APPENDIX A

Detailed Discussion of Results of the Phase II Assessment of the Sprinkler System at LANL TA-48, RC-1

BACKGROUND AND SCOPE OF ASSESSMENT

LANL TA-48 RC-1 Facility

The Radiochemistry Facility (RC-1) is a radiochemistry research and development facility originally constructed in 1955-1957 with several subsequent major additions. RC-1 is a 103,000 ft^2 single-story structure with both a basement and two penthouses. It is constructed with a concrete foundation and supporting steel columns. The exterior walls are constructed of various materials, including reinforced masonry with stucco and metal siding exterior finish. The roof is a flat, built-up roofing system. The basement houses ventilation ductwork, maintenance shops, several storage areas, and three laboratories. Air supply fans and equipment for heating and cooling are located in the penthouse.

A majority of the work is conducted in laboratories on the main floor. The facility is divided into the following areas:

- an office wing,
- a light chemistry laboratory area for performing low-level radiochemistry,
- a hot cell complex used for small-scale production of medical radioisotopes,
- an Alpha Wing used for chemical research of alpha-emitting radioactive and toxic materials,
- a Counting Wing used for final analysis of radiochemical samples,
- a Dissolving Wing used for environmental sciences research and development (focusing on actinide transport and fate in natural systems and waste streams),
- a secure data wing, and
- a vault.

LANL TA-48, RC-1 Fire Sprinkler System

The Fire Sprinkler System (FSS) in RC-1 provides fire suppression for all areas except those inside the Hot Cells. To perform this safety function, the following equipment must be operational:

- flow sensors,
- sprinkler heads, and
- water supply and distribution system.

There are two fire sprinkler systems for the building. Each is a suspended wet-pipe automatic system with a common gravity fed supply. The original construction of Facility RC-1 in 1955 included installation of a riser located in the southwest corner of basement Room 56. The original sprinkler system coverage included the basement area (except Rooms 10, 26, 48, 50 and 68), the first floor north/south corridor and all rooms extending off of the corridor, and the east/west wings (corridors only). The non-covered areas, including the Hot Cell Addition, were protected by ceiling heat detectors. When the Alpha Wing and Dissolving Wing additions were added, including the small penthouse, sprinklers were included in the construction. In 1978,

Grinnell Fire Protection performed a major upgrade to the RC-1 automatic sprinkler system, which included calculations of the existing system. Heat detection was removed from all areas retrofitted with automatic sprinklers during this upgrade. Upgrades to the system included:

- adding a second sprinkler riser in basement Room 244,
- installing sprinklers in the basement Rooms 10, 26, 48, 50, and 68,
- installing sprinklers in all non-sprinklered areas of the first floor, including the Hot Cell addition, and
- installing sprinklers in the main penthouse.

Automatic sprinklers were also installed at the time of construction in the Data Wing and Synthetic Laboratory addition, as well as other miscellaneous space additions after 1978.

As a result of the upgrades, the facility is entirely protected by automatic sprinkler systems, with the exception of Stairway 3 and the retired Hot Cell Corridor (next to Room 314). These systems were installed using the pipe schedule method for Ordinary Hazard as defined in NFPA 13, *Standard for the Installation of Sprinkler Systems* [1999]. Subsequent calculations have verified that the systems qualify as Ordinary Hazard Group I in all first floor, penthouse, and Alpha Wing basement areas. The basement, excluding the Alpha Wing has been calculated as Ordinary Hazard Group II. Control valves associated with the automatic sprinkler system are electronically supervised as defined in the NFPA Life Safety Code 101, Chapter 9, *Building Service and Fire Protection Equipment* [2000].

The sprinkler water supply and distribution system consists of fire sprinkler piping that runs parallel to the main corridors, with branches into the process and laboratory areas. The distribution pipes are connected to the basement risers. The original sprinkler riser, located in basement Room 56, is a Grinnell 6 in. wet pipe alarm check valve supplied by a 6 in. underground fire water line fed from a 12 in. site utility line which also feeds a 6 in. cold water domestic line to the RC-1 Complex. This riser covers the basement, the first floor south wing, Counting Wing, Dissolving Wing addition, Data Wing addition, and penthouses.

A Hot Cell Addition sprinkler riser, located in Basement Room 244, is a Grinnell 6 in. wet pipe alarm check valve supplied by a 6 in. underground fire water line fed from a 6 in. cold water domestic feed to the RC-1 Complex. This riser covers the first floor north wing, Alpha Wing addition, Hot Cell addition, and Synthetic Laboratory addition.

Both of these risers are supplied by a 6 in. underground fire water line that forms a loop around the building and was installed during the sprinkler system upgrade. The loop contains isolation valves to allow continued water supply to portions of the system in the event of a line break. Water for the fire sprinkler loop is provided from the LANL combined domestic and fire protection water supply system, gravity fed from a single 12 in. water main to the TA-03 grid. This grid is also fed from a 14 in. line supplied by Pajarito Tanks Nos. 4 (TA-62-01) and 4A (TA-69-7) with 1,500,000 gallon and 4,000,000 gallon capacities respectively.

The basement level contains several sprinkler protected laboratories and storage areas. Two areas in the RC-1 are protected by antifreeze loops fed from the automatic sprinkler system; Rooms 360 and 360A are fed from an antifreeze loop drop in Room 313A; and the north

receiving dock of the Dissolving Wing Addition are fed from an antifreeze loop drop in Room 425.

The automatic sprinkler system is equipped with a flow alarm on each sprinkler riser, which transmits an alarm to the main fire alarm panel. In addition, each major section of the sprinkler system is provided with a flow alarm switch to annunciate the specific area of operation. Control valves associated with the automatic sprinkler system are also electronically supervised.

The FSS is designated as Maintenance Level 2 (ML2).

Scope of Review

The scope of the review for this assessment was generally limited to the sprinkler system inside TA-48, RC-1, to include the sprinkler heads, risers, and water distribution system. Other than the water distribution system, no other systems are required for the sprinkler system to perform its safety function. The fire detection system, including flow sensors, alarms, and power sources, was not included in the review.

