# Manual of Emergency Events

**Revision 7**

**SONGS2/3**

Please update your copy of the Manual of Emergency Events using the attached instructions, and direct questions regarding filing of sections to: **CDM Controlled Manuals Desk (949) 368-9356 (PAX 89356).**

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EP 123
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A045



Rec'd 11/25/03

## SAN ONOFRE NUCLEAR GENERATING STATION

# MANUAL OF EMERGENCY EVENTS

Revision 7.0
November 14, 2003

Southern California Edison Company
San Diego Gas and Electric Company
City of Anaheim
City of Riverside

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## FOREWORD

Protecting the health and safety of the public and plant workers is a primary concern in the design, maintenance and operation of San Onofre Nuclear Generating Station (SONGS). The SONGS nuclear reactors have been built with redundant safety systems to prevent the accidental release of radioactive material. A stringent quality control program ensures that plant structures and components are maintained to the highest standards. Detailed procedures govern the use of all plant systems and components. Highly-trained personnel maintain their qualifications through continuing training programs that combine formal classroom studies with hands-on practice.

As a final precaution, plans have been developed to safeguard the public in the event of an accident. Emergency plans for San Onofre comply with guidance established by the Nuclear Regulatory Commission (NRC) and the Federal Emergency Management Agency (FEMA). The SONGS Emergency Plan provides a graded response to emergencies, dependent upon the severity level. Emergencies are categorized in the following classes, from least to most severe: Unusual Event, Alert, Site Area Emergency, and General Emergency.

There are various plant conditions that would fall into these emergency classes. The SONGS Emergency Plan identifies the plant conditions by a system of event codes. In an emergency, state and local authorities would receive notification that includes the emergency class and event code. This manual describes the plant conditions associated with each event code, identifies actions taken by plant operators, and indicates the potential, if any, for escalation of the emergency. Also included are a basic description of the nuclear power plant and background information about radiation. This material is intended to assist offsite personnel responding to an emergency at San Onofre.

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## 1.0 EMERGENCY CLASSIFICATION

### 1.1 EMERGENCY ACTION LEVELS (EALs)

Specific conditions requiring declaration of an emergency have been identified to ensure accurate and timely response by emergency response organizations. These Emergency Action Levels are based on postulated accidents, equipment malfunctions and other conditions of potential degradation of plant safety. Emergency Action Levels (EALs) include objective criteria based on plant conditions.

### 1.2 EMERGENCY CLASS

Emergency Action Levels are grouped into four emergency classes. The emergency class indicates the severity of the emergency, and determines the scope of response by station and offsite emergency response organizations. The Site Area Emergency class is not applicable for the ISFSI. The General Emergency class is not applicable for Unit 1 or the Independent Spent Fuel Storage Installation (ISFSI).

The classes, from least to most severe, are:

| | |
|---|---|
| Unusual Event - | Potential degradation of plant safety. No offsite response is required. |
| Alert - | Actual or potential significant degradation of plant safety. Any release of radioactive material will be a small fraction of the Environmental Protection Agency (EPA) limits. |
| Site Area Emergency - | Actual or likely failures of plant functions needed for protection of the public. Any release of radioactive material is not expected to exceed EPA limits. |
| General Emergency - | Actual or imminent substantial plant damage. A release of radioactive material can be expected to exceed EPA limits. |

### 1.3 EVENT CATEGORY

Specific EALs which constitute the four emergency classes are grouped into seven event categories. Whereas emergency classes indicate the severity of an emergency, event categories indicate the type or nature of the emergency. The event categories are:

A. Uncontrolled Release of Radioactivity
B. Loss of Reactor Coolant System (RCS) Inventory
C. Core Degradation or Overheating
D. Loss of Safety Equipment
E. Disasters
F. Security Contingency
G. Miscellaneous

### 1.4 EVENT CODE

An event which meets the criteria of an EAL is identified and referenced by an event code which includes the event category, the emergency class, and the EAL number. This event code indicates to station and offsite personnel the type, severity and specific plant conditions of a declared emergency. Event codes and the associated emergency conditions are listed in section 2 of this manual.

1.5 EMERGENCY NOTIFICATION

Verbal notification of the state and local authorities will be initiated within 15 minutes of the declaration of an emergency. This notification will be made to local authorities via the Yellow Phone System. The Governor's Office of Emergency Services will be notified via the Blue Phone System. Message authenticity is assured by use of these dedicated phone circuits. Backup notification is made using the Pacific Bell Telephone System.

Notification to the NRC will be made immediately after notification to the state and offsite agencies and must be made within one hour. Notification is made via the Federal Telephone System.

1.6 EVENT NOTIFICATION FORM

A printed Event Notification Form (ENF) message will be transmitted to state and local authorities within 30 minutes of emergency declaration. The form is transmitted to local authorities via the Yellow Phone System and to state officials by FAX machine. Information provided on the ENF includes the event code, emergency class, meteorological data, radioactive release information, any protective action recommendation and the basis for such a recommendation.

1.7 OFFSITE AGENCIES NOTIFIED

The following offsite agencies will be notified within 15 minutes of the declaration of an emergency:

- Orange County
- San Diego County
- City of Dana Point
- City of San Clemente
- City of San Juan Capistrano
- Marine Corps Base, Camp Pendleton
- California Department of Parks and Recreation, Orange Coast District Office
- California Highway Patrol
- Governor's Office of Emergency Services

1.8 OFFSITE RESPONSE TO NOTIFICATION

During an Alert, Site Area Emergency, or General Emergency, each of the primary offsite agencies will operate from an Emergency Operations Center (EOC) in their respective localities. Additionally, each of the primary offsite agencies will send a representative(s) to the Emergency Operations Facility for liaison purposes. The emergency response plans of the offsite agencies describe their respective responsibilities, authorities, capabilities and emergency functions, and are contained in three separate volumes titled "Offsite Emergency Response Plans."

## 2.0 EVENT CODES

This section of the manual lists event codes for the full spectrum of postulated emergencies and explains their meaning and significance. The descriptions following each event code indicate the associated plant condition, actions required to ensure plant safety or restore the plant to a safe condition, and any potential for escalation of the event.

## 2.1 UNUSUAL EVENT

The Unusual Event classification is characterized by a potential degradation of the level of safety in the plant. No release of radioactive material requiring offsite response or monitoring is expected.

The primary purpose for this classification is to ensure that the plant operating staff takes appropriate actions such as assessment and verification and comes to a state of readiness to respond, should the condition become more significant. The Unusual Event classification also requires that state and local offsite authorities are informed of abnormal conditions at the San Onofre Nuclear Generating Station. With the exception of possible assistance by local support groups such as fire departments or medical facilities, no response is necessary by offsite organizations for events within this classification. Upon declaration of an Unusual Event, notification of the State and local authorities will be initiated within approximately 15 minutes consistent with the need for other emergency action. Notification to the NRC of an Unusual Event will be made immediately after notification to the state and local agencies, but must be made within one hour.

Conditions which may constitute an Unusual Event classification are listed on the following pages.

RECOMMENDED OFFSITE PROTECTIVE ACTIONS: These events do not require offsite response.

**UNUSUAL EVENT NO. A1-1: Release of airborne radioactivity**

**EVENT:** A release of airborne radioactivity has occurred or is occurring which exceeds Federally Approved Operating Limits and results in a Total Effective Dose Equivalent (TEDE) of 0.2 mrem in a single hour at the Exclusion Area Boundary, as indicated by specified radiation monitor readings.

**EXPLANATION:** Radioactive airborne releases have two possible sources: System boundary failure leading to leakage and a system or administrative failure leading to an uncontrolled release of a Waste Gas Decay Tank.

Liquids from the Radwaste and Reactor Coolant Systems normally contain small amounts of radioactive gasses. Leakage from these system results in liberation of these radioactive gasses. Very small quantities of radioactive gas resulting from system leakage are routinely discharged to the atmosphere after being diluted with clean air. Such releases of radioactive gas are maintained below Federally Approved Operating Limits, as specified in San Onofre's Offsite Dose Calculation Manual (ODCM). The limits specified in the ODCM are specific to each isotope, are conditions of San Onofre's license to operate, and are reviewed and approved by the NRC. Radiation detection systems are installed in the plant vent stack ducting to detect abnormal radiation levels from discharged gasses.

A waste gas processing system is used to manage the concentration of radioactive gasses in the Radwaste and Reactor Coolant Systems. The waste gas processing system allows plant operators to remove radioactive gas from these liquid systems. The operators then use other components in the system to compress the gas and then store it in large tanks to allow the short lived isotopes to decay away. This system reduces the total quantity of gas discharged to the environment to a value As Low As is Reasonably Achievable. Once the gas has decayed, the long lived radioactive isotopes, now at a much lower concentration, are slowly released into the atmosphere in a controlled manner. The release system is closely monitored by installed radiation monitors. In the event that the alarm setpoint is exceeded, isolation valves close to terminate the release.

**OPERATOR ACTION:** Leakage is identified and stopped, and the release of the waste gas decay tank would be terminated.

**POTENTIAL FOR ESCALATION:** There is little or no potential for escalation from the waste gas decay tank release. A release due to system leakage could escalate if the leakage becomes worse or the concentration increases.

**UNUSUAL EVENT NO. A1-2: Release of radioactive liquid**

**EVENT:** A radioactive liquid release which exceeds Federally Approved Operating Limits for greater than 1 hour, as indicated by specified radiation monitor readings.

**EXPLANATION:** The most likely source of the release would be the liquid Radwaste System. Liquids from the Radwaste Tanks normally contain very small amounts of radioactivity. The liquids are routinely discharged to the ocean after first being processed through demineralizers, gas strippers, and then stored in hold-up tanks to allow the decay of short-lived radioactive isotopes. The liquids are diluted by cooling water systems before being discharged. All releases of liquid-borne radioactive material are maintained below Federally Approved Operating Limits, as specified in San Onofre's Offsite Dose Calculation Manual (ODCM) The limits specified in the ODCM are specific to each isotope, are conditions of San Onofre's license to operate, and are reviewed and approved by the NRC. Radiation detection systems are installed in the discharge piping to detect abnormal radiation levels from discharged liquids. If these levels increase, a signal is sent to automatically shut the discharge valve stopping the release. In addition, automatic interlocks are provided to minimize the accidental discharge of highly radioactive liquids or liquids that have not been adequately diluted by the cooling water systems.

**OPERATOR ACTION:** Actions taken would be directed to terminate the release by closing appropriate valves and turning off the discharge pumps. Plant personnel would evaluate conditions to determine how much radioactivity was released and project further effects.

**POTENTIAL FOR ESCALATION:** This event has a very small potential for escalation.

**UNUSUAL EVENT NO. A1-3: Loss of Integrity of a Dry Storage Cask**

**EVENT:** Any incident which leads to or causes a loss of integrity of a Dry Storage Cask containing irradiated nuclear fuel.

**EXPLANATION:** An analysis of accidents was conducted during the licensing of the Dry Storage Casks used for interim storage of irradiated nuclear fuel at SONGS. The result of this analysis shows that there is no credible accident which would lead to a loss of integrity of the Dry Storage Cask. This event code was created in the event that an accident occurred which actually leads to a loss of integrity.

Spent nuclear fuel is required to be stored in the Spent Fuel Pools from the point it is removed from the reactor until the heat generated by the decay of the shorter lived radioactive isotopes has been reduced to levels that active cooling by water is no longer required. Most of the radioactive noble gasses, and all of the radioactive iodine, will have decayed to insignificant levels prior to any fuel assemblies being placed into Dry Storage Casks. The fuel in the Dry Storage Casks represents no potential for release to the environment in the postulated accidents. In the event that a Dry Storage Cask were somehow breached, an airborne release would only occur if the integrity of the fuel cladding was also breached. In the event that both of these barriers were lost, only small quantities of radioactive noble gas would be available for release.

**OPERATOR ACTION:** Operators would direct that the vicinity of the container be surveyed to validate that no release of radioactive material was occurring. Following an assessment of damage, a recovery plan would be developed.

**POTENTIAL FOR ESCALATION:** This event has a very small potential for escalation.

**UNUSUAL EVENT NO. B1-1: Reactor Coolant System leakage**

**EVENT:** A leak has developed in the Reactor Coolant System (RCS) which exceeds:

A. 10 gallons per minute (gpm) from an unidentified point
B. 10 gpm "pressure boundary" leakage
C. 25 gpm from an identified point in the system

**EXPLANATION:** Several factors are used in determining the limits for leakage from the RCS and they must all be observed in order to allow operation of the plant. These limits are very small, on the order of several gallons per minute. Reactor coolant leakage of this magnitude is usually detected by means of radiation monitoring devices and RCS volumetric calculations. A likely source of leakage would be through valve stem packing or from leaking valve seats.

**OPERATOR ACTION:** The operators manipulate systems in an attempt to identify and isolate the leakage. The reactor may be shut down to allow corrective maintenance to be performed.

**POTENTIAL FOR ESCALATION:** Plant system and building designs permit safe operation at these leak rates. Depending on the location of the leak, radioactive releases to the environment may not occur. In the event that leak rates increase or radioactive releases occur, alternate Emergency Action Levels prescribe additional measures, including reactor shut down.

**UNUSUAL EVENT NO. C1-1: Uncontrolled depressurization of the secondary plant**

**EVENT:** A failure has occurred in the secondary system which has caused the steam pressure to drop rapidly to the Main Steam isolation setpoint.

**EXPLANATION:** The steam pressure in the Steam Generator varies inversely with the demand for steam by the turbine-generator and other secondary systems. A significant failure in the secondary system causes an increase in steam flow and resultant decrease in steam pressure. This increase in secondary steam demand causes the temperature of the Reactor Coolant System to decrease faster than the reactor can reheat it. The decrease in temperature reduces the RCS pressure faster than the pressurizer can maintain pressure causing Safety Injection System actuation at a preset low pressure setpoint.

A significant pressure loss in the secondary system could result from:

1. Steam line break
2. Main Steam relief valve failure
3. Cold water injected into the secondary side of a steam generator
4. Feedwater line break.

**OPERATOR ACTION:** The operators verify that all automatic actions of plant safety systems have taken place, isolate the steam leak, and maintain the plant in a stable and safe condition.

**POTENTIAL FOR ESCALATION:** The transient is safeguarded by various safety features designed into the plant. It would take a number of highly unlikely concurrent failures to escalate this condition to a higher emergency level.

**UNUSUAL EVENT NO. C1-2: Reactor Coolant System activity exceeds Technical Specification limits**

**EVENT:** The level of radioactivity in the Reactor Coolant System (RCS) exceeds Technical Specification limits for continued operation.

**EXPLANATION:** In order to insure that the RCS remains as clean as possible, routine samples are analyzed for unwanted radioactive and chemical impurities. These include particles resulting from normal wear and tear from the pumps and valves that have become radioactive. A rapid increase in the activity levels may also be an indication of a very small fuel element failure.

**OPERATOR ACTION:** The operators will shutdown the reactor in an orderly fashion.

**POTENTIAL FOR ESCALATION:** The Technical Specification limits are set conservatively enough that no offsite radiological consequences would be observed. Without further independent, simultaneous failures, there is little likelihood that this event would escalate to a higher level.

**UNUSUAL EVENT NO. D1-1: Reactor shutdown due to loss of minimum required offsite power sources OR loss of standby diesel generators**

**EVENT:** Technical Specifications prohibit continued reactor operation with less than a minimum number of offsite electrical power sources or onsite emergency diesel generators.

**EXPLANATION:** At SONGS, there are several independent sources of power available from the Southern California Edison and San Diego Gas and Electric Company systems. All AC power offsite could be temporarily interrupted only by very large catastrophes, such as major fires, earthquakes, or high winds.

Each unit at SONGS has two emergency diesel generators which automatically start and supply power to vital system electrical loads if the normal AC power sources are lost. The capacity of each Diesel Generator is sufficient to supply power to one complete train of components required to maintain the plant in a safe, shut down condition.

**OPERATOR ACTION:** The reactor will trip on a loss of all offsite power. The operators will carry out the required actions of a reactor trip using AC power supplied by the emergency diesel generators. As offsite power becomes available, the operators will transfer the electrical load to the normal sources of power and shut down the diesel generators.

Loss of both emergency diesel generators has no effect on the safety status of the reactor if offsite power is available. However, the operators will begin an orderly shutdown of the reactor as a precaution and take steps to return the diesel generators to operability.

**POTENTIAL FOR ESCALATION:** This event could escalate to an Alert if all offsite AC power is lost and both emergency diesel generators on either unit fail to start and load properly.

**UNUSUAL EVENT NO. D1-2: Loss of most or all Control Room annunciators with alternate plant alarm indications available**

**EVENT:** The unplanned loss of most or all Control Room annunciators for greater than 15 minutes, and backup alarm indications are available.

**EXPLANATION:** Control Room annunciators are visual and audible indicators which aid operators in determining plant status. These annunciators are typically the first indication of unplanned plant activity, and are monitored at all times by operators. If these annunciators become unavailable, a dedicated Plant Monitoring System (PMS) computer will provide information of these plant alarms.

**OPERATOR ACTION:** The operators will continue to monitor plant conditions utilizing the PMS computer until Control Room annunciators are repaired.

**POTENTIAL FOR ESCALATION:** If a plant transient occurs or if backup alarm indications become unavailable, this event would escalate to an Alert.

**UNUSUAL EVENT NO. D1-3: Loss of RCS heat removal capability**

**EVENT:** Loss of Reactor Coolant System (RCS) heat removal capability for greater than 10 minutes due to inoperability of the Shutdown Cooling System AND inoperability of the Steam Generators.

**EXPLANATION:** This event applies when the reactor is shutdown. The Shutdown Cooling System is utilized to cool down the RCS when the RCS temperature is below 350°F by circulating the reactor coolant through dedicated heat exchangers.

The Steam Generators are used for reactor heat removal when the RCS temperature is above 200°F by removing steam through the steam dump valves to the main condenser. The steam can be dumped to atmosphere if necessary.

The inoperability of both of these methods would prevent placing and maintaining the reactor in a cold shutdown condition.

**OPERATOR ACTION:** The operators would attempt to maintain stable reactor coolant temperatures until the required systems were returned to operability.

**POTENTIAL FOR ESCALATION:** If the plant were shutdown and if RCS temperature increased above 200°F due to the loss of heat removal capability, this event would escalate to an Alert.

**UNUSUAL EVENT NO. E1-1: Fire which threatens vital or safety related equipment**

**EVENT:** Fire which affects or is adjacent to areas and structure containing vital, safety related, safe-shutdown equipment, or licensed radioactive material, and which is not extinguished within 15 minutes of control room notification or verification of a Control Room alarm.

**EXPLANATION:** A fire in these areas could damage systems that are necessary for the safe operation of the plant, or lead to the uncontrolled airborne release of licensed radioactive material. To mitigate this potential, a fire fighting crew is maintained onsite at all times.

**OPERATOR ACTION:** Onsite fire fighting personnel will be dispatched to combat the fire.

**POTENTIAL FOR ESCALATION:** If the fire damages key safety, vital or safe-shutdown systems, the event could be escalated to an Alert or Site Area Emergency. If the fire leads to the uncontrolled release of licensed radioactive material, the event would be classified by Emergency Action Levels in the Uncontrolled Release of Radioactivity Event Category Tabs (A-tabs).

**UNUSUAL EVENT NO. E1-2: Earthquake**

**EVENT:** An earthquake which causes activation of the most sensitive seismic alarm in the Control Room.

**EXPLANATION:** Any time a seismic alarm is activated, the plant operating staff is required to inspect the plant for possible damage.

The plant is designed to withstand the largest credible earthquake for the area surrounding the plant site.

**OPERATOR ACTION:** The operating staff would inspect the plant for possible damage.

**POTENTIAL FOR ESCALATION:** If the earthquake, or subsequent shocks, result in ground movement greater than 0.33 g the event level would be upgraded to an Alert. If an earthquake were to cause damage to plant equipment necessary for the safe operation of the reactor, higher levels of classification based on the loss of equipment could apply.

**UNUSUAL EVENT NO. E1-3: Natural disaster causing inoperability of a plant safety system**

**EVENT:** The National Weather Service (NWS) issues a hurricane warning and San Onofre is in the projected path, or the NWS issues a tornado warning and a tornado is observed touching down in the protected area or the Independent Spent Fuel Storage Installation, or the National Oceanic and Atmospheric Administration (NOAA) has issued a tsunami warning and the predicted wave height is calculated to be greater than the 30 foot seawall.

**OR**

Storm flooding or severe wind which causes inoperability of any safety system to the extent that reactor shutdown has been initiated as specified by the applicable Technical Specification.

**EXPLANATION:** Any large amount of uncontrolled water onsite, due to rain, tsunami, or the destructive forces of a tornado or severe hurricane impacting the site can result in damage to equipment necessary for safe operation of the plant.

All credible sources of water and the likelihood of a tornado or severe hurricane impacting the plant site have been considered in the design of the plant.

**OPERATOR ACTION:** The operators would assess the situation and take the required actions necessary to repair damage to the plant.

**POTENTIAL FOR ESCALATION:** The potential for this event and escalation to a higher emergency level is highly unlikely because of the design features of the plant. If the conditions worsened such that the capability to achieve or maintain cold shutdown is lost, the emergency condition would be upgraded to an Alert.

**UNUSUAL EVENT NO. E1-4: Manmade disaster causing inoperability of a plant safety system**

**EVENT:** Technical Specifications require a reactor shutdown due to the inoperability of plant safety systems as a result of a manmade disaster such as an aircraft crash or missile impact, train derailment, explosion, or release of toxic or flammable material.

**EXPLANATION:** An aircraft has crashed, a missile (flying object) has impacted, a train has derailed, or an explosion has occurred which has affected operability of required key safety systems within the plant. In the case of a toxic gas release, the location of the fumes can preclude access for plant personnel. With flammable gas, there is the danger of fire or an explosion, or both.

**OPERATOR ACTION:** The operators will assess the situation to determine the impact on plant operations. The fire fighting personnel, first aid teams, and damage control teams would be activated as required.

