LANL Phase II Assessments
Fire Sprinkler System at TA-48, RC-1
Fire Detection System at TA-55, PF-4
and
LANL Comprehensive Fire Safety Review
TA-48, RC-1 and TA-55, PF-4

June 2002

I, by signature here, acknowledge that I concur with the contents and conclusions of this report.

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ACRONYMS

AB	Authorization Basis
AL	DOE Albuquerque Operations Office
BIO	Basis for Interim Operations
BRASS	Basic Rapid Alarm Security System
CAS	Central Alarm Station
CFM or C-FM	Chemistry Facility Management Group
CFR	Code of Federal Regulations
CGS	Central Guard Station
CM	Configuration Management
CMMS	Computerized Maintenance Management System
CRAD	Criteria and Review Approach Document
DNFSB	Defense Nuclear Facilities Safety Board
DOE	Department of Energy
DP	Defense Programs
ECN	Engineering Change Notice
EEPROM	Electrically Erasable Programmable Read-Only Memory
ETL	Expandable Thermal Link
FCC	Field Control Cabinet
FCS	Facility Control System
FDS	Fire Detection System
FHA	Fire Hazard Analysis
FM	Facility Manager
FMU	Facility Management Unit
FPE	Fire Protection Engineer
FSS	Fire Sprinkler System
FWO-FIRE	Facility and Waste Operations – Fire Protection Group
I&C	Instrumentation and Control
IP	Implementation Plan
ISM	Integrated Safety Management
IT&M	Inspection, Testing, and Maintenance
JCNNM	Johnson Controls of Northern New Mexico
JCO	Justification for Continued Operations
LANL	Los Alamos National Laboratory
LAFD	Los Alamos County Fire Department
LIR	Laboratory Implementation Requirements
LPR	Laboratory Performance Requirements
MIP	Maintenance Implementation Plan
ML	Management Level
MTE	Measurement and Test Equipment
NFPA	National Fire Protection Association
NMT	Nuclear Materials Technology
OC	Operations Center
OLASO	Office of Los Alamos Site Operations

nble Logic Controller
Facility
Maintenance Instruction
nagement Plan
nistry
lysis Report
Configuration Management Plan
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tructures, and Components

of California
d Controlled Nuclear Information
ed Safety Question
d Safety Question Determination

EXECUTIVE SUMMARY

This report provides the results of Phase II assessments of the Los Alamos National Laboratory (LANL) Technical Area 48 Radiochemistry Building 1 Fire Sprinkler System (TA-48, RC-1 FSS) and the Technical Area 55 Plutonium Facility Building 4 Fire Detection System (TA-55, PF-4 FDS). It also documents the results of Facility Fire Safety Reviews conducted at the TA-48, RC-1 and TA-55, PF-4 facilities. The overall purpose and objectives of these assessments are discussed in the Introduction section of this report. The specific objectives and criteria used during the assessment, and the detailed results of the assessment are provided in Appendix A for the TA-48, RC-1 FSS; in Appendix B for TA-55, PF-4 FDS; and in Appendix C for the Fire Safety Reviews at both facilities. Significant findings from the assessment are summarized below. The assessment results are summarized in Section 2.0 of this report.

Safety System Assessments

This assessment team has concluded that the TA-48, RC-1 FSS and the TA-55, PF-4 FDS are currently operable and able to perform their safety functions as assumed in the facility safety basis documents and fire hazard analyses. This conclusion is primarily based on the systems' satisfactory performance during periodic surveillance testing, combined with the quality of the procedures used for work control and change control as applied to the systems. The team also notes that both facilities generally appeared well kept and in good condition. However, the team is unable to conclude that these systems will continue to be capable of successfully performing their safety functions for their remaining service life. This is based on several factors common to both systems, including:

- the expected service life of installed equipment and components has not been identified,
- maintenance procedures do not address age-related degradation,
- maintenance procedures do not adequately incorporate requirements from NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, and NFPA-72, *National Fire Alarm Code*, as committed to in the DOE/NNSA-UC contract,
- system performance history data is not analyzed/trended, and the feedback of lessons learned information (e.g., failure data from on-site, off-site at other DOE/NNSA facilities, or industry sources) is minimal -- this has been identified by the Office of Los Alamos Site Operations (OLASO) as a LANL site-wide issue which is being addressed through a contractual performance measure that requires implementation of a lessons learned feedback and improvement process,
- vendor information is not well maintained, and
- spare parts inventory controls were found lacking.

Although it is difficult to quantify the potential effect of these factors on long-term system operability and reliability, they clearly could potentially have a negative effect. This would appear to be more of an issue for the TA-48, RC-1 FSS than the TA-55, PF-4 FDS. This is because the FDS is principally an electronic system that is approximately 25 years old (or newer depending on the component) and was found to be in good condition, and which is located in a mild environment. However, portions of the FSS that are approximately 50 years old, are approaching, or in some cases may be past, their expected service lifetime. The FSS is a fluid system that appears to exhibit some signs of age-related degradation. This degradation has not been analyzed to determine the potential effect on system performance.

