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Final Safety Analysis Report for the Transuranic-Contaminated Solid Waste Treatment Development Facility

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FINAL SAFETY ANALYSIS REPORT
FOR
TRANSURANIC CONTAMINATED SOLID WASTE TREATMENT
DEVELOPMENT FACILITY

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**FINAL SAFETY ANALYSIS REPORT
FOR THE
TRANSURANIC-CONTAMINATED SOLID-WASTE
TREATMENT DEVELOPMENT FACILITY**

Compiled and Edited by

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ABSTRACT

The Final Safety Analysis Report (FSAR) for the Transuranic-Contaminated Solid-Waste Treatment Facility has been prepared in compliance with the Department of Energy (DOE) Manual Chapter 0531, Safety of Nonreactor Nuclear Facilities.

The Treatment Development Facility (TDF) at the Los Alamos Scientific Laboratory is a research and development facility dedicated to the study of radioactive-waste-management processes.

This analysis addresses site assessment, facility design and construction, and the design and operating characteristics of the first study process, controlled air incineration and aqueous scrub off-gas treatment with respect to both normal and accident conditions.

The credible accidents having potentially serious consequences relative to the operation of the facility and the first process have been analyzed and the consequences of each postulated credible accident are presented. Descriptions of the control systems, engineered safeguards, and administrative and operational features designed to prevent or mitigate the consequences of such accidents are presented.

The essential features of the operating and emergency procedures, environmental protection and monitoring programs, as well as the health and safety, quality assurance, and employee training programs are described.

1. INTRODUCTION

The increasing production of plutonium for both military and civilian application has added a new dimension to the problems of management of transuranic (TRU) contaminated wastes. There are currently several development programs under the direction of the Department of Energy's Office of Nuclear Waste Management aimed at improvement of the technology of TRU waste management and treatment.

One of these programs is the LASL waste treatment process development program, whose main goal has been the specification of one or more total waste treatment plans for TRU wastes which offers the optimum combination of improvements in safety and economy. The approach is to examine such factors as improved container development, plutonium assay of waste materials and process residues, waste volume reduction techniques including feed preparation, interim storage, enhancement of safety by achieving chemical stability, and ultimate disposal of residues from waste treatment processes under study, and optimization of associated aircleaning methods. Waste generating activities are scrutinized to identify means by which the generator may be able to minimize treatment problems.

Incineration is a process which has, in the past, been plagued by technical problems. The difficulties have never been attacked systematically, and more economically attractive alternatives, such as earth burial, have been chosen. It has become apparent, however, that environmental impact must be considered along with economics, and these alternatives are becoming less acceptable. The first process being studied, therefore, is controlled-air incineration. The intent is to define the advantages and limitations of incineration and to establish the design parameters for successful incineration of TRU contaminated wastes. Subsequent investigations will be made into other waste treatment processing techniques to develop an improved TRU solid waste management system.

Flexibility was designed into the off-gas treatment train to accomodate a range of off-gas characteristics. An intermediate goal of the process development program was the design and construction of a facility to house the LASL solid waste treatment research programs. The present facility is a two-story, multi-purpose building with approximately 11,000 ft² of floor space. The first floor is capable of handling actual TRU contaminated materials and provides a large, ventilation controlled bay for production-scale testing of treatment processes as well as laboratories and other facilities for support activities. The second floor contains offices for project personnel and laboratories for cold support activities. A second building, the Warehouse and Staging area building, houses a machine shop and work area in which to fabricate and assemble large pieces of process equipment prior to installation in the process line. This building also provides space for storage of equipment and material for the TDF programs. The Warehouse and Staging Area building is a cold support facility and will not contain radioacative materials. The purpose of this report is to establish that this facility and the controlled-air incineration process will operate in a safe manner.

2. SUMMARY AND CONCLUSIONS

2.1 Site

2.2 Facility

2.3 Operations

2.4 Safety

2.5 Environmental Impact

2.6 Conclusions

2. SUMMARY AND CONCLUSIONS

2.1 Description of Site

The Los Alamos Scientific Laboratory is located on the eastern slopes of the Jemez Mountains in northern New Mexico, between the altitudes of 6,500 and 7,700 ft. The location, which is remote from large population centers, provides an ideal setting from the standpoint of security and minimal environmental interaction. The semiarid climate and rough terrain precludes using the area for extensive crop production, but supports wildlife such as rodents, deer, bear, elk, coyotes, cougar, and birds.

The location of the building was unused, and consisted of open fields with some grass and scrub oak. Minor changes to the natural browse area have been unavoidable due to the construction of the building, roads and parking areas.

The site selected for the Treatment Development Facility (TDF) comprises an area of about 3 acres located on a finger mesa near the center of Pajarito Plateau, a shelf about 10 to 15 mi wide and 45 mi long. Access to the site is by Pajarito Road which is a primary, DOE controlled road within the DOE-controlled land. The nearest public habitation is a trailer court some 4,000 ft to the north. The residential areas of Los Alamos and White Rock are within a 10-mi radius to the site and together have a population of about 17,000. Most of these people are involved either directly or indirectly with the operation of Los Alamos Scientific Laboratory.

Two DOE-controlled facilities, TA-55 and the east portion of TA-50 are in close proximity to the facility. TA-55 is the Plutonium Processing Facility and is located approximately 500 ft west of the TDF. The central radioactive Liquid Waste Treatment Facility occupies the eastern portion of Technical Area 50. A solid radioactive waste burial site adjoins TA-50 on the south.

The TDF is isolated from any external fires in the area. The top of the finger mesa is an open field, with the nearest forested canyon located several hundred feet to the north. The closest

vegetation consists of the landscaping planting along the north side of the building. There is a minimum of 30 ft of paving on the east, south, and west sides, and fire fighting equipment has access to all sides of the building.

Services, including electric power, water and fuel gas are supplied to the site from existing nearby sources. The nearest existing fire station is 2 mi road distance from the site with a response of about 3.5 min. Two pump trucks would respond from this station. Back-up equipment would come from other stations within 5 to 10 mi of the site.

Winds at the site are generally light and southerly with periods of strong, gusty winds during the spring months. Tornadoes are very rare above 7,000 ft in the Rocky Mountains. The site elevation is 7,200 ft. Temperature inversions, which occur usually at night, are subject to considerable mixing caused by moderate winds which accompany fronts and by a drainage effect of air flowing into the adjacent canyons.

Temperatures are moderate in both winter and summer with day time highs in the 80's during the summer, and 30's in the winter. Night time temperatures are about 20 degrees lower.

The site, being located on a finger mesa, is not subject to flooding. The average annual precipitation is slightly more than 18 in.

The sanitary wastes generated at this facility are discharged to a waste treatment facility, including a lagoon, designed to serve the facilities at Technical Areas 35, 48, 50, and 55.

Storm runoff is channeled to the existing surface drainage paths to the adjacent canyons in such a manner that erosion is negligible. These normally dry canyons contain intermittent streams that flow only during periods of intense rain storms or heavy spring snow melt. Hydrologic observations begun in 1960, indicate that except during the infrequent periods listed above, all storm runoff and industrial water effluents have infiltrated into the alluvium and remained within DOE-controlled land. It is not

anticipated that this land-use change will add enough water to the runoff to alter the present hydrologic conditions.

The stream-connected aquifer is in the surface alluvium, perched on the underlying tuff at a depth of 20 ft. As the water in the perched aquifers moves eastward, steady losses by evapotranspiration and capillary infiltration into the tuff occur so that the aquifer remains essentially constant in size.

The main aquifer is about 1200 ft. below the surface along the western edge of the plateau. Water in the main aquifer is moving laterally eastward at approximately 400 ft/yr toward the Rio Grande where there is some discharge into the river through a series of springs and seeps. The recharge area for this aquifer is several miles to the west in the Jemez Mountains.

The major geological features of the Los Alamos area are the Jemez Mountains on the west and the discontinuous aprons of tuff and pumice stretching eastward toward the Rio Grande Valley. The area is in a structural trough near large faults. There is no geologic evidence to indicate that intensive earthquakes have occurred in the Los Alamos region within the recent geologic history, but tremors from quakes originating in other parts of the trough are known. The rock present near the surface at the site location provides an excellent foundation material on which to place a structure designed to withstand seismic accelerations.

Although the area of the Jemez Mountains has a long history of volcanoes, it is presently quiescent and is not considered to be an important consideration to be included in the construction design.

2.2 FACILITY

The TDF, Building 37, and the Warehouse/Staging Area, Building 54, are of precast reinforced concrete construction utilizing interior insulated, prestressed, pretensioned concrete double "T" sections for the exterior walls, roof and upper floor. Reinforced concrete slabs are utilized for the ground level floors. Total gross area of Building 37 is approximately 11,000 ft², and the

volume is approximately 160,000 ft³. The first floor, with an area of 7,000 ft², includes a shipping and receiving area; a process feed preparation area; a high bay process and air cleaning area; counting and chemistry laboratories; a process control room; a small machine shop; mechanical equipment room, and change rooms. The second floor, with an area of about 4,500 ft², includes engineering development, electronics and chemistry laboratories, restrooms and office space. The office area is of open space design and movable room dividers are used to separate the offices and work areas, and a conference and library area.

The lower floor, with the exception of the mechanical equipment room and the entry and stairwell is intended for handling transuranics in operational quantities. Therefore, it is specially equipped and ventilated to contain these materials. All surfaces are finished to render them easily cleanable for decontamination purposes. The second floor is not intended for handling radioactive materials above tracer activity levels and is heated and ventilated by an independent air supply system.

Auxiliary buildings presently include an office-instrument shop trailer to house technical support personnel and a 2600 ft² warehouse and storage area building. This building provides non-radioactive storage space and a nonradioactive machine shop and fabrication area in which to assemble large process equipment items prior to moving them into the radioactive process bay.

2.3 OPERATIONS

The TDF was constructed to permit production-scale testing, evaluation and demonstration of processes for volume reduction, stabilization and packaging of transuranic contaminated solid waste.

The first process selected for development and evaluation consists of a feed preparation and inspection system, a conventional waste incinerator system modified to handle and confine radioactive contaminated trash and an effluent treatment system to assure safe disposal and/or discharge of the combustion products.

Waste is received at the facility in sealed plastic bags inside of sealed cardboard boxes. Waste contaminated to levels less than 100 nCi/g is transported and stored at the TDF area in Dempster Dumpsters modified for radioactive service. Wastes contaminated to more than 100 nCi/g are shipped to the TDF in DOT approved drums. Drums are unloaded from trucks and placed four on a pallet. The pallets are stacked in the drum storage areas, including the loading dock and in the low bay area south of the feed preparation line. Approximately 400 ft² of dock space is provided for storage. When waste is introduced into the process area, a pallet of drums or waste packages are moved from the storage area into the feed enclosure by the forklift. The drums are loaded singly onto a short conveyor, manually rolled under the insertion slot box, and raised vertically through the box floor. The raising of the drum automatically establishes an annular air flow into the slot box around the drum. The drum is then opened and the seal ring and lid surveyed for contamination. If there is no evidence of contamination on the lid or seal, the exterior surface of the package within the drum is surveyed. If these exterior surfaces are not contaminated, the package is passed through a door to the next station.

Should the exterior of the package and/or interior of the drum or drum lid be contaminated, the package is withdrawn from the drum into a bag sleeve and sealed. The rebagged package, its exterior free of contamination, is then passed to the next station. The contaminated surfaces of the drum are wiped down and surveyed to determine if the contamination is removable. If the contamination is not easily removable, the lid and seal are replaced on the drum and the drum removed from the slot box to be decontaminated by more rigorous methods or to be disposed of. If contamination has been spread to the exterior surfaces of the drum, the drum is placed inside a bag prior to removal from the line. The second station in the line is used for waste assay. A high sensitivity multiple energy gamma assay system (MEGAS) and

weighing determines the concentration of transuranics in the package. From the MEGAS station, the waste package is passed through an airlock tunnel by conveyor belt where a microdose x-ray scanner provides a cathode ray tube display of the package contents. The package exits the airlock tunnel into a sorting glovebox where the package may be opened to remove any noncombustibles. High density combustibles, such as wood, catalogs, and computer print paper may also be removed, shredded, compacted and repackaged for more efficient incineration.

Metals and other noncombustibles are segregated: Metal cans and stainless steel beakers are crushed flat; metal items are sawed into lengths not to exceed 0.3 m (12 in.); glass items, whose volume may be reduced by crushing, are run through the glassbreaking machine in the glovebox and placed in containers. Standard glovebox procedures are followed to assure proper packaging of possible sharp or otherwise hazardous material and to insure the safety of the operating personnel and glovebox integrity. An auxiliary compartment is attached to one work station under which there is located a short conveyor for handling 55-gal DOT drums into which noncombustibles may be bagged out of the glovebox line. The respective combustible components are sorted and bagged.

Packages containing no noncombustibles may be passed directly through the sorting glovebox to the storage glovebox with no further processing prior to incineration.

Procedures for input/output from the feed preparation line will be developed and finalized as a result of the experimental program.

Waste is fed through an air lock to the incinerator where it is burned at a nominal 1500° F to yield solid ash and gaseous effluents as products. The ash may be accumulated in the bottom of the ignition chamber or may be removed periodically via a gravity ash drop out system. A vacuum ash removal system provides for removal of ash from both the ignition (lower) chamber and the

combustion (upper) chamber after an experimental run and subsequent cool down. The vacuum ash removal system also provides capability for periodic removal of ash from the gravity ash removal hopper during incinerator operation. Gloveboxes attached to the ignition and combustion chambers permit access to the incinerator interior and enclose the vacuum ash removal articulated suction lines.

The vacuum ash removal system transports the ash to a collection hopper which feeds the ash to a packaging glovebox via an ash assay system. The transport air from the vacuum ash removal operation is filtered through sintered metal filters and a HEPA filter prior to being exhausted into the glovebox exhaust plenum for additional HEPA filtration prior to release.

Combustion gases and unburned products from the ignition chamber pass to a secondary combustion chamber which provides the high temperature and residence time necessary for complete combustion of the waste material. The temperature (up to 2600° F) is selectively variable, allowing optimization of the oxidation process. Supplemental fuel gas is fed to both the primary and secondary chambers as required to maintain predetermined temperatures.

The flame safeguard system, stream flows, and chamber temperatures are monitored to facilitate incineration control and analysis of operation. Interlocks are provided to assure safe operations.

The hot combustion gases exit the incinerator through a refractory lined duct to the offgas cleanup system. A weir at the top of the quench chamber provides a solid moving curtain of water as the first cold surface encountered by the combustion gases. Additional water sprays in the quench chamber cool the gases to about 180° F. A liquid-gas separator chamber immediately below the quench chamber de-entrains the excess liquid which is collected for recirculation.

The offgas is then passed to a high energy venturi scrubber with variable throat which permits adjustment of the pressure differential (ΔP) over the range of 15 in. W.C. to 80 in. W.C. Circulating water is contacted with the offgas to remove 89 to 99 percent of the particulates over the operating range of the venturi. Particulate removal is greater than 95 percent at 40 in. W.C. ΔP (the current operating set point is 50 in. W.C. ΔP). The excess liquid is separated from the gas stream in the absorber sump and is collected for recirculation.

The offgas passes through the sump to a packed column scrubber. The counter flow packed column scrubber initially contacts an aqueous solution with the gases to remove more than 90 percent of the HCl and, depending on scrub solution temperature, up to 80% of the SO₂. The scrub solution is collected for recirculation. The quench and scrub solutions are collected from the sumps, neutralized by a proportionate introduction of 20% sodium hydroxide and filtered to remove large solid particulates. This solution is passed through a heat exchanger to remove the heat of chemical reaction and vapo-condensation and collected in a 500 gallon scrub sump tank. A portion of this scrub solution, based on either a periodic proportionate blow down or by continuous specific gravity measurement, is transferred to the building collection sump for transfer to the LASL Liquid Treatment Plant. The balance of the scrub solution is recirculated to the quench, venturi and packed column scrubbers.

The treated offgas, which is saturated with water vapor, is passed through a condenser for cooling. This condenses water vapor from the gas stream which is collected for recirculation. The cooled offgas is then passed through a reheater which raises the temperature above the saturation point, essentially drying the gases, prior to passing through a prefilter and a double set of HEPA filters.

Effluent gases from the process offgas treatment system are exhausted through the facility stack which is continuously sampled

for radioactivity.

Liquid effluents from the process are collected in the building acid waste collection tank. These are neutralized with caustic, as required, and discharged on a batch basis through the special radioactive waste drain line to the radioactive Liquid Treatment Facility on the east side of TA-50.

Solid effluents from the process are collected and placed in sealed containers for storage and future studies. An objective of the TDF is to develop technology for the packaging and storage of transuranic wastes. Solid effluents are handled in accordance with this phase of the research program.

A major shortcoming of past radioactive waste incinerator systems has been inadequate offgas treatment. Carry-over of particulates and tar has caused plugging and excessive loading of offgas treatment and filtration systems. The present system was designed to alleviate these problems and to permit the testing of different process systems in order to develop and establish an optimum practical system.

2.4 SAFETY

Safety analyses of the TDF facility and the initial incineration process operations have been made, and it is concluded that the TDF will pose no significant threat to public safety. The structure will remain standing as a confinement structure during and after the design basis fire (DBF). The maximum credible accident (MCA) has been postulated to be a natural gas explosion. Even though the MCA may breach the building, the maximum quantity of transuranics available to be dispersed by the event will be on the order of 440 mCi. The airborne fraction has been demonstrated to be 6.4×10^{-5} c leading to a maximum concentration at the White Rock residential area of 2.4×10^{-13} $\mu\text{Ci}/\text{ml}$ under worst case conditions. This is higher than the NRC 0524 limit of 6×10^{-14} $\mu\text{Ci}/\text{ml}$ for soluble plutonium. However, due to the mechanism of release, it is not probable that the airborne fraction of the plutonium (the major constituent of the contaminants) would exist in

any chemical form except as an oxide. Even low temperature (600° C) plutonium oxides are considered insoluble except in strong acid solutions, thus the appropriate concentration limit should be considered as 10^{-12} $\mu\text{Ci/ml}$ in accordance with NRC 0524.

Calculations of the 50 yr dose commitment resulting from exposure of the worst case conditions at White Rock are 0.86×10^{-3} Rem to the lungs and 1.97×10^{-3} Rem to the bones.

Additional possible sources of accidents have been examined and are of lesser consequences than the DBF and MCA. Fire detection and suppression equipment and engineered safeguards are used to reduce the probabilities of occurrence of accidents and to minimize the consequences of those accidents that might actually occur.

2.5 ENVIRONMENTAL IMPACT

At the Los Alamos Scientific Laboratory, solid wastes contaminated with radioactive materials are buried in trenches located on the basis of geologic and hydrologic factors which indicate an extremely low probability of movement of radioactivity. Environmental monitoring confirms that movement has not occurred.

Compaction techniques presently in use at LASL have resulted in reductions in volumes of up to five. Operation of the controlled-air incineration process during the nonradioactive test phase has resulted in volume reduction ratios of 28 to 44 depending on the waste feed characteristics, and a fairly constant mass reduction factor of about 17. Enhanced recovery of transuranic isotopes may be achieved by this or other methods of combusting solid wastes.

Specific treatment techniques may be required to process wastes generated by alternate fuel cycles or to meet terminal storage criteria; other methods such as acid digestion or fluidized bed combustion may be of interest because of potential improvements in control of the process, recovery of plutonium from residues, or maintenance of equipment and simplification of treatments for evolved gases and vapors. Once developed, these other

processes may be incorporated in the new facility for testing.

The present LASL annual generation of solid radioactive contaminated wastes is about 70,000 ft³, most of which is contaminated with transuranic radionuclides. A portion of this volume, sufficient to perform representative demonstrations, is sent to the development facility. The radioactivity inventory in the facility at any one time is limited to 100 g of transuranics, principally ²³⁹Pu and 10 mCi of mixed fission products. Criticality considerations are not a factor, as the 100 g limit is well below the optimum geometry minimum critical mass of both ²³⁹Pu and ²⁴¹Pu. Americium, cesium, berkelium, etc., are not fissionable products. Furthermore, all wastes sent to the facility are screened at the source to eliminate materials unsuitable for incineration and the presence of noncombustibles or hazardous materials will be checked again during assay and feed preparation operations at the facility.

Although wastes from other DOE sites will not be shipped to the TDF, waste handling practices at other sites are comparable in part to those at LASL. The waste treatment experiences gained in this demonstration facility thus have application elsewhere. In cases where radioactive wastes are shipped offsite for burial, volume reductions will provide corresponding cost savings in packaging and transportation or storage. Incineration technology is proposed for the future preparation of plutonium-contaminated solid wastes for long-term storage in a Federal Repository. There do not appear to be near-term prospects of developing this volume reduction experience for transuranic, carcinogenic, and hazardous wastes from plutonium scrap management activities.

The present project provided for construction of a building at Technical Area 50 (TA-50) for development of an engineering demonstration of processes for radioactive solid waste treatment. The building has an area totaling approximately 11,000 ft². Equipment is provided to demonstrate four primary treatment subsystems; feed preparation, incineration, offgas treatment, and

ash removal. The facility will be utilized for demonstration or pilot plant operation of other processes for treating radioactive solid waste which may be developed at LASL and other DOE sites. Improvements to land and modification to existing utility systems were made. New tie-ins for radioactive liquid wastes to an existing waste collection and treatment system within the area as well as filtration for airborne effluents are provided.

The location of the building was unused, and consisted of open fields with some grass and scrub oak. The soil in general is volcanic tuff with a thin covering of clay. No streams exist upon the narrow mesa, but intermittent water-courses are present in the deep canyons to the north and south. The environment is semi-arid with rainfall about 18 in/yr. Minor changes to the natural browse area was unavoidable due to the construction of buildings, roads, and parking areas. No other impact is considered probable from routine operation of the facility. The most adverse accident postulated for the operation is a fuel gas explosion and fire; however, the facility and operation are designed to minimize the probability of such an event and to minimize radioactivity which might be released from the containers or process equipment. The building is provided with fire protection systems and with automatic shutdown equipment for malfunctions.

No problem is foreseen in the eventual decontamination and removal of the building, if necessary or desirable, at the end of the demonstration operations. Therefore, the project does not involve any conflict between short-term and long-term uses or any irreversible commitment of resources. No state, local, or regional conflicts are believed to exist.

2.6 CONCLUSIONS

In assessing and balancing the anticipated benefits against the environmental and economic costs of the facility and first process, and after considering the range of alternatives and their environmental impacts, it has been concluded that the solid radioactive waste volume reduction facility should be operated as

designed and constructed.

This brief summary shows, and the more detailed data in the subsequent chapters confirm, that the facility has been designed to operate safely under normal or accident conditions. The health and safety of the public and the environment is assured.

- 3. Description and Safety Assessment of Site
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3. DESCRIPTION AND SAFETY ASSESSMENT OF THE SITE

3.1. GENERAL DESCRIPTION OF AREA

3.1.1 INTRODUCTION

The Los Alamos Scientific Laboratory is located in northern New Mexico at elevations between 6500 and 7700 ft on the eastern slopes of the Jemez Mountains, about 35 highway miles northwest of the state capitol, Santa Fe (Figs. 3.1.1-1 and 3.1.1-2). This location was chosen during World War II to provide isolation.

In June 1949, Los Alamos County was formed from the northeast corner of Sandoval County. In the early 1960's, the Atomic Energy Commission began disposal of residential and commercial property by sale to the residents and general public, retaining only that land necessary for the operation of the Laboratory. As a result, private construction has expanded the original townsite to the north, and a new area, White Rock, has been developed about 7 mi east of the original town along the rim of the White Rock Canyon of the Rio Grande. Local government is entirely in the hands of the county which has ordinance making powers and serves in lieu of a town or city organization. The geography of Los Alamos County is shown in Fig. 3.1.1-3. The Transuranic Contaminated Solid Waste Treatment Development Facility (TDF) is located at Technical Area (TA) 50 on DOE controlled land approximately 1 mi from the nearest residential area to the north.

The county is located on the Pajarito Plateau which is a shelf about 10 to 15 mi wide and 45 mi long on the eastern flanks of the Jemez Mountains. The plateau has been deeply eroded by runoff toward the Rio Grande resulting in an area consisting of a series of mesas separated by canyons, many of which are several hundred feet deep.

Vegetation at the eastern edge of the county is that of a continental semiarid region with pinons and junipers along with sagebrush and other hardy species. Toward the western edge of the county at higher elevations, the vegetation becomes forests of Ponderosa pine and spruce with groves of aspen. Wildlife is

Fig. 3.1.1-2
Topography of the Los Alamos, N.M., area.

FIG. 3.1.1-3

Los Alamos County residential areas and LASL technical areas (numbered).

plentiful, particularly in the restricted areas of governmental ownership, and includes numerous species of birds as well as rodents, deer, bear, mountain lion, elk, and coyotes.

The entire area is of archeological interest because of the presence of several hundred ruins of prehistoric Indian dwellings built during the period before the Spanish occupation. Bandelier National Monument is situated at locations in Sandoval and Santa Fe Counties immediately adjacent to Los Alamos County.

3.1.2 POPULATION DISTRIBUTION

The TA-50 site is located within the Los Alamos Scientific Laboratory technical area in Los Alamos county. Fig. 3.1.2-1 shows the daytime population distribution within a 6-mi radius, while Fig. 3.1.2-2 shows the nighttime distribution. The population rose figures are from the LASL "Pathfinder" computer program.

The resident population of Los Alamos county approaches 17,000 with over 5,000 located in the White Rock area southeast of the site and about 12,000 in the townsite north and northwest of the TDF. The daytime population of the county is increased to about 20,000 by employees who live outside the county, principally in the Rio Grande Valley from the Santa Fe, Pojoaque, and Espanola areas, and commute daily to the Laboratory.

Except for the residential areas of Los Alamos and White Rock, the area within the 10-mi circle is sparsely populated. There are approximately 55 permanent residents at Frijoles Canyon, 5 mi SSE, but summer visitors to the Bandelier National Monument can increase this population to more than 1,000. At San Ildefonso Pueblo, 9 mi to the ENE, there are approximately 500 people.

In the 10-20 mi zone, the total population is about 21,500, with about 10,000 concentrated around Espanola, 15 mi to the northeast, and 5,000 in the Pojoaque-Nambe-El Rancho area.

Between 20 and 30 mi away from the site, the total population is almost 55,000 with about 45,000 concentrated in the vicinity of Santa Fe, 22 mi to the southeast. Fig. 3.1.2-3 shows

LOCATIONS OF DAYTIME POPULATION CONCENTRATIONS
WITH RESPECT TO TA-50

FIG. 3.1.2-1

LOCATIONS OF NIGHTTIME POPULATION CONCENTRATIONS
WITH RESPECT TO TA-50

FIG. 3.1.2-2

LOCATIONS OF DAYTIME POPULATION CONCENTRATIONS
WITH RESPECT TO TA-50

FIG. 3.1.2-3

the population distribution within 35 mi of the TDF site. There are no other population centers within 50 mi. Albuquerque, population 300,000, lies 53 mi to the south.

3.1.3 METEOROLOGY

3.1.3.1 WINDS

Surface movements of air in this region are strongly influenced by the mesa which slopes away from the Jemez Mountains to the west. The mesa is divided by erosion canyons that drain eastward into the Rio Grande Valley some 1,000 to 1,500 ft below. After sunset, cooler air from the mountains flows across the mesas and channels through the canyons into the river valley. During the day, the flow is reversed with upslope winds.

The average wind speed is less than 10 mph more than 75% of the time and over 30 mph only 0.2% of the time, usually in gusts (Fig. 3.1.3-1). A breakdown of the winds by time of day shows the westerly flow to be most dominant at night, giving way to southeasterly mode after sunrise, and a weak maximum occurrence of south winds in the afternoon. In terms of diffusive mixing of airborne material, however, the west-northwest flow was dominant during the night when turbulence levels and mixing rates are lowest.

In addition to the mean transport property of the winds, the turbulent energy of the airflow is an important factor in the dispersal of contaminants. A useful measure of the turbulence is the variation or total range of the fluctuating wind direction in a specified period of time, and another is the gust factor, the ratio of the maximum wind speed to the average wind speed over a given time interval. A one-year period ending May 7, 1972 was selected, and the average 10-min variations in wind direction and gust factor were estimated for each hour from the chart rolls produced by the wind sensors at the Administration Building (TA-3). These two sets of hourly estimates were analyzed according to direction variation (Fig. 3.1.3-2) and gust factor (Fig. 3.1.3-3) as functions of average wind direction and average wind

Fig. 3.1.3-1

Fig. 3.1.3-2

Fig. 3.1.3-3

speed. The totality of each set of measurements was grouped according to direction, speed, and direction variation or gust factor, and the occurrence frequency (percentage) was calculated. Tornadoes in New Mexico are very rare above 7,000 ft. In one degree square of latitude and longitude in which Los Alamos is located, seven have been reported since 1916. The actual location of these storms was in the east and at lower elevations. The tornado problem specifically for Los Alamos is addressed by Fujita (1972).

Maximum wind speeds are generally less than 90 mph with a mean occurrence interval of 100 mph once per 100 years. A 15 yr study of maximum wind speeds is shown in Table 3.1.3-1.

3.1.3.2 TEMPERATURES

Summers in the Los Alamos area are cool with maximum temperatures reaching 90° F of an average on only two days a year and with 95° F being the highest recorded. In July, the hottest month, high readings average in the mid-80's and the temperature usually drops to the low 60's during the night. Freezes have been recorded in all months except July and August. Winters are rather cold, although a great many winter days are clear and sunny and daytime warming under cloudless skies is rapid at this elevation. Even in January, the coldest month, the daytime shade temperatures in the high 30's can be expected on most days, and an average winter includes only 18 days when the mercury fails to rise above 32° F. During winter nights temperatures drop below freezing from November through mid-April, but below zero readings can be expected only occasionally. The minimum temperature recorded was -18° F. The average temperature data at Los Alamos are given in Table 3.1.3-2. In the Los Alamos area, temperature inversions are almost always caused by surface cooling or frontal activity. Surface cooling inversions, by far the most common, can be expected to form during any night when the skies are generally clear and wind speeds are low. On the mesas, such inversions usually dissipate by midmorning. Inversions due to frontal activity are

TABLE 3.1.3.1-1

MAXIMUM WIND SPEEDS BY MONTH (MPH)

A Fifteen Year Study

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEARLY MAXIMUM
1971	40	50	59	43	65	48	38	54					
1970	45	32	38	52	45	43	56	50	50	58	54	58	58
1969	40	43	50	52	41	43	46	34	34	40	37	51	52
1968	34	42	38	50	38	41	30	41	66	42	56	58	66
1967	57	69	53	67	47	45	32	35	31	38	37	59	69
1966	40	33	52	54	52	52	33	43	30	41	47	43	54
1965	61	36	49	44	54	43	35	36	39	40	61	37	61
1964	73	45	75	70	73	55	50	40	50	31	51	59	73
1963	48	40	63	70	62	49	53	46	33	46	40	53	70
1962	60	57	52	68	64	46	46	56	35	34	37	32	68
1961	35	52	62	60	56	55	48	40	60	44	53	45	62
1960	44	62	90	90	55	57	50	52	59	60	62	55	90
1959	52	62	65	50	52	53	48	40	50	52	45	55	65
1958	38	50	46	59	53	40	51	39	40	41	53	61	61
1957	57	44	51	53	49	44	42	41	47	46	42	47	57
1956						46	61	37	44	61	43	40	

Start June 18, 1956

TABLE 3.1.3-2
TEMPERATURES, LOS ALAMOS

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Average Maximum	39	43	49	59	68	78	80	78	72	62	49	41	60
Average Minimum	18	22	26	34	43	52	55	54	48	38	27	20	36
Extreme Maximum	64	66	71	80	89	93	95	92	94	82	69	62	95
Extreme Minimum	-18	-14	-3	5	24	28	37	40	23	16	-4	-10	-18

subject to considerable mixing caused by the moderate winds that usually accompany the fronts. Lateral mixing is reinforced by vertical mixing created by the mechanical turbulence of the winds flowing across the broken terrain. Observations at the site of the ultra-high temperature reactor experiment (near the meteorological tower at the center of the area) indicate that stable layers of air form during the night, but that they are disturbed by the drainage effect of air flowing into the adjacent canyons.

