Docket

DEC 4 1973

Docket Nos. 50-438
and 50-439

Tennessee Valley Authority
ATTN: Mr. James E. Watson
Manager of Power
818 Power Building
Chattanooga, Tennessee 37401

Gentlemen:

The Regulatory staff has determined the need for providing additional guidance related to electrical and control systems. The enclosed document, "Physical Independence of Electric Systems," has been prepared for this purpose. Sections 4 and 5 of the enclosure present criteria that are acceptable for implementing the separation requirements of IEEE Standard 279-1971 and AEC General Design Criteria 17 and 21.

You are requested to examine your facility design and provide within 30 days of receipt of this letter a discussion of the degree of conformance with the criteria contained in the enclosure. Where less stringent criteria are proposed, discuss the reasons for concluding that the less stringent criteria are adequate.

Please inform us within 7 days after receipt of this letter of your ability to respond within 30 days or the date by which you will be able to respond.

Sincerely,

Original Signed

A. Schwencer, Chief
Pressurized Water Reactors
Branch No. 4
Directorate of Licensing

Enclosure:
Physical Independence of Electric Systems

cc: See Next Page

LB

OFFICE▶						
SURNAME▶						
DATE▶						

cc: Mr. R. H. Marquis
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629 New Sprakle Building
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UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

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Enclosure 1

PHYSICAL INDEPENDENCE OF ELECTRIC SYSTEMS

1.0 SCOPE

The scope of this document is the physical independence of the circuits and electric equipment comprising or associated with the Class IE power systems, the protection system, systems actuated or controlled by the protection system, and auxiliary supporting systems that are essential to the operation of these systems. This document sets forth criteria for the separation of circuits and equipment that are redundant. The determination of which circuits and equipment are redundant is outside the scope of this document.

2.0 PURPOSE

The purpose of this document is to delineate acceptable methods of complying with the requirements of IEEE Std 279-1971 and General Design Criteria 17 and 21 with respect to the physical independence of the circuits and electric equipment within the scope of this document.

3.0 DEFINITIONS

3.1 Acceptable

Demonstrated to be adequate by the safety analysis of the station.

3.2 Associated Circuits

Non-Class IE circuits that share power supplies, enclosures, or raceways with Class IE circuits or are not physically separated from Class IE circuits by acceptable separation distance or barriers.

3.3 Barrier

A device or structure interposed between Class IE equipment or circuits and a potential source of damage to limit damage to Class IE systems to an acceptable level.

3.4 Class IE

The safety classification of the electric equipment and systems that are essential to emergency reactor shutdown, containment isolation, reactor core cooling, and containment and reactor heat removal, or are otherwise essential in preventing significant release of radioactive material to the environment.

3.5 Design Basis Events

Postulated events specified by the Safety Analysis of the station

used in the design to establish the acceptable performance requirements of the structures and systems.

3.6 Enclosure

An identifiable housing such as a cubicle, compartment, terminal box, panel or enclosed raceway, used for electrical equipment or cables.

3.7 Flame Retardant

Capable of preventing the propagation of a fire beyond the area of influence of the energy source that initiated the fire.

3.8 Isolation Device

A device in a circuit which prevents malfunctions in one section of a circuit from causing unacceptable influences in other sections of the circuit or other circuits.

3.9 Raceway

Any channel that is designed and used expressly for supporting wires, cables or busbars. Raceways consist primarily of, but are not restricted to, cable trays and conduits.

3.10 Redundant Equipment or System

An equipment or system that duplicates the essential function of another equipment or system to the extent that either may perform the required function regardless of the state of operation or failure of the other.

3.11 Safety Class Structures

Structures designed to protect Class IE equipment against the effects of the design basis events. For purposes of this document, separate safety class structures can be separate rooms in the same building. The rooms can share a common wall.

3.12 Separation Distance

Space without interposing structures, equipment, or materials that could aid in the propagation of fire or that could disable the Class IE system.

4.0 GENERAL SEPARATION CRITERIA*

4.1 Required Separation

Separation shall be provided to maintain the independence of sufficient

numbers of circuits and equipment so that the protective functions required during and following any design basis event can be accomplished. The degree of separation required varies with the potential hazards in a particular area.

4.2 Equipment and Circuits Requiring Separation

Equipment and circuits requiring separation shall be determined and delineated early in the plant design and shall be identified on documents and drawings in a distinctive manner.