**POTENTIAL FOR ESCALATION:** The potential for this event and escalation to a higher emergency level is highly unlikely because of the design features of the plant. If the conditions worsened such that the capability to achieve or maintain cold shutdown is lost, the emergency condition would be upgraded to an Alert.

**UNUSUAL EVENT NO. F1-1: Security threat**

**EVENT:** The Nuclear Regulatory Commission or the Security Shift Commander/Security Leader reports a security threat, attempted entry, or attempted sabotage.

**EXPLANATION:** This event includes any of the following conditions:

a. A credible threat to attack the Unit 2/3 protected or vital area, the Unit 1 Fuel Storage Building, or the Independent Spent Fuel Storage Installation ISFSI has been received.

b. A credible threat to bomb the Unit 2/3 protected or vital are, the Unit 1 Fuel Storage Building, or the ISFSI has been received.

c. A non-explosive sabotage attempt, to include tampering or unauthorized manipulation of vital area safety equipment or security-related safeguards equipment, for the purpose of sabotage or for gaining undetected or unauthorized entry into the Unit 2/3 protected or vital area, the Unit 1 Fuel Storage Building, or the ISFSI, has been confirmed.

d. An attempt to introduce prohibited items (such as firearms, explosives or unauthorized incendiary devices) into the Unit 2/3 protected or vital area, the Unit 1 Fuel Storage Building, or the ISFSI, for the purpose of sabotage or disruption of plant activities has been discovered.

e. Tampering with the protected area perimeter intrusion detection system (IDS) (e.g., E-fields, microwaves, and protected area entry card-readers) or the vital area IDS (e.g., vital area card-readers, portal locking hardware, or intrusion alarm mechanisms) for the purpose of gaining undetected or unauthorized access to the protected or vital area has been confirmed.

f. NRC notifies SONGS that a credible threat of attack by surface vehicle bomb(s) has been received, and that short-term contingency measures to protect against a surface vehicle bomb threat must be implemented within 12 hours.

g. A confirmed security event with the actual or potential loss of level of safety of the ISFSI.

**OPERATOR ACTION:** The operators will assess the situation, notify offsite personnel and agencies, and take action to keep the plant in a safe condition.

**POTENTIAL FOR ESCALATION:** If the security force notifies the Shift Manager that there is an ongoing security compromise, the emergency level may be increased to an Alert.

**UNUSUAL EVENT NO. G1-1: Plant conditions warrant emergency notification of onsite and offsite authorities OR event criteria met except for mode applicability.**

**EVENT:** Plant conditions warrant increased awareness and emergency notification of plant personnel and local, state, or federal offsite authorities OR plant conditions meet the criteria of an Alert or higher emergency action level, except for mode applicability, and no other emergency action level applies.

**EXPLANATION:** This event allows the Shift Manager to declare an Unusual Event and notify key plant and offsite personnel of conditions in the plant not covered by any of the other specific Emergency Action Levels.

This event would also be declared if the conditions for an Alert, Site Area Emergency or General Emergency existed except for mode applicability (there are six operational modes defined in Tech Specs; Mode 1 is power operations, Mode 6 is refueling operations), and no other emergency action level applies.

An example of such a condition specific to Unit 1 would be an ongoing, uncontrolled loss of Spent Fuel Pool inventory to below Tech Spec levels.

**OPERATOR ACTION:** The operators' actions will be as required to place the plant in a safe operating condition.

**POTENTIAL FOR ESCALATION:** If the situation deteriorates to the level which warrants the activation of the Emergency Response Facilities and recall of emergency response personnel, the event level would be upgraded to an Alert.

**UNUSUAL EVENT NO. G1-2: Reactor shutdown due to Technical Specification noncompliance AND plant conditions warrant emergency notification of offsite authorities**

**EVENT:** Plant conditions require reactor shutdown in accordance with Technical Specifications AND emergency notification of local or state authorities is warranted.

**EXPLANATION:** This event allows the Shift Manager to declare an Unusual Event and notify offsite personnel of conditions that require a reactor shutdown due to specific Technical Specification criteria.

**OPERATOR ACTION:** The operators will shutdown the reactor as required by Technical Specifications.

**POTENTIAL FOR ESCALATION:** There is no potential for escalation.

**UNUSUAL EVENT NO. G1-3: Failure to shut down the reactor within Technical Specification Action Statement time limits.**

**EVENT:** The operators are unable to place the reactor in the required operating mode as dictated by Technical Specifications time limits.

**EXPLANATION:** If any one or a combination of safety systems are determined to be not fully operational, a time limit is imposed for continued plant operation while those systems are repaired. The plant is shutdown as a precautionary measure if the systems are not restored to normal operating condition in the required time. These rules are designed to keep the plant in the safest possible operating state.

**OPERATOR ACTION:** The operators would shutdown the plant and notify repair personnel to restore the systems to operability.

**POTENTIAL FOR ESCALATION:** This event by itself has no potential for escalation.

## 2.2 ALERT

An Alert is declared at SONGS when events are in progress or have occurred which involve substantial degradation of the level of safety at the plant. During an ALERT, any radioactive material released is expected to be limited to small fractions of the Environmental Protection Agency's Protective Action Guideline exposure levels. An Alert requires response by the augmentation of the on shift emergency organization and constitutes the lowest level where offsite emergency response may be anticipated. Notification of state and local offsite agencies shall commence within 15 minutes after declaration of an Alert. Notification to the NRC of an Alert will be made immediately after notification to the state and offsite agencies and must be made within one hour.

SONGS general actions for an Alert are summarized as follows:

1. Assess the plant conditions and respond to these conditions following established plant procedures.

2. Promptly inform state and local authorities of the Alert status and the reason for the Alert within 15 minutes of the declaration of an Alert condition.

3. Dispatch onsite radiological monitoring teams if required.

4. Make offsite dose projections and provide these to offsite agencies if any radiological releases exceed Federally Approved Operating Limits.

5. Provide periodic updates on plant status to offsite authorities.

6. Escalate to a higher class of emergency if the situation warrants.

7. Close out or reduce the emergency class if appropriate. Verbally summarize the situation to offsite authorities followed by a written summary within 8 hours of the close-out or class reduction.

RECOMMENDED OFFSITE PROTECTIVE ACTIONS: Precautionary beach evacuation will be recommended for an Alert if a concurrent accident-related release of airborne radioactive material were to occur.

**ALERT NO. A2-1: Release of airborne radioactivity**

**EVENT:** A release of airborne radioactivity has occurred or is occurring which exceeds Federally Approved Operating Limits and results in a Total Effective Dose Equivalent (TEDE) dose of 2 mrem in a single hour at the Exclusion Area Boundary, as indicated by specified radiation monitor readings.

**EXPLANATION:** Radioactive airborne releases have two possible sources: System boundary failure leading to leakage and a system or administrative failure leading to an uncontrolled release of a Waste Gas Decay Tank.

Liquids from the Radwaste and Reactor Coolant Systems normally contain small amounts of radioactive gasses. Leakage from these system results in liberation of these radioactive gasses. Very small quantities of radioactive gas resulting from system leakage are routinely discharged to the atmosphere after being diluted with clean air. Such releases of radioactive gas are maintained below Federally Approved Operating Limits, as specified in San Onofre's Offsite Dose Calculation Manual (ODCM). The limits specified in the ODCM are specific to each isotope, are conditions of San Onofre's license to operate, and are reviewed and approved by the NRC. Radiation detection systems are installed in the plant vent stack ducts to detect abnormal radiation levels from discharged gasses.

A waste gas processing system is used to manage the concentration of radioactive gasses in the Radwaste and Reactor Coolant Systems. The waste gas processing system allows plant operators to remove radioactive gas from these liquid systems. The operators then use other components in the system to compress the gas and then store it in large tanks to allow the short lived isotopes to decay away. This system reduces the total quantity of gas discharged to the environment to a value As Low As is Reasonably Achievable. Once the gas has decayed, the long lived radioactive isotopes, now at a much lower concentration, are slowly released into the atmosphere in a controlled manner. The release system is closely monitored by installed radiation monitors. In the event that the alarm set point is exceeded, isolation valves close to terminate the release.

**OPERATOR ACTION:** System leakage is identified and stopped, and the release of the waste gas decay tank would be terminated.

**POTENTIAL FOR ESCALATION:** There is little or no potential for escalation from the waste gas decay tank release. A release due to system leakage could escalate if the leak rate or the concentration of the gas were to increase.

**ALERT NO. A2-2: Release of radioactive liquid**

**EVENT:** A radioactive liquid release which exceeds 10 times the Federally Approved Operating Limits for greater than 1 hour, as indicated by specified radiation monitor readings.

**EXPLANATION:** The most likely source of the release would be the liquid Radwaste System. Liquids from the Radwaste Tanks normally contain very small amounts of radioactivity. The liquids are routinely discharged to the ocean after first being processed through demineralizers, gas strippers, and then stored in hold-up tanks to allow the decay of short-lived radioactive isotopes. The liquids are diluted by cooling water systems before being discharged. All releases of liquid-borne radioactive material are maintained below Federally Approved Operating Limits, as specified in San Onofre's Offsite Dose Calculation Manual (ODCM) The limits specified in the ODCM are specific to each isotope, are conditions of San Onofre's license to operate, and are reviewed and approved by the NRC. Radiation detection systems are installed in the discharge piping to detect abnormal radiation levels from discharged liquids. If these levels increase, a signal is sent to automatically shut the discharge valve stopping the release. In addition, automatic interlocks are provided to minimize the accidental discharge of highly radioactive liquids or liquids that have not been adequately diluted by the cooling water systems.

**OPERATOR ACTION:** Actions taken would be directed to terminate the release by closing appropriate valves and turning off the discharge pumps. Plant personnel would evaluate conditions to determine how much radioactivity was released and project further effects.

**POTENTIAL FOR ESCALATION:** This event has a very small potential for escalation.

**ALERT NO. A2-3: High Area Radiation Monitor readings**

**EVENT:** The loss of control of radioactive material inside the plant resulting in an unplanned high indication on a specified Area Radiation Monitor AND verified by local survey to be indicating 1000 times normal radiation levels.

**EXPLANATION:** Movement and storage of radioactive materials is controlled and only performed in specific areas of the plant. It is possible that while movement of radioactive material is in progress a container may be dropped or a radioactive source can become separated from its shielding. If this occurs near one of the specified Area Radiation Monitors, an alarm for that area may be received.

Alarms on these monitors could also be indicators of system malfunction. In such an event, the area monitor alarms would be leading indicators to other indications of system malfunction.

**OPERATOR ACTION:** Plant personnel would investigate the high radiation problem and initiate corrective action.

**POTENTIAL FOR ESCALATION:** When the alarm is solely due to proximity to solid radioactive materials, there is no potential for escalation. When the alarm is a leading indicator of a system malfunction, the situation may escalate to higher levels of classification as indicated on other system monitors.

**ALERT NO. A2-4: High plant area airborne radioactivity levels**

**EVENT:** An unplanned plant area iodine or particulate airborne concentration greater than 1000 times the Derived Air Concentration as determined by Health Physics survey.

**EXPLANATION:** The most likely causes for this event would be a leak from the Radwaste System or a small primary system leak. Liquids from the Radwaste System and the Reactor Coolant System contain small amounts of radioactivity which, if released to the atmosphere, could present an airborne contamination problem.

**OPERATOR ACTION:** Actions would be directed toward minimizing the release by closing appropriate valves, shutting down pumps, or taking other actions as required. Plant personnel would evaluate the best methods for cleanup of the affected areas.

**POTENTIAL FOR ESCALATION:** Limited, but could possibly escalate to a Site Area Emergency depending on the concentration and type of radioactive material being released.

**ALERT NO. A2-5: Spent Fuel handling accident**

**EVENT:** Spent fuel handling accident causing the release of radioactivity and resulting in a high radiation condition on specified radiation monitors.

**EXPLANATION:** A spent fuel assembly is highly radioactive and could be damaged during transfer from the reactor to the spent fuel storage pool or while being loaded into a spent fuel cask. Internal plant ventilation systems are monitored for high levels of airborne radioactivity, and will initiate actions to preclude a release of airborne radioactive material to the environment in the event of damage to a spent fuel assembly.

**OPERATOR ACTION:** The operators would investigate the problem and take corrective action.

**POTENTIAL FOR ESCALATION:** Limited, depending upon the amount of damage at the Units 2 or 3 Spent Fuel Pool (SFP). No potential for escalation exists at Unit 1 SFP primarily due to the decayed fuel stored.

**ALERT NO. A2-6: Steam line break with primary to secondary leak**

**EVENT:** A steam line break or uncontrolled steam release as determined by rapid Main Steam System depressurization AND either greater than 10 gpm primary to secondary Steam Generator leakage OR a valid steam line radiation monitor indication.

**EXPLANATION:** The main steam line transports steam necessary to operate the turbine-generator. A primary to secondary leak could allow radioactive materials present in the RCS to enter the secondary steam system through a steam generator. With a break in the steam line, this material could be released to the environment.

**OPERATOR ACTION:** The operators would verify proper response of plant safety systems following automatic reactor trip followed by cooldown and depressurization of the RCS to prevent further leakage.

**POTENTIAL FOR ESCALATION:** Not likely; would depend on the radioactivity levels of the reactor coolant leaking from the primary to the secondary systems. If high enough, this event could escalate.

**ALERT NO. B2-1: Reactor Coolant System leakage**

**EVENT:** Reactor Coolant System (RCS) leakage greater than 50 gpm but less than the makeup capacity of the charging system.

**EXPLANATION:** Reactor coolant could leak from a number of sources, such as through valve stem packing, failed welds, or from a crack in the primary system piping. This leakage would be to the containment building. RCS leakage greater than 50 gpm but less than the makeup capacity of the charging system would not affect RCS pressure and automatic Safety Injection System actuation would not occur.

The containment building is designed to minimize the leakage of RCS to the atmosphere.

**OPERATOR ACTION:** The operators will shutdown the reactor and commence a plant cooldown. RCS water inventory would be maintained by the charging pumps. The operators will attempt to isolate the leak as soon as possible.

**POTENTIAL FOR ESCALATION:** If the leakage increases beyond the charging pump capacity, this event will escalate to a Site Area Emergency.

**ALERT NO. B2-2: Steam Generator Tube Leakage**

**EVENT:** Steam Generator Tube Leakage greater than the available charging pump capacity.

**EXPLANATION:** During normal operation non-radioactive gasses are vented from the secondary system. A steam generator tube leak provides a pathway for reactor coolant to exit the primary system and enter the secondary system. If the tube leakage were to occur during normal operation a release of radioactive noble gas and iodine above the Federally Approved Operating limits could occur. Equipment is in place to reduce the release of radioactive iodine.

**OPERATOR ACTION:** The operators will shutdown the reactor and commence a plant cooldown. The operators will identify which steam generator is affected and attempt to isolate steam flow from the affected generator. Isolation of the affected steam generator will stop the release of radioactive material.

**POTENTIAL FOR ESCALATION:** If a loss of offsite power occurs, intentional venting of the Steam Generator to atmosphere may be necessary to continue cooldown of the reactor core, causing the normal low level radioactivity of the RCS to be released to the environment. If this event occurs, the emergency level may be increased to a Site Area Emergency.

**ALERT NO. C2-1: Fuel cladding failure**

**EVENT:** Severe fuel cladding failure verified by Reactor Coolant System (RCS) analysis indicating RCS activity corresponding to 1% failed fuel.

**EXPLANATION:** Sampling of the RCS is performed on a routine basis to verify fuel cladding integrity. If a defect in fuel cladding developed, it would be possible for fission products to leak into the RCS. A substantial increase in fission product activity in the RCS would indicate a fuel cladding failure.

**OPERATOR ACTION:** The operators would shutdown and cooldown the reactor and take necessary actions to purify the reactor coolant.

**POTENTIAL FOR ESCALATION:** Concurrent loss of core cooling capability would lead to an escalation to Site Area Emergency. With no compromise to the core cooling or other safety related systems, the potential for escalation is unlikely.

**ALERT NO. D2-1: Loss of all offsite and onsite AC power**

**EVENT:** Loss of all offsite power AND the loss of operability of both emergency diesel generators AND the buses remain de-energized for greater than 5 minutes.

**EXPLANATION:** At SONGS, there are several independent sources of offsite electrical power available to operate the plant from the Southern California Edison and San Diego Gas and Electric Company systems. Backup sources of AC power for each unit are supplied by two emergency diesel generators and by batteries which supply vital AC buses through DC to AC inverters. If all offsite power were lost and both emergency diesel generators failed to operate, the batteries would be able to supply sufficient power to operate the essential plant systems necessary to maintain the plant in a safe condition until normal sources of power could be restored.

All AC power onsite and offsite could be temporarily interrupted only by very large catastrophes, such as major fires, earthquakes, or high winds.

**OPERATOR ACTION:** The reactor will trip on a loss of all offsite power. The operators will carry out the required actions to ensure that the plant is maintained in a safe condition until normal power is restored and a cooldown is commenced.

**POTENTIAL FOR ESCALATION:** If the loss of all power sources continued for more than 15 minutes, this event would escalate to a Site Area Emergency.

**ALERT NO. D2-2: Loss of all vital DC power**

**EVENT:** Loss of all vital DC power for greater than 5 minutes, confirmed by specified Control Room indications.

**EXPLANATION:** The loss of DC power would affect some valve and breaker controls associated with the following loads:

- key plant safety systems
- emergency lighting

The 125 volt DC power system consists of 4 independent buses each with redundant power sources. The two sources of power are batteries and AC buses via AC to DC inverters. The most probable event causing a loss of vital DC power would be a short or fire in a DC bus panel.

**OPERATOR ACTION:** The operators ensure that the reactor is shutdown and maintained in a safe condition. Actions are taken to reestablish DC power.

**POTENTIAL FOR ESCALATION:** If the loss of vital DC continued for more than 15 minutes, this event would escalate to a Site Area Emergency.

**ALERT NO. D2-3: Loss of most or all Control Room Annunciators with the loss of backup alarm indications or plant conditions become unstable**

**EVENT:** An unplanned loss of most or all Control Room annunciators occurs AND either backup alarm indications from the Plant Monitoring System (PMS) computer are inoperable OR plant conditions are unstable.

**EXPLANATION:** The alarm and annunciator panels provide the operator with visible and audible alarms when various plant systems or equipment operate abnormally or change status. If this condition is combined with the loss of alternate indications from the Plant Monitoring System computer or if plant transients occur causing the plant to be unstable, the plant is shutdown until all systems are repaired.

**OPERATOR ACTION:** The operators ensure that the reactor is safely shutdown using local indications where possible. Actions are taken to reestablish power to the annunciators.

**POTENTIAL FOR ESCALATION:** If the loss of the Control Room annunciators continues, plant conditions became unstable, and alternate alarm indications (PMS) become unavailable all at the same time, this event would escalate to a Site Area Emergency.

**ALERT NO. D2-4: Control Room evacuation**

**EVENT:** Control Room evacuation is required AND control of shutdown systems is established locally or at the remote shutdown panel within 15 minutes.

**EXPLANATION:** The reactor plant is normally controlled by operators in the Control Room. If the Control Room were to become uninhabitable for any reason, such as a fire or smoke, provisions have been made to provide auxiliary control of the reactor from remote locations.

**OPERATOR ACTION:** Prior to leaving the Control Room, the operators would shut down the reactor. If this is not possible, the operators would shut down the reactor at local control panels and monitor the plant condition at the remote shutdown panel. Control Room accessibility would be reestablished as soon as possible.

**POTENTIAL FOR ESCALATION:** If the Control Room is evacuated and control of shutdown systems is NOT established locally or at the remote shutdown panel within 15 minutes, this event would escalate to a Site Area Emergency.

**ALERT NO. D2-5: Failure of reactor to trip**

**EVENT:** The Reactor Protection System, (RPS), fails to complete a reactor trip and manual reactor trip is successful.

**EXPLANATION:** When certain plant operating parameter set points are exceeded, the Reactor Protection System will automatically initiate signals to shutdown the reactor. If this shutdown signal does not result in a reactor trip, operators can initiate a manual reactor trip signal.

**OPERATOR ACTION:** The operators will take actions necessary to safely achieve reactor shutdown.

**POTENTIAL FOR ESCALATION:** In the event that both an automatic trip signal and an effort to manually trip the reactor fail, this event would escalate to a Site Area Emergency.

**ALERT NO. D2-6: Loss of adequate shutdown margin**

**EVENT:** Loss of adequate shutdown margin while the reactor is in hot or cold shutdown, or in a refueling condition.

**EXPLANATION:** There are a number of means available to ensure that once the reactor is shutdown, it will remain shutdown by a conservative margin. One means of keeping the reactor shutdown is through the use of boron which slows the fission process in the reactor. Excessive dilution of the Reactor Coolant System boron concentration could decrease the reactor shutdown margin below the Technical Specification requirements.

**OPERATOR ACTION:** The operators would reestablish the required reactor shutdown margin.

**POTENTIAL FOR ESCALATION:** If the cause of the decrease in shutdown margin is not found and corrected and Reactor Coolant System temperature were to increase abnormally, this event could escalate to a Site Area Emergency.

**ALERT NO. D2-7: Loss of heat removal capability**

**EVENT:** Inoperability of the Steam Generators or the Shutdown Cooling System resulting in an uncontrolled Reactor Coolant System (RCS) temperature increase to greater than 200°F OR inability to maintain or reduce RCS temperature to less than or equal to 200°F.

**EXPLANATION:** Cooling the reactor coolant from its operating temperature to less than 200°F requires the operation of two systems. The steam generators are used for reactor heat removal when the RCS temperature is above 200°F by removing steam through the steam dump valves to the main condenser. The steam can be dumped to atmosphere if necessary.

The Shutdown Cooling System is utilized when the RCS temperature is below 350°F by circulating the reactor coolant through dedicated heat exchangers.

The inoperability of either of these methods would prevent placing the reactor in a cold shutdown condition.

**OPERATOR ACTION:** The operators would attempt to maintain stable reactor coolant temperatures until the cooldown systems are returned to operability.

**POTENTIAL FOR ESCALATION:** If RCS temperature increases above 350°F due to the loss of heat removal capability, this event would escalate to a Site Area Emergency.