3.1.3.3 PRECIPITATION

The climate for Los Alamos is typical of a semi-arid continental mountain region. Precipitation for the Los Alamos area is shown in Table 3.1.3-3. The average annual precipitation is slightly more than 18 in., 75% of it falling during the months of May through October. Nearly 40% is received during the months of July and August, much of it released through thundershower activity. The maximum 24-hr rainfall recorded was 3.48 in. On the average, a trace or more occurs on 140 days of the year.

Shower activity reaches its peak in August when rainfall of one-tenth inch or more can be expected on one day out of four. These showers normally develop in the afternoon or early evening and are usually relatively brief. Although some hail may accompany the more severe thunderstorms, no serious hail damage to Laboratory facilities has been reported. Most of the winter precipitation falls as snow, with 50 in. descending during an average winter and as much as 6 in. often falling in 24 hrs.

3.1.4 HYDROLOGY

Sites located on the finger mesas high above adjacent canyons are not subject to flooding. Collection and ultimate discharge of surface runoff from rain, snow melt, or external fire fighting in the immediate vicinity of a building and runoff from other areas generally follow existing drainage patterns to the adjacent canyons. Stream flows in these canyons are ephemeral.

TABLE 3.1.3-3
PRECIPITATION, LOS ALAMOS

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
<u>Days of Precipitation</u>													
Average	6.2	7.6	8.7	7.1	8.2	8.4	16.9	16.9	9.7	6.3	5.5	6.6	108.1
Maximum	18.0	13.0	23.0	16.0	23.0	18.0	24.0	27.0	19.0	20.0	14.0	11.0	
Minimum	2.0	2.0	2.0	1.0	2.0	1.0	12.0	8.0	3.0	0.0	2.0	1.0	
<u>Days of Snow</u>													
Average	6.0	7.0	7.0	3.3	0.7	0.0	0.0	0.0	0.0	1.2	4.7	5.7	35.6
Maximum	16.0	13.0	23.0	12.0	4.0	0.0	0.0	0.0	0.0	4.0	10.0	11.0	
Minimum	2.0	2.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	
<u>Days of Thunderstorms</u>													
Average	0.0	0.2	0.05	1.5	6.5	8.7	17.5	17.3	7.7	2.3	0.4	0.0	61.5
Maximum	0.0	1.0	3.0	5.0	13.0	19.0	25.0	24.0	13.0	8.0	2.0	1.0	
Minimum	0.0	0.0	0.0	0.0	1.0	2.0	5.0	8.0	1.0	1.0	0.0	0.0	
<u>Snowfall (inches)</u>													
Average	9.6	8.2	9.9	4.1	0.8	0.0	0.0	0.0	0.2	1.5	5.1	10.8	50.2
Maximum	39.3	23.8	35.5	33.6	17.0	0.0	0.0	0.0	6.0	9.0	34.5	41.3	
<u>Precipitation (Since 1910) (inches)</u>													
Average	0.83	0.69	0.95	0.99	1.28	1.37	3.39	3.76	1.97	1.61	0.71	0.92	18.47
Maximum	6.75	2.44	3.27	4.64	4.47	5.57	7.98	11.18	5.79	6.77	3.30	2.85	

Stream-connected aquifers perched in the surface alluvium at a depth of 20-30 ft are recharged by industrial effluents and runoff. As the water in these perched aquifers moves eastward, steady losses by evapotranspiration and capillary infiltration into the tuff occur.

The main aquifer which is the source of the Los Alamos municipal water supply is in the Tesuque Formation and lower part of the Puye Formation. The main aquifer slopes gently from the recharge area to the west in the Jemez Mountains eastward to the Rio Grande. The depth to the aquifer is about 1200 ft below the surface along the western edge of the plateau. Water in the main aquifer is moving eastward towards the Rio Grande at approximately 400 ft/yr. There is some discharge from the main aquifer into the river through a series of springs and seeps.

Due to the high evaporation rate in this locality and the hydrologic characteristics of the tuff, it is extremely unlikely that surface runoff or liquid effluents will infiltrate to the depth of the main aquifer.

Age dating of the water in the main aquifer collected from supply wells showed no measurable amount of tritium (electrolysis enrichment method). It is calculated, therefore, that the water in the aquifer has been in a transit from the recharge area to the wells for more than 50 yrs.

3.1.5 GEOLOGY

The major geological features of the Los Alamos area are the Jemez mountains on the west and the discontinuous aprons of tuff and pumice stretching eastward to the Rio Grande Valley. During the early Pleistocene, the Jemez Mountains were a large active volcanic complex. Eruptions spread thick layers of tuff and pumice on the eastern slope of the volcanic pile. The ash flows, more than 1000 ft thick in places, form the elevated gently sloping surface of the Pajarito Plateau where the TDF site is situated.

The Pajarito Plateau is on the western margin of the Rio Grande structural trough which extends from southern Colorado

through central New Mexico into Mexico. This depression is 25-30 mi wide at Los Alamos and is filled with 7,000 to 12,000 ft of sediments and volcanics resting on the basement complex of Precambrian crystalline rocks.

Rocks that outcrop at the TDF site are of the Bandelier Tuff Formation. This overlies the Puye and Tesuque Formations (Fig. 3.1.5-1).

The Tesuque Formation consists of siltstones, sandstones with lenses of clay, and pebbly conglomerate. Some basalt flows interbed with the sediments. The formation does not outcrop in the site area. The total thickness is unknown, but is thought to exceed 2,350 ft based on test hole information.

The Puye Formation overlies the Tesuque and is composed of conglomerates of primarily volcanic debris interbedded with basalt flows. Based on data from a test hole near the TDF site, the formation is about 600 ft thick which includes a basalt flow of 120 ft thickness (Table 3.1.5-1).

The Bandelier Tuff underlies the surface of the Pajarito Plateau. It has three members which are in ascending order: the Guaje Member, an ashfall pumice; the Otowi Member, an ashflow tuff; and the Tshirege Member, a series of ashflow tuffs. The rhyolitic and tuff contain quartz and sanidine crystals and crystal fragments, with some small rock fragments of latite and rhyolite. The tuff and pumice range in porosity from 30 to about 60% by volume with a density of less than 60 lbs/ft³ (pumice) to as much as 115 lbs/ft³ (moderately welded tuff).

Unit 3 of the Tshirege Member of the Bandelier Tuff forms the mesa top at the TDF site, with Unit 2 of the Tshirege Member exposed in the walls of the canyon north of the area. The Guaje Member, the Otowi Member, and Unit 1 of the Tshirege Member are found at depth beneath the mesa. Thickness of the Bandelier Tuff is about 770 ft at the TDF site (Table 3.1.5-1).

3.1.6 SEISMICITY

The Los Alamos area, classified as Zone 2 (Uniform Building

Fig. 3.1.5-1

TABLE 3.1.5-1

Geologic Section at TA-50

	<u>Thickness (Feet)</u>	<u>Depth (Feet)</u>
Bandelier Tuff (Surface)		
Tsherege Member		
Unit 3 moderately welded tuff	110	110
Unit 2 moderately welded tubb	135	245
Unit 1 non-welded to moderately welded tuff	90	340
Otowi Member		
Non-Welded Tuff	385	725
Guaje Member		
Pumice	45	770
Puye Formation (See Note)		
Conglomerate, basalt from 860 to 980 feet	600	1370
Tesuque Formation		
Siltstone, sandstone with lenses of clay and conglomerate	2350	3720

NOTE: The top of main aquifer is 1050 feet below the surface of the mesa in the Puye Formation.

Code) on earthquake probability charts, lies in the Rio Grande depression, a structural trough bounded by large faults. The Los Alamos area might experience tremors from quakes originating in other parts of the trough. However, there is no geologic evidence to indicate that intensive earthquakes have occurred in the Los Alamos region within recent geologic history.

The Pajarito fault extends along the east front of the Jemez Mountains approximately 2 1/2 mi west of the TDF site. This fault is part of a fault zone that forms the western boundary of the Rio Grande structural trough and as such, has probably had a long history of movement. The inferred development of the Pajarito fault is shown in Fig. 3.1.6-1, which also shows a gravity profile across the west side of the Rio Grande structural trough. The basement rocks have been displaced more than the pre-caldera volcanic rocks, which in turn have been displaced more than the Bandelier Formation. At the surface the Pajarito fault displaces a pumice sheet (popcorn tuff) that is believed to be correlative with the El Cajete pumice which has been radiometrically dated as greater than 42,000 years B.P. (before present). The pumice sheet (popcorn tuff) is preserved on the downthrown block and has been completely eroded from the uplifted block.

The Pajarito fault-line scarp has a maximum height of 400 ft before it branches into two strands. The combined height of the two branch fault-line scarps is 500 ft. This 400-500 ft of displacement need not all have taken place after the deposition of the pumice sheet. The displaced pumice sheet does permit the determination of a minimum frequency of displacement along the Pajarito Fault. If it is assumed the pumice sheet is 50,000 yrs old and has been displaced the maximum of 500 ft and if it is further assumed the displacement has been small increments that may average 10 ft, then one such increment has occurred every 1,000 yrs. Should the pumice be older and the post-pumice displacement appreciably smaller, the displacement frequency could be drastically reduced.

Code) on earthquake probability charts, lies in the Rio Grande depression, a structural trough bounded by large faults. The Los Alamos area might experience tremors from quakes originating in other parts of the trough. However, there is no geologic evidence to indicate that intensive earthquakes have occurred in the Los Alamos region within recent geologic history.

The Pajarito fault extends along the east front of the Jemez Mountains approximately 2 1/2 mi west of the TDF site. This fault is part of a fault zone that forms the western boundary of the Rio Grande structural trough and as such, has probably had a long history of movement. The inferred development of the Pajarito fault is shown in Fig. 3.1.6-1, which also shows a gravity profile across the west side of the Rio Grande structural trough. The basement rocks have been displaced more than the pre-caldera volcanic rocks, which in turn have been displaced more than the Bandelier Formation. At the surface the Pajarito fault displaces a pumice sheet (popcorn tuff) that is believed to be correlative with the El Cajete pumice which has been radiometrically dated as greater than 42,000 years B.P. (before present). The pumice sheet (popcorn tuff) is preserved on the downthrown block and has been completely eroded from the uplifted block.

The Pajarito fault-line scarp has a maximum height of 400 ft before it branches into two strands. The combined height of the two branch fault-line scarps is 500 ft. This 400-500 ft of displacement need not all have taken place after the deposition of the pumice sheet. The displaced pumice sheet does permit the determination of a minimum frequency of displacement along the Pajarito Fault. If it is assumed the pumice sheet is 50,000 yrs old and has been displaced the maximum of 500 ft and if it is further assumed the displacement has been small increments that may average 10 ft, then one such increment has occurred every 1,000 yrs. Should the pumice be older and the post-pumice displacement appreciably smaller, the displacement frequency could be drastically reduced.

After Smith, Bailey, and Ross, 1970

Fig. 3.1.6-1. Faults in the Los Alamos vicinity.

Considerable evidence suggests that the rate of faulting is much lower than the above figure. Rock capped pinnacles eroded in the Bandelier Tuff are common features in the vicinity of Los Alamos. Ross and Smith⁷ described them as...

conical shaped pinnacles...that are locally known as tent rocks because of their resemblance to conical tents or tepees. There is a tendency for the formation of these in nearly all the non-welded parts of the ash-flow tuff deposits, but they are particularly outstanding in two members of the Bandelier Formation. The Bandelier Formation occupies an area of about 400 square miles and at least one of the tent rock members is present over most of this area. Some of the tent rocks are cones only a few feet high while others are 100 or more feet high and the capping boulders are from 2-5 times the diameter of the neck supporting them.

There are also boulder-capped pinacles eroded in the Puye conglomerate which are prominent in Rendija Canyon, located approximately 4 mi from the TA-50 site. These pinnacles are 10-60 ft high and the capping boulders are from 2-5 times the diameter of the neck supporting them.

These pinnacles, particularly the boulder-capped ones, are unstable and probably could not survive a strong earthquake in their vicinity. The height of the pinnacles indicates a long period of ground stability. A 60-ft pinnacle would require 75,000 to 120,000 yrs to develop based on the estimated rate of downcutting for the major canyons in the area.

Remains of the Indian dwellings constructed with free standing walls with little lateral support indicate the absence of strong tremors for at least 500 yrs. Nearby pueblos that have been occupied continuously since the late sixteenth century, buildings in Santa Fe constructed by the Spanish in the early

seventeenth century, and a lack of references to earthquakes in surviving records add support to this contention.⁸

S. A. Northrup, Head of the Department of Geology, University of New Mexico,⁹ reports that of 575 earthquakes recorded in New Mexico during the century preceding 1949, 95% originated in a 75-mi long section of the Rio Grande Valley extending south from Albuquerque (53 mi south of Los Alamos) to Socorro. In a study made in connection with reactor safety analysis, Northrup states that only 2% of these shocks were of intensity VII to IX on the Rossi-Forel Scale.^a One of the strongest shocks, reported to be of intensity IX, originated near Cerrillos, 33 mi south of Los Alamos on May 28, 1918. The resultant shock at Los Alamos presumably attained intensity VI, the most severe ever reported. U.S. Coast and Geodetic survey lists a brief shock of intensity V that occurred at Los Alamos on August 17, 1952.

Of the future, Northrup writes that it is quite likely that the Socorro-Albuquerque zone will experience many more earthquakes. A swarm, such as the one Belen, New Mexico, experienced in 1935, may be expected at any time in this zone. It is, however, unlikely that many of these shocks will be very strong as far north as Los Alamos.

The Cerrillos earthquake noted above, faded rather rapidly, obtaining an estimated intensity of only VI at Los Alamos. A deeper-focus quake at Cerrillos of intensity IX might not fade so rapidly, in which event Los Alamos might experience a shock of intensity VII.

Two studies were made in 1972 of the seismic risks for earthquakes that may occur within 100 km (65 mi) of Los Alamos. The

^aOn the Rossi-Forel Scale, Intensity V is a disturbance of furniture; VI, swinging chandeliers (people run outdoors); VII, overthrowing of movable objects (people panic); VIII, falling chimneys and cracking of walls; IX, partial or total destruction of some buildings; and X, general disaster.

first study was made using seismological data, historical records prior to 1962, and records from instrumental studies of shocks from 1962 to 1972. The strongest earthquake to occur within the region of study during the 100-yr period, based upon extrapolation of earthquake frequency/magnitude relation, ranges from 3.9 to 5.4 depending upon the data set used. The study concludes that the Los Alamos area is subject to an earthquake of magnitude 5.5 once every 100 yrs within the Rio Grande depression from Albuquerque to Questa.

The second evaluation of seismic risk in the Los Alamos area was based upon geologic evidence. Geologic studies related to fault characteristics yield theoretical data on the magnitude and frequency of shocks produced from rupture along faults or in fault zones, that is, data on the past seismic history of the area. Data required are the length of the fault, offset or throw of the fault, and age of stratigraphic units broken by the faults. The major faults studied were the Pajarito, Los Alamos, Guaje Mountain, and Water Canyon faults. All are north-south trending faults downthrown to the east or west and breaking the upper Tshirege Member of the Bandelier Tuff. The age of the Tshirege Member has been estimated by the potassium-argon method at 1.1 million years.

Calculation revealed that these faults produced 133 seismic events with average local magnitude of 6.7 (range 5.9 to 6.8) in the past 1.1 million years. In terms of seismicity of the area this means that magnitude 6.7 earthquakes occurred at approximately 8,270 yr intervals or that magnitude 4.8 earthquakes occurred at 100 yr intervals. The seismicity of the Los Alamos region is thus estimated to be five earthquakes of one magnitude per 100 yrs, in good agreement with the seismological study.

Dames and Moore prepared a site-specific seismic analysis for the Los Alamos Plutonium Facility, located at TA-55 immediately west of the Treatment Development Facility. They concluded after studying the geologic environment of the area that the Plutonium

Facility Operating Basis Earthquake (OBE) should be estimated at a ground motion at the site of Intensity VII to VIII and that the Safe Shutdown Earthquake should be estimated at a ground motion of Intensity VIII. Response spectra based upon horizontal ground motions are 0.17 g and 0.33 g, respectively.

In summary, it can be concluded that the TDF site is located in an area of moderate earthquake activity. Although a major surface fault exists to the west of the site, there is no indication of strong earthquakes associated with it or its associated faults over an extended period of time. No signs of surface faulting are found in the immediate site vicinity. The maximum earthquake intensity to be expected at the site is VII on the Rossi-Forrel Scale.

3.1.7 OTHER PHYSICAL CHARACTERISTICS

Geologic hazards of possible significance in building design other than seismic hazards, include ground compaction due to withdrawal of water, landslides, and renewed volcanism. Dames and Moore¹² concluded that risks of new volcanism in the Los Alamos are minimal.

Ground compaction due to withdrawal of water is not considered to be significant geologic hazard because pumping to the present time has lowered the water table significantly only in the vicinity of the well fields. The aquifers are silty sandstones, sandstones, and conglomerates, and as such, are not particularly susceptible to compaction when the water is withdrawn.

Landslides, except for isolated rock falls from the mesa rims, are an unlikely hazard at Los Alamos because of the dry climate, the deep water table, and the rock formation characteristics. The Bandelier Formation is a nearly flat-lying cohesive unit with a low specific gravity, producing a relatively small load on the underlying formations. These rocks are essentially dry to a depth of several feet below the canyon bottoms. Thus, ground and climatic conditions conducive to landslide development

are generally not present at Los Alamos. Landslides, except rock falls at the base of the mesa-rim cliffs, are virtually nonexistent topographic features in the area, which indicates that favorable conditions for their development have not existed in the recent geological past.

The area of the Jemez Mountains has a long history of volcanism and it is possible that volcanism has not ended. This volcanism has been characterized by alternating periods of dormancy and activity, some of which produced catastrophic eruptions.

Whether the present quiescent period is a dormant interval or marks the end of volcanism in the area is unknown. Smith¹⁰ has stated that when he began work in the area about 20 years ago there were active fumaroles within the Valles Caldera and boiling water issued from some of the thermal springs. The fumaroles have now ceased to play and the temperature of the springs is much lower. The failing of the springs might be due to lowering of ground temperatures, which would also account for the cessation of the fumaroles.

TABLE 3.1.6-2

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3.2 SITE

3.2.1 GENERAL

The TDF is located immediately west of the Industrial Liquid Waste Disposal Plant and shares Technical Area (TA) 50 with it. TA-50 is located on a mesa bounded on the north by Mortandad Canyon and on the south by a small canyon tributary to Mortandad that is sometimes referred to as Ten Site Canyon. The location of the facility within Los Alamos County and the Los Alamos Scientific Laboratory Technical Areas is shown in the previous section in Fig. 3.1.1-3. The site is shown in the aerial photographs, Fig. 3.2.1-1 and Fig. 3.2.1-2.

The site is at an elevation of approximately 7,200 ft. Access to the site is by Pajarito Road, one of the primary roads within the DOE-controlled land, and Pecos Drive (Fig. 3.2.1-3). The nearest residential section of Los Alamos, the trailer court, is about 4,000 ft to the northwest. The top soil of the mesa is sandy clay-like material that supports a sparse growth of native grasses. Scrub-oak, pine, and fir grow along the rims and walls of the canyons.

The geological formations are similar to those found elsewhere in the area. The geologic section of Mortandad and Ten-Site Canyon is shown in Fig. 3.2.1-4.

Mortandad Canyon heads on the Pajarito Plateau and is tributary to the Rio Grande. The stream in the upper reach of the canyon is perennial due to release of cooling water from TA-48 and the release of treated low-level effluent from the waste treatment plant at TA-50-1 East. The lower canyon streams are intermittent and flow to the Rio Grande some 5 mi below the TA-50 site only during major storms or heavy spring snow melt. Except during these infrequent periods, all natural runoff and industrial effluents have, since 1960 when hydrologic observations in the canyon began, infiltrated into the alluvium west of the Santa Fe-Los Alamos County line due to the small drainage area of the canyon and the large volume of the alluvium (Fig. 3.2.1-4). Perennial

FIG. 3.2.1-1

FIG. 3.2.1-2

LEGEND

1. OFFICE / INSTRUMENT CALIBRATION SHOP TRAILER
2. AUXILIARY GENERATOR
3. ARGON TUBE TRAILER
4. HEPA FILTER PLENUM
EXHAUST BLOWERS
STACK
5. COOLING TOWERS
6. COOLING TOWER SUMP

FIG. 3.2.1-3

TDF Site Plan

FIG. 3.2.1-4

flow and storm runoff recharge a body of water in the alluvium which is temporarily perched on the underlying tuff. As the water moves eastward, steady loss to evapotranspiration with minor infiltration losses into the tuff occur so that the water in the alluvium is of limited extent.

3.2.2 PROXIMITY TO OTHER FACILITIES AND OPERATIONS

The TDF is isolated from external hazards such as explosion, radiation, and fire associated with other facilities and operations, either private or DOE-controlled.

Three DOE-controlled facilities, TA-50 Building 1, TA-55 and TA-35 are in close proximity to the TDF site. Building 1 is the central liquid waste treatment plant and it occupies the east portion of TA-50. This plant processes relatively low-level radioactive wastes collected from other laboratory facilities, including the TDF. TA-55 is the LASL Plutonium Processing Facility and is located about 500 ft west of the TDF site. An inactive solid radioactive waste burial plot, Area "C," adjoins TA-50 to the south.

TA-35, the Laser Research Facility, lies to the east of the TDF, beyond Building 1, TA-50. The closest current activity at TA-35 is the construction project for the Laser Fusion Building. This area is some 600 ft from the TDF. It is not expected that this construction activity will interact with the operations at the TDF and construction schedules indicate the CAI program will be concluded prior to completion of the Laser Fusion Building.

3.2.2.1 EXPLOSION

As a plutonium handling facility, TA-55 was built to meet the minimum requirements for such facilities and developed by the DOE. It is constructed of reinforced concrete, and an explosion which would breach the integrity of the building and endanger the TDF is not considered to be a credible accident.

There is little chance of an explosion in the liquid treatment plant on the east half of TA-50. If an explosion should occur, it would be minor and unlikely to generate missiles. TA-35

is located to the east at a distance of 600 ft and is not likely to disrupt activities at the TDF. Private industry is located at a sufficient distance and is such that explosions need not be considered. DOE-controlled facilities at Los Alamos storing or working with explosives are located at a sufficient distance such that neither the force of an explosion nor explosion-generated missiles present a threat to the TDF.

3.2.2.2 RADIATION

The levels of radiation from radioactive materials handled at the liquid disposal facility are so low that this operation does not conceivably present a hazard to the TDF or interfere with its operation.

Calculations indicate that under upper accident conditions at TA-55, a maximum of 1.5 nCi of ^{239}Pu or 1.02 nCi of ^{238}Pu would be released. This is an order of magnitude less than the maximum permissible bone burden (Radiological Health Handbook, January 1970, Department of Health, Education and Welfare) and is not considered to be a hazard at the TDF.

3.2.2.3 AIRCRAFT CRASH

The distance from the site to the west end of the Los Alamos airport runway is 1.7 mi. A waiver of the 2-mile limit design requirement has been granted by the DOE for the Plutonium Facility at the adjacent TA-55 because the Laboratory area is listed as a Restricted Area on FAA charts, use of the air port is limited to pilots holding special permits, and traffic is only slightly more than the minimum for a limit requirement. Due to the low inventory limit of transuranics at the TDF, it is not required to meet the plutonium facility requirements outlined in DOEM Chapter 6301. For these reasons, an aircraft crash was not considered in the design.

3.2.2.4 FIRE

The construction of the building and the clearing of the site surrounding the building minimize the possibility of fire as an external hazard.

Fires affecting the facility might occur at the liquid waste treatment plant at TA-50, or at the canyon north of the site such as a forest fire. The facility is isolated from these fires by a clearing of 100 ft width or more. Response time by the firefighting equipment is approximately 3 1/2 min.

3.2.3 PROXIMITY OF SUPPORT FACILITIES

In selecting the TDF site, access to support facilities and services was considered and evaluated.

3.2.3.1 ELECTRIC POWER

Electric power is provided from a 13.2 kVA aerial transmission line extending along Pecos Drive adjacent to the site.

3.2.3.2 WATER

Domestic, industrial and fire-fighting water is drawn from a 12 in. cast iron water main extending along the north side of Pecos Drive. This main serves TA-50 and TA-35, and via an 8 in. branch line, TA-52 and TA-46.

The 12 in. main is supplied from two sources (Fig. 3.2.3-1). One source is a 100,000 gal air-gapped tank (ULR-8) at TA-3. The other source is a 500,000 gal air-gapped tank (ULR-497) near Pajarito Booster Station 3 in TA-0-497, south of Pajarito Road. A 12 in. cast iron water main extends from this tank along the south sides of Pajarito Road and Pecos Drive to TA-35. A 12 in. cross-connection loops the two Pecos Drive water mains at TA-35.

The two air-gapped water storage tanks are in turn supplied from a 1.5 million gallon terminal storage tank (Pajarito Tank Number 4) west of TA-3 via a 16 in. concrete pipe water main that extends around the west and south sides of TA-3 along the south side of Pajarito Road. Pajarito Tank 4 is recharged via Booster Station 3 from the Pajarito Well Field into the main aquifer. Pajarito Booster Station 3 also includes a one million gallon storage tank.

An additional supply source can be provided from the TA-3 water system via a manual valve crossconnection to the TA-48 12 in. main that also extends along the north side of Pajarito Road.

FIG. 3.2.3-1

FIRE AND INDUSTRIAL WATER SUPPLY SYSTEM

Further, manual valves crossconnect the Guaje Well Field water mains to recharge the Pajarito Number 4 and TA-3 tanks if required.

3.2.3.3 GAS

Natural gas for building heat, laboratory, and process line uses is supplied from a 3 in. 100 psig gas main on the north side of Pecos Drive. This supply line is a looped double supplied main serving several Laboratory sites.

3.2.3.4 FIRE STATION AND SERVICE

The Los Alamos Fire Department must be self-sufficient. The possibility of obtaining fire fighting or rescue assistance from nearby towns is very unlikely. In case of serious brush or forest fire, the U.S. Forest Service will assist if equipment and manpower are available.

The fire department, which is operated by the DOE at both Los Alamos and White Rock, has an authorized strength of 106 fire fighters. The department is supervised by one chief, three assistant chiefs, eight station chiefs, and sixteen crew chiefs. Each normal shift, which is set up with 24 hrs on, 24 hrs off, consists of 30-35 men. The remainder are on days off, vacation, training, etc.

The replacement values of the property protected are in excess of \$300,000,000 for DOE, LASL, and ZIA, and \$150,000,000 for residential and business areas. Although first priority is given to DOE facilities, protection and response must also be given to the other areas.

The fire stations are manned (as of January 1979) as follows:

- a. Number 1 (Main), three engine companies, one of which is equipped with a 75 ft elevating platform, one tanker, ambulance, station chief vehicle, and a rescue vehicle;
- b. Number 2 (DP Site), one engine company, a crash truck, a purple K (dry powder) unit, and a pick-up truck unit;

- c. Number 3 (White Rock), one engine company, a reserve engine, a tanker, an ambulance, and a pickup truck unit.
- d. Number 4 (Golf Course), two engine companies, a tanker, an ambulance, and a pickup truck unit, and
- e. Number 5 (S Site), an engine company, and two tankers.

Fire engines are all Class "A" pumpers rated at 1,000 gpm and 150 psig. Engines each carry two scaling ladders and one 35 ft extension ladder.

Each pumper carries 1,500 ft of 2 1/2 in. hose, 600 ft of 1 1/2 in. hose and 400 ft of 1 in. booster line, five self contained breathing apparatus, plus four salvage covers and a full array of nozzles, pipes, jacks, blocks, manila and nylon line, etc. The rescue rig and station chief's wagon carries additional self contained breathing apparatus, clothing, salvage covers, cutting torch, saw, smoke ejectors, etc. All response crews carry high range radiation detection instruments.

Test runs made from Station Number 1 to the TA-55 site just across Pecos Drive, a total of 2.0 mi, under ideal conditions of daylight, good clear weather, and essentially no traffic took 3 min and 20 s. Included in this time were 30 s for receipt of the alarm, transmission of the alarm to the companies and in manning the equipment. Snow, rain, bad road conditions, or traffic could easily add 50-100% to the response time.

In case of a fire at the TDF, the first alarm response from Station Number 1 would include two 1,000 gal/min pumpers (each with 500-gal booster tanks), a station chief's wagon, and a rescue vehicle. Personnel would include one station chief, two crew chiefs, two driver/operators, and two to three firefighters on each pumper. The station chief and fireman-aide would usually arrive just before the pumpers. Finally, two additional firefighters would man the rescue vehicle.

Another pumper from Station Number 4, would respond to the

second alarm and be manned by one crew chief, one driver/operator and two firefighters. It would arrive at TA-50 about 7 min after the initial alarm (as prime moveup located 3.0 mi and 4 min running time from Station Number 1).

A similar pumper from Station Number 5, with one crew chief, one driver, operator, and two firefighters is the second moveup to Station Number 1 and would respond to a third alarm within 8.5 min.

Therefore, at least 25 firefighters and six pieces of equipment would arrive well within ten minutes after a major alarm. While the fire attack would proceed under a station chief, the Senior Fire Officer could call for "off duty" personnel and for the trained auxiliary (about 25 men) to man the municipal stations.

Procedures at the TDF would be in the following sequence. The responding station chief and first-in company would evaluate the fire and initiate rescue efforts and fire fighting tactics as required. The first or second arriving company would connect to the appropriate sprinkler and standpipe systems fire department connections, then man hand lines and additional large supply lines.

