



LAWRENCE
LIVERMORE
NATIONAL
LABORATORY

Emergency Response Capability Baseline Needs Assessment Requirements Document

J. A. Sharry

December 27, 2012

Disclaimer

This document was prepared as an account of work sponsored by an agency of the United States government. Neither the United States government nor Lawrence Livermore National Security, LLC, nor any of their employees makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States government or Lawrence Livermore National Security, LLC. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States government or Lawrence Livermore National Security, LLC, and shall not be used for advertising or product endorsement purposes.

This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

Emergency Response Capability Baseline Needs Assessment Requirements Document



Lawrence Livermore National Laboratory

Also Covers:
Sandia National Laboratory/California

December, 2012

SIGNATURE PAGE

Lawrence Livermore National Laboratory

2012

Emergency Response Capability
BASELINE NEEDS ASSESSMENT
Requirements Document

Revision 7.0

December 2012

Prepared by: _____
John A. Sharry, LLNL Fire Marshal

12/27/12
Date

Reviewed by: _____
James D. Colson, EMD Department Head

12/27/12
Date

Table of Contents

1.0	Introduction and Executive Summary	4
2.0	Assumptions.....	9
3.0	<u>Scope</u>	9
4.0	Description of LLNL Fire Protection Organization.....	9
5.0	Requirement and Guidance Documents.....	11
5.1	Requirement Documents	11
5.2	Guidance Documents	13
6.0	Primer on Fire Department Organization	14
7.0	Determination of Baseline Needs	15
7.1	DOE Fire Fighting Requirements	15
7.2	LLNL Situation Status	16
7.3	Manual Fire Fighting – Livermore S-200	16
7.4	Manual Fire Suppression Requirements-Site 300.....	23
7.5	Emergency Medical Service.....	25
7.6	Hazardous Materials Response Requirements	26
7.7	Technical Rescue Response Requirements	30
7.8	Response to Second Incidents	31
7.9	Emergency Communications and Dispatch Requirements	32
7.10	Training and Certification	35
7.11	Pre-Fire Plan Requirements.....	36
7.12	Emergency Response Apparatus and Equipment Requirements.....	37

1.0 Introduction and Executive Summary

1.1 Introduction

This document was prepared by John A. Sharry, LLNL Fire Marshal and LLNL Division Leader for Fire Protection and reviewed by LLNL Emergency Management Department Head James Colson. The document follows and expands upon the format and contents of the DOE Model Fire Protection Baseline Capabilities Assessment document contained on the DOE Fire Protection Web Site, but only address emergency response.¹

The original LLNL Fire Protection Baseline Needs Assessment (BNA) was created on April 23, 1997 as a means of collecting all information concerning emergency response capabilities at LLNL, which includes response to emergencies at Sandia/CA. The document pulled together the theory of emergency response, staffing rationale and justifications, and equipment justifications utilized over the years. The document has been updated and reissued six times since in 1998, 1999, 2000, 2002, 2004, and 2009. The 2009 BNA was approved by NNSA's Livermore Site Office on July 2, 2010.

This baseline needs assessment follows the format and process of the 2009 BNA in that it is “zero based.” Starting with the requirement documents, the BNA evaluates the requirements, and determines minimum needs without regard to previous evaluations. In this 2012 BNA, as in the previous BNA, the process has been intentionally divided into two separate documents – the needs assessment (1) and the compliance assessment (2). The needs assessment will be referred to as the BNA and the compliance assessment will be referred to as the BNA Compliance Assessment. The primary driver for separation is that the needs assessment identifies the detailed applicable regulations (primarily NFPA Standards) for emergency response capabilities based on the hazards present at LLNL and Sandia/CA and the geographical location of the facilities. The needs assessment also identifies areas where the modification of the requirements in the applicable NFPA standards is appropriate, due to the improved fire protection provided, the remote location and low population density of some the facilities. As such, the needs assessment contains equivalencies to the applicable requirements. The NNSA approval of the 2009 BNA included approval of equivalencies contained in the BNA requirements document. The compliance assessment contains no such equivalencies and simply assesses the existing emergency response resources to the requirements of the BNA.

There are numerous NFPA codes and standards and other requirements and guidance documents that address the subject of emergency response. These requirements documents are not always well coordinated and may contain duplicative or conflicting requirements or even coverage gaps. Left unaddressed, this regulatory situation results in frequent interpretation of requirements documents. Different interpretations can then lead to inconsistent implementation. This BNA addresses this situation by compiling applicable requirements from all identified sources (see Section 5) and analyzing them collectively to address conflict and overlap (see Section 7). The BNA also generates requirements when needed to fill any identified gaps in regulatory coverage. Finally, the BNA produces a customized simple set of requirements, appropriate for the DOE protection goals, such as those defined in DOE O 420.1B, the hazard level, the population density, the topography, and the site layout at LLNL that will be used as the baseline requirements set – the “baseline needs” - for emergency response at LLNL and Sandia/CA. A template approach is utilized to accomplish this evaluation for each of the nine topical areas that comprise the baseline needs

for emergency response. The basis for conclusions reached in determining the baseline needs for each of the topical areas is presented in Sections 7.1 through 7.9.

This BNA identifies only mandatory requirements and establishes the minimum performance criteria. The minimum performance criteria may not be the level of performance desired Lawrence Livermore National Laboratory or Sandia/CA. Performance at levels greater than that established by this document will provide a higher level of fire safety, fire protection, or loss control and is encouraged.

In Section 7, Determination of Baseline Needs, a standard template was used to describe the process. Each service being evaluated contains a determination of minimum requirements, an analysis of the requirements, a statement of minimum performance, and finally a summary of the minimum performance.

The requirement documents, listed in Section 5, are those laws, regulations, DOE Directives, contractual obligations, or LLNL policies that establish service levels. The determination of minimum requirements section explains the rationale or method used to determine the minimum requirements. The minimum performance measure describes a method for evaluating if the minimum requirements are being met. The requirement summary states the minimum requirement without explanation or justification.

On October 1, 2007 LLNL contracted with the Alameda County Fire Department (ACFD) to provide emergency response services. The emergency response services contract was again awarded to the ACFD in 2011 with a start date of July 1, 2012. The new contract included some staffing changes that were considered equivalent to those previously provided. Those changes are reflected in the 2012 BNA Compliance Assessment.

1.2 Executive Summary

This section provides a listing of the results of this baseline needs assessment for the assessed elements of emergency response. Because total response time (which includes dispatch time, turn-out time, and travel time) is a more comprehensive metric than just travel time, this analysis will use total response time for all evaluations.

1.2.1 Performance Summary – Manual Fire Fighting LLNL Site 200

Table 1.2.1 Performance Summary – Manual Fire Fighting Site 200

Type Incident	Responders	Minimum Staffing (persons)	Total Response Time	Performance Criteria
Fire Sprinklered Bldg	1 st Unit 1 st Alarm	11	380 sec. 620 sec.	90 %
Fire Unsprinklered Bldg	1 st Unit 1 st Alarm	13	380 sec. 620 sec.	90 %
Wildland Fire	Fire Attack	4	440 sec.	90%
	Battalion Chief	5	620 sec.	

1.2.2 Performance Summary – Fire Responses Site 300

Table 1.2.2 Requirement Summary – Fire Response Site 300

Type Incident	Responders	Minimum Staffing (persons)	Total Response Time	Performance Criteria
GSA Area Fire Sprinklered Bldg	1 st Unit	4	380 sec.	90 %
	Battalion Chief	1	1800 sec.	
GSA Area Fire Unsprinklered Bldg	1 st Unit	4	380 sec.	90 %
	1 st Alarm	13	1800 sec.	
Non GSA Area Fire Sprinklered Bldg	1 st Unit	4	960 sec.	90 %
	1 st Alarm	1	2760 sec.	
Non GSA Area Fire Unsprinklered Bldg	1 st Unit	4	960 sec.	90 %
	1 st Alarm	13	2760 sec.	
Wildland Fire	Fire Attack	4	1020 sec.	90%
	Battalion Chief	1	2760 sec.	

1.2.3 Performance Summary -- EMS

Table 1.2.3 Performance Summary -- EMS

Type Incident	Responders	Minimum Staffing (persons)	Response Time
All EMS (Site 200 and 300) Except Non GSA Site 300	1 st Responder/Transport	1 ALS 2 BLS	480 sec.
EMS Non GSA Site 300	1 st Responder/Transport	1 ALS 2 BLS	900 sec.

1.2.4 Performance Summary -- HAZMAT

Table 1.2.4 Requirement Summary -- HAZMAT

Task	Staffing	Training Level
Investigation Level Incident		
Incident Commander	1	Hazmat IC & Technician
HazMat Group	3	Awareness
Total	4	380 sec. 90% of the time
Level I Incident		
Incident Commander	1	Hazmat IC & Specialist
Safety and Tech Reference	2	HM Safety and Technician
HazMat Group	7	Technician
Medical Group	2	Operations & EMT
Total	12	
Level II Incident		
Incident Commander	1	Hazmat IC & Specialist
Safety and Tech Reference	3	Specialists & Technicians
HazMat Group	9	Technician & Operations
Time Recorder & Access Control	2	Operations
Medical Group	2	Operations and EMT
Total	17	

1.2.5 Requirement Summary – Technical Rescue

Table 1.2.5 Requirement Summary – Technical Rescue

Location	Responders	Minimum Staffing (persons)	Total Response Time	Performance Criteria
S-200, Sandia/CA GSA Area S-300	Operations Level	4	380 sec.	90 %
S-200, Sandia/CA GSA Area S-300	Technician Level	7	620 sec.	90 %
Non GSA Area S-300	Operations Level	4	960 sec.	90 %
Non GSA Area S-300	Technician Level	7	2760 sec.	90 %

1.2.6 Requirement Summary – Second Incident

Table 1.2.6 Performance Summary – Second Incident

Type Incident	Responders	Total Response Time	Performance Criteria
Second Incident	1 Company	1240 seconds	90 %

1.2.7 Requirements Summary – Emergency Communications

Table 1.2.7 Performance Summary – Emergency Communications

Event	Time Criteria	Performance
Dispatcher training	N/A	NFPA 1061
ACRECC Answer or Acknowledge Alarm	15 seconds	95%
	40 seconds	99%
ACRECC Dispatch Emergency	60 seconds	80%
	106 seconds	95%
Lab Alarms transmit alarms to ACRECC	45 seconds	95%
ACRECC and/or Lab Alarms Notify Appropriate Party of Supervisory or Trouble Alarm	600 seconds	95%

1.2.8 Performance Summary – Training

Table 1.2.8 Performance Summary - Training

Personnel	Performance Measure
Entry level	Qualifications are established for entry level fire department personnel that include medical and physical performance criteria.
Entry level	There is an established training criterion for minimum performance of entry level personnel.

Incumbents	There is an established on-going training criterion for training for incumbents.
Officers	There is a minimum training criteria established for fire officers or supervisors of emergency responder.
Special Operations	There is a minimum training criteria established for special operations such as hazardous materials and technical rescue.
Drills and Exercises	There is an established program of drills and exercises at various facilities on LLNL site.
All	Documented training records exist for each individual.

