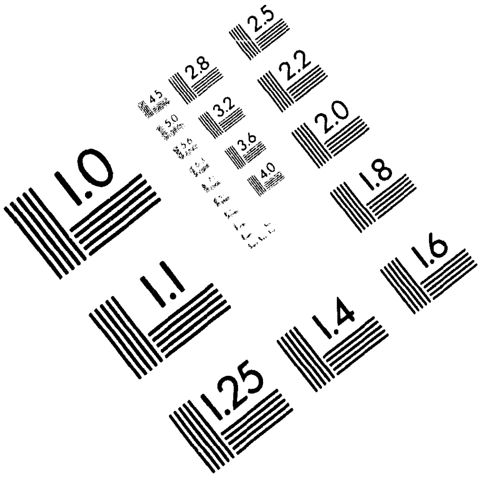

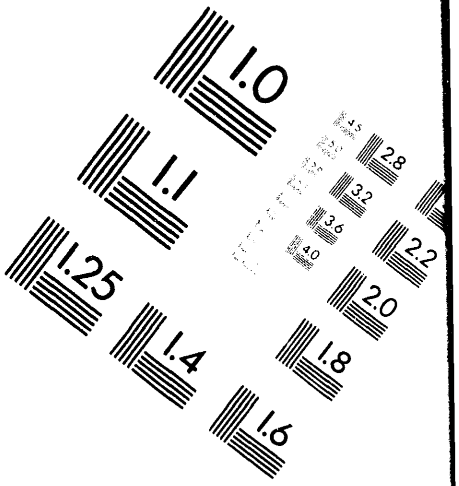

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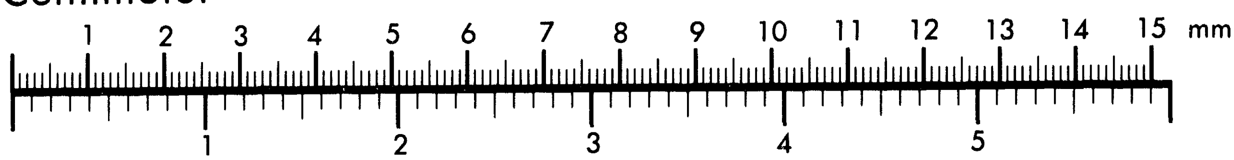

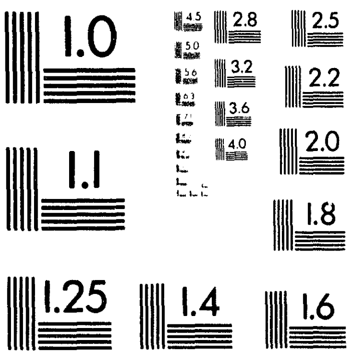

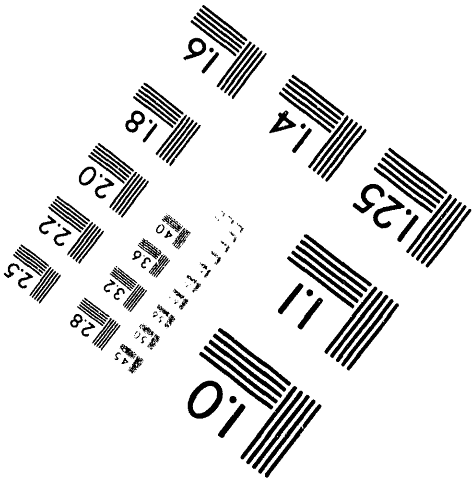

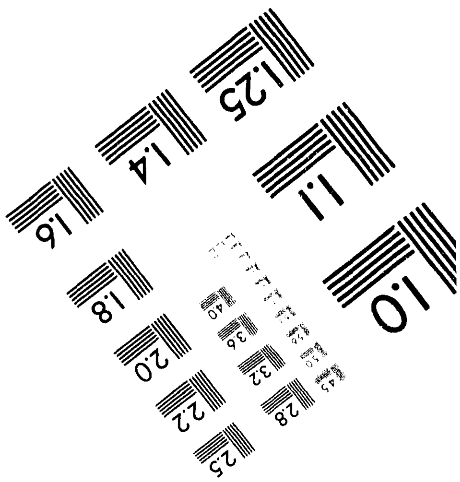

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SANDIA REPORT

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Printed April 1994

Generic Safety Documentation Material

Jeffrey A. Mahn

Prepared by
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GENERIC SAFETY DOCUMENTATION MATERIAL

Jeffrey A. Mahn, Compiler
Risk Management and NEPA Department
Sandia National Laboratories
Albuquerque, NM 87185

Abstract

This document is intended to be a resource for preparers of safety documentation for Sandia National Laboratories, New Mexico facilities. It provides standardized discussions of some topics that are generic to most, if not all, Sandia/NM facility safety documents. The material provides a "core" upon which to develop facility-specific safety documentation. The use of the information in this document will reduce the cost of safety document preparation and improve consistency of information.

Acknowledgments

This document was compiled from material that was extracted from the following documents:

Sandia National Laboratories, New Mexico Environmental Baseline Update (SAND92-7339)

1991 Environmental Monitoring Report Sandia National Laboratories Albuquerque, New Mexico (SAND92-0939)

Safety Assessment for the Center for National Security and Arms Control (SAND92-2170)

Emergency Preparedness Plan, Sandia National Laboratories, Albuquerque, New Mexico, Issue A, December 1991

Sandia National Laboratories Program Documents for Radiation Protection, Quality Assurance, Waste Management, Self-Assessment, etc.

In addition, R.O. Murphy and L. Shyr, Environmental Services, Inc., provided a significant contribution in formulating the accident evaluation guidance material in Chapter 7.

Numerous Sandians also contributed to the document by providing review comments.

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Tables

1.0 Site Characteristics

1.1 Description of the Site and Boundaries

Sandia National Laboratories/New Mexico (Sandia/NM) is located approximately 10 kilometers (6 miles) east of downtown Albuquerque, New Mexico, in the foothills of the Manzano Mountains (see Figures 1.1-1 and 1.1-2). Sandia/NM is surrounded by Kirtland Air Force Base (KAFB) and has co-use agreements on some portions of Air Force property. KAFB is located on two broad mesas that are bisected by the Tijeras Arroyo, an east-west trending canyon. These mesas are bounded by the Sandia and Manzano Mountains (Cibola National Forest) to the east and the Rio Grande to the west. Regional elevations range from a low of 1,500 meters (4, 922 fee) at the Rio Grande to a high of 3,255 meters (10,680 feet) at Sandia Crest. KAFB is at a mean elevation of 1,630 meters (5,348 feet).

Sandia/NM is operated for the Department of Energy (DOE). It consists of five technical areas (TAs) and remote test areas situated in the eastern half of the 74-square-mile KAFB military reservation (see Figure 1.1-3). Adjacent to and physically combined with the KAFB installations is the Albuquerque International Airport, in what constitutes a large joint military and commercial transportation complex. Landing and takeoff patterns for the various runways at the airport facilities are not expected to affect Sandia/NM operations. The runway of most concern is the east-west runway.

1.2 Weather and Climate

Sandia/NM temperatures are characteristic of high-altitude, dry, continental climates. Sunshine is a predominant feature of Sandia/NM and occurs approximately 75 percent of daylight hours. Maximum daytime temperatures during the winter of 1988 averaged near 10°C (50°F); summer daytime maximum temperatures averaged less than 32°C (90°F) except in July when the maximum average reached 34°C (93°F) (NOAA, 1988). Temperature extremes below -27°C (-17°F) or above 41°C (105°F) occur infrequently (MHE, 1991).

The average annual precipitation for Sandia/NM is 21 centimeters (8.3 inches); half of this precipitation occurs from July through September in the form of convective thundershowers. Winters are typically dry with less than five cm of precipitation normally recorded in a given month. This includes occasional snowstorms with accumulations of 20-to-30 centimeters (8-to-12 inches) of snow. The maximum observed precipitation in 24 hours occurred in September, 1983, when 5.7 centimeters (2.3 inches) of rain was recorded. The total annual precipitation of 33 centimeters (13 inches) for 1988 was 12 centimeters (4.8 inches) above the 30-year average of 21 centimeters (8.3 inches). The average annual relative humidity recorded from 1951 to 1980 was about 43 percent, with the average humidity dropping to less than 20 percent in April, May, and June.

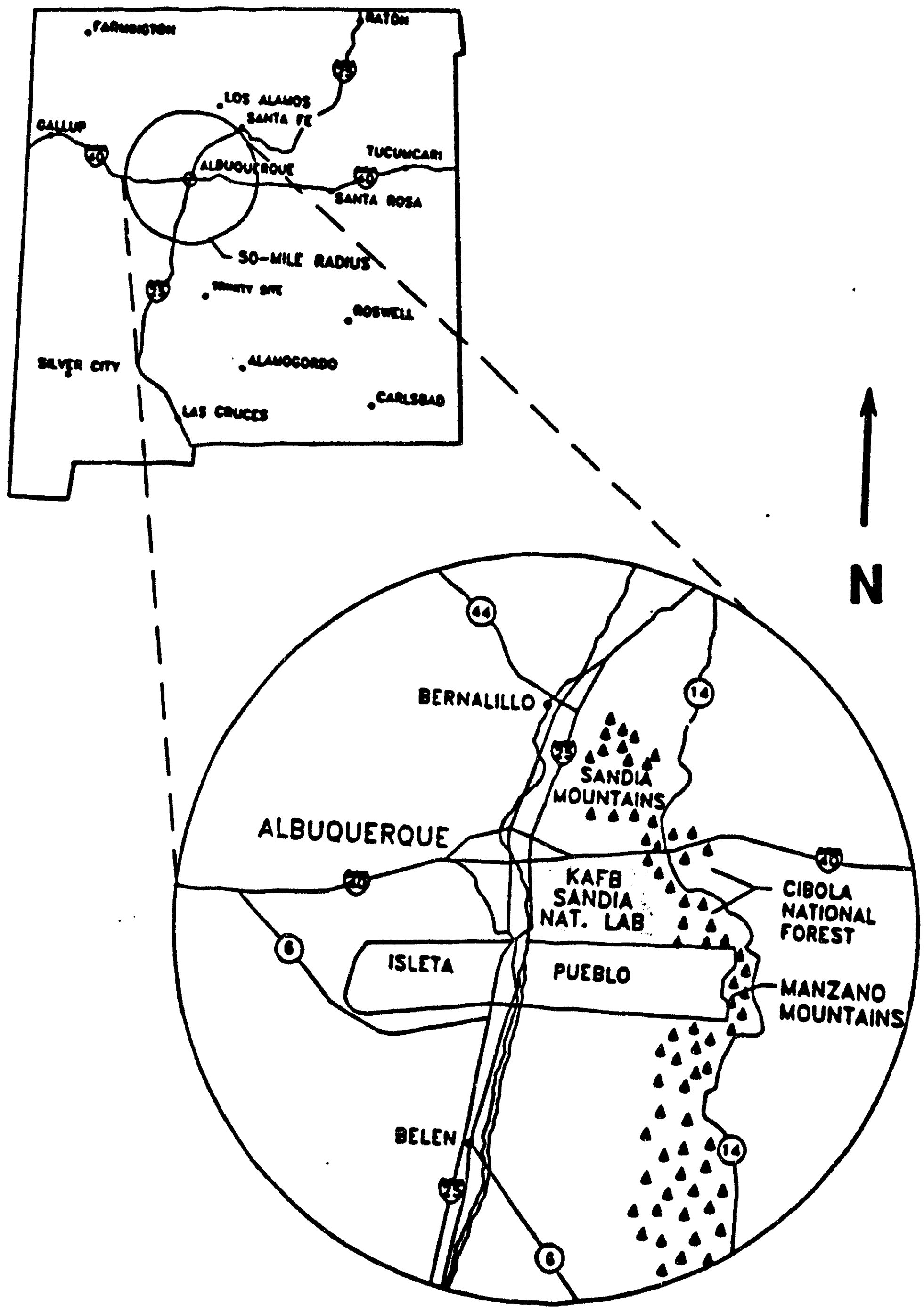


Figure 1.1-1 General Location Map, Sandia National Laboratories, Albuquerque, NM

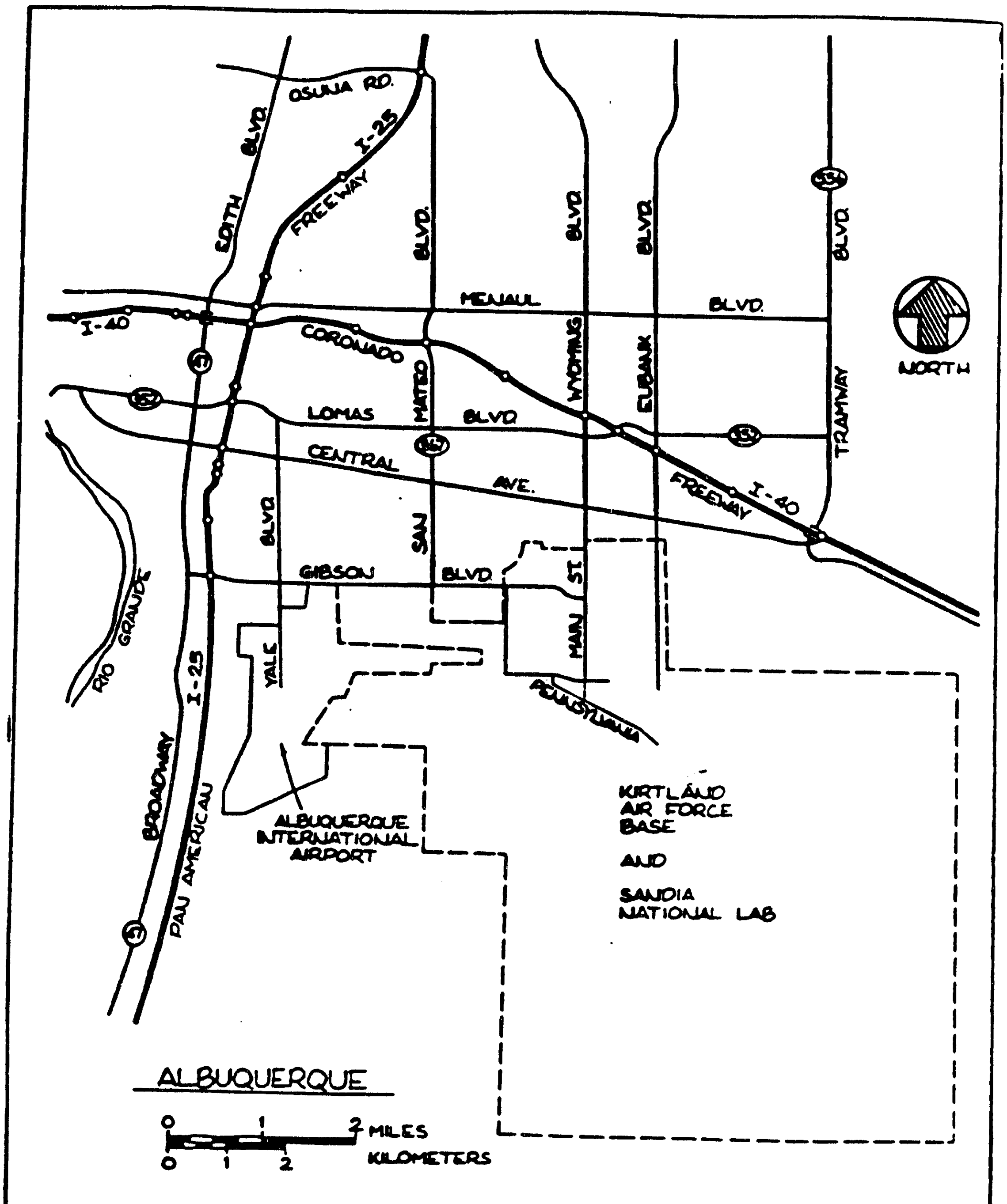


Figure 1.1-2 Location Map for Sandia National Laboratories/New Mexico

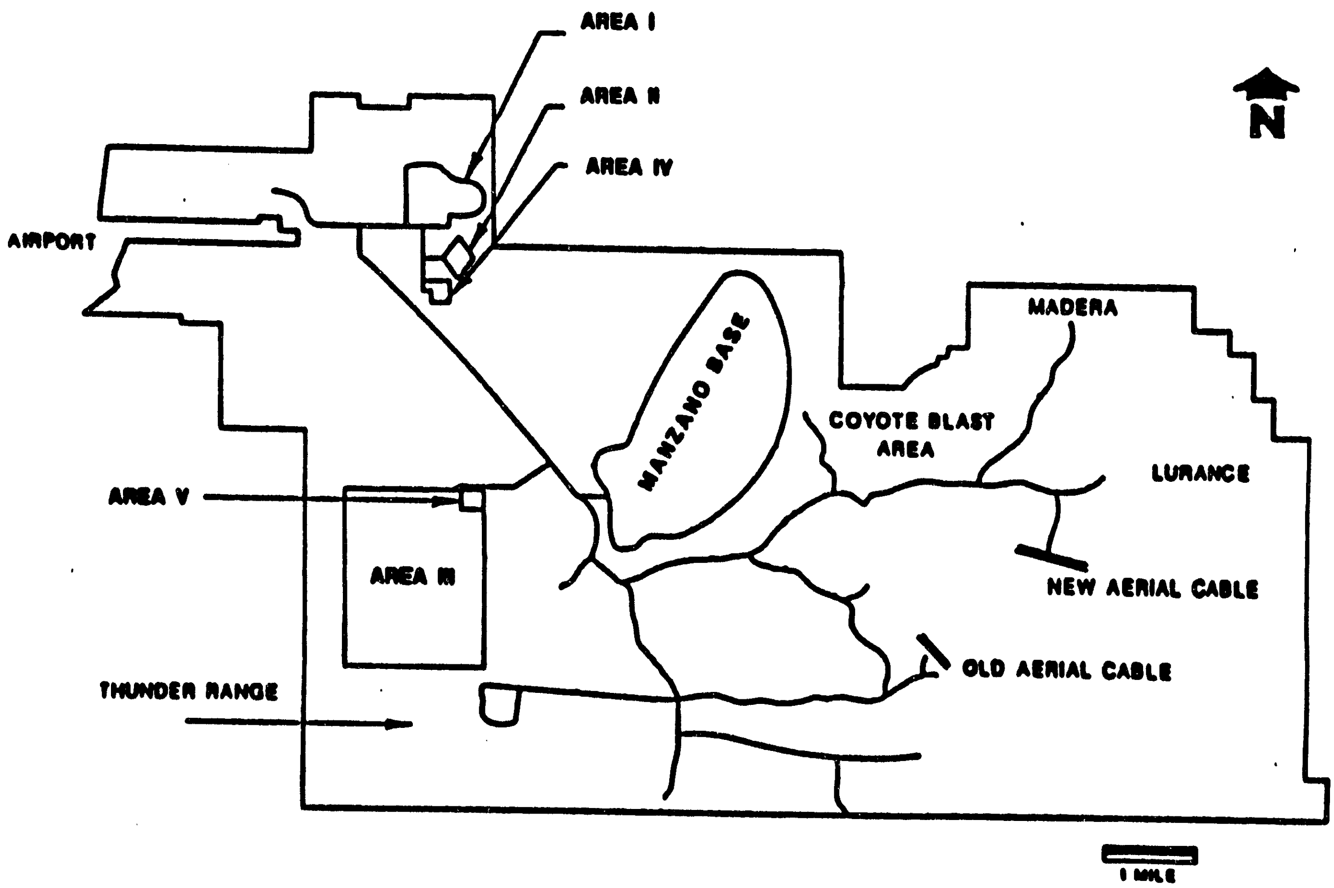


Figure 1.1-3 Sandia/NM Technical Areas

Strong winds, often accompanied by blowing dust, occur mostly in late winter and early spring. Wind speeds reach a maximum velocity of 28 knots (32 miles per hour) on an average of 46 days per year. Every two years, a one-minute duration gust of 52 knots (60 miles per hour) is expected (MHE, 1991). The average hourly wind velocity at the Albuquerque International Airport recorded from 1951 to 1980 ranged from 6.7 knots (7.7 miles per hour) in December to 9.6 knots (11 miles per hour) during April (NOAA, 1988). The annual surface wind speed and direction for Sandia/NM Technical Area I are depicted in Figure 1.2-1. Rapid nighttime ground cooling produces strong temperature inversions as well as drainage winds that flow out of the mountains during evening hours (ERDA, 1977).

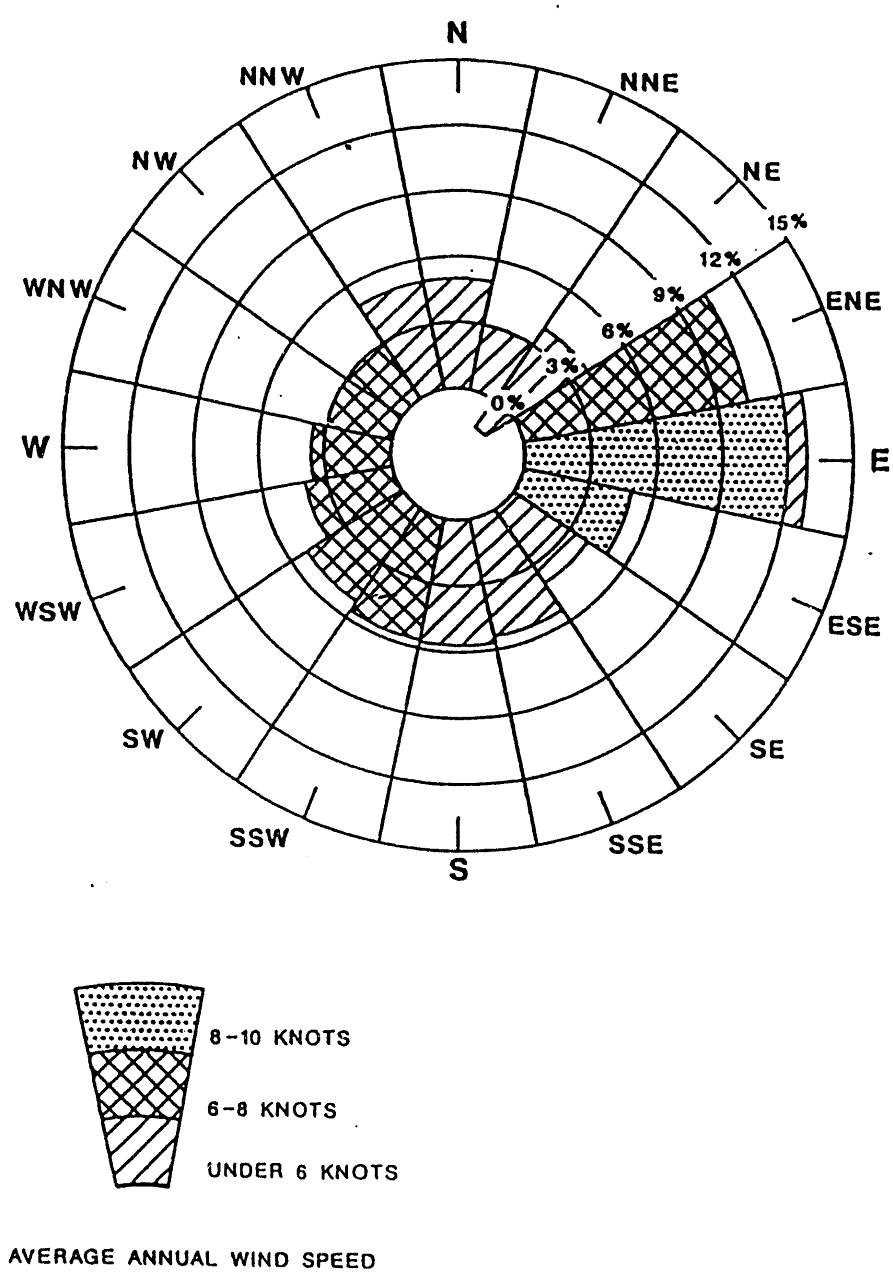
Tornado occurrences within the state of New Mexico vary from a minimum annual frequency of 0.2 to a maximum of 1.1 (Thom, 1963). Statistically, the highest frequency has been observed in the eastern half of the state. For the western half of the state, generally demarcated by the Rio Grande and the mountain ranges that parallel it on the east side, tornado frequencies are 0.3 or less. In the Albuquerque area, which lies west of the Sandia and Manzano Mountains, only two tornadoes have been reported in more than a 20-year span. These occurred within the center of the city of Albuquerque in the years 1985 and 1987 and are officially listed in the climatological records of the National Weather Service as "small tornadoes.' Damage was light and no official wind readings are available.

In addition, one funnel cloud has been observed in the same 20-year period. This was reported in the Four Hills area of Albuquerque about 2 kilometers to the east of Technical Area I on KAFB, but it was not observed to touch down and accordingly, it did not cause any reported damage. Based on the climatological records available, Albuquerque can be classified as a region of low occurrence with an annual frequency of 0.1 or less.

1.3 Air Quality

The air quality at Sandia/NM is strongly influenced by the presence of the Albuquerque metropolitan area to the north and west.

Sandia/NM is situated in the Rio Grande Valley, which is flanked by the Sandia and Manzano Mountains on the east and the Puerco Plateau on the west. This protects the Rio Grande Valley from many passing storms and reduces much of the air flow that would carry air pollution away from the metropolitan area (NMAQB, 1984). During many winter nights, the air in the metropolitan area becomes very stable and still, creating a temperature inversion which traps the pollutants emitted into the colder air at ground level. During the winter months, Albuquerque occasionally exceeds the ambient standards for carbon monoxide. Air quality has been improving, with fewer violations of the standards being reported over the past few years basically because of implementation of the Albuquerque/Bernalillo Air Pollution Control Program (NMAQB, 1988).



From SNL DIVISION 7251, 1970.
*Most current data available.

Figure 1.2-1 Annual Surface Wind Speed and Direction, Technical Area I

1.4 Geology: Surface and Subsurface Features

Sandia/NM is located in the Rio Grande Rift Valley of the Basin and Range physiographic province. The Rio Grande Rift is a structural feature that trends north-south from southern Colorado to El Paso, Texas (Kelley, 1979). The Sandia/NM area is situated on the East Mesa in the east-central portion of the Albuquerque-Belen basin segment of the rift (Figure 1.4-1). The basin is bounded on the east by the fault-block Sandia and Manzano Mountains, which consist of Precambrian granites, schist, gneisses, quartzite, and metavolcanics; on the west by the Lucero uplift and Puerco plateau; on the north by the Nacieniento uplift; and on the south by the Socorro Channel.