The third responding company would lay large lines for possible need of heavy fire streams and then be assigned as needed. Subsequent companies ordered to the fire scene would be assigned rescue duties, fire fighting and salvage work.

As more personnel arrive, salvage activities would become increasingly important. Canvas salvage covers, squeegees, brooms, mops, submersible pumps, and similar gear would be put into use as needed. Since control of contamination, including radioactive particulates would be a prime concern, a minimum of water would be used and disruption to operating equipment and processes would be held to a minimum. To the fullest possible extent, building integrity would be maintained.

The ambulance response to TA-50 is first from Station Number 1, then Station Number 4 (Golf Course) and then Station Number 3 (White Rock). All ambulance crew members are qualified Emergency medical technicians and the hospital is equipped with victim decontamination and emergency treatment facilities which are manned by H-2 LASL Medical Group and H-1 Health Physics personnel. Ambulance transit time from TA-50 to the hospital is about four minutes.

3.2.3.5 OTHER SERVICES AND FACILITIES

Other services and facilities are provided either by new facilities constructed within the site or by other DOE facilities and services.

The sanitary waste generated at this site is discharged to a waste treatment facility, including a lagoon, which serves the facilities at Technical Areas 35, 48, and 55, as well as TA-50.

Radioactive liquid waste from the facility is sent by underground pipeline to the LASL liquid waste treatment facility which serves several technical areas. There is an addition of about 500 gal/day of operation of waste of similar composition to the approximately 50,000 gal/day received by the treatment facility from the other facilities.

All storm water runoff is channeled to the adjacent canyons in such a manner that erosion is negligible.

Solid wastes generated at the site are segregated into two categories, nonradioactive, and radioactive. The nonradioactive solid wastes from the office and laboratory activities in Zone 4 and other clean areas is collected and transported by Zia Company Supply and Transportation Division to the County Sanitary Landfill in accordance with current Laboratory policy.

Selected amounts of wastes generated by routine operations elsewhere in the LASL complex are sent to this facility for developmental processing. All solid wastes from the process area and from the Zone 3 laboratories and machine shop are collected separately. These wastes consist mostly of noncombustible

compacted or incinerated solid wastes, along with occasional wastes from repair or replacement of failed equipment. These wastes are transported to the existing LASL radioactive solid waste burial ground for disposal or storage.

In accordance with DOE requirements, solid wastes with significant contamination of transuranium nuclides are packaged and stored in a way that they can be retrieved in an intact, contamination-free condition for 20 years.

3.3 SAFETY ASSESSMENT OF SITE

3.3.1 GENERAL

The primary purpose of this facility is to permit development and testing of transuranic contaminated solid waste processing techniques in conjunction with the waste management program presently in progress at LASL.

There are various hazards associated with the use of plutonium contaminated materials, toxic chemicals, and high-energy value gases and solids. These, however, are hazards commonly experienced in such research activities and are properly minimized through the use of recognized safety precautions, operating procedures, and facility design.

No particular restrictions on the site external to the facility are foreseen as a result of the activities within the facility.

3.3.2 RADIATION EVALUATION

During the 25 years of operation of plutonium facilities throughout the country, the frequency and severity of accidents have been significantly lower than those in the related chemical industry. Only a few accidents involving radioactive material have occurred, and none resulted in damage offsite. The experience gained from those few accidents has resulted in improved engineering safety features and operating procedures, such that the probability is low for occurrence of accidents in the future.

Nevertheless, for the purpose of evaluating the TDF, TA-50 site and the protection inherent in the facility design, major

accidents which represent the upper limit accidents that could occur at the facility have been postulated. For each postulated accident, the worst consequence has been assumed. Assumptions and evaluations are discussed in the Safety Analysis Section on Upper Limit Accidents.

3.3.3 INVENTORY CONTROL

Administrative controls are utilized to limit the facility inventory to no more than 100 g of transuranics. The TDF processes contaminated waste materials generated as room trash in the LASL Plutonium Facility for the contaminated waste treatment phases of the development program. These wastes are contaminated to an average level of less than 100 nCi/g of material. The LASL Plutonium Facility products have compositions as listed:

TABLE 3.3.1

<u>Plutonium</u>	<u>Weapons Grade (Ave.)</u>	<u>Reactor Grade (Ave.)</u>
^{238}Pu	0.015%	0.06%
^{239}Pu	94.02%	86.20%
^{240}Pu	5.64%	11.82%
^{241}Pu	0.31%	1.70%
^{242}Pu	0.02%	0.21%

The inventory limit of 100 g of transuranics will include the above listed isotopes of plutonium plus the products of spontaneous fission and radioactive decay. A maximum inventory limit of 10 mCi of mixed fission products has been adopted to preclude unnecessary radiation exposure to the facility operating personnel and is considered to be in line with the contaminant levels expected in the 100 g of transuranics. Containers of these waste materials are assayed by the generating group prior to shipment to the TDF. They are assayed again in the Feed Preparation Line receiving slot boxes prior to introduction of the waste package into the air lock entrance to the sorting line glovebox. No criticality considerations are involved as the 100 g limit is considerably less than the minimum critical mass of ^{239}Pu , the major

constituent, as well as ^{241}Pu , the other fissionable constituent having a relative small minimum critical mass. Other transuranics, americium, berkelium, curium, neptunium, etc., are not fissile. Further, at a concentration level of 100 nCi/g of wastes, the geometry is less than ideal for criticality as the volume of wastes containing 100 g of transuranics at this level would be some 21,000 ft³. Even after processing at a volume reduction factor of 20, this quantity of material would occupy over 1,000 ft³ or some 150-55 gal DOT drums. Initially, each incineration run will be made individually, with recovery evaluations and cleanup made prior to the start of the next run. Inventory control and process efficiency determinations will thus be on a batch basis. As the program advances, additional accountability programs may be devised to allow for the extension of the runs.

3.3.4 RADIOACTIVE PLANT EMISSIONS

3.3.4.1 NORMAL OPERATION EMISSIONS

Three levels of confinement and/or containment for all in-process transuranic contaminated wastes are provided. These are the building, the Zone 2 partitions, and the process components themselves. These are designated as Zones 3, 2, and 1, respectively. All air transfer between zones is from the zone of least contamination probability to the zone of greater contamination probability, that is, from Zone 3 to Zone 2 to Zone 1. Exhaust air from all three zones is double HEPA filtered prior to being released through the facility stack. The stack is continuously sampled.

The initial controlled air incineration process offgases are fed to an air cleaning train consisting of a quench chamber, venturi scrubber, packed column scrubber, condensor, offgas heater and double HEPA filtration prior to insertion in the stack.

The fourth zone, Zone 4, consists of the second floor laboratory, office space, the building entry and stairway, and mechanical equipment room which are not used for process functions and

are ventilated independently of the first floor process areas.

The HEPA filters, which are fire-resistant, are designed to operate at temperatures up to 300° F. They remove 99.97% of 0.3 μ /mass median diameter (MMD) particles. The efficiency of the HEPA filters is higher than 99.97% for sizes larger and smaller than 0.3 μ .¹ The HEPA-type filters are designed to withstand a pressure loading of 10 in. water gauge across the entire face for short periods without permanent damage to the filters. These filters are capable of surviving short pulses at about 3 psi for 50 ms.^{2,3,4}

For cases of "normal" discharge from the plant, the effluents are well below the emission limits. Design matrix wastes containing transuranics at an activity concentration of 100 nCi/g burned at the rate of 100 lb/hr in the incinerator will produce 5.4 lbs. (2452 g) of ash containing 4540 μ Ci of transuranics. Incinerator manufacturers data and Environmental Protection Agency incinerator acceptance test data indicate a particulate loading of 0.1 grain/ft³ of offgas for the incinerator design proposed for the TDF. At the design offgas rate of 30900 ft³/hr, some 200 g of ash containing 2.0 μ Ci of transuranic would be carried over into the offgas clean up train. Calculations of venturi scrubber performance over the operating range of 15 to 80 in. of water P indicate an overall particulate removal efficiency from 88.59% to 98.79%.

Using a particulate removal efficiency of 96.13% for the venturi scrubber at 40 in. W. C. Δ P (normal operation is at 50 in. W.C. Δ P), and assuming no allowance for particulate removal in the quench chamber, liquid-gas separator, packed column scrubber, condenser or roughing filter, double HEPA filtration of the venturi scrubbed offgas would lead to a concentration in the facility stack plume of 3.14×10^{-18} μ Ci/m ℓ , which is well below the Manual Chapter 0524 limits of 6×10^{-14} μ Ci/m ℓ of air for soluble plutonium and a factor of six decades below the 10^{-12} μ Ci/m ℓ limit for insoluble plutonium. Considering the high

temperature oxidation process of incineration, it is not probable that the transuranics would exist in any form except oxides. Detailed calculations are presented in Section 4.3.3 of this study.

3.3.4.2 EMISSIONS UNDER UPPER ACCIDENT CONDITONS

The consequences of the maximum credible accident for the facility and the incineration process have been evaluated. The quantity of plutonium that would be released by an upper limit accident would produce a possible two hour exposure at the White Rock residential area as follows:

50 Year Dose Commitments

Lungs = 0.86×10^{-3} Rem

Bone = 1.97×10^{-3} Rem

This is the worst case situation for public exposure outside the DOE controlled area of the Laboratory, and is well below the 10 CFR 100 limits as adjusted for plutonium. This level of exposure, thus, would not create a significant hazard to the public. Detailed calculations are presented in other sections of this study.

TABLE 3.3.4-1

REFERENCES:

1. Final Safety Analysis Report, Plutonium Processing Facility, LASL Group CMB-11, March 5, 1978.
2. Memo, Robert V. Fultyn to Harry S. Jordan, "Considerations of Effects of Tornado Induced Pressure Transients on HEPA filters in the TA-55 Facility." Los Alamos Scientific Laboratory, H8-M 2736.
3. C. E. Billings, R. Dennis and L. Silverman, "Blast Damage to Air Cleaning Devices (Filter Test)," Harvard University Air Cleaning Laboratory Report NYO-1595 (November 28, 1955).
4. R. Dennis and C. E. Billings, "Blast Effects on an Air Cleaning System," Operator. Plumbob Report ITR-1475 (November 15, 1957).

4. DESCRIPTION OF THE FACILITY

4.1 General

4.1.1 First Floor

4.1.2 Second Floor

4.1.3 Warehouse/Staging Area Building

4.2 Structural Design

4.2.1 Materials

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4.2.1.4 Upper Floor and Roof

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4.2.1.6 Concrete

4.2.2 Windstorm and Natural Phenomena Resistance

4.2.2.1 Wind Loads

4.2.2.2 Earthquake

4.2.2.3 Tornado

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4.2.4 Explosion Considerations

4.3 Ventilation Systems

4.3.1 Ventilation Zones

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4.3.1.2 Zone 2

4.3.1.3 Zone 3

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4.3.2 Air Cleaning Streams

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4.3.2.1.1 Process Gloveboxes

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 - 4.4.1.1 Head End
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 - 4.5.4.2 Instrument Air
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 - 4.5.6 Emergency Lighting
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- 4.6 Radiation Protection and Plant Instrumentation
 - 4.6.1 Continuous Air Monitors (alpha)

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- 4.6.6 Personnel Safety Equipment
- 4.7 Effluent Control and Monitoring
 - 4.7.1 Contaminants in Effluents
 - 4.7.1.1 Combustion Products
 - 4.7.1.2 Other Air Contaminants
 - 4.7.2 Liquid Effluents
 - 4.7.3 Gaseous Industrial Effluents
 - 4.7.4 Sanitary Sewer
 - 4.7.5 Natural Run-Off

4. DESCRIPTION OF THE FACILITY

4.1 GENERAL

The TDF (WM-37) is precast reinforced concrete construction utilizing interior insulated, prestressed, pretensioned concrete double "T" sections. All walls are load bearing, supported on reinforced concrete beams on grade. Process area partitions in the feed preparation and process bays are removable and designed to be compatible with the various process requirements. Movable partitions or room dividers are utilized in the office area. Reinforced concrete slabs are utilized for the ground level floors. Total gross area of the facility is approximately 11,000 ft² and the volume is approximately 160,000 ft³ (Fig. 4.1-1).

The Warehouse Staging Area (WM-54) is a 40 by 64 ft single story building of the same type construction as the TDF. This building provides the storage, shop, and assembly space to support the R&D efforts in the TDF. The 2560 ft² floor area is serviced by a five ton overhead bridge crane having a clear hook height of 12 ft.

4.1.1 FIRST FLOOR

The first floor of the TDF houses all process testing activities and all other activities in which transuranics are handled. It consists of a process and air cleaning bay; a shipping and receiving area; an equipment egress area; a hot-wet chemistry laboratory; a counting and instrumental analysis laboratory; a process control room, shop, and men's and women's change rooms. Also located on the first floor is the mechanical equipment room which houses the building ventilation and heating systems, electrical motor control centers, air compressors, and other mechanical equipment. The mechanical equipment room is isolated, except for ducting, conduit, and piping, from the rest of the first floor. The floor plan is shown in Fig. 4.1.1-1.

The process and air cleaning bay is a 40 by 46 ft high-bay area with a 25-ft clear ceiling height. It houses the incinerator and ash removal vacuum system and the air cleaning train, as

TREATMENT DEVELOPMENT FACILITY

Fig. 4.1-1

FIRST FLOOR

Fig. 4.1.1-1

well as the instrumentation and control systems required to operate and study the process. A portion of this bay may be used for ash fixation studies or other activities requiring high-bay space.

The low bay area is an open 40 by 39 ft area that houses the shipping, receiving and feed preparation functions. Modular, removable partitions separate the shipping-receiving area and the equipment egress area from the Zone 2 process area and forms the Zone 2 ventilation barrier. Storage of incoming wastes will be on the covered concrete apron outside this room and accessible by forklift.

The two laboratories provide general analytical support for the entire process area. They are equipped so as to provide for wet chemical and instrumental analyses and radioactivity counting to provide the information on residue and effluent materials required to evaluate the processes tested in the TDF.

The shop is intended for modifications and maintenance and repair of lightly contaminated equipment. The change rooms provide for sanitary facilities and space for process area workers to change from street to work clothes and vice versa.

4.1.2 SECOND FLOOR

The second floor of the TDF (Fig. 4.1.2-1) houses all administrative functions and research and development laboratories in which process quantities or concentrations of transuranics are not involved. Note, however, that this does not preclude low-level counting or the utilization of radioactive tracer techniques. For the purposes of this document and the operating procedures implemented for the TDF, low level radioactivity is defined to be equal or less than the maximum permissible concentrations specified in Manual Chapter 0524. For solids, the MPC/g of material for each isotope shall be the same as is listed per milliliter of water in Manual Chapter 0524.

The process engineering laboratory is intended for bench-scale development of techniques which could eventually become candidates for production-scale testing in the process and air

SECOND FLOOR

Fig. 4.1.2-1

cleaning bay. It may also be used for other treatment studies such as ash fixation. A window and conduits in this room provides visual and electrical contact with the process and air cleaning bay.

The waste storage technology laboratory provides space for research and development activities to improve interim storage and ultimate disposal technology. Container development and ash fixation are primary candidates for study here.

The wet chemistry and electronics and instrumentation laboratories to some extent duplicate the functions of the two first floor laboratories, but only for nonradioactive, low-level materials or the utilization of tracer techniques. This duplication is necessary for contamination control which requires minimal interplay between the process area on the first floor and the cold area on the second floor.

The single large office bay area is partitioned into offices and a library and conference area for the operational and research staff of the TDF utilizing movable room dividers.

4.1.3 WAREHOUSE/STAGING AREA BUILDING

The Warehouse/Staging Area (WM-54) houses the nonradioactive machine and fabrication shop and provides an assembly area in which to construct process and test equipment prior to installation in the process laboratory area. This building also provides a storage area for nonradioactive equipment. This building contains a 5-ton overhead bridge crane that services the work areas. As there are no radioactive materials permitted in this building, the heating-ventilation system is of a standard industrial type.

4.2 STRUCTURAL DESIGN

4.2.1 MATERIALS

All structural materials used were as approved in the applicable Codes and Standards.

4.2.1.1 EXTERIOR WALLS

The exterior walls are load bearing and are interior insulated, prestressed, pretensioned concrete double "T" sections.

4.2.1.2 INTERIOR WALLS

The interior load bearing walls are of concrete block construction. Non-load bearing walls are of metal stud and gypsum board construction.

4.2.1.3 LOWER FLOOR

The concrete slab lower floor is reinforced using deformed steel bars.

4.2.1.4 UPPER FLOOR AND ROOF

The upper floor and roof consists of interior insulated prestressed, pretensioned concrete "T" sections.

4.2.1.5 CEILINGS

The process bay area ceiling is suspended below the roof "T" sections and is of gypsum board construction. Ceilings in the change rooms and first floor labs, and control room are of suspended gypsum board construction and ducting conduits, pipes and low maintenance mechanical equipment items are installed in the crawl space thus created. These ceilings are sealed to provide ventilation zones 2 and 3 air confinement.

4.2.1.6 CONCRETE

All poured structural concrete was tested to insure that it developed a minimum 28 day compressive strength of 4000 psi, and included an air entraining agent.

4.2.2 WIND, STORM, AND NATURAL PHENOMENAL RESISTANCE

Building design loads used were in accordance with American National Standards Institute (ANSI) A58.1; 1972, and the Uniform Building Code as follows:

4.2.2.1 WIND LOADS

Wind loads were computed using ANSI A58.1 based upon a maximum wind of 100 mph with a 100 year Mean Recurrence Interval, Exposure B.

4.2.2.2 EARTHQUAKE

Earthquake loads were determined, using Zone 2, as shown on Fig. 1, page 131, Part VI, Section 2314 Earthquake Regulation, Uniform Building Code, 1973.

4.2.2.3 TORNADO

No tornado loads were considered.

4.2.2.4 SNOW LOADS

Roof loads were determined as dead load with an additional snow load of 30 psf added.

4.2.2.5 LIVE AND DEAD LOADS

Minimum design live and dead loads were determined from ANSI A58.1, 1972.

4.2.3 FIRE PROTECTION

The facility is designed for one hour Fire Code resistance and is equipped with firefighting systems to prevent, suppress, or contain a fire in compliance with appropriate requirements of the National Fire Protection Association and the DOE's level of "Improved Risk." The minimum protection provided for any area in the facility is an ordinary hazard wet pipe automatic sprinkler system. The overall firefighting system design meets or exceeds DOE M 0552 to meet minimum requirements for "Improved Risk" level of protection.

4.2.4 EXPLOSION CONSIDERATIONS

The currently projected activities within the facility and the safety assessment of the incineration process do not require special considerations for explosions in the design of the facility. The consequences of the maximum credible accident, and explosion in the building due to natural gas leakage, are increased above those of a standard industrial facility only by the amount of plutonium that could be released. Due to the 100 nCi/g average activity level limit of waste material and the operating procedures limit of 2400 lb of unburned wastes in the process area, the

quantity of plutonium available for release by maximum credible accident will not create a significant hazard to the public. The air concentration at the White Rock residential district, the highest potential exposure location outside the DOE controlled Laboratory area would result in inhalation dose to the lungs and deposition to the bone far below the 10 CFR 100 limits as adjusted for plutonium.

4.3 VENTILATION SYSTEM

Three levels of containment with appropriate ventilation are provided in the first floor process areas of the TDF to minimize the possibility of spread of transuranic contaminants; a standard recirculatory industrial-type ventilation system serves the upstairs non-process areas.

4.3.1 VENTILATION ZONES

The ventilation system consists of four zones separated from each other by physical barriers and/or pressure gradients (Fig. 4.3.1-1).

The first floor process area ventilation supply and exhaust systems are shown schematically in Fig. 4.3.1-2. Air flows are based on which ever of the following requirements are applicable for a given area:

- a. Eight air changes per hour in all work areas
- b. Occupancy and equipment heat load
- c. Air flow past the incinerator sufficient to maintain the surface temperature below specified limits
- d. Hood face velocities

4.3.1.1 ZONE 1

Zone 1 is defined as the process line equipment, including the feed preparation line gloveboxes, incinerator, and offgas treatment train. These Zone 1 areas are held negative with respect to their surrounding Zone 2 area. The feed preparation line gloveboxes are held at -0.5 in. of water with respect to the surrounding Zone 2 area. Air is drawn into the gloveboxes through

PROCESS AREA FLOOR PLAN
TREATMENT DEVELOPMENT FACILITY

Fig. 4.3.1-1

TDF PROCESS AREA VENTILATION SYSTEM

Fig. 4.3.1-2

single HEPA filters from the surrounding Zone 2 area. This air is removed from the gloveboxes through single HEPA filters (Fig. 4.3.1-3), thence to a double HEPA filter system and then it is drawn out of the building through a separate duct to the inlet of the main exhaust blower to be exhausted through the facility stack. The HEPA filter unit shown in Fig. 4.3.1-4 is a standard bagout filter plenum containing 24 by 24 in. roughing and double in-line HEPA filters.

The side ram feeder and the main ram feeder enclosures form an air lock between the feed preparation glovebox line and the incinerator. Air is exhausted from these enclosures into the incinerator. Air pressures range from -0.7 to -2.0 in. with respect to the Zone 2 area during ram feed operations.

The incinerator ash door gloveboxes and the vacuum ash removal glovebox are supplied with air and exhausted in the same manner as the feed preparation line gloveboxes and also range from -0.7 to -0.9 differential pressure with respect to Zone 2.

Combustion air is supplied to the incinerator through the combustion air glovebox. Inlet air to this glovebox is supplied from Zone 2 through a 24 x 24 in. single stage HEPA filter. Air is continuously swept through the combustion air glovebox and exhausted through a 24 x 24 in. HEPA filter to the glovebox exhaust filter plenum where it is double HEPA filtered prior to injection to the facility exhaust blower to be released from the stack. The continuous air sweep provides assurance that any gas leak inside the combustion air glovebox from the gas burner supply lines will be swept from the glovebox precluding a buildup of fuel gas. The air inlet and outlet filters prevent contamination of the Zone 2 area in the event of a blow-back from the incinerator interior.

The offgas treatment train and incinerator are held negative to the surrounding Zone 2 area by means of the process high head exhaust blowers.

The offgas treatment train components are each, in series, held at increasingly greater negative pressures from -5 in. of

Glove Box Filter Installation

Fig. 4.3.1-3

GLOVEBOX HEPA FILTER PLENUM

Fig. 4.3.1-4

water at the quench chamber up to a possible -110 in. of water at the inlet to the high head blowers. The venturi scrubber sustains the greatest pressure drop. Air from Zone 2 is introduced into the offgas treatment train via a HEPA filter at the quench chamber to compensate for the varying volume of air required as the variable throat in the venturi scrubber is changed. This air also attenuates pressure changes introduced from the incinerator, either from intentional process parameter changes or the pressure/flow perturbations inherent in incineration processes.

All offgases from the treatment train are filtered through a double HEPA filtration unit. This unit is a standard bagout plenum containing a stainless steel screen, prefilters and two stages of HEPA filters. Each stage contains two filters side-by-side giving a 24 by 48 in. filter bank at each stage.

Due to the high vacuum at this location in the offgas stream (-110 in. W.C. possible), this plenum is contained within an outer reinforced vacuum vessel (Fig. 4.3.1-5). The pressure equalization annuli are connected and vented through an 8 in. round push-through HEPA filter to the connecting duct (Fig. 4.3.1-6). Thus, the bagout plenum is not subjected to the high negative pressure between the Zone 2 area and the offgas cleanup line. Therefore, this high negative pressure will affect neither the structural integrity nor the efficiency of the HEPA filters, as the pressure drop across a filter unit will not exceed 3 in. of water. Each filter stage P is monitored and individually annunciated with both visual and audible alarms. Each filter stage can be individually DOP tested in situ.

Induced draft is provided the incinerator and the offgas treatment train by redundant high head blowers. These blowers are interlocked so that failure of the designed blower will automatically start the standby blower. In the event both blowers fail, an automatic crossover routes the process offgases to the main building HEPA filter plenum so that the main exhaust blowers will maintain a negative head on the process. The crossover enters the

PROCESS HEPA FILTER PLENUM

Fig. 4-31-5

PROCESS HEPA FILTER PLENUM
PRESSURE EQUALIZATION SYSTEM

Fig. 4.3.1-6

main plenum just upstream from the second bank of HEPA filters providing an additional filtration stage in the event of a penetration of a process HEPA filter.

4.3.1.2 ZONE 2

Zone 2 is separated by physical barriers (Fig. 4.3.1-1) from the Zone 3 areas and is held negative at -0.2 in. of water pressure with respect to the Zone 3, and -0.3 in. of water with respect to atmospheric pressure. Make-up air is supplied to Zone 3 via the supply ducts and is transferred to the Zone 2 areas through single stage HEPA filters, thus precluding backflow of contamination into Zone 3 if Zone 2 were overpressured. The receiving line slot boxes are also designated as Zone 2 and are essentially at the same negative pressure as Zone 2. However, to preclude possible spread of contamination during the surveying and opening of the drums, 320 ft³/min of air is swept into the slot box, through the annular ring between the drum and the slot box receiving port, and through the hand slots. This air is single HEPA filtered at the slot box prior to insertion into the Zone 2 exhaust plenum. Similarly, 320 ft³/min of air is swept into the package assay slot box and HEPA filtered prior to introduction into the Zone 2 plenum. It is to be noted that the packages containing radioactive wastes are not opened in these slot boxes, and that waste packages and both the outer drums and inner sealed containers when used are surveyed (by both swipe and direct instrument reading) by the generating group prior to shipment, and by the TDF operating personnel as the packages are introduced or the drums opened. Provisions are made (Ref. Section 5) for rebagging a breached or contaminated package and bagging or decontaminating a drum whose inner surfaces are contaminated. Standard Health Physics procedures for monitoring the packages and drums prior to loading on the truck or other conveyance at the point of origin and also at the TDF receiving dock when unloaded are followed to assure contamination free exterior surfaces.

4.3.1.3 ZONE 3

Zone 3 is defined as the process area entrances and consists of the change rooms, counting room, hall, control room, and the shipping and receiving area and the equipment egress air lock. These areas are held negative at -0.1 in. W.C. with respect to the second floor non-process area, the first floor stairwell and entry, the mechanical equipment room, and the outside atmosphere. Outside air is drawn through filters and heaters, distributed throughout the process area. Air supplied to Zone 2 is single HEPA filtered. Air supplied to Zone 3 is HEPA filtered prior to transfer to Zone 2. All process area air is double HEPA filtered before being expelled through the building stack. The first floor process area ventilation system, including support areas, is diagrammatically shown in Fig. 4.3.1-2. Although not shown in the diagram, there are redundant high head process exhaust fans. A low flow or high bearing temperature alarm on the operating blower will automatically shut it down and start the other unit. Also, a 10,000 CFM exhaust blower is installed as an auxiliary to the 12,000 CFM main exhaust blower. The valves and motors of the exhaust blowers are remotely operated from a process area control panel.

4.3.1.4 ZONE 4

The second floor, stairwell and entry area, and the mechanical equipment room are designated as Zone 4 and their ventilation systems are separate and independent, including the outside air intake louvers, of the first floor process area ventilation system.

The second floor heating and ventilation system is a standard industrial partial air recirculating system (Fig. 4.3.1-7). Recirculating hot water is utilized to heat the air. This zone is held slightly positive with respect to the atmosphere with make-up air being drawn through filters and heaters and distributed throughout the area. The second floor is exhausted, unfiltered, through the hood exhausts, the restroom exhaust fans, and by

SECOND FLOOR
ZONE 4 VENTILATION SYSTEM

HEATING AND VENTILATION SUPPLY AIR
RE-CIRCULATING AIR RETURN
EXHAUST AIR FROM FUME HOODS, ETC.

Fig. 4.3.1-7

leakage through the windows and doors as these are opened and closed during normal usage. The differential pressure assures that the air flows from the stairwell, Zone 4, into the change rooms, Zone 3.

The mechanical equipment room air supply is drawn through an independent louver. This air is used to provide combustion air to the boilers and water heaters and cooling air to motors, etc. Room air is exhausted unfiltered via a thermostat controlled blower and louver.

4.3.2 AIR CLEANING STREAMS

All air exhausted from the process area is cleaned and exhausted through the stack about 12 ft above the facility. The stack exhaust is continuously sampled for radioactivity. The process offgases are periodically monitored or sampled as required to adequately monitor the process operation and other air contaminants.

4.3.2.1 ZONE 1

The Zone 1 air cleaning system is divided into two sections to facilitate glovebox ventilation, combustion air feeding to the incinerator, and proper zone air pressure differential control.

4.3.2.1.1 PROCESS GLOVEBOXES

All process gloveboxes receive air from the surrounding Zone 2 area with the air entering the gloveboxes through HEPA filters. These filters also act to prevent contamination of the Zone 2 area in the event some incident pressurizes a glovebox with respect to Zone 2. There is an air lock between the slot boxes and the gloveboxes. Air out of the Feed Preparation line is HEPA filtered locally and exhausted through a 10 in. diameter duct to a double HEPA filter system located locally in the Zone 2 area. Air from this filter system is transferred through an independent duct to the main blowers to be exhausted through the stack.

4.3.2.1.2 OFFGAS CLEANING TRAIN

Exhaust from the CAI upper chamber contains both particulates and mineral acids which result from combustion of rubber and

plastics present in the waste feed. Removal of these chemical pollutants and potentially radioactive particles is accomplished by the offgas cleaning system, which consists of a quench column, a venturi scrubber, a packed-column scrubber, a condenser, a mist eliminator, a reheater, HEPA filters, and an induced-draft blower.

The quench column is divided into an upper contacting section and a lower separating section. Combustion gases are cooled from the incinerator exit temperature to approximately 75° C (167° F) by evaporation of recycled scrub solution. Excess solution collects in the separator while the saturated gas phase is routed to the inlet of the venturi scrubber.

The variable-throat venturi scrubber, located between the quench column and the packed column, removes up to 99 wt % (Ref. Section 4.3.3) of the offgas particulate. The venturi assembly consists of converging and diverging cones with a clamp valve throat to allow the pressure drop to be varied. Scrub solution is injected through a nozzle located upstream of the throat. Mineral acids are removed from the gas phase by counter-current contact with process condensate, recycled scrub solution, or fresh water in the packed-column scrubber.

The condenser, mist eliminator, and reheater are included to condition the process exhaust gases before final HEPA filtration. The condenser lowers the offgas temperature, removing the bulk of the water vapor from the scrubbed gas stream. The offgas is then reheated to approximately 12° C above the saturation temperature to avoid condensation and attendant corrosion on the HEPA filters, exit ducting, and offgas blowers. The functional parts of each of these subsystem components are commercial equipment which are housed in enclosures specially designed to withstand the -110 in. W.C. maximum vacuum of this process.

Redundant HEPA filtration is provided for final removal of particulates. The filter module houses two frames in series; the first consisting of a prefilter and two HEPA filters, the second being similar but without the prefilter. The filter housing is

designed to withstand the -110 in. W.C. vacuum of the process and is fitted with hatches to access the bagout doors and in-place filter testing ports.