1.2.9 Performance Summary – Pre-Fire Plans

Table 1.2.9 Performance Summary – Pre-Fire Plans

Performance Measure	Frequency
Provide pre-fire plans for all buildings	Quarterly
Provide written standard operating procedures for response to occupancies with hazardous materials or other unique hazards	Annually

1.2.10 Requirement Summary – Emergency Apparatus

Table 1.2.10 LLNL Required First Line and Reserve Apparatus

Type Apparatus	Number	Comment
Engine	3	Livermore Site – 2, S-300 – 1
Aerial Ladder		Available via Automatic Aid
Ambulance	2	Livermore Site – 1, S-300 – 1
Type 3 Engine	2	Livermore Site – 1, S-300 – 1
Type 4 Engine	2	Livermore Site – 1, S-300 – 1
Hazardous Materials	1	Responds both sites
Command	1	Battalion Chief
Reserve Type 1 Engine	1	1 Reserve per 5 in front-line service
Reserve Ambulance	1	1 Reserve per 5 in front-line service
Reserve Type 3 Engine	1	1 Reserve per 5 in front-line service
Reserve Type 4 Engine	1	1 Reserve per 5 in front-line service
Apparatus Plan		Written 5 year Plan
Apparatus Maintenance		Per NFPA and GSA Fleet Requirements

2.0 Assumptions

In developing this assessment, the following assumptions were made:

- a. That LLNL acknowledge an assumption of risk commensurate with emergency response and standard industry practices.
- b. In developing the necessary response capability, the BNA applies only the DOE requirements and those requirements of referenced DOE documents.
- c. This BNA is based on the accuracy of information, documents, and data provided to the author from LLNL and the Alameda County Fire Department.
- d. That all fire suppression systems and alarm systems are maintained in operational condition per NFPA codes and standards.
- e. The nature of the experimental work at the LLNL can produce unusual hazards which require special treatment, training, and site knowledge. Emergency response services are best provided by an on-site fire department.
- f. Because of the unique nature of the Laboratory's classified work, LLNL desires to control the majority of emergencies utilizing personnel having the necessary security clearances.
- g. LLNL, because of its large number of employees, their critical value to the LLNL mission, and the nature of its work, wishes to provide emergency medical service equal to or superior to that provided in the surrounding community.
- h. Staffing and equipping a single fire department to control all potential worst case scenarios is neither reasonable nor financially practical. Instead, LLNL desires an emergency response force that is organized and staffed to handle the most probable incident scenarios and relies on automatic and mutual aid to provide response to worst case scenarios.

3.0 Scope

This document covers the following

- ♦ Response to fire emergencies
- ♦ Response to medical emergencies
- ♦ Response to hazardous materials emergencies
- ♦ Response to situations requiring technical rescue
- ♦ Response to second incidents
- ♦ Monitoring of the site-wide emergency alarm system
- ♦ Emergency communications and dispatch requirements
- ♦ Pre-fire plan requirements
- ♦ Emergency response apparatus

Other fire protection program components (typically those requiring fire protection engineering support) are not included in this assessment, but are the subject of another analysis.

4.0 Description of LLNL Fire Protection Organization

Emergency response services are provided by a contract with the Alameda County Fire Department (ACFD). ACFD provides trained, security cleared, fire fighters and

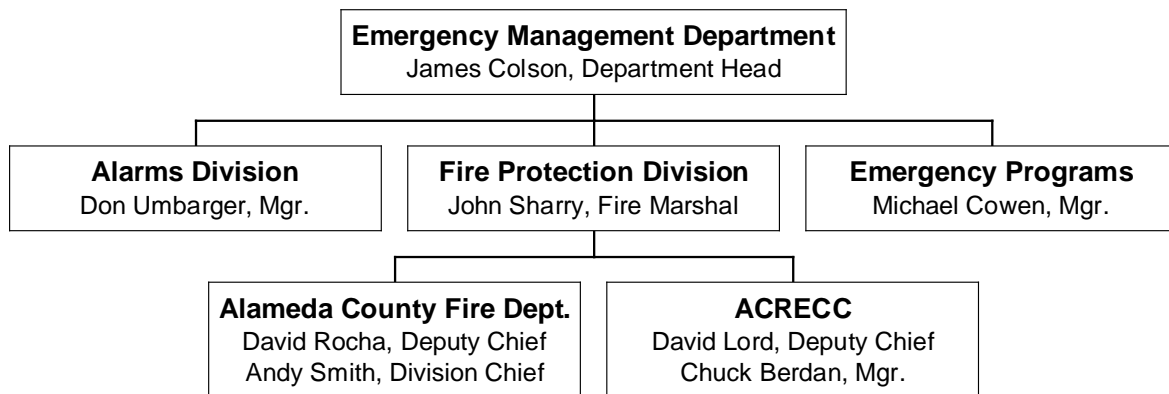
paramedics for response to emergencies at Sites 200 and 300. As part of the contract, ACFD is also responsible for the monitoring of the LLNL Fire and Emergency Voice Alarm (FEVA) system, answering emergency telephone calls, tracking emergency and non-emergency response resources, providing emergency pager notification for deaf employees, and coordinating response with LLNL and Sandia protective forces.

The Emergency Management Department is the parent organization for fire protection, consisting of the Alarms Division, the Emergency Programs Division, and the Fire Protection Division. The Fire Protection Division is responsible for administering the contract with ACFD as well as managing fire protection engineering and general fire protection and inspection. Fire Protection Engineering is provided by three fire protection engineers who report to the Fire Marshal and deliver fire protection guidance to the laboratory programs by having assignments to one of the ES&H Teams. Three fire inspectors provide general inspection, fire extinguisher service and inspection, and impairment control.

Because of the proximity of Sandia National Laboratory-California (Sandia/CA), another DOE facility, the LLNL contract with ACFD also provides Sandia with emergency dispatch and response services. This arrangement is via a Memorandum of Understanding has been in place for over 30 years. That MOU was updated in 2012

The Emergency Management Department organization is shown in Figure 5.1. For emergency response, ACFD provides three shifts each lead by a Battalion Chief. Each shift is divided into three companies. Two companies are assigned to the Livermore Site (ACFD Fire Station 20) and one company is assigned to Site 300 (ACFD Fire Station 21). Each shift is staffed at 11 to provide a Battalion Chief, two three-person and one four-person companies. Minimum staffing is two three-person and one four-person companies and a Battalion Chief.

Figure 4 Emergency Management Department Organization Chart



LLNL is signatory to several automatic aid and mutual aid agreement. LLNL meets its obligations to these agreements through its subcontractor, the Alameda County Fire Department. The agreements are as follows:

- Automatic Aid Agreement with the Livermore-Pleasanton Fire Department
- Alameda County Mutual Aid Agreement
- Mutual Threat Zone MOU with California Division of Forestry

- Mutual Fire Protection Resources Agreement with City of Livermore

5.0 Requirement and Guidance Documents

5.1 Requirement Documents

DOE Order (O) 420.1B, *Facility Safety*, requires that contractor sites have a comprehensive fire protection program that minimizes the potential for: an occurrence of a fire or related event; fires that cause unacceptable onsite or offsite release of hazardous or radiological material that could impact the health and safety of employees, the public, or the environment; unacceptable interruption of vital DOE programs; property loss from fire exceeding limits established by DOE; and fire damage to critical process controls and safety class systems structures and components. The order presumes access to a qualified and trained fire fighting staff. The Order requires the implementation of applicable NFPA codes and standards.²

DOE O 151.1C, *Comprehensive Emergency Management System* requires establishment and maintenance of plans and procedures for response to operational emergencies involving or affecting DOE facilities. The Order also requires that an organization be established and maintained for each site with overall responsibility for the initial and ongoing response to and mitigation of an emergency.³ In this analysis only the sections of Order dealing with emergency response and pre-planning, including Emergency Planning Hazards Assessments, are used.

Title 10 Code of Federal Regulations Part 851, *Department of Energy Worker Safety and Health Program, Appendix A.2 Fire Protection*, requires that the DOE Contractor implement and maintain a comprehensive multi-faceted fire safety and emergency response program that is predicated, in part, on compliance with applicable building codes and National Fire Protection Association (NFPA) codes and standards and incorporate applicable provisions of DOE Order 420.1B. The rule specifically adopts NFPA 70 and NFPA 70E and generically references additional NFPA codes and standards that may be applicable. The rule specifically incorporates the following Occupational Safety and Health Administration (OSHA) standards for compliance at DOE sites:

Title 29 Code of Federal Regulations Part 1910.120, *Hazardous Waste Operations and Emergency Response*

Title 29 Code of Federal Regulations 1910.134 (g) (4), *Procedure for Interior Structural Firefighting* requires that anytime fire fighters are performing interior structural fire fighting in IDLH atmospheres, the fire fighting operations within the IDLH atmosphere shall operate in teams of at least two persons and that an additional team of two persons be available outside the IDLH atmosphere to provide emergency rescue.

Both the DOE O 420.1B and 10CFR851 require compliance with applicable NFPA codes and standards. These include as follows:

NFPA 13, *Standard for the Installation of Automatic Sprinkler Systems*, provides minimum criteria for the installation of automatic sprinkler systems including water

supply requirements for sprinkler and hose line operation. For this analysis only the sections of the standard pertaining to water supply for hose lines are used.⁴

NFPA 72, *National Fire Alarm and Signaling Code*, provides minimum criteria for installation of fire alarm systems and minimum requirements for operation of a proprietary supervising station. For this analysis only the portions of the standard dealing with operation of a proprietary supervising station alarm system are used.⁵

NFPA 472, *Standard for Professional Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents*, establishes training standards for personnel responding to hazardous materials incidents.⁶

NFPA 473, *Standard for Competencies for EMS Personnel Responding to Hazardous Materials Incidents* establishes training standards for EMS personnel responding to hazardous materials incidents.⁷

NFPA 1001, *Standard for Fire Fighter Professional Qualifications* establishes minimum job performance requirements for career fire fighters whose duties are primarily structural in nature.⁸

NFPA 1002, *Standard on Fire Apparatus Driver/Operator Professional Qualifications* establishes minimum job performance requirements for fire fighters who drive and operate fire apparatus, in both emergency and nonemergency situations.⁹

NFPA 1006, *Standard for Rescue Technician Professional Qualifications* establishes the minimum job performance requirements necessary for emergency response personnel who perform technical rescue operations.¹⁰

NFPA 1021, *Standard for Fire Officer Professional Qualifications* establishes performance requirements necessary to perform the duties of a fire officer.¹¹

NFPA 1051, *Standard for Wildland Fire Fighter Professional Qualifications* establishes the minimum job performance requirements for wildland fire duties and responsibilities.¹²

NFPA 1061, *Standard for Professional Qualifications for Public Safety Telecommunicator* establishes minimum job performance requirements for public safety telecommunicators, who are individuals whose primary responsibility is to receive, process, or disseminate information of a public safety nature via telecommunication devices.¹³

NFPA 1221, *Standard for the Installation, maintenance, and Use of Emergency Services Communications Systems* provides minimum provisions for reliable communications systems including provisions for the construction, maintenance and operation of an emergency communications center. For this analysis only the portions of the standard pertaining to operating procedures are used.¹⁴

NFPA 1404, *Standard for Fire Service Respiratory Protection Training* establishes minimum requirements for the training component of the respiratory protection program.¹⁵

NFPA 1403, *Standard on Live Fire Training Evolutions* establishes minimum requirements for training all fire suppression personnel engaged in fire-fighting operations under live fire conditions.¹⁶

NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, establishes an occupational safety program which includes provisions for operating at an emergency. Among those provisions is the requirement commonly known as the Two-In/Two-Out Rule which requires a minimum of four fire fighters present and arranged in two teams of two before interior structure fire fighting can commence.¹⁷ In this analysis only those sections of the standard dealing with staffing are used.

