O'Donohue-14/033

Watts Bar Nuclear Plant
Fire Protection Inspection
March 2004

NRC Inspector: Kathleen O'Donohue Date: 3/24/2004

Information Requested:
Need a copy of calculation WB-DC-40-51.

Assigned To:	Licensing/Stockton
Response Due By:	

Information Request Response:
See attached copy of WB-DC-40-51.

Response Provided By:	Licensing/Stockton
Response Date:	3/24/2004
Response Acceptable:	

CCC-27

TENNESSEE VALLEY AUTHORITY

Division of Nuclear Engineering

N E

RIMS
QA RECORD

N/A
DESIGN CRITERIA DOCUMENT

No. WB-DC-40-51

WATTS BAR
NUCLEAR PLANT

TITLE: FIRE PROTECTION OF SAFE SHUTDOWN CAPABILITY

*Signatures on Original

REVISION	R0	R1	R2	R3		
DATE:	9-6-85	6-6-88	5-10-91	12-13-2000		
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TVA

Title: FIRE PROTECTION OF SAFE SHUTDOWN CAPABILITY		REVISION LOG WB-DC-40-51
REVISION NO.	DESCRIPTION OF REVISION	DATE APPROVED
0	Initial Issue	9-6-85
1	This revision incorporates applicable commitments and requirements through May 16, 1986. The revised portions or the document are identified by vertical lines. Section 1.0: Deleted reference to modifications and broadened compliance to all of Appendix R. Section 2.0: Deleted reference to modifications and broadened compliance to all of Appendix R. Section 3.1: Substituted definition from separation/isolation design criteria. Section 3.5: Corrected definitions. Section 3.6: Added definition. Section 3.8: Broadened definition. Section 3.9: Changed name of term. Section 3.10: Added definition for fire damage. Section 3.11 and 3.12: Added definitions. Section 4.0: Added new section to require identification of safe shutdown of equipment. Section 5.0: Changed numbering throughout Section 5.0. Rewrote and expanded section. Section 6.0: Changed numbering through Section 6.0 and eliminated reference to modifications. Section 6.1: Changed editorially. Section 6.2: Changed editorially. Section 6.3: Added new section on alternative shutdown capability. Section 7.0: Deleted old Section 7.0, "MODIFICATION EVALUATION." Changed numbering throughout Section 7.0 and reorganized subsections. Section 7.2: Added requirement for justification where fire suppression or detection is not provided. Section 7.6: Consolidated Sections 6.6, 6.7, and 6.8. Section 7.11: Corrected discussion of cable trays. Deleted last sentence on entranced sprinkler coverage.	6-6-88

Title: FIRE PROTECTION OF SAFE SHUTDOWN CAPABILITY		REVISION LOG WB-DC-40-51
REVISION NO.	DESCRIPTION OF REVISION	DATE APPROVED
1 (cont'd)	Section 7.11: Added Information on Cable Trays. Section 7.12: Changed editorially. Section 7.14: Added section on circuit faults and moved requirements for nondivisional circuits from separation/isolation design criteria. Section 7.16: Added new section for alternative shutdown requirements. Section 7.17: Added Section 7.5.1 through 7.5.4 to establish fire detection and suppression system requirements. Section 7.18: Added Section 7.6.1 through 7.6.6 to establish fire barrier requirements. Section 7.19: Added Section 7.7.1 and 7.7.2 to establish manual fire-fighting equipment requirements. Section 7.20: Added reference to plant lighting system description. Section 7.21: Added new section to establish breathing air requirements. Section 7.22: Added new section on reactor coolant pump oil collection system. Section 8.0: Deleted first sentence. Added requirement for NRC approval of exceptions. Deleted Section 8.2. Section 9.0: Revised the References. Attachment 1: Deleted Attachment 1, "10 CFR 50 APPENDIX R MODIFICATION COMPLIANCE REVIEW."	
2	General Revision. This revision incorporates the applicable material from DIM-WB-DC-40-51-1.	5-10-91
DCN S-36183-A	DCN RIMS NO. T56 950505 978 Revised paragraph 3.2 to refer to Section 7 for specifics of fire. Revised Section 7 paragraphs 7.6 and 7.7 to reflect use of offsite power if its loss is not caused by the fire of concern. Revised pages: iv, 2, 6 Added Page: 6a Total Pages in this Revision: 4	5-5-95