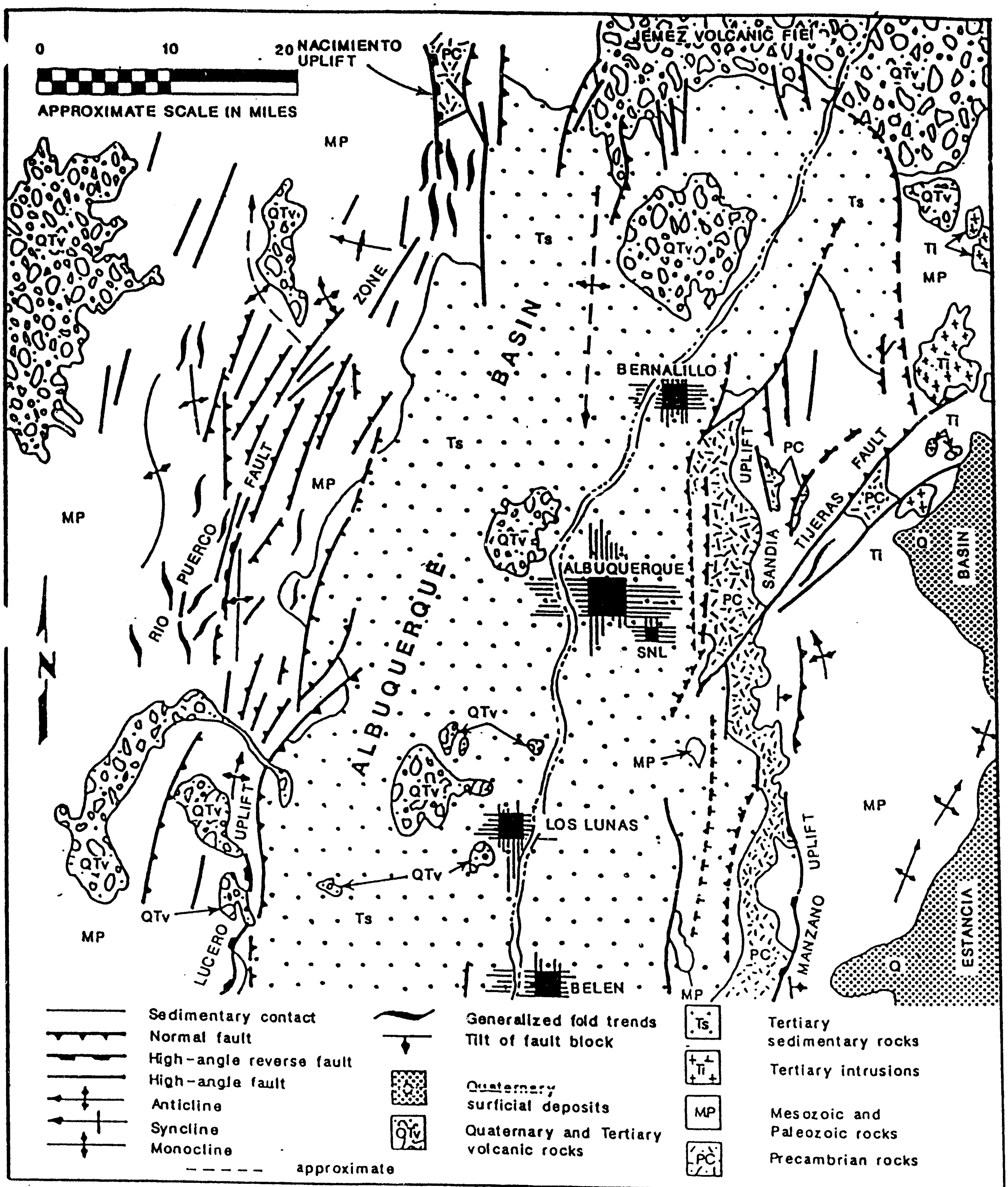
Large-scale faulting, deepening of the basin and tilting of the mountains in the late Miocene period have resulted in a differential vertical movement of 6,000 to 7,000 meters (3.7 to 4.4 miles) on the eastern basin border (Kelley, 1977). Both concurrent with and subsequent to the structural changes, the basin began to fill due to a complex mixture of eolian, channel, debris flow, levee, and flood plain-type mechanisms (Millard et al., 1989) resulting in a complex sequence of gravel, sand, silt, clay, and caliche deposits known as the Santa Fe Formation. The basin, which consists primarily of Tertiary and Quaternary deposits, is estimated to be 1,200 to 1,500 meters (0.75 to 0.9 miles) thick (Figure 1.4-2).

The East Mesa is characterized by alluvial and colluvial deposits formed due to runoff from the mountains onto alluvial fans or stream channels. The soils are the Embudo gravely, fine, sandy loam and the Wink fine, sandy loam, both of which are part of the Maurez-Wink Association (SDP, 1989; SCS, 1977). The Embudo soils are deep, moderately alkaline, well-drained soils that formed in alluvium derived from decomposed, course-grained, granitic rocks on old alluvial fans (SCS, 1977). The Wink soils are deep, calcareous, and moderately alkaline, well-drained soils that formed in old, unconsolidated alluvium modified by wind (SCS, 1977). Runoff from both these soils is medium with moderate water erosion hazard (DOE, 1988) and the shrink-swell potential for both is low (SDP, 1989).

The Rio Grande Rift between Albuquerque and Socorro is the most seismically active area in New Mexico. Seismic records date back to 1849, when the first reported earthquake occurred in Socorro; however, complete instrumental records are available only after 1962 (Northrop, 1982). Instrumental data since 1960 indicate a maximum probable local magnitude shock (M_L) within a 100-year period of 4.2 to 4.9 on the Richter scale (Sanford et al., 1972).

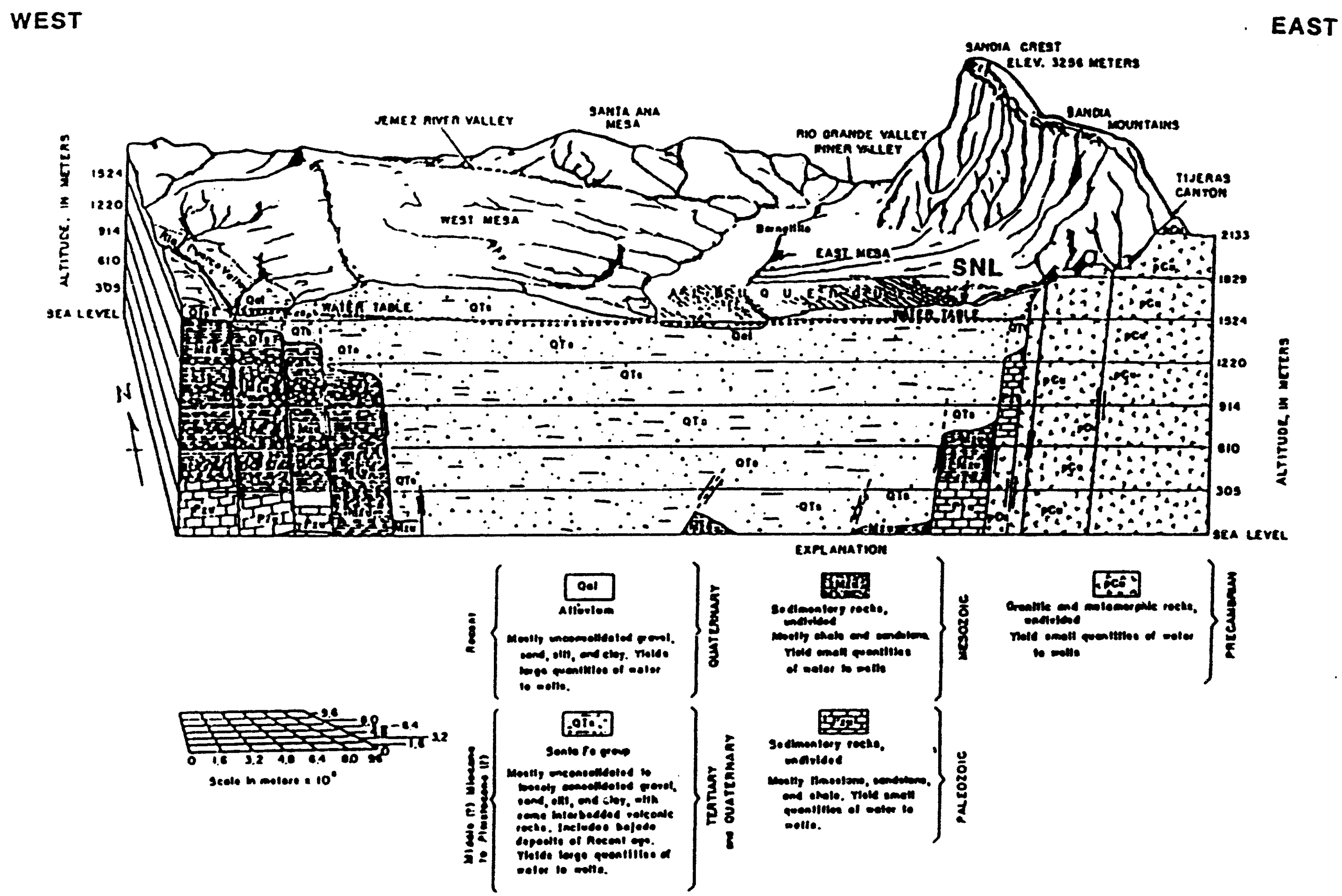
The Sandia/NM area is located in Seismic Risk Zone 2B (Figure 1.4-3) in which moderate damage from earthquakes (corresponding to Intensity VII of the Modified Mercalli Intensity Scale of 1931) may be expected to occur.

The largest recorded earthquakes in the Albuquerque-Socorro area have been measured at 4.7 on the Richter scale. An earthquake of this magnitude occurred on January 4, 1971, with the epicenter in the Albuquerque area. Minor damage to buildings was reported by the University of Albuquerque (now St. Pius High School); however, no damage to Sandia/NM buildings was reported.



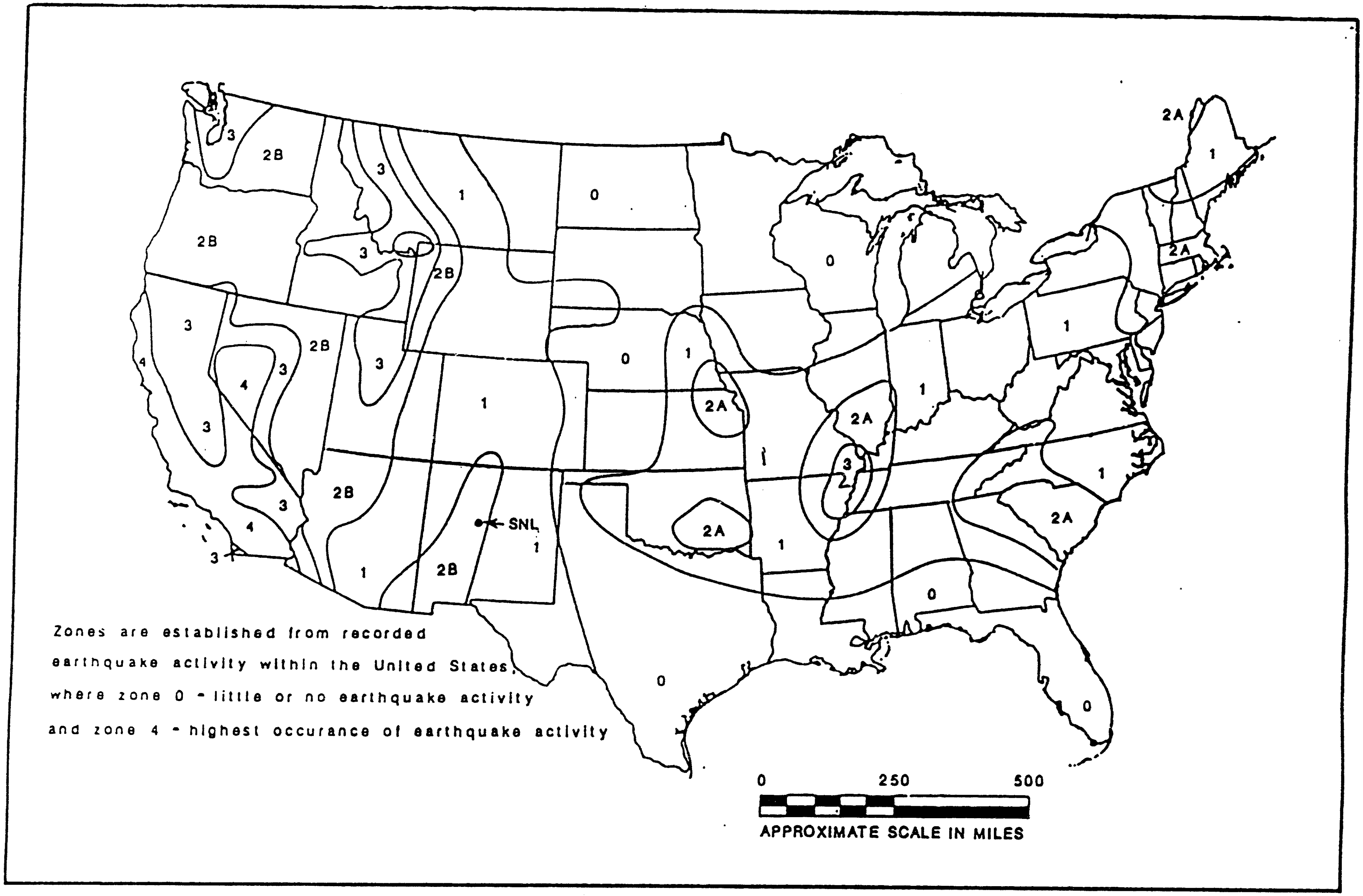
Modified from Woodward, 1982.

Figure 1.4-1 Tectonic Map of the Middle Rio Grande Depression



From ERDA, 1977.

Figure 1.4-2 Block Diagram of a Cross Section Through Sandia/NM Showing Topography, Generalized Geography, and the Water Table



From UBC, 1988.

Figure 1.4-3 Seismic Risk Map of the U.S.

Two other earthquakes with magnitudes of approximately 4.7 on the Richter scale occurred on November 28, 1970, and January 4, 1990, near the town of Bernardo, New Mexico, 65 miles south of Albuquerque. Damage to the Bernardo area was the only damage reported.

The fault zones along the eastern and western sides of the Albuquerque-Belen Basin were active in Miocene times and appear to have become stable since the mid-Pleistocene. Present seismic activity shows little correlation with the Albuquerque area fault zones, but is concentrated more with the mountains west of Socorro, 120 kilometers (75 miles) south of KAFB.

Numerous small volcanic centers occur along a line paralleling the axis of the Albuquerque basin to the west of the metropolitan area. The volcanoes include five small cones and 13 nubbins, the largest of which protrude about 180 feet above the ground surface. At least eight flows (andesite and basalt) occurred in the volcanic field, which was active only for a short period approximately 190,000 years ago.

1.5 Water Resources

1.5.1 Surface Water

The East Mesa has a generally west-southwestward ground surface slope ranging from about 47 meters per kilometer (250 feet per mile) near the mountains to 3.8 meters per kilometer (20 feet per mile) near the river. The distance from the foot of the mountains to the river varies from 4.8 kilometers (three miles) in the northern part of the mesa to 14.5 kilometers (nine miles) in the southern part of the mesa (ERDA, 1977).

Tijeras Arroyo, the major drainage of the East Mesa area, originates in the mountains and joins the Rio Grande at approximately 16 kilometers (10 miles) south of Albuquerque, cutting across the eastern part of KAFB. In addition, numerous small drainages emerge from the mountains onto the mesa. In general, very little of this surface water reaches the Rio Grande (USGS, 1977) because most surface water runoff enters the permeable deposits of the Quaternary-Tertiary alluvium or is evaporated or transpired.

During heavy precipitation, the elevated interfluvial regions drain by sheet flow into small gullies and rivulets. This water is carried by natural or artificial flow paths into Tijeras Arroyo and eventually reaches the Rio Grande. Occasional flooding is likely within these gullies and arroyos. The Army Corps of Engineers has estimated that a 100-year flood will reach a crest of 5,240.5 feet. The 80-foot walls of the Tijeras Arroyo are adequate to protect Sandia/NM against flooding.

1.5.2 Subsurface Water

The major subsurface reservoir beneath the Albuquerque area (including Sandia/NM) is composed of basin fill material of the Rio Grande (for deposits and alluvial material of Quaternary and Tertiary age) with a depth to bedrock of nearly 1.6 kilometers (5,000 feet) throughout most of the basin (Figure 1.4-2). The alluvial aquifer is bounded on the west by the Lucero uplift and on the east by the Sandia-Manzano Mountains (ERDA, 1977).

Groundwater in the alluvial aquifer generally occurs under unconfined conditions and flows in a southward direction under an overall gradient of approximately two meters per kilometer (10 feet per mile). The transmissivity of the alluvial aquifer is estimated to be 2,480 square meters per day (200,000 gallons per day per foot), and storativity (quantity of water that the aquifer will release from or the quantity that will be taken into storage per unit surface area of the aquifer per unit of head) is approximately 0.2 . The groundwater flow velocity is approximately six meters per year (20 feet per year) (ERDA, 1977). The water table beneath Sandia/NM on the East Mesa is approximately 150 meters (500 feet) beneath the surface, and groundwater generally flows in a southwestern direction towards the axis of the Rio Grande alluvial basin.

The alluvial aquifer is recharged principally by the Rio Grande. The aquifer also receives recharge at the base of the mountains where small canyons open onto alluvial fans and the alluvium is relatively coarse. Relatively little water percolates into the aquifer through the unsaturated zone, as most runoff from precipitation ultimately flows into drainages and into the Rio Grande, or is lost through evapotranspiration.

The greatest water level changes from 1960 to 1978 in the Albuquerque area were recorded on the east side of the Rio Grande. In the future, water levels will continue to decline on both the east and west sides of Albuquerque due to increased population. Total decline of the water table by the year 2000 will probably not exceed 37 meters of fresh-water saturation in the aquifer beneath the Albuquerque area (Kelly, 1982).

1.6 Flora and Fauna

The vegetation in this area is typical of an arid grassland. While more than 50 grasses may be found within this grassland association and the surrounding area, only a small number of species are abundant. The homogeneous nature of the vegetation does not support a high diversity of wildlife. Small mammals, reptiles, and birds are the most abundant species found. No species of federally listed endangered or threatened plants or animals have been observed at Sandia/NM. The New Mexico Energy, Minerals and Resources Department (NMEMRD, 1990) lists two state endangered species of cacti as potentially occurring in the area—the grama grass cactus and Wright's fish-hook cactus. The New Mexico Game and Fish Department's *Handbook of Species Endangered in New*

Mexico lists four animal species that may occur in Bernalillo County. However, these species are not expected to reside at Sandia/NM because of specific habitat requirements.

1.7 Demography

Sandia/NM is on KAFB, which is located in Bernalillo County, New Mexico. The population of Bernalillo County in 1990 was 480,577 (DOC, 1990). KAFB is bordered on the north and west by densely populated residential areas of the City of Albuquerque. To the east of KAFB is the Four Hills residential area of Albuquerque. Albuquerque had a population of 384, 736 in 1990 (DOC, 1990). To the south of KAFB is the Isleta Indian Reservation, which had a population of 2,915 in 1990 (DOC, 1990), and Valencia County. Valencia County is a rural and sparsely populated area. The most recent population figure for Valencia County is 45, 235 (DOC, 1990). KAFB itself houses up to 7,830 residents in barracks and detached or semi-detached family houses. As of 1990, the residential population of KAFB was 5,761. The total estimated population within a 50 mile radius of Sandia/NM is 632,500.

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2.0 Waste Management Program

Hazardous and radioactive waste management programs at Sandia/NM are administered in compliance with pertinent U.S. Department of Energy (DOE), U.S. Environmental Protection Agency (EPA), U.S. Department of Transportation (DOT), and State of New Mexico regulations, requirements, and guidance.

Responsibilities for waste management at Sandia/NM are divided among four departments—the Clinic Operations Department, the Transportation/Distribution Service Department, the Chemical Waste Management Department, and the Radioactive and Mixed Waste Department.

The Clinic Operations Department operates the Medical Waste Program for medical waste generated by the on-site employee medical clinic. The Transportation/Distribution Service Department operates the collection and transportation system for solid waste (i.e., normal trash such as paper and boxes) that is disposed of in the Kirtland Air Force Base (KAFB) sanitary landfill.

The Chemical Waste Management Department is responsible for providing guidance to Sandia/NM Resource Conservation and Recovery Act (RCRA) and non-RCRA chemical waste generators, performing spot checks of generator compliance with regulatory requirements, providing the interface to the DOE, EPA, and State of New Mexico on matters concerning chemical waste, preparing permit applications, and reviewing regulations for applicability or impact.

This department manages four types of waste: RCRA hazardous waste, asbestos, PCBs, and non-RCRA-regulated chemical waste. RCRA hazardous waste, TSCA waste and non-RCRA-regulated chemical waste responsibilities include collecting waste from generator locations, packaging waste into DOT-approved containers, operating the Hazardous Waste Management Facility (HWMF), arranging for and oversight of off-site shipment, treatment, and disposal of the waste, and preparing, revising, and submitting storage permit applications for the HWMF.

The Chemical Waste Management Department is also responsible for operation of the Thermal Treatment Facility (TTF), located at Building 6715 in Technical Area III.

The Radioactive and Mixed Waste Department is responsible for providing the programmatic framework to assure that radioactive waste (RW) and mixed waste (MW) generated by Sandia/NM is managed safely and in compliance with applicable laws, regulations, and DOE Orders. It is further responsible for providing operational support for the analysis, collection, storage, treatment, and ultimate disposal of Sandia/NM-generated radioactive and mixed waste. The department currently collects radioactive and mixed waste and stores it on an interim basis at the Technical Area III Interim Storage Site. This storage facility will be replaced by covered storage facilities that are being developed. The department is constructing two facilities for processing RW/MW prior to disposal: the Radioactive and Mixed Waste Management Facility (RMWMF) and the Waste Assay Facility (WAF). A Real-Time Radiography System (RTR) will be operated by the department as part of waste characterization and certification activities.

2.1 Sanitary Wastes

Sandia/NM has approximately 15 miles of sewer lines that are interconnected with those of KAFB. General discharges to sanitary sewers at Sandia/NM are regulated under the City of Albuquerque Sewer Use and Wastewater Control Ordinance. Sandia/NM currently holds seven wastewater discharge permits that cover both categorically regulated and general discharges to the Albuquerque sanitary sewer system.

Sandia/NM must comply with limitations and provisions contained in the city ordinance at the seven permitted outfalls. Several activities at Sandia/NM are subject to "National Categorical Pretreatment Standards" as described in *EPA Effluent Guidelines and Standards*, as well as by city ordinance. These activities are metal finishing processes and electronic parts manufacturing. Two other manhole permit stations are subject to general limitations.

To ensure compliance with the permits and reduce sewer corrosion, non-categorically regulated discharges must comply with the Sandia/NM guidelines for discharges of chemicals to the sanitary sewer. These guidelines prohibit the discharge of all but small quantities (no more than 100 milliliters or 100 grams, whichever is less, not including rinse waters) of inorganic acids and bases and short-chain alcohols and ketones to the sanitary sewer. In addition, these compounds must not be radioactive, explosive, or produce disagreeable odors.

Compounds that do not fall in the above permitted categories must be referred to the Sandia/NM Environmental Protection Department for disposal advice.

2.2 Radioactive and Mixed Waste

Sandia/NM manages its radioactive and mixed waste program in accordance with DOE Orders, principally 5820.2A (*Radioactive Waste Management*) and 5400.3 (*Hazardous and Radioactive Mixed Waste Program*), and other pertinent federal and state regulations. Mixed waste is managed according to requirements for radioactive waste as well as those for hazardous waste.

The Sandia/NM inventory of radioactive and mixed waste consists of approximately 81% radioactive waste and 19% mixed waste, or approximately 10,000 cu ft and 2,500 cu ft, respectively, by volume. Radioactive waste is essentially all low-level waste (LLW), with less than 1% transuranic waste (TRU). LLW consists of: activation products - 46%; fission products - 27%; tritium - 12%; uranium and thorium - 11%; and other - 4%. Mixed waste consists of: listed waste - 78%; characteristic waste - 17%; and other - 5%. The characteristic waste is approximately 63% toxic; the remainder has a combination of toxic, reactive, corrosive or ignitable constituents. Mixed waste exhibiting only reactive, corrosive or ignitable constituents is less than 1%. Listed waste is almost entirely from nonspecific sources (F-listed waste), with less than 1% being listed toxic (U-listed) waste.

All radioactive and mixed waste will be shipped off-site for disposal. Treatment of mixed waste may be performed on site, or off site by contract. Some limited treatment will be performed in the RMWMF, including compaction, solidification, and neutralization. In preparation for off-site shipment, the RMWMF serves as the central collection, characterization, packaging, and certification point. Operations in the facility will include sorting and inventorying, sampling, limited treatment, and waste packaging for off-site shipment. Chemical analysis will be performed at other Sandia facilities or by contract. Radiological analysis will be done at the adjacent WAF. Compaction of radioactive and mixed waste will be achieved where possible. In some instances, staff from the RMWMF will supervise the packaging of special waste forms (such as large pieces of equipment) at the waste-generating site. Final waste certification will be performed at the RMWMF and associated facilities prior to off-site shipment. These supporting facilities will consist of the WAF and the RTR.

Radioactive waste will be disposed of at the Nevada Test Site provided the waste meets the waste acceptance criteria and the appropriate applications for disposal are approved. Transuranic (TRU) waste will be packaged according to Waste Isolation Pilot Plant (WIPP) certification requirements, and will be stored at Sandia pending approval for disposal at the WIPP Site. Mixed waste will be treated in accordance with RCRA regulations and will be packaged and stored pending eventual disposal at a mixed waste disposal facility.

2.3 Non-Radioactive Wastes

The management of RCRA and non-RCRA chemical waste is regulated by DOE Order 5400.3, 40 CFR 260-265, the New Mexico Hazardous Waste Management Regulations, and the hazardous waste operations permit issued to DOE and Sandia/NM.

Sandia/NM currently operates two hazardous waste storage and treatment facilities: the Hazardous Waste Management Facility (HWMF) in Technical Area I and the Thermal Treatment Facility (TTF) in Technical Area III.

The HWMF, a permitted facility, is used to manage the large variety of chemical waste that is generated by Sandia/NM research and development activities. Chemical waste generated by Sandia/NM activities is collected from generator locations, segregated according to DOT hazard class, and transported to the HWMF for storage. Non-RCRA chemical waste is consolidated and packaged at the HWMF according to DOT and EPA requirements. Such waste is transported off site by permitted carriers for treatment and/or disposal at permitted Treatment, Storage, and Disposal Facilities (TSDFs).

More than 10,000 separate waste streams have been identified and are being managed through the HWMF. The separate waste streams typically are small and generally consist of:

- Waste process materials from development facilities,
- Expended chemicals from research laboratories, and
- Contaminated material and scrap from test and evaluation operations.

Approximately 85 percent of the waste arrives at the HWMF packaged in containers less than 10 gallons in size. In preparation for storage, transportation, and disposal, these containers are packaged with absorbent materials and inserted in larger, laboratory pack containers.

The TTF, for which a permit has been requested, was constructed to thermally treat residual explosives formed and used at the light-initiated high explosives (LIHE) site that are too reactive to be transported off site. The TTF is used to thermally treat small quantities of explosive contaminated wastes that are non-fragment producing or are mass detonating.

Other explosive waste is sent to the explosive storage area (managed as a less-than-90-day accumulation area) for temporary storage prior to shipment off site to a permitted facility for ultimate treatment and disposal.

Laboratories and experimental activities at Sandia/NM require Standard Operating Procedures (SOPs) to describe specific procedures for managing regulated and non-regulated RCRA chemical waste in accordance with applicable regulatory and Sandia/NM requirements. These procedures are reviewed and approved by the Environmental Protection Department before waste generation begins.

All waste oils at Sandia/NM are sampled for polychlorinated biphenyls (PCBs) and other halogen content prior to disposal. Depending on the results of the analyses, the oil can be recycled by a local firm, disposed of as PCBs, or disposed of as hazardous waste by commercial EPA-permitted facilities.

All Toxic Substances Control Act (TSCA) regulated waste is transported and disposed of at off-site permitted facilities. Several buildings in TA-I in a secured area adjacent to the HWMF are available for temporary storage of TSCA-regulated waste, principally PCBs, prior to off-site transport.

Asbestos waste at Sandia/NM is managed by two programs. Facilities asbestos waste (insulation) is generated during building renovation and demolition activities and is managed and disposed of through the facilities engineering asbestos department in the KAFB asbestos landfill. Nonfacilities asbestos (laboratory equipment such as ovens, gloves, instruments, and protective sheeting for covering laboratory surfaces) is managed by the Chemical Waste Department. This waste is stored in Building 897 for transport to disposal or abatement.

Medical waste is collected in containers provided by a medical waste disposal contractor. The containers are periodically collected by the contractor and transported off site for incineration and land filling.

Waste storage and disposal for chemical waste generated at Sandia/NM is summarized in Table 2.3-1.

Table 2.3-1. Waste Storage and Disposal for Chemical Wastes Generated at Sandia/NM		
Waste Type	**Storage Facility**	**Treatment/Disposal**
PCB	Technical Area I	Commercial off-site
Nonfacilities Asbestos	Technical Area I, Building 897	KAFB landfill and commercial off-site
Medical	Technical Area I, Building 831	Commercial off-site
RCRA Hazardous	Technical Area I, Buildings 958 and 959	Commercial off-site
Nonregulated	Technical Area I, Buildings 958 and 959	Commercial off-site
Energetic Materials	Technical Area III, Building 6715	On-site thermal treatment

2.4 Waste Minimization Program

A Waste Minimization and Pollution Prevention Awareness Plan was completed in December 1991. The plan addresses activities and methods that will be used to reduce the quantity and toxicity of waste and materials at all Sandia/NM sites. Process Waste Assessments (PWAs) are performed to identify the use of hazardous and radioactive materials and the generation of waste in specific operations. As a result of the PWAs, waste minimization opportunity assessments (WMOAs) are conducted on those processes and operations that need to be improved or replaced in order to promote waste minimization.