**ALERT NO. E2-1: Earthquake**

**EVENT:** An earthquake recording greater than 0.33g ground acceleration.

**EXPLANATION:** SONGS nuclear reactors are designed to withstand greater than the maximum earthquakes expected in this area. The function of the required plant systems will not be impaired for a safe reactor shutdown.

**OPERATOR ACTION:** Following a confirmed earthquake, the operators would evaluate plant conditions and shutdown the reactor if required. A thorough inspection of the plant would be made to determine the extent of any damage.

**POTENTIAL FOR ESCALATION:** This event could escalate to a Site Area Emergency if significant damage to key plant safety systems were to occur.

**ALERT NO. E2-2: Natural disaster causing loss of ability to achieve or maintain cold shutdown**

**EVENT:** A natural disaster including hurricane, tornado, tsunami, earthquake or flooding causing loss of the ability to achieve or maintain cold shutdown conditions.

**EXPLANATION:** The major threat to SONGS from a natural disaster would be water or structural damage to support systems necessary for the operation of heat removal systems.

The containment buildings and the diesel generator buildings are designed to be watertight and withstand winds up to 100 mph.

**OPERATOR ACTION:** The operators would evaluate plant conditions and shutdown the reactor if required. A thorough site inspection would be made to determine the extent of damage.

**POTENTIAL FOR ESCALATION:** If damage occurred to safety systems necessary to maintain the plant in a hot shutdown condition, the event could escalate to a Site Area Emergency.

**ALERT NO. E2-3: Manmade disaster causing loss of ability to achieve or maintain cold shutdown**

**EVENT:** Any manmade disaster including fire, explosion, aircraft or missile impact, or toxic or flammable gas release causing loss of the ability to achieve or maintain cold shutdown conditions.

**EXPLANATION:** Damage to onsite buildings or equipment due to a manmade disaster could result in the loss of safety or support systems necessary to achieve or maintain cold shutdown conditions. An example would be a fire in both 4160 volt switchgear rooms simultaneously. Although unlikely, the loss of both 4160 volt buses could impair the operators' ability to cool the reactor.

**OPERATOR ACTION:** The operators would evaluate plant conditions and shutdown the reactor if necessary. A thorough plant inspection would be made to determine the extent of damage.

**POTENTIAL FOR ESCALATION:** If damage occurred to safety systems necessary to achieve or maintain the plant in a hot shutdown condition, the event could escalate to a Site Area Emergency.

**ALERT NO. F2-1: Ongoing security compromise**

**EVENT:** The Shift Commander/Security Leader reports an ongoing security compromise.

**EXPLANATION:** An ongoing security compromise could result in damage to safety systems necessary to maintain safe plant conditions at SONGS and includes any of the following conditions:

a. A bomb is discovered within the Unit 2/3 protected or vital area or the Unit 1 Fuel Storage Building.

b. An intruder has been confirmed in the Unit 2/3 protected or vital area or the Unit 1 Fuel Storage Building.

c. Discovery of non-explosive prohibited items such as firearms, or unauthorized incendiary devices inside the protected or vital area, for the purpose of sabotage, has been confirmed.

d. An adversary force has assaulted the site, but has not attempted to or succeeded in penetrating the protected area perimeter. The adversary force has taken hostages and is barricaded in the owner controlled area.

e. A forceful assault on the protected or vital area by an adversary force is imminent.

f. A bomb or unauthorized explosive device explodes within the protected area or vital area, or a fire or explosion of suspicious origin occurs, with willful intent to damage vital area safety or security safeguards equipment.

g. An act of sabotage has damaged or destroyed Unit 2/3 vital area safety equipment or security safeguards equipment or Unit 1 Fuel Handling Building equipment required to maintain Spent Nuclear Fuel in a safe storage mode, but the security force maintains control of the protected area perimeter.

h. An adversary force has attacked the site and has succeeded in penetrating the protected area perimeter. The adversary force has taken hostages and is barricaded within the protected area or vital area, but the security force maintains control of the protected area perimeter.

**OPERATOR ACTION:** The operators would shutdown the reactor as required. SONGS security forces would be dispatched to regain security of the plant site.

**POTENTIAL FOR ESCALATION:** If control of the plant could not be maintained by SONGS security forces, the event could escalate to a Site Area Emergency.

**ALERT NO. G2-1: Degradation of safety**

**EVENT:** Plant conditions indicate a significant trend leading to a degradation of safety.

**EXPLANATION:** Conditions in the plant indicate a degradation of safety not covered by other event criteria.

An example of such a condition specific to Unit 1 would be an uncontrolled loss of Spent Fuel Pool (SFP) inventory to below the lowest piping penetration of the SFP.

**OPERATOR ACTION:** The operators would take appropriate actions to mitigate the event and maintain the plant in a safe condition.

**POTENTIAL FOR ESCALATION:** Dependent upon the event.

## 2.3 SITE AREA EMERGENCY

A Site Area Emergency is declared at SONGS when events involve actual or likely failure of plant systems needed for the protection of the public. Conditions which would lead to a Site Area Emergency at the Independent Spent Fuel Storage Installation are not possible due to the extended time the spent fuel has had to decay.

Any radioactive material released is expected to be limited to below the Environmental Protection Agency's Protective Action Guideline exposure levels. Although emergency actions involving members of the public may not be necessary, offsite emergency response organizations should be mobilized and ready to implement protective measures. Notification of state and offsite emergency organizations shall commence within 15 minutes after declaration of a Site Area Emergency. Notification to the NRC of a Site Area Emergency must be made immediately after notification to the state and offsite agencies and will be made within one hour.

SONGS general actions for a Site Area Emergency are summarized as follows:

1. Assess the plant conditions and respond to these conditions following established plant procedures.
2. Promptly inform state and local authorities of the Site Area Emergency status and the reason for the Site Area Emergency within 15 minutes of the declaration of a Site Area Emergency condition.
3. Warn people to evacuate the beach areas, if not previously performed.
4. Assemble site personnel in preparation to evacuate if the situation warrants.
5. Dispatch onsite and precautionary offsite radiological monitoring teams if required.
6. Provide periodic meteorological assessments, dose estimates, and dose projections to offsite authorities.
7. Provide periodic plant status updates to offsite authorities.
8. Escalate to a higher class of emergency if the situation warrants.
9. Close out or reduce the emergency class if appropriate. Verbally summarize the situation to offsite authorities followed by a written summary within 8 hours of the close-out or class reduction.

RECOMMENDED OFFSITE PROTECTIVE ACTIONS: The Emergency Coordinator will recommend offsite protective actions as warranted by plant conditions. In all Site Area Emergencies, an evacuation of the State Beach will be recommended.

**SITE AREA EMERGENCY NO. A3-1: Release of airborne radioactivity**

**EVENT:** A release of radioactivity resulting in the following projected or measured dose rates at the Exclusion Area Boundary (EAB):

(1) 50 mrem/hr TEDE for ½ hour
(2) 250 mrem/hr Thyroid Committed Dose Equivalent (CDE) for ½ hour
(3) 2500 mrem/hr Thyroid Committed Dose Equivalent (CDE) for 2 minutes

OR

Either of the following doses are measured or projected at the EAB for the duration of the release:

(1) 50 mrem TEDE
(2) 500 mrem Thyroid CDE

OR

Dose projections cannot be made because meteorological data are not available, and the release results in specified monitor indications.

**EXPLANATION:** This condition does not relate to any specific initiating event. Instead, it provides general criteria to insure that a Site Area Emergency is declared if significant amounts of radioactive materials are released, regardless of the cause. This condition would be determined by utilizing installed radiological instrumentation to predict dose rates at the EAB, or by actual measurements taken at the EAB.

**OPERATOR ACTION:** The operators would take actions necessary to reduce the release of airborne radioactivity. Plant personnel would determine the amount and level of airborne activity and perform projected offsite dose calculations.

**POTENTIAL FOR ESCALATION:** If the source of airborne radioactivity cannot be stopped or sufficiently reduced, this event could escalate to a General Emergency.

**SITE AREA EMERGENCY NO. A3-2: Spent fuel pool water level decrease exposing irradiated fuel.**

**EVENT:** An uncontrolled decrease in spent fuel pool water level exposing irradiated fuel as indicated by a spent fuel pool low level alarm in the Control Room AND a Spent Fuel Building high radiation alarm.

**EXPLANATION:** The Units 2/3 spent fuel pools, located in the Units 2/3 Spent Fuel Buildings, are constructed of reinforced concrete, lined with stainless steel, and filled with water that provides shielding and cooling for the spent nuclear fuel.

If a leak were to occur in one of the spent fuel pools the fuel in the pool could become exposed. Failure to keep the spent fuel covered and cooled by water could result in damage to the fuel and a release of radioactive gas to the fuel handling building.

**OPERATOR ACTION:** The operators would take action to isolate the leak and establish makeup water to refill the spent fuel pool. Health Physics personnel would survey the area and determine the radiation levels.

**POTENTIAL FOR ESCALATION:** If the spent fuel pool cannot be filled sufficiently and damage to the spent fuel occurs, this event could escalate to a General Emergency.

**SITE AREA EMERGENCY NO. A3-3: Steam line break with primary to secondary leak**

**EVENT:** A steam line break or uncontrolled steam release as determined by:

(1) rapid Main Steam System depressurization

AND

(2) greater than 50 gpm primary to secondary leakage

OR

2 mrem/hr indicated on a Main Steam Line Radiation Monitor

OR

the most recent RCS chemical analysis indicates dose equivalent I-131 greater than 1 microcurie per gram of coolant.

**EXPLANATION:** The main steam lines transport steam from the Steam Generators to the turbine-generator. With primary to secondary leakage, radioactivity enters the steam lines and is released through the break in the main steam line. The amount of the radioactive release and the necessity for offsite protective action would depend upon the level of RCS activity and the size of the steam line break.

**OPERATOR ACTION:** The operators would verify proper response of plant safety systems following automatic reactor trip followed by cooldown and depressurization of the RCS to prevent further leakage.

**POTENTIAL FOR ESCALATION:** The potential for escalation is unlikely unless a concurrent failure in fuel cladding integrity occurs. Concurrent fuel element failures could cause escalation to a General Emergency based on the level of release of radioactive material.

**SITE AREA EMERGENCY NO. B3-1: Reactor Coolant System leakage greater than charging pump capacity**

**EVENT:** Reactor Coolant System(RCS) leakage greater than the available charging pump capacity.

**EXPLANATION:** A reactor coolant leak of this magnitude would require a significant breach in RCS integrity. The Safety Injection System (SIS) would be activated to maintain RCS water inventory and shutdown the plant.

**OPERATOR ACTION:** The operators would shutdown the reactor, commence a plant cooldown, and ensure proper operation of the SIS to keep the reactor core covered with water to prevent core damage.

**POTENTIAL FOR ESCALATION:** Due to the redundant safety systems provided in the plant, escalation is unlikely. However, if the core could not be kept covered AND if there were also a possibility of a loss of containment integrity, this event could escalate to a General Emergency.

**SITE AREA EMERGENCY NO. B3-2: Steam Generator tube leakage with release to atmosphere**

**EVENT:** Steam generator tube leak greater than available charging pump capacity with concurrent release of steam to atmosphere for greater than 30 minutes from a pathway other than the condenser air ejector exhaust filter.

**EXPLANATION:** Excess steam is normally directed to the condenser where radioactive noble gas and iodine are removed and released through the condenser air ejector. During a Steam Generator Tube Rupture accident a charcoal filter is used to reduce the radioactive iodine in this release path. If, during such an emergency, the condenser air ejector becomes unavailable or a breach occurs in the secondary system, releases directly to the atmosphere would occur. Releases from a pathway other than the condenser air ejector are unfiltered pathways to the environment. This breach of the secondary system coupled with a primary to secondary leak could allow the normally low levels of radioactive iodine present in the Reactor Coolant System to be released to the environment.

**OPERATOR ACTION:** Operators will trip the reactor and commence a controlled cooldown. The operators will attempt to isolate the affected steam generator and may open the Atmospheric Dump Valve of the unaffected generator to cool down the plant.

**POTENTIAL FOR ESCALATION:** Due to the redundant safety systems provided in the plant, escalation is unlikely, However, if the core is uncovered due to an independent incident causing significant fuel failure, this event would escalate to a General Emergency.

**SITE AREA EMERGENCY NO. C3-1: Degraded core with possible loss of coolable core geometry.**

**EVENT:** A degraded core with possible loss of coolable geometry is identified based on:

(1) determination of inadequate core cooling

AND

RCS activity analysis indicates greater than 1% fuel element failure.

OR

(2) high containment radioactivity levels.

OR

(3) elevated radiation levels outside containment.

**EXPLANATION:** Fuel assemblies are arranged in the reactor core in an orderly geometric pattern. Distortion of this orderly arrangement could block reactor coolant flow through the core. If the coolant flow was reduced significantly, fuel rods could overheat and be damaged. The core geometry could be disturbed by structural failure of core components but would more likely be caused by uncovering the core, as a result of a loss of coolant accident. Without water to cool the core, the subsequent overheating could lead to severe fuel damage and possible fuel melt inside the core.

**OPERATOR ACTION:** The operators will ensure that the reactor has been shutdown and that adequate core cooling is achieved.

**POTENTIAL FOR ESCALATION:** Due to the redundant safety systems provided in the plant, escalation is unlikely. However, if the core cannot be kept cooled AND if there is also a possibility of a loss of containment integrity, this event could escalate to a General Emergency.

**SITE AREA EMERGENCY NO. D3-1: Loss of all offsite and onsite AC power**

**EVENT:** Loss of all offsite power AND the loss of operability of both emergency diesel generators AND the buses remain de-energized for greater than 15 minutes.

**EXPLANATION:** At SONGS, there are several independent sources of offsite electrical power available to operate the plant from the Southern California Edison and San Diego Gas and Electric Company systems. Backup sources of AC power for each unit are supplied by two emergency diesel generators and by batteries which supply vital AC buses through DC to AC inverters. If all offsite power were lost and both emergency diesel generators failed to operate, the batteries would be able to supply sufficient power to operate essential plant systems necessary to maintain the plant in a safe condition until normal sources of power could be restored.

All AC power onsite and offsite could be temporarily interrupted only by very large catastrophes, such as major fires, earthquakes, or high winds.

**OPERATOR ACTION:** The reactor will trip on a loss of all offsite power. The operators will carry out the required actions to ensure that the plant is maintained in a safe condition until normal power is restored and a cooldown is commenced.

**POTENTIAL FOR ESCALATION:** The potential for escalation is unlikely.

**SITE AREA EMERGENCY NO. D3-2: Loss of all vital DC power**

**EVENT:** Loss of all vital DC power for greater than 15 minutes, confirmed by specified Control Room indications.

**EXPLANATION:** The loss of DC power would affect some valve and breaker controls associated with the following loads:

- key plant safety systems
- emergency lighting

The 125 volt DC power system consists of 4 independent buses each with redundant power sources. The two sources of power are batteries and AC buses via AC to DC inverters. The most probable event causing a loss of vital DC power would be a short or fire in a DC bus panel.

**OPERATOR ACTION:** The operators ensure that the reactor is shutdown and maintained in a safe condition. Actions are taken to reestablish DC power.

**POTENTIAL FOR ESCALATION:** The potential for escalation is unlikely.

**SITE AREA EMERGENCY NO. D3-3: Loss of most or all Control Room Annunciators with the loss of alternate plant alarm indications AND plant conditions are unstable**

**EVENT:** Loss of most or all Control Room annunciators with backup alarm indications from the Plant Monitoring System (PMS) computer inoperable AND plant conditions unstable.

**EXPLANATION:** The alarm and annunciator panels provide the operator with visible and audible alarms when various plant systems or equipment operate abnormally or change status. If this condition is combined with the loss of alternate indications from the Plant Monitoring System (PMS) and if a plant transient occurs causing the plant to be unstable, the plant is shutdown until all systems are repaired.

Annunciators provide the operators the most immediate indications of abnormal operating conditions. The loss of these indications, coupled with the loss of backup methods, reduce the effectiveness of operators to monitor plant status and, therefore, hamper response to abnormal plant conditions.

**OPERATOR ACTION:** The operators would ensure that the reactor is safely shutdown and action is taken to return the plant to a stable and controlled condition. Immediate steps would also be taken to reestablish operability of the annunciators.

**POTENTIAL FOR ESCALATION:** The potential for escalation is unlikely.

**SITE AREA EMERGENCY NO. D3-4: Control Room evacuation**

**EVENT:** The Control Room has been evacuated AND control of shutdown systems has NOT been established locally or at the remote shutdown panel within 15 minutes.

**EXPLANATION:** The reactor plant is normally controlled by operators in the Control Room. If the Control Room were to become uninhabitable for any reason, provisions have been made to provide auxiliary control of the reactor from remote locations. If local control at the remote stations is not established within 15 minutes, unstable plant conditions could exist without plant personnel being fully aware of the status of the reactor.

**OPERATOR ACTION:** The operators would take necessary actions to establish control at the remote shutdown panel as soon as possible. Control Room accessibility would be reestablished as soon as possible.

**POTENTIAL FOR ESCALATION:** The potential for escalation is unlikely.

**SITE AREA EMERGENCY NO. D3-5: Failure of reactor to trip**

**EVENT:** The Reactor Protection System, (RPS), fails to complete a reactor trip and manual reactor trip is unsuccessful.

**EXPLANATION:** When certain plant operating parameter set points are exceeded, the RPS will automatically initiate signals to shutdown the reactor. If automatic reactor trip signals are unsuccessful, operators will initiate a manual trip signal. If both shutdown signals do not result in a reactor trip, additional safety systems can be utilized to safely shutdown the reactor. An example would be the injection of a boric acid solution to the reactor coolant to stop the nuclear chain reaction. However, due to the increased time where the reactor is critical with parameters outside normal range, the potential for fuel damage is increased.

**OPERATOR ACTION:** The operators will take actions necessary to safely achieve reactor shutdown and control of key plant systems.

**POTENTIAL FOR ESCALATION:** Potential for escalation is unlikely.

**SITE AREA EMERGENCY NO. D3-6: Loss of adequate shutdown margin**

**EVENT:** Loss of adequate shutdown margin while the average reactor coolant temperature is greater than 350°F.

**EXPLANATION:** The amount of reactivity in a reactor determines the rate of nuclear fission. Fissionable nuclear fuel represents positive reactivity. Boron dissolved in the reactor coolant and the control rods represent negative reactivity, since they remove neutrons from the chain reaction through absorption.

When the reactor is at operating temperature, whether critical or not, the operators must always be able to shut it down, and/or maintain it shut down. The ability to shut down, or maintain the reactor shutdown, is called the shutdown margin. Situations where sufficient shutdown margin is not available represent unsafe operation of the plant. Examples of this condition would be a system failure which results in the inability to add boron to the reactor coolant system, or not having the control rods withdrawn far enough such that they can add sufficient negative reactivity to stop the nuclear chain reaction when inserted.

**OPERATOR ACTION:** The operators would reestablish the required reactor shutdown margin and shut down the reactor if required.

**POTENTIAL FOR ESCALATION:** Without concurrent failures there is no potential for escalation.

**SITE AREA EMERGENCY NO. D3-7: Loss of heat removal capability**

**EVENT:** Inoperability of Steam Generators or Residual Heat Removal/Shutdown Cooling System resulting in an uncontrolled Reactor Coolant System (RCS) temperature increase to greater than 350°F OR the inability to maintain or reduce RCS temperature to less than or equal to 350°F.

**EXPLANATION:** Cooling the reactor to 350°F requires the operation of the steam generators by removing steam through the steam dump valves to the main condenser. The steam can be dumped to atmosphere if necessary.

The Residual Heat Removal/Shutdown Cooling System is utilized when the RCS temperature is below 350°F by circulating the reactor coolant through dedicated heat exchangers.

The inoperability of both of these methods prevent the ability to place the reactor in a cold shutdown condition.

**OPERATOR ACTION:** The operators would take the necessary actions to restore the capability of either system.

**POTENTIAL FOR ESCALATION:** The potential for escalation is unlikely.

**SITE AREA EMERGENCY NO. E3-1: Natural disaster causing loss of hot shutdown capability.**

**EVENT:** A natural disaster, including earthquake, hurricane, tornado, tsunami, or flooding causing the loss of the ability to achieve or maintain hot shutdown.

**EXPLANATION:** The major threat to SONGS from a natural disaster would be damage to support systems necessary for the operation of heat removal systems. This could be caused by water damage due to flooding, structural damage due to earthquake, or damage resulting in the partial or complete loss of electrical power.

The buildings at SONGS housing key safety systems are designed to be watertight, withstand winds up to 100 mph, and withstand the greatest possible seismic disturbance predicted to occur in this region.

**OPERATOR ACTION:** The operators would evaluate plant conditions and shutdown the reactor if required. A thorough site inspection would be made to determine the extent of damage.

**POTENTIAL FOR ESCALATION:** The potential for escalation is unlikely.

**SITE AREA EMERGENCY NO. E3-2: Manmade disaster causing loss of hot shutdown capability**

**EVENT:** Any manmade disaster, including fire, explosion, aircraft or missile impact, or toxic or flammable gas release causing the loss of the ability to achieve or maintain hot shutdown conditions.

**EXPLANATION:** Damage to onsite buildings or equipment due to a manmade disaster could result in the loss of safety or support systems necessary to achieve or maintain cold shutdown conditions. An example would be a fire in both 4160 volt switchgear rooms simultaneously. Although unlikely, the loss of both 4160 volt buses could impair the operators' ability to cool the reactor.

**OPERATOR ACTION:** The operators would evaluate plant conditions and shutdown the reactor if necessary. A thorough plant inspection would be made to determine the extent of damage.

