

10CFR50, APPENDIX R SAFE SHUTDOWN EVALUATION

OUTSIDE CONTROL ROOM FIRE
SPURIOUS ACTUATION STUDY

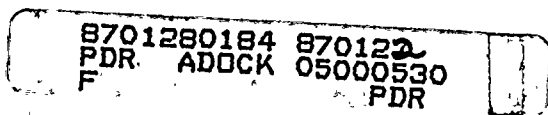
FOR THE

PALO VERDE NUCLEAR GENERATING STATION

UNIT 3

STUDY 03-NS-110

REVISION 0



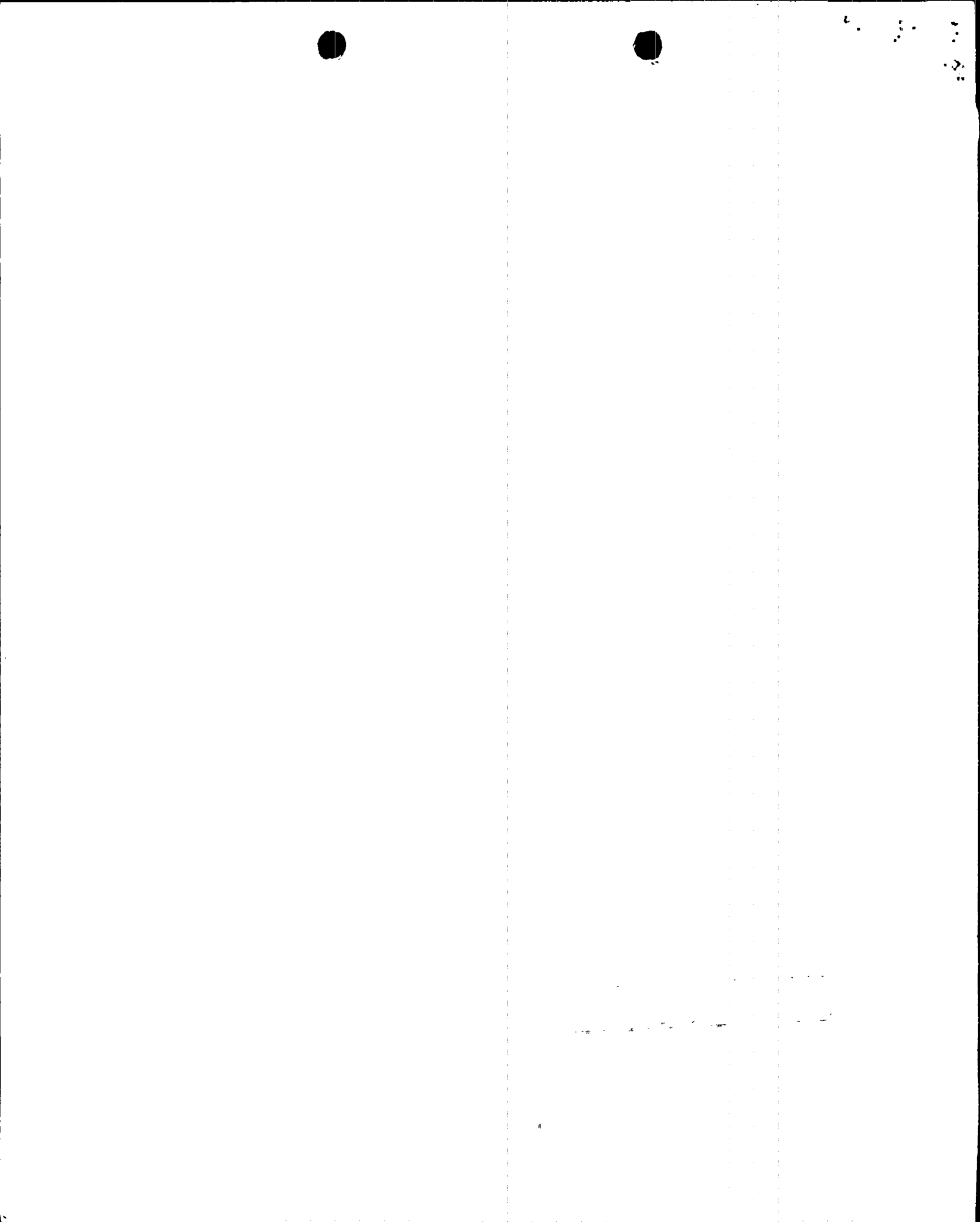


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1. INTRODUCTION

1.1 SCOPE

Evaluate the impact of fire-induced hot shorts, open circuits and shorts to ground in electrical circuitry which are routed different from Unit 1 for each fire zone outside the control room on the ability to safely shut down the plant using the safe shutdown (SSD) systems listed in Table 1-1, both with and without offsite power.

1.2 OBJECTIVE

The objective of this evaluation is to define any necessary special operating procedure requirements and/or design changes to ensure safe shutdown capability within the operational time constraints.

2. SUMMARY

Fire-induced hot shorts, open circuits and shorts to ground in electrical circuitry can result in the spurious actuation and/or inability to control components, which can impact the capability to achieve safe (cold) shutdown. To assess the extent of the potential fire damage on safe shutdown, the electrical circuitry in each of the fire zones identified in Table 3-1 has been evaluated. The conclusions and recommendations derived for Unit 1 are applicable for Unit 3; additional Unit 3 specific findings are presented in section 3.