4.3 Methods of Separation

The separation of circuits and equipment shall be achieved by safety class structures, distance, or barriers, or any combination thereof. In general, locating redundant circuits and equipment in separate safety class structures affords a greater degree of assurance that a single event will not affect redundant systems. Therefore, this method of separation should be used whenever practicable and its use does not conflict with other safety objectives.

4.4 Compatibility with Mechanical Systems

The separation of Class IE circuits and equipment shall be such that the required independence will not be compromised by the failure of mechanical systems served by the Class IE systems. For example, Class IE circuits shall be routed or protected such that failure of related mechanical equipment of one redundant system cannot disable Class IE circuits or equipment essential to the operation of the other redundant system(s).

4.5 Associated Circuits

Associated circuits shall comply with one of the following:

a. they shall be uniquely identified as such and shall remain with, or be separated the same as,those Class IE circuits with which they are associated; they shall be subject to all requirements placed on Class IE circuits such as cable derating, environmental qualification, flame retardance, splicing restrictions and raceway fill, unless it can be demonstrated that the absence of such requirements could not significantly reduce the availability of the Class IE circuits, or

b. they shall be in accordance with 4.5a from the Class IE equipment to and including an isolation device. Beyond the isolation device a circuit is not subject to the requirements of this document provided it does not again become associated with a Class IE system, or

*Figure 4.0 shows examples of acceptable circuit arrangements.

c. they shall be analyzed or tested to demonstrate that Class IE circuits are not degraded below an acceptable level.

NOTE: Preferred power supply circuits from the transmission network and those similar power supply circuits from the unit generator that become associated circuits solely by their connection to the Class IE distribution system input terminals are exempt from the requirements of section 4.5.

4.6 Non-Class IE Circuits

Non-Class IE circuits shall comply with either 4.6.1 or 4.6.2.

4.6.1 a. The Non-Class IE circuits shall be separated from Class IE Circuits by the minimum separation requirements specified in sections 5.1.3, 5.1.4, or 5.6.2, and

b. The Non-Class IE circuits shall be separated from associated circuits by the minimum separation requirements specified in sections 5.1.3, 5.1.4 ot 5.6.2 or the effects of lesser separation between the Non-Class IE circuits and the associated circuits shall be analyzed to demonstrate that the Class IE circuits were not degraded below an acceptable level.

4.6.2 The Non-Class IE circuits shall be treated as associated circuits.

4.7 Documentation of Analyses

Analyses performed in accordance with 4.5c and 4.6.1b should be submitted as part of the Safety Analysis Report and should identify those circuits installed in accordance with these sections.

5.0 SPECIFIC SEPARATION CRITERIA

5.1 Cables and Raceways

5.1.1 General

5.1.1.1 The routing of Class IE circuits and location of equipment served by these Class IE circuits shall be reviewed for exposure to potential hazards such as high pressure piping, missiles, flammable material, flooding and wiring that is not flame retardant. A degree of separation commensurate with the damage potential of the hazard shall be provided such that the independence of redundant Class IE systems are maintained at an acceptable level. The separation of Class IE circuits and equipment shall make effective use of features

inherent in the plant design such as using different rooms or opposite sides of rooms or areas, except that the use of opposite sides of rooms or areas does not constitute separation if such rooms or areas are confined or otherwise incapable of dissipating the heat generated from a fire; cable tunnels are examples of such confined areas.

5.1.1.2 In those areas where the damage potential is limited to failures or faults internal to the electrical equipment or circuits, the minimum separation distance can be established by analysis of the proposed cable installation. This analysis shall be based on tests performed to determine the flame retardant characteristics of the proposed cable installation considering features such as cable insulation and jacket materials, cable tray fill and cable tray arrangement.

5.1.1.3 The minimum separation distances specified in 5.1.3 and 5.1.4 are based on open ventilated trays. Where these distances are used to provide adequate physical separation;

a. Cable splices in raceways shall be prohibited;

b. Cables and raceways involved shall be flame retardant;

c. The design basis shall be that the cable trays will not be filled above the side rails and

d. Hazards shall be limited to failures or faults internal to the electric equipment or cables.

If lesser separation distances are used they shall be established as in 5.1.1.2.

5.1.2 Identification

Exposed Class IE raceways shall be marked in a distinct permanent manner at intervals not to exceed 15 feet and at points of entry to and exiting from enclosed areas. Class IE raceways shall be marked prior to the installation of their cables.