**POTENTIAL FOR ESCALATION:** The potential for escalation is unlikely.

**SITE AREA EMERGENCY NO. F3-1: Imminent loss of physical control of the Unit 2/3 protected area or the Unit 1 Fuel Handling Building**

**EVENT:** The Shift Commander/Security Leader reports the imminent loss of physical control of the Unit 2/3 protected area or the Unit 1 Fuel Handling Building and includes the following condition: (1) a forceful assault on the Unit 2/3 protected area barrier occurs, or has occurred, and has succeeded in penetrating the protected area perimeter and is continuing in the protected or vital area; or (2) a forceful attack on the Unit 1 perimeter boundary by an adversary force has succeeded in penetrating the boundary and is continuing toward the Unit 1 Fuel Handling Building with the assumption that the adversary force's target is the spent nuclear fuel stored in the Unit 1 Fuel Handling Building.

**EXPLANATION:** A loss of physical control of the plant could result in damage to safety systems necessary to maintain safe plant conditions at SONGS.

**OPERATOR ACTION:** The operators would shut down the reactor and maintain the plant in a safe condition. Security forces would take necessary actions to regain control of the plant.

**POTENTIAL FOR ESCALATION:** If loss of physical control of the plant were to occur, this event would escalate to a General Emergency.

**SITE AREA EMERGENCY NO. G3-1: Major failures of plant functions**

**EVENT:** Plant conditions indicate likely major failures of plant functions needed for protection of the public.

**EXPLANATION:** Conditions in the plant indicate a degradation of safety not covered by other event criteria.

**OPERATOR ACTION:** The operators would take appropriate actions to mitigate the event and maintain the reactor in a safe condition.

**POTENTIAL FOR ESCALATION:** Dependent upon the event.

## 2.4 GENERAL EMERGENCY

A General Emergency will be declared at SONGS based on the occurrence of events which involve actual or imminent substantial core degradation with the potential for loss of containment integrity. It is possible that a lesser emergency has been declared, emergency measures taken, and due to a deterioration in plant conditions, the event has been upgraded to a General Emergency. Conditions which would lead to a General Emergency at Unit 1 or the Independent Spent Fuel Storage Installation (ISFSI) are not possible due to the extended time the spent fuel has had to decay.

The General Emergency classification includes actual or imminent events for which offsite protective actions will be needed. In consideration of the lead time necessary to implement offsite protective actions, notifications to offsite authorities must be made immediately after declaration of a General Emergency. Notification of state and local offsite emergency organizations shall commence within 15 minutes of the declaration of a General Emergency. Notification to the NRC of a General Emergency will be made immediately after notification to the state and local offsite agencies and must be made within 1 hour.

SONGS general actions for a General Emergency are summarized as follows:

1. Assess the plant conditions and respond to these conditions following established plant procedures.
2. Promptly inform state and local authorities of the General Emergency status and the reason for the General Emergency within 15 minutes of the declaration of a General Emergency condition.
3. Warn people to evacuate the beach areas, if not previously performed.
4. Evacuate unnecessary personnel from the SONGS Site. Current meteorological data will be used to determine the proper evacuation routes.
5. Dispatch onsite and precautionary offsite radiological monitoring teams if they are not already in the field.
6. Provide periodic meteorological assessments, dose estimates, and dose projections to offsite authorities.
7. Provide recommended offsite protective actions to offsite authorities as information becomes available.
8. Provide periodic plant status updates to offsite authorities.
9. Escalate to a higher class of emergency if the situation warrants.
10. Close out or reduce the emergency class if appropriate. Verbally summarize the situation to offsite authorities followed by a written summary within 8 hours of the close-out or class reduction.

RECOMMENDED OFFSITE PROTECTIVE ACTIONS: In a General Emergency, an evacuation of all sectors of the Emergency Planning Zone to 10 miles normally will be recommended. If there were circumstances which would inhibit timely evacuation, such as flooding or severe earthquake damage, or the termination of an in-progress release is imminent, sheltering may be recommended. If there is an airborne release containing radioactive iodine, a recommendation for members of the public to take Potassium Iodide to minimize exposure to the thyroid will be issued.

DISCUSSION: Postulated General Emergencies will be described in this section. Unlike the previous accident classes, these accidents cannot be caused by a single, specific initiating event. Instead, they are a result of the potential consequences of multiple events which were described individually in previous sections. These resulting conditions are:

- Release of airborne radioactive materials for which the projected or measured dose rate at the Exclusion Area Boundary is greater than 1000 mrem TEDE or greater than 5000 mrem Thyroid CDE for the duration of the release.
- Loss of two of the three barriers between the fuel in the reactor and the environment, together with a potential loss of the third barrier (the three barriers are, in order: fuel cladding, Reactor Coolant System and the containment building).
- Control of the plant lost to an outside party.
- The plant is in a condition such that releases of large amounts of radioactive material are possible within a short time period or significant fuel damage is possible.

Specific actions would depend on the various events that caused the General Emergency. Nevertheless, the following actions apply to all General Emergencies:

1. Fire fighting personnel, first aid and/or rescue teams are notified as needed.
2. Offsite authorities are notified of the General Emergency and the corresponding plant status. Offsite actions, such as evacuation or shelter, are recommended depending on the circumstances surrounding the event. Potassium Iodide for members of the general public may also be recommended. Certain incidents, such as a sudden single release of radioactive material, may dictate shelter rather than evacuation. An evacuation would not be appropriate while a short-lived radioactive plume was passing over the area being evacuated. This could result in exposing the moving population to more radiation than if they had stayed at home with their doors and windows shut.
3. If radiation levels in and around the site were to exceed predetermined levels non-essential personnel onsite and on the beach near the site would be instructed to leave.
4. Onsite and offsite radiation monitoring teams would be dispatched.

It is important to understand that, even if a General Emergency (the most severe and unlikely accident) has occurred, the public is not necessarily in any danger. For example, declaration of a General Emergency does not necessarily indicate that a massive release of radioactivity has or will likely occur. The emergency classifications are designed to ensure an adequate and timely response to different degrees of emergency in order to minimize public risk. Hence, the declaration of a General Emergency ensures that the highest degree of emergency response has been initiated.

**GENERAL EMERGENCY NO. A4-1: Release of airborne radioactivity**

**EVENT:** A radioactive release occurs for which the dose measured or projected to be at the Exclusion Area Boundary:

(1) 1000 mrem TEDE

OR

(2). 5000 mrem Thyroid CDE

**EXPLANATION:** This condition does not relate to any specific initiating event. It is designed to ensure that a General Emergency is declared if significant amounts of radioactive materials are released, regardless of the cause.

**OPERATOR ACTION:** The operators would take necessary actions to reduce the release of airborne radioactivity. Plant personnel would determine the amount and level of airborne activity, generate offsite dose projections and promptly relay this information to authorities.

**GENERAL EMERGENCY NO. B4-1: Loss of Coolant Accident (LOCA) with loss of 2 of 3 fission product barriers with the potential loss of the third barrier**

**EVENT:** For LOCA sequences:

(a) The loss of 2 of 3 fission product barriers as determined by any 2 of the following 3 conditions:

(1) Any LOCA requiring or resulting in Safety Injection System actuation
(2) The loss of containment integrity
(3) Significant fuel damage is probable

AND

(b) A challenge to the third fission product barrier.

**EXPLANATION:** This event traces the progression of the "B" Tab sequence in the SONGS Emergency Plan Implementing Procedures and assumes an escalation of events starting with a Loss of Coolant Accident. In addition, either a breach in containment has occurred or the fuel cladding has been damaged. These conditions would result in the loss of 2 of 3 fission product barriers. This event is declared if a potential exists for loss of the third barrier.

**OPERATOR ACTION:** The operators would take the necessary actions to reestablish the integrity of all fission product barriers.

**GENERAL EMERGENCY NO. B4-2: Steam Generator Tube Rupture (SGTR) with fuel damage and a release path to the environment**

**EVENT:** For SGTR sequences:

(a) The loss of 2 of 3 fission product barriers as determined by any 2 of the following 3 conditions:

(1) A SGTR requiring or resulting in Safety Injection System actuation
(2) Probable significant fuel damage
(3) An active flowpath for release of fission product gases from the affected steam generator to the atmosphere.

AND

(b) A challenge to the third fission product barrier

**EXPLANATION:** This event traces the progression of the "B" Tab sequence in the SONGS Emergency Plan Implementing Procedures and assumes an escalation of events starting with a Steam Generator Tube Rupture. The Safety Injection System has either actuated or is required due to reduced Reactor Coolant System pressure and conditions exist for potential significant fuel damage to occur. In addition, there exists either an active or potential flowpath for the release of fission product gases to the atmosphere. A SGTR allows the containment building to be bypassed via the RCS to the affected steam generator to the secondary system. A release path could be provided through the secondary steam relief valves or through leaks in the secondary system.

**OPERATOR ACTION:** The operators would take the necessary actions to isolate the affected steam generator and cooldown and depressurize the RCS to reduce the leakage.

**GENERAL EMERGENCY NO. C4-1: Loss of Coolant Accident (LOCA) with loss of 2 of 3 fission product barriers with the potential loss of the third barrier**

**EVENT:** For LOCA sequences:

(a) The loss of 2 of 3 fission product barriers as determined by any 2 of the following 3 conditions:

(1) Any LOCA requiring or resulting in Safety Injection System actuation
(2) The loss of containment integrity
(3) Significant fuel damage is probable

AND

(b) A challenge to the third fission product barrier.

**EXPLANATION:** This event traces the progression of the "C" Tab sequence in the SONGS Emergency Plan Implementing Procedures and assumes an escalation of events starting with core degradation or overheating. In addition, either a breach in containment or a Loss of Coolant Accident has occurred. These conditions would result in the loss of 2 of 3 fission product barriers. This event is declared if a potential exists for loss of the third barrier.

**OPERATOR ACTION:** The operators would take the necessary actions to reestablish the integrity of all fission product barriers.

**GENERAL EMERGENCY NO. C4-2: Steam Generator Tube Rupture (SGTR) with fuel damage and a release path to the environment**

**EVENT:** For SGTR sequences:

(a) The loss of 2 of 3 fission product barriers as determined by any 2 of the following 3 conditions:

(1) A SGTR requiring or resulting in Safety Injection System actuation
(2) Probable significant fuel damage
(3) An active flowpath for release of fission product gases from the affected steam generator to the atmosphere.

AND

(b) A challenge to the third fission product barrier

**EXPLANATION:** This event traces the progression of the "C" Tab sequence in the SONGS Emergency Plan Implementing Procedures and assumes an escalation of events starting with a core degradation or overheating. A Steam Generator Tube Rupture has occurred and the Safety Injection System has either actuated or is required due to reduced Reactor Coolant System pressure. In addition, there exists either an active or potential flowpath for the release of fission product gases to the atmosphere. A SGTR allows the containment building to be bypassed via the Reactor Coolant System (RCS) to the affected steam generator to the secondary system. A release path could be provided through the secondary steam relief valves or through leaks in the secondary system.

**OPERATOR ACTION:** The operators would take the necessary actions to isolate the affected steam generator and cooldown and depressurize the RCS to reduce the leakage.

**GENERAL EMERGENCY NO. D4-1: Loss of Coolant Accident (LOCA) with loss of 2 of 3 fission product barriers with the potential loss of the third barrier**

**EVENT:** For LOCA sequences:

(a) The loss of 2 of 3 fission product barriers as determined by any 2 of the following 3 conditions:

(1) Any LOCA requiring or resulting in Safety Injection System actuation
(2) The loss of containment integrity
(3) Significant fuel damage is probable

AND

(b) A challenge to the third fission product barrier.

**EXPLANATION:** This event traces the progression of the "D" Tab sequence in the SONGS Emergency Plan Implementing Procedures and assumes an escalation of events starting with a loss of safety equipment and leading to the loss of 2 of 3 fission product barriers. This event is declared if a potential exists for loss of the third barrier.

**OPERATOR ACTION:** The operators would take the necessary actions to reestablish the integrity of all fission product barriers.

**GENERAL EMERGENCY NO. D4-2: Steam Generator Tube Rupture (SGTR) with fuel damage and a release path to the environment**

**EVENT:** For SGTR sequences:

(a) The loss of 2 of 3 fission product barriers as determined by any 2 of the following 3 conditions:

(1) A SGTR requiring or resulting in Safety Injection System actuation
(2) Probable significant fuel damage
(3) An active flowpath for release of fission product gases from the affected steam generator to the atmosphere.

AND

(b) A challenge to the third fission product barrier

**EXPLANATION:** This event traces the progression of the "D" Tab sequence in the SONGS Emergency Plan Implementing Procedures and assumes an escalation of events starting with a loss of safety equipment. A Steam Generator Tube Rupture has occurred and the Safety Injection System has either actuated or is required due to reduced Reactor Coolant System pressure. In addition, there exists either an active or potential flowpath for the release of fission product gases to the atmosphere. A SGTR allows the containment building to be bypassed via the Reactor Coolant System (RCS) to the affected steam generator to the secondary system. A release path could be provided through the secondary steam relief valves or through leaks in the secondary system.

**OPERATOR ACTION:** The operators would take the necessary actions to isolate the affected steam generator and cooldown and depressurize the RCS to reduce the leakage.

**GENERAL EMERGENCY NO. E4-1: Loss of Coolant Accident (LOCA) with loss of 2 of 3 fission product barriers with the potential loss of the third barrier**

**EVENT:** For LOCA sequences:

(a) The loss of 2 of 3 fission product barriers as determined by any 2 of the following 3 conditions:

(1) Any LOCA requiring or resulting in Safety Injection System actuation
(2) The loss of containment integrity
(3) Significant fuel damage is probable

AND

(b) A challenge to the third fission product barrier.

**EXPLANATION:** This event traces the progression of the "E" Tab sequence in the SONGS Emergency Plan Implementing Procedures and assumes an escalation of events starting with a natural or manmade disaster and resulting in the loss of 2 of 3 fission product barriers. This event is declared if a potential exists for loss of the third barrier.

**OPERATOR ACTION:** The operators would take the necessary actions to reestablish the integrity of all fission product barriers.

**GENERAL EMERGENCY NO. E4-2: Steam Generator Tube Rupture (SGTR) with fuel damage and a release path to the environment**

**EVENT:** For SGTR sequences:

(a) The loss of 2 of 3 fission product barriers as determined by any 2 of the following 3 conditions:

(1) A SGTR requiring or resulting in Safety Injection System actuation
(2) Probable significant fuel damage
(3) An active flowpath for release of fission product gases from the affected steam generator to the atmosphere.

AND

(b) A challenge to the third fission product barrier

**EXPLANATION:** This event traces the progression of the "E" Tab sequence in the SONGS Emergency Plan Implementing Procedures and assumes an escalation of events starting with a natural or manmade disaster. A Steam Generator Tube Rupture has occurred and the Safety Injection System has either actuated or is required due to reduced Reactor Coolant System (RCS) pressure. In addition, conditions exist for potential significant fuel damage to occur and either an active or potential flowpath for the release of fission product gases to the atmosphere exists. A SGTR allows the containment building to be bypassed via the RCS to the affected steam generator to the secondary system. A release path could be provided through the secondary steam relief valves or through leaks in the secondary system.

**OPERATOR ACTION:** The operators would take the necessary actions to isolate the affected steam generator and cooldown and depressurize the RCS to reduce the leakage.

**GENERAL EMERGENCY NO. F4-1: Loss of physical control of the protected area**

**EVENT:** The Shift Commander/Security Leader reports the loss of physical control of the protected area due to either of the following conditions:

a. An adversary force has attacked the site and has succeeded in penetrating the protected area perimeter. The adversary force has taken hostages and is barricaded within the protected area or vital area, and the security force has lost control of the protected area perimeter.

b. An act of sabotage has damaged or destroyed vital area safety equipment, and the security force has lost control of the protected area perimeter.

**EXPLANATION:** A security compromise, as defined in the Security Plan, has occurred.

**OPERATOR ACTION:** The operators would shutdown the reactor, if operating, and maintain the plant in a safe condition. Security forces would take necessary actions to regain control of the plant.

**GENERAL EMERGENCY NO. G4-1: Imminent substantial core degradation with potential loss of containment.**

**EVENT:** Plant conditions indicate imminent substantial core degradation with potential for loss of containment integrity.

**EXPLANATION:** As obtained at the time of event.

**OPERATOR ACTION:** Take whatever actions necessary to mitigate the event and place the reactor in a safe condition, limit core damage, and minimize the radiological release to the atmosphere.

## 3.0 INTRODUCTION TO THE SONGS NUCLEAR REACTORS

Much of the electricity in Southern California is produced through steam-electric generation. With this method, water is heated to form high pressure steam, which is used to drive the steam turbines that turn the electric generators. Steam-electric generation has traditionally used the heat from burning fossil fuels (oil, gas, and coal) to produce steam. In a nuclear power plant, a nuclear reactor supplies the heat to make steam. Electric energy is then generated in the same manner as a fossil fuel steam-electric plant. Thus, the primary difference between a nuclear electric generating plant and a fossil fuel electric generating plant is the source of heat used to convert water to steam.

San Onofre Nuclear Generating Station, owned by Southern California Edison Company, San Diego Gas and Electric, and the cities of Anaheim and Riverside, is located about 3 miles south of San Clemente, California. To the east is Camp Pendleton Marine Corps Base, and to the west is the Pacific Ocean. Interstate 5 passes about 225 yards to the east of the reactor containment buildings (Figure 1-1).

The most prominent structures at SONGS are the reactor containment buildings that are cylindrical in shape. Unit 1 is the northernmost building. Unit 2 is in the center and Unit 3 is the southernmost building. Units 2 and 3 have hemispherical, or dome, tops. The turbine generators are located adjacent to each containment building. Each turbine generator has a large overhead crane nearby. Access into the Protected Area is controlled through the Security Processing Facility.

Unit 1 was permanently shut down in 1992. The fuel has been removed from the Unit 1 reactor and is stored in spent fuel storage pools on site. Decommissioning and deconstruction of Unit 1 has begun.

Units 2 and 3 are identical 1181 MWe Pressurized Water Reactors (PWR). Each unit is divided into two separate closed-loop systems: the primary and secondary systems (Figure 1-2). The primary system, or Reactor Coolant System (RCS), is the heat generating portion and the Secondary System is the steam-electric portion of the plant.

An Independent Spent Fuel Storage Installation (ISFSI) has been constructed adjacent to Unit 1. This facility is used for dry, long-term storage of spent nuclear fuel.

The Spent Fuel Building at Unit 1, the entire ISFSI, and Units 2 and 3 are secured inside the Protected Area. This area is guarded by SONGS Security Forces. Access to these areas is controlled by Security.

Within the Protected Area at Units 2 and 3 are areas with higher levels of access control. These "Vital Areas" contain all equipment required for safe operation and shutdown of the nuclear reactor.

The entire site is surrounded by an Exclusion Area, where SCE may exclude access during an emergency. The Exclusion Area Boundary (EAB) is roughly an arc prescribed by a radius of 600 meters from the center of Unit 2 and Unit 3. The arcs are connected by a straight line on the east. The EAB coincides with SCE property lines on the north and the south. It encompasses the State Beach on the west, and Old Highway 101 and the I-5 freeway on the east.

## 3.1 REACTOR COOLANT SYSTEM

The Reactor Coolant System is filled with demineralized water. During normal reactor operation, the water is kept at an average temperature of about 580 °F and a pressure of about 2250 pounds per square inch. This pressure allows the water to be heated without boiling.

Figure 1-2 shows the major components of the SONGS units. Primary coolant water is circulated through the Reactor Coolant System loop by Reactor Coolant Pumps (RCPs). The primary coolant is first heated in the reactor core before passing through the hot leg piping to the steam generators. The primary coolant circulates through tubes in the steam generators and transfers heat to the water on the secondary side. The primary coolant never comes in contact with the secondary side water, or secondary coolant. The secondary coolant, at a lower pressure than the primary coolant, is heated above its boiling point and produces steam. The steam in the secondary system drives the turbine generators to produce electricity. The primary coolant flows out of the steam generator tubes and is returned to the reactor core by the RCPs via the cold leg piping to be heated again.

The heat in the reactor is produced by the splitting of atoms, called the fission process. This occurs when a neutron strikes a uranium atom. Each fission event produces heat energy and releases more neutrons. The fission rate, and the amount of heat produced by the reactor, are controlled by introducing or removing material into the reactor core that will absorb the neutrons. The neutron absorbing material is boron. The boron is contained in control rods that are inserted and withdrawn from the reactor core. Boron is also contained in solution in the primary coolant water. Thus, the temperature of the reactor core and primary and secondary coolant, and the amount of electricity generated are regulated by inserting and withdrawing the boron control rods or by increasing and decreasing the boron concentration in the primary coolant.

## 3.2 PRESSURIZER

Pressure in the Reactor Coolant System is maintained by the pressurizer, which is connected to the RCS hot leg by a surge line (Figure 1-4). The pressurizer is a cylindrical vessel half-filled with primary coolant water. The rest of the pressurizer is filled with steam. Steam pressure is controlled by electric heaters and a spray nozzle. The heaters, submerged in coolant, are turned on to increase pressure. The spray nozzle at the top of the pressurizer allows cool water to be sprayed into the steam to reduce pressure.

Relief valves mounted on top of the pressurizer prevent the RCS from being over pressurized. Steam discharged during operation of the pressure relief valves is piped to the Pressure Relief Tank (PRT).

## 3.3 SECONDARY SYSTEM

The steam generators transfer heat from the primary coolant to the secondary coolant (Figure 1-5). Within each steam generator are thousands of tubes surrounded by the secondary coolant water. The hot primary coolant flows through the tubes, transferring its heat to produce steam in the secondary side. The steel tubes readily conduct heat and withstand the large differential pressure (approx. 1300 psi) between the primary and secondary sides. The heat from the primary coolant boils the water in the steam generator to produce steam. This steam then travels through the steam piping of the secondary loop to the steam turbine which turns the generator that produces the electricity. Main steam dump valves can be used to bypass the turbine-generator and exhaust steam directly to the main condenser. In the event that the steam dumps are not available, steam safety relief valves on the main steam line piping provide an alternate path to vent the steam directly to atmosphere, preventing secondary system over pressurization.

The steam exhausts from the turbine-generator into the main condenser where it is condensed back into water. Main feedwater pumps return the water to the steam generators where it is reheated to steam and repeats the cycle.

