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SAFETY ANALYSIS REPORT FOR
THE HEAVY-ELEMENT FACILITY (BUILDING 251),
LAWRENCE LIVERMORE NATIONAL LABORATORY

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ABSTRACT

A comprehensive safety analysis was performed on the Lawrence Livermore National Laboratory's Heavy Element Facility, Building 251. The purpose of the analysis was to evaluate the building and its operations in order to inform LLNL and the Department of Energy of the risks they assume at Building 251. This was done by examining all of the energy sources and matching them with the physical and administrative barriers that control, prevent, or mitigate their hazards. Risk was evaluated for each source under both normal and catastrophic circumstances such as fire, flood, high wind, lightning, earthquake, and criticality. As a result of this analysis, the report found no significant safety deficiencies and concludes that the operation of the facility presents no unacceptable risk.

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Preface

This report is a draft Safety Analysis Report (SAR) for Building 251. It is required by the DOE Order 5481.1. An earlier SAR was published in November 1974 and is here being rewritten to reflect significant improvements in the structure and operation of the facility; some of these changes being recommended by the earlier SAR.

The purpose of the SAR is to advise the DOE and the Lawrence Livermore National Laboratory (LLNL) of potential risks which they may assume in operating the Building 251 facility.

This SAR is shorter than the 1974 edition because it attempts to increase information density and eliminate data that has marginal safety-related significance. Brevity in some areas should not be viewed as cursory analysis. Building 251 has been formally reviewed many times over the years by experts at LLNL as well as outside consultants and the San Francisco Operations Office (SAN) of the Department of Energy (DOE).

The reader is encouraged to study the Appendix which contains information on how business is conducted at Building 251. It also contains guidance for obtaining detailed information on the facility subsystems; i.e. ventilation, storage, alarms, etc.

Data on the site description and some environmental factors have not been included in this report. These matters are adequately covered by DOE/EIS-0028-D, Final Environmental Impact Statement, Livermore, Site, July 1982.

FACILITY DESCRIPTION

Introduction

Building 251, the Heavy Element Facility, was built to provide research areas for conducting experiments in radiochemistry using uranium and transuranic elements.

The original Diagnostics Chemistry building (now Heavy Element Facility) has been expanded several times since its construction in 1955. The key plan of the building is presented in Figure 1, in which the oldest structural increment is identified as 1 and the newest addition is identified as 7. Increments 1 through 6 are single-storied, while increment 7 is single-storied on the north side and two-storied on the south side. All the increments have 0.2 m thick fully grouted concrete block shear walls. The 3,000 m² structure houses forty lab areas and their supporting offices, mechanical equipment, storage, and change rooms.

Although Building 251 is seven different buildings "butted" together, structurally they could be viewed as two. Recent modifications to increment 6 and part of increment 3 (Fig. 1) have upgraded this northwest corner to withstand 0.8 g earthquakes, 50 m/s winds, and a Design Basis Fire (DBF) of two hours duration. Values chosen for the earthquake and winds are justified in the Supporting Documents for LLNL Safety Analysis Reports.⁽¹⁾ This upgraded section of the facility will be referred to as the "hardened" area.

FIGURE 1 BUILDING 251 INCREMENT PLAN

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ORATORY, REPRODUCTION PROHIBITED
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Special Construction

The following special construction features have been incorporated into the Heavy Element Facility.

- o Ventilation flow is from areas of least possible contamination toward areas of increasing contamination potential. (from the outside through corridor, room, glovebox, filter, and back to outside).
- o The main entry into the hardened area is through air locks, and the service entrance on the dock is also used as an air lock to control the air flow at a negative pressure differential.
- o All exhaust air from the glove box, cells, and cave enclosures is filtered through at least two HEPA filters in-series. Room air is exhausted through 95% NBS stain test filters in the unhardened part of the facility. Exhaust air from the hardened rooms is discharged through double HEPA filters, each having an efficiency of 99.97% or better.
- o The room air and exhaust air are continuously sampled and monitored for contamination.
- o Nuclear criticality and radiation detection alarm systems are provided.
- o Emergency power is provided to assure continuous operation of critical systems. This power is provided by two generators. Should one generator fail, priority switching maintains power in the hardened area.

Except where noted, the above-listed special features exist for the entire facility. The difference is that in the hardened area all structural, electrical, and mechanical systems have been strengthened to Seismic Category I. In this category, all structures, systems and components are designed to remain functional during and after an 0.8 g earthquake. Category I structures, systems, and components also remain functional during and after a 50 m/s wind and survive penetration of a 30 m/s timber impact.

Another special feature of the hardened area is a Category I fire sprinkler system with a dedicated water supply that will provide sprinkler protection even if the underground main supplying the building fails. The building structure surrounding the area is designed as a two-hour fire barrier.

Hardened Area Seismic Category I Items

- o Upgraded portion of the building structure and components.
- o Room and glove box exhaust fans/starters/circuit breakers.
- o Room supply air fan/starters/circuit breakers.
- o Engine generator set/transfer switch/circuit breakers.
- o Glove boxes and associated duct system.
- o Fire dampers.
- o Dedicated fire sprinkler system.
- o Differential pressure controls.
- o Piping, tubing and electrical conduit which is considered critical in nature.

- o Hangers, supports, valves, etc. associated with critical systems.
- o Items which could cause failure of any of the above items.

Special Facilities

STORAGE FACILITIES

Most of the radioisotope inventory is stored in "hardened" containers in the unhardened part of the facility. This unhardened area is permitted to have up to 5 Ci that are not in hardened containers but kilocurie amounts of material may be stored in containers that are specially approved to withstand the design basis earthquake and fire. Transfers to the hardened area, that is the area that is approved for working with up to 5,000Ci, takes place in the hardened containers.

Two separate storage facilities are available in Room 1165 for storing radioactive materials: a storage pool and a series of underground pits.

The pool storage facility measures 1.8 x 4.6 m and is normally filled to a depth of 3.0 m with purified water that is recirculated in a closed-loop system through a filter and ion exchange column. The pool can serve as a water-shielded storage facility, a calorimeter tank; and also permits underwater packaging of high-level gamma and neutron emitters. Only material encapsulated in liquid-tight containers may be stored or introduced in the pool. A continuous water monitor is incorporated into the closed loop to measure the activity levels, and weekly samples are taken for analysis when radioactive material is in the pool.

There are six storage pits in Room 1165 and twelve storage pits in Room 1320. These storage pits are designed to provide shielded, water-tight storage for radioactive material. They are provided with removable metal liners should decontamination become necessary. Each pit has shelves (six in Room 1165 pits, nine in Room 1320 pits) which are attached to the gasketed steel cap that rises as a unit when entry is made to the pit. The pit caps may be raised by the overhead crane, and each of the pits in Room 1320 are equipped with padlocks. Procedures for both storage areas require that all material placed in the pits be doubly contained and sealed in waterproof containers; Room 1165 pits may not store fissile material, while those in Room 1320 may store ^{233}U oxide (U_3O_8) or other fissile material with maximum limits of 550 g per container and 4500 g per storage well. Material storage logs are maintained by the Facility Manager.

CAVES AND CELLS

Rooms 1302, 1320, and 1356 provide housing for four neutron shielded cells that have wall thicknesses of 1.2m which are water and magnetite ore filled. Each of these cells is located above the legs of an X-shaped tunnel system that allows transfers between the cells, the solid waste pit, and a shipping cask.

Room 1150 has two cave units with 0.3m, water-filled walls. These units provide a wet chemistry work place for smaller amounts of neutron/gamma materials. Upon completion of the construction of the hardened area, these two caves and two caves from Rm. 1232 will be moved into the hardened area (Rm. 1047).

Special Service Utilities and Support Systems

These systems are described here only as they relate to safety.

- o Natural gas (propane gas backup system)
- o Piped nitrogen
- o Acetylene (used only on one solder bench in Rm. 1301A)
- o Oxygen
- o Process cooling water (in-house loop)

General practices in this installation includes:

- o Shut-off valves are installed at all penetrations of the outer containment wall.
- o Reduced pressure backflow preventers are provided on all city water lines that enter areas of possible radioactive contamination.
- o Critical orifice in the acetylene line limits flow to minimize explosion/fire potential.
- o No flammable utilities are piped to the Hardened Area.
- o Double check-valve backflow preventers are provided on the nitrogen and compressed air lines.
- o Seismic shut-off valves and safety regulators are on all natural gas or propane gas supply lines.

- o The building drainage piping is similar to that for process piping. The main safety requirement is that there be no capability that drainage piping can become a source of uncontrolled or unknown radioactive effluent discharge from the building. There are two drainage systems in the Building 251 facility.
- o Water from all floor drains, the roof and the pavement around the building is collected by the area retention sump.
- o Waste from the laboratories, the shower room in Room 1001B, the drain around the storage pits in Room 1165, and the solid waste pit (including the loading pad) is collected by the liquid waste retention system.

Pipe-conducted services are as follows:

Nitrogen. Nitrogen gas service can be supplied from a large tank located outside Building 251 and will be used for fire suppression in the four neutron-shielded cells housed in Rooms 1302, 1320, and 1356 if they are used.

Natural Gas. Natural gas service is provided from the utility mains on Fourth Street and Avenue B. This service is provided to three mechanical equipment rooms on the north, south, and west sides of the building.

Acetylene. Acetylene service is provided by a bottled gas manifold system located outside of the building. This service is limited to the solder bench in Room 1301A.

Oxygen. Oxygen service is provided by a bottled gas manifold system located in the northwest corner of the building. This service is provided to four laboratories and to the solder bench.

Process Cooling Water. Process Cooling Water (PCW) is an internal closed-loop system within the facility. This system eliminates the possibility of unknown release of contamination.

Ventilation and Air Filtration

The basic scheme of the ventilation system in Building 251 is filtered air flow from outside into areas of least possible contamination toward areas of greatest possible contamination, then through filtered exhaust and back to the atmosphere. This flow is designed to confine radioactive materials to their designated areas and to reduce the spread of contamination in the event of an accidental spill. All of the rooms and hallways in the hardened area are supplied by a once-through system.