The turbine blower provides the induced draft for the incinerator and the offgas treatment train and transports the cleaned gases into the facility stack to be released.

During nonoperating periods, ventilation is maintained at a reduced flow rate through the incinerator and offgas cleaning train through an economizer valve system and the main ventilation blowers. This flow path is also available in the event of loss of both high head blowers during operation. Loss of the high head blowers automatically shuts down the incinerator and sets up the flow through the economizer valve. Except for the loss in efficiency of the venturi scrubber at the reduced pressure differential and the resultant increased loading of the filters, this mode of operation provides adequate offgas cleanup and ventilation to provide safe shut down of the process.

4.3.2.2 ZONE 2

Zone 2 includes the high and low bay areas around the process enclosures, the contaminated equipment maintenance shop and the chemistry laboratory. These areas share the main ventilating system with the Zone 3 areas. Air from the maintenance shop and chemistry laboratory are exhausted through their respective fume hoods into the main exhaust plenum.

4.3.2.3 ZONE 3

The Zone 3 areas include the process bay equipment egress area, shipping and receiving area, control room, hallway, counting laboratory, and change rooms. Due to the heat load in the counting lab and the low occupancy level of the shop area, these rooms are ventilated in series through a single HEPA filter to provide a high air change rate in an economical manner. This is advantageous in the shop area also, as it provides for rapid removal of fumes from the machines and welding operations.

Air from the Zone 2 and 3 areas is double HEPA filtered prior to being exhausted through the facility stack.

4.3.3 RADIOACTIVE PLANT EMISSIONS UNDER NORMAL OPERATIONS

Radioactive emissions from the Zones 2 and 3 filter systems will be a small fraction of that from the incineration offgas cleanup train filters (Zone 1). This is due to the relatively smaller quantities of airborne contaminants along with the generally larger particle sizes associated with the sorting and feed preparation operations and other facility activities.

The incineration of 100 lbs of design matrix wastes per hour at a level of 100 nCi/g will contain 4540 μ Ci of transuranics. Incinerator manufacturers data and the Environmental Protection Agency incinerator acceptance test data indicate an offgas particulate loading of 0.1 grain/ft³ for the incinerator design installed in the TDF. At the design offgas rate of 30900 ft³/h, some 200 g of ash containing 20 μ Ci of transuranics would be carried over into the offgas treatment train.

Particle removal efficiency is a strong function of particle size distribution and density which will be determined during the development test programs. The design particle size distribution is based on the average of data received from Dow Chemical Company, (Rocky Flats)¹ and data from the Environmental Protection Agency incinerator acceptance test data for the type incinerator proposed for the TDF. Cellulosics waste feed for this second set of data was from cigarette filters.

¹Conceptual Design Report for the Transuranic Contaminated Solid Waste Treatment Development Facility, TA-50, Los Alamos Scientific Laboratory, ENG-9 RP-54, September 4, 1973.

Design Particle Size Distribution

<u>Size</u>	<u>Weight Percent</u>
> 10 μ	10
5 - 10 μ	20
2 - 5 μ	40
1 - 2 μ	20
0.5 - 1 μ	10

The variable throat venturi scrubber particle removal efficiency was calculated for each of the above listed fractions at each of three pressure drop settings of the venturi:

$$\eta = 1 - \exp \frac{-6.1 \times 10^{-9} (P_l) (d_{pa})^2 (\Delta P) (f)^2}{\mu_g} \quad 1$$

ΔP = Pressure loss (cm H₂O)

η = Particle removal efficiency, dimensionless

P_l = Liquid density, g/cm³

d_{pa} = Aerodynamic particle diameter, μ g/cc

μ_g = Gas viscosity, poise

f = Relative liquid/gas velocities (0.20 to 0.25 for air/
water)

¹ After Calvert, Lundgren and Month, Transactions APCA, 1970.

Size	Inlet	<u>15 ΔP</u>		<u>40" ΔP</u>		<u>80" ΔP</u>	
		Eff.	Outlet	Eff.	Outlet	Eff.	Outlet
>10μ	17.46	99.99	--	99.99	--	99.99	--
5-10μ	34.93	99.99	--	99.99	--	99.99	--
2-5 μ	69.86	99.97	0.019	99.99	--	99.99	--
1-2 μ	34.93	76.60	8.17	97.90	0.73	99.957	0.015
0.5-1 μ	<u>17.46</u>	32.87	<u>11.72</u>	65.45	<u>6.03</u>	88.06	<u>2.084</u>
Totals	174.60		19.91		6.76		2.099
Overall Efficiency		88.59		96.13%		98.79%	

Using the middle value of 96.13% particulate removal efficiency for the venturi scrubber (normal operating pressure drop is 50"), and assuming no allowance for particulate removal in the quench chamber, liquid-gas separator, packed column scrubber, demister or ash or roughing filters, 7.74 g of ash containing 0.77 μCi of transuranics is expected to impinge on the HEPA filters. Each of the HEPA filters is 99.97% efficient for the removal of 0.3 micron/mass median diameter (MMD) particles.¹ The efficiency increases both above and below this particle size. The stack flow rate is 746,950 SCFH or $2.12 \times 10^4 \text{ m}^3/\text{hr}$ yielding a plutonium concentration in the effluent of $3.14 \times 10^{-18} \text{ μCi/ml}$, well below the DOE 0524 limit of $6 \times 10^{-14} \text{ μCi/ml}$ for soluble plutonium. Additionally, plutonium incinerated at 2300° F is most probably in the oxide form and insoluble except in acid digestion. Therefore, the DOE 0524 limit of 10^{-12} μCi/ml is considered to be the applicable standard.

¹ Preliminary Safety Analysis Report, Plutonium Processing Facility, Los Alamos Scientific Laboratory, Group CMB-11, June 15, 1972, with revisions through October 30, 1972.

4.4 PROCESS

The TDF, constructed for production scale testing of waste treatment processes such as volume reduction, chemical and physical stabilization and packaging, currently houses the controlled-air incineration process shown diagrammatically in Fig. 4.4-1 and schematically in Fig. 4.4-2. Additional processes may be added later.

4.4.1 CONTROLLED AIR INCINERATION

The controlled-air incinerator (CAI) process is an assembly of largely commercially available equipment which has been modified and otherwise incorporated into a continuous train for the purpose of incinerating low-level TRU solid wastes. The subsystems, by process function, are: a feed preparation and introduction train, an incinerator, an offgas cleanup system, and a scrub solution recycling system. A brief description of the selected equipment and the overall processing sequence is provided in the following paragraphs. A more detailed description of the operation of individual components is contained in Section 5.

4.4.1.1 HEAD END

The process head end area of the facility includes a loading and storage dock area, a 40 by 39 ft bay with a 14 ft ceiling housing the receiving area and feed preparation glovebox line (Fig. 4.4.1-1). Space for shipping and receiving activities and fork lift access from the storage dock to the feed preparation area is provided.

Wastes are packaged at their source in sealed plastic bags and contained in 1-ft x 1-ft x 2-ft sealed cardboard boxes. Waste contaminated to levels less than 100 nCi/g are transported and stored at the TDF area in Dempster Dumpsters modified for radioactive service. Wastes contaminated to more than 100 nCi/g are shipped to the TDF in DOT-approved drums. The drums are unloaded in the receiving slotbox of the CAI feed preparation line and the packages are assayed for TRU content. Packages containing wastes at less than 100 nCi/g are removed from the storage dumpster,

CONTROLLED AIR INCINERATION
PROCESS FLOW DIAGRAM

Fig. 4.4-1

TDF FIRST FLOOR AND CAI PROCESS
DEMONSTRATION EQUIPMENT LAYOUT

Fig. 4.4-2

FEED PREPARATION LINE SCHEMATIC

Fig. 4.4.1-1

placed on pallets, and transported to the receiving area by forklift. These packages are surveyed and introduced into the receiving slotbox for assay. Assay is performed using a MEGAS (Multiple Energy Gamma Assay System), a nondestructive assay system developed by LASL to determine TRU content near the 10 nCi/g level. The boxes are passed through an x-ray assembly, similar to airport security equipment, which scans for materials incompatible with the combustion process such as large noncombustible items and bottles of liquid. If necessary, the packages are opened in the sorting glovebox and these items are removed.

For development purposes, the sorting glovebox includes a bucket crusher for reducing the volume of noncombustibles prior to packaging for storage at a TRU repository. A low-speed shredder and a kitchen-type compactor are included for determining the efficiency of increasing the surface area of high-density or closely packed combustibles. Following inspection and possible sorting, the waste packages are next transported to the storage glovebox where enough waste is accumulated for about eight hours of incinerator operation. During operation, waste packages are manually transferred from the storage box to the side ram feeder, which in turn loads the main ram feeder in preparation for waste introduction into the incinerator.

4.4.1.2 INCINERATOR

The incinerator, a conventional dual-chamber design, is located in a 40 by 46 ft bay with a 25 ft clear ceiling height. Similar models are frequently used for disposal of municipal and industrial solid wastes. Both chambers are refractory lined and natural gas is used for waste ignition and to supply supplemental heat. Wastes are charged batchwise via the main ram feeder to the lower chamber where underfire air is used to support combustion at near-stoichiometric conditions (Fig. 4.4.1-2). Unburned volatile components and entrained particles exit the lower chamber through an interconnecting port where excess air and supplemental heat are introduced to promote complete combustion. The secondary, or

INCINERATOR RAM FEEDERS

Fig. 4.4.1-2

upper, chamber provides the needed residence time for completion of combustion reactions. Normal operating temperatures are 1400° F to 1600° F in the lower chamber and 1600° F to 2000° F in the upper chamber. Air introduction rates and nominal chamber temperatures are varied depending on the waste composition.

The incinerator is located in the Zone 2 area which is supplied with sufficient air to insure adequate process, feed air and cooling to control the surface temperature of the incinerator. The ventilation system and zone barriers limit the spread of contamination.

4.4.1.3 OFFGAS TREATMENT

Exhaust from the CAI upper chamber contains both particulates and mineral acids which result from combustion of rubber and plastics present in the waste feed. Removal of these chemical pollutants and potentially radioactive particles is accomplished by the offgas cleaning system which consists of a quench column, a venturi scrubber, a packed-column scrubber, a condenser, a mist eliminator, a reheater, HEPA filters, and an induced-draft blower (Fig. 4.4-2). The components of the offgas cleaning system are shown diagrammatically in Fig. 4.4.1-3 and schematically in Fig. 4.4.1-4.

The quench column is divided into an upper contacting section and a lower separating section. Combustion gases are cooled from the incinerator exit temperature to approximately 75° C (167° F) by evaporation of recycled scrub solution. Excess solution collects in the separator while the saturated gas phase is routed to the inlet of the venturi scrubber.

The variable-throat venturi scrubber, located between the quench column and the packed column, removes up to 98 wt% of the offgas particulate. The venturi assembly consists of converging and diverging cones with a clamp valve throat to allow the pressure drop to be varied. Scrub solution is injected through a nozzle located upstream of the throat. Mineral acids are removed from the gas phase by counter-current contact with process

INCINERATOR OFFGAS TREATMENT EQUIPMENT

Fig. 4.4.1-3

CONTROLLED AIR INCINERATION PROCESS

condensate, recycled scrub solution, or fresh water in the packed-column scrubber.

The condenser, mist eliminator, and reheater are included to condition the process exhaust gases before final HEPA filtration. The condenser lowers the offgas temperature, removing the bulk of the water vapor from the scrubbed gas stream. The offgas is then reheated to approximately 12° C (21° F) above the saturation temperature to avoid condensation and attendant corrosion of the HEPA filters, exit ducting, and offgas blowers. The functional parts of each of these subsystem components are commercial equipment which are housed in enclosures specially designed to withstand the -110 in. W.C. maximum vacuum of this process.

Redundant HEPA filtration is provided for final removal of particulates. The filter module houses two frames in series; the first consisting of a prefilter and two HEPA filters, the second being similar but without the prefilter. The filter housing is designed to withstand the -110 in. W.C. vacuum of the process and is fitted with hatches to access the bag-out doors and in-place filter testing ports.

The induced-draft blower produces 290 in. W.C. static pressure at 53.8 m³/min (1900 CFM) with a discharge pressure of 400 in. W.C. (to accomodate the 7300 ft elevation at LASL).

4.4.1.4 SCRUB SOLUTION RECYCLING

A scrub solution recycle system is used to minimize liquid blowdown (waste to final treatment) from the offgas cleaning system (Fig. 4.4.1-2). This system consists of full-flow cartridge liquid filters, a graphite tube primary heat exchanger, a stainless steel plate secondary heat exchanger, two evaporative cooling towers, a scrub solution receiver tank, a condensate receiver tank, and a caustic makeup tank. Excess liquid drains from the bottom of the quench column and combines with scrub solution in the packed-column base. This solution is pumped through the cartridge filter and the primary heat exchanger to the receiver tank and is recycled from the receiver tank back to the venturi

and quench column. Solution recycling through the quench column is refiltered to remove even smaller size particulates.

The graphite heat exchanger cools recycling solution from 80° C (176° F) to 50° C (122° F). The process (tube) side is operated at a lower pressure than the secondary coolant (shell) side to guarantee in-leakage in the event of tube failure.

The secondary heat exchanger loop consists of the heat exchanger, circulation pump, and surge tank. The secondary side is operated at a lower pressure than the tertiary (cooling tower) side to assure in-leakage in the event of a heat exchanger leak and the system provides an added level of containment to preclude release of radioactivity to the environment.

To control scrub solution acidity, 20% caustic solution is added upstream of the packed-column sump pump. The addition rate is controlled by a pH sensor on the outlet of the receiver tank.

Condensate from the condenser/mist eliminator drains into a condensate receiver tank. The level in this tank is maintained at 80% by addition of fresh water. The solution is then pumped to the top of the packed-column scrubber at a determined rate.

The blowdown rate from the scrub solution receiver tank is controlled by level and specific gravity. If the specific gravity of the scrub solution exceeds a specified value (currently 1.05), or if the tank level exceeds 80%, the rate of blowdown which is sent to the liquid waste treatment plant is increased.

4.4.1.5 ASH REMOVAL

Ash is removed from the primary chamber by two methods: gravity drop into a hopper, and direct vacuuming. Ash may be removed from the secondary chamber by vacuuming if required; however, cold tests have shown only a trivial ash accumulation. Pneumatic transport is used with both methods to transfer solids from either the gravity dropout hopper or the vacuum hose to the ash packaging hopper and glovebox where it is bagged and placed in storage containers.

The gravity dropout hopper is attached beneath the primary chamber. A refractory lined door, normally closed and located at the end of the incinerator hearth, is actuated by pneumatic cylinders. Upon opening, a portion of ash drops into the hopper through a grate to the bottom V-section. Large metallic items caught by the grate are removed through an access door and bagout section attached to the hopper. Ash collected in the bottom is periodically transported to the packaging hopper by the pneumatic system.

The vacuum wands, housed in the incinerator door access gloveboxes, consist of a 3-in. dia. flexible hose connected to a fixed 3-in. pipe that penetrates the glovebox and connects to the pneumatic system. After opening the incinerator doors, the hose is extended into the chamber for removal of ash and small objects such as buttons. The hose is manipulated with a rod using the gloveports.

The pneumatic transport system can be valved to one of these collectors (gravity dropout hopper, primary chamber vacuum, or secondary chamber vacuum). The collected solids and transport air are separated using a high efficiency cyclone and sintered metal filters. The cyclone removes over 90% of the solids greater than $2\ \mu$ particles. Ash from the cyclone enters the packaging hopper through a rotary star valve. Ash on the sintered metal filters is periodically blown back and drops into the same hopper. After the transport blower is shut down, the hopper is emptied through a double valve chute that drops a controlled volume into a bag. Several small sealed bags are bagged out into a storage container for future studies.

The motive force for the pneumatic system is supplied by a positive displacement blower. The discharge connects to the glovebox suction manifold and is filtered through two banks of HEPA's before entering the stack. A small HEPA filter is located between the blower suction and the sintered metal filters.

4.4.2 FOLLOW-ON PROCESS

Space is provided in the low and high bay areas for development of subsequent or additional processes. Although a follow-on process has not been selected, it will probably be related to controlled incineration, such as an ash stabilization process.

4.4.3 RESEARCH AND DEVELOPMENT SUPPORT FACILITIES

The office space, laboratories, shop, and change rooms provide facilities for the support of research for process development and other facets of the waste management research and development effort.

4.5 UTILITIES AND SERVICES

The utility systems provide reliability consistent with operational and safety requirements, value and potential hazard for all probable conditions.

Utility systems are designed to avoid cross contamination between zones and areas and contamination of areas normally uncontaminated.

The utilities are monitored by appropriate detectors and devices to ensure against interruption and to provide proper measurement of pressures, temperatures, flows, etc. Signals from the monitoring devices are transmitted to the central control panel and selected measurements are recorded.

4.5.1 FIRE PROTECTION

The TDF will remain standing as a confinement structure during and after the design basis, (DBF), assuming complete failure of all normal fire suppression systems to operate or control the fire. The concrete external shell and upper floor section have a minimum of a two hour fire rating. There are no external windows in the process bay and the windows into the second floor laboratories are wire reinforced glass. Exterior doors and doors leading into the stair well have a minimum 1 1/2 hr fire rating. The interior wall and doors and zone partitions have a minimum one hour fire rating. Emergency exit from the first floor is either through the change room areas into the entry vestibule or through

the process bay emergency exit doors. The emergency exit doors open outward and are equipped with panic hardware on the inside and have no exterior hardware. There are no windows in these doors.

Emergency exit from the second floor is either through the front entry stairwell or the emergency exit and ladder at the opposite end of the building in the Process Laboratory.

Design and operating procedures minimize the combustible loading of the facility. Noncombustible construction is used where practical. Fire dampers and automatic sprinklers are used to confine and suppress the design basis fire.

The DOE Manual, publications of Underwriters Laboratories (UL), Factory Mutual System (FM), National Fire Protection Association (FIA), and the Uniform Building codes are used in the design and specifications of systems and equipment and the construction of the facility.

The water system is designed to Uniform Building Code Seismic Zone II design criteria. Sprinkler systems are provided in all building areas and to the ventilation system HEPA filters.

4.5.1.1 FIRE WATER SUPPLY

Water for fire fighting is supplied from the 12 in. fire and domestic water supply main along the north side of Pecos Drive via an 8 in. fire and domestic water supply line under Pecos Drive to the TDF. This 8 in. line provides water to the outside fire hydrants, a 6 in. tap into the building for automatic and manual fire protection systems and a 3 in. domestic and process water tap. The water supply system is described further in Section 3.2.3.2.

4.5.1.2 AUTOMATIC SPRINKLER SYSTEMS

a) Fire Detection and Alarms

A central supervisory type alarm system is provided. An annunciator and graphic display panel is located at the building entrance. A fire alarm is automatically transmitted to the fire department from the central annunciator panel.

The fire alarm system is initiated by any one of the special detectors or the fire water flow alarms. Additionally, alarms may be initiated manually from any one of the pull box stations located at each of the exit doors from the facility.

b) Sprinkler Systems

A conventional wet pipe sprinkler system is provided in all rooms and process bay areas of the TDF. Room system sprinklers are located so as to provide no more than one hundred square feet of floor space per sprinkler head using ordinary hazard schedule. The loading dock area is provided with an antifreeze filled sprinkler system. Standard 212° F rated automatic sprinkler heads are used in all areas unless otherwise noted.

c) Special Extinguishers Systems

The main exhaust duct to the building (Zones 2 and 3) HEPA Filter Plenum is equipped with an automatic cool-down spray system, and the filter plenum is equipped with an automatic deluge sprinkler system. The control valves are located in a below-grade pit to preclude freezing as the duct and plenum are located external to the heated building. Sprinkler water, if activated, is drained through 20 in. "P" traps to the radioactive liquid waste drain line. The "P" traps are filled with glycol to prevent evaporation and freezing. The feed preparation line gloveboxes are equipped with 140° F heat detectors connected to the building fire alarm system and automatic sprinklers supplied by an air pressurized limited volume water system. The detectors will notify the Fire Department of any potential hazard. The limited volume water spray system is used to preclude the spread of contamination.

The limited volume of water is contained in a 30 gal capacity tank pressurized with air. A bladder separates the water from the compressed air to preclude dissolution. The water is supplied to on-off spray heads in the glovebox line. A fire test was conducted on 13 February 1979 in the sorting glovebox. The fuel, 1 1/2 lbs of shredded and crumpled paper, provided approximately 10,500

Btu for the fire. A spray head was actuated 1 min 10 s after ignition of the fuel. The fire was out at 1 min 45 s. The fire rekindled briefly but self-extinguished prior to reactivating the spray head. A portion of the fuel remained unburned. A total of 2.5 gal of water was used by the spray system. No water was leaked from the glovebox and the water level did not rise to the bagout port curbs.

The individual boxes are isolated by air lock doors and procedures preclude leaving waste feed materials in the glovebox line or feed preparation area during nonoperational periods. The single exception to this rule is the overnight storage of inspected feed material in the storage glovebox during a pre-run preparation period.

The main ram feeder and side ram feeder serve as air locks to prevent the spread of any fire to the feed preparation line. The main ram feeder is fitted with an argon quench system to extinguish any flames from plastics sticking to the ram face as it is withdrawn from the primary chamber. The argon is activated by a uv detector located a few inches behind the guillotine door. After the door closes, the ram, stopped at the checking position, is examined for UV. If UV is detected, argon is injected and the ram recycled. If not, the ram retracts.

4.5.1.3 MANUAL SYSTEMS

Fire hose stations (hose racks) and extinguishers are located at appropriate points in the facility. A fire department siamese connection is located at the central fire protection system and three fire hydrants external to the building are provided.

4.5.1.4 COMBUSTIBLE LOADING STUDIES

The combustible loadings in the process areas will range from less than 1,000 Btu/ft² to spot loads as high as 80,000 Btu/ft² for compacted "plastic" feed matrix material stored in the feed preparation line glovebox. However, the average combustible loading for the feed preparation line enclosure will be less than 10,000 Btu/ft².

Maintenance of average combustible loadings per enclosure of less than 10,000 Btu/ft² is an objective of good housekeeping practices and administrative control.

4.5.2 DOMESTIC AND PROCESS WATER SUPPLIES

4.5.2.1 COLD WATER

A 3 in. cold water service line enters the building from the 8 in. fire protection and domestic water line west of the building. The service line enters the west end of the building and the pressure reducing valve and backflow preventer is located so that water from the building cannot contaminate the service line outside of the building. A second backflow preventer is located on the branch main (inside the building) which supplies water to the entire first floor including the lab areas. This prevents possible backflow from contaminating the supply to the second floor. The main pressure reducing valve is set at 60 psi so that a residual pressure of 50 to 55 psi will be available at the second floor. All faucets and hose bibbs in lab areas throughout the building are furnished with vacuum breakers to prevent backflow at hose connections. Outside watering and wall hydrants are connected to the "potable" water branch main which serves the second floor and makeups to the mechanical equipment.

4.5.2.2 HOT WATER

Hot water is provided to the building by two gas-fired hot water heaters. A recirculation pump is located adjacent to each water heater controlled by an aquastat in the hot water return line. Water heater, HWH-1, provides hot water for the first floor. Water heater, HWH-2, serves the second floor.

4.5.2.3. CHILLED WATER

Two cooling towers located outside the building provide cooling water for the process area. The capacity of these towers will cool a minimum of 150 gpm of water from 100° F (37° C) to 75° F (24° C). The pumping system includes the cooling towers, a below-grade collection reservoir, and a circulation pump located in a pit in the mechanical room. The pump is capable of delivering the

150 gpm of 75° F water at a pressure of 75 psig for process use. The estimated pressure drop through the process secondary heat exchanger is 25 psig, leaving a pressure of 50 psig available to deliver the water to the tower and from there to flow by gravity into the below-grade reservoir. Locating the reservoir below grade means that the system can operate throughout the year, since no water will be stored above grade.

4.5.3 NATURAL GAS

A 2 in. gas line provides gas to the facility from the 3 in. gas main on the north side of Pecos Drive. The gas regulator loop is located on the west side of the building. From this point the gas is routed to the mechanical equipment room, incinerator in the process bay and to all laboratories.

4.5.4 COMPRESSED AIR

Two separate compressed air distribution systems are provided in the facility.

4.5.4.1 SERVICE AIR

Compressed air at 100 psig is supplied to the mechanical equipment room, shop, process bay, loading and storage dock and all laboratories from the main air compressor in the mechanical equipment room. An auxiliary compressor provides a back-up system in the event of failure of the main compressor.

4.5.4.2 INSTRUMENT AIR

Instrument air at 30 psig is supplied to the mechanical equipment room and process bay. Instrument air is supplied by the main instrument air compressor; an auxiliary compressor provides a backup system. In the event of failure of both the instrument air compressors, a cross over loop from the service air system provides an auxiliary source of instrument air. In the event of failure of all air compressors, a rack of compressed air cylinders provides adequate capacity to the instrument and control systems for an orderly shut down.

4.5.5 ELECTRICAL SERVICE

4.5.5.1 PRIMARY SERVICE

The basic electrical service is provided to the facility from a 13.4 kV overhead distribution line through an underground conduit to a 500 kVA on-site substation which provides 480/277 volt distribution to the facility. The load distribution center general service transformers and motor control centers are located in the mechanical equipment room. The facility can be shut down for a required planned power outage on a two-hour notice from the Utilities Section.

4.5.5.2 AUXILIARY SERVICE

4.5.5.2.1 AUXILIARY GENERATOR

An on-site 500 kVA auxiliary diesel generator and automatic switch gear is located exterior to the building. An "essential load" motor control center provides connection of the auxiliary generator to the control panels, the essential lighting, and the fire alarm system along with essential mechanical equipment and communications systems for emergency operation. During the operation of the incinerator and offgas process line, the auxiliary diesel engine will be running at operating speed (60 cps electrical output) and under no load. Loss of line power will immediately activate the automatic transfer and the generator will pick up the electrical load. Long operating runs are not expected and this mode of generator operation is not anticipated to create problems.

4.5.5.2.2 AUXILIARY INSTRUMENT POWER

A 5 kW Uninterruptible Power System (UPS) supplies power to the incinerator instrumentation in event of power failure. The UPS consists of a battery pack, battery charger, an inverter, and a logic system to sense a power failure and switch to the UPS battery backup.

The batteries are lead-calcium; they have a large reservoir which provides for safe easy maintenance. Hydrogen emission is

low ($1.7 \text{ ft}^3/\text{cell}/\text{yr}$) therefore, no special ventilation system is required. The inverter and logic system is synchronized to the line power. A transfer to UPS power occurs in less than 0.4 ms. This transfer cannot be detected by the incinerator controls.

4.5.6 EMERGENCY LIGHTING

Emergency lighting and exit signs are provided by standard battery powered units with self-contained trickle chargers. These lights are actuated by loss of line voltage and reset upon resumption of line voltage.

4.5.7 HEATING

Building heat is provided by a natural gas fired recirculating hot water furnace. Hot water is circulated to heating coils located in the air supply plenums to the various areas of the building. The building ventilation zones are further divided into regions. Each region is provided with a standard industrial type thermostat to control the air supply plenum heating coils for that region. The thermostat locations were determined according to occupancy and use of each room or area to minimize the number of thermostats and heating coils in the building.

4.5.8 ROADS AND SERVICES

Access to the site is by Pajarito Road and Pecos Drive, both DOE controlled Laboratory roads. Public access is allowed to Pajarito Road as it is the most convenient route between the White Rock residential area and the Laboratory Technical Areas and a necessary link between the White Rock area and the townsite western area, including the Los Alamos Medical Center.

Pecos Drive provides access from Pajarito Road to TA-35, TA-55, and TA-50. This road is open to the public only as far as the DOE Protective Force entry gate adjacent to the northeast corner of the TDF site.

Access to the TDF site is provided by a road beginning at the present liquid waste disposal site entry, traversing the east, south, and west side of the TDF to provide access to the loading dock, vehicle door and mechanical equipment room, and the

Warehouse Staging Area Building. Freight access to the second floor of the building is provided by a double door and exterior landing with removable guard railings on the building's southwest side into the process Engineering Laboratory. After initial occupancy, only infrequent use of this access is expected.

A space around the building provides access for firefighting and other emergency vehicles.

4.5.9 GENERAL SECURITY

The Treatment Development Facility is not in an established security area. However security for the protection of government property is provided in accordance with DOE IMD 6105 by the LAAO Protective Force. Access to the site is through an entry gate located on Pecos Drive. This gate is open during normal working hours but is locked during non-working hours. A key operated electric gate provides access to authorized employees possessing site keys during the non-work periods. An additional vehicle gate is located in the west perimeter fence. This gate provides egress for vehicles, such as semi-trailer trucks, that cannot easily negotiate the sharp turns required at the entry gate. This west gate is locked except during periods of actual use. The site is enclosed by an eight foot chain link fence topped with three strands of barbed wire. Access to the building is through the outer door into the stairwell to both the first and second floors. Entry to the first floor is through the cold entry to the change rooms. These doors are equipped with electrical mechanical locks opened by the keys issued to regularly assigned personnel or by an electrical contact switch located in the site secretary's office on the second floor. Communication is provided by the common line in the telephone system. This is to provide access to authorized personnel who are not regularly assigned to the site and issued a key.

Access to the second floor is not controlled beyond that of access to the site; however, the site secretary's office is located immediately inside the second floor door, providing visual observation of persons entering the second floor area.

All other outside doors remain closed and locked except during periods of actual use by site personnel. During periods of non-occupancy, all exterior doors as well as the gates in the TA-50 perimeter fence are locked.

4.6 RADIATION PROTECTION AND PLANT INSTRUMENTATION

4.6.1 CONTINUOUS AIR MONITORS (ALPHA)

Automatic alarming alpha radiation monitors for radioactive airborne particulates are located in the Zone 2 Feed Preparation Area and the Zone 2 High Bay Area. Standard operating procedures insure personnel safety during operation. Special monitoring will be accomplished as described in Section 4.6.4. The constant air monitors are single channel pulse height analyzers having a lower limit of detection of 4 MPC hrs of ^{239}Pu with rejection capability for radon-thoron daughters. Each Continuous Air Monitor (CAM) has a local audible and visual pulsating alarm to warn personnel of airborne contamination. The monitors are located as near as possible to the probable source of release and situated between the source and the ventilation exhaust in such a manner that the air movement will sweep the material toward the monitor. Smoke tubes may be used to evaluate ventilation air movement within the zones to insure proper placement of the monitors. Standard operating procedures (SOP's) require the immediate evacuation of an area upon the occurrence of a CAM alarm. Re-entry for surveying and evaluation is supervised by the responsible staff member and the site Health Physics surveyor (during duty hours). Use of respiratory protective devices and protective clothing is required by standard operating procedures. Health Physics assistance is available upon request to the H-1 monitoring supervision during both duty and non-duty hours.