Systems and equipment important to safety can operate successfully well past their anticipated service life given proper monitoring, maintenance, testing, inspection, service environment, and operation. The team believes that it is prudent to have the affect of the above factors on future operability and reliability of the two systems further analyzed by appropriate subject matter experts to determine whether actions to address these issues are needed.

Based on the above, the team recommends the following two actions:

1. Because of the potential impact of the factors listed above on long-term operability/reliability of safety system equipment and components, and because these factors were common to both facilities reviewed during this assessment (suggesting that they may be common site-wide at LANL), the team recommends that it be determined if the identified issues represent a site-wide concern, and how best to incorporate appropriate measures for identifying the expected service life of systems and equipment important to safety; addressing the potential for age-related degradation, and the associated monitoring of system equipment and components; and controlling spare parts.

2. Because of the age of the FSS components in the original portion of TA-48, RC-1, and the observed signs of potential age-related degradation, the team recommends that a plan be developed for analyzing an appropriate sample of system components to determine their integrity and reliability for continued service.

Another area of concern identified that is common to both facilities relates to the quality of the documentation reviewed. Although the quality of the procedures used at both facilities for surveillance, testing, and work and change control typically ranged from good to excellent, the design and safety basis documents, from which such procedures are typically developed, were found in need of improvement in some cases. When combined with the lack of current vendor information mentioned above, this could have a potential impact on understanding of the system and its configuration. Accurate information concerning system safety functions, the system requirements/performance criteria that the system must meet in order to accomplish those safety functions, the associated basis information for these requirements and criteria, and the features of the installed design that satisfy those requirements and criteria is necessary to understand system operation, appropriately control changes, and to effectively monitor the system and make informed decisions concerning its design, operation, and maintenance. The team has the following two recommendations:

1. At TA-55, the System Design Description and system drawings are not up-to-date, and the version of the draft upgrade to the FSAR provided to the team does not adequately address the FDS (this has apparently been corrected in a subsequent version of the draft FSAR). Although the FDS is not credited in the facility accident analysis, it is clearly an important part of the defense-in-depth safety basis for the facility, and performs important safety functions that protect workers and prevent loss of property, and can result in lower doses for analyzed accident scenarios. The facility clearly recognizes the importance of this system as evidenced by their controlling and maintaining the system as if it were a safety SSC. However, in some cases system documents do not reflect changes to the system that have been in place for years. The team recommends that the safety benefit of updating these important documents be assessed and prioritized.

2. The TA-48 FSS has been designated a SS SSC by OLASO in their evaluation of the facility JCO. The FSS safety functions, and system requirements/performance criteria are not currently addressed in facility authorization/safety basis documents, systems drawings are piecemeal and in need of updating, and there is no SDD. A JCO was required when the facility classification was changed from a radiological facility to a Hazard Category 3 (HC3) nonreactor nuclear facility a couple of years ago. The facility has been working to develop appropriate safety basis documents for a HC3 facility, but is planning to return to a radiological facility in the not too distant future. The team believes that regardless of the facility hazard classification, the significance of the FSS essentially remains constant, and that the facility should plan to develop or upgrade the associated design and safety basis documents.

During a comparison review of drawings for the TA-48, RC-1 FSS to the actual installed system configuration, it was noted that two areas in the facility (Room 314-B and the hot cells) contain combustible materials, but lack automatic fire suppression. This has been identified in the facility FHA.

Fire Safety Reviews

Site and facility management commitment to fire safety is clearly evident, and the TA-48, RC-1 and TA-55, PF-4 facilities exhibit fire protection defense-in-depth. No conditions were observed that pose an imminent threat to the health and safety of workers, the public, or the environment, program continuity, or property protection.

Fire Hazards Analyses (FHAs) have been recently completed for both facilities. The FHAs were generally found to be thorough, complete, and accurate. Because of the quality of the FHAs, the assessment focused on the implementation of corrective actions to address identified deficiencies. The lack of available funds has resulted in delays in implementing corrective actions at TA-48, RC-1. The FHA for TA-55 identified a range of deficient conditions that require corrective action. Although the FHA has just been formally issued to DOE, the conditions have been noted in previous drafts of the FHA for approximately two years, and there is no corresponding corrective action plan. Some of the deficient conditions have been resolved through changes to the FSAR. Some of the deficiencies can be resolved on the basis of equivalency determinations and approved variances. Resolution of the remaining fire safety

issues is pending further analysis. The team believes that a plan should be developed that evaluates the deficiencies, and schedules corrective actions based on safety significance, available funds, and competing priorities.