Safety Function Definition - TA-48, RC-1 Sprinkler System

Objective:

Safety basis-related technical, functional, and performance requirements for the system are identified/defined in appropriate safety documents.

Criterion 1:

Safety/Authorization Basis documents identify and describe 1) the system safety functions and the safety functions of any essential supporting systems, and 2) the system requirements and performance criteria that the system must meet to accomplish its safety functions.

Is the Criterion met?

Yes, with Opportunities for Improvement.

How the Review was Conducted:

The assessment was conducted by reviewing the Authorization Basis and other documents, attending facility briefings and tours, and interviewing facility personnel.

Documents reviewed included:

- Fire Hazard Analysis, Radiochemistry Facility 1, Technical Area 48 (TA-48-/RC-1), Los Alamos National laboratory (LANL), Revision 0, October 17, 2000.
- Justification for Continued Operation for Radiochemistry Building (RC-1), Technical area 48, Los Alamos National Laboratory, Revision 1, July 28, 2000.
- DOE Memorandum, Approval of Justification for Continued Operation (JCO) for Radiochemistry Building (RC-1) at TA-48, August 18, 2000.
- LANL Facilities Safety Deliverables Master Schedule, Rev. 1, December 10, 2001.
- DOE Memorandum, Extension of Authorization Basis Documents for TA-48 and WCRR and General Expectations for Authorization Basis Management, March 21, 2002.

Facility Tours:

- TA-48, Radiochemistry Facility (Building RC-1)

Interviews:

- RC-1 Facility Manager

Discussion of Results:

The authorization basis (AB) document for TA-48, RC-1 is the Justification for Continued Operation (JCO), dated July 28, 2000. The JCO was required following a change in the hazard classification of RC-1 from a Radiological Facility to a Hazard Category 3, Non-Reactor Nuclear Facility, in accordance with DOE-STD-1027. The JCO contains only a limited discussion of the sprinkler system, however, the JCO is intended only as an interim document. The JCO will be

replaced by a more detailed Basis for Interim Operation (BIO), due in June 2002. An AB document was not in place prior to the DOE approval of the JCO on August 18, 2000. The DOE approval of the JCO required that the Fire Suppression System (Sprinkler System) be classified as a Safety Significant SSC. The JCO approval also required that a Fire Hazard Analysis (FHA) be performed for the facility and that the results be incorporated into the BIO. The FHA was published in October 2000. Although the Facility Manager does not consider the FHA to be an AB document, it contains additional information on the safety functions of the sprinkler system.

The review of the above documents identified the following statements concerning the safety functions of the RC-1 Sprinkler System:

- The sprinkler system provides fire suppression for all areas except inside the Hot Cells.
- Flow sensors on each sprinkler riser transmit a signal, upon sprinkler activation, to the main fire alarm panel to initiate the building fire alarm.

The following statements of systems requirements/performance criteria were identified from the AB document review:

- Sprinkler head temperature ranges include:
  1. *Ordinary* (135-170° F) in the west office areas of the main facility and Data Wing.
  2. *Intermediate* (175-225° F) in the first floor laboratories and basement area except utility spaces.
  3. *High* (250-300° F) in the Penthouses, boiler rooms, and utility areas (Room 21 and Room 26)
- Control valves associated with the automatic sprinkler system are electronically supervised as defined in the NFPA Life Safety Code 101, Chapter 9, *Building Service and Fire Protection Equipment* [2000].

The FHA brought to light new information on fire hazards that was not available when the JCO was completed. The JCO was originally approved through August 18, 2001, at which time the BIO was due. A review of the LANL Facilities Safety Deliverables Master Schedule, Rev. 1, indicates that the new BIO due date is now June 28, 2002. Footnote 1 of the Master Schedule states that "This schedule takes precedence over any prior dates established in DOE SERs .... ". Therefore, the effective date for the JCO has been extended until June 28, 2002. The March 21 DOE Memorandum referenced above confirms that the JCO has been extended.

The AB document (JCO or BIO) and the Fire Hazard Analysis are controlled documents that should be maintained and updated as changes are made that affect the facility. The AB documents need to be reviewed to determine if updates are required to reflect the results of new analyses, such as the FHA, to ensure that they continue to provide an adequate safety basis for the facility.

System Operability Issues or Concerns: None

Opportunities for Improvement:

- Ensure that the sprinkler system safety functions, requirements, and performance criteria are clearly described in the BIO, scheduled to be completed in June 2002.
- Ensure that the results of the FHA are appropriately incorporated into the BIO.

Configuration Management - TA-48, RC-1 Sprinkler System

Objective:

Changes to safety basis-related requirements, documents, and installed components are controlled.

Criterion 1:

Changes to system safety basis requirements, documents, and installed components are designed, reviewed, approved, implemented, tested, and documented in accordance with controlled procedures. Consistency is maintained among system requirements and performance criteria, installed system equipment and components, and associated documents as changes are made.

Criterion 3:

Changes to system safety basis requirements, documents, and installed components conform to the approved safety/authorization basis (safety envelope) for the facility, and the appropriate change approval authority is determined using the Unreviewed Safety Question (USQ) process.

Criterion 4:

Facility procedures ensure that changes to the system safety basis requirements, documents, and installed components are adequately integrated and coordinated with those organizations affected by the change.

Criteria 1, 3, and 4 are addressed together below.

Are the Criteria met?

Yes, with Opportunities for Improvement.

How the Review was Conducted:

The team conducted interviews with facility management and engineering support personnel. Safety basis-related requirements and documents were reviewed including but not limited to:

- TA-48, RC-1 JCO, Rev 1, Justification for Continued Operations for Radiochemistry Building (RC-1) Technical Area 48, dated July 28, 2000
- FIRE HAZARD ANALYSIS, Radiochemistry Facility 1, Technical Area 48 (TA-48/RC-1) Los Alamos National Laboratory (LANL), Revision 0, dated October 17, 2001
- Approval of Justification for Continued Operation (JCO) for radiochemistry Building (RC-1) at TA-48, DOE Memo, dated August 18, 2000, Steele to Sattelberger.