3. CONCLUSIONS AND RECOMMENDATIONS

For postulated fires outside the control room, Table 3-1 lists all fire zones evaluated. Only those that were found to impact the ability to achieve SSD have been included in this section.

For each fire zone, this summary identifies:

- o Evaluation Findings

Potential undesirable spurious control actions/inactions of Unit 3 systems which are different from Unit 1.

- o Key Monitorable Parameters (functional)

Those available parameters which enable the operator to identify and mitigate the consequences of spurious control action/inactions, and to reach and maintain a safe (cold) shutdown are listed. These parameters are electrically and physically independent of the fire being evaluated.

- o Time Constraints

Critical time constraints for system or components operation are quantified.

- o Operational Considerations

The necessary action(s) required to prevent the adverse effects of the spurious control action/inactions summarized in the evaluation findings are detailed.

- o Compensatory Measures

The recommendations to accomplish each of the operational considerations are presented. These compensatory measures will be available to the plant operators for post-fire shutdown.

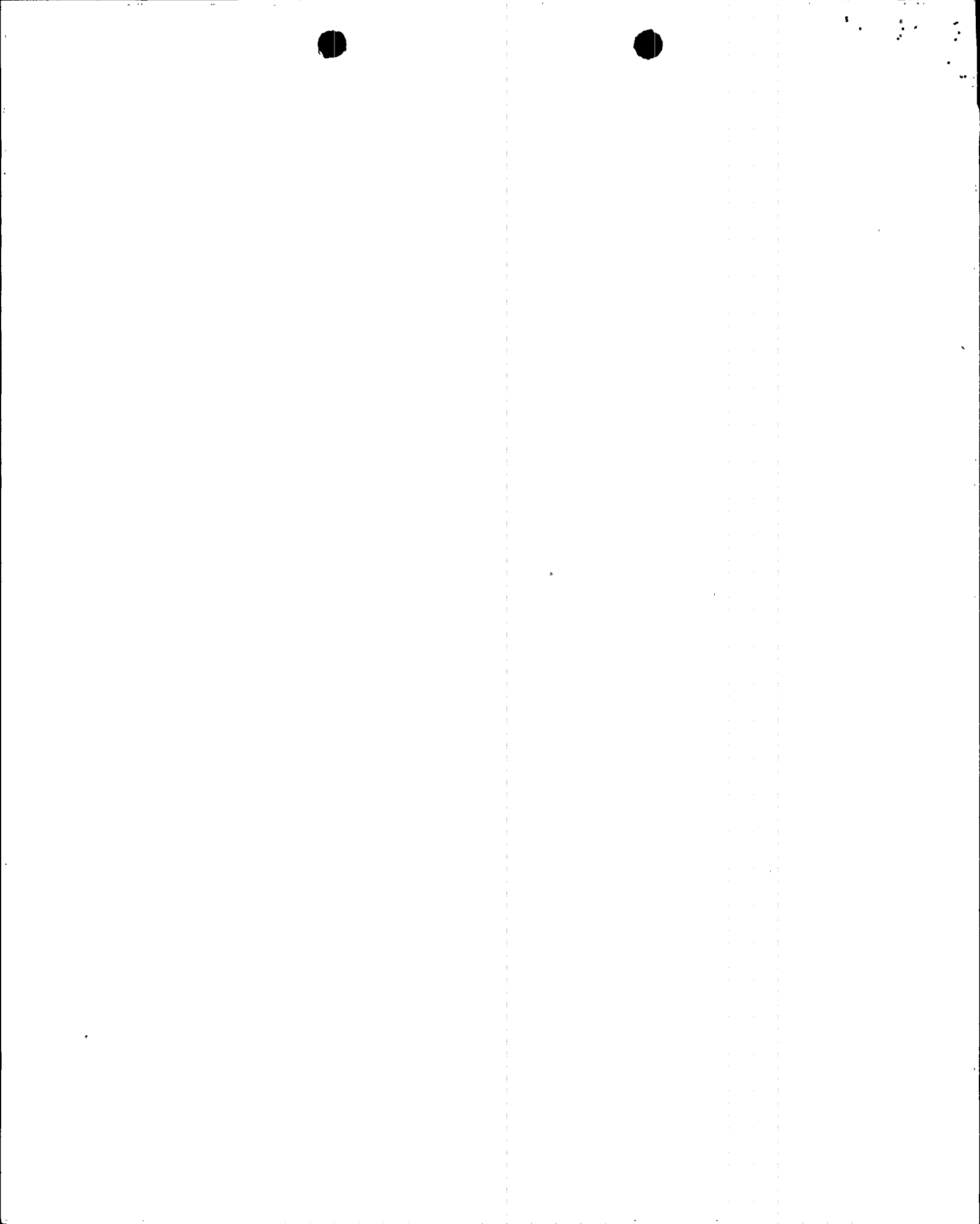


TABLE 1-1

FIRE EVENT SAFE SHUTDOWN SYSTEMS

<u>System Designator</u>	<u>System</u>
AF	Auxiliary Feedwater
CH	Chemical and Volume Control
CT	Condensate Storage and Transfer
DF	Diesel Fuel Oil Storage and Transfer
DG	Diesel Generator
EC	Essential Chilled Water
EW	Essential Cooling Water
HA	HVAC - Auxiliary Building
HD	HVAC - Diesel Generator Building
HJ	HVAC - Control Building
HS	HVAC - Ancillary Building (Spray Pond Pump House)
PB	4160V-ac Class 1E Power
PE	Class 1E Standby Generating System
PG	480V-ac Class 1E Power
PH	480V-ac Class 1E Power
PK	125V-dc Class 1E Power
PN	120V-ac Class 1E Power
RC	Reactor Coolant System
SG	Main Steam
SI	Safety Injection and Shutdown Cooling
SP	Essential Spray Pond