Most of the findings related to the facility-specific fire safety reviews concern issues that are common to both facilities, and which often involve interface with outside organizations. The two most significant of these are: 1) the continuing failure to negotiate a contract between LANL and the Los Alamos County Fire Department that clearly defines agreed to roles and responsibilities, required response capabilities and expectations, and compliance with appropriate NFPA standards and applicable DOE guidance and criteria, and 2) OLASO does not have a fire protection engineer on staff, and their oversight of LANL fire protection programs has been minimal. Other issues include the following:

- fire safety surveillance self-assessments are not being tailored to address areas of concern identified in the FHAs,

- although feedback and lessons learned information from major (high visibility) fire safety incidents is being disseminated and evaluated, routine evaluation of operating experience, including trend and root cause analysis, for identification of precursors and feedback of lessons learned is not occurring,

- the process for FWO-FIRE interface with facilities is not sufficiently defined with respect to: 1) the review of facility modifications (this role may vary from facility to facility), and 2) the information and data to be provided from the facilities for evaluation and analysis, and

- fire sprinkler system piping internals are not being inspected to evaluate system degradation.

1.0 INTRODUCTION

1.1 Phase II Safety System Assessments

In Recommendation 2000-2, *Configuration Management, Vital Safety Systems,* the Defense Nuclear Facilities Safety Board (DNFSB or "the Board") expressed concern that DOE nuclear facilities constructed many years ago are approaching the end of their design life. The Board advised that as facilities age, a combination of age-related degradation and deficient maintenance can adversely affect the reliability of safety systems and their ability to perform their safety functions as designed. In their letter of September 8, 2000, the Board stated that: 1) the operational readiness of vital safety systems, their continued surveillance, maintenance and configuration management are at the core of Integrated Safety Management (ISM); and 2) full implementation of ISM cannot be considered accomplished until such vital safety systems are identified, responsibility is clearly established for their operational readiness, a satisfactory state of operational readiness is established, and a functional maintenance and configuration management system is put in place to ensure future readiness. In the context of the 2000-2 Implementation Plan (IP), vital safety systems are safety class or safety significant, or they perform an important defense-in-depth function[1].

While DOE acknowledges the Board's concern, it also recognizes that safety systems can remain operable and reliable into perpetuity with proper condition monitoring and assessment, maintenance and testing, modification, repair or replacement of aging components, and analysis of long-term facility missions and system requirements to support these missions.

The 2000-2 Implementation Plan[2] specifies two phases of assessments. Phase I assessments call for a review of operational and maintenance records and a qualitative determination of a "readiness state" for each vital safety system within defense nuclear facilities of interest to the DNFSB as listed in Appendix E of the 2000-2 Implementation Plan (IP). Phase II assessments call for more detailed assessments of the operational readiness of these safety systems. The Phase II assessments evaluate processes/programs in place to prevent the adverse effects of age-related degradation of safety systems, and are intended to build upon the Phase I results where additional assessment is determined to be beneficial by line management.

The overall purpose of the Phase I and Phase II assessments is to determine the operational readiness of safety systems at NNSA/DOE defense nuclear facilities, and the ability of these safety systems to operate reliably on a continuing basis for their remaining service life. The assessments will evaluate the effects of age-related degradation on systems, and the processes in place to ensure that age-related degradation will not compromise the future ability of the systems to accomplish their safety functions when required. The Phase II assessments obtain information necessary to fully understand and characterize system operability or reliability issues, problems, or concerns identified during the Phase I assessments; determine the associated causes; and,

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[1] DOE memorandum from Steven V. Cary to Distribution dated March, 19, 2001, *Clarification of the Term "Vital Safety System" under Implementation Plan for Defense Nuclear Facilities Safety Board Recommendation 2000-2, Configuration Management, Vital Safety Systems*

[2] DOE memorandum from Bill Richardson to John T. Conway dated October 31, 2000 with enclosed *Implementation Plan for Recommendation 2000-2, Configuration Management, Vital Safety Systems*

identify a clear path forward for restoring system operability/reliability to acceptable levels and ensuring these levels are maintained on a continuing basis.

Commitment 7 of the 2000-2 IP tasks field element managers to assemble teams and conduct the Phase II assessments where determined necessary based on the analysis of the Phase I assessment results. The DOE/NNSA Albuquerque Field Office and Office of Los Alamos Site Operations (OLASO) in conjunction with Los Alamos National Laboratory (LANL) determined that the Fire Sprinkler System (FSS) at TA-48, RC-1 and the Fire Detection System (FDS) at TA-55, PF-4 should receive Phase II assessments. The selection of these systems was discussed with NNSA/HQ and the DNFSB. These assessments were conducted at LANL from April 8 – 19, 2002 using the *Model Assessment Criteria and Guidelines for Performing Phase II Assessments of Safety Systems at Defense Nuclear Facilities*, dated November 2001. These criteria and guidelines[3] were issued to provide a consistent overall framework for conducting Phase II assessments of safety systems to fulfill Commitment 7 of the IP.

