Command and Control of Fire Department Operations at Target Hazards

CCTH-Student Manual

2nd Edition, 10th Printing-August 2017

U.S. Department of Homeland Security
FEMA

FEMA/USFA/NFA
CCTH-SM
August 2017
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U.S. DEPARTMENT OF HOMELAND SECURITY

UNITED STATES FIRE ADMINISTRATION

NATIONAL FIRE ACADEMY

FOREWORD

The U.S. Fire Administration (USFA), an important component of the Department of Homeland Security (DHS), serves the leadership of this Nation as the DHS's fire protection and emergency response expert. The USFA is located at the National Emergency Training Center (NETC) in Emmitsburg, Maryland, and includes the National Fire Academy (NFA), and the National Fire Data Center (NFDC). The USFA also provides oversight and management of the Noble Training Center in Anniston, Alabama. The mission of the USFA is to save lives and reduce economic losses due to fire and related emergencies through training, research, data collection and analysis, public education, and coordination with other Federal agencies and fire protection and emergency service personnel.

The USFA's National Fire Academy offers a diverse course delivery system, combining resident courses, off-campus deliveries in cooperation with State training organizations, weekend instruction, and online courses. The USFA maintains a blended learning approach to its course selections and course development. Resident courses are delivered at both the Emmitsburg campus and the Noble facility. Off-campus courses are delivered in cooperation with State and local fire training organizations to ensure this Nation's firefighters are prepared for the hazards they face.

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PREFACE

Command and Control of Fire Department Operations at Target Hazards is a 6-day course that relies heavily on student involvement and instructional strategies that emphasize learning objectives at the application, analysis, and synthesis levels. The instructors function as guides and facilitators more than as stage presenters; therefore, classroom management and interunit connections are critical elements in the course process.

Course Goals

The goals of the course are to:

1. Increase the Incident Commander's (IC's) ability to integrate both fire and community resources to address an incident that

    a. Consumes the majority of the readily available fire department assets.

    b. Demands additional equipment and personnel.

    c. Entails multiagency response to confront the problem.

    d. Places the Command Officers in a position of managing both fire department and nonfire department activities over an extended time period.

2. Increase the student's ability to apply recognition-primed decision making (RPD) techniques to incidents at target hazards.

3. Increase the student's ability to organize and implement an Incident Command System (ICS) at target hazard incidents.

The 20 activities included in the course account for approximately two-thirds of class time. There are eight simulations, five-case studies, and seven-skill exercises. Eight competencies identified as critical for Command Officers at target hazard incidents are stressed throughout the simulations and case studies.

Target Audience

The target audience for this course includes officers who are charged with setting up initial operations at a major multialarm incident, and those officers involved in the transfer of Command to a higher level officer. In general this could include chief officers or those who perform in Command positions.

Students attending this class will be working with the number of units responding on a second alarm or greater (or mutual aid).

The target audience for this course includes persons involved with preparations for response to a target hazard incident, as well as for incident management and Postincident Analysis (PIA).

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SCHEDULE

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
AM	Unit 1: Introduction Target Hazard Profile Unit 2: Incident Command System	Unit 4: Decision Making Activity 4.1: NDM Activity 4.2: Seton Hall Dorm Fire	Unit 6: Documentation and Resource Management Activity 6.1: Case Study: Hazardous Materials Processing Plant Incident Unit 7: Penal Institutions or Grain Elevators Activity 7.1: Penal Institution Simulation	Unit 9: Enclosed Malls Activity 9.1: Mall Simulation Unit 10: Transportation Incidents	Unit 11: Bulk Storage Facilities and Tank Farms or Mill Buildings Activity 11.1: Bulk Storage or Mill Building Simulation Unit 12: Mitigation Strategies Activity 12.1: Mitigation Strategies	Unit 14: Terrorism Activity 14.1: Terrorism Simulation
	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch
PM	Unit 2: Incident Command System Unit 3: Nursing Homes	Unit 5: College Dormitories Unit 5: College Dormitory Simulation PIA Lecture and Activity 5.2: College Dorm PIA	Activity 7.2: Documentation Unit 8: Public Assemblies Activity 8.1: Airport Simulation	Activity 10.1: Train Derailment Activity 10.2: Train Derailment Simulation	Activity 12.2: One Meridian Plaza Unit 13: Highrise Incidents Activity 13.1: Highrise Simulation	Activity 14.1: Terrorism PIA Unit 1: Target Hazard Profile Course Summary, Evaluations, Cleanup, and Graduation
Evening	Evening Assignment: Read Units 4 and 5 and Activity 4.2: Seton Hall Dorm Fire	Evening Assignment: Read Units 6, 7, 8, and do Activity 6.1: Haz Mat Processing Plant	Evening Assignment: Read Units 9, 10, and Activity 10.1: Train Derailment	Evening Assignment: Read Units 11, 12, 13, and do Activity 12.2: One Meridian Plaza	Evening Assignment: Read Unit 14	

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FIREFIGHTER CODE OF ETHICS

Background

The Fire Service is a noble calling, one which is founded on mutual respect and trust between firefighters and the citizens they serve. To ensure the continuing integrity of the Fire Service, the highest standards of ethical conduct must be maintained at all times.

Developed in response to the publication of the Fire Service Reputation Management White Paper, the purpose of this National Firefighter Code of Ethics is to establish criteria that encourages fire service personnel to promote a culture of ethical integrity and high standards of professionalism in our field. The broad scope of this recommended Code of Ethics is intended to mitigate and negate situations that may result in embarrassment and waning of public support for what has historically been a highly respected profession.

Ethics comes from the Greek word ethos, meaning character. Character is not necessarily defined by how a person behaves when conditions are optimal and life is good. It is easy to take the high road when the path is paved and obstacles are few or non-existent. Character is also defined by decisions made under pressure, when no one is looking, when the road contains land mines, and the way is obscured. As members of the Fire Service, we share a responsibility to project an ethical character of professionalism, integrity, compassion, loyalty and honesty in all that we do, all of the time.

We need to accept this ethics challenge and be truly willing to maintain a culture that is consistent with the expectations outlined in this document. By doing so, we can create a legacy that validates and sustains the distinguished Fire Service institution, and at the same time ensure that we leave the Fire Service in better condition than when we arrived.

FIREFIGHTER CODE OF ETHICS

I understand that I have the responsibility to conduct myself in a manner that reflects proper ethical behavior and integrity. In so doing, I will help foster a continuing positive public perception of the fire service. Therefore, I pledge the following…

- Always conduct myself, on and off duty, in a manner that reflects positively on myself, my department and the fire service in general.
- Accept responsibility for my actions and for the consequences of my actions.
- Support the concept of fairness and the value of diverse thoughts and opinions.
- Avoid situations that would adversely affect the credibility or public perception of the fire service profession.
- Be truthful and honest at all times and report instances of cheating or other dishonest acts that compromise the integrity of the fire service.
- Conduct my personal affairs in a manner that does not improperly influence the performance of my duties, or bring discredit to my organization.
- Be respectful and conscious of each member's safety and welfare.
- Recognize that I serve in a position of public trust that requires stewardship in the honest and efficient use of publicly owned resources, including uniforms, facilities, vehicles and equipment and that these are protected from misuse and theft.
- Exercise professionalism, competence, respect and loyalty in the performance of my duties and use information, confidential or otherwise, gained by virtue of my position, only to benefit those I am entrusted to serve.
- Avoid financial investments, outside employment, outside business interests or activities that conflict with or are enhanced by my official position or have the potential to create the perception of impropriety.
- Never propose or accept personal rewards, special privileges, benefits, advancement, honors or gifts that may create a conflict of interest, or the appearance thereof.
- Never engage in activities involving alcohol or other substance use or abuse that can impair my mental state or the performance of my duties and compromise safety.
- Never discriminate on the basis of race, religion, color, creed, age, marital status, national origin, ancestry, gender, sexual preference, medical condition or handicap.
- Never harass, intimidate or threaten fellow members of the service or the public and stop or report the actions of other firefighters who engage in such behaviors.
- Responsibly use social networking, electronic communications, or other media technology opportunities in a manner that does not discredit, dishonor or embarrass my organization, the fire service and the public. I also understand that failure to resolve or report inappropriate use of this media equates to condoning this behavior.

Developed by the National Society of Executive Fire Officers

GRADING METHODOLOGY

Precourse Assignment

The precourse assignment is an individual assignment leading into the main theme of the course. The instructors will read, comment, and provide feedback on students' work within the first 2 days of the course.

The assignment/project will receive a score. The criteria used to determine this score is outlined below.

When evaluating course assignments/projects, instructors will consider the following:

1. Did the student comprehensively answer the assigned questions?

2. Did the student comprehensively address all issues within the response?

3. As a professional, is the student writing at a collegiate level, analyzing, reflecting on, and evaluating subject matter using appropriate grammar, punctuation, and spelling?

As this assignment is evaluated, emphasis should be placed on ensuring that instructor comments are positive, diagnostic, and corrective, based on the supplied rubric. Diagnostic means that instructors clearly indicate in a positive and constructive manner, where and how the assignment/project succeeded or fell short of meeting the requirements. Corrective means instructors specifically described what the student must do to bring the assignment/project up to a passing level.

Instructors will record the appropriate grade for all students on the Master Evaluation Sheet.

Case Study Projects

Students will participate as team members in the case studies provided as part of the course material and complete the documentation required for each. Evaluation will be based on the following elements:

1. Identify key issues involved with Command decisions--Case Study 2.1.

2. Identify Naturalistic Decision Making--Case Study 4.1.

3. Determine and identify 10 Primary Factors--Case Study 4.2.

4. Determine strategies and develop a Plan B; write a Safety Plan--Case Study 10.1.

Instructors will document the evaluation of students' Case Study Projects on the Case Study Projects Grade Sheet based on the supplied rubric. Any corrective and/or diagnostic comments about the students' plans should also be written on the form.

Instructors will record the appropriate grade for all students on the Master Evaluation Sheet.

Incident Simulation Learning Activities

The presentations required at the conclusion of the course are scored as follows:

1. The format and content of the presentation includes all of the elements listed in the objectives for the assignment in accordance with the learning outcomes.

2. Instructors will document the evaluation of students' incident debriefings. Any corrective and/or diagnostic comments about the students' plans should be written on the form.

3. Instructors will record the appropriate grade for each student on the Exercise Evaluation Sheet.

4. Instructors will share grade sheets including any comments/recommendations with the student after completion of the presentation and grading.

Note: The Evaluation Master Sheet will be used for official recordkeeping of students; scores which will be turned in to the Training Specialist at the conclusion of the course.

Final Course Grade

The student's final grade for *Command and Control of Fire Department Operations at Target Hazards* will be computed as follows:

Point Distribution

Attendance = 10 percent
Precourse assignment = 15 percent
Case studies = 40 percent
Incident learning activities = 35 percent

Letter Grade	Point Range	Student Performance Criteria
A	90-100	• Demonstrates ability to interpret, integrate, and apply learning outcomes beyond the context of the course through application of critical and creative thinking skills. • Completes work assignments that consistently exceed requirements and that interprets and applies objectives in new, unique, or creative ways.
B	80-89	• Completes work assignments that consistently meet most requirements. • Contributes regularly to class participation activities.
C	70-79	• Demonstrates a satisfactory level of competence in learning outcomes for the course. • Completes work assignments that satisfy minimum requirements for the course. • Satisfies minimum requirements for class participation activities.
D	60-69	• Completes work assignments that usually meet minimum requirements. • Contributes inconsistently or infrequently to class participation activities.
F	59 and below	• Cannot demonstrate competence in many fundamental outcomes for the course. • Submits work assignments that frequently do not meet minimum requirements, or does not complete the assigned work. • Does not satisfy minimum requirements for attendance or contribution to class activities.
I	—	• Satisfactorily completed most of the required work for the course, but due to medical reasons or other extenuating circumstances, is unable to complete the work by the end of the next semester. • Fails to request a deadline extension from the Training Specialist.

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A Student Guide to End-of-course Evaluations

Say What You Mean ...

Ten Things You Can Do to Improve the National Fire Academy

The National Fire Academy takes its course evaluations very seriously. Your comments and suggestions enable us to improve your learning experience.

Unfortunately, we often get end-of-course comments like these that are vague and, therefore, not actionable. We know you are trying to keep your answers short, but the more specific you can be, the better we can respond.

Actual quotes from student evaluations:	Examples of specific, actionable comments that would help us improve the course:
1 "Update the materials."	• The (ABC) fire video is out-of-date because of the dangerous tactics it demonstrates. The available (XYZ) video shows current practices. • The student manual references building codes that are 12 years old.
2 "We want an advanced class in (fill in the blank)."	• We would like a class that enables us to calculate energy transfer rates resulting from exposure fires. • We would like a class that provides one-on-one workplace harassment counseling practice exercises.
3 "More activities."	• An activity where students can physically measure the area of sprinkler coverage would improve understanding of the concept. • Not all students were able to fill all ICS positions in the exercises. Add more exercises so all students can participate.
4 "A longer course."	• The class should be increased by one hour per day to enable all students to participate in exercises. • The class should be increased by two days so that all group presentations can be peer evaluated and have written abstracts.
5 "Readable plans."	• The plans should be enlarged to 11 by 17 and provided with an accurate scale. • My plan set was blurry, which caused the dotted lines to be interpreted as solid lines.
6 "Better student guide organization," "manual did not coincide with slides."	• The slide sequence in Unit 4 did not align with the content in the student manual from slides 4-16 through 4-21. • The instructor added slides in Unit 4 that were not in my student manual.
7 "Dry in spots."	• The instructor/activity should have used student group activities rather than lecture to explain Maslow's Hierarchy. • Create a pre-course reading on symbiotic personal relationships rather than trying to lecture on them in class.
8 "More visual aids."	• The text description of V-patterns did not provide three-dimensional views. More photographs or drawings would help me imagine the pattern. • There was a video clip on NBC News (date) that summarized the topic very well.
9 "Re-evaluate pre-course assignments."	• The pre-course assignments were not discussed or referenced in class. Either connect them to the course content or delete them. • The pre-course assignments on ICS could be reduced to a one-page job aid rather than a 25-page reading.
10 "A better understanding of NIMS."	• The instructor did not explain the connection between NIMS and ICS. • The student manual needs an illustrated guide to NIMS.

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UNIT 1: INTRODUCTION

OBJECTIVES

The students will be able to:

1. *Introduce themselves to the other class members.*
2. *Review the course methodology and content.*
3. *Discuss the results of the Target Hazard Profile that was completed prior to attending the course.*

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INTRODUCTION

This is an intensive 6-day course. Evening assignments are part of the course structure. This course is designed to improve competency, knowledge, and skill in managing a target hazard incident.

Target hazards are defined as incidents that

- overload fire department equipment and personnel resources;
- involve atypical hazards;
- produce a significant negative impact on the community;
- require technical advice for effective strategic development; and
- initiate multiagency involvement.

Course Units

Unit 1: Introduction
Unit 2: Incident Command System
Unit 3: Nursing Homes
Unit 4: Decision Making
Unit 5: College Dormitories
Unit 6: Documentation and Resource Management
Unit 7: Penal Institutions
Unit 7: Grain Elevators (Optional)
Unit 8: Public Assemblies
Unit 9: Enclosed Malls
Unit 10: Transportation Incidents
Unit 11: Bulk Storage Facilities and Tank Farms
Unit 11: Mill Buildings (Optional)
Unit 12: Mitigation
Unit 13: Highrise Incidents
Unit 14: Terrorism

Components of Student Manual

Your Student Manual (SM) text is designed to serve as a reference book after you have completed this course. For this reason, we encourage you to avoid trying to read along in the manual as the course progresses, unless specifically asked to do so by the instructor.

There are many activity pages to which you will need to refer; the instructor will let you know when you are to perform these activities.

Each unit begins with the Unit Objectives.

NATIONAL FIRE ACADEMY INCIDENT MANAGEMENT CURRICULUM

The following courses make up the program, Incident Management.

- *Command and Control Decision Making at Multiple Alarm Incidents* (CCDMMAI).

  This is the first in the series of high-level command courses. It is for chief officers who have command responsibility for multicompany operations.

- *Executive Analysis of Fire Service Operations in Emergency Management* (EAFSOEM).

  The highest level course in the series, it is for department chiefs and senior chief officers who are responsible for planning and administering fire department activities.

- *Command and Control of Fire Department Operations at Natural and Man-Made Disasters* (CCNMMD).

  This course is designed for senior-level officers in charge of field operations at large-scale catastrophic disasters (floods, hurricanes, earthquakes, civil unrest, etc.).

- *Command and Control of Incident Operations* (CCIO).

  This is the first in the series of command level courses. It is for individuals who are placed in a command position on any incident operation.

- *Command and Control of Fire Department Operations at Target Hazards* (CCTH).

  This course is for senior-level chief officers who are responsible for multialarm incidents at target hazards.

COMPETENCIES

When we discuss competencies in this course we are talking about knowledge, skills and abilities that command officers should possess. If we, as Incident Commanders, are to be safe, effective and efficient we need to develop these traits. While there is a broad base of knowledge and many skills we need to develop over our careers, these core competencies form the foundation.

- Preincident planning;
- Size-up;
- Decision making cues;
- Incident command organization;
- Command staff positions;
- Communications;
- Resource management; and
- Mitigation and documentation.

The list may appear to be overwhelming but remember we are talking about developing a *foundation,* a basic "tool box" that we continue to add to as we continue in our career. Let's take a closer look at these competencies.

Preincident Planning

Fire officers must recognize the value of preincident planning and actively participate in the program. This means recognizing what constitutes a **target hazard** in your community, what should be included in the plan, understanding the results of the preplan and most importantly train your people in the use of them.

Size-up

We all have been taught and can quote the basics principles of size-up, but do we really understand the process? Do you recognize the problems before developing your plan or just become the "moth to the flame?" Do you understand how you arrive at your conclusions? Size-up is part of the decision making process and it is critical that you understand how you make decisions; that you correctly interpret the information; and that you apply the appropriate solutions.

Decision Making Cues

Cues are "red flags," pieces of information that should, coupled with your experience, help you make good decisions. Our ability to develop a comfort level as an Incident Commander and correctly read the cues is base on our total learning and experience. Simply stated, "The more we experience a situation the more comfortable we are with it."

Incident Command Organization

Taking Incident Command System (ICS) courses and being able to speak the ICS lingo is important but the question you have to ask is "Do I really understand and am I able to apply ICS under stress?" Incident Commanders (ICs) must recognize the organizational demand an incident is creating. You can't just fill in the boxes; you must be able to create the organization necessary to mitigate the situation.

Command Staff Positions

Many fire officers do not understand these positions and the value they can provide to the IC. We need to develop a true understanding of what each of those positions do, what they can contribute to the command structure and what training and direction they need to be effective.

Communications

Communications is a highly technical component of the incident and most of us do not understand the details of communications hardware. It is not important for the IC to be a technical expert, however what is important is that he/she understand the value of incident communications. What information is needed, who needs it, how is it accomplished and do my people understand the process. Policies should be in place to guide a personnel accountability process, progress reports, frequency use and interagency operations.

Resource Management

Usually when we want resources in our community we just call dispatch and request them. However, the ICs knowledge must go well beyond that, he/she must understand the capability and capacities of resources; how long does it take for incoming resources to be operational?; how are specialized resources obtained and what is the ordering process? If you don't understand the resource you are asking for, chances are you will not get what you really want.

Mitigation and Documentation

Mitigation in this context goes beyond day-to-day strategy and tactics. We are talking about prediction, projection and long-term community impact. The documentation component is not exciting but it is critical for reimbursement, resolving legal issues, compensation/claims and budget justification just to name a few areas that documentation will impact.

We have just scratched the surface in explaining these competencies. We will address them further as we move through the course but it is recommended that every fire officer continue to study, learn and strengthen these traits as they progress in their careers.

Activity 1.1

Student Introductions

Purpose

To meet the instructors and other students.

Directions

1. An instructor will perform roll call.

2. The instructors will then introduce themselves and briefly discuss their background.

3. Next, you will each be allotted two minutes to introduce yourselves and give an overview of your background and expectations for this course. Information should include:

   a. Name and rank.

   b. Department or agency.

   c. Basic information on department/agency.

   d. Size of department/agency.

   e. Size of community.

   f. Current responsibilities.

   g. Expectations from attending this course.

4. One of the instructors will record the expectations and review them periodically to ensure that expectations are being met during the course.

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Activity 1.2

Target Hazard Chart Profile

Purpose

To collate your precourse research and find common areas of concern in other communities.

Directions

1. You will work individually to complete a Target Hazard Chart for your community, and then work as a group to find common areas of risk.

2. Record in priority order the six most important target hazards identified while completing your precourse assignment. The first priority should be the hazard with the greatest risk and the least preparation, followed by the hazard with the next highest risk and next lowest level of preparation. The process should continue until six target hazards have been summarized on the chart.

    a. Column 1 should show the name and location of the target hazards.

    b. Column 2 should be used to describe the important impact factors that caused these properties to be identified as target hazards, such as life safety, firefighter safety, environmental impact, conflagration potential, and economic impact. More than one factor can be described on the chart for a hazard.

    c. Column 3 should describe the current level of preincident planning (PIP) completed by your department for each target hazard. Use the following terms:

        - **None:** Indicates that nothing has been done to prepare for an incident at this location.

        - **Minimal:** Some planning has been completed, but the document is old or cannot be found; companies assigned to first response may have visited the site at some time in the past.

        - **Fair:** PIP has taken place recently, and a document has been created or updated; first-response units have toured the facility recently and have reviewed the plan.

        - **Good:** The preincident plan is updated regularly; responding units tour the location, review the plan, and conduct drills based on potential scenarios.

    d. Column 4 will be completed during a later assignment.

3. When all the members of your group have completed a Target Hazard Chart, share the results and identify at least three common target hazards among the lists. The group then should complete a Target Hazard Chart on an easel pad, duplicating columns 1, 2, and 3 on the chart. The information placed in columns 2 and 3 should be a compilation of the information on the individual lists.

4. Present a report to the class.

Activity 1.2 (cont'd)

Target Hazard Chart Profile

Target Hazard Chart			
Name:	Rank:	Years of Service:	
Community Population:	Department Name and Size:		
Target Hazards	Impact Factors	PIP*	

*N=None M=Minimal
F=Fair G=Good

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UNIT 2: INCIDENT COMMAND SYSTEM

TERMINAL OBJECTIVE

At the end of this unit students will be able to develop an effective incident organization to assemble, coordinate, and control tactical resources, allowing for expansion based on complexity of the incident.

ENABLING OBJECTIVES

The students will be able to:

1. *Identify the components of the Incident Command System (ICS).*

2. *Discuss the ICS organization for example incidents.*

3. *Using the Los Angeles Central Library Fire Case Study, analyze the responsibilities of the Incident Commander (IC), Operations, Plans, Logistics, Safety, Liaison, and Public Information.*

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INTRODUCTION

In the early 1970s, Southern California experienced several devastating wildland fires. The overall cost and loss associated with these fires totaled $18 million per day. This multijurisdictional disaster was the impetus for the development of an improved interagency incident management system known as the **Incident Command System (ICS)**. ICS is one of the beneficial results of a Federally funded project called ***FIRESCOPE*** that was convened after these fires, and whose charter was to examine various aspects of interagency response to incidents.

FIRESCOPE derives its name from: **FI**re **RES**ources of **C**alifornia **O**rganized for **P**otential **E**mergencies. The *FIRESCOPE* ICS is primarily a command and control system delineating job responsibilities and organizational structure for the purpose of managing day-to day operations for all types of emergency incidents. While originally developed for wildland incidents it was found that the system could be applied easily to day-to-day fire and rescue operations. It also is flexible enough to manage catastrophic incidents involving thousands of emergency response and management personnel.

In 1986, the National Fire Academy (NFA) supported the FIRESCOPE ICS as the model fire service incident management system for all its courses. The Federal Emergency Management Agency (FEMA) formally adopted the FIRESCOPE ICS as the IMS for any Federal response required by the agency. When the Department of Homeland Security released the National Incident Management System (NIMS) in 2004, the National Fire Academy, as a component of FEMA, adopted the NIMS and incorporated it into its courses.

THE NATIONAL INCIDENT MANAGEMENT SYSTEM

On February 28, 2003, President Bush issued Homeland Security Presidential Directive-5 (HSPD–5). One purpose of HSPD-5 is "to enhance the ability of the United States to manage domestic incidents by establishing a single, comprehensive national incident management system." This excerpt from HSPD-5 outlines the tasking given to the Secretary of Homeland Security:

> (15) The Secretary shall develop, submit for review to the Homeland Security Council, and administer a National Incident Management System (NIMS). This system will provide a consistent nationwide approach for Federal, State, and local governments to work effectively and efficiently together to prepare for, respond to, and recover from domestic incidents, regardless of cause, size, or complexity.

On March 1, 2004, after close collaboration with State and local government officials and representatives from across a spectrum of public safety organizations, the Department of Homeland Security (DHS) issued the National Incident Management System (NIMS). The NIMS integrates existing best practices into a consistent, nationwide approach to domestic incident management that is applicable at all jurisdictional levels and across functional disciplines in an all-hazards context.

NIMS is more than the Incident Command System (ICS). The NIMS is comprised of the following four components:

1. Compliance.

2. Training.

3. Standards and Technology.

4. Resource Management/Mutual Aid--Standardized procedures for resource management processes.

Command and Management envisions the most familiar (and easily implemented) part of NIMS--the ICS. Organizations must, as a condition of Federal preparedness assistance, take steps to begin institutionalizing the use of ICS during prevention and response efforts. Actions to institutionalize the use of ICS take place at two levels--policy and organizational/operational.

- At the policy level, institutionalizing the ICS means government officials, i.e. governors, mayors, county and city managers, tribal leaders, and others:

  - adopt the ICS through executive order, proclamation, or legislation for the jurisdiction; and
  - direct that incident managers and response organizations in their jurisdictions train, exercise, and use the ICS in their response operations.

- At the organizational/operational level, evidence that incident managers and emergency response organizations are institutionalizing the ICS would include the following:

  - ICS is being integrated into functional and system-wide emergency operations policies, plans, and procedures;
  - ICS training is planned or under way for responders, supervisors, and command level officers; and
  - responders at all level are participating in and/or coordinating ICS-oriented exercises that involve responders from multidisciplines and jurisdictions.

Throughout this training course, when the term "ICS" is used it should be understood that the reference is to the incident management system described in NIMS, and to include the application of NIMS principles to the specific scenario being discussed.

Many other agencies besides fire agencies--both public and private--will be adopting the NIMS as required by the DHS.

The ICS established in the NIMS is not a new emergency incident management system. It is based on the *Incident Command System Operational System Description* document (ICS 120-1) developed by FIRESCOPE. The two most significant differences between NIMS and FIRESCOPE ICS are

1. The Command Staff Information Officer position is now called the Public Information Officer (PIO).

2. The Intelligence and Investigation function may be organized in one of the following ways:

   - as an Officer within the Command Staff,
   - as a Unit within the Planning Section,
   - as a Branch within the Operations Section, or
   - as a separate General Staff Section.

The following discussion helps guide the determination for the most effective placement of the Intelligence and Investigation option in the NIMS.

- **As an Officer in the Command Staff.** This option may be most appropriate in incidents with little need for tactical or classified intelligence and in which incident-related intelligence is provided by supporting agency representatives, through real-time reach-back capabilities.

- **As a Unit within the Planning Section.** This option may be most appropriate in an incident with some need for tactical intelligence and when no law enforcement entity is a member of the Unified Command.

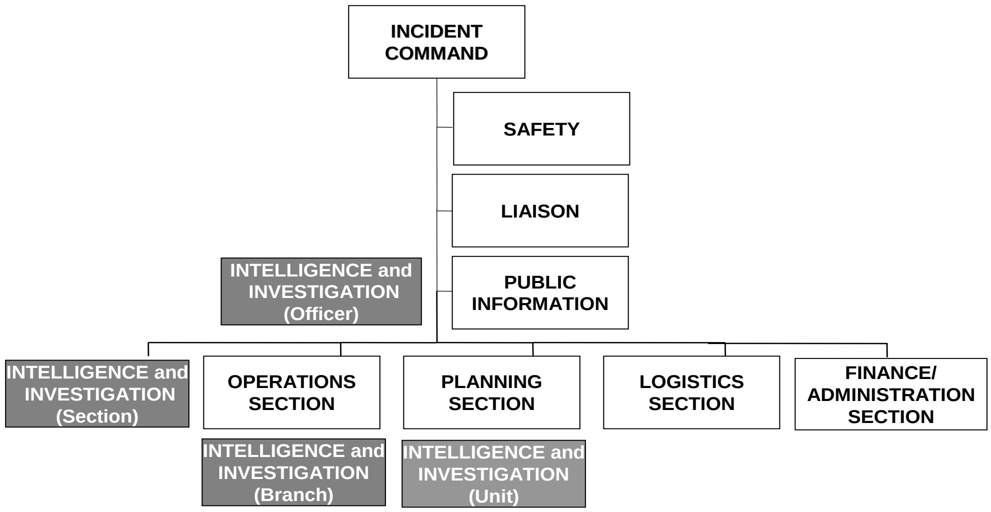
- **As a Branch within the Operations Section.** This option may be most appropriate in incidents with a high need for tactical intelligence (particularly classified intelligence) and when law enforcement is a member of the Unified Command.

- **As a General Staff Section.**

  - This option may be most appropriate when an incident is heavily influenced by intelligence factors, or when there is a need to manage and/or analyze a large volume of classified or highly sensitive intelligence or information.

  - This option is particularly relevant to a terrorism incident, for which intelligence plays a crucial role throughout the incident life cycle.

INTELLIGENCE and INVESTIGATION OPTIONS



Intelligence and Investigation Options in the National Incident Management System--Summary

- Regardless of how it is organized, the Intelligence and Investigation function also is responsible for developing, conducting, and managing information-related security plans and operations as directed by the IC.

- These can include information security and operational security activities, as well as the complex task of ensuring that sensitive information of all types (e.g., classified information, sensitive law enforcement information, proprietary and personal information, or export-controlled information) is handled in a way that not only safeguards the information but also ensures that it gets to those who need access to it so that they can conduct their missions effectively and safely.

- The Intelligence and Investigation function also has the responsibility for coordinating information- and operational-security matters with public awareness activities that fall under the responsibility of the PIO, particularly where such public awareness activities may affect information or operations security.

ICS has evolved into an all-risk, all-situation emergency management system. ICS is a people management tool. We manage people, not fires, floods, tornadoes, plane crashes, hazardous materials incidents, mass casualties, etc. ICS has been used on all types of emergency situations as well as nonemergency situations.

THE NATIONAL RESPONSE PLAN

Certain events/incidents can escalate to a level that requires Federal resources. The Homeland Security Act of 2002 and HSPD-5 mandated the development of a National Response Framework (NRF) that would define a single, comprehensive national approach to incidents requiring Federal response and assistance. Additionally, the NRF identifies coordination structures and mechanisms, direction for the incorporation and concurrent implementation of existing plans, and a consistent approach to reporting incidents. The NRF also requires providing incident assessments and making recommendations to the President, DHS Secretary, and the Homeland Security Council (HSC).

The NRF supersedes the National Response Plan (NRP), the Domestic Terrorism Concept of Operations Plan (CONPLAN), the Federal Radiological Emergency Response Plan (FRERP), and the Initial National Response Plan (INRP). Many of the familiar concepts and mechanisms associated with these plans have been carried over to the NRF, such as the Emergency Support Function (ESF) components of the NRP. Elements introduced in the Initial National Response Plan (INRP), such as the Homeland Security Operations Center (HSOC), Interagency Incident Management Group (IIMG), Principal Federal Official (PFO), and the Joint Field Office (JFO) are now a part of the final NRF.

The NRF, as the base plan, establishes the national framework for assessing domestic incidents to determine the appropriate level of Federal involvement. It is designed to link to an array of national-level hazard-specific contingency plans, such as the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). These contingency plans can be implemented independently during localized incidents or concurrently with the NRP to coordinate interagency incident management efforts, using the NIMS, for events considered "Incidents of National Significance."

HSPD-5 defines Incidents of National Significance as those that meet the following criteria:

- when another Federal department or agency has requested DHS assistance;
- when State/local capabilities are overwhelmed and Federal assistance is requested;
- when an incident substantially involves more than one Federal department/agency; or,
- when the Secretary of DHS has been directed by the President to assume incident management responsibilities.

ADDITIONAL INFORMATION

National Incident Management System

A downloadable, PDF version of the NIMS can be found on the NIMS Integration Center Web site, http://www.fema.gov/nims/nims.shtm

An online, independent study program for the NIMS can be found on the Emergency Management Institute (EMI) Web site. The course, IS700 NIMS: *An Introduction to the NIMS*, is a Web-based awareness-level course that explains NIMS components, concepts, and principles. The course can be accessed at http://training.fema.gov/EMIweb/IS/is700.asp

Additional information, requirements, and guidelines for fulfilling an organization's NIMS compliance can be found on the NIMS Integration Center's Web site: http://www.fema.gov/nims/ Of particular interest to fire service organizations is NIMCAST (National Incident Management Compliance Assessment Tool), a Web-based self-assessment system that will allow evaluation of an organization's preparedness and response capabilities against the requirements of the NIMS.

National Response Framework

The NRF specifies how the resources of the Federal government will work in concert with State, local, and tribal governments and the private sector in response to Incidents of National Significance. The NRF is predicated on the NIMS. Together the NRF and the NIMS provide a nationwide template for working together to prevent or respond to threats and incidents regardless of cause, size, or complexity.

An initial review of the NRF will occur 1 year after implementation. Following this, the NRF will be subject to a deliberate 4-year review and re-issuance cycle. The most current version of the NRF can be found on the DHS Web site, http://www.dhs.gov/

An online, independent study program for the NRF can be found on the EMI Web site. The course, IS-800: *An Introduction to the NRF*, includes the concept of operations upon which the plan is built, roles and responsibilities of the key players, the organizational structures for NRF coordination, the field-level organizations and teams activated under the NRF, and the incident management activities addressed by the NRF. The course is designed for DHS and other Federal department/agency staff responsible for implementing the NRF, as well as State, local, and private sector emergency management professionals. The course can be accessed via the Web site: http://training.fema.gov/EMIweb/IS/is800.asp

COMPONENTS

In emergency operations, we must have the ability to move rapidly from a nonincident organization to an incident organization. We must have a standard methodology that allows us to react out of habit and to get into the basic level of our emergency scene organization immediately.

Common Terminology

For effective communication, words must have a single definition, functional areas must have one set of responsibilities, and no two words may have the same definition. If this axiom is changed, confusion is introduced into the conveyance of information, orders, etc.

Modular Organization

Usually, the ICS organization at routine incidents is simple. There are relatively few problems, a limited number of resources, and the IC can handle all management functions.

At a more complex incident, more problems need solutions. Additional resources result in an increase in management concerns. The IC is unable to do all the jobs and to provide all the answers without assistance.

The basic ICS organization must expand with the needs of the incident. As conditions or needs change so must the organizational structure. The modular design of ICS allows the organization to be structured for specific incidents.

Attempting to deal with all management functions may overload the IC. When overload occurs, the IC may overlook important details, and personnel safety may be compromised.

The solution is to use the ICS to delegate specific responsibilities and authority to other personnel. The ICS provides a systems approach to effective incident organization.

Unified Command Structure

The Unified Command Structure allows combinations of agencies and/or municipalities to coordinate the command of an incident.

Consolidated Action Plan

The ICS approach also provides a mechanism for coordinating the efforts of all areas involved through delegation of authority and responsibility. Giving someone else the authority to carry out responsibilities develops a clear line of authority and creates a manageable span of control (the number of individuals or jobs that can be supervised effectively by one person). Delegating authority means that one individual does not have to oversee all facets of all operations. It is also conducive to the "one person--one boss" concept (unity of command).

Identifying functional areas also makes it easier to identify necessary tasks. Concentration on one area, rather than on many areas, tends to ensure that all tasks in that area are addressed.

Equally important is the prioritizing of tasks. When objectives are limited within the scope of the functional area, tasks necessary for their accomplishment are more easily identified and are carried out in the proper order. People are less likely to freelance.

Manageable Span of Control

Span-of-control refers to the number of personnel reporting to any given individual. Optimum span-of-control in the Incident Command System (ICS) is five, with an acceptable spread of two to seven. On a situation that is not yet under control, no one operating under ICS should have more than five personnel reporting to him/her.

Span-of-control ratios can be driven by a number of factors:

- **Training/Experience level of subordinates**--Poorly trained or less experienced personnel require more direct supervision, thereby lessening the number of subordinates one can manage effectively.

- **Complexity of the incident**--A hazardous materials incident may require more mental concentration, thereby leaving less time available to supervise personnel.

- **Type or timeframe of the incident**--The speed of operations may influence span-of-control. A fast-moving incident may require a tighter span-of-control with fewer divisions/groups in place, whereas, in a slower moving operation such as overhaul, the supervisor is less pressed for time for decision making and therefore can manage more personnel/divisions/groups.

For span-of-control purposes, the following functions are **not** counted as reporting to a supervisor:

- Safety Officer;
- Liaison Officer;
- Public Information Officer; and
- Staging Area Manager.

In ICS, these positions are basically assistants to the Incident Commander (IC), or in the case of Staging, to the Operations Section Chief.

Predesignated Incident Facilities

In order to manage large incidents effectively, we must develop the appropriate habits that get us efficiently into the ICS. Predesignated incident facilities ensure that when large incidents do occur there is no confusion or time wasted.

Comprehensive Resource Management

ICS is not a rank-oriented system, but a performance-oriented one. The best-qualified person is placed into the appropriate functional level for the situation.

All personnel who are going to be involved anywhere, at any level in the system, must be trained in the use of ICS.

The only position (function) in the ICS that always must be staffed is that of Incident Commander (IC). There always must be someone in charge, responsible, and accountable. This position must be assumed by the first or ranking member of the fire department to arrive at the scene.

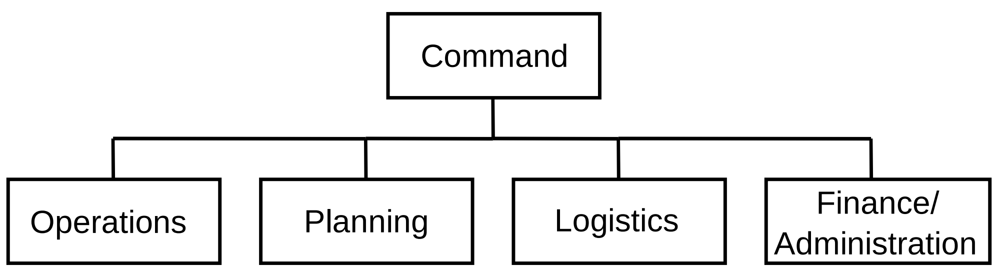
Unless Federal, State, or local law states otherwise, the ranking officer from the jurisdiction is the IC. He/She cannot be removed from this position unless the law provides otherwise. However, command may be transferred to another person from another agency or jurisdiction at the IC's discretion.

INCIDENT COMMAND SYSTEM STRUCTURE

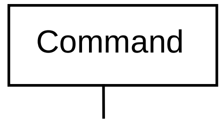
A Command Officer must understand the functional positions in the ICS, and the responsibilities and roles of each.

These are the five major management functional areas of the ICS.

It is important to remember that the blocks are functions or jobs, not positions that **must** be staffed.



Incident Commander and Command Staff



The first component of the ICS is Command. No operation can be implemented unless someone is in charge. Command is responsible for:

- determining strategy;
- selecting tactics;
- setting the action plan;
- developing the ICS organization;
- managing resources;
- coordinating resource activities;
- providing for scene safety;
- releasing information about the incident; and
- coordinating with outside agencies.

Command Options

The first-arriving unit or member to assume Command of the incident has several command options, depending on the situation. If a Chief Officer, member, or unit without tactical capabilities (i.e., staff vehicle, no equipment, etc.) initiates Command, the establishment of an Incident Command Post (ICP) should be a top priority. At most incidents, the initial Incident Commander (IC) will be a Company Officer (CO). The following Command options define the CO's direct involvement in tactical activities.

Nothing-Showing Mode: These situations generally require investigation by the initial arriving company while other units remain in a staged mode. The CO should go with the company to investigate while using a portable radio to command the incident.

Fast-Attack Mode: Situations that must be stabilized immediately require the CO's assistance and direct involvement in the attack. In these situations, the CO goes with the crew to provide the appropriate level of supervision. Examples of these situations include

- offensive fire attacks (especially in marginal situations);
- critical life safety situations (i.e., rescue) that must be achieved in a compressed timeframe;
- any incident where the safety and welfare of firefighters are major concerns; and
- obvious working incidents that require further investigation by the CO.

Where fast intervention is critical, using a portable radio will permit the CO's involvement in the attack without neglecting Command responsibilities. The Fast-Attack mode should not last more than a few minutes and will end with one of the following:

- The situation is stabilized.
- The situation is not yet stabilized, and the CO may withdraw to the exterior and establish Command in a fixed location. At some time, the CO must decide whether or not to withdraw the remainder of the crew, based on the crew's capabilities and experience, safety issues, and the ability to communicate with the crew. No crew should remain in a hazardous area without radio communications capabilities.
- The situation is not yet stabilized, and the CO remains inside with the crew in a Combat/Command mode. This option is chosen when the officer can make a difference in the effectiveness of the crew.
- Command is transferred to another officer. When a Chief Officer is assuming Command, the Chief Officer may opt to return the CO to his/her crew, or assign him/her to a subordinate position.

Command Mode: Certain incidents, by virtue of their size, complexity, or potential for rapid expansion, require immediate strong, direct, overall Command. In such cases, the CO initially will assume an exterior, safe, and effective Command position and maintain that position until relieved by another officer. A tactical worksheet shall be initiated and used to assist in managing this type of incident.

If the CO selects the Command mode, the following options are available regarding the assignment of the remaining crew members.

- The CO may assign an "acting" officer within the company, and place the company into action with the remaining members. One of the crew members will serve as the acting CO and should be provided with a portable radio. The collective and individual capabilities and experience of the crew will regulate this action.
- The CO may assign the crew members to work under the supervision of another CO. In such cases, the officer assuming Command must communicate with the officer of the other company and indicate the assignment of those personnel.
- The CO may elect to assign the crew members to perform staff functions to assist Command.

A CO assuming Command has a choice of modes and degrees of personal involvement in the tactical activities, but continues to be fully responsible for the Command functions. The initiative and judgment of the officer are of great importance. The modes identified are guidelines to assist the officer in planning appropriate actions. The actions initiated should conform with one of the previously mentioned modes of operation.

Strategic Level, Tactical Level, Task Level

Operational responsibilities of Command include three levels:

1. **Strategic Level:** Determines overall direction of the incident.

2. **Tactical Level:** Assigns operational (tactical) objectives.

3. **Task Level:** Completes specific tasks assigned to companies.

The strategic level is a function of the IC. The IC sets the overall plan and strategic priorities.

The tactical level is a function of the Operations Section Chief. Operations selects the tactical objectives and prioritizes the accomplishment of the objectives. When an Operations Chief has not been designated, the IC must perform the tactical-level responsibilities.

When and if the Planning Section is established, the strategic and tactical levels of the operation should become part of the information given to the Planning Section Chief. This is vital information for Planning, since the primary function of this section is evaluating the incident and forecasting incident needs. The Planning Section also must develop alternative plans that include strategic- and tactical-level information.

The task level is a responsibility of the CO and the firefighters who are performing the individual tasks that achieve the tactical objectives.

Command Staff

Safety Officer

The person assigned as an Incident Safety Officer (ISO) must have certain specific knowledge before being assigned or assuming the function. For example, a structural fire Safety Officer should have a good background in fire behavior factors, building construction, strategy and tactics, general safety rules (NFPA 1500), departmental safety rules, local, State, and Federal regulations.

A Safety Officer for hazardous materials should be certified as a Hazardous Materials Technician.

The Safety Officer has the authority, from the IC, to immediately halt any unsafe operation and move personnel to a safe location. This is only allowed when the Safety Officer perceives an "imminent danger" situation for the personnel involved. After giving the directive to stop an operation, the Safety Officer must notify Command of the order so Command can redirect tactical operations.

In situations that do not present "imminent danger," the Safety Officer notifies Command of the approaching hazard and Command makes the decision on redirecting tactical operations.

The Safety Officer function should be staffed when Command does not have the time to focus on the incident safety issues. This would likely occur at almost all working incidents, except for the most simplistic incidents.

Liaison Officer

The Liaison Officer is an interface between Command and any outside agencies that may be required at the incident. This would not include agency representatives that are part of Unified Command. Some of those agencies may include police departments, third party EMS, Red Cross, power company personnel, facilities management, etc.

The Liaison Officer, once established, should set-up a Liaison Area where all outside agency representatives would be directed to report.

The Liaison Officer function should be established when Command does not have the time to interface with numbers of outside agency representatives due to the strain and time constraints of managing the incident.

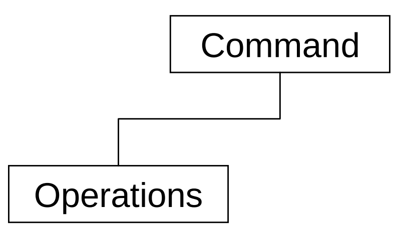
Public Information Officer

The PIO is responsible for the release of incident information to the media and other agencies. The PIO coordinates the activities of the media and provides positive, effective support to allow them the ability to properly do their job.

The PIO function is staffed when Command does not have the time to interface with the media at any given incident.

General Staff

Operations



Operations is responsible for the management of all operations directly applicable to the primary mission. Its function is to direct the organization's tactical operations to meet the strategic goals developed by Command. Operations allocates and assigns resources to establish control of the incident, and participates in the development of the Incident Action Plan (IAP).

Staffing Operations

The Operations Section is responsible for the direct management of all incident tactical activities, tactical priorities, and the safety of personnel working in the Operations Section.

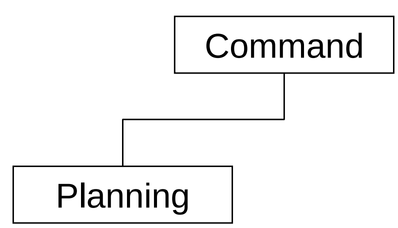
The most common reason for staffing Operations is to relieve the span-of-control problems for the IC. These span-of-control problems occur when the number of branches, divisions, and groups, coupled with Planning and/or Logistic Section elements exceeds the IC's ability to manage effectively. The IC may then implement the Operations Section to reduce the span-of-control, transferring the direct management of all tactical activities to the Operations Section. The IC is then able to focus attention on the overall management of the entire incident as well as interact with the Command Staff and General Staff.

A complex incident, in which the IC needs assistance determining strategic goals and tactical objectives, also may require implementing Operations. However, Operations should be staffed only to improve the management of the incident. If it is not used to maintain a manageable workload or an effective span-of-control, the IC could end up with a span-of-control of one.

After Operations is implemented, the duties of the IC are modified slightly. Operations will be responsible for all tactical operations, resources, and accomplishment of specific activities. The IC will be responsible for the development of the incident strategy and the communication of that strategy to the Operations Section Chief.

When Operations is staffed, the IC focuses on strategy and the Operations Chief focuses on tactics. The IC no longer talks to the operational companies.

<u>Planning</u>



The Planning Section Chief reports directly to Command. Planning is responsible for the collection, evaluation, dissemination, and use of information about the development of the incident. Planning must understand the current situation, predict the probable course of events, and prepare optional strategies and tactics.

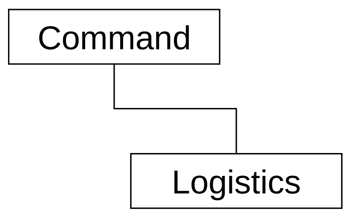
For an organization to operate effectively, it must base its decisions on the best information available. This information must be evaluated and trends must be projected. Command will use this information to prepare and develop strategic goals as well as to develop alternate plans.

Planning also is responsible for maintaining the status of resources, documenting the incident, and providing for demobilization. Planning participates in the development of the IAP.

The Planning Section Chief position is staffed when the IC needs assistance at the Command Post (CP) to determine the appropriate strategy and tactics. This need could be the result of having little or no experience with the incident type. In this case, two heads may be better than one. The function also is staffed on complex incidents where information analysis and strategic options cannot be accomplished by one person in a timely manner.

Technical Specialists report initially to the Planning Section. For example, a military officer from a nearby base has the ability to supply the IC with certain types of resources for control of the incident. That person would be directed to the Planning Section where all applicable information would be transferred. The military officer would then be directed to the Logistics Section where the actual movement of the resources would be determined.

Logistics



The Logistics Section Chief reports directly to Command. Logistics is responsible for providing facilities, services, and materials in support of the incident; it is the supply sergeant for the incident. Logistics participates in the development of the action plan.

The Logistics Section Chief position is staffed when service and support functions are required to maintain the operational forces. This generally occurs on complex, resource-intensive, or long-duration incidents.

Responder Rehabilitation

Logistics is responsible to establish a Responder Rehab under the Medical Unit in this section. Responder rehab should be considered by the IC during the initial planning stages of an emergency response. However, the climatic or environmental conditions of the emergency scene should not be the sole justification for establishing responder rehab. Any activity/incident that is large in size, long in duration, and/or labor intensive will deplete the energy and strength of personnel rapidly, and therefore merits consideration for responder rehab.

A critical factor in the prevention of heat injury is the maintenance of water and electrolytes. Water must be replaced during exercise periods and at emergency incidents. During heat stress, the member should consume at least 1 quart of water per hour. The rehydration solution should be a 50/50 mixture of water and a commercially prepared activity beverage, administered at about 40 °F. Alcohol, caffeine, and carbonated beverages should be avoided, as they interfere with the body's water conservation mechanisms.

Food should be provided at the scene of an extended incident of 3 or more hours' duration. A cup of stew, soup, or broth is highly recommended because it is digested much faster than sandwiches and fast food products. Fatty and/or salty foods should be avoided.

The "two air bottle rule," or 45 minutes of work time, is recommended as an acceptable level prior to mandatory rehabilitation. Members shall rehydrate (at least 8 ounces) while self-contained breathing apparatus (SCBA) cylinders are being changed. Firefighters, having worked for two full 30-minute-rated bottles, or 45 minutes, shall be placed immediately in responder rehab for rest and evaluation. Rest shall not be less than 10 minutes and may exceed an hour as determined by the responder rehab manager. Crews released from rehab shall be available in Staging to ensure that fatigued members are not required to return to duty before they are rested, evaluated, and released by the responder rehab manager.

Members in the rehab area should maintain a high level of hydration. Members should not be moved from a hot environment directly into an air-conditioned area, because the body's cooling system can shut down in response to the external cooling.

Emergency medical services (EMS) should be provided and staffed by the most highly trained and qualified EMS personnel on the scene (at a minimum of basic life support (BLS) level). The heart rate should be measured for 30 seconds as early as possible in the rest period. If the member's heart rate exceeds 110 beats per minute, an oral temperature should be taken. If the member's temperature exceeds 100.6 °F, he/she should not be permitted to wear protective equipment. If it is below 100.6 °F, and the heart rate remains above 110 beats per minute, **rehabilitation time should be increased.** All medical evaluations shall be recorded on standard forms along with the member's name and complaints; they must be signed, dated, and timed by the responder rehab manager or his/her designee.

Members assigned to responder rehab shall enter and exit as a crew. The crew designation, number of crew members, and the times of entry and exit from the responder rehab area shall be documented on the company's check-in/checkout sheet. Crews shall not leave the responder rehab area until authorized by the responder rehab manager.

HEAT STRESS INDEX

TEMPERATURE °F	RELATIVE HUMIDITY 10%	20%	30%	40%	50%	60%	70%	80%	90%
104	98	104	110	120	132				
102	97	101	108	117	125				
100	95	99	105	110	120	132			
98	93	97	101	106	110	125			
96	91	95	98	104	108	120	128		
94	89	93	95	100	105	111	122		
92	87	90	92	96	100	106	115	122	
90	85	88	90	92	96	100	106	114	122
88	82	86	87	89	93	95	100	106	115
86	80	84	85	87	90	92	96	100	109
84	78	81	83	85	86	89	91	95	99
82	77	79	80	81	84	86	89	91	95
80	75	77	78	79	81	83	85	86	89
78	72	75	77	78	79	80	81	83	85
76	70	72	75	76	77	77	77	78	79
74	68	70	73	74	75	75	75	76	77

Note: Add 10 °F when protective clothing is worn, and add 10 °F when in direct sunlight.

Humiture °F	Danger Category	Injury Threat
Below 60°	None	Little or no danger under normal circumstances.
80° to 90°	Caution	Fatigue possible if exposure is prolonged and there is physical activity.
90° to 105°	Extreme Caution	Heat cramps and heat exhaustion possible if exposure is prolonged and there is physical activity.
105° to 130°	Danger	Heat cramps or exhaustion likely, heat stroke possible if exposure is prolonged and there is physical activity.
Above 130°	Extreme Danger	Heat stroke imminent!

Temperature °F

Wind Speed (MPH)	45	40	35	30	25	20	15	10	5	0	-5	-10	-15
5	43	37	32	27	22	16	11	6	0	-5	-10	-15	-21
10	34	28	22	16	10	3	-3	-9	-15	-22	-27	-34	-40
15	29	23	16	9	2	-5	-11	-18	-25	-31	-38	-45	-51
20	26	19	12	4	-3	-10	-17	-24	-31	-39	-46	-53	-60
25	23	16	8	1	-7	-15	-22	-29	-36	-44	-51	-59	-66
30	21	13	6	-2	-10	-18	-25	-33	-41	-49	-56	-64	-71
35	20	12	4	-4	-12	-20	-27	-35	-43	-52	-58	-67	-75
40	19	11	3	-5	-13	-21	-29	-37	-45	-53	-60	-69	-76
45	18	10	2	-6	-14	-22	-30	-38	-46	-54	-62	-70	-78

	Wind Chill Temperature °F	Danger
A	Above -25 °F	Little danger for properly clothed person.
B	-25 °F -75 °F	Increasing danger, flesh may freeze.
C	**Below -75 °F**	Great danger, flesh may freeze in 30 seconds.

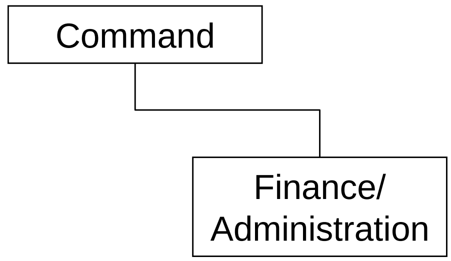
Rehab Unit
Company Check-IN/-OUT Sheet

Crews Operating on the Scene: ____

____

Unit #	# Persons	Time In	Time Out		Unit #	# Persons	Time In	Time Out

Finance/Administration



Finance/Administration is the fifth and last major component of the ICS. The Finance Section Chief reports directly to Command, and has responsibility for all costs and financial aspects of the incident. This is the one function that receives the least amount of consideration at the majority of incidents, since associated costs are dealt with after the fact. However, large-scale or long-term incidents generally require immediate cost consideration. This is particularly true when outside resources must be procured quickly.

The Finance/Administration Section Chief position is staffed on incidents at which abnormal costs will be encountered, or on incidents where reimbursement of incident costs is a possibility. These include Federally declared disaster situations or hazardous materials incidents where reimbursement may come from the shipper, carrier, or producer of the chemical, or from their insurance companies.

Command Responsibility

If any function is not delegated, the IC must be familiar with those responsibilities and perform them as necessary to meet incident needs. Command's ultimate responsibility is to ensure that all incident requirements are met.

Task-Level Elements

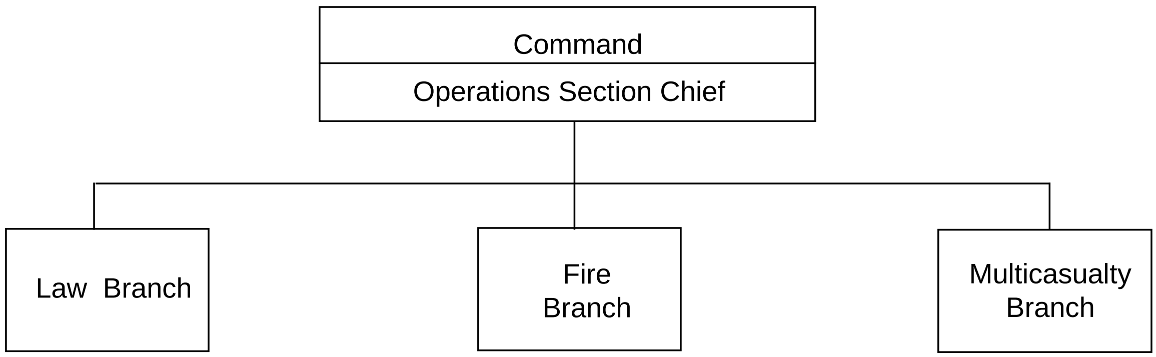
The terms engine and truck represent personnel at the scene of an incident who are doing specific tasks. If you do not have truck companies, you still need to perform the tasks discussed.

The ICS organization charts used in this section and those presented in the classroom lecture represent the fire scenes shown on the slides during lectures. These charts are correct, but they are just one way of managing a specific incident using ICS.

Functional Branch Structure

When the nature of the incident calls for a functional branch structure, e.g., a major aircraft crash within a jurisdiction, three departments within the jurisdiction (police, fire, and health service) may be organized into a functional branch structure operating under the direction of a single

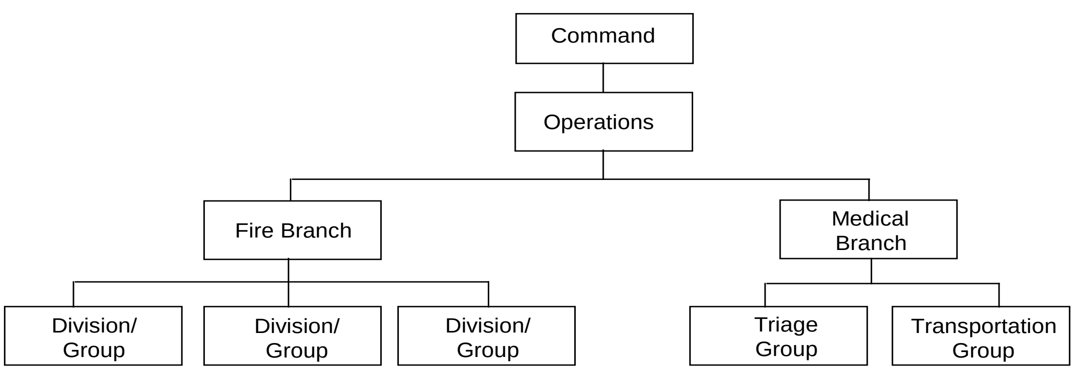
Operations Section Chief. In this example, the Operations Section Chief is from the fire department with branch directors from all three departments. Other alignments could be made depending upon the jurisdiction's plan and type of emergency. Note that Incident Command in this situation could be either Single Command or Unified Command, depending on the jurisdiction.



Functional Branches

Multijurisdictional Incidents: When the incident is multijurisdictional, resources are managed best under the agencies which have normal control over their local resources.

Branches should be used at incidents involving two or more distinctly different major management components (e.g., a large fire with a major evacuation; a large fire with a large number of patients). The IC may elect to assign Branches to forward positions to manage and coordinate activities, as illustrated below.

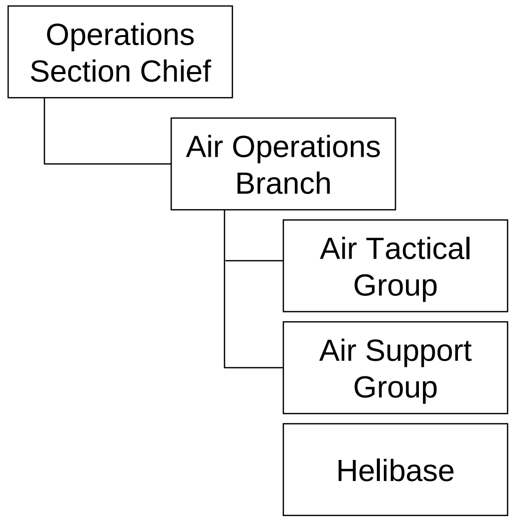


Multibranch

When the incident requires the use of aircraft, such as for the transportation of victims from a multicasualty incident, highrise rooftop rescue, swift water rescue, or wildland fire, the Operations Section Chief should establish the Air Operations organization. Its size, organization, and use will depend primarily on the nature of the incident and the availability of aircraft.

Air Operations

Air operations are complex operational elements. Air operations must be closely coordinated and fully understood by the IC and Operations Section supervisors.



Divisions and Groups

The terms Division and Group are common designators used by the U.S. fire service to define tactical-level management positions in the Command organization. Divisions represent geographic responsibilities such as Division C (the rear of the facility). Groups represent a functional (job) responsibility such as the Ventilation Group.

When initial assignments are ordered to incoming resources, the IC should begin assigning COs to appropriate Division and Group responsibilities. By doing this at all small incidents, the department is preparing itself to manage effectively the resource-intense incidents that occur much more sporadically.

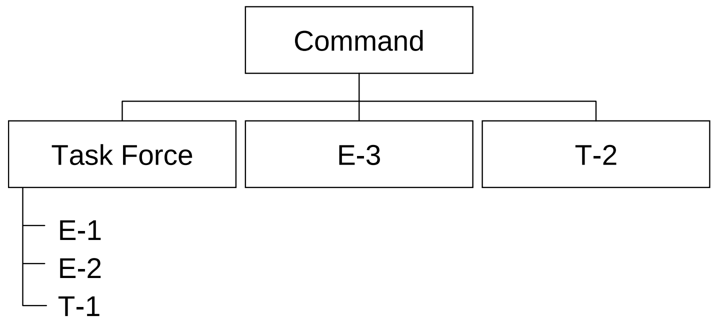
Note: The term sector is used by many departments in the United States. This term is generic and can be used to represent both geographic and functional responsibilities, such as Sector C and Ventilation Sector. The National Fire Academy (NFA), due to the need for consistency and application during activities and simulations and a prior agreement with FIRESCOPE, will use the terms division and group in all its courses.

Single Resources and Crews

A single resource is an individual company, e.g., engine, truck, rescue, ambulance, etc.

Personnel who arrive at the incident scene on other than a piece of fire apparatus (engine, truck, etc.) are formed into a working unit called a crew, with a crew leader. Crew size should conform to span-of-control guidelines; crews normally are designated by the crew leader's name, or by function (e.g., Crew Burns, Vent Crew).

Task Forces and Strike Teams

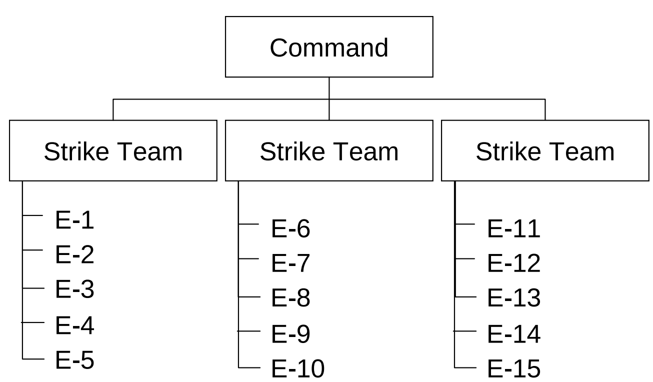


A task force includes from two to five different types of single resources and a leader assembled to accomplish a specific task. A task force may be one engine and one truck, two engines and a brush vehicle, two engines and two ambulances, three engines and two trucks, etc. A task force operates under the supervision of a task force leader.

The task force may be assembled at the incident scene to provide specialized resources required for a specific job. Task forces may be assembled before an incident and become part of the department's dispatch philosophy. For example, Los Angeles City dispatches task forces of two engines and one truck. These apparatus arrive on scene with several officers and personnel, but only one officer is designated as the task force leader. All communications for the task force units are directed to the task force leader.

Some departments create task forces of one engine and one brush unit for response during brush fire season. The brush unit responds with the engine company wherever it goes.

A strike team is five of the same type of single resource, with a leader. A strike team may be five engines (Engine Strike Team), five trucks (Truck Strike Team), five medic units (Medical Strike Team), etc. The strike team concept is used frequently at wildland fires. A strike team operates under the supervision of a strike team leader. Strike teams generally are comprised of engine companies.



Strike teams most usually are assembled for wildland fires. It is the most reasonable way to control 100 to 200 single engine companies, since they would represent only 20 to 40 strike teams. Strike teams may be used at structure fires (as may any ICS function) but this is not the norm.

Strike teams, and, more often, task forces, may be used by Division and Group Supervisors to correct a poor span-of-control problem.

COMMAND TRANSITION

Transfer/Pass Command

Transfer of Command: Command is transferred to improve the quality of the Command organization. The following information outlines a sample Transfer of Command process. The Transfer of Command procedures/guidelines must be predetermined by individual agencies for their use.

The fact that a higher ranking person has arrived on the scene does not necessarily mean that he/she is prepared to assume Command of the incident. The person may or may not have knowledge of previous orders or a grasp of the current situation. Without a thorough briefing of the situation, the officer may compromise incident operations.

It is essential that a standard operating guideline (SOG) for the Transfer of Command to a qualified person be developed and practiced within the organization. It is important to remember that Command is transferred in both directions: up as the incident escalates and down during the demobilization phase.

The best method of transferring Command is through a face-to-face meeting between the initial IC and the subsequent IC. In face-to-face conversation, the relieving IC is able to take full advantage of all communication media. Communication is more than just words--the pitch of the voice, facial expressions, hand gestures, and other body language assist greatly in conveying necessary information. The officer being relieved also can read the receiver's body language, helping him/her to see whether or not the message is understood.

The person being relieved of Command should review the tactical worksheet with the officer assuming Command. (A sample tactical worksheet is in the Appendix.) This sheet provides the most effective framework for Transfer of Command because, properly used, it outlines the location and status of personnel and resources. The person being relieved then should be reassigned to the best advantage of the officer assuming Command. Remember, as the relieving IC, you are at a disadvantage. You probably have not been on the scene long; some actions have taken place prior to your arrival, other actions have yet to take place, and you are in a catch-up mode. The information that you receive and retain is critical to your knowledge of the situation and the success of the next operational phase.

The second best method of transferring Command is by radio. However, because this is only spoken communication, radio transfer often leaves the relieving commander with information gaps and extends the time needed to "catch up" to the incident. Information gaps can lead to poor initial decisions and may affect firefighter safety.

The least desirable is a Command change without an information exchange. Use this method only when the other methods cannot be used. The new commander usually is at such an informational disadvantage that catch-up time is extended significantly.

As stated previously, it is critical that a briefing take place when Command is transferred. Such a briefing should include, as a minimum, the following information:

- present incident status/conditions (rescue situations, injuries, hazards, etc.);
- an IAP (strategies and tactics being employed);
- progress toward achieving incident objectives;
- safety considerations and concerns; and conduct personnel accountability roll call;
- ICS organization structure indicating those functions with whom Command must communicate; and
- projection of incident condition and additional resource needs.

Passing of Command: The initial IC has three options of personal involvement at the incident:

1. IC.

2. Combat--hands on.

3. Tactically involved commander.

Select the IC role when there are sufficient personnel to accomplish the initial high-priority tasks or when the initial officer's involvement will not resolve a critical incident priority. Two examples of the latter are a well-involved structure fire needing numerous hoselines to bring control with no life hazards present, or a fire in a nursing home where 50 trapped persons may perish. In both of these examples, it is likely that the first-in officer's involvement in tactical operations will not affect the outcome significantly. Will the addition of the officer and a small amount of water extinguish the structure fire? Probably not. How many of the 50 lives can be saved by the addition of one additional person in the combat role? These types of incidents require immediate Command.

Choose the combat role when the first-in officer's involvement will resolve a critical incident priority. For example, a room-and-contents fire in a dwelling that can be extinguished with one hoseline. Only one firefighter is available to enter the structure with the hoseline. In this case, the first-in officer should assist the firefighter in advancing the hoseline into the dwelling and extinguishing the fire. When in the combat role, the first-in officer may pass Command to the officer on the next-arriving unit.

Passing Command is a process that alerts the next-arriving officer to be in the "order-giving" mode rather than the "order-receiving" mode immediately on arrival. This is an important alert. Instead of receiving an assignment and focusing on tasks, the focus changes to developing strategies and tactics, making assignments, coordinating tactical applications, scene safety, and a number of other mentally intensive tasks.

A unit not yet on the scene should be advised that it will assume Command on arrival. This allows the other unit leader time to change roles and get into the "order-giving" mode (a primary reason for passing Command in the first place). The new IC should not assume Command until he/she is on the scene and declares so via radio and contacts the first-in officer who passed Command. This prevents a gap in the Command function which may create confusion and interrupt the continuity of Command. It also is recognized by most authorities that one cannot manage an incident until one is on the scene and should, therefore, not be accountable until then.

In addition, Command should be passed only one time (except under very extraordinary conditions); otherwise free-enterprise firefighting may result as Command is passed from one unit to the next based on the arrival sequence. It is imperative that this, as well as the other parameters of Passing/Transfer of Command, are stated clearly in a department policy, and that all personnel are familiar with that policy.

From the first unit to arrive to the last unit to leave, someone is always the IC. Command is transferred to improve the quality of the command organization. The first-arriving officer/member first assumes Command. Subsequent transfers are based on local procedures.

Command is transferred after the officer assuming Command has communicated with the person being relieved, either by radio or in person; in-person transfer is the preferred method.

Person being relieved will brief the person assuming Command with the following:

- incident conditions;
- IAP;
- current progress;
- safety considerations;
- ICS organization and who Command communicates with; and
- need for additional resources.

The person assuming Command will advise the dispatcher of the transfer once the briefing has been completed.

The Communications Order Model

In order for the IC (or any message sender) to obtain confirmation that his radio message/order was received, understood, and being acted upon, the radio message must be repeated. This does not need to be a word-for-word repetition of the original message, but it should be a brief and concise summary of the intent of the message or order from the sender. The format of the repeat should assure the IC (or other sender) that the message was received by the intended receiver, was understood correctly, and that the receiver is taking correct action.

The purpose of the communications order model becomes clear when the receiver misunderstands the message and is taking incorrect action. This inappropriate action could be life-threatening to firefighters. During the repeat back, the IC has an opportunity to detect the error and make corrections before inappropriate actions are taken.

Example:

Command: "Engine 4, Command, lay a supply line to the rear of the building and take a handline through the rear door to check for downward extension. You'll be Division C."

Engine 4: "Command, Engine 4, lay a line to the rear, advance a handline to extinguish the fire. I'm Division C."

Command: "Engine 4, Command, negative! Lay a line to the rear, take a handline through the rear door, and check for downward extension."

Engine 4: "Command, Engine 4, copy, lay to the rear, and take a handline through the rear to check for downward extension. I'm Division C."

Radio Communications Format: The NFA has adopted the following format for effective radio communications. This format follows the military protocol for radio conversations.

In this protocol, the sender gives the receiver's radio designation first, then follows the sender's designation, e.g., for Command calling Vent Group.

"Vent Group from Command" or "Vent Group, Command"

Saying the receiver's designation first is an attention-getting device. By getting the receiver's attention up front in the message, the receiver is less likely to say, "Unit calling Vent Group, repeat." Remember that the amount of radio traffic during responses is generally high, and all of us listen for our own radio designation before tuning in to the radio traffic. This method reduces confusion and preserves air time for more important messages.

While this method will facilitate the exchange of information between two communicators, it does not relieve the responsibility of scanning other operational channels for vital information.

Progress Reports

A fire department's communications guidelines should include communications necessary to gather and analyze information to plan, issue orders, and supervise operations. For example, a tactical-level officer should communicate the following:

- assignment completed;
- additional resources required;
- unable to complete the assignment;
- special information;
- Personnel Accountability Report (PAR); and
- operational location.

It is important for the IC to understand what is happening at an incident scene. Once orders are given to CO Group/Division Supervisors, or Branch Directors, feedback is critical to that understanding. The items listed above allow the IC to understand effectively to what point the various operations have progressed. Through these reports, the IC can track what has been done or completed, what additional resources will be needed for any given assignment, when tactics have to be changed or modified to overcome an impossible task, and what special factors, safety and otherwise, need to be involved in the assignments.

Progress reports are essential to incident management. They allow for effective decision making and assist in prioritizing the commitment of resources. Progress reports allow for effective refinement and revision of the action plan. To be effective, progress reports need to be timely, complete, and concise.

Progress reports should detail briefly where and what actions have been completed and where and what actions are being undertaken. For example, a Vent Group Supervisor directed to do vertical and horizontal ventilation may provide a progress report as follows:

> *Vertical ventilation will be completed in about 5 minutes. Horizontal ventilation of the fire floor is completed. Ventilation of the floor above is just beginning.*

Progress reports will occur with greater frequency in the early stages of an incident, typically every 5 to 15 minutes, or as major parts of the job are completed. An IC or Operations Section Chief must request progress reports from subordinate personnel on a periodic basis, when these reports are not given by those personnel. Some departments have the dispatch center announce time on location every 15 minutes to assist the IC with timetracking and to act as a mind-jogger for the progress reports. It is important to ensure that if timetracking is done, emergency communication procedures are not overridden by these reports.

In catastrophic events using large numbers of resources and a large ICS organization, it is critical that the progress of operations be conveyed to all General Staff functions on a timely basis. Branch directors must query their subordinate group and division supervisors frequently as to the state of their operations. This information must be transmitted to the Operations Section Chief and upwards to the IC.

Without the progress report information, the IC, as well as Operations and Planning, will find their information processing ability lessened. They often will initiate or recommend actions that are unneeded as well as untimely for the situation.

Rapid Intervention Crew

NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, requires having specifically designated rescue crews at the incident scene. This requirement is based on the realization that firefighters are exposed to the highest risk of injury or death while operating at the scene of an emergency and that one of the most effective mechanisms for reducing that risk is to have a Rapid Intervention Crew (RIC) ready to come to the assistance of emergency personnel should the need arise.

One of our primary concerns should be to reduce the risks that we and our firefighters are exposed to during emergency operations. It is not realistic, however, to assume that all the risks can be avoided, controlled, or eliminated from the firefighter's environment. We realize that danger is part of our work environment, and the possibility that things can go wrong always must be considered. Recognizing this possibility, we must make some provisions to assist members who find themselves in trouble.

An important aspect of incident management is to identify the risk characteristics of the situation and to evaluate specific risk factors that apply to each activity. A situation involving a high level of risk requires a greater commitment to rapid intervention for the rescue of emergency personnel should something go wrong. An interior fire in a small, single-story building presents a certain level of risk to the firefighters who enter to search for occupants and to extinguish the fire. While a situation may appear to be routine, there are still things that could go wrong and place firefighters in imminent danger. A flashover could envelop them in flames, a structural collapse could trap them, or faulty SCBA could cause a firefighter to run out of breathable air. In a small, single-story occupancy, the chances are fair that firefighters could extricate themselves from most situations if they are a short distance from an exit that leads directly to the exterior.

The same fire situation in a large building, in a basement or an upper floor, in the hold of a ship or in a highrise building presents a much greater danger simply because, in these areas, the ability of individuals to rescue themselves is reduced by the distance they would have to travel to reach a safe area and the difficulties they might encounter along the way.

The risk also may be increased by the nature of the task in which firefighters are involved. Rescuing an unconscious worker from a confined space that is filled with toxic and flammable vapor is much more dangerous to rescuers than removing an unconscious person from a wrecked automobile on a city street. Both situations involve a degree of risk to the rescuers, but the nature and degree of the risks are very different.

The composition and placement of RICs may be somewhat agency-specific, dictated by individual needs and resource availability. However, it is important that written procedures/guidelines be developed for the use of these crews, especially when they are performing exterior operations in support of interior crews. These written procedures should also include evacuation signals and guidelines for implementing evacuation and relocation of personnel from the area of danger. In addition, for agencies involved in auto/mutual-aid response, it is important to develop consistency among the participating agencies in the use of RICs.

A RIC should consist of a minimum of two members, fully equipped with appropriate clothing, SCBAs, portable radio, and necessary tools to be effective. It also should monitor the tactical radio channel to maintain a complete and accurate understanding of operations and changing conditions as well as location of tactical personnel. This information should be documented on a tactical worksheet by a member of RIC. In the early stages of an incident, RIC personnel may perform other functions, e.g., secure utilities, flake-out hoselines, work in the CP. However, they must remain prepared to redeploy to perform rapid intervention functions. As the incident expands in size or complexity, personnel should be assigned as a **dedicated** RIC. Placement of the RIC may be dependent on the incident; for example, in a highrise operation, the RIC should be located in Staging (two floors below the fire). In many other situations, a good location would be near the ICP or close to Operations. It should not be located in a position that would interfere with ICP operations. If the incident covers a large geographic area, more than one RIC may be required.

In a hazardous materials operation, the Entry Team Leader must ensure that there is an RIC of at least two personnel in the appropriate level of protection before the primary entry team accesses the hot zone. In a hazardous materials operation, this team is designated as the Backup Team. The personnel of the Backup Team need to have the same level of required technical competency as the Entry Team. This includes the appropriate level of protection required for the material(s) involved.

While there is some flexibility in procedural issues regarding rapid intervention, it is paramount that whenever personnel are operating in positions or performing functions that would subject them to immediate danger to life and health (IDLH) in the event of equipment failure or other unexpected sudden event, at least one properly attired RIC must be available to provide assistance or rescue.

Rapid intervention procedures should not be confused with initial interior structural firefighting operations **(two-in, two-out)** addressed in NFPA 1500. NFPA 1500 requires the presence of four personnel before beginning interior structural firefighting. Two members operate in the hazardous atmosphere, while the other two members are the rescue team outside the hazardous atmosphere. If there is an immediate life safety situation, rescue may be initiated, but members should evaluate carefully the level of risk that they would be exposed to by taking such actions. If it is determined that the situation warrants such action, incoming companies should be notified so that they will be prepared to provide necessary support and backup upon their arrival. When waiting to be deployed, the outside members of the two-in, two-out may be assigned to other tasks, e.g., pump operator, initial IC, as long as these other activities do not interfere with their ability to respond to the two-in should they require it.

Example: A chief officer with two engines and one truck is operating at a structure fire. A portion of the second floor collapses. That information is transmitted to IC. At this point, a likely scenario is as follows:

- The IC activates a signal and, by radio, orders all personnel out of the building.
- A PAR is taken, and it is found that one member is missing. That member was last seen working near the collapse area.
- The RIC is directed to enter the structure, quickly assess its stability, recover the missing firefighter, and remove the member from danger.

Incident Scene Accountability

All officers holding positions within the Command organization are responsible for the welfare and accurate accountability of all assigned firefighters. Several fireground accountability systems have been developed by various fire departments around the country. While these may vary in overall design, there are common elements of personnel accountability that fire departments should apply at emergency incidents to fully account for their personnel. These common elements are

- required use;
- hardware--nametags/documentation;
- point-of-entry control of nametags;
- accountability officers;
- benchmarks for required roll calls throughout operations;
- plans for describing the Command organization response to reports of lost firefighters; and
- use of RICs.

Whatever the design, the system must be able to locate every firefighter within a small geographic work area within the hazard (IDLH) zone at any moment in time. Furthermore, the system must be able to determine if a firefighter is delayed from an assignment, initiate an immediate rescue effort, if indicated, and fully integrate into the ICS. **All fire departments are strongly encouraged to develop and implement a workable accountability system for their department.** The final product should be compatible with metro-area or regional accountability systems.

STRATEGIC PLANNING--OPERATIONAL PLANNING MEETING

All incidents need some type of plan. For small incidents of short duration, the plan need not be written. Written plans should be considered when any of the following occur:

- resources from other agencies are used;
- more than one jurisdiction is involved;
- the incident requires changes in shifts of personnel or equipment; and
- major incidents not requiring written plans, but still warrant organized planning personnel including
  - IC,
  - Operations Section Chief and key subordinates,
  - Planning Section, and
  - Logistics Section.

During long-term incidents, operational planning meetings should occur at regular intervals, at least every 12 hours.

ADDITIONAL ELEMENTS OF AN INCIDENT COMMAND SYSTEM

Single Versus Unified Command

In a Single Command situation, only one agency has legal responsibility.

Hazardous materials incidents, mass casualty incidents, natural disasters, or wildland fires, among others, may involve a number of jurisdictions and/or agencies that have a legal or functional need to be involved directly in the decision making process. The worst thing that can happen is to allow each of these responsible agencies to establish an ICP of its own, separate and distinct from the others. In this instance, it is critical that there be a Unified Command.

What cues the need for a Unified Command?

- More than one agency responsible for decision making within a single jurisdiction.

  Example: A passenger airline crash within a national forest. Local fire, local medical, Federal forestry, and National Transportation Safety Board (NTSB) are all involved.

- More than one jurisdiction is involved.

  Example: A major flood, hurricane, etc.

All agencies with responsibility to manage the incident contribute to the Command process. Together they determine overall incident objectives and strategies, and plan tactics jointly. This method ensures the maximum use of assigned resources.

- The location of the incident.

  Example: An inland waterway entirely within the boundaries of a single jurisdiction also could involve U.S. Fish and Wildlife Service and the U.S. Coast Guard (USCG).

Who is involved?

- All agencies with responsibility to manage the incident contribute to the Command process. Together they determine overall incident objectives, determine strategies, and plan tactics jointly. This method ensures maximum use of assigned resources.

- One key official from each jurisdiction or responsible agency.

- Representatives from departments in a single jurisdiction.

The IC may be determined by local or State law. For example, California law states that the law enforcement agency is the IC for hazardous materials incidents on the highways. Where there is no law determining who is in charge, agencies should work together to determine which agency takes the lead for each risk a community faces.

Generally, the agency with the greatest jurisdictional involvement is assigned the Operations function. Depending on the type of incident, someone must determine which agencies actually have responsibility. It is important to recognize prior training and experience when staffing the Unified Command Post and Operations function.

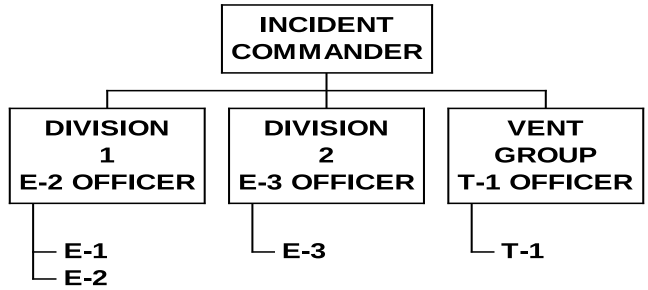
Single/Unified Command Differences

- In Single Command structure, a single IC is solely responsible for management strategy of the incident.
- In a Single Command structure, the implementation of strategy and tactics to achieve operational control is the responsibility of one person--the Operations Section Chief.
- In a Unified Command structure, individuals designated by involved jurisdictions/ departments jointly determine objectives, strategy, and priorities.
- The determination of which jurisdiction/agency the Operations Section Chief represents must be made by mutual agreement of the Unified Command.

PRACTICAL APPLICATION OF THE INCIDENT COMMAND SYSTEM--OPERATIONS SECTION

On any basic working incident that will require the deployment of more than two companies, the initial IC should establish Divisions and Groups immediately. This is accomplished by the IC, after giving a brief initial report (BIR) and assuming Command. The IC simply assigns in-coming companies to tactical operations and assigns the CO to a Division or Group Supervisor role. For example:

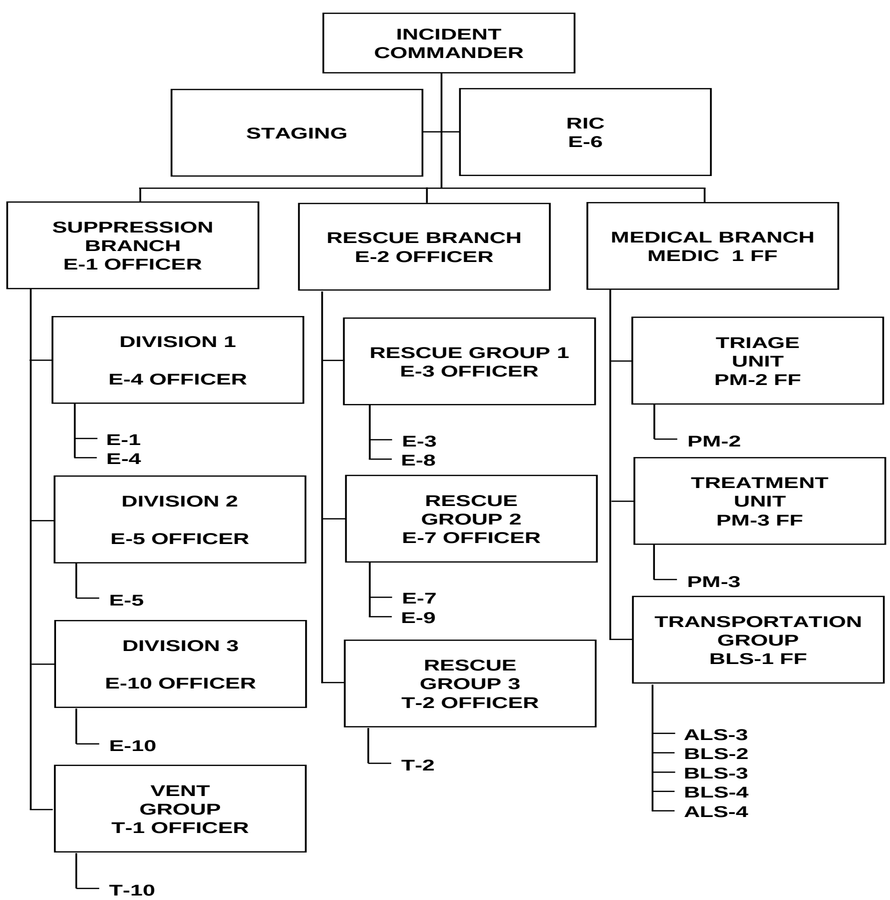
- "Dispatch from Engine 1, arrived location Side A of a two-story wood-frame dwelling, fire and smoke coming from Side D first floor. Engine 1's crew is making an interior attack from Side A. Captain Engine 1 is Command."
- "Engine 2 from Command, bring a second handline into Side A, assume Command of Engine 1's crew, you are Division 1."
- "Engine 3 from Command, get a line to the second floor through Side A, check for extension and do primary search, you are Division 2."
- "Truck 1 from Command, start horizontal ventilation, you are Vent Group."



However, at target hazard type incidents, it is often necessary to start the ICS at the Branch Level. Given sufficient magnitude of the incident, many resources are going to be required to achieve a successful outcome. This is due to the great life hazard or monetary loss probability and the complexity of the situation.

Starting at the Branch Level reduces what will surely be great confusion if the IC starts with Division and Groups and waits until a later time to change the ICS organization from Divisions and Groups to Branches.

For example, a large, three-story nursing home with a smoky fire on the first floor may require the following type of organization from the beginning.



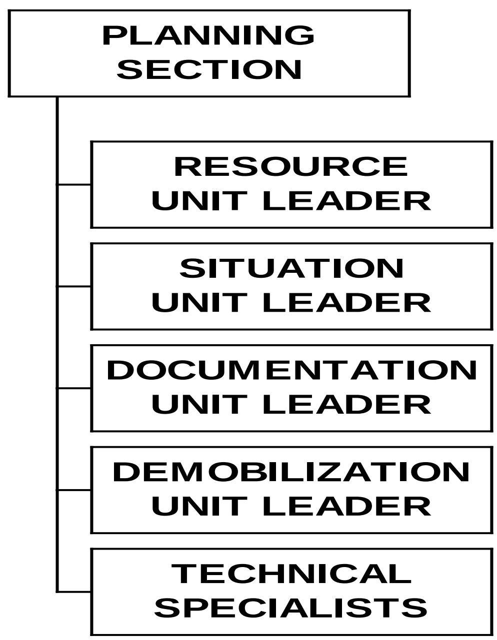
Obviously, a nursing home fire with smoke is a serious event that would take a large amount of resources to overcome. It can readily be seen that if the IC choose to go with Divisions and Groups, the span-of-control would have been overwhelming.

Starting at the Branch Level also allows the Branch Director to establish the type of ICS organization that will most effectively solve the problems in that specific area of the incident.

STAFFING THE PLANNING AND LOGISTICS SECTIONS

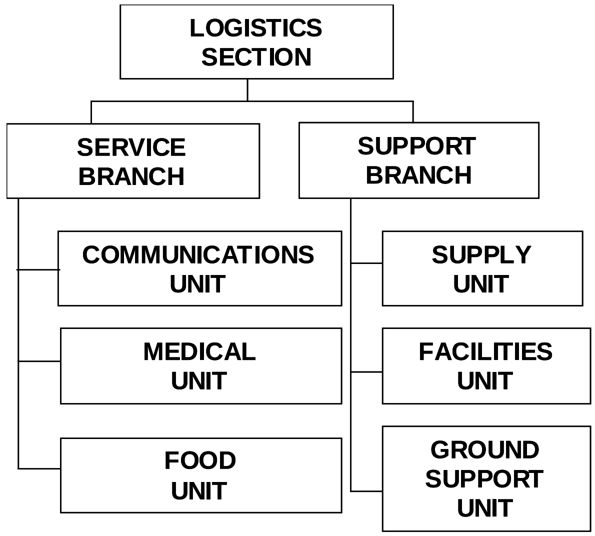
Initially it is usually only possible to assign a single officer to either Planning or Logistics.

As additional resources and officers arrive on scene, the Planning Section will require at least one additional company to achieve its tasks.



The Logistics Section may require numerous companies to adequately support the needs of the incident. The One Meridian Plaza Incident eventually had as many personnel in Logistics as in the Operations Section.

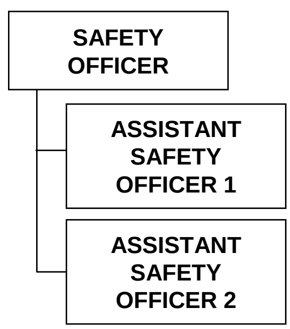
It is imperative that personnel assigned as the Logistics Section Chief recognize the personnel needs of the Section and request those resources from the IC as soon as possible. The continuous operation of the entire incident, especially the Operations Section, may be totally dependent on the ability of the Logistics Section to adequately perform the service and support roles in a timely manner.



STAFFING THE COMMAND STAFF FUNCTIONS

Safety Officer

The Safety Officer function may need to be staffed by more than one person due to the complexity of the incident or the size of the structure or facility. Additional personnel may be assigned to work for the Safety Officer as Assistant Safety Officers.



Liaison Officer

The Liaison Officer function may need additional personnel assigned, especially on incidents requiring a significant amount of outside resources.

Public Information Officer

The PIO function may need additional personnel assigned when the needs of the media and other agencies outstrip the capabilities of a single person.

Activity 2.1

Los Angeles, California, Central Library Fire

Purpose

To identify the key issues in Command decisions.

Directions

1. You read the case studies (in the Appendix of this unit) as part of your precourse reading. View the videotape that discusses the Los Angeles Library Fire incident.