A comprehensive material tracking system to support the waste minimization methodology is being developed. This system will follow the movement of material from procurement, through use in processes and operations, to final disposition. Bar-coded tracking systems will be used for incoming material and for waste management. PWAs will follow materials within processes and operations.

The Chemical Exchange Program is a centralized operation that redistributes surplus chemicals to avoid the unnecessary disposal of usable materials. Although the program is expanding its supply base, it is expected that as waste minimization efforts increase, the overall supply of excess chemicals will level off or decrease.

A Sandia/NM Halogenated Materials Elimination Project is being developed to address growing concerns about the use of chlorofluorocarbons (CFCs) and other halogenated chemicals. This project will facilitate the Sandia-wide transition to non-halogenated materials.

3.0 Radiation Protection

3.1 Sandia Radiological Control Organization and General Program Summary

Radiological control at Sandia is distributed organizationally and is under the general coordination and oversight of the Sandia Radiological Control Manager. Radiological control is accomplished by all or portions of the Radiation Protection Engineering, Radiation Protection Operations, Radiation Protection Measurements, and Radioactive Waste Management departments. The senior staff of the Sandia Radiological Control Organization includes health physicists and other professionals with four-year degrees in science or engineering. Pursuit of certification by the American Board of Health Physics for senior and professional staff members is encouraged.

Radiological support personnel perform radiation protection operations and radiological engineering, dosimetry, bioassay, independent oversight, instrumentation, and calibration functions. Radiological Control Technicians (or Radiation Protection Technicians) and their supervisors perform the functions of assisting and guiding workers in the radiological aspects of their jobs. They have the responsibility and authority to stop work or mitigate the effect of an activity if they suspect that the initiation or continued performance of a job, evolution, or test will result in the violation of Sandia radiological control standards or result in imminent danger or unacceptable risk.

The objective of the Sandia/NM radiological control program is to maintain personnel radiation doses well below regulatory dose limits. To accomplish this objective, challenging numerical administrative limits are established at levels below the regulatory limits to control and help reduce individual and collective radiation doses. These control limits are multi-tiered with increasing levels of authority required to allow an individual to exceed each limit.

The remainder of this chapter describes the various radiation protection activities that assure adequate radiation protection at Sandia.

3.2 Radiation Protection Standards for On-Site Exposure of Personnel (Ionizing Radiation)

This section outlines the activities implemented at Sandia to limit the risks from exposure to ionizing radiation to an acceptable level. These activities cover the use, handling, processing, storage, and activation of, as well as the experimentation with, radioactive material or radiation-producing devices or equipment. This section describes specific implementation requirements and responsibilities throughout Sandia, from senior management on down, relative to the exposure of personnel to ionizing radiation.

3.2.1 Standards for Occupational Exposure (Internal and External) to Ionizing Radiation

Radiation protection standards for occupational exposure are met by an ongoing evaluation of the workplace to identify the applicability of radiation protection program elements. This evaluation is conducted by the Radiation Protection Operations Department in cooperation with the line organization. Radiation exposure rates in controlled workplace areas are reduced to levels considered As Low As Reasonably Achievable (ALARA) by proper facility design and physical controls. Administrative controls and procedural requirements are considered as supplemental means to achieve control. Other elements of the protection program include radiation monitoring, contamination control, and radioactive material accountability, radiation worker safety training, the use of radiation work permits and standard operating procedures, the maintenance of radiation worker training records, and the performance of internal audits, appraisals, and self-assessments.

3.2.2 Standards for the Exposure of the Unborn Child, Minors, Students, and Members of the General Public

Line managers as well as their subordinates are responsible for being knowledgeable regarding the radiation protection requirements for the unborn child. A female occupational worker is responsible for notifying Sandia in writing that she is pregnant. The Radiation Protection Operations Department and the Occupational Medicine Center will evaluate the workplace radiation hazards and provide on-going pregnancy counseling to ensure that the limiting value of annual dose equivalent received by the unborn child is not exceeded. Pregnant female workers may be assigned to tasks where additional occupational exposure is not likely in order to comply with the established limit. This will be accomplished in conformance with the provisions of Title VII of the Civil Rights Act of 1964.

Managers are responsible for identifying any students or minors that may work, visit, or tour an area where external or internal radiation exposure may occur. Guidance concerning radiation protection requirements for minors and students is provided by the Radiation Protection Operations Department. As a minimum requirement, minors and students will always be escorted and the location of the tour, visit, or work documented.

Line organization personnel who bring members of the public (i.e., visitors) on site are responsible for their health and safety. Personnel who bring members of the public into controlled areas are required to be knowledgeable of the hazards in the workplace and a trained radiation worker. The Radiation Protection Operations Department is to be notified if there is any question or concern regarding a potential radiation exposure.

3.2.3 Standards for Emergency or Accidental Personnel Exposures

When an occupational worker has been exposed to radiation in excess of the allowable limits as a result of an unplanned or accidental situation, the decision to allow the worker to return to work in a radiological area will be made by line management based on technical guidance from the Radiation Protection Operations Department and the Occupational Medicine Center. The dose received in an unplanned or accidental situation will be documented in the radiation exposure record of the exposed individual and reported pursuant to DOE Order 5484.1. Sandia is required to verify to the DOE Albuquerque Manager that the conditions under which the emergency or accidental exposure(s) was received have been corrected. The resumption of operations following an emergency or accidental exposure in excess of the allowable occupational limits is subject to approval by the DOE Albuquerque Manager.

Investigations and reporting will be carried out pursuant to DOE Orders 5484.1 and 5000.3B. The Radiation Protection Operations Department will participate in any resulting investigation and will notify Sandia senior management when the conditions under which the emergency or accidental exposure(s) was received have been corrected. The Radiation Protection Operations Department will review and approve the information reported to the DOE under the requirements of DOE Orders 5484.1 and 5000.3B.

3.2.4 Review and Approval Requirements for Planned Special Exposures

A planned special exposure to ionizing radiation requires the review and approval of the Radiological Control Manager, the Occupational Medicine Center Director, the Vice President responsible for Environment, Safety and Health, the Vice President responsible for the line organization in which the planned special exposure is to occur, and the DOE/Albuquerque Operations Manager. The Sandia Legal Department is also required to be consulted on the planned special exposure. Planned special exposures are required to be fully documented in extreme detail to demonstrate that ALARA and the appropriate radiological engineering practices have been maximized to limit the potential personnel radiation exposure.

3.3 Radiation Protection Standards for Response to Radiological Emergencies

This section provides emergency response guidance for determining appropriate actions for the rescue and recovery of persons, and the protection of health and property in the event of an emergency involving ionizing radiation at Sandia. It also specifies radiation dose criteria and judgment factors to be used for the various types of emergency action (i.e., saving human life, recovering deceased victims, and protecting health and property). Specific implementation requirements and responsibilities throughout Sandia, from senior management on down, relative to response to radiological emergencies are also delineated. Furthermore, it specifies radiation monitoring equipment requirements for response to radiological incidents, as well as radiation safety training requirements for personnel involved in the response to radiological incidents.

3.3.1 Risk Evaluation

The official in charge of an emergency is responsible for evaluating any proposed action involving radiation exposure. The evaluation must weigh the risks of radiation insults, actual or potential, against any benefits to be gained. Essential elements in risk determinations include potential exposure, biological consequences related to the exposure, and the number of people involved. Any rescue action that might involve substantial personal risk is to be performed on a voluntary basis. Considerations of volunteer age and previous exposure history are to be taken into account when authorizing any action. Prior to participation, emergency workers are to be advised of the known or anticipated hazards by the person on site having the emergency action responsibility.

3.3.2 Dose Criteria

The following specific dose criteria and judgment factors are established for three types of emergency action:

Type 1 - Saving of Human Life

The course of action is determined by the person on site having the emergency action responsibility (i.e., the Incident Commander). The Incident Commander is responsible for evaluating the inherent risks to personnel involved in the rescue mission by considering the reliability of the prediction of radiation injury from measured/estimated dose rates, the effects of acute external and/or internal exposure, the capability to reduce the risk through physical mechanisms or other means, and the probability of rescue mission success.

Type 2 - Recovery of Deceased Victims

The amount of radiation exposure received by persons in recovery operations is to be controlled within existing occupational exposure limits, except when it is not feasible to recover a body without personnel entering the area. In this case, the Incident Commander may determine that it is necessary to exceed the allowable occupational exposure limits. In no instance is the planned exposure of an individual participating in the recovery allowed to exceed 10 rem (0.1 sievert) per year. When fatalities are located in areas inaccessible due to high direct radiation fields, and when the recovery mission would result in exposure in excess of allowable occupational exposure limits, special remote recovery devices are to be used to retrieve bodies.

Type 3 - Protection of Health and Property

When the radiation risk following an incident is such that life might be in jeopardy, or that there might be sever effects on public health or loss of property inimical to the public safety, the criteria for saving of human life apply. When the Incident Commander deems it essential to reduce a potential hazard to protect worker health or prevent a substantial loss of property, a planned exposure not to exceed 10 rem (0.1 sievert) per year may be permitted for an individual's participation in the operation.

3.3.3 Exceptions/Exemptions

The DOE Albuquerque Operations Office (DOE/AL) Manager may approve, if warranted, requests for exceptions from the requirements of DOE Order 5480.11 in emergency situations where immediate decisions and actions are required. Such action must be reported in accordance with DOE Order 5484.1. The DOE/AL Manager may also temporarily suspend the requirements of DOE Order 5480.11 when doing so, in his or her judgment, is necessary to minimize danger to life or property or to protect public health or safety. Whenever this provision is invoked, such suspension and the reason for it must be reported to the Assistant Secretary for Environment, Safety and Health (EH-1) at the earliest practicable opportunity.

3.3.4 Required Equipment

On-site capability for conducting emergency surveys and monitoring is maintained in a state of readiness at all times. Emergency response teams are responsible for the maintenance and availability of appropriate emergency response equipment, including portable radiation monitoring equipment and self-reading dosimeters that meet the requirements specified in ANSI N320-1985.

3.3.5 Training

Emergency response training is required for management, specialized emergency duty personnel, and other personnel having emergency response duties. The training is coordinated by the Environment, Safety and Health training organization. The training program includes the qualification of primary and backup emergency response personnel, retraining of qualified personnel to assure that proficiency is maintained, instruction in the application of emergency procedures, and periodic training exercises.

3.4 As Low as Reasonably Achievable (ALARA) Concept

The ALARA concept applies to all Sandia organizations and subcontractors that have radiation workers or utilize radioactive materials or radiation-producing devices at Sandia. It consists of specific implementation requirements and responsibilities throughout Sandia, from senior management on down, relative to the control of personnel exposure to ionizing radiation to the lowest levels that are reasonably achievable.

The Radiation Protection Engineering Department provides technical guidance and assistance in the development of ALARA Plans, and training and assistance to the line organization to ensure program responsibilities are consistently accomplished.

3.5 Radiation Protection Requirements for Radioactive Source Control

Source control and accountability activities encompass the procurement, manufacture, registration, use, inventory, transfer, and disposal of radioactive sources used at Sandia, and the control of personnel radiation dose equivalents resulting from their use.

Source custodians and authorized users are responsible for determining the registrability of a radioactive source based on the requirements found in Appendix C of 10 CFR 20. If a source is determined to be registrable, then appropriate forms (obtained from the Radiation Protection Engineering Department Source Registrar) are completed and filed.

Authorized users must have an approved ES&H Standard Operating Procedure (SOP) or Radiation Work Permit (RWP) before using a registered source. The SOP specifies the source control number, ALARA program requirements, personnel training requirements, monitoring requirements, instrument calibration requirements, type of leak test required, and type of instrument to be used in performing the leak test. The SOP also establishes the appropriate workplace controls to be used.

3.6 Radiation Protection for Release of Radioactive Material or Contaminated Material

Control of radioactive contamination is achieved by using engineering controls and worker training to contain contamination at the source, and promptly decontaminate areas that become contaminated during work activities. These activities control the transport of radioactive material or radioactively contaminated material from Controlled and Radiological Areas at Sandia. They also ensure that the loss of control of radioactive material or radioactively contaminated material within Sandia will be prevented. In addition, the release of radioactive material or radioactively contaminated material to unauthorized personnel or agencies will be prevented.

3.7 Radiation Signs, Labels, and Alarms

Warning personnel of site-specific radiological hazards at Sandia is accomplished through the use of signs, labels, and warning devices (e.g., alarms). Radiological postings are used to alert personnel to the presence of radiation and radioactive materials, and to aid them in minimizing exposures and preventing the spread of contamination. Radiological buffer areas are established within controlled areas to provide a second boundary to minimize the spread of contamination. The radiological hazards include radioactive material, fissile material, and external ionizing radiation. Through the use of these devices, personnel will be informed of actual and potential radiological hazards (including their boundaries) and emergency conditions in a manner consistent with DOE requirements.

3.8 Radiation Protection Standards for Radiation Work Permits and ES&H Standard Operating Procedures

Radiation Work Permits (RWPs) and ES&H SOPs are required for any job or operation involving ionizing radiation (i.e., including both radioactive materials and radiation-producing devices or machines). Maintenance and modification plans and procedures are reviewed by Sandia/NM line management to identify and incorporate radiological control requirements, such as engineering controls and dose and contamination reduction techniques. For routine tasks, such as surveillance activities, tours, and minor maintenance, this review and documentation of identified radiological control requirements may be conducted as part of the Radiological Work Permit (RWP) process. The Sandia/NM Radiological Control Manual establishes the following triggers requiring formal radiological control review:

- Estimated individual or collective dose greater than pre-established values
- Predicted airborne radioactivity concentrations in excess of pre-established values
- Removable contamination in the workplace grater than 100 times the values given in Table 2-2 of the Radiological Control Manual
- Entry into areas where dose equivalent rates exceed 1 rem/hour
- Potential radioactive material releases to the environment

Radiological control requirements identified as part of this review are documented in the job plans, procedures, or work packages.

Radiological control requirements identified as part of this review are documented in the job plans, procedures, or work packages.

3.8.1 General

Sandia personnel, including line organization managers and Radiation Protection Operations Department personnel, have the responsibility and authority to ensure that work involving radiation and radiological protection is performed correctly. Sandia ES&H SOPs and RWPs are used to provide personnel with detailed instructions concerning the radiological protection measures and controls to be used during specific jobs. RWPs are also used to control personnel access to Radiological Areas at Sandia.

All Sandia work activities involving radiation require either an ES&H SOP or an RWP that has been reviewed and approved by the Radiation Protection Operations Department. Approved SOPs and RWPs are used as the primary administrative controls by which radiological work is performed.

3.8.2 Supervision and Monitoring of Radiological Work

Line organization supervisory personnel have the responsibility for the following radiological work activities:

- Pre-job briefing of radiation workers on job requirements, radiological conditions of the work site, and any radiological protection requirements
- Consideration of the use of mock-ups and dry runs prior to initiating work in radiologically controlled areas
- Monitoring the performance of organization personnel during work to ensure that proper radiological protection measures are being used
- Investigation of radiological incidents and accidents involving organization personnel and follow-up monitoring to ensure adequacy of corrective actions

Radiation Protection Operations Department personnel have the responsibility for periodically monitoring the performance of radiation workers and correcting improper work practices. They also provide continuous coverage of work if required in the RWP or SOP to ensure maintenance of adequate radiological controls during the course of work activities. Radiation Protection Operations personnel have the responsibility for conducting pre-job briefings of workers on the radiological conditions of the work site and any radiological protection requirements. They have both the responsibility and authority to stop work or to prevent initiation of any job or work activity involving radiation if the work is not covered by an approved RWP or SOP, or if continued performance of the work would result in the violation of radiological protection requirements, programs, or procedures, or would otherwise endanger the safety of personnel.

3.8.3 ES&H Standard Operating Procedures

Approved ES&H SOPs serve as the means to describe general operations to be performed frequently or repeatedly at one or more locations. They are used for technical and administrative control of normal or abnormal activities (e.g., tests, experiments, or emergency operations). Approved ES&H SOPs represent one of the administrative controls by which radiological work is planned and radiation worker health and safety is addressed at Sandia. SOPs specify the following:

- Job qualification and training requirements
- Responsibilities of the owning organization(s) and users of the SOP
- Discussion of hazards and precautions related to the activity
- Listing of equipment and materials needed for the activity
- Detailed, step-by-step procedures and instructions for the conduct of the activity (including emergency procedures)
- Waste disposal requirements
- ES&H reporting and documentation requirements
- Effective date(s) of the procedure
- Identification of the personnel authorized to perform the work
- Location where the work is to be performed
- Protective equipment and apparel required by workers
- Descriptions of conditions that would terminate or suspend work in progress
- Identification of individuals approving the procedure

3.8.4 Radiation Work Permits

The Radiological Work Permit (RWP) is an administrative mechanism used to establish radiological controls for intended work activities in radiologically controlled areas. The RWP informs workers of area radiological conditions and entry requirements, and provides a mechanism to relate worker exposure to specific work activities. The responsibility for ensuring adequate planning and control of work activities in radiologically controlled areas, including preparation of RWPs, resides with the line organization management.

Approved RWPs serve as the means to describe specific operations to be performed, including location and participants, anticipated radiological conditions under which the operations are to be performed, any radiological protection requirements, measures, and/or equipment for mitigating potential hazards, any post-job reviews to be conducted, and survey/dosimetry results to be recorded.

RWPs represent the other administrative control by which radiological work is planned and radiation worker health and safety is addressed at Sandia. Unlike ES&H SOPs, however, approved Sandia RWPs are to be used as formal, documented mechanisms for Radiation Protection Operations Department personnel to communicate radiological conditions and job controls to radiation workers. RWPs accomplish this goal in a manner that radiological hazard postings cannot, since involvement and accountability by all workers for proper job conduct is built into the RWP process. RWPs specify the following:

- Effective date(s) of the RWP
- Identification of the personnel authorized to perform the work
- Detailed description of the job location and work authorized to be performed
- Information regarding the whole-body, extremity, and skin dose equivalent rates in and near the work area, including hot spot areas and areas with low radiation levels, and abnormal radiation sources, as appropriate
- Special dosimetry requirements
- Specific procedures, instructions, and precautions to be observed
- Protective equipment and apparel required by workers
- Descriptions of conditions that would terminate or suspend work in progress
- Identification of individuals approving the RWP

Prior to using a RWP, workers must sign a statement signifying they have read the RWP, fully understand all requirements and radiological conditions, and agree to comply with the stated requirements. At the conclusion of radiological work activities covered by RWPs, post-job reviews are performed and documented. These reviews include, as a minimum, problems encountered, changes needed for future jobs, post-job radiological surveys, and recording of personnel dose equivalents.

The Radiological Control Manual establishes requirements for controlling radiological work in localized benchtop areas, laboratory fume hoods, sample stations, and glove-box operations located in areas that are otherwise contamination-free. It also establishes requirements for Continuous Air Monitor (CAM), Radiation Area Monitor (RAM), criticality, and personnel-contamination monitor-alarm response procedures, as well as for control of hot particles.

3.9 Health Physics Records and Document Control

Document control activities provide for the systematic generation, distribution, and retention or disposition of official health physics procedures, records, and documents at Sandia in accordance with the requirements of DOE Order 1324.2A, DOE Order 5484.1, Sections III and IV, and ANSI N136-1972, Section 8. The scope of document control encompasses all radiological protection/safety records and documents that accomplish the following:

- Establish the conditions under which individuals were exposed to ionizing radiation

- Document the appropriateness, quality, and accuracy of monitoring methods, techniques, and procedures in use at any given time

- Describe the technical and administrative basis for the overall radiation protection program

- Document the radiation safety training of radiation protection personnel

- Allow for the evaluation of the radiation protection program's effectiveness

- Allow for the reconstruction, for legal or medical purposes, of situations and conditions for analysis of radiation dose equivalents received by individuals working at or visiting Sandia

3.10 Radiation Protection Training Requirements and Training Records

The Radiological Control Manual establishes the requirements to ensure that Sandia/NM personnel have the training to work safely in and around radiological areas, and to maintain their individual radiation dose and the radiation doses of others as low as reasonably achievable. Training requirements apply to personnel entering facilities where radiological work activities are conducted.

Radiation protection training ensures that all personnel who enter controlled or radiological areas at Sandia are aware of the potential radiation hazards that may exist as part of work activities or at work sites. This information enables employees to reduce exposures to themselves or other personnel. Radiation safety training is based on the requirements in DOE Order 5480.11, "Radiation Protection for Occupational Workers," which includes site-specific and job-specific training requirements for special operations. Retention of training records of employees, radiation workers, and radiation safety personnel is in accordance with DOE Orders 5480.11 and 1324.2A.

The Education and Training Department is responsible for administering radiation protection training and preparing training implementation procedures. The Radiation Protection Engineering Department is responsible for providing the necessary subject matter, expertise, and technical support for all radiation safety training at Sandia, including approving all training materials, and monitoring the registration, presentation, and documentation of all radiation protection training courses. The line organizations interface with the Radiation Protection Engineering Department in determining the subject content of site-specific training.

3.10.1 General Employee Radiation Protection Training

General Employee Radiation Protection Training is required for all Sandia employees, contractors, and others who perform work at Sandia. Refresher training is required every two years. The subject matter covered by this training includes the risk of low-level occupational radiation exposure (including cancer and genetic effects), the risk of prenatal radiation exposure, basic radiation protection concepts, DOE and Sandia radiation protection policies, programs, and procedures, employee and management responsibilities for radiation safety, and emergency procedures.

3.10.2 Radiation Worker Safety Training

Radiation Worker Safety Training is required for occupational workers who operate radiation-producing devices, work with radioactive materials, or who are likely to routinely receive exposures above 0.1 rem per year. Refresher training is required every two years. The subject matter covered by this training includes the following topics:

- Radioactivity and radioactive decay
- Characteristics of ionizing radiation
- Man-made radiation sources
- Acute effects of exposure to radiation
- Risk associated with occupational radiation exposures
- Special considerations in the exposure of women of reproductive age
- Dose-equivalent limits
- Mode of exposure, internal and external
- Dose-equivalent determinations
- Basic protective measures (time, distance, shielding)
- Specific plan procedures to maintain exposure as low as reasonably achievable
- Radiation survey instrumentation, calibration, and limitation
- Radiation monitoring programs and procedures
- Contamination control, including protective clothing and equipment and workplace design
- Personnel decontamination
- Emergency procedures
- Warning signs and alarms
- Responsibilities of employees and management
- Interaction with radiation protection staff
- Operational procedures associated with specific job assignments (e.g., radiation-generating machines)

3.10.3 Supervisor's and Manager's Radiation Protection Training

Supervisor's and Manager's Radiation Protection Training is a supervisory training requirement for those first-line managers who supervise radiation workers. The purpose of the course is to provide fundamental background information about nuclear radiation, protection methods, and regulatory concerns. The technical depth of the training is limited to basic concepts and general principles in order to familiarize the supervisor with his or her responsibilities as a supervisor of radiation workers, and with the reasons for regulatory and safety concerns where nuclear radiation is involved.

3.10.4 Site-Specific of Job-Specific Training Requirements

Site-specific or job-specific training may be required by the line organization for a specific work activity or work environment. Hazards associated with each job assignment may introduce unique training requirements (e.g., operating radiation-generating machines and glove boxes) in addition to the general Radiation Worker Safety Training course. The line organization is responsible for identifying individuals who may require site-specific or job-specific training, developing and presenting the training modules, and documenting training in accordance with DOE and Sandia requirements. As a minimum, refresher training is required every two years.

3.10.5 Continuing Education for Radiation Protection Professionals

Continuing Education for Radiation Protection Professionals is required for all health physicists, health physics technicians, and any other employees who perform qualitative and quantitative radiological evaluations to prescribe and implement protection measures for personnel or equipment. Participation in the program is required as often as changes in regulations or procedures make training or retraining necessary or desirable. As a minimum, radiation safety personnel are required to attend at least one of the training classes related to radiation protection subject matters.

In addition, General Health Physics Review for Radiation Protection Technicians is required of all radiation protection professionals every two years as defined by DOE Order 5480.11.

3.11 Alarms and Entry and Access Control Systems for Radiation Facilities

The overall objective of these systems is to minimize the potential for the inadvertent exposure of Sandia employees, visitors, or contractors to significant levels of ionizing radiation at any Sandia radiation facility.

3.12 General Workplace Compliance for Radiation Protection

Formal workplace guidelines are established for the control of radioactive material and radiation-producing devices at Sandia. Guidelines for the control of personnel exposure to ionizing radiation, radioactive material, and radiation-producing devices are also established. An overview of the regulatory requirements is provided for use by the line organizations, for the evaluation of the workplace for ionizing radiation hazards. This overview includes requirements for the following:

- Personnel and workplace radiation monitoring
- Release of equipment from radiological areas
- Posting, labeling, and alarms
- Use of protective equipment
- Personnel entry and exit controls
- Incorporation of the ALARA philosophy into the conduct of operations

3.13 Radiation Protection Standards for X-Ray Generating Devices

Mandatory radiation protection requirements for the operation of x-ray generating devices to assure regulatory compliance and radiologically safe operating practices in the workplace have been established. They specify ownership, responsibilities, and accountabilities for individual operating practices, as well as ALARA program requirements relative to the use of x-ray generating devices.

3.14 Workplace Airborne Radioactivity Monitoring

Workplace air monitoring and sampling for the detection and quantification of airborne radioactive material provide personnel respiratory protection for jobs and situations involving airborne radioactive materials. Specific implementation requirements and responsibilities pertaining to workplace airborne radioactivity monitoring or sampling, as well as the use of confinement, ventilation, and administrative controls, maintain airborne radioactive material concentrations as low as reasonably achievable.

3.15 Workplace External Radiation Monitoring

Workplace monitoring for external, penetrating radiation (e.g., beta/gamma and neutron radiation) encompasses the use of portable radiation survey instruments, stationary radiation monitors, and workplace thermoluminescent dosimeters (TLDs). Radiation monitoring assists both in the identification and control of potential or actual sources of ionizing radiation, as well as the implementation of the ALARA philosophy throughout Sandia's operations.

Workplace radiation exposure monitoring includes the use of radiation area monitors (RAMs), radiation survey instruments, and workplace TLDs for measuring external radiation dose rates and doses in the workplace. Radiation Protection Operations Department personnel use a combination of instruments that can measure different types of radiation (neutron, gamma, beta, or x-radiation) that could be encountered at a facility and their dose rate (or doses within a given time interval for pulsed-radiation-generating devices) characteristics.

Radiation Protection Operations Department personnel use the data of radiation surveys to determine postings and RWPs, and to control access to and work in Radiation Areas, High Radiation Areas, or Very High Radiation Areas. The results of radiation surveys are also used in ALARA planning and review, estimation of personnel radiation dose equivalent when TLD badges are lost or damaged, and accident investigation.

3.15.1 Radiation Protection Survey for New Installations

The line organizations are responsible for ensuring that all new radiation installations have a radiation protection survey performed by the Radiation Protection Operations Department before they are placed into routine operation. Radiation Protection Operations Department personnel resurvey after every modification in equipment or operating parameters that might significantly change the radiological conditions of a radiation installation. Surveys of radiation installations include installation inspection to verify or determine the present and expected occupancy of the adjacent areas. Radiation-generating equipment is inspected for proper operation of the required radiation alarms, and entry and access control.

3.15.2 Routine Radiation Surveys

The Radiation Protection Operations Department provides routine radiation surveys using appropriate instruments to identify and quantify sources of radiation in the workplace where radioactive materials or radiation-generating devices are present. The Radiation Protection Operations Department establishes workplace radiation survey frequencies based on radiation levels and types of work involved. The results of radiation surveys are documented and retained by the Health Physics Department.

3.15.3 Radiation Area Monitors

The Radiation Protection Operations Department determines the number and locations of RAMs based on the radiation levels and nature of work in a facility and determines the setpoint of a RAM based on the types of work involved at a workplace. Alarm capability is checked daily using the procedures established by the Radiation Protection Engineering Department to ensure proper operation.

3.15.4 Workplace Thermoluminescent Dosimeters

Workplace TLDs are used for measuring the cumulative radiation dose at a given location over a specific time interval. In general, Radiation Protection Operations Department personnel use workplace TLDs for confirmatory and trend analysis purposes. They may use the results of workplace TLDs as part of the radiation exposure ALARA review in the workplace.

3.15.5 Records

The Radiation Protection Engineering Department maintains records of workplace external radiation monitoring that establish workplace radiological conditions to provide a chronological, historical record. The Department also maintains records to document the techniques, procedures, and accuracy of external radiation monitoring methods. Records are maintained in accordance with DOE Order 1324.2A and the Health Physics Records and Document Control Program.