Phase II assessments are intended to build upon the results of the Phase I assessments. The Phase II assessment scope is typically tailored to focus on those areas where the Phase I assessment results indicate that questions or concerns exist regarding safety system operability/reliability, and to avoid unnecessary duplication of the Phase I assessment. However, Phase I assessments were not required for either the TA-48, RC-1 FSS or the TA-55, PF-4 FDS. Therefore, the Phase II assessment criteria and guidelines were applied in their entirety, i.e., no tailoring of the criteria and guidelines was performed. The TA-48, RC-1 FSS did not receive a Phase I assessment because it was not on the list of facilities of interest to the DNFSB (Appendix E of the IP). The TA-55, PF-4 FDS did not receive a Phase I assessment because it was not identified as a vital safety system under DNFSB Recommendation 2000-2. These systems were selected for Phase II assessments because DOE/NNSA and LANL determined that there would be safety benefit (i.e., value added) given the resources expended to conduct the assessments. The process for selecting systems for Phase II assessments is discussed in DOE memorandum from Steven V. Cary to Deputy Administrator for Defense Programs, et al, dated July 9, 2001, *Defense Nuclear Facilities Safety Board Recommendation 2000-2 Process for Evaluating Phase I Assessment Results and Identifying Phase II Assessment Candidate.*

1.2 Facility Fire Safety Reviews

In October 2002, following a series of wildland fires throughout the U.S., most notably the Cerro Grande wildland fire that threatened LANL, the Secretary of Energy directed a multi-faceted fire safety initiative to assess the ability of DOE sites to prevent and respond to fires[4]. In addition to a review of wildland fire vulnerability at DOE sites and promulgation of a new wildland fire safety policy, the initiative also created an independent commission on fire safety and directed that a comprehensive review of DOE facility fire safety and fire protection programs be performed. Commitments 12 and 13 of the Department's IP for DNFSB Recommendation 2000-

[3] DOE memorandum from Steven V. Cary to Deputy Administrator for Defense Programs, et al, dated November 30, 2001, *Model Assessment Criteria and Guidelines for Performing Phase II Assessments of Safety Systems at Defense Nuclear Facilities*

[4] DOE memorandum from Bill Richardson to David M. Michaels, et al, dated October 2, 2000, *DOE Facility Fire Safety Initiative*

2 required DOE/EH take the results of the Secretary's fire safety initiative, combined with the results of Phase I assessments of fire protection-related safety systems and the concepts and principles of DNFSB Technical Report 27, *Fire Protection at Defense Nuclear Facilities*, and develop a comprehensive plan for in-depth evaluation of the capability to respond to wildfires -- emphasizing facility fire safety, including fire detection and suppression systems and facility-specific programs that support those systems. This comprehensive study is characterized in the 2000-2 IP as being comparable in nature to the Phase II safety system assessments. The resulting *Evaluation Plan, Department of Energy Facility Fire Safety Review*, dated May 2001 was used to conduct the Facility Fire Safety reviews at TA-48 and TA-55. The performance objectives and evaluation criteria of this plan were tailored slightly for this assessment to be integrated with the Phase II assessment criteria and guidelines discussed above, and to avoid an unnecessary repeat assessment of emergency services recently performed by NNSA/OA. The fire safety reviews were conducted at the facility level. Facility compliance with site-wide fire safety programs and requirements was reviewed.

1.3 Assessment Team Composition and Review Approach

To conduct this assessment, the DOE/NNSA formed a multidisciplinary team of experts with knowledge and experience in systems engineering, nuclear facility fire protection and safety, nuclear safety analysis and documentation, software quality assurance, as well as nuclear facility maintenance, surveillance, and configuration management. The team included representation from DOE HQ and Field Offices, LANL, and consultants from SAIC, Parallax Corp., and Westinghouse Safety Management Solutions (WSMS). Biographical sketches for the team members are provided in Appendix D.

Prior to the on-site assessment, several members of the assessment team, including the team leaders, met separately with TA-48 and TA-55 facility management, safety basis, and technical personnel (including the system engineers), and with the LANL Fire Protection Group. The purpose of these meetings was to discuss and arrive at a common understanding and agreement on the scope of the safety system assessments (i.e., define system boundaries for purposes of the assessment), to identify and collect documents required for the review, to request an in-briefing for the team upon arrival on-site, and to make other logistical arrangements.

