02-0001555

Department of Energy
National Nuclear Security Administration
Washington, DC 20585

July 23, 2002

The Honorable John T. Conway
Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, NW
Suite 700
Washington, D.C. 20004

Dear Mr. Chairman:

Consistent with the Department of Energy's Implementation Plan for Defense Nuclear Facilities Safety Board Recommendation 2002-2, *Configuration Management, Vital Safety Systems*, I am forwarding an initial Phase II assessment report for Los Alamos National Laboratory (LANL), TA-48 Facility RC-1 Fire Sprinkler System and TA-55 Facility PF-4 Fire Detection System. This report also includes the LANL Comprehensive Fire Safety Review for Facility RC-1 at TA-48 and Facility PF-4 at TA-55. It is noted that these reviews were completed in cooperation with the Office of Environment, Safety and Health, Office of Performance Assessment and Analysis. Initial Phase II reports from the remaining National Nuclear Security Administration sites will be forwarded as they are completed.

If you have any questions, please contact me at (202) 586-2179 or have your staff contact Mr. Jeff Kimball at (301) 903-6413.

Sincerely,

Everet H. Beckner
Deputy Administrator
for Defense Programs

Enclosure

cc w/o enclosure:
B. Cook, EH-1

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D. Beck, NA-12
D. Crandall, NA-1.1

cc w/enclosure:
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R. Erickson, LAAO

02-1555

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.

Signature on file
Dave Berkey, DOE/EH (Parallax Inc.)

Signature on file
James Kelly, SAIC/WSMS

Signature on file
Brian T. Debs, DOE/EH (Parallax Inc.)

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Bill Radzinski, LANL, FWO-SEM

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Dennis Kubicki, DOE/EH-24

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Rick Kendall, NNSA/NA-53
Team Leader

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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

PLC	Programmable Logic Controller
PF	Plutonium Facility
PMI	Preventive Maintenance Instruction
QMP	Quality Management Plan
RC	Radiochemistry
SAR	Safety Analysis Report
SCMP	Software Configuration Management Plan
SDD	System Design Description
SE&M	Systems Engineering and Maintenance
SER	Safety Evaluation Report
SSCs	Systems, Structures, and Components
STD	Standard
UC	University of California
UNCI	Unclassifed Controlled Nuclear Information
USQ	Unreviewed Safety Question
USQD	Unreviewed 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.

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.

APPENDIX B

Detailed Discussion of Results of the Phase II Assessment of the Fire Detection System at LANL TA-55, PF-4

BACKGROUND AND SCOPE OF ASSESSMENT

LANL TA-55 PF-4 Facility

The Plutonium Facility at TA-55 (PF-4) was designed and constructed to consolidate and update plutonium handling operations at LANL. The facility was first occupied in 1977, and DOE approval to begin operations was officially received in April 1978. PF-4 is a two-story, cast-in-place reinforced concrete structure approximately 284 ft by 265 ft in plan dimension. The height between the basement floor and the laboratory floor is approximately 18 ft. and the height from the laboratory floor to the top of the roof slab is approximately 22 ft. The laboratories are housed on the main level, and the equipment used to support their operation is contained in the basement. A 4-hour fire-rated wall divides PF-4 into two equal sections, each having its own ventilation and electrical systems. A corridor that is equipped with a set of fire doors provides access between the two halves on the first floor. Each half of the first floor is in turn divided into two processing areas by a corridor running the length of the building. Each processing area is designated as 100 area, 200 area, 300 area, or 400 area. Each area contains several rooms where process gloveboxes are located.

LANL TA-55, PF-4 Fire Detection System

The existing Fire Detection System (FDS) at TA-55, PF-4 monitors the status of various devices throughout the facility including:

- glovebox thermal detectors,
- manual fire alarm pull boxes,
- area heat detectors,
- sprinkler and hose rack flow sensing pressure switches,
- flow switches,
- smoke detectors, and
- post indicator valve assembly tamper switches.

