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HAZARDS ANALYSIS FOR THE GENERAL ATOMICS HOT CELL FACILITY

PREPARED FOR

GA HOT CELL D&D PROJECT
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LIST OF ACRONYMS

AIChE	American Institute of Chemical Engineers
ALARA	As Low As Reasonably Achievable
ANSI	American National Standards Institute
CEDE	Committed Effective Dose Equivalent
CFR	Code of Federal Regulations
D&D	Decontamination and Decommissioning
DOE	Department of Energy
DOE/OAK	Department of Energy/Oakland Operations Office
EPA	Environmental Protection Agency
ERO	Emergency Response Organization
ERT	Emergency Response Team
GA	General Atomics
H&S	Health and Safety
HCF	Hot Cell Facility
HEPA	High Efficiency Particle Air filter
HTGR	High Temperature Gas-Cooled Reactor
HWA	Hazardous Work Authorization
HP	Health Physics
IFS/SNM	Irradiated Fuel Specimen/Special Nuclear Material
NIOSH	National Institute Occupational Safety and Health
MIL-STD	Military Standard
MSDS	Material Safety Data Sheet
MSHA	Mine Safety and Health Administration
NRC	Nuclear Regulatory Commission
OES	Office of Emergency Services
OSHA	Occupational Safety and Health Administration
PEL	Permissible Exposure Limits
PHA	Preliminary Hazards Analysis
PPE	Personal Protective Equipment
R&D	Research & Development
RERTR	Reduced Enrichment Research Test Reactor
RWP	Radioactive Work Procedure
QA	Quality Assurance
SARA	Superfund Amendment and Reauthorization Act
SR	Scientific Research
UCSD	University of California at San Diego
WA	Work Authorization

1. EXECUTIVE SUMMARY AND CONCLUSIONS

A Hazards Analysis has been prepared for the Hot Cell Facility (HCF) at General Atomics in response to guidance from the US Department of Energy (DOE) per Ref. 1-1 and attendant standards. The purpose of the Hazards Analysis is to establish a hazard classification for the HCF and to identify approximate levels of risk to workers and the public due to future activities involving decontamination and decommissioning (D&D) of the HCF. Also, the safety importance of design controls and administrative procedures during D&D is evaluated.

HCF operations considered in this Hazards Analysis include characterization of the site by HCF workers; packaging of contaminated debris, parts and equipment; removal of the irradiated fuel from the wells in the HCF and placing it into interim storage casks; movement of the fuel to another building at GA for temporary storage; possible later transfer of the fuel from the interim storage cask to the shipping cask; decontamination of building/structure surfaces; and removal of contaminated parts, equipment and waste generated by decontamination operations.

Methods of analysis include a Preliminary Hazards Analysis to identify potential accident situations, logic diagrams to develop and group accident scenarios, application of generic accident statistics to the site specific conditions and operations to estimate the likelihood of accident scenarios, consequence analysis, and use of a risk matrix diagram to illustrate the approximate levels of risk.

Two key potential accident scenarios were identified in the Hazards Analysis. Scenario A is a release of radioactivity or hazardous waste. Scenario B is a release of external radiation. Calculated probabilities and consequences of the scenarios were found to correspond to the acceptable risk portion of the risk matrix diagram, namely extremely low risk rating for Scenarios A and B. No additional Technical Safety Requirements or operational restrictions were considered to be necessary.

Estimates were made of the total maximum radioactivity inventory in the HCF. This inventory was compared, isotope by isotope, with minimum thresholds for Hazard Category 2 and 3 facilities given in Ref. 1-2. It was found that the radioactive inventory corresponded to a Hazard Category 3 facility with a wide margin below Category 2 levels. Hazardous materials have been identified and the majority removed. An unknown amount may remain, associated with the structure itself; therefore, inventories of (non-radioactive) hazardous materials have not been finally established. However, there is a lack of any highly hazardous materials as defined by OSHA in 29 CFR 1910.119 and extremely hazardous substances as defined in 40 CFR 355. Key hazardous materials (as defined in 40 CFR 302.4) appear to be asbestos and lead. The bulk of the asbestos is believed to be in non-friable form and procedures will be implemented to preclude airborne dust. No accident was identified that could impact persons off-site, either for radioactive or for hazardous material exposure. Therefore, the HCF is concluded to be a Hazard Category 3 facility.

2. INTRODUCTION AND DOE STANDARDS/REQUIREMENTS

The purpose of this section is, first, to present a brief background discussion of the Hot Cell Facility (HCF) and the operations pertaining to this Hazards Analysis. Second, applicable statutes, DOE Orders and Standards, Management Directives and other guidance relating to preparation of this Hazards Analysis are identified and interpreted with regard to requirements.

2.1 Background

In support of DOE and privately funded nuclear research and development (R&D), General Atomics (GA) has maintained a fully operational HCF at its headquarters in San Diego, California for over 30 years. The HCF is located in Building 23 at the GA main site on Torrey Pines Mesa (see Fig. 2-1 for regional location map). The GA site and surrounding area are shown in Fig. 2-2. Fig. 2-3 shows the location of the HCF within the GA site. A layout of the HCF is depicted in Fig. 2-4. A photograph of the operating gallery inside Building 23 is shown in Fig. 2-5.

Currently, the HCF is operational but maintained in a "safe shutdown" condition. Planning is underway supporting future decommissioning and decontamination (D&D) activities. Site characterization and contaminated fuel and waste packaging activities are beginning. Movement of irradiated fuel out of the HCF to another storage location at GA prior to transport off-site for disposal will be performed before decontamination activities begin. D&D activities will include removal of contamination from building surfaces, removal of equipment and debris, packaging and shipment of low-level radioactive and mixed wastes to the DOE Hanford site, restoration of the building, and possible remediation of any contaminated soil. If it is determined that the building or the underlying soil cannot be decontaminated sufficiently or cost effectively to allow release of the building to unrestricted use, then the building would be dismantled.

This scope of this Hazards Analysis addresses the above activities and specifically includes:

1. Site characterization
2. Fuel and waste packaging and removal
3. Packing (into interim storage casks) and movement of irradiated fuel from the HCF to another building at GA
4. If needed, transfer irradiated fuel from interim storage cask to shipping cask for transport off-site.
5. Decontamination of surfaces
6. Remediation of any contaminated soil found
7. Dismantling building structures, if necessary.

2.2 Applicable Standards/Requirements

This Hazards Analysis uses methods and formats recommended in DOE Orders, Standards, Safety Guides, and Management Directives. The HCF is a private facility supporting DOE and private programs at the GA site regulated by NRC and State of California license requirements. However, the DOE recommended methods are similar to methods used for private industry, for example, for acutely hazardous materials in California's Risk Management and Prevention Programs (Ref. 2-1), OSHA's Process

Safety Management described in 29 CFR 1910.119, and EPA's Hazards Analysis methods for SARA Title III (Ref. 2-2).

Top level DOE documents that provide guidance on the methods, content and format of Hazards Analyses, including the use of the graded approach, are Ref. 2-3 and 2-4.

The graded approach requires that the level of analysis and documentation must be commensurate with:

a. Facility hazard magnitude or severity

b. Facility complexity

c. Facility life-cycle stage (e.g., beginning or ending operation).

Application of the guidance to the HCF is interpreted to require a relatively less detailed level of analysis, such as a Preliminary Hazards Analysis (Ref. 2-5). Content requirements include a description and inventory of all hazardous and radioactive materials, identification of energy sources or accidental release causes, bounding analysis of probabilities and consequences of potential releases, and hazard classification for the overall facility.

Details of the requirements are specified in DOE Standards (STDs) and Safety Guides (SGs) Ref. 2-5, 2-6, 2-7 and 1-2.

