

PALO VERDE NUCLEAR GENERATING STATION

UNITS 1, 2, & 3

ELECTRICAL TRAIN AND CHANNEL SEPARATION STUDY -

SAFE SHUTDOWN ANALYSIS

SUMMARY REPORT

August 28, 1981

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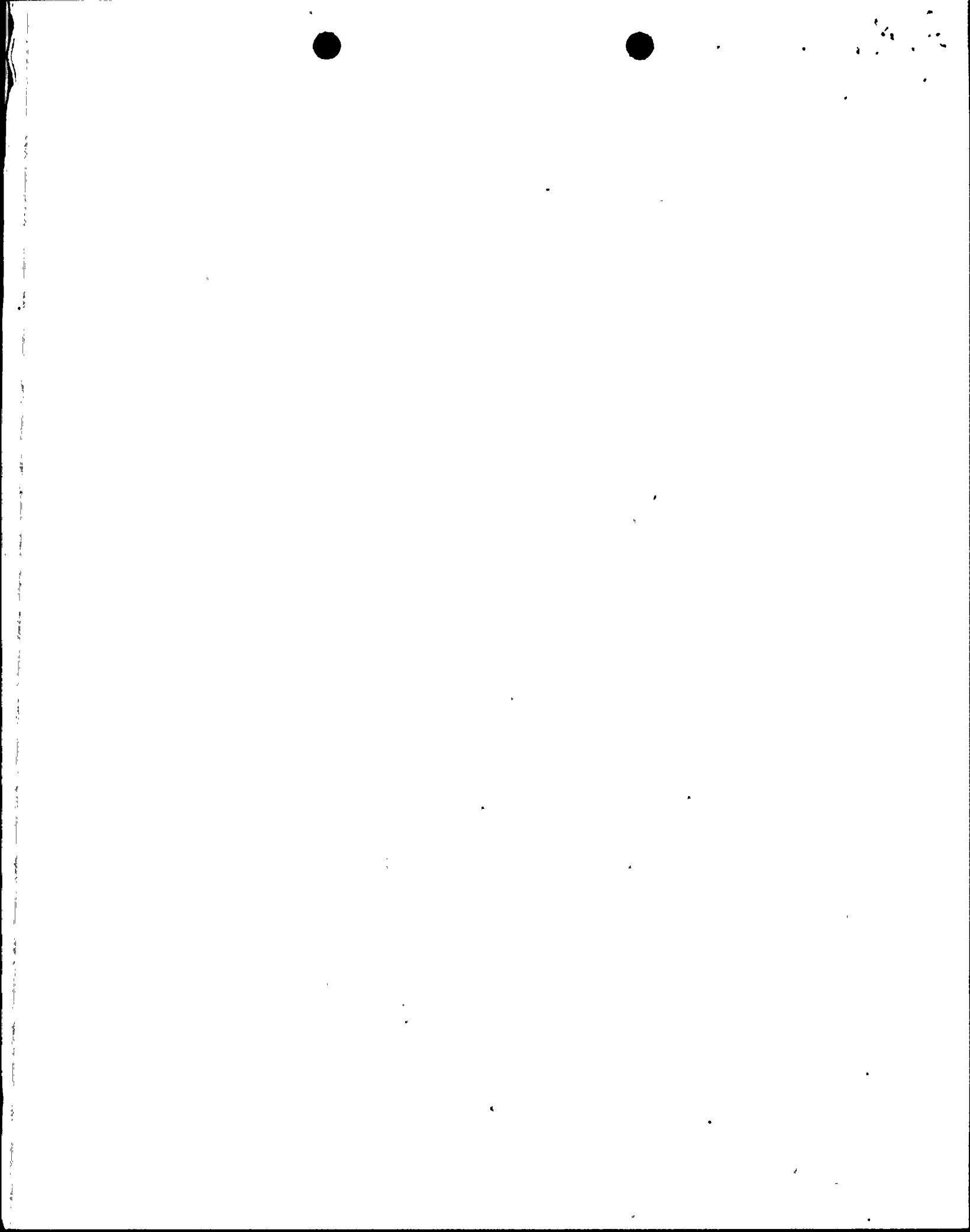
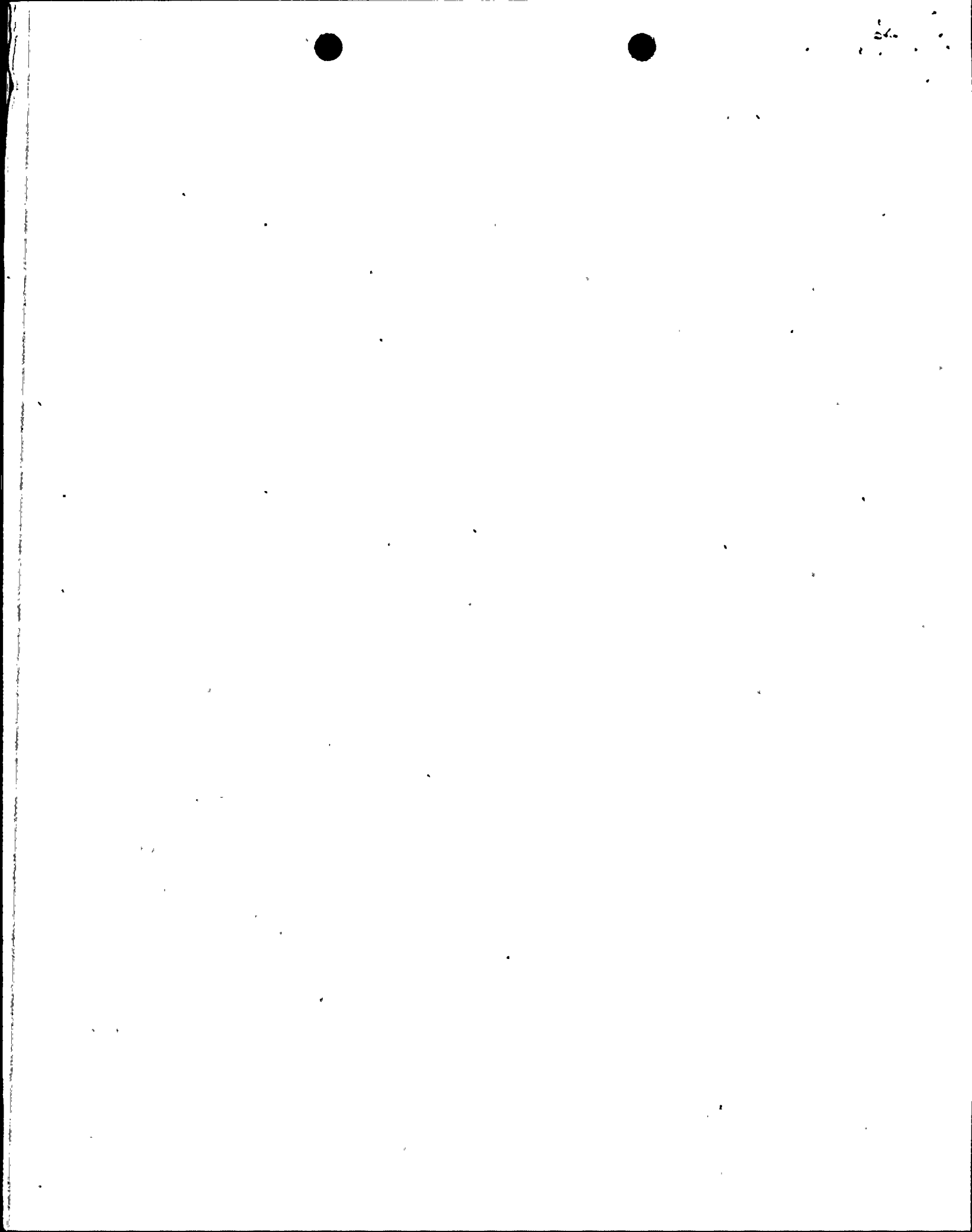