Enclosures in the laboratory work areas are connected to a glove box manifold. The manifold exhauster maintains a negative pressure within the enclosure with respect to the room. These glove boxes are known as "air" boxes since their atmosphere is air rather than inert gas. Two of these enclosures (located in Room 1364) are supplied with flammable gases. The use of gases or other flammable chemicals requires compliance with the Health and Safety Manual.

Room air is exhausted through a combination control damper-fire damper, through filters rated at 95% by NBS stain test (60-65% by 0.3- μ m DOP smoke test) then through an exhauster and vertical discharge stack. The glove boxes are supplied air from the room, exhaust through two 50-cfm-HEPA in-series filters to a manifold, a final HEPA (99.97%) filter, an exhauster and vertical discharge stack. The neutron cells in Rooms 1302, 1320, and 1356 are exhausted by under-floor ducts into Room 1314 and then through HEPA filters up

to Room 1312 and out to the atmosphere through a vertical discharge stack (the boxes in the cells have triple HEPA in-series exhaust systems). The fume hoods are exhausted through FARR filters to risers that extend to the roof.

In the hardened area, all air from the enclosures or the rooms is filtered through at least two HEPA filters in series before being discharged. There is no recirculation of air in this part of the building.

Glove Box Exhaust System -- The glove box exhaust system is controlled to maintain a negative pressure differential with respect to the room. This differential may vary depending on the number of boxes in use at one time. A preset minimum pressure differential must be maintained, or an alarm will be transmitted and a second blower energized. The alarm alerts the building personnel and the Fire Station that a blower or filter blockage has reduced the pressure differential below the minimum requirements.

Room Exhaust System -- The room exhaust systems are controlled to maintain a negative pressure differential of approximately 0.03-in. water gauge with respect to the hallway. Manual controls in the hallway outside the rooms are used to adjust the room discharge damper. An inclined manometer shows the differential pressure. In normal operation as the filters become clogged, the static pressure is manually increased by a pneumatic damper motor. When the damper is fully open and there is insufficient exhaust flow the filters must be changed.

Air Sampling System -- The samples are taken isokinetically from approximately 50 points throughout the exhaust system.

ALARM SYSTEMS

- o Fire alarm
- o Nuclear criticality alarm
- o Security alarm
- o Paging and disaster alarm
- o Air monitoring alarm
- o Supervisory alarm (this includes room radiation alarms)

Fire Alarm

The building is equipped with either rate-of-rise or fixed-temperature heat detection system in the laboratories and glove boxes. Each area is wired separately to alarm panels in Room 1102 and outside the building at the main entrance. The fire alarm bell is at the main entrance. The fire alarm bell is activated when one of the alarms in the building is tripped, and the location is displayed on the referenced indicator panels and a signal is transmitted to the Fire and Police Stations. A flow indicator on the automatic sprinkler system (discharge heads are in each room and hallway) also transmits a fire alarm when there is any flow of water in the system.

The cell boxes and cells in the Neutron-Shielded Cell Complex (rooms 1302, 1320, and 1356) are designed for flooding with nitrogen gas in the event of fire. Liquid nitrogen is drawn from the storage tank at 25 psig, expanded through a heat exchanger, and piped to the inlet air location for both the cell box and the neutron-gamma shield. This system is actuated automatically by in-cell sensors. Signals are relayed directly to the Fire and Police Stations.

Nuclear Criticality Alarm

The nuclear criticality alarm is a system of detectors that sense neutrons that would occur during a criticality accident. Any two sensors alarmed simultaneously will set off the building evacuation Klaxon horns and transmit an alarm to the Fire Station. The system is internally monitored for performance and calibrated at appropriate intervals.

Security Alarm

The security alarm system is being revised and will be complete within the next year. There are administrative controls and a CAIN access for the building. Control of access is an important safety aspect.

Paging and Disaster Alarms

There are speakers installed in each laboratory and hallway. The system is arranged so that it can be activated from within the building, the Fire Station, the Police Station, or Building 151.

Air Monitoring Alarm

Each laboratory where work is conducted with radioactive material is supplied with an alpha-sensitive continuous air monitoring system which alarms the laboratory and the Fire Station when the alarm point is passed. Portable alpha continuous air monitors are also used.

A continuous radiation monitoring system is incorporated in exhaust stacks from the hardened area. The alarm is relayed to the Supervisory Alarm System (see below) and the readout/control panels. In addition, all of the exhaust points of the building have a sampling system that isokinetically collects a fraction of any particulates being exhausted to the environment.

Supervisory Alarm

Several alarm indicator panels in the building are located in prominent positions throughout the building. This system is an alerting mechanism to sound an alarm within the building and at the Fire Station. When such an alarm is activated, the Health and Safety Technicians are informed and investigate the alarm. The supervisory alarm board indicates alarms due to high alpha radiation levels, to a failure in the ventilation system or waste sump systems, or to the failure of the manifold exhaust blowers for the glove box system. This alarm system functions continuously.

Emergency Power

There are three independent sources of power in the event of primary power failure. These include a 200 KW "no break" system, several banks of batteries, and a system of two auxiliary diesel-driven engine-generators. The two emergency generators produce 150 KW each and are hooked to a priority switching system so that if one generator fails, the remaining unit powers the hardened area.

The following safety-related equipment is connected to the emergency generator:

- o All exhaust fans and related controls serving the hardened area.
- o Some exhaust fans and related controls (hoods)
- o Glove box manifold system and related controls
- o Electrical controls related to the ventilation system
- o Continuous air monitors in the laboratories and stacks
- o Alpha hand and foot counters in laboratories, corridors, and air locks
- o Emergency lights within the building
- o Fire alarm system (battery powered, recharged from emergency power)
- o Critically alarm system (with battery back-up)
- o Paging system and disaster alarm system
- o Telephone system
- o Room 1116 (Counting Room) equipment

DESCRIPTION OF OPERATIONS

Introduction

The Nuclear Chemistry Division administers Building 251. This facility primarily handles, processes and stores kilocurie quantities of the actinides. Since these materials pose potential radiological and criticality problems, operations within the building are governed by written safety procedures and the Facility Management Plan (see Appendix). All of these documents have assigned review or expiration dates to keep them viable.

Since equipment requirements change, there is a continuous need to modify existing equipment or to obtain new equipment. Modifying, moving, and replacing equipment is an integral part of the facility operation and no description of the physical plant is accurate for more than a limited time. In the 20-year history of the building, operation of the facility has been upgraded with respect to capability and safety features.

Quantities and Types of Materials to be Processed or Stored

The quantities and types of materials associated with this facility are variable, strictly controlled, and kept to a minimum amount. The use of a computer bookkeeping code gives the exact amount of material, the location, the identity of the material, the people using the material, the chemical form, and the type of container. Since the facility has, at times, kilocurie amounts of fissionable material primarily in the oxide form, criticality is a concern. This subject is discussed in the Criticality Section of this report.

The facility has a variable amount of fissionable material primarily in the oxide form.

Material Flow

With the exception of small sealed sources, movement of all radioactive materials in and out of Building 251 is controlled by the Materials Management Group. Within the facility, materials are moved from one work station to another only by an authorized member of the staff. The movement of fissile material from one laboratory area to another must be authorized by the Facility Manager. The mass limit for each work station is posted at the station.

Description of Enclosure Equipment

Several types of enclosures are used when working with radionuclides in Building 251. The standard enclosure is the metal glove box. This 0.9 m long, 0.6 m high and 0.6 m deep box (made of coated 11 gauge mild steel) is provided with glove ports and a Plexiglas window. The box has cove corners with ground inside welds and is coated with plastic. A gentle current of filtered air moves through the box providing approximately one air change per minute. This flow is measured and discharged through HEPA filters. When flow drops below 8 ft^3/s , the filter is changed. The box and its filters is mounted on a pipe frame stand and is anchored with cable to the floor.

A second type of enclosure is essentially the same as the glove box but has an additional lead shielding. A lead glass window and manipulators are also provided.

A third type of enclosure is neutron-shielded chemistry cells. Larger than the standard box, these cells have walls 0.3 to 1.2 m thick constructed of steel tanks filled with borated water and, in some instances, magnetite ore. Operations in these cells are performed with manipulators.

Operations

Operations in Building 251 vary according to programmatic requirements but, in general, the activities fall into two major categories. The first area of work relates to the diagnostic activities associated with the underground testing of nuclear devices. Approximately half of the hardened area is devoted to the fabrication of capsules containing aluminum metal powder and actinide oxide mixtures. These mixtures are used as tracers for identifying the performance of a nuclear explosive. Also associated with this postshot evaluation is the capability for dissolving recovered rock to separate and identify the device fraction and its detectors and tracers.

The balance of the building's work involves basic research devoted to enlarging the current understanding of the nuclear behavior of the heavy elements. Such activities as preparing accelerator targets, developing ultra pure isotopic standards, and understanding the early characteristics of fission are examples of the research function of this facility.

Figure 2 (page 5) shows the floor plan for the first floor of Building 251. Reference to this drawing plus the following description will provide a description of activities conducted.

ROOMS 1035, 1047, 1053.

These three laboratories are used for preparing the nuclear device fraction tracers. The diagnostic tracers or "slugs" are typically a mixture of powdered aluminum and an actinide oxide encapsulated in wafers or small cylinders usually less than 0.03 m in length. The aluminum or lead capsules are sealed by heat and pressure and, in some cases, by welding. After sealing, the tracers are checked for leaks, cleaned, sorted into sets, labeled and stored until needed.

To avoid cross contamination, a multiplicity of enclosures and equipment are required. Each isotope require individual facilities, since different amounts of each isotope impose unique requirements.

ROOM 1003

This laboratory is used in postshot diagnostic work. After an underground detonation, rock is reclaimed from the area of the explosion. If the rock sample is highly contaminated with an alpha-active radioisotope, it is taken to Room 1003. Here the rock is placed in one of four lead-shielded glove boxes and dissolved in a $\text{HF-HClO}_4\text{-HCL}$ process. Off-gas from the boxes is cleaned in caustic scrubber columns before passing through HEPA filters.