The following requirements and procedures controlling the change process were reviewed:

- LIR220-01-01, Construction Project Management
- LIR230-01-02, Graded Approach of Facility Work
- LIR230-03-01, Facility Management Work Control
- LIR230-04-01, Laboratory Maintenance Management Program
- LIR240-01-01, Facility Configuration Management
- FAP-CFM-046, Management of Engineering Change Notices and Engineering Drawings
- FAP-CFM-003, Preparing, Reviewing and Controlling Documents at Chemistry Facility Management Group
- FAP-CFM-021, Performing Facility Work in FMU 66/71
- FAP-CFM-034, C-FM Change Control and Unreviewed Safety Question Screening and Determination
- FAP-CFM-028, Facility and Programmatic Changes in CST-25 Facilities
- FAP-CFM-037, Procurement in CST Nuclear Facilities
- FAP-CFM-043, Management of Commitments from the RC-1 JCO
- FAP-CFM-047, C-FM Nuclear Facility Maintenance Parts Change Requirements
- FAP-CFM-048, C-FM Nuclear Facility Parts Equivalency Determinations
- FWO-SE&M-QMP-601-01, Engineering Change Notice

Fire protection system modifications installed since original facility construction were selected for verification review. Incorporated changes were reviewed to ensure that consistency was maintained among system requirements and performance criteria, installed system equipment and components, and associated documents. Drawings listed below were identified as the configuration set of drawings for the RC-1 fire sprinkler system and were included in the team's review scope:

Original Construction RC-1
C20842, Sprinkler & Fire Protection Basement Plan Unit "A"
C20843, Sprinkler & Fire Protection Basement Plan Unit "B"
C20844, Sprinkler & Fire Protection First Floor Plan Unit "A"
C20845, Sprinkler & Fire Protection First Floor Plan Unit "B"

Core Processing Facility Addition
C36958, Fire Protection System (Basement)
C36959, Fire Protection System (First Floor)
C37760 Sht 46/76, Sprinklers and Fire Control Core Processing Facility Bldg RC-1 Add.

Alpha Wing Addition
C37202, Fire Sprinkler System Alpha Facility Addition Mechanical Plan
C37203, Fire Sprinkler System Alpha Facility Addition Mechanical Sections & Detail

Alpha Wing Exhaust Plenum Improvements
C42666, Improve Exhaust & Ventilation System, Alpha Facility *

Fire Separation
C39956, Fire Separation Architectural *

Fire Protection Improvements (ERDA Design)
C42929 Sheets 1 through 22 *

Fire Protection Improvements (Grinnell As-builts)
C42929 Sheets 1 through 22

Room 346 Kingdom Addition
C43786, Radiochemistry Experimental Area Addition
C43798, Building Platform

Clean Room Addition
C43894, Clean Room Installation Automatic Sprinkler System
C43898, Building Site Prep Sprinkler Plan, Sections & Notes

Office Addition 100 Wing
C43903, Office Addition, Floor Plan, Bill of Mat'l
C43924, Office Addition Rm-100, Fire protection Plan

Office Addition Room 409
C43930, Office Addition Rm-409 Fire Protection & Piping Plan

Alpha Wing Office Addition
C44131, Office Addition New Ductwork Plan, New Fire Protection Plan
Dock Enclosure addition
C44891, Dock Enclosure Fire Sprinkler Plan

Data Wing Fire Panel
C45173, Radiochemical Data Wing For Weapons Diagnostics Single Line, Power and Fire Alarm *

Room 311 Addition
C46296, Plastic Wet Bench Sprinkler Addition

Room 302 Clean Room
C47214, Experimental Clean Area Sprinkler Modifications Room 302

Hot Cell Addition Clean Room
C47395, Automatic Sprinkler Addition,RM-346 Clean Room Cubicles
C47426, Clean Room – Air Lock Sprinkler Plan

Basement Room Addition
C47477, Lab Addition Sprinkler Extension
C47522, Building Platform Fire Protection Plan

Basement Dark Room
C47540, Services for Dark Room

Compressor Shed
C47542, Compressor Shed & Services Sprinkler System

Room 421
C47603, Modify Room 421 Sprinkler Modifications

Specific modifications to the system safety basis requirements, documents, and installed components were then reviewed to ensure compliance with the approved safety/authorization basis (safety envelope). A detailed comparison was made between C42929 Sheets 1 through 22 Fire Protection Improvements (ERDA Design), and C42929 Sheets 1 through 22 Fire Protection Improvements (Grinnell As-builts).

Selected modifications were then reviewed to ensure that the appropriate change approval authority was determined using the Unreviewed Safety Question (USQ) process as specified in FAP-CFM-034, *C-FM Change Control and Unreviewed Safety Question Screening and Determination.*

Walk-down reviews to determine consistency between sprinkler system drawings and the actual installed sprinkler system configuration were performed for portions of all drawings listed above with the exception of those marked with an asterisk (*). The results of the walk-down reviews are presented under Configuration Management Criterion 2 below.

Discussion of Results:

LIR240-01-01, *Construction Project Management*, requires that each Facility Management Unit (FMU) develop, implement, and maintain a configuration management (CM) program. Changes to the RC-1 Fire Sprinkler System are developed, reviewed, approved and tracked to completion. This process is specified in a formal procedure, FAP-CFM-046, *Management of Engineering Change Notices and Engineering Drawings*. FAP-CFM-046 was first issued and approved on August 31, 2001.

FAP-CFM-046 provides administrative directions for processing changes to the RC-1 fire sprinkler system to ensure the safe and efficient implementation of system design modifications. The FAP-CFM-046 process ensures that changes are developed and processed for RC-1 designs or modifications in accordance with FWO-SE&M-QMP-601-01, *Engineering Change Notice (ECN) Form.* ECN's for ML-2 equipment must be approved by a design authority, a Facility Manager (FM), and an independent design reviewer.

FAP-CFM-046 also requires a change-impact review to evaluate and update documents affected by the change including procedures, master equipment list data sheets, facility safety plans, system design descriptions and other documents as required. After receipt of the completed ECN, incorporating all approved drawing changes and re-issue of updated documents is required. The Team noted that a current and up-to-date system design description — an important configuration management tool — has not been prepared and maintained for the safety significant fire sprinkler system. System design descriptions can be used by System Engineers to help ensure that safety significant systems will be maintained in the proper configuration and will continue to perform their intended safety function.