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ELECTRICAL TRAIN AND CHANNEL SEPARATION STUDY -  
SAFE SHUTDOWN ANALYSIS

1. SUMMARY

An intensive study was conducted to determine the capability to safely shut down the plant in the event of an exposure fire whose zone of influence could impact redundant equipment, cables, or components necessary for safe shutdown. All safety-related plant areas except the control room and containment building were considered in this study. The control room fire study is part of a separate effort.

Access to the containment is limited during operations by strict administrative control which minimizes the possibility of transient combustibles accumulating in the containment. Further, before significant access could occur for refueling, the plant would be placed in a cold shutdown condition.

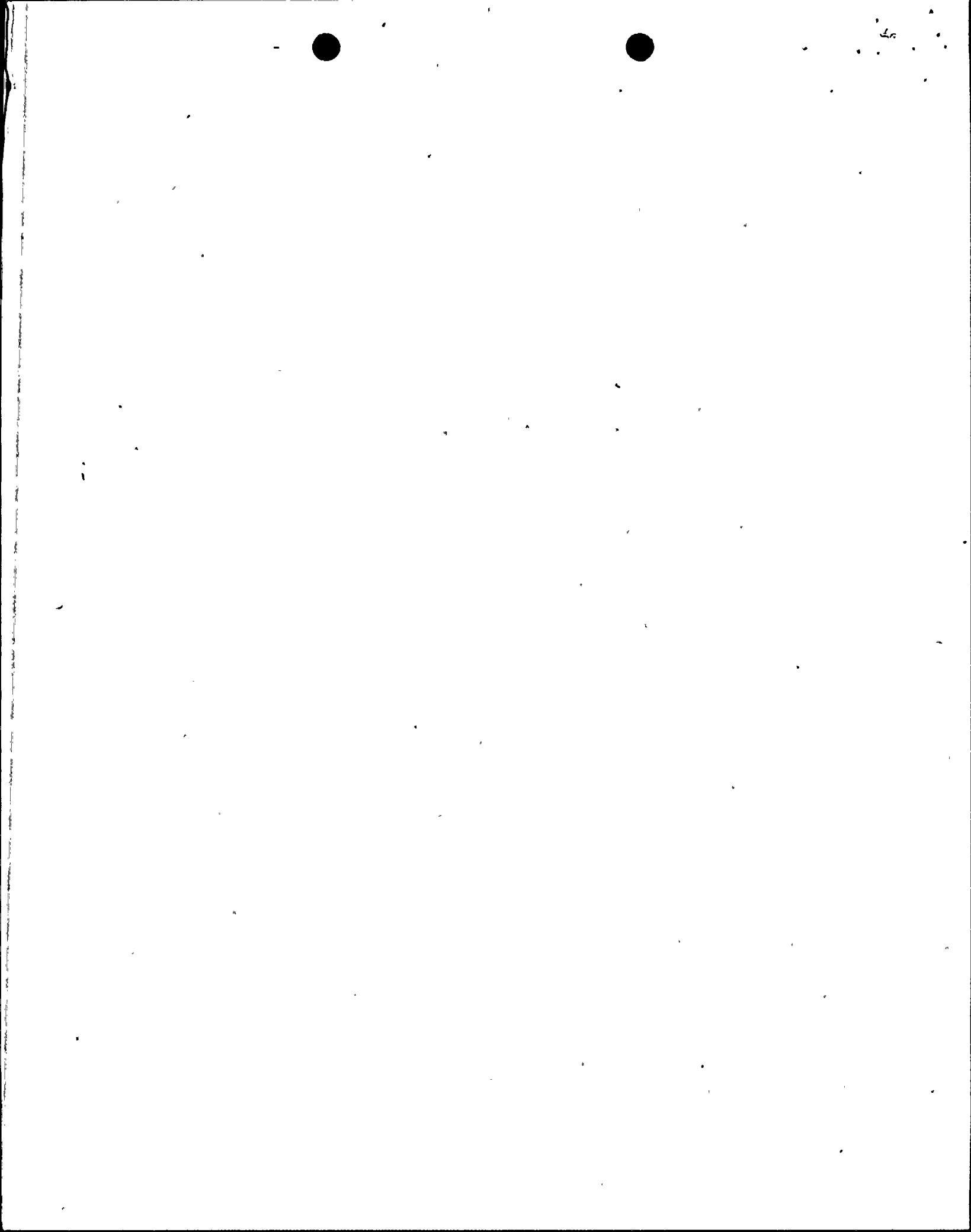
The only source of substantial flammable exposure fire material is the reactor coolant pump lube oil and this is contained by a leak collection system which will remain functional after an SSE. The system is designed to preclude leakage onto hot surfaces.

The study began with the development of a comprehensive list of equipment required to achieve and maintain safe shutdown. All electrical cables connected to the respective equipment were identified. Raceways containing safe shutdown cables were color coded on electrical layout drawings.

Criteria for adequate separation were based on 10CFR50, Appendix R, and were used to identify problem areas. Problem areas were identified where adequate separation was not maintained. Each problem area was resolved by providing adequate separation as identified below.

For structures other than the containment building, adequate separation is maintained by providing early warning fire detection and manual fire protection and separating redundant equipment, cables, or components by one of the following:

- a. 3-hour rated fire barrier, wall, or floor slab,
- b. 1-hour rated fire barrier for one division and automatic fire suppression,
- c. 1/2-hour rated fire barrier for both divisions and automatic fire suppression,
- d. Twenty feet minimum separation with no intervening combustibles and automatic fire suppression,
- e. Alternate or dedicated shutdown and automatic fire suppression.



As a result of field walkdowns, problem areas were and are being resolved by providing adequate separation of safe shutdown raceways. Specific problem area solutions for all areas are expected to be completed by late November 1981.

The study concludes that PVNGS can achieve and maintain a safe plant shutdown in the event of a fire, with or without available offsite power. This complies with 10CFR50, Appendix R, Section III.G.2.