TABLE 3-1
(Sheet 1 of 4)

OUTSIDE CONTROL ROOM FIRE EVALUATED FIRE ZONES

<u>FIRE ZONE</u> ^(a)	<u>SSD TRAIN SUBJECT TO DAMAGE</u>	<u>SSD TRAIN TO BE USED FOR FIRE</u>	<u>NOTES:</u>
<u>CONTROL BUILDING</u>			
<u>Fire Area I</u> ^(a)			
1	A	B	See findings
3A	A	B	See findings
4A	A	B	No findings
5A	A	B	No findings
6A	A	B	No findings
7A	A	B	No findings
8A	A	B	No findings
9A	A	B	No findings
10A	A	B	No findings
11A	A	B	No findings
15A	A	B	No findings
18A	A	B	No findings
20	A	B	No findings
86A	A	B	No findings
<u>Fire Area II</u>			
2	B	A	See findings
3B	B	A	See findings
4B	B	A	No findings
5B	B	A	No findings
6B	B	A	No findings
7B	B	A	No findings
8B	B	A	No findings
9B	B	A	No findings
10B	B	A	No findings
11B	B	A	No findings
12	Neither	A	No findings
13	Neither	A	No findings
14	B	A	No findings
15B	Neither	A	** No findings
18B	Neither	A	** No findings
19	Neither	A	No findings
86B	B	A	No findings

**No safety-related raceway in the zone.

^(a) Fire areas and zones are defined in FSAR Appendix 9B.

TABLE 3-1
(Sheet 2 of 4)

OUTSIDE CONTROL ROOM FIRE EVALUATED FIRE ZONES

<u>FIRE ZONE^(a)</u>	<u>SSD TRAIN SUBJECT TO DAMAGE</u>	<u>SSD TRAIN TO BE USED FOR FIRE</u>	<u>NOTES:</u>
<u>MAIN STEAM SUPPORT STRUCTURE</u>			
<u>Fire Area XII</u>			
72	A	B	No findings
73	B	A	No findings
74A	A	B	No findings
74B	B	A	No findings
<u>AUXILIARY BUILDING</u>			
<u>Fire Area XIII</u>			
30A	A	B	No findings
31A	A	B	No findings
32A	A	B	No findings
<u>Fire Area XIV</u>			
30B	B	A	No findings
31B	B	A	No findings
32B	B	A	No findings
<u>Fire Area XV</u>			
33A	Neither	B	*No findings
33B	Neither	A	*No findings
87A	A	B	No findings
87B	Neither	A	**No findings
89	Neither	A	**No findings
90	Neither	B	**No findings
88A	Neither	B	*No findings
88B	B	A	No findings
34A	A	B	No findings
34B	B	A	No findings
35A	A	B	No findings
35B	B	A	No findings
36	Neither	B	**No findings
37A	A	B	No findings

*No raceway in the zone.

**No safety-related raceway in the zone.

TABLE 3-1
(Sheet 3 of 4)

<u>FIRE ZONE^(a)</u>	<u>SSD TRAIN SUBJECT TO DAMAGE</u>	<u>SSD TRAIN TO BE USED FOR FIRE</u>	<u>NOTES:</u>
37B	B	A	No findings
37C	A	B	No findings
37D	B	A	No findings
37E	Neither	A	**No findings
39A	Neither	B	No findings
39B	B	A	No findings
42C	B	A	No findings
42D	A	B	No findings
43	Neither	B	No findings
44	A	B	No findings
45	Neither	B	**No findings
46A	A	B	No findings
46B	B	A	No findings
46E	Neither	A	No findings
48	B	A	No findings
49A	Neither	B	*No findings
49B	Neither	B	*No findings
49C	Neither	B	*No findings
49D	Neither	B	*No findings
49E	Neither	B	*No findings
49F	Neither	B	*No findings
49G	Neither	B	*No findings
49H	Neither	B	**No findings
50A	B	A	No findings
50B	Neither	A	**No findings
51A	Neither	A	**No findings
51B	B	A	No findings
52A	A	B	No findings
52D	B	A	No findings
53	B	A	No findings
54	B	A	No findings
55A	Neither	B	**No findings
55C	Neither	B	No findings
55E	Neither	B	No findings
56A	Neither	B	No findings
56B	A	B	No findings
56C	A	B	No findings
57A	Neither	B	**No findings
57B	A	B	No findings
57C	Neither	B	**No findings

*No raceway in the zone

**No safety-related raceway in the zone.

TABLE 3-1
(Sheet 4 of 4)

<u>FIRE ZONE</u> ^(a)	<u>SSD TRAIN SUBJECT TO DAMAGE</u>	<u>SSD TRAIN TO BE USED FOR FIRE</u>	<u>NOTES:</u>
57D	Neither	B	**No findings
57E	Neither	B	**No findings
57F	Neither	B	**No findings
57G	Neither	B	**No findings
57H	Neither	B	**No findings
57I	A	B	No findings
57J	A	B	No findings
57K	Neither	B	**No findings
57L	Neither	B	**No findings
57M	Neither	B	**No findings
57N	A	B	No findings
57P	A	B	No findings
<u>Fire Area XVI</u>			
42A	A	B	No findings
47A	A	B	No findings
<u>Fire Area XVII</u>			
42B	B	A	No findings
47B	B	A	No findings