3	• Revised to convert scanned document to a Word document. • Incorporates DCN S-36183-A. • Deleted Coordination Log from the Table of Contents, since it was not in the design criteria, and is not required to have per NEDP-10. • Reference 9.2.11 changed from "NEP 3.2 - Design Input" to "NEDP-1 - Design Basis and Design Input Control." • Renumbered entire document, which changed page numbers on the Table of Contents (page v). Pages Revised: All Total Pages: 16 (includes pages i-v and 1-11)	12-13-2000

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Title: FIRE PROTECTION OF SAFE SHUTDOWN CAPABILITY	WB-DC-40-51

1.0 PURPOSE

This design criteria is intended to provide requirements to the Watts Bar Engineering Project (WBEP) to ensure that structures, systems, and components important to safety shall be designed and located to minimize, consistent with other safety requirements, the probability and effect of fires and explosions. These criteria define the means to limit fire damage to structures, systems, or components important to safety so that the capability to safely shutdown the plant is ensured.

2.0 SCOPE

This design criteria comprises the design requirements to ensure that structures (walls, floors, ceilings, penetrations, etc.) and redundant safe shutdown systems and components (motors, valves, electrical cables, associated circuits of concern, etc.) maintain the separation, performance, and design requirements of 10 CFR 50, Appendix R, Sections III. G, J, and O (Reference 9.3.2). This will be referred to as fire safe shutdown (FSSD). Additional information and clarification of Nuclear Regulatory Commission (NRC) requirements and recommendations are found in references 9.3.1 through 9.3.5.

3.0 DEFINITIONS

3.1 Associated Circuits of Concern (Reference 9.2.2)

Associated Circuits of Concern are defined as those safety-related and non-safety-related circuits not directly required to perform a safe shutdown function, but which are associated with FSSD circuits and have a physical separation less than that required by Section 6.0 and have one of the following (see Figure 3.1):

3.1.1 Type I

Circuits that share a common power source with a required circuit where the power source is not electrically protected from the nonrequired circuit by coordinated circuit breakers, fuses, or similar devices.

3.1.2 Type II

Circuits to equipment whose spurious operation could prevent operation or cause maloperation and thereby adversely affect safe shutdown capability.

3.1.3 Type III

Circuits that share a common enclosure (e.g., cable tray, conduit, panel, or junction box) with a shutdown circuit and;

a. are not electrically protected by circuit breakers, fuses, or similar devices, or;

b. Could allow propagation of fire into the common enclosure.

A potential Type I or Type III circuit is not an Associated Circuit of Concern if it has adequate electrical protection.

3.2 Postulated Fire

A fire that is assumed to occur in a specified area of the plant. The origin of the fire and the combustible materials involved are not defined. For extent of assumed fire see Section 7.

3.3 Safe Shutdown

The process of bringing the affected reactor from power operation to hot standby and then to cold shutdown.

3.4 Hot Standby

A stable plant condition where the affected reactor is subcritical and the average reactor coolant system (RCS) temperature is greater than 350°F.

3.5 Cold Shutdown

A stable plant condition where the affected reactor is sub-critical and the average RCS temperature is less than or equal to 200°F.

3.6 Component

Equipment, instrument sense lines, or cables (including associated circuits of concern) that are required to safely shutdown the plant in the event of a fire.

3.7 Spurious Operation

A change in state of equipment due to fire induced faults (hot shorts, open circuits, or shorts to ground) on its power or control circuitry. Spurious operations include but are not limited to:

a. The opening/closing of normally closed/open valves.

b. Starting/stopping of pumps or motors.

c. Actuation of logic circuits.

3.8 High-Low Pressure Interface

A valve or set of valves that separates a high pressure primary coolant system from a low pressure system. Fire induced faults on the valve(s) circuitry may cause a) loss of the ability to close the valve(s), or b) spurious opening of the valve(s) and thereby inducing a LOCA or overpressurizing the low pressure system.

3.9 Fire Safe Shutdown (FSSD) Train

Minimum set of FSSD components necessary to fulfill a shutdown path required by the FSSD functional criteria and shutdown logic diagram.

3.10 Fire Damage

An electrical component is considered to be damaged by a postulated fire if it is within the zone of influence of the fire and is not protected from the fire by one of the separation criteria of Section 6.0.