3.16 Radioactive Contamination Control and Monitoring

Workplace radioactive contamination control and monitoring, and personnel and personal property monitoring at Sandia include administrative controls that are vital to an effective contamination control program, and supplement any physical/engineered controls and barriers that are included as part of facility design. These administrative controls include such things as protective clothing requirements, personnel and property monitoring requirements, personnel respiratory protection, use of step-off pads, control over consumable goods, minimization of commingling, and other good practices. Workplace contamination control surveillance activities provide a mechanism for evaluating the effectiveness of the entire Sandia contamination control program by identifying areas and activities needing improvement.

4.0 Quality Assurance

Sandia National Laboratories' management has established a quality policy (SLI 2800) which reflects their belief that using well-defined quality controls to guide the entire range of Sandia activities reflects good management principles and practices. The policy of Sandia management is to implement and maintain effective operations with the elements of quality, safety, cost, and research in the proper balance. Responsibility for developing, administering, evaluating, and maintaining appropriate quality programs to achieve these objectives rests with the management of each organization. These quality plans must be appropriate to the organization's particular activities.

The requirements and guidance contained in DOE Order 5700.6C (Quality Assurance) are being implemented through Sandia's Management Integration and Implementation Program (MIIP). Quality controls in a Sandia facility or process are implemented in a graded manner that is commensurate with the risks involved in the associated operations or activities. That is, the graded approach reflects the degree to which individual elements of the MIIP, as reflected in the organization's Compliance Plan, are implemented in a facility or process to ensure operational quality and safety.

4.1 Organization

The vice-presidents of the line organizations have ultimate responsibility for ensuring the quality of ES&H activities conducted within their groups. Center Directors are responsible for incorporating ES&H requirements and regulations into the routine and non-routine operations of the Center. These responsibilities include:

- Incorporating elements of the Management Integration and Implementation Project into the line organization's day-to-day processes and activities
- Ensuring coordinated corrective action responses to identified deficiencies in center processes and ensuring that the corrective action addresses the root cause(s) and resolves the problem
- Evaluating lessons learned and performance indicator trends as they apply to the center
- Appointing a center ES&H Coordinator to assist in implementing the ES&H programs and procedures

The center ES&H Coordinator reports to the director and is responsible for assisting the director, managers, and supervisors within the center in (1) establishing ES&H responsibility, qualification, and performance criteria for center personnel, (2) establishing meaningful ES&H performance indicators that allow the center to monitor and judge performance against ES&H requirements and standards, and (3) communicating to personnel the lessons learned (operating experience) that are applicable to the activities performed within the center. He or she is also responsible for coordinating and participating in the center's internal self-appraisal process.

Division Quality Coordinators are responsible for consulting, facilitating, and coordinating Quality activities within the Division and/or Sector, thereby assisting the Vice-president in maintaining continuous improvement.

The ES&H Assessments Department supports the MIIP by (1) assisting the line organization in identifying performance indicators that allow line activity performance to be measured, (2) analyzing ES&H performance trends, (3) evaluating ES&H operating experience within Sandia and from other DOE facilities, determining applicability to Sandia operations, and communicating lessons learned to both management and the line organizations, (4) helping the line organization establish and implement a self-appraisal program that allows them to periodically assess their performance against established criteria, (5) providing an independent, internal self-assessment of line organization activities with ES&H requirements and/or governing regulations, and (6) supporting the Quality Assurance Assessments Department in independently auditing and appraising activities subject to the requirements contained in ES&H policies, programs, and procedures.

The manager of the ES&H Assessments Department is responsible for the following:

- Establishing a comprehensive appraisal and assessment program that evaluates Sandia compliance with ES&H programs
- Establishing and distributing a schedule of independent appraisals
- Providing qualified individuals to serve as the ES&H Appraisal Team Leaders
- Selecting appraisal teams that include, as a minimum, the ES&H Coordinator from the organization being reviewed and one or more technical experts, as appropriate, to perform technical reviews beyond the capabilities of the appraisal/assessment team
- Developing an ES&H appraisal plan checklist to be used in conducting the appraisal/assessment
- Writing appraisal reports that include areas reviewed, criteria used, and findings (both positive and negative)
- Developing trend reports for distribution in accordance with written schedules

The ES&H Assessments Department and the Quality Assurance Assessments Department conduct independent overviews of ES&H activities subject to the requirements of the QA program. The former department reviews the effectiveness of ES&H policies, programs, and procedures which are implemented within the line operations, while the latter department focuses on reviewing how the MIIP is implemented in accordance with DOE Order 5700.6C. These two organizations cooperate to provide the independent oversight of both ES&H and quality activities performed by Sandia.

4.2 Corrective Actions for Identified Conditions Adverse to Quality

Sandia's ES&H Program (MN471001) ensures that conditions adverse to ES&H quality, such as failures, malfunctions, deficiencies, deviations, defective material and equipment, and nonconformances are promptly identified, documented, and corrected in a consistent manner throughout Sandia.

4.3 Documents and Records

4.3.1 Instructions, Procedures, and Drawings

An ES&H Manual Supplement (GN470000) has been developed to provide specific guidance in the development of ES&H SOPs and other ES&H program documents. This supplement provides step-by-step instructions for writing, reviewing, and approving ES&H SOPs and other program documents.

4.3.2 Document Control

An ES&H Manual Supplement (GN470001) provides detailed guidance for controlling ES&H-related documents generated by Sandia line organizations. The supplement specifies that these documents, including changes, be reviewed for adequacy, approved for release by authorized personnel, and distributed to and used at the location where the ES&H-related activity is performed. The supplement identifies documents that must be controlled and the parties responsible for preparing, reviewing, approving, and issuing these documents and revisions. It establishes methods to ensure that procedural activities, performed to meet regulatory requirements, will not be inadvertently deleted when a document is revised, and that changes in orders and regulations are incorporated in the affected documents.

4.3.3 Quality Assurance Records

The Sandia Records Management Program ensures compliance with DOE Order 1324.5 to assure the control and maintenance of ES&H-related documentation at Sandia. This program defines appropriate physical storage and establishes responsibility for records centers and permanent retention. It addresses record identification, storage, retrieval, access, control, retention, and safeguarding of all ES&H quality-related records.

4.4 Work Processes

4.4.1 Packaging and Transportation of Materials and Wastes

The Packaging and Transportation of Materials and Wastes Program assures that all Sandia packaging and transportation operations achieve and maintain compliance with the applicable U.S. DOE orders, federal, state, local, and international transportation regulations to ensure the safe handling and transporting of all nonhazardous and hazardous materials, wastes, and substances. The program applies to all nonhazardous and hazardous materials either procured or fabricated at Sandia and any Sandia-operated sites. The program scope encompasses all aspects of material control activities including, identification, communication, handling, packaging, storage, material compatibility, vehicle standards and operation, records keeping, auditing and assessments, and training.

4.4.2 Control of Processes, Tests, and Experiments

Special processes are controlled by using SOPs. Special processes are processes in which the results depend on the control of the process or the operator's skill, or both, and in which the effect on the user's safety cannot be determined by inspecting or testing the item.

Sandia conducts extensive tests and experiments. All such tests and experiments must address ES&H issues and, if necessary, must be conducted using ES&H SOPs. These documents include, as applicable, provisions for ensuring that prerequisites have been met, that adequate instrumentation is available, calibrated, and used, that test personnel are trained, that environmental conditions have been considered, and that necessary monitoring is performed. In addition to necessary instructions and drawings, the test procedures/plans may include the following:

- Documentation of the interfaces that must be controlled throughout the duration of the test or experiment if the SOP involves more than one division and/or contract personnel
- The chain-of-custody to be used to ensure traceability and control if samples are prepared
- Identification of the facilities and equipment used to conduct the test or experiment and verification of the calibration status of measuring and test equipment
- Verification and validation of data acquisition systems (hardware and software) used to collect or reduce ES&H-related data

4.5 Design Control

This element of the MIIP covers ES&H-related activities, such as preliminary or conceptual design of testing programs and/or facilities, including the development, review, and approval of all design activities originating within Sandia or contracted to others.

4.5.1 Design Input

Applicable design inputs, such as the original design bases, ES&H-identified risks/hazards, regulations, and DOE requirements are identified and translated into the design specifications, drawings, procedures, and instructions.

4.5.2 Design Documents

Design documents are controlled during the design process and, upon completion, are distributed in accordance with written document control procedures.

4.5.3 Design Interfaces

The responsible line organization identifies all individuals, groups, and organizations affected by the design or design change. Interfaces with these individuals, groups, and organizations are specified in the design package.

4.5.4 Verification

Design packages receive a technical review and a review by applicable ES&H organizations to assure overall adequacy.

4.5.5 Design Changes

Changes in design input are reviewed and approved, and the justification for the change is documented. Design changes are controlled and documented in the same manner as the original design.

4.5.6 Use of Computer Software

Software used for the purpose of performing unique, specific functional calculations that support ES&H-related design control are verified and validated before use. All verifications and validations are documented.

4.6 Control of Purchased Items and Services

Sandia management has established policies for receipt inspection of property and materials and receipt of services (SLI 6640-1 and 6640-2, respectively). Acceptance criteria are established for all purchased equipment and services for which specific quality standards are necessary to avoid personal injury or preclude a risk or hazard to the environment or public or personal property. These criteria are used to verify that the parts, materials, components, and/or services meet the requirements of the purchase order. The criteria are applied by means of receipt inspection instructions and right of access to a supplier's facilities for source inspections and audits.

4.7 Inspections, Preoperational Inspections, and Testing

4.7.1 Inspections

Sandia policy is to prevent problems or deficiencies before or during a process, rather than implementing corrections after the problem or deficiency has occurred. The line organizations are responsible for ensuring that inspections are planned within their organization for applicable ES&H-related activities. Inspections are performed by qualified individuals who are independent of the activity being performed. Inspectors have the authority to stop work if unsafe conditions exist.

The types of inspections to be performed include receipt inspections, peer inspections, and in-process monitoring. The line organization is responsible for identifying the specific characteristics of an item to be inspected upon receipt and for establishing appropriate acceptance criteria. Defective or damaged material, deviations, deficiencies, defects, inadequate documentation, and other nonconforming items are documented at the time of the inspection.

On special occasions the line may require an additional level of inspection due to the nature of the work or the complexity. These inspections are accomplished through a "peer" inspection process in which other individuals who are not involved in the activity provide the independent check.

In-process monitoring is performed for ES&H-related activities that should be routinely inspected and monitored within a division. The line organization is responsible for the following:

- Identifying the applicable scope of activities
- Defining the objectives of the inspections and in-process monitoring
- Identifying the specific characteristics to be inspected and the frequency of inspections
- Selection of inspection methods (e.g., visual, nondestructive examination, testing, etc.)
- Identification of the individual(s) qualified to perform the inspection
- Establishing appropriate acceptance/rejection criteria
- Identification of applicable procedures, drawings, and specifications, including revisions, that will be used to control and direct the activity
- Documentation of inspection results, including proposed corrective actions for identified nonconformances

4.7.2 Preoperational Inspection and Testing

The purpose of preoperational inspection and testing is to confirm the adequacy of design, quality of construction, and to ensure manufactured parts perform as intended. Preoperational inspection and testing is performed by members of the contracted A/E firm, Sandia design engineers, mechanical contractors, and DOE cognizant representatives. Their significant findings make up a final inspection "punch list" highlighting deficiencies that must be satisfactorily corrected and reinspected before final acceptance and sign off.

Preoperational tests are based upon the following key events: (1) initial individual component testing, (2) system operations—minimum parameters, (3) system operations—normal parameters, and (4) operation testing. The initial test consists of installation checks where personnel visually inspect all components and equipment to assure that installation is in accordance with design plans. Fluid systems are checked for proper arrangement and control systems are checked for proper installation, including grounding connection, mechanical operability of components, and proper wiring. Circuit continuity, wiring, insulation, and proper ventilation will also be checked. For flushing strength and tightness tests, the strength and tightness of the fluid systems are proven by hydrostatic testing. System testing continues beginning with minimum parameters and increasing up to operating levels of 100 percent.

Final inspection includes all data gathered from preoperational testing and any other deficient findings uncovered during the inspection. Thus, the final inspection comprehensively covers all major structural, mechanical, electrical, instrumentation and control, and fire protection requirements to ensure the safety of the occupants.

The status of inspection and test activities will be identified either on the items or in documents traceable to the items where it is necessary to assure that required inspections and tests are performed and to assure that items that have not passed the required inspections and tests are not inadvertently installed, used, or operated. Status will be maintained through indicators, such as physical location and tags, markings, shop travelers, stamps, inspection records, or other suitable means. The authority for application and removal of tags, markings, labels, and stamps will be specified. Status indicators will also provide for indicating the operating status of systems and components of the facility, such as by tagging valves and switches, to prevent inadvertent operation.

Both Sandia and DOE/AL are required to conduct a formal Operational Readiness Review prior to the start of normal operations at a facility. The purpose of the review is to (1) review and certify that the systems critical to safety are constructed and installed as designed, (2) review the overall ES&H aspects of the facility/operation to ensure an acceptable low level of risk to the public, employees, and the environment, (3) determine that an ES&H program and plan are in effect for operations, and (4) establish a baseline for future ES&H appraisals under DOE Order 5482.1B, "Environment, Safety, and Health Appraisal Program."

4.7.3 Control of Measuring and Test Equipment

Sandia management has established a policy for the calibration of measurement standards and measurement and test equipment (SLI 2855). Sandia measuring and test equipment (M&TE) whose failure or improper functioning can result in worker or public safety problems or unanticipated environmental releases is calibrated in accordance with Sandia Engineering Procedure EP401560. Other M&TE (including Contractor-owned and calibrated M&TE) is controlled by procedures that address calibration frequencies, labeling, and methods of documentation for tools, gauges, and instruments. These procedures ensure that such equipment is properly controlled, calibrated, and adjusted at specified periods to maintain accuracy within the necessary limits. Equipment calibrations and calibration checks are traceable to either Sandia measurement standards organizations or another nationally recognized standards organization.

Calibrated equipment is uniquely identified by the manufacturer, make, model, serial number, and/or Sandia recall system number. This identification along with the date of last calibration, date next calibration is due, and the initials and organization number of the individual who performed the calibration is attached to the equipment. A complete set of calibration records is maintained on all equipment subject to the Sandia calibration control system. Calibration records are archived when such calibrated equipment is retired.

4.8 Quality Audits and Appraisals

Sandia management has established a policy for conducting audits, appraisals and surveys of Sandia (SLI 9010). The primary responsibility for assessing the effectiveness of the implementation of ES&H requirements is assigned to the manager of the ES&H Assessments Department. This organization is focused strictly on compliance with ES&H requirements contained in DOE Orders; federal, state, and local regulations; ES&H programs; and corresponding implementing procedures. It has a charter to independently appraise ES&H activities; provide procedural guidance to all Sandia organizations on internal self-assessment activities; gather, analyze, and disseminate information about lessons learned and operating experience; and receive, compile, and communicate data that indicates ES&H performance.

The QA Assessments Department is responsible for auditing ES&H activities and verifying compliance with the MIIP.

Qualified personnel audit and appraise activities in accordance with written procedures or checklists. They document and report results of formal audits and assessments to the managers responsible for the area being reviewed. Follow-up action is taken where indicated when deficiencies, discrepancies, and nonconformances are identified.

Audit and appraisal plans are developed for every audit/appraisal conducted. These plans identify the scope of the review, the schedule for reviews, the selected team members and their assigned responsibilities, organizations affected (including interfaces), audit checklists, reference documents used in the evaluation, and written instructions when the review is widespread or technically complicated. The ES&H Assessments Department and the QA Assessments Department establish the time frame for resolving immediate problems identified in the assessment. The organization being audited must respond in writing on all findings within a time period specified in the written audit/appraisal report. Audit/appraisal follow-up, completion, and close-out is scheduled to ensure that identified deficiencies are promptly corrected.

5.0 Environmental Monitoring Program

The Environmental Monitoring Program at Sandia, begun in 1959, ensures compliance with pertinent environmental monitoring requirements. Its original objective was to monitor radioactive effluents and associated environmental impacts resulting from Sandia operations. The program has expanded greatly to encompass nonradioactive effluent monitoring, hazardous and radioactive waste site monitoring, and other environmental compliance activities. The program has grown in response to new environmental regulations as well as expanded Sandia research programs.

5.1 Radiological Monitoring

Sandia has maintained an environmental radiological monitoring program since February, 1959. The objectives of this surveillance program are to detect any releases and/or migration of radioactive material to off-site locations related to on-site operations. Another objective of this program is to determine potential (if any) impacts of site-related activities to the off-site population and the surrounding environment. This monitoring program also provides a check on the effectiveness of reactor radiological safety systems in effect at Technical Area V. Soil and vegetation are monitored for tritium and undergo gamma screening analysis. Soil is also monitored for uranium. Gross alpha, beta, and gamma screening analysis, as well as tritium and uranium analysis are performed on water samples.

In 1981, a program was begun that uses thermoluminescent dosimeters (TLDs) to measure ambient levels of external gamma radiation at each major facility. TLD monitoring locations have been established around the Sandia/NM perimeter as well as in the surrounding community. The type of TLD phosphor used is LiF in chip form. All dosimeters are placed in open areas over soil substrates one meter above ground level. At least five TLDs are placed at each location in order to get an estimate of the variability in TLD response at that location. TLDs are exchanged on a quarterly basis. Transit controls are used to document additional exposure received during transit from Sandia/NM to field locations. The TLD readout equipment is calibrated by exposing TLDs to 0, 10, 20, 30, and 50 mR of Cs-137 midway through each quarterly field cycle. Ten TLDs are exposed at each level.

Few facilities within Sandia/NM routinely generate radioactive effluents or emissions. Furthermore, because Sandia/NM's radionuclide air emissions are so small, they are not measurable, and the release data must be calculated based on theoretical parameters.

5.1.1 Environmental Sampling and Surveillance

Monitoring Locations

Most environmental surveillance locations remain essentially the same from year to year (Figures 5.1-1 and 5.1-2). Selection of these sampling locations was based on potential impacts to the off-site residents and the surrounding environment.

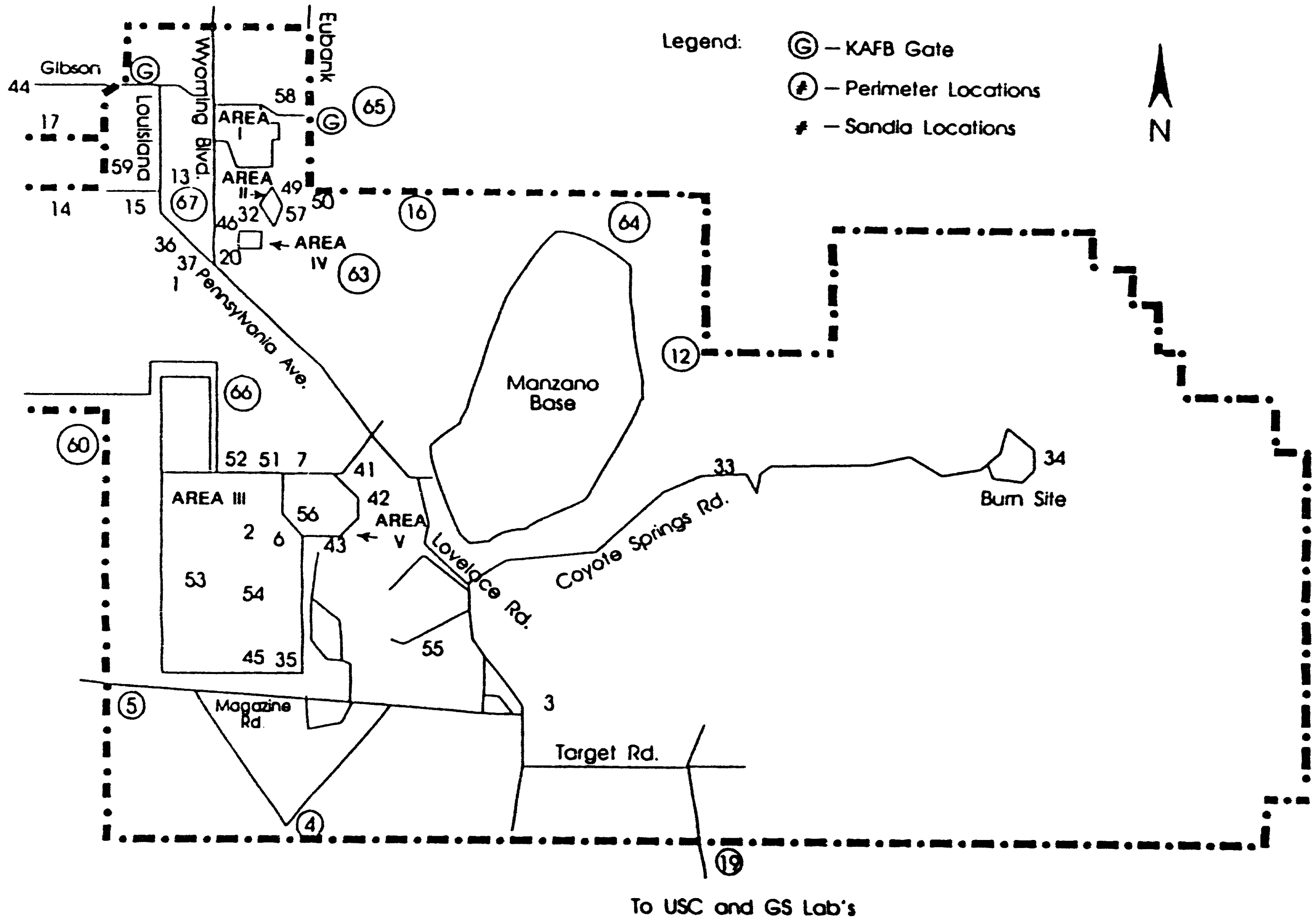
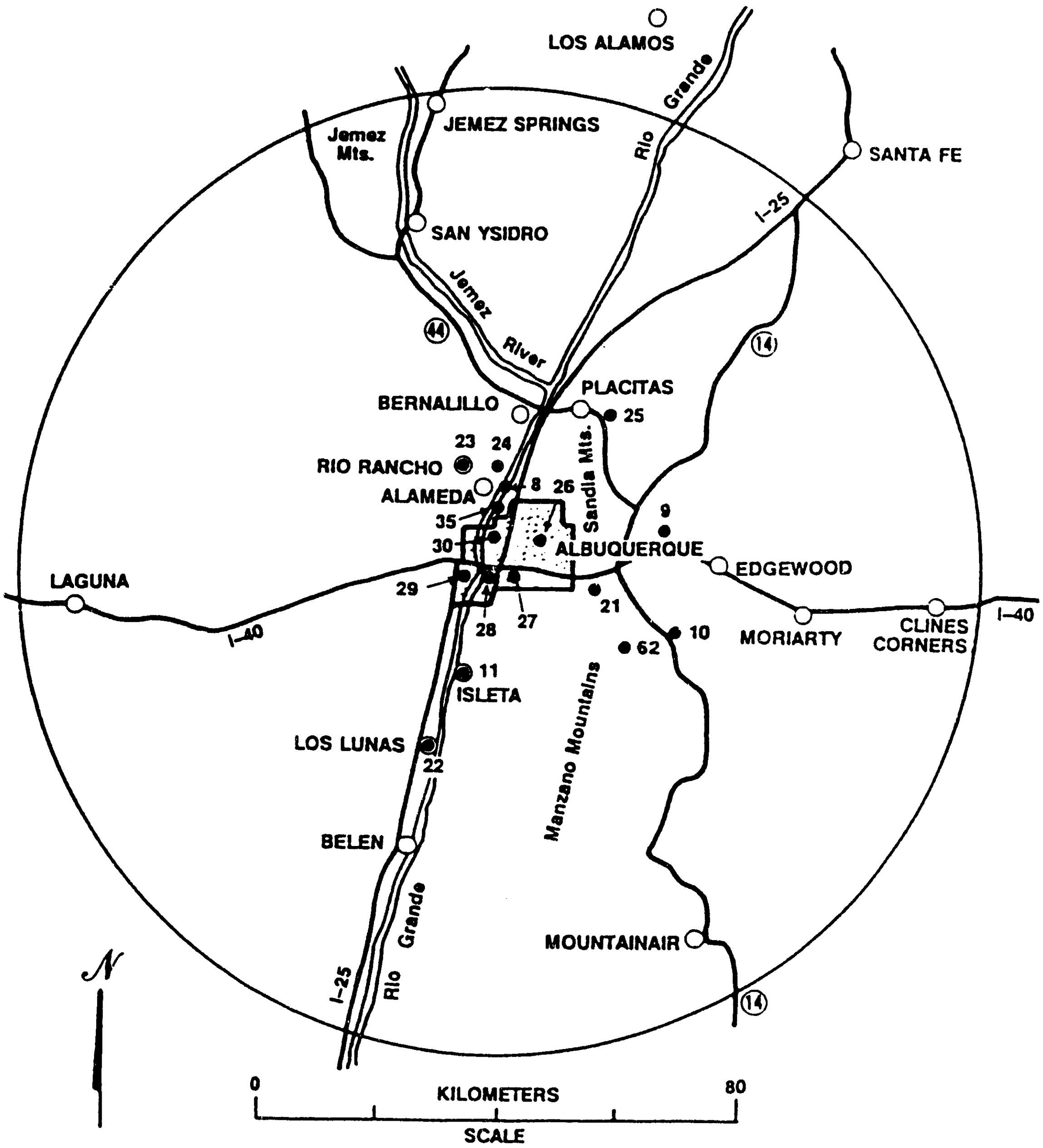


Figure 5.1-1 Environmental Monitoring Locations in Technical Areas I- V and Kirtland Air Force Base



○ Location of a community

● Sampling location with individual identification number

◉ Community where a sampling station exists

Figure 5.1-2 Community Monitoring Locations in the Albuquerque Areas

Table 5.1-1 lists the Sandia/NM environmental monitoring locations and specifies the type of sample collected (vegetation, water, and soil) and the presence of a TLD station for each location. Sampling locations include the Sandia site, KAFB, and various community or background sites distributed in and around Albuquerque within an 80-kilometer radius of Sandia/NM. Water monitoring locations include ten KAFB wells and three surface water locations. Groundwater samples for radiological analysis are collected from base wells in use at the time of sample collection; sampled wells may differ from one year to the next. In cases of replicate sampling, only the first sample collected is used in summary calculations to avoid skewing summary data toward replicate sample data.

New monitoring locations are added as necessary to monitor new facilities or operations, or to supplement data from existing stations. During 1991, five new stations were added to the environmental surveillance network: two perimeter stations (labeled P), one community station (labeled C), and two on-site stations (see Table 5.1-1 and Figure 5.1-1).

The new 1991 sampling locations are stations 63, 64, 65, 66, and 67. Stations 63 and 64 are located on the northeastern site boundary. These stations are used for vegetation and soil sampling. Station 65 is a community location in the vicinity of the Eubank gate entrance to Kirtland Air Force Base and is used to sample soil and vegetation. Station 66 is an on-site location for vegetation and soil sampling. This station is located between Technical Areas III and IV. Station 67 is Base Well 13, located in the northeastern portion of the site; it is used for groundwater sampling.

Sample Collection and Analysis

Samples are gathered and stored in accordance with methods described in USDOE/EP-0023 (DOE, 1981). These procedures have been documented in an Environmental Monitoring Manual (Millard, 1986) and sampling procedure (Procedure 90-07). Native vegetation (mostly grasses), soil, and water samples are collected annually at the end of the growing season.

5.1.2 Soil and Vegetation Monitoring

Soil and vegetation samples are randomly collected from a nine-square-meter quadrant at each location. Three 100-square-centimeter samples of the top five centimeters of soil are collected and composited at each station. Three vegetative samples, each consisting of approximately half a kilogram of stems and leaves representative of the species of each site, are collected and composited at each station. Three replicate soil samples are collected at three or more locations to determine sample variability. Replicate vegetative samples consisting solely of grasses are collected at each of three adjacent sample plots in order to estimate variability due to location.