NFPA 1521, *Standard for Fire Department Safety Officer* establishes minimum requirements for the assignment, duties, and responsibilities of a health and safety officer (HSO) and an incident safety officer (ISO) for a fire department. In this analysis only the sections pertaining to incident safety officer will be used to evaluate training for both fire department and LLNL incident safety officers.¹⁸

NFPA 1561, *Standard on Emergency Services Incident Management System* NFPA 1561 establishes minimum requirement for an incident management system to be used by emergency agencies in managing all emergency incidents.¹⁹

NFPA 1582, *Standard on Comprehensive Medical Program for Fire Departments* contains descriptive requirements for a comprehensive occupational medical program for fire departments including medical requirements for persons performing the job duties described in NFPA 1001, *Standard for Fire Fighter Professional Qualifications*; NFPA 1002, *Standard for Fire Apparatus Driver/Operator Professional Qualifications*; NFPA 1006, *Standard for Rescue Technician Professional Qualifications*; NFPA 1021, *Standard for Fire Officer Professional Qualifications*; and NFPA 1051, *Standard for Wildland Fire Fighter Professional Qualifications*.²⁰

NFPA 1620, *Standard for Pre-Incident Planning*, establishes criteria for developing pre-incident plans for use by personnel responding to emergencies.²¹

NFPA 1670, *Standard on Operations and Training for Technical Rescue Incidents*, establishes standards for operations and training for personnel responding to technical rescue incidents.²²

NFPA 1710, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments*, establishes minimum response criteria for a variety of emergency events including structural fire fighting.²³

NFPA 1901, *Standard for Automotive Fire Apparatus* provides minimum specifications for fire apparatus.²⁴

NFPA 1906, *Standard for Wildland Fire Apparatus* provides minimum specifications for wildland fire apparatus.²⁵

NFPA 1911, *Standard for the Inspection, Maintenance, Testing, and Retirement of In-Service Automotive Fire Apparatus*, provides minimum specifications for inspection, testing and maintenance of fire apparatus.²⁶

5.2 Guidance Documents

DOE G-420.1-3 *Implementation Guide for DOE Fire Protection and Emergency Services Programs for Use with DOE O 420.1B, Facility Safety*, provides detailed

guidance information on key program elements including Fire Hazards Analysis and Baseline Needs Assessments.²⁷

DOE G 440.1-1b *Worker Safety and Health Program for DOE (including the National Nuclear Security Administration) Federal and Contractor Employees*, provides detailed guidance information on key program elements for compliance with the Rule.²⁸

DOE STD 1066-99, *Fire Protection Design Criteria*, provides supplementary guidance on fire protection criteria applicable for the design and construction of DOE facilities.²⁹

DOD Instruction 6055.06, *DoD Fire and Emergency Services (F&ES) Program*, is referenced in DOE G-420.1B as a source for analysis of emergency response needs in a Baseline Needs Assessment.³⁰

6.0 Primer on Fire Department Organization

This assessment contains terminology and uses terms that are common in the emergency response community. This primer of fire department organization is provided to assist readers who may not be familiar with the organization and operations of a paramilitary emergency response organization such as a fire department.

Apparatus

Fire department terminology is steeped in tradition. Vehicles are termed apparatus from the old days of horse drawn wagons. Similarly, tactical vehicles (apparatus) have historical names. For example, a vehicle that pumps water is often called a pumper but is usually referred to as an “engine” a reference to the original stream engine driven pumps of yester year. Originally pumper apparatus provided one service, pumping water. Vehicle limitations prevented more than the single function. To get the water to the fire required hose which was carried on a separate vehicle called a hose wagon or wagon. As vehicle technology improved, hose was added to the same vehicle as the pump, later, the ability to carry storage tanks of water was also included. This resulted in a vehicle that provided three services, pump, hose, and water and was termed a triple combination pumper. However, the historic term engine is still used to describe this vehicle.

Similarly, a vehicle that carried ground ladders was termed a ladder truck. When technology evolved to produce the aerial ladder, the vehicle continued to be known as a ladder truck or more commonly simply referred to as a “truck.”

Companies

Fire departments are typically organized into operational units called “companies.” A “company” consists of a leader (typically a Captain) and fire fighters who are assigned to an emergency response vehicle (apparatus) for the purposes of performing specific tasks at an incident. The type of apparatus to which the personnel are assigned dictates their basic task assignment. For example, an Engine is an emergency response vehicle that is equipped with a pump, hose and water. The apparatus and the personnel assigned become an Engine Company. An Engine Company’s basic task assignment is fire attack using the pump, hose, water and other equipment carried on their vehicle. Similarly, a Truck is an emergency response vehicle that carries ladders, an aerial ladder, and

specialized tools and equipment. The apparatus and personnel assigned become a Truck Company. A Truck Company's basic task assignment is search, rescue, ventilation, salvage and overhaul.

Staffing and Safety Basics

The company is the basic working unit of emergency operations. The number of personnel assigned to a company and basic safety practices dictate that a company can safely perform only one major task at a time. If the assignment of multiple simultaneous tasks results in the division of the company into single fire fighter task units, additional companies should be called. Any tactical task at an incident requires assignment of at least 2 persons. Assignment of a single fire fighter results in a fire fighter's attempting to perform task(s) that require multiple fire fighters, invariably resulting in injury. If an incident requires that multiple tasks be performed simultaneously resulting in assignment of single fire fighters to a task, sufficient additional companies must be assigned so that the task can be performed safely.

Because emergency response is an around-the-clock need, emergency response organizations must organize and staff for 24/7 response capability. Fire Departments on the west coast are typically organized and staffed based on 24-hour shifts with personnel working an average 56-hour work week. Each shift is supervised by a shift commander, often called a Battalion Chief.

7.0 Determination of Baseline Needs

7.1 DOE Fire Fighting Requirements

The requirements of DOE Order 420.1B state that contractor sites must have a comprehensive fire protection program that minimizes the potential for: an occurrence of:

- ♦ A fire or related event
- ♦ Fires that cause unacceptable onsite or offsite release of hazardous or radiological material that could impact the health and safety of employees, the public, or the environment;
- ♦ Unacceptable interruption of vital DOE programs;
- ♦ Property loss from fire exceeding limits established by DOE; and
- ♦ Fire damage to critical process controls and safety class systems structures and components.

DOE O 420.1B requires access to a qualified and trained firefighting staff.³¹ Further guidance is contained in DOE G-420.1-3 which states that a baseline needs assessment is to establish the site firefighting capabilities to provide effective response to suppress all fires and respond to emergency medical and hazardous materials incidents.³²

This section will assess the capability of LLNL to meet these requirements using a set of performance metrics derived from NFPA standards and standards from other recognized organizations. The performance metrics derived in this section are based on the concept of being practical, reasonably achievable, economically viable and providing equivalent performance.

7.2 LLNL Situation Status

LLNL has an emergency response force of two three person engine companies at Site 200 (Station 20) and one four person company at Site 300 (Station 21) staffed under contract by the Alameda County Fire Department. ACFD has co-located Engine 8 at Station 20 giving LLNL access to a third three person company when that company is not otherwise committed. The initial response at Site 300 is backed-up by an automatic move-up response of one company from Site 200. An Alameda County Battalion Chief is dispatched on major incidents. Additional resources are also available from the Livermore Pleasanton Fire Department, other nearby ACFD companies, and by activation of the Alameda County Mutual Aid Plan.

7.3 Manual Fire Fighting – Livermore S-200

Minimum response requirements for structural firefighting can be broken into two major segments; initial attack and sustained attack. Initial attack is the actions taken by the first alarm units at a fire emergency. Sustained attack is actions taken by units beyond the first alarm assignment usually indicating the need for a large fire flow to contain or control the fire.

This assessment only addresses the ability to initiate an effective initial attack. There are three components to an initial attack: fire flow required, staffing, and response time.

The timely arrival of initial attack units is inconsequential unless they can deliver an effective initial fire flow to the fire. Historically fire flow was used to determine minimum staffing, however, modern analysis of fire attack recognizes that fire attack is more than the ability to deploy a certain flow of water to the fire. Other tasks must be accomplished in conjunction with application of the fire flow, however, the ability to deliver an effective fire flow is still a critical part of initial fire attack and is assessed below.

7.3.1 Determining Structural Fire Flow

NFPA 1710 performance metrics are based on a fire in an unsprinklered residential occupancy which requires the delivery of a 300 gallon per minute (GPM) fire flow through the use of two attack lines, each flowing 150 gpm. As noted in the annex to NFPA 1710, fire flows for other occupancies and situations must be developed taking into account such factors as adopted building codes, type of construction, occupancy hazards, and fire/life safety engineering controls. The determination of initial attack fire flow has been the subject of much debate, but there are several more or less standard means of making this determination. Usually the determination is broken into two general categories; sprinklered buildings and unsprinklered buildings.

7.3.2 Sprinklered Buildings

NFPA 1710 bases its response times and staffing on the ability to arrive and provide an aggressive offensive fire attack prior to a phenomenon known as flashover. Flashover is that point in the development of a fire where there is a rapid transition in fire behavior from localized burning of fuel to involvement of all the combustibles in the enclosure.³³ NFPA 1710 explains that, “two of the most important elements in limiting fire spread are the quick arrival of sufficient number of personnel and equipment to attack and extinguish the fire as close to the point of its origin as possible.”³⁴

Research indicates that there are two triggering conditions for flashover: 1) a ceiling gas layer temperature of 1100°F and 2) a radiant flux on the unignited materials in the room of approximately 20 kW/m². Both of these conditions can be interrupted or prevented by the application of suppression agents.³⁵ Therefore, it can be concluded that the operation of automatic sprinklers will prevent flashover. Since each automatic sprinkler head operates independently, with the closest sprinkler to the fire operating first, it can be expected that the goal of extinguishing or controlling the fire as close to the point of origin as possible will be accomplished. In summary, an automatic sprinkler system can be expected to prevent development of flashover conditions during a fire and meet the goals of NFPA 1710 of extinguishing the fire as close to the point of origin as possible.

The history of automatic sprinkler protection is well documented within the DOE and the fire protection community as a whole. DOE statistics indicate that 99% of all fires will be contained by the operation of the sprinkler system.³⁶ Factory Mutual Research Corp. reports that in a study of 2,860 fires in industrial buildings, 92% of all fires will be contained by the operation of 20 or fewer sprinklers.³⁷ A 2012 study of fires in sprinklered occupancies in calendar years 2006-2010 by the National Fire Protection Association estimates that sprinklers are effective in 96% of the fires large enough to cause sprinkler activation. Sprinklers were reported to have an effectiveness reliability of 91% over-all when considering all fires, which includes those deemed too small to activate the sprinkler system.³⁸ From the research it can be concluded that in sprinklered buildings, where the sprinkler systems prevent flashover and control the fire, it will not be necessary to mount a full initial fire attack, but rather to provide a single hose line to “mop-up” any remaining fire. Based on this information the fire flow for sprinklered buildings is determined to be 150 gpm, the fire flow from a standard fire department attack line.

7.3.1.2 Un-Sprinklered Buildings

Based on data provided by facility management 92% of the building area at LLNL and Sandia are provided with automatic sprinkler protection; however, this accounts for only about 65% of the structures. Many small and moderate sized buildings are not protected with any form of automatic suppression. Fire flows for sample un-sprinklered buildings of various sizes were calculated using methods contained the Society of Fire Protection Engineers Technical Publication TP2007/1.³⁹ These calculations indicate fire flow requirements ranging from 320 to 2,250 gpm. For purposes of determining minimum requirements for manual firefighting in an industrial occupancy during initial attack, a fire flow of 500 gpm was selected which is consistent with NFPA 1710, which assumes a 300 gpm fire flow for a residential structure.⁴⁰ Fire flows exceeding 500 gpm are considered sustained fire attack that will involve multiple alarms or extensive use of mutual aid and are beyond the scope of initial fire attack. The higher values provided by the various methods to determine flow are theoretical maximums for purposes of design of water supply piping which must supply water during a sustained attack as well as an initial attack. The 500 gpm initial attack fire flow represents a bounding worst case for the water demand during an initial attack.

7.3.2 Delivering Structural Fire Flow

From the determined fire flow, staffing can be derived by determining hose line size and minimum staffing for each hose line. Hose line delivery capacity and minimum staffing as determined via a number of sources is shown in the following table:

Table 7.3.2 Hose Line Staffing

Attack Line Diameter	Water Delivery in G.P.M.	Minimum Staffing**
1-1/2 in.	125	2
1-3/4 in.	190	2
2 in.	250	2
2-1/2 in.	250	3

** Staffing for hose line only. Does not include rescue team if operating in IDLH atmosphere.

Using this table, partial staffing for an initial attack by deploying attack lines capable of delivering a total of 500 gpm can be determined. Typically, this would be accomplished by two hose lines, each delivering 250 gpm which would require a minimum of 4 personnel. Mounting a sustained fire attack would require additional personnel.