The main condenser is cooled by seawater from the Circulating Water System. Seawater flowing through tubes in the main condenser is used to cool the steam. Circulating water pumps draw seawater through a large diameter pipe from about 3/4 of a mile offshore. This water is pumped through the condensers and returned to the ocean.

The turbine-generators produce electricity at 22,000 volts and provide up to 1,181,000 kilowatts (KW) or 1181 megawatts (MW) of power each from Units 2 and 3.

## 3.4 PROTECTIVE BARRIERS

The Reactor Protection System (RPS) monitors important plant conditions and will rapidly shutdown (trip) the reactor if any of the conditions approach safety limits. The system limits the consequences of an accident by protecting the reactor fuel and Reactor Coolant System components. Four measurement channels with electrical and physical separation are provided for each parameter used in the direct generation of trip signals. A two-out-of-four coincidence of like trip signals is required to generate a reactor trip signal. The reactor trip signal de-energizes the Control Element Drive Mechanism (CEDM) coils, allowing all of the Control Element Assemblies (CEAs) to drop into the core.

In addition to the Reactor Protection System, special engineered safety features also help to ensure that significant quantities of radioactive fission products would not be released to the environment, even under severe accident conditions. The fundamental design principle is to preserve at least one barrier of high integrity between radioactive fission products in the reactor core and the environment. At San Onofre, there are three (3) distinct barriers of high integrity:

- fuel cladding material
- Reactor Coolant System (reactor vessel and associated piping)
- containment building and protective barriers

The reactor fuel consists of highly compressed pellets of uranium dioxide ($UO_2$). The fuel pellets retain most fission products, minimizing their release under accident conditions.

Fission products that escape from the fuel are retained within the fuel cladding. Degradation or failure of the fuel cladding will release some fission products to the reactor coolant. Since the Reactor Coolant System is a closed loop, fission products that escape from the cladding are contained within the RCS. Fission products which would escape the Reactor Coolant System if a breach of the RCS integrity occurred are retained within the containment building. The containment building is designed to withstand the internal pressure resulting from a major rupture of the Reactor Coolant System.

## 3.5 SAFETY INJECTION SYSTEM

The Safety Injection System (SIS, Figure 1-6) supplies makeup water to the reactor if there is a loss of primary coolant due to a break in the Reactor Coolant System. The SIS also provides a rapid means of increasing the water inventory of the RCS if a rapid cooldown of the RCS were to occur. The SIS pumps highly borated water into the Reactor Coolant System, which ensures the reactor is shut down.

The SIS uses two separate, independent pumping systems to deliver water to the Reactor Coolant System from the Refueling Water Storage Tank. Each SIS pump is supplied from a separate, independent 4160 volt power source. The SIS starts automatically when it receives an activation signal. Safety Injection could be initiated under the following conditions:

- Low Reactor Coolant System pressure
- High containment building pressure
- Manual initiation from the Control Room

When activated, electrical signals open appropriate valves and start the safety injection pumps. Each of the injection lines penetrates the containment and discharges into one of the reactor coolant loops.

Although additional safety injection flow is unnecessary, the charging pumps in the Chemical and Volume Control System (CVCS) are placed into service to augment SIS flow (see Figure 1-8). The safety injection signal aligns the valves in the CVCS to draw water from the RWST through the charging pumps to the Reactor Coolant System.

Safety Injection System makeup to the Reactor Coolant System is augmented by Safety Injection Tanks. The four tanks are connected directly to the RCS piping, and flood the system with borated water anytime pressure drops below about 600 pounds per square inch.

## 3.6 SHUTDOWN COOLING SYSTEM

Radioactive materials (fission products) in the fuel continue to produce a considerable, though diminishing, amount of heat in the hours and days following reactor shutdown. This heat, known as decay heat, must be removed to keep the reactor core from overheating. After shutdown, the reactor is cooled first by continued normal operation of the steam generators until the Reactor Coolant System temperature has been reduced to approximately 350°F and system pressure has been reduced below 350 psi. At that time, the Shutdown Cooling System (SDC) is placed in service and valves are opened to allow the SDC pumps to circulate coolant through the reactor core to the SDC heat exchangers (Figure 1-7). This system is used to reduce RCS temperature to about 120-140°F. The SDC system can be run continuously to remove the radioactive decay heat from the core.

Primary coolant is taken from the RCS hot legs to the SDC pumps, then through one of two SDC heat exchangers. Flow is controlled to obtain the correct RCS cooldown rate or to maintain RCS temperature. The primary coolant is returned to the RCS cold legs.

## 3.7 CHEMICAL AND VOLUME CONTROL SYSTEM

The Chemical and Volume Control System (CVCS, Figure 1-8) is a major support system for the Reactor Coolant System (RCS). Its functions are:

- reduce the concentration of radioactive materials in the coolant
- maintain the proper amount of water in the system
- adjust the boron concentration in the RCS
- adjust the concentration of corrosion inhibiting chemicals in the coolant
- fill and pressure test the RCS prior to startup
- provide RCS water level (inventory) control.

The CVCS is used for purification of the RCS coolant. Primary coolant from the cold leg flows through heat exchangers where it is cooled to between 120°F and 130°F. The coolant passes through a disposable filter to remove particulate matter, through a temperature control valve and enters an ion exchanger. In the ion exchanger ionic contaminants are removed and the alkalinity is adjusted. Upon leaving the ion exchanger the water enters the Volume Control tank.

If the coolant temperature increases to 140°F, the temperature control bypass valve opens, bypassing the resin bed ion exchanger and directing the coolant to the Volume Control Tank. This action prevents damage to the resins which are sensitive to overheating.

The Volume Control Tank stores the purified coolant before it is injected into the RCS by the charging pumps. Chemicals can be added in the Volume Control Tank to inhibit corrosion and to adjust the boron concentration of the RCS. The charging pumps then pump the coolant back into the RCS through the Regenerative Heat Exchanger to either the cold leg or the pressurizer.

In the boration mode, concentrated borated water is pumped from the Boric Acid Tank or the Refueling Water Storage Tank by the charging pumps to the RCS. This allows for a faster increase in the RCS boron concentration than would be accomplished through chemical addition to the Volume Control Tank.

## 3.8 ELECTRICAL SUPPORT SYSTEMS

Electrical power to operate equipment at each unit at SONGS is supplied by the unit's own generated power when the unit are operating and by other operating plants or offsite sources when the unit is not operating. Two independent sources of 220 kilovolt (kV) electricity, one from Southern California Edison and the other from San Diego Gas and Electric, supply the SONGS switchyard. Each unit also has two 4160 volt emergency diesel generators and batteries to supply emergency power in the event that all offsite electrical power is lost. This arrangement ensures a reliable source of power to maintain the plant in a safe condition at all times.

When the units are operating, the main generators supply electricity at 22,000 volts to the main and unit auxiliary transformers. Voltage is stepped up to 220,000 volts in the main transformers and directed to the switchyard, where large circuit breakers and switches connect the station to the offsite distribution system (see Figure 1-9). At substations in the various communities, the distributed electricity is further reduced in voltage for consumer use. Back at SONGS, power from the main generator is also supplied to the unit auxiliary transformers, where it is stepped down to 4160 and 6900 volts (not illustrated) for onsite use.

Figure 1-10 illustrates alignment of the electrical system when the plant is shutdown. Power from the switchyard, either from the operating plant's main generator or from offsite sources, is reduced to 4160 and 6900 volts by transformers and supplied to distribution switchgear. The switchgear consists of cabinets which contain fuses or circuit breakers that connect electrical equipment to the distribution bus. The 4160 and 6900 volt switchgear supply power to large motors. Power from 4160 switchgear is also stepped down to 480 volts to supply smaller motors and equipment. The voltage is reduced further to 125 volts for lighting and receptacle use.

Figure 1-11 shows the electrical system alignment when the plant is operating. The main generator feeds power to the switchyard for distribution to consumers. A small portion of this power is directed to the plant's 4160 and 6900 volt switchgear to supply electricity necessary to run pumps and support systems required to operate the plant.

A 125 volt DC bus provides power to various DC equipment at the station. Inverters change the 125 volt DC power to 120 volt AC for the vital 120 volt AC bus. The 125 volt DC bus is normally supplied by two battery chargers, each powered from a different 480 volt AC source. If the station should lose both offsite and onsite sources of power, the 125 volt DC bus would be supplied from batteries which are kept charged during normal operations by the battery chargers. This equipment arrangement ensures that there is always a source of power to the 125 volt DC bus and 120 volt vital AC bus. This is important since station communications and instrumentation are powered from the vital AC bus (Figure 1-12).

In addition to the batteries, the two diesel generators serve as emergency sources of power in the event offsite power is lost and the main generator is shut down. The emergency diesel generators provide power only to safety related equipment. Each diesel generator can supply sufficient power to maintain the plant in a safe condition (Figure 1-13).

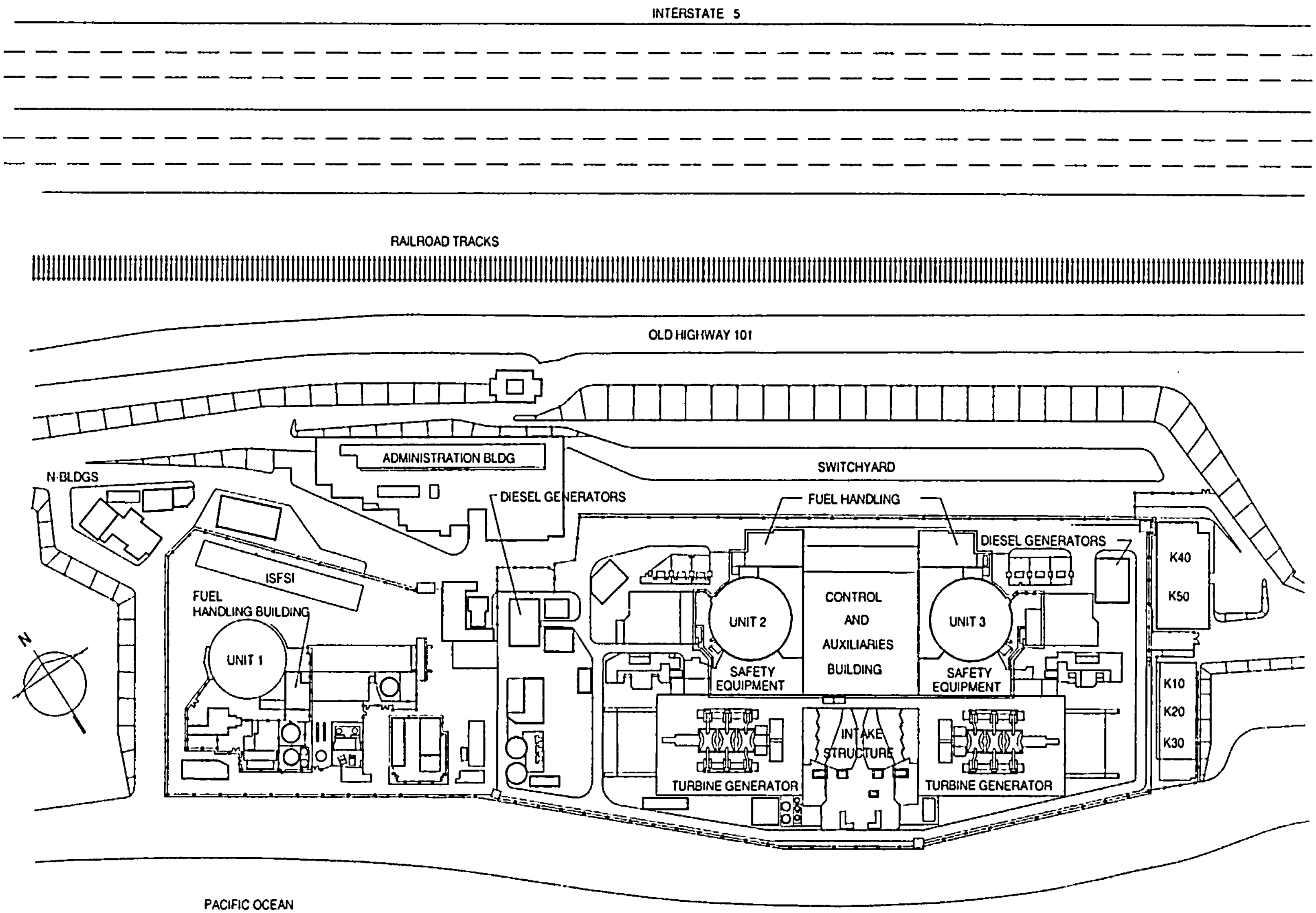
## 3.9 RADIOACTIVE WASTE SYSTEM

The Radioactive Waste (Radwaste) System processes, filters, and stores gaseous and liquid waste from various plant systems (Figure 1-14 and 1-15). All components of the Radwaste System are common to Units 2 and 3 with the exception of the Reactor Coolant Drain Tank and its associated pump, which are located inside the containment buildings. Liquid waste is sent to the Reactor Coolant Drain Tank where it is collected for processing. The gases are collected and sent to the Waste Gas Surge Tank. The liquid is then added to liquid diverted from the CVCS system, and is then pumped through a filter, a pair of ion exchangers, and another filter. The liquid then travels to the gas stripper which removes any remaining gases. Liquid collected at the bottom of the gas stripper is drained to the radwaste primary tanks.

Each of four radwaste primary tanks has a 60,000 gallon capacity, and is used to store wastes while the radioactive materials decay. The liquid is then passed through another set of ion exchangers and transferred to the radwaste secondary tanks (Figure 1-14). The two radwaste secondary tanks have a total storage capacity of 240,000 gallons. These tanks can be recirculated and sampled for chemical content. From this point most of the water is returned to primary make up tanks and stored as make up water for the RCS. Excess water can be discharged. The water to be discharged is sampled for radioactivity levels to determine the rate at which the liquid may be discharged. Liquid to be discharged then passes through isolation valves that are interlocked with the circulating water pumps to ensure that proper dilution is achieved. A radiation monitor in the discharge piping will detect abnormal radiation levels from the discharged liquid. If the level increases above a designated set point, the radiation monitor automatically shuts the discharge valve which terminates the discharge.

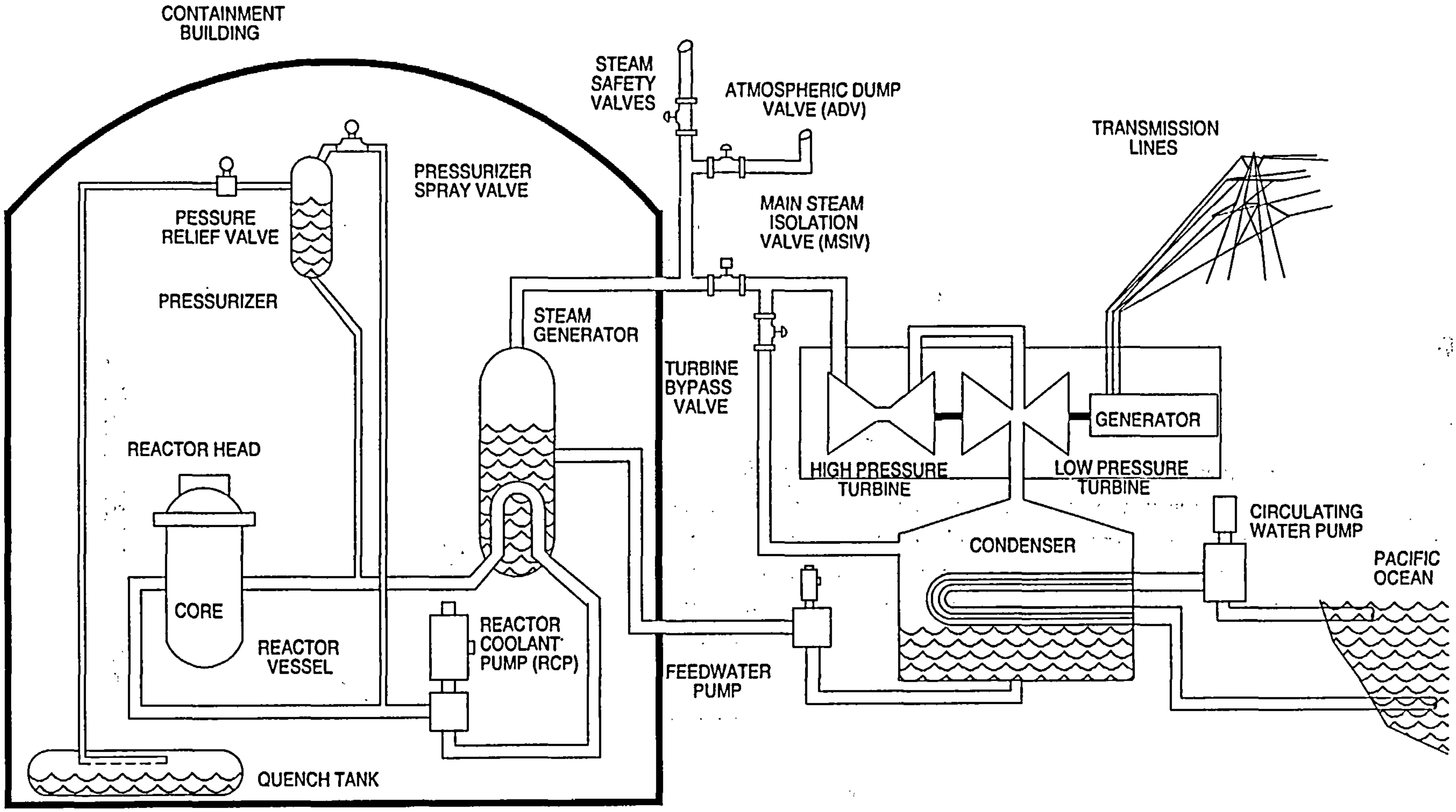
Radioactive gases collected from the tanks and gas strippers are sent to the waste gas surge tank (Figure 1-15). Gases collected in the waste gas surge tank are compressed by the gas compressor and stored in one of six waste gas decay tanks. When a decay tank is full, storage is shifted to another tank. After a storage period of at least 30 days (to allow for radioactive gas decay) the gas is released to the continuous exhaust plenum of the ventilation system and discharged into the main vent stack. Radiation detectors monitor the release and will automatically isolate the waste gas system to prevent radioactive gases from being released to the environment. In addition, gas monitors are installed in the discharge line to ensure the hydrogen concentration is less than 1%, well below the combustion limits.

Solid radioactive wastes for both units are processed and packaged for offsite shipment to a burial site.