## 2. EQUIPMENT REQUIRED FOR SAFE SHUTDOWN

The list of equipment required for safe shutdown was developed from existing lists of systems or equipment required for safe shutdown taken from:

- A. CESSAR-F, Section 7.4, Systems Required for Safe Shutdown
- B. PVNGS FSAR, Section 7.4, Systems Required for Safe Shutdown
- C. PVNGS Fire Protection Evaluation Report, Table A-1, Equipment Required for Cold Shutdown Without Offsite Power Available

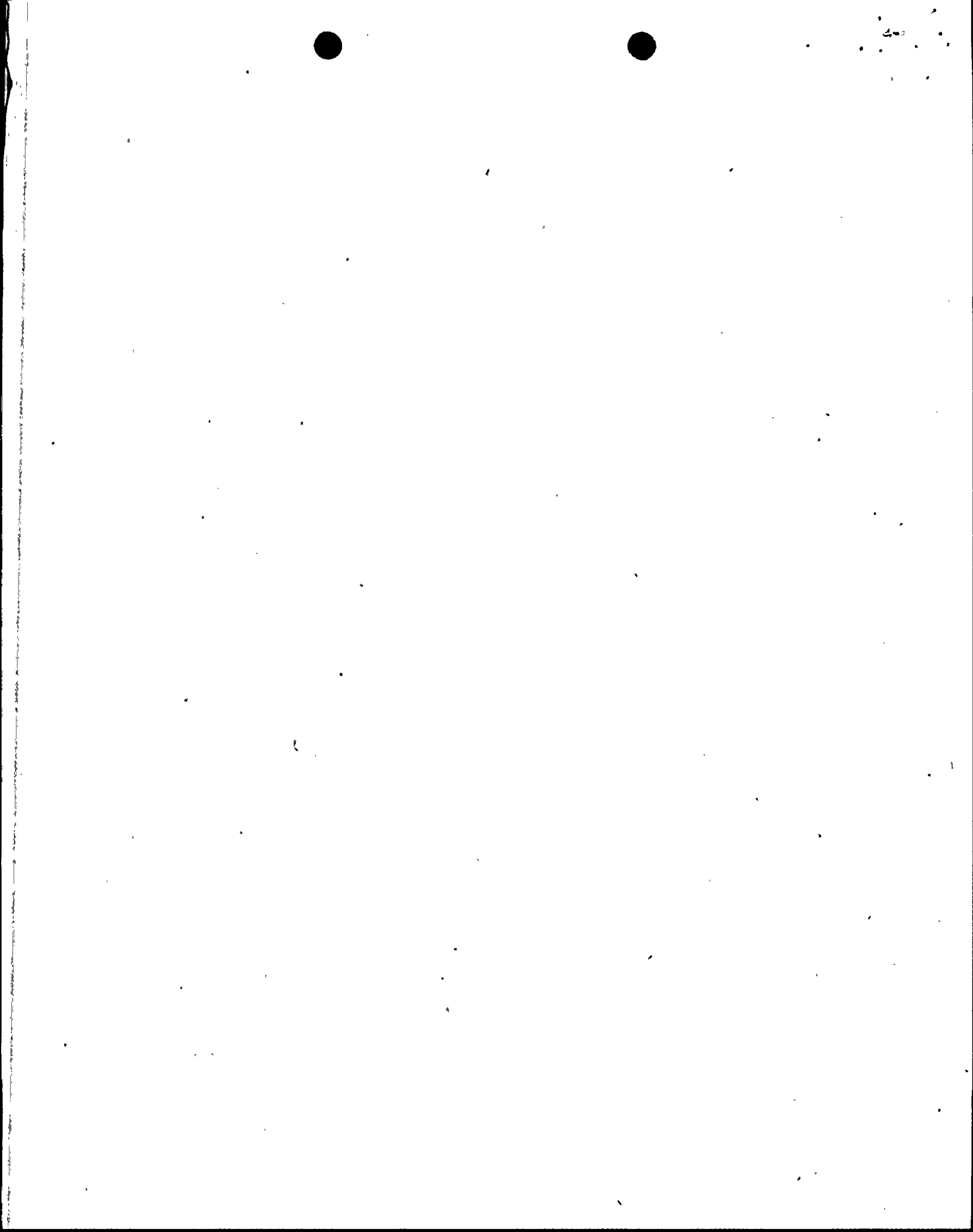
Support systems (e.g., essential cooling water, essential HVAC, etc.) were also included.

Consistent with 10CFR50, Appendix R, the following criteria were used to finalize a list of safe shutdown systems and safe shutdown functions:

- A. Achieve and maintain a safe plant shutdown in the event of a fire, with or without available offsite power.
- B. Achieve and maintain hot standby from the main control room.
- C. Achieve and maintain cold shutdown within 72 hours from either the main control room or locally.