2. Report on the answers to the questions that you were assigned.

   Command--For students whose last name begins with letters A thru D.

   a. Develop the incident objectives. What would they be?

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   b. What strategies would you determine for the incident?

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c. What types of questions would you want answered by the IC you are relieving?

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Operations--For students whose last name begins with letters E thru H.

a. What tactical operations would you want performed to control this incident?

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b. Draw an ICS organization chart that you would have for the Operations Section at the Library fire.

Planning--For students whose last name begins with letters I thru L.

Write a Plan "B" for the Library fire.

Logistics--For students whose last name begins with letters M thru O.

What types of service and support operations will be required to keep the Operations Section operating?

Safety--For students whose last name begins with letters P thru R.

a. What are the safety issues at the Library fire?

b. Write a general Safety Plan for the Library fire.

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Liaison--For students whose last name begins with letters S thru U.

List the different nonfire agencies and possible private contractors that you would most likely have to interface at the Library fire.

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Public Information--For students whose last name begins with letters V thru Z.

Write a press release for the Library fire.

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APPENDIX

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Executive Summary
Central Library Fire
April 29,1986

Alarm
At 1052 hours the Fire Department received a telephone report of "Bells Ringing" at 630 W. 5th Street, the Central Library.
A category "B" assignment, consisting of TF-3, TF-9, E-10, SQ-4, and Batt-1, was dispatched to that location.
At 1057 E-10 arrived on scene. They went to the main entrance located on the north side of the building on 5th Street, E-10 reported that nothing was showing.
TF-9 responded to south entrance of the library located on Hope Street. TF-9's original report was nothing showing. A short time later E-9 observed light smoke coming from east side roof area and reported this on the radio.
TF-3, SQ-4, and Batt-1 all responded to the main library entrance on 5th Street. Investigation by E-10 and E-3 disclosed a fire in the northeast stack area on the 5th and 6th tier.

Fire Cause
The fire has been determined to be incendiary, caused by ignition of ordinary combustibles. The point of origin was in the southeast corner of the 5th tier of the northeast stack.

Resources Committed
The Department committed 60 firefighting companies, 9 paramedic rescue ambulances, 3 helicopters, 2 emergency air units, a heavy utility and command staff, and support personnel for a total of almost 350 personnel. Almost 1/2 of the total on duty Fire Suppression resources were committed to this fire.
In addition to our own resources, 6 mutual aid companies from the Los Angeles County Fire Department were used to fill vacant Fire Stations, until Fire Prevention Personnel staffed six ready reserve apparatus to relieve them.
Five private rescue ambulances and a Hospital Emergency Response Team from USC assisted our Medical Division in the care and treatment of injured Firefighters.

Estimated Property Loss
Property loss to the structure was limited to only 4% of the $50 million value of the building.
Property loss to the contents was limited to only 20% of the $100 million total value of the contents.
Of the 1.2 million books in the library at the time of the fire only 350,000 received any fire or water damage.

Loss to Structure	$ 2 million
Loss to Contents	$20 million
Total Loss	$22 million

Only 14.6% of the total value of the building and its contents were lost in this fire.
Number of injuries: 51.

1	Civilian injury
50	Firefighter injuries
51	Total

There were no deaths or critical injuries.

Weather
Weather conditions at the time of the fire:

Humidity-47 percent
Temperature-76 degrees
Wind Speed-5 knots
Wind Direction - south to north

Weather was not a serious factor in this fire.

Water

The area immediately surrounding the library is served by 8-inch, 12-inch, and 24-inch water mains, which provided adequate water throughout the fire.

From the Fire Department calculations and the Department of Water and Power's figures showing the amount of water use increase over the daily average for the period of the fire. It is estimated that over 3 million gallons of water were used to extinguish and overhaul this fire.

Salvage

One key reason for the minimal loss of the library contents was the high priority placed on salvage operations.

Chief Anthony requested 3 fully-staffed salvage companies immediately upon being dispatched to the fire.

Salvage operations began very early in the fire and continued throughout the night and into the next day.

Over 90 bags of sawdust and 98 rolls of polyethylene plastic and 60 salvage covers were used to protect the 5 tiers of books and the 2 main floors below the fire from water damage. This is enough plastic to cover over two square acres.

Building Construction

The building, which was build in 1926, is of fire resistive construction. The bearing walls, floors, and roof are reinforced concrete. The non-bearing walls are hollow tile covered with plaster. The size of the library is 334 feet by 200 feet.

The building has three floors plus a basement. Inside the building, surrounding the Rotunda, are four book stacks, one in each quadrant. The stacks run from the basement to the 3rd floor. There are seven tiers in each stack, 2 in the basement, 2 on the 1st floor, and 3 on the 2nd floor. The floor of the 3rd floor is the ceiling of the 7th tier.

The multi-tier bookstacks were modeled after those invented for the Library of Congress in 1893. The tiers are supported on unprotected steel columns and beams at intervals of 7 feet. Vertical openings between tiers are provided around the bookstack shelves to permit heating and ventilation of the stack area by convection air currents. Under fire conditions these same openings function as a flue to accelerate vertical fire spread to the upper tiers. Each stack area is approximately 49 feet by 42 feet.

The four stack areas are connected by horizontal hallways at the 7th tier and basement levels. Access to the stack areas can only be made through narrow doors from the 1st and 2nd floors and the basement. Thirty-six-inch wide steel stairways connect the tiers vertically. Each tier contained book shelves from floor to ceiling with 30-inch aisles.

The estimated fire load in the stack area was 93 lbs per square foot.

The only fire protection in the library was interior stand pipes, fire extinguishers, and smoke detectors. A small area in the basement is protected by automatic sprinklers.

Fire Information

The fire began on the 5th tier of the northeast stack and spread very rapidly up through the open spaces in the floors of the tiers to the 6th and 7th tier. Eventually, there was collapse of both the 6th and 7th tier.

When the fire reached the concrete ceiling of the 2nd floor the heat mushroomed down forcing the fire to spread horizontally. The fire then spread down a hallway, on the north side of the building, that connected the northeast and northwest stacks, at the 7th tier level. Only aggressive firefighting kept the fire out of the southeast and west stacks.

In the northwest stack the fire banked down from the 7th tier to the 6th tier and then into a room on the west end of the building where it broke through to the outside on the mezzanine level. The fire totally consumed the 6th and 7th tier of the northwest stack causing a large section of both tiers to collapse. Because of the heavy fire load, temperatures in the fire areas reached in excess of 2000º. The extreme heat caused bond beams in this area to be spalled to a depth of 6 inches and expose the steel reinforcement. The concrete 3rd floor suffered cracking and a 1 inch to 1½ inch separation. If the fire had continued, it is very possible that this area of the building would have collapsed.

Because of the construction in the stack areas with 6" thick concrete floors and roofs, it was not possible to ventilate the heat and smoke. There was no way to attack the fire from the outside, so all fire fighting required an interior attack.

Due to the intense heat build-up, the total lack of visibility, the narrow aisles with book shelves and tiers collapsing, the extending of hose lines was extremely difficult and slow.

Due to the type of construction, the building acted as a heat sink and absorbed tremendous amounts of heat. Even after the fire was knocked down it was not possible to enter the fire areas for a long time, these areas had to be cooled down using hose streams before they could be entered even with full protective gear.

Seven hours and 38 minutes elapsed from receipt of alarm until a knock down was declared.

Overhaul

In order to prevent additional loss to the valuable contents of the building overhaul operations were conducted using a minimum amount of water.

Hot spots were dug out and extinguished with small lines. No wet water was used in order to prevent further damage to water-soaked books and paper material. Hot spots were found up to five days after the fire. All floors and stack areas below the fire were covered with polyethylene plastic. Siphon ejectors were used to remove water from the basement area and elevator shafts. Fire Department personnel provided protection for Library personnel and volunteers while they removed the books from the building during the next seven days.

Demobilization

A joint plan of action was developed by the Fire Department, the CAO's Office, General Services, and the Library Department for the removal of burned materials and the collapsed bookstacks from the building. This is expected to take several weeks. The Fire Department's role will be to provide Safety Officers and an engine company to stand by during hot work.

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Fire in Los Angeles Central Library Causes $22 Million Loss

Firefighters faced a nightmare of overpowering heat, restricted access, heavy smoke, and stood in boiling-hot water battling this tricky, fast-spreading fire in an old, complexly laid-out library that housed invaluable collections. Amazingly, 85 percent of the contents was saved.

Michael S. Isner[1]

On April 29, 1986, a fire in the Central Library in Los Angeles, California, destroyed an estimated 200,000 books, the largest collection of patents in the western United States, and two-thirds of the library's magazine collection. In addition, water and smoke damaged about half the library's 1.2 million volumes. Four hundred occupants were evacuated from the building in about eight minutes. Although nearly 350 firefighters and over 70 pieces of fire apparatus were sent to the scene, it took 7½ hours to extinguish the blaze, during which 55 firefighters suffered only minor injuries. The fire, of suspicious origin, had been started in one of the book stacks. A smoke detector in one of the stacks first alerted security personnel. They called the fire department, assisted the library staff in evacuation, and helped firefighters find their way through the huge building.

[1] Michael S. Isner is a Fire Protection Specialist in the NFPA's Fire Investigations and Applied Research Division.

Because of the intricate arrangement of the interior, firefighters had difficulty locating the fire immediately and assessing its severity. After they reached the point of origin, they found a hot, rapidly spreading fire in areas where they had limited access. Openings in the bookshelves allowed the fire to spread rapidly, both vertically and horizontally. Lack of sprinkler protection, vertical ventilation, and other unprotected openings in the book-stack area, and abundant fuel provided by the many books contributed to the intensity of the fire, and the complex design of the building prevented quick extinguishment.
Salvage operations were started early in the fire and helped prevent a larger loss.

The Library and Its History

The Los Angeles Central Library is the third largest library in the United States. In addition to its collection of 1.2 million books, the facility contains trademark records, patents, magazines, sheet music, maps, and other materials that make it an extremely valuable resource for researchers. For years, the Central Library had been considered too small for the collections. Several plans to remedy the situation were proposed, but they caused considerable controversy regarding the building's future. Some developers proposed razing the library to provide space for new construction. Other groups suggested that the building be modified, and still others wanted to preserve the original structure. The controversy became more complex in 1967, when the city listed the library as an historical monument and again in 1970, when it was included in the National Register of Historical Buildings. While the debate on the library's future continued, the Los Angeles Fire Department strongly urged the library's management to deal with conditions in the building that could affect public safety and increase the possibility of fire spread. Many of the conditions they noted had been identified back in the 1940s.

Investigation Report

Because a plan to upgrade many life-safety features of the building was approved in 1981, there were operational smoke detectors in the book-stack areas when the fire occurred. A 1-hour fire separation at each stairway and each entrance to the book-stack area was being installed, but had not been completed.

The Central Library was constructed in 1926, using the latest technology then available. The main structure, which consists of three stories plus a basement (see Figure 1), measures 240 by 200 feet. A two-story, 130- by 90-foot wing is attached to the southeast side. A central tower-like structure extends above the roof of the main building over an open area called the Rotunda. The Rotunda's 40 by 40 foot floor is on the building's second-floor level; its ceiling is 55 feet above the second floor.

Except for the main book storage areas, the library is considered a fire resistive structure (i.e., Type I-332)[2] with external bearing walls of reinforced concrete, 16 inches thick. The bearing walls that surround the Rotunda and support the tower are also of reinforced concrete, but are three feet thick. A network of concrete columns, some as large as three by five feet, and concrete beams support the 6-inch roof and floor slabs. Non-bearing walls are constructed with a terra-cotta material and mortar. Both the bearing and non-bearing building components are covered with plaster veneer up to 1 inch thick.

[2]NFPA 220, Standard on Types of Building Construction, 1985 edition. A Type I (332) structure will have a 3-hour fire rating for the exterior bearing walls (first digit), 3-hour fire rating for structural frame or columns and girders, supporting loads for more than one floor (second digit), and 2-hour fire rating for the floor assembly (third digit).

The main book storage areas, which are called the book stacks, are closed to the public. Located at the four corners of the Rotunda, these areas are separated from the main structure by the three-foot-thick concrete walls and terra-cotta walls. Originally, non-rated wood doors at each floor level led to the stack area; these doors were being replaced with 20-minute-rated solid-core wood doors equipped with magnetic door holders.

The four stacks (which are actually voids resembling large elevator shafts) extend from the basement to the underside of the ceiling/floor assembly between the second and third floors (see Figure 1).

There are seven tiers in each stack: two in the basement, two on the first floor, and three on the second floor. The building's third floor is the ceiling of the seventh tier. The two stacks on the west side of the building are connected and form a single horizontal space at the first--and second-tier levels in the basement. Similarly, the east stacks are connected and form a horizontal space at the first--and second-tier levels.

The four stacks are separated as they pass through the first and second floors (tier levels 3, 4, 5, and 6). At these levels, the northeast and northwest stacks are rectangular and measure 40 by 45 feet. The two southern stacks are basically rectangles the same size, but these stacks are also open to an attached area that is 10 feet by 25 feet. The four stack areas are connected by corridors on the seventh-tier level (see Figures 1 and 2).

In addition to seven levels of tiers, there are four rooms--the Fiction/Literature Work Room, the History Work Room, the Map Work Room, and the Science and Technology/Patent Work Room--that are located between the sixth-and seventh-tier levels; these rooms are considered the 6½ tier and are shown in Figure 2.

Because of their size, each book stack contains a central access aisle that leads to the open stairway within the stack. There are rows of bookshelves perpendicular to and along both sides of this aisle. Smaller aisles also perpendicular to the central access aisle run between the rows of bookshelves.

The shelves are supported by steel columns spaced three feet on center along the length of the bookshelves and four feet on center between each row of shelves (see Figure 3). The steel columns consist of two pieces of shaped steel placed together to form a 2-inch-square cross-section. The columns are continuous from the first tier in the basement through the seventh tier, just below the third floor. There are normally seven or eight shelves between columns at all tier levels. Because most of the shelves were filled to capacity, fuel loading in the book stacks is estimated at 93 lbs. per square foot.

Stairways in the stack area are only 36 inches wide and have no doors to protect the openings at floor levels. These stairways are vertically in line (one above the other) and do not have landings between tier levels. Anyone traveling between tier levels would have to leave the stairway at any tier and go down an aisle to reach the entrance of the stairway to the next tier level.

Openings between the bookshelves and walkways (Opening No. 1 on Figure 3), between the backs of bookshelves (Opening No. 2 on Figure 3), and around the entire perimeter of the stack area permit air to circulate within the book stacks.

Apparently, circulating air contributed to the heating of the stacks and helped preserve books and reduce mildew in the non-air-conditioned building.

Fire Protection

The building has a wet-pipe sprinkler system that protects only the bindery in the basement. This partial system has a 6-inch feed main and an alarm valve interlocked to the building alarm system and to a central alarm service. In addition, manual hose stations are provided throughout the basement and at each floor level in the stairways for the main structure. Portable, pressurized water fire extinguishers are provided for the entire building, while the boiler room and work areas in the basement contained portable carbon dioxide and dry chemical extinguishers.

As part of the project to improve the building's fire protection, manual pull stations and smoke detectors had been installed in all the book stacks. The detectors, which were connected to the building's local alarm system, were placed in every other aisle between the bookshelves and were spaced 18 feet apart in each aisle. In addition, manual pull stations that both initiated a local alarm and notified the central alarm service were provided in areas normally occupied by patrons. Emergency lighting provided in the stack areas operated if a power outage occurred.

When activated by any means, the alarm system sounded an audible alarm throughout the building and displayed a visual confirmation of the alarm on annunciator panels in a third-floor communications room, in a first-floor corridor by the Fifth Street entrance, and in the basement boiler room. Although the building has 38 zones, the alarm panel on the first floor would indicate only the general part of the building where the alarm activated. The other two panels provided more complete information on the fire zones.

Nearly 200 staff personnel and four security guards occupied the building during the day, but only two guards remained when the building was closed.

Both staff personnel and guards were trained in fire emergency and other procedures according to the library's disaster plan, which states that employees and managers are responsible for the safe evacuation of patrons in their respective work areas. According to the library's head administrator, they are well practiced in evacuating the building. In addition to periodic drills, the library is frequently evacuated because of earthquake alerts.

Municipal Fire Protection

The Los Angeles City Fire Department, incorporated in 1886, protects an area covering approximately 470 square miles with 1,813 full-time paid firefighters, 614 officers, 347 emergency medical personnel, and a fire prevention bureau of about 130 inspectors and officers. The 100 fire stations and 3 boat houses contain over 205 fire and emergency medical apparatus. The fire station nearest to the library is only 0.6 miles away.

Discovery of the Fire and Fire Department Response[3,4]

On the morning of April 29, the Central Library was occupied by approximately 200 patrons plus the usual staff of about 200. Everything appeared normal until local alarm bells, activated by a smoke detector, began to sound. While security personnel investigated, the library telephone operator called the fire department at 10:52 a.m. to report that bells were ringing. The central alarm service also called the fire department at 10:55. The library staff made sure that all patrons in their respective areas evacuated the building and carried out other emergency duties specified in the Library's disaster plan. The evacuation was completed in about eight minutes.

When the fire department's Operations Control Division (OCD) received the telephone report, it dispatched two task forces,[5] Engine Company 10, a squad, and a battalion chief at 10:53 a.m. The engine company, arriving four minutes later, saw no visible sign of fire. The crew entered the building through the main entrance on Fifth Street and went to the alarm panel on the first floor. Moments after the first engine company's arrival, Engine 3 (E-3 from Task Force 3) arrived; its crew also entered the Fifth Street corridor and met the crew from the first engine company (10) at the alarm panel. Since they were unable to determine the nature of the problem or reset the alarm, one crew went to the alarm panel on the third floor, while the other crew (E-3) went to the alarm panel in the basement.

When the squad and battalion chief arrived at the Fifth Street side of the library, about the same time as E-3, there was still no visual sign of fire from that point. The second-arriving task force responded to the Hope Street side of the building, where one of its engine companies saw light smoke at roof level on the east side of the building. The battalion chief requested assistance and the OCD dispatched four more task forces, a light force,[6] and two engine companies.

The E-10 crew reached the third floor, where they found light smoke in a corridor and heavy smoke in a room in the northeast corner. They requested assistance at 11:14 a.m. When deteriorating conditions eventually forced them to leave the third floor, they descended by a fire escape ladder to the roof of the two-story east wing, where

[3] Details in this section and diagrams indicating fire extension were based upon the Los Angeles City Fire Department report prepared by Deputy Chief Donald Anthony.

[4] For more details regarding the firefighting operations, see "Fire Strikes the Los Angeles Central Library," *Fire Command*. Vol. 53 No. 10 (October 1986), pp. 26-29, 42-43.

[5] A task force (TF) includes a two-piece engine company, a truck company, and 10 firefighters.

[6] A light force (LF) includes an engine, a truck, and six firefighters.

they requested 1½ inch hoses and other equipment. With this equipment, they reentered the building through the Fiction and Literature Work Room on the 6½-tier level and went up a ramp to enter the seventh-tier of the northeast stack (see Figure 2). The E-10 crew was joined at the seventh-tier by the crew from Light Force 11, who also entered the building from the east wing.

Meanwhile, the E-3 crew, having identified the location of the activating detector on the main alarm panel in the basement, entered the northeast stack in the basement and climbed the 36-inch wide open stairs to the fifth tier, where they left the stack to connect their hose lines to a hose station in a stairway leading to the second floor (see Figure 4). Reentering the stack at the fifth-tier level, they advanced their lines through the maze of bookshelves and winding stairs in order to attack the fire on the sixth tier. Several other crews that entered the northeast stack from the second floor assisted in attacking the fire in that stack. Another crew entered the southeast stack from the second floor, advanced their line to the seventh tier, and attacked the fire from the south side.

By 11:30 a.m., 22 fire companies, 8 command and staff officers, and a rescue ambulance had been dispatched to the scene. Fire officers began to recognize many of the problems they would face throughout the fire: extremely high temperatures, heavy smoke, narrow aisles, and very limited access. Access to the fire area in the book tiers was confined to the four small 36-inch-wide stairways in the stacks and the ramp from the Fiction and Literature Work Room. The lack of ventilation permitted both smoke and heat to build up, making firefighting difficult and conditions unbearable.

Between 11:30 a.m. and noon, the fire appeared to be confined to the northeast stack, even though firefighters were unable to advance hose lines within the stack levels. Outside the building, additional fire companies continued to arrive.

Three salvage companies were requested about 11:25, and some firefighters started salvage operations on the first and second floors, and in the lower tiers in the northeast stack. They covered bookshelves and furniture with polyethylene plastic or salvage covers, and built up sawdust dikes to direct water out of the building. Other arriving firefighters were assigned to assist the fire attack crews, which were being rotated every 15 or 20 minutes because of the intense heat in the attack area.

By noontime, a command post and medical area had been established on Fifth Street. A unit was ordered to bring a resupply of air cylinders. By this time, 24 fire companies, 10 command and staff officers, and 5 rescue ambulances had been assigned to the emergency.

Shortly after noon, an officer reported fire inside a third-floor wall in the northwest corner of the building. The lack of ventilation continued to make conditions increasingly untenable in the fire-attack area. Attack crews were feeding 2½-inch hoses through the bookshelves and winding stairways to use as attack lines, but they were unable to advance them because of the heat, even though other firefighters directed 1½-inch handlines on the attack crew to keep them cool. Occasionally, when attack teams opened their nozzles, the superheated steam drove them back.

At 12:25 p.m., firefighters discovered that the fire had progressed from the northeast stack to the northwest stack through a corridor connecting the two areas. Fire attack teams assigned to the northwest stack found that the fire there had begun to spread down and now involved both the sixth and seventh tiers. They also experienced the extreme heat that had plagued firefighters in the northeast stack. Attempts to improve ventilation by using sledge hammers and axes on a patio roof did not produce holes large enough to be effective.

By 1:30, the fire department had sent 34 companies, 12 officers, 1 helicopter, and 7 rescue ambulances. About this time, fire had become visible in windows to the Patent Room on tier 6½. Because of a potential structural collapse in the book stack areas, a rescue team was kept on standby to respond immediately, if necessary. The need to open up walls and roofs for ventilation was imperative, and fire officers requested a heavy utility vehicle containing pneumatic jackhammers that could be used to cut ventilation holes.

At approximately 1:33, most of the fire in the northeast stack had been knocked down. The connecting corridor, with temperatures at an estimated 2,000° to 2,400°F, was still too hot to enter. Because extreme heat in the northwest stack and Patent Room prevented firefighters from entering, two ladder pipes were positioned in the parking lot outside the Patent Room. After the attack crews were ordered from the area, exterior heavy streams were directed into the Patent Room for two minutes. Because the fire and high temperatures continued to prevent firefighters' entry into the Patent Room, the external streams were repeated for another six minutes. About this time, part of the seventh tier in the northwest stack collapsed. The interior attack in the northwest stack was resumed at 2:00 p.m. Some firefighters entered the Patent Room to extinguish the remaining fire. Others took 2½-inch and 1½-inch hoses into the stack areas from the Patent Room, from the southwest side of the seventh tier, and up the stairs in the northwest stack. Progress in the stacks was extremely slow because of high heat and limited access.

By 3:00 p.m., the spread of fire to uninvolved areas was apparently stopped, but firefighters still could not enter the seventh tier of the northwest stack or the connecting corridor. The heat absorbed by the concrete walls kept many areas unbearably hot, even though the fire had been knocked down. Firefighters equipped with pneumatic jackhammers went to the third floor and began to cut holes in the 6-inch thick concrete floor slab to ventilate the seventh tier. Even though fans were used to ventilate the third-floor corridor, firefighters operating the jackhammers had to be cooled with water spray from 1½-inch hoses, and many firefighters stood in water that was boiling because the slab was so hot.

At 3:30, once some of the holes had been made, fire crews placed distributor nozzles in areas where they could not gain access. Simultaneously a large hole was cut in a wall in the Patent Room to provide additional access to the seventh tier of the northwest stack.

The improved ventilation dramatically affected firefighting efforts, and attack teams began to make progress into the fire area. By 5:00 p.m., the fire in the northeast stack, the Patent Room, and two rooms on the third floor had been controlled; however, the fire in the northwest stack was still burning. Although the fire in the Central Library was declared extinguished at 6:30 p.m., firefighters remained on the scene to prevent hotspots and rekindling.

The Los Angeles City Fire Department committed 45 percent of its resources to fighting this 7½-hour fire--a total of 60 fire companies (engines and trucks), 1 arson unit, 9 paramedic rescue ambulances, 3 helicopters, 4 salvage companies, 1 squad, 2 emergency air units (on the scene for several days), 1 heavy utility company, and 350 fire personnel, including 40 staff, and support personnel. In addition, six mutual-aid units from Los Angeles County, five private ambulances, and a hospital emergency response team from the University of Southern California responded.

Book Salvage Operations[7]

Firefighting crews began to protect books early in the fire, using nearly 100 huge rolls of polyethylene in addition to their normal salvage covers. As soon as they were allowed to enter, library staff personnel began to formulate their plan for salvaging books. It was important to remove the books quickly, especially the wet and damp ones, because mildew can begin to grow in about 48 hours and can be as damaging to books as flames or smoke. Eventually, crews of city employees and others were brought in to help remove the water and stabilize conditions.

A consultant was hired to organize the book removal operation. He established the procedure for packaging, identifying, and recording the books and supervised personnel in carrying out these operations. In addition to organizing these activities, he had to obtain several lift trucks to move the pallets of books, many tractor-trailer trucks to transport the books to the storage areas, and large freezers to hold the estimated 1,600 pallet loads of wet books. He also made arrangements with a local convention center for temporary storage of the estimated 650 pallets containing dry books.

Because an immense number of books had to be removed from the building, a call for volunteers was made to the community. In response, relatives of staff personnel, people from the City of Los Angeles and adjacent communities, youth groups such as the California Conservation Corps, and many other people came to the Central Library to help. An estimated, 1,500 people volunteered and assisted during the four-day, 24-hour book-removal operation. In addition to training and supervising these people, the library administrators had to make sure that their sanitation, nutritional, and medical needs were met.

Injuries

During the fire, 50 firefighters were treated for burns or heat-related injuries; 28 were transported to the hospital and all but eight were released the same day. In addition, one civilian suffered a minor ankle injury.

The Damage

The fire on the fifth tier of the northeast stack spread along the shelves on both sides of the aisle and extended about 10 feet horizontally in both directions from the suspected point(s) of origin. It then spread into adjacent aisles and up into the tier level above (see Figure 4). Only a small percentage of books on the fifth tier level was damaged. In the sixth tier, nearly one-third of the books were damaged.

How the Investigation was Conducted

The NFPA's Fire Investigations and Applied Research Division investigated this fire to document and analyze significant factors that resulted in the loss of property so that it may report lessons learned for life safety and property loss prevention purposes.

The International Conference of Building Code Officials (ICBO) assisted the NFPA in data collection and analysis under an agreement between the NFPA and the ICBO, the Building Officials and Code Administrators International (BOCA) and the Southern Building Code Congress International (SBCCI) to investigate significant structural fires in the United States. The three model building code groups support the NFPA by lending

[7] For information regarding the salvage of water-damaged library materials, see *Emergency Procedures for Salvaging Flood- or Water-damaged Materials* by Peter Waters, Library of Congress, Washington, D.C., 1972.

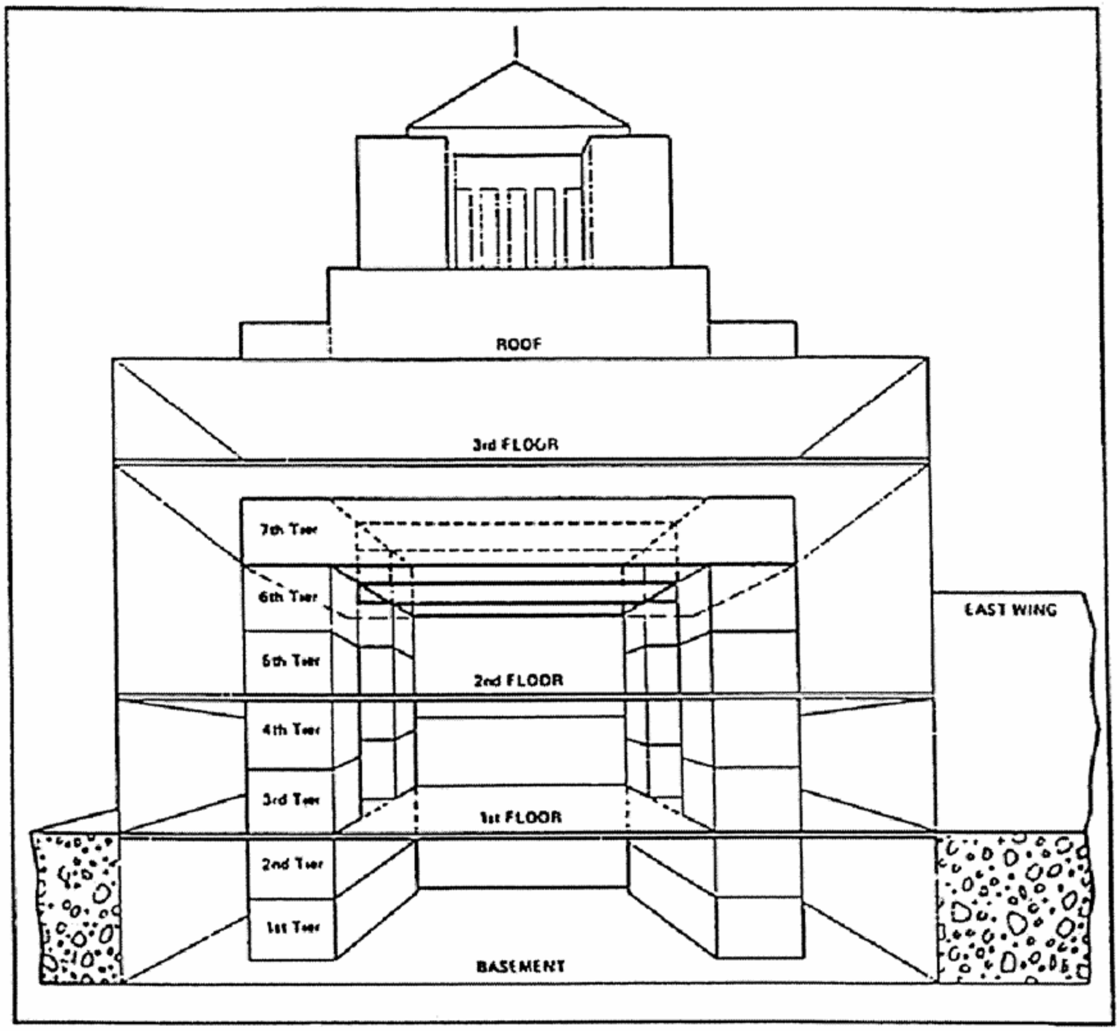
technical staff for on-site field work and building code analysis.

To document the facts, Michael S. Isner, from the NFPA Fire Investigations and Applied Research Division, visited the Library where he was assisted by T. J. Koyamatsu of the ICBO and John Morris, a private consultant. This report was based on a four-day, on-site study and subsequent analysis. The cooperation of the Los Angeles City Fire Department made entry to the fire scene and data collection activities possible.

It is not the NFPA's intention that this report, which is based on the best data available during the on-site data collection phase and during the report development process, pass judgment on, or fix liability for, the property loss at the Los Angeles Central Library fire.

The cooperation and assistance of Fire Chief Donald Manning, Fire Marshal Craig Drummond, Battalion Chief Raymond Olsen, and Deputy Chief Donald Anthony of the Los Angeles City Fire Department, and others in the Bureau of Fire Prevention, Los Angeles City Fire Department, are acknowledged and appreciated. The author thanks John Morris, private consultant, for his on-site assistance and input during analysis of the incident. The assistance of Stephen Bush, Safety Officer, Library of Congress, and Peter Waters, Library of Congress, are also recognized.

Special thanks go to T. J. Koyamatsu, P.E., Chief Plan Check Engineer, ICBO, for his on-site assistance in the data collection phase and his input in the code analysis portion of the report.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BASEMENT

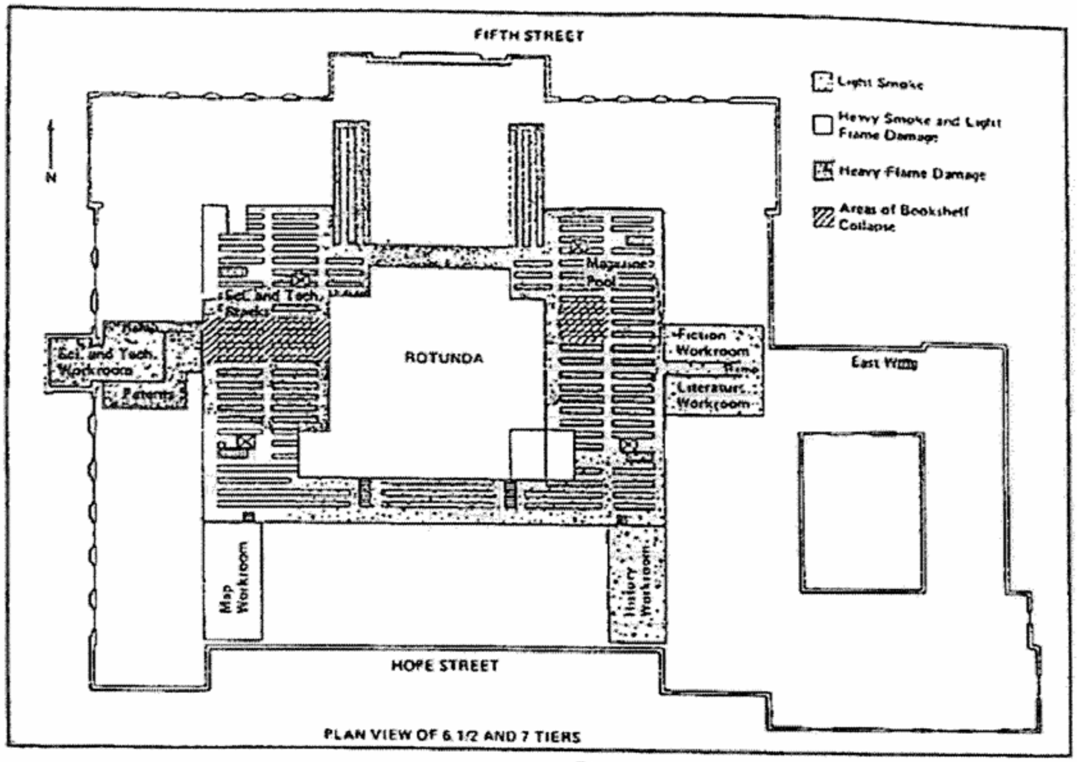

Figure 2. Floor plan of Tiers 6½ and 7. The three workrooms and the Patent Room were on the 6½-tier level.

Typical Shelf Arrangement (Not to Scale)

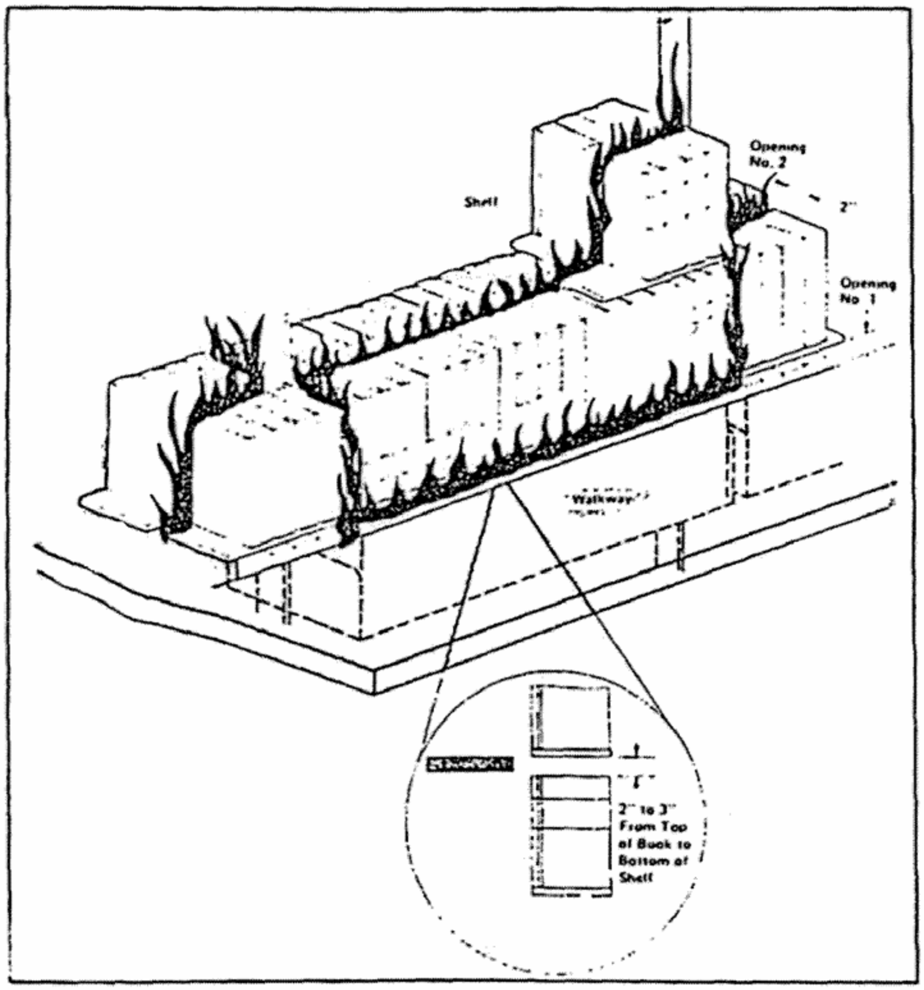

Figure 3 Typical shelf arrangement, showing area of fire spread (Not to scale)

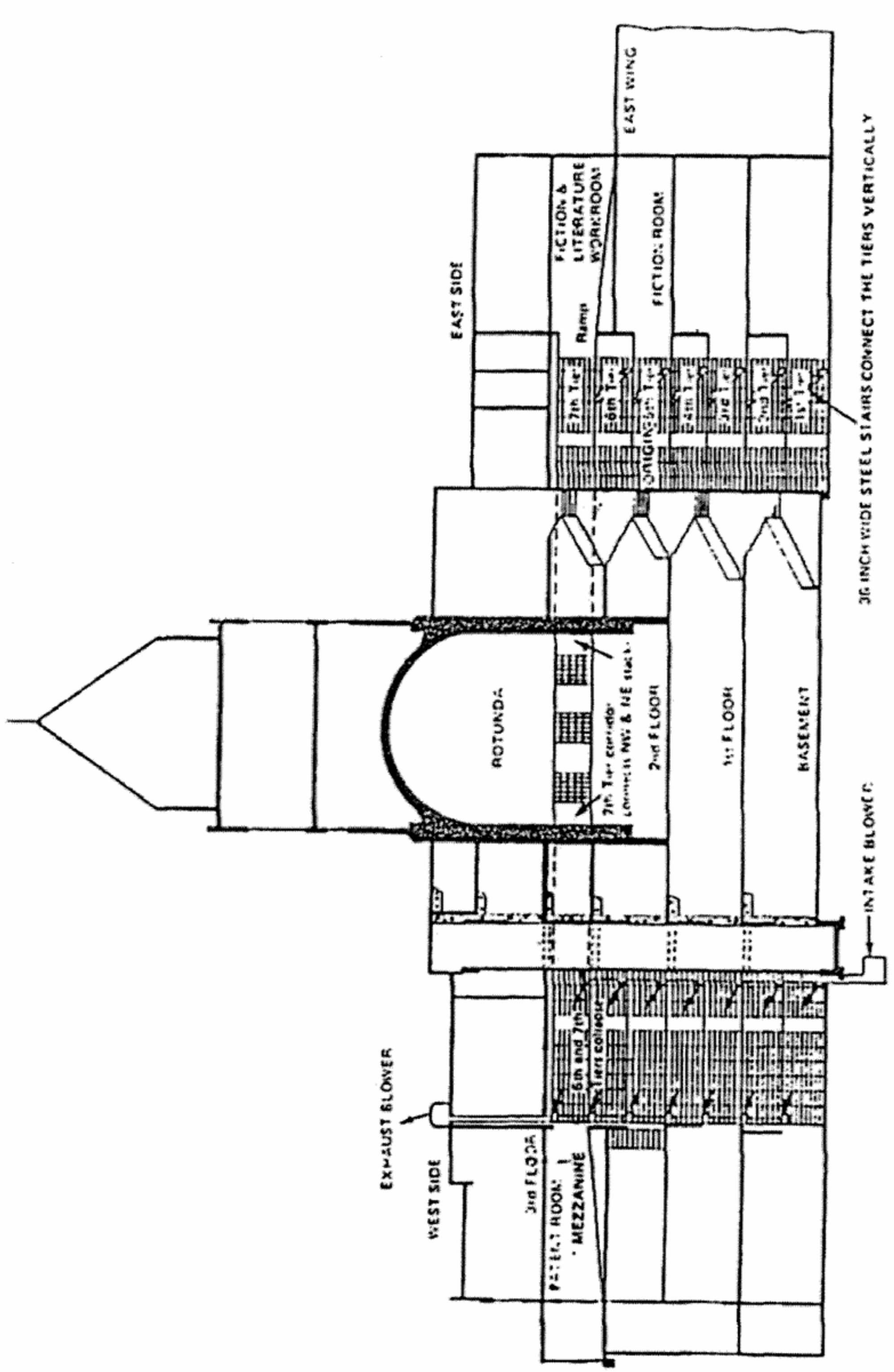

Figure 4. Side view showing stairways, connecting corridors, and areas of fire spread.

On the Job
By Alan Simmons
Los Angeles: $22 Million Blaze at Central Library Requires City's Largest Commitment of Firefighting Forces

A major emergency fire struck the Central Library in downtown Los Angeles on April 29, 1986, injuring 44 firefighters and one civilian and forcing the evacuation of 400 people. The stubborn, arson-caused blaze resulted in $20 million damage to the books and $2 million to the unsprinklered structure, but through aggressive interior firefighting and diligent salvage work, the LAFD saved 85 percent of the book collection, valued at $100 million, and averted major damage to the $50 million historic building. Chief Engineer Donald Manning called the incident "the most significant structure fire that this department has had to encounter."

Before the fire could be controlled, 60 fire companies, 4 fully manned salvage units, a squad, 2 air utilities, a heavy utility rescue, 9 rescue ambulances, a helicopter and 30 command officers would work at the blaze--a total of 350 personnel, or 45 percent of the city's on-duty firefighting force. "It was certainly the largest commitment to any structure that we can recall in the history of the city," according to Deputy Chief Donald Anthony, commander of the fire suppression bureau. The extensive firefight lasted seven-and-a-half hours.

Located at 630 West 5th Street, the library is a three-story concrete-reinforced structure measuring 480 feet long and 250 feet wide. It has a full basement and a large open six-story-high rotunda in the center of the building. Built in 1926 and patterned after the Nebraska State Capitol, the structure is an exotic mixture of Byzantine, Egyptian and Roman architecture.

The library is designed around a center core, in which each of the four corners house silo-type units known as "stacks."

Approximately 2 million books are stored in the stacks, which have no access from the public reading rooms that surround them. The stacks extend from the first through the second floors and have seven levels or tiers, with narrow metal stairways connecting each tier and a book elevator in the center of each stack. On each tier are 36-inch-wide aisleways, connecting several rows of floor-to-ceiling metal bookshelves. Open vertically through all seven tiers, the stacks are connected by a hallway at the second-floor level.

With its unprotected vertical and horizontal openings, the Central Library has long been considered a fire problem. Compounding this problem is the inability to ventilate the structure adequately due to its 16-inch-thick concrete walls and 6-inch-thick concrete roof. In 1956, Fire Chief John Alderson said that "a fire in the library would be an intolerable situation and would have to be fought from the street with an extreme loss." In 1979, Chief Craig Drummond, commander of the Fire Prevention Bureau, along with several inspectors, put together a multi-point correction program designed to minimize fire damage and create a safer environment for library employees and patrons. The program addressed basement storage, installation of a smoke detector system, enclosure of stairshafts, one-hour separation from public areas and employee fire-safety education. All of these items had been completed at the time of the fire, except for the one-hour separations, which were in progress.

The Los Angeles City Fire Department protects 3 million people in a 464-square-mile area consisting of every imaginable fire problem: industrial, commercial and residential structures; wildland brush; refineries; high-rises; two major airports and a major seaport. Responding to about 100,000 alarms a year, the 2750-man department operates 104 fire stations with 48 task forces, 52 triples, 7 helicopters, 3 hazardous material squads, and 5 fireboats within 3 divisions and 16 battalions. A task force consists of a two-piece engine company (both triple combination pumpers), a truck company (100-foot tractor-trailer aerial) and 10 members. A light force is a shortened version of a task force, consisting of the pump of a two-piece engine, a truck and 6 members.

At 10:52 a.m. on April 29, the LAFD's dispatch center (OCD) received an alarm of "bells ringing" from a library telephone operator. Task Forces 3 and 9, Engine 10, Squad 4 and Battalion Chief 1 Don Cate were dispatched to a "reported automatic alarm at the Central Library, 630 West 5th Street." Arriving at the main entrance at 10:57 a.m., Engine 10 under the command of Captain Don Stukey, reported, "Bells ringing, people outside, with nothing showing."

Most of the building's 400 occupants were already outside the structure when the units arrived on the scene. Task Force 3, Squad 4 and Battalion Chief 1 responded to the 5th Street address, while Task Force 9 took the rear of the building off Hope Street.

Engines 10 and 3 formed the investigation team and proceeded through the main entrance. Engine 3 went to the basement to check the alarm panel, while Engine 10 proceeded to the third floor. Standing fast on Hope Street, Engine 9 reported "light smoke" from the roof at the east end of the building.

Arriving on the third floor, Captain Stukey and his crew discovered light smoke hanging in the hallway in the northeast corner of the building. Upon further investigation, Engine 10 found a room with heavy smoke and heat, and radioed Battalion 1 that it had encountered a smoke condition on the third floor. Then they connected a 1-1/2-inch line to the building's wet standpipe and entered the smoke-filled room. Finding a stairwell, the crew attempted to make it down the stairs but returned to the hallway after encountering untenable conditions. As heavy smoke began banking down in the hallway, Captain Stukey tried to radio for help but could not make contact due to heavy radio traffic. Calling OCD via landline, he requested hoselines from the outside and high-rise packs to the second floor where the main body of the fire appeared to be.

OCD notified Battalion 1, via radio, of Engine 10's request for help and their instructions. Battalion Chief 1 Cate asked for four additional task forces and set up a command post on 5th Street, just east of the main entrance, labeling it "5th Street I.C." At 11:11 a.m., OCD dispatched Light Force 10, Task Forces 11, 4 and 15, and Engine 29 to the greater alarm fire.

Unable to attack the fire from the third floor, Engine 10 exited down an exterior stairway to the second-floor roof. They drop-bagged up to the roof two 1-3/4-inch lines from the 5th Street side, and proceeded through windows into a second-floor office. ("Drop-bagged" means dropping a 150-foot rope attached to a Scott Air Pak and pulling up the hose to the firefighters' position.)

Finding a ramp leading up to the seventh tier of the northeast stack, they advanced their lines to the doorway. It was at this position that Engine 10, accompanied by members of Light Force 10 and several other rotating companies, would be held for two hours, unable to advance due to the tremendous heat in the stack. "All you could see ahead was red," said Stukey. "Get a good shot of water down an aisleway and you got cooked from the steam. Water coming off the ceiling burned right through our coats."

Engines 3 and 9 attacked the fire in the northeast stack from the fifth up to the sixth tiers. Joined by Engine 11, Light Force 9 drop-bagged a 2-1/2-inch and a 1-1/2-inch line up from Hope Street and advanced the lines to the fifth tier, while other firefighters from Light Force 10 and Squad 4 brought a 2-1/2-inch line up from the south side of the northeast stack. John Jacobson and Vince Manzo of Truck 10 met Engine 10's crew at the stack doorway and took over their line. Says Jacobson: "At the same time, the rest of our truck company was bringing a 2-1/2 up from the south side in the east wing, but all those guys got blown off by the heat and smoke. Three of them went to the hospital and a guy from Squad 4 got burned pretty bad from steam and hot water. The engineer went down, he got trampled--and the captain went down with smoke. They took a beating."

Battalion Chief 5 Don Mello arrived with additional companies ordered by 5th Street I.C. and, assigned ventilation, ordered windows and skylights opened on the third floor. Light Force 3, assigned to the roof, proceeded up their aerial at the northeast corner, only to find that ventilation was impossible due to the 6-inch-thick concrete roof.

Arriving on the scene, Battalion Chief 11 Claude Creasey, assigned operations chief, took a position in the northeast quadrant and directed firefighting operations. Says he: "Engines 10 and 9 were already in there and had lines in place--right at the seat of the fire--and I came in on a line behind them into the fifth tier off of the second-floor level. You could see that the fire had already run up through the entire stack. There was so much fire in there that they couldn't make any headway." Recalls Truck 10's Jacobson: "Ten or fifteen minutes was all the guys could take. Four guys at a time would go in, take a beating and come out. We couldn't gain headway."

At 11:27 a.m. Deputy Chief Donald Anthony arrived and assumed command of the fire. He requested three fully manned salvages and five additional chief officers. By 11:30, 22 fire companies, eight chief officers and one rescue ambulance had been assigned to the fire. Division 1 Assistant Chief Ray Rojo arrived and was assigned as operations chief, replacing Chief Creasey who was reassigned to fire attack. Battalion Chief 18 William Lilly and Battalion Chief 3 Ken Dameron arrived and were assigned logistics and salvage respectively. Three problems faced the arriving command personnel and firefighters: ventilation of the fire area, rotation of teams and salvage. Additional companies were requested.

By noon Chief Creasey reported heavy heat and smoke problems in the northeast quadrant of the building. Companies were unable to advance lines, and Creasey was concerned about flashover in uninvolved areas due to tremendous heat build-up. Although windows and skylights had been broken, there were still no positive results from the ventilation effort. Says Creasey: "Things were happening so fast. I asked for additional lines to back up those already in place. Still, no ventilation was possible." He adds: "I believe the fire had filled that entire stack before we got a chance to get an attack going and, of course, the next thing that happened is that it spread horizontally through that tunnel."

The "tunnel" is a passageway below the third floor, connecting the northeast and northwest stacks. By 1 p.m., the fire had extended into the 300-foot-long passageway into the northwest stack, spread through the patent room and was blowing out the second-floor windows on the west side of the building. When the fire was discovered running the passageway, officers ordered holes cut in the floor of the third story in an attempt to stop the spread of fire. Explains Creasey: "We breached a hole in the floor that actually went into that tunnel. You could see nothing but solid fire, and it was drawing toward the west end. That's where one of the first cellar nozzles went, to cut that fire off, but it had gone past them."

After running the passageway, the first visible flames presented themselves to the hundreds of spectators viewing the fire from the north and west sides. Burning for two hours in the oven-like structure, with its thick walls and roof, the fire finally vented itself from the second floor windows of a lightwell. The fire, having traveled the hallway, now had complete control of the northwest stack, the patent room, and the lightwell, where flames were showing from five windows. Task Force 35 and Light Force 3 attempted to attack the blaze from northwest stack access, but were continually beaten back by intense heat.

Two-and-a-half hours after the initial alarm, firefighters from 15 rotational companies were beginning to get a knockdown in the northeast stack, the original location of the fire. Task Force 10, redirected to the west end of the building, joined the fire suppression effort in the northwest stack, where all the crews were taking a tremendous beating from the overwhelming heat. Recalls engineer Don Bair of Engine 10: "We needed a 1-1/2-inch line to protect the guys using a 2-1/2, just to keep them cool."

Chief Creasey, in command of fire attack, had also taken position in the west quadrant. "We went up a stairway into that stack twice and used up a full bottle, but couldn't even make a turn to head up the stairwell," he says. "We just couldn't advance with the heat. We had a 2-1/2 and a 1-1/2 in there, and I had a company bring in a 1-3/4. And we took that in there also, and we still couldn't make any headway. We coordinated everyone backing out, making a stand at the bottom of the stairway, out of the fire, and that's when we hit it with the heavy streams."

When the order was given to operate heavy streams, Engine 29, located at the northwest corner, opened up its wagon battery into windows of the patent room and lightwell. Truck 75 positioned its ladder pipe stream to hit the west windows of the lightwell. After 10 minutes of operation, all visible fire in the west end darkened, and the heavy streams were shut down. Notes Creasey: "We went back in with the 2-1/2 and 1-3/4 lines, and we started to make some headway then."

By 3 p.m. all fire spread had been halted. Though all of the heavy fire had been knocked down in both stacks, considerable fire still remained in the rubble of the stack aisleways. The metal shelving of the tiers, some of which had collapsed down through the stacks, glowed cherry red. The 16-inch-thick concrete walls retained the intense heat of the fire well into the following day.

Early in the fire, Rescues 9 and 3 of LAFD's paramedic division were dispatched to the greater alarm blaze. Rescues 9 and 3 established communications with the medical alert center and started initial triage of the first injured firefighters as they came out. Chief Paramedic J. Fasana arrived on scene at 11:27 a.m. and set up a medical command post and treatment center on 5th Street, just west of the main entrance of the library. While four rescue ambulances were committed directly to treatment and triage, the Hospital Emergency Response Team from Los Angeles County U.S.C. Medical Center was requested. Five fire department rescue ambulances and one helicopter were committed to transportation, as well as five private ambulances.

All injuries were treated at the 5th Street treatment center; those victims not transported were removed to a rehabilitation division established on the grounds of the library at the east side. In all, 46 firefighters were treated for injuries, with 28 transported to four local hospitals, three in serious condition. Thirty-two firefighters were treated for heat exhaustion.

After a seven-and-a-half hour battle, firefighters finally knocked down the blaze, requiring 350 members manning 78 units. The blaze has been labeled as arson and is still under investigation.

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Fire Strikes the Los Angeles Central Library

Donald F. Anthony
Deputy Chief
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Los Angeles City Fire Department, California

National experts on library fires, as well as a former chief engineer of the Los Angeles City Fire Department, had predicted that if a major fire ever struck the Los Angeles Central Library, it would be a complete loss. Yet such a fire did strike the library, on April 29, 1986. And the losses--estimated at $2 million to the structure and $20 million to the contents--were not as disastrous as anticipated.

The Los Angeles Fire Department made a maximum commitment to the fire. It included about 45 percent of all on-duty resources, a total of almost 350 fire personnel. Fire operations took place in an unsprinklered, fire-resistive building of huge proportions whose internal design is intricate and complex, to say the least (see sidebar, "The library building"). Seven hours and 38 minutes passed before knockdown was declared.

When the battle drew to a close an impressive 85 percent of the total value of the structure and contents had been saved. Of an estimated 1.2 million library books, about 350,000 received fire or water damage.

A major factor in preventing a larger loss was the early implementation of salvage operations. Three fully staffed salvage companies were requested at about 23 minutes into the fire. Salvage operations began early in the fire and continued through the night and into the next day. Sixty salvage covers and more than 98 rolls of polyethylene plastic--enough to cover two square acres--were used to protect books in four separate stack areas and the many public reading areas.

During fire operations, 50 Los Angeles firefighters were treated for injuries; 28 were transported to medical facilities. Yet no critical injuries or deaths occurred and only one minor civilian injury was reported.

1052 to 1130 Hours
The Alarm

At 1052 hours on April 29, 1986, an audio alarm, activated by a smoke detector, sounded in the Los Angeles Central Library. The library telephone operator called the fire department, while security personnel directed employees and patrons to evacuate the building. The evacuation was completed in approximately eight minutes.

Upon receiving a telephone report that "bells are ringing," the fire department dispatched a category "B" assignment, consisting of Task Forces 3 and 9, Engine 10, Squad 4, and Battalion Chief 1. (A task force includes a two-piece engine company, a truck company and 10 members.) Engine 10 arrived at 1057 hours and went to the main entrance at the north side, on Fifth Street. The company reported nothing showing. Engine 3, Squad 4, and Battalion Chief 1 arrived together on Fifth Street. Task Force 9 responded to Hope Street on the south side. Light Force 3 responded nonemergency, due to a broken siren, to Fifth Street. (A light force includes a pumper, a truck and six members.)

The crew from Engine 10, followed by the crew from Engine 3, entered the building to investigate. They found light smoke on the third floor, and heavy smoke in one room on the northeast side of the library. From Hope

Street, Engine 9 reported light smoke showing from the east end roof.

At 1111 hours, four more task forces were requested. Light Force 10, Task Force 11, Task Force 4, Engine 6, Task Force 15, and Engine 29 were dispatched. Battalion Chief Cate announced that the library incident command and the staging area would be on "Fifth Street, across from the library."

The Engine 10 firefighters were in the northeast corner of the building using a handline on the third floor. At 1114 hours, they requested help on the third floor and on the floor below. Then they backed out of the building and descended a metal ladder to the roof of a two-story wing at the east end of the building. They "drop-bagged" (i.e., they dropped a 150-foot rope and used it to pull lines up to their position) two 1-1/2-inch lines up to the roof from the Fifth Street side, then attacked the fire through a window, into an office and up a ramp into the seventh tier of the northeast stack of books (see Figure 1, Building design).

Library security personnel directed Engine 9 firefighters to the fifth tier of the northeast stack. Finding fire, they used high-rise hose packs to connect to an interior standpipe. They staged an attack from the "fiction room."

Engine 3 members checked the main alarm panel in the basement before climbing the stairs in the northeast stack. They left the stack area on the second floor to obtain a water supply, then began a fire attack up the stairs inside the stack to the sixth tier.

Ventilation Begins

Light Force 3 raised an aerial to the roof on the northeast corner, and began ventilation efforts.

Light Force 9, unable to reach the building with an aerial from Hope Street, used ground ladders up to balconies on the south side. These firefighters, joined by Engine 11 firefighters, drop-bagged a 2-1/2-inch line up from the Hope Street side. Proceeding to the fifth tier of the northeast stack, they used 1-1/2-inch and 2-1/2-inch lines to attack the fire up the stack stairs to the sixth tier.

Engine 203 took the hydrant on Fifth Street, and pumped into two standpipes situated on either side of the library's main entrance.

Engine 9 took a hydrant on Hope Street and pumped into standpipes on the south side of the library. Engine 209 laid hose from Engine 9 to a hydrant on the southeast corner and supplied water to Engine 9.

Meanwhile, Squad 4 proceeded to the second floor to help companies there advance lines up the stairs in the northeast stack area.

Incident command directed Light Force 4 to the third floor northeast stack area, where members drop-bagged two 1-1/2-inch lines up from Fifth Street. Finding no fire on the third floor, they went to the second floor roof of the east wing and joined Engine 10 firefighters in an attack from this location.

Engine 11 members drop-bagged a 2-1/2-inch supply line up from the Hope Street side, to supplement the interior standpipes on the second floor. Engine 11 then joined Task Force 9's fire attack in the northeast stack.

Attack from the South

Light Force 10 used the main entrance, climbed to the second floor and, went up the stairs in the southeast stack to the seventh tier. These firefighters used 2-1/2-inch and 1-1/2-inch lines to attack the fire from the south side.

When Battalion 5's Chief Mello arrived, incident command requested him to reconnoiter outside the building. He found the south, west, and north sides clear, but light smoke was showing from the east end roof. Assigned to ventilation, Mello went to the third floor and tried to cross ventilate using windows and skylights.

Battalion 11's Chief Creasey, who was assigned to operations, went inside to direct the firefighting operations in the northeast section of the building.

Light Force 4 raised its aerial to the roof on the northeast side (see Figure 2, Apparatus placement). The crew then went into the building, where Operations assigned this task force captain operations inside the northeast stack.

Engine 4 firefighters laid a line from Fifth Street and Grand Avenue to the front of the library and supplied lines to members on the east end roof. These firefighters then joined Engine 6 firefighters in an attempt to bring lines down into the fire area from the third floor. Engine 6 had taken the hydrant at Fifth Street and Grand Avenue to pump to Engine 4.

Firefighters on the third floor abandoned the attack from above when they discovered opposing lines coming in from the east wing roof and up the stack stairways from below the fire.

Arriving on the south side, Engine 29 provided a supply line to the second floor to supplement the standpipe system. Engine 29 was assigned "water control officer," to ensure that all standpipes were being supplied.

Task Force 15 arrived and raised its aerial to the roof on Fifth Street, west of the main entrance. These firefighters also were assigned to the fire attack in the northeast stack.

Salvage Companies Ordered

At 1120 hours, Bureau Commander Chief Anthony and Assistant Bureau Commander Chief Schnitker responded from headquarters. Realizing the need for salvage work, Chief Anthony ordered three fully staffed salvage companies. At 1127 hours, Chief Anthony took charge, assigned Battalion Chief Cate as plans chief, and requested five more battalion chiefs.

At about this time, fire attack teams on the sixth and seventh tiers in the northeast stack began to experience tremendous heat and heavy smoke. The intense heat prevented attack teams from advancing handlines.

Heat build-up hampered fire fighting efforts throughout operations. The library construction and complex design left no practical way to ventilate the involved areas. In addition, the building acted as a "heat sink," holding the heat long after the fire was out. These combined factors made penetration into involved areas extremely difficult. Access to the book tiers was limited to four, narrow, 36-inch-wide stairways and one window.

By 1130 hours, 22 fire companies, 8 command and staff officers, and 1 rescue ambulance were committed to the Los Angeles Central Library fire.

1130 to 1200 Hours

Battalion 7's Chief Allen arrived and established lobby control inside the main library entrance on Fifth Street.

Now the fire appeared to be contained in the northeast stack. The three major tasks were to provide ventilation, to rotate members of the fire attack teams, and to conduct salvage operations below the fire area.

Chief Lilly of Battalion 18 and Chief Dameron of Battalion 3 arrived and were assigned to logistics and salvage, respectively.

Chief Mello's division continued efforts to ventilate. Windows and skylights were opened or broken out, with little or no positive effect. The 16-inch-thick reinforced concrete walls and 6-inch-thick reinforced concrete roof and floors, combined with the lack of vertical or horizontal passages, made ventilation almost impossible.

Salvage operations began on the first and second floors and in the first through fifth tiers in the northeast stack, beneath the fire area. Crews used polyethylene plastic and salvage covers to cover book shelves and furniture, and arranged sawdust to direct water out of the building.

When Division 1's Chief Rojo arrived, he was assigned operations and Chief Creasey was assigned fire attack. The incident was redesignated as the "Fifth Street I.C."

Chief Paramedic Fasana arrived at 1145 hours and established a medical division across from the library on Fifth Street, west of the main entrance. Medical operations were sheltered in the entrance to an underground garage.

The order to shut down the building's ventilation and electrical systems was made at 1156 hours. At about the same time, the first two firefighter injuries occurred: one suffered heat exhaustion and one had burned knees.

The department's supply and maintenance division was notified of the fire in progress, and Emergency Air 2 was ordered to respond with a full load of air cylinders.

Chief Anthony directed that staff be notified of a major emergency in progress.

By noon, 24 fire companies, 10 command and staff officers, and 5 rescue ambulances had been assigned to the Central Library fire.

1200 to 1230 Hours
Fire in the Wall

At 1201 hours, Chief Mello reported fire in a third floor wall. His position was above the west end of a hall connecting the northeast and northwest stacks at the seventh tier level (see Figure 1).

Fire fighting efforts still were concentrated in the northeast stack area, where Chief Creasey reported that forces were experiencing serious problems caused by heat and smoke banking down due to restricted ventilation. Creasey also expressed concern about a possible flashover resulting from the tremendous heat build-up in the northeast stack.

Heat and smoke were so intense that crews had to be rotated every 15 to 20 minutes. Firefighters were taking a beating. Whenever they opened a nozzle, superheated steam drove them back.

From outside, dark smoke was visible at the center and west portions of the building. At 1225 hours, Engine 60 reported fire showing at the windows of a light shaft at the west end of the seventh tier corridor connecting the northeast and northwest stacks. This was close to the area where Chief Mello had reported fire in the wall.

Chief Rojo directed an attempted fire attack at the light shaft. Light Force 3 and Task Force 35 personnel launched this attack.

More companies were ordered, including Emergency Air 88 and an air ambulance.

Supply and maintenance delivered 13 blowers, 50 bags of sawdust, and 30 rolls of plastic to the scene.

1230 to 1300 Hours
Fire in the Northwest Stack

By about 1230 hours, fire had spread through the corridor connecting the northeast and northwest stacks. The sixth and seventh tiers of the northwest stack were involved in fire. Forces were directed up the stairs in the northwest stack, to attack the fire from below.

They encountered the same problems--extremely high temperatures, heavy smoke, narrow aisles and very limited access. Firefighters reported that the metal bookshelves were bright red from intense heat. Attack forces used 2-1/2-inch lines; meanwhile, they were protected by 1-1/2-inch lines. Little progress could be made, and fire attack teams had to be rotated every 10 to 15 minutes because of the intense heat.

At 1241 hours, Chief Anthony requested an additional fire ground radio frequency and was assigned Channel 5. Chief Anthony gave Chief Engineer Donald Manning an update on operations. At about the same time, Chief Drummond, the fire marshal, arrived on the scene. The medical division requested all available saline solution to the fire, for use in treating firefighters suffering burns and heat exhaustion. Assistant Chief Lucarelli and Battalion Chief Defeo, both from supply and maintenance, arrived and were assigned logistics and lobby control. Chief Lilly was reassigned to second floor staging and Chief Allen to the northeast stack area.

The ventilation division wielded sledgehammers and axes to breach the roof, but still could not open a hole large enough for effective ventilation.

Two hours into the fire, 34 fire companies, 12 command and staff officers, 1 air ambulance, and 7 rescue ambulances had been committed to the incident.

1300 to 1400 Hours

Change of Command

Between 1300 and 1330 hours, Chief Drummond became incident commander, and Chief Anthony took over operations, coordinating all fire fighting. Fire had become visible in the patent room at the west end of the building. Fire now extended almost 300 feet across the entire second floor, having traveled from the northeast stack through the connecting hall into the northwest stack, and out the window on the west end.

Chief Anthony and Chief Rojo toured the building interior, assessing the situation and developing further attack plans. The decision was to alternate between the use of heavy streams to cool the fire and the use of an interior attack to extinguish it.

The need to open up walls and roofs with jackhammers became even more apparent. At 1314 hours, Heavy Utility 27 was requested, as well as a second helicopter for observation purposes.

The fire in the northeast stack area was being controlled. Only spot fires and deep-seated hot spots remained. But the connecting hallway, with temperatures of 2000°F to 2500°F, was untenable, even for firefighters in full protective gear.

Tiers Collapse

Far from being controlled, the fire in the northwest stack area raged until it led to the collapse of the sixth and seventh tiers. Chief Anthony called an operations planning meeting and divided the building into four quadrants, each including a stack and approximately one-fourth of the building. Placed in command of the quadrants were Chief Rojo, the northwest quadrant; Chief Vega, assisted by Chief Allen, the northeast quadrant; Chief Creasey, the southeast quadrant; and Chief Mello, the southwest quadrant.

At 1344 hours, forces were removed from the northwest quadrant so that Engine 29 and Truck 75 could begin a heavy stream attack. A portable monitor was used in the east end of the connecting hallway, to cool the area and to prevent heavy streams from pushing the fire back. Despite the portable monitor and the use of handlines, the connecting hall remained too hot to work in for several more hours.

The coordinated attack, alternating between exterior heavy streams and interior handlines, continued until about 1400 hours. By then, any fire that could be reached with exterior heavy streams had been knocked down.

1400 to 1530 Hours

An interior attack in the northwest stack resumed, using 2-1/2-inch and 1-1/2-inch handlines. Companies advanced from the patent room on the west, the southwest stack from the south and up the stairs of the northwest stack. Temperatures in the connecting hall still prevented an attack from the east. Companies continued to be rotated every 15 minutes.

The attack was maintained until utility forces could use jackhammers to ventilate the stack area through the third floor.

Meanwhile, five task forces were requested to provide emergency relief to attack crews.

Chief Allen called a knockdown on the northeast stack, where fire had been stopped from entering the southeast stack.

Between 1430 and 1500 hours, the fire attack continued in the northwest stack. Extreme heat and limited access slowed progress, but between 1500 and 1530 hours, all fire spread was stopped and the only remaining fire was limited to the northwest stack. But the advance of handlines was difficult; the concrete walls retained heat, even where the fire had been knocked down; and very little progress could be made in reaching the seat of the fire.

1530 to 1730 Hours

Jackhammering holes through the third floor to ventilate the northwest stack area began at about 1530 hours. As each hole was opened, large volumes of pressurized heat and smoke were vented. The jackhammer crews were required to wear full protective gear, including SCBA, as well as ear muffs. They were protected by hose lines and blowers, which kept smoke and heat away. Water applied to cool this area would actually boil when it hit the hot floors. Eighteen holes eventually were punched through the 6-inch-thick concrete steel-reinforced floor.

Simultaneously, crews in the patent room used sledgehammers to break the wall into the seventh tier of the northwest stack. By 1600 hours, ventilation efforts took effect, and fire attack teams began making slow progress into the fire area.

By 1630 hours, command in the northeast, southeast and southwest quadrants reported that crews were being removed from those areas. Salvage operations, begun early in the fire, continued throughout the building, including all areas below the fire. In the northwest stack area, firefighters using handlines continued to advance slowly into the fire area, and the size of the uncontrolled fire continued to shrink. Finally, 7 hours and 38 minutes after the alarm was received, a knockdown was declared in the Los Angeles Central Library fire.

Analysis

It has been determined that the Central Library fire was incendiary and was caused by the ignition of ordinary combustibles. No arrests have been made, and the fire remains under investigation.

The fire began on the fifth tier of the northeast stack and spread rapidly up through open spaces in the floors to the sixth and seventh tiers. When the fire reached the concrete ceiling, it mushroomed down and spread horizontally along a hallway that connected the northeast and northwest stacks at the seventh tier level. Only aggressive fire fighting kept the fire out of the southeast and southwest stacks.

No deaths or critical injuries occurred during this fire. Fifty firefighters and one civilian suffered injuries. Twenty-eight of the firefighters were transported to medical facilities; the remainder were treated at the scene.

The $2 million property loss to the structure represents only 4 percent of the building's value of $50 million. The $20 million loss of contents represents just 20 percent of the library's $100 million in contents.

A key reason for the minimal loss to contents was the high priority placed on salvage operations. At about 23 minutes into the fire, three fully staffed salvage companies were requested. Salvage operations began early in the fire and continued throughout the night and into the next day.

Sixty salvage covers and more than 98 rolls of polyethylene plastic--enough to cover two square acres--were used to protect the books in the four stack areas and the numerous public reading areas.

The design and construction of the building contributed to the severity of the fire for the following reasons:

- The interior traffic patterns were confusing.
- The stack design caused rapid spread of the fire both vertically and horizontally.
- The lack of vertical and horizontal openings into the stacks, coupled with the steel-reinforced concrete floors and roofs, made ventilation extremely difficult.
- The heavy fire load of 93 pounds per square foot allowed temperatures in excess of 2000°F to develop.
- The thick concrete walls, roof and floors held heat long after the fire was extinguished, making entry into burned areas impossible for hours after the fire was out.

Editor's note: ***An in-depth article analyzing the Los Angeles Central Library building and fire is being prepared by Michael S. Isner, fire protection specialist, NFPA Fire Investigations and Applied Research Division. It will appear in the NFPA membership magazine, Fire Journal, early next year.***

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The Salvage Effort:

One for the Books

Robert Day

A unique bond between the Los Angeles Fire Department personnel and Central Library employees grew out of this fire.

At the urging of Mayor Tom Bradley, library employees gathered at 9 p.m., on the evening of the fire to begin salvage operations. In groups of five they entered the still-smoldering building, escorted by exhausted firefighters. It was the first chance librarians had had to see the damage--and to realize what a tough, hazardous fire it had been to fight.

Even to a layman, the fire department's extraordinary efforts to minimize the damage were evident. Huge sheets of plastic had been placed carefully over shelved books to reduce water damage. Library employees learned that this was done by a specially trained salvage team. Tears of gratitude mixed with tears of grief.

Over the next days, the salvagers entered more burned out areas. With each new bit of evidence of the fire's savagery, esteem for the firefighters' skill and courage grew. The library staff received news of the firefighter injuries with deep sadness; they began looking for ways to express their thanks and appreciation to LAFD.

The first opportunity came at a press conference, where a fund-raising committee for the library was announced. Civic and business leaders received polite applause. But the introduction of Fire Chief Donald Manning brought 200 cheering employees to their feet. Photos of the minutes-long ovation were carried in newspapers and on television.

A more tangible form of gratitude followed: Printed shirts declaring "Central Library Lives" were made available to all library employees, with the proceeds to go to the Fireman's Widow and Orphans Fund. So far, $3,000 has been raised.

In addition, the new, renovated Central Library will display a plaque listing the name of every firefighter involved with the fire.

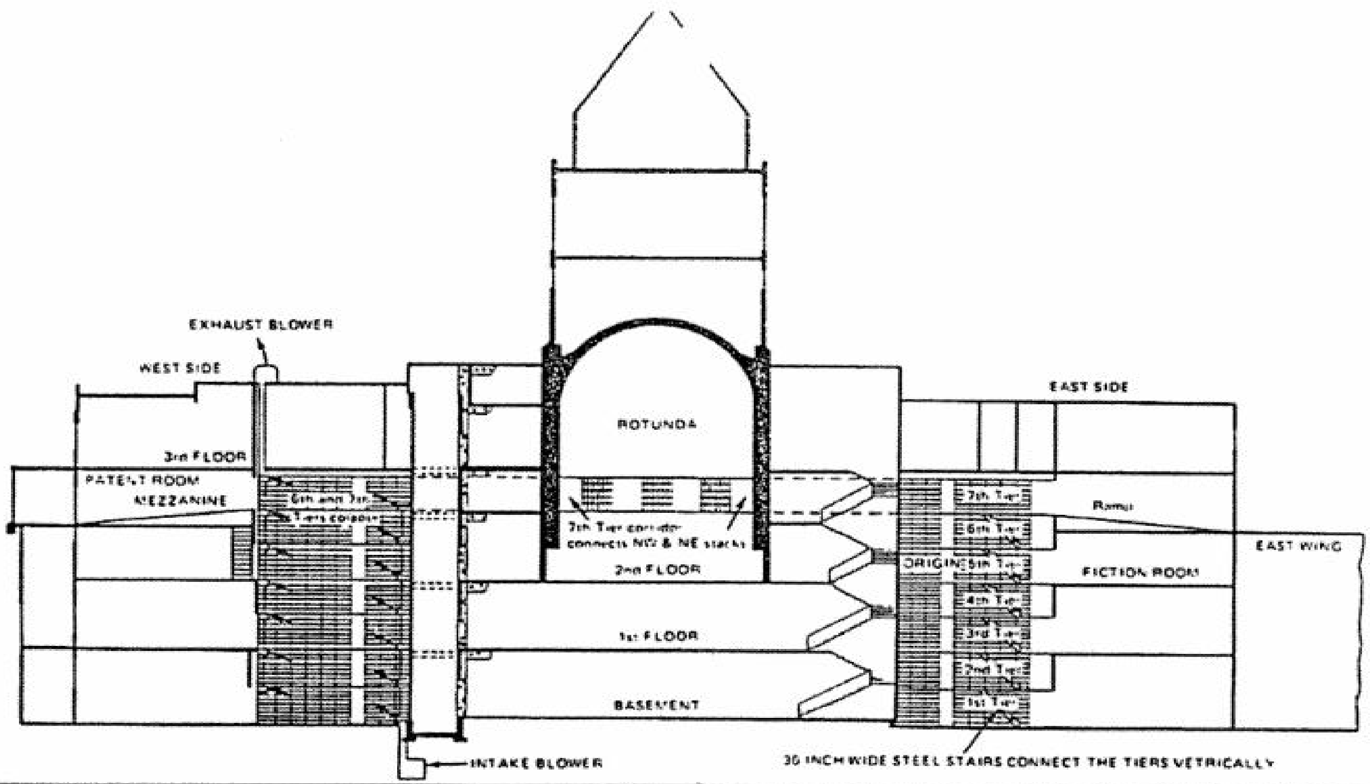
Chief Manning, in turn, surprised library employees by recognizing their efforts. Explaining to the Board of Library Supervisors the tremendous morale boost the library staff has given the fire department, he presented a handsome plaque with this inscription: "In appreciation of outstanding support and dedication by the administration and staff of the library department following the disastrous Central Library fire."

These feelings of mutual appreciation are bound to continue and strengthen as the library moves to temporary quarters while the original building is upgraded and expanded.

Two major library fires in four years, both arson related, have impressed on civic leaders and fire department and library personnel the need to cooperate as never before on fire prevention.

Books sometimes are irreplaceable, but lives always are.

Editor's note: ***Robert Day's mother is head children's literature librarian at the Central Library.***



The library building

The Central Library was built in 1926 of fire resistive construction. The bearing walls, floors and roof are reinforced concrete. The non-bearing walls are hollow tile covered with plaster. The building measures 334 feet by 200 feet.

The library has three floors and a basement. A 54-foot-high rotunda forms the core of the building. Surrounding it are four book stacks, one in each quadrant, which run from the basement to the third floor. There are seven tiers in each stack; two in the basement, two on the first floor, and three on the second floor. The building's third floor is the ceiling of the seventh tier.

Modeled after those invented for the Library of Congress in 1893, the tiers are supported on unprotected steel columns and beams. Vertical openings between tiers permit heating and ventilation by convection air currents. Under fire conditions these openings functioned as a flue, accelerating vertical fire spread.

The four stack areas are connected by horizontal hallways at the basement and seventh tier levels. Each stack area measures about 49 feet by 42 feet. Access can be made only through narrow doors from the first and second floors and the basement, then up 36-inch-wide steel stairways. Each tier contained book shelves from floor to ceiling with 30-inch-wide aisles for access to the shelves.

The only fire protection devices in the library were interior standpipes, fire extinguishers, and smoke detectors. A small area of the basement is protected by automatic sprinklers.

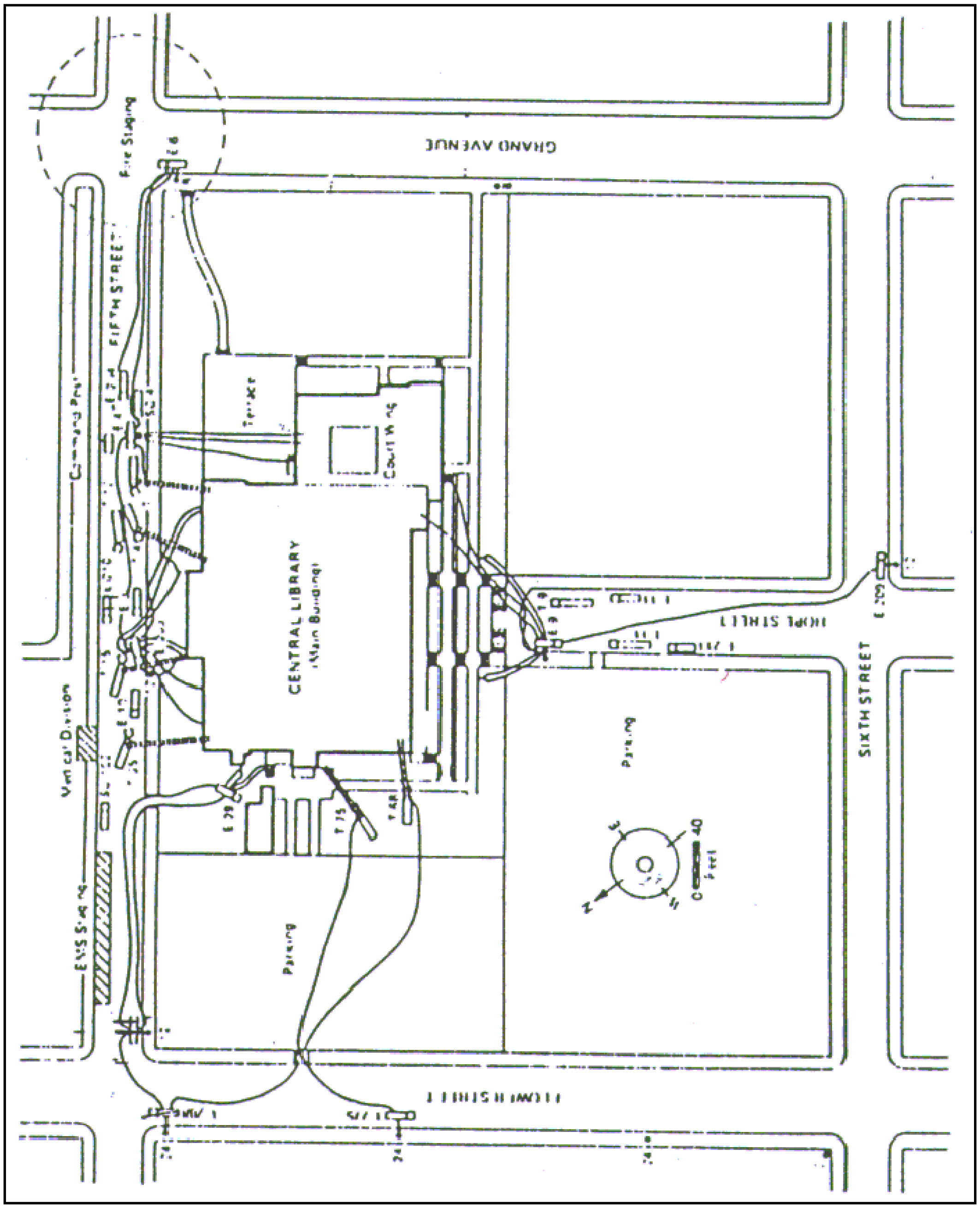


Figure 2. Apparatus placement.

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UNIT 3:
NURSING HOMES

TERMINAL OBJECTIVE

At the end of this unit students given a simulated major fire scenario, will be able to develop an effective incident organization to assemble, coordinate, and control tactical resources and implement a plan of action based on critical cues, information gathered and critical elements presented.

ENABLING OBJECTIVES

The students will be able to:

1. *Describe the need to effectively manage a nursing home incident.*
2. *Identify the critical cues posed at nursing home incidents.*
3. *Determine the Incident Command System (ICS) organization required at nursing home incidents.*
4. *Perform the ICS management roles at a nursing home simulation.*

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INTRODUCTION

A nursing home is a structure designed for the care of elderly or disabled persons. Many of the patients may be bed-ridden and either partially or fully nonambulatory. Most nursing homes must meet a number of State and Federal requirements to maintain their licenses. Depending on the local jurisdiction and the State requirements that are in effect, many nursing homes may be considered relatively safe. However, even small fires create large amounts of smoke and this smoke is detrimental to the life safety of the occupants.

OCCUPANCY-SPECIFIC CUES

The construction of nursing homes will vary with the age of the building, its design, and the building codes that were in effect when it was constructed. These types of buildings may be of ordinary, fire-resistive, noncombustible and, in many cases, may be wood-frame construction. It is not unusual to find buildings of this type that have been expanded or remodeled and are of mixed construction types.

Nursing homes fit the target hazard definition by virtue of their resident population, which represents an atypical hazard, and because a major incident will involve multiagency involvement. Evacuation will exhaust initial alarm responders quickly, and can easily outstrip local resources. Response plans will need to address evacuation tactics, equipment, personnel, sheltering and transportation requirements, and documentation issues

Nursing homes can be virtually any type of construction. Construction type will play a major role in fire spread and fire containment. Type I--Fire Resistive, and Type II--Noncombustible, creates the likelihood that the fire will be contained to one floor. However, Type III--Ordinary, Type IV--Heavy Timber, and Type V--Wood Frame, may allow fire spread through combustible voids in the walls and floors. The roof assembly in the various construction types may also pose a problem for effective vertical ventilation. Roofs could be some type of reinforced concrete, heavy timber, or nominal wood frame, as well as steel bar-joist with metal decking.

It must be remembered that construction type refers only to the basic structural elements of the building and not to the furnishings or contents of the building. In many cases, modifications to the original basic structure may have occurred during remodeling or renovation.

In terms of separation of space on individual floors, nursing homes normally are well compartmented. The concept of compartmentation helps to contain a fire to the area of origin but is valid only if the concept is maintained by closed doors that separate an area of fire origin from the rest of the building. There may also be an open space concept in many nursing homes where patients are housed in dormitory style areas.

Vertical compartmentation in multistoried nursing homes relies on protected shaft enclosures. This concept can fail if fire enters stair shafts, elevator shafts, or vertical voids that penetrate floors. It also is defeated when fire laps upward on the outside of the building.

The type of construction and code requirements for built-in fire protection will have a dramatic impact on problems that are encountered in these occupancies.

In some cases the building was constructed originally as a nursing home. In other cases a single-family or multifamily dwelling, an apartment house, or a hospital may have been converted into a nursing home. Although internal fire protection systems such as smoke detectors, central alarms, sprinkler systems, standpipe systems, and smoke removal systems are frequently in place, they may or may not be in working order.

Successful fire control and life safety operations in nursing home occupancies require knowledge of the construction and physical layout of the building. Because of the potential for large life loss, these types of occupancies should be preplanned periodically, and the preplan information should be available at the incident scene for use by Command Officers.

As part of preincident planning process, you should know the number and condition of the occupants, the type of construction, and the adequacy of fire department access. Using a preincident plan similar to the NFA's Quick Access Prefire Plan (QAP) is critical to having the necessary critical information at the scene. Get to know the nursing home personnel on duty and the fire and evacuation procedures. Ensure that the staff is well trained and understand that they should alert the fire department before attempting to control a fire, and that they regularly practice evacuation procedures.

Alarm systems have to be considered the first line of defense in any habitational occupancy, and in nursing homes they can range from barely compliant to state-of-the-art. Even though alarm systems are installed, they may not be well maintained and may fail to function when fires do occur. Added to this is the fact that nursing home staff personnel often are reluctant to report fires until they have checked out the area.

Sprinkler systems are certainly one of the most effective built-in life safety features, yet they are found only in the newest structures of this type, or, in some cases, have been retrofitted under local or State ordinances that were passed following tragic fire losses. Often nursing homes will have sprinklers installed only in selected areas such as basements or possibly in hallways, but not in individual rooms.

Sprinkler/Standpipe systems found in nursing homes may consist of Class I systems which provide 2-1/2-inch outlets that are designed for firefighting purposes. These systems are to be considered reliable for primary fire department use and required in buildings of three or more stories (above or below grade). They are provided to reduce time in laying hoses from fire apparatus to remote building areas while providing better flow rates, preventing low working pressure and minimal water supply. Class I systems can used for initial attack but as always, should be backed up with regular fire department lines from an outside supply source.

Class II standpipe systems with 1-1/2-inch outlets may be found in many nursing homes. Class II systems are designed for occupant use and may be either wet systems or dry systems. Wet systems normally are supplied by a fire pump that provides much more water volume and pressure than a Class I system.

Standpipe systems found in nursing homes may only consist of Class III systems may be provided with 2-1/2- or 1-1/2-inch outlets that are supplied from the domestic water supply system. These systems should not be considered reliable for primary fire department use. In most cases, they provide low working pressure, minimal water supply, and any equipment attached to them is inferior when compared to fire department standards. If Class III systems are used for initial attack they should be backed up with regular fire department lines from a reliable supply source.

The location of standpipe outlets in the building should be noted on preplans.

Because of the occupant load in nursing homes, life safety is the major issue. The occupant load in a nursing home at any given time will vary according to several factors, such as the size of the structure and community size.

Access to these types of structures will vary depending on the design of the building and original code requirements. Normally a minimum of two means of egress are required. In some cases, the number of access points may be determined by exit requirements, based on occupant load. Access to all sides of the structure by fire apparatus may be hampered by parking lots filled with vehicles or narrow driveways and alleys. Because access points can be critical to fire control operations, they should be noted on preplans.

In addition to access to the building, access to the fire area may be delayed. This is especially true if the fire is located on an upper floor of a multistoried building. Smoke and heat in the hallways also may delay access to the area where the fire is burning. The horizontal distance that must be traveled as well as the lengths of hose required to reach the fire area can delay access in some cases.

The use of ground or aerial ladders to access the fire area may be difficult. Ground-level obstructions may prevent placing apparatus in positions from which ladders can be used. Utility poles and wires are common obstructions that often make ladder placement difficult or sometimes impossible. Many newer multistoried structures may have inoperable windows that complicate entering the building from exterior ladders.

Multiple stair shafts are common in many multistory nursing homes. This requires a decision as to which stairway should be used and for what purpose. Selection of specific stair shafts for fire attack, ventilation, and evacuation may be necessary. It is also important to remember that all stair shafts in the building may not provide access to the roof. This can cause serious problems when occupants attempt to evacuate upward in the building and also limits options for ventilating smoke-filled floors.

Multistory nursing homes are equipped with elevators that may be hydraulically or electrically operated. Regardless of the type of elevator system, they are subject to system malfunctions, which can cause them to respond to nonselected floors or become stuck in the hoistway. The safest approach to use of elevators is that they should not be used by fire personnel until it is determined that they are safe to use and the elevator lobby on the fire floor is under fire department control. A departmental procedure regarding use of elevators under fire conditions should be in place and followed by all personnel.

Water supply in areas where nursing homes are located is usually from hydrants, which will provide adequate supply for most firefighting needs. However, many nursing homes are built in non-hydrant areas. If the fire involves several rooms or more than one floor, consideration should be given to the ability of the hydrant supply to deliver the necessary fire flow. If a sprinkler system also must be supplied, it may be necessary to assign additional resources to deliver the required fire flow.

Fire development and behavior in nursing home fires normally are no different than in other types of structures, as the fires usually are confined to a single room or living unit. Extinguishment can be relatively simple if doors to the fire area are closed, and vertical lapping does not occur. However, if a door to the unit is open or fails, fire and smoke entering the corridors can create major problems. Any time that fire and smoke are allowed to enter corridors or stair shafts, serious life safety problems are created.

If vertical lapping occurs, the potential for fire on more than one floor exists. The rate of vertical extension will depend on several factors. The volume of fire exiting the area of origin certainly will be a factor as will the type and thickness of glass and the window frame material on upper floors. Single-strength glass set in aluminum frames can fail very quickly when exposed to flames from a fire below.

Resources must be considered in terms of fire condition and the amount of work that must be done. A small fire with no extensive search and rescue required usually can be handled with the initial alarm assignment. In these cases fire attack, limited evacuation, and possibly some simple ventilation will be required. However, with a larger fire that can spread rapidly, coupled with a major search and rescue operation and complex ventilation requirements, additional resources will be required. If any doubt exists that initial alarm resources are adequate, additional resources should be requested in a timely manner.

MEDICAL GROUP/BRANCH

A Medical Group or Medical Branch may have to be established at a multicasualty situation.

The following units may have to be established in a Medical Group/Medical Branch:

- Triage;
- Treatment;
- Transportation;
- Medical supply; and
- Morgue.