The FAP-CFM-046 process ensures that changes are adequately integrated and coordinated with those organizations affected by the change. Interviews with FWO-FIRE personnel reveal that changes to fire sprinkler system components and safety basis documents are communicated to and reviewed by FWO-FIRE.

Configuration control of the fire sprinkler system during the performance of maintenance activities is ensured by FAP-CFM-021, *Performing Facility Work in FMU 66/71*. FAP-CFM-021 provides administrative controls and requires the use or development of instructions and procedures to control work such that vital fire protection systems, structures and components are not adversely impacted.

FAP-CFM-034, *C-FM Change Control and Unreviewed Safety Question Screening and Determination*, specifies the process for change control and change approval routing including Unreviewed Safety Question (USQ) screens and determinations. The change control and USQ process allows C-FM to make changes to the fire sprinkler system to support operations and provides a mechanism for keeping the facility safety basis current, documenting changes of all types and reviewing, reporting and dispositioning potential USQs.

Use of the procedures discussed above will provide assurance that changes to the sprinkler system will be appropriately controlled. However, there is no current comprehensive configuration drawing for the RC-1 fire sprinkler system. Historically, major changes and additions have been incorporated into individual as-built drawings. As a result, the as-built drawing set now includes over 50 sheets of drawings depicting numerous fire protection system upgrades and additions that have occurred over the past 45 plus years of facility operation. Lacking a comprehensive fire sprinkler system configuration drawing, the evaluation of as-built configuration is complex and time consuming making it difficult to ensure that consistency is maintained between the installed system and associated design requirements. Furthermore, the current processes controlling the configuration of the RC-1 sprinkler system are relatively new. There have been no major modifications made to the system over the past several years. As a result, the team was unable to review the application of these processes to the sprinkler system.

System Operability Issues or Concerns: None

Opportunities for Improvement:

- LANL should consider consolidating the fire sprinkler system as-built drawings into a comprehensive system configuration priority drawing. This configuration drawing should be updated and maintained current to ensure that the RC-1 fire sprinkler system configuration is established and controlled as a safety significant system, structure and component (SSC) in accordance with the JCO Conditions of Approval.

- LANL should consider developing a system design description (SDD) for the fire sprinkler system. An SDD identifies the system requirements, explains the basis for the requirements, and describes the features of the system design provided to meet those requirements. An SDD is an effective coordinating link among the engineering design documents, the facility authorization basis, and facility operating and maintenance procedures, and can help ensure that consistency is maintained between system requirements, installed system components, and associated documentation as changes are made (see DOE-STD-3024, *Content of System Design Descriptions*).

Criterion 2:

Limited technical walk-down of selected system components verifies that the actual physical configuration of these components conforms to documented design and safety basis documents for the system.

Is the Criterion met?

No

How the Review was Conducted:

The Team initially conducted reviews of the TA-48 FHA and JCO to determine specific system requirements that should be reflected in the as-built facility. Then interviews were conducted with facility management and technical support personnel to identify the as-built drawing set for the fire sprinkler system. Once the as-built set of drawings was determined, specific drawings were selected for configuration walk-down to verify that the actual physical configuration of fire protection sprinkler system, components and structures conformed to the documented design and safety basis documents for the system. The design and as-built drawings selected for this review are identified under Configuration Management Criteria 1, 2, and 4 above.

Discussion of Results:

Due to the difficulty encountered in establishing the full set of as-built drawings for the fire sprinkler system as described under Configuration Management Criterion 1 above, the Team could not fully validate the as-built configuration. Notwithstanding, several potential discrepancies in the as-built configuration of the system were identified. However, validation of these discrepancies could not be ascertained due to the state of the as-built drawings. Potential discrepancies identified included the following:

1. A sprinkler run located in the south end of the basement appears to have been modified from the as-built configuration shown in drawing C20843. The modified configuration appears to reroute a short run of sprinkler piping. However, an as-built drawing depicting this change to the sprinkler system configuration could not be identified.

2. Sprinkler coverage in Room 46 appears to have been modified from the as-built configuration shown in drawing C20842. The modified configuration appears to have extended the sprinkler coverage to a space under a stairway in an adjoining closet/storage space. However, the Team was unable to identify an as-built drawing depicting this change to the sprinkler system configuration. Additionally, during the walk down, the Team found that a broken sprinkler piping hanger located under the stairway had been repaired with what appeared to be copper wire in an unapproved configuration not in conformance with the requirements of NFPA 13, *Standard for the Installation of Sprinkler Systems*.

3. Sprinkler coverage in the main first floor hallway closet located between the men's and women's locker rooms appears to have been modified from the as-built configuration shown in Drawing C-42929 Sheet 5 of 22. The modified configuration appears to have added a second sprinkler to cover the closet space. However, the Team was unable to identify an as-built drawing depicting this change to the sprinkler system configuration.

4. A sprinkler run located in the west-end of Room 338 appears to have been modified from the as-built configuration shown in drawing C-42929 Sheet 6 of 22. The modified configuration appears to have added a capped tap-off from the sprinkler run. However, the Team was unable to identify an as-built drawing depicting this change to the sprinkler system configuration.

5. Drawing C-42929 Sheet 2 of 22 shows the installation of a new Fire Hydrant east of RC-1. However, the installed Fire Hydrant does not match the details shown on Sheet 3 of 22.

A walk-down of the 1978 major modification to the RC-1 fire sprinkler system, entitled *Fire Protection Improvements*, confirmed that the sprinklers for Room 314-B were not installed as specified in the design (Design drawing C-42929 Sheet 9 of 22). Room 314-B initially housed the original hot cells for the facility. These hot cells have been turned into storage space for a variety of materials including items such as plastics, cardboard boxes and bags of wood pellet fuel. Design drawing C-42929 Sheet 9 of 22 shows sprinkler heads 15 and 16 located in Room 314-B of the hot cell wing. However, the as built drawing Grinnell C-42929 Sheet 9 of 22 does not show sprinkler coverage for this space. The facility could not provide justification for the deletion of sprinkler coverage in this room as specified in the design drawing. A review of the current authorization basis for the facility revealed that this issue was previously identified in the FHA and is being tracked in the issues management system for resolution. The FHA recommends that sprinkler protection be installed in this space.