ROOMS 1302, 1320, and 1356

Rooms 1302, 1320 and 1356 are essentially one large room housing for neutron-shielded research cells. These cells are equipped with total-containment, replaceable cell-liners and are constructed so that

radioactive operations are conducted from the front face of the shielding and noncontaminated operations are carried on through the rear face.

Each of the four cells is located above the legs of an x-shaped tunnel system that allows transfers between the cells, a waste facility, and a shipping cask. Manipulations are performed in the cells by the use of short-stroke, extended-reach, master-slave manipulators. Currently there is no plan to use this equipment and the 5 Ci restriction on this part of the building will limit future use unless the area is upgraded.

ROOM 1364

Fundamental research is conducted in Room 1364. Various actinides (primarily transcurium actinides) are reacted with halogens and their physical properties are studied. After reaction, the radionuclides are placed in capillary tubes, x-rayed, and the x-ray patterns are studied in order to determine the structure of the resulting compound. The film is processed in the photographic dark room and forms the basis of the structural determination of the compound. Properties of materials, such as optical spectra and crystalline structure, are measured and recorded.

ROOM 1117

This laboratory is known as the "box room" because it houses seventeen glove boxes. Each box contains less than curie levels of actinides. These boxes are assigned to individuals who normally work in other buildings and utilize the facilities on an unscheduled basis. Chemical manipulations can be performed in the boxes.

ROOMS 1211, 1363, and 1142

These three laboratories do not have enclosures. They have standard chemistry hoods and equipment and since the hoods do not have HEPA filtered exhaust, work in the hoods is very limited. Wet chemistry separations are conducted in the hoods as they are in the glove boxes except on lesser amounts of radioactive materials. Again, this work is related to understanding heavy element nuclear behavior.

ROOM 1212

This laboratory houses a large isotope separator. Up to milligram quantities of ionized high-purity actinides are accelerated through a magnetic field that deflects the particles in relation to their mass. Various mass components are collected on different areas of a target, resulting in ultra-high isotopic purity materials, which can be utilized as accelerator targets or standards.

ROOMS 1225, 1301A, 1234, 1301, 1321, and 1330

These rooms are shops that are used to repair, manufacture, or assemble the various mechanical or electrical equipment used in the building. Room 1234 is of special interest in that it alone has close capture capabilities for performing machine shop operations on actinide contaminated equipment. Exhaust air from Rm. 1234 is filtered through a HEPA filter.

ROOMS 1359 and 1116

These are the counting laboratories. Samples prepared in other laboratories are evaluated and their radiation is measured in terms of individual ionizations. Room 1359 measures the radioactive content of materials with low levels of activity. Room 1116 measures higher levels of radioactivity.

ROOM 1364 and 1027

Besides counting, another means of determining radioactive content is by measuring the amount of heat produced by the decay of radioactive nuclides. Room 1364 measures low-level sources and Room 1027, because it is in the hardened area, is capable of handling larger sources.

ROOM 1225, 1130, 1165, 1301B, 1312, 1314, 1354, and 1320

These rooms are used, all or partly, for storage. Rooms 1130 and 1301B store clean laboratory supplies and equipment. Room 1225 stores alpha contaminated glove boxes. These boxes are mounted on wheels and are moved into various laboratories as required. Room 1354 stores the manipulator boxes that fit into the various water-wall cells. Rooms 1312 and 1314 store the equipment used in solidifying and packaging radioactive intermediate or high-level liquid waste produced in the building. Room 1165 stores high-level non-fissile radionuclides in steel and concrete pits and also in the pool. Fissile material is stored in pits in Room 1320.

ROOMS 1053 and 1048

The main feature these two labs have in common is that they share space in the "hardened" area and can accommodate greater than 5 Ci of radioactive material. Room 1053 will use glove boxes while 1048 will incorporate water shielded caves.

OTHER ROOMS

Offices and machinery spaces were inspected for hazards also and are included in the Safety Analysis Section of this report.

Contaminated Waste

Building 251 generates radioactive solid, liquid, and gaseous waste. All solid and liquid effluents are assayed and evaluated before discharge to the environment. The principal radioactive contaminants are ^{233}U , ^{241}Am , ^{237}Np , ^{244}Cm , ^{238}Pu , ^{239}Pu , and ^{242}Pu . An insignificant amount of decay-chain radon is released from the stacks.

Solid Waste

Contaminated solid waste material is normally generated during hot-cell or glove-box operations. In either case, the material is transferred out of the enclosure in a closed, sealed primary container free of contamination on the outer surface. Following an estimate of the identity and quantity of radionuclides present, the material is placed in a secondary container usually consisting of a heavy paper sack, plus a heavy plastic bag. This bag, when full, is sealed in a metal 210 L drum and sent to the solid-waste handling area (Building 612) for repackaging for off-site shipment.

Liquid Waste

Highly contaminated liquid waste is processed within the building.

Processing consists of transferring the liquid from its point of origin to a central waste block through double-walled polyethylene lines. The liquid is then solidified by addition of a cement-vermiculite mixture. When filled, the waste block is capped off and turned over to Waste Management (Building 612) for final disposal. Moderately contaminated liquids are placed in polyethylene waste jugs and sent to Building 514 for treatment and disposal.

All water, except sanitary sewage, that is discharged from Building 251 is held in retention tanks until it is analyzed for radioactivity. This is achieved by a central collection system that directs all water, except sanitary sewage, to two 4 m³ retention tanks. Water flow to the tanks is continuously monitored for gross contamination by a scintillation detection system. The detector is set to alarm at twice background. All water in the tanks is held until laboratory analysis shows that contamination levels are within acceptable discharge limits. If the water exceeds discharge limits, it is transferred via tank truck to Building 514 for treatment prior to disposal.

Airborne Effluents

Alpha-contaminated airborne particulate waste is generated by work performed in the enclosures within the facility. As discussed earlier, particulates are removed by redundant HEPA filtration.

SAFETY ANALYSIS

Safety Analysis Methodology

This section summarizes the findings of a safety review of the equipment and operations in Building 251. The facility people were interviewed and observed in action. The equipment was evaluated and, in cases of question, an expert viewpoint was solicited. All available QA data, procedures, and administrative controls were examined as were the support functions of Hazards Control and LLNL management. On a room-by-room basis, the facility was examined for the potential hazard energy sources listed in Table 1. These sources were evaluated as diagrammed in Fig. 3 and summarized in Table 2. Table 3 is a summary of subsystems response to some postulated major accidents.

Safety Analysis Comments

DOE Order 5481.1A defines Building 251 as a high-hazard facility in that if control were lost of the entire inventory of radioactive material, there would be a potential for onsite and offsite impacts to a large number of people and the environment. Because of features that prevent or mitigate this loss of control, Building 251 is a high-hazard but low-risk facility. Also the quantity of material discussed in the following maximum credible spill is "at risk" for only a few hours per year. The activities conducted in the facility are of a low enough manpower/frequency distribution to significantly lower accident probabilities.

The room-by-room energy source survey failed, in most cases, to discover potential hazards not having adequate preventive/mitigating features. The few discrepancies, such as housekeeping and a missing machine guard, were corrected before this report was published.

Table 1

TYPICAL EXAMPLES OF ENERGY SOURCESElectrical

Battery Banks
 Diesel Units
 High Lines
 Transformers
 Wiring
 Switchgear
 Underground Wiring
 Cable Runs
 Service Outlets and Fittings
 Pumps
 Motors
 Heaters
 Power Tools
 Small Equipment

Nuclear

Vaults
 Temporary Storage Areas
 Receiving Areas
 Shipping Areas
 Casks
 Burial Ground
 Storage Racks
 Canals and Basins
 Reactor In-Tank Storage Areas
 Dollies
 Trucks
 Hand Carry
 Cranes
 Lifts
 Commercial
 Shops
 Hot Cells
 Assembly Areas
 Inspection Areas
 Test Rigs
 Reactors
 Critical Facilities
 Subcritical Facilities
 Laboratories
 Pilot Plants

Thermal Radiation

Furnaces
 Boilers
 Steam Lines
 Lab and Pilot Plant Equipment
 Solar

Mass, Gravity, Height

Human Effort
 Stairs
 Lifts
 Cranes
 Bucket and Ladder
 Trucks
 Slings
 Hoists
 Elevators
 Jacks
 Scaffolds and Ladders
 Crane Cabs
 Pits
 Excavations
 Elevated Doors
 Canals
 Vessels

Pressure-Volume/K-Constant-Distance

Boilers
 Heated Surge Tanks
 Autoclaves
 Test Loops and Facilities
 Gas Bottles
 Pressure Vessels
 Coiled Springs
 Stressed Members
 Gas Receivers

Kinetic-Linear

Cars
 Trucks
 Buses
 Fork Lifts
 Carts
 Dollies
 Railroad
 Surfaces
 Obstructions
 Shears
 Presses
 Crane Loads in Motion
 Pv Blowdown
 Powder Assisted Driving Tools

Kinetic-Rotational

Centrifuges
Motors
Pumps
Cooling Tower Fans
Cafeteria Equipment
Laundry Equipment
Gears
Shop Equipment (Grinders,
Saws, Brushes, etc.)
Floor Polishers

Corrosive

Acids
Caustics
"Natural" Chemicals (Soil,
Air, Water)
Decon Solutions

Explosive Pyrophoric

Caps
Primer Cord
Dynamite
Powder Metallurgy
Dusts
Hydrogen (Incl. Battery Banks
and Water Decomp.)
Gases-Other
Nitrates
Electric Squibbs
Peroxides-Superoxides

Toxic Pathogenic

Acetone
Fluorides
Carbon Monoxide
Lead
Ammonia and Compounds
Asbestos
Trichlorethylene
Dusts and Particulates
Pesticides-Herbicides-Insecticides
Bacteria
Beryllium and Compounds
Chlorine and Compounds
Decon Solutions
Sandblast
Metal Plating
Asphyxiation-Drowning

Flammable Materials

Packing Materials
Rags
Gasoline (Storage and in Vehicles)
Lube Oil
Coolant Oil
Paint Solvent
Diesel Fuel
Buildings and Contents
Trailers and Contents
Grease
Hydrogen (Incl. Battery Banks)
Gases - Other
Spray Paint
Solvent Vats

Thermal (Except Radiant)

Convection
Heavy Metal Weld Preheat
Exposed Steam Pipes
Electric Heaters
Fire Boxes
Lead Melting Pot
Electrical Wiring and Equipment
Furnaces

Electromagnetic and Particulate Radiation

Canals
Plug Storage
Storage Areas
Storage Buildings
Radioactive Sources
Waste and Scrap
Contamination
Irradiated Experimental and
Reactor Equipment
Electric Furnace
Blacklight (e.g., Magniflux)
Laser
Medical X-ray
Radiography Equipment and Sources
Welding
Electric Arc - Other (High
Current Circuits)
Electron Beam

Acoustical Radiation

Equipment Noise
Ultrasonic Cleaners

Fig. 3. Methodology for safety analysis of Bldg. 251.