The following list of safe shutdown systems and safe shutdown functions was developed:

<u>Safe Shutdown System</u>	<u>Functions Necessary to Achieve Safe Shutdown</u>
Reactor Protection	Insert Control Rods
Auxiliary Feedwater	Feedwater to Steam Generators
Condensate Storage Tank	Level Instrumentation
Main Steam System	Atmospheric Dump Valves
	Main Steam Isolation
	Steam Generator Level Indication
	Steam Generator Pressure Indication



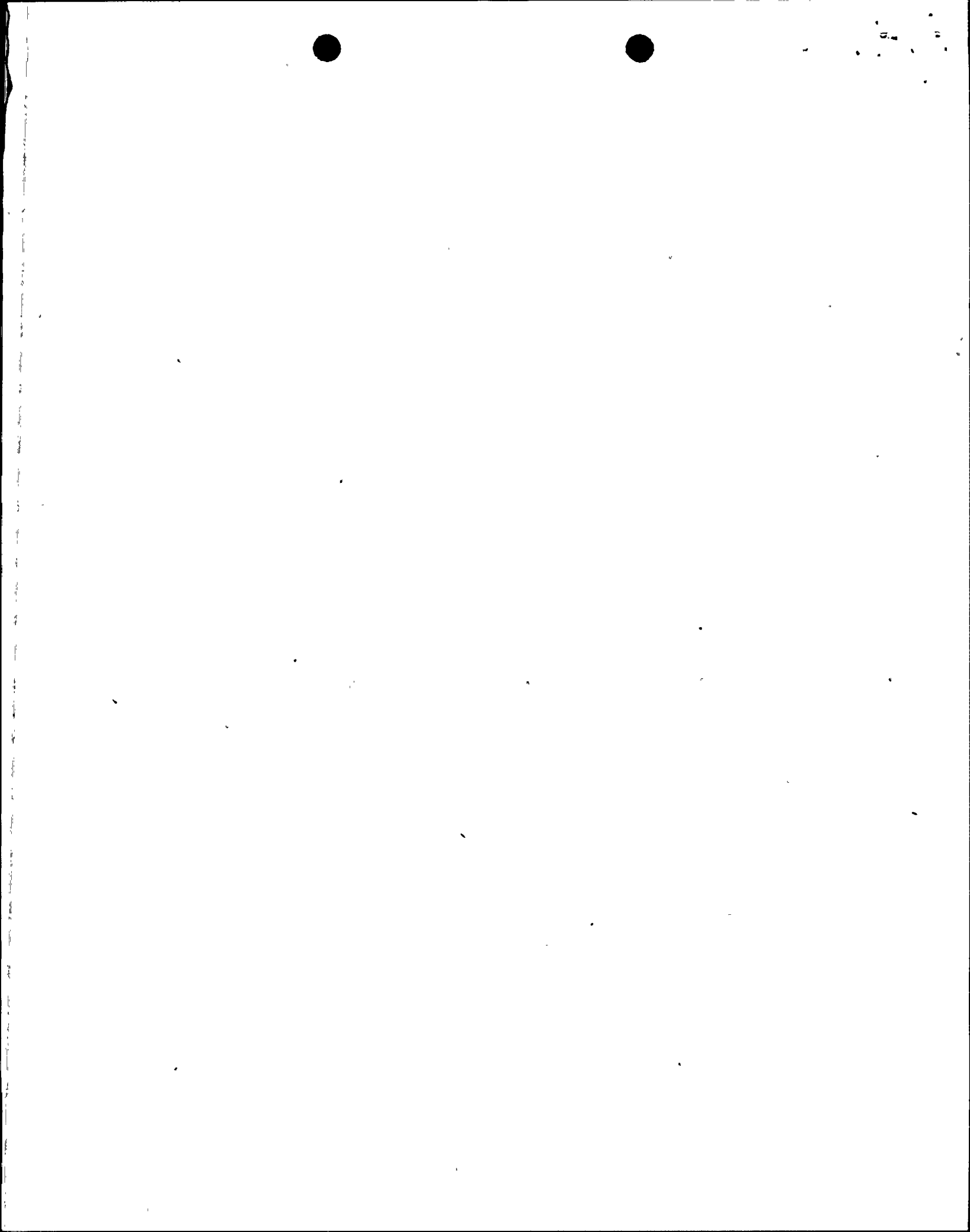


<u>Safe Shutdown System</u>	<u>Functions Necessary to Achieve Safe Shutdown</u>
Reactor Coolant System	Pressurizer Pressure Indication
	Pressurizer Level Indication
	Pressurizer Heaters
	RCS Temperature Indication
	Isolation of RCPB
Essential Chilled Water	Essential Equipment Rooms
	Auxiliary Feedwater Pump Rooms
	LPSI Pump Rooms
	ECW Pump Rooms
Essential HVAC	Control Building Equipment
Essential Cooling Water	Cooling for Essential Chilled Water
Essential Spray Pond	Ultimate Heat Sink
Diesel Generator and Support	Emergency Electric Power
CVCS	RCS Makeup (Includes Charging Pumps)
	Pressurizer Auxiliary Spray
Emergency Lighting	Control Room Emergency Lighting
Shutdown Cooling	RCS Cooldown

With the list of functions itemized, P&IDs and electrical elementary drawings were used to develop a specific list of equipment, by tag number, required to achieve and maintain a safe shutdown configuration.