4.6.2 STACK EFFLUENT MONITORING

An in-line sampling filter and pump are used to constantly sample the air released from the facility stack. The collection filter of the stack effluent monitor is routinely removed, replaced by a new filter, and analyzed by the Health Physics Group.

4.6.3 GAMMA MONITORS

Portable instruments are used to establish x-ray and gamma exposure rates. Due to the low inventory level of mixed fission products permitted in the facility, continuous gamma monitors are not required.

4.6.4 HEALTH PHYSICS SUPPORT

A Health Physics technician is assigned to the Transuranic Waste Reduction Treatment Development Facility (TDF) and is available during normal working hours. He is responsible for air monitoring, surface contamination control, and for dose rate measurements in the facility. He will advise the responsible staff member of Health Physics safety requirements and procedures during operations involving the presence of radioactivity, i.e., maintenance or replacement of components within the Zone 1 process line, decontamination or unusual work in the 'hot' chemistry laboratory. He is responsible for providing additional personnel monitoring equipment and devices as required to insure the safety of operating personnel, such as portable air samplers or finger ring film packets. The Health Physics Group provides for personnel dosimetry with TLD badges as well as scheduling whole body counting, chest counting, and urinalysis.

4.6.5 WARNING DEVICES

Local warning devices that produce an audible and visible pulsating alarm are integral parts of the continuous air monitoring system to warn personnel in the area of abnormal high airborne contaminants. Hand, foot, and clothing monitors with audible alarms are provided at main exit locations and work areas where there is a potential for contamination.

4.6.6 PERSONNEL SAFETY EQUIPMENT

Cabinets are provided with the following Health Physics and safety equipment: Alpha and beta-gamma survey instruments; self-contained breathing air (SCBA) equipment (two air packs with tanks, masks, hoses, regulators, etc., complete); clean protective clothing; respiratory protective equipment (full face masks);

surgeon's gloves; masking tape; plastic bags; gauze; kim-wipes; rope; signs and necessary decontamination equipment. Fire extinguishers (metal, CO₂ and multipurpose dry chemical will be provided in appropriate locations). Operations personnel are trained and certified in SCBA use.

4.7 EFFLUENT CONTROL AND MONITORING

The primary mission of the TDF is radioactive waste treatment and waste management research, therefore, control and monitoring of radioactive and chemical effluents, part of the needed program data, are incorporated in the operating procedures for the facility. Other effluent paths are monitored directly or indirectly through the LASL Environmental Monitoring Program.

4.7.1 CONTAMINANTS IN EFFLUENTS

In addition to the transuranics and possible small amounts of fission products or other radioactive contaminants, the facility also generates combustion products from the incineration process and small quantities of industrial wastes from the laboratories and machine shop.

4.7.1.1 COMBUSTION PRODUCTS

The incineration process uses natural gas for temperature maintenance in the incinerator and to assure complete combustion of the wastes. Table 4.7.1-1 lists the combustion product quantities produced by the complete oxidation of 100 lbs. of the design matrix (No. 2) wastes. The design waste compositions are listed in Table 4.7.1-2. This effluent is processed by the offgas treatment equipment. It is shown elsewhere that the offgas treatment train reduces the radioactivity levels in the exhaust to well below DOE Manual standards. This treatment is also effective in reducing the noxious components of the offgas prior to release to the environment. Principally, these are NO_x, SO₂, HCl, Cl, and possibly HF. While the offgas treatment train will remove varying quantities of these noxious gases, some small release through the stack to the environment is expected. The packed column scrubber,

Table 4.7.1-1
GASEOUS COMBUSTION PRODUCTS
 Basis - 100 lb. of Waste

	<u>No. of Moles</u>	<u>Mass (lb)</u>	<u>Mol. Fract.</u>
CO ₂	5.15	226.5	.096
H ₂ O	2.55	45.9	.048
O ₂	4.21	134.9	.079
N ₂	41.29	1159.4	.774
SO ₂	0.02	1.0	.0004
HCl	0.16	5.6	.0029
NO ₂	<u>0.01</u>	<u>.4</u>	<u>.00015</u>
Total	53.49	1573.7	1.00045

Table 4.7.1-2
DESIGN BASIS WASTE COMPOSITIONS

	<u>Weight Percent</u>	
	<u>Waste 1</u>	<u>Waste 2</u>
Paper and rags	60	35
Plastic		
Non Cl containing	12	23
Polyvinyl choloride	8	12
Rubber	20	30

using only water, removes at least 90% of the HCl and a temperature dependent fraction of up to 80% of the SO₂. At a production rate of 5.6 lbs/hr, the HCl is reduced to about 0.15 grains/ft³ (.33 g/m³). While it is not generally desirable to subject HEPA filters to acid fumes, experience within the Laboratory has shown that no damage occurs at low levels such as these during the operating lifetime of the filters. Further dilution in the facility stack reduces this concentration to 1.56×10^{-5} g/m³.

4.7.1.2 OTHER AIR CONTAMINATE.

The first floor fume hood in the Hot Wet Chemistry Laboratory is a source of other air contaminants. These are intermittent and of relatively low levels. However, administrative controls have been imposed to prevent damage to the Zones 2 and 3 HEPA filters by activities in these areas. All acid handling procedures, especially using perchloric acid, are required to have a wet scrubber or neutralization chamber in the hood to process the offgases.

Due to the explosive characteristics of organic perchlorates, the use of perchloric acid in the TDF laboratories is administratively controlled in accordance with a Standard Operating Procedure and the safety procedures to insure that no fumes are released into the ventilating system and HEPA filter systems. The primary air contaminants from the machine shop are from the welding hood and will pose no particular problems.

The second floor fume hood exhausts are not filtered as there will be no radioactivity hazards from these areas. Atmospheric dilution of the normal chemical fumes are adequate to preclude any hazardous concentrations.

4.7.2 LIQUID EFFLUENTS

All liquid effluents from the preparation and process bays and the hot laboratories are collected in separate drain systems, and transferred to the process scrub tank and facility collection sump tank. These liquid wastes are sampled, pH adjusted if required, and transferred (on a batch basis) through the special underground pipeline to TA-50 East, the LASL Industrial Liquid

Waste Treatment Facility,¹ for treatment and disposal.

Collection equipment for this system includes a 950 ℓ /m (250 gal/m) chemical-treatment station at Area 3 (TA-3, SM-700), and a large number of building storage, neutralization, and/or pumping stations within the Laboratory complex.

The TA-50 facility provides a bar screen, grit chamber, raw waste storage tanks, flash mixers, chemical feeders, flocculator-clarifiers, gravity filters, distributor for CO₂ storage, ionexchange columns, spent regenerant storage-treatment tank, sludge storage tanks, vacuum filter, and treated waste storage tanks. Chemicals used in the treatment for separation and concentration of alpha-emitting radioisotopes include ferric sulphate, lime, tri-sodium phosphate and coagulant aids.

The sludge produced by chemical treatment is dewatered by vacuum filtration to 25-40% solids, placed in lined 215- ℓ (57-gal) steel drums if the transuranium (TRU) radionuclide activity is >10 nCi/g or ^{238}Pu activity is >100 nCi/g, and forwarded to the solid waste retrievable storage area at TA-54. Dewatered sludges with ^{238}Pu <100 nCi/g or TRU activity <10 nCi/g are placed in 215- ℓ (57-gal) steel, or 210- ℓ (55-gal) fiber drums lined with 125 μm (.005 in.) polyethylene. These units are sent to burial at TA-54.

The ion-exchange columns contain high-capacity synthetic cation-exchange resins which are used in the hydrogen phase for removal of beta- and gamma-emitting radioisotopes. Upon exhaustion, the resins are regenerated with nitric acid and the spent regenerant is collected and treated chemically. The chemical sludge is dewatered with the other sludge after analyses to determine activity levels, packaged in lined steel or fiber drums, and sent to TA-54 for storage or burial. Proportional samples are collected during all phases of the operation and analyzed to determine treatment efficiencies.

¹Emelity, L. A., Buchholz, J. R., and P. E. McGinnis. 1977. "Review of Radioactive Liquid Waste Management at LASL," LA-UR-77-1195.

Operation of the controlled air incineration process at the TDF adds about 500 gals/day of waste of similar composition to the approximately 50,000 gals/day received at the Liquid Treatment Facility from the other laboratory facilities, and thus does not impact significantly on its operation.

Nonradioactive liquid industrial effluents from the second floor laboratories are collected in an acid waste drain system and collected in the same collection sump as the radioactive liquids from the process bays, and thus are processed by the Liquid Waste Treatment Facility prior to release to the environment.

All other liquid effluents from the facility except the natural runoff is handled by the sanitary sewer. This sewer is not monitored except as discharge to the environment is monitored in the LASL Environmental Monitoring program described elsewhere in this report.

There is no air-conditioning for the facility. Two evaporative water cooling towers supply chilled water to the process heat exchangers only. At the rated load of 2.2 million Btu/hr and a blowdown factor of 25% to control total dissolved solids, an estimated 700 gals/day of operation of tertiary cooling water (city water make up) is discharged to the sanitary sewer. This effluent contains approximately three times the total dissolved solids (TDS) of that of the domestic water supply, has a pH range of from 9.2 to 10.5, and consists of the naturally occurring minerals, plus a small amount of water treatment compounds, principally phosphonates, low molecular weight polyacrylates, and polystyrenes to control corrosion, scaling and biological growth in the cooling system. All of the water treatment materials are non-toxic and biodegradable. The sanitary waste collection system discharges to a three cell oxidation stabilization pond system which is authorized under National Pollutant Discharge Elimination System (NPDES) permit NM 00 28355. The additional hydraulic load

imposed by the cooling tower blowdown is negligible and is estimated to be 700 gpd for five days every four to six weeks. The NPDES limits the average flow to 30,000 gpd and the maximum flow to 50,000 gpd. Average and maximum flows currently being discharged are generally well below the permit limits. On an annual basis the cooling towers will increase the effluent flow from the ponds 2.5% to 3.5%.

As the streams in the adjacent canyons are intermittent and flow to the Rio Grande some 5 mi below the point of introduction of effluents from the TDF site only during major storms or heavy spring snow melt runoff, the added mineral content of this small amount of water constitutes no burden on the environment. Hydrologic studies covering the past 17 yrs indicate except during the intermittent flow periods mentioned above, all such cooling water and other natural runoff infiltrates into the alluvium in the canyon bottoms. The water does not reach the main aquifer in the Tesuque and Puye Formations which lie some 600 to 1200 ft below the surface of the plateau.

The secondary and tertiary coolants are routinely monitored by the Health Physics surveyor assigned to the facility to insure that in the event of a leak from the primary system into the secondary coolant, no radioactivity will enter the tertiary coolant to be released with the blowdown.

4.7.3 GASEOUS INDUSTRIAL EFFLUENTS

The ventilation system is used to control air and gaseous effluents from the facility. Equipment is provided to sample air and gaseous effluents in the ventilation ducts which exhaust to the stack. Flow elements are used to measure the flow in exhaust ducts to allow determination of total emissions released.

An in-line sampling filter and pump constantly samples the air released from the facility stack. The collection filter is routinely removed and replaced. The collection filter is sent to the Health Physics Group for analysis.

4.7.4 SANITARY SEWER

The sanitary wastes generated at this facility are discharged to a sanitary waste treatment plant and lagoon serving this and adjacent Technical Areas on the finger mesas between Mortandad and Ten-Site canyons.

4.7.5 NATURAL RUN-OFF

All storm water runoff is channeled to the adjacent canyons in such a manner that erosion is negligible. Surface runoff follows established drainage patterns to the adjacent canyon. Since 1960, when hydrologic observations began, all storm runoff as well as cooling water and industrial effluents have infiltrated into the alluvium. The land-use change and operations at the TDF have not added enough water to the natural runoff to alter the present hydrologic conditions.

5. DESCRIPTION OF OPERATIONS

5.1 Feed System

5.1.1 Feed Receiving and Storage

5.1.2 Feed Inspection and Preparation

5.1.2.1 Waste Introduction

5.1.2.2 Package Assay

5.1.2.3 Sorting

5.1.3 Noncombustible Processing

5.1.4 Combustible Processing

5.2 Incineration

5.3 Ash Removal

5.4 Effluent Treatment

5.4.1 Offgas Treatment

5.4.2 Liquid Effluents

5.4.3 Solid Effluents

5. DESCRIPTION OF OPERATIONS

The TDF was constructed to permit production scale testing, evaluation, and demonstration of processes for volume reduction, stabilization, and packaging of transuranic contaminated solid waste.

The first process selected for development and evaluation is controlled-air incineration and consists of a feed preparation system, a conventional waste incinerator modified to handle and confine radioactive contaminated wastes, and an effluent treatment system to permit safe discharge of the combustion products. An artist's illustration of the process is shown in Fig. 5.0-1.

5.1 FEED SYSTEM

5.1.1 FEED RECEIVING AND STORAGE

TRU contaminated wastes are received at the facility in sealed plastic bags inside of sealed cardboard boxes. Wastes contaminated to levels less than 100 nCi/g, are transported and stored at the TDF area in Dempster Dumpsters modified for radioactive service. Wastes contaminated to more than 100 nCi/g are shipped to the TDF in DOT-approved drums.¹ Drums are unloaded from trucks and placed four on a pallet. The pallets are stacked in the drum storage areas, including the loading dock and in the low bay area south of the feed preparation line. Approximately 400 ft² of dock space will be allowed for storage.

Nonradioactive trash and scrap materials for waste feed matrix studies and feed preparation tests are stored in a metallic shed. These will be located not closer than 30 ft from the building and separated from it by the access drive.

¹ The majority of currently available TRU contaminated waste feed materials are considerably less than 100 nCi/g. It may be necessary to include a percentage of specially prepared packages containing greater than 100 nCi/g to challenge the system. However, the average loading will not exceed the 100 nCi/g discussed in Chapter 6.

- ① Receiving glovebox
- ② Multiple energy gamma assay system (MEGAS)
- ③ Micro-dose x-ray system
- ④ Sorting glovebox
- ⑤ Storage glovebox
- ⑥ Side ram feeder
- ⑦ Main ram feeder
- ⑧ Combustion fuel/air supply glovebox
- ⑨ Ignition chamber
- ⑩ Interchamber
- ⑪ Combustion chamber
- ⑫ Ash cleanout glovebox
- ⑬ Off-gas sample ports
- ⑭ Quench column
- ⑮ High energy venturi scrubber
- ⑯ Packed column scrubber
- ⑰ Off-gas condenser
- ⑱ Off-gas superheater
- ⑲ High efficiency particulate air filter (HEPA)
- ⑳ Process exhaust blower
- ㉑ Vent stack
- ㉒ Process sump solution tank

CONTROLLED AIR INCINERATION PROCESS

Fig. 5.0-1

5.1.2 FEED INSPECTION AND PREPARATION

The process feed preparation line is shown diagrammatically in Fig. 5.1.2.-1. and schematically in Fig. 5.1.2-2.

5.1.2.1 WASTE INTRODUCTION

When high activity waste is introduced into the process, a drum is moved from the storage area to the feed enclosure by the forklift. The drum is loaded singly onto a short conveyor, manually rolled under the insertion slot box, and raised vertically through the access port in the box floor.

The bolt holding the lid onto the drum is loosened, using a wrench, and the seal ring and lid of the drum are monitored for contamination as they are removed. If there is no evidence of contamination on the lid or seal, they are removed, set aside, and the exterior of the top of the package within the drum are monitored. The package is then raised from the drum using a small hoist in the slot box and its surface monitored. If the surface is not contaminated, the package is removed from the hoist and passed through a door to the next station.

Should the exterior of the package and/or interior of the drum and drum lid be contaminated, the package is withdrawn from the drum into a bag sleeve and sealed. The rebagged package, its exterior free of contamination, can be passed to the next station (see Fig. 5.1.2-3) or repackaged in the drum and returned to the generator. The contaminated surfaces of the drum can be wiped down and monitored to determine if the contamination is removable. If it cannot be removed easily by wiping, the lid and seal are replaced on the drum and it is bagged out of the slot box to be decontaminated by extensive cleaning, painting, or for disposal.

5.1.2.2 PACKAGE ASSAY

The second station in the line is used for high sensitivity package assay and weighing by the Multi-Energy Gamma Assay System (MEGAS). The sealed boxes are placed on the assay platform (plastic bags can be suspended from a fixture on the platform) and

FEED PREPARATION LINE EQUIPMENT

Fig. 5.1.2-2

ENTRY SLOT BOX REBAG SYSTEMS

Fig. 5.1.2-3

rotated and translated past the detector which is coupled with an electronic weighing scale and a computer that displays the resulting data in nanocuries per gram.

5.1.2.3 SORTING

From the assay slot box, the waste package is passed through an air lock via a mechanical conveyor. As the package is conveyed through the air lock into the sorting glovebox, it is scanned by a high resolution x-ray device that displays the image on a video storage and display screen. Tramp metals, extraneous hardware, and other noncombustibles are readily detectable on the x-ray scanner (Fig. 5.1.2-4). The conveyor can be reversed and the package rotated for an alternative picture. After x-ray scanning is satisfied, the package passes through the air lock door to the sorting glovebox.

5.1.3 NONCOMBUSTIBLE PROCESSING

If required, the package is opened in the sorting glovebox. Metals and other unacceptable items are segregated. A 5-gal bucket crusher is used to compact some metallic items. Broken glass is repackaged in a suitable container. An auxiliary compartment is attached to one work station under which there is a short conveyor for handling 55-gal DOT drums. Noncombustibles are bagged out into a plastic bag inside the plastic liner of a 55-gal drum (Fig. 5.1.3-1). The operator places sorted noncombustible items into the drum.

Smaller bag ports are provided to allow removal of smaller quantities of materials as needed.

5.1.4 COMBUSTIBLE PROCESSING

Combustible materials may be processed directly, compacted, shredded, or shredded and compacted. Dense combustibles such as computer paper are shredded, possibly compacted and repackaged for storage in the next glovebox. From the storage glovebox, the material is transferred to the ram feeder system.

X-RAY SCANNER

Fig. 5.1.2-4

BAGGING NONCOMBUSTIBLE WASTE

Fig. 5.1.3-1

5.2 INCINERATION

Waste is fed by the side ram and main ram feeders to the incinerator where it is burned to yield solid ash and gaseous effluents (Fig. 5.2-1). The ash amounts to approximately 5-10 weight percent of the original combustible feed. The remaining feed material is converted to combustion gases which are discharged to the atmosphere after cleanup to remove particulates and acid gases.

Air is fed to the primary combustion chamber at a rate of approximately 300 scfm by supply blowers, which draw air from the surrounding Zone 2 enclosure via the combustion air glovebox. Waste is periodically charged to the incinerator by the main ram feeder. A natural gas burner maintains flame and temperature within the range of 1200-1600° F in the primary combustion chamber.

The ash accumulates in the bottom of the primary combustion chamber. As the ash accumulates, it is forced to the rear of the combustion chamber by the insertion of additional waste boxes. An ash dropout box is provided to remove ash from the combustion chamber as it is pushed to the rear of the hearth. Additionally, a glovebox is provided to allow access to the combustion chamber to obtain samples and data for test purposes, to allow removal of ash following shutdown, and to provide containment during these operations. An ash vacuum system is used for final incinerator clean out.

Combustion gases and unburned products pass to a secondary combustion chamber which provides the high temperature (1860 to 2000° F) and residence time necessary for complete combustion of the waste material. Supplemental heat from a natural gas fed burner maintains proper temperatures.

The primary and secondary combustion chambers each have pilot flames, ignitors, and flame safeguard systems to monitor and assure safe operation as described in Section 6.4, Engineered Safeguards.

INCINERATION AND ASH REMOVAL SYSTEM

Fig. 5.2-1

5.3 ASH REMOVAL

During CAI operation, ash on the hearth is displaced toward the gravity dropout chutes by freshly charged packages. Therefore, ash accumulation during a run is limited. The contents of the gravity dropout hopper are transferred periodically to the ash packaging hopper where they can be stored during the run or emptied as needed. At the end of the run, following cooldown, the lower chamber access door is opened. The door and ash removal wand are enclosed in a glovebox. The vacuum system is started and remaining ash is transported to the packaging hopper. Metallic objects stranded on the hearth are removed with hand tools and bagged out of the ash removal gloveboxes.

Ash packaging is accomplished in a small glovebox below the packaging hopper. A 3-in. pipe with double valves is attached to the hopper and used to control volumes for the small bags used for the first containment layer. Ash is motivated by gravity and a bin vibrator into the pipe. The small bags are bagged out of the glovebox and stored in a container for future studies.

5.4 EFFLUENT TREATMENT

One major shortcoming of past radioactive waste incinerator systems has been inadequate offgas cleanup and treatment. Carry-over of particulates and tar have caused plugging and excessive loading of offgas treatment and filtration systems. The controlled-air system was designed to alleviate some of these problems and permit testing of different components to develop and establish a practical system. For the initial process, a high-energy aqueous offgas system with scrub solution recycle (Fig. 5.4-1) was chosen. Principal effluents are cleaned offgas, contaminated liquids, and contaminated filters.

5.4.1 OFFGAS TREATMENT

Hot 2000° F combustion gases discharge to the offgas cleanup system. As a direct result of the incinerator design, the offgas contains only a small fraction of the ash. Most of the ash (>99%) remains in the primary combustion chamber. The air cleaning train

AQUEOUS OFFGAS TREATMENT SYSTEM

Fig. 5.4-1

consists of a quench column, venturi scrubber, a condenser, and a reheater. Incinerator offgases enter the quench column (Fig. 5.4.1-1) where water sprays cool the gases to a saturated condition (approximately 170° F). The saturated offgases then enter a variable-throat high-efficiency venturi scrubber where turbulent contact with water droplets remove more than 95 percent ($\Delta P = 40$ in. of water) of the entrained fly ash particles (Ref. Sec. 4.3.3). In the packed column, (Fig. 5.4.1-2), counter current contact between the offgases and scrub solution removes the mineral acids (HCl and SO_x). The scrubbed gases then pass through a condenser and demister which removes most of the water vapor and drops the temperature from 150° F to 120° F. An electrical reheater superheats the gas to approximately 30° F above the dew-point prior to final filtration by one bank of roughing filters and two banks of HEPA filters.

Flow and negative pressure in the offgas treatment system are maintained by redundant high head blowers. In the event of loss of these blowers, flow (though reduced) and negative pressure will be maintained through an automatic crossover valve and duct to the main ventilation blower.

Effluent gases from the process offgas treatment system is exhausted through the facility stack which is continuously sampled.

5.4.2 LIQUID EFFLUENTS

Liquid effluent from the process is collected in the building sump tank. This neutralized solution is discharged on a batch basis through the special drain to the Industrial Liquid Waste Treatment Facility on the east side of TA-50.

5.4.3 SOLID EFFLUENTS

The solid effluents from the process consist of non-combustibles from the process feed and failed equipment from the line, HEPA filters from the ventilation systems, the filter elements from the scrub solution filter system, and the ash removed from the incinerator.

QUENCH COLUMN

Fig. 5.4.1-1

PACKED COLUMN SCRUBBER

Fig. 5.4.1-2

The noncombustibles, HEPA filters, and failed equipment are bagged out of the process line, placed in sealed containers for storage or disposal in accordance with current LASL Waste Management standard practices.

The filter units from the scrub solution filter system are constructed of polypropylene and are completely combustible. These filter units may be bagged out of the liquid filter glovebox and stored awaiting further studies, or may be reintroduced into the feed line for incineration.

The ash removed from the incinerator is bagged out of the ash removal system glovebox and stored in sealed containers for future studies.

6. ACCIDENT ANALYSIS

6.1 Maximum Credible Accident

6.2 Design Basis Fire

6.3 Other Accidents

6.3.1 Shredder Fires

6.3.2 Nitrocellulose

6.3.3 Perchlorates

6.3.4 Pyrolysis

6.3.5 Nuclear Criticality

6.3.6 Tornados

6.3.7 Earthquake

6.4 Engineered Safeguards

6.4.1 Process Feed Preparation Line

6.4.1.1 Slot Box Receiving Station

6.4.1.2 Drum Lift

6.4.1.3 Package Lift

6.4.1.4 Assay System

6.4.1.5 Alpha Monitor

6.4.1.6 Air Lock

6.4.1.7 Package X-Ray

6.4.1.8 Sorting Glove Box

6.4.1.9 Shredder

6.4.1.10 Compactor

6.4.1.11 Waste Storage Box

6.4.1.12 Ram Feeders

6.4.2 Incinerator

6.4.2.1 Incinerator Controls and Interlocks

6.4.2.2 Start-Up Controls

6.4.2.3 Pre-Ignition Interlocks

6.4.2.4 Operating Controls

6.4.2.5 Shutdown Controls

6.4.2.5.1 Scram

6.4.2.5.2 Fast Shutdown

**6.4.2.5.3 Consequences of Scram or
Fast Shutdown**

**6.4.2.5.3.1 Temperature
Reduction**

6.4.2.5.3.2 Corrosion

6.4.2.5.4 Controlled Shutdown

6.4.3 Offgas Cleaning Train

6.4.3.1 Quench Chamber

6.4.3.2 Venturi Scrubber

6.4.3.3 Packed Column Scrubber

6.4.3.4 Condenser

6.4.3.5 Offgas Heater

6.4.3.6 Impingement Screen and Roughing Filter

6.4.3.7 HEPA Filters

6.4.3.8 Induced Draft Blowers

6. ACCIDENT ANALYSIS

The most probable accident relative to the handling and treatment of waste material is fire. However, analysis of the TDF facility and the initial incineration process operations indicate the most severe consequences would result from a natural gas explosion. The Treatment Development Facility construction and operating procedures are designed to minimize the probability of occurrence and limit the consequences of fire. While no special construction has been utilized to reduce the effects of an explosion, the incinerator controls and interlocks are designed to prevent unsafe operation of the incinerator and are a direct result of many hundreds of hours of review. The controls and equipment exceed all present and anticipated standards such as U.L., F.M., and F.I.A. The safety of the CAI far exceeds that of the vendor supplied equipment which met all O.S.H.A. and F.I.A. industrial standards. Other engineered safeguards are utilized on the incinerator and the offgas treatment train to assure the safety of the process operations (See Section 6.4).

Additionally, the TDF experimental program requires a high standard of inspection and preventive maintenance. Further, the process area has a high rate of air change for ventilation which would limit the amount of fuel gas that could collect, and still further, each process will have a limited lifetime in the facility. As new processes are installed for evaluation, the older processes will of necessity be removed.

6.1 MAXIMUM CREDIBLE ACCIDENT

The maximum credible accident (MCA) postulated for the TDF is an explosion caused by natural gas leakage in the gas supply system followed by a fire in the process area. An explosion of this assumed magnitude would breach the containment and cause heavy damage to the building. The consequences of such an accident are increased above those of a standard industrial facility only by the amount of plutonium that could be released. It is not credible that the current method of operation could lead to a hazard to the public via such an accident.

The maximum permitted facility inventory is 100 g of trans-uranics, but the actual inventory will be much less than this. LASL room generated trash, processed in the TDF experimental programs, has an average activity of less than 100 nCi/g of trash. The LASL processed plutonium has a specific activity of about 0.0714 Ci/g, thus about 1.6×10^5 pounds of waste material ($2.3 \times 10^4 \text{ ft}^3$) would be required to reach the inventory limit. Operating procedures limit the quantity of unburned waste feed within the process area to 2400 lbs (Ref. Sec. 6.2).

Assuming 100 nCi/g of waste, the probable maximum quantity of plutonium available to be dispersed by an accident of this type is 440 mCi distributed as follows:

Headend Area, Slotbox and Glovebox Line	1600 pounds	$7.3 \times 10^{-2} \text{ ci}$
Storage Glovebox	800 pounds	$3.6 \times 10^{-2} \text{ ci}$
Ash in Incinerator and Ash Removal Glovebox	3 days run	$3.3 \times 10^{-1} \text{ ci}$
Ash Collected in Process Line HEPA Filters	40 days run	$2 \times 10^{-3} \text{ ci}$

These quantities are based on a six day incineration run, which is felt to be a reasonable assumption for a research and development facility such as the TDF. The 40 day run on the process line HEPA filters is based upon a predicted maximum ash loading for the filters. Additionally, another $2 \times 10^{-3} \text{ Ci}$ is assumed for the feed preparation HEPA filters and general contamination in the gloveboxes and air plenums in the release calculations.

The remainder of the facility's transuranic inventory would be located outside the building and thus would not be involved in the event of the postulated accident.

The consequences of such an accident would be localized. The majority of the above listed quantity of transuranics would be contained in incinerated ash and not subject to widespread dispersal.

The combustion of the 2400 lbs of unburned wastes in the feed preparation area and glovebox line, based on the design waste matrix, would produce the following gaseous products:

CO ₂	5.6 x 10 ⁴ g mol
H ₂ O	2.77 x 10 ⁴ g mol
N ₂	3.01 x 10 ⁵ g mol
SO ₂	2.19 x 10 ² g mol
HCl	1.73 x 10 ³ g mol
NO ₂	1.1 x 10 ² g mol

The nitrogen component includes both the nitrogen from the wastes and the nitrogen fraction of the air required to burn the wastes. It is further assumed that complete combustion occurs over a period of one hour. The volume of the offgases at ambient conditions would be $1.3 \times 10^4 \text{ m}^3$.

The following conservative assumptions are made:

1. Fractional Airborne Release: 0.053% (BNWL-1730, April 1973).
2. No allowance for partial retention by the breached building structure is assumed.
3. A 50 percent increase in cloud volume is assumed for the release of the transuranics held in the preparation line filters.

The above assumptions indicate a total release of 6.4×10^{-5} Ci of transuranics. Given the source factors of a volume source where Volume (V) = $1.3 \times 10^4 \text{ m}^3$ with a concentration of $4.9 \times 10^4 \text{ } \mu\text{Ci m}^3$, we can get concentration estimates downwind subject to a number of additional assumptions. Important factors turn out to be:

1. The source function time (assumed 1 hr)
2. The source shape - height, width
3. The height of release above ground including buoyant plume rise

4. Additional dilution in the circulation of air due to fire, building wake, etc.
5. Atmospheric factors; turbulence, wind speed.

Estimates were made using a Gaussian Plume Model for a continuous source. This is generally quite good if the travel time is less than the source function time. Since longitudinal expansion is neglected, it will be conservative by a factor of about 2 for travel times ~ 10 source function time. The initial source size was accounted for by a virtual point source concept with the virtual source distance selected to be 100 m. A ground level release was assumed which is undoubtedly conservative.