5.1.3 Air Monitoring

Air and building exhaust or vent samples are collected and analyzed for radionuclides (primarily Cs-137 and tritium) at least annually. The samples are gathered and stored in accordance with DOE/EP-0023 (DOE, 1981). Dose

Table 5.1-1. Sandia/NM Environmental Monitoring Locations and Sample Types for Radioactive Surveillance

Location Number	Location	Sample Description[a]	Type[b]
1	Pennsylvania Avenue	S	V,S,T
2 NW	Radioactive Waste Disposal Site NW	S	V,S,T
2 NE	Radioactive Waste Disposal Site NE	S	V,S
2 SE	Radioactive Waste Disposal Site SE	S	V,S
2 SW	Radioactive Waste Disposal Site SW	S	V,S
3	Coyote Canyon Control	S	V,S,T
4	Isleta Reservation Gate	P	V,S,T
5	McCormick Gate	P	V,S,T
6	East of Technical Area III, Water Tower	S	V,S,T
7[c]	North of Technical Area V, Arroyo	S	V,S,T
8	Corrales Bridge	C	V,S,W
9	Sedillo Hill, I-40, East of Albuquerque	C	V,S
10	Oak Flats	C	V,S,T
11	Isleta Pueblo, Rio Grande	C	V,S,T,W
12	NE Perimeter	P	V,S
13	Base Well 1 (Not running)	S	W
14	Base Well 2 (Not running)	S	W
15	Base Well 7	S	W
16[c]	Four Hills	P	V,S,T
17	Base Well 14 (Not running)	S	W
18	North Perimeter Road	P	T
19	Seismic Center Gate	P	V,S,T
20	Technical Area IV, SW	S	V,S,T
21	Bernalillo Fire Station 10, Tijeras	C	T
22	Los Lunas Fire Station	C	T
23	Rio Rancho Fire Station, 19th Avenue	C	T
24	Corrales Fire Station	C	T
25	Placitas Fire Station	C	V,S,T
26	ABQ[d] Fire Station 9, Menaul NE	C	T
27	ABQ Fire Station 11, Southern SE	C	T
28	ABQ Fire Station 2, High SE	C	T
29	ABQ Fire Station 7, 47th NW	C	T

[a]S = SNL, Albuquerque; P = Perimeter of SNL, Albuquerque; and C = Community.
[b]V = Vegetation, S = Soil, W = Water, and T = TLD (thermoluminescent dosimeters).
[c]Replicate sampling sites: {7, 16, and 60 for V and S. 33 for W only.
[d]ABQ = Albuquerque.

Table 5.1-1. Sandia/NM Environmental Monitoring Locations and Sample Types for Radioactive Surveillance (continued)

Location Number	Location	Sample Description[a]	Type[b]
30	ABQ[c] Fire Station 6, Griegos NW	C	T
31	Technical Area II Guard Gate	S	T
32S	Technical Area II, Building 935 (South Bay Door)	S	S
32E	Technical Area II, Building 935 (East Personnel Door)	S	S
33[d]	Coyote Spring	S	V,S,W
34	Lurance Canyon	S	V,S
35	Chemical Waste Disposal Site	S	V,S
36	Base Well 4	S	W
37	Base Well 8	S	W
38	Base Well Lift Station to Manzano	S	W
39	NW DOE Complex	P	T
40	Technical Area I NE by Building 852	P	T
41	Technical Area V, NE Fence	S	V,S,T
42	Technical Area V, E Fence	S	V,S,T
43	Technical Area V, SE Fence	S	V,S,T
44	Base Well 12	S	W
45	Technical Area III, RMWMF Site, NW Corner	S	V,S,T
46	Technical Area II, South Corner	S	T
47	Tijeras Canyon East of AIV	S	T
48	Tijeras Canyon Northeast of AIV	S	T
49	Near the proposed ECF Site	S	V,S
50	Base Well 11	S	W
51	Ditch, Technical Area V, N	S	V,S
52	Technical Area III, NE/6563	S	V,S
53	Track, Technical Area III, S	S	V,S
54	Technical Area III, 6630	S	V,S
55	Technical Area III, 9939	S	V,S
56	Technical Area V, W/6488	S	V,S
57	Technical Area IV, NE/970	S	V,S
58	N Base Housing	P	V,S
59	Zia Park/SE	P	V,S

[a] S = SNL, Albuquerque; P = Perimeter of SNL, Albuquerque; and C = Community.
[b] V = Vegetation, S = Soil, W = Water, and T = TLD (thermoluminescent dosimeters).
[c] ABQ = Albuquerque.
[d] Replicate sampling sites: {7, 16, and 60 for V and S. / 33 for W only.

Table 5.1-1. Sandia/NM Environmental Monitoring Locations and Sample Types for Radioactive Surveillance (continued)

Location Number	Location	Sample Description[a]	Type[b]
60[c]	Tijeras Arroyo	P	V,S
61	Airport (west end)	P	V,S
62	East Resident	C	V,S
63	No Sweat Boulevard	P	V,S
64	North Manzano	P	V,S
65	Sandia Research Park	C	V,S
66	KUNSC	S	V,S
67	Base Well 13	S	W

[a]S - SNL, Albuquerque; P - Perimeter of SNL, Albuquerque; and C - Community.
[b]V - Vegetation, S - Soil, W - Water, and T - TLD (thermoluminescent dosimeters).
[c]Replicate sampling sites: {7, 16, and 60 for V and S. {33 for W only.

estimates are then calculated for site boundaries and for the Albuquerque area population as a whole.

5.1.4 Surface and Groundwater Monitoring

Both surface- and groundwater are sampled at least annually (at the end of the growing season) in the environmental monitoring program. Groundwater samples are collected from water supply wells in use at the time of collection and will differ from year to year. These samples are analyzed for radionuclides (primarily Cs-137, tritium, and uranium) and are screened for gross alpha and gross beta. Surface water samples are collected at two sites on the Rio Grande River. One site is upstream and the other downstream from Sandia/NM. The samples are analyzed for the radionuclides mentioned above. Samples are gathered and stored in accordance with DOE/EP-0023 (DOE, 1981) and are analyzed in accordance with American National Standards (ANSI) / Institute of Electrical and Electronics Engineers (IEEE) Standard 680-1978 (ANSI/IEEE, 1978).

5.2 Nonradiological Monitoring

5.2.1 Wastewater Programs

Sandia/NM contains more than 15 miles of sewer lines interconnected with those of Kirtland Air Force Base. Discharges to the City of Albuquerque publicly owned treatment works are regulated by the Albuquerque Public Works Department, Liquid Waste Division, under the authority of the city's sewer use and wastewater control ordinance, which is approved by the EPA in accordance with the Clean Water Act (CWA, 1948) as amended. The permits for discharging waste water to the city's publicly owned treatment works specify the required quality of discharges and the frequency of reporting the results of the monitoring. Tables 5.2-1 and 5.2-2 and Figure 5.2-1 describe the wastewater sampling locations and brief characteristics of each. Both grab and composite samples are collected. Grab sample analyses include CN, S, phenols, oil, grease, pH, temperature, total toxic organics, organics, chlorinated solvents, and naphthalene. Composite sample analyses include fluoride and metals such as As, Ba, Cd, Cr, Cu, Pb, Mn, Hg, Ni, Se, Ag, and Zn. The sampling procedures, permit limits for individual sampling stations, dates of sample collection and sample frequency, analytical methods, and quality control/quality acceptance criteria are defined in the Wastewater Sampling Plan for Sandia/NM.

5.2.2 Storm Water Program

Storm water sampling is conducted at selected locations to support Sandia/NM's site-wide National Pollutant Discharge Elimination System (NPDES) permit application.

Table 5.2-1. Sandia/NM Wastewater Sample Locations

Permit Number	Station Manhole	Location	Average Flow (gpd)[a]
2069A-2	WW001	South Technical Area IV Tijeras Arroyo	28,849
2069C	WW003	Technical Area I Building 841 SW	15,000[b]
2069D-3	WW004	Technical Area I Building 841 SE	39,154
2069E	WW005	Technical Area I Building 841 SW	91,476
2069F-2	WW006	East of KAFB Lagoons	514,123
2069G-2	WW007	Technical Area I Building 858 Basement	110,939
2069H-2	WW009	Technical Area I Building 878 Basement	3,659
2069I	WW008	South Technical Area I Tijeras Arroyo	25,576
2069K	WW011	Technical Area III	10,000

[a]gpd = Gallons/day.
[b]Estimated.

Table 5.2-2. Summary of Characteristics for Sandia/NM Wastewater Sampling Stations

Station Number	Flumes	Flow Meter and Sampling Equipment
WW001	3-in. Parshall	Isco 3210 Flow Meter Isco 2700R Sampler Leeds and Northrop pH Analyzer System
WW003	None	Isco 2700 Sampler
WW004	2-in. Parshall	Isco 3210 Flow Meter Isco 2700R Sampler Leeds and Northrop pH Analyzer System
WW005	3-in. Parshall	Isco 3210 Flow Meter Isco 2700R Sampler Leeds and Northrop pH Analyzer System
WW006	6-in. Parshall	Isco 3210 Flow Meter Isco 2700R Sampler Leeds and Northrop pH Analyzer System
WW007	45° V-Notch Weir	Isco 3210 Flow Meter Isco 2700R Sampler Leeds and Northrop pH Analyzer System
WW008	6-in. Parshall	Isco 3210 Flow Meter Isco 2700R Sampler Leeds and Northrop pH Analyzer System
WW009	2-in. Parshall	Isco 3210 Flow Meter Isco 2700R Sampler Leeds and Northrop pH Analyzer System
WW011	6-in. Parshall	Isco 3210 Flow Meter Isco 2700R Sampler Leeds and Northrop pH Analyzer System

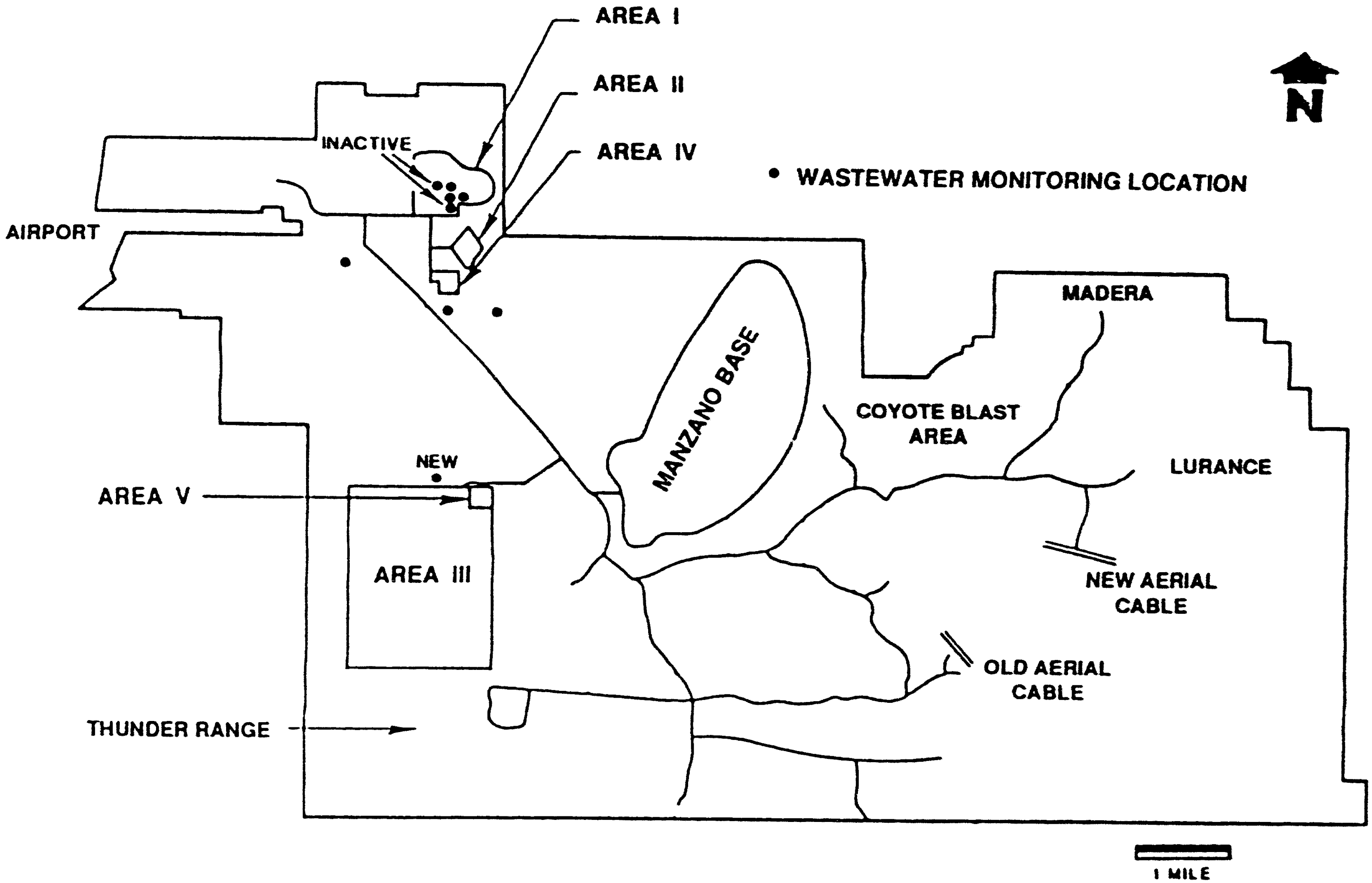


Figure 5.2-1 Wastewater Discharge Sampling Locations

5.2.3 Surface Discharge Program

Nonsanitary discharges to surface impoundments for Sandia/NM are under the authority of the New Mexico Water Quality Control Commission (NMWQCC) Regulations (NMWQR, 1991) as implemented by the New Mexico Environmental Department (NMED) Ground Water Bureau. Discharge Plan DP-530 has been approved for discharging storm water from oil storage tank areas and building basements associated with the Pulsed Power Development Facilities in Technical Area IV to two lagoons. The approved discharge plan, as amended, requires quarterly measurement of water levels and semiannual sampling and analysis. Approved Discharge Plan DP-771 allows for the discharge of up to 2700 gallons per day of tap water from solar detoxification of water experiments at the Solar Detoxification Facility. This permit requires quarterly monitoring of listed contaminants, discharge volumes, starting concentrations, and discharge concentrations for each test.

5.2.4 Groundwater Monitoring

Groundwater monitoring activities conducted by Sandia/NM include measuring the water-level elevations of monitor wells in the Sandia/NM area and sampling the chemical waste landfill (CWL), mixed waste landfill (MWL), and the KAFB-wide monitor wells for water quality analyses. CWL monitoring includes quarterly assessment monitoring and annual groundwater quality monitoring in accordance with 40 CFR 265.92 and New Mexico Hazardous Waste Regulations 206.C.1 (New Mexico Hazardous Waste Act, 1978). These samples are analyzed for groundwater contamination indicators, total dissolved metals, and constituents listed in Appendix VIII of 40 CFR 262. Quarterly background monitoring is conducted at the MWL. KAFB-wide groundwater monitoring is conducted in order to establish background characteristics of the regional groundwater flow system.

The groundwater monitoring program was established in accordance with DOE Order 5400.1 (DOE, 1988). In addition, the CWL currently must meet the interim status Resource Conservation and Recovery act (RCRA, 1976) groundwater monitoring regulations (40 CFR 265, Subpart F). Groundwater monitoring activities at the MWL are dictated by DOE Order 5400.4 (DOE, 1989), which sets forth the policy that DOE facilities will respond to all releases in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, 1980), as amended, 42 U.S.C. 9601 et seq., and the National Oil and Hazardous Substances Pollution Contingency Plan (NESHAP, 1985).

The Sandia/NM groundwater monitor well network includes 35 Sandia/NM and KAFB wells and five springs (Figures 5.2-2 through 5.2-4). The protocols for collection and analysis of representative groundwater samples at the CWL and MWL are specified in the "Chemical Waste Landfill Sampling and Analysis Plan" and in the draft, "Mixed Waste Landfill Sampling and Analysis Plan," respectively. Samples for the KAFB-wide hydrogeochemical characterization are collected in accordance with the "Regional Hydrogeochemical Sampling and Analysis Plan" as well as the "Chemical Waste Landfill Sampling and Analysis Plan."

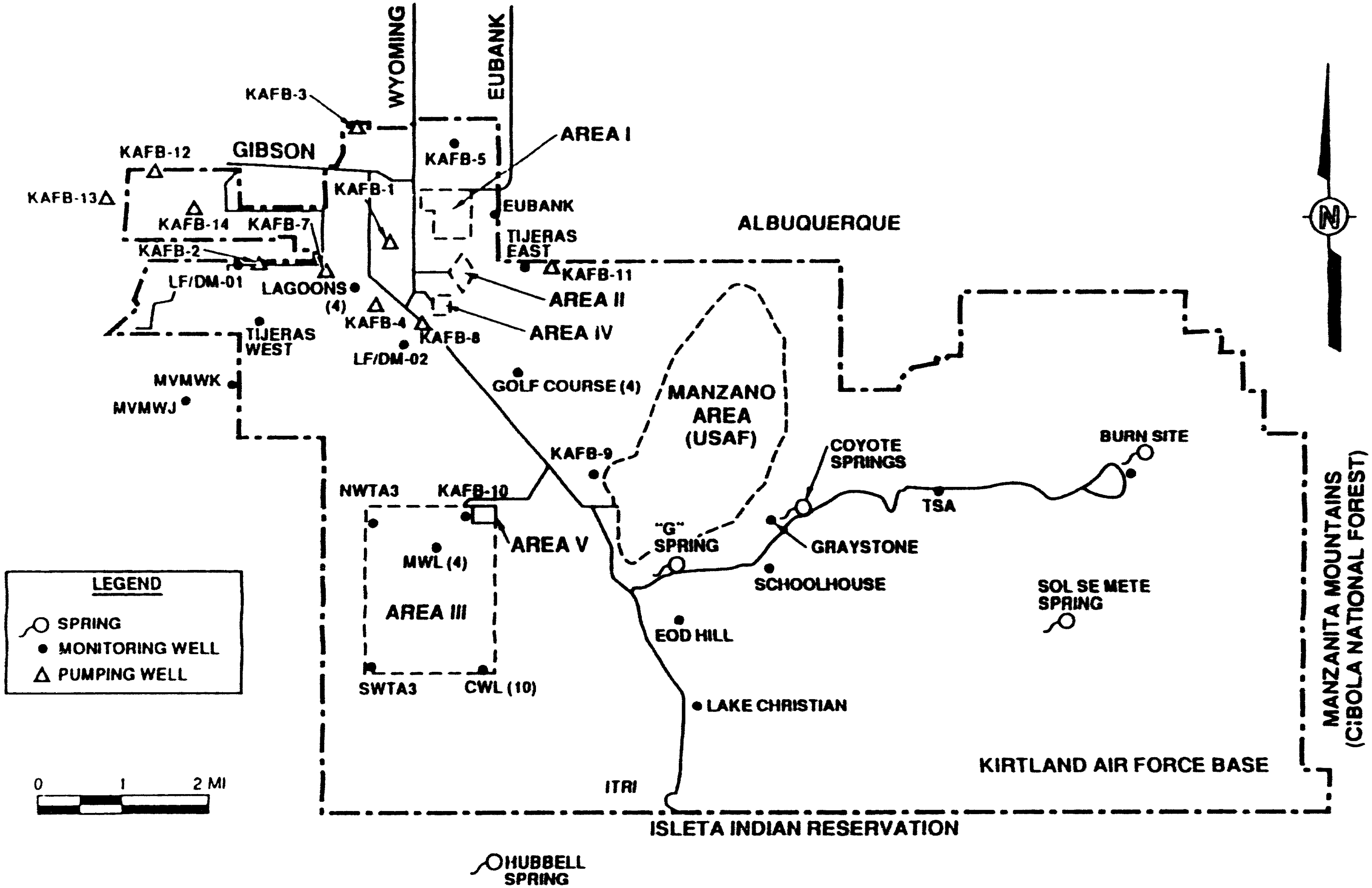


Figure 5.2-2 Location Map of Sandia/NM and Kirtland Air Force Base Wells and Springs

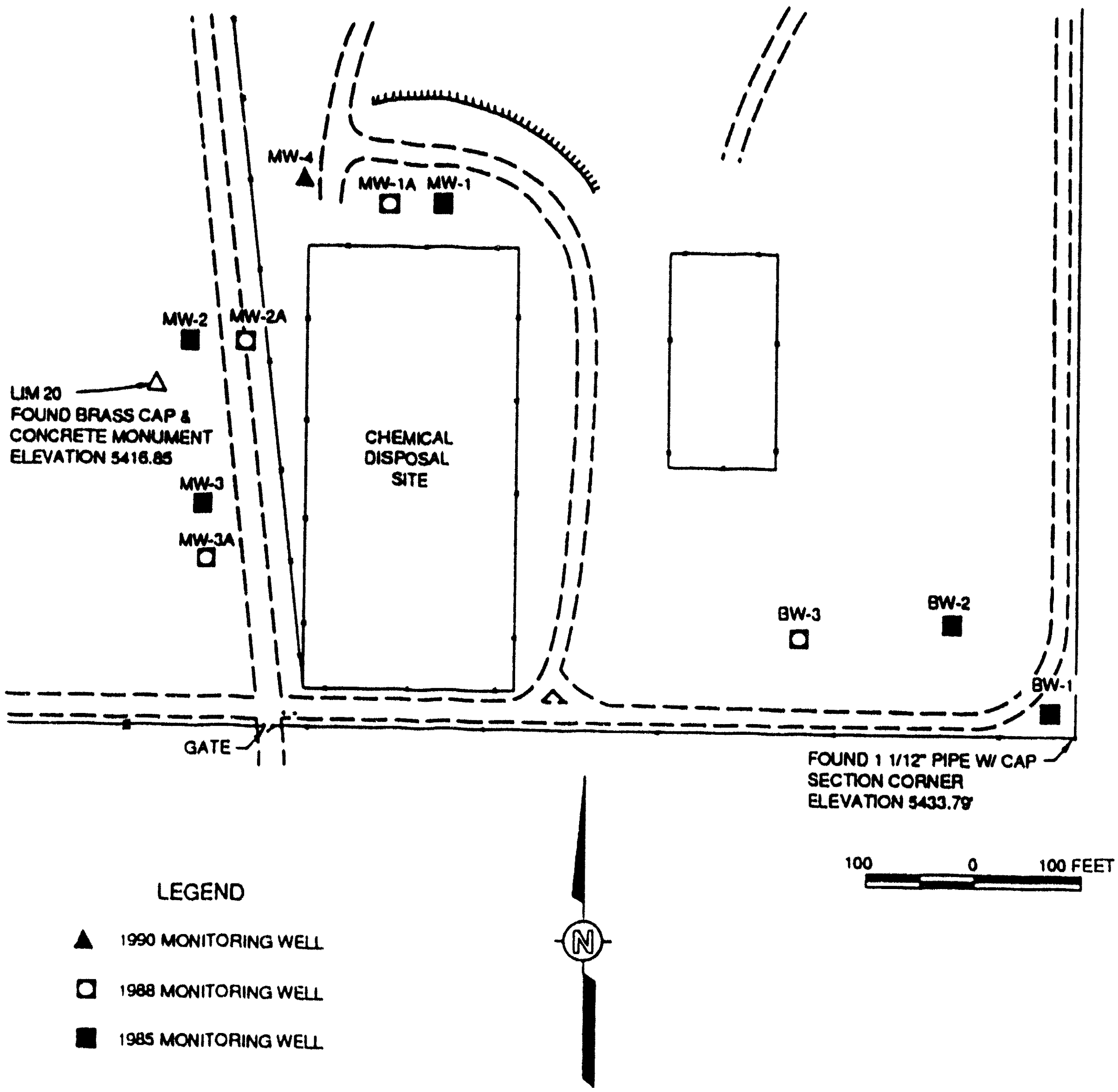


Figure 5.2-3 Chemical Waste Landfill Monitor Well Locations

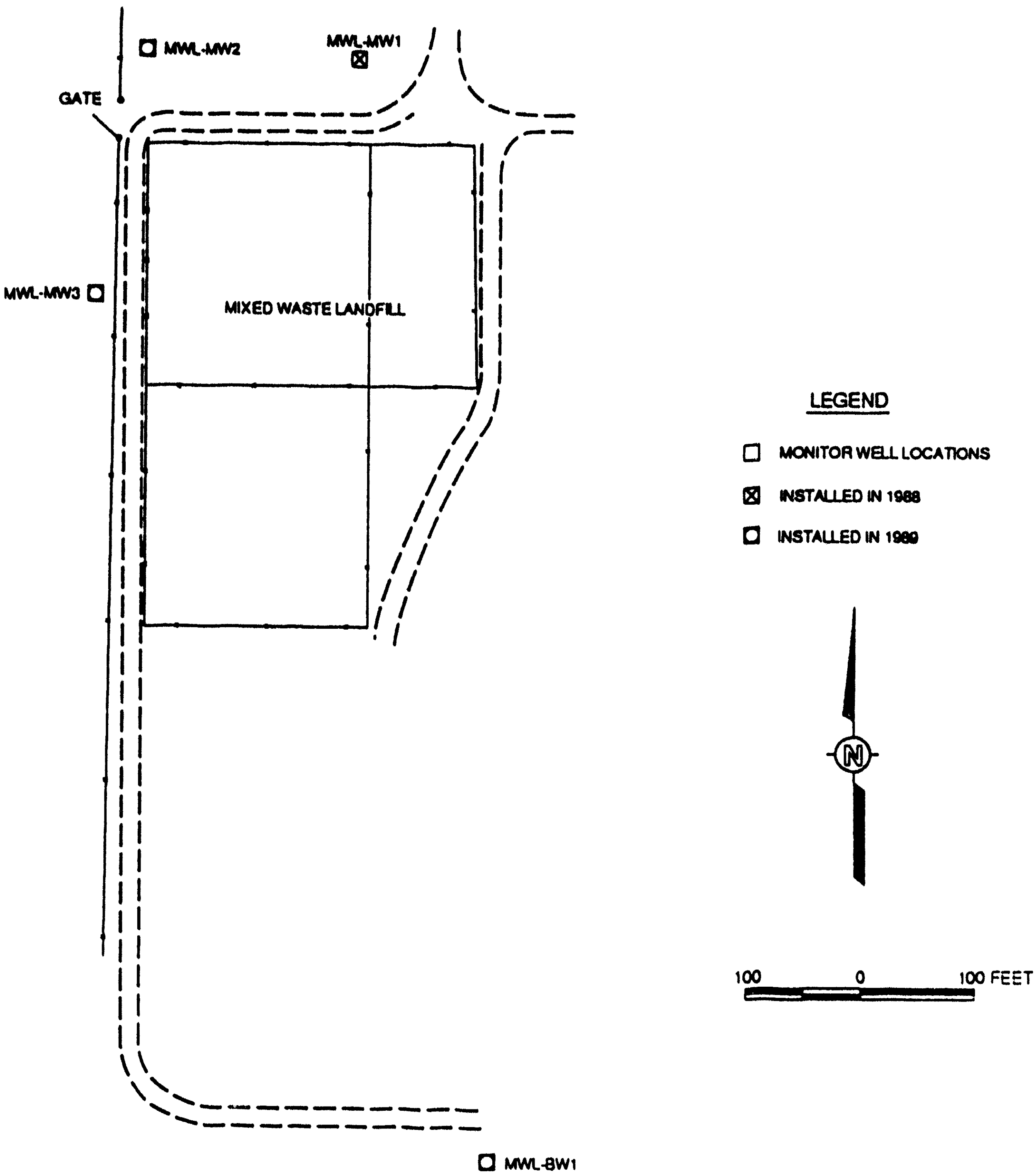


Figure 5.2-4 Mixed Waste Landfill Monitor Well Locations

5.3 References

40 CFR 262. 1980, as amended.

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ANSI/IEEE. 1978. *IEEE Standard Techniques for Determination of Germanium Semiconductor Detector Gamma-Ray Efficiency Using a Standard Marinelli (Reentrant) Beaker Geometry*. ANSI/IEEE 680.

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NMWQR (New Mexico Water Quality Regulations). 1991. New Mexico Water Quality Control Commission Regulations (1967, as amended through August 17, 1991).

RCRA (Resource Conservation and Recovery Act). 1976. Public Law 94-580, 1976, 90 Statute 2795.

6.0 Emergency Preparedness

This chapter captures the essence of the Sandia/NM emergency preparedness program, the details of which are contained in the Emergency Preparedness Plan for Sandia National Laboratories (EPP, 1991).

6.1 Emergency Classification and Emergency Action Levels

Department of Energy Orders list three categories of emergencies: Operational Emergency, Energy Emergency, and Continuity of Government Emergency. This chapter will address only those conditions listed in the Operational Emergency category. The Energy Emergency and Continuity of Government Emergency categories are outside the scope of the Sandia/NM Emergency Plan.