**No safety-related raceway in the zone.

3.1 GENERAL OPERATIONAL CONSIDERATIONS

1. For a fire in any given fire zone, safe shutdown is to be accomplished using the Table 3-1 identified safe shutdown systems for that specific fire zone.
2. Isolate the control room HVAC by manual initiation of CRVIAS upon indication of a control building fire outside the control room. In addition, for a fire in Fire Zone 1, override and stop essential AHU M-HJA-F04 and for a fire in Fire Zone 2, override and stop essential AHU M-HJB-F04.
3. To preclude intolerable spurious concerns for outside the control room fires, the pending plant changes/operational considerations must be implemented:
 - o Place the breaker for SDC suction valves J-SIC-UV-653 and J-SID-UV-654 in the open condition during normal plant operating conditions when RCS pressure is greater than the SDC system suction isolation interlock setpoint.
 - o To prevent a fire in Fire Zone 42C from disabling all charging pumps, the Train A charging pump low suction pressure switch (J-CHA-PSL-216) separation concerns are resolved as part of the Appendix R separation review efforts.
 - o The atmospheric dump valve (ADV) nitrogen supply must remain operable.
4. To ensure availability of a borated water source to the charging pumps, the RWT gravity feed flow path through air-operated valve J-CHE-HV532 (fails open) and motor-operated valve J-CHE-HV-536 is designated as Train A while the RWT gravity feed flow path through motor-operated valve J-CHB-HV-530 and manual valves CHV327, and CHV755 (Train A charging pump) or CHV756 (Train B charging pump) is designated as Train B. The train defined to be used for safe shutdown in the event of a specific fire identified in Table 3-1 along with the evaluation findings for that fire zone will ensure proper charging pump suction alignment. (The basis for designating the flow paths as Train A or Train B is the physical location of the valves.)

3.2 FIRE ZONE: 1

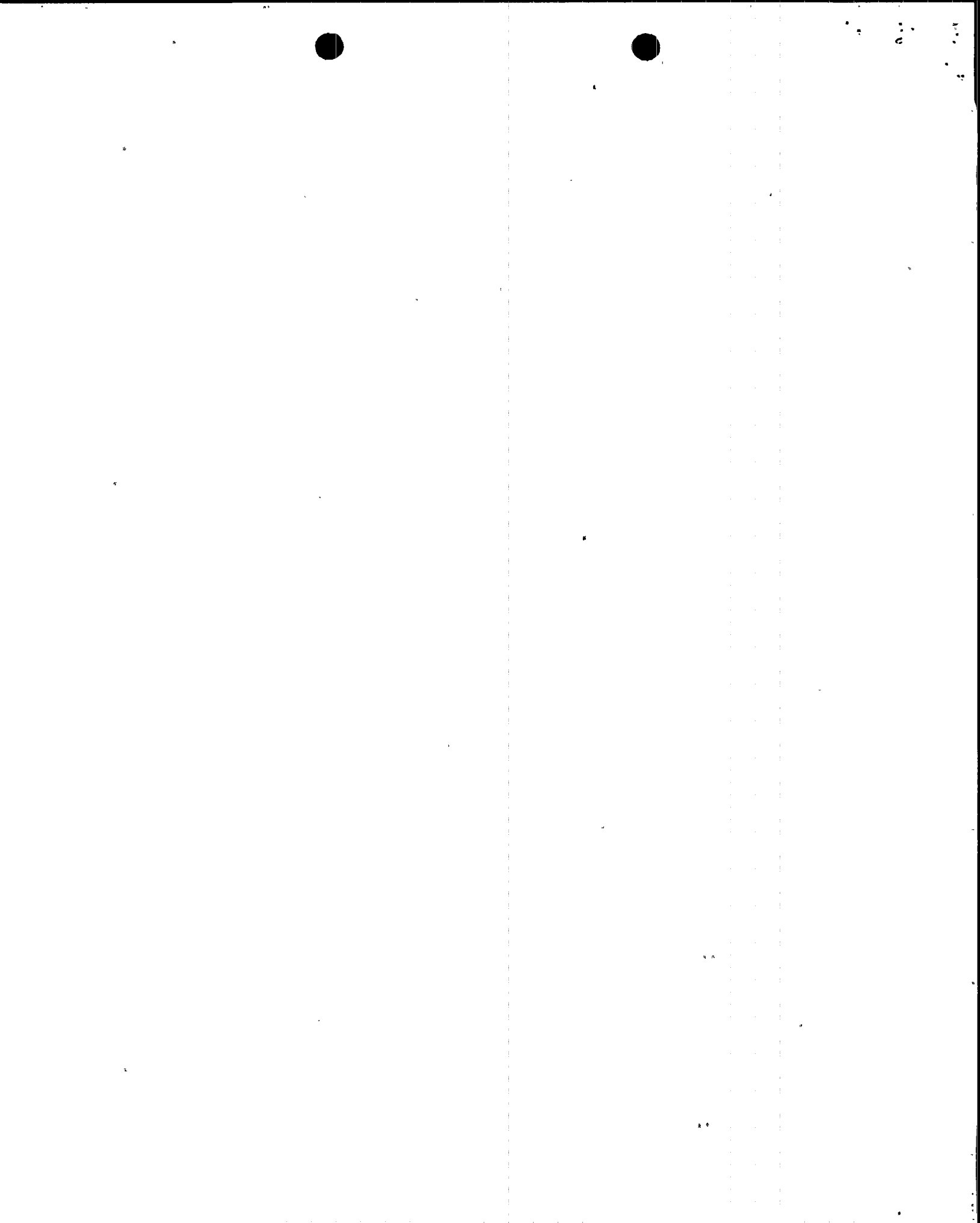
(for a fire in this zone, use SSD Train B)