### 3. ELECTRICAL CIRCUITS REQUIRED FOR SAFE SHUTDOWN

To determine which electrical circuits were required for safe shutdown, the electrical elementary diagram containing a given piece of equipment required for safe shutdown (see Section 2) was selected. Electrical power, control, and instrument circuits terminating at that piece of equipment were identified by unique scheme numbers. Each scheme was traced back through panels, motor control centers, load centers, and switchgear equipment to the main Class IE 13.8 kV bus, 4.16 kV switchgear bus, 480V MCC bus, or 125 V-dc bus, as appropriate, for the respective electrical separation group. Any additional equipment or electrical circuitry considered as related were also identified. This process was done for each piece of equipment required for safe shutdown.



4. SELECTED CABLES BY RACEWAY

The circuits identified in Section 3 as required for safe shutdown were assigned a code letter R to denote "Required for Safe Shutdown." This information was inserted into an existing computerized data base. Ordinarily, the data is used to provide cable routing information indicating all electrical cables contained in a given electrical raceway. In this case, the code letter clearly identifies each safe shutdown cable.

A computer sort entitled "Selected Cables by Raceway" was made to identify the raceways containing safe shutdown cables. The sort identifies raceway numbers, electrical separation groups, and electrical cables, including safe shutdown (Code R) cables in each raceway for each raceway drawing. Raceway drawings are divided according to building, level, and area. The separation groups consist of Trains A or B for ac power and control cables, Trains A, B, C and D for dc power and control cables, and Channels A, B, C, and D for instrumentation cables.

5. COLOR CODED RACEWAY DRAWINGS

Using the computer sort entitled "Selected Cables by Raceway" (see Section 4) to identify raceways containing safe shutdown cables, raceway layout drawings were selected and individual raceways were color coded according to the following scheme:

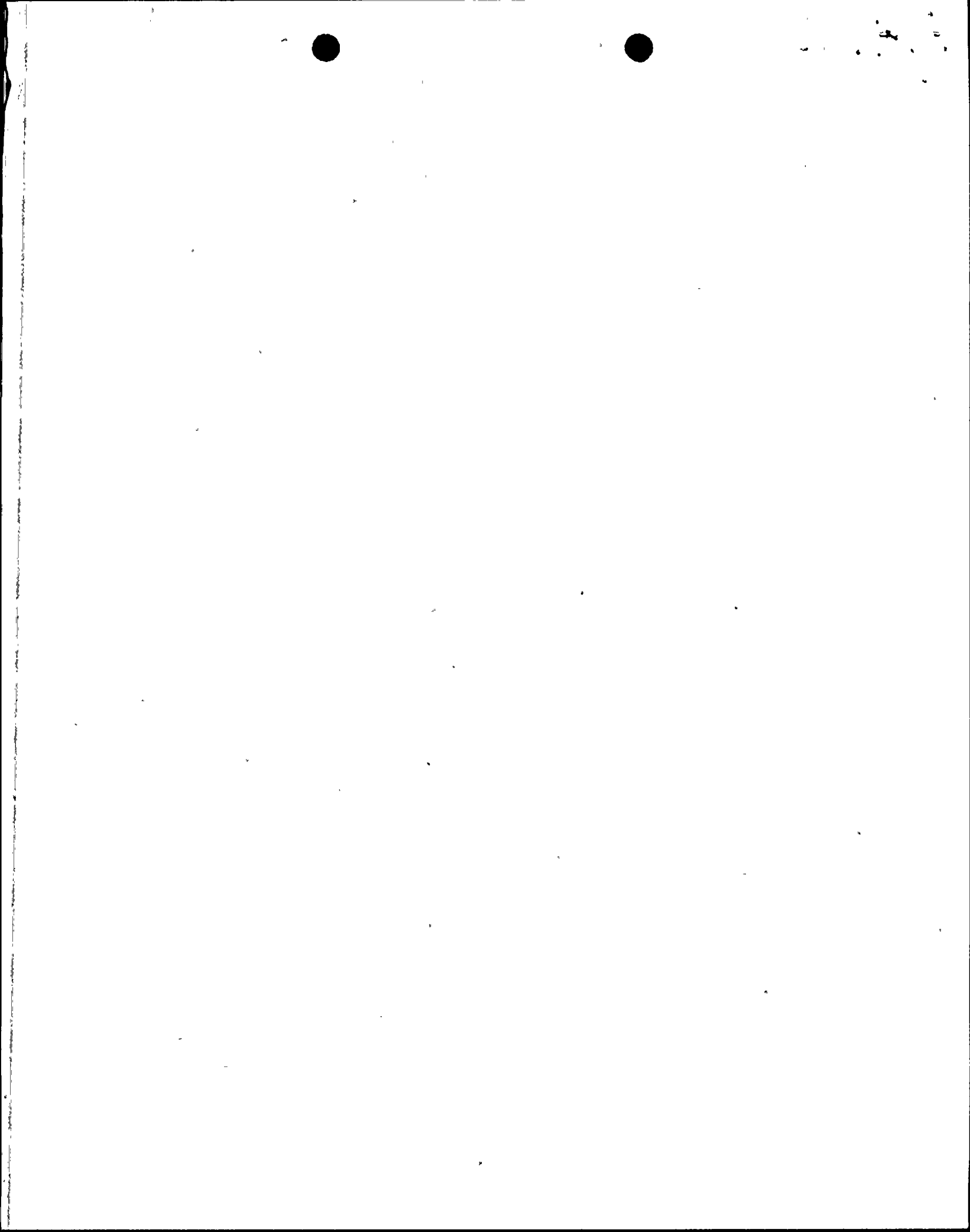
AC Power and Control Cables:	Train A	RED
	Train B	GREEN
DC Power, Instrumentation, and Control Cables:	Channel A	RED
	Channel B	GREEN
	Channel C	YELLOW
	Channel D	BLUE