7.3.3 Minimum Requirements – Structural Fire Fighting

7.3.3.1 Critical Task Method

The Critical Task Method was developed by the Center for Public Safety Excellence (formerly the National Fire Service Accreditation Task Force and Commission on Fire Service Accreditation).⁴¹ This method considers staffing for certain “critical tasks” which are deemed necessary for an initial fire attack. Staffing for Search and Rescue, Ventilation, Back-up Lines, Safety Crews, Pump Operators, Water Supply, and Incident Command are considered in addition to that required for hose line operation. The method assumes that these tasks must be performed simultaneously in order to have an effective fire attack. The following table summarizes the staffing necessary for a 500 gpm initial fire attack using this method:

Table 7.3.3.1 Critical Task Method Staffing Level

Task	Staffing	Comments
1 st 250 gpm. hose line	4	2-In/2-Out
2 nd 250 gpm. hose line	2	2-In, 2-Out shared with first line
Search and Rescue	2	2-person crew
Ventilation	2	2-person crew
Pump Operations	2	Pump operator and hose support
Incident Command	1	Chief Officer
TOTAL	13	

7.3.3.2 Response Standards Method

The Response Standards Method is based on the critical task method but broadened to include additional personnel. It is the method contained in NFPA 1710.⁴²

The basic provisions of NFPA 1710 with regard to staffing are as follows:

- Establishment of a dedicated Incident Command
- Establishment of effective fire attack from two hose lines
- Establishment of Initial Response Intervention Crew (IRIC)¹ of 2 persons
- Fire attack hose lines staffed by at least 2 persons each
- Establishment of uninterrupted water supply of 400 gpm for 30 minutes maintained by an operator
- Establishment of at least one search and rescue team consisting of 2 persons
- Establishment of a ventilation team consisting of 2 persons
- Provision of at least one support person for each attack and back-up line

The staffing for these requirements adjusted for 500 gpm fire flow is summarized below:

Table 7.3.3.2 NFPA 1710 Staffing Level

Task	Staffing	Comments
Incident Command	1	Battalion Chief
Deploy two hose lines	4	2-In for each hose line
Search & Rescue	2	2-Person crew
Ventilation	2	2-Person crew
IRIC	2	2-Person crew
Water Supply	1	Pump Operator
Support	2	1 for each hose line in service
TOTAL	14	

7.3.3.3 Analysis

Both the Critical Task Method and the Response Standards Method treat all buildings equally making no allowance for buildings with built-in fire protection. Annex note A.5.2.3.2.1 to NFPA 1710 states that the provisions of the standard are based on response to a structural fire in a 2,000 sq ft, two-story, single-family dwelling, with no basement or exposures and that other occupancies and structures that present greater hazards should be addressed.⁴³ Presumably, occupancies in structures that present lesser hazards can also be addressed. In support of that presumption, it is noted that NFPA 1710 contains an equivalency statement that permits “the use of systems, methods or approaches of equivalent or superior performance.”⁴⁴

As indicated above in Section 8.3.1.1 Determining Fire Flow for Sprinklered Buildings, from research it can be concluded that in sprinklered buildings, where the sprinkler systems prevent flashover and control the fire, a single 150 gpm hose line to “mop-up” any remaining fire is adequate. Further, it is generally accepted that the Ventilation task can be delayed or eliminated in sprinklered buildings and that the Search and Rescue task can be delayed for occupancies present on the LLNL and Sandia campuses. The Search and Rescue function is very important in sleeping occupancies, the occupancy on which 1710 was based. The LLNL and Sandia campuses do not contain sleeping occupancies, the

¹ Initial Rapid Intervention Crew or IRIC consists of two members of the initial attack crew who are assigned for rapid deployment to rescue lost or trapped members.

exception being the fire stations. If confronted with a rescue situation, the first arriving company can perform that function and delay fire attack. In practice, the allocation of one support person for each hose line in service is found to be excessive. One support person for all hose lines in initial attack is adequate.

Based on the above, buildings protected by automatic sprinklers systems provide a superior level of protection than contemplated by the NFPA 1710; therefore staffing for initial fire response can be set at as follows:

Table 7.3.4-1 Staffing for Fire Attack Sprinklered Facilities

Task	Staffing	Comments
1 st . 150 gpm. hose line	4	2-In/2-Out
Search and Rescue	-	Delayed
Ventilation	-	Delayed
Pump Operations	-	Pump operator shared w/2-Out
Incident Command	1	Chief Officer
TOTAL	5	

For buildings without automatic sprinkler protection the minimum staffing for initial fire attack is as follows:

Table 7.3.4-2 Staffing Level Non Sprinklered Buildings

Task	Staffing	Comments
Incident Command	1	Battalion Chief
Deploy two hose lines	4	2-In for each hose line
Search & Rescue	-	Can be delayed
Ventilation	2	2-Person crew
IRIC	2	2-Person crew
Water Supply	1	Pump Operator
Support	1	1 for each hose line in service
TOTAL	11	

DOE's Fire Safety Program Implementation Guide suggests that fire departments should respond with emergency medical capabilities. Typically, this is the response of an ambulance with the fire attack crews. In many instances, emergency medical services can be provided by one of the fire crews (Engine Company) with transport being provided by mutual aid resources. NFPA 1710 is silent on this topic, but NFPA 1500 provides that the Incident Commander shall assess the risk to personnel and determine if on-scene medical support and transportation is necessary.⁴⁵ Companies staffed and equipped to provide emergency medical service are considered a satisfactory means of meeting this concern.

Although not directly related to fire protection, the Emergency Preparedness Hazards Assessments produced as part of LLNL's implementation of DOE 151.1 require prompt response from trained emergency responders to mitigate the potential threat to the public from incidents involving hazardous materials. The on-site fire department provides this service. DOE 151.1 does not provide specific staffing criteria or response times and, therefore, was not used to develop minimum response criteria.

Firefighter collateral duties need to be examined to determine if these duties interfere with or cause delays in response to emergencies. Collateral duties that create delays in response or that create staffing reductions need to be factored into the compliance evaluation.

.3.4 Minimum Requirements – Wildland Fire Fighting

LLNL S-200 has a small wildland fire threat mostly concentrated on the West and North sides in the buffer zone. Sandia/CA has a more significant wildland fire threat on three sides; East, West, and South. Vegetation at on both LLNL and Sandia/CA consists of native perennial grasses. This vegetation creates a fuel during the summer months that is generally light and flashy resulting in fast moving fires that pose little threat to permanent buildings with adequate clear space around them.

Both LLNL and Sandia/CA impose measures mitigate the wildland fire threat. Both sites restrict fuels within 20 ft. of permanent buildings. LLNL limits fuel by mowing the buffer zones to a height of less than 6 inches, a height that will not sustain a fast moving fire. Sandia/CA cuts fire breaks and mows grass using a hay mower.

The standard fire attack for a grassland fire is a two-flank attack utilizing off-road wildland fire fighting vehicles. This provides a fast initial attack for fire containment. Each wildland vehicle must be staffed with two personnel (one driver and one person to attack the fire) and be capable of pumping one hose line providing 20 gpm while moving.

NFPA 1710 recognizes special deployment provisions for wildland fires that can be summarized as follows:⁴⁶

- ♦ Staffing operations shall be the number necessary for safe and effective firefighting performance.
- ♦ Personnel assigned to wildland operations shall have appropriate apparatus.
- ♦ Wildland companies shall be staffed as required by the tactical, topographical, environmental, fuel (vegetation), and occupancy hazards.
- ♦ Safely initiate a direct attack within 10 minutes after arrival at fire scene.
- ♦ No specific response time is specified for wildland fire responses.

Fire companies in California are well versed in wildland fire attack and arrive at the fire scene ready to initiate fire attack. The 10 minute time factor to initiate fire attack contained in NFPA 1710 is not realistic for companies located in wildland fire areas. In recognition of these facts, the NFPA 1710 time to fire attack is reduced to 1 minute. Time for direct attack will be determined by adding 1 minute to the Total Response Time.

7.3.3.4 Response Time – Livermore S-200

To truly measure response time to an emergency it is logical to evaluate the entire time sequence from initial contact of the reporting party until arrival at scene which includes dispatch processing time, turn-out time and travel time. Dispatch processing time, sometimes called dispatch hold time, is the time from initial contact until dispatch of companies. Turn-out time, sometimes called reflex time, and is the time from dispatch until travel to the emergency begins. The summation of dispatch hold time, reflex time, and travel time is often called Total Response Time.

Because Total Response Time is a more comprehensive metric than just travel time, this analysis will use total response time for all evaluations. The following table shows the

response time metric and its components of dispatch hold time, turn-out time and travel time as specified in NFPA 1710 and 1221. Response time for wildland fires will include the added minute to prepare for fire attack.

Table 7.1.5-1 Total Response Times

Service	Dispatch Hold Time (seconds)	Turn-Out Time (seconds)	Travel Time (seconds)	Response Time (seconds)
Structure Fire 1 st Arriving Fire Unit	60	80	240	380
Structure Fire Remainder of 1 st Alarm	60	80	480	620
Wildland Fire 1 st Arriving Fire Unit	60	80	300	440
Wildland Fire Remainder of 1 st Alarm	60	80	480	620

7.3.3.5 Minimum Performance Measure – LLNL S-200

The level of emergency response is based on the potential hazard presented. The hazard level presented can be grouped into two basic categories, sprinklered building and unsprinklered buildings. Based on the provisions of NFPA 1710 and the above rationale regarding the level of protection provided, the following minimum performance measures are derived:

Sprinklered Buildings

Respond to reported fires from buildings with sprinkler protection with an alarm assignment of two engine companies and a Battalion Chief in a manner to provide for arrival of the first engine company within a Total Response Time of 380 seconds 90% of the time and the arrival of the remainder of the alarm assignment within a Total Response Time of 620 seconds 90% of the time.

Unsprinklered Buildings

Respond to reported fires from buildings without sprinkler protection with an alarm assignment of three engine companies and a Battalion Chief in a manner to provide for arrival of the first engine company within a Total Response Time of 380 seconds 90% of the time and the arrival of the remainder of the alarm assignment within a Total Response Time of 620 seconds 90% of the time.

Wildland Fire

Respond to a reported wildland fire within a Total Response Time for a two-flank wildland fire attack of 440 seconds 90% of the time and provide for the arrival of a Battalion Chief within a Total Response Time of 620 seconds 90% of the time.

7.3.3.6 Performance Summary – Manual Fire Fighting LLNL Site 200

Table 7.3.3.6 Performance Summary – Manual Fire Fighting Site 200

Type Incident	Responders	Minimum Staffing (persons)	Total Response Time	Performance Criteria
Fire Sprinklered Bldg	1 st Unit	7	380	90%
	1 st Alarm		620	
Fire Unsprinklered Bldg	1 st Unit	11	380	90%
	1 st Alarm		620	
Wildland Fire	Fire Attack	4	440	90%
	1 st Alarm	5	620	

7.4 Manual Fire Suppression Requirements-Site 300

7.4.1 Determination of Minimum Response Requirements

The minimum response requirements for structural fires at Site 300 are the same as that derived for the Livermore Site. However, the nature of operations at Site 300 (high explosive formulation and testing) dictates that buildings outside of the general service area be widely spaced, generally require a high explosive (HE) setback, and require a cooling off period, delaying building entry for a minimum of 30 minutes. Because of these factors, a response time for those buildings outside of the general service area can be extended as a matter of necessity and reason. This delay is in keeping with NFPA 1710 which states that there can be areas where the response criteria are impacted by circumstances such as natural barriers, insufficient water supply, or low density of population or property.⁴⁷ A Total Response Time of 960 seconds 90% of the time has been selected as a reasonable response time for those buildings outside of the General Service Area.

The response schedule for Site 300 calls for the automatic dispatch of an engine company from the Livermore Site on any fire response at Site 300; however, because of the remote location and travel distance to Site 300, travel time will be 15 to 30 minutes. Because there is no fire department responsible for the area surrounding Site 300 (The California Division of Forestry and Fire Protection is responsible for fire response to this area during wildland fire season, nominally June through October, and is not available to assist during the rest of the year) there is no fire department with a better response time. In keeping with NFPA 1710's provisions for such situations, a Total Response Time for the second engine has been set at 1800 seconds. The same criterion is used for the arrival of a Battalion Chief.