The assessment was conducted using the *Model Assessment Criteria and Guidelines for Performing Phase II Assessments of Safety Systems at Defense Nuclear Facilities*, dated November 2001, and *Evaluation Plan, Department of Energy Facility Fire Safety Review*, dated May 2001. These documents contain performance objectives, criteria, and associated lines of inquiry, and a recommended review approach in specific functional areas. For determining safety system operational readiness, these areas are: Safety Function Definition, Configuration Management, System Maintenance, and System Surveillance and Testing. For determining the adequacy of facility fire safety programs, the functional areas are: Facility Fire Safety Program, Comprehensive FHA and Self-Assessment, Fire Prevention Procedures and Fire Safety Features, Personnel Qualification and Training, and Feedback and Lessons Learned. This required assessment team members review documents related to the TA-48, RC-1 FSS and the TA-55, PF-4 FDS design, safety basis and controls, operation, maintenance, and surveillance. The team conducted interviews with appropriate facility staff, reviewed system drawings, performed walk-

downs of installed equipment to evaluate material condition and determine consistency with associated documents, and assessed the programs used to control changes to and conduct work on these systems. The assessment included the review of facility authorization basis and supporting documents to identify the system safety functions, and the system requirements and performance criteria that the systems must meet to successfully accomplish their safety functions. Facility records were reviewed to assess equipment performance history and identify trends. The effectiveness of programs (maintenance, surveillance and testing, and configuration management) that help to ensure continued long-term reliable system performance was also evaluated.

Additional documents reviewed include fire protection program documents (e.g., fire prevention procedures, fire hazard analyses, training records, and assessment reports). Facility implementation of fire safety programs and management commitment to fire safety were reviewed. Walk-downs of the facilities were performed to determine effectiveness of implementation.

Daily team meetings were held to discuss the team's activities and key observations, and to identify concerns or emerging issues with regard to either meeting the assessment criteria or conducting the assessment (e.g., getting access to personnel or documents) in order to plan subsequent activities and ensure that issues are identified and addressed. These meetings were open to the DNFSB and cognizant LANL and NNSA/DOE personnel such as facility management and Facility Representatives. Prior to publishing the report, each team member had his input to the report reviewed for factual accuracy by their counterpart points of contact at TA-48 and TA-55. The report was also reviewed by a derivative classifier to ensure it did not contain sensitive information.

Areas emphasized during the assessment included: (1) the identification of degrading conditions of installed system equipment, and the basis for the acceptability of the conditions or the planned corrective actions; and (2) the effectiveness of mechanisms used to monitor, detect, correct, and prevent age-related degradation of system equipment important to safety. Based upon the assessment results and the engineering judgment of team members, a qualitative assessment was made of the ability of the TA-48, RC-1 Sprinkler System and the TA-55, PF-4 FDS to reliably perform their safety functions over their anticipated remaining service lifetime. The specific documents reviewed, interviews conducted, and facility walk-downs performed and observations made are listed in Appendix A for the TA-48, RC-1 FSS, Appendix B for the TA-55, PF-4 FDS, and in Appendix C for the facility fire safety reviews at both TA-48, RC-1 and TA-55, PF-4.

Consistent with the Assessment Criteria and Guidelines, the assessment did not involve re-evaluation of the underlying analyses that support the approved facility authorization/safety basis, nor involve a detailed review of the installed design or its basis. However, where questions in these areas arose during the assessment, they are noted in the report for use by NNSA/OLASO and LANL as considered appropriate.

An intent of the Phase II review was to have independent technical experts evaluate safety system performance and facility fire safety, and to identify opportunities for improvement that would provide value added toward resolving system operability/reliability or fire safety issues or

concerns, thus improving safety system performance and facility fire safety. The appendices of this report provide opportunities for improvement for consideration by OLASO and LANL. These opportunities for improvement (recommendations) are also listed in the Assessment Results section of the report. The opportunities for improvement are provided for review to determine their safety benefit and cost-effectiveness in context of the facility management prioritization process.

2.0 ASSESSMENT RESULTS

This section of the report presents the overall results of the assessment and lists the Opportunities for Improvement identified by the assessment team. The details surrounding the results, including how the review was conducted, documents reviewed and personnel interviewed, and noteworthy practices and opportunities for improvement are provided in the Appendices A, B, and C.

Results from Application of the Safety System Assessment Criteria and Guidelines to the LANL TA-48, RC-1 Sprinkler System

Safety Function Definition: The current DOE/NNSA-approved facility authorization basis for TA-48, RC-1 is a Justification for Continued Operations (JCO) pending completion of a Basis for Interim Operation (BIO) due in June 2002. The JCO combined with the facility Fire Hazard Analysis (FHA) identify and describe the TA-48, RC-1 Sprinkler System functions, requirements, and performance criteria. No major concerns were identified. However, the JCO has been extended from August 18, 2001 to June 28, 2002. The FHA was completed in October 2000 and contained safety information not available when the JCO was written.

The following Opportunities for Improvement were identified:

- 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: Current procedures established to control and ensure proper system configuration are relatively new. These procedures should ensure the proper control of changes to the fire sprinkler system. Validation of the as-built configuration of the fire sprinkler system was found to be difficult and time consuming. Although as-built drawings were available covering the design and modification of the fire sprinkler system back to original construction in 1955, individual drawing changes have never been consolidated. As a result, a comprehensive system configuration drawing — an essential element in assuring and maintaining proper system configuration—does not exist for the fire sprinkler system. Additionally, several potential discrepancies were identified between the "as-designed" and as-built configuration of the system. The more significant of these discrepancies had been previously identified by the facility and should be resolved as part of the ongoing BIO development effort. System components are not well labeled.