System: Bldg. 251

PROBABILITY OF ACCIDENT
ASSUMING PREVENTIVE ACTIONH-High
M-Moderate
L-Low
U-Unlikely

ACCIDENT SEVERITY

I. Death/Catastrophic
Damage
II. Major Equipment Damage/Major Injury
III. Minor Equipment Damage/Minor Injury
IV. Insignificant Damage

By: D. Kvam

Reviewed By: Team #4

Date 5/81

Date 6/81

ITEM	HAZARDOUS ELEMENT	SUBSYSTEM OR COMPONENT	OPERATIONAL MODE	EVENT CAUSING HAZARDOUS CONDITION	HAZARDOUS CONDITION	POTENTIAL ACCIDENT	EFFECTS	SEVERITY CLASS.	ACC. PROB.	MITIGATING/ PREVENTATIVE ACTION
1	Radiation	. X-ray Diffraction	. Operating	. Scattering of X-rays	. Hand in Beam	. X-ray Burn 10,000 R/min.	. Injury	II	L	. Shielding . Interlocks . Warning Devices . Training . Procedures . Infrequent Use
2	Radiation	. Enclosure i.e. Caves, Glove Boxes Hot Cells	. Operating	. Transfer In/Out	. Spill	. Lung Dose	. Injury . Environ- mental Impact	II	L	. Training . Procedures . Respirators . HEPA Filters . Protective Clothing . Alarms . Short Time at Risk
3	Radiation	. Enclosures	. Operating	. Penetrating Radiation	. Proximity	. Whole Body Exposure . Hand Exposure	. Injury	IV	M	. Shielding . Remote Operation . Procedures . Training . Dosimeters . Meters

Bldg. 251

ITEM	HAZARDOUS ELEMENT	SUBSYSTEM OR COMPONENT	OPERATIONAL MODE	EVENT CAUSING HAZARDOUS CONDITION	HAZARDOUS CONDITION	POTENTIAL ACCIDENT	EFFECTS	SEVERITY CLASS.	ACC. PROB.	MITIGATING/ PREVENTATIVE ACTION
4	Radiation	Mass Spec.	Running	X-rays	Removal of shield- ing	Soft X-ray Exposure	No Symp- toms	III	L	Warning Signs Training
5	Radiation	Test Components	Assembly Testing Disassembly Storage	Change in Mass/Geometry Moderation	Personnel Area	Criticality	Death Environ- mental Impact	I	L	Safe Geometry Design Mass Limits Physical Separation Procedures Physical Verification Training/Retraining Audits Liquid Control Special Studies
6	High-Voltage	All	Operation/ Maintenance	Energized Equipment	Exposed Electrical Equipment	Personnel Shocks/Burn	Injury Death	I	L	Interlocks Automatic Grounding Enclosures Barriers Warning Devices Procedures Training Codes
7	Implosion/ Explosion	High Vac or Pres- sure Systems	Operation	System Overstressed	Contain- ment Rupture	Personnel/ Equipment Impacted	Injury Death Equip. Damaged	I	L	QA Program Codes Admin. Control Protective Clothing Barriers Safety Glasses
8	RF Radiation	Power Tubes	Operation	Microwaves Low Frequency	Personnel in Area	Eye Damage Pacemaker Int.	Injury	II	L	Shielding Interlocks Training Transmission Lines

Bldg. 251

ITEM	HAZARDOUS ELEMENT	SUBSYSTEM OR COMPONENT	OPERATIONAL MODE	EVENT CAUSING HAZARDOUS CONDITION	HAZARDOUS CONDITION	POTENTIAL ACCIDENT	EFFECTS	SEVERITY CLASS.	ACC. PROB.	MITIGATING/ PREVENTATIVE ACTION
9	X-radiation	Power Tubes	Operation	Voltage Over 15 kw	Personnel in Area	X-ray Exposure	No Symptoms	III	L	<ul style="list-style-type: none"> Lead Glass Tube Shielding Periodic Checks Interlocks
10	Beryllium (BeO)	Power Tubes	Salvage/ Disposal	Tube Rupture	Personnel in Area	Oxide Dust is Inhaled	Lung Damage Berylliosis	II	L	<ul style="list-style-type: none"> Disposal Specialists Procedures Protective Equip. Labeling
11	Heat	Power Tubes	Operation	3000 Sur- face	Contact	Thermal Burn	Injury	III	L	<ul style="list-style-type: none"> Glove Shielding
12	Fire	All	Operation	Assumed Risk	Combust- ibles Present + Ignition Source	Fire	Equip- ment Damage Injury	II	H	<ul style="list-style-type: none"> Sprinklers Smoke/Heat Alarm Fire Resistant Construction Low Fire-load Fire Protected HEPA Filters O₂ Deficient Enclosures 3 Minute Fire Dept. Response
13	Fire	Radio- active Metals	Operation	Equipment Failure	Combust- ibles + O ₂ + Ignition Sources	Toxic Smoke Off-site	Envir- onmental	III	U	<ul style="list-style-type: none"> Detailed Analysis + All of Above

Bldg. 251

ITEM	HAZARDOUS ELEMENT	SUBSYSTEM OR COMPONENT	OPERATIONAL MODE	EVENT CAUSING HAZARDOUS CONDITION	HAZARDOUS CONDITION	POTENTIAL ACCIDENT	EFFECTS	SEVERITY CLASS.	ACC. PROB.	MITIGATING/ PREVENTATIVE ACTION
14	Chemical	. Dielectric Oil	. Maintenance	. Personnel Contacting	. Chem. Reaction	. Rash Forms . Eye Irritant	. Injury	III	M	. Protective Clothing . Safety Glasses
15	Chemical	. Chem. Lab Reagents	. Operating	. Personnel Contacting Chem. . Adverse Chem. RXN	. Toxic/ Corrosive Chemicals	. Spills . Bodily Intake	. Injury . Irritation	III	L	. Protective Clothing . Safety Goggles . Eye-Wash Equip. . Training . Procedures . Limited Quantities . Tested Fume Hoods
16	Gravity	. All	. All	. Normal Conditions	. Working at Elevations	. Slip/Trip Falling Items	. Death . Injury	I	M	. Guard Rails . Scaffolding . Harnesses . Nets . Safety Lines . Procedures
17	Mass	. Non Hardened Area	. All	. Earthquake	. Over- stress of Supporting Members	. Falling Equip/ Facility	. Injury . Death . Spill	I	L	. Tie Downs . Re Evaluate Need for Upgrade
18	Mass	. Cranes	. All	. Suspended Load	. Over- stress . Equip. Failure . Rigging Failure	. Dropped the Load	. Injury . Death . Spill	I	L	. Licensing Operators . Routine Testing . Routine Maintenance . Engineered Features

Bldg. 251

ITEM	HAZARDOUS ELEMENT	SUBSYSTEM OR COMPONENT	OPERATIONAL MODE	EVENT CAUSING HAZARDOUS CONDITION	HAZARDOUS CONDITION	POTENTIAL ACCIDENT	EFFECTS	SEVERITY CLASS.	ACC. PROB.	MITIGATING/ PREVENTATIVE ACTION
19	Mass	. Fork Lifts	. Operating	. Suspended/ Moving Load	. Overstress . Equipment Failure . Operator Failure	. Struck by Load	. Injury . Spill	II	M	. Training . Licensing . Routine Inspection . Routine Maint.
20	Noise	. Slug Line . Pumps . Blowers . Machine Tools	. Operational	. Pumps are Noisy	. People are Exposed to Noise	. Hearing Loss . Hypertension	. Injury	III	L	. Duration Brief . Ear Protection . Damping Source Measurements
21	Oil	. Roughing	. Operational	. Oil En- trained in Exhaust	. Ignition	. Fire	. Injury . Equip. Loss	II	L	. Demisters . Condensors . Remote Operation
22	Moving/ Rotating	. Pumps . Blowers . Machine Tools	. Operational . Maintenance	. High Kinetic Energy	. Personnel in Area	. Personnel Entanglement	. Injury	II	M	. Guards/Barriers . Training . Interlocks

BUILDING 251 SAFETY ANALYSIS REPORT (SAR)
SUBSYSTEM RESPONSE TO A POSTULATED ACCIDENT IN HARDENED AREA

TABLE 3

Postulated Accidents	Ventilation System	Building Envelope	Glove Boxes	Normal Power	Standby Power	Fire Protection	Combustion Detectors	HEPA Filter Plenum	Accident Results
Fire in Contained Laboratory (2) Filtration	Motors and Fans isolated from Labs w/Fire Rated Separation	Maintained- 2 Hr. Exterior Skin	Glove Box Barrier Fails in < 5 Min. Spill Into Lab	May Fail Locally Conductors Burn Off	Maintained, Isolated From Fire w/Fire Rated Separations (1)	Fire Sprinklers Initiate, Put Out	Detect Fire, and Signal to Fire Station	Spray Damper Initiates and Protects Filters	Fire & Spill in Lab Room Exhaust Through Double HEPA
Fire inside Glove Box Exhaust	Maintained	Maintained- 2 Hr. Exterior Skin	1st G. B. Filter Loads 2nd Remains Functional	Maintained	Maintained	Fire Contained in G. B. Sprinklers Don't Initiate	Fire Contained in G. B. No Smoke Escape	Maintained Double HEPA on Room Exhaust	Fire Contained in Glove Box Room Filters intact No Branch to Atmosphere
Fire in Mech. Equipment Room	Maintained *	Maintained- 2 Hr. Exterior Skin	Maintained	Maintained	Maintained	Fire Sprinklers initiate, Put Out Fire	Detect Smoke/Heat Signal Fire Station	Maintained	Fire Sprinklers Put Out, Fire-Containment Barriers Maintained
Chemical Spill in Laboratory HCL Worst Case	Maintained	Maintained	Inert to HCL	Maintained	Maintained	Maintained	Possible Activation From Fumes Signal to Fire Dept.	Maintained Ducts Designed for Corrosion Resistance Filters Fail	Minor Consequences