Operational Emergencies are significant accidents, incidents, events, or natural phenomena that have the potential to seriously degrade the safety or security of DOE facilities. Operational Emergencies apply to DOE reactors and other DOE facilities (nuclear and nonnuclear) involved with hazardous materials; DOE-controlled nuclear weapons, components, or test devices, DOE safeguards and security events; and transportation accidents involving hazardous material.

The three classes of Operational Emergencies, listed in order of increasing severity, are Alert, Site Area Emergency, and General Emergency. These classes are differentiated by severity in order to specify appropriate emergency actions, including required response activities and notifications commensurate with the degree of hazard presented by the event. These emergencies, plus less severe events categorized at the "unusual" or "off normal" level, must be reported as required by DOE Order 5000.3B.

The Operational Emergency category is divided into five response areas: (1) reactors; (2) nonreactor facilities; (3) nuclear weapons, components, and test devices; (4) safeguards and security; and (5) transportation.

This chapter addresses the event classification system to include the post-event conditions of recovery and termination. Emergency Action Levels (EALs) are defined and explained in Section 6.1.3.

6.1.1 Emergency Classification

A key element in the identification, mitigation, and recovery from any emergency is a classification system that identifies the severity of the event and provides a minimum level of response guidance. The identification of the event severity in common terminology will aid in the mutual understanding of the problem or potential problem when communicating with on-site responders and off-site agencies.

The event classifications for the system that has been developed and is in use at DOE facilities are: Alert, Site Area Emergency, and General Emergency. The

Alert classification provides early and prompt notification of minor events that could lead to more serious consequences given human error and/or equipment malfunction or events that could be indicative of more serious conditions not fully realized. The Site Area Emergency and General Emergency classifications indicate that more serious problems are occurring or are about to occur, and that augmented staffing and aggressive emergency response actions are required.

The Alert, Site Area Emergency, and General Emergency classifications present a graduated approach to providing adequate emergency response preparations.

6.1.2 Post-Event Declarations

When emergency conditions permit, the Emergency Response Director (ERD) will downgrade the response effort and reduce the number of emergency responders. *Recovery* and *Termination* are the two post-event declarations used by the ERD.

Recovery

The ERD may declare the emergency to be in the recovery phase when the following conditions have been met: the event has stabilized and any radiological or other hazardous material releases have been terminated, no Protective Action Guides (PAGs) or EALs are being exceeded, and the possibility of escalation of the event is minimal. Before the recovery operation can start, post-event planning will consider and evaluate area status, reentry requirements, personnel protection requirements, clean-up requirements, permits needed, repairs necessary, and spare part and any additional equipment necessary.

Termination

The ERD may terminate the event when the following conditions are met: the emergency no longer exists, operations can return to normal, remaining damage or repair activities are minor, all documentation (written logs, notes, floppy disks, audio tapes, video tapes, etc.) associated with the event have been collected, and final reports of the event are being prepared.

6.1.3 Emergency Action Levels

An Emergency Action Level (EAL) is a predetermined, facility-specific, observable threshold that places the facility in a given emergency class.

An EAL can be an instrument reading, an equipment status indicator, a measurable parameter (on-site or off-site), a discrete, observable event, results of analyses, an entry in specific operating procedures, or another phenomenon that, if it occurs, indicates entry into a particular emergency class.

EALs are defined for each emergency classification and are described in the Emergency Plan Implementing Procedures (EPIPs).

6.1.4 Emergency Response Personnel Action

Action required by emergency response personnel is addressed in respective EPIPs. Specific security-related responses and activities are contained in security operation orders.

6.2 Sandia Emergency Response Organization

Sandia emergency response organization structure encompasses personnel from the executive ranks down through a field organization structure to individual responders in the field.

Two different but interconnected elements are included in this structure: (1) the Emergency Operations Center (EOC) and (2) the Sandia Incident Command System (ICS), which is the field structure used to obtain, direct, and control on-scene emergency response. The details of the Sandia ICS and the specific relationships, communication links, and responsibilities of ICS and EOC functions are provided in Section 6.2.2. Staffing levels are maintained to ensure that sufficient personnel are available for a protracted emergency.

The function of the EOC is first to establish a central point from which the overall emergency response program can be administered by Sandia management personnel. Second, the EOC serves as a data collection point where information from the emergency scene can be analyzed, consequences assessed, and protective action recommendations formulated. Third, from that analysis, mitigation, recovery, and termination plans can be formulated, and reports and information can be prepared and approved for release. Fourth, the EOC serves as liaison for other activities.

The function of the ICS is to provide a field structure to ensure that (1) a functional, controlled, recognizable chain-of-command exists at the scene of the incident, (2) response resources are determined, acquired, staged, dispatched, properly used, and demobilized, and (3) an effective interface is established with facility responders.

6.2.1 Emergency Response Director and Emergency Operations Center Cadre, Albuquerque

Emergency Response Director

The Emergency Response Director (ERD) is a trained Sandia manager. The Incident Commanders (ICs) may serve as the Sandia ERD until relieved by the ERD. The ERD is the individual who is in overall command and control of the emergency.

The ERD is responsible for ensuring that EOC positions are properly staffed; the ICS is activated, staffed, and functional; proper reports and information releases are prepared and dispatched as required; action is taken to obtain resources in support of the ICS; off-site authorities such as the Department of Energy, Department of Defense, and Environmental Protection Agency, and state, local, and tribal governments are briefed.

Incident Commander

The Incident Commander (IC) is the individual who has control of all field activities during response to emergency events and serves as the single authority in command at the scene. Incident Commanders are members of the Sandia Emergency Management Department and provide continuous on-site coverage. During an emergency event, the IC interfaces directly with the ERD.

Security Manager

The Security Manager is a member of the EOC cadre who is knowledgeable of safeguards and security requirements. The security office provides support to the Operations Section Chief in the EOC cadre.

The Security Manager is the EOC interface with the Kirtland Air Force Base (KAFB) security police and city, county, and state law enforcement agencies. The Security Manager acts as the primary information interface with the FBI on security matters and provides support as requested.

Logistics Manager

The Logistics Manager is a member of the EOC cadre who determines, acquires, uses, and controls resources associated with moving people, material, or supplies in response to an emergency. The Logistics Manager is knowledgeable of certain services such as control of utilities (gas, electric, and water), facility floor plans, and construction services.

Working through the Logistics Section Chief at the emergency scene, the Logistics Manager is responsible for assessing the extent of damage to facilities and evaluating possible impact to nearby facilities that may require shut-down of gas and electrical systems and closure of buildings.

Environment, Safety, and Health Manager

The Environment, Safety, and Health Manager is a member of the EOC cadre and is responsible for performing dose projection calculations, plume modeling, recommending on-site and off-site protective actions, and tracking and evaluating the radiological exposures of emergency response personnel. This includes advising the ERD that prescribed radiological or other exposure limits are being approached.

The ES&H Manager is responsible for obtaining information on radioactive substances or other hazardous materials and pertinent weather information to determine risks associated with the emergency. This information is used to determine (1) the area at risk and protective actions, such as areas requiring evacuation, safety and/or protective gear necessary to effectively deal with the situation, and spill containment procedures and (2) reentry, recovery, and clean-up procedures.

The ES&H Manager consults with the EOC Medical Manager about the hazards to which personnel have been exposed. This information is used by the Medical Manager to determine decontamination methods and transportation requirements of affected personnel.

Medical Manager

The Medical Manager is a physician from the Occupational Medicine Center who ensures that qualified medical response personnel with necessary treatment equipment and properly equipped transport capabilities are at the scene to perform victim triage, treat injuries, arrange for transportation and decontamination, and take other measures to minimize injury to personnel.

The Medical Manager maintains direct contact with medical personnel in the field through the ES&H Section Chief in the ICS (see "Sandia Incident Command System," Section 6.2.2).

Public Information Officer

The Public Information Officer (PIO) is a member of the EOC cadre and the official spokesperson for Sandia. The PIO is a member of the Public Relations staff and operates from the EOC.

The Public Relations staff will also monitor media activities from the Media Center for misinformation and rumors that may be generated. This information is relayed to the PIO, who will advise the EOC cadre.

Emergency Operations Center Coordinator

The EOC Coordinator is a member of the Emergency Preparedness staff and is responsible for overall administrative management of the EOC, including supervising maintenance of the status board, telephone operation, and other administrative support. This includes ensuring the flow of information within the EOC and verifying that EOC members are properly documenting their activities.

Emergency Management Information System Operators

The Emergency Management Information System (EMINS) is a network of hardware and software that enables EOC personnel to quickly access, update, and display emergency information and archive it for future reference. The EMINS Operator is responsible for entering information into the data and graphic overlay stations, requesting printouts from the system, and controlling the big screen displays to visually display and record all pertinent information during operation of the EOC.

Emergency Operations Center Support Staff

Other staff will be used as needed to operate various communications systems; assist with the EOC cadre in acquiring maps, view graphs, or other materials; making contacts (as directed) to other agencies or response groups; establishing reentry/recovery plans; conducting consequence assessment, dose projections, and plume modeling; and providing general support to the EOC cadre.

U.S. Department of Energy

The ERD will notify the Department of Energy (DOE) when the Sandia EOC is operational. In the EOC, the DOE representative performs the duties of the Cognizant Federal Agency (CFA), such as verifying the categorization of the incident, communicating with other DOE offices, coordinating with other federal agencies, providing event information and DOE-related information to DOE representatives located at the Joint Information Center (JIC).

The DOE/Albuquerque Operations (AL) Public Information Officer (PIO) is responsible for establishing a JIC and will be the moderator for the press conferences at the JIC. PIOs from each authority or contractor serve as members of the briefing team.

6.2.2 Incident Command System (ICS)

The Sandia Incident Command System (ICS) provides on-scene emergency management. The ICS is based on the recognition that mitigation of the incident in the field is absolutely critical to successfully dealing with an emergency.

ICS is the second element in the Sandia emergency management system. Its purpose is to establish a field management system to ensure an easily recognizable, integrated, unified command structure with common terminology so that multiple authorities such as the USAF, the U.S. Forest Service, and the fire department will be integrated efficiently into the Sandia emergency response organization.

The ERD has overall command and control of the emergency management system, which includes activities such as interfacing with the community, the press, and other agencies. The Incident Commander (IC) and the ICS personnel at the scene are responsible for the control and mitigation of the emergency, including initial assessment of the incident, control of the area, containment of the incident, determination of resources, protection of the health and safety of the responders, and proper demobilization of resources on conclusion of the incident.

The basic structure of the Sandia ICS is shown in Figure 6.2-1.

Operations Section Chief

The Operations Section Chief reports to the IC and is responsible for supervising and coordinating those groups at the scene who establish perimeters, control access to the scene, and take action to deal with facility fires, security emergencies, and other situations.

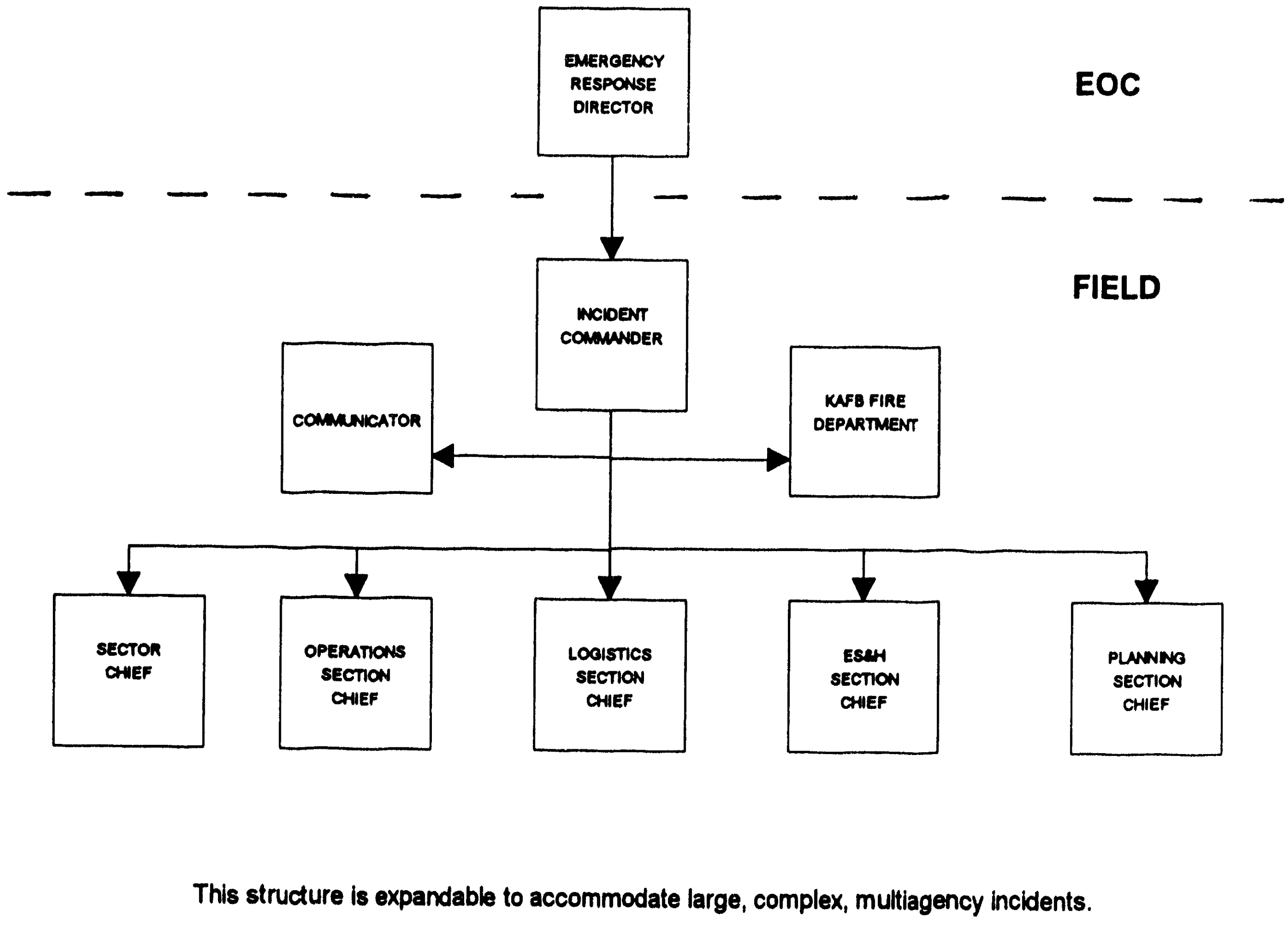

Figure 6.2-1 SNL/NM Incident Command System

Logistics Section Chief

The Logistics Section Chief reports to the IC and is responsible for identifying, acquiring, deploying, and mobilizing supplies, material, transportation, and equipment to deal with an emergency.

ES&H Section Chief

The ES&H Section Chief reports to the IC and is responsible for identifying, acquiring, deploying, and mobilizing all resources needed at the scene to deal with the injured, to prevent further injury, to provide on-scene assessments and plans for mitigation of environmental hazards and recommend action to prevent further damage, to assure safety for responders, and to assist in the implementation of clean-up plans.

Planning Section Chief

The Planning Section Chief reports to the IC and is responsible for monitoring all elements of the situation, staying current of developments, discussing circumstances with other ICS section chiefs, and assisting the OSC in determining the appropriate response action. That is, the Planning Section Chief assists the OSC in developing and modifying a plan to mitigate the emergency.

Sector Chief

The Sector Chief responsibilities at Sandia/NM include being an advisor to the IC during emergencies. The Sector Chief is normally the most knowledgeable about the area affected by the emergency. As such, the Sector Chief should be used as a source of information for the ICS.

Interface with Other Agencies/Organizations

The Sandia ICS can be used in multi-agency operation. This is important because Sandia/NM facilities are integrated with KAFB and adjacent to the City of Albuquerque and U.S. Forest Service-controlled areas. The Sandia ICS incorporates a unified command structure based on the national ICS model.

Emergency Response, Criminal Act, FBI Involvement. In the event of a criminal act creating or potentially creating an emergency event, the FBI is contacted and advised of circumstances. If circumstances warrant, the FBI may decide to staff an agent in the EOC and, if necessary, assume command of security and tactical operations. Any FBI personnel assigned to the event scene will be integrated into the ICS.

6.3 Emergency Response Facilities, Communications Systems, and Equipment

The following Sandia/NM facilities are designated as emergency response facilities:

6.3.1 Emergency Operations Center

The Emergency Operations Center (EOC) is located in Tech Area (TA) I. The EOC is under the direction of the ES&H Center, Emergency Management Department. It is a hardened facility with a secure entrance within a building that has additional organizational functions. The EOC is a self-contained, dedicated emergency response facility that is staffed by the IC personnel 24 hours a day.

The EOC contains primary and back-up communications equipment and incident reporting equipment. Auxiliary power is provided by two battery systems and a diesel generator. The ventilation system provides filtered air at all times and can be adjusted, if necessary, to provide positive pressure. A separate heating and cooling system, independent of the regular system, is available for use.

6.3.2 Headquarters Communication Center

The Headquarters Communication Center (HCC), located in TA I, is a dedicated hardened facility that is staffed 24 hours a day. The HCC provides security support to all Sandia-controlled property north of the Tijeras Arroyo.

An uninterrupted power supply and a diesel generator provide emergency power. The emergency telephone number, 144, is directed to the HCC and to the Security Command Center (SCC) in TA III. Security communications personnel staff the HCC on a 24-hour basis.

6.3.3 Security Command Center

The SCC, located in TA V, is a dedicated hardened facility. The SCC is responsible for security support for all Sandia-controlled property south of the Tijeras Arroyo. Entrance to the SCC is controlled electrically from the SCC, and the entire area is under constant electronic surveillance. Oxygen canisters and self-contained breathing apparatus provide back-up to the ventilation system. A variety of primary and back-up communications equipment exists in the facility.

6.3.4 Decontamination Facilities

The main Medical Decontamination Facility at Sandia/NM is located in the Medical Building. Both radiological and chemical hazards can be decontaminated in the facility. It is a dedicated area that can be isolated from the rest of the Medical Building. It is equipped with provisions for total body and wound decontamination. All irrigation water is contained and held for proper disposal.

Another dedicated decontamination facility is located in the TA-V Assembly Building and is used by personnel within the area. The facility is used for total body decontamination, and contaminated waters from this facility drain into a holding tank and are held for proper disposal.

6.3.5 Mobile Command Post

Sandia uses a modified step van as a Mobile Command Post (MCP). The MCP is the assembly point for ICS personnel and is equipped to serve as a communications center in the field in response to emergencies. It has a wide variety of communications equipment, as well as weather monitoring equipment, an electrical generator, maps, and a collection of miscellaneous emergency tools and equipment for use in the field.

6.3.6 Emergency Radio Communications Network

The emergency radio communications network is depicted in Figure 6.3-1. It is also covered in detail in the Sandia ICS procedural manual (see Section 6.2.2).

6.3.7 Joint Information Center (JIC)

The JIC is a centralized media assembly point operated by the Department of Energy. The JIC is only operational during emergencies and is located at the KAFB Officers Club.

6.4 Notifications

Sandia/NM must notify the Department of Energy within specific time periods after an event is classified as one of the emergency classification levels. Immediate notification is necessary to ensure that prompt actions can be taken by all emergency organizations to mitigate the consequences to all workers, the public, and the environment. The Department of Energy/Kirtland Area Office is responsible for the timely notification of DOE/Albuquerque Operations Office, DOE/Headquarters, U.S. Nuclear Regulatory Commission, and other appropriate federal, state, local, and tribal authorities.

Details for providing notification are provided in the Sandia/NM Emergency Plan.

Personnel may be advised of a protective action by a computerized telephone system, known as the Group Emergency Telephone System (GETS), the Emergency Paging System (EPS), a public address system, security police, or runners, if necessary.

6.5 Protective Actions

Protective actions have been established to reduce or prevent exposure of personnel to significant hazards arising from Sandia emergencies. Protective actions include, but are not limited to, exposure controls, protective clothing, respiratory protection, access control, sheltering, and evacuation of personnel from buildings and areas.

NET	ELEMENT	LOCATION
1. Command Net	Emergency Response Director	EOC
	On-Scene Commander (ICS)	FIELD
	Operations Section Chief (ICS)	FIELD
	Logistics Section Chief (ICS)	FIELD
	ES&H Section Chief (ICS)	FIELD
	Planning Section (ICS)	FIELD
2. Security Net	Security Manager	EOC
	Operations Section Chief	FIELD
	Operations Personnel	FIELD
3. Logistics Net	Logistics Manager	EOC
	Logistics Section Chief	FIELD
	Logistics Personnel	FIELD
4. ES&H Net	ES&H Manager	EOC
	Medical Officer	EOC
	ES&H Section Chief	FIELD
	ES&H and Medical Personnel	FIELD

Figure 6.3-1 Emergency Radio Communications Network

Sandia/NM employs the following methods for personnel accountability. These methods ensure that personnel in an evacuated area are accounted for in the minimum amount of time.

- Tech Area (TA) V. Each person entering TA V is given a personal electronic accountability badge. In case of an emergency, all personnel in TA V evacuate to an assembly area where the accountability badge is read. Information on missing personnel is relayed to the TA-V Emergency Supervisor.

- Other Sandia/NM locations use the "sweep" method. An evacuation team will conduct a manual "sweep" of all affected buildings to ensure that the buildings are vacant. The fire team may be activated to assist in providing manual "sweeps." Results of the building "sweep" will be reported to the IC via the Section Chief.

6.6 Recovery, Termination, and Documentation

6.6.1 Recovery

When the emergency situation stabilizes sufficiently, the Emergency Response Director (ERD) can enter into a recovery mode. This indicates that no radiological or other hazardous material (HAZMAT) releases are occurring or are likely to occur, and that the possibility of escalation of the event is minimal. During recovery, emphasis is placed upon repair and restoration of normal operations. If it is suspected that another hazardous situation may occur during the performance of repair activities, repair activities may begin prior to the recovery phase. Until the ERD is confident that the probability of creating another hazardous situation is minimal, recovery will not be initiated.

As part of the ongoing consequence assessment, a comprehensive investigation into the extent of damage will be conducted. Attention shall be directed to the condition of fire detector/suppression systems, gas lines, electrical systems, building integrity, and equipment in the affected area.

6.6.2 Termination

Termination from any emergency classification can be declared by the ERD when the emergency situation no longer exists and operations can return to normal. Termination may be declared if the ERD determines that any residual damage is minor and is not disrupting the effort to return to normal site activities.

6.6.3 Documentation

Each declared emergency will be investigated, documented, and reported as required by DOE Order 5000.3B and other DOE orders.

Members of the EOC cadre and staff are responsible for keeping accurate records of chronological events in their respective areas. These logs will be collected upon termination of the event.

6.7 Maintaining Emergency Preparedness

The Sandia/NM Emergency Management Department maintains emergency preparedness as outlined in the Emergency Readiness Assurance Program (ERAP). The ERAP is reviewed and updated on an annual basis.

6.7.1 Emergency Preparedness Training

Training Requirements

All personnel assigned to the Sandia Emergency Response Organization (ERO) must receive training related to their emergency response position. This training will be given prior to their appointment to the ERO. Retraining is provided annually thereafter. Prior to the completion of training requirements, members of the ERO remain in probationary status.

Training Methods

Emergency Preparedness training for ERO personnel is presented in formal classroom instruction. Documentation that an individual has satisfactorily completed the classroom instruction is indicated on the training attendance record for each presentation. Written tests may be employed as an evaluation tool for formal classroom instruction and the self-study option.

The second phase of Emergency Preparedness training requires trainees to participate in the drill and exercise program. This program includes table-top drills, walk-through drills, partial and full-scale drills, and annual exercises. These drills provide hands-on experience of theory presented in the classroom or self-study program.

Newly hired Sandia employees receive Emergency Preparedness training during new hire orientation. The training is prepared by a member of the Emergency Preparedness staff.

Off-site support organizations have extensive in-house training provided to their EROs that is provided by state and/or federal agencies. These support organizations are considered qualified to perform their emergency response functions without additional Sandia-sponsored training, with the exception of site orientation training.

Sandia will provide site-specific training and retraining to the support organizations, if requested, on an annual basis. This training will be scheduled and presented by the EPPL. The local news media may be included in the scheduled training, as appropriate.

Training Courses

The Emergency Preparedness training program consists of training modules that are developed to instruct emergency responders on their roles, responsibilities, and proper response actions during a declared emergency. A Training matrix provides a cross reference of emergency response positions and required training modules.

6.7.2 Drill Program

The drill and exercise program will be implemented in accordance with applicable DOE Orders.

6.8 Reference

EPP, 1991. *Emergency Preparedness Plan,* Sandia National Laboratories, Albuquerque, NM, December 1991.

7.0 Accident Evaluation Guidelines and Models

7.1 Plant Conditions

DOE Order AL 5481.1B presents the following qualitative accident frequency categorization scheme or plant conditions (PCs) that can be used to assess the likelihood of postulated accident scenarios or events that are expected or postulated to occur during the operation of a facility:

1. **Likely** - Those events expected to occur with a probability > 10^{-2}/year.
2. **Unlikely** - Those events expected to occur with a frequency range between 10^{-2} and 10^{-4}/year.
3. **Extremely Unlikely** - Those events expected to occur with a frequency range between 10^{-4} and 10^{-6}/year.
4. **Incredible** - Those events expected to occur with a frequency < 10^{-6}/year.

Several similar frequency categorization schemes have been introduced by the nuclear power industry (10 CFR 50, Reg. Guide 1.48, Reg. Guide 1.70, ANSI/ANS-51.1, ANSI/ANS-52.1, ANSI/ANS-53.1), although some of these documents are no longer in effect (e.g., ANSI/ANS-53.1). Table 7.1-1 presents a recommended scheme and compares it to other categorizations including those recommended for use in nonreactor facilities by DOE (DOE/TIC-11603). Most of the categorizations do not use definitions that precisely indicate the relationships between event categories and the quantified frequency of occurrence scale. The dashed lines in the table represent a judgment as to where those definitions could be located on the frequency scale. In order to assign maximum credible accidents (MCAs) to a particular frequency range or PC, the frequency of occurrence must be first quantified.

The safety criteria for PCs include consideration of the cause of the event; expected frequency of occurrence, radiological or toxicological dose criteria for each PC for off-site population, on-site personnel, and the immediate workers; and the need for particular protection function(s). Plant safety criteria are established for each PC with the objective that the more likely the event, the lower the potential consequences, and conversely, the higher the potential consequences, the lower the probability of occurrence. Criteria for various PCs are established with the goal of having a constant risk for all combinations of accident frequencies and their associated consequences (ANSI/ANS-51.1, ANSI/ANS52.1).

Table 7.1-1 Event Categorization

EVENT FREQUENCY RANGE	PLANT CONDITIONS CATEGORIES	DOE	OTHER CATEGORIZATION SCHEMES (NRC)				
		DOE/TIC-11603	10CFR	RG 1.48	RG 1.70	ANS 51.1/52.1	ANS 53.1
Planned Operations	PC-1	Normal Events	Normal Events	Normal Events	Normal Events	PC-1	PC-A
10^{-1}	PC-2	Anticipated Events	Anticipated Operational Occurrences	Upset	Moderate Frequency	PC-2	PC-B
10^{-2}			Accidents		Infrequent Incidents	PC-3	PC-C
10^{-3}	PC-3	Unlikely Events		Emergency		PC-4	
10^{-4}					Limiting Faults		
10^{-5}	PC-4	Extremely Unlikely Events		Faulted		PC-5	PC-D
10^{-6}	Not Considered	Incredible Events				Incredible Events	

7.2 Radiological Dose Guidelines

Secretary of Energy Notice SEN-35-91 (DOE/HQ 91) established safety goals for DOE nuclear facilities to limit the risk to nearby members of the public from nuclear operations. These goals apply to the total risk posed by the nuclear facility and not to individual equipment, operations, or postulated accident sequences. Furthermore, these goals apply only to members of the public and not to on-site workers at DOE nuclear facilities. In order to have a standard by which to judge calculated risk to on-site personnel and off-site public from individual equipment, operations, or postulated accident sequences, the following safety decision thresholds are proposed. These safety decision thresholds would be used in conjunction with unreviewed safety question (USQ) determinations and safety analyses to judge whether additional prevention or mitigation of hazards should be considered to reduce the risk from a specific hazard. Risks that cannot reasonably be reduced below the safety decision thresholds would be submitted to Sandia and DOE management for their acceptance or further direction. These safety decision thresholds do not imply that any risk below the threshold is acceptable, since the "as low as reasonably achievable" (ALARA) principle should always be the risk control objective.