Some agencies establish a Medical Staging area for patient transport vehicles under the Transportation Unit.

CUE-BASED PREDICTIONS

- A large number of people may become victims in any fire that produces large amounts of smoke.

- The ability to access the floors quickly may be hampered by open stairwells, people evacuating, limited number of stairways, or narrow stairways.

- Lack of a standpipe system may make fire attack more difficult.

- Many occupants are disabled and will require assistance to evacuate the building.

- Fires often contained to a single room.

- A Medical Group or Medical Branch may be required to care for the injured.

INCIDENT MANAGEMENT CUES

Working fires in nursing homes frequently require that several simultaneous tactical operations be performed. Fire attack, search and rescue, and ventilation usually are occurring at the same time. From the standpoint of personnel safety and effective fire control, these operations must be coordinated.

The responsibility for coordinating tactical operations rests with command officers who are directing or supervising these operations. Proper coordination requires not only good communication but also feedback from personnel who are involved in the specific operations.

Failure to coordinate tactical operations can result in some very serious problems. One result of poor coordination can be mixed attack modes where offensive and defensive operations are occurring at the same time in opposition to each other. Delayed or improper ventilation is another example of poor coordination that can have a serious negative effect at incidents of this type.

Lack of coordination of tactical operations during nursing home fires can jeopardize the lives of both building occupants and firefighters. Untenable conditions can be created within the building, which may prevent evacuation of occupants. Tactical operations may be impeded seriously, and smoke and fire can be spread throughout the entire building.

ORGANIZATIONAL RESPONSE TO CUES

- a Vent Group for vertical and horizontal ventilation;
- a Division on each floor where operations are needed;
- a Rescue Group. A Branch in multistoried nursing homes; and
- a Safety Officer.

STRATEGY AND TACTICS

The basic strategy for fires in nursing homes should be based on the principles of Incident Priorities:

- life safety;
- incident stabilization; and
- property conservation.

An effective sizeup that identifies the problems that are present will be critical in determining the proper strategy. However, the problems may not all be evident from outside the building. Outside observations should be used as an indicator of problems inside the building until additional information can be provided.

An evaluation of conditions inside the building should be obtained as soon as possible. In addition to life safety concerns, information should be provided on horizontal or vertical extension of the fire. Once the problems are identified, solutions should be developed in terms of what the strategy will be and what specific tactical operations will need to be done.

Identifying the problems is also the first step in determining what resources are required. In simple terms, match the problems with resources. In order to do this, it is necessary to have an understanding of the availability and capability of the resources that are on scene or have been requested. Consideration must be given to how long it will take requested resources to arrive at the scene and how much work they can do when they get there.

The assignment of initial alarm resources should be based on what initial actions will do the most good. In most cases, an immediate and aggressive attack on the fire will ensure the safety of the largest number of building occupants. If an immediate attack on the fire cannot be started, evacuation of building occupants may be the best approach. Ideally, an immediate fire attack coupled with evacuation of those occupants in the most danger will work the best.

Consideration must be given to how stairways will be used for fire attack and occupant evacuation. Doing both from the same stairway should be avoided because it can impede the progress of firefighters and endanger civilians who are trying to exit the building. It is much better to designate one stairway for evacuation and another for fire attack. The stairway used for evacuation purposes should be maintained free of smoke. This can be done by using a stair shaft with a roof opening to remove smoke from the stairway and by pressurizing the stair shaft from below.

The attack on the fire should be from a direction that does not push the fire into unburned areas of the floor. This can be difficult depending on the location of the fire in relation to access points. However, positioning a separate hoseline to limit fire extension is often possible; care must be taken, however, that this protective hoseline is not used to attack the fire, which could create an opposing hoseline situation.

With regard to hoseline selection, 1-3/4-inch hoselines normally are sufficient for fires that are confined to one room or a small area. A backup line also should be positioned as soon as possible. Search and rescue personnel should have a protection line when working in areas exposed to the fire. Heat buildup in hallways may require a large (2-1/2-inch) handline to absorb the heat and provide access to the fire area.

Search and rescue operations during fires in nursing homes should consist of a primary and secondary search. The search should be started in the areas most affected by fire conditions. This normally will be the areas of the floor of origin, which are in close proximity to the fire, and floors above to which heat and smoke have traveled. Occupants of the building should be directed to designated evacuation routes.

In some cases, depending on fire conditions, all occupants of the building may not have to be evacuated. If the fire is contained quickly and smoke removal is started early, many of the building occupants will be in no danger and will be safe staying in their rooms. The decision not to evacuate must be based on fire conditions, good judgment, condition of the patients, and the knowledge that the fire and smoke are being controlled.

Removal of smoke and heat for most fires that are confined to one room can be accomplished by simple horizontal ventilation. Placing smoke ejectors in the hallway and opening windows or sliding doors in the affected areas usually is sufficient. Positive-pressure ventilation also can be used effectively in some situations. One of the difficulties with this approach is that narrow corridors make it difficult to obtain the air seal needed if a single room is to be directly pressurized. An alternative is to pressurize the hallway from the stair shaft and open the door to the fire room or area.

Stair shafts in nursing homes can be used to exhaust smoke from the building under certain conditions. The first requirement is that the stair shaft have a roof exit and that it be opened. Smoke ejectors/blowers can be used to channel smoke down corridors to the stair shaft. Care must be taken that this type of operation does not jeopardize building occupants who may be attempting to evacuate the building.

Salvage operations should be started as soon as resources are available. Normally this will entail removal of water from the fire floor and floor below, and smoke removal from the entire building.

Safety issues associated with nursing home fires must be considered when these types of incidents are encountered. Firefighters will become exhausted quickly from the physical labor of moving patients, especially in large single floor nursing homes or in multistory ones. The duration of the incident and exertion associated with performing tasks at above-ground fires can quickly tire firefighters and lead to injuries. For this reason, periodic reliefs and use of rehab areas at extended incidents are recommended.

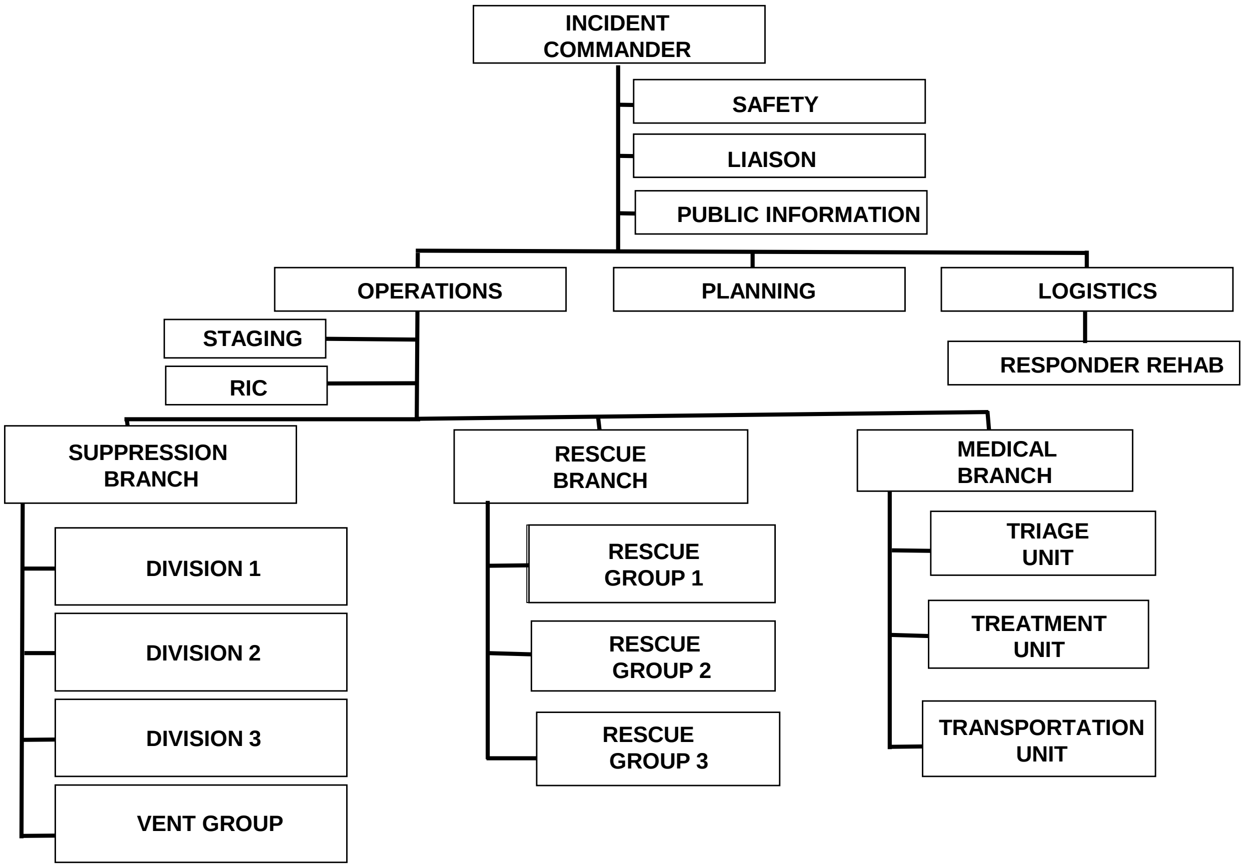
The primary incident consideration is life safety. Occupants are elderly and perhaps nonambulatory. Nursing home patients are typically susceptible to the effects of smoke, even light-smoke conditions. Pneumonia is one of the greatest dangers for this population. This situation may require two- or three-to-one rescue operations, and thus indicate high staffing requirements. Consider a plan that would include separating the fire and smoke from the occupants and internal evacuation. In the event of an actual incident, provide search and rescue and medical assistance. Include locate, confine, ventilate, extinguish, and overhaul as part of the plan.

Fires in nursing homes, depending on the amount of compartmentation and fire location, can usually be contained to a relatively small area. Should a nursing home fire require the full evacuation of many patients, transportation needs, medical support needs, and shelter needs have to be taken into account.

- Do you have sufficient medical units?
- Do you need mutual aid or third party assistance?
- Will city buses or school buses be available?
- What is their response time after they are requested?
- What about police assistance?
- What about air supply and the ability to refill cylinders for firefighters?
- Is there an MCI unit available or are there MCI trailers that can be brought to the scene?
- What if the incident escalates, is there a Plan "B?"
- Have you considered the safety of the response personnel?
- How will you handle the media?

All of these questions reflect real problems that you will face at a nursing home incident of any magnitude. You must be mentally prepared to solve those problems. Failure to solve the problems will severely tarnish the reputation of your department and yourself.

ICS organization for a nursing home incident of serious magnitude:



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Activity 3.1

Nursing Home Simulation

Purpose

To prepare students for the simulation exercises that will follow, and to provide the instructors with an opportunity to watch students handle a decision making activity.

Overview

A three-story building of ordinary construction, 200 by 75 feet, with central alarm, smoke detectors in rooms and hallways, and sprinklers in the basement area. The system is a wet-type suppression that uses city water. The kitchen facilities are located in the basement with the laundry. Forty residents live on each floor in dormitory-style rooms, four residents per room. Although the majority of the residents in the building are ambulatory, many of the third-floor residents are not. Residents in wheelchairs live on the first floor.

Directions

1. A fire is in progress at the Boulevard Nursing Home. A first-alarm assignment has been dispatched. The Operations Chief is on the incident scene and will brief the IMT on conditions upon their arrival on the incident scene. As a group, you will staff positions within the ICS of the Central City Fire Department (CCFD) for the exercise. All members of the CCFD Command Staff will arrive on the incident scene simultaneously.

2. CCFD Incident Command Staff:

    a. Incident Commander (IC).

    b. Incident Commander Aide.*

    c. Operations Chief.

    d. Operations Aide.

    e. Planning Chief.

    f. Logistics Chief.

    g. Public Information Officer (PIO).

    h. Liaison Officer.

    i. Safety Officer.

*The IC Aide is not used unless there are nine students in a group. Some students may play multiple roles based on the Assignment Sheets. If there are ten in a group, a second Operations Aide will be designated.

3. All command decisions and actions during the simulation will be recorded on the ICS Forms. Entries on the forms are made in response to written or visual messages or in anticipation of problems that could surface during the incident.

   Examples of the methods for completing the chart are shown on the following pages. The first three examples respond to visual or written messages that were received by the CCFD Incident Command Staff during the simulation. The last three examples illustrate actions taken by the CCFD Incident Command Staff beyond the written or visual messages, anticipating potential escalating problems or assigning specific roles under any function of the ICS.

4. At the conclusion of the simulation exercise, all groups will participate in a debriefing facilitated by the instructors. Your group will display both the ICS Forms and Simulation Action Charts developed during the exercise. Be prepared to explain the reasons for your decisions.

5. The following will be turned into the instructors at the conclusion of the PIA. The Planning Section Chief will collect all of these from their group, making sure that the group number and students' names are on the sheets.

   a. IC: Incident Objectives.

   b. The Planning Section Chief: Plan "B."

   c. The Safety Officer: Safety Message.

   d. Operations Aide: Actions Taken.

   e. Logistics: Resources.

   f. Liaison: Document Agencies Contacted.

   g. PIO: Press Release.

Activity 3.1 (cont'd)

Quick Access Prefire Plan

Nursing Home

Building Address:
1340 Federal Blvd.

Building Description:
3-story/ordinary construction--75' x 200' w/basement

Roof Construction:
Beam and rafter, 1" x 6" sheathing, composition/asphalt roof covering

Floor Construction:
Beam and joist, 1" x 6" sheathing, hardwood floors

Occupancy Type:
Nursing Home

Initial Resources Required:
First-alarm assignment

Hazards to Personnel:
Oxygen/Life support system

Location of Water Supply:
Hydrant, 8-inch municipal system 300' apart

Available Flow:
2,800 gpm per hydrant

	Estimated Fire Flow*			
Level of Involvement	25%	50%	75%	100%
Estimated Fire Flow	150	300	450	600

**Fire flow based on common area (lobby, hallways) of 1,200 sq. ft., plus 2 exposure floors.*

Fire Behavior Prediction:
Possible vertical extension. Oxygen feeds fire.

Predicted Strategies:
Rescue, confinement, extinguishment, ventilation

Problems Anticipated:
Nonambulatory occupants--Wheelchair occupants

☐ **Standpipe:** *N/A*

☒ **Sprinklers:** *Basement only*

☐ **Fire Detection:**

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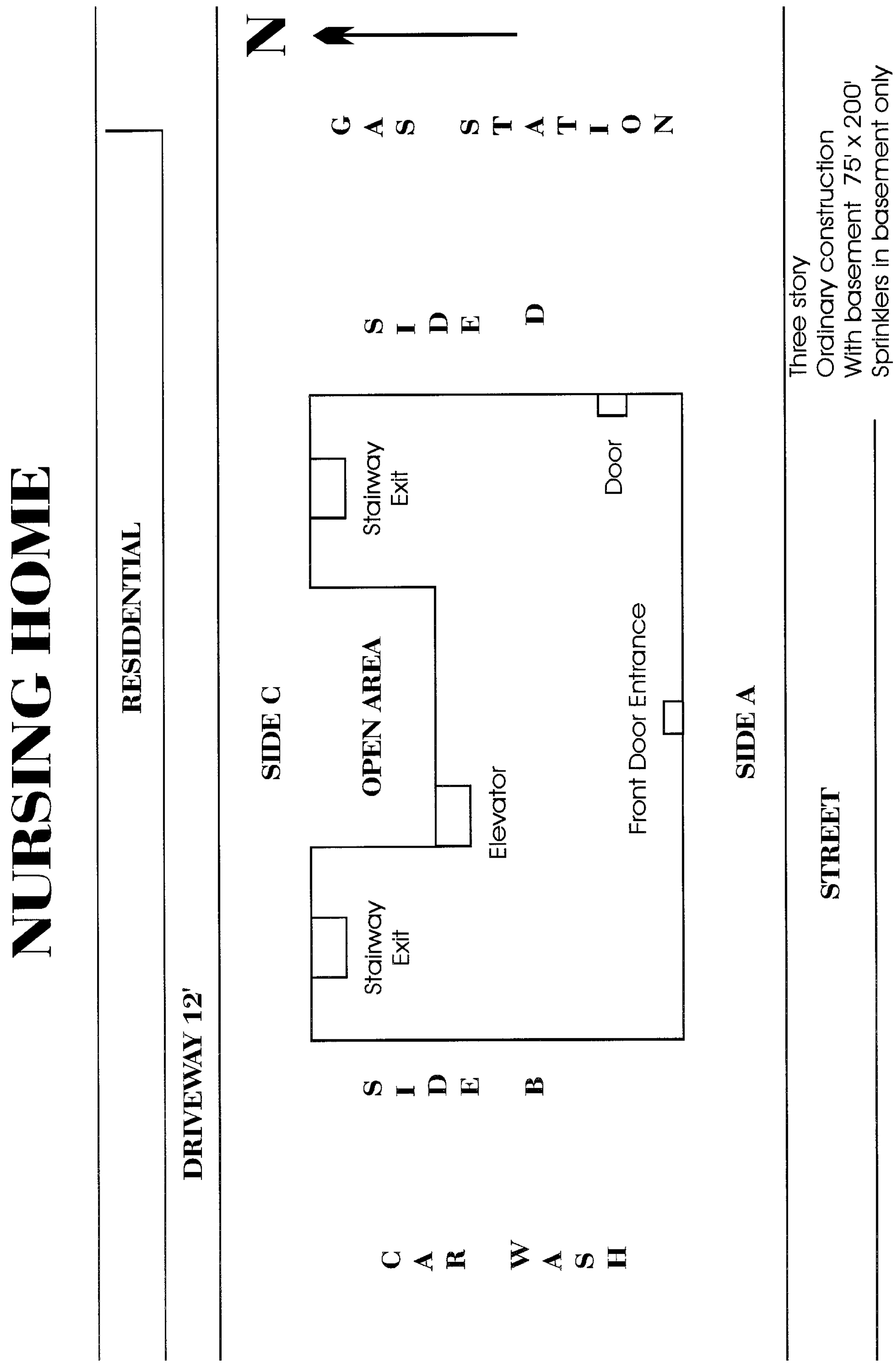
Activity 3.1 (cont'd)

Nursing Home Plot Plan



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UNIT 4: DECISION MAKING

TERMINAL OBJECTIVE

At the end of this unit, students will be able to make sound, effective and timely decisions to support operations when faced with complex situations.

ENABLING OBJECTIVES

The students will be able to:

1. *Apply the Naturalistic Decision Making (NDM) Model during an activity that reinforces the positive effects of NDM.*
2. *Discuss the empirical method.*
3. *Describe the primary sizeup factors and determine their impact on objectives and strategies.*
4. *Define limits and indicate practical limits.*
5. *Analyze the Seton Hall Dormitory Case to determine the critical sizeup factors.*

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OVERVIEW OF INCIDENT SCENE DECISION MAKING

There are **two** primary methods used by incident scene decision makers to reach conclusions, determine results, and institute actions. They are the **Classical Decision Making (CDM) Method** and the **Naturalistic Decision Making (NDM) Method**.

CLASSICAL DECISION MAKING

The **CDM Method** is a time-consuming process where the decision maker:

- gathers information;
- analyzes the information;
- determines the problems that are present and selects and prioritizes those problems in order of importance;
- determines and prioritizes the possible solutions;
- selects tactics from one or more possible options; and
- issues directives to have the tactics implemented.

The use of this system, called the **Command Sequence**, can develop into a habit. When this happens, the Command Officer will tend to use this technique under unfamiliar emergency conditions, thus structuring the decision making process and reducing stress. Using the command sequence also helps the Command Officer stay proactive.

Decision makers need the classical method when they are in the **training mode**. In the training mode, they will be taught to look for cues, draw conclusions, consider results, and take action for an incident type not previously learned, or learned incorrectly. Whether the cues, conclusions, results, and actions are learned, they must be tested in an application format. Such a format is called a simulation. Such training must be from an **expert** in the incident type: for example, an urban or city fire officer learning wildland firefighting from a wildland expert.

The classical process is used for evaluating and planning when time is not a factor.

The decision makers need the classical methods when they **are evaluating and comparing the critical cues used, conclusions and results determined, and actions taken** by other decision makers. This form of training typically involves case studies. Here the student uses a case study to examine the obvious and subtle cue differences. The examination provides optional conclusion, result, and action sets based on those differences. By using a case study and the classical method, students are able to evaluate whether or not the cues match the conclusions and actions of the decision maker at the actual scene. If they do not, then specific actions to avoid also may be learned.

In addition, use the classical method at an **actual incident scene where there has been little or no previous experience or training** with this specific incident type. There also may be little or no experience or training with an incident with the variables that are now present. The decision maker must formulate a basic plan before directing tactical actions. A process that does not include an evaluation of the incident information, risk-benefit analysis, and appropriate strategies and tactics, is not a plan. It is a design for disaster.

Base the plan on incident information (critical cues), real problems, and appropriate broad solutions (strategies). Choose the best solutions (tactics) from several options.

STEPS IN NATURALISTIC DECISION MAKING

The **NDM Method** is a more rapid and intuitive process in which the decision maker:

- looks for certain critical cues (visual, verbal, touch, smell);
- relates those cues to previous similar situations (from experience or training);
- recalls the previous conclusion, results, and actions that most fit the new situation; and
- issues directives to have the tactics implemented.

Questions

- When were you born?

- Where were you born?

- What color hair does your mother have?

We are sure that you have readily answered those questions, without regard as to how you came up with the information. Well, what happened as you read each question is rather simple. Your brain searched your long-term memory and retrieved the information. You were not cognitive of the mental process that took place, you simply knew immediately the answer to each question. In other words you knew immediately the result required by the question based on the information being stored in your memory.

This methodology is now described as **NDM**. This methodology is called Recognition-Primed Decision Making (RPD), which is a type of NDM. Every time you are confronted with the need for a question to be answered, whether it be like those above or strategy or tactical decisions at an incident, your brain will always check the long-term memory to see if there is an answer stored in your long-term memory. If it is, you are immediately cognitive of the answer/decision that must be made for the situation.

It is obvious that basing decisions on the understanding gained from **previous experience** can produce results much faster than following a step-by-step classical process.

The **more experience** the fire officer has on similar types of incidents, the greater that person's ability will be to read the subtle differences at the incident, draw refined conclusions, and direct the most appropriate actions to provide a solution.

Use the naturalistic method when the decision maker has adequate experience or training of the incident type, or the variables within the incident type. The naturalistic method is almost an instant recall of previously learned conclusions, results, and actions. It includes the inter-relationships of specific information with conclusions, results, and actions based on whether or not they worked before. Therefore, it provides a direct, lightning-fast transition from what you see, hear, feel, and smell to what you conclude and what you do.

TIME-PRESSURE NATURE OF DECISION MAKING

Because of the time-pressure nature of emergency-scene decision making, the choice between naturalistic and classical will not be conscious. **The decision maker's brain will attempt the naturalistic method first.** This is the way the brain operates, even though it is not cognitive to the person.

The decision maker must recognize when he/she possesses insufficient information to use this method. Some cues for this recognition are

- It is obvious to the decision maker that there has been little or no experience or training on the specific incident type.
- The decision maker recognizes that the incident cues are very unfamiliar and do not immediately result in appropriate action decisions.
- The decision maker feels lost or overwhelmed, cannot think, or is in a panic.
- In these cases, **CDM** is the appropriate response.

What happens when your brain does not immediately provide an answer from long-term memory?

As stated, there is an emotional response to the brain not coming up with an answer to the problem presented. There is only one course of action to take when you get that overwhelming, panic, wish the chief were here to take this off your back, feeling. That is your cue to cognitively switch to the **CDM methodology (command sequence).**

Now you must take the time to analytically work through the problem using the six steps of the command sequence.

Another thing which you must be aware is the power of the mind. When the brain recognizes that there is an emotional response (panic, etc.), you are said to be out of your "comfort zone." The brain will try to get you back to your comfort zone so the negative emotional feeling goes away. Your brain could lead you to take an action that is in the long-term memory. For example, you are standing in front of a building fire with which you have little or no experience, like a strip shopping center with a fire in the common attic area and one occupancy well-involved.

If you have little experience (training or practical) with this type of fire, you may feel the negative emotional response. You will be "out of your comfort zone." Well, what is your comfort zone? It is obvious that it will be a dwelling fire and the tactics that are applied at a dwelling fire (since most of us do these routinely and have much experience with them). You will get back to your comfort zone by ordering your companies to do dwelling tactics on this fire. However, the return to your comfort zone will be short-lived as the fire continues to spread in the common attic and more of the building becomes involved.

The correct response should have been to cognitively tell yourself to switch to the command sequence and work your way through the problems by identifying as many cues as possible and then making decisions on those cues.

Obviously, the better method (than the command sequence) is to learn as much about strip shopping center fires as possible--taking as much training as is possible so the correct actions for the strip shopping center incident type are in your long-term memory. Now you can NDM the decisions with rapidity.

This is the basis for the training in this course.

Beware: You must get your training from an incident-type expert, for example a city firefighter learning wildland-urban interface firefighting from a wildland expert. If you are not taught by an expert in the field, you will commit to your long-term memory wrong actions to the cues. If this is the case, you will now make very rapid wrong decisions.

LACK OF THE ABILITY TO DO NATURALISTIC DECISION MAKING

What happens when our brain does not immediately provide an answer from long-term memory? There is an emotional response. Your cue is the emotional response that you get that (panic, etc.) feeling. This emotional response is your cue to cognitively switch to the CDM methodology. You must now work your way through the problem using the six steps of the command sequence.

Beware of the temptation to do something that is in your comfort zone, like doing dwelling tactics at a strip shopping center fire.

PRACTICAL APPLICATION OF NATURALISTIC DECISION MAKING

A person can be taught how NDM works, but there is no shortcut to developing the cues in the long-term memory.

We develop the ability to perform NDM by learning the critical information in our specific professional area. We do this by using the CDM methodology which is time consuming. Once the information is in our long-term memory, we simply, and instantly, recall it for use at a real incident.

USE AN EMPIRICAL METHOD

The Empirical Method involves observing facts, then testing the accuracy of these facts through continued observation. If the facts prove accurate, seek some causal relationships between them and other happenings from which a logical hypothesis can be deduced. Such hypotheses are in turn tested. If they are found to be true they are used to explain some aspect of reality and therefore to have value in predicting what will happen in similar circumstances. These hypotheses are then called principles.

For decades, the fire service has been observing facts at fire situations. These facts have led to valid hypotheses, or principles. By putting these principles into some logical order, that is, by systematizing them, we can take a step toward developing a science of firefighting. We can take an even greater step if we accept the help of scientific researchers in experimentation and verification.

Recognized authorities maintain that science is said to be systematizing. This is not only because the underlying principles have been discovered, but also because the relationships between variables and limits have been ascertained. Accordingly, in this text, we will try to explain what variables and limits are, and how relationships between them have been ascertained. We will also try to explain how principles relating to firefighting or fire suppression have been derived.

Variable: In this text, variables associated with fire situations are classified as "primary" and "Objectives and Strategy." This is done to indicate a time sequence for evaluation and not necessarily a degree of importance. Such factors are variables because they change from fire to fire. Primary factors are the conditions or elements that should be recognized and evaluated on arrival and during operations.

Objectives and Strategy are the activities undertaken to achieve objectives; such activities include forcing entry, ventilating, using hoselines, over-hauling, making decisions, and establishing command posts, and so on. These variables have reciprocal relationships because of the inevitable effect of one activity on another.

For example, effective ventilation facilitates the advance of hoselines. Yet ineffective stretching or laying of hoselines nullifies the effectiveness of ventilation or even causes it to be harmful if it results in spreading the fire before a line is ready to operate.

Therefore, Objectives and Strategy can also affect such primary factors as extent of fire after arrival, heat and smoke conditions, exposure hazards, duration of operation, requirements to operate, and so on.

Limits: Limits are specifications for acceptable solutions at fires. For practical purposes, there are two particular limits. First, if there is a life hazard for occupants, risks to personnel ranging from merely unusual to extreme may be warranted. Second, if there is no life hazard for occupants, personnel are never to be jeopardized unnecessarily.

Underlying Principles: Underlying or basic principles are fundamental truths applicable to a given set of conditions or circumstances; they indicate what may be expected to happen under these conditions or circumstances. Scientists have already discovered some of these principles that concern combustion: extinguishing of fire; transfer of heat by conduction, convection, and radiation; and the flow of liquids and gases. Using these basic principles, the fire service has formulated more specific principles governing fire activities, such as ventilating and using hoselines.

Principles governing flow of fluids enable fire personnel to expect that when an obstruction reduces the velocity of convection currents rising through a vertical structural channel, pressure will increase and will be greatest immediately beneath the obstruction. This will cause the fire to spread toward areas of lower pressure, or least resistance, either mushrooming or moving horizontally. But if the obstruction is removed, for example, by making an opening in the roof directly above the involved vertical structural channel, the velocity of the rising gases will increase and the pressure will decrease. The decreased pressure will then minimize the possibility of horizontal spread of fire in the cockloft (the space between the top-floor ceiling and the underside of the roof). Similar reasoning applies to the formation of many other specific firefighting principles.

Firefighting principles are universal in application. That is, they are the same for all departments, large or small, paid or volunteer. But, they may have to be applied in different ways because the primary factors change from one community to the next. For example, the primary factor of the availability of water supply varies in different communities. But when there is a life hazard for occupants the same principle applies to all: the first water available is used as quickly as possible, and as long as necessary between the fire, and the endangered occupants or their means of escape. It does not matter whether the water comes from a booster tank in a small community or standpipes riser in a city highrise building. It is this universal application of firefighting principles that makes standardized training both possible and practical.

PRIMARY FACTORS CHART

It has been established that to systematize the science of firefighting, it is necessary to define variables and limits and to ascertain the relationships between them. Primary factors are considered variables because they change from fire to fire. The study of primary factors and the relationships between them will help officers carry out the first two steps in the action plan. These two steps are quite important. The first is to note and evaluate as accurately as possible the primary factors that are pertinent in the given situation. The second is to select objectives and activities on the basis of the evaluation made.

The Primary Factors Chart (SM p. 4-10) facilitates the study of relationships between primary factors, and indicates the sequence of coverage. Extensive explanations are necessary since all primary and secondary factors that could conceivably be pertinent at all types of fires are considered. Lectures or discussions of past or structured fire situations, even when supplemented by motion pictures or diagrams, are of limited value. This is because the critical factors are specified, whereas at an actual fire critical factors must be recognized and evaluated under possible hectic conditions. In addition, such lectures or discussions may only provide helpful information about one set of circumstances in one given situation. Officers actually need helpful information about any set of circumstances in any fire situation.

LIFE HAZARD FOR OCCUPANTS

Rescue work--Forcible entry is made with less regard for structural damage, exposure hazards, or the availability of a hose stream to protect personnel.

Ventilation unfavorable to controlling and extinguishing the fire may be needed to draw heat and smoke away from endangered occupants.

Available hose streams are used as required to cover the life hazard. In short, a life hazard for occupants and the resultant rescue activity can delay efforts to control the fire, making extinguishment more difficult.

Covering exposures--Life hazard may make the task of covering exposures more difficult and may delay the attack on the fire itself, e.g., aerial ladders used to remove occupants may have to be repositioned to use ladder pipes in protecting exposures.

This can entail a harmful delay, intensifying and possibly creating new exposure hazards. In addition, involvement in rescue work will delay the evaluation of factors to establish an order of priority in covering exposures. Such coverage may have to wait for the arrival of additional resources.

Column #1 Primary Factor Size-Up Chart

Pertinent Factors (P)	(Check appropriate boxes)	P
Life Hazard	Occupants	
	Firefighters	
Location/Fire	Where and how big Exposures on Arrival	
	After Arrival – Burn Time	
	Radiation/Conduction/Convection	
Construction	F/R, NC, HT, ORD., WF	
	Fire Bldg./Exposures	
Occupancy (Contents)	Fire Building	
	Exposures	
Height	Fire Building (Front/Rear)	
	Exposures (Front/Rear)	
Area	Fire Building/Configuration	
	Proximity of Exposures /Config.	
Exposures	Fire Building	
	Structural Collapse	
	Collapse Zone	
	Apparatus Placement	
Weather	Visibility	
	Temperature/Humidity	
	Wind – Direction/Velocity	
Apparatus/ Personnel	Special Equipment - RIC	
	Sufficient Companies/Personnel	
Auxiliary Appliances	Fire Building Supplied	
	Exposures Supplied	
Special Matters	HazMats, Open shafts, etc.	
Water	Available/Needed	
Time	Duration of Operations (Rest-Rehab) Time of Day Time of Alarm	

Column #2 Incident Objectives Attainable/ Measurable/ Flexible

Examples of Incident Objectives:

- Remove all civilians from danger.
- Contain and Control Fire.
- Remove smoke from the building.
- Care for any injured civilians or FF's.

List Incident Objectives:

1. ____________
2. ____________
3. ____________
4. ____________
5. ____________
6. ____________
7. ____________
8. ____________
9. ____________
10. ____________

Column #3 Strategies / Column #4 Evaluate Effect of Strategies Every 10 Minutes

Strategies	Effective	Ineffective
[R] Rescue • Interior/Exterior/Both		
[E] Exposure Protection • Exposure lines		
[C] Confinement • Hoseline Placement – six sides		
[E] Extinguishment • Hoseline Placement		
[O] Overhaul • Expose Hidden Fire		
[V] Ventilation • Removal of smoke/toxic gases • Fire Control		
[S] Salvage • Water – Run-Off • Apply Covers		

List Incident Strategies	Assigned To:
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	

Identify alternative strategies for firefighter safety when occupant safety has been determined not to be a Primary Factor.

- ____________
- ____________
- ____________
- ____________
- ____________
- ____________
- ____________

LIFE HAZARD FOR FIREFIGHTERS

Safety--Acceptance of warranted risks is essential for good results in carrying out fire activities.

LOCATION OF FIRE ON ARRIVAL

Forcible entry--It is preferable to force entry near the location of the fire especially when the area involved is large. This enables firefighters to get water on the fire more quickly and minimizes the physical hardship entailed in advancing hoselines.

Ventilation--The main objective of ventilation is to localize the fire--to stop its horizontal spread within a structure. For example, if a fire is extending into a cockloft via pipe recess or similar channel, the roof should be opened. If this were done in the wrong place, it could be disastrous.

Opening a roof in the front when the fire is coming up in the rear can involve the entire cockloft and turn a first alarm fire into a major fire. It is not advisable, however, to open directly over a fire on an intermediate floor, because this could involve the upper floor.

Another objective of ventilation is to protect occupants pending rescue. For example, if a fire has cut off the escape of occupants, the decision where to vent is determined by the need to draw heat and smoke away from them. This is done even if the required openings increase the intensity of the fire and the possibility of spread (not to occupied areas, of course). If only horizontal ventilation is required, the location of the fire will indicate the floor to be vented and the openings in the roof.

The decision when to vent is determined by whether or not the location of the fire is creating a life hazard. If it is, ventilation may have to be started as soon as possible, even if hoselines are not ready or if an unoccupied exposure hazard may be created or intensified.

Removal of occupants--Location of fire is critical. A fire on the first floor of a five-story residential building could endanger all the occupants and necessitate their removal.

However, if the same fire originated on the fourth floor, it may be better to move occupants of the fifth floor to the first or second floors. This is especially true if the fire occurs on a cold night and occupants are scantily clothed.

Checking for extension of fire--A fire near a vertical or horizontal structure channel will spread readily. Officers assigned to check for fire extension should therefore note the location of fire and keep in mind how heat travels by conduction, convection, and radiation via exposed channels.

Placement and use of hoselines--The location of the fire determines the amount of hoseline to be stretched, and in some cases, the size. The minimum sizes of hoseline which provide adequate protection for personnel are 1-3/4-inch and 2-1/2-inch. Smaller hoselines may not provide adequate water to combat the heat.

If the location of the fire has created a life hazard, hoselines should be placed to facilitate rescue, and should operate as soon as possible and until rescue is completed. If there is no life hazard, the fire location will still govern the placement of lines.

Use of special equipment--High-level fires may require the use of standpipe systems, a ladder pipe, or other high-caliber streams. The fire may also influence the decision to use sprinkler systems or fixed systems of various types.

EXTENT OF FIRE AFTER ARRIVAL

Forcible entry--A light haze of smoke visible through heavy glass doors that feel cool to the touch usually indicates fire of small extent. In such circumstances, entry should be made in the manner least damaging to property. Use of a key may be a solution. Where the extent is obviously substantial, however, such consideration is not warranted. Speed in getting an efficient operation under way is more important.

Ventilation--The extent of fire should have a reasonable relationship to the amount of structural damage done in ventilating. That is, a hole should not be made in the roof when opening top floor windows is sufficient. But if the extent of fire is great, proper ventilation is more important than any necessary structural damage.

Fire extent may determine whether roof ventilation should be attempted at all. For example, if two or more floors in an old loft building are fully involved in fire, one should not try to work either on the roof or in the structure unless rescue work makes it essential. If the fire is so great that roof or fire escape venting is out of the question, heavy outside streams or aerial-ladder pipes may be used to break windows.

CONSTRUCTION

It is important for fire officers to know the type of structure that is burning. Such knowledge will help them determine the speed with which the fire may spread, whether it will spread vertically or horizontally or both, and how the objectives of rescue and extinguishment can best be achieved.

Knowledge of construction is essential if officers are to operate efficiently at structural fires, which often provide the consummate test of their knowledge and skill (science and art). Officers who can more frequently check internal extension of fire without unduly jeopardizing their subordinates should be rated more highly than those who resort to exterior operations. These latter operations cause maximum instead of minimum damage and consequently more often "lose the building."

Officers are not expected to be personally familiar with the structural layout of every building in their districts or communities. It is not unreasonable, however, to expect them to be familiar with structural features of special significance in local types of construction. In addition they should realize that a fire in a highrise or large industrial complex is no longer the sole responsibility of city firefighters. Hence, suburban as well as city firefighters should know how the construction associated with such occupancies can affect other related factors, and thereby an entire fire operation.

Fire restiveness in buildings depends, among other things, on the manner in which floors, walls, partitions, ceilings, columns, and girders are constructed. It also depends upon floor areas, combustibility of the structural parts, roof conditions, and the degree to which horizontal and especially, vertical channels are fire-stopped.

Horizontal channels could include hallways, corridors, ceiling spaces, cocklofts and plenums, floor spaces, doors, windows, and ducts. Fire can also travel horizontally when heat is conducted, for example, by metal beams, through intervening walls and partitions, or from wooden beam to wooden beams when they abut.

Vertical channels could include partitions, stairways, elevators shafts, dumbwaiters shafts, laundry chutes, ramps, escalators, air and light shafts, recesses enclosing pipes or electrical conduits, conveyors, and ducts associated with air-conditioning systems and large cooking ranges. Fires can also spread vertically by burning through floors or ceilings or from floor to floor on the outside of the building.

Materials used in construction naturally affect the spread of fire. Some masonry materials with high fire-resistive ratings contain water in their makeup. This water slows down the heat transfer rate, it absorbs large amounts of heat and delays transmission until it has been evaporated. On the other hand, good insulating materials generally have low fire-resistive ratings. They, too, can slow down the heat transfer rate, partly by means of entrapped air, which absorbs heat and delays transmission, but not as effectively as high fire-resistive materials.

Ordinary Construction in Residential Buildings

This construction is common in congested areas of many large cities. It features many combustible structural members, fire escapes with gated windows, and numerous inadequately fire-stopped horizontal and vertical structural arteries, both open and concealed. It has one advantage, however; it is not tight enough to prevent the escape of considerable heat by convection and radiation, and it is therefore less likely to cause a backdraft or smoke explosion. Roof bulkheads, doors, and plain glass windows allow for ordinary ventilation.

The disadvantages cited for this type of construction can cause extensive fires on and after arrival, severe heat and smoke conditions, poor visibility, interior exposure hazards, and life hazard for occupants. The open construction allows much heat to escape, but this can become a disadvantage if it creates or worsens an exterior exposure hazard. Such a hazard can increase requirements to operate effectively, prolong the operation, and increase hazards for personnel.

Forcible entry--In recent years it has taken longer to gain entry because of the increase in crime and the resulting increase in locks on hallway doors and extended locked gates inside fire escapes windows.

Ventilation--Horizontal ventilation is achieved by opening doors and windows. Vertical ventilation is achieved by opening roof bulkheads and making an opening in the roof as conditions warrant. Usually both kinds of ventilation are required.

Placement and use of hoselines--Usually, hoselines are stretched via the interior stairs, and less frequently via fire escapes, ladders, and ladder-tower platforms.

Overhauling--There is likely to be more overhauling than usual if combustible structural parts are involved and concealed spaces have to be checked out.

Removal of occupants--Interior stairs are the preferred means of removing occupants, unless they are above the fire. In the latter case, fire escapes are usually used, but aerial ladders or tower-ladder platforms may sometimes be necessary. Occupants trapped in the rear without access to fire escapes or not reachable from ladders may be removed by firefighters who are lowered to them by ropes. In some instances, occupants taken to the roof via rear fire escapes can be brought down interior stairways of adjoining buildings.

Ordinary Construction in Commercial Buildings

These ordinary structures have combustible structural members that burn readily. They also lack fire-stopping material, thus enabling fire to spread quickly both horizontally and vertically. In addition, they are frequently old, which aggravates structural defects. Older loft buildings have still other unfavorable characteristics: subcellars, unusual depth (in some instances, 200 feet), unprotected metal columns, wide floor spans, and iron shutters.

Forcible entry--In commercial buildings, entry is seldom a problem during business hours. At other times, entry is hindered by iron shutters and door locks that are often intricate and difficult to force.

Ventilation--Ventilation is greatly hampered by iron shutters. Sometimes there are conditions conducive to smoke explosions. In such cases it is of utmost importance to vent the roof, side, rear or front of fire area before opening at lower levels of the fire for entry. Fires in cellars or subcellars have limited means of ventilation; dead-lights in sidewalks, sidewalks covering entrances into cellars, and under definitely controlled conditions, openings made in floors above the fire. In some situations fog lines or smoke ejectors can be helpful.

Rescue work--Rescue work can be impeded by a number of factors. High temperatures are common; severe smoke conditions may impair visibility; floor space may be crowded by workbenches, machines, and other materials, in some instances only a 3-foot aisle space is required by law. Frequently there are many employees, and exits may be unfavorably located, particularly above the second floor. Some exits, for example, are about 40 feet from the street front because the stairs run straight back to the third-floor landing, in addition, these exits may be in the heart of the fire. In such cases a ladder pipe or other appliance can be operated through the street front windows so that entry can be made with a handline (two lines if warranted) via ladders or even the interior stairway.

Ventilation--Ventilation is a potent weapon for minimizing the life hazard. But it cannot always be used effectively unless the fire is located favorably or a roof opening can be quickly made to draw heat and smoke away from the life-hazard area. Occupants may be found conscious but so panic-stricken that rescuing them unusually becomes complicated. Some, unless strongly urged and guided, seek safety blindly, even disastrously.

Some of these building have two interior stairways located at a distance form each other; others have one stairway and a fire escapes. Occupants can also be rescued by means of ladders, tower-ladder platforms, and interior stairways of adjoining buildings when such buildings are accessible from the roof of the fire building. In extreme cases, life nets have to be used.

Placement and use of hoselines--Where a life hazard is present the first hoseline is stretched and operated as quickly as possible between the fire and the endangered occupants or between the fire and the means of escape. Outside streams may be needed at times to help with the positing of handlines.

Where no life hazard exists, lines are placed and used according to principles. However, in these loft buildings, the first line is more often stretched up the interior stairway and used to execute a holding action, to confine the fire to the involved occupancy, while the second line is brought up the fire escape, if one is available, to put out the fire. Because of the unusual depth of some buildings, and if the location of the fire is favorable for using such a technique, this is an acceptable variation of the usual procedure of operating the line from inside. Any auxiliary appliances (sprinklers, perforated pipe systems) must be supplied as conditions dictate. The correct inlet must be supplied or warranted, and severe water damage may result. At low-level fires the correct inlet may be chosen by feeling for heat conducted from the fire area by connecting piping. Even the location of the fire may be found this way if all inlets are properly marked.

Supervision--The unusually risky nature of operations at loft fires requires extremely careful supervision. Entire fire companies have been injured or killed by falling through collapsed roofs and floors. Effects of relationship among pertinent factors at these fires must be weighed with exceptional care before operations are initiated. All officers should be keenly alert to signs indicating possible structural collapse so that firefighters can be removed in time, and communication should be promptly established so that all units can be quickly contacted. Some authorities recommend an exterior operation when two or more floors in such buildings are fully involved. This is a sound recommendation. An exterior operation may be advisable even before the fire reaches that extent if there are conditions, such as wide-floor spans, unusual depth, combustibility of structural parts, unprotected metal columns susceptible to failure when heated and struck by cold water, excessive age of building, long duration of fire, and/or presence of heavy machinery or stock that absorbs water.

Overhauling--Since many parts of these structures are combustible, more than unusual amounts of structural overhauling can be anticipated.

Wood-Frame Construction

There are many variations of exterior walls; wood shingles, clapboard, matched boards, brick veneer, stucco, metal-clad over wood sheathing, and so forth. Private, one-, or two-story dwellings feature such construction.

Some authorities maintain that large multistory frame buildings can be made reasonably safe if proper attention is given to protection against the horizontal and vertical spread of fire, against exposure fire, and against fire conditions which may be anticipated on the basis of expected fire loads. However, the same authorities also point out that conflagration may occur at fires in primarily residential sections due to closely built combustible construction and wood-shingle roofs. Conflagrations are considered possible where certain construction practices are allowed, and where protection forces are weak and water supplies inadequate. As a matter of fact, such fires can occur even where protection is strong and water supply is adequate, as attested by a fire involving many beach bungalows within the limits of a large city.

Statistics show that there is a large loss of life in rural and urban dwellings, presumably in buildings of frame construction. The lack of a prompt and adequate response by firefighters has much to do with these statistics, but structural features also play an important role.

Fire-Resistive Construction

In fire-resistive construction, walls and structural members are made of noncombustible materials or assemblies with the following minimum fire-resistive ratings; four hours for exterior walls, firewalls, party walls, piers, columns, and interior structural members which carry walls; three hours for other girders, fire partitions, floors (including their beams and girders), roofs, floor fillings, and required stairway enclosures. Such construction does not feature central air-conditioning systems. The Empire State Building fire is a good example of how fire-resistive construction affects primary factors and Objectives and Strategy.

The Empire State Building is of steel skeleton construction and, although it differs somewhat from the specifications mentioned above, it fully qualifies as fire-resistive. The fire occurred after a United States Air Force bomber crashed squarely into the upper part of the building, spraying approximately 800 gallons of gasoline where it struck. Parts of the 78th and 79th floors caught fire and burned furiously. Gasoline also descended one elevator shaft and caused a shaft fire all the way down to the basement level. "Too much cannot be said of the sturdy, well-constructed and fire-resistive nature of the Empire State Building. Structural damage is comparatively negligible. The fire did not spread to other floors or portions of the building."

At the same time, it must be admitted that the fire is not always confined to one floor in the type of construction referred to as truly fire-resistive. The Woolworth Building had a grease-duct fire that extended from the basement to the roof, and the Empire State Building had a water-pipe insulation fire in a shaft that reached from the 31st to the 66th floor. Fires in shafts enclosing electrical cables, as well as elevator shafts, contribute to the spread of heat and smoke in any construction. However, the records show that spectacular fires were very few and the loss of life was minimal in such structures as compared with their successors. The exception, of course, was the plane crash that sprayed 800 gallons of gasoline on two floors of the Empire State Building, although it still did not jeopardize the strength of the building.

Fire towers in fire-resistive buildings are in all likelihood the best means devised for the escape of occupants at fires. With some exceptions, older building codes required at least one such tower for public and business buildings that are 75 feet or more in height. Enclosing walls have a four-hour fire-resistive rating. Outside balconies or fireproof vestibules connect the fire tower and the structure. Such balconies or vestibules are separated from the structure and the stairs by self-closing fire doors, which can be opened from both sides without a key. They open on a street or yard, or on a vertical open court, which has a minimum net area.

It is practically impossible for heat and smoke to get into such fire towers because when doors are open between an involved occupancy and the balcony to advance a line or for other reasons, emerging heat and smoke rise vertically through the open court, rather than travel horizontally through the fire door into the tower. Stringent regulations governing openings in court walls minimize the hazard created by rising heat and smoke.

Forcible entry--In commercial structures, the watchman may cause some delay if he/she waits for the fire department at the fire floor instead of at the street level from where he/she can direct the firefighters. In residential fire-resistive structures, such as hotels, one should use great care in opening obviously hot doors to unventilated, involved guest rooms; this can cause a backdraft with drastic results for personnel. In such cases, it is suggested that the door be kept closed, and indirect attack should be used by injecting fog through a small opening made in the partition to the fire room. The fire room can then be entered.

Ventilation--Doors and windows are used for cross-ventilation. Make openings first on the leeward and then on the windward side. Elevator shafts are not recommended because they only transfer the ventilating problem to an upper floor, endangering occupants who may be using the elevators and personnel working near the open shaft. In addition, they may cause unnecessary damage to the elevator mechanism. Use of fire stairs for ventilating is not recommended because the rising heat and smoke could endanger occupants trying to come downstairs. Also, if the stairs are not needed by the occupants, they could be used to alleviate heat and smoke conditions on the top floor.

Placement and use of hoselines--Fire departments have their own regulations about supplying and using hoselines from standpipes systems.

Usually, it is advisable to stretch the first line from the outlet on the floor below the fire, and the second line (if needed) from the outlet on the fire floor. Also, lines are usually advanced from the windward side of the fire, especially down along corridors.

Overhauling--Overhauling is likely to be confined to contents rather than to structure, even though a major purpose of overhauling after control is established is to check contents and structural parts for any lingering fire. Since structural channels have to be checked out in order to declare a fire under control, comparatively little remains to be done about such channels thereafter, although smoldering contents may require much overhauling.

Removal of occupants--In buildings featuring fully fire-resistive construction without central air-conditioning systems, the fire department rarely has occasion to vacate occupants above the fire floor. As a matter of fact, at fires in hotels of this type, it is preferable to leave occupants of the floor in their own rooms rather than take them out of smoke- and heat-free areas into hot and smoky corridors toward fire stairs.

In very unusual cases, however, fires can extend vertically in the best fire-resistive construction due to explosions or via exterior windows or shafts enclosing electrical conduits or insulated water pipes. In these instances, occupants above the fire floor must be removed, preferably by means of fire towers. Other ways include using a stairway that does not enclose the standpipe riser used to supply hoselines, because such a stairway is open at the fire floor and allows smoke and heat to enter and rise. Where removal of occupants from above the fire is necessary, particularly at high levels, it can be accelerated by leaving them just a floor or two below the fire, unless the need for medical attention dictates otherwise. Elevators exposed to heat and/or smoke, or affected by call buttons responsive to heat, smoke, or flames should not be used.

Modern Highrise Buildings

These structures have generally been built in the international style of steel and glass, with open floors, service cores, sealed windows, air-conditioning systems, and plenums (the space between the ceiling and the floor above). The cores are of reinforced concrete and contain stairs, elevators, utilities, and air-conditioning equipment. Plenums contain air-supply ducts, lighting fixtures, power lines in conduit, telephone cables, and communication cables. Careful study of the 1993 World Trade Center fire shows how modern highrise construction affects other primary factors.

The building is subdivided into many vertical components so that the possibility of total involvement in fire is almost impossible. There are only three vertical shafts (elevator) that travel the height of the building. Only one of these has openings on every floor and is designated for fire department use. The other two shafts open only at the ground floor, the sky lobbies (44th and 78th floors), and in the upper third of the building. The chimney effect so often mentioned in highrise buildings is not 110 stories in effect, but is divided into four components by the action of the air-conditioning systems. None of the stairways runs straight from the top to the bottom of the building. Stair towers are offset at various floors where the size of the core changes or the number of elevators serving a floor is reduced. At each of these points, horizontal passageways lead to the new shaft location and fire doors are provided in the passageway. These doors would prevent smoke from contaminating a stairway from top to bottom. The arrangement of elevators is such that they could not carry fire throughout the building but could be a factor in only a limited number of floors. It might even be feasible to use most elevators for evacuation; all except those that served the seven or eight floors that included the fire floor.

An item of particular interest to the fire service is the fact that the air-conditioning system can be placed in the purge mode after a fire alarm is received. This means that fresh air is drawn out of all the tenant areas on the affected floor to prevent smoke from spreading throughout the building. By supplying fresh air to the core and shutting down its normal vents, elevators as well as stairs can be pressurized and exit corridors can be kept free of smoke. To draw air out of the tenant areas, only the return air fans operate and discharge to the outside of the building.

Proponents of this system apparently feel that a normal temperature would exist in the return air shaft because of the volume of cool air being drawn in from other floors. In the meanwhile, the supply air fans are shut down, and a question arises about the overall effects of such tactics on occupants in the tenant areas affected, especially if the fire operation is prolonged and the weather is hot.

Air conditioning systems--In one of the types of highrise construction, the air-conditioning system serves the core only, and occupancies around the perimeter of the building are provided with individual units. Thus, smoke and heat cannot be conveyed into these occupancies by air-conditioning-system ducts. In case of fire, the main system can be shut down temporarily and the individual units can be operated on exhaust, thereby creating a favorable flow of smoke and heat, facilitating the advance of hoselines, and expediting extinguishing. At the same time, smoke and heat are being driven away from rather than toward the main air-conditioning system, thus lessening the likelihood of the spread of smoke to other floors via the ducts in such systems. If necessary, smoke and heat in the plenum area over an involved occupancy can be effectively dissipated by operating the return-air fans only and dumping outside the building. Low-velocity fog injected into involved plenums could minimize heat conditions. In addition, it is possible that individual air-conditioning units, operating on intake on the fire, except in the involved occupancy, may abet the flow of heat and smoke out of the structure. They may also make it unnecessary to break windows to get air.

In the best fire-resistive construction, mechanical failure of controls, inadequate control over flammable contents and structural defects which negate the fire-resistive rating of floors and partitions, increase the possibility of both vertical and horizontal spread of heat and especially smoke at a highrise fires. Aside from such possibilities, however, construction that features an air-conditioning system that serves the core of the building only and individual units for occupancies around the periphery of the building is a major improvement in fire protection.

Moreover, fire operations can be carried out more safely and effectively. Finally, such construction suggests a favorable alternative to the use of pressurized stairways and elevators. Pressurized systems are not features of the construction discussed here.

Although the air-conditioning systems in a new highrise building prevent some hazards, older systems present even more. Many systems in use today were installed before effective laws governing their installation came into being. At the least, this lack resulted in little standardization, and generally it resulted in many shortcomings. A few examples are the following. Combustible materials, such as cotton, paper, steel wool, and felt were used for filters, and many were also coated with high-flash-point oil to catch the dust. Some portions of the ducts were lined to reduce transmission of noise or heat through the duct walls, and sometimes the lining was combustible. In addition, ducts could be dangerously near other combustible materials, which would eventually be susceptible to ignition. Sometimes, too, coils containing a toxic or flammable refrigerant gas could then be distributed throughout the ducts, intensifying the life hazard for all concerned.

Dampers may help to check the spread of heat in both new and old systems, but to date there is no evidence that they can satisfactorily control the spread of smoke and gas. Another common feature is supply inlets in exterior walls that create an exposure hazard from fires in other buildings.

Other air ducts--Of special significance are air ducts with roof fan housing that are designed to remove gas and heat from large cooking ranges in restaurants, night clubs, hospitals, and so forth. With improper maintenance, grease can accumulate in ducts and ignite, usually in peak hours in restaurants and night clubs. Rescue work can be difficult when owners are reluctant to let customers go without paying their bills and customers are reluctant to leave without their coats and hats.

Smoke may obliterate exit signs and occupants may try to get out by the way they entered. Or a sudden worsening of heat and smoke conditions caused, for example, by prematurely shutting down the fan, can result in panic and havoc. The life hazard can worsen if the involved occupancy is below ground or inaccessible from ladders or tower-ladder platforms.

Regulations governing access to exits are frequently violated. Difficulties are complicated by the fact that protective hoselines have to be stretched without interfering with the egress of occupants. In such cases, fans should be kept operating to alleviate smoke and heat conditions pending rescue, assuming a worse hazard is not thereby created on the lee side of the roof fan housing.

While operating in an involved kitchen area, personnel should be aware of some unusual hazards: gas valves still in the "on" position after the flame is out, large pots containing very hot contents which can be overturned, and floors made slippery by melted grease. Extinguishing can usually be achieved in the kitchen area by one or two fog lines.

Extension can be reduced by sweeping the exterior surface of exposed ducts with fog, or injecting fog into the duct if there is sufficient heat to cause vaporization. A line to the roof fan housing may also be needed to extinguish and prevent extension of fire.

The hazards presented by these fires can be greatly reduced by the installation and proper maintenance of auxiliary appliances such as approved steam extinguishing, carbon dioxide, dry powder, fine water spray, or the newly developed combination fan-and-grease collector systems. However, such protection is not provided everywhere and, in addition, there is always the possibility of mechanical failure or human shortcomings relative to maintenance.

Ducts are present in many forms in various occupancies, and in many respects their effects resemble those created by horizontal and vertical structural channels. Fog can be helpful in coping with fires in such ducts and channels, provided there is sufficient heat to vaporize the fog so that it can exert an effective smothering and cooling effect. In vertical ducts and channels it is preferable to inject the fog at fire level. Experimentation by fire research scientists in this area is desirable.

Alterations in Building Construction

Alterations are not always effected in accordance with the law or with recommendations in nationally recognized codes, nor are defects of many years standing always fully rectified by retroactive laws. In addition, structural changes required at times because of a new occupancy are not always made. As a result, in some cases areas remain excessive, metal columns are inadequately protected, and door assemblies in dividing walls lack the required fire resistance. In other cases, installed dropped ceilings cover structural defects, and frequently alterations increase the number of concealed spaces by various kinds of false-work, double or triple flooring, and so on. Before explaining how alterations in construction can affect other primary factors and Objectives and Strategy, let us review an actual fire in a building that had undergone alterations.

The fire originated about noon on a Sunday in September. It started in the kitchen area at the rear of a restaurant in a seven-story residential brick-and-joint building erected in 1887. Originally a brick and concrete roof served as a terrace but it was subsequently covered with wood roofing seven layers of tarpaper, and tar finish. Many years later, in 1967, extensive alterations were made to increase the number of apartments per floor. In the process, ceilings of bathrooms and the public hall were dropped and sheet-rock was used between apartments and public halls. The sheet-rock was omitted, however, on the inner side of public hall partitions next to furred-out pipe spaces, and these pipe spaces were not adequately fire-stopped. The required sheet-rock had also been omitted on one or both sides of public hall partitions, but this omission was covered by the hung ceiling. Fiberglass bats used between studs for firestopping and soundproofing proved to be completely ineffective as a fire-stop under the heavy fire conditions.

As a result, the fire entered an L-shaped 5 x 5 foot pipe recess at the second floor and raced unimpeded into the cockloft. Openings punched through walls for wiring and plumbing lines and covered by the hung ceiling caused horizontal spread of the fire. Fortunately, the time of origin minimized the life hazard for occupants who could be readily alerted and removed. Fortunately, fire escapes had been provided during the alterations and were helpful in the operation.

The major objective was to confine, control, and extinguish. The greatest difficulties were in trying to confine and control the fire in the cockloft. The fire there had to be attacked from below, and the severe heat smoke conditions and poor visibility could not be effectively alleviated by roof ventilation. Control was finally achieved by a third-alarm assignment and use of eleven handlines, aided by the work of ladder and rescue companies. Thirty-seven injuries were reported as a result of this fire and forty-four air cylinders were expanded, attesting to the severity of the smoke conditions and the absence of effective roof ventilation.

Alteration in this case represented errors of omission as well as commission and adversely affected location and extent of the fire on and after arrival. They also worsened heat, smoke, and visibility conditions and the exposure hazard; increased the duration of operation and requirements to operate, especially rescue company equipment; intensified the life hazard for personnel, and could have created a very serious life hazard for occupants if the fire had occurred at night.

Neither alterations abetting horizontal spread of the fire, or the pipe recess abetting vertical spread were visible and made it difficult to determine the location and extent of the fire on and immediately after arrival. Concrete and brick construction on the roof prevented ventilation that could have localized the fire and alleviated smoke and heat conditions. This made it extremely difficult to operate lines used to attack the fire in the cockloft from the floor below. Roof construction and other alterations increased the amount of structural overhauling needed both before and after control was established.

If required structural alterations are not made when an occupancy changes from noncombustible, highly undesirable results can accrue. Such alterations may necessitate new partitions to subdivide areas, protection of metal columns, a higher fire-resistive rating for doors in subdividing walls, and so forth. In one case, however, failure to comply with these requirements resulted in total involvement and collapse of the fire building, and a $2 million fire loss.

Buildings Under Construction

During the day, fires in these structures usually do not present serious life hazards because they are discovered quickly and the average worker can readily get out of harm's way. At night, however, the fire department may have to search for one or more watchmen and the hazards in general, already great, are intensified.

Fires in buildings under construction, particularly at high levels, can quickly reach major proportions. Reasons for this include: construction that is wide open, which provides ample oxygen; fuel supplied by combustible debris, such as wooden interior scaffolding, chutes, sheds, shanties, and possibly concrete forms; paints, oakum, excelsior, and tarpaulins, (additional sources of fuel); tanks containing flammable gases for use in cutting torches, gases used for heating purposes, cartridges used for riveting; and winds prevailing at high levels. There may be, and often are, abnormal delays in getting water to the fire floor. In addition, openings in floors and the absence of windows, doors, and completed walls and partitions abet horizontal and vertical extension of the fire.

There is always the danger of timber falling from above. The exposed steelwork on top may buckle, weakening the structure. The concrete beams and slabs on upper stories may not be set; if the wooden supporting forms burn, the floors may drop. Fires at high levels beyond the range of high-caliber outside streams present the most serious problems, especially if standpipe systems are inoperative. In such cases, a fire that actually requires only one stream for extinguishing may necessitate the use of a full first-alarm assignment because the line may have to be stretched up the outside of the structure, is a laborious process, requiring much manpower.

Danger from the use of explosives for blasting in the very early stages of construction is somewhat alleviated by strict regulations, careful surveillance, and a competent watchman. Some fire departments, as a precautionary measure, prohibit the use of radio transmitters on department vehicles within 150 feet of magazines containing explosive caps; at close quarters radio waves may energize the detonating mechanism.

Structural features are considered in conjunction with occupancy contents (such as combustible materials and flammable gases). Such total situations can have adverse effects on the location and extent of the fire, on and after arrival. They can create smoke conditions that develop problems in exterior exposures, heat conditions that can buckle exposed steelworks, and a spark-and-ember hazard that can worsen the exterior exposure hazard. They can also result in greater alarm requirements to operate, a prolonged operation, and considerable danger for personnel, especially if the fire is at night. There is even more danger if tanks containing flammable gases explode.

An oddity about this type of structural fire is the minimal need for forcible entry and ventilation. Stress is on the placement and use of lines. Inadequate guardrails may protect when lines are being advanced via stairways and on floors. Supervision is exceptionally important because stairs at the upper levels may be unfinished and there may be floor openings. Operative standpipe systems should be supplied and used, or else lines may have to be stretched up the outside of the structure, in which case the need for sufficient personnel must be anticipated.

Fire buildings under construction can sometimes be kept minor by the prompt use of a deck pipe or similar equipment. For example, in one case in which the standpipe system was inoperative, a deck pipe was used to extinguish a fire in debris on a setback on the twelfth floor while a line was being stretched up the outside of the building.

If the fire is within reach of streams from ladder pipes or tower ladder platforms, fog from the windward side can be effective. Solid streams would be advisable, however, if greater penetration were needed.

The exterior exposure hazard in buildings under construction can present multiple problems because, besides the danger to nearby buildings from radiation and convection of heat, a spark-and-ember hazard may exist. Sparks can start other fires at surprising distances from the original fire building. At times, they are drawn into buildings by fans in exterior wall openings on the lee side of the fire.

Officers should remember that hoists for materials are not intended to transport people. If possible and feasible, however, they can be used to transport rolled-up hoses and other equipment to upper floors. Where elevators designated for fire-department use are required and provided, it is preferable to use them if the fire does not affect them. When such elevators have been installed, guards should be provided to operate them.

In some localities, standpipe systems are required under certain conditions; for example, when floors are in place above the seventh story, or more than 75 feet above the curb level. Quite often, however, these systems are not dependable at night because of carelessness about closing valves that have been opened during the day.

New highrise building construction has presented serious problems for the fire service, but in some respects it has one advantage. The buildings are erected more quickly because of curtain-wall construction, thereby reducing the time period of potential hazards that are inherent in buildings under construction.

Buildings Under Demolition

Much that has been said about buildings under construction applies to those under demolition. For example, the fire department may have trouble getting water to high fires if the standpipe system has already been put out of service, but the structure is still 25 stories tall. Some constructors, using modern techniques, just peel off exterior walls, remove undesirable partitions, and erect a new building on the metal framework of the old.

Dismantling of sprinkler systems can also have disastrous results, as demonstrated on several occasions. A notable example was the Wanamaker fire, which originated in the building's sub-cellar in New York City. The building was in the process of demolition. The fire injured more than 200 fire personnel, did extensive damage to the subway system, and took several days to extinguish. A major cause of this disaster was the fact that the dismantled sprinkler system in the subcellar and cellar prevented the fire department from discharging water upon fire in accessible areas.

OCCUPANCY

Human occupancy--An awareness of the mental, physical, emotional, or other relevant condition of the human element in various types of occupancies helps officers gage the severity of the life hazard and anticipate problems of rescue.

In nightclubs, churches, theaters, and so forth, the allowable occupancy may be so large that there may be such density as to induce panic in the event of fire and smoke. Schools can present somewhat similar problems.

In hospitals, inns, and institutions for the care of infants, the elderly, the blind, the deaf, and the physically handicapped, occupants may have to be carried or led out of the building with extreme care.

In jails or mental hospitals, rescuers may have to contend with uncooperative, hostile, or generally difficult occupants, as well as coping with heavy locked doors or cutting through bars and windows.

In multiple-residential structures, particularly those of old ordinary construction, occupancies are often overcrowded by tenants who speak mostly foreign languages and therefore have difficulty in describing where other occupants are trapped.

Contents

Ventilation--Oils, fats, rubber, wax, tar, and some plastics produce large volumes of smoke, which may be unburned vapors. The heat from this type of smoke is low, as is its buoyancy. Visibility therefore is impaired, and ventilation is slowed down. Some materials give off gases that are toxic or injurious to the eyes or skin. Burning silks and woolens, for example, give off carbon dioxide and hydrogen cyanide gases. Both are toxic, and the skin can absorb the latter. Ammonia is also given off and causes injuries to the eyes, lungs, and damp skin areas.

PVC (polyvinyl chloride) gives off chlorine gas and forms hydrochloric acid with moisture in eyes, armpits, groins, and wherever the human body perspires. Ventilation is achieved more slowly in such cases because firefighters must take time to don appropriate protective clothing while being hampered by poor visibility.

Where the presence of explosive mixtures or substances is suspected, exterior ventilation measures should be taken to prevent an explosion or to minimize the results.

Placement of hoselines--Difficulty in ventilating can reduce the effectiveness of hoselines. Effectiveness may also be adversely affected by an excessive amount of contents and by the manner in which they are stored. Stock may be stored so high that it reduces the effectiveness of sprinklers and streams.

Where contents are combustible and plentiful, as in a lumberyard, rapid spread, high temperatures, and a spark and ember hazard characterize fires. To extinguish the main body of fire, heavy caliber and high-pressure streams are in order. Lighter mobile lines can cover the spark and ember hazard and finish the job.

In some cases, two occupied structures can be equally distant from, and endangered by, a fire in an unoccupied building. "Equally endangered" implies similar construction height, area, and so on. In such an event, the human element in the occupancy presenting the greater life hazard would be covered first. Thus, an endangered hospital would be given priority over a factory because many occupants might be able to walk.

Selecting an extinguishing agent--In some cases water will spread the fire. For example, gasoline, kerosene, and similar materials are lighter than water, float on the top, and spread the fire.

Calcium carbide with water gives off acetylene gas, which may cause an explosion. Some flammable liquids are miscible with water, and unless they can be diluted to a point at which flammability is no longer possible, the fire may spread.

Water used improperly in the presence of combustible dusts, such as wood, flour, zinc, or magnesium, may throw them into suspension and develop an explosive mixture.

The use of water near acid in carboys, such as wholesale drug occupancy, may cause failure of the carboys by sudden chilling or impact of stream, permitting spread of the acid. The resulting release of gases may intensify and abet extension of the fire.

These examples are far from exhaustive. Chief Officers should carry reference material to help them evaluate the occupancy factor in case unusual hazardous flammables or chemicals require special extinguishing agents. It is dangerous to depend on memory or the availability of competent advice.

Overhauling--The quantity of material involved, the manner in which it is stored, its nature, and the degree to which it has been subjected to the fire, affect overhauling. In addition, the degree to which contents have been subjected to fire and heat affects the amount of overhauling required.

HEIGHT

Ventilation--Height can affect activities at fires in highrise buildings. At lower-level fires, roof or window ventilation may be possible, thus facilitating the advance of lines from either side of the fire as well as the search for and removal of occupants.

Placement of hoselines--Exterior lines may also be used. In either case, control is likely to be established more quickly than at a similar but higher fire, which can be attacked only from the interior. This earlier control tends to minimize the overhauling required at lower-level fires.

AREA

If the fire can be confined to a small room, the fact that the total floor area is 200' x 200' hardly matters. However, if such an area is not effectively subdivided and there is no small room, the extent of the fire can sooner or later correspond to the total floor area.

If there is no life hazard, this development should make it logical to select, confine, control, and extinguish as the major objective. The decision could be to operate from the exterior and not try to ventilate the roof, especially at supermarkets with wide roof spans.

The extent of fire--rather than merely the area of an occupancy, such as a lumber yard--influences the placement and use of hoselines.

PROXIMITY OF EXPOSURES

Proximity alone does not make an exposure vulnerable. To evaluate the effects of proximity in selecting objectives and activities, it must be considered in conjunction with other contributing factors, such as construction, location of fire, occupancy, and wind direction and velocity.

Proximity is hardly a problem if the construction of both the fire and adjoining buildings feature exterior windowless walls with four-hour fire-resistive ratings, assuming no inlets to air-conditioning systems is exposed. On the other hand, inferior construction, with inadequately protected openings in intervening shafts or narrow courtyards, can intensify proximity hazards.

In evaluating proximity of exposures, special considerations must always be given to the factors of direction and velocity of wind. These factors can minimize the effects of proximity on the windward side of the fire and maximize those on the leeward side to such a degree that the building nearest the fire is not necessarily the one most severely exposed.

STRUCTURAL COLLAPSE

In assessing the effects of other factors on structural collapse, officers should carefully consider the type of construction involved in the fire. Nonfireproof or brick-joist construction is usually susceptible to collapse, and has presented some of the most serious problems.

Age of the structure intensifies structural defects. Duration of fire--how long has it been in progress and how much water has been poured into the building, location, and extent of the fire present obvious problems. Other important considerations are conditions upon arrival, particularly where an explosion or backdraft condition is present, or where an explosion has already occurred; presence of heavy machinery; and the nature of the burning or exposed material.

Still other points to consider are proper supervision (overloading of stairs); the span of floor between supporting members (wide spans are more susceptible to collapse); and whether supporting metal structural members are protected. (They may fail rapidly if heated and then struck by cold water from streams, especially if they are made of cast iron.)

In vacant buildings, officers can anticipate that floor beams have been weakened by vandalism and, quite often, by previous fires. Signs of imminent collapse are a rumbling sound that may accompany a wall disturbance or collapse, cracking or bulging walls, water or smoke seeping through the walls, twisted or warped columns and beams, and floors sagging or pulling out from walls.

TIME ELEMENTS

Time of year--Time of origin tells when a fire occurs, in terms of time of year, holiday time, and day or night. The time of year ordinarily reflects the usual seasonal tendencies relative to topography in woodland areas; humidity, rain, snow, and dry spells. Major holiday seasons maximize the hazards associated with churches and department stores.

Nighttime fires--Visibility is poor and it takes longer to evaluate factors that are pertinent in determining objectives and activities. The life hazard is maximized. At night fires in unoccupied buildings the selection of objectives and activities may be more difficult in borderline cases because of darkness. It is likely that these fires have been burning for some time before discovery, thereby worsening the effects of all related primary factors.

Consequently, night fires usually require more hose streams, apparatus, and personnel for control and extinguishment.

Daytime fires--The fact that occupants are awake can result in quicker discovery, alarm, and response with favorable effects on the life hazard, location and extent of fire on and after arrival, heat and smoke conditions, and exposure hazards. In ordinary weather visibility is good and fire officers can more quickly evaluate the primary factors pertinent to selecting objectives and assigning activities.

On the other hand, traffic conditions are heavier during the day, hydrants may be blocked, and pressure in the water mains is generally lower because of increased demand.

AUXILIARY APPLIANCES

Sprinkler systems--Long-term records show that automatic sprinklers either extinguished a fire or held it in control more than 96 percent of the time in a wide variety of occupancies. Reasons for unsatisfactory performance were found mainly to be as follows: water to sprinklers shut off, only partial sprinkler protection, inadequate water supplies, faulty building construction, and obstruction to distribution, hazards of occupancy, inadequate maintenance, antiquated systems, and slow operation.

Pressurization of stairways or other building areas--Internal systems may have this capability; therefore, building maintenance personnel knowledgeable about building systems should be immediately brought to the Incident Command Post (ICP) for consultation with the IC.

HEAT, FLAME, COMBUSTION

Heat transfer/radiation--Radiation is energy in the form of electromagnetic waves, which are traveling disturbances in space and which include light, heat, radio, and cosmic rays. The distance is the major consideration where structures are endangered by heat conditions. Consequently, proximity of exposures to the fire building in some cases determines the order of priority in covering exposures, despite the direction of the wind.

The wind influences the situation, however, when it changes the direction of the convection current. Wetting down the exposed surfaces with water fog best protects exterior exposures against radiation.

Heat transfer/conduction--Conduction is the process by which heat is transferred within a material from one particle to another or from one to another in contact with it, without any visible motion. The amount of heat transferred by conduction varies with the conductivity of the material and the area of the conducting path.

Heat transfer/convection--Convection is the process in which heat is transferred by a circulating medium in the gas or liquid state. If the rise of convection currents in a shaft is checked by some obstruction, and if the stoppage is complete and sufficiently prolonged, appositive pressure will build up and will be greatest immediately below the stoppage.

VISIBILITY

Impaired visibility makes it more difficult to recognize and properly evaluate pertinent factors, thereby hampering decision making and increasing the possibility of error. Poor visibility is a serious handicap in searching for trapped occupants, in determining the order in which exterior exposures should be covered, or in carrying out any fire activity.

In addition, supervision becomes a more critical matter because of the increased dangers to personnel.

WEATHER

The Effects on Objectives and Strategy

Low temperatures--Extremely low temperatures retard the initial development of fire, but once a fire has started they impair the efficiency of the operation in general in that they necessitate such things as heavy, encumbering clothing, which slows actions.

Frozen hydrants and appliances hamper operations. Snow accentuates the disadvantages of low temperatures.

High temperatures--High temperatures are generally classified as temperatures in the eighties and nineties. High humidity and inversion conditions are characterized by dense smoke and poor visibility.

High-humidity and high-moisture content make it more difficult for a vigorous fire to become established, but do not slow its spread once it is well started.

Rain--Rain greatly reduces the probability of fire spreading from building to building. Rain droplets cool convection currents and help extinguish flying sparks and embers.

Steaming sections of the roof during a fire may indicate the location of hot spots and where opening should be made.

Wind conditions--Velocity is an important factor. Winds under 15 miles per hour (mph) usually can be controlled if defensive measures are taken; with winds 15 to 30 mph, the rate of fire propagation increases dramatically. Thirty mph wind is a threat to exposures downwind and is conducive to conflagrations.

The higher the velocity, the more the pillar slants from vertical in the direction of the wind, and thereby limits the need for other requirements. Chief Officers should know the benefits and limitations of the effects of stream application. On the leeward side fog streams may be ineffective. Conversely, on the windward side high winds can make fog preferable when operating streams.

Firestorm--A firestorm may develop in the absence of ground winds sufficiently strong to support conflagration. Data from wartime experiences indicate that an area less than one square mile is probably incapable of sustaining a firestorm. In addition, building density **(**the total ground area of buildings divided by the total area of the zone) must be greater than 20 percent.

A firestorm is basically a windstorm. It may produce rain if the rising column of hot smoke meets a stratum of cold air, causing the moisture in the air to condense around moots of smoke or soot and fall in large black raindrops. To the fire service, however, the firestorm is comparable to a conflagration in size although different in other ways. It results from the merging of numerous smaller fires into one massive inferno and is more likely to be a wartime, rather than a peacetime, phenomenon.

Minimum area and building density are essential, and the absence of strong ground wind is necessary. The thermal columns (convection currents) rise almost vertically (that of a conflagration is bent over by the prevailing wind), and the rising column creates a powerful centripetal force that draws air along the ground at velocities that may exceed 100 mph, toward the expansive low side-pressure area at its base. The true firestorm should not extend beyond its perimeter because of the centripetal pattern of the air currents created. High temperatures prevail, and combustible building material and plant life are consumed, with only brick and similarly resistant walls and charred trees remaining.

REQUIREMENTS TO OPERATE

The term **requirements to operate** pertain to the water, apparatus, equipment, personnel, and special extinguishing agents required and available for an effective fire operation.

All of these items form a balance if, for example, the water supply required is available, the need for additional personnel, apparatus, and so forth is ordinarily decreased. If water supply required is not available, the other needs are ordinarily increased. The same "rule" holds true for each of the other primary factors comprising requirements to operate.

Water--To use water most effectively and thereby limiting the need for other requirements, chief officers should know the benefits and limitations of fog and additives, when and how to employ master streams, and the principles governing the use of hose streams, apart from the effects of ventilation, selecting hydrants, the mechanics of stretching hoselines, and so forth.

Advantages of fog--Fog can be effective with master stream appliances, with wetting agents, and also with foam. It has greater and quicker absorption of heat per gallon than plain water.

Water has its maximum cooling and extinguishing effect when applied as a cold fog and evaporated into steam. Fog causes less water damage to property and the contents of fire buildings. This has a favorable effect on the public, as the salvage problem is simplified and business can be resumed and homes reoccupied more quickly.

Disadvantages of fog--It has been proven many times that personnel are uselessly endangered and injured when they try to advance fog lines into seriously involved, unventilated fire areas; the steam created pushes back through the means of entry.

Unless ventilation can be effected to prevent such an occurrence, another technique must be used. Fog cannot be aimed as well as a solid stream. Whereas the latter can throw 75 percent of the water within a 10-inch circle or 90 percent within a 15-inch circle when it reaches the seat of the fire. Much of the water from a fog stream will not reach the seat of the fire if turbulent currents have to be overcome.

Under ordinary conditions, fog lines do not have a good vertical or horizontal range. This could be a disadvantage in extinguishment or in covering exposures. A serious disadvantage is that some firefighters do not realize that fog is no more a panacea than solid streams. It is important to know how to use each kind of stream to its maximum advantage.

Chief Officers who favor one technique for all fires have closed their minds to the possible alternatives. Officers should be familiar with all recognized techniques and should learn to select and apply the most appropriate one in each situation.

Placement and use of fog lines--In covering life hazard, extinguishing fires, and protecting exposures, the principles that govern solid streams are applied, bearing in mind the limitations and peculiarities of fog.

For example, when life hazard is present, the first line must of course be placed to operate between the fire and the endangered occupants or between the fire and means of escape. However, the possible effects of the fog on the occupants as it vaporizes to steam must be kept in mind. Accordingly, where there is a life hazard, the use of fog attack is inadvisable.

Water with Additives

Advantages--There are greater penetrating qualities and less runoff, and consequently less water is required. It could be used with fog, resulting in greater heat absorption. In this form, it is particularly effective on some Class B fires involving high-flash point products.

It is effective on smoldering and hidden fires, as in baled cotton, paper, and rags; fires in sawdust or where charring might ordinarily repel water penetration; and brush, grass, and duff fires.

It is estimated that one-fifth to one-third the usual amount of water will suffice when a wetting agent solution is used on such fire. It has a definite favorable effect on the overhauling phase of an operation, on preventing rekindling, protecting exposures, and reducing the life hazard for fire personnel.

Disadvantages--It is sometimes corrosive. It may increase the electrical conductivity of the stream. If electrical equipment comes in contact with water with additives it must be flushed clean before it is restored to service. It should not be used with foam. The wetting agent breaks down foam. Its lower surface tension tends to increase the breaking up of a stream.

Foam

Mechanical--Foam is applied primarily to extinguish fires in flammable liquids by blanketing the liquid surface, sealing off the escape of vapors, insulating the liquid from the heat of the fire, and cooling the surface. Foam is effective on hydrocarbon fires that are liquid at ordinary temperatures and pressures, but cannot extinguish fire in liquefied compressed gases. Foam can be used for alcohols and esters.

Foams must have a lower density than the flammable liquid it is used on, so that the foam will float on the surface. The quantity of foam required for extinguishment varies widely. For fires in small indoor tanks of flammable liquids, a few inches may suffice; in larger outdoor tanks, several feet of foam may be required.

The amount of foam needed will be affected by (1) the required rate and time of application, and (2) the quality of the foam and the effectiveness with which it is applied.

Wetting-agent foams--They break down into their original liquid state at temperatures below the normal boiling point of water, and in this respect differs from mechanical foam. If a wetting agent of the synthetic detergent type is used, the structure formed can intercept and reflect radiant heat, and thereby provides effective protection for exposed surfaces.

The effectiveness of wetting-agent foams as a blanket on Class B fires is limited because of the comparatively quick breakdown when heat is absorbed. However, the resulting liquid retains the penetrating qualities of the wetting agents and this aids in creating cooling action.

Surfactant foams--Surfactant means a **surface-active** material. The surfactant foam referred to as "light water" is a fluorochemical material, and is described as a fluorinated surfactant. It produces aqueous film-forming foam when mixed with air, either in a foam pump or at an aspirating type nozzle.

Apparatus and equipment--Apparatus and equipment can be more effective if selected in accordance with the potential fire problem in the community as indicated by such primary factors as life hazard, possible location and extent of fire on and after arrival, heat and smoke conditions, exposure hazards, construction, height, area, auxiliary appliances, weather conditions, time of response, and naturally, the water, personnel, and special extinguishing agents available.

Apparatus and equipment are obviously more effective if they arrive at their destinations on schedule. Placement of apparatus is a matter of prime importance. One poorly placed apparatus can seriously impair the usefulness of others.

Misplacement is a particularly severe handicap at the start of an operation and should be guarded against when much of the assignment is approaching the fire from the same direction.

Tools such as electric-powered or hydraulic-powered, and imaging cameras should be used appropriately. Chief Officers should understand the capabilities and limitations.

Protective clothing--Enforcing department policies by chief officers for wearing protective equipment appropriately, such as approved bunker gear, helmets, hoods, gloves, and breathing apparatus is critical to the safety of personnel.

EXPLOSIONS

Backdraft or smoke explosions--Smoke explosions or backdrafts at fires are essentially caused by the rapid combustion of a mixture of flammable gas, vapor, mist, or dust and air. They can occur before or after arrival of the fire department. Smoke explosions or backdrafts can occur before arrival if heat breaks windows, abetting an inflow of air to an unventilated fire area in which active combustion has ceased because of oxygen depletion. The inflow of air replenishes the oxygen supply and can accelerate combustion of the accumulated smoke and gases with explosive results.

This can also happen after arrival if injudicious forcible entry supplies air to otherwise unventilated and susceptible fire areas. Smoke explosions or backdrafts can cause structural collapse. If they occur before arrival they can adversely affect the life hazard, location, and extent of fire on and after arrival, occupancy, auxiliary appliances, smoke and heat conditions, exposure hazards, requirements to operate, duration of operations, life hazard for personnel, and street conditions, especially if there is frontal collapse.

If smoke explosions or backdrafts occur after arrival, the foregoing effects are intensified, especially for fire personnel who may be in the fire building or within range of collapsing walls. In some cases, the first explosion throws flammable dusts into suspension causing additional explosions.

A cardinal principle is that any enclosed and inadequately ventilated fire area should be considered susceptible to a smoke explosion or backdraft. If the fire building is unoccupied, such areas should not be entered until they are properly ventilated.

Bomb explosions--Sporadically, certain groups explode bombs as a means of "sending their message." Warnings of the impending explosion may or may not be given. Chief Officers responding to the designated target must assume the warning is authentic and conduct operations accordingly.

If the suspected building is occupied, it should be vacated forthwith. Fire personnel can assist in the evacuation but should not participate in searching for the bomb since they have neither the protective equipment or the special training required for such a task.

TOPOGRAPHY

Hilly communities--When operating at a fire on steeply graded streets, it may also be advisable to position aerial trucks or tower ladders on the high side of the fire to ensure maximum reach. The effective use of wedges to level portable ladders to allow for safe climbing on hilly terrains must be enforced.

EXPOSURE HAZARDS

Covering interior exposures--The interior exposure hazard, depending on the degree of severity, can favorably or unfavorably affect life hazard, extent of fire after arrival, occupancy (human element and contents), structural collapse, heat and smoke conditions, wind direction and velocity, requirements to operate, duration of operation, smoke explosion or backdraft, and exterior exposure hazard.

Covering exterior exposures--Exterior exposure hazards pertain to buildings or occupancies that may be endangered by the original fire. Occupied exposures may create a life hazard or intensify the one already present in the original fire building, thereby increasing the risks that may have to be taken by personnel in rescue work. The existence of a life hazard can have detrimental effects on many other primary factors.

Interior and exterior exposure hazards are affected by the same primary factors, except that the exterior exposure hazard can also be affected by the proximity factor.

DURATION OF OPERATIONS

For one reason or another, fire operations of long duration are generally difficult to deal with from the beginning. They may feature heavy involvement and structural collapse, especially if the structure is old and the contents are water-absorbent.

They may maximize the exposure hazard and cause other fires if sparks or embers created by structural collapse are carried by the wind. They indicate that auxiliary appliances such as sprinklers are absent or ineffective, and usually necessitate more than the usual requirements to operate.

STREET CONDITIONS

One-way streets that are congested by vehicular traffic, or are covered by snow or ice, tend to delay response of the fire department. Hence, under such conditions, fires are likely to be more extensive than usual on arrival, intensifying the existing hazards. Ice-covered streets can slow down the movements of personnel.

Canopies, overhead wires, and tree-lined streets can delay efforts to use portable, aerial, or tower ladders. The width of the street has a bearing on the proximity of exposures and therefore on the exterior exposure hazard.

Piers, dead-end streets, and buildings facing only one street restrict avenues of attack. Steeply graded streets can affect the placement of apparatus. The danger of falling glass from involved highrise buildings has added a new and sizeable dimension to the problems of the fire service.

Some communities convert a main thoroughfare into a mall with sidewalk cafeterias and extensive garden trimmings. This creates considerable problems for the fire and rescue efforts.

See next page for the Primary Factors Sheet for hazardous materials incidents.

Column #1
Primary Factor Size-Up Chart-Hazardous Materials

Pertinent Factors (P)	(Check appropriate boxes)	P
Life Hazard	Civilians	
	Firefighters	
	Hot Zone	
	Warm Zone	
Site Management	Deny Entry	
	Hot & Warm Zones	
	Exposures	
	Evacuation	
ID Problem	Hazard Class	
	Type of Container	
	Placards	
Hazard Risk & Evaluation)	Environmental Monitoring	
	Container	
PPE	Chemical Clothing	
	Respiratory Protection	
Area	HM Incident Site	
	Proximity of Exposures /Configuration.	
Exposures	HM Site	
	Structural Collapse	
	Collapse Zone	
	Apparatus Placement	
Weather	Visibility	
	Temperature/Humidity	
	Wind – Direction/Velocity	
Decontamination	Personnel & Equipment	
	Public	
Terminating the Incident	Private Sector Interface	
	Restoration/Recovery	
Time	Duration of Operations (Rest-Rehab) Time of Day Time of Alarm	

Column #2
Incident Objectives
Attainable/
Measurable/
Flexible

Examples of Incident Objectives:

- Remove all civilians from danger.
- Contain and Control Fire.
- Contain and Control Spill, Leak, Release.
- Care for any injured civilians or FF's.
- Define Hot and Warm Zones

List Incident Objectives:

1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________
7. ______________________
8. ______________________
9. ______________________
10. ______________________

Column #3
Strategies

Column #3 Strategies	Column #4 Evaluate Effect of Strategies Every 10 Minutes: Effective	Ineffective
[I] Isolation • Upwind & 2500 feet • Deny entry • Set zones		
[N] Notification • NRC/EPA/Coast Guard • Local Health • Appropriate Local/State/Federal		
[I] Identification • Material • ID number		
[P] Protection • PPE/Monitoring • EMS available		
[SC] Spill Control • Personnel and Equipment		
[FC] Fire Control • Personnel and Equipment		
[SC] Leak Control • Personnel and Equipment		
[R/T] Recovery/Termination		

List Incident Strategies	Assigned To:
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	

Column #4
Evaluate Effect of Strategies
Every 10 Minutes

Identify alternative strategies for firefighter safety when civilian safety has been determined not to be a Primary Factor.

- ______________________
- ______________________
- ______________________
- ______________________
- ______________________
- ______________________
- ______________________

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Activity 4.1

Naturalistic Decision Making

Purpose

To reinforce the concepts of NDM by analyzing a case study used in the original research* that identified the NDM Model.

Directions

1. You will work in four groups.

2. Review your group's assigned case study. Identify and list on an easel pad as many cues and actions as time permits.

   a. **Group 1:** Incident Account #1: "Tanker Truck."

Cues	**Decisions and Actions**
________________________________	________________________________
________________________________	________________________________
________________________________	________________________________
________________________________	________________________________
________________________________	________________________________
________________________________	________________________________
________________________________	________________________________

* "Rapid Decision Making on the Fire Ground," Klein Associates, Inc., Dept. of Army, June 1988.

b. **Group 2:** Incident Account #2: "Backdraft."

Cues	**Decisions and Actions**

c. **Group 3:** Incident Account #16: "Hotel Fire."

Cues	**Decisions and Actions**

d. **Group 4:** Incident Account #23: "Chemical Plant Fire."

Cues	**Decisions and Actions**
________________	________________
________________	________________
________________	________________
________________	________________
________________	________________
________________	________________
________________	________________

3. Have a spokesperson from your group report its findings.

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Activity 4.1 (cont'd)

Case Studies

TANKER TRUCK

This incident occurred 18 months ago. The incident involved an overturned tanker truck on fire. It had been carrying a full load of jet fuel, on an access ramp of an interstate highway during morning rush hour. The Chief had never been involved with a tanker fire before and this was particularly hazardous because of the existence of another tanker approximately 50 feet behind the overturned one.