1. Evaluation Finding:

Loss of pressurizer pressure control may occur due to spurious opening of pressurizer spray valve J-CHA-HV-205

2. Key Monitorable Parameters (Functional)

Pressurizer pressure



3. Time Constraints:

Not applicable (see compensatory measures)

4. Operational Considerations:

Stop pressurizer auxiliary spray flow to prevent uncontrolled RCS depressurization

5. Compensatory Measures:

To overcome spurious uncontrolled RCS depressurization, stop charging flow and open disconnect switch DS-09-07 at auxiliary relay cabinet E-ZAA-C03 to close J-CHA-HV-205.

3.3 FIRE ZONE: 2

(for a fire in this zone, use SSD Train A)

1. Loss of pressurizer pressure control may occur due to spurious opening of pressurized spray valve J-CHB-HV-203

2. Key Monitorable Parameters (Functional)

Pressurizer pressure

3. Time Constraints:

Not applicable (see compensatory measures)

4. Operational Considerations:

Stop pressurized auxiliary spray flow to prevent uncontrolled RCS depressurization

5. Compensatory Measures:

To overcome spurious uncontrolled RCS depressurization, stop charging flow and open disconnect switch DS-09-12 at auxiliary relay cabinet E-ZAB-C03 to close J-CHB-HV-203.

3.4 FIRE ZONE: 3A

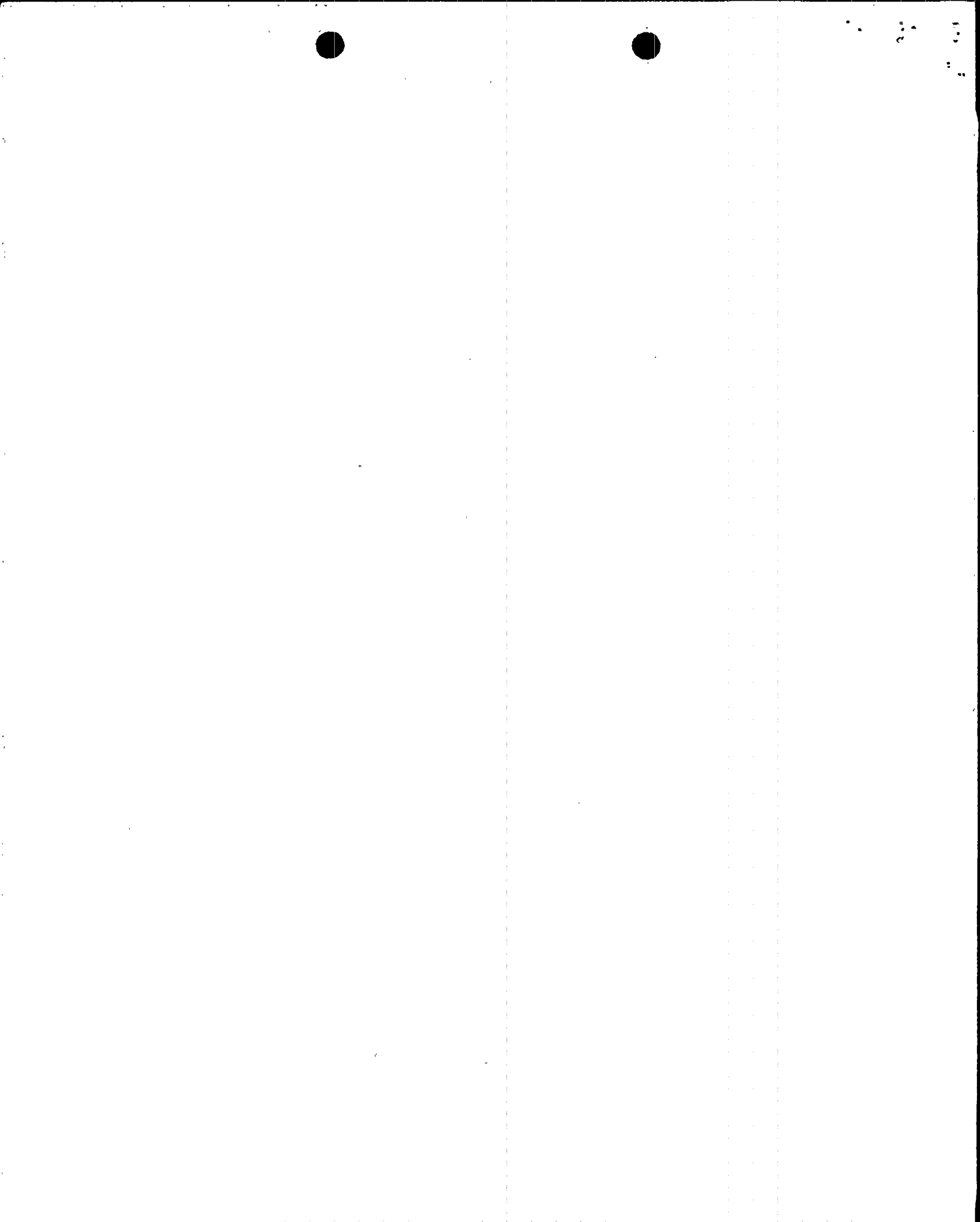
(for a fire in this zone, use SSD Train B)