Two areas in the facility (Room 314-B and the hot cells) contain combustible materials, but lack automatic fire suppression. This has been identified in the facility FHA, and should be given appropriate priority for resolution.

The following Opportunities for Improvement were identified:

- 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*).

- Provide consistent labeling of fire sprinkler system components.

- Repair the broken pipe hanger found under the stairway in the storage space adjoining Room 46.

Maintenance: The system was found to be operational. Sprinkler heads, both upright and pendant were generally in good condition. However, in 2005 many of the sprinkler heads in RC-1 will be fifty years old. Additionally, sprinkler piping in the older sections of RC-1 (circa 1955) exhibited signs of corrosion at threaded unions and tees. Approximately five to ten percent (5% - 10%) of the threaded unions and tees in the basement showed evidence of discoloration and corrosion products at the threads. There are no criteria in place to accommodate age-related system degradation such as the corroded pipe fittings and slow leaks identified in the basement fire protection piping. The Facility Manager was not aware of the corrosion, and the resultant effect on system operability has not been analyzed. The effects of aging on components (sprinkler heads and piping) installed in 1955 need to be evaluated to determine whether they still support system operation as assumed in the facility safety basis.

On January 26, 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 obligated to meet these commitments. However, it was determined that implementation of these IT&M requirements is not documented, and in some cases are not implemented in the facility. OLASO is reviewing rescinding the equivalency authorization due to implementation issues. In addition, maintenance history is not retrieved, analyzed, tracked or trended to determine component reliability.

The following Opportunities for Improvement were identified:

- Develop an NFPA-25 implementation matrix that specifies the frequencies of IT&M for each applicable component and list the implementing procedures.

- 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.

- 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 the floor drains that were found to be completely or partially obstructed with debris so that they can fulfill their design function of draining fire sprinkler system water from the facility.

Surveillance and Testing: Although the surveillance and test procedures used were found to be adequate, the team found a general lack of trending of test results and equipment maintenance history needed to effectively evaluate component and system reliability. Industry experience and current vendor information, useful in adjusting testing regimes, were also found lacking at both the facility and their contract service provider, Johnson Controls of Northern New Mexico (JCNNM). Inconsistencies were noted between the various listings of system components used (e.g., the Computerized Maintenance Management System, the Master Equipment List, and the FWO-FIRE inventory of components). The end of service life has not been defined for Fire Sprinkler System components. The team also observed a lack of inventory controls for ML-2, fire system spare parts at the facility. Additionally a concern was raised regarding the use of uncalibrated, installed instrumentation to demonstrate the operability of safety significant components in the Fire Sprinkler system.

The following Opportunities for Improvement were identified:

- 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-related degradation or manufacturer deficiencies then 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.

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

Results from Application of the Safety System Assessment Criteria and Guidelines to the LANL TA-55, PF-4 Fire Detection System

Safety Function Definition: The 1996 FSAR, the FHA, and the SDD, identify and describe the PF-4 Fire Detection System (FDS) safety functions, requirements, and performance criteria. The FDS is not considered a safety significant system, and is not credited in the facility accident analysis. However, proper functioning of the FDS, combined with proper response by the LAFD, can result in lower doses than assumed in the accident analysis, and can limit property damage and personnel injury. The FDS is part of the defense-in-depth safety basis for the facility. Most of the discussion of the FDS had been deleted in the copy of the draft FSAR provided to the team by NMT, although this material has apparently been reinstated in a subsequent draft. Additionally, the System Design Description (SDD) has not been updated in six years and does not accurately reflect portions of the current FDS design (e.g., FDS interfaces with the Facility Control System).

The following Opportunities for Improvement were identified:

- Update the FDS SDD to ensure that it is consistent with the installed design and that it contains the information necessary to be a useful document for controlling changes to the FDS, and understanding the basis for the FDS design, and maintenance, surveillance, and testing activities.

- Ensure that the FDS is appropriately discussed in the FSAR.

Configuration Management: Effective controls are established and implemented to ensure and maintain the configuration of the fire detection system. Configuration management processes appeared to be institutionalized at TA-55 and consistently applied to safety significant structures, systems and components (SSCs). In the field, fire detection SSCs were found to be properly configured and well labeled. A comprehensive configuration drawing was available, however, the drawing had not been updated to show several components that had been added to the fire detection system.

Making changes to the FDS EEPROM firmware is an expert-based process. The facility is forced to rely on a single individual from a separate organization who is the sole point of contact

for reprogramming. Documentation relating to FDS firmware and its controls, programming, installation, and testing is largely unavailable. A software QA Plan is being developed for the FCS, but progress has been slow.