Chief McW heard the dispatcher call sometime during the city's morning rush hours. Instantly recognizing the location as being within his area, he headed out in his car toward the area given by the original dispatcher call. The only information given by the dispatcher was that a tractor trailer was involved. On his way to the scene, the Chief saw a huge column of black smoke coming from the freeway at a location that was not the area of the original report. The location of the box alarm was some distance from the incident. The Chief acted on the visual cue of the smoke and arrived at an expressway off-ramp of a major interstate within two minutes of the call. Getting closer to the scene, the Chief saw a column of flame and citizens running from the scene, abandoning their cars. On his arrival he saw a tanker truck lying on its side, ruptured lengthwise, and engulfed in flame. "I immediately breathed a sigh of relief, because the danger of explosion was less than if it (the truck) was split in half," the Chief noted. A second tanker was about 50 feet from the overturned one. At the same time as this quick size-up, the Chief started toward a group of citizens who were helping the injured driver of the crashed vehicle away from the immediate area. While assisting in this evacuation, the Chief questioned the driver about his load and found that the tanker was carrying JP-4 jet fuel and had just been fully loaded. About 30 seconds had elapsed from the Chief's arrival.

The Chief then got on his radio and 1) corrected the address given by the original dispatcher call, 2) called for a rescue unit for the injured driver, 3) requested police action to stop the flow of traffic, and 4) called for a special firefighter unit that dispensed foam. By the time the call was completed, the first-alarm units had arrived and were attempting to hook up to the nearest hydrant located some distance from the scene. A five-inch hose was going to be used from this source--a size that would drain the reservoir carried on an engine in about a minute. A smaller size hose was connected to the engine and was directed toward setting up a stream of water around the wrecked tanker; the hydrant supply was not available for about 15 minutes after the units had arrived. The Chief directed the streams to be set up for the protection of the firefighters and would not allow his men to advance on the fire until protective streams were in place. He saw that the fire was well underway and pretty intense, but burning straight up and not threatening to expand much. The danger was that the saddle tanks of the tanker or other pockets of fuel would explode. A ladder truck was also directed to extend its ladder pipe and aim a water stream down on the scene. While this was being accomplished the Chief sent the driver of the first fire truck on the scene down the ramp to check for occupants in the abandoned cars.

Two foam units then arrived, one at each end of the damaged tanker. The Chief coordinated their foam-dispensing operations so that the streams were at acute angles to each other. At this point the Chief felt that the situation was pretty much under control, but then a storm sewer behind him "blew," i.e., exploded into flame. He realized that burning fuel was now in the sewer system and recognized that this new aspect of the situation would exceed his span of control. He called for another alarm to be given. The next Chief arriving with these new units was tasked with removing the danger from the sewers while Chief McW left his attentions on the tanker.

The total time to confinement was more than an hour. Chief McW was at the end of his shift during the mop-up phase of the tanker operations and decided to go home when all that remained was to right the truck.

BACKDRAFT

The incident took place two months prior to the interview and was of interest because of 1) the spread and size of fire involved, 2) a backdraft explosion that caused firefighter injuries, and 3) the IC was only a Captain with a year in grade, but was acting District Chief at the time.

The alarm call came in at 0950 hours on a Sunday morning in May. Capt. N, acting District Chief, arrived at the scene in about one minute. When he was three blocks from the scene, he saw large amounts of black smoke and flames at a building he knew to be occupied as a renovated four-story, multi-family dwelling. The Captain knew then another alarm would need to be called. He pulled his car past the building to allow the alarm equipment to arrive and, as he was stepping onto the street, he scanned the windows for life and the location of the fire. Now citizens were exiting the building's front doors and the Captain was getting reports of trapped citizens still on the third floor. He quickly continued to scan the smoke line of the front of the building, seeing smoke forced from the eaves of the roof and much more smoke and flames from the rear of the building. Then he called a Code 3 alarm (special equipment) to get an additional engine and a rescue squad.

Continuing his sizeup, the Captain made his way to the rear of the building. The fire could be seen to involve the second and third floors but was progressing rapidly, jumping from eave to eave on the fourth floor. This markedly quick advancement convinced him he didn't have the manpower at the scene to fight and that a second alarm was necessary. Quickly noting the exposures as he completed a circuit of the building, Capt. N came back to the north end or front.

The involved building was seen to have two priority exposures: the south end, where an adjacent building abutted it; and the east side where the structure crowded the sidewalk and posed a threat to the buildings across the street.

This appraisal gave the Captain the information he needed to place his equipment. However, he first had to pull a ladder crew from the north-end roof, where it had automatically begun to set up ventilation operations to perform search and rescue of the third floor rear area of the building. This action was against the Captain's conceived operational fire plan but was made urgent by the persistence of a woman from the involved building who had continued to trail the Captain, insisting that a woman known to her was still trapped on the third floor. Dispatching this crew, the Captain radioed for a second alarm to be given. Only six minutes had elapsed since the first alarm, and only three since the Code 3 was called.

Although he had realized that a second alarm was necessary much earlier, the captain had somewhat delayed the second alarm call on his experience that the first alarm and Code 3 units would need a little time to set up. The confusion of too many units arriving and attempting to set up operations was what he wanted to avoid.

The arriving second-alarm units were radio-directed to their positions by the Captain. He had prefigured their placement before their arrival, committing the second-alarm engine heavy rescue and ladder companies to search and rescue in the back with the one first-alarm ladder company. He then turned over responsibility for the back operations to the second-alarm District Chief. The other first-alarm ladder company had been tasked with knocking out the third- and fourth-floor windows in the front. Before allowing both the first- and second-alarm companies inside the building, Capt. N made clear he wanted quick radio communication on the nature of the fire when they encountered it.

No other staff officers had arrived at this time and the Captain maintained overall IC responsibility as he stationed himself in the front to oversee the north and east sides of the building. He became concerned when several minutes had elapsed after the dispatched crews had entered the building but no white smoke (water turning to steam) could be seen. This indicated that the firefighters had not yet made contact with the fire and this delay was distressing because of the rapid progress the fire had made since the fire companies' arrival. A radio report then came in from the firefighters inside that steel safety doors were obstructing attempts to enter the third floor. The delay in getting the information to Capt. N had occurred because the firefighters had, on their own initiative, gone to obtain the necessary equipment to open the doors and were in the process of that operation.

Monitoring the situation, he saw that a crowd of 15 to 20 people had gathered in the front to watch the fun. They posed a danger to themselves and to firefighter operations; in the interest of safety, Capt. N shepherded them across the street. As this action was completed, a large explosion was heard--a backdraft had occurred. Immediately fearing that the building was coming down, he ran about 50 feet up the street without pausing to ascertain the nature of the event. Capt. N then turned back to see a firefighter enveloped in flames on the third floor jump out of the building to an aerial ladder positioned near there. Trapped firefighters on the burning third floor were now yelling to be evacuated.

The explosion had occurred on the second floor, blowing out all the windows, including those that had remained on the third and fourth floors after the ventilation crews had been through. Shards of glass littered the street, where shortly before a crowd of naive, gawking bystanders had gathered. The potential civilian casualties could have been extensive had Capt. N not cleared the scene.

Coming only eight minutes after the second alarm, Capt. N immediately radioed a third alarm with the information that firefighters were trapped. He feared that some firefighters had been killed and others badly injured. He specifically ordered extra rescue units to the scene. Capt. N ordered all internal building operations discontinued and all crews inside to evacuate. The Captain wanted a head count to assess his casualties and was conducting one when the Assistant Fire Chief, responding to the third alarm, arrived. Capt. N gave a report of the situation as he knew it at that time, emphasizing that not everyone (firefighters or civilians) could be accounted for yet and that a fourth alarm was probably necessary. The arriving Chief now assumed overall IC responsibility, with the Captain taking charge of the front and east side operations. A fourth alarm was called 10 minutes after the third; a completed head check had revealed no firefighter deaths, but six injuries.

The fire companies regrouped and then resumed internal building operations.
Fire containment occurred with two hours of the first alarm and the entire incident was judged to have been handled successfully. A training film had been made of the operations at this site as captured by the media.

HOTEL FIRE

This incident occurred 15 years prior to the interview, but stuck out in the officer's mind as a time when his decision made a critical difference in the outcome of a serious hotel fire.

The alarm came in as an observation of smoke on the eighth floor of a downtown nine-story hotel at 0200 hours. The late hour would indicate that guests would be in their rooms asleep, although Chief W reported that, initially, the call was not viewed as critical. Such alarms are received fairly frequently and usually result in only a minor incident. In approximately three minutes his staff car had arrived at the bridge about one-half mile from the hotel, and Chief W could see a large volume of smoke coming from the fifth floor of the hotel. He concluded that the eighth-floor report must have been secondary smoke. Immediately the magnitude of the threat to life was evident, and Chief W's stress level peaked to perhaps the highest level he had ever experienced in his career. Chief W mentally reviewed the structure of the hotel, which he had learned during a recent inspection tour: open interior stairwells would provide a chimney for the fire, and in the hot night many windows would be open, providing ventilation for the flames. He could only expect the worst. Chief W also recalled the location of the hallway standpipes, and this knowledge greatly aided the success of the operation.

At approximately 0205, Chief W and the southside Battalion Chief arrived simultaneously at the scene. It was customary for the first-arriving officer to take charge of the inside, with the second company taking charge outside. In this case, the rule was not applied. The southside Chief was an older gentleman and offered Chief W the inside.

Within approximately two minutes, Chief W had reached the fifth-floor landing and could see smoke coming out from around the fire door. By the amount of smoke and the blackish color (from burning carpet and materials) Chief W inferred that the fire was going to be extensive and that it would be risky to try to use the fifth-floor standpipes. He instead decided to use the fourth- floor standpipes and stretch them to the fifth floor, a decision which turned out to be absolutely correct. The fifth-floor standpipes were later found to be totally unusable.

Immediately after he made the standpipe decision, he ordered a second alarm. He knew that the ladders would not reach the fifth floor and would be of no help during rescue, so his primary goal was to ensure an exit for the trapped victims on the fifth floor. He radioed for the incoming crews to enter through the main lobby side of the hall, so that he would have a two-pronged attack.

The fire was contained within 15 minutes of arrival, and only one person had to be hospitalized for severe smoke inhalation. This was considered a highly successful operation.

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CHEMICAL PLANT FIRE

The incident took place at a manufacturing plant producing/ packaging paint thinner and related solvents. The high volatility and explosive nature of the products made this fire a high-risk event to both firefighters and property. Because of this danger, two men refused to take part in operations. A second potentially explosive situation developed from the firefighting foam operations performed at the alarm site; foam and flammable liquid runoff drained into the basement of an adjacent building and was not found for some time after a few units were released from the scene.

A box alarm came in at about 1530 hours. Chief G heard the dispatcher give the alarm and recognized the location as the scene of a chemical fire about 10 years earlier. When the first units arrived and said they had a working fire, the Chief left for the site before being officially called. ("Because of that fire 10 years ago, I knew it would be more than a one-alarm fire. You see, factories aren't real neat areas...there are tanks and drums scattered in different areas...")

On his way to the scene, he heard the dispatcher activate the Hazardous Materials Unit, of which Chief G was in charge. The dispatcher then began to relay windspeed and velocity information, followed some time after by "CHEMTREC" file information, which contained the last fire inspection of the building, e.g., type and location of stored chemicals, drains, exits, etc. The Chief also noted specific cues about the fire on his way there. He mentioned particularly the volume of the smoke and its color, as well as its location when he got there. White smoke would indicate that the firefighters were hitting the fire close to the core ("...that white steam helps you know where the men are positioned and where their lines are"). In response to a query on how much planning he did on the way to the scene, the Chief indicated that he actually didn't make any specific plans and the few made regarded the importance of protecting the flammable/toxic material holding tanks.

At about 1540 hours, the Hazardous Materials Unit arrived on the scene. By this time, the Chief had sized up the scene and identified the exposures to protect from being enveloped by the blaze. These were the west side (to protect adjacent buildings), the east side (to protect the storage tank yard), and the roof. He recognized the roof as being made of composite material that included tar, the ignition of which could spread the fire to adjacent buildings, or other areas in the same structure. The first-arriving units were already defending the first two exposures, but the Chief had to give the explicit order for a line to be laid directed at the roof by the next-arriving unit.

His next concern was to set up foam operations and put them on standby until the tanks exposed to the heat were cooled down. Then exposed tanks had to be cooled down with water because they were potentially explosive. The fire itself could not be fought with the foam operations until the water operations ceased, because water renders the foam inoperative. When to initiate foam operations was conditional on the relative temperature of the tanks. The Chief mentioned several possible cues that helped him get an indication of when the tanks were "cool enough," i.e., if heat waves were still rising from the tanks, if the tanks were still swollen by heat expansion, the sound of water from the hoses hitting the sides of the tanks, could be heard actually feeling the larger tanks with one's hand.

("I **know** when the tanks are cool enough but I couldn't tell you how to judge it. It's just like cooking...how do you tell when something's done?")

At approximately 1610 hours, the tanks were judged to be cool enough for foam operations to begin. The fire was successfully controlled within 40 minutes of this operation. However, routine explosion meter readings (indicates ratio of flammable gas to air) taken during salvage and mop up at approximately 1730 hours revealed a potentially explosive situation in the basement of the adjoining building -- hazardous runoff, comprised of the flammable liquids and foam had been draining undetected into the basement. The Chief considered this situation to have resulted from insufficient monitoring of fluid drainage. Because of the late discovery of this situation, equipment and men had to be recalled, and available personnel recruited. Operations to clear the basement continued for another hour, and were completed successful.

Activity 4.2

Seton Hall Dormitory Case Study

Purpose

To analyze the Seton Hall Dormitory Case Study to determine critical sizeup factors.

Directions

1. As a group, review the articles that you read as a precourse reading assignment.
2. Make a list of the 10 most pertinent primary factors in this case.
3. If you were the IC at this incident, "What would be your Incident Objectives?"
4. As a group determine what strategies you would use.

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Activity 4.2 (cont'd)

Precourse Reading Assignment Articles

SETON HALL:
FROM TRAGEDY TO TRIUMPH

By Gerald J. Naylis
Training Officer
Bergenfield Fire Department
Bergenfield, New Jersey
President of International Association of Arson Investigators

The evening of January 18, 2000 was a momentous one for the Seton Hall University community in South Orange, New Jersey. That night, the Pirates basketball team of Seton Hall defeated its Big East rival, the Red Storm of St. John's University. No one expected that the events of the next 12 hours would completely overshadow the basketball victory and change the lives of many forever.

At approximately 4:30 a.m., a fire alarm was received for Boland Hall in the security office at Seton Hall. Boland Hall is a six-story coed dormitory located on the western end of the South Orange, New Jersey campus, near the main green. The original building was completed in 1952. A major addition was completed in 1976. The building is of noncombustible construction. Hollow-core block walls separate the common hallways from the individual dormitory rooms. Most rooms have double occupancy. Smoke detection equipment in the common areas of Boland Hall was tied to the fire alarm system together with the manual pull stations that transmit to the security office. In many cases, the construction and fire protection features of the Boland Hall dormitory are not unlike those of many other college dormitories across America.

FIRE SPREAD QUICKLY

The fire on the third floor quickly involved the furniture in the roughly 25-foot by 25-foot elevator lobby and adjoining area. The couches, made of polyurethane-like foam rubber, burned rapidly generating high heat and thick, blinding, choking smoke that would prove deadly. The heat and smoke from these limited combustibles filled the hallways while many students remained in their rooms, ignoring the fire alarms. In just a few short minutes, conditions in the hallways became oven-like.

Within minutes, students became aware that there indeed was a fire and this was no false alarm. The screams of awakened students aroused others, who found themselves trapped. Students would later recount that false fire alarms were almost considered a way of life on the college campus, with the result that they tended to be largely ignored.

Arriving, firefighters immediately began a simultaneous attack on the fire and worked to rescue and remove trapped occupants. However, their efforts were stymied by limited staffing. Mutual aid was called, but the stage was already set for a tragedy. Ultimately, three freshman students lost their lives, and 58 additional students and staff members and four firefighters were injured. Of the 58 students injuries, five were critical, requiring extensive hospitalization, four at the St. Barnabas Burn Center and one at a trauma center.

MEDIA FOCUS ON CAUSES FOR THE TRAGEDY

The ensuing news reports focused on many things: fire inspections were found to be lacking. The fire alarms sounded, but they were largely ignored. The fire department response was delayed while the validity of the fire alarm was checked. And, like so many other fire tragedies, the building was reportedly in compliance with code requirements at the time of construction but not with current standards--in other words, the building did not have a working functional sprinkler system. This proved to be a defining conclusion by the news media. They finally had identified the single most important issue surrounding this tragedy. The only trouble was that they didn't realize it for several days.

Print and electronic media sought comments from the fire service community and public officials. They asked, "Why weren't sprinklers required? Would sprinklers have made a difference? How did the fire start?" These questions were met with icy replies: "The fire is under investigation," and worse yet, "No comment." While the aspects of the investigation should have been kept close to the vest, why couldn't there have been an official comment that addressed the known and perceived fire protection issues? Unfortunately, the fire service, to a large extent, does not know how to deal with the media, let alone master art.

Several days passed before the media were able to reach individuals they described as prominent fire fighting officials who were willing to comment on record. Not surprisingly, the focus of almost all of the comments was on the lack of automatic sprinkler protection. Now the news media had their story. Front-page headlines and leading story introductions dominated the news coverage of the story. Newspapers and television stations were asking the same question, "Why didn't the building have a sprinkler system?"

A CATALYST FOR ACTION

As has happened in the case of past tragedies, the Seton Hall fire set in motion a chain of events that ultimately taught the nation and the nation's fire service lessons that resulted in fire code revisions aimed at preventing such disasters in the future.

Following the fire at the Cocoanut Grove nightclub in Boston on November 28,1942, which killed 492 people, the news media focused on the fact that the exit doors swung inward instead of outward. The fire codes were soon revised to have the exit doors swing out instead of in.

During the 1958 Our Lady of Angels School fire in Chicago, Illinois, fire raced up the unenclosed stair towers unchecked. The news media documented how 95 students and nuns were killed as a result. The fire codes were changed to require that exit stair towers be enclosed.

In the wake of the Seton Hall fire, some members of New Jersey's fire service community felt that the time was ripe to take advantage of this tragedy and salvage some good from it.

Shortly after the news reports, a number of state legislators expressed, sorrow and indignation. They also introduced at least six pieces of legislation aimed at requiring the retrofit installation of automatic sprinkler protection in all college and university dormitories. Each of the proposed bills had its own special requirements with just enough differences that the bills could be log jammed in the legislature with no hope of passage in sight. The bills designated different buildings to be sprinklered, different time frames for compliance, different funding mechanisms, and varying amounts of funding.

COALITION FORMED

The fire service leadership decided to develop alliances with those outside the fire service to push the legislation along to a successful conclusion. This group came to be known as the Coalition for Safe School Housing and included the fire service; organized labor; the sprinkler industry; and a multitude of organizations, including the state's AFL-CIO. It was also apparent to this group that most of the political figures dealing with this issue needed to be educated about what automatic sprinklers are and how they work.

Within weeks, hearings were scheduled on the bills in the State Senate and Assembly. The Senate bill called for only dormitories to be sprinklered. Amendments to extend it to fraternities, sororities, and boarding schools were initially spurned. The first bill would have required compliance within 15 months, but that was soon amended to two years. It was clear that there was support for the installation of sprinklers, but the proposed legislation was not as broad as the fire service would have liked. The college community also expressed support for the requirement. Its concerns were the time frame for compliance and the funding mechanism.

On the Assembly side, no fewer than three separate hearings were held on the bills. John V. Kelly chairman of the, Assembly's Housing Committee and also chairman of the state's Fire Safety Commission, called for the hearings. In a wise procedural move, Kelly invited members of the Assembly's Education Committee to participate in the hearings. During these hearings, the sentiment was to ensure that the legislation was complete and comprehensive enough to address the need rather than rush something through for the sake of appearance.

Testimony offered was in support of the need for sprinkler protection and covered the size and scope of the areas that needed to have sprinkler systems, the resources within the sprinkler industry to meet the need, and the time frame in which the work could be done. There was conflicting testimony pertaining to the latter. The colleges and universities' position was that the work could be done only during the summer months when school was not in session. The sprinkler industry countered that work could proceed throughout the year.

It cited experience in hotels and motels as evidence of its ability to work within an operating building. Ultimately, in April, Kelly visited Seton Hall, which was in the process of installing sprinklers in all dorms. Based on that visit, Kelly found out first-hand that the work could be done while school was in session.

Other concerns were identified, and had to be addressed as the process evolved. These issues included how asbestos abatement needed to be done at many of the older buildings that would be affected. Legislators asked whether price per square foot could be relied on to develop budgeting numbers for the legislation. The range of anticipated costs was from a low of $2.50 to a high of $11 per square foot. The higher numbers typically included other work that would result from the sprinkler installation, such as patching, spackling, and painting.

Glaring differences between the Senate and Assembly bills included the time frame for compliance, what would be included in the requirement, the amount of money for the work, and where the money would come from. The Senate bill was requiring compliance in two years and covered only dormitories. Money was to come from a modification of a higher education bonding act that developed approximately $50 million. The Assembly version was leaning to five years, and, more importantly, included fraternities, sororities, and boarding schools. The Assembly bill set up funding of between $90 and $100 million to establish a revolving low-interest loan program.

For several weeks following the Seton Hall fire, area newspapers reported almost every fire that occurred at a college or university in New Jersey. They were all relatively minor in nature, and at least one fire was contained by, a single sprinkler resulting in minor damage.

PENNSYLVANIA TRAGEDY

Then, two months to the day after the Seton Hall fire, tragedy struck at a fraternity house fire in Bloomsburg, Pennsylvania. Five fraternity brothers were killed. Ironically, one of the fraternity brothers killed in the Bloomsburg University frat house fire was from the same town and church parish as one of the freshman students killed eight weeks earlier at Seton hall.

The momentum initially generated gained even more steam. The focus now became not just dormitories but all student residences. The deaths in Bloomsburg reinforced the lessons of the 1996 University of North Carolina, Chapel Hill fraternity house fire. Among the contributing factors in that fire were lack of a sprinkler system, careless disposal of smoking materials, and unclosed central stairways. For this legislation to be truly effective, fraternities, sororities, and boarding schools would have to be included.

The scope of the installation meant that more than 36,000 beds were to be protected by sprinklers. This represented approximately 71 percent of the college beds in New Jersey and affected 56 of the state's public and private colleges and universities. This would mean that it would more likely take up to five years to complete the work instead of the two years stated in the Senate bill, which by now had passed in the Senate and was awaiting action in the Assembly. Just as it appeared that the five-year plan was to be adopted. Governor Christine Todd

Whitman's office issued a statement indicating her support of the bill, but with a four-year window for implementation.

It was late May, and the legislature was busy working to formulate the state budget, which by state constitution had to be completed by July 1. In what can only be described,
as an incredible game of legislative ping pong, the sprinkler bill was passed in the Assembly with the five-year window; was sent over to the Senate, where it was amended to the four-year window, as requested by the Governor; and was sent back to the Assembly, where the amended bill was approved. All this was done in a matter of three weeks. The bill was sent to the Governor for her signature to complete the process.

On July 5, 2000, in a modestly attended bill signing ceremony on the green of Seton Hall University, in the shadow of Boland Hall, the most comprehensive legislation requiring sprinkler protection in the college dormitories, fraternities, sororities, and boarding schools was signed into law. The law requires that automatic sprinkler be installed within a maximum period of four years. All schools are required to submit a compliance plan within 120 days to the state's Division of fire Safety. The installation must be done in phases that stipulate that roughly 25 percent of the work be done each year at a minimum. One key element of the legislation is that water companies are prohibited from assessing water supply stand-by charges for any of these sprinkler systems. This was seen as a major victory for the fire service in New Jersey, which has been pushing this issue for almost two decades. Similar legislation is pending in Pennsylvania.

Naturally, there are some downsides to the legislation. For one, the state of New Jersey still does not have any regulations on the books for the licensing or certification of individuals or firms that install automatic sprinkler systems. Interestingly enough, there is strong support for this type of regulation from the affected industry. The fear expressed by the fire service is that "anyone with a pickup truck and pipe wrench" will be flocking to the state to install sprinklers.

LESSONS LEARNED AND REINFORCED

What are the lessons learned from the Seton Hall fire?

- Perhaps the most important is that it is possible to have an impact and effect positive change in light of a serious tragedy. But that would require doing things that the fire service hasn't really done well in the past, including talking and working with the media, building coalitions, educating pubic policy makers about fire safety issues, and recognizing that there are others who do not share our passion for a particular issue.

- We still have a long way to go to overcome attitudes about fire safety, including the subject of fire-related human behavior. Most people still think that fire don't happen to them, that they happen to other people, and that when a fire alarm activates it must mean it's a false alarm because that's all it ever is. The even larger issue is overcoming the acceptance of false fire alarms.

- The fire at Seton Hall University also exposed a number of areas where improvement is warranted. Fire department staffing and response, alarm notification procedures, pre-incident planning, fire code enforcement, and inspections have all been identified as lacking. Passing a mandatory sprinkler law will not alleviate the need to address these issues. At the bill signing, Assemblyman Kelly reminded all present that sprinklers alone are not the answer. Sprinklers in conjunction with strong fire prevention efforts, code enforcement, fire safety education, and an adequately staffed fire department are all necessary components of an effective fire defense system.

Recognizing that most advances in fire safety come only after we have made a prepayment in human suffering, the fire service must be ready to seize the moment when a tragedy strikes. This may sound cold, but it is truth. If the deaths and injuries sustained in fires are to result in any positive outcomes, it will only be because the fire service was prepared to act on them. We also need to constantly remind ourselves that if it has happened somewhere else, it can happen here. The real tragedy of the Seton Hall fire is that there is little, if any, action moving ahead for similar legislation in other states other than Pennsylvania.

Taken from:
Fire Engineering
September 2000

COLLEGE DORMITORY FIRE SAFETY

BY FRANCIS L. BRANNIGAN
FIREHOUSE CONTRIBUTOR EDITOR
FELLOW OF THE SOCIETY OF FIRE PROTECTION ENGINEERS

After the recent Seton Hall University dormitory fire in which three students died and a number of others were injured, some seriously, I was asked by *Firehouse* to write on the subject.

The first material at hand was the *Operation Life Safety Bulletin* of July/August 1999, which contained the winning essay in a contest, "Why Campus Housing Should Have Fire Sprinklers, by Kathleen Grant of Huntington, WV. She reported on several fires at major universities and commented, "Students who have scored high enough on the SAT to be accepted by MIT, Yale and Duke caused fires. They must be bright, yet they committed stupid acts leading to the destruction of property and risk of human life."

It is not only students who are ignorant of or unreceptive to fire safety. College managers often lack a fundamental understanding of the fire problem, possibly because it is considered too menial for their attention or they resent some other authority telling how to spend THEIR money. At Princeton University, professors--world leaders in the physical sciences--attempted to inert a huge room, which was open to the atmosphere, with portable CO_2 extinguishers because of fear of "water damage." The fire chief of the Naval Air Station at Lakehurst, NJ, traveled 60 miles to put the fire out in 90 seconds.

Students are naturally rebellious and resist rules. Like many older people, they place great reliance on their own experiences and reject out of hand precautions based on blood and tears shed elsewhere. Therefore, the only real fire protection for them is automatic sprinklers and smoke detectors in any area where people sleep.

In my experience, scientists and many administrators are born with a severe prejudice against using water on fires. When a fire at the Livermore Laboratory was stopped just short of dispersing enough radioactive material to contaminate the place out of existence, they were organizing committees to control experiments. I argued that they were cutting their throats in the research field and that if they would only sprinkler the buildings; they could work with anything short of dynamite. They were unimpressed, until I declaimed, "Automatic sprinklers gave academic freedom." They cheered and drowned out the three last words, "to do stupid things."

Automatic sprinklers free the decent, responsible students who will probably contribute to society from death by idiots who smoke while drunk, go to sleep with candles or incense burning, bring hazardous materials into their dorm rooms, or even set fires "just for fun." Educational programs are fine, but unfortunately soon forgotten.

EXTINGUISHERS NO HELP

When this subject is discussed, much is sometimes made about fire extinguishers. I spent a number of years on the National Fire Protection Association (NFPA) Portable Extinguisher committee looked hard for cases in which extinguishers made an effective difference. There were few, and they probably were balanced by the number of times the futile use of extinguishers delayed the sounding of the alarm.

Some years ago, the University of Maryland tired of extinguishers being used as moron play-toys and took them all out. A reporter rushed to the campus to get the opinions of students. One said, "I don't feel safe without an extinguisher in the hall." Unfortunately, there was no one there to toss him one and say, "Show us how to use it." The answer might have been, "I can't read the directions. I took off my glasses to look better on TV."

We expect an untrained civilian in ordinary clothes (or less) to tackle a fire with a 1/8- inch stream--to send a firefighter that close; we provide thousands of dollars' worth of equipment. In today's fast-burning toxic plastic environment, the opportunity window to use an extinguisher effectively and safely is very narrow. Fire creates a deadly environment and the students should get away from it as fast as they can.

ARSON IS LEADING CAUSE

There have been a number of disastrous fires in college dormitories. The Federal Emergency Management Agency (FEMA) reports an estimated 1,700 dormitory fires occur each year. The most prevalent cause is arson, proven or suspected. Years ago, college administrators often refused to accept arson as the cause of such fires, feeling that such a crime was beneath the intellectual college community.

The Princeton Cyclotron fire in 1950 occurred in a pre-war "Model T" cyclotron. Carnegie Tech and Rochester were getting brand-new, up-to-date cyclotrons from the Atomic Energy Commission. A burned cyclotron would be replaced by a new model. The focusing magnets had been left on, a deviation from procedure, but this had been pronounced impossible. When I suggested arson, the magnets became the cause of the fire.

Nowadays, arson can be cited to excuse poor management, because of our national focus on the CAUSE OF THE FIRE instead of THE CAUSE OF THE DISASTER, WHICH OFTEN INVOLVES MANAGEMENT CULPABILITY.

TWO COLLEGE FIRES STAND OUT IN THE NUMBER OF DEATHS

Providence College, December 13, 1977, 2:47 A.M. the building was a high-rise dormitory of protected non-combustible construction, deficiencies were:

- Dead-end corridors.
- The design of the heating system. Room air returned to the corridor through louvers in the doors.
- No self, closers on doors.
- High-density (think Masonite) ceiling finish concealed above the suspended mineral tile ceiling.

The corridors and room partitions were masonry. The corridors were lined with Christmas decorations for a contest involving both rooms and corridors. Material included natural Christmas trees and paper on walls and ceilings. Masking tape was "rolled" to provide an attachment, which left about a half inch of air space behind the paper, thus accelerating combustion. Obviously the administration was totally unaware of the potential for deadly flame spread.

The fire started in a fourth-floor room occupied by three girls. They opened the window, thus providing, air which spread the fire to the corridor. Sadly, two of the girls jumped as fire apparatus arrived. The third stayed in the room and was rescued by ladder, uninjured.

When firefighters reached the fourth floor, the fire was almost out. The paper was mostly consumed. The fiberboard above the ceiling was not involved, probably there was not enough sustained heat and smoke to kill eight young women, frighten two into jumping to their deaths and injure several others.

The 60-plus-foot-long, one-way-out, dead-end corridor was involved in four of the deaths, though one girl who was injured made a run for the stairway early in the fire and survived.

I have checked with Battalion Chief Curt Varone of the Providence Fire Department and learned that the building is now sprinklered and the dead-end corridors situation corrected.

Cornell University Ithaca, NY, Nine Die in Dormitory Fire. The dormitory was a fire-resistive two-story and basement building. There was mush combustible plywood finish, furred out with wood strips, thus providing two fire surfaces. Combustible acoustical ceilings had been removed, but the hazard of the plywood was unrecognized.

At 4:00 A.M., 69 students were sleeping. The fire originated in the basement lounge (smoking?). The doors had been removed from the stairway on the second floor for shortening to accommodate carpeting, but the basement doors were wedged open. (The wedged-open door is a perennial problem. The only solution is the door held open by a magnetic latch that is tripped by smoke detectors on both sides of the doorway.) There was no alarm system.

The Cayuga Heights Volunteer Fire Department responded and on arrival requested mutual aid from the Ithaca Fire Department. (Automatic first-alarm mutual aid should be in place for any building that presents a major life hazard. I am unaware if it would have made a difference in this case.)

Nine victims died, all of asphyxiation. The professor who telephoned the alarm to university security was among the victims. The building had sprinkler system and Cornell adopted a proactive fire safety program. At FDIC, I spoke with a person close to the situation and it appears that the memory of the disaster has faded and the fire safety program greatly reduced.

THE CODE PROBLEM

It has been reported that the State of New Jersey has taken over the inspection authority of the South Orange Fire Department on the Seton Hall campus because the last inspection showed no problems. I know nothing of the details, but I will say that very often an inspection centers on violations of the CODE. Here I cite two instances of how inspecting to the CODE did not produce safety to the occupants.

Some years ago, we delivered a bright granddaughter to a major North Carolina university for a special summer program for gifted high school students. The dormitory hall ceiling was finished in combustible acoustical tile glued up to the surface. This is extremely hazardous--fire can spread faster than a person can run. Tall plastic rubbish containers in the halls were full to overflowing, providing ready fuel to ignite the ceiling. All the rooms had deadly transoms and most were open for ventilation. The stage was set for a terrible disaster.

Fortunately, outside fire escapes had been added to the building and the entrance to one was right opposite our granddaughter's room. I bought a smoke detector, installed it over the door on the corridor side, closing the transom in the process, and instructed the girls in the action to be taken if the alarm sounded: Head down, open the door running, hit the panic bar on the exit and keep going.

I immediately wrote a two-page letter to the university expressing my concerns. They were most appreciative and promised to take action. The following quote is most interesting, but unfortunately not surprising; "Our Safety Office has looked at the acoustical tile and agrees with your recommendation that it be replaced. In fact we hired an architectural firm to do an exhaustive study in 1973 of safety and BUILDING CODE deficiencies (caps supplied) in our dormitories and this item should have been picked up corrected at that time.

Here I can only surmise. Was the architectural firm ignorant of the flame-spread hazard? Based on my experience, very likely, particularly with respect to existing buildings. Or was "CODE" the key word?

"Grandfather" clauses that permit the continuing existence of, known hazards are common in codes. Essentially, they represent the thinking of those who put property rights above human rights. Retrospective safety requirements to existing buildings are not "unconstitutional," though building interests often make this argument to uninformed legislators. Professor Vincent Brannigan, JD, of the Fire Protection Engineering Department at UMD, will be happy to provide legal citations for you if this argument is used.

My children attended a parochial school lined with combustible tile. When I protested the principal triumphantly produced the last inspection report. The only deficiency noted was a cracked glass in the occupancy sign!

The fire marshal's idiotic bureaucratic defense was that they couldn't report anything that wasn't illegal! As is often the case, there was a RIGHT reason and a REAL reason. In fact, the reason was that the county school board had spent about $2 million putting in combustible tile and would be embarrassed if the county passed a law against it. They promised to take it out quietly during two summers if the fire marshal would not go for legislation. The tile was removed after the situation was brought to the archbishop.

If "grandfathered" hazards are a problem in your area, I urge that you add a section to your report; "The following conditions are hazardous, but not illegal because the code unfortunately refers only to new construction. For the safety of the occupants we urge that the following action be taken." Then let the management know informally that such a report would be fatal to their defense in the inevitable negligence lawsuits after a fire. Mere compliance with the code is no defense to negligence, particularly when the hazard has been pointed, out by competent authority. (I am a grandfather of 14. "Grandfathers" are kindly senior citizens who give their grandchildren candy and later help them go to college. I don't like the kindly word "grandfather" being used to describe maintaining conditions known to be safe.)

When sprinklers are recommended in existing buildings, the cost is often cited as prohibitive. Be sure to make the owner distinguish between the cost of sprinklers and the cost of hiding the system for aesthetic reasons. We want only the sprinklers. Aesthetics is his problem. Why not paint the pipes red and put up signs "You are incredibly safer from fire in this building because of the sprinkler system"?

The historic Hotel Colorado in Glenwood Springs, CO, was retrofitted with exposed sprinkler piping. I stood at the desk as scores of guests were registered. I heard no one say, "Honey, let's go to another hotel, this one has exposed sprinkler piping.

A SURVIVOR'S LETTER

A power full letter appeared on the Internet shortly after the Seton Hall Fatal fire. It is printed here verbatim with misspellings and Internet shorthand. I was heartened to see the evidence that it had been relayed to many other colleges. It would be worthwhile to get into the hands of every dormitory resident.

Note among other items that the writer's roommate was going to hide in the closet because she had heard that the administration was going to check on those who stayed in rooms. Firefighters know to look under beds and in closets for little children who don't know better. We had best include this practice in SOPs for dormitory fires.

She changed her clothes. Some years ago, I investigated a garden apartment fire; there had been a wild party. A woman's husband went to his car to sleep. Her boyfriend went to sleep on the couch. He awoke with couch in flames and jumped out over the balcony. The fire was alarmed by the tenant next door when the fire, which burned down through the floor, came up along side his bed. The wife and another woman went to closet to get suitable clothes. They were dead at the closet.

Hi everyone! I'm writing to you to tell you what happened at my dorm since some of you want to know the story.

It was 4:30 am and I was about to go to sleep. My roommate Becky was already sleeping. The fire alarm went off so I tried to wake her up. Although we never go out for them b/c we have so many fake ones, I had a feeling about this one b/c it was out of the blue. Also, we had a floor meeting a few days before and my RA said that they are going to check every room to make sure everyone goes out. I had to fight with Becky to go outside. She was saying that she was going to hide in the closet. Eventually she got up, went to the bathroom, and changed her clothes. When she was in the bathroom she looked outside to see if there were any people outside and she said there weren't so she wasn't going. I had to tell her off to get her outside. Finally, she was going to go so I played mommy making sure that she had her coat, gloves, shoes, and of course, cigarettes. Then I went to my friends, room across the hall and banged on their door, thinking they were already outside b/c I knew they were awake. Right before I was about to go outside, they opened the door. They were pretending to be sleeping. Then I told them off and told them to hurry up b/c it was real. Then I went to the next door and did the same thing.

When we were in the hallway of my floor about to go downstairs, we started to see a lot of gray smoke. I though it was just someone stupid who lit a smoke bomb. Then we walked down the stairs to the 3rd floor (I live on the 4th) and it was all black. I was in shock just standing there, looking at it, and breathing it in. That's when Becky became my mommy. She yelled at me to cover my face and to keep walking. The smoke was so heavy that I became lightheaded. I couldn't imagine actually being where the fire was; I probably would've passed out.

Finally we got outside and walked around to the front of the building. That's when it was the most, scary. There were a few girls hanging out of their window screaming for help with a huge cloud of black smoke behind them. Becky said, "let's get out of here whatever we see is going to be bad." There were no fire trucks here yet so we didn't know how long they would last. Finally one came and a huge crowd of people jumped in front of it pointing at the girls. They were going to go the other side of the building.

They yelled for anyone to help and a bunch of the guys ran to assist them. Eventually they got the girls out. Then we just stood outside for hours in the cold worrying if everyone was OK. While standing there, we talked to a kid who jumped out of his 3rd floor window. He was limping and his clothes were all ripped. Also kids, who got out early enough, ran across the street to some mans house and woke him up and he brought over a ladder, which saved dozens of kids

I was home for a week wearing only the clothes on my back. I had no money, no license, no make-up, nothing. I went home wearing slippers. Ironically, I had to bring everything to school because we are moving out of my house. Everything I owned was at school.

Now I just got back to school and things are very different. A lot of people moved out and the 3rd, 4th, and 5th floors north are in a hotel. It's not ever going to be the same. Luckily, none of my things are ruined. I actually think they cleaned up our room a little bit. I had a beer in the room, and it ended up hidden behind my bed and our window fan was out.

I just wanted to let you know to take fire alarms seriously! Even if it is just drill. On the news…I heard about a fire alarm in another dorm on campus going off and some girl from Seton Hall said that the fire alarm went off and she looked out the window, saw no fire trucks so went back to bed. Obviously, some people haven't learned, even when a real fire killed some people on her campus.

Thank you all for being so concerned. It means a lot.
Feel free to forward this to anyone who asks.

Lizzy

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3 KILLED IN FRATERNITY HOUSE FIRE

An early morning fire in a fraternity house near Bloomsburg University in Bloomsburg, PA, left three people dead on March 19. Three other people escaped the fast-moving fire, which broke out at 6 A.M. The two-story structure, located two blocks from the campus, collapsed before the three victims could be removed.

It was reported that the fraternity house had been cited for code violations in October. Most of them were corrected within a month. (In 1944 five people died in a fraternity house fire at the university)

Related recent incidents include:

- A two-alarm fire on March 6, ripped through an apartment complex near Duke University in Durham, NC, displacing dozens of students.
- On March 16, a student a Doane College, in Crete, NE was charged with arson after playing a prank by moving a smoldering couch into a dormitory where eight students were sleeping. The fire gutted one room.
- Three people were injured in a March 19 dormitory fire at Ferris State University in Big Rapids MI.
- A fire in a Boston College dormitory on March 24 injured six students, some of who were rescued by ladder.
- Two students at Drew University in Madison, NJ, were charged with setting four fires in campus dormitories on March 26.
- On April 3, a student at St. Joseph's College in Standish, ME was accused of setting fire to her dormitory room to divert suspicion regarding previous fires in the dormitory.
- A female student suffered burns over 65% of her body from an April 10 fire in a dormitory at the Massachusetts Institute of Technology in Cambridge, MA. Seven campus police officers were treated at a hospital after inhaling smoke and fumes from fire extinguishers.

Taken from:
Firehouse Magazine
May 2000

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OPERATION LIFE SAFETY

BY KATHLEEN GRANT
FIRST PLACE ESSAY IN AFSA
1998-99 NATIONAL SCHOLARSHIP
ESSAY CONTEST

Why Campus Housing Should Have Fire Sprinklers

It's time! All of the preparation, studying, and testing of high schools are now behind me. No longer will my parents be there to counsel and direct me. I am now a high school graduate and will head to college. I leave behind friends, family, and a level of security, which I have taken for granted. In my new world many decisions will be mine and mine alone. What to do, where *go*, who to see, and where I live will be a few of the choices that must be made in the near future.

The choice of a living space for my freshman year will be made by the college, however. They know what is best. They will provide me to provide me with a safe, and secure environment. They would not let harm come their way. Would they?

"Fire at East Campus Does Little Damage," reported *The Tech*, student newspaper of the Massachusetts Institute of Technology. "A trash receptacle under a chute caught fire when some flammable material was dropped down the chute. Not all of the smoke detectors went off, even when smoke was quite dense".

Fire causes $2,000 Damage in House P" stated *The Chronicle* of Duke University. A fire started in a student's room when the student left candles unattended, igniting a lampshade reported the Director of Public Safety.

"Freshman Suspected of Arson" blared, the headlines of the *Yale Daily News*. "The freshman laughed and took pictures, but the joke went too far when the couch shot up in flames and the students found nearby fire extinguishers ineffective."

Students who scored high enough on the SAT to be accepted by MIT, Duke, and Yale caused these fires. They must be bright, yet they committed stupid acts leading to the destruction of property and the risk of human life.

In each of these fires, while no loss of life occurred, lives were disrupted and the belongings of students in adjacent rooms were subjected to smoke and water damage. College students are living in a period of their lives when all of their possessions can fit in a single room. These students lived in college-supervised dormitories yet they found themselves displaced and without clothing, texts, and the few items which made their room their own.

The National Fire Protection Association reported on the fire in a Franklin, Massachusetts dormitory that the "building was successfully evacuated without loss of life or injury. The building, however, was a total loss." The dormitory had "an automatic fire alarm system with heat and smoke detectors." Yet the report gave "significant factors which contributed to the loss of property in this incident." Among those listed were "lack of an automatic sprinkler system, which would have controlled the fire in the early stages." In a second report of the NFPA, a fraternity fire at the University of North Carolina is investigated. Five occupants of the fraternity were killed and three were injured. While the building had "noncombustible interior finishes" and "battery powered smoke detectors were installed", a "significant contribution to the loss of life" was the "lack of automatic sprinkler protection." These fires were in college-supervised structures, yet the thoughtless actions of students brought about tragic results.

What can a college do to protect students from their own stupidity and that of their neighbors? Rutgers University has Fire Safety Regulations that lists the types of fire safety equipment (extinguishers, smoke alarms, manual pull stations, and heat detectors) and the items, which are prohibited in student living spaces. Space heaters, hot plates, candles, incense, and a variety of wall hangings are among those prohibited items. Common sense would dictate that these items and their use are unacceptable in a dormitory environment. Other items would appear to be less dangerous as they have received the Good Housekeeping Seal for general use by the public. These include Halogen lamps; extension cords exceeding six feet in length, and light dimmer switches. Other prohibited items could make the students studies more difficult. A chemistry major could justify the possession of magnesium ribbon and an art student's collection of paints and thinners may appear to be normal. Yet when these items are brought into a living environment, the safe handling and storage of these items is compromised. The university and its students accept some level of responsibility for reasonable behavior. Rules will be bent, and violations will occur.

While smoke detectors and alarms provide some warning, an immediate response to the flames within a confined space is necessary. A turnout time of three to five minutes by a local fire department is excessive when the fire is in room with less than two hundred square feet of living spare. "Fire sprinklers are widely recognized as the single most effective method for fighting the spread of fires in their early stages."

Sprinklers, in use for over 100 years, react to the temperature at the point of installation. They will only respond to their own environment, confining the application of water to the area of the fire. The NFPA reports that "damage in fires was 78% less in structures with sprinklers and there is no record of a fire killing more than two people in a completely sprinkler system building."

Given the immediate alert sprinklers provide, coupled with the reduced heat, smoke, and water damage, it is apparent that the best protection available is a fully sprinkler building coupled with smoke and heat detectors. College students represent what some believe are "the best and the brightest." They will, however behave, like the rest of the population, in a manner which involves risk. The security of the sprinkler head in dorm rooms will provide some measure of the sense of well being I left at home.

Taken from:
Operation Life Safety Newsletter
July/August 1999

UNIT 5:
COLLEGE DORMITORIES

TERMINAL OBJECTIVE

At the end of this unit students given a simulated major fire scenario, will be able to, coordinate, and control tactical resources and implement a plan of action based on critical cues, information gathered and critical elements presented during a dormitory incident.

ENABLING OBJECTIVES

The students will be able to:

1. *Identify critical building construction factors and special considerations at a dormitory.*
2. *Work as a team to command an incident at a simulated dormitory fire.*
3. *Conduct a group debriefing of the dormitory incident that follows a management plan.*

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DORMITORY ISSUES

Dormitories overload fire department resources by the nature of their construction and their occupancy loads. Students frequently add to the fuel load with room decorations and contribute to fire hazards with propped-opened doors and disabled smoke detectors. Early involvement of mutual-aid resources is required to be able to find and fight the fire as well as search the building. Preincident actions include heavy use of inspections to reduce hazards, and mutual-aid agreement updates.

Dormitory occupancies always have presented a large life hazard concern. Often fires in these occupancies are tragic and cause large property damage. One such fire took the lives of 10 students at Providence College, Providence, Rhode Island. Other recent serious fires have occurred at George Washington University in Washington, DC, Wesley College in Dover, Delaware, and Longwood College in Farmville, Virginia. Building construction features and lack of sound fire training programs led to the loss of life and large property damage during these fires.

These occupancies are found in a variety of building sizes and shapes. Dormitories are frequently constructed in a low-rise style with ordinary and mixed combustible construction components. However, newer construction often finds midrise and highrise buildings that have noncombustible construction components. Frequently, dormitory building construction may be a combination of both combustible and noncombustible materials.

School buildings designed for another type of occupancy often undergo extensive renovations and then are converted to a dormitory occupancy. These renovations often create concealed void spaces that permit the spread of fire and smoke. One very serious fire in a dormitory occupancy occurred in such a converted, renovated, building at the College of William and Mary in Williamsburg, Virginia, in a fully sprinklered building; it caused $4 million in damages.

Ordinary Construction Features

Ordinary construction describes a variety of buildings. The chief characteristic of this construction type is that the walls are of masonry and they often have wood-frame members. There is a limit to the height of a masonry building. The usual rule is that the solid masonry walls shall be 12 inches thick for the first 35 feet of height and increase in thickness 4 inches for each additional 35 feet or fraction in height. Masonry buildings rarely exceed six stories in height. The tallest old-style masonry building in the United States is 15 stories and is located in Chicago, Illinois. The flooring is wood joist with simple beams spanning from wall to wall. The joists usually run parallel to the street frontage of the building. The roof construction may be similar to the floor construction or may have a peak provided through the use of rafters or simple trusses.

Firefighting Problems in Ordinary Construction

Many masonry walls collapse during fires, while others do not. There are certain indicators of probable collapse. For example, if there is inherent structural instability this will be aggravated by the fire. With the collapse of a floor or roof, a masonry wall also may collapse because of the impact. In some cases, firefighting operations result in retained water and increase the load on a masonry wall; this then results in collapse. Masonry walls can be an effective barrier to the extension of fire to the next building if there are no void spaces through which the fire could travel. Void spaces, however, are inherent in ordinary construction and may be even more prevalent when alterations to the building have been made. In large buildings of ordinary construction, interior masonry walls may provide the interior load-carrying structure. Interior columns, girders, and beam systems provide stability during fire conditions. However, since the purpose of these systems was not to stop fire but merely to carry the interior floor loads, it is unusual to find such a wall through the attic space. The combustible attic may provide a path by which fire may pass over the top of the wall.

Noncombustible Construction Features

Noncombustible construction consists of steel (modern style) or concrete frame (old style) buildings commonly found in highrise (13 or more stories) and midrise (6 to 12 stories) buildings. Fire-resistive requirements include 3-hour columns, 2-hour girders and beams, 2-hour roofs, 2-hour floors, and 4-hour exterior walls.

Firefighting Problems in Noncombustible Construction (Midrise/Highrise)

In noncombustible construction each floor is divided into several small units, and partitions must go from floor to floor to be fully effective. If this is not the case and compartmentalization is not complete, fire can spread throughout the plenum areas. Open space around a core area of the structure also may spread fire. Open space areas found in midrise and highrise dormitories often are occupied as student lounge areas, game rooms, etc. Ground-level access normally is not a problem, but access to upper floors may be questionable because of limited use of elevators and required time to walk up the stairs.

Ventilation can be extremely difficult and time consuming. Understanding the heating, ventilating, and air conditioning (HVAC) system, stairwell configuration, and pressurization capability is extremely critical. During ventilation, consider the problems that falling glass may cause. The water supply may be dependent on a system built into the building. Systems may have been tampered with or vandalized.

Midrise and highrise construction present much greater demands on firefighting resources and require well defined standard operating procedures (SOP's). Consider firefighters' limitations because most fires will be labor intensive. There is a high potential for large life loss, and total evacuation may be difficult.

Mixed Construction Features

Mixed construction often consists of composites of older sections, which could possibly be frame or ordinary construction. They may be combined with newer sections of steel or concrete construction that contains more noncombustible components. The newer sections are often fire-resistive. Attaching a new section to an older section may compromise the newer building, particularly when the architect wishes to make the result look like one building.

Often, voids are created when additions are added to existing construction. Blind, covered-up stairwells or shaftways are common. An alert fire department can present a convincing analysis of the total fire problem and take steps to prevent large fire losses before they occur.

Firefighting problems in mixed construction are similar to those in ordinary construction. They include concealed void spaces, lack of compartmentalization, and common lofts or attics.

Life Safety/Fire Training/Fire Prevention Principles for Dormitories

Any delay when an emergency is known to exist should be thoroughly investigated and action taken to avoid the problem in the future. All students and Resident Assistants should fully understand the proper method for reporting an emergency. Fire evacuation drills should be held on a regular basis (monthly). At the beginning of the school year, students and Resident Assistants should be given instructions on the proper procedures to follow if a fire is discovered. Continual fire education sessions for students and Resident Assistants should be held periodically throughout the school year.

Room keys must be accessible. A lock box should be kept on each floor for access by that Resident Assistant and fire personnel during an emergency. If no lock box is installed at each floor, keys must be available at the main security desk at all times. All interior doors should be self-closing and exit doors should have panic hardware installed.

Sprinklers should be installed in all dormitory occupancies. Concealed spaces should be considered when sprinklers are installed. Smoke detectors should be installed and tested regularly. Local alarm systems should be checked and tested several times a year.

Students often contribute to the interior fire load. Fishnet decorations, blankets on ceilings, and large posters hanging on walls and windows are highly combustible interior decorations. Unannounced inspections will help prevent these practices. Changing fire safety attitudes is an ongoing challenge for all fire departments that have dormitories within their community. Changing the attitudes of students and college officials is an ongoing educational goal. Conducting fire incident simulations periodically will help raise the level of awareness for all students and school officials. It also will prepare the fire department members to be more cognizant of the potential problems that will face them during a true emergency at a dormitory occupancy.

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Activity 5.1

College Dormitory Simulation

Purpose

To practice command at an incident with high exposure risks and potentially serious community economic impact.

Overview

Occupancy is a five-story university dormitory building with the first floor partially underground. The building is of ordinary construction, 60' x 200'. The first-floor area is occupied as a locker storage area for students' personal belongings. The second, third, fourth, and fifth floors are occupied as student dormitory rooms. Each dormitory room and hallway has smoke detectors. The building is not sprinkled. Student occupancy is three students per room. Sixty students occupy each floor. There are three exit stairways located on Side A. A similar dormitory building connects on Side B. There are access doors between the two buildings on each floor.

Directions

1. As a group, you will staff positions within the Incident Command Structure of the Central City Fire Department (CCFD) for the exercise. All members of the CCFD Command Staff will arrive on the fireground simultaneously.

2. CCFD Incident Command Staff:

   a. Incident Commander (IC).

   b. Incident Commander Aide.*

   c. Operations Chief.

   d. Operations Aide.

   e. Planning Chief.

   f. Logistics Chief.

   g. Public Information Officer (PIO).

   h. Liaison Officer.

   i. Safety Officer.

*The IC Aide is not used unless there are nine students in a group. Some students may play multiple roles based on the Assignment Sheets. If there are ten in a group, a second Operations Aide will be designated.

3. All command decisions and actions during the simulation will be recorded on the ICS Forms. Entries on the ICS Forms are made in response to written or visual messages or in anticipation of problems that could surface during the incident.

4. At the conclusion of the simulation exercise, all groups will participate in a debriefing facilitated by the instructors. Your group will display both the ICS Forms developed during the exercise. Be prepared to explain the reasons for your decisions.

5. The following will be turned in to the instructors at the conclusion of the PIA. The Planning Section Chiefs will collect all of these from their groups, making sure that the group number and students' names are on the sheets.

    a. IC: Incident Objectives.

    b. The Planning Section Chief: Plan "B."

    c. The Safety Officer: Safety Message.

    d. Operations Aide: Actions Taken.

    e. Logistics: Resources.

    f. Liaison: Document Agencies Contacted.

    g. PIO: Press Release.

Activity 5.1 (cont'd)

Quick Access Prefire Plan

College Dormitory

Building Address:
240 30th St.

Building Description:
Five-story/ordinary construction 60' x 200' with two-story attachment in rear L-shaped design.

Roof Construction:
Ridgepole and rafter, 1" x 6" sheathing, slate roof gable with dormers.

Floor Construction:
Beam and joist, 1" x 6" sheathing, hardwood floors.

Occupancy Type:
College dormitory

Initial Resources Required:
First-alarm assignment

Hazards to Personnel:
First-floor storage lockers

Location of Water Supply:
Hydrant, 8-inch municipal system 300' apart

Available Flow:
1,200-gpm per hydrant

	Estimated Fire Flow*			
Level of Involvement	25%	50%	75%	100%
Estimated Fire Flow in gpm	250	500	750	1,000

**Fire flow based on common area (lobby and hallways) of 1,500 sq. ft. with 4 exposure floors.*

Fire Behavior Prediction:
Rescue, confinement, ventilation.

Predicted Strategies:
Rescue, confinement, extinguishment, ventilation, salvage.

Problems Anticipated:
60 students per occupied floor--3 students per room.

❑ **Standpipe:**
N/A

❑ **Sprinklers:**
N/A

❑ **Fire Detection:**

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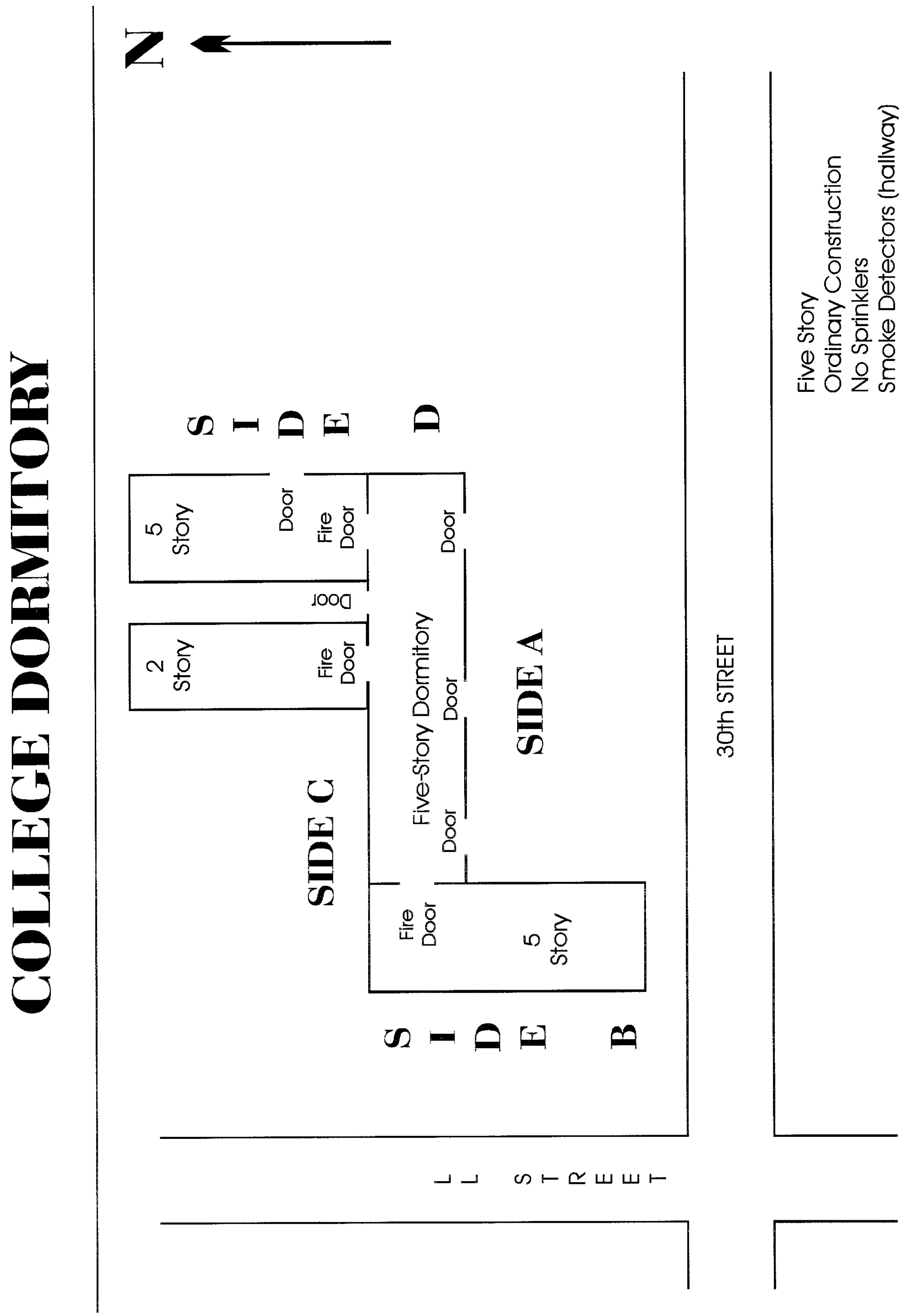
Activity 5.1 (cont'd)

College Dormitory Plot Plan



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POSTINCIDENT ANALYSIS (PIA)

Purpose

The purpose of a PIA is to identify and evaluate the elements of discovery listed below and use the evaluation to correct errors, identify procedures requiring change, validate and encourage positive actions, and enable a common understanding of all elements of the recent incident.

Guidelines

- Someone is in charge.
- The purpose is to improve future activities, not to place blame.
- Everyone must show courtesy and respect to one another.
- Not all participants must speak, but all should be permitted to.
- The activity is not a show-and-tell for each participant; the person in charge must ensure that this does not occur.
- Problems are either solved or assigned (important).
- Activity should be documented.

PIA Should Include

- positive actions taken;
- problems encountered; and
- resources.

Positive Actions Taken	Problems Encountered	Resources	
		Used	Unused
Early ventilation Aggressive initial attack, etc.	Access to rear of building Excessive radio traffic, etc.	K-12 saws, etc.	Aerial ladder, etc.

Format/Process

The PIA meeting should be held in a room large enough to accommodate the attendees comfortably. Small rooms and cramped conditions are not conducive to having people "open up." All supporting materials from the incident should be part of the presentation, e.g., actual incident resource status sheets, dispatch audiotapes, dispatch run cards, chronology of resources dispatched and arrival times, any videotapes, slides, or prints of the incident scene, and a easel pad, chalkboard, etc.

All personnel and, most importantly, upper-level management, must understand that discipline is not the purpose of a PIA meeting.

Based on the arrival sequence, each officer or crew leader describes what was seen, what orders were given and received, and what actions were taken. Continue until all the important incident factors have been discussed. This process allows each individual to reflect on his/her own decisions and actions. Without accusing anyone, personnel will see where there was a problem, what the probable remedies are, and what needs to be done on future incidents.

Activity 5.2

Postincident Analysis/Dormitory Debriefing

Purpose

To prepare you to use the PIA method in actual incident or major exercise critiques.

Directions

1. You will be divided into four groups.

2. Each group will identify the elements of discovery and list them on a easel pad.

    a. Positive actions taken.

    b. Problems encountered.

    c. Resources used/unused.

3. A spokesperson from each group will report on the elements of discovery for that group.

4. These are the actions to be taken regarding each element of discovery (i.e., identify corrective action, recognize the effectiveness of an action, assign someone to develop a solution to a problem identified, etc.).

UNIT 6: DOCUMENTATION AND RESOURCE MANAGEMENT

TERMINAL OBJECTIVE

At the end of this unit, students will be able to apply the appropriate techniques to document incidents.

ENABLING OBJECTIVES

The students will be able to:

1. *Determine the types of information and reports needed to adequately document incidents.*

2. *Analyze a hazardous material (haz mat) case study to examine incident management and documentation needs.*

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DOCUMENTATION

Writing and reporting what happens at an incident for later reference is important so that you do not have to rely on your memory to prove what happened. Your concise written report would document the facts for you 3 years later, which is the normal period for the filing of lawsuits. One out of 300,000 incidents actually develops an exposure to liability and leads to a lawsuit. Document what will be required in detailed reports, including serious injuries, firefighter deaths, and major losses. Include witnesses interviewed, photos of incident activities, and your personal notes or tapes. Detailed reports mitigate future liability problems associated with target hazards and their complexity.

Insurance companies need fire reports that reflect incident decisions based on department policies and reflect the need for that action based on inputs and cues. Write a precise report if you anticipate that you will be questioned in the future. The report must be consistent with other documentation. For instance, do your report times match the times on your recorded dispatch tapes? Include answers to who, why, what, where, when, how, and how many. Witnesses can provide a statement at the scene that can be included in your report. Other information to include would be photos, tapes, audiotapes of notes, and videotapes of what happened.

If your department uses the Uniform Fire Incident Reporting System (UFIRS), all personnel should be familiar with the forms and the information required to complete reports. If local reports are used in lieu of UFIRS reports, the appropriate local form should be used and filled out completely.

The civilian casualty report is different when UFIRS is used. The civilian report is yellow and not as detailed as the firefighter casualty report. Firefighter/Responder casualty reports are usually blue and are much more detailed in terms of content and the circumstances of the injury or death.

Finance/Administration

Finance/Administration is responsible for documenting the following:

Equipment Type and Use

- damaged equipment, numbers of units; and
- air bottles, sections of hose, etc.

Personnel

- Actual number of personnel needed; numbers may fluctuate.

- Shift change can alter the numbers, so accuracy is necessary to reflect the target hazard need.

Hours

- Arrival times and return-to-service times normally reflect the actual time spent at the incident.

- Company size may vary from station to station. Take all variables into consideration.

Incident Information

Incident information that requires documentation:

- Areas actually involved in the incident, as well as exposures that may have been affected.

- Staging location for various resources.

- Company assignments are excellent references back to the operation during a Postincident Analysis (PIA).

- Response and arrival times, as well as return-to-service times, are all important references.

There are valuable informative cues on the UFIRS forms:

- type of incident;
- type of action found;
- type of building complex; and
- extent of damage.

Activity 6.1

Case Study: Hazardous Materials Processing Plant Incident

Purpose

To identify the critical cues in Command decision making.

Directions

1. Read the case study material that discusses the haz mat incident (TR-027).

2. Note key issues to the following Incident Command System (ICS) positions and operations during your reading.

3. Answer the questions posed for the ICS function that you are playing in the Hazardous Materials Processing Plant Incident. You have 20 minutes to complete your work. (Use 40 minutes to "report out.")

4. Discuss how this incident should be documented.

Command

Determine the second incident's objectives and determine the strategies for the incident.

a. **Incident objectives**

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b. **Strategies**

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Operations

a. What are the appropriate tactical operations you would select for the second incident?

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b. What is your ICS organization for the Operations Section? Provide for an Operations Section Chief and whatever Branches are needed. Draw the ICS organization for the Operations Section.

Planning

Understand the present Plan "A" and develop a Plan "B" for a worsening situation. Describe your Plan "B."

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Logistics

What functions in the Logistics Section would you need to provide as the Logistics Section Chief at the second fire incident? Draw the ICS organization for the Logistics Section.

Safety

a. Write a general Safety Plan for the second fire incident.

b. Does there have to be an Assistant Safety Officer--Hazardous Materials (ASO-HM) at this incident?

Liaison

a. Where would you establish a Liaison Area for all outside agency representatives?

b. What outside agencies would you expect to interface with?

Information

a. Where would you establish an Information Area?

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____

b. How often would you provide information to the media?

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Activity 6.1 (cont'd)

Case Study

Swimming Pool Chemical Plant Fire
Springfield, Massachusetts
Springfield Fire Department
605 Worthington Street
Springfield, MA 01106

OVERVIEW

One of the most challenging problems facing the fire service today is the combined fire and hazardous/toxic chemical incident. Decisions have to be made regarding the timing of fire fighting activities with respect to evacuation priorities. In many cases, a decision must be made as to whether or not to fight the fire at all. Where the chemicals or products involved are water reactive, fighting the fire may make matters worse, endangering the firefighters or the general population. Just such a situation presented itself to Chief Raymond Sullivan of the Springfield, Massachusetts Fire Department and the city's hazardous materials incident response team on Friday, June 17, 1988.

The incident occurred in that part of an 87-year-old industrial building housing a company that produced water treatment chemicals for swimming pools. Rain leakage wetted chemicals that released chlorine along with sufficient heat to cause ignition of ordinary combustibles. In the course of the incident, large amounts of chlorine gas were released, triggering several levels of evacuation involving more than 6,000 people. The fire resulted in the collapse of a portion of the roof. The fire and corrosive action of the chlorine gas resulted in almost complete loss of the contents of both floors and caused significant structural damage prompting razing of the second floor. At the time this report was written it was not known whether the building would be reoccupied.

SUMMARY OF KEY ISSUES

Issues	Comments
Cause of Fires	First fire--Rain leaking in mixed with chlorine chemical compounds, releasing heat. Second fire--Lack of complete protection of the premises from weather after first fire allowed rainwater in, which started the second fire.

Evacuations	Gaseous chlorine generated by mixing chemicals with water and from products of combustion required several levels of evacuation as incident progressed. Approximately 6,000 people were evacuated.
Firefighter Protective Equipment	City found itself short of self-contained breathing apparatus for an incident of this magnitude, for both firefighters and police. Consideration is being given to providing cartridge-type masks for police and other emergency personnel.
Sprinkler System	Building was sprinklered, but part of the system had been disconnected because of the presence of water-reactive chemicals. The part of the sprinkler system remaining in service did operate, but was shut down by FD in attempt to reduce production of chlorine gas.
Incident Command	Dual problem: Hazardous Materials incident and fire with Hazardous Materials properties. Size of incident was large relative to forces available. In the second incident, mixed scientific advice was received on whether to flood the building or not apply water at all, causing delay in action. In retrospect, permitting the sprinkler system to continue operating supplemented with copious quantities of water is most likely the best option for such an incident.
Duration of Incident	Lasted 4 days; FD remained on scene for cleanup operations for 27 days. Eleven of the city's 13 companies was involved.
Firefighting Agents	6 million gallons of water and 65 tons of neutralizing agents were required to treat the chemicals before removal. Soda ash used successfully in first fire. In second fire, due to presence of water, soda ash used but ineffective.

Cost of Incident	$2 million loss to building and contents; $500,000 cost to fire department includes overtime and actual and anticipated damage to equipment from chlorine exposure; $700,000 other costs to city.

During the incident, which lasted 31 days, 11 of the city's 13 engine companies were involved and over six million gallons of water used to extinguish the fire and to wet down the scene sufficiently for the chemicals to be removed and neutralized. It is estimated that 65 tons of neutralizing chemicals were employed.

Over 100 buses and 35 ambulances participated in the evacuation of the areas affected by the chlorine. Forty firefighters and approximately 275 civilians were treated for chlorine exposure at local hospitals and released. Principal means of exposure to firefighters was inhalation while changing breathing apparatus. Some firefighters received chemical exposed skin and through turnout gear, especially when perspiring.

$2 million loss to building and contents; $500,000 cost to fire department includes overtime and actual and anticipated damage to equipment from chlorine exposure; $700,000 other costs to city.

THE BUILDING

The two-story brick building at 1 Allen Street was built in two sections. The first section was built as an armory in 1858. A second section added in 1901 and paralleled Allen Street was the location of the incident. This "newer" section was constructed of brick and cast iron. Its floors were brick arches supported on cast iron beams, with a concrete cover on top overlayed with heavy wood plank. In the interior of the building, the floors were supported by cast iron columns. The slate roof was placed on wood purlins supported by cast iron truss work.

The occupant of the area in which the incident occurred was Advanced Laboratories, Inc., manufacturers of tablets for chlorination of swimming pools. They occupied the first and second floors of the newer section of the building.

The "chlorine" tablets were produced by mixing raw materials including trichloro-S-triazinctrione known as TCT (trichloroisocyanuric acid) in a mechanical blender and pressing the resulting mixture into tablets. When TCT is exposed to water, heat is released. In the presence of heat, TCT will break down to form chlorine gas. An intermediate product of TCT breakdown is nitrogen chloride, which presents a severe explosion hazard when heated or exposed to shock.

Two types of tablets were produced by Advanced Laboratories--a "quick" tab that was a blend of TCT and soda ash with other chemicals, and a "slow" tab that did not contain soda ash. TCT blended with alkaline materials such as soda ash is subject to more rapid decomposition in the presence of water than TCT alone and produces temperatures sufficiently high to ignite paper products or wood.

Mixing was accomplished on the second floor where the raw materials were stored. Three blenders were in use, two for the Quick Tab product and one for Slow Tab blend. The mixing area on the second floor was called the "Blending Room." The blended mixture was discharged into chutes leading down to the tablet presses (one for each blender) on the first floor in the "Tab Room."

A pneumatic dust collection system was employed to recover products from the blender and discharge areas on the second floor. The dust was deposited in a collection bin on the second floor. Recovered dust and reground broken or defective tablets were saved to be added later, in small amounts, to new batches of raw ingredients in the blenders. This recycled material, called "remix," was stored in paper drums against the (east) wall.

In addition to the remix, approximately 1,000 polyethylene lined paper drums of pure TCT, each weighing 300 pounds, were stored two to three pallets high on the (east and west) sides of the second floor.

The building was equipped with a dry pipe automatic sprinkler system. On the second floor, however, the sprinkler piping had been disconnected by the occupants in the area where the chemicals were mixed. The first floor also had a partial sprinkler system.

THE FIRST FIRE

At 0959, Springfield Fire Alarm was notified of a fire in the dust collection system at Advanced Laboratories. The Department had previously responded to small fires at this company involving floor sweepings in a dumpster.

Arriving firefighters went to the second floor and attacked a small fire in the dust collection duct with soda ash (sodium carbonate) as called for in the most recent Fire Department prefire plan (March 1987). The use of soda ash to quench the reaction was reported to be the employee practice at Advanced Laboratories. This procedure was effective so long as no moisture was present. (As noted earlier, soda ash speeds the decomposition reaction in the presence of water.) Flames were noted in the dust collector. In order to reduce the high level of chlorine fumes in the Blending Room area, doors were opened and windows opened or broken out.

At about 1015, the Command Post vehicle arrived and was set up. After surveying the conditions and the spread of chlorine gas odor, orders were given to evacuate the schools in the area. Residents were warned to stay inside with the windows closed and to leave if they smelled chlorine.

The school evacuation was initially carried out in the downwind direction for about half a mile. Schools on the perimeter were also evacuated and the students moved to other schools.

Fire fighting continued employing soda ash and at 1129 hours the fire was out. Hot dust had been removed from the ducts and the dust collector, mixed with soda ash, placed in drums and disposed of in the alley. The fire and chlorine release were considered under control at 1148. At this time the evacuation order was rescinded. People were allowed to return home and the School Board was notified. The Fire Department remained on the scene until approximately 1515 to 1530. During this time period, the Advanced Laboratories foreman and the employees were engaged in cleaning up the debris and boarding *over* the windows that had been broken to ventilate the chlorine fumes.

The cause of this first fire was most likely rainwater blowing in under the sliding door at the south end of the building and entering the dust collection duct.

In post-fire interviews with employees, the Fire Department was told that the windows on the east wall in the vicinity of the remix and dust storage were not boarded over. This was reportedly due to the difficulty in reaching the windows over the pallets of TCT drums. It was also reported that in the past, a number of dust and remix drums had split or been broken discharging their contents into inaccessible areas under the pallets where the material could not be cleaned up. The foreman was reported to have left the building at approximately 1615.

THE SECOND FIRE

Weather records indicate that at approximately 1700 hours there was a light rainfall in the area driving rain against the east wall that contained the open windows. At 2254, a police patrol reported "smoke" coming from the second floor of Advanced Laboratories in the area of the blending room. At 2256, the first arriving firefighters on the second floor reported seeing orange flames in the TCT drum storage area and applied soda ash with some success, reducing the fire to intermittent flareups. After approximately 10 minutes, the chlorine levels were so severe that the firefighters had to leave the building.

The Command Post had been activated at 2300 hours. At 2316, shortly after the firefighters were driven from the building, the second alarm was sounded.

The dry pipe automatic sprinkler system operated at 2317, most likely controlling the fire, but discharging water over the stored TCT and remix materials. After about 20 minutes of operation, water supply to the system was cut off in the street because of concern that the water would do more harm than good among the water reactive chemicals.

Evacuation of the area began for the second time that day at 2320, when local residents were again asked to leave.

Throughout Friday night, sounds were heard attributed to rupturing barrels on the second floor. Although no flaming was noted, chlorine gas and hydrochloric acid fumes continued to be released in large quantities from the building.

Early Saturday, June 18, conditions improved and the evacuation was called off at 0400 hours. At 0550, personnel from Clean Harbors, a contract hazardous waste disposal company retained by the State of Massachusetts, arrived on the scene. At this point, most areas of the city were reportedly clear of chlorine odor.

By 0900 hours, Fire Department and Clean Harbors personnel in Hazardous Materials entry suits were engaged in attempting to remove drums of reacting material from the second floor and releasing the blended mixture from two hoppers. At 0940, another local evacuation was initiated. By approximately 1000 hours, conditions began to worsen again and by 1100 hours orders were given to clear the building and the evacuation was expanded again. The perimeter was established by roving police and Fire Department vehicles, and the decision to expand or contract the evacuation zone was based on the presence or absence of the chlorine odor (chlorine can be detected by smell at a level about one tenth of the danger level). At its greatest extent, the evacuation zone was approximately 6 to 7 miles long and 1-1/2 miles wide.

At 1220, one of the drums "blew," pushing a firefighter back, and all personnel left the building. Around 1900 hours, the fire began developing on the second floor and flames appeared on the first floor. Water was discharged on the first floor fire at 1915. As the fire continued to grow, the City Solicitor gave the authority to forcibly evacuate the area and preparations were made to attack the fire and flood the building with as much water as possible in order to minimize heating of the TCT. This was the procedure recommended by the Material Safety Data Sheet (MSDS) and CHEMTREC.

A portion of the roof collapsed near the center of the building at 2200 hours, and the fire extinguishment and flooding operations continued throughout the night.

By shortly after 0500 hours on Sunday, June 19, the chlorine conditions were improving once more and the fire was nearly under control. Clean Harbors prepared a powder mixture of sodium sulfate and boric acid to be used in neutralizing the TCT, allowing its clean up and disposal.

During Sunday, areas affected by the chlorine were checked and if found to be clear, people were allowed to return.

All hoselines were shut down at 0619 Monday morning. By 1230, Clean Harbors had spread the neutralizing powder throughout the building. Checks were made of schools and other facilities by the federal and state Environmental Protection Agencies during the day as removal of the chemical debris from the building was underway.

At 1840 Monday, after almost four days, "Recall" was sounded for the second fire and Hazardous Materials incident. Some Fire Department apparatus and personnel stood by at the scene during final clean up for an additional 27 days, until July 17, 1988.

The remaining chemical sludge was removed by Clean Harbors and placed in 10 above-ground swimming pools. After neutralization in the pools, the water, now chlorinated, was disposed of in the city storm sewer system. The second fire was determined to have originated within the remix storage area. The cause was thought to most likely have been water from rain storms following the first fire entering through the open windows on the east wall.

DECISION ON WHETHER OR NOT TO FIGHT THE FIRE

In dealing with Hazardous Materials incidents, the incident commander must rely heavily on information from published sources and available experts. Many resources are available to assist command officers in making these tough decisions. Included are manuals, such as NFPA 49 Hazardous Chemicals Data, the United States Coast Guard's Chemical Hazard Response Information System Manual (CHRIS) Volume II and Sax's Dangerous Properties of Industrial Materials, industry "hot lines" such as CHEMTREC, and computerized Hazardous Materials information systems such as CAMEO. Frequently, "experts" from nearby industry also will be available to assist. In some instances, however, the various sources will provide incomplete data or conflicting instructions, and the information provided may not fit exactly with the situation at hand. Nevertheless, the command officer must sift through the available information, suggested procedures, expert advice, and past experience and develop a strategy to minimize the effects of both the fire and hazardous materials aspects of the incident. To further complicate matters, as the incident develops the initial strategies may have to be altered rapidly to react to changing conditions.

Chief Sullivan and the Springfield Hazardous Materials Response Team had literature available to them, including NFPA 49, Sax, CHRIS, and the Material Safety Data Sheet for TCT.

Additional guidance was obtained from the Chlorine Institute (prior to the fire), CHEM-NET, CHEMTREC, and even a phone call from a chemist who learned of the incident on cable television. In addition, the local Monsanto plant that is a participant in Springfield's Hazardous Materials response planning had a representative on the scene to advise. Based on all were available information the following choices were available:

- Let the reaction run its course.
- Fight the fire using large volumes of water.

In the first choice, evacuation of the area would be carried out and attempts made to control the fire with soda ash, as had been done in the first fire incident. One advisor had suggested that the reaction might last two to three days if left alone.

In the second choice, the scope of the evacuation might to be quickly increased in the event that the fire streams released additional chlorine. Once the fire was out, the chlorine would be controlled chemically.

Many factors relating to the actual incident conditions need to be considered when selecting an option or seeking others in a situation such as this. These factors include:

- Presence or absence of fire.
- Size and growth rate of the fire.
- Location of the fire.
- Need to minimize injury to public.
- Need to minimize fire loss.
- Fire control resources available.

- Present amount of chlorine being produced.
- Effect of fire fighting on chlorine.
- Wind direction and speed.
- Status of evacuation.
- Hazardous material control resources.

Taking the above into consideration, Chief Sullivan first treated the incident as a minor fire in which soda ash was applied. The area was evacuated. During Friday night, the chlorine conditions varied. By early Saturday, conditions were clear, and the evacuation order was rescinded. By early Saturday evening, however, the Chief was faced with a significant fire . In addition, not only was more chlorine being generated, but the plume of hot gases from the fire could aid in the spread of the gases throughout the community. At this time, aggressive fire fighting with large amounts of water was initiated.

LESSON LEARNED

1. Managing combined fire and Hazardous Materials incidents often requires access to in-depth technical expertise. The chief needs the best possible technical information, but still may have to make a decision in the face of conflicting expert opinion. The incident commander needs to quickly gather all the relevant information regarding the chemicals involved, the properties of their decomposition products, the danger of explosion, and the danger of toxic byproducts.

   In addition to the literature and "hot lines," efforts should be made to contact industry experts directly. Do not expect strong positive recommendations from "hot lines." They usually can't and won't do more than offer options. And the technical experts and sources may disagree. The Hazardous Materials incident control options must be evaluated in light of the incident conditions before decisions are made. This remains a major problem for today's chiefs.

   A recently released (1989) set of guidelines for handling chlorinated pool chemicals is now available. Produced by Monsanto, Olin, and PPG, manufacturers of the chlorine compounds used in these products, the guidelines address hazards, storage, processing, protective equipment, emergency procedures, and other safety related aspects. A list of emergency telephone numbers is also included.

   The guidelines recommend that if "there are any signs of fire, the building should be evacuated and the fire department called immediately, even if the building has a sprinkler system. In extinguishing a fire, copious amounts of water should be used. Do not use dry powder extinguishers."

2. Hazardous Materials incident response planning makes a difference. The value of a hazardous materials incident response organization was proven again. This incident had excellent interdepartmental cooperation. This was largely due to the fact that the major actors in dealing with Springfield's Hazardous Materials incidents had met regularly for planning sessions and table top incident exercises. In fact, 1 Allen Street was the subject of a chlorine leak exercise prior to the incident. Participants in this group included the Fire, Police, Health, and Public Works Departments; Emergency Medical Services; and a representative of the local Monsanto facility. Other groups were the Red Cross, the School Board, area hospitals, and the Springfield Civic Center.

   The Command Post vehicle was a project that evolved from this Hazardous Materials response group. The truck was donated by Coca Cola, and Monsanto split the cost of equipment for the Command Post with the city of Springfield.

3. There may be "hidden" costs to the fire department associated with a Hazardous Materials incident involving corrosives such as chlorine. After the Allen Street incident, the Springfield Fire Department rebuilt and tested all regulators on their breathing apparatus as a precaution. In addition to thorough steam cleaning, the oil and oil filter were changed on all exposed vehicles. Even with washing and treatment, the life of fire hose and turnout gear is expected to be reduced. All exposed fire hose had to be tested. Electrical and electronic equipment needed cleaning and overhauling. The Department already has replaced two generators that failed after being used at Allen Street. Overtime was paid as well as "stand-by" time for mutual aid companies. It has been estimated that cost to the Springfield Fire Department will exceed $500,000.

4. Evacuation plans should incorporate clearly defined zone boundaries. Although the evacuations went well, they would have been easier and less complicated if evacuation zones had been established citywide prior to the incident. It was suggested that street maps showing the boundaries of the zones should be placed in police patrol cars. Planned use of public transportation buses for the evacuation proved to be highly successful.

5. Multiple channel radio communications are essential in an evacuation situation. The greatest communications problem in the incident was the limitation of fire department radio channels. The current system has only one channel. The city had previously addressed this problem but new equipment had not yet been installed. Cellular phones proved to be extremely helpful as did the services of amateur radio operators. The Command Post was also equipped with radios on the bus frequency. Having direct communication with the buses not only helped coordinate the evacuations but provided an additional means for obtaining chlorine condition reports.

6. It was useful to have the City Attorney on the Hazardous Materials team and available at the incident. The city attorney can provide valuable advice in such matters as evacuation authority, issuing of evacuation orders, arrests, and city liability.

In summary, the Allen Street incident points out the problems of dealing with hazardous material information as well as the importance of planning and inter-departmental cooperation before the incident. The value of communications and the need for legal assistance were also pointed out. It is hoped that the lessons described above can be applied by others in order to learn from Springfield's experience.

POSTSCRIPT--CHLORINE PLANT FIRE IN GLENDALE, ARIZONA

Following the Springfield fire, a fire in a Glendale, Arizona warehouse storing similar swimming pool chemicals totally destroyed the building on August 21, 1988. Rainstorms had moved through the area shortly before the fire. On arrival, the building was well involved in fire. Heavy red-brown smoke, probably due to nitrogen-trichloride, was issuing from the building, and explosions could be heard inside the structure. The warehouse was fully sprinklered, but it is possible that the sprinkler piping may have been damaged, since only a slight amount of water was coming from the water motor gong. Eventually, the roof collapsed. Extinguishment was accomplished through an external attack. Approximately 200-300 people were evacuated from the area. (For more information, contact Lt. Greg Victor, Glendale Fire Department, 7505 North 55th Avenue, Glendale, AZ 85301, (602) 931-5614.)

Even though the cause is officially listed as undetermined, review of the circumstances of the Springfield fires suggested rain leakage as a possible cause scenario for the Glendale fire. The most likely explanation of the red-brown smoke was the presence of nitrogen oxides that were released along with chlorine when trichloroisocyanuric acid breaks down in reaction to heat.

UNIT 7: PENAL INSTITUTIONS

TERMINAL OBJECTIVE

At the end of this unit students given a simulated major fire scenario, will be able to, coordinate, and control tactical resources and implement a plan of action based on critical cues, information gathered and critical elements presented during an incident involving correctional facilities.

ENABLING OBJECTIVES

The students will be able to:

1. *Identify critical building construction factors and special considerations at a penal institution.*

2. *Perform the Incident Management Team (IMT) roles assigned in order to effectively manage a penal institution incident.*

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PENAL INSTITUTIONS

The strategies for addressing incidents in penal institutions not only require technical advice, but cannot be implemented without multiagency involvement. The construction methods used in jails and prisons inhibit strategies that could be used in lighter construction methods.

Penal institutions often are built of steel-reinforced concrete with larger diameter reinforcement bars, roll bars (bar within a tube) on windows, and Lexan™ window glazing. The roof is often bar-joist, steel-truss supports with a poured concrete deck. There are interlocking double-entry door systems controlled from a command room with video monitoring. These institutions may be located in high-density areas close to the courthouse for the city and county, or in rural areas (generally state and Federal facilities). Fire protection may include sprinklers and compartmentalized construction. Typically, sprinklers are in newer areas with tamper-resistant heads, in highrise sections, pods, and work areas such as the laundry, kitchen, or shops.

Many communities have local penal facilities that vary in age and construction methodology. Small communities may have buildings of Type V--Frame Construction or Type II--Noncombustible Construction. In smaller communities, the inmate population is usually small in number.

Counties across America often have detention centers. These are often Type II--Noncombustible or Type I--Fire Resistive structures of one- to three-stories. These facilities often have an inmate population of 300 to 1,000.

State and Federal penal facilities were often located in rural areas, many of which are now well-populated regions. Many of the inmates in these facilities have a violent nature and pose a greater degree of concern for emergency response and correctional personnel.

Incident Considerations

Response will develop slowly, as with any incident. Command considerations will evolve in a way similar to a hazardous materials incident. There is a large life load with average-to-low fire load. This may require a larger than normal initial response.

There are three types of confinement of inmates defined for this course. They are first-, second-, and third-generation.

- **First-generation confinement** involves indirect, intermittent supervision. These penal institutions contain bars and corridors. Guards view prisoners only periodically. Inmates are isolated within a cell-block. There is wide-spread use of cameras and audio receivers. This is often called maximum security.

- **Second-generation confinement** involves indirect supervision, there is little contact between the guards and the prisoners. These penal institutions contain Plexiglas™ by which the guards are separated from the inmates. This is often called medium security.

- **Third-generation confinement** involves direct supervision; there are guards within the units. Interpersonal skills are required of the guards in interaction with inmates. This is often called minimum security.

Incident Potential

All types of occupancies are included in a penal institution:

- kitchen;
- cooking facilities;
- dining hall;
- laundry, including chemicals for cleaning, and drying equipment;
- vocational shops--machinery and related equipment;
- repair shops with tools and equipment;
- warehouse--property room or area for guards and inmates; and
- public assembly with open pods and visitor areas.

All of these facilities within the penal institution pose a hazard for fire. There are large amounts of Class "A", as well as, Class "B", and Class "C" combustibles. It is necessary to point out that many prison riots have been initiated by inmates and many fires have been set in anything that would combust.

Evacuation Concerns

Evacuation concerns are affected by the overriding need to maintain security. Emergency keys may or may not be made available, depending on the philosophy of the responsible personnel at the institution. These concerns make it imperative that an evacuation plan be developed and coordinated between the fire department and the administrator of the institution. This should provide for access to secure areas and ensure the safety of all--correctional employees, responding personnel, inmates, and related occupants--at the time of the incident and during the duration of the incident.

Preplan information must include location of Command Post (CP) for Unified Command, types of fire alarms/sprinklers, locations of fire flow valves and equipment, locations of guards' air packs and related equipment, extent of fire protection equipment (sprinklers, standpipe connections, etc.), evacuation and fire and emergency plans of the institution, and building floor/plot plan.

Penal Institution Emergency Operations Plan (EOP)

Many penal institutions have a well-developed EOP for all types of contingencies. These include:

- riots;
- fires;
- power outages;
- lock-downs;
- transfer of inmates, both internally and externally;
- call-back of corrections personnel;
- utilization of outside police agencies; and
- contracts for buses, etc.

Authority of the Warden

The warden is incharge of all operations within the facility to include handling of the inmates. The warden, or a deputy, must be part of the Unified Command structure.

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Activity 7.1

Penal Institution Simulation

Purpose

To practice Command of a high-life-hazard incident in a restricted-access environment.

Directions

1. As a group, you will staff positions within the Incident Command Structure of the Central City Fire Department (CCFD) for the exercise. All members of the CCFD Command Staff will arrive on the incident simultaneously. CCFD Incident Command Staff:

   a. Incident Commander (IC).

   b. IC Aide.*

   c. Operations Chief.

   d. Operations Aide.

   e. Planning Chief.

   f. Logistics Chief.

   g. Public Information Officer (PIO).

   h. Liaison Officer.

   i. Safety Officer.

   *The IC Aide is not used unless there are nine students in a group. Some students may play multiple roles based on the Assignment Sheets. If there are ten in a group, a second Operations Aide will be designated.

2. All command decisions and actions during the simulation will be recorded on the ICS Forms. Entries on the ICS Forms are made in response to written or visual messages or in anticipation of problems that could surface during the incident.