1. Evaluation Finding:

Loss of pressurizer pressure control may occur due to spurious opening of pressurizer spray valve J-CHA-HV-205

2. Key Monitorable Parameters (Functional)

Pressurizer pressure



3. Time Constraints:

Not applicable (see compensatory measures)

4. Operational Considerations:

Stop pressurizer auxiliary spray flow to prevent uncontrolled RCS depressurization

5. Compensatory Measures:

To overcome spurious uncontrolled RCS depressurization, stop charging flow and open disconnect switch DS-09-07 at auxiliary relay cabinet 3E-ZAA-C03 to close J-CHA-HV-205.

3.5 FIRE ZONE: 3B

(for a fire in this zone, use SSD train A)

1. Evaluation Finding:

Loss of pressurizer pressure control may occur due to spurious opening of pressurizer spray valve J-CHB-HV-203

2. Key Monitorable Parameters (Functional)

Pressurizer pressure

3. Time Constraints:

Not applicable (see compensatory measures)

4. Operational Considerations:

Stop pressurizer auxiliary spray flow to prevent uncontrolled RCS depressurization.

5. Compensatory Measures:

To overcome spurious uncontrolled RCS depressurization, stop charging flow and open disconnect switch DS-09-12 at auxiliary relay cabinet 3E-ZAB-C03 to close J-CHB-HV-203

4.0 OUTSIDE CONTROL ROOM FIRE SPURIOUS ACTUATION EVALUATION GROUND RULES

4.1 NRC REQUIREMENTS

1. No accidents are assumed concurrent with the fire.
2. Cold shutdown must be achieved and maintained with and without offsite power.
3. As the consequence of the fire, hot shorts, open circuits, or shorts to ground must be considered.

4. Where hi/low pressure interface is involved (RCS only), any number of fire-induced actions/inactions must be postulated.

4.2 ASSUMPTIONS AND BASES

1. Either the Train A or the Train B fire event safe shutdown components and monitorable parameters identified in FSAR Table 9B.1-4 will be operable following any fire event.

Basis:

Appendix R train separation is provided for the FSAR Table 9B.1-4 components.

2. The worst case combination of spurious actuation of the device under consideration and fire damage to circuits of other components in the fire zone will be evaluated. In addition, the effects of hot shorts, shorts to ground and opens on ESFAS initiating and power supply circuits shall be evaluated.

Basis:

This assumption considers that a fire will damage more than one circuit in the fire zone but not necessarily all circuits. No other components with circuits in the same fire zone can be used to mitigate the effects of the spurious actuation under consideration; conversely, the action/inaction of these components combined with the spurious actuation may preclude safe shutdown.

3. A spurious control signal action/inaction shall be defined as being caused by a single hot short, open circuit, or short to ground, impacting a single component.

Basis:

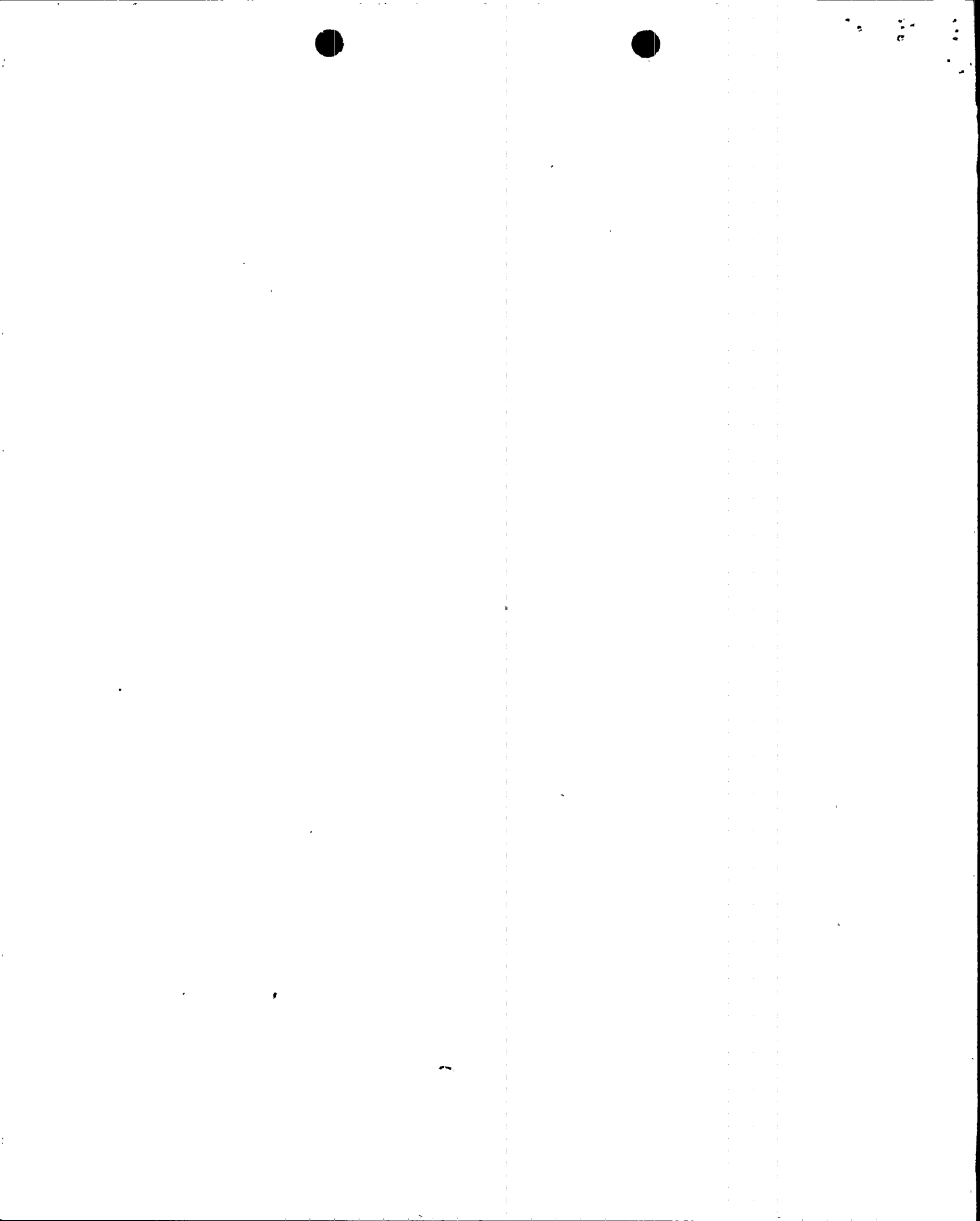
Each electrically-operated component has its own unique control circuits, which may be affected by the single hot short, open circuit, or short to ground.