NOTE: 1. Some Electrical Components rated for 1/2 hr
2. Design Basis Fire (DBF) * 1/2 hr. duration in one lab.
3. Design Basis Earthquake (DBE) * 0.82 g
4. Design Basis Accident (DBA) * DBF + DBE

TABLE 3 (cont'd)

Postulated Accidents	Ventilation System	Building Envelope	Glove Boxes	Normal Power	Standby Power	Fire Protection	Combustion Detectors	HEPA Filter Plenum	Accident Results
Criticality 1018 Fissions	Maintained	Maintained	Maintained	Maintained	Maintained	Maintained	May Alarm		Gas Released From Bldg. Site Boundary Doses Within Prescribed Limits
Interior Explosion in Lab No Missile	No Credible Damage	No Credible Damage	Possible Local Damage & Spill	May Fail Locally	Maintained, Isolated From Labs	Maintained	Possible Activation From Fumes, Signal to	Maintained	Local Damage-Spill Confined to Lab. with Ventilation System
Interior Explosion and Reluctant Missile in Lab	No Credible Damage	Possible Small Hole in Envelope	Possible Local Minor Damage and Spill	May Fail Locally	Maintained Isolated From Labs	Knock Off Sprinkler Hds. or Damaged Piping Sys. Still Operable	Possible Activation From Fumes, Signal to Fire Dept.	Maintained	Local Damage-Spill Confined to Lab. with Ventilation Sys.
Failure of Exhaust Fan	Alternate Fan Starts Sounds Alarm	Maintained	Maintained	Maintained	Maintained	Maintained	Maintained	Maintained	No Consequence
Failure of Supply Fan	Exhaust Fan Throttles Back Alarm Sounds	Maintained	Maintained	Maintained	Maintained	Maintained	Maintained	Maintained	No Consequence Temporary
External Fire	Enclosed in 2 Hr. Envelope Maintained	2 Hr. Construction Envelope	Enclosed in 2 Hr. Envelope	May Fail	Maintained Enclosed in Cabinet & away from Fire Exposure	Enclosed in 2 Hr. Envelope Separate Zone	Maintained Enclosed in 2 Hr. Envelope	Maintained Enclosed in 2 Hr. Envelope	No Consequence Hard Area Isolated With 2 Hr. Fire Barrier

TABLE 3 (cont'd)

Postulated Accidents	Ventilation System	Building Envelope	Glove Boxes	Normal Power	Standby Power	Fire Protection	Combustion Detectors	HEPA Filter Plenum	Accident Results
Earthquake 0.5 g Ground Acceleration	Maintained	Structure Maintained w/Some Cracking	Maintained *	May Fail	Maintained	Won't Fail Designed For 0.8 g	May Fail	Maintained *	Building Confinement Breached Nothing Released Contained by Glove Boxes and Room Exhaust
Earthquake 0.5 g Glove Box Not Upgraded for E.Q.	Maintained	Structure Maintained w/Some Cracking and Deformation	May Fail w/Resultant Release Into Lab	May Fail	Maintained	May Fail	May Fail	Maintained	Building Confinement Breached Spill Contained (Probably to Single Lab) by Room Exhaust
High Wind	Maintained	Maintained	Maintained	May Fail	Maintained	Maintained	Maintained	Maintained	No Consequence
High Wind	Maintained	Envelope Designed to Resist Missile	Maintained	May Fail	Maintained	Maintained	Maintained	Maintained Plenum is Inside Bldg.	No. Consequence
Tornado									Tornado Accident Not Considered Credible
Lightning									Grounded-No Consequence
Flood									Not Credible
DBA 0.8g Earthquake w/fire	Maintained	Structure Maintained w/Some Cracking and Deformation	Will Fail w/Resultant Leak into Building	Fails	Maintained	Activates Dedicated water supply	Fails	Maintained	One Lab Destroyed 1.25 Ci/s of a Activity Released From Bldg. for 10 minutes.

The facility staff, those people spending most of their time in the building, are outstanding in their safety awareness. The transient population, such as chemists, technicians, and support people, were not evaluated individually; however, all people working in the building are required to attend a formal indoctrination before entering the facility. The indoctrination intensity is commensurate with their duties and is repeated at appropriate intervals.

Upper management has given the Facility Manager full responsibility and authority for safety at Bldg. 251 and there is no doubt that he and his people are making a conscientious and capable safety effort. Upper management reviews all potentially hazardous operations at the facility, and frequent inspections by upper management strengthen the safety program.

The facility staff was enthusiastic about the support of their Hazards Control Safety Team. The few instances of conflict, when examined, appeared to be merely communication difficulties.

There have been no lost time injuries at Building 251. Other than minor spills, there has been only one accident at this facility. In November of 1960, there was a fire in a curium processing cave that started as the result of an overheated oil bath. The fire was extinguished in 12 minutes and did an estimated \$194,000 damage. The cave contained only a few Ci of curium and the contamination was restricted to the immediate area. Changes have been made in the facility to prevent and mitigate a recurrence such as:

- o Overhead sprinklers were installed.
- o A research program on coatings and their flammability was started.
- o A drain and sump system was installed to retain contaminated runoff water from fire fighting.

ACTS OF NATURE

Earthquakes

Several studies have been made to evaluate the response of Building 251 to a Safe Shutdown Earthquake (SSE) of 0.5 g. These analyses show that the hardened part of the building will survive intact.² They also indicate that the balance of the building will not survive the SSE.³

High Wind

A study of tornadoes concluded they pose no significant threat in the central California area,³ and that high winds are rare. Building 251 is designed to UBC criteria that insures the facility will survive 38 m/s wind loads. The hardened part of the facility will withstand 49 m/s winds.²

Missile

Large aircraft as missiles were considered but rejected as credible due to the low probability of impact on buildings this size. High winds at LLNL are not strong enough to produce missiles that threaten these buildings.

Lightning

Studies of the thunderstorm activities in the Livermore Valley indicate that thunderstorms occur less than five days per year, are not intense, and do not last more than one-half day per storm. No modifications are required for lightning protection.³

Flood

An analysis performed at LLNL and by the Department of Housing and Urban Development indicate that the LLNL site would be unaffected by a postulated 100-yr flood.

HUMAN ERROR AND/OR EQUIPMENT FAILURE

Explosions

The probability of various types of explosions occurring were considered, including those due to liquid or solid chemical reactions, flammable gases, and carbon monoxide/air mixtures generated by fires. The only area where there is a probability of explosion is with flammable gases in five rooms of the facility and this would entail a multiplicity of events. It is difficult to postulate a scenario that would achieve the following events without breaching the facility.

- o The worst case ventilation rate is 1 cfm of air movement.
- o The worst case gas flow is at least four times the measured flow.

- o The safety regulators fail to shut off gas flows.
- o The seismic valve fails to close.
- o The manual shut-off fails.
- o All power fails (including emergency generators.)
- o A source of ignition exists.

There are no flammable gases piped into the hardened area and it appears unlikely that a gas explosion in the low-level area of the facility would breach the hardened area.

Fire

The fire hazard analysis of Building 251 was based on a review of those factors that either affect the potential for propagation of a localized fire within the building or the release of radioactivity as a result of the fire. These include ignition sources, flame spread, fire loading, and the limiting effects of fire control and alert hardware.

The facility has a number of features to minimize fire damage.

- o All exhausts from the building are filtered and equipped with fusible plug, pneumatically-activated fire dampers.
- o All supply fans are automatically shut down upon activation of the automatic sprinklers, the heat detection system, or the manual fire alarm.
- o The entire building is protected with automatic sprinklers connected to the Laboratory water supply. In addition, the hardened area has a pressurized Seismic Cat. I, dedicated water supply which will operate any one sprinkler head for one-half hour.

- o Glove box heat detectors can be plugged into the fire alarm system.
- o There is a special nitrogen inerting system for fire in the hot cells.
- o Activation of any of the above features automatically notifies the fire department.

Assuming the failure of the manual and automatic fire suppression system, the passive containment system (walls, dampers, etc.) should remain intact during the period of a fully developed fire which would not exceed two hours.

Criticality

The mass limits on fissile materials for work stations and storage locations in Building 251 make it physically impossible for a criticality accident to take place--provided the rules are always followed. Safety design features, batch process work procedures, and administrative operational controls all make the unplanned and accidental assembly of a critical mass within the facility an extremely remote possibility. Examples of these design features, work procedures, and operational controls include:

- o Safe geometry design whenever an operation involves accumulation of finely divided solids or liquids.
- o Safe geometry design for carrying containers and storage pits.
- o Work always involves batch processing of subcritical masses.
- o Work station mass limits for fissile material.
- o Physical separation of individual work stations.
- o Responsible persons' sign-off on all material transfers.
- o Physical or chemical verification of masses transferred.

- o Periodic physical inventory of amount and location of fissile material present in building.
- o Control of the amount or type of liquids or other materials that can act as neutron moderators or reflectors.
- o Periodic criticality safety re-training of operating personnel.

The extremely unlikely combination of a number of concurrent equipment failures and human errors leading to a critical assembly cannot be ruled out with absolute certainty. Thus, a nuclear criticality incident with the attendant release of fission products will be considered. A maximum postulated criticality accident and an analysis of the possible quantities of fission products released to the environment is presented in this section.