The following Opportunities for Improvement were identified:

- Resolve the specific drawing discrepancies identified and consider the safety benefit of conducting a comprehensive verification walk down of Drawing No. 55Y-001843 to ensure that all discrepancies are identified and corrected. While it is typically not cost-effective to update drawings every time a change is made, especially if the change is minor and simple in nature, it is important to ensure that the system configuration is known, understood, and well documented. System drawings need to be updated as necessary to ensure that they, in conjunction with accurate change information, are usable (e.g., so that System Engineers, Design Engineers, Operators, etc. can make informed and correct decisions regarding system design, operation, and maintenance).

- While the technical actions implemented with regard to the software driven aspects of the FDS are reasonable and appropriate for the system as currently configured, implementation of the following recommendations should help ensure continued long-term operability and reliability of the FDS.

  - Revise NMT8-SDD-3200 to clearly state that the only microprocessor in the Fire Detection System is an electrically erasable programmable read-only memory (EEPROM) device located in Supervisory Panel 3225. Further state in the SDD that this EEPROM is considered to be firmware.
  - Evaluate the code and standard commitments in NMT8-SDD-3200 against currently available relevant codes and standards and determine the code(s) and standard(s) that should apply to Supervisory Panel 3225 at this time. Revise the code and standard commitments in NMT8-SDD-3200 to reflect the results of this evaluation.
  - Put in place a set of basic controls, e.g., procedures, manual, or a plan, that includes a basic process to identify, evaluate, and resolve operational problems associated with the Panel 3225 EEPROMs. The controls thus established should provide sufficient guidance that personnel not involved in previous revisions of the Panel 3225 EEPROM programming can identify problems associated with the EEPROM, troubleshoot EEPROM related problems, determine the need to re-program the EEPROM, successfully revise the EEPROM programming and return the panel to operable status, and demonstrate configuration management from one version of EEPROM programming to the next.
  - Retrieve the documentation that describes the 1992 EEPROM programming effort or re-create from the collective memory of personnel involved in the 1992 EEPROM programming effort a detailed description of that effort. In particular, retrieval or development of information on the post installation test program should be pursued. Enter this documentation into the current records system and provide controlled distribution to key TA-55 and JCNNM personnel.
  - Place the Autocall Division, Federal Signal Corporation, *Fire Alarm System Data Manual* that reflects installation of the Autocall 3225 panel as described in Work

Order 6-8108-65 into the current records system and provide controlled distribution to key TA-55 and JCNNM personnel.

- Enter the undated document *BRASS PANEL 3225 EEPROM PROGRAMMING* into the current records system and provide controlled distribution to key TA-55 and JCNNM personnel.
- Place a master copy of the EEPROM programming executable software into the records system and issue a controlled copy to JCNNM. Develop a rudimentary set of instructions on use of the software, enter these instructions into the site records system, and provide controlled distribution to appropriate JCNMM personnel. Train an appropriate number of JCNNM personnel to properly use the software.

- NMT-8 has made significant progress toward development and implementation of software controls. The following recommendations are provided for enhancing continued long-term operability and reliability of the FCS.

  - NMT management should evaluate progress in developing and implementing the FCS software QA effort and take appropriate action to support timely implementation.
  - NMT should implement the FCS Software QA Plan in place as soon as practical.
  - NMT should revise the FCS SCMP to reflect the cancellation of the *TA-55 Change Control Manual.*

Maintenance: The procedures used for inspection, maintenance, and testing of the FDS are of high quality, and the system was found to be operational. Inspection of fire alarm system panels, batteries, and actuator mechanisms for glovebox fire dampers found the components to be in good condition with no signs of age-related degradation.

The following Opportunities for Improvement were identified:

- Develop an NFPA-25 implementation matrix that specifies the frequencies of IT&M for each applicable component and list the implementing procedure.

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

- 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.

- Verify that inspections and tests of alarm devices satisfy NFPA-25 requirements.

Surveillance and Testing: Test procedures are adequate and well written. However, the team found a general lack of trending of test results and equipment maintenance history needed to effectively evaluate component and system reliability at TA-55. Industry experience and current vendor information, useful in adjusting testing regimes, were also found lacking at the facility as well as their contract service provider, Johnson Controls of Northern New Mexico (JCNNM). The end of service life has not been defined for the Fire Detection System components. The team also observed a lack of inventory controls for system spare parts at the facility and JCNNM.

The following Opportunities for Improvement were identified:

- Trend test results and equipment maintenance history to identify reliability or operability concerns resulting from such influences as age-related degradation or manufacturer deficiencies then adjust testing regimes accordingly.

- Establish vendor manual controls to receive information that may impact testing regimes.

- Establish better inventory controls for ML-2 Fire Detection System spare parts.