Site 300 has a significant wildland fire threat. That threat requires additional evaluation for minimum response requirements. (In 1984 a large wildland fire originated in the HE burn pit adjacent to B827 at Site 300. The fire eventually spread off site and consumed several thousand acres both on and off Site 300 property, but did not cause pilot ignition of any building.)

To mitigate the wildland fire threat, Site 300 imposes measures to restrict fuels within 20 ft. of permanent buildings and conducts a prescribed burn of specific areas. The prescribed burn, conducted in the spring of each year, is designed to contain any fires originating within Site 300 to within Site 300 and to create a barrier to prevent fires originating off Site 300 property from burning onto Site 300.

The wildland attack and NFPA 1710 comments mentioned for LLNL Site 200 apply at Site 300 as well. Total response time for wildland fires will be the same as structural fires outside of the GSA area, plus the one minute preparation for fire attack.

7.4.2 Minimum Performance Measure – Site 300

Based on the provisions of NFPA 1710 and the above rationale, the following minimum performance measures are derived:

GSA Sprinklered Buildings –

Respond to alarms in buildings with sprinkler protection within the General Services Area of Site 300 with an alarm assignment of one engine company (minimum staff of 4) to provide for arrival within a Total Response Time of 380 seconds 90% of the time and provide for the arrival of a Battalion Chief within a Total Response Time of 1800 seconds 90% of the time.

GSA Unsprinklered Buildings

Respond to alarms in buildings without sprinkler protection within the General Services Area of Site 300 with alarm assignment of three engine companies (each with a staff of 4) and a Battalion Chief in a manner to provide for arrival of the first engine company within a Total Response Time of 380 seconds 90% of the time and the arrival of the remainder of the alarm assignment within a Total Response Time of 1800 seconds 90% of the time.

Outside of GSA Sprinklered Buildings

Respond to fire incidents outside of the general services area with an alarm assignment of one engine company to provide for arrival within a Total Response Time of 960 seconds 90% of the time and provide for the arrival of a Battalion Chief within a Total Response Time of 2760 seconds 90% of the time.

Outside of GSA Unsprinklered Buildings

Respond to alarms in buildings without sprinkler protection outside of the General Services Area of Site 300 with alarm assignment of three engine companies (each with a staff of 4) and a Battalion Chief in a manner to provide for arrival of the first engine company within a Total Response Time of 960 seconds 90% of the time and the arrival of the remainder of the alarm assignment within a Total Response Time of 2760 seconds 90% of the time.

Wildland Fires

Respond to a reported wildland fire at Site 300 within a Total Response Time for a two-flank wildland fire attack of 1020 seconds 90% of the time and provide for the arrival of a Battalion Chief within a Total Response Time of 2760 seconds 90% of the time.

7.4.3 Performance Summary – Fire Responses S-300

Table 8.4.3 Performance Summary – Fire Response S-300

Type Incident	Responders	Minimum Staffing (persons)	Total Response Time	Performance Criteria
GSA Area Fire Sprinklered Bldg	1 st Unit	4	380 sec.	90 %
	Battalion Chief	1	1800 sec.	
GSA Area Fire Unsprinklered Bldg	1 st Unit	4	380 sec.	90 %
	1 st Alarm	11	1800 sec.	
Non GSA Area Fire Sprinklered Bldg	1 st Unit	4	960 sec.	90 %
	1 st Alarm	1	2760 sec.	
Non GSA Area Fire Unsprinklered Bldg	1 st Unit	4	960 sec.	90 %
	1 st Alarm	11	2760 sec.	
Wildland Fire	Fire Attack	4	1020 sec.	90%
	Battalion Chief	1	2760 sec.	

7.5 Emergency Medical Service

7.5.1 Determination of Minimum Response Requirements EMS

The NFPA 1710 response standards for emergency medical service (EMS) are dependent upon the service level authorized by the local health authority. The standard contemplates a minimum response of basic life support (BLS) first responder trained personnel with automatic external defibrillator (AED) capability for arrival on scene within a Total Response Time of 300 seconds. If advanced life support is provided, response standards require the arrival of advanced life support (ALS) personnel within a Total Response Time of 600 seconds assuming a BLS with AED first response within 300 seconds.⁴⁸

Aside from NFPA 1710 there are no national standards for emergency medical response. The Department of Transportation has driven the emergency medical training requirements for many years under the guise of requiring state to adopt certain minimum standards to receive federal highway funds. The DOT requirements do not include response time standards. However, the Alameda County Emergency Medical Services District has established response times for both fire department first responders and ambulance transport units in their Ambulance Transport Provider Agreement. The Total Response Time under these standards for fire department first responder ALS units in the Metro/Urban Area (those areas, such as LLNL) is 480 seconds.⁴⁹ This local EMS Agency standard will be the Total Response Time used for LLNL and Sandia/CA responses. In Suburban/Rural Areas (those areas such as that around Site 300), the EMS agency establishes an ambulance Total Response Time criteria of 900 seconds 90%. The performance criteria is based on 90% compliance.

The Alameda County EMS District standards establish a minimum staffing of 1 ALS and 1 BLS qualified personnel for an ALS transport. NFPA 1710 presumes that there will also be 2 BLS qualified personnel on scene. One ALS and 2 BLS qualified personnel will be used as the staffing standard for LLNL.

DOE's Fire Safety Program Implementation Guide suggests that fire departments should respond with emergency medical capabilities. Typically, this is the response of an

ambulance with the fire attack crews. NFPA 1710 is silent on this topic, but NFPA 1500 provides that the Incident Commander shall assess the risk to personnel and determine if on-scene medical support and transportation is necessary.⁵⁰ EMS needs at a fire event can be handled by one of the responding engine companies. Fire companies assigned to LLNL and their mutual aid and automatic aid partners provide ALS first responder engine companies which carry all ALS medical equipment and supplies. If EMS needs arise during a fire event, one company can be assigned to EMS while other companies continue firefighting efforts. Transport capabilities under these circumstances can be provided via outside agency ambulance.

7.5.2 Minimum Performance Measure – EMS

Based on the requirements of NFPA 1710 and the Alameda County EMS District, the minimum performance measure is established as follows:

Site 200, Sandia/CA, GSA Area of S-300

Arrive on scene of an EMS incident on the at Site 200, Sandia/CA, or the GSA Area of S-300 with first responder/transport ALS capability of one ALS and two BLS qualified responders within a response time of 480 seconds 90% of the time.

Outside of GSA Area of S-300

Arrive on the scene of an EMS incident Outside of the GSA Area of Site 300 with first responder/transport ALS capability of one ALS and two BLS qualified responders within a Total Response Time of 900 seconds 90% of the time.

7.5.3 Performance Summary – EMS

Table 7.5.3 Performance Summary -- EMS

Type Incident	Responders	Minimum Staffing (persons)	Response Time
All EMS Except Non GSA Site 300	1 st Responder/Transport	1 ALS 2 BLS	480 sec.
EMS Non GSA Site 300	1 st Responder/Transport	1 ALS 2 BLS	900 sec.

7.6 Hazardous Materials Response Requirements

7.6.1 Determination of Minimum Requirements -- HazMat

Both Sandia and LLNL perform experimental work using hazardous materials of various types, in a secure environment. The materials range from normal research chemicals to exotic one-of-a-kind compounds and include radioactive materials of various types, forms, and quantities. It is important that there be a hazardous materials response capability that can have immediate access to classified areas and can maintain the classified nature of the work being performed.

The responsibility for emergency response to hazardous materials incidents was assigned to the LLNL Fire Department in 1984, when it was determined that the fire department would be the first responder to all emergency incidents other than security incidents.

NFPA 1710 does not establish specific response or staffing requirements for response to hazardous materials incidents. It simply states that the fire department shall ensure that the fire department's hazardous materials response capability includes personnel, equipment, and resources to deploy at the first responder operational level as required by 29 CFR 1910.120.⁵¹ DOE 420.1B simply states that the emergency response organization (assumed to be the fire department) establish capabilities to respond to hazardous materials incidents.

7.6.2 Analysis -- HAZMAT

NFPA 472, *Standard for Professional Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents* sets standards for competencies for those responding to hazardous materials operations by categorizing those responders into one of four categories:

- ♦ Awareness Level. Awareness level personnel are those persons who, in the course of their normal duties, can be the first on the scene of an emergency involving hazardous materials. Awareness level personnel are expected to recognize the presence of hazardous materials/WMD, protect themselves, call for trained personnel, and secure the area.
- ♦ Operations Level. Operations level responders are those persons who respond to hazardous materials/WMD incidents for the purpose of protecting nearby persons, the environment, or property from the effects of the release. They should be trained to respond in a defensive fashion to control the release from a safe distance and keep it from spreading. Operations level responders can have additional competencies that are specific to their response mission, expected tasks, and equipment and training as determined by the AHJ.
- ♦ Technician Level. Hazardous materials technicians are those persons who respond to releases or potential releases of hazardous materials for the purpose of controlling the release. Hazardous materials technicians are expected to use specialized chemical protective clothing and specialized control equipment. Hazardous materials technicians respond to hazardous materials/WMD incidents using a risk-based response process with the ability to analyze a problem involving hazardous materials/WMD, select appropriate decontamination procedures, and control a release using specialized protective clothing and control equipment. Hazardous materials technicians can have additional competencies that are specific to their response mission, expected tasks, and equipment and training as determined by the AHJ.
- ♦ Command Level. The incident commander is that person who is responsible for all decisions relating to the management of the incident. The incident commander is in charge of the incident site.⁵²

Depending upon the level of response, the training and competencies contained in NFPA 472 must be followed. While no specific mandatory staffing is defined by any of the referenced documents, it is clear that certain functions and actions outlined in OSHA 1910.120 and NFPA 472 and 473 must be taken at the scene of a hazardous materials event, from which minimum staffing can be derived.

The response time criteria established by NFPA 1710 for structural fires and the staffing requirements described below will be the basis for the response requirements. Training requirements, although mentioned here, will be evaluated in the Training and Certification Section.

Based on the provisions of the requirements documents, response to hazardous materials incidents can be classified into three levels. Investigation Level incidents are those incidents in which no operational actions must be taken, but the material must be isolated until arrangement for clean-up. These incidents require personnel trained to the Awareness Level per NFPA 472⁵³. The minimum response staffing is determined to be 4 (Incident Commander and three personnel with a minimum of Awareness Training).

Level One incidents are those incidents in which minimal operational actions must be taken to stabilize the situation and make the scene safe until clean-up. Level One incidents can be handled with persons trained to the Technician Level (NFPA 472⁵⁴ and California Hazardous Materials Technician Certification). Minimum staffing is as follows:

Table 7.6.2-1 Level One HAZMAT Staffing

Task	Staffing	Minimum Training Level
Incident Commander	1	Command
Hazmat Group Supervisor	1	Technician
Hazmat Safety	1	HM Safety Officer
Technical Reference	1	Technician
Entry Team	2	Technician
Back-up Team	2	Technician
Decon Team	2	Operations
Medical Group	2	Operations and EMT
Total	12	

Level Two incidents are those incidents in which operational actions must be taken to stabilize the situation and that require staffing levels greater than typically provided on the initial response. Level Two incidents require personnel trained to the Technician Level and supervisory personnel trained to the Specialist Level⁵⁵ (California Hazardous Materials Specialist Certification). Minimum staffing for a Level II incident is determined to be the following:

Table 7.6.2-2 Level Two HAZMAT Staffing

Task	Staffing	Training Level
Incident Commander	1	Hazmat. IC
Hazmat Group Supervisor	1	Specialist
Hazmat Safety	1	Specialist
Technical Reference	2	Technician
Entry Team Leader	1	Technician
Entry Team	2	Technician
Back-up Team	2	Technician
Entry Team Time Recorder	1	Operations
Decon Team Leader	1	Technician
Decon Team	2	Operations
Site Access Team Leader	1	Operations
Medical Group	2	Operations and EMT qualified
Total	17	

There are no specific response time criteria established by NFPA 1710 for hazardous materials incidents, so no specific response criteria is demanded by that standard, however, it is expected that the engine company assigned to LLNL will respond to the area of the hazardous materials incident in a timely manner, assuming there is a safe route of travel, so that the incident can be isolated and entry to the area can be denied to avoid injuries or contamination. The structure fire response time will be used for the initial response only. Level one and Level Two responses are considered beyond initial attack and no times are assigned or required.