During the review of RC-1 safety basis documentation and the walk down of the Room 338, the Team also noted that the interior of the hot cells are not sprinklered. The original design of the hot cells included a CO_2 flooding system that could be manually activated to flood individual

cells in the event of a fire. The primary driver for removal of the system were life safety considerations following the fatalities at INEEL resulting from CO_2 discharge, with additional concerns for the lack of confidence in how the system operated. In 1995, recommendations were made for alternative protection within the cells, (*Memorandum FSS-21-95-280 dated July 18. 1995 from Jim Tsiagkouris to Gregory Rand*), and shortly thereafter the CO_2 supply cylinders were removed from the system located in basement Room 244.

According to the FHA, combustible loads are minimized through administrative controls; however, transient combustibles are present during operation of the cells. Fuel sources include these transient combustibles, natural gas through spigots provided at each cell, and the cell interior, which includes fiberglass liners with rubber gasket windows, plastic shielding, and several hydrocarbon products used in the manipulators and various utilities that supply the hot cells.

The FHA concludes that, although unlikely, potential for an incipient stage fire within a cell exists, supported through available combustibles within the cell, to propagate to other cells by pooling of melted burning plastics entering the warm corridor or train canyon that runs under each cell. The FHA recommends that a feasible detection/suppression system for the internal space of the cells be installed that would function automatically upon overheat conditions. Use of water, Halon alternatives, dry chemical, or reinstallation of CO_2 should be considered.

The FHA for the facility was not completed until October 17, 2000. As a result, the two potentially degraded sprinkler conditions identified in the hot cell and the subsequent recommendations were not part of the JCO. However, the Team found that the Department's JCO approval dated August 18, 2000 specifically required the inclusion of the FHA results in the BIO submittal. This should ensure that this issue is properly addressed in the facility safety basis.

During the walk down, the Team noted that labeling of components in the fire sprinkler system varied throughout the facility. For example, flow switches for Zone D, Zone C, Zone J, Zone A and Zone G located in the TA-48 basement were not labeled, making it difficult to correlate/identify flow switch/zone coverage.

System Operability Issues or Concerns:

- A comprehensive set of accurate as-built drawings for the fire sprinkler system does not exist. As a result, the limited walk down of the "actual" physical configuration of the system revealed several potential discrepancies and/or system configurations that could not be fully validated. The Team recommends a systematic re-verification that the current as-built system is consistent with design/safety basis documents and drawings. Additionally, it is recommended that the issues identified in the FHA be appropriately addressed in facility design or safety basis documents.

- Although not an FSS operability issue, the Team believes that the lack of automatic fire suppression in Room 314-B and in the hot cells, as identified in the FHA, is a safety concern, and should be given high priority for resolution.

Opportunities for Improvement:

- Provide consistent labeling of fire sprinkler system components.
- Repair the broken pipe hanger.

Criterion 5:

Software used in system instrumentation and control (I&C) components that perform functions important to safety is subject to a software quality process consistent with 10 CFR 830.120.

This criterion is not applicable to the TA-48, RC-1 FSS design as it does not use any software/firmware to perform its safety function.

System Maintenance -- TA-48, RC-1

Objective:

The system is maintained in a condition that ensures its integrity, operability and reliability.

Criterion 1:

Maintenance processes consistent with the system safety classification are in place for prescribed corrective, preventive, and predictive maintenance, and to manage the maintenance backlog.

Is the Criterion met?

No.

How the Review was Conducted:

The Review Team conducted interviews, reviewed documentation based on the DOE Phase II Model CRAD approach, and performed a walk down of the system to:

1. Verify that maintenance for the system satisfies system requirements and performance criteria in safety basis documents or other local agreements.

2. Evaluate maintenance of aging system equipment and components. Determine whether there are criteria in place to accommodate age-related system degradation that could affect system reliability or performance.

3. Review the plans and schedules for monitoring, inspecting, replacing, or upgrading system components needed to maintain system integrity, including the technical basis for such plans and schedules.

4. Determine whether maintenance source documents such as vendor manuals, industry standards, DOE Orders, and other requirements are used as technical bases for development of system work packages.

Discussion of Results:

There are no maintenance-related commitments in the JCO. However, the system and many of its components are identified as Management Level (ML) 2. Management Level is a classification system for determining the degree of management control applied to a facility's work as defined in LIR 230-01-02.2. For example, ML-2 as stated in the LIR requires selective application of applicable codes, standards, procedural controls, verification activities, documentation requirements, and formalized maintenance programs (i.e., certain elements may require extensive controls, while others may only require limited control measures).

On 26 January 2000, DOE approved LANL's request for establishing equivalent inspection, testing, and maintenance (IT&M) frequencies for automatic fire protection sprinkler systems and valves per NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*. LANL is contractually committed to these commitments. These equivalent IT&M frequencies maintain some NFPA-25 frequencies unchanged, while others are less frequent. This equivalency approval by DOE was based on LANL's documentation of system and device reliability rates (i.e., maintenance history records). However, because of the issues associated with the site's maintenance history system described below, LANL is no longer within the parameters of the equivalency authorization.

The Facility Manager and System Engineer were questioned regarding implementation of these IT&M activities; neither were familiar with the specific requirements. Reference was made to implementation via the Johnson Controls PMI procedures listed below. No facility documentation was available to demonstrate implementation of the IT&M frequencies. TA-48 assumes that the Johnson Controls PMIs cover these commitments. The Site Fire Marshal does not maintain data for implementation of NFPA-25 commitments or assess facility implementation.

Regarding control valves for example--the NFPA-25 maintenance frequency for fire suppression system control valves (ML-2 components) is annually by representative sampling as follows:

1. Lubricate the operating stems of outside screw and yoke (OS&Y) valves. Then close and reopen the valve completely to test its operation and distribution of the lubricant. Graphite or graphite in light oil should be used.