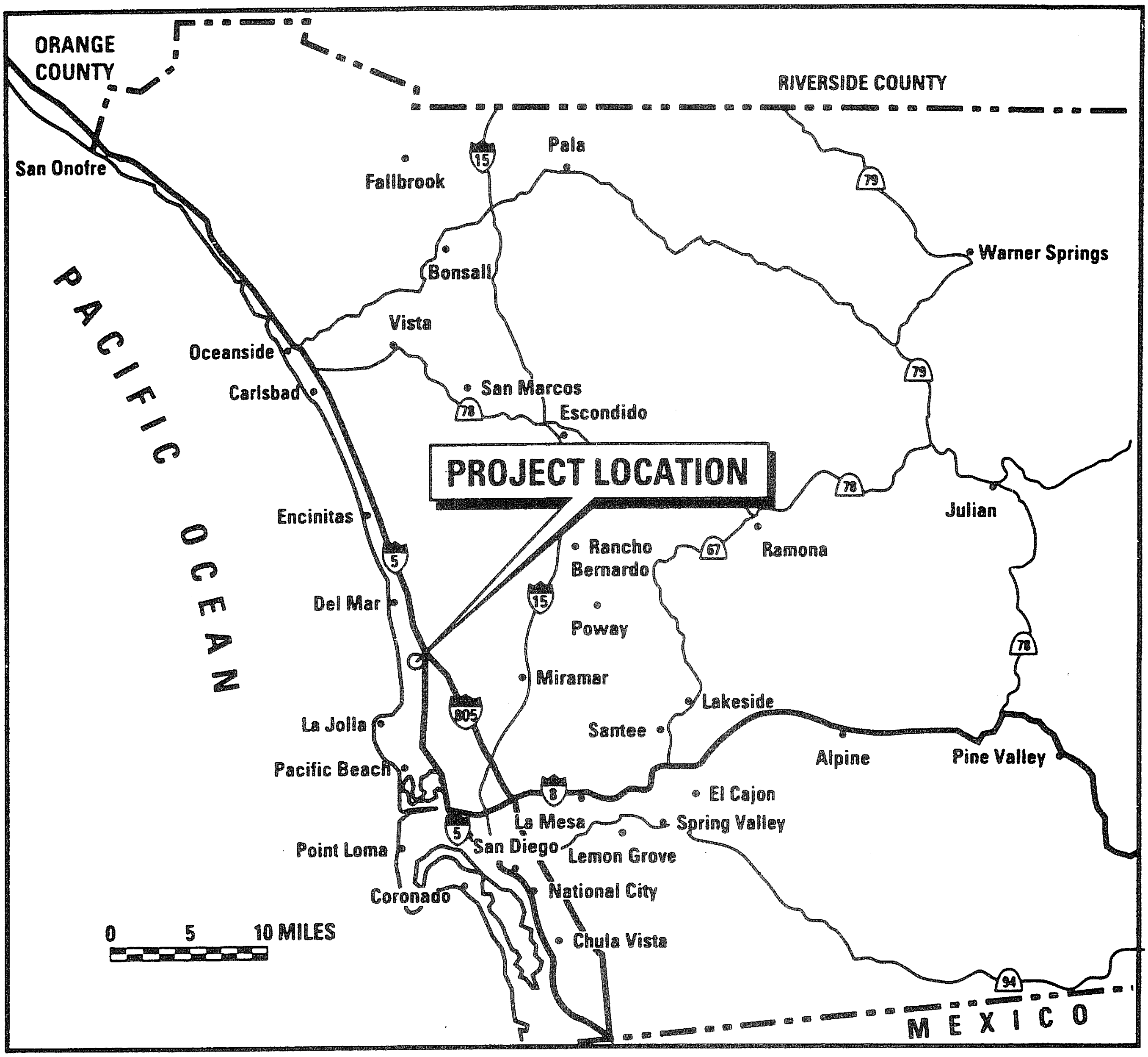

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Fig. 2-1 Regional Location

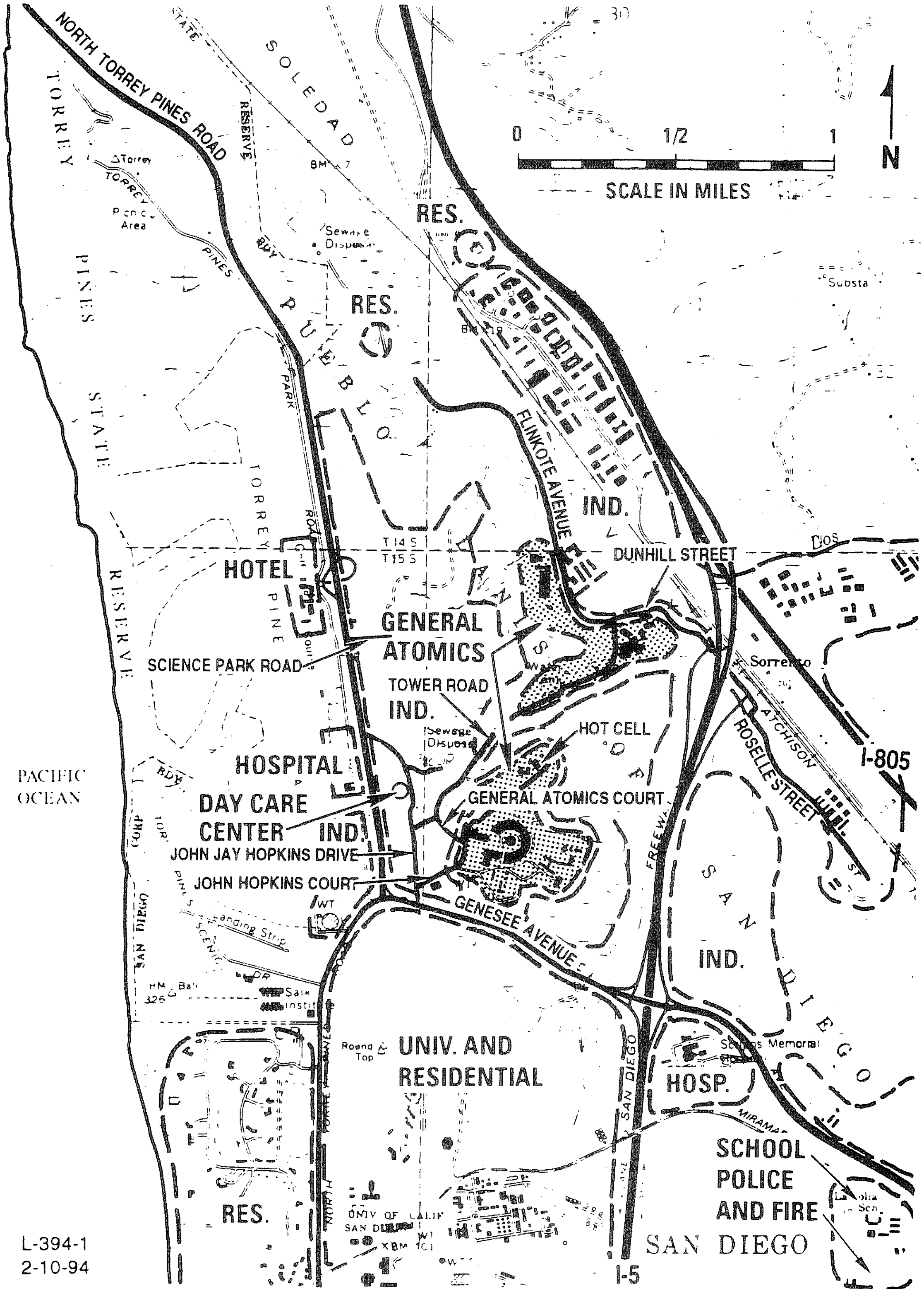

Fig. 2-2 GA Site and Surrounding Areas

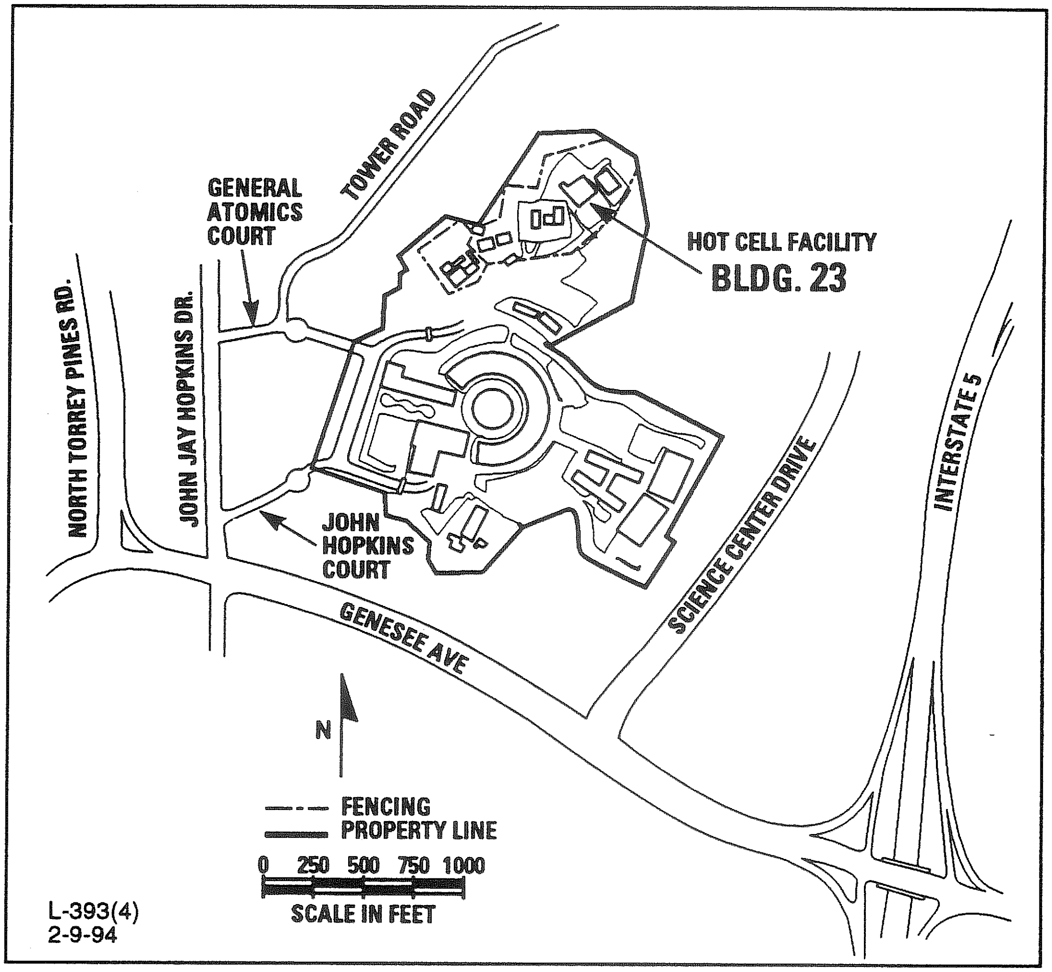

Fig. 2-3 Hot Cell Building Location on the GA Site

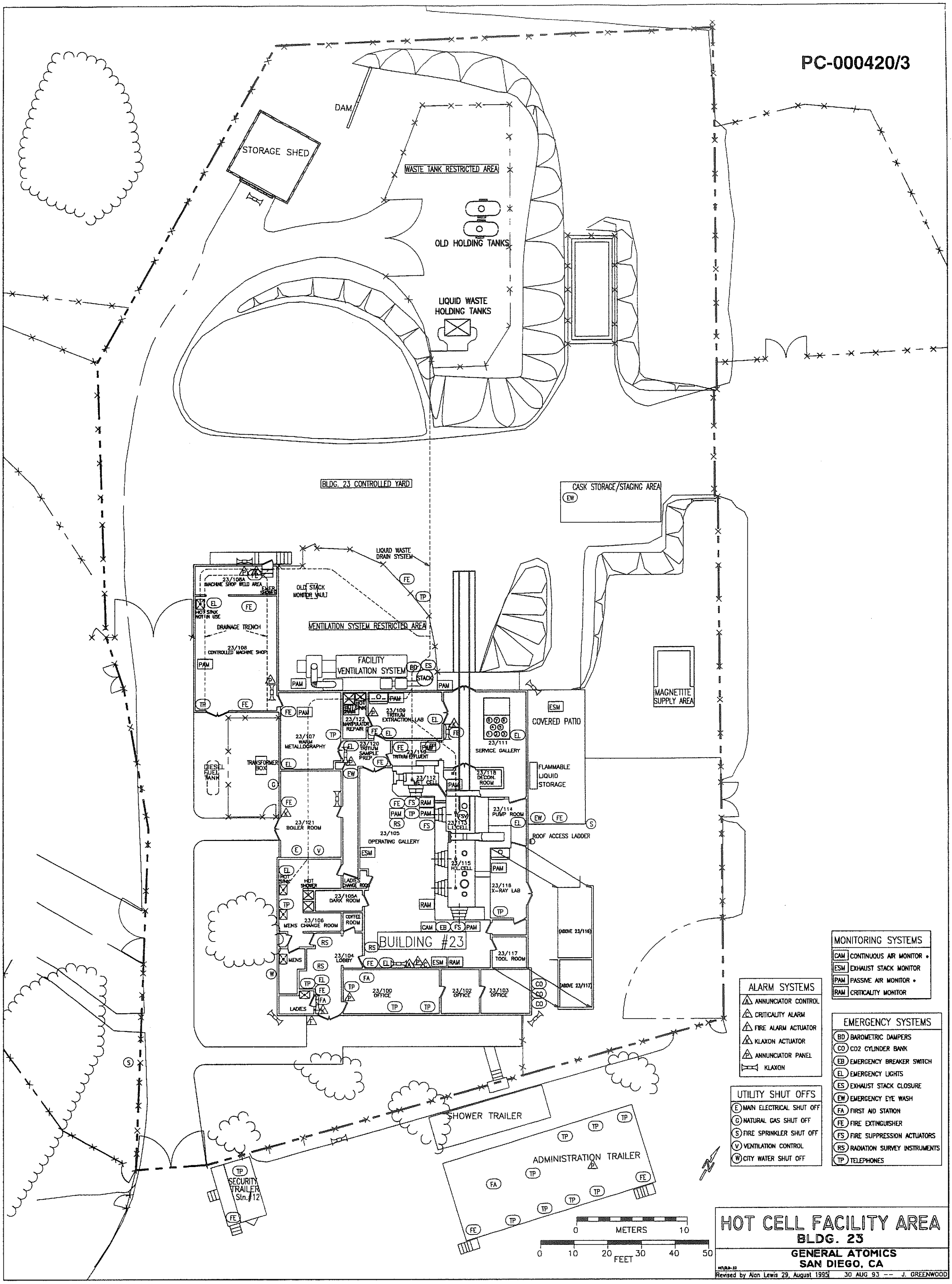

Fig. 2-4 Hot Cell Facility Layout Drawing

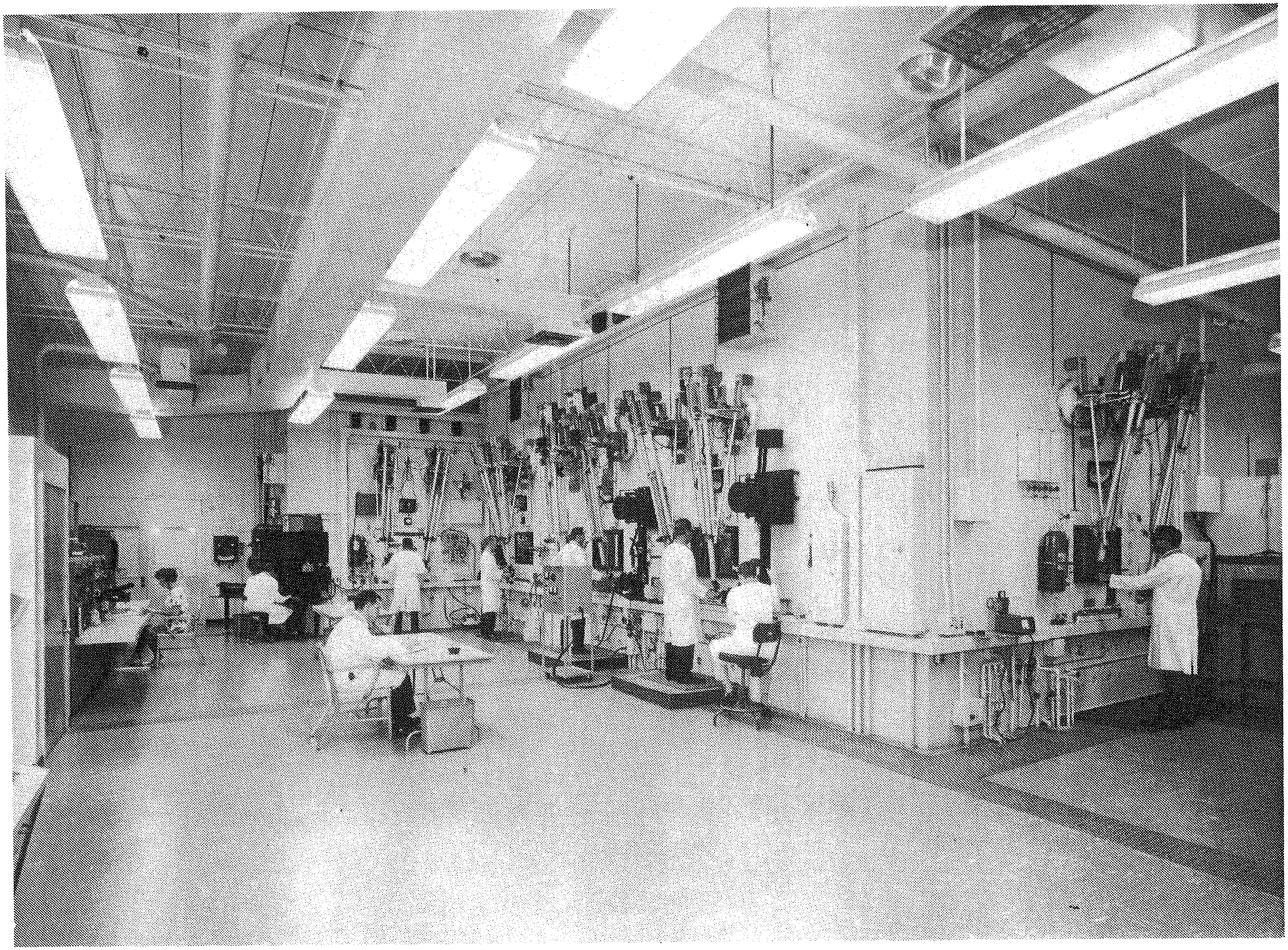

Fig. 2-5 Interior View of the Hot Cell Facility

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3. DESCRIPTION OF SITE AND FACILITY

This section provides information on the site setting and facility characteristics which could affect the probability of accidents or the consequences. Site data enabling understanding of any off-site consequences are emphasized. Facility data focus on design characteristics and features, building construction, and engineered safety features.

3.1 Site Location

General Atomics occupies two approximately 60-acre (24-hectare) sites about 13 miles (21 km) north of downtown San Diego, California, just southwest of the convergence of Interstates 5 and 805, and approximately one mile east of the Pacific Ocean. The two locations are referred to as the Main Site and the Sorrento Valley site, or collectively as the GA site. The location of the site in relation to San Diego County is shown in Fig. 2-1. The site is located in the center of the Torrey Pines Mesa Science Center, an industrial park.

The topography of the area is typical of coastal San Diego County, with bluffs and mesas interspersed with cliffs and ravines. The topography of GA's site is characterized by steeply sloping canyons and relatively level mesas.

There are approximately 43 buildings on the GA compound with ample open spaces. Approximately 1400 employees have offices at the GA site. The nearest office of a GA nonradiological worker is 720 ft. (220 m) from the Hot Cell facility. The nearest property boundary is about 330 ft. (100 m) from the Hot Cell facility.

Access to the site is through two entrances; from General Atomics court and from John Jay Hopkins Court. Traffic into the site is controlled by a guard posted at a guard shack and by personnel at an office reception area. Off hour access is through a keycard gate at each entrance. The nearest entrance to the site is 1500 ft. (457 m) from the Hot Cell facility. The Hot Cell facility has an additional fenced barrier with controlled access, and is manned by security personnel to limit access to authorized D & D project staff.

The site is currently zoned SR (Scientific Research). The University Community Plan designates open space and scientific research land uses for the site. Land uses surrounding the GA site include scientific research and development parks to the north and to the east across I-5, undeveloped land associated with Torrey Pines State Park, research and development parks and a hospital to the west and the University of California at San Diego (UCSD) to the south. Surrounding land uses are shown graphically on Fig. 2-2.

3.2 Description of the Hot Cell Facility

The HCF occupies Building 23 and the outdoor service yard on GA's Main Site, as shown on Fig. 2-4. The interior of the Building 23 has approximately 7,400 ft.^{2} (690 m^2) of floor space consisting of offices, three hot cells, an operating gallery (Fig. 2-5) and auxiliary areas.

The HCF has been used for numerous examinations of structural materials and instrumentation. Operations in the HCF building have been performed subject to NRC Special Nuclear Material License No. SNM-696 (Ref. 3-1) and the California Radioactive Materials License No. 0145-80 (Ref. 3-2). The HCF has been routinely and periodically reviewed and inspected by these agencies.

The focal points within the facility are the three hot cells. These cells and their associated equipment have been used for examining irradiated capsules and small fuel elements, mechanical testing, metallographic preparation and examination, and photography. The walls of the three hot cells are constructed of high density magnetite concrete (225 lb/ft.^{3} or 3600 kg/m^3) to provide shielding.

Building 23 is surrounded by a 46,740 ft.^{2} (4,340 m^2) fenced service yard. The service yard includes several concrete pads used for staging heavy equipment and making material transfer into and out of the HCF building. The remaining area is comprised of asphalt, soil, scattered small rocks and disturbed vegetation. There is a small 400 ft.^{2} (37 m^2) metal ancillary building and two above ground waste storage tanks. Other equipment includes the ventilation filtration system and stack, and temporary storage areas. The yard is enclosed by a 7 ft. (2.13 m) high galvanized chain link fence. Access to the yard is controlled by physical barriers (fences and locked gates) and security personnel.

The HCF is presently in a fully-operational, yet safe shut-down condition. All required utility services, such as electrical service, water supply and natural gas supply are active. Building air ventilation and HEPA-filtered cell exhaust systems, instrument air supply compressors, and license-required radiological monitoring instrumentation systems are in operation. All manually actuated and automated fire alarm/suppression systems are operational. All installed facility security and radiological alarm systems are operating normally. All remote handling mechanisms and auxiliary facility support equipment are operational, or are available for activation and use. The HCF presently houses a significant quantity of materials and equipment, normally associated with the work scope requirements of an operational HCF, which are radioactively-contaminated and/or contain minimal amounts of hazardous materials.

3.3 Traffic and Utilities

The main roadways in the vicinity of the GA site include Genesee Avenue beyond the southern boundary, John Jay Hopkins Drive beyond a portion of the western boundary, North Torrey Pines Road further to the west, and Interstate 5 to the east. Genesee Avenue is a four-lane primary arterial beyond the frontage of the property.

The GA site is generally accessed from the Interstate 5 freeway, exiting on Genesee Avenue and traveling west, turning north on John Jay Hopkins Drive and east on General Atomics Court. The site can be entered through two entrances shown on the map (Fig. 2-3) from General Atomics Court and from John Hopkins Court. Traffic into the site is controlled by a guard posted at a guard station and by personnel at an office reception area. Off hour access is through a keycard gate at the south entrance. The nearest entrance to the GA compound is 1500 ft. (457 m) from the HCF.

Utilities at the HCF include electrical power supply with 440V, 220V, and 110V fuses. Natural gas is used to fuel a boiler/compressor unit which provides space heating, air conditioning and hot water. The water supply is standard city water.

3.4 Demography

The present population within a one kilometer (0.62 miles) radius of the HCF is primarily of an industrial makeup, with an estimated daytime total of up to 8000 (about 1500 are GA employees, including but not limited to HCF personnel). The immediate vicinity of the Flintkote Avenue facilities is zoned for industrial activity. Interstate Highway 5 is located about 0.8 km (1/2 mile) to the east of the site.

Through the use of the 1990 census tract data (Ref. 3-3), aerial photographs, telephone surveys, reconnaissance, and the EIR (Ref. 3-4), the total daytime population within a 5 km (3.1 mile) radius has been estimated to be near 146,500. The locations and populations of nearby communities and businesses are listed in Table 3-1.

Due to terrain, zoning and current land use, most future residential development will occur beyond a 3 km (1.9 mile) radius from the site. Appreciable residential development is presently under way in the Del Mar-Mira Mesa Subregion 8 km (5 miles) to the north and north east of the HCF.

Immediately surrounding the GA site are open areas and other industrial buildings. In the area further from the HCF there are general population receptors. The potentially sensitive human populations nearby are in–patients at nearby acute care hospitals and children at a day care center along John Hopkin's Drive. There are also two wildlife reserves, Torrey Pines State Reserve and Los Penasquitos Lagoon (Ref. 3-4).

TABLE 3-1
Distance/Population of Surrounding Communities

Community	Distance & Direction	Population
Census Subregion		
University	Immediate Vicinity	42,725
Kearny Mesa	12.8 km (6 miles) SSW	137,165
Coastal (La Jolla)	8 km (5 miles) WSW	74,167
Del Mar-Mira Mesa	8 km (5 miles) NNE	97,157
Miramar	8 km (5 miles) East	3,089
Nearby Businesses		
Main Site (GA)	0.0 - 1.0 km	1500
John J. Hopkins Dr. Businesses	0.5 - 1.0km	2500
Sorrento Valley Site (GA)	0.75 - 1.5 km	200
Day Care Center	0.85 km	200
Torrey Pines Rd. Businesses	1.0 - 2.0 km	1250
Green Hospital	1.25 km	2650
Sorrento Valley Businesses	1.5 - 2.5 km	6500
Campus Drive Businesses	1.5 - 2.5 km	3,000
UCSD	1.5 - 3.5 km	17,000
Scripp's Memorial Hospital	2.0 km	4,000
Sorrento Valley Businesses	2.5 - 5.0 km	3,000
Thornton Hospital	2.75 km	4,000
Veteran's Admin. Hospital	3.0 km	4,000

3.5 Meteorology and Climate

The Torrey Pines Mesa and Sorrento Valley, as with most of San Diego County's coastal areas, has a semi-arid Mediterranean climate characterized by hot, dry summers and mild winters. The mean annual temperature in the project vicinity is 61°F (33.8°C), with summer high temperatures in the low-90s (50°C) and winter lows in the mid-30s (16°C) (Ref. 3-4).

The dominating meteorological feature affecting the region is the Pacific High Pressure Zone, a semipermanent high pressure cell located over the Pacific Ocean. This high pressure cell maintains clear skies for much of the year, drives the prevailing westerly to northwesterly winds, and creates two types of temperature inversions (reversals of the normal decrease of temperature with height) that act to degrade local air quality. When a buoyant parcel of polluted air rises, it cools by expansion. If the air around the parcel is warm, as in an inversion, the parcel sinks back down toward its source and is effectively prohibited from dispersing. During the summer, a marine/subsidence inversion is formed when the warm, sinking air mass in the Pacific High Pressure Zone is undercut by a shallow layer of cool marine air flowing onshore. This inversion forms over the entire coastal plain and allows for mixing below the inversion base at 1,100 - 1,500 ft. (457 m), but not any higher. During the winter offshore flow regime, cold air pools in low areas and air in contact with the cold ground cools while the air aloft remains warm. A nightly shallow inversion layer [at about 800 ft. (244 m)] forms between the two air masses which can trap pollutants.

The prevailing day time wind direction is westerly, although easterly winds are almost as common during the winter months. During the day, the westerly winds developing from the Pacific high-pressure system are reinforced by the sea-land breeze caused by the Pacific Ocean resulting in stronger average wind velocities [6 to 9 mph (10 to 15 km/h)] than from the easterly land breeze [1 to 7 mph (1.6 to 11.6 km/h)]. The land breezes are most common during stable conditions and dominate the flow toward the ocean during the night and early morning hours. The airflow in either direction is channeled effectively by topographical features of the area. Strong winds are infrequent; the strongest recorded was 51 mph (82 km/h) from the southeast in 1944. Thus the occurrence of severe winds is unlikely (Ref. 3-5).

Data from an on-site meteorological system were used to provide atmospheric stability and wind frequency results. The on-site annual wind data are in good agreement with the wind rose data from the Miramar Naval Air Station (Fig. 3-1).

In the summer, when the high pressure system is at its most northerly extent, eastward-traveling storm and pressure centers are blocked, resulting in little rain due to frontal activity. The migration of this system to its most southerly extent in the winter allows the transient storm and pressure centers to pass through the area, resulting in winter rains in southern California.

The predominant pattern is sometimes interrupted by so-called Santa Ana conditions, when high pressure over the Nevada-Utah area overcomes the prevailing westerlies, sending strong, steady, hot, dry winds east over the mountains and out to sea. Strong Santa Anas tend to blow pollutants out over the ocean.

3.6 Off-Site Environment

Land uses surrounding the GA site include:

- scientific research and development parks to the north and to the east across Interstate 5 (I-5);
- undeveloped land associated with Torrey Pines State Park;
- research and development parks and a hospital to the west; and
- the University of California at San Diego to the south.

No significant fresh water recreation areas exist within the local hydrological area, nor is there significant agricultural activity. Los Penasquitos Creek flows into part of the Torrey Pines State Park called the Sorrento Slough. This area is approximately one mile (1.6 km) away from the GA site. The slough is a game refuge and an area of tidal mud flats. All plants and animals in the area are protected. A rare tree species, the Torrey Pine, grows naturally on Torrey Pines Mesa, but not on or next to the site.

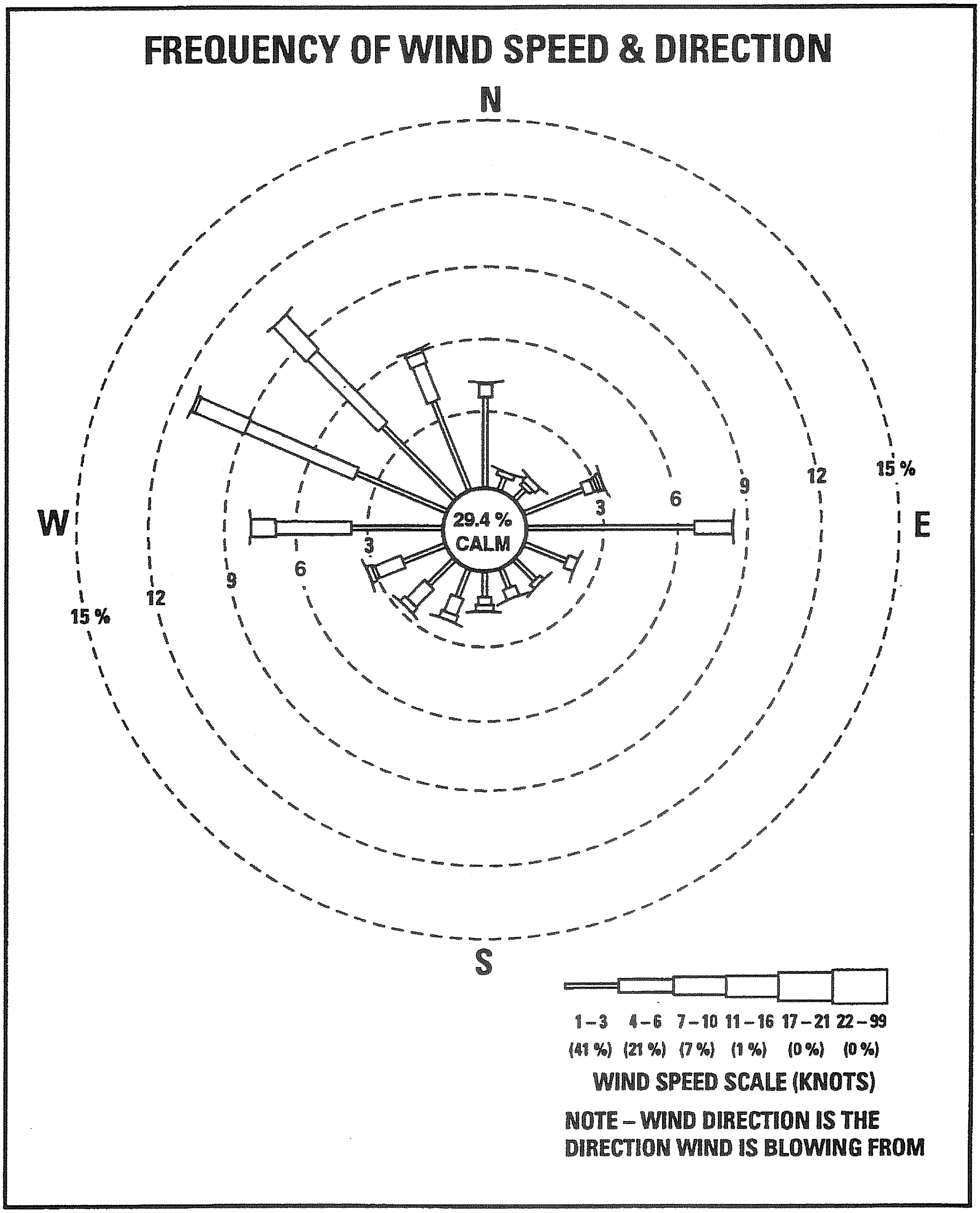


Fig. 3-1 Wind Rose for Miramar Naval Air Station

3.7 Underlying Soil

The HCF is located on the top of the Torrey Pines Mesa at an elevation of approximately 105 meters (m) (340 feet [ft.]) above sea level. The HCF has been built on materials that have been mapped as artificial fill in Bulletin 200A, "Geology of the San Diego Metropolitan Area, California" (Ref. 3-6). Areas immediately adjacent to the artificial fill are mapped as Ardath Shale, a member of the La Jolla Group of Eocene Deposits, that "is predominantly weakly fissile [not in the nuclear sense, but in the geologic sense, i.e., easily split along closely spaced planes], olive-gray shale" (Ref. 3-6). Ref. 3-6 presents a cross section on the Del Mar quadrangle showing subsurface formations approximately 230 m (750 ft.) northeast of the HCF. Based on this cross section, the Ardath Shale deposit in the HCF area is approximately 90 m (300 ft.) thick and is underlain by approximately 150 m (500 ft.) of Torrey Sandstone over approximately 76 m (250 ft.) of Delmar Formation.