7.6.3 Minimum Performance Measure

Initial response to a hazardous materials incident at Site 200, Sandia/CA, and the Site 300 General Services Areas will arrive within a Total Response Time of 380 seconds 90% of the time.

Provide sufficient personnel trained to the proper level for a Level I or Level II hazardous materials incident prior to beginning any operations activities.

7.6.4 Performance Summary – HAZMAT

Table 7.6.4 Performance Summary -- HAZMAT

Task	Staffing	Training Level
Investigation Level Incident		
Incident Commander	1	Hazmat IC & Technician
HazMat Group	3	Awareness
Total	4	380 sec. 90% of the time
Level I Incident		
Incident Commander	1	Hazmat IC & Specialist
Safety and Tech Reference	2	HM Safety and Technician
HazMat Group	7	Technician
Medical Group	2	Operations & EMT
Total	12	

Level II Incident		
Incident Commander	1	Hazmat IC & Specialist
Safety and Tech Reference	3	Specialists & Technicians
HazMat Group	9	Technician & Operations
Time Recorder & Access Control	2	Operations
Medical Group	2	Operations and EMT
Total	17	

7.7 Technical Rescue Response Requirements

7.7.1 Determination of Minimum Requirements

The LLNL and Sandia campuses contain unique buildings and structures used for a variety of experimental purposes. Areas such as confined spaces, tall buildings, specially constructed test chambers, radioactively contaminated rooms and test chambers, explosive test chambers, and other one-of-a-kind structures can present unusual rescue problems after an accident.

DOE Order 420.1B and DOE G-420.1-3 discuss the need for DOE contractors to have a timely and effective response to a spectrum of emergency conditions that they encounter, including technical rescue.⁵⁶ LLNL policy states that the Fire Department is the first responder to all emergency incidents other than security incidents.

7.7.2 Analysis – Technical Rescue

There are several federal requirements for responses to confined space incidents (29CFR1910.120 and 29CFR1910.146) which form the basis for those responses. NFPA 1670 *Standard on Operations and Training for Technical Search and Rescue Incidents*⁵⁷ establishes the training requirements for other technical rescue incidents.

NFPA 1670 categorizes responses and the training and staffing necessary for those responses based on the hazard presented. The training necessary to respond to the various hazards is divided into three categories, Awareness, Operations, and Technician. The various types of technical rescue incidents (structural collapse, rope rescue, confined space search and rescue, vehicle and machinery search and rescue, wilderness search and rescue, and trench and excavation search and rescue) base staffing on the confined space search and rescue scenario. Staffing for an Operations Level confined space search and rescue incident is established at four persons,⁵⁸ while staffing for a Technician Level confined space search and rescue is established at six persons.⁵⁹

Staffing requirements will vary depending upon the type of technical rescue, however LLNL minimum staffing is based on an Operations Level incident which requires four qualified personnel and a Technician Level incident which requires an Incident Commander and six qualified personnel based on NFPA 1670. Response times will be based on NFPA 1710 times for a structural fire since the first responding company will normally be an engine company with four personnel. Technician Level incidents will be established at the same times as a full structural assignment.

7.7.3 Minimum Performance Measure

Based on the requirements of OSHA 29CFR1910.120, 29CFR1910.146 and NFPA 1670, the minimum performance measure for a Technical Rescue incident is established as follows:

Respond to reported technical rescue incidents to provide rescue and extrication of victims of structural collapse, vehicle accidents, and construction accidents or confined space accidents at Site 200, Sandia/CA, and the GSA Area of Site 300 within a total response time of 360 seconds for an Operational Level Incident 90% of the time.

Respond to reported technical rescue incidents to provide rescue and extrication of victims of structural collapse, vehicle accidents, and construction accidents or confined space accidents at Site 200, Sandia/CA, and the GSA Area of Site 300 within a total response time of 600 seconds for a Technician Level Incident 90% of the time.

Respond to reported technical rescue incidents to provide rescue and extrication of victims of structural collapse, vehicle accidents, and construction accidents or confined space accidents in the Outside of the GSA Areas of S-300 within a total response time of 960 seconds for an Operational Level Incident 90% of the time.

Respond to reported technical rescue incidents to provide rescue and extrication of victims of structural collapse, vehicle accidents, and construction accidents or confined space accidents in the Outside of the GSA Areas of S-300 within a total response time of 2760 seconds for a Technician Level Incident 90% of the time.

7.7.4 Performance Summary

Table 7.7.4 Performance Summary – Technical Rescue

Location	Responders	Minimum Staffing (persons)	Total Response Time	Performance Criteria
S-200, Sandia/CA GSA Area S-300	Operations Level	4	380 sec.	90 %
S-200, Sandia/CA GSA Area S-300	Technician Level	7	620 sec.	90 %
Non GSA Area S-300	Operations Level	4	960 sec.	90 %
Non GSA Area S-300	Technician Level	7	2760 sec.	90 %

7.8 Response to Second Incidents

7.8.1 Determination of Minimum Requirements

There are no minimum requirements for a response to a second incident. While NFPA 1710 discusses deployment of additional alarm assignments to provide capability that is beyond the capability of an initial full alarm assignment to an incident, it does not set requirements for a second incident response. The DOE Guide on Order 420.1B states that a

BNA should be based on one emergency incident, but should describe how the site would respond to a second simultaneous incident.⁶⁰ At a minimum, the second response should be based on response of a single company.

7.8.2 Analysis -- Response to Second Incidents

Based on the lack of specific guidance, the minimum performance measure is determined to be the response of a single company to a second simultaneous event.

7.8.3 Minimum Performance Measure

Since there is no firm guidance for response to a second event, there is no time metric for such a response. For the purposes of this BNA, a time factor of twice the full structure fire alarm response time, 1240 seconds, will be used.

7.8.4 Performance Summary

Based on the above analysis the following is established as the base performance measure for a second simultaneous incident.

Respond to a second simultaneous incident of any type with a single engine company within a Total Response Time of 1240 seconds 90 percent of the time.

Table 7.8.3 Performance Summary -- Second Incident

Type Incident	Responders	Total Response Time	Performance Criteria
Second Incident	1 Company	1240 seconds	90 %

7.9 Emergency Communications and Dispatch Requirements

7.9.1 Determination of Minimum Requirements

The LLNL Fire and Emergency Voice Alarm (FEVA) system monitors fire alarms for LLNL, Lawrence Berkeley National Laboratory, Sandia/CA, and Parks Army Training Center. For the purposes of monitoring LLNL alarms, the system is considered a Remote Supervising Station System meeting the provisions of Section 26.5 of NFPA 72, *National Fire Alarm and Signaling Code*.

The LLNL system maintains a data base of alarm points for all sites and reports as much detailed alarm information as is available from the remote system. During normal working hours, the LLNL Alarms Center (Lab Alarms) monitors the alarms from the various sites, participates in alarm testing for the various sites by acknowledging and validating tests, maintains and updates the data base of alarm points, and passes actual alarms to the Alameda County Regional Emergency Communications Center (ACRECC) for emergency dispatch. During off hours, ACRECC monitors the LLNL Alarm System (which includes alarms from the other agencies), and dispatches emergencies. To avoid unnecessary delay in alarm processing, alarms are automatically sent to ACRECC for emergency dispatch within 45 seconds of receipt at Lab Alarms. This minimum delay allows Lab Alarms to intercept alarm tests and prevent unnecessary emergency dispatch.

Performance standards contained in NFPA 72 require that alarms signals shall be retransmitted to the fire department immediately; the automatic transmission of alarms to the dispatch screen satisfies this requirement. The maximum 45 second delay is judged to be less than that required to retransmit the alarm by another means. Remote supervising station systems are also required to monitor and notify appropriate personnel of supervisory signals and trouble signals. During normal LLNL working hours supervisory and trouble alarm processing is done by Lab Alarms with off hours monitoring and notification by ACRECC.

LLNL 911 calls are answered in the ACRECC center with ALI (automatic location identification) and ANI (automatic number identification) information displayed to the dispatcher. Any security emergency call is routed to the LLNL Protective Force. Sandia/CA's security force answers emergency phone calls at their central alarm station (CAS) for calls from their campus and transfers the call to ACRECC if it is a fire or EMS incident.

ACRECC is Alameda County's regional emergency communications center serving communities, fire departments, and the Alameda County Emergency Medical Services District who are subscribers to the ACRECC service. The center was operated by the LLNL Fire Department until January of 2008, when the center's operation was turned over to the Alameda County Fire Department. The modern center is securely located in B-313 on the secure LLNL campus.

As a fire department emergency communications center, ACRECC is expected to meet the requirements of NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems*. The provisions of NFPA 1221 establish the minimum call handling criteria for receipt of alarm and dispatch of emergencies. Those performance requirements are:

- ◆ 95% of incoming emergency calls or alarms are answered within 15 seconds
- ◆ 99% of incoming emergency calls or alarms are answered within 40 seconds
- ◆ 80% of alarms are dispatched within 60 seconds
- ◆ 95% of alarms are dispatched with 106 seconds

The provisions of NFPA 1221 establish the minimum call handling criteria for receipt of alarm and dispatch of emergencies. The provisions of NFPA 72 are not specific for handling of supervisory and trouble signals. Recognizing the procedures utilized by LLNL for these events, a minimum performance criterion of 10 minutes for notification of an appropriate party was chosen as the minimum performance criteria.

The minimum staffing for a center providing emergency medical dispatching is two persons at all times. Additional staffing is based on meeting the performance criteria.

Further, NFPA 1221 provides that dispatchers meet the qualifications provisions of NFPA 1061, *Standard for Professional Qualifications for Public Safety Telecommunicator* and certain other general requirements contain in Section 7.2 of NFPA 1221.

Additionally the dispatch center shall have the following capabilities:

- ◆ Record keeping system for all events including times of alarm receipt, dispatch, dispatch acknowledgement, enroute time, arrival time, patient contact time, and return to service time.
- ◆ Written operating procedures
- ◆ Written communications plan

- ◆ TDD/TTY capability
- ◆ Logging voice recorder
- ◆ Instant playback recorder of radio and phone conversations
- ◆ Emergency power
- ◆ Redundant radio communications capabilities

DOE Order 420.1B specifically mentions the ability of the fire fighting force to have radio communications capability with mutual aid resources.

7.9.2 Minimum Performance Measure

Based on the above analysis the minimum performance measures for Emergency Communications are as follows:

ACRECC shall provide evidence that their dispatch staff is trained to meet the qualifications of NFPA 1061 and is capable of meeting the provisions of Section 7.2 of NFPA 1221.

ACRECC shall provide evidence that alarms received, via telephone or alarms from LLNL's site-wide alarm system, are answered or in the case of signals from the alarm system, acknowledged, within 15 seconds 95 % of the time and within 40 seconds 99% of the time.

ACRECC shall provide evidence that LLNL alarms are dispatched within 60 seconds 80% of the time and within 106 seconds 95% of the time.

Lab Alarms shall provide evidence that alarms are transmitted to ACRECC for dispatch within 45 seconds of receipt by Lab Alarms 95% of the time.

ACRECC and/ Lab Alarms will notify the appropriate party within 10 minutes of a supervisory or trouble alarm 95% of the time to allow for response of appropriate personnel.

7.9.3 Performance Summary

Table 7.9.3 Performance Summary – Emergency Communications

Event	Time Criteria	Performance
Dispatcher training	N/A	NFPA 1061
ACRECC Answer or Acknowledge Alarm	15 seconds 40 seconds	95% 99%
ACRECC Dispatch Emergency	60 seconds 106 seconds	80% 95%
Lab Alarms transmit alarms to ACRECC	45 seconds	95%
ACRECC and/or Lab Alarms Notify Appropriate Party of Supervisory or Trouble Alarm	600 seconds	95%

7.10 Training and Certification

7.10.1 Determination of Minimum Requirements – Training

All the requirement documents state that there needs to have a trained emergency response organization. The references in DOE 420.1B and 10CFR 851 refer to use of the applicable NFPA codes and standards as well as training necessary to understand the site hazards, building layouts, site emergency plans, and any special fire fighting instructions, such as limitations on the use of water as an extinguishing agent. DOE 151.1C requires a coordinated program of training, drills, and exercises to be able to respond to the various emergencies on the LLNL site. In addition, training is required to meet OSHA requirements.