3. The incident occurs in a county penal facility. Approximately 400 prisoners live in 4 dormitory-room pods clustered around a central hall. The five-story building was constructed in the early 1990's to the rear of the county courthouse.

The jail security area begins on the second floor and continues up to the fifth floor. Prisoners live in individual dormitory-style rooms, located around the outer wall of the pod, with sealed windows. Roll bars secure the interior of each window; Lexan™-type glazing is used in all window openings. Solid metal doors are fitted into each door opening; each room door includes a secure window. Dormitory rooms are located on the third through fifth floors. The second floor houses the infirmary, property rooms, processing area, and staff offices. The pod area is open from the second to fifth floors.

A five-level parking garage is connected to the jail and courthouse on the west side of the complex. Courthouse staff numbers about 250 during business hours; about 50 to 100 visitors can be in the courthouse building under normal circumstances. A single, unsecured corridor on the first floor serves all three parts of the complex. The basement area of the prison houses the service areas, including kitchen, laundry facilities, and storage.

Personnel entry into the secure prison areas is through a double locking compartment, remotely controlled from a monitoring station. Television cameras scan all areas of the prison. Fire department equipment access is available through a loading area on the basement level between the pods on the north and south sides of the complex. Equipment is transported to the upper floor on secure elevators or via locked stairwells. No access is available from the first floor.

4. At the conclusion of the simulation exercise, all groups will participate in a debriefing facilitated by the instructors. Your group will display both the ICS Forms developed during the exercise. Be prepared to explain the reasons for your decisions.

5. The following will be turned in to the instructors at the conclusion of the PIA. The Planning Section Chiefs will collect all of these from their groups, making sure that the group number and students' names are on the sheets.

   a. IC: Incident Objectives.

   b. The Planning Section Chief: Plan "B."

   c. The Safety Officer: Safety Message.

   d. Operations Aide: Actions Taken.

   e. Logistics: Resources.

   f. Liaison: Document agencies contacted.

   g. PIO: Press Release.

Activity 7.1 (cont'd)

Quick Access Prefire Plan

Penal Institution

Building Address:
501 Central Ave.

Building Description:
Five-story noncombustible construction 350' x 1,000'

Roof Construction:
Steel bar joist, metal decking, concrete, asphalt covering

Floor Construction:
Steel bar joist, metal decking, concrete slab

Occupancy Type:
Jail/Courthouse
Parking garage

Initial Resources Required:
First-alarm assignment

Hazards to Personnel:
Hostile occupants--commercial fire load internal exposures/courthouse

Location of Water Supply:
12-inch municipal system
Hydrants--300' apart

Available Flow:
1,500 gpm per hydrant

	Estimated Fire Flow*			
Level of Involvement	10%	25%	50%	100%
Estimated Fire Flow in gpm	330	825	1,650	3,300

**Fire flow based on common corridor of 10,000 sq. feet.*

Fire Behavior Prediction:
Commercial fire load in courthouse. Horizontal and vertical exposures in jail.

Predicted Strategies:
Rescue, confinement, extinguishment, ventilation

Problems Anticipated:
Security of occupants--set-up Unified Command.

[X] **Standpipe:** *Jail only*	[X] **Sprinklers:** *Jail only*	[X] **Fire Detection:**

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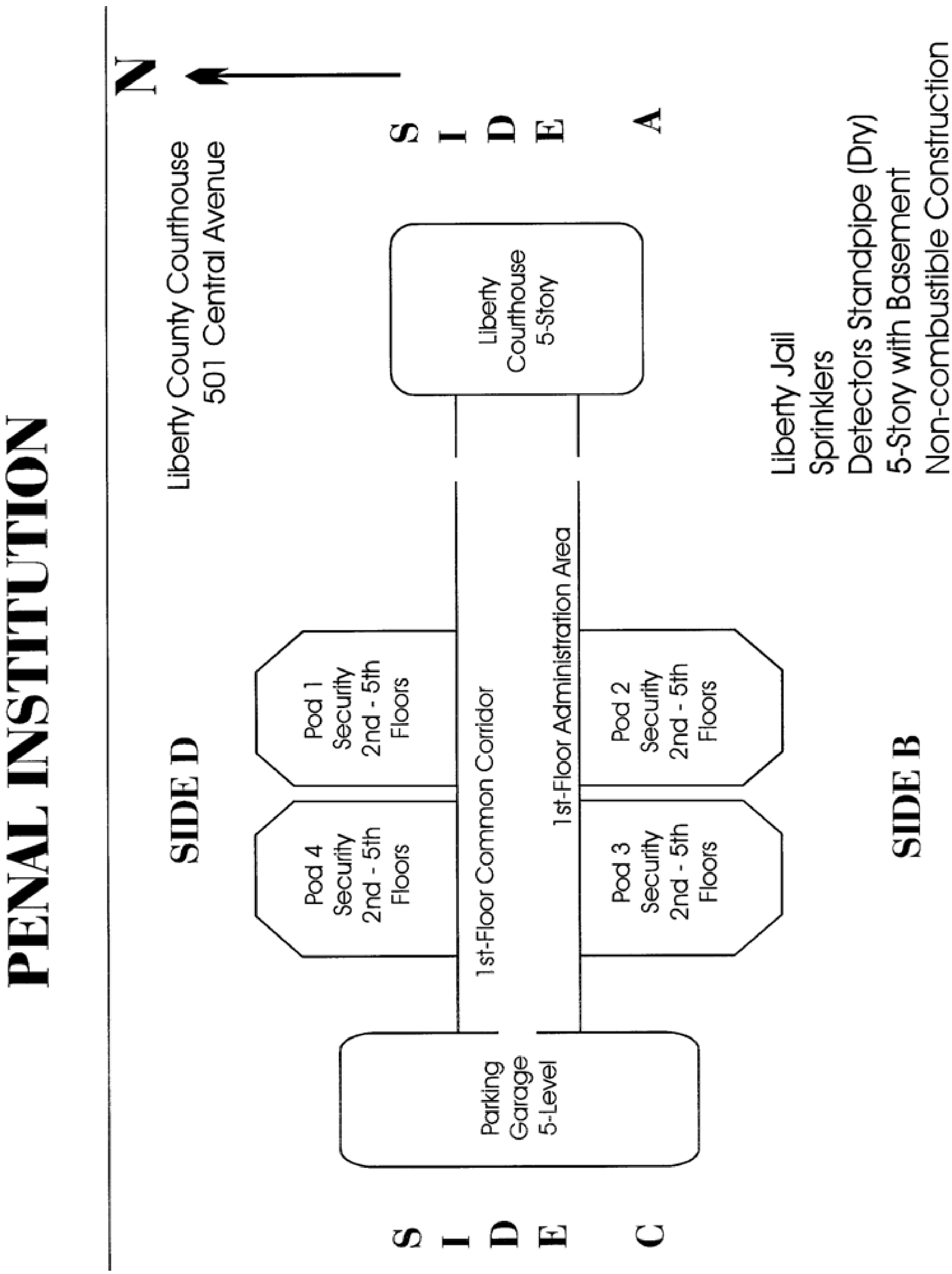
Activity 7.1 (cont'd)

Penal Institution Plot Plan



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Activity 7.2

Penal Institution Documentation

Purpose

To use incident management materials to document actions.

Directions

1. Some of the prisoners' families are unhappy with the fire department response and they have complained formally to the States Attorney. The attorney's office has contacted the fire department and wants all reports, information, and all other relevant documentation regarding the jail fire.

2. As a group, review your materials for consistency and accuracy.

    a. List all staff who were involved in the incident.

    b. Compare your notes and documentation, looking for consistency between dispatch information (e.g., times) and field reports, etc.

    c. List sources for photos, videos, or other forms of information that may be available to the attorney's office in addition to the "official" reports.

    d. If news media were present, make a complete list of print and electronic agencies represented so your attorney might track down that information.

    e. Be prepared to report out.

3. The questions posed by the city attorney:

    a. When did the first fire department units arrive?

    b. When were you first notified of smoke in the pods?

    c. What actions did you take to protect the inmates?

    d. When were you notified of the inmates needing transport to the hospital?

    e. Who was assigned to transport the inmates from the infirmary?

    f. When and where were they transported?

UNIT 7: GRAIN ELEVATORS (OPTIONAL UNIT)

TERMINAL OBJECTIVE

At the end of this unit students given a simulated major fire scenario, will be able to, coordinate, and control tactical resources and implement a plan of action based on critical cues, information gathered and critical elements presented during an incident involving grain elevators.

ENABLING OBJECTIVES

The students will be able to:

1. *Identify the management cues required to manage an incident at a grain elevator.*

2. *Effectively manage a grain elevator simulation.*

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GRAIN ELEVATORS

Grain elevator incidents can have a significant negative economic impact on a community. They present a Commander with a typical hazard. Firefighting strategies need to be developed with the elevator's specific hazards in mind, particularly the problem of dust explosions.

The normal thread of comparability that ties target hazards together is that, typically, they are complex and present a challenge to the Command and operational capabilities of most fire and rescue organizations. The consideration here is complex in construction contents, life loads, fire loads, or a combination of all of the above. Scale and magnitude also present unusual challenges.

The mainstay of the fire service is the constant training and upgrading of training that keeps it prepared for everyday, normal responses, e.g., room and contents fires. We all know we have the training and experience to handle the routine; we not only train for it, we experience it on a regular basis.

Normally we do not have the luxury of routine experience, other than preplanning activities and, possibly, response exercises with the facility staff and management. Because of these practical restrictions, the preplanning process and the sharing of the preplanning information become most critical to our ultimate success when it becomes necessary to respond to a target hazard.

Incident Considerations--Grain Elevators

Grain elevators present unique and unusual problems. Grain elevators, large and small, like all target hazards, require a thorough and complete preplan.

Preplan Points to Emphasize

- means of egress (exits, entrances, etc.);
- machinery and related equipment used in the processing and storage of grain; and
- hazardous materials.

The complexity of these facilities can present an unfamiliar challenge to firefighters unless they have acquainted themselves with the preplan information. Each grain-handling facility is unique in layout, design, construction, operation, equipment, and personnel. Each facility requires individual preplanning. Such plans should be a mutual effort between the facility's management and the fire department.

Dust Explosions

Dust explosions are always a threat during a response to a grain elevator complex and normally consist of a small initial explosion, followed by a second, much more powerful explosion. The second explosion usually is caused when the initial explosion disturbs dust that has built up on equipment and the building itself. Dust explosions cause large-scale damage. Destruction can be widespread. Firefighters in this environment are vulnerable, and are always a safety consideration for Command. The primary consideration for all responders is to constantly be aware that operations should never disturb large amounts of dust.

Responders could be endangered by large pieces of falling concrete and structural steel that break loose in the extreme pressures that are generated by the series of explosions. After the explosion occurs, the pressure front follows the path of least resistance, so that one part of a structure is unharmed and another area is destroyed.

In recent years there have been improvements in the prevention of dust explosions. There is an increased awareness of the danger of grain dust. Also there is a widespread use of safety equipment designed to prevent explosions and improvements in elevator design.

Hazardous Materials

Pesticides, fumigants, dryer fuels, gasoline or diesel fuel, lubricants, and cleaning solvents are stored at grain-handling facilities. Identification of haz mat is important because some materials react rapidly in the presence of moisture-causing explosive gases or fires.

Incident Considerations--Grain Dryers

Normal grain operations require grain to be dried in large dryers. These dryers are usually fueled by propane, fuel oil, or natural gas. These fuels can create additional hazards. Dryers have some safety features. They typically have an automatic shutoff to avoid overheating or over-drying the grain product. A typical fire department response to a dryer operation problem is caused when one leg of the dryer discharge chute clogs and backs up, causing grain to overheat and ignite into a smoldering fire. The "hot" grain may remain in the dryer, or it eventually can be conveyed to adjoining elevators or bins. Normally, the elevator staff can and will assist firefighters in locating and extinguishing these types of fires. It is important to shut down all operations during a response of this type. Large fires of this type are seldom easy to control; they rarely show open flame.

Fire Extinguishment

Grain fires generate heat, but locating the seat of the fire is often a challenge. Water is normally used to extinguish grain fires. It should always be applied gently and slowly to avoid raising large amounts of surrounding dust. In large, stubborn elevator fires, the bin or elevator is sometimes sealed off and CO_2 is injected from the bottom. This is a very effective alternative.

Interior offensive attack is never recommended. Instead, remove smoldering pockets of grain manually. If it becomes absolutely necessary to enter a grain bin, tank, or silo, use protective equipment and life lines, and always use proper confined-space operating procedures.

Normal Causes or Sources of Ignition for Fire or Explosion

- bearing friction: overheated grease/oil/lubricant ignites grain or dust;
- rubber conveyor belt fires: friction of belt rubs against metal framework;
- belt/friction slippage;
- frayed or faulty wiring or electrical connections; and
- damaged electrical conduit exposes arcing or faulty electrical components.

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Optional Activity 7.1

Grain Elevator Simulation

Purpose

To practice Command at an incident with high-exposure risks and potentially serious community economic impact.

Directions

1. As a group, you will staff positions within the Incident Command Structure of the Central City Fire Department (CCFD) for the exercise. All members of the CCFD Command Staff will arrive on the fireground simultaneously. CCFD Incident Command Staff:

    a. Incident Commander (IC).

    b. IC Aide*.

    c. Operations Chief.

    d. Operations Aide.

    e. Planning Chief.

    f. Logistics Chief.

    g. Public Information Officer (PIO).

    h. Liaison Officer.

    i. Safety Officer.

    *The IC Aide is not used unless there are nine students in a group. Some students may play multiple roles based on the Assignment Sheets. If there are ten in a group, a second Operations Aide will be designated.

2. All Command decisions and actions during the simulation will be recorded on the Simulation Action Chart. Entries on the ICS Chart are made in response to written or visual messages or in anticipation of problems that could surface during the incident.

3. At the conclusion of the simulation exercise, all groups will participate in a debriefing facilitated by the instructors. Your group will display both the ICS Charts and Simulation Action Charts developed during the exercise. Be prepared to explain the reasons for your decisions.

4. The following will be turned into the instructors at the conclusion of the PIA. The Planning Section Chief will collect all of these from their group, making sure that the group number and students' names are on the sheets.

   a. IC: Incident Objectives.

   b. The Planning Section Chief: Plan "B."

   c. The Safety Officer: Safety Message.

   d. Operations Aide: Actions Taken.

   e. Logistics: Resources.

   f. Liaison: Document Agencies Contacted.

   g. PIO: Press Release.

Optional Activity 7.1 (cont'd)

Quick Access Prefire Plan

Grain Elevator

Building Address:
310 Commerce Road

Building Description:
Grain elevator-60' x 600' x 120' with 180' center tower--reinforced concrete grain bins

Roof Construction:
Concrete with corrugated metal housing

Floor Construction:
Concrete floors in tower

Occupancy Type:
Grain elevator

Initial Resources Required:
First-alarm assignment

Hazards to Personnel:
Heavy operating machinery, dust explosion--hazardous material--high voltage

Location of Water Supply:
Hydrant, 12-inch municipal systems 1,000' apart

Available Flow:
1,500 gpm per hydrant

	Estimated Fire Flow*			
Level of Involvement	25%	50%	75%	100%
Estimated Fire Flow				

**Fire flow not used in this type of facility*

Fire Behavior Prediction:
Hidden fire in bins--friction fire in conveyor system--product fire in conveyor system

Predicted Strategies:
Confinement, extinguishment

Problems Anticipated:
Access to fire area, height, potential dust explosion

☒ **Standpipe:** *Yes*

☐ **Sprinklers:** *No*

☐ **Fire Detection:** *No*

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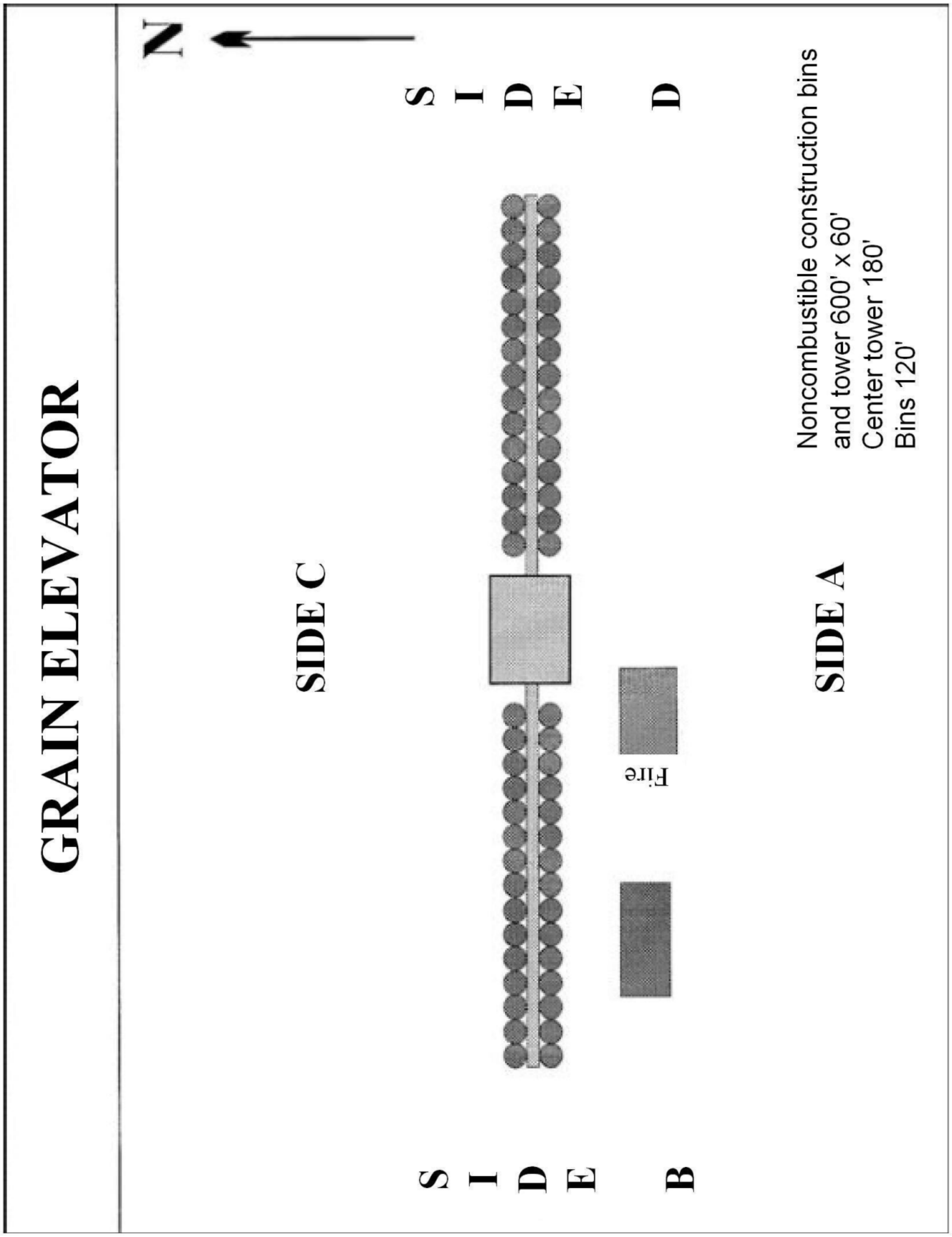
Optional Activity 7.1 (cont'd)

Grain Elevator Plot Plan



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Optional Activity 7.1 (cont'd)

International Chemical Safety Cards

ALUMINIUM PHOSPHIDE			**ICSC: 0472**
INHALATION			
SKIN	**ACUTE HAZARDS/ SYMPTOMS**	**PREVENTION**	**FIRST AID/ FIREFIGHTING**
EYES	Not combustible but forms flammable gas on contact with water or damp air. Gives off irritating or toxic fumes (or gases) in a fire.	NO open flames, NO sparks, and NO smoking. NO contact with acid(s) and water.	Special powder, dry sand, NO other agents. NO water.
EXPLOSION	Risk of fire and explosion on contact with acid(s) and water.		
EXPOSURE		PREVENT DISPERSION OF DUST! STRICT HYGIENE!	
	Sore throat. Cough. Shortness of breath. Headache. Dizziness. Nausea. Vomiting.	Local exhaust or breathing protection.	Fresh air, rest. Half-upright position. Artificial respiration if indicated. Refer for medical attention.
	Redness. Burning sensation.	Protective gloves.	Remove contaminated clothes. Rinse and then wash skin with water and soap. Wear protective gloves when administering first aid.
	Redness.	Safety goggles, or eye protection in combination with breathing protection.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
INGESTION	Nausea. Vomiting. Diarrhea. Abdominal pain. Headache. Convulsions. Shock or collapse. Unconsciousness.	Do not eat, drink, or smoke during work. Wash hands before eating.	Induce vomiting (ONLY IN CONSCIOUS PERSONS!). Refer for medical attention.

SPILLAGE DISPOSAL	**STORAGE**	**PACKAGING AND LABELLING**
Evacuate danger area! Consult an expert! Do NOT wash away into sewer. Sweep spilled substance into sealable containers. Carefully collect remainder, then remove to safe place. Do NOT let this chemical enter the environment. (Extra personal protection: complete protective clothing including self-contained breathing apparatus (SCBA).	Fireproof. Provision to contain effluent from fire extinguishing. Separated from acids, water, food and feedstuffs. Dry.	Airtight. Do not transport with food and feedstuffs. F symbol T+ symbol R: 15/29-28 S: 1/2-3/9/14-30-36/37-45 UN Hazard Class: 4.3 UN Subsidiary Risks: 6.1 UN Packing Group: I

I M P O R T A N T D A T A	**PHYSICAL STATE; APPEARANCE:** DARK GREY OR DARK YELLOW CRYSTALS. **PHYSICAL DANGERS:** **CHEMICAL DANGERS:** The substance decomposes on contact with water, moist air, and acids producing highly flammable and toxic gases (phosphine, see ICSC # 0694). **OCCUPATIONAL EXPOSURE LIMITS:** TLV not established.	**ROUTES OF EXPOSURE:** The substance can be absorbed into the body by inhalation of its aerosol and by ingestion. **INHALATION RISK:** Evaporation at -6.7 °F is negligible; a harmful concentration of airborne particles can, however, be reached quickly. Hydrolysis in atmospheric moisture or perspiration may yield gaseous phosphine which can be inhaled. **EFFECTS OF SHORT-TERM EXPOSURE:** The substance irritates the eyes, the skin, and the respiratory tract. Inhalation of phosphine liberated from aluminum phosphide may cause lung edema (see Notes). The substance may cause effects on the cardiovascular system, nervous system, and respiratory tract, resulting in impaired functions and respiratory failure. Exposure may result in death.
		EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:
PHYSICAL PROPERTIES	Melting point: 537.8 °F Relative density (water = 1): 2.9	Solubility in water: reaction
ENVIRON-MENTAL DATA	The substance is toxic to aquatic organisms.	

N O T E S

Commercial formulations for fumigations usually contain 57 percent of active ingredient. Reacts violently with fire extinguishing agents such as water. The symptoms of lung edema often do not become manifest until a few hours have passed and they are aggravated by physical effort. Rest and medical observation are therefore essential. Immediate administration of an appropriate spray, by a doctor or a person authorized by him/her, should be considered. Do NOT take working clothes home. Alutal, Celphide, Celphine, Celphos, Delicia Gastoxin, Detia Gas-Ex-B, Detia Gas-Ex-P, Detia Gas-Ex-T, L fume, Phosfume, Phostek, Phostoxin, Quickfos, and Zedesa are trade names. Also consult ICSC # 0694 for Phosphine.

Optional Activity 7.1 (cont'd)

Chemical Hazard Response Information System (CHRIS)

ALUMINUM PHOSPHIDE
OVERVIEW
Material name:
ALUMINUM PHOSPHIDE.
CHRIS Code APH.
Common synonyms:
Aluminum monophosphide.
AIP.
Characteristics:
Solid crystals or powder dark gray; dark yellow, may have "fishy," phosphine odor.
Sinks and reacts with water to produce poisonous and spontaneously flammable phosphine gas.
Emergency actions:
AVOID CONTACT WITH SOLID, DUST, OR GASES PRODUCED FROM REACTION WITH WATER.
KEEP PEOPLE AWAY.
Wear positive-pressure breathing apparatus and full-protective clothing.
Shut off ignition sources and call fire department.
Stop discharge if possible.
Isolate and remove discharged material.
Notify local health and pollution control agencies.
Fire:
FLAMMABLE AND POISONOUS GAS PRODUCED ON CONTACT WITH WATER.
POISONOUS GASES ALSO PRODUCED IN FIRE.
Wear positive-pressure breathing apparatus and full-protective clothing.
DO NOT USE WATER OR FOAM.
Extinguish small fires: dry chemical, soda ash, or lime.
Large fires: withdraw from area and let burn.
Move container from fire area if you can do it without risk.
Exposure:
CALL FOR MEDICAL AID.
POISONOUS VAPOR PRODUCED IN REACTION WITH WATER MAY BE FATAL IF INHALED.
SEVERE PULMONARY IRRITANT AND AN ACUTE SYSTEMIC POISON; MAY CAUSE SUDDEN OR DELAYED DEATH.
Effects may be delayed; keep under observation.
DUST.
POISONOUS; MAY BE FATAL IF INHALED.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.
Effects may be delayed; keep under observation.

SOLID.
POISONOUS IF SWALLOWED OR SKIN EXPOSED.
IF IN EYES OR ON SKIN, flush with running water for at least 15 minutes; hold eyelids open periodically if appropriate.
Remove and isolate contaminated clothing and shoes.
IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS do nothing except keep warm.
Water pollution:
Effects of low concentration on aquatic life is unknown.
May be dangerous if it enters water intakes.
Notify local health and wildlife officials.
Notify operators of nearby water intakes.
RESPONSE TO DISCHARGE
Issue warning--high flammability, poison, air and water contaminant. Restrict access, evacuate area (large discharge only). Should be removed.
LABEL
Category: Flammable solid; dangerous when wet.
Class: 4.
CHEMICAL DESIGNATIONS
CG compatibility class: Not listed.
Formula: AIP.
IMO/UN designation: 4.3/1397.
DOT id no.: 1397.
OBSERVABLE CHARACTERISTICS
Physical state: Solid (crystals or powder).
Color: Dark gray; dark yellow.
Odor: May generate fishy odor of phosphine upon exposure to moisture in air.
HEALTH HAZARDS
Personal protective equipment: Wear positive-pressure breathing apparatus and full-protective clothing.
Symptoms following exposure: Highly toxic. May be fatal if inhaled (dust) or swallowed. Also poisonous via skin contact. (Readily reacts with moisture or acids to produce phosphine gas which is a severe pulmonary irritant, an acute poison and spontaneously flammable. Ingestion may result in respiratory, cardiac, hepatic, and renal involvement. Exposure to phosphine gas may cause headache, fatigue, nausea, vomiting, cough, severe breathing difficulties, shortness of breath, jaundice, paresthesias, ataxia, intention tremor, diplopia, and miocardial injury. Breathing difficulties may be delayed several hours after exposure to phosphine has ceased.)
Treatment of exposure:
INHALATION: Move victim to fresh air; call for emergency medical care. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Breathing difficulties may be delayed; keep under observation. EYES OR SKIN: Immediately flush with running water for at least 15 minutes holding upper and lower eyelids open periodically if appropriate. Remove and isolate contaminated clothing and shoes at the site. Keep victim quiet and maintain normal body temperature.

INGESTION: If unconscious or having convulsions, do nothing except maintain normal body temperature.
Threshold limit value: 2mg/m(3) (A1).
Toxicity by ingestion: Grade 4; LD(50) = 20 mg/kg (human).
Vapor (gas) irritant characteristics: In the presence of moisture, it generates phosphine gas, a severe pulmonary irritant.
Liquid or solid irritant characteristics: Data not available.
IDLH value: Data not available.
FIRE HAZARDS
Flashpoint: Not pertinent (reacts with moisture to produce phosphine gas, which is spontaneously flammable at room temperature).
Flammable limits in air: Not pertinent. (Data not available for the phosphine gas produced upon exposure to moisture.)
Fire extinguishing agents: Small fires: dry chemical, soda ash, or lime. Large fires: withdraw from area and let fire burn.
Fire extinguishing agents NOT to be used: Do not use water or foam.
Special hazards of combustion products: May contain toxic gases and vapors such as oxides of phosphorous and phosphoric acid mist.
Behavior in fire: Can react with water or acids to produce spontaneously flammable and acutely toxic phosphine gas.
Ignition temperature: Not pertinent. (Reacts with water or acids to produce phosphine gas, which is spontaneously flammable at room temperature.)
Burning rate: Not pertinent.
Flame temperature: Data not available.
CHEMICAL REACTIVITY
Reactivity with water: Reacts with water or steam to produce phosphine gas. Phosphine is highly toxic and spontaneously flammable; and its combustion products, such as oxides of phosphosus, are also highly toxic.
Reactivity with common materials: May react with the moisture in wood to produce spontaneously flammable phosphine gas. Reacts violently with oxidizing substances.
Stability during transport: Stable (when dry).
Neutralizing agents for acids and caustics: Not pertinent.
Polymerization: Not pertinent.
Inhibitor of polymerization: Not pertinent.
WATER POLLUTION
Aquatic toxicity: Data not available.
Waterfowl toxicity: Data not available.
HAZARD CLASSIFICATIONS
Code of federal regulations: Flammable solid.
NFPA hazard classification: Not listed.
PHYSICAL AND CHEMICAL PROPERTIES
Physical state at 15 °C. and 1 ATM: Solid.
Molecular weight: 57.96.
Freezing point: >1,832 °F. = > 1,000 °C. = >1,273 °K.
Specific gravity: 2.85 at 25 °C.

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UNIT 8:
PUBLIC ASSEMBLIES

TERMINAL OBJECTIVE

At the end of this unit students given a simulated major fire scenario, will be able to, coordinate, and control tactical resources and implement a plan of action based on critical cues, information gathered and critical elements presented during an incident occurring in a location for public assembly.

ENABLING OBJECTIVES

The students will be able to:

1. *Identify the life safety problems associated with public assemblies.*

2. *Describe the level of preparedness necessary to respond to a multicasualty incident.*

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ASSEMBLY FACILITIES

Definition

Assembly occupancies include, but are not limited to, all buildings or portions of buildings used for gathering together 50 or more persons for such purposes as deliberation, worship, entertainment, eating, drinking, amusement, or awaiting transportation.

The size and use are both essential elements in classifying buildings as assemblies. A restaurant with an occupant load of less than 50 has the same use as one with the capacity for 110 persons, but the smaller one is not an assembly. The code requirements for the nonassembly will vary greatly from those adopted to keep assembly occupants safe during times of fire, panic, or other emergencies.

Types of Assembly Occupancies

- armories;
- assembly halls;
- auditoriums;
- bowling lanes;
- churches;
- college/university classrooms (50 persons or more);
- conference rooms;
- courtrooms;
- dance halls;
- drinking establishments;
- exhibition halls;
- gymnasiums;
- libraries;
- mortuary chapels;
- motion picture theaters;
- museums;
- passenger stations and terminals of air/surface, underground, and marine public transportation facilities;
- pool rooms;
- recreation piers;
- restaurants;
- skating rinks; and
- theaters.

Critical Factors Regarding Assemblies

Construction of the assembly will be a critical factor in developing strategy for a fire or multicasualty incident:

- ordinary construction;
- bowstring construction;
- truss construction;
- steel bar joists;
- concrete/steel construction with an atrium (midrise/highrise style);
- wood frame;
- prefabricated structures; and
- tents.

Characteristics of Assembly Design

- large unbroken area;
- multiple levels of occupancy;
- open stairwells;
- below grade assembly areas;
- doors often locked for security reasons;
- exit doors often hidden by furnishings;
- often passageways are narrow corridors leading to assembly area;
- occupancy flow designed for entering and exiting from the same point;
- people evacuating will seek the same door to exit from which they entered; and
- apparatus placement limited by single access roads.

Fire Protection

- Sprinklers may or may not be present.

- Large kitchens are common.

- Knowledge of heating, ventilating, and air conditioning (HVAC) systems may be limited.

- Various types of alerting systems are installed.

- Employee training in fire safety usually is limited.

- Water supply for firefighting may be limited because of assembly location, in remote areas, etc.

MULTICASUALTY INCIDENTS

Preparedness for Target Hazards

Are you aware of the multicasualty potential in your area? For example, if there are airports in your jurisdiction, you should have an airport procedure. Network with an urban department to identify what that procedure entails.

Prisons are potential sites of multicasualty incidents that would present special problems. Safety of your people is a paramount consideration in writing a procedure, holding a drill, or if an actual incident occurs. Do not be misled by a uniform. Prisoners have exchanged their attire with guards by force in the past. Security must be a major part of your prison plan. (Example: Camp Hill, PA, October, 1989.)

Manufacturing plants can be of many varieties. Familiarization is important. If you are at least cognizant of what is manufactured and the process, it will assist in your capability to handle an emergency of any kind at the facility. (Example: Chicken Mfg., North Carolina, 1991.)

Chemical plants are another type of facility where familiarization is important. You should be provided a list of hazardous materials on site. You must be aware of the potential problems, not only on site, but also to the surrounding area. Evacuation plans should be established. Identify key plant personnel. (Example: Bhopal, India, 1985.)

Public transportation systems recently have been the source of several MCIs. They can present unique problems. Be aware of the problems and solutions that those responders faced. You can learn from their experiences. (Example: Philadelphia, PA, March 1990.)

Interstate highway systems can present problems as varied as major accidents or hazardous materials releases. Knowledge of accesses and alternative means of reaching the scene are important. Removing victims from the scene also can be difficult. You will need cooperation. (Example: Calhoun, CA, February, 1991.)

Geographical concerns. If your potential for MCIs is especially acute during certain times of the year, i.e., floods, tornadoes in the spring, hurricanes in the late summer, do you prepare for these seasonal problems? (Example: Earthquake, San Francisco, CA, October, 1989.)

Teambuilding

Identify how you can build a stronger team. Identify, via training and drills, potential problems. Do not wait for an emergency situation to identify problems.

Be diplomatic enough to address problems in a way that strengthens the team rather than causes resentment or hard feelings. Your goal is to build a team, not paralyze or destroy it.

You should have a sound professional relationship with neighboring departments. You need each other. Is a mutual-aid plan in effect or needed? If it is, you must be familiar with it. The chain of command and lines of authority should be clear to all. Jurisdictional disputes are unwarranted and unprofessional. Mass casualties will expose your shortcomings if you do not work on them.

What has been said about interdepartmental considerations also applies to interagency. You must communicate with potential interagency responders before an emergency. Review your relationships and/or procedures regarding police, medical, helicopter, utilities, etc.

Training

Identify what **relevant material** or courses you can provide for your people. Have a positive program. You are teambuilding.

Instructors must be motivated properly and care about the people they are instructing and the quality of their work. Instructors must have credibility.

If you have a training facility, use it. Your people will be more able to learn if you provide an **environment** that lends itself to that goal.

If you do not have a training facility, the area you use should be made as conducive to learning as possible. Control the environment. Remove distractions such as newspapers; turn off televisions and radios. Students should not be responsible for watch duty.

Conduct **multicasualty drills**. Be as realistic as possible. Students must realize drill is serious, not a picnic.

Use what you learn in this course to set up your drill. Make drill as full scale as possible. It will pay off. It will improve morale and confidence.

Evaluate your own performance and how, as an individual, you can improve. Share it with others. This is leadership. Reinforce the idea that training is a learning experience.

Conduct a critique of your drill: What did you learn? What worked? What went wrong? Why did it go wrong? Identify and rectify areas of concern.

Start planning for your next drill.

Access

Above Grade

Elevated trains. If there are elevated trains in your area, you should be prepared for the **multicasualty** potential and the specific problems of laddering, stability, and the structure itself.

Mountaintops/Sides. You must be able to reach the incident to be of value. You must be able to get there with the needed equipment.

Highway spans/bridges are potential areas of difficult access if a MCI should occur there. It may be necessary to move injured persons to the opposite side of your jurisdiction. All bridges that have separate jurisdictions on opposite ends should have a bridge procedure. If your bridge has standpipes, you must be knowledgeable of connections.

Below Grade

Subways. Tunnels are potential **multicasualty** locations. You must have plans. Is there access between stations? You may need water, and lighting is a must. Long carries, up several levels, are personnel intensive. Power must be turned off immediately for a safer atmosphere for workers. Remember, you may have victims coming out at different locations.

Mines. Explosions or collapses in mines may trap workers. Balancing speed and safety is agonizing but necessary. Secondary collapse or explosions are a threat.

Highway spans/tunnels. Highways underground or underwater are difficult to access. Traffic may be gridlocked.

Remote Locations

Is the incident difficult to access?

Evaluate response times and nearness of medical facilities. It may be necessary to request medical and surgical teams to come to the scene. You should know beforehand how they will be transported. If your area has access to a medical helicopter, a policy for its use should be in place.

Separate But Related

It is possible to have an incident that is spread over a large area appear to be separate incidents, e.g., air, land, or water collisions. Keeping control of all aspects of the incident is vital. You may have units responding from diverse locations. All units and personnel involved in the incident must be integrated into the Incident Command System (ICS).

Resources

Vehicles/Apparatus

Medic units. Do you have the necessary transportation vehicles, e.g., medic units, ambulances?

Police units. Police will be on scene. You must identify how they will be of assistance. Police can be of assistance for crowd control, traffic control, security, and, if necessary, drive vehicles if medic unit drivers are committed. They also can be of assistance in transporting medical supplies and personnel. It is necessary to have police be a part of your ICS.

Helicopters. Helicopters can be used. Your helicopter policy will identify when they may be requested and who is in charge. Policy on establishing landing zones should be in place.

Buses. If a large number of victims have sustained minor injuries, a bus may be a feasible way of removing them from the scene rapidly. EMTs or paramedics should be on the bus. Do not take large numbers of minor injuries to the closest facility if you anticipate more seriously injured shortly thereafter.

Tow truck. Tow trucks can be used to separate wreckage.

Fire apparatus and equipment. You may need pumpers, ladders, special equipment, e.g., jaws of life, heavy rescue equipment, etc. Call help early and maintain scene discipline. Mass casualty is personnel intensive. If personnel are being used and apparatus is standing by, perhaps apparatus can be used to pick up equipment or have drivers return to service to maintain adequate protection in the area.

Personnel

People are the most vital resource. Without people, nothing would move or operate. Personnel fall into two classifications: direct and peripheral.

Direct people refers to those involved with the emergency scene directly. These people must be considered when thinking of assistance, fatigue, weather conditions, emotional/stress conditions, etc. A Staging Area should provide people at-the-ready for additional help or relief to members directly involved. This can be on a rotating basis or permanent relief. (If the emergency involves great loss of life and/or injury, the emotional/stress load on the emergency personnel must be considered.) A resource pool for direct people could be any of the following:

- further alarms (on-duty members);
- fire and/or EMS training schools dismissed to the emergency;
- call back (off-duty members);
- volunteers (only qualified personnel);
- mutual aid (neighboring townships/counties); and
- National Guard or Reserves.

Peripheral people refers to those indirectly involved with the emergency scene, yet very important in the totality of management of the overall scene. The needs would vary from laborious tasks to professional help. A resource pool for peripheral people could be any of the following:

- police department;
- police training schools;

- college/university;
- high school seniors; and
- large corporations.

All of these suggested personnel pools require preplanning and development of interagency partnerships. A crisis, by its nature, causes people to pull together to accomplish feats beyond comprehension. All of the agencies listed would be very interested in the preservation of life and/or property within their community. Look around your community to determine your resources, develop a sound emergency plan, and when you approach these agencies you will get positive results.

Hospitals

Trauma centers. Victims in need of a trauma center must be identified and taken to that facility. Contact with the facility is necessary to see how many can be handled.

Pediatric care center. If you have a pediatric care center nearby, pediatric cases should be transported there. Again, contact with the facility is necessary to see how many can be handled.

Special care--burns, spinal, eye, etc. Victims needing a special-care facility should, of course, go to that facility if one is available.

Equipment

Medical. Do you have appropriate and adequate medical equipment? You must know where adequate supplies can be obtained on short notice, e.g., spine boards, collars, splints, and drugs.

Lighting. Extensive lighting may be necessary on many **multicasualty** operations. Are you capable of supplying the need? Ascertain who may be able to provide you with assistance.

Construction equipment. Contractors may have specialty equipment that can be helpful, e.g., cranes, backhoes, etc. You should have some agreement with such people as to what they could provide in an emergency. Naturally this agreement cannot be abused.

Communications

Interdepartmental

Do you have enough **radios**? Can **hard-line telephones** be obtained, and will they be of help? Also, **cellular telephones** are a valuable tool, if you can obtain them.

Interagency

Communications must flow smoothly through various agencies on scene. One aspect of the ICS is the span-of-control and how communications should flow. ICS should be used on small incidents so that terminology and theory of incident command is familiar to everyone in the organization.

Microphone

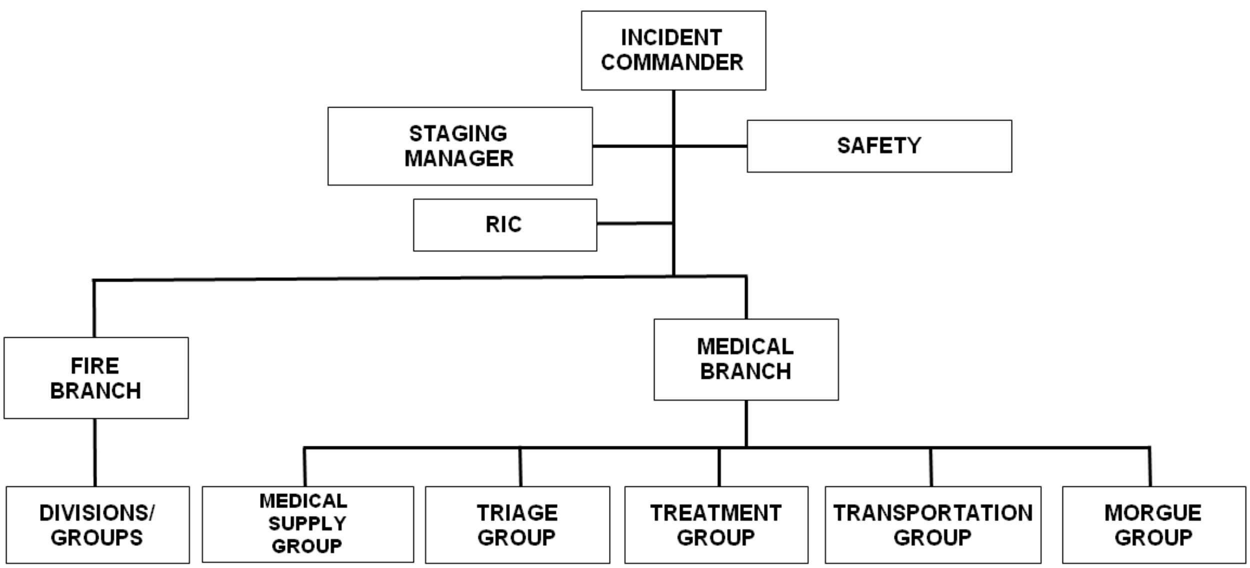
Can you provide communication equipment to the entrapped if they are not within voice distance?

Media

Media should be accommodated but controlled. The Public Information Officer (PIO) will keep the media apprised of the situation at the proper time and place. Media should be informed that their needs are being considered, if information is not available or released immediately.

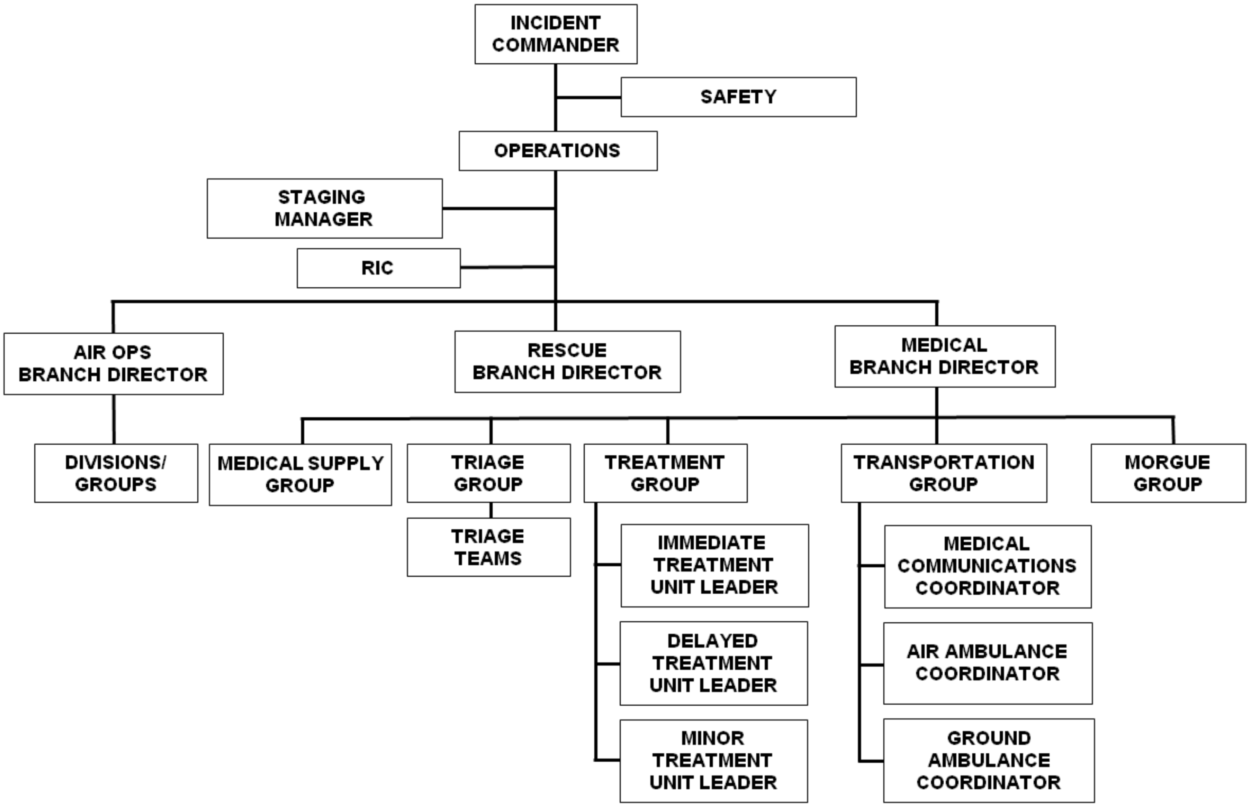
Coordination

Fire/Medical ICS



Keep medical communication on separate band or frequency so as not to tie up one band.

Medical ICS



Safety/Security

Rescuers

Do all that can be done to establish safety for the rescuers. Safety Officer should be assigned.

Casualties

Use principle of "No Further Harm" for casualties.

Police Assistance

Secure area from onlookers, press, etc. Anyone who is not involved in bringing the event to a conclusion and who is not needed should not be in close proximity to the incident.

Precautions must be maintained to prevent the possibility of looting.

Technical Assistance

Is there a higher level of expertise that can be contacted, either via phone or on site, e.g., chemical or structural engineer? Have them work with Planning unless IC requests their presence at the Command Post (CP).

Media/Bystanders

Secure areas from the media/press, bystanders, etc. Only those people involved in bringing the event to a conclusion should be in close proximity to the incident.

Monitor the Scene

Constantly monitor. Do not let secure areas be compromised or slowly close in on you. Assign responsibility for this chore.

Hazardous Materials Considerations

Make arrangements to handle hazardous and medical waste. Do it right. Do not leave yourself open to criticism at this point. By this time, you may be fatigued or emotionally spent. Don't let these emotions deter you from sound decisions.

Conclusion/Recovery

Withdrawal

It is necessary at any emergency scene to have an orderly, effective, and safe conclusion.

Check the area of the incident and make sure all responders and casualties are withdrawn.

Security

Secure the scene for investigators. Use the proper personnel for this function. Make sure the roles of security personnel are known.

Transfer

Have an effective transition with the agency that will remain on scene after withdrawal, e.g., airport, Federal Aviation Administration (FAA), prisons, etc.

Debriefing

Determine if critical incident debriefing is appropriate and necessary. Are you prepared to have a critical incident debriefing team interface with your people?

Critique

Have a critique as soon as possible after the event. Remember, critical incident debriefing and critique are never related.

A critique should be a learning experience. If you feel or know that an individual made mistakes, be tactful and diplomatic. If members see critiques as a fault-finding operation, they will lose their effectiveness.

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Activity 8.1

Airport Incident Simulation

Purpose

To practice commanding an incident with a growing EMS requirement.

Directions

1. As a group, you will staff positions within the Incident Command Structure of the Central City Fire Department (CCFD) for the exercise. All members of the CCFD Command Staff will arrive on the fireground simultaneously. CCFD Incident Command Staff:

    a. Incident Commander (IC).

    b. IC Aide.*

    c. Operations Chief.

    d. Operations Aide.

    e. Planning Chief.

    f. Logistics Chief.

    g. Public Information Officer (PIO).

    h. Liaison Officer.

    i. Safety Officer.

    *The IC Aide is not used unless there are nine students in a group. Some students may play multiple roles based on the Assignment Sheets. If there are ten in a group, a second Operations Aide will be designated.

2. All command decisions and actions during the simulation will be recorded on the ICS Forms. Entries on the ICS Forms are made in response to written or visual messages or in anticipation of problems that could surface during the incident.

3. At the conclusion of the simulation exercise, all groups will participate in a debriefing facilitated by the instructors. Your group will display both the ICS Forms developed during the exercise. Be prepared to explain the reasons for your decisions.

4. The Liberty County Airport is located near the town of Kingston. The airport is governed by the Liberty County Airport Authority, which has contracted with Central City for fire, EMS, and security services. The agreement with the Authority places the airport property within Central City jurisdictional control.

5. The following will be turned in to the instructors at the conclusion of the PIA. The Planning Section Chiefs will collect all of these from their groups, making sure that the group number and students' names are on the sheets.

    a. IC: Incident Objectives.

    b. The Planning Section Chief: Plan "B."

    c. The Safety Officer: Safety Message.

    d. Operations Aide: Actions Taken.

    e. Logistics: Resources.

    f. Liaison: Document Agencies Contacted.

    g. PIO: Press Release.

Activity 8.1 (cont'd)

Quick Access Prefire Plan

Airport Terminal Building

Building Address:
110 Sky View Drive

Building Description:
One and two story--Noncombustible--75' x 175'

Roof Construction:
Steel bar joist with concrete asphalt deck and covering

Floor Construction:
First floor--concrete slab
Second floor--Steel bar joist, concrete

Occupancy Type:
Airport terminal building

Initial Resources Required:
First-alarm assignment

Hazards to Personnel:
Restaurant facilities--fuel tank storage

Location of Water Supply:
Hydrants--8-inch county system--hydrants 100' apart

Available Flow:
1,000 gpm per hydrant

	Estimated Fire Flow*			
Level of Involvement	10%	25%	50%	100%
Estimated Fire Flow	550	1,400	2,750	5,500

** Fire flow based on first floor or terminal building with one exposure story.*

Fire Behavior Prediction:
Internal exposures, open areas, terminal
Flammable liquid fire, storage areas, aircraft

Predicted Strategies:
Rescue, confinement, extinguishment, ventilation

Problems Anticipated:
Access, water supply, aircraft

☐ **Standpipe:** *N/A*	☐ **Sprinklers:** *N/A*	☒ **Fire Detection:**

UNIT 9:
ENCLOSED MALLS

TERMINAL OBJECTIVE

At the end of this unit students given a simulated major fire scenario, will be able to, coordinate, and control tactical resources and implement a plan of action based on critical cues, information gathered and critical elements presented during an enclosed mall incident.

ENABLING OBJECTIVES

The students will be able to:

1. *Identify critical building construction factors and special considerations at a mall.*

2. *Perform the Incident Management Team (IMT) roles assigned in order to effectively manage the mall incident.*

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INTRODUCTION

Key Concepts

- Fire departments can anticipate and reduce the community risk at target hazards.
- Community contact and involvement helps with mitigation activities.
- Target hazard incidents can have a significant economic impact on a community.
- Assembly occupancies are diversified and numerous in most communities.
- Mass casualty incidents involve unique strategic concerns.
- Mall properties include both economic impact and mass casualty issues.

Structure

Shopping malls have been referred to as "horizontal highrises." Malls vary and include many different types of construction. There are open and enclosed malls, but all contain combustible materials in ceiling supports, store partitions, and display equipment. Mall roofs are metal decking (most common), concrete, wood, glass, Plexiglas™, or Lexan™. There are large areas under the roof. Most major building codes require building components (columns, beams and floor/ceiling systems) to be protected. Protection can range from 1 to 3 hours depending on the code in force. Store partitions may not penetrate the ceiling, or reach the underside of the roof. Fire service personnel must determine and note firewalls or fire separations on preplan. Display equipment may include extremely combustible materials and/or possibly block sprinkler cone spray coverage. Enclosed malls with high-rise structures attached may include hotels, office buildings or a combination of both. The highrise structure may open directly into mall; creating significant exposure problems especially smoke propagation. Numerous ventilators, skylights, and heat, ventilating, and air conditioning (HVAC) units are located on the roofs of malls. Roof surveys and preplans should indicate what occupancies these units serve.

Anchor stores are major stores, usually part of a chain, such as Sears. There may be as many as six or more in a single mall. These buildings are large mercantile (possibly multilevel) occupancies that may have their own fire alarm, fire suppression, and/or fire detection system. They also contain large storage areas that may confuse and trap firefighters. Storage areas for these occupancies may be remotely located in large maze-like storage rooms in lower levels or to the rear of the mall. Specialty stores or linking stores face an open mall or concourse area, which connects the anchor stores. There are often small booths usually located throughout the mall in the concourse or pedestrian traffic area making it difficult to navigate in blackout conditions.

A mall is made up of many different types of occupancies under one common roof. Frequently malls are remodeled, resulting in breached firewalls and second or third dropped ceilings. Open ceilings and common lofts may allow for rapid undetected fire spread and require effective search for the fire. Fire load in most malls is heavy due to a large variety of Class A-type combustibles. This problem is compounded by restaurant cooking facilities. Automobiles may be on display in a mall concourse.

Mall entrances and store entrances often are locked or limited. It is important that communications regarding entrances are specific. In some cases multiple entrances provide for good access and evacuation. It is strongly recommended that local fire departments devise a unique marking system to identify each of the many mall entrances with numbers or letters.

Malls frequently are located on the fringes of a city or between cities. Sufficient resources should be dispatched on the initial alarm to support sprinkler and standpipe systems, and augment water supply. Water supply may be inadequate, and response time may be increased due to distance and traffic.

Internal Fire Protection Systems

- zoned sprinkler and standpipe systems (with shutoffs located significant distances from grid served);
- hydrants on property; and
- smoke removal systems.

Preincident Preparation

The best type of preplanning for this type of structure is participation in the planning and construction phases of the project. Ensure that adequate water supply, fire department access, and life safety issues have been considered. Long stretches of hoseline may be necessary, even when using standpipes. Old/Used rescue rope marked at 50 foot intervals may be used to estimate the length of hoseline necessary from standpipe outlets or from engines to potential fire locations.

A thorough knowledge of structure and fire protection systems and frequent drills and incident preplanning sessions are essential. Include establishing good working relationships with management and security in preincident preparation. Consider assigning a single inspector to monitor the site during initial construction and subsequent renovations to ensure that fire suppression, detection, and alarm systems remain in service. The fire department must control access, fire loading, and use of hazardous materials (flammable, caustic substances, etc.).

Keeping up with store names is difficult. Many mall management companies notify the water department, power company, realtors, and others of changes in rental occupants via email. One possible answer is to have your preplan officer added to the mall notification tree.

Incident Considerations (Command)

- Divide the building into geographic areas inside, outside, and on the roof for all operations.
- Assist with evacuation. First-alarm companies must be preassigned to proper standpipe and sprinkler connections.
- Protect lanes of egress.
- Provide search and rescue. The large areas and configuration of a mall require larger search teams than for other occupancies.
- Provide for medical assistance.

Forms of Notification

The fire department may receive calls for assistance in numerous manners. Alarm systems, cell phone calls, and landline requests for assistance are possible mediums. Type of fire alarm and detection systems and how they may be transmitted to the fire department are shown below:

- **Water flow:** Reported by sprinkler zones.
- **Smoke detector:** Reported in separate smoke detector zones, and may be tied to HVAC systems.
- **Pull box fire alarm:** May be reported by pull box station or in separate zone.
- **Heat detectors** in kitchens of restaurants.
- Small **dry chemical, CO_2, or other type suppression system** activation may trip separate alarm.

Other types of calls for assistance and how they may be characterized.

- Call for assistance at an address--"12811 Jones Branch Road."
- Call for assistance at a store name--"at Smith's Shoe Store you have an injured woman."
- Calls for assistance at mall entrances--"at Entrance 2 you have an automobile out front on fire."
- By parking area--"at the south parking garage you have a pedestrian struck."

All of the these possibilities must be accounted for in preincident preparation.

Support internal fire protection systems. Water should go to sprinklers first. Know sprinkler/standpipe locations and zones. Mall fires require long attack line stretches (300 to 500 feet). A single-attack line probably will require personnel from more than one Engine Company. It may be more advantageous to extend attack lines through the closest entrance to the fire rather than make use of horizontal standpipes in some cases (should be noted on preplan). This may require a search within the structure before committing the initial handline. Firefighters must be instructed to make use of tether lines, or hoselines when entering large open areas, or confusing maze like hallways found in malls. Thermal imagers may help. However, a marking system must be used to follow when leaving the building.

Consider master streams inside structures but avoid opposing streams.

Some roofs may be difficult to breach for ventilation. Use mechanical roof openings such as skylights and ventilators. Be aware of the dangers of rooftop work such as false fronts, hidden drop-offs, heavy equipment (HVAC, generators, signs, etc.), and wires. Take advantage of the HVAC system. It may be possible to regulate air supply to evacuate smoke from involved areas of the mall and reduce smoke advancement into uninvolved areas of the mall. Preplan with the building engineer. If it is not possible to make use of the HVAC system, shut it down as soon as possible.

Fire Extinguishment

Support private fire suppression systems.

- Confirm location of fire in mall by the read out on the alarm panel.
- Assign resources to strategic locations and establish Incident Command System (ICS).
- Cover flanks, and monitor cockloft for possible fire spread.
- Determine fire flow requirements.
- Provide sufficient initial personnel, forcible entry resources, ventilation, and relief personnel.

Firefighting in malls involves large personnel needs for search and rescue, water management, fire attack, and ventilation. A ventilation group or roof division may be an entire single-alarm assignment. Fire can spread in two or more directions after reaching the mall area. Key areas include front, rear, flanks, and roof.

Large merchandise value necessitates that effective salvage efforts be started as soon as is practical. Preplan must note locations of floor drains to remove potentially large amounts of water resulting from sprinkler activation. Consider using mall water vacuums, from mall maintenance that may be available.

To avoid opposing streams, delegate fire attack responsibilities out to branches and divisions with specific directions included in the Incident Action Plan (IAP).

Activity 9.1

Shopping Mall Simulation

Purpose

To practice commanding an incident in a large, complex structure with heavy-life risk.

Directions

1. As a group, you will staff positions within the Incident Command Structure of the Central City Fire Department (CCFD) for the exercise. All members of the CCFD Command Staff will arrive on the fireground simultaneously. CCFD Incident Command Staff:

   a. IC.

   b. IC Aide.

   c. Operations Chief.

   d. Planning Chief.

   e. Logistics Chief.

   f. Public Information Officer (PIO).

   g. Liaison Officer.

   h. Safety Officer.

2. Prior to beginning the exercise, determine which members of the group will fill the staff positions. Record the names on the ICS Chart.

3. All Command decisions and actions during the simulation will be recorded on the ICS forms. Entries on the ICS forms are made in response to written or visual messages or in anticipation of problems that could surface during the incident.

4. At the conclusion of the simulation exercise, all groups will participate in a debriefing facilitated by the instructors. Your group will display both ICS forms developed during the exercise. Be prepared to explain the reasons for your decisions.

Overview

The incident occurs in Columbia Mall, a large structure with more than 2.1 million-square feet of space under roof. Built in the 1980s, the building includes five major department stores and over 196 assorted specialty shops and restaurants. Construction is concrete block covered by a bar-joist, flat-pan roof. The entire mall is sprinklered, with the heads mounted below the drop ceiling. Access to the facility can be made from two roads (south and north) into the 7,500-car parking lot, which surrounds the building. There are three parking garages, one on the north side and two on the south side of the complex. Fire apparatus cannot enter the raised portions of the parking garages.

The alarm sounds just before 1400 hours on the Friday after Thanksgiving. The mall has been heavily patronized since it opened at 0900 hours. Virtually all parking places are occupied with some cars parked on grassy areas at the perimeters of the parking lot. Outside temperature is 31 °F with a south wind of 15 mph.

Mall maintenance and the Central City Gas Company have been working on a reported minor gas odor at Entrance 4 all morning. An explosion occurs in the egress hallway of Entrance 4 on the south side of the complex, on the Lower Level. The fire that is triggered extends into the Miaro Bistro and down the hallway toward the main east-west mall concourse where it spreads to stores on the south side of that corridor. The sprinkler system in the egress corridor area has been damaged, making it inoperable in that section. All stores have been overstocked for the holiday shopping season, so the fuel load is high.

The size and complexity of the structure, large fire area, and heavy life risk should lead to the most extensive command structure among course simulations. Although the sprinkler system eventually will hold the fire, misleading information from security could lead the Commander to underestimate the firefighting response. Large crowds of people leaving the mall while fire companies are entering, an overcrowded parking lot with restricted access, and the need for extensive mutual-aid support, add to Command problems.

Activity 9.1 (cont'd)

Quick Access Prefire Plan

Shopping Mall

Building Address:
1000 Columbia Avenue (Route 50)

Building Description:
Shopping Mall 2.1 million-square feet
Two and three stories, portions built in 1980s
CBS--five major dept. stores, 196 shops and restaurants

Roof Construction:
Bar-joist flat-pan--Lexan™ skylight length of center mall

Floor Construction:
Concrete, covered by ceramic tile/carpet

Occupancy Type:
Shopping center

Initial Resources Required:
One commercial bldg. alarm

Hazards to Personnel:
Ingress, egress, horizontal interior hose lays

Location of Water Supply:
Hydrants on site (10) 12-inch main

Available Flow:
1,600 gpm per hydrant

	Estimated Fire Flow			
Level of Involvement	1 store	3-5	Dept. Store	Wing
Estimated Fire Flow	500 gpm	1,000 gpm	3 - 5,000 gpm	5,000 gpm

Fire Behavior Prediction:
Horizontal spread, common ceiling between stores

Predicted Strategies:
Rescue (primary search), confinement, ventilation

Problems Anticipated:
Access to fire, occupants, zoned sprinklers, and long hose lays

[X] **Standpipe:** *Horizontal*	[X] **Sprinklers:** *Zoned*	[X] **Fire Detection:** *Smoke, water flow, heat detection*

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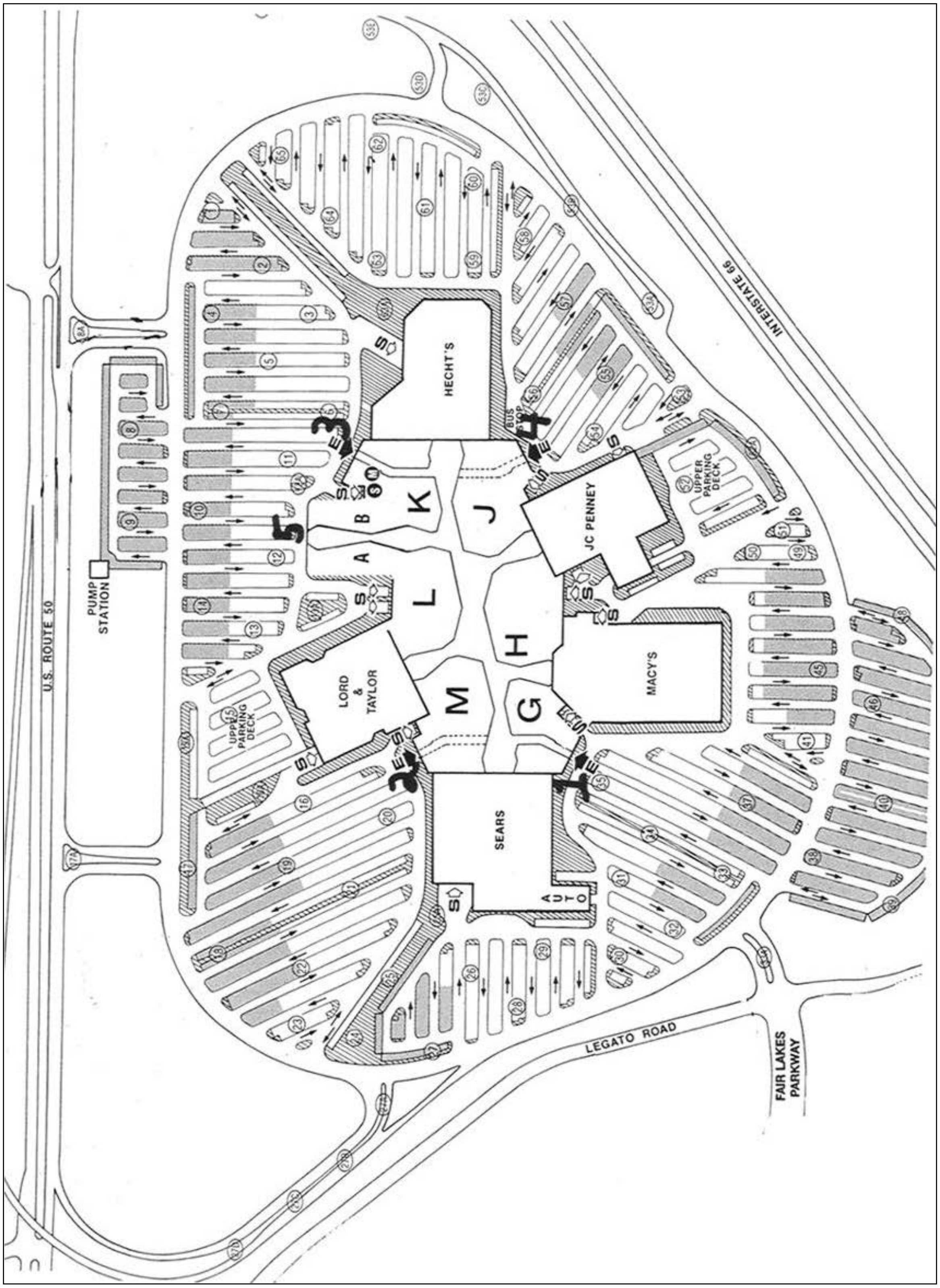
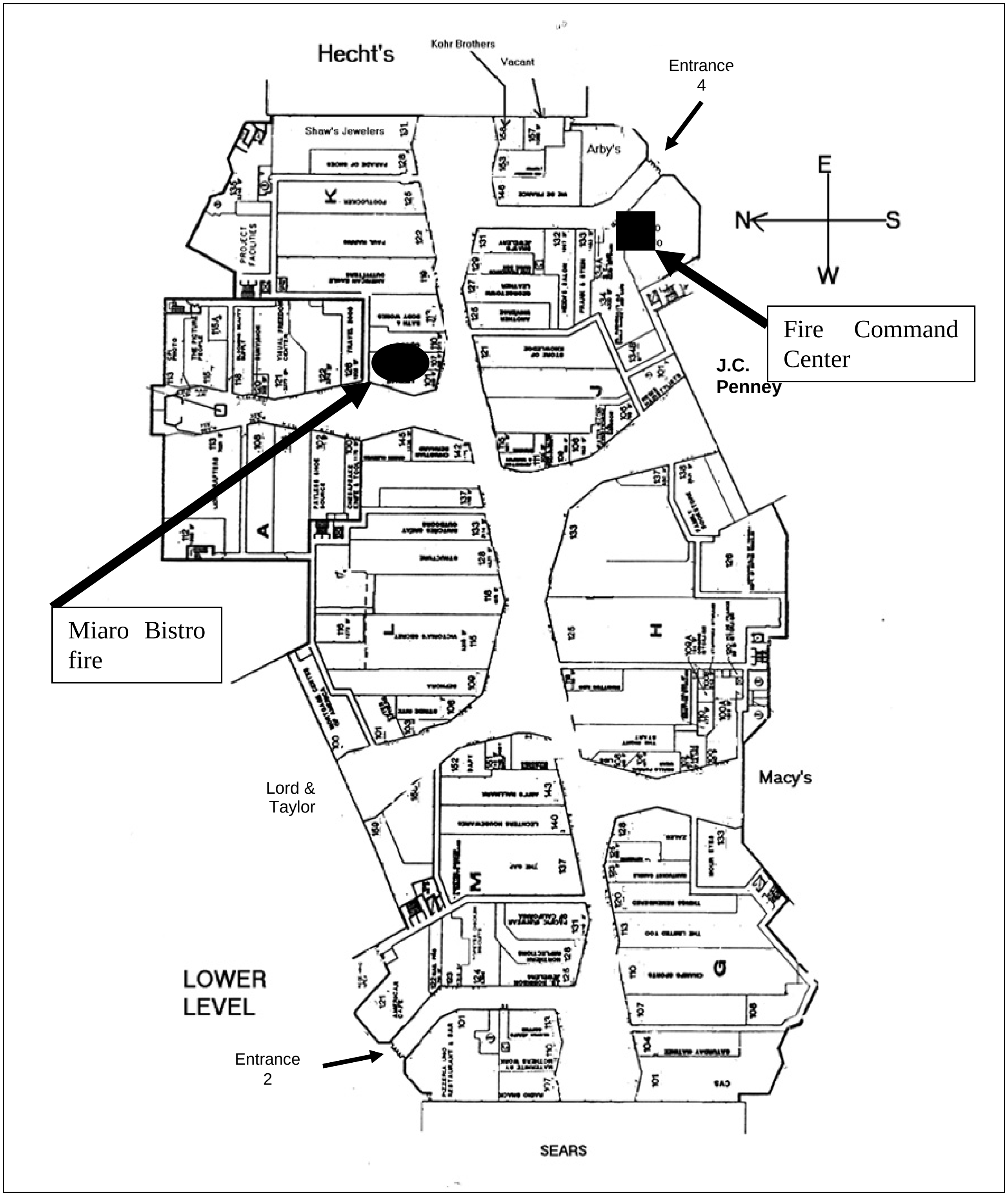
Activity 9.1 (cont'd)

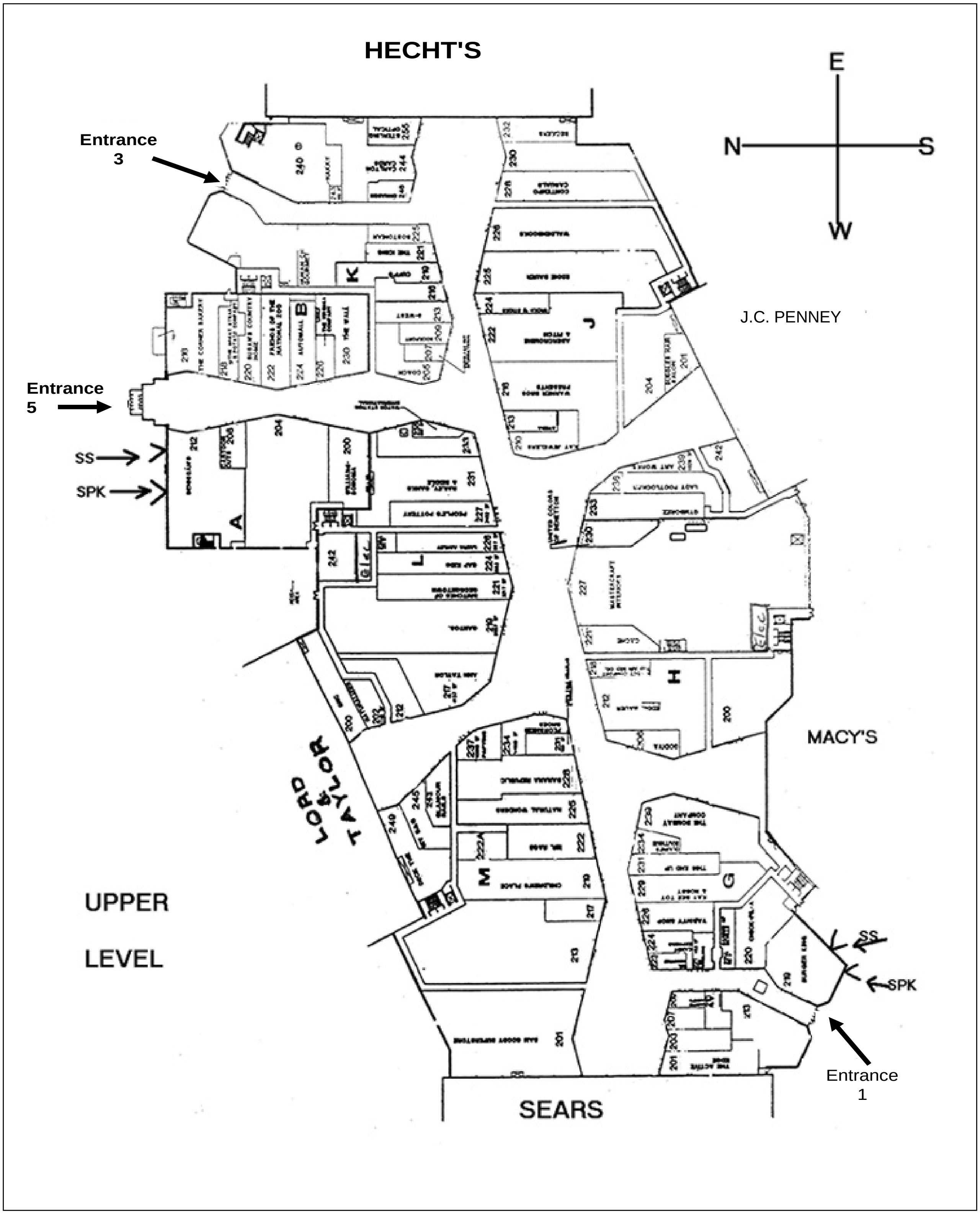
Shopping Mall Plot Plan



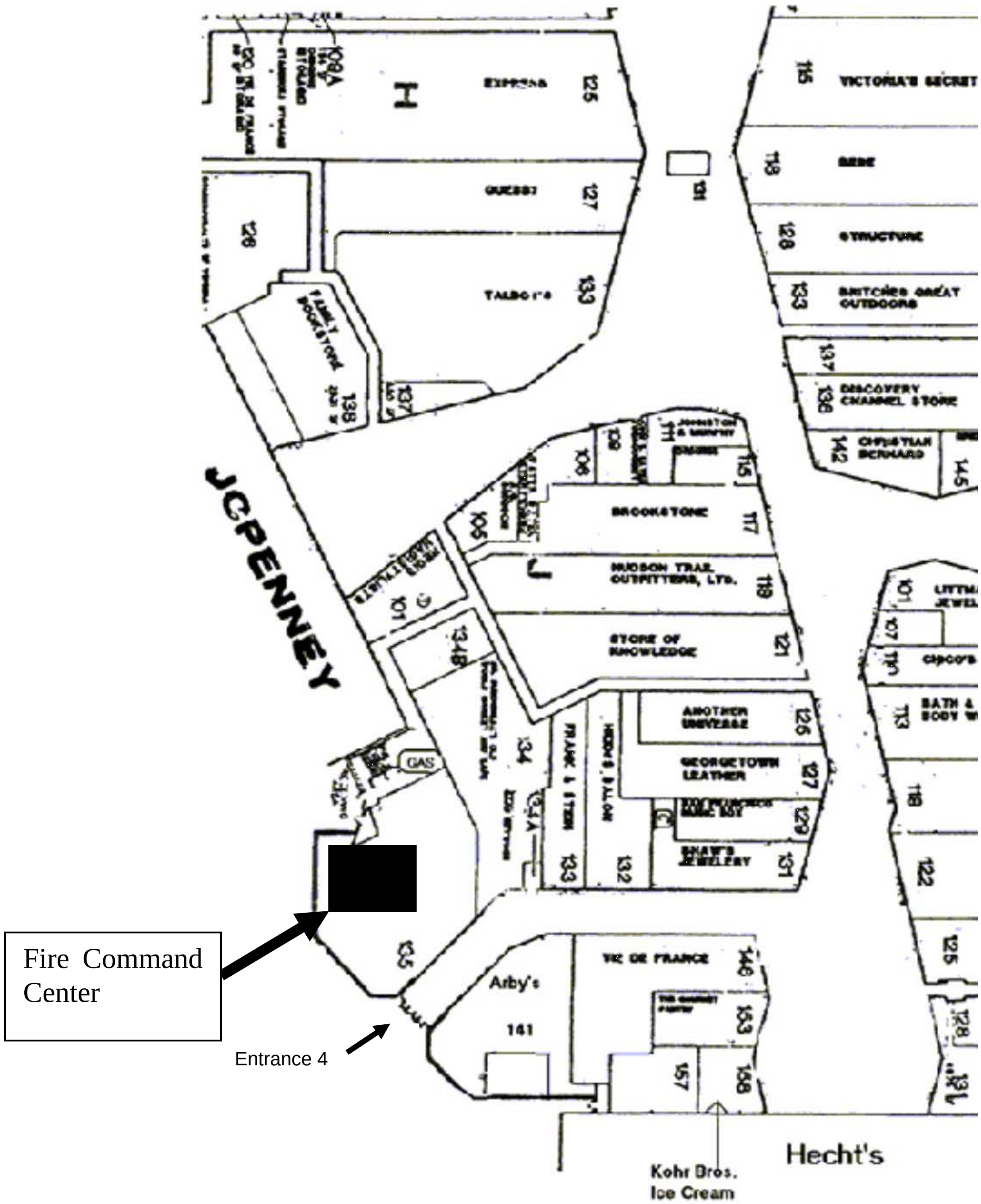
Shopping Mall Plot Plan



Shopping Mall Plot Plan



Shopping Mall Plot Plan



Activity 9.1 (cont'd)

Central City
Incident Locator Preplan
Columbia Mall

SPRINKLER ZONE 1	SPRINKLER ZONE 2	SPRINKLER ZONE 3
1. Jones Shoes 2. Johnson's Fashions 3. Office Providers 4. Multi-Screen Theaters 5. Bert's Drug Store 6. Phil's Steak and Cheese 7. Doctor John Offices 8. Central Women's Store	1. Tri-City Toys 2. Jeffries Department Store 3. U.S. Cards 4. Personal Things 5. O'Neil's Gifts 6. Bob's Dental 7. Murgallis Fine Dining 8. Phelps Dollar Store	1. Gaines Electronics 2. MacDonald's Running Store 3. Mall Conference Rooms 4. Maxine's Pets 5. Central Specialty Foods 6. Tomorrow's Fashions 7. Cooking Things
	SPRINKLER ZONE 4	
	1. Women Today 2. Shoe Family 3. Harrison's Restaurant 4. China Specialty Store 5. Dancing Dan's Furniture 6. Josephine's Furnishings 7. The Arcade 8. Goode Hunting Equipment 9. Boyd's School Supplies	

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Activity 9.1 (cont'd)

Occupancies at Columbia Mall				
Alphabetical List	**Sprinkler Zone**	**Smoke Detector Zone**	**Entrance**	**Heat Detector**
Bert's Drug Store	1	A	Clock	AA
Bob's Dental	2	A	Fashion	AA
Boyd's School Supplies	4	B	Grand	**N/A**
Central Specialty Foods	3	C	Stable	CC
Central Women's Store	1	A	Clock	AA
China Specialty Store	4	B	Grand	**N/A**
Cooking Things	3	C	Stable	CC
Dancing Dan's Furniture	4	B	Grand	N/A
Doctor John Offices	1	A	Fashion	AA
Gaines Electronics	3	C	Stable	CC
Goode Hunting Equipment	4	B	Grand	**N/A**
Harrison's Restaurant	4	B	Grand	BB
Jeffries Department Store	2	A	Clock	AA
Johnson's Fashions	1	A	Clock	AA
Jones Shoes	1	A	Clock	AA
Josephine's Furnishings	4	B	Grand	**N/A**
MacDonald's Running Store	3	C	Stable	CC
Mall Conference Rooms	3	C	Stable	CC
Maxine's Pets	3	C	Stable	CC
Multi-Screen Theaters	1	A	Clock	AA
Murgallis Fine Dining	2	A	Clock	AA
Office Providers	1	A	Clock	AA
O'Neil's Gifts	2	A	Clock	AA
Personal Things	2	A	Clock	AA
Phelps Dollar Store	2	A	Clock	AA
Phil's Steak and Cheese	1	A	Clock	AA
Shoe Family	4	B	Grand	**N/A**
The Arcade	4	B	Grand	**N/A**
Tomorrow's Fashions	3	C	Stable	CC
Tri-City Toys	2	A	Clock	AA
U. S. Cards	2	A	Clock	AA
Women Today	4	B	Grand	**N/A**

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UNIT 10: TRANSPORTATION INCIDENTS

TERMINAL OBJECTIVE

At the end of this unit students given a simulated major fire scenario, will be able to, coordinate, and control tactical resources and implement a plan of action based on critical cues, information gathered and critical elements presented during a transportation related incident.

ENABLING OBJECTIVES

The students will be able to:

1. *Analyze a case study to identify the responsibilities of the Incident Management Team (IMT).*
2. *Determine critical factors in a transportation incident.*
3. *Perform the IMT roles assigned in order to effectively manage a train derailment incident.*

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TRANSPORTATION HAZARDS--GENERAL INFORMATION

Transportation and pipeline incidents require technical advice for strategy development. They overload department equipment with the size and complexity of the response required, and often require multiagency involvement.

Five general types of vehicles can be involved in transportation hazards.

1. **Air transportation** includes hazards both at airports and in approach paths.

2. **Sea transportation** hazards include incidents in port and in open water.

3. **Rail transportation** hazards include those on the rails and the surrounding land and occupancies.

4. **Ground transportation** hazards include primarily major thoroughfares, such as interstate highways.

5. **Pipelines** include both liquid transportation such as gasoline and fuel oil, as well as natural gas pipeline transmissions.

The contents being transported affect the hazard. For example, the number and types of passengers and their locations within the vehicles, the type of cargo (hazardous material (haz mat)) and the relationship between the people and the cargo all will affect the incident strategy.

Transportation hazards are regulated by a number of agencies, including the Department of Transportation (DOT), Federal Aviation Administration (FAA), National Transportation Safety Board (NTSB), U.S. Air Force, U.S. Coast Guard (USCG), the Environmental Protection Agency (EPA), and various State and local agencies.

PREINCIDENT PREPARATION FOR TRANSPORTATION HAZARDS

Transportation incidents may be multicasualty and include both fire and haz mat. In each type of incident there are considerations that require planning before the incident occurs. In a multicasualty incident there will be emergency medical services (EMS) considerations. How will victims be transported? What hospitals are available? When fire is involved, exposures must be considered. What is the content of the vehicle and what hazard is the vehicle fuel tank presenting? What haz mat is involved, is there outside agency involvement, and what special types of equipment are required? The geography of the hazard location and the wind direction and speed may affect the course of the incident.

Become familiar with all transportation routes within the community and the types of cargo common to your community. Develop a working relationship with other support agencies such as law enforcement, local public works, and local EPA. Through these relationships, an understanding of the responsibilities of all involved agencies can be determined before the incident occurs.

INCIDENT CONSIDERATIONS FOR TRANSPORTATION HAZARDS

The primary concern is for life safety. Evacuation and search and rescue may be required. Ensure the safety of fire department personnel through a coordinated and controlled effort using the Incident Command System (ICS). Transportation incidents involving large numbers of people may require special multicasualty procedures such as triage, treatment, and transport.

Haz mat incidents require decontamination. Know the answers to these questions: What are the onscene capabilities of the fire department? How will you decontaminate large numbers of victims before transporting to a hospital? Who is in charge of a haz mat incident?

Fire incidents require confinement of the fire and protection of exposures. What type of extinguishment materials will be used? Should the fire be permitted to continue burning?

During overhaul, prevent rekindle and preserve the incident information and evidence. Is haz mat involved in the cleanup operation? Are other agencies required to be involved?

PIPELINE TRANSPORTATION HAZARDS--GENERAL INFORMATION

Although most pipelines are found underground and contain some form of fuel (liquid or gas), pipelines (or portions of pipelines) may be found aboveground and may be used to transport a wide variety of compounds or chemicals necessary for manufacturing, food processing, and other applications.

Although an underground pipeline may be safer, the fact that it is not visible makes it more hazardous in some ways. Roadways and utility right-of-ways may be above the underground pipelines. Maps can be supplied by the pipeline transportation company, and should be coordinated with department maps and carried on Command vehicles. Are you aware of the types of street/ground markings in your community?

Pipelines may be made of welded steel (such as interstate transmission lines); these are underground and have some degree of flexibility. They may be made of polyvinyl chloride (PVC), which often is located both above and below ground and has good flexibility. Iron is not flexible and is easily fractured, but is often used in local distribution. Know how to contact the appropriate personnel either on the fire department haz mat team or the pipeline/utility company employees when a pipeline needs to be plugged or sealed.

Pipelines may contain liquid or gas. Liquids are carried in larger lines. Lines under pressure may send the product into the atmosphere if ruptured. Natural gas is lighter than air and will disperse into the atmosphere. Have evacuation procedures in place. Liquefied petroleum gas (LPG) is heavier than air and will hug the ground and migrate to low areas. This will affect evacuation actions.

If a pipeline incident occurs, one of the first considerations is how to shut down the line. Identify who knows where the control systems are located and how they work. Know how to contact local pipeline transmission companies and what the notification and shutdown time will be. When shut down occurs, the method of control may change. A reduction in pressure to liquid fuel lines may result in flowing liquid.

Knowledge of leak detectors, central alarms, sprinkler systems, and standpipe systems will affect command decisions. Know where they are located and who monitors them. Access and control issues should be addressed before an incident occurs. Ensure that utility companies are dispatched if an incident occurs, and then manage the representatives when they arrive. Be aware of the EPA's ability to commit funds to acquire equipment or supplies that are not readily available in the community.

PREINCIDENT PREPARATION FOR PIPELINES

Command personnel should be aware of the following issues in order to preplan effectively:

- location of lines within your community;
- where to assign representatives from owners or operators when they arrive;
- construction and methods of sealing pipelines;
- access to pipeline; and
- control points.

Before an incident occurs, develop a working relationship with operators. This relationship will affect nearly all Command decisions. Know the capabilities of the haz mat response team. What is the expected response time? Is the team local, neighboring, or private?

INCIDENT CONSIDERATIONS FOR PIPELINES

Protection of life safety may require evacuation, fire/leak containment, search and rescue, decontamination, and provision for medical assistance. Evacuation will depend on geography, wind direction, and staffing needed. Leak containment affects evacuation decisions as well as the positioning of equipment and personnel. Ensure that the area is safe before beginning search and rescue procedures, then track and document the search. Providing medical assistance for victims found in rescue operations must be coordinated with the decontamination process at the scene and at the hospital. Consider a separate branch for medical operations.

High-pressure burning product usually is dissipated into the atmosphere. Control of the flow must be established before fire extinguishment. Before overhaul, ensure complete shutoff of the product flow. Keep units on the scene long after extinguishment to ensure that the fire does not rekindle. Finally, consider who will accomplish clean up and what type of support the fire department will be required to provide.

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Activity 10.1

San Bernardino Train Derailment and Pipeline Incident

Purpose

To identify issues related to sizeup, decision making cues, Command structure, and preincident planning (PIP) for the pipeline incident.

Directions

1. Refer to the case study material in the Student Manual.

2. For the first simulation role you will be playing the next day, develop a list of actions that you must take to successfully perform that ICS function to lead or support the incidents.

   Command

   Determine the pipeline Incident Objectives and determine the strategies for the incident.

   a. **Incident objectives:**

   ____

   ____

   ____

   ____

   b. **Strategies:**

   ____

   ____

   ____

   ____

Operations

a. What are the appropriate Tactical Operations you would select for the pipeline incident?

____

____

____

____

b. What is your ICS organization for the Operations Section? Provide for an Operations Section Chief and whatever Branches are needed. Draw the ICS organization for the Operations Section.

____

____

Planning

Understand the present Plan "A" and develop a Plan "B" for a worsening situation. Describe your Plan "B."

____

____

____

____

____

____

____

____

Logistics

What functions in the Logistics Section would you need to provide as the Logistics Section Chief at the pipeline incident? Draw the ICS organization for the Logistics Section.

____

____

Safety

a. Write a general Safety Plan for the pipeline incident.

____

____

____

____

b. Does there have to be an Assistant Safety Officer-Hazardous Materials (ASO-HM) at this incident?

____

____

____

____

Liaison

a. Where would you establish a Liaison Area for all outside agency representatives?

____

____

____

____

b. What outside agencies would you expect to interface with?

____

____

____

____

Public Information

a. Where would you establish a Public Information Area?

____

____

____

____

b. How often would you provide information to the media?

____

____

____

____

Activity 10.1 (cont'd)

Case Studies

On The Job
by Alan Simmons
California Train Derailment and Pipeline Explosion Devastate San Bernardino

At 7:41 a.m. on Friday, May 12, 1989, 911 operators in the city of San Bernardino, California, received a report of a "train versus auto" at an intersection in the northwestern section of the city. Fire department dispatchers sent a single engine company to what appeared to be a routine incident. As San Bernardino City Fire Department (SBCFD) Engine 223 pulled out of quarters, crew members observed a tremendous cloud of dust in the air and could not imagine what connection this might have with the incident. Within a few minutes, however, they were confronted with an overwhelming and stunning event that would live forever in their memories. Ironically, the same platoon would face an equally overwhelming incident in the same location at approximately the same time, 13 days later.

The SBCFD protects a population of 135,000 people spread over 54 square miles. The city consists of heavy industry, several commercial districts, high-rise structures, residential areas, a major Air Force base and heavy brush covering the steep foothills of the adjoining San Bernardino National Forest. The SBCFD has 11 stations housing 11 engines, two trucks, one heavy rescue and one air utility. All engine and truck companies are manned by three firefighters with a total department complement of 192 personnel. Fire Chief Richard Moon commands the department with one deputy chief and eight battalion chiefs.

Climatically, the city is hot and dry during the summer months with mild temperatures reigning the rest of the year. The area is subject to unforgiving northeast winds that are channeled through the Cajon Pass during Santa Ana wind conditions. The most devastating fire in recent history was the "panorama fire" on November 25, 1980, when 100-mph winds swept an incendiary fire down the steep slopes of the San Bernardino National Forest and into the residential flatlands, destroying 232 houses.

As San Bernardino City Engine 223 responded toward the dust cloud, 911 operators were deluged with calls from people on Duffy Street, San Carlos Avenue and Donald Street, all reporting a train derailment into houses. The response was upgraded to a structure assignment and two engines, a truck and a battalion chief were added. Engine 223 Acting Captain Allen Simpson remembers arriving on Duffy Street: "I was stunned by the sight in front of us.