Two important transport problems are identified. One is flow toward the Trailer Park about 0.8 mi (1.3 km) NNE of the TDF. This direction is associated with light to moderate flow across the mesas which implies mechanical generation of turbulence. In view of this additional mixing condition, the diffusion coefficients selected correspond to the near neutral Pasquill category D as a conservative measure of the turbulent dilution of the plume. Concentrations derived with these assumptions and a 2 m s^{-1} wind are given in curve A of Fig. 6.1-1. The second case involves a nocturnal event of drainage flow in the canyons adjacent to the facility. This flow generally occurs as a very light ($\sim .5 \text{ m s}^{-1}$) drift under stable thermal stratification giving limited dilution. Furthermore, horizontal spread of contaminant is bounded by the canyon walls so after a certain initial dilution, the concentrations decrease more slowly with distance. The net effect is higher estimated concentrations at White Rock, 7 mi (11 km) down Pajarito Canyon than at the trailer court, only 0.8 mi (1.3 km) away from the TDF. The canyon flow regime is indicated by curve B in Fig. 6.1-1. Diffusion calculations (Fig. 6.1-1) indicate a concentration of $7.2 \times 10^{-14} \text{ } \mu\text{Ci/ml}$ at the trailer court for daytime cross-canyon wind conditions and $2.4 \times 10^{-13} \text{ } \mu\text{Ci/ml}$ at the White Rock residential area for a nocturnal drainage flow under stable thermal stratification.

ESTIMATED CONCENTRATIONS FROM A ONE HOUR RELEASE OF
 6.4×10^{-5} CI OF PU FROM TREATMENT DEVELOPMENT FACILITY, TA-50

Fig. 6.1-1

Both lung and bone dose calculations have been made for these conditions and are as follows:

50 Year Dose Commitment		
Lungs	=	0.86×10^{-3} Rem
Bone	=	1.97×10^{-3} Rem

In addition to the preceding worst-case meteorological conditions assumption, the following assumptions have also been made.

1. The radionuclide mix is assumed to be 100% ^{239}Pu , as a worst case as weapons and reactor grade plutonium compositions are greater than 85% ^{239}Pu .
2. The chemical form is assumed to be PuO_2 , as the release mechanism involves burning. However, for lung dose calculations the radionuclide is assumed to be 100% insoluble, and for the bone dose calculations, 100% soluble, for worst case conditions.
3. The particle size is assumed to be 0.02μ for inhalation worst case conditions.
4. The breathing rate for persons exposed is assumed at the $20 \text{ m}^3/\text{day}$ ICRP Standard.

The above listed concentration levels are comparable to the DOE 0524 RCG for soluble plutonium for uncontrolled areas.

However, due to the mechanism of release, it is not probable that the airborne fraction of the plutonium would exist in any chemical form other than an oxide. Even the low temperature (600°C) plutonium oxides are considered insoluble except in strong acid solutions, thus the appropriate maximum concentration limit should be considered as $10^{-12} \mu\text{Ci}/\text{mL}$. The White Rock area would therefore be a factor of four less than the maximum permissible guide limits. The maximum credible accident would therefore pose no significant hazard to the public.

An explosion of the magnitude postulated for the maximum credible accident would lead to heavy damage of the facility. It

is estimated that 75% of the building could be destroyed. Additionally, light damage could be inflicted at the Liquid Waste Disposal Facility, primarily in the form of shattered windows. Total loss, including decontamination, has been estimated to be less than \$2,000,000.

6.2 DESIGN BASIS FIRE

The Design Basis Fire (DBF) is postulated to occur in the feed preparation area of the process bay, the largest single area in the facility. The activities in this area lead to it having the highest combustible loading in the facility.

Combustible waste feed for the incinerator is brought into the TDF via the shipping and receiving bay. This waste is stored in the head-end of the feed preparation area until introduced into the processing enclosures. The total quantity of combustible waste permitted in storage and in the processing enclosures is limited to 2400 lbs (24 hrs of incinerator processing capacity).

The following assumptions have been made to support the DBF. The fire starts in the waste stored in the head-end of the feed preparation area. The design basis waste has the following composition: 35% cellulose, 23% polyethylene, 12% polyvinylchloride, and 30% polyisoprene, with a total heat loading of 6900 Btu/lb. The combustible loading for the feed preparation area, excluding the waste feed, is 1000 Btu/ft². The fire occurs during a non--occupancy period, the sprinkler system fails to function, and the fire department is delayed up to one hour in responding. The waste feed is totally consumed by the fire. All the combustible loading in about 30% (800 ft²) of the feed preparation area is totally burned, one-half of the combustibles are burned in 37% (1000 ft²) of the area, and one-quarter of the combustibles are burned in 33% (900 ft²) of the area.

The total heat release from the waste feed is 16.56×10^6 Btu. The additional heat release from the other combustibles in the feed preparation area will contribute an additional 1.52×10^6 Btu for a total involvement of 18.08×10^6 Btu.

The feed preparation area receives 3600 ft³/min make up air from the shipping and receiving area, 3200 ft³/min through ceiling exhausters, and 1600 ft³/min from the equipment egress air lock. All the make-up air enters the feed preparation area via HEPA filters. Ventilation air for the processing enclosures is supplied from the feed preparation area room air. The air from the processing enclosures and the feed preparation area is exhausted to the atmosphere after passing through a spark arrester, a roughing filter, and two stages of HEPA filtration.

The average and maximum heat releases depend on the burning rate. The air flow without fire in this area totals 8400 ft³/min; the pressure changes due to a hot fire should reduce flow into the feed preparation area to less than one-half this value. About 360 Btu is released for each gram mole of oxygen in burning organic material. One gram mole of gas at 70° F and 600 torr pressure has a volume of about one cubic foot. Air contains 20 volume per cent oxygen. Therefore, the maximum release rate would be $(8400 \times 0.5 \times 0.2 \times 360 = 302,400)$ 302,400 Btu/min. Assuming complete failure of the fire detection and suppression systems, a one hour fire at 3.02×10^5 Btu/min would yield a total heat release of 18.1×10^6 Btu, which is in reasonable agreement with the total heat release of 18.08×10^6 Btu, above, and is within the one hour fire rating required for the facility (Sec. 4.2.3).

Occurrence of the design basis fire would lead to heavy damage in the feed preparation area and partial damage to the surrounding areas. Total loss, including decontamination of the affected areas would be less than \$500,000. The building would remain as a containment structure and the design basis fire would not create an off-site hazard.

6.3 OTHER ACCIDENTS

During the course of the safety analysis of the facility, initial incineration process and other operations, it was apparent that other accidents, of less consequence than the maximum

credible accident and design basis fire, were a possibility. Some of these are described below while others are mentioned in the Engineering Safeguards section.

6.3.1 SHREDDER FIRES

A common accident in commercial waste incineration processes is fire in the shredders caused by metal objects inadvertently entering the shredder. Sparks can easily ignite the shredded wastes. The CAI shredder is actually a low speed cutter (Shred Pax AZ-7) with automatic reverse to prevent overloading and damage. The unit is housed in a special enclosure in the sorting glovebox; any fire would be snuffed rapidly by an automatic on/off sprinkler head connected to a pressurized controlled-volume water supply.

6.3.2 NITROCELLULOSE

Waste material originating from laboratory and metallurgical process areas has the possibility of containing nitrocellulose produced by the use of materials such as cheesecloth or paper tissues to clean up a nitric acid spill. The incinerator at the LASL Plutonium Facility has experienced two such incidents, neither of a serious nature, in fifteen years of operation. No incidents have occurred since the initiation of operating instructions requiring thorough water rinsing of such materials prior to disposal.

There are currently no methods to adequately screen wastes in the feed preparation line to prevent nitrocelluloses from entering the incinerator where, if significant quantities of pyroxlin (cellulose hexanitrate) were present, an explosion would occur.

The production of pyroxylin in the absence of sulfuric acid or other dehydrating agents is difficult with the majority of the nitrated celluloses being in the form of collodion (cellulose triand and tetranitrate). Collodion is a fire hazard, but not explosive.

If 500 ml (one standard reagent bottle) of concentrated nitric acid (70 percent) were absorbed into cellulose material it is exceedingly unlikely that more than 10 percent, or 0.79 g-mol of the acid would result in the production of pyroxylin.

Upon incineration of 0.79 g-mol of pyroxylin the resulting explosion would create 165 ft³ of gases. With no allowance for venting, the resultant pressure would be on the order of 11 psi. The incinerator would, of course, vent through the offgas stack.

It is not probable that the offgas treatment equipment would be damaged, and the pressure pulse would be attenuated by both the volume and the restrictions of the offgas treatment components. It is also not probable that the offgas HEPA filter would be breached. The combustion air glovebox confines any venting through the underfire air and burner air nozzles (Fig. 6.3.2-1). Expansion of the leaked gases from the pressure pulse into the combustion air glovebox and ash removal gloveboxes might breach these gloveboxes through the gloveports or HEPA filters, venting into the Zone 2 areas.

It might also be possible that the incinerator would vent through the loading guillotine door into the ram feed glovebox and possibly start a fire if a waste package were present and ready for loading. The automatic fire suppression system would be activated, and no serious consequences beyond the possible venting in to the Zone 2 area would be expected. The Zone 2 area partitions would not be breached. Contaminated ash could be spread into the Zone 2 area. The process line would have to be shutdown, affected areas decontaminated, and repairs made. No further consequences would be expected.

An accident of this magnitude from a nitrocellulose explosion is on the edge of credibility, but this example indicates the capability of the process line to be operated safely through any reasonably likely incident.

6.3.3 PERCHLORATES

Accidents involving perchlorates from the use of perchloric acid in chemistry procedures has also been considered. However,

**SEALED INCINERATOR
AIR DELIVERY SYSTEM**
TREATMENT DEVELOPMENT FACILITY

Fig. 6.3.2-1

the use of perchloric acid is restricted both in the TDF and in other LASL facilities, and is essentially limited to microchemical techniques, so that the consequences of an accident involving perchlorates received in the waste matrix would be much less than that of organic nitrates described above.

6.3.4 PYROLYSIS

Waste material fed into the incinerator, particularly when fed on a batch basis, could lead to pyrolysis with possible collection of unburned gases within the lower chamber. Sudden ignition of such collected gases might cause a pressure pulse within the incinerator. This is a common occurrence in commercial installations where the incinerator is charged to capacity prior to ignition of the burners, but this rarely causes any damage.

The incinerator controls require that the incinerator is started and brought to operating temperature prior to the introduction of any waste feed. The controls also require that the lower chamber burner is on before waste is charged. A low chamber temperature or loss of the burner flame automatically prevents feeding of fresh waste by interrupting the ram feeder cycle.

Three types of shutdowns are used for the CAI process: controlled, fast, and emergency. A controlled shutdown takes approximately 12 hrs to complete. There is no danger of accumulating pyrolysis products because the burner flame is maintained well after feeding has stopped. A fast shutdown is for more serious faults. A two minute delay is used after the last charge before all combustion air supplies and the burners are shut off. Snuffing steam is used to deny oxygen to the combustible waste and cool the system. The two minute delay is used to prevent accumulation of pyrolysis products that are rapidly produced immediately after the charge. An emergency shutdown is used for very serious faults that could lead to release of contamination to the outside environs or potential operator harm. For such a shutdown the two-minute delay is eliminated, the blowers are shut off immediately, and snuffing steam is injected. In an emergency

shutdown, the risk of accumulating pyrolysis products is less severe than the primary fault.

6.3.5 NUCLEAR CRITICALITY

Nuclear criticality is not a consideration in the TDF Safety Analysis due to the 100 g maximum inventory limit for transuranics. As the 100 g limit is considerably less than the minimum critical mass of ^{239}Pu , the major constituent of the contaminants to be processed at the TDF, as well as ^{241}Pu , the other fissionable constituent having a relatively small critical mass. Other transuranics, americium, berkelium, curium, neptunium, etc., are not fissile. Further, at a concentration level of 100 nCi/g, the volume of wastes containing 100 g of transuranics would be some 23,000 ft³ or 11,500 containers packaged as planned. Even after processing at a volume reduction factor of 20, this quantity of material would occupy some 1100 ft³ or some 170 55-gal DOT drums, the geometry of which would be somewhat less than ideal for criticality.

6.3.6 TORNADOES

Tornadoes in New Mexico are very rare above 7000 ft. Although seven have been reported in the Los Alamos region since 1916, the actual locations of these storms were to the east and at lower elevations. No tornado loadings have been considered in the facility design.

6.3.7 EARTHQUAKE

Los Alamos is located in an area of moderate earthquake activity and is listed as being in a Uniform Building Code Seismic Zone II region. Although a major surface fault exists to the west of the site, there is no indication of strong earthquakes associated with it or its associated faults over an extended period of time. No signs of surface faulting are found in the immediate site vicinity. The maximum earthquake intensity to be expected at the site is VII on the Rossi-Forel scale. The facility and utilities are constructed to meet or exceed these Design Code specifications.

6.4 ENGINEERED SAFEGUARDS

To reduce the probability and consequences of accidents and to enhance the overall safety of the operations, a number of engineered safeguards have been incorporated in the design of the Controlled-Air Incineration process. The following descriptions are based on operational sequence modes for clarity of explanation.

6.4.1 PROCESS FEED PREPARATION LINE

The following functions are performed in the feed preparation line:

1. Receiving and storing of packaged contaminated waste,
2. introduction and inspecting of packaged waste, assay, and x-ray examination.
3. sorting and segregating of materials into combustible and noncombustible fractions and the removal of undesirable chemicals not compatible with the process,
4. volume reduction and packaging of noncombustible waste, and
5. shredding, compaction, and interim storage of combustible fractions for feed to the incinerator.

The equipment required to perform these tasks and the function of each piece of equipment with the engineered safeguards for each component in the line is explained in the following paragraphs.

6.4.1.1 SLOT BOX

The slot box serves as the receiving station for all radioactive trash introduced into the Feed Preparation Line. A drum lift, package lift, assay system, and an alpha monitor are located in the slot boxes.

A heat-operated, controlled volume, sprinkling system is installed in the slot box as are 140° F heat detectors which initiate a fire alarm when activated. Additionally, operating procedures do not allow waste to be left unattended in the slot boxes.

6.4.1.2 DRUM LIFT

The drum lift is used to raise 30-gal DOT drums into the receiving slot box through an annulus in the bottom of the box. The stroke of the drum lift is limited to that required to translate the top of the drum four inches into the slot box. The lift has a position locator to center the drum on the lift. The opening in the bottom of the box is large enough to admit the drum clamp ring; therefore, it is too large to catch fingers and hands between the drum and the edge of the slot box.

6.4.1.3 PACKAGE LIFT

The package lift is a small electrically operated hoist with clamps for attaching the bag or box contained in the drum and raising it into the slot box. There is no hazard connected with the operation of this hoist since it is electrically shielded against shock and mechanically shielded for protection of hands and fingers.

6.4.1.4 ASSAY SYSTEM

The Multi Energy Gamma Assay (MEGAS) is a device and method designed for automatically assaying a package of waste and determining the TRU content in nCi/g. The major portion of the electronics of the MEGAS is located external to the slot box. Components inside the slot box are a detector and a package support that rotates the waste container and translates it vertically past the detector.

No shock hazard exists with the MEGAS because of electrical shielding and grounding. Mechanical hazards are eliminated by placing all motors and gears in a closed compartment underneath the slot box.

6.4.1.5 ALPHA MONITOR

The alpha monitor used in the slot box is an air proportional type. The detector is inside the slot box and the electronics are external to the box. The alpha monitor is used to check each incoming waste package for external alpha contamination. No hazard is associated with its use.

6.4.1.6 AIR LOCK

An air lock with a conveyor is used to transfer waste packages from the receiving slot boxes to the sorting gloveboxes. The air lock isolates the gloveboxes from the slot boxes for contamination control. The exit hatch into the glovebox is interlocked to prevent opening the slot box entrance hatch until the exit hatch is closed allowing the air lock pressure to equalize with the glovebox pressure. All airflow is toward the gloveboxes. The exit door cannot be closed by the operator at the entrance, thus preventing injury to the receiving operator. Additionally, all of the doors within the feed preparation line are vertically operating and are actuated by pneumatic cylinders. The downstroke exhaust air from each cylinder passes through a whistle which produces an audible alarm. The pressure relief time and the downstroke speed provide ample time to alert an operator that the door is closing.

6.4.1.7 PACKAGE X-RAY

An x-ray system similar to those used at airport security inspection stations is installed around the air lock. The operator opens the hatch, places the waste package on the conveyor, removes his hands from the box, and starts the system in motion. The conveyor moves the package into the air lock past two 6" x 14" Lexan windows, one on either side of the air lock near the center of the air lock tunnel. The package is automatically scanned by the x-ray system.

The "flying spot" x-ray beam is 0.04 in. wide and 0.26 in. high at the face of the detector. The detector, x-ray source, collimator, and the chopper wheel assembly are located external to the air lock.

The dose rate at the face of detector housing is 0.004 mR/hr at 100 keV and 8 mA. The air scatter dose rate at all points outside the plane of the x-ray beam is less than 0.01 mR/hr, which is a factor of five below the natural background dose rate at this altitude. No hazard is associated with normal operation of the x-ray inspection system.

When the x-ray scan is complete, the operator closes the entrance hatch and the air lock pressure equalizes with the glovebox pressure. The glovebox pressure is negative with respect to the air lock, therefore, the air flow is into the glovebox preventing the back-spread of contamination. The exit door is opened, but only if the interlock with the entrance door is satisfied. Both doors cannot be opened simultaneously and the exit door can be closed from the exit station only. The waste package is then conveyed to the sorting glovebox.

6.4.1.8 SORTING GLOVEBOX

The sorting glovebox serves as a station for opening the contaminated waste container to remove noncombustibles and hazardous materials detected by the x-ray scan. If the x-ray scan indicates there are no noncombustible materials in the container, the package is passed to the storage glovebox. If noncombustibles or hazardous materials are present, the package is opened and sorted. Glass and metals are separated and placed in suitable containers for bagging out of the line. Bottles of liquids or other items judged to be hazardous to the incineration process are bagged out and returned to the sender. The can crusher is interlocked to prevent operation unless the loading door is closed. The operating controls are located on the outside of the glovebox.

The sorting glovebox is equipped with an automatically operated, controlled volume sprinkler system using on/off heads. Heat sensors with associated alarms and controls are used to alert the Fire Department and operating personnel of any abnormal temperature rise in the boxes. The water spray valves close when the temperature inside the boxes is lowered below 190° F.

6.4.1.9 SHREDDER

The shredder used in the feed preparation line is a coarse chopper or pre-shredder. It is equipped with a loading door designed to preclude the operator's hands from entering the

shredder blades. The operator places the material on the loading door, as the door is raised to the closed position, the material dumps into the shredder hopper. Pieces of tramp metal that might accidentally be placed in this shredder will not cause a fire because the slow speed operation does not generate enough heat. However, an automatic water spray system is installed as an extra precaution for protection against fire. The loading door isolates the shredder from the sorting line so an incident in the sorting line is not easily translated to the shredders and likewise an incident in the shredder is isolated from other components in the facility. The shredder discharge shield blocks hand access to the shredder discharge area during shredding operation.

6.4.1.10 COMPACTOR

After the material has been sorted, the operator has the option of passing it directly to the incinerator without further processing, shredding, compacting or a combination of these depending on the operational program.

The compactor is a small inexpensive commercially produced machine that can be bagged out of the line in case of a failure. The compactor is key locked and interlocked to prevent operation unless the loading door is closed.

6.4.1.11 WASTE STORAGE BOX

The waste storage box serves to accumulate a sufficient quantity of materials for a run or part of a run. No operation is performed at this location that requires the use of mechanical equipment. The storage glovebox is the only location in the feed preparation line where waste may be left unattended. However, the waste boxes have been inspected and this glovebox is isolated from the adjacent gloveboxes by one-half inch thick metal doors. Heat detectors installed in the box initiate a fire alarm if the temperature rises above 140° F. The waste storage box is protected by a heat sensitive controlled volume water spray device that will automatically initiate water spray in the event of a temperature in the box greater than 140° F.

6.4.1.12 RAM FEEDERS

Two ram feeders are used to charge the incinerator--a side ram and a main ram. The entrance to the side ram is at the exit of the waste storage box. The operator places waste material on the side ram elevator platform, closes the loading hatch, and presses the load button. The loading hatch controls are located exterior to the glovebox in a position that requires the operator's right hand be removed from the glove to operate the controls. The loading door cannot be reached with the left hand in the glove, and the left hand cannot reach the controls with the right hand in the loading door. If all interlocks are satisfied, the sequence of events are as follows:

1. The elevator platform raises the package to the level of the incinerator charging door.
2. The side ram starts forward.
3. The side to main ram door opens.
4. The side ram continues forward and displaces the package in front of the retracted main ram.
5. The side ram retracts and pauses behind the side to main ram door.
6. The side to main ram door closes.
7. The side ram retracts fully.
8. When the side to main ram door closes the refractory lined incinerator loading door (or guillotine door) opens and the main ram starts forward.
9. The main ram pushes the material into the incinerator and retracts to a point just behind the loading door.
10. The loading door closes; a UV detector scans for fire, and if no fire is detected,
11. The main ram retracts fully.

Interlocks prevent operation of the side ram until the loading door is closed and the incinerator is ready to receive waste. The main ram will not operate until the side ram to main ram door is closed. If either ram is jammed, it will recycle until the obstruction is cleared or is shut down for subsequent cleaning. The ultraviolet flame detector in the main ram feed chamber will initiate an argon gas purge and cause the main ram and loading door to cycle if a flame is detected. The flow of argon and cycling of the ram and loading door will be interrupted only when the flame is extinguished.

6.4.2 INCINERATOR

The TDF incinerator is a commercially produced dual chamber unit modified to insure combustion flexibility and efficiency and to provide confinement and permit operation and maintenance under radioactive service conditions.

The primary chamber operates over a variable temperature range of 1400 to 1600° F at near stoichiometric air conditions. Supplementary natural gas feed is provided to maintain flame and temperature. Saturated steam is injected as a tempering medium to control high temperatures associated with combustion of waste species with high caloric content. The steam also serves to retard the formation of free carbon and increases the overall combustion efficiency.

Gaseous products from the primary chamber discharge to a secondary chamber and mix with air sufficient to increase total air to 150% of that theoretically required for combustion of design basis feed. Supplementary natural gas is provided to maintain flame and 2000° F chamber temperature. The chamber provides sufficient residence volume for complete combustion of gaseous combustion products.

6.4.2.1 INCINERATOR CONTROLS AND INTERLOCKS

The controls and interlocks are designed to prevent unsafe operation of the incinerator and are a direct result of many hundreds of hours of review. The controls and equipment exceed

all present and anticipated standards such as U.L., F.M., and F.I.A. The safety of the CAI far exceeds that of the vendor supplied equipment which met O.S.H.A. and F.I.A. standards.

6.4.2.2 STARTUP CONTROLS

The start-up of the incinerator automatically controlled by a programmable timer and all pre-ignition interlocks must be satisfied. The start-up sequence is as follows: 1) purge air flows until at least four complete air changes have occurred to insure that there is no combustible gas mixture in the incinerator or the offgas cleaning train. 2) Upon completion of the air purge cycle, pilot ignition must occur and prove within ten seconds. If the flame detector does not sense a pilot flame, the operator must re-initiate the start sequence from 1 above after correcting the fault. 3) The main burner receives a signal to fire. 4) Gas and air are supplied to the main burner and flame must be proven within 15 s or the complete system is shut down and the operator must re-initiate the start sequence after correcting the problem.

6.4.2.3 PRE-IGNITION INTERLOCKS

The control system for the controlled-air incinerator process is wired to prevent process start-up if certain faults in process equipment are detected.

The following process faults must not be present in order to start the incinerator:

- Lower chamber temperature high
- Upper chamber temperature high
- Combustion air pressure low
- Secondary air pressure low
- Lower burner fuel gas pressure high/low
- Upper burner fuel gas pressure high/low
- Lower chamber pressure high
- Lower chamber pressure low
- Upper chamber excess air low
- Upper ash door not closed

- Lower ash door not closed
- Quench tower sump temperature high
- Weir liquid flow low
- Quench spray lance #1 liquid flow low
- Quench spray lance #2 liquid flow low
- Quench spray lance #3 liquid flow low
- Auxiliary water pressure low
- Auxiliary water level low
- Scrubber sump pump pressure low
- Scrubber sump pump seal water flow low
- Process liquid pump pressure low
- Plant water pressure low
- Plant air pressure low
- Instrument air pressure low
- Process steam pressure low
- Quench tower sump level low
- Absorber tower sump level low
- Absorber tower liquid flow low
- Venturi liquid flow low
- Cooling tower sump pump pressure low
- Secondary heat exchanger sump pump pressure low
- Condensate sump pump pressure low
- Primary heat exchanger outlet temperature high
- Process liquid specific gravity high
- Process offgas superheat low
- Process liquid pump seal water flow low
- Condensate sump pump seal water flow low
- Auxiliary generator down
- Primary heat exchanger shell to tube pressure drop low
- Process HEPA #1 pressure drop high
- Process HEPA #1 pressure drop low
- Process HEPA #2 pressure drop high
- Process HEPA #2 pressure drop low
- Process liquid pH low

- Condensate pH low
- Primary heat exchanger sump liquid level high
- Primary heat exchanger sump liquid level low
- Process sump liquid level high
- Process sump liquid level low
- Condensate sump liquid level high
- Condensate sump liquid level low
- Induced draft blower #1 and #2 flow low or bearing temperature high

6.4.2.4 OPERATING CONTROLS

After start-up, the incinerator is brought to the operating temperatures specified by the run plan. This can be done manually by periodically resetting the chamber temperature controllers or automatically with a programmable set point generator.

In the run mode, the incinerator temperature is maintained within the limits prescribed in the run program plan by the temperature controllers. If any of the operating parameters differ from preset limits, the incinerator is automatically shut down.

6.4.2.5 SHUTDOWN CONTROLS

The detection of certain faults in the process equipment controls and interlocks will initiate one of three logic sequences provided to shut down the process in a safe and orderly manner as dictated by the nature and possible subsequent consequences of the fault.

Combustion air is supplied to the incinerator from the Zone 2 enclosure via electric motor driven blowers which operate off the normal electrical power or the auxiliary generator power. In the event of failure of both blowers, the low air flow switch causes a shutdown of the incinerator. However, the main facility blower supplies sufficient draft for a safe, orderly shutdown. All of these blowers are connected through the emergency load control center and are powered by the auxiliary generator in the event of a failure of the normal electrical power.

6.4.2.5.1 SCRAM

The most serious faults are designated **SCRAM**, or emergency shutdown, and result from any condition that can lead to an immediate loss of radioisotope containment. **SCRAM** can be initiated at any time at the discretion of an operator by way of a manual override.

The following faults will initiate a **SCRAM**:

- Loss of power (main and auxiliary)
- Process HEPA #1 pressure drop low
- Process HEPA #2 pressure drop low
- (Manual activation)

The resultant action associated with activation of a **CAI SCRAM** fault will simultaneously cause:

- Waste feeding interrupted
- Upper and lower burners shut down
- Combustion air blower shut down
- Combustion air dampers (3) closed
- Secondary air blower shut down
- Secondary air damper closed
- Snuffing steam injected into lower chamber
- Venturi throat opened
- Primary and secondary induced draft blowers shut down
- Induced draft dampers (2) closed

6.4.2.5.2 FAST SHUTDOWN

Faults that likely will result in damage to major process components are designated **FAST SHUTDOWN**.

The following faults will initiate a **FAST SHUTDOWN**:

- Lower chamber temperature high-high
- Upper chamber temperature high-high
- Process Liquid pump pressure low-low
- Quench tower sump temperature high-high

The resultant action associated with activation of a fast shutdown is identical to that of a **SCRAM** except it is delayed for a two-minute period following the last waste feeding

operation. Should the fault circuit be activated during the two-minute period, the action will be delayed for the balance of the period. Should the fault circuit be activated outside the two-minute period, there will be no delay.

6.4.2.5.3 CONSEQUENCES OF A SCRAM OR FAST SHUT-DOWN

The main objective of a SCRAM or fast shutdown is to reduce the incinerator to a nonreactive state as quickly as possible. This is done by reducing the incinerator temperature and by producing an inert atmosphere in the incinerator.

6.4.2.5.3.1 TEMPERATURE REDUCTION

The primary thermal containment in the incinerator is a 5" thick dense refractory lining. The inner surface of this lining is heated to 2000° F and the outer surface reads a temperature of about 1000° F during constant incinerator operation. The refractory can withstand the stress associated with a thermal gradient of this magnitude.

In a SCRAM or fast shutdown situation the burners are extinguished and saturated steam is injected. The interior surface of this lining is thus suddenly cooled several hundred °F resulting in a thermal gradient that ranges from about 1000° F at the outer surface of the refractory to about 1800° F near the surface; from that high point to the inner surface, the gradient then reverses to some lower temperature. This gradient reversed results in a very high stress near the inner refractory surface, and in weaker areas the surface will tend to relieve by forming small cracks. In the worst instance, rarely seen, rapid cooling will cause flaking at the surface.

Inspection of refractory linings in incinerators that are subjected to rapid temperature changes shows interior surface degradation. This degradation migrates back through the lining in time.

6.4.2.5.3.2 CORROSION

The CAI process uses saturated steam as a snuffing medium during **SCRAM** and fast shutdown. One consequence in using steam is that it permits ionization and transport of acids present in the reaction zone of the incinerator when the temperature is reduced to a point to allow condensation. Materials of construction were selected with this eventuality in mind. Nonetheless, some corrosive damage is anticipated to the refractory and to any area where corrosion barriers may not be intact each time the process experiences a **SCRAM** or fast shutdown.

6.4.2.5.4 CONTROLLED SHUTDOWN

CONTROLLED SHUTDOWN faults are those that may result in significant damage to minor process components if uncorrected. Faults that fall into this category do not pose an immediate threat to the safe operation of the process and tend to be remediable without requiring an abort of the incinerator operation.

The following faults will initiate a controlled shutdown:

- Lower burner flame failure
- Upper burner flame failure
- Lower chamber temperature high
- Upper chamber temperature high
- Combustion air pressure low
- Secondary air pressure low
- Lower burner fuel gas pressure high/low
- Upper burner fuel gas pressure high/low
- Lower chamber pressure high
- Upper chamber excess air low
- Ram feeder fire
- Quench spray lance #1 liquid flow low
- Quench spray lance #2 liquid flow low
- Quench spray lance #3 liquid flow low
- Auxiliary water pressure low
- Auxiliary water level low
- Scrubber sump pump pressure low

- Scrubber sump pump seal water flow low
- Process liquid pump pressure low
- Plant water pressure low
- Plant air pressure low
- Instrument air pressure low
- Process steam pressure low
- Cooling tower sump pump pressure low
- Secondary heat exchanger sump pump pressure low
- Condensate sump pump pressure low
- Primary heat exchanger outlet temperature high
- Process liquid specific gravity high
- Process offgas superheat low
- Process liquid pump seal water flow low
- Condensate sump pump seal water flow low
- Auxiliary generator down
- Primary heat exchanger shell to tube pressure drop low
- Process HEPA #1 pressure drop high
- Process HEPA #2 pressure drop high
- Induced draft blower #1 and #2 flow low or bearing temperature high
- Manual activation

When a controlled shutdown fault occurs, a programmable set point generator is activated that directs remote set point input to the temperature controllers for the upper and lower chambers. The resulting input causes a gradual decrease in the chamber temperatures. Switches internal to the set point generator cause the following actions:

Sequentially:

- Waste feeding interrupted (at activation)
- Upper burner shut down (at upper chamber temperature of 1000° F)
- Lower burner shut down (at lower chamber temperature of 750° F)

6.4.3 OFFGAS CLEANING TRAIN

The primary purpose of the offgas system is treatment of the incinerator combustion products to reduce release of noxious materials to as low as practical and permit safe discharge to the environment. The standards used for gaging acceptable discharge limits are DOE Manual Chapters 0510 and 0513. The system is capable of handling a wide range of input parameters. Among the adverse conditions anticipated are tars and soot from incomplete combustion, high particulate loadings, and corrosive gases (HCl, SO₂, NO_x, and possible HF). In addition to the primary requirement of assuring that all effluents satisfy health and safety standards, the effluent treatment systems must provide capability for testing and evaluation of incinerator and effluent treatment system component performance.