2. Clean, repair, or replace internal components as necessary in accordance with the manufacturer's instructions.

When Johnson Controls Maintenance Management was questioned regarding implementation of control valve maintenance for fire suppression systems site-wide, it was determined that preventive maintenance of control valves is not performed at TA-48. Nor is it implemented site-wide because the Work Control System does not direct it for LANL facilities.

The Review Team reviewed the maintenance of aging system equipment and components as well as maintenance source documents, and determined there are no criteria in place to accommodate age-related system degradation such as pipe wall thickness, corroded pipe fittings, and slow leaks identified in the basement fire protection piping. There are no maintenance procedures or programs such as Reliability Centered Maintenance in place that address age-related degradation.

Maintenance of the fire sprinkler system is to be performed in accordance with the following Johnson Controls procedures:

- PMI 40-35-007, Fire Suppression Sprinkler Inspection and Flow Device Testing
- PMI 40-35-008, Fire Hose Cabinet Inspection and Standpipe Testing
- PMI 40-35-009, Fire Alarm Initiating Device Inspection, Maintenance, and Testing
- PMI 40-35-015, Fire Panel Battery Bank Inspection, Maintenance, and Testing

These procedures are not specific to TA-48; accordingly, TA-48 vendor data is not included in these procedures.

A review of preventative maintenance activities showed that preventative maintenance is generally performed on the schedules generated by the work control system.

The facility Maintenance Implementation Plan (MIP) was reviewed. This plan was written to DOE Order 4330.4B, *Maintenance Management Program*, and approved by DOE on 1/22/01. There are some discrepancies between the MIP and its implementation. For example, the MIP describes full compliance with the maintenance history requirements of the Order. The Review Team found the maintenance history program is not fully implemented (see discussion under criterion 2). In addition, Facility Condition Inspections do not include inspection of fire protection piping for corrosion as written in the MIP.

DOE is in the process of implementing DOE 433.1, *Maintenance Management Program for DOE Nuclear Facilities*, for the Maintenance Program. When implemented, the MIP should be rewritten to that Order.

System Operability Issues or Concerns:

There were no immediate system operability issues identified. However, the lack of criteria for the review and evaluation of age-related equipment degradation appears to have contributed to the situation, described under System Maintenance Criterion 2 below, where corrosion in older sections of the FSS piping had not been identified, and the effect on system operation had not been analyzed. This raises questions regarding the capability of the system to successfully perform its safety function over its remaining service lifetime.

Opportunities for Improvement/Recommendations:

- Develop an NFPA-25 implementation matrix that specifies the frequencies of IT&M for each applicable component and list the implementing procedures. OLASO is reviewing rescinding the equivalency authorization due to implementation issues.

- Define age-related degradation criteria for system components (e.g., corroding pipe fittings) and identify appropriate corrective actions. Inspections should be performed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, and NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.

- Update MIP to DOE O 433.1 when the Order is implemented into the UC contract.

- Expand Facility Condition Inspections to include condition of fire protection piping.

Noteworthy Practice:

- The monthly building inspections, which include a Life Safety inspection, are performed by a Fire Protection Engineer and are very thorough.

Criterion 2:

The system is periodically walked down in accordance with maintenance requirements to assess its material condition.

Is the Criterion met?

Yes, with Opportunities for Improvement.

How the Review was Conducted:

The Review Team conducted a physical walk down of the TA-48 RC-1 wet pipe automatic sprinkler system to assess its material condition. Specifically, the Team sought to: verify that the system is inspected periodically according to maintenance requirements; to inspect, on a sample basis, the system focusing on the material condition of the installed equipment, components, and operating conditions; to identify and document any observed conditions that could challenge the ability of the system to perform its safety function (e.g., leaks, cracks, deterioration, or other degraded or abnormal conditions); to determine whether observed deficiencies have been identified and addressed in a facility condition assessment or deficiency tracking system; to identify whether excessive component failure rates have been identified; and, to determine how failure rates were used in establishing priorities and schedules for maintenance or system improvement proposals.

Discussion of Results:

The scope for the System Maintenance functional area covered approximately 75% of the wet pipe automatic sprinkler system at TA-48, RC-1. This was visually inspected for material condition. Areas not inspected were the Data Wing and Dissolving Wing. The Alpha Wing was viewed through windows and not entered. Distribution piping above suspended ceilings in laboratories, offices, and corridors was not visually inspected. There was no visual examination of pipe internals.

From the inspection, the Team observed that:

1) The system was operable at time of visual inspection. Per NFPA, this means: control valve is in the open position; water flow alarm is operable; sprinkler heads are unobstructed; piping, fittings, hangers, sprinklers and other components are in their proper locations and in good repair; and there is an adequate available water supply.

2) Control valves or indicator post valves were open, locked and had no visible signs of leakage.

3) Sprinkler risers were free of damage and leakage. Gauges indicated pressure. Retard chamber, shut off valves, and check valves were free of leakage.

4) Sprinkler piping in the older sections of RC-1 (circa 1955) exhibited signs of corrosion at the threaded unions and tees. Approximately 5% - 10% of the threaded unions and tees in the basement showed evidence of discoloration and corrosion products at the threads. There was no evidence of sustained leakage. New sections of piping, including the hot cell area were free of discoloration and corrosion products at the threaded connections.

5) Sprinkler heads, both upright and pendant, were generally in good condition. No leakage or corrosion products were observed on any sprinkler heads. In equipment room 344A, one sprinkler head was spray painted (overspray from ceiling painting). The basement machine shop 46 also had a sprinkler head with painting overspray. NFPA 25 2-2 1.1 requires sprinklers to be replaced when painted. In the south penthouse, one sprinkler head under duct number 501 was covered with a sheet of insulation. The facility engineer removed the insulation.

6) Pipe hangers were generally in good condition. In the 344A equipment room one hanger was not properly secured. In the basement, one hanger was removed to allow placement of a new duct and meter, and not reinstalled. In the basement of machine shop 46, a hanger for a stairwell sprinkler line was improperly fastened. In basement equipment room 21, one sprinkler line was tied to another sprinkler line.

7) Some floor drains designed to drain fire protection water were either completely or partially obstructed with debris.