Three 9.1 m (30 ft.) deep bore holes were completed in conjunction with the design of the HCF in 1958. Ground surface elevation at the boring locations ranged from 103 to 104 m (339.0 to 340 ft.) above mean sea level. The report indicated that the soils in the upper 1.5 to 2.4 m (5.0 to 8.0 ft.) of the three borings (A, B, and C) were "a sand, gravel and cobble mixture." The test hole logs described the upper soil as "brownish gray sand, gravel and cobbles" that were "very tightly bedded together."

3.8 Surface and Subsurface Hydrology

The HCF is located within the Southwestern portion of the Soledad Basin. The Soledad Basin makes up the northwestern part of the Los Penasquitos hydrographic subunit (Ref. 3-7) and has not been developed for water supply purposes. No groundwater wells are present at or immediately adjacent to the HCF. Ground water beneath the HCF is believed to be approximately 300 feet below ground surface. Test borings on the GA site ranging from approximately 6 to 30 ft. (1.8 - 9.1 m) did not encounter groundwater (Ref. 3-8). There is currently no reason to suspect that any groundwater contamination exists under the HCF. However, further studies may be conducted if warranted during site characterization and D&D activities.

Based on ground surface elevations and surface drainage patterns, surface run-off from the HCF Controlled Yard Area currently flows primarily northwesterly, across paved and unpaved surfaces in the service yard. Run-off that accumulates in the service yard are retained at the HCF by a dam and tested prior to release into an existing drainage feature that directs surface run-off eastward, into the Soledad Valley. Surface run-off from the eastern corner of the HCF currently flows eastward, across paved surfaces, into the stormwater drainage system.

The HCF lies within the Los Penasquitos Creek drainage basin. Drainage runs through the Soledad Valley into Los Penasquitos Creek, which flows to the northwest and empties into the Pacific Ocean. Detention basins and silt collection structures have been constructed for the development of the Torrey Pines Science Park that surrounds and includes the GA site to ensure that adverse downstream impacts will not occur from stormwater run-off.

Surface water downstream from the site cannot be used domestically because of its intermittent flow and dirty condition during periods following rainstorms or heavy run-offs. No significant freshwater recreation areas exist within the local vicinity. Agriculture is not prevalent because soils are not well suited for agriculture, precipitation is limited, and groundwater quality (primarily in Penasquitos Valley) is considered marginal or inferior for irrigation. Water use in the vicinity of the site is limited by the ephemeral nature of many streams and the high suspended solids content of flow during the winter.

Floods do not represent a danger to the site as it is situated approximately 340 ft. (103 m) above the valley floor on a mesa. Drainage downstream from the site to the Pacific Ocean is unrestricted. The site is not located within a 100-Year Flood Zone.

Wastewater collection services are supplied to the GA site by the San Diego Department of Public Utilities. Wastewater from the site is discharged through the City's sewer system to the Point Loma treatment plant. Any wastewater released to the city treatment system must meet the requirements of the San Diego Industrial Waste Discharge Permit.

3.9 Seismicity

The HCF is approximately 130 miles (208 km) west of the San Andreas Fault. A recent study (Ref. 3-9) has estimated the probabilities of large earthquakes occurring in California on the major strands of the San Andreas fault system. In addition to the principal traces of the San Andreas fault, earthquakes occurring on the other major faults of the system (San Jacinto, Imperial, etc.) were considered. The study estimated that the probability of a large (greater than 7) earthquake occurring in the next 30 years in Southern California (along the Southern San Andreas, Imperial, or San Jacinto faults) is 0.5 or greater. However, due to the intervening distance, an earthquake of this magnitude on these fault lines is not expected to significantly impact the GA site.

Current information (Appendix A) indicates the Rose Canyon, Coronado Bank, San Diego Trough, La Nacion, and Elsinore fault zones are capable of generating strong ground motion in the San Diego area. A seismic hazard evaluation of the San Diego Metropolitan Region (Ref. 3-10) identified maximum magnitudes on these faults as 7.0, 7.5, 7.5, 6.3, and 7.5 respectively. Although distant, the Newport-Inglewood, San Jacinto and Southern San Andreas faults increase the total seismic risk to San Diego. They are historically active faults and are considered capable of generating earthquakes of maximum magnitude 7.3, 7.5 and 8.3, respectively. However, because of their greater distances from the site, they are unlikely to produce the strongest ground motions. The activity of faults in Mexico is not yet understood. It is thought that the distance to the San Miguel/Vallecitos Fault Zone is too great to produce severe ground motions in the area of the GA site.

The presence of three small, local faults was confirmed by a field reconnaissance of the site (Ref. 3-11). An unnamed fault in the northern portion of the site trends east to west through Science Park lots 25, 26, 31, and 32. The Salk fault is mapped in the southern portion of the site and also trends east to west. A northerly trending fault is located in the southeastern area and crosses the Genesee Avenue canyon. All of these faults are mapped as being overlain by early Pleistocene formations which have not been displaced. Therefore, the faults on-site are not considered active.

Passing approximately 3 miles (5 km) west of the GA site, the Rose Canyon fault is the nearest active fault. Recent excavations (Ref. 3-12) showed definite evidence of Halocene (within the last 10,000 years) activity. It is clear from this that San Diego has experienced major earthquakes in the recent geologic past.

4. DESCRIPTION OF OPERATIONS

This section provides information on the way that the HCF manages operations of the site characterization, fuel movement and D&D activities. Section 4.1 describes the activities planned and Section 4.2 summarizes the administrative procedures and controls affecting the safety of the workers and the public.

4.1 Planned Activities

During the site characterization work, the following activities may be performed:

a. Facility walkdowns, comparisons with drawings, markup of sampling locations, direct reading instrument measurements, and identification of contaminated areas.

b. Radiological surveys, identify specific radionuclides and further quantifying contaminated areas. Surveys include taking smears/wipes, soil and concrete surface samples, tile/paint/dust/chip samples, sludge/drain samples, or roofing samples.

c. Hazardous materials surveys, identifying specific toxic, flammable, reactive or corrosive substances along with amounts present and chemical/physical form.

d. Core sampling, including 0.15 to 3 meters deep drillings in the floor, walls and ceiling along with scraping, cutting and grinding.

e. Evaluation of asbestos locations and friability characteristics.

f. Soil sampling and analysis, within the facility restricted area.

g. Soil remediation and verification surveys, if contaminated soil is indicated.

Equipment to be used during the site characterization phase includes tools (picks, chisels, hammers, drills, abrasers, grinders) and instruments (meters, sample containers, dosimeters).

Another important phase of activity involves packaging and removing contaminated loose parts, equipment and waste fuel. As summarized in Section 5.2, a significant fission product inventory has been estimated to be associated with the waste fuel (consisting of broken fuel particles, etc.). Pieces of equipment and parts will be boxed, while small debris, believed to contain the larger portion of the radioactivity inventory, will be placed in leak-tight drums and properly disposed of as radioactive or mixed waste. Hanford, Washington has been designated as the disposal site.

In the event that soil within the HCF restricted area is found (during site characterization) to be contaminated and in need of remediation, there may be some soil removed for disposal. In that case, the contaminated soil would be placed into drums or other containers and properly disposed of as radioactive, hazardous or mixed waste.

During the decontamination phase, surface contamination may be removed using one or more of the following methods: wiping, dry abrasive blasting with vacuum, scabbing/scarification, high pressure water, or ultra high pressure water jets. Ducting and piping will be sectioned (cut-up) or disassembled, wrapped, and removed to the decon area. Sinks, traps, and drain line piping will be sectioned and removed to the decon area.

Equipment to be used during the decontamination phase includes:

1. Ventilation system with HEPA filter

2. Abrasive removal devices (e.g., Blastrac, Vacu-blast or Flex-hone)
3. Scabbing devices (e.g., multi-point tungsten carbide bits on 7-bit piston heads)
4. High pressure water jets for washing and flushing
5. Ultra high pressure water lance to scarify concrete and to remove paint, oxidation and waxes.
6. Volume reduction equipment (shredder, compactor, baler)
7. Support equipment (electricity, compressed air, water supply, vacuums, drums, boxes and containers)
8. CO_2 pellet blaster

Controls during the decontamination phase include:

a. Containment tents
b. Glove bags
c. Surface fixatives (sheetings, wrappings, coatings)
d. Local ventilation, negative pressure and HEPA filtered.

If dismantling is required to render the facility suitable for unrestricted use, those operations would involve use of cranes, demolition equipment, heavy-duty lifting equipment, dozers and associated supporting equipment (engines, fuel, trucks). The structure would be taken apart slowly in pieces and the air and debris would be closely monitored for contamination.

The operations associated with moving the HTGR and RERTR irradiated fuel (IFS/SNM) out of the HCF to another building are illustrated in Fig. 4-1. The four cans containing IFS/SNM will be retrieved from the HCF below-ground storage wells. In the HCF high level cell, the 2 cans of HTGR fuel will be consolidated into a secondary enclosure, which will then be loaded into a BCL-4 Liner. The secondary enclosure and BCL-4 Liner are called a canister assembly. The two cans of RERTR fuel will be loaded into a second similar canister assembly. The two canister assemblies will be inserted into separate interim storage casks and will be transferred to Building 30, Room 118, which is located within GA's main site.

The transfer process between the HCF and Building 30/31 Complex, and interim storage in Room 30-118 will occur entirely within GA's main site (see Fig. 4-2) under GA's existing state and federal licenses. The interim storage casks were fully designed and fabricated to survive 10 CFR 71 accident scenarios.

In the event that the irradiated fuel is to be transferred from the interim storage cask to the off-site shipping cask in the HCF, the procedure would occur as depicted in Fig. 4-3. During the inter-cask transfer, most operations would be performed remotely. The canister assembly would be removed from the interim storage cask by utilizing the shielded transfer cask system and a crane. During this transfer, the fuel canister would be held by the portable hoist on the transfer cask system. A steel pin would be inserted to prevent the canister from falling in event of failure of the hoist hold. During movement, the canister would be relatively unshielded at the bottom of the transfer cask; scattering doses from the radiation shine to the concrete floor would not pose a significant hazard to the crane operator or others. The canister would be well shielded when placed in the shipping cask and the top latched on.