There were twisted railroad cars perched on top of flattened houses and everything was covered with gray silt."

Battalion Chief Ron Izard, responding from headquarters, completed a preliminary size up by driving the perimeter of the incident before committing himself to the Duffy Street location. Chief Izard states: "By using a perimeter size up, we ascertained that all the rail cars involved were identical hopper cars. You can't haul hazardous materials in open gondola cars, so we immediately knew that we didn't have any hazardous materials involved and we were able to concentrate on other aspects of the incident."

Nearby, Engine 75 of the Central Valley Fire Protection District, which borders San Bernardino on the northwest side, responded on a still alarm and arrived shortly after Battalion Chief Izard. The incident command system (ICS) was initiated with Chief Izard as the Duffy Street incident commander (IC) and the Engine 75 officer as the rescue group supervisor. Engine 223 members relayed to the IC that people were trapped in some of the houses, but they still were unaware of how many railroad personnel were trapped.

Additional fire department resources were requested by the IC: Some units were assigned to the triage center and others to rescue operations. The incident was divided into three divisions: north, south and east. Incoming companies were assigned to these sectors to carry out search and rescue.

An off-duty Central Valley firefighter and two Southern California Gas Company employees had extricated the train engineer from the lead engine minutes after the accident occurred. He was transported to a hospital with multiple traumatic injuries. Chief Izard assigned his aide to walk the length of the completely derailed train to locate any other rail employees and count the cars.

There were four lead engines with 69 cars, followed by two helper engines in the rear. All 69 hopper cars were filled with a sodium carbonate product weighing more than 8,000 tons. Two rail employees emerged from the rear engines with relatively minor injuries and informed rescuers that there were five railroad personnel aboard the train. This left two unaccounted for and presumed trapped.

Police, who had arrived early in the incident, informed IC that a woman had reported her two children trapped in their house. Chief Izard directed rescue efforts at the house, which was three quarters demolished. As additional engine companies arrived, crew members searched the remaining damaged houses with negative results.

At 8:10 a.m., 29 minutes into the incident, SBCFD Deputy Chief Jim Knight relieved Chief Izard as IC, reassigning him to operations. Additional city services were summoned and power and gas utilities were shut off in the affected area. A mobile command post was dispatched; barricades, shoring, a foam unit, backhoes, skiploaders and a tractor were requested. The Southern Pacific Railroad wrecking crew arrived and obtained the necessary cranes, which included two 100-ton derrick cranes, and crews for rescue.

Fire Chief Richard Moon responded to the Emergency Operations Center (EOC) where the police chief and other department heads were gathering to make functional and policy decisions.

The EOC kept track of the situation and the resource status of the incident. Chief Moon stated that cellular phones at the command post were valuable in maintaining communications rather than relying on radios. At 10:30 a.m., Chief Moon delegated a battalion chief from dispatch to replace him at the EOC while he responded to the command post where he remained throughout the incident.

Unfortunately, after considerable digging by fire crews, two expired children were discovered in the house where they had been trapped. Another report indicated that a Duffy Street resident also was missing, along with a brakeman from the train. The conductor's body had been found in the lead engine; his removal required cutting torches to penetrate the heavy steel of the engine's cab.

Due to the mass destruction at the scene, Chief Knight realized that any rescue attempt of the missing individuals could be time-consuming because rescuers did not know where to begin. Then, through the California Office of Emergency Services (OES), he requested that search dogs from the California Rescue Dog Association (CRDA) be flown to the scene. These dogs are trained to find people trapped in earthquakes or similar situations. Rescue crews waited five hours for the dogs to arrive. As Chief Izard says: "There was no place to dig except everywhere. The material was like snow, covering all the houses that were damaged." Seven houses were destroyed by the runaway train: one completely flattened and covered with cars; the remaining six were in various states of collapse and covered with thousands of tons of soda ash.

One Duffy Street resident indicated that her son, who was unaccounted for, had been asleep on the couch in their house, five minutes prior to the accident. As rescuers feared, the victim lived in the house that had been demolished and had rail cars piled on top. Says Chief Izard: "The debris from the house was four or five feet deep. Combined with the eight or 10 cars stacked on top and the load they were carrying, we had a pile of debris 35 feet high with rail cars sticking out all over."

The CRDA arrived by air from the San Francisco Bay area at 4 p.m. Rescue personnel were removed from the area around the victim's house. Two rescue dogs scoured the area. One dog gave a single bark to alert rescuers to the pile of debris over the victim's house. Along with additional scratching in a 10-foot diameter by both dogs, a sketched floor plan of the house and an estimation of the point of impact, rescuers were able to pinpoint an area to begin excavation. After hours of careful digging, shoring and support of the unstable rail cars by derrick cranes, the victim was found alive at 9 p.m. After another 90 minutes of digging and additional debris removal, he was lifted out of the remains and transported to a hospital where his injuries were labeled serious but survivable.

During the entire time that rescue operations were progressing, Chief Knight was extremely concerned about a 14-inch pipeline buried directly under the area where all 69 cars and six engines lay derailed. The pipeline was the main product transportation line between South California and Las Vegas, Nevada, carrying three million gallons of gasoline each day at pressures exceeding 1600 psi. Located adjacent to the railroad right of way, the pipeline ran four to eight feet underneath the backyards of the homes on Duffy Street. Chief Knight took extra precautions to ensure that heavy rescue equipment was not operated over the line and removal of the cars during the following days was done with the utmost regard for the integrity of the pipeline and the safety of personnel involved.

During the period of rescue and rail car removal, the pipeline company shut down the line. However, due to the faulty operation of a check valve, several hundred thousand gallons of gasoline remained in the line under high pressure. After the rail cars were removed successfully, the pipeline company made several spot checks and examinations of the line and determined that it had received no damage from the accident. On May 16, 1989, gasoline again was allowed to flow through the pipeline at 1600 psi, delivering it over the Cajon Grade to the High Desert and on to Las Vegas.

On Thursday, May 25, 1989, SBCFD "B" platoon had just come on duty when members received an alarm for a structure fire on Donald Street in the vicinity of the train derailment 13 days earlier. Engines 223, Truck 224, Squad 222, and Battalion Chief Ron Izard were enroute to the second major incident to devastate the same Duffy Street neighborhood within two weeks.

While the SBCFD units were responding, 911 operators were receiving many calls reporting a flaming geyser of gasoline with people trapped in several burning houses. Residents of Duffy Street reported a large rumbling sound followed by a sound of rain hitting their homes. One Duffy Street resident looked out her window and saw an enormous stream of liquid shooting several hundred feet into the air, cascading fuel onto the roof of her house and her neighbor's roof. As she and her grandson ran toward the rear of the house, everything turned red. Fortunately, they were able to escape through a window and over a rear fence to safety.

Arriving on the scene first, Battalion Chief Izard reported heavy fire conditions with seven to 10 houses fully involved. He immediately asked fire dispatch to double the assignment and initiated ICS. Deputy Chief Knight saw the column of smoke from headquarters and responded to the scene. Says he: "While responding, I could see flames from three miles away."

First arriving Engine 223 laid a four-inch supply-line down Donald Street and proceeded as close to the radiant heat as possible. The deck gun was turned on the exposures on both sides of the street. Other arriving companies went into heavy stream and hand-line operations to prevent the fire from spreading to additional exposures. All first-alarm companies were engaged heavily in suppression efforts, including the first-arriving paramedic unit whose manpower was needed to assist in line placement. Chief Knight states: "We were able to hold the fire to the first 10 houses already involved upon our arrival." These 10 houses were the initial buildings doused with the gasoline before it ignited. Six others were damaged, but were saved from total loss by firefighting efforts.

In contrast to the scene two weeks before when residents waved in arriving firefighters, residents at this incident were running over and into each other in an attempt to get out. Chief Izard says: "As we approached the incident from Highland Avenue (the main street accessing the area), we passed a head-on collision and as we turned onto the residential streets, we passed two more collisions. No one was trying to show us where the incident was; they just wanted out."

Chief Knight arrived approximately 10 minutes into the incident, set up a command post and assumed the role of IC. He divided the scene into four divisions: two suppression, one rescue and one to prevent the burning gasoline from flowing through a culvert under Highland Avenue. Three strike teams of mutual-aid companies from surrounding communities were ordered. This gave Chief Knight 15 engine companies at his disposal and three additional battalion chiefs. Two of the strike teams were used; the third was released.

It was estimated that during the five hours the fire burned, 400,000 gallons of gasoline was consumed. The product spewed out of the broken line on a 45-degree angle toward the houses on Duffy Street, across from the break.

For the first two hours, the gasoline almost was consumed completely as the thermal column carried the flames 200 to 300 feet into the air. The heat radiating downward from the thermal column was felt as far away as 500 feet. The radiant heat actually melted the suspenders of an engineer wearing full protective turnouts while operating at a pump panel. Chief Knight states: "We could feel the heat easily at the command post several hundred feet away. The firefighters working the structure fires were taking a real beating."

A triage center was set up near the command post to treat the injured residents. Several burned victims were walking around the neighborhood, some in a shocked and dazed condition. A paramedic squad was assigned to rove the neighborhood street to bring injured people to the triage site. Thirty-one people were injured, six seriously. Burned or injured animals were handled by animal control officers.

One hour into the incident, the pipeline was confirmed shut down by the pipeline company. The same check valve that failed to operate during the train accident, leaving the pipeline highly pressurized, also failed during the fire, causing eight miles of liquid to backflow through the break. Two hours after the initial rupture, the pressure began to subside, resulting in a gradual reduction of the thermal column to a flame height of 30 feet. The structure fires were controlled within the first hour with exposure protection continuing until the radiant heat was no longer a threat.

By 1 p.m., the pipeline fire was declared extinguished. Overhaul of the structures continued and fatality assessment began. Two adult bodies were found amid the ruins of Duffy Street.

SBCFD firefighters faced two demanding tragedies within two weeks of each other. Each of the incidents amounted to more than what many firefighters across the nation might face in a career. Many of us think of and prepare for that incident that never happens. In this case, it did.

Alan Simmons, a Firehouse *correspondent, is a captain with the Burbank, California, Fire Department.*

Rail Crash Buries
San Bernardino in Tragedy —

At 0736 hours on Friday, May 19, 1989, a southbound Southern Pacific freight train loaded with in excess of 8,000 tons of sodium bicarbonate product lost control on the Cajon Pass main line. At the bottom of the two-percent grade, the train—four lead engines, 69 cars and two rear-end helper engines—derailed in a quiet northwest neighborhood of San Bernardino city.

The "Duffy Street Incident," as it became known, made national news for its successful handling and dramatic rescue. Here, two principals in the response give a chronological account of the activities on that fateful day.

By Jim Knight

Deputy Chief, San Bernardino F.D.

And

Gene Brooks

Division Chief, Senior Heavy Rescue Instructor

Loma Linda F.D.

The initial report was of a car vs. train. However, early reconnaissance units led by San Bernardino City Battalion Chief Ron Izard were greeted by something much more serious-and horrifying.

Numerous homes lay smashed and destroyed, some totally moved off their foundations. Their residents clamored around the firefighters, begging for assistance in locating family and friends.

Izard immediately initiated an upgraded response. Joint response Engine 75 from the Central Valley Fire Protection District Station 10 blocks away arrived next. Engine 75's Captain Jerry Almond had witnessed a monumental cloud of dust on his way to work that morning and launched an engine response upon reaching quarters.

Incident Commander Izard assigned Engine 75 the responsibility of rescue group supervisor. Responding city units were directed to a centralized triage site, until it became evident that hardly any walking wounded needed assistance, except for one adult male, who was treated for chest pains.

Other incoming resources were immediately assigned to assist established rescues in progress.

Off-duty Central Valley Firefighter John Flesher, with the assistance of two Southern California Gas Company employees, had completed extrication of the head-end engineer. He had multiple traumatic injuries and was transported by ambulance.

Two crewmen who were ambulatory emerged from the rear helper engines. They were also transported, for observation.

Izard was relieved by Deputy Chief Jim Knight at 0810. Izard then took over Operations. Aided by the police department's K-9 dogs, they began a general search of the accident scene, as several residents were still unaccounted for.

Two deceased juveniles were soon located. Strong credible reports still indicated, however, that a male, age 24, had been in his home at the time of the crash, but had not been seen since.

Almond initiated a debris search, but it was discontinued because of the unstable condition of the structures.

Meanwhile, B/C John Banfield was assigned responsibility for extricating the train's conductor. A borrowed exothermic cutting torch was used to cut the structural members of the lead engine's cab.

At this point, two victims were still unaccounted for. One was the train's brakeman, thought to be riding in the cab of the third lead engine. It was now upside down and appeared to be completely buried immediately over the CAL NEV pipeline.

The second missing person was the previously-mentioned Duffy Street resident, Chris Shaw, who was positively identified as being in his house five minutes prior to the incident. The probability was high that he was still in his completely destroyed home.

Resisting advice to immediately bring in heavy equipment to move debris, now-Incident Commander Deputy Chief Jim Knight of San Bernardino City Fire made arrangements through the California Office of Emergency Services (OES) to have California Rescue Dog Association (CRDA) search dogs flown in.

Considerable concern was centered upon possible damage to the CAL NEV pipeline, and representatives from that firm were directed by the IC to initiate and continue shutdown and drainage of their line.

Southern Pacific Railroad personnel were asked to obtain necessary cranes and crews for rescue support. This would consist of lifting and supporting the rail cars laying across the smashed houses. Two 100-ton derrick cranes arrived at approximately 1400 hours and were staged in front of Chris Shaw's house.

A local house-moving contractor was commissioned to supply heavy timber shoring and hydraulic lifting jacks. Night lighting was also going to be a necessity, and a three-million-candlepower light tower was contracted.

Southern Pacific Railroad personnel and logistical support included vice presidents, division supervisors, car-shop and maintenance-of-way foremen and engineers from the locomotive shops.

At 1415 hours, IC Knight requested mutual aid personnel from the city of Loma Linda Department of Public Safety. He asked that Gene Brooks, division chief and a state senior heavy rescue instructor, assist in debris and tunnel shoring. Shutdown of the CAL NEV pipeline was still in progress.

DC Brooks, assigned to relieve the rescue group supervisor, requested three eight-person digging and debris-removal teams. They would rotate in 20-minute shifts.

Now, Knight's resources were effectively handling the situation so far, but this additional request for 24 personnel represented a real challenge. One crew of San Bernardino fire personnel and two crews from the city's Department of Public Works were mustered.

It was felt that vertical shafts with horizontal laterals appeared to be the safest, most-logical approach, due to the stacked nature of the railroad wreckage and slight laminar appearance of the structural debris.

Prior to arrival of the CRDA dogs, Rescue Supervisor Brooks surveyed the Shaw house and compared its features with other houses in the neighborhood. He then sketched a sample floor plan. Nancy Bohl, a city contract psychologist, approached the distraught Shaw family to have it verified. A revised floor plan was returned, and Brooks and a Southern Pacific car shop foreman surveyed the immediate debris pile in the area of the house to identify potential problems and assess the wrecked cars on top of the structure.

Now two CRDA dog handlers, Shirley Hammond and John Koerner, arrived with Cinnamon, a female Doberman, and Alf, a German Shepherd.

At 1930 hours, Gary Heston, an assistant heavy rescue instructor from Lake Arrowhead Fire who is also a ham radio operator (W6K VC), installed an amateur television link back to the command post to allow the IC and OPS chiefs a visual and audio picture of the rescue scene.

After all personnel in the area of the Shaw house and upwind were relocated, Cinnamon and Alf were given free rein to survey the area. Atop a debris pile, in the immediate vicinity of the house, Cinnamon gave a single initial barking alert. Subsequent scratching in the debris by both dogs centered on a 10-foot-diameter area of the still-unknown location of the victim. As subtle as these indicators were, they would later prove accurate.

Based on these alerts, plus the visible remains and drawn floor plan of the Shaw house, as well as an estimation of the impact direction and the fact that this point was in a central, accessible entry area, rescue work would begin here.

First, all loose sodium bicarbonate product and building debris in a six-foot-wide-by-30-foot strip across the front of the house was removed. Excavation down to the virgin soil was by hand. Each progressive strip advanced three to four feet into the pile. Discarded material was removed by skid loader.

This process uncovered numerous small voids that allowed the dogs deeper access. Exposed structural members that projected into the space being cleared were cut off with chain saws.

Once the first debris removal cleared a strip immediately in front of the rescue area, the derrick cranes were set up to support hopper car number two, which had landed on the house. As work continued, the two 100-ton cranes would support the car against the anticipated settling and shifting.

At 2030 hours, DC Brooks was relieved by San Bernardino BC Charles Martinez as rescue group supervisor. Brooks returned to the ICP and debriefed with Izard and Knight.

At 2100 hours, excited rescuers came up to the command post requesting that paramedics be dispatched to the excavation site. Had someone been injured? Knight asked. No, the answer came, "He's alive-they've found him alive!"

DC Brooks returned to the excavation site and rejoined the rescue operation. He was informed by San Bernardino City Firefighter/paramedic George Avery that he (Avery) had first seen moving fingers in a void.

The victim was conscious and answered quickly when Brooks called him by name. His first words were, "I'm Chris Shaw, and are my mother and sister all right?"

Avery had been probing and examining the debris face of the third strip when he found a small six- or eight-inch void that had been filled with fiberglass house insulation. The fiberglass was removed, and Avery, aided by a flashlight, identified the victim's face close to the opening.

Avery would remain by the victim for the rest of the rescue to keep everyone apprised of the young man's condition. He was to give immediate notification of anything amiss by raising his clenched fist in the air and calling "All stop!"

The victim was determined to be in a semi-fetal position, completely buried below the level of his face and left hand. He complained only of minor back pain and said he had prayed "every time I heard you leave," possibly referring to crew rotation.

Personnel were now pulled off the pile directly above the victim. Product removal was accomplished with long-handled shovels to prevent cave-ins. A moment of extreme tension occurred when a large 800-pound car coupler was uncovered and then tumbled down the face of the debris. Fortunately, it landed to the left of the victim and rescuers.

Engineer Vince Gates, an assistant heavy rescue instructor, was assigned the immediate chore of identifying the victim's exact body position. At approximately 2145, the third and fourth strip of debris were removed, uncovering Shaw's upper torso. He was immediately placed in a cervical collar, and his vital signs monitored.

Excavation was progressing from three directions: down from above, laterally from the face of the debris pile and laterally from the right side of the debris pile. The victim's feet were uncovered on the right side, helping determine his location as against or under a large 3,000-pound railroad car wheel set side frame.

Excavation was continued from under this considerable obstacle until the victim's legs were discovered crossed with one leg under the side truck frame. Continued lateral excavation eventually provided enough of a "maneuvering zone" (one to two inches) to remove Shaw without lifting the still half-buried frame.

Shoring procedures consisted of two-by-four cribbing blocks supporting an impromptu ¾-inch plywood "roof" over the victim, as well as a 12-by-12-by-12 inch horseshoe-shaped arch to support the dome over the victim's face.

As the level of debris was made lower and lower, the victim's air space was protected by a tube made from a plastic bucket which was placed over his head. This also kept out any minimal free-falling debris.

At 2230, the victim was ready to be lifted out of the hole to a backboard. He was fitted with a MAST suit and an exit corridor was established. At 2236 hours, 15 hours-to the minute-after his entombment, Chris Shaw was pulled from the debris of his home.

Summary

Hospital assessment of the victim's condition was "serious but stable, with multiple lower-limb fractures and a slight compression fracture of the lower back." The entire rescue cadre was ecstatic. Not only had a victim been located, but he was alive and would survive his ordeal.

During the Shaw house excavation, the CRDA dogs had also been surveying the overall wreck scene to find possible unknown victim(s) and the still-missing brakeman. Additional crews began extrication in the train wreckage, and his body was recovered at 0300 Saturday morning.

Then, unbelievably, on May 25, at 0805, tragedy struck again. The CAL NEV pipeline, reactivated and operating at capacity, ruptured and ignited. The rupture and resulting fireball created an inferno that further devastated the beleaguered neighborhood.

Lessons Learned

1. Rescue dogs, a new resource to many emergency personnel, were valuable assets. If only they could talk to us! We, as rescuers, must learn to accept the subtle indicators the canines give.

   However, rescuers must also be certain the dogs are alerting on victim's scents. One secluded area had been used as a urinal, and the dogs alerted vigorously on this area. Fortunately, someone was honest enough to identify the source.

2. Victims can, have and do survive the most incredible catastrophes. Always give the victim the benefit of the doubt.

3. Obtaining resources does take time. Plan ahead and don't be embarrassed if resources are called but not used.

4. Amateur television links are a new technology that can be valuable tools if used correctly.

5. The efficient running of an emergency operations center can make the incident commander's job much easier. Purchase orders can be processed, resources identified and suppliers assured of proper payment.

6. The advantages of early setup of an incident command structure cannot be over-emphasized.

7. The early implementation of a Public Information Officer is essential. This major incident required two field PIOs supplying information to a centralized PIO at the EOC.

8. Finally, at some time in everyone's career, all the immeasurable hours of training, classroom instruction, manipulative evaluations, book learning, journal reading, seminar attendance, peer-group discussions and incident critique will pay off. Train, retrain, then train some more; you never know when it will come in handy.

Six Die in Twin Tragedies

James Wait, Acting Division Chief
Pipeline Safety Division
California State Fire Marshal's Office
Sacramento, California

A freight train derailment and a ruptured gasoline pipeline devastate a residential neighborhood in California.

Folklore tells us that lightning never strikes the same place twice. Officials and citizens of San Bernardino, Calif., however, would dispute that saying.

Almost unbelievably, two major disasters occurred on one residential street in San Bernardino in less than two weeks. On Friday morning, May 12, 1989, as commuters were leaving for work and children were waiting for their school buses, a fully loaded Southern Pacific freight train hurtled off the tracks, demolishing a row of houses on Duffy Street. The derailment killed two residents and two railroad employees, and injured dozens.

It is estimated that the train, which had lost its braking ability while coming down the grade from the Cajon Pass, was traveling 90 miles per hour when it left the tracks. The train, with its six locomotives and approximately 70 hopper cars filled with hundreds of tons of trona—a mineral used in manufacturing building products and fertilizer—landed directly on the houses.

Pipeline Below Wreckage

Later that morning, the office of the California state fire marshal (CSFM) learned that a 14-inch pipeline was located directly below the train wreckage. Carrying unleaded gasoline at high pressure to the Las Vegas area, the pipeline was operated by the CalNev Pipeline Company. The pipeline had been purchased recently by the Chicago-based GATX Corporation. In addition to supplying gasoline to the Las Vegas area, it also supplies jet fuel to three air force bases.

In California, hazardous liquid pipelines are regulated by the state fire marshal's Pipeline Safety Division. A pipeline safety engineer was dispatched to the scene and arrived early in the afternoon. His job was to contact various authorities involved in search and rescue and to ensure that they were aware of the presence of the pipeline and the inherent danger it presented.

One of the reasons the fire marshal's staff was so concerned was that six months earlier a train had derailed in the city of Montclair, which is also in San Bernardino County. This derailment also occurred above a gasoline pipeline. The pipeline was punctured while the railroad cars were being removed during salvage operations, causing a spill. Fortunately, there was no fire. The lesson, however, was clear. CSFM pipeline safety engineers worked to ensure that all parties involved in the various phases of search and rescue, salvage, reshaping of the railroad berm, and trona removal at the Duffy Street location were aware of the Montclair incident.

Pipeline Rupture

On May 16, after all railroad salvage was completed, pipeline operations resumed. CSFM pipeline safety engineers and CalNev, the pipeline operator, were convinced that there had been no damage to the pipeline based on various tests and indicators. They determined that there had been no leaks or loss of pressure, and in the many areas where the pipeline had been exposed, there was no visible damage to either the pipe or its coating.

On the morning of May 25, 13 days to the hour after the derailment, the pipeline ruptured, and a stream of unleaded gasoline shot 300 feet into the air and rained down on Duffy Street.

Within approximately one minute, the gasoline and vapor mixture reached an ignition source and erupted in a huge fireball. The fire killed two persons, burned scores of people, and destroyed more Duffy Street homes. These were the first fatalities in the history of CalNev, which has been operating since 1970, and the first pipeline fatalities in California since the passage of the California Pipeline Safety Act of 1981.

Once again, CSFM's pipeline safety engineers rushed to the area, arriving at approximately 9:30 a.m. The pipeline pumps had shut down automatically due

to loss of pressure, but thousands of barrels of gasoline in the pipe still were feeding the fire. After extinguishment in the late afternoon, the pipeline was exposed, revealing a 28-inch rupture. Adjacent to the rupture were several distinct gouges or dents on the surface of the steel pipe. The depth of cover at the point of the rupture was only 2 to 2½ feet. It should be noted that when CSFM staff left on May 16, the depth of cover was 4½ to 8 feet throughout this area.

Investigation

The National Transportation Safety Board (NTSB) formed an investigation team on May 26. The CSFM is a participant in this ongoing NTSB investigation. The section of pipeline containing the rupture and gouges underwent metallurgical tests at the NTSB's laboratory in the Washington, D.C., area. The tests were unable to determine exactly what damage, or during which operations the damage occurred.

The NTSB investigation involved thousands of persons and hours of analysis and interviews. A week-long public hearing was held in late summer 1989. While the final report is still unavailable as of this writing, it is clear that the cause of the derailment was the overloaded freight train which could not be controlled coming down the steep grade of the El Cajon Pass. San Bernardino sits at the base of this grade. The cause of the pipeline rupture, however, is not as clear. At this point, the cause of the dents and gouges on the pipe in the vicinity of the rupture remains undetermined.

In the aftermath of the tragedy, the government, the parties directly involved, the media, and others are searching for answers. Was human error involved? Are there fatal weaknesses in the system of laws and regulations that apply to railroad and pipeline operations? Were errors in engineering judgment made? Could the emergency response systems have worked better?

California recently enacted a new law which increases the regulation of pipelines located near railroads and calls for further studies of the co-location of pipelines and railroads, a fairly common situation in California.

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James Wait has worked for the state of California for 30 years. During the past 10 years, he has held various management, positions with the state fire marshal's office. In May 1989, Wait became manager of the Pipeline Safety Division. The incident described in this article occurred later in that month.

San Bernardino's Twin Tragedies

Almost unbelievably, one residential street in the City of San Bernardino has been subjected to two major disasters in less that two weeks. On Friday morning, May 12, 1989, as commuters were leaving for work and school children were waiting for their buses, a Southern Pacific freight train loaded with potash hurled off the tracks, demolishing a row of houses on Duffy Street. Two residents and two Southern Pacific employees were killed, and dozens were injured.

It is estimated that the train, which had lost its braking ability while coming down the grade from the Cajon Pass, was traveling 90 mph when it left the tracks. This train, with its six locomotives and approximately 70 "hopper cars" filled with hundreds of tons of potash, landed directly on these houses.

Later that morning CSFM management became aware that there was a 14 inch CalNev pipeline directly below this train wreckage. A Pipeline Safety Engineer from our West Covina office was dispatched to the scene, arriving early in the afternoon of May 12. His mission was to establish contact with the various authorities involved in search and rescue and to ensure they were aware of the presence of the pipeline and the inherent danger.

One reason for concern was that just six months earlier, a train derailment occurred in the City of Montclair in San Bernardino County. This derailment was also above a gasoline pipeline, and during salvage operations (removal of the railroad cars) the pipeline was punctured, causing a spill. Fortunately, in the Montclair case, there was no fire. CSFM Pipeline

On May 16, after all railroad salvage was completed, the pipeline operation resumed. CSFM Pipeline Safety Engineers and CalNev, the pipeline operator, were convinced there had been no damage to the pipeline, based on various tests and indicators. There had been no leaks or loss of pressure, and in the areas where the pipeline had been exposed, there was no visible damage to either the pipe or its coating.

On the morning of May 25, thirteen days after the derailment, the pipeline ruptured, sending a stream of unleaded gasoline shooting hundreds of feet into the air - raining down on the (remaining) homes of Duffy Street.

Within approximately one minute, this gasoline and vapor mixture reached an ignition source and erupted into a huge fireball. Two persons were killed, scores were burned, and still more Duffy Street homes were destroyed.

Once again CSFM Pipeline Safety Engineers were rushed to the area. The pipeline pumps automatically shut down (due to loss of pressure), but there were still thousands of barrels of gasoline in the pipe feeding the fire. After extinguishment, the pipeline was exposed revealing a 28' rupture. Adjacent to the rupture were several distinct gouges or dents on the surface of the steel pipe. The "depth of cover" at the point of rupture was only 2 to 2½ feet. It is important to note that when CSFM staff left on May 16, the depth of cover was 4½ to 8 feet throughout this area.

The National Transportation Safety Board (NTSB) formed an investigation team the morning of May 26. The CSFM is a participant in this ongoing NTSB investigation. The section of pipeline containing the rupture and gouges is now undergoing metallurgical tests in the NTSB's laboratory in the Washington, DC area. These tests should tell us exactly what damaged the pipe, and when or during which operation it occurred.

As in the aftermath of all such tragedies, all levels of government, all parties directly involved, the media and others are searching for answers to their many questions.

By James Wait, Acting Division Chief Pipeline Safety Division

"I would like to express my concern and sympathy for the citizens of the Muscoy neighborhood of San Bernardino. Hopefully the findings of the California State Fire Marshal and the National Transportation Safety Board will provide us with the answers to avoid this type of tragedy in the future."

- James F. McMullen

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Activity 10.2

Train Derailment

Purpose

To perform the IMT roles assigned in order to effectively manage a train derailment incident.

Overview

Wednesday March 7, at 0830 hours. Along the Central City Market-Frankford commuter subway-surface transit system, a six-car subway train derailed approximately 400 feet west of the 30th and X Streets station. A traction motor underneath Car 3 had fallen from its bracket dragging along under the car, striking the wooden ties of the track section. Approximately 350 feet into the tunnel from the 30th Street station the traction motor struck a switching gear in the center of the track causing Cars 3 and 4 to derail and crash into the metal beam uprights that support the tunnel.

Cars 3 and 4 were severely damaged with Car 4 being cut in half on impact. The subway system consists of four commuter rail lines, and one set of east and west tracks for the subway cars transit system that normally has six cars in a train. A second set of east and west tracks were trolley tracks where the subway/surface trolley cars traveled. The electrical system is a 600-volt direct current electrical power system delivered from remote locations. There is no mechanical ventilation in the tunnel, only vents to the outside. Air movement is natural, assisted by train movement. At the time of the accident the westbound train carried approximately 75 people in each car.

From the entrance at grade level to the subway system, approximately 100 feet west of 30th Street to the scene of the derailment was approximately 1,700 feet and three levels below ground. Power to the system has been disconnected leaving the tunnel in complete darkness. Passengers are wandering aimlessly up and down the track, and many are trapped in Cars 3 and 4.

The next closest access point entrances for the subway/transit system are from grade level at the 20th and 40th Street stations.

UNIT 11: BULK STORAGE FACILITIES AND TANK FARMS

TERMINAL OBJECTIVE

At the end of this unit students given a simulated major fire scenario, will be able to, coordinate, and control tactical resources and implement a plan of action based on critical cues, information gathered and critical elements presented during a bulk storage facility and tank farm incident.

ENABLING OBJECTIVES

The students will be able to:

1. *Analyze the features and characteristics associated with bulk storage facility and tank farm incidents.*

2. *Perform the Incident Management Team (IMT) roles assigned in order to effectively manage a bulk storage incident.*

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BULK STORAGE FACILITIES AND TANK FARMS

Specialized technical advice and multiagency involvement place bulk storage facilities in the target hazard class.

Open Floating Roof Tank Characteristics

A wind girder around the top portion of the tank shell (360°) provides stability for the tank shell. The thickest portion of the tank is at the bottom, the thinnest at the top. A stairway is provided for access from ground level, and a heat shield is provided for protection. The foam outlet provided at the top of the stairs is protected by a heat shield and is pressurized from ground level.

The foam piping system permits foam to be applied to seal the area from ground level. The floating roof is separated from the tank shell by a panograph arrangement or a neoprene seal. This seal is protected by a fabric or metal weather shield. New tanks have a double seal to reduce emissions; this makes a fire inaccessible and more difficult to extinguish.

Floating roofs have drains that can be opened to drain excess water from the roof. Stairs are available to access the roof and wind girder. The roof has vents and manway access points. A drain valve from the roof drain is located at the bottom of the tank to drain excess water from the tank roof.

Certain open floating roof tanks have geodetic-covered tops as a protective covering. These are made of lightweight metal designed to burn away quickly under fire conditions. They provide additional protection against the weather.

Most fires occur around the weather shield area and tank shell. These fires can be extinguished from the wind girder, top of the stairs, or from the floating roof. Breathing apparatus always must be worn. When large portions of the seal area are involved, it is preferable to have at least two hose streams working around the wind girder, in opposite directions. Most wind girders do not have a railing; be careful when working from these girders. If a fire is burning beneath the stairs and preventing access, use portable towers, foam monitors, or streams from elevated platforms. Exercise caution so that excessive amounts of foam do not flow onto the roof, resulting in the roof sinking. An observer should be watching applications closely. If a seal has been burning for a long period of time, apply cooling water to the outside of the tank shell. The need to use cooling water will be indicated by blistering or discoloring of the shell paint. Avoid directing large straight streams of foam or water onto the flammable product at the damaged roof seal: this could intensify the fire. Good foam-aspirating nozzles are needed, regardless of the type of foam used. When foam is delivered from grade level, it is difficult to get sufficient foam into the annular space. Foam has a tendency to flow onto the roof. In this event, immediately open the roof drains to reduce the possibility of sinking the roof. Monitor the drain valve area for product release. If the roof sinks, there will be complete involvement of the entire liquid surface. Flammable liquids normally are stored in these types of tanks.

Covered Floating Roof Tank Characteristics (Internal Floating Roof/Pan)

Characteristics include

- cone roof;
- identified by exterior vents (eyebrows);
- weak seal-to-roof joint;
- roof is designed to separate from the shell joint in the event of an ignition source and explosion;
- roof can remove itself in one piece or in fragments, and parts can travel a considerable distance;
- flammable liquids normally are stored in these types of tanks. Flashpoint is below 100 °F; and
- internal foam system is delivered through fixed foam chambers.

These tanks usually do not hold an ignitable mixture, except during periods of initial fill and up to 18 to 25 hours thereafter. Seal or rim fires are virtually impossible to fight in a covered roof tank with portable fire extinguishing equipment. Side vents are too small to permit access with foam streams directed from ground level. On some occasions, cone roofs have blown off, thus involving the entire surface area. If this occurs, the floating roof or pan may sink, and the fire should be treated as a cone roof fire and extinguished by monitor nozzles or other topside application. Subsurface injection is not recommended, since the roof, either afloat or in a sunken state, could obstruct foam travel to the tank surface.

Cone Roof Tank Characteristics

Cone roof tanks have no floating roof. They appear similar to covered floating roof tanks; however, there are no external side vents at the top of the tank. These tanks have a vapor space between the liquid and the underside of the roof. If this vapor space is in the explosive range and an ignition source is introduced, an explosion will occur. The roof may separate from the shell joint if an explosion occurs. It may separate in one piece, or fragments could travel a considerable distance. Other times it may fall back into the tank or remain intact. Current standards dictate that only combustible liquids are stored in these tanks, but this is not always the case. Consider foam application from internal foam chambers, if available.

Fires normally involve the entire surface area of the tank. Consider two extinguishment options: topside and subsurface. If fire involves a polar solvent, the extinguishment technique is limited to topside application with alcohol-resistant foams only. When topside application is indicated for hydrocarbon fuels, use fixed-foam systems, foam towers, high-capacity monitor nozzles, or elevated platform devices.

Tank Vent Fires

Fires burning in Pressure Vacuum Vents (PVVs) with a yellow or orange flame, and emitting black smoke, indicate that the vapor/air mixture in the tank is above the flammable or explosive limits. This type of fire can be extinguished readily with dry chemical. Fire burning in a tank vent with a snapping blue-red, nearly smokeless flame indicates the vapor/air mixture in the tank is flammable and explosive. As long as the tank is outbreathing through the PVV, the flame cannot pass from the low-pressure side through the PVV into the high-pressure side of the tank. However, extinguishment with dry chemical should be accomplished quickly to avoid flashback into the tank if heat damages the PVV. Reducing the pressure in the tank will extinguish the fire when the PVV closes. This can be accomplished by applying cooling water to the tank roof and shell. Maintain a positive pressure in the tank by introducing fuel gas. When a vapor-rich condition is indicated by the change of flame character, extinguishment can be accomplished with dry chemical.

Fighting Ground and Dike Fires Around Tanks

Extinguish all ground fires first. Apply cooling water as soon as possible to all flame-exposed metal. Close pertinent valves under the cover of water spray. Displace sufficient hydrocarbon with water to produce a water leak rather than a hydrocarbon fire. Water pressure must be greater than the hydrocarbon pressure in the tank. Do not overfill tank. Gain control of dike drains, roof drain, and water drain valves. When tanks that contain a high-flashpoint oil are exposed to ground fires, be aware of the possibility of a flammable mixture being created in the tank that can be ignited by the hot metal tank shell.

Vertical Atmospheric Tank Phenomena

Boilover occurs mostly with crude oil; there must be a major fire involving the entire liquid surface. Boilover occurs only in tanks with no floating roof. When the crude oil burns, the light volatile fractions distill and burn off. The unvaporized hot (300 °F) residue, which is more viscous than the cold oil, begins to sink. As the fire progresses, the lighter fractions continue to distill at the interface between the hot residue layer and the cold crude oil. The burning vapor supplies the heat that continues the distillation. As the residue layer increases in depth, the interface moves downward two to three times faster than the burnoff rate at the oil's surface. The hot residue is called the heat wave layer, and the interface is called the heat wave front. Crude oil tanks normally contain water or wet emulsion bottoms. As the hot interface reaches the water or emulsion in the bottom of the tank, it flashes the water into steam. At 400 °F, water expands 2,000 times, to a frothy steam mixture. A good rule of thumb for the distance a boilover may travel is 10 times the diameter of the tank. Medium crudes are most likely to boil over. To estimate the time of a boilover, check the progress of the heat wave front by applying water to the tank shell, noting the location of the interface by the steam generated above the heat wave front. The heat wave front advances downward about 18 to 36 inches per hour. An imminent boilover generally is indicated by an increase in flame height and brightness. The best method to prevent boilover from occurring is to extinguish the fire rapidly. Foam application should begin within 30 minutes of ignition.

Slopover can result when a water stream is applied to the hot surface of a burning oil, provided the oil is viscous and its temperature exceeds the boiling point of water. Since only the surface is involved, a slopover is a relatively mild occurrence.

Frothover means the overflowing of a tank not on fire when water or volatile hydrocarbons boil under the surface of a viscous hot oil. An example would be when hot asphalt is loaded into a tank car that contains some water. The hot asphalt is cooled initially by contact with the cold metal.

At first nothing may happen; later the water can become superheated.

When it finally starts to boil, the asphalt may overflow the tank car. A similar situation can arise when a tank used for storing slops or residue at temperatures below 200 °F, and containing a water bottom or wet emulsion, receives a substantial addition of hot residue at a temperature above 212 °F. After sufficient time has elapsed for the effect of the hot oil to reach the water in a tank, a prolonged boiling action can occur, which can remove a tank roof and spread froth over a wide area.

Firefighting Agents

Water has the greatest heat-absorbing quality. It is used to cool equipment, structures, and tank shells that are exposed to fire, and prevent or reduce both heat damage and overpressure that result from overheating a vessel. When properly applied, it can extinguish hydrocarbon fires having a flashpoint above 100 °F. Water applied lightly to burning viscous liquids with flashpoints above 2,000 °F can produce a layer of froth on a liquid surface that acts like foam and smothers the fire. It can be used as a displacement medium in leaking hydrocarbon lines, or it may be used to float liquid hydrocarbons above a leak in a tank to interrupt product leakage. Water can be used effectively to control, but not extinguish, fires in low-flashpoint fuels.

Foam is used principally to form a cohesive floating blanket on the fuel surface that extinguishes the fire by smothering and cooling the fuel, and prevents ignition by averting formation of combustible mixtures of vapor and air. Foams are suited particularly for extinguishing two-dimensional flat flammable liquid fires that involve spills or storage tanks. To achieve extinguishment of a tank fire or liquid fire of depth, continuous foam application at the required rate is critical. Unless the required rate of foam is applied and maintained on the liquid surface until a sealing, cohesive foam blanket is established, the fire will not be extinguished.

The formula for required rate of foam to extinguish a tank fire:

Surface area of tank	=	πr^2
Solution required per ft^2	=	0.16
Percent of concentrate being used	=	0.03 or 0.06
Required application time	=	30 or 60 minutes

πr^2 times solution required per ft^2 times percent of concentrate being used times total application time = total gallons of foam concentrate required to deliver the appropriate foam solution for one hour.

For example: 10,000-square foot tank

Step 1: 10,000 ft^2 times 0.16 = 1,600 gallons of foam solution required per minute.

Step 2: 1,600 gpm times 0.03 = 48 gallons of foam concentrate required per minute to produce 1,600 gpm.

Step 3: 48 gpm times 60 minutes = 2,880 gallons concentrate required for a 1-hour application of 1,600 gpm of solution to extinguish a flammable liquid tank fire.

Application rate required for flammable liquids, 60 minutes.

Application rate required for combustible liquids, 30 minutes.

Subsurface Injection

The application rate for this technique is 0.1 gpm per square foot of surface area. The formula is the same as over-the-top delivery. High-back foam makers are required. The inlet velocity of foam into the tank is critical. In the case of flammable liquids, it should not exceed 10 feet per second. Combustibles will tolerate 20 feet per second Subsurface injection is not recommended for internal or external floating roof tanks; it is recommended for cone roof tanks only.

Cooling Water

Cooling of adjacent tanks usually is unnecessary unless there is direct flame contact or sufficient radiant heat to scorch the paint. Check the temperature and heat absorption of a tank by applying water on its side to see if steam is produced. For best results, water should be fanned on the sides and roof; this does not apply to roofs of floating roof tanks. Heat on shells of tanks containing stocks, with an oil temperature above atmospheric temperature, may bring the vapor space of the tank within the flammable range. Heat on shells of tanks containing low-flashpoint stocks may cause the tank pressure to rise and expel flammable vapors, which may ignite or cause failure to the tank. A common error in tank firefighting is using too much cooling water on exposures. This can rob volume and water pressure from the water supply, and overtax sewers and drainage ditches, making firefighting difficult.

Dikes

Excessive water in a dike area can cause a leaking product to overflow the dike's containment. Dikes should be monitored constantly during firefighting operations. Excessive water should be removed to another containment area until the fire is extinguished.

Activity 11.1

Bulk Storage Facility and Tank Farm Simulation

Purpose

To perform the IMT roles assigned in order to effectively manage a bulk storage incident.

Directions

1. As a group, you will staff positions within the Incident Command Structure of the Central City Fire Department (CCFD) for the exercise. All members of the CCFD Command Staff will arrive on the fireground simultaneously. CCFD Incident Command Staff:

   a. Incident Commander (IC).

   b. IC Aide.*

   c. Operations Chief.

   d. Operations Aide.

   e. Planning Chief.

   f. Logistics Chief.

   g. Public Information Officer (PIO).

   h. Liaison Officer.

   i. Safety Officer.

   *The IC Aide is not used unless there are nine students in a group. Some students may play multiple roles based on the Assignment Sheets. If there are ten in a group, a second Operations Aide will be designated.

2. All Command decisions and actions during the simulation will be recorded on the ICS forms. Entries on the ICS forms are made in response to written or visual messages or in anticipation of problems that could surface during the incident.

3. At the conclusion of the simulation exercise, all groups will participate in a debriefing facilitated by the instructors. Your group will display both the ICS forms developed during the exercise. Be prepared to explain the reasons for your decisions.

4. The following will be turned in to the instructors at the conclusion of the PIA. The Planning Section Chiefs will collect all of these from their groups, making sure that the group number and students' names are on the sheets.

   a. IC: Incident Objectives.

   b. The Planning Section Chief: Plan "B."

   c. The Safety Officer: Safety Message.

   d. Operations Aide: Actions Taken.

   e. Logistics: Resources.

   f. Liaison: Document Agencies Contacted.

   g. PIO: Press Release.

Overview

1. All tanks in dike area of the fire tank are internal floating roof tanks.

2. All tanks in adjacent dike area (Side B) are external floating roof tanks.

3. There are four tanks in each dike area.

4. Each internal floating roof tank has three foam chambers that may be pressurized outside the dike area.

5. All tanks in both dike areas are 48 feet high and 100 feet in diameter.

6. Water supply is from an 8-inch private hydrant system in the plant. The flow is 1,000 gpm.

7. Facility has a 1,000-gpm foam pumper with a 500-gallon foam tank.

8. Plant has 500 gallons of foam in storage (5-gallon cans).

9. No tanks are set up for subsurface injection. If subsurface injection is used it will have to be improvised.

Activity 11.1 (cont'd)

Quick Access Prefire Plan

Bulk Storage Facility and Tank Farm

Building Address:
U and 6th Streets

Building Description:
Bulk storage plant--flammable and combustible materials
Storage tanks 48' x 100'
Cylindrical

Roof Construction:
Internal floating pan with cone roof
External floater--external floating pan roof with wind girder

Floor Construction:
N/A

Occupancy Type:
Bulk storage facility

Initial Resources Required:
First-alarm assignment

Hazards to Personnel:
Flammable/Toxic materials

Location of Water Supply:
8-inch private yard system

Available Flow:
1,000 gpm hydrant

	Estimated Fire Flow*			
Level of Involvement				
Estimated Fire Flow				

**Fire flow not determined for this facility type*

Fire Behavior Prediction:
Flammable liquids' characteristics

Predicted Strategies:
Exposures--confinement--extinguishment

Problems Anticipated:
Access to tanks: integrity of tank structure
Water/Foam application

☐ **Standpipe:**	☒ **Sprinklers:** *Foam chambers on tanks*	☐ **Fire Detection:**

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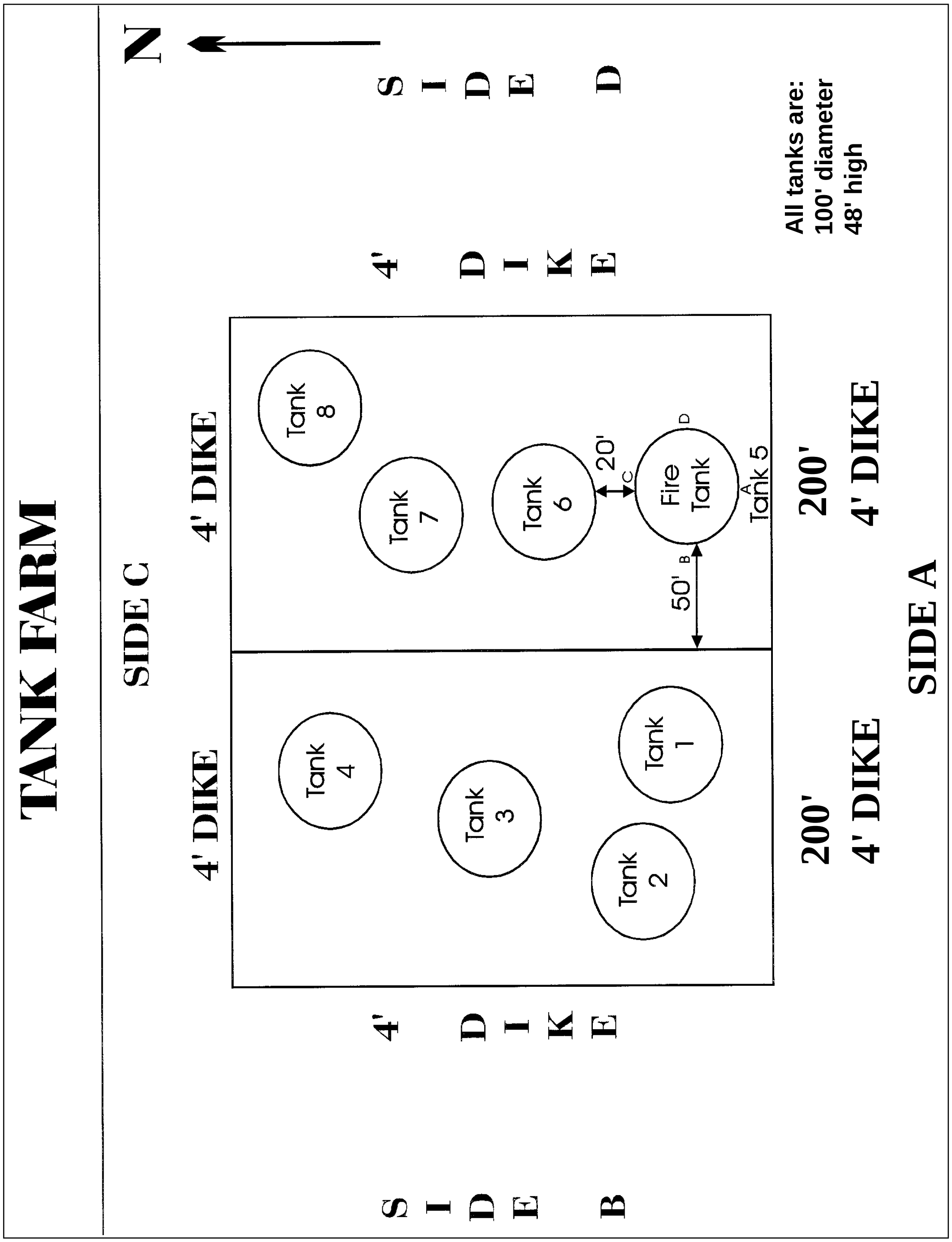
Activity 11.1 (cont'd)

Bulk Storage Facility and Tank Farm Plot Plan



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UNIT 11: MILL BUILDINGS (OPTIONAL UNIT)

TERMINAL OBJECTIVE

At the end of this unit students given a simulated major fire scenario, will be able to, coordinate, and control tactical resources and implement a plan of action based on critical cues, information gathered and critical elements presented during a bulk storage facility and tank farm incident.

ENABLING OBJECTIVES

The students will be able to:

1. *Describe the major problems associated with incident communications and communication systems during target hazard incidents.*

2. *Work as a team to command an incident at a mill building fire.*

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COMMUNICATIONS INTRODUCTION

Communication equals or equates to control. The sooner you are communicating, the sooner control is in hand. The two major components of communication are speaking and listening; the latter is the harder, but the more important. As Incident Commander (IC), insist that all persons on the fireground listen as hard and as carefully as they can.

Command presence is projected in person and by your communication style. Talking fast, shouting, or not being sure of how you want to express yourself all detract from your communication effectiveness and your Command presence.

It should be standard practice to make the Incident Command Post (ICP) the center of communications. The ICP is your fireground office and communications should reflect that.

- Use clear text--simple assignments to reach goals.
- Use staff for support at the ICP.
- Project your Command presence over the radio.
- Always be ready to accept important or priority messages.
- Remember--face-to-face communications are the most effective.
- Always listen carefully--if you do not understand, ask for clarification.
- Keep connected--communicate through the flowchart of your organization or through the functions on the fireground.

With target hazards, a larger problem may exist. Community warning systems may be needed in order for rapid evacuation or in-place sheltering, etc. This expanded responsibility could be handled by the Public Information Officer (PIO), i.e., coordinating and disseminating the information to the public through the media.

PLAN COMMUNICATION NEEDS FOR TARGET HAZARDS

Know options available for central dispatch failure; some of the communications options include pager operation, voice, radio-to-radio hard-wire phones for highrise incidents, mobile communications, talk-around groups, face-to-face (the most accurate for onsite operations), cellular phone communications, and ham radio operations.

Identify communications necessary for activating mutual aid. Normally, Command requests mutual aid through central dispatch. It is important to understand the critical nature of communication needs at each target hazard. Special needs usually can be solved during the preplanning and analysis of target hazards. Prepare for 9-1-1 overload or Public Safety Answering Point (PSAP) overload.

Typically, the local phone company can switch around 9-1-1 calls to a seven-digit number. This normally means you lose your Computer-Aided Dispatch (CAD) System, mapping, and other capabilities.

MILL CONSTRUCTION

Mill buildings, with their heavy construction and extensively modified interiors, fit the target hazard profile because they can overload department resources that must search for and extinguish the fire. In buildings of mixed occupancy, an incident with job and tax-base loss can cause significant negative impact to the community.

Mill construction includes wood and masonry construction and construction of structures without any consideration for normal engineering methods. Masonry outer walls (for fire resistance) and wood for roof members and internal supports are used in these buildings. An alternative to mill construction would be engineered construction (lightweight, steel-trussed construction).

Characteristics

The single most obvious common characteristic of mill construction is that the bearing walls are of some type of masonry. An exception might be support of some type of cast iron in certain areas. Normally there is no fire separation or protection from floor to floor or within floors.

Firefighting problems presented by mill construction:

- structural stability of old masonry may be questionable--lack of firestops;
- structural stability of cast iron/wood interior supports; beam and joist connections;
- structural voids related to this type of construction usually are made worse by modernization or alteration; and
- structural ability of the masonry walls to act as barriers to fire in adjoining exposures.

Some additional problems:

- building additions;
- lateral load impacts (natural gas explosion);
- openings or chases in masonry walls heating, ventilating, and air conditioning ((HVAC) and utility);
- cast iron fronts and supports;
- overloaded floors (commercial uses); and
- interior balloon construction (spread of fire).

Normally, fire extension through this type of construction is not restricted by any design or specific engineering. Interconnected chases, voids, utility shafts, etc., provide conduits for fire to spread rapidly.

Mill-type buildings are built with heavy timber and masonry construction. Originally they were found in the New England textile areas. Many of these old buildings have been converted into:

- factory;
- storage (warehousing);
- retail/wholesale operations;
- lofts and apartments/condos; and
- combinations--multiuse, office, warehouse.

The term "mill construction" is synonymous with "heavy timber construction." Traditional mill construction has certain characteristic features:

- Exterior walls are solid masonry.

- Columns and beams are usually massive wood construction.

- Floors are thick planks.

- Roofs are thick planks supported by timber arches and trusses.

- Openings between floors are enclosed.

The massive dimensions of most wood components in mill construction make them difficult to ignite. Once ignition occurs, mill construction may burn for days and exceed the suppression capability of most fire departments. The rate at which a wood fire burns is greatly influenced by the rate of air supply. However, in a heavy-timber building the quantity of fuel is so great that the building probably will be destroyed in a fire unless adequate sprinkler protection is in place.

Fire loads often exceed sprinkler capacity. However, automatic water flow alarms and adequate sprinklers can make the difference. Conversions create voids and areas that did not exist when the original design was open and without voids. Due to conversion and secondary use patterns, preplanned inspections are necessary to expect success in any fire attack.

The tendency for mill construction to burn slowly is not an advantage if firefighters are driven off an interior attack by heat and smoke (excessive fire load). Early ventilation is an integral and necessary component of this type of fire suppression.

Building Collapse Indicators

Critiques of various collapses have shown that only after a collapse has occurred was it realized that seemingly unrelated occurrences (or indicators) contributed to the collapse. The probability of only one indicator or defect causing the collapse was probably remote, but prompt reporting of any collapse indicators to the fireground Commander will allow him/her a clearer picture of the building's stability. The following are indicators of possible collapse.

Time/Temperature

- continued or heavy fire;
- heavy smoke and high heat, when coupled with inadequate ventilation, could precede a backdraft;
- two or more floors of a building fully involved;
- numerous previous fires in a building; and
- unprotected steel columns and beams exposed to heavy fire.

Visual

- smoke showing through walls (this may precede a backdraft);
- fire showing through a wall;
- sagging floors;
- bulging walls;
- leaning walls;
- failure of part of a wall;
- interior collapse;
- visible spalling of a brick wall;
- spalling of concrete and exposure of steel rods;
- wall breaking down under a hose stream;
- water between bricks;
- excessive water in a building;
- water not coming out of a building as fast as it is going in;
- absorbing bales in a building;
- new wall cracks;
- old wall cracks enlarging;
- severely dry-rotted or termite-eaten supporting wood beams exposed to heavy fire;
- expansion of structural steel beams;
- large machinery in a building;
- excessive snow or water on a roof; and
- wall spreaders.

Auditory

- cracking noises coming from a building; and
- plaster sliding off of walls in large sheets.

Optional Activity 11.1

Mill Building Simulation

Purpose

To practice Command at an incident with high-exposure risks and potentially serious community economic impact.

Overview

The incident occurs in a six-floor converted mill building that houses warehouse facilities for textiles and paper goods, as well as offices. A clothing manufacturer occupies the top two floors (50 sewing machine operators are on each floor with management offices on the sixth floor). A publishing company, with approximately 75 employees, occupies the middle two floors (printing operations on third floor, offices on fourth). The basement and lower two floors are storage (second floor has textile rolls stored in high storage racks; basement has newsprint rolls stored about 12 inches off the floor). Ten people work in the warehouse section.

The structure was built in 1916 as a textile facility, using mill construction. The incident begins at 1440 hours. The building is sprinkled. Dry standpipes are available in stairwells. Stairwells are not pressurized.

Directions

1. As a group, you will staff positions within the Incident Command Structure of the Central City Fire Department (CCFD) for the exercise. All members of the CCFD Command Staff will arrive on the fireground simultaneously. CCFD Incident Command Staff:

   a. IC.

   b. IC Aide.*

   c. Operations Chief.

   d. Operations Aide.

   e. Planning Chief.

   f. Logistics Chief.

   g. PIO.

h. Liaison Officer.

i. Safety Officer.

*The IC Aide is not used unless there are nine students in a group. Some students may play multiple roles based on the Assignment Sheets. If there are ten in a group, a second Operations Aide will be designated.

2. All Command decisions and actions during the simulation will be recorded on the Simulation Action Chart. Entries on the ICS Chart are made in response to written or visual messages or in anticipation of problems that could surface during the incident.

3. At the conclusion of the simulation exercise, all groups will participate in a debriefing facilitated by the instructors. Your group will display both the ICS Charts and Simulation Action Charts developed during the exercise. Be prepared to explain the reasons for your decisions.

4. The following will be turned in to the instructors at the conclusion of the Postincident Analysis (PIA). The Planning Section Chiefs will collect all of these from their groups, making sure that the group number and students' names are on the sheets.

   a. IC: Incident Objectives.

   b. The Planning Section Chief: Plan "B."

   c. The Safety Officer: Safety Message.

   d. Operations Aide: Actions Taken.

   e. Logistics: Resources.

   f. Liaison: Document Agencies Contacted.

   g. PIO: Press Release.

Optional Activity 11.1 (cont'd)

Quick Access Prefire Plan

Mill Building

Building Address:
115 12th Street

Building Description:
Six-story/mill construction w/basement 75' x 300'

Roof Construction:
Beam and rafter, 1-1/4-inch wooden roof decking, composition asphalt covering

Floor Construction:
Beam and joist, 2-inch wooden floor decking

Occupancy Type:
Mixed commercial

Initial Resources Required:
First-alarm assignment

Hazards to Personnel:
High-fire load contents--heavy machinery--hazardous materials

Location of Water Supply:
12-inch municipal system
Hydrants 300' apart

Available Flow:
1,500 gpm per hydrant

	Estimated Fire Flow*			
Level of Involvement	15%	25%	50%	100%
Estimated Fire Flow	330	550	1,100	2,200

**Fire flow based on largest fire area of 3,000 sq. ft. and 5 exposure floors*

Fire Behavior Prediction:
Horizontal spread--high-fire loading, vertical extension

Predicted Strategies:
Exposures: rescue, confinement, extinguishment

Problems Anticipated:
High-fire loading--rack storage--baled materials

[X] **Standpipe:** *Dry system*

[X] **Sprinklers:** *Yes*

[X] **Fire Detection:** *Yes*

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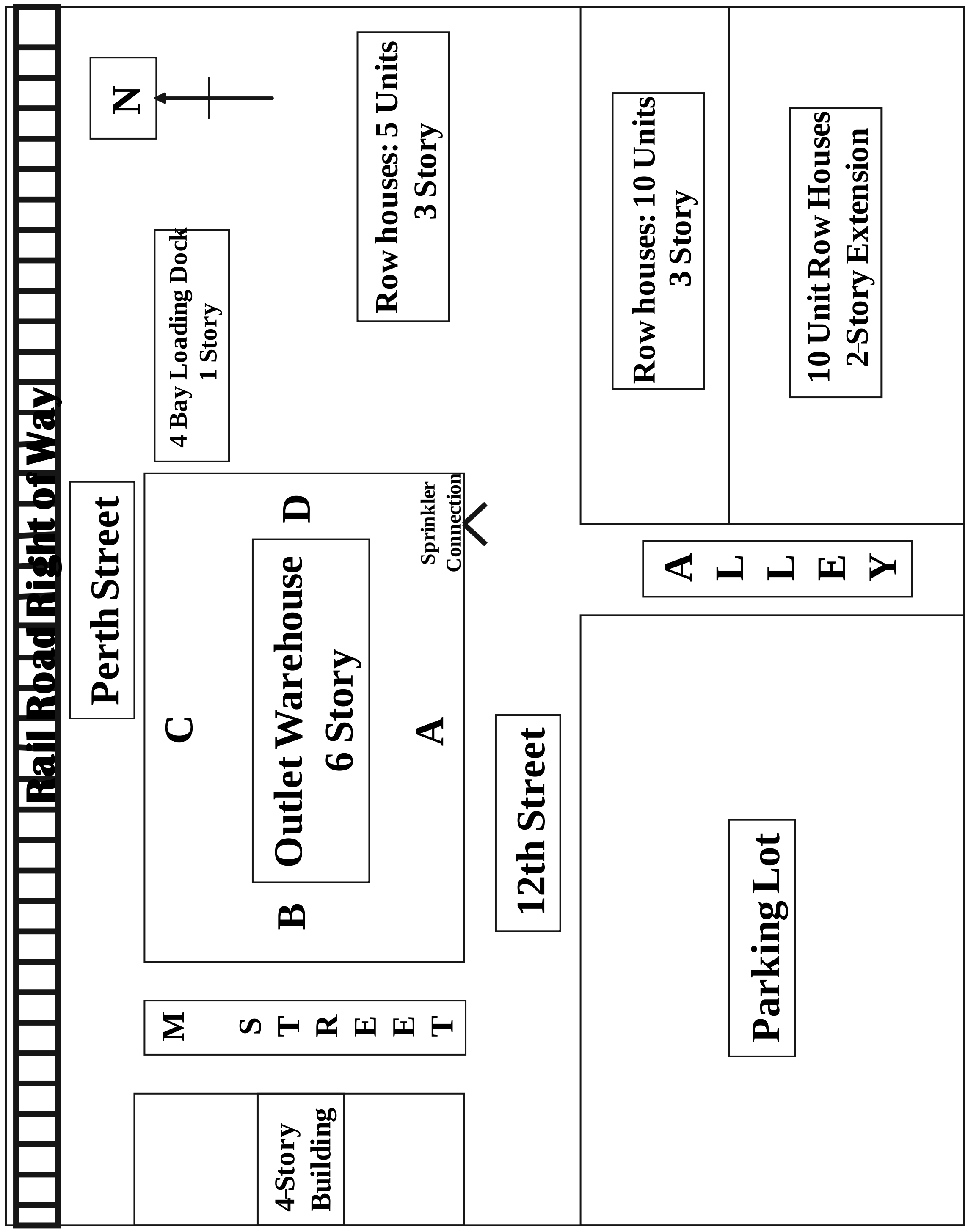
Optional Activity 11.1 (cont'd)

Mill Building Plot Plan



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UNIT 12: MITIGATION STRATEGIES

TERMINAL OBJECTIVE

At the end of this unit students will be able to determine initiative or actions that will mitigate the threats and dangers to the community and to responders for the local occupancy or hazard.

ENABLING OBJECTIVES

The students will be able to:

1. *Develop a mitigation strategy for a specific community target hazard.*

2. *Analyze a case study describing a highrise building incident for the eight competencies.*

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MITIGATION

The definition of mitigation in relation to target hazards is "to cause to be less harsh or hostile; to make less severe or painful" *(Webster's 9th Collegiate Dictionary).* The fire officer who determines initiatives that will mitigate the threats and dangers to the community and to responders is a leader.

PREINCIDENT SITE PLANNING TOURS

Suppression personnel can benefit from site planning tours of target hazard locations. These tours enable suppression personnel to familiarize themselves with the specific hazards associated with the facility and surrounding exposures.

Target hazard representatives will welcome contact by local fire officials and supply the necessary support and information to mitigate any future incident, large or small. This cooperation is absolutely necessary for preplanning.

SMOKE DETECTORS AND FIRE PROTECTION ENGINEERING

Installation of smoke detectors should be encouraged by the fire department, as well as by local ordinances requiring them in rental and multifamily structures.

Employee and patron response/evacuation plans should be in place for all commercial operations. Some local ordinances already require them for hotel and multifamily dwellings. The operators of these facilities should support and help mitigate any danger that exists in connection with their operations.

PLAN REVIEW COMMITTEES/PARTICIPATION

Fire department officials always should be included in reviewing new construction plans in the community, and in new fire protection engineering changes or additions. This participation underscores the department's commitment to mitigate future problems in the community.

FIRE PREVENTION INSPECTIONS

Fire prevention inspections are the traditional way to update information and changes related to a target hazard. Suppression inspections may be necessary if fire inspectors or staff are not available.

Training reflective of target hazard concerns can be very valuable. Training and drilling with target hazard employees and representatives can be very helpful for future incidents. Recording and documenting that training also are recommended actions.

CODE CHANGE INITIATIVES

Local code and ordinance changes may be necessary to protect the community and responders from target hazard dangers. Fire departments should be aware that it is possible to cite national codes and standards in order to resolve target hazard concerns.

Airport and mall emergencies overload fire department personnel resources, can involve a typical hazard, and will require technical advice for effective strategy development.

Activity 12.1

Mitigation Strategies

Purpose

To consider mitigation strategies for one of the hazards.

Directions

1. Choose one of the community hazards from your group's precourse research assignment. Select the one that has the greatest potential for community impact if there is an incident.

2. Brainstorm several mitigation strategies that could be used to reduce the hazards.

3. Prioritize the mitigation strategies, then list the barriers that must be overcome.

4. Present results of your discussion to the class.

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Activity 12.2

Philadelphia, Pennsylvania, One Meridian Plaza Incident

Purpose

To identify the key issues in Command decisions.

Directions

1. Read the case study material and view the "One Meridian Plaza Incident" video.

2. Note key issues in the following during your reading.

   a. Preincident planning.

      ____

      ____

      ____

   b. Sizeup.

      ____

      ____

      ____

   c. Decision making cues.

      ____

      ____

      ____

   d. Incident Command structure.

      ____

      ____

      ____

e. Communications.

f. Resource management.

g. Mitigation and documentation.

United States Fire Administration

Technical Report Series

High-Rise Office Building Fire
One Meridian Plaza
Philadelphia, Pennsylvania

Federal Emergency Management Agency

United States Fire Administration

National Fire Data Center

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Foreword

This report on the Philadelphia, Pennsylvania, One Meridian Plaza fire documents one of the most significant high-rise fires in United States' history. The fire claimed the lives of three Philadelphia firefighters and gutted eight floors of a 38-story fire-resistive building causing an estimated $100 million in direct property loss and an equal or greater loss through business interruption. Litigation resulting from the fire amounts to an estimated $4 billion in civil damage claims. Twenty months after the fire in this building, one of Philadelphia's tallest, situated on Penn Square directly across from City Hall, still stood unoccupied and fire-scarred, its structural integrity in question.

This fire is a large scale realization of fire risks that have been identified on many previous occasions. The most significant new information from this fire relates to the vulnerability of the systems that were installed to provide electrical power and to support fire suppression efforts. In this incident there was an early loss of normal electrical power, a failure of the emergency generator and a major problem with the standpipe system, each of which contributed to the final outcome. These experiences should cause responsible individuals and agencies to critically re-examine the adequacy of all emergency systems in major buildings.

When the initial news reports of this fire emerged, attention focused on how a modern, fire-resistive high-rise in a major metropolitan city with a well-staffed, well-equipped fire department could be so heavily damaged by fire. The answer is rather simple—fire departments alone cannot expect or be expected to provide the level of fire protection that modern high-rises demand. The protection must be built-in. This fire was finally stopped when it reached a floor where automatic sprinklers had been installed.

This report will demonstrate that the magnitude of this loss is greater than the sum of the individual problems and failures which produced it. Although problems with emergency power systems, standpipe pressure reducing valves, fire alarm systems, exterior fire spread, and building staff response can be identified, the magnitude of this fire was a result of the manner in which these factors interacted with each other. It was the combination of all of these factors that produced the outcome.

At the time of the One Meridian Plaza fire, the three model fire prevention codes had already adopted recommendations or requirements for abating hazards in existing high-rise buildings. Each of the model building codes contains explicit requirements for fire protection and means of egress in high-rise buildings. Actions were and are underway in many cities and several states to require retrofitting of existing high-rise buildings with automatic sprinkler systems, fire detection and alarm systems, and other safety provisions. Since the Meridian Plaza fire, the National Fire Protection Association's Technical Committee on Standpipe Systems has proposed a complete revision of NFPA 14, *Standard for Installation of Standpipe and Hose Systems.* The new version of NFPA 14 was approved by the NFPA membership at the 1992 fall meeting in Dallas, Texas.

All of these efforts are necessary and commendable. To prove successful, however, they must take a comprehensive, holistic approach to the problem of high-rise fire safety, if we are to keep One Meridian Plaza from being surpassed by yet another devastating fire.

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High-Rise Office Building Fire
One Meridian Plaza
Philadelphia, Pennsylvania
February 23, 1991

Reported by: J. Gordon Routley
Charles Jennings
Mark Chubb

Local Contacts: Commissioner (ret.) Roger Ulshafer
Commissioner Harold Hairston
Deputy Commissioner (ret.) Christian Schweizer
Deputy Commissioner Phil McLaughlin
Deputy Commissioner Matthew J. McCrory, Jr.
Theodore Bateman, Battalion Chief
Richard Bailey, Battalion Chief
Matthew Medley, Lieutenant
City of Philadelphia Fire Department
240 Spring Garden Street
Philadelphia, Pennsylvania 19123-2991
(215) 592-5962

Overview

A fire on the 22nd floor of the 38-story Meridian Bank Building, also know as One Meridian Plaza, was reported to the Philadelphia Fire Department on February 23, 1991 at approximately 2040 hours and burned for more than 19 hours. The fire caused three firefighter fatalities and injuries to 24 firefighters. The 12-alarms brought 51 engine companies, 15 ladder companies, 11 specialized units, and over 300 firefighters to the scene. It was the largest high-rise office building fire in modern American history--completely consuming eight floors of the building--and was controlled only when it reached a floor that was protected by automatic sprinklers. A table summarizing the key aspects of the fire is presented on the following pages.

The Fire Department arrived to find a well-developed fire on the 22nd floor, with fire dropping down to the 21st floor through a set of convenience stairs. (For an elevation drawing of the building and the 22nd floor plan see Appendix A.) Heavy smoke had already entered the stairways and the floors immediately above the 22nd. Fire attack was hampered by a complete failure of the building's electrical system and by inadequate water pressure, caused in part by improperly set pressure reducing valves on standpipe hose outlets.

The three firefighters who died were attempting to ventilate the center stair tower. They radioed a request for help stating that they were on the 30th floor. After extensive search and rescue efforts, their bodies were later found on the 28th floor. They had exhausted all of their air supply and could not escape to reach fresh air. At the time of their deaths, the 28th floor was not burning but had an extremely heavy smoke condition.

After the loss of three personnel, hours of unsuccessful attack on the fire, with several floors simultaneously involved in fire, and a risk of structural collapse, the Incident Commander withdrew all personnel from the building due to the uncontrollable risk factors. The fire ultimately spread up to the 30th floor where it was stopped by ten automatic sprinklers.

Summary of Key Issues	
Issues	Comments
Origin and Cause	The fire started in a vacant 22nd floor office in a pile of linseed oil-soaked rags left by a contractor.
Fire Alarm System	The activation of a smoke detector on the 22nd floor was the first notice of a possible fire. Due to incomplete detector coverage, the fire was already well advanced before the detector was activated.
Building Staff Response	Building employees did not call the fire department when the alarm was activated. An employee investigating the alarm was trapped when the elevator opened on the fire floor and was rescued when personnel on the ground level activated the manual recall. The Fire Department was not called until the employee had been rescued.
Alarm Monitoring Service	The private service which monitors the fire alarm system did not call the Fire Department when the alarm was first activated. A call was made to the building to verify that they were aware of the alarm. The building personnel were already checking the alarm at that time.
Electrical Systems	Installation of the primary and secondary electrical power risers in a common unprotected enclosure resulted in a complete power failure when the fire-damaged conductors shorted to ground. The natural gas powered emergency generator also failed.
Fire Barrier	Unprotected penetrations in fire-resistance rated assemblies and the absence of fire dampers in ventilation shafts permitted fire and smoke to spread vertically and horizontally. Ventilation openings in the stairway enclosures permitted smoke to migrate into the stairways, complicating firefighting. Unprotected openings in the enclosure walls of 22nd floor electrical closet permitted the fire to impinge on the primary and secondary electrical power risers
Standpipe System and Pressure Reducing Valves (PRVs)	Improperly installed standpipe valves provided inadequate pressure for the fire department hose streams using 1¾-inch hose and automatic fog nozzles. Pressure reducing valves were installed to limit standpipe outlet discharge pressures to safe levels. The PRVs were set too low to produce effective hose streams; tools and expertise to adjust the valve settings did not become available until too late.
Locked Stairway Doors	For security reasons, stairway doors were locked to prevent reentry except on designated floors. (A building code variance had been granted to approve this arrangement.) This compelled firefighters to use forcible entry tactics to gain access from stairways to floor areas.
Fire Department Pre-Fire Planning	Only limited pre-fire plan information was available to the Incident Commander. Building owners provided detailed plans as the fire progressed.
Firefighter Fatalities	Three firefighters from Engine Company 11 died on the 28th floor when they became disoriented and ran out of air in their SCBAs.
Exterior Fire Spread "Autoexposure"	Exterior vertical fire spread resulted when exterior windows failed. This was a primary means of fire spread.

Structural Failures	Fire-resistance rated construction features, particularly floor-ceiling assemblies and shaft enclosures (including stair shafts), failed when exposed to continuous fire of unusual intensity and duration.
Interior Fire Suppression Abandoned	After more than 11 hours of uncontrolled fire growth and spread, interior firefighting efforts were abandoned due to the risk of structural collapse.
Automatic Sprinklers	The fire was eventually stopped when it reached the fully sprinklered 30th floor. Ten sprinkler heads activated at different points of fire penetration.

The Building

One Meridian Plaza is a 38-story high-rise office building, located on the corner of 15th Street and South Penn Square in the heart of downtown Philadelphia, in an area of high-rise and mid-rise structures. On the east side, the building is attached to the 34-story Girard Trust Building and it is surrounded by several other high-rise buildings. The front of the building faces City Hall.

One Meridian Plaza has three underground levels, 36 above ground occupiable floors, two mechanical floors (12 and 38), and two rooftop helipads. The building is rectangular in shape, approximately 243 feet in length by 92 feet in width (approximately 22,400 gross square feet), with roughly 17,000 net usable square feet per floor. (See Appendix A for floor plan.) Site work for construction began in 1968, and the building was completed and approved for occupancy in 1973.

Construction was classified by the Philadelphia Department of Licenses and Inspections as equivalent to BOCA Type 1B construction which requires 3-hour fire rated building columns, 2-hour fire rated horizontal beams and floor/ceiling systems, and 1-hour fire rated corridors and tenant separations. Shafts, including stairways, are required to be 2-hour fire rated construction, and roofs must have 1-hour fire rated assemblies.

The building frame is structural steel with concrete floors poured over metal decks. All structural steel and floor assemblies were protected with spray-on fireproofing material. The exterior of the building was covered by granite curtain wall panels with glass windows attached to the perimeter floor girders and spandrels.

The building utilizes a central core design, although one side of the core is adjacent to the south exterior wall. The core area is approximately 38 feet wide by 124 feet long and contains two stairways, four banks of elevators, two HVAC supply duct shafts, bathroom utility chases, and telephone and electrical risers.

Stairways

The building has three enclosed stairways of concrete masonry construction. Each stairway services all 38 floors. The locations of the two stairways within the building core shift horizontally three or four times between the ground and the 38th floor to accommodate elevator shafts and machine rooms for the four elevator banks. Both of these stairways are equipped with standpipe risers.

Adjacent to the stairway enclosures are separate utility and HVAC shafts. There are pipe and duct penetrations through the shaft and stairway enclosure walls. The penetrations are unprotected around the sleeved pipes and fire dampers are not installed in HVAC ducts penetrating the fire-resistance rated wall assemblies. This effectively creates many openings between the utility shafts, and the individual floors, primarily in the plenum area above the ceilings, as well as between the shafts and the stairway enclosures.

The third enclosed stairway is located at the east end of the building. This stairway attaches the floors of the Meridian Plaza to the corresponding floors of the Girard Trust Building. Adjacent to the east stairway is an additional enclosed utility shaft which also has pipe and duct penetrations through the shaft enclosure walls. There are no fire or smoke barriers around the sleeved pipes and no fire dampers in the HVAC ducts that penetrate the shaft walls.

Elevators

Elevator service is provided by four zoned elevator banks identified as A through D. Elevator Bank A serves floors 2-11. Elevator Bank B has two shafts which enclose seven elevators: six are passenger elevators that serve floors 12-21, and one is a freight elevator that serves floors 22-38. Elevator Bank C serves floors 21-29, and Elevator Bank D serves floors 29-37. The elevator shafts are constructed of concrete and masonry and extend from the first floor or lower levels to the highest floor served by the individual elevator banks. At the top of each elevator bank is the associated elevator equipment room.

The elevator shafts that serve the upper floors are express rise and do not have openings to the lower floors. Only the Bank C passenger elevators and the freight elevator served the fire floors. The elevator shafts did not appear to play a significant role in the spread of combustion products.

Each elevator lobby is equipped with a smoke detector that, when activated, recalls the elevator cars to the first floor lobby. Firefighter's service (elevator recall) features were added in 1981 under provisions of the State Elevator Code.[1]

Heating, Ventilation, and Air Conditioning

The heating, ventilation, and air conditioning (HVAC) system is composed of four air handling systems. Two systems are located in the 38th floor mechanical room and service the east and west halves of the upper floors. The other two systems are located in the 12th floor mechanical room and service the east and west halves of the lower floors. Each system supplies air to its respective floors through one or two supply air shafts located within the building core and receives return air from its associated return air shafts. Return air shafts are located at each of the four building corners. Upon examination at selected locations, the HVAC supply and return air shafts did not appear to have fire dampers at the duct penetrations on each floor.

Plumbing

The bathroom utility piping extends through the 38 floors through pipe chases that are formed by the space between two walls. These pipe chases transfer location as the bathroom locations change floor to floor. Upon a sample examination of the pipe chases, it was found that floor penetrations were not closed or sealed to maintain the integrity of the fire-resistance rated floor/ceiling assemblies.

[1] In Pennsylvania, elevator are regulated through the State Department of Labor and Industry.

Electrical and Communications Risers

The electrical and telephone risers are enclosed in separate rooms on each floor. The rooms are located directly above one another and are intended to function as vertical shafts, with rated separations required at horizontal penetrations from the shafts into floor and ceiling spaces at each level. Within the telephone and electrical rooms, unprotected penetrations of the floor assemblies allow conduits and exposed wires to travel from floor to floor. Several breaches of fire-resistance rated construction were observed in the walls separating the electrical and telephone rooms from the ceiling plenums and occupied spaces on each floor.

Emergency Power

The building electrical system receives power from two separate electrical substations and is backed-up by an emergency generator. The two sources of power are arranged so that the load would automatically transfer to the second source upon failure of the first. Electrical power for One Meridian Plaza and four adjacent buildings is distributed from the basement of 1414 S. Penn Square.

The electric service enters the building via the basement from the adjoining building and is distributed to the 12th and 38th floor mechanical rooms via the electrical risers in the building core. From the 12th and 38th floor mechanical rooms, electrical power is distributed to the major mechanical systems and to a buss bar riser, which services distribution panels on the individual floors.

Emergency power was provided by a 340 kw natural gas-fired generator located in the 12th floor mechanical room. The generator was sized to supply power for emergency lighting and the fire alarm system, the fire pump located on the 12th floor and one car in each bank of elevators. The generator's fuel was supplied by the building's natural gas service. This generator was not required by the building code, since the building's electrical power was supplied by two separate substations.

The generator was reported to have been tested weekly. The last recorded test date was January 30, almost four weeks before the fire, and the maintenance records indicate that problems were encountered during engine start-up under load conditions at that time. During a detailed inspection following that test, a damaged part was discovered and replaced. After the repair, the generator was started without a load and appeared to work properly, but no subsequent tests were performed to determine if the problems persisted under load conditions.

Records of earlier maintenance and test activity suggest that load tests were performed only occasionally. Test and maintenance records indicate a long history of maintenance problems with the emergency generator system. Many of these problems became manifest during or immediately after conducting tests under load.

Fire Protection Systems

At the time of construction, the Philadelphia Building Code required only a local fire alarm system with manual stations at each exit and smoke detectors in the supply and return air shafts. Hose stations supplied from the domestic water service and portable fire extinguishers were required for occupant use. Dry standpipes were installed for fire department use. Below ground levels were required to be provided with automatic sprinklers.

As a result of local code changes, several improvements to the fire protection systems were made in the years following the building's construction.

In 1981, the Philadelphia Department of Licenses and Inspections implemented amendments to the fire code which were intended to address the life safety of high-rise building occupants. These requirements included installation of stair identification signs, provisions to permit stairway reentry, and installation of smoke detection in common areas in the path of access to exits. The "common areas" provision of the code was intended to address corridors and exit passageways in multi-tenant floors. The smoke detector requirements were interpreted in such a way that single tenant "open plan" floors were only required to have detectors installed at the exits; the entire floor, although open, was not considered a "common area." Smoke detectors were also installed in the return air plenum adjacent to the return air shaft intakes in each corner of the building. These provisions required that building owners file permits for this work within one year of the code change. City records do not indicate when this work was performed in this particular building or if it was inspected and approved.

Fire Detection and Alarm Systems

At the time of construction, One Meridian Plaza was equipped with a coded manual fire alarm system with pull stations installed adjacent to each of the three exit stairwells on each floor. Smoke detection was provided in the major supply and return air ducts at the mechanical floor levels.

After the 1981 fire code amendments were enacted, the hardware on stairway doors was required to allow access from stairs back to floor areas or to be unlocked automatically in the event that the fire alarm was activated. One Meridian Plaza was granted a variance from this provision and generally had unlocked doors every three floors.

Approximately one and a half years before the fire, a public address system was installed throughout the building. This system was operable from the lobby desk and had the capability of addressing floors, stairways, elevator machine rooms, and elevators. Two-way communication was possible with elevators and elevator machine rooms.

As additional devices and systems were installed, they were connected to the fire alarm system to sound through the single-stroke bells originally installed with the manual fire alarm system. Smoke detector and water flow signals were assigned their own codes to allow annunciation not only at the lobby but throughout the building for those members of the building staff who knew the codes.

Standpipes

The occupant use standpipe system, which was connected to the domestic water supply, provided two outlets per floor with 100 feet of 1½-inch hose and a nozzle. The hose cabinets were located in corridors on each floor.

A dry standpipe system was originally installed with 6 inch risers in the west and center stair towers and outlets for 2½ fire department hose lines at each floor level. This system was converted to a wet riser system in 1988, to supply automatic sprinklers on some of the upper floors. An 8 inch water supply was provided to deliver water to two 750 gpm electric fire pumps, one in the basement and one on the 12th floor.

The basement pump supplied the lower standpipe zone (floors B-12) while the 12th floor pump served the upper zone (floors 13-38).

There was no standpipe in the east stair tower.

A November 1988 Board of Building Standards decision permitted both zones to be served by a common fire department connection, as part of a plan that would provide for the installation of automatic sprinklers on all floors by November 1993.[1]]

Due to the height of the zones and the installation of fire pumps, pressures exceeded the 100 psi limit permitted by NFPA 14, *Installation of Standpipe and Hose Systems* at the standpipe hose outlets on several lower floors in each zone. Pressure restricting devices, which limit the discharge through standpipe outlets by restricting the orifice, were installed on the mezzanine and second floor levels and on floors 26 through 30. Pressure reducing valves, which regulate both static pressure and discharge pressure under variable flow conditions, were installed on floors 13 through 25. Both types of devices prevent dangerous discharge pressures from hose outlets at the lower floors of each standpipe zone. The Philadelphia Fire Department investigators report that the plans submitted at the time the standpipes were converted did not indicate that PRVs were to be installed.

Automatic Sprinklers

Only the service floors located below grade were protected by automatic sprinklers at the time of construction. Conversion of the dry standpipe to a wet system with fire pumps facilitated the installation of automatic sprinklers throughout the building. At the request of selected tenants, sprinklers were installed on several floors during renovations, including all of the 30th, 31st, 34th, and 35th floors, and parts of floors 11 and 15. Limited service sprinklers, connected to the domestic water supply system, were installed in part of the 37th floor. The building owners had plans to install sprinklers on additional floors as they were renovated.

The Fire

Delayed Report

At approximately 2023 hours on February 23, 1991, a smoke detector was activated on the 22nd floor of the One Meridian Plaza building. The activated detector is believed to have been located at the entrance to the return air shaft in the northeast corner of the building. At that time there were three people in the building, an engineer and two security guards.[2] The alarm sounded throughout the building and elevator cars automatically returned to the lobby. The building engineer investigated the alarm using an elevator on manual control to go to the 22nd floor. The central station monitoring company that served the building reportedly called the guard desk in the lobby to report the alarm. The call came in before the engineer reached the fire floor, and the alarm company was told that the source of the alarm was being investigated. The alarm company did not notify the Fire Department at that time.

When the elevator doors opened at the 22nd floor, the engineer encountered heavy smoke

[1] Philadelphia Fire Department, "Investigative Report," Section M, p. 2.

2 The building staff regulated the after-hours population of the building through a lighting request system where tenants lights would be turned on for the duration of their work. In addition, there was a security system in the building that recorded any passage through stairwell doors.

and heat. Unable to reach the buttons or to leave the elevator car to seek an exit, the building engineer became trapped. He was able to use his portable radio to call the security guard at the lobby desk requesting assistance. Following the trapped engineer's instructions, the security guard in the lobby recalled the elevator to the ground floor using the Phase II firefighter's safety feature.

The second security guard monitored the radio transmissions while taking a break on the 30th floor. This guard initially mistook the fire alarm for a security alarm believing that he had activated a tenant's security system while making his rounds. He evacuated the building via the stairs when he heard the building engineer confirm there was a fire on the 22nd floor.

The roving guard reported that as he descended from the 30th floor the stairway was filling with smoke. He reached the ground level and met the engineer and the other security guard on the street in front of the building.

The Philadelphia Fire Department report on the incident states that the lobby guard called the alarm monitoring service to confirm that there was an actual fire in the building when the engineer radioed to her from the 22nd floor. After meeting outside and accounting for each other's whereabouts the three building personnel realized that they had not yet called the Fire Department.

The first call received by the Philadelphia Fire Department came from a passerby who used a pay telephone near the building to call 911. The caller reported smoke coming from a large building but was unable to provide the exact address. While this call was still in progress, at approximately 2027 hours, a call was received from the alarm monitoring service reporting a fire alarm at One Meridian Plaza.

Initial Response

The Philadelphia Fire Department dispatched the first alarm at 2027 hours consisting of four engine and two ladder companies with two battalion chiefs. The first arriving unit, Engine 43, reported heavy smoke with fire showing from one window at approximately the mid-section of the building at 2031 hours. A security guard told the first arriving battalion chief that the fire was on the 22nd floor. Battalion Chief 5 ordered a second alarm at 2033 hours.

While one battalion chief assumed command of the incident at the lobby level, the other battalion chief organized an attack team to go up to the fire floor. The battalion chief directed the attack team to take the low-rise elevators up the 11th floor and walk up from there.

Electrical Power Failure

Shortly after the battalion chief and the attack team reached the 11th floor there was a total loss of electrical power in the building. This resulted when intense heat from the fire floor penetrated the electrical room enclosure. The heat caused the cable insulation to melt resulting in a dead short between the conductor and the conduit in both the primary and secondary power feeds, and the loss of both commercial power sources. The emergency generator should have activated automatically, but it failed to produce electric power. These events left the entire building without electricity for the duration of the incident in spite of several efforts to restore commercial power and to obtain power from the generator.

This total power failure had a major impact on the firefighting operations. The lack of lighting made it necessary for firefighters to carry out suppression operations in complete darkness using only battery powered lights. Since there was no power to operate elevators, firefighters were forced to hand carry all suppression equipment including SCBA replacement cylinders up the stairs to the staging area that was established on the 20th floor. In addition, personnel had to climb at least 20 floors to relieve fellow firefighters and attack crews increasing the time required for relief forces to arrive. This was a problem for the duration of the incident as each relief crew was already tired from the long climb before they could take over suppression duties from the crews that were previously committed.

Initial Attack

As the initial attack crews made their way toward the 22nd floor they began to encounter smoke in the stairway. At the 22nd floor they found the west stair tower door locked. The door was already warped and blistering from the heat, and heavy fire could be seen through the door's wire glass window. A 1¾-inch hand line was stretched up the stairway from a standpipe connection on the floor below and operated through the window while a ladder company worked on forcing open the door.

It took several minutes before the door could be forced open and an attempt could be made to advance onto the fire floor with the 1¾-inch attack line. The crews were not able to penetrate onto the 22nd floor due to the intense heat and low water pressure they were able to obtain from their hose line.

An entry was also made on the 21st floor where the firefighters were able to see fire on the floor above through the open convenience stair. They attempted to use an occupant hose line to attack the fire but could not obtain water from that outlet. They then connected a 1¾-inch attack line to the standpipe outlet in the stairway, but they could not obtain sufficient pressure to attack the flames. A Tactical Command Post was established on the 21st floor and a staging area was set up on floor 20.

Fire Development

By this time fire was visible from several windows on the 22nd floor and crews outside were evacuating the area around the building and hooking up supply lines to the building's standpipe connections. As flames broke through several more windows around a major portion of the fire floor, the floor above was subject to autoexposure from flames lapping up the side of the building. Additional alarms were called to bring personnel and equipment to the scene for a large scale fire suppression operation.

As the fire developed on the 22nd floor, smoke, heat, and toxic gases began moving through the building. Vertical fire extension resulted from unprotected openings in floor and shaft assemblies, failure of fire-resistance rated floor assemblies, and the lapping of flames through windows on the outside of the building.

Water Supply Problems

The normal attack hose lines used by the Philadelphia Fire Department incorporate 1¾-inch hose lines with automatic fog nozzles designed to provide variable gallonage at 100 psi nozzle pressure. The pressure reducing valves in the standpipe outlets provided less than 60 psi discharge pressure, which was insufficient to develop effective fire streams. The pressure reducing valves (PRVs) were field adjustable using a special tool.