Results from Application of the Facility Fire Safety Review Evaluation Plan to the LANL TA-48, RC-1 and TA-55, PF-4 Facilities

Facility Fire Safety Program: Both DOE and LANL management demonstrate commitment to fire safety, including new contractual requirements and relevant performance measures, and implementation of a site-wide program, respectively. The lack of a contract between LANL and the Los Alamos County Fire Department raises questions concerning the ability to respond to emergencies, and may impact fire safety defense-in depth at the site. Both facilities are encompassed by a comprehensive fire protection program as defined in LANL directives, as implemented by the operations staff, and as confirmed by FWO-FIRE. Some weaknesses were noted in this program within the realm of funding, self-assessment activities, analysis of performance data, and DOE oversight.

The following Opportunities for Improvement were identified:

- The dissemination of additional guidance to Facility Managers and other operational staff pertaining to the circumstances under which FWO-FIRE review and approval is required will help ensure that facility changes progress in a (fire) safe manner.

- Completion of contract negotiations with Los Alamos County for emergency services on site that sets forth expectations, responsibilities, capabilities, and applicable standards will help ensure effective response to fires and related events.

- Issuance of a revision to LANL Program criteria (LPR/LIR as appropriate) to adopt the Urban Wildland Interface Code for facilities will help ensure preservation of required defensible zones around critical facilities.

Comprehensive FHA and Self-Assessment: Generally, fire and related safety hazards have been effectively identified and evaluated in the FHAs. The FHAs are thorough and demonstrate a conservative approach to fire safety. However, the FHAs do not analyze the capabilities of the Los Alamos County Fire Department to respond effectively to fire emergencies in a timely manner. Although annual fire protection self-assessments have been performed for both facilities, weaknesses were found in the fire safety surveillance program, which include inconsistencies in self-assessment reports as compared to the FHAs and conditions in the

facilities. The DOE is not performing effective oversight of LANL and facility-specific fire protection programs.

The following Opportunities for Improvement were identified:

- Complete a Baseline Needs Assessment and a review against current NFPA codes and standards governing fire departments to provide reasonable assurance that the LAFD will be able to respond effectively to fires and related emergencies in this facility.

- Implement the proposed plan to augment the fire safety surveillance program to ensure that fire safety reviews address administrative controls, issues or concerns identified in facility FHAs, findings from LANL and facility surveillances, inspections, assessments, and management walk-arounds (including analysis of root cause), and significant hazards, trends, and precursors.

- Revise the subject FHAs to clearly establish the adequacy of the safety margin as it relates to the threat from fire to avoid potential misunderstanding by stakeholders of the nature of fire risk at these facilities.

- Support the acquisition of fire modeling skills by other members of the staff of FWO-FIRE to enhance the capability of LANL to perform these calculations "in house."

Fire Prevention Procedures and Fire Safety Features: Fire protection defense-in-depth is evident at both facilities. This includes fire barriers, fire protection systems, and administrative controls. The FHAs, self-assessments, and this independent review identified a significant number of deficiencies in compliance with established fire safety criteria. At TA-48, funding limitations preclude a definitive path forward and timely resolution of these deficiencies. At TA-55, some of the deficiencies identified in the FHA have been addressed. Disposition of the remaining deficiencies is pending further analysis.

The following Opportunities for Improvement were identified:

- Implementation of a formal corrective action plan addressing all recommendations from the TA-55 FHA would help to expedite their remediation.

- Provision of additional funding, through an increase in the "space tax" (for example), would help to eliminate the inventory of needed safety-related work requests at TA-48.

Personnel Qualification and Training: Programs are established to ensure that certain employees and emergency responders receive training consistent with fire risk, and that fire safety staff are appropriately qualified to perform their required duties. All personnel performing work in TA-48 receive general employee training in fire safety commensurate with facility hazards. At TA-48, non-mandatory facility-specific refresher training is available to resident personnel. All personnel performing work in TA-55 receive general employee training and mandatory facility-specific initial and refresher training commensurate with facility hazards.

The following Opportunities for Improvement were identified:

- Consider making facility-specific fire safety refresher training a mandatory requirement at TA-48, RC-1.

- OLASO should expedite the hiring of a full-time fire protection engineer to oversee LANL and facility-specific fire safety activities.

Lessons Learned and Feedback: A framework exists to promote the exchange of information pertaining to relevant fire safety lessons learned and near misses. While information pertaining to major fire safety events throughout the DOE is generally captured and disseminated, lessons learned from minor incidents generally do not receive wide-spread distribution and attention. Performance data that could provide helpful fire safety information is not being analyzed.

The following Opportunities for Improvement were identified:

- Ensure that FWO Fire Protection Group personnel take a more proactive role in conducting briefings with facility personnel to convey important fire safety lessons learned.

- Establish a lessons learned champion at TA-48, and task this individual with responsibility for disseminating information from throughout LANL and the balance of the DOE complex on all (i.e., major and minor) relevant lessons learned.