3.11 Fire Area

An area of the plant that is separated from other adjacent areas by boundary fire barriers (walls, floors, ceilings/roofs) with any opening or penetrations protected with closures seals or that have a minimum fire resistance equal to or greater than the rating required of the barrier. The rating of the barrier shall be either 3 hours or exceed the maximum anticipated combustible loading of the area.

3.12 Fire Zone

A subdivision of a fire area based upon separating the redundant FSSD components by either one hour fire rated barriers or 20 or more feet horizontally. Both of these methods require fire detection and automatic fire suppression in the zones.

3.13 Combustible Material

A material is combustible if in the form in which it is used and under the conditions anticipated, it will ignite, burn, support combustion, or release flammable vapors when subjected to heat or fire.

3.14 Intervening Combustibles

A combustible material located between redundant FSSD components. Examples of intervening combustibles are insulation on cables in trays, plastics inside electrical boards, oil in open sumps, etc.

4.0 IDENTIFICATION OF FSSD COMPONENTS

A list of components required for safe shutdown shall be compiled. The division or train of components, if any, in which the component is required to function shall also be identified.

Either train of primary or alternative FSSD components shall be capable of performing the following functions in the event of a fire:

1. Achieving and maintaining sub-critical reactivity conditions in the reactor.

2. Maintaining the reactor coolant inventory such that plant safety limits are not violated.

3. Achieving and maintaining hot standby conditions.

4. Achieving and maintaining cold shutdown conditions. If alternative shutdown equipment is used, cold shutdown must be achieved within 72 hours.

5. Providing support functions such as process cooling, lubrication, etc., necessary to permit operation of the FSSD components.

6. Providing direct readings of the process variables necessary to perform and control the FSSD functions.

5.0 LIMITING SAFETY CONDITIONS

The following damage limits shall not be exceeded as a result of a single postulated fire.

5.1 Limiting Safety Conditions

5.1.1 During a postfire shutdown, the fission product boundary integrity shall be maintained (e.g., no fuel clad damage, no rupture of any primary coolant boundary, no rupture of the primary containment boundary).

5.1.2 The reactor coolant system process variables shall be maintained within those predicated for a loss of normal off site power.

5.2 Fire Damage Limits

5.2.1 One FSSD train necessary to achieve and maintain hot standby shall be maintained free of fire damage.

5.2.2 Both FSSD trains necessary to achieve cold shutdown may be damaged; however, the damage shall be limited so that a minimum set of components can be repaired or made operable within 72 hours and cold shutdown achieved and maintained thereafter. Materials for such repairs shall be readily available on site and procedures in effect to implement such repairs.

5.2.3 When using alternative shutdown capability, both FSSD trains necessary to achieve cold shutdown may be damaged; however, the damage shall be limited so that a minimum set of components can be repaired or made operable AND cold shutdown achieved within 72 hours and maintained thereafter. Materials for such repairs shall be readily available on site and procedures in effect to implement such repairs.

5.2.4 Equipment and electrical cables necessary for mitigation of design basis events, but not required for hot standby, may be damaged.

5.3 To ensure that electrical designs are maintained in compliance with associated circuits requirements of FSSD, compliance to the electrical design criteria WB-DC-30-13 (Reference 9.2.2) is required.

6.0 SEPARATION CRITERIA

6.1 Where components of redundant trains of systems necessary to achieve and maintain hot standby conditions are located within the same fire area outside of the Reactor Building, one of the following means of ensuring that one redundant train is free of fire damage shall be provided:.

6.1.1 Separation of redundant FSSD trains by a fire barrier having a 3-hour rating. Structural steel forming a part of or supporting such fire barriers shall be protected to provide fire resistance equivalent to that required of the barrier.

6.1.2 Separation of redundant FSSD components by a horizontal distance of 20 or more feet free of intervening combustibles. In addition, fire detectors and an automatic fire suppression system shall be installed in the fire zones. If intervening combustibles are present, then the fire zones shall be protected by a suppression system installed per the expanded sprinkler criteria in Reference 9.2.8.

6.1.3 Enclosure of one redundant FSSD train by a fire barrier having a one-hour fire resistance rating. In addition, fire detection and an automatic fire suppression system shall be installed in the fire zones.

6.2 For FSSD components located inside the Reactor Building, one of the means of separation specified in subsection 6.1 or one of the following means of separation shall be provided:

6.2.1 Separation of redundant FSSD trains by a horizontal distance of 20 or more feet free of intervening combustibles or fire hazards.