Magnitude of Postulated Criticality Accident

The maximum credible fission yield for an accident in Building 251 is postulated to be 10^{18} fissions. This estimate follows from an analysis of the operation conducted in the building and the theoretical and actual yield data provided by Aspinall and Daniels⁴, Woodcock⁵, and Stratton.⁶ The possible causes of such an accident will not be discussed because a review of the some 60 accidents that have occurred since the beginning of the nuclear industry shows that most of these accidents were a direct result of human error. For this facility, the most probable maximum accident is assumed to be an accidental combination of solutions of fissile material into a critical assembly. From the guidance, the spike and total yield for this type of accident will be as indicated in Table 4 (taken in part from Woodcock's report on the potential magnitude of criticality accidents).

TABLE 4. Postulated Nuclear Accident.

<u>System</u>	<u>Spike yield (fissions)</u>	<u>Plateau power (fission/sec)</u>	<u>Total yield (fissions)</u>	<u>Likely mechanical damage</u>
Solution	10^{17}	3×10^{15}	10^{18}	Little or none

Fission Products Produced -- at $t + 1$ min, the total quantity of fission products remaining after a 10^{18} fission accident is approximately 2.5×10^5 curies. At $t + 10$ min, the total activity will have decayed to 1.5×10^4 Ci. By far the largest portion of the fission products will be in the nonvolatile form. The volatile isotopes, which are the most significant when considering possible release to the environment, are given in Table 5.

TABLE 5. Volatile Isotopes From 10^{18} Fission Accident.

<u>Isotope</u>	<u>Activity released Ci at t = 0</u>
^{131}I (8.05 d)	0.75
^{132}I (2.4 h)	3.3
^{133}I (20.5 h)	18
^{134}I (52.5 m)	450
^{135}I (6.68 hr)	48
$^{135\text{m}}\text{Xe}$ (15 m)	395
^{138}Xe (17 m)	1050
^{87}Kr (1.3 h)	112
$^{83\text{m}}\text{Kr}$ (1.86 h)	13.5
^{88}Kr (2.8 h)	69.5
$^{85\text{m}}\text{Kr}$ (4.4 h)	18.5
^{135}Xe (9.2 h)	36.4
$^{133\text{m}}\text{Xe}$ (2.3 d)	0.2
^{133}Xe (5.27 d)	2.7
$^{131\text{m}}\text{Xe}$ (12.0 d)	0.06
^{85}Kr (10.4 y)	2×10^{-3}
Total	2218 Ci

Effects of Fission Product Release to the Environment -- As indicated above, about 1.5×10^4 Ci of fission product activity would be present 10 min after the postulated 10^{18} fission criticality accident. It has been suggested⁷ that to estimate fission product releases the following release fractions be used: 100% for noble gases, 25% for halogens, and 1% for all remaining fission isotopes. Air exhausted from Building 251 (hardened area) is HEPA filtered to ensure minimum release of particulates to the environment.

By using conservative dispersion meteorology, one can calculate the concentrations and possible doses to persons downwind. Doses at the site boundary are summarized in Table 6.

TABLE 6. Doses at Site Boundary^b (rem)

	Wet Season		Dry Season		Annual	
	Median	95th Percentile ^c	Median	95th ^c	Median	95th ^c
Submersion	1.8(-3) ^a	8.4(-3)	3.6(-3)	1.3(-2)		
Inhalation	1.4(-2)	7.0(-2)	2.8(-2)	1.3(-1)	2.8(-2)	1.2(-1)
Forage-cow-milk	8.0(-1)	3.9(0)	1.5(0)	7.7(0)	1.60(0)	7.1(0)

^a1.8(-3) means 1.8×10^{-3}

^bSite Boundary (0.6 km)

^c95th percentile means the probability is 0.95 that the actual dose will be less than stated

It should be noted that the Livermore Valley is not a milk producing area. The milk from the few existing cows could be replaced in the event of an accident.

The maximum doses listed in Table 6 are well below reactor siting criteria of 25 rem for a whole-body dose and 300 rem for a thyroid dose in an accident (Code of Federal Regulations, Title 10, Chapter 100). Also, these doses are below those recommended by the Environmental Protection Agency for considering evacuation of populations at risk.^{8/9}

For a more detailed discussion of criticality/meteorological/dose interactions, the reader is referred to the LLNL Environmental Impact Statement.⁸

Effects of Criticality on Building Personnel

Assuming prompt evacuation, it is unlikely that people not in the immediate vicinity would be seriously injured by the accident. Table 7 presents a general statement based on one particular model to illustrate the importance of rapid egress in the event the criticality alarm sounds. Personnel training and the facility design emphasize prompt evacuation.

TABLE 7. DOSE (REM)

Initial distance from incident	Without evacuation	Evacuation at 5 m/sec after initial delay times of			
		2 sec	1.5 sec	1 sec	0.5 sec
1 m	9100	2300	1900	1500	850
2 m	2300	620	510	400	260
3 m	1000	270	240	190	140
5 m	360	110	94	78	58
10 m	91	29	27	23	19

Maximum Credible Spill

A spill is a loss of control of radioactive material. For the purpose of analyzing the maximum credible spill, it is assumed that 15 g of ^{244}Cm are dispersed in a room as the result of a fire. Fifteen grams represents 1250 Ci and is the largest amount of activity ever expected to be out of an approved shipping container in a single room. Even then, it is within a single glove box for a short time, until it can be divided into smaller amounts and distributed to other locations within the facility. It is unlikely that this much activity could be involved in a spill. The worst past spills in Building 251 have involved curie amounts approximately one-thousand times smaller than the spill discussed here.

The amount of Cm that is spilled and becomes airborne and therefore a respiratory hazard will depend primarily on particle size. The oxide used in Building 251 is 400 mesh with not more than 10% of the particles having a diameter less than 2.0 microns. For this analysis, it is assumed that 0.2% of the curium becomes airborne.

Mechanical and/or human fire fighting efforts are assumed to compromise the first of the series HEPA filters permitting 0.03% of the airborne curium to penetrate the filter system.

Thus, for the total release period:

$$\frac{(1.25 \times 10^3 \text{ Ci})(2 \times 10^{-3})(3 \times 10^{-4})(10^6 \mu\text{Ci/Ci})}{(10 \text{ min})(60 \text{ s/min})} = 1.25 \mu\text{Ci/sec}$$

are released to the outside atmosphere. At the west Site boundary, we apply the diffusion value that is exceeded only 5% of the time, $x/Q = 1.3 \times 10^{-3} \text{ s/m}^3$ and using the values found in ICRP Publication 19, "The Metabolism of Compounds of Plutonium and Other Actinides," May 1972, we can calculate the total integrated dose to the pulmonary region from breathing the fence-line cloud during its passage. This dose is found to be 0.17 rem and the dose to the nearest resident is 0.09 rem. Applying the guidance of EPA 520/1-75-001 which calls for evacuation when 3 to 5 rem may be encountered, clearly no evacuation is indicated by the maximum credible spill⁹.

CONCLUSION AND RECOMMENDATIONS

Three interrelated factors have enhanced the safety picture at Building 251 significantly since the 1974 SAR was written.

The first factor is the increased awareness and active participation of top management in the safety program. For example, the formation of the Director's Safety Committee can be expected to involve upper management in evaluating the overall safety posture of the facility, as well as forming policy and guidance.

The second major safety feature is the development of a viable quality assurance program for the building providing auditable records of the performance of safety related items and control features.

The third factor is, of course, the up-grade of that portion of the building that performs the higher risk functions of the facility. This analysis found no significant deficiencies in the up-grade design. It conforms to the state-of-art and its operation presents no unacceptable risk.

This report has no purely safety-related recommendations to offer. Safety deficiencies considered by this analysis were corrected before they could be printed. We do, however, make the recommendation that the balance of the facility be hardened to the standards of the upgraded portion of the building in order to provide greater flexibility for future programmatic projects.

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GLOSSARY

ACCEPTABLE RISK: A management decision that the safety system is adequate.

CAIN ACCESS: A system of gaining entrance to an area by using a computer to compare a magnetic identification card with a list of authorized people.

ENERGY SYSTEM: Interrelated components having a hazard potential from a common type of energy such as "electrical".

EPA: Environmental Protection Agency.

FARR FILTER: Any filter manufactured by the FARR Co. As used in this report, the filter is intermediately efficient and fire resistive.

HEPA FILTER: High efficiency particulate air filter. A type of filter designed to remove 99.96% of particles down to 0.3 microns in diameter from a flowing air stream.

ICRP: International Commission on Radiological Protection.

MAINTAINED SYSTEM: Equipment that continues to function under adverse conditions such as a fire or earthquake. The term is usually qualified by time or other limiting conditions.

NBS: National Bureau of Standards.

QA (QUALITY ASSURANCE PLAN): A formal written system verifying the continued effectiveness of safety-related items and control features.

SAFETY SYSTEM: Hardware, software, and people used in the detection, prevention, and mitigation of hazards.

SINGLE SOURCE: A component of an energy system, such as a "capacitor", that is part of an electrical energy system.

APPENDIX

LAWRENCE LIVERMORE NATIONAL LABORATORY
FACILITY MANAGEMENT PLAN
FOR
BUILDING 251 - HEAVY ELEMENT FACILITY

November 1981

Approved by:

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Building 251

Concurred with:

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Nuclear Chemistry Division

P. Coyle
Associate Director for Testing

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FIGURE - Organization Chart, Figure 1

LAWRENCE LIVERMORE NATIONAL LABORATORY
FACILITY MANGEMENT PLAN FOR BUILDING 251
HEAVY ELEMENT FACILITY

1.0 INTRODUCTION

Facility Management Plan Objective

This Facility Mangement Plan prescribes the responsibilities, major concerns and controls necessary to reduce risk to an acceptable level, controls necessary to provide for performance, and methods of verifying implementation of the controls to assure THE SAFE AND CORRECT OPERATION OF THE BUILDING 251 HEAVY ELEMENT FACILITY.

The major concerns are:

- a. The safety of the public and employees.
- b. The protection of the environment.
- c. The security and accountability of materials.
- d. Providing a facility that helps support Lawrence Livermore National Laboratory objectives.
- e. Providing a facility that meets Nuclear Chemistry Division and programmatic objectives.

Facility Handbook

Detailed descriptions of controls and procedures referenced herein are contained in the Facility Handbook.