7.10.2 Analysis – Training

The various DOE references to NFPA codes and standards result in application of the following NFPA standards as a minimum:

- ◆ NFPA 472, *Standard for Professional Competence of Responders to Hazardous Materials Incidents*, 2008 Edition.
- ◆ NFPA 473, *Standard for Competencies for EMS Personnel Responding to Hazardous Materials Incidents*, 2008 Edition
- ◆ NFPA 1001, *Standard for Fire Fighter Professional Qualifications*, 2008 Edition.
- ◆ NFPA 1002, *Standard on Fire Apparatus Driver/Operator Professional Qualifications*, 2009 Edition.
- ◆ NFPA 1021, *Standard for Fire Officer Professional Qualifications*, 2009 Edition.
- ◆ NFPA 1041, *Standard for Fire Service Instructor Professional Qualifications*, 2007 Edition
- ◆ NFPA 1051, *Standard for Wildland Fire Fighter Professional Qualifications*, 2007 Edition
- ◆ NFPA 1404, *Standard for Fire Service Respiratory Protection Training*, 2006 Edition.
- ◆ NFPA 1403, *Standard on Live Fire Training Evolutions*, 2007 Edition.
- ◆ NFPA 1670, *Standard on Operations and Training for Technical Rescue Incidents*, 2009 Edition.

Further, a written training policy and program and documentation that training has been completed is required as well as a refresher training schedule and task performance evaluations. Site specific training is also required particularly for specific hazards, such as radiation hazards, biological hazards, and chemical hazards.

7.10.3 Minimum Performance Measure - Training

Based on the above requirement and analysis the minimum performance measures for Training are as follows:

Qualifications are established for entry level fire department personnel that include medical and physical performance criteria.

There is an established training criterion for minimum performance of entry level personnel.

There is an established on-going training criterion for training for incumbents.

There is a minimum training criteria established for fire officers or supervisors of emergency responder.

There is a minimum training criteria established for special operations such as hazardous materials and technical rescue.

There is a program of drills, exercises, and familiarization tours on the LLNL site.

Documented training records exist for each individual.

7.10.4 Performance Summary – Training

Table 7.10.4 Performance Summary - Training

Personnel	Performance Measure
Entry level	Qualifications are established for entry level fire department personnel that include medical and physical performance criteria.
Entry level	There is an established training criterion for minimum performance of entry level personnel.
Incumbents	There is an established on-going training criterion for training for incumbents.
Officers	There is a minimum training criteria established for fire officers or supervisors of emergency responder.
Special Operations	There is a minimum training criteria established for special operations such as hazardous materials and technical rescue.
Drills, Exercises, Tours	There is an established program of drills and exercises at various facilities on LLNL site.
All	Documented training records exist for each individual.

7.11 Pre-Fire Plan Requirements

7.11.1 Determination of Minimum Requirements

DOE 420.1B, *Facility Safety*, requires that contractors provide an “improved risk” level of fire protection. One specific component of this level of protection is the maintenance of written pre-fire plans and standard operating procedures.^{61, 62}

DOE 151.1C, *Comprehensive Emergency Management System*, requires establishment and maintenance of plans and procedures for response to operational emergencies involving or affecting DOE facilities. 151.1C requires the preparation of Emergency Planning Hazards Assessments (EPHAs) which identify hazards and potential consequences from unplanned releases of hazardous materials (where quantities of hazardous materials exceed established screening thresholds) and provides protective actions for such releases.

NFPA 1620 Standard for Pre-Incident Planning has recently been converted from a Recommended Practice to a Standard. Although now titled a Standard, it still contains criteria for developing pre-incident plans and does not contain mandatory requirements for format and leaves actual contents up to the local AHJ.

7.11.2 Analysis – Pre-Fire Plans

All requirement documents discuss the need for written pre-fire plans and written policies and operating procedures to assist in the emergency response. The minimum performance requirement is the development of pre-fire plans for all buildings on LLNL and Sandia/CA property. The format and contents of these plans should meet the provisions of ACFD OAG 30-106 Building and Trailer Run Cards and the needs of the emergency responders from the Alameda County Fire Department. NFPA 1620 *Standard for Pre-Incident Planning*⁶³ provides a possible format for pre-plans.

7.11.3 Minimum Performance Measure – Pre-Fire Plans

Pre-fire plans shall exist for all LLNL and Sandia/CA buildings as well as an established policy to ensure that the pre-plans are accurate and updated annually. In addition, written standard operations procedures for emergency response to the various hazards encountered at LLNL buildings are required. The performance criteria for Pre-Fire Plans are as follows:

Provide pre-fire plans for all LLNL and Sandia/CA buildings meeting ACFD OAG 30-106 with a quarterly review frequency to ensure that they are current and accurate.

Provide and maintain written standard operating procedures for emergency response to occupancies with hazardous materials or other unique hazards.

7.11.4 Performance Summary – Pre-Fire Plans

Table 7.11.4 Performance Summary – Pre-Fire Plans

Performance Measure	Frequency
Provide pre-fire plans for all buildings	Quarterly
Provide written standard operating procedures for response to occupancies with hazardous materials or other unique hazards	Annually

7.12 Emergency Response Apparatus and Equipment Requirements

7.12.1 Determination of Minimum Response Requirements

To perform its function, the fire department must be equipped with the necessary fire apparatus and equipment. Typically, this will involve the purchase of specialized emergency response vehicles suitable to the hazards present and to the duties of the fire department.

7.12.2 Analysis – Emergency Apparatus

Engines (sometimes called pumpers because they pump water) are the fundamental tactical unit of a fire department. Engines are versatile and respond to every incident. In California ICS terminology, engines are categorized by Type which describes their characteristics and capability. This categorization is as follows:

Table 7.12.2-1 California ICS Apparatus Type Description

Apparatus Type	Characteristics	Minimum Requirements
Type 1 Engine	Structural	1,000 gpm pump 400 gal tank 1,200 ft. 2-1/2 inch hose 400 ft – 1-1/2 inch hose 500 gpm master stream device
Type 2 Engine	Limited Structural Vehicle/Rescue Limited Wildland	500 gpm pump 400 gal tank 1,000 ft. 2-1/2 inch hose 500 ft – 1-1/2 inch hose
Type 3 Engine	Heavy Wildland Short Wheelbase Short After Axle High Ground Clearance Often 4X4	120gpm pump 300 gal tank 1,000 ft. 1-1/2 inch hose 800 ft – 1 inch hose
Type 4 Engine	Light Wildland 4X4 Skid Load Pump Module	50 gpm Pump 200 gal tank 300 ft. 1-1/2 inch hose 800 ft – 1 inch hose

Other, more specialized apparatus, may or may not be required depending upon the character of the area being protected. Aerial ladder apparatus is an example. The need for an aerial ladder is predicated on the number of tall buildings or structures. One guide for determining the number of aerial ladders was the “grading schedule” of the National Board of Fire Underwriters. That schedule, was used to evaluate municipal fire protection for the determination of insurance rates and for many years was the only guide on fire department organization, staffing and operation. The original grading schedule recommended an aerial ladder if the area being served contained five buildings four or more stories in height.⁶⁴ More current versions of the grading schedule have a more generalized requirement of being able to reach the roof of any building up to 100 ft.⁶⁵

The fire department at LLNL provides emergency response to structure fires, vehicle fires, wildland fires, vehicle accidents, hazardous materials incidents, emergency medical incidents, and technical rescue incidents. In addition to emergency response, the fire department also conducts a prescribed burn of S-300 wildland fuel each spring. Routine functions including performing fire inspections, issuing open flame permits and conducting sprinkler shutdowns and restorations are now handled by the Fire Inspectors at Site 200. These functions are still performed by fire fighters at Site 300. The following table describes the type of service provided and the appropriate apparatus for that service.

Table 7.12.2-2 Apparatus Needs per Service Required

Type Service	Type Apparatus	Basic Function
Structure Fire	Type 1 Engine	Fire Attack Pump, Water, Hose
Structure Fire	Aerial Ladder	Rescue from heights, Access to Roof, Elevated Master Streams Ladders, Rescue Tools, Salvage Equip., Lights
Vehicle Fire	Type 1 or 3 Engine	Fire Attack Pump, Water, Hose
Wildland Fire	Type 3 or 4 Engine	Fire Attack Pump, Water, Hose, Off road capability.
Vehicle Accident	Engine, Any Type	Fire Control Pump, Water, Hose, Extrication Capability
Emergency Medical Incident requiring transportation	Ambulance	Emergency Medical Care Emergency Transportation ALS Medical Equipment
Hazardous Materials Incident	Hazardous Materials Vehicle	Evaluation of and containment of Hazardous Materials. Protective suits, dike and absorbing materials, analysis capability.
Technical Rescue	Pumper Aerial Ladder Hazardous Materials Vehicle	Stabilize Situation and Extricate Victims
Incident Command	Passenger Vehicle	Command and Control Off Road Capability
Inspection, Testing, Permits, Shut downs	Passenger Vehicle	Transportation Carry necessary tools
Controlled Burn S-300	Type 3 Engines (2) Type 4 Engines (2)	One of each can be used at each station for normal response to wildland fires

Given the types of emergencies, services provided, and the staffing requirements derived in other sections of this analysis the following table contains the minimum apparatus necessary to meet the demands imposed on the Fire Department at LLNL. The need for aerial ladder apparatus is a function of building height.

Table 7.12.2-3 LLNL Apparatus Requirements

Site	Service	Apparatus	Number	Comment
Livermore	Structure Fire Vehicle Fire Vehicle Accident Technical Rescue	Type 1 Engine	2	Two company fire attack Response to simultaneous incidents
Livermore	Structure Fire Technical Rescue	Aerial		When required can be mutual or automatic aid resource.
Livermore	Wildland Fire	Type 4 Engine	1	Responds Livermore Site Required for Controlled Burn at Site 300.
Livermore	Emergency Medical	Ambulance	1	
Livermore Site 300	Hazardous Materials	HazMat	1	
Livermore Site 300	Incident Command	Command	1	Battalion Chief
Livermore	Inspection Fire Extinguishers Alarm Testing	Passenger	3	Fire Prevention Techs. Reserve Command Vehicles
Site 300	Structure Fire Vehicle Fire Vehicle Accident Technical Rescue	Type 1 Engine	1	Second pumper responds from Livermore
Site 300	Wildland Fire	Type 3 Engine Type 4 Engine	1 1	
Site 300	Prescribed Burn	Type 3 Engine Type 4 Engine	2 2	
Site 300	Emergency Medical	Ambulance	1	

Certain emergency apparatus is critical to providing a response capability. Those units must be provided with readily available back-ups to allow for breakdowns and routine maintenance. There is no national standard for ratio of reserve apparatus to apparatus in front-line service. The type and complexity of apparatus, number of responses, and degree of preventive maintenance being performed will dictate the number and type of breakdowns. It is clear that there will be breakdowns and routine maintenance; therefore, some number of reserve apparatus must be available. A historic guide for reserve apparatus was a ratio of one reserve pumper for every 8 pumpers in front-line service.⁶⁶ A more modern rule of thumb is one reserve for every 5 in front-line service. This same rule can be applied to wildland pumpers and ambulances. It is not appropriate to apply the reserve ratio to unique or specialized apparatus such as hazardous materials units. Single aerial apparatus are typically not provided with a reserve, especially if another aerial apparatus is available via mutual or automatic aid.

The following table summarizes the determined minimum reserve apparatus.

Table 7.12.2-4 Reserve Apparatus Requirements

Type	Number	Comment
Type 1 Engine	1	1 Reserve per 5 in front-line service.
Ambulance ALS	1	1 Reserve per 5 in front-line service.
Type 3 or 4 Engine	1	1 Reserve per 5 in front-line service.