DOE Order 4330.4B, *Maintenance Management Program*, requires a maintenance history and trending program be maintained to document data, provide historical information for maintenance planning, and support maintenance and performance trending of facility systems and components. This information is increasingly important with aging facilities and systems.

The TA-48, RC-1 Facility Manager was requested to provide the maintenance history documentation for the Fire Sprinkler System. The information provided was a listing of standpipe work orders performed for the last two years. The System Engineer was also questioned regarding how maintenance history records are retrieved and analyzed. He correctly recognized that two years of Work Order records are available via the Passport Computerized Maintenance Management System (CMMS); however, he has not retrieved those records or trended the data. Component failure rates are not identified or trended and are not used for planning maintenance activities.

The lack of a maintenance history system is a recognized site-wide issue at LANL. In February 2002, OLASO took action to specify a contractual performance measure for LANL to develop a plan to implement a maintenance history system for equipment important to safety and mission critical equipment for all critical facilities. In addition, OLASO has commented on recent submittals of nuclear facility Maintenance Implementation Plans to develop Maintenance History

processes. This assessment confirms the DNFSB 2000-2 observation of the Maintenance History program being rudimentary.

System Operability Issues or Concern:

While the wet pipe system in general appeared to be in good condition, the age of components installed in 1955 needs to be considered--specifically, aging sprinkler heads and aged piping. In 2005, many of the sprinkler heads in RC-1 will be 50 years old. Appendix 11.1 of O&M Criterion 721 recommends testing a representative sample of sprinklers at a recognized testing laboratory. If one sprinkler fails, all sprinklers represented by the sample are to be replaced. Distribution piping is also a concern. The DOE CAS Manual provides age-related degradation guidance for water-based fire protection piping by recommending replacement of 20% of the piping in worst condition after 30 years. NFPA codes do not require replacement of fire protection water piping because the piping is not expected to degrade significantly over the service life of the facility. Most of the piping in RC-1 is beyond the DOE CAS assigned designed life. The degradation (corrosion of older piping) had not been recognized by the facility, and the potential impact on system performance had not been evaluated.

Opportunity for Improvement:

- Ensure that equipment performance history data/records are maintained by the System Engineer and periodically reviewed to identify trends, potential problems, or areas of concern that could affect system operation or reliability.
- Perform a 100% inspection of the fire protection system to verify its operability.
- Clear floor drains so that they can fulfill their design functions.

System Surveillance and Testing TA-48, RC-1

Objective:

Surveillance and testing of the safety system demonstrates that it is capable of accomplishing its safety functions and continues to meet applicable system requirements and performance criteria.

Criterion 1:

Requirements for surveillance and testing are adequate for demonstrating overall system reliability and operability, and are linked to the technical safety basis.

Criterion 2:

Surveillance and test procedures confirm that key operating parameters for the overall system and its major components are maintained within operating limits.

Criteria 1 and 2 are addressed together below.

Are the Criteria met?

Yes, with Opportunity for Improvement.

How the Review was Conducted :

The review consisted of walk downs of selected portions of the TA-48, RC-1 Sprinkler System and interfacing Fire Detection System, document reviews, and interviews with TA-48 Facility management, staff as well as laboratory and contract service providers.

Documents Reviewed:

- LANL Sprinkler Data Deliverable Summary Report, Dtd. 04/11/02
- PMI NUMBER 40-35-009, REV.1 Dtd. 21 March 1996
- Fire Protection Maintenance Log
- JCNNM Activities Log Date: April 05, 2002
- FWO Fire Impairments Automated Listing
- JCNNM Preventative Maintenance Instruction 40-35-007, Fire Suppression Sprinkler and Flow device Testing
- JCNNM Preventative Maintenance Instruction 40-35-009, Fire Alarm Initiating Device Inspection, Maintenance, and Testing
- JCNNM Administrative Procedure
- JCNNM 80-10-006, Calibration Of Measuring and Test Equipment

Drawings:

- ENG-C 20844
  ENG-C43930
- ENG-C44131
- ENG-C44891
- ENG-C45173
- ENG-C46296
- ENG-C47214
- ENG-C47395
- ENG-C47426
- ZT-4777
- ENG-C47522
- ENG-C47540
- ENG-C47542
- ENG-C 47603
- ENG-C 37202
- ENG-C 37203
- ENG-C 42666
- ENG-C 39956
- ENG-C 42929
- ENG-C 44065
- ENG-C20842
- LASL 36969
- ENG-C 37760
- ENG-C42929
- ENG-C 4386
- ENG-C43798
- ENG-C43894
- ENG-C43898
- ENG-C43903
- ENG-C43924

Interviews:

- JCNNM Superintendent of Fire and Electrical
- TA-48 Facility Manager
- TA 48 Fire Systems Engineer
- FWO-FIRE Protection Engineers

Discussion of Results:

At LANL, TA-48 has been designated as a Hazard Category 3 Nuclear Facility. Within TA-48, the Fire Sprinkler System, as well as the Fire Detection System, have been categorized as Safety Significant under Management Level 2 (ML-2) administrative controls. Testing and surveillance of the systems are performed by a contract service provider, Johnson Controls of Northern New Mexico (JCNNM). At TA-48, maintenance and testing is performed in accordance with JCNNM approved procedures. The LANL FWO-FIRE organization provides fire protection engineering support to the facility as well as some independent oversight for the Laboratory.

The requirements, associated procedures, and acceptance criteria for surveillance testing of the FSS generally appear adequate for ensuring system operability. Tests and their periodicity were initially established based, in part, on code requirements, industry experience, manufacturer recommendations, and equipment maintenance history to ensure functionality of components. However, several issues were identified during a walk-down of the system, and the review of test data and records as documented below.