The Facility Management Plan and Facility Handbook are intended to incorporate, in a logical and easily used format, the management system and detailed procedures provided by the Quality Assurance Plan, Facility Safety Procedure, Operational Safety Procedures and other procedures.

Approval of Facility Management Plan and Facility Handbook

Changes to the Facility Management Plan require the approval of the Facility Manager, and concurrence of the Division leader and Associate Director. Changes to the appendices of the Management Plan and to the Facility Handbook require only the approval of the Facility Manager.

2.0 SCOPE

This plan is a documentation of a system that has proven to facilitate the management of the Building 251, Heavy Element Facility, where safety is of paramount purpose.

3.0 ASSIGNMENT OF RESPONSIBILITIES

FUNCTIONAL RELATIONSHIPS FOR HEAVY ELEMENT FACILITY OPERATIONS

RESPONSIBILITIES:

----- Advise/Coordinate

_____ Line

3.1 Division Leader:

- a. The Division Leader is responsible for but assigns this responsibility and delegates the authority to a Facility Manager for the safe and correct operation of the Building 251 facility, and the personnel, equipment, and materials therein. The Division Leader is responsible for verifying compliance.
- b. Reviews the Facility Management Plan and Facility Handbook for compliance with overall Division objectives.
- c. Provides the Facility Manager access to all pertinent Division or other sources of information, such as meetings and publications, for planned usage of the Building 251 facility.
- d. Reviews and approves all published experimental reports planned for distribution outside the Division.
- e. Approves the assignment of an Assistant Facility Manager.
- f. Concurs with the Facility Management Plan.

3.2 Facility Manager:

Provides for the safe and correct operation of the Building 251 heavy-element facility and equipment and materials therein. This includes:

- a. Providing and modifying as necessary, equipment and space to meet the existing and near-term requirements of the lead experimenters and program requirements.
- b. Adding to or modifying Building 251 facility and equipment, as required, with the approval of the Division Leader, to meet the future needs of lead experimenters and programs.
- c. Providing clear policy and objectives for safety and performance of Building 251.
- d. Providing for and approving plans, procedures and instructions required to implement and ensure the safety and performance of the facility. These include approval of the following:
 - (1) Facility Management Plan
 - (2) Facility Handbook
 - (3) Other check lists or instructions, for inclusion in the Facility Handbook, necessary to meet safety and performance requirements.
- e. Reviewing and approving activities conducted in Building 251.
- f. Approving access of all personnel entering Building 251.
- g. Providing a plan, for approval by the Division Leader, for the training of replacements for key staff members.

3.2 (continued)

- h. Obtaining and incorporating into the Building 251 activity plan information pertinent to short- and long-term planned use of the Building 251 facility.
- i. Selects the Assistant Facility Manager.

3.3 Assistant Facility Manager:

- a. Assumes the duties of the Facility Manager during his absence.
- b. When not assigned as Facility Manager, performs administrative, training, and monitoring tasks as required by the Facility Manager, and per the controls in this plan.
- c. Provides and maintain records of safety training for all experimenters in Building 251.

3.4 Tracer Technology Leader

- a. Provides, monitors and records safety training and operating capability of all personnel working in the Tracer Technology area of the facility. Obtains the assistance and advice of the Health and Safety Coordinator and the Staff Lead Experimenter in this endeavor.
- b. Provides plans to the Facility Manager for his approval on all Tracer Technology operations to be conducted in the B 251 facility, and for training an alternate Tracer Technology Leader.

3.5 Staff Lead Experimenter

- a. Verify and monitor adequacy of safety training of all personnel performing experiments in Building 251. Obtains the assistance of the Health and Safety Coordinator for this training.
- b. Review plans, as provided by Lead Experimenters, on all experiments.
- c. Advises the Facility Manager on all operations to be conducted in Building 251 facility.

3.6 Lead Experimenters:

- a. Prior to working in Building 251, provides plans of experiments, including experimental apparatus and equipment, to the Facility Manager for approval.
- b. Provides for training of all other personnel involved in the experiment.

3.7 Facility Coordinator:

- a. Provides, coordinates, and verifies correct emergency shutdown operation of Building 251.
- b. Provides office equipment and space for Building 251 occupants, and others who use the Building 251 facility.

3.7 (continued)

- c. Provides for, coordinates, and verifies correct operation of Building 251 heating, ventilation, air conditioning, utilities and alarm systems and custodial services.
- d. Provides for, coordinates, and verifies correct operation and safety of all experimental support equipment, and equipment in storage or not in use.
- e. Resolves conflicts between mechanical support personnel and facility personnel for Building 251 activities.

3.8 Health and Safety Coordinator

- a. While assigned to the Building 251 facility, reports to the Facility Manager on all matters pertaining to health and safety.
- b. Provides to the Facility Manager, in a staff function, all safety-related services necessary to maintain a safe environment in Building 251. This includes but is not necessarily limited to:
 - (1) Monitoring of experimental and programmatic work using the Facility Handbook as a guide. Maintenance of appropriate permanent records of this activity.
 - (2) Using various Hazards Control team disciplines, assessing and advising on the adequacy of existing controls, facility plant equipment, and safety procedures. This includes hazardous and radioactive materials in handling, waste control and disposal, bioassay and exposure control, record keeping, inventory control, safety equipment and all other actions necessary for the safety of an experiment or the facility.
 - (3) Advising on the adequacy of controls and equipment for future experiments and programs.
 - (4) Advising and functioning as part of the emergency response team.
 - (5) Provides a safety training plan for the Facility Custodian and maintains the plan current. Assures that the Facility Custodian understands the safety requirements of Building 251.
- c. Controls the entry, exit, and movement within Building 251 of all radioactive and toxic materials. Provides storage, handling and record keeping of this material for facility personnel.

3.9 Mechanical and Electrical Technicians

- a. Electronic Technician Supervisor — Upon request, provides support to facility personnel on electronic apparatus. Resolves conflicts in support to facility personnel.
- b. Mechanical Technicians
 - (1) Upon request, provides mechanical technical support to facility personnel.
 - (2) Advises Facility Coordinator of conflicts in support to Facility personnel.

3.10 Plant Engineering Team 5

- a. Provides liaison for all work, except maintenance activities, to be accomplished by Plant Engineering in or on the Building 251 facility.
- b. Upon request, provides counsel to the Facility Manager for proposed changes to the conventional part of the facility.
- c. Provides to the Facility Manager for his approval, heating, ventilating, and air-conditioning, air-balancing, and seismic analyses conducted on Building 251.
- d. Provides to the Facility Manager a periodic overview of all activity in process or planned in the Team 5 area, with the intention of reviewing activities which may have possible impact on Building 251 activities.

3.11 Plant Engineering Maintenance

- a. Provides to the Facility Manager for his approval, a listing of all Building 251 maintenance activities and their schedules.
- b. Advises the Facility Manager on all Building 251 maintenance activities.
- c. Provides to the Facility Manager a periodic overview of all plant maintenance activities, with the intention of incorporating better methods of building maintenance.

3.12 Facility Custodian

- a. Responds to the safety training plan of the Health and Safety Coordinator. Seeks advice from the H&S Coordinator on all matters of safety.
- b. Responds to day-to-day instructions from the Facility Coordinator on facility custodial requirements.

4.0 CONTROL SYSTEMS

The control systems that are described in this section are to be implemented per the requirements of the Facility Handbook, and as specified herein. The control systems will be kept current so as to ensure that this facility continues to support Lab programs in a safe and technically progressive manner. Control systems will be physical barriers, procedures, and administrative requirements necessary to reduce risks to an acceptable level.

Procedures and instructions for assistance in implementing each control system are found in the Facility Handbook.

4.1 Personnel Control

- a. Training and Qualification Program — A training and qualification program is required to assure that personnel who reside in or have access to the facility have appropriate training, are qualified, are current, and are authorized to perform the work that has been assigned to them. This includes safety training, general actinide and fissile material handling training, and specific task training. Personnel must be approved by the Facility Manager prior to working in Building 251.

4.1a (continued)

Responsibility: Assistant Facility Manager

Reference: Facility Handbook (HDBK): Sec. ____: "Special/Operational Safety Procedures" and pending list of training aids.

- b. Access Control System — A control system is required to assure that all personnel entering the facility have appropriate need for access, and have been correctly indoctrinated.

The existing control system provides access to Building 251 by a CAIN reader. Only those personnel that have been trained and qualified and approved by the Facility Manager are on the CAIN reader access. All other doors are alarmed. Selected doors may be put on "access mode" during normal working hours for use by approved individuals possessing keys. Personnel with keys may also use these entrances for movement of material. Personnel with keys are responsible for controlling use of doors on "access mode."

Responsibility: Facility Coordinator, for the maintenance of and verification that this system is being used as required, and is adequate.

Reference: HDBK: Sec. XVII: "Off-shift Access," Intro: "Building Control" and as specified herein.

- c. Muster System — A control system is required to assure that personnel within the facility are identified and their whereabouts known at all times.

The existing control system provides for a muster log at the Cain reader entrance. Personnel entering the facility are required to check in and check out, and specify their location while in the facility.

Responsibility: Facility Coordinator, for maintenance of and verifying that the control system is adequate.

Reference: As specified herein.

- d. Equipment Room Access Control — a personnel access control system is required for the equipment rooms within the building to assure that modification or removal of critical equipment occurs only with the approval of the Facility Coordinator or Hazards Control Coordinator.

Access to the equipment room is currently controlled by lock and key.

Responsibility: Health and Safety Coordinator

Reference: As specified herein.

- e. Operator Control — A control system is required to assure that only qualified individuals work in potentially hazardous zones or critical work areas.

An individual will be assigned to be responsible for each room. That individual is responsible for maintaining that room.

4.1e (continued)

Responsibility: Facility Manager

Reference: Appendix 7.1: Personnel Assignments

- f. Building Zone Control System — A control system is required to assist personnel in maintaining a safe working place by assuring that certain hazardous work is conducted only in designated areas, and to designate other remote and low hazard areas for smoking and eating.

The building is divided, physically and operationally, into three zones of different potential hazards. Radioactive materials are limited to the Radioactive Materials Area (RMA).