6.2.2 Fire detectors and automatic fire suppression installed in the fire zones.

6.2.3 Separation of redundant trains of safe shutdown components by a noncombustible radiant energy shield.

6.3 If safe shutdown trains do not meet the separation criteria of 6.1 or 6.2 in an area (e.g., main control room, cable spreading room, etc.), an alternative capability which meets the separation criteria shall be provided (see section 7.16).

7.0 DESIGN BASIS AND REQUIREMENTS

7.1 A fire is postulated to occur in any area containing FSSD components, whether or not the area contains in situ combustibles.

7.2 If area suppression and detection are present in the area under consideration, the zone of influence of a postulated fire is considered to be a 20-foot diameter cylinder from floor to ceiling or areas bounded by fire-rated structures shown on the compartmentation drawings, whichever is smaller. If unprotected openings (e.g., stairwells and equipment hatches without suppression, HVAC ducts without fire dampers, nonfire rated equipment hatches, etc.) are within the 20 foot cylinder, the zone of influence of the fire is extended into the adjacent areas. If area suppression and/or detection are not present, a qualified fire protection engineer must assess the potential for damage and develop a justification for submission to the NRC.

7.3 A FSSD circuit is postulated to be damaged if it is in the zone of influence of a postulated fire unless it is protected as described in Section 6.0.

7.4 It is not considered credible for a postulated fire to cause a design basis pipe failure.

7.5 The unit(s) is (are) operating at full power when the fire is postulated.

7.6 No design basis events are considered concurrent with a postulated fire except that for a fire in areas requiring alternative shutdown, i.e. evacuation of Control Building, a loss of offsite power must be assumed to occur concurrent with the fire.

7.7 FSSD components shall be operable from offsite electrical power sources when available. If offsite power sources become inoperable due to the fire, the equipment which is relied upon to achieve safe plant shutdown shall be capable of being powered from the onsite emergency diesel generators.

7.8 FSSD components need not be designed to meet seismic Category I requirements, single failure requirements, or other design basis event criteria, except where required for other reasons.

7.9 Only failures directly attributable to a postulated fire are to be considered.

7.10 Either a manual action by an operator or an automatic trip by the reactor protection system will trip the reactor before a postulated fire could cause a spurious actuation that could cause a DBE less severe than a line break. However, after the reactor is tripped, a postulated fire is assumed to be capable of causing the following design basis events unless adequate protection is provided:

1. Opening the pressurizer power-operated relief valve.

2. Opening the steam generator atmospheric dump valve.

3. Boron dilution event.

4. Inadvertent safety injection.

7.11 Cables routed in conduit are not considered as intervening combustibles for the purpose of meeting the separation criteria of Section 6.0. Cables routed in enclosed cable trays or in open trays, coated or uncoated are considered as intervening combustibles. When intervening combustibles are present, fire detectors and an automatic fire suppression system must be installed throughout the fire zone per the criteria of Reference 9.2.8.

7.12 Manual actions by operations personnel may be used to meet the damage limits of Section 5.0. Manual actions by operations personnel may include manually operating or aligning equipment located in any accessible area of the plant provided such actions are within the capabilities of the minimum number of operators defined by the plant staffing requirements. Use of additional manual operations to perform safe shutdown functions must be coordinated with Nuclear Operations.

7.13 The following postulates shall be used when analyzing fire induced spurious actuation of equipment.

7.13.1 FSSD capability shall not be adversely affected by simultaneous spurious actuation of all valves in a single high to low pressure interface line when the power or control circuits for the valves can be damaged by a postulated fire.

7.13.2 For other than high-to-low pressure boundaries, FSSD capability shall not be adversely affected by any one spurious actuation or signal resulting from damage to a power or control circuit from a postulated fire.

7.13.3 Two separate conditions must be analyzed concurrent with the spurious actuation(s) or signal addressed in 7.13.1 and 7.13.2. First, all automatic equipment must be assumed to function properly; then, all automatic functions (signal, logic, etc.) from the circuits that can be damaged by the postulated fire should be assumed lost.

7.13.4 Items 7.13.1 and 7.13.2 are not postulated to occur at the same time.

7.14 The following types of faults must be evaluated in each circuit involved in the fire: open circuit, short circuit, and short to ground.