New facilities or major modifications to existing facilities should be designed to accommodate the accident conditions within the recommended radiological dose criteria for each PC. Based on the results of the frequency quantification, events can be categorized into PCs according to their respective frequency ranges and the applicable consequence criteria shall apply. As indicated by DOE 6430.1A and DOE/TIC-11603, facility design or accident analyses should not consider events that have less than 10^{-6}/year as a best estimate (or at least conservative) frequency of occurrence.

The overall intent of the radiological dose guidelines as they relate to plant conditions is to ensure that facilities are designed so they can be operated without undue risk to the public or the workers. This is achieved by requiring that all exposures from normal operations remain ALARA and that all other exposures from abnormal or accidental conditions be scaled as a function of the likelihood of occurrence of the initiating event. Consequences from radiological exposures are expressed as rem from one or more predominant exposure pathways.

Table 7.2-1 shows the recommended safety decision threshold criteria that are proposed for safety analysis purposes. Three categories of receptors are identified. These categories are not explicitly defined here because the specific bounds of each category might be best defined based on the characteristics of a given site. However, it is recommended that the definitions given in the proposed DOE-DP-STD-3005-93 (DOE, 1993a) be used as general guidance in deriving site-specific definitions. Credit may be taken for reasonable mitigating actions (e.g., don respirators, evacuate, take shelter) for on-site workers, but no such credit may be taken for off-site individuals. Any credit for mitigating actions must be carefully justified.

Table 7.2-1 Radiological Safety Decision Threshold Criteria				
	Annual Probability of Occurrence (P)			
Receptor	Normal Operation	$0.1>P\geq 10^{-2}$	$10^{-2}>P\geq 10^{-4}$	$10^{-4}>P\geq 10^{-6}$
Off-site Individual	(Note 1)	0.5 rem	5 rem	25 rem
On-site Collocated Personnel	(Note 2) (Note 4)	5 rem	25 rem	100 rem
Facility Worker	(Note 3) (Note 4)	25 rem	100 rem	200 rem

Notes: 1. 0.1 rem/yr - annual EDE plus CEDE limit in DOE Order 5400.5
0.01 rem/yr - annual airborne EDE limit (40 CFR 61 Subpart H) for releases other than radon

2. 5 rem/yr for certified radiological workers or trained visitors; otherwise, 0.1 rem/yr per the DOE Radiological Control Manual

3. 5 rem/yr if facility workers are certified radiological workers; otherwise, 0.1 rem/yr in non-radiologically controlled areas

4. In accordance with the Sandia Radiation Control Manual, exceeding the Sandia facility administrative limit of 1.5 rem/yr or the DOE administrative limit of 2.0 rem/yr requires prior approval by Sandia management and the DOE Program Secretarial Officer (DP-1), or designee, respectively.

The radiological safety decision thresholds represent external effective dose equivalents (EDEs) plus CEDEs from all significant pathways (inhalation, air submersion, ingestion, and direct exposure). The reporting of radiological doses in safety analyses should identify the contributions from each pathway by considering actions taken to reduce doses from ground contamination, ingestion, and water immersion.

Criteria used for the selection of Table 7.2-1 values are based on the following:

1. The criteria shall be consistent with DOE and NRC requirements and regulations.

2. The safety decision thresholds assume that high-probability events should have more restrictive criteria than low-probability events.

3. Criteria for off-site individuals should be more restrictive than for on-site personnel. Setting off-site criteria lower than on-site criteria is consistent with common practice within the nuclear industry.

4. For off-site calculations, the maximum exposed individual (MEI), assumed to be located at the plant boundary, is to be used as the dose/risk receptor criterion.

The bases for the safety thresholds shown in Table 7.2-1 are as follows:

1. Normal Operation

   For an off-site individual, the annual limit of 0.1 rem effective does equivalent (EDE) plus CEDE as specified in DOE Order 5400.5 cannot be exceeded. The limit of 0.01 rem EDE per year on airborne emissions, as specified in 40 CFR 61, should also be observed. For both on-site collocated personnel and facility workers, safety thresholds are defined for radiological and non-radiological personnel as 5 rem per year and 0.1 rem per year, respectively, per the DOE Radiological Control Manual.

2. Accidents

   A 25-rem ceiling for off-site individuals is well established in the nuclear industry as a siting criterion (e.g., DOE Order 6430.1A [DOE 6430.1A], LA-10294-MS [Elder et al., 1986], and 10 CFR 100 [10 CFR 100]) and is also suggested in the DOE non-reactor nuclear facilities accident analysis guide (Elder et al., 1986) as an off-site risk acceptance criterion for low-probability events. The end point for off-site criteria is thus established at the point corresponding to an annual probability of 10^{-6} and a dose consequence of 25 rem external EDE plus CEDE. The thresholds for 10^{-2}/year and 10^{-4}/year events are 0.5 rem/year and 5 rem/year, respectively. They are consistent with the limits recommended by DOE (DOE, 1993a).

   Due to dispersion phenomena, consequences of any given accident will usually be higher on site than off site. However, credit for protective measures may be taken in the evaluation of consequences to collocated workers. Industrial accident statistics indicate approximately 10^{-4}/year fatality rate. The probability of latent cancer fatalities is approximately 10^{-4}/rem according to the International Commission on Radiation Protection, Publication 26 (ICRP 26), and 10^{-3}/rem according to Publication 60 (ICRP 60). Using the higher latent cancer value with a 0.1% reduction (i.e., off-site SEN-35-91 safety goal [DOE/HQ91]) and the industrial fatality rate results in 100 rem at 10^{-6}/year. This value is being proposed as an acceptable risk criterion for DOE high-level waste tanks safety analyses (Halliman et al., 1992). The thresholds for 10^{-2} /year and 10^{-4}/year events are 5 rem/year and 25 rem/year, respectively. They are consistent with the limits recommended by DOE (DOE, 1993a).

   In Table 7.2-1, the criteria for "facility worker" apply to all workers whose day-to-day activities are controlled by various safety management programs and a common emergency response plan associated with a facility or facility area (DOE, 1993a). The criteria for "collocated worker" apply to the most affected worker outside the day-to-day process safety management controls of a given facility area (DOE, 1993a). The criteria for "off-site" personnel apply to the most affected individual located at or outside the site boundary.

7.3. Toxicological Exposure Guidelines

DOE Order 5480.23 (DOE 5480.23) and DOE/AL-5481.1B also require that nonradiological hazards be assessed as part of the safety analysis documentation. In order to be able to assess whether the facility could be operated without undue risk to the public or workers based on the results of the accident analysis involving toxic hazardous materials, acceptable toxicological exposure criteria need to be established. This section proposes toxicological exposure guidelines as functions of PCs for the public, on-site collocated and local workers.

Exposure guidelines for the public and for local workers are based on exposure limits proposed or introduced by various regulatory and advisory agencies. Since most of these guidelines have one or more caveats associated with their use (e.g., some guidelines apply only to public exposures and not to workers and vice versa), the following definitions are provided to serve as a basis for the selection of the recommended exposure levels proposed in this guideline.

1. The following are public exposure limits associated with short-term, accidental exposure:

   - **Level of Concern (LOC)** - LOCs were developed by the Environmental Protection Agency (EPA) to aid community emergency planning for accidental releases. LOCs are defined as those concentrations of an extremely hazardous substance (EHS) in air, above which there may be serious irreversible health effects or death as a result of a single exposure for a relatively short period of time. LOCs were estimated by using one-tenth of the Immediately Dangerous to Life and Health (IDLH) level published by the National Institute for Occupational Safety and Health (NIOSH, 1973). LOCs for EHS are found in the EPA document titled *Technical Guidance for Hazard Analysis: Emergency Planning for Extremely Hazardous Substances* (EPA, 1987).

   - **Emergency Response Planning Guidelines (ERPGs)** - ERPGs were developed by a consortium of chemical firms based on the National Research Council Emergency Exposure Guidance Levels and Short-Term Public Emergency Guidance Levels, with oversight and review from the American Industrial Hygiene Association (AIHA). Presently, ERPGs exist for only a few dozen chemicals. Three concentration levels have been identified for several chemicals of concern; these are:

     - ERPG - 1: The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing other than mild, transient adverse health effects or perceiving a clearly defined objectionable odor.

     - ERPG - 2: The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair an individual's ability to take protective action.

- ERPG - 3: The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing life-threatening health effects.

• **Short-Term Public Exposure Guidance Level (SPEGL)** - SPEGLs were developed by the National Research Council's Committee on Toxicology (NRCCT). A SPEGL is an acceptable ceiling concentration for a single, unpredicted, short-term exposure to the public of one hour or less and never more than 24 hours.

2. The following are public exposure limits associated with long-term chronic or routine exposures:

• **The EPA in its Integrated Risk Information System (EPA-IRIS)** database provides information on hazard identification, dose-response assessment, and exposure levels which, when combined with specific exposure information, can be used for characterization of the public health risks of a given chemical.

The levels in the EPA-IRIS database (EPA, 1988) and EPA-HEAST data (EPA, 1992) are intended for chronic lifetime exposures rather than for exposure to accidental releases. Two airborne exposure levels are presented in the database system:

- Reference Dose (RfD): the RfD represents the threshold level (at which no adverse effect is expected to occur) for oral exposures, expressed in units of mg/m^3.

- Reference Concentration (RfC): the RfC represents the threshold for inhalation exposures, expressed in units of mg/m^3.

3. The following are occupational exposure limits for short-term accidental exposures:

• **Immediately Dangerous to Life and Health (IDLH)** - IDLHs were developed by the National Institute of Occupational Safety and Health (NIOSH) exclusively for respirator selection in the workplace. An IDLH is the maximum concentration which one could escape within 30 minutes without any escape-impairing symptoms or any irreversible health effects. IDLHs can be found in the NIOSH Pocket Guide to Chemical Hazards (NIOSH, 1990).

• **Emergency Exposure Guidance Level (EEGL)** - EEGLs are also developed and available from the National Research Council's Committee on Toxicology (NRCCT).

4. The following are occupational exposure limits for routine or normal operations:

   - **Permissible Exposure Limit (PEL)** - PELs are OSHA workplace exposure standards listed in 29 CFR 1910, Subpart Z, General Industry Standards for Toxic and Hazardous Chemicals (29 CFR 1910). A PEL is the maximum airborne concentration of a contaminant to which an employee may be exposed over the duration specified by the type of PEL assigned to the contaminant. Three types of PELs are provided:

     - Time-Weighted Average (TWA): PEL-TWA is the average exposure that shall not be exceeded in any eight-hour shift of a 40-hour work week.

     - Short-Term Exposure Limit (STEL): PEL-STEL is the employee's 15-minute time-weighted average exposure that shall not be exceeded at any time during a work day unless another time limit is specified in a parenthetical notation below the limit.

     - Ceiling (C): PEL-C is the exposure that shall not be exceeded during any part of the work day.

   - **Threshold Limit Values (TLVs)** - TLVs are published annually by the American Conference of Governmental Industrial Hygienists (ACGIH 92). TLVs are airborne concentrations of substances representing conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effects. Three TLV limit categories are published:

     - Time-Weighted Average (TWA): TLV-TWA is the time-weighted average concentration for a normal eight-hour work day and a 40-hour work week, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect.

     - Short-Term Exposure Limit (STEL): TLV-STEL is the concentration to which workers can be exposed continuously for a short period of time without suffering from irritation; chronic or irreversible tissue damage; or narcosis of sufficient degree to increase the likelihood of accidental injury, impair self-rescue, or materially reduce work efficiency, provided that the daily TLV-TWA is not exceeded.

     - Ceiling (C): TLV-C is the concentration that should not be exceeded during any part of the working exposure.

Another measure proposed but not listed above is the lethal concentration low (LCLO), which is the lowest concentration of a material in air, other than the lethal concentration fifty (LC_{50}), which has been reported to cause death in humans or animals. As with radiological consequence guidelines, nonradiological guidelines are intended to ensure that the operation of the facility will not result in undue risk to the public or workers.

In order to develop a correlation between exposures and PCs similar to that proposed for radiological exposures in Table 7.2-1, the exposure guidelines are ranked in descending order of exposure as follows: LCLO > IDLH ~ ERPG-3 > LOC ~ ERPG-2 ~ TLV-C ~ PEL-C ~ SPEGL ~ EEGL > ERPG-1 ~ TLV-STEL ~ PEL-STEL > TLV-TWA ~ PEL-TWA .

Table 7.3-1 presents the correlation between PCs and toxicological exposure levels for the public and workers (local and collocated on-site).

Table 7.3-1 Toxicological Safety Decision Threshold Criteria

Receptor	Annual Probability of Occurrence (P)			
	Normal Operation (Note 1)	$0.1 > P \geq 10^{-2}$ (Note 2)	$10^{-2} > P \geq 10^{-4}$ (Note 2)	$10^{-4} > P \geq 10^{-6}$ (Note 2)
Off-site Individual	(Note 3)	0.1×ERPG-1	ERPG-1	ERPG-2
On-site Collocated Personnel	(Note 4)	ERPG-1	ERPG-2	ERPG-3
Facility Worker	PEL-TWA (Note 5)	ERPG-2	ERPG-3	2×ERPG-3

Notes:
1. Thresholds are defined for inhalation exposures. For multiple exposure pathways, thresholds may be defined using the EPA approach for defining a hazard index for multiple toxicants (EPA, 1989).

2. AIHA (AIHA, 1991) short-term exposure limits.

3. Use EPA chemical-specific Reference Concentration, RfC (in $\mu g/m^3$), for non-carcinogenic effects (EPA, 1992) and (7E-4) ÷ (Unit Risk) for carcinogenic effects (EPA, 1992); Unit Risk is an EPA chemical-specific cancer risk factor for inhalation exposures in units of $(\mu g/m^3)^{-1}$. This limit was derived based on the same lifetime excess cancer risk produced by a radiological exposure of 0.01 rem/year for 70 years.

4. Use EPA chemical-specific RfC for non-carcinogenic effects and (7E-3) ÷ (Unit Risk) for carcinogenic effects. This limit was derived based on the same lifetime excess cancer risk produced by a radiological exposure of 0.1 rem/year for 70 years.

5. Use TLV-TWA (ACGIH 92) for the facility worker if PEL-TWA (29 CFR 1910) is not available.

The safety threshold criteria presented in Table 7.3-1 were derived mostly based on the available exposure limits or recommendations developed by various agencies and organizations. These limits, as described above, were developed for different purposes, exposure durations, and biological end-points. As a result, a safety threshold system developed based on these values inherits the original limitations. However, this is the first step toward developing a more realistic and technically sound safety threshold system. The criteria and references used in selecting the safety thresholds shown in Table 7.3-1 are described below.

1. Normal Operation

   For off-site individuals and on-site collocated personnel, EPA factors, RfC, and Unit Risk are the recommended safety thresholds because they were derived based on chronic exposure data. RfC is the exposure limit for non-carcinogenic effects. Unit Risk is a risk factor for carcinogenic effects and was used to derive exposure limits.

   The proposed air concentration limit for an off-site individual, (7E-4)+(Unit Risk), was derived using the same acceptable risk level for the corresponding radiological safety threshold shown in Table 7.2-1. The derivation of this exposure limit is illustrated below. The lifetime excess cancer risk for a chronic daily exposure to an air concentration of (7E-4) + (Unit Risk) over 70 years is 7E-4, the product of (7E-4) + (Unit Risk) and 'Unit Risk.' This lifetime excess cancer risk, 7E-4, is the same as that for receiving an annual radiological dose of 0.01 rem over a period of 70 years by using a risk factor of 1E-3/rem from ICRP 61 [ICRP 61] (i.e., 7E-4 lifetime excess cancer risk = 0.01 rem × 1E-3 lifetime excess cancer risk/rem × 70 years of exposure). The estimation of the radiological lifetime excess cancer risk is conservative because the lifetime cancer risk is limited by the lifetime of an individual.

   The limit (7E-3)+(Unit Risk) for on-site collocated personnel was derived based on the same methodology as described above. The corresponding radiological exposure limit used for calculation is 0.1 rem as shown in Table 7.2-1.

   The safety thresholds defined above are intended for exposures through inhalation because inhalation is the dominant pathway in most cases. If other routes of exposure need to be considered, the safety thresholds may be calculated by using the approach recommended by EPA for calculating a hazard index for multiple toxicants (EPA, 1989).

   For the facility worker, the ACGIH limit (ACGIH 92), PEL-TWA, is the recommended safety threshold because it was derived for worker populations. TLV-TWA should be used when PEL-TWA is not available.

2. Accident Scenarios

   ERPGs are recommended as the toxicological safety criteria for accident scenarios associated with DOE facilities and operations in various documents (DOE, 1993a, DOE, 1993b, Craig et a., 1992). ERPG-3 was selected to be the toxicological threshold for collocated workers in the proposed DOE-DP-STD-3005-93 (DOE, 1993a). This limit was also recommended in this document as the threshold for "extremely unlikely" scenarios. The thresholds for categories "unlikely" and "likely" are ERPG-2 and ERPG-1, respectively. ERPG-2 was selected to be the toxicological threshold for the public in the proposed DOE-DP-STD-3005-93 (DOE, 1993a). This value was also used in this document as the threshold for "extremely unlikely" scenarios. The thresholds for categories "unlikely" and "likely" are ERPG-1 and 0.1 × ERPG-1, respectively. The fraction 0.1 was assigned to reflect the difference in radiological thresholds for off-site individual (0.5 rem) and on-site collocated personnel (5 rem).

For acute exposures, the concept of "dose," instead of exposure concentration, should be used to assess whether an exposure exceeds a recommended safety threshold. For example, for "extremely unlikely" scenarios, the dose received by an off-site individual during an accident exposure should be calculated as the product of the exposure concentration and the exposure duration. This does value should be compared to the product of ERPG-3 and the inhaled volume in 60 minutes.

If ERPG values are not available for compounds of interest, the following alternative safety thresholds are recommended. IDLH could be the substitute for ERPG-3 because both are defined based on life-threatening effects. This substitution was also proposed in draft DOE-DP-STD-3005-93 (DOE, 1993a) and SRF-RAM-930097 (Craig et al., 1992). In the absence of ERPG-2, the most commonly used alternative is IDLH÷10 (DOE, 1993a). In addition, TLV-STEL or PEL-STEL could be used as the surrogate for ERPG-1. It should be borne in mind that these numerical alternatives should be evaluated by qualified personnel for chemicals of interest. If more appropriate substitutions can be identified for a particular compound, sufficient information should be provided with a SAR to allow an independent review.

7.4 Meteorological Evaluation Model

This section includes information on the programs to estimate off-site and on-site concentrations from stack or other effluents; the methods to be used to determine the joint frequency distributions of wind speed, direction, and stability based on appropriate meteorological measurements, heights, and data-reporting periods; and the appropriate parameters for diffusion-estimate calculations for both routine effluents (long-term) and accident releases (short-term).

The information and modeling techniques presented in UCRL-53526 (Coats and Murray, 1985) are used to evaluate the design basis wind (DBW) and tornado (DBT), and the accident scenarios from the DBW and DBT instead of meteorological information (i.e., joint distribution of high winds).

A modified Gaussian bivarian dispersion model similar to the one used for the Reactor Safety Study (Strange, 1980) could be used to hand calculate, if needed, the dispersion factor (χ/Q - sec/m^3) or air concentration (χ - Ci/m^3), as shown in equation 7.4-1 (Strange, 1980):

$$\chi/Q = [2 / [3\sigma_y (2\pi)^{1/2} \sigma_z \, v \, E_t]] * \exp(-h_e^2/2\,\sigma_z^2) \qquad (7.4\text{-}1)$$

where

χ/Q	is the dispersion factor, sec/m^3
v	is the average wind speed at the release elevation, m/s
E_t	is the expansion factor to correct for prolonged release times, unitless ($E_t = (2T_r)^{1/2}$, where T_r is the release duration for airborne releases in hrs)
h_e	is the effective height of the plume center line at the downwind location, m
σ_y	is the cross-wind horizontal standard deviation of the plume concentration at the downwind distance, m
σ_z	is the cross-wind vertical standard deviation of the plume concentration at the downwind distance, m

The horizontal and vertical dispersion coefficients, σ_y and σ_z, respectively, are evaluated by the following empirical expressions:

$$\sigma_y = aX^b \text{ and } \sigma_z = cX^d + e \qquad (7.4\text{-}2)$$

where the values for the empirical constants a, b, c, d, and e are given in Table 7.4-1, and X is the downwind distance from the release point.

7.4.1 Data for Routine Effluent Releases

The AIRDOS-PC computer code will be used to evaluate doses to members of the public from routine airborne releases in accordance with 40 CFR 61 (40CFR61). AIRDOS-PC provides meteorological (wind) data files for the various Department of Energy sites and cities around the country. The wind file representing Albuquerque, NM (i.e., ABQ0282.WND) should be used to model all routine effluent releases from Sandia/NM facilities.

Table 7.4-1 Empirical Constant Values

Stability Class	σ_y a	σ_y b	σ_z (X<1000 m) c	d	e	σ_z (X≥1000 m) c	d	e
A	0.3658	0.9031	0.0015	1.941	9.27	0.00024	2.094	-9.6
B	0.2751	0.9031	0.028	1.149	3.3	0.055	1.098	2.0
C	0.2089	0.9031	0.113	0.911	0.0	0.113	0.911	0.0
D	0.1471	0.9031	0.222	0.725	-1.7	1.26	0.516	-13.0
E	0.1046	0.9031	0.211	0.678	-1.3	6.73	0.305	-34.0
F	0.0722	0.9031	0.086	0.74	-0.35	18.05	0.18	-48.6

7.4.2 Data for Accident Releases

To support the off-site consequence calculations from postulated accident releases, the MELCOR Accident Consequence Code System (MACCS) computer code (Chanin et al., 1990) will be used when possible. MACCS has the flexibility to use plant-specific meteorological data representing one year of hourly meteorological data. This meteorological data has been compiled and extracted from the meteorological data recorded from the Sandia Meteorological Instrumentation Logging Equipment (SMILE) system, and is based on hourly data for a typical year around the Albuquerque area, which includes wind speed, direction, atmospheric stability, and rainfall.

7.5 Airborne Radioactivity Dose Models

7.5.1 Off-Site Consequences

The off-site consequences from a postulated radioactivity release scenario are expected to be dominated by the inhalation and immersion pathways. That is, given the dry conditions and low amounts of food grown in the Albuquerque area, other exposure pathways such as ingestion are expected to make an insignificant contribution to the overall consequences from such postulated releases.

The off-site consequences from puff releases are calculated manually instead of by standard codes like MACCS (Chanin et al., 1990) since MACCS is not suitable for assessing instantaneous doses.

The committed effective does equivalent (CEDE) to the whole body resulting from inhalation of radioactive material due to a puff release of a radionuclide to the environment may be calculated from:

$$CEDE_{inhalation} = BST * ICU * BR * DCF_{inhalation} \quad (7.5\text{-}1)$$

where

$CEDE_{inhalation}$	is the committed effective dose equivalent (in rem) received by an individual from inhalation of a given radionuclide at a given downwind distance from the release location
BST	is the amount of airborne respirable radionuclide released in an accident, in curies
ICU	is the crosswind integrated receptor concentration over the time of cloud passage for unit release, in sec/m^3, and can be calculated by using the formula presented in "Meteorology and Atomic Energy" (AEC, 1968)
BR	is the breathing rate (3.3×10^{-4} m^3/sec) for light occupational work based on 0.02 m^3/min (ICRP 23)

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$DCF_{inhalation}$ is the committed effective dose equivalent conversion factor from inhalation of a given radionuclide in rem/Ci (DOE/EH-0071).

The following equation should be used to calculate the external dose from immersion in the plume containing the radionuclide released to the environment:

$$EDE_{immersion} = BST * ICU * DCF_{immersion} \quad (7.5\text{-}2)$$

where

$EDE_{immersion}$ is the annual dose rate (rem/yr) received by an individual immersed in a radioactive plume at a given downwind distance from the release location

$DCF_{immersion}$ is the annual dose rate conversion factor from immersion in a plume containing a given radionuclide in rem-m^3/Ci-yr (DOE/EH-0070).

The total CEDE and EDE received from all radionuclides present in the release is found by summing the individual CEDE and EDE values for each radionuclide. Thus, the total dose received by the receptor (on-site or off-site) from airborne radioactive sources is calculated by adding the doses received from the two exposure pathways (i.e., inhalation and immersion). That is,

$$\text{Total Dose} = CEDE_{inhalation} + EDE_{immersion} \quad (7.5\text{-}3)$$

The following assumptions should be used to determine the off-site consequences from the radioactivity release scenario:

- All respirable material has one particle size (i.e., 1 micrometer activity median aerodynamic diameter - AMAD).
- No ingrowth or decay between release and intake inhalation is assumed for all radionuclides.
- All exposure or concentration calculations are made assuming a Pasquill stability class F with no rain conditions and one meter per second wind speed.
- A breathing rate of 3.3×10^{-4} m^3/sec (light activity) is assumed for conservative purposes.

Estimating the concentration of a radionuclide downwind of a building in close proximity to the origin of the plume requires special consideration because the Gaussian plume dispersion model assumes the air moves in straight lines and buildings disrupt this straight-line air flow, causing a wake cavity. Local concentrations within the wake cavity are calculated by dividing the amount of airborne material released to the environment (e.g., BST) by the wake cavity volume.

The following equation is used to determine the volume created by a building wake cavity (SAND90-2072):

$$Volume_{wake\ cavity} = H * W * X_{cavity} \qquad (7.5\text{-}4)$$

where

H and W — are the building height and width, respectively

X_{cavity} — is the wake cavity length, calculated from the following equations depending on the ratio between the building length (L) and its height (H):

For short buildings (L/H < 2.0),

$$X_{cavity}/H = A(W/H) / (1.0+B(W/H)) \qquad (7.5\text{-}5)$$

where

$$A = -2.0 + 3.7\ (L/H)^{-1/3} \qquad (7.5\text{-}6)$$

$$B = -0.15 + 0.305\ (L/H)^{-1/3} \qquad (7.5\text{-}7)$$

For longer buildings ($L/H \geq 2.0$),

$$X_{cavity}/H = 1.75\ (W/H) / (1.0+0.25\ (W/H)) \qquad (7.5\text{-}8)$$

As stated before, the MACCS computer code is capable of handling up to 60 radionuclides at this time (i.e., the DOS.DATA file contains dose conversion factors for only 60 radionuclides). Future analyses at Sandia will determine whether additional radionuclides will be required for new versions of MACCS, especially in support of non-power plant facilities (i.e., research facilities and non-reactor facilities). The MACCS computer code is to be run under the following assumptions and input:

- Meteorological conditions are fixed, i.e., Pasquill F,1 m/s.
- No relocation or evacuation of exposed individuals is assumed; rather, all personnel and the public are exposed to the total amount of material released for the duration of the accident. That is, mitigating actions (i.e., evacuation, sheltering, decontamination, interdiction, relocation, etc.) are ignored in the public consequence calculations since the main objective is to determine the doses at the plant boundary and at different locations around the facility.
- Potential economic impacts due to the contamination and mitigating actions are ignored.
- Only the ATMOS and EARLY input files are used to evaluate the consequences (doses in Sv) to the population since the analysis ignores the contribution from chronic exposures (i.e., ingestion, chronic resuspension, etc.). This is reasonable because of the low amounts postulated to be released and because the

consequence of interest is dose to the maximum exposed individual, postulated to be located at various distances from the facility for the duration of the accident release only.

- Public health risks are evaluated only for total cancer latent fatalities. Early fatalities are ignored due to the small postulated BST.

7.5.2 Worker Consequences

The methodology for calculating the consequences to individuals located in the vicinity of the accident (i.e., local workers) depends on whether or not the accident category can cause the radioactive material to become airborne.

For radioactive material that becomes airborne the consequences or dose from the inhalation of or immersion in radioactive material can be calculated by using the following equations:

$$CEDE_{inhalation} = C' * BR * DCF_{inhalation} * T \qquad (7.5\text{-}9)$$

$$CEDE_{immersion} = C' * DCF_{immersion} * T \qquad (7.5\text{-}10)$$

where

C'	is the local concentration of airborne radioactive material release (Ci/m^3 or g/m^3)
T	is the exposure time.

All other variables are previously defined in equations 7.5-1 and 7.5-2.