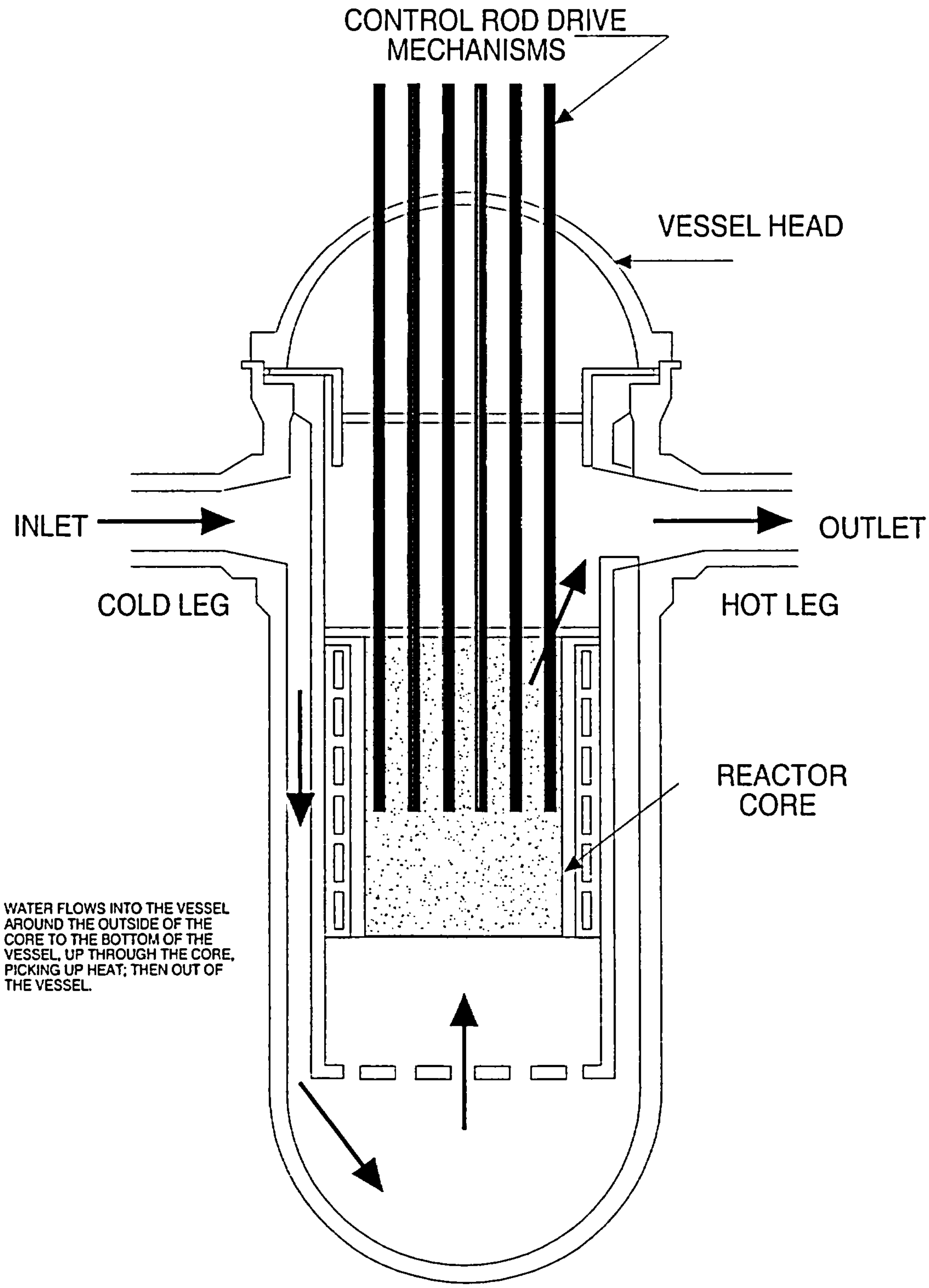

# SONGS SITE PLAN

FIGURE 1-1

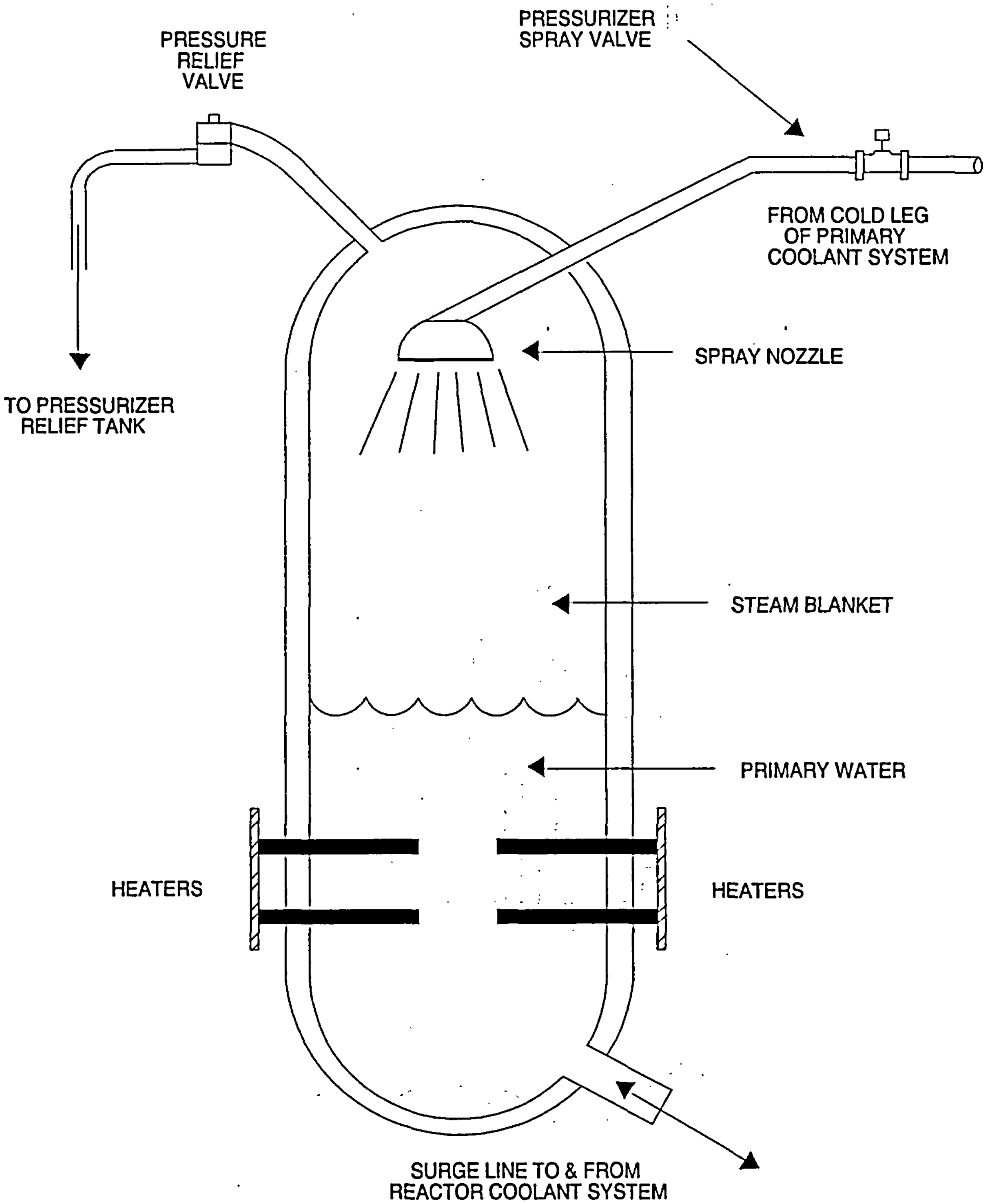



## SONGS BASIC POWER PLANT

FIGURE 1-2

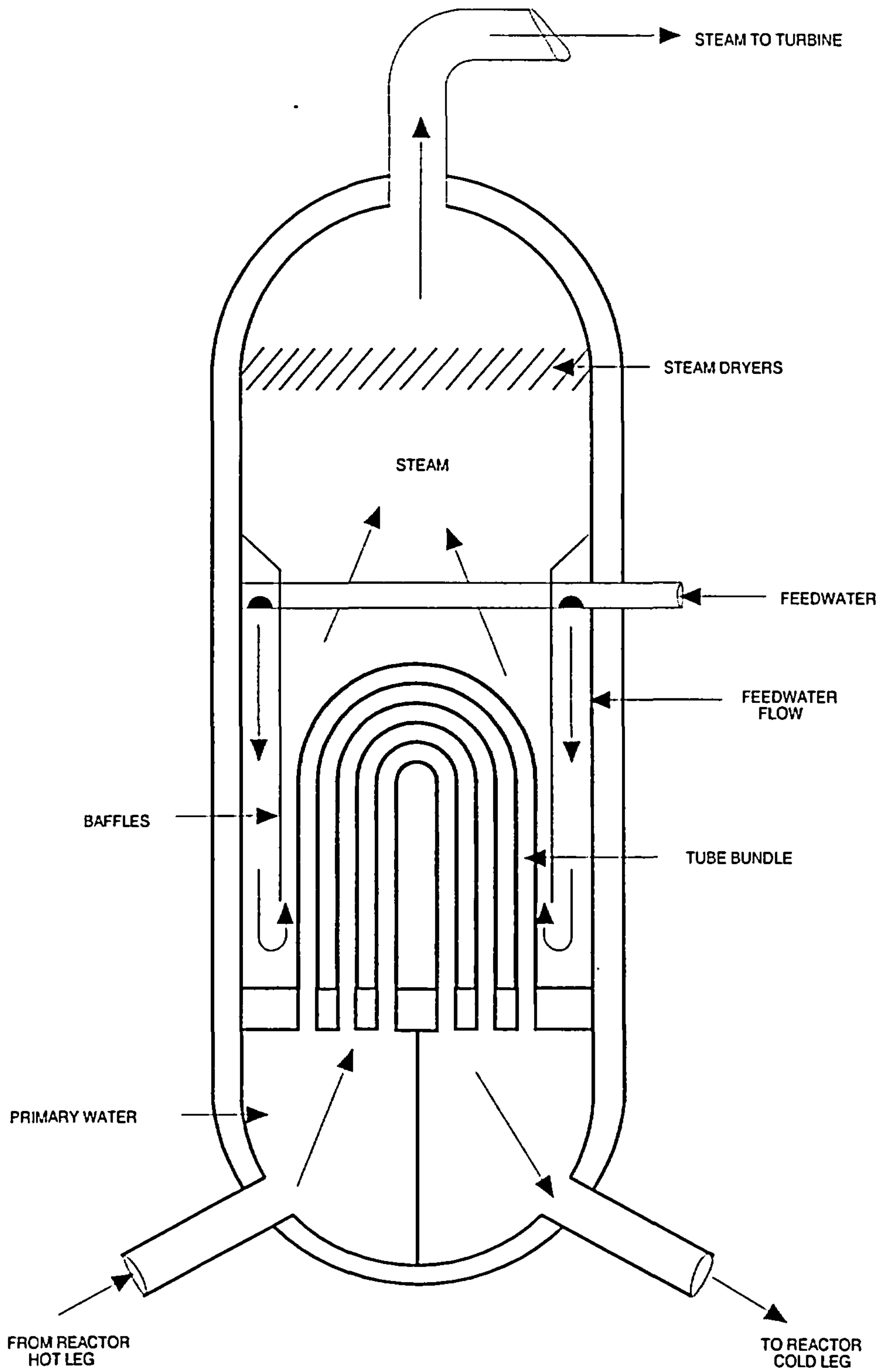



**REACTOR VESSEL**
**FIGURE 1-3**



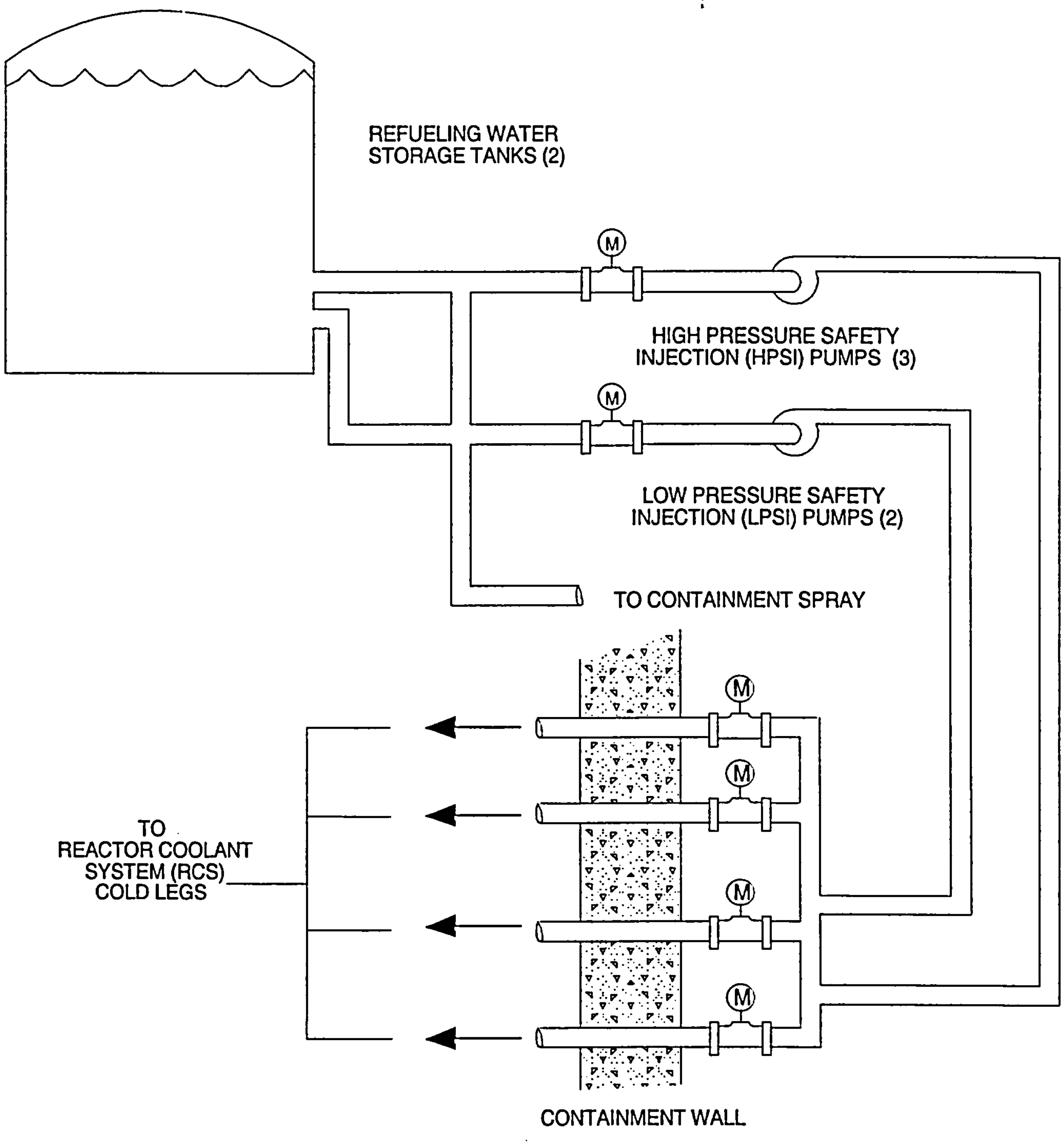

PRESSURIZER

FIGURE 1-4



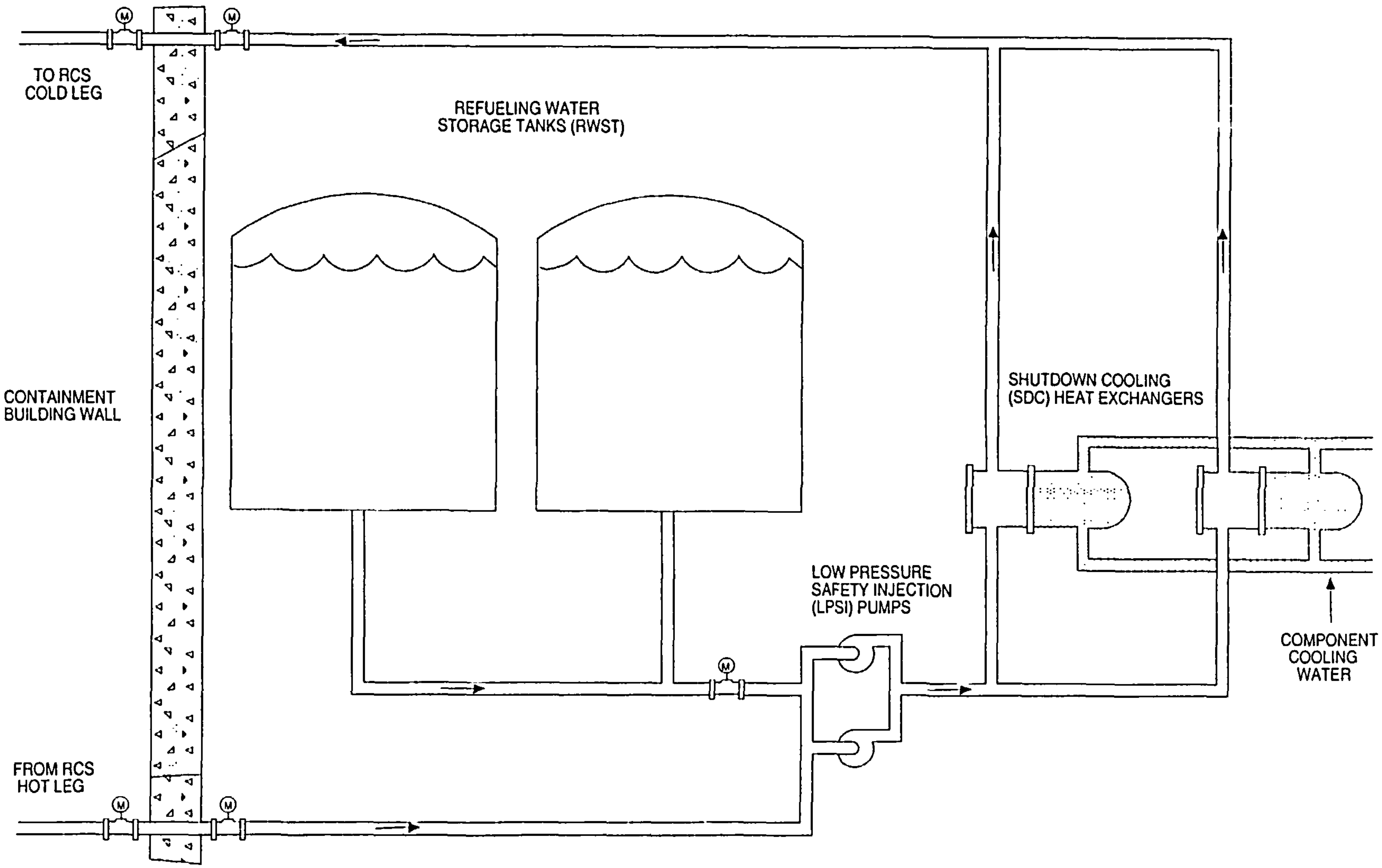

STEAM GENERATOR

FIGURE 1-5



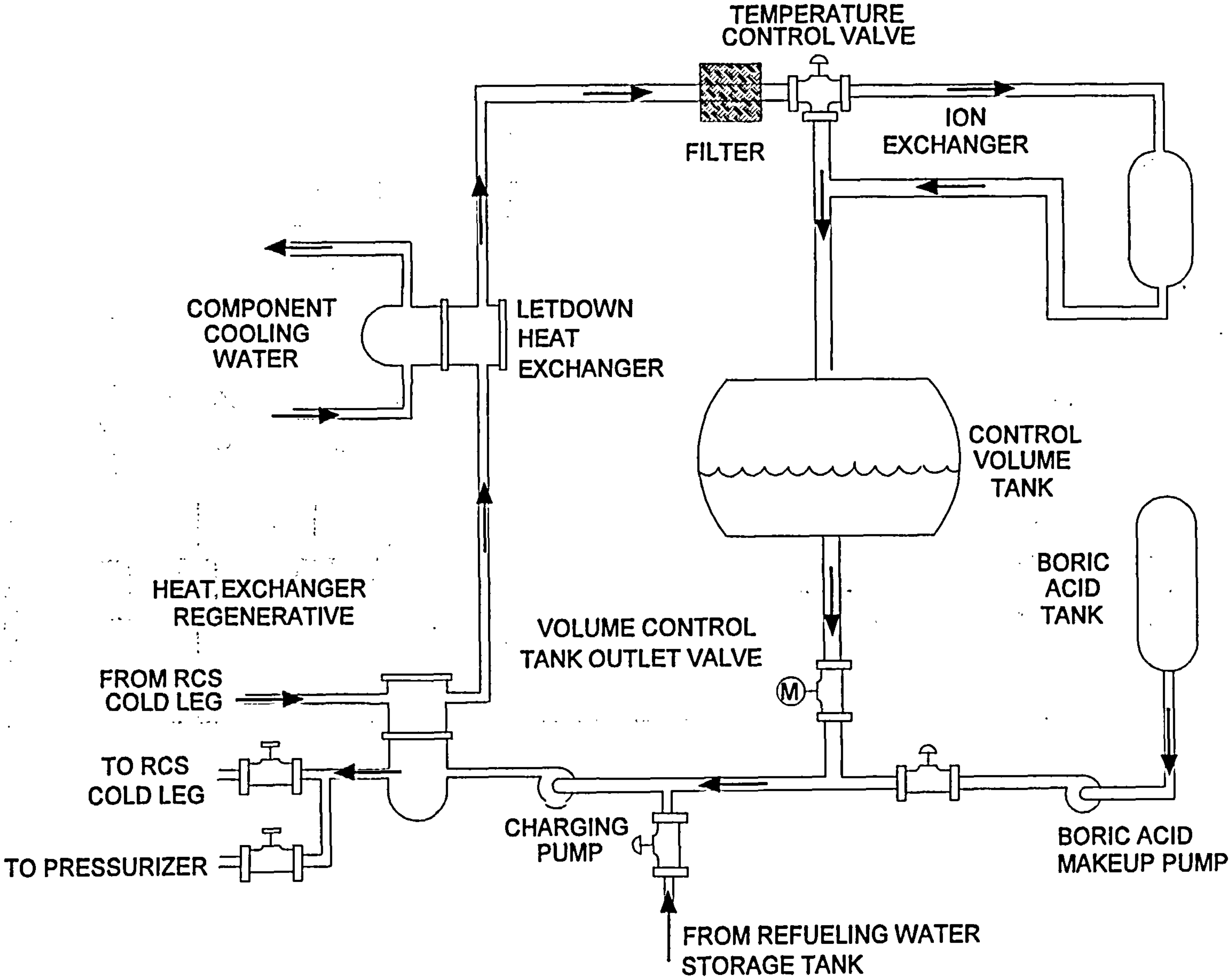

SAFETY INJECTION SYSTEM (SIS)