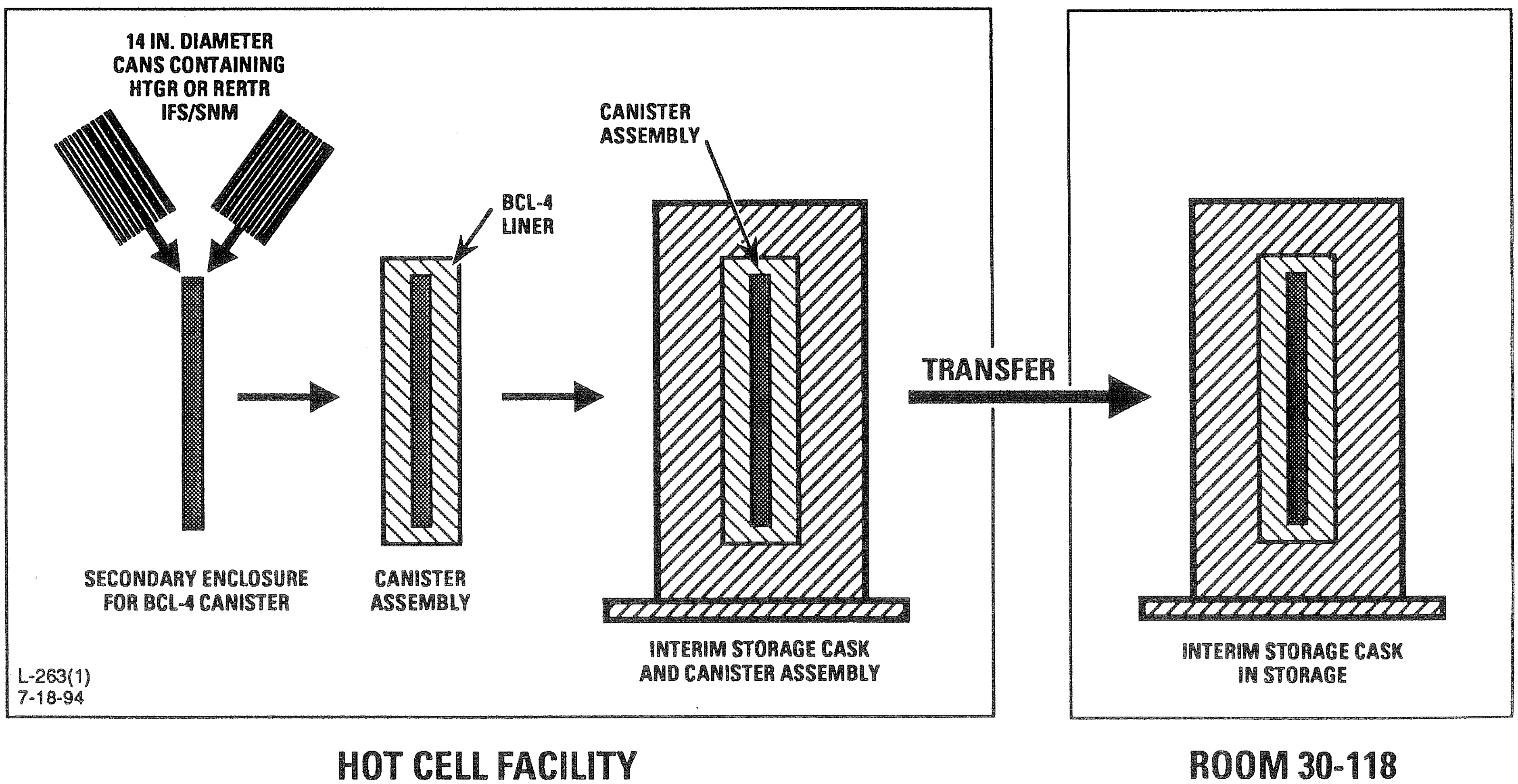


Fig. 4-1 IFS/SNM Retrieval, Packaging and Transfer from HCF to Room 30-118

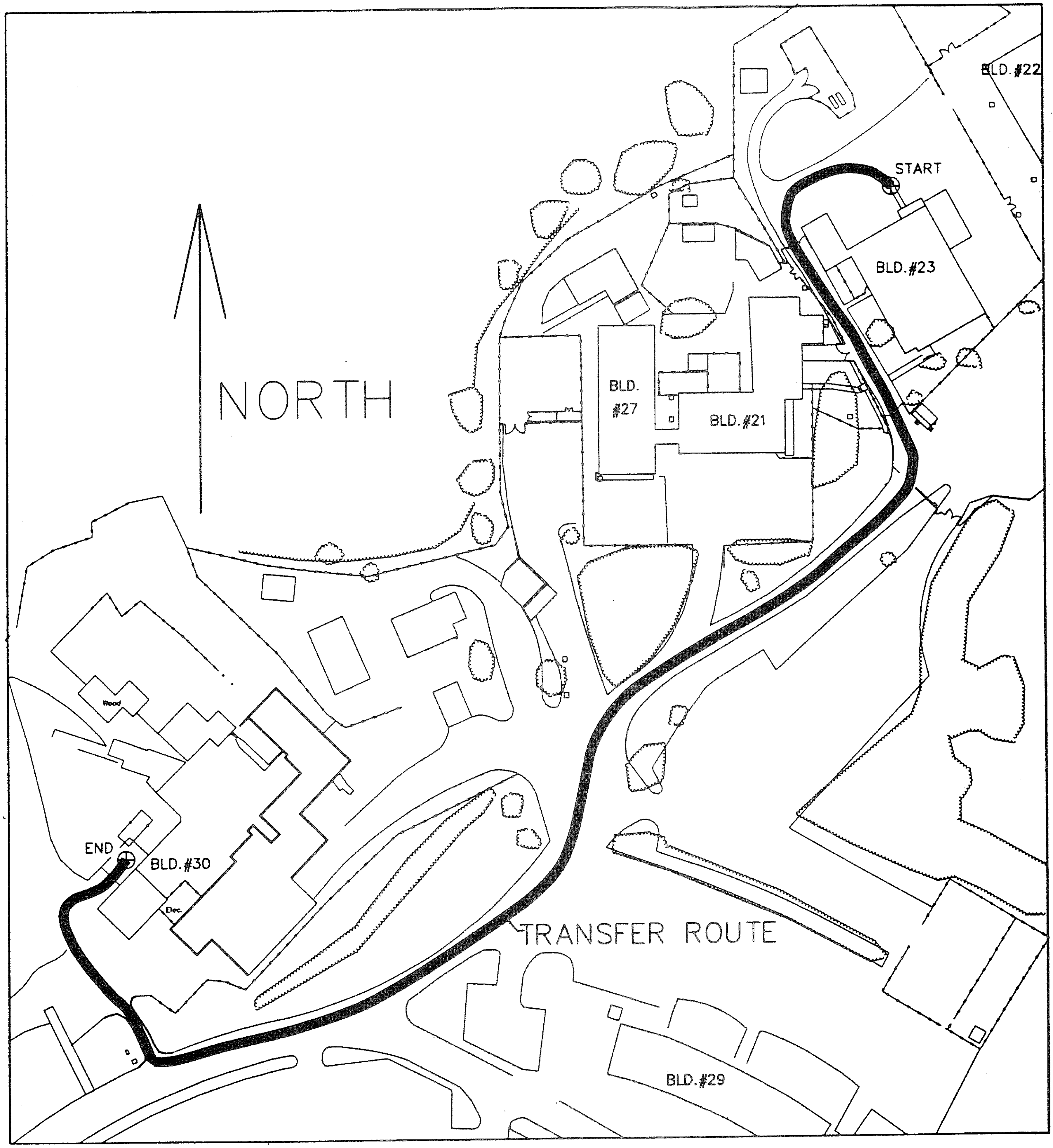
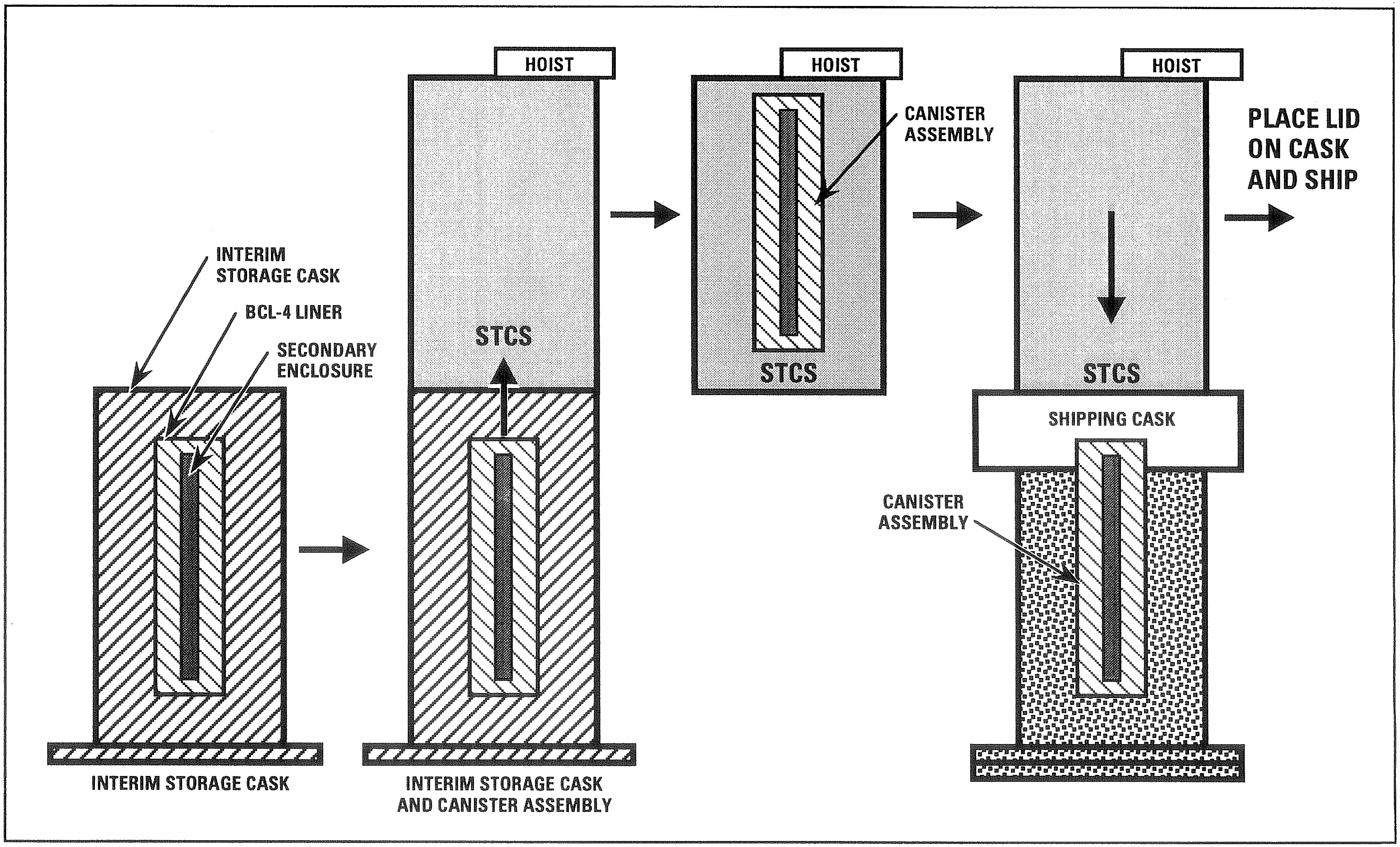


Fig. 4-2 Transfer Route from HCF (Building 23) to Room 30-118



Building 31-2

Fig. 4-3 IFS/SNM Transfer to Shipping Cask

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4.2 Administrative Procedures and Controls

4.2.1 Health and Safety Training

All personnel working at the HCF receive Health and Safety training in order to understand the potential risks involving personnel health and safety. The Health & Safety training implemented at General Atomics is to ensure compliance with the requirements of the NRC (10 CFR), the EPA (40 CFR), and both OSHA and CAL-OSHA (29 CFR and CCR Title 8). Workers, and regular visitors, are made familiar with plans, procedures, and operation of equipment to conduct themselves safely.

Training plans will be developed as required by the Hot Cell Facility Training Procedure, "Indoctrination and Training Procedure" HCD-1.3 (Ref. 4-1), for the project before physical work on the project commences. Copies of records of health and safety training received specifically for this project will be maintained by the QA manager of this project, or designated person.

4.2.2 Hazard Communication

The HCF has established a hazard communication training program in accordance with the GA Accident Prevention Program Manual (Ref. 4-2) the GA Radiological Safety Guide GA-417 (Ref. 4-3), GA Site and Project Health Physics procedures, and the Indoctrination and Training Procedure (Ref. 4-1). This program will promote awareness of chemical and/or radiological hazards and provide means to communicate those hazards to employees. The project health and safety manager or designated person will maintain the hazardous material inventory, material safety data sheets for on site hazardous materials, and provide all project personnel with information advising them of the potential for hazardous materials at the project location. A hazardous chemical inventory of such materials for this project will be available at the job site, and copies of the appropriate Material Safety Data Sheets (MSDS) will be available to site workers upon request. The MSDS form provides more detailed information about the chemical than a label.

A current hazardous chemical inventory is maintained by the site Project Material Disposition Manager which reflects the current audit of the work area. Any chemicals not previously located and identified or new chemicals received on the job site will be added to the inventory list. There is no intention of bringing any new hazardous chemicals into the Hot Cell Facility, if it can be avoided.

4.2.3 Waste Handling

4.2.3.1 Characterization

Characterization operations were considered moderate hazard to the personnel performing the hands-on tasks. Personnel assigned to those tasks were trained in the handling of both radioactive and hazardous materials. Those were considered to be moderate hazard tasks because personnel were handling uncharacterized substances. Due to the unknown factor, extra precautions were taken to ensure worker safety.

4.2.3.2 Waste Disposition

These tasks have an associated hazard to the personnel performing the hands-on waste disposition task. Personnel assigned to these tasks have been trained in the handling of both radioactive and hazardous materials. The handling of waste from the various sources is considered a moderate hazard task due to uncertainties in the levels of radioactivity exposure.

4.2.4 Safety Controls

The safety of the HCF is controlled by the GA Policy Manual and the GA Accident Prevention Manual. The specific tasks to be performed at the HCF are covered by specific procedures which incorporate the Engineering and Administrative safety controls for each specific task. All work at the HCF is performed under the control of Work Authorizations (WA). Radiation Safety is controlled by Radiation Work Permits (RWP), which define limits, controls, personal protective equipment, instrumentation, conditions expected, and instructions. Any hazardous work will be performed under the control of a Hazardous Work Authorization (HWA), or permits.

Safety oriented walkdowns are performed to examine the general facility, waste storage, personnel equipment, emergency equipment and emergency postings. Logged records of the inspections of the fire suppression equipment and the testing of the alarms are kept. The breathing air is checked every quarter and has always been found to meet the breathing air requirements. The GA Medical Surveillance program has been implemented for those workers identified as needing to be respirator trained, and for those workers designated to handle hazardous substances. Those workers identified as needing to be respirator trained have been trained. All the procedures supporting a specific work task, as identified in the procedure master list are reviewed for safety aspects and must be issued prior to the start of that task. The inventory list is reviewed periodically for hazardous substances and the locations of these substances are inspected during the walkdowns. The training records are updated regularly. The training for the industrial health and safety is current for all Hot Cell personnel. Safety "Tail-gate" meetings are held at least every ten working days, and are generally held every Monday morning at commencement of shift.

The HCF building is maintained at negative air pressure by the ventilation system in order to contain any potential contamination. The direction of the air flow in the HCF building is always from clean to contaminated areas and from ceiling to floor. Ventilation air is supplied by a single fan located in the boiler room at a design rate of 10,950 cfm. This air is prefiltered and may be heated to control building temperature. Building air is released to the atmosphere through a special high-grade filtering system.

In the past, the focal point of HCF activities has been the three hot cells. These cells and their associated equipment have been used for examining irradiated capsules and small fuel elements, mechanical testing, metallographic preparation and examination and photography. The walls of the three hot cells are constructed of high density magnetite concrete (225 lb./ft.^{3}) to provide shielding.

4.2.5 Access to Controlled Areas

Control of the site is maintained through a system of Work Authorizations (WA), restricted work areas, and site access controls.

4.2.5.1 Site Access Control

The site has an established site control program managed by the GA security staff. The control measures include security fence surrounding the Hot Cell Facility, a specific entry point with security personnel on duty, and routine security patrol. The GA security officer assigned to the HCF will have access to a radio which has compatible frequencies with the lead health physics employee and the site supervisor. Hard hats, visitors safety glasses, and rolls of the appropriate warning tape will be stored at the security trailer.

4.2.5.2 Restricted Work Area Access Control

General Atomics maintains access control for all the areas involved in decommissioning. Additional restricted work areas are established in order to control access and operations in areas where exposure to radioactive or hazardous materials above guidelines can occur. Physical features, boundaries, and posting of these boundaries are established and/or incorporated into the design of a restricted work area based on the level of contamination and/or potential for radiological exposure. The boundaries of each restricted area are marked and no one will be allowed to enter the area without being alerted to the hazards present. The boundaries of these areas are indicated with the use of ropes, painted or taped stripes on the floors, or physical barriers (i.e., existing walls or fences). Access control points are designed to minimize personnel and equipment traffic, as well as control the spread of contamination from contaminated areas to clean areas. An access control point is established for each of the restricted areas. This access control point shall be maintained to control personnel movement into and out of the restricted areas.

4.2.6 Medical Surveillance

The medical surveillance program is designed to monitor the health status of radiological workers who wear respirators and hazardous waste workers who need medical surveillance in order to meet the intent of 29 CFR 1910.120 (f)(2) requirements. The project medical surveillance program includes a baseline medical evaluation prior to participating in on-site operation. Upon termination of employment, personnel who have worked continuously on the Hot Cell site for more than six months, shall be required to have an examination equivalent to the baseline health assessment.

The purpose of the medical surveillance program is:

- To assess the individual's health prior to handling or operating potentially radioactive or hazardous equipment, and/or exposure to hazardous materials;
- To determine the individual's suitability for work assignments requiring the use of personal protective clothing and equipment;
- To monitor for evidence of changes in the individual's medical indicators which could be related to the on-site work; and
- To determine if the individual would be predisposed to illness upon exposure to hazardous substances or from physical demands required while using personal protective equipment.

A physician's statement, certifying the employee is physically fit to wear a negative pressure respirator, shall be received by GA Emergency Services and Health Physics before the employee is assigned work in a restricted area which requires respirators. Each physician subcontracted to GA must maintain medical records for the period specified and meet the criteria of 29 CFR 1910.20. In accordance with 29 CFR 1910.120, annual exams will be given as needed.

4.2.7 Bioassay Program

4.2.7.1 Radioactive Materials

Individuals who are authorized workers on the HCF Work Authorization receive a quarterly whole body count. Routine bioassay frequency and types of analyses are specified by the Health Physics manager based on the radionuclides present at the location. Non-routine analyses are conducted upon the direction of the project Health Physics manager or the project health and safety manager.

4.2.7.2 Hazardous Materials

Any special site specific bioassay requirements for monitoring physiological samples for hazardous substances or agents are determined on an as needed basis, dependent upon identification of hazardous substances suspected to remain in a specific work area.

4.2.8 Monitoring Program

Personnel and area monitoring strategies have been devised to ensure the prompt identification of areas and work activities for which engineering controls and/or respiratory protection are required. Monitoring shall also be conducted to confirm that the levels of protection provided by the respiratory protection program and by the engineering controls are adequate to protect the workers, the environment, and the public.

National Institute of Occupational Safety and Health (NIOSH) approved respiratory protection shall be mandatory for nonradiological tasks when working where dust contamination cannot be controlled, working in areas containing asbestos, etc., unless air monitoring results indicate that protection is not required. Direct reading measurements, where available, will be supplemented by breathing zone samples analyzed by a method approved by NIOSH, OSHA, or EPA.

Monitoring may include assessments of airborne contaminants in work areas and at the site boundary. Swipe and grab samples may be collected to identify radioactive contamination on surfaces and equipment. Equipment adequate to meet monitoring needs shall be available, properly calibrated, and controlled. Depending on the operation, surveys shall be performed to determine the following:

- External radiation exposure levels.
- Surface contamination levels and extent.
- Airborne concentrations of radioactive and/or chemical materials.
- Occupational and clearance asbestos sampling.
- Combustible, explosive gas, vapor levels.
- Toxic gas levels.
- Oxygen levels.
- Noise levels.
- Personnel contamination.
- Contamination of personal protective apparel and equipment.

The health and safety and/or health physics staff will identify the appropriate type of monitoring. Either area or personnel monitoring may be utilized based upon on-site specific conditions.

The Hot Cell building exhaust air is HEPA filtered and exhausted through a stack located on the west side of the building. This stack extends above the roof. This exhaust system stack has installed monitoring which is monitored by General Atomics to detect and control any radiological contamination exhausted. Continuous evaluation of air sampling results shall be used to assess the cumulative amount discharged. Appropriate investigation and follow up action will be instituted if stack sample results indicate levels which exceed the limits imposed by site administration action levels or regulations.

Radiation, contamination and airborne radioactivity is monitored on a routine basis. Survey results are used to update radiological posting in contaminated areas, airborne radioactivity areas, and RWPs and HWAs.

The health physics, health and safety, and project managers have the authority to investigate facility conditions and to stop work or implement protective measures necessary to protect the health and well being of site personnel, the public, and the environment.

4.2.9 Personal Protective Equipment

Whenever site activities are planned where potential exposure to hazardous materials and/or radiation could occur, an evaluation has to be made of the personal protective equipment (PPE) required. The purpose of the PPE is to isolate the employee from exposure to both radiological and hazardous materials, and ensuring that the Committed Effective Dose Equivalent (CEDE) from both external and internal exposure is maintained ALARA. The primary pathway of exposure for airborne contamination is inhalation. The primary method of controlling personnel contamination will be by keeping personnel away from the problem as much as possible, or to control at its source by local tents or confinement around the source, and HEPA ventilation as close to the source as possible. The specific selection of PPE to protect these contamination pathways will be based on project procedural control. PPEs may include respirators, gloves, hard hats, steel toed safety shoes, eye protection, hearing protection, coveralls or full body suits, and shoe covers. The individual components of clothing and equipment must be assembled into a full protective ensemble that both protects the worker from the site specific hazards at the location where the work will be performed, accounts for the ALARA principle, and also minimizes the hazards and drawbacks of the PPE.

The protective apparel and equipment requirements for site personnel working in restrictive areas of the HCF will be determined by the health and safety or health physics managers or by their designated personnel. The level of protection will be based on the type of chemical or radioactive material, its concentration and toxicity, and the potential for exposure through inhalation, ingestion, skin absorption, direct contact, splash, impact while ensuring that the Committed Effective Dose Equivalent (CEDE) from both external and internal exposure is maintained ALARA. The equipment used shall be listed in the "NIOSH/MSHA Certified Equipment List" described in 30 CFR 11.

There are four levels of PPE components based on the widely used Environmental Protection Agency (EPA) Levels of Protection: Levels A, B, C, and D. Levels A and B are used for protection against toxic atmospheric vapors, high potential for splash of noxious substances, substances with high degree of skin hazard, high or low oxygen concentrations.

4.2.10 Contamination Control

4.2.10.1 Contamination Control Practices

Contamination at this job site is controlled through training of the personnel, boundary control, ventilation control, etc. Cross contamination will be limited by the use of training, confinement and/or administrative controls. All equipment used in a radiological control area shall be surveyed using wipes and/or friskers before leaving the area. All vehicles which are taken into the radiological control areas of the HCF are surveyed by site HP personnel to determine the presence of radioactive contamination prior to leaving the radiological control areas.

Radiological and hazardous material contamination will be strictly controlled during all D&D work. HWAs and/or RWPs will be used to identify the contamination control practices that will be employed, as well as the personnel protective equipment and respiratory protection equipment that is to be used for each phase of the job.

4.2.10.2 Apparel Decontamination

There is one safety apparel decontamination station for the decontamination of respirators, and equipment, e.g., boots, hard hats, etc. Any wastes generated from A040 work scope activities shall be properly disposed of as waste. After daily work has been completed, outer protective clothing shall be removed and may be either placed in plastic bags for disposal or retained for laundering and reuse, depending on the contamination and physical condition. Disposable clothing will be disposed of in accordance with the applicable rules and regulations. Company issued safety work boots will be decontaminated from hazardous materials on an as-required basis, and left on-site.

4.2.10.3 Personnel Decontamination

Site personnel may be subjected to skin contamination from radioactive and/or toxic substances on the job site. The appropriate methods for decontaminating the skin shall be available at areas where skin contamination may result from contact with radioactive and/or toxic substances. The actual personnel decontamination will be at the discretion of HP experts, or trained HP technicians depending on the level of contamination. Portable eye wash stations are available at discreet locations on the job site to assist with the removal of foreign objects in the eyes, and to wash any possible contamination that may have been splashed onto the face or entered the eye.

Due to the fact that the work area has been determined to be potentially radioactively and/or chemically contaminated, decontamination shower facilities are available for personnel decontamination.

4.2.11 Emergency Contingency Procedure

A General Atomics Emergency Plan exists, as does a Radiological Contingency Plan, as required by the NRC and the State of California. The Hot Cell will use a specific independent implementing procedure (Ref. 4-4) for these plans.

4.2.11.1 General

There are three major categories of emergencies that could occur during the work activities of the General Atomics Hot Cell:

- Illnesses and physical injuries, including potential injuries from injury causing chemical or radiological releases.
- Catastrophic event, fire, explosion, major earthquake, major chemical, or radiological release.
- Problems with safety equipment.

Although every precaution will be taken to avoid a catastrophic event or severe medical emergency, an emergency contingency plan will be maintained based on the General Atomics Accident Prevention Policy Manual. The purpose of the plan is to establish the appropriate response actions for emergency situations, the means of communication, and the responsibilities of key personnel at the site. In the unlikely event of such an occurrence, the project manager shall be notified immediately or as quickly as emergency response allows.

4.2.11.2 Responsibilities

Responsibilities are defined in General Atomics HCF Emergency Response Procedure, HCP-4-0, 1994 (Ref. 4-4), and are summarized below.

Emergency Response and Recovery Director

The Project Manager or the designated representative will be the prime Emergency Response and Recovery Director (ERRD) and the coordinator of all emergency activities. The Project Manager or the designated representative shall:

- Be notified of any and all emergency events at the Hot Cell Facility.
- Respond accordingly to provide assessment input for Primary Support Group personnel.
- Be responsible for the direction of all activities at the Facility.
- Ensure the proper implementation of established Hot Cell Facility emergency procedures.
- Direct the efforts of the Facility Emergency Response Team members to mitigate the emergency with available resources.
- Assist efforts to mitigate the emergency situation in support of the ERO, as required.
- Be responsible for decisions concerning the extent of Hot Cell Facility shutdown and/or personnel evacuation to be implemented, to ensure personnel and public safety.

Project Health and Safety Manager

Will provide oversight to the site supervisor in providing the Emergency Services Supervisor with pertinent health and safety hazard information needed to report the incident, effectively evaluate the incident, and recommend appropriate response action. Will review these plans with the work force on a regular basis at safety meetings.

Project Health Physics Manager

Will provide the General Atomics Health Physics Manager, and the project manager with pertinent health physics hazard information needed to report the incident, effectively evaluate the incident, and recommend appropriate response action.