The offgas system includes the following primary components to treat the offgas prior to discharge to the environment.

6.4.3.1 QUENCH CHAMBER

The incinerator offgases are cooled to a temperature of 150° F to 180° F by evaporation of water mist to permit use of conventional structural materials to the extent practical and to minimize thermal problems in the system. Quench water is supplied from the recirculatory scrub solution system. A pressurized water tank is employed as an auxiliary quench water reservoir. Two other backup sources of water are available: 1) city water, and 2) water recirculated from the scrubber sump. The auxiliary quench water supply is initiated on loss of pressure to the spray nozzles or high quench chamber exit temperature. These alarms also shut down the incineration process.

6.4.3.2 VENTURI SCRUBBER

A high efficiency venturi scrubber provides removal of fine particulates and extends HEPA filter life. The venturi scrubber is a variable throat unit to permit adjustment of pressure drop (15 to 80 in. W.C.) and vary efficiency for test purposes. The normal set point is 50 in. W.C.

6.4.3.3 PACKED COLUMN SCRUBBER

A packed column scrubber is installed to provide counter-current contact between the offgases and scrub water to remove mineral acids such as HCl and SO_x. The scrub solution is returned to the process sump tank for recirculation. There are no hazards associated with this passive device.

6.4.3.4 CONDENSER

The condenser is a vapor-liquid generator that operates by cooling the saturated gas stream. It is followed by an integral chevron demister that removes entrained water droplets. There are no critical parameters associated with the operation of this unit.

6.4.3.5 OFFGAS HEATER

An electric resistance-type offgas heater is provided to precede the filters and is sized to assure a 30° F (17° C) super heat of the gases prior to filtration to raise the temperature above the dew point thus preventing moisture condensation in the filter medium and subsequent blocking. The heater is alarmed if the temperature differential drops below 30° F (17° C).

Overheat protection is provided by a thermal switch set at 250° F (121° C). The switch is located downstream from the heater section, but close enough to be responsive in a static or near-static flow situation. The switch is shielded from direct radiation from the heater elements. It is wired in series in the heater power supply circuit.

6.4.3.6 IMPINGEMENT SCREEN AND ROUGHING FILTER

A 0.125 in. screen of 20 gauge 316 stainless steel convoluted plate is installed in the process filter plenum to protect the filters from projectiles or sparks from damaged or failed upstream equipment. A roughing filter is provided to prevent premature loading of the HEPA filters. The differential pressure across this filter is monitored in conjunction with the HEPA

filters and the process is shut down if the pressure drop exceeds a preset value.

6.4.3.7 HEPA FILTERS

The final gas cleanup is provided by a High Efficiency Particulate Air (HEPA) filter system of the type and design used for cleanup of air streams containing radioactive particulates. Provisions for in situ DOP testing are included. The differential pressure across the HEPA's is monitored and the process is shut down if this pressure drop exceeds preset high and low limits.

6.4.3.8 INDUCED DRAFT BLOWERS

Two multistage centrifugal blowers are provided to maintain air flow through the incinerator and offgas system. Each fan is connected to both the normal and auxiliary power supply systems. One of these blowers is in service to provide the negative system pressure when transuranic materials are being processed. The blowers are interlocked with the incinerator controls and prevent a start-up if the blowers are inoperative and initiate a shutdown if either blower fails. These blowers are also interlocked so that the failure of the designated blower will automatically start the standby blower.

An automatic crossover routes the process offgases to the main building HEPA filter plenum so that the main exhaust blowers will maintain a negative head on the process in the event of loss of both induced draft blowers.

Both the main exhaust blower and the auxiliary blower are powered by the normal electrical supply and the auxiliary generator.

The process exhaust crossover enters the main filter plenum just upstream from the second bank of HEPA filters providing an additional filtration stage in the event of a penetration of a process HEPA filter.

7. FACILITY EXPANSION

7. FACILITY EXPANSION

The design of the process high bay area and the feed preparation area allow considerable flexibility for interchange, movement, or relocation of equipment for process modifications and installation of subsequent processes.

The loading and storage areas are located on the east side of the building and the building ventilation blowers, building stack and auxiliary generator are located on the west so that adequate space is left available to allow construction of additional buildings or facilities adjacent to the south and part of the east sides of the present building for future expansion.

8. POLLUTION CONTROL

8.1 Radioactive Effluents

8.1.1 Gaseous Effluents

8.1.2 Liquid Effluents

8.1.3 Solid Wastes

8.2 Nonradioactive Effluents

8.2.1 Gaseous Effluents

8.2.1.1 Process Offgases

8.2.1.2 Zone 4

8.2.1.3 Mechanical Equipment Room

8.2.1.4 Cooling Tower

8.2.2 Liquid Effluents

8.2.2.1 Sanitary Sewer

8.2.2.2 Industrial and Cooling Water

8.2.2.3 Natural Run Off

8.2.3 Solid Wastes

8. POLLUTION CONTROL

8.1 RADIOACTIVE EFFLUENTS

8.1.1 GASEOUS EFFLUENTS

Three levels of containment, with ventilation control, are provided for the process areas to minimize the possibility of spread of transuranic contaminants. The initial process, controlled air incineration, is provided with an offgas cleaning train consisting of a quench chamber, venturi scrubber, gas-liquid separator, packed column scrubber, condenser offgas heater, and an ash filter. The gas stream is then double HEPA filtered prior to release from the facility stack.

All air exhausted from the feed preparation line, incinerator, and ash removal enclosures is HEPA filtered as it leaves the gloveboxes and then double HEPA filtered in the head end process filter plenum prior to injection into the main exhaust blower inlet duct to be released through the facility stack. All air from the low and high bay process areas, the support laboratories, shop, control room, and change rooms, Zones 2 and 3 is exhausted via the facility exhaust system and is double HEPA filtered prior to transport to the facility stack. The stack is continuously sampled to assure that DOE annual standards are not exceeded.

8.1.2 LIQUID EFFLUENTS

All liquid effluents from the preparation and process bays and the hot laboratories are collected in a separate drain system and sump. Process scrub liquid is filtered, cooled and recirculated to the scrub tank. These liquid wastes are transferred through the special underground pipeline to TA-50 East, the LASL Industrial Liquid Waste Disposal Site, for treatment and disposal.

8.1.3 SOLID WASTES

All solid wastes from the Zone 2 and 3 laboratories and machine shop is collected separately. These wastes consist

mostly of compacted or incinerated solid wastes, along with occasional wastes from repair or replacement of failed equipment. A part of the purpose of the TDF is to develop technology for packaging and storing of these wastes and handling of these solid effluents in accordance with this phase of the research program. In accordance with DOE requirements, solid wastes with significant transuranium nuclides are packaged and stored in the LASL Retrievable Storage Facility at TA-54.

8.2 NONRADIOACTIVE EFFLUENTS

8.2.1 GASEOUS EFFLUENTS

8.2.1.1 PROCESS OFFGASES

Incineration of the plastics and rubber components of the waste materials processed in the TDF leads to the formation of several noxious gases. Principally, these are NO_x , SO_x , HCl , Cl , and possibly HF . This effluent is processed by the offgas treatment equipment which is effective in reducing the noxious components prior to release to the environment. This effluent will be continuously sampled and analyzed during experimental process runs to insure Federal and State emissions standards are not exceeded (ref. Section 4.7.1.1).

offgases from the Zone 2 and Zone 3 areas are double filtered prior to insertion in the facility stack. Administrative controls are utilized to minimize acid fume impingement on the HEPA filters from the chemistry and decontamination activities. Other gaseous contaminants are diluted in the ventilation exhaust system and facility stack prior to dispersion in the atmosphere, and do not constitute a hazard to the environment.

8.2.1.2 ZONE 4

The air exhausted from Zone 4, the second floor, is not contaminated with radioactive material. This air is exhausted to the atmosphere unfiltered. Fumes from the chemistry, process, and waste technology laboratories are exhausted through standard fume hoods. Dilution from the hood ventilation flow rates and atmospheric dispersion preclude any excessive fume concentrations.

8.2.1.3 MECHANICAL EQUIPMENT ROOM

Air exhausted from the mechanical equipment room is also not filtered. The exhaust gases from the heating furnace exhausts through a separate stack in the west end of the building. As this is a natural draft system, these effluents cannot be introduced into the facility stack. The furnace is natural gas fired, therefore no problems with pollution standards are anticipated.

8.2.1.4 COOLING TOWER

The cooling towers are mechanical draft counter flow towers utilizing city water for the tertiary coolant. Warm air, water vapor and a small amount of drift (entrained water droplets) are exhausted to the atmosphere. The water treatment chemicals, a small amount of which will be contained in the drift, are non-toxic and biodegradable. The towers will operate only intermittently, about five days per four to six week period. Numerous towers of this general type, largely at much greater capacities, are currently in use in the Laboratory, and create no problems.

8.2.2 LIQUID EFFLUENTS

8.2.2.1 SANITARY SEWER

The sanitary wastes generated by the staff occupying this facility is discharged to a sanitary waste treatment plant and lagoon designed to serve this facility and other laboratory facilities at TA-35, TA-48, TA-50, and TA-55.

8.2.2.2 INDUSTRIAL AND COOLING WATER EFFLUENTS

All liquid effluents from the facility except the natural runoff are handled by either the sanitary sewer or the special drain system and transferred to TA-50.

Process and laboratory liquid wastes are collected in the building sump and transferred by underground pipeline to the LASL Liquid Waste Treatment Facility which serves several technical areas. There is an addition of about 500 gal/day of operation to the 50,000 gal/day received by the Treatment Facility from the other facilities. Thus, the TDF activities have a very small impact on the operation of the Liquid Treatment Facility. There

is no air-conditioning for the facility and the cooling towers supply chilled water to the process heat exchangers only.

The two cooling towers are mechanical draft counter flow towers. At the rated load of 2.2 million Btu/hr and a blowdown factor of 25% to control total dissolved solids, a maximum of 700 gal/day of operation (an average of five days per four to six weeks) of tertiary cooling water (city water make up) is released to the sanitary sewer. This does not add enough water to the sewage treatment system to alter its operation. While this effluent does contain a larger percentage of dissolved solids, this is not considered to be a problem.

It is not probable that these effluents could enter the main aquifer that supplies the Laboratory and community wells, as this lies in the Tesuque and Puye Formations 600 to 1200 ft beneath the surface of the plateau. The recharge area for the main aquifer lies in the Jemez Mountains several miles west of the TDF Site.

8.2.2.3 NATURAL RUNOFF

All storm water runoff is channeled to adjacent canyons in such a manner that erosion is negligible. Native grasses planted in the disturbed areas minimize runoff erosion. Surface runoff generally follows existing drainage patterns to the adjacent canyons. Since 1960, when hydrologic observations began, all storm runoff as well as cooling water and industrial effluents have infiltrated into the alluvium, and except in rare periods mentioned above, and in Section 3.2, have remained in the canyons. It is not anticipated that there will be a great land-use change which would add enough water runoff to alter the present hydrologic conditions.

8.2.3 SOLID WASTES

The nonradioactive solid wastes from the office and Laboratory activities in Zone 4 and other clean areas are collected and transported by the Zia Company Supply and Transportation Division to the County Sanitary Landfill in accordance with current Laboratory policy.

9. ENVIRONMENTAL MONITORING PROGRAM

9.1 General

9.2 Atmospheric Monitoring

9.3 Penetrating Radiation Monitoring

9.4 Water Monitoring

9.5 Soil and Sediment Monitoring

9.6 Foodstuffs Monitoring

9.7 Chemical Constituents Monitoring

9.8 Flora and Fauna Monitoring

9.9 Special Monitoring

9. ENVIRONMENTAL MONITORING PROGRAM

9.1 GENERAL

The Laboratory has maintained an environmental monitoring program essentially throughout its existence. This program has changed in emphasis over the years as new programs are added and new potential sources of discharge to the environs have developed or older programs and sources are phased out.¹ By far the greatest emphasis in this program has been placed on measurements of radiation and radioactive materials in the environs along with programs for measuring quantities of effluents and radioactive contaminants at the point of discharge. However, special studies, and in some cases, continuing programs to measure the quantities of toxic agents such as beryllium or explosives have been conducted as needed.

Since a program covering all activities in the Laboratory is available, a specific environmental monitoring program for this facility is not envisioned. The current monitoring program is described to indicate the extent of the coverage.

9.2 ATMOSPHERIC MONITORING

Worldwide background atmospheric radioactivity is composed of fallout from atmospheric nuclear weapons tests, natural radioactivity constituents in dust from the earth's surface, and radioactive materials resulting from interactions with cosmic radiation. Air is routinely sampled at several locations on Laboratory land, along the Laboratory perimeter and in distant areas to determine the existence and composition of any contributions to radionuclide levels from Laboratory operations.

Atmospheric radioactivity samples are collected at 30 continuously operating air sampling stations in Los Alamos County and vicinity (Fig. 9.2-1). Perimeter stations are located 0 to 4 km from the Laboratory boundary. The regional monitoring

¹ Environmental Surveillance at Los Alamos during 1977, LA-7263-MS, issued April 1978.

stations, located 28 to 44 km from the Laboratory at Espanola, Pojoaque, and Santa Fe serve as reference points in determining the regional background for atmospheric radioactivity.

Atmospheric radioactivity samples are collected daily (Monday through Friday) at the Occupational Health Laboratory (OHL), located immediately southeast of TA-3. This facility houses part of the Environmental Surveillance Group and was chosen both for convenience and the fact it is reasonably close to the center of the Technical Areas. These daily air samples are analyzed for gross alpha and beta activities on collection day and again seven to ten days after collection. These data are used to determine daily and annual atmospheric concentrations.

Tritium analyses are performed on biweekly samples from each of the 30 air sampling stations. A liquid scintillation counting technique is used in conjunction with measured absolute humidity to give the two week average tritiated water vapor concentration in air.

After being measured for gross-alpha and gross-beta activities, the biweekly filters from each station are combined and dissolved to produce composite six- or eight-week samples for each station. An aliquot of each sample is saved for uranium analysis, and plutonium is separated from the remaining solution. For 11 selected stations, the plutonium solutions are combined to represent 12- or 14-week samples. For each of these 11 stations, americium samples are measured for alpha-particle emission with a solid-state alpha detection system. Appropriate alpha-particle energy groups are then integrated, and the concentrations of ^{238}Pu , ^{239}Pu , and ^{241}Am are calculated. This technique does not differentiate between ^{239}Pu and ^{240}Pu . Uranium content of filters is determined from 12- or 14-week composites for each of the 30 air sampling stations. The uranium content of the samples is determined by fluorometric techniques.

9.3 PENETRATING RADIATION MONITORING

Levels of penetrating radiation, including x- and gamma-rays from cosmic, terrestrial, and man-made sources in the Los Alamos area are monitored with thermoluminescent dosimeters (TLD's) at 50 locations. Three of these locations are 28 to 44 km from the Laboratory at Espanola, Pojoaque, and Santa Fe. Sixteen locations are within 4 km of the Laboratory boundary and serve to monitor the perimeters. Thirty-one locations are within LASL boundaries (Fig. 9.2-1). Data from these locations are analyzed to determine regional levels of penetrating radiation and contributions from activities within LASL.

9.4 WATER MONITORING

Surface and ground waters are monitored to provide routine surveillance of potential dispersion of radionuclides from LASL operations (Fig. 9.4-1). Analyses of surface and ground waters from regional perimeter stations reflect base line levels of radioactivity in the areas outside the LASL boundaries. Regional surface waters are collected within 25 km of LASL from six stations on the Rio Grande, Rio Chama, and Jemez River (Fig. 9.4-2). Samples are also collected from seven perimeter stations located within about 4 km of the LASL boundaries, and from 31 stations in White Rock Canyon at the Rio Grande (Fig. 9.4-3).

The on-site surface and groundwater sampling stations are grouped according to areas that are not located in effluent release areas and those located in areas that receive or have received industrial liquid effluents.

The municipal and industrial water supply for the Laboratory and community is from 15 deep wells in three well fields and one gallery. The wells are located on the plateau and in canyons east of the Laboratory (Fig. 9.4-1.). The water is pumped from the main aquifer, which lies at a depth of about 350 m below the surface of the plateau. The gallery discharges from a perched water zone in the volcanics west of the plateau. Water samples are collected from the wells and gallery and at five stations on the distribution system in the Laboratory and community.

WATER, SEDIMENT AND SOIL
SAMPLING LOCATIONS

REGIONAL SAMPLING
LOCATIONS

Fig. 9.4-2

WHITE ROCK CANYON OF
THE RIO GRANDE
SAMPLING LOCATIONS

Fig. 9.4-3

9.5 SOIL AND SEDIMENTS MONITORING

Soil and sediment samples are collected in the same general locations as the regional and perimeter water sampling stations. These samples provide a normal baseline for comparison with samples collected in and adjacent to the Laboratory. On-site soils are collected from four stations within Laboratory boundaries. Sediment samples are collected from four on-site noneffluent release areas and from 13 stations in canyons that have received industrial effluents.

9.6 FOODSTUFFS MONITORING

A sampling program was initiated during 1975 to evaluate possible dose commitment resulting from the consumption of locally produced foodstuffs. As an initial objective, radionuclide detectability was established for certain foodstuff samples. Levels of tritium oxide (HTO), ^{238}Pu and ^{239}Pu , and uranium are determined for selected samples of fruits, vegetables, and cows' milk. Sampling locations include Los Alamos County and the Rio Grande Valley.

9.7 CHEMICAL CONSTITUENTS

A monitoring program for chemical composition of selected on-site and off-site samples is used to determine the impact of Laboratory operations on the environment.

Nonradioactive effluents include airborne and liquid discharges. Airborne effluents from the power plant, steam plant, asphalt plant, beryllium shop, and experiments with explosives are monitored to determine if there is any degradation of air quality. Discharges from the nine sanitary sewage treatment facilities are monitored as are 102 industrial discharge points.

Regional and perimeter surface and ground waters are sampled at the same locations as are used for radioactivity monitoring. These data are used to establish a baseline for natural chemical compositions. On-site water samples are collected from three surface stations, six wells completed in the main aquifer, and one well completed in a perched aquifer in areas that do not

receive industrial effluents, and samples are collected at 21 stations located in canyons that receive sanitary and/or industrial effluent. Comparison of these analyses are used to determine the effects of LASL operations and are reported in the previously referenced annual report.

Municipal and industrial water supplies for the Laboratory and community are sampled at the 15 deep wells, one gallery, and the five stations on the distribution system used for radioactivity monitoring. Chemical analyses of these samples are utilized to ensure the water supply meets all applicable standards.

9.8 FLORA AND FAUNA MONITORING

This program has been recently initiated and is intended to be flexible as to scope and intent. It will probably be conducted on a biennial basis. To date, a cataloging of plant life at six test locations and two control locations in Los Alamos has been carried out. Trap lines have been established at those locations and a number of small animals have been captured. These animals are classified, i.e., weight, sex, and age. The carcasses are then dissected and analyzed: kidneys for mercury; liver and soft tissue for tritium, lead, cadmium, and plutonium; and bone for plutonium and ^{90}Sr .

9.9 SPECIAL MONITORING

The Environmental Surveillance Group maintains a capability to conduct special monitoring studies in all the above areas. These studies are conducted in conjunction with single experiments performed by groups in the technical operating divisions of the Laboratory when deemed necessary or prudent. Special studies are conducted to determine the data of special containments in our environment.

10. WASTE HANDLING, STORAGE AND DISPOSAL

10.1 General

10.2 Process Residues

10.3 Room Trash

10.4 Sanitary Wastes

10. WASTE HANDLING, STORAGE AND DISPOSAL

10.1 GENERAL

The TDF was constructed as part of the federal nuclear waste management developmental program aimed at the improvement of the technology of transuranium waste management and treatment. The TDF program mission is to develop volume reduction techniques, interim storage and improved container development and ultimate disposal of residues from waste treatment processes.

10.2 PROCESS RESIDUES

The solid residues from the processes are collected and placed in sealed containers for storage in accordance with the state of the art as the program progresses. In accordance with DOE requirements, solid wastes with significant transuranium nuclides are packaged and stored in the LASL Retrievable Storage Facility at TA-54.

10.3 ROOM TRASH

All trash from the Zone 3 laboratories and the machine shop are collected separately, packaged and transported to the existing LASL radioactive solid waste burial ground for disposal or storage. Combustibles from these areas may also be incinerated in the TDF study program. The nonradioactive wastes from the office and laboratory activities in Zone 4 and other clean areas are collected and transported by the Zia Company Supply and Transportation Division to the County Sanitary Landfill in accordance with current Laboratory policy.

10.4 SANITARY WASTES

The sanitary waste generated by the staff occupying this facility is discharged to a sanitary waste treatment plant designed to process the sanitary waste from this and adjacent LASL Technical Areas.

11. QUALITY ASSURANCE REQUIREMENTS

11.1 Facilities Construction Quality Assurance Requirements

11.1.1 Scope of Requirements

11.1.1.1 Table of Organization Requirements

11.1.1.2 Resume Requirements

11.1.1.3 Qualifications Requirements

11.1.1.4 Design Review Requirements

11.1.1.5 Construction Inspection Requirements

11.1.2 Compliance Requirements

11.1.3 Documentation Requirements

11.1.4 Auditing

11.2 Waste Management Research and Development Quality Assurance Requirements

11.2.1 Program Plan

11.2.2 Organization

11.2.3 Program Elements

11.2.3.1 Health and Safety

11.2.3.2 Experimental Planning

11.2.3.3 Design

11.2.3.4 Procurement and Fabrication

11.2.3.5 Assembly and Installation

11.2.3.6 Experimental Results/Program Accomplishments

11. QUALITY ASSURANCE REQUIREMENTS

11.1 FACILITIES CONSTRUCTION QUALITY ASSURANCE REQUIREMENTS

The LASL Quality Assurance Program for Engineering and Construction was implemented for this project. The requirements were defined in the issue of LA-5220-M, "LASL Quality Assurance Program for Construction Projects," current at the time of design and construction of the facility.

11.1.1 SCOPE OF REQUIREMENTS

Since the consequences-of-failure of the structures and systems are not more severe than Type III or Type IV, the architect-engineer (A-E) was not required to develop a Quality Assurance/Quality Control (QA/QC) program manual. However, the QA/QC procedures developed by the A-E were approved for compliance by the LASL Engineering Department Office of Quality Assurance (ENG-DO/QA). Documentation defining the following as a minimum was transmitted to ENG-DO/QA and evaluated upon execution of the DOE/A-E contract. All records are on file in the Engineering Department in accordance with the requirements of LA-5220-M.

11.1.1.1 TABLE OF ORGANIZATION REQUIREMENTS

A table of A-E organization indicating those individuals who were responsible for implementation of the required QA/QC procedures was submitted.

11.1.1.2 RESUME REQUIREMENTS

Resumes of individuals responsible for the major design disciplines, including degrees, years of professional experience and registration were submitted.

11.1.1.3 QUALIFICATION REQUIREMENTS

Qualifications and proposed QA/QC activities of any consultants and/or subcontractors were submitted.

11.1.1.4 DESIGN REVIEW REQUIREMENTS

Internal design review procedures, construction drawing and specification review procedures, design change procedures, document control procedures, and coordination and review procedures for contractor descriptive submittals were established.

11.1.1.5 CONSTRUCTION INSPECTION REQUIREMENTS

A construction inspection staff was assigned and a description of construction QC and inspection procedures were established and the required reviews and inspections were performed.

11.1.2 COMPLIANCE REQUIREMENTS

The architect-engineer was required to comply with the applicable provisions of the LASL Quality Assurance Manual, including establishing component level classifications for consequence-of-failure Type III structures and systems, by using the procedures outlined in the LA-5220-M, "LASL Quality Assurance Program for Construction Projects." A listing of the components and associated quality level classifications was furnished by ENG-DO/QA to the A-E prior to the Title II Review.

11.1.3 DOCUMENTATION REQUIREMENTS

The A-E was required to perform and document all design reviews necessary to verify the adequacy of design. The construction contract documents included technical requirements commensurate with the quality level classifications assigned.

11.1.4 AUDITING

The QA/QC activities of the architect-engineer were audited by ENG-DO/QA for compliance with the LASL Quality Assurance Program for Construction Projects.

11.2 WASTE MANAGEMENT RESEARCH AND DEVELOPMENT QUALITY ASSURANCE REQUIREMENTS

11.2.1 PROGRAM PLAN

The following quality assurance plan was designed to establish a systematic and documented approach for the implementation

of assigned R&D programs. It is intended to supplement the LASL QA program (LA-5220-M) which covers all major construction and equipment procurement associated with these projects. Specifically, this quality assurance program addresses program accomplishment, health, safety, and environmental protection measures.

11.2.2 ORGANIZATION

A. The Section Leader for Waste Management R&D in the H-7 Waste Management Group has overall responsibility for program implementation.

B. The authority for experimental planning, design, and health and safety concerns is vested in three internal review committees. The chairpersons and staff of each committee are cognizant personnel designated by the Section Leader. Committee approval is required prior to adoption of a specific new or modified provision.

C. Adherence to approved Standard Operating Procedures (SOPs) is the responsibility of the Section Leader or his designated alternate.

D. Experimental operations are the responsibility of the designated lead or project engineer.

E. Buildings, grounds, building equipment, their inspection and maintenance are the responsibility of the Facilities Manager designated by the Section Leader.

F. Quality Assurance documents will be retained in a central file maintained by the Section Leader or his designated alternate.

11.2.3 QUALITY PROGRAM ELEMENTS

The following specific quality assurance elements apply only to those considerations identified by the Section Leader as vital to meeting programmatic objectives.

11.2.3.1 HEALTH AND SAFETY

The safety evaluation of a specific activity and the requirement for SOPs are vested in the Safety Review Committee. It is the responsibility of this committee to review proposed

operations and associated equipment to assure the safety of personnel and the protection of physical property. Proposals submitted by project engineers may be reviewed wholly within the committee, or may include the independent review and approval of other expert sources either within LASL or outside LASL. Proceedings and actions of the committee as reported by the committee chairman via memo to the Section Leader constitutes documentation for quality assurance.

11.2.3.2 EXPERIMENTAL PLANNING

General as well as specific experimental plans are submitted for review and approval to the experimental review committee. Timing, integration with construction activities, and dependence on results from other functions are taken into consideration. Review is primarily by cognizant personnel within the R&D Section but outside review is requested when deemed necessary. Memos submitted by the chairman to the Section Leader constitutes documentation for quality assurance purposes.

11.2.3.3 DESIGN

Proposed new designs, concepts, or modification of existing designs are submitted by the project engineer for review by the Design Committee. Concurrence of the committee is needed prior to initiating purchase requests or work orders. Drawings, specifications, and memos prepared by the chairman describing committee action will constitute QA documentation.

11.2.3.4 PROCUREMENT AND FABRICATION

Purchase Requests, Job Orders, and Service Requests shall be initiated by the Project Engineer. The correctness of these documents regarding drawings, specifications, standards, inspections, and procedures shall be assured by the Design Committee review and/or informal (undocumented) review by the Section Leader or his delegate. Initialing of the document by the Section Leader or his designate shall occur only after the completion of these reviews. Copies of these documents and the memos accompanying them shall be retained in the R&D Section purchasing file.

Determination of nonconforming items, corrective action measures, any necessary handling, packaging, warehouse control, or shipping controls, and the necessity of inspection reports shall be the responsibility of the Project Engineer. The implementation of these controls shall be by memo, a copy of which shall be retained in the quality assurance central file.

11.2.3.5 ASSEMBLY AND INSTALLATION

Job orders, both internal to the Section and those requiring outside organizations (e.g., Zia) shall be initiated by the Project Engineer. These documents shall be informally reviewed by the Section Leader or is designated alternate and a copy will be placed in the Central QA file. Initialing of these documents by the Section Leader or his delegate shall indicate approval of the requests.

The Project Engineer or his designated alternate shall monitor and inspect all assembly and installation work. The Project Engineer shall assure the accuracy of any measuring and test equipment used during the assembly and installation. All documentation related to job completion shall be entered in the quality assurance files. Determination of nonconforming items and corrective actions required shall be the responsibility of the Project Engineer. Control of these items shall be by memo, a copy of which shall be retained in the QA file.

11.2.3.6 EXPERIMENTAL RESULTS/PROGRAM ACCOMPLISH- MENT

Progress realized in R&D programs is documented in several ways. Monthly reports are submitted to DOE Headquarters with copies to DOE/ALO and the TRU Waste Management Lead Laboratory. Topical reports and technical society papers are written periodically. Copies of these reports will be retained in the central quality assurance file. Peer review, when documentable, likewise will be retained on file for quality assurance purposes.

12. FACILITY DECONTAMINATION

12.1 General

12.2 Process Areas

12.4 Utilities

12.5 Nonradioactive Areas

12. FACILITY DECONTAMINATION

12.1 GENERAL

One of the design objectives in the TDF is the ease of decontamination, particularly in the preparation and process bay areas, to allow their use for subsequent process investigations or upon decommissioning of the facility.

Process and ventilation equipment whose interiors cannot be adequately decontaminated will be disposed of in accordance with Laboratory procedures in affect at the time of removal or decommissioning.

12.2 PROCESS AREAS

Surfaces in the preparation and process bay areas are painted with epoxy paint which is resistant to common decontaminating agents and will retain its covering properties through repeated washings. Floor surfaces are painted with two-component epoxy paint and are considered adequate for normal industrial traffic. Other surfaces are finished with a semi-gloss enamel or equivalent.

12.3 UTILITIES

Utility piping, conduit runs, and ventilation duct work is kept to an economic minimum in the operating areas.

Where piping, conduit, duct work, etc., penetrates a wall, floor, or ceiling separating different zones, rooms or compartments, the penetration and conduit are sealed to prevent the spread of contamination or fire between zones or into the wall.