An apparatus replacement program must be in place to insure the fire department is equipped with reliable modern apparatus. Historic guidance for apparatus replacement was 20 years in front-line service and 5 years in reserve. The complexity of modern apparatus and the frequency of technology change dictate a more frequent replacement schedule. Removal from front-line service at 15 years with a potential for 5 years of reserve service is a realistic goal for engines. Heavily used aerial ladder apparatus would follow the same schedule where lightly used aerials, such as that of LLNL, would be removed from front-line service at 20 years.⁶⁷ Emergency vehicles such as ambulances, wildland patrols, and hazardous materials need to be replaced on a more frequent schedule, depending upon maintenance, use, and condition of the apparatus. A replacement schedule, such as that recommended by the General Services Administration, can be a useful planning guide. Detailed records of repairs, use, and replacement needs will allow the development of an organization-specific replacement schedule.

7.11.3 Minimum Performance Measure

Provide the following apparatus for use by the Fire Department at LLNL:

Type Apparatus	Number	Comment
<i>Engine</i>	<i>3</i>	<i>Livermore Site – 2, S-300 – 1</i>
<i>Aerial Ladder</i>		<i>Available via Automatic Aid</i>
<i>Ambulance ALS Configuration</i>	<i>2</i>	<i>Livermore Site – 1, S-300 – 1</i>
<i>Type 3 Engine</i>	<i>2</i>	<i>Livermore Site – 1, S-300 – 1</i>
<i>Type 4 Engine</i>	<i>2</i>	<i>Livermore Site – 1, S-300 – 1</i>
<i>Hazardous Materials</i>	<i>1</i>	<i>Responds both sites</i>
<i>Command</i>	<i>1</i>	<i>Battalion Chief</i>
<i>Reserve Type 1 Engine</i>	<i>1</i>	<i>1 Reserve per 5 in front-line service</i>
<i>Reserve Ambulance</i>	<i>1</i>	<i>1 Reserve per 5 in front-line service</i>
<i>Reserve Type 3 Engine</i>	<i>0</i>	<i>1 Reserve per 5 in front-line service</i>
<i>Reserve Type 4 Engine</i>	<i>1</i>	<i>1 Reserve per 5 in front-line service</i>

Apparatus and equipment must meet NFPA Standards for design, minimum equipment, and maintenance.

Provide a written replacement schedule for all emergency apparatus to allow timely replacement.

7.11.4 Requirement Summary

Table 7.12.4 LLNL Required First Line and Reserve Apparatus

Type Apparatus	Number	Comment
Engine	3	Livermore Site – 2, S-300 – 1
Aerial Ladder		Available via Automatic Aid
Ambulance	2	Livermore Site – 1, S-300 – 1
Type 3 Engine	2	Livermore Site – 1, S-300 – 1
Type 4 Engine	2	Livermore Site – 1, S-300 – 1
Hazardous Materials	1	Responds both sites
Command	1	Battalion Chief
Reserve Type 1 Engine	1	1 Reserve per 5 in front-line service
Reserve Ambulance	1	1 Reserve per 5 in front-line service
Reserve Type 3 Engine	0	1 Reserve per 5 in front-line service
Reserve Type 4 Engine	1	1 Reserve per 5 in front-line service
Apparatus Plan		Written 5 year Plan
Apparatus Maintenance		Per NFPA and GSA Fleet Requirements

¹ U.S. Department of Energy, *DOE Model Fire Protection Baseline Capabilities*, [cited February 25, 2008] available from <http://www.tis.eh.doe.gov/fire/models/baseline.pdf>.

² U.S. Department of Energy, *Facility Safety Order*, DOE 420.1B, Attachment 2, 12/22/2005, Chapter II.

³ DOE 151.1C, *Comprehensive Emergency Management System*, November 2, 2005.

⁴ National Fire Protection Association, *Standard for the Installation of Sprinkler Systems*, NFPA 13, Quincy, MA: 2013

⁵ National Fire Protection Association, *National Fire Alarm and Signaling Code*, NFPA 72, Quincy, MA: 2013.

⁶ National Fire Protection Association, *Standard for Professional Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents*, NFPA 472, Quincy, MA: 2013.

⁷ National Fire Protection Association, *Standard for Competencies for EMS Personnel Responding to Hazardous Materials/Weapons of Mass Destruction Incidents*, NFPA 473, Quincy, MA: 2013.

⁸ National Fire Protection Association, *Standard for Fire Fighter Professional Qualifications*, NFPA 1001, Quincy, MA: 2013.

⁹ National Fire Protection Association, *Standard on Fire Apparatus Driver/Operator Professional Qualifications*, NFPA 1002, Quincy, MA: 2009.

¹⁰ National Fire Protection Association, *Standard for Rescue Technician Professional Qualifications*, NFPA 1006, Quincy, MA: 2008.

¹¹ National Fire Protection Association, *Standard on Fire Officer Professional Qualifications*, NFPA 1021, Quincy, MA: 2009.

¹² National Fire Protection Association, *Standard for Wildland Fire Fighter Professional Qualifications*, NFPA 1051, Quincy, MA: 2012.

¹³ National Fire Protection Association, *Standard for Professional Qualifications for Public Safety Telecommunicator*, NFPA 1061, Quincy, MA: 2007.

¹⁴ National Fire Protection Association, *Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems*, NFPA 1221, Quincy, MA: 2013.

¹⁵ National Fire Protection Association, *Standard for Fire Service Respiratory Protection Training*, NFPA 1404, Quincy, MA: 2006.

¹⁶ National Fire Protection Association, *Standard on Live Fire Training Evolutions*, NFPA 1403, Quincy, MA: 2012.

¹⁷ National Fire Protection Association, *Standard for Fire Department Occupational Safety and Health Program*, NFPA 1500, Quincy, MA: 2010, Paragraph 8.4.7.

¹⁸ National Fire Protection Association, *Standard for Fire Department Safety Officer*, NFPA 1521, Quincy, MA: 2013.

-
- ¹⁹ National Fire Protection Association, *Standard on Emergency Service Incident Management System*, NFPA 1561, Quincy, MA: 2008.
- ²⁰ National Fire Protection Association, *Standard on Comprehensive Occupational Medical Program for Fire Departments*, NFPA 1582, Quincy, MA: 2013.
- ²¹ National Fire Protection Association, *Standard for Pre-Incident Planning*, NFPA 1620, Quincy, MA: 2010.
- ²² National Fire Protection Association, *Standard on Operations and Training for Technical Rescue Incidents*, NFPA 1670, Quincy, MA: 2009.
- ²³ National Fire Protection Association, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments*, NFPA 1710, Quincy, MA: 2010.
- ²⁴ National Fire Protection Association, *Standard for Automotive Fire Apparatus*, NFPA 1901, Quincy, MA: 2009.
- ²⁵ National Fire Protection Association, *Standard for Wildland Fire Apparatus*, NFPA 1906, Quincy, MA: 2012.
- ²⁶ National Fire Protection Association, *Standard for the Inspection, Maintenance, Testing, and Retirement of In-Service Automotive Fire Apparatus*, NFPA 1911, Quincy, MA: 2012.
- ²⁷ DOE Implementation Guide for DOE Fire Protection and Emergency Services Programs, G 420.1-3, 9-27-07, Paragraph 4.9-6.
- ²⁸ DOE G 440.1B, *Worker Safety and Health Program for DOE (including the National Nuclear Security Administration) Federal and Contractor Employees*, October 20, 2011 [cited December 2, 2012] available from: http://www.directives.doe.gov/pdfs/doe/doetex/neword/g440.1-1b_final_10-21-11.pdf.
- ²⁹ DOE STD 1066-99, *Fire Protection Design Criteria*, July, 1999.
- ³⁰ DoD Instruction 6055.06, *DoD Fire and Emergency Services (F&ES) Program*, December 21, 2006.
- ³¹ DOE Order 420.1B, *Facility Safety*, 12-22-07, Chapter II, Section 3b (7).
- ³² DOE G 420.1-3 Section 3b (8).
- ³³ National Fire Protection Association, *Fire Protection Handbook*, 19th Edition, Quincy, MA: 2003, 3-137.
- ³⁴ *Ibid.* Paragraph A.5.2.2.2.1.
- ³⁵ *Fire Protection Handbook*, 2-79.
- ³⁶ U.S. Department of Energy, *Automatic Sprinkler Performance and Reliability in United States Department of Energy Facilities 1952 — 1980*, U. S. Department of Energy, DOE/EP—0052, 1982
- ³⁷ *Fire Protection Handbook*, 10-187.
- ³⁸ Hall, John R., *U. S. Experience with Sprinklers*, National Fire Protection Association, Quincy, MA: 2012, Pg. 7.
- ³⁹ Society of Fire Protection Engineers (NZ), Technical Publication TP 2007/1, [Comparison of 11 methods for Determining Water Used for Fire Fighting](http://www.sfpe.org.nz/index.php/technical/technical_papers/). [Cited November 13, 2009] available from: http://www.sfpe.org.nz/index.php/technical/technical_papers/
- ⁴⁰ NFPA 1710, Paragraph 5.2.3.2.2.
- ⁴¹ *Creating and Evaluating Standards of Response Coverage for Fire Departments*, 4th. Edition, Center for Public Safety Excellence, Chantilly, VA: 2004.
- ⁴² National Fire Protection Association, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments*, NFPA 1710, Quincy, MA: 2010.
- ⁴³ *Ibid.*, Paragraph A.5.2.3.2.1
- ⁴⁴ *Ibid.*, Subsection 1.3.
- ⁴⁵ National Fire Protection Association, *Standard on Fire Department Occupational Safety Program*, NFPA 1500, Quincy, MA: 2002, Paragraph 8.4.23.
- ⁴⁶ NFPA 1710, Section 5.7.
- ⁴⁷ NFPA 1710, Paragraph A.4.1.2.
- ⁴⁸ NFPA 1710, Paragraph 5.3.3.4.
- ⁴⁹ Alameda County Emergency Medical Services District, RFP Specifications, Terms & Conditions for EMS Ambulance Transport Provider, June 25, 2009, Table 3, Page 45. (cited 20 November 2012), available at http://www.acphd.org/media/133650/ems_rpf_ambulance_provider_2009_addendum123.pdf.
- ⁵⁰ National Fire Protection Association, *Standard on Fire Department Occupational Safety Program*, NFPA 1500, Quincy, MA: 2004, Paragraph 8.5.21.
- ⁵¹ NFPA 1710, Paragraph 4.4.2.
- ⁵² NFPA 472, Annex H.

⁵³ NFPA 472, Chapter 4.

⁵⁴ Ibid, Chapter 6.

⁵⁵ Ibid, Chapter 8.

⁵⁶ DOE G-420.1-3, Section 4.1 Program Objectives.

⁵⁷ National Fire Protection Association, *Standard on Operations and Training for Technical Search and Rescue Incidents*, NFPA 1670, Quincy, MA: 2009.

⁵⁸ NFPA 1670, Standard on Operations and Training for Technical Search and Rescue Operations, 2009 Edition, Section 7.3.2.

⁵⁹ Ibid, Section 7.4.2

⁶⁰ DOE G-420.1-3, Section 4.9 Baseline Needs Assessment.

⁶¹ DOE 420.1B, Attachment 2, Chapter 2, 3b (10).

⁶² DOE Fire Safety Program Implementation Guide, Section 4.8

⁶³ National Fire Protection Association, *Standard for Pre-Incident Planning*, Quincy, MA: 2010

⁶⁴ National Board of Fire Underwriters, *Standard Schedule for Grading Cities and Towns of the United States with Reference to Their Fire Defenses and Physical Conditions*, New York, NY: 1956, 51.

⁶⁵ Insurance Services Office, Public Protection Classification Program, [electronic guide] (Jersey City, New Jersey) {cited 13 March 2004}, available from <http://www.isomitigation.com/fire72.html#18>.

⁶⁶ Insurance Services Office, Fire Suppression Rating Schedule, Jersey City, NJ: 2003, 61.

⁶⁷ NFPA 1901, Annex D.