Emergency Response Personnel

General Atomics Emergency Response Personnel (Telephone Extension 2000), are available to administer emergency medical treatment, and provide emergency evacuation assistance to any worker in need. There will be additional people on the job site who have been trained in emergency response techniques who will be available to assist the General Atomics Emergency Response Personnel.

Other On-Site Personnel

The site personnel are trained to inform the Project Manager of all emergency situations and to follow their trained response actions to the emergency event. Special medical problems i.e., allergies to insects, plants, chemicals, etc., of site personnel should be reported to the health and safety manager upon arrival at the job site.

4.2.11.3 Work Stoppage

The health and safety and/or health physics manager and/or site supervisor is empowered to unilaterally stop work if necessary to meet health and safety requirements. The site managers may recommend temporary work stoppages and corrective actions in specific or all work zones if any of the following conditions are encountered:

- Air monitoring shows concentrations of airborne hazardous contaminants exceeding the preset limits.
- Concentrations of airborne contaminants outside the site exceeds the 50% of the unprotected permissible exposure limits (PEL) recommended by OSHA.
- Emergency conditions directly affect the health and safety of on-site workers or off-site personnel or property.
- Potential for unacceptable radiation dose rates.
- Potential for unacceptable airborne concentrations of radioactive materials.

Furthermore, in pre-job briefings, the aspect of stop work authority is discussed to ensure that both workers and Health Physics Technicians involved in a task are aware that they also may call for work stoppage to review potential safety hazards or concerns.

Corrective actions may include modification of personal protection levels, ventilation, evacuation, or other necessary measures.

4.2.11.4 Medical Emergencies

Medical emergencies are described as situations that present a significant threat to the health of personnel. These can result from chemical exposures, injuries with radiological contamination, heat stress, cold stress, heart attacks, and poisonous insect or snake bites. Medical emergencies must be dealt with immediately and the correct care administered promptly. The care will be first aid and if necessary emergency hospitalization.

4.2.11.5 Safety Equipment Problems

A situation may develop due to malfunction or other problems associated with health and safety equipment being used by site personnel. All equipment is required to be checked for soundness and function prior to entering the job site. These equipment problems must be corrected before proceeding with site activities. Health and safety problems that may occur include:

- Leaks or tears in protective clothing.
- Failure of respiratory protective devices.
- Encountering contaminants for which the prescribed equipment may not be suitable.

4.2.11.6 Emergency Equipment

Provisions will be made to have appropriate emergency equipment available and in proper working condition, This equipment will include:

- First aid kits.
- Eye wash stations.
- Emergency showers.
- Fire Extinguishers.
- Air horns.
- Spill containment equipment.

Equipment will be checked per the Hot Cell surveillance and maintenance plan, on a regular schedule, and defective equipment repaired or replaced before performing site work. Provisions will be made for backup safety equipment. The location of this equipment is defined in Ref. 4-4, the Hot Cell Facility Emergency Response Procedure.

4.2.11.7 Catastrophic Event Procedure

In the event of a catastrophic incident, the work force will:

- Call the emergency response number 2000, and give location and details.
- Stop all work activities.
- Evacuate the site and go to the designated assembly location.
- A head count will be taken of the assembled personnel.
- Injured individuals will receive first aid.
- Notify the Project Manager or the designated person.
- Notify the DOE/OAK Project Manager.

4.2.11.8 Emergency Communication

The fire alarm system is used as the main signaling method for a catastrophic event. If electric power has failed at the site, air horns are used as signal devices to alert personnel of emergencies. The designated air horn signals shall consist of the following:

- Intermittent double blast-signifies a medical emergency.
- Intermittent single blast-signifies a fire or chemical release emergency.
- Continuous blast-signifies immediate site evacuation.

5. HAZARDS ANALYSIS

Methods for performing Hazards Analysis are described in the DOE guidance documents and other sources referenced in Section 2.1. Various types of Hazards Analysis are described in more detail in a document published by the Center for Chemical Process Safety of the American Institute of Chemical Engineers (Ref. 5-1). For a facility where the design or the operations/procedures have not been finalized, and feedback from the Hazards Analysis results are desired for finalization, a Preliminary Hazards Analysis (PHA) is often recommended. The PHA approach was adopted for the HCF since the exact procedures related to D&D activities have not been developed.

A description of the methods used to identify hazards, analyze accident scenarios, bound the consequences and assess the risk is presented in Section 5.1. Maximum inventories of hazardous and radioactive materials are discussed in Section 5.2 and their use in establishing the preliminary hazard classification for the HCF is described. Seismic hazard and building fragility are given in Section 5.3. Identification and analysis of specific accident scenarios is presented in Section 5.4. Consequences for these accident scenarios are assessed in Section 5.5, along with a summary of the risk results on a risk matrix diagram for key scenarios.

5.1 Hazards Analysis Methodology

An overview of the Hazards Analysis methodology is presented in Fig. 5-1. The first step is to review the HCF procedures, design drawings and other documents related to the HCF activities described in Section 2.1. HCF project personnel are then interviewed to augment the documents and drawings as the base source of information for the Hazards Analysis.

Inventories of hazardous and radioactive materials are assessed and compared with thresholds of hazard categories 2 and 3 in order to establish the preliminary hazard category as required by DOE standards (Ref. 1-2) and (Ref. 2-5). Due to the fact that hazardous inventories can only be estimated until decontamination has been successfully completed, therefore, bounding estimates of inventories were used.

A key element of the Hazards Analysis is a systematic identification of potential accident scenarios from their root causes, including equipment failure, human error or natural causes (earthquake, storm or other natural phenomena). The PHA approach uses a list of energy sources to identify how an accident can happen based on possible root causes. Logic models have been found to be useful as a supplemental tool to display root causes and to show how multiple root causes combine to produce a common outcome. These logic models also provide a framework for estimating probabilities of accident scenarios. They also add confidence that significant root causes have been considered and that the list of important accident scenarios is complete.

Identification of accident scenario and analysis of the sequence of events, that may either lead to release and exposure or to recovery and no release, makes use of the worksheet format. For each type of consequence, such as fire or hazardous material release, the energy sources that can produce the consequence are identified in a column of the worksheet. Subsequent columns list the design and administrative features or controls available at the facility to prevent or, respectively, to mitigate the accidents. In the last column, the potential outcomes of the accident scenarios are listed.

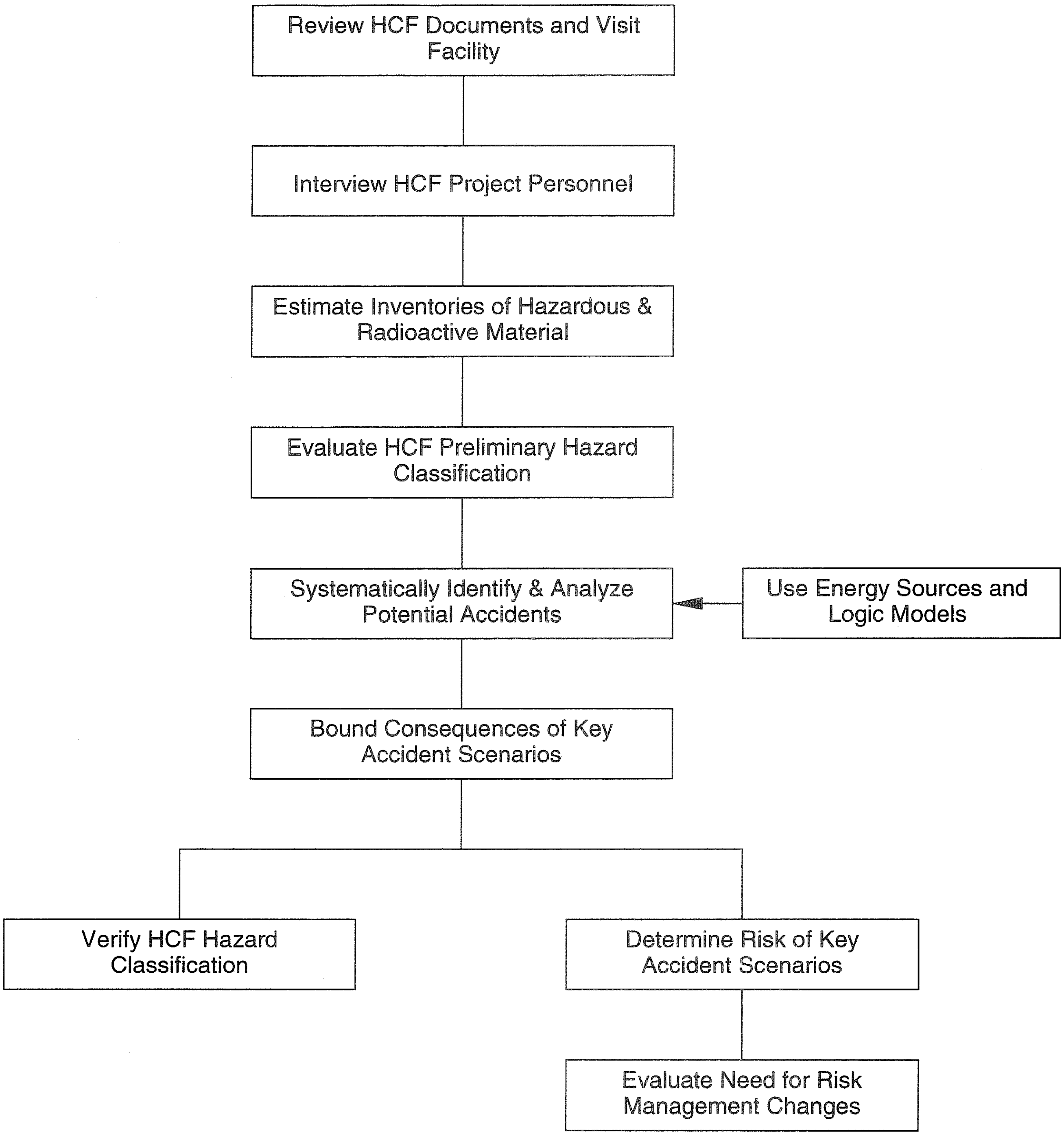

Fig. 5-1 HCF Hazard Analysis Process

Based on generic data for equipment failure rates or human error, combined with the site specific operations and circumstances, estimates are made of the probabilities of key accident scenarios. These estimates are then compared with the discrete probability rating levels defined in the DOE guidelines (Ref. 1-2), similar to the probability ranges in U.S. Department of Defense. Military Standard-System Safety Program and Requirements. MIL-STD0882C. January, 1993 (Ref. 5-2). Table 5-1 shows these probability ranges (Ref. 5-3). These serve to define the probability boxes in the risk matrix diagram described below.

Consequences of potential accident scenarios are assessed according to whether impacts (relative to personal health and safety) are minor or major on-site (affecting workers) or minor or major off-site (affecting other industry workers or members of the public). Table 5-2 depicts the consequence ranges, taken from Ref. 5-3, that are used in this analysis.

To assess the risk of potential accident scenarios, use is made of the risk matrix diagram shown in Fig. 5-2 (Ref. 5-3). This diagram combines the probability ranges in Table 5-1 and the consequence ranges in Table 5-2 to produce a two dimensional matrix or box diagram. Boxes with high probability and high consequence correspond to high risk and, therefore, must be avoided. If necessary, additional risk management measures will be recommended in order for accident scenarios to fall into lower risk boxes.

5.2 Inventories and Hazard Classification

5.2.1 Radioactive Material

In accordance with the guidance of DOE-STD-1027-92 (Ref. 1-2), a preliminary assessment of HCF hazards requires the identification of the inventory of radioactive material and a comparison to the Threshold Quantities provided in the Standard.

A wide range of potential radioisotopes may be found in waste generated during the decontamination phase; however, most exist at low concentrations. Waste containing fissile isotopes may be treated in the HCF although it is expected that these materials will meet the "less than 100 nCi/g" standard for handling as low-level wastes in accordance with DOE Order 5820.2A (Ref. 5-4). Inventories of fissile isotopes (Tables 5-4 and 5-5) are below those required for a critical mass. Therefore, there is no possibility of a nuclear criticality at the HCF. Facility maximum inventory limits shall be established in the HCF Safety Procedures for all classes of radioisotopes to support maintenance of the facility hazard classification.

The following categories of radioactive sources present in the HCF were examined to estimate or characterize the inventories:

1. Special sealed sources stored in the HCF.
2. Irradiated fuel stored below ground in the high level cell, including HTGR fuel and RERTR fuel.
3. Waste containing broken fuel particles or other radioactive substances (primarily in the high level cell).
4. Contamination on equipment, piping, sinks, drains and other parts that will be removed.
5. Contamination on the building structure, floor, walls, ceiling and roof that will be removed as waste generated during surface decontamination.

Table 5-1
Probability Levels

Probability Level			**Estimated Range of Occurrence Rate per year**
Category	**Symbol**	**Description**	
Incredible	A	Probability of occurrence is so small that a reasonable scenario is not conceivable. These events are considered in design or accident analysis.	$<10^{-7}$
Extremely Low	B	Probability of occurrence is extremely unlikely or event is not expected to occur during the life of the facility or operation.	$>10^{-6}$ and $<10^{-4}$
Low	C	Probability of occurrence is unlikely, or event is not expected to occur but may occur during the life of the facility or operation.	$>10^{-4}$ and $<10^{-2}$
Moderate or Medium	D	Event is likely to occur during the facility or operation lifetime.	$>10^{-2}$ and $<10^{-1}$
High	E	Event is likely to occur several times during the facility or operation lifetime.	$>10^{-1}$

Table 5-2
Consequence Levels

Consequence Level[a]	**Category**	**Maximum Consequences**
1	High	Serious impact on-site or off-site. May cause death or loss of the facility/operation. Major impact on the environment.
2	Moderate or Medium	Major impact on-site and/or minor impact off-site. May cause severe injury or severe occupational illness to personnel or major damage to a facility/operation or minor impact to the environment. Capable of returning to operation.
3	Low	Minor on-site with no off-site impact. May cause minor injury or minor occupational illness, or minor impact on the environment.
4	Extremely Low	Will not result in a significant injury, occupational illness, or impact on the environment.

[a] Worker consequence levels addressed in this table are for workers outside the immediate area in which an accident occurs.

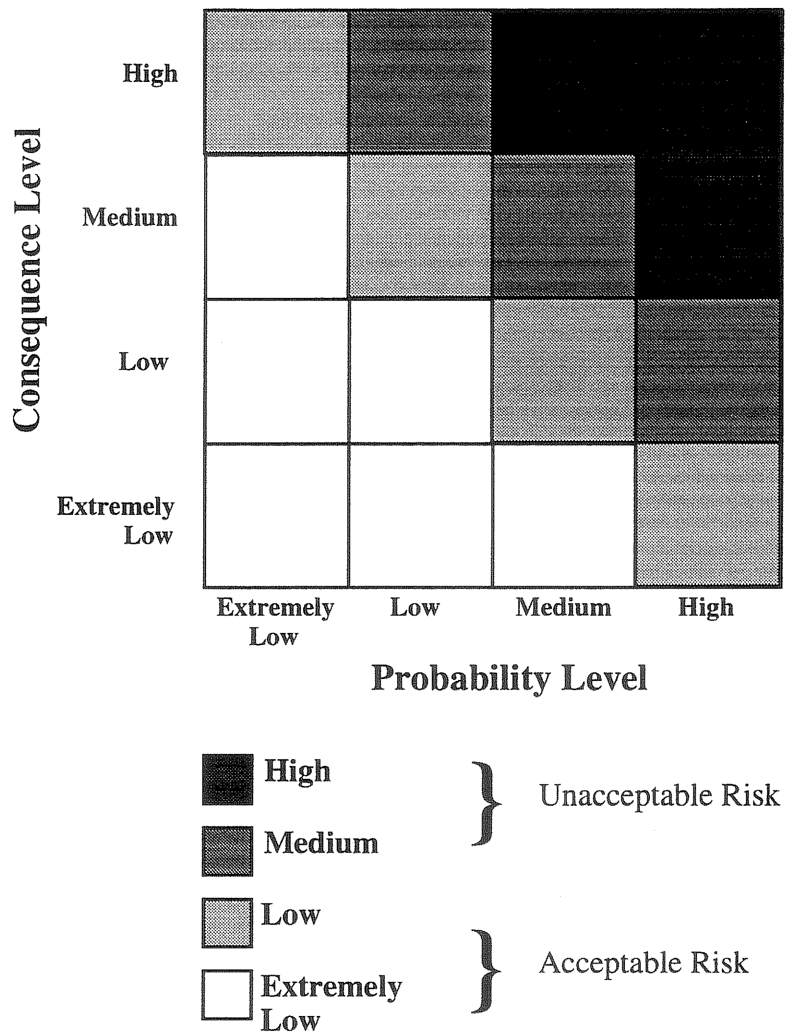

Fig. 5-2 Risk Matrix Diagram (Hallinan, 1988)

Sealed Sources

Inventories of sealed radioactive sources are routinely tracked by the GA health physics accountability system, including radioactive decay. Table 5-3 presents the calculated inventories as of the end of December, 1994 for all sources combined, the total inventory is less than one curie.

Sealed sources are constructed and distributed in accordance with US NRC requirements in 10 CFR 30 through 34 to pose minimal hazards. Specifically licensed sealed sources are constructed to withstand accident environments. The analyses of this section assume any significant sealed source will withstand accident conditions and they are excluded from the inventory of material at risk in accordance with Ref. 1-2 guidance.

Table 5-3
Inventories of Sealed Sources in HCF
(as of December 1994)

Isotope	No. Sealed Sources	Combined Activity (Ci).
^{3}H	5	1.130E-3
^{36}Cl	2	4.000E-7
^{60}Co	1	4.300E-7
^{90}Sr	1	1.500E-3
^{99}Tc	5	4.220E-7
^{133}Ba	3	5.610E-7
^{137}Cs	9	4.820E-1
^{226}Ra	1	8.000E-7
^{230}Th	3	1.442E-8
^{241}Am	2	1.042E-6
NaI*	1	<0.1 mR/hr

* Thallium is the radioactive ingredient.

Irradiated Fuel

The irradiated fuel to be transported from the HCF has been characterized (Ref. 5-5). The RERTR fuel was irradiated between 1979 and 1984 and is summarized as follows:

- Physical Form: Solid uranium-zirconium hydride, (U, Zr) H_x, 0.508″ diameter x 22″ long rods
- Weight Percent Uranium: 20, 30 or 45%
- ^{235}U Enrichment: 19.75%
- SNM Amount: 382.6g total, 352 g ^{235}U

The RERTR fuel is encased in solid, seamless tubing (cladding) made of Incoloy 800 of 0.016″ wall thickness and with end plugs. Table 5-4 summarizes the amounts and activity levels of radionuclides in the RERTR fuel as of January 1, 1994. By the time the fuel is transported, the activity levels of shorter lived (non-daughter) fission products, such as ^{144}Ce, ^{134}Cs, ^{155}Eu, ^{147}Pm, ^{106}Ru, and ^{125}Sb, will be diminished somewhat by decay. Other (long-lived) radionuclide inventories will remain relatively unchanged. Overall external (gamma) radiation levels will be diminished somewhat because, in addition to the longer-lived ^{154}Eu, ^{137}Cs and ^{235}U radionuclides, shorter-lived ^{134}Cs, ^{106}Ru and ^{144}Ce or their daughters also contribute measurably to the gamma dose. Half-Lives are taken from Ref. 5-6. Also, for RERTR fuel only, activation products are present and contribute strongly (especially ^{60}Co) to the external radiation dose.