The Team's review of testing and maintenance records indicate there is no formal trending of Fire Sprinkler System test results by the facility, FWO-FIRE, or JCNNM. JCNNM reports failed tests resulting in an impairment to TA-48 and FWO-FIRE; however, impairments are not formally trended to identify generic or precursor component or subcomponent deficiencies that may compromise the reliability or operability of other fire systems at LANL, including TA-48. Additionally, there is no program in place to capture, trend, or evaluate equipment maintenance history associated with age-related component degradation. For example, JCNNM maintainers are seeing an increased number of circuit board failures due to changes in capacitor value (a direct result of aging). Although these failures are being identified, they are not being trended to

establish the need for predictive testing. Additionally, there is no traceability of subcomponents such as capacitors (an expendable) used in TA-48 ML-2 components. JCNNM indicated that due to the unavailability of components from the manufacturer, unserviceable circuit boards are cannibalized to maintain installed or spare circuit boards. Consequently, circuit boards used at TA-48, providing ML-2 functions, cannot be traced. Without traceability of some ML-2 components, coupled with no formal trending program, TA-48 does not capture valuable performance data. This could have a potential impact on component reliability. As another example, JCNNM has noticed an increasing number of test failures associated with FCI Inc. Model MS-2 Fire Pull Stations. These failures were not identified as a result of a formal trending program. The failures appear to be due to corroded terminals that may be limited to a specific manufacturer's batch. Corrosion of fire pull box terminals has also been identified at the Hanford Site including the Plutonium Finishing Plant. This information apparently was not received by LANL. FWO-FIRE or JCNNM were not aware of the recent pull box failures at Hanford. JCNNM is taking action to impair these devices when they are identified during routine test call-ups. The Review Team, however, believes that waiting for a routine call-up to address a suspect ML-2 Fire Protection component may allow a possibly degraded condition to exist for an extended period of time.

Expected service life of components is not well defined. TA-48 management and staff are aware that many components within the Fire Suppression System are aged and may be near or beyond the end of their service life. TA-48, FWO-FIRE, and JCNNM do not have information that specifically identifies expected service life of components or potential aging effects on reliability or operability. Also, vendor manuals and related vendor information are either not available or not kept current. TA-48, therefore, is without the benefit of service instruction letters or notices which could affect system and component testing necessary to ensure continued reliability or operability of the Safety Significant Fire Sprinkler System. Operational experience and vendor information is particularly important as some early TA-48 design and test information are not available.

The Computerized Maintenance Management System (CMMS) generates the call-ups for the TA-48 Fire Suppression System testing. When JCNNM has completed the work packages, the data is sent to FWO-FIRE. There it is reviewed to determine if all the required devices were tested. This is accomplished by comparing components listed on the test against an inventory of components maintained by FWO-FIRE. This inventory is different than that maintained within the CMMS and the MELs. These differences raise questions concerning the fidelity of current inventories and component lists, the configuration control of as-built conditions, and the completeness/adequacy of the testing and review of test results. If components are missed during scheduled testing, they are flagged, and the facility is notified. Missed components are rescheduled for testing. For those components past their required periodicity, the current convention is to not consider the overdue component as impaired until it is subsequently tested and then fails. A review of available records indicates that no components were missed at TA-48 during the past year. However, the Team views not considering overdue tests as impairments to be nonconservative.

Fuses are not controlled for ML-2 usage as they are an off-the-shelf item. During a walk down, the Team observed fuses lying in the bottom of ML-2 cabinets. Because of the fuse holder

configuration, the Team could not verify the proper fuse use in the ML-2 battery charger that supports Panel Control Number BRASS 1513-000, a ML-2 component. The Team noted that the battery charger has a manufacturer sticker, which stated that the warranty was voided if improperly fused. Typically there are multiple critical characteristics associated with fuses employed in safety applications. Due to the operability implications of improper fusing, fuse controls may be necessary to preserve safety significant component functionality.

The Team observed that the Gel batteries associated with Panel Control Number BRASS 1513-000, both ML-2 components, were not seismically protected by spacers or shims.

System Operability Issues or Concerns:

No immediate system operability concerns were identified regarding the adequacy of system surveillance test procedures or acceptance criteria. However, several concerns were identified regarding the capability of the Fire Sprinkler System to continue to perform its safety function over its remaining service lifetime as discussed above, and in the Opportunity for Improvement below.

Opportunity for Improvement:

- Consider improving the reliability of the Fire Sprinkler System and interfacing equipment by:
  - Trending test results and equipment maintenance history to identify reliability or operability concerns resulting from such influences as age degradation or manufacturer deficiencies and adjust testing regimes accordingly.
  - Reconciling the various inventories of Fire Protection Devices (provide missing information and eliminate conflicting information).
  - Establishing vendor manual controls to receive information that may impact testing regimes.
  - Define the expected life for ML-2 system components, and ensure proper inventory controls for spare/replacement parts.
  - Evaluating the need to secure the Fire Detection System (BRASS) batteries to prevent damage during a seismic event.

Criterion 3:

Instrumentation and measurement and test equipment for the system are calibrated and maintained.

Is the Criterion met?

No

How the Review was Conducted:

The Team conducted interviews, document reviews, and walk downs of the TA-48 Fire Sprinkler System, which is classified as a Safety Significant System.

Discussion of Results:

Some installed system instrumentation, such as gauges used in NFPA- required testing, is not under a calibration program. For example, installed Fire Suppression System gauges GPW-001, 002, 003, and 004 used in JCNNM Fire Suppression Sprinkler Inspection and Flow Device Testing at TA-48 are not in a calibration program. Step 7 of the test procedure requires the tester to verify that the certifications for all calibrated instruments are current in accordance with JCNNM Calibration of Measuring Test Equipment procedure 80-10-006. This procedure requires the user of Management Level 1 and 2 equipment to be responsible for assuring calibration. The installed gauges however, are identified in the MEL as ML-3. Although not required for the activation of the system and correctly designated ML-3, the gauges are relied upon to determine the operability of Riser Check Valves SPW-001 and 002 that are ML-2 components. These components must function to ensure the Fire Suppression System performs its safety significant function. If these gauges are not properly calibrated, test results could be compromised and the operability of the riser valves would not be ensured. Therefore, Gauges GPW-001 through 004 should be maintained under a calibration program.

System Operability Issues or Concerns:

- Where test procedures employ installed, uncalibrated instrumentation, test results are suspect and may not confirm the operability of certain safety significant components such as SPW1 and 2.

Opportunity for Improvement:

- Enter system installed measuring devices used to test ML-2 components into a calibration program.