FIGURE 1-6

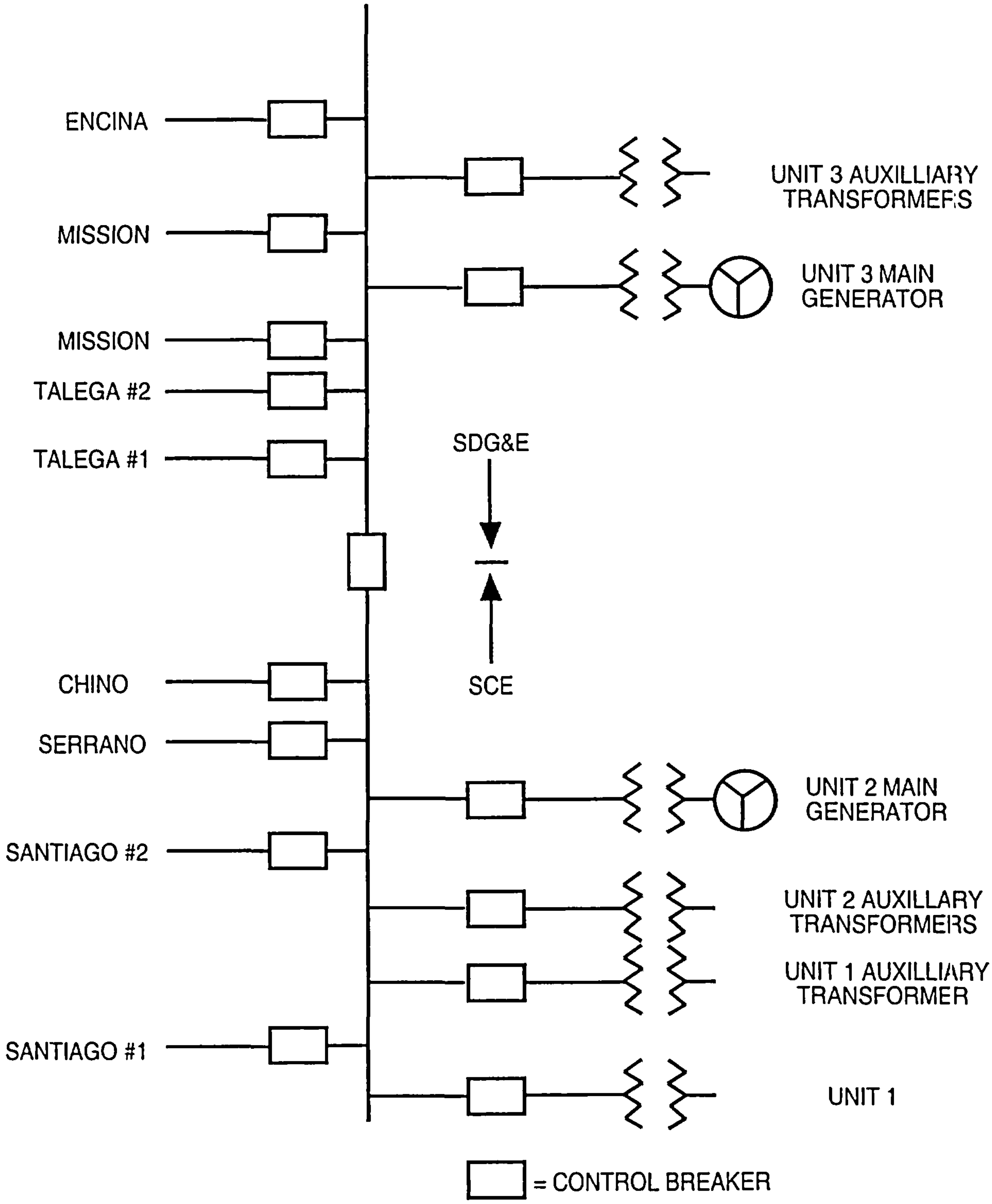



## SHUTDOWN COOLING SYSTEM

FIGURE 1-7

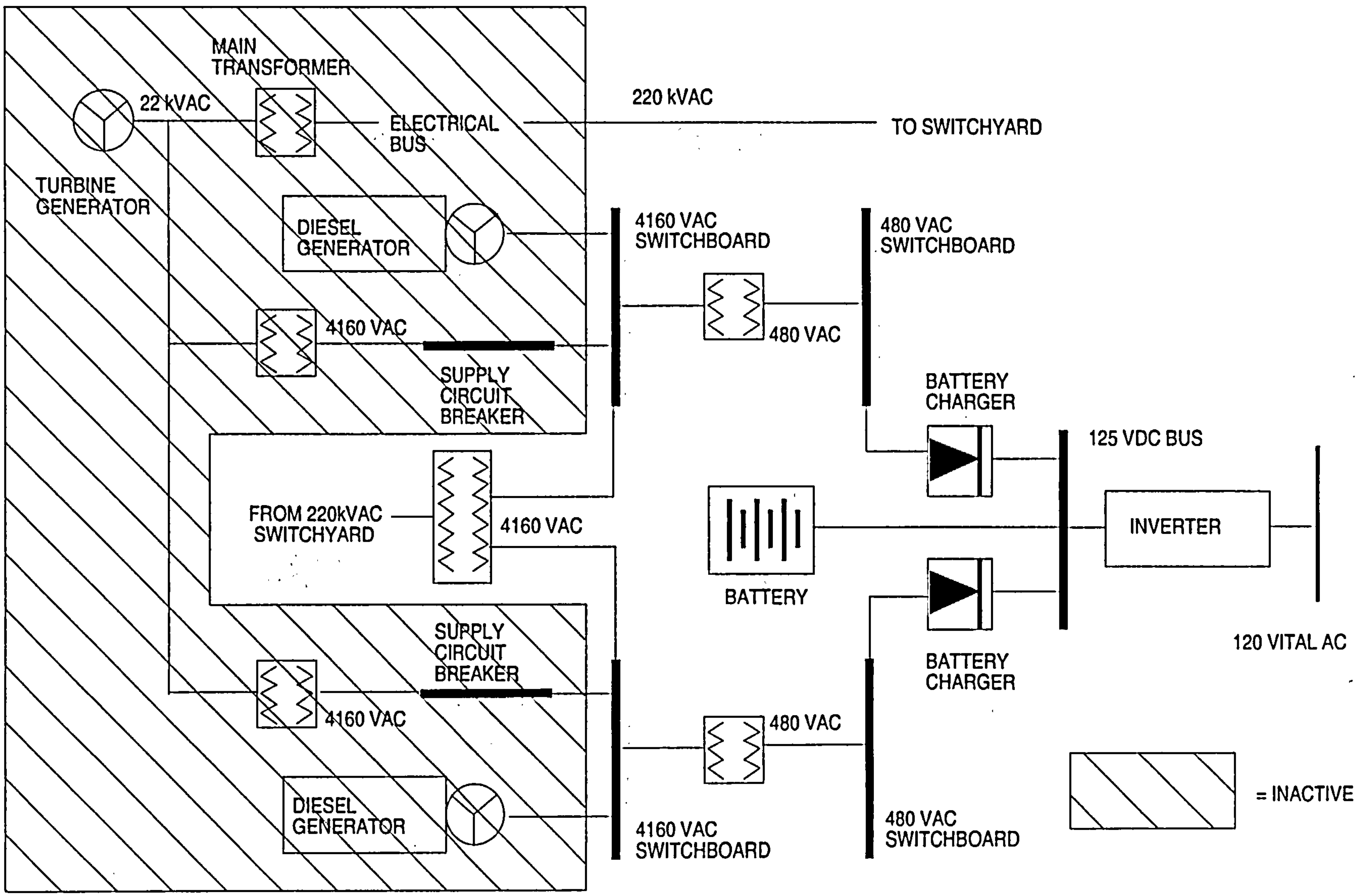



CHEMICAL AND VOLUME CONTROL SYSTEM
FIGURE 1-8



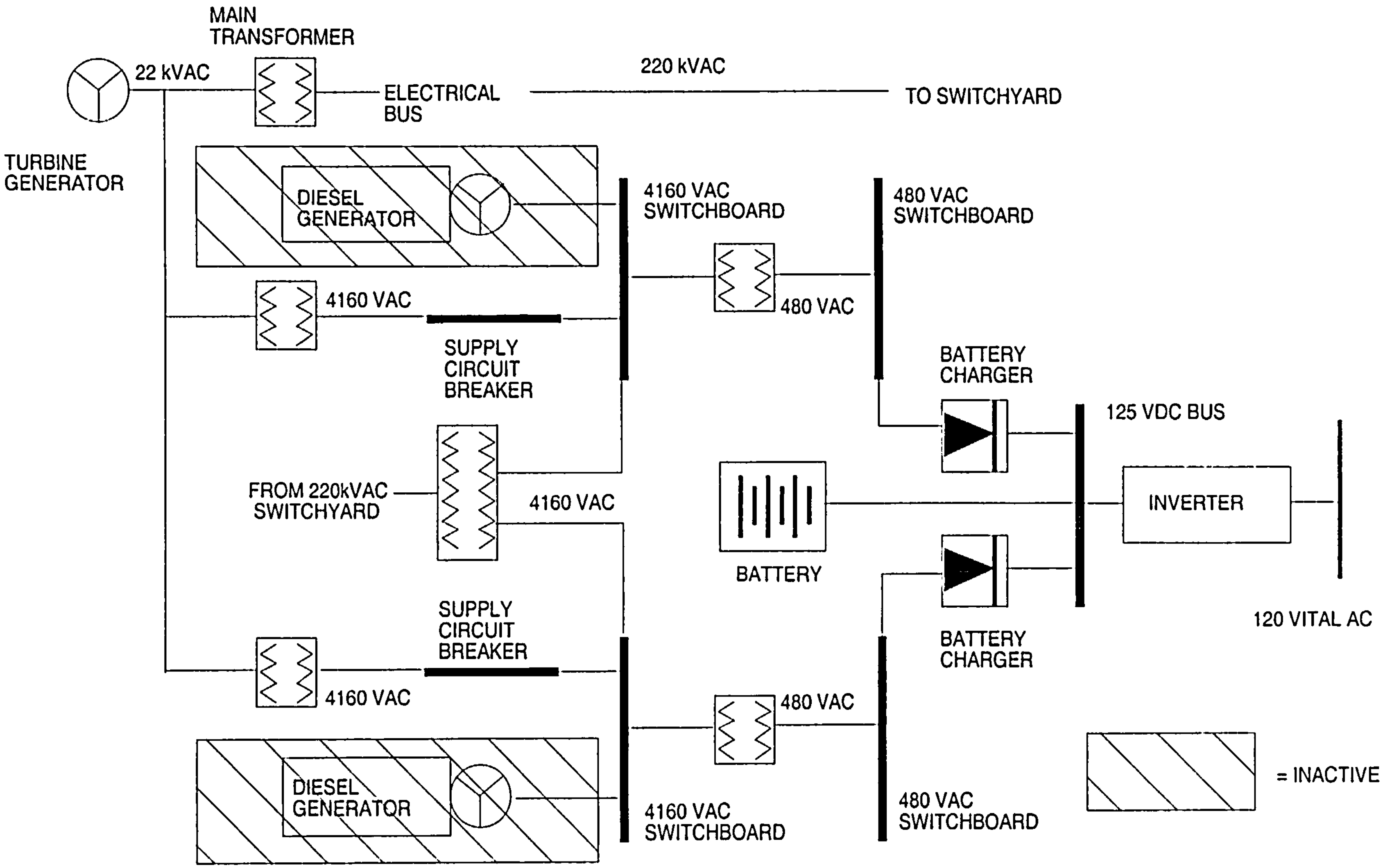

SWITCHYARD DIAGRAM

FIGURE 1-9



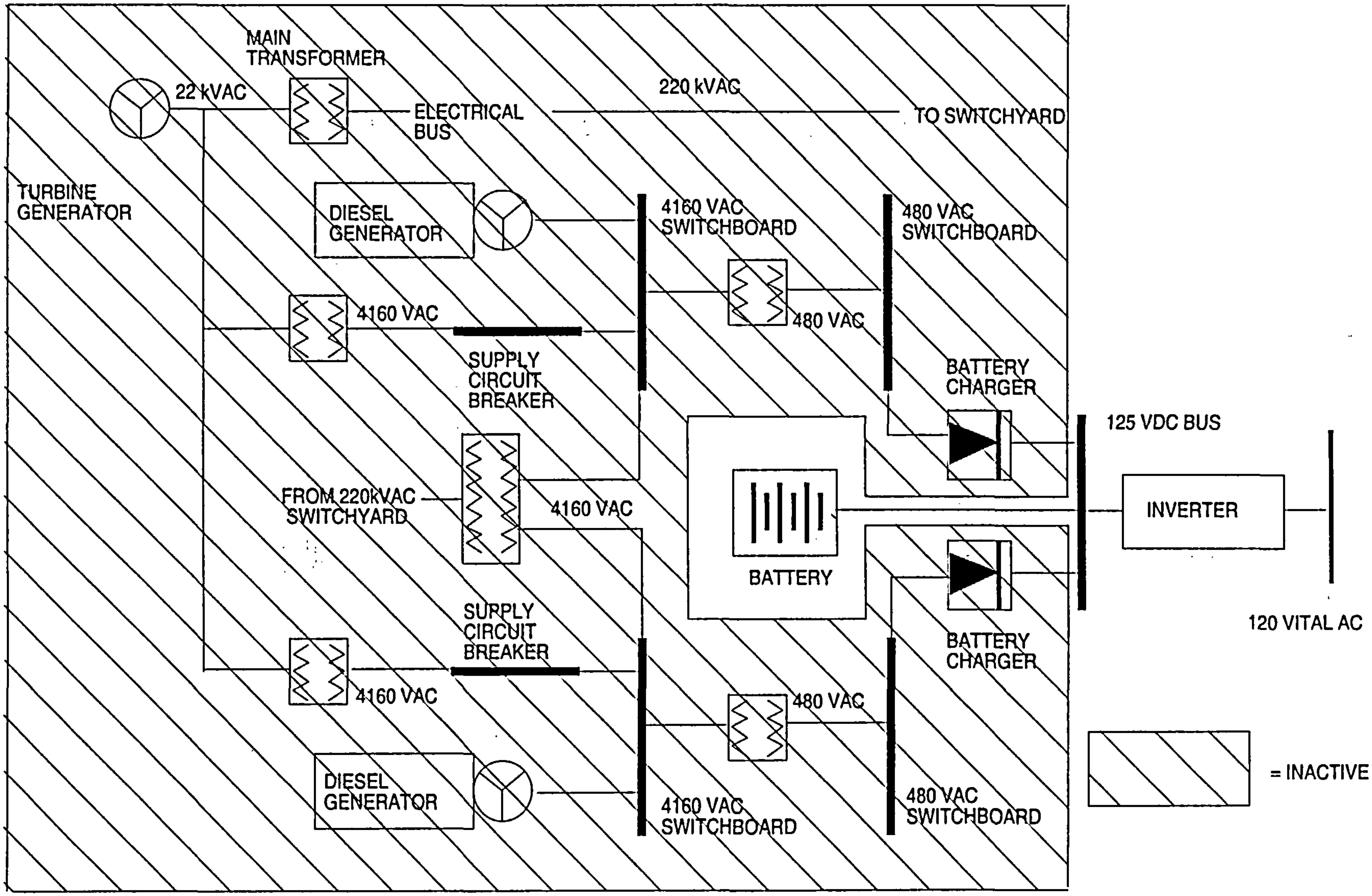

# ELECTRICAL SYSTEM - PLANT SHUTDOWN

FIGURE 1-10



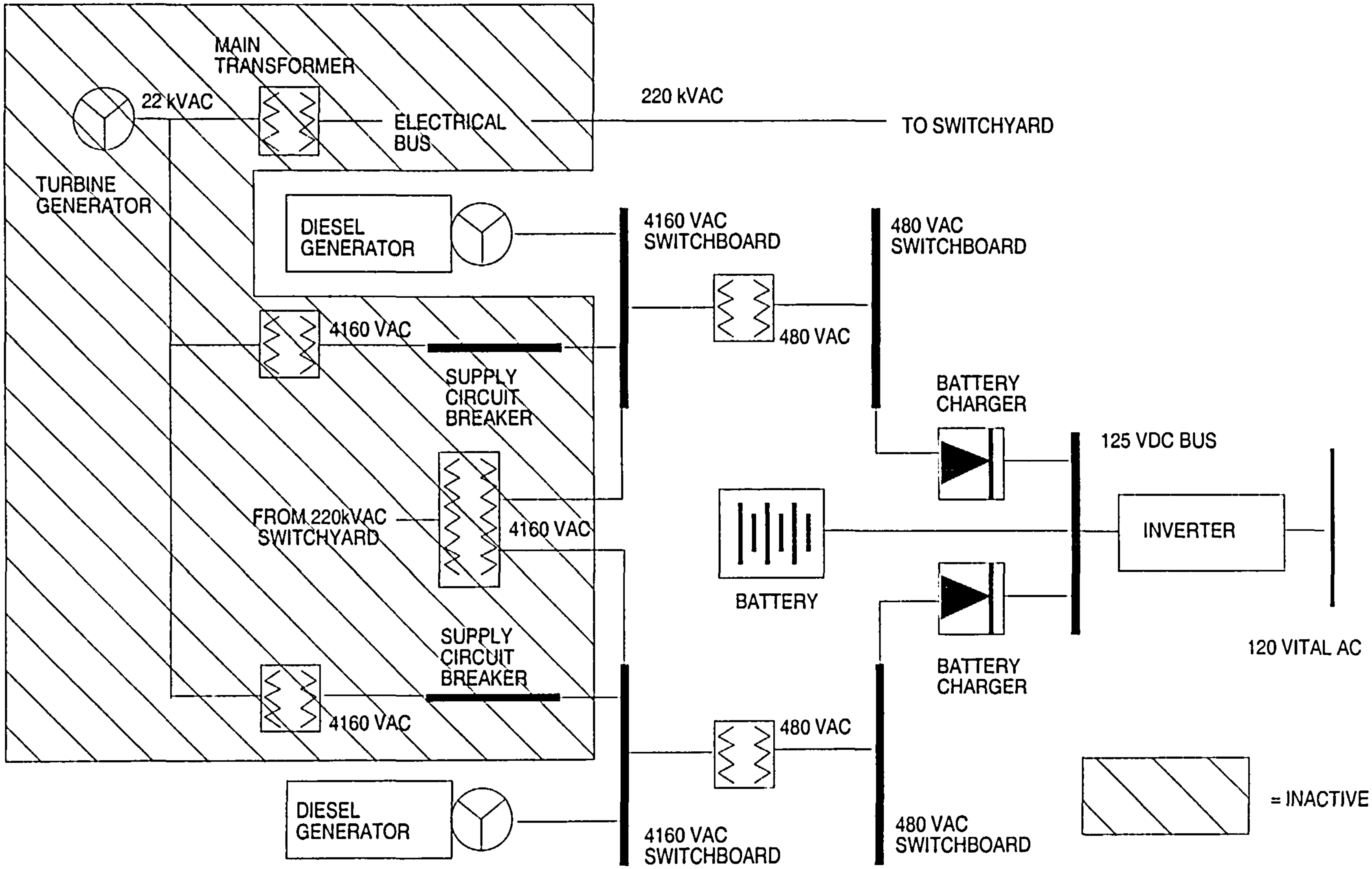

ELECTRICAL SYSTEM - PLANT OPERATING

FIGURE 1-11



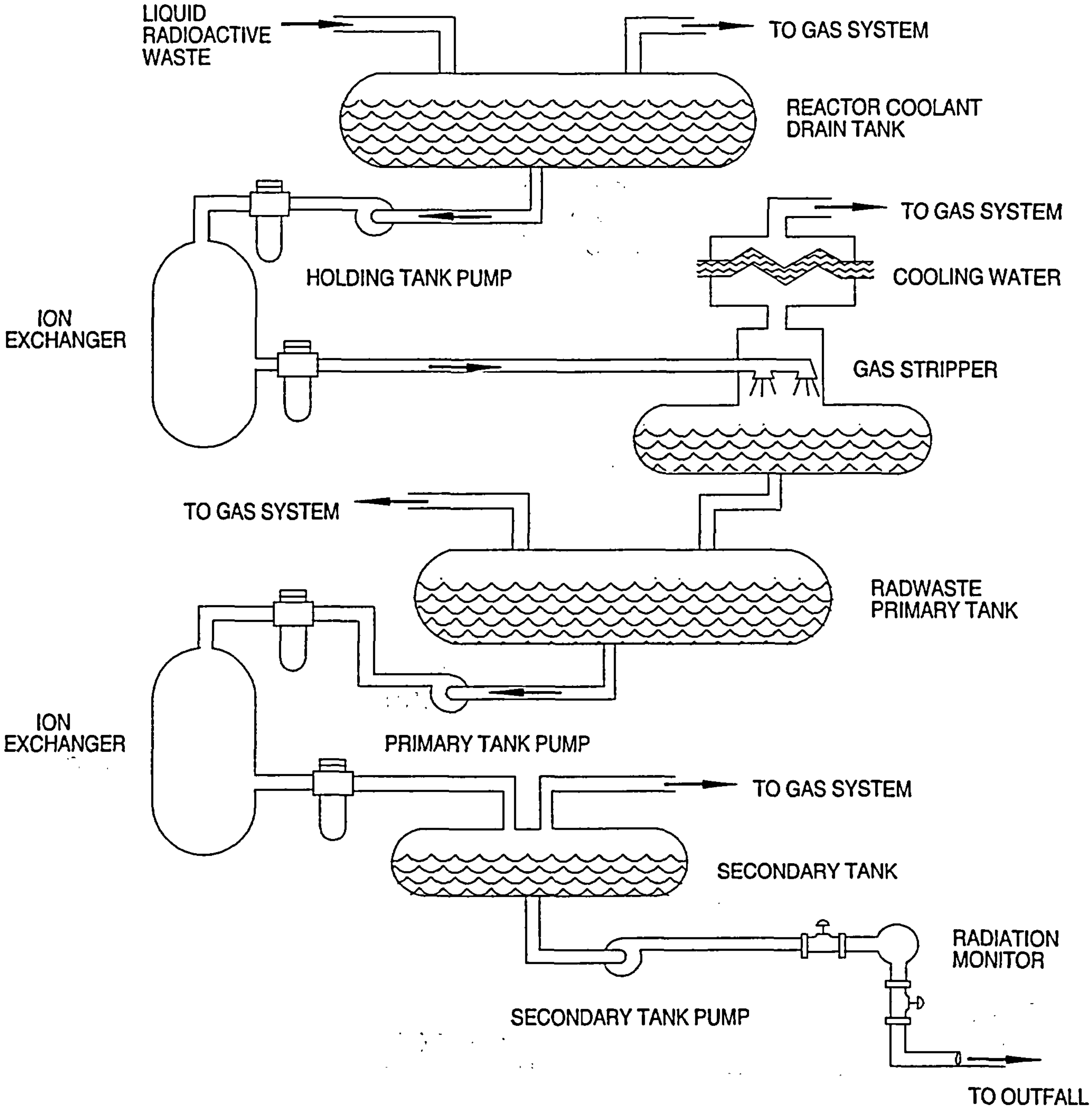

## ELECTRICAL SYSTEM - BATTERY

FIGURE 1-12



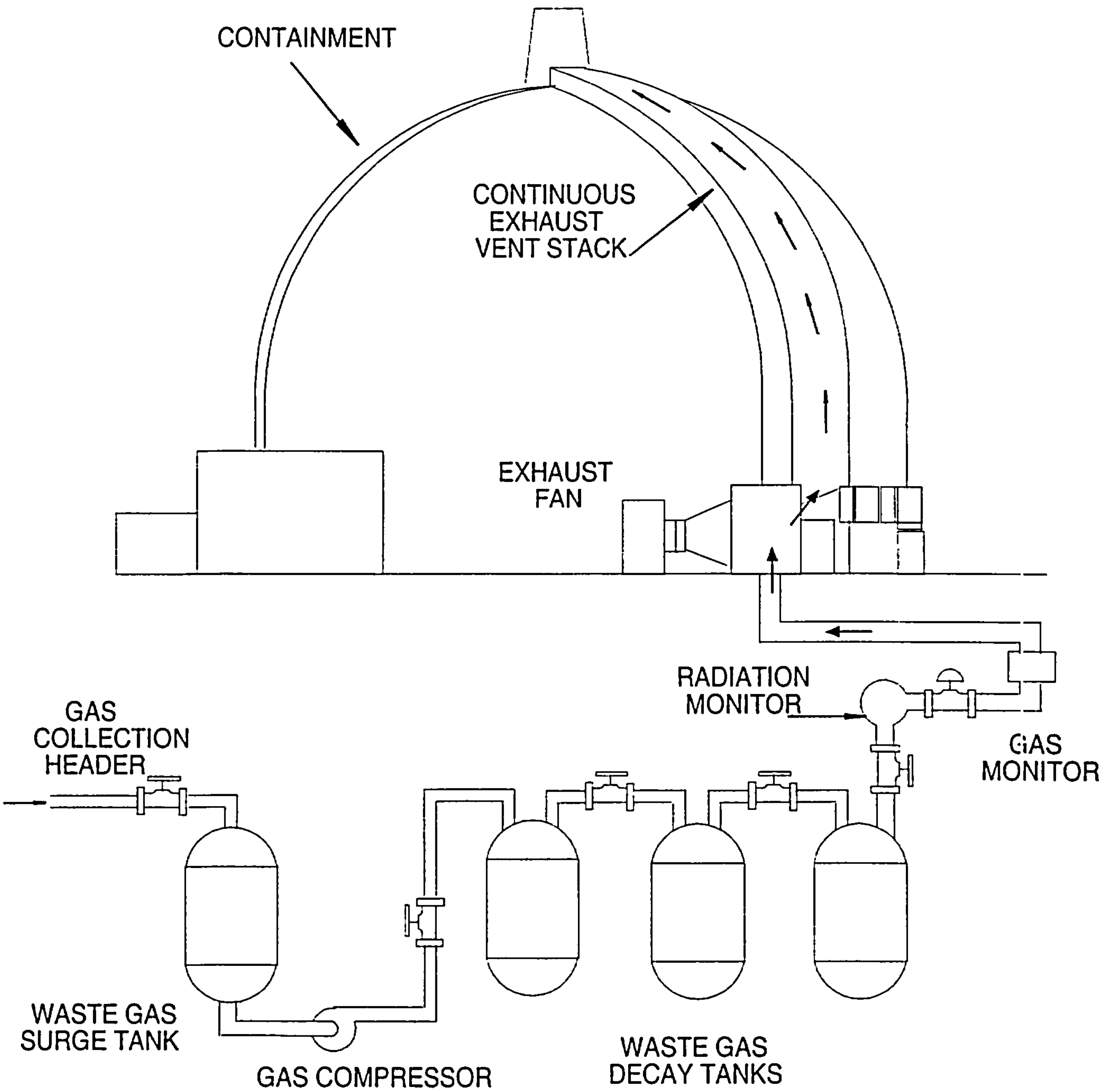

## ELECTRICAL SYSTEM - DIESEL GENERATOR

FIGURE 1-13



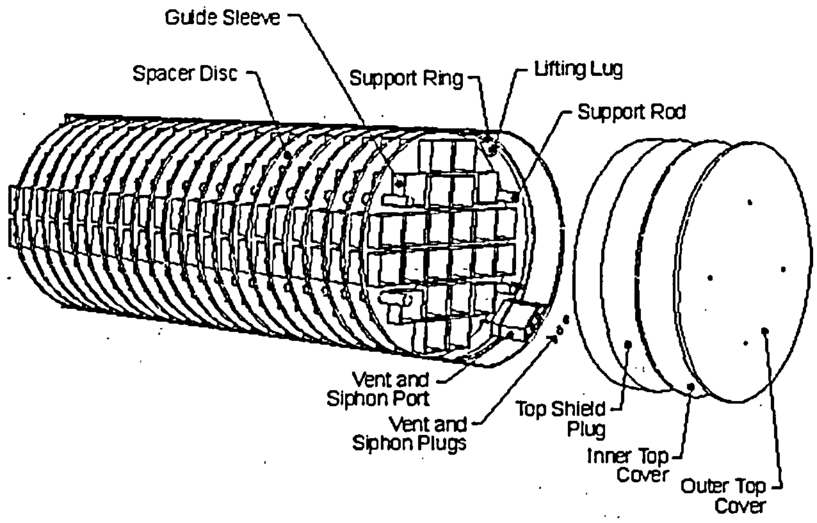

LIQUID RADIOACTIVE WASTE SYSTEM

FIGURE 1-14

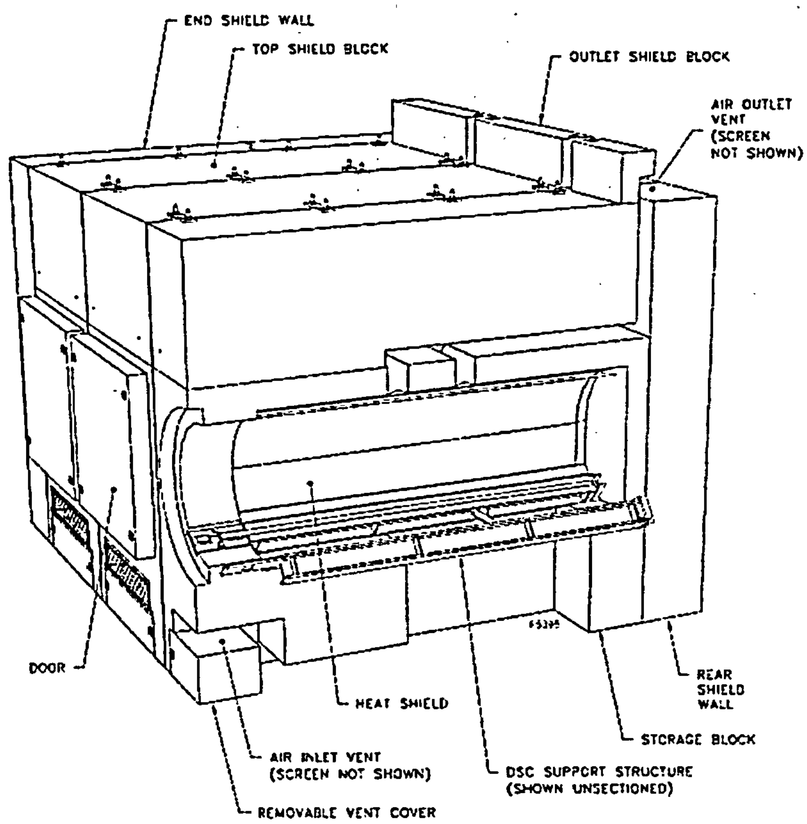



GASEOUS RADIOACTIVE WASTE SYSTEM

FIGURE 1-15




**Independent Spent Fuel Storage Installation Dry Storage Cask**




**Independent Spent Fuel Storage Installation Horizontal Storage Unit**

FIGURE 1-15

## 4.0 INFORMATION ABOUT RADIATION

### 4.1 MAKEUP OF MATERIAL

Everything in the universe is made up of one or more chemical elements, ninety-two of which occur naturally and thirteen which are manmade. The lightest and simplest of these element is hydrogen and the heaviest naturally occurring element is uranium. Elements such as sodium, oxygen, copper, iron, gold, and lead are grouped in between.

The atom is the smallest unit into which an element can be divided without losing its identity as an element. The element oxygen, for instance, is composed entirely of atoms of the same kind: oxygen atoms. Atoms of different kinds can combine or join together to form molecules. Most of the things we see and use in our daily lives are made up of molecules. Water is made up of molecules, composed of two hydrogen atoms joined to an oxygen atom.

As small as atoms are, they are made up of even smaller atomic particles: protons, neutrons, and electrons. The center of the atom, called the nucleus, contains protons and neutrons. Electrons orbit around the nucleus like the planets orbit the sun.

Most atoms are stable, that is, the forces within the nucleus are balanced. When an atom is not stable, its nucleus must undergo a change or rearrangement in order to establish a balance of forces. This change is accompanied by a release of energy, known as radiation. Unstable atoms are called radioactive and the process of stabilization is called radioactive decay.

Each radioactive element has a special characteristic, called its half-life, which is the amount of time required for one-half of the original number of atoms present in a sample of that element to undergo radioactive decay. For example, if we had 100 atoms of a radioactive element with a one hour half-life, at the end of one hour only 50 radioactive atoms would remain. The other 50 atoms would have undergone radioactive decay. Table 1 shows decay of this material over a period of seven hours.

Table 1 - Radioactive Decay for a One Hour Half-Life

| Elapsed Time in Hours | Number of Radioactive Atoms Remaining* | Number of Stable Atoms Produced* |
|---|---|---|
| 0 | 100 | 0 |
| 1 | 50 | 50 |
| 2 | 25 | 75 |
| 3 | 13 | 87 |
| 4 | 6 | 94 |
| 5 | 3 | 97 |
| 6 | 2 | 98 |
| 7 | less than 1 | greater than 99 |

*Rounded off to the nearest whole number

After a radioactive material has been through seven half-lives, less than one percent of the original quantity remains. This is true regardless of whether the material has a half-life of just seconds or of years. For example, one type of radioactive iodine has a half-life of about 8 days. If we had 100 of those atoms to begin with, at the end of 56 days (8 day half-life times 7 half-lives = 56 days), less than one percent or about one atom would remain.

The rate by which a radioactive element decays is defined in terms of the number of radioactive decays (disintegrations) occurring in one second, or the disintegration rate. A quantity of radioactive material with a disintegration rate of $3.7 \times 10^{10}$ per second (37 followed by 9 zeros) is called a curie. The curie is a very large number, so two smaller terms are more commonly used: the millicurie and the microcurie. The millicurie is one-thousandth of a curie, or 37,000,000 decays per second. The microcurie is one-millionth of a curie or 37,000 decays per second.

Three terms that are commonly used in discussions about radioactivity are the source of radioactivity, contamination, and radiation. The source is the radioactive material itself. Radiation is the particles or electromagnetic energy given off by the source.

Contamination is the presence of radioactive material where it is not wanted. We can use a fire in a fireplace as an example of the three terms. The burning wood is like a radiation source, the heat and light from the fire is like radiation, and an ember popping out of the fire onto the floor is like contamination.

Radioactive atoms decay by giving off or emitting specific types of radiation. Only two of these types of radiation, beta and gamma (or x-rays), are of any importance to people located offsite. Beta radiation consists of particles of matter (electrons) whereas gamma radiation is "electromagnetic" energy, similar to visible light, radiowaves and microwaves. Except for the method by which they are produced, gamma rays and x-rays are identical.

Protection from radiation exposure requires shielding or avoiding the source of exposure. Most beta radiation can be stopped by about one-quarter inch of aluminum. Gamma radiation is much more penetrating and requires much more shielding. The difference is due to the fact that beta radiation results from a particle and gamma radiation results from an electromagnetic wave of energy. Beta radiation is stopped by solid materials, like water stops a high speed bullet. Gamma radiation penetrates matter, very much like light penetrates water. In general, the more dense the substance, the better it will block gamma radiation. For this reason, the same thickness of lead provides more protection than concrete and concrete provides more protection than wood.

## 4.2 NATURAL BACKGROUND RADIATION

We are exposed to naturally occurring radiation in our daily lives. Almost everything around us contains radioactive material, including the soil, rocks, rivers and oceans; the houses we live in, the food and water we consume, the air we breath, and even our own bodies. Most people are exposed to an average of about 300 millirem of natural radiation and an additional 60 millirem of radiation from man-made sources each year. Natural radiation exposure varies with your location depending on the altitude and the concentration of radioactive minerals in the ground. Natural background radiation accounts for nearly 85 percent of our total annual exposure; of the rest, about 50 millirem comes from X-rays or medical diagnosis and therapy. The other 10 millirem come from consumer products like television and smoke detectors.

Radiation from nuclear power plants contributes about one tenth of one millirem to our annual exposure. This compares to about 5 millirem of exposure experienced in a cross-country airplane flight.

## 4.3 RADIOACTIVE MATERIALS IN NUCLEAR REACTORS

Uranium is a very heavy, naturally occurring, radioactive metal with a half-life of about 4 ½ billion years. It is found in nearly all rocks and soil in the earth's crust. Some rocks such as pitchblende contain uranium in such high concentrations that they are commercially valuable. Uranium is mined, purified, and converted into the chemical form of uranium dioxide powder. This compound is then compressed into pellets which are then inserted into tubes which are bundled together into a fuel assembly and positioned to make up the reactor core. The uranium fuel is one source of radioactive material in the reactor.

When the reactor begins operation, the uranium atoms are caused to split apart or fission, releasing heat. This process is initiated by a small atomic particle called a neutron. The neutron hits and fuses with the nucleus of a uranium atom, causing an extreme imbalance of energy within the nucleus. As a result, the nucleus of the atom splits apart. Each time a uranium atom fissions, it releases energy and more neutrons to continue the process. The uranium atoms split into two parts called fission products. Fission products are actually atoms of entirely different elements from the uranium parent and are both radioactive. Most fission products have very short half-lives, that is, less than 30 minutes. With undamaged fuel, the fission products are contained within the fuel pellet or within the fuel cladding. Fission products include gases such as krypton and xenon, and solids such as iodine, cesium, and strontium. These materials constitute a second source of radioactive materials.

A third source of radioactive materials is the reactor vessel and core support structure and the water in the Reactor Coolant System. The neutron, the same small particle which causes the uranium atom to split, may also be absorbed by the nucleus of atoms of other materials. However, there is a fundamental difference between these materials and uranium. While uranium atoms become so unstable that they split apart, these atoms simply become radioactive. When the reactor is operating, the materials which are used in the structure of the reactor vessel, the hydrogen and oxygen which make the primary coolant water, and the impurities in the water can become radioactive. These radioactive materials are called activation products and are found throughout the Reactor Coolant System. Radioactive iron, cobalt, and other metallic elements are common. They result from small particles of metal in the piping and other material in the Reactor Coolant System being carried through the very high neutron fields in the vicinity of the reactor core.