- (1) The (RMA) High Potential Hazard Zone — This zone includes the rooms where radioactive materials are stored or worked. Enclosures are provided for working of radioactive materials. The enclosure room itself provides an adequate and a secondary enclosure, should materials be released from the working enclosures. This area is maintained at the lowest air pressure relative to the rest of Building 251.
- (2) The Intermediate Hazard Zone — This zone includes hallways and the hot side of the change rooms. Regulations are designated to maintain this zone as a buffer between high and low potential hazard zones. This area is maintained at a higher air pressure than the RMA, but lower than the rest of Building 251.
- (3) The Low Potential Hazard Zone — This zone includes the rest of the building.

Responsibility: Facility Manager

Reference: Appendix 7.2: Facility Floor Plan of Zones

4.2 Physical Plant Controls

- a. New Construction and Major Modification Control System: — A control system is required to assure that new additions or major modifications to the building or other parts of the physical plant meet established criteria for this facility and are approved by the Division Leader. The existing control system consists of the following:
- (1) Preliminary plans, cost estimates, sketches, and rationale for change are provided to the Division Leader and his designated staff for concurrence prior to detailed planning and design.
 - (2) Upon concurrence, the Facility Coordinator assembles or acquires staff experts as needed to plan and design the modification to meet the safety and programmatic support requirements for the facility.
 - (3) The Facility Manager verifies through the Facility Coordinator that all pertinent people have reviewed the planned modifications. The Facility Manager approves the Plan and presents it to the Division Leader for funding.

4.2a (continued)

Responsibility: Facility Manager, for implementing the existing control system.

Reference: As specified herein.

- b. Minor Modification Control System — A control system is required to assure that minor modifications do not change the risk level of building operations. Work orders for minor modifications are reviewed by appropriate Building 251 facility staff before approval is given by the Facility Manager.

- (1) Minor modifications to Building 251 may be conducted simultaneously with notification of the Division Leader of the planned change. The Facility Coordinator assembles the team required to implement the change, and to assure the change does not increase the building risk level. The Facility Manager approves and funds the change.

Responsibility: Facility Coordinator

Reference: As specified herein.

- c. Equipment Control System — A control system is required to assure that all equipment, such as enclosures, alarm systems, mass spectrometers, isotope separators, vacuum systems and power supplies, used in the facility meets established safety criteria for the facility. Procurement plans and design reviews are required to assure acceptable equipment. In particular, all new enclosures for use with radioactive materials shall be certified for their intended use.

- (1) Various procedures contained in the Health and Safety Manual Chapter 12, Facility Handbook Section I, and individual assignments of responsibility per this QA Plan, require that all critical equipment to be installed and used in Building 251, such as HEPA filters and enclosures, meet certain design and operational safety and performance requirements. These administrative and test requirements are considered to comprise an adequate control system.

Responsibility: Health and Safety Coordinator

Reference: As specified herein.

- d. Equipment-Movement Control System — A control system is required to assure that equipment will not be moved within, or in or out of the facility without proper approval and checking for the presence of radioactive contamination. Equipment is checked by authorized individuals for radioactive contamination and must be appropriately marked before it can enter or leave the facility.

Responsibility: Health and Safety Coordinator

Reference: IIDBK: Pending

- e. Maintenance Control System — A monitoring system is required to assure that all building systems are specified and maintained in accordance with a preventive maintenance plan approved by the Facility Manager, and that the configurations of these systems are not modified by maintenance activities.

4.2e (continued)

A list of all critical building systems shall be approved by the Facility Manager and be included with the procedure for this monitoring system. This monitoring system must ensure that scheduled and nonscheduled maintenance and repair actions do not degrade building safety levels during repair periods. Maintenance plans and finished work are inspected and approved. A log is kept of all scheduled and completed maintenance work. The log will also contain approved plans and procedures.

Responsibility: Facility Coordinator

Reference: HDBK: Pending

- f. Radioactive Confinement System — A control system is required to assure that a radioactive confinement system (e.g. glovebox, cave, hood) is not changed, or a critical system or apparatus modified without proper review and approval. Proposed changes to critical systems are reviewed by facility staff before the change is made. Final sign-off is not given until the work has been inspected and the design records updated to reflect the change. A list of all critical designs, systems, or equipment shall be approved by the Facility Manager and be included with the procedure for this control system.

Responsibility: Facility Coordinator

Reference: HDBK: Pending

- g. Building Tests and Inspection System — A control system is required to assure that all necessary building systems are operating correctly and that radioactive contamination levels are monitored. A list of the monitored building systems shall be maintained by the Assistant Facility Manager and be included with the procedure for this control system. Log books of all tests and inspections are maintained by the Health & Safety Specialist. A monthly summary of the results of all inspections are prepared for approval by the Facility Manager.

Responsibility: Health and Safety Coordinator

Reference: HDBK: Pending

4.3 Material Controls

- a. Criticality Safety Control System — A criticality control system is required to assure that the risk of a criticality accident is reduced to a level judged acceptable by the cognizant members of the Laboratory criticality safety community. Mass limits, equipment design restrictions, and handling restrictions apply to all areas and operations using fissile materials.

Responsibility: Facility Manager

Reference: HDBK: Sec. II: "Criticality Safety"

- b. Transuranic (TRU) Operating Control System — A control system is necessary to assure that the risk of release of TRU material is reduced to a level that is in compliance with the requirements of the LLNL and the DOE.

4.3b (continued)

TRU amount limitations, procedures and safety policies apply to all operations in the facility.

Responsibility: Facility Manager

Reference: H&SM Chapter 33; DOE Order 5480.1, Chapter XI; HDBK, Sec. XIX, "TRU Limitations"

- c. Materials Accountability System — A materials accountability system is required to assure that Materials Management (MM) policies and practices for inventory and control of fissile materials (either stored or being processed within the facility) are being followed and that unauthorized removal of radioactive materials from the facility is prevented.

Responsibility: Health and Safety Coordinator

Reference: HDBK: Sec. III & IV "Material Control"

- d. Two-Man Surveillance System (TMSS) — A control system is required to assure that nuclear assemblies and significant fissile material are not accessible to unauthorized personnel.

Although primary protection is provided by the access system to the facility, a further level of protection is provided by the TMSS. Certain assemblies and materials will be identified as requiring special safeguards to assure protection.

Responsibility: Facility Manager

Reference: HDBK: Sec. IV "Material Control," Sec. XV "Radioactive Storage"

- e. Radioactive Material Control System — A control system is required to assure that radioactive materials are handled and controlled in a manner to limit exposure to radiation.

Health and Safety procedures, equipment design, and handling restrictions to limit exposure to radiation apply to all areas of operations and waste disposal involving radioactive materials.

Responsibility: Health and Safety Coordinator

Reference: HDBK: Sec. III & IV: "Material Control," Sec. V: Waste Disposal"

- f. Nonradioactive Hazardous Material Control System — A control system is required to assure that explosive, flammable, corrosive, or other hazardous materials are handled and controlled in a manner that will prevent injury to personnel and damage to the facility.

High explosives are prohibited within this facility. Small explosive devices classified as Type O by the LLNL classification system may be allowed into the facility when approved by a safety procedure. Toxic, flammable, and corrosive materials may be used in the facility when approved by a safety procedure.

Responsibility: Facility Manager

4.3f (continued)

Reference: H&SM, Chapter 24; HDBK: Sec. XVI: "Reactive/Flammable Substances."

4.4 Operational Controls

- a. Programmatic Operations Approval System — A control system is required to review all proposed operations to assure that they do not pose an unacceptable risk to this facility. Experimenters must prepare procedures for all operations for staff review and approval by the Facility Manager.

Responsibility: Facility Manager

Reference: As specified herein and in Para. 3.5.

- b. Emergency and Disaster Planning — A control system is required to assure that emergency plans are formulated and coordinated with Laboratory emergency personnel, and that facility personnel receive appropriate training in emergency procedures for both potential operational accidents and accidents caused by nature (e.g., earthquake). Included in emergency plans are check sheets and training requirements. The Facility Manager approves plans of the Emergency Self-Help group for the facility.

Responsibility: Facility Manager

Reference: HDBK: Sec. VI: "Emergency Procedures"

5.0 QUALITY ASSURANCE

Quality assurance is the administrative mechanisms that provide feedback to management on the implementation and adequacy of the Facility Management Plan. Quality Assurance is the management system that: (1) assesses and documents adequacy of each control system; (2) verifies implementation and determines effectiveness of the Plan; and (3) assists the facility personnel in improving the operation and safety of Building 251.

Within 30 days after approval of this plan by the Facility Manager, and periodically thereafter as specified by the Division Leader (at intervals not to exceed 12 months), an independent team of personnel will be assigned by the Facility Manager to audit the Building 251 facility management system, and verify compliance with and evaluate the effectiveness of this Plan. A person from the Quality Assurance Office will be included on the audit team.

Responsibility: Facility Manager

5.1. Corrective Action

Corrective action is a formal system providing assurance that deviations from this Plan and its implementing procedures are documented, and resolved by changed or implemented control systems to minimize or prevent recurrence.

Responsibility: Facility Manager

5.2 Records

A record keeping and filing system is provided to assure that records generated by this Plan are reasonably accessible and correctly identified. This documentation will consist of quality assurance certifications, verification documents, check-off lists, and procedures for all hardware, equipment, and operations required by the Facility Management Plan, or design documents used by personnel in preparation of an experiment. Documentary evidence that items conform to requirements shall be made available upon installation or use.

Responsibility: Facility Manager

5.3 Audits

The audit program verifies that the control systems described in this Plan are functioning as planned and are effective. The requirements of the audit program are:

- a. Schedule and Assignments — The Facility Manager establishes and maintains a schedule of internal audits, and assigns one or more persons to each audit team.
- b. Performance — Auditors shall prepare and follow written checklists tailored to the requirements of this Plan. Audit findings and observations are reported in writing first to the audited activities for their correctness, and then to the Facility Manager and Division Leader for their review and response.
- c. Response — If applicable, the Facility Manager uses the Corrective Action system to request further study or implement a change.

Responsibility: Facility Manager with concurrence by Division Leader

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