4. Fire-induced failures in three-phase power cables can only result in a loss of power to, or the inability to supply power to, the component.

Basis:

Hot shorts in three-phase power circuits resulting in maintained contact are not considered credible.

5. The conditions stated in Assumption 2 can be assumed to occur at any time following the onset of the fire event, until action is taken to defeat or preclude the action/inaction from occurring.



Basis:

Because of the Appendix R mandate to achieve and maintain cold shutdown, the plant can be in any of its normal operating modes (i.e., Modes 1-6) at the initiation of the fire event.

6. For offsite power available, all equipment not affected by the fire will remain in its prefire condition (i.e., condition during normal plant operation for the assumed mode). For loss of offsite power, all equipment goes to its loss of offsite power design failure position. (NOTE: One strategy may be to selectively shed power from equipment/buses to minimize adverse spurious action/inaction impact.)

Basis:

The basis for this assumption is simply that the components/systems will function as designed, with the exception of the single spurious actuation.

7. The analysis of fire damage will be performed on a fire zone basis and only components in safety-related systems will be considered.

Basis

Generic Letter 81-12 allows for the choice of evaluating spurious actuation on a fire area or systems basis. The security system monitoring of plant fire detection systems identifies fire situations on a fire zone basis and alerts the operators of an incipient fire. Using the result of a fire zone analysis, the operators can take immediate action for the affected zone and anticipate safe shutdown system alignment needs for the possibility of fire spreading to adjacent zones. The inherent plant design is such that the safe shutdown equipment listed in FSAR Table 9B.1-4 can overcome any effects by nonsafety-related systems on the capability to achieve safe shutdown. The fire event safe shutdown systems are identified in Table 1-1.

8. There will be some time interval between the onset of the fire event (time $t=0$) and that time when the operator can reasonably be expected to be able to counter the adverse effects of the spurious action/inaction. (This time interval should be quantified.)

Basis:

This assumption is intended to reflect the "real world" situation an operator may face as a result of a fire. The evaluation will define necessary operational considerations and applicable time constraints necessary to aid an operator in assessing overall plant conditions and controlling the plant.

9. Protection of nonsafe shutdown equipment is not a priority item of this evaluation.

Basis:

The Appendix R mandate is to achieve and maintain cold shutdown to protect the health and safety of the public.

10. All plant operating modes except refueling will be evaluated (i.e., Modes 1, 2, 3, 4 and 5).

Basis:

There is sufficient time during the refueling mode (Mode 6) for an operator to assess plant status and respond to conditions without jeopardizing reactivity control or fission product boundary integrity.

11. Only systems and components which can affect (positive or negative impact) safe shutdown are subject to evaluation.

Basis:

Appendix R requires being able to achieve and maintain cold shutdown. Any systems/components not impacting safe shutdown are not within the scope of this evaluation.

12. Turbine trip does not necessarily result in an LOP condition.

Basis:

Given a turbine trip, it may be more conservative to assume that an LOP condition does not occur. The turbine trip circuitry is subject to the single hot short, open circuit, or short to ground.