## 4.4 MEASURING RADIATION

Radiation measurement falls into two general categories, the determination of the amount of radioactive contamination in or on a given area, and the measurement of the amount of radiation in an area.

The amount of contamination or contamination level is normally expressed in terms of disintegrations per second per unit of surface area. If the contamination levels in an area exceed a predetermined maximum level, the area must be decontaminated before normal work can continue in the area. Geiger-Muller counters, a type of radiation detection device, are sometimes used to measure contamination levels.

The three terms used in the measurement of radiation levels are: the Roentgen (R), the Radiation Absorbed Dose (Rad), and the Roentgen Equivalent Man (Rem). The Roentgen is simply a measure of the amount of x-ray or gamma radiation in the air. The rad is a measure of the amount of radiation energy absorbed by a material. As radiation passes through a material it is slowed and gives up energy to the material. The rem is the measure of the biological effect of a quantity of radiation to an individual. So the appropriate unit pertaining to radiation dose to people is the rem.

## 4.5 RADIATION PROTECTION GUIDANCE

Radiation protection standards and procedures are derived from many national and international organizations. The International Commission on Radiological Protection (ICRP) has been the world's principle standards-setting group in the radiation protection field since its inception in 1928. In the United States, the National Council on Radiation Protection and Measurement (NCRP) was most influential in establishing radiation standards.

The Atomic Energy Act of 1954 delegated the Atomic Energy Commission (AEC) the responsibility for ensuring safe development of the Atomic Energy industry. In 1974, this agency was reorganized and is now identified as the Nuclear Regulatory Commission (NRC). The regulatory program is published in the Code of Federal Regulations (CFR).

In 1970 the Environmental Protection Agency was created. Within this agency a Radiation Office was given responsibility for development of guidelines for radiation and environmental radiation standards.

Individual states reserve the right to regulate radiation related activities which are non-federally (NRC, EPA, DOT, etc.) regulated.

## 4.6 PHILOSOPHY OF RADIATION PROTECTION

Radiation protection programs for nuclear power plants are designed to control relatively small doses delivered over an extended period of time. Current dose limits are designed to prevent somatic effects, and to minimize the risk of long term and genetic effects. The derivation of these limits is based on actual human experience in which effects have been seen. These observed effects followed acute doses in excess of 100 rad. The relationship of dose and effect at chronic, low level exposures is extrapolated from effects observed at high, acute doses.

Three categories of exposure are recognized for purposes of radiation safety standards:

1. Worker occupational exposure
2. Exposure to members of the general public
3. Medical exposures: diagnostic and therapeutic

For occupational exposure, the following annual dose equivalent limits are recommended:

1. To prevent stochastic effects:

    a) 50 rem committed effective dose equivalent (CEDE) to all tissue except lens of the eye
    b) 15 rem committed dose equivalent (CDE) to the lens of the eye
    c) 50 rem committed dose equivalent (CDE) to the skin

2. To minimize stochastic effects, the total effective dose equivalent (TEDE) limit is 5 rem in one year.

For members of the general public the total effective dose equivalent (TEDE) limit is 500 mrem in a year. No specific dose limit was recommended for medical exposure. Exposure should be justifiable on the basis of benefits that would otherwise not have been received.

## SIGNIFICANCE OF RADIATION DOSE

| | |
|---|---|
| 2.5 mRem | Mean dose on plane trip from Los Angeles to New York |
| 8 mRem | Mean dose per chest X-ray |
| 10 mRem | Mean dose per dental X-ray |
| 26 mRem/year | Cosmic radiation dose rate at sea level |
| 40 mRem/year | Internal dose rate from food and water uptake |
| 43 mRem/year | Mean terrestrial dose rate at sea level |
| 80 mRem | Calculated dose at Three Mile Island for the duration of the accident |
| 200 mRem/year | Mean dose rate from airborne radon |
| 1,250 mRem | Dose leading to an increase in cancer risk of 1 in 1,000 |
| 10,000 mRem | Dose leading to an increase in chromosome aberrations in peripheral blood; no detectable injury or symptoms. |
| 75,000 mRem | Dose leading to the earliest onset of Radiation Sickness |
| 100,000 mRem | Dose to double the increased risk of genetic effects |
| 200,000 mRem | Threshold dose to the lens of the eye to cause cataracts |
| 300,000 mRem | Dose leading to the onset of hemopoietic syndrome |
| 400,000 mRem | Dose resulting in an expected 50% death no medical |
| 500,000 mRem | Dose to double the increased risk of cancer |
| 1,000,000 mRem | Dose leading to the onset of gastrointestinal syndrome |
| 10,000,000 mRem | Dose leading to cerebrovascular syndrome |

Sources:

•National Council on Radiation Protection and Measurement Reports # 92, 93, 94, 95 and 100.
•Radiobiology for the Radiologist, Eric Hall
•"Health Effects of Exposure to Low Levels of Ionizing Radiation", Report of the National Research Council's Fifth Committee on the Biological Effects of Ionizing Radiation V (BEIR V), National Academy of Science

## GLOSSARY OF RADIOLOGICAL TERMS

| | |
|---|---|
| Absorbed dose: | Energy deposited in matter by ionizing radiation per unit mass of irradiated material. The unit of absorbed dose is the rad. |
| Acute exposure: | Radiation exposure in less than one day. |
| Background radiation: | Radiation in man's natural environment, including cosmic rays and radiation by naturally occurring radioactive elements, from both inside and outside human bodies. |
| Beta particle ($B^-$): | An elementary negatively charged particle emitted from a radioactive nucleus. |
| Chronic exposure: | Radiation exposure of long duration (more or less continuous). |
| Committed Dose Equivalent (CDE) | The internal organ dose to a target organ accumulated by an individual over a 50 year period. |
| Committed Effective Dose Equivalent (CEDE): | The sum of all internal organ doses times their risk weighing factors |
| Decay, radioactive: | Spontaneous transformation of one nuclide into another, accompanied by emissions of radiation (particulate and gamma or x-rays). |
| Deep Dose Equivalent (DDE): | The whole body gamma plus neutron dose. This term is taken to be equal to the external dose equivalent and, if the exposure is uniform, to the effective dose equivalent. |
| Dose Equivalent (DE): | Quantity expressing effective absorbed dose. Each type of radiation affects the body differently. A modifying or normalizing factor is applied to gamma, beta, alpha or neutron dose. |
| Dose rate: | Radiation dose delivered per unit time, for example, milliRem per hour. |
| Exposure: | Measure of the ionization produced in air by "x"- or gamma radiation. The special unit of exposure is the roentgen. |
| Gamma radiation: | High energy, short wavelength electromagnetic radiation. Gamma rays are more energetic than x-rays. |
| Genetic effects: | Radiation effects that can be transferred from parent to offspring; any radiation-induced changes in the genetic material of sex cells. |
| Iodine Spiking Phenomena: | Iodine spiking may occur after a rapid drop in reactor power where production of iodine reaches a peak then rapidly decays away. With undamaged fuel, the iodine fission products are contained within the ceramic fuel pellet or fuel cladding and do not pose a hazard. |

GLOSSARY OF RADIOLOGICAL TERMS
(Continued)

| | |
|---|---|
| Linear hypothesis: | Assumption that a dose-effect curve derived from data in the high dose and high dose-rate ranges may be extrapolated through the low dose and low dose-rate range to zero, implying that, theoretically, any amount of radiation will cause some damage. |
| Man-rem: | Product of the average individual dose in a population times the number of individuals in the population. |
| Median lethal dose: | Dose of radiation required to kill, within a specified period, 50% of the individuals in a large population; called LD50. |
| Protective action guide (PAG): | Absorbed dose of ionizing radiation to individuals in the general population which would warrant protective action. |
| Rad: | Unit of absorbed dose in any medium. |
| Radiation protection guide: | Officially determined doses that should not be exceeded without careful consideration of reasons for doing so. |
| Radio-sensitivity: | Relative sensitivity of cells, tissues, organs, organisms, or any living substance to the injurious effects of radiation. |
| Relative Biological Effectiveness (RBE): | A factor used to compare biological effectiveness of different types of ionizing radiation. |
| REM: | Unit of dose equivalent. The dose equivalent in rem is numerically equal to the absorbed dose in rad multiplied by the quality factor, distribution factor, and other necessary modifying factors. |
| Roentgen (R): | Unit of exposure to ionization radiation. |
| Somatic effects: | Effects of radiation limited to the exposed individual, as distinguished from genetic effects. |
| Total Effective Dose Equivalent (TEDE): | The sum of the Deep Dose Equivalent (DDE) and the Committed Effective Dose Equivalent (CEDE) |
| Threshold hypothesis | Assumption that no radiation injury occurs below a specified dose level. |