Table 5-4
Radiological Inventory of RERTR Fuel[a]

Chemical Element	Isotope	Half-Life (year)	Activity (curies)
Fission Products, Uranium and Plutonium			
Hydrogen (Tritium)	^{3}H	1.23E+01	2.80E+00
Krypton	^{85}Kr	1.07E+01	6.67E+01
Strontium	^{90}Sr	2.91E+01	7.97E+02
Yttrium	$^{90}Y^{b}$	7.32E-03	7.97E+02
Ruthenium	^{106}Ru	1.02E+00	2.60E+00
Rhodium	$^{106}Rh^{b}$	9.51E-07	2.60E+00
Antimony	^{125}Sb	2.76E+00	6.90E+00
Tellurium	$^{125m}Te^{b}$	1.59E-01	1.70E+00
Cesium	^{134}Cs	2.07E+00	4.48E+01
Cesium/Barium	$^{137}Cs/^{137m}Ba^{b}$	3.00E+01/4.85E-06	1.68E+03
Promethium	^{147}Pm	2.62E+00	1.60E+02
Samarium	^{151}Sm	9.00E+01	3.40E+00
Europium	^{154}Eu	8.59E+00	2.81E+01
Europium	^{155}Eu	4.71E+00	9.00E+00
Uranium	^{233}U	1.59E+05	1.71E-07
Uranium	^{234}U	2.46E+05	3.91E-04
Uranium	^{235}U	7.04E+08	7.39E-04
Uranium	^{236}U	2.34E+07	5.61E-03
Neptunium	^{237}Np	2.14E+06	2.48E-03
Uranium	^{238}U	4.47E+09	8.57E-04
Plutonium	^{239}Pu	2.41E+04	1.30E+00
Plutonium	^{240}Pu	6.56E+03	1.35E+00
Plutonium	^{241}Pu	1.44E+01	3.12E+02
Plutonium	^{242}Pu	3.75E+05	3.35E-03
		Subtotal =	3.92E+03
Activation Products			
Manganese	^{54}Mn	8.55E-01	5.80E-02
Iron	^{55}Fe	2.73E+00	5.09E+01
Nickel	^{59}Ni	7.60E+04	3.30E-01
Cobalt	^{60}Co	5.27E+00	3.20E+00
Nickel	^{63}Ni	1.00E+02	4.02E+01
Technetium	^{99}Tc	2.13E+05	1.40E-01
		Subtotal =	6.84E+01
		Grand Total =	4.02E+03

Notes: a. Decayed up to January 1, 1994
b. Daughter product generated from decay of another element of like atomic weight

The HTGR fuel is in ceramic form and contains no significant activation products. Table 5-5 summarizes the amounts and activity levels of fission product and uranium/plutonium radionuclides. Both the total activity level and total mass of radionuclides is lower for the HTGR fuel compared to the RERTR fuel. Based on relative amounts of predominant gamma radiation contributors, the total gamma radiation level is over 6 times lower for HTGR fuel than for RERTR fuel.

Table 5-5
Radiological Inventory of HTGR Fuel[a]
(Fission Products Plus Uranium and Plutonium)

Chemical Element	Isotope	Half-Life (years)	Activity (curies)
Hydrogen	^{3}H	1.23E+01	3.40E-01
Krypton	^{85}Kr	1.07E+01	1.05E+01
Strontium	^{90}Sr	2.91E+01	1.60E+02
Yttrium	^{90}Y[b]	7.32E-03	1.60E+02
Antimony	^{125}Sb	2.76E+00	1.90E-01
Cesium	^{134}Cs	2.07E+00	7.08E-01
Cesium/Barium	$^{137}Cs/^{137m}Ba$[b]	3.00E+01/4.85E-06	3.19E+02
Promethium	^{147}Pm	2.62E+00	4.39E+00
Samarium	^{151}Sm	9.00E+01	1.30E+00
Europium	^{154}Eu	8.59E+00	1.78E+00
Europium	^{155}Eu	4.71E+00	2.00E-01
Thorium	^{232}Th	1.40E+10	2.10E-04
Uranium	^{233}U	1.59E+05	2.92E-01
Uranium	^{234}U	2.46E+05	3.13E-02
Uranium	^{235}U	7.04E+08	2.27E-04
Uranium	^{236}U	2.34E+07	1.04E-03
Uranium	^{238}U	4.47E+10	3.84E-06
Plutonium	^{238}Pu	8.77E+01	2.91E-01
Plutonium	^{239}Pu	2.41E+04	1.71E-02
Plutonium	^{240}Pu	6.56E+03	1.91E-02
Plutonium	^{241}Pu	1.44E+01	3.14E+00
Plutonium	^{242}Pu	3.75E+05	1.08E-04
		Total =	6.62E+02

Notes: a. Decayed up to January 1, 1994
b. Daughter product generated from decay of another element of like atomic weight

The HTGR fuel characteristics are summarized as follows:

- Physical Form: Solid coated ceramic fuel particles, fuel rods and fuel compacts
- ^{235}U Enrichment: 10 to 93%
- SNM Amount: 139.3 g total, 108 g ^{235}U
- Fuel types: (U, Th) C_2, UCO and (U, Th) O_2

Other Inventory

Other inventories consist of contamination on debris, equipment and parts to be removed, and structure surfaces. The total activity of all these sources was calculated by modeling the high level cell of the HCF with the PATH computer code (Ref. 5-7) to determine the total number of curies of ^{137}Cs, ^{134}Cs and ^{60}Co based on a general area dose rate measured at the high level cell. The PATH code is a gamma shielding program, based on a common point-kernel integration attenuation coefficients for gamma shielding analysis.

The total activity of ^{137}Cs from PATH was used to determine the other isotopic constituents based on correlation factors developed from a radiochemistry analysis of sample wipes. An uncertainty factor of two was included in order to bound the inventory. This factor considers possible uncertainty in the general applicability of the sample wipes and uncertainties due to activities in other areas of the HCF (contamination in other HCF areas is considered to be low relative to the high level cell, based upon current site characterization information). Table 5-6 presents the estimated inventory by radionuclide. The total activity is estimated to be approximately (slightly less than) 2000 Ci.

The large majority of the contamination inventory is considered to be associated with the debris, partly consisting of broken fuel particles and pieces of fuel, that was previously tested in the HCF. The relative activity on surfaces and equipment is considered to be substantially smaller, based on current information.

Table 5-6
Estimated Radiological Inventory of Contamination in HCF[a]

Chemical Element	Isotope	Half-Life (year)	Activity (curies)
Hydrogen	^{3}H	1.23E+01	2.60E-01
Iron	^{55}Fe	2.73E+00	5.60E+01
Cobalt	^{60}Co	5.27E+00	9.70E+01
Nickel	^{63}Ni	1.00E+02	4.30E+01
Strontium	^{90}Sr	2.91E+01	4.93E+02
Yttrium	^{90}Y	7.32E-03	4.93E+02
Rhodium	^{106}Rh	9.51E-07	8.00E+00
Ruthenium	^{106}Ru	1.02E+00	8.00E+00
Antimony	^{125}Sb	2.76E+00	3.00E+00
Cesium	^{134}Cs	2.07E+00	2.72E+02
Cesium/Barium	$^{137}Cs/^{137m}Ba$	3.02E+01/4.85E-06	3.50E+02
Cerium	^{144}Ce	7.79E-01	2.60E+01
Praseodymium	^{144}Pr	3.23E-05	2.50E+01
Europium	^{154}Eu	8.59E+00	5.00E+00
Europium	^{155}Eu	4.71E+00	2.00E+00
Thorium	^{228}Th	1.91E+00	4.00E-01
Uranium	^{232}U	7.00E+01	6.00E-01
Uranium	^{233}U	1.59E+05	5.00E-01
Uranium	^{234}U	2.46E+05	1.00E-01
Uranium	^{235}U	7.04E+08	1.00E-03
Uranium	^{236}U	2.34E+07	1.60E-03
Uranium	^{238}U	4.47E+06	6.00E-04
Plutonium	^{238}Pu	8.77E+01	7.00E+00
Plutonium	^{239}Pu	2.41E+04	7.00E-01
Plutonium	^{241}Pu	1.44E+01	3.30E+01
		Total =	1.92E+03

Note: a. Decayed up to January 1, 1994

5.2.2 Hazardous Material

The preliminary assessment of HCF hazard is performed in accordance with the requirements of DOE Order 5481.1B (Ref. 5-8) by examining the range of hazardous materials found in mixed waste. The hazard classification system contained in Ref. 5-8 for facilities containing hazardous (chemical) materials is not provided with specific guidance on the evaluation of hazards and consequences as is contained in DOE-STD-1027-92 (Ref. 1-2) for radioactive materials.

Hazardous materials are considered to be those chemicals which could present a significant hazard to on-site and off-site personnel if they were released in sufficient amount, called a "Reportable Quantity" (RQ). A list of RQs for hazardous materials under CERCLA, including RCRA hazardous wastes, can be found in 40 CFR 302.4. Table 5-7 lists the specific hazardous materials which are present in the HCF, along with their RQ values and indication whether the RQ is exceeded. The list was compiled considering not only the CERCLA list, but also a broader range of materials classified as hazardous under federal definitions in 49 CFR 172 and 173 and under California definitions in the Health and Safety Code Section 25501. Thus, RQ values are not available for some chemicals, but those not listed tend to be less hazardous chemicals.

In the HCF, there are no materials which have been designated as highly hazardous by OSHA in 29 CFR 1910.119 (or by California State Law in 8 CCR 5189). There are also no extremely hazardous substances as defined by the US EPA in 40 CFR 355 (equivalent to acutely hazardous materials in California definitions in the Health and Safety Code Chapter 6.95).

Table 5-7
List of Potential Hazardous[1] Materials at the HCF

Hazardous Chemicals	Physical Form	RQ[2] (lb)	Amount Present >RQ?
Acetone	liquid	5000	no
Asbestos	solid	1	yes
Benzene	liquid	10	no
Beryllium	solid	10	no
Beryllium Oxide	solid	10	no
Bromoform	liquid	100	no
Cadmium	solid	10	no
Chromium	solid	5000	no
Copper	solid	5000	no
Diesel oil	liquid	none	NA[3]
Ethanol	liquid	none	NA
Hydraulic oil	liquid	none	NA
Isopropanol	liquid	none	NA
Kerosene	liquid	none	NA
Lead	solid	10	yes
Lubricating oil	liquid	none	NA
Mercury	solid	1	yes
Methanol	liquid	5000	no
Mineral oil	liquid	none	NA
PCBs	solid	1	yes
Sodium	solid	10	no
Toluene	liquid	1000	no
Xylene	liquid	1000	no
Zinc	solid	1000	no

1 Under either federal (40 CFR 302) or California (Health and Safety Code Section 25501) definitions)
2 Reportable Quantity under 40 CFR Part 302.4 (Ref. 1-5), List of Hazardous Substances and Reportable Quantities
3 NA = Not Applicable

5.2.3 Preliminary Hazard Classification

The lower threshold quantities for Hazard Category 2 and Category 3, along with the radioactive inventories, are given in Table 5-8. The threshold quantities are as indicated in Ref. 1-2. The inventories of radioactivity in the HCF exist above the lower threshold for Category 3, but well below the lower threshold for Category 2.

The inventory comparisons indicate that the HCF may be an Exempt or a Category 3 facility based on the inventory of radioactive material present. The quantities of radioactive material in the HCF would present a hazard only to personnel in on-site and would, therefore, be classified as a Low Hazard facility. Furthermore, once decommissioning of the HCF has begun, the quantities of radioactive materials existing within the HCF would decrease.

Section 6.1 discusses verification of the Preliminary Hazard Classification, incorporating results of the accident consequence analysis.

Table 5-8
Comparison of Radioactive Inventories with DOE Hazard Classification

Isotope	Irradiated Fuel Inventory [a] (Ci)	Contamination Inventory [b] (Ci)	Category 3 Lower Threshold (Ci)	Category 2 Lower Threshold (Ci)
Fission Products and TRU				
^{3}H	3.14E+00	2.60E-01	1.00E+03	3.00E+05
^{85}Kr	7.72E+01	0.00E+00	2.00E+04	2.80E+07
^{90}Sr	9.57E+02	4.93E+02	1.60E+01	2.20E+04
$^{90}Y^{c}$	9.58E+02	4.93E+02	1.40E+03	4.30E+05
$^{106}Ru/^{106}Rh^{c}$	5.20E+00	1.60E+01	1.00E+02/2.00E+03	6.50E+03/4.30E+05
^{125}Sb	7.09E+00	3.00E+00	1.20E+03	4.30E+05
$^{125m}Te^{c}$	1.70E+00	0.00E+00	7.20E+02	4.30E+05
^{134}Cs	4.55E+01	2.72E+02	4.20E+01	6.00E+04
$^{137}Cs/^{137m}Ba^{c}$	2.00E+03	3.50E+02	6.00E+01	8.90E+04
^{144}Ce	0.00E+00	2.60E+01	1.00E+02	8.20E+04
$^{144}Pr^{c}$	0.00E+00	2.50E+01	4.80E+02	4.30E+05
^{147}Pm	1.64E+02	0.00E+00	1.00E+03	8.40E+05
^{151}Sm	4.70E+00	0.00E+00	1.00E+03	9.90E+05
^{154}Eu	2.99E+01	5.00E+00	2.00E+02	1.10E+05
^{155}Eu	9.20E+00	2.00E+00	9.40E+02	7.30E+05
^{228}Th	0.00E+00	4.00E-01	1.00E+00	9.20E+01
^{232}Th	2.10E-04	0.00E+00	1.00E-01	1.80E+01
^{232}U	0.00E+00	6.00E-01	4.20E+00	2.2E+02
^{233}U	2.92E-01	5.00E-01	4.20E+00	2.20E+02
^{234}U	3.17E-02	1.00E-01	4.20E+00	2.20E+02
^{235}U	9.66E-04	1.00E-03	4.20E+00	2.40E+02
^{236}U	6.65E-03	1.60E-03	4.20E+00	5.50E+01
^{237}Np	2.48E-03	0.00E+00	4.20E-01	5.80E+01
^{238}U	8.61E-04	6.00E-04	4.20E+00	2.40E+02
^{238}Pu	2.91E-01	7.00E+00	6.20E-01	6.20E+01
^{239}Pu	1.32E+00	7.00E-01	5.20E-01	5.60E+01
^{240}Pu	1.37E+00	0.00E+00	5.20E-01	5.50E+01
^{241}Pu	3.15E+02	3.30E+01	3.20E+01	2.90E+03
^{242}Pu	3.46E-03	0.00E+00	6.20E-01	5.50E+01
Activation Products				
^{54}Mn	5.80E-02	0.00E+00	8.80E+02	4.30E+05
^{55}Fe	5.09E+01	5.60E+01	5.40E+03	1.10E+07
^{59}Ni	3.30E-01	0.00E+00	1.10E+04	4.30E+05
^{60}Co	3.20E+00	9.70E+01	2.80E+02	1.90E+05
^{63}Ni	4.02E+01	4.30E+01	5.40E+03	4.50E+06
^{99}Tc	1.40E-01	0.00E+00	1.70E+03	3.80E+06

[a] Combined HTGR and RERTR Inventory. Reference decay date for all activity levels is January 1, 1994.
[b] Values are from Table 5-6 and represent the activity in the HCF. Reference decay date for all activity levels is January 1, 1994.
[c] Daughter products generated from decay of another element of like atomic weight

5.3 Seismic Hazard and Building Fragility

No site-specific seismic hazard analysis is available for the GA site. However, a number of detailed reviews and analyses of the probable effects of earthquakes in the San Diego area have been carried out (Ref. 3-10, Ref. 5-9 and Ref 5-10). In particular, Ref. 3-10 performed a probabilistic seismic hazard analysis (PSHA) covering three sites in the San Diego-Tijuana metropolitan area. The analysis included the latest estimates for earthquake probability on the Rose Canyon Fault Zone. The seismic faults included in the analysis were the same as those which would be considered in a site-specific analysis for the GA site, namely, Rose Canyon, Coronado Bank, San Diego Trough, Elsinore, and La Nacion. The distances from these faults to the sites evaluated by Berger and Schug are given in Table 5-9 together with the corresponding distances to the GA site.

Table 5-9
Seismic Sources Summary

Fault Name	Closest Distance to Site, km (approximate)			
	Site 1	Site 2	Site 3	GA Site
Rose Canyon	1	5	10	5
Coronado Bank	19	26	33	26
San Diego Trough	36	37	43	40
Elsinore	66	54	55	58
La Nacion	11	17	2	13

As can be seen from the table, the GA site corresponds roughly to Site 2. For the GA site the distance from Elsinore is slightly more but the distance from La Nacion is slightly less. It is therefore a reasonable assumption, in the absence of a site specific analysis, to utilize the results from Ref. 3-10 Site 2 for the GA site.

The conclusion from the Ref. 3-10 analysis is that for Site 2 a free-field peak ground acceleration of 0.34g would be appropriate for design purposes.

Additional factors contributing to the low level of risk associated with seismic event are that the highly radioactive items (i.e., fuel) are stored below ground in steel tubes embedded in concrete and the Category 3 waste is stored inside the thick steel lined High Level Cell which, as shown by calculations, can withstand ground level accelerations of 0.4 g.

5.4 Accident Scenario Identification and Analysis

The boundaries for the Hazards Analysis include all operations within the HCF, including Building 23 and the grounds within the restricted area. Such operations/activities are described in Section 4.1. In addition, the boundaries include packing and movement of the irradiated fuel to Building 30 for temporary storage. If transfer of fuel into the shipping casks for transport to Oak Ridge national Laboratory is to be done in the HCF, those operations would also be within the boundaries of this Hazards Analysis.

Potential hazards were identified using the "hazardous energy" concept (Ref. 2-6), in which energy sources can cause hazards such as potential releases of, or exposures to, hazardous or radioactive materials. A potential hazard source list was developed specifically for facility operations such as those at the HCF, and within the boundaries of this analysis. This list is presented in Table 5-10. Individual hazard sources are grouped in Table 5-10 by category of source or by type of effect.

The potential hazard sources serve the same purpose as guide words in Hazard and Operability (HAZOP) studies (Ref. 5-1). Namely, they stimulate "brainstorming" ways in which accidents can happen, and they provide a checklist of items to consider. Applying the potential hazard source list to the specific HCF operations and design described in Sections 3.0 and 4.0 yielded potential initiating events for accidents. For example, the hazard source fire suggests combustion of nearby burnable material or of the natural gas supply. The initiating events were qualitatively evaluated as to likelihood of occurrence and consequence. For example, hazard sources of transformers and batteries, all pressure sources, infrared/ultraviolet and plasma beam radiation sources, and external events other than earthquakes were considered to be relatively negligible causes of accidents, given the HCF operations and site.

Table 5-10
Potential Hazard Sources

a. Electric Sources	e. Criticality
High voltage and current sources	
Transformers or batteries	f. Release of Hazardous Chemical due to:
Static electricity	Fire or explosion
	Handling mishap
b. Motion Sources	HEPA filter failure
Shears, sharp edges, pinch points	Earthquake
Machinery	Other external event
Vehicles, forklifts, trucks	
Mass in motion	g. Exposure of Heat/Cold due to:
	Plasma torch
c. Gravity-Mass Sources	Natural gas
Falling	Friction
Falling objects	Chemical reactions
Lifting	Spontaneous combustion
Tripping, slipping	Cryogenic material
Earthquakes	
	h. Radiation Exposure due to:
d. Pressure Sources	Radioactive material release
Chemical Reactions	External radiation source
Noise	Infrared or ultraviolet sources
Confined gases	
Extreme wind	

The next step was to develop accident scenarios (chain of events or conditions that could produce human exposure or injury) for the important initiating events (such as earthquakes). Such scenarios are described in Appendix B; they were developed considering facility specific controls and mitigating features (both design and administrative). For example, accident scenarios A, F, and N stemmed from hazard source category "c" (gravity-mass sources); accident scenario G stemmed from hazard source category "a" (electric sources); and the other scenarios stemmed from hazard source categories "f" and "h."

The framework for documentation of the HCF preventive features, method of detection, mitigative features, and impacts of potential types of accidents is the Hazards Analysis Worksheet, shown in Table 5-11. Note that preventive features refer to those aspects at the facility or operations which reduce the probability of accident occurrence. Mitigative features reduce the severity of accident consequences. Each row represents a Hazard Event (HE) and is related to hazard source category in Table 5-10. For example, HE4 is related to hazard source category "a" (electric sources) and HE5 is related to hazard source categories "b" (motion sources) and "c" (gravity-mass sources).