12.4 EQUIPMENT DECONTAMINATION FOR REPAIR

Process line equipment requiring replacement or repair is cleaned within the glovebox line and bagged out for further decontamination. These and small and medium sized items, initially decontaminated in situ, may be bagged and transported to the H-1 decontamination facilities at the adjacent Liquid Waste Treatment and Disposal Facility for decontamination. Large items are

decontaminated in situ. Repairs and modifications are made in the contaminated equipment repair shop, Room 110. Items to be disposed of will be handled in accordance with current LASL procedures.

12.5 NONRADIOACTIVE AREAS

The second floor and mechanical equipment room are not designed for routine decontamination since they have separate ventilation systems and should not become contaminated in the normal operation of the facility. The cold laboratory areas on the second floor are designed for routine cleaning for nonradioactive procedures.

13. THE LASL SAFETY MANAGEMENT SYSTEM

13.1 Organization

13.2 Responsibility

13.2.1 Individuals

13.2.2 Supervisory

13.2.3 Group Leaders

13.2.4 Division Leaders

13.2.5 Safety Director

13.2.6 Nuclear Criticality Safety Committee

13.2.7 Nuclear Criticality Safety Officer

13.2.8 Liquid Hydrogen Safety Committee

13.2.9 LASL Reactor Safety Committee

13. THE LASL SAFETY MANAGEMENT SYSTEM

13.1 ORGANIZATION

Each LASL Division and Department is required to prepare, submit to the Director's Office for approval, and thereafter carry out an internal program of safety organization. Detailed procedures differ from group to group but generally include the organization of a Group Safety Committee, a specifically identified Chairman, and regular meetings. A representative of the Safety Director is a permanent member of these committees. The Group H-7 safety organization includes a safety committee consisting of a designated chairman and a member representing each operating section. The primary function of the safety committee is to perform periodic safety inspections and submit a report to the Group Leader with comments regarding safety conditions in each area.

The Laboratory Health Division provides a full range of consultants and services on matters of health, safety and fire protection. These include Health Physics (H-1), Occupational Medicine (H-2), Safety (H-3), Industrial Hygiene (H-5), Waste Management (H-7), and Environmental Surveillance (H-8). In addition, the group leader of Safety (H-3) serves as the Safety Director. The Safety Director's Office makes periodic unannounced inspections of all laboratory activities with regard to the safety of their operations and safety practices; the staff fire protection engineers make periodic fire risk analyses of all facilities. In addition, reviews are made with the operating groups of new and existing operations and procedures.

The Laboratory Director appoints committees as needed to provide specialized advice and safety surveillance in designated problem areas. Some of these are the Nuclear Criticality Safety Committee, the LASL Reactor Safety Committee, and the Liquid Hydrogen Safety Committee. Special directives are issued or programs devised as needed to cover new situations which may arise. For example, a Fire Protection Systems Policies and Procedures Committee monitors the standards for protective systems and an Ad

Hoc High Pressure Committee prepares standards for laboratory pressurized systems.

Most problems are examined jointly by several health and safety disciplines. Primary guidance for the operating groups is spelled out in the various nationally recognized standards and guidelines. These guidelines along with standards established by LASL are designed to fit the requirements needed for such a flexible and continually changing operation. Deviations from national norms or LASL guidelines are well justified with review by the operating groups, selected representatives from LASL in the particular area of question, outside consultants, and literature search. Finalized changes are reviewed in total by the various disciplines and required operating procedures are also reviewed.

13.2 RESPONSIBILITY

Responsibilities, safety practices, and emergency procedures are outlined in the "LASL Health and Safety Manual." This document is updated periodically as needed. A partial list of responsibilities will be included here to indicate how they are generally delegated throughout the administrative organization.

13.2.1. INDIVIDUALS

Individuals at LASL who have any contact with toxic materials or radiation are responsible for:

A. Keeping their own exposures to radiation and also of those of others as low as possible and, specifically, below the maximum permissible levels recommended in the Safety Manual. Exceptions are exposures received in medical examinations and treatments and with prior approval by the Health Division, in cases where urgent situations require exposures in excess of the recommended levels.

B. Wearing the prescribed monitoring equipment (pocket dosimeters and film badges) in radiation areas; requesting that neutron films be read when exposure to 0.1 rem is suspected.

C. Surveying hands, shoes, and body for radioactivity, and removing loose contamination to the tolerance levels before leaving the area, in accordance with recommended decontamination procedures.

D. Wearing appropriate protective clothing whenever clothing contamination is possible, and not wearing such clothing outside the Laboratory areas; using gloves, hoods, and respiratory protection (respirators or supplied air masks, as recommended by the Health Division) when necessary; using proper techniques and facilities in operations involving radioactive materials.

E. Observing the recommended procedures in regard to eating and smoking in contaminated areas.

F. Reporting injuries and ingestion or inhalation promptly to the Health Division and carrying out the recommended corrective measures; cooperating in any and all attempts to evaluate exposures, particularly by promptly returning requested urine specimens.

G. Carrying out recommendations of the Health Division in roping off hazardous areas, posting warning signs, and otherwise controlling special hazards for which they are responsible; contacting the Health Division for recommended procedures when highly toxic materials are used or when conditions are altered significantly.

H. Cleaning up contamination for which they are responsible, arranging for a survey by the Health Division, and carrying out the decontamination recommended for the area when changing locations or ending an operation.

I. Storing and labeling toxic materials for which they are responsible.

J. Proper packaging (sealed containers whenever possible) and labeling (origin and date) of contaminated waste materials.

13.2.2 SUPERVISORY

Supervisors are responsible for ensuring that the above individual responsibilities are discharged by those under their control, and are further responsible for:

A. Instructing those employees for whom they are responsible in the use of safe techniques and in the application of approved safety practices.

B. Checking that Standard Operating Procedures are written for operations wherein potential hazards exist.

C. Providing such staff as is required for packaging contaminated waste and for decontaminating anything for which they are responsible.

D. Furnishing information to the Health Division concerning individuals and activities in their areas, particularly additions to or deletions from their personnel rosters.

E. Contacting the approving authority whenever major changes in operational procedures, new techniques, alterations in physical plant, or new operations which might lead to personnel exposures, are anticipated.

13.2.3 GROUP LEADERS

Group Leaders are responsible for ensuring that safety responsibilities are discharged by those under their control.

A. Each Group Leader is responsible for nuclear criticality safety within his group. The responsible Group Leader must maintain current written procedures for this operations involving significant quantities of fissile materials. Copies of procedures and addenda must be filed with Nuclear Criticality Safety Committee.

13.2.4 DIVISION LEADERS

Division Leaders must prepare, maintain, and test the effectiveness of emergency plans in all areas and operations under their jurisdiction. Three copies of each plan must be sent to Safety (H-3).

A. Division Leaders must keep the Laboratory Director informed of all emergencies.

B. Division Leaders must provide within 30 days, follow-up for the execution of recommended changes issued by the Safety Director's Office.

13.2.5 SAFETY DIRECTOR

The Safety Director's Office must make periodic unannounced inspections of all Laboratory activities with regard to the safety of their operations and safety practices. Such inspections must be at least annually, and must be at least quarterly in all areas where chemical, physical, mechanical, high explosive, or electrical operations are regularly carried out. The reports of these inspections must be given formally to the Division Leader with copy to the Group Leader.

A. The safety Director must notify the Laboratory Director's Office of any disagreement or failure to comply with any safety regulations or practices.

13.2.6 NUCLEAR CRITICALITY SAFETY COMMITTEE (NCSC)

The NCSC reports directly to the Laboratory Director without regard to the organizational affiliation of its members.

A. The NCSC acts in an advisory capacity to the Safety Director or to any Group or individual within the Laboratory.

B. The NCSC establishes a review system which will periodically appraise those operations involving significant quantities of fissile materials. The operations may be reviewed by the NSCS or the NSCS may assign specific review functions to the Nuclear Criticality Safety Officer, to the H-3 Safety Group, or to other appropriate individuals or bodies. The secretary will maintain a record fo NSCS actions.

13.2.7 THE NUCLEAR CRITICALITY SAFETY OFFICER (NCSO)

The NCSO serves as an instrument of the NSCS.

A. The NCSO provides assistance to operating groups in

setting up criticality controls for new operations and in evaluating such controls.

B. The NCSO maintains contact with all LASL operations involving fissile materials.

C. The NCSO provides technical consultation on matters of Criticality safety.

13.2.8 THE LIQUID HYDROGEN SAFETY COMMITTEE (LHSC)

The LHSC reports to the Safety Director of the Laboratory without regard to the organizational affiliation of its members.

A. The LHSC collects pertinent safety data concerning liquid hydrogen and distribute such information to using groups.

B. The LHSC keeps current the Liquid Hydrogen Chapter of the LASL Health and Safety Manual.

C. The LHSC reviews (including physical inspection of facilities when considered necessary by the Committee) all liquid hydrogen operations undertaken by Laboratory users in Los Alamos or elsewhere.

D. The LHSC suggests safety experiment to be conducted within the Laboratory or elsewhere to extend the knowledge in needed fields.

E. The LHSC certifies and lists systems and users of liquid hydrogen, and restricts issue of liquid hydrogen to this list.

13.2.9 THE LASL REACTOR SAFETY COMMITTEE (RSC)

The RSC reports directly to the Director of LASL without regard to the organizational affiliation of its members.

A. The RSC is charged with the responsibility for continuing surveillance of the operation of LASL nuclear reactors and critical assemblies to assure that high standards of safety are maintained and that operations are conducted in accordance with applicable DOE regulations.

B. The RSC is authorized to approve or disapprove changes in facilities or procedures proposed by the operating staffs and to enforce changes in existing arrangements.

C. The RSC must maintain a written record of its meetings and other major activities and will provide copies of these records to the Laboratory Director.

D. The RSC must operate in accordance with the existing written charter. Changes in the charter require the approval of the Laboratory Director or the Technical Associate Director.

14. SUMMARY OF EMERGENCY PLANS AND PROCEDURES

14.1 Emergency Plan

14.1.1 General

14.1.1.1 Organization

14.1.1.2 Individual Responsibilities

14.1.2 Fire and/or Explosion

14.1.3 Evacuation

14.1.4 Civil Disturbance

14.1.5 Bomb Threat

14.1.6 Police Assistance

14.1.7 Theft or Destruction of Government Property

14.1.8 Emergency Maintenance

14.2 Process Operations Emergency Procedures

14.2.1 Emergency Shutdown of the Incinerator

14.2.2 Other Emergency Situations

14. SUMMARY OF EMERGENCY PLANS AND PROCEDURES

14.1 EMERGENCY PLAN

14.1.1 GENERAL

The TDF Emergency Plan Manual is distributed to each person assigned to the TDF who will be responsible for knowledge of its content. Copies of the plan are on file in the Group Office, R&D Section Office, Group Safety Committee, and with H-3. The plan is reviewed periodically to keep it updated and workable.

14.1.1.1 ORGANIZATION

In any emergency condition, accident or incident at the TDF, the R&D Section Leader or in his absence, his assistant, is charged with the responsibility for the safety of personnel and to a reasonable extent, the safety of equipment and facilities, and the initiation of actions to reduce or limit the spread of hazardous conditions. In the absence of the above personnel, the lead engineers or the senior staff member present is automatically charged with these responsibilities.

14.1.1.2 INDIVIDUAL RESPONSIBILITY

In the event of a major emergency, immediate action by an individual can limit the extent of the hazard, the spread of contamination, and possibly save lives and property. Each person assigned to the TDF is responsible for knowledge of the location and operation of the emergency equipment, fire alarm and evacuation alarm boxes, public address and intercom stations in his work area.

If an evacuation is ordered, it is the responsibility of each individual to leave the building immediately, turning off equipment or activating fire suppression systems as appropriate (to limit the contribution of such equipment to the emergency) as he leaves his work area. It is further the responsibility of the individual to proceed immediately to the muster area and not to leave that area until accounted for and permitted to leave by the person in charge.

14.1.2 FIRE AND/OR EXPLOSION

The Fire Department must be notified if any fire or explosion occurs at the TDF.

To report a fire or explosion, the current laboratory policy is to pull a fire alarm box and then telephone the Fire Department (9-911) to give details of the location and nature of the fire or explosion. Request ambulance service if injuries have occurred.

The fire alarm is a double-slow woop audible signal. There are numerous automatic fire alarm switches within the TDF that will activate the alarm on such things as sprinkler water flow (whether from a sprinkler, a break in the fire water line, or the opening of a fire hydrant), high air duct temperature or a too rapid rate-of-temperature-rise in an air duct.

The activation of a fire alarm is a signal to evacuate the building. All persons are to leave the building and report to the muster area.

14.1.3 EVACUATION

To initiate a building evacuation, the evacuation alarm may be sounded and/or the public address system may be used. The evacuation alarm, which is more suitable for evacuation of the whole facility, is a steady continuous audible signal.

Notify Building 1 personnel if the TDF building is breached.

To evacuate a portion of the building, such as the Zone 2 Process Area, the PA system is more appropriate. Use of the PA will accomplish the notification of the occupants of the area to be evacuated, and additionally, will advise personnel in the rest of the facility of the existence of a problem in that specific area.

Upon initiation of an evacuation, either via the PA or the evacuation alarm, personnel are to leave the specified area.

Outbuilding and outlying work area evacuations, such as the warehouse/staging area (Building 54) or the office trailer (ULR-665) will be conducted in the same manner as an evacuation

of a portion of the TDF. That is, the PA should be used to announce the evacuation and the lead engineer or senior staff member or senior technician in charge of the area will be responsible for the evacuation and roll call.

Non-assigned personnel such as ZIA maintenance personnel and site visitors are probably not cognizant of the emergency procedures at the TDF, and therefore it is necessary that the staff be aware of the presence, location, and activities of these persons. Further, it is the staff's responsibility to insure that they are evacuated in a timely and orderly manner.

14.1.4 CIVIL DISTURBANCE

Civil disturbances are to be handled by the DOE Protective Force. Employees are instructed to notify the Protective Force immediately of any incident involving a person or persons gathering, picketing, demonstrating, or trespassing within or in the vicinity of any DOE/LASL facility.

14.1.5 BOMB THREAT

In the event of a telephone call of a bomb threat or other ominous warning, the LASL Bomb Threat Procedure will be followed. Personnel are expected to be familiar with this procedure. A copy of the procedures and checklist are on page 1 of the LASL telephone directory and a copy is included in the appendix of the Emergency Plan.

14.1.6 POLICE ASSISTANCE

Law enforcement and traffic accident investigations are the responsibility of the Los Alamos Police Department. Employees are instructed to notify the Los Alamos Police Department immediately of any incident of violation of state or local law or of a traffic accident.

14.1.7 THEFT OR DESTRUCTION OF GOVERNMENT PROPERTY

The FBI is responsible for the investigation of federal crimes such as the theft or destruction of government property. Employees are instructed to notify **LASL SECURITY OFFICE**, or the FBI immediately in the event of such an incident.

14.1.8 EMERGENCY MAINTENANCE

The ZIA Company is responsible for the custodial services and maintenance of LASL facilities with ENG-4 acting as liason. If an emergency condition exists such as a broken water line, employees are instructed to notify ENG-4 during working hours and the ZIA Company work order desk during non-working hours to initiate corrective action and repairs.

14.2 SUMMARY OF EMERGENCY PROCESS OPERATING PROCEDURES

14.2.1 EMERGENCY SHUTDOWN OF THE INCINERATOR

An emergency shutdown of the CAI process is used if there is an immediate potential for release of contamination to the environment or an immediate danger to the operators. The emergency shutdown is automatically executed for 1) loss of power (normal and auxiliary), and 2) low ΔP across either of the two process HEPA filter banks. In addition, two manually activated "SCRAM" buttons for emergency shutdown are available--one near the ram feeder loading station, and one in the control room. Therefore, the shutdown can be triggered easily before evacuation, if required.

The shutdown sequence consists of the following:

1. Shut down the process blowers
2. Shut down the burners
3. Shut down the combustion air blowers
4. Shut off water to venturi
5. Drive venturi wide open
6. Initiate steam quench

14.2.2 OTHER EMERGENCY SITUATIONS

Other emergencies can be handled using normal LASL procedures and available facility safety equipment and alarms. For example, a breach of containment in the feed preparation line might result in the evacuation of the immediate zone if contamination is present. The evacuation alarm and/or PA system could be used to initiate the action. Similarly, an uncontrolled fire in the feed storage area could be handled in the same manner with the additional activation of the building fire alarm.

15. SUMMARY DESCRIPTION OF EMPLOYEE TRAINING

15.1 Employee Training

15.1.1 Introductory Orientation

15.1.2 Drills

15.1.3 Routine Safety Meetings

15.2 Employee Operational Training and Qualification

15.2.1 Training Courses

15.2.1.1 Introductory Training

15.2.1.2 Technician Training

15.2.1.3 Process Engineers Training

15.2.1.4 Shift Supervisors Training

15.2.2 Qualification

15. SUMMARY DESCRIPTION OF EMPLOYEE TRAINING

15.1 EMPLOYEE TRAINING

There are several categories of employee training and orientation categories for TDF employees in addition to the direct supervisory guidance provided in the daily operations.

15.1.1 INTRODUCTORY ORIENTATION

Each new employee is given a copy of the Emergency Plan, an orientation, and training intended to instruct him in the use of personal safety equipment and emergency procedures. The recognition of the fire and evacuation signals are reinforced by announced tests of the alarm system on a monthly basis. Routes of evacuation and designated outside assembly points for each laboratory section are described during the session and in the site Emergency Plan.

15.1.2 DRILLS

The evacuation alarm is sounded without warning on an unscheduled basis to check the efficiency of the evacuation procedure and to provide practice in employee evacuation. Head counts are made at the designated assembly points to assure compliance by all personnel. In these instances all personnel must be accounted for and procedures for quickly locating missing people are tested.

15.1.3 ROUTINE SAFETY MEETINGS

The H-7 Safety Committee chairperson is responsible for arranging regular group safety meetings. A relevant topic relating to safety is presented and the quarterly safety inspection results are discussed at each of these meetings. An attendance record is maintained and used to encourage the best possible observance by H-7 personnel compatible with sustained operational activities.

15.2 EMPLOYEE OPERATIONAL TRAINING AND QUALIFICATION

When possible the positions in the Treatment Development Facility (TDF) are filled by hiring personnel who have relevant experience for a particular opening. The principle objective of the training and qualification program for new technicians, process engineers, and shift supervisors is to insure that the

persons responsible for and in charge of the operation of the contaminated waste treatment processes have the knowledge and ability necessary to operate the equipment safely and efficiently under all conditions, both normal and abnormal.

15.2.1 TRAINING COURSES

The Section Leader, with assistance of the shift supervisors, will organize and conduct courses to provide the necessary basic theory and on-the-job training for TDF personnel. Full advantage shall be taken of the training and orientation provided by the Health Physics, Safety, and Industrial Hygiene groups of the Health Research Division of the Laboratory.

15.2.1.1 INTRODUCTORY TRAINING

Prior to work assignment in the process area during operations, each employee will be given a program covering:

- a. Basic Facility and Process description and hazards identification.
- b. Facility and Process equipment familiarization and orientation.
- c. Basic Radiological Safety indoctrination.

15.2.1.2 TECHNICIAN TRAINING

This program must provide technicians with at least the following knowledge and abilities:

- a. A basic understanding of the physical and chemical processes involved in the operation of the process equipment.
- b. A basic understanding of the design features of the controlled air incinerator.
- c. A basic understanding of the principles and functions of associated equipment and subsystems, i.e., offgas cleaning and scrubbing components, liquid loop filtration and neutralization components, air filtration systems, instrumentation and control systems, etc.
- d. An understanding of the significance of and a detailed knowledge of all emergency procedures, and potential

- process hazards both nuclear and non-nuclear.
- e. An understanding of the significance of and a detailed knowledge of all Feed Preparation Line, Facility, and Utility SOP's.
 - f. An understanding of radiological safety, including:
 - All Health Physics related requirements for working in various areas of the facility
 - Types and characteristics of radioactive materials present at the facility
 - The proper use of radiation monitoring instruments, anti-c clothing, and dosimetry badges
 - General biological effects of radiation
 - Regulatory limits for exposure to radiation
 - The basic elements of contamination control and de-contamination procedures
 - g. Detailed knowledge and understanding of the principles and requirements of glovebox operations.
 - h. Ability to operate process equipment and instruments and other auxiliary systems and equipment as required.
 - i. Upon approval by the Industrial Medicine Group, each trainee assigned to the process operations area shall attend an Industrial Hygiene Group training course in the use of self-contained breathing apparatus (SCBA) and/or face mask respirators.

15.2.1.3 PROCESS ENGINEERS TRAINING

In addition to the above, the training program for process engineers shall include the following:

- a. Detailed knowledge and understanding of the locations and function of each component of the process control system, instrumentation systems and all other components and systems essential to the operation and safety of the process equipment.
- b. Ability to operate all process control and instrumentation systems and all other auxiliary systems and equipment.

- c. Ability to interpret operating conditions both normal and abnormal and to determine the proper course of action.

15.2.1.4 SHIFT SUPERVISORS

The training for shift supervisors will be essentially the same as for process engineers, except that the level shall be appropriate for supervisors.

15.2.2 QUALIFICATION

Training will be complete when each of the shift supervisors has concurred that the trainee has completed the requirements for qualification.

Upon recommendation of the Section Leader, and the concurrence of the Safety Review Committee, the trainee will be qualified as a process operator, process engineer, or shift supervisor, and the qualification shall be noted in the Safety Review Committee meeting minutes.

16. SUMMARY OF OPERATING PROCEDURES

16.1 Administrative Procedural Controls

16.2 Operations Manual

16.2.1 Process Description

16.2.2 Experimental Planning and Documentation

16.2.3 Standard Operating Procedures

16.3 LASL Health and Safety Manual

16. SUMMARY OF OPERATING PROCEDURES

16.1 ADMINISTRATIVE AND PROCEDURAL CONTROLS

The administrative and procedural controls, to assure that the Treatment Development Facility (TDF) and the first study process are performed in a safe manner, are delineated in the Operating Manual for the Controlled-Air Incineration Process. The LASL Health and Safety Manual delineates the organization, requirements, and responsibilities for health and safety throughout the Laboratory.

16.2 OPERATING MANUAL

The Operating Manual for the Controlled-Air Incineration Process is divided into three sections which describe the CAI process, experimental planning and documentation, and the Standard Operating Procedures.

16.2.1 PROCESS DESCRIPTION

To assure an overall and complete understanding of the CAI process by all operators, the Operating Manual contains a detailed description of the process line equipment and its function and operation.

16.2.2 EXPERIMENTAL PLANNING AND DOCUMENTATION

The charter of the TDF is to construct, operate, and evaluate various waste treatment processes. To meet these requirements, a process must be operated in an orderly manner to achieve investigative goals, and all operating parameters and experimental results must be recorded in a meaningful manner. This section delineates the organization and responsibilities for the content and documentation of the run plans, process logs, and equipment maintenance and modification records.

16.2.3 STANDARD OPERATING PROCEDURES

Standard Operating Procedures (SOPs) are written instructions for performing specific tasks which emphasize the precautions to be observed. SOPs identify the known and the

anticipated hazards, and outline the controls selected to eliminate or mitigate those hazards. Their purpose is to ensure that tasks and operations are performed safely and effectively. Supervisors who oversee any work operations involving hazardous processes, materials or environments are required to develop an SOP for such work and ensure employees compliance with it. Approved SOPs are required for such specific operations as the following:

- Work on energized electrical components.
- Work with radiation-generating machines, significant quantities of radioactive materials, or the management of radioactively contaminated waste.
- Work in enclosures with limited egress or ventilation
- Work with biologically hazardous agents, known or suspect cancer-causing agents or extremely toxic materials

SOPs are generated by the operating group and approval gained through the following steps. A Document Control Number is issued and a Hazard Identification Form (HIF) completed. The SOP and HIF are reviewed by LASL Groups H-1, 3, 5, 7, and 8 (Health Physics, Safety, Industrial Hygiene, Waste Management, and Environmental Monitoring, respectively). Comments are recorded on a Procedure Review Record Form. If approval is granted by the reviewers, an expiration date is assigned by the H-Division SOP coordinator.

16.3 LASL HEALTH AND SAFETY MANUAL

This manual details the responsibilities of the individual employee, the supervisory employees, and the LASL Health and Safety organizations to assure the safe operation of the Laboratory.

17. CONCLUSIONS

17. CONCLUSIONS

An analysis has been made of the Transuranic Contaminated Waste Treatment Development Facility at TA-50. The site comprises three acres located on a finger mesa near the center of the Plateau at an elevation of 7,200 ft. Access is by Pajarito Road, one of the primary roads within DOE-controlled land. The nearest public habitation is a trailer court approximately 4,000 ft to the north. Except for the townsite of Los Alamos and White Rock, the area within a 10-mi circle around the site is sparsely populated.

Calculations of the stack maximum normal concentration release rates indicate that these are well below the upper limit air concentration values as listed in DOE 0524 Annex A, Table II, Column 1, for soluble plutonium. The concentration at ground level and at the exclusion area boundary (fenced area of site) is several orders of magnitude lower in concentration.

The air concentration of plutonium at the point of nearest permanent occupancy, as the result of an upper limit accident with the resulting inhalation dose to the lungs and deposition to the bone, is in conformance with 10 CFR 100 as adjusted for plutonium. Therefore, the TA-50 site is acceptable from the standpoint of effluent as a location for a transuranic contaminated waste processing facility.

Due to the limited inventory of transuranics (100 g total) and the low concentrations of contaminants in the received waste material (100 nCi/g), seismic and geologic considerations are the same as for standard industrial design. Los Alamos is located in a Uniform Building Code Seismic Zone II area, and the facility is designed to meet these code standards.

The process area in the TDF is separated to provide zone ventilation control, prevent cross-contamination, and to isolate hazardous areas. Interior building walls and Zone 2 partitions are designed to provide the required air circulation and glovebox differential pressures. All ventilation systems are designed using standard and industrial components and controls as opposed

to package or unitary equipment. The systems are designed to minimize the potential release of contamination to the environs and to control it within the building. A multiple zone containment concept provides the features required. The ventilation system provides for adequate heating and ventilation (eight air changes per hour minimum) for all occupied spaces. Three levels of confinement (zones) are designed to maintain building pressure gradients such that air flow due to pressure differential is from the outside to the progressively higher levels of potential contamination within the building. Zone 1 is limited to areas within gloveboxes, conveyors, the incinerator and offgas treatment train. Zone 2 consists of the receiving slot boxes, process line area, laboratories, and support areas, which could become contaminated. Zone 3 is limited to uncontaminated areas within the process and feed preparation bays, control room, and support laboratories not otherwise defined as Zone 2.

Nuclear criticality is not a factor at the TDF, as the maximum permitted inventory is 100 g of transuranics. Process input is monitored directly by the Multiple Energy Gamma Assay System (MEGAS). The utility systems provide reliability consistent with operational requirements, value and potential hazard for all probable conditions. Utility systems are designed to avoid cross contamination between zones and contamination of areas normally uncontaminated.

The utilities are monitored by appropriate detectors and devices to ensure against interruption of service and provide proper measurement of pressures, temperatures, flows, etc. Signals from the monitoring devices are transmitted to the central control panel and selected measurements are recorded.

The TDF is designed to remain standing as a confinement structure during and after the design basis fire (DBF), assuming complete failure of all fire suppressions systems to operate or control the fire. The building external shell has a minimum of a two-hour fire rating. There are no external windows in the

process bay areas, and exit doors and stairwell doors have 1 1/2 fire ratings.

The design and operating procedures minimize combustible loading of the facility. Noncombustible construction, fire walls, and fire dampers are utilized to contain the design basis fire.

The ventilation exhaust duct is provided with a cooldown spray system to protect the exhaust HEPA filters from high temperatures in the event of a fire in the process area. The cooldown spray is upstream of two 90° bends in the exhaust duct and during tests the spray water was observed to conglomerate and run into the plenum in the form of a small stream. The plenum is provided with deep "P" traps that drain to the acid waste collection system. The HEPA filters are also protected by a fire screen constructed of 20 gauge stainless steel plate with .0125 in. perforations. The perforations are formed from convolutions pressed into the plate in a wavy pattern that does not present a straight-through path. The filter plenum is also protected by a fire water sprinkler system that is temperature actuated. The sprinkler and cooldown spray systems are of the deluge type to preclude freezing.

Automatic sprinklers are provided in all spaces of the building to suppress or limit any fire. An adequate supply of water for fire service is provided by the DOE water system from a 12 in. cast iron main paralleling Pecos Drive, via an eight inch fire and domestic water supply main to the facility. The facility fire main is a 6 in. line and supplies water to the sprinkler systems and the fire fighting systems in and around the building.

Natural gas is supplied to the facility by an underground line connected to a 100 psig 3 in. main that parallels Pajarito Road along its north side.

Hot water supplied from a gas-fired furnace is used for heating throughout the facility.

Electrical service to the facility is provided by a 13.2 kVA primary feeder. An on-site auxiliary 500 kW diesel generator with

an automatic transfer sytem is provided as an independent power source. During incineration runs, the generator will be on the line and the diesel engine running at 1800 RPM. In the event of a primary power failure, the automatic transfer switch gear will transfer the load to the generator with only minimal interruption of less than one second in the power.

Approved Standard Operating Procedures and appropriate safety, design, and experiment reviews assure the safe operation of the facility.

Facility access drives and parking areas are provided. Desert landscaping and erosion control plantings have been installed.

Security for the protection of government property is provided by the LAAO Protective Force in accordance with the requirements of DOE IMD 6105.

The ventilation system controls air and gaseous effluents from the faciity. Flow and radioactivity are continuously sampled. Chemical effluents are less than the standards of the Environmetnal Protection Agency and the State of New Mexico.

Industrial and process wastes are collected, monitored and treated prior to discharge or storage. Sanitary wastes are discharged to a sanitary treatment plant and lagoon designed to serve the TDF and numerous facilities at adjacent sites.

Descriptions of the safety considerations and accident analyses for the TDF are presented in Chapters 4 and 6. In most cases, a series of gross errors and/or equipment failures must occur before a potential accident becomes a reality. The maximum credible accident, even if the external shell of the TDF is breached, would not pose a threat to the general public. The engineered safeguards assure the facility meets or exceeds standard industrial safety requirements.

The process effluents, as well as the techniques employed are not a threat to the natural environment.

The layouts of the TDF allow the interchange, movement, or relocation of equipment as necessary for programmatic modifications.

Space is provided for future expansion by additions to the side of the building.

The environmental monitoring program, which is described in Chapter 9, includes atmospheric, radiation, water, soil and sediment, and flora and fauna monitoring.

A Quality Assurance program was implemented to assure that the design, construction, and operation of this facility complied with the applicable requirements, drawings, and specifications.

The TDF is constructed so that decontamination can be accomplished to allow its use rather than demolition upon decommissioning.

The facilities at Technical Area-50 are suitably designed, constructed and staffed to conduct transuranic contaminated waste treatment research and development without undue hazard to employees or to the general public.