The FDS monitored devices are divided into zones. Each zone consists of one or more of the devices listed above, and is monitored by a separate circuit. There are 199 zone circuits that provide alarm and trouble status information to the main FDS supervisory panel via jurisdictional boxes (junction boxes) and transponders. Multiple zone circuits are assigned to each jurisdictional box. There are seven transponders, each with a zone input module that can monitor up to eight jurisdictional boxes, and a command output module that provides up to four output signals to actuate facility equipment as directed by the supervisory panel. The supervisory panel is commonly referred to as the BRASS (Basic Rapid Alarm Security System) panel. The BRASS panel is part of a site wide security and fire alarm system that is monitored remotely from the facility. The BRASS panel is a microprocessor based monitoring system that uses Electrically Erasable Programmable Read Only Memory (EEPROM) firmware to process digitally coded address and status signals and generate appropriate output signals. It monitors all 199 zones, and its front cover contains trouble and alarm status lights for each zone. This panel is located in the hallway directly outside of the facility Operations Center (OC). All of the zones are scanned by the panel every 1.6 to 1.7 seconds. The BRASS panel provides direct output

signals to the Central Alarm Station (CAS) via a concentrator circuit. From the CAS, located in TA-3, the alarms are forwarded to the Central Guard Station (CGS) and broadcast to the Fire Department. Alarms are also sent to the Fire Department from the Central Alarm Station via telephone circuits to printers in the Fire Stations. The BRASS panel also provides direct output signals to trouble and alarm lights and a printer in the OC, and to the PF-4 vault pre-action solenoid-operated pilot valve to charge the normally dry vault sprinkler header with water for subsequent actuation by a heat activated sprinkler head.

The BRASS panel also provides outputs via the transponders and jurisdictional boxes to local alarms, and to close drop box doors by actuating expandable thermal links (ETLs). A drop box is a vertical duct that connects a row of interconnected gloveboxes to the PF-4 overhead conveyor system which is collocated within the glovebox inlet ventilation ducting. Upon receipt of a signal from either a glovebox heat detector or a local drop box station manual pushbutton within the drop box fire detection zone, a command signal from the BRASS panel activates transponder panel relays. This causes 24V dc to be applied to the ETL, causing it to expand radially, breaking an enveloping frangible link releasing the glovebox doors (ventilation dampers) to isolate the corresponding row of gloveboxes from the normal inlet ventilation source. The BRASS panel and the transponders are provided with 24 V dc batteries and battery chargers. The batteries are provided to supply power until the diesel generator comes on line and provides power to FDS loads following a loss of normal power.

The FDS jurisdictional boxes are monitored by the Facility Control System (FCS) via Field Control Cabinets (FCCs) located throughout the facility. The FCS is a computer based data acquisition and supervisory control system that uses programmable logic controllers (PLCs) and dual communications networks (Ethernet and DH+) to transmit data. The FCS monitors facility systems including the confinement system, ventilation system, criticality alarm system, continuous air monitors, fire detection and suppression systems, electrical power distribution system, and various plant utility systems. The FCS displays FDS system status information and alarms to the operators in the OC on CRT displays, automatically performs control actions based on plant conditions as determined by system software, and allows manual control of facility systems and equipment from the OC via keyboard commands. The FCS monitors all 199 zones and BRASS panel outputs via the transponders through an interface with the jurisdictional boxes, and provides output signals when conditions warrant. The FCS generates signals that close fire doors in the PF-4 H-wall, shutdown basement ventilation system recirculation fans, open filter plenum cool-down spray valves, and sound audible fire alarms throughout PF-4 via the paging system. The FDS also monitors the Halon systems in PF-4 and the cafeteria stove hood dry chemical system.

The PF-4 FDS also serves PF-1, PF-2, PF-3, and PF-5. The original FDS was installed in 1978 when PF-4 became operational. There have not been any significant changes made to the FDS since the BRASS panel was installed in 1987.