The drawings show the physical layout of each electrical raceway. Care was taken to note noncontiguous colored raceways, which would imply omission or coding errors.

6. PROBLEM AREAS

The color coded raceway drawings from Section 5 were checked to determine whether adequate separation was maintained between all redundant raceways with the exception that RED did not have to be separated from YELLOW, and GREEN did not have to be separated from BLUE. This exception was based on the electrical separation groups established at PVNGS. Safety channels A and C are considered part of safety train A, while safety channels B and D are part of safety train B.

Consistent with 10CFR50, Appendix R, for structures other than the containment building, adequate separation is maintained by providing early



warning fire detection and manual fire protection and separating redundant equipment, cables, or components by one of the following:

- a. 3-hour rated fire barrier, wall, or floor slab,
- b. 1-hour rated fire barrier for one division and automatic fire suppression,
- c. 1/2-hour rated fire barrier for both divisions and automatic fire suppression,
- d. Twenty feet minimum separation with no intervening combustibles and automatic fire suppression,
- e. Alternate or dedicated shutdown and automatic fire suppression.

Each drawing was designated as a problem area if adequate separation was not maintained between redundant safe shutdown raceways. Buried or embedded conduit in concrete were exempted from problem area considerations.

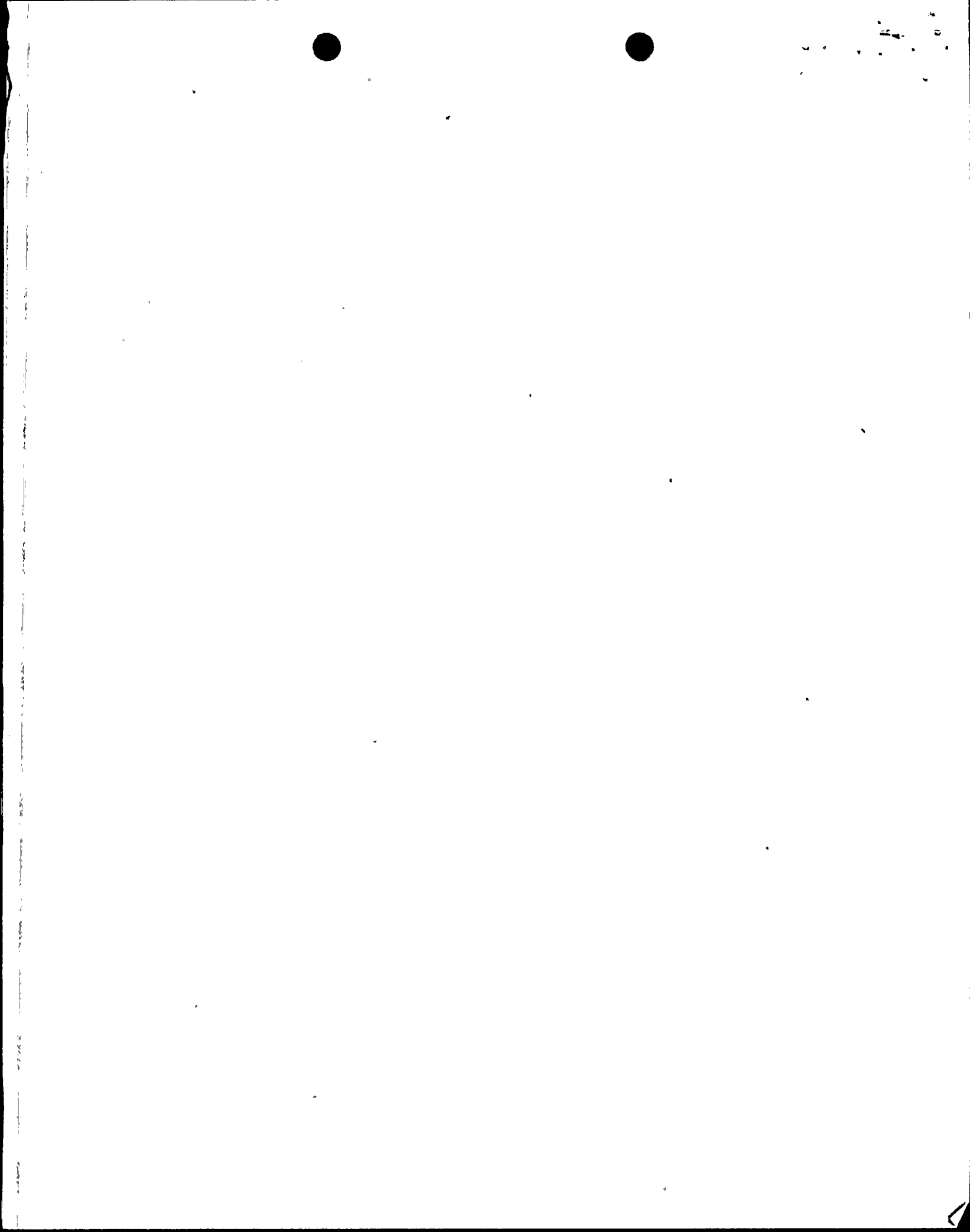
#### 7. FIELD WALKDOWNS

Beginning in April 1981 and continuing through July 1981, approximate weekly walkdowns were conducted at the PVNGS jobsite. The purpose of these walkdowns was twofold:

1. To review all raceways that contain safe shutdown cables,
2. To ensure compliance with separation requirements of 10CFR50, Appendix R.

The walkdowns involved tracing and following the installed configuration of safe shutdown raceways and comparing with color-coded raceway drawings. The walkdown checklist consisted of the following:

- a. 20'-0" separation (with no intervening combustibles) between trains A and B raceways containing shutdown cables
- b. Reroute raceways (if possible) to meet 20'-0" separation
- c. Reroute cables (if possible) to eliminate need to reroute raceways.