However, not until several hours into the fire did a technician knowledgeable in the adjustment technique arrive at the fire scene and adjust the pressure on several of the PRVs in the stairways.

When the PRVs were originally installed, the pressure settings were improperly adjusted. Index values marked on the valves did not correspond directly to discharge pressures. To perform adjustments the factory and field personnel had to refer to tables in printed installation instructions to determine the proper setting for each floor level.[3]

Several fire department pumpers were connected to the Fire Department connections to the standpipe system in an attempt to increase the water pressure. The improperly set PRVs effectively prevented the increased pressure in the standpipes from being discharged through the valves. The limited water supply prevented significant progress in fighting the fire and limited interior forces to operating from defensive positions in the stairwells. During the next hour the fire spread to the 23rd and 24th floors primarily through autoexposure, while firefighters were unable to make entry onto these floors due to deteriorating heat and smoke conditions and the lack of water pressure in their hose lines. Windows on the 22nd floor broke out and the 23rd and 24th floor windows were subject to autoexposure from flames lapping up the sides of the building.

On the street below pedestrians were cleared from the area because of falling glass and debris as more and more windows were broken out by the fire. Additional hose lines were connected to the standpipe connections, attempting to boost the water pressure in the system. However, the design of the PRVs did not allow the higher pressure to reach the interior hose streams. Additional alarms were requested to bring a five-alarm assignment to the scene.

Three Firefighters Lost

As firefighters attempted to make entry to the burning floors from the stairways, heavy smoke continued to build up within the stair shafts and banked down from the upper floors. An engine company was assigned to attempt to open a door or hatch to ventilate the stairways at the roof level to allow the smoke and heat to escape. A Captain and two firefighters from Engine 11 started up the center stair from the 22nd floor with this assignment. Engine 11 subsequently radioed that they had left the stairway and were disoriented in heavy smoke on the 30th floor. Attempts were made to direct the crew by radio to one of the other stairways.

Shortly thereafter a radio message was received at the Command Post from Engine 11's Captain requesting permission to break a window for ventilation. This was followed moments later by a message from a crew member of Engine 11 reporting that "the Captain is down." Approval was given to break the window and rescue efforts were initiated to search for the crew. Search teams were sent from below and a helicopter was requested to land a team on the roof. The search teams were able to reach the 30th floor, which was enveloped in heavy smoke, but were unable to find the missing firefighters. They then searched the floors above without success. An eight member search team became disoriented and ran out of the air in the mechanical area on the 38th floor, while trying to find an exit to the roof.

[3] The pressure reducing valves in the vicinity of the fire floor (floors 18 through 20) were set at "80" on the valve index which corresponded to a discharge pressure between 55 and 57 psi, depending on the elevation. This would provide a nozzle pressure of 40 to 45 psi at the end of a 150 to 200 foot hose line.

They were rescued by the team that had landed on the roof and were transported back to ground level by the helicopter.

Several attempts were made to continue the search, until helicopter operations on the rooftop had to be suspended due to the poor visibility and the thermal drafts caused by the heat of the fire. The helicopter crew then attempted an exterior search, using the helicopter's searchlight, and at 0117 located a broken window on the southeast corner of the 28th floor, in an area that could not be seen from any of the surrounding streets. Another rescue team was assembled and finally located the three missing members just inside the broken window on the 28th floor at approximately 0215. At that time the fire was burning on the 24th and 25th floors and extending to the 26th.

The victims were removed to the Medical Triage Area on the 20th floor, but resuscitation efforts were unsuccessful and they were pronounced dead at the scene. An estimated three to four hours had elapsed since they had reported that they were in trouble and all had succumbed to smoke inhalation.[4]

The three deceased members of Engine Company 11 were Captain David P. Holcombe (age 52), Firefighter Phyllis McAllister (43), and Firefighter James A. Chappell (29).

Prior to being assigned to this task, the crew had walked up to the fire area wearing their full protective clothing and SCBA and carrying extra equipment. It is believed that they started out with full SCBA cylinders, but it is not known if they became disoriented from the heavy smoke in the stairway, encountered trouble with heat build-up, or were exhausted by the effort of climbing 28 floors. Some combination of these factors could have caused their predicament. Unfortunately, even after breaking the window they did not find relief from the smoke conditions which were extremely heavy in that part of the building.

Continuing Efforts to Improve Water Supply

Because of the difficulty in obtaining an adequate water supply, a decision was made to stretch 5-inch lines up the stairs to supply interior attack lines. The first line was stretched up the west (#1) stairwell to the 24th floor level and was operational by 0215, approximately six hours into the fire. At 0221, a 12th alarm was sounded to stretch a second line, in the center (#2) stair. At 0455, a third 5-inch line was ordered stretched, in the east (#3) stair. The operation in the east stair was discontinued at the 17th floor level at 0600. While the 5-inch lines were being stretched, a sprinkler contractor arrived at the scene and manually adjusted the pressure reducing valves on the standpipe connections. This improved the discharge pressure in the hoses supplied by the standpipe system, finally providing normal hand line streams for the interior fire suppression crews. At this point, however, the fire involved several floors and could not be contained with manual hose streams.

Firefighting Operations Suspended

All interior firefighting efforts were halted after almost 11 hours of uninterrupted fire in the building. Consultation with a structural engineer and structural damage observed by units operating in the building led to the

4 The exact time that Engine 11 was assigned to attempt ventilation and the time the crew reported they were in trouble are not known, since the tactical radio channel they were using is not recorded and detailed time records of this event were not maintained during the incident. Estimates from individuals who were involved suggest that the assignment was made between 2130 and 2200 hours and search efforts were initiated between 2200 and 2230 hours. The bodies were located at approximately 0215 hours.

belief that there was a possibility of a pancake structural collapse of the fire damaged floors. Bearing this risk in mind along with the loss of three personnel and the lack of progress against the fire despite having secured adequate water pressure and flow for interior fire streams, an order was given to evacuate the building at 0700 on February 24. At the time of the evacuation, the fire appeared to be under control on the 22nd through 24th floors. It continued to burn on floors 25 and 26 and was spreading upward. There was a heavy smoke condition throughout most of the upper floors. The evacuation was completed by 0730.

After evacuating the building, portable master streams directed at the fire building from several exposures, including the Girard Building #1 and One Centre Plaza, across the street to the west were the only firefighting efforts left in place.

Fire Stopped

The fire was stopped when it reached the 30th floor, which was protected by automatic sprinklers. As the fire ignited in different points at this floor level through the floor assembly and by autoexposure through the windows, 10 sprinkler heads activated and the fires were extinguished at each point of penetration. The vertical spread of the fire was stopped solely by the action of the automatic sprinkler system, which was being supplied by Fire Department pumpers. The 30th floor was not heavily damaged by fire, and most contents were salvageable. The fire was declared under control at 3:01 p.m., February 24, 1991.

Analysis

Smoke Movement

The heated products of combustion from a fire have a natural buoyancy, which causes them to accumulate in the upper levels of a structure. In a high-rise building the stairways, elevator shafts, and utility shafts are natural paths for the upward migration of heated products of combustion.

Stack effect is a natural phenomenon affecting air movement in tall buildings. It is characterized by a draft from the lower levels to the upper levels, with the magnitude of the draft influenced by the height of the building, the degree of air-tightness of exterior walls of the building, and temperature differential between inside and outside air.[5] This effect was particularly strong on the night of the fire due to the cold outside temperature. Interior air leakage rates, through shaft walls and openings, also modulate the rate of air flow due to stack effect. Smoke and toxic gases become entrained in this normal air movement during a fire and are carried upward, entering shafts through loose building construction or pipe and duct penetrations. The air flow carries smoke and gases to the upper portions of the structure where the leakage is outward.

At the upper portions of the structure, smoke and toxic gases fill the floors from the top floor down toward the fire, creating a dangerous environment for building occupants and firefighters. During the investigation of this fire, this upward flow was evidenced by the presence of heavy soot in the 38th floor mechanical room and all the upper floors of the building. The path of smoke travel to the upper floors was vividly evidenced by the soot remnants in HVAC shafts, utility chases, return air shafts, and exhaust ducts.

[5] Fitzgerald, R. (1981), "Smoke Movement in Buildings," in *Fire Protection Handbook*, 15th ed., McKinnon, G.P., ed., Quincy, MA: National Fire Protection Association, p. 3-32.

Fuel Loading

Fuel loading on the fire floors consisted mainly of files and papers associated with securities trading and management consulting. At least one floor had a significant load of computer and electronic equipment. In some cases, correlation could be found between heavy fuel load and damage to structural members in the affected area. From the 22nd floor to the 29th floor, the fire consumed all available combustible materials with the exception of a small area at the east end of the 24th floor.

Structural Conditions Observed

Prior to deciding to evacuate the building, firefighters noticed significant structural displacement occurring in the stair enclosures. A command officer indicated that cracks large enough to place a man's fist through developed at one point. One of the granite exterior wall panels on the east stair enclosure was dislodged by the thermal expansion of the steel framing behind it. After the fire, there was evident significant structural damage to horizontal steel members and floor sections on most of the fire damaged floors. Beams and girders sagged and twisted--some as much as three feet--under severe fire exposures, and fissures developed in the reinforced concrete floor assemblies in many places. Despite this extraordinary exposure, the columns continued to support their loads without obvious damage.

Incident Command

During nearly 19 hours of firefighting, the Philadelphia Fire Department committed approximately 316 personnel operating 51 engine companies, 15 ladder companies, and 11 specialized units, including EMS units, to the 12-alarm incident. The incident was managed by 11 battalion chiefs and 15 additional chief officers under the overall command of the Fire Commissioner. All apparatus and personnel were supplied without requesting mutual aid. Off-duty personnel were recalled to staff reserve companies to maintain protection for all areas of the city. Philadelphia uses an incident management system known within the department as Philadelphia Incident Command (PIC). It is based on the ICS system taught at the National Fire Academy.

Operations

The Department's standard operating procedures for a high-rise incident were implemented at the time of arrival. Incident commanders were confronted with multiple simultaneous systems failures. As a result, command and control decisions were based on the need to innovate and to find alternate approaches to compensate for the normal systems that firefighters would have relied on to bring this incident to a more successful conclusion.

Philadelphia Fire Department tactical priorities in a high-rise fire focus on locating and evacuating exposed occupants and making an aggressive interior attack to confine the fire to the area or at least the floor of origin. Confronted with total darkness, impaired vertical mobility because the elevators were inoperable, water supply deficiencies which made initial attack efforts ineffective, vertical fire spread via unprotected interior openings and external auto-exposure, and worsening heat and smoke conditions in the stairways, the tactical focus shifted to finding something (perhaps anything) which could be accomplished safely and effectively.

When Engine 11's crew reported their predicament, the priority changed to attempting to locate and rescue the trapped firefighters. Unfortunately, these efforts were in vain and nearly proved tragic when the eight firefighters conducting search and rescue operations became disoriented and ran out of air in the 38th floor mechanical room and nearly perished while trying to locate a roof exit. The rescue of these members was extremely fortunate in a situation that could have resulted in an even greater tragedy.

Communications

As is often the case, communication at such a large incident presented a serious challenge to maintaining effective command and control. The loss of electrical power plunged the entire building into total darkness, forcing firefighters to rely on portable lights. This impacted even face-to-face communications by making it difficult for people to identify with whom they were talking.

Radio communication was also affected by the significant duration of the incident. A field communications van was brought to the scene early in the incident with a supply of spare radios and batteries, but it was a major challenge to provide charged batteries for all of the radios that were in use in the incident.

To ease congestion on fireground radio channels, cellular telephones were used to communicate between the Command Post in the lobby and the staging area on the 20th floor. Several other communications functions took advantage of the cellular telephone capability.

Logistics

The Logistics Section was responsible for several functions including refilling SCBA cylinders, supplying charged radio batteries, and stretching the 5-inch supply line up the stairways. These were monumental endeavors which required the labor of approximately 100 firefighters. Equipment and supplies were in constant demand including handlights and portable lighting, deluge sets, hose, nozzles and other equipment. The Staging Area on the 20th floor included the Medical and Rehabilitation sectors.

The Philadelphia Fire Department used its high-rise air supply system to refill air cylinders on the 20th floor. Falling glass and debris severed the airline, which is extended from the air compressor vehicle outside the building to the staging area, and the system had to be repaired and reconnected at the scene.

Safety

When things go wrong on a scale as large as One Meridian Plaza, safety becomes an overriding concern. Firefighters were continually confronted with unusual danger caused by multiple system failures during this incident. The deaths of the three firefighters and the critical situation faced by the rescue team that was searching for them are clear evidence of the danger level and the difficulties of managing operations in a dark, smoke-filled high-rise building.

A perimeter was set up around the building to prevent injuries from falling glass and stone panels, but it was necessary for personnel to cross this zone to enter and exit the building and to maintain the hose lines connected to the standpipe system. One firefighter was seriously injured when struck by falling debris while tending the hose lines. In addition, all supplies and equipment needed inside the building had to cross the safety perimeter at some point.

Many firefighters working inside the building were treated for minor injuries and fatigue during the fire. Rest and rehabilitation sectors contributed to firefighter safety by improving mental and physical stamina, and a medical triage treatment area was established on the 20th floor.

The physical and mental demands on personnel were extraordinary. In addition to managing the physical safety of personnel, their emotional and psychological well-being were considered. The Department activated its critical incident stress debriefing program and relieved first and second alarm companies soon after discovering that the crew of Engine 11 had died on the 28th floor. More than 90 firefighters were debriefed on site after the dead firefighters were evacuated. The CISD involvement continued after the fire, due to the tremendous impact of the loss and the risk to the hundreds of firefighters who were involved in the incident.

The most courageous safety decision occurred when Fire Commissioner Roger Ulshafer ordered the cessation of interior firefighting efforts and evacuated the building due to the danger of structural collapse. Firefighters did not reenter the structure until the fire had been controlled by the automatic sprinklers on the 30th floor and burned out all of the available fuels on the fire-involved lower levels.

Building and Fire Regulations

When One Meridian Plaza construction began in 1968, the City of Philadelphia was enforcing the 1949 edition of the Philadelphia Building Code. This code was of local origin and contained minor amendments that had been incorporated since its enactment. This building code made no distinction between high-rise and other buildings; and therefore, no special high-rise construction features were required. The general focus of the code was to provide a high degree of fire-resistive construction rather than relying on automatic sprinkler protection or compartmentation.

In 1984, Philadelphia switched from a locally developed building code to one based on the *BOCA Basic Building Code/ 1981*. That code has since been updated, and the *BOCA National Building Code/ 1990* is currently in force in Philadelphia. Both of these codes contain provisions expressly addressing high-rise building fire protection, including a requirement for automatic sprinkler systems in all new high-rise buildings.

As a result of this fire, the City of Philadelphia has adopted an ordinance requiring all existing high-rise buildings to be protected by automatic sprinklers by 1997. Also, officials of the Philadelphia Fire Department have discussed proposing adoption of the *BOCA National Fire Prevention Code* with local amendments, as opposed to continuing to develop their Philadelphia Fire Prevention Code locally.

In 1981, the City enacted amendments to its Fire Code requiring the installation of special fire protection features in existing high-rise buildings. These modifications included:

- Fire alarm systems with smoke detection in elevator lobbies, entrances to exit stairways, return air plenums, corridors, and other common or public areas.
- Stairway identification signs, (i.e., identification of the stairway, floor level, and the top and bottom levels of the stairway).

- Stairway re-entry to permit occupants to retreat from stairways compromised by smoke or fire and return to tenant spaces. (In the event doors were locked from the stairway side for security reasons, provisions had to be made to unlock doors automatically upon activation of the fire alarm system.)

In November 1984, the Philadelphia Department of Licenses and Inspections issued a notice of violation to the owners of One Meridian Plaza requiring compliance with these amendments. The Board of Safety and Fire Prevention later granted the owners a variance to permit stairway doors to be locked, provided that doors were unlocked to permit re-entry every third floor.[6]

Fire Code Enforcement

The preparation and adoption of fire safety regulations is managed by the Philadelphia Fire Department under the direction of the Fire Marshal. However, the department does not perform or direct compliance inspections of individual properties. Fire code enforcement is delegated to the Department of Licenses and Inspections (L&I) by city charter. This department performs the functions of the building official in Philadelphia.

The Fire Department conducts inspections of properties applying for variances, follows-up citizen complaints, and makes referrals to L&I. The block inspection program detailed in Fire Department Operational Procedure 4 provides for the annual inspection of all buildings except one and two family dwellings. However, Fire Department activities to detect and abate hazards are primarily of an educational nature. Guidelines for referring serious or continuing hazards to L&I are not detailed in the Block Inspection procedure; however, information regarding the maintenance of referral and appeal records for individual properties is detailed.

It has been questioned whether the working relationships between line company personnel, the Fire Marshal's office, and the Department of Licenses and Inspections produces effective fire code compliance. Senior Fire Department officials have expressed considerable dissatisfaction with the relationship between the Fire Department and L&I, and continue to advocate a more active role for the Fire Department in code enforcement matters.

Fire inspection records for One Meridian Plaza were examined after the fire to document code enforcement actions requiring the installation or upgrade of fire protection features required by the 1981 fire code amendments. An August 17, 1990, L&I violation notice cited the owner for failing to pay a non-residential inspection fee and noted that a reinspection would be conducted within 30 days. However, no record of a subsequent inspection was produced.

Lessons Learned

Perhaps the most striking lesson to be learned from the One Meridian Plaza high-rise fire is what can happen when everything goes wrong. Major failures occurred in nearly all fire protection systems. Each of these failures helped produce a disaster. The responsibility for allowing these circumstances to transpire can be widely shared, even by those not directly associated with the events on and before February 23, 1991.

[6] Records and reports provided by the Philadelphia Fire Department during this investigation do not indicate the dates of either the appeal or this variance. Firefighters did report having to force entry on several floors during firefighting because some stairway doors were locked.

To prevent another disaster like One Meridian Plaza requires learning the lessons it can provide. The consequences of this incident are already being felt throughout the fire protection community. Major code changes have already been enacted in Philadelphia and new proposals are under consideration by the model code organizations. These changes may eventually reduce the likelihood of such a disaster in many communities.

1. <u>Automatic sprinklers should be the standard level of protection in high-rise buildings.</u>

The property conservation and life safety record of sprinklers is exemplary, particularly in high-rise buildings. While other fire protection features have demonstrated their effectiveness over time in limiting losses to life and property, automatic sprinklers have proven to provide superior protection and the highest reliability. Buildings in some of the nation's largest cities, designed and built around effective compartmentation, have demonstrated varying success at containing fires, but their effectiveness is often comprised by inadequate design or installation and may not be effectively maintained for the life of the building. Even with effective compartmentation, a significant fire may endanger occupants and require a major commitment of fire suppression personnel and equipment. Retrofitting of automatic sprinklers in existing buildings has proven effective in taking the place of other systems that have been found to be inadequate.

2. <u>Requirements for the installation of automatic sprinklers are justified by concerns about firefighter safety and public protection effectiveness, as well as traditional measures such as life safety and property conservation.</u>

The property protection value of sprinklers was recognized long before life safety became a popular justification for installing fire protection. Life safety has become the primary concern in recent times, justifying the installation of automatic sprinklers in high-rise buildings. The value of sprinklers as a means of protecting firefighters has rarely been discussed.

Members of the fire service should promote automatic fire sprinklers if for no other reason than to protect themselves. Requiring the installation and maintenance of built-in fire protection should become a life safety issue for firefighters.[7] The opposition to retrofit protection has consistently cited cost concerns. Communities need to be made aware that the costs they defer may be paid by firefighters in terms of their safety. This is above and beyond the potential loss to citizen and businesses that is usually considered.

3. <u>Code assumptions about fire department standpipe tactics proved invalid.</u>

One of the principal code assumptions affecting fire department operations at One Meridian Plaza concerned the installation of standpipe pressure reducing valves. The rationale for PRVs is the concern that firefighters would be exposed to dangerous operating pressures and forces if they connected hose lines to outlets near the base of standpipe risers of substantial height, particularly those supplied by stationary fire pumps. *For example, in a 275 foot high standpipe zone (the highest permitted using*

[7] A study by Charles Jennings reports that the firefighter injury rate in non-sprinklered high-rise buildings is seven times higher than in comparable buildings equipped with automatic sprinklers. "In High-Rise Fires, Sprinklers Beat Compartmentation--Hands Down." *U.S. Fire Sprinkler Reporter*, April 1992, pp. 1, 5-7.

standard pipe and fittings), a pressure of 184 psi is required at the base of the riser to overcome elevation and produce the minimum required outlet pressure of 65 psi at the top of the riser. At this pressure, a standard 2½-inch fire hose fitted with a 1⅛-inch straight bore nozzle would produce a back pressure (reaction force) in excess of 500 pounds. This is well-founded concern; however, it is built upon the assumption that fire departments use 2½-inch attack lines and straight bore nozzles to attack fires from standpipes. Most fire departments today use 1¾-inch and 2-inch hose with fog nozzles for interior attack. These appliances require substantially greater working pressures to achieve effective hose streams.

In the aftermath of this incident, the NFPA Technical Committee on Standpipes has proposed a complete revision of NFPA 14[8] to more closely reflect current fire department operating practices. Section 5-7 of the proposed standard requires a minimum residual pressure of 150 psi at the required flow rate from the topmost 2½-inch hose outlet and 65 psi at the topmost 1½-inch outlet (presumably for occupant use). Minimum flow rates of 500 gpm for the first standpipe and 250 gpm for each additional standpipe remain consistent with past editions of the standard. The proposed new requirements limit the installation of pressure regulating devices to situations where static pressures at hose outlets exceed 100 psi for occupant use hose or 175 psi for fire department use hose. This will provide substantially greater flow and pressure margins for fire department operations. These requirements are intended to apply to new installations and are not retroactive.

8 The report of the Technical Committee on Standpipes appears in the NFPA *1992 Fall Meeting Technical Committee Reports*, pp. 331-367.

Firefighters at One Meridian Plaza had great difficulty determining how to improve flow and pressure from hose outlets during the fire. Even if firefighters could have closely examined the valves, with good light and under less stressful conditions, it is unlikely that they would have been able to readjust the valves. Numerical indicators on the valve stems represented an index for adjustment not the actual discharge pressure. (This may have confused the technicians responsible for installing and maintaining the valves. Investigators found valves set at "20" and "80" on the index markings. To achieve 65 psi would have required a setting from 88 to 91 on the index. A setting of 150 to 158 was necessary to produce the maximum allowable 100 psi.)

Pressure regulating devices come in three different types:

Pressure restricting devices which reduce pressure under flowing conditions by reducing the cross-sectional areas of the hose outlet.

Pressure control valves are pilot-operated devices which use water pressure within the system to modulate the position of a spring-loaded diaphragm within the valve to reduce downstream pressure under flowing and non-flowing conditions.

Pressure reducing valves use a spring-loaded valve assembly to modulate the position of the valve disc in the waterway to reduce the downstream pressure under flowing and non-flowing conditions.

Further differentiation within each of these types results from differences in manufacturer specifications. (Details are provided in the Philadelphia Fire Department fact sheet on pressure regulating devices in Appendix G.) Some devices are field adjustable, some are not. Some can be removed to permit full, unrestricted flow, others cannot.

4. <u>The requirements and procedures for design, installation, inspection, testing, and maintenance of standpipes and pressure reducing valves must be examined carefully.</u>

The proposed revision of NFPA 14 (1993) and a new NFPA document, NFPA 25, *Standard for the Installation, Testing, and Maintenance of Water-Based Fire Protection Systems* (1992), address many of the concerns arising from this fire regarding installation and adjustment of pressure reducing valves. NFPA 14 requires acceptance tests to verify proper installation and adjustment of these devices. NFPA 25 requires flow tests at five year intervals to verify proper installation and adjustment.

Neither of these standards proposes changes in the performance standards for the design of pressure reducing valves.

Standard performance criteria for the design and operation of each type of valve should be adopted to encourage user-friendly designs that will permit firefighters to achieve higher pressure and flow rates without interrupting firefighting operations. The operation and adjustment of valves should be easy to identify and clearly understandable by inspection and maintenance personnel without reliance on detailed operating or maintenance instructions.

It is extremely important to have all systems and devices thoroughly inspected and tested at the time of installation and retested on a regular basis. Fire suppression companies that respond to a building should be familiar with equipment that is installed in its fire protection systems and confident that it will perform properly when needed.

5. <u>Inconsistencies between code assumptions and firefighting tactics must be addressed.</u>

The inconsistency between fire department tactics and design criteria for standpipe hose outlet pressures was widely recognized before this fire. However, little was done to change fire department tactics or to amend the code requirements for standpipe installations.

Fire departments utilize lightweight hose and automatic nozzles for the same reasons the code requires pressure reducing valves: firefighter safety. The inconsistency between these approaches can cause serious problems. Where pressure reducing valves are not installed, fire departments can usually augment water supplies by connecting to the fire department connections. However, when contemporary firefighting tactics are employed and improperly adjusted PRVs are installed, the combination is likely to produce hose streams with little reach or effectiveness.

The PRV equipped hose outlets on the 22nd floor of One Meridian Plaza, adjusted as reported at the time of the fire, would have produced nozzle pressures of approximately 40 psi. This is insufficient for a straight stream device and dangerously inadequate for a fog nozzle.

Standard operating procedures for high-rise buildings, particularly those not protected by automatic sprinklers, should reflect the potential need to employ heavy firefighting streams, which may require higher flows and pressures.

6. <u>Pre-fire planning is an essential fire department function.</u>

The availability of information about the building was a problem in this incident.

The purpose of conducting pre-fire plans is to gather information about buildings and occupancies from the perspective that a fire will eventually occur in the occupancy. This information should be used to evaluate fire department readiness and resource capabilities. At a fire scene, pre-fire plan information can be used to formulate strategies for dealing with the circumstances which present themselves

Pre-fire planning activities should identify building and fire protection features which are likely to help or hinder firefighting operations and record this information in a format usable to firefighters at the scene of an emergency. Recognizing and recording information about pressure restricting devices and pressure reducing valves should be among the highest priorities. Information on fire alarm systems and auxiliary features such as elevator recall, fan control or shutdown, and door releases should also be noted.

The Fire Department was unable to obtain important details about the installed fire protection at One Meridian Plaza during critical stages of the fire attack. Detailed information about the design and installation of standpipes, pressure relief valves and the fire pump, could have aided firefighters significantly if it had been available earlier in the fire.

Pre-fire plans and standard operating procedures should also consider evacuation procedures and plans for the removal of occupants.

7. Standard Operating Procedures (SOPs) and training programs for fire in high-rise buildings should reflect the installed protection and high-rise fire behavior.

Training and SOPs should consider ways to achieve adequate fire flow with available pressures and ways to improve flow and pressure when required. Tactics for placing multiple lines in service simultaneously must also be developed and discussed.

Extensive pre-fire planning and training are required for fire department control of mechanical smoke management systems to be effective. Training in the management of smoke should consider stack effect and the ability to predict and/or direct ventilation in a real incident.

8. Safety-oriented strategies should dominate command decisions when multiple systems failures become evident.

This incident presented command officers with an unprecedented sequence of system failures. As more things went wrong, officers had to seek alternative approaches to manage the situation. The time pressure and stress of fireground command can make it difficult to thoroughly evaluate each alternative approach, particularly as new and unanticipated problems are presented in rapid succession. Conservative tactics, oriented toward protecting the firefighters who must execute them, should take precedence when confronted with an unknown and unanticipated situation, since the potential consequences of fireground decisions can rarely be fully evaluated during the incident. As much as possible, these alternatives should be considered beforehand in pre-fire planning, standard operating procedures, and training materials, and by reviewing post-fire critiques and reports of other incidents. This is an incident that will make a major contribution to the knowledge of what can and will happen when major system failures occur in the worst imaginable sequence.

9. Fire code enforcement programs require the active participation of the fire department.

In Philadelphia, responsibility for the fire code is fragmented. The Fire Department is responsible for developing and maintaining fire code requirements, supervising the appeals process, and investigating and referring fire code complaints. However, it does not conduct regular periodic code enforcement inspections, issue permits, or develop target hazard protocols for ensuring that inspections conducted by the responsible agency are addressing critical fire protection problems.

Many of the model code requirements that apply to high-rise buildings are predicated upon assumptions about firefighting strategies and tactics. Most model code organizations designate the fire department, fire prevention bureau, or fire marshal's office as the principal enforcement authority for fire protection system requirements. Fire department personnel are in the best position to validate code assumptions and see that the built-in fire protection and life safety systems are functional and compatible. Moreover, the first-hand knowledge and experience of firefighters with fire behavior is often an invaluable resource when interpreting fire and building code requirements.

10. <u>Code provisions should be adopted requiring high-rise building owners to retain trained personnel to manage fire protection and life safety code compliance and assist fire department personnel during emergencies.</u>

Model fire prevention codes require building owners to develop high-rise fire safety and evacuation plans to manage the life safety complexities of these buildings. The requirements are not specific about what must be included in these plans, and they give no explicit consideration to the problems of firefighting and property conservation.

Mandating the appointment and certification of individuals with specialized knowledge in code requirements and building systems would go a long way toward ensuring that the unique aspects of each high-rise building are incorporated into detailed plans. (New York City Local Law 5 requires that each owner designate a fire safety director. The responsibilities of this individual for managing the life safety plan during an incident are clearly established in this ordinance.)

11. <u>Occupants and central station operators must always treat automatic fire alarms as though they were actual fires, especially in high-rise buildings.</u>

Building personnel, alarm services, and fire departments must develop an expectation that an automatic alarm may be an indication of an actual fire in progress. Automatic detection systems have gained a reputation for unnecessary alarms in many installations. This has caused an attitude of complacency that can be fatal in responding to such alarms. To change such attitudes and expectations, it will be necessary to improve the reliability and performance of many systems.

By choosing to investigate and verify the alarm condition, the building engineer nearly lost his life. If not for the ability to communicate with the lobby guard to relay instructions for manually recalling the elevator, this individual would likely have shared the fate of his counterpart who died in a service elevator at the First Interstate Bank Building Fire in Los Angeles (May 4, 1988).

Technological advances and improved maintenance procedures are the answers to solving the nuisance alarm problem. In addition to requiring regular maintenance of systems by qualified individuals, Philadelphia and other cities have stiffened the penalties on owners, occupants, and central station operators who fail to report automatic fire alarm activations.

12. Incomplete fire detection can create a false sense of security.

Automatic fire detectors, like automatic sprinklers, are components of engineered fire protection systems. A little protection is not always better than none. Over-reliance on incomplete protection may lead to a false sense of security on the part of building owners and firefighters alike.

Automatic fire detectors can only notify building occupants or supervisory personnel at a central, remote, or proprietary station that an event has occurred, and in some cases initiate action by other systems to limit the spread of fire, smoke, or both. (In this case, automatic detectors initiated an alarm, recalled elevators, and shutdown air handling equipment; however, an elevator was subsequently used to go to the fire floor to investigate the alarm.)

Smoke detectors at One Meridian Plaza were installed in particular areas as required by the 1981 amendments to the fire code; that is at the point of access to exits, at the intakes to return air shafts, and in elevator lobbies and corridors. The apparent underlying logic was to protect the means of egress and to detect smoke in the areas where it was most likely to travel. It appears in this case that the partitions and suspended ceiling contained the smoke and heat during the fire's incipient phase and prevented early detection. In all likelihood, the first detector may not have activated until after the room of origin had flashed-over. Shortly after flashover, the suspended ceiling in this area probably failed permitting the fire to spread throughout the return air plenum. Once the fire broke the exterior windows and established an exterior air supply there was little that could be done to control the fire. Firefighters were disadvantaged by the delay in reporting the fire.

13. Nationally recognized elevator code requirements for manual control of elevators during fire emergencies work.

Elevator control modifications at One Meridian Plaza were accomplished in accordance with Commonwealth of Pennsylvania requirements based on ANSI/ASME A17.1, *Safety Code for Elevators and Escalators.* The elevators performed as expected by the standard. The only problem with the elevator response was the decision of the building engineer to override the system to investigate the alarm.

14. The ignition source provided by oil-soaked rags is a long recognized hazard that continues to be a problem.

Had the contractor refinishing paneling on the 22nd floor not carelessly left oil soaked cleaning rags unattended and unprotected in a vacant office, this fire would not have occurred. To pinpoint the particular source of ignition of this fire as the sole cause of the death and destruction that followed is a gross oversimplification. Nevertheless, failure to control this known hazard is the proximate cause of *this* disaster. The danger of spontaneous heating of linseed oil-soaked rag waste is widely recognized. Each model fire prevention code requires precautions to prevent ignition of such materials. At a minimum, waste awaiting removal from the building and proper disposal must be stored in metal containers with tight-fitting self-closing lids. Leaving these materials unattended in a vacant office over a weekend was an invitation to disaster. This is both an education and an enforcement problem for fire prevention officials.

15. Building security personnel should be vigilant for fire safety as well as security threats, especially while construction, demolition, alteration, or repair activities are underway.

Earlier in the day, the building engineer had become aware of an unusual odor on the 22nd floor which he associated with the refinishing operations which were underway there. When the alarm system activated later that evening he first believed the solvent vapors had activated a smoke detector.

The roving security guard made no mention of anything unusual during his rounds of the fire area earlier in the evening. It is conceivable that no detectable odor of smoke or audible or visible signals of a fire were present when the guard last checked the floor. However, a cursory check is not adequate when construction, demolition, renovations, or repair activities are underway in a building area. Fire hazards are often associated with construction activities, and buildings are especially vulnerable to fire during such operations. For these reasons, it should be standard practice to check these areas even more carefully and thoroughly than usual. All building operating and security personnel should have basic training in fire prevention and procedures to be followed when a fire occurs.

16. Emergency electrical systems must be truly independent or redundant.

Article 700 of the *National Electrical Code* recognizes separate feeders as a means of supplying emergency power. However, Section 700-12(d) requires these services to be "widely separated electrically and physically.....to prevent the possibility of simultaneous interruption of supply." Installing the primary and secondary electrical risers in a common enclosure led to their almost simultaneous failure when the fire penetrated voids in the walls above the ceiling of the 22nd floor electrical closet. The intense heat melted conductor insulation resulting in dead shorts to ground which opened the overcurrent protection on each service interrupting power throughout the building.

Auxiliary emergency power capability was provided by a natural gas powered generator located in the basement mechanical room. This generator was intended to supply one elevator car in each bank, fire pumps, emergency lighting and signs, and the fire alarm system. However, this generator set failed to produce power when needed. (Generator maintenance records indicated a history of problems; however, the root cause or mechanism responsible for these problems was not identified.)

Supplying the generator from the building natural gas service also left the emergency power system vulnerable in the event of simultaneous failure of the electrical and gas public utilities. The transformers that provided power for the adjacent building were installed in the basement of the One Meridian Plaza Building. These transformers had to be shut down due to the accumulation of water in the basement, resulting in the loss of power to this building as well. As a result the elevators in the adjoining building could not be used.

17. The regulations governing fire-resistance ratings for high-rise structural components should be re-evaluated.

The degree of structural damage produced during the fire at One Meridian Plaza suggests that the requirements for structural fire resistance should be reexamined. Floor assemblies deflected as much as three feet in some places. The fire burning on multiple floors may have produced simultaneous exposure of both sides of these assemblies, which consisted of concrete slabs on corrugated decks, supported by structural steel beam and girder construction, sprayed with cementitious fireproofing materials.

The standard fire test for floor and ceiling assemblies involves exposure from a single side only.

Columns and certain other structural elements are normally exposed to fire from all sides. In this fire, the steel columns retained their structural integrity and held their loads. Experience in this and similar high-rise fires suggests that columns are the least vulnerable structural members, due to their mass and relatively short height between restraints (floor to floor). Major damage has occurred to horizontal members, without compromising the vertical supports.

The development of uniform criteria for evaluating structural fire endurance accompanied the development of skyscrapers in the early 20th century. Test methods developed at the beginning of the century became the first fire-resistance standard in 1909,[9] which endures today as ASTM E119, *Method of Fire Test for Building Construction and Materials.* One of the principal criticisms of this standard has been its lack of correlation with actual fire conditions.

Many fire protection professionals believe that the standard time-temperature curve used to produce the standard fire exposure during testing is less severe than actual fires involving contemporary fuel loads. (The original test method was based on less volatile, primarily cellulosic, fuels, while modern plastics and hydrocarbon-based furnishings and finishes produce much more dangerous and severe fire exposures.) Others believe that the current test method works well because it provides a good yardstick for *comparing* the performance of different systems and has been in widespread use for many decades, generating volumes of data on many systems.[10]

18. <u>Inspections must be conducted during and after construction to verify that penetrations in fire-resistance rated assemblies are properly protected.</u>

Voids and so-called poke-throughs in horizontal and vertical fire separation assemblies presented ideal avenues of fire spread during the One Meridian Plaza fire. Openings in the partitions enclosing electrical equipment on the floor of origin permitted the fire to reach and damage the electrical risers, plunging firefighters into darkness early in the fire. Voids in stairwell enclosures permitted smoke to spread in stairwells making firefighting operations difficult and exposing upper floors. Smoke and fire also extended via pipe chases, and telephone and electrical closets.

Through-penetration protection has been a continuing concern and has received considerable attention in building and fire codes in recent years. Each of the model building codes now contains provisions requiring protection of poke-throughs in fire-resistance rated assembled. Moreover, a whole new industry has been developed to fill the technological void in through-penetration protection which developed with the widespread acceptance of plastic pipe and cable.

The absence of fire dampers in mechanical system supply and return ducts at shaft penetrations on each floor is of particular concern. There is evidence of smoke and

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[9] Fitzgerald, R.W. (1981), "Structural Integrity During Fire," in *Fire Protection Handbook,* 15th ed., McKinnon, G.P., ed., Quincy, MA: National Fire Protection Association, p. 5-62.

[10] Actual conditions in most fires produce heat release curves similar to the standard exposure up to the point where oxygen, i.e., ventilation, becomes restricted by fire product release, i.e., smoke and heated gases. However, at this point, actual fires usually diminish in size unless ventilation improves or a renewed oxygen supply is established. Once refreshed with a new air supply, most fires will resume growth, reach a peak, and then diminish as the fuel supply is consumed.

fire spread through the air handling system. Nationally recognized model building, fire, and mechanical codes have contained requirements for fire dampers in these locations for many years. The installation of smoke detectors in these locations was an ineffective substitute for protecting the integrity of smoke and fire barriers. This fire clearly illustrates that smoke and fire spread through mechanical system plenums, ducts, and shafts is substantial even without the aid of operating fans.[11]

19. Features to limit exterior vertical fire spread must be incorporated in the design of high-rise buildings.

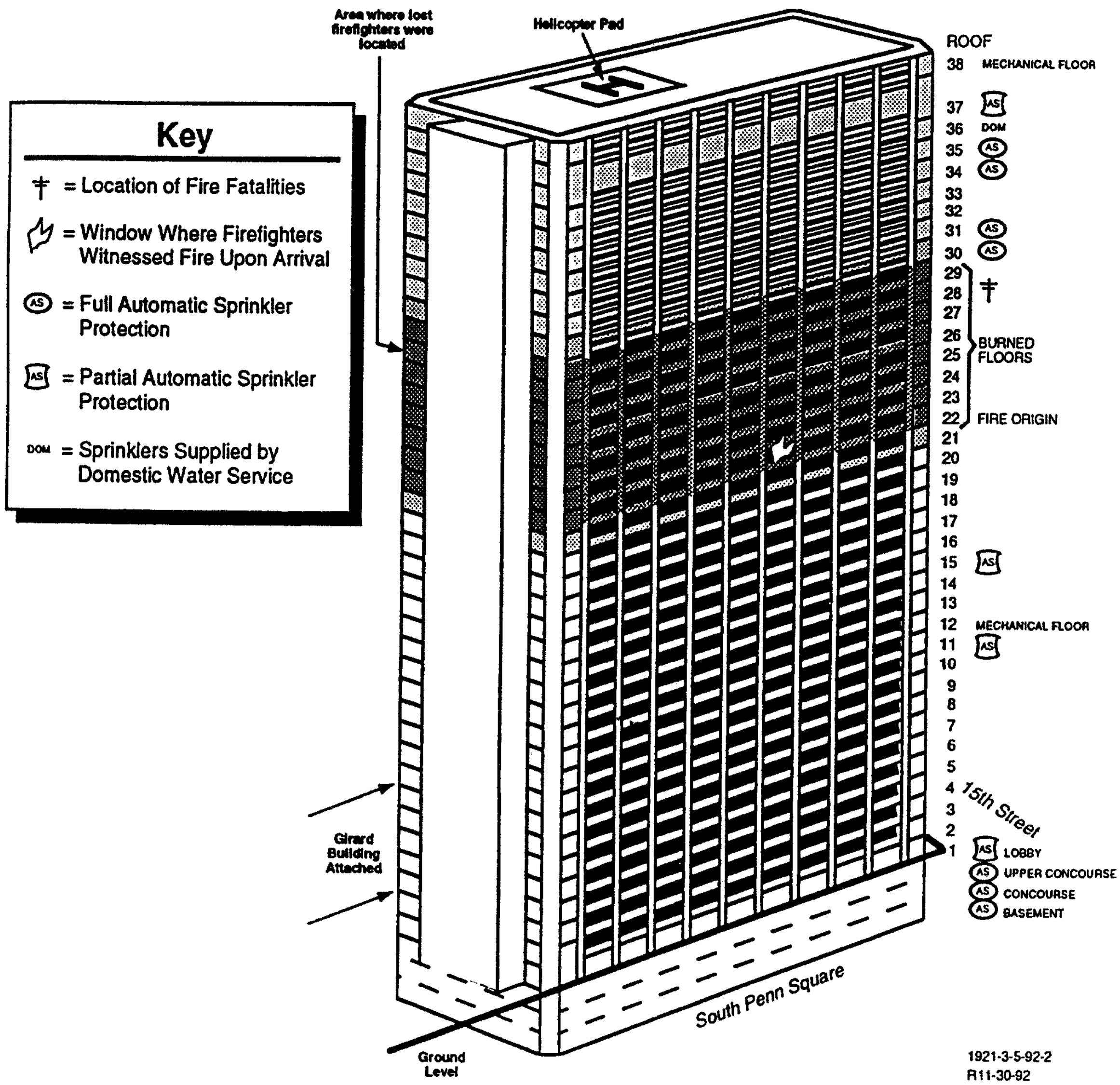
Exterior vertical fire spread or autoexposure can be a significant fire protection problem in construction of high-rise buildings if interior fire growth is unrestricted. Because of the difficulty with retrofitting exterior features to restrict fire spread, the installation of automatic sprinklers to restrict fire growth is the most simple approach to managing this risk in existing buildings. Exterior features to prevent fire spread must usually be designed and built into new buildings. Many modern (international style) and post-modern building designs present difficult exterior fire spread challenges because of their smooth exterior facades and large glazing areas. Variegated exterior facades and larger noncombustible spandrels significantly reduce exterior fire spread effects by increasing the distance radiant and conductive heat must travel to stress exterior windows and to heat materials inside the windows on floors above the fire.

Conclusion

The ultimate message delivered by this fire is the proof that automatic sprinklers are the most effective and reliable means at our disposal to protect high-rise buildings. When all other systems failed, automatic sprinklers were successful in controlling the fire. The Philadelphia Fire Department was confronted with an essentially impossible situation and did a commendable job of managing the incident. The loss of three firefighters is a tragedy that will always be remembered by the Philadelphia Fire Department. Analysis of the situation reveals, however, that the toll could have been much worse, had it not been for the courage, skills, and experience of this Department. Several extremely difficult decisions were made under the most severe conditions. This fire will also be remembered for the lessons that it brings with respect to fire protection systems. To work effectively, such systems must be properly designed, installed, and maintained. When those requirements are not satisfied, the results can be devastating, as clearly demonstrated by this incident.

[11] HVAC fans were shut down at night and on weekends, and were not operating at the time of the fire.

NORTH ELEVATION
1414 South Penn Square
One Meridian Plaza



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UNIT 13: HIGHRISE INCIDENTS

TERMINAL OBJECTIVE

At the end of this unit students given a simulated major fire scenario, will be able to, coordinate, and control tactical resources and implement a plan of action based on critical cues, information gathered and critical elements presented during a high rise incident.

ENABLING OBJECTIVES

The students will be able to:

1. *Understand the management, building construction, and building systems cues required to command a highrise incident.*

2. *Effectively manage a highrise simulation incident.*

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HIGHRISE DEFINITION

A highrise building is a structure that has a height above the ground of 75 feet or more. However, some buildings that are less than 75 feet present the same problems as ones over that height. Also, it is likely that buildings constructed just short of code requirements for a highrise do not have all the fire protection and life safety features of a building that meets a highrise code.

PREFIRE CONSIDERATIONS

An important point to remember is that all highrise buildings are not of the same design or construction. Nor do they all have the same types of fire protection features. Construction methods and code requirements have changed through the years and can be a factor in fire behavior within a building. These changes can also impact the built-in protection features that help to mitigate or control fires within the building. Because highrise buildings can be so different, it is critical that firefighting personnel be familiar with each building and the operation of the life safety and fire protection systems that it contains.

KNOWLEDGE OF BUILDING

Strategy and tactics for highrise fires are affected greatly by the fire personnel knowledge of the building's construction and design features. Some of the questions that need to be answered in the prefire plan include

- Are there "built-in" life safety or fire protection features? What are they? Where are they? How do they operate?

- What is the current occupancy and layout of those parts of the building affected by the fire?

- Is the fire floor compartmented?

- Is the fire floor an open space area that will allow the fire to spread quickly?

This critical information must be gathered ahead of time through effective preincident planning (PIP). The degree of firefighting success may be measured not only by the presence of fire safety features, but also by the ability of firefighting personnel to take advantage of these features.

COMPARISON OF "OLD-STYLE" AND "NEW-STYLE" BUILDING CHARACTERISTICS

"Old-Style" Highrise Construction

"Old-style" highrise buildings were constructed with bearing walls made of masonry. Most of these buildings were constructed of reinforced concrete. Due to the weight of the construction materials, the walls at the bottom were many feet (meters) thick. As the building rose and the upper levels supported less weight, the walls were tapered. These buildings really are the epitome of what fire-resistive construction means.

"Old-style" highrises have more mass due to their concrete construction. Buildings of this construction type also generally have operable windows. The "old-style" highrise is least likely to collapse under fire conditions. This is due to both the mass of the bearing materials and the supporting nature of the exterior walls.

The symbol of old style construction is New York City's Empire State Building. A B-25 bomber once crashed into the building--the structure suffered some minor structural damage and content loss (due to running gasoline fires).

There are many highrise buildings that have unreinforced masonry wall construction. The contents of these buildings are prone to destruction during fires as well as earthquake situations.

"New-Style" Highrise Construction

The modern method of constructing highrise buildings is commonly called "core construction." This method involves erecting a steel skeleton by using a column and girder and beam system. The elevators, stairshafts, utility shafts, etc., are placed in a core area. Most commonly this core is found in the center of the building and is referred to as "center-core" construction. It should be noted that in **some** buildings this core will be found on the side. When this occurs, the construction is referred to as "side core." In the case of "side-core" construction, stairways and elevators are located on exterior walls.

Core construction has less mass than "old-style" construction and is more vulnerable to heat from a fire. Floors have been known to sag nearly two feet under intense fire conditions and have caused, in at least one case, several portions of the wall assembly to fall. Some of these buildings have a sprayed coating on support members that assists in maintaining strength when subjected to heat or flames.

The following table lists highrise structural features and components. This table provides a comparison of features found in "old-" and "new-style" highrise buildings.

Highrise Structural Features/Qualities

Feature/Component	Found in "Old Style"	Found in "New Style"	Found in Both Styles
Structural Framing Systems			
Reinforced concrete	X		
Structural steel		X	
Exterior Walls			
Part of bearing member	X		
Prefabricated/Curtain		X	
Roofs			
Concrete			X
Shingled/Other			X
Shafts			
Stair			X
Conventional			X
Pressurized		X	
Scissor		X	
Elevator			X
HVAC			
Electrical			
Mail			
Dumbwaiter			
Floors			
Concrete poured over metal deck		X	
Poured concrete	X		
Interior Walls			
Poured concrete	X		
Concrete block			X
Drywall on wood or metal stud		X	
Compartmentation			
Concrete with walls running floor to floor	X		
Large open areas		X	
Drywall with walls running floor to floor		X	
Partition walls		X	

Feature/Component	Found in "Old Style"	Found in "New Style"	Found in Both Styles
Ceiling Assemblies			
Steel wire attached to grid of metal channels (with plenum area)			X
Electrical Systems			
Standard system			X
Emergency generator(s)			X
Elevators			
Multiple			X
Low, medium, highrise banks			X
Firefighter service			X
Active Smoke Control Systems			
Stairway pressurization		X	
Building smoke control		X	
Zone smoke control		X	
Corridor smoke control		X	
Elevator smoke control		X	
Atrium smoke control		X	
HVAC Systems			
Standard system		X	
Water Supply			
1-1/2-inch wet standpipe	X		
2-1/2-inch dry standpipe			X
2-1/2-inch wet standpipe			X
Sprinkler system		X	
Combination system			
Standpipe sprinkler			
Emergency Communication Systems			
Hard-wired, jacks at every floor		X	
Fire Control Room/Station			
Sometimes on basement level			X

STRUCTURAL FEATURES

Structural Framing Systems

The structural frame of a highrise building is the skeleton of the structure that supports not only the dead load of the building, but also live loads (such as occupants and building contents). The most common systems in highrise buildings use one of the following as the basis for forming the building skeleton:

- **reinforced concrete** ("old-style"); and
- **structural steel** ("new-style").

Both types use vertical interior and exterior columns to which lateral girders are attached. The girders span the horizontal distance between the columns and structural support beams. Although there is a difference in materials used for structural elements in a concrete versus a steel structural frame, they both serve the same function.

The construction design for highrise buildings is based on the concept that structural integrity of the building must be maintained sufficiently in any potential fire. Principal structural components have a high degree of heat resistance. However, a number of structural stability concerns (that fire personnel must be concerned with) exist during fire conditions:

- Component failure (possible under prolonged exposure to sufficient heat).
- Floor beam failure (somewhat serious, but is also a localized occurrence).
- Girder failure (far more critical than floor beam failure as it would affect a significantly larger area).
- The failure of one or two girders could cause column instability (potentially leading to a progressive collapse of the framing system).
- Column failure could result in serious structural instability. (Depending on the location of the column, it could conceivably trigger extensive collapse damage to the structure.)

To achieve fire protection required by building codes for Type I (fire resistive) construction, steel frame members in highrise buildings are "fireproofed." This is accomplished by encasing them in concrete, sheet rock, or by spraying them with a protective coating. Concrete has the advantage of being the most permanent type of fireproofing, but its use is limited due to the effect that it has on the dead weight of a building. Improperly applied, sprayed on protective coatings can spall during a fire. This may leave the steel structural member exposed and subject to failure from excessive heat.

Concrete frame structures tend to resist the effects of fire better than steel frame structures, but they are less resistant to the effects of earthquakes. The ability of properly designed and constructed steel frame highrise buildings to withstand moderate earthquakes has been proven in many parts of the world in recent years.

Exterior Walls

As stated earlier, the exterior walls of an "old-style" highrise are part of the bearing members. Wall construction is reinforced concrete. These walls are very thick at the bottom and become smaller as they rise.

The exterior walls of modern highrise buildings are commonly prefabricated and typically are lighter in weight than those in older buildings. In many cases, these walls are nonload bearing and may be referred to as "curtain" walls. A complete curtain wall consists of a panel with finished surfaces and a means for attaching it to the building frame.

The most common method for attaching curtain walls to the building is by bolting them to clips that are attached to the structural frame or floor slab. This method of attaching walls often leaves a space of several inches between the end of the floor and the exterior wall. Unless this space is sealed with an effective fire and smoke barrier, it can provide a ready path for fire and smoke (to spread to floors above) and allow water to penetrate (to floors below).

The outside finish of a modern highrise building is often referred to as the "skin" and usually consists of decorative materials such as aluminum, stainless steel, or lightweight concrete. Large window areas are also often present. These windows may be made of plain, tempered, or decorative glass. Metal alloy frames, backed up with conventional construction, hold the glass in place.

Roofs

Roofs on highrise buildings are required to have at least a two-hour fire-resistive rating. In most cases, concrete construction exceeds this requirement. Careful consideration must be given to roof configuration during PIP. Pay particular attention to stairshaft exits and other obstructions that would limit certain types of ventilation activities on the roof.

In many cases, all stairshafts in the building will not exit to the roof. Knowing which stairshafts exit to the roof can be critical when moving occupants to the roof for safe refuge or evacuation, and when using stairshafts to exhaust smoke. It is also important to know if it is possible to land a helicopter on the roof for a top-down approach to firefighting, interior rescue, or to lift building occupants from the roof. Evacuation stairs should be vented (if possible) at roof level to make stairs tenable for occupants.

In most cases (unless the code under which the building was built required the provision of a helipad) it will probably be impossible to land a helicopter on the roof. Various obstructions such as machinery rooms, antennas, or lack of adequate landing space will usually exist.

Shaft Enclosures

Shaft enclosures in highrise buildings are required to have a minimum of a two-hour fire-resistive rating. Examples of shaft enclosures are: stair, elevator, utility, heating, ventilating, and air conditioning (HVAC), supply/return, and electrical shafts. Any vertical shaft in a highrise building, under fire conditions, can transfer heat and smoke to other parts of the structure. Therefore, it is critical that shaft integrity be maintained. These shafts may be used as escape routes for building occupants or as access routes for firefighters. Failure to maintain the integrity of vertical shafts can:

- transfer combustion products to remote parts of the building;
- impede safe exit of building occupants; and
- greatly restrict the ability of fire personnel to perform tactical operations.

Stairshaft Systems

If there is one construction component of a highrise building that firefighting personnel don't know enough about, it is stairshaft systems.

As a rule, highrise building stairshafts are built into the center core. Additional stairshafts **may** be on the structure's outer perimeter (depending on the height and occupancy type of the building).

Shafts other than the conventional, return type can be found in highrise buildings. The building may contain "pressurized" or "smoke proof" stairshafts. Activation of special equipment can provide a smoke free atmosphere within these stairshafts. In many cases, however, even though the building has multiple stairshafts, only one stairshaft may be designed to provide this smoke-free environment. Some highrise buildings feature stairshafts that are often referred to as "smoke towers." These are either fully or partially open to the outside atmosphere to prevent smoke from filling the stairshaft.

Many newly constructed highrise buildings have "scissor" stairshafts that feature two sets of stairs in one common shaft. In some cases, each set of stairs may serve every floor, but entry points at alternate floors are on different sides of the center core. Others are designed so that one set of stairs serves odd numbered floors while the other set serves even numbered floors. While these subtle differences may not seem important, under fire conditions they can be responsible for firefighters approaching the fire from a less than desirable location or they can result in fire personnel going to the wrong floor.

Doors that provide access to the stairshaft from individual floors are often locked from the stairshaft side. This requires that firefighting personnel have a key to provide immediate access to the floors from the stairshaft. A substantial amount of time can be wasted forcing entry to the floor if a key is unavailable. Forcing the door is often difficult due to the metal construction of the door and jamb. Sometimes it is faster to poke a hole through the wall and reach inside to open the door.

As a rule, stairshaft systems in highrise buildings are not designed to handle the total occupant load of the building **simultaneously.** This is further complicated by the fact that the number of usable stairshafts may be reduced by heat, smoke, or fire department operations. This is one of the main reasons why **total evacuation of building occupants during a highrise fire is often impractical.**

During early fire stages, when there is a rapid spread of fire products to floors above the fire area, it may be best to relocate occupants from upper floors to safe refuge areas below the fire, rather than attempting to evacuate them from the building. When this is done, it is critical that occupants be placed in areas that will not be subject to smoke or heat. An escape route from the area must be maintained and responsible personnel (such as police, floor wardens, or building security) must remain along the route to prevent panic.

Stairshafts in highrise buildings should be marked at each landing with signs that provide specific information about the shaft. Signs should identify the stairshaft by name or number (for example: Stair #1, Stair #2, etc.). They should specify what floor you are currently on and list the lower and upper terminal points of that stairshaft (for example: B-3 to 18). The sign should also indicate whether the stairshaft provides access to the roof of the building. This seemingly simple information can be critical to occupants who are using the stairshaft under fire conditions and it can provide critical information for firefighters.

Floors

Floors in highrise buildings are also required to have a minimum of a 2-hour fire-resistive rating. Floors are normally concrete poured over a metal deck that remains in place after the concrete has set. After the concrete has set, holes are bored in the concrete to allow for passage of various utility lines or equipment between floors. This procedure is called "poke through" construction. Poke through, if not properly sealed around the bored holes, can seriously diminish the floor's 2-hour fire resistance.

While most recent codes require that poke through openings be sealed with a material that reestablishes 2-hour fire resistance, in many cases, it is not done properly or is completely overlooked. In older buildings, poke throughs may not be sealed due to a lack of code requirements when the building was built. Not sealing these poke through spaces can allow fire and smoke to travel to upper floors and provide a path for water to travel to floors below. During a fire situation, a check must be made of the floors above and below the fire floor to ensure that poke throughs are not causing a problem.

Interior Partition Construction and Compartmentation

In "old-style" construction, interior walls are usually poured concrete or concrete block. There is generally a high level of compartmentation. Walls usually run from floor to floor and provide a high degree of horizontal fire spread protection.

In "new-style" construction, the interior partitions and walls are usually constructed of drywall on a wood or metal stud. There may or may not be a high level of compartmentation. The office type occupancy buildings may have large open areas containing new modular furniture and cubicles. This may be combined with certain portions of the floors also having conventional offices. Another configuration is to have the entire floor consist of full size offices.

The residential type occupancy building usually has floor-to-floor drywall on wood or metal studs enclosing each individual living unit or apartment. There may only be floor-to-ceiling partitions on the interior of the living unit or apartment. This allows a common area above the entire living unit.

Floor Configuration

There are two general design concepts for horizontal floor separations in highrise buildings. They are referred to as "compartmentation" and "open space." Compartmentation in highrise buildings is based on the concept that small protected areas separated from others will allow the fuel within them to burn out. This keeps the fire from spreading beyond the separated or protected area. An example of compartmentation would be a typical highrise apartment building.

Compartmentation can be an essential design consideration in limiting the size of a highrise fire. Compartment separations must offer adequate fire resistance and must divide plenum areas above dropped ceilings. They must also prevent vertical fire travel by use of protective construction features around vertical shafts and above windows. Proper compartmentation also requires all poke through openings between floors to be properly fire stopped.

Examples of the "open space" concept are highrise office buildings where floors are virtually wide open. This openness is designed to allow unrestricted movement of employees throughout the floor. In a fire situation, however, the lack of physical barriers will allow the fire to spread quickly throughout the floor. Highrise floors often are divided by partitions that extend from the floor to the dropped ceiling. These conditions do not represent true compartmentation. Should the fire reach the open plenum area above the dropped ceiling, it will move unrestricted through the plenum and extend into other areas of the floor.

Ceiling Assemblies

Ceiling assemblies in highrise buildings are usually suspended from the floor assembly by steel wires attached to a grid of metal channels. These channels hold acoustical tile (or other ceiling material) and in most cases they also hold lighting fixtures. The open space between the suspended ceiling and the floor above is normally used for horizontal distribution of utility services (air conditioning ducts, electrical conduits, plumbing lines, etc.). It often serves as a common exhaust plenum for the HVAC system.

WARNING: Under prolonged exposure to sufficient heat, suspension wires will weaken, often causing ceiling assemblies to fall. When this occurs, it can greatly impede the progress of fire attack personnel or cause firefighters to become entangled in the wire or to become trapped.

ELECTRICAL SYSTEMS

Electrical systems in highrise buildings can be extremely complex and very hazardous under fire conditions. Electrical chases are one cause of vertical fire spread.

Much of the electrical equipment is likely to be located in the basement of the building. This makes it susceptible to flooding occurring as a result of broken pipes or water used to control the fire. The danger of working near electrical equipment when water is present is well known and must be remembered. Sending fire personnel into electrical vaults to terminate building power is usually not recommended for the following reasons:

- The shutdown procedure is usually complicated and requires specific knowledge on how to perform it safely.
- Randomly throwing switches in these types of situations can be extremely dangerous. (You could terminate power to equipment that should continue to operate.)
- If power must be terminated on the floor or floors involved in the fire, it can usually be done through subpanels that control the electrical supply to specific floors.
- Because of high voltage and power present in electrical vaults, a sudden shut down by inexperienced personnel can cause dangerous surges that can harm personnel. **Have a utility company or the building engineer do the shut down in electrical vaults.**

An emergency power supply, usually provided by an engine driven generator, may be found in many highrise buildings. The building systems that receive power from the emergency system will vary and are usually dependent on code requirements in effect when the building was constructed. In older buildings, the emergency power may supply only exit lighting in the stairshafts. In newer buildings, it may serve a large number of fire protection or life safety features such as fire pumps, elevators, and smoke removal systems. Emergency power activation may be automatic when normal power is interrupted or it may require manual activation (by throwing switches). During PIP inspections be sure to determine if the building has emergency power, what it supplies, and how it is activated.

ELEVATORS

Under normal conditions, elevators are the only practical method of moving between floors in a highrise building. **Under fire conditions**, elevator operation can become erratic and extremely dangerous. Many elevator system control components can be affected by smoke, moisture, and heat--all of which are present during a fire situation. Control components that can be affected include floor call buttons, electrical contacts located in shaftways, and electrical elements located at the bottom of the hoistway.

Safe use of elevators under fire conditions requires:

- Knowledge of how elevators work.

- An understanding of what malfunctions may occur (i.e., erratic movement, traveling to unselected floors, traveling to the fire floor, ceasing to operate, doors opening without use of "Open Door" button).

- Familiarity with standard operating guidelines (SOGs) and their use under emergency conditions.

- A department wide policy regarding the use of elevators during fire conditions should be developed and adhered to by all department personnel.

Hoistways are the vertical shafts in which elevator cars travel. In buildings with multiple elevators, all elevator cars in a bank are usually in a common hoistway. Some highrise buildings are equipped with low, medium, and highrise bank elevators--also known as **split bank.** These are configured so that some elevators serve only lower floors of the building while others serve the upper floors. It is important to know whether or not the building has split bank elevators and, if so, which floors the different banks serve. This information can be critical in deciding whether it is safe to use the elevator system.

The hoistway is separated from each floor by a hoistway door. This door is opened by movement of the elevator car door (once the car is level with the floor landing). Smoke and heat under pressure at the fire floor can enter the hoistway (even though the hoistway doors are closed) and travel up or down the shaft. If a large volume of fire enters the hoistway shaft, the shaft acts like a chimney and draws the fire upward where the heat may be sufficient enough to ignite materials on upper floors next to the hoistway. As heat and smoke rise within the hoistway, pressure will force it out the hoistway doors onto the upper floors.

Elevator cars will burn to the point where hoisting cables can fail and cause the car to fall down the shaft. If fire has penetrated an elevator car or the hoistway, it is important that personnel be assigned to floors above and below the fire floor (including the floor where the shaft terminates) to check for spread of fire or smoke.

Almost every highrise building is required to be equipped with elevator emergency service features that automatically moves the elevator cars to specific locations under fire conditions. The feature also allows firefighting personnel to place the elevator cars in a "firefighter service" mode that provides specific safety features. Automatic recall may be initiated whenever an alarm device is activated. Manual recall can be done through recall switches located in a lobby control panel or in a fire control room. Automatic or manual recall of elevators (available through firefighter service mode) is important for a couple reasons:

- It reduces the possibility of occupants being trapped in an elevator car.

- It provides the fire department access to elevator cars (if the decision is made to use them).

Firefighter Service During Fire Operations

Whenever possible, elevators equipped with a firefighter service mode should be used for fire operations. The following guidelines should be followed when using these elevators:

- Make sure that the elevators have been placed in the "firefighter service mode."

- First arriving units should (if possible) **initially** avoid a firefighter service equipped elevator that is capable of stopping at all floors.

  - Many of the converted service or freight elevators are so arranged and are therefore capable of being affected by fire on any floor.

  - Only after the Incident Commander (IC) has determined that the fire is not adjacent to the shaft should these elevators be utilized. Experience indicates that many fires in highrise office buildings have been found in the service elevator lobby (in piles of collected rubbish). Heat and flame have affected the doors and control wiring of nearby service elevators.

- Personnel **shall never** take an elevator that services all floors in order to travel to a floor above the fire.

  - When assigned to go above the fire via an elevator, choose an elevator that has a blind shaft on the fire floor.

  - Remember, a firefighter service equipped elevator is not necessarily a "safe" elevator. It can still be affected by heat, smoke, or water entering the shaft.

  - If there is no blind shaft elevator to go above the fire, stairshafts shall be used. **Note:** When available, use a fire tower to ascend.

The decision to use elevators during a fire in a highrise building is one that must be tempered with good judgment. While it is true that using elevators will speed up initial investigation and fire control efforts, malfunction that causes response to a nonselected floor can result in loss of firefighter lives. Therefore, using stairshafts is the safest method of ascending to the fire floor.

The decision to use elevators should be based on assurances that the elevator lobby on any involved floor is safe and that the cars that are used are not physically capable of reaching the fire floor (they belong to a split bank). Fire personnel already on fire floors can confirm that the elevator lobbies on those floors are tenable.

Even when assurances are in place that elevators can be safely used, any additional safety features or procedures should be employed. These include the use of split bank elevators that terminate at least five floors below the lowest reported fire floor. Only use cars that allow firefighter service. In addition, all personnel riding in elevator cars should wear full-protective equipment and have forcible entry tools, a means of communication, an extinguisher, and a knowledgeable firefighter assigned to operate the car.

Note: All firefighting personnel should be well trained in the operation of firefighter service controls on elevator cars. The time to conduct this training or to develop department policies regarding emergency use of elevators is **not** on the day of the fire.

Do not use an elevator in a bank that services the fire floor unless it is determined to be safe using local SOGs. The one exception to this rule is that **early** consideration of elevator usage is acceptable when split bank elevators exist in which the top of the shaft and machinery room is a minimum of five floors below the **reported** fire floor. In this case, take the low or medium bank elevator to the highest floor, and then take the most desirable access stairshaft to the fire floor. Progress up the stairshaft, and check the floor two floors below the reported fire floor for use by Staging.

Information on the Staging floor and stairshaft number used by fire attack shall be transmitted to the IC. A good rule of thumb is to give the IC an update every two to three floors during the ascent. On arrival at the reported fire floor, the IC shall be given an update on conditions on the floor as well as for the floor above. In addition, the fire attack company shall give a periodic update on conditions and fire location to the IC.

The first thing that should be done when assessing the safety of elevators that service the fire floor is to account for all cars serving the floor and then check them for victims. Upon verification by fire department personnel that the elevators are safe to use during emergency operations, a fire department member shall be designated to control the operation of each elevator car. The operator, in addition to required safety equipment, shall have a portable radio to maintain communication with the Systems Unit.

Even though the elevator may be capable of traveling directly to the fire floor, it is always recommended that **all elevator travel cease two floors below the lowest fire floor.** Initial fire attack team personnel traveling in elevator cars, even though the maximum travel is five floors below the reported fire floor, must be equipped with donned breathing apparatus and a face piece, a portable radio, dry chemical extinguisher, forcible entry tools, and a portable spotlight. Breathing apparatus face pieces should be connected to regulators and be ready for **immediate** use. The firefighter shall be assigned to keep the dry chemical extinguisher in readiness with the lock pin removed and the nozzle pointed at the elevator door. The portable spotlight is to be used in case of lighting power failure. It can also be used to check the hoistway for smoke before use. **If even the slightest amount of smoke is in the hoistway, the elevator should not be used.**

At all times that the elevator is in motion, firefighters should be prepared to take immediate action that will cause the doors to close if the car responds to a floor where smoke or fire conditions are present. The action will be dictated by the elevator control equipment and the current operating mode. Precautionary stops should be made to confirm elevator operation and to check for smoke in the hoistway.

If sound-powered phone jacks are available in the elevator car, they should be placed in service with a sound-powered phone/headset. Also consider the weight capacity for the elevator car to prevent overloading with personnel and equipment.

Departments that allow personnel to use elevators at emergency incidents shall consider the following items as a minimum when developing SOGs:

- Only use an elevator car with the firefighter service feature that allows for emergency control of the elevator car. (**Note:** In older highrise buildings, "firefighter service" is sometimes identified as "firemen service.")

- Consult with the company that installed the elevator. Ask about the machine's features and use.

- Follow all previous guidelines for split bank elevators.

For all personnel who respond to highrise fires in your community--**there must be training** on elevators and procedures. **It is not enough** to just have procedures in your SOGs!

Procedures: Firefighters Trapped in Stalled Elevator Cars

If the elevator car door opens on the fire floor and exposes the firefighter to severe heat and/or smoke--discharge the dry chemical extinguisher to knockdown a flame front, and attempt to close the door **immediately.** This should be done by either pushing the DOOR CLOSE button or forcing the doors closed. Push the button for a lower floor and exit the elevator when it reaches that floor.

If the car fails to move, check the emergency stop button. It may have been accidentally activated. Deactivate it by pulling it out, or if a switch type, move the switch to the OFF position. If necessary, open the top emergency exit (if available) to relieve smoke in the car. Try to keep low in the car, and don your self-contained breathing apparatus (SCBA) face piece if necessary. Remember, it is important to conserve air. Communicate the situation to your supervisor.

One option is to open the elevator roof access and take control of the car by using controls located on the car roof. When two or more elevator cars exist in the same shaft, it may also be possible to gain access to the adjoining car. (This may be accomplished through roof access or side panels.)

If necessary and available, use the side emergency exit for a rope slide to the safety of a lower floor. If this is to be attempted, have power removed to the adjacent car. In an **extreme emergency**, fire department hose can be used to slide down to the floor below. If more than one length of hose is used, first tie the lengths together, then couple them. Personnel can be lowered to the hoistway door interlock and exit at the floor landing below.

Handlines on the floor below can be used to spray a fog stream between the car and the hoistway door. A thirty-degree fog pattern should be used to cool and protect people trapped during the rescue operation.

Pertinent General Information

- Take time to become familiar with specific elevators before leaving the lobby. Early staffing by one or more personnel who have become familiar with the elevators is important.

- Use stairs whenever possible, and limit elevator use to those in banks that cannot be affected by the fire.

- Consider calling in an elevator repair/service company that provides personnel on emergency duty. Many highrise buildings have these personnel on 24-hour call. The telephone numbers **must** be posted in the elevator machinery room and are often posted in the vicinity of the elevator lobby.

- Conduct fire department operations using elevators that have been placed in "Manual Mode" if firefighter service equipped elevators have not been installed in the building.

- Use all applicable sections of this procedures guide when using elevators in the "Manual Mode."

HOISTWAY DOORS (OPERATIONAL CONSIDERATIONS)

For security reasons, some occupants lock hoistway doors on their floor when the building is closed. If your elevator arrives at the selected floor, but the car door does not open, make no attempt to force it. In this instance, the locked hoistway door (attached via the vane to the elevator car door) is keeping both doors closed. **Any attempt at forcing them open may damage the interlock, putting the car out of service.** The following procedures may be employed to deal with a locked hoistway door:

- If the hoistway door security lock can be removed or opened with no damage to the door, do so.

- If removal of the locking device threatens bending or warping of the door or door buck, make no attempt at removal. Drop down to a floor where exit is possible. Find the stairshaft and walk up to the original floor.

Caution: Warping or springing of the door assembly may interfere with the car's electrical circuits and put the car out of service.

VENTILATION

Ventilation complexities will usually be dependent on the type of windows installed in the building. Inoperable windows complicate ventilation procedures. Operable windows, used in conjunction with normal smoke removal equipment, simplifies ventilation.

Highrise **residential** buildings normally have operable windows made from regular plate glass. In addition, many highrise apartment buildings have large sliding glass doors that open onto balcony areas. Windows in highrise **office** buildings are often inoperable and are typically made of plate glass. When broken, plate glass often produces large shards that can cause serious injury to those below. To reduce this risk, special "tempered" glass windows may be required at certain locations. When a tempered glass window is broken, it will shatter into very small pieces, providing a degree of safety that is not offered by plate glass under the same circumstances. Depending on applicable building codes, tempered glass or operable windows (on every floor) may be required in sealed buildings. Usually, they are located in each corner of the exterior wall and at specific horizontal intervals. These special windows are normally required to be aligned vertically throughout the building. Tempered glass windows are normally marked as such in one of the lower corners. A decal may be affixed in a visible place near the window.

Instead of tempered glass for emergency ventilation, some buildings may be equipped with special operable window panels that are secured from the inside by a tool-operated locking device. This tool is required to be kept on the premises.

It is important to note that removal of window glass during a fire situation, whether caused by the fire or done intentionally for ventilation purposes, can create a situation where fire can extend up the building exterior to the floors above. Anytime glass is removed or fails, consideration must be given to the possibility of exterior lapping.

SMOKE CONTROL SYSTEMS

Smoke and its toxic products account for more than 80 percent of fire deaths in the United States. Plastics greatly increase the volume and toxicity of smoke. For example, polyvinyl chloride (commonly known as PVC) produces 500 times as much smoke as red oak. Highrise buildings have contents that, like most occupancies, are petrochemical products that produce large amounts of smoke and toxic gas.

The forces that affect smoke movement in a highrise building include stack effect, expansion, wind, and HVAC systems. Smoke control can be either passive or active in nature. Passive smoke control measures have been in use for many years. They consist of:

- barriers;
- curtains;
- gravity venting;
- smoke proof towers; and
- smoke removal shafts.

Active smoke control systems are relatively new and normally automatic. In addition to methods of passive smoke control that might be in use, active smoke control employs mechanical assistance to route smoke in a planned manner. Active smoke control systems can be used to control the movement in many different ways.

A small highrise may have a single HVAC system that controls the atmosphere on all floors. This simple system may (or may not) have a single control to exhaust the entire building. This control is referred to as the Building Smoke Control System.

Zoned HVAC systems exist in more complex highrise buildings. It may be possible to control single floors or an entire zone through these types of systems. (See the HVAC section of this manual for a discussion of zoned systems.) HVAC zones could cover:

- a given number of floors;
- a stairway pressurization system (often accomplished by having fans in all or certain stairshafts);
- a corridor smoke control system;
- an elevator shaft control system; and
- an atrium smoke control system.

It is important to have this information on the prefire plan and to work together with the building engineer to control operation of various HVAC zones.

These smoke control systems are prone to fail under fire conditions. The areas that they are designed to clear smoke from should be closely monitored. In the event of adverse effects, the system should be immediately shut down.

HEATING, VENTILATING, AND AIR CONDITIONING SYSTEMS

HVAC systems are designed to provide conditioned air throughout the structure by means of a ductwork system. For reasons of economy and efficiency, these systems operate on the concept of recirculating most of the air within the building. Under fire conditions, smoke or heat can enter the system at fire floors and quickly fill other parts of the building with contaminated air. When smoke and heat are pumped through the building in this manner, many occupants can be exposed to highly toxic gases and are placed in serious jeopardy (even though they may be on floors remote from the fire). In a highrise building with a recirculating air handling system, the fire may be small but smoke spread can be a major problem.

The air handling system in most new highrise buildings is required by code to have dampers in the system. These dampers are smoke activated and control the spread of fire products from the area of origin to other parts of the building. Don't rely totally on these dampers. In many cases the building may not have dampers installed or these dampers may not function properly.

Since the spread of fire products throughout the building is critical in life safety terms, **the best approach is to shut down the system when there is any doubt or concern that it may be contributing to the spread.** Once the fire is controlled and the safety of building occupants has been ensured, the system can be reactivated (if it has the capability of exhausting smoke from the building).

Methods of shutting down the HVAC system vary depending on the particular building. In some buildings (especially older ones) it may be necessary to close switches that control system air intake fans. Many times these switches are located in machinery rooms on upper floors of the building, or they may be located on the roof of the building. In many newer buildings, and in some older buildings that have been modified, the air handling system will shut down automatically under fire conditions. In some cases, they will provide exhaust capability on the fire floor and pressurization of the floors above and below the fire floor.

Information about the air handling system in a highrise building should be a critical part of prefire planning inspections. This includes how the system operates under fire conditions and where and how the system can be deactivated if necessary. When the building engineer is available, it is imperative to use his/her assistance with the HVAC system.

WATER SUPPLY

A variety of different water supply systems can be found in highrise buildings. They may include

- 1-1/2-inch wet standpipe systems;
- 2-1/2-inch dry standpipe systems;
- 2-1/2-inch wet standpipe systems; and
- sprinkler systems.

Note: The sizes 1-1/2 inch and 2-1/2 inch refer to the diameter of the fire hose discharge connections on the standpipe system. Piping within the standpipe system may be considerably larger than this.

The importance of the water supply systems built into highrise buildings demands that we have knowledge of how these systems work and what problems may be expected in emergency situations. The specific types of water supply systems found in highrise buildings will vary with the age of the particular building and code requirements that were in effect at the time it was constructed. PIP information should include specifics on the water supply system, its capacity, and functional components.

1-1/2-Inch Wet Standpipe Systems

For many years, 1-1/2-inch wet standpipe systems have been used in highrise buildings. These systems are often supplied by the domestic water system and are intended as a first-aid device for building occupants. They have limited water volume and pressure and inferior hoselines and nozzles. The 1-1/2-inch wet standpipe system should not be considered as adequate for primary fire department attack. If the 1-1/2-inch system is used for initial attack, any attached hose or nozzles should be replaced with standard fire department equipment.

2-1/2-Inch Dry Standpipe Systems

The 2-1/2-inch dry standpipe systems are used in many older highrise buildings and, in some cases, in new buildings that do not exceed specific heights. These systems are relatively simple in design compared with wet standpipe systems, but they have some important differences that must be considered.

Since they do not have a constant water supply, it is important that they be charged by an engine company who hooks to the fire department connection as quickly as possible. This will give firefighters an available water supply for fire attack. Fire department connections on 2-1/2-inch dry standpipe systems typically serve only one standpipe riser. It is critical that the riser being supplied is the same one that is used for fire attack lines.

2-1/2-Inch Wet Standpipe Systems

The 2-1/2-inch wet standpipe systems are required by code in all new highrise buildings over certain heights. These systems provide a constant supply of water under pressure adequate to produce effective hose streams on each floor of the building. The primary water supply source for these systems may be the domestic supply that can be supplemented by an auxiliary supply (kept in a holding tank in the building). The 2-1/2-inch wet standpipe systems differ in design. They may serve both 1-1/2-inch and 2-1/2-inch outlets as well as the sprinkler system, if the building is so equipped.

The necessary pressure and flow for a 2-1/2-inch wet standpipe system is usually provided by one or more fire pumps that serve as the primary supply. Fire pumps for highrise buildings are usually multistage centrifugal pumps. They may be powered electrically or with diesel engines. These pumps are designed to produce the required flow at a pressure that is sufficient for working streams at the highest point in the building. If an emergency or backup pump is required by code, there will be a backup system that activates automatically should power to the electric pump(s) fail. Backup pumps are usually diesel driven. In many older highrise buildings, the water flow capacity in gallons per minute (liters per minute) is inadequate for the fire potential within the building.

Note: It is important to know what outlet pressure your system produces in order to determine the type of nozzle to use (smooth bore or fog). Typical outlet pressure found is approximately 65 pounds per square inch (psi). This pressure would require a smooth bore tip. Fog nozzles that require 100 psi at the nozzle will produce ineffective streams.

Since wet standpipe systems must contain sufficient pressure to produce effective hose streams at the top most floor of the building, the pressure within the standpipes at lower floors must be reduced. This is normally accomplished by pressure reducing devices installed at each outlet. These valves are preset to provide the proper outlet pressure for that location. Pressure reducing valves (PRVs) have the advantage of being able to supply multiple hoselines (within reason) while maintaining the proper pressure and flow rate. These valves control the pressure but can automatically adjust to varying flows depending on the size of the hose and nozzle (or the number of hoselines). PRVs on each floor should be checked for proper operating pressure and flow before the floor is occupied.

In place of a valve, there may be orifice plates in the outlet valve barrel. Orifice plates are stainless steel or brass washers with calibrated holes and are designed to handle one line. These holes control the outlet pressure by restricting the flow from the outlet. The plates are often tack welded into the standpipe valve outlet barrel. The outlet pressure from these devices is not reduced until water is flowing.

Pressure restricting devices are yet another method of providing proper pressure to standpipe hoselines. They reduce outlet pressure in much the same manner as orifice plates. The pressure restricting device allows the valve to be opened only a predetermined distance. Firefighters who remove orifice plates or alter the setting of pressure restricting devices need to be aware that the outlet will then deliver increased pressure from the system.

Two drawbacks to the orifice plate and other pressure restricting devices are that they:

1. Have no effect on static pressure.

2. Do not allow for multiple hoselines (because of the limited flow that comes through the orifice opening).

If orifice plates are removed to provide for multiple hoselines from an outlet, the pressure to the lines must be controlled at the standpipe valve, and care must be taken when opening or closing nozzles.

SPRINKLER SYSTEMS

Sprinkler systems in highrise buildings are now required by code in virtually every area of the country. However, there are many older highrise buildings (maybe some in your jurisdiction) that still do not contain sprinkler systems. There is no doubt that sprinkler systems provide the added degree of life safety for newer buildings that is sadly lacking in older, unsprinklered highrise buildings. In some cases retroactive legislation, enacted as the result of tragic highrise fires, has mandated that older highrise buildings be fully sprinklered. However, these cases are the exception rather than the rule. PIP inspections should take particular note of sprinkler systems when present, what areas they serve, and how they can be supplemented.

SOGs require initial response units to supplement any built-in water supply system in a highrise building during a fire. To do this effectively, firefighting personnel must be acquainted with the building, the water supply system, and the location of fire department water supply inlets.

A fire department **must** have SOGs for connecting to and supplying the highrise sprinkler system. Officers and pump operators must understand the pressure and flow required to be supplied from the engine(s) supplying the sprinkler system. Current national standards for supplying sprinkler systems (such as NFPA 13E) should be referenced.

COMMUNICATION SYSTEMS

When discussing problems that occur at emergency incidents, communication always seem to be at the top of the list. Highrise fires are no exception. Communications problems can be magnified and their results much more severe than those seen at ground level incidents. In any type of an emergency, good communications are vital to effective operations--maybe even more so at a highrise emergency.

It is a known fact that portable fire department communications equipment can be ineffective or even completely unusable in a highrise. There are locations inside highrise buildings where it is virtually impossible to transmit or receive messages using portable radios. In some cases, satisfactory communications will cease with the movement of the radio location by only a few feet.

There is a definite correlation between portable radio effectiveness and the frequencies on which they operate. As a rule, radio frequencies in the VHF band are very ineffective. Those in the UHF band are fairly effective in most situations. Those in the 800 megahertz band produce the most consistent results although they are not perfect. It is important to note that any frequency (in any building) may have inherent transmission/reception problems. Evaluate the system during prefire planning to avoid future trouble.

Many new highrise buildings (and a number of older ones that have been retrofitted) have built-in emergency communications systems. These hard-wired systems have jacks at specific locations on every floor (and in some cases even in elevator cars) that allow fire personnel at different building locations to communicate. Using the system requires plugging into it with a handset or headset. A number of handsets are normally kept on site. A built-in emergency communications system can be used as a primary communications channel if portable equipment is not functioning properly. It can also be used as a secondary channel to avoid overloading fire department frequencies.

Built-in emergency communications systems are not the same in every highrise building. Effective use of these systems requires PIP by fire department personnel on how the particular system works and how it would be used during an actual emergency.

DETECTION AND ALARM SYSTEMS

There are three basic types of detection and alarm systems: 1) smoke/heat detectors, 2) enunciator panels, and 3) manual fire alarm stations.

Smoke/Heat detectors in a highrise building may or may not be connected to an enunciator panel. It is possible for smoke detectors to be incorporated into the HVAC system and be located in building air shafts. These detectors may then activate fire dampers within the HVAC system.

Effective management of a highrise fire through preplanning (obtaining knowledge of these types of building characteristics) is necessary for effective decision making.

It is important to know of the existence/location of any enunciator panel(s) in the building. They may be located on a wall at a specific location or they may be part of the fire control room/station. A full understanding of how to interpret the information given on the panel is critical to effective response.

Manual fire alarm boxes may be located on each floor of a highrise. Several boxes may be present on each floor. These boxes may be local alarms for the floor, connected to an enunciator panel, or connected to the fire control room/station.

FIRE CONTROL ROOMS/STATIONS

Most current codes require that newly constructed highrise buildings contain a fire control room/station within the building. At a minimum, the room should provide:

- specific information on alarms that have been activated; and
- the status of fire protection systems within the building.

The information available at this location can be extremely useful for determining the exact location of a fire and the status of fire protection systems that may have activated. These rooms or stations frequently have communications systems that allow the transmission of emergency alarms or instructions to building occupants and firefighters.

While a great deal of information is available from a fire control room/station, there are several reasons why it may not be the best place to locate the IC. If the room is on a basement level, then radio communication will probably be difficult. Positioning the IC at the fire control room may also remove that person from face-to-face contact with other officers. In all cases, fire department personnel should be sent to monitor the information available at the fire control room/station and **relay** it to the IC. This relay can often be established by commercial telephone from the fire control room/station to the fire department dispatch office.

As with other systems installed in highrise buildings, fire control rooms/stations are not all the same. Monitoring the information that is displayed in these locations or accessing the various systems that they contain requires prior knowledge that can only be gained through PIP.

LIFE SAFETY

Large numbers of people can be exposed to potential danger during a highrise fire. This requires that immediate attention be given to the issue of life safety. The following life safety issues must be taken into consideration by fire personnel when responding to a highrise fire:

- Life safety can be enhanced by timely control of the HVAC system.

- Failure to control smoke movement within the building can put many lives at great risk.

- Evacuation takes time--this must be anticipated by Command Staff and sufficient personnel must be assigned to perform the task.

- Occupant behavior during a highrise fire is **largely unpredictable.**

- If occupants are going to be evacuated from the building, it is critical that they use stairshafts that are not contaminated with smoke and heat.

FIRE BEHAVIOR AND FIRE SPREAD

There are certain fire behavior and fire spread phenomena that must be considered by all Command Officers and operating forces at highrise fires. These include:

- stack effect;
- negative stack effect;
- vertical extension;
- core construction effect;
- fire loading; and
- heat buildup.

Stack Effect

Normally, we perceive smoke as being heated and, therefore, lighter than the air surrounding it. Thus, when we cut a hole in the roof of a small structure that is on fire, the hot smoke and gases easily exit the structure. However, this is not so simple when we are dealing with a fire in a highrise building. Vertical shafts in a tall building tend to act as a chimney or smokestack by channeling heat, smoke, and other products of combustion upward because of convection. As this process occurs, a stratification process also takes place in which hotter smoke moves toward the roof and the cooler smoke stays lower. As long as the air inside the building is hotter than the atmospheric air outside the building, ventilation will occur by having fresh air drawn in through lower building openings and discharged through the top. This is considered the "normal" stack effect.

Negative Stack Effect

When the outside air temperature is higher than the inside air temperature (at the building's upper levels) a negative stack effect may take place. Such a condition is more likely to occur in warm climates. As the smoke leaves the fire area (usually by way of the stairshafts and other vertical openings) it cools. This effect pushes the smoke **down** the vertical shafts, or it settles to floors **below** the fire. This situation may cause Staging to be relocated farther from the fire, or cause firefighters trying to reach the fire floor to use SCBA earlier than desired.

Vertical Extension

Typical construction methods for highrise buildings provide common avenues through which fire may vertically extend. The three common methods of fire extension in highrise buildings include

1. Auto extension.

2. Curtain wall extension.

3. Vertical shaft extension.

Auto extension occurs when the fire generates enough heat to break out windows, after which the fire "rolls out" of the fire floor and up the outside of the building. Heat is transmitted to the floor above causing the window glass to break and combustibles on the floor to ignite.

As previously discussed, most modern highrise buildings are constructed of structural steel. Exterior walls (curtain walls) are attached to the structure. A space is created between the floor assemblies and the curtain wall. These spaces are supposed to be sealed during construction. Should there be faulty installation or heavy fire conditions, there may be vertical spread of the fire through this space. This is called curtain wall extension.

There are a number of features incorporated into highrise design and construction that contribute to vertical fire extension:

- stairshafts;
- elevator shafts;
- electrical chase ways;
- plumbing/electrical/data cable "poke throughs" (holes created through floors for cable or piping distribution);
- air conditioning supply/return shafts;
- mail chutes;
- trash chutes; and
- access stairs (open, private stairways constructed for tenants who occupy more than one floor of a highrise).

Core Construction Effect

A fire that reaches the plenum area around the center core of a highrise can spread in that plenum area. Firefighters entering the fire floor and advancing on the fire may inadvertently push the fire around the center core. This may cause the fire to circle behind the firefighters cutting off their escape route.

When fire is predicted to be in the plenum area, firefighters entering the corridor from a stairshaft should remove the ceiling tiles in both directions before advancing. This may allow the firefighters to see if fire is in the plenum area. A backup hoseline should be in place and operating in the opposite direction to protect the advancing crew(s).

Fire Loading

The quantity of fuel that is available to a fire on any given floor directly affects the firefighters' ability to gain fire control. Where fuel is limited (such as on a vacant floor) it may be possible to mount a greater effort to keep the fire from getting by that floor.

Heat Buildup

Fire in highrise buildings generates large quantities of heat. Unfortunately for firefighters, this heat cannot be easily dissipated from the building. Usually, there is no means to effectively ventilate the building. This high heat also takes its toll on the firefighter. The higher the heat, the more one perspires. Perspiration dehydrates the firefighter and removes energy. Rehydration at Staging is critical.

BASIC ORGANIZATIONAL APPROACH

The purpose of this unit is to relate the basic organizational approach taken toward highrise firefighting using the framework of the Incident Command System (ICS) as covered up to this point in the manual. The information in this chapter provides the firefighter with a clearer understanding of how to specifically organize the Command system for a highrise incident.

HIGHRISE INCIDENT COMMAND SYSTEM SUPPORT FUNCTIONS

ICS is used to manage the resources at a highrise incident. While a highrise incident may seem to pose the same problems as those in buildings of one or two stories, there are certain aspects of the highrise configuration that impacts ICS.

The location of Staging, as well as the need for some special functions within the ICS, is unique to highrise structures.

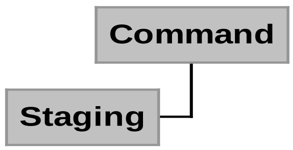
TIME AND DISTANCE FACTORS

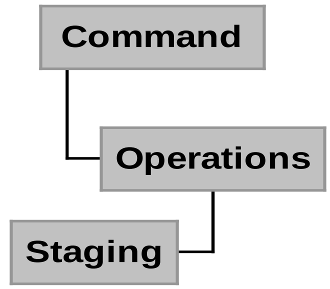
Time factors play an important role in control operations at highrise fires. At any fire, it takes time to transform orders into actions. At a highrise fire, time becomes a much more critical element. Being reactive and waiting for things to happen before requesting additional resources or before moving onscene resources close to the fire area can be disastrous for Command Officers.