Scope of Review for TA-55 PF-4

The scope of review for this assessment included most of the FDS equipment and components described above, including the BRASS panel EEPROM firmware. The support systems for the

FDS include the 24V dc backup batteries and associated chargers. These were included in the assessment. The TA-55 diesel generator, which ultimately provides power to the FDS on loss of normal power, was not included in the review. The FDS components included in this review are located in controlled environments inside various buildings at TA-55, including PF-4, PF-1, PF-3 and the OC. The environmental controls (i.e., heating, ventilation, and air conditioning systems) for these buildings were not included within the assessment scope.

The FCS is a separate safety system that underwent its own Phase I assessment and was not selected for Phase II assessment. Therefore this review only addressed the surveillance and testing of those safety functions initiated by the FCS based on its monitoring of the FDS, and the FCS software used to perform these functions. The FCS has an additional interface with the FDS in addition to those described above, namely to activate a Paging System audible alarm upon receipt of an alarm signal from the BRASS panel. The Paging System was not reviewed. The following additional systems that interface with the FDS were not reviewed during this assessment.

- Central Alarm Station and associated concentrator
- Halon systems

Safety Function Definition –TA-55, PF-4

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:

- NMT8-SDD-3200, System Design Description, Fire Detection System, 2/01/96.
- LA-CP-02-113, TA-55 Fire Hazard Analysis, April 2002.
- TA-55 Final Safety Analysis Report, 7/31/96
- LA-CP-95-169 (Rev.1), Draft TA-55 Final Safety Analysis Report, 2001
- NMT8-ASI-006-R00, Fire Alarm Initiating Device Inspection, Maintenance, and Testing, 10/19/99
- NMT8-ASI-020-R00.3, Non PF-4 FSS Flow, Main Drain And Alarm Surveillance, 5/9/01.
- NMT8-TSR-005-R03.2, Transient Combustible Control Inspection, 4/16/01.
- NMT8-TSR-203-R00.1, Site Audible Alarm Test, 3/16/01.
- Safety Evaluation Report, Revision 1, December 1996.

Facility Tours:

- TA-55, Plutonium Facility (PF-4) – General orientation tour to locate and view the Fire Detection System (FDS) components.

Interviews:

- Authorization Basis Group Leader (GL)
- Authorization Basis Deputy GL

Discussion of Results:

The review of the above documents identified the following requirements concerning the safety functions of the TA-55, PF-4 sprinkler system:

- The fire detection system will detect a fire in PF-4, and generate signals indicating the presence and location of fire.

- The PF-4 system will communicate audible and visual signals between field devices and the main control panel. Visual signals appear on monitor screens in the Operations Center (OC) and at the CAS.

- The FDS will alert the TA-55 OC/FCS to off normal or emergency situations that could require immediate response, including heat detection, smoke detection, and water flow. This action causes the FCS to close fire doors at the basement and main floor H wall and to turn off the corresponding Ventilation System re-circulation fans. The FCS will also signal the paging system to sound appropriate alarms when an FDS sensor activates and the OC will also use the paging system to provide evacuation instructions to workers.

- The FDS heat detectors in Glove Boxes served by a Drop Box, when activated, will actuate the fire damper located in the Drop Box.

- Both photoelectric and ionization type smoke detectors in the OC and vault rooms will initiate alarms as appropriate.

- Flow from any sprinkler sensed by a flow switch or pressure switch will cause an alarm to the supervisory panel of the FDS.

- Flow switches on the cool-down sprays provide input signals to the supervisory panels in the FDS.

- Early warning heat detectors are mounted at the vault corridor ceilings, which will initiate appropriate alarms.

- The Switchgear/Motor Control Rooms have photoelectric and ionization type smoke detectors mounted at the ceilings which activate Halon systems with an 18 second delay.

- Heat detectors and manual pull stations in Switchgear/Motor Control Rooms immediately activate Halon systems.

- Heat detectors at the vault ceiling activate the pre-action water control valve.