7.14.1 For three-phase ac circuits, the probability of getting a hot short on all three phases in the proper sequence to cause spurious operation of a motor is considered sufficiently low as to not require evaluation except for any cases involving high-low pressure interface.

7.14.2 For ungrounded ac and dc circuits, if it can be shown that only two hot shorts of the proper polarity without grounding could cause spurious operation, no further evaluation is necessary except for any case involving high-low pressure interfaces.

7.15 Nonrequired associated circuits shall conform to the following:

7.15.1 All nonrequired cables associated with equipment and components required for FSSD are isolated by coordinated circuit breakers or fuses. These devices protect the function of the safety circuit in the event of fire damage to the nonrequired associated circuit.

7.15.2 When nonrequired signals are used in the power or control circuitry for FSSD components, they provide anticipatory or interlock signals for normal plant operation. The signals are arranged such that any failure of the nonrequired circuit, such as a short or open circuit, will not adversely affect the safety circuit function.

7.15.3 The only nonrequired cables routed to FSSD components are those for monitor lights or similar functions. These cables are not terminated in the control circuits of the devices. Therefore, if these cables are destroyed by fire, the only loss will be the contacts to which the monitor lights or similar circuits are connected. The control of the safety function of the component will not be impaired.

7.16 Alternative Shutdown Capability

7.16.1 Alternative shutdown capability shall be provided where FSSD components do not meet the separation criteria of Section 6.0, or where redundant trains of FSSD components could be damaged by operation of fire suppression systems.

Note: Four areas do not meet the separation criteria of Section 6.0: The main control room, the spreading room, and the two auxiliary instrument rooms in the control building. The alternate control system provides alternative capability for all of the control facilities within the control building, including the four above-mentioned areas. Reference 9.2.5 defines the requirements for the alternative control system.

7.16.2 To meet alternative shutdown requirements, manual actions may be performed by operations personnel as described in Section 7.12.

7.17 Fire Detection and Suppression Systems

7.17.1 Fire detection systems requirements are in References 9.2.7.

7.17.2 Fire suppression suitable for each area within the plant is provided based on a fire hazards analysis, Reference 9.2.3. Plant fire suppression requirements are established in References 9.2.6 and the systems are described in References 9.2.8 and 9.2.9.

7.17.3 Redundant fire protection water supplies shall be provided in accordance with Reference 9.2.8.

7.18 Fire Barriers

7.18.1 Cable penetration seals shall be qualified to provide the same fire resistance rating that is required of the barrier, as outlined in Reference 9.2.6.

7.18.2 Requirements for fire doors are contained in References 9.2.6 and 9.2.8.

7.18.3 Requirements for mechanical penetration seals (e.g., pipe and HVAC duct penetrations) are contained in References 9.2.6 and 9.2.8.

7.18.4 Requirements for fire dampers are contained in References 9.2.6 and 9.2.8.

7.18.5 Fire barriers shall be installed in tested or approved configurations in accordance with Reference 9.2.6.

7.18.6 Structural steel forming a part of or supporting fire barriers shall be protected to provide fire resistance equivalent to that required of the barrier.

7.19 Manual Fire-Fighting Equipment

Portable extinguishers, standpipes, hose stations, and fire-fighting access shall be provided for areas which pose an exposure fire hazard to safety-related equipment, as outlined in Reference 9.2.6. Reference 9.2.8 lists the locations of standpipes and hose stations.

7.20 Emergency Lighting

Emergency lighting units with an 8-hour battery power supply shall be provided in all areas needed for operation of FSSD components and in access and egress routes thereto. Illumination levels must be adequate for the manual operations to be performed. Reference 9.2.10 contains a description of the plant emergency lighting.

7.21 Reactor Coolant Pump Oil Collection

The reactor coolant pumps shall be equipped with an oil collection system per the requirements in Reference 9.2.6.

8.0 EXCEPTIONS

All exceptions to the requirements of these criteria must be technically justified and documented in accordance with Reference 9.2.11 and in a form suitable for submittal to the NRC.