The impact of time factors can be greatly reduced by placing personnel and equipment in the Staging Area (normally two floors below the fire) quickly. Being proactive is the key. Anticipate what may happen, and move resources before the need is actually there. Also, it is important to know that it takes much longer to perform critical tactical operations during a highrise fire. The heat of a highrise fire is physically draining. You should know that rehabilitation with rehydration is critical at a highrise fire.

STAGING

Staging reports to the IC in the initial phases of an incident. If, and when, Operations (Ops) is staffed, Staging reports directly to the Operations Section Chief.





The purpose of Staging is twofold. It is a designated area to pool and quickly deploy personnel and equipment in proximity to the incident. It is also established to manage and control the flow of personnel and equipment to the upper portions of the building. Staging will also provide previously assigned companies an area for rehabilitation, equipment exchange, and first aid.

Staging should be a priority on all working highrise incidents. It is recommended that a company from the first-alarm assignment be used to set up Staging. The Staging Area Manager and personnel assigned this responsibility must ascend by a safe route. Some fire departments have preassigned companies to establish Staging. However, company availability or staffing constraints may not allow the preassigned company to establish Staging. When this occurs, the IC shall assure that the responsibility for Staging is reassigned to another company.

Normally, Staging is located two floors below the fire floor to minimize time and distance factors. The location may be altered because of floor arrangement or incident conditions. Staging shall be the primary point for all fire department personnel who enter the fire area. Staging is also the assembly point where a reserve of personnel and equipment are maintained awaiting deployment within the building.

The Staging Area Manager reports to the IC/Ops Chief, and verifies the location of the Staging Area. The Staging Area Manager maintains separate stockpiles of reserve and expended equipment, as well as a reserve force at a level specified by the IC. A medical treatment station shall be established in Staging to provide medical treatment/rehab care for incident personnel. Resources are dispatched from Staging at the direction of the IC/Ops Chief. Anytime reserves fall below the specified level, additional resources are requested by the Staging Area Manager.

Functions of Staging

As a minimum, the following will be performed when implementing Staging during a highrise incident:

- verify location of Staging with the IC/Ops; and
- maintain a complete and accurate record of resource status for personnel accountability.

After the above minimum requirements are met, there are a number of other issues that must be considered. Staging personnel must control stairwell access and prevent arriving companies from bypassing Staging.

If the HVAC system has not been shut down or if the Staging floor cannot be isolated from the system, confirm with Lobby Control that the HVAC system must still be shut down. If possible, open windows for ventilation of the Staging floor or have blowers set up to establish a positive pressure air flow.

Establish effective communications with the IC/Ops Section Chief to coordinate personnel deployment, and communicate with the Logistics Section/Base to coordinate equipment movement. Ideally, a separate radio frequency should be used for communications between IC/Ops and Logistics/Base. Cellular phones or regular telephones may be used as an alternative to radios.

Plan the layout of the Staging Area, using signs taped to walls to identify specific areas. Consider using open storage rooms for fire department equipment. Control reserve and rehabbing personnel in separate areas. Maintain a separate stockpile of reserve and expended equipment. Expended equipment should be placed well apart from ready equipment, preferably at the opposite end of the established Staging Area. Equipment ready for use should be placed in areas closest to stairwells ascending to the fire floor.

Develop an equipment inventory, and order specific quantities from Logistics/Base. Record what equipment was ordered, the time it was ordered, and the time it was delivered. Equipment that is commonly stockpiled in Staging includes

- SCBA air cylinders;
- fire hose and fittings;
- forcible entry tools;
- ladders;
- resuscitators;
- complete SCBA;
- smoke ejectors/fans;
- salvage equipment; and
- medical supplies.

Additional companies directed to Staging should bring priority equipment from Base/Lobby. **DON'T COME TO STAGING EMPTY-HANDED!**

Staging must also make arrangements to take care of the physical needs of the firefighters who will be located there. A medical treatment area should be established to handle any firefighter injuries that occur. Locate and open restrooms for firefighter use. Secure liquids for firefighters who are in Staging. If available, consider using 5-gallon drinking water bottles on the Staging floor.

The building's lighting system should be used to illuminate Staging as long as possible. Once this becomes impossible, consider the use of portable generators on the floor below Staging. Extension cords may then be run to the Staging floor. Plenty of flashlights with spare batteries should be available in the event all other lighting systems fail. They probably will be in high demand by firefighters operating on or above the fire floor.

The Staging Area Manager must anticipate future needs and request appropriate resources at all times. All requests for additional personnel for Staging shall be made through the IC/Ops Chief. It may help the Staging Area Manager to operate from a "Staging Responsibility Check-Off Sheet" for smoother operations.

Note: In many jurisdictions, the term Staging Area as it is applied to structure fires is used to describe a location one or two blocks from the fire scene where apparatus and equipment are located in a state of readiness for tactical deployment. In a highrise firefighting operation, the term Staging Area is applied to a floor where personnel and equipment pools are located, usually two floors below the lowest fire floor. The organizational structure is expanded to include an Incident Base to facilitate the parking of apparatus, consolidation of equipment, and logistical support.

INITIAL FIRST-ALARM COMMITMENT

The first-alarm resource commitment dispatched to a reported highrise fire is critical. Recognize the potential for life loss and the need to have adequate resources on the scene quickly. Most departments increase the amount of resources dispatched to a highrise fire compared with those sent to other types of structure incidents.

Most fire departments do not dispatch enough first-alarm resources to handle the full potential of a large-scale fire in a highrise building. First-alarm responses are typically based on the number of resources required to handle the immediate work that has to be done in these situations. Resource needs must take into account the number of personnel needed to perform support operations (Base, Staging, Lobby Control, Ground Support, Systems, etc.). The need to frequently relieve and/or rehab personnel assigned to tactical operations must also be considered.

The first-alarm resources should be sufficient to:

- provide prompt investigation of the reported fire;
- start an initial fire attack; and
- handle any immediate support functions required to ensure the safety of building occupants.

The amount of resources dispatched on the first alarm should be standard, regardless of how the alarm is received, to ensure that a planned course of action can be followed by Command Officers at the incident scene.

If the first-arriving company has any indication that a working fire is in progress, an immediate request should be made for additional resources. This early call for help minimizes the lead time needed by second-due companies to get to the scene and into operational positions. These resources should be directed to report to Base. Base should be located in close proximity to the incident. The Base location must be identified and communicated to dispatch. If preliminary investigation indicates that these additional resources are not needed, they can be returned to available status from the incident scene or while en route.

EXAMPLE RESOURCE REQUIREMENTS AT A WORKING HIGHRISE FIRE

The following example shows how to estimate the companies needed at a working highrise fire. **This example information is offered as a guideline only.** The actual number of companies needed by a specific department will depend on company staffing and training levels. However, this example will illustrate the need for:

- sufficient first-alarm resources on dispatch to the initial report of a highrise fire; and
- a prompt request for additional help when a working fire is actually encountered.

Note: This example uses **four-person staffing** on each unit. You should adjust the number of your companies to match approximately the number of response personnel required. It is important to remember that working highrise incidents are resource intensive, and the number of personnel is the critical issue--not the number of apparatus.

The hypothetical fire situation used to illustrate the need for additional first-alarm resources includes the following factors:

- the fire is on the 12th floor;
- there exists potential for fire extension to the 13th floor;
- the elevators cannot be used;
- ventilation problems exist on two floors; and
- rescue/evacuation procedures will be needed.

Basic Functional Organization:

12th Floor Fire Attack	3 companies
13th Floor	1 company
Lobby Control, Base, Systems (Divided)	1 company
Staging on 10th Floor	1 company
Total Basic Commitment	**6 companies**

The fire attack and support resources total six companies. This response totals 24 personnel and a chief. It is recommended that your first-alarm response be similar in number of personnel.

Additional resources (to those above) called on recognition of a working fire may be used as follows:

Rescue/Evacuation Ventilation Ground Support	2 companies 1 company 1 company
Basic Working Fire Situation Total Resources	**10 companies**

There are seven companies assigned to fire attack, extension control, ventilation, and rescue/evacuation. Three companies are starting to set up the support operations at Base, Lobby Control, Ground Support, and Staging.

Using this example for a moderate fire in a highrise building with the potential extension problems, a minimum of 10 four-person firefighting companies are required. Ten companies provide the minimum resource to allow an attack on the fire and initiate the needed support functions. Additional chief officers, resources permitting, should be dispatched to staff Command functions. If the fire was prolonged and three companies for each working hoseline were used, a commitment of 18 or more companies would be needed to provide a sustained attack on the fire and perform the needed support functions.

Based on response patterns of fire departments that have experience with highrise fires, it is generally agreed that a **minimum of 50 personnel** will be required to handle a relatively small working fire in a highrise. These departments place at least this many personnel on scene with the arrival of:

- the first-alarm assignment (24 or more personnel); and
- the first call for assistance when an indication of a fire in the building is recognized (24 or more personnel plus additional chief officers).

Departments with limited resources **must** have working mutual- or automatic-aid agreements. In addition, they must train with their mutual- or automatic-aid companies for highrise operations.

THE RELIEF CYCLE

The objective of the relief cycle is to maintain a constant application of water on the fire. It is based on the use of three companies for each handline placed in service. One company operating the handline, one company at the stairshaft landing, and one company at the Staging Area.

- The company at the stairshaft landing moves into position on the hoseline soon enough to ensure that the company being relieved has enough air remaining to exit the floor safely and return to Staging.

- The company being relieved returns to Staging to change air cylinders and take a brief rest.

- The third company in the relief cycle that had been waiting in Staging moves up to the stairshaft landing. This company relieves the company on the hoseline at the appropriate time.

The objective of this relief cycle is to maintain constant application of water on the fire. The coordination of the relief cycle should be the responsibility of the tactical level management unit supervisor. The Staging Area Manager must be informed of the relief cycle and must have companies ready to make reliefs at the needed times. IC/Ops is accountable for deployment and tracking of all resources. The Staging Area Manager shall maintain a complete and accurate record of resource status for personnel accountability.

AIR CYLINDERS

Operating in the hostile and humid environment of a highrise fire will mean that time actually spent attacking the fire will be extremely limited. A 30-minute breathing apparatus cylinder typically is usable for only 15 minutes of work, depending on the skill and physical condition of the individual. Normally, it takes at least 2 or 3 minutes to both reach and exit the fire area. This means that 10 minutes may be the maximum time that can be spent performing the actual fire suppression activity.

The relatively short time that can be spent actually fighting fire, and the debilitating effect of an extremely hot and humid environment are reasons why large numbers of personnel must be committed to suppression activities. The number of times that firefighters can change cylinders and return to firefighting is limited. In most cases, after firefighters have used two SCBA cylinders, they should be assigned to a rehab area in Staging for a brief rest before returning to any tactical activities.

FIRST-ARRIVING UNIT RESPONSIBILITIES

There are certain tasks required of the first-arriving unit at a highrise fire. Whether an engine company or a truck company, the following tasks must be addressed. If the first-arriving unit is an engine company, it is normal for that company to also be the first unit that ascends to the fire floor. As a minimum, the first-company should carry out the following tasks:

- **Initial size up--rapidly evaluate the situation.** There are a number of considerations that the first-arriving company officer should keep in mind when doing the initial size up. Do not be fooled by a lack of visible fire conditions outside the building upon arrival. It is possible to have a working fire and not see anything from outside the building.

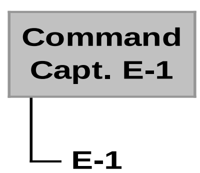
  Obviously, if smoke and/or fire is showing from the building, additional resources should be requested immediately. However, there are other indicators that may signal a fire condition within the building. Fire alarm system enunciator panels in the building will indicate if and which smoke alarms or water flow alarms have been tripped. Elevators that have returned to ground level because of a fire alarm activation are another clue of a problem. Lastly, information from building personnel or occupants indicating that there is fire or smoke in the building is usually a reliable method of determining that a fire exists and more resources may be required.

- **Give an initial radio report of visible conditions that includes at least the following information:**

  - building size;
  - occupancy;
  - obvious conditions (working fire and what levels are involved);
  - any safety concerns (e.g., falling glass/debris); and
  - actions being taken.

- **Assume and announce Command; for example, "Captain Engine 1 is Wilshire Command."**

Example organization:



The first-arriving Company Officer (CO) should assume initial Incident Command. This will allow the IC to assign companies and personnel consistent with SOGs. On first sign of a smoke or fire condition, the IC should request additional resources immediately. Preparations must be made to augment the water supply to any fixed fire protection systems in the building. The IC should also try to obtain keys for affected portions of the building. This will make access for firefighting crews much simpler. The IC should be prepared to maintain Command until a proper Transfer of Command can be made to a chief officer.

- **Determine the location of the fire or emergency.**

  - use the building's enunciator panel (if equipped with one);
  - gather information from occupants;
  - gather information from the building engineer or fire safety director; and
  - act on visual observations.

- **Determine the status of occupants in the immediate fire area, above the fire, and below the fire.**

- **Control the elevators.**

  - All cars should be returned to the ground level.

  - Cars are placed on firefighter service mode.

Additional Considerations

There are a number of other functions that can be done if sufficient personnel are available. One helpful thing is to obtain the phone number for a lobby phone. This can be used in the event communications are disabled or distorted. The companies operating at different levels can call the lobby phone, and relay information or make requests.

Attempts should also be made to obtain as much information about the building as possible. This can be accomplished by referring to the prefire plan, making contact with the building engineer or fire safety director, or reading onsite building diagrams.

INCIDENT COMMANDER DUTIES

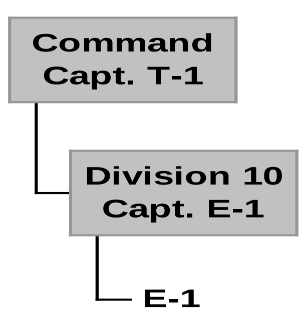
The officer of the first company to remain at ground level will assume Command or relieve the officer of the first-ascending unit. It is essential for effective command, control, and support of operating forces that there be an IC at ground level. Some departments prefer to operate Command from the building, while others prefer a position on the exterior 200 feet (60 m) from the building. The first IC to stay at ground level may be a CO. That officer should do the following until relieved:

- **Assume or Transfer Command.**

  - obtain briefing from person being relieved;
  - confirm and announce the Transfer of Command; and
  - announce the location of the Incident Command Post (ICP) (if being changed).

- **Size up and report conditions as they are on assumption of Command.**

Example organization (fire on 10th floor):



- **Confirm the Staging floor location.**

  - establish resources on this floor (include personnel, equipment, etc.); and
  - announce location.

- **Determine initial strategy and tactics.**

  - develop the initial incident strategy; and
  - assign tactical objectives to other companies/personnel.

- **Evaluate resource needs.**

  - Are there enough personnel to accomplish the tactical objectives desired?

  - Anticipate the need for future resources.

Should the first-ground level officer be a chief officer, along with the above, the following must be accomplished:

- **Determine overall strategy and tactics.**

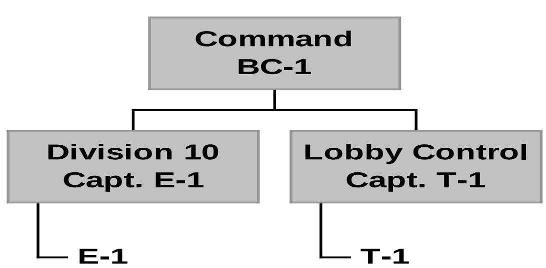
  - develop the incident strategy;
  - assign tactical objectives to other companies/personnel; and
  - obtain progress reports on a periodic basis.

- **Assign personnel to the Planning Section as needed to maintain situation and resource status.**

- **Provide for the safety, accountability, and welfare of personnel.** This priority is ongoing throughout the incident.

- **Expand the Incident Management System (IMS) to include the necessary functions to gain control of the incident.**

Example organization:



FIRST-ASCENDING OFFICER DUTIES

It is imperative that a company ascend to the fire floor as quickly as possible. Based on local SOGs, the company performing this task may or may not be the first company to arrive on the scene.

The initial actions of the first-ascending company at a highrise fire are extremely critical to the outcome of the incident. This company not only has the responsibility to initiate confinement and suppression efforts, it also provides valuable information that will assist the IC in the development of strategy, tactics, and organization.

The fire department must have SOGs regarding the use of elevators, stairshafts, or combinations of both when ascending to the upper floors in a highrise building during a fire or reported fire operations. The safest method of ascending to the fire floor is to use a stairshaft that accesses the reported fire floor. However, in some situations, such as extremely tall buildings, this might not be practical. Therefore, it may be necessary to explore the use of elevators for firefighting operations. The determination to use the elevator is ultimately the responsibility of the IC. Information received from the ascending team(s) regarding the safety of elevators and actual floor conditions on the reported fire floor and preceding floors should be relayed immediately to the IC. The IC will then determine if the elevators are safe to use. The initial attack team(s) may need to use stairwells to reach reported fire floors, and make a visual assessment of actual conditions that might affect elevator use.

Note: A fire attack company that uses a stairshaft for fire attack shall pace itself while ascending, and take aloft only necessary equipment, such as SCBA, highrise hose packs with nozzles, forcible entry tools, radios, and stairshaft keys.

Determine Floor Configuration

The determination of the floor configuration is critical information that will assist fire attack companies as tactical objectives are assigned. It is important for the first-ascending company to determine the fire floor layout. This can be accomplished through the use of preincident plans, floor surveys during ascent, or an assessment of the fire floor.

Report During Ascent

On the way to the fire floor, the officer should check several floors below the predicted fire floor. This should give the officer an idea of the general layout of the building, specifically the layout of the fire floor. This check will allow the officer to recommend to the IC a habitable floor for Staging that is two or three floors below the fire floor. It will also allow the officer to report on the condition of floors other than the fire floor(s).

Report from the Fire Floor

On arrival at the fire floor, immediately transmit a description of conditions found, including

- floor number;
- occupancy type;
- percentage of involvement and conditions;
- rescue problems;
- other specific problems;
- what your crew is doing; and
- additional crews needed and for what.

For example, "Engine 14 has reached the 20th floor. This is an office occupancy. I have about 10 percent of the total floor involved with possible extension to the offices on each side. There is no obvious rescue, we will perform a primary search. Engine 14 is connecting to the standpipe and moving to attack the fire. I will need two additional engines and one truck company to my location. Companies need to be sent to the floors above."

Initial Fire Floor Operations

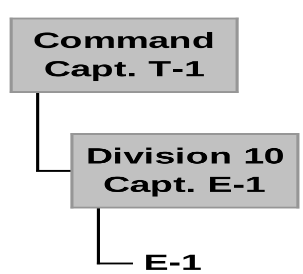
The primary objectives of the first-ascending company are to provide for rescue and locate and confine the fire. The order in which these objectives should normally be achieved is

- determine fire attack stairs;
- communicate information;
- conduct primary search; and
- begin initial fire attack.

Check the Floor Above the Fire Floor

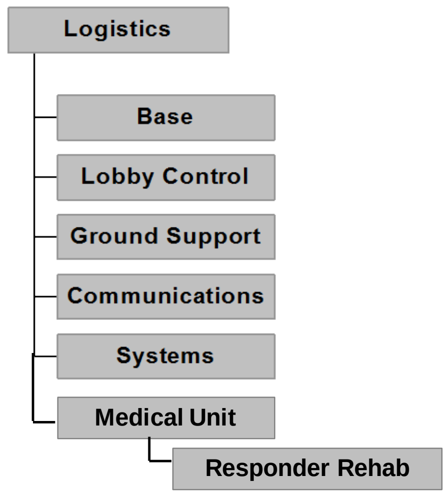
After giving the brief report, the officer should quickly check the floor above. This should provide information necessary for initial determination of fire spread.

Example organization:



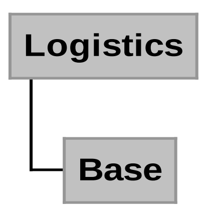
BASE, LOBBY CONTROL, GROUND SUPPORT, COMMUNICATIONS, SYSTEMS, AND MEDICAL UNIT

Four of the six functions listed above (Base, Lobby Control, Ground, and Systems Support) in the ICS are necessary elements that, when implemented early, allow continued operations in a highrise fire situation. However, these functions may be applicable in other types of structure incidents. Base for highrise situations is simply a more limited definition than the original Base used in wildland situations.



Base

The Base area of a highrise structural incident serves as an assembly and deployment point from which large quantities of personnel and equipment are distributed. The Base area serves as the primary point outside the structure to which responding resources report and from which resources receive their initial orders for entering the incident. Base works in coordination with Lobby Control. The Base Manager reports to the Logistics Section Chief or to the IC if the Logistics Section has not been activated.



The IC will determine the need for Base at any highrise incident. The IC will establish the level of resources required in Base, and request those resources from the dispatching center. Once the level of resources is established, the Base Manager will assure that the level is maintained (replenished) until notified by the appropriate incident supervisor. The Base Manager must maintain communications with the Resource Status Unit (Planning Section) to assure accountability of resources within the incident.

The responsibilities of the Base Manager may be summarized as follows:

- verify location of Base with the IC;
- assure that the Base location is a safe distance from the involved highrise--normally 200 feet (60 m) or more from the structure;
- determine the most effective access route to Base for responding resources--advise dispatch center.
- establish one or more safe routes to the fire building--coordinate the route(s) with Lobby Control;
- maintain an accurate log of apparatus, equipment, and available personnel within Base;
- coordinate movement of equipment and resources into the fire building through Lobby Control;
- establish equipment pools by priority of need according to the Incident Action Plan (IAP)--coordinate with Logistics Chief;
- assure that Base resources (apparatus, equipment, personnel) are requested **before** they are actually needed;
- assure the security of Base--utilize police if necessary; and
- supply water to the base of the stairwell for use by Ground Support personnel.

The Base Manager must control resources as they arrive at Base. Strict control must be maintained over the parking location and movement of personnel and equipment through Base. The Base Manager must select a Base site that is large enough for the parking and movement of a large number of responding apparatus. Typical Base sites include very wide streets or large parking areas. Park apparatus at diagonal angles to allow easy access and egress in Base. If a street is used as a Base site, block the street to nonemergency vehicles. If police are not available for this function, use aerial ladder apparatus or other large fire department vehicles. Make sure the apparatus driver(s) remain with the vehicle(s) so that they may be moved when other apparatus need to pass by.

Establish safe traffic flow routes that will assure the effective movement of personnel and equipment into and out of the highrise. Pickup trucks or similar vehicles may be used to move personnel and portable equipment if necessary. Establish a priority order for deployment of personnel and equipment to the incident: **spare SCBA air cylinders are always the first priority!**

Assure that fire company integrity is maintained. Fire companies must stay together as cohesive units. Maintain an accurate log of fire companies--their arrival in and departure from Base--by time interval.

Lobby Control

The responsibilities for Lobby Control at a highrise incident are extensive. Lobby Control should be a priority like Staging, and it is recommended that it be established on all working highrise incidents from the first alarm assignment. The Lobby Control Officer reports to the Logistics Section Chief or the IC if the Logistics position has not been established.

The Lobby Control Officer shall report to Logistics/IC the number of floors in the building (based on elevator floor indicators) and whether the elevators have been recalled. This is valuable information for the IC because of the possibility that people may be trapped in elevators.

The Lobby Control Officer is responsible for the control of fire department personnel and civilians entering and exiting the building. It is very important to direct incoming resources to the correct stairwell when they are ascending to upper floors or Staging. All personnel entering or exiting the building should be accounted for by maintaining records that include in and out times and destinations. When directing companies to upper floors, make sure that they are carrying additional equipment.

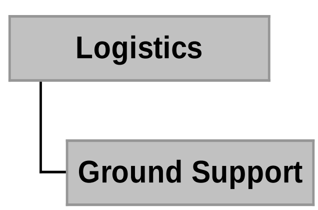
When the elevators are determined to be safe, the Lobby Control Officer shall designate specific elevators to be used by fire personnel. Lobby Control will assign a fire department elevator operator. Any car not equipped with firefighter service should be placed out of service.

The responsibilities of the Lobby Control Officer may be summarized as follows:

- use the building communications system to address civilian occupants;
- pressurize the stairwells with fans when the building's HVAC cannot be used;
- determine occupant egress to ensure a safe corridor for exiting people (consider the use of police officers to control civilians evacuated from the building); and
- direct personnel to move occupants a minimum of 200 feet (60 m) from the building.

Ground Support

The Ground Support Unit Leader is responsible for the stairwell support duties when equipment cannot be moved to Staging by elevators or when an additional water supply is needed. This operation can consume a large number of personnel, not only for the initial set up but also for relief personnel. The Ground Support Unit Leader reports to the Logistics Section Chief or the IC if the Logistics Section has not been activated.



The responsibility of Ground Support is the priority of transporting equipment by way of a stairwell to the staging floor. If equipment is delivered to the roof by helicopter, Ground Support will handle equipment movement down the stairwell to Staging. If an auxiliary water supply is required by way of the stairwell, the officer in charge of Ground Support will coordinate and supervise this effort. In this situation, a request should be made for Base to provide a water supply line to the stairwell entrance.

The following strategies will be helpful in performing Ground Support:

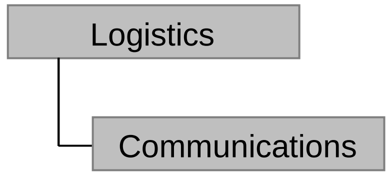
- Determine the number of personnel necessary to accomplish the task. Consider one person per two floors and one officer per four or five personnel.
- If available, provide a separate radio channel for Ground Support.
- Officers must remain mobile to supervise the operation. Ground Support is very demanding work, and officers must ensure a smooth flow of equipment at a pace that can be sustained.
- Officers must monitor their personnel for signs of undue fatigue or distress. If it is to be an extended operation, arrange for timely relief and consider assigning two-person teams alternating with one carrying and one resting.
- Lobby Control or Base will deliver equipment to the stairwell entrance at ground level.

Normally, one person picks up equipment at the ground floor entrance to the stairwell and carries it to the third-floor landing. That person then returns to the ground floor for another load. The person at the third floor carries the equipment to the fifth-floor landing and then returns to the third floor for another load. This process continues until the equipment is delivered to the Staging floor hallway. Moving equipment beyond that point is the responsibility of the Staging Area Manager.

If the route involves unusual problems, long or crossover hallways, scissor stairwells, etc., supervising officers may need to adjust assignments. Ground Support personnel shall have their personal safety equipment (turnouts, helmets, breathing apparatus, and flashlights) available to them in the stairwell. In addition, officers will have their portable radios and, when available, the building's sound-powered phones.

Communications

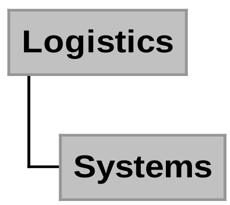
The Communications Unit Leader reports to the Logistics Section Chief and ensures that an effective communications system is maintained between the IC and incident personnel. This includes portable radios, spare batteries, cellular phones, and the building's sound-powered system. The Communications Unit Leader will also coordinate communication needs with outside agencies.



Systems

The Systems Unit Leader monitors and maintains built-in fire control, life safety, environmental control, communications, and elevator systems. This unit may operate, support, or augment the systems as required to support the Incident Action Plan (IAP).

The System Unit Leader reports to the Logistics Section Chief of the IC, if the Logistics Section Chief has not been staffed. This unit may respond to direct requests from the Operations Section Chief.



The Unit Leader must establish a close liaison with the building engineer or fire safety director, utility company representatives, and the technical specialists.

The major responsibilities of the System Unit Leader are to:

- obtain a briefing from the Logistics Section Chief or the IC and building staff;
- assess current situation and request needed personnel and resources; and
- request response of, and make contact with:
  - building engineer,
  - utility company representative,
  - elevator service company representative, and
  - others as necessary.

Anticipate the failure of critical building systems:

- Appoint personnel to monitor and operate system display/control panels (personnel should be radio-equipped);
- evaluate status and operation of fire and domestic water pumps and water supply;
- evaluate and operate, as required, the HVAC and smoke removal and stairwell protection systems;

- evaluate, support, and control the building's electrical system and emergency power plant;
- evaluate and support the public address, telephone, emergency phone, and other building communications systems;
- secure operations and demobilize personnel as determined by the demobilization plan; and
- maintain a Unit Log (ICS Form 214).

Medical Unit

The Medical Unit Leader is under the direction of the Service Branch Director or the Logistic Section Chief. Primary responsibilities include the development of the ICS Form 206 Medical Plan, obtaining medical aid and transportation for injured and/or ill emergency responders, establishment of Responder Rehab and preparation of appropriate reports and records. See Field Operations Guide ICS Form 420-1 for additional details.

Activity 13.1

Highrise Simulation

Purpose

To practice Command at a highrise incident and to effectively manage a complex, high-life hazard occupancy fire.

Directions

1. As a group, you will staff positions within the Incident Command Structure of the Central City Fire Department (CCFD) for the exercise. All members of the CCFD Command Staff will arrive on the incident scene simultaneously. CCFD Incident Command Staff:

    a. IC.

    b. IC Aide.*

    c. Operations Chief.

    d. Operations Aide.

    e. Planning Chief.

    f. Logistics Chief.

    g. Public Information Officer (PIO).

    h. Liaison Officer.

    i. Safety Officer.

    *The IC Aide is not used unless there are nine students in a group. Some students may play multiple roles based on the Assignment Sheets. If there are ten in a group, a second Operations Aide will be designated.

2. All Command decisions and actions during the simulation will be recorded on the ICS forms. Entries on the ICS forms are made in response to written or visual messages or in anticipation of problems that could surface during the incident.

3. At the conclusion of the simulation exercise, all groups will participate in a debriefing facilitated by the instructors. Your group will display the ICS forms developed during the exercise. Be prepared to explain the reasons for your decisions.

4. The following will be turned in to the instructors at the conclusion of the Postincident Analysis (PIA). The Planning Section Chiefs will collect all of these from their groups, making sure that the group number and students' names are on the sheets.

   a. IC: Incident Objectives.

   b. The Planning Section Chief: Plan "B."

   c. The Safety Officer: Safety Message on the Safety Message Form.

   d. Operations Aide: Actions Taken.

   e. Logistics: Resources.

   f. Liaison: Document Agencies Contacted

   g. PIO: Press Release.

Activity 13.1 (cont'd)

Quick Access Prefire Plan
Highrise

Building Address:
Tonnalee Apartments--LL Street and 22nd Street

Building Description:
110' x 75', 22-story, noncombustible, highrise

Roof Construction:
Prestressed concrete T-beams

Floor Construction:
Poured reinforced concrete with carpet

Occupancy Type:
Elderly highrise

Initial Resources Required:
First-alarm assignment

Hazards to Personnel:
Electrical transformer and panel in basement

Location of Water Supply:
Hydrant, 12-inch municipal systems 600' apart

Available Flow:
1,000 gpm hydrant

	Estimated Fire Flow*			
Level of Involvement	25%	50%	75%	100%
Estimated Fire Flow	75	150	225	300

**Fire in one apartment (22' x 24') with two exposures on fire floor and one exposure above--rounded*

Fire Behavior Prediction:
Rapid horizontal spread in one apartment, slow vertical spread

Predicted Strategies:
Rescue, exposures, confinement, ventilation

Problems Anticipated:
Large numbers of elderly residents; resource intensive operations

[X] **Standpipe:** *Yes--both stairshafts*

[ ] **Sprinklers:** *No*

[X] **Fire Detection:** *Yes*

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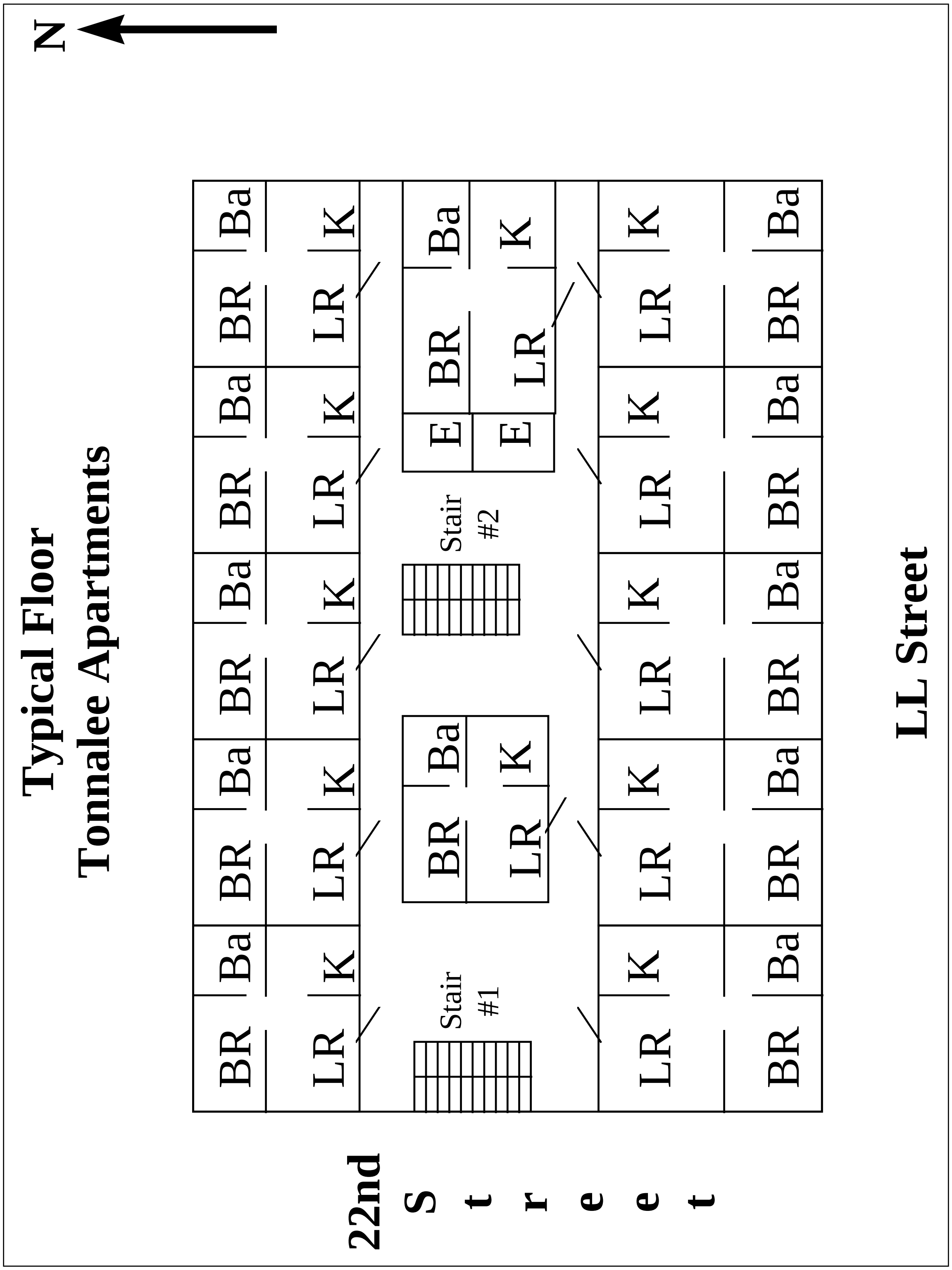
Activity 13.1 (cont'd)

Highrise Plot Plan



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UNIT 14:
TERRORISM

TERMINAL OBJECTIVE

At the end of this unit students given a simulated major fire scenario, will be able to, coordinate, and control tactical resources and implement a plan of action based on critical cues, information gathered and critical elements presented during a terrorism related incident.

ENABLING OBJECTIVE

The students will be able to work as an Incident Management Team (IMT) to command a terrorism incident.

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INTRODUCTION

The Federal Bureau of Investigation (FBI) defines terrorism as "the unlawful use of force against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in the furtherance of political or social objectives."

All communities in the United States are vulnerable to terrorism and most have a reason to be considered a target by some local, national, or international group. An act of terrorism can occur anywhere, at any time and when it is least expected. No jurisdiction, urban, suburban, or rural, is immune.

PREINCIDENT PLANNING

The key to success in the event of a chemical, biological, radiological, nuclear, or explosive (CBRNE) terrorist incident lies in the level of preparedness that a community has established before the incident. Preparedness is a combination of awareness, training, equipment, resources, and planning.

First responders need training to identify initial actions before an actual CBRNE terrorist incident. They need specialized equipment and resources to treat hundreds or thousands of victims and the knowledge to use them.

Command Officers need to train on Command and control issues regarding terrorism. They need to be familiar with available local, State, and Federal resources, and how to access them. Ongoing CBRNE terrorist training needs to be incorporated into local training programs where all local agencies participate so they understand each other's responsibilities, capabilities, needs, and even their weaknesses prior to a real situation. For example, who will search for a secondary device and how and when will it be rendered safe? You may find that the bomb squad has never worked in a Level A suit, and hazardous materials teams have never disarmed a bomb. There is a need for cross-training and teamwork prior to the event.

INCIDENT ACTION PLAN

The initial Incident Commander (IC) most often will take action using a verbal action plan. In the case of a terrorist incident, a written plan should be developed as soon as possible. A written action plan is a document that contains general control objectives reflecting the overall incident strategy, and specific tactical objectives. The plan consolidates all of the incident information to reduce confusion.

Another important planning step is to create a "Site Safety and Health Plan" (SSHP). If the incident involves hazardous materials, which most terrorist incidents do, do Federal regulations (29 CFR 1910.120) require that you create one?

The SSHP helps document the specific actions and safety procedures that will be used. Included in the SSHP are the locations of the control zones, the nature of the hazard, type of personal protective equipment (PPE) to be worn, and type of decontamination procedures to be followed.

Obtaining Needed Resources

Your community already should have an Emergency Operations Plan (EOP) in place to deal with natural and manmade disasters. When such disasters occur and overwhelm local resources, it is the State's responsibility to provide assistance to the affected community. If the State's resources and capabilities are not adequate to mitigate the incident, Federal assistance would be requested through the governor's office.

Emergency Operations Plan

An EOP is a document that:

- assigns responsibility to organizations and individuals for carrying out specific actions at projected times and places in an emergency that exceeds the capabilities or routine responsibilities of any one agency;
- sets forth lines of authority and organizational relationships, and shows how all actions will be coordinated;
- describes how people and property will be protected in emergencies and disasters;
- identifies personnel, equipment, facilities, supplies, and other resources available, within the jurisdiction or by agreement with other jurisdictions, for use during response and recovery operations; and
- identifies steps to address mitigation concerns during response and recovery actions.

State Emergency Operations Plan

The State plays three roles:

1. Assists local jurisdictions that request assistance.
2. Responds to emergencies.
3. Works with the Federal government when Federal assistance is requested.

The State's EOP is the framework that guides the Federal assistance to the local jurisdictions.

The National Response Plan

Issued in 1992, the Federal Response Plan (FRP) outlined how the Federal government implemented the Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended, to assist State and local governments when a major disaster or emergency overwhelmed their ability to respond effectively to save lives; protect public health, safety, and property; and restore their communities. The FRP described the policies, planning assumptions, concept of operations, response and recovery actions, and responsibilities of 25 Federal departments and agencies and the American Red Cross. The FRP guided Federal operations following a Presidential declaration of a major disaster or emergency.

The Homeland Security Act of 2002 and Homeland Security Presidential Directive-5 (HSPD-5) mandated the development of a National Response Plan (NRP) that would define a single comprehensive national approach to incidents requiring Federal response and assistance. Additionally, the NRP identifies coordination structures and mechanisms, direction for the incorporation and concurrent implementation of existing plans, and a consistent approach to reporting incidents. The NRP also requires providing incident assessments and making recommendations to the President, Department of Homeland Security (DHS) Secretary, and the Homeland Security Council (HSC).

The NRP supersedes the FRP, the Domestic Terrorism Concept of Operations Plan (CONPLAN), the Federal Radiological Emergency Response Plan (FRERP), and the Initial National Response Plan (INRP). Many of the familiar concepts and mechanisms associated with these plans have been carried over to the NRP, such as the Emergency Support Function (ESF) components of the FRP. Elements introduced in the INRP, such as the Homeland Security Operations Center (HSOC), Interagency Incident Management Group (IIMG), Principal Federal Official (PFO), and the Joint Field Office (JFO) are now a part of the final NRP.

The NRP, as the Base Plan, establishes the national framework for assessing domestic incidents to determine the appropriate level of Federal involvement. It is designed to link to an array of national-level hazard-specific contingency plans, such as the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). These contingency plans can be implemented independently during localized incidents or concurrently with the NRP to coordinate interagency incident management efforts, using the National Incident Management System (NIMS), for events considered "Incidents of National Significance."

HSPD-5 defines Incidents of National Significance as those that meet the following criteria:

- when another Federal department or agency has requested DHS assistance;
- when State/local capabilities are overwhelmed and Federal assistance is requested;
- when an incident substantially involves more than one Federal department/agency; or
- when the Secretary of DHS has been directed by the President to assume incident management responsibilities.

National Response Plan Components

The following excerpt from the NRP identifies the component parts of the plan:

A. The **Base Plan** describes the structure and processes comprising a national approach to domestic incident management designed to integrate the efforts and resources of Federal, State, local, tribal, private sector, and nongovernmental organizations. The Base Plan includes planning assumptions, roles and responsibilities, concept of operations, incident management actions, and plan maintenance instructions.

B. The **Appendixes** provide other relevant, more detailed supporting information, including terms, definitions, acronyms, authorities, and a compendium of national interagency plans.

C. The **ESF Annexes** detail the missions, policies, structures, and responsibilities of Federal agencies for coordinating resource and programmatic support to States, tribes, and other Federal agencies or other jurisdictions and entities during Incidents of National Significance. The introduction to the ESF Annexes summarizes the functions of ESF coordinators and primary and support agencies. (Note that there is an increase in the number of ESF's in the NRP, to 15, from the original 12 in the old FRP.) The ESF Annexes include:

- ESF #1--Transportation;
- ESF #2--Telecommunications and Information Technology;
- ESF #3--Public Works and Engineering;
- ESF #4--Firefighting;
- ESF #5--Emergency Management;
- ESF #6--Mass Care, Housing, and Human Services;
- ESF #7--Resource Support;
- ESF #8--Public Health and Medical Services;
- ESF #9--Urban Search and Rescue;
- ESF #10--Oil and Hazardous Materials Response;
- ESF #11--Agriculture and Natural Resources;
- ESF #12--Energy;
- ESF #13--Public Safety and Security;
- ESF #14--Community Recovery, Mitigation, and Economic Stabilization; and
- ESF #15--Emergency Public Information and External Communications.

The **Support Annexes** provide guidance and describe the functional processes and administrative requirements necessary to ensure efficient and effective implementation of NRP incident management objectives. The Support Annexes are described below:

- **Financial Management** provides guidance for NRP implementation to ensure that incident-related funds are provided expeditiously and that financial management activities are conducted in accordance with established law, policies, regulations, and standards. (For the purposes of the NRP, "hazardous materials" is a general term intended to include hazardous substances, pollutants, and contaminants as defined by the National Contingency Plan.)

- **International Coordination** provides guidance for carrying out responsibilities regarding international coordination in support of the Federal response to domestic Incidents of National Significance.

- **Logistics Management** describes the framework within which the overall NRP logistics management function operates. It also outlines logistics management responsibilities and mechanisms for integrating Federal, State, local, and tribal resource providers.

- **Private-Sector Coordination** outlines processes to ensure effective incident management coordination and integration with the private sector, including representatives of the Nation's Critical Infrastructure/Key Resources (CI/KR) sectors and other industries.

- **Public Affairs** describes interagency incident communications procedures designed to enable the coordination and dissemination of timely public information during Incidents of National Significance.

- **Science and Technology** provides guidance and mechanisms to ensure that all levels of government can leverage the Nation's science and technology resources efficiently and effectively in the management of Incidents of National Significance.

- **Tribal Relations** describes the policies, responsibilities, and concept of operations for effective coordination and interaction with tribal governments and communities during Incidents of National Significance.

- **Volunteer and Donations Management** provides guidance on volunteer and donations management functions related to Incidents of National Significance.

- **Worker Safety and Health** details processes to ensure coordinated, comprehensive efforts to identify responder safety and health risks and implement procedures to minimize or eliminate illness or injuries during incident management and emergency response activities.

The **Incident Annexes** address contingency or hazard situations requiring specialized application of the NRP. The Incident Annexes describe the missions, policies, responsibilities, and coordination processes that govern the interaction of public and private entities engaged in incident management and emergency response operations across a spectrum of potential hazards. These annexes are typically augmented by a variety of supporting plans and operational supplements. The Incident Annexes are described below:

- The **Biological Incident Annex** describes incident management activities related to a biological terrorism event, pandemic, emerging infectious disease, or novel pathogen outbreak.

- The **Catastrophic Incident Annex** establishes the strategy for implementing and coordinating an accelerated national response to a catastrophic incident.

- The **Cyber Incident Annex** establishes procedures for a multidisciplinary, broad-based approach to the preparation for, remediation of, and recovery from catastrophic cyber events affecting critical national processes and the national economy.

- The **Food and Agriculture Incident Annex** describes incident management activities related to a terrorist attack, major disaster, or other emergency involving the Nation's agriculture and food systems. (To be published in a subsequent version of this plan.)

- The **Nuclear/Radiological Incident Annex** describes incident management activities related to nuclear/radiological incidents.

- The **Oil and Hazardous Materials Incident Annex** describes incident management activities related to certain nationally significant oil and hazardous materials pollution incidents.

- The **Terrorism Law Enforcement and Investigation Annex** describes law enforcement and criminal investigation structures and processes in response to a terrorist event.

A basic premise of the NRP is that incidents are handled at the lowest level possible. DHS becomes involved through the routine reporting and monitoring of threats and incidents, and/or when notified of an incident or potential incident of the severity, magnitude, complexity, and/or threat to homeland security that it is considered an Incident of National Significance. DHS will then establish multiagency structures at the headquarters, regional, and field level to coordinate efforts and provide support to the onscene incident command structures. Other Federal agencies carry out their incident management and emergency response authorities within this overarching framework.

The NRP replaces certain Federal plans, e.g., the FRP, while providing for the coordination of remaining plans during Incidents of National Significance. The NRP requires the compliance and participation of Federal departments and agencies. Although there is no mandate for compliance with the NRP outside of the Federal partners, State and local governments are encouraged to work within the concept of operations. An initial review of the NRP will occur 1 year after implementation. Following this, the NRP will be subject to a deliberate 4-year review and reissuance cycle. The most current version of the NRP can be found on the DHS Web site, http://www.dhs.gov/

An online, independent study program for the NRP can be found on the Emergency Management Institute (EMI) Web site, http://training.fema.gov/EMIWeb/ The course number is IS-800.

Crisis management and consequence management are separate and distinct terms previously associated with response to terrorism events. Under the NRP, crisis and consequence management actions are combined without distinction--they are intended to be incorporated in a complementary manner in the Incident Action Plan (IAP).

In a similar manner, White House-issued Presidential Decision Directive-39 (PDD-39) had previously identified responsibilities and measures to reduce the Nation's vulnerability to terrorism, to deter and respond to terrorist acts, and to manage the consequences of CBRNE agents. These actions are now guided by the NRP and the use of NIMS. One of the provisions of PDD-39, however, was preserved. The FBI (acting on behalf of the Attorney General of the United States) continues to be the lead agency for the criminal investigation of terrorist acts inside the United States.

TERRORISM--INCIDENT CONSIDERATIONS

Experts generally agree that there are five categories of terrorist incidents: chemical, biological, radiological, nuclear, and explosive. The acronym CBRNE is a simple way to remember them.

When first reading about the five categories of terrorism it would seem that the response requirements are overwhelming, and certainly far above the capabilities of first responders. As we continue you will start to see that the knowledge and equipment that you already possess for Urban Search and Rescue (US&R) and hazardous materials incidents will go a long way toward answering most of the problems associated with terrorist incidents.

We are in no way minimizing the potential or suggesting that you should feel comfortable about the threat of terrorism; however, we are saying that terrorist weapons are not doomsday machines. The vast majority of people involved in a terrorist attack will survive. These agents certainly will make the job of the first responder more difficult, but not impossible. Many of our current procedures and much of our current equipment can be used in terrorist incidents. There is a great deal that first responders can do to prepare for such an event.

What makes the terrorist event so dangerous is that it is intended to cause damage, to inflict harm, and, in some cases to kill. Recent bombings have shown that there are many groups that have every intention of causing further chaos by inflicting additional harm on the first responder.

Secondary devices are intended to kill and add further psychological damage and confusion. First responders must be constantly aware of this very real threat, and assume that it is always present. Therefore, it sometimes is wise to always pick the "perfect" place to park at an incident.

Several types of terrorists include

- lone individuals;
- right-wing radical organizations;
- internationally sponsored groups; and
- issue-oriented groups.

Lone individuals are similar to the Unabomber in that they strike without predictable motive or pattern. These people may act on a whim and have been found, for the most part, to be the least successful in accomplishing their goal. While they lack funding, organization, and sophistication, these people account for many of the reported attempts.

Right-wing radical organizations include racist, antiauthority, and survivalist groups. These groups present a larger threat to domestic terrorism because they often have funding and the ability to build (or purchase) CBRNE weapons. These groups have the advantage of integrating into society so that they appear unnoticed.

Internationally sponsored groups present a threat because they have access to technology and facilities able to produce weapons.

Issue-oriented groups pose a major threat because they embrace terrorism as a means to an end. These people are identified as extremist, animal rights, environmental, religious, antiabortionist groups, etc. They have funding, organization, and commitment.

Possible Terrorist Targets

The most effective places for terrorists to use agents include

- enclosed areas that are protected from the elements;
- areas that contain large numbers of people (more casualties equals greater media coverage);
- building air and ventilation systems (because they can transport CBRNE dust or vapor); and
- areas that would present major decontamination problems.

It is important to realize that we already possess some knowledge of how to handle events of these types. US&R and hazardous materials incidents share distinct similarities with terrorist incidents. Many of our current procedures and equipment can be used.

TERRORIST WEAPONS

As previously stated, terrorist weapons comprise five identifying categories:

1. Chemical.

2. Biological.

3. Radiological.

4. Nuclear.

5. Explosive.

Chemical Devices

Chemical agent weapons are composed of super-toxic chemicals used for the purpose of poisoning victims. They are similar to hazardous industrial chemicals, but are hundreds of times more toxic. Most chemical agents are heavier than air and may be **persistent** or **nonpersistent**. Persistent agents (vapor, liquid, or dust) remain in the affected area for hours, days, or weeks. Nonpersistent agents (primarily vapors) remain a hazard in the affected area for a shorter time period, usually minutes or hours.

Being extremely toxic means the downwind hazard could be a much greater risk than at a typical hazardous materials incident. Some other factors regarding chemical agents are as follows:

- They are usually liquid when in a container, and become gases when released.
- They are usually disseminated as vapors or as a gas, and thus will dissipate with time.
- They are influenced by weather conditions such as temperature, wind, and humidity.
- They can be protected against, treated, and decontaminated.

Chemical Agent Classifications and General Characteristics

Classification	Example	Characteristics	Shared Characteristics
Choking Agent	*Phosgene (CG)*	Smells like newly mown hay.	• Becomes a gas when released from their containers. • Will dissipate rapidly in open air. • On contact with body moisture, produces hydrochloric acid that burns tissue. • Coughing or choking will appear immediately. • Serious symptoms involving oxygen starvation and suffocation may take 2 to 3 hours. • No absorption is possible through the skin; however does burn and should be flushed immediately. • Can be decontaminated by flushing with water.
	Chlorine (CI)	Smells like a swimming pool.	
Blood Agent	*Hydrogen Cyanide (AC)*	Smells like bitter almonds.	• Commercially available and used in manufacturing processes. • Turns to gas at room temperature. • Inhalation threat. • Attacks body by blocking the transfer of oxygen from the blood stream to the individual cells. • Symptoms appear rapidly--reddish skin and lips (blue in dark-skinned people), gasping for air, frothing or vomiting, unconsciousness, and death. • No absorption is possible through the skin. • Antidotes are available. • Once removed from the chemical, no decontamination is necessary.
	Cyanogen Chloride (CK)	--	

Classification	Example	Characteristics	Shared Characteristics
Blister Agent	*Mustard (H)*	Easiest to make (therefore, most likely to be used). Freezes at 58 °F (so most likely not used outside in cold weather). Smells like garlic. Appears as an oily liquid.	• Normally disseminated as liquid at normal temperatures, making chemicals persistent (as they do not evaporate rapidly). • Vapors are extremely irritating to the eyes, throat, and lungs. • Affects respiratory tract and skin--making full protection required. • To treat a victim, remove him/her from the contaminated area and remove agent from skin with water.
	Lewisite (L)	--	
	Phosgene Oxime (CS)	--	
Nerve Agent	*Tabun (GA)* *Sarin (GB)* *Soman (GB)*	Generally a vapor, not persistent. Colorless. Fruity odor.	• Heavier than air. • Extremely fast-acting. • Act as an inhalation and skin contact threat. • Block body's normal electrical impulses to muscles (causes a state of contraction). • Constant muscle contraction causes difficulty breathing due to bronchoconstriction and fluid buildup in airways. • Death usually occurs from cardiopulmonary failure. Symptoms: • Runny nose, tightness of chest, dimness of vision, pinpoint pupils, difficulty breathing, drooling, excessive sweating, muscle twitching, involuntary urination/defecation, nausea, vomiting, cramps, staggering, confusion, drowsiness, coma, convulsions, and finally death. • Lethal dose received through skin contact can lead to death within 2 hours. • Respiratory lethal dose can cause death in 1 to 10 minutes.

Classification	Example	Characteristics	Shared Characteristics
Nerve Agent (cont'd)	*VX*	Liquid. Persistent (days or months). Consistency/ Evaporation rate similar to motor oil. Slight yellowish color. Sulfur odor. Generally considered a skin contact hazard (can be inhaled if aerosolized).	• Antidotes are available. • First responder cannot make entry with regular bunker gear. • Entry into a hot zone can be made only with Level A suits. • Contaminated clothing will continue to "off gas," and full Level A protection is required through decon. • Decon consists of flushing with diluted bleach. This must be done as soon as possible.

Biological Devices

Weapons made with **biological agents** contain living organisms that cause disease in people. Some of these are deadly to animals as well, though they usually are not the primary targets. Toxins are poisonous byproducts made by living organisms and also are categorized as biological agents. Biological agents have no color, taste, or smell.

All biological agents have a delayed effect or incubation period, which is the time it takes for the organism or toxin to overpower the body's natural immune system. The incubation period can range from several hours, to days, and in some cases, weeks. So, unlike most of the other terrorist weapons, the first responder may never get called to an actual incident where the weapon was released. In fact, the first indication that a biological agent has been used in your community most likely will be through emergency medical services (EMS) responders and hospital emergency rooms seeing numerous patients with similar symptoms. Nevertheless, as a first responder you should know something about these agents and how to protect yourself if you do encounter one.

Most biological agents need to be inhaled or ingested to be harmful. Just as with any other germ, your skin provides a good barrier for protection. Biological agents will be disseminated as a solid aerosol or liquid. Since most of these agents are living organisms they are affected adversely by such environmental factors as heat, cold, moisture, and sunlight; once released they tend to live only for a few hours or days. Because they are somewhat frail they most likely will be used in enclosed areas.

The following chart provides descriptions of some commonly used agents.

Disease and Toxin Agents

Agent Type	Name	Characteristics
Disease (Treatment for these agents includes antibiotics and supportive therapy.)	*Anthrax bacteria*	Incubation 1 to 7 days; mortality can reach 90 percent; flu-like symptoms and swelling lymph nodes.
	Plague bacteria	Incubation 2 to 3 days; untreated mortality can reach 100 percent; flu-like symptoms, spitting up blood, and shortness of breath.
	Q-fever rickettsia (bacteria/virus)	Incubation 2 to 10 days; mortality under 1 percent; flu-like symptoms.
	Smallpox virus	Incubation 10 to 12 days; mortality can reach 30 percent; flu-like symptoms, rigors, and backaches.
	Ebola virus	Incubation 3 to 21 days; mortality can reach 90 percent; flu-like symptoms, blotches on skin from subcutaneous bleeding.
	Venezuelan Equine Encephalitis virus	Incubation 1 to 5 days; mortality under 1 percent; flu-like symptoms.
Toxins (Treatments for these agents includes antitoxins and supportive measures.)	*Botulim (neurotoxin)*	Incubation 24 to 72 hours; mortality can reach 60 percent; symptoms include weakness, dizziness, dry mouth and throat, and blurred vision.
	Ricin	Incubation 24 to 72 hours; untreated mortality rate can be high; symptoms include vomiting, bloody diarrhea, abdominal cramps, and difficulty breathing. Ricin is made from the castor bean plant, is readily available, and is two to three times more toxic than the most deadly nerve agent VX.
	Staphylococcus Enterotoxin B (Cytotoxin)	Incubation 4 to 6 hours; recovery is spontaneous after 6 to 8 hours; symptoms of food poisoning, including vomiting, abdominal cramps, explosive diarrhea.

Nuclear (or Radiological Material) Devices

Weapons made of **nuclear or radiological materials** can pose both an acute and long-term hazard to humans. In many ways, they behave like some of the chemical agents in that they cause cell damage. A major difference is that the radiological agents do not necessarily have to be inhaled or come in contact with the skin to do damage. Some radiation can penetrate significant layers of protective materials.

Despite what we see on the television and in the movies, producing a functional nuclear device is highly improbable and considered to be the least likely of the terrorist threats. Even devices made from medical grade radioactive materials, which are relatively easy to acquire, would be very unlikely due to the amount required to be placed in an area where people can be exposed long enough to produce an effect. Terrorists favor using radioactive materials to inflict more psychological damage versus physical casualties.

Radiation can be classified as:

- Alpha particles: Limited range and penetrating power.

- Beta particles: More range and penetrating power than alpha.

- Gamma radiation is not a particle but a ray with long-range and deep-penetrating power.

Radiation is measured in millirems and rems (1,000 millirems). For example, a chest x ray will expose you to 30 to 50 millirems (mrem) of radiation. Exposure to 200 rems will cause mild radiation sickness and 450 rems is considered a lethal dose.

A person's amount of risk depends on the amount of radiation received (dose) and the duration of the exposure. The three types of exposure are whole body exposure, inhalation, and ingestion of contaminated materials.

Alpha and beta particles are primarily an inhalation and ingestion risk involving dust and contaminated food and water. Gamma radiation is difficult to protect against, and the first responder needs to use time, distance, and shielding to limit his/her exposure.

Decontamination consists of:

- **wetting down** (tends to reduce the risk of contaminated materials becoming airborne and ingested);
- **stripping off** contaminated clothing;
- **flushing** contamination from exposed skin and hair; and
- **covering up** (to protect against exposure).

Protection against radiation exposure consists of time, distance, and shielding. PPE requirements for rescue depend on the type of radiation emitted as follows:

- Alpha particles: Wearing a self-contained breathing apparatus (SCBA) and turnout gear is sufficient.

- Beta particles: SCBA and Level A are insufficient protection for this hazard. Quick in-and-out may be the only viable rescue option.

- Gamma radiation: Limiting the duration of exposure is the only viable precaution.

Most hazardous materials teams already have detection devices and it would probably be a good idea to hold regular drills on their use and to check for the presence of radiation on any suspicious incidents.

The key elements for first responders when radioactive materials are found are to back out, and use full-protective clothing and SCBAs, and to consider time, distance, and shielding.

Explosive Devices

An **explosive device** consists of a substance or article designed to function by explosion (an extremely rapid release of gas and heat); or a substance which, by chemical reaction within itself, can function in a similar manner even if not designed to function by explosion.

It is apparent that bombs are the current weapon of choice among terrorist groups. It is estimated that 70 percent of all terrorist attacks worldwide involve explosives.

The FBI also noted three other interesting facts:

1. When public safety agencies know of the presence of a device, they have only a 20 percent chance of finding it.
2. Hundreds more "hoax" bomb threats are reported each year.
3. Residential properties are the most common targets for bombers.

Incendiary Devices

An **incendiary device** is any mechanical, electrical, or chemical device used intentionally to initiate combustion and start a fire in other materials or structures. These elements may be used alone or in simple or elaborate combinations, and come in all shapes and sizes.

Each device consists of three basic components: an igniter or fuse, a container or body, and an incendiary material or filler.

Only specially trained personnel should handle incendiary devices discovered before ignition. The handling of such devices by inexperienced individuals can result in ignition and possible injury or death. In addition, proper handling is critical for crime scene preservation.

CHEMICAL, BIOLOGICAL, RADIOLOGICAL, NUCLEAR, AND EXPLOSIVE AGENTS

CBRNE devices differ from incendiary and explosive devices in that they can employ military warfare agents as their primary ingredients and therefore are designed to injure or kill people by the hundreds or even by the thousands. CBRNE weapons also are referred to as weapons of mass destruction (WMD). The two terms are synonymous.

Experts suggest that it would be very difficult for a terrorist group to obtain and transport a military grade nuclear weapon and a program to produce a nuclear device would cost hundreds of millions of dollars. Therefore, the likelihood of their use is very small; however, radiological material, biological or chemical agents are relatively easy to obtain, and thus pose a greater threat. The materials are found in school laboratories, research facilities, and are used legitimately in industry.

Biological and chemical weapons are called, "the poor man's atomic bomb." Biological and chemical agents can be made with knowledge gained at the college level and "recipes" are available in the library or over the Internet. Some CBRNE agents are super toxic and can be 1,000 times more toxic than the normal industrial chemicals and have a very high potential to create mass casualties or fatalities.

The most effective place to use any of the terrorist agents would be in an enclosed area that is protected from the elements. Since most terrorist groups are looking for attention to further their cause or to make a statement, an enclosure with lots of people would cause more casualties and thus receive more media attention.

CBRNE agents as dust or vapors can move with the air and ventilation systems in buildings or transportation facilities can become part of the dissemination system. Once disseminated, CBRNE agents can cause major decontamination efforts, creating time-consuming and resource intensive operations that can go on for days, weeks, or even months. The potential numbers of casualties and the extent of the area involved could overwhelm even the largest of the municipal agencies.

The mere mention of the use of WMD can have a psychological impact far greater than the effects of the agent.

As an example, sarin was the chemical nerve agent used in the Tokyo subway attack that caused 12 deaths and more than 5,500 casualties (mostly psychological). It is quite likely that the figures would have been much higher if the sarin had been full strength instead of only about 25 percent pure (about 20 pounds total) and the terrorists had not botched the release of the chemical.

In its full strength, sarin is close to 200 times more toxic than chlorine and 60 times more toxic than methylisocyanate (the chemical involved in the Bhopal, India disaster).

The Bhopal, India, hazardous materials incident was a large accidental industrial release that affected 200,000 people; 10,000 were serious casualties, and there were 3,300 fatalities. It is very likely that a terrorist group could get similar results with an intentional release of an industrial agent in this country.

Limitations of Use

Despite their advantages, CBRNE agents do have drawbacks associated with their use.

Chemical weapons require gallons of agent to have a massive effect, which can be detected and can produce a handling problem. During the manufacturing process the agent may kill the producer.

Biological agents are less attractive because of their delayed effect. Much of the political benefits are lost when it becomes difficult to determine whether an outbreak of disease was the result of natural causes or a terrorist incident. Additionally, once released, a biological agent is hard to control and the terrorist cannot anticipate the impact. The biological agent has a high potential of infecting the grower.

Radiation materials are difficult to shield; thus, the container will be very heavy and difficult to transport without detection. If the terrorist reduces the shielding to improve the ease of transportation and reduce detection, he/she increases his/her potential of exposure.

Warning Signs of CBRNE Agents

Initial response personnel need to be on the lookout for warning signs and indicators of a potential terrorist incident and the presence of WMD. As mentioned earlier, always be on the lookout for a secondary device.

The first indication that there may be CBRNE agents involved will be symptoms of the agent in the victims. Chemical agents have unique symptoms that differ from other illnesses. Another indicator is the massive number of casualties all resulting from the same symptoms. These casualties may be localized or spread over a large area, such as in a rapid transit system.

You may find the actual dissemination device or low-level explosion surrounded by a cloud or vapor.

Concentrated liquid agents pose a grave risk to first responders who have not yet established the extent of the attack or that there has even been an attack.

Many victims may leave the scene prior to your arrival, carrying the contamination on their clothes and into the emergency rooms.

Chemical Agents

Chemical agents, once released, are the easiest to detect. Within minutes, the most significant sign will be the rapid onset of similar symptoms in a large group of people. Because nerve agents are so lethal, mass fatalities without signs of trauma are common. Other outward signs of chemical agent release include:

- hazardous material or lab equipment that is not relevant to the occupancy;
- exposed individuals report unusual odors or tastes;
- explosions that dispersed liquids, mist, or gases;
- explosions that seem to destroy a package only;
- unscheduled spraying of an area;
- numerous dead animals, fish, or birds;
- lack of insects;
- mass casualties without trauma;
- distinct pattern of casualties with common symptoms; and
- any one of the above in connection with government buildings, public assemblies, subway systems, etc.

Biological Agents

Biological agents will be hard, if not impossible, to detect since the agents are usually colorless and odorless, and onset of symptoms may take days or even weeks. Because of this delayed reaction the affected area and number of victims may be significant due to the migration of infected individuals. Indicators of a biological incident may include any or all of the following:

- unusual number of sick or dying people or animals;
- dissemination of unscheduled and unusual sprays, especially outdoors and/or at night; and
- abandoned spray devices with no distinct odors.

Nuclear Agents

Nuclear agents can be detected in one of two ways. One is to observe the Department of Transportation (DOT) placards and labels (located on trucks and on the outside of boxes). The other is to use the monitoring devices that most hazardous materials response teams now carry.

Dissemination Devices

There are three main devices used for dissemination of CBRNE agents.

1. **Breaking devices** are the easiest to make and use. They are constructed most often from common containers such as Thermos bottles, glass jars, balloons, light bulbs, etc. The agent is sealed in the container and simply thrown to break and disseminate the agent.

2. **Bursting/Exploding devices** are those that use explosives to break the agent container and disseminate the agent. First responders should consider the presence of a CBRNE agent at any incident where a small explosion has occurred.

3. **Spraying devices** use pressure rather than an explosion to disseminate an agent from the container. Examples include garden sprayers, crop dusters, mosquito control trucks, building ventilation systems, or water systems.

When dealing with biological agents a vector such as mosquitoes, fleas, ticks, etc., could be employed.

OPERATIONAL CONSIDERATIONS

Command Issues

A response to a possible terrorist incident should be considered as entry into a hazardous area, since deadly chemical and biological agents **may have** contaminated the area. The presence of fire and structure collapse may complicate the scene and intensify the risks.

First responders are in the habit of responding and going to work quickly when human life is at risk. As we have been trained to employ a great deal of self control in the day-to-day hazardous materials incident, the same is necessary when dealing with CBRNE agents.

Experience has shown that those incidents managed in a systematic way are the most successful. The NIMS Incident Command System (ICS) is the management system recognized by the National Fire Academy (NFA) for developing incident objectives and managing personnel and equipment at terrorist incidents.

A CBRNE terrorist incident will require the initial IC to anticipate the full expansion of the ICS. As Command is transferred, the IC will need to assign areas of responsibility to other Command Officers. The IC also needs to anticipate the expansion of Command from Single Command to Unified Command that includes multiple jurisdictions and multiple agencies. Some of these agencies may not even have been requested.

A CBRNE terrorist incident has the potential to overwhelm even the largest local response organizations.

A CBRNE terrorist incident demands immediate action from first responders if lives are to be saved and specialized help from State and Federal resources is at least several hours away.

Law Enforcement Considerations

Crime scene and evidence preservation are subjects about which hazardous materials teams and first responders already have been trained; however, acts of terrorism are Federal crimes and the interaction of local, State, and Federal agencies will be very important (because of the complexity of the situation and the public interest).

Physical evidence may be critical to connecting the terrorist to the scene. The recognition, collection, and preservation of physical evidence may be the only means to identify those responsible.

If you are involved in a terrorist incident as a first responder, law enforcement personnel most likely will want an interview. You may be required to testify in court (as to what your actions were and what you saw at the incident). It is recommended that Company and Chief Officers keep a record of their activities and observations on ICS Form 214 for this purpose. The hazardous materials group also will have the site safety plan.

Photographs and videotape should be used whenever possible to document the entire scene and before any objects are moved.

Command Considerations

The common steps to managing a major disaster that involves a terrorist act include conducting a sizeup, setting incident priorities, identifying potential incident complexity, choosing objectives, and strategies.

Potential Incident Complexities

Personnel exhaustion--working in full PPE and Level A suits is very exhausting. Consider recalling off duty personnel for crew rotation and rehabilitation and do it early.

Weather problems--contingencies for weather changes, rain, wind shift, extreme cold, extreme heat, etc.

Communications overload and inability to communicate with other agencies.

Incident stabilization while preserving the crime scene.

Airspace overload--media aircraft can make the skies dangerous and helicopter down drafts can push toxic vapor clouds.

Medical system overload and contamination--contaminated victims will self-transport to a hospital emergency room (ER) before the fire department's arrival. Consider bringing the hospital to the victim.

Objectives and Strategies

Understand scope of problem. Gather critical information about the incident. Identify the agent category as quickly as possible using available detection equipment. The quickest way will probably be by symptom recognition.

There is currently no single piece of equipment that will detect all hazardous materials, chemicals or CBRNE agents. Most of the chemical agent detectors are intended for use by soldiers in a military situation and information about their acquisition and use is now being made available.

Most of the identification work on biological agents will take place in the lab of a hospital, university, or at the Centers for Disease Control and Prevention (CDC).

Make notifications. Early notification of type and magnitude of incident to the Emergency Operations Center (EOC), hospitals and other medical facilities to warn of mass casualties and self-transported contaminated victims is critical.

Federal assets are needed to conduct low-level monitoring, detection, and identification to verify and certify the site is safe to reoccupy.

Request adequate/specialized resources. Do it early.

Develop an incident organization. To manage the incident (fully expanded ICS and Unified Command).

- Establish incident facilities as far away as possible to reduce exposure or the possibility of relocation due to wind change, Command Post, Staging, and Base, etc.
- Establish liaison with cooperating and assisting agencies.
- Fire department is responsible for detection, rescue, decontamination, triage, treatment, and transportation.
- Law enforcement is responsible for evacuation, security, and the crime scene.
- Health services and other agencies are responsible for sheltering, cleanup, and medical care (and usually final "say-so").

Personnel safety. Following the recommendations outlined below can enhance personnel safety.

- Stay upwind, uphill, and upstream.

  - A safe distance from a chemical attack is a minimum of 300 feet (hot zone).

  - Be aware of ventilation exhaust ports from the incident site such as from buildings and subways.

- Only responders wearing the proper protection should attempt victim rescue. (Decontamination procedures need to be in place and first responder operations (FRO) engine company can start.)

- Structural firefighting PPE can be compared to Occupational Safety and Health Administration (OSHA) Level C protection and will protect against inhalation exposure but only provides limited splash protection and no protection against skin absorption.

  - May provide adequate protection against airborne biological agents and some radiological materials.

- Only Level A protection is recommended for initial entry into a chemical agent hot zone until the actual agent and health risk are known. To adjust the level of protection, you need advanced detection equipment.

- Be alert for secondary devices.

- In no case should you come in contact with the victim without the proper PPE to do the job safely.

- Be alert for signs and symptoms of agent exposure among responders.

- Follow up with medical assessments (after the incident) to ensure that response personnel have not been contaminated.

Stabilize the incident. Successful stabilization of the incident involves adhering to the following guidelines.

- Isolate the area.

  - Establish hot, warm, and cold zones.

  - Give specific verbal instructions and warn people of the dangers. Maintain crowd control.

  - Walking casualties or people with possible exposure should be moved upwind, and be upgraded and segregated.

    -- Remove clothing.

    -- Set up a gross decontamination area (first).

    -- Set up a safe refuge area (second).

    -- FRO engine company then can proceed with gross decontamination.

- Within the limits of your PPE, remove nonambulatory victims and conduct rescue operations.

- Elderly and small children are more susceptible to the toxic effects and may need special attention.

- Deny entry. (Realize that you may be unsuccessful.)

    - Cordon off the area to prevent people from entering or leaving.

    - The site (and downwind hazard area) must be secured and entry restricted.

- Shelter-in-place versus evacuation. Consider:

    - Wind direction and speed.

    - Population to be moved.

    - Hospitals, schools, etc., in the path.

    - Where to evacuate to, how much time would be needed, what means of transportation would be used.

    - If the chemical agent is in the area.

Protect the environment. Runoff may need to be contained (but don't delay decontamination of victims while doing so).

Protect the crime scene. Remember that this is a crime scene and that every effort should be taken to preserve evidence that could be used to apprehend and prosecute the perpetrators later.

Develop a written plan.

Deal with the media. There will be many media representatives at this type of incident. It is important to establish a good relationship immediately. You should strive to give them accurate and timely information. It is beneficial to think of the incident as an opportunity to educate the public.

Decontamination Process

The everyday hazardous materials incident usually requires the decontamination of only a few people while CBRNE agents could require decontamination of numerous people, possibly hundreds or even thousands. The decontamination process may be the single most important and demanding task the public safety community can perform. Due to their high toxicity and fast action, CBRNE agents must be decontaminated rapidly to reduce exposure.

The challenge will be the speed with which decontamination operations must be implemented to save lives, the number of victims involved, and the limitations caused by availability of proper PPE to do the job safely.

Emergency Decontamination Considerations

Emergency decontamination considerations include the following:

- Have a plan in place. (Planning/Preaction is important!)
- Realize that time is critical.
- Communicate what you want the exposed people to do by loudspeaker/public address system ("go to gross decontamination area", etc.).
- Keep casualties away from the CBRNE device, but still in exclusion zone.
- Isolate upwind, uphill, upstream.
- Separate those with symptoms from those with no symptoms. (Ambulatory = first priority; nonambulatory = labor intensive.)
- Locate the gross decontamination area within the exclusion zone.
- Consider the need for defensive control operations (such as dikes) to contain runoff and limit the spread of contamination. Anticipate runoff to enter sewer system, streams, rivers, etc., and notify the proper authorities. (This may or may not be a problem; check with health officials or other authorities.)
- Provide emergency medical care after decontamination is completed.
- Decedents and their personnel effects will be managed by the coroner's office; however, if contaminated, bodies and items will need to go through decontamination prior to removal.

Emergency Medical Services Considerations

- Establish triage, treatment, and transportation of victims to a clean area.
- Ensure that all responders are aware of the signs and symptoms.
- Victims must go through decontamination prior to treatment.
- Wear PPE and respiratory protection.
- Drug therapy may be required to stabilize casualties.

- Develop a traffic plan (in the multicasualty incident) area and to the hospital).
  - Interface with local hospitals receiving casualties.
  - Consider mass transit to move casualties.
- After working in EMS areas, consider yourself contaminated and go through decontamination.
- Limit the number of responders exposed to victims.

Chemical Downwind Hazard Analysis

Depending on the concentration of the agent, people downwind of the release can become victims. However, just as with any hazardous materials incident, the cloud eventually will be diluted by the air to the point that it poses no further hazard.

The weather plays a major role in determining the potential for downwind contamination hazards. Just as with your everyday hazardous materials incident, wind speed, direction, temperature, and humidity are all factors that must be considered.

There are numerous references and instruments available to assist responders with technical information and plume predictions.

The "Emergency Response Guidebook" (ERG) is a reference that most first responders already use. This book helps establish the initial downwind hazard area(s). When using this reference you can follow these steps:

Step 1: Look up the chemical ID number in the blue pages. If you don't know the exact agent, or its name is not there, use the agent class.

- Nerve agents ID 2810.
- Blood agents ID 1051.
- Blister agents ID 2810.
- Choking agents ID 1076.

If unknown agent or class, use ID 2810 until more exact information is available.

Step 2: Look up ID number in green pages and read across to establish the initial isolate and protect distances. A small spill is less than 55 gallons, and a large spill is more than 55 gallons.

Step 3: On a map of the incident draw a circle, to scale, using the **isolate** distance as the radius. The center of the circle will be the center of the release site. Draw a line from the center of the circle in the direction of the wind and indicate the wind speed above the line. Then, using the **protect** distance, draw a line perpendicular to the wind direction through the center of the circle. This line represents the upwind edge of a square box, which is the **protect** distance on each side. You now have identified the potential hazard area and the toxic plume should pass somewhere within this area. You can identify the leading edge of the plume by multiplying the wind speed by the time.

Now that you have a prediction of where the hazard might exist, you can decide if you are going to evacuate or shelter in place.

Radiological and biological hazard predictions can be determined by contacting the National Response Center (NRC) for technical assistance.

COMMUNICATION INTRODUCTION

Communication equals or equates to control. The sooner you are communicating, the sooner control is in hand. The two major components of communication are speaking and listening; the latter is the harder, but the more important. As IC, insist that all persons on the fireground listen as hard and as carefully as they can.

Command presence is projected in person and by your communication style. Talking fast, shouting, or not being sure of how you want to express yourself all detract from your communication effectiveness and your command presence.

It should be standard practice to make the Command Post (CP) the center of communications. The CP is your fireground office and communications should reflect that.

- Use clear text--simple assignments to reach goals.
- Use staff for support at the CP.
- Project your command presence over the radio.
- Always be ready to accept important or priority messages.
- Remember: face-to-face communications are the most effective.
- Always listen carefully--if you do not understand, ask for clarification.
- Keep connected--communicate through the flowchart of your organization or through the functions on the fireground.

With target hazards, a larger problem may exist. Community warning systems may be needed in order for rapid evacuation or in-place sheltering, etc. This expanded responsibility could be handled by the Information Officer, coordinating and disseminating the information to the public through the media.

PLAN COMMUNICATION NEEDS FOR LOCAL TARGET HAZARDS

Know options available for central dispatch failure; some of the communications options include pager operation, voice, radio-to-radio hard-wire phones for highrise incidents, mobile communications, talk-around groups, face-to-face (the most accurate for onsite operations), cellular phone communications, and ham radio operations.

Identify communications necessary for activating mutual aid. Normally, Command requests mutual aid through central dispatch. It is important to understand the critical nature of communication needs at each target hazard. Special needs usually can be solved during the preplanning and analysis of target hazards. Prepare for 9-1-1 overload or Public Safety Answering Point (PSAP) overload.

Typically, the local phone company can switch around 9-1-1 calls to a seven-digit number. This normally means you lose your Computer-Aided Dispatch (CAD) System, mapping, and other capabilities.

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Activity 14.1

Terrorism Simulation

Purpose

To work as a team to Command a terrorism incident.

Objectives

1. Incident objectives.
2. Life safety.
3. Exposure protection.
4. Confinement.
5. Extinguishment.
6. Property conservation.
7. Establish Command Staff and functional ICS assignments.
8. Manage resources effectively.
9. Use the response sequencer in the IG to determine the arrival time for additional alarms and resources.

All nonfire department resources would take approximately 30 minutes to arrive on scene.

Directions

1. Central City Fire Department Incident Command Staff:
   a. Incident Commander (IC).
   b. IC Aide.*
   c. Operations Chief.
   d. Operations Aide.
   e. Planning Chief.

f. Logistics Chief.

g. Public Information Officer (PIO).

h. Liaison Officer.

i. Safety Officer.

*The IC Aide is not used unless there are nine students in a group. Some students may play multiple roles based on the Assignment Sheets. If there are ten in a group, a second Operations Aide will be designated.

2. All Command decisions and actions during the simulation will be recorded on the ICS forms. Entries on the ICS forms are made in response to written or visual messages or in anticipation of problems that could surface during the incident.

3. At the conclusion of the simulation exercise, all groups will participate in a debriefing facilitated by the instructors. Your group will display both ICS forms developed during the exercise. Be prepared to explain the reasons for your decisions.

4. The following will be turned in to the instructors at the conclusion of the Postincident Analysis (PIA). The Planning Section Chiefs will collect all of these from their groups, making sure that the group number and students' names are on the sheets.

a. IC: Incident Objectives.

b. The Planning Section Chief: Plan "B."

c. The Safety Officer: Safety Message.

d. Operations Aide: Actions Taken.

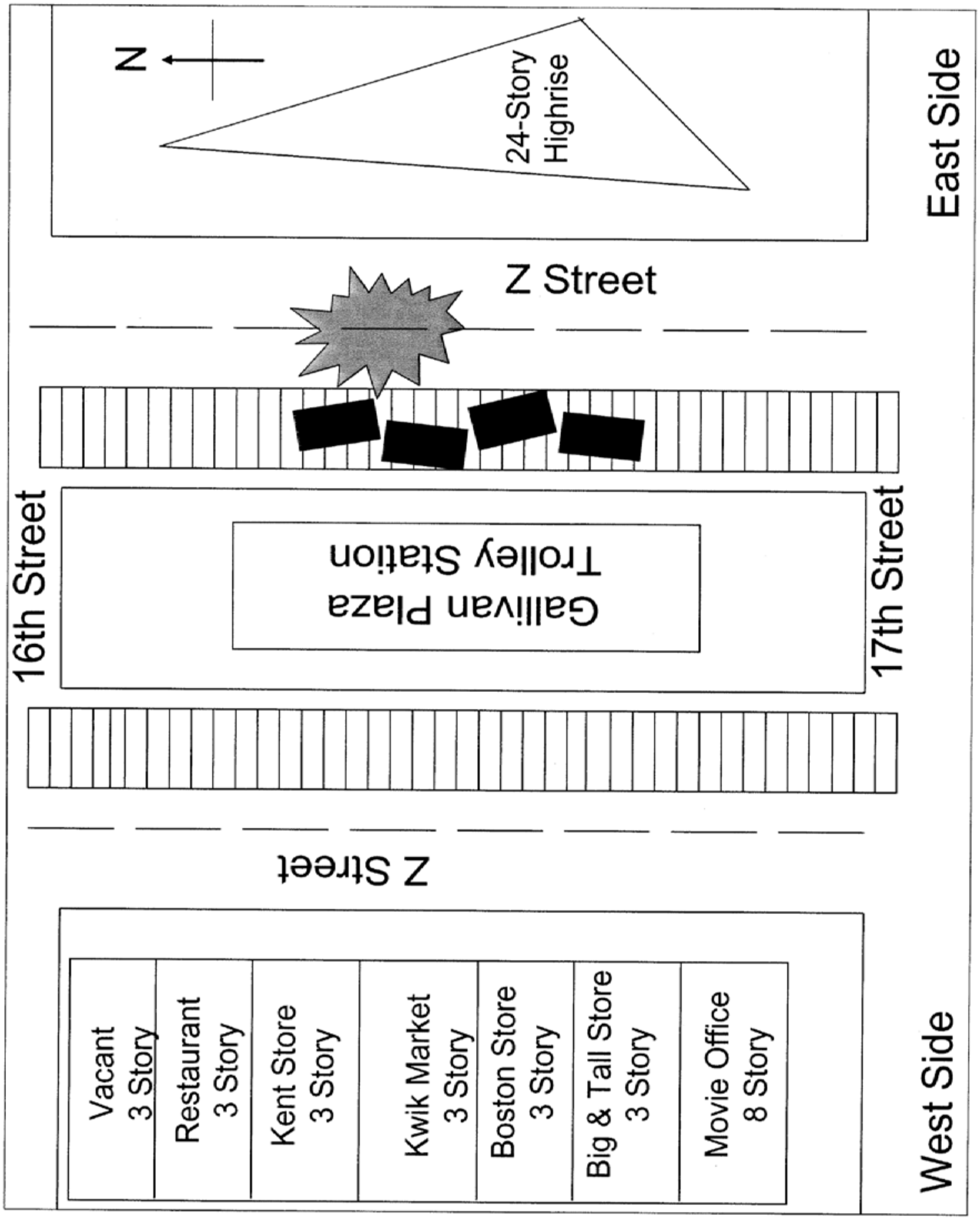
e. Logistics: Resources.

f. Liaison: Document Agencies Contacted.

g. PIO: Press Release.

Activity 14.1 (cont'd)

Plot Plan



APPENDIX
CENTRAL CITY RESOURCES

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Central City Fire Department

Staffing Levels

Normal Daily Staffing

Eleven Engine companies--Engine 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11
Engine Company--staffed with one officer/three firefighters.

Four Truck Companies--Truck 1, 3, 5, 8
Truck Company--staffed with one officer/three firefighters.

Three Rescue Companies--Rescue 3, 5, 8
Rescue Company--staffed with two firefighters.

One Squad--Squad 1--staffed with one officer/five firefighters.

Squad 1 also serves as the CCFD Hazardous Materials Unit.

Firefighters from Engine 1, Truck 1, and Squad 1 are trained to Hazardous Material Technician Level.

One Air Support Unit--Air Unit 6--staffed with one firefighter.

Two Battalions--Battalion 1--Battalion 2--staffed with two Battalion Chiefs.

One Deputy Chief--staffed with one Deputy Chief and one firefighter.

Reserve/Special Apparatus

Reserve apparatus are housed in the station that the last digit of their call number designation represents. (103 at Station 3)

Boat 2--Not staffed.

Reserve Engines--103, 105, 109--Not staffed.

Reserve Engine--104--Not staffed. 1,500 gpm Foam Pumper with 500-gallon foam tank containing 3% fluorprotein foam.

200--five-gallon cans of 3% floroprotein foam are stored at Engine 4 station.

100--five-gallon cans of universal foam are stored at Engine 4 station.

Truck 103--Reserve Truck--Fully Equipped--Not staffed.

Light Unit--Not staffed. (Engine 206)

One Air Support Unit--Staffed with one firefighter. (Engine 106)

Central City Fire Department

Response Criteria

	ENGINE	TRUCK	RESCUE	SQUAD	BC
TYPE 1--RESPONSE					
Single Family Occupancy	2	1	1	*	1

* Squad is dispatched on "all hands" working fires for Type 1 responses

	ENGINE	TRUCK	RESCUE	SQUAD	BC
TYPE 2--RESPONSE					
Multiple Family Occupancy	2	1	1	1	1
TYPE 3--RESPONSE					
Commercial Industrial Target Hazard Occupancies	3	1	1	1	1
TYPE 4--RESPONSE					
Motor Vehicle Accident Industrial Accident Water Incident	1	1	1	1	1
TYPE 5--RESPONSE					
Alarm System	1	1			
TYPE 6--RESPONSE					
Rubbish	1				
Vehicle Fire	1				
Investigation	1				
Ems Response	1		1*		

* Masked/Service Unit is dispatched on all working fires.
* Rescue Company(s) respond to EMS incidents when requested.
* Truck companies do not respond to EMS incidents.

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Central City Fire Department

Response Criteria--Target Hazards

1st Alarm Response	3 Engines 1 Truck 1 Squad 1 Ambulance	1 Rescue 1 Air Unit 1 Battalion Chief

One ALS EMS ambulance responds to all target hazard occupancies on 1st Alarm response.

2nd Alarm Response	3 Engines 1 Truck 1 Rescue	1 Battalion Chief 1 Deputy Chief

EMS ambulance response as requested. **(10 minute response time for 2nd alarm)**

3rd Alarm Response	2 Engines 1 Truck	1 Ass't Chief 1 Rescue

Ass't Chief responds to the Fire Communications Center. Fire Chief has the prerogative to respond to the incident or staff the EOC if activated. **(12 minute response time for 3rd Alarm)**

4th Alarm Response 2 Engines

Upon transmission of the 4th Alarm only one engine company and one truck company Remain in the CCFD fleet. Upon transmission of the 5th Alarm the Central City/Liberty County automatic mutual aid system is activated. Mutual Aid companies respond to the emergency incident unless otherwise directed. No automatic CCFD station coverage is provided by mutual aid. **(15 minute response time for 4th Alarm)**

5th Alarm Response 3 Engines

The first due engine companies for mutual aid would be Fisherville Engine 1, Harvest Junction Engine 2, and Kingston Engine 1, if available**. (18 minute response time for 5th Alarm)**

6th Alarm Response 3 Engines

The first due engine companies for mutual aid would be Jasper Engine 1, Bayport Engine 2, and Deep River Engine 2, if available. (**20 minute response time for 6th Alarm)**

7th Alarm Response 2 Engines

The next due engine companies for mutual aid would be Bayport Engine 3 and Kingston Engine 3, if available. **(25 minute response time for 7th Alarm)**

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Emergency Medical Services

Central City's Emergency Medical Services Ambulance units respond to all emergency medical requests within the city limits and to certain adjoining Liberty County areas who do not have an EMS system in place

EMS services come under the direction of the Liberty County Health Department with the EMS Director in command. The EMS Director's office is located at the Nelson Center, FF and 11th Streets, in Central City. The Nelson Center also contains the offices of the Liberty County Public Health Department, the Liberty County Department of Human Services, and the Liberty County Medical Examiner's office.

EMTs and Paramedics work 24-hour shifts, utilizing the same work schedule as the Central City Fire Department.

- State of Columbia ambulances are staffed by at least two Emergency Medical Technicians, of which at least one must be certified as an EMT-Defibrillator.

- The base hospital is Central City Hospital in Central City. The Medical Director is Dr. Louis Anacker.

The EMS Dispatcher will dispatch Central City ambulance units. Also, the dispatcher will be responsible for dispatching units from Fisherville, Harvest Junction, Kingston, Bayport and Apple Valley within their respective communities. The dispatcher may, under present agreement with all units in the county, dispatch or move up Fisherville, Harvest Junction, Kingston, Bayport and Apple Valley units into Central City provided there is ample coverage in those cities. Requests for mutual aid assistance from other counties into Central City should come from the Central City EMS Coordinator to the county that the request is being made of. Although mutual aid agreements are in place, nothing is automatic at time of need. Keep in mind the time elements for mutual aid units, such as preparation time, travel time to Central City, etc.

The EMS ambulance telephone number is 436-CPRU.

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Emergency Medical Services

Central City EMS Vehicles/Personnel

1. Five--BLS units staffed by 2 EMTs per shift. (Total: 36)

2. Five--ALS units staffed by 2 Paramedics per shift. (Total: 33)

3. One--EMS Supervisor unit staffed by 1 Paramedic Supervisor per shift. (Fly car)

Central City EMS Unit Assignments

Unit #	Type	Location	Address
1	Supervisor	Fire Station 1	X and 19th Streets
2	ALS	Fire Station 2	W and 12th Streets
3	BLS	Fire Station 3	EE and 4th Streets
4	ALS	Fire Station 4	F and 3rd Streets
5	BLS	Fire Station 5	F and 15th Streets
6	BLS	Fire Station 6	L and 21st Streets
7	ALS	Fire Station 7	F and 30th Streets
8	BLS	Fire Station 8	W and 30th Streets
9	ALS	Fire Station 9	CC and 37th Streets
10	BLS	Fire Station 10	HH and 23rd Streets
11	ALS	Fire Station 11	KK and 11th Streets

Reserve

Unit #	Type	Location	Address
R1	BLS	Fire Station 1	X and 19th Streets
R4	BLS	Fire Station 4	F and 3rd Streets

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