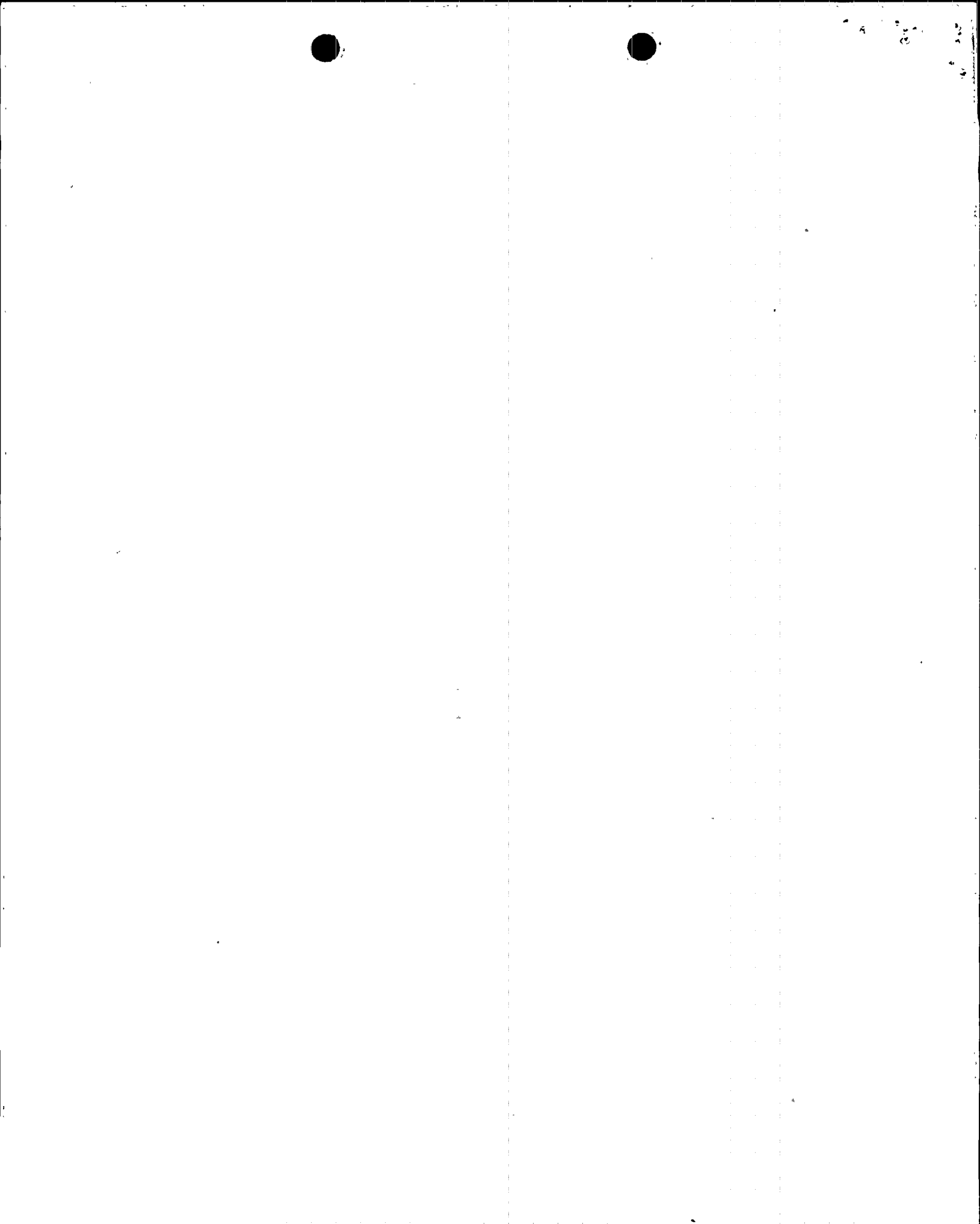
13. No single (including common mode) failures in addition to the spurious action/inaction will be evaluated.

Basis:

Appendix R's scope does not consider any failures other than those caused by the fire.

14. Evaluation drawings will be Bechtel-controlled project documents. Examples are:

P&ID's 13-M-XXP-XXX
 Elementaries 13-E-XXB-XXX
 Loop Diagrams 13-J-XXE-XXX
 One-Line Diagrams 13-E-XXA-XXX
 Controlled Vendor Prints
 FSAR Chapter 9 Appendix 9B



Basis:

The identification of the control drawings defines the source material used for the evaluation and aids in traceability and reproducibility of results.

15. Postulated fires in each FSAR Table 9B fire zone of the Auxiliary Building, Control Building and Main Steam Support Structure will be evaluated for their impact on the ability to achieve SSD.

Basis:

The Turbine Building and Radwaste Building are excluded since no safety-related equipment is housed in these areas. The Fuel Handling Building is excluded since it does not house safe shutdown components. The Diesel Generator Building is excluded because it complies with Appendix R with no deviations. The Containment Building is excluded because it is addressed by the deviation from the separation requirements of Appendix R for components and circuits located inside containment.

16. Deleted.

17. Simultaneous failures of both power supplies to one of the BOP ESFAS cabinets (FBEVAS, CREFAS, CPIAS, Load Shed, CRVIAS, DGSS, Load Sequencer) cannot prevent the ability to achieve safe (cold) shutdown.

Basis:

Simultaneous failures of both power supplies to a BOP ESFAS cabinet can result in activation of both trains of sequencer activated devices associated with FBEVAS, CREFAS, and CPIAS. This is not a significant concern since actuation of these devices (essential chilled water, cooling water, spray pond, etc.) has no negative impact on the ability to achieve safe shutdown. NSSS components (LPSI, HPSI and containment spray pumps) will start only in the affected train but system operation will not occur (i.e., valves will not align) without simultaneous NSSS ESFAS present.

5.0 OUTSIDE CONTROL ROOM FIRE SPURIOUS ACTUATION EVALUATION LOGIC

Figure NS-110-1 details the logic used in evaluating the outside control room fires.