Cables installed in these raceways shall be marked in a manner of sufficient durability and at a sufficient number of points to facilitate initial verification

that the installation is in conformance with the separation criteria. These cable markings shall be applied prior to or during installation.

Class IE cables shall be identified by a permanent marker at each end in accordance with the design drawings or cable schedule.

The method of identification used to meet the above requirements shall readily distinguish between redundant Class IE systems, associated circuits assigned to redundant Class IE divisions, and non-Class IE systems. The preferred method of identification is color coding.

5.1.3 Cable Spreading Area and Main Control Room

The cable spreading area is the space(s) adjacent to the control room where instrumentation and control cables converge prior to entering the control, termination or instrument panels. Where practicable, redundant cable spreading areas shall be utilized.

The cable spreading area(s) and main control room shall not contain high energy equipment such as switchgear, transformers, rotating equipment or potential sources of missiles or pipe whip and shall not be used for storing flammable materials. Circuits in the cable spreading area(s) and main control room shall be limited to control functions, instrument functions and those power supply circuits and facilities serving the control room and instrument systems.

Power supply feeders to instrument and control room distribution panels shall be installed in enclosed raceways that qualify as barriers. The minimum separation distance between redundant Class IE cable trays shall be determined by 5.1.1.2 or, where the conditions of 5.1.1.3 are met, shall be one foot [1] between trays separated horizontally and three [1] feet between trays separated vertically. Where termination arrangements preclude maintaining the minimum separation distance, the redundant circuits shall be run in enclosed raceways that qualify as barriers or other barriers shall be provided between redundant circuits. The minimum distance between these redundant enclosed raceways and between barriers and raceways shall be one inch. Figures 5.1, 5.2, 5.3 and 5.4 illustrate examples of acceptable arrangements of barriers and solid enclosed raceways where the minimum separation distance cannot be maintained.

5.1.4 General Plant Areas

In plant areas from which potential hazards such as missiles,

external fires and pipe whip are excluded, the minimum separation distance between redundant cable trays shall be determined by 5.1.1.2. or, where the conditions of 5.1.1.3 are met, shall be three feet[1] between trays separated horizontally and five feet[1] between trays separated vertically. If, in addition, high energy electric equipment such as switchgear, transformers and rotating equipment is excluded and power cables are installed in enclosed raceways that qualify as barriers, or there are no power cables, the minimum separation distance may be as specified in 5.1.3.

Where plant arrangements preclude maintaining the minimum separation distance, the redundant circuits shall be run in solid enclosed raceways that qualify as barriers or other barriers shall be provided between redundant circuits. The minimum distance between these redundant enclosed raceways and between barriers and raceways shall be 1 inch. Figures 5.1, 5.2, 5.3, and 5.4 illustrate examples of acceptable arrangements of barriers and solid enclosed raceways where the minimum separation distance cannot be maintained.

5.2 Standby Power Supply

5.2.1 Standby Generating Units

Redundant Class IE standby generating units shall be located in separate safety class structures and shall have independent air supplies.

5.2.2 Auxiliaries and Local Controls

The auxiliaries and local controls for redundant standby generating units shall be located in the same safety class structure as the unit they serve or be physically separated in accordance with the requirements of Section 4.0.

5.3 D-C System

5.3.1 Batteries

Redundant Class IE batteries shall be palced in separate safety class structures. Where ventilation is required, these safety class structures shall be served by independent ventilation systems.

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[1] Horizontal separation is measured from the side rail of one tray to the side rail of the adjacent tray. Vertical separation is measured from the bottom of the top tray to the top of the side rail of the bottom tray.

5.3.2 Battery Chargers

Battery chargers for redundant Class IE batteries shall be physically separated in accordance with the requirements of Section 4.0.

5.4 Distribution System

5.4.1 Switchgear

Redundant Class IE distribution switchgear groups shall be physically separated in accordance with the requirements of Section 4.0.

5.4.2 Motor Control Centers

Redundant Class IE motor control centers shall be physically separated in accordance with the requirements of Section 4.0.

5.4.3 Distribution Panels

Redundant Class IE distribution panels shall be physically separated in accordance with the requirements of Section 4.0.