The overall dose received by the workers from airborne radioactive sources is calculated by the use of equation 7.5-3. Computer codes like DOSES (SAND91-0572) can be used to implement such equations and to calculate the worker consequences, especially when ingrowth and decay play a major role in the consequences. However, due to the assumption of no ingrowth and decay of radionuclides (each of the radionuclides is relatively long-lived in comparison to the exposure times and the time of travel of the plume to the receptor), all worker calculations are calculated manually.

For non-airborne radionuclides or for inadvertent exposure to highly penetrating radiation (i.e., gamma or energetic beta radiation), the dose from direct penetrating radiation sources like Co-60 or Cs-137 are calculated using shielding models.

7.6 Natural Phenomena Events

According to DOE Order 6430.1A (DOE 6430.1A), Sandia non-nuclear facilities are to be designed to the Design Basis Natural Phenomena Events or Accidents (DBAs) specified in UCRL-15910 (Kennedy et al., 1989) and other referenced UCRL Reports (i.e., Coats and Murray, 1984, Coats and Murray, 1985, etc.). These DBAs are based on the site location (i.e., Sandia National Laboratories/New Mexico) and on the usage category of the facility.

7.6.1 Design Basis Earthquake (DBE)

For the seismic design of nuclear facility structures and systems, a two-level system of classification has been established. Category I structures and systems are those that must function or remain functional following a seismically induced accident to ensure that the radiation exposure to personnel is consistent with 10 CFR Part 100 (10 CFR 100). The seismic event associated with Category I is defined as the safe shutdown earthquake (SSE). Category II structures and systems are those that must function or remain functional following a seismically induced accident to ensure operational control of the facility. The failure of Category II structures and systems does not result in the release of significant amounts of radioactive material or prevent safe facility shutdown. The seismic event associated with Category II is defined as the operating basis earthquake (OBE).

Based on the design basis accident analyses for Sandia/NM nuclear facilities, the downwind radiation exposures at the exclusion area boundary (3,000 meters) do not exceed the 10 CFR 100 guidelines. Therefore, there is no need to designate any nuclear facility structures or systems as Category I. For these facilities, the design basis earthquake (DBE) is then the OBE.

Based on the methodology defined in the UCRL reports and on a low-hazard facility usage category, the following design basis guidelines are identified for non-nuclear facilities. These design basis guidelines provide the criteria that define the design basis earthquake (DBE):

- Seismic Zone 2B
- An annual probability of exceedance of 1×10^{-3}
- A maximum horizontal ground acceleration (Z) of 0.22
- Structural system coefficient (R_w) from Table 23-O of UBC, 1988, or Table 4-7 of UCRL-15910, whichever is more conservative
- Importance factor (I) of 1.25
- Spectral amplification (C) from the 5% damped median site response spectra (Figure 4-3 of UCRL-15910)

For a moderate-hazard non-nuclear facility usage category (UCRL-15910), the following design basis guidelines define the DBE:

- Seismic Zone 2B
- An annual probability of exceedance of 1×10^{-3}
- A maximum horizontal ground acceleration (Z) of 0.22
- Inelastic demand-capacity ratio (F_μ) from Table 4-7 of UCRL-15910
- Spectral amplification (C) from the 5% damped median site response spectra (Figure 4-3 of UCRL-15910)

The horizontal ground acceleration of 0.22 corresponds to a modified Mercalli intensity of VIII or a Gutenberg-Richter scale of about 6. Earthquakes below this magnitude are not expected to cause any major damage or risk to the low- or moderate-hazard non-nuclear facilities, nor are they expected to pose radiological or toxicological consequences or risk to workers or the public. Earthquakes of higher magnitudes (i.e., higher g values) are not to be considered as part of this accident analysis as indicated in Kennedy et al. (1989). It is expected, however, that major earthquakes (i.e., greater than 5 on the Richter scale) may cause personnel injury from falling equipment or supplies but would not create a major program disruption.

7.6.2 Design Basis Wind (DBW)

Extremely high winds, and particularly tornadoes, are atypical of the Rio Grande Valley. Wind gusts of 45 m/sec (101 mph) have been observed at Sandia/NM, and the Laboratories' nuclear facilities have sustained these wind gusts without damage or threat to their structural integrity. Although significant structural damage would be expected from a direct tornado strike, the potential radiological hazard to personnel is insignificant compared to the potential loss of life. Any downwind dose hazard at the exclusion area boundary would be minimal, although it is conceivable that radioactive debris could be carried away from the site by the tornado, resulting in minor localized off-site deposits of radioactivity.

Based on Table 5-1 of Kennedy et al. (1989), Sandia/NM non-nuclear facilities should be designed only for extreme winds since for Sandia/New Mexico, the transition wind speed exceeds the best estimate wind speed for an annual probability of exceedance of 10^{-5} for the low- or moderate-hazard use categories.

Based on the methodology defined in the UCRL reports and on the low-hazard usage category, the following minimum wind design criteria define the design basis wind (DBW):

- Annual hazard exceedance probability of 2×10^{-2}
- Importance factor (I) of 1.07
- Basic wind speed of 35 m/sec (78 mph)

According to the above design wind loads, a low-hazard facility would be designed for sustained wind speeds up to 36 m/sec (81 mph) instead of the 35 m/sec (78 mph) required by Kennedy et al. (1989). Winds at or below this magnitude are not expected to cause any damage or risk to low-hazard non-nuclear facilities, nor to pose radiological or toxicological consequences or risk to workers or the public.

For a moderate-hazard facility usage category (UCRL-15910), the following minimum wind design criteria define the DBW:

- Annual hazard exceedance probability of 1×10^{-3}
- Importance factor (I) of 1.0
- Basic wind speed of 42 m/sec (93 mph)

Winds at or below 42 m/sec (93 mph) are not expected to cause any damage or risk to moderate-hazard Sandia/NM facilities, nor to pose radiological or toxicological consequences or risk to workers or to the public.

For a high-hazard facility usage category (UCRL-15910), the following minimum wind design criteria define the DBW:

- Annual hazard exceedance probability of 1×10^{-4}
- Importance factor (I) of 1.0
- Basic wind speed of 48 m/sec (107 mph)

7.6.3 Design Basis Flood (DBFL)

The Tijeras Arroyo presents the only potential flooding risk to the Sandia/NM site on an intermittent basis during periods of precipitation. This arroyo originates in the Tijeras Canyon to the northeast of Sandia and provides area drainage to the Rio Grande, located several hundred feet lower than Sandia. There are no natural lakes in the surrounding areas.

The maximum flood stage recorded by the U.S. Geological Survey was 2.7 meters (8.75 feet) at a point where the channel width of the arroyo is 15 meters (50 feet). Downstream the channel widens to 610 meters (2,000 feet), is 24 meters (80 feet) deep, and has a slope that is much less steep than it is in the mountains. The size and species distribution of vegetation within the walls of the flood plain indicate that there has been no flooding in this area for several decades.

As all Sandia/NM facilities are located well outside the 500-year flood plain (SAND92-0939) there is no credible flood risk from the Tijeras Arroyo. The only standing water problem at individual facility locations would result from a very heavy, short-term rainfall. The design basis requirements for this flood analysis are specified in UCRL-15910.

7.7 Airplane Crash Event

An airplane crash accident scenario is postulated for Sandia/NM facilities and evaluated due to the proximity of the Albuquerque International Airport. A significant fraction of the more than 225,000 annual operations at the airport could pass over Sandia/NM facilities. Sandia/NM is also located about 25 kilometers from Coronado Airport. However, since the general aviation aircraft using this facility would, in general, avoid the Albuquerque International Airport traffic area and based on the relatively long distance to Coronado Airport and the altitude that such aircraft will have if they happen to pass over Sandia, such aircraft are not a significant factor in determining the crash probability. Therefore, they are not considered to pose a significant risk to Sandia/NM facilities.

7.7.1 Event Frequency Estimation

Several low- and high-altitude airways pass over or in the vicinity of Sandia/NM. Because of nearby high terrain, the minimum en route altitudes of these airways are relatively high, about 1,400 meters (approximately 4,600 feet) or more above ground level. Although the frequency of flights using these airways is unknown, the crash frequency resulting from on-airways (or in-flight) through traffic would not be significant relative to the crash probability resulting from landings and takeoffs at the Albuquerque International Airport. The contribution of in-flight or airways traffic to the crash probability is therefore ignored.

The threat to Sandia/NM facilities is from operation at the east end of the runway, that is, from the landings taking place in the westward direction and takeoffs in the eastward direction. The number of crashes per year into a Sandia facility can be calculated using the following equation (Smith, 1983):

$$P_{cp} = [\Sigma_i F_i N_i P_i f_{ij}(r,\theta) A]_{landings} + [\Sigma_i F_i N_i P_i f_{ij}(r,\theta) A]_{takeoffs} \quad (7.7\text{-}1)$$

where

P_{cp}	is the annual crash probability
F_i	is the fraction of movements j (i.e., landing or takeoffs) at the east end of the runway
N_i	is the number of movements j (i.e., landings or takeoffs) per aircraft type i, per year
P_i	is the aircraft crash type i probability per movement j (i.e., landing or takeoff)
$f_{ij}(r,\theta)$	is the crash probability density per Km^2 for the i^{th} type of aircraft and type of movement j
A	is the effective target or facility area in Km^2 upon landing or takeoff.

The Albuquerque International Airport is utilized by commercial air carriers, the military, and general aviation aircraft. The carrier aircraft are jet transports, of which the largest currently in use at the airport is the Lockheed 1011. The military aircraft are primarily jet fighters but also include other aircraft ranging from small helicopters to the Lockheed C-5. General aviation aircraft include light single and twin engine airplanes. In this analysis, three types of aircraft are considered: air carrier jets typified by jet transports of the Boeing 737 through the DC-8 and 9; military aircraft typified by the A7; and air taxi (commuter) airlines and general aviation aircraft typified by light twin-engine aircraft.

Since only data on the total aircraft movement at the Albuquerque International Airport is available and because of the lack of specific data on the number of take-offs and landings, it will be assumed that the number of landings and takeoffs are the same.

Due to safety and noise abatement considerations, the preferred directions for takeoffs and landings is to the south, east, and west of the airport. If it is assumed that these directions are equally likely to be used for both landings and takeoffs, the east end of the East-West runway will have approximately 34% of the total aircraft movement. The movement of aircraft west of the East-West runway or south of the South-North runway are assumed not to contribute to the probability or number of crashes. In other words, the fraction of movements (landings and takeoffs) at the east end of the runway will be 0.34 for all types of aircraft. Table 7.7-1 presents aircraft movement data at Albuquerque International Airport for the calendar year 1990. These data were provided by the Albuquerque Airport Manager's Office.

Table 7.7-1 Total Aircraft Movement at Albuquerque International Airport (1990)

Aircraft Type	Operations
Air Carriers	70,108
Military	35,792
General Aviation/Air Taxi	19,991
Total	225,891

This movement has been steadily increasing each year. Therefore, to ensure conservatism in aircraft movement in the future, an average increase of 100% is assumed over the life of the facility (assuming on the average, a growth rate of 2.5% per year for an assumed facility life of 40 years). Thus, the total number of movements (landings or takeoffs) at the east end of the runway per year for each of the categories of aircraft is assumed to be

$N_{carrier} = N_1 = 140,216$
$N_{military} = N_2 = 71,584$
$N_{general} = N_3 = 239,982,$

for a total of 451,782 movements. The probability of a crash per aircraft movement (landing or takeoff), P_i, for all types of aircraft is given in Table 7.7-2.

Table 7.7-2 Crash Probability (P_i) per Aircraft Movement and Type of Aircraft

Movement	Air Carrier	Military	General Aviation
Landing	2.3×10^{-6}	3.1×10^{-6}	2.3×10^{-6}
Takeoff	6.0×10^{-6}	1.6×10^{-6}	6.0×10^{-7}

The probability per unit area of a crash per aircraft movement for each aircraft type can be obtained based on the spatial distribution of landings and takeoff accidents from the nearest runway end; that is, the crash probability is a function not only of the radial distance from the airport but also of the angle from the line along the runway direction.

The crash probability density per Km^2 for the i^{th} type of aircraft for both landing and takeoffs has been obtained by fitting equations to plots of spatial distributions of landings and takeoff accidents (Kaplan et al., Smith, 1983). The equation for such a crash probability density function is of the form

$$f_{ij}(r,\theta) = f_{ij}(x,y,\theta) = c_{ij} \exp [- |x| / \theta(x,i,j) - |y| / \theta (y,i,j)] \qquad (7.7\text{-}2)$$

where

c_{ij}, $\theta(x,i,j)$, and $\theta(y,i,j)$	are crash density constants for aircraft movement j (landing or takeoff).
x and y	are the radial and perpendicular linear distances between the end of the runway and the Sandia facility of interest.

Using equation 7.7-2 and the values for the various crash density constants from Table 7.7-3 and the distances to the facility, the crash probability density per Km^2 for both landings and takeoffs can be obtained.

Table 7.7-3 Parameters for Estimating the Effective Crash Area for Various Aircraft

Aircraft Type (i)	Aw_i (m)
Air Carrier	43
Military	46
General Aviation	15

The effective area of the facility is taken to be the area of the entire structure augmented by the effective areas to account for the increased cross-section for impact resulting from the building height and for a skid area for aircraft which would impact some distance from the facility.

To make a conservative estimate, no credit is taken from the protection of a facility from skidding aircraft by adjacent buildings and structures or for pilot action in steering toward nearby open grounds. In other words, the effective area of the facility is given by Smith (1983) as

$$A = \Sigma_i [A_{FAC\text{-}i} + A_{SHADOW\text{-}i} + A_{SKID\text{-}i}] \qquad (7.7\text{-}3)$$

where

A	is the total effective crash area for aircraft i, for the subject facility (KM^2)
$A_{FAC\text{-}i}$	is the area of the subject facility for the aircraft type i and is given by

$$A_{FAC\text{-}i} = (L + Aw_i)\, W \qquad (7.7\text{-}4)$$

where

L is the length of the subject facility

Aw_i is the total aircraft wingspan (see Table 7.7-3)

W is the width of the subject facility

$A_{SHADOW\text{-}i}$ is the effective shadow area of the facility for the aircraft type i and is given by

$$A_{SHADOW\text{-}i} = (L + Aw_i)\, H \cot \theta \qquad (7.7\text{-}5)$$

where

H is the height of the subject facility

θ is the angle of approach (or crash) of the aircraft (conservatively assumed to be 5°)

$A_{SKID\text{-}i}$ is the effective skid area of the facility and is given by

$$A_{SKID\text{-}i} = b_i^2[\sin^{-1}(a/b_i) + a^2/b_i^2((b_i^2/a^2 - 1)^{0.5} - \sin^{-1}(1))] \qquad (7.7\text{-}6)$$

where

a is the equivalent facility radius

b_i is the impact distance for aircraft type i, that is, the distance from the center of the facility to the impact location that will result in a collision with the facility (m)

7.8 References

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8.0 Management, Organization, and Institutional Safety Provisions

8.1 Occurrence Management System (OMS)

The Sandia Occurrence Management System (OMS) is a process for the investigation and analysis of occurrences at Sandia sites. This program complies with DOE Order 5000.3B, "Occurrence Reporting and Processing of Operations Information," which requires that occurrences be consistently reported and thoroughly analyzed to assure that both DOE and Sandia line management are kept fully and currently aware of all occurrences and emergencies affecting the environment, safety, health, security, property, and operations. It does not apply to routine and preventative maintenance activities or personnel concerns.

8.1.1 Purpose

The purpose of the OMS is to

- Create an environment that emphasizes the proactive prevention of occurrences and encourages individuals to report all occurrences and participate in determining appropriate corrective action
- Identify, categorize, and report occurrences promptly to DOE
- Analyze occurrences to identify root causes, corrective actions, and lessons learned as soon after the occurrence as possible
- Take corrective action to prevent recurrence of similar events

8.1.2 Responsibilities

One of the essential features of the OMS is line ownership of occurrences. That is, Sandia line organizations have direct responsibility for reporting and analyzing occurrences. The OMS Process Owner/Manager provides overall OMS Program direction and coordination for Sandia and assures that OMS activities are in compliance with the DOE order. The OMS Manager develops the OMS policies and procedures, provides support resources necessary to assist the facility manager or designee in carrying out his or her responsibilities, and facilitates the resolution of problems as necessary.

Sandia/NM facilities are divided into two categories—facilities by VP and site-wide facilities. Facilities by VP include the facilities under the control of each VP and those that DOE wants to see reported separately. Site-wide facilities are those that are common to all facilities across the site, such as plant facilities and safeguards and security. The vice presidents have primary responsibility for occurrences within their organizations. The administrative responsibilities, however, are delegated to other individuals who represent the vice president and report to him for occurrence management. Their responsibilities include

- Ensuring that all reporting requirements are satisfied

- Tracking occurrences from identification to close-out
- Participating in occurrence root cause analysis and the tracking and verification of corrective actions, disseminating lessons learned, training of personnel, and maintaining duty rosters of required OMS personnel
- Keeping all related documentation updated

These support personnel ensure consistency and quality throughout the process.

8.1.3 Training

Facility managers and their designees are given initial occurrence management process training by the occurrence management staff and are required to attend a refresher training course annually. This training includes the following:

- Philosophy of DOE Order 5000.3B
- Philosophy and compliance requirements of Sandia OMS
- Procedures for identification, categorization, and notification of reportable occurrences
- Quality requirements for occurrence reports
- OMS responsibilities of facility managers and designees, occurrence management representatives, and DOE facility representatives
- Requirements and benefits of root cause analysis

Occurrence management representatives receive training in the following areas:

- Philosophy of DOE Order 5000.3B
- Philosophy and compliance requirements of Sandia OMS
- How to determine whether an event or condition is a reportable occurrence
- How to categorize the seriousness of a reportable occurrence
- Notification requirements of a reportable occurrence
- Root cause analysis
- Quality requirements for occurrence reports
- Requirements for proper maintenance of evidence files
- OMS responsibilities of occurrence manager representatives and DOE facility representatives

All root-cause analysts receive formal training in root-cause analysis from the ES&H Assessments Department.

8.2 ES&H Self-Assessment Program

The Environment, Safety, and Health (ES&H) Self-Assessment Program is an integral part of the overall process of continuous improvement. This ES&H Self-Assessment Program is the umbrella program for three other ES&H self-assessment programs: Appraisal, Performance Indicator, and Operating Experience Evaluation. The ES&H Assessments Department (EAD) is responsible for all three programs.

Self-assessment comprises different assessment techniques. For example, appraisals include audits, reviews, surveillances, and inspections.

The Sandia National Laboratories Self-Assessment Program contains the following elements:

- Formal program charter with specified roles for multiple organizational levels
- Comprehensive scope, addressing all ES&H functional areas and management issues
- Defined schedules for performing self-assessments
- Procedures for self-assessment (specifying authority, responsibility, and implementing requirements)
- Formal reporting system to document and communicate findings and corrective actions
- Root cause analysis of findings
- Formal system for performing corrective actions (specifying authority, responsibility, and schedules)
- Formal process to identify trends and mechanisms to communicate root causes, trends, and lessons learned throughout the organization (and DOE) and incorporate them into daily operations and planning
- Formal training program for personnel with assessment responsibility
- Full cooperation with, and openness and responsiveness to, external oversight or assessment organizations and personnel
- Line-management-fostered atmosphere of continual self-evaluation and quality improvement in ES&H at all levels

8.2.1 ES&H Appraisal Program

ES&H appraisals are conducted by internal Sandia organizations and by external organizations such as the DOE. Internal appraisals are conducted in the following three-level hierarchy:

(1) Self-appraisals by the organizations responsible for ES&H program implementation (line organizations)
(2) Independent assessments by the ES&H Assessments Department (EAD)
(3) Management appraisals by the Process Improvement Department and senior Sandia management as a management overview

Self Appraisals

The first level in the formal Sandia appraisal hierarchy is comprised of the functional appraisals, management appraisals, and management surveillances that are conducted by organizations responsible for ES&H program implementation. These are called self-appraisals.

Line organizations plan, schedule, perform, and document the results of self-appraisals in accordance with written procedures. Root cause analysis is done for significant findings. Corrective actions for all findings are developed and tracked to completion. Noteworthy practices are identified. Reports are prepared. Line organizations conduct management appraisals to assess their performance in implementing and managing ES&H programs. Line organizations conduct management surveillances of their facilities and program areas. Management surveillances include planned tours by all levels of Sandia management. The results are documented and any findings are addressed.

Independent Assessments

The second level in the formal Sandia appraisal hierarchy is the independent assessment organization, EAD, which is not directly responsible for the performance of the ES&H activities it is appraising. EAD conducts independent functional appraisals of Sandia line and ES&H support organizations for those ES&H areas where the organizations have identified ES&H responsibilities. Independent functional appraisals are planned, scheduled, performed, and the results documented in accordance with written procedures. Root cause analysis is done by the appraised line organization for significant findings. Noteworthy practices are identified. Corrective actions for all findings are developed and tracked to completion by the appraised organization, and appraisal reports are prepared.

Management Appraisals

The third level in the formal Sandia appraisal hierarchy is the management overview of EAD and the entire ES&H program. The Quality Assurance Assessments Department (QAAD), part of the Sandia quality improvement organization, assures that management appraisals of all organizations, including EAD, are done. QAAD is responsible for assuring that Quality Assurance audits are done as part of the ES&H Quality Program. They integrate their management appraisal and Quality Assurance audit schedules to minimize duplication of effort and to maximize effectiveness. Functional appraisals, management appraisals, and Quality Assurance audits are timed to coincide wherever possible. Senior Sandia management arranges for independent appraisals of the effectiveness of the ES&H Appraisal Program implementation through the Sandia ES&H Council (SEC). Senior Sandia management also receives regular summary reports on the results of internal appraisals and the status of corrective actions.

8.2.2 ES&H Performance Indicator Program

The purpose of the ES&H Performance Indicator Program is to (1) establish a minimum set of performance indicators; (2) provide basic requirements for the collection and trending of data, the analysis of trends, and the reporting of results; and (3) provide for the addition, deletion, and modification of performance indicators.

All performance indicator data is collected monthly, trended, analyzed, and reported quarterly. The ES&H Assessments Department does the trending of all performance indicator data elements regardless of the type of performance indicator or the assignment of responsibility for data collection, analysis, and reporting. This results in one database available to all organizations and assures consistency in trend format and content.

There are two types of performance indicators specified by this program: organization-specific and ES&H program indicators. Facility-specific performance indicators are applicable to only some Sandia facilities, as identified by each organization. ES&H program performance indicators are those included in the ES&H program documents.

Organizations with ES&H program ownership are responsible for the development of performance indicators included in the ES&H program documents. Organizations with ES&H program ownership collect data. The ES&H Assessments Department trends data and returns the trends to the ES&H program owner for analysis. Organizations with ES&H program ownership analyze the trend. The ES&H Assessments Department publishes a quarterly report of the trend analyses for Sandia management and the DOE.

The ES&H Performance Indicator Program supports the Corporate Self-Assessment Program, which establishes goals and objectives for continual improvement and tracks progress toward attaining those goals and objectives. The total set of performance indicators supports the evaluation of corporate performance by the DOE.

8.2.3 ES&H Operating Experience Evaluation Program

The ES&H Operating Experience (OE) Evaluation Program provides the means to share operating experience information within Sandia and between Sandia and other DOE facilities. The ES&H Assessments Department is responsible for implementation of the program. This department gathers information from Sandia activities and evaluates the information for lessons learned, near misses, suspect equipment and materials, and noteworthy practices. The department also reviews information available on the DOE Occurrence Reporting and Processing System (ORPS) database. Appropriate operating experience reports are generated and distributed to the DOE, other DOE facilities, and other Sandia organizations. Typical information that is shared includes an occurrence description, causes of the occurrence, lessons learned, and subject matter expert contacts.

Sources of Operating Experience Data

The ORPS database, accessible by modem through the EG&G Idaho System Safety Development Center, is reviewed daily for information applicable to Sandia. The Safety Performance Measurement System (SPMS), also accessible by modem through the EG&G Idaho System Safety Development Center, is reviewed bi-weekly for applicable information. Data generated from the implementation of the Sandia ES&H Appraisal and Performance Indicator programs are evaluated for information that could be of value at other DOE facilities. In addition, OE reporting forms are used by Sandia personnel to submit beneficial information to the OE program for evaluation. These forms are available from all vice-president and center ES&H coordinators.

OE Applicability Selection Criteria

The basic criteria for selecting information for dissemination within Sandia is that the information (1) have applicability to some aspect of Sandia operations, (2) have value to Sandia organizations in improving their ES&H operations, (3) is not already being evaluated and disseminated through some other Sandia program or procedure, and (4) is not merely a statement of noncompliance with a requirement.

The criteria for selecting information for dissemination to other DOE facilities is that the information have applicability to some aspect of DOE operations or have value to DOE organizations in improving their ES&H operations.

OE Interfaces

The ES&H Operating Experience Evaluation Program and procedures are developed, maintained, and controlled in accordance with the ES&H Quality Assurance Program and associated procedures.

8.3 Sandia Safety Committees

8.3.1 Sandia Reactor Safety Committee

The Sandia Reactor Safety Committee (SRSC) represents Sandia management. It is an interdisciplinary committee composed, with one exception, of individuals not directly associated with Sandia reactor operations. One member of the committee must be from outside Sandia. The chairman, appointed by the Vice President of the Energy and Environment Division, may request, at his or her discretion, that individuals with expertise in other fields than that available within the assigned committee membership also be assigned as members. The SRSC acts in a direct advisory capacity to the Vice President of the Energy and Environment Division and to the reactor operating organization on questions related to the effect of reactor activities on reactor safety as defined in the applicable safety documents.

The scope of SRSC responsibilities includes the review and evaluation of reactor safety documents, reactor procedures, and operational control parameters (including Technical Safety Requirements) to assure that conduct of reactor operations will not result in an undue hazard to operating and other plant personnel, to the general public, to equipment, or to public or private property. Its review responsibilities also include the review of reactor committee charters, specific types of reactor experiments, and modifications of equipment, systems, procedures, and operating safety limits.

The SRSC typically meets at least annually. However, meetings may be convened as often as required at the discretion of the chairman. It does not have approval authority. Rather, it makes recommendations and submits its findings to line management.

8.3.2 Technical-Area V Radiological and Criticality Safety Committee

The Technical-Area (TA) V Radiological and Criticality Safety Committee (RCSC) is responsible for reviewing the operation of nonreactor nuclear facilities and the use of fissile and radioactive materials in Technical Area V. The RCSC reviews all safety-related activities involving significant quantities of radioactive materials associated with the Hot Cell Facility (HCF), the Gamma Irradiation Facility (GIF), the Californium Source, and other nonreactor nuclear facilities in TA V. It also reviews the storage, handling, and testing of all significant quantities of fissile and radioactive materials exclusive of the TA-V reactor facilities (those areas covered by DOE Order 5480.6), including the TA-V accelerator facilities.

The RCSC operates under charter from the Sandia Radiological and Criticality Safety Committee (SRCSC). The RCSC advises the department manager responsible for TA V and the responsible line organization on matters of radiological and criticality safety. The chairman and all members are appointed by the TA-V Manager. It is the responsibility of the TA-V Manager to staff the RCSC so that independent, multi-disciplined reviews with in-depth technical completeness are given to the areas being considered. The RCSC meets as required to consider items brought to it by its members, experimenters, or supervision, but not less than once every six months.

8.3.3 Sandia Radiological and Criticality Safety Committee

The objective of the Sandia Radiological and Criticality Safety Committee (SRCSC) is to provide Sandia management with an internal safety review system and assure that nuclear facilities are operated safely, and that nuclear materials with criticality potential are used in a safe manner and in compliance with DOE regulations. The SRCSC meets at least annually. The majority of those present must be independent of the facility or activity being reviewed. Committee findings and proceedings are recorded in sufficient detail to allow audit by Sandia management and the DOE, and a written report of review findings is prepared annually for the Director of the ES&H Program Management Center.

The SRCSC reviews and makes recommendations on the safety aspects of (1) proposed modifications to nuclear facilities and equipment having safety significance, (2) proposed experiments and operations having safety significance, (3) administrative, operating (normal and abnormal), maintenance, repair, testing, quality assurance, and emergency procedures and significant changes thereto, (4) organization and staffing, (5) standards, nuclear criticality safety limits (NCSL), operational safety requirements (OSR), and changes thereto, (6) nuclear facility safety training programs, (7) unusual occurrences, operating anomalies, and violations of NCSLs or OSRs, (8) the physical condition of nuclear facilities, (9) the accuracy and completeness of record-keeping and documentation, and (10) compliance with the requirements of DOE Order 5480.5.

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