabinet form a part of one protection channel. Redundant modules or circuits of redundant protection channels are not contained within the same cabinet, thus physical separation of cabinet internals is not required.

II.1.b: Par. 5.6.3 of IEEE 384-1974, Internal Wiring Identification

Wiring and modules internal to B&W protection systems are not specifically identified according to channel since all components within any one cabinet form a part of one protection channel. Each cabinet is identified as belonging to a particular protection channel. This method of identification is in accordance with Section 4.22 of IEEE Std 279-1971.

II.1.c: Par. 5.6.4 of IEEE 384-1974, Common Terminations

Coincidence logics require that two or more redundant signals converge at a common device. Redundant coincidence circuits are physically separated, each circuit being located in a separate redundant cabinet which provides physical protection of the circuit and associated wiring. Electrical isolation is provided between each channel providing inputs to the coincidence logics. The combination of physical separation between redundant coincidence logic circuits and electrical isolation between redundant input circuits is adequate to meet the intent of Regulatory Guide 1.75, Rev. 1.

II.1.d: Par. 5.6.5 of IEEE 384-1974, Non-Class 1E Wiring

Some process analog and digital signals available within the boundaries of protection systems are transmitted to non-safety equipment for recording indications, and annunciation purposes. Electrical isolators are provided in the protection systems for the transmission of 1E signals to non-1E equipment. The signals at the output of these isolation devices are considered to be non-1E. However, the output wiring from the isolation devices to the field wiring terminal strips is of the same grade as the internal 1E wiring with the same flame retardance characteristics. In addition, this wiring is within the protective boundaries of the system cabinets. Therefore, no effort is made to physically separate internal 1E wiring from internal non-1E wiring. The cabinets provide the physical boundaries of the systems and electrical boundaries are provided by the isolation devices.

II.1.e: Par. 5.6.6 of IEEE 384-1974, Cable Entrance

Minimum distances for physical separation were neither defined nor required at the time of design and construction of the B&W protection systems. As a result, the B&W protection system cabinets cannot provide the physical separation described in section 5.6.6 of IEEE Std 384-1974 without major redesign. Some physical protection is provided by wiring insulation and flame retardance, insulation between terminal strip connectors and by the system cabinets, sinch all field wiring terminations are inside the cabinet boundaries.

II.2: Par. 5.8 of IEEE 384-1974, Sensors and Sensor-to-Process Connections

Inputs for redundant channels of the protection systems are supplied by separate, redundant sensors.

Items II.1.a, b, c, and d are not really exceptions to Regulatory Guide 1.75 rather interpretations of alternate design methods that meet the intent of the Guide.

1. EMERGENCY CORE COOLING ACTUATION SYSTEM (ECCAS)

a. General

The ECCAS is a protection system designed to sense that a loss of coolant accident has occurred and to automatically initiate emergency core cooling to mitigate the consequences of the accident.

The ECCAS has four analog sensing channels. Each analog channel monitors reactor coolant pressure and outputs a trip signal when it reaches a predetermined setpoint indicating that a loss of coolant accident has occurred.

The ECCAS has two digital actuation channels. Each digital channel receives trip inputs from all four analog RC pressure channels, and from four customer-supplied reactor building pressure instruments. When any two of four inputs indicate a tripped condition, the digital channel sends actuation signals to one train of ECC equipment. The redundant digital channel sends actuation signals to a redundant train of ECC equipment.

b. ECCAS Cabinets

There is one cabinet for each of the four analog channels, and one cabinet for each of the two digital channels, for a total of six ECCAS cabinets. Each cabinet is Seismic Class I and provides physical protection of the cabinet internals from external hazards as well as providing physical separation between redundant circuits located in redundant cabinets.

All modules mounted within any given cabinet form a part of one analog or digital channel. Therefore, internal physical separation is not required. The cabinets form the physical boundaries between redundant channels and between the ECCAS and non-1E equipment.

In addition to separation provided between redundant protection channels, all protection equipment is separate and independent of all other control and instrumentation equipment. Some process analog and digital signals available within the boundaries of protection systems are transmitted to non-safety equipment for indication and annunciation purposes. Electrical isolators are provided in the protection system for the transmission of 1E signals to non-1E equipment. The signals at the output of these isolation devices are considered to be non-1E. Thus, the system cabinets form the physical boundaries of the protection systems and isolation devices form the electrical boundaries.

The wiring between the isolation devices and the terminal strips is of the same grade as the internal 1E wiring with the same flame retardance and voltage insulation characteristics; thus, physical separation of internal wiring is not required.

The entire ECCAS cabinet array is located in a room or rooms within a safety class structure. The rooms protect the ECCAS from and do not contain hign energy switchgear, transformers, rotating equipment, or potential sources of missiles or pipe whip. The rooms do contain low energy switchgear, transformers and rotating equipment that are integral parts of the instrumentation and control systems (e.g., cabinet fan motors). A list of typical low energy devices is contained in Table 1.

2. REACTOR PROTECTION SYSTEM (RPS)

a. General

The RPS is a protection system which performs the sole function of initiating a trip of all full length reactor control rods when the plant conditions require such actions to protect the core. The RPS initiates a reactor trip when a sensed parameter (or group parameters) exceeds a setpoint value indicating the approach of the unsafe condition.

The RPS consists of four separate, independent and redundant channels with identical functions. All functions of the RPS are implemented by redundant sensors, measuring channels, logic and actuation devices.

b. RPS Cabinets

There are two cabinets for each protection channel, providing a total of eight cabinets. Each cabinet is Seismic Class I and provides physical protection of the cabinet internals from external hazards, as well as providing physical separation between redundant circuits located in redundant cabinets.

All modules mounted within any given cabinet form a part of one protection channel. Therefore, internal physical separation is not required. The cabinets form the physical boundaries between redundant channels and between the protection system and external non-1E equipment. Electrical isolation devices form the electrical boundaries.

The wiring between the isolation devices and the terminal strips is of the same grade as the internal 1E wiring with the same flame retardance characteristics, thus physical separation of internal wiring is not required.

The entire RPS cabinet array is located in a room or rooms within a safety class structure. The rooms protect the RPS from and do not contain high energy switchgear, transformers, rotating equipment, or potential sources of missiles or pipe whip. The rooms do contain low energy switchgear, transformers and rotating equipment that are integral parts of the instrumentation and control systems (e.g. cabinet fan motors). A list of typical low energy devices is contained in Table 1.

Table 1. Typical Low-Energy Devices Located in Control Room

Component	Rating	Function
Motor	250 VA	Recorder drive
Motor	120 V-2 A	Cabinet fan
Circuit breakers	30A	Distribution
Transformer	240/120 V:24/12 V @ 0.75 kVA	ECCAS control
Power supply	±15 V dc @ 12 A max	ECCAS cabinet power
Motor	120 Vac	Printer drive
Motor	120 Vac	Printer fan
Motor	120 Vac	Printer-plotter drive
Motor	120 Vac	Printer-plotter blower