5.5 Containment Electrical Penetrations

Redundant Class IE containment electrical penetrations shall be physically separated in accordance with the requirements of Section 4.0. Compliance with 4.0 will generally require that redundant penetrations be widely dispersed around the circumference of the containment. The minimum physical separation for redundant penetrations shall meet the requirements for cables and raceways given in Section 5.1.4.

Non-Class IE circuits routed in penetrations containing Class IE circuits shall be treated as associated circuits in accordance with the requirements of Section 4.5.

5.6 Main Control Boards

5.6.1 Location and Arrangement

The main control boards shall be located in a control room within a safety class structure. The control room shall protect from and shall not contain high energy equipment such as switchgear, transformers, rotating equipment or potential sources of missiles or pipe whip.

5.6.2 Internal Separation

The minimum separation distance between redundant Class IE

equipment and circuits internal to the control board can be established by analysis of the proposed installation. This analysis shall be based on tests performed to determine the flame retardant characteristics of the wiring, wiring materials, equipment and other materials internal to the control board. Where the control board materials are flame retardant and analysis is not performed, the minimum separation distance shall be six inches. In the event the above separation distances are not maintained, barriers shall be installed between redundant Class IE wiring.

5.6.3 Internal Wiring Identification

Class IE wire bundles or cables internal to the control boards shall be identified in a distinct permanent manner at a sufficient number of points to readily distinguish between redundant Class IE systems and between Class IE and non-Class IE systems.

5.6.4 Common Terminations

Where redundant Class IE circuits are terminated on a common device, the provisions of paragraph 5.6.2 shall be met.

5.6.5 Non-Class IE Wiring

Non-Class IE wiring not separated from Class IE wiring by the minimum separation distance (determined in paragraph 5.6.2) or by a barrier shall be treated as associated circuits in accordance with the requirements of 4.5.

5.6.6 Cable Entrance

Redundant Class IE cables entering the control board enclosure shall meet the requirements of Section 5.1.3

5.7 Instrument Cables

The separation requirements of 5.6 apply to instrumentation cabinets. In addition, redundant Class IE instruments shall be located in separate cabinets or compartments of a cabinet.

Where redundant Class IE instruments are located in separate compartments of a single cabinet, attention must be given to routing of external cables to the instruments to assure that cable separation is retained.

In locating Class IE instrument cabinets, attention must be given to the effects of all pertinent design basis events.

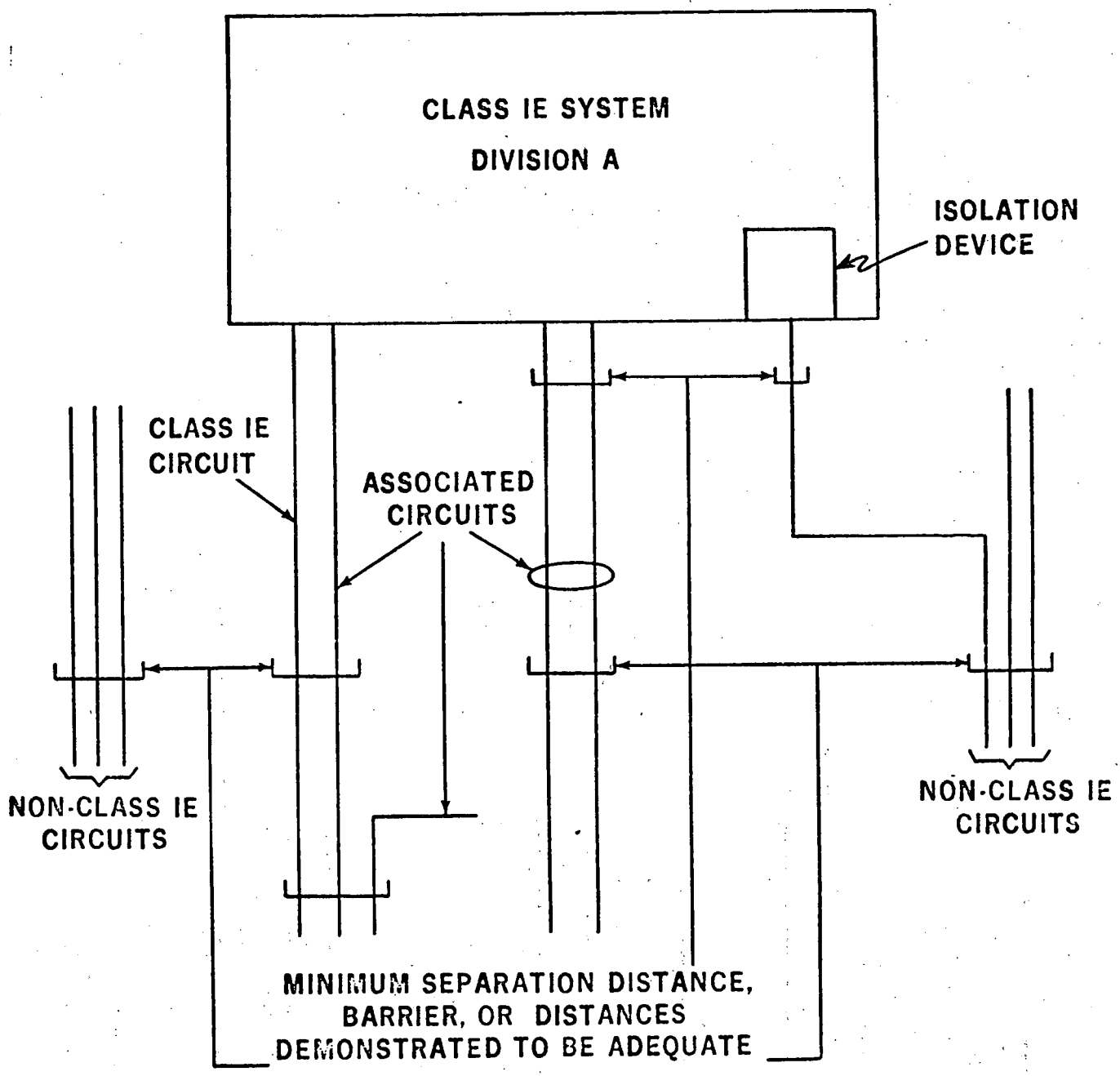
5.8 Sensors and Sensor to Process Connections