The first two columns of the worksheet present the hazard event (the deleterious outcome that the initiating event could lead to) and the underlying causes of the initiating event. To more closely tie these two columns together, use was made of logic diagrams for the first three (and most important) hazard events, namely, fire, toxic exposure and ionizing radiation exposure. Figs. 5-3 and 5-4 present these diagrams. They show how potential causes combine to yield the hazard event on a fault-tree type of format. These diagrams also provide a framework for showing how probabilities of the various causes combine into the hazard event probability.

After the worksheet was filled out and the logic diagram structure was developed, the next step was to estimate the likelihood or probabilities of the accidents occurring. With regard to external events, the site information described in Section 3 indicates that the HCF location is not susceptible to severe weather, tornadoes or hurricanes. The site is also not within an airport takeoff or landing pattern (although a Miramar NAS jet flight path passes nearby). Probabilities of severe weather or aircraft crash causing a fire or chemical/radioactive release are considered to be negligibly low compared to other causes of these accidents.

Based on information on the seismicity characteristics of the HCF site (Appendix A and Section 3.9), the chance of earthquake motions causing a release is closely tied to probabilities of a large earthquake occurring on the Rose Canyon Fault nearby. While the Rose Canyon Fault was recently upgraded to active status, evidence indicates that large earthquakes are relatively infrequent. An occurrence interval of 500 years has been estimated for a large quake of Richter magnitude around 7. The corresponding occurrence probability is $2x10^{-3}$ yr^{-1} (one divided by 500 years).

Earthquake, severe storm and aircraft crash are types of external events that could cause both an ignition source and a gas pipe leak. As such, they cause dependent or common mode failure in the logic diagram that otherwise is considered to consist of independent failures. This effect is accounted for in the logic diagram structure.

For a natural gas pipe leak, the concern is for a large pipe break. Such breaks are often experienced in earthquakes and other external events. Also, breaks have been experienced due to corrosion or other causes; frequency of $1.5x10^{-7}$ breaks per linear foot of pipe per year is recommended in FEMA, 1989 (Ref. 5-11) (page 11-36) for corrosive causes. There is less than 200 ft. of pipe within the HCF, this corresponds to a failure probability of $3x10^{-5}$ yr^{-1}.

Fueling of moving equipment (crane, forklifts) in the HCF is controlled by procedures and is not done within the HCF. It is considered to be relatively unlikely that a leak of large enough size to endanger the waste drums or boxes could occur without being extinguished by the fire fighting and emergency procedures described in Section 4.2.11.

The presence of an ignition source is assumed to be relatively likely, given operation of motor operated equipment. Therefore, the fire probability is directly linked to the probability of a burnable source, which has low probability.

Table 5-11
Preliminary Hazard Analysis Worksheet
(HE = Hazard Event)

Hazard Event	Causes	Preventative Features		Method of Detection	Mitigative Features		Potential Impact
		Design	Administrative		Design	Administrative	
1. Fire (see Fig. 5-3)	Electrical fault; equipment failure; earthquakes; ignition of combustibles; human error; aircraft crash; terrorism; gas line rupture	Electrical system compliance with NEC; fire prevention building design	No on-site refueling; employee training; fire inspection and drills; GA Accident Prevention Plan	Worker observation; smoke or heat detectors	Automatic fire sprinkler system; fire extinguishers; on-site ERT equipment; fire hydrant	Employee training; emergency response plan with on-site ERT; security	Facility workers exposure to radioactive material; potential release of radioactive material to the environment
2. Toxic Exposure (see Fig. 5-3)	Human error; fire; equipment failure; falling object; earthquakes; uncontrolled chemical release; mechanical impact; failure of HEPA filter	Approved hazardous materials containers; ventilation system	GA Accident Prevention Plan; fire controls per HE 1; forklift training; handling training	Worker observation; ventilation or building air monitoring	HEPA monitors; fire controls per HE1; air monitors	Hazard Communication Program; controls per HE1; PPE; inventory minimization	Facility workers exposure to radioactive or hazardous material; potential release of radioactive or hazardous material to the environment
3. Ionizing Radiation Exposure (see Figs. 5-3 & 5-4)	Human error; equipment failure; fire; falling object; earthquake; mechanical impact; radiant sources; criticality; crane failure	Approved radioactive material containers; ventilation system	GA Accident Prevention Plan; fire controls per HE 1; forklift training; handling training	Worker observation; system indicators; ventilation and building air monitoring; area monitor indicator	HEPA monitors; fire controls per HE1; air monitors	Hazard Communication Program; controls per HE1; PPE	Facility workers exposure to radioactive material; potential release of radioactive material to the environment
4. High Voltage Hazard	Human error; electrical fault; equipment failure; earthquake	Electrical system compliance with NEC	Employee training; Hazard Communication Program; protective shoes and mats	Worker detection; electrical system fault indication; circuit breaker trip; detection of electrical fire	Circuit breakers	Health & Safety Plan; lock-out and tag-out procedure	Worker injury; equipment damage; facility damage
5. Industrial Hazards (mass in motion)	Human error; equipment failure; falling objects; earthquakes; pressure sources; corrosive materials; oxygen deficiency	Machinery Standards; seismic restraints; alarms	Crane and forklift operator certifications; PPE; signs, postings; Hazard Communication Program	Worker observation	None identified	Employee training; lock-out and tag-out procedure	Worker injury; equipment damage; facility damage
6. Explosion	Equipment failure; flammable materials; buildup of explosive gas; natural gas leak, criticality	Lack of explosive sources, except natural gas line	No on-site refueling; employee training; fire inspection and drills; GA Accident Prevention Plan	Worker observation; process indicator changes	Automatic fire sprinkler system; fire extinguishers; on-site ERT equipment; fire hydrant	Employee training; emergency response plan with on-site ERT; security	Worker injury; equipment damage; facility damage; potential release of radioactive & hazardous material to the environment
7. Thermal Sources (Heat & Cold)	Human error; container failure; process system failure; criticality; flammable materials; heat/cold sources	Lack of critical mass or heat/cold sources	No on-site refueling; employee training; fire inspection and drills; GA Accident Prevention Plan	Worker observation; process system indicator changes	Alarms; emergency response equipment	Health & Safety Plan	Worker injury

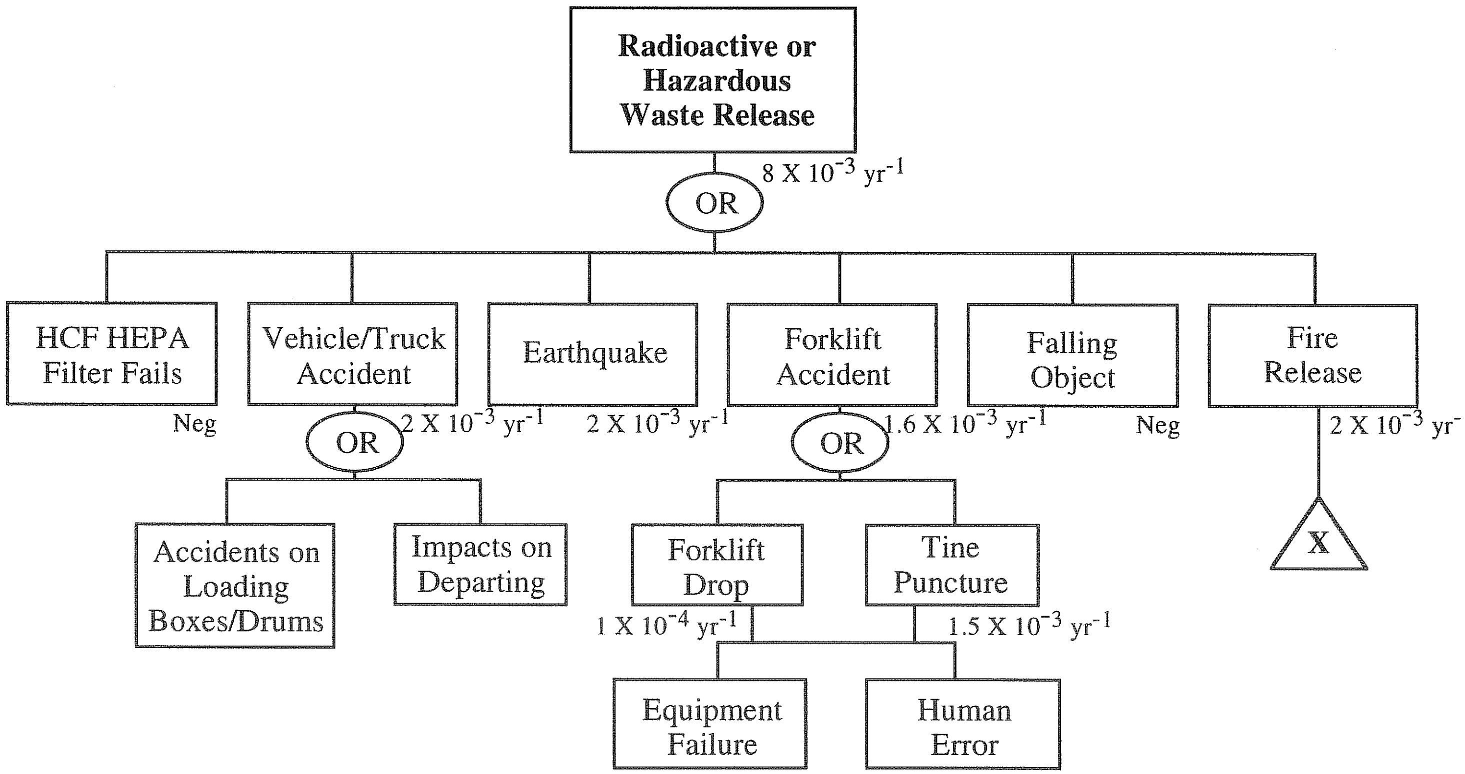

Fig. 5-3 Logic Diagram for Hazardous or Radioactive Material Release (Page 1 of 2)

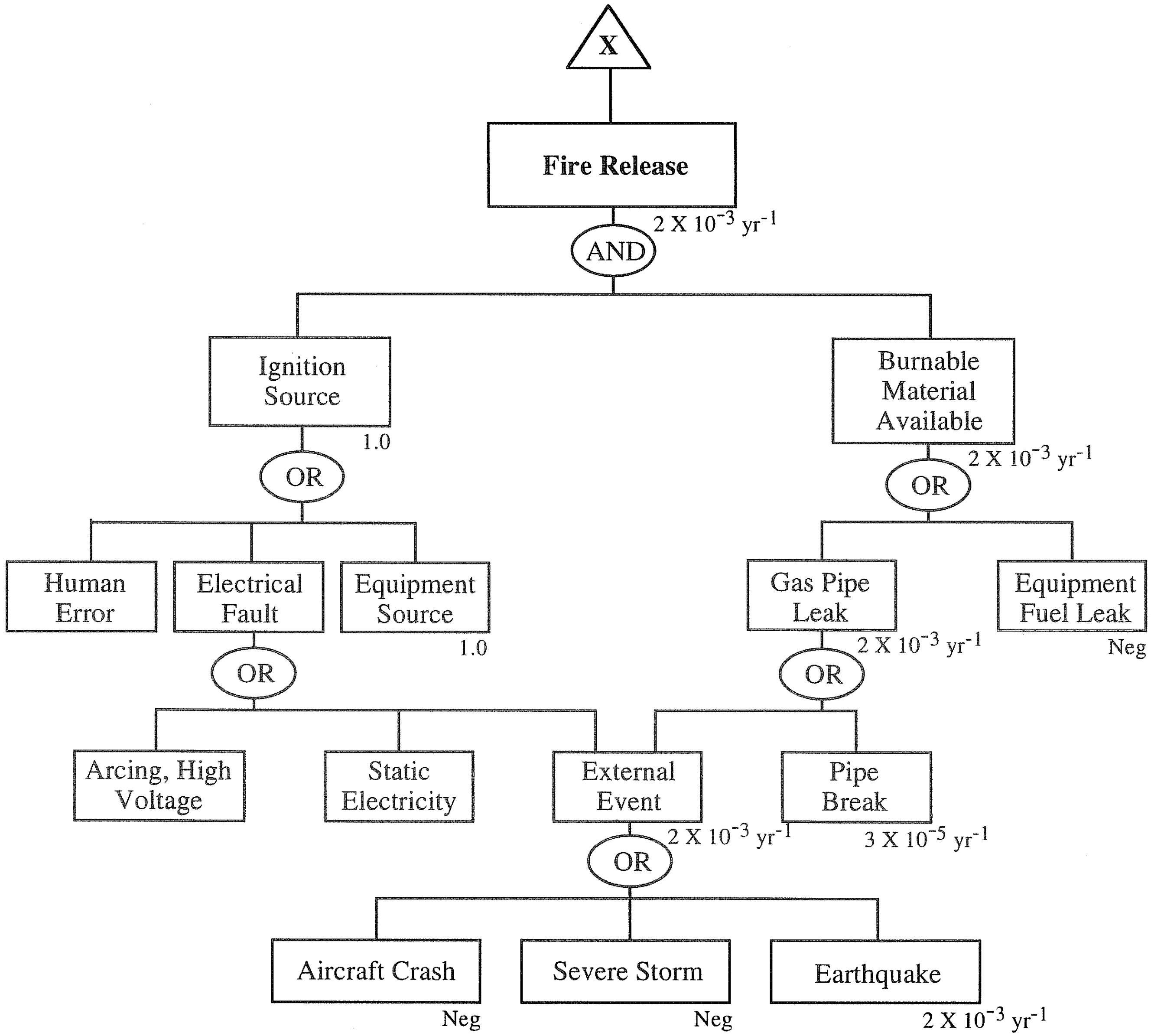

Fig. 5-3 Logic Diagram for Hazardous or Radioactive Material Release (Page 2 of 2)

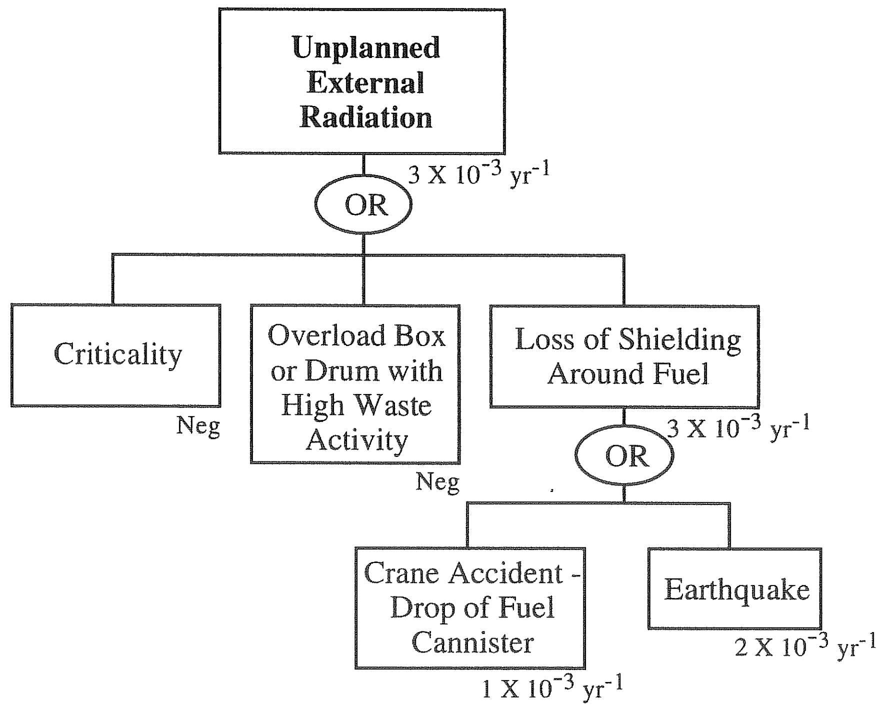

Fig. 5-4 Logic Diagram for External Radiation Accident

5.5 Consequences and Risks

The accident scenario analysis in Section 5.4 identified the following key accident concerns:

Scenario A: Radioactive or hazardous waste release (Fig. 5-3).
Scenario B: External radiation exposure (Fig. 5-4).

To bound the accident consequences of Scenario A, the drum inventory was estimated based on the bounding inventories of contamination in the HCF in Table 5-6. According to procedures and waste characterization and movement plans, it was assumed that no more than (usually much less than) one hundredth of the total inventory would be placed in any one container or drum. This is much more than the maximum calculated allowable activity, for the mix of isotopes at the Hot Cell Facility, than can be shipped in a barrel or LSA box. In accident Scenario A, a mechanical impact is the primary cause of loss of container/drum integrity. Release fractions recommended in Ref. 1-2 were used to estimate actual releases to air. These release fractions are:

Gases:	1.0
Highly volatile:	none present
Semi-volatile:	cesium and ruthenium: 0.01
Less volatile solids:	all others: 0.001

Results of the calculated radionuclide releases to air for Scenario A are summarized in Table 5-12. Dose impacts of these releases were estimated at 100m, the approximate shortest distance to the GA property boundary from the HCF. This was done by scaling the dose at 100 m (namely, 1 rem) calculated in Ref. 1-2 for Category 2 inventories by the ratio of Scenario A release amount to the threshold amount in the standard. This calculation is summarized in Table 5-12 and serves to illustrate the margin for the qualitative category 3 definition of no off-site consequences. The maximum dose for all radionuclides at the nearest property boundary is found to be less than 0.005 mrem, or about 20,000 times lower than the allowable annual dose to persons in unrestricted areas per 10 CFR 20.105. Therefore, Scenario A corresponds to consequence level 4 (Table 5-2), extremely low, in the risk matrix diagram in Fig. 5-2.

To bound the accident consequences of Scenario B, it was assumed that the worst accident conditions correspond to a drop of the RERTR fuel canister on the HCF floor and the unshielded end of the canister allows horizontal "shine," or direct radiation, along the ground. Dose rates at various distances were calculated using the PATH computer code based on no credit for shielding. Results from the PATH code (Ref. 5-7) are shown in Table 5-13; dose rates at locations of the crane operator, nearest non-radiological workers and the nearest sensitive receptors (day care center on John Jay Hopkins Drive) are indicated. Total doses will depend upon the time to remotely retrieve the canister and place it in the shipping cask. If the accident is unplanned for, this time might be long. However, contingency measures will be developed so that a prompt recovery can be made, well within the time (70 hours) for non-radiological workers to be exposed to the allowable dose of 100 mrem per 10 CFR 20.105. Recovery within minutes should be achievable. Based on the above consequences, Scenario B is calculated to correspond to consequence level 3, low (minor on-site with no off-site impact).