9.0 REFERENCES

9.1 TVA Drawings

9.1.1 Drawing Series 47W240 - Compartmentation

9.1.2 Drawing Series 45E893 - Appendix R Separation

9.2 TVA Documents

9.2.1 WB-DC-30-4 - Separation/Isolation

9.2.2 WB-DC-30-13 - 10 CFR 50 Appendix R Type I, II, III Items

9.2.3 WBN-26-D053, EPM-DOM-012990 - Combustible Loading Summary

9.2.4 WB-DC-30-27 - AC and DC Control Power System

9.2.5 WB-DC-40-58 - Alternate Shutdown Capability

9.2.6 WB-DC-40-62 - Fire Protection

9.2.7 N3-13-4002 - Fire Detection System

9.2.8 N3-26-4002 - High Pressure Fire Protection

9.2.9 N3-39-4002 - CO_2 Storage, Fire Protection and Purging

9.2.10 N3-228-4003 - Plant Lighting

9.2.11 NEDP-1 - Design Basis and Design Input Control

9.3 Other

9.3.1 Title 10, Code of Federal Regulations, Part 50, Section 50.48 - Fire Protection

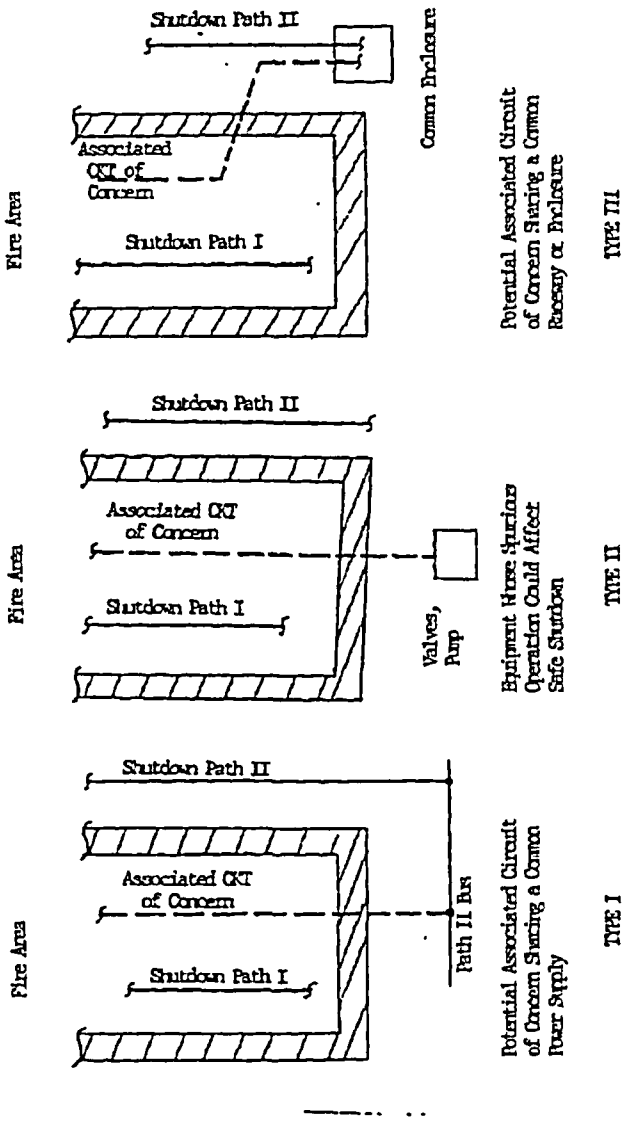
9.3.2 10 CFR 50 Appendix R - Fire Protection Program for Nuclear Power Facilities Operating Prior to January 1, 1979

9.3.3 Fire Protection Rule - Generic Letter 81-12, dated February 20, 1981

9.3.4 Fire Protection Rule - Appendix R - Clarification of Generic Letter 81-12, dated March 22, 1982

9.3.5 Implementation of Fire Protection Requirements - Generic Letter 86-10, dated April 24, 1986

Figure 3-1


Shutdown Path II
Common Enclosure
Associated CKT of Concern
Fire Area
Shutdown Path I
Potential Associated Circuit of Concern Sharing a Common Raceway or Enclosure
TYPE III
Shutdown Path II
Associated CKT of Concern
Fire Area
Shutdown Path I
Valves, Pump
Equipment Hose Spurious Operation Could Affect Safe Shutdown
TYPE II
Shutdown Path II
Associated CKT of Concern
Fire Area
Shutdown Path I
Path II Bus
Potential Associated Circuit of Concern Sharing a Common Power Supply
TYPE I