Redundant Class IE sensors and their connections to the process system shall be sufficiently separated that functional capability of the protection system will be maintained despite any single design basis event or result therefrom. Consideration shall be given to secondary effects of design basis events such as pipe whip, steam release, radiation, missiles and flooding.

Large components such as the reactor vessel can be considered a suitable barrier if the sensor to process connecting lines are brought out at widely divergent points and routed so as to keep the component between redundant lines. Redundant pressure taps located on opposite sides of a large pipe may be considered to be separated by the pipe, but the lines leaving the taps must be protected against damage from a credible common cause unless other redundant or diverse instrumentation is provided.

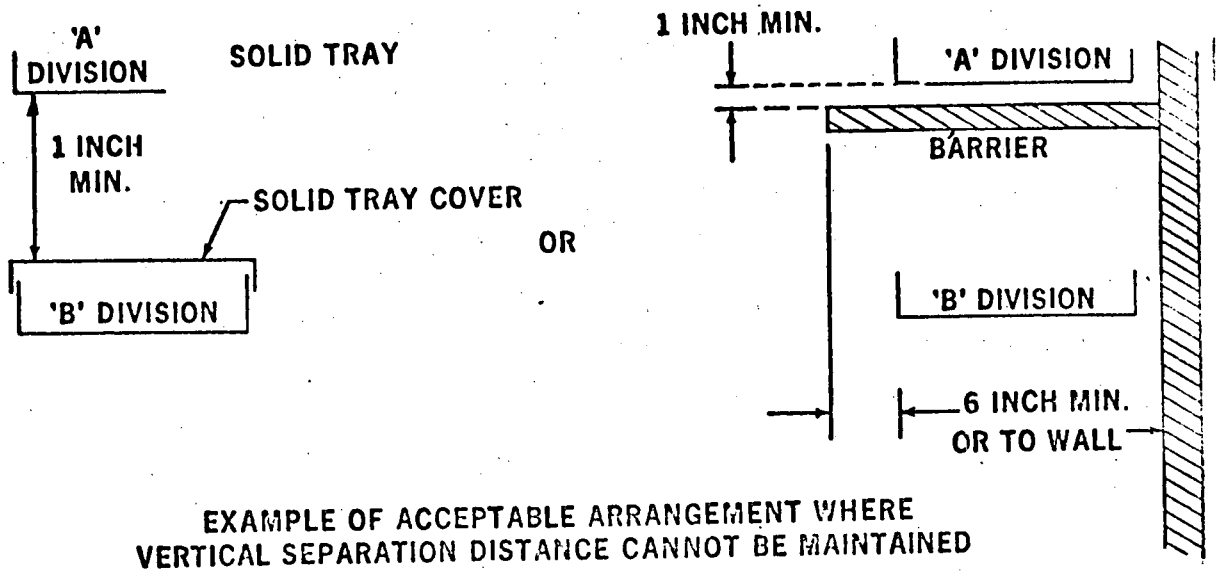
5.9 Actuated Equipment

Locations of Class IE actuated equipment, such as pump drive motors and valve operating motors are normally dictated by the location of the driven equipment. The resultant locations of this equipment must be reviewed to ensure that separation of redundant Class IE actuated equipment is acceptable.



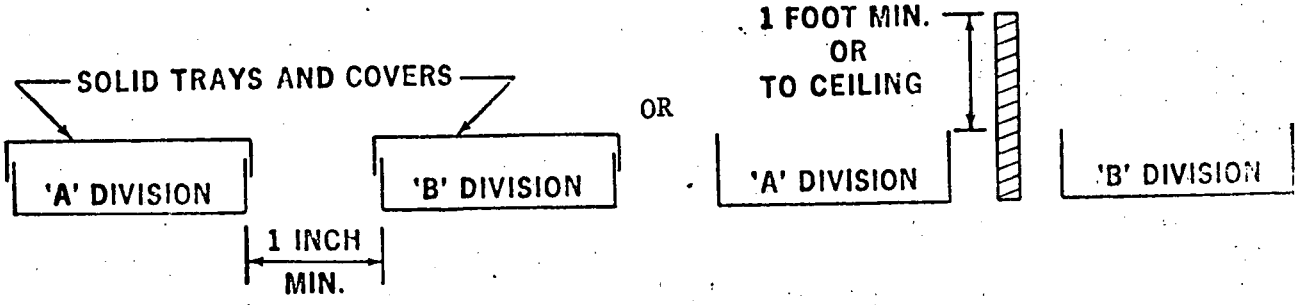
EXAMPLES OF ACCEPTABLE CIRCUIT ARRANGEMENTS

Figure 4.0



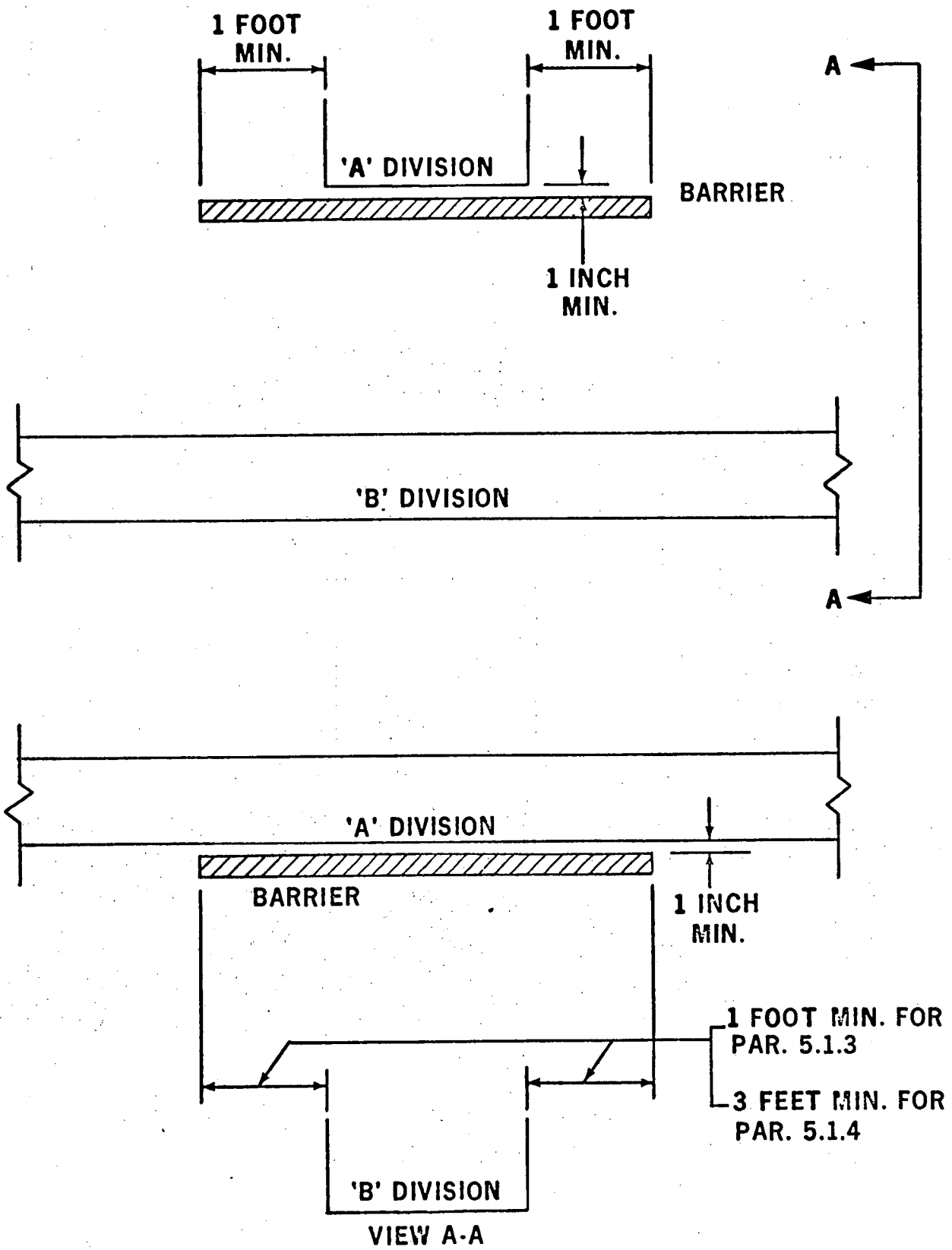
EXAMPLE OF ACCEPTABLE ARRANGEMENT WHERE VERTICAL SEPARATION DISTANCE CANNOT BE MAINTAINED