The risks associated with Scenarios A and B can be compared to the risk matrix diagram in Fig. 5-2 as follows:

Scenario A:	Probability Level C - Low ($8x10^{-3}$ yr^{-1})
	Consequence Level 4 - Extremely low
	Risk Level - Extremely Low (acceptable)
Scenario B:	Probability Level C - Low ($3x10^{-3}$ yr^{-1})
	Consequence Level 3 - Low
	Risk Level - Extremely Low (acceptable)

Table 5-12
Summary of Dose Calculations for Scenario A

Isotope	Maximum Drum Inventory (Ci)	Release Fraction	Release to Air (mCi)	Dose at 100m (mrem)
^{3}H	2.6E-04	1.0E+00	2.6E-01	8.7E-11
^{55}Fe	5.6E-01	1.0E-03	5.6E-01	5.1E-08
^{60}Co	9.7E-01	1.0E-03	9.7E-01	5.1E-06
^{63}Ni	4.3E-01	1.0E-03	4.3E-01	9.6E-08
^{90}Sr	4.9E+00	1.0E-03	4.9E+00	2.2E-04
^{90}Y	4.9E+00	1.0E-03	4.9E-00	1.2E-05
^{106}Rh	8.0E-02	1.0E-03	8.0E-02	1.9E-07
^{106}Ru	8.0E-02	1.0E-02	8.0E-01	1.2E-04
^{125}Sb	3.0E-02	1.0E-03	3.0E-02	7.0E-08
^{134}Cs	2.7E+00	1.0E-02	2.7E+01	4.5E-04
^{137}Cs/^{137m} Ba	3.5E+00	1.0E-02	3.5E+01	3.9E-04
^{144}Ce	2.6E-01	1.0E-03	2.6E-01	3.2E-06
^{144}Pr	2.5E-01	1.0E-03	2.5E-01	5.8E-07
^{154}Eu	5.0E-02	1.0E-03	5.0E-02	4.6E-07
^{155}Eu	2.0E-02	1.0E-03	2.0E-02	2.7E-08
^{228}Th	4.0E-03	1.0E-03	4.0E-03	4.4E-05
^{232}U	6.0E-03	1.0E-03	6.0E-03	3.3E-04
^{233}U	5.0E-03	1.0E-03	5.0E-03	2.3E-05
^{234}U	1.0E-03	1.0E-03	1.0E-03	4.6E-06
^{235}U	1.0E-05	1.0E-03	1.0E-05	4.2E-08
^{236}U	1.6E-05	1.0E-03	1.6E-05	2.9E-07
^{238}U	6.0E-06	1.0E-03	6.0E-06	2.5E-08
^{238}Pu	7.0E-02	1.0E-03	7.0E-02	1.1E-03
^{239}Pu	7.0E-03	1.0E-03	7.0E-03	1.3E-04
^{241}Pu	3.3E-01	1.0E-03	3.3E-01	1.1E-04
Total =	**1.9E+01**		7.6E+01	2.9E-03

Table 5-13
Summary of Path Code Results for Horizontal RERTR Canister

Distance		Dose Rate	Location
feet	meters	mrem/hr	
10	3	5,500	
20	6	1,500	Crane Operator
30	9	670	
40	12	380	
500	152	1.4	Non-rad. workers
2300	700	0.003	Day Care Center

6. SAFETY MANAGEMENT

This section addresses the need for, based on the Hazards Analysis, and/or the effect of any additional engineered controls or administrative procedures to further help prevent accidents from occurring or to mitigate the accident consequences. The issue of restrictions of operation or Technical Safety Requirements is also addressed.

6.1 Verification of Safety Classification

Comparison of total radioactive inventories with thresholds for Hazard Categories 2 and 3 (per Ref. 1-2) was performed in Section 5.2.3. Results showed that the HCF corresponds to Hazard Category 3 with wide margins below Category 2 thresholds, in regard to radiological hazards. Bounding accident consequences of key scenarios indicated that the qualitative definition of Hazard Category 3 is satisfied, namely, that a potential exists for significant but localized on-site consequences but no significant impacts are projected off-site.

Although hazardous materials have been identified in the HCF and the majority removed, an unknown amount may remain within the structure itself. Therefore, inventories of the hazardous materials have not been finally established. A list of estimated quantities indicated that amounts present in the HCF may exceed the Reportable Quantity (RQ, as defined in 40 CFR 302.4) for some chemicals such as lead. The Ref. 1-2 interpretation of Hazard Category 3 is that significant quantities of hazardous material are present that, if released, would have to be reported to the EPA. Thus, exceeding the RQs for some materials means that the HCF qualifies for Hazard Category 3. Because the bulk of the key hazardous materials is not in friable form but in large sizes that cannot become airborne, the potential for off-site consequences is considered to be negligible. Procedures will be implemented to preclude the formation of dust particles of beryllium, beryllium oxide or lead during D&D activities.

6.2 Operational/Technical Safety Requirements

DOE Order 5480.23 (Ref. 1-1) requires that the need for any restrictions of operations or addition/modification of any Technical Safety Requirements be identified by Safety Analysis Documents. Based on the low risk level calculated for key potential accidents and a review of the existing engineering controls and administrative procedures at the HCF, it is concluded there is no need for any additional operational restrictions or Technical Safety Requirements in order to protect the health and safety of the public.

6.3 Adequacy of Engineering and Administrative Controls

The calculated risk level is low for future activities at the HCF. However, several improvements were identified which would provide even further risk reduction.

The fire risk was shown to be dependent upon the availability of flammable fuel or burnable material in the HCF. One source of fuel that could enable a large fire to occur is the natural gas supply. Gas lines have been known to rupture during an earthquake.

In order to assure that amounts of radioactive and hazardous waste in any one container be limited, more formal procedures could be developed to assure that packaged amounts are closely monitored and compared with levels calculated in the Hazards Analysis to be within the qualitative definition of a Hazard Category 3 facility.

Contingency procedures could be developed to recover, in a timely manner, a dropped irradiated fuel canister upon its transfer from the interim storage cask to the shipping cask, in the unlikely event that the crane hold fails.

6.4 Quality Assurance

Quality Assurance (QA) procedures written for the HCF activities demonstrate an appropriate commitment to a QA program that is required by Ref. 6-1, "Quality Assurance." The QA program includes document control; inspection, surveillance and testing control; handling, storage and shipping control; worker health and safety control; and instrument and equipment control.

The GA Quality Assurance program is a company-wide system documented in the QA Manual (QAM) (Ref. 6-2). This manual meets the QA requirements of the latest edition of ASME NQA-1. The manual also implements the requirements of 10 CFR, Part 50, Appendix B and Part 71, Subpart H. The procedures in the QAM describe various aspects of quality that will be applicable to the HCF D&D project. The GA QA program has been reviewed and accepted by the NRC.

Throughout the HCF project, GA QA will:

1. Ensure that decommissioning personnel are trained and qualified for their assignments and that records of training and certification are documented and maintained.
2. Review and approve procedures and changes to verify compliance with regulatory requirements and the decommissioning plan.
3. Ensure that calibrations and control of measurement ant test equipment are accomplished prior to use.
4. Perform surveillance and periodic audits of decommissioning activities to ensure programmatic conformance to approved procedures and plans.
5. Verify that records documenting waste disposal activities are accurate, complete and maintained.
6. Initiate corrective actions for any conditions that do not meet procedural requirements or that are deemed detrimental to the safety of decommissioning workers or the public.

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APPENDIX A—SEISMIC FAULTS IN THE SAN DIEGO AREA

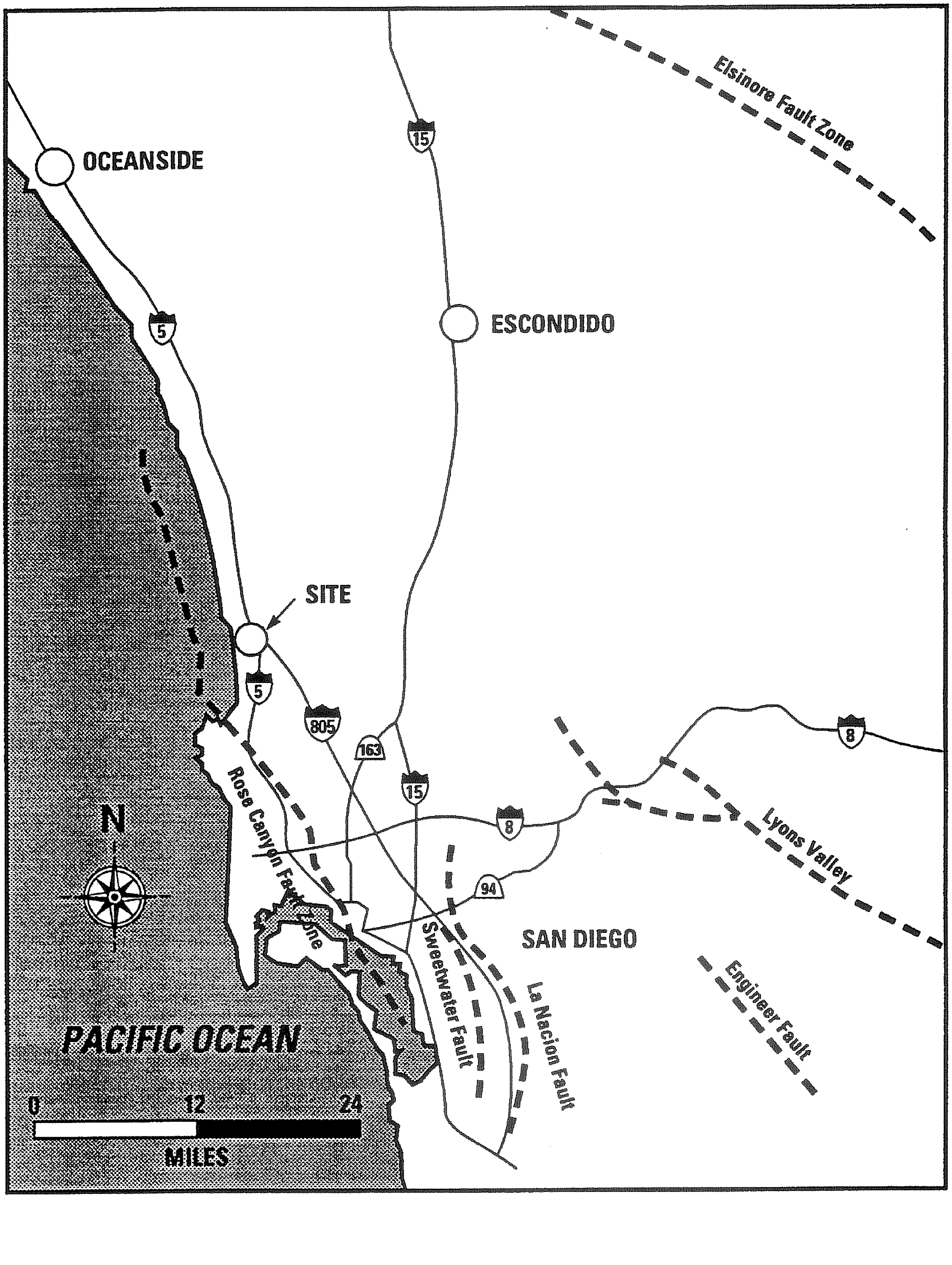

Fig. A-1 Seismic Faults in the San Diego Area

Elsinore Fault—This zone is one of the major active faults in Southern California. It trends northwest-southwest over approximately 180 miles along the east side of the Santa Ana Mountains and passes through Lake Henshaw about 20 miles northeast of Escondido. Since 1900, five earthquakes with magnitudes between 5.0 and 6.0 have occurred along this fault. In 1910 an earthquake with a magnitude in excess of 6.0 was felt over most of Southern California. Ref. 3-10 estimated the maximum earthquake on this fault to be magnitude 7.5.

La Nacion Fault—The La Nacion fault zone lies 6 miles east of and parallel to the Rose Canyon Fault Zone in urban San Diego. The zone includes several disjointed sections known as the La Nacion, Sweetwater and Chula Vista faults. Based on shallow subsurface evidence it is believed that the La Nacion Fault Zone is active. However, there is no firm evidence as to the rate of activity other than that is must be relatively low. The zone extends a length of 15 miles from the south side of Mission Valley, within the City of San Diego, to near the U.S. Mexican border. The Sweetwater fault extends south of Division Street, along 58th Street, and adjacent to the westerly edge of the Paradise Hill community. The La Nacion fault lies less than a mile farther to the east and is the most prominent segment, extending about 10 miles in length. Based on segment lengths, this zone is believed to be capable of generating an earthquake with a magnitude of 6.5 (Ref. 5-9).

Newport-Inglewood Fault—This zone is made up of a series of subsurface faults which have been documented with extensive oil exploration in the Long Beach area. As viewed on aerial photographs, the fault zone is marked by a prominent series of small mesas, folded rocks and strong linear marks that trend to the northwest. This fault zone generated the Long Beach Earthquake of 1933. The full extent of the Newport-Inglewood Fault Zone in the southeast direction has not been established. Evidence of possible faulting can be found along the coast as far south as Newport Beach. The fault continues offshore toward the southeast and may be associated with the South Coast Offshore Zone of Deformation (SCOZD). Conservatively, the SCOZD is considered to have similar characteristics to the Newport-Inglewood fault and a magnitude of 7.0(Ref. 5-8).

Rose Canyon Fault—The Rose Canyon Fault Zone consists of a discontinuous series of fault segments which run parallel to the coastline and intersect land at La Jolla Cove, south through Rose Canyon, and along the east side of Mission Bay. In the vicinity of Old Town, the fault bends southeast toward downtown San Diego and appears to splay into a number of different fault segments. The Rose Canyon fault has been the source of repeated small-to-moderate magnitude earthquakes. A series of earthquakes in 1985 (the largest being magnitude 4.7) was centered approximately 0.6 mile south of the San Diego-Coronado Bay Bridge. A similar series of earthquakes located beneath San Diego Bay occurred in 1964. In 1862, an earthquake centered southwest of downtown San Diego produced shaking of estimated intensity 6.0 to 7.0 and caused minor damage. Information regarding the probabilities of different size earthquakes is limited. Recent investigations in this area indicate that the zone is active. In a recent analysis, (Ref. 3-10) a maximum magnitude of 7.0 is assigned to the fault with a cumulative rate of occurrence at a level of 1.708×10^{-3} per year (i.e., a return period of 586 years). The cumulative mean rate of occurrence for magnitude 6.5 earthquakes was estimated at approximately 2.00×10^{-3} (return period of 500 years).

San Jacinto Fault—The San Jacinto Fault Zone is a 160 mile long complex system of faults. The fault extends from the eastern San Gabriel Mountains south through Borrego Valley. This fault appears to merge with the San Andreas fault zone at the north side of the San Gabriels near Pearblossom. One of the most active faults in the state, the San Jacinto has been the origin of many small and moderately large historic earthquakes. During the magnitude 6.5 earthquake of April 1968, ground surface rupture occurred along this fault in Borrego Valley in San Diego and Imperial Counties.

Coronado Bank and San Diego Trough Faults—These zones extend roughly parallel to the coastline about 14 miles and 23 miles (respectively) offshore from San Diego. They are considered capable of producing earthquakes up to 7.5. Since these are offshore faults, it is difficult to confidently assign slip rates based on scant geologic information. (Ref. 3-10)

APPENDIX B—POTENTIAL ACCIDENT SCENARIOS WHICH WERE CONSIDERED

POTENTIAL ACCIDENT SCENARIOS

Potential accidents were identified by studying previous documents and analyses dealing with the subject activities and evaluating the potential for energy sources to initiate an accident scenario. Potential accident scenarios which were considered include the following:

A. Failure of power for the crane or canister hoist—This failure would result in a stoppage in loading, transfer or unloading operations which would increase the time duration of exposure, and the associated risk, slightly. However, the safety/holding pin prevents the canister from falling and power failure of the hoist, or crane, would not release the cask or canister. A portable backup power source will be available to limit the time period of exposure.

B. Small fire occurring within the HCF—This incident may be caused by the inadvertent ignition of the diesel fuel from mobile equipment or hydraulic oil. No other flammable source is present. A potential cause of fire initiation is associated with the electrical system. During an earthquake or any situation in which movement occurs within the building there is the possibility that wires may short out or spark. The structure of the Building 30/31 Complex is primarily concrete and steel. Therefore, the threat of a fire causing a large amount of damage is highly improbable.

The potential impact of this accident scenario could be the release of some hazardous material or radioactivity. In addition, there could be some hazardous products of combustion, such as carbon monoxide. The likelihood of the fire involving the entire facility, except in the unlikely case of an airplane crash on the site, is extremely remote. GA maintains fire fighting equipment on site for quick response to any fire emergency. This is in addition to the fire fighting equipment of the City of San Diego which is responsible for all the areas of the GA facility.

In the case of a radioactive release from fire or other accident, GA would follow the NRC approved GA Radiological Contingency Plan for any emergency involving radioactive materials. The San Diego County Department of Health Services (DOHS) has a copy of GA's Radiological Contingency Plan. Both DOHS and NRC expect GA to follow this plan. The plan addresses classification and assessment of events, actions to take, safety equipment and facilities, notifications, reporting, etc. in detail.

C. A loss of radiological shielding due to shaking motions or impacts involving the irradiated fuel during an earthquake—The seismic potential at nearby faults is discussed in Appendix A. For the nearest faults, such as Rose Canyon, the frequency of large earthquakes beyond the design basis of the facility is very low. However, due to the fact that the radioactive fuel material is contained within the transportation casks, the likelihood of a radioactivity release resulting from an earthquake is extremely low. Risk management measures will be implemented by providing structural supports to the casks to prevent tip-over. With this measure loss of shielding (tip-over of the cask or drop of the fuel canister) is very unlikely.

D. Formation of a critical mass of special nuclear material leading to a large heat release—This cannot occur because the amounts of SNM present in the HCF are below the minimum amounts needed to form a critical mass.

E. Man made catastrophes—This might include airplane crash, terrorism, bomb threat, or civil disturbance. Such events are considered possible but highly unlikely. The GA property security (24-hour guards with gated access) provides a redundant deterrent against hostile actions. The HCF is not located on an airport takeoff/landing approach path so that aircraft crash probability is diminished.

F. Drop of the canister due to a handling accident caused by human error or equipment failure—Radiological Work Authorization procedures and on-site emergency response plans will prevent this event from occurring and will mitigate the consequences. In addition, the event is prevented by the safety devices described under Accident A and C.

G. Failure of the power system presently existing in the HCF—There is no longer a back-up power source for the HCF, therefore, if a power failure were to occur it would be necessary to evacuate the workers from the building.

H. Tritium monitor detects high tritium levels inside the HCF—All workers not wearing suitable personal protective equipment should be evacuated from the HCF. The cause of the high levels of tritium should be investigated.

I. A release of hazardous chemicals from their containers due to shaking motions or impacts during an earthquake—The seismic potential at nearby faults is discussed in Appendix A. For the nearest faults, such as Rose Canyon, the frequency of large earthquakes beyond the design basis of the facility is very low. Consequences should not involve off-site impacts.

J. Waste processing mishap including liquid transfer from carboy—For the flexible hoses and electric pumps that transfer liquids from the carboy to the 55-gallon drums, the hoses are assumed to be the critical component for leakage. FEMA (FEMA, 1989) recommends a failure rate of 10^{-4} per loading operation for large hose failure. The number of drums expected to be transported should be less than 100 drums per year. Based on the failure rate and the estimated number of loadings, the spill probability is,

$$P(\text{hose}) = 10^{-4} \times 100\ \text{yr}^{-1} = 0.01\ \text{yr}^{-1}$$

At this low probability, such a mishap would not be expected over the 5 year D&D duration. Consequences are not expected to impact persons off-site.

K. Drum or container spill/release due to a handling accident caused by human error or equipment failure—Included are containment tent or bag releases. Such events have been known to occur at similar facilities and are mitigated by the air monitoring and other accident prevention measures described in the HCF Work Authorization procedures and on-site emergency response plans. Spills are a greater concern for worker safety than for off-site impacts.

L. Failure of the HEPA filter system—Possible incidents include failure of the fan within the system, blowout of the filter, or accidents occurring during filter change-out. These incidents would lead to contamination of the air in the area of the HCF.

M. Failure of the personal protective equipment/clothing being worn during D&D activities—This is largely controlled by periodic inspection of the equipment and clothing, looking for signs of degradation or breakthrough. However, there is still a low probability of a leakage path created by snagging or puncture. The consequence might be that a worker is exposed above the permissible exposure limit.

N. Drop of irradiated fuel canister upon placing it in the interim storage casks. The entire operation of removing the irradiated fuel from the current storage location and placing it in the interim storage cask will take place within the hot cells. The cells are fully shielded and remote instruments are fully operational to retrieve the canister dropped anywhere within the high level cell.

O. Workers come in contact with a previously unidentified radiation source. Radiation surveys and decontamination procedures make this very unlikely for a gamma emitter source. For beta or alpha emitter sources, special precautions will be implemented to protect workers from inhalation or ingestion of such sources, as described in Section 4.2.

P. <u>Worker exposure to mineral oil upon removal of Hot Cell windows</u>. About 300 gallons of mineral oil are contained in the windows. The windows will be taken apart in small pieces and workers will be protected with appropriate personal protective equipment. Mineral oil also has a low toxicity. Therefore, no hazardous work exposures are expected.