- d. When insufficient space exists between trains A and B raceways, review the possibility of wrapping both trains with an approved material (e.g., junction boxes one inch apart)
- e. Identify raceways to be wrapped with an approved material for trains A or B raceways that do not meet 20'-0" separation and cannot be rerouted
- f. When it is determined to wrap raceways, it must be checked and verified that sprinklers will be installed in the area



- g. Identify possibility of installing fire barrier with 3-hour rating
- h. Check walkdown against physical color-coded drawings
- i. Mark any major and significant differences between the physical drawings and actual installation that would affect the installation drawings
- j. Document observations and recommendations after jobsite walkdown.

The walkdowns were a vital part in analyzing a problem area (see Section 8), drawing correct conclusions, and selecting optimum solutions.

#### 8. RECOMMENDED SOLUTIONS

In conjunction with the weekly plant walkdown effort (see Section 7), consideration was given to selecting the most practical alternative in view of the advanced stage of construction at PVNGS. Considerations included:

- a. Space availability
- b. Installation status of existing equipment
- c. Cost and schedule impact of implementation
- d. Operating and maintenance concerns
- e. Percent completion of pulled cable.
- f. Existing or potential fire barriers.

Each problem area was resolved by providing adequate separation of redundant safe shutdown raceways in accordance with 10CFR50, Appendix R, as specified in Section 6.

As a result of this study, it was determined that approximately 3000 feet of wrapped electrical raceways and approximately 18 zones needing additional fixed water suppression were necessary for simply separating Train A from Train B. However, a detailed functional analysis is being performed to determine whether a safe shutdown can be achieved with the loss of all safe shutdown circuits in the affected fire zone. It is expected that this analysis will result in a reduced amount of wrapping and a reduced amount of additional sprinklers.

This study did not specifically address the separation of equipment. However, the results of the study apply to all electrically operated safe shutdown equipment since the study covered all safe shutdown cabling. In the Palo Verde design, redundant components are located in separate rooms.