Figure 5.1



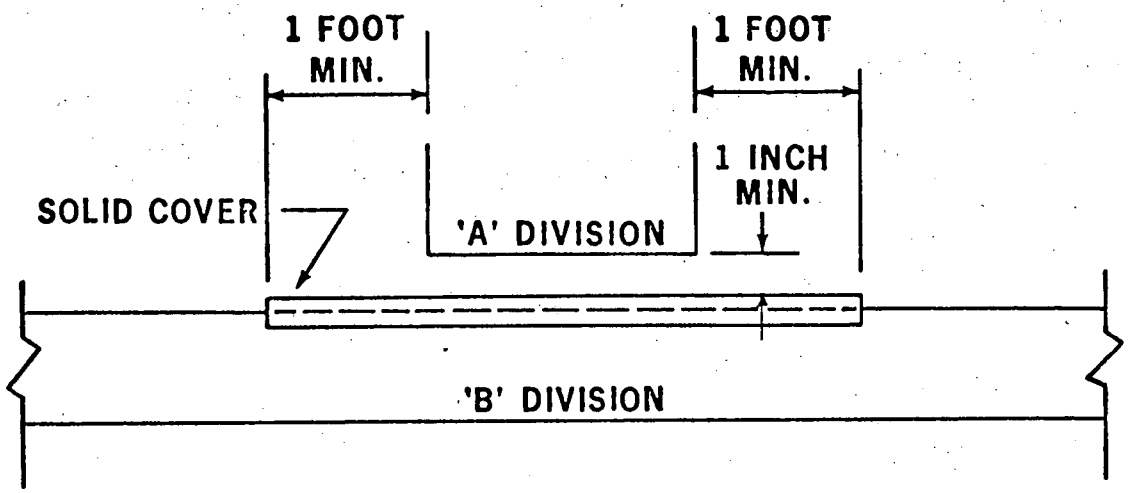
EXAMPLE OF ACCEPTABLE ARRANGEMENT WHERE HORIZONTAL SEPARATION DISTANCE CANNOT BEMAINTAINED

Figure5.2



EXAMPLE OF ACCEPTABLE ARRANGEMENT FOR REDUNDANT CABLE TRAY CROSSINGS WHERE VERTICAL SEPARATION DISTANCE CANNOT BE MAINTAINED

Figure 5.3



EXAMPLE OF ACCEPTABLE ARRANGEMENT FOR REDUNDANT CABLE TRAY CROSSINGS WHERE VERTICAL SEPARATION DISTANCE CANNOT BE MAINTAINED

Figure 5.4